Cherry Creek Southwest Tributaries Major Drainageway Plan
Cottonwood, Lone Tree, Windmill, and Dove Creeks







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1. Executive Summary

1.1. Purpose and Objective

Wright Water Engineers, Inc. (WWE) has prepared this report to present results of an updated Major Drainageway Plan (MDP) for Cottonwood, Windmill, Lone Tree, and Dove Creeks within the jurisdiction of the Southeast Metro Stormwater Authority (SEMSWA) south of the Cherry Creek Reservoir.

This MDP addresses updated conditions since the last master planning efforts were conducted in 2010 and 2011 for the southwest tributaries to the Cherry Creek Basin. The purpose of the MDP is to address flooding, water quality, and stream health through implementation of this plan. The main objectives of the MDP are to improve the stability in each drainageway, identify opportunities for regional stormwater detention, and quantify hydrologic impacts from changing land use. The plan is being updated to reflect current hydrology (completed by WWE, 2020), incorporate regional detention improvements since the 2010 plan, and to credit runoff reduction policy implemented by SEMSWA since 2012. This MDP evaluates the Cottonwood, Lone Tree, Windmill, and Dove Creek watersheds using updated hydrology in the context of a system-wide approach to stormwater management. Because many of the regional detention pond improvements from the previous master planning efforts have been implemented, there are only a handful of roadway crossings remaining with inadequate capacity issues for the 100-year storm event. This allows for the current MDP update to focus more on higher level system function, such as retrofitting existing ponds for Excess Urban Runoff Volume (EURV). This MDP seeks to transition from stream restoration projects with large construction impacts to adaptive stream management and stream rehabilitation, where appropriate. This MDP also encourages the use of open channels as a best practice in land development and planning, even when not required by regulatory agencies.

1.2. Study Area Description

The four study watersheds shown in Figure 1 generally drain from south to north to the Cherry Creek Reservoir and include a combined area of approximately 15.0 square miles. Portions of the watersheds are located in the City of Lone Tree, unincorporated Douglas County, unincorporated Arapahoe County, the City of Centennial, the City of Greenwood Village, and Cherry Creek State Park. The majority of the study area lies within the SEMSWA service area boundary, which extends to the south just past County Line Road and north to Cherry Creek State Park (CCSP). The northern extent of the plan stops at the boundary with CCSP. Areas within the CCSP were evaluated as part of a companion study, which is included in Appendix H. The east and west boundaries of SEMSWA lie beyond the watershed extents. Unlike previous master plans, the area studied for this MDP is limited to that within the SEMSWA service area, which includes approximately 9.7 square miles of the study watersheds. Most areas outside of SEMSWA lie within Douglas County, and a 2010 Outfall Systems Plan (OSP) provides recommended projects to address the stormwater needs of the upper watershed. However, they are not prescribed under this plan as they did not undergo the alternatives assessment process for this study. These projects are included by reference, and this MDP assumes the completion of these projects and that all upstream Water Quality Control Volume (WQCV) demands have been met when flow enters the SEMSWA management area. Meeting a WQCV demand is achieved when the volume of the 80th percentile runoff producing storm event (0.6 inches of rainfall) is infiltrated or detained over the drain times specified in the Mile High Flood District's (MHFD's) Urban Storm Drainage Criteria Manual (MHFD Manual) for different types of stormwater control measures (SCMs).

Hydrology used for the MDP builds on the *Southeast Metro Stormwater Authority Cottonwood, Lone Tree, Windmill & Dove Creeks Hydrology Update* (2020 Hydrology Update) prepared for SEMSWA by WWE and published in June 2020. The 2020 Hydrology Update included updated imperviousness for current conditions, and both existing and future impervious values used in the 2020 Hydrology Update have been incorporated into the current MDP. Both Cottonwood Creek and Lone Tree Creek include Federal Emergency Management Agency (FEMA) mapped floodplains. A Letter of Map Revision (LOMR) was completed in 2022 for Cottonwood Creek based on the 2020 Hydrology Update, and the results of that study are included in the mapping for this MDP. The Environmental Protection Agency's (EPA's) Stormwater Management Model (SWMM) version 5.2.0 was used to evaluate regional detention ponds, water quality facilities, channels, and drainage infrastructure (EPA, 2023). This MDP serves as an update to information presented in the 2011 Lone Tree, Windmill, and Dove MDP and the 2010 Cottonwood Creek OSP.

The SEMSWA service area generally encompasses the City of Centennial and unincorporated Arapahoe County, with a few exceptions, as indicated in the attached Figure 2. SEMSWA is also the Municipal Separate Storm Sewer System (MS4) permit holder for the City of Centennial and areas of ownership or operation within unincorporated Arapahoe

County. SEMSWA is obligated through that permit to ensure SCMs for runoff that comply with state and permit water quality standards. In general, SEMSWA provides services related to stormwater drainage, flood control, and water quality with an approach of administration on a watershed basis. The regional detention pond and major drainageways are effectively maintained through SEMSWA's maintenance program. As a result, this MDP can propose alternatives that require simultaneous projects for functionality and intensive maintenance and monitoring.

1.3. Alternatives Analysis

The alternatives considered for this MDP were developed in response to areas of known or predicted flooding, WQCV deficits, and channel instability. Approximately 134 project alternatives were developed as a result of this study. Each alternative was assigned a score between 1-5 in each of eleven categories, with 1 being the least favorable and 5 being the most favorable. These categories, their weight, and the project scores were developed and reviewed by the MDP Sponsors and were informed by public and stakeholder feedback. Additional information on this process, including the full list of categories evaluated and a detailed description of each, can be found in Section 4 and Appendix A of this report.

1.4. Selected Plan

The selected plan proposes 66 projects total with 36 in Cottonwood Creek, 12 in Lone Tree Creek, nine in Windmill Creek, and nine in Dove Creek. This plan includes nine retrofit and one new regional detention facilities. In the four study watersheds, 4.3 miles of adaptive stream management, 1.7 miles of stream reclamation and rehabilitation, and 0.6 miles of stream restoration are proposed. Implementation priorities for these projects will be contingent on funding availability, the severity of the issue within the context of the watershed, and opportunities for collaboration with other entities.

This MDP report provides schematic maps, calculations, and cost estimates for the selected drainage improvements. This MDP considers adaptive stream management strategies in addition to larger stream reclamation and restoration projects. The intent of this approach is to provide a mechanism to address small problems before they become larger, more expensive ones.

The selected plan includes projects that address all regional WQCV deficits and localized flooding. There are three residential structures currently in the FEMA 100-year floodplain which will be addressed with the selected plan. Three non-residential areas, two wastewater treatment plants, and a golf course driving range, will remain in the floodplain. No structures will be added to the 100-year floodplain as a result of these improvements. Section 5.5 provides more discussion on structures within the floodplain.

2. Introduction

2.1. Authorization

WWE was contracted to complete this MDP by the MHFD. The agreement number is 21-12.21 10825 dated December 17, 2021.

2.2. Scope

The goal of an MDP is to assess the function of major drainageways and propose regional drainage improvements that can be implemented by municipal agencies, developers, and engineers. This MDP update has been developed to be used primarily in the SEMSWA service-area for the Lone Tree, Windmill, Cottonwood, and Dove Creek watersheds. Unlike an OSP or a FHAD, an MDP does not provide comprehensive hydraulic or floodplain modeling. Rather, it seeks to use a multifaceted approach of regional detention and drainage improvements to improve the function of the drainageway system. The original scope of this MDP update outlined the objectives in five primary tasks:

1. Evaluate current conditions including updated hydrology for these watersheds and identify areas needing stormwater improvements or refinements to previously planned improvements. Meet with MDP Sponsors and other stakeholders to identify priority areas for evaluation, including a discussion of the observed condition. A wetland subconsultant, Blair Leisure with of Iris Mitigation, will conduct fieldwork to evaluate existing wetland and riparian zones at a high level and will revisit conclusions from 2004 study by WWE.
2. Develop and select alternatives based on the findings of the field work and discussions with plan Sponsors and stakeholders including a list of potential improvement projects.

3. Evaluate selected alternatives and incorporate into the effective hydrologic models to develop a proposed conditions model. This includes evaluating the effectiveness of SEMSWA's 20-10 Rule in these watersheds as referenced in two recently completed studies (WWE, 2021) included in Appendix B. For the selected alternatives, develop all MHFD required MDP materials including cost estimates, graphics, and modeling.
4. Submit the MDP report and all required supplementary materials to SEMSWA and MHFD for review and approval. Address and respond to formal comments from the MDP Sponsors documented in Appendix E.
5. Conduct bi-weekly check-in meetings with the MDP Sponsors during alternatives development and selection. Perform stakeholder and public outreach and solicit feedback on selected alternative. Conduct a presentation providing an overview of the master plan update that can be provided to stakeholders.

During the scoping process, MDP Sponsors reviewed and modified the MHFD MDP checklist to re-allocate budget in a way that would provide deliverables that will be used by those implementing the plan. Some of the major modifications included the addition of the following:

- Adaptive stream management strategies,
- Runoff reduction crediting,
- A more detailed project history review for regional detention facilities,
- An ArcGIS Story Map of selected alternatives,
- SEMSWA-specific practices for frequent maintenance and hands-on management,
- “Fact Sheet” approach to replace text in report narrative (See Section 3.4 for additional description of this approach).

Modifications also included the elimination of:

- Detailed grading plans and profiles,
- HEC-RAS modelling of conceptual channel work, and
- Detailed cost estimates for proposed alternatives.

This scope was amended to include a more robust website development, stakeholder outreach, and public feedback process than is typical for master planning. This included the production of an ArcGIS Story Map for the selected alternatives that can be used independently of the temporary website by the client. This additional scope was reviewed and approved in August of 2022 and authorized at a SEMSWA board meeting in November 2023. The reason this authorization occurred in 2023 rather than 2022 was to wait and see whether it would be needed in case the project was able to accomplish more than what was originally scoped.

Sponsors agreed that a downstream study within CCSP could be appended to this report. The CCSP position of the plan was funded and coordinated by the Cherry Creek Basin Water Quality Authority (CCBWQA). The primary objective was to extend the hydrologic models downstream to the Cherry Creek Reservoir and to integrate those models at the confluences of Lone Tree, Windmill, and Cottonwood Creeks. Other objectives include alternatives assessments and project recommendations. Additional discussion on this project can be found in a separate narrative in Appendix H.

2.3. Planning Process

The planning process included public outreach, stakeholder meetings, and coordination with nearby municipal entities. Sponsors and participants met biweekly for 14 months during the start of the planning process through the development of project alternatives. These meetings allowed for the MDP update to be well coordinated and responsive to the needs of the users of the plan. Table 1 includes a list of these participants.

Table 1. MDP Participants

Project Participant	Affiliation
Ashley Byerley	Southeast Metro Stormwater Authority
Tiffany Clark. PE. CFM	Southeast Metro Stormwater Authority
Molly Trujillo, PE, CFM	Southeast Metro Stormwater Authority
Jessica Traynor, PE, CFM	Southeast Metro Stormwater Authority
Britni Kahler	Southeast Metro Stormwater Authority
Jim Watt, PE, CFM	Mile High Flood District
Laura Hinds, PE	Mile High Flood District
Kurt Bauer, PE, CFM	Mile High Flood District
Sue Liu, PE, CFM	Arapahoe County
Andrew Earles, Ph. D, PE, CFM, PH, D. WRE	Wright Water Engineers, Inc.
Maggie Lewis, PE	Wright Water Engineers, Inc.
Stacy Wilson	Wright Water Engineers, Inc.

For the duration of this MDP planning process, a website was maintained and made available to the public, which included the scope and background for the proposed study. As the study progressed, information and opportunities for feedback were added to the website pertinent to key meetings and milestones.

MDP stakeholders were identified from nearby municipalities and institutions that manage large portions of the study area. Prior to the development of project alternatives, two stakeholder meetings were held on September 20, 2022, and September 29, 2022, the former being a hybrid in-person meeting and the latter fully online. The objectives of these meetings were to introduce the scope of the MDP update and to identify major concerns or problem areas. The PowerPoint from this meeting was uploaded to the plan website to be made available for any interested parties who were not able to attend the meetings. An ArcGIS Story Map and a Miro Whiteboard were used during the meeting to orient attendees to the MDP and solicit feedback. A post-meeting survey was given to meeting invitees to collect more detailed information on these topics and nearby planning efforts that could impact the alternative development process. This more robust feedback process was important so that the proposed alternatives were well coordinated with nearby projects from outside entities. Attendance roster, survey results and meeting notes can be found in Appendix E.

Table 2. Plan Stakeholders

Stakeholder Contact	Organization
Cayla Cappello	City of Greenwood Village
Lauren Wiarda	Arapahoe County Airport Authority
Jacob James	City of Lone Tree
Brad Robenstein	Douglas County
David Vasquez	Shea Properties
Luis Tovar	Muller Engineering
Richard Borchardt	R2R Engineers
Dave Steinmetz	Inverness Golf Club

For the general public, a virtual outreach strategy was used to solicit feedback on the MDP. An interactive ArcGIS Story Map was developed with photographs and location information for each recommended project alternative. This gave users the ability to look up an address and view information about which projects were proposed in their neighborhood. Survey questions included a request for feedback on specific project alternatives that were being proposed. This information was distributed on social media and community posts by SEMSWA and other stakeholders, and to the attendees of the Annual Cherry Creek Watershed Conference on August 24, 2023. The map and survey were made available to the public from August to November 2023. Results for the survey can be found in Appendix E.

The recommendations presented in this study reflect the evolution of the discussions from these meetings, presentations, and feedback.

2.4. Acknowledgements

This MDP was completed in close coordination with staff from SEMSWA, MHFD, and Arapahoe County, as well as representatives from other stakeholders and interested parties. The authors of this MDP would like to acknowledge the valuable contributions of various project stakeholders and the public including, but not limited to the City of Greenwood Village, City of Centennial, Arapahoe County Airport Authority (ACAA), Inverness Water and Sanitation District, Inverness Metro District, CCBWQA, and the Inverness Golf Course. Please see Appendix H for acknowledgements of participants related to the CCSP portion of the MDP.

2.5. Mapping and Data Collection

The data collection process included mapping, hydrologic models, Geographic Information System (GIS) files, drainage reports, and floodplain studies. There was a detailed review of the recommendations and methods presented in previous master planning studies for these watersheds including the 2010 Cottonwood Creek OSP and the 2011 Lone Tree, Windmill, and Dove MDP. Table 3 below summarizes the major sources of data used in the MDP.

Table 3. Data Collected

Title	Author	Date
Southeast Metropolitan Stormwater Authority Cottonwood, Lone Tree, Windmill & Dove Creeks Hydrology Update ("Hydrology Update")	Wright Water Engineers, Inc.	June 2020
SEMSWA District-Wide Stream Assessment (Data Collection, Assessment Methods, and Technologies) ("Enginuity Stream Assessment")	Enginuity Engineering Solutions, LLC	April 2021
Cottonwood Creek Outfall Systems Plan	Muller Engineering Company, Inc.	August 2010
Lone Tree Creek, Windmill Creek, and Dove Creek – Major Drainageway Plan Conceptual Design Report	ICON Engineering, Inc.	April 2010
Lone Tree Creek, Windmill Creek, and Dove Creek – Major Drainageway Plan Conceptual Design Report – Addendum	ICON Engineering, Inc.	May 2011
Cottonwood Creek LOMR	Wright Water Engineers, Inc.	2023
ArcGIS files: Contours, Counties, Municipal Boundaries, Zoning	Denver Regional Council of Governments	2013, December 2021, January 2022, September 2023
ArcGIS files: Land Use, Open Space, Parcels, Parks, Trails, Centerlines	Douglas County	January 2022
ArcGIS files: Official Zoning	City of Centennial	January 2022
ArcGIS files: Zoning	City of Aurora	January 2022
Water Quality Control Division 2022 Stream Segmentation Data	Colorado Department of Public Health & Environment	January 2022
ArcGIS files: Flood Zones	FEMA	January 2022
ArcGIS files: Flowlines	United States Geological Survey	January 2022
ArcGIS files: Basins, Channels, CIP Projects, Control Structures, Culverts, Detention Facilities, Impervious Areas, Pipes, SEMSWA Service Area	SEMSWA	January 2022 March 2022
ArcGIS files: Assessor Parcels, Centerlines, Parks and Public Space, Trails, Zoning	Arapahoe County	January 2022
Arapahoe County, Colorado Land Development Code	Arapahoe County	August, 2019
City of Centennial Official Zoning Map	City of Centennial	September 2018
Map of Zone Districts, Douglas County	Douglas County	June 2021
City of Greenwood Village Zoning and Site Development Plans	City of Greenwood Village	April 2021
City of Lone Tree Zoning Map	City of Lone Tree	October 2018
Regulation #93 – Colorado's Section 303(D) List of Impaired Waters and Monitoring and Evaluation List	CDPHE	January 2022
Basemap Imagery	Nearmap	2023

Mapping for the 2020 Hydrology Update was completed using contours derived from LiDAR data collected in 2013 (vertical datum NAVD1988) available from Denver Regional Council of Governments (DRCOG). Since that study, new LiDAR data were made available in 2020 by DRCOG. Rather than revisit the entire study, this MDP used the 2020 contours only in areas that were added or revised since the 2020 Hydrology Update.

Data used for the MDP builds on the Hydrology Update prepared for SEMSWA by WWE and published in June 2020. The Hydrology Update includes updated rainfall data from the National Oceanic and Atmospheric Administration

(NOAA) Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 8 (Perica et al. 2013). This is the current rainfall data recommended by the MHFD in the MHFD Manual and is based on a longer period of record than the NOAA Atlas 2 data used in previous planning efforts.

This MDP and the 2020 Hydrology Update also use the Colorado Urban Hydrograph Procedure (CUHP) 2005 version 2.0.0 (UDFCD, 2016), to generate runoff hydrographs for each subbasin. This version of CUHP was the result of a recalibration by MHFD to attain better agreement between modeled and observed flows. In general, these updates resulted in a decrease in 100-year peak flow rates for the study watersheds.

Basin parameters developed for the 2020 Hydrology Update are carried over into this MDP, with a small number of subbasins updated based on contour data or at the request of SEMSWA as a result of development or a need for corrections. Except in those cases, updated information on imperviousness for current conditions largely remained unchanged from the Hydrology Update and are based on SEMSWA and DRCOG GIS data. There were several sub-basins identified as needing re-routing in these hydrologic models, which were also updated. The most significant changes in the hydrologic modeling are in regard to the additional basins in CCSP added as part of the companion study, which can be found in Appendix H.

The 2020 Hydrology Update also incorporated information on regional detention ponds, water quality facilities, and drainage infrastructure in the SWMM modeling. These updated stage-discharge curves for regional detention facilities constructed since the effective modeling are included in this MDP. More information on the methods and results of the 2020 Hydrology Update can be found in Appendix B.

Data describing stream health were obtained from Colorado Department of Public Health and the Environment (CDPHE) and the *SEMSWA District-Wide Stream Assessment* provided by Enginuity Engineering Solutions, LLC (2021) which SEMSWA previously commissioned as a study of the health of the major drainageways and tributaries within their boundary. The results of this study were used to inform the MDP regarding the condition of each channel and its outfalls. Each stream reach was evaluated for overall health (floodplain connectivity, vegetation community, nutrient indicators, etc.), geomorphic condition (erosional or depositional), and the presence and severity of headcuts (an indicator of stream longitudinal instability). Structures within the drainageway were evaluated for integrity, maintenance need, and function, including outfalls, grade control structures, and crossings. Any special points of interest along the channel were noted. This study was used to identify maintenance and repair problems, as well as conditions in the watershed contributing to channel instability or degradation. A link to the results of the analysis and the accompanying report is provided in Appendix B. The results of this study are included in the fact sheets and mapping presented in Appendix A which were used to inform the development and selection of project alternatives.

All regional facilities, channel reaches, and problem areas were field assessed for this study. Entire channel lengths were walked in areas that were not covered in the 2021 Enginuity Assessment or in areas that needed additional information for the MDP, including those in CCSP. These MDP field assessments did not perform all the quantitative analyses of the Enginuity Assessment, but were more qualitative to evaluate general stability and options for improvement, if needed. Areas included in the stream assessment were visited as needed to review alternatives or as directed by SEMSWA. Existing regional detention ponds were visited to assess functionality and need for any additional or retrofit features.

3. Study Area Description

3.1. Project Area

This plan includes the portions of the four study watersheds within the SEMSWA service area. However, because the service area boundary does deviate somewhat from the City and County limits, there are some areas of Douglas County and the City of Greenwood Village which are included. See the Watershed Map in Figure 2 for the jurisdictional boundaries and watershed area within the SEMSWA service area.

For the Cottonwood Creek mainstem, the SEMSWA service area includes all portions north of Liberty Boulevard downstream to CCSP including its Havana, Inverness Tributaries, and Peoria Tributaries. For the Airport Tributary to Cottonwood Creek, this only includes reaches north of the Douglas County line. At various portions of the watershed, Cottonwood Creek is under the jurisdiction of Colorado Parks and Wildlife (and the U.S. Army Corps of Engineers), Arapahoe County, the City of Greenwood Village, the City of Centennial, the City of Lone Tree, and Douglas County. A large portion of the stormwater in this watershed in the Cottonwood Creek watershed is

managed by SEMSWA. This plan includes nearly all of the Dove Creek and Lone Tree Creek watersheds and most of the Windmill Creek watershed.

3.2. Study Watersheds

The four study watersheds shown in Figure 2 generally drain from south to north to the Cherry Creek Reservoir through the SEMSWA service area and CCSP (which is addressed in Appendix H). The Cottonwood Creek watershed extends approximately 8.7 miles from its upstream limit in the City of Lone Tree to its downstream limit at the Cherry Creek Reservoir. The Cottonwood Creek watershed is generally 1.4 to 1.7 miles wide along most of its length. It has a drainage area of 8.1 square miles when it enters the park and 14.2 square miles when it reaches the reservoir, including the Lone Tree and Windmill Creek tributaries. The highest point in the watershed is approximately 6320 feet above Mean Sea Level (MSL). The lowest point in the project area, at the confluence with Windmill Creek, is at 5590 MSL. Cottonwood Creek drops 732 feet between these two points over a stream length of 10.0 miles, producing an average slope of 1.4% for the full watershed length. Within the CCSP, the average slope is just 0.4% in CCSP and there are a number of areas where the stream alignments were previously diverted and split. This is described in further detail in Appendix H which focuses solely on the CCSP portion.

The Lone Tree Creek, Windmill Creek, and Dove Creek watersheds are located within Arapahoe County, Douglas County, the City of Centennial, and the City of Aurora. All three creeks generally flow in a northerly direction towards Cherry Creek State Park. Lone Tree Creek is a left bank tributary to Windmill Creek, and Windmill Creek is a right bank tributary to Cottonwood Creek. Both creeks generally flow in a northerly direction toward CCSP. Dove Creek is east of Windmill Creek and flows directly to Cherry Creek, then the Cherry Creek Reservoir. In general, these watersheds are bound by Cherry Creek and CCSP to the north, Cottonwood Creek to the west, Cherry Creek to the east, and the E-470 Tollway to the south. Most of the area of these watersheds is located within the SEMSWA service area. The three watersheds encompass 5.9-square miles. Of these 5.9-square miles, 1.6-square miles are located within the Lone Tree Creek watershed; 3.3-square miles are located within the Windmill Creek watershed; and 1.0-square miles are located within the Dove Creek watershed. Elevations within the Lone Tree Creek, Windmill Creek, and Dove Creek watersheds range from approximately 5,900 to 5,600 feet MSL. Both Lone Tree and Windmill Creek have an average watershed slope inside and outside CCSP of 1.1 - 1.2%. Dove Creek has an average watershed slope of 1.6%.

Soil classifications from the Natural Resource Conservation Service (NRCS) Web Soil Survey (WSS) were determined in the 2020 Hydrology Update. The soils map from this study can be found in Appendix B. The NRCS hydrologic soil classification can be used to assess the tendency of a soil to produce runoff and is used in the EURV and CUHP calculations. The four study watersheds are dominated by type C/D soils which have low infiltration rates and produce high volumes of runoff. However, there are portions of these watersheds that include type A and B soils which produce less runoff. For this study, the percent soil classification was determined for each subbasin to calculate EURV and hydrology for storm events up to the 100-year return period, which can be found in Appendix G.

3.3. Land Use

The land use in the study area is dominated by mixed use, commercial and industrial parks. Most of the residential development can be found at the lower portions of the watersheds near CCSP in the City of Greenwood Village. A small number of parks and open space are scattered throughout, and some vacant land remains, although these areas are rapidly developing. Two significant land uses in these watersheds including several golf courses and an airport. The Centennial Airport, administered by the Arapahoe County Airport Authority (ACAA), occupies a significant portion of the upper watershed for both Lone Tree and Windmill Creeks and the eastern portion of Cottonwood Creek, including the Airport Tributary. This airport has an individual industrial water quality permit #COR900731 with monitored outfall locations within the study area. The Inverness Golf Course lies along the main stem of Cottonwood Creek and the Inverness Tributary.

Existing imperviousness was determined from SEMSWA and DRCOG GIS data. Undeveloped land was assumed to have an imperviousness of 2%.

Except for corrections or revisions requested by SEMSWA, future imperviousness was modeled to be consistent with the 2010 OSP, 2011 MDP, and 2020 Hydrology Update, as shown in Appendix G. In general, these numbers are used by agency plan review staff to determine allowable imperviousness. Master drainage reports provided for these areas since 2011 were also reviewed. The following table summarizes existing and future imperviousness for the four study watersheds.

Table 4. Watershed Imperviousness

Drainageway	Existing Imperviousness (%)	Future Imperviousness (%)
Dove	28	80
Windmill	34	69
Lone Tree	52	75
Cottonwood	39	56

A full list of existing and future imperviousness for all modeled subbasins can be found in Appendix G. The allowable imperviousness for individual parcels may vary from that of the subbasins because these numbers include imperviousness from roadway and ROW areas. A map of impervious areas is included in the 2020 Hydrology Update excerpts in Appendix B.

This MDP uses an approach which develops a "fact sheet" and map for each reach to better integrate information for the existing and future condition. It also allows for a systemic approach to discrete problem areas for which upstream and downstream factors leading to waterway degradation can be addressed. Table 5 includes a list of fact sheets and associated maps that were developed as part of the reach evaluation for this MDP.

Table 5. Fact Sheet Maps

Fact Sheet/Map	Description
Reach DR1	Dove Creek from Grasslands Drive to East Broncos Parkway
Reach DR2	Dove Creek from East Broncos Parkway to the Confluence with Cherry Creek
Reach WR1	Windmill Creek in Douglas County (upstream of SEMSWA service area and shown for informational purposes only)
Reach WR2	Windmill Creek from East County Line Road to East Broncos Parkway
Reach WR3	Windmill Creek from East Broncos Parkway to East Briarwood Avenue
Reach WR4	Windmill Creek from East Briarwood Avenue to East Maplewood Avenue
Reach WR5	Windmill Creek Pond W-9
Reach LR1	Lone Tree Creek from Pond L-1 to Tucson Way
Reach LR2	Lone Tree Creek from Tucson Way to East Arapahoe Road
Reach LR3	Lone Tree Creek from East Arapahoe Road to Cherry Creek State Park
Reach CR1	Cottonwood Creek south of Douglas County Line (upstream of SEMSWA service area and shown for informational purposes only)
Reach CR2	Cottonwood Creek from Liberty Boulevard to Inverness Way
Reach CR3	Airport Tributary to Cottonwood Creek
Reach CR4	Cottonwood Creek from Inverness Way to Carrie's Pond
Reach CR5	Cottonwood Creek from Carrie's Pond to Inverness Regional Pond
Reach CR6	Inverness Tributary to Cottonwood Creek
Reach CR7	Cottonwood Creek from Inverness Regional Pond to Lincoln Executive Center Pond
Reach CR8	Havana Tributary to Cottonwood Creek
Reach CR9	Cottonwood Creek Lincoln Executive Center Pond to Peoria Street Pond
Reach CR10	Peoria Tributary to Cottonwood Creek.

One set of fact sheets and two sets of maps (one set with all alternatives shown and one with only selected alternatives) are included in this report. Fact sheets and maps that include all the alternatives considered for this MDP are included in Appendix A and are prefixed with the letter A. Maps that include only the projects selected for this MDP are included as attachments to this report. Figures 3-7 show the index of these fact sheets and maps. Because these fact sheets include drainageway descriptions on a reach-by-reach basis, this information is not repeated in the narrative of this report and MDP users should refer to the fact sheets, as needed.

Two maps outside of the SEMSWA service area for Windmill and Cottonwood Creek, maps WR1 and CR1, are included to give context to the downstream condition. The fact sheets for those two areas do not include proposed project alternatives, as this is outside of the scope of this plan.

The first page of each fact sheet summarizes the existing reach condition, the problem areas, and their corresponding project alternatives. The existing factors evaluated include water quality, stream stability, riparian quality, WQCV, hydrology, community resources, and previously completed projects in the regional system. Existing major crossings with inadequate capacity are summarized in the following table.

Table 6. Major Crossings with Adequate Capacity Structure Inventory Table

Crossing Description	Fact Sheet	Size & Type	Constraint	Street Type	Other Information
East Peakview Avenue crossing of Lone Tree Creek	Reach LR3	14.3'x8.2' Culvert	Low roadway crossing	Local	Planning effort currently underway to improve as part of the Centennial Center Park redevelopment
South Revere Parkway crossing of unnamed western tributary to Lone Tree Creek	Reach LR2	24" RCP	Undersized segment of storm system	Arterial	Downstream storm drain system through new development should be reviewed for design constraints
Hospital access road crossing of Windmill Creek	Reach WR4	72" x 24" RCP	Low roadway crossing and undersized culvert	Local	This road is a secondary access only. The primary access on Briarwood Ave does not have issues with overtopping.
Inverness Drive East Crossing of Inverness Tributary to Cottonwood Creek	Reach CR5	2-42" and 1-36" culverts w/ riser structure	Golf Course wet pond embankment and outfall is roadway	Local	Capacity is constrained by upstream outlet structure for private wet pond in Inverness Regional Golf Course

This report also references minor crossings of these drainageways from the 2021 SEMSWA Stream Assessment (Enginuity). While addressing minor crossings is not a component of this MDP, this information can provide clues as to overall system function and is therefore shown in the attached fact sheets in Appendix A. Minor crossings include maintenance access roads, pedestrian paths, and golf course path crossings of the drainageways. A complete table of roadway crossings is included in Appendix G.

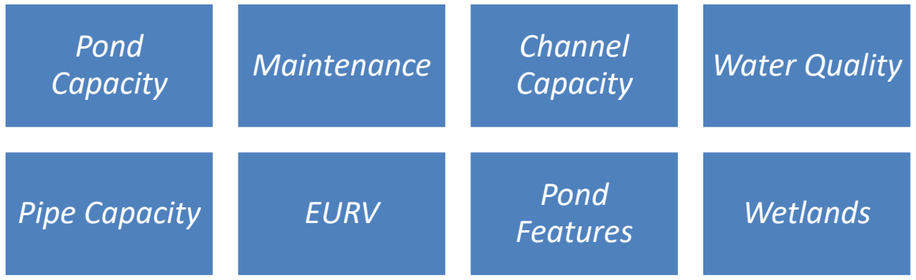
During the development of this MDP, flooding occurred in the study area in May of 2023 with reported rainfall of up to a 10-year storm event. Photos and videos of these events were provided by MHFD and SEMSWA and can be found in Appendix E. Significant damage occurred in the CCSP during this event that is further discussed in Appendix h. There was not significant roadway or structure damage reported from any other parts of the study area.

4. Alternative Analysis

4.1. Alternative Development Process

Project alternatives were developed through reviewing information from previous planning efforts, input from stakeholder entities, requests from the public, and the revised hydrologic modeling. In instances where the previous OSP or MDP proposed a project that had not yet been implemented, that was included as an alternative. The alternatives analysis developed 134 project alternatives for the study area. Potential improvement areas that were evaluated in each reach fact sheet in Appendix A are included in Table 7.

Table 7. Potential Improvement Areas



Most project alternatives addressed one or more "problem areas." Nearly all "problem areas" considered a "do nothing" alternative. The "do nothing" alternative scored well in complexity, cost, and environmental evaluation categories.

Channel projects in this MDP are addressed using a three-tiered approach intended to provide options that address the needs of the channel and have the greatest likelihood of being implemented given site and funding constraints while minimizing the environmental, ecological, and soil impacts. This plan assigns channel projects to one of the following three tiers:

1. Adaptive Stream Management
2. Stream Reclamation and Rehabilitation
3. Stream Restoration.

Adaptive stream management involves 3 to 5 years or more of monitoring and maintenance of a stream reach. When isolated areas of repair are identified, these should be addressed immediately with small-scale projects. Small problems are therefore prevented from becoming large ones over time. The adaptive stream management approach uses the natural adaptive attributes of a drainageway corridor, like mature vegetation and well-developed soil profile, to help stabilize the channel through urban development in the watershed. Projects in this tier can be accomplished within a maintenance program or a small capital improvement project. This type of project is most appropriate when it is anticipated that the existing natural stream dynamics can function well with a little help.

Stream reclamation and rehabilitation projects concern isolated areas of instability that need engineered and constructed improvements. However, these projects still do not include large-scale grading and design. These projects include isolated head cuts and isolated or small (under 5 ft) areas of bank erosion.

Stream restoration projects include engineered channel profiles, addition of multiple drop structures, and engineered channel cross sections. These projects often cost upwards of one million dollars or $1,200 per linear foot and have large construction (temporary) environmental effects on a stream reach. They are most appropriate in reaches with significant degradation and undetained runoff from nearby development.

4.2. Criteria and Constraints

MHFD and SEMSWA criteria were primarily used in developing the alternatives including WQCV and EURV volumes, runoff hydrologic parameters, pipe capacity, and channel width. EURV detention, also known as full spectrum detention, is achieved when the full range of storm events (up to the 100-year event) are detained at or below pre-development peak flow rates. Regional detention facilities are required to provide adequate storage of the 100-year storm event to allowable peak flow rates. SEMSWA Stormwater Management criteria manual does not allow overtopping for any street classification at major drainageway crossings in the 100-year event (SEMSWA, 2017). Additionally, MHFD criteria of headwater depth to culvert height ratio was referenced (MHFD, 2016). The SEMSWA and MHFD criteria are generally applied to projects that have improvements related to new and re-development. This MDP developed alternatives with the goal of preventing damage to buildings and critical infrastructure in the 100-year event. However, there is one crossing for Inverness Tributary at Inverness Drive East with an augmentation pond with such a constrained existing condition that it may not be feasible to prevent overtopping above the 25-year event and to meet the required headwater to culvert depth ratio.

Problem areas were identified by review of previous studies, consultation with SEMSWA staff, use of the Enginuity Stream Assessment, interviews with various watershed stakeholders, and site visits to areas with known or suspected issues. Alternatives were developed in coordination with plan Sponsors and a matrix developed to evaluate each project for feasibility, impact, and value. Various factors were considered in the evaluation, as outlined in sections below and the fact sheets found in Appendix A

Due to the mostly developed nature of the watersheds, opportunities for building new regional facilities are somewhat limited. Costs associated with land acquisition made some projects infeasible and were not included in the alternatives analysis.

Channel projects are often constrained by adjacent development with limited space for the stream corridor or improved access for maintenance. Additionally, mapped floodplains along Lone Tree and Cottonwood Creek and deed-restricted wetlands complicate the permitting process for some channel rehabilitation projects. For the Cottonwood Creek watershed, this included limitations to the regional detention pond discharge peak flow rates to be consistent with the effective 2023 LOMR. For the Lone Tree Creek floodplain, this did not constrain the pond retrofit outflows because the hydrology used in that floodplain delineation is based on older hydrology methods and larger flow rates.

All four study watersheds are in the Cherry Creek Reservoir watershed and subject to the provisions outlined in Regulation 72 (CRS 25-8.5-101) Cherry Creek Reservoir Control Regulation (CDPHE, 2022). This requires MS4 permit holders, such as SEMSWA and Arapahoe County, to adhere to enhanced stormwater quality protection practices in the watershed area. It also requires the CCBWQA to implement certain water quality projects in CCSP that are further discussed in Appendix H.

Centennial Airport resides within or adjacent to the upper regions of the watersheds, and compliance with FAA regulations for standing water is a significant factor in evaluating pond projects in the vicinity.

4.3. Runoff Reduction

This MDP update examines the effects of quantifying runoff reduction due to implementation of green infrastructure and the SEMSWA 20/10 Rule on the required WQCV at regional detention facilities in the study watersheds. It also applies a recent volume analysis study by WWE staff with a focus on the application of runoff reduction practices which can be found in Appendix B. Results of this study provide the basis for a "rule of thumb" to estimate runoff reduction due to the 20/10 Rule and how to credit this practice in the SEMSWA service area, as well as recommendations for incorporating this work into future studies at the watershed scale that involve quantification of the WQCV required in SEMSWA's regional facilities.

The SEMSWA Stormwater Management Manual Chapter 14 "Post Construction Stormwater Management for Development and Redevelopment Implementation Document" describes the runoff reduction and water quality requirements for projects in the SEMSWA service area (SEMSWA, 2019). Implemented by SEMSWA in 2012, the 20/10 Rule requires new and redevelopment projects that use regional WQCV facilities to provide onsite water quality pre-treatment by disconnecting 20% of new impervious area to drain to receiving pervious areas that are at least 10% of the area of the unconnected impervious area. Prior to 2012, SEMSWA did not require projects that discharged directly to regional WQCV facilities to provide pretreatment under the 20/10 Rule. After 2012, additional guidance in the interpretation of this rule concluded that onsite pretreatment must occur for all projects, including those that pipe runoff directly to regional WQCV facilities. The intention of the 20/10 Rule is to provide water quality treatment prior to discharge to major drainageways (waters of the State) that convey runoff to regional WQCV facilities to ensure that these drainageways are not adversely impacted by developed sites that drain to downstream regional WQCV facilities via the major drainageway. SEMSWA requires that this 20/10 rule be met through a runoff reduction approach known as "Minimizing Directly Connected Impervious Areas" for the site. The 20/10 Rule is met onsite by the inclusion of green infrastructure and permanent stormwater control measures including grass swales and buffers designed in accordance with the MHFD Manual's Volume 3, Fact Sheet T-0, and Section 14.5 of the SEMSWA Stormwater Management Manual. Although the 20/10 Rule uses standard runoff reduction practices, the runoff reduction due to stormwater control measures implemented to meet the 20/10 requirement historically have not been credited towards the watershed WQCV for regional facilities. This MDP update seeks to quantify the impact of the 20/10 rule by including runoff reduction practices in the quantification of WQCV demand in the four study watersheds. This MDP uses the approach described in the referenced study to quantify the reduction in WQCV afforded by runoff reduction practices.

To establish a "rule of thumb" for quantifying the impact of runoff reduction to the WQCV demand, this recent study was performed using six sample project sites within the SEMSWA service area that use regional detention facilities for water quality (WWE, 2021). In this study, WQCV runoff reduction provided was determined as a percent of the watershed WQCV. All six sites are within the Dove, Windmill, and/or Lone Tree Creek watersheds and include runoff reduction practices such as MDCIA, grass swales, and grass buffers to meet the 20/10 Rule requirements. This study found that a 7% volume reduction in WQCV due to implementation of the 20/10 Rule should be applied to impervious areas constructed in these watersheds after 2012. Excerpts from this study can be found in Appendix B.

To account for existing development at the time the 20/10 rule was implemented, historical GIS data were used to establish the effective watershed imperviousness in 2012. This was then compared to the future watershed imperviousness to quantify the increase in imperviousness under the 20/10 Rule and corresponding increase in WQCV demand during that same period. The regional WQCV demand was then reduced during the study time period by 7% to account for runoff reduction practices implemented as a result of the 20/10 Rule. The following is a table of these values for each watershed that was credited for runoff reduction.

Table 8. Watershed Runoff Reduction Table

Watershed	Percent Imperviousness in 2012 (%)	Future Planned Imperviousness (%)	Percent Runoff Reduction Based on 2012 Imperviousness (%)	Runoff Reduction (ac-ft)
Lone Tree Creek	37	75	3.3	0.8
Dove Creek	13	80	5.9	1.0
Windmill Creek	18	69	5.1	2.3

With the runoff reduction associated with the 20/10 Rule now credited towards the WQCV required in regional facilities, some of the shortfalls in the regional system for future development are addressed. This is supported by the findings of the referenced studies which are supportive of recognizing the WQCV reduction benefits of the 20/10 Rule at a regional level.

Pond volumetric or retrofit improvements were considered in cases where the total demand for WQCV or EURV exceeded the direct or cumulative volume provided. However, since the MS4 permit and system function does not allow for over-detention, proposed ponds were sized for the entire undetained tributary area and only that drainage area. Figures 8-10 include a summary of WQCV required and proposed in the study area.

The previous master plans did not provide an inventory of EURV demand at all existing and proposed facilities at a watershed scale. This MDP does include this to better assess existing facilities for retrofit. This MDP presents more opportunities for retrofit of existing ponds due to the revised hydrology methods and runoff reduction crediting. Unlike WQCV, which is required by the MS4 permit, EURV attainment on a watershed-level is not similarly regulated. However, it is considered a best practice and is required for most new development. For this MDP, the potential to attain EURV was considered in all regional facilities but was not included as a project alternative in cases where the retrofit was infeasible. For alternatives in which EURV was feasible, the stability of the downstream channel was also considered. In some instances, the channel had already been formally stabilized for an urbanized watershed and EURV improvements were not warranted.

4.4. Alternative Evaluation

Eleven categories were evaluated and scored for each project alternative considered:

1. Complexity: challenges associated with cost and timing of planning, including engineering complexity, easement and permitting requirements, and compatibility with other projects.
2. Project cost: approximation of project cost (did not include detailed estimates for each project).
3. Maintenance efficiency: consequences regarding maintenance of either completing a project or doing nothing. Primarily pertains to ease of maintenance and likelihood that adequate and routine maintenance will be performed for continued function of infrastructure.
4. Comprehensive water quality benefit: spectrum of water quality benefits not easily quantifiable or regulated such as baseflow and snowmelt.
5. WQCV and EURV provided: quantification of current and projected WQCV and EURV demand and treatment.
6. Stream Health: measure of stream degradation that will occur with or without the project, as well as improvements to stream function and stability.
7. Flood Capacity: measure of flood attenuation provided by project.
8. Public Safety: the degree to which adjacent properties are impacted by the problem or the project regarding public health, safety, and infrastructure.
9. Environmental: impact to wetland and riparian areas.
10. Public Access and Esthetics: impact to aesthetics and the accessibility of an area for enjoyment by the public (i.e., community value).
11. Feedback: extent of impact of a problem and concern expressed by staff, property owners, and the wider community.

For each category, a given project was scored between 1-5 with a higher score indicative of a more preferential project alternative. The full scoring rubric can be found in Appendix A which gives more information on how the scores were assigned and the weight of each parameter. The results of this assessment can also be found in Appendix A. Consistent with the reach fact sheets, the scoring matrix frames the alternatives in terms of “problem areas” and allowing the watershed to be assessed on a systematic basis.

5. Recommended Plan

5.1. Plan Description

There are a total of nine projects recommended with this MDP in the Dove Creek watershed, nine in the Windmill Creek watershed, 12 in the Lone Tree Creek watershed, and 36 in the Cottonwood Creek watershed, including its tributaries. The tables that follow summarize the selected project alternatives and identify the corresponding fact sheets and maps.

Table 9. Dove Creek Recommended Projects

Project ID	Fact Sheet/Map	Purpose	Description
DC1	**Reach DR1**	Retrofit Pond D-0 to reduce standing water	Improvements to Pond D-0 are proposed along this reach in **Project DC1**. Pond D-0 currently has an issue with standing water in the trickle channels and in the bottom of the pond outside of the micropool. This is of particular concern near the Centennial Airport where there are Federal Aviation Administration regulations to prevent standing water due to safety requirements in the bird strike zone. Any retrofit to the outlet structure for Pond D-0 should consider incorporating features to aid in maintaining a dry pond bottom. This could include increasing fall across the pond bottom or incorporation of the Initial Surcharge Volume (ISV) within the micropool and trickle channel design. SEMSWA is currently in progress of a minor retrofit to the outlet plate of this pond to improve drain times.
DC4	**Reach DR1**	Improve inlet capacity downstream of Pond D-0 outfall	Pond D-0 currently does not have a designated overflow path to serve the spillway, which overtops in the 10-year and 100-year storm events. There is also an existing 36" diameter RCP storm drain pipe system serving Pond D-0 which likely has a drainage easement (SEMSWA Project No. 2021-0407). **Project DC4** includes improving the Type C storm drain inlet serving the outfall of D-0 such that it can fully intercept the 100-year storm event. The current interceptive capacity is 18 cfs with the 100-year detained peak flow rate from Pond D-0 being 45 cfs at full build-out.
DC5	**Reach DR1**	Retrofit Pond D-1 to capture EURV and include sediment forebays and trickle channel	Pond D-1 improvements proposed in **Project DC5** include addition of trickle channels and sediment forebays and retrofit of the outlet structure to release the upstream EURV at appropriate discharge rates. Construction of sediment forebays could be combined with the construction of outfalls for adjacent developments which might also include modifications to pond access. The existing pond has a 100-year detention volume of 34.6 ac-ft and an excess WQCV of 4.2 ac-ft considering the entire upstream area at full build-out. This excess is due in part to credits from implementation of the SEMSWA 20-10 Rule and in part due to modifications to the WQCV calculation since the 2010 MDP. Pond D-1 is a good candidate for retrofit to detain the EURV and care should be taken in modifying the outlet structure such that there is not an increase in 100-year peak flow rates. All ponds in the Dove Creek watershed have achieved the required WQCV for the upstream contributing drainage area at full build-out. **Project DP5** proposes a retrofit Pond D-1 to capture direct EURV volume of 18.2 ac-ft.
DC6	**Reach DR1**	Larger stream restoration and channel stabilization with drop structures between Ponds D-0 and D-1 (in progress)	Design of channel stabilization for the reach between Ponds D-0 and D-1 is currently in progress as a potential phased 2024 capital improvement project and is included as **Project DC6**. A significant reduction in peak flow rates in the 2020 Hydrology Update Report should be reviewed by the design team to ensure an appropriate channel cross section is selected. Adaptive stream management strategies such as low-impact timber walls can be used in the interim as in the scenario that channel stabilization becomes a lower-priority project for implementation. It is recommended that channel design and construction work in tandem with Pond D-0 design in **Project DC1** such that appropriate hydrology is used to design the channel cross section.
DC8	**Reach DR1**	Stabilize erosion at E Otero Rd and Aurora RV (in progress)	There is an unstable flow condition on private property at Otero Road on the northwest corner of the Aurora RV large parking area where flow does not go where intended. **Project DC8** proposes a small project that would stabilize erosion in this area using grading and slope protection. This project is currently in the development phase.
DC10 and DC11	**Reach DR2**	Keep west and east tributaries as open channel with development	Two smaller unnamed tributary channels contribute flow to Dove Creek along this reach. The first is located west of Sub-Reach 1 and flows into an existing private extended detention facility before entering the main channel. The second flows parallel to and east of Sub-Reach 1 and becomes piped flow at Jordan Rd. **Project DC10** and **Project DC11** propose keeping these two tributaries as open channels with future development. While they are both under the 130-acre threshold to require an open channel, recommending these in the master plan might highlight the financial and environmental benefits of this practice. The typical section provided in Appendix F can be used to determine an appropriate conceptual corridor width.

Project ID	Fact Sheet/Map	Purpose	Description
DC12	**Reach DR2**	Perform adaptive stream management between Ponds D-1 and D-2 and keep west tributary open channel with development	Sub-Reach 1 is an undeveloped channel upstream of Pond D-2 which was proposed to have stabilization check structures with the previous MDP. This entire reach is privately owned, and **Project DC12** and future planning efforts should focus on setting aside a tract wide enough to accommodate an appropriate meander belt width for the natural sinuosity of the channel. This MDP provides a typical channel section for future development conditions in Appendix F. The stream management corridor for this reach is 175 feet which should be used to determine tract width. Currently there are no high priority degraded features in the channel. However, with future development stabilization check structures may need to be included.
DC15	**Reach DR2**	Sediment Forebay	Add a sediment forebay and maintenance access at storm drain pipe outfall to channel.

Table 10. Windmill Creek Recommended Projects

Project ID	Fact Sheet/Map	Purpose	Description
WC1	**Reach WR2**	Adaptive stream management strategies between Pond W-1/W-1 and Broncos Parkway	The channel downstream of Pond W-1/W-2 is exhibiting some erosion, while dense vegetation provides some stability. Adaptive stream management strategies are proposed with **Project WC1**. These would include repairing a moderate headcut and providing energy dissipation for channelized flow coming in laterally from the Building Materials Holding Corporation parking lot to the west of the main channel. This project would also include annual monitoring of this reach, to identify and repair any localized erosion as it occurs. A portion of the improvements are outside SEMSWA ownership on private property and would need to secure an easement or tract.
WC3	**Reach WR2**	Retrofit pond W-1/W-2 to include EURV	EURV is not currently provided at Pond W-1/W-2. **Project WC3** proposes retrofitting Pond W-1/W-2 to provide 38.7 acre-feet of EURV to address downstream channel erosion, reducing the hydrologic loading in the channel downstream. The inclusion of EURV in Pond W-1/W-2, as proposed in **Project WC3**, might reduce the risk of long-term instability and erosion in the downstream channel. The combination of **Projects WC1** and **WC3** could provide long term stability in the channel, especially when considering that much of the upstream contributing watershed has already been developed.
WC7	**Reach WR3**	Stream corridor preservation and some grade control downstream of confluence	The channel downstream of Pond W-4 has been classified as depositional (Enginuity, 2021), and the presence of wetlands within the channel is a complicating factor that makes maintenance somewhat difficult. Large-scale stream restoration was first suggested in the 2010 MDP. This alternative includes a revised channel invert and multiple drop structures designed to convey the peak flow rates from future development. Development is expected to occur soon within the properties surrounding this reach of Windmill Creek. **Project WC7** prioritizes the preservation of the riparian area with the addition of some grade control downstream of the confluence with the Pond W-5 tributary. This project includes assessing the existing channel cross section for future development since much of this area appears to be stable. However, it should be noted that much of the proposed adjacent development is planned to have a very high imperviousness at 80%. More information for a conceptual typical section can be found in Appendix F . The recommended stream corridor width from MHFD is 364 feet which should be used to determine proposed tract width. The profile provided in Appendix B from the 2010 MDP con be used for planning purposes by the SEMSWA land development review team to consolidate outfalls from the proposed development to reduce channel impacts.
WC10	**Reach WR3**	Retrofit Pond W-5 to provide EURV.	**Project WC10** proposes retrofitting Pond W-5 for 3.9 ac-ft of EURV to benefit the downstream channel and adding a concrete trickle channel to the pond bottom. The attenuation of the EURV provided by these improvements could protect the downstream channel and improve long-term stability. The downstream channel exhibits some instability and has been described as depositional (Enginuity, 2021). Pond W-5 was improved in 2010 and currently provides 2.3 ac-ft of WQCV, exceeding the future water quality demand of 1.7 ac-ft. Park redevelopment to the east side of the Pond W-5 is currently under construction including mass regrading of over 20 acres adjacent to the pond. This could cause additional wear and tear on the existing pond features which might accelerate their need for rehabilitation. Pond W-6/W-7 is located at the downstream end of this reach. Pond W-1/W-7 currently provides WQCV but not EURV.
WC14	**Reach WR3**	Energy dissipation structure and possible sediment forebay at major outfall	The channel downstream of Fremont Ave is erosional, with a loss of connectivity to the floodplain and poor vegetation. Some scour is noted at a grade control structure downstream of easter Avenue. There are also plans for additional storm system pipe outfalls from Johnson Properties north of the channel adjacent to Pond W-6/W-7. **Project WC14** includes the addition of energy dissipating structures and a sediment forebay at the outfall of a piped lateral storm system from the west.
WC15	**Reach WR3**	Restore vegetation along channel and on south side of Pond W-6/W-7	The quality of vegetation along this reach is compromised, with a riparian vegetation quantity score of only six out of ten. Revegetation along the channel and along the southern end of Pond W-6/W-7 is proposed in **Project WC15** to promote stability of the channel and improve the overall health of the riparian community along Windmill Creek. This can be combined with **Project WC14** or occur independently.

Project ID	Fact Sheet/Map	Purpose	Description
WC18	**Reach WR4**	Enlarge culvert under hospital access road	The culvert under the hospital access road off South Jordan Road north of E Arapahoe Road has some embankment instability noted (Enginuity, 2021) and overtops in the 10-year storm event. Enlarging the culvert with **Project WC18** will reduce the frequency of overtopping of the access road and the accompanying erosion of the embankment. Minor improvements were made to the pond just upstream of the culvert with the hospital project. This access road is a secondary access to the hospital and the primary access road, Briarwood Ave, is not a concern for flooding.
WC19	**Reach WR5**	Analyze storm drain system capacity	The receiving storm drain system for Pond W-9 may be undersized to convey the 100-year peak flow rate. This system has complexity that requires a more detailed assessment than an MDP can provide and should be studied separately. If needed, this project should provide design recommendations to increase system capacity. A part of the system crosses private property before entering the Cherry Creek State Park. If **Project WC20** includes modifications to the Pond W-9 outlet structure, pond volume, or if the current pond volume is found to be less than what is required by this MDP, then **Project WC20** should be completed prior to **Project WC19.**
WC20	**Reach WR5**	Retrofit Pond W-9 for safety	Pond W-9 was not included in the previous MDP in which its tributary was not classified as a major drainageway prior to entering the CCSP. Since then, SEMSWA has secured a maintenance easement to bring it into the regional detention system. This pond reportedly no longer contains the original design volume due to sedimentation. Pond should be field surveyed and current stage-storage information should be reviewed for consistency with MDP volumes including at least 4.3 acre-feet of WQCV and 11.9 acre-feet of 100-year volume. The micropool structure for Pond W-9 is tall and poses a safety hazard. The handrail is frequently stolen which further increases the risk. This project proposes a retrofit to the outlet structure to improve this risk by making the micropool shallower. If less volume is currently provided, retrofit should include volume expansion or model modification. Ideally this should be completed prior to **Project WC19** and incorporated into the hydraulic assessment of the downstream system.

Table 11. Lone Tree Creek Recommended Projects

Project ID	Fact Sheet/Map	Purpose	Description
LC2	**Reach LR1**	Sediment control of Arapahoe County material stockpile	The channel downstream of County Pond 3 is accumulating significant sediment and a minor headcut is noted where Arapahoe County Pond 3 channel drains into the mainstem of Lone Tree Creek. The most likely source of this sediment is a material stockpile and facility operations adjacent to County Pond 3. County Pond 3 currently serves a material storage facility that is operated by the Arapahoe County Public Works Department. Arapahoe County manages the material stockpile, which currently lacks any perimeter control measures. **Project LC2** proposes discussing with the County the installation of source controls around the material stockpile to reduce the contribution of sediment to the pond and downstream channel. Opportunities for improvements to the forebays of County Pond 3 should also be considered to improve the sediment removal function of the pond and reduce the sediment contribution to the downstream channel.
LC3	**Reach LR1**	Targeted drop structures along reach upstream of Pond L-2	The channel reach upstream of Pond L-2 has localized areas of instability. A 3.5-foot high headcut upstream of Broncos Parkway has been assigned a high priority for remediation by the SEMSWA District-Wide Stream Assessment project (Enginuity, 2021). The culvert crossing at Broncos Parkway has sediment blocking part of the structure. This stream reach has been classified as erosional with some routine outfall maintenance required due to cattails and accumulated sediment. The previous MDP recommended large-scale stabilization of this reach, which was considered as an alternative in this MDP update, but ultimately not selected. Given that the watershed draining to this reach of Lone Tree Creek is mostly developed and that future additions of impervious surface are not anticipated, **Project LC3** considers less invasive and less costly adaptive stream management measures. These would include targeted grade control structures to stabilize the headcut and increase energy of flow through the culvert at Broncos Pkwy, resulting in more sediment movement through the culvert and reduced accumulation. Additional grade control structures downstream of Broncos Parkway may be used to stabilize the channel and reduce erosion. These targeted structures could include discrete maintainable features, such as sediment forebays, to address upstream sediment and phosphorous loading. Much of this reach is located within SEMSWA-owned properties, the exception being the furthest upstream portion, which is owned by the ACAA.
LC6	**Reach LR1**	Retrofit Pond L-2 for WQCV	Pond L-1 East currently provides adequate WQCV for the upstream watershed. However, the current design of downstream Pond L-2 does not include WQCV. There is a cumulative WQCV deficit at Pond L-2 of 7.0 ac-ft which is resolved at downstream Pond L-3. **Project LC6** would include a retrofit of Pond L-2 to detain the WQCV. Shifting that 7.0 ac-ft of WQCV from Pond L-3 to L-2 could provide more flexibility in the retrofit design of downstream Pond L-3, which is currently experiencing significant maintenance problems. This project could also be a simple intermediate way to address the WQCV deficit while other, larger projects take longer to implement. This project could include acquisition of a tract for Pond L-2 which is currently under a dedicated easement.
LC8	Reach **LR1**	Request control measures by the ACAA to reduce phosphorous loading	This stream reach has had reports of complaints annually from the public regarding poor water quality and discoloration. This is likely due to high phosphorous loading from the Centennial Airport and may be exacerbated by high sediment loads from the nearby material storage area operated by Arapahoe County **(see Project LC2). Project LC8** includes a formal request to the ACAA for control measures to be implemented upstream to reduce phosphorous loading. This project might be implemented alongside any other capital improvement projects selected and would include a review of the current ACAA stormwater management plan and industrial permit for source controls with targeted recommendation based on downstream needs.
LC10	**Reach LR2**	Upsize storm drain pipe under Revere Parkway.	An unnamed tributary to the west of Lone Tree Creek has been piped through an area of development and the storm drain pipe needs upsizing where it crosses Revere Parkway. **Project LC10** proposes upsizing storm drain within ROW to convey the 100-year storm event.
LC12	**Reach LR2**	Conversion to soft bottom channel between Revere Parkway and Briarwood Avenue	The channel downstream of Pond L-2 is straight with a concrete low flow channel. Grade control structures are installed intermittently along the channel, and rip rap is eroding and blocking the low flow channel at several locations, which is causing some erosion of the channel due to side cutting. In addition to stabilizing the channel. **Project LC12** promotes the removal of concrete from the low flow channel as the material degrades and the gradual transition to a soft-bottom channel. **Project LC12** would include addition of concrete sediment forebays to facilitate maintenance. This project includes area along the channel which are currently under a dedicated easement.

Project ID	Fact Sheet/Map	Purpose	Description
LC15	**Reach LR2**	Improve culvert apron at East Arapahoe Road	The SEMSWA District-Wide Stream Assessment project (Enginuity, 2021) identified the culvert under Arapahoe Road as in poor condition and with an apron which exhibits cracking, piping, and undermining. This culvert and apron should be improved as part of the Arapahoe Road widening project and/or City of Centennial's trail improvement program (**Project LC15**).
LC16	**Reach LR3**	Install safety guardrail at Peakview Avenue.	The previous MDP Plan (ICON, 2010) called out the culvert at Peakview Avenue as overtopping in events as frequent as the 10-year with proposed culvert and roadway improvements that have not yet been implemented. While the addition of detention at Pond L-2, and the implementation of revised hydrology methods alleviated some of this, overtopping continues to be a concern above the 25-year storm event. A handrail was installed then removed along Peakview Ave above the culvert to avoid worsening flooding at this crossing. **Project LC16** proposes the installation of a safety guardrail above the culvert, either alone or in conjunction with other projects addressing overtopping here. This project would require a LOMR which is in progress and under review by FEMA.
LC19	**Reach LR3**	Retrofit outlet structure of Pond L-3 to reduce clogging and standing water.	Pond L-3 is currently losing capacity to sediment accumulation, extremely challenging maintenance, and a thriving cattail community. This pond contains a constructed wetland, which has presented maintenance challenges due to ponded water and lack of access to perform sediment removal and vegetation management. **Project LC19** suggests pond retrofit improvements to facilitate management of the pond vegetation and periodic removal of sediment. Opportunities to improve the features of Pond L-3 to improve maintenance access should be included in this retrofit. **Project LC19** proposes improvements to the outlet structure, such as the installation of a gate valve, that would allow the pond to be drained periodically for maintenance. **Project LC19** and **Project LC20** can be combined into one project if preferred.
LC20	**Reach LR3**	Install drain pipe for easier pumping during maintenance.	The Pond L-3 sediment forebay tends to hold water due to poor drainage from the forebay to the rest of the pond, and the crossing of a sewer line between the forebay and the rest of the pond limits options for improvements. The installation of a drain pipe above the sewer line between the pond forebay and the rest of the pond might allow for water to be pumped out of the forebay more easily for maintenance. **Project LC20** proposes the installation of a pipe above the sewer line connecting the forebay to the main pond that could be used to pump water out of the forebay to allow crews access to remove accumulated sediment.
LC25	**Reach LR3**	FHAD update for Lone Tree Creek once upstream improvements are complete.	Adjacent ACWAA facilities are in the 100-year floodplain primarily due to being constructed below the base flood elevations (BFEs) and are separated from the channel by an informal levee. **LC25** proposed a LOMR or FHAD update which is currently in progress.
LC26	**Reach LR3**	Adaptive stream management between Caley Avenue and the Cherry Creek State Park	The channel adjacent to the ACWWA is challenging to maintain and may be losing capacity. **Project LC26** proposes small-scale channel improvements to address erosion and channel capacity. Small projects in this reach could potentially be combined with efforts to more easily drain Pond L-3 for maintenance by lowering the receiving channel invert.

Table 12. Cottonwood Creek Recommended Projects

Project ID	Fact Sheet/Map	Purpose	Description
CC8	**Reach CR2**	Stream reclamation and rehabilitation with targeted grade control	The channel between Inverness Drive South and Inverness Way has been classified as "highly erosional" (Enginuity, 2021), with two major eroded grade control structures identified east of the Inverness Park sand volleyball courts. Along this reach, utilities have been exposed and bank undercutting can be seen. The 2010 OSP identified this reach as requiring moderate work. There is a shortage of detention and water quality treatment in the upstream reaches of Cottonwood Creek upstream of the SEMSWA service area that is likely contributing to channel degradation downstream. Upstream pond improvements in Douglas County would likely benefit channel stability but are not within the scope of this MDP. The most appropriate approach to addressing the erosion along this reach may depend in part on what upstream pond projects are, or are not, chosen and work in the channel itself may also improve stability. **Project CC8** proposes stream reclamation and rehabilitation with targeted bank stabilization and grade control repair to improve channel stability. Small interim projects are currently underway along this reach.
AT3	**Reach CR3**	New Airport South Pond	The previous OSP recommended outlet modifications to Meridian Northeast Pond to provide EURV for Airport Tributary. This MDP recommends that the entire upstream EURV is detained at Airport South Pond in **Project AT3**. Note that the site of Airport South Pond is located on private property and an easement or tract will be needed to complete this project.
AT5	**Reach CR3**	Adaptive stream management to repair localized erosion	The Stream Assessment Study (Enginuity, 2021) identified depositional channel along Airport Tributary. Field assessment in the SEMSWA service-area showed a well vegetated stable channel without much degradation. Upstream pond projects upstream of the study area could help to control peak flow rates and improve channel stability. Project AT5 proposes implementation of adaptive stream management strategies, as needed, to repair localized erosion. These improvements are proposed downstream of the county line to the confluence with the Cottonwood Creek mainstem. Upstream of the SEMSWA service-area there are some portions of the channel with eroded areas that could benefit from the addition of wetland vegetation to the stream bed. This is not evaluated as a formal project in this MDP due to the relatively small scale, lack of ownership, and given that it is outside of the SEMSWA service-area in Douglas County.
CC10	**Reach CR4**	Repair erosion	A culvert crossing and pond near a golf course green approximately 400 ft upstream of Inverness Drive East is undersized. **Project CC10** proposes removing this culvert and potentially converting the wet pond to an open channel at this crossing. Due to utility conflicts, the feasibility of this alternative should be determined after field survey. If an open channel is not feasible, erosion should be repaired, and armoring added in areas where flows overtop.
CC11	**Reach CR4**	Install rock at toe of dam of Unnamed Pond	The channel downstream of the unnamed wet pond in the Inverness Golf Course at the Airport Tributary confluence is erosional with locations of bank instability. Scour has been noted at the toe of the check dam of the unnamed wet pond at the Airport Tributary confluence. To address scour downstream of the Airport Tributary unnamed wet pond outfall, **Project CC11** recommends the installation of rock at the toe.
CC12	**Reach CR4**	Adaptive stream management with targeted erosion repair and infrastructure rehabilitation	The previous OSP (2010) identified this reach as requiring moderate work, The channel downstream of the pond outfall has been classified as erosional with a bank hazard index of high. It is possible that this instability can be attributed to the recently repaired outlet structure by the Inverness Golf Course for the upstream unnamed wet pond at the Airport Tributary Confluence. **Project CC12** includes adaptive stream management and targeted erosion repair. The golf course should also consider leaving a vegetative buffer along this reach by not mowing to the edge of the channel banks and incorporating into a nutrient management plan to reduce nutrient loading from fertilizers.
CC14	**Reach CR4**	Stream reclamation and rehabilitation from Inverness Drive to Carrie's Pond	**Project CC14** proposes applying targeted stream reclamation and rehabilitation of degraded areas from Inverness Drive to Carrie's Pond. These should incorporate high functioning, low maintenance stream restoration strategies with targeted grade control, bank stabilization with vegetation, and infrastructure repair.

Project ID	Fact Sheet/Map	Purpose	Description
CC17	**Reach CR4**	Culvert repair in golf course	A culvert crossing under the golf course fairway was observed as having no flow at the outlet and exhibiting cracking. It appears that upstream flow is having trouble entering the concrete culvert due to inlet elevation and bend head losses and is instead bypassing through a relic crushed metal pipe. The downstream portion of the headwall was recently repaired and there are two 200-foot-long parallel pipes crossing the golf course fairway, a 36" RCP and an 18" HDPE. The solution for this crossing may depend on a more detailed design assessment of the constraints. **Project CC17** proposes a retrofit headwall and slip-lining one or both pipes.
CC19	**Reach CR4**	Widen channel near building	Bank erosion has also been identified in the channel downstream of Inverness Drive East. **Project CC19** proposes widening the channel near the building to reduce BFEs and potentially remove the building from the floodway. The culvert immediately downstream of this project is undersized for any flood event and is used as a golf cart path crossing. This crossing should be evaluated to see if relocating or configuring it can further improve the flood condition.
CC20	**Reach CR5**	Stream reclamation and rehabilitation from Inverness Golf Course to Inverness Regional Pond	The channel downstream of Carrie's Pond exhibits evidence of instability with bank erosion index of "high" (Enginuity, 2021) and storm pipe outfalls in poor condition due to scour. **Project CC20** proposes stream reclamation and rehabilitation from the Inverness Golf Course to Inverness Regional Pond. This project would include applying grade control at targeted locations, using vegetation to stabilize the channel, possibly raising the channel invert at select locations, and rehabilitating degrading infrastructure, among other rehabilitation strategies. This project should consider any potential changes to the BFE that may impact the building in the floodplain.
CC22	**Reach CR5**	Retrofit Airport Pond 2 to include outlet structure, EURV, and forebays (2010 OSP)	The 2010 OSP for Cottonwood Creek proposed modifications to Airport Pond 2 that include the addition of a formal outlet structure, EURV, and maintainable forebays. This recommendation has been carried over into the MDP in **Project CC22**. The type of runoff from Centennial Airport may influence which features are selected for the pond and should be evaluated during the design phase. For example, if there is a high loading of phosphorous during snowmelt due to de-icing activities, the designer may elect for a soft bottom trickle channel. Since this is outside of the SEMSWA service area, this project is shown for informational purposes only.
CC23	**Reach CR5**	Widen channel near building	A building just downstream of Carrie's Pond may be in the 100-year floodplain. Any upstream project that expands the capacity of current ponds or involves the construction of new ponds should help to attenuate peak flows and potentially lower the floodplain elevation. This will likely occur upstream of the SEMSWA service area in Douglas County which will require coordination and a determination of allowable release rates for proposed ponds. Because the floodplain delineation is based on a hydrology LOMR study (WWE 2023) that used the surveyed actual, reduced volume of Meridian Flashboard Dam Pond, and given that the 2010 OSP designated a larger volume detained upstream of the SEMSWA service-area, it is even more likely that this condition is being caused by a need for detention volumes upstream, including maintained volumes. Within the SEMSWA service area, **Project CC23** proposes widening the channel in the reach near the building in the floodplain to increase capacity and lower BFEs.
IT1	**Reach CR6**	Adaptive stream management	The channel between the golf course path and the second of three golf course ponds is in overall good condition, although it is somewhat erosional and mostly straightened. **Project IT1** proposes adaptive stream management in the areas as indicated on map CR6A with monitoring and structural repair, as needed. Additionally, the golf course should consider leaving a vegetative buffer along this reach by not mowing to the edge of the channel banks.
IT2	**Reach CR6**	Remove concrete lining of channel as it erodes and install targeted grade control	The upstream reach of Inverness Tributary flows through the Inverness Golf Course. The most upstream portion, the channel between Inverness Drive West and the first of three golf course ponds, is lined with grouted boulder riprap. A drop structure is eroding, and the channel is in an overall fair and erosional condition. **Project IT2** proposes the removal of the concrete lining as it erodes and the installation of targeted grade control structures. It also proposes widening of the stream channel to a more stable naturalized stream section. This project is currently under design by the Inverness Golf Course and no further exploration of this alternative is needed in the MDP.

Project ID	Fact Sheet/Map	Purpose	Description
IT5	**Reach CR6**	Enlarge culverts under Inverness Drive East	Flow from the golf course is conveyed under Inverness Drive East by three culverts of 42”-, 42”-, and 36”-diameter. All three culverts are controlled by grated riser structures. The previous OSP identified this crossing as being in need of improvement and proposed upsizing the 36” CMP to a 48” RCP. The HEC-RAS model developed as part of the Cottonwood Creek LOMR (WWE, 2022) and 2011 FHAD identifies overtopping at this crossing with a 2- to 5-year event. There has also been some overtopping observed and reported to SEMSWA at the upstream end of this crossing. **Project IT5** similarly proposes enlarging the capacity of the culverts to accommodate the 10-year event, without overtopping by enlarging the culvert capacity of the roadway crossing by adding culvert above the normal pool of the pond. It should be noted that this inadequate capacity does not cause any buildings to be in the FEMA regulatory floodplain and is primarily due to the low freeboard between the pond riser structures and the roadway crest. Preventing overtopping at this location up to the 100-year event was deemed infeasible due to the roadway profile and upstream normal pool elevation.
IT8	**Reach CR6**	Widen channel and increase conveyance	The channel downstream of Inverness Drive East has two 90-degree bends and limited flow capacity. A nearby building, Dry Creek Surgery Center, is currently within the FEMA 100-year floodway. Upstream flood detention expansion opportunities are extremely limited and were not selected in this MDP. **Project IT8** proposes that SEMSWA secure additional property to allow for stream widening and realignment to eliminate the sharp bends. Opportunities to secure adjacent properties for the channel widening include a fire “turn-around” adjacent to the Dry Creek Surgery Center, a grassy area just north of the Tetra Tech building, and a corner of the parking lot of Pulte Mortgage.
IT9	**Reach CR6**	Adaptive stream management	As the channel moves past the roundabout at the end of Iola Street, a headcut is present and a grade control structure has been degraded by heavy erosion and instability. **Project IT9** proposes adaptive stream management along this reach with targeted repair and maintenance. The erosion along this reach is partly from vegetation falling and causing side cutting around existing drop structures which include a handful of buried cutoff walls and one grouted boulder drop.
IT10	**Reach CR6**	Development planning for riparian preservation	There is a MHFD Stream Management Corridor width for this tributary of 132 feet to the upstream limit of the mapped floodplain. This is significantly larger than the current 85-foot easement along the channel between Joliet Street and Iola Street adjacent to an undeveloped four-acre parcel. **Project IT10** proposes development planning to increase the easement and riparian area to 132 feet to include the regulatory floodway. This alternative can be incorporated into **Project IT9** to allow for greater flexibility in performing targeted repairs.
IT12	**Reach CR6**	Keep Inverness C Pond, preserve existing wetlands, and remove 1.6 AF WQCV crediting	Inverness Tributary C Pond is a wetland basin constructed in 2005 which provides a WQCV in excess of what is needed for the Inverness Tributary watershed. This pond is an offline water quality pond just upstream of the confluence with the mainstem of Cottonwood Creek. It has been retaining much more water than when it was originally constructed, based on a review of aerial imagery. According to the 2020 Hydrology Update, the future required WQCV is 6.0 AF for this watershed. Inverness Trib C Pond currently provides 7.6 AF. The excess WQCV provided brings some flexibility in assessing possible alternatives to alleviate the maintenance burden presented at Trib C Pond. **Project IT12** proposes the pond be kept, but the WQCV credit be reduced by the excess volume of 1.6 AF. The reduction in WQCV crediting would allow for some loss of pond capacity and the associated cost and environmental impacts of trying to maintain the design WQCV. This would relieve some of the cost of maintenance while still providing adequate WQCV for the upstream watershed. **Project IT12** will need to be implemented with a method to address water rights regulations.
IT14	**Reach CR6**	Modifications to inlet and outlet structure to promote drainage	The inlet to Inverness Tributary C Pond includes a high flow bypass structure which allows for only the WQCV to be directed to this pond with larger storm events discharging directly into Inverness Regional Pond. **Project IT14** proposes modifications to both the inlet and outlet structures for this pond that will improve drainage. These may have the added benefit of promoting recession of the wetland vegetation to better observe how the pond is behaving and how it may be improved, as well as make future projects easier.
CC37	**Reach CR5**	Sediment forebay	SEMSWA staff has identified a need for improved maintenance to the sediment forebay of Inverness Regional Pond. **Project CC37** proposes design alternatives be assessed and implemented in a separate detailed study.

Project ID	Fact Sheet/Map	Purpose	Description
CC24	Reach CR7	Stream reclamation and rehabilitation with targeted grade control and erosion repair	The channel downstream of East Easter Avenue is erosional with high bank erosion hazards. Some improvements to the channel were completed in 2011, including the installation of drop structures. Since those improvements, the channel has continued to exhibit some instability between the drop structures. The wetlands are reported to be deed-restricted which could complicate permitting. A maintenance path abuts the channel to the west and presents a constraint to lateral channel migration and increased sinuosity. This path cannot be moved further to the west to increase the channel corridor width because it is adjacent to private property. **Project CC24** proposes the use of smaller-scale and targeted stream reclamation strategies to mitigate channel erosion.
CC26	Reach CR7	Bank stabilization between Briarwood and Arapahoe	The channel downstream of Briarwood Ave has significant bank erosion. Two offline stormwater detention ponds, also known as the Centennial Corner ponds, are located on either side of this channel. **Project CC26** proposes smaller-scale bank stabilization strategies. This project is currently in design and no further assessment will be provided in this MDP.
CC28	Reach CR7	Scour protection at the toe of the drop structure at inflow	The 2021 Enginuity Stream Assessment study noted possible channel degradation occurring downstream of the drop structure into Lincoln Executive Center Pond. **Project CC28** proposes the addition of scour protection at the toe of the drop structure to address this erosion.
CC29	Reach CR7	New and retrofitted forebay structures	Lincoln Executive Center Pond has issues with standing water and sediment deposition. Pond maintenance is difficult, in part due to the lack of a concrete forebay at the major inflow from East Arapahoe Road. **Project CC29** proposes improvements to the pond to make maintenance easier, including the addition of more easily maintainable concrete forebay structures. Opportunities to provide temporary diversions or drains for baseflow for maintenance of these features should be explored.
HT2	Reach CR8	Increase culvert capacity under East Arapahoe Road	The 2011 Cottonwood Creek FHAD identified overtopping at the Kenton Street and East Arapahoe Road crossings. **Project HT2** proposes increasing the storm system capacity at East Arapahoe Road.
HT3	Reach CR8	Increase pipe capacity connecting channel to outfall into LEC Pond	**Project HT3** proposes increasing the pipe capacity connecting the open channel to the outfall at Lincoln Executive Center Pond. **Project HT3** would mitigate overtopping of Kenton Street and potentially change the floodplain boundary upstream where an office building currently resides in the area of shallow flooding.
HT9	Reach CR8	Retrofit Rampart Upper Pond for EURV	**Project HT9** proposed an EURV retrofit of Rampart Upper Pond, which currently provides 10-yr and 100-yr detention. **Project HT9** also includes the construction of a sediment forebay and is carried over as a recommendation from the 2010 OSP.
HT10	Reach CR8	Modify outlet of Rampart Lower Pond (2010 OSP)	**Project HT10** proposes modifications to the outlet of Rampart Lower Pond to improve drain time and ease of maintenance. Some maintenance is required along this reach. An outfall located just south of E Arapahoe Rd is fifty percent blocked and in poor condition. Sediment accumulation has partially blocked the crossing of the north reach at Havana St. **Project HT10** proposes modifications to the outlet of Rampart Lower Pond to improve drain time and ease of maintenance. Rampart Lower Pond currently provides WQCV and 100-yr detention. If **Project HT9** is completed prior to **Project HT10,** a reduction of 3.3 acre-feet in WQCV could ease volumetric requirements. This project is currently in design by Icon Engineers.
HT13	Reach CR8	Adaptive stream management between S Havana and E Arapahoe	The reach between East Arapahoe Road and South Havana Street to has some minor headcuts. **Project HT13** proposes adaptive stream management be implemented as needed along this reach.

Project ID	Fact Sheet/Map	Purpose	Description
CC30	**Reach CR9**	Adaptive stream management	The channel between Lincoln Executive Center Pond and Caley West Pond was identified in the 2010 OSP as requiring major improvements with significantly incised areas. However, these areas appear to have stabilized with upstream detention improvements with only one isolated grade control structure still needing repair. **Project CC30** recommends an adaptive stream management approach to address localized areas along the channel needing improvement.
CC32	**Reach CR9**	Adaptive stream management	The channel between Caley West Pond and Peoria Pond was also identified in the 2010 OSP as requiring major work. Field assessment performed for this MDP showed an overall stable channel with isolated areas of erosion at drop structures, indicating a need for energy dissipation at those locations. Development is ongoing along this reach and new outfalls have been proposed or constructed. **Project CC32** proposes the use of adaptive stream management strategies to target isolated sites of erosion. Only a portion of this project is in the SEMSWA service area, and remainder is in the City of Greenwood Village.
CC35	**Reach CR9**	Enlarge WQ orifices (2010 CC OSP)	The 2010 OSP recommended enlarging the water quality orifices of Peoria Street Pond in the City of Greenwood Village to shorten drain times of a 2-yr event. This recommendation is carried over in this MDP update with **Project CC35.** This MDP additionally proposes a study in baseflow to determine whether the capacity of the baseflow bypass needs to be increased. This study should incorporate the upstream Caley West Pond, which has an adjustable orifice for baseflow. Care should be taken to maintain drain times required by SEMSWA's MS4 permit. While this pond is privately-owned and downstream of the SEMSWA service-area, SEMSWA has a shared maintenance responsibility with other entities including the Homeowners Association (HOA) via an Inter-governmental Agreement (IGA), and the pond is frequently maintained. The land is currently owned by Cherry Creek Vista HOA. There is a monitoring station used by the CCBWQA for credit as a Pollution Reduction Facility (PRF). Based on SEMSWA's experience in maintaining this pond, the debris screen requires quarterly cleaning which alone does not fully address the issue of retained water.
CC36	**Reach CR9**	Install sediment forebay at Peoria Tributary outfall	Improvements to Peoria Street Pond to improve maintenance ease and access are proposed in **Project CC36**. This project includes adding a sediment forebay to the Peoria Tributary pipe outfall and the installation of an additional maintenance access road to that outfall. Based on SEMSWA's experience in maintaining this pond, there is currently a high sediment load from the Peoria Tributary and the functionality is very sensitive to the buildup of sediment and cattails.
PT1	**Reach CR10**	Stream reclamation and rehabilitation with isolated structural repair	The 2021 Stream Assessment (Enginuity) noted both erosional and depositional reaches of channel between Airport Ponds C3/C4 and Arapahoe Road. Visually, most of the channel appears to be in relatively good condition with an abundance of stabilizing mature wetland vegetation. South Suburban Parks and Recreation currently owns the easement around the channel through the Family Sports Center golf course. Three check structures are in poor condition with undercutting, cracking, and piping (Enginuity, 2021). Infrastructure along this reach is aging and in need of repair or replacement. The 2010 OSP identified this section of channel as requiring "moderate" channel work including a revised channel invert profile and nine additional drop structures. Alternatively, **Project PT1** proposes stream reclamation and rehabilitation including the isolated repair and replacement of drop structures, establishment of better vegetative buffers, and addition of isolated structures to stabilize flow, as needed. Based on overall good channel condition and recent upstream detention improvements upstream, larger-scale stream work such as what was proposed in the 2010 OSP was not considered for this reach.
PT3	**Reach CR10**	Adaptive stream management and development planning	The channel downstream of East Arapahoe Road is piped until after the crossing of Peakview Ave and Peoria Street where it outfalls into open channel. The channel here is erosional, and the surrounding watershed is projected to have future development. **Project PT3** recommends adaptive stream management be used to address localized erosion in conjunction with a comprehensive plan for the coordinated placement of outfalls as development progresses. The consolidation of outfalls along the Peoria Tributary will reduce maintenance needs over time.

Conceptual design information for the proposed improvements, including the MHFD-Detention spreadsheet calculations for stage-storage discharge curves, can be found in Appendix F. There are some cases where this information is not included for recommended projects which are in progress or planned to be completed by others.

The capacity of each facility was assessed with the most current hydrology. Each watershed was also evaluated for potential buildings residing within the 100-year floodplain, or the area inundated by stormwater from the 100-year event. The previous MDP and OSP were reviewed to identify crossings with inadequate conveyance capacities and anticipated overtopping during specified storm events. Comments from SEMSWA personnel were also used to identify areas of potential flooding or inadequate drainage. All regional detention facilities provide 100-year detention to allowable release peak flow rates. The following table summarizes additional detention volumes proposed in each watershed:

Table 13. Recommended Water Quality and Detention Pond Improvements Summary

Watershed	Number New and Retrofit EURV Facilities	Number New and Retrofit WQCV Facilities	Description	Retrofit Volume[1] (acre-feet)
Dove	1	0	EURV retrofit for Pond D-1	20.8
Windmill	2	1	EURV retrofit for Ponds W-1/W-2 and W-6/W-7; WQCV retrofit for Pond W-9	46.9
Lone Tree	0	1	Add WQCV to L-2 and reduce crediting in L-3	-1.6[2]
Cottonwood	3	1	Add EURV to Rampart Upper and Airport South. Reduce some WQCV crediting in Rampart Lower and Inverness Trib C Pond.	23.6

(1) See table in Appendix F for full runoff reduction, WQCV, and EURV calculations.
(2) This is a reduction in the crediting only and not a physical reduction in pond size.

In addition to the assessed need and capacity for water quality in each basin, the functionality of water quality and detention facilities was evaluated. Facilities that provide detention but are not currently fitted for WQCV or EURV were evaluated as potential locations for adding WQCV to meet the watershed's requirements for water quality treatment.

The following table is a list of proposed pond volume improvements with this MDP:

Table 14. Summary of Pond Volume Improvements

Pond Name	Current WQCV Provided (ac-ft)	Proposed Additional WQCV Provided (ac-ft)	Proposed Additional EURV Provided (ac-ft)
L-2	0.0	7.0	-
L-3	20.2	-7.7[1]	-
Airport South	0.0	6.2	17.6
Rampart Upper	0.0	3.3	7.6
Rampart Lower	3.8	-3.3	0.0
Inverness Trib C	7.6	-1.6[1]	-
W-1/W-2	16.3	0.0	38.7
W-6/W-7	23.1	0.0	3.9
W-9	0.0	4.3	0.0
D-1	9.8	0.0	20.8

(1) This is a reduction in the crediting only, and not a physical reduction in pond size.

In Tables 9 and 10, negative proposed volumes are indicated in cases where an existing maintenance challenge has made it cost prohibitive to continue maintaining the feature at the design WQCV. Rather than maintain the volume of the original pond design, this MDP proposes reducing WQCV crediting in these cases such that the lower stages of the existing wetland ponds can remain in place. This will not result in a physical change to these ponds, but the

amount of the WQCV that is claimed for these ponds will be reduced to the extent it is provided elsewhere. This MDP provides a cumulative WQCV adequate for all future imperviousness in the four study watersheds.

The following table is a list of proposed channel improvements with this MDP:

Table 15. Summary of Channel Improvements

Reach	Project Number	Tier	Description
LR1	LC3	Stream Reclamation and Rehabilitation	County Pond 3 to Pond L-2
LR2	LC12	Stream Reclamation and Rehabilitation	Pond L-2 to East Arapahoe Road
LR3	LC26	Adaptive Stream Management	Pond L-3 to Cherry Creek State Park
DR1	DC6	Stream Restoration	Otero Avenue to Pond D-1
DR2	DC12	Adaptive Stream Management	Pond D-1 to Pond D-2
WR2	WC1	Adaptive Stream Management	Airport property to Pond W-1
WR3	WC15	Adaptive Stream Management	Fremont Avenue to Pond W-6/W-7
CR2	CC8	Stream Reclamation and Rehabilitation	Inverness Drive South to Inverness Way
CR3	AT5	Adaptive Stream Management	Airport tributary from the Centennial Airport to the main stem of Cottonwood Creek
CR4	CC12	Adaptive Stream Management	Airport tributary to Inverness Drive
CR4	CC17	Stream Reclamation and Rehabilitation	Inverness Drive to Carrie's Pond
CR5	CC20	Stream Reclamation and Rehabilitation	Carrie's Pond to Inverness Regional Pond
CR6	IT1	Adaptive Stream Management	Inverness Tributary from Inverness Golf Course to Inverness Main Street
CR6	IT8	Stream Restoration	Inverness Tributary from Inverness Properties Wet Pond to Dry Creek Medical Center
CR6	IT9	Adaptive Stream Management	Inverness Tributary from Dry Creek Medical Center to Joilet Street
CR7	CC24	Stream Reclamation and Rehabilitation	Easter Avenue to Briarwood Avenue
CR8	HT13	Adaptive Stream Management	Havana Street to Briarwood Avenue
CR9	CC30	Adaptive Stream Management	Peakview Avenue to Caley West Street
CR9	CC32	Adaptive Stream Management	Caley Avenue to Peoria Street Pond
CR10	PT1	Stream Reclamation and Rehabilitation	Airport Pond C3/C4 to East Arapahoe Road
CR10	PT3	Adaptive Stream Management	Peakview Avenue to Peoria Street

5.2. Selected Alternative Costs

For stream stabilization projects, information from UD-MP Cost was considered with recently acquired bid data provided by SEMSWA to determine an appropriate cost per linear foot based on the project type. Detailed cost estimate information can be found in Appendix F.

Limitations for these cost estimates include unpredictable construction costs, inflation, transitioning federal wetland permitting systems, and the conceptual nature of these projects inherent in master planning. A separate, more detailed cost estimate should be performed for all projects prior to implementation. The cost estimates in this MDP include a 25% contingency. For MDP projects, typically an easement or tract is dedicated to SEMSWA as a component of the plan review process. Due to this, right-of-way acquisition is not anticipated for any of the proposed projects and is not included in the cost estimates.

Maintenance costs were not evaluated on a project-by-project basis as a part of this MDP except in instances where intensive maintenance was used as a component of the project. This decision was made with SEMSWA in part due to historic inflation and operations costs causing multi-year projections to be much less useful.

5.3. Water Quality Impacts

The recommended plan incorporates WQCV treatment for all areas within the study area draining to an existing or proposed regional WQCV facility. For existing detention facilities that do not already provide WQCV treatment, downstream ponds were used in some cases to treat the cumulative volume deficit.

EURV is proposed for five additional and retrofit facilities, bringing the total drainage area receiving full spectrum detention to approximately 4,000 acres or 30% of the study area, up from 20% of the study area. EURV is credited when the full spectrum of storm events and EURV volume is detained for the WQCV treatment area. For an EURV retrofit, the WQCV drain time should be verified as modifications to the outlet structure may change this. All projects that propose EURV retrofit include 100-year detention.

One component of water quality that is often overlooked in stormwater planning is the inherent value of naturalized waterways and mature riparian and wetland areas. The contribution to overall water quality is difficult to quantify and therefore often ignored. This MDP includes these beneficial natural or naturalized systems in the evaluation of comprehensive water quality impacts. There are several projects that remove concrete channel lining and provide for wider riparian corridors than what was previously planned.

5.4. Environmental and Safety Impacts

Public safety was the highest-ranking weighting factor in the alternatives analysis composing 13% of the total score. All problem areas that were identified as a threat to public safety were used to select a corresponding project alternative.

The recommended plan seeks to minimize unnecessary construction environmental impacts by providing additional options for stormwater management on a regional scale. These additional options, such as adaptive stream management, were developed to reduce construction and permanent impacts to wetlands and mature riparian vegetation. Reduced construction impacts prevent soil loss and sedimentation downstream and maintain habitat for wildlife that can be pushed out from noise associated with construction activities. A discussion of wetlands considerations for the selected plan can be found in the study by Iris Mitigation in Appendix D.

5.5. Hydrology and Hydraulics

A MHFD-Detention routing spreadsheet was developed for all new or retrofit ponds in the study area to have a somewhat refined stage-discharge curve for use in the SWMM model. However, all stage-discharge curves used are conceptual and not necessarily to be used for design. The hydrologic routing performed in these spreadsheets sometimes used upstream inflow hydrographs from SWMM when an online pond configuration necessitated this. Revised stage-discharge and stage-storage curves can be found in Appendix F. Most retrofit ponds did not have revisions to the stage-storage curve. Only Airport South Pond and Pond L-2 use stage-storage curves based on conceptual grading. Conceptual grading figures for applicable projects from previous master planning efforts can be found in Appendix B.

Subbasin parameters used in the MHFD-Detention spreadsheet and CUHP are mostly unchanged from the 2020 Hydrology Update Report, except in circumstances where corrections were warranted. A table of new basin parameters can be found in Appendix G.

Runoff reduction crediting was used to achieve the WQCV in a few existing facilities that have lost capacity over time due to sedimentation. For example, wetland detention areas can pose challenges with maintenance due to complex permitting and dewatering during construction. The crediting of runoff reduction allowed for less required volume to be maintained in some basins which preserved existing wetlands and lowered plan costs.

Due to the implementation of many regional facilities projects designated in the previous MDP, most of the roadway crossings in the study have adequate capacity, with exceptions described in Section 3.4. Alternatives were selected that address all of the capacity issues highlighted in that table. There are a few instances in which site constraints will limit the improvement's capacity and overtopping may continue to occur in the 100-year flood event. These should be evaluated during detailed design, and improvements should target conveyance of the 100-year event. To

evaluate crossing capacity, existing truncated HEC-RAS models were used, where available, as well as the Federal Highway Administration (FHWA) HY-8 software.

With the implementation of the recommended plan, four structures in the FEMA 100-year floodplain might be removed. Since all three of those projects involve detailed hydraulics involving channel widening and reconfiguration, the feasibility of removal based on surveyed lowest adjacent grade should be revaluated prior to design. There are two areas that include structures that would remain in the 100-year floodplain. One is a wastewater treatment plant which would require building floodproofing which is outside of the scope of SEMSWA services. Wastewater treatment plants are often commonly constructed within the mapped floodplain due to these facilities needing to be close to the waters they are discharging to. The other structure remaining in the floodplain is associated with the driving range for the Family Sports Center Golf Course which would be unoccupied in a flood event. SEMSWA determined that removing these two structures from the floodplain would not be included in this MDP.

Typical sections were developed for two stream restoration projects and are provided in Appendix F. These sections are based on channel criteria in the MHFD Manual for velocity, shear, and geometry. They are conceptual and should only be used for planning purposes in terms of obtaining enough land to complete the project. For some reaches the MHFD stream management corridor has been determined which should be used to determine tract width during planning.

5.6. Retrofit Options for Existing Regional Ponds

The retrofit of existing facilities was an important consideration in this planning process, especially given how many existing facilities in the study area were originally constructed over 10-20 years ago. This plan recommends the retrofit of eight regional detention pond facilities. Many of the selected pond retrofit projects will provide detention for a larger range of storm events or EURV. In many cases the opportunity for a retrofit comes from the revised hydrology methods applied to these areas (WWE, 2020). In general, if the revised hydrology led to reduced peak flow rates for storm flood events, a regional detention pond is likely able to accommodate a retrofit to detain the EURV within its existing footprint. Methods to retrofit existing ponds include, but are not limited to, orifice plate modification, secondary embankments, restrictor plates, and raising the tops of riser structures.

One common challenge in the implementation of MDPs is their use during the design process. During design, engineers should always revisit the assumptions used in this report and hydrologic modeling. This includes subbasin parameters, imperviousness, stage-storage curves, and rating curves. Rather than assume any reported volumes in this MDP are final, the design engineer must revisit routed hydrographs with their proposed grading plan. The use of detained volumes reported from SWMM in this MDP are to be used only as a starting point in design. Often the final designed detained volumes vary from those reported in an MDP due to factors related to detailed grading and the shape of the stage-storage curve.

Stage-discharge curve development for pond retrofits is also an important consideration, especially at greater flood depths. It is important for design engineers to consider the transition of a riser box opening from weir to orifice flow, as well as the clogging from debris of those openings. This transition is sometimes difficult to quantify based on the current available literature, and portions of the 2020 Hydrology Update address corrections to discharge curves provided in the drainage reports for previously retrofitted regional detention ponds. The 2020 report references several sources for guidance on how to develop this relationship for an existing constructed riser box in the mapped FEMA floodplain. However, given the uncertainty in those calculations, it is advised that the riser box for all pond retrofits be oversized such that the outlet pipe and restrictor plate are controlling the peak flow released from the facility, consistent with MHFD guidance (UDFCD, 2017).

Baseflow is often another characteristic in regional planning that requires careful consideration. Baseflow can fluctuate over time and is susceptible to variations in climate, land use, and groundwater. The objective of regional detention ponds to bypass base flow can be challenging when the major drainageway flows through the detention facility, as is common in these four watersheds. This configuration requires that an orifice or bypass be provided that is sized to pass the base flow undetained and detain the runoff volumes of larger storm events and the WQCV. Given the challenges in predicting baseflow, a number of retrofit projects in this MDP propose modification of the baseflow bypass orifice to include an adjustable plate in anticipation of future climatic and other trends that are challenging to predict and design for.

5.7. Prioritization and Phasing

In general, the alternatives selection matrix can be referenced in terms of relative priority of implementation. However, there are a few projects that require an upstream project to be first completed, as noted in the project description. For example, the Pond L-2 WQCV retrofit should be performed prior to reducing volumetric crediting and maintenance requirements on Pond L-3. SEMSWA has an ongoing capital improvement program project prioritization process that tracks changes to implementation priorities as they arise. This system is more responsive to the needs of a developing watershed and should be used as the primary decision-making process with the MDP. The methods developed in this study to rank project alternatives can be used to inform SEMSWA's prioritization process. However, the timeline of implementation for selected alternatives will be contingent on funding availability, adjacent site development, and opportunities for collaboration with other entities.

A legal opinion was solicited by the MHFD for the selected alternatives which can be found in Appendix C.

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FIGURES

Figure 1 Vicinity Map

Figure 2 Watershed Map

Figure 3 Dove Creek Index Map

Figure 4 Windmill Creek Index Map

Figure 5 Lone Tree Creek Index Map

Figures 6-7 Cottonwood Creek Index Maps

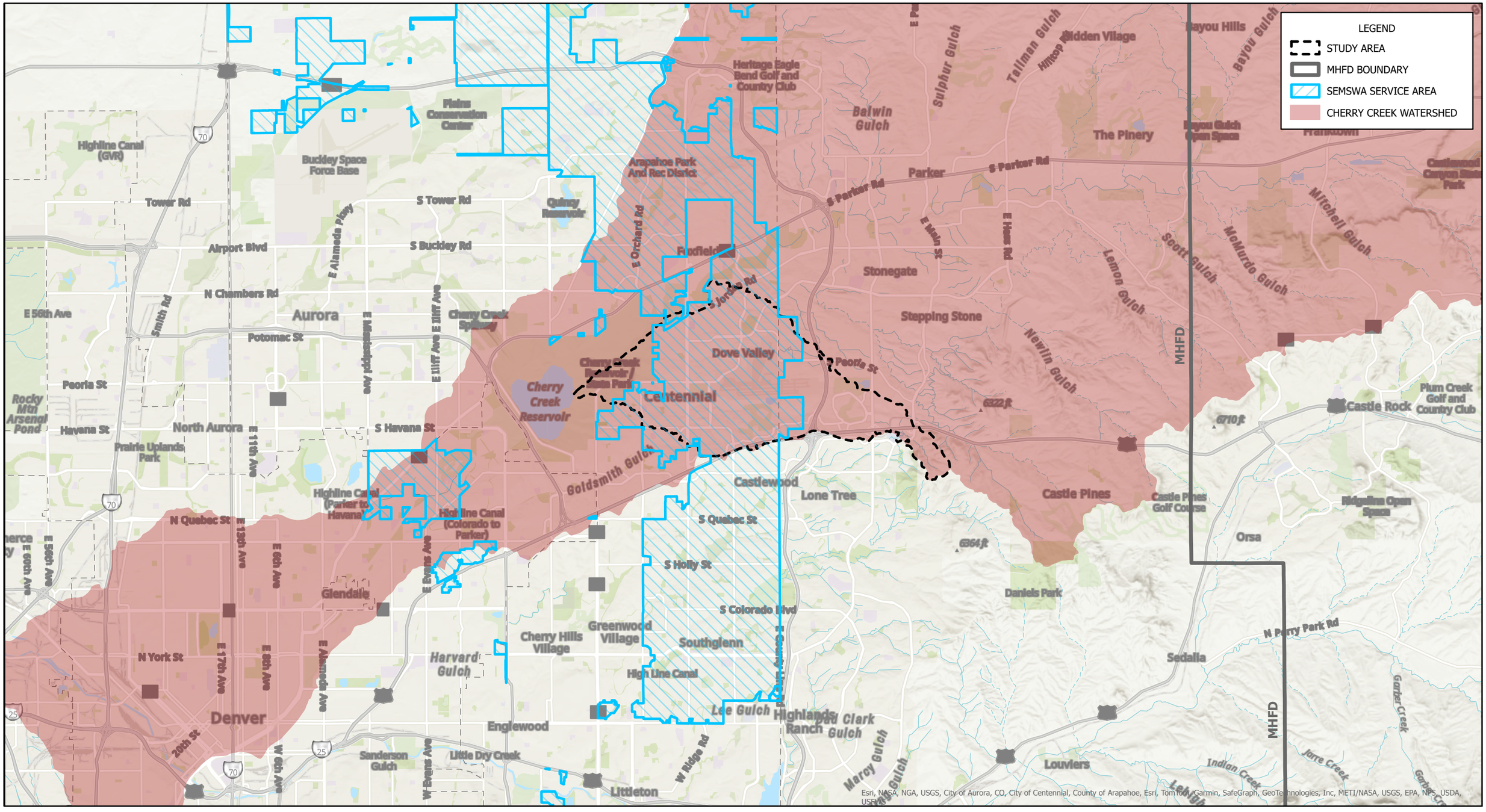
Figures 8-10 WQCV and 100-Year Peak Discharges

Figures DR1-DR2 Dove Creek Selected Alternatives

Figures WR1-WR5 Windmill Creek Selected Alternatives

Figures LR1-LR3 Lone Tree Creek Selected Alternatives

Figures CR1-CR10 Cottonwood Creek Selected Alternatives



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DATE: 03.11/2024

VICINITY MAP
COTTONWOOD, LONE TREE, WINDMILL, AND DOVE CREEKS

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

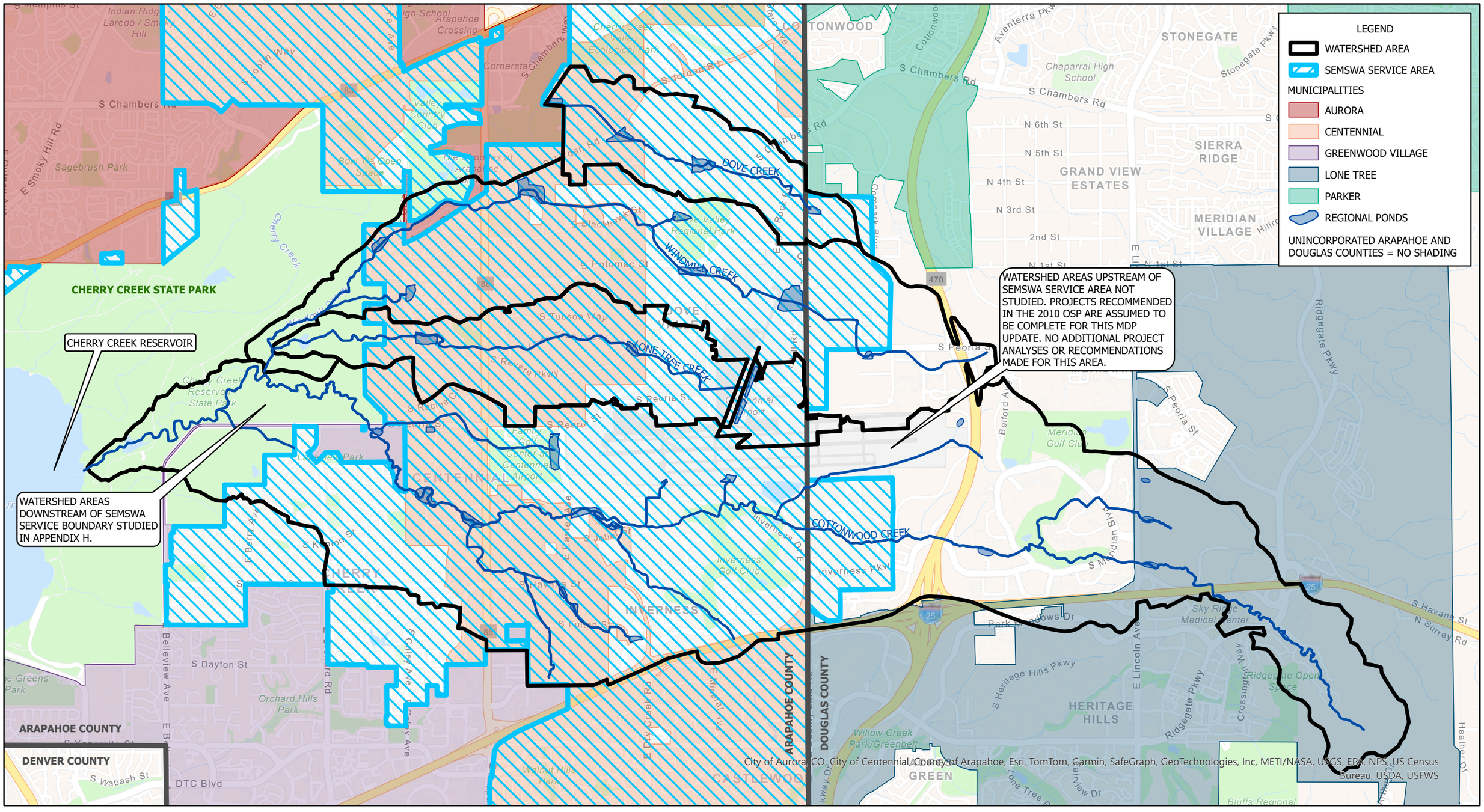
1 in = 2.0 mi

0 1 2

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE 1



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DATE: 3/11/2024

WATERSHED MAP

COTTONWOOD, LONE TREE, WINDMILL, AND DOVE CREEKS

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

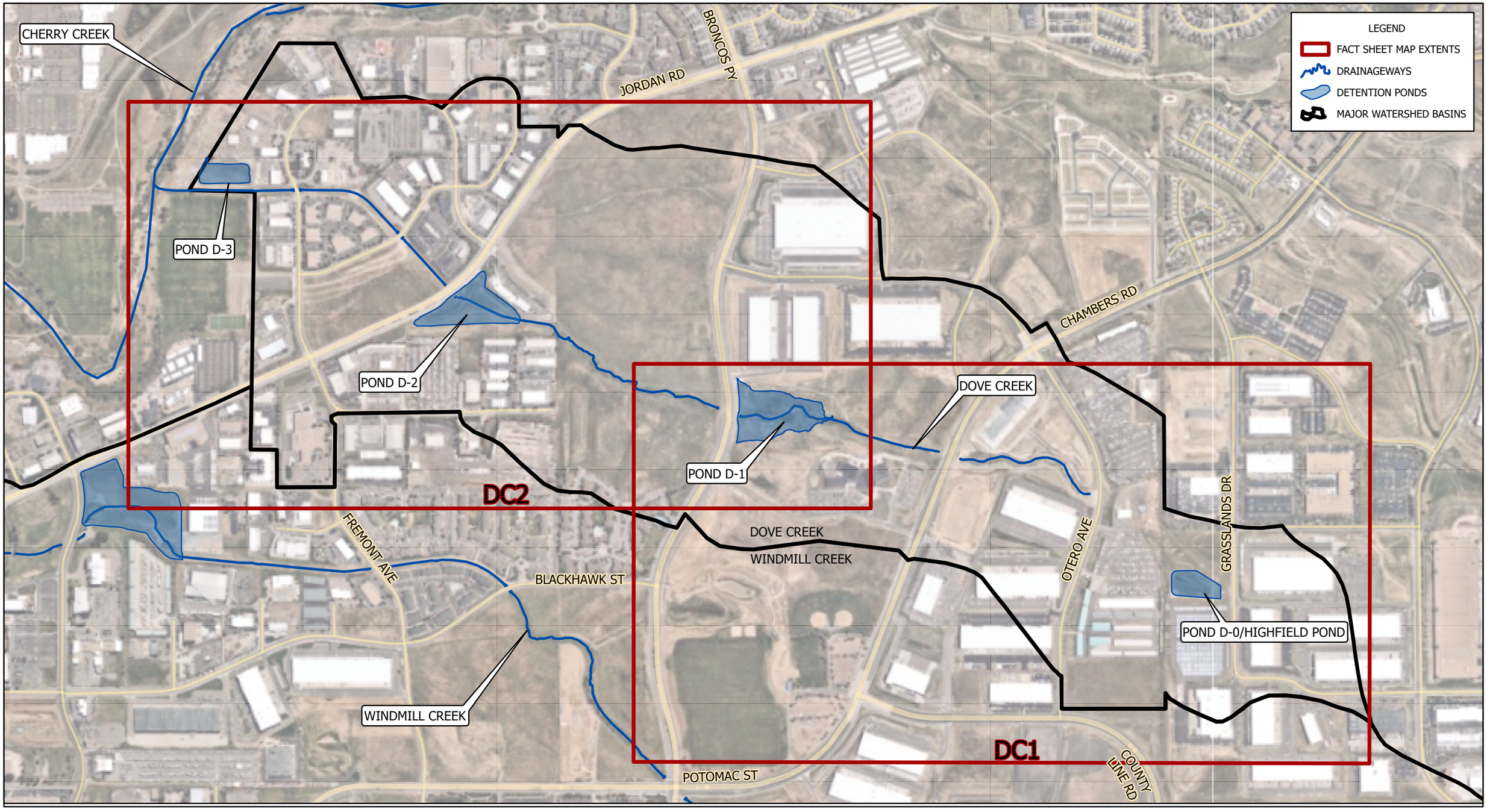
1 in = 3,000 ft

0 1,500 3,000

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE 2



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211-088.000

DATE: 3/11/2024

INDEX MAP FOR DOVE CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

1 in = 800 ft

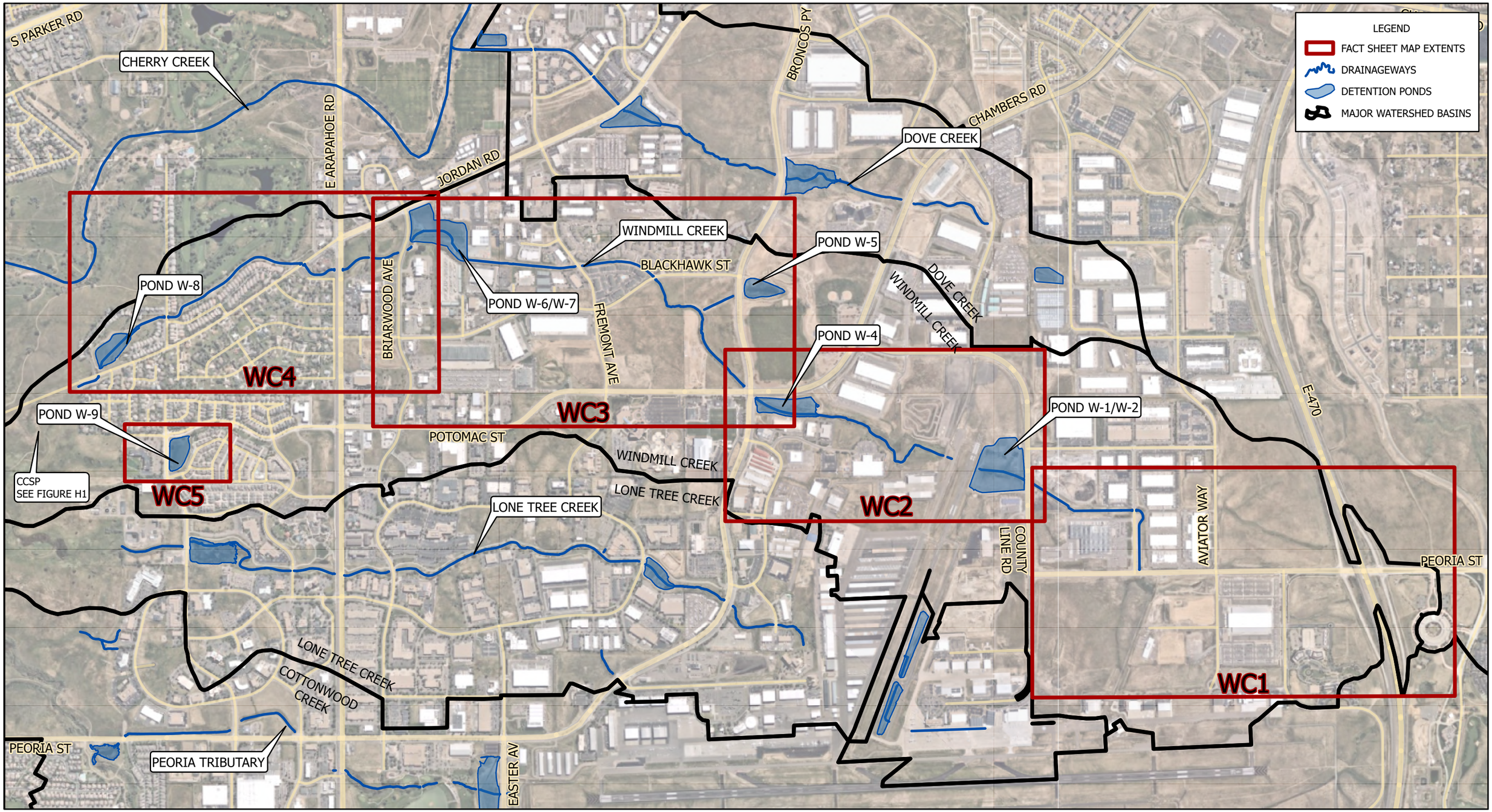
0 400 800

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE

3



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WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO. 211-088.000

DATE: 3/11/2024

INDEX MAP FOR WINDMILL CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

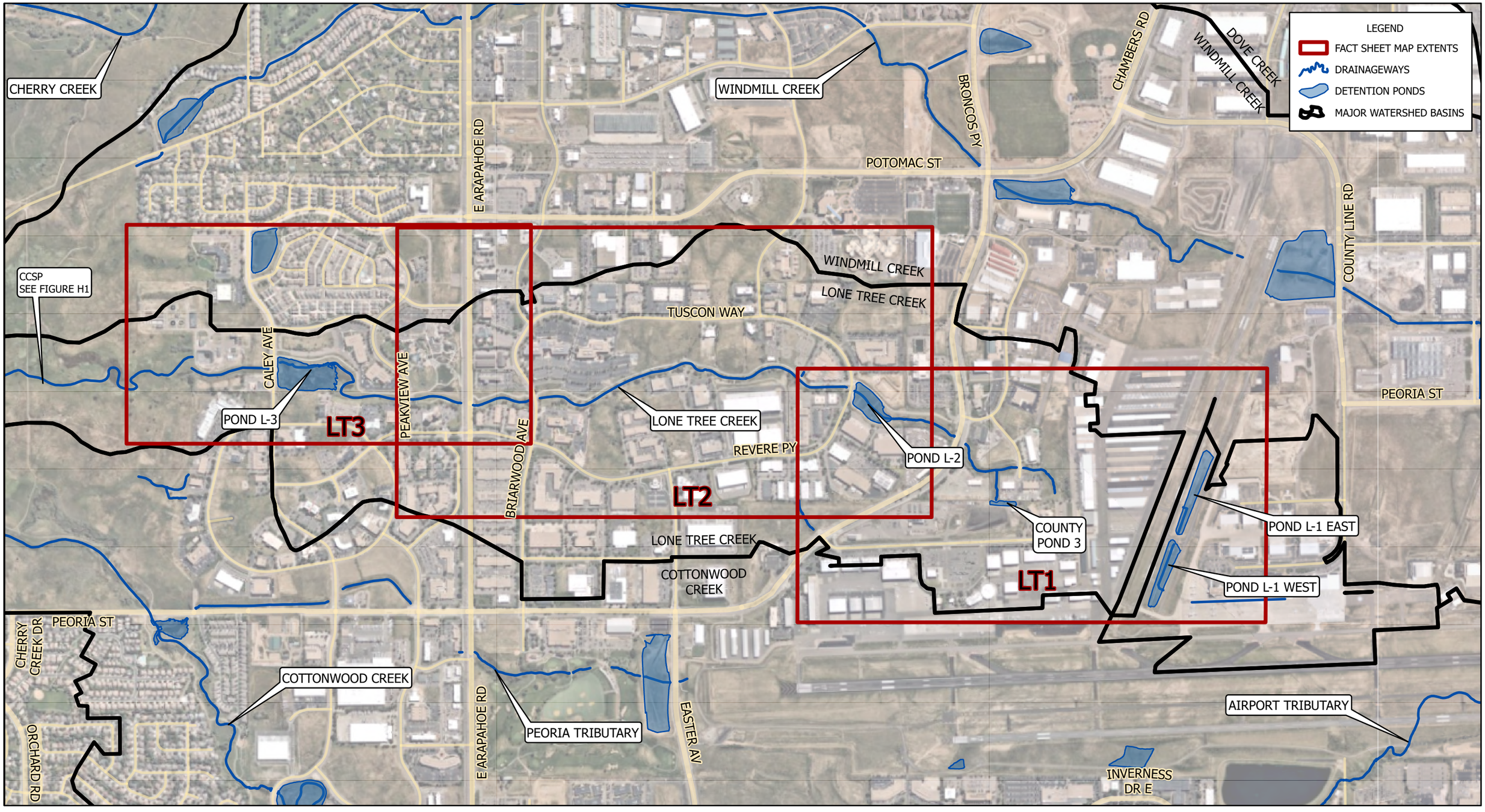
1 in = 1,400 ft

0 700 1,400

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE 4



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INDEX MAP FOR LONE TREE CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

1 in = 1,100 ft

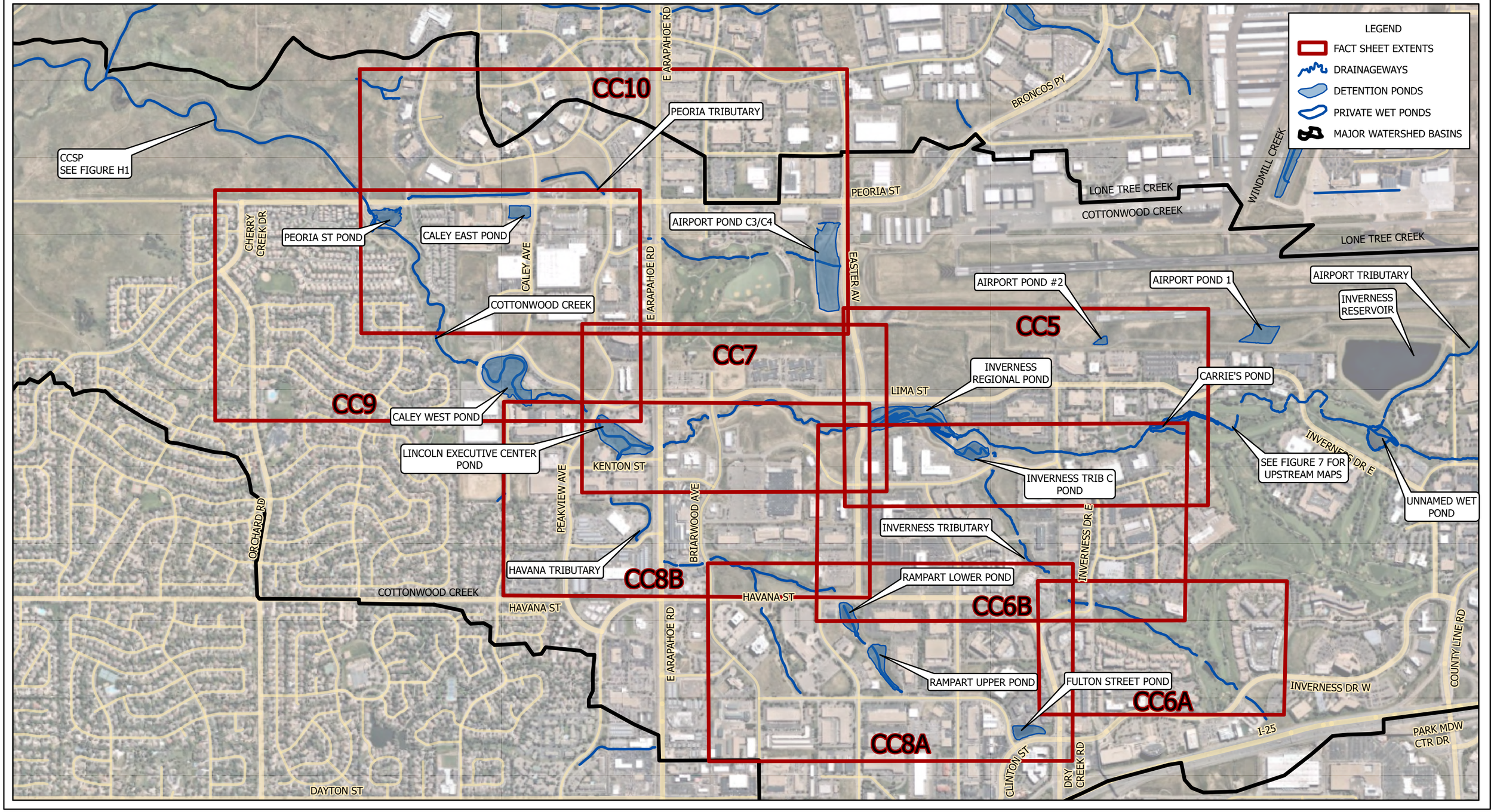
0 550 1,100

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE

5



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Maxar

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WWE PROJECT NO. 211-088.000

DATE: 3/11/2024

INDEX MAP A FOR COTTONWOOD CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

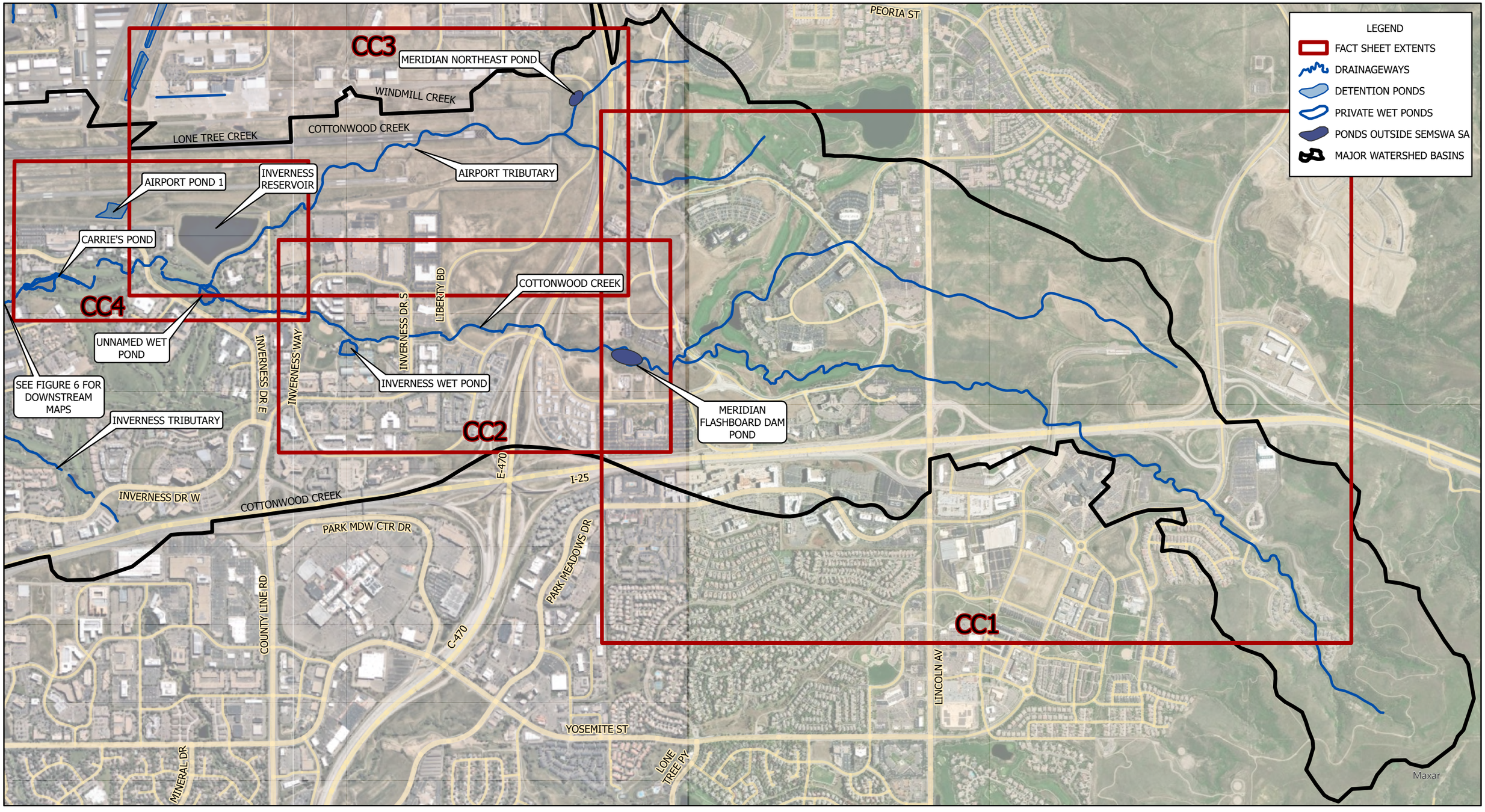
1 in = 1,200 ft

0 600 1,200

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE 6



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INDEX MAP B FOR COTTONWOOD CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

1 in = 1,500 ft

0 750 1,500

Southeast Metro Stormwater Authority

MILE HIGH FLOOD DISTRICT

FIGURE 7

MAP KEY

SUBBASIN*

WATERSHED

SCHEMATIC ELEMENT

WATER QUALITY AND/OR DETENTION FACILITY

WATER QUALITY CAPTURE VOLUME FOR FACILITY

POND ID — FACILITY ID
X.X AF ← CURRENT DIRECT DEMAND
X.X AF ← FUTURE DIRECT REQUIRED
X.X AF ← CURRENT PROVIDED (FUTURE PROPOSED)
X.X AF ← CURRENT 100 YEAR VOLUME (FUTURE 100 YEAR VOLUME)

SWMM ELEMENTS

ID
xxx CFS

SWMM ELEMENT

MDP 100YR PEAK FLOW RATE

*SUBBASIN COLOR CORRESPONDS TO REGIONAL DETENTION BASIN. SEE SUPPLEMENTARY GIS FILES FOR DETAIL.

CHERRY CREEK
ARAPAHOE ROAD
S. JORDAN ROAD
DOVE CREEK
HIGHFIELD POND D-0 WQCV
0.6 AF
1.8 AF
2.1 AF
7.5 AF
E-470
WINDMILL CREEK
LONE TREE CREEK
COTTONWOOD CREEK SEE FIGURES 9 & 10
PEORIA ST

D3 WQCV
1.9 AF
2.9 AF
4.1 AF
6.3 AF

D2 WQCV
2.2 AF
5.3 AF
8.3 AF
25.3 AF

D1 WQCV
2.1 AF
5.9 AF
9.8 AF (18.1 AF EURV)
34.6 AF

W6/W7 WQCV
9.3 AF
16.2 AF
23.1 AF
33.1 AF

W5 WQCV
0.8 AF
1.6 AF
2.3 AF (3.9 EURV)
28.5 AF

W8 WQCV
4.4 AF
5.7 AF
8.0 AF
12.9 AF

W9 WQCV
2.8 AF
4.3 AF
0.0 AF (4.3 AF)
11.9 AF

L3 WQCV
8.5 AF
12.9 AF
19.4 AF (13.0 AF)
19.4 AF

L2 WQCV
4.9 AF
7.0 AF
0.0 AF (7.0 AF)
13.8 (18.0 AF)

W1/W2 WQCV
6.1 AF
12.6 AF
16.3AF (38.7 EURV)
105.3 AF

L1 EAST AND WEST WQCV
2.4 AF
3.0 AF
3.8 AF
8.9 AF

MP WQCV
1.9 AF
3.8 AF
4.7 AF
15.4 AF

POND W4

POND L1 WEST

115 475 CFS
113 516 CFS
303 369 CFS
107 191 CFS
301 180 CFS
104 742 CFS
103 387 CFS
122 196 CFS
313 714 CFS
124 1063 CFS
119 735 CFS
126 833 CFS
134 914 CFS
116 430 CFS
307 289 CFS
136 976 CFS
137 247 CFS
140 1585 CFS
L-133 1082 CFS
L-126 1074 CFS
124 1508 CFS
303 1477 CFS
123 1587 CFS
120 1399 CFS
118 1366 CFS
116 1269 CFS
108 743 CFS
301 551 CFS
105 878 CFS
104 607 CFS
102 174 CFS
W-143 2120 CFS
351 90 CFS
350 201 CFS
111 320 CFS
110 55 CFS
104 1062 CFS
150 607 CFS

D-14 D-12 D-13 D-10 D-5 D-9 D-8 D-11 D-7 D-4 D-2 D-3 D-112 D-1

W-24 W-19 W-21 W-34 W-32 W-26 W-33 W-23 W-16 W-18 W-20 W-15 W-14 W-35 W-31 W-36 W-37 W-29 W-25 W-27 W-22 W-17 W-39 W-12 W-10 W-40 W-38 W-28 W-30 W-13 W-58 W-5 W-57 W-7 W-4 W-41 W-55 W-61 W-6 W-11 W-9 W-8 W-63 W-69 W-66 W-62 W-64 W-65 W-42 W-43 W-1 W-2 W-3 W-67 W-68

L-32 L-26 L-25 L-33 L-24 L-23 L-21 L-20 L-17 L-16 L-12 L-9 L-6 L-8 L-5 L-4 L-11 L-14 L-22 L-19 L-18 L-15 L-28 L-13 L-10 L-7 L-2 L-3 L-27 L-31 L-30 L-29

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WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO.
211-088.000

DATE: 03/18/2024

WQCV AND 100-YEAR PEAK DISCHARGES

LONE TREE, WINDMILL AND DOVE CREEKS

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

1 in = 1,500 ft

0 1,500 3,000

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE
8

WINDMILL CREEK
SEE FIGURE 8

LONE TREE CREEK
SEE FIGURE 8

CHERRY CREEK

CHERRY CREEK RESERVOIR

S PEORIA ST

AC-101 AC-98 AC-99 AC-104 AC-102 AC-105 AC-103 AC-100 AC-96 AC-95 AC-86 AC-85 AC-74 AC-72 AC-87 AC-46 AC-44 AC-45 AC-27 AC-36 AC-58 AC-47 AC-35 AC-26 DC-28 AC-20 AC-37 AC-19 DC-20 AC-28 AC-29 AC-25 AC-24 AC-21 DC-21 AC-38 AC-34 AC-23 DC-22 AC-33 AC-30 AC-22 AC-40 AC-31 AC-32 AC-39 AC-108 AC-107 AC-106 AC-109 AC-97 AC-94 AC-88 AC-84 AC-75 AC-73 AC-71 AC-89 AC-83 AC-76 AC-60 AC-82 AC-77 AC-70 AC-69 AC-92 AC-93 AC-61 AC-57 AC-48 AC-42 AC-56 AC-68 AC-78 AC-81 AC-91 AC-62 AC-67 AC-80 AC-63 AC-66 AC-79 AC-65 AC-55 AC-50 AC-51 AC-54 AC-53 AC-64 AC-49

CV-4 CV-3 CV-2 CV-1 CV-1 WT-2 WT-1 WT-1

210
6116 CFS

199
6175 CFS

200
6272 CFS

209
6274 CFS

WT-1
284 CFS

CV-1
142 CFS

PEORIA ST. POND
6.7 AF
8.7 AF
11.6 AF
34.4 AF

312
4259 CFS

390
74 CFS

CALEY EAST
1.2 AF
1.5 AF
4.9 AF EURV
6.2 AF

242
236 CFS

343
194 CFS

POND C3/C4
3.2 AF
4.3 AF
14.1 AF EURV
30.2 AF

INVERNESS
REGIONAL
17.0 AF
22.9 AF
29.2 AF EURV
103.5 AF

AIRPORT POND #2
(BY OTHERS)
0.4 AF
0.4 AF
0.4 AF (1.0 EURV)
2.9 AF

321
21 CFS

AIRPORT POND #1
(BY OTHERS)
0.6 AF
0.6 AF
0.5 AF (1.0 EURV)
5.4 AF (6.6 AF)

323
20 CFS

107
3672 CFS

CALEY WEST
3.2 AF
3.7 AF
19.0 AF EURV
49.8 AF

414
3942 CFS

214
3947 CFS

416
3888 CFS

216
3910 CFS

319
3555 CFS

112
3905 CFS

212
4273 CFS

LEC POND
9.3 AF
12.6 AF
6.7 AF
37.4 AF

133
899 CFS

381
724 CFS

INVERNESS TRIB C
5.5 AF
6.0 AF
7.6 AF (6.0 AF)
11.7 AF

SEE FIGURE 10 FOR
UPSTREAM REACH

262
684 CFS

139
447 CFS

117
575 CFS

365
166 CFS

RAMPART LOWER
0.4 AF
0.5 AF
3.5 AF (0.5 AF)
6.1 AF

367
185 CFS

267
401 CFS

369
74 CFS

RAMPART UPPER
2.7 AF
3.3 AF
0.0 AF (7.6 AF EURV)
10.9 AF (15.4 AF)

FULTON ST. POND
1.2 AF
1.4 AF
1.4 AF
5.4 AF

E ARAPAHOE RD

I-25

MAP KEY

SUBBASIN*

WATERSHED

SCHEMATIC ELEMENT

WATER QUALITY AND/OR DETENTION FACILITY

WATER QUALITY CAPTURE VOLUME FOR FACILITY

SWMM ELEMENTS

ID
xxx CFS

SWMM ELEMENT

MDP 100YR PEAK FLOW RATE

POND ID	FACILITY ID
X.X AF	CURRENT DIRECT DEMAND
X.X AF	FUTURE DIRECT REQUIRED
X.X AF	CURRENT PROVIDED (FUTURE PROPOSED)
X.X AF	CURRENT 100 YEAR VOLUME (FUTURE 100 YEAR VOLUME)

*SUBBASIN COLOR CORRESPONDS TO REGIONAL DETENTION BASIN. SEE SUPPLEMENTARY GIS FILES FOR DETAIL.

Service Layer Credits: World Imagery (Clarity): Source: Esri, Maxar, Earthstar Geographics, IGN, and the GIS User Community

Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\WQCV_Figures\WQCV_Figures_sw_03.11.2024.aprx

WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO.
211-088.000

DATE: 03/17/2024

WQCV AND 100-YEAR PEAK DISCHARGES

COTTONWOOD CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

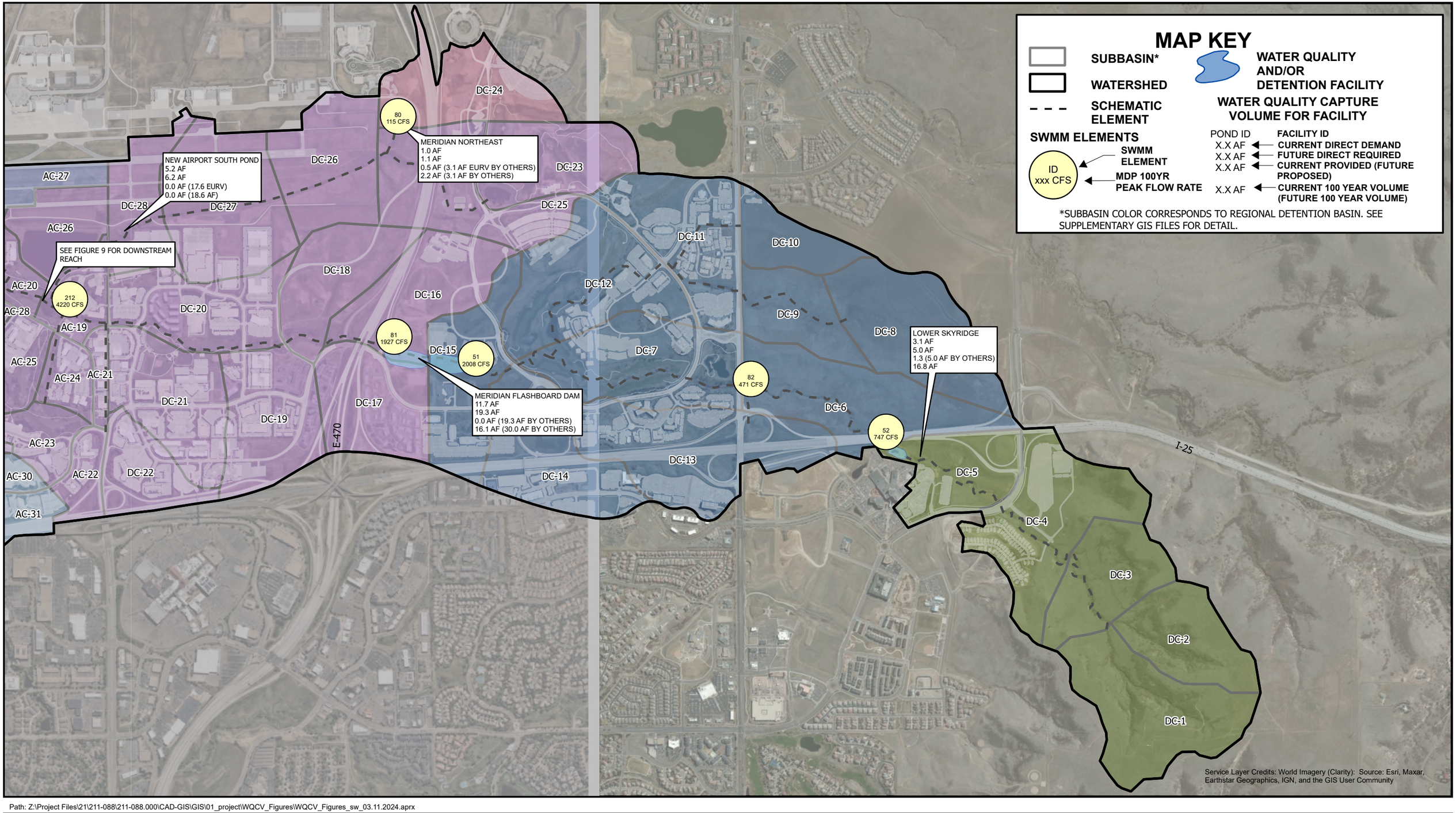
1 in = 1,500 ft

0 1,500 3,000

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE
9



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WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO.
211-088.000

DATE: 03/18/2024

WQCV AND 100-YEAR PEAK DISCHARGES

COTTONWOOD CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

1 in = 1,500 ft

0 1,500 3,000

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE
10

PROJECT DC5: RETROFIT POND D-1 TO CAPTURE EURV AND INCLUDE POND MAINTENANCE FEATURES

PLEASE SEE FACT SHEET DR2 FOR DOWNSTREAM REACH

POND D-1 HAS AN EXCESS OF WQCV COMPLETED DETENTION POND IMPROVEMENTS (2010)

PROBLEM AREA #3 MAINTENANCE CHALLENGES

PROBLEM AREA #4 CHANNEL INSTABILITY

PROJECT DC6: LARGE-SCALE STREAM RESTORATION AND CHANNEL STABILIZATION

SUB-REACH 2

SUB-REACH 3

SUB-REACH 1

8'HX10'W BOX CULVERT 1000 CFS CAPACITY

PROJECT DC8: STABILIZE EROSION AT E OTERO RD AND AURORA RV

PROBLEM AREA #5 UNSTABLE FLOW

60" RCP

72" RCP

36" RCP

PROPERTY MANAGED BY TRITON ENVIRONMENTAL

PROJECT DC4: IMPROVE INLET CAPACITY DOWNSTREAM OF POND D-0 OUTFALL

PROBLEM AREA #1 OVERFLOW ISSUES 24" RCP

PROBLEM AREA #2 STANDING WATER

POND D-0/HIGHFIELD POND 2.1 AF PROVIDED EXCEEDS WQCV

PROJECT DC1: RETROFIT OUTLET STRUCTURE TO REDUCE STANDING WATER

OPUS DEVELOPMT CO

DOVE VALLEY PROP

DOVE VALLEY BUS PARK ASSOCS

DIGICOMM DR

AURORA RV SELF STORAGE

PRAIRIE TRAIL DR

CHERRY CREEK SCHOOL DISTRICT

DOVE VALLEY LAND

SEMSWA

ARAPAHOE COUNTY

DOUGLAS COUNTY

TOWN OF PARKER

GRASSLANDS DR

DOVE CREEK

OTERO OWNER

POSEIDON REAL PROP

UPLAND DR

HAPPY CANYON CREEK

HIGHFIELD BUSINESS PARK LLC

CHAMBERS RD

OTERO AV

BRONCOS PY

BLACKHAWK ST

DGT ENTERPRISES

ARAPAHOE COUNTY COMMUNITY PARK

AVORIC

WINDMILL CREEK

J-R MOTORS COMPANY SOUTH

ACAA

POTOMAC ST

COUNTY LINE RD

HIGHFIELD PKWY

EDB

GS

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- EASEMENTS
- MAJOR WATERSHED BASINS
- SEMSWA SERVICE AREA BOUNDARY
- TRAILS
- PARKS AND OPEN SPACE
- MUNICIPAL BOUNDARY
- PARCELS & OWNER

STREAM CONDITION OVERALL SVAP*
- GOOD
- FAIR

CHANNEL GEOMORPHOLOGIC STATE*
- STABLE
- DEPOSITIONAL
- EROSIONAL

GRADE CONTROL CONDITION*
- STABLE

HEADCUT PRIORITY*
- MINOR
- SEVERE

OUTFALL OVERALL CONDITION*
- GOOD

CROSSING CONDITION*
- GOOD

CHANNEL IMPROVEMENT PROJECTS
- ADAPTIVE STREAM MANAGEMENT
- STREAM RESTORATION

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE AND DOUGLAS COUNTIES, COLORADO

DOVE CREEK SELECTED ALTERNATIVES POND D-0 TO POND D-1

SOUTHEAST METRO STORMWATER AUTHORITY

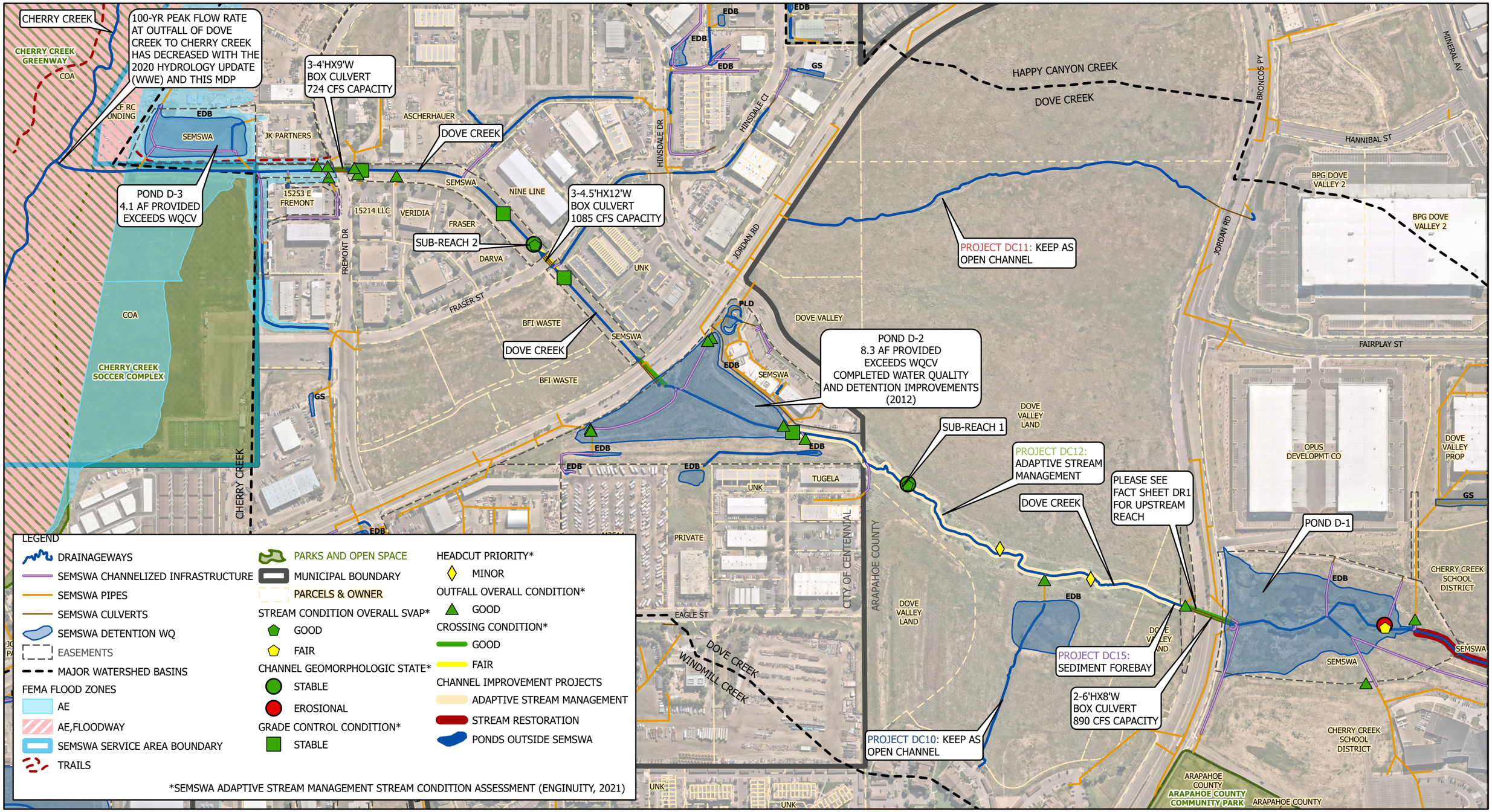
N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

REACH DR1



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\Basin_Fact_Sheets\Fact_Sheets_DWMLT\Fact_Sheets_DWMLT_selected.aprx

WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

DOVE CREEK SELECTED ALTERNATIVES
POND D-1 TO CONFLUENCE WITH CHERRY CREEK

SOUTHEAST METRO STORMWATER AUTHORITY

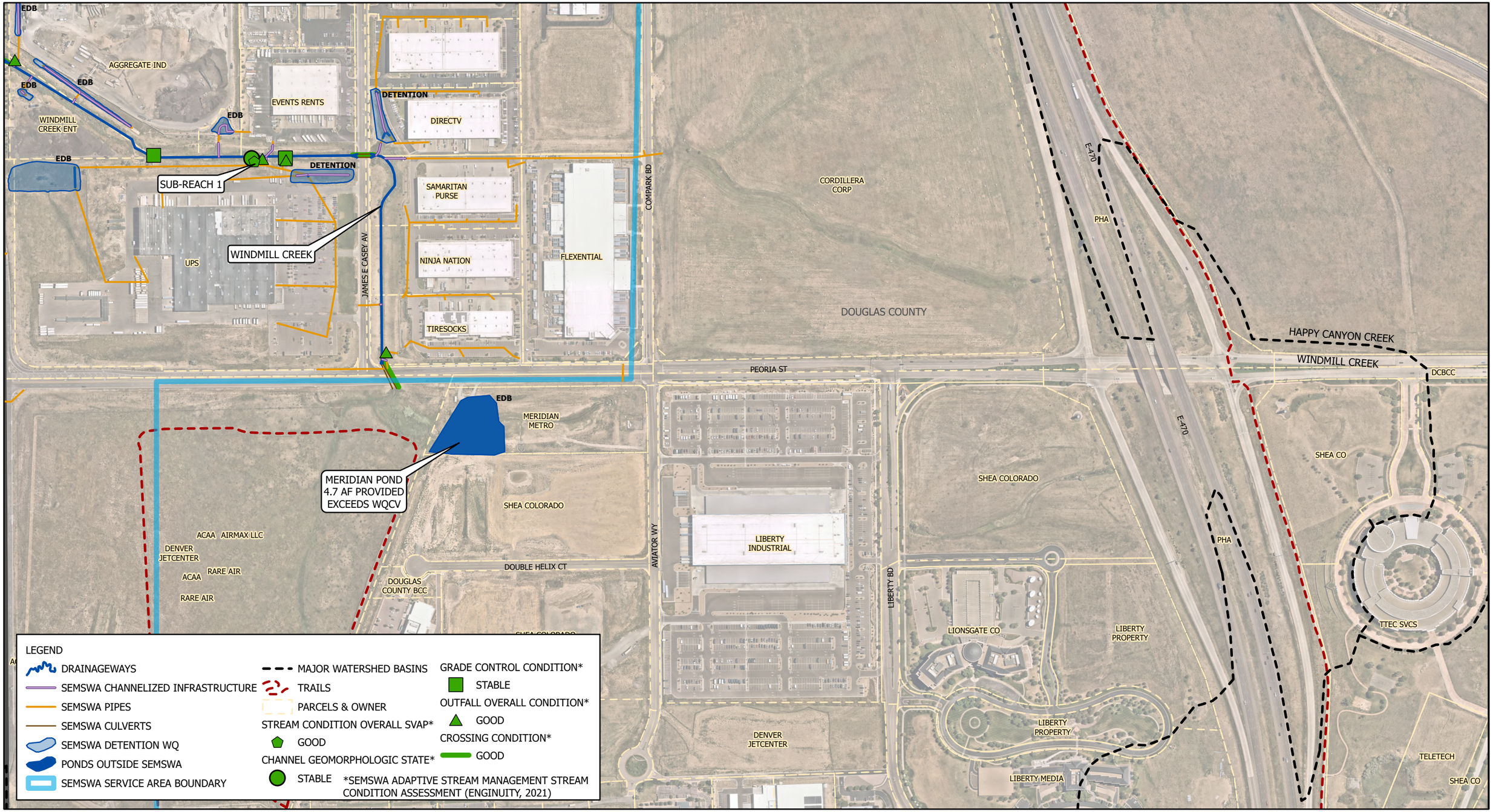
N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

REACH DR2



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WRIGHT WATER ENGINEERS, INC.

DOUGLAS COUNTY, COLORADO

WINDMILL CREEK OUTSIDE SEMSWA SERVICE AREA

SOUTHEAST METRO STORMWATER AUTHORITY

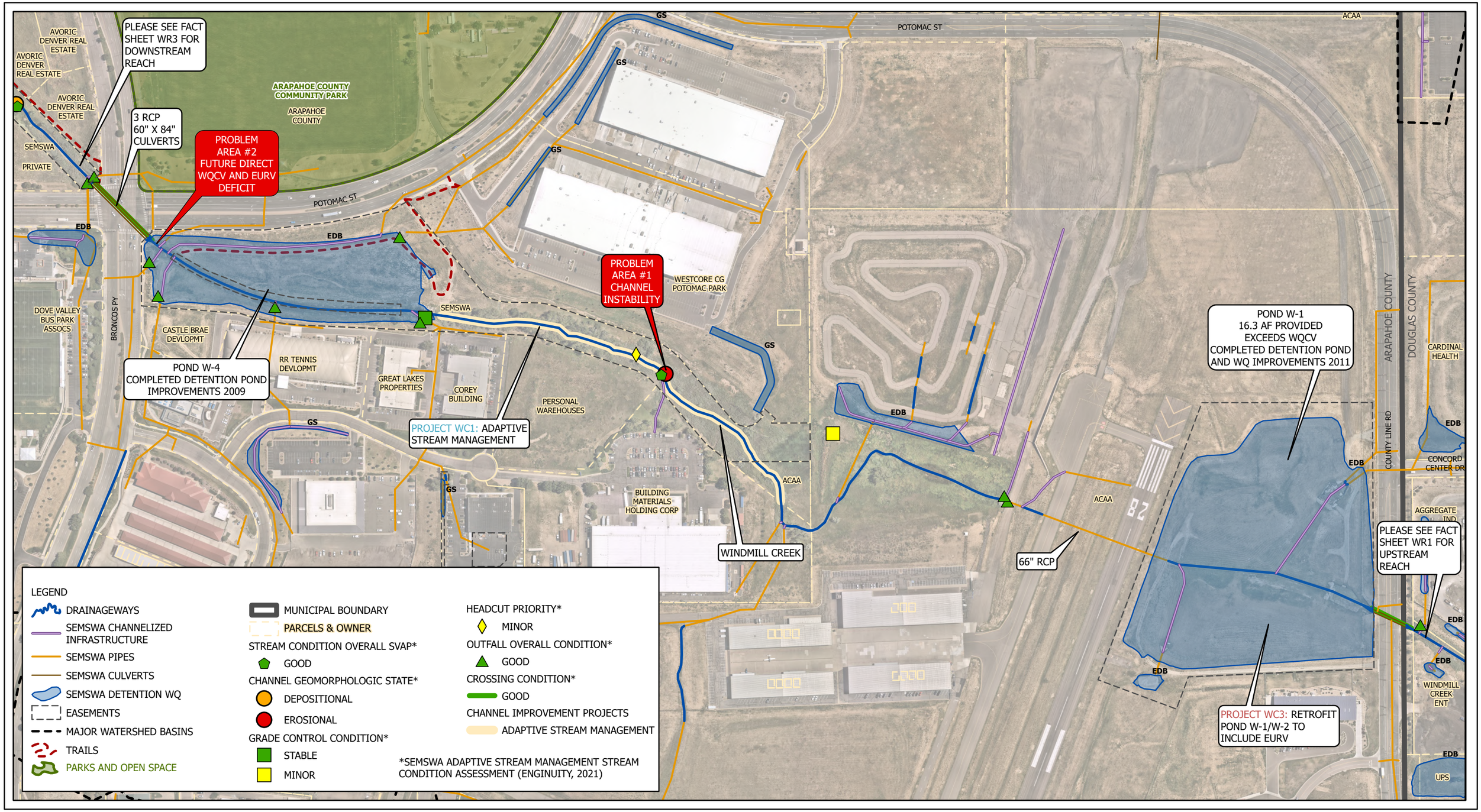
N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

REACH WR1



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE AND DOUGLAS COUNTIES, COLORADO

WINDMILL CREEK SELECTED ALTERNATIVES
POND W-1 TO POND W-4

SOUTHEAST METRO STORMWATER AUTHORITY

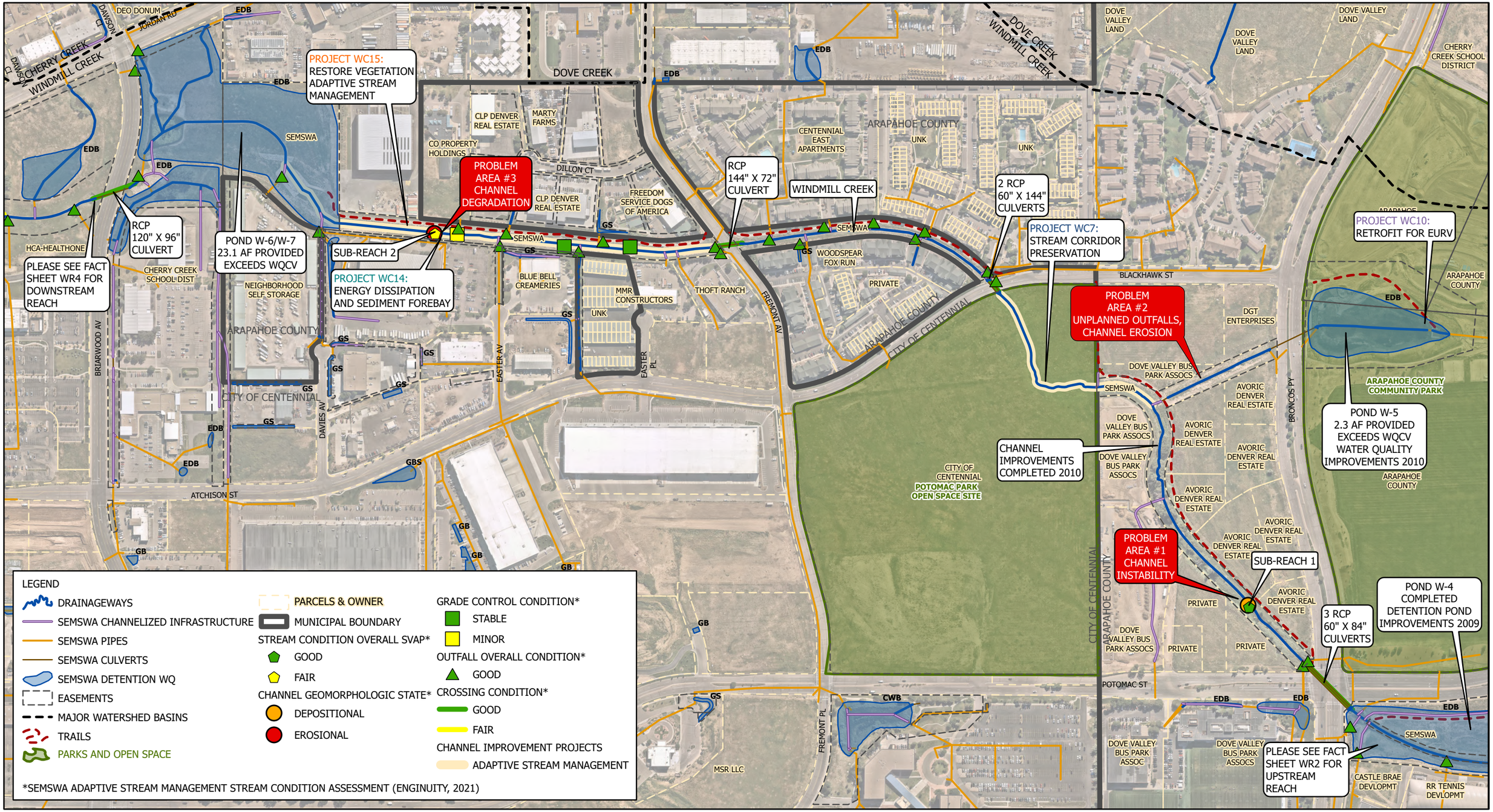
N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

REACH WR2



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

WINDMILL CREEK SELECTED ALTERNATIVES
POND W-4 TO POND W-6/W-7 AND INCLUDING POND W-5

SOUTHEAST METRO STORMWATER AUTHORITY

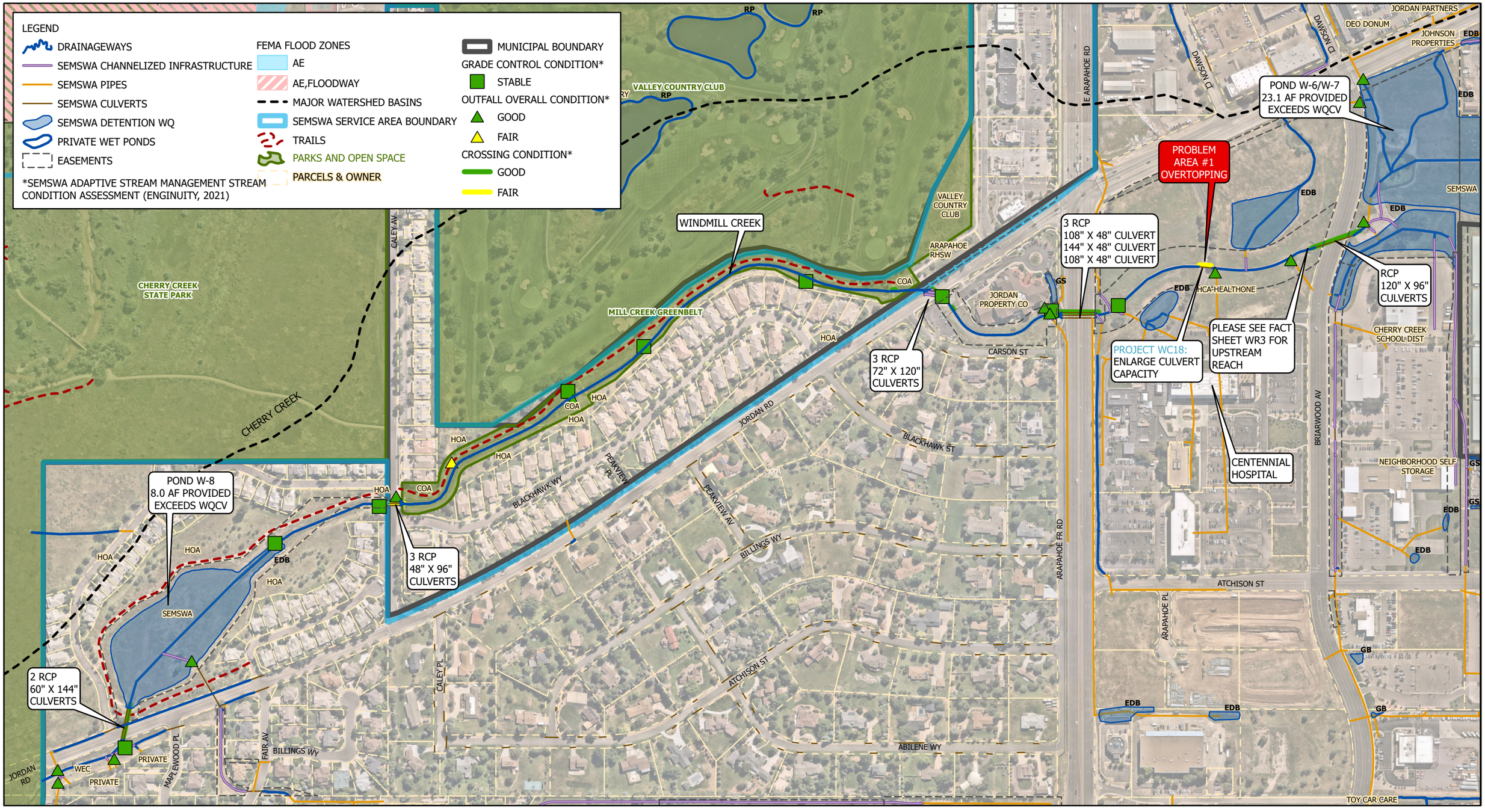
N

1" = 400 FEET

0 200 400

PROJECT NO.
211-088.000

REACH
WR3



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

WINDMILL CREEK SELECTED ALTERNATIVES
POND W-6/W-7 TO POND W-8

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 350 FEET

0 175 350

PROJECT NO. 211-088.000

REACH WR4

PLEASE SEE FACT SHEET LR2 FOR DOWNSTREAM REACH

EX 4'X10' CULVERT

PROJECT LC6: RETROFIT L-2 FOR WQCV

PROBLEM AREA #6 WQCV DEFICIT

PROBLEM AREA #7 WATER QUALITY

PROBLEM AREA #4 EROSIONAL CHANNEL

EX 4'X7' CULVERT ~800 CFS CAPACITY

PROBLEM AREA #3 CULVERT IN POOR CONDITION

POND L-2 WQCV NOT PROVIDED DETENTION IMPROVEMENTS (2012)

PROBLEM AREA #5 CONDITION OF INFRASTRUCTURE

SUB-REACH 1

PROBLEM AREA #2 CHANNEL INSTABILITY

EX 6'X14' CULVERT

ACAA MONITORING OUTFALL LOCATION

PROJECT LC3: TARGETED DROP STRUCTURES ALONG REACH

LONE TREE CREEK

PROBLEM AREA #1 EXCESS SEDIMENT AND VEGETATION

ACAA 48" RCP OUTFALL

COUNTY POND 3

PROJECT LC2: SEDIMENT CONTROL OF ARAPAHOE COUNTY MATERIAL STOCKPILE (BY OTHERS)

ARAPAHOE COUNTY ROAD AND BRIDGE

POND L-1 EAST 3.8 AF PROVIDED EXCEEDS WQCV COMPLETED WATER QUALITY RETROFIT (2010)

PROJECT LC8: REQUEST CONTROL MEASURES BE IMPLEMENTED UPSTREAM BY THE ACAA TO REDUCE PHOSPHOROUS LOADING (BY OTHERS)

POND L-1 WEST COMPLETED WATER QUALITY RETROFIT (2011)

LONE TREE CREEK

COTTONWOOD CREEK

WINDMILL CREEK

LONE TREE CREEK

7309 TUCSON WAY

TUCSON WY

INDUSTRIAL PRODUCTS

REVERE PY

FR MASSACHUSETTS

BRONCOS PKWY RV

BRONCOS PY

CITY OF CENTENNIAL

ARAPAHOE COUNTY

DOVE VALLEY SS

12525 JAMISON PLACE

DRAGONFLY PROP

ADAM AIRCRAFT CI

JAMISON PL

SCHMIDT VENTURES

MOUNTAIN STATES LENDING

E CONTROL TOWER ROAD

WALLACE CT

INTERPORT BD

ACAA

EDB

GS

SEMSWA

SP

GBS

CACA

UNK

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- EASEMENTS

FEMA FLOOD ZONES

- AE
- AE,FLOODWAY
- MAJOR WATERSHED BASINS
- TRAILS
- PARCELS & OWNER
- MUNICIPAL BOUNDARY

STREAM CONDITION OVERALL SVAP*

- GOOD

CHANNEL GEOMORPHOLOGIC STATE*

- STABLE
- EROSIONAL

GRADE CONTROL CONDITION*

- STABLE

HEADCUT PRIORITY*

- MINOR
- SEVERE

OUTFALL OVERALL CONDITION*

- GOOD
- FAIR

CROSSING CONDITION*

- GOOD
- FAIR

CHANNEL IMPROVEMENT PROJECTS

- STREAM RECLAMATION AND REHABILITATION
- PONDS OUTSIDE SEMSWA

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

LONE TREE CREEK SELECTED ALTERNATIVES
POND L-1 TO POND L-2
SOUTHEAST METRO STORMWATER AUTHORITY

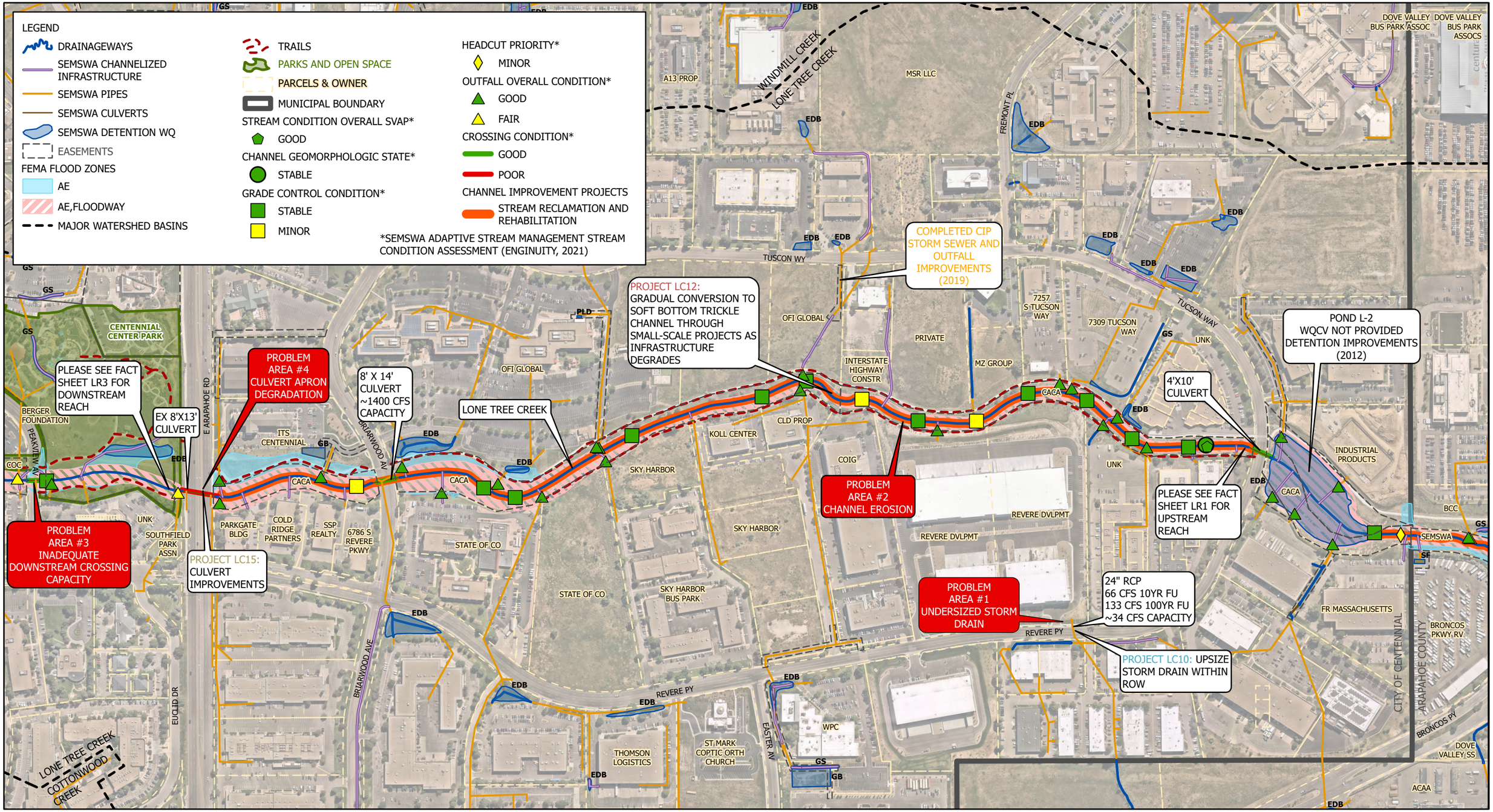
N

1" = 350 FEET

0 175 350

PROJECT NO. 211-088.000

REACH LR1



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\Basin_Fact_Sheets\Fact_Sheets_DWMLT\Fact_Sheets_DWMLT_selected.aprx

WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

LONE TREE CREEK SELECTED ALTERNATIVES
POND L-2 TO E ARAPAHOE RD
SOUTHEAST METRO STORMWATER AUTHORITY

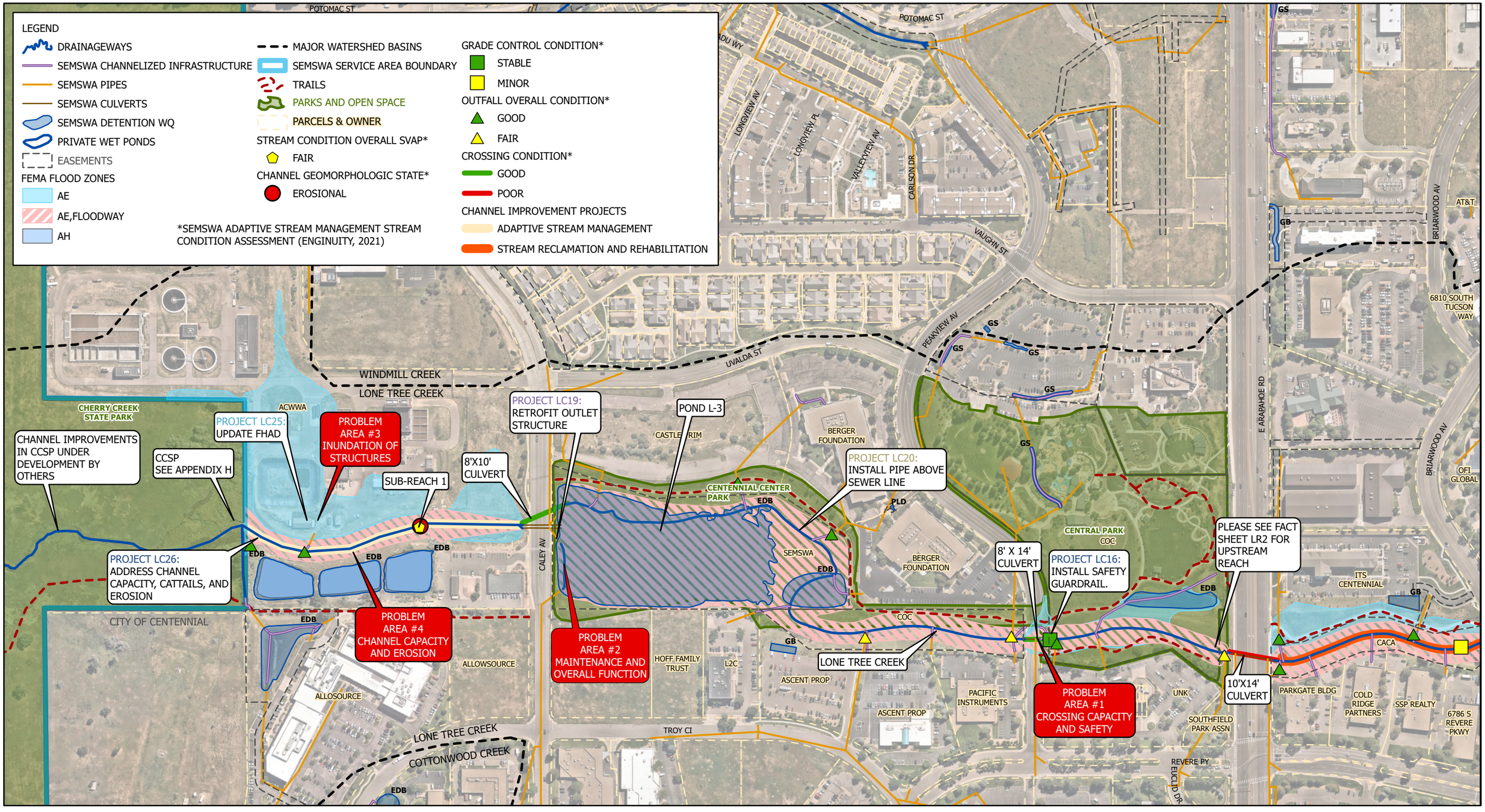
N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

REACH LR2



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

LONE TREE CREEK SELECTED ALTERNATIVES
EAST ARAPAHOE ROAD TO CHERRY CREEK STATE PARK

SOUTHEAST METRO STORMWATER AUTHORITY

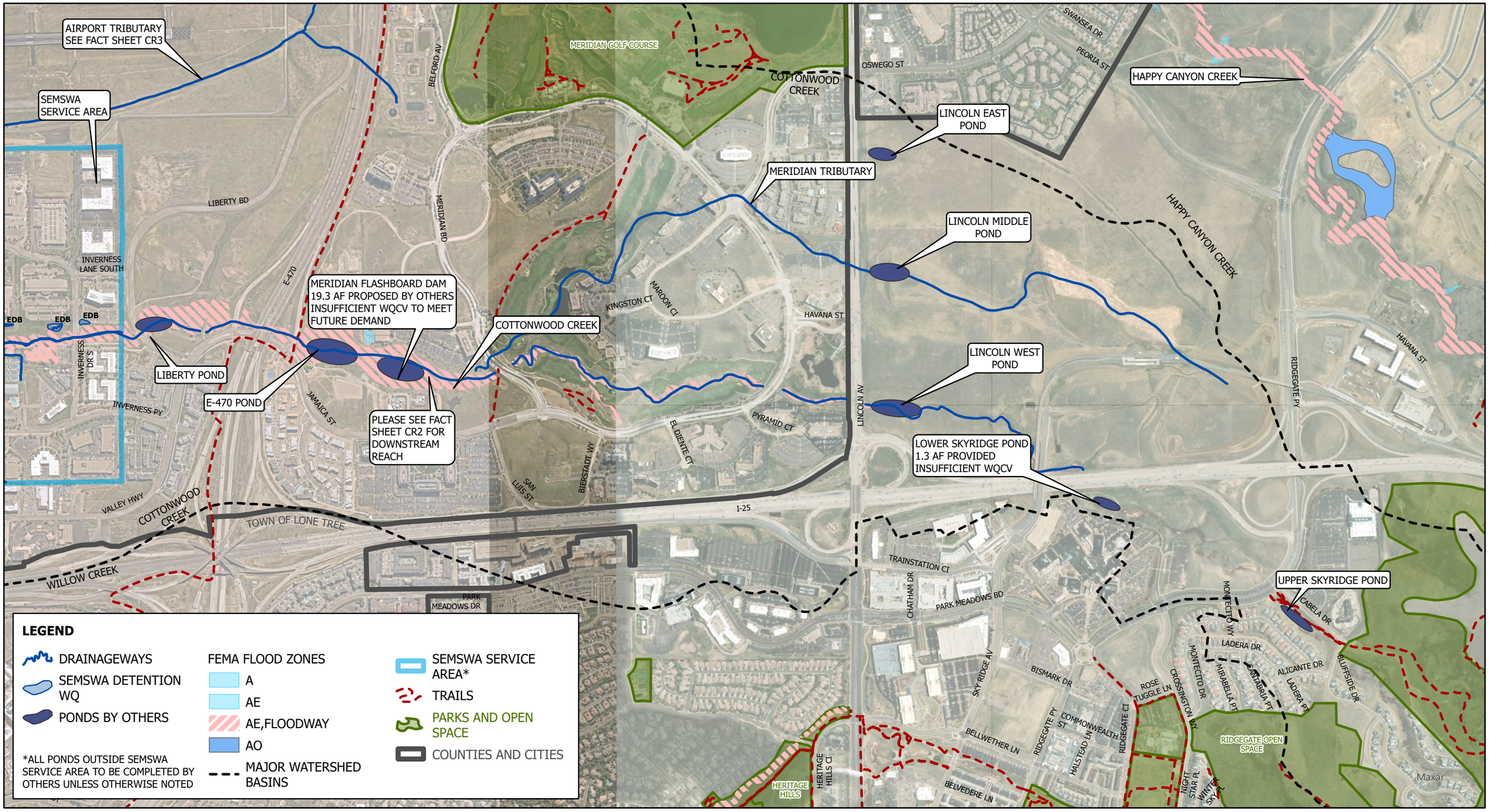
N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

REACH LR3



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WRIGHT WATER ENGINEERS, INC.

DOUGLAS COUNTY, COLORADO

COTTONWOOD CREEK OUTSIDE SEMSWA SERVICE AREA

SOUTHEAST METRO STORMWATER AUTHORITY

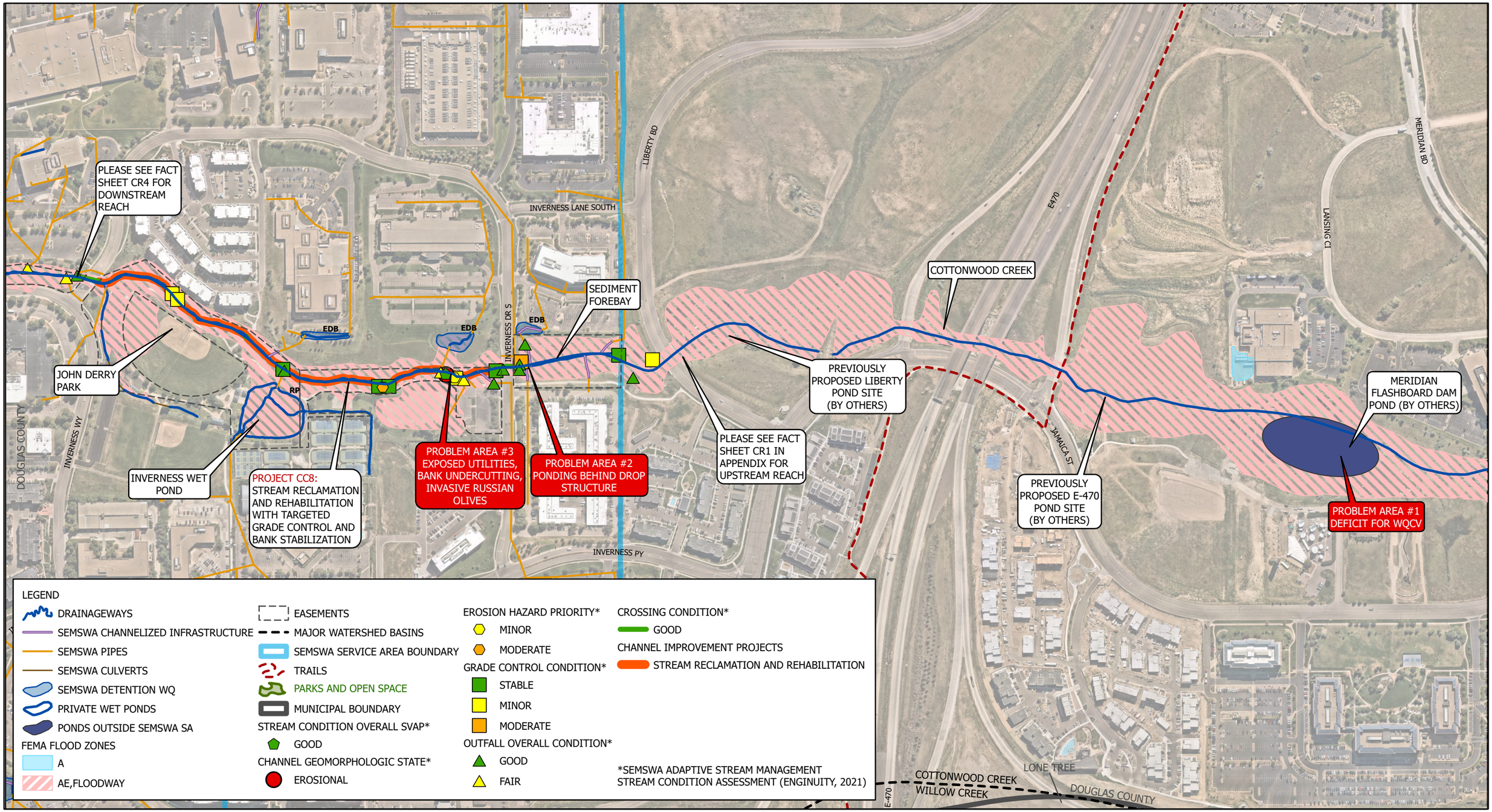
N

1" = 1,000 FEET

0 500 1,000

PROJECT NO.
211-088.000

REACH
CR1



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\Basin_Fact_Sheets\Fact_Sheets_CC\Fact_Sheets_CC_selected.aprx

WRIGHT WATER ENGINEERS, INC.

DOUGLAS COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
LIBERTY POND TO INVERNESS WAY
SOUTHEAST METRO STORMWATER AUTHORITY

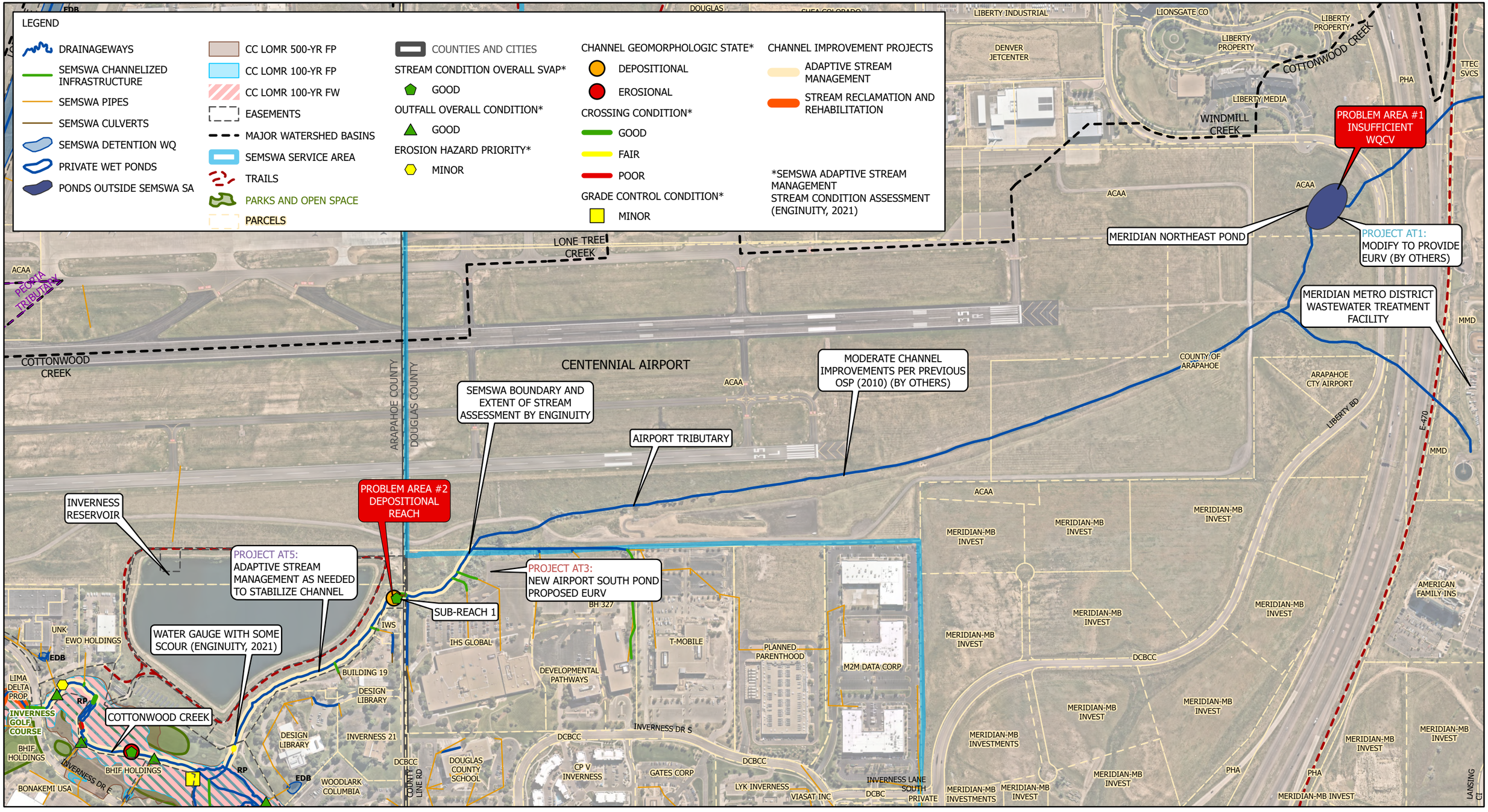
N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

REACH CR2



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\Basin_Fact_Sheets\Fact_Sheets_CC\Fact_Sheets_CC_selected.aprx

ARAPAHOE AND DOUGLAS COUNTIES, COLORADO

AIRPORT TRIBUTARY SELECTED ALTERNATIVES

SOUTHEAST METRO STORMWATER AUTHORITY

WRIGHT WATER ENGINEERS, INC.

N

1" = 500 FEET

0 250 500

PROJECT NO. 211-088.000

REACH CR3

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- PRIVATE WET PONDS
- CC LOMR 100-YR FW
- CC LOMR 100-YR FP
- CC LOMR 500-YR FP
- EASEMENTS
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS
- COUNTIES AND CITIES

STREAM CONDITION OVERALL SVAP*
- GOOD

OUTFALL OVERALL CONDITION*
- GOOD
- FAIR

EROSION HAZARD PRIORITY*
- MINOR
- MODERATE

CHANNEL GEOMORPHOLOGIC STATE*
- DEPOSITIONAL
- EROSIONAL

CROSSING CONDITION*
- GOOD
- FAIR
- POOR

GRADE CONTROL CONDITION*
- MINOR

CHANNEL IMPROVEMENT PROJECTS
- ADAPTIVE STREAM MANAGEMENT
- STREAM RECLAMATION AND REHABILITATION

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

PROJECT CC18: RETROFIT AIRPORT POND 1 TO INCLUDE OUTLET STRUCTURE, EURV, AND FOREBAYS (BY OTHERS)

CENTENNIAL AIRPORT

ACAA

INVERNESS RESERVOIR

AIRPORT POND 1

EDB

PROBLEM AREA #5 GOLF COURSE REACH SOME BANK EROSION

COMPLETED MINOR BANK STABILIZATION PROJECT 2023

PROJECT CC10: RELOCATE POND AND CONVERT TO OPEN CHANNEL TO REPAIR EROSION

PROBLEM AREA #4 BLDG MAY BE IN FW

PROBLEM AREA #6 GOLF COURSE CROSSING IN POOR CONDITION WITH CRUSHED CULVERT ON THE UPSTREAM SIDE

PROBLEM AREA #3 CROSSING IN POOR CONDITION

PROBLEM AREA #1 SCOUR DOWNSTREAM OF UNNAMED WET POND

AIRPORT TRIBUTARY CONFLUENCE

AIRPORT TRIBUTARY SEE FACT SHEET CR3

PLEASE SEE FACT SHEET CR5 FOR DOWNSTREAM REACH

CARRIE'S POND (PRIVATE WET POND)

COTTONWOOD CREEK

PROJECT CC19 WIDEN CHANNEL NEAR BUILDING

PROJECT CC17: REPLACE HEADWALL AND SLIPLINE CULVERT

PROBLEM AREA #2 EROSIONAL CHANNEL

PROJECT CC14: STREAM RECLAMATION AND REHABILITATION FROM INVERNESS DRIVE EAST TO CARRIE'S POND WITH TARGETED EROSION AND INFRASTRUCTURE REPAIR

PROJECT CC11: INSTALL SCOUR PROTECTION

PROJECT CC12: ADAPTIVE STREAM MANAGEMENT WITH TARGETED EROSION REPAIR AND INFRASTRUCTURE REHABILITATION

UNNAMED WET POND

COLORADO EARLY COLLEGES INVERNESS HIGH SCHOOL

PLEASE SEE FACT SHEET CR2 FOR UPSTREAM REACH

45 IDE
43 INV
TEN-O-NINE
EWO HOLDINGS
INVERNESS DR E
BUCKEYE POWDER
UNK
IWS
IHS GLOBAL
DOUGLAS COUNTY
ARAPAHOE COUNTY
BUILDING 19
DESIGN LIBRARY
BHIF HOLDINGS
LIMA DELTA PROP
RP
LIMU
FSHS PROP
IMD
INVERNESS GOLF COURSE
BONAKEMI USA
INVERNESS 21
WOODLARK COLUMBIA
DOUGLAS COUNTY SCHOOL
SAUNDERS COMMERCIAL
PRIDE REALTY
86 INVERNESS INVEST
PLD
INVERNESS PL E
INTER-CAPITAL
MJRJN HOLDINGS
LARSON FAMILY
COUNTY LINE RD
DCBCC
HONEYWELL INTERNATIONAL
INVERNESS WY
INVERNESS WY S
INVERNESS DR S
INTERNAP CORP
INVERNESS MET IMPROVEMENT

Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\Basin_Fact_Sheets\Fact_Sheets_CC\Fact_Sheets_CC_selected.aprx

WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
INVERNESS WAY TO CARRIE'S POND
SOUTHEAST METRO STORMWATER AUTHORITY

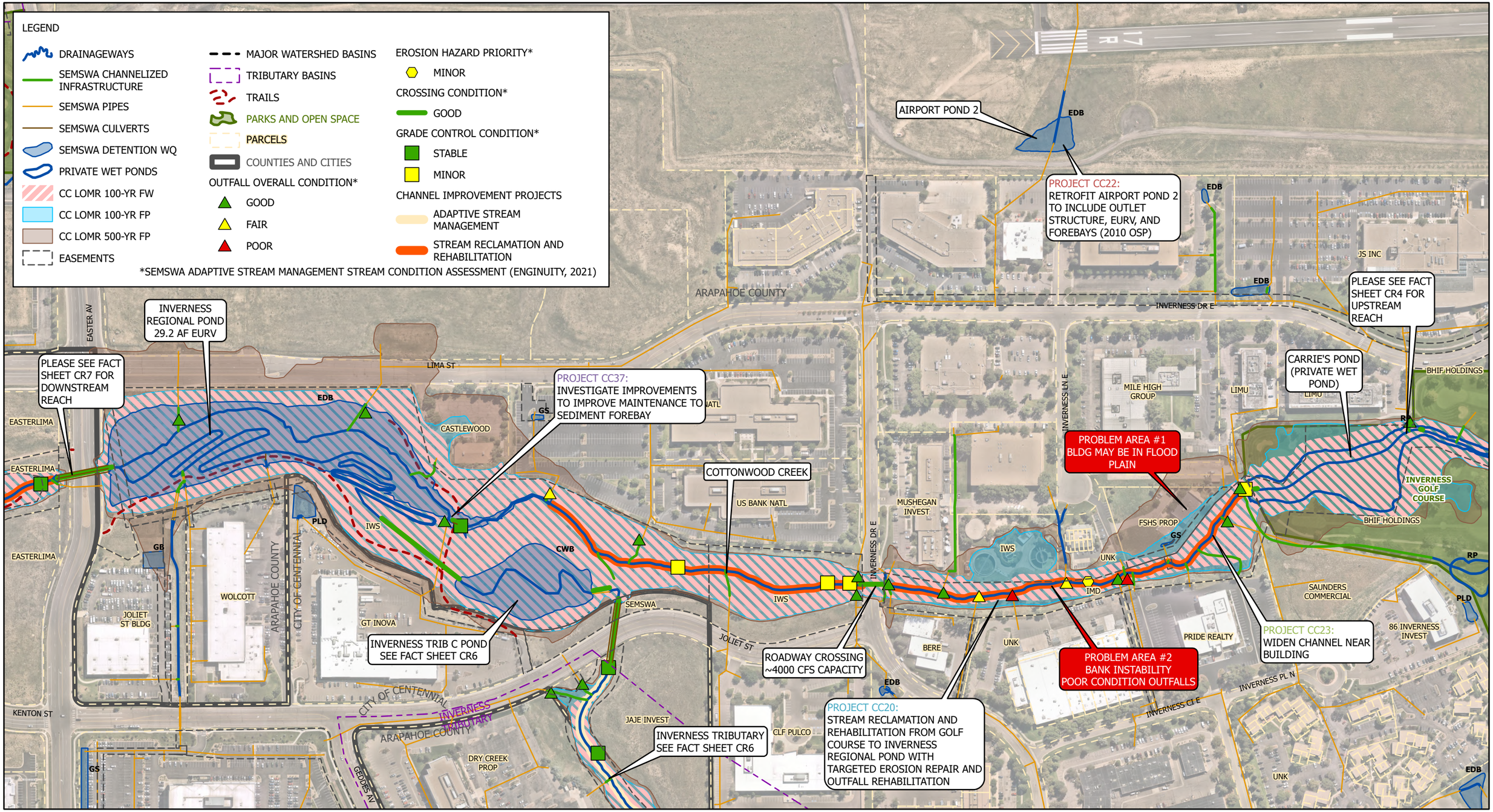
N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

REACH CR4



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\Basin_Fact_Sheets\Fact_Sheets_CC\Fact_Sheets_CC_selected.aprx

WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
CARRIE'S POND TO INVERNESS REGIONAL POND

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

REACH CR5

PLEASE SEE FACT SHEET CR6B FOR DS REACH

PROJECT IT5: INCREASE CAPACITY

PROBLEM AREA #2 INADEQUATE CAPACITY FOR 10-YR

ADV PROP SVCS

JUNIPER DRY CREEK

RP

IWS

INVERNESS DR E

INVERNESS PROPERTIES WET POND INVERNESS WATER & SANITATION

THREE CULVERTS 36", 42", 42"

INVERNESS MAIN ST

MGMA REALTY

COTTONWOOD CREEK MAINSTEM

INVERNESS TRIBUTARY

ECHOSTAR REAL ESTATE

BHIF HOLDINGS

INVERNESS TRIBUTARY

PERMANENT DRAINAGE EASEMENT SEMSWA

SUB-REACH 2

INVERNESS GOLF COURSE

BHIF HOLDINGS

PROBLEM AREA #1 EROSIONAL CHANNEL

PROJECT IT1: ADAPTIVE STREAM MANAGEMENT WITH TARGETED GRADE CONTROL.

GS

UNK

24" RCP

PROJECT IT2: REMOVE CONCRETE CHANNEL LINING AS ERODES. TARGETED GRADE CONTROL. WIDEN CHANNEL. (IN PROGRESS)

SUB-REACH 1

36" RCP

CRITOBAL PROP

INVERNESS DR W

SAN MIGUEL VALLEY CORP

UC HEALTH

CITY OF CE

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- PRIVATE WET PONDS
- EASEMENTS
- MAJOR WATERSHED BASINS
- TRIBUTARY BASINS
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS
- COUNTIES AND CITIES
- CC LOMR 100-YR FW
- CC LOMR 100-YR FP
- CC LOMR 500-YR FP

STREAM CONDITION OVERALL SVAP*
- GOOD
- FAIR

OUTFALL OVERALL CONDITION*
- GOOD
- FAIR
- POOR

HEADCUT PRIORITY*
- MINOR
- MODERATE

CHANNEL GEOMORPHOLOGIC STATE*
- EROSIONAL

CROSSING CONDITION*
- GOOD
- FAIR

GRADE CONTROL CONDITION*
- STABLE
- MINOR

CHANNEL IMPROVEMENT PROJECTS
- ADAPTIVE STREAM MANAGEMENT
- STREAM RECLAMATION AND REHABILITATION
- STREAM RESTORATION

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
INVERNESS TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

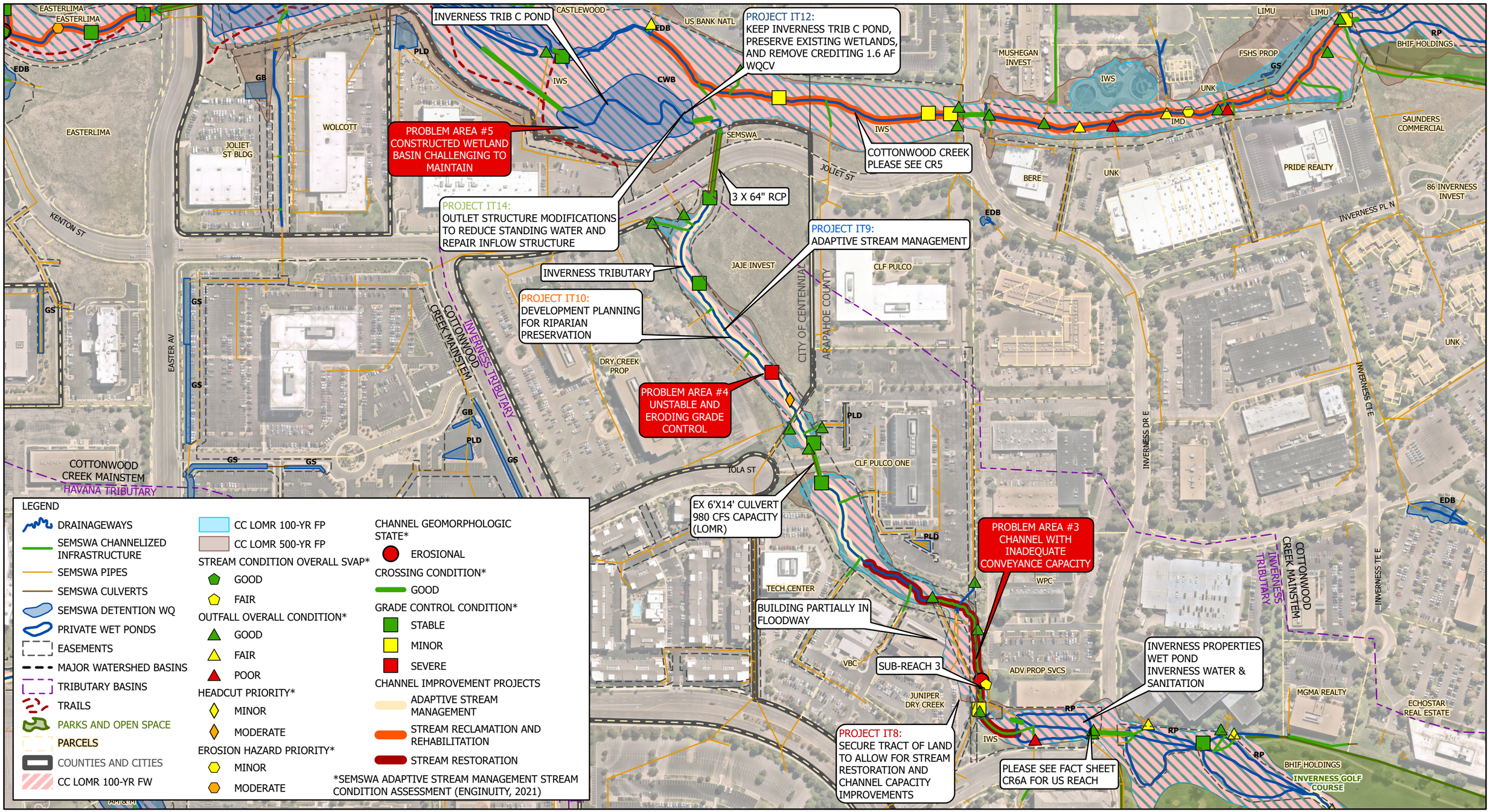
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1" = 200 FEET

0 100 200

PROJECT NO. 211-088.000

REACH CR6A



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
INVERNESS TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

REACH CR6B

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- CC LOMR 100-YR FW
- CC LOMR 100-YR FP
- CC LOMR 500-YR FP
- EASEMENTS
- MAJOR WATERSHED BASINS
- TRIBUTARY BASINS
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS
- COUNTIES AND CITIES

STREAM CONDITION OVERALL SVAP*
- GOOD

OUTFALL OVERALL CONDITION*
- GOOD

EROSION HAZARD PRIORITY*
- MINOR
- MODERATE

CHANNEL GEOMORPHOLOGIC STATE*
- DEPOSITIONAL
- EROSIONAL

CROSSING CONDITION*
- GOOD

GRADE CONTROL CONDITION*
- STABLE
- MINOR

CHANNEL IMPROVEMENT PROJECTS
- ADAPTIVE STREAM MANAGEMENT
- STREAM RECLAMATION AND REHABILITATION

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

PEORIA TRIBUTARY
FAMILY SPORTS CENTER GOLF COURSE
ACAA
UPD INOVA
CITY OF CENTENNIAL
ARAPAHOE COUNTY
AC
EDB
2011 COMPLETED CIP MINOR CHANNEL IMPROVEMENTS/DROP STRUCTURE INSTALL
EASTER AV
INVERNESS REGIONAL POND 29.2 AF EURV
PLEASE SEE FACT SHEET CR9 FOR DOWNSTREAM REACH
PEAKVIEW AV
ROADWAY CROSSING CAPACITY ~5600 CFS (LOMR)
LINCOLN EXECUTIVE CENTER POND COMPLETED CIP REGIONAL FACILITY WITH WATER QUALITY
PROJECT CC26: BANK STABILIZATION BETWEEN BRIARWOOD AND ARAPAHOE RD
PROBLEM AREA #2 BANK INSTABILITY
SEMSWA
LIMA ST
JP MORGAN
CENTENNIAL CORNERS
COTTONWOOD CREEK
EASTERLIMA
PLEASE SEE FACT SHEET CR5 FOR UPSTREAM REACH
BPAZ HOLDINGS
SUB-REACH 2
EX TRIPLE BOX CULVERT ~4900 CFS CAPACITY (LOMR)
KSE MEDIA
ZACHER
PRIVATE
BRIARWOOD AV
GBS
MCCAIN PROP
SELF STORAGE
PROJECT CC24: STREAM RECLAMATION AND REHABILITATION WITH TARGETED GRADE CONTROL AND EROSION REPAIR
IWS
GB
SUB-REACH 1
PROBLEM AREA #1 EROSIONAL CHANNEL BETWEEN EASTER AND BRIARWOOD
EX TRIPLE BOX CULVERT W/ RISER ~3700 CFS CAPACITY (LOMR) POTENTIAL ROAD WIDENING PROJECT
E ARAPAHOE RD
TWC
PRINTLABS
KENTON ST
CENTENNIAL CORNER PONDS
PROJECT CC28: SCOUR PROTECTION
ECE I
SEMSWA EASEMENT
JOLIET ST BLDG
GS
PROBLEM AREA #3 SEDIMENT DEPOSITION, STANDING WATER, AND DIFFICULT MAINTENANCE
PROJECT CC29: IMPROVEMENT OF POND FEATURES, INCLUDING FOREBAYS
ASC
HAVANA TRIBUTARY SEE FACT SHEET CR8
JOLIET ST
WAL-MART
ARAPAHOE CENT DEVLOPMT

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
INVERNESS REGIONAL POND TO LINCOLN EXECUTIVE CENTER POND
SOUTHEAST METRO STORMWATER AUTHORITY

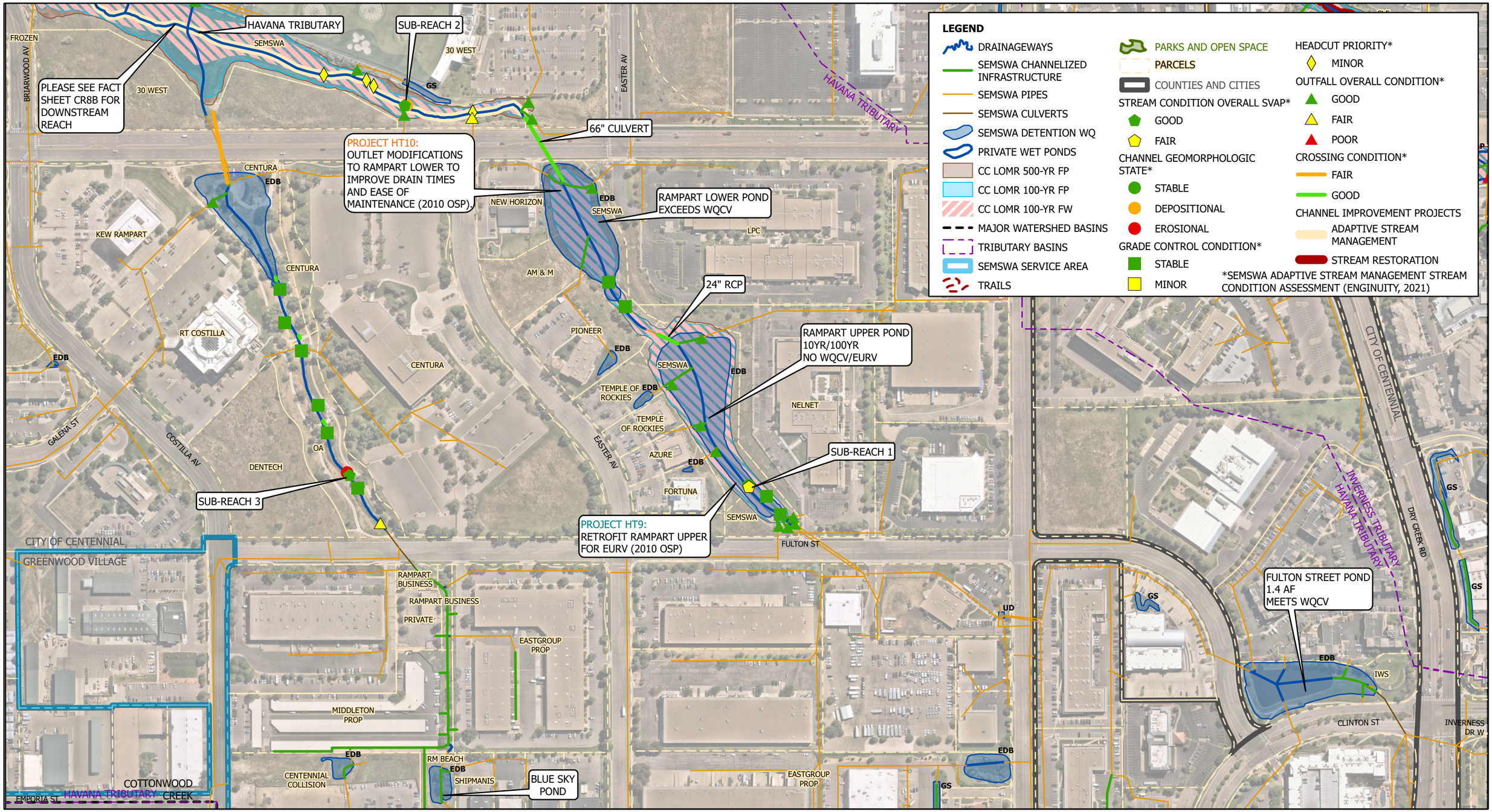
N

1" = 250 FEET

0 125 250

PROJECT NO. 211-088.000

REACH CR7



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
HAVANA TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

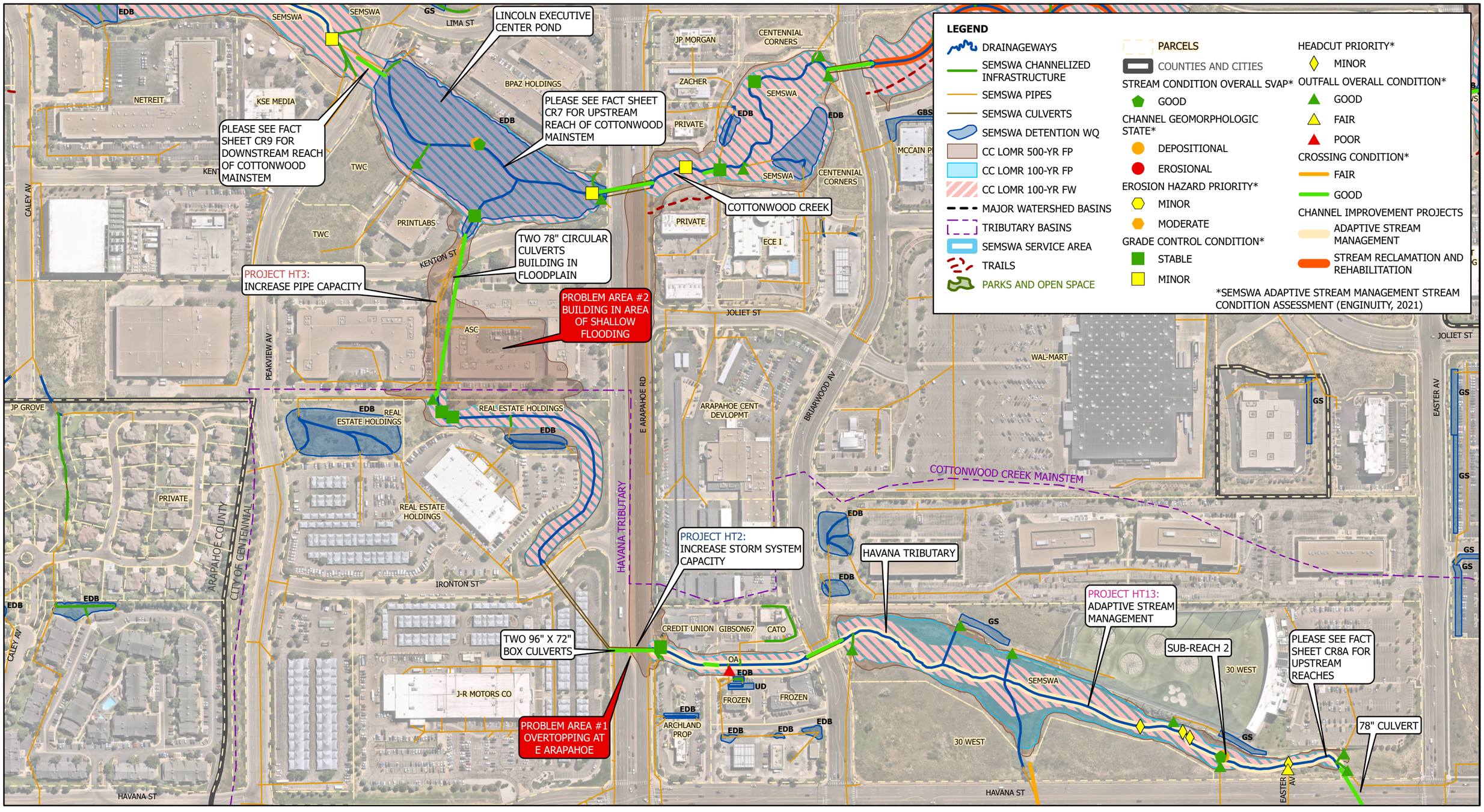
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1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

REACH CR8A



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
HAVANA TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

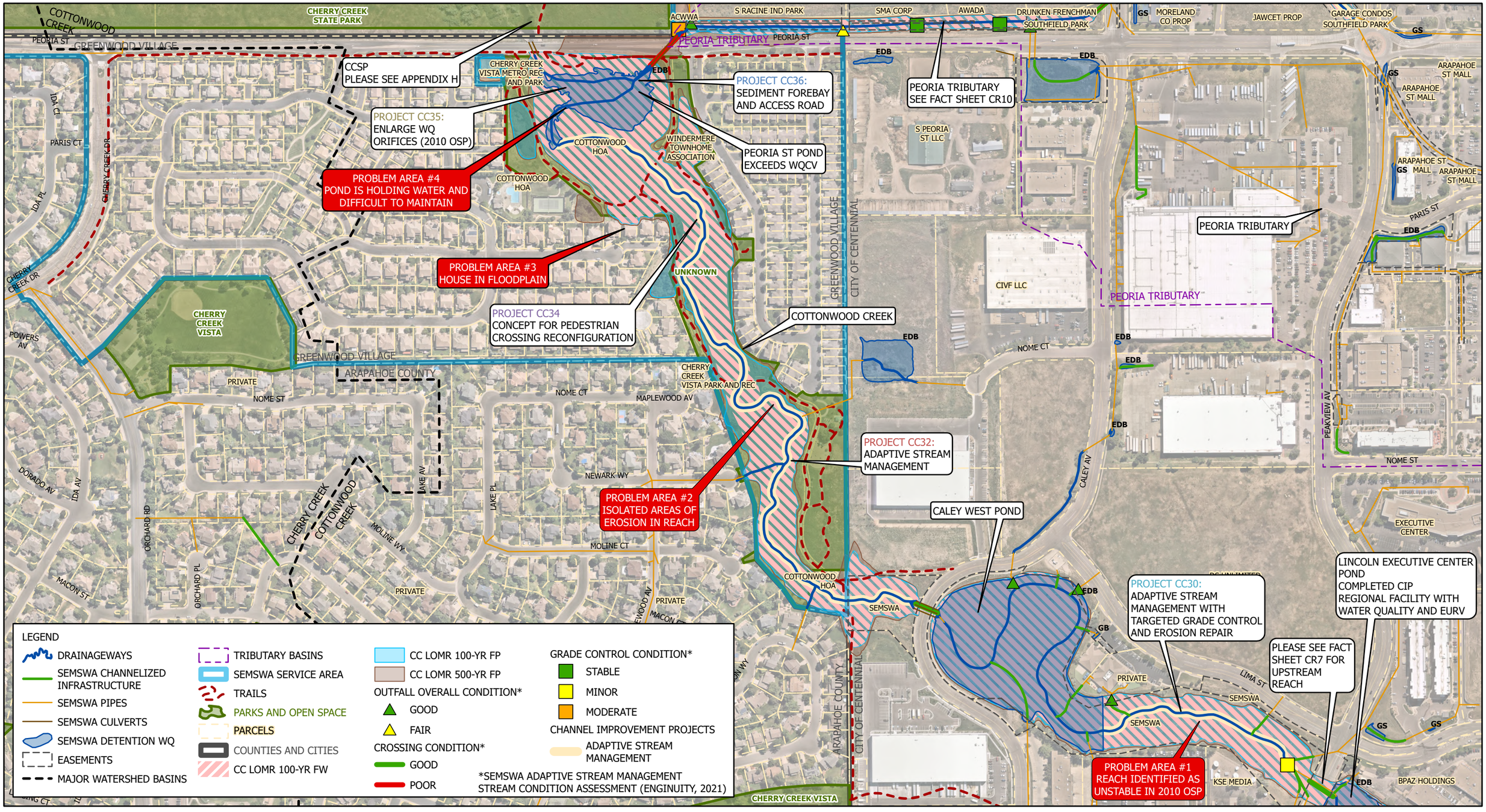
N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

REACH CR8B



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
LINCOLN EXECUTIVE CENTER POND TO PEORIA STREET POND
SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 350 FEET

0 175 350

PROJECT NO. 211-088.000

REACH CR9

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- CC LOMR 100-YR FW
- CC LOMR 100-YR FP
- CC LOMR 500-YR FP
- EASEMENTS
- MAJOR WATERSHED BASINS
- TRIBUTARY BASINS
- SEMSWA SERVICE AREA
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS
- COUNTIES AND CITIES

STREAM CONDITION OVERALL SVAP*
- GOOD
- FAIR

OUTFALL OVERALL CONDITION*
- GOOD
- FAIR

HEADCUT PRIORITY*
- MINOR

CHANNEL GEOMORPHOLOGIC STATE*
- DEPOSITIONAL
- EROSIONAL

CROSSING CONDITION*
- GOOD
- POOR

GRADE CONTROL CONDITION*
- STABLE
- MODERATE
- SEVERE

CHANNEL IMPROVEMENT PROJECTS
- ADAPTIVE STREAM MANAGEMENT
- STREAM RECLAMATION AND REHABILITATION

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

PROBLEM AREA #3 EROSIONAL CHANNEL

PROBLEM AREA #4 INFRASTRUCTURE IN NEED OF REPAIR/ REPLACEMENT

PLEASE SEE FACT SHEET CR9 FOR COTTONWOOD CREEK MAINSTEM

PEORIA TRIBUTARY

36" RCP
18" RCP

SUB-REACH 3

PROJECT PT3: ADAPTIVE STREAM MANAGEMENT AND DEVELOPMENT PLANNING

2 84" X 54" ELLIPTICAL RCP

PEORIA ST POND

CALEY EAST POND EURV PROVIDED

POTENTIAL ROAD PROJECT AT INTERSECTION OF BRIARWOOD AND PEORIA (BY OTHERS)

PROJECT PT1: STREAM RECLAMATION AND REHABILITATION WITH ISOLATED STRUCTURAL REPAIR

PROBLEM AREA #1 AGING INFRASTRUCTURE

COTTONWOOD CREEK

SUB-REACH 2

SUB-REACH 1

PROBLEM AREA #2 GOLF COURSE STRUCTURES IN FLOODWAY

AIRPORT POND C3/C4 EXCEEDS EURV

CITY OF CENTENNIAL
GREENWOOD VILLAGE
ARAPAHOE COUNTY
CHERRY CREEK STATE PARK
SOUTHFIELD PARK
ACWWA
SMA CORP
AWADA
DRUNKEN FRENCHMAN
GARAGE CONDOS
MORELAND CO PROP
JAWCET PROP
PEORIA ST
CHERRY CREEK VISTA METRO REC AND PARK
WINDERMERE TOWNHOME ASSOCIATION
S PEORIA ST LLC
COTTONWOOD HOA
UNKNOWN
CIVF LLC
CHERRY CREEK VISTA PARK AND REC
NOME CT
MAPLEWOOD AV
NEWARK WY
DS UNLIMITED
EXECUTIVE CENTER
ARAPAHOE ST MALL
PARIS ST
E ARAPAHOE RD
PEAKVIEW AV
BRIARWOOD AV
KW FUND
LONE TREE CREEK
COTTONWOOD CREEK
STATE OF CO
SKY HARBOR BUS PARK
REVERE PY
THOMSON LOGISTICS
ST MARK COPTIC ORTH CHURCH
QUENTIN ST PARTNERS
QUENTIN ST
NGP V DENVER
EASTER AV
WPC
FAMILY SPORTS CENTER
ACAA
FAMILY SPORTS CENTER GOLF COURSE
EDB
GS

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
PEORIA TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

REACH CR10

LEGEND

DRAINAGEWAYS
SEMSWA CHANNELIZED INFRASTRUCTURE
SEMSWA PIPES
SEMSWA CULVERTS
SEMSWA DETENTION WQ
PRIVATE WET PONDS

FEMA FLOOD ZONES
AE
PARKS AND OPEN SPACE
PARCELS & OWNER
MUNICIPAL BOUNDARY
EASEMENTS
MAJOR WATERSHED BASINS

PROJECT WC19:
ANALYZE STORM DRAIN SYSTEM CAPACITY

PROJECT WC20:
RETROFIT POND W-9 FOR SAFETY

POND W-9

EDB

RP

CHERRY CREEK STATE PARK

TRASON WESTLAND

CASTLE-PRIM LLC & STONE RIDGE CAPITAL

ACWWA

WINDMILL CREEK

LONE TREE CREEK

CITY OF CENTENNIAL

FAIR AV

FAIR PL

CALEY AV

CALEY DR

CALEY PL

WEAVER AV

WEAVER LN

ABILENE ST

POTOMAC ST

POTOMAC CT

PEAKVIEW AV

XANADU WY

XANADU ST

LONGVIEW AV

LONGVIEW PL

VALLEYVIEW AV

CARLSON DR

WORCHESTER ST

VAUGHN ST

UVALDA ST

CASTLE-PRIM

BERGER FOUNDATION

GS

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

WINDMILL CREEK SELECTED ALTERNATIVES
POND W-9

SOUTHEAST METRO STORMWATER AUTHORITY

N

1 IN = 200 FEET

0 100 200

PROJECT NO.
211-088.000

REACH
WR5

Appendices

Appendix A – Alternatives Analysis

Cottonwood Creek: Upper Skyridge Pond to Liberty Pond (Upstream of SEMSWA Service Area) Fact Sheet Reach CR1

Reach Description: The headwaters of Cottonwood Creek originate outside the SEMSWA service area in the southwest corner of the City of Lone Tree. The channel flows northeast, exiting city limits and entering unincorporated Douglas County at E Lincoln Ave. Flow continues north, crosses E-470, and enters SEMSWA service area just north of Liberty Blvd. The Cottonwood Creek OSP identified potential improvements along this reach, including two proposed new detention facilities, E-470 Pond and Liberty Pond. The Meridian Flashboard Dam was recommended for retrofitting to provide EURV detention, a new forebay and outlet structure, and the removal of accumulated sediment. Other proposed improvements included new detention facilities Lincoln West Pond, Lincoln Middle Pond, Lincoln East Pond, and Upper Skyridge Pond. It was recommended that Lower Skyridge Pond be retrofit for EURV. Lower Skyridge Pond was found to have less WQCV than calculations indicate is needed by the Hydrology Update (WWE, 2020).

Approximate length of reach (Upper Skyridge Pond to SEMSWA Service Area boundary): 3.5 miles

Sources: Enginuity 2021 Stream Condition Assessment; SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Approved Hydrology Update Report

Potential or Known Problem Areas:

#1 Lower Skyridge Pond: currently has less WQCV than calculations indicate is needed.

#2 Meridian Flashboard Dam: Not improved since OSP.

SEMSWA Adaptive Management Stream Condition Assessment:

This area falls outside SEMSWA service area.

Floodplain Mapping Summary Information:

Effective Date of FIRM: 12/17/2017

FIRM Panel: 08005C0500K

FEMA Flood Zone: AE Floodway, X (0.2 Pct annual chance flood hazard area), and X (Area of minimal flood hazard).

Previously Proposed Projects:

New detention facilities: Lincoln West Pond, Lincoln Middle Pond, Lincoln East Pond, Upper Skyridge Pond, E-470 Pond, and Liberty Pond.

Meridian Flashboard Dam: Retrofit to provide EURV detention. Provide new forebay and outlet structure and remove portion of accumulated sediment.

Lower Skyridge Pond: Retrofit for EURV.

Water Quality:

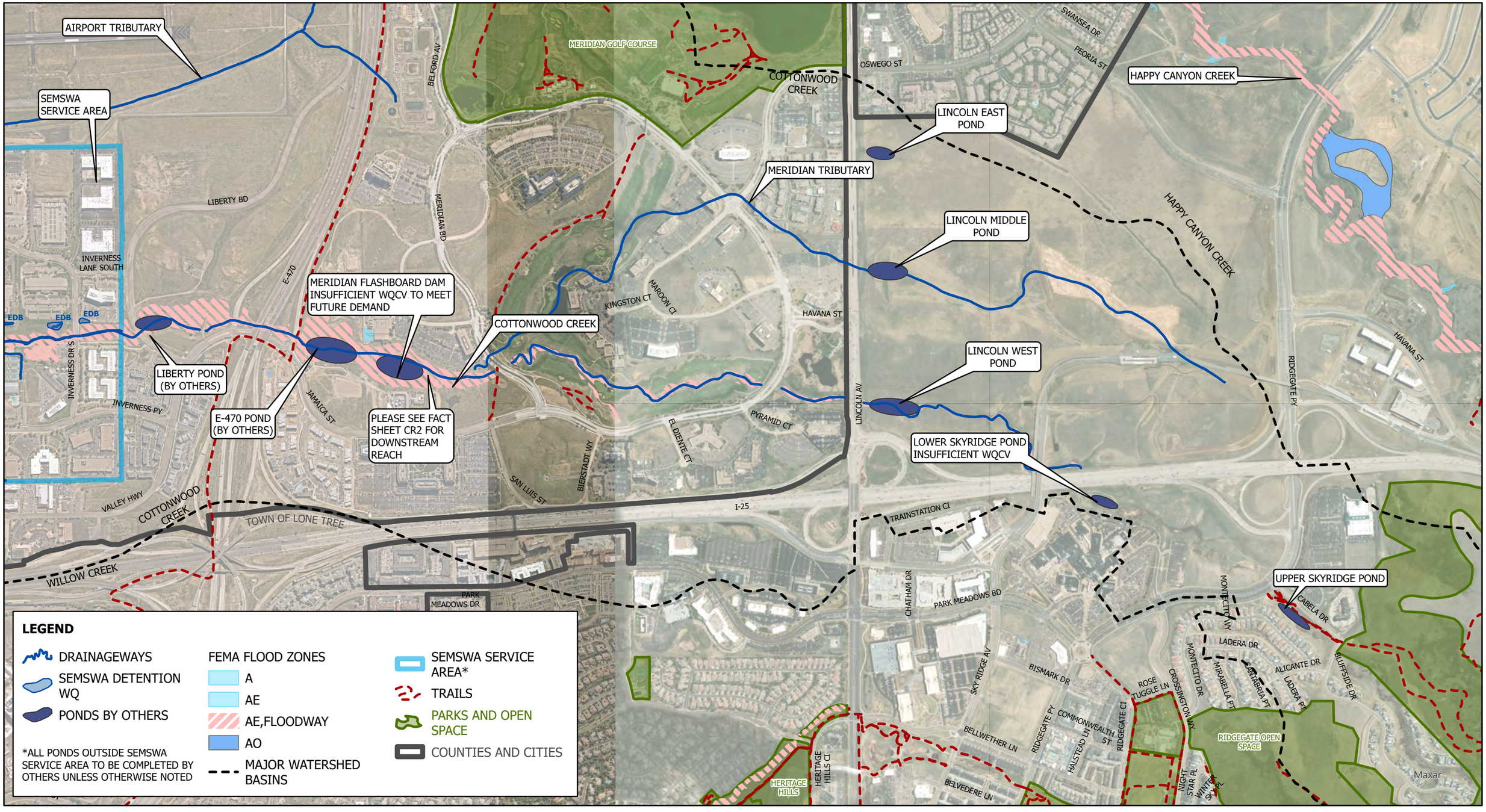
CDPHE river segment: COSPCH04b_A

Affected Use: N/A

Analyte: N/A

Category/List: N/A

NOTE: THIS MAP DOES NOT INCLUDE ANY PROPOSED PROJECTS WITHIN THE SEMSWA SERVICE AREA AND IS SHOWN FOR INFORMATIONAL PURPOSES ONLY



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WRIGHT WATER ENGINEERS, INC.

DOUGLAS COUNTY, COLORADO

COTTONWOOD CREEK OUTSIDE SEMSWA SERVICE AREA

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 1,000 FEET

0 500 1,000

PROJECT NO. 211-088.000

APPENDIX A

REACH CR1

Cottonwood Creek: Liberty Pond to Inverness Way
Fact Sheet Reach CR2

Reach Description: Cottonwood Creek enters SEMSWA jurisdiction just north of Liberty Blvd. The channel between Liberty Blvd and the confluence with Airport Tributary has been previously identified as requiring moderate work. A drop structure just south of Inverness Dr S has vegetation growing in the low flow notch causing 6" of ponding behind the drop, and two bank erosion hazards have been located along the reach just east of the sand volleyball courts. Several outfalls along this reach are in "fair" condition and in need of maintenance. The channel is described as "erosional" and has been identified for a possible future capital improvement project to address exposed utilities and bank undercutting. Several detention ponds are located a short distance from the drainageway.

Approximate length of reach: 0.8 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Approved Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010, 2/17/2017
FIRM Panel: 08005C0500K, 08005C0478L
FEMA Flood Zone: AE Floodway, X (0.2 Pct annual chance flood hazard), and X (Area of minimal flood hazard).

Zoning:
Surrounding areas are zoned Planned Development, Light Industrial, and Open Space.

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A

Community Resources:
The Inverness Wet Pond resides in John Derry Park. Cottonwood Creek flows along the eastern boundary of John Derry Park and continues along the western boundary of Colorado Early Colleges Inverness High School.

A sidewalk borders the channel to the west from the SEMSWA south boundary all the way to Inverness Way downstream of John Derry Park.

Strategies for adding value along the drainage corridor for the community:
The bordering sidewalk provides recreational value to the surrounding community. Any opportunity to improve the channel may be considered an added amenity and should consider expanding this system.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Stream Health
Floodplain Connectivity	Good
Overall Quality SVAP	Good
Bank Stability	7
Riparian Quality	7
Riparian Quantity	8
Nutrient Enrichment	10

**A higher score is indicative of greater stream health*

Potential or Known Problem Areas:

Potential or Known Problem Areas	Alternatives
#1 Insufficient WQCV upstream of SEMSWA service area boundary	**Project CC1:** Retrofit Meridian Flashboard Dam Pond for EURV (2010 OSP) and WQCV
	Project CC2: Increase capacity of Meridian Flashboard Dam Pond to attenuate peak flow
	Project CC3: Construct E-470 Pond and include EURV (2010 OSP) and WQCV
	Project CC4: Construct Liberty Pond and include EURV (2010 OSP) and WQCV
#2 Ponding behind drop structure	**Do nothing. Maintain as is.**
	Project CC6: Retrofit drop structure to ease maintenance
#3 Channel from Inverness Dr S to Inverness Way high erosion hazard and exposed utilities	**Do nothing**
	Project CC5: New Extended Detention Basin (EDB) with WQCV upstream of Inverness Drive South
	Project CC7: New EDB with WQCV downstream of Inverness Drive South
	Project CC8: Stream reclamation and rehabilitation with targeted grade control and bank stabilization
	Project CC9: Large-scale channel improvements from Inverness Dr S to Inverness Way (2010 OSP)

Potential Improvement Areas:

Water Quality: There is currently a shortage of WQCV in the upstream reaches of Cottonwood Creek in Douglas County, with the only current WQCV treatment occurring at Lower Skyridge Pond. The 1.3 ac-ft provided at Lower Skyridge is insufficient to meet the future WQCV demand. The previous OSP (2010) recommended a retrofit of Meridian Flashboard Dam to incorporate WQCV and EURV. The construction of two new ponds, E470 Pond and Liberty Pond was also proposed in the 2010 OSP. Both would include treatment of the EURV and WQCV. None of the recommended pond improvements in Douglas County have been completed to-date, resulting in an existing and future cumulative WQCV deficit at the SEMSWA County Line. However, for the purposes of project planning in this MDP, which deviates from the 2010 OSP in that it only focuses on the SEMSWA service-area, WQCV crediting will assume that upstream deficit will be resolved post-development. **Projects CC1**, **CC3**, and **CC4** carry over the recommended improvements from the 2010 OSP for Meridian Flashboard Dam (15.0 ac-ft WQCV/EURV), E470 Pond (21.9 ac-ft WQCV/EURV), and Liberty Pond (10.0 ac-ft WQCV/EURV). None of these projects are evaluated further in this MDP given their location outside of the SEMSWA service-area boundary.

Since some of the downstream channel degradation can be attributed to this WQCV deficit, opportunities to increase WQCV treatment along Cottonwood Creek within the SEMSWA service-area are explored in **Projects CC5** and **CC7** to address current channel degradation downstream. Two potential locations for new detention ponds that may include WQCV are located north and south of Inverness Dr S, **Project CC5** and **Project CC7**, respectively. Both are highly constrained by nearby developments, flood elevations, and complex permitting requirements.

Pond Capacity: The construction of a new pond in this upstream reach would provide additional detention and help to mitigate channel degradation occurring downstream due to a shortage of detention upstream. Two locations are considered for new ponds. **Project CC5** proposes a new EDB upstream of Inverness Dr S. This area is currently owned by Inverness Water and Sanitation. A smaller on-site EDB is located downstream of Inverness Dr S and could be absorbed into a larger semi-regional pond (**Project CC7**). The site is privately owned and an agreement with the owner would need to be pursued for SEMSWA to accept maintenance responsibility.

Channel Capacity: Cottonwood Creek enters the SEMSWA service area just north of Liberty Blvd. The channel upstream of Inverness Dr S appears to have been increasing in vegetation density for the past decade or more according to historical imagery and observation. The SEMSWA Stream Assessment Study (Enginuity, 2021) survey of channel condition identified willows growing along the drop structure upstream of Inverness Dr S as contributing to ponding behind the drop structure. **Project CC6** proposes improvements to the drop structure to facilitate drainage and make maintenance easier.



Inverness Drive East Upstream (Google, 2023)

The channel between Inverness Dr S and Inverness Way has been described as highly erosional (Enginuity, 2021), with two major erosion areas identified east of the Inverness Park sand volleyball courts. Along this reach, utilities have been exposed and bank undercutting can be seen. The 2010 OSP identified this reach as requiring moderate work. There is a shortage of detention and water quality treatment in the upstream reaches of Cottonwood Creek outside of the SEMSWA service area that is likely contributing to channel degradation downstream. All upstream pond improvements would likely also benefit channel stability downstream (**Project CC1**, **Project CC2**, **Project CC3**, **Project CC4**, **Project CC5**, and **Project CC7**). The most appropriate approach to addressing the erosion along this reach may depend in part on what upstream pond projects are, or are not, chosen. Work in the channel itself may also improve stability. **Project CC8** proposes stream reclamation and rehabilitation with targeted bank stabilization to improve channel stability, while **Project CC9** proposes larger-scale channel improvements from Inverness Dr S to Inverness Way. This was recommended in the 2010 OSP as needing a "moderate" amount of work including over 19 new drop structures and a revised channel invert.

Pipe Capacity: No pipe capacity issues are identified along this reach of Cottonwood Creek.

Maintenance: Any channel improvement projects should consider opportunities to locate structures in the channel for sediment capture and removal from the system, reducing sedimentation of ponds downstream and making channel and pond maintenance easier.



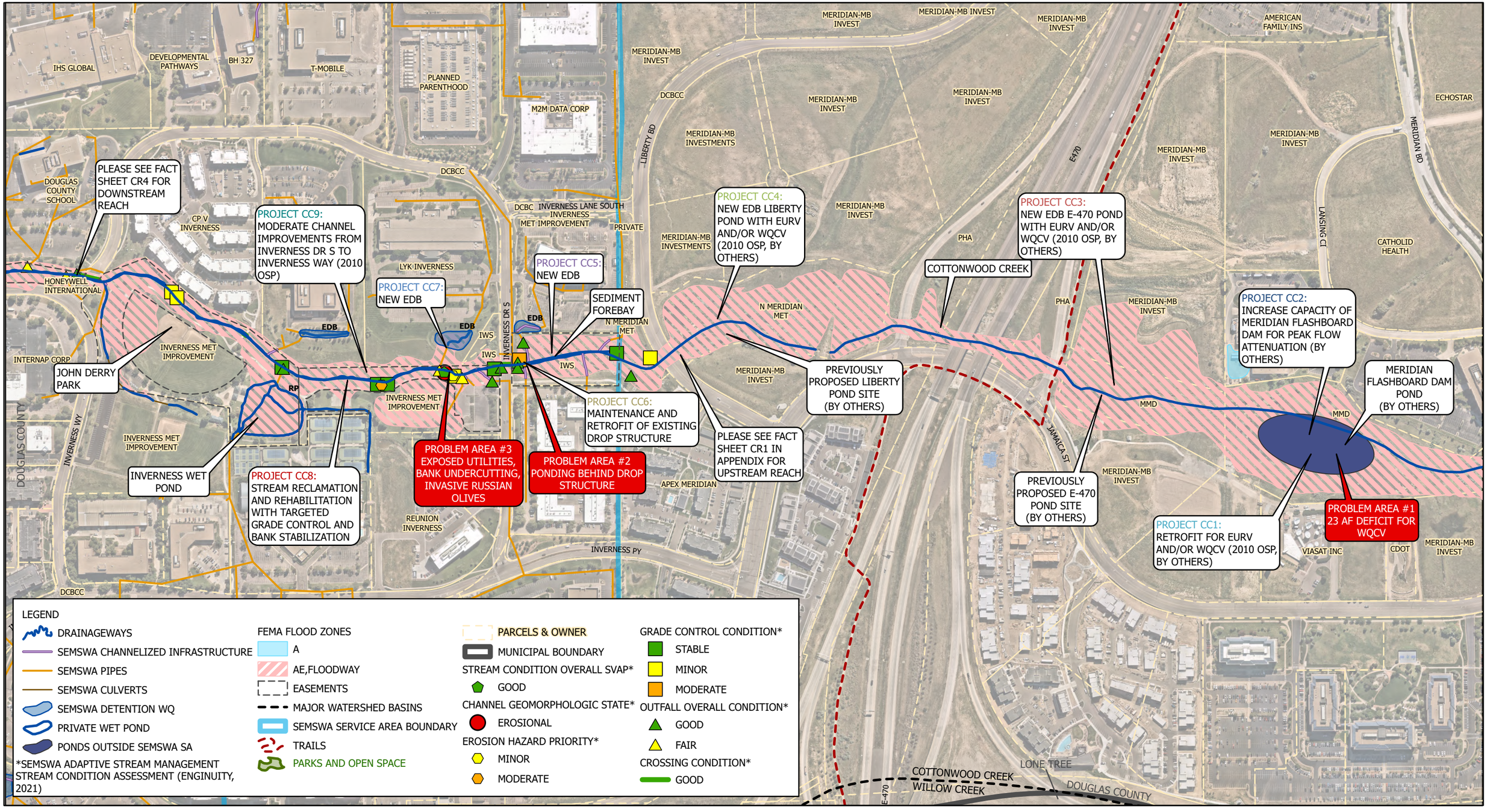
Cutbank near Inverness Park sand volleyball courts (Enginuity, 2020)



Severe Erosion near Inverness Park sand volleyball courts. (Enginuity, 2020)

EURV: The addition of EURV treatment to any new or existing ponds will benefit the downstream channel by attenuating the increase in peak flows resulting from added impervious surfaces. Pond **Projects** **CC1**, **CC3**, and **CC4** all include opportunities for the addition of EURV treatment to new or existing ponds. However, since these projects are all upstream of the SEMSWA service area, none of these projects are evaluated further in this MDP.

Wetlands: This reach is well vegetated with nearly continuous jurisdictional wetland areas. Preserving or restoring existing wetlands while providing discrete locations for sediment removal should be a priority in any project selected. Projects disturbing jurisdictional wetland areas will need to secure the appropriate permits.



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WRIGHT WATER ENGINEERS, INC.

DOUGLAS COUNTY, COLORADO

COTTONWOOD CREEK ALTERNATIVES
LIBERTY POND TO INVERNESS WAY
SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

APPENDIX A
REACH CR2

Cottonwood Creek: Airport Tributary
Fact Sheet Reach CR3

Reach Description: Airport Tributary to Cottonwood Creek begins outside the SEMSWA service area in unincorporated Douglas County. Meridian Northeast Pond is located just north of E-470 where Liberty Blvd curves to the northeast and has been recommended for modifications to provide EURV. The pond currently has less WQCV than calculations indicate is needed. The channel flows to the north where it enters the SEMSWA service area just south of the Arapahoe/Douglas County line, follows the southwest shore of Inverness Reservoir, and discharges into the main stem of Cottonwood Creek in the Inverness Golf Course. The channel is classified as "depositional," and some scour has been noted along the reach. The pedestrian crossing just upstream of the confluence is classified as being in "fair" condition with some corrosion.

Approximate length of reach: 1.7 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity, 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Approved Hydrology Update Report

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Stream Health
Floodplain Connectivity	Good
Overall Quality SVAP	Good
Bank Stability	9
Riparian Quality	4
Riparian Quantity	8
Nutrient Enrichment	7

**A higher score is indicative of greater stream health; this assessment was only performed within the SEMSWA service area*

Potential or Known Problem Areas:

Potential or Known Problem Areas	Alternatives
#1 Meridian Northeast Pond currently has less WQCV and EURV than calculations indicate is needed.	**Do nothing**
	Project AT1: Modify to provide EURV per previous OSP (by others)
	Project AT2: Add new pond downstream of confluence with west minor tributary and south of airport maintenance road
	Project AT3: Complete Airport South Pond: New detention facility proposed by previous OSP
#2 "Depositional" reach and a pedestrian crossing in "fair" condition.	**Do nothing**
	Project AT4: Channel improvements and stream restoration per previous OSP (2010)
	Project AT5: Adaptive stream management as needed to stabilize the channel

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010, 2/17/2017
FIRM Panel: 08005C0500K, 08005C0478L
FEMA Flood Zone: X (Area of minimal flood hazard). No riverine floodplain along this reach of Airport Tributary has been designated by FEMA.

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A

Zoning:
Surrounding areas are zoned Planned Development, Centennial Airport Review Area (CARA) Overlay District, Light Industrial, and Rural Residential.

Community Resources:
A trail winds around Inverness Reservoir. However, there is a "No Trespassing" sign at the access on County Line Road.

Strategies for adding value along the drainage corridor for the community: Opportunities for adding community value are limited along Airport Tributary given that the majority of the reach is located within Centennial Airport and is inaccessible to the public.

Potential Improvement Areas:

Pond Features: The 2010 OSP recommended modifications to the outlet structure of Meridian Northeast Pond to add EURV detention along Airport Tributary and help control peak flow rates along this reach. This recommendation is carried over into the current Master Plan in **Project AT1**.

Pond Capacity: The 2010 OSP for Cottonwood Creek recommended pond projects along Airport Tributary to address increased flow rates. **Project AT3** proposes the building of the new Airport South Pond just inside the SEMSWA service area boundary and south of Inverness Reservoir. The pond is intended to be a full regional detention facility that will help to alleviate increased flows along Airport Tributary. Alternatively, **Project AT2** proposes the building of a new detention facility approximately 500 feet downstream of Meridian Northeast Pond, just downstream of the confluence with the west minor tributary.



Airport Tributary at Inverness Reservoir

Channel Capacity: The Enginuity survey completed for SEMSWA in 2021 identified the occurrence of deposition along Airport Tributary. Field assessment in the SEMSWA service area showed a well vegetated stable channel without much degradation. Pond projects will help to control peak flow rates and improve channel stability. **Project AT4** proposes channel improvements and stream restoration, as suggested in the 2010 OSP. Previously suggested projects to provide channel stabilization include drop structures, channel grading, and revegetation. These improvements are proposed downstream of the county line to the confluence with the Cottonwood Creek main stem. Upstream of the SEMSWA service-area there are some portions of the channel with eroded areas that could benefit from the addition of wetland vegetation to the stream bed. This is not evaluated as a formal project in this MDP due to the relatively small scale and given that it is outside of the SEMSWA service-area. **Project AT5** proposes adaptive stream management strategies as needed to repair localized erosion.

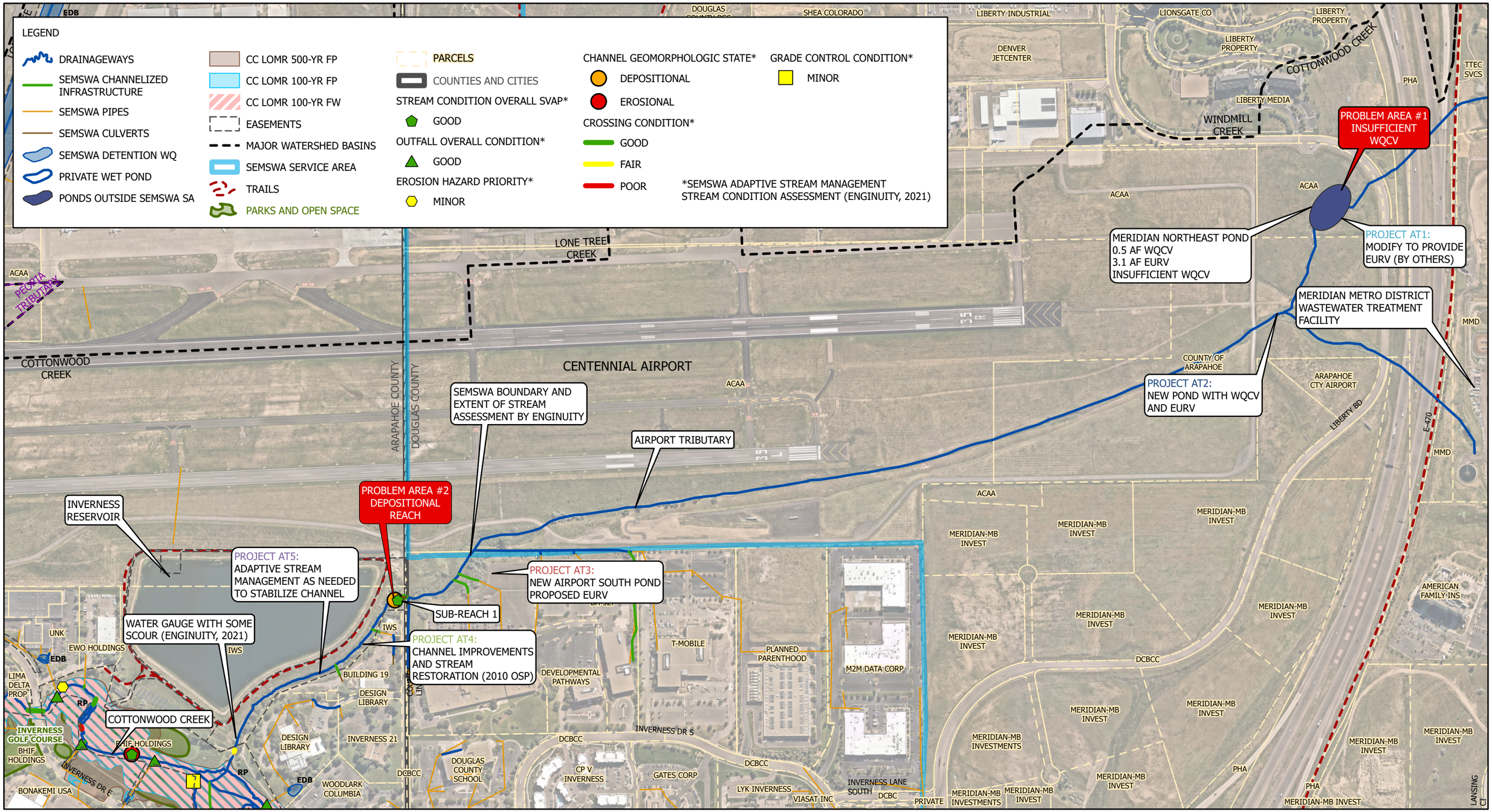
Pipe Capacity: There are no pipe capacity issues identified along this reach. Corrosion of a pedestrian crossing near the confluence with Cottonwood Creek should be evaluated with **Project AT4.**

Maintenance: No maintenance issues have been identified along this reach.

Water Quality: The Meridian Northeast Pond currently provides 0.5 acre-feet of WQCV, which is insufficient to treat the current demand of 1.0 acre-feet and the future demand of 1.1 acre-feet. A retrofit to the Meridian Northeast Pond to provide full WQCV should be evaluated with **Project AT1**. New WQCV facilities are recommended in both **Projects AT2** and **AT3**.

EURV: The previous OSP recommended outlet modifications to Meridian Northeast Pond to provide EURV for Airport Tributary. New full spectrum facilities are recommended in both **Projects AT2** and **AT3**.

Wetlands: This reach has a poor riparian quality with several identified wetland areas. Preserving or restoring existing wetlands and the riparian buffer while providing discrete locations for sediment removal should be a priority in any project selected.



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ARAPAHOE AND DOUGLAS COUNTIES, COLORADO

AIRPORT TRIBUTARY ALTERNATIVES

SOUTHEAST METRO STORMWATER AUTHORITY

WRIGHT WATER ENGINEERS, INC.

N

1" = 500 FEET

0 250 500

PROJECT NO. 211-088.000

APPENDIX A

REACH CR3

Cottonwood Creek: County Line Rd to Carrie's Pond
Fact Sheet Reach CR4

Reach Description: The channel between County Line Rd and Carrie's Pond has been identified as needing moderate work along most of the reach. Scour has been noted at the check dam just downstream of the Unnamed Pond located at the confluence with Airport Tributary. The channel is "erosional" with two crossings in "poor" condition, one with a submerged outlet, the other with no flow at the outlet, possibly due to piping. Two locations have been identified with hazard indices of "high" or "very high." Two outfalls are in "poor" condition due to scour. Two sub-reaches have been identified for improvements due to bank instability, erosion, and the condition or capacity of infrastructure.

Approximate length of reach: 0.9 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity, 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Approved Hydrology Update Report

Completed Projects/Objectives:
None.

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0478L
FEMA Flood Zone: AE, AE Floodway, X (0.2 Pct annual chance flood hazard), and X (Area of minimal flood hazard).
2023 Cottonwood Creek LOMR: 100-yr Floodplain and 100-yr Floodway shown on map.

Zoning:
Surrounding areas are zoned Light Industrial, Mixed Use, Business Park, Floodplain, and Open Space.

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A

Community Resources:
Much of the channel in this area is on private land in the Inverness Regional Golf Course and is inaccessible to the public. The Inverness Reservoir has a trail that encircles it and connects to Inverness Drive East.

Strategies for adding value along the drainage corridor for the community:
Increased accessibility for the public to the waterway or riparian area should be explored with any alternative selected.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Stream Health
Floodplain Connectivity	Good
Overall Quality SVAP	Good
Bank Stability	7
Riparian Quality	6
Riparian Quantity	9
Nutrient Enrichment	10

**A higher score is indicative of greater stream health*

	Potential or Known Problem Areas	Alternatives
#1	Scour at outlet structure downstream of Unnamed Wet Pond	**Do nothing** **Project CC11:** Install rock at toe of dam of Unnamed Pond
#2	Channel downstream of Unnamed Wet Pond is "erosional" with a bank erosion hazard index of "high"	**Do nothing** **Project CC12:** Adaptive stream management with targeted erosion repair and infrastructure rehabilitation **Project CC13:** Large-scale channel improvements to address bank erosion and undersized culvert from Airport Tributary pond to Inverness Dr E (2010 OSP)
#3	Channel downstream of Unnamed Wet Pond has a crossing in poor condition with a submerged outlet	**Do nothing** **Project CC10:** Convert to open channel, relocate pond offline, and repair erosion
#4	Building may be in floodway.	**Do nothing** **Project CC15:** Large-scale channel improvements from Inverness Dr E to Carrie's Pond (2010 OSP) **Project CC19:** Widen channel near building **Projects CC2, CC3, CC4, CC5, CC7, CC10**
#5	Bank erosion is occurring in the channel from Inverness Dr E to Carrie's Pond	**Do nothing** **Project CC14:** Stream reclamation and rehabilitation with targeted grade control, bank stabilization, and infrastructure repair **Project CC15**
#6	Crossing in the golf course in poor condition with no flow at the outlet	**Do nothing** **Project CC16:** Upsize culvert **Project CC17:** Replace headwall and slipline culvert depending on site condition
#7	Other projects	**Project CC18:** Retrofit Airport Pond 1 to include outlet structure, EURV, and forebays (2010 OSP)

Potential Improvement Areas:

Pond Capacity: A building just north of Inverness Dr E might be in the floodway. Upstream projects that expand current ponds or involve the building of new ponds will help to attenuate peak flows and potentially lower the floodway elevation.



Channel Downstream of Airport Tributary Unnamed Wet Pond

Channel Capacity: The channel downstream of Unnamed Wet Pond in Inverness Golf Course is erosional with locations of bank instability. The previous OSP (2010) identified this reach of Cottonwood as requiring moderate work. Scour has been noted at the toe of the check dam of an unnamed wet pond at the Airport Tributary confluence. The channel downstream of the pond outfall has been classified as erosional with a bank hazard index of high. It is possible that this instability can be attributed to the recently repaired outlet structure by the Inverness Golf Course for the upstream unnamed wet pond at the Airport Tributary Confluence. Improvements to the channel itself are considered in **Projects CC12** and **CC13**, with small and large-scale approaches recommended, respectively. **Project CC12** would involve adaptive stream management and targeted erosion repair, while **Project CC13** would include large-scale improvements, as recommended in the 2010 OSP. The project(s) chosen to improve channel stability should be considered in the context of any upstream improvements that might provide attenuation of frequent flow events, such as the addition of WQCV or EURV treatment. Should EURV be added to the upstream watershed, targeted adaptive stream management strategies may be sufficient to improve the channel. To address scour downstream of the Airport Tributary unnamed wet pond outfall, **Project CC11** recommends the installation of rock at the toe.



Proposed Conversion to Open Channel

Bank erosion has also been identified in the channel downstream of Inverness Dr E. **Project CC14** proposes applying targeted rehabilitation of degraded areas that incorporates high functioning, low maintenance stream restoration strategies. **Project CC15** proposes large-scale channel improvements, as recommended in the 2010 OSP. These improvements include a revised channel profile and new drop structures. It appears from aerial imagery that a building just north of Inverness Dr E may be in the floodway. Any channel improvement projects should take into consideration a potential rise in the BFE. **Project CC19** proposes widening the channel near the building to reduce BFEs and potentially remove the building from the floodway. The culvert immediately downstream of this project is undersized for any flood event and is used as a golf cart path crossing. This crossing should be evaluated to see if relocating or configuring it can further improve the flood condition.

Pipe Capacity: A culvert crossing and pond near a golf course green approximately 400 ft upstream of Inverness Drive East is undersized. **Project CC10** proposes removing this culvert and potentially converting the wet pond to an open channel at this crossing. Due to utility conflicts, the feasibility of this alternative should be determined after field survey. If an open channel is not feasible, erosion should be repaired, and armoring added in areas where flows overtop.

A second culvert crossing under the golf course fairway was described by Enginuity (2021) as having no flow at the outlet and exhibiting cracking. The downstream portion of the headwall was recently repaired and there are two 200-foot-long parallel pipes crossing the golf course fairway, a 36” RCP and an 18” HDPE. The solution for this crossing may depend on a more detailed design assessment of the constraints. **Project CC17** proposes a retrofit headwall and sliplining one or both pipes. **Project CC16** proposes increasing the culvert capacity with larger or additional pipes and a new headwall.

Pond Features: The 2010 OSP recommended modifications to Airport Pond 1 including an outlet structure, EURV, and forebays. These recommendations are carried into the new MDP in **Project CC18**.



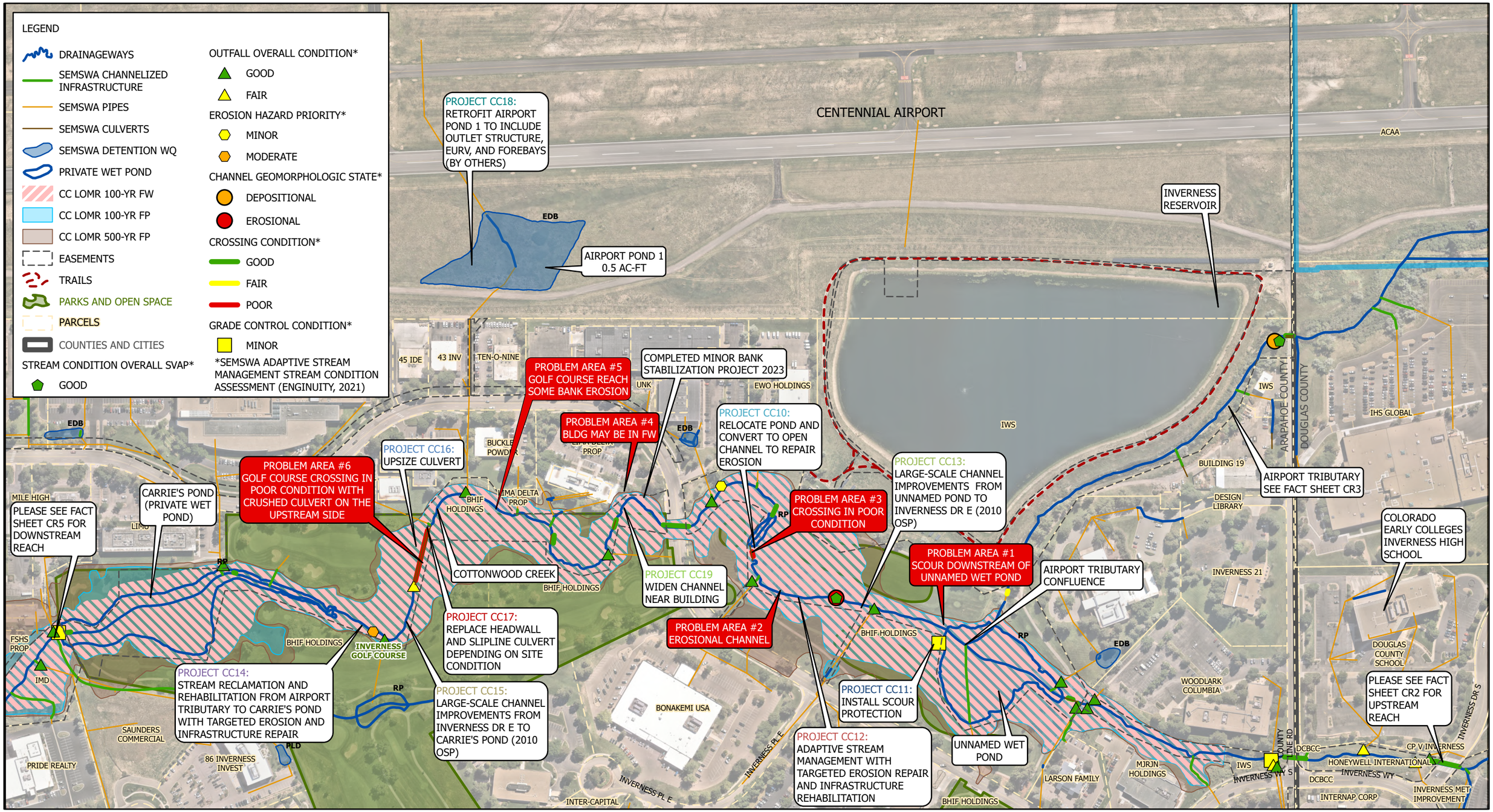
Culvert under golf course fairway

Maintenance: Alternatives chosen for implementation along this reach of Cottonwood Creek should consider including structures in the channel to facilitate sediment collection and removal, making channel and pond maintenance easier.

Water Quality: There is currently a shortage of WQCV in the reaches upstream of the SEMSWA service area boundary in Cottonwood Creek. Fact Sheet Reach CR2 describes potential opportunities to increase WQCV and EURV recommended for Cottonwood Creek in Douglas County in the 2010 OSP.

EURV: In addition to the Douglas County pond improvements, the 2010 OSP recommended modifications to Airport Pond 1 that include the addition of EURV. These recommendations are carried over in the new MDP in **Project CC18**.

Wetlands: This reach is well vegetated with nearly continuous jurisdictional wetland areas. Preserving or restoring existing wetlands while providing discrete locations for sediment removal should be a priority in any project selected. Projects disturbing jurisdictional wetland areas will need to secure the appropriate permits.



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK ALTERNATIVES
INVERNESS WAY TO CARRIE'S POND
SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

APPENDIX A

REACH CR4

Cottonwood Creek: Carrie's Pond to Inverness Regional Pond
Fact Sheet Reach CR5

Reach Description: The channel between Carrie's Pond and Inverness Drive E was identified as needing moderate work along most of the reach in the 2010 OSP. The 2021 Enginuity survey noted bank erosion and outfalls in fair or poor condition. Shortly after crossing Inverness Dr E, the channel discharges into Inverness Regional Pond, which was improved in 2014.

Approximate length of reach: 0.5 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity, 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0478L
FEMA Flood Zone: AE, AE Floodway, X (0.2 Pct annual chance flood hazard), and X (Area of minimal flood hazard).
2023 Cottonwood Creek LOMR: 100-yr Floodplain and 100-yr Floodway shown on map.

Zoning:
Surrounding areas are zoned Light Industrial, Mixed Use, Business Park, Floodplain, and Open Space.

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A

Community Resources:
A trail and maintenance path winds around Inverness Regional Pond and many people can be seen walking this area throughout the day.

Strategies for adding value along the drainage corridor for the community:
Provide trail connectivity to upper portion of pond inflow channel.

SEMSWA Adaptive Management Stream Condition Assessment:
Sub-reaches were not identified here, and stream condition assessment is as indicated on the attached map.

Completed Projects/Objectives:
Inverness Regional Pond: Improved in 2014.
Repaired erosion at outfalls between Carrie's Pond and Inverness Drive East in 2022.

Potential or Known Problem Areas	Alternatives
#1 Building may be in floodplain	**Do nothing**
	Project CC23: Widen channel near building
	Projects CC2, CC3, CC4, CC5, CC7, CC19
#2 Erosion along channel from Carrie's Pond to Inverness Dr E	**Do nothing**
	Project CC20: Stream reclamation and rehabilitation from golf course to Inverness Regional Pond with targeted erosion repair and outfall rehabilitation
	Project CC21: Large-scale channel improvements from Carrie's Pond to Inverness Dr E (2010 OSP)
#3 Other projects	**Project CC22:** Retrofit Airport Pond 2 to include outlet structure, EURV, and forebays (2010 OSP)
	Project CC37: Investigate improvements to improve maintenance to sediment forebay of Inverness Regional Pond

Potential Improvement Areas:

Pond Capacity: A building just downstream of Carrie's Pond may be in the 100-year floodplain. Any upstream project that expands the capacity of current ponds or involves the construction of new ponds should help to attenuate peak flows and potentially lower the floodplain elevation. This will likely occur upstream of the SEMSWA service area in Douglas County which will require coordination and a determination of allowable release rates for proposed ponds. Because the floodplain delineation is based on a hydrology update (WWE 2020) that used the surveyed actual, reduced volume of Meridian Flashboard Dam, and given that the 2010 OSP designated a larger volume detained upstream of the SEMSWA service-area, the modeling for an MDP in Douglas County should revisit this area to determine an allowable 100-year release rate to be referenced upstream which might eliminate flooding in some locations.

Channel Capacity: The channel downstream of Carrie's Pond exhibits evidence of instability with bank erosion index of "high" and outfalls in poor condition due to scour. **Project CC20** proposes stream reclamation and rehabilitation from the golf course to Inverness Regional Pond. This project would include applying grade control at targeted locations, using vegetation to stabilize the channel, possibly raising the channel invert at select locations, and rehabilitating degrading infrastructure, among other rehabilitation strategies. **Project CC21** proposes channel improvements along this reach, as described in the 2010 OSP, which included a revised channel invert and new drop structures for the entire reach from Carrie's Pond to Inverness Drive East. The selected approach should consider any potential changes to the base flood elevation that may impact the building in the floodplain. Upstream projects that include pond volume expansion might also add opportunities for additional reduced peak flows in the channel and influence the magnitude of channel work required for stabilization. **Project CC23** proposes widening the channel in the reach near the building in the floodplain to increase capacity and lower BFEs.

Pond Features: The 2010 OSP for Cottonwood Creek proposed modifications to Airport Pond 2 that include addition of a formal outlet structure, EURV, and maintainable forebays. This recommendation has been carried over into this MDP in **Project CC22**. The type of runoff from the Centennial Airport may influence which features are selected for the pond and should be evaluated during the design phase. For example, if there is a high loading of phosphorous during snowmelt due to de-icing activities, the designer may elect for a soft bottom trickle channel.

Maintenance: Alternatives chosen for implementation along this reach of Cottonwood Creek should consider including structures in the channel to facilitate sediment collection and removal, making channel and pond maintenance easier. **Project CC37** proposes improvements that will improve maintenance of the sediment forebay of Inverness Regional Pond.



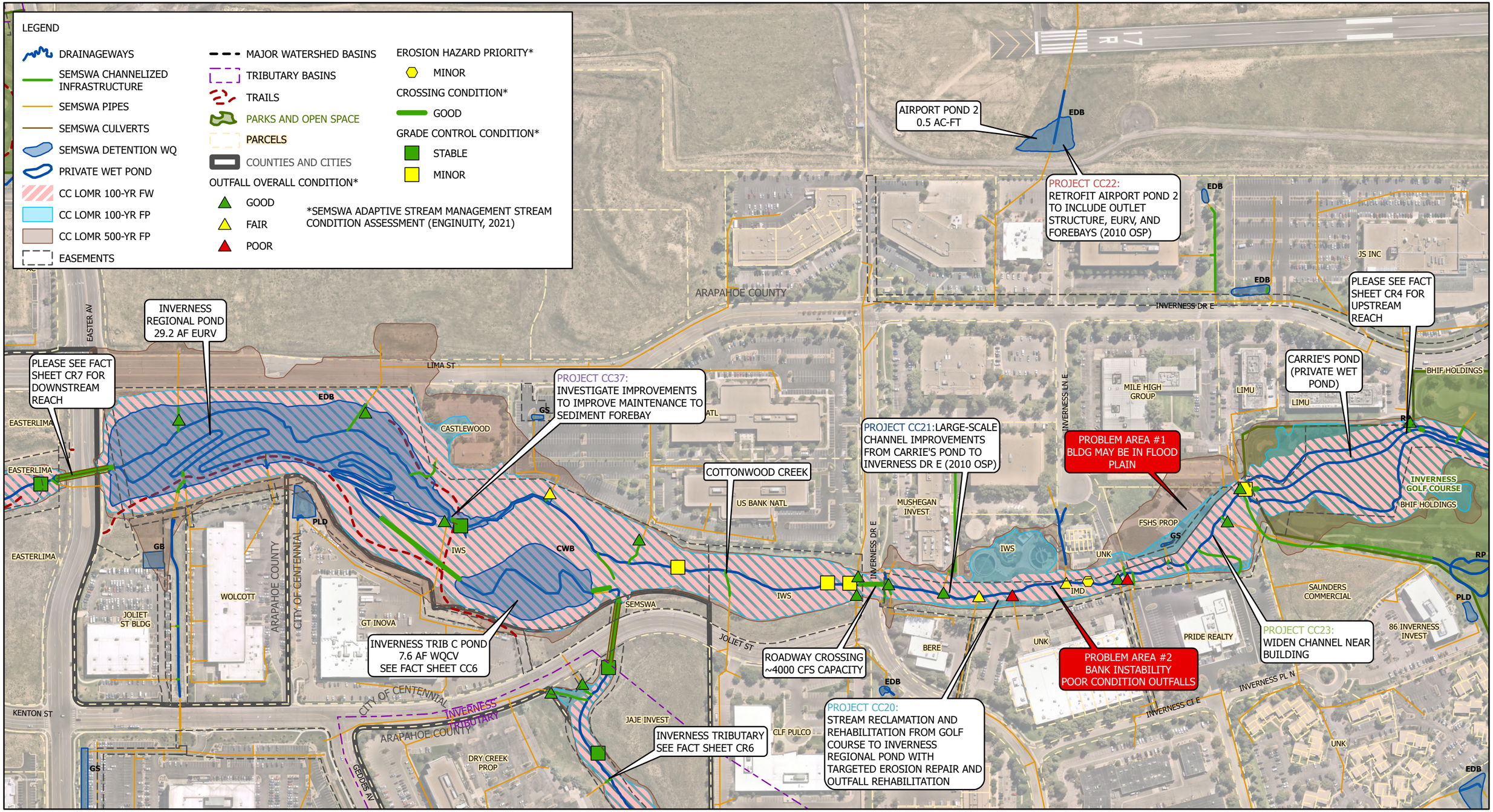
Cottonwood Creek between Carrie's Pond and Inverness Drive E. (Enginuity, 2020)

Water Quality: There is currently a shortage of WQCV in the upstream reaches of Cottonwood Creek in Douglas County. Fact Sheet Reach CR2 describes projects proposed in the 2010 OSP to increase WQCV and EURV along Cottonwood Creek before entering the SEMSWA service area. Because the contributing development to this deficit is outside of the SEMSWA service-area, this MDP assumes the upstream obligations with regard to WQCV will be met.

EURV: The 2010 OSP recommended modifications to Airport Pond 2 that include the addition of EURV. These recommendations are carried over in the new MDP in **Project CC22**. Inverness Regional Pond was improved to detain EURV in 2014 and there are no additional opportunities for retrofit along the main stem.

Pipe Capacity: No pipe capacity issues have been identified along this reach.

Wetlands: This reach of Cottonwood Creek has been identified as having USACE jurisdictional wetlands. **Projects CC20** and **CC21** would likely be complicated by these but would improve upon the existing condition.



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK ALTERNATIVES
CARRIE'S POND TO INVERNESS REGIONAL POND
SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

APPENDIX A

REACH CR5

Cottonwood Creek: Inverness Tributary
Fact Sheet Reach CR6

Reach Description: The watershed for Inverness Tributary to Cottonwood Creek begins just west of I-25 where it flows northeast as an open channel through the Inverness Golf Course. The reach has been classified as "erosional" with "minor" instability at an existing grade control structure due to concrete erosion (Enginuity, 2021). There is a headcut approximately 200 feet downstream of a wet pond owned and maintained by the golf course. Like other portions of the golf course, there are several small informal culvert and footbridge crossings that serve a recreational purpose. Three private wet ponds are located on the golf course and one downstream of the golf course owned and maintained by Inverness Properties. A network of pipes routes runoff from surrounding developed areas to the channel and pond. The reach downstream of the Inverness Properties Wet Pond has been identified as a potential future priority area for a project due to degradation and a building in the 100-year FEMA Floodway. The reach east of S Iola St has some erosion areas and instability with a handful of existing drop structures. Just east of S Joliet St, flow discharges into Inverness Tributary C Pond and from there into Inverness Regional Pond and the mainstem of Cottonwood Creek.

Approximate length of reach: 1.3 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity, 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Hydrology Update Report

Completed Projects/Objectives
None.

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0478L
FEMA Flood Zone: AE, AE Floodway, X (0.2 Pct annual chance flood hazard area), and X (Area of minimal flood hazard).
2023 Cottonwood Creek LOMR: 100-yr Floodplain and 100-yr Floodway shown on map.
Zoning:
Surrounding areas are zoned Light Industrial, Mixed Use, Business Park, Open Space, and Floodplain.

Community Resources:
The channel immediately upstream of Inverness Tributary C Pond is bordered on the south by vacant land and has informal running paths.

Strategies for adding value along the drainage corridor for the community:
Opportunities to extend walking paths up from Inverness Regional Park should be explored.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Sub-Reach 1	Sub-Reach 2	Sub-Reach 3
Floodplain Connectivity	Good	Good	Poor
Overall Quality SVAP	Fair	Good	Fair
Bank Stability	6	8	5
Riparian Quality	4	5	2
Riparian Quantity	8	9	4
Nutrient Enrichment	4	7	8

**A higher score is indicative of greater stream health*

Potential or Known Problem Areas	Alternatives
#1 Erosional Channel	**Do nothing**
	Project IT1: Adaptive stream management
	Project IT2: Remove concrete lining of channel as it erodes, targeted grade control, and channel widening
	Project IT3: Improve outlet structure on wet pond
	Project IT4: Large scale stream restoration through the golf course
	Project IT16: Add sediment forebay upstream of golf course
#2 Inadequate culvert capacity at Inverness Drive East	**Do nothing**
	Project IT5: Enlarge culvert capacity under Inverness Drive East
	Project IT6: Expand golf course pond to detain 10-year storm event
#3 Channel has inadequate conveyance capacity	**Do nothing**
	Project IT7: Expand Inverness Properties Wet Pond to include 100-year and retrofit outlet structure
	Project IT8: Secure tract of land to allow for channel improvements such as widening and straightening
#4 Unstable and eroding grade control structure	**Do nothing**
	Project IT9: Adaptive stream management with targeted stream stabilization and maintenance
	Project IT10: Development planning for riparian preservation
	Project IT15: Large scale stream restoration in Sub-Reach 3
#5 Constructed wetland basin is challenging to maintain	**Do nothing**
	Project IT11: Remove Inverness C Pond and 7.6 AF WQCV credit
	Project IT12: Keep Inverness C Pond, modify outlet, preserve existing wetlands, remove 1.6 AF WQCV credit
	Project IT13: Retrofit to be easier to maintain
	Project IT14: Modifications to outlet structure to promote drainage

Potential Improvement Areas:

Channel Capacity: The upstream reach of Inverness Tributary flows through the Inverness Golf Course. The most upstream portion, the channel between Inverness Drive West and the first of three golf course ponds, is lined with grouted boulder riprap. A drop structure is eroding, and the channel is in an overall fair and erosional condition. **Project IT2** proposes the removal of the concrete lining as it erodes and the installation of targeted grade control structures. It also proposes widening of the stream channel to a more stable naturalized stream section. This project is currently under design by the Inverness Golf Course and no further exploration of this alternative is needed in the MDP.



Grouted boulder-lined channel upstream in Inverness Regional Golf Course

Discharge leaves the first golf course pond through two pipes, a 42" straight pipe outfall and a 36" lateral pipe system. The main channel crosses a golf course path where flow enters an 18" culvert and flows under the path. This is common on golf courses where there are often small informal culvert and footbridge crossings not intended for flood control, which can sometimes cause headcuts due to flow overtopping. A headcut exists on the downstream side of the golf cart path and has been categorized as a "moderate" priority due to its proximity to nearby residential buildings (Enginuity, 2021). The *Data Collection, Assessment Methods, and Technologies Report* accompanying the Enginuity stream assessment states that headcuts are categorized as a threat to infrastructure if they reside within 100 ft of a structure. **Project IT3**, which includes improvements to the wet pond outlet structure, may also help control flow entering the channel here, reducing erosion. The channel between the golf course path and the 2nd of three golf course ponds is in overall good condition, although it is erosional and mostly straightened. **Project IT1** proposes adaptive stream management with monitoring and structural repair and replacement as needed. **Project IT4** proposes large-scale stream restoration, similar to the 2010 OSP, which included over forty feet of grade control. The entirety of the Inverness Tributary channel was slated for improvements in the 2010 OSP including a revised channel invert, over a dozen 2' drop structures, and two 6' grouted boulder rundowns. **Project IT4** is modified from the OSP to include widening of the channel and increasing sinuosity, both of which would require land dedication or acquisition from the golf course.

The channel downstream of Inverness Drive East has two 90-degree bends and limited flow capacity; the previous OSP identified this reach of Inverness Tributary as requiring major work. A nearby building, Dry Creek Surgery Center, is currently within the FEMA 100-year Floodway. Upstream flood detention expansion opportunities in **Project IT6** and **Project IT7** may mitigate flooding here and are discussed later in this fact sheet. **Project IT8** proposes that SEMSWA secure additional property to allow for stream widening and realignment to eliminate the sharp bends. Opportunities to secure adjacent properties for the channel widening include a fire "turn-around" adjacent to the Dry Creek Surgery Center, a grassy area just north of the Tetra Tech building, and a corner of the parking lot of Pulte Mortgage.



Golf Course Pond at Inverness Drive East

As the channel moves past the roundabout at the end of Iola St., a headcut is present and a grade control structure is in in "severe" condition due to heavy erosion and instability. **Project IT9** proposes adaptive stream management along this reach with targeted repair and maintenance. The erosion along this reach is partly from vegetation falling and causing side cutting around existing drop structures which include a handful of buried cutoff walls and one grouted boulder drop. There is a MHFD Stream Management Corridor width for this tributary of 132 feet to the upstream limit of the mapped floodplain. This is significantly larger than the current 85-foot easement along the channel between Joliet Street and Iola Street adjacent to an undeveloped four-acre parcel. **Project IT10** proposes development planning to increase the easement and riparian area to 132 feet to include the

regulatory floodway. This alternative can be incorporated into most other channel projects. **Project IT15** proposes large-scale stream restoration of Sub-Reach 3.

Pipe Capacity: Flow from the golf course is conveyed under Inverness Drive East by three culverts of 42”-, 42”-, and 36”-diameter. All three culverts are controlled by grated riser structures. The previous OSP identified this crossing as being in need of improvement and proposed upsizing the 36” CMP to a 48” RCP. The HEC-RAS model developed as part of the Cottonwood Creek LOMR and 2011 FHAD identifies overtopping at this crossing with a 2- to 5-year event. There has also been some overtopping reported to SEMSWA at the upstream end of this crossing. **Project IT5** similarly proposes enlarging the capacity of the culverts to accommodate the 10-year event, without overtopping. It should be noted that this inadequate capacity does not cause any buildings to be in the FEMA regulatory floodplain and is primarily due to the low freeboard between the pond riser structures and the roadway crest. **Project IT5** proposes enlarging the culvert capacity of the roadway crossing by adding culvert above the normal pool of the pond. Increasing flood detention upstream of this crossing might mitigate flooding at this crossing.

Pond Capacity: Opportunities to expand detention capacity along Inverness Tributary were explored to help alleviate overtopping at Inverness Drive East and channel capacity issues downstream. **Project IT6** proposes increasing the detention capacity of one of the upstream Inverness Golf Course wet ponds to accommodate the 10-year event. The three culverts downstream of the golf course, conveying flow under Inverness Drive East, are currently undersized to convey the 2-year event per the 2022 Cottonwood Creek LOMR and 2011 FHAD. An opportunity for increased detention could be provided with an expansion of the Inverness Properties Wet Pond proposed in **Project IT7,** which is in an easement shared by SEMSWA, and should be explored as an option to detain the 100-year event. Increasing detention here, just downstream of Inverness Drive East, would help alleviate channel capacity issues downstream where a building currently resides in the floodway (Dry Creek Surgery Center).

Maintenance: **Project IT16** proposes the installation of a sediment forebay where Inverness Tributary enters the golf course. This will improve maintenance of the channel and help to mitigate sediment accumulation in downstream ponds. This project is currently in the planning phase and no additional development will be performed as a part of this MDP.

Maintenance challenges exist at Tributary C Pond. In addition to the presence of wetlands that complicate maintenance, the pond appears to have been holding water for several years. This pond is an offline water quality pond just upstream of the confluence with the main stem of Cottonwood Creek. The inlet includes a high flow bypass structure which allows for only the WQCV to be directed to this pond with larger storm events discharging directly into Inverness Regional Pond. **Project IT13** proposes modifications to the pond to make maintenance easier. This project would include removing the standing water, clearing wetlands, and constructing sediment forebays and a trickle channel. **Project IT14** proposes modifications to the outlet structure that will improve drainage out of the pond. This may have the added benefit of promoting recession of the wetland vegetation to better observe how the pond is behaving and how it may be improved, as well as make future projects easier.



Sub-Reach 3 Downstream of Iola Street

Water Quality: Inverness Tributary Pond C is a wetland basin constructed in 2005 and currently provides WQCV in excess of that needed for the Inverness Tributary watershed. It also has been retaining much more water than was originally designed and constructed based on a review of aerial imagery. According to the *Approved Hydrology Update Report* (WWE, 2020), the future required WQCV is 6.0 AF for this watershed. Inverness Trib C Pond currently provides 7.6 AF. The excess WQCV provided brings some flexibility in assessing possible alternatives to alleviate the maintenance burden presented at Trib C Pond. **Project IT11** proposes the removal altogether of Inverness Tributary C Pond, which would include the removal of the 7.6 AF WQCV credit and some small flood detention currently provided by this pond. This would create a net deficit of 6.0 AF for WQCV in the Inverness Tributary. **Project IT12** proposes the pond be kept, but the WQCV credit be reduced by the excess volume of 1.6 AF. The reduction in WQCV crediting would allow for some loss of pond capacity and the associated cost of trying to maintain the design WQCV. This would relieve some of the cost of maintenance while still providing adequate WQCV for the upstream watershed. If selected, **Project IT12** will need to be implemented with a method to address retained water to address water rights regulations such as **Project IT14** described below.

Pond Features: **Project IT3** proposes improvements to the outlet structures on the first golf course wet pond to better control discharge and protect the downstream channel, which has a headcut and is categorized as erosional. **Project IT14** proposes modifications to the outlet structure on the Inverness Tributary C Pond that will improve drainage out of the pond. **Project IT13** involves constructing sediment forebays

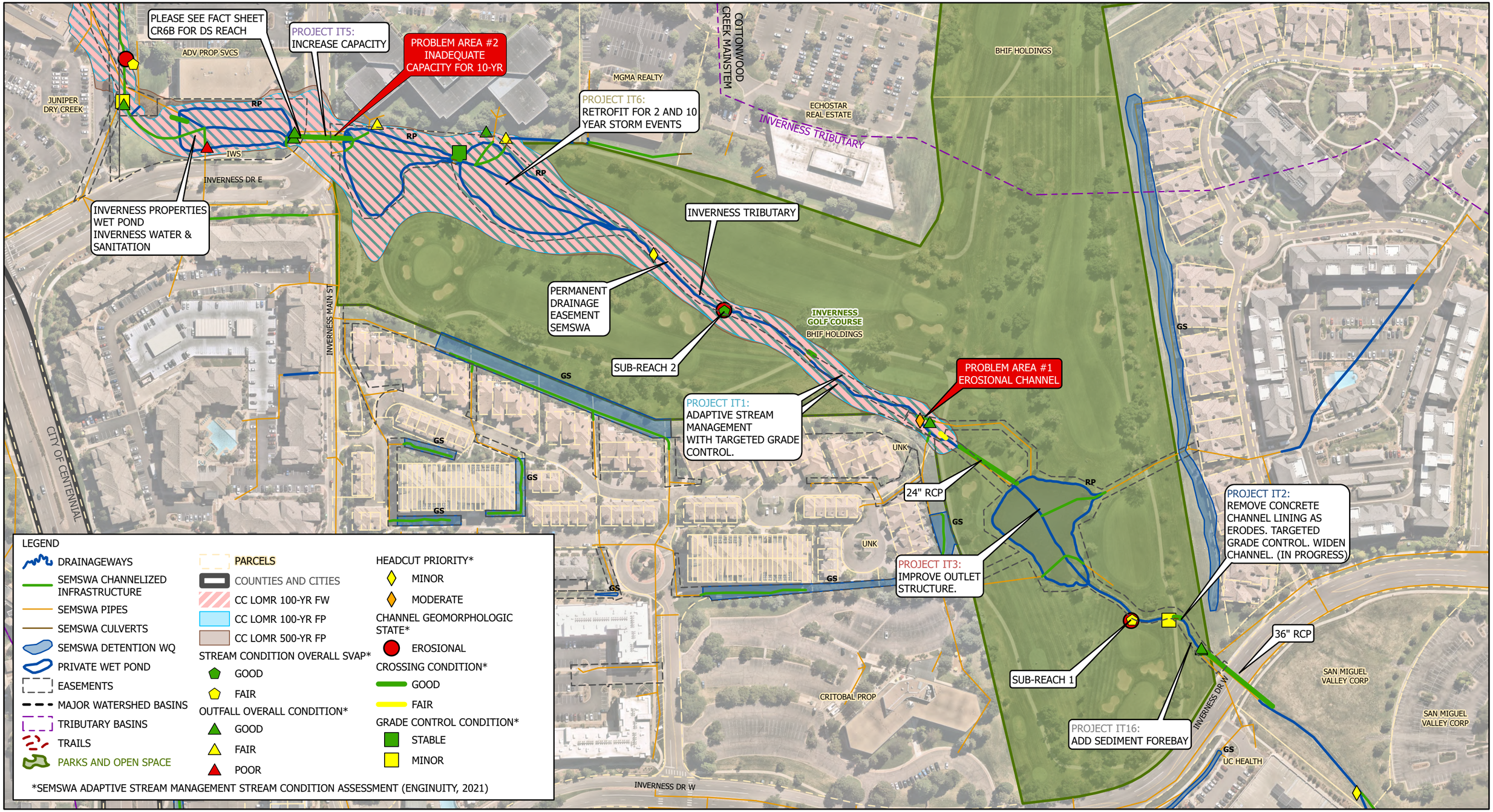
and a trickle channel in Tributary C Pond as well. **Project IT13** and **Project IT14** can be done together or separately and with other pond retrofit projects proposed in this fact sheet.

EURV: There is no EURV provided or proposed along this tributary.

Wetlands: This tributary to Cottonwood Creek has been identified as having USACE jurisdictional wetlands. **Project IT11** and **Project IT13** would likely be most complicated by these.



Inverness Tributary C Pond



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ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK ALTERNATIVES
INVERNESS TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

N

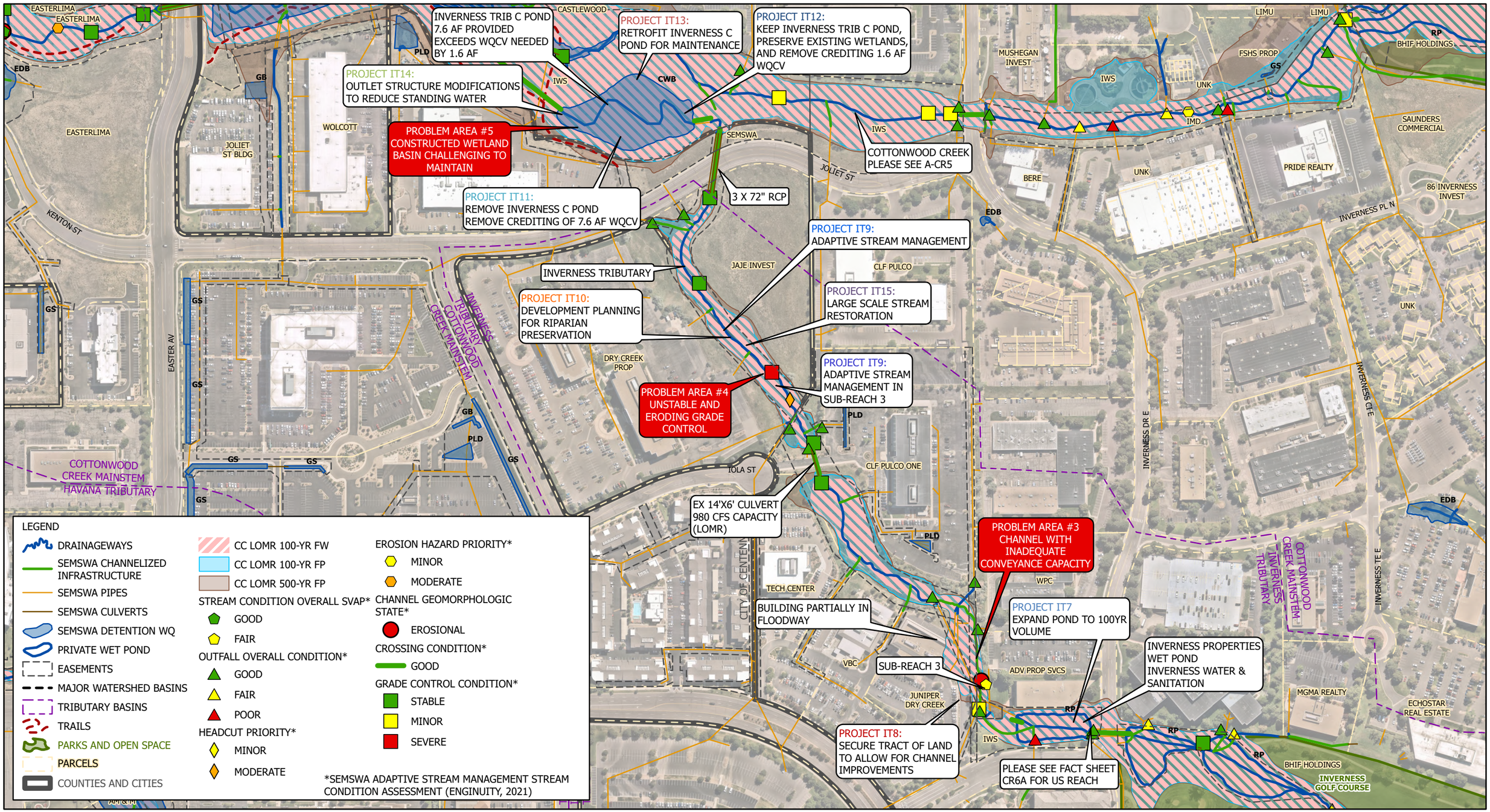
1" = 200 FEET

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PROJECT NO. 211-088.000

APPENDIX A

REACH CR6A



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ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK ALTERNATIVES
INVERNESS TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 300 FEET

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PROJECT NO. 211-088.000

APPENDIX A

REACH CR6B

Cottonwood Creek: Inverness Regional Pond to Lincoln Executive Center Pond
Fact Sheet Reach CR7

Reach Description: The reach of Cottonwood Creek immediately downstream of Inverness Regional Pond (IRP) has been identified as a priority for channel stabilization. The channel has been classified as in an "erosional" state and there are two locations with bank erosion hazards, one "moderate" and the other "very high," one of "minor" priority and the other of "moderate" priority. Two offline detention facilities currently reside at the Centennial Corner commercial development just north of E Briarwood Ave, and a new detention facility has been proposed to replace these two. The channel continues north across E Arapahoe Rd and discharges into Lincoln Executive Center Pond (LEC). The pond inflow has a drop structure causing some widening at the upstream end of the pond. This pond currently has less WQCV than the calculations indicate is needed with the deficit being compensated for downstream in the system.

Approximate length of reach: 0.8 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0478L, 08005C0476L
FEMA Flood Zone: AE Floodway, X (0.2 Pct annual chance flood hazard), and X (Area of minimal flood hazard).
2023 Cottonwood Creek LOMR: 100-yr Floodplain and 100-yr Floodway shown on map.

Zoning:
Surrounding areas are zoned Mixed Use, Business Park, General Commercial, Floodplain, and Open Space and Recreation.

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A Analyte: N/A
Category/List: N/A

Community Resources:
A maintenance path borders the channel on SEMSWA property through a stretch of vacant land from E Easter Ave to E Briarwood Ave. Some open space exists around Lincoln Executive Center Pond, also owned by SEMSWA.

Strategies for adding value along the drainage corridor for the community:
Improvements to the maintenance path bordering the channel would add aesthetic and recreational value for the nearby community. Consideration should be given to tying this pathway to the existing trail system around Inverness Regional Pond. Opportunities may exist for developing outdoor amenities with projects surrounding the Centennial Corner Ponds.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Sub-Reach 1	Sub-Reach 2
Floodplain Connectivity	Good	Good
Overall Quality SVAP	Good	Good
Bank Stability	8	9
Riparian Quality	7	7
Riparian Quantity	9	9
Nutrient Enrichment	9	7

**A higher score is indicative of greater stream health*

Completed Projects/Objectives:
Inverness Regional Pond: Improved in 2014.
Lincoln Executive Center Pond: Improved in 2015.
Channel: Improvements and drop structures installed in 2011.
Wetlands are deed restricted.

Potential or Known Problem Areas	Alternatives
#1 Channel between Easter Ave and Briarwood Ave is erosional	**Do nothing**
	Project CC24: Stream reclamation and rehabilitation with targeted grade control and erosion repair
	Project CC25: Large scale channel restoration with stabilization of channel between drop structures
	Any upstream detention project
#2 Bank instability near Centennial Corner Ponds	**Do nothing**
	Project CC26: Bank stabilization between Briarwood and E Arapahoe Rd
	Project CC27: New Centennial Corner regional pond with WQCV and EURV to replace two offline ponds. Includes forebay and access improvements (2010 OSP)
#3 Lincoln Executive Center Pond: sediment deposition, standing water, and difficult maintenance	**Do nothing**
	Project CC28: Scour protection at the toe of the drop structure
	Project CC29: Renovation of forebay structures in LEC pond

Potential Improvement Areas:



Drop structure into Lincoln Executive Center Pond (Enginuity, 2020)

Pond Capacity: No flooding issues have been identified along this reach of Cottonwood Creek. However, channel instability and flood capacity would be improved with added upstream detention. The 2010 OSP recommended the consolidation of the two offline Centennial Corner Ponds into one regional facility with EURV. The project would include a forebay and access improvements. This project is carried over into the current MDP with **Project CC27**. This area is within the mapped FEMA floodway, which may complicate any future improvements to these ponds.

Pond Features: Lincoln Executive Center Pond has issues with standing water and sediment deposition. Pond maintenance is difficult, in part due to the lack of a concrete forebay at the major inflow from East Arapahoe Road. **Project CC29** proposes the renovation of forebay structures for ease of maintenance. The 2020 Enginuity Stream Assessment study noted possible channel widening occurring downstream of the drop structure into Lincoln Executive Center Pond. **Project CC28** proposes the addition of scour protection at the toe of the drop structure to address this erosion.

Channel Capacity: The channel downstream of E Easter Ave is erosional with bank erosion hazards of moderate and very high. Some improvements to the channel were completed in 2011, including the installation of drop structures. The wetlands are reported to be deed-restricted which could complicate permitting. The channel continues to exhibit instability between the drop structures, although deed restrictions along this reach may limit options for additional channel stabilization. A maintenance path abuts the channel to the west and presents a constraint to lateral channel migration and increased sinuosity. This path cannot be moved further to the west to increase the channel corridor width because it abuts private property. **Project CC24** proposes the use of smaller-scale and targeted stream reclamation and rehabilitation strategies to mitigate channel erosion. **Project CC25** proposes large-scale channel restoration with additional stabilization between drop structures. Most of the channel erosion appears to be occurring in the upper half to two-thirds of this reach of Cottonwood Creek. Targeted improvements could be applied to the lower half of this reach with the large-scale improvements completed in the upper half.



Bank erosion downstream of Easter Ave. (Enginuity, 2020)

The channel downstream of Briarwood Ave has significant bank erosion. Two offline stormwater detention ponds, the Centennial Corner ponds, are located on either side of this channel. **Project CC26** proposes smaller-scale bank stabilization strategies. As discussed above, **Project CC27** recommends replacing the two offline ponds with a new detention facility with EURV. This additional EURV might also help to stabilize the channel downstream.

Pipe Capacity: No pipe capacity issues have been identified along this reach.

Maintenance: Maintenance of Lincoln Executive Center Pond is currently difficult, and the pond is depositional and has issues with standing water. **Project CC29** proposes improvements to the pond to make maintenance easier, including the addition of more easily maintainable concrete forebay structures.



Centennial Corner Ponds (Google Earth Image, 2023)

Water Quality: Lincoln Executive Center Pond currently provides 6.7 ac-ft of WQCV detention. The future direct WQCV needed is 12.6 ac-ft. The WQCV deficit at this pond is resolved downstream at Peoria St Pond.

EURV: While EURV is not a regulatory requirement, treatment of the EURV provides protection to downstream channels and reduces erosion and the accompanying costly channel rehabilitation. Opportunities to add EURV treatment along Cottonwood Creek should be explored with all projects and new development and is considered in **Project CC27.**

Wetlands: All channel projects should preserve and improve existing wetlands along these reaches of Cottonwood Creek to the extent possible. Any project resulting in a disturbance to jurisdictional wetlands will need to secure the appropriate permits. Much of this reach has been identified as having jurisdictional wetlands.

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- CC LOMR 100-YR FW
- CC LOMR 100-YR FP
- CC LOMR 500-YR FP
- EASEMENTS
- MAJOR WATERSHED BASINS
- TRIBUTARY BASINS
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS
- COUNTIES AND CITIES

STREAM CONDITION OVERALL SVAP*
- GOOD

OUTFALL OVERALL CONDITION*
- GOOD

EROSION HAZARD PRIORITY*
- MINOR
- MODERATE

CHANNEL GEOMORPHOLOGIC STATE*
- DEPOSITIONAL
- EROSIONAL

CROSSING CONDITION*
- GOOD

GRADE CONTROL CONDITION*
- STABLE
- MINOR

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

PEORIA TRIBUTARY
FAMILY SPORTS CENTER GOLF COURSE
ACAA
UPD INOVA
AC
EDB
2011 COMPLETED CIP MINOR CHANNEL IMPROVEMENTS/DROP STRUCTURE INSTALL
PROJECT CC25: LARGE SCALE CHANNEL REHABILITATION IN UPSTREAM PORTIONS WITH STABILIZATION OF CHANNEL BETWEEN DROP STRUCTURES
INVERNESS REGIONAL POND 29.2 AF EURV
PLEASE SEE FACT SHEET CR5 FOR UPSTREAM REACH
EASTER AV
LIMA ST
EASTERLIMA
PLEASE SEE FACT SHEET CR9 FOR DOWNSTREAM REACH
PEAKVIEW AV
SEMSWA
ROADWAY CROSSING CAPACITY ~5600 CFS (LOMR)
LINCOLN EXECUTIVE CENTER POND
COMPLETED CIP
REGIONAL FACILITY WITH WATER QUALITY
PROJECT CC26: BANK STABILIZATION
PROBLEM AREA #2 BANK INSTABILITY
JP MORGAN
CENTENNIAL CORNERS
COTTONWOOD CREEK
BPAZ HOLDINGS
SUB-REACH 2
KSE MEDIA
EX TRIPLE BOX CULVERT ~4900 CFS CAPACITY (LOMR)
ZACHER
PRIVATE
E ARAPAHOE RD
BRIARWOOD AV
GBS
SELF STORAGE
MCCAIN PROP
PROJECT CC24: STREAM RECLAMATION AND REHABILITATION WITH TARGETED GRADE CONTROL AND EROSION REPAIR
PROBLEM AREA #1 EROSIONAL CHANNEL BETWEEN EASTER AND BRIARWOOD
SUB-REACH 1
EX TRIPLE BOX CULVERT W/ RISER ~3700 CFS CAPACITY (LOMR)
POTENTIAL ROAD WIDENING PROJECT
IWS
GB
TWC
PRINTLABS
KENTON ST
CENTENNIAL CORNER PONDS
PROJECT CC28: SCOUR PROTECTION
PROJECT CC27: NEW CENTENNIAL CORNER REGIONAL POND TO REPLACE TWO OFFLINE PONDS (2010 OSP)
SEMSWA EASEMENT
PROBLEM AREA #3 SEDIMENT DEPOSITION, STANDING WATER, AND DIFFICULT MAINTENANCE
PROJECT CC29: IMPROVEMENT OF POND FEATURES, INCLUDING FOREBAYS
HAVANA TRIBUTARY SEE FACT SHEET CR8
ASC
JOLIET ST
ARAPAHOE CENT DEVLOPMT
WAL-MART
GS
JOLIET ST BLDG

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ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK ALTERNATIVES
INVERNESS REGIONAL POND TO LINCOLN EXECUTIVE CENTER POND
SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 250 FEET

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PROJECT NO. 211-088.000

APPENDIX A

REACH CR7

Cottonwood Creek: Havana Tributary
Fact Sheet Reach CR8

Reach Description: Havana Tributary to Cottonwood Creek consists of a northern and southern reach that have their confluence just east of S Havana St. Upstream of the Upper and Lower Rampart Ponds on the south branch, the Fulton Street Pond collects flow from surrounding areas and is piped to Upper Rampart Pond. The south branch has been classified as "depositional" east of S Havana St, and the channel between S Havana St and E Arapahoe Rd has been identified for stream improvements as needed by the previous OSP. The north branch of Havana Tributary is "erosional," and the crossing at S Havana St is in "fair" condition. An outfall in "poor" condition is noted downstream of the confluence, just south of E Arapahoe Rd. Flow continues north and east of E Arapahoe Rd in pipes and open channels before discharging into Lincoln Executive Center Pond and entering the Cottonwood Creek mainstem. The floodplain and floodway determination for the Cottonwood Creek LOMR (WWE, 2023) indicate a building in the area of shallow flooding just east of the open channel north of E Arapahoe Rd. The Cottonwood Creek FHAD completed in 2011 found overtopping during the 100-year event at the Kenton St and E Arapahoe Rd crossings.

Approximate length of reach (from Upper Rampart Pond to Lincoln Executive Center Pond): 1.0 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0478L, 08005C0476L
FEMA Flood Zone: AE, AE Floodway, X (0.2 Pct annual chance flood hazard), and X (Area of minimal flood hazard).
2023 Cottonwood Creek LOMR: 100-yr Floodplain and 100-yr Floodway shown on map.

Zoning:
Surrounding areas are zoned Business Park, General Commercial, Mixed Use, and Open Space and Recreation.

Community Resources: There is good sidewalk coverage in this area and some informal walking trails in LEC Pond. Sub-reach 3 has open space walking trails on both sides of the tributary.

Strategies for adding value along the drainage corridor for the community: Opportunities for new walking trails exist along much of the channel, especially in the riparian area along Havana Street.

Completed Projects/Objectives:
Lincoln Executive Center Pond: Improved in 2015.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Sub-Reach 1	Sub-Reach 2	Sub-Reach 3
Floodplain Connectivity	Fair	Good	Good
Overall Quality SVAP	Fair	Good	Good
Bank Stability	10	10	8
Riparian Quality	4	6	6
Riparian Quantity	7	9	8
Nutrient Enrichment	4	5	4

**A higher score is indicative of greater stream health.*

Potential or Known Problem Areas	Alternatives
#1 Flooding at E Arapahoe crossing	**Do nothing**
	Project HT1: New EDB upstream of E Arapahoe.
	Project HT2: Increase storm system capacity at E Arapahoe.
#2 Building in area of shallow flooding	**Do nothing**
	Project HT1
	Project HT3: Increase pipe capacity connecting channel to outfall into LEC Pond.
	Project HT4: Provide additional flow path along the north side of E Arapahoe Rd to LEC Pond through pipes, open channel, or combination.
	Project HT5: Enlarge private pond.
	Project HT6: Allow flow from channel to spill into EDB to north during high flow events.
	Project HT7: Add inlets in the parking lot to facilitate increased drainage.
Other Potential Projects	**Project HT8:** Retrofit Fulton Street Pond for EURV (2010 OSP).
	Project HT9: Retrofit Upper Rampart Pond for EURV (2010 OSP).
	Project HT10: Modify outlet of Lower Rampart Pond (2010 OSP).
	Project HT11: Blue Sky Pond improvements (2010 OSP).
	Project HT12: Moderate level channel improvements to stabilize as needed between S Havana and E Arapahoe (2010 OSP).
	Project HT12: Adaptive stream management between S Havana and E Arapahoe.

Potential Improvement Areas:

Pond Capacity: There are several flooding issues in the reach of Havana Tributary from E Arapahoe Rd to the outfall into Lincoln Executive Center Pond. According to the Cottonwood Creek LOMR, an office building adjacent to the channel north of E Arapahoe Rd resides almost entirely within the area of shallow flooding. The 2011 FHAD for Cottonwood Creek showed overtopping of both Kenton St and E Arapahoe Rd during the 100-year event. Two private ponds provide detention between E Peakview Ave and E Arapahoe Rd. **Projects HT5** and **HT6** include improvements to these ponds to help alleviate flooding in this area. **Project HT5** would increase the capacity of the private pond, while **Project HT6** would allow for high flows to spill over into the pond to the north. This would involve the acquisition of drainage easements for these ponds, or transfer of ownership to SEMSWA. The possibility of increasing the volume of these ponds should be explored. Retrofits for WQCV and EURV are also options and would help to mitigate the insufficient WQCV provided at downstream Lincoln Executive Center Pond.

Project HT1 increases detention upstream of E Arapahoe Rd with the installation of a new regional facility in the property just north of Briarwood Ave. SEMSWA currently owns the property adjacent to this reach. Limited additional property acquisition may be required, depending on the footprint of the new facility. Adequate open space exists here to explore this option presented in **Project HT1**. The new facility would provide flood control for downstream capacity issues, as well as provide WQCV and EURV.

Pond Features: Several improvements to existing facilities were proposed in the 2010 OSP and are incorporated into the current Master Plan. **Project HT11** includes combining the two cells of Blue Sky Pond into one, and improvements to the water quality outlet, spillway, forebays, and access road. **Project HT8** implements additional full spectrum detention in the watershed by retrofitting Fulton Street Pond with EURV. **Project HT9** accomplishes the same with Rampart Upper Pond, which currently provides 10-yr and 100-yr detention but could be retrofit to provide EURV as well. **Project HT9** also includes the construction of a forebay. Rampart Lower Pond currently provides WQCV and 100-yr detention. **Project HT10** proposes modifications to the outlet of Rampart Lower Pond to improve drain time and ease of maintenance.

Channel Capacity: The channel between Kenton St and E Arapahoe Rd has limited capacity and a 90-degree bend just upstream of where the open channel converts to pipe flow upstream of the outfall into Lincoln Executive Center Pond. The 2023 Cottonwood Creek LOMR shows the building adjacent to the channel here residing almost entirely within the area of shallow flooding. Opportunities to increase the channel capacity are limited due to the constrained character of the reach. **Projects HT1** and **HT5** increase the detention volume along Havana Tributary and may help to alleviate flooding in this area. Increased pipe capacity downstream, as in **Project HT3**, and a high flow path into the EDB to the north, as in **Project HT6**, would improve flow through the open channel. **Project HT4** proposes the construction of an additional flow path along the north side of E Arapahoe Rd to carry flows from Havana Tributary to Lincoln Executive Center Pond. Open channel, pipes, or a combination of the two may be used to convey flows, reducing flow through the existing channel and alleviating flooding of the adjacent building and overtopping of Kenton St.

The 2010 OSP identified the reach between E Arapahoe Rd and S Havana St as potentially needing stabilization in the future and recommended moderate level channel improvements be completed as needed (**Project HT12**). Prior recommendations for this reach included drop structures, channel grading, revegetation, and the construction of a maintenance access road along the channel and Rampart Upper and Lower Ponds. Alternatively, **Project HT13** proposes adaptive stream management be implemented as needed along the reach between E Arapahoe Rd and S Havana St.

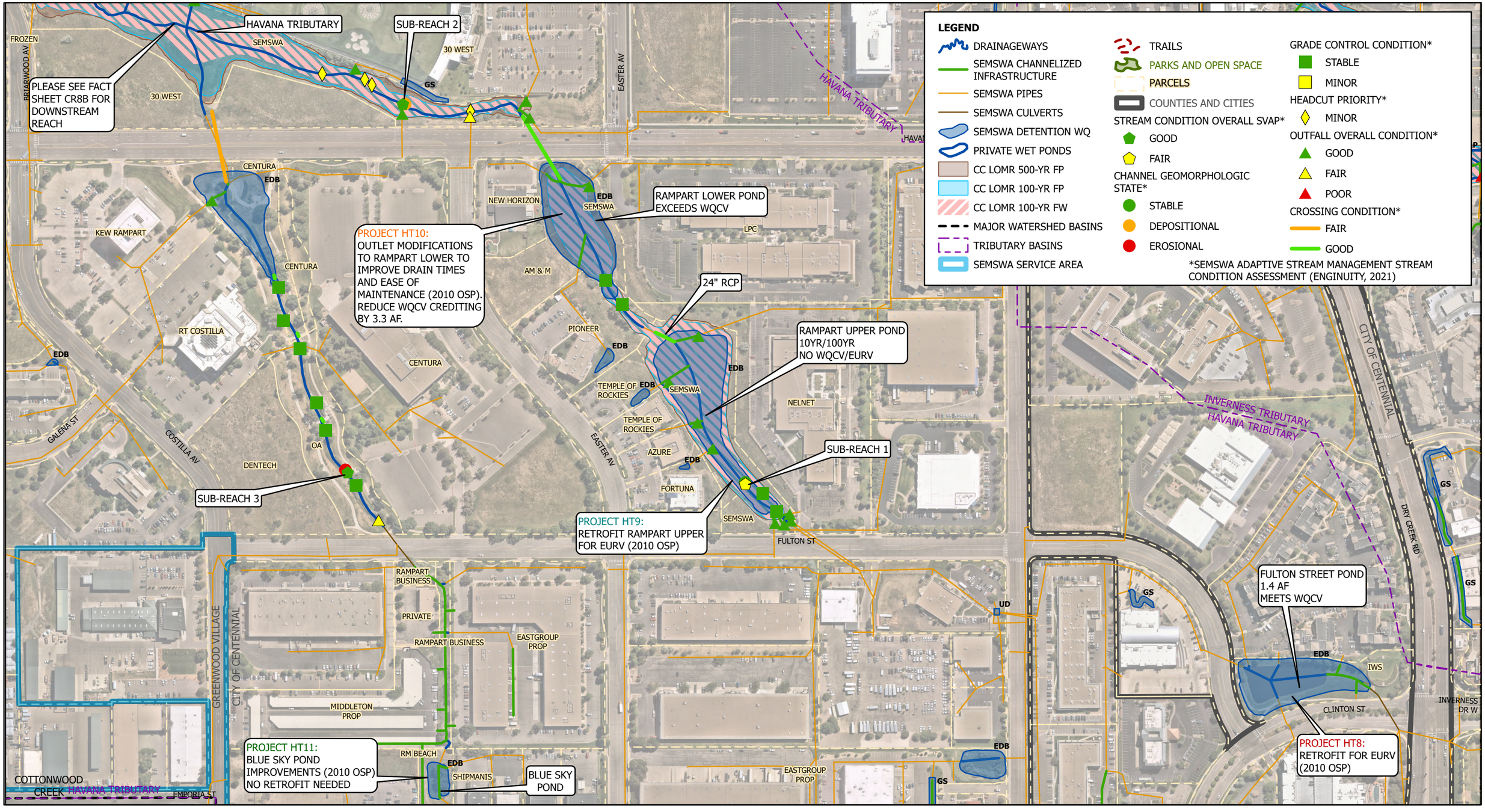
Pipe Capacity: The 2011 Cottonwood Creek FHAD identified overtopping at the Kenton St and E Arapahoe Rd crossings. **Project HT2** proposes increasing the storm system capacity at E Arapahoe Rd. **Project HT3** proposes increasing the pipe capacity connecting the open channel to the outfall at Lincoln Executive Center Pond. This project would mitigate overtopping of Kenton St and potentially change the floodplain boundary upstream where an office building currently resides in the area of shallow flooding.

Maintenance: Some maintenance is required along this reach. An outfall located just south of E Arapahoe Rd is fifty percent blocked and in poor condition. Sediment accumulation has partially blocked the crossing of the north reach at Havana St. **Project HT10** proposes modifications to improve the ease of maintenance at Rampart Lower Pond.

Water Quality: Adequate water quality is currently provided along Havana Tributary at Rampart Lower Pond and Fulton Street Pond. However, a future cumulative WQCV deficit of 0.3 AF is predicted at Rampart Lower Pond. A cumulative WQCV deficit exists at Lincoln Executive Center Pond under current and future conditions. **Projects HT1**, **HT5**, and **HT6** provide potential additional opportunities for water quality treatment lower in the Havana Tributary watershed before the confluence with the mainstem of Cottonwood Creek.

EURV: Several opportunities to increase full spectrum detention throughout the tributary watershed are presented. **Projects HT1**, **HT5**, **HT8**, **HT9**, and **HT11** each provide an opportunity for new or retrofit EURV outlets.

Wetlands: This tributary to Cottonwood Creek has been identified as having USACE jurisdictional wetlands. **Projects HT1** and **HT2** would likely be complicated by these.



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK ALTERNATIVES
HAVANA TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

N

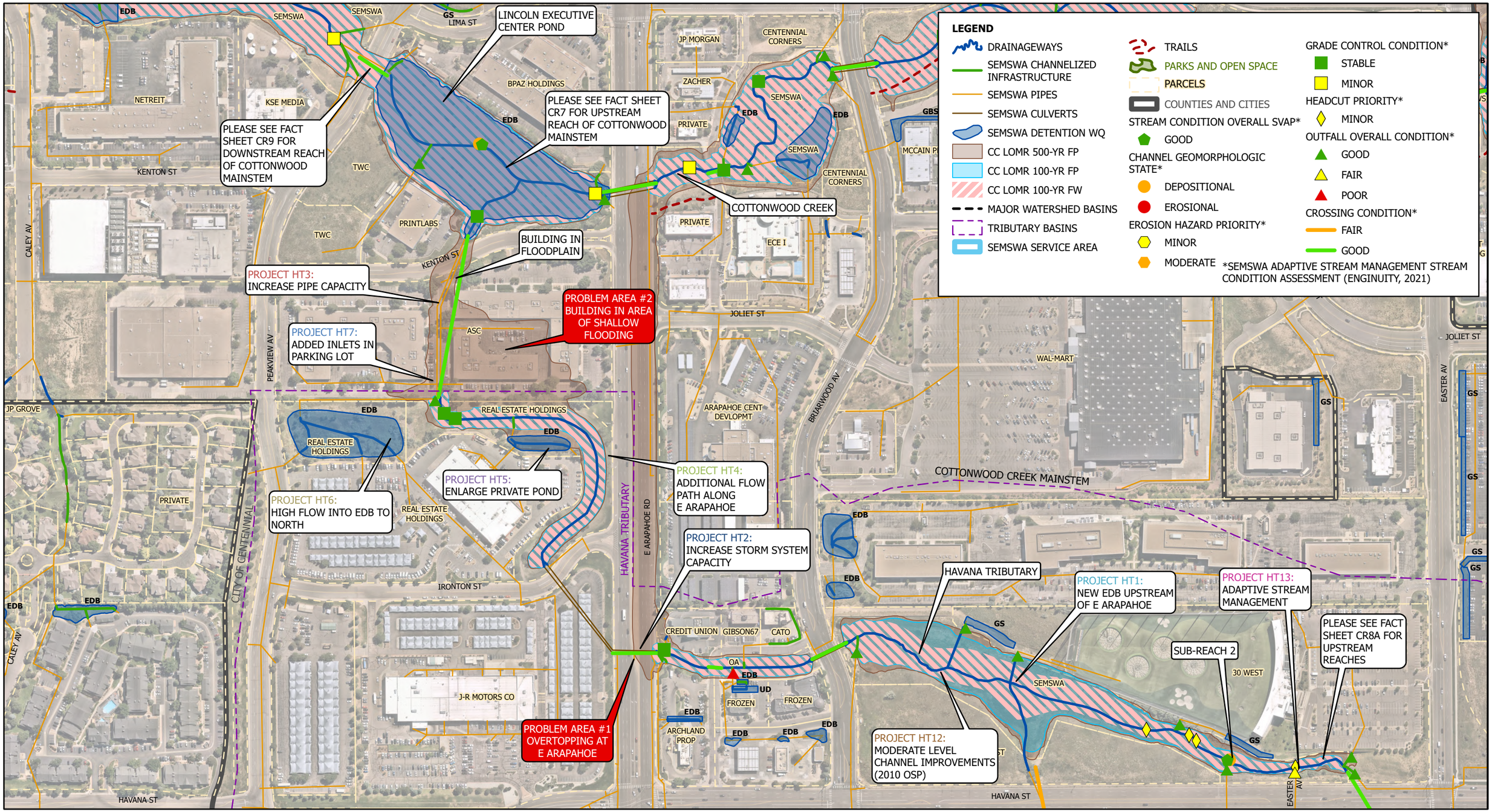
1" = 300 FEET

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PROJECT NO. 211-088.000

APPENDIX A

REACH CR8A



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ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK ALTERNATIVES
HAVANA TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

APPENDIX A

REACH CR8B

Cottonwood Creek: Lincoln Executive Center Pond to Peoria St Pond
Fact Sheet Reach CR9

Reach Description: Cottonwood Creek flows northeast from Lincoln Executive Center Pond (LEC) and discharges into Caley West Pond approximately two tenths of a mile downstream. Shortly downstream of Caley West Pond, the channel enters Greenwood Village where flow continues northeast for another half mile through before entering the Peoria Street Pond which SEMSWA has a shared maintenance agreement for and is included in their MS4 permit. Flow exits the pond to the northeast, entering Cherry Creek State Park.

Approximate length of reach: 1.4 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0476L
FEMA Flood Zone: AE, AE Floodway, X (0.2 Pct annual chance flood hazard), and X (Area of minimal flood hazard).
2023 Cottonwood Creek LOMR: 100-yr Floodplain and 100-yr Floodway shown on map.

Zoning:
Surrounding areas are zoned Business Park, Residential, and Open Space and Recreation.

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A

Community Resources:
Open space surrounds most of the channel along this reach, which is owned by SEMSWA within Centennial and the Cottonwood HOA in Greenwood Village. The channel downstream of Caley West Pond and the Peoria Street Pond itself are bordered by a privately owned, open space park and a system of trails, one of which crosses the channel upstream of the pond. Public information signs have been erected near the pond.

Strategies for adding value along the drainage corridor for the community:
Consideration should be given for strategies to connect the trail network from Lincoln Executive Center Pond to the trail system downstream of Caley West Pond. Not only would this provide a continuous recreational trail along the length of Cottonwood Creek, but it would also improve non-motorized access to Cherry Creek State Park downstream of Peoria Pond.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Stream Condition
Floodplain Connectivity	Good
Overall Quality SVAP	Good
Bank Stability	9
Riparian Quality	7
Riparian Quantity	9
Nutrient Enrichment	7

**A higher score is indicative of greater stream health*

Completed Projects/Objectives:
Lincoln Executive Center Pond: Improved in 2015.
Caley West Pond: New detention facility.

Potential or Known Problem Areas	Alternatives
#1 Reach identified as being unstable in 2010 OSP	**Do Nothing**
	Project CC30: Adaptive stream management
	Project CC31: Large-scale channel rehabilitation
#2 Reach identified as being unstable in 2010 OSP	**Do Nothing**
	Project CC32: Adaptive stream management
	Project CC33: Large-scale channel rehabilitation
#3 Residential house in mapped floodplain	**Do Nothing**
	Project CC34: Conceptual configuration of pedestrian path crossing for replacement at end-of-life span
#4 Peoria Street Pond is holding water and difficult to maintain	**Do Nothing**
	Project CC35: Enlarge WQ orifices (2010 CC OSP) and baseflow orifices
	Project CC36: Add sediment forebay at Peoria Tributary outfall and access road for ease of maintenance

Potential Improvement Areas

Pond Capacity: No pond capacity issues are identified along this reach of Cottonwood Creek.

Pond Features: The 2010 OSP recommended enlarging the water quality orifices of Peoria Street Pond in Greenwood Village to shorten drain times of a 2-yr event. This recommendation is carried over in this MDP in **Project CC35** which also proposes a study in baseflow to determine whether the capacity of the baseflow bypass needs to be increased. This study should incorporate the upstream Caley West Pond which has an adjustable orifice for baseflow. Care should be taken to maintain drain times required by SEMSWA's MS4 permit. While this pond is privately-owned and downstream of the SEMSWA service-area, SEMSWA has a shared maintenance responsibility with other entities including the HOA via an IGA and the pond is frequently maintained. The land is currently owned by Cherry Creek Vista. There is a monitoring station used by the CCBWQA for credit as a Pollution Reduction Facility. Based on SEMSWA's experience in maintaining this pond, the debris screen requires quarterly cleaning which alone does not fully address the issue of retained water.



Peoria Street Pond

Channel Capacity: The channel between Lincoln Executive Center Pond and Caley West Pond was identified in the 2010 OSP as requiring major improvements with significantly incised areas. **Project CC31** carries these large-scale improvements into the current master plan. Alternatively, **Project CC30** recommends adaptive stream management approaches to address localized areas along the channel needing improvement.

The channel between Caley West Pond and Peoria Pond was also identified in the 2010 OSP as requiring major work. Field Assessment performed for this MDP showed an overall stable channel with isolated areas of erosion at drop structures indicating a need for energy dissipation at those locations. Development is ongoing along this reach and new outfalls have been proposed or constructed. **Project CC32** proposes the use of adaptive stream management strategies to target isolated sites of erosion, while **Project CC33** recommends large-scale channel stabilization of this reach. Either channel improvement approach should incorporate a plan for the coordinated placement of new outfalls with development.



Cutbank along Cottonwood Creek between Lincoln Executive Pond and Caley West Pond (Enginuity, 2020)

Based on aerial imagery, a house near Peoria Pond appears to be located in the mapped FEMA floodplain. The structure may be removed from the floodplain with the reconfiguration of a nearby pedestrian bridge crossing Cottonwood Creek. **Project CC34** proposes the development of a conceptual configuration of the crossing that would result in the house's removal from the floodplain that could be implemented at the end of the crossing's life span.

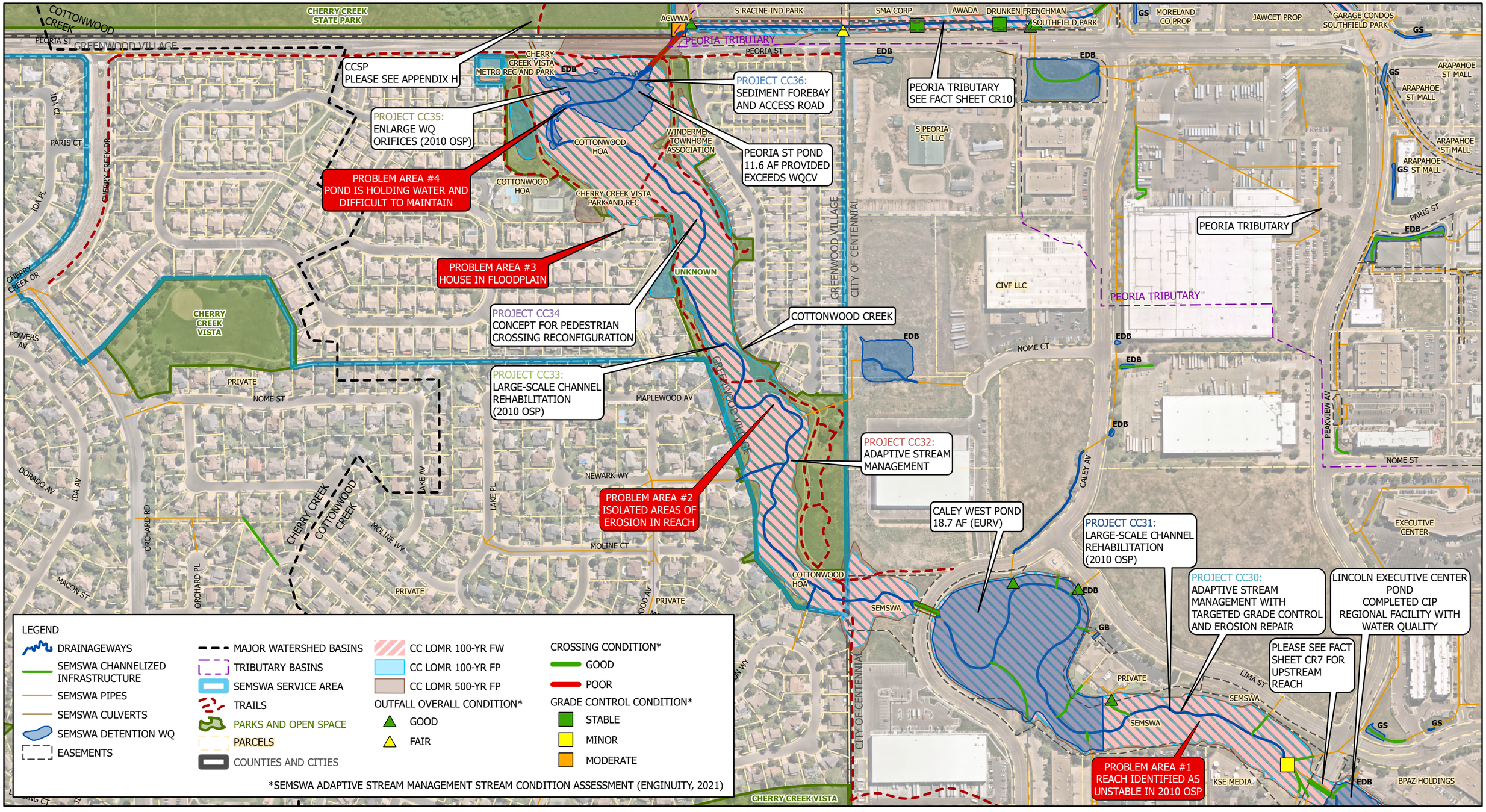
Pipe Capacity: No pipe capacity issues identified along this reach.

Maintenance: Improvements to Peoria Pond to improve maintenance ease and access are proposed in **Project CC36**. This project includes adding a sediment forebay to the Peoria Tributary pipe outfall and the installation of an additional maintenance road. Based on SEMSWA's experience in maintaining this pond, there is currently a high sediment load and the functionality is very sensitive to the buildup of sediment and cattails.

Water Quality: Please see Fact Sheet CC7 for a discussion of upstream WQCV crediting. Cumulative water quality deficits noted upstream appear to be resolved at Peoria Pond, which currently provides 11.6 ac-ft of WQCV with a future direct demand of 8.6 ac-ft.

EURV: While EURV is not a regulatory requirement, treatment of the EURV provides protection to downstream channels and reduces erosion and the accompanying costly channel rehabilitation. EURV is currently provided at Caley West Pond. Opportunities to add additional EURV treatment along Cottonwood Creek should be explored with all projects and new development. The reach of Cottonwood Creek downstream of Peoria Street flows through a well-functioning system in the Cherry Creek State Park which is being addressed in an addendum to this report. Based on field observations during and after mid-range storm events, this system does not show a need for additional attenuation of the EURV.

Wetlands: Significant wetland vegetation exists along this reach of Cottonwood Creek and has been identified as jurisdictional. All channel projects should preserve and improve existing wetlands to the extent possible and should weigh the benefit of formal channel stabilization against the current functionality of well-established vegetation. Any project resulting in a disturbance to jurisdictional wetlands will need to secure the appropriate permits.



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
LINCOLN EXECUTIVE CENTER POND TO PEORIA STREET POND
SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 350 FEET

0 175 350

PROJECT NO. 211-088.000

APPENDIX A
REACH CR9

Cottonwood Creek: Peoria Tributary
Fact Sheet Reach CR10

Reach Description: Peoria Tributary to Cottonwood Creek begins just south of E Easter Ave in unincorporated Arapahoe County in the Centennial Airport. Runoff from upstream areas is piped to Airport Pond C3/C4, which discharges to the channel flowing north through the Family Sports Center Golf Course. Three grade control structures are located just downstream of the pond, one of which is in "severe" condition and is completely undercut. The other two nearby structures demonstrate some cracking and piping. The soil in this reach is silt and clay, and the channel here is in an "erosional" state, becoming "depositional" shortly downstream. The channel continues north along the east boundary of the golf course and crosses into City of Centennial at E Arapahoe Rd. Flow is piped under a shopping center before discharging into an open channel to the northeast of the intersection of E Peakview Ave and S Peoria St. This channel has been classified as "erosional" along this reach but is generally in good condition from the Caley Ave crossing to the confluence with Cottonwood Creek. The Caley East Pond is "offline" to the tributary main stem and discharges laterally into the channel. The drainageway continues north, crossing S Peoria St, into Greenwood Village, and discharging into the Peoria St Pond and the mainstem of Cottonwood Creek. The grade control structure to the east of S Peoria St is in "moderate" condition with an undercutting drop, erosion and undercutting of boulders has been noted, and the culvert is in "poor" condition.

Approximate length of reach: 1.3 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity 2021); SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Cottonwood Creek Outfall Systems Plan: Conceptual Design Report August 2010; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0478L & 08005C0476L
FEMA Flood Zone: AE Floodway, X (0.2 pct annual chance of flood hazard), and X (Area of minimal flood hazard).
2023 Cottonwood Creek LOMR: 100-yr Floodplain and 100-yr Floodway shown on map.

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A

Zoning:
Surrounding areas are zoned Mixed Use, General Commercial, Business Park, and Open Space and Recreation, with Rural Residential zoning to the south.

SEMSWA Adaptive Management Stream Condition Assessment:

Stream Parameter	Sub-Reach 1	Sub-Reach 2	Sub-Reach 3
Floodplain Connectivity	Fair	Fair	Fair
Overall Quality SVAP	Good	Fair	Fair
Bank Stability	7	9	6
Riparian Quality	6	5	5
Riparian Quantity	7	5	7
Nutrient Enrichment	7	NA	3

**A higher score is indicative of greater stream health*

Completed Projects/Objectives
Ponds C3/C4: In 2012 these ponds were merged and expanded into one large detention facility which provided EURV and 100-year detention, a new outlet structure, and sediment forebays.
Caley East Pond: In 2015 this pond was retrofitted to have a new outlet structure, EURV storage, and a sediment forebay.
The Arapahoe Street Mall was removed from the mapped floodplain in the 2022 Cottonwood Creek LOMR.

Potential or Known Problem Areas:

Potential or Known Problem Areas	Alternatives
#1 Aging infrastructure	**Do nothing**
	Project PT1: Stream reclamation and rehabilitation with isolated structural repair
#2 Golf course structures in floodway	**Do nothing**
	Project PT2: Upsize culverts near structures
#3 Erosional channel	**Do nothing**
	Project PT3: Adaptive stream management and development planning
	Project PT5: Construct proposed new detention facility, Arapahoe Pond, just upstream of E Arapahoe Rd (2010 OSP)
#4 Infrastructure in need of repair/replacement	**Do nothing**
	Project PT4: Replacement of structure and repair of grade control

Community Resources:
Peoria Tributary flows through Family Sports Center Golf Course which is not accessible to the public. A dirt maintenance path currently exists along Peoria Tributary from Peakview Ave to Caley Ave. Consideration to maintaining and improving this path should be given with plans for development of surrounding properties. From Caley Ave to the crossing into Peoria Pond, the channel closely parallels Peoria St which has a trail on the west side.

Potential Improvement Areas

Pond Capacity: The 2010 Cottonwood Creek OSP recommended the construction of a new pond to provide both EURV and 100-yr detention just upstream of Arapahoe Road in an existing mature wetland complex and FEMA 100-yr Floodway. This recommendation is carried over and included in **Project PT5** for the Arapahoe Pond. This pond would help control flows from additional development to the east of the Family Sports Center Golf Course. However, there would be complex wetland and FEMA permitting with this project. The complexity of this project combined with a net surplus of WQCV in the Cottonwood Creek system may decrease the priority of this alternative.

Pond Features: No improvements to existing pond features are proposed for Peoria Tributary. The new pond included in **Project PT5** should consider all required pond features such as sediment forebays and trickle channels.

Channel Capacity: The SEMSWA Stream Assessment Survey (Enginuity, 2021) noted both erosional and depositional reaches of channel between Airport Pond C3/C4 and Arapahoe Road. Visually, most of the channel appears to be in relatively good condition with an abundance of stabilizing mature wetland vegetation. South Suburban Parks and Recreation currently owns the easement around the channel through the golf course. Three check structures are in poor condition with undercutting, cracking, and piping (Enginuity, 2021). Infrastructure along this reach is aging and in need of repair or replacement. The 2010 OSP identified this section of channel as requiring "moderate" channel work including a revised channel invert profile and nine additional drop structures. **Project PT1** proposes stream reclamation and rehabilitation including the isolated repair and replacement of drop structures, establishment of better vegetative buffers, and addition of isolated structures to stabilize flow, as needed. Based on overall good channel condition and recent detention improvements upstream, larger-scale stream work such as what was proposed in the 2010 OSP was not considered for this reach.



Grade Control in Golf Course (Enginuity, 2021)

The channel downstream of E Arapahoe Rd is piped until after the crossing of Peakview Ave and Peoria Street where it outfalls into open channel. The channel here is erosional, and the surrounding watershed is projected to have future development. **Project PT3** recommends adaptive stream management be used to address localized erosion in conjunction with a comprehensive plan for the coordinated placement of outfalls as development progresses. The consolidation of outfalls along the Peoria Tributary will reduce maintenance needs over time.



Peoria St Crossing Upstream (Enginuity, 2021)

Pipe Capacity: Golf course buildings associated with the driving range are located in the floodway due to insufficient culvert flood capacity. **Project PT2** recommends increasing the size of these culverts to potentially remove the golf course structures from the floodway. The 54" pipe near the golf course driving range is partially blocked by dense vegetation at the upstream inlet which should be addressed in this project.

Maintenance: The SEMSWA Stream Assessment survey (Enginuity, 2021) identified infrastructure in need of repair where Peoria Tributary crosses Peoria Street and outfalls into Peoria Pond. The headwall and apron of the culvert are in poor condition and there is undercutting of a drop structure and erosion of a boulder structure. **Project PT4** recommends addressing these infrastructure maintenance needs and providing repair or replacement as needed. This project should include improvements to culvert capacity, if feasible, to prevent overtopping in the 100-year event.

Channel infrastructure downstream of Pond C3/C4 is aging and in need of repair or replacement, which is proposed with **Project PT1**, as discussed above.

Water Quality: Pond C3/C4 provides treatment of the WQCV of 5.6 AF, which exceeds the future WQCV need of 4.1 AF at this pond. There is a 3.9 AF deficit in WQCV for the Peoria tributary that is resolved downstream at the Peoria Street Pond. **Project PT5** would include 0.9 AF of WQCV and would be designed to target phosphorus removal.

EURV: Pond C3/C4 provides treatment of both the WQCV and EURV. Caley East Pond was improved in 2012 to increase the 100-yr detention volume to 6.2 AF and provide an EURV of 3.9 AF. **Project PT5** would include an additional 3.8 AF of EURV.

Wetlands: The Peoria Tributary upstream of Arapahoe Road is well vegetated with several identified wetland areas. Preserving or restoring existing wetlands while providing discrete locations for sediment removal should be a priority in any project selected. Complex permitting might be required for projects that might fully remove jurisdictional wetlands such as **Project PT5.**

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- CC LOMR 100-YR FW
- CC LOMR 100-YR FP
- CC LOMR 500-YR FP
- EASEMENTS
- MAJOR WATERSHED BASINS
- TRIBUTARY BASINS
- SEMSWA SERVICE AREA
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS
- COUNTIES AND CITIES

STREAM CONDITION OVERALL SVAP*
- GOOD
- FAIR

OUTFALL OVERALL CONDITION*
- GOOD
- FAIR

HEADCUT PRIORITY*
- MINOR

CHANNEL GEOMORPHOLOGIC STATE*
- DEPOSITIONAL
- EROSIONAL

CROSSING CONDITION*
- GOOD
- POOR

GRADE CONTROL CONDITION*
- STABLE
- MODERATE
- SEVERE

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

PROJECT PT4: REPLACEMENT OF STRUCTURE AND REPAIR OF GRADE CONTROL

PROBLEM AREA #4 INFRASTRUCTURE IN NEED OF REPAIR/ REPLACEMENT

PROBLEM AREA #3 EROSIONAL CHANNEL

PEORIA TRIBUTARY

PLEASE SEE FACT SHEET CR9 FOR COTTONWOOD CREEK MAINSTEM

SUB-REACH 3

PROJECT PT3: ADAPTIVE STREAM MANAGEMENT AND DEVELOPMENT PLANNING

CALEY EAST POND 3.9 AF EURV PROVIDED

POTENTIAL ROAD PROJECT AT INTERSECTION OF BRIARWOOD AND PEORIA (BY OTHERS)

PROJECT PT1: STREAM RECLAMATION AND REHABILITATION WITH ISOLATED STRUCTURAL REPAIR

PROBLEM AREA #1 AGING INFRASTRUCTURE

PROJECT PT2: UPSIZE CULVERTS NEAR STRUCTURES

PEORIA ST POND

COTTONWOOD CREEK

PROJECT PT5: ARAPAHOE POND NEW EURV FACILITY (2010 OSP)

SUB-REACH 2

SUB-REACH 1

PROBLEM AREA #2 GOLF COURSE STRUCTURES IN FLOODWAY

AIRPORT POND C3/C4
5.6 AF WQCV
14.1 AF EURV
EXCEEDS WQCV

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

COTTONWOOD CREEK SELECTED ALTERNATIVES
PEORIA TRIBUTARY

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

APPENDIX A
REACH CR10

Reach D-0 to D-1 – Dove Creek
Fact Sheet Reach DR1

Reach Description: The most upstream portion of Dove Creek begins just north of Grasslands Drive and just south of the county line between Arapahoe and Douglas Counties. Runoff flows into Pond D-0 (i.e., Highfield Pond) from an industrial business park where it flows northeast through a 36" RCP adjacent to the Triton Environmental facility. The drainageway emerges just north of Otero Ave via a 72" RCP roadway culvert and continues north to Pond D-1. A few minor headcuts are noted along the reach between Otero Ave and Chambers Rd. A headcut classified as "severe" is present just north of Chambers Rd but appears to be somewhat stabilized by riparian vegetation. A heavily incised area can be seen along this section of the channel, which has been previously assessed to be in an "erosional" state (Enginuity, 2021). Drainage swales and rundowns flow laterally from neighboring areas into Pond D-1. Channel restoration is in the design phase for the reach north of Otero Ave to Pond D-1. The current landscape is a mix of industrial development and vacant land which is rapidly developing.

Approximate length of reach: 0.7 miles

Sources: Enginuity 2021 SEMSWA Adaptive Management Stream Condition Assessment Map; SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA; Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Cottonwood, Lone, Tree, Windmill, and Dove Creeks Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010, 09/30/2005, 09/04/2020
FIRM Panel: 08005C0479K, 08035C0054F, 08035C0062H
FEMA Flood Zone: X (Area of minimal flood hazard). No riverine floodplain along this reach of Dove Creek has been designated by FEMA.

Water Quality:
CDPHE river segment: COSPCH04a_A
Affected Use: Water Supply
Analytes: Fe (d) and Mn (d)
Category/List: 3b./M&E

Zoning:
Primarily multiple use zoning in Arapahoe County. Unincorporated municipal planning area in Douglas County.

Community Resources:
A walking path winds around Pond D-0. Open space encompasses Pond D-1, which is located adjacent to Cherry Creek Innovation Campus and the Arapahoe County Community Park.

Strategies for adding value along the drainage corridor for the community:
A walking and biking path could be included in SEMSWA owned tracts around Pond D-1 and along the corridor of Sub-Reaches 1 and 2 and connect with large pedestrian walkway along Chambers Road.

SEMSWA Adaptive Management Stream Condition Assessment (Enginuity, 2021):

Stream Parameter	Sub-Reach 1	Sub-Reach 2	Sub-Reach 3
Floodplain Connectivity	Fair	Poor	Good
Overall Quality	Good	Fair	Fair
Bank Stability	9	4	6
Riparian Quality	6	3	5
Riparian Quantity	8	8	7
Nutrient Enrichment	6	7	7

**A higher score is indicative of greater stream health*

Projects	Status
Pond D-0: Obtained maintenance easement for Highfield (D-0) detention and water quality pond, built 2006.	Complete
Pond D-1: Water quality and detention improvements, 2010.	Complete
Pond D-0: Proposed outlet structure modification.	In progress
Channel: Restoration of channel between Ponds D-0 and D-1.	In design

Potential or Known Problem:	Alternatives
#1 Overflow Issues at Pond D-0	**Do nothing.**
	Project DC2: Pond D-0 overflow path.
	Project DC3: Pond D-0 high flow bypass.
	Project DC4: Improve inlet capacity downstream of Pond D-0 outfall.
#2 Standing water in Pond D-0	**Do nothing.**
	Project DC1: Retrofit Pond D-0 to reduce standing water.
#3 Pond D-1 challenging to maintain	**Do nothing: Maintain as-is.**
	Project DC5: Retrofit Pond D-1 capture EURV and include sediment forebays and trickle channel.
#4 Channel instability	**Do nothing: Wait for channel restoration.**
	Project DC6: Larger stream restoration and channel stabilization with drop structures in Sub-Reaches 1 and 2.
	Project DC7: Use Adaptive Stream Management Strategies to promote channel stabilization in Sub-Reaches 1 and 2.
#5 Unstable flow at Otero Road near Aurora RV large parking area	**Do nothing.**
	Project DC8: Stabilize erosion at E Otero Rd and Aurora RV.

Potential Improvement Areas:

Pond Capacity: Improvements to Pond D-0 outlet structure are proposed along this reach in **Project DC1**. Pond D-0 currently has an issue with standing water in the trickle channels and in the bottom of the pond outside of the micropool. This is of particular concern near the Centennial Airport where there are Federal Aviation Administration regulations to prevent standing water due to safety requirements in the bird strike zone. Any retrofit to the outlet structure for Pond D-0 should consider incorporating features to aid in maintaining a dry pond bottom. This could include increased fall across the pond bottom or incorporation of the Initial Surcharge Volume (ISV) within the micropool and trickle channel design. SEMSWA is currently in progress of a minor retrofit to the outlet plate of this pond to improve drain times.



Pond D-0 Outlet Structure

Pond Features: Pond D-0 currently does not have a designated overflow path to serve the spillway, which overtops in the 10-year and 100-year storm events. **Project DC2** proposes planning and potentially constructing an overflow path through the downstream receiving properties. This alternative would include grading an overflow channel in a landscaped area south of an existing fence line in alignment with the existing outfall. Flow would then be directed north through an existing access drive for a construction equipment storage facility to Otero Ave. This may require securing drainage easements through the downstream properties. Based on the Highfield Business Park development plans dated January 2006, there is an existing 30' utility easement over water and sanitary lines through the downstream property that looks as though it might have been graded with the intention of providing a pond overflow. There is also an existing 36" diameter RCP storm drain pipe system serving Pond D-0 which likely has a drainage easement that might need to be modified to include overland flow (SEMSWA Project No. 2021-0407).



Pond D-0 Outlet Structure

Pond D-1 improvements proposed in **Project DC5** include addition of trickle channels and sediment forebays and retrofit of the outlet structure to release the upstream EURV at appropriate discharge rates. Construction of sediment forebays could be combined with the construction of outfalls for adjacent developments which might also include modifications to pond access. The existing pond has a 100-year detention volume of 34.4 ac-ft and an excess WQCV of 4.2 ac-ft considering the entire upstream area at full build-out. This excess is due in part to credits from implementation of the SEMSWA 20-10 Rule and in part due to modifications to the WQCV calculation since the 2010 MDP. Pond D-1 is a good candidate for retrofit to detain the EURV and care should be taken in modifying the outlet structure such that there is not an increase in 100-year peak flow rates.



Dove Creek between D-0 and D-1 (Google Earth)

Channel Capacity: Design of channel stabilization for Sub-Reaches 1 and 2 between Ponds D-0 and D-1 is currently in progress as a potential phased 2024 capital improvement project and is included as an alternative in **Project DC7**. A significant reduction in peak flow rates in the 2020 Hydrology Update Report should be reviewed by the design team to ensure an appropriate channel cross section is selected. Adaptive stream management strategies such as low-impact timber walls can be used in the interim as **Project DC6** in the scenario that channel stabilization becomes a lower-priority project for implementation. If **Project DC1** is selected it is recommended that channel design and construction work in tandem with Pond D-0 design such that appropriate hydrology is used to design the channel cross section.

Pipe Capacity: Upstream of Pond D-0 on the western portion of the contributing drainage area there may be an opportunity to construct a high-flow bypass to divert larger storm events around the pond and through the stormdrain system on Otero Ave. **Project DC3** would require securing a drainage easement through an undeveloped parcel owned by the Centennial Airport Authority and construction of approximately 900 linear feet of stormdrain pipe. **Project DC4** includes improving the Type C

stormdrain inlet serving the outfall of D-0 such that it can fully intercept the 100-year storm event. The current interceptive capacity is 18 cfs with the 100-year detained peak flow rate from Pond D-0 being 45 cfs at full build-out.

Maintenance: Problem Area C concerns an unstable flow condition on private property at Otero Road on the northwest corner of the Aurora RV large parking area where flow does not go where intended. **Project DC7** proposes a small project that would stabilize erosion in this area using grading and slope protection.

Water Quality: Both ponds in this study reach have achieved the required WQCV for the upstream contributing drainage area at full build-out.

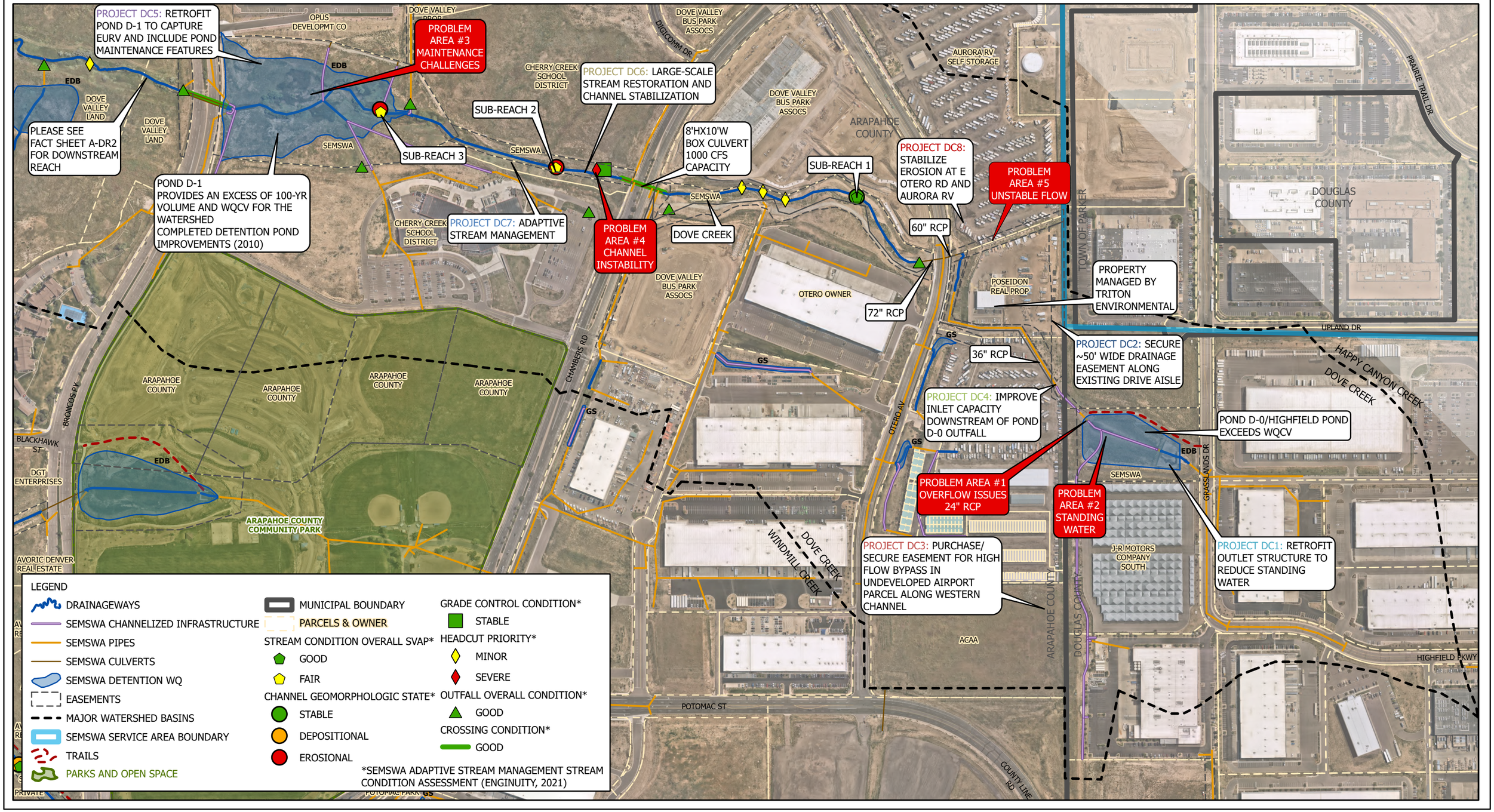


Pond D-0 Overflow Weir

EURV: No pond along this reach currently has EURV. Pond D-1 has a current 100-year volume of 34.6 acre-ft and an excess watershed WQCV provided of 4.2 acre-feet for future imperviousness. The cumulative EURV volume future demand for Pond D-1 is 23.1 acre-feet. **Project DC5** proposes a retrofit Pond D-1 to capture direct EURV volume of 18.1 ac-ft and include pond maintenance features such as sediment forebays and trickle channels.

Because D-0 is a more constrained site and given that channel restoration downstream of Pond D-0 is currently in the design phase, the cumulative EURV volume is included only in the D-1 pond retrofit option and consideration was not given to an option with D-0 and EURV.

Wetlands: The Army Corps issued a letter in 2021 stating that Dove Creek was non-jurisdictional. WWE subconsultant IRIS Mitigation and Design will review documentation provided for this to assess whether any updates to federal rulemaking or legislation would affect this determination.



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE AND DOUGLAS COUNTIES, COLORADO

DOVE CREEK ALTERNATIVES
POND D-0 TO POND D-1

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

APPENDIX A

REACH DR1

Reach D-1 to Confluence with Cherry Creek – Dove Creek
Fact Sheet Reach DR2

Reach Description: Flow discharges from Pond D-1 to the north and flows through undeveloped areas before entering Pond D-2 just southwest of Jordan Rd. The previous master drainage plan (MDP) identified the channel above Pond D-2 for stabilization. Comments from SEMSWA indicate this area is under private ownership with limited access, while some erosion and increased flows have been noted. Two "minor" headcuts along this reach have been identified. Pond D-2 outfall flows northeast via a constrained open channel. Dove Creek continues north of Fremont Dr before entering the Cherry Creek Greenway Corridor. There is an offline Pond D-3 just upstream of the confluence with Cherry Creek adjacent to the Cherry Creek Greenway and Soccer Complex. Pond D-3 includes a high flow bypass and detains only the WQCV.

Approximate length of reach: 1.1 miles

Sources: Enginuity 2021 SEMSWA Adaptive Management Stream Assessment Map; SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA; Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010, 09/04/2020
FIRM Panel: 08005C0479K, 08005C0483L
FEMA Flood Zone: AE, AE Floodway, X (0.2 Pct annual chance flood hazard), X (Area of minimal flood hazard). No riverine floodplain along this reach of Dove Creek has been designated by FEMA. Zones above are mapped along Cherry Creek.

Water Quality:
CDPHE river segment: COSPCH04a_A
Affected Use: Water Supply
Analytes: Fe (d) and Mn (d)
Category/List: 3b./M&E

Zoning:
Zoning is Mixed Use, Business Park, Industrial, and Parks and Open Space.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Sub-Reach 1	Sub-Reach 2
Floodplain Connectivity	Good	Fair
Overall Quality	Good	Good
Bank Stability	9	10
Riparian Quality	4	4
Riparian Quantity	9	7
Nutrient Enrichment	7	NA

**A higher score is indicative of greater stream health*

Projects	Status
Pond D-1: Water quality and detention improvements, 2010.	Complete
Pond D-2: Water quality and detention improvements, 2012	Complete

No Potential or Known Problem Areas Identified

Potential or Known Problem:	Alternatives
General projects to address future development	**Do Nothing**
	Project DC9: Large-scale channel improvements along Sub-Reach 1
	Project DC10: Keep west tributary to Sub-Reach 1 as open channel
	Project DC11: Keep east tributary as open channel
	Project DC12: Perform adaptive stream management
	Project DC13: Channel improvements along Sub-Reach 2
	Project DC14: EURV improvements to Pond D-2

Community Resources:
The channel is bordered to the west by Cherry Creek Soccer Complex just before the confluence with Cherry Creek. The Cherry Creek trail system extends along the channel up to Fremont Drive. There is an existing demonstration rain garden on the north side of Pond D-2 at the SEMSWA offices.

Strategies for adding value along the drainage corridor for the community:
Future planning in Sub-Reach 1 should maintain a wide riparian area and potentially provide connectivity between Cherry Creek Trail System and the Arapahoe County Community Park. Sub-Reach 2 is limited by existing development on both sides but could potentially retrofit existing maintenance access roads for the channel to trails. As the opportunity arises in redevelopment for the lower portions of the creek, trails, natural riparian buffer and meander belt width should also be considered.

Potential Improvement Areas:

Pond Capacity: Improvements to the detention volume of Pond D-2 for the 100-year storm event were recommended and completed from the previous MDP. The revised peak flow rates in Sub-Reach 2 were evaluated regarding whether an EURV retrofit with increased 100-year peak flow discharge rates would be a valid alternative. However, based on the capacity of the downstream culverts and the constrained layout of the channel, this option was not developed.

Pond Features: Pond D-3 was improved in 2006 and has a high flow bypass. It receives direct drainage from a large industrial lot and includes two sediment forebays and a trickle channel. The runoff from these areas could benefit from enhanced treatment of the EURV, however, there is currently little opportunity for expanding or retrofitting the pond volume as it would need to nearly double its capacity.



Pond D-2 Outlet Structure



Dove Creek between Ponds D-1 and D-2

Channel Capacity: Sub-Reach 1 is an undeveloped channel upstream of Pond D-2 which was proposed to have stabilization check structures with the previous MDP. This entire reach is privately owned, and future planning efforts should focus on setting aside a tract wide enough to accommodate an appropriate meander belt width for the natural sinuosity of the channel (**Project DC12**). Should **Project DC12** be chosen, the Master Plan will provide a typical channel section or suggested tract width for future development conditions. Currently there are no high priority degraded features in the channel. However, with future development stabilization check structures may need to be included. Similar to the previous MDP, **Project DC9** proposes lower priority channel stabilizations measures in Sub-Reach 1 with a higher functioning natural stream corridor than was previously proposed.

Two smaller unnamed tributary channels contribute flow to Dove Creek along this reach. The first is located west of Sub-Reach 1 and flows into an existing private extended detention facility before entering the main channel. The second flows parallel to and east of Sub-Reach 1 and becomes piped flow at Jordan Rd. **Project DC10** and **Project DC11** propose keeping these two tributaries as open channels with future development. While they are both under the 130-acre threshold to require an open channel, recommending these in the master plan might highlight the financial and environmental benefits of this practice.

Sub-Reach 2 flows downstream from Pond-D-2 through urbanized industrial areas and is highly constrained by development on both sides. The reach has a concrete trickle channel and flood conveyance but lacks naturalized stream design features such as a floodplain terrace or a meandering bankfull channel. **Project DC13** proposes enhancing the existing channel with naturalized features such as riparian vegetation and some areas of soft bottom channel which was previously not feasible without the since-completed upstream detention improvements. Concrete sediment forebays or other discrete, maintainable features would be included with this alternative.

Pipe Capacity: All major culverts along this reach have sufficient capacity to convey the 100-year design storm. Previous problem areas identified in this area in the 2010 MDP were related to inadequate culvert capacities at Fraser St and Fremont Dr. Improvements to Pond D-2 have resolved the culvert capacity issues at these crossings. Both crossings have low cover and constrained width. Consideration should be given to performing a FHAD along Dove Creek in these areas using future hydrology and draft FHAD delineation to establish Base Flood Elevations for nearby buildings.



Dove Creek at Fremont Dr (Google Earth Image, 2022)



Constrained Sub-Reach 2

Maintenance: Culvert crossings and channels in the constrained Sub-Reach 2 should be a high priority for regular maintenance. The culvert under Fraser St is in "fair" condition, needs to be assessed, and may require more frequent sediment removal.

Water Quality: Dove Creek is no longer in a deficit for WQCV when compared to the 2010 MDP and now has a watershed-wide excess of 8.4 ac-ft at future imperviousness. Pond D-2 provides an excess WQCV of 2.7 ac-ft for direct drainage and 7.2 ac-ft for the cumulative watershed, assuming that Project DC5 from the DR1 fact sheet has not been implemented.

EURV: Both Ponds D-2 and D-3 along this reach are constrained by nearby buildings. Based on revised hydrology, Pond D-2 provides an excess of direct WQCV of 2.7 ac-ft and an excess 100-yr volume of 6.9 ac-ft. The calculated EURV needed for the directly contributing watershed is 15.6 ac-ft, which is not currently included in the pond design. Based on the total 100-year volume of 25.3 ac-ft currently provided in Pond D-2, this pond might make a good candidate for retrofit for full or partial EURV detention. **Project DC14** proposes retrofitting the existing outlet structure to detain the EURV volume. This retrofit might require a restrictor plate for the barrel pipe to avoid increasing the 100-year peak flow rates on the downstream system.

Wetlands: The Army Corps issued a letter in 2021 stating that Dove Creek was non-jurisdictional. WWE subconsultant IRIS Mitigation and Design will review documentation provided for this to assess whether any updates to federal rulemaking or legislation would affect this determination.

CHERRY CREEK

100-YR PEAK FLOW RATE AT OUTFALL OF DOVE CREEK TO CHERRY CREEK HAS DECREASED WITH THE 2020 HYDROLOGY UPDATE (WWE) AND THIS MDP

CHERRY CREEK GREENWAY

COA

CF RC UNDING

EDB

SEMSWA

3-4'HX9'W BOX CULVERT 724 CFS CAPACITY

ASCHERHAUER

JK PARTNERS

DOVE CREEK

PROJECT DC13: NATURALIZED CHANNEL IMPROVEMENTS

SEMSWA

NINE LINE

3-4.5'HX12'W BOX CULVERT 1085 CFS CAPACITY

POND D-3 PROVIDES A CUMULATIVE EXCESS WQCV AT FUTURE IMPERVIOUSNESS

15253 E FREMONT

15214 LLC

VERIDIA

FRASER

FREMONT DR

SUB-REACH 2

DARVA

UNK

HINSDALE DR

HINSDALE CL

JORDAN RD

HAPPY CANYON CREEK

DOVE CREEK

BRONCOS PY

MINERAL AV

HANNIBAL ST

BPG DOVE VALLEY 2

PROJECT DC11: KEEP AS OPEN CHANNEL

FRASER ST

PLD

DOVE VALLEY

COA

CHERRY CREEK SOCCER COMPLEX

BFI WASTE

DOVE CREEK

SEMSWA

POND D-2 EXCEEDS WQCV COMPLETED WATER QUALITY AND DETENTION IMPROVEMENTS (2012)

FAIRPLAY ST

GS

SUB-REACH 1

DOVE VALLEY LAND

PROJECT DC12: ADAPTIVE STREAM MANAGEMENT

POND D-1 PROVIDES A 100-YR VOLUME AND WQCV WHICH IS AN EXCESS FOR THE WATERSHED WQCV COMPLETED DETENTION POND IMPROVEMENTS (2010)

DOVE VALLEY PROP

PLEASE SEE FACT SHEET A-DR1 FOR UPSTREAM REACH

TUGELA

PROJECT DC14: EURV IMPROVEMENTS

M2514

PRIVATE

CITY OF CENTENNIAL

ARAPAHOE COUNTY

DOVE CREEK

CHERRY CREEK SCHOOL DISTRICT

EAGLE ST

DOVE CREEK

WINDMILL CREEK

PROJECT DC9: LARGE-SCALE CHANNEL IMPROVEMENTS

PROJECT DC15: SEDIMENT FOREBAY

2-6'HX8'W BOX CULVERT 890 CFS CAPACITY

PROJECT DC10: KEEP AS OPEN CHANNEL

ARAPAHOE COUNTY COMMUNITY PARK

ARAPAHOE COUNTY

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- EASEMENTS
- MAJOR WATERSHED BASINS

FEMA FLOOD ZONES

- AE
- AE,FLOODWAY
- SEMSWA SERVICE AREA BOUNDARY

- TRAILS
- PARKS AND OPEN SPACE
- MUNICIPAL BOUNDARY
- PARCELS & OWNER

STREAM CONDITION OVERALL SVAP*

- GOOD
- FAIR

CHANNEL GEOMORPHOLOGIC STATE*

- STABLE
- EROSIONAL

GRADE CONTROL CONDITION*

- STABLE

HEADCUT PRIORITY*

- MINOR

OUTFALL OVERALL CONDITION*

- GOOD

CROSSING CONDITION*

- GOOD
- FAIR

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

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WWE WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

DOVE CREEK ALTERNATIVES
POND D-1 TO CONFLUENCE WITH CHERRY CREEK

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

APPENDIX A

REACH DR2

Pond L1 to Pond L2 – Lone Tree Creek
Fact Sheet Reach LR1

Reach Description: This reach begins at Ponds L-1 East and L-1 West in the Arapahoe County Airport. Flow discharges north of the airport via permitted pipe outfalls and becomes open channel flow just past E Control Tower Rd. From here, the channel flows northeast approximately 0.5 mile before discharging into Pond L-2. Excess sediment and vegetation are observed in the short channel connecting the County Pond 3 to the main channel. A headcut classified as "severe" is located just south of E Broncos Pkwy, after which flow continues northeast through a 4'x7' box culvert. The channel north of Broncos Pkwy is classified as "erosional". Another minor headcut is located approximately 100 feet upstream of the pond. Drainage from the surrounding area enters Pond L-2 through several piped outfalls.

Approximate length of reach: 0.8 miles

Sources: Enginuity 2021 SEMSWA Adaptive Management Stream Condition Assessment Map; SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA; Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Cottonwood, Lone, Tree, Windmill, and Dove Creeks Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010
FIRM Panel: 08005C0479K
FEMA Flood Zone: AE, AE Floodway, and X (Area of minimal flood hazard).

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A
Note: There is significant phosphorous loading from the upstream ACAA permitted outfalls and there have been annual complaints from public regarding water discoloration.

Zoning:
Zoning is Light Industrial, Mixed Use, and Business Park.

Community Resources:
Pond L-2 is bordered to the east by a gravel path for maintenance.

Strategies for adding value along the drainage corridor for the community: A trail system downstream of Pond L-2 borders Lone Tree Creek north of Tucson Way. There is some space on the east side of Pond L-2 where the trail system could be extended upstream, possibly as far as Broncos Pkwy. Implementation of the existing Cattail Management Plan along this reach could add visibility to stream reaches from future trail system expansions.

Projects	Status
Pond L2: Detention improvements, 2012.	Complete
Pond L2: City's current trail project is improving a portion of the access drive to this pond.	In Progress

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Stream Health
Floodplain Connectivity	Good
Overall Quality SVAP	Good
Bank Stability	7
Riparian Quality	6
Riparian Quantity	9
Nutrient Enrichment	6

**A higher score is indicative of greater stream health*

Potential or Known Problem Areas	Alternatives
#1 Excess sediment and vegetation in connecting channel between County Pond 3 and Lone Tree Creek	**Do nothing: Maintain as-is.**
	Project LC1: Improvements to County Pond 3 for ease of maintenance.
	Project LC2: Request perimeter control surrounding material stockpile on Arapahoe County property.
Problem Areas 2-4 Channel Instability #2 Severe headcut just south of Broncos Pkwy #3 Culvert under Broncos Pkwy in "fair" condition with some sediment #4 Channel north of Broncos Pkwy labeled "erosional" #5 Outfall in "fair" condition and partially blocked midway along channel	**Do nothing: Maintain as-is.**
	Project LC3: Adaptive stream management with targeted drop structures along reach upstream of Pond L-2.
	Project LC4: Large scale stream stabilization project upstream of Pond L-2 as recommended in previous MDP.
#6 WQCV Deficit at Pond L-2	**Do nothing: Address downstream.**
	Project LC5: New pond with WQCV upstream of Broncos Pkwy.
	Project LC6: Retrofit Pond L-2 for WQCV.
	Project LC7: Retrofit ACAA outfall area for WQCV and EURV.
#7 Public complaints of poor water quality and discoloration from phosphorous	**Do nothing: Current implementation of cattail management program and Cherry Creek Phosphorous Program.**
	Project LC7
	Project LC8: Request control measures be implemented upstream by the ACAA to reduce phosphorous loading.
	Project LC9: New constructed wetland pond upstream of Jamison Place at ACAA outfall.

Potential Improvement Areas:

Pond Capacity: Detention improvements for the 10-year and 100-year storm events were completed for Pond L-2 in 2012. The previous Master Drainageway Plan (MDP) identified overtopping at South Revere Parkway, East Briarwood Avenue, and East Arapahoe Road downstream of Pond L-2. Analysis completed in the previous MDP and in the final drainage report for the pond improvements demonstrated that overtopping at these locations was resolved with the improvements at Pond L-2 for up to the 100-year storm event.



Pond L-2 Outlet Structure

Channel Capacity: The channel downstream of County Pond 3 is accumulating significant sediment and a minor headcut is noted where Arapahoe County Pond 3 channel drains into the main stem of Lone Tree Creek. The most likely source is a material stockpile and facility operations adjacent to County Pond 3. County Pond 3 currently serves a material storage facility that is operated by the Arapahoe County Public Works Department. Arapahoe County manages the material stockpile, which currently lacks any perimeter control measures. Improvements to the forebays of the pond and enhanced maintenance features are proposed in **Project LC1** to reduce the sediment load to this stream. This project would require some coordination and potentially an Intergovernmental Agreement (IGA).

Project LC2 proposes approaching the County to discuss the installation of source controls around the material stockpile to reduce the contribution of sediment to the pond and downstream channel. This project could be implemented on its own or in conjunction with **Project LC1.**



Lone Tree Creek upstream of Pond L-2 (Photo by Jim Watt, 2023)

The channel reach upstream of Pond L-2 has localized areas of instability. A 3.5-foot deep headcut upstream of Broncos Pkwy has been assigned a high priority for remediation by the SEMSWA District-Wide Stream Assessment project (Enginuity, 2021). The culvert crossing at Broncos Pkwy is in fair condition with sediment blocking part of the structure. This stream reach has been classified as erosional with some routine outfall maintenance required due to cattails and accumulated sediment. The previous MDP recommended large-scale stabilization of this reach, which is considered in **Project LC4**. However, given that the watershed draining to this reach of Lone Tree Creek is mostly developed and future additions of impervious surface are not anticipated, **Project LC3** considers less invasive and less costly adaptive stream management measures which may be more appropriate. This would include targeted grade control structures to stabilize the headcut and increase energy of flow through the culvert at Broncos Pkwy, resulting in more sediment movement through the culvert and reduced accumulation. Additional grade control structures downstream of Broncos Pkwy may be used to stabilize the channel and reduce erosion. These targeted structures could include a discrete maintainable feature such as a forebay to address upstream sediment and phosphorous loading. The majority of this reach is located within SEMSWA-owned properties, the exception being the furthest upstream portion, which is owned by the Arapahoe County Airport Authority (ACAA).

Pond Features: Opportunities for improvements to the forebays of County Pond 3 are explored as part of **Project LC1** to improve the sediment removal function of the pond and reduce the sediment contribution to the downstream channel.

Pipe Capacity: No pipe capacity issues have been identified along this reach. The culvert at Broncos Pkwy is partially filled with sediment which could be due to a need for routine maintenance or potentially an upstream source that is addressed in **Project LC1** and **Project LC2.**

Maintenance: **Project LC1** proposes improvements to the multiple forebays of County Pond 3 to facilitate maintenance of the pond and downstream channel. Improved maintenance of the pond may reduce sediment loading to the downstream channel. All

new and retrofit detention pond projects should consider maintainability. Discrete locations for sediment removal should be evaluated in channel projects. The high sediment loading upstream of Broncos Pkwy will affect the alternatives assessment in terms of the maintainability for any features at this location.

Water Quality: Pond L-1 East currently provides adequate WQCV for the upstream watershed. The current design of Pond L-2 does not include WQCV. There is a cumulative WQCV deficit at Pond L-2 of 6.1 ac-ft which is resolved at downstream pond L-3. **Project LC6** would include a retrofit of Pond L-2 for water quality. Shifting that 6.1 ac-ft of WQCV from Pond L-3 to L-2 could provide more flexibility in the retrofit design of downstream Pond L-3, which is currently experiencing significant maintenance problems. This project could also be a simple intermediate way to address the WQCV deficit while other, larger projects take longer to implement. **Project LC5** provides a second option to address the WQCV deficit in Lone Tree Creek. The property adjacent to Lone Tree Creek upstream of Broncos Pkwy is owned by SEMSWA and potentially adequate space is available for the installation of a new water quality pond at this location. **Project LC7** considers a retrofit of the ACAA-owned outfall area for WQCV and potentially EURV.

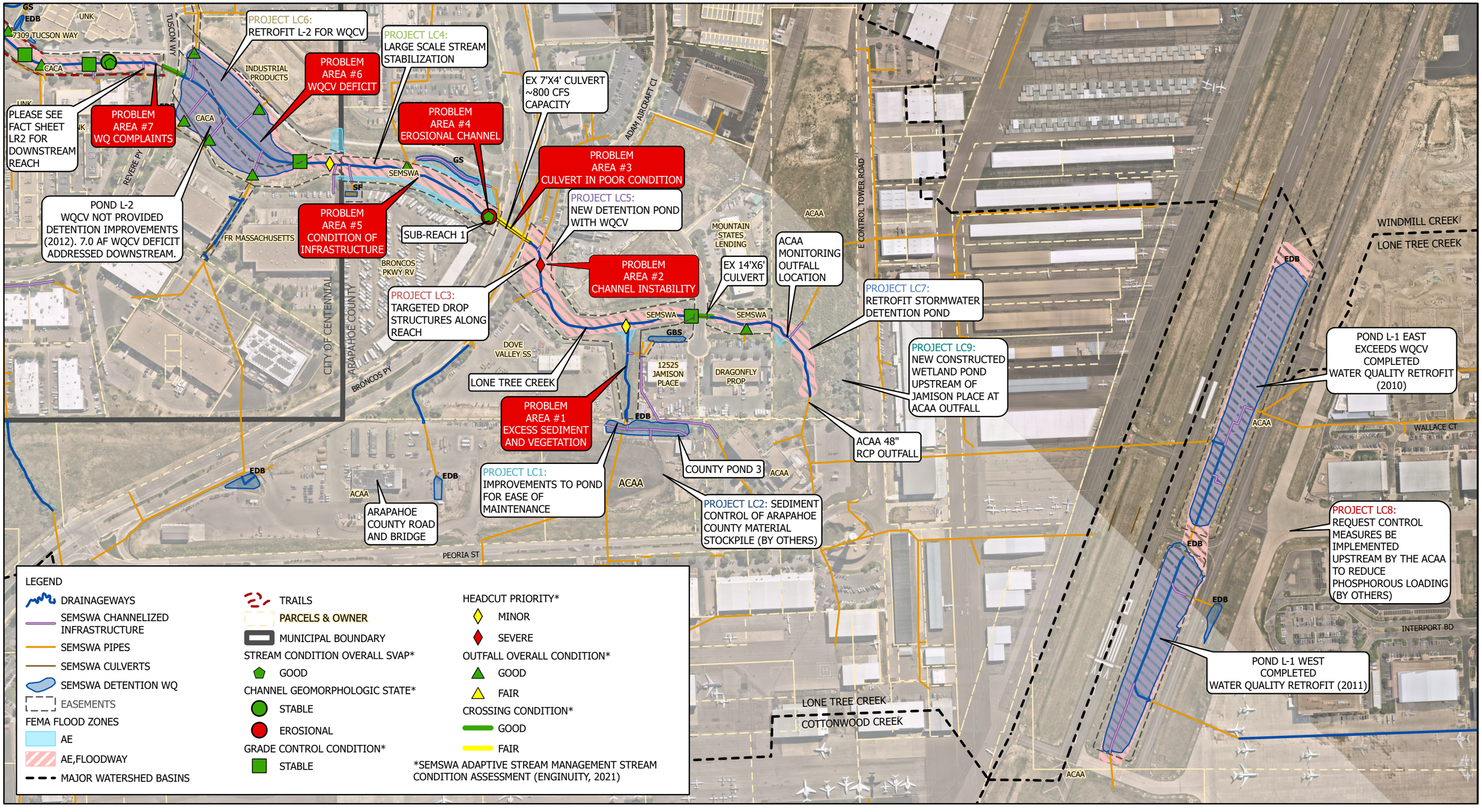
This stream reach has had reports of complaints annually from the public regarding poor water quality and discoloration. This is likely due to high phosphorous loading from the Centennial Airport and may be exacerbated by high sediment loads from the nearby material storage area operated by Arapahoe County (**Project LC1** and **Project LC2).** The impairments of high phosphorus loading could also be addressed by **Project LC7** depending on the pond features implemented. However, if high phosphorous loading is limited to dry weather flows and stream base flows, maintainable concrete features such as trickle channels may reduce the ability of the existing vegetated waterway to reduce phosphorous levels. **Project LC8** includes a formal request to the ACAA for control measures to be implemented upstream to reduce phosphorous loading. This project might be implemented alongside any other capital improvement projects selected and would include a review of the current ACAA stormwater management plan and industrial permit for source controls with targeted recommendation based on downstream needs. **Project LC9** proposes a new constructed wetland pond upstream of Jamison Place to achieve higher levels of phosphorous removal for this flow regime. The ACAA has indicated that they would be interested in sharing costs for this type of project in this location as it might help them achieve effluent limitations for phosphorous in this area. If cost-sharing is implemented with the ACAA, it could help offset additional costs of permitting and water rights associated with this type of stormwater facility.

EURV: This reach is constrained by adjacent developments and the existing mapped FEMA Floodway Zone AE which extends almost the entire width of the SEMSWA-owned tract. Care should be taken with all new and retrofit stormwater facilities such that changes in Base Flood Elevations (BFEs) do not affect adjacent buildings. If selected, **Project LC7** and **Project LC9** will potentially provide EURV depending on the results of design-level grading analysis and floodplain modeling. However, this is not the primary issue being addressed by either of these projects, which may only be able to achieve WQCV based on these site constraints.

Wetlands: This reach is well vegetated with several identified wetland areas. Preserving or restoring existing wetlands while providing discrete locations for sediment removal should be a priority in any project selected. Cattail removal under the Cherry Creek Wetland Phosphorous Program should be explored with any projects selected for this reach. **Projects LC3** through **LC7** and **LC9** will be evaluated in part on the potential for wetland impacts and permitting challenges both for construction and for long-term maintenance. This area has been previously assessed as jurisdictional and these projects will likely need an individual permit. If wetlands are reestablished in the same location, such as in **Projects LC3** and **LC9**, the impact may be viewed as a temporary wetland impact.



Centennial Airport 48” RCP Outfall



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

LONE TREE CREEK ALTERNATIVES
POND L-1 TO POND L-2

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 350 FEET

0 175 350

PROJECT NO. 211-088.000

APPENDIX A

REACH LR1

Lone Tree Creek Downstream of Pond L-2 – E Arapahoe Rd
Fact Sheet Reach LR2

Reach Description: Flow exits Pond L-2 and flows north in a drainageway bordered intermittently by industrial development and open space. A small tributary crosses S Revere Pkwy and joins Lone Tree Creek approximately a quarter of a mile downstream of Pond L-2. The storm drain in S Revere Pkwy needs to be upsized. Runoff from recent development along S Revere Pkwy is piped to the main channel another approximately 650 feet downstream. Most of the channel between S Revere Pkwy and E Briarwood Ave is bordered by trails. Most of the roadway overtopping since the previous Master Drainageway Plan (MDP) was resolved with the detention improvements to Pond L-2. However, there is still overtopping downstream at Peakview Ave (see Fact Sheet Reach LR3). The culvert under E Arapahoe Rd is in "poor" condition due to a failing concrete apron.

Approximate length of reach: 0.5 miles

Sources: Enginuity 2021 SEMSWA Adapative Stream Management Stream Condition Assessment Map; SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA; Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010, 2/17/2017
FIRM Panel: 08005C0479K, 08005C0477L
FEMA Flood Zone: AE, AE Floodway, and X (Area of minimal flood hazard).

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A

Zoning:
Surrounding areas are zoned Open Space and Recreation, Business Park, and General Commercial.

Community Resources:
Most of this reach of Lone Tree Creek is bordered by trails with intermittent undeveloped areas. The channel flows through Centennial Center Park north of E Arapahoe Rd.

Strategies for adding value along the drainage corridor for the community:
Given how accessible this reach is to the community with its extensive network of bordering trails, projects including naturalized channel features will provide aesthetic benefits for the community.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Stream Health
Floodplain Connectivity	Fair
Overall Quality SVAP	Good
Bank Stability	8
Riparian Quality	6
Riparian Quantity	7
Nutrient Enrichment	9

**A higher score is indicative of greater stream health*

Completed Projects/Objectives

Projects	Status
Pond L-2: Detention improvements 2012.	Complete
Pond L-2: City's current trail project is improving a portion of the access drive to this pond.	In Progress

Potential or Known Problem Areas:

Potential or Known Problem Areas	Alternatives
#1 Small tributary at S Revere Pkwy is being piped with current development. Storm drain in S Revere Pkwy needs to be upsized.	**Do Nothing**
	Project LC10: Upsize storm drain within ROW
#2 Channel erosion occurring in part due to undersized and aging grade control structures and concrete-lined trickle channel.	**Do Nothing: Maintain as is**
	Project LC11: Adaptive stream management to address isolated channel instability
	Project LC12: Conversion to soft bottom trickle channel as infrastructure degrades
	Project LC13: Remove concrete trickle channel from entire reach
#3 Capacity issues at downstream crossings (Peakview Ave).	**Do Nothing: Address downstream**
	Project LC14: Install new detention facility upstream of E Briarwood to alleviate downstream overtopping
#4 Culvert under E Arapahoe Rd in "poor" condition due to cracking, piping, and/or undermining of apron.	**Do Nothing: Maintain as is**
	Project LC15: Improve culvert apron

Potential Improvement Areas:



Lone Tree Creek Downstream of Tucson Way

Pond Capacity: Detention improvements for the 10-year and 100-year storm events were completed for Pond L-2 in 2012. The previous Master Drainageway Plan (MDP) identified overtopping at S Revere Pkwy, E Briarwood Ave, and E Arapahoe Rd downstream of Pond L-2. Analysis completed in the previous MDP and in the final drainage report for the pond improvements demonstrated that overtopping at these locations was resolved with the improvements at Pond L-2 for up to the 100-year storm event. However, overtopping still occurs at Peakview Ave as shown in downstream Fact Sheet Reach LR3.

Project LC14 proposes the installation of a new detention facility upstream of E Briarwood Ave to increase detention storage in the drainage system. The additional flood attenuation provided will help alleviate overtopping of downstream crossings.

Pond Features: No improvements to pond features are suggested along this reach of Lone Tree Creek.

Channel Capacity: The channel downstream of Pond L-2 is straight with a concrete low flow channel. Grade control structures are installed intermittently along the channel, and rip rap is eroding and blocking the low flow channel at several locations, which is causing some erosion of the channel. In addition to stabilizing the channel, **Projects LC11** through **LC13** offer opportunities to create a more naturalized channel. **Project LC11** proposes adaptive stream management strategies to address localized areas of instability. **Project LC12** promotes the removal of concrete from the low flow channel as the material degrades and the gradual transition to a soft-bottom channel. **Project LC13** takes the large-scale approach of the complete removal of the concrete channel bottom. This alternative would require the widening of the channel to accommodate reduced flow capacity resulting from the increase in roughness. Any channel project chosen should potentially include the preliminary location of outfalls to serve future development as well as a channel profile. **Projects LC12** and **LC13** would include addition of concrete sediment forebays to facilitate maintenance. **Project LC13** might take longer to implement based on cost and scale and would likely not be able to address immediate needs as this generally would be ranked lower on the CIP priority list.

Pipe Capacity: The previous MDP completed for this basin concluded that roadway overtopping would occur along Lone Tree Creek at S Revere Pkwy (above 50-yr capacity), E Briarwood Ave (above 50-yr capacity), E Arapahoe Rd (above 50-yr capacity), and E Peakview Ave (below 10-yr capacity). An unnamed tributary to the west of Lone Tree Creek has been piped through an area of development and the storm sewer needs upsizing where it crosses Revere Pkwy. Road overtopping issues along this reach that were identified in the previous master plan have been resolved with the improvements to Pond L-2. **Project LC10** proposes upsizing storm drain within ROW to convey the 100-year storm event.

Maintenance: The SEMSWA District-Wide Stream Assessment project (Enginuity, 2021) identified the culvert under Arapahoe Rd as in poor condition with the outfall on the downstream side in need of maintenance. The culvert feature driving the poor rating is the apron, which exhibits cracking, piping, and/or undermining. **Project LC15** improves this culvert in conjunction with the Arapahoe Road widening project and/or City of Centennial's trail improvement program.

To facilitate maintenance, discrete locations for sediment removal such as sediment forebays should be evaluated in all channel projects. This is of particular importance in **Projects LC12** and **LC13** which remove a failing maintainable feature (the trickle channel) in favor of a naturalized flow path.

Water Quality: Pond L-2 does not currently provide treatment of the WQCV. The cumulative WQCV needed for the watershed is resolved downstream at Pond L-3. Please see Fact Sheet Reaches LR1 and LR3 for a discussion of these ponds. It should be noted that there are a large number of private offline EDBs in this watershed feeding into relatively long piped systems up to several thousand feet long.



Lone Tree Creek Upstream of East Briarwood Ave (Google, 2018)

The low flow channel along the length of this reach is mostly concrete-lined, providing no water quality benefits through infiltration. The removal of the concrete bottom and conversion to soft-bottom channel will provide enhanced water quality treatment along this reach of Lone Tree Creek.

EURV: Please see Fact Sheet Reaches LR1 and LR3 for a discussion of EURV along Lone Tree Creek.

Wetlands: There are very few existing wetlands along this reach and much of the main channel of Lone Tree Creek here is concrete-lined. With the removal of this concrete in a number of proposed project alternatives, the implication of wetland restoration and preservation should be considered.

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- EASEMENTS

FEMA FLOOD ZONES

- AE
- AE,FLOODWAY
- MAJOR WATERSHED BASINS
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS & OWNER
- MUNICIPAL BOUNDARY

STREAM CONDITION OVERALL SVAP*

- GOOD

CHANNEL GEOMORPHOLOGIC STATE*

- STABLE

GRADE CONTROL CONDITION*

- STABLE
- MINOR

HEADCUT PRIORITY*

- MINOR

OUTFALL OVERALL CONDITION*

- GOOD
- FAIR

CROSSING CONDITION*

- GOOD
- POOR

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

PROBLEM AREA #3 INADEQUATE DOWNSTREAM CROSSING CAPACITY

PLEASE SEE FACT SHEET LR3 FOR DOWNSTREAM REACH

PROBLEM AREA #4 CULVERT APRON DEGRADATION

~1400 CFS CAPACITY

PROJECT LC15: CULVERT IMPROVEMENTS

PROJECT LC14: NEW DETENTION POND UPSTREAM OF BRIARWOOD AVE

PROJECT LC12: GRADUAL CONVERSION TO SOFT BOTTOM TRICKLE CHANNEL THROUGH SMALL-SCALE PROJECTS AS INFRASTRUCTURE DEGRADES

PROJECT LC13: FULL REMOVAL OF CONCRETE TRICKLE CHANNEL

PROBLEM AREA #2 CHANNEL EROSION

PROJECT LC11: ADAPTIVE STREAM MANAGEMENT TO ADDRESS ISOLATED INSTABILITY

COMPLETED CIP STORM SEWER AND OUTFALL IMPROVEMENTS (2019)

PROBLEM AREA #1 UNDERSIZED STORM DRAIN

24" RCP
66 CFS 10YR FU
133 CFS 100YR FU
~34 CFS CAPACITY

PROJECT LC10: UPSIZE STORM DRAIN WITHIN ROW

POND L-2
WQCV NOT PROVIDED
DETENTION IMPROVEMENTS (2012). 7.0 AF WQCV DEFICIT ADDRESSED DOWNSTREAM.

PLEASE SEE FACT SHEET LR1 FOR UPSTREAM REACH

LONE TREE CREEK

WINDMILL CREEK

LONE TREE CREEK

COTTONWOOD CREEK

CENTENNIAL CENTER PARK

E ARAPAHOE RD

BRIARWOOD AV

BRIARWOOD AVE

EUCLID DR

TUSCON WY

REVERE PY

FREMONT PL

EASTER AV

BRONCOS PY

CITY OF CENTENNIAL

ARAPAHOE COUNTY

OFI GLOBAL

MSR LLC

A13 PROP

PRIVATE

MZ GROUP

INTERSTATE HIGHWAY CONSTR

7257 S TUCSON WAY

7309 TUCSON WAY

CLD PROP

KOLL CENTER

COIG

SKY HARBOR

SKY HARBOR BUS PARK

STATE OF CO

REVERE DVLPMT

UNK

GACA

CACA

INDUSTRIAL PRODUCTS

BCC

SEMSWA

FR MASSACHUSETTS

BRONCOS PKWY RV

DOVE VALLEY SS

ACAA

WPC

ST. MARK COPTIC ORTH CHURCH

THOMSON LOGISTICS

DOVE VALLEY BUS PARK ASSOC

DOVE VALLEY BUS PARK ASSOCS

BERGER FOUNDATION

COG

PEAKVIEW AV

ITS CENTENNIAL

PARKGATE BLDG

COLD RIDGE PARTNERS

SSP REALTY

6786 S REVERE PKWY

SOUTHFIELD PARK ASSN

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

LONE TREE CREEK ALTERNATIVES
POND L-2 TO E ARAPAHOE RD
SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

APPENDIX A

REACH LR2

Lone Tree Creek: E Arapahoe Rd – Cherry Creek State Park
Fact Sheet Reach LR3

Reach Description: Lone Tree Creek flows north less than half a mile from E Arapahoe Rd through Centennial Center Park and into Pond L-3. The channel between E Arapahoe Rd and E Peakview Ave may be improved as part of City Park improvements. The previous Master Drainage Plan (MDP) recommended increasing culvert capacity at E Peakview Ave as roadway overtopping is predicted (below 10-year capacity). The culvert has not been replaced to date, although City of Centennial may add a railing as a future project. The previous MDP performed a "Without Levee" analysis at the ACWWA facility that resulted in inundation of structures at the WWTP. The channel adjacent to the facility is full of cattails and has been assessed "erosional."

Approximate length of reach: 0.75 miles

Sources: Enginuity 2021 SEMSWA Adaptive Management Stream Condition Assessment Map; SEMSWA GIS; Arapahoe and Douglas Counties GIS; CDPHE; FEMA; Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0477L
FEMA Flood Zone: AE, AE Floodway, AH, and X (Area of minimal flood hazard).

Water Quality:
CDPHE river segment: COSPCH04b_A
Affected Use: N/A
Analyte: N/A
Category/List: N/A

Zoning:
Surrounding areas are zoned Open Space and Recreation and Business Park.

Community Resources:
Lone Tree Creek flows through Centennial Center Park immediately north of E Arapahoe Rd. Pond L-3 is partially bordered by undeveloped properties and a recreational bike path. The channel flows into Cherry Creek State Park just past the ACWWA facilities. An existing trail system parallels Lone Tree Creek from Pond L-2 to Pond L-3 and is currently being extended into the park by the City of Centennial along the western border of the ACWWA property line.

Strategies for adding value along the drainage corridor for the community:
Improved aesthetics to the waterways should be considered in all alternatives given this reach's proximity to recreation areas.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Stream Health
Floodplain Connectivity	Fair
Overall Quality SVAP	Fair
Bank Stability	8
Riparian Quality	4
Riparian Quantity	6
Nutrient Enrichment	6

**A higher score is indicative of greater stream health*

Potential or Known Problem Areas	Alternatives
#1 Possible roadway overtopping at E Peakview Ave (below 10-year capacity). Culvert needs increased capacity. Downstream of culvert is a partially blocked outfall. Safety upgrades are needed.	**Do nothing.**
	Project LC14: New detention pond south of Briarwood Ave
	Project LC16: Install safety guardrail
	Project LC17: LT16 and increase conveyance capacity of culvert under road
	Project LC18: Raise the road
#2 Pond L-3: Difficult to maintain and has diminished overall function due to filling up with cattails and sediment	**Do nothing.**
	Project LC19: Retrofit outlet structure
	Project LC20: Install pipe above sewer line
	Project LC21: Install shallow underdrains
	Project LC22: Manage vegetation to improve flow through and out of pond
	Project LC23: Wetland banking
	Projects LC14 and LC6: Add WQCV upstream
#3 Inundation of ACWWA structures at WWTP due to "Without Levee" floodplain analysis.	**Do nothing.**
	Project LC24: Floodproof adjacent structures (by others)
	Project LC25: Possible update to FHAD if new hydrology shows reduction in BFE (by others)
#4 Reduced channel capacity due to vegetation. Erosion occurring along this segment of channel.	**Do Nothing.**
	Project LC26: Improve channel capacity, remove cattails, and erosion
Other Projects:	
Arapahoe Rd to E Peakview Ave	City may improve as part of park improvements
Lone Tree Creek trail adjacent to creek	Channel improvements in CCSP

Potential Improvement Areas:



Pond L-3 Near Outlet Structure

Pond Capacity: Pond L-3 is currently losing capacity to sediment accumulation, extremely challenging maintenance, and a thriving cattail community. **Projects LC19** through **LC22** suggest improvements to facilitate management of the pond vegetation and periodic removal of sediment. Wetland banking, as proposed in **Project LC23**, would allow the removal of the wetland from the pond bottom and the installation of pond features to improve maintenance and restore the pond's previous capacity. Projects discussed in upstream Lone Tree Creek Fact Sheet Reaches LR1 and LR2 propose the relocation of WQCV and pond capacity upstream (**Projects LC14** and **LC6**) to provide some margin for loss of capacity in Pond L-3 and allow for its continued maintenance as a wetland pond.

Pond Features: Opportunities to improve the features of Pond L-3 to facilitate better maintenance access are explored in **Projects LC19** through **LC21**. The outlet structure could be modified to allow for periodic draining of the pond to allow for maintenance access, as proposed in **Project LC19.** The installation of a drain pipe above the sewer line between the pond forebay and the rest of the pond might allow for water to be pumped out of the forebay more easily for maintenance (**Project LC20**). Shallow underdrains installed along the bottom of the pond could improve drainage but also might fill with sediment frequently and would need to be accessible for periodic replacement (**Project LC21**).

Channel Capacity: The channel adjacent to the Arapahoe County Water and Wastewater Authority (ACWWA) is challenging to maintain and may be losing capacity. Adjacent ACWWA facilities are in the 100-year floodplain primarily due to being constructed below the base flood elevations and are separated from the channel by an informal levee. **Project LC26** proposes small-scale channel improvements to address erosion and channel capacity. This project could potentially be combined with efforts to more easily drain Pond L-3 for maintenance by lowering the receiving channel invert.

Pipe Capacity: The previous Master Plan (ICON, 2010) called out the culvert at Peakview Ave as overtopping in events as frequent as the 10-year with proposed culvert and roadway improvements that have not yet been implemented. While the addition of detention at Pond L-2 and the implementation of revised hydrology methods alleviated some of this, overtopping continues to be a concern above the 25-year storm event. A handrail was installed then removed along Peakview Ave above the culvert to avoid worsening flooding at this crossing. **Project LC16** proposes the installation of a safety guardrail above the culvert, either alone or in conjunction with other projects addressing overtopping here. **Project LC14** proposes the addition of a new detention facility south of Briarwood Ave, which would help to decrease the 100-year flow rate at the Peakview crossing. The previous Master Plan recommended replacing the current box culvert with a double box culvert and raising the road. The proposal to upsize the culvert is carried into the current MDP with **Project LC17**, with the additional recommendation to include the installation of a safety guardrail. **Project LC18** proposes raising Peakview Ave, and enlarging the culverts, consistent with the previous master plan.



Pond L-3 Sediment Forebay

Maintenance: Pond L-3 contains a constructed wetland, which has presented maintenance challenges due to ponded water and lack of access to perform sediment removal and vegetation management. **Project LC19** proposes improvements to the outlet structure, such as the installation of a gate valve, that would allow the pond to be drained periodically for maintenance. The pond forebay tends to hold water due to poor drainage from the forebay to the rest of the pond, and the crossing of a sewer line between the forebay and the rest of the pond limits options for improvements. **Project LC20** proposes the installation of a pipe above the sewer line connecting the forebay to the main pond that could be used to pump water out of the forebay to allow crews access to remove accumulated sediment. Another option to improve drainage in the pond is the possible addition of shallow underdrains as proposed in **Project LC21**. This option recognizes this site is not optimally designed for underdrains, which are likely to fill with sediment at a faster rate and would need to be replaced frequently.

Water Quality: Pond L-3 currently treats 20.2 ac-ft of WQCV, which exceeds the future direct WQCV demand of 12.9 ac-ft. The cumulative WQCV provided at L-3 is 24.8 ac-ft, when implementation of the 20-10 rule is considered. The future cumulative WQCV needed for the upstream contributing areas is 23.2 ac-ft. Given the surplus of WQCV currently provided at Pond L-3, options for shifting WQCV treatment further upstream and allowing Pond L-3 to lose some capacity to the wetland may be considered (**Projects LC14** and **LC6**).

EURV: Pond L-3 does not currently provide EURV. Given site constraints and issues maintaining current design volumetric capacity, EURV is not proposed along this reach.

Wetlands: Pond L-3 currently functions as a constructed wetland. Alternatives for improving this pond (**Project LC20**, **Project LC21**, and **Project LC22**) will need to be evaluated for any potential wetland impact. Alternatively, wetland banking is an option (**Project LC23**) that would allow for improvements to the pond capacity, function, and ease of maintenance without consideration of the potential impact to wetlands.



Pond L-3 Facing Northwest

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- PRIVATE WET PONDS
- EASEMENTS

FEMA FLOOD ZONES

- AE
- AE,FLOODWAY
- AH

- MAJOR WATERSHED BASINS
- SEMSWA SERVICE AREA BOUNDARY
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS & OWNER

STREAM CONDITION OVERALL SVAP*

- FAIR

CHANNEL GEOMORPHOLOGIC STATE*

- EROSIONAL

GRADE CONTROL CONDITION*

- STABLE
- MINOR

OUTFALL OVERALL CONDITION*

- GOOD
- FAIR

CROSSING CONDITION*

- GOOD
- POOR

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

POTOMAC ST
XANADU WY
WEAVER PL
LONGVIEW AV
LONGVIEW PL
VALLEYVIEW AV
CARLSON DR
VAUGHN ST
PEAKVIEW AV
UVALDA ST
BRIARWOOD AV
E ARAPAHOE RD
6810 SOUTH TUCSON WAY
AT&T
OFI GLOBAL
ITS CENTENNIAL
CACA
PARKGATE BLDG
COLD RIDGE PARTNERS
SSP REALTY
6786 S REVERE PKWY
SOUTHFIELD PARK ASSN
REVERE PY
EUCLID DR
CHERRY CREEK STATE PARK
ACWWA
WINDMILL CREEK
LONE TREE CREEK
CENTENNIAL CENTER PARK
BERGER FOUNDATION
CENTRAL PARK
COC
SEMSWA
CALEY AV
S DENVER ISLAMIC CENTER
ALLOWSOURCE
ASCENT PROP
PACIFIC INSTRUMENTS
UNK
TROY CI
COTTONWOOD CREEK
CITY OF CENTENNIAL
GS
GB
EDB
PLD

CHANNEL IMPROVEMENTS IN CCSP UNDER DEVELOPMENT BY OTHERS

CCSP SEE APPENDIX H

PROJECT LC25: UPDATE FHAD

PROBLEM AREA #3 INUNDATION OF STRUCTURES

PROJECT LC24: FLOODPROOF ADJACENT STRUCTURES

SUB-REACH 1

2-10'X8' CULVERTS

PROJECT LC19: RETROFIT OUTLET STRUCTURE

POND L-3 FUTURE WQCV EXCEEDED AND 100-YR DETENTION NOT PROVIDED

PROJECT LC23: WETLAND BANKING

PROJECT LC21: INSTALL SHALLOW UNDERDRAINS

PROJECT LC20: INSTALL PIPE ABOVE SEWER LINE

PROJECT LC14: INSTALL NEW DETENTION POND SOUTH OF BRIARWOOD AVE TO ALLEVIATE FLOODING AT PEAKVIEW AVE

PLEASE SEE FACT SHEET LR2 FOR UPSTREAM REACH

PROJECT LC16: INSTALL SAFETY GUARDRAIL.

PROJECT LC26: ADDRESS CHANNEL CAPACITY, CATTAILS, AND EROSION

PROBLEM AREA #4 CHANNEL CAPACITY AND EROSION

PROBLEM AREA #2 MAINTENANCE AND OVERALL FUNCTION

PROJECT LC22: MANAGE VEGETATION

LONE TREE CREEK

PROJECT LC18: RAISE THE ROAD

PROBLEM AREA #1 CROSSING CAPACITY AND SAFETY

IMPROVEMENTS WITH PARK PROJECTS

PROJECT LC17: LT16 AND INCREASE CONVEYANCE CAPACITY

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

LONE TREE CREEK ALTERNATIVES
EAST ARAPAHOE ROAD TO CHERRY CREEK STATE PARK

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

APPENDIX A

REACH LR3

Windmill Creek in Douglas County (Upstream of SEMSWA Service Area) – Windmill Creek Fact Sheet Reach WR1

Reach Description: The most upstream extent of the Cottonwood Creek watershed begins just south of E-470 in unincorporated Douglas County, outside of the SEMSWA service boundary. Flow moves northward through a combination of open channel and pipe flow. The culvert at Liberty Blvd was identified in the previous MDP as having insufficient capacity with roadway overtopping predicted to occur above 50-year capacity. The culvert at Aviator Way is also identified by previous MDP as needing to be enlarged with overtopping occurring above the 10-year capacity. Flow continues north, emptying into Meridian Pond. The previous MDP proposed channel stabilization for reaches immediately up and downstream of Meridian Pond. As flow exits Meridian Pond and crosses S Peoria St, it enters into SEMSWA service area. Flow is piped into the channel from surrounding development and nearby detention ponds. Flow crosses E County Line Rd and enters Pond W-1.

Approximate length of reach: 1.5 miles

Sources: Enginuity Map (2021); SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA, Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Hydrology Update Report

Potential or Known Problem Areas:

#1 Culvert at Liberty Boulevard: Roadway overtopping predicted above 50-year capacity (previous MDP).

#2 Culvert at Aviator Way: Roadway overtopping predicted above 10-year capacity (previous MDP).

SEMSWA Adaptive Management Stream Condition Assessment:

Stream Parameter	Sub-Reach 1
Floodplain Connectivity	Fair
Overall Quality SVAP	Good
Bank Stability	10
Riparian Quality	5
Riparian Quantity	8
Nutrient Enrichment	6

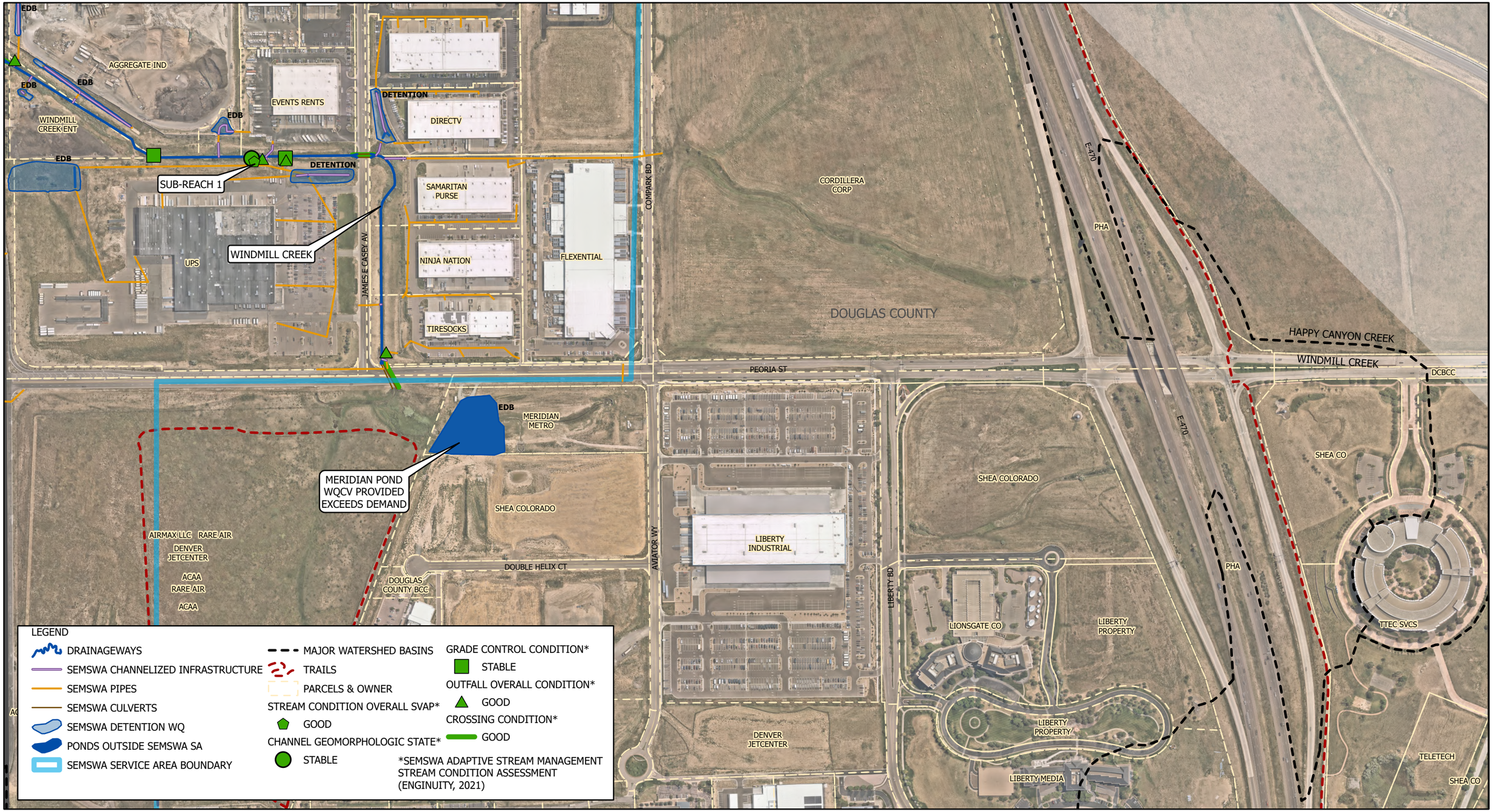
**A higher score is indicative of greater stream health*

Water Quality:
CDPHE river segment: COSPCH04b_B
Affected Use: Aquatic Life Use
Analytes: Selenium (D)
Category/List: 303(d)

Completed Projects/Objectives
Meridian Pond: As-builts from 2017.

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010
FIRM Panel: 08005C0479K, 08005C0500K
FEMA Flood Zone: X (Area of minimal flood hazard). No riverine floodplain along this reach of Windmill Creek has been designated by FEMA.

NOTE: THIS MAP DOES NOT INCLUDE ANY PROPOSED PROJECTS WITHIN THE SEMSWA SERVICE AREA AND IS SHOWN FOR INFORMATIONAL PURPOSES ONLY



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\Basin_Fact_Sheets\Fact_Sheets_DWMLT\Fact_Sheets_DWMLT.aprx

WRIGHT WATER ENGINEERS, INC.

DOUGLAS COUNTY, COLORADO

WINDMILL CREEK OUTSIDE OF SEMSWA SERVICE AREA

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 400 FEET

0 200 400

PROJECT NO. 211-088.000

APPENDIX A

REACH WR1

Reach W-1 to W-4 – Windmill Creek
Fact Sheet Reach WR2

Reach Description: Pond W-1 is located just downstream of the Arapahoe County Line within the Centennial Airport. Flow enters the pond from an open channel to the south through a culvert under E County Line Rd. Additional flow is piped into the pond from surrounding areas through three large concrete sediment forebays and a concrete trickle channel that were improved in 2011. Water exits the pond through a 66" pipe, which continues under the airport runway, briefly converts to open channel, and continues as a 12" pipe under Eaglerock Rd and into a large wetland complex on the other side. This pipe was extended with the addition of a new runway in 2016. The channel here is not well-defined until the downstream property line of the Centennial Airport where there is also a CDPHE water quality monitoring location. Flow continues to the north toward Pond W-4. The reach to the east of Builders First Source has been declared "erosional," and a "minor" headcut has been noted along the channel here. Future development is expected in the empty lot at 7852 S Wheeling Ct, just south of Reata Engineering and Machine Works. No floodplain has been mapped along this reach of Windmill Creek by FEMA.

Approximate length of reach: 0.6 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity 2021); SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA, Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010
FIRM Panel: 08005C0479K
FEMA Flood Zone: X (Area of minimal flood hazard). No riverine floodplain along this reach of Windmill Creek has been designated by FEMA.

Zoning:
The area to the west of Pond W-1 is designated Agricultural, while most of the remaining surrounding areas are zoned Light Industrial or Mixed Use.

Water Quality:
CDPHE river segment: COSPCH04b_B
Affected Use: Aquatic Life Use
Analytes: Selenium (D)
Category/List: 303(d)

Community Resources:
Trail borders Pond W-4 to the east. Arapahoe County Community Park (Dove Valley Regional Park) is just east of Pond W-4 on the other side of Potomac Street.

Strategies for adding value along the drainage corridor for the community:
A section of trail upstream of Pond W-4 was removed with development. The trail bordering Pond W-4 may be extended upstream, although the industrial nature of development on either side of the channel and the proximity to the airport may make this less desirable.

SEMSWA Adaptive Management
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Stream Health
Floodplain Connectivity	Good
Overall Quality SVAP	Good
Bank Stability	9
Riparian Quality	8
Riparian Quantity	8
Nutrient Enrichment	7

**A higher score is indicative of greater stream health*

Completed Projects/Objectives
Pond W-1/W-2: Water quality and detention improvements (2012).
Pond W-4: Improvements (2009).
Channel: Stabilization and water quality pilot projects implemented including unravelling "present".
Pond W-4: Active cattail management, in progress.

	Potential or Known Problem:	Alternatives
#1	Channel not formally stabilized and in an "Erosional" state.	**Do nothing.**
		Project WC1 Adaptive stream management strategies
		Project WC2 Large-scale stream stabilization project
		Project WC3 Retrofit pond W-1/W-2 to include EURV
#2	Future EURV Deficit and "direct" WQCV deficit (not watershed)	**Do nothing.**
		Project WC3
		Project WC4 Retrofit pond W-4 to include WQCV and EURV
		Project WC5 Explore impervious area removal crediting airport in "race track" area

Potential Improvement Areas:



Pond W-1/W-2.

Channel Capacity: The channel downstream of Pond W-1/W-2 is exhibiting some erosion, while dense vegetation provides some stability. Adaptive stream management strategies are proposed with **Project WC1**. These would include repairing a moderate headcut and providing energy dissipation for channelized flow coming in laterally from the Building Materials Holding Corp parking lot to the west of the main channel. This project would also include annual monitoring of this reach, to identify and repair any localized erosion as it occurs. The inclusion of EURV in Pond W-1/W-2, as proposed in **Project WC3**, might reduce the risk of long-term instability and erosion in the downstream channel. The combination of **Projects WC1** and **WC3** could provide long term stability in the channel, especially when considering that much of the upstream contributing watershed has already been developed. Alternatively, large-scale stream stabilization is proposed with **Project WC2**. This would be more comparable to what was proposed in the previous MDP with multiple drop structures and a revised channel profile.

Pipe Capacity: No pipe capacity issues noted along this reach.

Wetlands: In Pond W-4 there are deed-restricted wetlands in the pond trickle channel that were likely designated as mitigation for impacts elsewhere. SEMSWA is currently exploring the option of buying wetland bank credit in order to remove this restriction and better maintain the pond. The Windmill Creek jurisdictional wetlands likely terminate in the Cherry Creek State Park. SEMSWA is currently working on a jurisdictional determination on this drainageway to aid in facility maintenance and retrofit projects.



Channel upstream of Pond W-4.

Maintenance: In 2011, fill from Pond D-1 was placed east of the channel upstream of Pond W-4 in the lot currently owned by Westcore CG. There are some vegetation management issues as reported by SEMSWA staff along the reach upstream of Pond W-4 which is challenging to access to remove vegetation. Pond W-4 is currently a challenge to maintain due to permitting associated with the deed-restricted wetlands in the low flow channel of the pond.

Water Quality: Pond W-1/W-2 currently provides WQCV in excess of the current and future direct demand. The future cumulative WQCV needed for the Windmill Creek watershed is also exceeded at Pond W-1/W-2 by the current system. No WQCV treatment is provided at Pond W-4. Future conditions in the watershed will result in a WQCV deficit of 1.2 ac-ft at this pond. **Project WC4** proposes that Pond W-4 be retrofitted to include WQCV and potentially EURV. This alternative is not recommended if the restrictions on maintaining the deed-restricted wetlands are not lifted. The alternatives assessment for this project assumes costs and effort associated with the removal of the restriction.

A paved track currently exists within the airport boundary to the east of the channel. **Project WC5** proposes the removal of this impervious surface which would reduce the amount of WQCV treatment needed in this watershed.

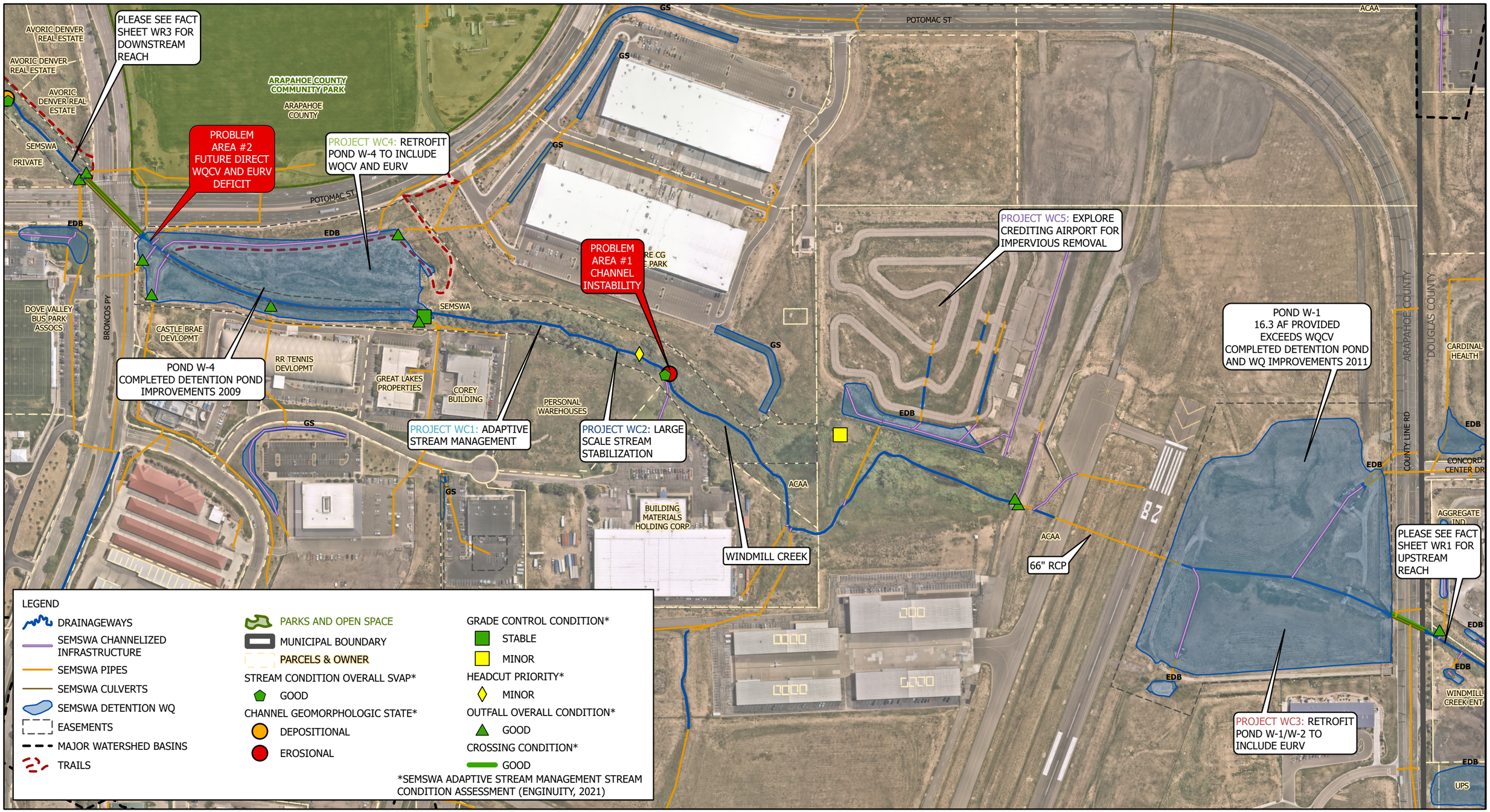


Paved track in the Centennial Airport (Google Earth image).

EURV: EURV is not currently provided at Pond W-1/W-2. **Project WC3** proposes retrofitting Pond W-1/W-2 to provide EURV to address downstream channel erosion. **Project WC4** would include EURV at Pond W-4, benefiting the channel downstream of this pond, which is also exhibiting some instability.

Pond Capacity: No significant pond flood capacity issues were identified for this reach.

Pond Features: Detention pond improvements in 2009 for Pond W-4 included adding an outlet structure, forebays, and earthen trickle channel. WQCV and EURV were not included. Deed restricted wetlands in Pond W-4 have made maintenance and retrofit for WQCV challenging since then. **Project WC3** proposes to retrofit Pond W-1/W-2 for EURV, reducing the hydrologic loading in the channel downstream. **Project WC4** proposes retrofitting Pond W-4 to include WQCV and EURV.



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE AND DOUGLAS COUNTIES, COLORADO

WINDMILL CREEK ALTERNATIVES
POND W-1 TO POND W-4

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 300 FEET

0 150 300

PROJECT NO. 211-088.000

APPENDIX A

REACH WR2

Reach W-4 to W-6/W-7 - Windmill Creek
Fact Sheet Reach WR3

Reach Description: Flow exits Pond W-4 and travels northeast through a culvert at the intersection of E Broncos Pkwy and S Potomac St. This drainageway, Sub-reach 1, is classified as "depositional" downstream of Potomac Street and heads northeast for approximately a quarter mile to the confluence with the outfall channel from Pond W-5. This area is largely undeveloped but subdivided for future commercial development including some proposed car dealerships. Pond W-5 is located within Dove Valley Regional Park and Open Space offline of the main stem for Windmill Creek. Downstream of this confluence, the open channel continues northeast, entering City of Centennial and crossing through the southeastern corner of the proposed Potomac Park and Open Space site, owned by City of Centennial. This is an undeveloped park which may be leased or sold in the future. The previous MDP identified the location in the park and just upstream of S Blackhawk St for a new detention pond, which has not been constructed at this time. Two 60" x 144" culverts under S Blackhawk St convey the creek north through a residential area in a highly constrained and straightened open channel. Flow continues via Sub-reach 2 another third of a mile through an industrial area before discharging into Pond W-6/W-7. Scour is noted at a grade control structure in this reach, which has been labeled "erosional."

Approximate length of reach: 1.1 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity 2021); SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA; Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Hydrology Update Report for Cottonwood, Lone Tree, Windmill, and Dove Creeks

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010
FIRM Panel: 08005C0479K
FEMA Flood Zone: X (Area of minimal flood hazard). No riverine floodplain along this reach of Windmill Creek has been designated by FEMA.

Zoning:
Includes Mixed Use, Light Industrial, Industrial, Education, and Recreational.

Water Quality:
CDPHE river segment: COSPCH04b_B
Affected Use: Aquatic Life Use
Analyte: Se (D) Category/List: 303(d)

Completed Projects/Objectives
Pond W-5: Small scale WQCV and riprap trickle channel improvements in 2009 (2010).
Small-scale channel improvements downstream of Pond W-4 (2010).
Small-scale channel improvements downstream of Pond W-5.

SEMSWA District-Wide Stream Assessment:
Stream Condition Assessment (Enginuity, 2021)

Stream Parameter	Sub-Reach 1	Sub-Reach 2
Floodplain Connectivity	Good	Poor
Overall Quality SVAP	Good	Fair
Bank Stability	10	6
Riparian Quality	7	3
Riparian Quantity	9	6
Nutrient Enrichment	7	6

**A higher score is indicative of greater stream health*

Potential or Known Problems:	Alternatives
#1 Channel Instability Sub-Reach 1	**Do nothing. Maintain As-is.**
	Project WC6 Large-scale stream stabilization project from previous MDP.
	Project WC7 Stream corridor preservation and some grade control downstream of confluence.
	Project WC4 Retrofit pond W-4 to include WQCV and EURV (See Fact Sheet WR2)
#2 Unplanned Outfalls/Channel Erosion	**Do nothing. Maintain As-is.**
	Project WC9 Formally stabilize and maintain open channel downstream of Pond W-5
	Project WC10 Retrofit Pond W-5 to provide EURV.
#3 Channel Degradation Sub-reach 2	**Do nothing.**
	Project WC8 Reconnect existing bankfull channel and grade control to widen floodplain corridor on W-5 outfall channel
	Project WC11 Construct Blackhawk Street Pond from previous MDP.
	Project WC13 Repair existing and possibly construct new grade control structure.
	Project WC14 Energy dissipation structure and sediment forebay at major pipe system outfall
	Project WC15 Restore vegetation along channel and on south side of Pond W-6/W-7
Other Projects	**Project WC10**
	Project WC16 Retrofit Pond W-6/7 to provide EURV
	Project WC17 New outlet structure for Pond W-6/W-7 with micropool reduction

Community Resources:
Maintenance and access trail borders most of this reach as it winds through industrial, residential, and undeveloped spaces. Pond W-5 is surrounded by Dove Valley Regional Park, and Windmill Creek meanders through the southeast corner of the proposed Potomac Park. Endeavor Academy of Cherry Creek School District is adjacent to Pond W-6/W-7 to the west.

Strategies for adding value along the drainage corridor for the community:
Development of Potomac Park provides opportunity to extend the trail system south from an existing multi-family residential area and provide connectivity with Dove Valley Regional Park. There may be opportunity to utilize grass swales for conveyance through Dove Valley Regional Park, rather than the current closed pipe.

Potential Improvement Areas

Pipe Capacity: Culvert capacity issues were identified in the 2010 MDP at Fremont Ave, Briarwood Ave, and Caley Ave. Overtopping at these locations appears to be resolved with the updated hydrology and upstream detention improvements since the 2010 MDP.

Pond Capacity: The previous Master Drainage Plan (ICON, 2010) recommended the addition of the Blackhawk Street Pond within the Potomac Park Open Space, just upstream of the Blackhawk Street culvert crossing of the Windmill Creek main stem. This recommendation is carried into the current alternatives assessment as **Project WC11**. The original intent of these improvements was to provide flow attenuation to mitigate culvert and channel capacity issues downstream as well as to provide additional WQCV and/or EURV in the watershed to allow more flexibility for projects at other ponds. However, the pipe capacity concerns have been mitigated since the 2010 MDP by changing hydrology and new upstream detention pond capacity and flood control is no longer a significant consideration in **Project WC11**. This project would require that SEMSWA obtain an easement for this area which is currently owned by the City of Centennial.



Pond W-6/W-7 with micropool



Windmill Creek downstream of Pond W-4

Channel Capacity: The channel downstream of Pond W-4 has been classified as depositional (Enginuity, 2021), and the presence of wetlands within the channel is a complicating factor that makes maintenance somewhat difficult. **Project WC6** proposes large-scale stream stabilization, which was first suggested in the 2010 MDP. This alternative includes a revised channel invert and multiple drop structures designed to convey the peak flow rates from future development. Development is expected to occur soon within the properties surrounding this reach of Windmill Creek. **Project WC7** prioritizes the preservation of the riparian area with the addition of some grade control downstream of the confluence with the Pond W-5 tributary. Both projects include assessing the existing channel cross section for future development since much of this area appears to be stable. However, it should be noted that much of the proposed adjacent development is planned to have a very high imperviousness at 80%. Both project alternatives **WC6** and **WC7** would provide information to be used by SEMSWA land development review team to consolidate outfalls from the proposed development to reduce channel impacts.

Some downcutting of the channel between Pond W-5 and the mainstem of Windmill Creek has been observed. This erosion can partly be attributed to poor vegetative cover due to prairie dogs. In addition to current channel instability, development is expected to occur along this reach in the near future. **Project WC9** would formally stabilize and maintain open channel downstream of Pond W-5. There is a contraint of an existing sanitary line on the east side of this reach of channel which would limit the ability to widen the channel. A plan for the coordinated installation and strategic placement of outfalls with new development would provide valuable guidance and improved outcomes for stream health as construction occurs in this part of the Windmill Creek watershed.



Grade control structure downstream of Fremont Ave (Photo provided by Enginuity, 2021)

The channel downstream of Fremont Ave is erosional, with loss of connectivity to the floodplain. The quality of vegetation along this reach is compromised, with a riparian vegetation quantity score of only six out of ten (Enginuity, 2021). Some scour is noted at a grade control structure downstream of Easter Avenue. There are also plans for additional storm system pipe outfalls from Johnson Properties north of the channel adjacent to Pond W-6/W-7. **Project WC13** proposes repair of the grade control structure or the addition of a new structure, while **Project WC14** includes the addition of energy dissipating structures and a sediment forebay at the outfall of a piped lateral storm system from the west. Reconnection of the floodplain and the addition of grade control structures with a new channel profile is proposed in **Project WC8**. The restoration of the vegetation community along the channel and along the southern end of Pond W-6/W-7 is proposed in **Project WC15** to promote stability of the channel and improve the overall health of the riparian community along Windmill Creek. These four projects could be combined or completed separately.

Water Quality and EURV: Pond W-4 resides at the upstream end of this reach of Windmill Creek and does not currently have WQCV or EURV. Improvements to Pond W-4 are discussed in Fact Sheet Reach WR2 and are also relevant to the current fact sheet. **Project WC4** is carried over from Fact Sheet Reach WR2 and involves modifications to Pond W-4, including the addition of WQCV and EURV, which would benefit the downstream channel that exhibits some instability and has been described as depositional (Enginuity, 2021). The attenuation of the EURV provided by these improvements could protect the downstream channel and improve long-term stability. Pond W-5 was improved in 2010 and currently provides 2.3 ac-ft of WQCV, exceeding the future water quality demand of 1.7 ac-ft. **Project WC10** proposes retrofitting Pond W-5 for EURV to benefit the downstream channel and adding a concrete trickle channel to the pond bottom. Park redevelopment to the east side of Pond W-5 is currently under construction including mass regrading of over 20 acres adjacent to the pond. This could cause additional wear and tear on the existing pond features which might accelerate their need for rehabilitation. Pond W-6/W-7 is located at the downstream end of this reach. This pond currently provides WQCV but not EURV. A retrofit to incorporate EURV at this pond would benefit the downstream channel, as proposed in **Project WC16**. This project could include a new outlet structure and reduction of current micropool area, which currently exceeds criteria. Pond W-6/W-7 provides 23.1 ac-ft of WQCV (2011 Addendum to LWD Major Drainageway Plan), which exceeds the future direct WQCV demand. The future cumulative WQCV treatment needed for the upstream watershed is exceeded by the volume of WQCV currently provided. The addition of EURV treatment to Pond W-5 with **Project WC10** would also benefit the channel downstream and could be completed in conjunction with or independent of improvements in the channel.

Pond Features: **Project WC17** proposes improvements to the outlet structure of Pond W-6/W-7 and the reduction of the micropool volume. No improvements to pond features outside of WQCV and EURV are proposed for Ponds W-4 or W-5.

Wetlands: Windmill Creek is a USACE jurisdictional wetland channel and becomes jurisdictional “Waters of the U.S.” approximately one-half of the way downstream of Pond W-4 toward where it intersects with South Blackhawk Street.

Maintenance: The Windmill Creek jurisdictional wetlands likely terminate in the Cherry Creek State Park. SEMSWA is currently working on a jurisdictional determination on this drainageway to aid in facility maintenance and retrofit projects.

PROJECT WC17:
NEW OUTLET STRUCTURE WITH MICROPOOL REDUCTION

PROJECT WC16:
RETROFIT FOR EURV

PROJECT WC8:
RECONNECT FLOOD PLAIN, ADD GRADE CONTROL

PROBLEM AREA #3
CHANNEL DEGRADATION

PROJECT WC15:
RESTORE VEGETATION ADAPTIVE STREAM MANAGEMENT

RCP
144" X 72"
CULVERT

WINDMILL CREEK

PROJECT WC7:
STREAM CORRIDOR PRESERVATION

PROJECT WC9:
FORMALLY STABILIZE OPEN CHANNEL

PROJECT WC10:
RETROFIT FOR EURV

RCP
120" X 96"
CULVERT

POND W-6/W-7
23.1 AF PROVIDED
EXCEEDS WQCV

SUB-REACH 2

PROJECT WC14:
ENERGY DISSIPATION AND SEDIMENT FOREBAY

PROJECT WC13:
REPAIR EXISTING AND/OR NEW GRADE CONTROL

PLEASE SEE FACT SHEET WR4 FOR DOWNSTREAM REACH

PROBLEM AREA #2
UNPLANNED OUTFALLS, CHANNEL EROSION

PROJECT WC11:
CONSTRUCT BLACKHAWK ST POND

PROJECT WC6:
LARGE SCALE STREAM STABILIZATION

CHANNEL IMPROVEMENTS COMPLETED 2010

POND W-5
2.3 AF PROVIDED
EXCEEDS WQCV
WATER QUALITY
IMPROVEMENTS 2010

PROBLEM AREA #1
CHANNEL INSTABILITY

SUB-REACH 1

POND W-4
COMPLETED
DETENTION POND
IMPROVEMENTS 2009

PLEASE SEE FACT SHEET WR2 FOR UPSTREAM REACH

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- EASEMENTS
- MAJOR WATERSHED BASINS
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS & OWNER
- MUNICIPAL BOUNDARY

STREAM CONDITION OVERALL SVAP*
- GOOD
- FAIR

CHANNEL GEOMORPHOLOGIC STATE*
- DEPOSITIONAL
- EROSIONAL

GRADE CONTROL CONDITION*
- STABLE
- MINOR

OUTFALL OVERALL CONDITION*
- GOOD

CROSSING CONDITION*
- GOOD
- FAIR

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

WINDMILL CREEK ALTERNATIVES
POND W-4 TO POND W-6/W-7 AND INCLUDING POND W-5

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 400 FEET

0 200 400

PROJECT NO.
211-088.000

APPENDIX A

REACH WR3

Reach W7 to W8—Windmill Creek:
E Briarwood Ave to Intersection of E Maplewood Ave with Jordan Rd
Fact Sheet Reach WR4

Reach Description: Flow exits Pond W-6/W-7 and flows north through a culvert underneath E Briarwood Avenue and into a concrete lined drainage that flows north through the Centennial Medical Plaza open space. The culvert under the medical center access road is in "fair" condition. Flow continues northward, crossing underneath both E Arapahoe Rd and Jordan Rd where the channel crosses into City of Aurora and flows along the western boundary of Valley Country Club. The reach from the Jordan Rd crossing just north of E Arapahoe Rd until Cherry Creek State Park is mostly surrounded by residential areas and open space. A trail borders this reach of Windmill Creek and circles most of Pond W-8. The culvert under E Caley Ave is in "fair" condition. At E Caley Ave, the drainageway crosses back into City of Centennial and empties into Pond W-8.

Approximate length of reach: 0.9 miles

Sources: SEMSWA Adaptive Stream Management Stream Condition Assessment (Enginuity 2021); SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA; Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Hydrology Update Report

Floodplain Mapping Summary Information:
Effective Date of FIRM: 12/17/2010, 2/17/2017
FIRM Panel: 08005C0479K, 08005C0477L
FEMA Flood Zone: X (Area of minimal flood hazard). No riverine floodplain along this reach of Windmill Creek has been designated by FEMA.

Zoning:
Includes Open Space & Recreation, Neighborhood Conservation, Low and Medium Density Residential, Business Park, Educational, Industrial, and Mixed Use, with Cherry Creek State Park to the North of Pond W-8.

Water Quality:
CDPHE river segment: COSPCH04b_B
Affected Use: Aquatic Life Use
Analyte: Se (D)
Category/List: 303(d)

SEMSWA Adaptive Management Stream Condition Assessment:
No Stream Condition Assessment along this reach.

Completed Projects/Objectives
None

Potential or Known Problems:	Alternatives
#1 Culvert under hospital access road off S Jordan Rd north of E Arapahoe Rd in "fair" condition.	**Do nothing.** **Project WC18** Enlarge culvert
Other projects	New outlet structure at Pond W-8 with updated WQ outlet.

Community Resources:
Trail parallels the downstream half mile of channel and partially circles Pond W-8.

Strategies for adding value along the drainage corridor for the community:
Recreational trail upstream of East Arapahoe Road.

Potential Improvement Areas:

Pond Capacity: No pond capacity issues identified along this reach.

Pond Features: An updated water quality outlet structure for Pond W-8 is currently in the design stage.

Channel Capacity: Channel northwest of the intersection between S Jordan Rd and E Arapahoe Rd was identified in the previous MDP for channel stabilization. No improvements were completed, and this reach appears functional and stable. It is recommended that SEMSWA maintain the ability to access this area for maintenance and continue to monitor for any channel instability.

Pipe Capacity: The previous MDP identified overtopping at Briarwood and Caley Ave. Hydraulic analysis with updated hydrology suggests that the culverts at these crossings have sufficient capacity to convey the 100-year event.

Maintenance: The culvert under the hospital access road off S Jordan Rd north of E Arapahoe Rd is in "fair" condition with some embankment instability noted (Enginuity, 2021) and overtopping of the 10-year storm event. Enlarging the culvert capacity with **Project WC18** will reduce the frequency of overtopping of the access road and the accompanying erosion of the embankment. Minor improvements were made to the pond just upstream of the culvert with the hospital project. CDOT may expand Arapahoe Rd in this area, which may impact the culvert.

Water Quality: A retrofitted water quality outlet structure for Pond W-8 is currently under design. No current or future WQCV deficits are identified at Ponds W-6/W-7 or W-8.

EURV: Pond W-6/W-7 does not currently provide EURV. **Project WC16** proposes adding EURV to this pond in Fact Sheet Reach WR3.

Wetlands: The Windmill Creek jurisdictional wetlands likely terminate in the Cherry Creek State Park. SEMSWA is currently working on a jurisdictional determination on this drainageway to aid in facility maintenance and retrofit projects.



Erosion above culvert at hospital access road (Photo by Enginuity, 2020)

LEGEND

- DRAINAGEWAYS
- SEMSWA CHANNELIZED INFRASTRUCTURE
- SEMSWA PIPES
- SEMSWA CULVERTS
- SEMSWA DETENTION WQ
- PRIVATE WET PONDS
- EASEMENTS

FEMA FLOOD ZONES

- AE
- AE,FLOODWAY
- MAJOR WATERSHED BASINS
- SEMSWA SERVICE AREA BOUNDARY
- TRAILS
- PARKS AND OPEN SPACE
- PARCELS & OWNER
- MUNICIPAL BOUNDARY

GRADE CONTROL CONDITION*

- STABLE

OUTFALL OVERALL CONDITION*

- GOOD
- FAIR

CROSSING CONDITION*

- GOOD
- FAIR

*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

WINDMILL CREEK

POND W-6/W-7
23.1 AF PROVIDED
EXCEEDS WQCV

PROBLEM AREA #1
EROSION ON CULVERT EMBANKMENT

RCP
120" X 96"
CULVERT

PLEASE SEE FACT SHEET WR3 FOR UPSTREAM REACH

PROJECT WC18:
ENLARGE CULVERT

3 RCP
120" X 72"
CULVERTS

POND W-8
8.0 AF PROVIDED
EXCEEDS WQCV

3 RCP
96" X 48"
CULVERTS

2 RCP
144" X 60"
CULVERTS

CHERRY CREEK STATE PARK
CHERRY CREEK
MILL CREEK GREENBELT
VALLEY COUNTRY CLUB
ARAPAHOE RHSW
JORDAN PROPERTY CO
HCA-HEALTHONE
CHERRY CREEK SCHOOL DIST
NEIGHBORHOOD SELF STORAGE
JORDAN PARTNERS
DEO DONUM
JOHNSON PROPERTIES
SEMSWA
TOY CAR CARE
CALEY AV
CALEY PL
JORDAN RD
CARSON ST
BLACKHAWK ST
BLACKHAWK WY
PEAKVIEW AV
PEAKVIEW PL
BILLINGS WY
ATCHISON ST
ABILENE WY
E ARAPAHOE RD
ARAPAHOE FR RD
ARAPAHOE PL
DAWSON CT
BRIARWOOD AV
MAPLEWOOD PL
FAIR AV
PRIVATE
WEC
HOA
COA
EDB
GS
GB
RP

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

WINDMILL CREEK ALTERNATIVES
POND W-6/W-7 TO POND W-8

SOUTHEAST METRO STORMWATER AUTHORITY

N

1" = 350 FEET

0 175 350

PROJECT NO.
211-088.000

APPENDIX A

REACH WR4

Pond W9 – Windmill Creek
Fact Sheet WR5

Reach Description: Pond W9 of Windmill Creek is a privately-owned extended detention basin managed by SEMSWA. The pond resides in Centennial, and Cherry Creek State Park is located just over 700 feet from the northern perimeter. The previous MDP acknowledged that Pond W9 may experience overtopping during the future conditions 100-year event. An alternatives assessment was not performed at that time as the pond does not reside along the Windmill Creek Drainageway. However this MDP proposes two project for this reach.

Sources: SEMSWA GIS; Arapahoe and Douglas County GIS; CDPHE; FEMA, Lone Tree Creek, Windmill Creek, and Dove Creek—Major Drainageway Plan Conceptual Design Report and Addendum; 2020 Approved Hydrology Update Report

Completed Projects/Objectives
None.

In Progress Projects:
Forebay addition. Olsson design complete (99%).

Zoning:
This area is zoned Neighborhood Conservation.

Floodplain Mapping Summary Information:
Effective Date of FIRM: 2/17/2017
FIRM Panel: 08005C0477L
FEMA Flood Zone: X (Area of minimal flood hazard).

Community Resources:
Pond W-9 is near the Cherry Creek State Park and some residential areas.

Strategies for adding value along the drainage corridor for the community:
Opportunities to improve connectivity and aesthetics to the residential areas and the park should be explores with any alternative implemented.

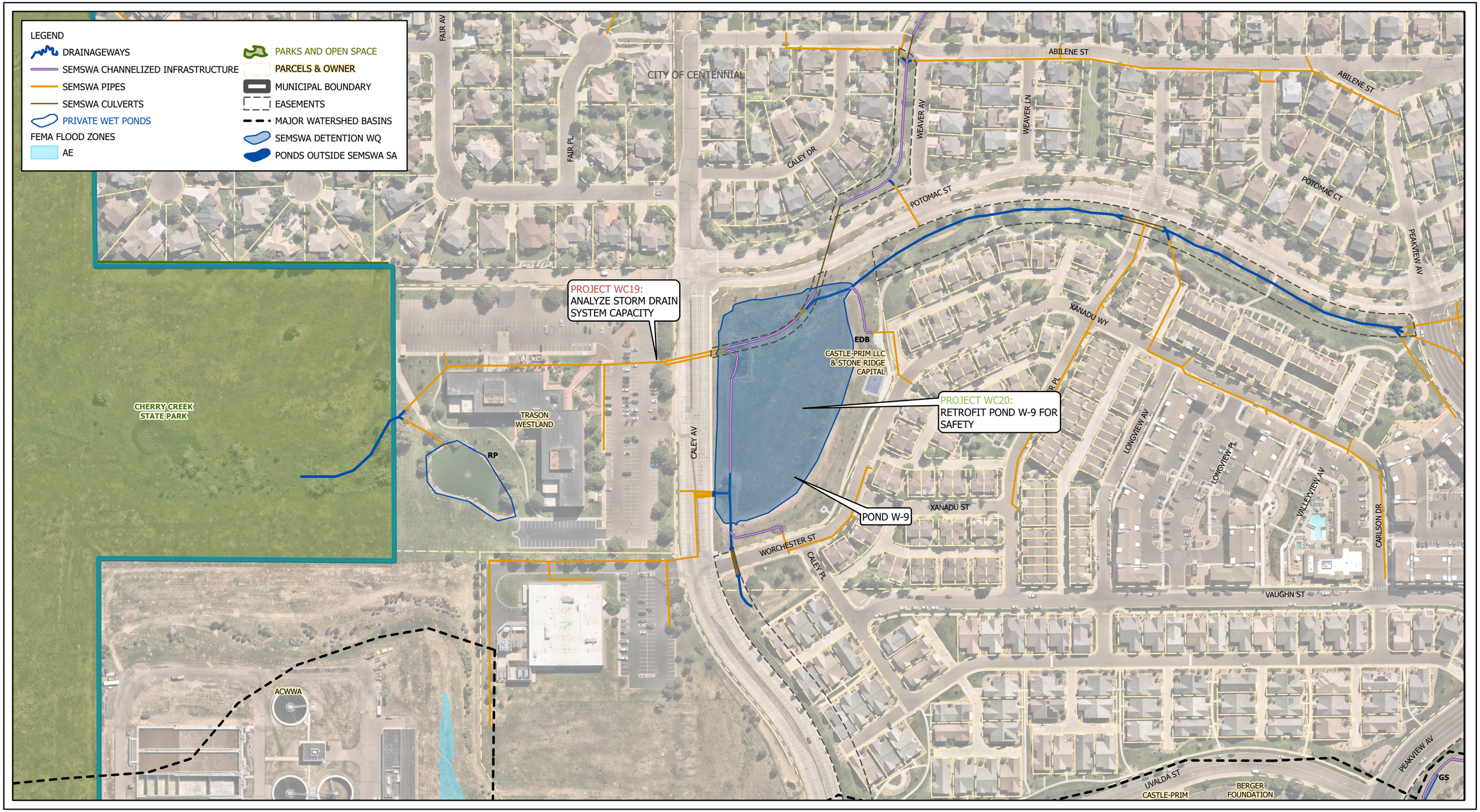
Potential Improvement Areas:

The receiving storm drain system for Pond W-9 may be undersized to convey the 100-year peak flow rate. This system has complexity that requires a more detailed assessment than an MDP can provide and should be studied separately. **Project WC19** proposed a study for the capacity and function of the downstream system. If needed, a second phase of this project should include design and construction to increase system capacity.

The micropool structure for Pond W-9 is deeper than the 2.5-foot standard requirement and poses a safety hazard. The handrail is frequently stolen which further increases the risk. Project **WC20** proposes a retrofit to the outlet structure to improve this risk by making the micropool shallower. This project is currently in the early stages of development and therefore this MDP will not include a cost estimate or design recommendations.



Pond W-9 Outlet Structure (Google Maps Street View, 2022)



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

WINDMILL CREEK POND W-9

SOUTHEAST METRO STORMWATER AUTHORITY

N

1 in = 200 Feet

0 50 100 200

PROJECT NO. 211-088.000

FACT SHEET A-WR5

	Scoring Scale					
Scoring Parameters	**1**	**2**	**3**	**4**	**5**	Parameter Weight (%)
Complexity	Project requires extremely complex engineering, easement, and permitting which poses risks of not being achievable.	Project is possible but planning and permitting will be extremely challenging and may take years to secure. Obtaining easement will need major coordination.	Planning, easements, and permitting will be a significant portion of project over (>40% project budget) and/or might take over a year to secure. Projects that require other projects to be completed before they are funtional should score here or less.	Some complex permitting required, but not anticipated to take over 6-12 months. Project area is mostly SEMSWA owned and/or all property owners likely amenable to project.	SEMSWA has implemented similar projects recently and project is compatible with other nearby projects, if applicable. Project area is completely SEMSWA-owned or with comprehensive easement. "Do nothing" alternatives will get this score.	11
Project Cost	Over $1M	$500,000-$1M	$100,000-$500,000	$30,000-$100,000	<$30,000	12
Maintenance Efficiency	Maintenance would be rarely be performed due to extreme challenges and might impede function of infrastructure	Maintenance regularly would not occur at recommended intervals due to difficulty and cost. SEMSWA maintenance personnel have identified a need to ease maintenance which is not being addressed.	Maintenance may be sometimes difficult to implement at recommended intervals due to difficulty and cost. Pumping equiment and vegetative clearing might be required.	Easy site access and slightly more complex tasks that require specialized experience or equipment	Easy site access with simple well-known tasks that maintenance personnel frequently perform and discrete maintainable features are provided throughout project	9
Comprehensive Water Quality Benefit	Project does not consider aspects of water quality	Minimally meets obligations of MS4 permit and Regulation 72	Improves aspects of multiple components of water quality or includes multiple additional approaches to address water quality such as runoff reduction or pretreatment measures	Meets most components of SEMSWA regulatory mission or significantly addresses water quality concern downstream areas. Runoff reduction and/or pretreatment are major components of the project.	Significant improvements to water quality above and beyond typical stormwater projects including stream base flow, snowmelt, or irrigation return flows.	8
WQCV and EURV Provided*	Less than 50% of the future WQCV demand is met and WQCV not increased due to project	Project increases WQCV provided by <30% of future demand or <10 ac-ft	increases WQCV provided by 30% of future demand or >10 ac-ft	100% future demand WQCV met in future or current condition watershed	100% future demand EURV met by project	8
Stream Health*	Alternative will not prevent current degradation or will exacerbate it.	Current degradation might continue but might lessen due to the project. This score should be used if the project is intended to prevent further degradation but likely will need replacement with future project.	Project likely will prevent further degradation to channel and long-term monitoring will indicate if future improvements are necessary.	Project goal is to completely stabilize channel section for long-term function.	Planning for high functioning and low maintenance stream that will function for the future developed watershed.	10
Flood Capacity*	Flooding concerns not addressed.	Minor attenuation <20% improvement ratio of current to future peak flow rates or capacity of system.	Moderate attenuation 20-60% improvement ratio of current to future peak flow rates or capacity of system. Projects should score here if flood attenuation is not a concern.	Major attenuation >60% or all improvement ratio of current to future peak flow rates or capacity of system.	All downstream flooding concerns mitigated and no roadways overtopping or structures removed floodplain.	10
Public Safety	Problem is severe or not addressed. Do nothing alternatives that do not address a public safety problem should score here.	Problem addressed minimally impacts drainageway health or adjacent properties.	Problem addressed moderately impacts drainageway health or adjacent properties.	Problem addressed impacts critical infrastructure and/or multiple property owners.	Project results in large improvement to public health, safety, and infrastructure.	13
Environmental	Completely removes and does not replace wetland or riparian area, adds concrete to drainageway, and/or includes a large land disturbance in waterway.	Major construction impacts to jurisdictional wetlands, major drainageways, and/or mature riparian area.	Minor construction impacts to mature riparian areas and non-jurisdictional wetlands. "Do nothing" alternatives that will result in ongoing moderate degradation to these environmental features should score here.	No impacts to wetlands or mature riparian areas or projects with moderate construction impacts but the final condition significantly improves upon the current environmental features.	Improves riparian buffer area or wetlands with minimal impacts to existing ecology.	8
Community						
Public Access and Esthetics	Proposed project reduces accessibility or aesthetic value.	Project area not accessible to any of the public or aethetics are lacking and not improved.	Public is able to view or access the improved areas, which might add aesthetic value.	Public is able to access the improvements which add aesthetic or recreational value and project can be considered an amenity.	100% ADA accessible walkways with recreational features proposed and improved aesthetics.	5
Feedback	Staff or public has identified and is monitoring a potential drainage problem, but no immediate action is warranted at this time. Do nothing projects that don't address a request for action should go here.	Staff has identified drainage problem which is likely to progress. Staff continues to observe and determine if the problem worsens and needs increased prioritization in the future.	Someone external to SEMSWA has reported the problem or it impacts nearby property. Projects with a need due to upcoming development should score here.	Individual property owners, utilities or other governmental organizations have identified drainage problems. Projects that are highly compatible with other projects should also score here.	An organized citizens group or an elected official has contacted the staff and requested prioritized action be taken to correct the problem.	6
					Subtotal Community Value	11
					Total	100

*a score of zero can indicate that the category is not being used and also if this problem does not occur in the watershed
note: highlighted cells indicate selected alternatives

Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Public Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Overflow Issues at Pond D-0	**Do Nothing**	**Do Nothing. Maintain as-is.**	5	5	3	1	4	0	1	1	5	2	1	261	450	58%
	Project DC1	Retrofit Pond D-0 to expand and reduce standing water	4	3	5	2	4	0	2	3	4	2	4	298	450	66%
	Project DC2	Pond D-0 overflow path.	2	3	4	2	4	0	3	4	4	2	2	278	450	62%
	Project DC3	Pond D-0 high flow bypass.	1	1	3	2	4	0	3	4	4	2	2	234	450	52%
	Project DC4	Improve inlet capacity downstream of Pond D-0 outfall.	5	5	4	2	4	0	3	3	4	2	2	322	450	72%
#2 Standing water in Pond D-0	**Do Nothing**	**Do Nothing.**	5	5	3	1	4	0	1	1	4	2	1	253	450	56%
	Project DC1	Retrofit Pond D-0 to expand and reduce standing water.	4	3	5	2	4	0	2	3	4	2	4	298	450	66%
#3 Pond D-1 challenging to maintain	**Do nothing.**	**Do nothing. Maintain as-is.**	5	5	4	1	4	1	2	1	4	2	1	282	500	56%
	Project DC5	Retrofit Pond D-1 to capture EURV and include sediment forebays and trickle channel.	4	2	5	2	5	2	3	2	4	2	2	299	500	60%
#4 Channel instability	**Do Nothing**	**Do nothing. Maintain as-is.**	5	5	2	1	0	1	0	1	3	2	2	210	410	51%
	Project DC6	Larger stream restoration and channel stabilization with drop structures in Sub-Reaches 1 and 2.	4	1	5	3	0	5	0	3	2	4	4	274	410	67%
	Project DC7	Use Adaptive Stream Management Strategies to promote channel stabilization in Sub-Reaches 1 and 2.	4	3	4	3	0	3	0	3	4	3	2	268	410	65%
#5 Unstable flow at Otero Road causing erosion	**Do Nothing**	**Do Nothing**	5	5	5	1	0	1	0	1	4	2	1	239	410	58%
	Project DC8	Stabilize erosion at E Otero Rd and Aurora RV.	4	4	5	2	0	2	0	1	4	2	2	240	410	59%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
General projects to address future development	**Do Nothing**	**Do Nothing. Maintain as-is.**	5	4	3	2	4	1	0	1	2	2	1	233	450	52%
	Project DC9	Large-scale channel improvements along Sub-Reach 1	3	1	4	2	4	5	0	4	2	3	3	280	450	62%
	Project DC10	Keep west tributary as open channel with development	2	2	4	4	4	5	0	3	5	4	1	301	450	67%
	Project DC11	Keep east tributary as open channel with development	2	2	4	4	4	5	0	3	5	4	1	301	450	67%
	Project DC12	Perform adaptive stream management	4	3	3	3	4	4	0	3	4	3	3	307	450	68%
	Project DC 13	Naturalized channel improvements along Sub-Reach 2	4	1	4	2	4	3	0	3	4	3	4	280	450	62%
	Project DC 14	EURV improvements to Pond D-2	4	3	5	3	5	2	5	2	3	2	1	325	500	65%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Excess sediment and vegetation in connecting channel between County Pond 3 and Lone Tree Creek	**Do Nothing**	**Do Nothing. Maintain as-is.**	5	5	2	1	0	1	0	1	3	2	2	210	410	51%
	Project LC1	Improve County Pond 3 to ease maintenance	3	3	4	3	0	3	0	3	4	2	2	252	410	61%
	Project LC2	Sediment Control of Arapahoe County Material Stockpile	3	5	3	3	0	3	0	3	4	2	2	267	410	65%
Problem Areas 2-5 Channel Instability #2 Severe headcut just south of E Broncos Pkway #3 Culvert under E Broncos Pkwy #4 Channel north of E Broncos Pkwy labeled erosional #5 Outfall in fair condition and partially blocked midway along channel	**Do Nothing**	**Do Nothing. Maintain as-is.**	5	5	2	1	0	1	1	1	3	2	2	220	460	48%
	Project LC3	Targeted Drop Structures along reach upstream of Pond L-2	4	3	3	2	0	4	2	3	4	2	2	276	460	60%
	Project LC4	Large scale stream stabilization upstream of L-2	3	1	4	2	0	5	3	4	2	3	2	272	460	59%
#6 WQ and EURV Deficit at Pond L-2	**Do Nothing**	**Do Nothing. Address Downstream.**	5	3	4	1	4	1	0	1	4	2	2	244	450	54%
	Project LC5	New WQCV pond upstream of Broncos pkwy	2	2	4	2	4	3	0	2	2	2	2	224	450	50%
	Project LC6	Retrofit Pond L-2 for WQCV.	3	3	5	2	4	3	0	2	4	2	2	272	450	60%
	Project LC7	Retrofit ACAA outfall area for WQCV and EURV.	3	2	3	2	5	3	0	3	2	1	3	248	450	55%
#7 Public complaints of poor water quality and discoloration from phosphorous	**Do Nothing**	**Do nothing. Current implementation of CCBWQA and SEMSWA Wetland Harvesting**	5	5	3	3	1	1	0	1	4	0	3	247	425	58%
	Project LC7	Retrofit ACAA outfall area for WQCV and EURV.	3	2	3	3	5	2	0	3	1	2	3	243	450	54%
	Project LC8	Request control measures be implemented upstream by the ACAA to reduce phosphorous loading.	2	5	3	4	1	3	0	4	5	2	4	305	450	68%
	Project LC9	New constructed wetland pond upstream of Jameson Place at ACAA outfall.	2	1	2	4	5	3	0	3	4	2	3	253	450	56%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Small tributary at S Revere Pkwy is being piped with current development. The storm drain in S Revere Pkwy needs to be upsized.	**Do Nothing**	**Maintain as-is.**	5	5	3	2	0	0	1	1	0	2	1	197	370	53%
	Project LC10	Upsize storm drain within ROW to support development	3	2	5	2	0	0	5	4	0	2	2	242	370	65%
#2 Channel erosion occurring in part due to undersized and aging grade control structures and concrete-lined trickle channel.	**Do Nothing**	**Maintain as-is.**	5	5	3	1	0	1	0	1	3	2	1	213	410	52%
	Project LC11	Adaptive stream management to address isolated channel instability	4	3	3	2	0	2	0	2	3	2	2	215	410	52%
	Project LC12	Conversion to soft bottom trickle channel as infrastructure degrades	4	4	3	4	0	3	0	3	5	3	2	287	410	70%
	Project LC13	Remove concrete trickle channel from entire reach	3	3	4	4	0	4	0	3	5	3	2	283	410	69%
#3 Capacity issues at downstream crossings.	**Do Nothing**	**Address downstream.**	5	5	4	2	0	0	1	5	3	3	3	299	410	73%
	Project LC14	Install new detention facility upstream of E Briarwood to alleviate downstream overtopping at Peakview Ave	1	1	4	2	0	0	5	5	2	3	3	239	410	58%
#4 Culvert Apron Degradation E Arapahoe Rd	**Do Nothing**	**Maintain as-is.**	5	5	2	2	0	1	1	1	4	2	1	230	460	50%
	Project LC15	Improve apron as part of City of Centennial trail improvement program	3	3	4	2	0	2	2	3	3	2	2	246	460	53%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Possible roadway overtopping at E Peakview Ave (above 25-year capacity). Culvert needs increased capacity. Downstream of culvert is a partially blocked outfall. Safety upgrades are needed.	**Do Nothing**	**Maintain as-is.**	5	5	3	2	0	0	1	1	3	5	1	236	410	58%
	Project LC14	New detention pond south of Briarwood Ave.	1	1	4	2	0	0	5	5	3	3	3	247	410	60%
	Project LC16	Install safety guardrail	5	5	3	2	0	0	1	3	3	5	4	280	410	68%
	Project LC17	LC16 and moderately increase conveyance capacity of culvert inlet under road	3	3	3	2	0	0	3	4	3	3	4	257	410	63%
	Project LC18	Raise the road and fully convey in culvert	2	2	4	2	0	0	5	5	3	3	4	276	410	67%
#2 Pond L-3: Difficult to maintain and has diminished overall function due to filling up with cattails and sediment	**Do Nothing**	**Maintain as-is.**	5	5	1	2	3	1	0	1	4	3	1	240	450	53%
	Project LC19	Retrofit outlet structure	4	3	2	3	4	2	0	2	4	3	2	259	450	58%
	Project LC20	Install pipe above sewer line for easier pumping during maintenance	2	4	3	3	4	2	0	2	4	3	2	258	450	57%
	Project LC21	Install shallow underdrains	2	3	2	3	4	2	0	3	3	3	2	242	450	54%
	Project LC22	Manage vegetation to improve flow through and out of pond	5	3	2	2	4	2	0	2	3	3	2	254	450	56%
	Project LC23	Use wetland banking to convert to maintain or convert to EDB	2	2	4	2	4	2	0	3	2	1	2	222	450	49%
	Project LC6	Add WQCV upstream and allow decreased volume in L-3	4	2	3	3	4	3	0	2	4	3	2	266	450	59%
#3 ACWWA: Inundation of structures at WWTP due to "Without Levee" analysis.	**Do Nothing**			5	3	2	0	0	1	1	4	2	1	174	355	49%
	Project LC24	Floodproof adjacent structures	1	2	3	2	0	0	1	4	4	2	2	194	410	47%
	Project LC25	Possible update to FHAD if new hydrology shows reduction in BFE	5	4	3	2	0	0	2	2	4	2	2	246	410	60%
#4 ACWWA: Channel capacity needs assessed. Full of cattails. Some erosion occurring along this segment of channel.	**Do Nothing**		5	5	3	2	0	1	1	1	3	2	1	231	460	50%
	Project LC26	Adapative stream management	2	3	4	3	0	3	2	2	4	2	2	248	460	54%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Channel not formally stabilized and in an "Erosional state".	**Do Nothing**	**Maintain as-is.**	5	5	3	2	4	1	0	1	3	3	1	258	450	57%
	Project WC1	**Project WC1** Adaptive stream management strategies to address problem areas number one and two along with subreach one	4	3	3	2	4	3	0	2	3	3	2	262	450	58%
	Project WC2	**Project WC2** Large-scale stream stabilization	3	2	4	2	4	4	0	2	2	4	2	255	450	57%
	Project WC3	**Project WC3** Retrofit pond W-1/W-2 to include EURV	4	3	3	3	5	3	0	2	4	2	2	281	450	62%
#2 Future direct WQCV (not watershed) and EURV Deficit	**Do Nothing**	**Do nothing.**	5	5	3	2	4	0	0	1	3	2	1	243	400	61%
	Project WC3	**Project WC3** Retrofit pond W-1/W-2 to include EURV	4	3	3	3	5	0	0	2	4	2	1	245	400	61%
	Project WC4	**Project WC4** Retrofit pond W-4 to include WQCV and EURV	2	2	3	3	5	0	0	2	2	1	2	196	400	49%
	Project WC5	**Project WC5** Explore crediting airport in "race track" area	1	4	3	3	4	0	0	2	4	2	1	216	400	54%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Channel Instability Sub-Reach 1	**Do Nothing**	**Maintain as-is.**	5	5	3	2	4	1	0	1	4	3	1	266	450	59%
	Project WC6	**Project WC6** Large-scale stream stabilization project from previous MDP.	3	2	4	2	4	4	0	2	2	4	2	255	450	57%
	Project WC7	**Project WC7** Stream Corridor preservation and some grade control downstream of confluence.	4	3	3	3	4	3	0	2	5	4	2	291	450	65%
	Project WC4	**Project WC4** Retrofit pond W-4 to include WQCV and EURV	2	2	3	3	5	2	0	2	4	3	2	242	450	54%
#2 Unplanned Outfalls/Channel Erosion	**Do Nothing**	**Do nothing.**	5	5	4	2	4	1	0	1	3	2	1	262	450	58%
	Project WC9	**Project WC9** Formally stabilize and maintain open channel downstream of Pond W-5	3	3	4	2	4	3	0	2	3	2	2	255	450	57%
	Project WC10	**Project WC10** Retrofit Pond W-5 to provide EURV.	4	3	4	3	5	3	0	2	4	2	2	290	450	64%
#4 Channel Degradation Sub-Reach 2	**Do Nothing**	**Do nothing.**	5	5	3	2	4	1	0	1	3	2	1	253	450	56%
	Project WC8	**Project WC8** Reconnect existing bankfull channel and grade control to widen floodplain corridor.	3	2	3	2	4	4	0	2	4	3	2	257	450	57%
	Project WC11	**Project WC11** Construct Blackhawk Street Pond from previous MDP.	2	2	3	3	5	3	0	2	3	2	2	239	450	53%
	Project WC13	**Project WC13** Repair existing and possibly construct new grade control structure.	4	3	3	2	4	3	0	2	3	2	2	257	450	57%
	Project WC14	**Project WC14** Energy dissipation structure and possible sediment forebay at major outfall	4	3	4	3	4	3	0	2	3	2	2	274	450	61%
	Project WC15	**Project WC15** Restore vegetation along channel and on south side of Pond W-6/W-7	4	4	4	3	4	3	0	2	4	3	2	299	450	66%
Other Projects	Project WC10	**Project WC10** Retrofit Pond W-5 to provide EURV.	2	2	4	3	5	2	0	2	4	2	2	246	450	55%
	Project WC16	**Project WC16** Retrofit Pond W-6/7 to provide EURV	2	2	3	3	5	2	0	2	4	2	2	237	450	53%
	Project WC17	**Project WC17** New outlet structure for Pond W-6/W-7 with micropool reduction	2	2	4	3	4	2	0	2	4	2	2	238	450	53%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Scour of embankment of culvert under hospital access road	**Do Nothing**	**Maintain as-is.**	5	5	4	2	0	1	1	1	4	1	1	243	460	53%
	Project WC18	**Project WC18** Enlarge culvert.	4	3	4	2	0	3	4	2	4	3	2	287	460	62%
Other Projects	Other	New outlet structure at Pond W-8 with updated EURV	2	2	3	2	4	0	0	1	3	3	0	173	370	47%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Insufficient WQCV upstream of SEMSWA service area boundary - **Alternatives outside SEMSWA NOT assessed**	Project CC1	**Project CC1** Retrofit Meridian Flashboard Dam Pond for EURV (2010 OSP) and WQCV														n/a
	Project CC2	**Project CC2** Increase capacity of Meridian Flashboard Dam Pond to attenuate peak flow														n/a
	Project CC3	**Project CC3** Construct E-470 Pond and include EURV (2010 OSP) and WQCV														n/a
	Project CC4	**Project CC4** Construct Liberty Pond and include EURV (2010 OSP) and WQCV														n/a
#2 Ponding behind drop structures	**Do Nothing**	**Do nothing. Maintain as-is.**	5	5	3	2	0	0	1	1	3	2	1	221	410	54%
	Project CC6	**Project CC6** Retrofit drop structure to ease maintenance	4	3	4	2	0	0	2	2	3	2	1	218	410	53%
#3 Channel from Inverness Dr S to Inverness Way high erosion hazard and exposed utilities	**Do Nothing**	**Do nothing.**	5	5	3	1	1	1	1	1	3	1	1	226	500	45%
	Project CC5	**Project CC5:** New Extended Detention Basin (EDB) with WQCV upstream of Inverness Drive South	1	2	3	2	2	3	2	3	2	1	3	222	500	44%
	Project CC7	**Project CC7:** New EDB with WQCV downstream of Inverness Drive South	1	2	3	2	2	3	2	3	3	1	3	230	500	46%
	Project CC8	**Project CC8:** Stream reclamation and rehabilitation with targeted grade control	4	3	3	2	1	3	1	2	4	3	2	256	500	51%
	Project CC9	**Project CC9:** Large-scale channel improvements from Inverness Dr S to Inverness Way (2010 OSP)	3	1	4	2	1	4	1	2	3	4	3	243	500	49%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Meridian Northeast Pond currently has less WQCV than calculations indicate is needed.	**Do Nothing**	**Maintain as-is.**	5	5	3	1	1	1	0	1	3	2	1	221	450	49%
	Project AT1	**Project AT1** Modify Meridian Northeast Pond to provide EURV per previous OSP (by others)	3	3	3	3	5	3	0	3	4	2	2	283	450	63%
	Project AT2	**Project AT2** Add new pond downstream of confluence with west minor tributary and south of airport maintenance road	2	2	3	3	5	3	0	3	4	2	2	260	450	58%
	Project AT3	**Project AT3** Complete Airport South Pond	3	2	4	3	5	3	0	3	4	3	2	285	450	63%
#2 Depositional reach	**Do Nothing**	**Do nothing.**	5	5	3	1	1	1	0	1	3	2	1	221	450	49%
	Project AT4	**Project AT4** Channel improvements and stream restoration per previous OSP	3	3	4	1	1	2	0	2	4	3	2	226	450	50%
	Project AT5	**Project AT5** Adaptive stream management as needed to repair localized erosion	4	4	4	1	1	2	0	2	5	3	2	257	450	57%

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Cottonwood Creek: County Line Rd to Carrie's Pond
Fact Sheet CC4

Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Scour at outlet structure downstream of Unnamed Wet Pond	**Do Nothing**	**Maintain as-is.**	5	5	4	2	0	1	0	1	3	2	1	230	410	56%
	Project CC11	**Project CC11** Install rock at toe of dam of Unnamed Pond	4	4	4	2	0	2	0	2	3	2	2	236	410	58%
#2 Channel downstream of Unnamed Wet Pond to Inverness Dr E	**Do Nothing**	**Maintain as-is.**	5	5	3	1	0	1	0	1	3	1	1	208	410	51%
	Project CC12	**Project CC12** Adaptive stream management with targeted erosion repair and infrastructure rehabilitation	4	3	4	2	0	3	0	3	3	2	2	247	410	60%
	Project CC13	**Project CC13** Large-scale channel improvements to address bank erosion and undersized culvert from Unnamed Pond to inverness Dr E (2010 OSP)	2	2	4	2	0	4	0	3	2	2	2	215	410	52%
#3 Channel downstream of Unnamed Wet Pond to Inverness Dr E has a crossing in poor condition with submerged outlet	**Do Nothing**	**Maintain as-is.**	5	5	3	2	0	1	1	1	3	1	1	226	460	49%
	Project CC10	**Project CC10** Repair erosion and potentially remove wet pond	4	3	4	3	0	3	2	2	4	2	2	270	460	59%
#4 Building may be in floodway	**Do Nothing**	**Do nothing.**	5	5	3	2	0	0	1	1	4	2	1	229	410	56%
	Project CC15	**Project CC15** Large-scale channel improvements from Inverness Dr E to Carrie's Pond (2010 OSP)	2	2	4	2	0	0	2	3	2	2	3	201	410	49%
	Project CC18:	**Project CC19** Widen channel near building	3	3	4	2	0	0	3	3	2	2	3	234	410	57%
	Upstream Projects	**Projects CC2, CC3, CC4, CC5, CC7, CC19**	2	1	4	3	0	0	3	3	2	2	2	201	410	49%
#5 Bank erosion is occurring in the channel from Inverness Dr E to Carrie's Pond	**Do Nothing**	**Do nothing.**	5	5	3	1	0	1	0	1	3	1	1	208	410	51%
	Project CC14	**Project CC14** Stream reclamation and rehabilitation from Inverness Drive East to Carrie's Pond with targeted grade control, bank stabilization with vegetation, and infrastructure repair	4	3	4	2	0	3	0	3	3	3	2	252	410	61%
	Project CC15	**Project CC15** Large-scale channel improvements from Inverness Dr E to Carrie's Pond (2010 OSP)	2	2	4	2	0	4	0	3	4	3	2	236	410	58%
#6 Crossing in the golf course is in poor condition	**Do Nothing**	**Do nothing.**	5	5	3	0	0	1	1	1	3	2	1	215	420	51%
	Project CC16:	**Project CC16** Upsize culvert under fairway	4	3	3	0	0	3	2	2	3	2	2	229	420	55%
	Project CC17	**Project CC17** Replace headwall and slipline culvert depending on site condition	4	4	3	0	0	3	3	2	3	2	2	251	420	60%
#7 Other projects	Project CC18:	**Project CC18** Retrofit Airport Pond 1 to include outlet structure, EURV, and forebays (2010 OSP)	2	3	3	3	5	2	0	2	2	2	1	227	450	50%

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Cottonwood Creek: Carrie's Pond to Inverness Regional Pond
Fact Sheet CC5

Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Building may be in floodplain	**Do Nothing**	**Do nothing**	5	5	3	2	0	0	1	1	1	2	1	205	410	50%
	Project CC23:	**Project CC23** Widen channel near building	3	3	4	2	0	0	3	3	2	2	3	234	410	57%
	Upstream Projects	**Projects CC2, CC3, CC4, CC5, CC7, CC19**	3	2	3	2	0	0	2	3	2	2	3	203	410	50%
#2 Erosion in c.hannel from Carrie's Pond to Inverness Dr E	**Do Nothing**	**Do nothing.**	5	5	3	2	0	1	0	1	3	2	1	221	410	54%
	Project CC20	**Project CC20** Stream reclamation and rehabilitation from golf course to Inverness Regional Pond with targeted erosion repair and outfall rehabilitation	4	3	3	2	0	3	0	3	4	2	2	246	410	60%
	Project CC21	**Project CC21** Large-scale channel improvements from Carrie's Pond to Inverness Dr E (2010 OSP)	3	2	3	2	0	4	0	3	2	2	2	217	410	53%
#3 Other projects	Project CC22	**Project CC22** Retrofit Airport Pond 2 to include outlet structure, EURV, and forebays (2010 OSP)	2	3	3	3	5	2	4	2	3	2	1	275	500	55%

*a score of zero can indicate that the category is not being used and also if this problem does not occur in the watershed

Cottonwood Creek: Inverness Tributary
Fact Sheet CC6A and 6B

Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Unstable channel in Inverness Golf Course	**Do Nothing**	**Maintain as-is.**	5	5	3	2	0	1	0	1	3	2	3	233	410	57%
	Project IT1	**Project IT1** Adaptive stream management Sub-Reaches 1 and 2	4	3	4	2	0	3	0	3	4	2	3	261	410	64%
	Project IT2	**Project IT2** Remove concrete lining of channel as it erodes and targeted grade control	4	2	4	2	0	4	0	3	4	2	3	259	410	63%
	Project IT3	**Project IT3** Retrofit outlet structure on retention pond	3	2	3	2	0	2	0	2	4	2	3	206	410	50%
	Project IT4	**Project IT4** Large scale stream restoration through the golf course in Sub-reaches 1 and 2	3	2	4	2	0	4	0	2	4	2	2	229	410	56%
	Project IT16	**Project IT16** Add sediment forebay upstream of golf course	5	3	4	2	0	1	0	2	3	2	3	231	410	56%
#2 Capacity issues at crossing of Inverness Drive E	**Do Nothing**	**Do nothing.**	5	5	5	2	0	0	1	1	4	2	1	247	410	60%
	Project IT5	**Project IT5** Enlarge 3 culverts under Inverness Drive E	4	3	5	2	0	0	4	4	4	2	2	287	410	70%
	Project IT6	**Project IT6** Expand golf course pond to include 10-year	2	2	3	2	0	0	5	4	4	2	2	245	410	60%
#3 Inadequate capacity of channel downstream of Inverness Properties Wet Pond	**Do Nothing**	**Do nothing.**	5	5	3	2	0	1	1	1	3	3	2	242	460	53%
	Project IT7	**Project IT7** Expand Inverness Properties Wet Pond to include 100-year and retrofit outlet structure	1	2	3	3	0	3	4	4	3	3	2	259	460	56%
	Project IT8	**Project IT8** Secure tract of land to allow for channel improvements such as widening and straightening	2	2	4	2	0	4	4	5	4	3	2	302	460	66%
#4 Channel erosion and instability	**Do Nothing**	**Do nothing.**	5	5	2	2	0	1	0	1	3	3	2	223	410	54%
	Project IT9	**Project IT9** Adaptive stream management in Sub-Reach 3 with targeted stream stabilization and maintenance	4	3	3	2	0	4	0	3	4	3	2	261	410	64%
	Project IT10	**Project IT10** Development planning for riparian preservation	3	3	3	3	0	4	0	3	5	4	2	271	410	66%
	Project IT15	**Project IT15** Large-scale stream restoration in Sub-Reach 3	2	2	4	2	0	4	0	3	3	4	2	233	410	57%
#5 Inverness C Pond challenges	**Do Nothing**	**Do Nothing**	5	5	2	2	4	0	0	1	4	3	1	247	400	62%
	Project IT11	**Project IT11** Remove Inverness C Pond	3	4	5	1	1	0	0	2	1	2	2	198	400	50%
	Project IT12	**Project IT12** Keep Inverness C Pond, modify outlet, preserve existing wetlands, and remove 1.6 AF WQCV crediting	4	5	3	3	4	0	0	2	4	3	2	272	400	68%
	Project IT13	**Project IT13** Retrofit to be easier to maintain	3	3	5	2	4	0	0	2	1	2	2	218	400	55%
	Project IT14	**Project IT14** Modifications to outlet structure to promote drainage, repair inflow structure	5	5	4	2	4	0	0	2	4	3	2	284	400	71%

*a score of zero can indicate that the category is not being used and also if this problem does not occur in the watershed

Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Channel between Easter Ave and Briarwood Ave is erosional	**Do Nothing**	**Do nothing.**	5	5	3	2	0	1	0	1	3	2	1	221	410	54%
	Project CC24	**Project CC24** Stream reclamation and rehabilitation with targeted grade control and erosion repair	4	3	3	3	0	3	0	3	4	3	2	259	410	63%
	Project CC25	**Project CC25** Large scale channel restoration with stabilization of channel between drop structures	3	1	4	2	0	4	0	3	4	2	2	230	410	56%
#2 Bank instability near Centennial Corner Ponds	**Do Nothing**	**Do nothing.**	5	5	3	2	1	1	0	1	3	2	1	229	450	51%
	Project CC26	**Project CC26** Bank stabilization between Briarwood and Arapahoe	4	3	3	2	1	3	0	3	3	2	2	246	450	55%
	Project CC27	**Project CC27** New Centennial Corner regional pond with EURV to replace two offline ponds. Includes forebay and access improvements (2010 OSP)	2	2	3	3	5	3	0	3	2	2	2	244	450	54%
#3 LEC Pond inflow has sediment deposition, standing water, and difficult maintenance	**Do Nothing**	**Do nothing.**	5	5	1	1	0	0	0	1	3	2	1	185	360	51%
	Project CC28	**Project CC28** Scour protection at the toe of the drop structure at inflow	4	4	2	1	0	0	0	2	3	2	2	190	360	53%
	Project CC29	**Project CC29** Renovation of forebay structures - possibly add concrete forebays for ease of maintenance	4	3	5	1	0	0	0	2	2	2	2	197	360	55%

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Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Flooding at E Arapahoe crossing	**Do Nothing**	**Do Nothing**	5	5	5	0	0	0	1	1	3	2	1	223	370	60%
	Project HT1	**Project HT1** New EDB upstream of E Arapahoe	1	1	3	0	0	0	4	5	2	1	3	194	370	52%
	Project HT2	**Project HT2** Increase storm system capacity under E Arapahoe	2	2	5	0	0	0	5	5	3	2	3	258	370	70%
#2 Building in area of shallow flooding	**Do Nothing**	**Do nothing.**	5	5	5	0	0	0	1	1	3	1	1	218	370	59%
	Project HT1	**Project HT1** New EDB upstream of E Arapahoe	1	1	3	0	0	0	4	5	2	1	3	194	370	52%
	Project HT3	**Project HT3** Increase pipe capacity connecting channel to outfall into LEC Pond	2	2	3	0	0	0	5	4	3	2	3	227	370	61%
	Project HT4	**Project HT4** Provide additional flow path along the north side of E Arapahoe Rd to LEC Pond through pipes, open channel, or combination	1	2	3	0	0	0	5	3	4	2	3	211	370	57%
	Project HT5	**Project HT5** Enlarge private pond	1	2	2	0	0	0	5	4	3	3	3	212	370	57%
	Project HT6	**Project HT6** Allow flow from channel to spill into EDB to north during high flow events	1	3	3	0	0	0	4	4	3	2	3	218	370	59%
	Project HT7	**Project HT7** Add inlets in the parking lot to facilitate increased drainage	3	3	4	0	0	0	4	4	3	2	3	249	370	67%
Other projects	Project HT8	**Project HT8** Retrofit Fulton Street Pond for EURV (2010 OSP)	2	2	3	3	5	3	0	2	4	3	4	264	450	59%
	Project HT9	**Project HT9** Retrofit Rampart Upper Pond for EURV (2010 OSP)	3	2	3	3	5	3	0	2	4	3	4	275	450	61%
	Project HT10	**Project HT10** Modify outlet of Rampart Lower Pond (2010 OSP)	3	2	3	3	5	3	0	2	4	3	4	275	450	61%
	Project HT11	**Project HT11** Blue Sky Pond improvements (2010 OSP)	2	1	3	3	5	3	0	2	4	3	4	252	450	56%
	Project HT12	**Project HT12** Moderate level channel improvements to stabilize as needed	4	2	3	2	4	3	0	2	3	3	4	262	450	58%
	Project HT13	**Project HT13** Adaptive stream management between S Havana and E Arapahoe	4	3	3	2	4	3	0	2	3	3	4	274	450	61%

*a score of zero can indicate that the category is not being used and also if this problem does not occur in the watershed

Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Reach identified as being unstable in 2010 OSP	**Do Nothing**	**Do Nothing**	5	5	3	2	0	1	0	1	3	2	1	221	410	54%
	Project CC30	**Project CC30** Adaptive stream management	4	3	4	2	0	3	0	2	4	3	2	247	410	60%
	Project CC31	**Project CC31** Large-scale channel rehabilitation	3	2	4	2	0	4	0	2	2	4	2	223	410	54%
#2 Reach identified as being unstable in 2010 OSP	**Do Nothing**	**Do nothing.**	5	5	3	2	0	1	0	1	3	4	1	231	410	56%
	Project CC32	**Project CC32** Adaptive stream management	4	3	4	3	0	3	0	3	4	2	3	269	410	66%
	Project CC33	**Project CC33** Large-scale channel rehabilitation	3	1	4	3	0	5	0	2	4	2	3	241	410	59%
#3 House in floodplain	**Do Nothing**	**Do nothing.**	5	5	3	2	0	0	1	1	4	4	1	239	410	58%
	Project CC34	**Project CC34** Conceptual configuration of pedestrian crossing for replacement at end-of-life span	5	4	3	2	0	0	2	3	3	3	1	250	410	61%
#4 Peoria Street Pond is holding water and difficult to maintain	**Do Nothing**	**Do nothing.**	5	5	3	2	4	0	0	1	3	3	1	248	400	62%
	Project CC35	**Project CC35** Enlarge WQ orifices (2010 CC OSP)	5	4	4	2	4	0	0	2	3	3	2	264	400	66%
	Project CC36	**Project CC36** Add sediment forebay at Peoria Tributary outfall and access road for ease of maintenance	4	4	5	2	4	0	0	2	3	3	2	262	400	66%

*a score of zero can indicate that the category is not being used and also if this problem does not occur in the watershed

Problem Areas	Alternative	Description	Complexity	Project Cost	Maintenance Efficiency	Comprehensive Water Quality Benefit	WQCV and EURV Provided*	Stream Health*	Flood Capacity*	Public Safety	Environmental	Access and Aesthetics	Feedback	Total Score	Total Possible Points	Percent Score
#1 Aging infrastructure in golf course	**Do Nothing**	**Maintain as-is.**	5	5	3	2	4	1	0	1	3	2	1	253	450	56%
	Project PT1	**Project PT1** Stream reclamation and rehabilitation with isolated structural repair	4	3	3	2	4	3	0	2	5	2	2	273	450	61%
#2 Golf course structures in floodway	**Do Nothing**	**Do nothing.**	5	5	3	2	0	0	1	1	3	2	1	221	410	54%
	Project PT2	**Project PT2** Upsize culverts near structures	3	3	3	2	0	0	5	1	3	2	1	215	410	52%
#3 Erosional channel in future development	**Do Nothing**	**Do nothing.**	5	5	3	2	0	1	0	1	3	2	1	221	410	54%
	Project PT3	**Project PT3** Adaptive stream management and development planning	4	3	3	3	0	3	0	3	3	3	2	251	410	61%
	Project PT5	**Project PT5** New EURV facility, Arapahoe Pond	1	1	3	2	5	3	4	3	2	2	2	253	500	51%
#4 Infrastructure in need of repair/replacement at Peoria Street	**Do Nothing**	**Do nothing.**	5	5	2	2	0	1	0	1	3	2	1	212	410	52%
	Project PT4	**Project PT4** Replacement of structure and repair of grade control	2	2	3	2	0	2	0	2	3	3	2	186	410	45%
Other Projects	Project PT5	**Project PT5** New EURV facility, Arapahoe Pond	1	1	3	2	5	3	4	2	2	2	2	240	500	48%

*a score of zero can indicate that the category is not being used and also if this problem does not occur in the watershed

Appendix B – Excerpts from Previous Studies

SOUTHEAST METROPOLITAN STORMWATER AUTHORITY COTTONWOOD, LONE TREE, WINDMILL & DOVE CREEKS HYDROLOGY UPDATE

INTRODUCTION

Wright Water Engineers, Inc. (WWE) has prepared this report to present results of an updated hydrology study for Cottonwood, Windmill, Lone Tree and Dove Creeks within the jurisdiction of the Southeast Metropolitan Stormwater Authority (SEMSWA) south of the Cherry Creek Reservoir. Figure 1 illustrates these watersheds. The purpose of this study was to update the hydrology for these watersheds based on:

- Updated rainfall data from the National Oceanic and Atmospheric Association (NOAA) Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 8 (Perica et al. 2013). This is the current rainfall data recommended by the Urban Drainage and Flood Control District (UDFCD) in the Urban Storm Drainage Criteria Manual (USDCM) and is based on a longer period of record than the NOAA Atlas 2 based data used in previous planning efforts.
- The latest version of the Colorado Urban Hydrograph Procedure (CUHP), CUHP 2005 2.0.0 (UDFCD 2017). This version of CUHP was the result of a recalibration by UDFCD to attain better agreement between modeled and observed flows.
- Updated information on regional detention ponds, water quality facilities, and drainage infrastructure, including updated rating curves for facilities that have been constructed since the most recent master planning efforts in these watersheds.
- Updated information on imperviousness for current conditions based on SEMSWA and Denver Regional Council of Governments (DRCOG) geographic information system (GIS) data.

The work has produced updated tables and mapping, showing peak flows for design events, available and committed regional water quality capture volume (WQCV) storage, and detention pond inflow and outflow hydrographs at key locations in the four study watersheds.

Because this report is an update to relatively current master plans, it is streamlined and focused on the results of the hydrologic analyses and highlights only deviations from the hydrology sections of those master plans. Results are provided in appendices including tables and maps of inputs and results. The master planning studies referenced below provide excellent background information on each of these watersheds and should be referenced for additional information.

BACKGROUND

STUDY WATERSHEDS

The four study watersheds shown in Figure 1 generally drain from south to north to the Cherry Creek Reservoir.

Cottonwood Creek

The Cottonwood Creek watershed is located generally along the east side of I-25. The watershed extends approximately 8.7 miles from its upstream limit near the I-25 Ridge Gate interchange south of Lincoln Avenue to its downstream limit north of Belleview Avenue where it flows into the Cherry Creek Reservoir. The watershed is approximately 0.5 miles wide at its upstream end and is generally 1.4 to 1.7 miles wide along most of its length. Cottonwood Creek corresponds to UDFCD Project Reuse Watershed #4602.

The highest point in the watershed is approximately 6320 feet above mean sea level (MSL). The lowest point in the project area, at the confluence with Lone Tree Creek, is at 5588 MSL. Cottonwood Creek drops 732 feet between these two points over a stream length of 10.0 miles, producing an average slope of 1.4%.

Within the project area, the watershed is under the jurisdiction of unincorporated Arapahoe County, Greenwood Village, the City of Lone Tree, the City of Centennial, and unincorporated Douglas County. A large portion of the watershed is managed with respect to stormwater by SEMSWA.

Lone Tree, Windmill and Dove Creek Watersheds

The Lone Tree Creek, Windmill Creek, and Dove Creek watersheds are located within Arapahoe County, Douglas County, the City of Centennial, and the City of Aurora. In general, the basins are bound by Cherry Creek and Cherry Creek State Park to the north, Centennial Airport to the west, S. Jordan Road to the east, and the E-470 Tollway to the south. Most of the area of these watersheds is located within the SEMSWA service area. Lone Tree Creek and Windmill Creek correspond to UDFCD Project Reuse Watersheds #4603 and #4604, respectively. Dove Creek falls within the Cherry Creek Watershed Project Reuse #4600.

Lone Tree Creek, Windmill Creek, and Dove Creek are left bank tributaries of Cherry Creek. All three creeks generally flow in a northerly direction towards Cherry Creek State Park. The three watersheds encompass 5.9-square miles. Of these 5.9-square miles, 1.6-square miles are located within the Lone Tree Creek watershed; 3.3-square miles are located within the Windmill Creek watershed; and 1.0-square miles are located within the Dove

Creek watershed. Elevations within the Lone Tree Creek, Windmill Creek, and Dove Creek watersheds range from approximately 5,900 to 5,600 feet NAVD 88.

PREVIOUS STUDIES & REPORTS

The starting points for updating hydrology for the four study watersheds were the most recent master plans and models completed for these watersheds by UDFCD, SEMSWA and other project sponsors. These include:

- ICON Engineering, Inc. 2010. Lone Tree Creek, Windmill Creek, and Dove Creek – Major Drainageway Plan Conceptual Design Report Addendum. UDFCD, Denver, CO, April 2010.
- ICON Engineering, Inc. 2011. Lone Tree Creek, Windmill Creek, and Dove Creek – Major Drainageway Plan Conceptual Design Report Addendum. UDFCD. Denver, CO, May 2011.
- Muller Engineering Company, Inc. 2011. Cottonwood Creek (Downstream of Lincoln Avenue) Outfall Systems Plan. UDFCD, Denver, CO, August 2011.

Table 1 lists water quality and detention facilities that were updated as a part of this effort. Updated information on detention ponds and water quality facilities was taken from the following engineering reports provided by SEMSWA:

- CH2M HILL 2012. Centennial Airport Construct Runway 17L/35R Shoulders and Improve Detention Ponds C3 and C4 Phase III Drainage Report. Case No. D11-2011. SEMSWA, Englewood, CO, January 2012.
- CH2M HILL 2012. Construction Plan – Improve Detention Pond C3 and C4. Arapahoe County Case No. E11-022. Arapahoe County, CO, August 2012.
- Flatirons Surveying, Inc 2020 Topographic Exhibit of the Meridian Flashboard Dam Prepared for Wright Water Engineers. Douglas County, CO, December 2019.
- ICON Engineering, Inc. 2012. Regional Detention Pond W-1 Record Drawings. SEMSWA Case No. C08-1004. SEMSWA, Englewood, CO, revised December 2012.
- J3 Engineering Consultants 2011. Phase III Drainage Report for Caley East Regional Pond Tract E, Lincoln Executive Center, 3rd Filing. SEMSWA Case No. C09-1007. SEMSWA, Englewood, CO, October 2011.
- J3 Engineering Consultants 2011. Record Drawings for Caley East Regional Pond Tract E, Lincoln Executive Center, 3rd Filing. SEMSWA Case No. C09-1007. SEMSWA, Englewood, CO, revised July 30, 2012.

- Jehn Engineering 2009. Construction Drawings for Windmill Creek Water Quality and Detention Pond W5 Improvements. SEMSWA Case No. C08-1005. SEMSWA, Englewood, CO, revised December 2009.
- Jehn Engineering 2009. Phase III Drainage Report for Regional Detention Pond W5 – Water Quality Outlet Retrofit. SEMSWA Case No. C08-1005. SEMSWA, Englewood, CO, revised December 2009.
- Martin/Martin, Inc. 2017. Master Drainage Study for Meridian Office Park Filing No. 6 – Amendment to Phase II Drainage Report. Shea Properties. Douglas County, CO, December 11, 2017.
- Matrix Design Group 2015. Caley West Pond Final Phase III Drainage Report. SEMSWA Case No. 13-1004. SEMSWA, Centennial, CO, December 2015.
- Matrix Design Group 2017. Caley West Pond Final Construction Drawings. SEMSWA Case No. 13-1004. SEMSWA, Centennial, CO, revised June 2017.
- Muller Engineering Company, Inc. 2013. Lincoln Executive Center Pond Phase III Drainage Report. SEMSWA Case No. C12-1001. SEMSWA, Englewood, CO, revised January 2013.
- Muller Engineering Company, Inc. 2013. Lincoln Executive Center Pond Record Drawings. SEMSWA Case No. C12-1001. SEMSWA, Englewood, CO, revised May 6, 2015.
- RESPEC, Inc. 2014. Construction Drawings for Inverness Regional Detention Pond. Southeast Metro Stormwater Authority. SEMSWA Case No. C13-1008. SEMSWA, Englewood, CO, revised July 8, 2014.
- RESPEC, Inc. 2014. Phase III Drainage Report for Inverness Regional Detention Pond. Southeast Metro Stormwater Authority. SEMSWA Case No. C13-1008. SEMSWA, Englewood, CO, revised July 2014.
- WRC Engineering, Inc. 2011. Phase III Drainage Report for Lone Tree Creek Detention Pond L-2. SEMSWA Case No. C08-1011. SEMSWA, Englewood, CO, revised December 9, 2011.
- WRC Engineering, Inc. 2012. Construction Drawings for Lone Tree Creek Detention Pond L-2. SEMSWA Case No. C08-1011. SEMSWA, Englewood, CO, revised August 27, 2012.
- Wright Water Engineers, Inc. 2011. Phase III Southeast Metro Stormwater Authority Regional Detention and Water Quality Pond D-2. SEMSWA Case No. C07-1007. SEMSWA, Englewood, CO, revised December 2011.
- Wright Water Engineers, Inc. 2012. Construction Drawings for Dove Creek Regional Detention and Water Quality Pond D-2. SEMSWA Case No. C07-1007. SEMSWA, Englewood, CO, revised November 13, 2012.

Table 1. Detention Ponds and Water Quality Facilities Updated by WWE

Basin	Detention Pond	SWMM Element	SEMSWA Case No.
Lone Tree Creek	Pond L2	301	C08-1101
Windmill Creek	Meridian Pond	302	Meridian Pond Master Drainage Report
	Pond W1/W2	110	C08-1004
	Pond W5	309	C08-1005
Dove Creek	Highfield Pond D-0	304	WQ Easement Acquired
	Pond D-1	301	C07-1007
	Pond D-2	303	
Cottonwood Creek	Caley West Pond	414	C13-1004
	Lincoln Executive Center Pond	416	C12-1001
	Inverness Regional Pond	319	C13-1008
	Caley East Pond	390	C09-1007
	Pond C3/C4	343	D11-2011
	Meridian Flashboard Dam Pond	81	Survey Performed by Flatirons Surveying

For the purposes of modelling the Windmill Creek watershed hydrology, all updated ponds in Table 1 were previously included in the master plan and are revised in this report to more accurately reflect existing site conditions. Pond W1 was improved in 2011 and has been updated to be consistent with information in record drawings dated December 2012. The hydrology for improvements to Pond W5 has also been revised to reflect as-builts dated August 2010. For the Meridian pond, updates were made to the model in accordance with existing site conditions reported in the Meridian Pond Master Drainage Report. This information was considered to be more reflective of existing site conditions when compared to the previous master plan which used an assumed functional curve rather than site specific stage-storage data.

Within the Dove Creek Watershed, Pond D2 was not previously included in the master plan and is now incorporated into the hydrologic model. Pond D2 was retrofitted in 2012 to improve the water quality capture volume and references as-builts dated November 2012. Pond D1 was previously included in the model and was updated in the current model to reflect as-builts dated June 2010. The Highfield pond was previously included in the master plan and was updated following water quality easement acquisition. Revisions

were only made to the water quality volumetric tabulation for future planning needs while the pond parameters in the SWMM model remained the same.

For the Cottonwood Creek watershed, the Lincoln Executive Center Pond, Caley Ponds, and Pond C3/C4 had not been included in the previous master plan. They are reported in this study consistent with their respective as-builts dated after 2011 which are included in Appendix G of this report. The Inverness Regional Pond was improved in 2014 and this report updates the hydrology to reflect as-builts dated October 2016. The Meridian Flashboard Dam Pond was surveyed in 2019 by Flatirons Surveying and has not been improved since the 2010 Outfall Systems Plan.

HYDROLOGIC PARAMETERS

RAINFALL

NOAA Atlas 14 was used to determine hourly point precipitation data for the 2-, 5-, 10-, 25-, 50- and 100-year events for individual sub-basins. This is a revision to the previous master planning methodology of using only point precipitation values designated by the municipal jurisdiction. Table 2 provides a comparison of one-hour point rainfall depths used in previous master plans with current NOAA Atlas 14 data. Reductions in one-hour point rainfall depths range from 11% to 21% for the return periods evaluated in this study. Hourly point precipitation data were used in CUHP to develop 2-hour hyetographs in accordance with UDFCD criteria. For calculating the WQCV, a design depth of 0.6 inches was used, corresponding to an 80th percentile storm event.

Table 2. Comparison of One-hour Rainfall Design Rainfall Depths

Design Storm	Previous Master Plan One-hour Rainfall Depths (inches)	NOAA Atlas 14 One-hour Rainfall Depths (inches)	Percent Decrease (%)
2-year	0.95, 0.97, 1.06	0.83, 0.84, 0.85, 0.86	~11%
5-year	1.35, 1.38, 1.43	1.09, 1.10, 1.11, 1.12	~21%
10-year	1.60, 1.65, 1.66	1.33, 1.34, 1.35,1.36, 1.37	~16%
25-year	1.98, 2.20	1.68, 1.69, 1.70, 1.71, 1.72	~15%
50-year	2.26, 2.32	1.96, 1.97, 1.98, 1.99, 2.01, 2.02, 2.03	~13%
100-year	2.59, 2.60, 2.67	2.27, 2.28, 2.29, 2.30, 2.31, 2.32, 2.33, 2.34, 2.35	~14%

SOILS

Natural Resource Conservation Service (NRCS) Hydrologic Soil Groups (HSG) were carried over from previous studies which used the NRCS Web Soil Survey (NRCS 2017) or other NRCS mapping to determine HSGs.

SUB-BASINS

Sub-basin delineations from the most recent master plans for each watershed were used for this analysis, with some minor updates. Minor adjustments were made to sub-basin boundaries in the Lone Tree, Windmill, and Dove Creeks based on updated localized drainage information from SEMSWA. Table 3 summarizes sub-basin modifications based on supporting documentation which can be found in Appendix G.

Table 3. Overview of Sub-basin Modifications

Watershed	Sub-basins	Modification
Lone Tree Creek	L-5, L-6	Sub-basins L-5 and L-6 were modified at the request of SEMSWA to reflect an existing storm system that directs flow into Pond L2.
Windmill Creek	W-1, W-2, W-62, W-64, W-65, W-66, W-67, W-68, W-69	Basin boundaries were revised to be consistent with the 2017 Meridian Pond Master Drainage Report by Martin-Martin which subdivided the Meridian Pond drainage basin into nine sub-basins.
	W-21	The modification of sub-basin W-21 corresponds to a Dove Creek revision along a shared watershed boundary with Windmill Creek.
Dove Creek	D-9, D-10, D-11, D-12, D-13, D-112	Revisions to Dove Creek sub-basins were requested by SEMWA in an email dating 4-20-2018 to be consistent with an approved drainage report for the development of a site at the northwest corner of Jordan Road and Fremont Avenue.
Cottonwood Creek	No Modifications	

Physical characteristics of sub-basins including area, length to centroid, and slope were retained from the previous master plan models with minor updates due to changes in sub-basin boundaries. Appendix A includes documentation of sub-basin input parameters used in CUHP for each watershed.

IMPERVIOUSNESS

Existing imperviousness was determined from SEMSWA and DRCOG GIS data. For some areas in Douglas County where GIS data was unavailable, WWE digitized impervious areas based on recent aerial photography. For the purposes of master planning, gravel areas were assumed to be impervious unless specifically designed as permeable gravel parking areas. Over time, gravel surfaces become more compacted and have low permeability. In addition, some gravel surfaces are eventually paved. For these reasons, gravel surfaces are assumed to be impervious. Undeveloped land was assumed to have an imperviousness of 2%.

Future imperviousness was modelled to be consistent with the previous master plan as shown in Appendix G and was not revisited as a part of this study. The decision to not include an update for these imperviousness values was based on the conservative assumption in the previous master plan that the maximum future imperviousness would be limited to 80% for undeveloped areas within Arapahoe County and the City of Centennial, and 75%-90% for areas within Douglas County. Master drainage reports provided for these areas since 2011 were reviewed and determined that these maximum requirements had been met.

DEPRESSION STORAGE PARAMETERS

Depression storage parameters were retained from the latest master planning models. Depression storage parameters are consistent with the criteria in the USDCM.

INFILTRATION PARAMETERS

WWE carried over infiltration parameters from previous master plans. Infiltration parameters for CUHP including the initial, final and decay rates for these studies were based on criteria in the USDCM based on the HSGs of the sub-basins.

ROUTING PARAMETERS

Routing parameters for channels were retained from the previous master plan models. These parameters are summarized in tables and figures in Appendix B. Routing parameters for detention ponds and regional water quality facilities were updated based on the best available information for each facility from as-built drawings and/or recent master plans. Updated pond rating curve information is summarized in Appendix C.

RESULTS

Results are presented in Appendices D through F:

- Appendix D presents peak flow results, including tables of the 2-, 5-, 10-, 25-, 50- and 100-year peak flow results with comparison to previous studies. These tables include results for current conditions and future imperviousness conditions with current facilities.
- Appendix E provides figures of detention pond inflow and outflow hydrographs with comparisons to previous studies at key locations where detention pond rating curve information was updated.
- Appendix F summarizes WQCV results. WQCVs were calculated in accordance with criteria in Volume 3 of the USDCM (UDFCD 2018). This appendix includes tables of existing WQCV provided and current WQCV demand for regional water quality facilities based on the updated imperviousness information.

Figures 2 through 6 are a series of watershed maps that illustrate impervious surfaces, soils, and peak flow and WQCV results from the current study for the four watersheds.

In general, the results are as expected for this study, and peak flow rates generally decrease. This is due to the decreases in the hourly point precipitation depths in NOAA Atlas 14 compared to NOAA Atlas 2 and the use of the latest version of CUHP, which was recalibrated in 2017 and tends to produce a somewhat lower unit peak runoff response than earlier versions of the model for stream systems with watershed configurations like those studied in this report.

Key findings include the following:

- Decreases in peak flow rates were expected based on using the updated NOAA Atlas 14 rainfall data and the latest version of CUHP, and results demonstrated a lower peak runoff response for design storms compared to earlier studies using NOAA Atlas 2 based data and the previous version of CUHP. The use of NOAA Atlas 14 data are justified because this has been adopted by UDFCD for master planning purposes and contains a longer period of record than NOAA Atlas 2. Using the latest version of CUHP is also consistent with UDFCD criteria. UDFCD currently has other master planning updates underway using updated NOAA Atlas 14 rainfall data and the latest version of CUHP, and has reviewed and accepted this hydrology update.
- While peak flow rates generally decreased at design points in all watersheds relative to previous master plans, the current 100-year peak flow rate for Cottonwood Creek at Easter Avenue increased from 2,980 cfs to 3,109 cfs. This is

attributable to more accurate and current pond information. This current-conditions peak discharge rate is still less than the future conditions peak flow rate from the 2010 master plan of 3,870 cfs. This evaluation also reinforces the need for additional detention in Cottonwood Creek in the future, as 100-year peak flow rates for future conditions with current facilities from Peakview Avenue to Easter Avenue would exceed the future master-planned 100-year peak flow rates.

- Other than this reach of Cottonwood Creek, comparison of 100-year results for future conditions with current facilities to the future peak flow rates from the most recent master plans indicates that current detention facilities provide adequate detention to accommodate future imperviousness conditions. For Lone Tree, Windmill and Dove Creeks, future 100-year peak flow rates with current facilities were lower than future master planned peak flow rates from the most recent UDFCD studies. The detention pond inflow and outflow hydrographs in Appendix E confirm this finding.
- There were several locations in each of the watersheds where 2-year peak flow rates for current conditions increased compared to previous master plans. This is primarily a reflection of the increase in impervious area in these watersheds since the most recent master planning studies were conducted. Increases in Dove Creek are due to adjustments in sub-basin boundaries based on improved data from SEMSWA.
- The amount of WQCV available to accommodate future development increased for many of the regional facilities. The increase in WQCV available capacity is primarily a function of elimination of 20% additional sediment accumulation volume criterion for calculating the design volume from previous UDFCD criteria. This requirement is no longer included in the USDCM (UDFCD 2018). Because SEMSWA is dedicated to maintenance of regional facilities within their jurisdiction and because SEMSWA's regional facilities are designed with sediment forebays, this volume reasonably can be considered as a part of the WQCV provided by facilities that were designed and constructed to the earlier standard.
- There are more than 25 stormwater quality facilities within the four watersheds, including 15 in the Cottonwood Creek watershed. The analysis in Appendix F compares the current WQCV provided by these facilities with current and future projected demands. The results show that most of the facilities have adequate available WQCV to accommodate future development at projected levels. This is primarily due to accounting for storage that was required by previous criteria for sediment accumulation as a part of the WQCV, given SEMSWA's maintenance program and updated UDFCD criteria.
- There are a few ponds including the Meridian Northeast Pond, the Lincoln Center Executive Pond and the Lower Sykridge Pond that currently have less WQCV than calculations indicate is needed for the levels of imperviousness in the tributary drainage areas. WWE has not evaluated the presence or extent of on-site water

quality practices, which may provide the WQCV for some of the areas tributary to these three facilities. In addition, the projected future WQCV demand for the Meridian Flashboard Dam Pond is greater than the WQCV proposed in the OSP, although it is adequate to serve current levels of development with approximately 3.3 acre-feet of remaining capacity.

- Changes in detention pond inflow and outflow hydrographs are due to two factors: (1) the changes in rainfall runoff hydrology described above and (2) updated rating curve and storage information for facilities. Based on the results, the ponds evaluated in SWMM are shown to discharge at or below design flow rates for modeled storm events for current conditions. In many cases detention pond peak inflow and outflow rates decreased relative to previous master plans due to the updated hydrology and the effects of facilities that have been constructed over time.

CONCLUSIONS

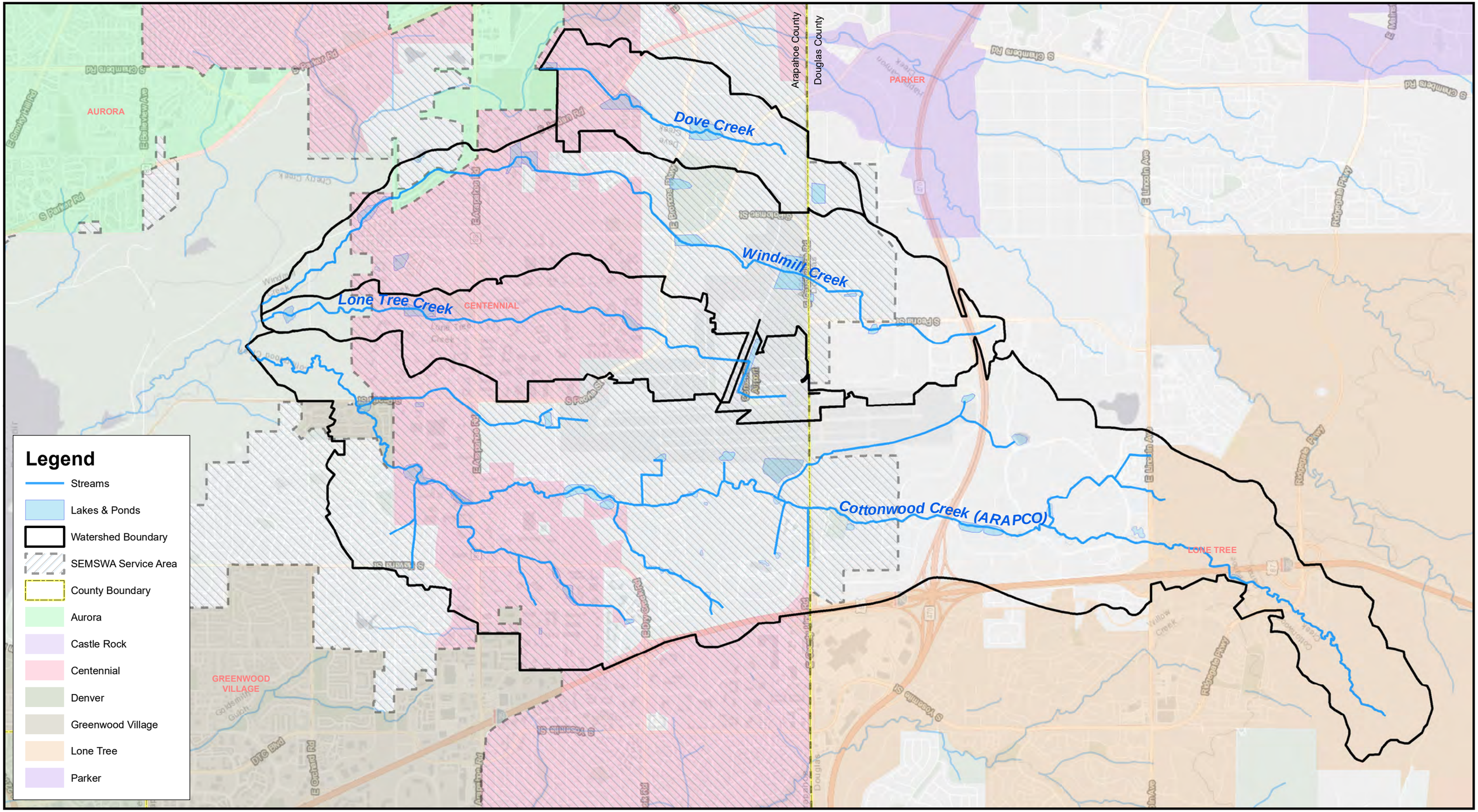
This study provides updated hydrology for Cottonwood, Windmill, Lone Tree and Dove Creeks within the SEMSWA service area. In general the peak flow results decreased for all four of the watersheds due to updated rainfall data and hydrologic methods. The results provide updates on the amount of WQCV and detention storage available in regional facilities. Increases in WQCV availability are primarily due to accounting for the 20% additional sediment storage volume, required at the time some facilities were designed, as part of the WQCV and updated impervious area mapping. Decreases in detention facility peak release rates and storage volumes for design events were due to the updated rainfall data and application of the latest version of CUHP, as well as updated stage-storage-discharge data for facilities constructed or modified since the most recent master planning studies.

These findings provide useful data for SEMSWA to use in management of the major drainage systems in these watersheds. The results related to facility detention and WQCV storage volumes will help SEMSWA manage development. The models and results can serve as a baseline for evaluating cumulative effects of future developments on peak flows and storage volumes in the system, similar to the way SEMSWA has been using the previous study to account for available WQCV in the watersheds.

While this study was conducted for SEMSWA and was limited to hydrology, the models developed as a part of this study and the hydrologic results lay the foundation for targeted updates to master plans and Flood Hazard Area Delineations (FHADs) for these watersheds, working in conjunction with UDFCD and other local sponsors. WWE has conducted this study using standard modeling procedures and criteria from the USDCM,

so this study could effectively form the hydrology section of an updated UDFCD master plan or FHAD. Assuming that the existing hydraulic models for these watersheds have been updated in recent years, updating the master plans and FHADs for these watersheds would be fairly straightforward based on updated hydrology.

WWE appreciates the opportunity to perform this hydrologic study for SEMSWA. We look forward to continuing to work with you on the drainage and water quality planning and regional system administration for these watersheds.



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WWE PROJECT NO.
171-074.000
171-074.010

DATE: 6/03/2020

PROJECT STUDY AREA

COTTONWOOD, LONE TREE, WINDMILL AND DOVE CREEKS

SEMSWA 2020 HYDROLOGY UPDATE

N E S W

0 0.5 1 Miles

1 in = 2,800 feet

Southeast Metro Stormwater Authority

FIGURE 1

Dove Creek

Windmill Creek

Lone Tree Creek

Cottonwood Creek (ARAPCO)

Legend

- Streams
- Sub-basins
- Impervious Surfaces
- Watershed Boundary
- SEMSWA Service Area

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DATE: 6/03/2020

IMPERVIOUS SURFACES

COTTONWOOD, LONE TREE, WINDMILL AND DOVE CREEKS

SEMSWA 2020 HYDROLOGY UPDATE

0 0.5 1 Miles

1 in = 2,800 feet

FIGURE 2

Dove Creek

Windmill Creek

Lone Tree Creek

Cottonwood Creek (ARAPCO)

S Chambers Rd

S Parker Rd

E Smoky Hill Rd

E Belleview Ave

E Lincoln Ave

Ridgegate Pkwy

S Yosemite St

E County Line Rd

Arapahoe Rd

Legend

- Streams
- Watershed Boundary
- SEMSWA Service Area

Hydrologic Soil Group

- A
- B
- C
- D

* Soil data from Soil Survey Geographic (SSURGO) Database for CO005 - Arapahoe County, CO and CO622 - Castle Rock Area. CO.

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SOILS

COTTONWOOD, LONE TREE, WINDMILL AND DOVE CREEKS

SEMSWA 2020 HYDROLOGY UPDATE

N E S W

0 0.5 1 Miles

1 in = 2,800 feet

Southeast Metro Stormwater Authority

FIGURE 3

Note: Table shown for informational purposes only and is overridden by MDP update

Table F1. Water Quality Capture Volume for Cottonwood, Lone Tree, Windmill and Dove Creeks

Watershed	Regional Water Quality Facility	SWMM Element ID	Drainage Area (ac)	Existing Watershed Imperviousness (%)	Current WQCV Needed (ac-ft)	Future Watershed Imperviousness (%)	Future WQCV Needed (ac-ft)	Current WQCV Provided (ac-ft)
Cottonwood Creek	Inverness Regional Pond	319	1,561	37.0	22.3	54.8	28.6	*29.2 (EURV)*
	Meridian Northeast Pond	80	77	30.2	1.0	35.0	1.1	*0.5*
	Inverness Tributary C WQ Pond	381	281	59.0	5.5	65.8	6.0	*7.6*
	Lincoln Executive Center Pond	416	490	57.8	9.4	76.5	12.6	*6.7*
	Fulton Street Pond	369	55	67.5	1.2	74.9	1.4	*1.4*
	Rampart Lower Pond	365	57	58.0	1.1	77.3	1.5	*3.5*
	Caley West Pond	414	182	52.9	3.2	61.8	3.67	*19.0 (EURV)*
	Peoria Street Pond	312	458	42.5	7.1	57.4	8.7	*11.6*
	Caley East Pond	390	54	71.2	1.3	80.0	1.5	*6.9*
	Airport West/East Dam (Pond C3/C4)	343	221	56.3	4.1	59.1	4.3	*14.1*
	Meridian Flashboard Dam	81	925	30.1	11.7	64.1	19.4	*15.0* [¥]
	Airport Pond #1	323	52	23.1	0.6	23.1	0.6	*1.0* [¥]
	Airport Pond #2	321	41	22.9	0.4	22.9	0.4	*0.8* [¥]
	Rampart Upper Pond	367	81	77.2	2.1	83.0	2.3	*8.6* [¥]
	Lower Skyridge Pond	82	422	14.1	3.1	27.1	5.0	*1.3*
Lone Tree Creek	Pond L1 East	351	155	45.0	2.5	59.7	3.0	*3.8*
	Pond L3	303	771	53.2	13.8	78.6	20.5	*20.2*
Windmill Creek	Meridian Pond	302	195	21.8	2.0	62.3	4.0	*4.7*
	Pond W1/W2	110	490	31.6	6.4	79.5	13.3	*16.3*
	Pond W5	309	119	13.6	0.9	35.3	1.7	*2.3*
	Pond W6/W7	313	671	38.5	9.8	75.4	16.9	*23.1*
	Pond W8	395	329	36.1	4.6	54.6	6.0	*8.0*
Dove Creek	Highfield Pond	304	57	26.3	0.7	90.0	1.9	*2.1*
	Pond D1	301	231	18.5	2.1	80.0	6.3	*9.8*
	Pond D2	303	215	24.3	2.4	80.0	5.9	*8.3*
	Pond D3	305	117	49.6	2.0	77.1	3.0	*4.1*

Notes:

1. Imperviousness is calculated as area-weighted average for all sub-basins draining to a water quality facility.
2. Windmill Creek subcatchment W-25 has a private pond. Area and imperviousness are incorporated into Pond W-8 calculations, similar to the master plan. Additional sub-basins W-64 and W-65 will be captured in a private pond on the Teletech property and released at historic rates.
3. WQCVs are calculated based on Volume 3 of the USDCM. WQCV design calculations for EDBs no longer require an additional 20% storage allowance for sediment per the November 2015 update to the USDCM.
4. The symbol "[¥]" next to the WQCV represents the proposed EURV or WQCV from Table 6-6 of the Cottonwood Creek OSP by Muller (2010).
5. Highlighted cells indicated a potential WQCV deficit for future conditions

MEMORANDUM

To: Lanae Raymond and Ashley Byerly
SEMSWA

From: Wright Water Engineers, Inc.
Jane Clary and Andrew Earles, P.E.

Date: December 31, 2020

Re: Runoff Reduction Analysis for Stormwater Control Measures with Underdrains

Introduction

SEMSWA's current Colorado Discharge Permit System Municipal Separate Storm Sewer (MS4) permit certification allows seven options to meet post-construction stormwater control measure requirements. One of these options is the Runoff Reduction Standard:

> Runoff Reduction Standard: The control measure(s) is designed to infiltrate into the ground where site geology permits, evaporate, or evapotranspire a quantity of water equal to 60% of what the calculated Water Quality Capture Volume (WQCV) would be if all impervious area for the applicable development site discharged without infiltration. This base design standard can be met through practices such as green infrastructure. "Green infrastructure" generally refers to control measures that use vegetation, soils, and natural processes or mimic natural processes to manage stormwater. Green infrastructure can be used in place of or in addition to low impact development principles.

While practices such as bioretention facilities and permeable pavement with "full infiltration" designs without underdrains are expected to meet this standard, there have been questions regarding the extent to which facilities with "partial infiltration" designs (i.e., designs with underdrains) perform relative to the 60% runoff reduction metric. Additionally, a better understanding of the performance of stormwater best management practices (BMPs, also known as stormwater control measures [SCMs]) providing some form of infiltration is important to understanding the volume (and load) reduction benefits of practices used in other permit standards. For example, for sites draining to a regional WQCV facility, the "20-10 rule" must be met on site, described in the MS4 permit as:

> Before discharging to a water of the state, at least 20 percent of the upstream imperviousness of the applicable development site must be disconnected from the storm drainage system and drain through a receiving pervious area control measure comprising a footprint of at least 10 percent of the upstream disconnected impervious area of the applicable development site.

As a special project to support SEMSWA's effort to understand volume reduction achieved by various BMP types, Wright Water Engineers (WWE) conducted an analysis of relevant studies included in the International Stormwater BMP Database (www.bmpdatabase.org). The analysis updates and builds upon two previous volume analysis reports conducted on the BMP Database in 2011 and 2012 (Geosyntec and WWE 2011, 2012) and updates selected findings including studies added to the BMP Database through 2020.

The scope of the analysis focused primarily on bioretention and permeable pavement sites with underdrains, but also includes some limited analysis of filter strips, grass swales, and extended detention basins (EDBs). The purpose of this memorandum is to establish a quantified basis for reductions that could be used in the water quality study for Cottonwood, Lone tree, Windmill, and Dove Creeks and to provide information for discussions with parties including the Mile High Flood District (MHFD) and regulators on this topic.

This memorandum includes the methodology used in the analysis, a summary of findings, conclusions and recommendations for follow-up analysis and research. Tabular data summaries supporting the discussion are attached to this memorandum.

Methodology

The BMP Database is a relational database that stores metadata about BMP study site locations and designs, as well as precipitation, flow and water quality data. Most studies report event mean concentration (EMC) data for water quality that is flow-weighted and collected using automated samplers and flow monitoring equipment. Ideally, both the flow and water quality data are suitable for calculation of loads and evaluation of volume reduction; however, this is not always the case because accurate flow monitoring is challenging. It is not uncommon for submissions to the BMP Database to flag flow data as not appropriate for volume-related analysis, even if the flow monitoring was sufficient to pace sample collection for purposes of collecting flow-weighted samples to support EMC water quality results. For example, sometimes inflow sampling does not capture all inflows to a BMP; therefore, volume reduction cannot be assessed based on comparison of measured inflow and outflow data. For these reasons, WWE screened the flow data sets retrieved for potential analysis to make sure that the data sets were suitable for purposes of this analysis. To be included in the evaluation, the following criteria had to be met for the study:

1. Five or more storm events with inflow and outflow monitoring. Inflow could also be represented by a reference outflow site, particularly for permeable pavement studies. For purposes of the comparison, outflows included the sum of outflow, subsurface, and overflow measurements, if multiple types of outflows were measured.

2. Sites and storm events flagged as not appropriate for volume comparison in the 2011 and 2012 BMP Database volume analysis reports were excluded.

3. Sites with flow data flagged by data providers as not appropriate for performance analysis were excluded. (As noted above, it is not uncommon for flow monitoring to be useful for

purposes of pacing sample collecting for EMCs but not being suitable for more rigorous volume analysis. For example, MHFD as a few bioretention sites in this category.)

4. Event-based paired inflow and outflow data were required for inclusion in the analysis.

5. Studies where the majority of the outflows exceeded inflows were completely excluded from the analysis and considered unreliable for purposes of this particular analysis. Reasons for this situation could be unmonitored inflows from overland flow, elevated groundwater, and equipment difficulties, among other reasons.

6. Studies remaining in the analysis data set after applying steps 1 through 5 were then further reviewed to remove occasional questionable flow results. As a general screen, outflows that exceeded inflows by 25% or more were removed from the analysis.

Several different methods can be used to evaluate volume-related performance. For purposes of this analysis, we compared the sum of inflows to the sum of outflows to calculate an overall percent volume reduction for the site (i.e., [$\sum$ Inflows-$\sum$ Outflows] / $\sum$ Inflows). In a few cases where this approach was not viable for various reasons, we report the original researchers' volume analysis findings.

Although not utilized in this analysis, another method that could be applied in future analysis could evaluate the presence or absence of outflows reported along with precipitation for storm events. This metric can be particularly useful when flow monitoring has been flagged for inaccuracies. It is possible that some of the MHFD studies that are flagged as not suitable for volume comparison (e.g., 21st and Iris, River Run) could be evaluated using this technique, although this technique has not been included at this time. Some of the testing conducted by Muller Engineering for SEMSWA and Douglas County that focused on infiltration rates could also be evaluated using this technique.

For bioretention facilities with and without underdrains, which are a key focus of this analysis, volume reduction was calculated for all reported storm events and then calculated for storm events less than or equal to 1 inch. Although the WQCV is based on a rainfall depth of 0.6 inches, the somewhat higher threshold of 1 inch was used to increase the amount of data available for analysis. The step was also completed for individual permeable pavement studies with sufficient data to complete this calculation. This step was not completed for other BMP types, given that bioretention and permeable pavement with underdrains were the primary focus of the analysis.

The evaluation of the BMP Database studies has also been supplemented with recent findings from WWE's water truck tests conducted on bioretention facilities on Brighton Boulevard in Denver. Simulated studies such as these are not included in the BMP Database, but are useful for purposes of this analysis.

Summary of Findings and Comparison to Previous Analysis

Table 1 summarizes the average volume reduction summaries resulting from this 2020 analysis along with previous analysis of the BMP Database in 2011/2012. The previous BMP Database analysis did not tabulate performance based on storms ≤ 1 inch, so that metric is not reported for the previous analysis. This 2020 analysis and the 2011/2012 BMP Database analysis used the same volume calculation procedure; however, the 2020 analysis used slightly more stringent screening criteria. For example, for a study to be included, five events had to be monitored in the 2020 analysis, as opposed to three events in the previous analysis.

Table 1. Comparison of 2020 Volume Reduction Analysis to the 2011-2012 BMP Database Volume Reduction Analysis

BMP Category	BMP Database 2011/2012 Analysis All Storm Sizes		2020 Analysis All Storm Sizes		2020 Analysis Storms ≤ 1 inch
	Nbr. Studies	Avg. Volume Reduction	Nbr. Studies	Avg. Volume Reduction	Avg. Volume Reduction
Bioretention (with underdrains)	2011: 7 2012: 14	2011: 61% 2012: 56%	21	73%	74%
Bioretention (no underdrains)	6	89%	7	95%	96%
EDB (grass-lined)	11	33%	12	33%	-
Permeable Pavement (with underdrains)	-	-	13	82%**	-
Grass Strips	16	38%	10*	64%	-
Grass Swales	13	48%	17	49%	-

- Indicates analysis not conducted. For the 2020 analysis, only bioretention studies were summarized for performance for storms ≤ 1 inch on the category level.
* The 2020 analysis applied more stringent screening criteria such as a 5-storm requirement per study as opposed to 3 storms; therefore, the study numbers decreased for biofilters.
**Excludes two lined facilities in the average.

Additional findings from the analysis are described narratively below and supported by tables attached to this memorandum.

1. **Analysis Data Set After Screening**: After flow data screening, 33 bioretention studies, 13 permeable pavement studies, 17 bioswales, 10 filter strips, and 12 EDBs were retained for further analysis.

2. **Availability of Design Information**: One of the long-term goals of the BMP Database project is to not only characterize the water quality and flow attenuation benefits of stormwater BMPs based on empirical data, but also to identify design factors that lead to the best performance. Robust reporting of design parameters continues to be a challenge – the entities monitoring a BMP may not have access to complete design information on the BMP or may be time-limited when submitting the study to the BMP Database. For purposes of this initial analysis, WWE has not attempted to backfill missing design information, but could do so for some studies as part of a more in-depth analysis. The primary design feature

documented is the presence/absence of underdrains. Other design information such as the ratio of the tributary area to the BMP surface area (hydraulic loading rate) and hydrologic soil group could likely be included in a more in a more in-depth analysis along with a few other design parameters. For example, bioretention media depth/type and use of "upturned elbow" outlet design information is available for some BMPs.

3. **Bioretention**: After flow data screening, 33 bioretention studies were retained for further volume reduction analysis. Of these, 21 sites had verifiable underdrains and considered appropriate for volume reduction analysis. Approximately 70% of these studies demonstrated volume reduction of 60% or greater, regardless of whether all precipitation depths or precipitation ≤ 1 inch were evaluated. Range of volume reduction for storms ≤ 1 inch was 34% to 100%, averaging 74%. Of particular interest was a Fort Collins bioretention study with an "upturned elbow" design that showed 68% volume reduction for storms ≤ 1 inch.

   In addition to the data included in the BMP Database, WWE has also led a series of water truck tests for bioretention cells installed by the City and County of Denver along Brighton Boulevard in the River North redevelopment area. These tests have been highly controlled and provide a reliable estimate for volume reduction for urban bioretention cells in the metro Denver area. These averaged 66% volume reduction for six tests conducted during 2019-2020, with a range of 58 to 84%. The volumes evaluated in the tests were greater than or equal to the WQCV. These installations operated as partial infiltration systems during these tests. For a final test, the Agri-drain orifice for the underdrain was closed and 100% volume reduction was achieved as a full-infiltration test (Olson and Rogers 2020).

4. **Permeable Pavement**: After flow data screening, 13 permeable pavement sites with underdrains were retained for analysis of volume reduction. Over 75% of the studies showed volume reduction greater than 60% regardless of precipitation depth, with an average of 79% and a range of 35% to 100%. Three sites monitored by MHFD ranged from 70 to 86% volume reduction for storms ≤ 1 inch. Two of the studies in Fort Collins were lined facilities with volume reduction reported in the 45 to 50% range. We would expect that if the facilities were unlined, those facilities would meet the 60% volume reduction target. The New Zealand site that showed lower volume reduction (35%) had some unique site conditions that may not be representative of hydraulic loading rates expected for typical permeable pavement sites in Colorado; for example, the ratio of tributary area to pavement surface area was 2.2:1.

5. **Grass Filter Strips**: All of the grass filter strips suitable for volume reduction analysis in the BMP Database are located in highway settings, with the majority in California. Ten sites were suitable for inclusion in analysis without available information on underdrains. Average volume reduction averaged 64%, ranging from 15 to 100%. Approximately 80% of the studies showed reductions of 60% or greater.

6. **Grass Swales**: Most of the grass swale studies in the BMP Database do not provide information on whether an underdrain is present; nonetheless, a basic volume reduction

analysis was completed for 17 sites. On average, volume reduction was 49%, ranging from 19 to 80%. Approximately 40% of the sites provided 60% volume reduction or more. These findings indicate that grass swales typically are not likely to be a reliable approach for meeting a 60% volume reduction target, even though they play a valuable role in disconnecting impervious area and providing some volume reduction.

7. **EDBs**: Although EDBs were not the primary focus of this analysis, WWE completed a limited analysis the EDB data set in the 2020 BMP Database as quick check on previous observations that EDBs provide roughly 30% volume reduction. Based on 12 EDB data sets screened for use in volume analysis, the average volume reduction was 33%, ranging from 0 to 68%. Out of the 12 studies, 8 had volume reduction greater than 30%. Thus, the 30% estimate referenced anecdotally in the Denver area appears to be reasonable, with actual volume reduction depending on site-specific conditions related to hydrologic soil group and other factors.

Conclusion

Based on this analysis, unlined bioretention and permeable pavement facilities with underdrains can meet a volume reduction objective of 60% in the majority of studies evaluated for volume reduction for precipitation events of 1 inch or less. This finding supports further consideration of these practices to meet the 60% volume reduction MS4 permit standard, even though underdrains are present.

The filter strip data set evaluated in this memorandum is limited to highway settings, mostly in California. Limited design information is available for the sites and most are assumed to not have underdrains. Out of the 10 sites monitored, 80% showed volume reduction of 60% or greater. This information may be useful for estimates associated with the 20-10 rule and other efforts associated with runoff-reduction calculations and efforts to minimize directly impervious area.

Practices such as grass swales and EDBs also help to reduce runoff volumes, but do not meet a 60% volume reduction metric, as expected. This data analysis generally confirms the ~30% rule of thumb for EDBs commonly referenced in the metro-Denver area. Grass swales average approximately 49% volume reduction. Site-specific conditions affect the performance at any particular site.

Suggestions for Follow-up

As follow-up to this analysis, we recommend meeting with MHFD to discuss findings and their relevance to the on-going Urban Storm Drainage Criteria Manual Volume 3 update. Additionally, supplemental analysis and monitoring in 2020 could include the following:

1. Additional monitoring for volume-related BMP performance would be beneficial in the SEMSWA area to better understand volume-related performance of BMPs. This could be done either with water truck simulations similar to recent tests that WWE has conducted for Denver or actual storm event monitoring could be conducted. There are several approaches that could be used to further develop a more robust local data set for several BMP configurations (e.g., with and without underdrains, lined and unlined, etc.). Precipitation and

flow monitoring can be conducted at a relatively reasonable cost (as compared to water quality monitoring).

2. Additionally, it is possible that some of the MHFD monitoring location data sets could be further reviewed looking at rainfall data combined with presence/absence of outflow, even if the actual flow measurements are not suitable for more rigorous volume-related analysis.

3. We suspect that additional design information for some of the BMPs in the BMP Database could be better integrated into this initial analysis. Due to the year-end time constraints, we did not do this additional research, but could do so in the interest of completing a more robust technical memorandum, given the encouraging findings related to volume reduction in this initial analysis. Previous analysis of the BMP Database has noted that volume reduction performance of bioretention is conceptually understood to be a function of a variety of factors, including surface area, volume, soil infiltration rate, temperature, and other factors. Performance at individual sites will depend on a variety of site-specific factors, as well as BMP design, installation and maintenance (Geosyntec and WWE 2012).

4. Consider monitoring grass swales and strips due to lack of data in Colorado. Additionally, other related work by Muller Engineering for SEMSWA and Douglas County in the 2012-2015 time period could be integrated into a more comprehensive analysis that integrates large lot runoff evaluations and infiltration rate testing on grassy areas. Additional metadata from the BMP Database related to soil/media type and vegetation could be extracted from the BMP Database and compared to some of the recent Muller research.

References

Geosyntec Consultants and Wright Water Engineers. 2011. International Stormwater Best Management Practices (BMP) Database Volume Reduction Technical Summary. January. Prepared under Support from WERF, FHWA, EWRI/ASCE and EPA.

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Muller Engineering. 2015. Memorandum: Regional Water Quality Evaluation. June 5, 2015.

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TABLES

Table 1. Bioretention Volume Reduction Analysis for Selected Sites in the BMP Database

Bioretention BMPs with Underdrains	State	Nbr. of Events	% Flow Reduction (All Storm Sizes)	% Flow Reduction (Storms ≤ 1 inch)	Underdrain (Y/N)	Comment
Fort Collins BR Cell Retro	CO	28	66%	68%	y	Has upturned elbow design
HR BR	TX	12	98%	100%	y	
Cell CP	MD	6	67%	43%	y	
Cell SS	MD	8	55%	53%	y	
BRC_A	NC	60	68%	61%	y	
BRC_B	NC	60	78%	75%	y	
G1	NC	57	89%	99%	y	
G2	NC	65	94%	96%	y	
Hal Marshall BR Cell	NC	13	60%	54%	y	
L1	NC	30	52%	61%	y	
L2	NC	28	38%	45%	y	
Large Cell	NC	27	56%	70%	y	
South cell	NC	19	60%	68%	y	
North cell	NC	17	35%	34%	y	
Rocky Mount Grassed BR Cell 1	NC	78	98%	100%	y	
Rocky Mount Grassed BR Cell 2	NC	73	82%	93%	y	
Rocky Mount Mulch/Shrub BR Cell 1	NC	78	100%	100%	y	
Rocky Mount Mulch/Shrub BR Cell 2	NC	73	100%	100%	y	
UC BR	OH	50	65%	89%	y	
CHS_BioFilter	VA	15	70%	77%	y	
Blacksburg Aquatic Center BMP	VA	28	97%		y	Missing precipitation data
	Average		73%	74%		
	Min		35%	34%		
	Max		100%	100%		

Bioretention Studies without Underdrains or Lacking Design Information	State	Nbr. of Events	% Flow Reduction (All Storm Sizes)	% Flow Reduction (Storms <=1 in)	Underdrain (Y/N)	Comment
BOD BR	TX	10	74%	87%	Unknown	
BR 3B	KS	7	18%	22%	Unknown	No design information available. Storm runoff volumes typically small, may be less reliable for volume reduction analysis.
BR 6	KS	19	34%	55%	Unknown	
BR Cells	KS	8	39%	43%	y	
Central Raingarden	MA	7	78%	74%	n	
Traffic Island	PA	755	100%	100%	n	
PumpHouseRainGardenPrairie	WI	279	99%	100%	n	
PumpHouseRainGardenTurf	WI	220	99%	100%	n	
OwenRainGardenPrairie	WI	308	100%	100%	n	
OwenRainGardenTurf	WI	387	100%	100%	n	
Cub_Run_BR	VA	13	92%	100%	n	
Small Cell	NC	27	50%	48%	y	Undersized facility; excluded from analysis. The small cell was only able to capture runoff from 0.76 cm (0.3 in) of rain, which is less than the intended 1.27 cm (0.5 in) design storm.

Table 2. Permeable Pavement Volume Reduction Analysis for Selected Sites in the BMP Database

Site Description			Selected Design Data			All Storms			Storms ≤ 1 inch		Comments
Site	BMP Name	State	Pavement Description	Ratio of Tributary Area to PP Area (hydraulic loading)	Underdrain?	Nbr. Events	% Volume Reduction	% Volume Reduction (author)	Nbr. Events	% Volume Reduction	
Denver Wastewater Building	PICP	CO (Denver)	PICP	2.9	Yes	12	89%		11	84%	Lined site
Lakewood Shops	LakewoodPC	CO (Lakewood)	Pervious Concrete	1.0	Yes	66	51%		51	70%	
Lakewood Shops	Slotted Concrete	CO (Lakewood)	Slotted Concrete	1.0	Yes	10	84%		9	86%	
262 E. Mountain Ave	Mountain Avenue Permeable Interlocking Concrete Pavers	CO (Fort Collins)	Paving Bricks	1.6	Yes	19		49-44%	19		Lined sites; author reports median & average of % reduction for storm events
Walnut	Walnut Street Permeable Interlocking Concrete Pavers	CO (Fort Collins)	Paving Bricks	1.0	Yes	19		45-47%	19		Lined sites; author reports median & average of % reduction for storm events
Kinston Public Service Pavements	KPSCGP	NC	Concrete Grid Pavers	1.0	Yes	42		96%			Compared to asphalt reference site
Kinston Public Service Pavements	KPSPermConc	NC	Permeable Concrete	1.0	Yes	44		>99%			Compared to asphalt reference site
Kinston Public Service Pavements	KPSPICP1	NC	Concrete Pavers	1.0	Yes	42		98%			Compared to asphalt reference site
Kinston Public Service Pavements	KPSPICP2	NC	Rima Concrete Stone	1.0	Yes	38		99%			Compared to asphalt reference site
Swansboro_NC_PICP	Swansboro_PICP_Eco_ Stone	NC	UNI ECO Stone Pavers	-	Yes	15	100%		6	100%	
Birkdale Rd NZ	BrickdaleNZPP	New Zealand	Block Pavers	2.2	Yes	15	32%		13	35%	
J Lot	ParkingLots	NH	Pervious	-	Yes	26	100%		21	100%	
Perkins Township	Perkins Township	OH	Pervious	8.9	Yes	91	54%		79	65%	

Table 3. Volume Reduction Summary for Grass Strips (in Highway Settings)

BMP Database Grass Strip Studies	State	Nbr. of Events	% Volume Reduction
Altadena Strip	CA	7	15%
Carlsbad strip	CA	11	86%
Div4_GS	NC	10	67%
Everett01-VFS	WA	24	78%
NC DOT Grass Strip	NC	7	24%
San Rafael RVTS 2	CA	13	72%
Westfield Level Spreader	NC	16	100%
Yorba Linda RVTS 2	CA	7	65%
Yorba Linda RVTS 3	CA	7	61%
Yorba Linda RVTS 5	CA	7	71%
		Average	**64%**
		Min	**15%**
		Max	**100%**

Table 4. Volume Reduction Summary for Grass Swales

BMP Database Grass Swale Studies	State	Nbr. of Events	% Volume Reduction
5/605 swale	CA	7	46%
605/91 swale	CA	4	65%
AlbanyNZSwale	NZ	9	58%
Bioswale	WA	32	80%
Bioswale Native East	OR	6	42%
Bioswale Non-Native West	OR	6	27%
Brodie Lane Swale	TX	34	77%
Cerritos	CA	7	47%
Del Amo	CA	6	27%
East Swale	OR	9	35%
F7 - Asphalt w/ Swale	FL	54	69%
F8 - Asphalt w/ Swale	FL	53	29%
Melrose	CA	7	76%
Palomar Swale	CA	10	41%
Russell Pond Bioswale	OR	7	65%
West Swale	OR	9	19%
Wilson	NC	9	35%
		Average	**49%**
		Min	**19%**
		Max	**80%**

Table 5. Volume Reduction Summary for EDBs

BMP Database EDB Studies	State	Nbr. of Events	% Volume Reduction
15/78	CA	19	17%
5/56	CA	14	36%
605/91 EDB	CA	13	68%
Carver County Dry Detention Pond	MN	12	48%
College Hills_Control	MD	8	13%
Extended Dry Detention Basin	KS	21	62%
Fields of Harvest_Control	MD	9	24%
Greenville Pond	NC	8	1%
Lex Hills Pond	OR	13	58%
Manchester	CA	14	33%
Whispering Heights Residential Pond	WA	6	0%
Worthington_Wetland	MD	8	35%
		Average	**33%**
		Min	**0%**
		Max	**68%**

LEGEND

- DRAINAGE BASIN BOUNDARY
- MAJOR DRAINAGE PATH
- PROPOSED CHANNEL STABILIZATION
- PROPOSED MASTER PLAN IMPROVEMENTS
- EXISTING DETENTION AND WATER QUALITY FACILITIES

NORTH

0 800 1600

SCALE: 1" = 800'

NEED TO BE ABLE TO MAINTAIN

EXISTING POND D3

STABILIZED CHANNEL, TYP.

DOVE CREEK BASIN

IMPROVEMENTS COMPLETED, NEED TO BE ABLE TO MAINTAIN

DETENTION IMPROVEMENTS AT POND D1 (EAST BRONCOS PARKWAY)

EXPAND POND VOLUME

POND D2

POND D1

DOVE CREEK

EXISTING POND W6/W7

IMPROVEMENTS COMPLETED, NEED TO BE ABLE TO MAINTAIN

S. BLACKHAWK ST. POND

POND W5 WATER QUALITY IMPROVEMENTS

WINDMILL CREEK

EXISTING POND W8

EXISTING POND W9

DETENTION AND WATER QUALITY POND AT SOUTH BLACKHAWK STREET

EXISTING POND W4

STABILIZED CHANNEL, TYP.

POND W1/W2

WINDMILL CREEK BASIN

INCREASE CULVERT CAPACITY AT AVIATOR WAY

IMPROVEMENTS COMPLETED, NEED TO BE ABLE TO MAINTAIN

IMPROVEMENTS COMPLETED, NEED TO BE ABLE TO MAINTAIN

IMPROVEMENTS COMPLETED, NEED TO BE ABLE TO MAINTAIN

INCREASE CULVERT CAPACITY AT EAST PEAKVIEW AVENUE

POND L2

MERIDIAN POND

INCREASE CULVERT CAPACITY AT LIBERTY BOULEVARD

EXISTING POND L3

LONE TREE CREEK

LONE TREE CREEK BASIN

CENTENNIAL AIRPORT

STABILIZED CHANNEL, TYP.

EXISTING POND L1 EAST/ L1 WEST

MASTER PLAN IMPROVEMENTS ALSO INCLUDE MAINTENANCE OF ALL EXISTING DRAINAGEWAYS, DETENTION, AND WATER QUALITY FACILITIES, BEYOND THE PROPOSED IMPROVEMENTS SHOWN BY THIS SHEET.

No.	DATE	REVISIONS	APPR.

IMAGERY DATE: 2007 (UDFCD)

08-023-LDW-415

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UTILITIES RESEARCHED DRAWN CHECKED

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SOUTHEAST METRO STORMWATER AUTHORITY
DOUGLAS COUNTY

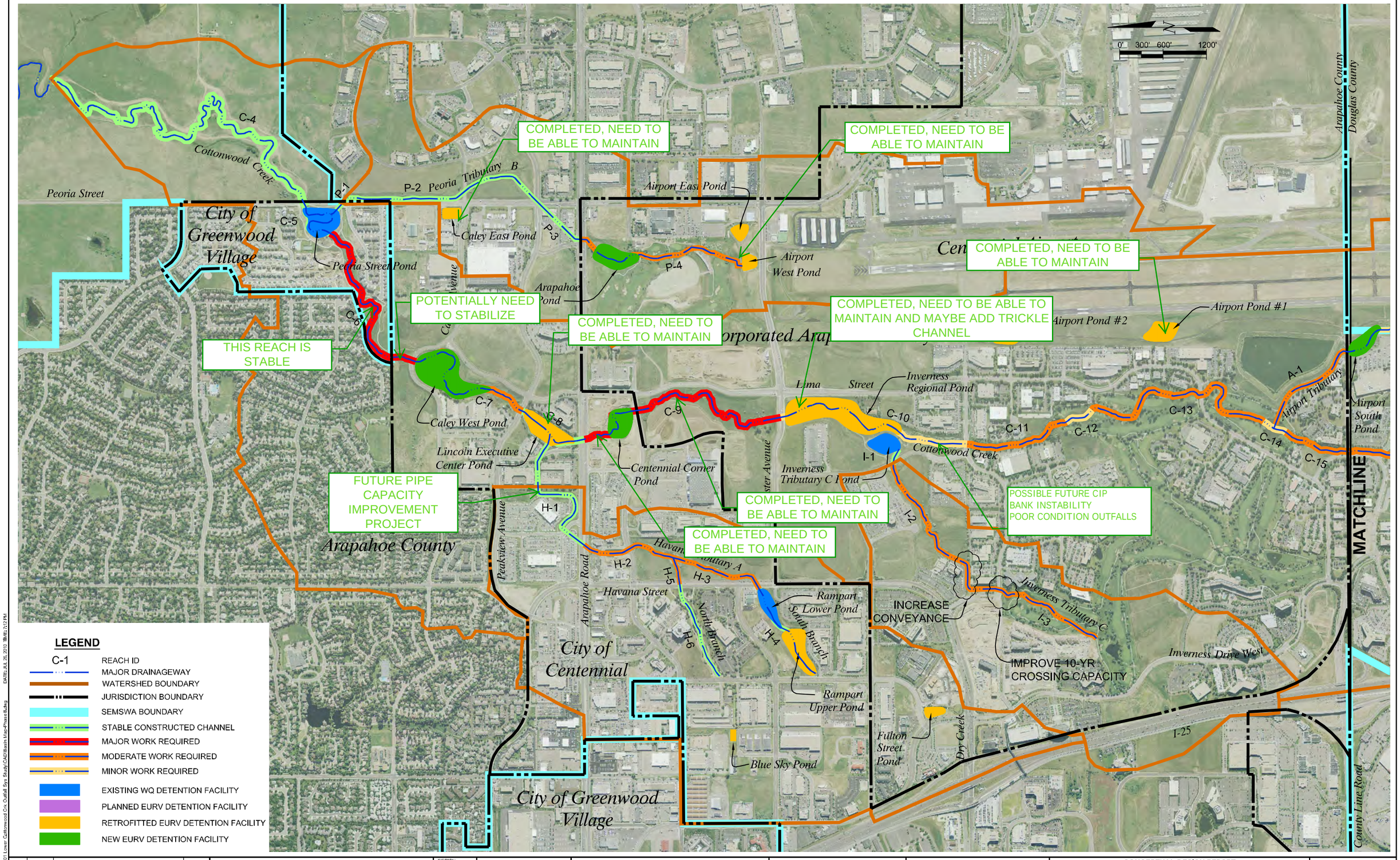
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LONE TREE CREEK, WINDMILL CREEK, AND DOVE CREEK
MAJOR DRAINAGEWAY PLAN
CONCEPTUAL DESIGN REPORT
RECOMMENDED IMPROVEMENT PLAN

DATE APR 2010

FIGURE ES-2

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LEGEND

- C-1 REACH ID
- MAJOR DRAINAGEWAY
- WATERSHED BOUNDARY
- JURISDICTION BOUNDARY
- SEMSWA BOUNDARY
- STABLE CONSTRUCTED CHANNEL
- MAJOR WORK REQUIRED
- MODERATE WORK REQUIRED
- MINOR WORK REQUIRED
- EXISTING WQ DETENTION FACILITY
- PLANNED EURV DETENTION FACILITY
- RETROFITTED EURV DETENTION FACILITY
- NEW EURV DETENTION FACILITY

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PROJECT NO. 07-068.01

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Southeast Metro Stormwater Authority

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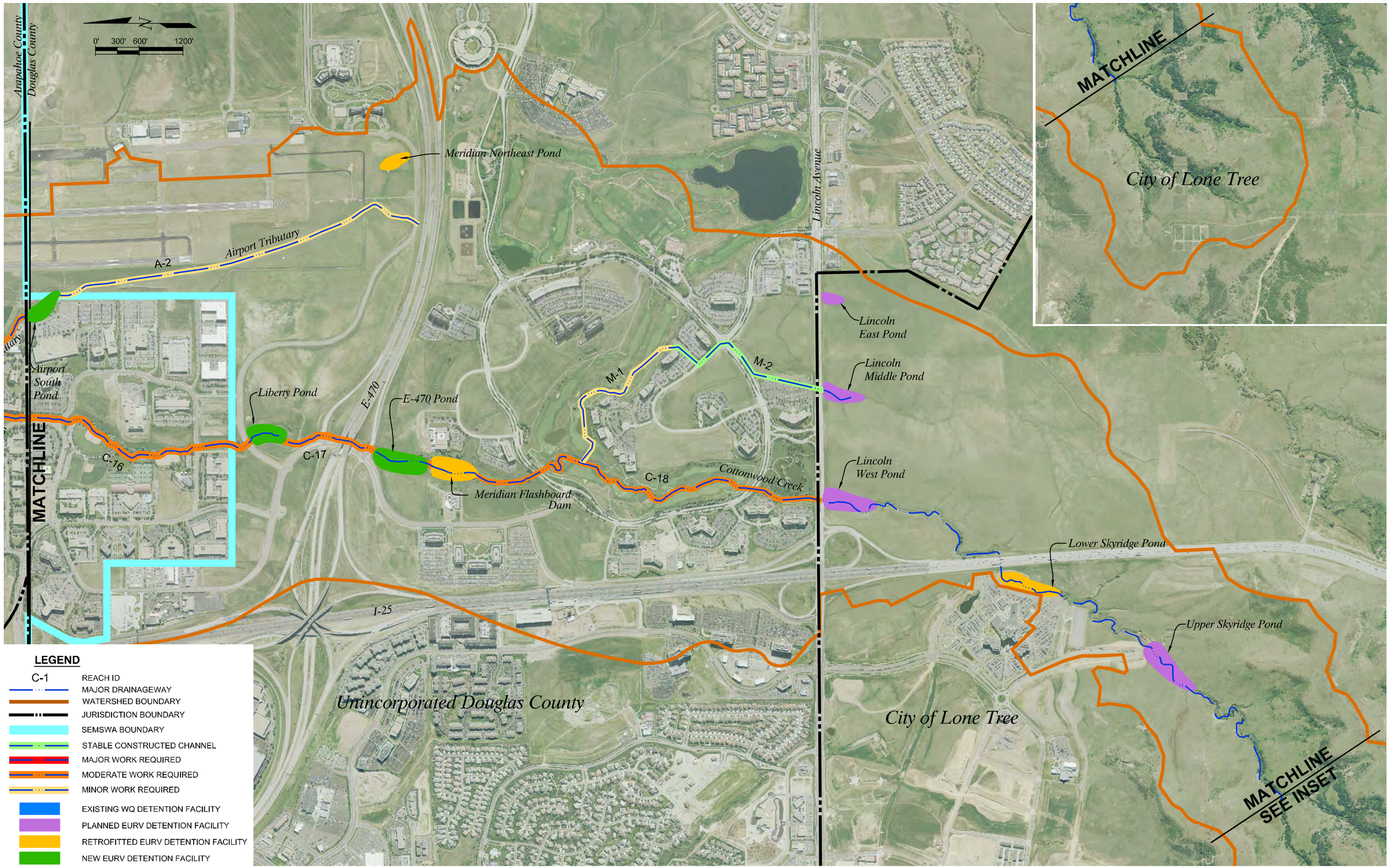
DOUGLAS COUNTY

COTTONWOOD CREEK OUTFALL SYSTEMS PLAN

CONCEPTUAL DESIGN REPORT
OUTFALL SYSTEMS PLAN
ARAPAHOE COUNTY

FIGURE ES-1

PAGE ES-4



LEGEND

C-1	REACH ID
	MAJOR DRAINAGEWAY
	WATERSHED BOUNDARY
	JURISDICTION BOUNDARY
	SEMSWA BOUNDARY
	STABLE CONSTRUCTED CHANNEL
	MAJOR WORK REQUIRED
	MODERATE WORK REQUIRED
	MINOR WORK REQUIRED
	EXISTING WQ DETENTION FACILITY
	PLANNED EURV DETENTION FACILITY
	RETROFITTED EURV DETENTION FACILITY
	NEW EURV DETENTION FACILITY

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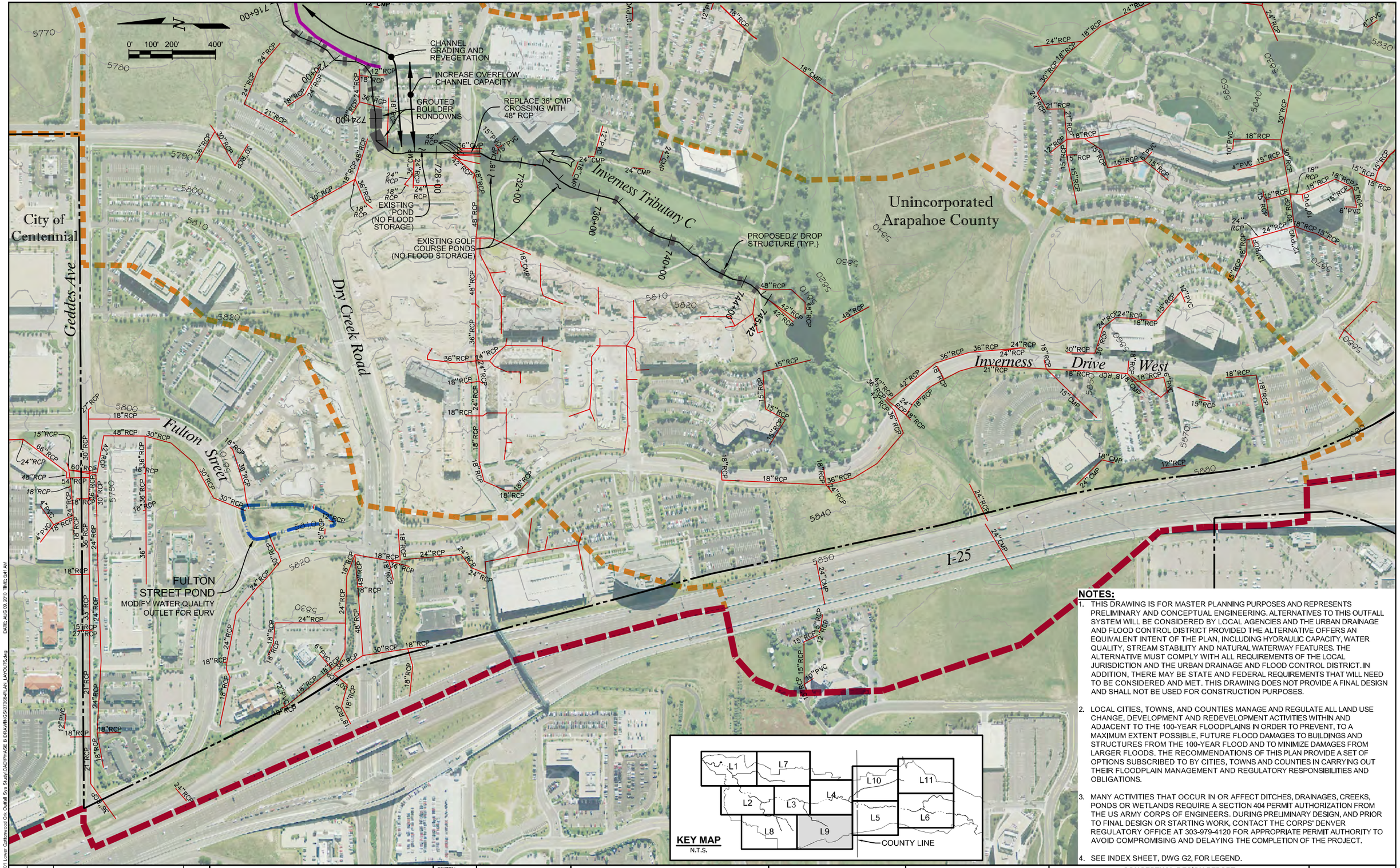
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OUTFALL SYSTEMS PLAN
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FIGURE ES-2

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NOTES:

1. THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY LOCAL AGENCIES AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PROVIDED THE ALTERNATIVE OFFERS AN EQUIVALENT INTENT OF THE PLAN, INCLUDING HYDRAULIC CAPACITY, WATER QUALITY, STREAM STABILITY AND NATURAL WATERWAY FEATURES. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE LOCAL JURISDICTION AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT. IN ADDITION, THERE MAY BE STATE AND FEDERAL REQUIREMENTS THAT WILL NEED TO BE CONSIDERED AND MET. THIS DRAWING DOES NOT PROVIDE A FINAL DESIGN AND SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.
2. LOCAL CITIES, TOWNS, AND COUNTIES MANAGE AND REGULATE ALL LAND USE CHANGE, DEVELOPMENT AND REDEVELOPMENT ACTIVITIES WITHIN AND ADJACENT TO THE 100-YEAR FLOODPLAINS IN ORDER TO PREVENT, TO A MAXIMUM EXTENT POSSIBLE, FUTURE FLOOD DAMAGES TO BUILDINGS AND STRUCTURES FROM THE 100-YEAR FLOOD AND TO MINIMIZE DAMAGES FROM LARGER FLOODS. THE RECOMMENDATIONS OF THIS PLAN PROVIDE A SET OF OPTIONS SUBSCRIBED TO BY CITIES, TOWNS AND COUNTIES IN CARRYING OUT THEIR FLOODPLAIN MANAGEMENT AND REGULATORY RESPONSIBILITIES AND OBLIGATIONS.
3. MANY ACTIVITIES THAT OCCUR IN OR AFFECT DITCHES, DRAINAGES, CREEKS, PONDS OR WETLANDS REQUIRE A SECTION 404 PERMIT AUTHORIZATION FROM THE US ARMY CORPS OF ENGINEERS. DURING PRELIMINARY DESIGN, AND PRIOR TO FINAL DESIGN OR STARTING WORK, CONTACT THE CORPS' DENVER REGULATORY OFFICE AT 303-979-4120 FOR APPROPRIATE PERMIT AUTHORITY TO AVOID COMPROMISING AND DELAYING THE COMPLETION OF THE PROJECT.
4. SEE INDEX SHEET, DWG G2, FOR LEGEND.

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

DOUGLAS COUNTY

COTTONWOOD CREEK OUTFALL SYSTEMS PLAN

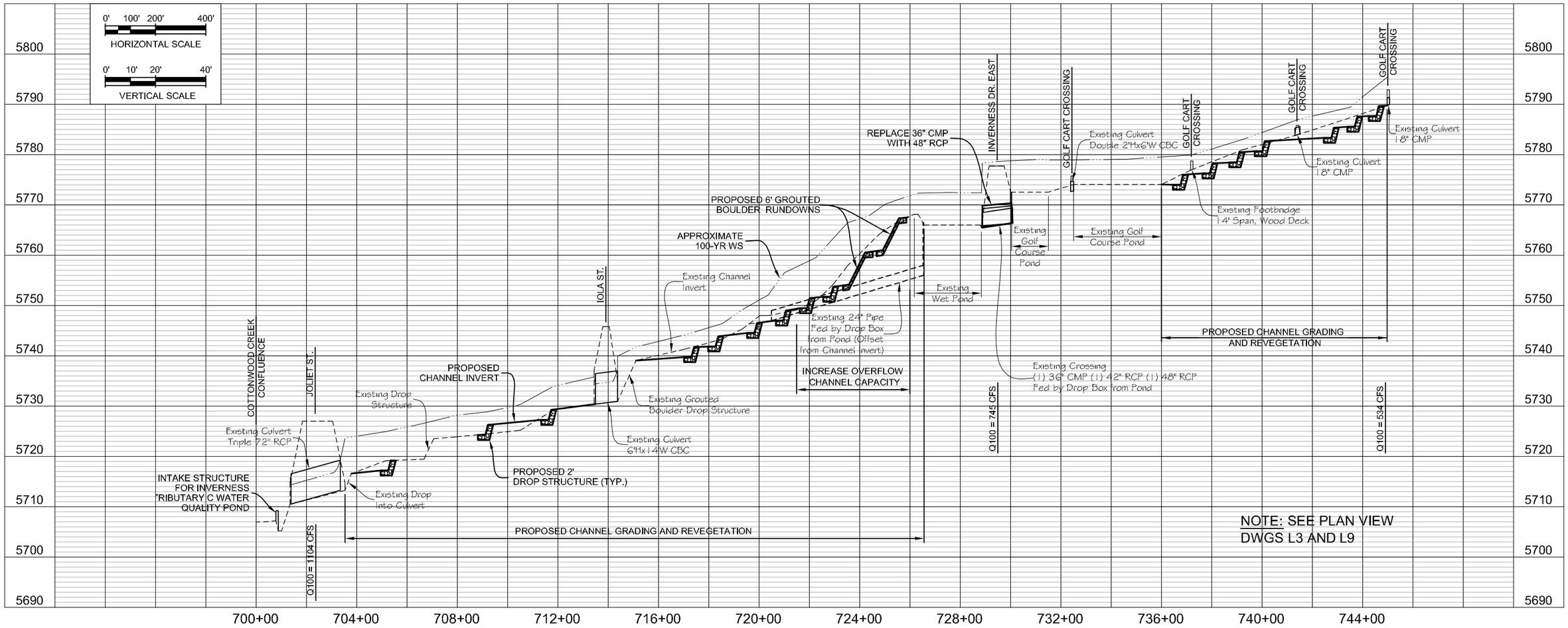
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PLAN LAYOUT 9

DWG L9

SHEET 11 OF 37

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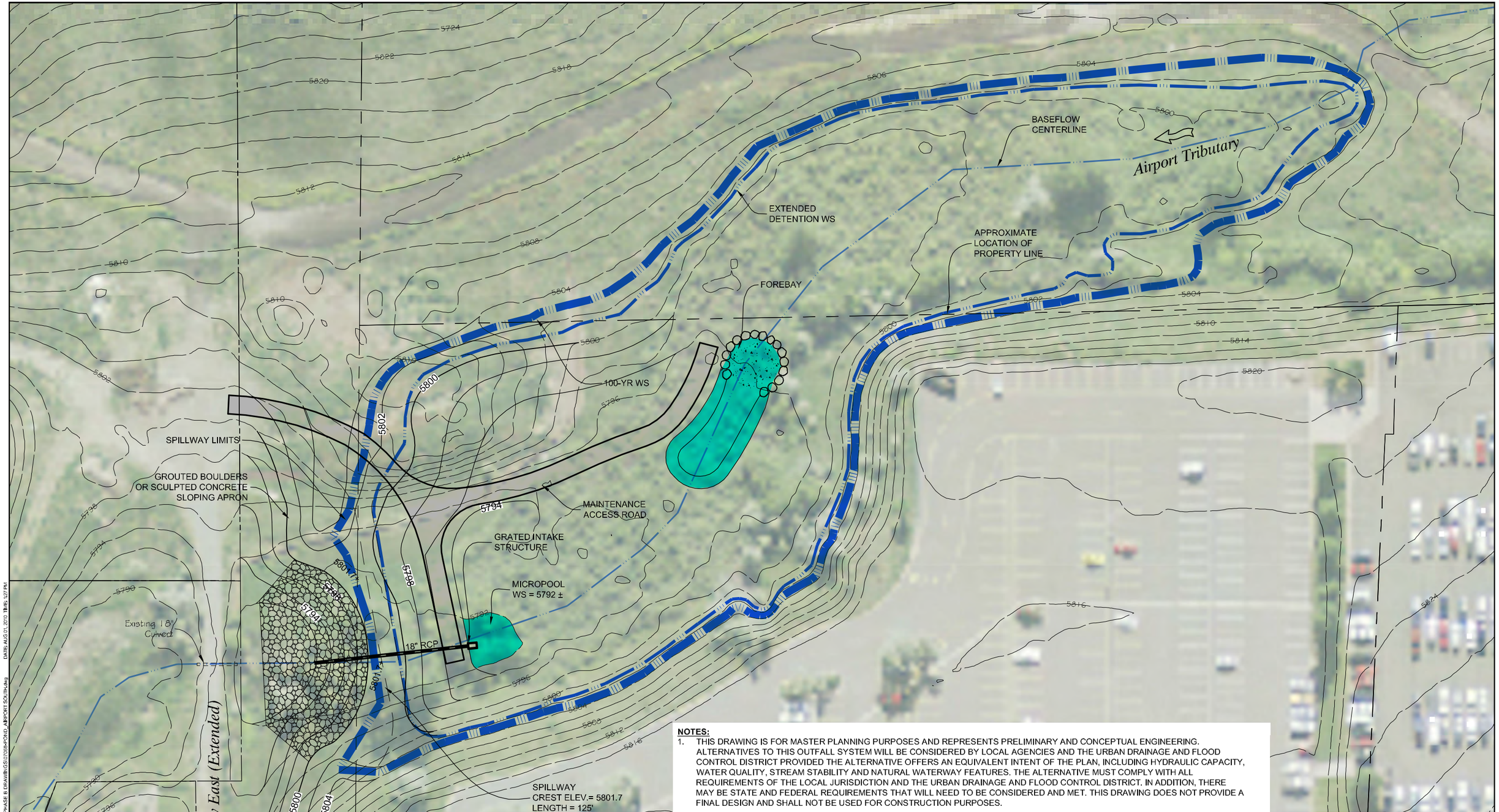
COTTONWOOD CREEK OUTFALL SYSTEMS PLAN

CONCEPTUAL DESIGN REPORT

INVERNESS TRIBUTARY C PROFILE

DWG P7

SHEET 20 OF 37



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HYDRAULIC INFORMATION

	EXTENDED DETENTION	100-YR
VOL, AF	11.0	15.5
W.S. EL.	5801.7	5803.4
RELEASE RATE, CFS	7.5	840

No.	DATE	REVISIONS	APPR.

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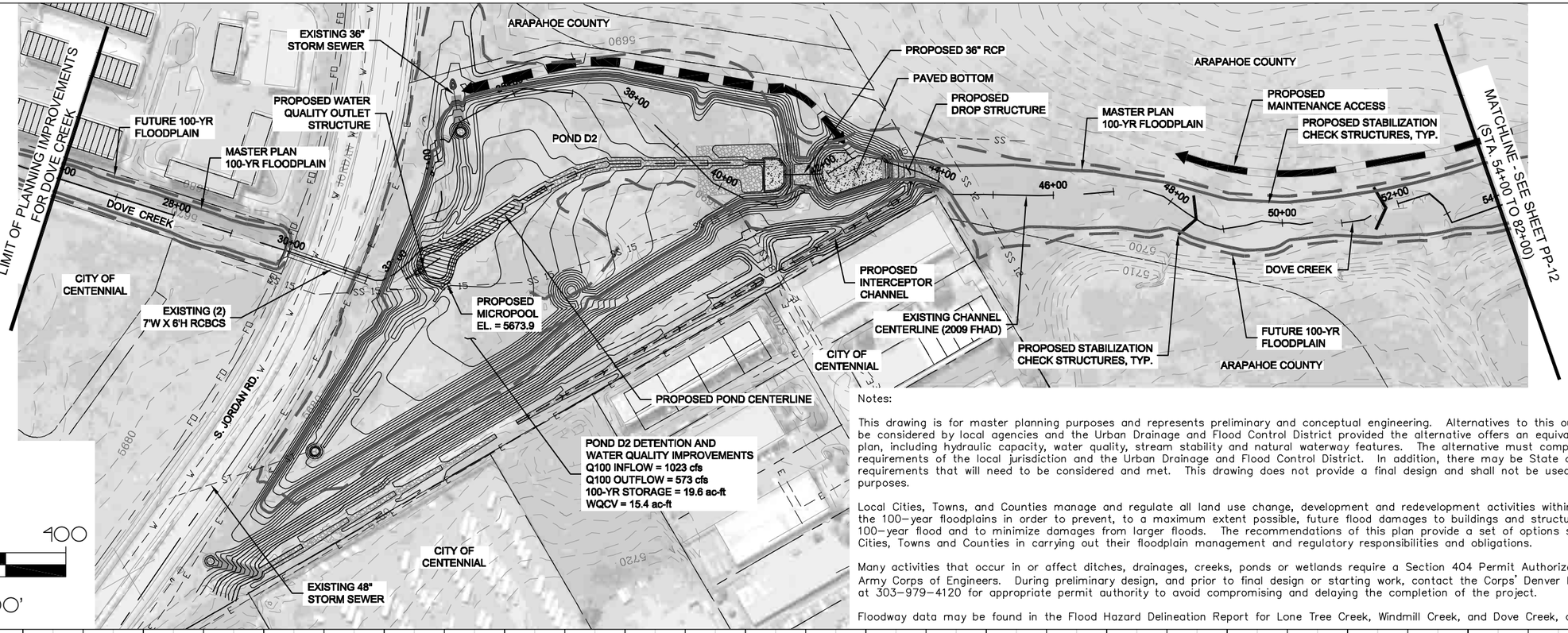
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COTTONWOOD CREEK OUTFALL SYSTEMS PLAN

CONCEPTUAL DESIGN REPORT
AIRPORT SOUTH POND

DWG D10
SHEET 32 OF 37

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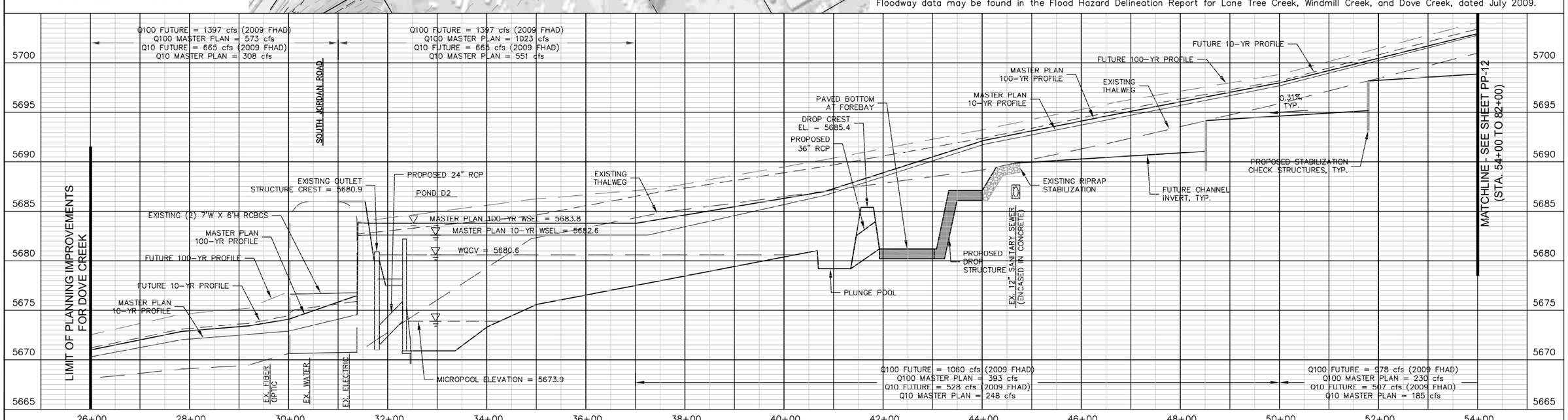
Notes:

This drawing is for master planning purposes and represents preliminary and conceptual engineering. Alternatives to this outfall system will be considered by local agencies and the Urban Drainage and Flood Control District provided the alternative offers an equivalent intent of the plan, including hydraulic capacity, water quality, stream stability and natural waterway features. The alternative must comply with all requirements of the local jurisdiction and the Urban Drainage and Flood Control District. In addition, there may be State and Federal requirements that will need to be considered and met. This drawing does not provide a final design and shall not be used for construction purposes.

Local Cities, Towns, and Counties manage and regulate all land use change, development and redevelopment activities within and adjacent to the 100–year floodplains in order to prevent, to a maximum extent possible, future flood damages to buildings and structures from the 100–year flood and to minimize damages from larger floods. The recommendations of this plan provide a set of options subscribed to by Cities, Towns and Counties in carrying out their floodplain management and regulatory responsibilities and obligations.

Many activities that occur in or affect ditches, drainages, creeks, ponds or wetlands require a Section 404 Permit Authorization from the US Army Corps of Engineers. During preliminary design, and prior to final design or starting work, contact the Corps' Denver Regulatory Office at 303–979–4120 for appropriate permit authority to avoid compromising and delaying the completion of the project.

Floodway data may be found in the Flood Hazard Delineation Report for Lone Tree Creek, Windmill Creek, and Dove Creek, dated July 2009.



No.	DATE	REVISIONS	APPR.

BASEMAP PRODUCED BY:
TRANSVISION, JANUARY 2008
NAVD 1998.
SURVEY BY:
ACCURATE ENGISURV LLC.
PROJECT No. 08-023-LDW-415

PLAN	
DRAWN	SV
DESIGNED	CDJ
CHECKED	CDJ

UTILITIES	
RESEARCHED	SV
DRAWN	SV
CHECKED	CDJ

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
SOUTHEAST METRO STORMWATER AUTHORITY
DOUGLAS COUNTY

ICON ENGINEERING, INC.
8100 South Akron Street, Suite 300, Englewood CO 80112
Phone (303) 289-0800 / Fax (303) 289-1099
www.iconeng.com

LONE TREE CREEK, WINDMILL CREEK, AND DOVE CREEK
MAJOR DRAINAGEWAY PLAN
CONCEPTUAL DESIGN
DOVE CREEK PLAN AND PROFILE
STA. 26+00 TO 54+00

DATE **APR 2010**
SHEET **PP-13**

P:\P08023LDW\dwg\Phase II\SHEET-DOVE-PP-11TO13.dwg, PP-13, 4/15/2010 11:58:41 AM, svarg, 1:1

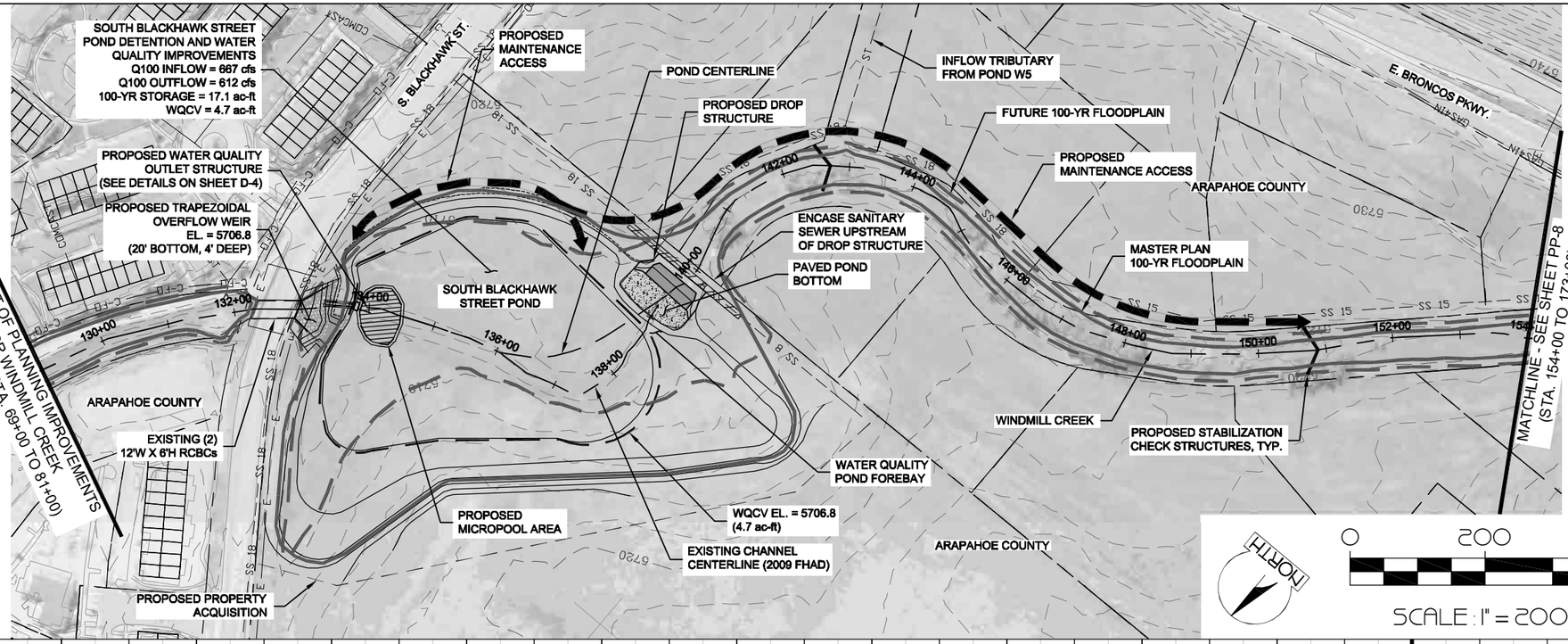
Notes:

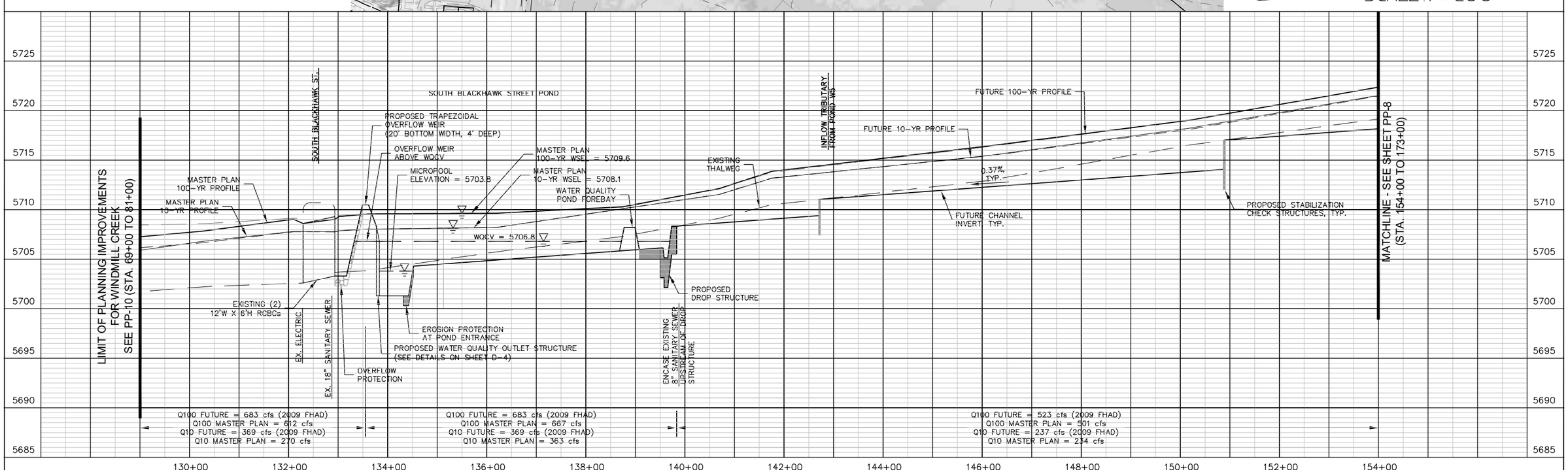
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No.	DATE	REVISIONS	APPR.

BASEMAP PRODUCED BY:
TRANSVISION, JANUARY 2008
NAVD 1988.
SURVEY BY:
ACCURATE ENGISURV LLC.
PROJECT No. 08-023-LDW-415

PLAN
DRAWN **SV**
DESIGNED **BJL**
CHECKED **CDJ**

UTILITIES
RESEARCHED **SV**
DRAWN **SV**
CHECKED **BJL**

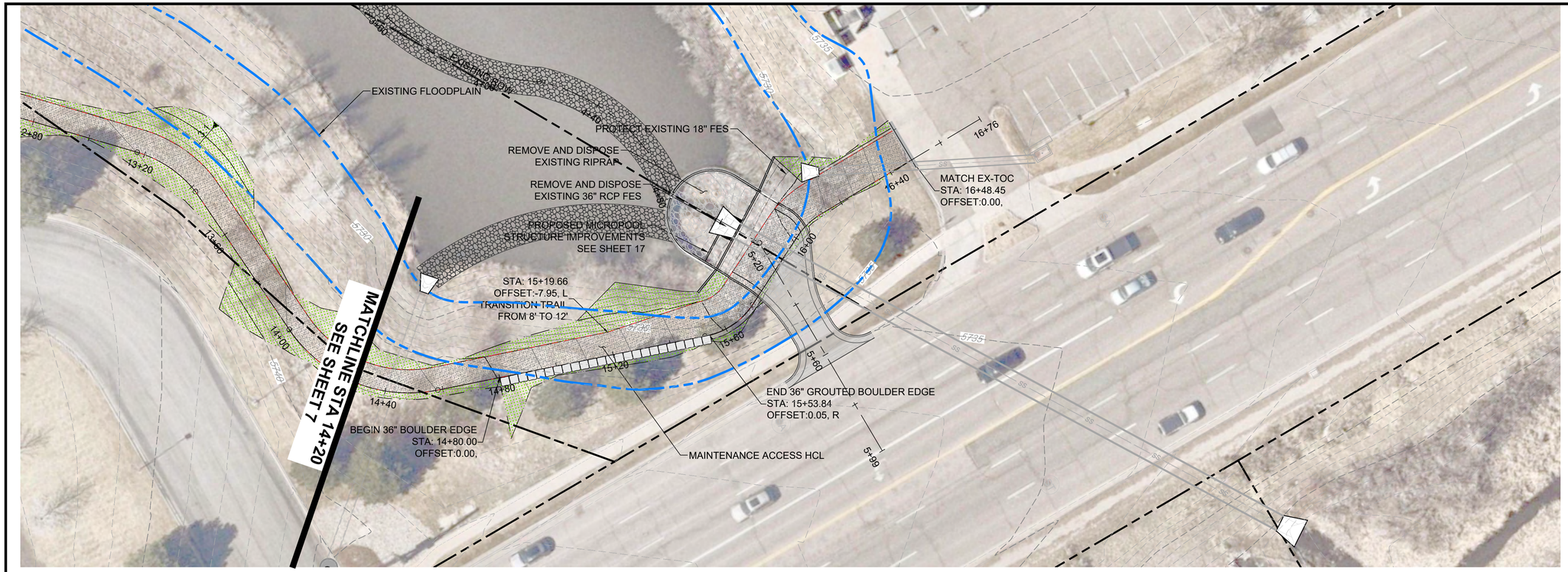
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
SOUTHEAST METRO STORMWATER AUTHORITY
DOUGLAS COUNTY

ICON ENGINEERING, INC.
8100 South Akron Street, Suite 300, Englewood, CO 80112
Phone (303) 289-0600 / Fax (303) 289-1049
WWW.ICONENG.COM

LONE TREE CREEK, WINDMILL CREEK, AND DOVE CREEK
MAJOR DRAINAGEWAY PLAN
CONCEPTUAL DESIGN
WINDMILL CREEK PLAN AND PROFILE
STA. 129+00 TO 154+00

DATE **APR 2010**
SHEET **PP-9**

P:\P08023LDW\dwg\Phase II\SHEET-WINDMILL-PP-4TO10.dwg, PP-9, 4/15/2010 11:48:54 AM, svang, 1:1



0 20' 40'

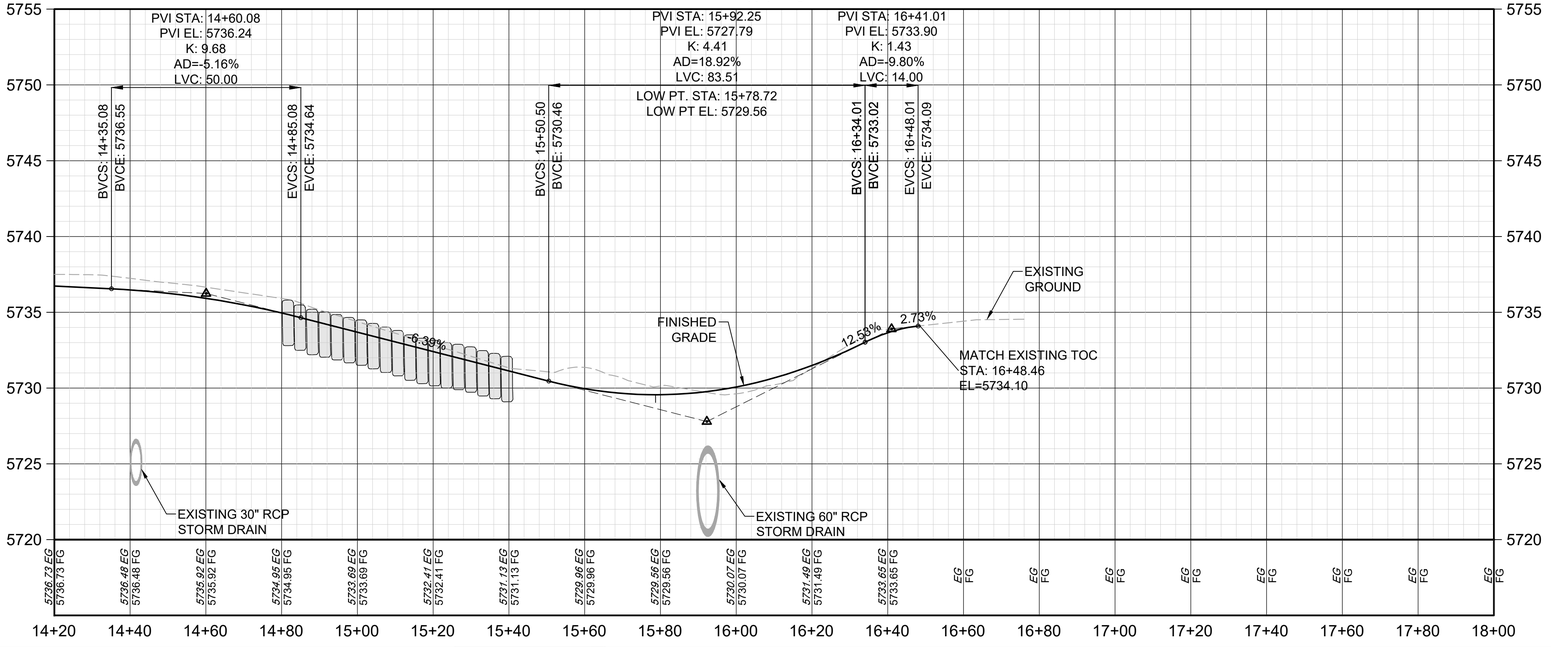
MAINTENANCE ACCESS NOTES:

1. PROTECT EXISTING LANDSCAPING, STRUCTURES AND UTILITIES UNLESS OTHERWISE NOTED.
2. MAINTENANCE ACCESS ROAD SHALL BE 12" COMPACTED CHOKED VTC, USE VTC ROCK AND CDOT SECT #703 AGGREGATE BASE COURSE WITH 6" THICK COMPACTED SUBGRADE.

ACCESS ROAD PLAN LEGEND

- GRADING LIMITS
- 5280 PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 5280 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING FLOODPLAIN
- ACCESS ROAD
- LANDSCAPE

PROFILE OF MAINTENANCE ACCESS HCL
H: 1" = 20
V: 1" = 5



No.	DATE	REVISIONS	APPR.

DRAWN BY: jMrkz
DESIGNED BY: jMrkz
APPROVED BY: TC

811 Know what's below. Call before you dig.

PREPARED FOR: Southeast Metro Stormwater Authority

PREPARED BY: ICON ENGINEERING

PRELIMINARY NOT FOR CONSTRUCTION

RAMPART PONDS RETROFIT

21-041

PLAN AND PROFILE - 4

DATE: MAY 2022

SHEET: 8 OF 25

P:\P21-041_Rampart_Ponds_Retrofit\06_DWG\04_CIVIL\04_PLAN SETS\PLAN AND PROFILE - 1.dwg; Opallares; Page Setup:----; ICON.stb; 8/17/2023 5:04 PM

PROTECT EXISTING 18" FES

12' MAINTANCE ACCESS ROAD

EXISTING 60" RCP

SLOPE VARIES

ELEV: 5731.69'

SLOPE VARIES

ELEV: 5727.63'

PROPOSED HEADWALL

ELEV: 5726.69'

5'

4'

4'

5'

SLOPE VARIES

PROPOSED HEADWALL

SAWCUT EXISTING WEIR WALL TO 5720.94'

PROPOSED TRASH PLATE

ELEV: 5722.44'

SAWCUT EXISTING WEIR WALL TO 5720.94'

PROPOSED 2.5' MICROPOOL

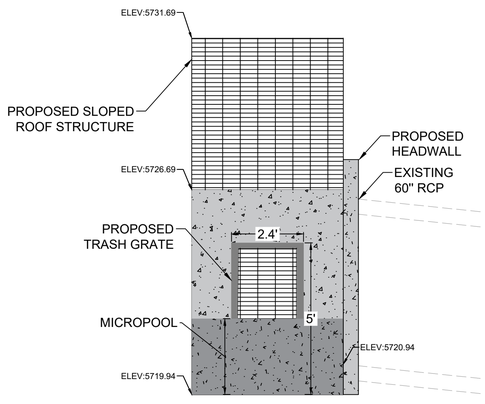
PROPOSED HEADWALL

ELEVATION VIEWS
(NTS)

PROPOSED SAWCUT WEIR WALL

ELEV:5720.94

ELEV:5719.94



P:\P21-041_Rampart_Ponds_Retrofit\06_DWG\04_CIVIL\04_PLAN SETS\SLOPED ROOF STRUCTURE.dwg; Jmarquez; Page Setup:----; ICON.stb; 8/17/2023 5:42 PM

No.	DATE	REVISIONS	APPR.

DRAWN BY: OP
DESIGNED BY: jMrkz
APPROVED BY: TC

811 Know what's below. Call before you dig.

PREPARED FOR: Southeast Metro Stormwater Authority

PREPARED BY: ICON ENGINEERING

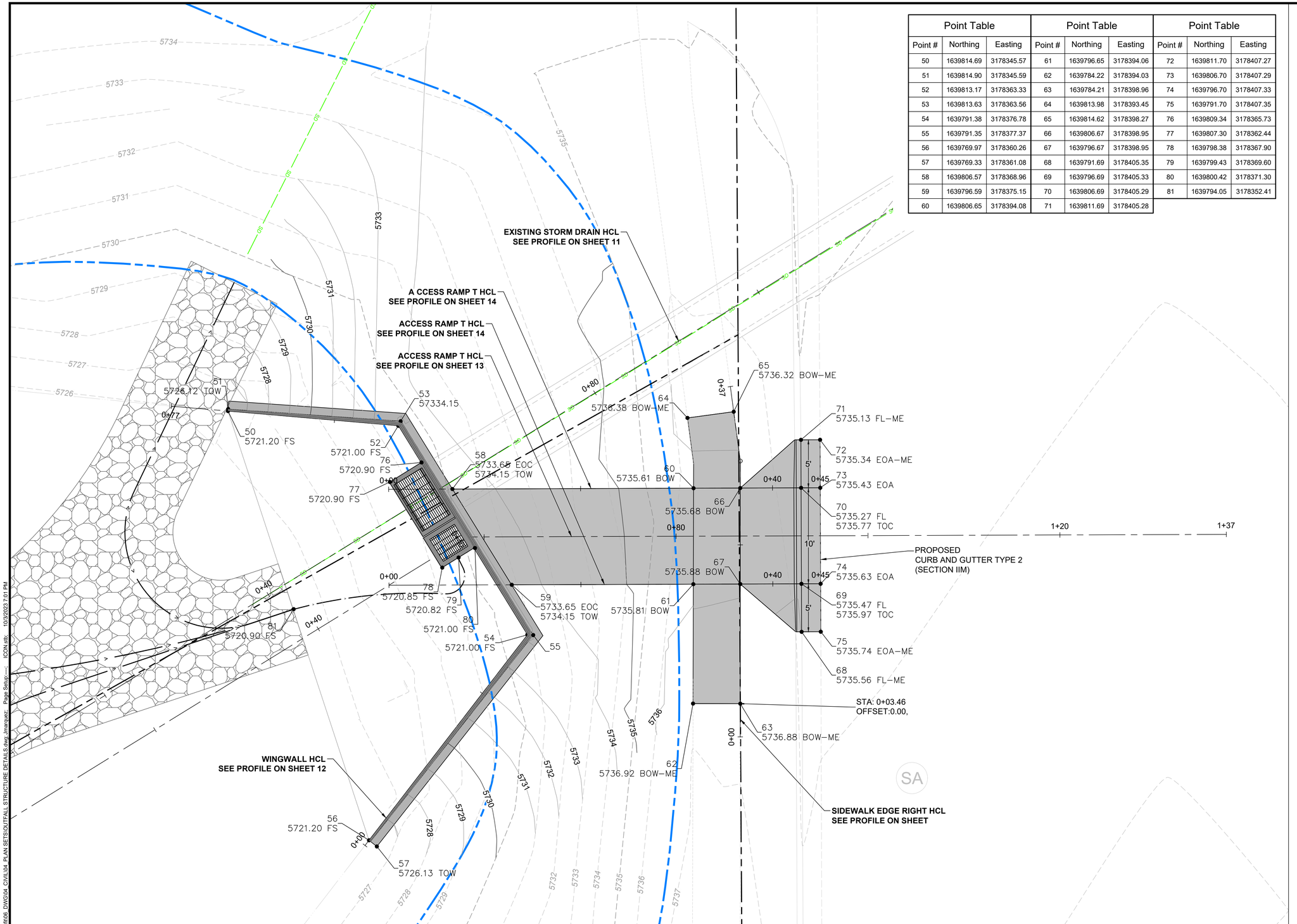
PRELIMINARY NOT FOR CONSTRUCTION

RAMPART PONDS RETROFIT

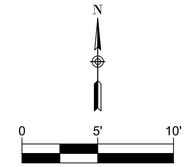
21-041 SLOPED ROOF STRUCTURE ISOMETRIC VIEW

DATE MAY 2022

SHEET 17 OF 25



Point Table			Point Table			Point Table		
Point #	Northing	Easting	Point #	Northing	Easting	Point #	Northing	Easting
50	1639814.69	3178345.57	61	1639796.65	3178394.06	72	1639811.70	3178407.27
51	1639814.90	3178345.59	62	1639784.22	3178394.03	73	1639806.70	3178407.29
52	1639813.17	3178363.33	63	1639784.21	3178398.96	74	1639796.70	3178407.33
53	1639813.63	3178363.56	64	1639813.98	3178393.45	75	1639791.70	3178407.35
54	1639791.38	3178376.78	65	1639814.62	3178398.27	76	1639809.34	3178365.73
55	1639791.35	3178377.37	66	1639806.67	3178398.95	77	1639807.30	3178362.44
56	1639769.97	3178360.26	67	1639796.67	3178398.95	78	1639798.38	3178367.90
57	1639769.33	3178361.08	68	1639791.69	3178405.35	79	1639799.43	3178369.60
58	1639806.57	3178368.96	69	1639796.69	3178405.33	80	1639800.42	3178371.30
59	1639796.59	3178375.15	70	1639806.69	3178405.29	81	1639794.05	3178352.41
60	1639806.65	3178394.08	71	1639811.69	3178405.28			



NOTES:

1. REFER TO CDOT STANDARD PLAN NO. M-609-4 FOR CURB AND GUTTER CONSTRUCTION REQUIREMENTS.
2. REFER TO CDOT STANDARD PLAN NO. M-601-20 FOR WINGWALL CONSTRUCTION REQUIREMENT.
3. CONCRETE SHALL CONFORM TO THE STANDARDS AND SPECIFICATIONS SECTION 600-CONCRETE WORK. 4500PSI CDOT CLASS D CONCRETE WITH FIBER MESH REINFORCEMENT IS REQUIRED.
4. JOINTS AND GRADE BREAKS SHALL BE FLUSH (0"±1/8"). THE JOINT BETWEEN THE ROADWAY SURFACE AND GUTTER PAN SHALL BE FLUSH.
5. REFER TO CDOT STANDARD PLAN NO. M-412-1 FOR GUIDANCE ON CONCRETE PAVEMENT JOINTS.
6. CONCRETE SIDEWALKS AND CURB RAMPS SHALL HAVE 4 INCHES OF CLASS VI AGGREGATE BASE COURSE.

NOMENCLATURE	
EC	EDGE OF CONCRETE
FS	FINISHED SURFACE
EOA	EDGE OF ASPHALT
FL	FLOW LINE
TOC	TOP OF CURB
TOW	TOP OF WALL
BOW	BACK OF WALK
ME	MATCH EXISTING
EL	ELEVATION
BOTW	BOTTOM OF WALL

P:\P21-041_Rampart_Ponds_Retrofit\06_DWG\04_CIVIL\04_PLAN SETS\OUTFALL STRUCTURE DETAILS.dwg, Jmarquez, Page Setup:----, ICON.stb, 10/3/2023 7:01 PM

No.	DATE	REVISIONS	APPR.

DRAWN BY: jMrkz
DESIGNED BY: jMrkz
APPROVED BY: TC

811 Know what's below. Call before you dig.

PREPARED FOR: Southeast Metro Stormwater Authority

PREPARED BY: ICON ENGINEERING

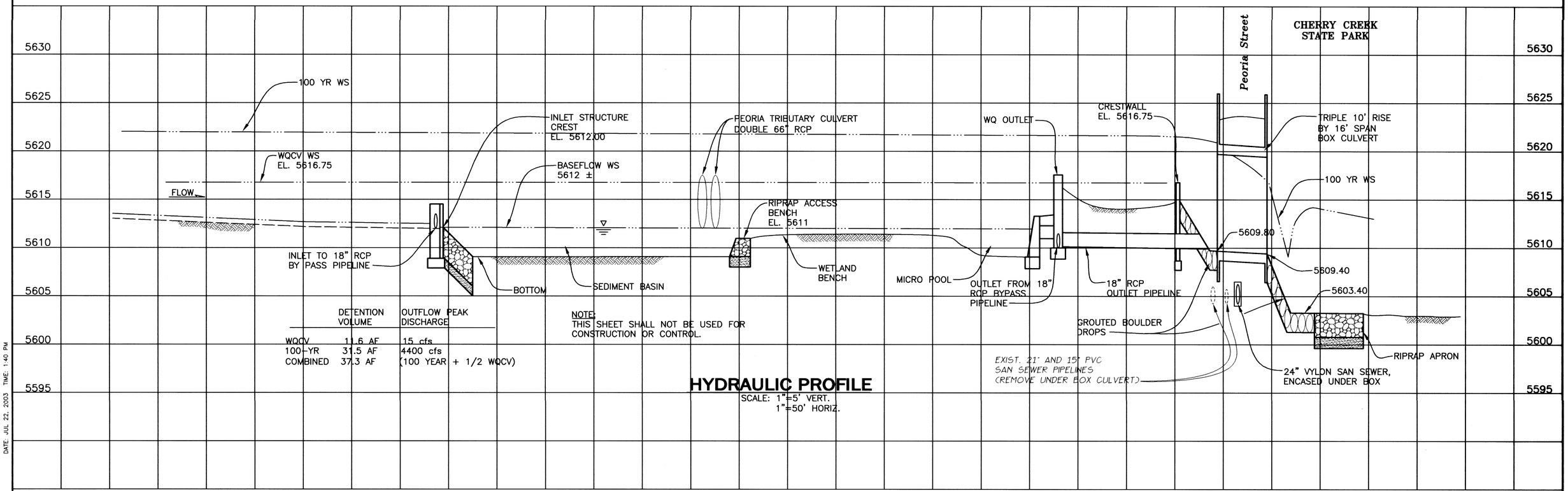
PRELIMINARY NOT FOR CONSTRUCTION

RAMPART PONDS RETROFIT

21-041 OUTFALL STRUCTURE DETAILS - PLAN VIEW

DATE: OCT 2023

SHEET: 10 OF 20



	DETENTION VOLUME	OUTFLOW PEAK DISCHARGE
WQCV	11.6 AF	15 cfs
100-YR	31.5 AF	4400 cfs
COMBINED	37.3 AF	(100 YEAR + 1/2 WQCV)

NOTE:
THIS SHEET SHALL NOT BE USED FOR CONSTRUCTION OR CONTROL.

HYDRAULIC PROFILE

SCALE: 1"=5' VERT.
1"=50' HORIZ.

RECORD DRAWING
7/22/03

THIS RECORD DRAWING HAS BEEN PREPARED, IN PART, BASED UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, MULLER ENGINEERING COMPANY, INC. CANNOT ASSURE IT'S ACCURACY, AND THUS IS NOT RESPONSIBLE FOR THE ACCURACY OF THIS RECORD DRAWING OR FOR ANY ERRORS OR OMISSIONS WHICH MAY HAVE BEEN INCORPORATED INTO IT AS A RESULT. THOSE RELYING ON THIS RECORD DRAWING ARE ADVISED TO OBTAIN INDEPENDENT VERIFICATION OF IT'S ACCURACY BEFORE APPLYING IT FOR ANY PURPOSE.

REVISIONS				
NO	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WHI/DIR	JTW	AS CONSTRUCTED RECORD DRAWINGS

MULLER

MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT — CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE — ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS

DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHKD: DDJ 1/5/01

HYDRAULIC PROFILE

SHEET 3
DWG G-3

NAME: S:\0032.01\dwgs\record dwg\0032-HDL-PRF-REC.dwg
DATE: JUL 22, 2003 TIME: 1:40 PM

POINTS	NORTHING	EASTING
A	112971.53	106448.17
B	113293.04	106468.20
C	113480.29	106508.33
D	113567.77	106327.70
E	113653.17	106239.55
F	113691.99	106251.97
G	113640.18	106413.91
H	113690.04	106506.32
I	113584.50	106838.88
J	113679.50	106838.88
K	113878.86	106745.83
L	113039.71	106652.81
M	113090.99	107054.20
N	113203.31	106947.98

RECORD DRAWING
7/22/03
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NOTES:
1. EXCAVATION FOR PHASE 1 STRUCTURES SHALL BE MINIMUM NECESSARY TO CONSTRUCT STRUCTURES. BACKFILL OF PHASE 1 STRUCTURES SHALL BE TO DESIGN SUBGRADE OR AS SHOWN WITHIN 2' OF STRUCTURE AND SLOPE AWAY FROM STRUCTURE AT 2:1 DOWN IN FILL OR UP IN CUT.
2. AREA OF PAYMENT FOR PHASE 1 TOPSOIL STRIPPING/REPLACEMENT AND SEEDING/MULCHING SHALL BE AREA REPRESENTED BY LIMITS OF PROPOSED CONTOURS.

20.00' UTILITY EASEMENT BK. 2557, PG. 542
U.S. GOVERNMENT, CORP OF ARMY ENGINEERS FLOOD PLAIN EASEMENT
150'
CHERRY CREEK VISTA FILING NO. 17
AREA AVAILABLE FOR PLACEMENT OF EXCESS EXCAVATED MATERIAL FROM PHASE 1
40'
A
AREA AVAILABLE FOR STAGING
WEST QUARTER CORNER OF SECTION 24, TOWNSHIP 5 SOUTH, RANGE 67 WEST OF THE SIXTH PRINCIPAL MERIDIAN, STAMPED LS 10717. APPROXIMATELY 1200' FROM COTTONWOOD CREEK CROSSING @ PEORIA.
B
LAST 20 LF SHALL NOT BE CONSTRUCTED UNTIL AFTER STORM DRAIN IS INSTALLED IN PHASE 2
C
SIDEWALK AND FLOODWALL SEE DWG S-5
CRESTWALL SEE DWG S-5
PEORIA TRIBUTARY CULVERT SEE DWG C-6
SAN. MH. RIM EL. 5623.23 INV. EL. 5607.51
SAN. MH. RIM EL. 5622.77 INV. EL. 5608.82
SAN. MH. RIM EL. 5623.47 INV. EL. 5606.67
SAN. MH. RIM EL. 5624.10 INV. EL. 5619.00
SAN. MH. RIM EL. 5617.92 INV. EL. 5605.17
37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00
SANITARY SEWER REPLACEMENT SEE DWG C-5
EX. MH. 1 RIM EL. 5618.92 INV. EL. 5605.12
CONCRETE ENCASEMENT
TRIPLE 10' RISE BY 16' SPAN BOX CULVERT AND WINGWALLS SEE DWG S-5
50'
30'
55'
CONTRACTOR SHALL PROTECT EXISTING UTILITIES IN PLACE DURING PHASE 1 WORK
ASPHALT ROAD
00+35
00+95
TIE MP 12 x 30
L
EXISTING SEDIMENT POND
25' DRAINAGE EASEMENT
8' UTILITY EASEMENT
ARAPAHOE W & S DISTRICT LIFT STATION EASEMENT BK. 3259, PG. 340
EXISTING 30" RCP
SOUTHFIELD PARK
LOT 3
ARAPAHOE WATER AND SANITATION DISTRICT PUMP STATION
SEE DWG A-2 FOR ACWWA LIFT STATION SITE PLAN
M
N
GATE IN FENCE W/ RR TIE STEPS
D
INLET STRUCTURE SEE DWG S-1
E
WATER QUALITY DETENTION POND OUTFALL SEE DWG C-6
F
20' TO CONSTRUCTION LIMITS
EXISTING WATER QUALITY DETENTION POND
BYPASS PIPELINE SEE DWG C-4
18" HDPE RCP
G
WATER QUALITY OUTLET SEE DWG S-3
24" HDPE RCP
WATER QUALITY OUTLET PIPELINE SEE DWG C-6
H
LIFT STATION DRAIN SEE DWG C-6
GROUTED BOULDER DROP SEE DWG S-5
U.S. GOVERNMENT, CORP OF ARMY ENGINEERS FLOOD PLAIN EASEMENT
N
0' 30' 60'
ORIGINAL SCALE: 1"=30'
CHERRY CREEK VISTA FILING NO. 17
HAVANA W & S DISTRICT LIFT STATION EASEMENT BK. 2489, PG. 541
SAN. MH. RIM EL. 5618.08 INV. EL. (E) 5600.36 INV. EL. (S) 5600.46
GRAVEL DRIVEWAY
EX. MH. 4 RIM EL. 5617.56 INV. EL. 5603.01
TELE
21" RCP
SAN. MH. RIM EL. 5615.09 INV. EL. 5603.69
EXISTING 48" RCP
CONTRACTOR SHALL MAINTAIN SECURE FENCE ENCLOSURE DURING MANHOLE REPLACEMENT
GROUTED BOULDER DROP/RIPRAP APRON SEE DWG S-5
SEDIMENT TRAP SEE DWG. C-1
COTTONWOOD TREE CLUMP
K
A
UNPLATTED
CHERRY CREEK STATE PARK
I
J
COTTONWOOD CREEK
PHASE 1 CONTRUCTION LIMITS, TYP.

PHASE 1 FINISHED GRADE SEE PLAN VIEW CONTOURS
6" TOPSOIL STRIPPING
EXISTING GRADE
6" TOPSOIL REPLACEMENT
UNCLASSIFIED EXCAVATION
SECTION A
1"=5' VERT.
1"=30' HORIZ.

REVISIONS

NO.	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WHB/CRR	JTW	AS CONSTRUCTED RECORD DRAWINGS

MULLER

MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT — CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE — ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS
DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHKD: DDJ 1/5/01

PHASE 1 WORK (IN THIS CONTRACT)

SHEET 5
DWG C-2

X0032-EX1, X0032-PR1, X0032-PRS2, X0032RD, X0032BDR, XMOD-CNT
NAME: S:\0032.01\dwgs\record dwg\0032-PLN-REC.dwg
DATE: JUL 23, 2003 TIME: 4:07 PM

RECORD DRAWING
7/22/03

THIS RECORD DRAWING HAS BEEN PREPARED, IN PART, BASED UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, MULLER ENGINEERING COMPANY, INC. CANNOT ASSURE IT'S ACCURACY, AND THUS IS NOT RESPONSIBLE FOR THE ACCURACY OF THIS RECORD DRAWING OR FOR ANY ERRORS OR OMISSIONS WHICH MAY HAVE BEEN INCORPORATED INTO IT AS A RESULT. THOSE RELYING ON THIS RECORD DRAWING ARE ADVISED TO OBTAIN INDEPENDENT VERIFICATION OF IT'S ACCURACY BEFORE APPLYING IT FOR ANY PURPOSE.

AREA USED FOR PLACEMENT OF EXCESS EXCAVATED MATERIAL FROM PHASE 2 GRADING. SEEDING AND MULCHING EXCESS EXCAVATED MATERIAL AND DISTURBED AREAS OUTSIDE PHASE 2 PROPOSED CONTOURS SHALL BE BY OTHERS

20.00' UTILITY EASEMENT
BK. 2557, PG. 542

CHERRY CREEK VISTA FILING NO. 17

U.S. GOVERNMENT, CORP OF ARMY ENGINEERS FLOOD PLAIN EASEMENT

EXISTING VEGETATION IN THIS AREA SHALL NOT BE DISTURBED

COTTONWOOD CREEK

ALL FINISHED GRADING, SIDEWALK, FENCE, AND PEORIA STREET IMPROVEMENTS NOT SHOWN ON DWG. C-2 SHALL BE BY OTHERS. FINISHED GRADING BY OTHERS SHALL INCLUDE RUBBLE REMOVAL, PAVEMENT REMOVAL, SURFACE PREPARATION, TOPSOIL REMOVAL AND REPLACEMENT, AND DISPOSAL OF EXCESS EXCAVATED MATERIAL.

SEE TABLE 2 DWG. C-10 FOR RIPRAP LAYOUT POINTS

20'-0"

EXIST. 18" RCP

SEE BLOWUP OF THIS AREA, DWG. C-11

NOTE:
1. BOXED ITEMS COMPRISE PHASE 2 WORK BY OTHERS.

0' 30' 60'
ORIGINAL SCALE: 1"=30'

CHERRY CREEK VISTA FILING NO. 17

WORK SHOWN ON CARROLL & LANGE DRAWINGS FOR GRADING, ACCESS DRIVE, RETAINING WALLS, AND FENCE MODIFICATIONS NORTH OF CORPS EASEMENT SHALL BE BY OTHERS

SILT FENCE

5617.50 ×

5616.5

WATER QUALITY DETENTION POND OUTFALL SEE DWG C-6

D50=18" RIPRAP 2'-6" THICK OVER 12" CLASS A FILTER MATERIAL

INLET STRUCTURE SEE DWG. S-1

EXISTING WATER QUALITY DETENTION POND

SIDEWALK

5613.5

RIPRAP TO BE CONSTRUCTED IN PHASE 3

36" RCP

MH

END SECTION

BASEFLOW WS

SEDIMENT BASIN

FLOW

ACCESS DRIVE TO BE CONSTRUCTED IN PHASE 3

BYPASS PIPELINE SEE DWG C-6

18" HDPE 18" RCP

RIPRAP ACCESS BENCH

WATER QUALITY OUTLET SEE DWG S-3

MICRO POOL

HAVANA W & S DISTRICT LIFT STATION EASEMENT
BK. 2489, PG. 541

WEST QUARTER CORNER OF SECTION 24, TOWNSHIP 5 SOUTH, RANGE 67 WEST OF THE SIXTH PRINCIPAL MERIDIAN, STAMPED LS 10717. APPROXIMATELY 1200' FROM COTTONWOOD CREEK CROSSING @ PEORIA.

CULVERT OULET SEE DWG C-8

GROUTED BOULDER DROP SEE DWG S-5

24" HDPE

WATER QUALITY OUTLET PIPELINE SEE DWG C-6

OUTLET PROTECTION

SIDEWALK AND FLOODWALL SEE DWG S-5

CRESTWALL SEE DWG S-5

5618.5

BOLLARD

LIFT STATION DRAIN SEE DWG C-6

PEORIA TRIBUTARY CULVERT SEE DWG C-6

SIDEWALK

DRIVEWAY

MH

SAN. MH.
RIM EL. 5618.08
INV. EL. (E) 5600.36
INV. EL. (S) 5600.46

RAISE/ADJUST ALL MANHOLES IN STREET ROW TO FINISHED GRADE, TYP

SAN. MH.
RIM EL. 5623.23
INV. EL. 5604.51
SAN. MH.
RIM EL. 5622.97
INV. EL. 5608.82
SAN. MH.
RIM EL. 5623.47
INV. EL. 5606.67
SAN. MH.
RIM EL. 5624.10
INV. EL. 5619.00

SANITARY SEWER REPLACEMENT SEE DWG C-5

SAN. MH.
RIM EL. 5621.92
INV. EL. 5605.17

EX. MH. 1
RIM EL. 5618.92
INV. EL. 5605.12

EX. MH. 4
RIM EL. 5621.56
INV. EL. 5603.01

TILE

42" RCP

36" RCP

CONCRETE ENCASEMENT

INLETS AND STORM DRAIN

SAN. MH.
RIM EL. 5615.68
INV. EL. 5603.67

EXISTING 48" RCP

ASPHALT ROAD

(2) 6" + (3) 4" CONDUITS FOR UTILITY RELOCATION. INSTALLED ABOVE 66" CULVERT

TRIPLE 10' RISE BY 16' SPAN BOX CULVERT AND WINGWALLS SEE DWG S-5

PEORIA STREET IMPROVEMENTS

RELOCATE (BURY) UTILITIES AFTER PEORIA STREET EMBANKMENT IS PLACED

REMOVE FENCE AND RELOCATE ON PROPERTY LINE

GATE IN FENCE W/ RR TIE STEPS

(6) 6" CONDUITS WITH LONG SWEEP BENDS UNDER BOX CULVERT. NOT USED FOR UTILITIES.

GROUTED BOULDER DROP/RIPRAP APRON SEE DWG S-5

EXISTING SEDIMENT POND
25' DRAINAGE EASEMENT
8' UTILITY EASEMENT

EXISTING 30" RCP

ARAPAHOE W & S DISTRICT LIFT STATION EASEMENT
BK. 3259, PG. 340

C-10

REVISIONS				
NO	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WMG/CMR	JTW	AS CONSTRUCTED RECORD DRAWINGS

MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
7777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT — CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE — ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS

DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHK'D: DDJ 1/5/01

PHASE 2 WORK (BY OTHERS)

SHEET 6 | DWG C-3

X-ROAD-CNT, X0032-EX1, X0032-PR2, X0032-PRS, X0032-RD, X0032BDR, XMOD-CNT
NAME: S:\X0032.01\dwgs\record dwg\0032-PLN4-REC.dwg
DATE: AUG 13, 2003 TIME: 8:32 AM

RECORD DRAWING
7/22/03

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NOTES:
1. BOXED ITEMS COMPRISE PHASE 3 WORK.
2. SEE DWG. C-3 FOR PHASE 2 WORK BY OTHERS.

0' 30' 60'
ORIGINAL SCALE: 1"=30'

CHERRY CREEK VISTA FILING NO. 17

CHERRY CREEK VISTA FILING NO. 17

COTTONWOOD CREEK

EXISTING VEGETATION IN THIS AREA SHALL NOT BE DISTURBED

CONTRACTOR SHALL SEED AND MULCH AREAS REPRESENTED BY LIMITS OF PROPOSED PHASE 2 AND PHASE 3 CONTOURS

20.00' UTILITY EASEMENT BK. 2557, PG. 542

U.S. GOVERNMENT, CORP OF ARMY ENGINEERS FLOOD PLAIN EASEMENT

WEST QUARTER CORNER OF SECTION 24, TOWNSHIP 5 SOUTH, RANGE 67 WEST OF THE SIXTH PRINCIPAL MERIDIAN, STAMPED LS 10717. APPROXIMATELY 1200' FROM COTTONWOOD CREEK CROSSING @ PEORIA.

5617.50 ×

5616.5

5613.5

BASEFLOW WS

SEDIMENT BASIN
TOP OF BERM 13.05-13.29

RIPRAP ACCESS BENCH

CULVERT OULET SEE DWG C-8

PEORIA TRIBUTARY CULVERT SEE DWG C-6

SAN. MH. RIM EL. 5623.23 INV. EL. 5607.51
SAN. MH. RIM EL. 5622.77 INV. EL. 5608.82
SAN. MH. RIM EL. 5623.47 INV. EL. 5606.67
SAN. MH. RIM EL. 5624.10 INV. EL. 5619.00

60 LF WOOD FENCE

ASPHALT ROAD

CULVERT INLET SEE DWG. C-8

EXISTING SEDIMENT POND
25' DRAINAGE EASEMENT
8' UTILITY EASEMENT

EXISTING 30" RCP

16 LF 58"x91" HERCP, TRANSITION TO 66" RCP (BOTH CULVERTS), 1 SECTION 66" RCP (NORTH CULVERT) SEE DWG. C-6

ARAPAHOE W & S DISTRICT LIFT STATION EASEMENT BK. 3259, PG. 340

FINISHED GRADING SHALL TRANSITION FROM CULVERT INLET TO EXISTING SECTION AT 30" OUTFALL

SEE ATTACHED SHEET C-8B FOR REDESIGN 1

~~REMOVE LIFT STATION, ABANDON PIPELINES, SALVAGE EQUIPMENT, FINISH GRADE, CONSTRUCT ACCESS PATH AS SHOWN ON DWG. A-1 AFTER NEW LIFT STATION IS COMPLETED~~
1 ~~WAS NOT REMOVED~~

RIPRAP BANK PROTECTION SEE DWG. C-11

SEE TABLE 2 DWG. C-11 FOR RIPRAP LAYOUT POINTS

WATER QUALITY DETENTION POND OUTFALL SEE DWG C-6

SEE BLOWUP OF THIS AREA, DWG. C-10

EXIST. 18" RCP

INLET STRUCTURE SEE DWG S-1

1 INV. = 5612.43

36" RCP

EXISTING WATER QUALITY DETENTION POND

RIPRAP

BYPASS PIPELINE SEE DWG C-6

18" RCP

ACCESS DRIVE

PERMANENT ELECTRICAL SERVICE (2) 120 V RECEPTICALS AND (2) 240V RECEPTICALS WITH 6" META CONDUIT UNDER DRIVE. 1

SEE DWG. C-3 FOR WORK BY OTHERS

HAVANA W & S DISTRICT LIFT STATION EASEMENT BK. 2489, PG. 541

WATER QUALITY OUTLET SEE DWG S-3

MICRO POOL

RIPRAP

GROUTED BOULDER DROP SEE DWG S-5

1 24" HDPE RCP

WATER QUALITY OUTLET PIPELINE SEE DWG C-6

SIDEWALL AND FLOODWALL SEE DWG S-5

CRESTWALL SEE DWG S-5

1 5618.65 ~~5618.5~~

5618.5

SAN. MH. RIM EL. 5617.92 INV. EL. 5605.17

LIFT STATION DRAIN SEE DWG C-6

SAN. MH. RIM EL. 5618.08 INV. EL. (E) 5600.36 INV. EL. (S) 5600.46

EX. MH. 4 RIM EL. 5617.58 INV. EL. 5603.01

GRAVEL DRIVEWAY

TELE

21" RCP

SAN. MH. RIM EL. 5618.08 INV. EL. 5603.84

EXISTING 48" RCP

EX. MH. 1 RIM EL. 5618.92 INV. EL. 5605.12

SANITARY SEWER REPLACEMENT SEE DWG C-5

CONCRETE ENCASEMENT

TRIPLE 10' RISE BY 16' SPAN BOX CULVERT AND WINGWALLS SEE DWG S-5

GROUTED BOULDER DROP/RIPRAP APRON SEE DWG S-5

GATE IN FENCE W/ RR TIE STEPS

REVISIONS				
NO	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WHI/DRB	JTW	AS CONSTRUCTED RECORD DRAWINGS

MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT — CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE — ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS
DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHKD: DDJ 1/5/01

PHASE 3 WORK (IN THIS CONTRACT)

SHEET 7
DWG C-4

X-ROAD-CNT, X0032-EX1, X0032-PR2, X0032-PRS, X0032-R0, X0032BDR, XWOD-CNT
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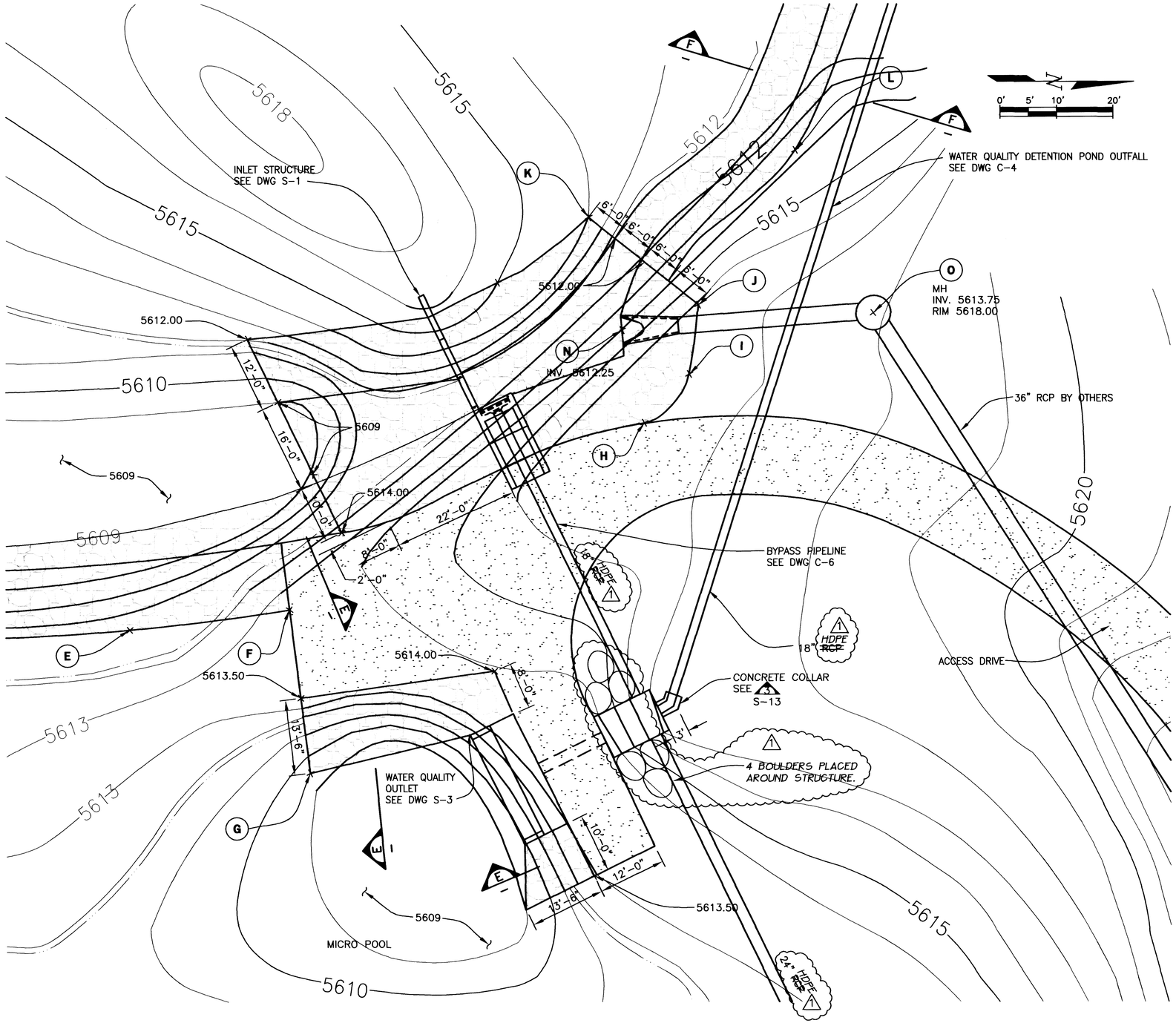
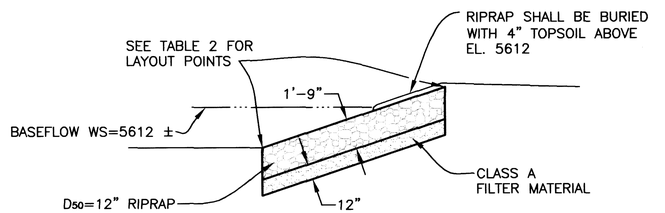


TABLE 2 RIPRAP LAYOUT POINTS

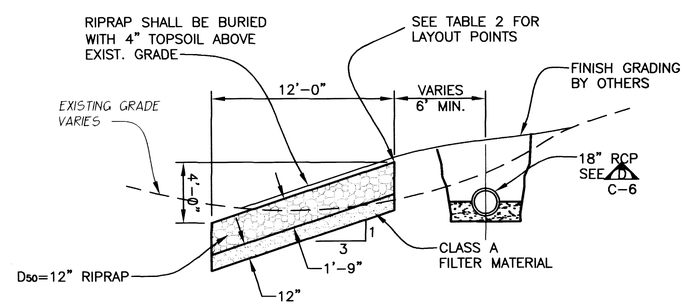
POINT	NORTHING	EASTING	ELEVATION
A	113293.51	106516.22	5616.00
B	113330.36	106456.82	5611.00
C	113384.48	106412.91	5611.00
D	113421.68	106400.59	5611.00
E	113526.60	106399.07	5611.00
F	113554.92	106395.52	5613.50
G	113558.57	106424.51	5609.00
H	113617.81	106362.23	5616.50
I	113625.81	106353.57	5616.00
J	113627.38	106341.25	5616.00
K	113607.94	106325.72	5614.00
L	113644.61	106313.77	5614.00
M	113671.92	106238.34	5614.00
N	113613.85	106345.78	-----
O	113658.41	106342.67	-----

RECORD DRAWING
7/22/03

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SECTION E
SCALE: 1"=5'



SECTION F
SCALE: 1"=5'

REVISIONS				
NO.	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WMI/CRB	JTW	AS CONSTRUCTED RECORD DRAWINGS

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CONSULTING ENGINEERS
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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT — CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE — ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

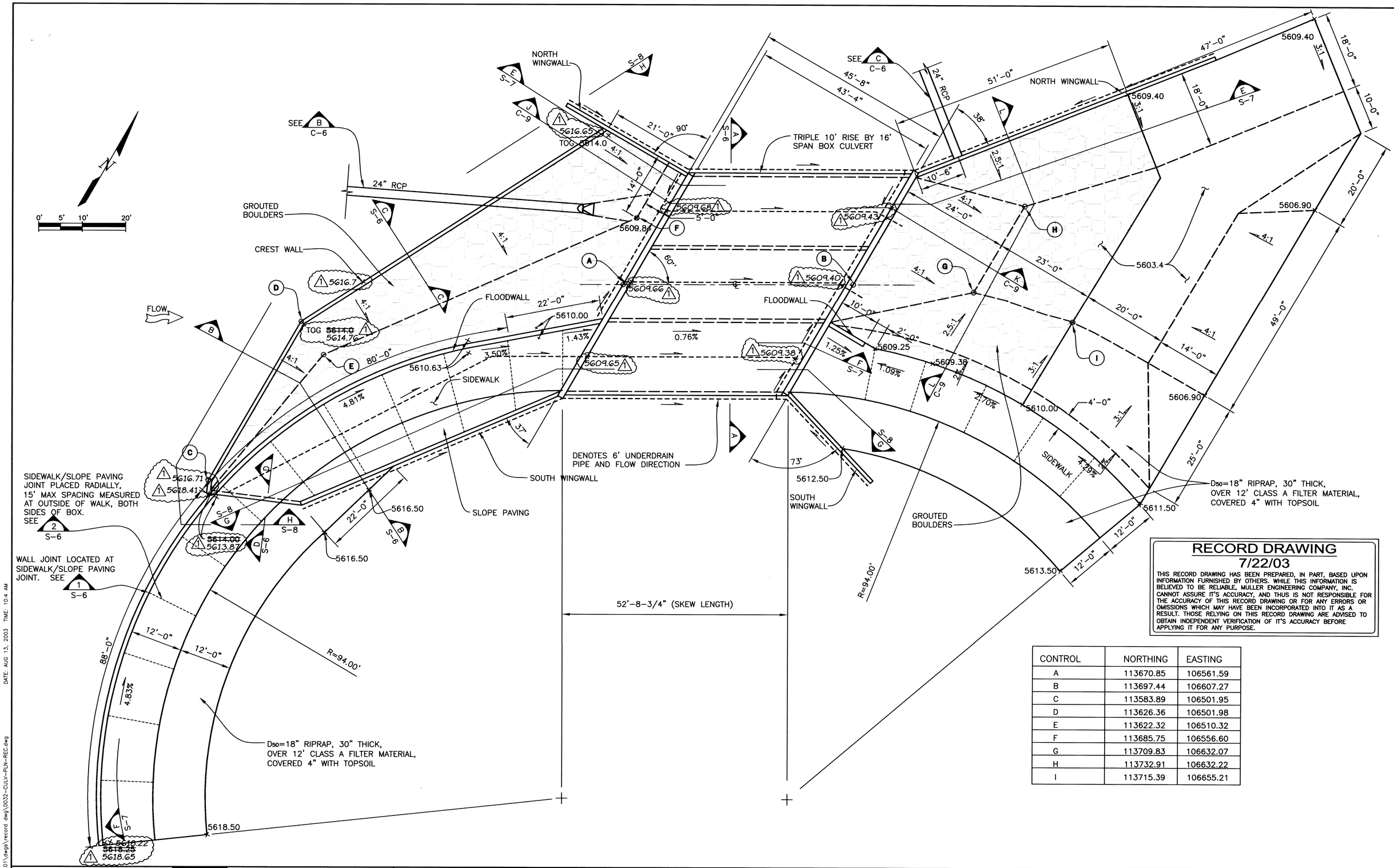
COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS

DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHKD: DDJ 1/5/01

INLET/OUTLET PLAN AND PHASE 3 SECTIONS

SHEET 14
DWG C-11

X-ROAD-CNT, X0032-EX1, X0032-PR2, X0032-PRS, X0032-RD, X0032BDR, XMOD-CNT
NAME: S:\0032.01\dwgs\record dwg\0032-PLN3-REC.dwg
DATE: JUL 24, 2003 TIME: 2:48 PM



RECORD DRAWING
7/22/03

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CONTROL	NORTHING	EASTING
A	113670.85	106561.59
B	113697.44	106607.27
C	113583.89	106501.95
D	113626.36	106501.98
E	113622.32	106510.32
F	113685.75	106556.60
G	113709.83	106632.07
H	113732.91	106632.22
I	113715.39	106655.21

REVISIONS

NO	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WW/DMR	JTW	AS CONSTRUCTED RECORD DRAWINGS

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(303) 988-4939

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT — CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE — ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

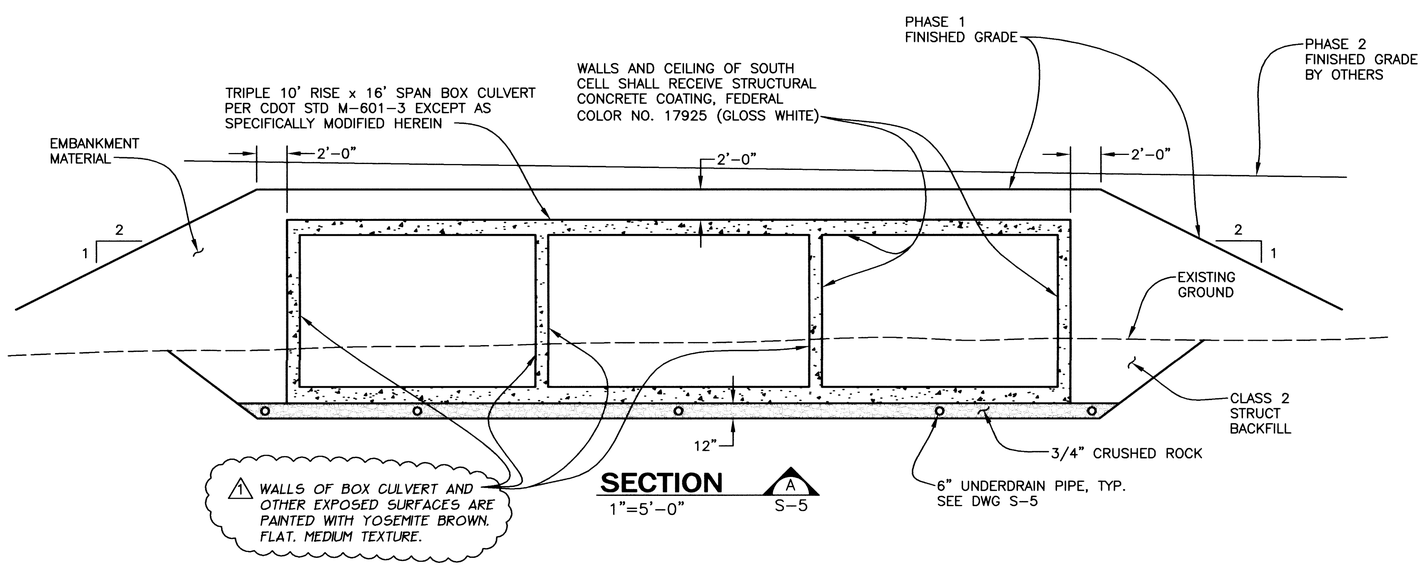
COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS

DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHKD: LJE 4/11/01

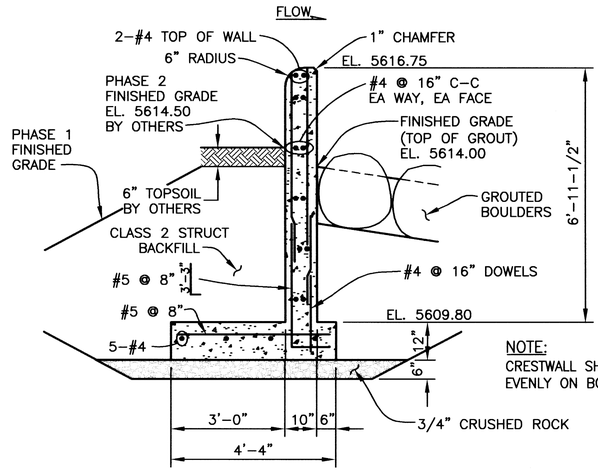
BOX CULVERT PLAN

SHEET 19
DWG S-5

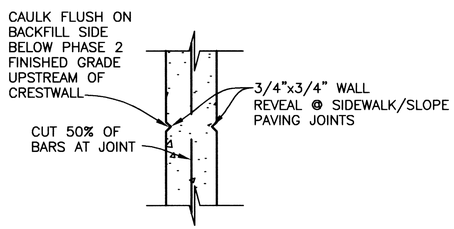
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DATE: AUG 13, 2003 TIME: 10:4 AM



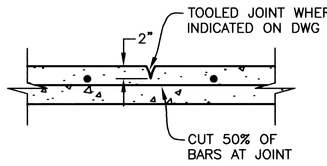
SECTION (A)
1"=5'-0"



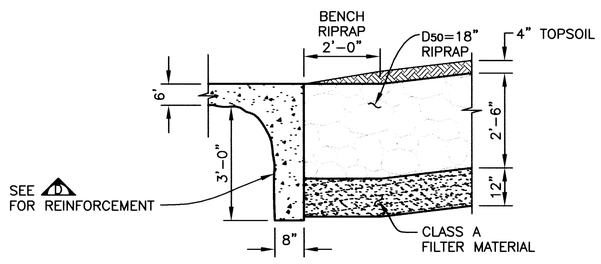
CRESTWALL - SECTION (C)
1/2"=1'-0"



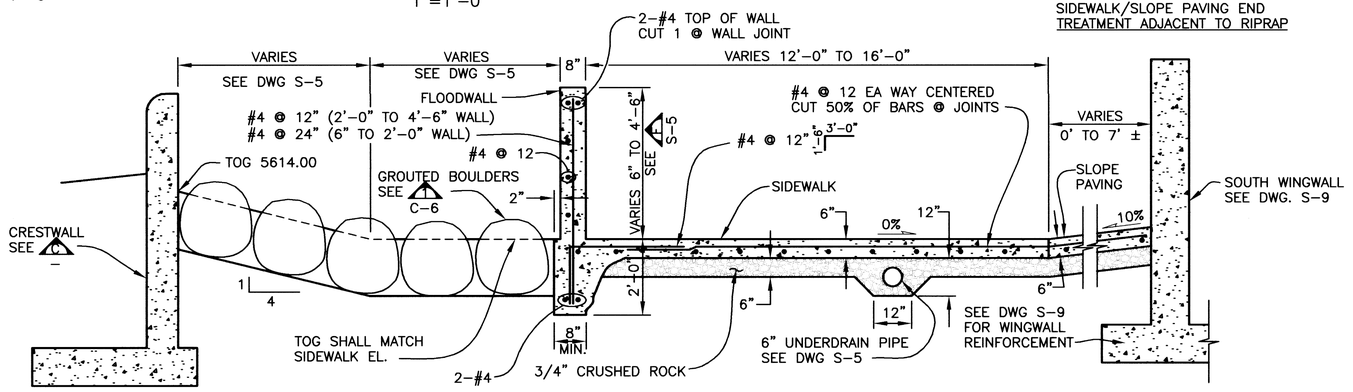
FLOODWALL JOINT - DETAIL (1)
1"=1'-0"



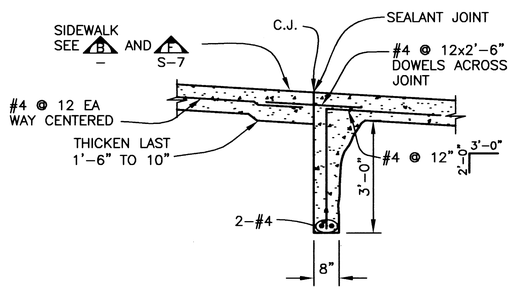
SIDEWALK/SLOPE PAVING JOINT - DETAIL (2)
1"=1'-0"



SIDEWALK/SLOPE PAVING END
TREATMENT ADJACENT TO RIPRAP



SECTION (B)
1/2"=1'-0"



SIDEWALK CUTOFF WALL - SECTION (D)
1/2"=1'-0"

RECORD DRAWING
7/22/03

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REVISIONS				
NO	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WW/CRR	JTW	AS CONSTRUCTED RECORD DRAWINGS

MULLER

MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
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(303) 988-4939

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT
CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE
ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

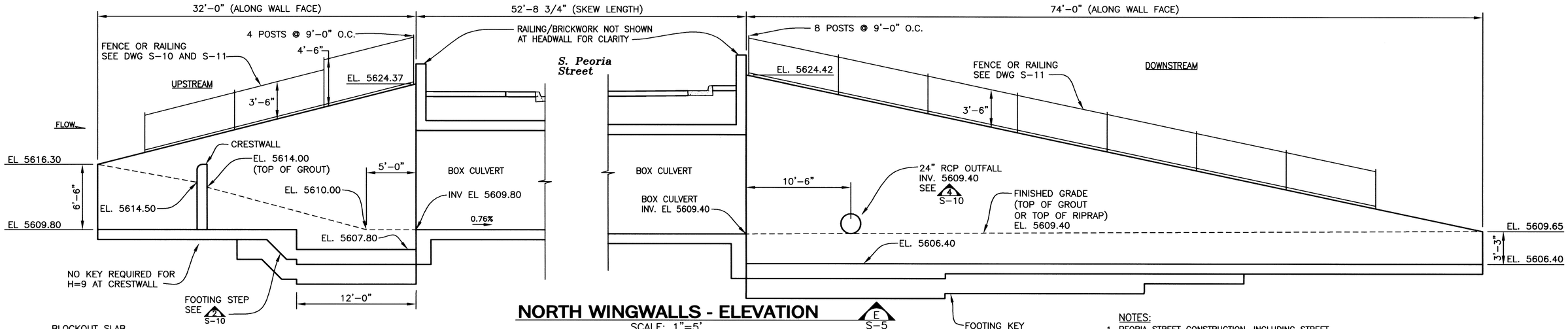
COTTONWOOD CREEK -
PEORIA STREET IMPROVEMENTS

DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHKD: LJE 4/11/01

BOX CULVERT AND
CRESTWALL SECTIONS

SHEET 20
DWG S-6

NAME: S:\0032.01\dwgs\record dwg\0032-SECT1-rec.dwg
DATE: JUL 25, 2003 TIME: 8:57 AM



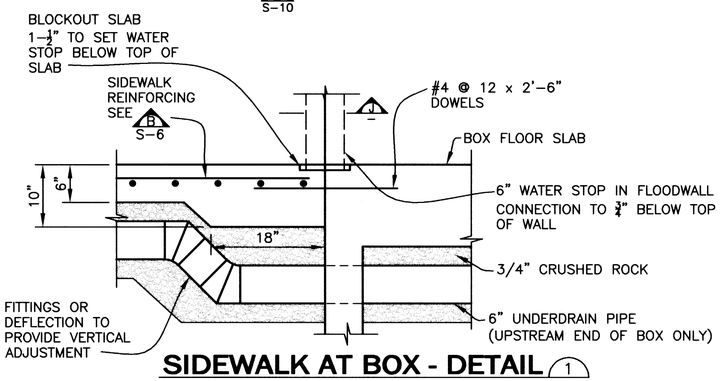
NORTH WINGWALLS - ELEVATION

SCALE: 1"=5'

E S-5

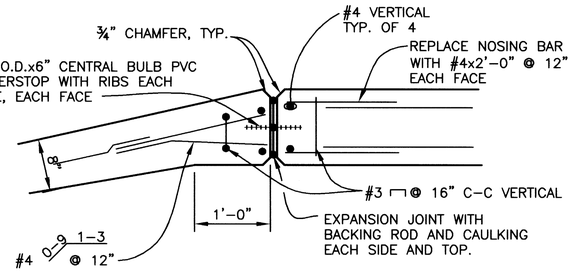
NOTES:

1. PEORIA STREET CONSTRUCTION, INCLUDING STREET, CURB AND GUTTER, PATTERNED CONCRETE, SIDEWALK, SLEEVING AND BACKFILL BEYOND LIMITS SHOWN ON A S-6 AND B S-9 SHALL BE BY OTHERS. SEE DWG. C-3.
2. BEDDING AND UNDERDRAIN NOT SHOWN FOR CLARITY.
3. BASE BID FENCE OR ALTERNATE A RAILING SHOWN. SEE DWG. S-12 FOR ALTERNATE B WINGWALL TREATMENT.



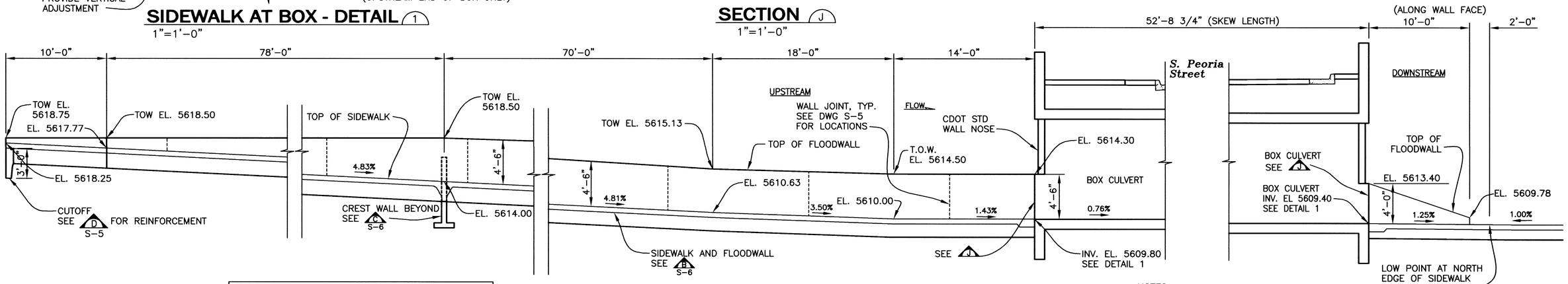
SIDEWALK AT BOX - DETAIL 1

1"=1'-0"



SECTION J

1"=1'-0"



NOTES:

1. PEORIA STREET CONSTRUCTION, INCLUDING STREET, CURB AND GUTTER, PATTERNED CONCRETE, SIDEWALK, SLEEVING AND BACKFILL BEYOND LIMITS SHOWN ON A S-6 AND B S-9 SHALL BE BY OTHERS. SEE DWG. C-3.
2. BEDDING AND UNDERDRAIN NOT SHOWN FOR CLARITY.
3. CHANGES IN SIDEWALK GRADE SHALL BE SMOOTH AND SHALL TAKE PLACE OVER A MINIMUM LENGTH OF 6'-0".

FLOODWALLS - ELEVATIONS

SCALE: 1"=5'

F S-5

RECORD DRAWING
7/22/03

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DATE: AUG 26, 2003 TIME: 10:45 AM

NAME: S:\0032.01\dwgs\record dwg\0032-CULV2-REC.dwg

REVISIONS				
NO	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WHR/GRR	JTW	AS CONSTRUCTED RECORD DRAWINGS

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LAKEWOOD, COLORADO 80226
(303) 988-4939

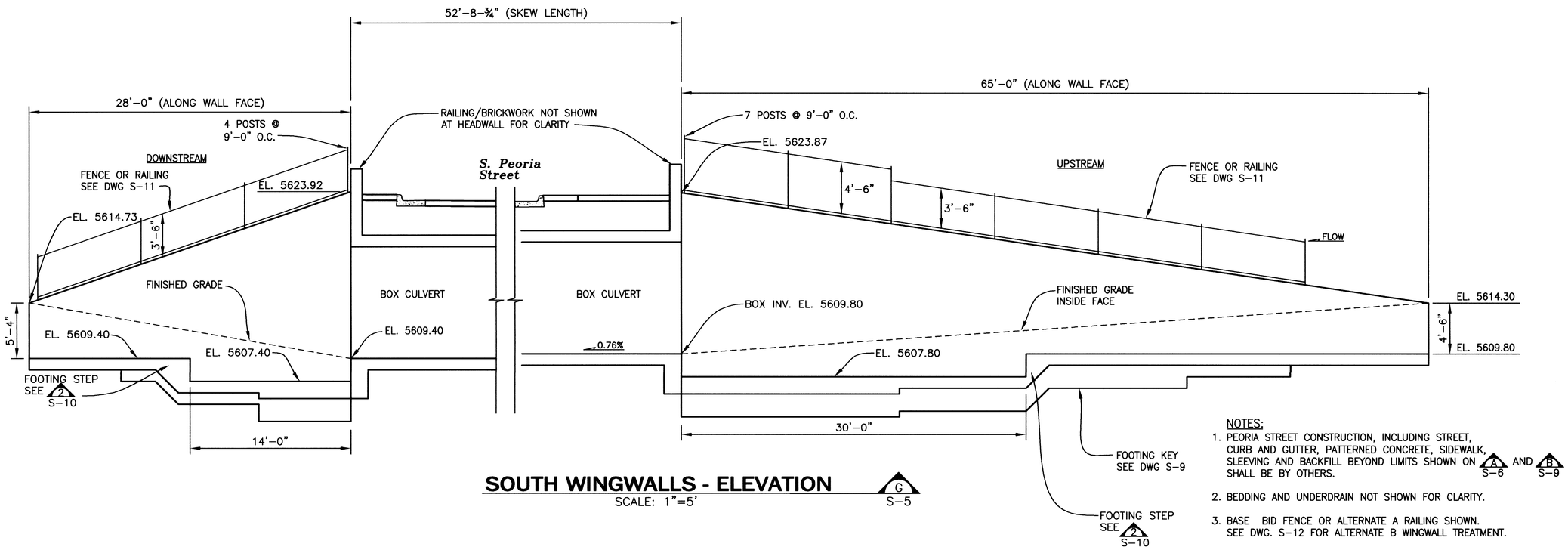
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT — CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE — ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS

DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHKD: LJE 4/11/01

NORTH WINGWALL AND FLOODWALL ELEVATIONS

SHEET 21
DWG S-7

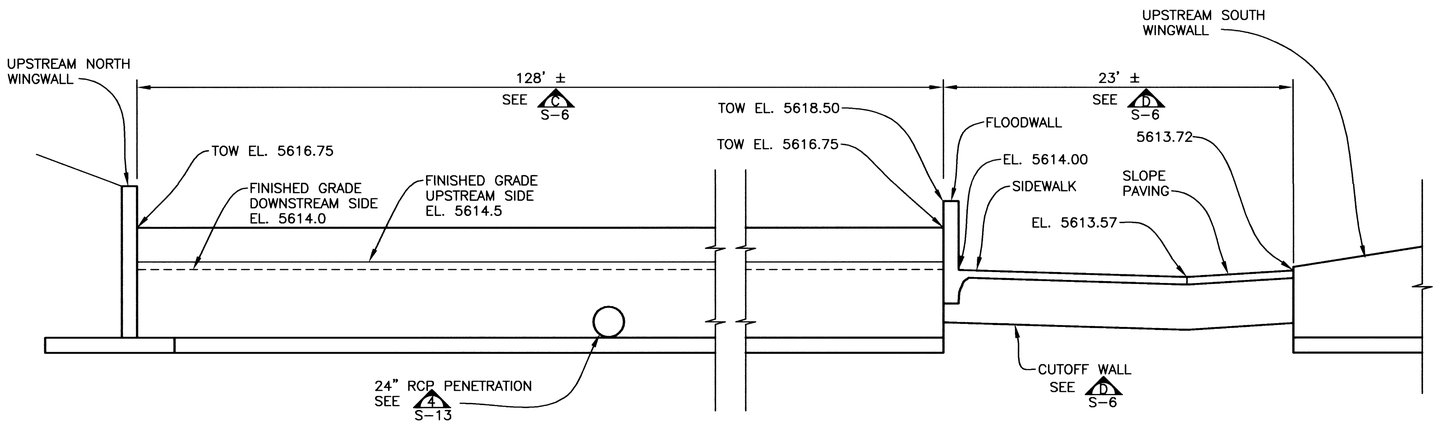


SOUTH WINGWALLS - ELEVATION (G S-5)

SCALE: 1"=5'

NOTES:

1. PEORIA STREET CONSTRUCTION, INCLUDING STREET, CURB AND GUTTER, PATTERNED CONCRETE, SIDEWALK, SLEEVING AND BACKFILL BEYOND LIMITS SHOWN ON 1 S-6 AND B S-9 SHALL BE BY OTHERS.
2. BEDDING AND UNDERDRAIN NOT SHOWN FOR CLARITY.
3. BASE BID FENCE OR ALTERNATE A RAILING SHOWN. SEE DWG. S-12 FOR ALTERNATE B WINGWALL TREATMENT.



CREST WALL - ELEVATION (H S-5)

SCALE: 1"=5'

RECORD DRAWING
7/22/03

THIS RECORD DRAWING HAS BEEN PREPARED, IN PART, BASED UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, MULLER ENGINEERING COMPANY, INC. CANNOT ASSURE IT'S ACCURACY, AND THUS IS NOT RESPONSIBLE FOR THE ACCURACY OF THIS RECORD DRAWING OR FOR ANY ERRORS OR OMISSIONS WHICH MAY HAVE BEEN INCORPORATED INTO IT AS A RESULT. THOSE RELYING ON THIS RECORD DRAWING ARE ADVISED TO OBTAIN INDEPENDENT VERIFICATION OF IT'S ACCURACY BEFORE APPLYING IT FOR ANY PURPOSE.

REVISIONS				
NO.	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WHR/CNR	JTW	AS CONSTRUCTED RECORD DRAWINGS

MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT — CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE — ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

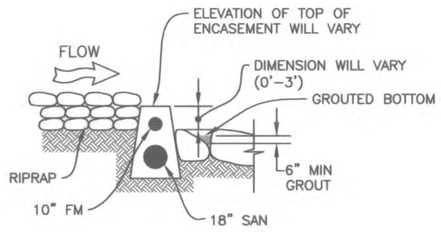
COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS

DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHK'D: LJE 4/11/01

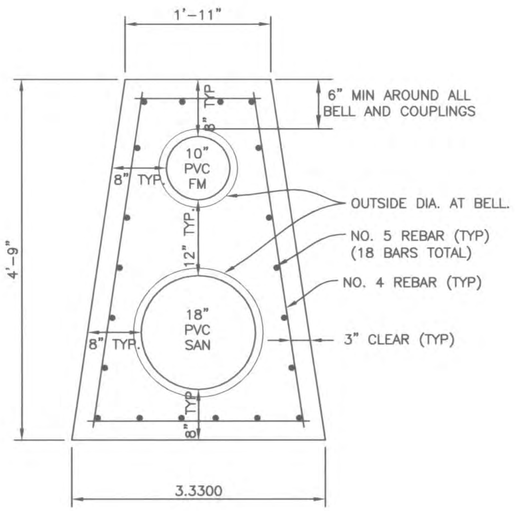
SOUTH WINGWALL AND CREST WALL ELEVATIONS

SHEET 22
DWG S-8

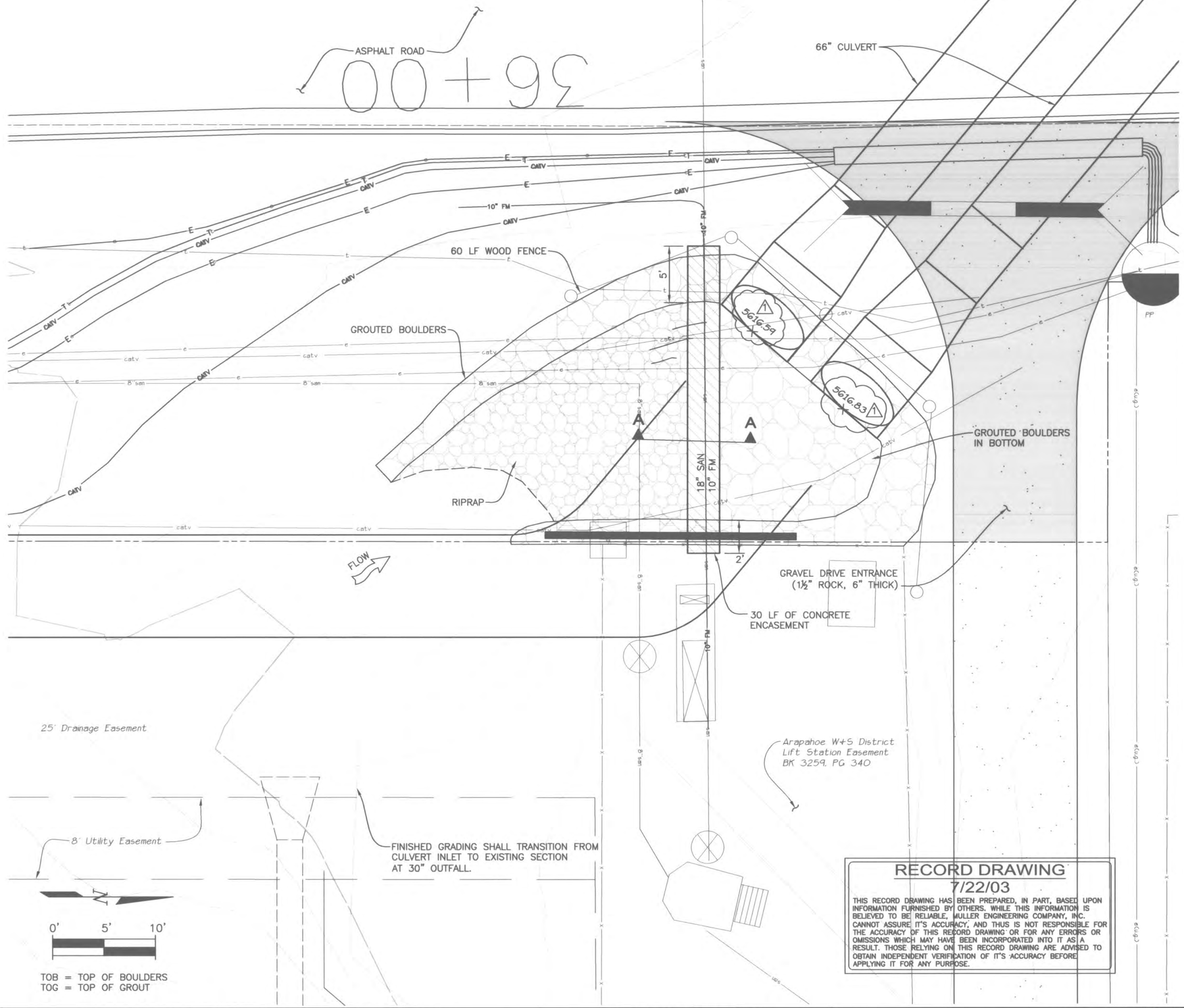
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SECTION A-A
SCALE: 1"=5'



ENCASEMENT DETAIL
SCALE: 1"=1'



RECORD DRAWING
7/22/03

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REVISIONS				
NO	DATE	BY	CHK'D	DESCRIPTION
1	7/22/03	WHR/CRR	JTW	AS CONSTRUCTED RECORD DRAWINGS

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MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
LANDMARK METROPOLITAN DISTRICT
CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CITY OF GREENWOOD VILLAGE
ARAPAHOE COUNTY
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY

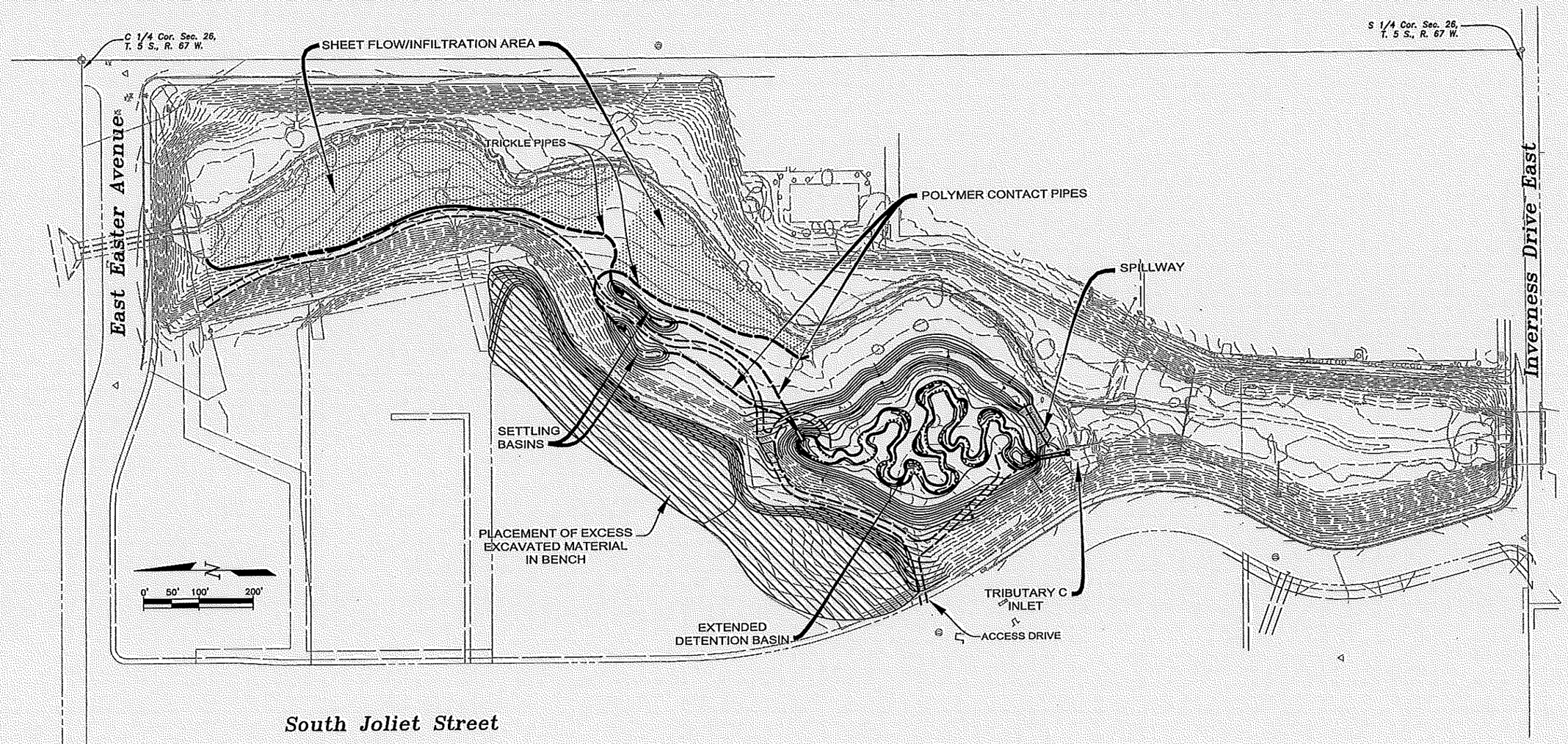
COTTONWOOD CREEK - PEORIA STREET IMPROVEMENTS

DRAWN: BKB 11/29/00 | DESIGNED: JTW 11/29/00 | CHKD: DDJ 1/5/01

PEORIA TRIBUTARY CULVERT INLET AND ENCASEMENT PLAN AND DETAIL

SHEET 11B
DWG C-8B

X-ROAD-CNT, X0032-EX1, X0032-PR2, X0032-PRS, X0032-RD, X0032BDR, XMOD-CNT
NAME: S:\0032.01\dwgs\record dwg\0032-02-ENCASE.dwg
DATE: AUG 07, 2003 TIME: 10:32 AM



INVERNESS POLLUTANT REDUCTION FACILITY
OVERALL SITE PLAN
SCALE: 1" = 100'

No.	DATE	REVISIONS	APPR.

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

MEC PROJECT No. 0037.02

DESIGN	CRR
DRAWN	CLJ
CHECK	JTW

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0037.02

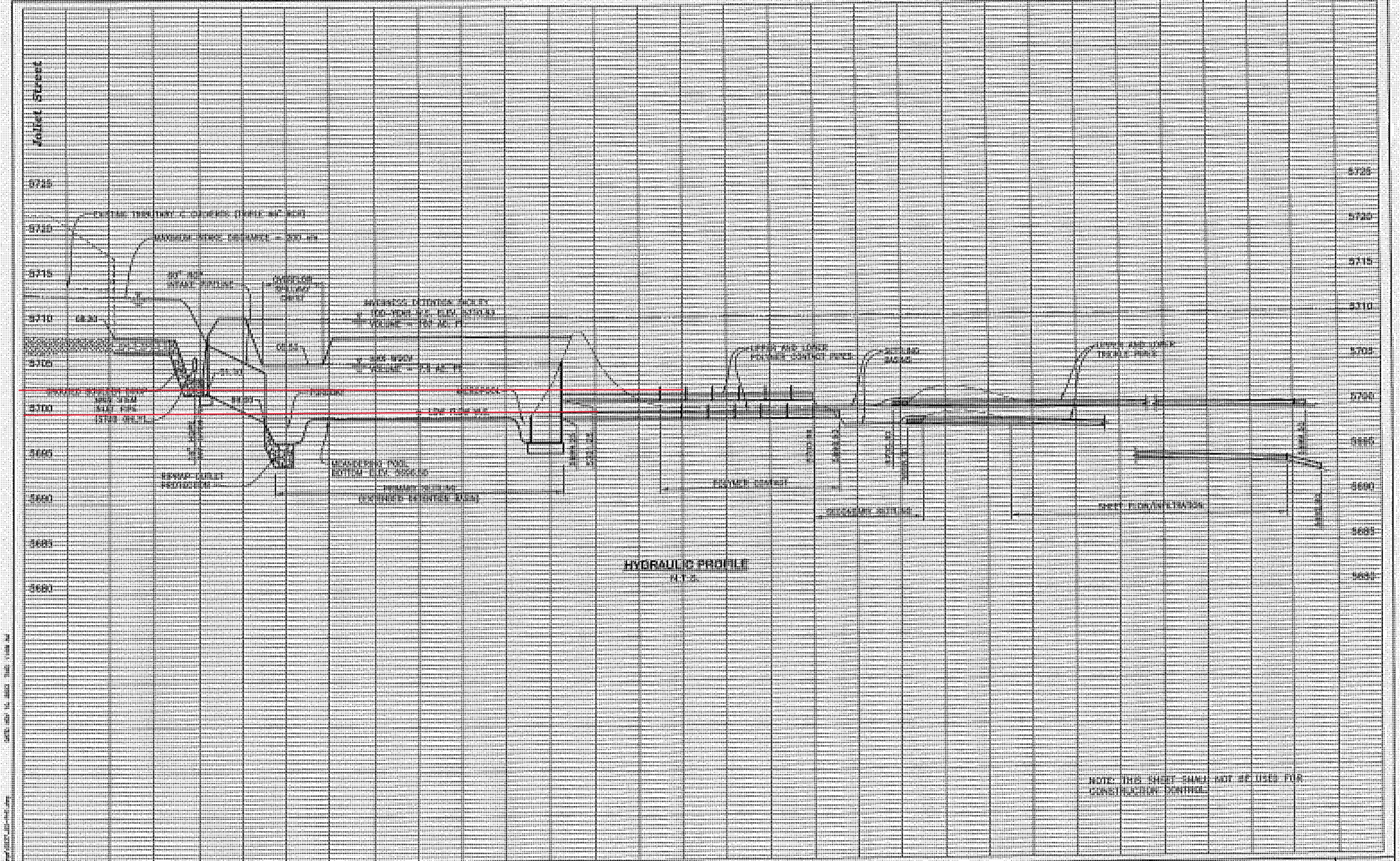
INVERNESS WATER QUALITY IMPROVEMENTS

OVERALL SITE PLAN

DRAWING G-3
SHEET 3 of 20

NAME: P:\0037.02\CAD-Dwgs\0037_02-SITE.dwg DATE: NOV 10, 2003 TIME: 11:03 AM

Alfred Street



HYDRAULIC PROFILE
PLT 2

NOTE: THIS SHEET SHALL NOT BE USED FOR CONSTRUCTION PURPOSES

No.	DATE	REVISIONS	APPD.

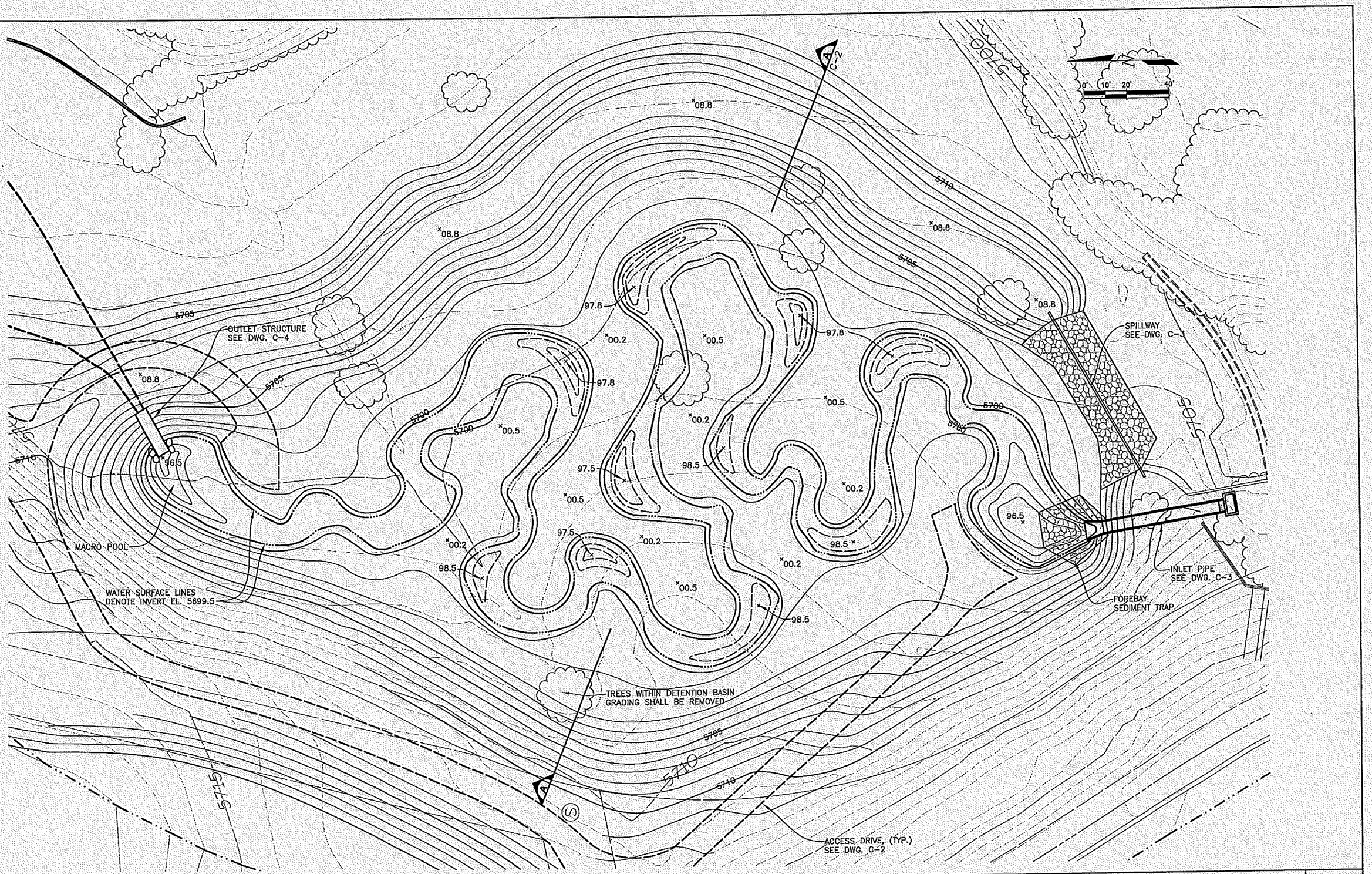
MILLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
MEC PROJECT No. 0607.02

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0607.02

INVERNESS WATER QUALITY IMPROVEMENTS

HYDRAULIC PROFILE

DRAWING
Plt 2
SHEET
4 of 20



NAME: P:\0037.02\CAD-Dwgs\0037_02-PLN2.dwg DATE: NOV 10, 2003 TIME: 11:17 AM

No.	DATE	REVISIONS	APPR.

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

MEC PROJECT No. 0037.02

DESIGN	CRR
DRAWN	BKB
CHECK	JTW

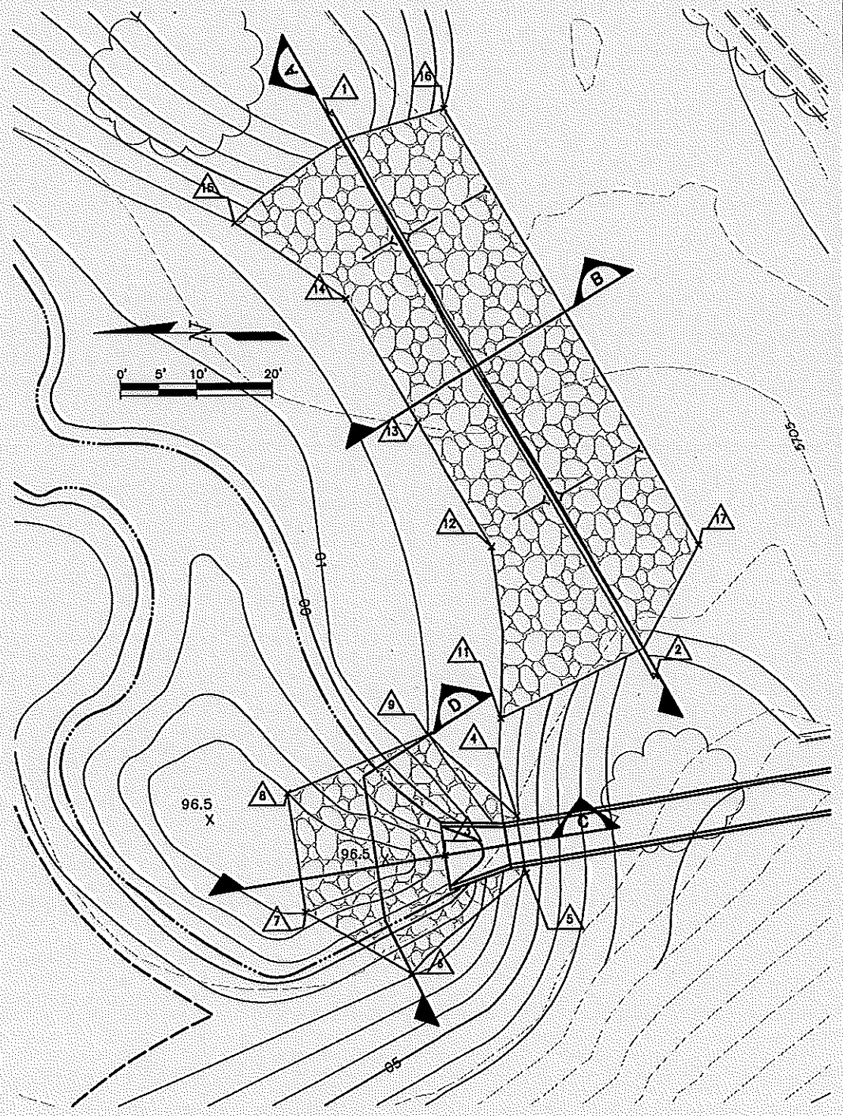
INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0037.02

INVERNESS WATER QUALITY IMPROVEMENTS

EXTENDED DETENTION BASIN GRADING PLAN

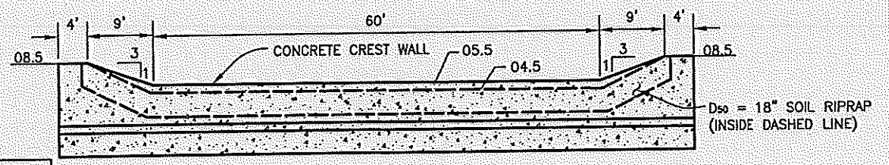
DRAWING C-1

SHEET 5 of 20

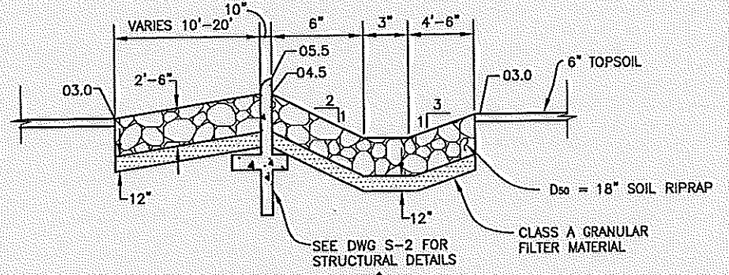


EXTENDED DETENTION BASIN SPILLWAY AND INLET
SCALE: 1" = 10'

CONTROL POINTS	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	20940.89	48078.21	5708.5	END OF CONCRETE
2	20897.33	48004.06	5708.5	END OF CONCRETE
3	20925.22	47980.57	5699.0	INVERT
4	20915.87	47985.70	5704.0	EDGE OF RIPRAP
5	20914.66	47978.12	5704.0	EDGE OF RIPRAP
6	20929.92	47964.95	5702.0	EDGE OF RIPRAP
7	20944.27	47973.09	5697.0	EDGE OF RIPRAP
8	20946.70	47988.84	5697.0	EDGE OF RIPRAP
9	20927.69	47996.46	5702.0	EDGE OF RIPRAP
11	20917.96	47998.55	5703.0	EDGE OF RIPRAP
12	20919.17	48021.15	5703.0	EDGE OF RIPRAP
13	20928.97	48037.46	5703.0	EDGE OF RIPRAP
14	20938.76	48053.77	5703.0	EDGE OF RIPRAP
15	20953.62	48063.83	5703.0	EDGE OF RIPRAP
16	20925.14	48078.73	5704.0	EDGE OF RIPRAP
17	20891.34	48021.19	5705.7	EDGE OF RIPRAP

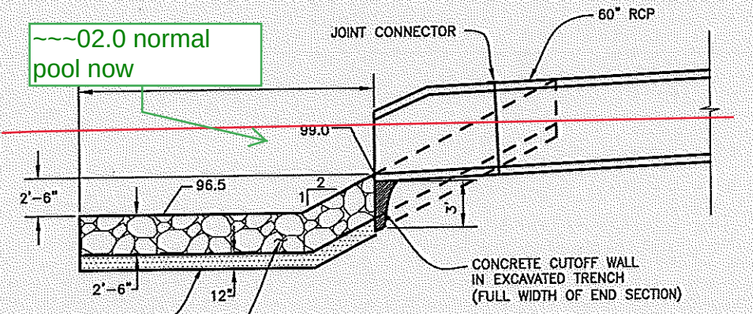


SECTION A
SCALE: 1" = 10'

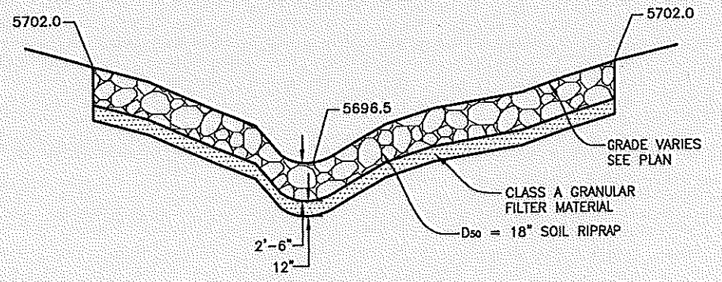


SECTION B
SCALE: 1" = 5'

~~~02.0 normal pool now



SECTION C
SCALE: 1" = 5'



SECTION D
SCALE: 1" = 5'

NAME: P:\0037.02\CAD-Dwgs\0037_02-SPILL-1.dwg DATE: NOV 10, 2003 TIME: 11:19 AM

No.	DATE	REVISIONS	APPR.

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

MEC PROJECT No. 0037.02

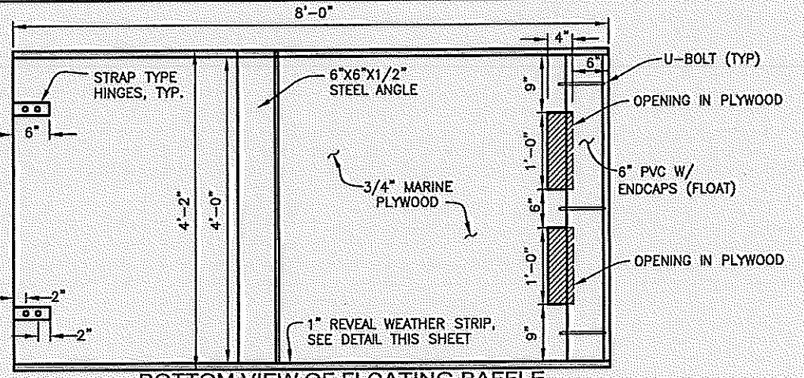
DESIGN	CRR
DRAWN	MAM
CHECK	JTW

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0037.02

INVERNESS WATER QUALITY IMPROVEMENTS

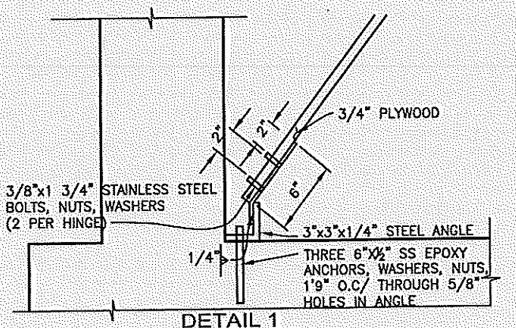
INLET AND SPILLWAY PLAN AND SECTIONS

DRAWING C-3
SHEET 7 of 20
~~~



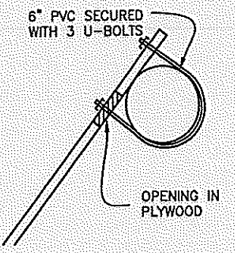
BOTTOM VIEW OF FLOATING BAFFLE

SCALE: 1" = 1'



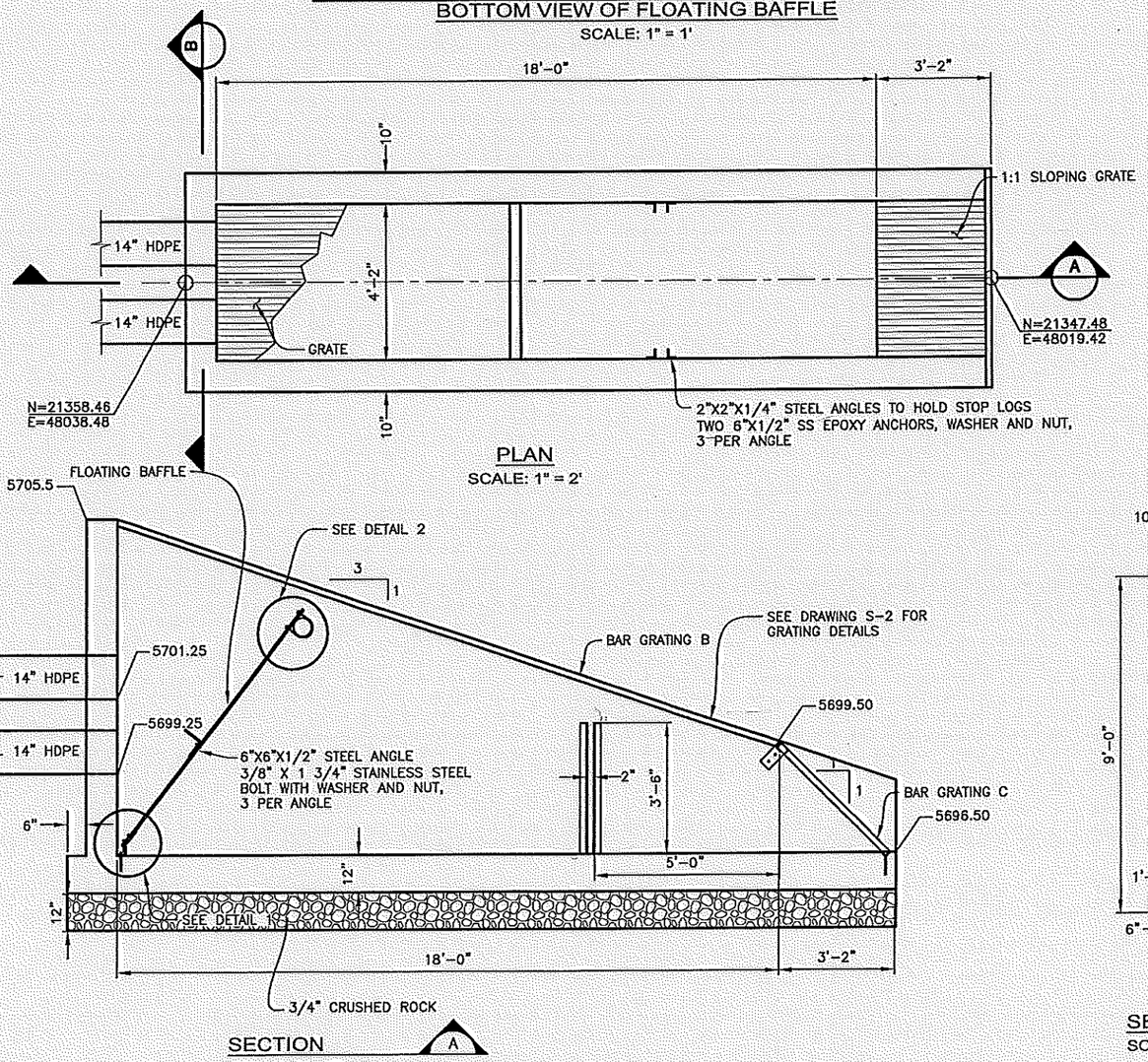
DETAIL 1

SCALE: 1" = 6"



DETAIL 2

SCALE: 1" = 6"

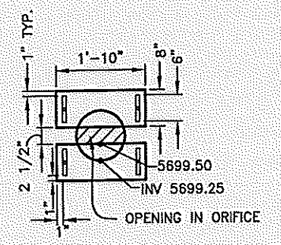


PLAN

SCALE: 1" = 2'

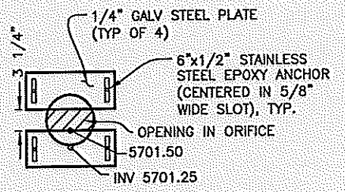
SECTION

SCALE: 1" = 2'



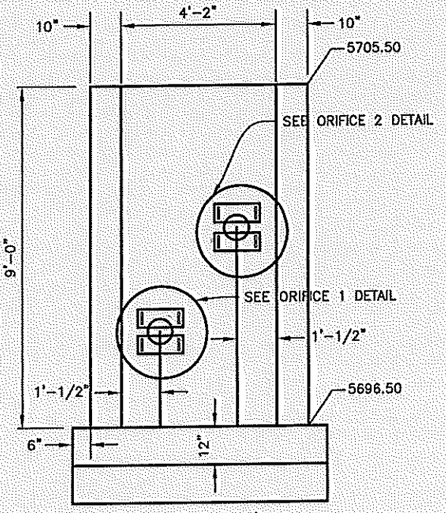
ORIFICE 1 DETAIL

SCALE: 1" = 1'



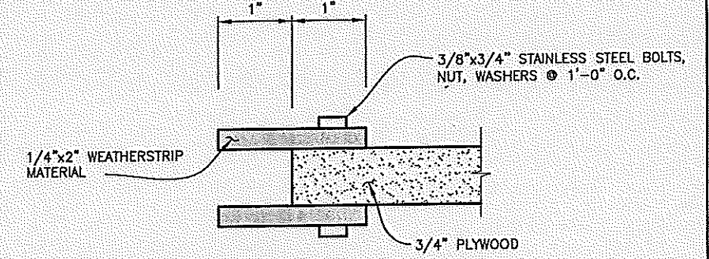
ORIFICE 2 DETAIL

SCALE: 1" = 1'



SECTION

SCALE: 1" = 2'



WEATHER STRIPPING ATTACHMENT

SCALE: 1" = 1"

No.	DATE	REVISIONS	APPR.

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CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

MEC PROJECT No. 0037.02

DESIGN	CRR
DRAWN	BKB
CHECK	JTW

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112

PROJECT NO. 0037.02

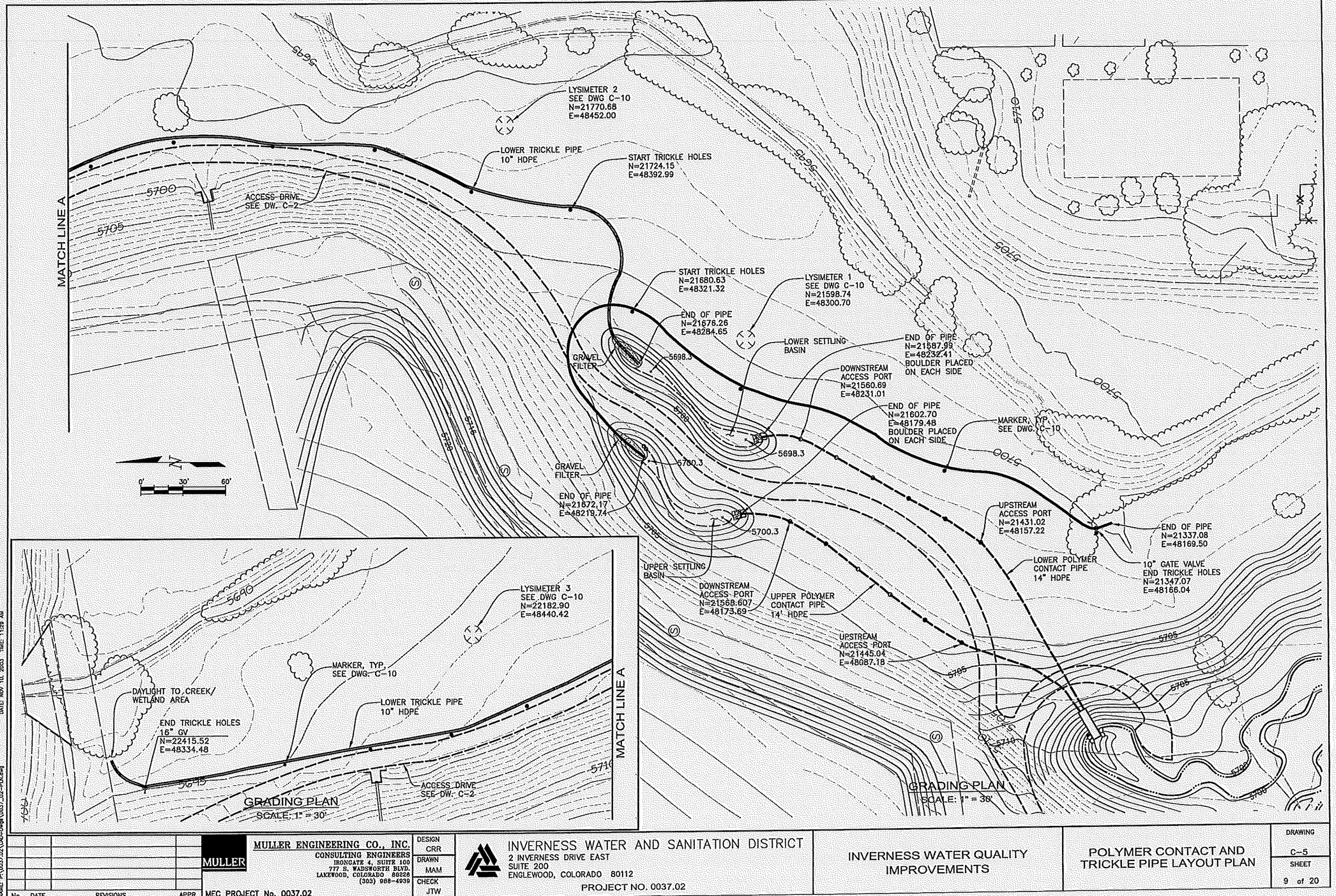
INVERNESS WATER QUALITY IMPROVEMENTS

OUTLET DETAILS DETENTION BASIN

DRAWING C-4

SHEET 8 of 20

NAME: P:\0037.02\CAD-Dwgs\0037_02-DET1.dwg DATE: NOV 10, 2003 TIME: 11:22 AM



NAME: P:\0037.02\CAD-Dwgs\0037_02-PLN.dwg DATE: NOV 10, 2003 TIME: 11:29 AM

No.	DATE	REVISIONS	APPR.

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777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

MEC PROJECT No. 0037.02

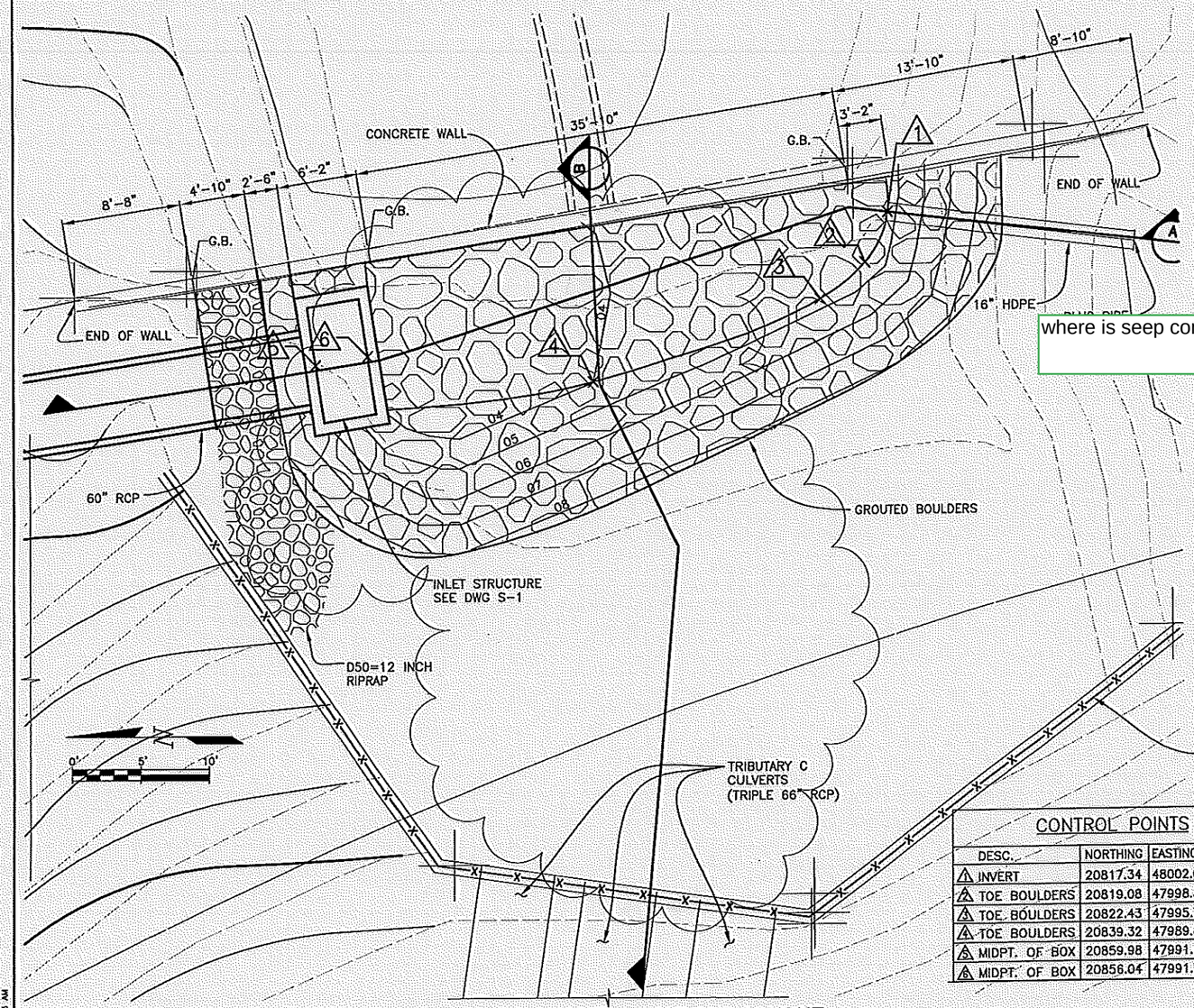
DESIGN	CRR
DRAWN	MAM
CHECK	JTW

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0037.02

INVERNESS WATER QUALITY IMPROVEMENTS

POLYMER CONTACT AND TRICKLE PIPE LAYOUT PLAN

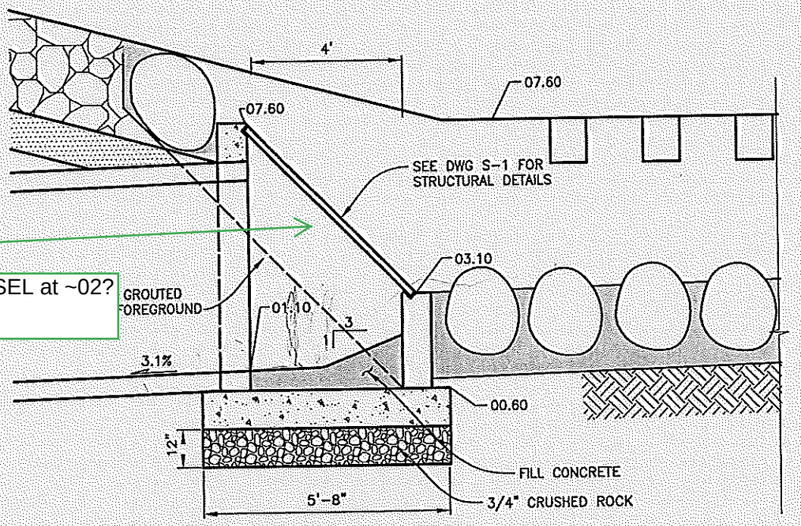
DRAWING	C-5
SHEET	9 of 20



TRIBUTARY C GROUTED BOULDER LAYOUT

SCALE: 1" = 5'

where is seep coming from if WSEL at ~02?



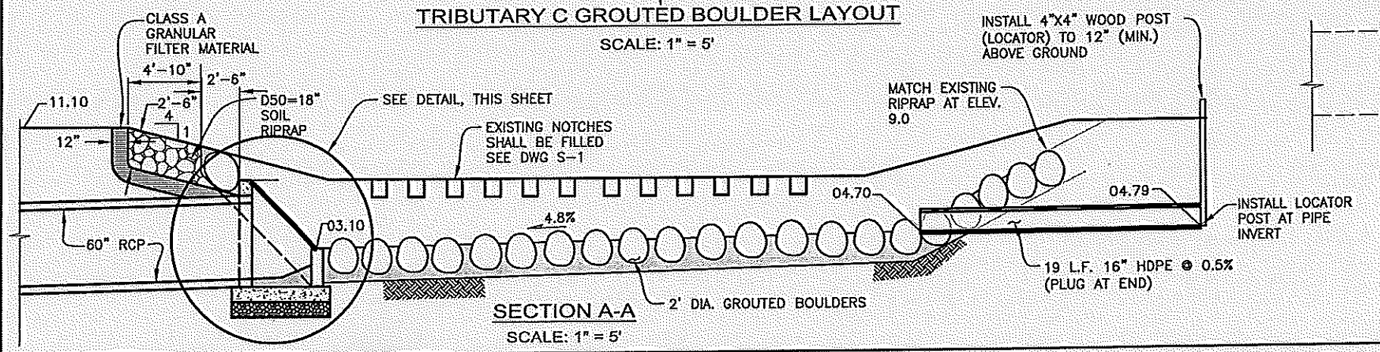
INLET STRUCTURE DETAIL

SCALE: 1" = 2'

CHAIN LINK FENCE (42" HIGH) FENCE POSTS SHALL HAVE MOUNTING PLATES WELDED TO THE BASE END AND ATTACHED TO WALL USING FOUR 1/2-INCH BY 6-INCH STAINLESS STEEL ANCHOR BOLTS. FENCE POSTS SHALL BE HOT DIP GAVLANIZED AFTER MOUNTING PLATES ARE WELDED ON. SHOP DRAWINGS DETAILING MOUNTING PLATES AND ATTACHMENT SHALL BE SUBMITTED TO ENGINEER FOR REVIEW AND APPROVAL PRIOR TO FABRICATION.

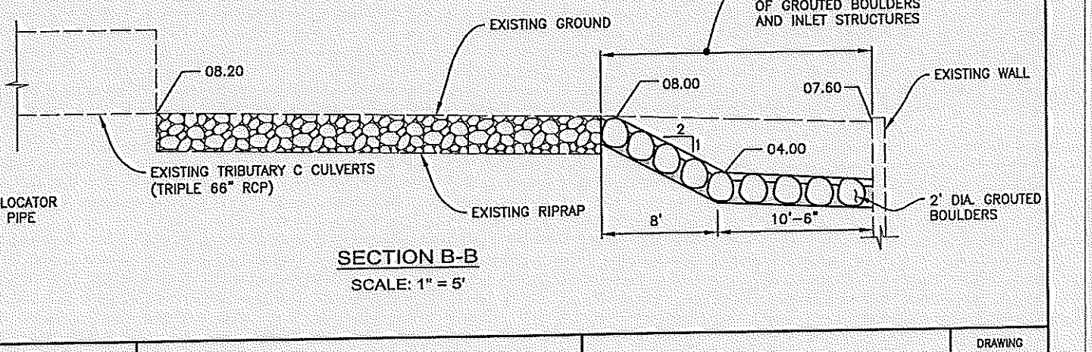
CONTROL POINTS

DESC.	NORTHING	EASTING	ELEV.
1 INVERT	20817.34	48002.00	5704.70
2 TOE BOULDERS	20819.08	47998.35	5704.58
3 TOE BOULDERS	20822.43	47995.73	5704.45
4 TOE BOULDERS	20839.32	47989.81	5704.00
5 MIDPT. OF BOX	20859.98	47991.10	5707.60
6 MIDPT. OF BOX	20856.04	47991.73	5703.10



SECTION A-A

SCALE: 1" = 5'



SECTION B-B

SCALE: 1" = 5'

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

MULLER

No.	DATE	REVISIONS	APPR.

MEC PROJECT No. 0037.02

DESIGN	CRR
DRAWN	CLJ
CHECK	JTW

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112

PROJECT NO. 0037.02

INVERNESS WATER QUALITY IMPROVEMENTS

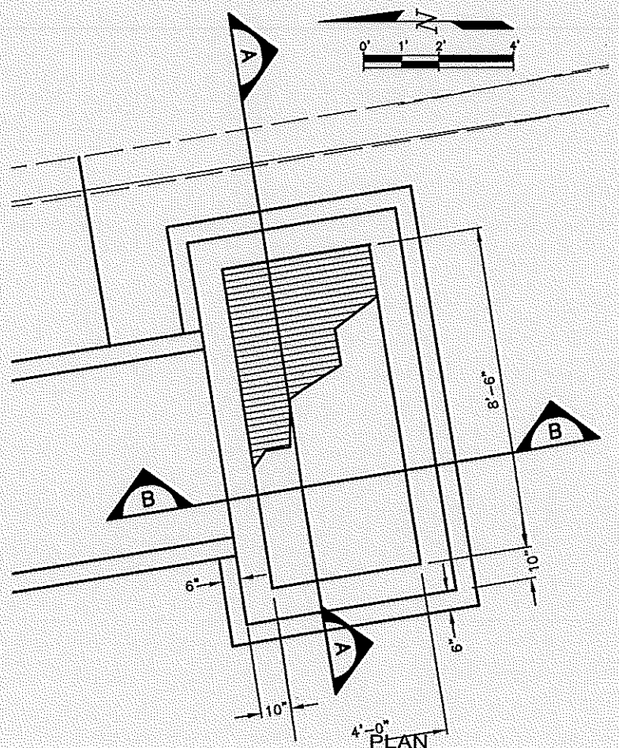
TRIBUTARY C INLET DETAILS

DRAWING C-9

SHEET 13 of 20

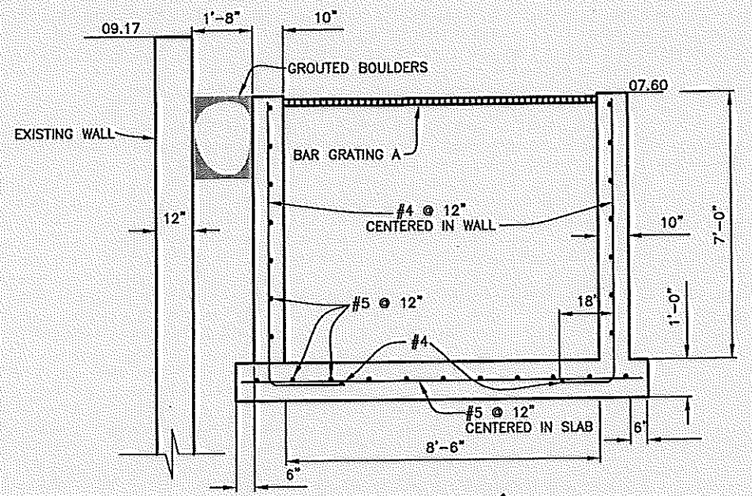
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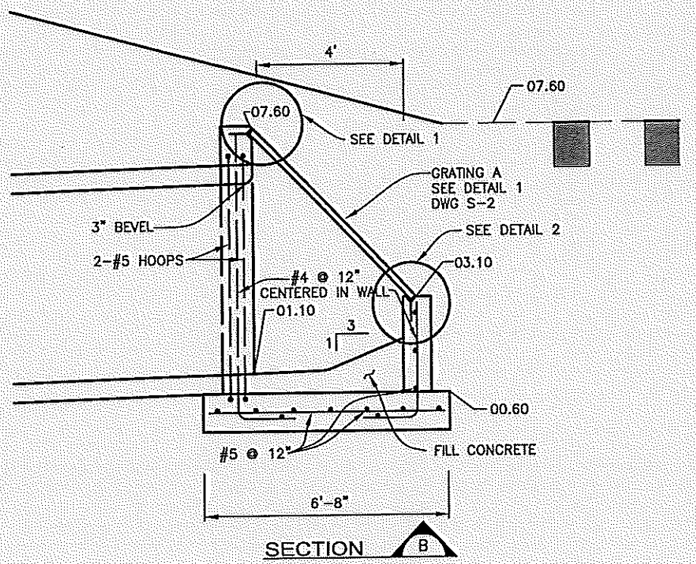
PLAN

SCALE: 1/2" = 1'-0 "



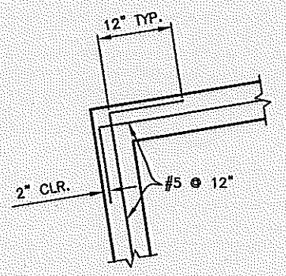
SECTION A

SCALE: 1/2" = 1'-0"



SECTION B

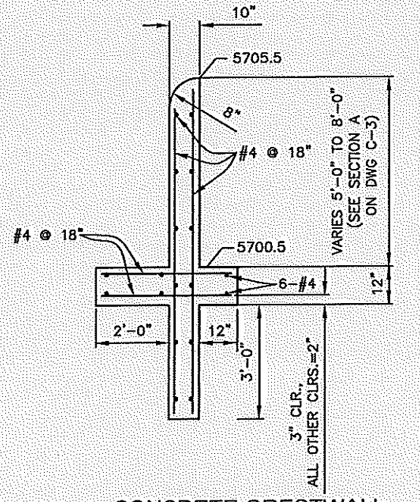
SCALE: 1/2" = 1'-0"



CORNER REINFORCEMENT DETAIL 3

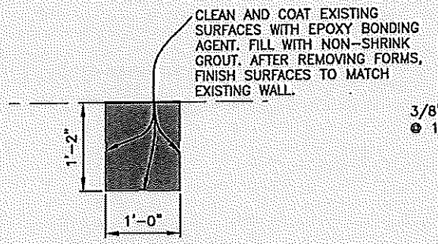
VERTICAL REINFORCEMENT NOT SHOWN

SCALE: 1" = 1'-0 "



CONCRETE CRESTWALL
DETENTION POND SPILLWAY

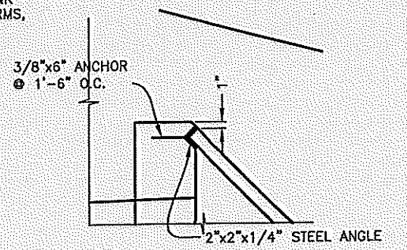
SCALE: 1/2" = 1'-0"



NOTE: ALL NOTCHES ARE TO BE FILLED (12 TOTAL)

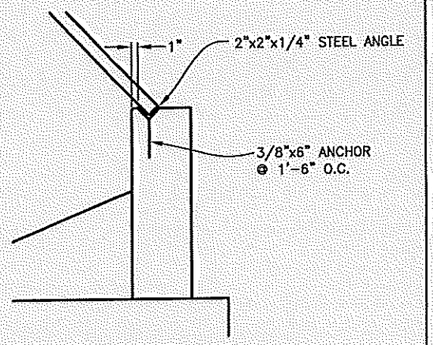
NOTCH FILL DETAIL

SCALE: 1" = 1'-0"



GRATE CONNECTION DETAIL 1

SCALE: 1" = 1'-0"



GRATE CONNECTION DETAIL 2

SCALE: 1" = 1'-0"

NAME: P:\0037.01\DWG\0037-DET4.dwg DATE: OCT 27, 2003 TIME: 10:34 AM

No.	DATE	REVISIONS	APPR.

MULLER

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

MEC PROJECT No. 0037.02

DESIGN	CRR
DRAWN	CLJ
CHECK	JTW

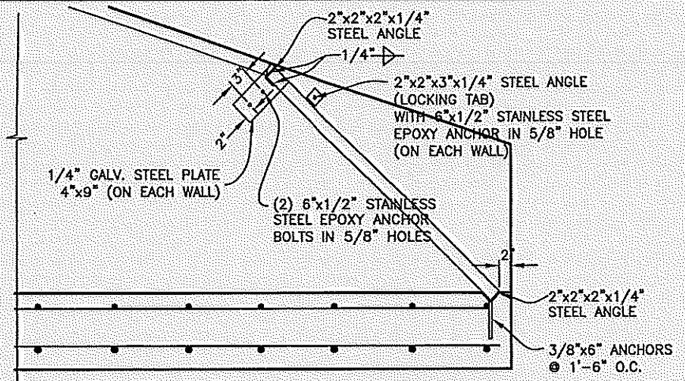
INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0037.02

INVERNESS WATER QUALITY IMPROVEMENTS

TRIBUTARY C INLET
STRUCTURAL DETAILS

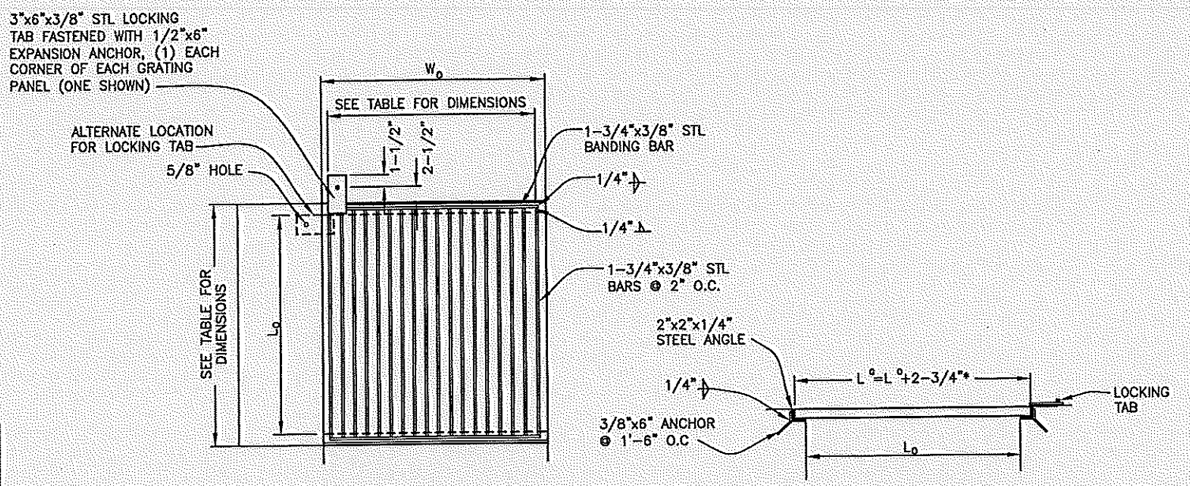
DRAWING S-1

SHEET 15 of 20



BAR GRATING C

SCALE: 1" = 1'-0"



*SEE TABLE FOR GRATE DIMENSIONS.

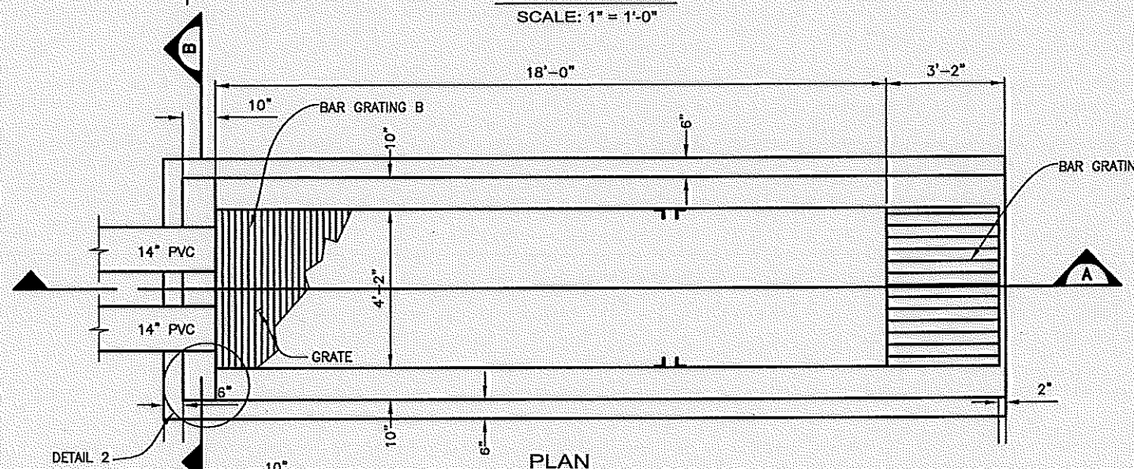
NOTES:

1. GRATING DIMENSIONS ARE SHOWN IN THE TABLE.
   L_o/ W_o = LENGTH/WIDTH OF OPENING.
   L_g/ W_g = LENGTH/WIDTH OF GRATE.
2. EMBEDDED GRATING SUPPORTS INCLUDING ANCHORS, BAR GRATING, ANGLES, AND LOCKING TABS SHALL BE HOT DIP GALVANIZED.
3. GRATINGS A AND B REQUIRE NO LOCKING TABS ON BOTTOM CORNERS.
4. LOCKING TABS FOR GRATING C SHALL BE 2"x2"x1/4" STEEL ANGLES 3" LONG DRILLED AND FASTENED INTO SIDE SLABS.

BAR GRATING	EA. PANEL		NO. OF PANELS
	L_o	W_o	
A	6'-2"	4'-2"	2
B	4'-4 3/4"	3'-8"	5
C	4'-1"	4'-2"	1

BAR GRATING DETAIL 1

SCALE: 1" = 1'-0"

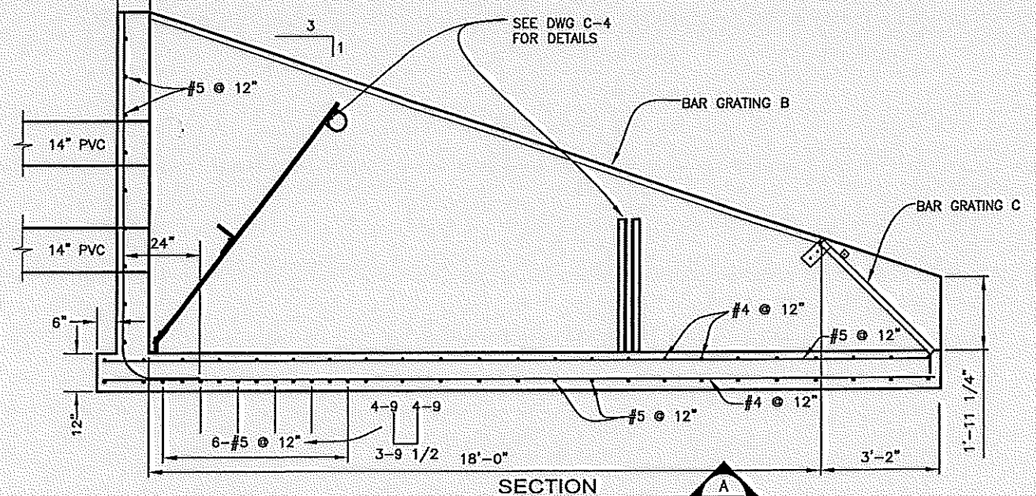


PLAN

SCALE: 1/2" = 1-0"

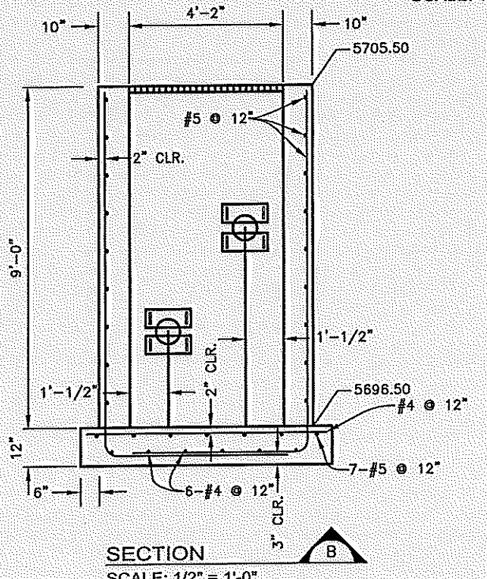
DETAIL 2

SCALE: 1" = 20'



SECTION A

SCALE: 1/2" = 1'-0"



SECTION B

SCALE: 1/2" = 1'-0"

NAME: P:\0037.01\DWG\0037-DETZ.dwg DATE: NOV 10, 2003 TIME: 11:57 AM

No.	DATE	REVISIONS	APPR.

MEC PROJECT No. 0037.02

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

DESIGN	CRR
DRAWN	CLJ
CHECK	JTW

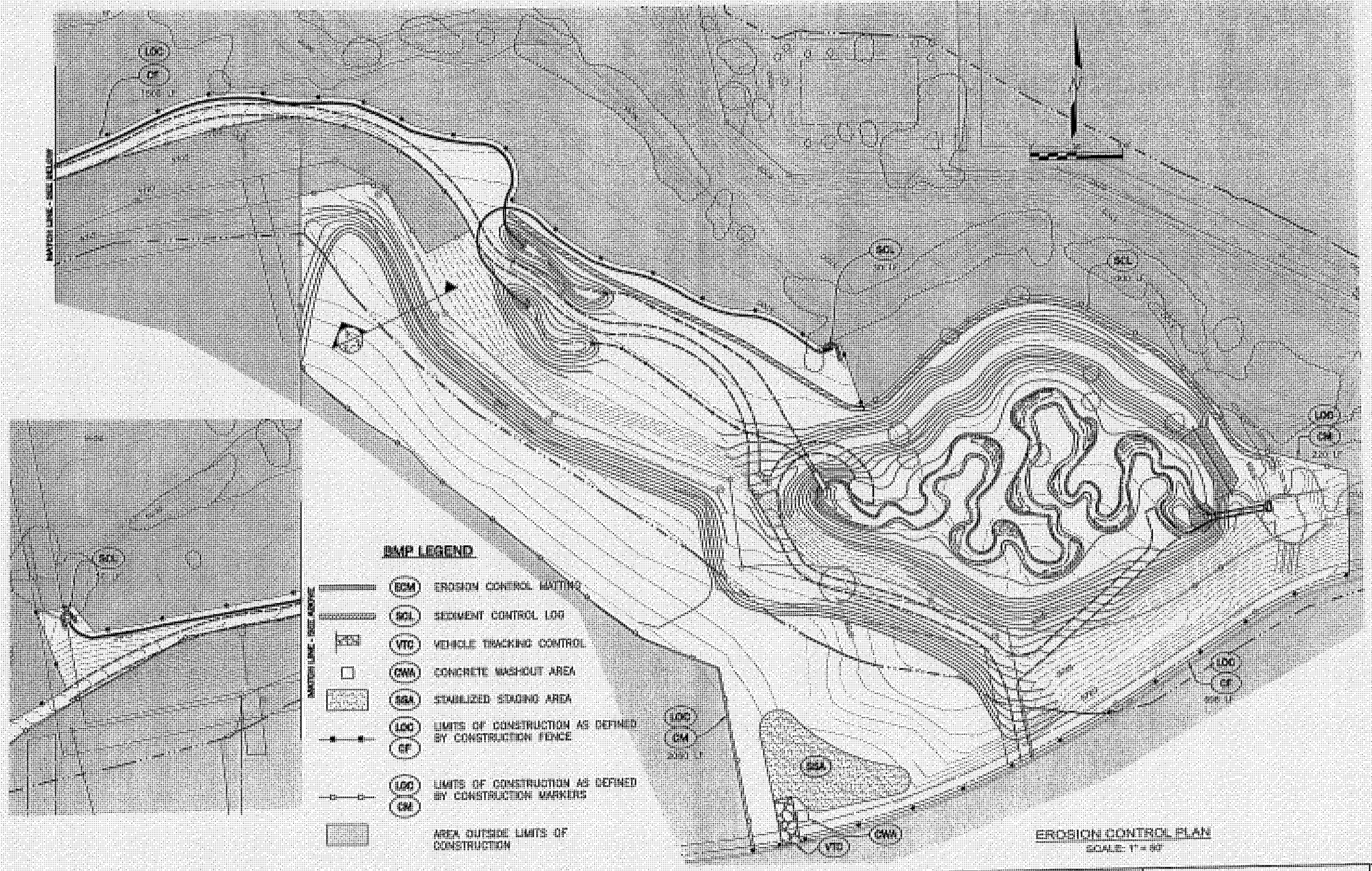
INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0037.02

INVERNESS WATER QUALITY IMPROVEMENTS

DETENTION BASIN OUTLET STRUCTURAL DETAILS

DRAWING S-2

SHEET 16 of 20



BMP LEGEND

EROSION CONTROL PLAN
SCALE: 1" = 40'

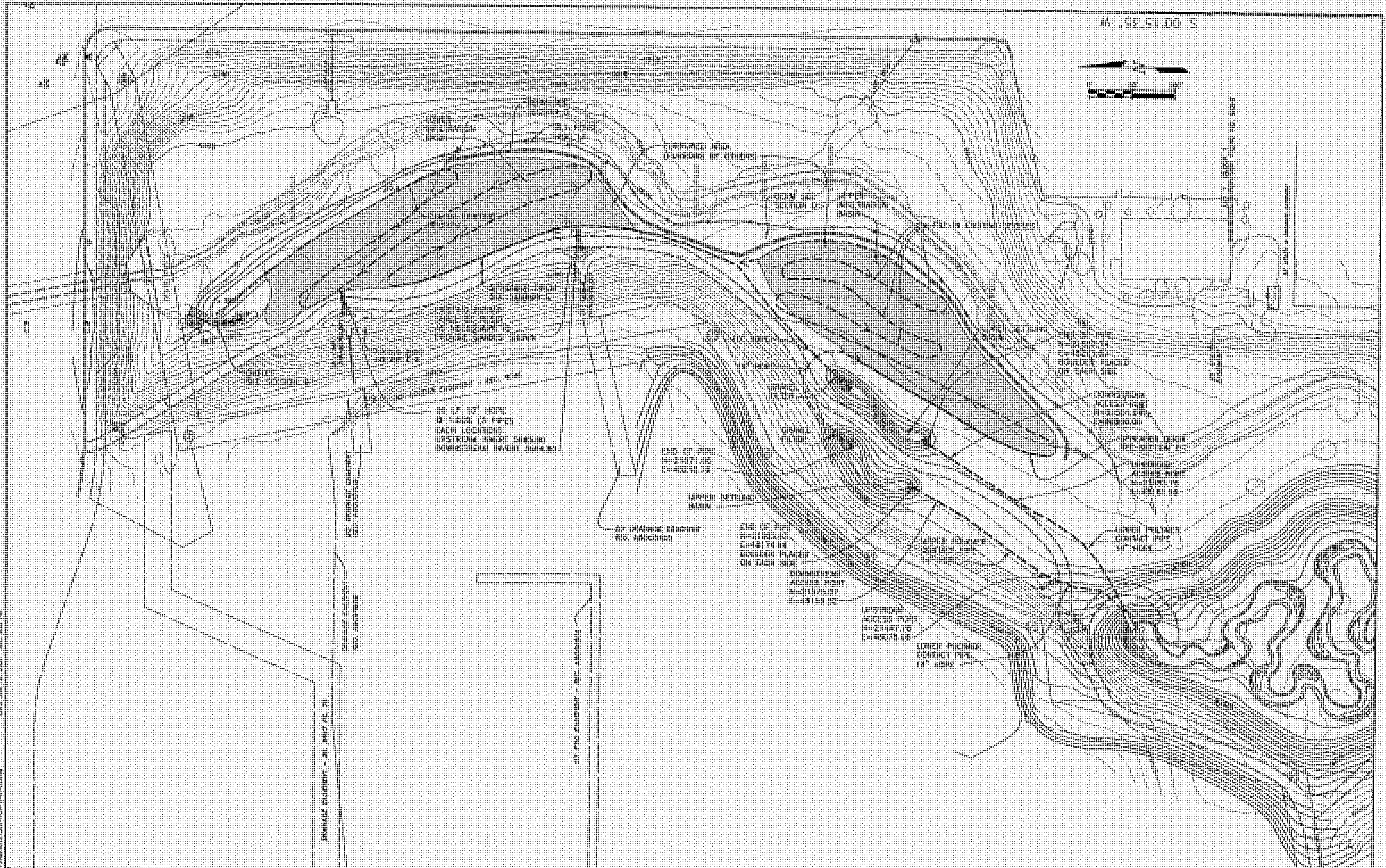
MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
LAND PLANNING & SURVEYING
MEC PROJECT No. 9407.02

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 205
ENGLEWOOD, COLORADO 80112
PROJECT NO. 9407.02

INVERNESS WATER QUALITY IMPROVEMENTS

EROSION CONTROL PLAN AND BENCH GRADING

17 of 39



MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS

MEC PROJECT No. 0037.02

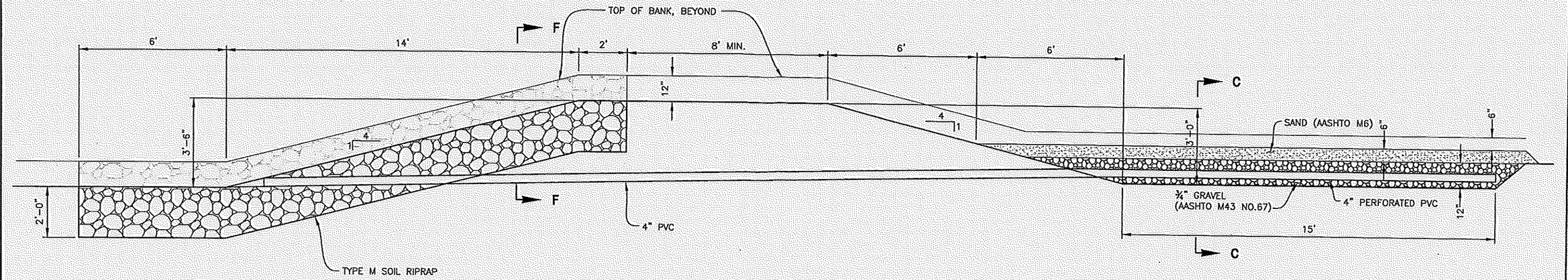
DESIGN CRR
DRAWN MMM
CHECK JTW

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0037.02

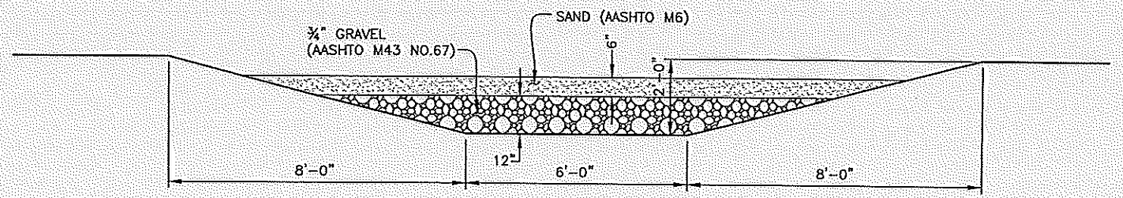
INVERNESS WATER QUALITY IMPROVEMENTS

POLYMER CONTACT PIPE AND INFILTRATION BASINS ALTERNATIVE 2

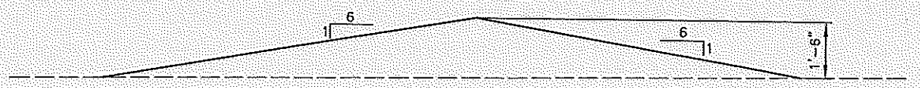
DRAWING C-5
SHEET



SECTION B - INFILTRATION BASIN OUTLET
SCALE: 1" = 2'



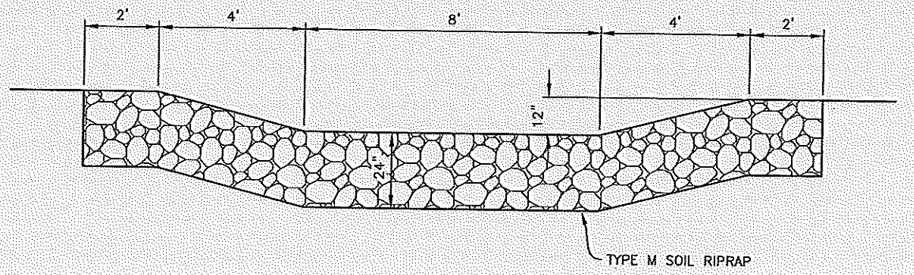
SECTION C
SCALE: 1" = 2'





SECTION E - SPREADER DITCH
SCALE: 1" = 2'

SECTION D - BERM
SCALE: 1" = 2'



SECTION F
SCALE: 1" = 2'

NAME: P:\0037.02\CAD-Dwgs\0037-02-DET-ALT2.dwg DATE: JUN 16, 2005 TIME: 8:35 AM

No.	DATE	REVISIONS	APPR.

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
IRONGATE 4, SUITE 100
777 S. WADSWORTH BLVD.
LAKEWOOD, COLORADO 80226
(303) 988-4939

MEC PROJECT No. 0037.02

DESIGN	CRR
DRAWN	MAM
CHECK	JTW

INVERNESS WATER AND SANITATION DISTRICT
2 INVERNESS DRIVE EAST
SUITE 200
ENGLEWOOD, COLORADO 80112
PROJECT NO. 0037.02

INVERNESS WATER QUALITY IMPROVEMENTS

TYPICAL SECTIONS ALTERNATIVE 2

DRAWING	C-5
SHEET	9C of 20

PROJECT CONTACTS

OWNER
SOUTHEAST METRO STORMWATER AUTHORITY
76 INVERNESS DRIVE EAST, SUITE A
ENGLEWOOD, CO 80112
303.858.8844
CONTACT: SCOTT PALMER (spalmer@semswa.org)

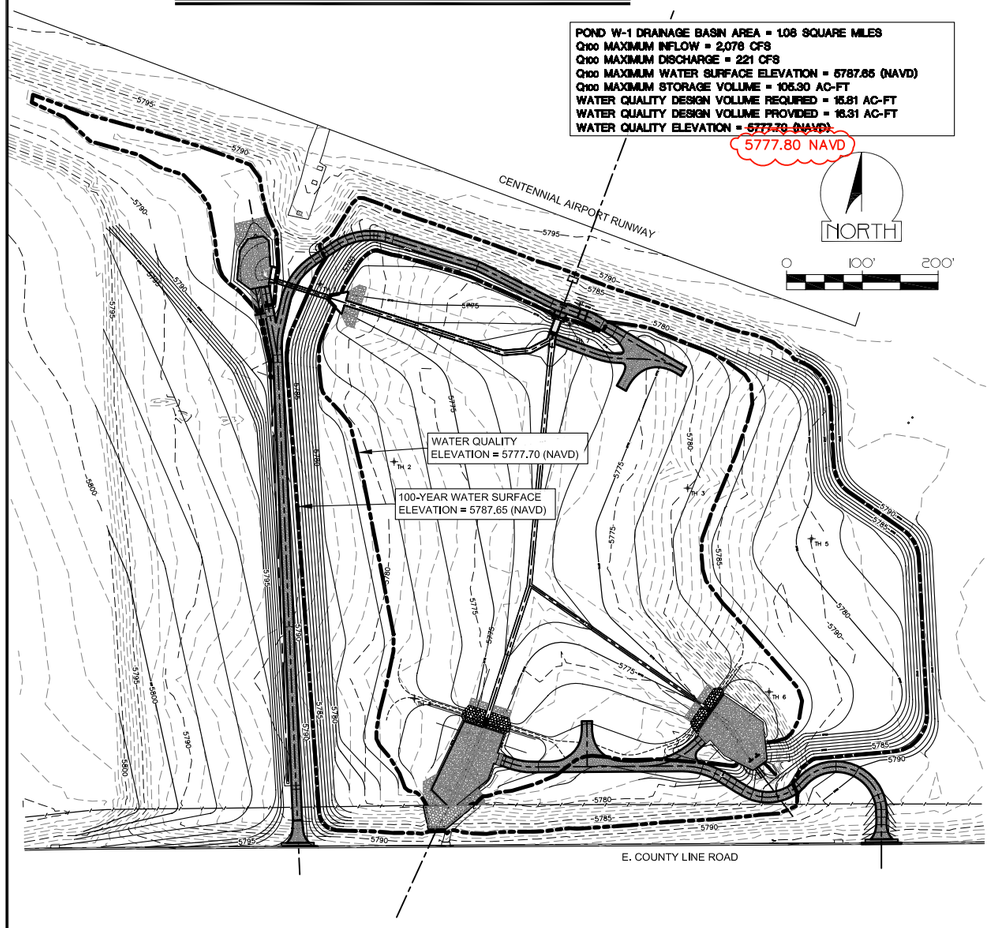
ENGINEER
ICON ENGINEERING INC.
8100 SOUTH AKRON STREET, SUITE 300
CENTENNIAL, CO 80112
303.221.0802
CONTACT: BRIAN LEDOUX (bledoux@iconeng.com)

ARAPAHOE COUNTY AIRPORT AUTHORITY (CENTENNIAL AIRPORT)
7800 SOUTH PEORIA STREET, BOX G-1
ENGLEWOOD, CO 80112
303.790.0598
CONTACT: MICHAEL FRONAPFEL (mfronapfel@centennialairport.com)
AFTER HOURS/OPERATIONS PHONE: 303.790.8736
24 HOUR OPERATIONS MOBILE 303.877.7307

SANITARY SEWER AND WATER
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY (ACWWA)
13031 EAST CALEY AVENUE
CENTENNIAL, CO 80111
303.790.4830
CONTACT: PATRICK REED (preed@arapahoewater.org)

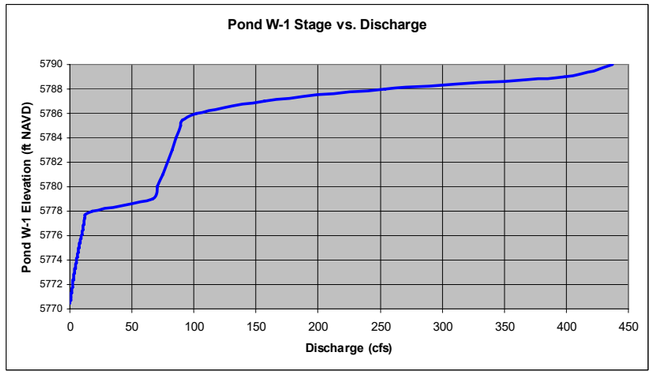
TRAFFIC
ARAPAHOE COUNTY PUBLIC WORKS AND DEVELOPMENT
ARAPAHOE COUNTY LIMA PLAZA
6924 SOUTH LIMA STREET
CENTENNIAL, CO 80112
720.874.6500

POND W-1 DESIGN INFORMATION



POND W-1 RATING CURVE INFORMATION

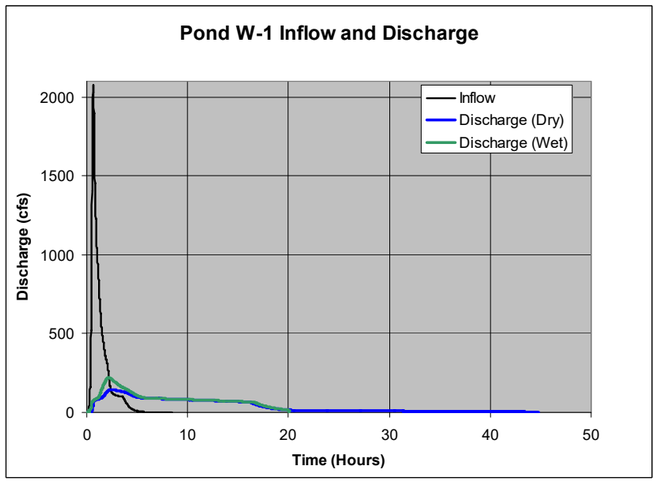
Total Outlet Works Discharge (cfs)	Water Surface Elevation (feet)	Pond W-1 Values: Surface Area (ft^2)	Contour Depth (ft)	Full Pond Depth (ft)	Detention Pond Depth (ft)	Contour Volume (ft^3)	Full Pond Cumulative Volume (ft^3)	Full Pond Cumulative Volume (ac-ft)	Detention Cumulative Volume (ac-ft)
0.0	5770.49	0.00	0.00	0.00	--	0	0	0.00	--
0.2	5770.60	321.71	0.11	0.11	--	12	12	0.00	--
0.4	5770.70	614.18	0.10	0.21	--	46	58	0.00	--
0.6	5770.80	906.64	0.10	0.31	--	76	133	0.00	--
0.7	5770.90	1199.11	0.10	0.41	--	105	238	0.01	--
0.9	**5771.00**	**1491.57**	0.10	0.51	--	134	373	0.01	--
1.0	5771.10	1743.90	0.10	0.61	--	162	534	0.01	--
1.1	5771.20	1996.24	0.10	0.71	--	187	721	0.02	--
1.3	5771.30	2248.57	0.10	0.81	--	212	933	0.02	--
1.4	5771.40	2500.90	0.10	0.91	--	237	1,171	0.03	--
1.5	5771.50	2753.24	0.10	1.01	--	263	1,433	0.03	--
1.6	5771.60	3005.57	0.10	1.11	--	288	1,721	0.04	--
1.8	5771.70	3257.90	0.10	1.21	--	313	2,034	0.05	--
1.9	5771.80	3510.23	0.10	1.31	--	338	2,372	0.05	--
2.0	5771.90	3762.57	0.10	1.41	--	364	2,736	0.06	--
2.2	**5772.00**	**4014.90**	0.10	1.51	--	389	3,125	0.07	--
2.3	5772.10	5130.50	0.10	1.61	--	456	3,581	0.08	--
2.5	5772.20	6246.09	0.10	1.71	--	568	4,149	0.10	--
2.6	5772.30	7361.69	0.10	1.81	--	680	4,828	0.11	--
2.8	5772.40	8477.28	0.10	1.91	--	791	5,620	0.13	--
2.9	5772.50	9592.88	0.10	2.01	--	903	6,523	0.15	--
3.1	5772.60	10708.48	0.10	2.11	--	1,015	7,537	0.17	--
3.2	5772.70	11824.07	0.10	2.21	--	1,126	8,663	0.20	--
3.4	5772.80	12939.67	0.10	2.31	--	1,238	9,901	0.23	--
3.5	5772.90	14055.26	0.10	2.41	--	1,349	11,251	0.26	--
3.7	**5773.00**	**15170.86**	0.10	2.51	--	1,461	12,711	0.29	--
3.9	5773.10	19141.52	0.10	2.61	--	1,712	14,423	0.33	--
4.0	5773.20	23112.18	0.10	2.71	--	2,110	16,533	0.38	--
4.2	5773.30	27082.83	0.10	2.81	--	2,507	19,040	0.44	--
4.4	5773.40	31053.49	0.10	2.91	--	2,905	21,945	0.50	--
4.5	5773.50	35024.15	0.10	3.01	--	3,302	25,246	0.58	--
4.7	5773.60	38994.81	0.10	3.11	--	3,699	28,946	0.66	--
4.9	5773.70	42965.47	0.10	3.21	--	4,096	33,042	0.76	--
5.0	5773.80	46936.12	0.10	3.31	--	4,494	37,536	0.86	--
5.2	5773.90	50906.78	0.10	3.41	--	4,891	42,426	0.97	--
5.4	**5774.00**	**54877.44**	0.10	3.51	--	5,288	47,714	1.10	--
5.6	5774.10	60951.12	0.10	3.61	--	5,789	53,503	1.23	--
5.7	5774.20	67024.80	0.10	3.71	--	6,396	59,900	1.38	--
5.9	5774.30	73098.48	0.10	3.81	--	7,004	66,904	1.54	--
6.1	5774.40	79172.16	0.10	3.91	--	7,612	74,515	1.71	--
6.3	5774.50	85245.84	0.10	4.01	--	8,219	82,734	1.90	--
6.5	5774.60	91319.51	0.10	4.11	--	8,827	91,561	2.10	--
6.7	5774.70	97393.19	0.10	4.21	--	9,434	100,995	2.32	--
6.8	5774.80	103466.87	0.10	4.31	--	10,041	111,036	2.55	--
7.0	5774.90	109540.55	0.10	4.41	--	10,649	121,685	2.79	--
7.3	**5775.00**	**115614.23**	0.10	4.51	--	11,256	132,941	3.05	--
7.4	5775.10	122761.69	0.10	4.61	--	11,917	144,858	3.33	--
7.6	5775.20	129909.14	0.10	4.71	--	12,632	157,490	3.62	--
7.8	5775.30	137056.60	0.10	4.81	--	13,347	170,837	3.92	--
8.0	5775.40	144204.05	0.10	4.91	--	14,062	184,898	4.24	--
8.2	5775.50	151351.51	0.10	5.01	--	14,776	199,675	4.58	--
8.4	5775.60	158498.96	0.10	5.11	--	15,491	215,166	4.94	--
8.6	5775.70	165646.41	0.10	5.21	--	16,206	231,372	5.31	--
8.8	5775.80	172793.87	0.10	5.31	--	16,921	248,293	5.70	--
9.0	5775.90	179941.32	0.10	5.41	--	17,636	265,928	6.10	--
9.3	**5776.00**	**187088.78**	0.10	5.51	--	18,350	284,279	6.53	--
9.5	5776.10	194646.16	0.10	5.61	--	19,086	303,364	6.96	--
9.7	5776.20	202203.54	0.10	5.71	--	19,841	323,205	7.42	--
9.9	5776.30	209760.93	0.10	5.81	--	20,597	343,802	7.89	--
10.1	5776.40	217318.31	0.10	5.91	--	21,353	365,155	8.38	--
10.3	5776.50	224875.69	0.10	6.01	--	22,109	387,264	8.89	--
10.5	5776.60	232433.07	0.10	6.11	--	22,864	410,128	9.42	--
10.7	5776.70	239990.45	0.10	6.21	--	23,620	433,748	9.96	--
10.9	5776.80	247547.84	0.10	6.31	--	24,376	458,124	10.52	--
11.0	5776.90	255105.22	0.10	6.41	--	25,132	483,256	11.09	--
11.2	**5777.00**	**262662.60**	0.10	6.51	--	25,887	509,144	11.69	--
12.0	5777.50	298472.64	0.50	7.01	--	140,188	649,332	14.91	--
12.3	5777.70	312796.66	0.20	7.21	0.00	61,121	710,453	**16.31**	0.00
18.4	**5778.00**	**334282.68**	0.30	7.51	0.30	97,044	807,497	18.54	2.23
66.3	**5779.00**	**391211.61**	1.00	8.51	1.30	362,374	1,169,872	26.86	10.55
70.6	**5780.00**	**427922.98**	1.00	9.51	2.30	409,430	1,579,302	36.26	19.95
74.7	**5781.00**	**453400.40**	1.00	10.51	3.30	440,600	2,019,902	46.37	30.06
78.5	**5782.00**	**471399.01**	1.00	11.51	4.30	462,371	2,482,273	56.99	40.68
82.2	**5783.00**	**483593.71**	1.00	12.51	5.30	477,483	2,959,756	67.95	51.64
85.7	**5784.00**	**495565.65**	1.00	13.51	6.30	489,567	3,449,324	79.19	62.88
89.1	**5785.00**	**508370.60**	1.00	14.51	7.30	501,955	3,951,278	90.71	74.40
90.7	5785.50	514439.55	0.50	15.01	7.80	255,701	4,206,979	96.58	80.27
101.9	**5786.00**	**520508.49**	0.50	15.51	8.30	258,736	4,465,715	102.52	86.21
156.9	**5787.00**	**532961.08**	1.00	16.51	9.30	526,723	4,992,437	114.61	98.30
254.0	**5788.00**	**545337.72**	1.00	17.51	10.30	539,138	5,531,575	126.99	110.68
398.4	**5789.00**	**559157.02**	1.00	18.51	11.30	552,233	6,083,808	139.67	123.36
437.0	**5790.00**	**574892.90**	1.00	19.51	12.30	567,007	6,650,814	152.68	136.37



RECORD DRAWINGS

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POND W-1 HYDROGRAPHS



NOTE:
DRY DISCHARGE REFLECTS A COMPLETELY EMPTY POND W-1 AT THE TIME OF THE DESIGN STORM. DRAIN TIME FOR THE DRY CONDITIONS IS 44.0 HOURS.
WET DISCHARGE REFLECTS 100% OF THE WATER QUALITY CAPTURE VOLUME UNAVAILABLE FOR STORAGE DURING THE DESIGN STORM.

No.	DATE	REVISIONS	APPR.

ARAPAHOE COUNTY CASE NO.: E10-044
SEMSWA CASE NO.: C08-1004
PROJECT No. 10-017-PW1-352

PLAN: DRAWN BJL; DESIGNED BJL; CHECKED CDJ
UTILITIES: RESEARCHED BJL; DRAWN BJL; CHECKED CDJ

Southeast Metro Stormwater Authority

ICON ENGINEERING, INC.
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Phone (303) 224-0802 / Fax (303) 224-0819
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WINDMILL CREEK REGIONAL DETENTION POND W-1 IMPROVEMENTS

GENERAL INFORMATION

DATE: DEC 2011
SHEET: 2

NORTHWEST FOREBAY
SEE DETAILED PLAN ON SHEET 14

LIMITS OF DISTURBANCE

WEST ACCESS ROAD
SEE PLAN AND PROFILE ON
SHEETS 17-19.

LIMITS OF DISTURBANCE

EXISTING HIGH LEVEL
OUTLET STRUCTURE

RUNWAY CENTERLINE

AIRPORT RUNWAY
SAFETY AREA, TYP.

AIRPORT OBJECT
FREE ZONE

CONTRACTOR SHALL
PROTECT EXISTING
12" SANITARY SEWER

CONTRACTOR SHALL
PROTECT EXISTING
SANITARY SEWER

NORTHWEST
CHANNEL. SEE PLAN AND
PROFILE ON SHEET 9

OUTLET STRUCTURE AND
CONCRETE PAN
SEE SHEET 11

WATER QUALITY WATER SURFACE
ELEVATION = 5777.70

EXISTING CONCRETE PAN
TO REMAIN IN PLACE

AIRPORT OBJECT
FREE AREA

100-YEAR WATER SURFACE
ELEVATION = 5787.65

MAIN POND CHANNEL. SEE PLAN AND PROFILE ON SHEETS 7 AND 8

WATER QUALITY WATER SURFACE
ELEVATION = 5777.70

AIRPORT RUNWAY
PROTECTION ZONE, TYP.

LIMITS OF DISTURBANCE

WEST ACCESS ROAD
SEE PLAN AND PROFILE ON
SHEETS 17-19.

DRAINAGE SWALE
SEE SHEETS 17-18

EXISTING CONCRETE PAN
TO REMAIN IN PLACE

SOUTHEAST CHANNEL. SEE PLAN AND
PROFILE ON SHEET 10

100-YEAR WATER SURFACE
ELEVATION = 5787.65

CONTRACTOR SHALL
PROTECT EXISTING
15" SANITARY SEWER

EAST FOREBAY
SEE DETAILED PLAN ON SHEET 13

CENTENNIAL AIRPORT
LEASE BOUNDRY

WEST FOREBAY
SEE DETAILED PLAN ON SHEET 12

EXISTING 72" RCP

EXISTING 30" RCP

SOUTH ACCESS ROAD
SEE PLAN AND PROFILE ON
SHEET 20 AND 21.

PERMANENT
ROADWAY
EASEMENT
(B1063427)

CONTRACTOR SHALL REMOVE AND RELOCATE 350± LF OF EXISTING FENCING TO LIMITS SHOWN. NEW GATE AND ADJACENT END POST BRACES SHALL BE INSTALLED AT WEST ACCESS ROAD. SEE GATE DETAIL SHEET 23 AND FENCE DETAIL SHEET 24.

EXISTING DOUBLE
10'X8' RCB

LIMITS OF DISTURBANCE

CONTRACTOR
SHALL PROTECT
EXISTING 16"
WATERLINE

CONTRACTOR SHALL PROTECT
ALL UTILITIES UNLESS
OTHERWISE SHOWN TO BE MODIFIED

PERMANENT ROADWAY
EASEMENT (B1063427)

E. COUNTY LINE ROAD

SEE SHEET 3 FOR ARAPAHOE /
DOUGLAS COUNTY BOUNDARY

LIMITS OF DISTURBANCE

CONTRACTOR
SHALL PROTECT
EXISTING 12"
WATERLINE

PERMANENT
ROADWAY
EASEMENT
(B1063427)

NORTH

0 50' 100'

LEGEND

- BUSH
- CATV CABLE TV RISER
- CD CLEANOUT
- DEL DELINEATOR
- ELC ELECTRICAL CONNECTION
- EM ELECTRIC METER
- EMH ELECTRIC MANHOLE
- FH FIRE HYDRANT
- GM GAS METER
- GV GAS VALVE
- GUYP GUY POLE
- GW GUY WIRE
- ICB IRRIGATION CONTROL BOX
- IGC INLET GRATE
- GP GUARD POST
- LP1 LIGHT POLE
- MP MILE POST MARKER
- PIPE PIPE
- PLP POWER AND LIGHT POLE
- PP POWER POLE
- SN SIGN
- POST SIGN
- SSMH SANITARY SEWER MANHOLE
- STMH STORM SEWER MANHOLE
- TH TEST HOLE
- TP TELEPHONE POLE
- TLP TELEPHONE AND LIGHT POLE
- TMH TELEPHONE MANHOLE
- TRB TELEPHONE RISER BOX
- UB UTILITY BOX
- UMH UTILITY MANHOLE
- UMKR UTILITY MARKER
- UPH UTILITY POTHOLE
- VP VENT PIPE
- WM WATER METER
- WMH WATER MANHOLE
- WMP WATER METER PIT
- WV WATER VALVE
- BM BENCHMARK
- CP CONTROL POINT

- UNDERGROUND GAS LINE
- UNDERGROUND ELECTRIC LINE
- UNDERGROUND FIBER OPTIC LINE
- UNDERGROUND TELEPHONE LINE
- UNDERGROUND CABLE LINE
- UNDERGROUND WATER LINE
- OVERHEAD ELECTRIC LINE
- OVERHEAD TELEPHONE LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- FENCE
- LIMITS OF DISTURBANCE
- EXISTING CONTOUR
- 5790 PROPOSED CONTOUR
- PROPOSED INTERMEDIATE CONTOUR

RECORD DRAWINGS

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No.	DATE	REVISIONS	APPR.

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SEMSWA CASE NO.: C08-1004
PROJECT No. 10-017-PW1-352

PLAN
DRAWN BJL
DESIGNED BJL
CHECKED CDJ

UTILITIES
RESEARCHED BJL
DRAWN BJL
CHECKED CDJ

Southeast Metro Stormwater Authority

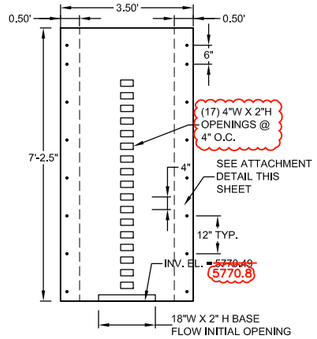
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Phone (303) 228-0900 / Fax (303) 228-1099
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WINDMILL CREEK REGIONAL DETENTION POND W-1 IMPROVEMENTS

OVERALL SITE LAYOUT AND GRADING PLAN

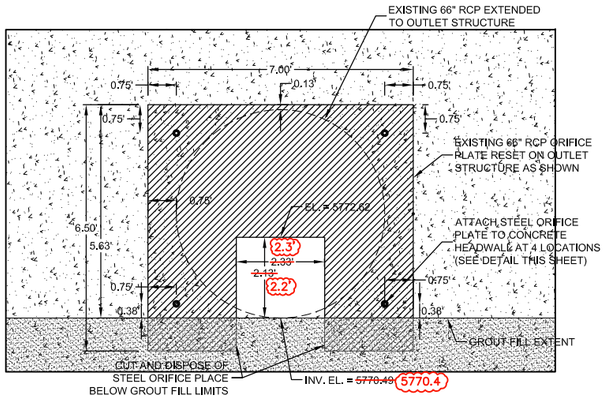
DATE
DEC 2011

SHEET
4



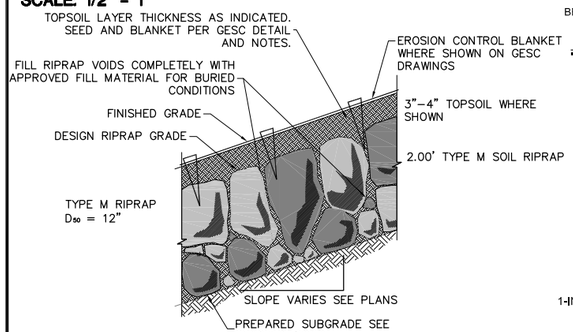
WATER QUALITY OUTLET PLATE

SCALE: 1/2" = 1'



ORIFICE PLATE

SCALE: 1" = 1'



NOTES:

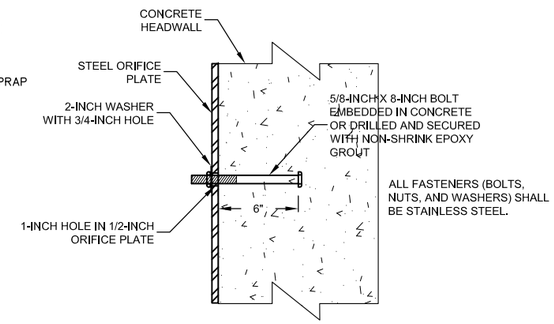
1. SOIL AND NON-SOIL RIPRAP DETAILS ARE APPLICABLE TO FLAT OR SLOPED AREAS. SLOPES STEEPER THAN 4:1 SHALL RECEIVE EROSION CONTROL BLANKET WHERE SHOWN ON THE GESC DRAWINGS. SLOPES 4:1 OR FLATTER SHALL BE SEEDED AND MULCHED.

2. GENERAL PLACEMENT TECHNIQUES SHOULD RESULT IN LARGER ROCK AT THE SURFACE WITH ROCK SECURELY INTERLOCKED AT THE DESIGN THICKNESS AND GRADE. COMPACTION AND LEVELING SHOULD RESULT IN MINIMAL VOIDS AND PROJECTIONS ABOVE GRADE.

3. ALL SOIL RIPRAP SHALL BE MIXED WITH ON-SITE SOIL PRIOR TO INSTALLATION. THE MIXTURE SHALL BE 70% RIPRAP AND 30% SOIL.

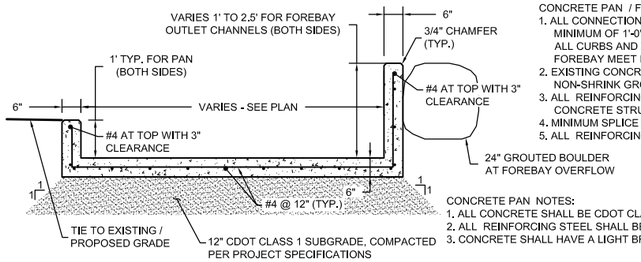
RIPRAP DETAIL

SCALE: NTS



WATER QUALITY AND ORIFICE PLATE ATTACHMENT

SCALE: NTS

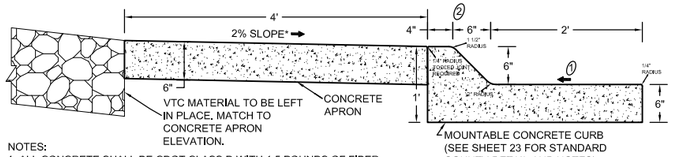


CONCRETE PAN / FOREBAY CONNECTION NOTES:
1. ALL CONNECTION LOCATIONS SHALL HAVE REINFORCING STEEL EXTEND A MINIMUM OF 1'-0" INTO THE ADJACENT CONCRETE STRUCTURE. THIS INCLUDES ALL CURBS AND WINGWALL LOCATIONS WHERE THE CONCRETE PAN OR FOREBAY MEET EXISTING OR PROPOSED CONCRETE STRUCTURES.
2. EXISTING CONCRETE SHALL BE DRILLED AND REINFORCING STEEL SET WITH NON-SHRINK GROUT OR EPOXY.
3. ALL REINFORCING STEEL SHALL BE BENT PRIOR TO INSERTION INTO EXISTING CONCRETE STRUCTURES.
4. MINIMUM SPLICE LENGTH FOR REINFORCING STEEL SHALL BE 1'-3".
5. ALL REINFORCING STEEL SHALL BE GRADE 60 AND EPOXY COATED.

CONCRETE PAN NOTES:
1. ALL CONCRETE SHALL BE CDOT CLASS D
2. ALL REINFORCING STEEL SHALL BE GRADE 60 AND EPOXY COAT
3. CONCRETE SHALL HAVE A LIGHT BROOM TO SMOOTH FINISH.

CONCRETE PAN

SCALE: 1/2" = 1'



NOTES:
1. ALL CONCRETE SHALL BE CDOT CLASS D WITH 1.5 POUNDS OF FIBER MESH PER CY.
2. ALL CONCRETE SUBGRADE SHALL BE COMPACTED PER THE PROJECT SPECIFICATIONS.
3. EXISTING CURB MAY BE CUT DOWN FOR CONSTRUCTION ACCESS PER THE GESC VTC DETAIL.
4. CONTRACTOR SHALL PROTECT EXISTING COUNTY LINE ROAD ASPHALT THROUGHOUT CONSTRUCTION. ANY DAMAGED ASPHALT SHALL BE REPLACED AT THE CONTRACTOR'S EXPENSE.
5. CONSTRUCTION JOINTS SHALL BE INSTALLED AT THE JOINT WITH EXISTING CURB AND GUTTER. CONTRACTION JOINTS SHALL BE SPACED TO MATCH THE EXISTING CURB AND GUTTER AND SHALL EXTEND THROUGH CONCRETE APRON. SEE JOINT DETAILS ON SHEET 25.

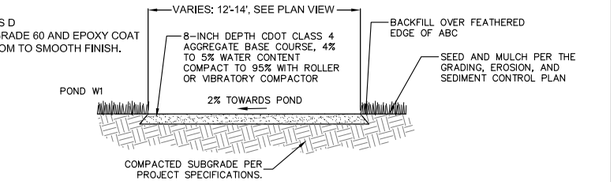
* CONCRETE APRON SHALL SLOPE TOWARDS COUNTY LINE ROAD FOR THE WEST ACCESS ROAD, AND AWAY FROM COUNTY LINE ROAD FOR THE SOUTH ACCESS ROAD.

MOUNTABLE CURB AND APRON

SCALE: 1" = 1'

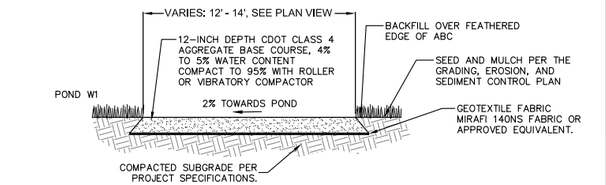
① GUTTER CROSS SLOPES SHALL BE 1/2 INCH PER FOOT WHEN DRAINING AWAY FROM CURB AND 1 INCH PER FOOT WHEN DRAINING TOWARD CURB. DRAIN DIRECTION SHALL MATCH EXISTING CURB THAT IS REPLACED.

② MOUNTABLE CONCRETE CURB SHALL BE TRANSITIONED TO THE EXISTING CURB OVER A 5-FOOT MINIMUM DISTANCE AS SHOWN ON THE PLAN VIEW. NO CONCRETE APRON SHALL BE INSTALLED ADJACENT TO THE TRANSITION CURB.



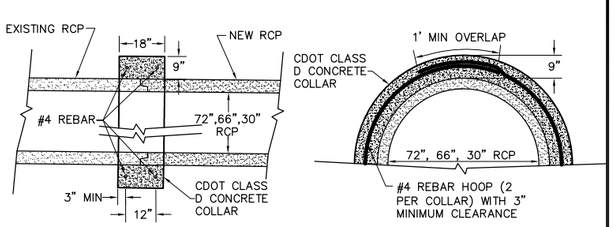
ACCESS ROAD ABOVE 5777.70 ELEVATION

SCALE: 1" = 5'



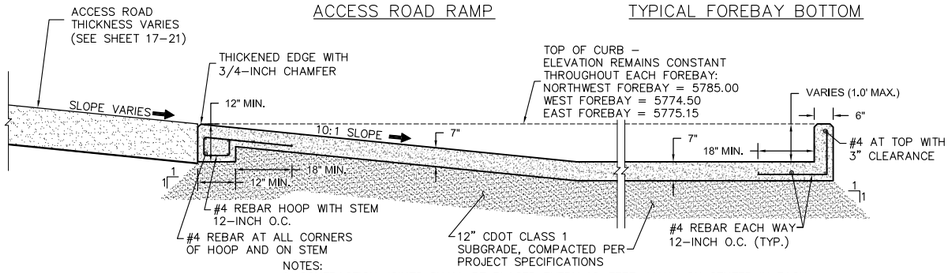
ACCESS ROAD BELOW 5777.70 ELEVATION

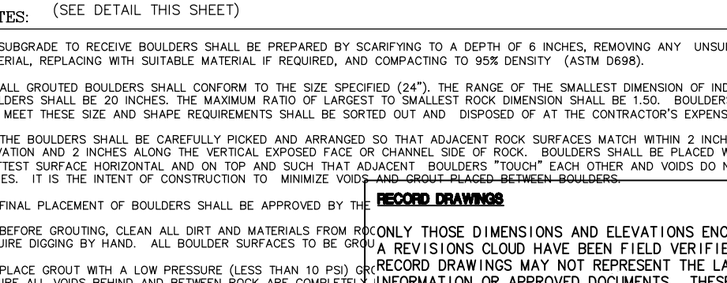
SCALE: 1" = 5'



CONCRETE COLLAR DETAIL

SCALE: NTS

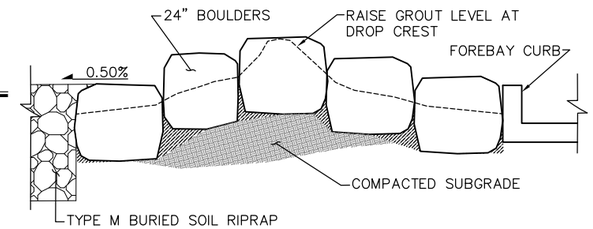




NOTES:
1. CONTRACTION JOINTS SHALL BE PLACED EVERY 10-FEET (MAX.) ON CENTER IN EACH DIRECTION. SEE SHEET 25 FOR CONTRACTION AND CONSTRUCTION JOINT DETAILS
2. ALL FOREBAY BOTTOM CONCRETE SHALL BE CDOT CLASS D WITH 1.5 POUNDS OF FIBER MESH PER CUBIC YARD.
3. ALL REINFORCING STEEL SHALL BE EPOXY COATED GRADE 60.
4. ALL EXPOSED EDGES SHALL HAVE A 3/4-INCH CHAMFER.
5. CONCRETE SHALL HAVE A LIGHT BROOM FINISH.

FOREBAY BOTTOM DETAIL

SCALE: 1/2" = 1'



NOTES:

1. SUBGRADE TO RECEIVE BOULDERS SHALL BE PREPARED BY SCARIFYING TO A DEPTH OF 6 INCHES, REMOVING ANY UNSUITABLE MATERIAL, REPLACING WITH SUITABLE MATERIAL IF REQUIRED, AND COMPACTING TO 95% DENSITY (ASTM D698).

2. ALL GROUTED BOULDERS SHALL CONFORM TO THE SIZE SPECIFIED (24"). THE RANGE OF THE SMALLEST DIMENSION OF INDIVIDUAL ROCK BOULDERS SHALL BE 20 INCHES. THE MAXIMUM RATIO OF LARGEST TO SMALLEST ROCK DIMENSION SHALL BE 1.50. BOULDERS THAT DO NOT MEET THESE SIZE AND SHAPE REQUIREMENTS SHALL BE SORTED OUT AND DISPOSED OF AT THE CONTRACTOR'S EXPENSE.

3. THE BOULDERS SHALL BE CAREFULLY PICKED AND ARRANGED SO THAT ADJACENT ROCK SURFACES MATCH WITHIN 2 INCHES IN TOP ELEVATION AND 2 INCHES ALONG THE VERTICAL EXPOSED FACE OR CHANNEL SIDE OF ROCK. BOULDERS SHALL BE PLACED WITH THE FLATTEST SURFACE HORIZONTAL AND ON TOP AND SUCH THAT ADJACENT BOULDERS "TOUCH" EACH OTHER AND VOIDS DO NOT EXCEED 4 INCHES. IT IS THE INTENT OF CONSTRUCTION TO MINIMIZE VOIDS AND GROUT PLACED BETWEEN BOULDERS.

4. FINAL PLACEMENT OF BOULDERS SHALL BE APPROVED BY THE

5. BEFORE GROUTING, CLEAN ALL DIRT AND MATERIALS FROM ROC REQUIRE DIGGING BY HAND. ALL BOULDER SURFACES TO BE GROU

6. PLACE GROUT WITH A LOW PRESSURE (LESS THAN 10 PSI) GR ENSURE ALL VOIDS BEHIND AND BETWEEN ROCK ARE COMPLETELY SPECIFIED FROM SURFACE TO MINIMIZE VISIBILITY. WASH OFF ALL SURFACES.

7. THE CONTRACTOR SHALL CONTROL GROUT MIX AND PLACEMENT THE GROUT LAYER.

8. GROUT SHALL BE UDFCD "TYPE B" - SEE NOTES 10-16.

9. DEPTH OF GROUT FROM TOP OF BOULDERS SHALL BE 12" MIN. OR 1/2 OF Dso IN ALL AREAS EXCEPT FOR OVER THE FOREBAY OVERFLOW CREST SECTION. GROUT DEPTH FROM THE TOP OF BOULDERS AT THE OVERFLOW CREST SHALL BE 1".

10. ALL GROUT SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH EQUAL TO 3200 PSI.

11. ONE CUBIC YARD OF GROUT SHALL HAVE A MINIMUM OF SIX (6) SACKS OF TYPE II PORTLAND CEMENT.

12. A MAXIMUM OF 25% TYPE F FLY ASH MAY BE SUBSTITUTED FOR THE PORTLAND CEMENT.

13. AGGREGATE SHALL BE COMPRISED OF 3/4" MAXIMUM GRAVEL, STRUCTURAL CONCRETE AGGREGATE.

14. THE GROUT SLUMP SHALL BE 4" TO 6".

15. AIR ENTRAINMENT SHALL BE 5.5%-7.5%.

16. TO CONTROL SHRINKAGE AND CRACKING, 1.5 POUNDS OF FIBERMESH, OR EQUIVALENT SHALL BE USED PER CUBIC YARD OF GROUT.

17. ALL FINISHED GROUT SURFACES SHALL BE SPRAYED WITH A CLEAR LIQUID MEMBRANE CURING COMPOUND AS SPECIFIED IN ASTM C-309.

18. SPECIAL PROCEDURES SHALL BE REQUIRED FOR GROUT PLACEMENT WHEN THE AIR TEMPERATURES ARE LESS THAN 40°F OR GREATER THAN 90°F. CONTRACTOR SHALL OBTAIN PRIOR APPROVAL FROM THE DESIGN ENGINEER OF THE PROCEDURES TO BE USED FOR PROTECTING THE GROUT.

RECORD DRAWINGS

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GROUTED BOULDER DETAIL AND NOTES

SCALE: NTS

No.	DATE	REVISIONS	APPR.

ARAPAHOE COUNTY CASE NO: E10-044
SEMSWA CASE NO.: C08-1004
PROJECT No. 10-017-PW1-352

PLAN	
DRAWN	BJL
DESIGNED	BJL
CHECKED	CDJ

UTILITIES	
RESEARCHED	BJL
DRAWN	BJL
CHECKED	CDJ

Southeast Metro Stormwater Authority

ICON ENGINEERING, INC
8100 South Akron Street, Suite 300, Centennial, CO 80112
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WWW.ICONENG.COM

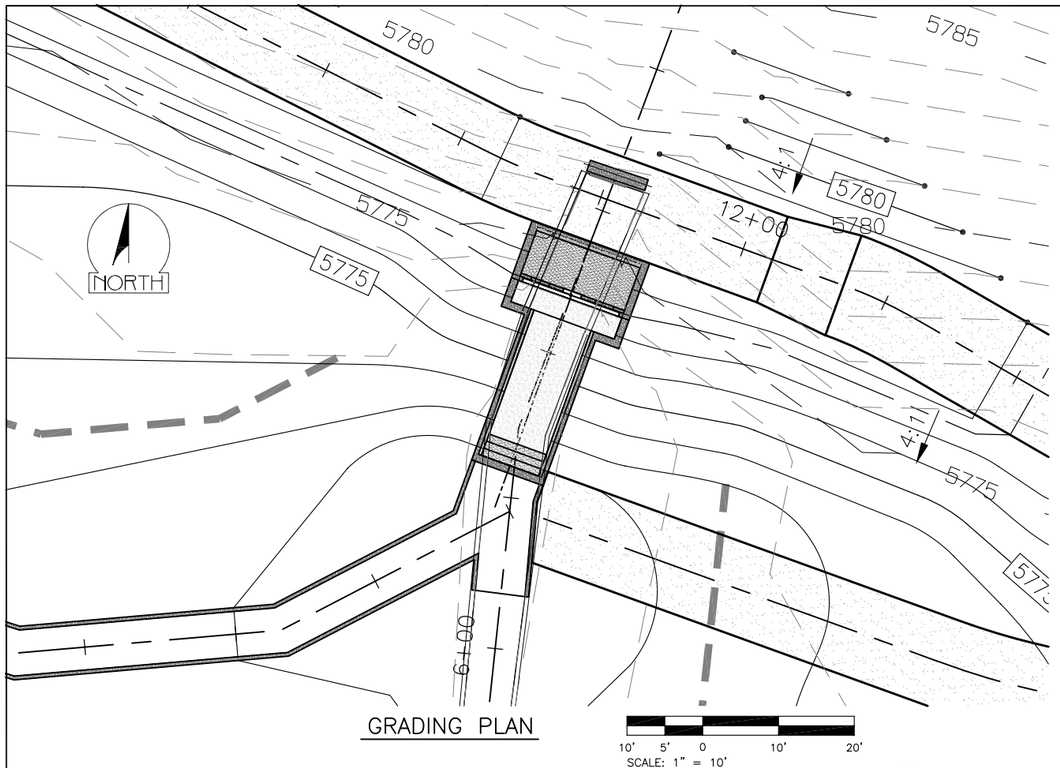
WINDMILL CREEK REGIONAL DETENTION POND W-1 IMPROVEMENTS

MISCELLANEOUS DETAILS

DATE DEC 2011

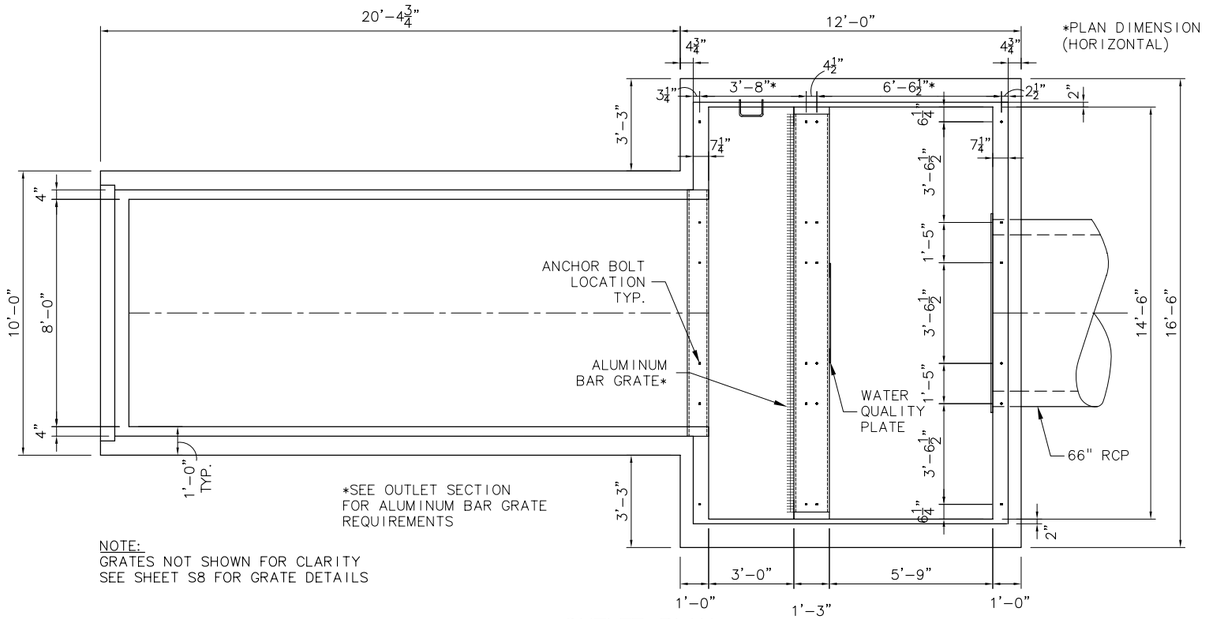
SHEET 22

P:\P\10017PW1\dwg\FINAL SHEET SET\RECORD\SHEET 22-GENERAL-DETAILS.dwg, Layout1, 2012-12-05 2:38:04 PM, Medoux, Adobe PDF, 1:2



GRADING PLAN

10' 5' 0 10' 20'
SCALE: 1" = 10'



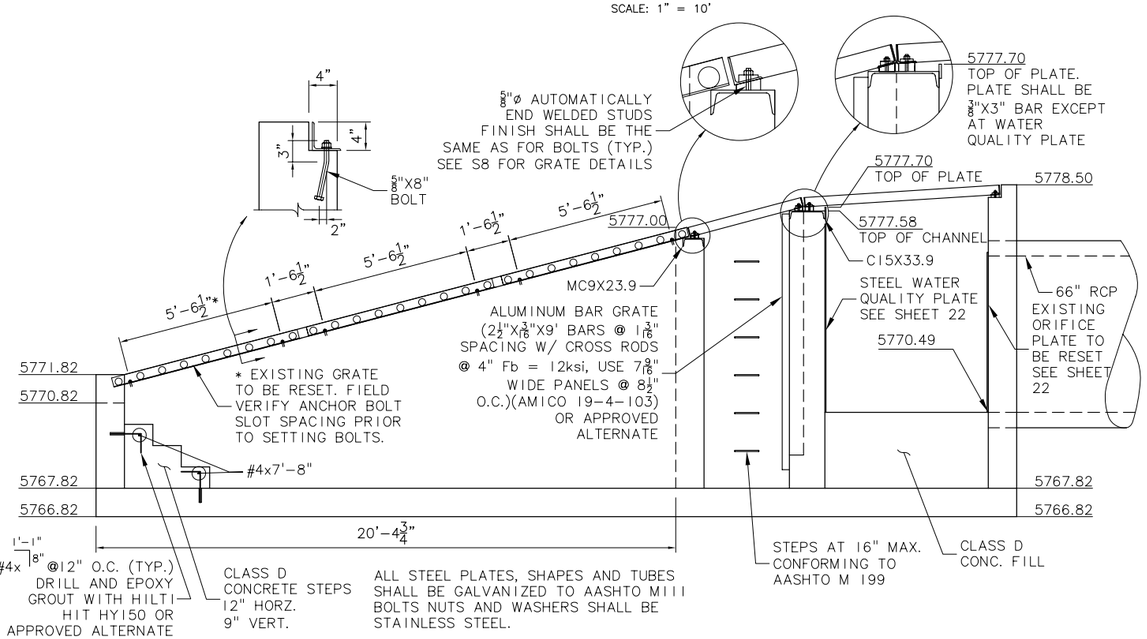
NOTE:
GRATES NOT SHOWN FOR CLARITY
SEE SHEET S8 FOR GRATE DETAILS

OUTLET PLAN

3' 2' 1' 0' 3' 6'
SCALE: 3/8" = 1'-0"

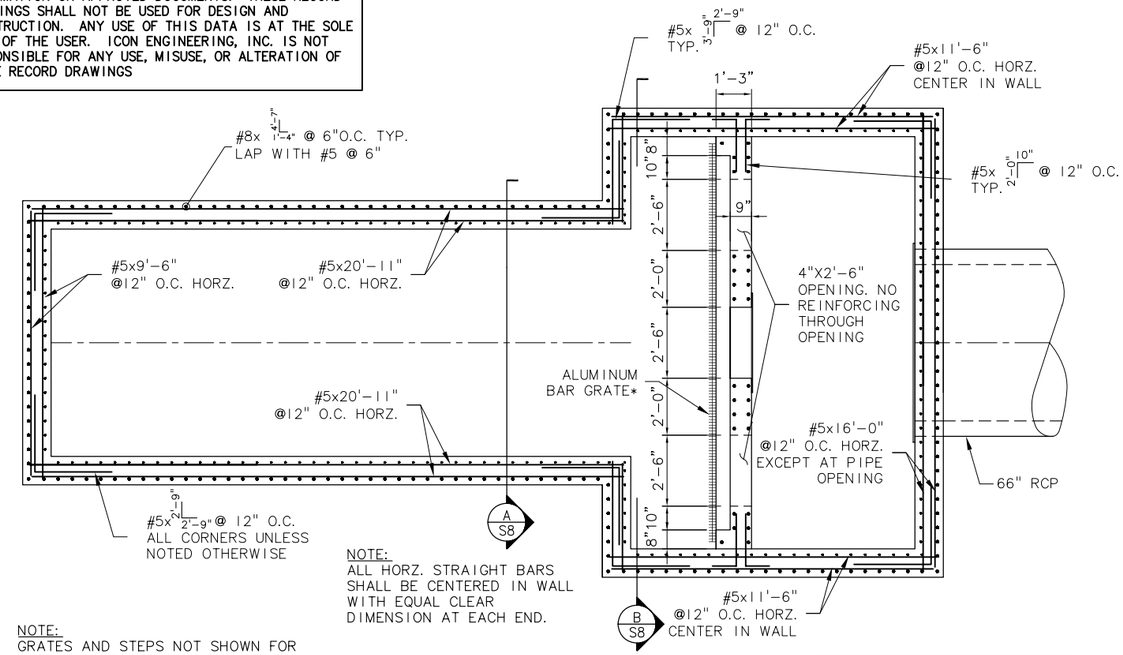
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OUTLET SECTION

3' 2' 1' 0' 3' 6'
SCALE: 3/8" = 1'-0"



NOTE:
ALL HORZ. STRAIGHT BARS SHALL BE CENTERED IN WALL WITH EQUAL CLEAR DIMENSION AT EACH END.

NOTE:
GRATES AND STEPS NOT SHOWN FOR CLARITY SEE SHEET S8 FOR GRATE DETAILS

REINFORCING PLAN

3' 2' 1' 0' 3' 6'
SCALE: 3/8" = 1'-0"

No.	DATE	REVISIONS	APPR.

ARAPAHOE COUNTY CASE NO.: E10-044
SEMSWA CASE NO.: C08-1004

10-017-PW1-352

PLAN	
DRAWN	DJB
DESIGNED	DJB
CHECKED	DJB

UTILITIES	
RESEARCHED	BJL
DRAWN	BJL
CHECKED	CDJ

Southeast Metro Stormwater Authority

LONCO, INC.
CONSULTING ENGINEERS 1700 BROADWAY SUITE 1512
DENVER, COLORADO 80290 (303) 620-0098

WINDMILL CREEK REGIONAL DETENTION POND W-1 IMPROVEMENTS

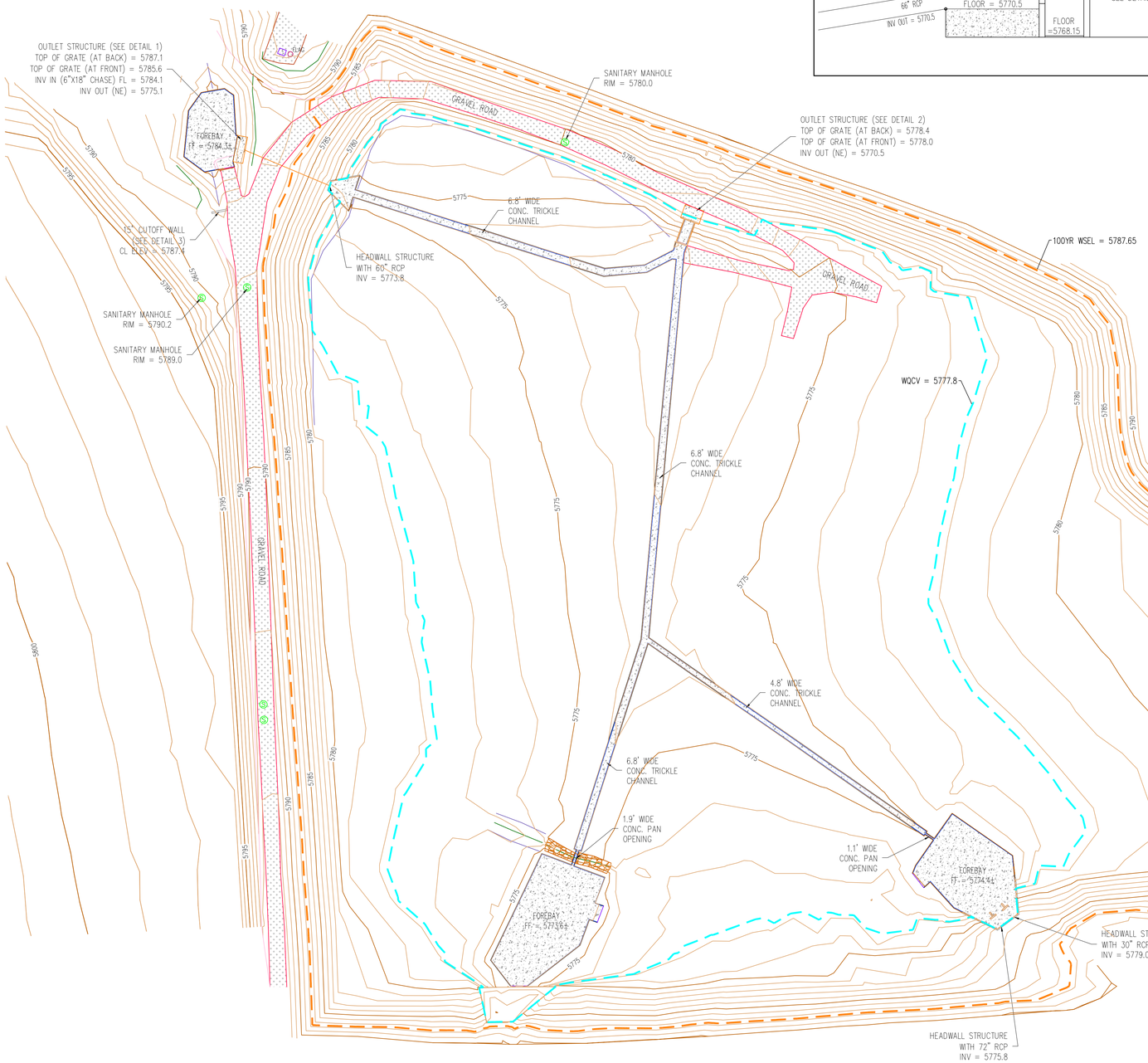
POND WATER QUALITY OUTLET

DATE
DEC 2011

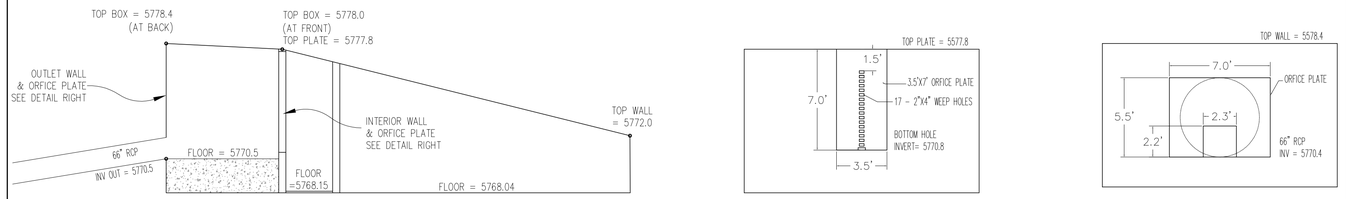
SHEET
S7

TOPOGRAPHIC MAP

WINDMILL POND W-1
Situated in the Southeast 1/4 Section 36
& Southwest 1/4 of Section 36,
Township 5 South, Range 67 West of the 6th P.M.
Town of Centennial, County of Arapahoe
State of Colorado.



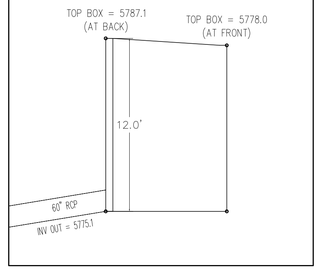
DETAIL 2
SCALE: 1" = 5'



LEGEND

- SANITARY MANHOLE
- RIPRAP
- STORM FES
- WALL
- STORM PIPE
- 5280 EX CONT–MJR
- EX CONT–MNR
- EDGE CONCRETE
- GRAVEL ROAD
- WATER QUALITY CAPTURE VOLUME WQCV = 5777.8
- 100YR WATER SURFACE VOLUME WSEL = 5787.65

DETAIL 1
SCALE: 1" = 5'



DETAIL 3
SCALE: 1" = 5'

TOP OF CUTOFF WALL



Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
TOPO 8-02 TO WQCV 5777.80	1.00	1.00	317060.22 Sq. Ft.	0.00 Cu. Yd.	27244.45 Cu. Yd.	27244.45 Cu. Yd.<Fill>
TOPO 8-02 TO 100YR 5787.65	1.00	1.00	539141.71 Sq. Ft.	0.00 Cu. Yd.	196258.13 Cu. Yd.	196258.13 Cu. Yd.<Fill>

1 inch = 50 ft.

MJN

DATE 12-05-12

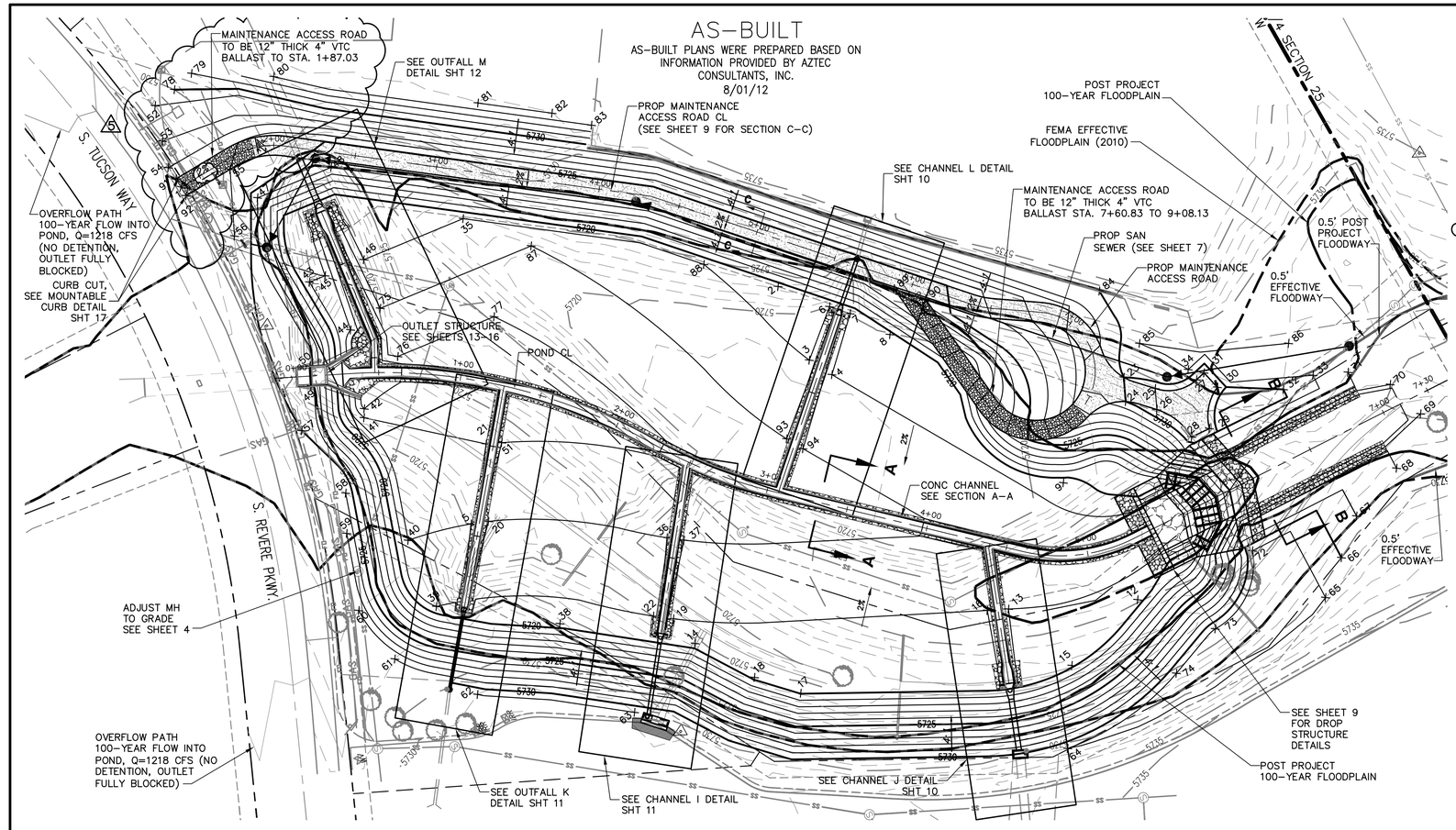
AZTEC CONSULTANTS, INC.
8000 South Lincoln St., Suite 201
Littleton, Colorado 80122
Phone: (303)713-1898
Fax: (303)713-1897
www.aztecconsultants.com

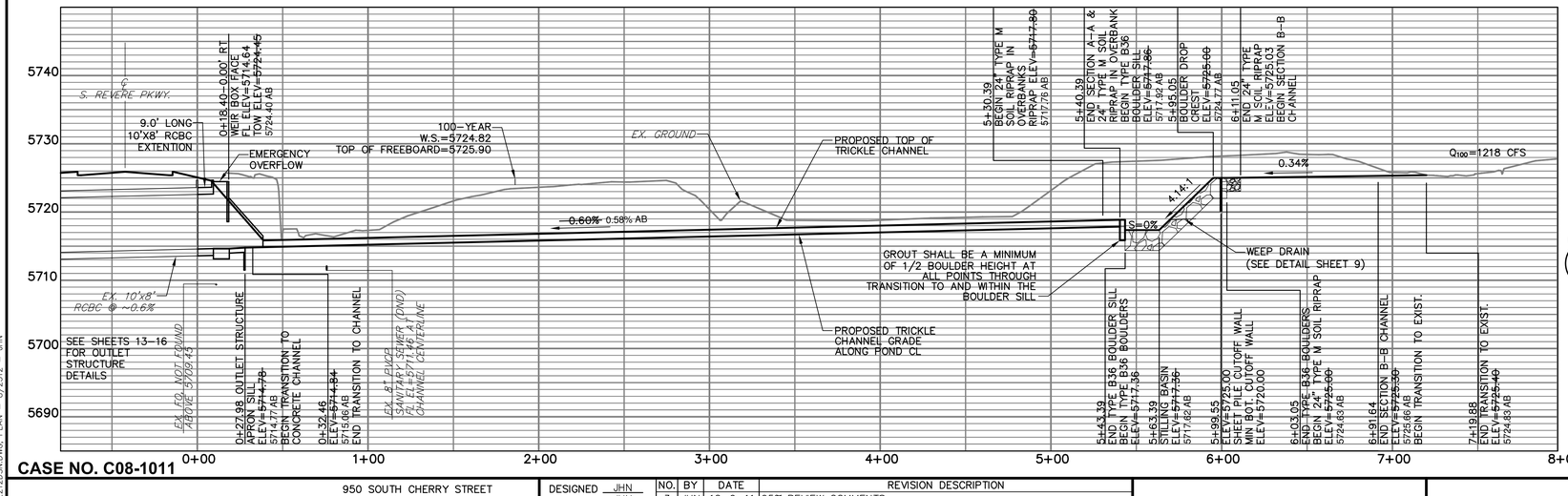
TOPOGRAPHIC SURVEY & VOLUMES
WINDMILL POND W-1

PREPARED FOR
SOUTHEAST METRO STORMWATER AUTHORITY

SHEET 1 OF 1 SHEETS

JOB NO. 23312-01





NOTES

1. EXISTING STRUCTURES, UTILITIES, AND FACILITIES ARE CALLED OUT ON THE EXISTING FEATURES & DEMOLITION SHEET.
2. EMBANKMENT SLOPES ARE 4:1 UNLESS NOTED OTHERWISE. ALL ACCESS ROAD CROSS SLOPES ARE 2% UNLESS NOTED OTHERWISE. ACCESS ROAD LONGITUDINAL SLOPE IS 10:1 MAX.
3. FOR CLARITY, EASEMENTS AND OWNERSHIPS ARE CALLED OUT ON THE SURVEY CONTROL & EASEMENTS SHEET.
4. SECTION CUTS ARE LOCATED ON SHEET 9 UNLESS NOTED OTHERWISE.
5. CURB CUT WHERE MAINTENANCE ROAD MEETS EXISTING CURB SHALL BE IN ACCORDANCE WITH CITY OF CENTENNIAL STANDARDS.

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

COLORADO REGISTERED ALAN J. LEAF 24167 PROFESSIONAL ENGINEER

DESIGN POINTS

PT	NORTHING	EASTING	ELEV.	DESC.
1	1638126.23	3187468.21	5726.50	CL RD
2	1637838.74	3187237.31	5719.41	GRADE BREAK
3	1637844.13	3187188.84	5719.00	GRADE BREAK
4	1637836.48	3187174.39	5719.00	GRADE BREAK
5	1638072.78	3187202.76	5718.00	GRADE BREAK
6	1637817.46	3187211.23	5719.00	GRADE BREAK
7	1637808.58	3187201.38	5719.00	GRADE BREAK
8	1637793.65	3187178.37	5719.77	GRADE BREAK
9	1637745.85	3187047.83	5719.22	GRADE BREAK
12	1637741.28	3186963.53	5719.29	GRADE BREAK
13	1637812.68	3186997.12	5719.00	GRADE BREAK
14	1637989.41	3187072.36	5719.22	GRADE BREAK
15	1637795.88	3186948.19	5719.73	GRADE BREAK
16	1637824.34	3187002.70	5719.00	GRADE BREAK
17	1637948.15	3187014.38	5719.88	GRADE BREAK
18	1637968.02	3187036.58	5719.64	GRADE BREAK
19	1637993.54	3187091.91	5719.00	GRADE BREAK
20	1638062.75	3187198.89	5718.00	GRADE BREAK
21	1638040.91	3187240.78	5717.00	GRADE BREAK
22	1638003.41	3187099.37	5719.00	GRADE BREAK
23	1637682.24	3187085.85	5730.00	EOR
24	1637688.47	3187072.40	5730.00	EOR
25	1637668.85	3187070.56	5731.00	EOR
26	1637674.32	3187058.83	5731.00	EOR
27	1637644.32	3187062.86	5731.00	EOR
28	1637664.00	3187033.89	5731.00	EOR
29	1637652.02	3187033.11	5731.00	EOR
30	1637635.49	3187052.64	5731.00	EOR
31	1637638.29	3187064.31	5731.00	EOR
32	1637601.05	3187031.79	5730.00	GRADE
33	1637581.09	3187030.49	5729.00	GRADE
34	1637645.68	3187070.76	5729.00	TIE TO EG
35	1637985.75	3187367.37	5719.00	GRADE BREAK
36	1637972.80	3187136.93	5718.00	GRADE BREAK
37	1637964.45	3187130.59	5718.00	GRADE BREAK
38	1638055.28	3187123.22	5719.30	GRADE BREAK
39	1638115.79	3187169.19	5719.00	GRADE BREAK
40	1638111.03	3187212.77	5718.00	GRADE BREAK
41	1638097.87	3187291.10	5717.00	GRADE BREAK
42	1638095.10	3187295.79	5716.00	GRADE BREAK
43	1638086.37	3187379.47	5719.00	GRADE BREAK
44	1638078.77	3187341.82	5718.00	GRADE BREAK
45	1638076.12	3187378.23	5719.00	GRADE BREAK
46	1638050.82	3187375.19	5719.00	GRADE BREAK
47	1638088.79	3187439.79	5724.00	GRADE
48	1638040.58	3187434.00	5724.00	GRADE
49	1638116.45	3187323.83	5724.66	COR WALL
50	1638111.24	3187334.64	5724.66	COR WALL
51	1638032.19	3187236.77	5717.00	GRADE BREAK
52	1638115.63	3187519.30	5729.00	TIE TO EG
53	1638122.28	3187498.28	5728.00	TIE TO EG
54	1638114.40	3187471.22	5727.00	TIE TO EG
55	1638094.86	3187463.10	5726.00	EOR
56	1638112.42	3187428.30	5726.00	TIE TO EG
57	1638134.74	3187302.83	5725.00	GRADE
58	1638130.13	3187256.51	5726.00	TIE TO EG
59	1638141.62	3187234.80	5727.00	TIE TO EG
60	1638158.23	3187190.23	5728.00	TIE TO EG
61	1638153.53	3187153.72	5729.00	TIE TO EG
62	1638120.20	3187110.17	5731.00	TIE TO EG
63	1638042.16	3187053.81	5731.00	TIE TO EG
64	1637822.89	3186905.40	5731.00	TIE TO EG
65	1637640.84	3186908.61	5731.00	TIE TO EG
66	1637620.45	3186925.05	5730.00	TIE TO EG
67	1637600.04	3186942.67	5729.00	TIE TO EG
68	1637564.48	3186956.15	5728.00	TIE TO EG
69	1637535.51	3186977.86	5727.00	TIE TO EG
70	1637542.84	3187002.56	5727.00	TIE TO EG
71	1637561.63	3187021.65	5728.00	TIE TO EG
72	1637665.71	3186955.24	5731.00	TOB
73	1637708.76	3186924.87	5731.00	TOB
74	1637742.69	3186912.86	5731.00	TOB
75	1638056.56	3187344.44	5718.00	GRADE BREAK
76	1638061.60	3187313.61	5717.00	GRADE BREAK
77	1637998.62	3187306.04	5717.00	GRADE BREAK
78	1638100.58	3187522.06	5730.00	TIE TO EG
79	1638086.82	3187525.62	5731.00	TIE TO EG
80	1638043.98	3187499.35	5733.00	TIE TO EG
81	1637943.33	3187424.36	5734.00	TIE TO EG
82	1637907.08	3187396.90	5734.00	TIE TO EG
83	1637889.68	3187378.71	5733.00	TIE TO EG
84	1637669.46	3187139.01	5730.00	TIE TO EG
85	1637663.76	3187099.18	5729.00	GRADE
86	1637584.56	3187054.72	5729.00	TIE TO EG
87	1637957.77	3187332.57	5718.00	GRADE BREAK
88	1637871.55	3187271.23	5719.00	GRADE BREAK
89	1637777.80	3187201.65	5724.76	EOR
90	1637764.23	3187186.60	5724.76	EOR
91	1638126.42	3187474.21	5726.50	EOR
92	1638126.06	3187462.21	5726.50	EOR
93	1637879.70	3187153.75	5718.00	GRADE BREAK
94	1637873.98	3187143.67	5718.00	GRADE BREAK

MAINTENANCE ACCESS ROAD CENTERLINE ALIGNMENT

PI	NORTHING	EASTING	DISTANCE	BEARING	RADIUS	LENGTH	DELTA
1+37.03	1638126.23	3187468.21					
			53.48	S01°37'42"E			
1+90.51	1638072.78	3187469.73			50.00	33.83	38°46'14"
			242.79	S37°08'32"W			
4+31.94	1637879.24	3187323.13					
			212.20	S47°57'50"W			
6+44.14	1637737.15	3187165.53			56.00	13.73	14°03'
			36.48	S33°55'14"W			
6+80.55	1637706.88	3187145.17					
			76.94	N33°55'14"E			
6+03.61	1637770.73	3187188.10			36.00	144.61	230°09'
			76.94	S84°04'08"W			
8+25.16	1637762.78	3187111.57					
			93.10	N84°17'49"E			
9+18.26	1637772.03	3187204.21					

MAINTENANCE ACCESS ROAD VERTICAL ALIGNMENT

VPI	CL ELEV.	GRADE AHEAD	VPI	CL ELEV.	GRADE AHEAD
1+37.03	5726.50	+0.00%	6+19.98	5724.88	+4.00%
1+49.43	5726.50	-2.00%	7+22.95	5729.00	+0.00%
2+24.43	5725.00	-2.00%	7+47.51	5729.00	-8.60%
2+30.43	5724.88	+0.00%	8+40.56	5721.00	+0.00%
			8+63.57	5721.00	+10.0%
			8+93.57	5724.00	+5.22%
			9+08.13	5724.76	

POND CENTERLINE ALIGNMENT

PI	NORTHING	EASTING	DISTANCE	BEARING	RADIUS	LENGTH	DELTA
0+00	1638121.00	3187332.42					
			129.68	S25°18'28"W			
1+29.68	1638003.76	3187276.98			330.00	194.38	33°45'
			139.94	S59°03'23"W			
2+63.80	1637931.80	3187156.95			280.00	79.16	16°12'
			232.48	S42°51'31"W			
4+95.75	1637761.39	3186998.82			100.00	70.38	40°20'
			263.10	S02°32'00"W			
7+55.79	1637498.55	3186987.19					

CASE NO. C08-1011

WRC ENGINEERING, INC.
950 SOUTH CHERRY STREET
SUITE 404
DENVER, COLORADO 80246
PHONE NO: (303) 757-8513
FAX NO: (303) 758-3208

DESIGNED	JHN
DRAWN	JHN
CHECKED	AJL
DATE	5/31/11
AS-BUILT	

NO.	BY	DATE	REVISION DESCRIPTION
3	JHN	12-9-11	95% REVIEW COMMENTS
4	JHN	1-17-12	CHANGE TRICKEL CHANNEL TO CONCRETE
5	JHN	6-4-12	MODIFY ACCESS ROAD ENTRY POINT
6	JHN	8-23-12	AS-BUILTS

SEMSWA

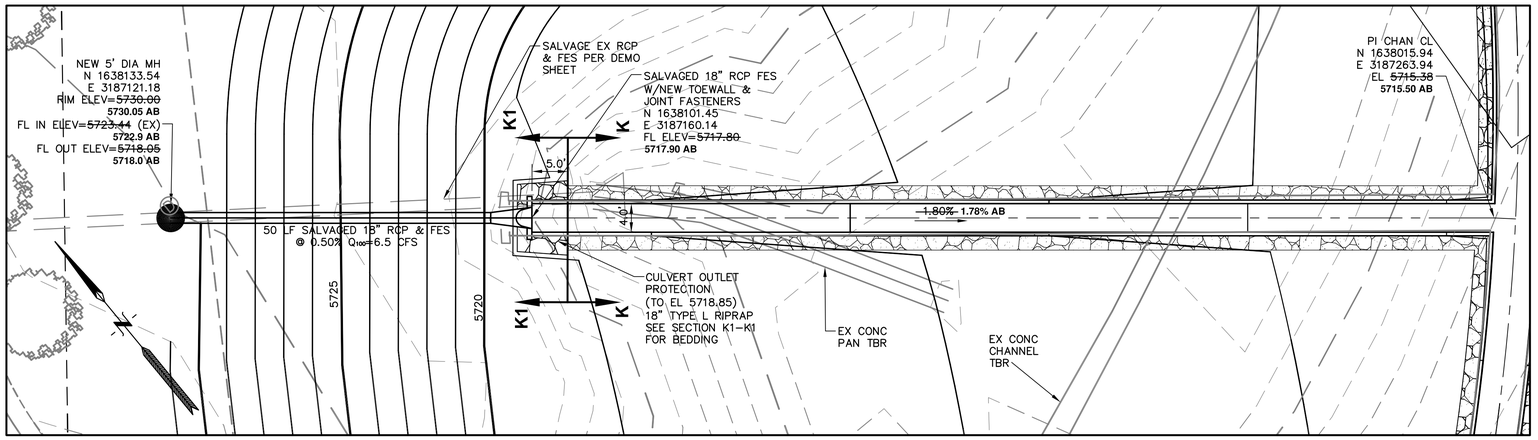
DETENTION POND L-2

L-2 GRADING PLAN & PROFILE

PROJECT NUMBER 2212

SHEET 6

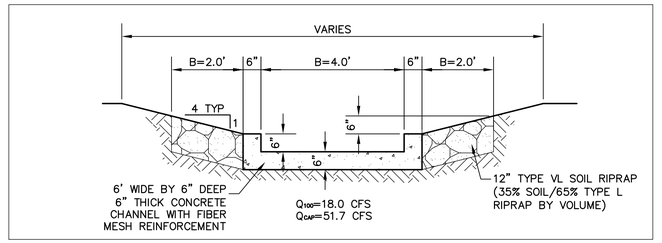
2212\DWG\2212GSN.DWG, PLAN - 8/2312 - JHN



OUTFALL K DETAIL

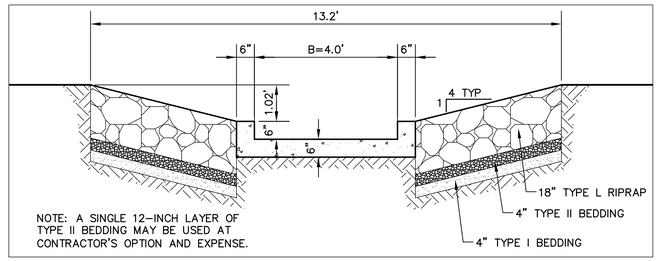
ORIGINAL SCALE: 1"=10'
(SEE SHEET 6 FOR LOCATION)

NOTE: Q_{CAP} IS THE CAPACITY OF THE CHANNEL AT THE TOP OF THE RIPRAP REVETMENT



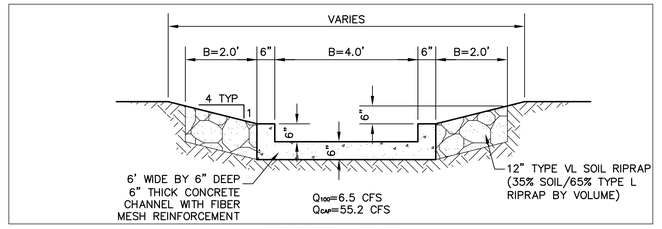
SECTION I-I

ORIGINAL SCALE: 1"=2'



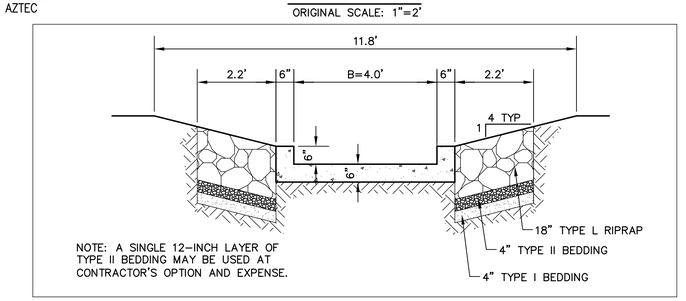
SECTION I1-I1

ORIGINAL SCALE: 1"=2'



SECTION K-K

ORIGINAL SCALE: 1"=2'

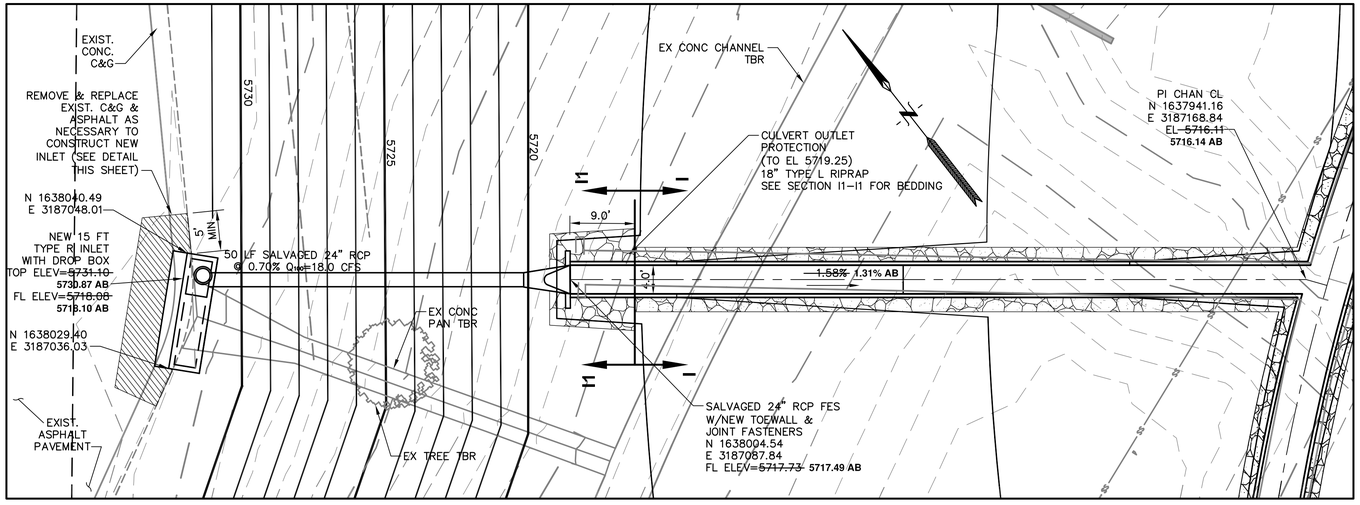


SECTION K1-K1

ORIGINAL SCALE: 1"=2'

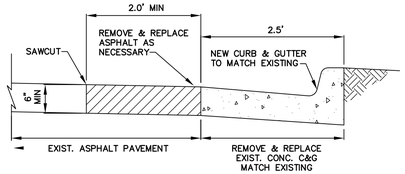
AS-BUILT

AS-BUILT PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY AZTEC CONSULTANTS, INC.
8/01/12



OUTFALL I DETAIL

ORIGINAL SCALE: 1"=10'
(SEE SHEET 6 FOR LOCATION)



NOTE: TRANSITION TO EXISTING CURB SHALL BE A MINIMUM OF 5 FEET. TRANSITION SHALL EXTEND TO NEAREST EXISTING CURB JOINT IF LESS THAN 10 FEET AWAY.

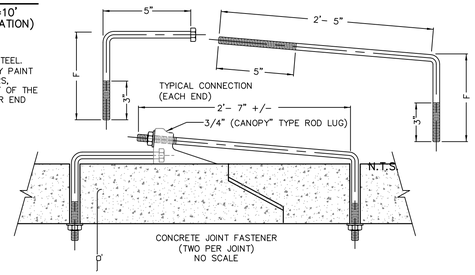
PAVEMENT & CURB & GUTTER REMOVEMENT & REPLACEMENT DETAIL AT NEW CURB INLET

N.T.S.

3/4" GALVANIZED ANCHOR BOLTS, NUTS, & WASHERS, MILD STEEL. ASTM A 307. ROD LUG SHALL BE COATED/ COAL-TAR, EPOXY PAINT OR APPROVED EQUAL. NOTE: CONCRETE PIPE JOINT FASTENERS, SHALL BE INSTALLED SO THAT A MINIMUM OF 15 LINEAR FEET OF THE OUTLET END OF THE PIPE ARE MECHANICAL LOCKED TOGETHER END SECTION LENGTHS, WHEN USED, WILL BE INCLUDED IN THE 15

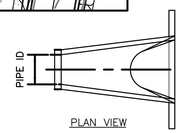
PIPE DIAMETER	F
18" – 30"	5"
36" – 42"	6"
48" – 60"	7"
72" – 48"	9"

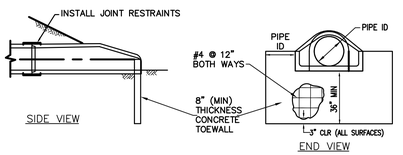




JOINT RESTRAINT DETAILS

N.T.S.





CONCRETE TOEWALL DETAILS

N.T.S.

GENERAL NOTES

1. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4 INCH.
2. IF A PRECAST HEADWALL IS USED, A PERMANENT EPOXY BOND, APPROVED BY THE ENGINEER, WILL BE REQUIRED BETWEEN PIPE AND HEADWALL.
3. HEADWALL SHALL BE PERPENDICULAR TO THE CULVERT CENTERLINE UNLESS OTHERWISE SPECIFIED.

COLORADO REGISTERED
ALAN J. LEAF
24167
PROFESSIONAL ENGINEER

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

APPURTENANCES FOR ALL FLARED END SECTIONS

CASE NO. C08-1011

WRC ENGINEERING, INC.
950 SOUTH CHERRY STREET
SUITE 404
DENVER, COLORADO 80246
PHONE NO: (303) 757-8513
FAX NO: (303) 758-3208

DESIGNED JHN
DRAWN JHN
CHECKED AJL
DATE 05/31/11
AS-BUILT

NO.	BY	DATE	REVISION DESCRIPTION
2	JHN	11-11-11	90% REVIEW COMMENTS
3	JHN	12-9-11	95% REVIEW COMMENTS
4	JHN	1-17-12	CHANGE TRICKEL CHANNEL TO CONCRETE
5	JHN	8-23-12	AS-BUILTS

SEMSWA

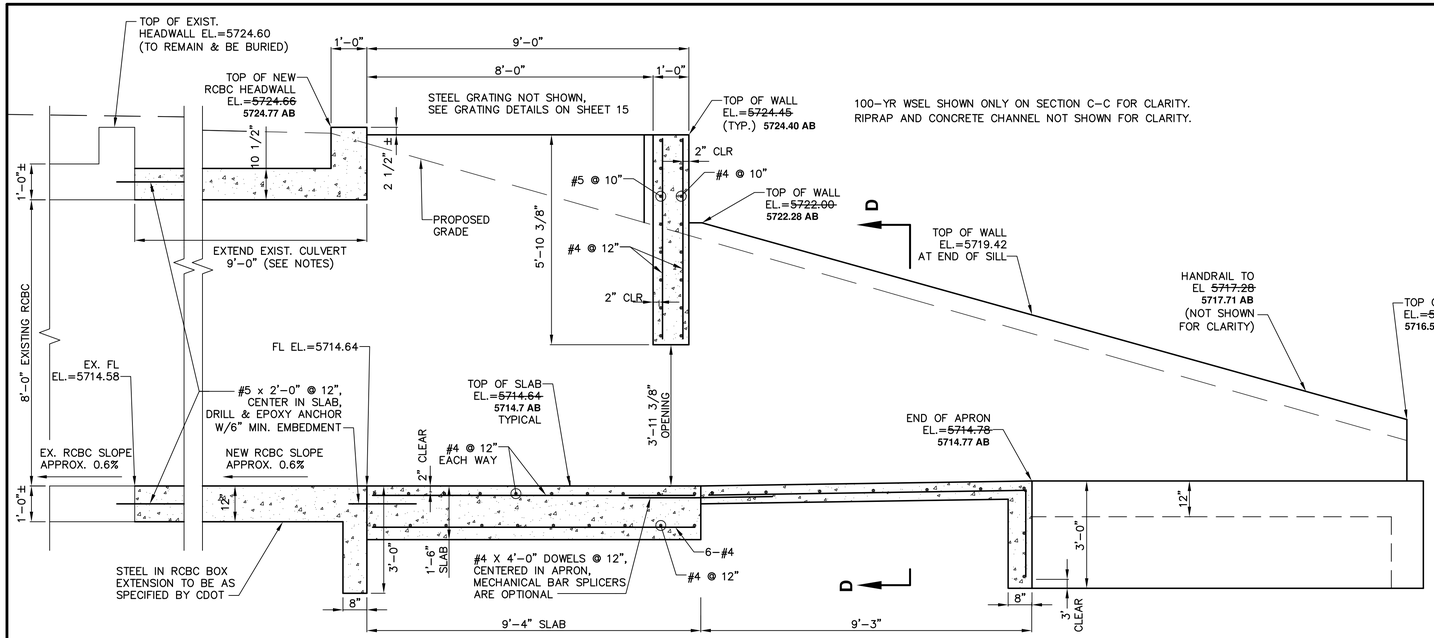
DETENTION POND L-2

SECTION DETAILS 2

PROJECT NUMBER 2212

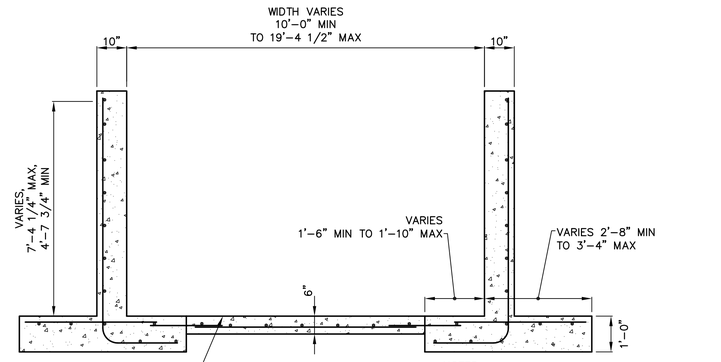
SHEET 11

2212\DWG\2212DSN.DWG, SECTION DET 2 - 8/27/12 - JHN



SECTION B-B

SCALE: 1"=2'



SECTION D-D

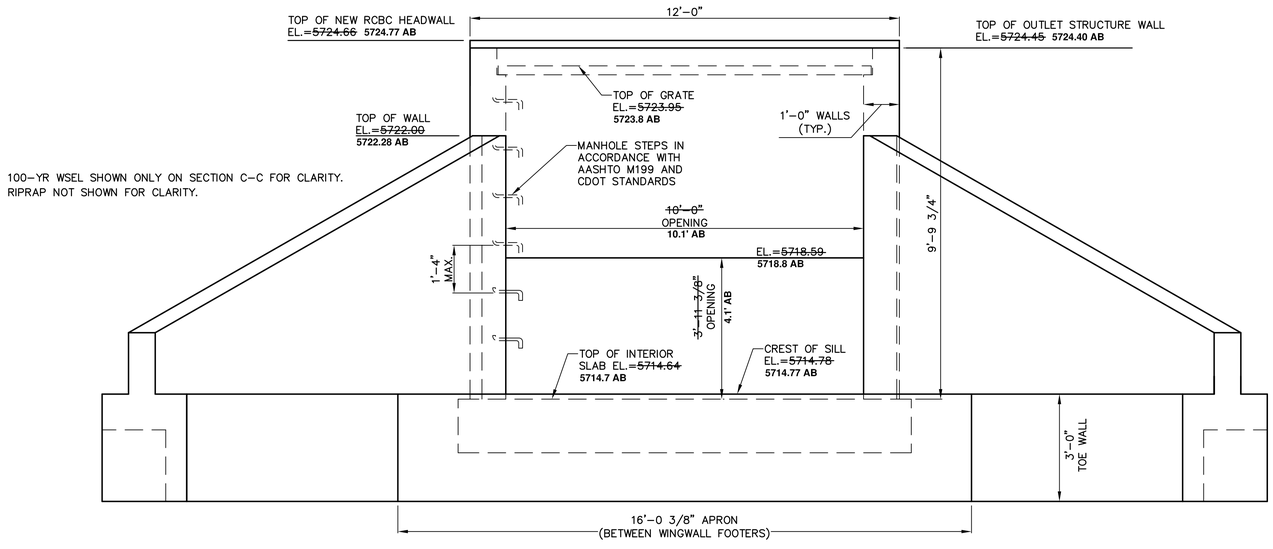
SCALE: 1"=2'

NOTES

1. SECTION D-D IS DOWNSTREAM OF SILL/END OF APRON ONLY.
2. SEE CDOT DETAIL M-601-20 ON SHEET 18 FOR REINFORCEMENT DETAILS.

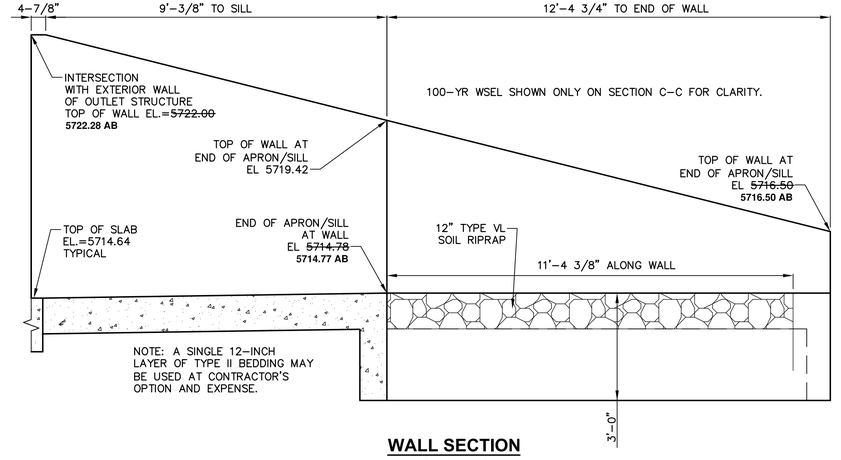
AS-BUILT

AS-BUILT PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY AZTEC CONSULTANTS, INC. 8/01/12



ELEVATION A-A

SCALE: 1"=2'



WALL SECTION

SCALE: 1"=2'

NOTES

1. SEE SHEETS 13, 14, AND 16 FOR ALL APPLICABLE NOTES.

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1-800-922-1987
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950 SOUTH CHERRY STREET
SUITE 404
DENVER, COLORADO 80246
PHONE NO: (303) 757-8513
FAX NO: (303) 758-3208

DESIGNED LONCO
DRAWN JHN
CHECKED LONCO
DATE 05/31/11
AS-BUILT

NO.	BY	DATE	REVISION DESCRIPTION
2	JHN	11-11-11	90% REVIEW COMMENTS
3	JHN	12-9-11	95% REVIEW COMMENTS
4	JHN	1-17-12	CHANGE TRICKEL CHANNEL TO CONCRETE
5	JHN	8-27-12	AS BUILTS

SEMSWA

DETENTION POND L-2

OUTLET STRUCTURE SECTIONS 2

PROJECT NUMBER 2212

SHEET 15

2212\DWG\2212DT.DWG, SECTIONS 2 - 8/27/12 - JHN

CRUSHER FINE TRAIL SPECS.

SIEVE SIZE	CS-1 % PASSING	CS-2 % PASSING	ASTM C-33 % PASSING
3/8"	100	100	100
#4	100	100	95–100
#8	96	97	80–100
#16	78	81	50–85
#30	48	53	25–60
#50	23	26	10–30
#100	5	7	2–10
#200	1.5	2.7	3.0 MAX

HORIZ. CNTRL TRAIL - LINE TABLE

LINE	LENGTH	BEARING
L1	212.85	N46°15'59"E
L2	33.65	N04°50'12"E
L3	35.57	S89°32'32"W
L4	4.03	N85°26'07"W

HORIZ. CNTRL TRAIL - CURVE TABLE

CURVE	DELTA	LENGTH	RADIUS	CHB	CHD
C1	41°25'47"	130.16	180.00	N25°33'06"E	127.34
C2	27°21'39"	89.78	188.00	N08°50'38"W	88.93
C3	27°05'20"	109.69	232.00	S08°58'47"E	108.67
C4	26°06'15"	45.56	100.00	N77°24'20"W	45.17
C5	24°32'58"	38.56	90.00	S76°37'42"E	38.27
C6	3°10'35"	83.16	1500.00	N89°30'32"E	83.15
C7	19°16'08"	67.26	200.00	N82°26'42"W	66.94
C8	12°37'29"	15.42	70.00	S79°07'22"E	15.39
C9	52°10'29"	36.42	40.00	N01°57'58"W	35.18
C10	15°51'32"	101.17	365.53	S16°11'31"W	100.85

OUTLET MODIFICATION SIGN

WARNING
UNAUTHORIZED MODIFICATION OF THIS OUTLET IS AN ARAPAHOE COUNTY LAND DEVELOPMENT CODE VIOLATION

NOTE:
1. ONE OUTLET MODIFICATION SIGN SHALL BE POSTED ON THE OUTLET STRUCTURE OR ON A SUITABLE SIGN POST NEARBY AT THE DIRECTION OF THE OWNERS REPRESENTATIVE.
2. SIGN SHALL HAVE A MINIMUM AREA OF 0.75 SQUARE FEET AND SHALL HAVE RED LETTERING ON A WHITE BACKGROUND.

FLOOD HAZARD WARNING SIGN

WARNING
THIS AREA IS A STORMWATER FACILITY AND IS SUBJECT TO PERIODIC FLOODING

NOTE:
1. TWO SIGNS SHALL BE POSTED AT THE PERIMETER OF THE POND ON A SUITABLE SIGN POST AT A LOCATION DIRECTED BY THE OWNERS REPRESENTATIVE.
2. SIGN SHALL HAVE A MINIMUM AREA OF 3 SQUARE FEET AND SHALL HAVE RED LETTERING ON A WHITE BACKGROUND.

3 STEEL BOLLARDS (BY OTHERS) SEE ARAPAHOE COUNTY. CASE E07-034
SLOPE ESMT. BK. 6216, P.265
FLOOD HAZARD WARNING SIGN PER ACSMM SECTION 13.3.17 (SEE DETAIL THIS SHEET)
12'W X 8'L CONCRETE CURB CUT WITH 6' FLARES PER COUNTY DETAIL SP-04 & CONCRETE PAVING (TO BE CONSTRUCTED IF NOT COMPLETED BY TIME OF BID)
MH RIM TO BE ADJUSTED IF NOT COMPLETED BY TIME OF BID
RIM = ~~5733.24~~ RD 33.15
CONNECT RELOCATED FENCE TO EXIST. FENCE
N 14332.02
E 24724.91
STUB OUT FOR FUTURE 10' WIDE TRAIL
RELOCATED FENCE, CONFIRM LOCATION WITH ARAPAHOE COUNTY OPEN SPACE PRIOR TO INSTALLATION
DOVE VALLEY BUSINESS PARK LOT 4, BLOCK 9
ORIGINAL SCALE: 1"=30'
ACWWA IRRIGATION LINE
PROPOSED VAULT (BY OTHERS)
CONNECT TO PATH BY OTHERS PT = 3+05.54
PROPOSED TRANSFORMER (BY OTHERS)
PT = 3+05.54
PRC = 2+90.11
PRC = 2+22.85
PCC = 1+39.69
PRC = 1+01.13
PC = 0+55.57
EX 15' TYPE R FL=5728.54
EX 36" RCP INV=5722.26
EX WINGWALLS EX 6'X4' RCBC INV=5717.56
ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY CHANNEL W1 4.202 ACRES REC. NO. B1227650 UNPLATTED
BEGIN ALIGNMENT N 14894.68 E 24437.57
BRONCOS PARKWAY
80.00
STA: 0+20 CONNECT TO EXIST. N 14740.35 E 24411.79
TRANSITION FROM 10' TO 12' FROM STA: 5+44.86–5+76.03
END TYPE 1 MAINTENANCE PATH
CONCRETE ACCESS PAD (BY OTHERS)
55'X95' UTILITY ACCESS ESMT.
TRANSITION CONCRETE TRAIL FROM 10' TO 12' FROM TRAIL STA: 2+90.11–3+05.54 END GRAVEL SHOULDER ONCE WALK WIDENS TO 12'
15' WATER EASEMENT
EXCESS CUT MATERIAL TO BE SPREAD OVER LOT 4, BLOCK 9 SEE SEPERATE POND W5 GESC PLANS FOR DETAILS.
EXIST. FENCE TO BE RELOCATED. CONTRACTOR TO VERIFY ALIGNMENT AND CONNECTIONS TO EXISTING FENCE WITH ARAPAHOE COUNTY OPEN SPACE.
EXISTING POND EASEMENT BOOK 6006, PAGE 159
30' WATER ESMT.
25' PSCO ESMT.
10' PUBLIC USE ESMT (BK. 6216, P. 249
EXISTING PROPERTY LINE
OUTLET MODIFICATION SIGN PER ACSMM SECTION 13.3.17 (SEE DETAIL THIS SHEET)
EXIST OUTLET STRUCTURE TO BE MODIFIED AND MICRO-POOL CONSTRUCTED (SEE DETAILS SHEETS 3&4)
APPROXIMATE EXISTING POND WETLAND AREA TO REMAIN EXCEPT FOR PROPOSED FOREBAY AND MICROPOOL AREAS
DRAINAGEWAY CL
MAINTENANCE PATH LANDING (SEE SHEET 4 FOR GRADING DETAILS)
MANHOLE FOREBAY AND 36" STORM SEWER (SEE SHEET 5 FOR DETAILS)
EX 36" RCP
TRANSITION FROM 8' TO 10' FROM STA: 0+56.57–1+01.13
EXISTING EDGE OF WALK
SECONDARY EMERGENCY OVERFLOW LOW POINT IN MEDIAN OF BRONCOS PARKWAY ELEV=5730.1±
100 YEAR WS ELEV=~~5727.84~~ RD 28.40
10 YEAR WS ELEV=~~5725.47~~ RD 25.96
WQCV WS ELEV=5722.56 RD 22.96
WETLAND LIMITS
TYPE 'M' RIPRAP 7.5'W X 8.5'L X 2'D w/ 8" TYPE II BEDDING
TYPE 'M' SOIL RIPRAP w/ 8" TYPE II BEDDING
19"X30" ELLIP. RCP
STA: 7+11.83 BEGIN PROPOSED FOREBAY BERM
PROPOSED FOREBAY W/ CONCRETE SURFACE (SEE DETAIL SHEET 4)
STA: 7+78.65 (DRAINAGEWAY) END CONC. FOREBAY CONSTRUCT 3' TOE WALL AT END (SEE DETAIL SHEET 4)
STA: 8+17.63 EXISTING 48" RCP INVERT ELEV=5723.33
EXISTING 48" RCP
EXISTING WINGWALL TO REMAIN
EXISTING TYPE 'H' RIPRAP STILLING BASIN CURRENTLY SILTED IN (TO REMAIN)
GROUTED BOULDERS (SEE SHEET 4 FOR DETAILS)
EXISTING MAINTENANCE ACCESS TO REMAIN
EXISTING 10' CONC. WALK
FLOOD HAZARD WARNING SIGN PER ACSMM SECTION 13.3.17 (SEE DETAIL THIS SHEET)
STA: 0+00 BEGIN TYPE 1 MAINTENANCE PATH N 14190.32 E 24546.98
STA: 7+36.89 (DRAINAGEWAY) END RIPRAP/BEGIN CONCRETE FOREBAY

NOTES:
1.) USE CASORON G-4, G-10 OR PENDULUM 2-G FOR WEED INHIBITOR

TYPE 1 MAINTENANCE PATH
N.T.S.
4" CRUSHER FINES PER SPEC THIS SHEET
8" COMPACTED CDOT CLASS 6 ROAD BASE
TURF
2%
12"
VARIES – 10'–12' SEE PLANS
UNDISTURBED EARTH OR 95% COMPACTED BACKFILL

TYPE 2 MAINTENANCE PATH
N.T.S.
6" THICK CONCRETE WALK CONSTRUCT PER ACIDCS DETAIL SP-3
6" DEPTH CRUSHER FINES PER SPEC THIS SHEET
1' SHOULDER
VARIES – 8'–12' SEE PLANS
UNDISTURBED EARTH OR 95% COMPACTED BACKFILL

ARAPAHOE COUNTY CASE #E09-012

EXISTING GRADE @ CL BOX CULVERT EL=5730.60
TYPE 2 MAINTENANCE PATH
MAINTENANCE PATH LANDING
EXISITING OUTLET STRUCTURE TO BE MODIFIED SEE SHEET 3 FOR DETAILS
~~5727.84~~=CREST OF EMERGENCY OVERFLOW WEIR (PRIMARY OVERFLOW) RD 28.40
PROPOSED WINGWALL (BEYOND)
MICRO-POOL (1.3% OF WQ)
MICRO-POOL WS ELEV=~~5720.0~~ RD 20.37
MICRO-POOL – SEE DETAIL SHEET 4
TOE WALL – SEE DETAIL SHEET 4
100 YR HGL
Q10 = 96.5 CFS
Q100= 244 CFS
EXISTING 6'X4' CONC. BOX CULVERT L=212.4 @ S=0.68%
STA: 0+00.00 EX 6'X4' RCBC INV=5717.56
STA: 2+12.41 EX 6'X4' RCBC INV=~~5719.90~~ RD 19.39
STA: 2+42.06 BEGIN CONCRETE APRON INV=~~5720.50~~ RD 20.37
100 YR WS ELEV=~~5727.84~~ RD 28.40
10 YR WS ELEV=~~5725.47~~ RD 25.96
WQCV WS ELEV=~~5722.56~~ RD 22.96
EXISTING GROUND @ POND LOW FLOW SWALE
6' WIDE TOP OF BERM
STA: 7+26.89 TOP OF BERM FG=~~5726.5~~ RD 24.5
STA: 7+32.89 TOP OF BERM FG=~~5726.5~~ RD 24.5
EXISTING WINGWALL (BEYOND)
PROPOSED FOREBAY BERM TYPE 'M' SOIL RIPRAP W/ 8" TYPE II BEDDING
RD 23.0
31.9 LF 19"X30" RCP @ ~~2.32%~~ RD 1.1%
JOINT RESTRAINT PER CDOT M-603-10
TYPE 'M' RIPRAP 7.5'W X 8.5'L X 2'D w/ 8" TYPE II BEDDING
3' DEPTH 8" THICK CONCRETE TOEWALL (SEE SHEET 4 FOR DETAIL)
STA: 7+03.90 BEGIN TYPE 'M' RIPRAP
STA: 7+13.90 19"X30" RCP FES INV=~~5725.28~~ RD 21.83
STA: 7+44.89 BEGIN 19"X30" ELLIP. RCP INV=~~5724.60~~ RD 22.19
B48 BOULDERS
4 @ 4 0.5' BOULDER SILL (SEE DETAIL SHEET 4)
0.45%
Q10 = 73 CFS
Q100= 148 CFS
EXISTING 48" STM @ S=2.00%
GROUTED B24 BOULDERS 2D DEPTH
CONCRETE FOREBAY SEE DETAIL–SHEET 4
3' TOEWALL
STA: 7+78.86 END GROUTED RIPRAP / BEGIN CONCRETE FL=~~5724.10~~ RD 23.40
STA: 8+17.35 EX 48" RCP INV=~~5723.85~~ RD 22.22
REMOVE EXISTING SEDIMENT AND FILL W/ NATIVE SOILS TO 26" BELOW TOP OF BOULDERS COMPACT TO 95% MODIFIED PROCTOR
EXISTING TYPE 'H' RIPRAP TO BE LEFT IN PLACE
SCALE: 1"=30' HORIZ. 1"=3' VERT.
0+00 0+60 1+20 1+80 2+40 3+00 3+60 4+20 4+80 5+40 6+00 6+60 7+20 7+80 8+40 9+00
5730 5724 5718 5712

SCALE VERIFICATION
THIS SHEET IS ORIGINALLY PRODUCED ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

Call utility notification center of Colorado 2 Working days before you dig
DigSafely. 1-800-922-1987
www.uncc.org
for marking of underground member utilities

REUSE OF DOCUMENT
THIS DOCUMENT AND THE IDEAS & DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF JEHN ENGINEERING & IS NOT TO BE USED FOR ANY OTHER PROJECT WITHOUT WRITTEN AUTHORIZATION OF JEHN ENGINEERING.

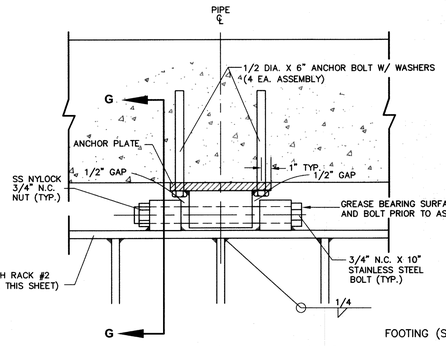
NO.	DESCRIPTION	DATE	BY
1.	REVISIONS PER COMMENTS	10/09	BSS
2.	REVISIONS PER COMMENTS	12/09	BSS

JEHN ENGINEERING LLC
5680 WEBSTER STREET
ARVADA, CO 80002
PH: (303) 423-6236 FAX: (303) 467-9438

WINDMILL CREEK WATER QUALITY AND DETENTION POND W5 IMPROVEMENTS
POND PLAN & PROFILE
prepared for: ARAPAHOE COUNTY/SEMSWA

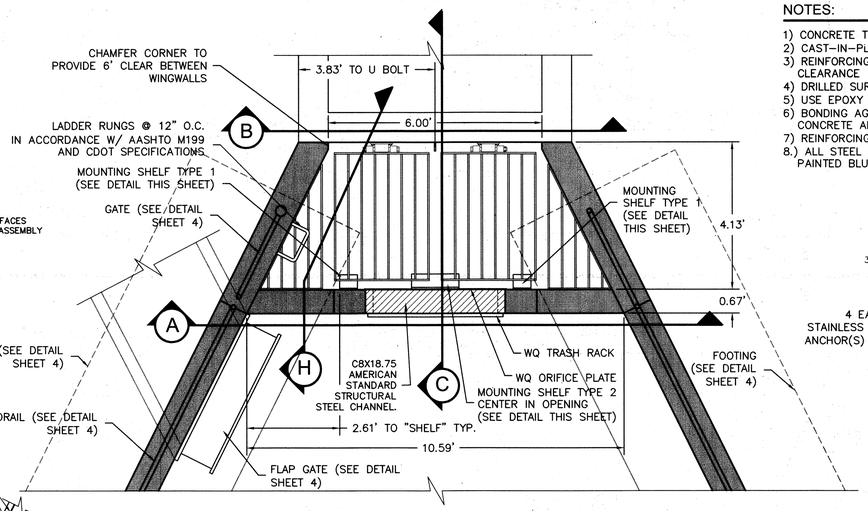
DRAWN BY: MWG
DESIGNED BY: MWG
DRAWING NAME: 8018-POND-W5
APPROVED BY:
JOB NUMBER: 1904-208-018
DATE: MAY. 2009
SCALE: 1" = 30'
SHEET NO: 2 of 6

SEMSWA CASE #C08-1005



ACCESS GRATE HINGE DETAIL - PLAN VIEW

NOTE: FABRICATED HINGES SHOWN IN THIS DETAIL MAY BE SUBSTITUTED WITH COMMERCIALLY AVAILABLE HINGE COMPONENTS ON APPROVAL OF THE ENGINEER.

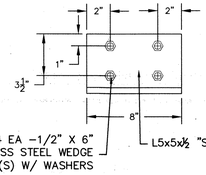


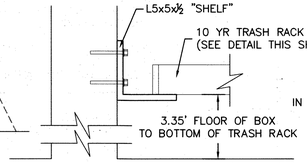
POND OUTLET STRUCTURE - PLAN VIEW

N.T.S.

NOTES:

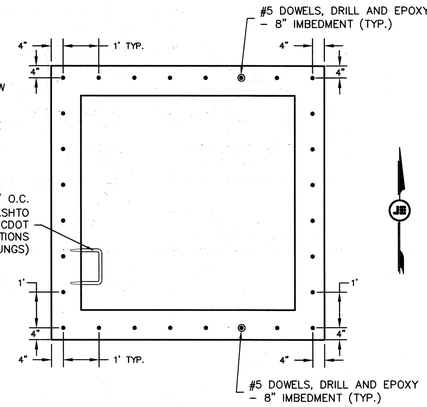
1) CONCRETE TO BE CDOT CLASS D..
2) CAST–IN–PLACE CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES
3) REINFORCING BARS SHALL BE DEFORMED AND SHALL HAVE A 2" MINIMUM CLEARANCE
4) DRILLED SURFACE TO BE CLEANED BEFORE INSTALLATION OF DOWEL.
5) USE EPOXY GROUTING IN DRILLED HOLES BEFORE PLACEMENT OF DOWEL.
6) BONDING AGENT TO BE APPLIED TO EXISTING CONCRETE SURFACE WHERE NEW CONCRETE ADDED.
7) REINFORCING STEEL SHALL BE GRADE 60
8.) ALL STEEL ANGLES AND HINGES TO BE HOT DIP GALVANIZED. GRATE TO BE PAINTED BLUE TO MATCH THE COLOR THE THE EXISTING GRATE.

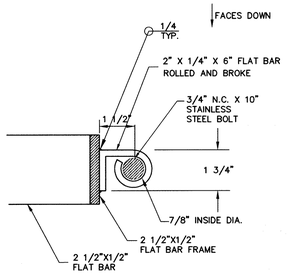




MOUNTING SHELF TYPE 1

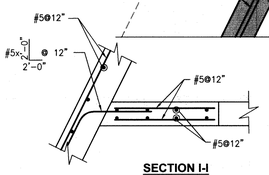
N.T.S.





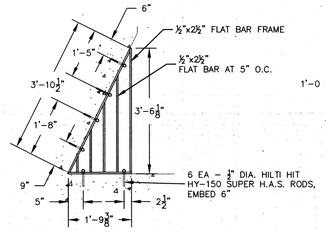
TYPICAL HINGE SECTION G-G

2 EACH PER HINGE



SECTION I-I

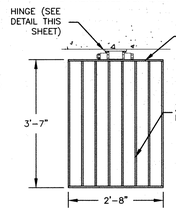
N.T.S.



10 YR TRASH RACK - TYPE 1

N.T.S.

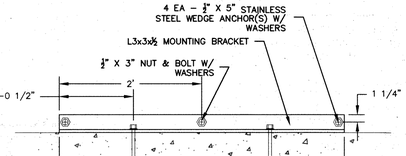
*NOTE: AN EXACT MIRROR OF THIS TRASH RACK IS TO FABRICATED FOR EAST SIDE



10 YR TRASH RACK - TYPE 2

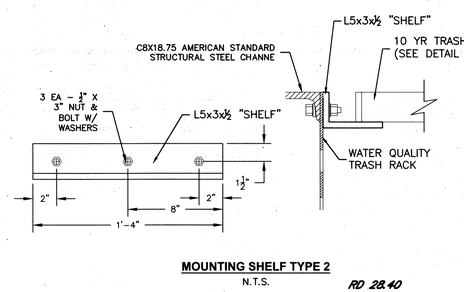
N.T.S.

*NOTE: FABRICATE TWO IDENTICAL TYPE 2 TRASH RACKS



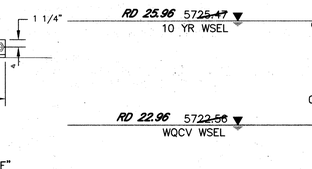
WQ MOUNTING BRACKET

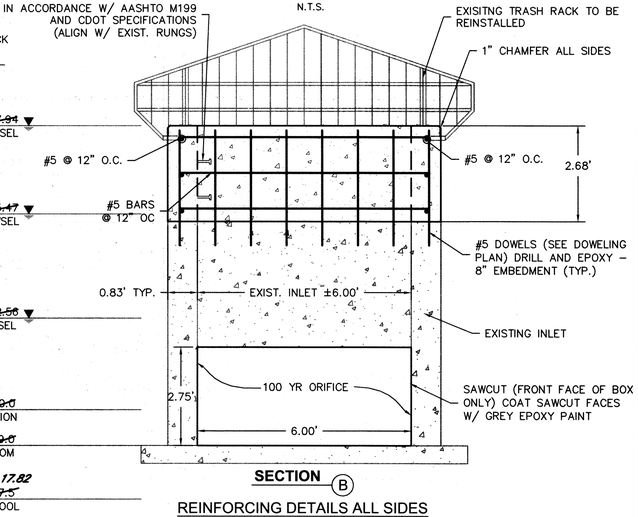
N.T.S.



MOUNTING SHELF TYPE 2

N.T.S.





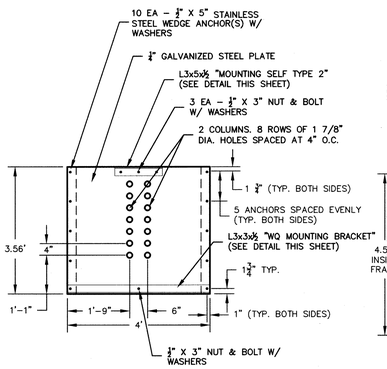
DOWELING PLAN

N.T.S.

SECTION (B)

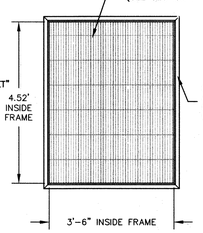
REINFORCING DETAILS ALL SIDES

N.T.S.



WATER QUALITY ORIFICE PLATE

N.T.S.



WATER QUALITY TRASH RACK

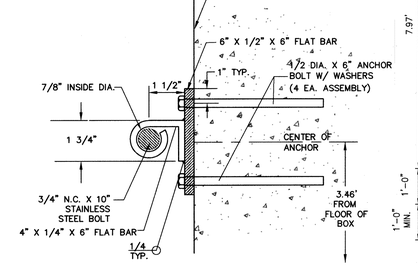
N.T.S.

SECTION (A)

N.T.S.

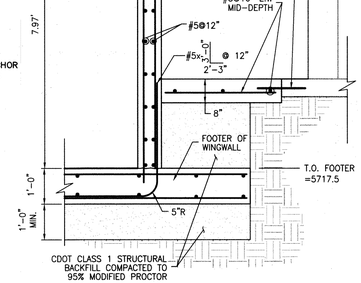
SECTION (C)

N.T.S.



TYPICAL HINGE MOUNTING ASSEMBLY IN HEAD WALL

1 EACH PER HINGE



SECTION (H)

N.T.S.

ARAPAHOE COUNTY CASE #E09-012

Call utility notification center of Colorado 2–business days in advance before you dig. DigSafely. 1-800-922-1987 www.unco.org for marking of underground member utilities.

SCALE VERIFICATION
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

REUSE OF DOCUMENT
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REVISIONS

NO.	DESCRIPTION	DATE	BY
1.	REVISIONS PER COMMENTS	10/09	BSS
1.	REVISIONS PER COMMENTS	12/09	BSS

JEHN ENGINEERING
5690 WEBSTER STREET
ARVADA, CO 80002
PH: (303) 422-8436 FAX: (303) 467-9438

WINDMILL CREEK WATER QUALITY AND DETENTION POND W5 IMPROVEMENTS

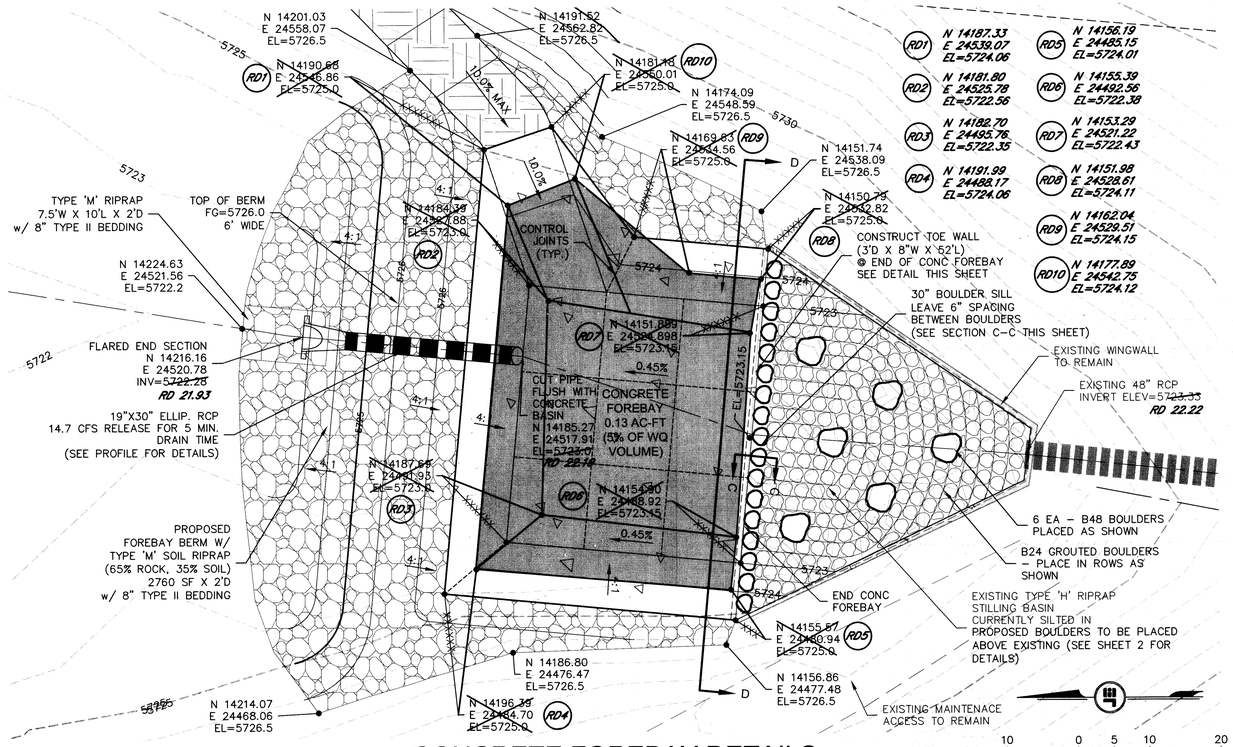
OUTLET STRUCTURE DETAILS

prepared for
ARAPAHOE COUNTY / SEMSWA

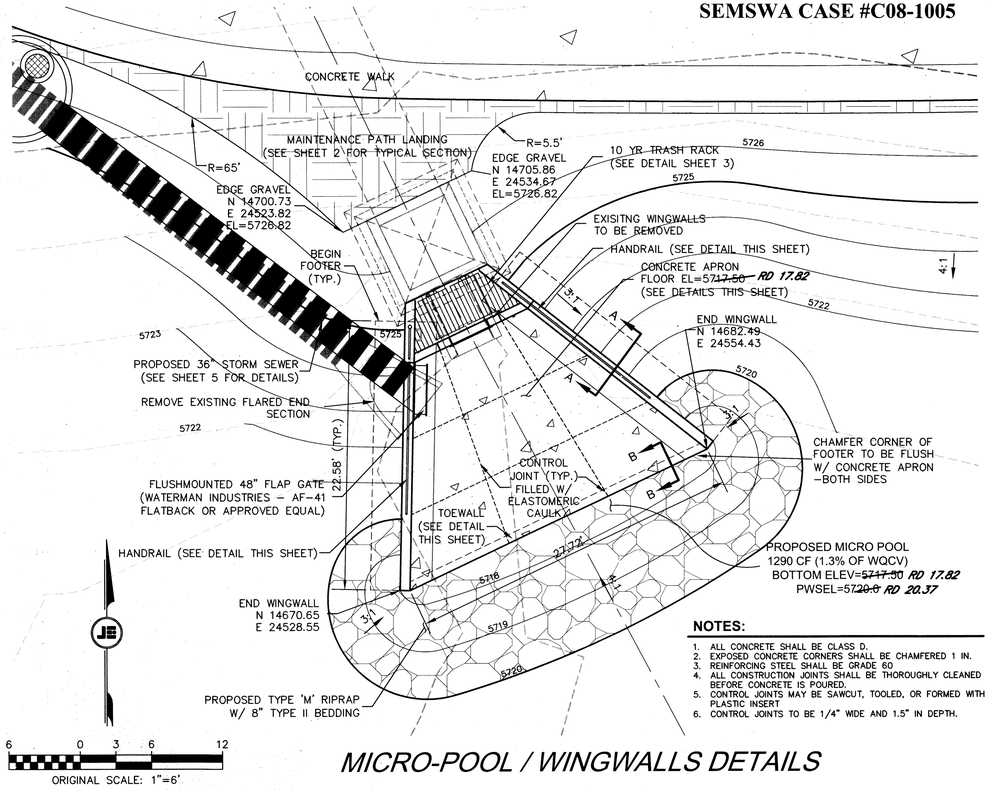
DRAWN BY: KNB
DESIGNED BY: KNB
DRAWING NAME: POND-W5-DET1
APPROVED BY:

JOB NUMBER: 1904-208-018
DATE: MAY 2009
SCALE: NO SCALE
SHEET NO: 3 OF 6

SEMSWA CASE #C08-1005



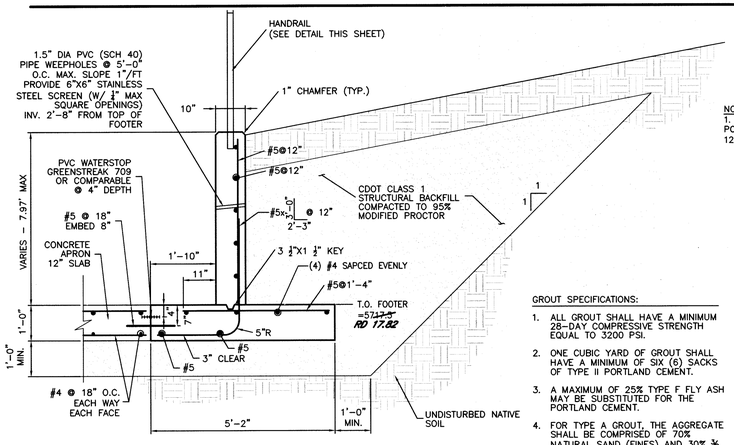
CONCRETE FOREBAY DETAILS



MICRO-POOL / WINGWALLS DETAILS

NOTES:

1. ALL CONCRETE SHALL BE CLASS D.
2. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 1 IN.
3. REINFORCING STEEL SHALL BE GRADE 60
4. ALL CONSTRUCTION JOINTS SHALL BE THOROUGHLY CLEANED BEFORE CONCRETE IS POURED.
5. CONTROL JOINTS MAY BE SAWCUT, TOOLED, OR FORMED WITH PLASTIC INSERT
6. CONTROL JOINTS TO BE 1/4" WIDE AND 1.5" IN DEPTH.



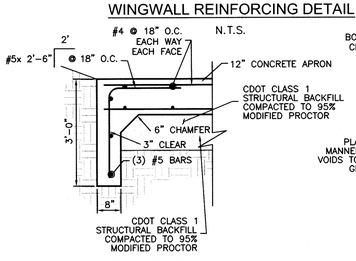
SECTION A-A

WINGWALL REINFORCING DETAIL

N.T.S.

GROUT SPECIFICATIONS:

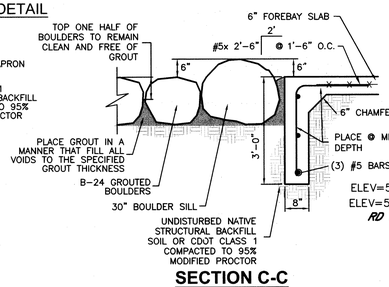
1. ALL GROUT SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH EQUAL TO 3200 PSI.
2. ONE CUBIC YARD OF GROUT SHALL HAVE A MINIMUM OF SIX (6) SACKS OF TYPE II PORTLAND CEMENT.
3. A MAXIMUM OF 25% TYPE F FLY ASH MAY BE SUBSTITUTED FOR THE PORTLAND CEMENT.
4. FOR TYPE A GROUT, THE AGGREGATE SHALL BE COMPRISED OF 70% NATURAL SAND (FINES) AND 30% ⅜-INCH ROCK (COARSE).



SECTION B-B

TOEWALL REINFORCING DETAIL

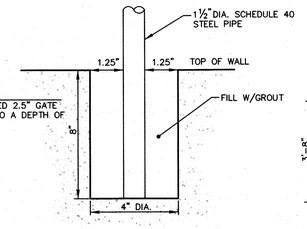
N.T.S.



SECTION C-C

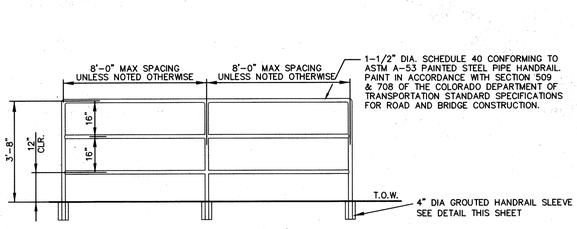
TOEWALL REINFORCING / BOULDER SILL DETAIL

N.T.S.



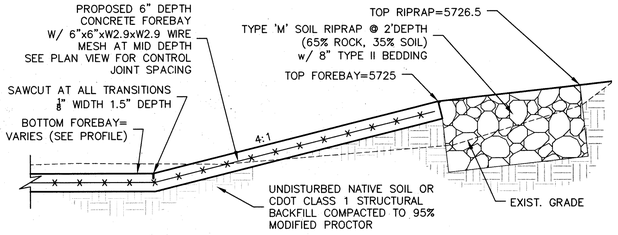
GROUTED HAND RAIL SLEEVE DETAIL

N.T.S.



STEEL HAND RAIL DETAIL

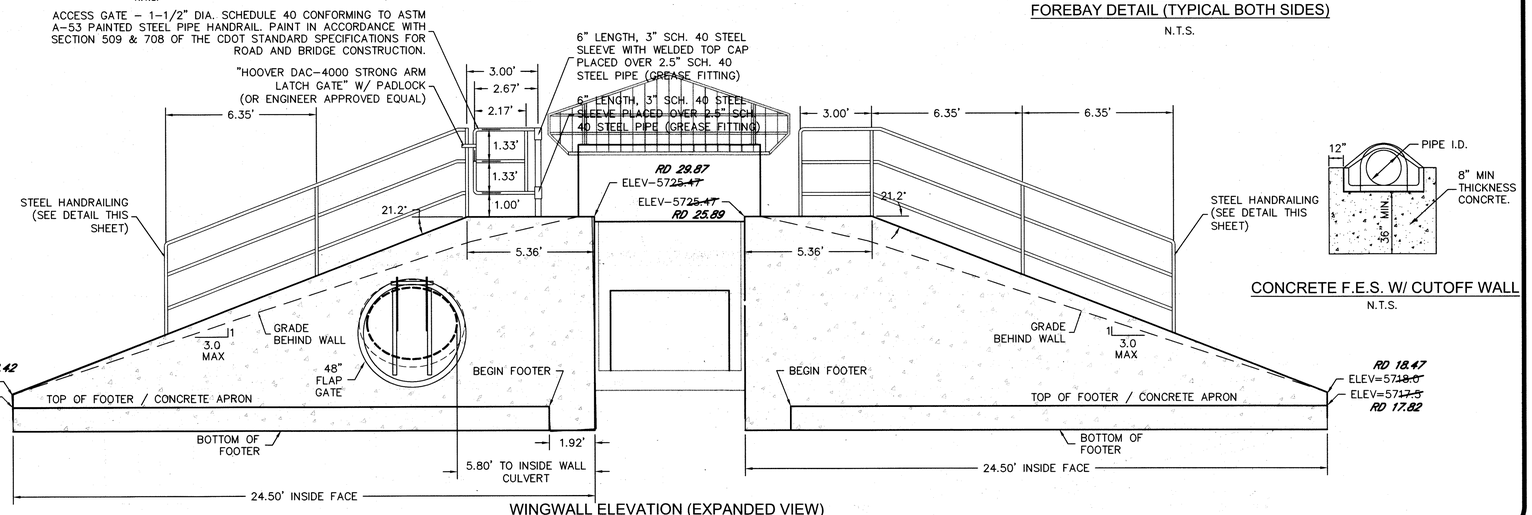
N.T.S.



SECTION D-D

FOREBAY DETAIL (TYPICAL BOTH SIDES)

N.T.S.



WINGWALL ELEVATION (EXPANDED VIEW)

N.T.S.

CONCRETE F.E.S. W/ CUTOFF WALL

N.T.S.

ARAPAHOE COUNTY CASE #E09-012

SCALE VERIFICATION
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

Call utility notification center of Colorado 2-business days in advance before you dig.
DigSafely. 1-800-922-1987
for marking of underground member utilities.
www.uncc.org

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REVISIONS

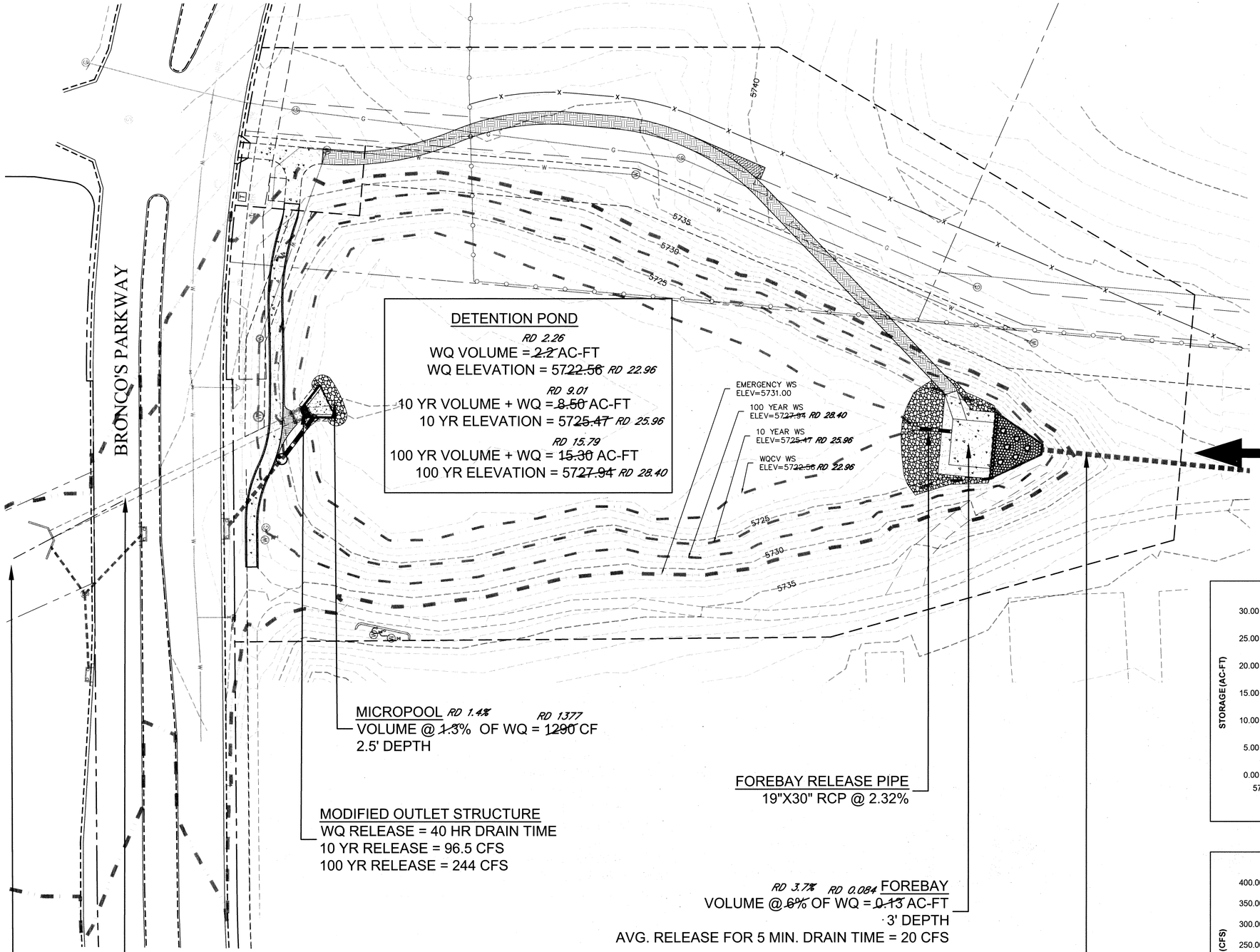
NO.	DESCRIPTION	DATE	BY
1.	REVISIONS PER COMMENTS	10/09	BSS
2.	REVISIONS PER COMMENTS	12/09	BSS

JEHN ENGINEERING
5680 WEBSTER STREET
ARVADA, CO 80002
PH: (303) 423-6036 FAX (303) 467-8438

WINDMILL CREEK WATER QUALITY AND DETENTION POND W5 IMPROVEMENTS
FOREBAY & MICRO POOL DETAILS
RETAINING WALL PROFILE
prepared for
ARAPAHOE COUNTY/SEMSWA

DRAWN BY: KNB
DESIGNED BY: KNB
DRAWING NAME: 0618-FB-MS01
APPROVED BY:
JOB NUMBER: 1904-208-018
DATE: MAY 2009
SCALE: AS NOTED
SHEET NO: 4 of 6

SEMSWA CASE #C08-1005



DETENTION POND

RD 2.26
WQ VOLUME = ~~2.2~~ AC-FT
WQ ELEVATION = 57~~22.56~~ RD 22.96

RD 9.01
10 YR VOLUME + WQ = ~~8.50~~ AC-FT
10 YR ELEVATION = 57~~25.47~~ RD 25.96

RD 15.79
100 YR VOLUME + WQ = ~~15.30~~ AC-FT
100 YR ELEVATION = 57~~27.94~~ RD 28.40

TRIBUTARY BASINS W14 - W15

TRIBUTARY AREA = 119.60 AC
PERCENT IMPERVIOUSNESS = 41.67%
TOTAL 100 YR PEAK INFLOW = 646 CFS

MICROPOOL RD 1.4%
VOLUME @ ~~1.3~~% OF WQ = ~~1290~~ RD 1377 CF
2.5' DEPTH

FOREBAY RELEASE PIPE
19"X30" RCP @ 2.32%

MODIFIED OUTLET STRUCTURE
WQ RELEASE = 40 HR DRAIN TIME
10 YR RELEASE = 96.5 CFS
100 YR RELEASE = 244 CFS

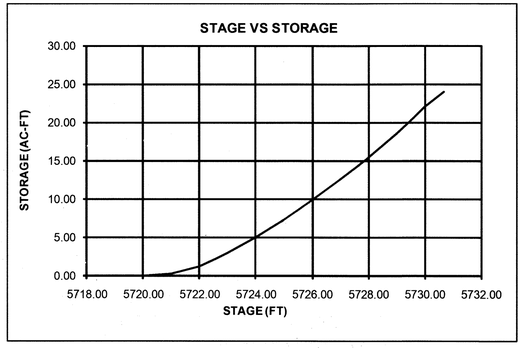
RD 3.7% RD 0.084 FOREBAY
VOLUME @ ~~6%~~ OF WQ = ~~0.13~~ AC-FT
3' DEPTH
AVG. RELEASE FOR 5 MIN. DRAIN TIME = 20 CFS

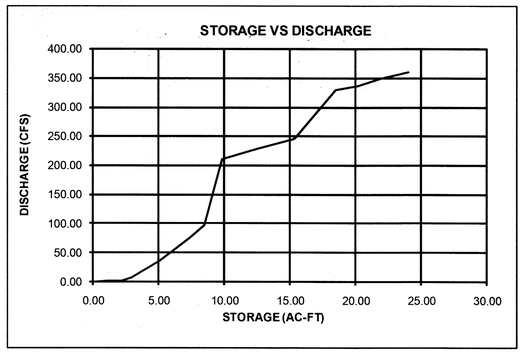
EXISTING 4'X6' CONC. BOX CULVERT
L=212.4 @ S=0.68%

SEMSWA DRAINAGE CHANNEL W1

EXISITNG STORM DRAIN
48" DIA. RCP @ 2.0%

Q10 = 73 CFS
Q100 = 148 CFS





ARAPAHOE COUNTY CASE #E09-012

SCALE VERIFICATION
BAR MEASURES 1" ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

Call utility notification center of Colorado 2-business days in advance before you dig. DigSafely. 1-800-922-1987 www.colorado.org for marking of underground member utilities.

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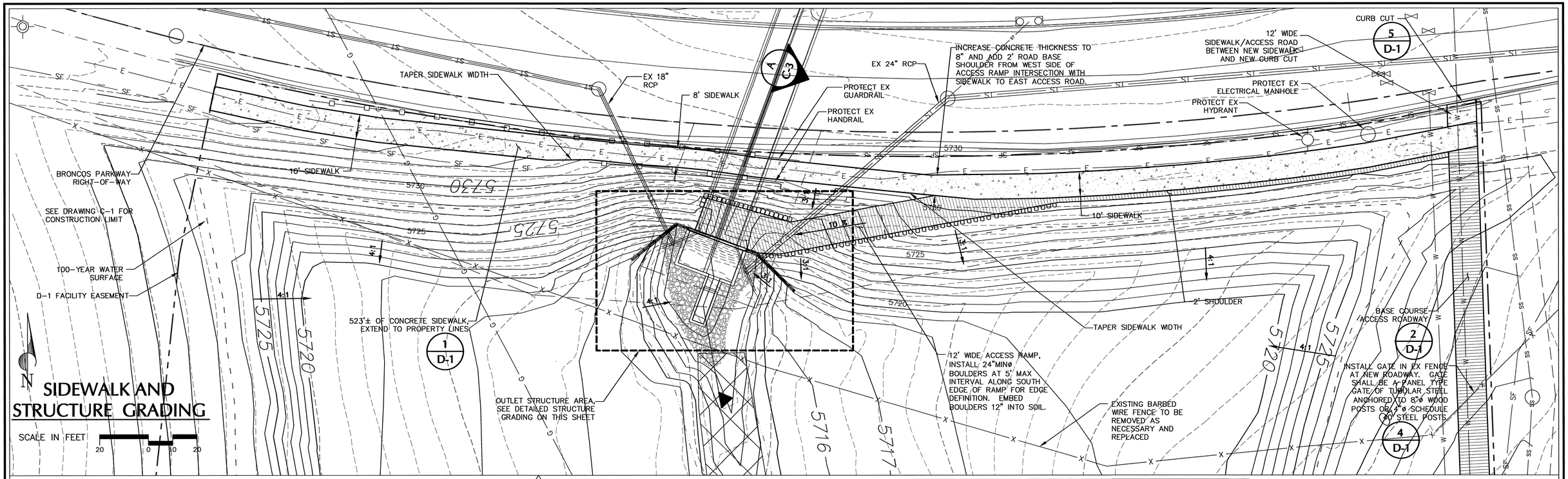
REVISIONS

NO.	DESCRIPTION	DATE	BY
1.	REVISIONS PER COMMENTS	10/09	BSS
2.	REVISIONS PER COMMENTS	12/09	BSS

JEHN ENGINEERING
5680 WEBSTER STREET
ARVADA, CO 80002
PH: (303) 423-8036 FAX: (303) 467-9438

WINDMILL CREEK WATER QUALITY AND DETENTION POND W5 IMPROVEMENTS
DRAINAGE SUMMARY INFORMATION
prepared for
ARAPAHOE COUNTY/SEMSWA

DRAWN BY: MWG
DESIGNED BY: MWG
DRAWING NAME: 8018-POND-W5
APPROVED BY:
JOB NUMBER: 1904-208-018
DATE: MAY 2009
SCALE: 1" = 30'
SHEET NO: 6 of 6



SIDEWALK AND STRUCTURE GRADING

SCALE IN FEET 20 0 10 20

LEGEND

EXISTING FEATURES

CONTROL POINT	CONTOUR; 5 FOOT
FOUND REBAR W/ CAP	CONTOUR; 1 FOOT
SET NO. 4 REBAR	ELECTRIC–UNDERGROUND
FIRE HYDRANT	TELEPHONE
WATER VALVE	GAS
TEST HOLE	SANITARY SEWER
MANHOLE	STORM SEWER/CULVERT
APPROXIMATE WETLANDS LOCATION	WATER
	SILT FENCE
RCBC REINFORCED CONCRETE BOX CULVERT	FENCE–BARBED WIRE
	GUARDRAIL
APPROXIMATE WETLAND AREA	METAL HANDRAIL
	CHANNEL/DITCH
	LOT LINE
	RIGHT OF WAY
	SECTION LINE
	EASEMENT
	PROPERTY LINE/DRAINAGE EASEMENT

PROPOSED FEATURES

CONCRETE SURFACE	10 YR VOLUME; ~~21.7~~ ACFT 22.04 RD (6)
BASE COURSE SURFACE	100 YR VOLUME; ~~34.3~~ ACFT 34.65 RD
RIP RAP	
	PROPOSED RAILING
	~~PROPOSED~~ CONTOUR; 1 FOOT RD (6)
5685	~~PROPOSED~~ CONTOUR; 5 FOOT RD (6)
	PROPOSED STRUCTURE
	PROPOSED BOULDERS

RECORD DOCUMENT

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RECORD DOCUMENT

RECORD PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY JONES ENGINEERING ASSOCIATES, INC., 3/17/10

E08-027

(6) 5712.48 RD — EX 18" RCP TO REMAIN AND BE CUT–OFF FLUSH WITH AND INTEGRATED INTO NEW WINGWALL, INVERT ~~5712.1~~ TO BE FIELD VERIFIED AND FINISHED GRADE AT CULVERT ADJUSTED AS NECESSARY TO MATCH CULVERT INVERT

(6) 5723.92 RD — T.O.W. EL ~~5724.00~~ B.O.W. EL 5712.00

(6) 5724.02 RD — T.O.W. EL ~~5724.00~~ B.O.W. EL 5712.00

CONCRETE OUTLET STRUCTURE, SEE STRUCTURAL SHEETS. EXISTING STRUCTURE TO BE DEMOLISHED NOT SHOWN

(6) 5716.94 RD — T.O.W. EL ~~5717.00~~ B.O.W. EL 5716.00

RIPRAP PROTECTION AT PIPE OUTFALLS AND IN CHANNEL BELOW ELEVATION 5712. EXTEND TO STRUCTURE AND WINGWALLS AS SHOWN

3
D-1

MICROPOOL EL ~~5708.40~~ (6) 5708.37 RD

TWIN 6'-0" x 8'-0" RCBC CULVERTS TO REMAIN

30" MAX. HIGH WALL OF 36"ø BOULDERS EMBEDDED 6" AND UNDERLAIN WITH MIRAFI 1120 N FABRIC

BOTTOM OF RAMP ELEVATION 5724'

SLOPE TO DRAIN

13.8'

15.6'

7.5'± RIPRAP TYP BOTH SIDES

T.O.W. EL ~~5726.70~~ 5726.63 RD

(6) 5724.00 RD — T.O.W. EL ~~5724.00~~ B.O.W. EL 5712.00

(6) 5723.94 RD — T.O.W. EL ~~5724.00~~ B.O.W. EL 5712.00

T.O.W. EL ~~5721.71~~ (6) 5721.60 RD

T.O.W. EL ~~5710.90~~ 5710.83 RD (6)

EX 24" RCP TO REMAIN AND BE CUT–OFF FLUSH WITH AND INTEGRATED INTO NEW WINGWALL, INVERT ~~5712.1~~ TO BE FIELD VERIFIED AND FINISHED GRADE AT CULVERT ADJUSTED AS NECESSARY TO MATCH CULVERT INVERT (6) 5711.8 RD

ACCESS RAMP, 10% MAX. GRADE
2
D-1

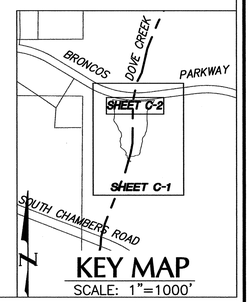
INSTALL 24" MINø BOULDERS AT 5' MAX INTERVAL ALONG SOUTH EDGE OF ACCESS RAMP FOR EDGE DEFINITION. EMBED BOULDERS 12" INTO SOIL.

HANDRAIL, TYP ON TOP OF BOTH WINGWALLS, SEE STRUCTURAL SHEETS

(6) 5719.09 RD — T.O.W. EL ~~5719.00~~ B.O.W. EL 5718.00

DETAILED STRUCTURE GRADING

SCALE IN FEET 8 0 4 8



KEY MAP

SCALE: 1"=1000'

WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

NO.	BY	DATE	REVISIONS DESCRIPTION	COMMENTS
1	DKW	05/05/09	INCORPORATE COMMENTS, REVISED TO ADD WQCV OUTLET	BASE MAPPING PROVIDED BY COTTONWOOD SURVEYING AND ASSOCIATES, INC.
2	DKW	08/05/09	INCORPORATE COMMENTS	
3	DKW	08/26/09	REVISED PROPERTY BOUNDARY PER LEGAL DESCRIPTION	
4	DKW	09/10/09	REVISED BOUNDARY, WIDENED SIDEWALK TO 8' MIN., DECREASED BOULDER WALL TO 30" MAX HEIGHT	
5	DKW	09/22/09	ISSUED FOR BID	
6	DKW	07/08/10	RECORD DRAWING	

COLORADO REGISTERED 38868 PROFESSIONAL ENGINEER

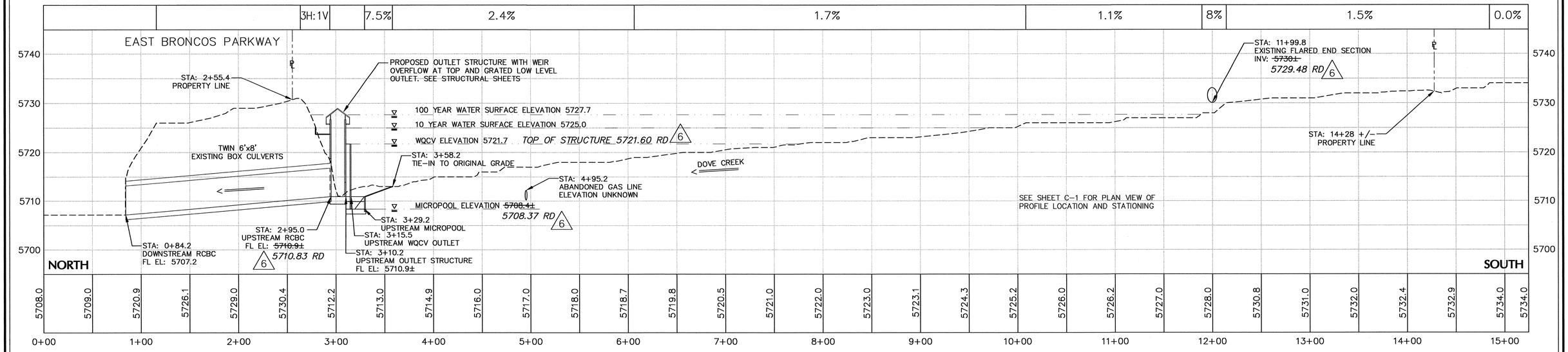
		DATE
DESIGN	DKW/CMC	05/05/09
DETAIL	DKW/CMC	05/05/09
CHECK	DWF/WFL	05/05/09
APPROVAL		
SCALE		NOTED
FILE	D1 C SHEETS.dwg	

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

SIDEWALK AND STRUCTURE GRADING AND DETAILED STRUCTURE GRADING

JOB NO. 071–136.000
REVISION NO. 6
SHEET NO. C-2

Plot Date/Time: 07/08/2010, 10:57:08 AM; Z:\PROJECT FILES\07\071-136\071-136.000\CAD-GIS\CAD\DESIGN\RECORD DRAWINGS 07\10\D1 C SHEETS.DWG-C-2



PROFILE ALONG CHANNEL

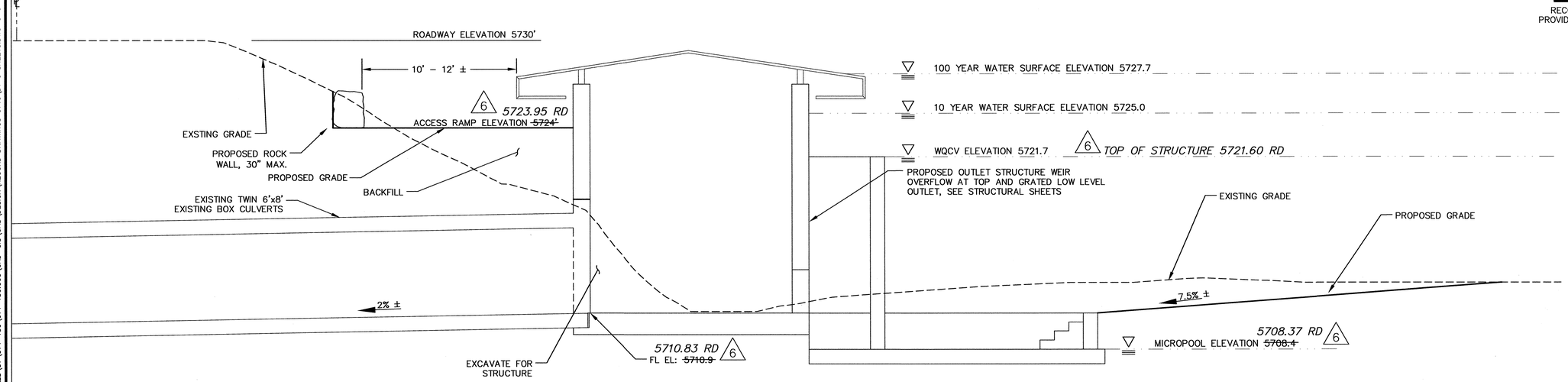
SCALE: HORIZONTAL 1" = 50' (50 0 25 50) VERTICAL 1" = 10' (10 0 5 10)

RECORD DOCUMENT

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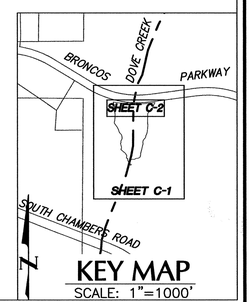
RECORD DOCUMENT

RECORD PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY JONES ENGINEERING ASSOCIATES, INC., 3/17/10



A C-3 **DIVERSION STRUCTURE SECTION**

SCALE: 1" = 4' (4 0 2 4)



E08-027

WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

NO.	BY	DATE	REVISIONS DESCRIPTION	COMMENTS
1	DKW	05/05/09	INCORPORATE COMMENTS, REVISED TO ADD WQCV OUTLET	BASE MAPPING PROVIDED BY COTTONWOOD SURVEYING AND ASSOCIATES, INC.
2	DKW	08/05/09	INCORPORATE COMMENTS	
3	DKW	08/26/09	REVISED PROPERTY BOUNDARY PER LEGAL DESCRIPTION	
4	DKW	09/10/09	DECREASED BOULDER WALL TO 30" MAX HEIGHT, REVISED 10-YEAR WATER SURFACE ELEVATION	
5	DKW	09/22/09	ISSUED FOR BID	
6	DKW	07/08/10	RECORD DRAWING	

COLORADO REGISTERED 38868 PROFESSIONAL ENGINEER

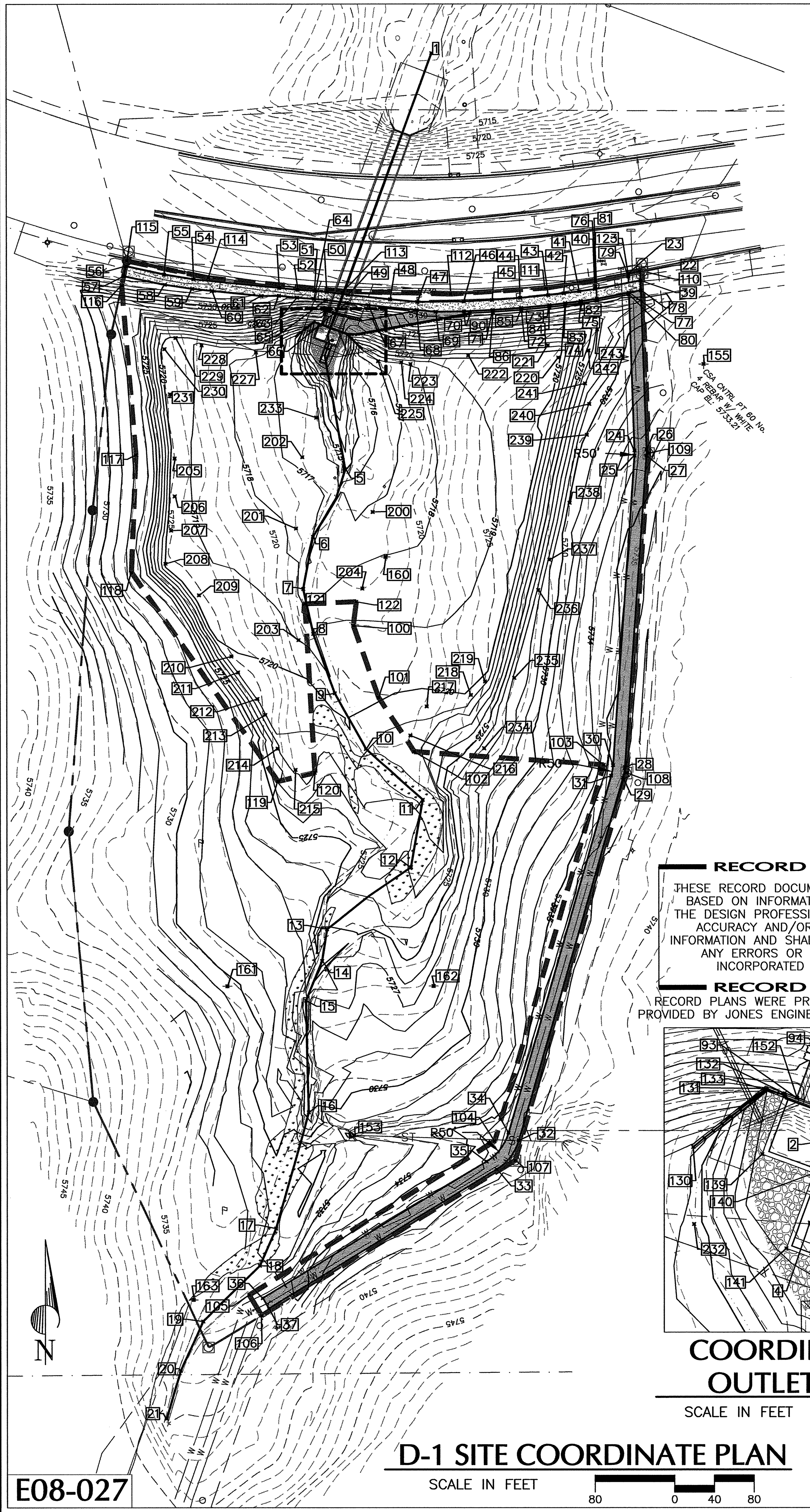
		DATE
DESIGN	DKW/CMC	05/05/09
DETAIL	DKW/CMC	05/05/09
CHECK	DWF/WFL	05/05/09
APPROVAL		
SCALE		NOTED
FILE	D1 C SHEETS.dwg	

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

PROFILE ALONG CHANNEL AND DIVERSION STRUCTURE SECTION

JOB NO. 071-136.000
REVISION NO. 6
SHEET NO. C-3

Plot Date/Time: 07/08/2010, 10:57:22 AM; Z:\PROJECT FILES\071-136\071-136.000\CAD-GIS\CAD\DESIGN\RECORD DRAWINGS 0710\D1 C SHEETS.DWG-C-3



E08-027

D-1 SITE COORDINATE PLAN

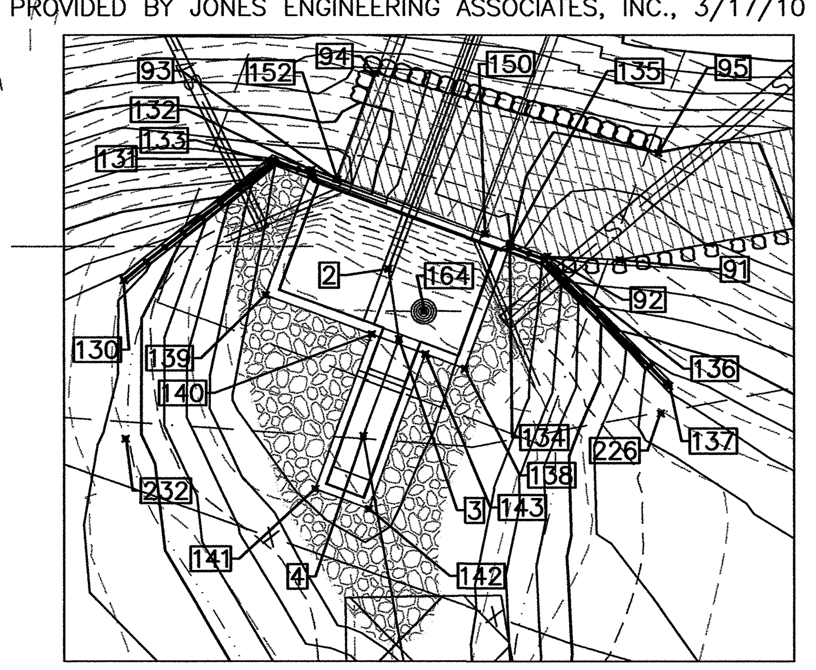
SCALE IN FEET 80 0 40 80

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RECORD DOCUMENT

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COORDINATE PLAN AT OUTLET STRUCTURE

SCALE IN FEET 20 0 10 20

SITE COORDINATES

Point Table

Point #	Raw Description	Northing	Easting	Elevation
1	PROFILE ALIGNMENT STA. 0+00	14342.6365	26323.0316	
2	PROFILE ALIGNMENT STA. 3+01	14060.3205	26218.6159	
3	PROFILE ALIGNMENT STA. 3+10	14051.7789	26219.9074	
4	PROFILE ALIGNMENT STA. 3+22	14039.9752	26215.5487	
5	PROFILE ALIGNMENT STA. 4+38	13925.9141	26236.0263	
6	PROFILE ALIGNMENT STA. 5+13	13858.8693	26203.4070	
7	PROFILE ALIGNMENT STA. 5+67	13806.4568	26193.5552	
8	PROFILE ALIGNMENT STA. 6+13	13761.1419	26203.6327	
9	PROFILE ALIGNMENT STA. 6+76	13701.6291	26225.1352	
10	PROFILE ALIGNMENT STA. 7+41	13645.4492	26256.4285	
11	PROFILE ALIGNMENT STA. 8+17	13594.4168	26313.5357	
12	PROFILE ALIGNMENT STA. 8+85	13527.1070	26301.6018	
13	PROFILE ALIGNMENT STA. 9+90	13465.4426	26217.1869	
14	PROFILE ALIGNMENT STA. 10+22	13433.6427	26212.1482	
15	PROFILE ALIGNMENT STA. 10+65	13394.2630	26195.9436	
16	PROFILE ALIGNMENT STA. 11+77	13281.7573	26198.5969	
17	PROFILE ALIGNMENT STA. 12+99	13165.0493	26165.6935	
18	PROFILE ALIGNMENT STA. 13+39	13128.0792	26149.2025	
19	PROFILE ALIGNMENT STA. 14+19	13072.6943	26092.1850	
20	PROFILE ALIGNMENT STA. 14+74	13021.9697	26069.6193	
21	PROFILE ALIGNMENT STA. 15+24	12973.7398	26055.5638	
22	ACCESS ROAD	14124.3899	26532.8750	5733.0
23	ACCESS ROAD	14122.1004	26520.9468	5729.8
24	ACCESS ROAD	13944.7321	26527.0675	5732.9
25	ACCESS ROAD	13939.5050	26526.9744	5733.0
26	ACCESS ROAD	13945.6262	26539.0453	5733.0
27	ACCESS ROAD	13939.2910	26538.9890	5733.2
28	ACCESS ROAD	13626.8451	26517.0466	5736.0
29	ACCESS ROAD	13616.4185	26515.1900	5736.0
30	ACCESS ROAD	13628.9607	26505.1656	5735.8
31	ACCESS ROAD	13618.5341	26503.3090	5735.8
32	ACCESS ROAD	13253.0343	26409.7829	5737.0
33	ACCESS ROAD	13224.1937	26387.6609	5737.0
34	ACCESS ROAD	13260.8739	26399.5623	5736.8
35	ACCESS ROAD	13232.0334	26377.4403	5736.8
36	ACCESS ROAD	13095.6107	26152.1470	5732.8
37	ACCESS ROAD	13085.3459	26158.3626	5733.0
39	SIDEWALK/ACCESS ROAD	14115.2863	26533.1909	5730.2
40	SIDEWALK	14106.4936	26487.3818	5730.5
41	SIDEWALK	14104.2452	26471.6787	5730.0
42	SIDEWALK	14102.2248	26456.0996	5730.6
43	SIDEWALK	14100.4082	26440.4712	5730.7
44	SIDEWALK	14097.6534	26412.1892	5730.8
45	SIDEWALK	14095.5759	26383.8252	5730.2
46	SIDEWALK	14094.1751	26355.3359	5730.1
47	SIDEWALK	14093.5784	26308.6355	5730.3
48	SIDEWALK	14096.2137	26281.2419	5730.4
49	SIDEWALK	14100.6549	26238.6968	5730.9
50	SIDEWALK	14103.5964	26217.3971	5731.0
51	SIDEWALK	14104.7416	26205.2229	5731.0
52	SIDEWALK	14105.9253	26188.2073	5731.2
53	SIDEWALK	14107.8652	26169.6235	5731.6
54	SIDEWALK	14116.8813	26083.2508	5733.3
55	SIDEWALK	14121.5880	26053.5304	5734.0
56	SIDEWALK	14129.8163	26015.1604	5734.7
57	SIDEWALK	14120.0386	26013.0636	5734.5
58	SIDEWALK	14111.3069	26054.5298	5733.8
59	SIDEWALK	14106.9629	26081.9484	5733.1
60	SIDEWALK	14104.8791	26101.9110	5731.8
61	SIDEWALK	14099.6939	26151.5838	5731.8
62	SIDEWALK	14099.8579	26169.2763	5731.5

Point Table

Point #	Raw Description	Northing	Easting	Elevation
63	SIDEWALK	14097.9446	26187.6522	5731.1
64	SIDEWALK	14096.7609	26204.6677	5730.9
65	SIDEWALK	14095.6315	26216.6479	5730.9
66	SIDEWALK	14092.7257	26237.6020	5730.8
67	SIDEWALK	14090.4398	26259.5004	5730.3
68	SIDEWALK	14085.6152	26307.8694	5730.2
69	SIDEWALK	14083.8140	26327.1367	5730.0
70	SIDEWALK	14084.1783	26355.6455	5729.9
71	SIDEWALK	14085.5938	26384.4361	5730.6
72	SIDEWALK	14087.6889	26413.0393	5730.5
73	SIDEWALK	14090.4643	26441.5333	5730.5
74	SIDEWALK	14092.2993	26457.3200	5730.4
75	SIDEWALK	14094.3368	26473.0305	5730.3
76	SIDEWALK	14096.6735	26489.2699	5730.3
77	SIDEWALK/ACCESS ROAD	14102.8809	26521.6101	5730.2
78	SIDEWALK	14105.1704	26533.5382	5730.0
79	SIDEWALK/ACCESS ROAD	14119.4123	26521.0535	
80	SIDEWALK SHOULDER	14100.8578	26521.6799	
81	SIDEWALK SHOULDER	14094.6551	26489.3643	
82	SIDEWALK SHOULDER	14092.3551	26473.3008	
83	SIDEWALK SHOULDER	14090.3143	26457.5647	
84	SIDEWALK SHOULDER	14088.4665	26441.6530	
85	SIDEWALK SHOULDER	14085.6960	26413.2094	
86	SIDEWALK SHOULDER	14083.6062	26384.6782	
90	ACCESS RAMP	14082.4525	26361.3771	
91	ACCESS RAMP	14061.4188	26246.9697	5723.3
92	ACCESS RAMP	14061.8387	26238.1303	5723.2
93	ACCESS RAMP	14071.4033	26212.2285	5724–
94	ACCESS RAMP	14084.3087	26217.0120	5724–
95	ACCESS RAMP	14074.5445	26251.7013	5724.0
100	CONSTRUCTION LIMIT	13769.4903	26243.8639	
101	CONSTRUCTION LIMIT	13697.3657	26269.1485	
102	CONSTRUCTION LIMIT	13642.8050	26304.8476	
103	CONSTRUCTION LIMIT	13629.5020	26495.6964	
104	CONSTRUCTION LIMIT	13252.4551	26385.5530	
105	CONSTRUCTION LIMIT	13098.6625	26138.3905	
106	CONSTRUCTION LIMIT	13078.4851	26150.8937	
107	CONSTRUCTION LIMIT	13233.0908	26406.1325	
108	CONSTRUCTION LIMIT	13621.2795	26518.7342	
109	CONSTRUCTION LIMIT	13941.9596	26541.2552	
110	CONSTRUCTION LIMIT	14124.7715	26534.8630	
111	CONSTRUCTION LIMIT	14107.8893	26437.3233	
112	CONSTRUCTION LIMIT	14101.6471	26342.2258	
113	CONSTRUCTION LIMIT	14103.3381	26232.7049	
114	CONSTRUCTION LIMIT	14118.4038	26098.0873	
115	CONSTRUCTION LIMIT	14135.1411	26016.3098	
116	CONSTRUCTION LIMIT	14110.5101	26011.0203	
117	CONSTRUCTION LIMIT	13940.4600	26025.2120	
118	CONSTRUCTION LIMIT	13822.9577	26020.6285	
119	CONSTRUCTION LIMIT	13613.2792	26167.8242	
120	CONSTRUCTION LIMIT	13621.7265	26204.9344	
121	CONSTRUCTION LIMIT	13791.5079	26195.1133	
122	CONSTRUCTION LIMIT	13793.6217	26246.8950	
123	CONSTRUCTION LIMIT	14120.8565	26520.9898	
130	WINGWALL CL	14058.9627	26186.2440	
131	WINGWALL CL	14073.6752	26204.6318	
132	STRUCTURE	14072.4995	26209.2601	
133	WINGWALL CL	14072.0360	26209.0889	
134	WINGWALL CL	14063.0624	26233.4912	
135	STRUCTURE	14063.4921	26233.6529	
136	WINGWALL CL	14061.5060	26237.7232	

Point Table

Point #	Raw Description	Northing	Easting	Elevation
137	WINGWALL	14046.0755	26253.0102	
138	STRUCTURE	14048.1710	26227.9923	
139	STRUCTURE	14057.1775	26203.6022	
140	STRUCTURE	14052.3856	26216.5790	
141	STRUCTURE	14033.6239	26209.6509	
142	STRUCTURE	14031.1991	26216.2175	
143	STRUCTURE	14049.9608	26223.1456	
150	EX CULVERT	14064.6571	26230.4979	
152	EX CULVERT	14071.3359	26212.4112	
153	EX 36" CULVERT	13258.0997	26244.2840	
155	CONTROL PT 60	14031.2640	26596.6980	5733.2
160	TEST HOLE 1	13838.8407	26276.3565	
161	TEST HOLE 2	13408.6751	26116.8064	
162	TEST HOLE 3	13408.6830	26324.2707	
163	TEST HOLE 4	13093.9618	26082.6192	
164	TEST HOLE 5	14055.1876	26222.9422	
200	GRADING	13883.2886	26263.5138	5717.0
201	GRADING	13867.2257	26186.3935	5718.0
202	GRADING	13938.1320	26192.7271	5717.0
203	GRADING	13754.9387	26188.7252	5719.0
204	GRADING	13806.8160	26253.0475	5718.0
205	TOE	13936.9899	26064.2885	5720.0
206	TOE	13898.9885	26064.3348	5720.0
207	TOE	13865.3434	26060.6756	5720.0
208	TOE	13832.0740	26054.8778	5720.0
209	TOE	13800.3627	26088.5934	5720.0
210	TOE	13738.4421	26121.0948	5720.0
211	TOE	13722.6844	26127.7963	5721.0
212	TOE	13695.9763	26147.3315	5721.0
213	TOE	13679.9915	26155.2118	5721.0
214	TOE	13645.8680	26167.5747	5722.0
215	TOE	13624.4728	26185.5664	5722.0
216	TOE	13658.6879	26301.2067	5721.0
217	TOE	13688.4127	26317.7014	5720.0
218	TOE	13699.7159	26362.1710	5720.0
219	TOE	13713.4333	26376.4247	5720.0
220	TOE	14037.7801	26450.4343	5720.0
221	TOE	14049.9809	26439.9244	5720.0
222	TOE	14039.8443	26359.7491	5719.0
223	TOE	14031.3972	26301.6888	5718.0
224	TOE	14033.2274	26292.5165	5718.0
225	TOE	14034.2915	26269.1883	5717.0
226	TOE	14042.7400	26252.0095	5717.0
227	TOE	14043.1106	26146.1649	5719.0
228	TOE	14050.1557	26091.4100	5719.0
229	TOE	14057.5554	26065.2438	5720.0
230	TOE	14046.3549	26054.0502	5720.0
231	TOE	14001.1155	26059.6553	5720.0
232	GRADE BREAK	14039.6516	26186.4420	5716.0
233	GRADE BREAK	13977.4045	26206.8295	5716.0
234	GRADE BREAK	13646.0581	26375.4534	5726.0
235	GRADE BREAK	13717.0653	26405.8425	5727.0
236	GRADE BREAK	13805.2146	26430.0622	5728.0
237	GRADE BREAK	13835.9600	26441.1984	5729.0
238	GRADE BREAK	13892.2837	26461.6930	5730.0
239	GRADE BREAK	13960.4248	26479.0759	5730.0
240	GRADE BREAK	13990.8601	26481.6343	5729.0
241	GRADE BREAK	14011.6882	26477.2924	5728.0
242	GRADE BREAK	14044.7729	26480.7571	5727.0
243	GRADE BREAK	14065.8005	26489.6491	5727.0

WWE WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

REVISIONS

NO.	BY	DATE	DESCRIPTION
1	DKW	05/05/09	INCORPORATE COMMENTS, REVISED TO ADD WQCV OUTLET
2	DKW	08/05/09	INCORPORATE COMMENTS
3	DKW	08/26/09	REVISED PROPERTY BOUNDARY PER LEGAL DESCRIPTION
4	DKW	09/10/09	REVISED BOUNDARY/CONSTRUCTION LIMITS, WIDENED SIDEWALK TO 8' MIN., REVISED RAMP WIDTH
5	DKW	09/22/09	ISSUED FOR BID
6	DKW	07/08/10	RECORD DRAWING

COMMENTS

BASE MAPPING PROVIDED BY COTTONWOOD SURVEYING AND ASSOCIATES, INC.

COLORADO REGISTERED PROFESSIONAL ENGINEER DAVID W. FOSS 38868 7-8-10

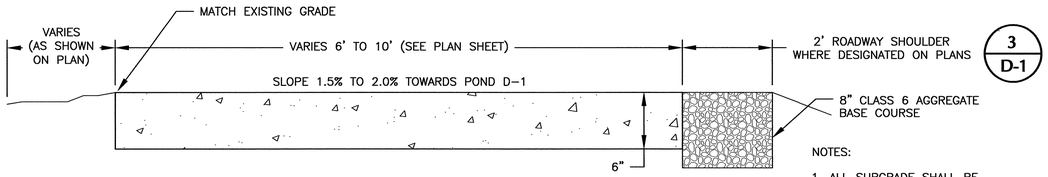
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DETAIL	DKW/CMC	05/05/09
CHECK	DWF/WFL	05/05/09
APPROVAL		
SCALE	NOTED	
FILE	D1 C SHEETS.dwg	

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

POND D-1 SITE COORDINATES

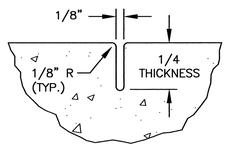
JOB NO. 071–136.000
REVISION NO. 6
SHEET NO. C-4

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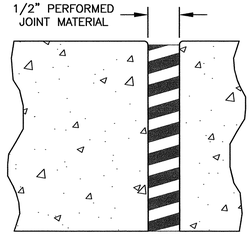


ATTACHED OR DETACHED WALK

3 / D-1



CONTRACTION OR
WEAKENED PLANE JOINT



EXPANSION JOINT

NOTES:

1. ALL SUBGRADE SHALL BE COMPACTED TO AN EQUIVALENT OF 95% PROCTOR DENSITY.
2. COMPLETE WITH A ROUGH BROOM FINISH.
3. WET SUBGRADE SHALL BE CORRECTED PRIOR TO PLACEMENT OF CONCRETE.
4. ALL SIDEWALKS ACROSS DRIVEWAYS WILL BE 8" REINFORCED CONCRETE.
5. SAWED OR GROOVED TRANSVERSE CONTRACTION (DUMMY) JOINTS AT 5-FOOT SPACING AND EXPANSION JOINTS AT 100-FOOT INTERVALS.
6. ALL SIDEWALKS SHALL BE AT A MINIMUM OF 3000 PSI CONCRETE AND REINFORCED WITH 6"x 6" #6 WIRE MESH OR #3 BARS AT 18" ON CENTER BOTH WAYS. ALL REINFORCEMENT SHALL HAVE A MINIMUM CONCRETE COVER OF 2".

STAGE/STORAGE/DISCHARGE DATA

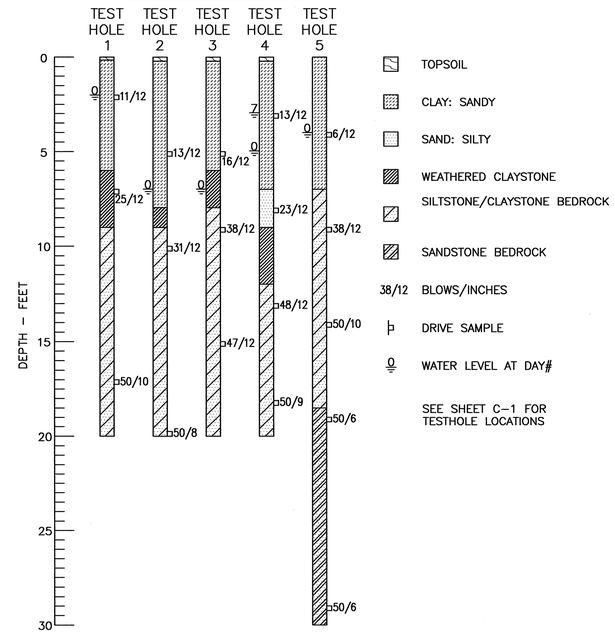
5

SEE KEY RD VOLUMES BELOW

Elevation (Ft)	Graded Area (ac)	Graded Volume (af)	Q (cfs)	Description
5710.9	0.00	0.00	0.00	ORIFICE PLATE
5711.0	0.01	0.00	0.00	
5712.0	0.02	0.01	0.16	
5713.0	0.04	0.03	0.46	
5714.0	0.06	0.10	0.69	
5715.0	0.11	0.18	1.0	
5716.0	0.17	0.31	1.4	
5717.0	0.34	0.56	1.9	
5718.0	0.94	1.1	2.3	
5719.0	1.78	2.52	2.8	
5720.0	2.69	4.73	3.3	
5721.0	3.00	7.58	3.8	
5721.7	*3.17*	*9.81*	*4.2*	WQCV-LOWER ORIFICE/WEIR
5722.0	3.24	10.90	11	
5723.0	3.52	14.08	68	
5724.0	3.83	17.75	153	
5725.0	*4.15*	*21.70*	*183*	10 YEAR ELEVATION
5725.0	4.15	21.74	183	
5726.0	4.50	26.07	208	
5726.7	*4.78*	*29.36*	*225*	UPPER ORIFICE/WEIR
5727.0	4.90	30.77	271	
5727.7	*5.31*	*34.30*	*486*	100 YEAR ELEVATION
5728.0	5.50	35.96	607	
5729.0	6.22	41.82	1097	
5730.0	6.96	48.41	1706	ROADWAY

TRIBUTARY BASIN AREA = 321 acres
PEAK POND INFLOW FOR 100-YEAR EVENT = 913 cfs, VOL = 34.65 AF RD
PEAK POND INFLOW FOR 10-YEAR EVENT = 456 cfs, VOL = 22.04 AF RD 5

TEST HOLE DATA

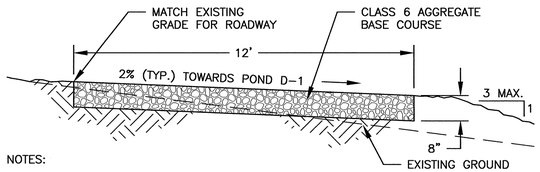


SEE SHEET C-1 FOR TESTHOLE LOCATIONS

TYPICAL SIDEWALK AND CONSTRUCTION JOINTS

1 / D-1

NOT TO SCALE



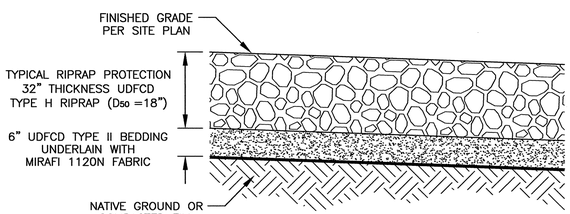
NOTES:

1. COMPACT UPPER 1' OF SUB GRADE TO 95% STANDARD DENSITY PER SPECIFICATIONS AND ASTM D-698.
2. USE CLASS 6 AGGREGATE BASE COURSE PER CDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION.
3. CROSS SLOPE DIRECTION SHALL BE ORIENTED TO MATCH CONTOURS ON SITE PLAN.

TYPICAL ROADWAY AND RAMP DETAIL

2 / D-1

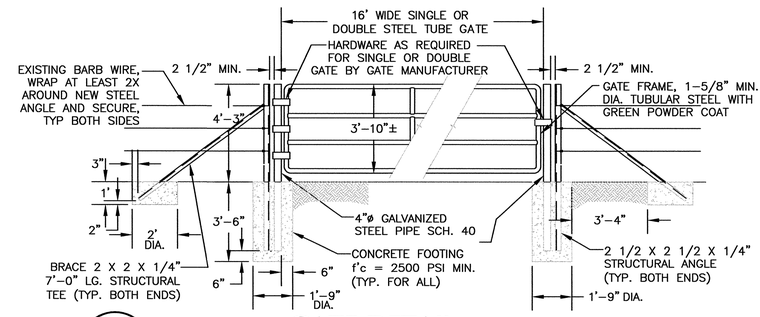
NOT TO SCALE



TYPICAL RIPRAP DETAIL

3 / D-1

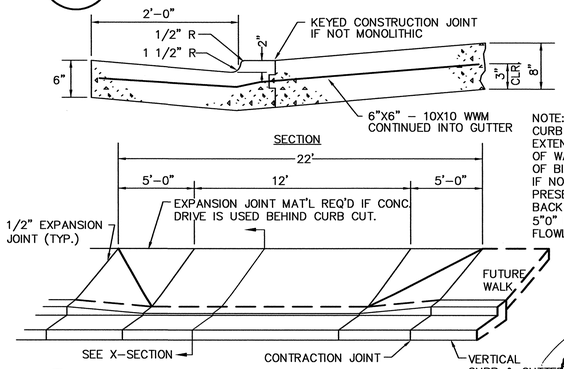
NOT TO SCALE



GATE DETAIL

4 / D-1

NOT TO SCALE



CURB CUT DETAIL

5 / D-1

NOT TO SCALE

COLORADO REGISTERED 38868 PROFESSIONAL ENGINEER

WARNING
THIS AREA IS A STORMWATER FACILITY AND IS SUBJECT TO PERIODIC FLOODING

FLOOD HAZARD WARNING SIGN

6 / D-1

NOT TO SCALE

NOTE:

1. TWO SIGNS SHALL BE POSTED AT THE PERIMETER OF THE POND ON A SUITABLE SIGN POST AT A LOCATION DIRECTED BY THE OWNERS REPRESENTATIVE.
2. SIGN SHALL HAVE A MINIMUM AREA OF 3 SQUARE FEET AND SHALL HAVE RED LETTERING ON A WHITE BACKGROUND.

WARNING
UNAUTHORIZED MODIFICATION OF THIS OUTLET IS AN ARAPAHOE COUNTY LAND DEVELOPMENT CODE VIOLATION

NOTE:

1. ONE OUTLET MODIFICATION SIGN SHALL BE POSTED ON THE OUTLET STRUCTURE OR ON A SUITABLE SIGN POST NEARBY AT THE DIRECTION OF THE OWNERS REPRESENTATIVE.
2. SIGN SHALL HAVE A MINIMUM AREA OF 0.75 SQUARE FEET AND SHALL HAVE RED LETTERING ON A WHITE BACKGROUND.

OUTLET MODIFICATION SIGN

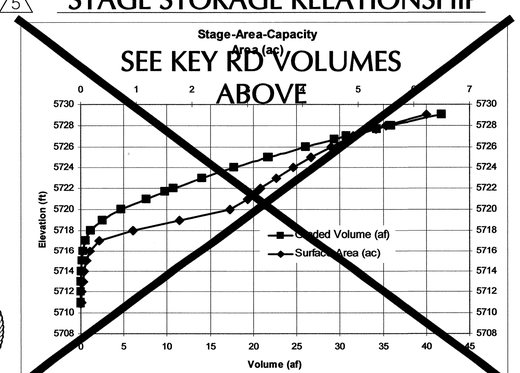
7 / D-1

NOT TO SCALE

STAGE STORAGE RELATIONSHIP

5

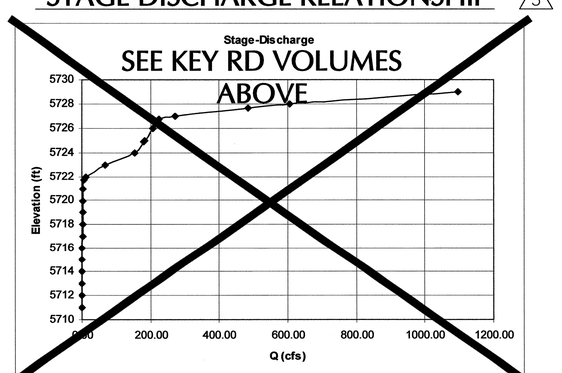
SEE KEY RD VOLUMES ABOVE



STAGE DISCHARGE RELATIONSHIP

5

SEE KEY RD VOLUMES ABOVE



E08-027

WWE
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

REVISIONS			
NO.	BY	DATE	DESCRIPTION
1	DKW	05/06/09	INCORPORATE COMMENTS, REVISED TO ADD WQCV OUTLET
2	DKW	08/05/09	INCORPORATE COMMENTS
3	DKW	09/10/09	REVISE 10 YEAR WATER SURFACE ELEVATION IN STAGE/STORAGE/DISCHARGE DATA
4	DKW	09/22/09	ISSUED FOR BID
5	DKW	07/07/10	RECORD DOCUMENT

RECORD DOCUMENT

THESE RECORD DOCUMENTS HAVE BEEN PREPARED BASED ON INFORMATION PROVIDED BY OTHERS. THE DESIGN PROFESSIONAL HAS NOT VERIFIED THE ACCURACY AND/OR COMPLETENESS OF THIS INFORMATION AND SHALL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS THAT MAY BE INCORPORATED HEREIN AS A RESULT.

RECORD DOCUMENT

RECORD PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY JONES ENGINEERING ASSOCIATES, INC., 3/17/10

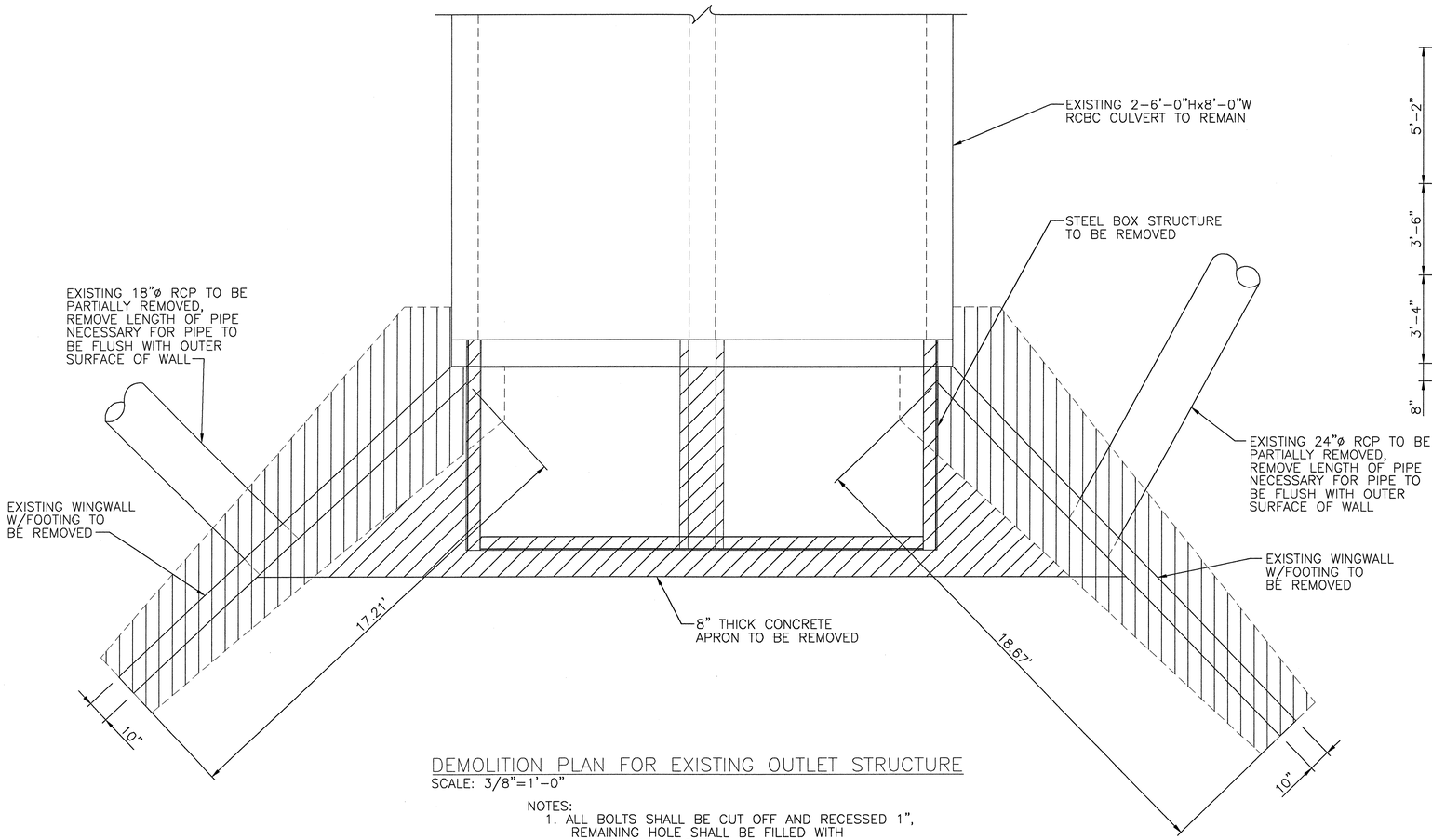
		DATE
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DETAIL	KAL/DKW	05/05/09
CHECK	DWF/WFL	05/05/09
APPROVAL		
SCALE		AS NOTED
FILE	D1 D1 DETAILS.dwg	

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

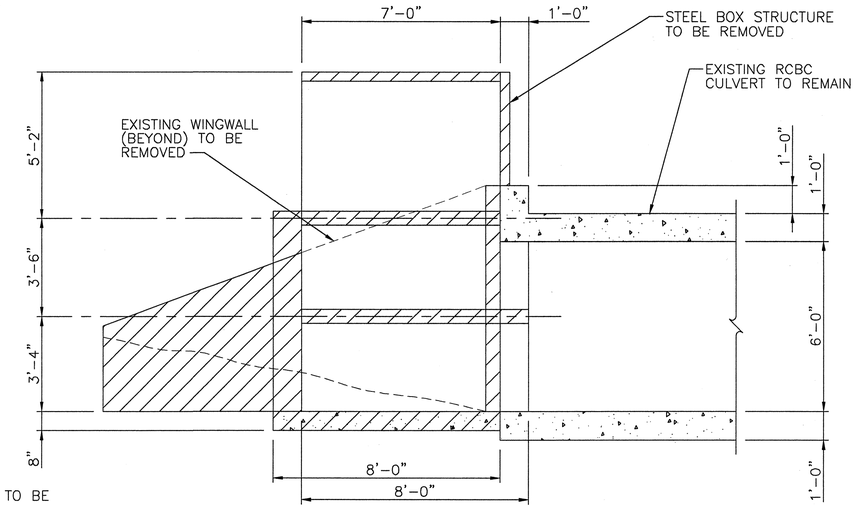
CIVIL DETAILS, TEST HOLE DATA, STAGE/STORAGE & STAGE/DISCHARGE RELATIONSHIPS

JOB NO. 071-136.000
REVISION NO. 5
SHEET NO. D-1

Plot Date/Time: 07/08/2010, 11:13:49 AM; Z:\PROJECT FILES\07\071-136\000\CAD-GIS\CAD\DESIGN\RECORD DRAWINGS 0710\D1 D1 DETAILS.DWG-D-1



DEMOLITION PLAN FOR EXISTING OUTLET STRUCTURE
SCALE: 3/8"=1'-0"



DEMOLITION PROFILE
SCALE: 3/8"=1'-0"

NOTES:
1. ALL BOLTS SHALL BE CUT OFF AND RECESSED 1", REMAINING HOLE SHALL BE FILLED WITH NON-SHRINK GROUT.
2. CONTRACTOR TO REMOVE AND DISPOSE OF ALL DEMOLITION DEBRIS INCLUDING STEEL BOX.
3. CONTRACTOR SHALL PROTECT THE EXISTING BOX CULVERT AND BOX CULVERT SUBGRADE.

RECORD DOCUMENT

THESE RECORD DOCUMENTS HAVE BEEN PREPARED BASED ON INFORMATION PROVIDED BY OTHERS. THE DESIGN PROFESSIONAL HAS NOT VERIFIED THE ACCURACY AND/OR COMPLETENESS OF THIS INFORMATION AND SHALL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS THAT MAY BE INCORPORATED HEREIN AS A RESULT.

RECORD DOCUMENT

RECORD PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY JONES ENGINEERING ASSOCIATES, INC., 3/17/10

E08-027

JFS&A
J.F. SATO AND ASSOCIATES
Engineering, Environmental, and Program Management Services
5898 South Rapp Street
Littleton, Colorado 80120
Phone 303.797.1200 • Fax 303.797.1187

REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	
1	J.C.	4-13-09	INCORPORATE COMMENTS, REVISE TO ADD WQCV OUTLET	-
2	J.C.	8-3-09	INCORPORATE COMMENTS	
3	J.C.	9-22-09	ISSUED FOR BID	
4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CONNELLY 24996 PROFESSIONAL ENGINEER

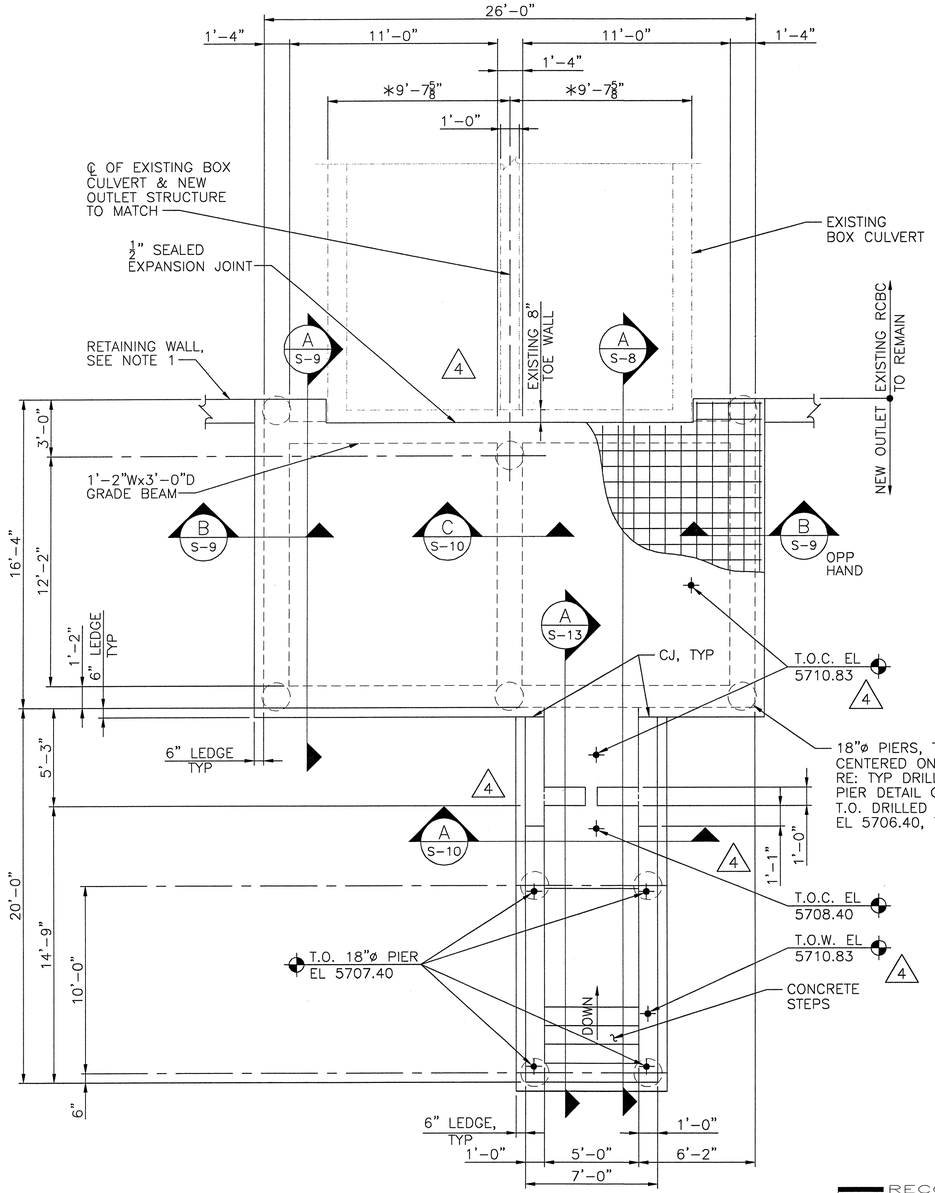
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CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-3.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

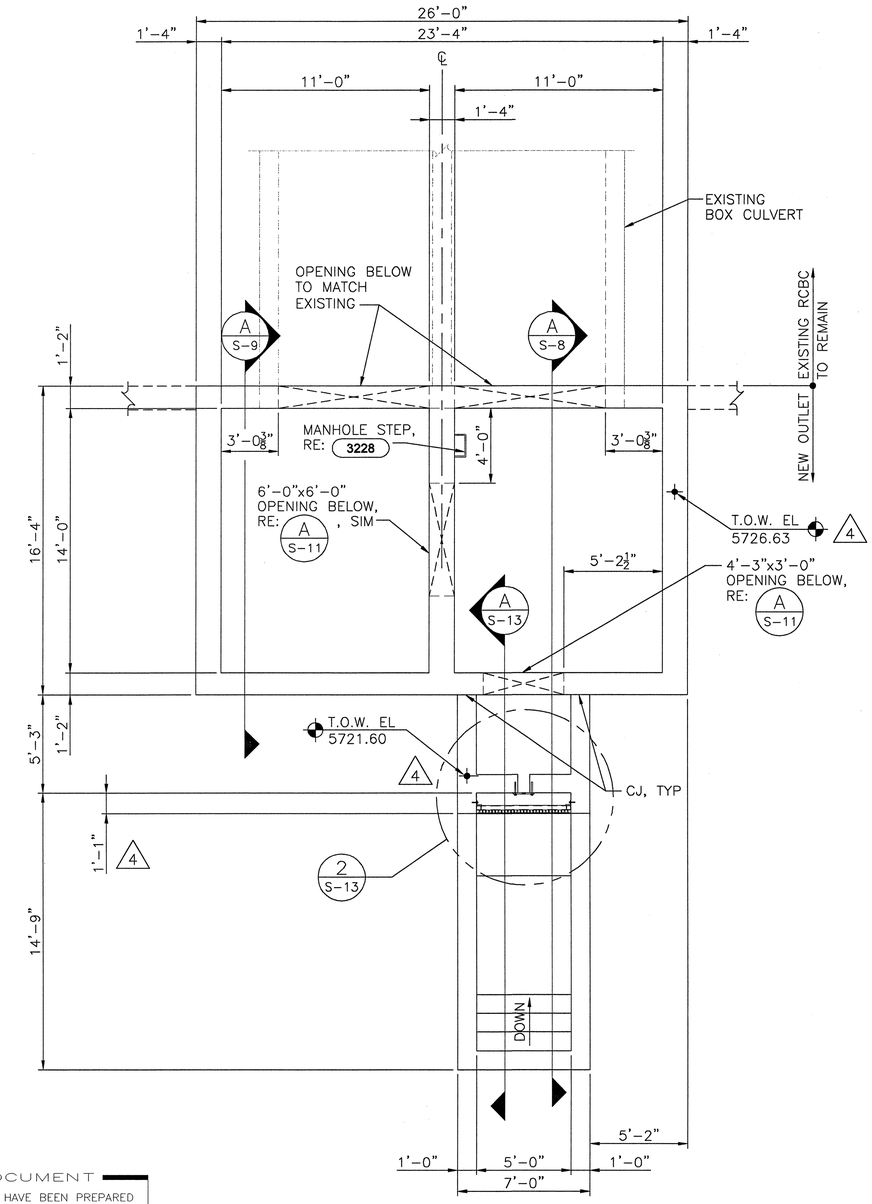
OUTLET STRUCTURE EXISTING STRUCTURE & WINGWALL DEMOLITION PLANS

JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-3

6/29/10 15:19 ROD R17 H:\0800_JOBS\0819-DOVE CREEK OUTLET STRUCTURE\CURRENT\AS-BUILT JUNE 30, 2010\S-3.DWG



FOUNDATION PLAN @ EL 5710.83 (4)
SCALE: 1/4"=1'-0"



PLAN VIEW @ EL 5726.63 (4)
SCALE: 1/4"=1'-0"

NOTES:
1. RETAINING WALL NOT SHOWN FOR CLARITY. RE: SHEETS S-5 AND S-10 FOR PLAN AND SECTIONS.
2. * INDICATES DIMENSIONS TO BE FIELD VERIFIED BY CONTRACTOR.
3. REFER TO CIVIL DRAWINGS FOR GRADING ELEVATIONS.

RECORD DOCUMENT

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RECORD DOCUMENT

RECORD PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY JONES ENGINEERING ASSOCIATES, INC., 3/17/10

E08-027

JFS&A J.F. SATO AND ASSOCIATES
Engineering, Environmental, and Program Management Services
5898 South Rapp Street
Littleton, Colorado 80120
Phone 303.797.1200 • Fax 303.797.1187

NO.	BY	DATE	DESCRIPTION	COMMENTS
1	J.C.	4-13-09	INCORPORATE COMMENTS, REVISE TO ADD WQCV OUTLET	-
2	J.C.	8-3-09	INCORPORATE COMMENTS	
3	J.C.	9-22-09	ISSUED FOR BID	
4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CONNELLY 24996 PROFESSIONAL ENGINEER

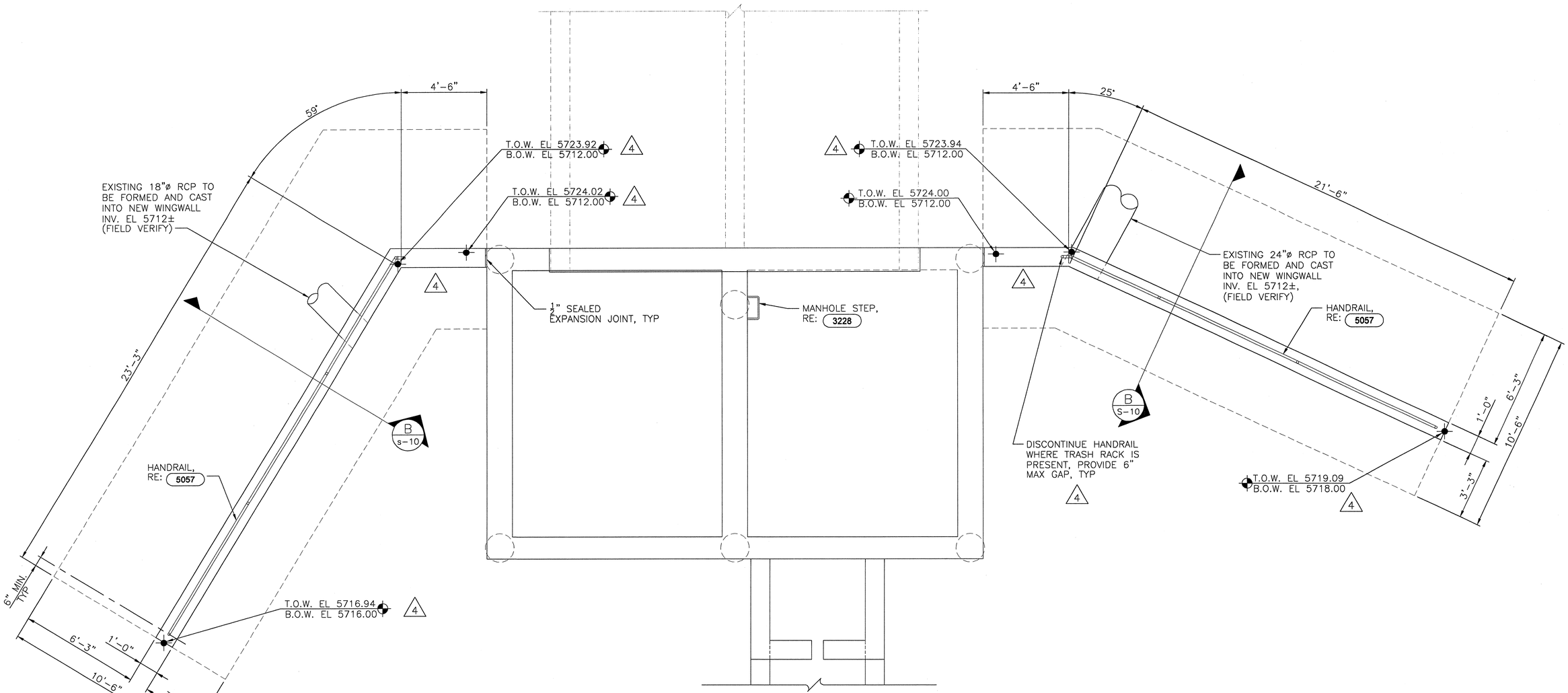
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DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-4.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

OUTLET STRUCTURE PLANS

JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-4

6/29/10 16:57 ROD R17 H:\0800_JOBS\0819-DOVE CREEK OUTLET STRUCTURE\CURRENT\AS-BUILT JUNE 30, 2010\S-4.DWG



WING WALL PLAN
SCALE: 3/8"=1'-0"

NOTE:
1. REFER TO CIVIL DRAWINGS FOR FINISHED GRADE ELEVATIONS.

RECORD DOCUMENT

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E08-027

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3	J.C.	9-22-09	ISSUED FOR BID	
4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CORNEJO 24996 PROFESSIONAL ENGINEER

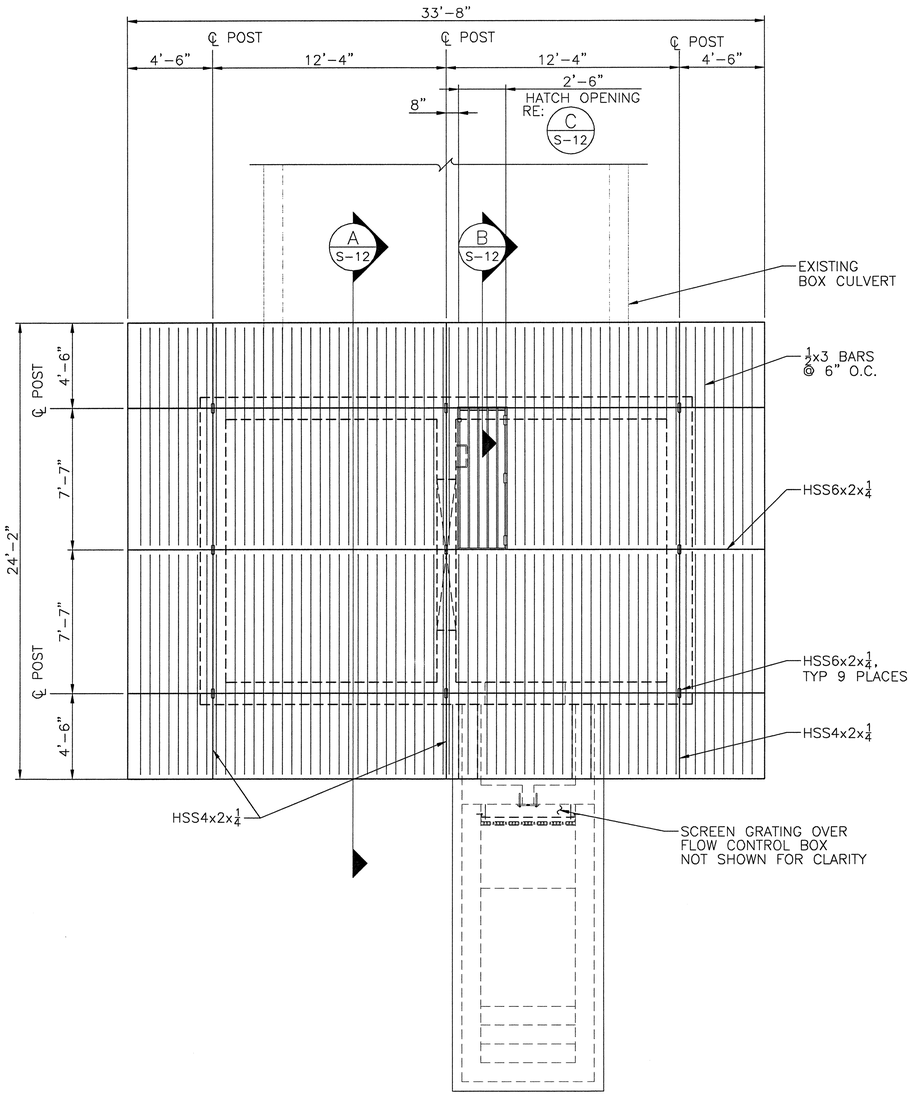
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DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-5.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

OUTLET STRUCTURE
RETAINING/WING WALL PLAN

JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-5

6/29/10 15:43 ROD R:\7 H:\0800_JOBS\0819-DOVE CREEK OUTLET STRUCTURE\CURRENT\AS-BUILT JUNE 30, 2010\S-5.DWG



PLAN VIEW @ EL 5729.00
SCALE: 1/4"=1'-0"

4 NOTE:
1. REFER TO TRASH RACK SHOP DRAWINGS FOR FINAL CONFIGURATION.

RECORD DOCUMENT

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REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	-
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3	J.C.	9-22-09	ISSUED FOR BID	
4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSIE M. CORNEJO 24996 PROFESSIONAL ENGINEER

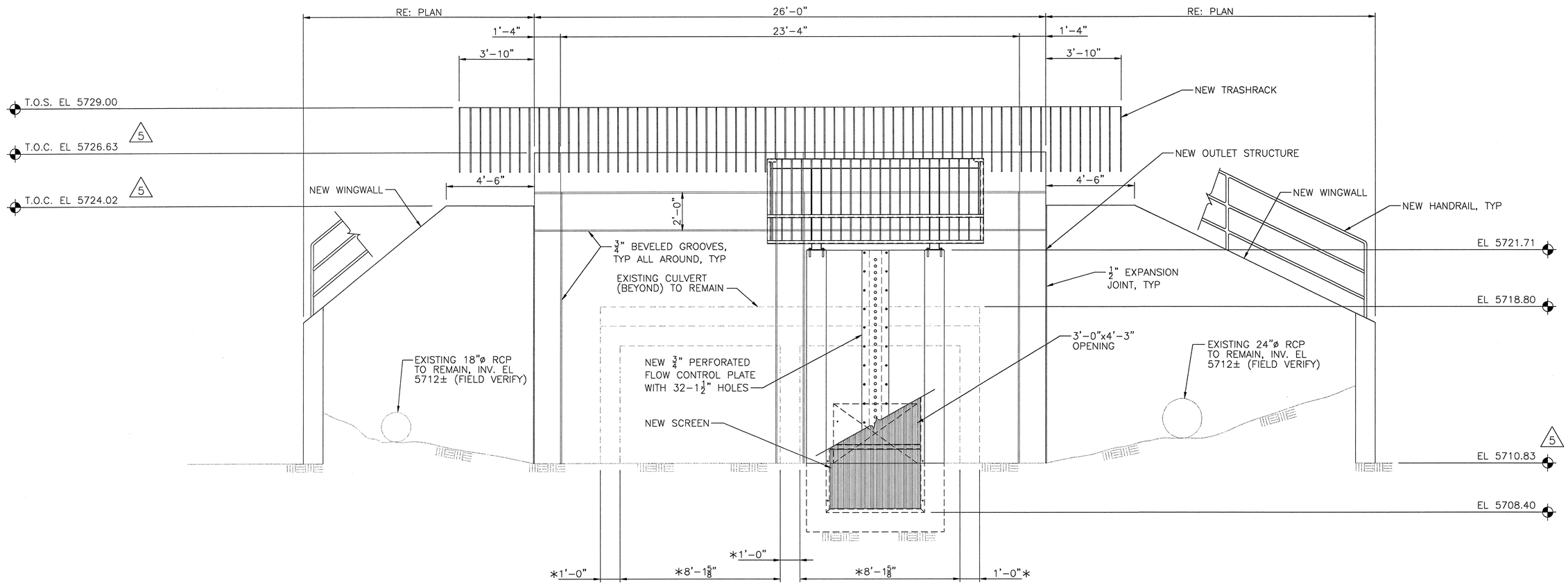
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DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-6.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

OUTLET STRUCTURE
TRASHRACK PLAN, SECTIONS AND DETAILS

JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-6

6/29/10 15:51 ROD R17 H:\0800 JOBS\0819-DOVE CREEK OUTLET STRUCTURE\CURRENT\AS-BUILT JUNE 30, 2010\S-6.DWG



FRONT ELEVATION
SCALE: 3/8"=1'-0"

NOTE:
1. * FIELD DIMENSIONS TO BE VERIFIED BY CONTRACTOR.

RECORD DOCUMENT

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J.F. SATO AND ASSOCIATES
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5898 South Rapp Street
Littleton, Colorado 80120
Phone 303.797.1200 • Fax 303.797.1187

REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	–
1	J.C.	4-13-09	INCORPORATE COMMENTS, REVISE TO ADD WQCV OUTLET	
2	J.C.	8-3-09	INCORPORATE COMMENTS	
3	DKW	9-10-09	INCORPORATE COMMENT: ADD ORIFICE HOLE INFORMATION	
4	J.C.	9-22-09	ISSUED FOR BID	
5	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CORNEJO 24996 PROFESSIONAL ENGINEER

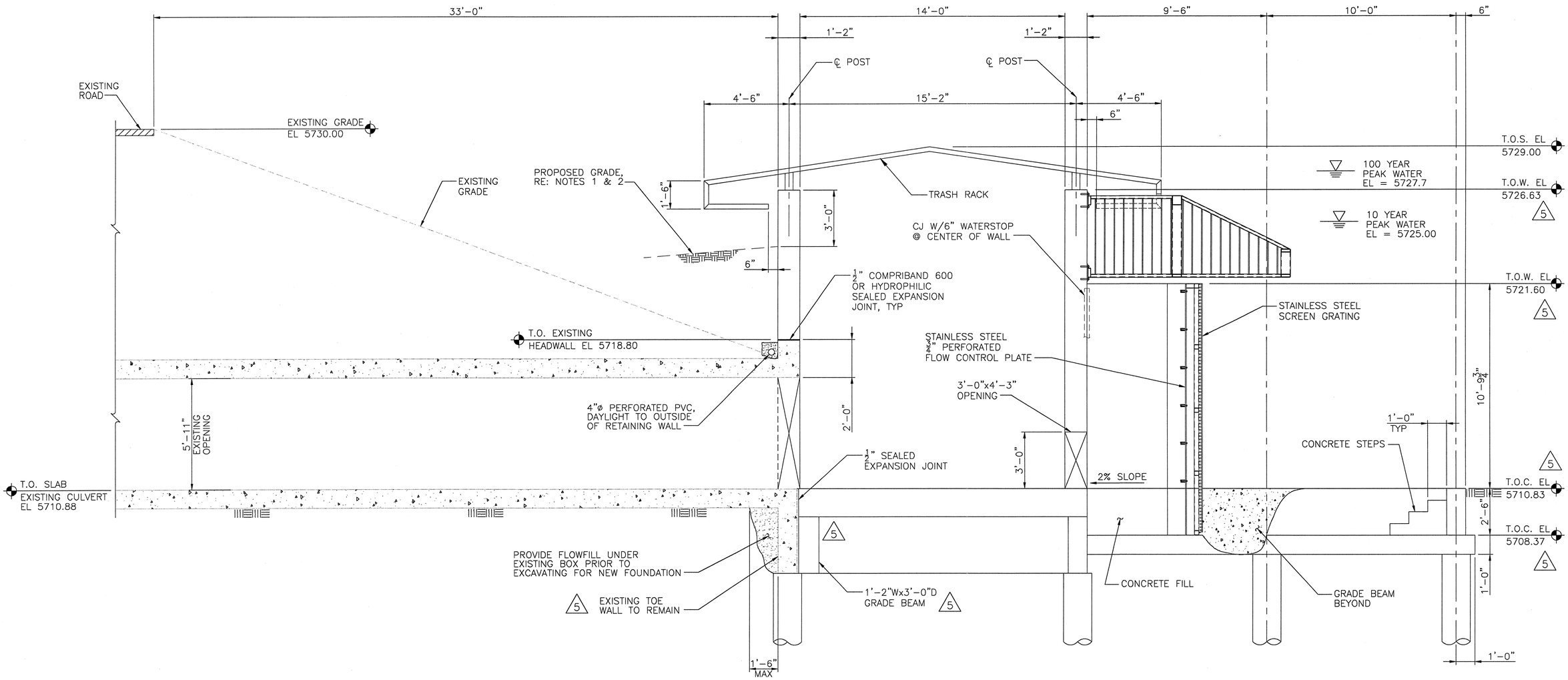
		DATE
DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-7 wwe.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

OUTLET STRUCTURE ELEVATION

JOB NO. 071-136.000
REVISION NO. 3
SHEET NO. S-7

6/29/10 15:55 ROD R17 H:\0800_JOBS\0819-DOVE CREEK OUTLET STRUCTURE\CURRENT\AS-BUILT JUNE 30, 2010\S-7 WWE.DWG



RECORD DOCUMENT

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RECORD DOCUMENT

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SECTION A S-8
SCALE: 3/8"=1'-0"

NOTES:
1. REFER TO CIVIL DRAWINGS FOR PROPOSED GRADE.
2. USE CLASS II FOR STRUCTURAL FILL AT NEW GRADE.

E08-027

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2	J.C.	8-3-09	INCORPORATE COMMENTS	
3	DKW	9-10-09	INCORPORATE COMMENT: REVISE 10 YEAR WATER ELEVATION	
4	J.C.	9-22-09	ISSUED FOR BID	
5	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CORNEJO 24996 PROFESSIONAL ENGINEER

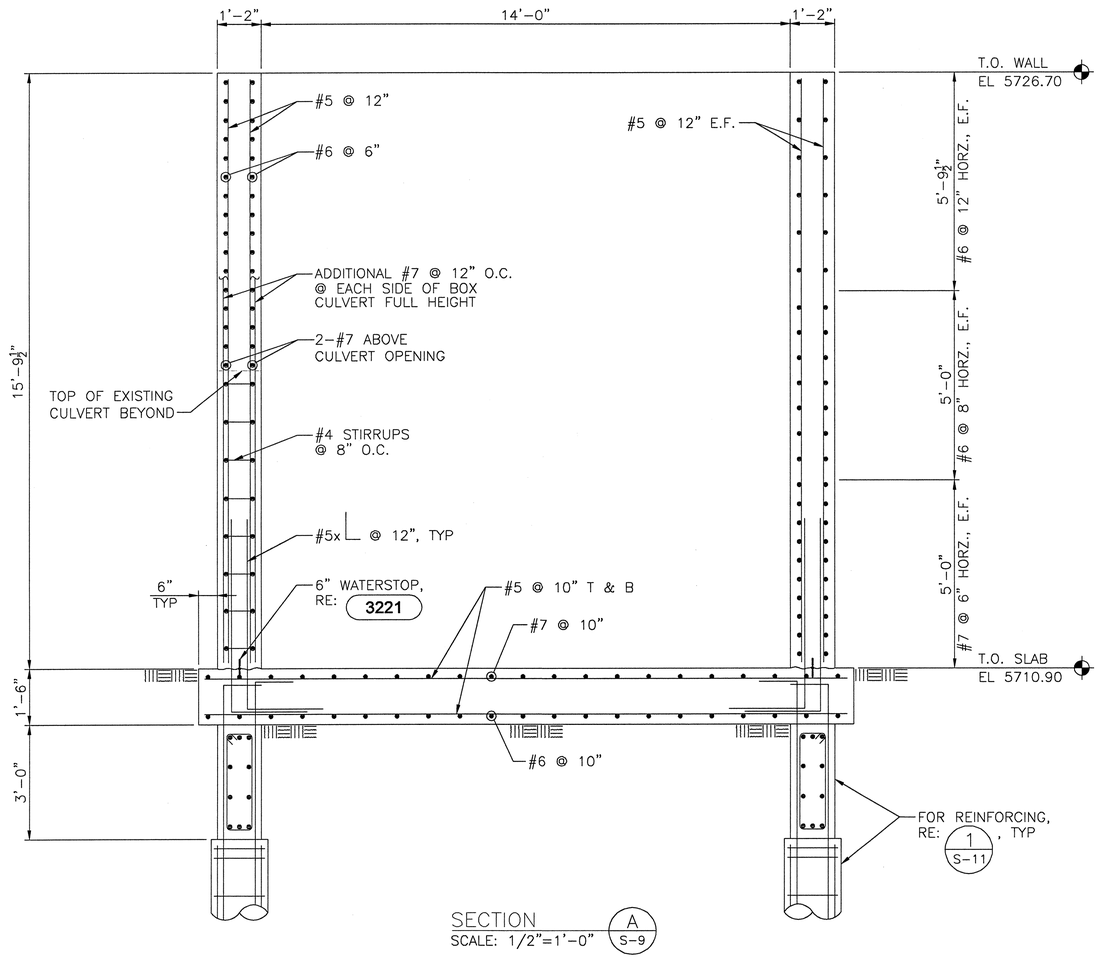
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DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-8 wwe.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

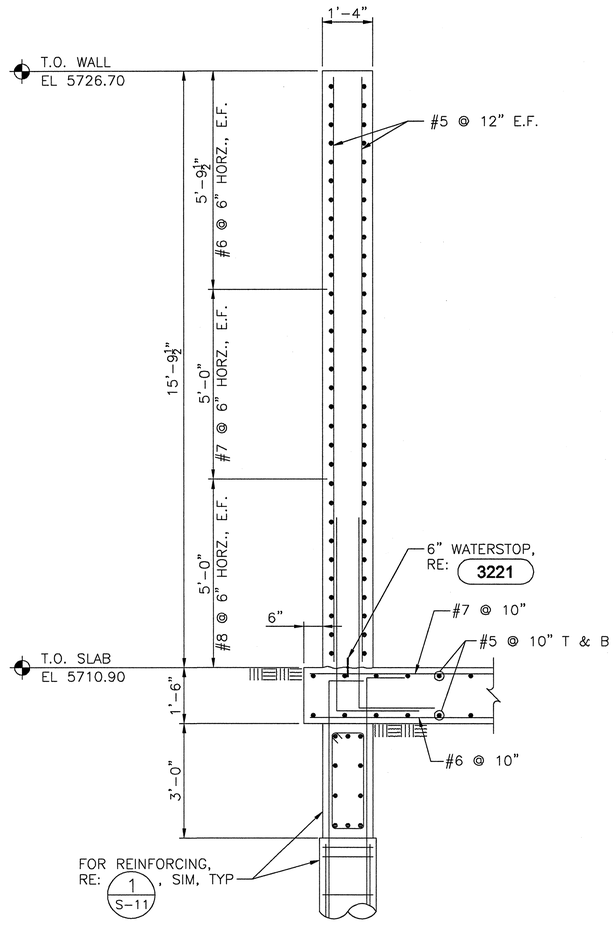
OUTLET STRUCTURE
SECTION

JOB NO. 071-136.000
REVISION NO. 3
SHEET NO. S-8

6/29/10 16:03 ROD R17 H:\0800_JOBS\0819_DOVE CREEK OUTLET STRUCTURE\CURRENT\AS-BUILT JUNE 30, 2010\S-8 WWE.DWG



SECTION A
SCALE: 1/2"=1'-0" (S-9)



SECTION B
SCALE: 1/2"=1'-0" (S-9)

NOTE:
1. PROVIDE 4-#6x6'-0" DIAGONALS, (2 EACH FACE) AT EACH CORNER OF OPENING TO BOX CULVERT.

RECORD DOCUMENT

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4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CONNELLY 24996 PROFESSIONAL ENGINEER

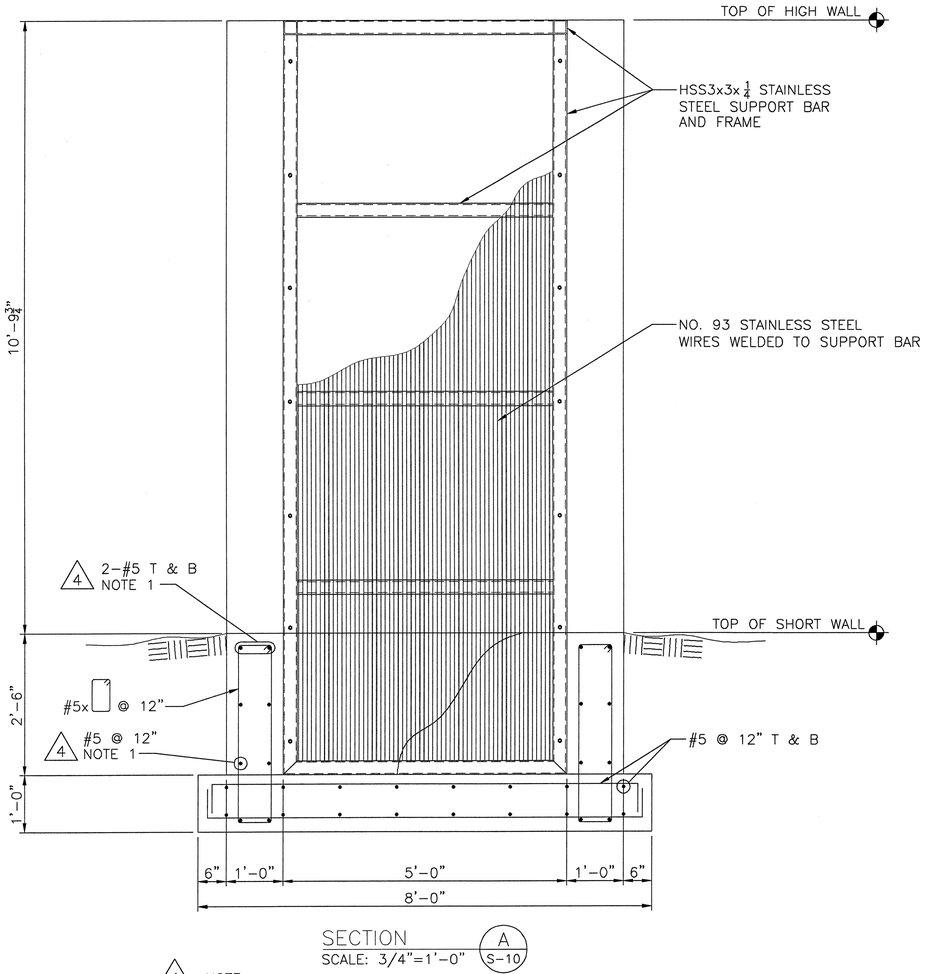
		DATE
DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-9.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

OUTLET STRUCTURE
SECTIONS AND DETAILS

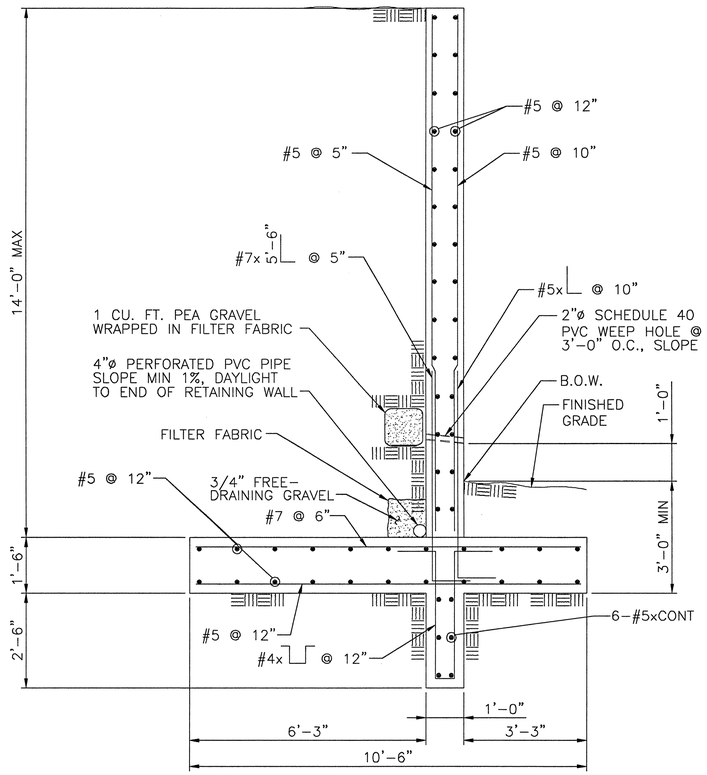
JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-9

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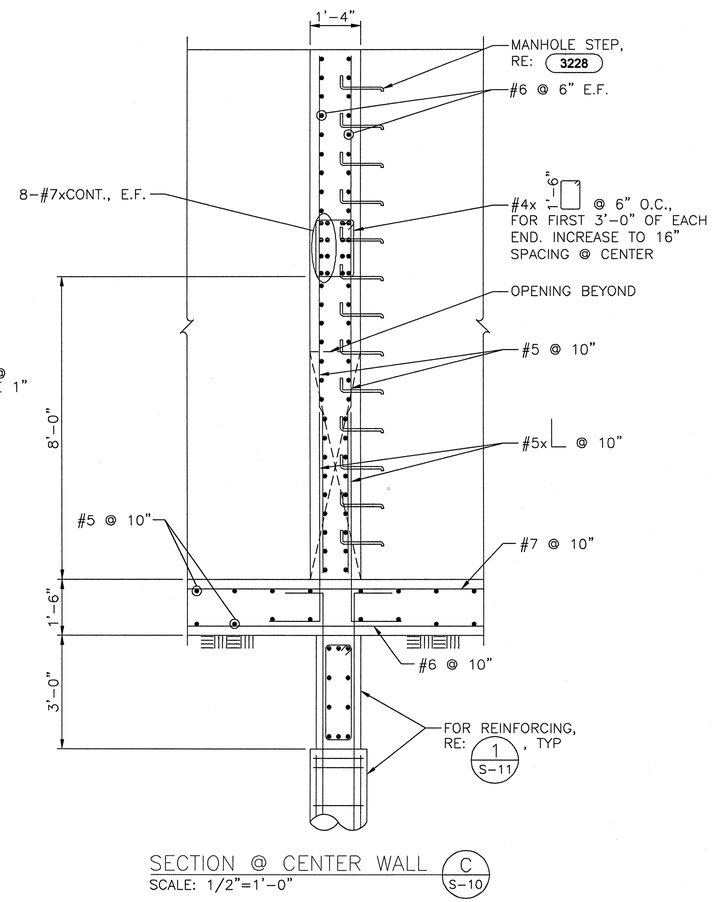


SECTION A (S-10)
SCALE: 3/4"=1'-0"

4 NOTE:
1. INSTALL #5 DOWELS INTO ADJACENT GRADE BEAM AND SLAB. MINIMUM EMBEDMENT OF 6" AT GRADE BEAM AND 1'-0" INTO SLAB. USE HILTI HIT HY150 ADHESIVE SYSTEM OR EQUIVALENT.



SECTION B (S-10)
SCALE: 1/2"=1'-0"



SECTION @ CENTER WALL C (S-10)
SCALE: 1/2"=1'-0"

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4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CONNELLY 24996 PROFESSIONAL ENGINEER

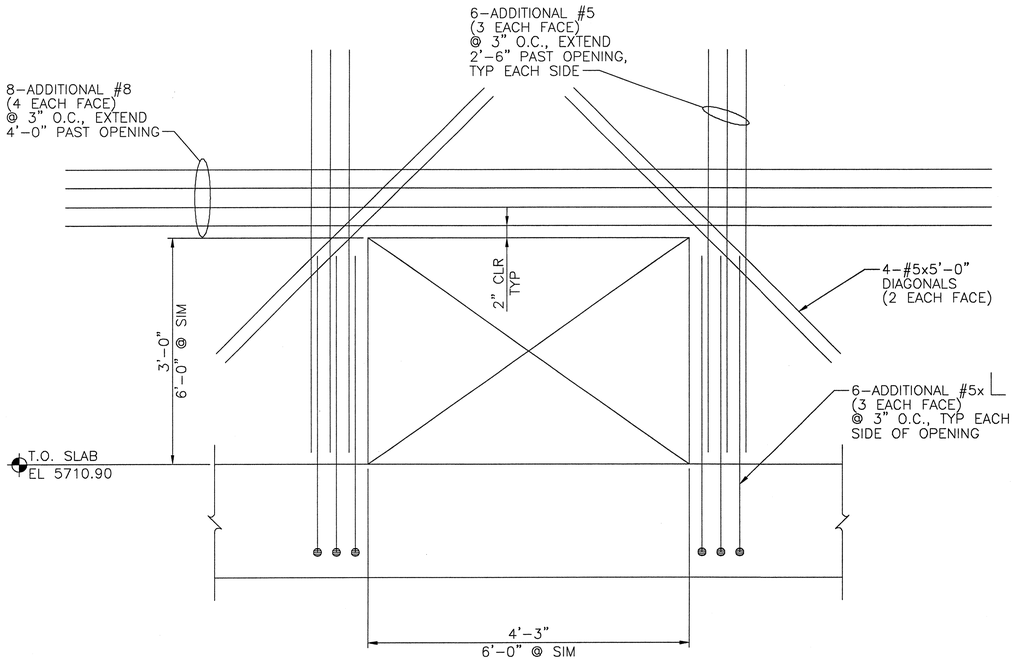
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DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-10.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

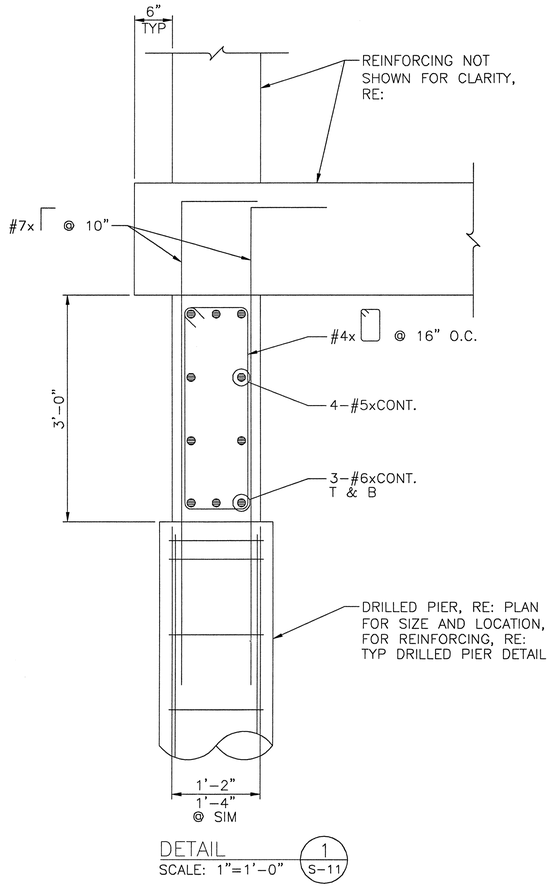
OUTLET STRUCTURE
SECTIONS AND DETAILS

JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-10

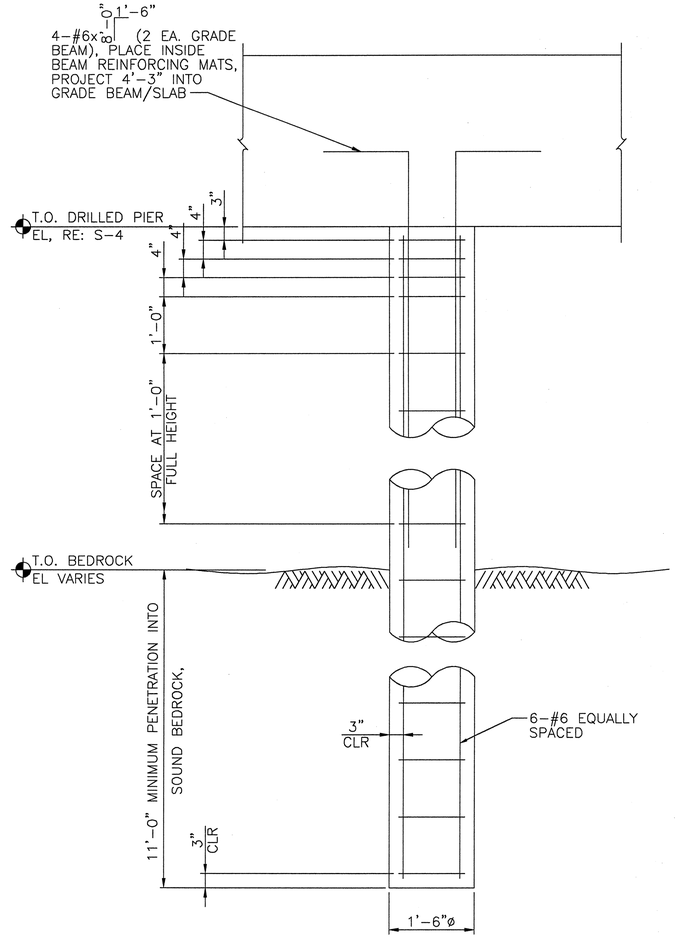
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ADDITIONAL REINFORCEMENT AT OPENING (A / S-11)
SCALE: 1"=1'-0"



DETAIL (1 / S-11)
SCALE: 1"=1'-0"



TYP DRILLED PIER DETAIL
SCALE: 1"=1'-0"

NOTES:
1. ALL DRILLED PIERS TO HAVE #4x○ TIES @ SPACING SHOWN.
2. USE 4000 PSI CONCRETE W/5" TO 7" SLUMP AND TYPE II CEMENT, RE: SPECS.
3. REINFORCING STEEL Fy=60,000 PSI.
4. TEMPORARY CASING OF PIER HOLE MAY BE REQUIRED. CONCRETE SHALL NOT BE CAST IF WATER HEIGHT IS MORE THAN 3" IN BOTTOM OF PIER BORING, SEE SOIL REPORT. TREMIE MUST BE USED FOR ALL PIER CONCRETE PLACEMENT.
5. ALL PIERS TO BE 25'-0" MINIMUM LENGTH.
6. GROUND WATER IS AT 4'-0" BELOW GRADE, CASING WILL BE REQUIRED FOR INSTALLATION.

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4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CORNEJO 24996 PROFESSIONAL ENGINEER

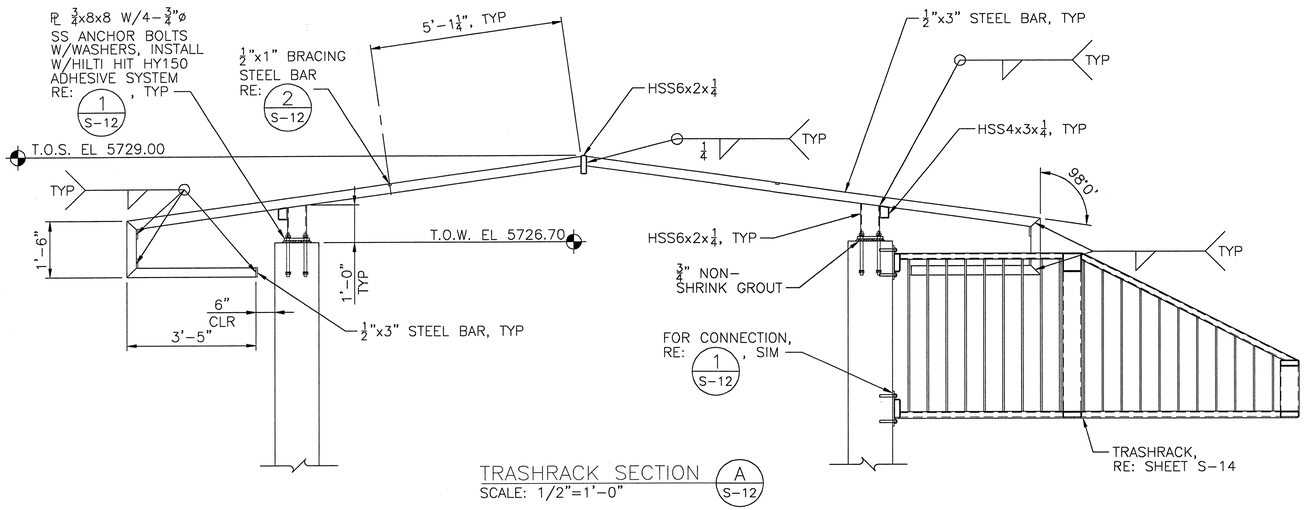
		DATE
DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-11.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

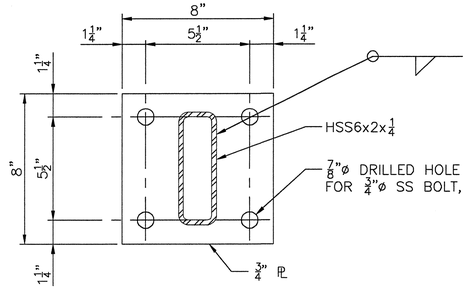
OUTLET STRUCTURE
SECTIONS AND DETAILS

JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-11

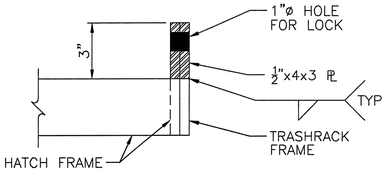
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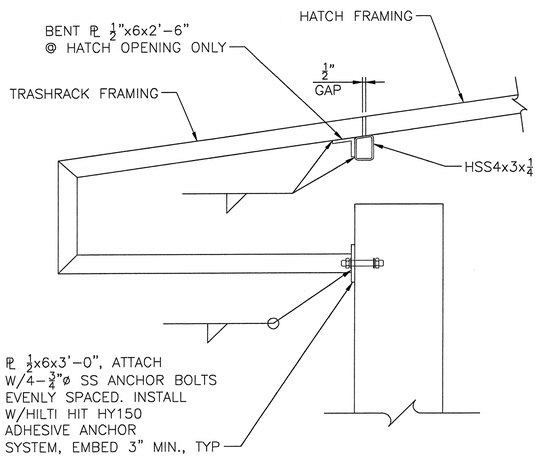
TRASHRACK SECTION A
SCALE: 1/2"=1'–0" S-12



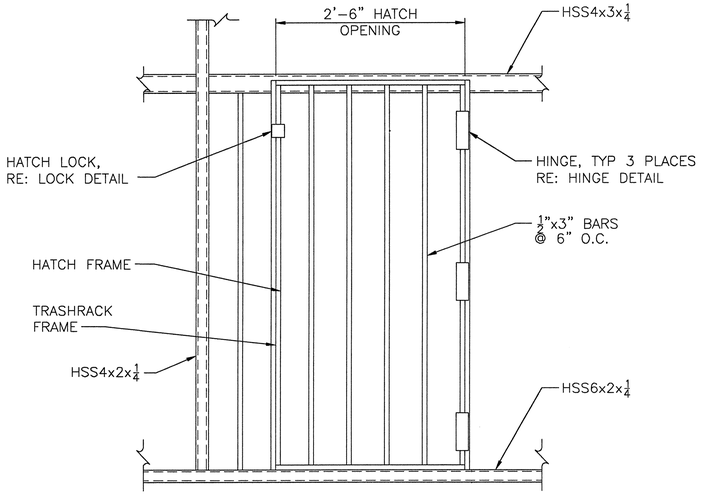
BASE PLATE DETAIL 1/S-12
SCALE: 3"=1'–0"



LOCK DETAIL
SCALE: 3"=1'–0"

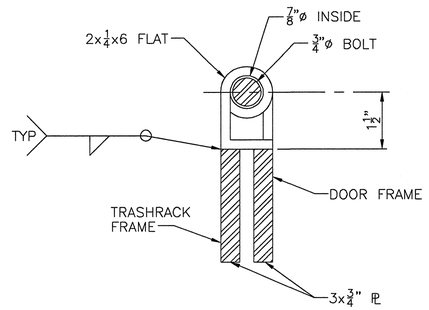


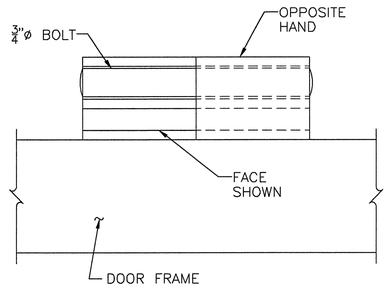
TRASHRACK @ HATCH OPENING B/S-12
SCALE: 1"=1'–0"



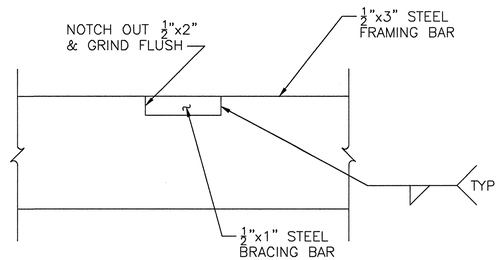
UPPER HATCH OPENING C/S-12
SCALE: 1"=1'–0"

NOTE:
1. TRASHRACK FRAMING NOT SHOWN FOR CLARITY.





HINGE DETAIL
SCALE: 6"=1'–0"



BRACING DETAIL 2/S-12
SCALE: 6"=1'–0"

RECORD DOCUMENT

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RECORD DOCUMENT

RECORD PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY JONES ENGINEERING ASSOCIATES, INC., 3/17/10

E08–027

JFS&A J.F. SATO AND ASSOCIATES
Engineering, Environmental, and Program Management Services
5898 South Rapp Street
Littleton, Colorado 80120
Phone 303.797.1200 • Fax 303.797.1187

REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	
1	J.C.	4–13–09	INCORPORATE COMMENTS, REVISE TO ADD WQCV OUTLET	–
2	J.C.	8–3–09	INCORPORATE COMMENTS	
3	J.C.	9–22–09	ISSUED FOR BID	
4	D.B.	7–2–10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CORNEJO 24996 PROFESSIONAL ENGINEER

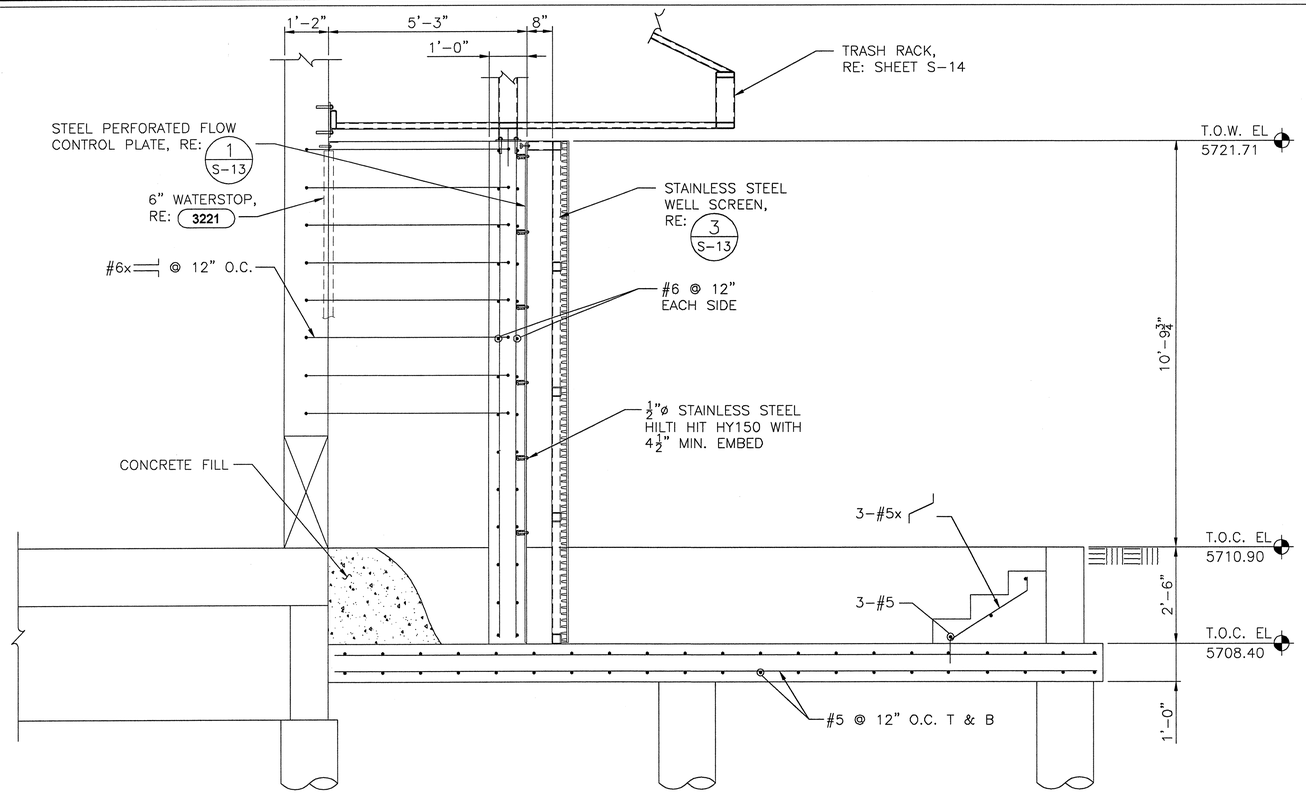
		DATE
DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-12.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D–1
PHASE I WITH INTERIM WATER QUALITY OUTLET

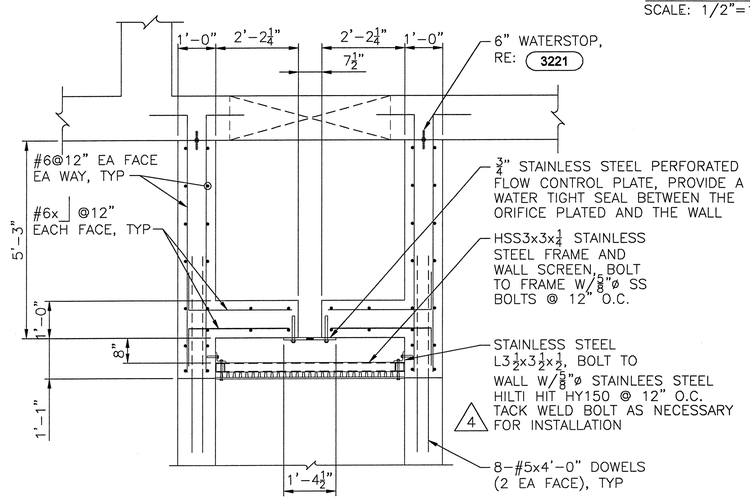
OUTLET STRUCTURE
TRASHRACK SECTIONS AND DETAILS

JOB NO. 071–136.000
REVISION NO. 2
SHEET NO. S–12

6/29/10 16:13 R17 H:\0800_JOBS\0819–DOVE CREEK OUTLET STRUCTURE\CURRENT\AS–BUILT JUNE 30, 2010\S–12.DWG

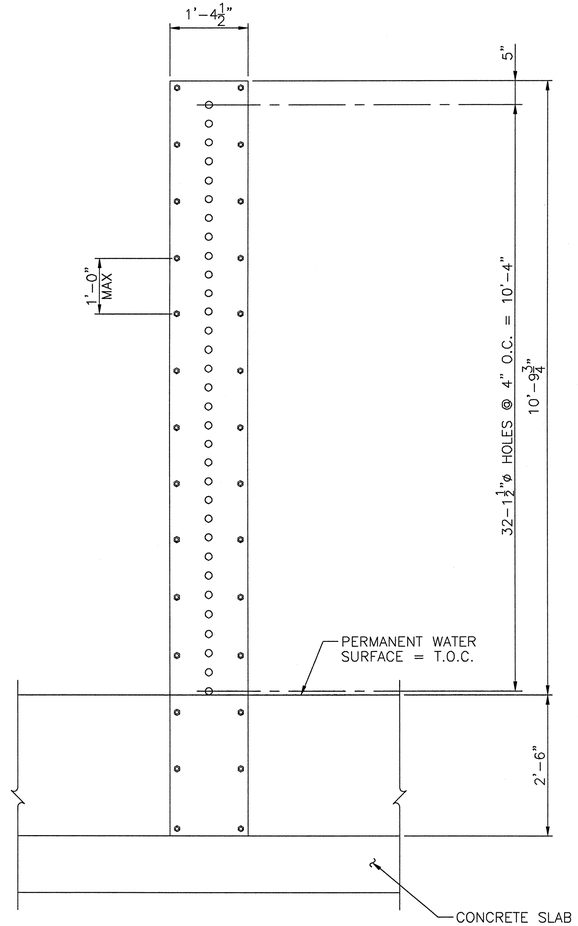


SECTION A
SCALE: 1/2"=1'-0" S-13

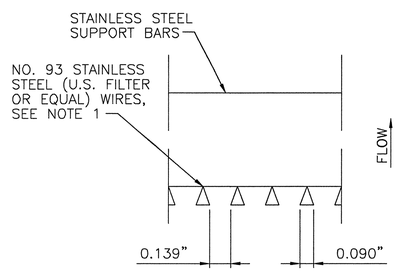


ORIFACE DETAIL 2 S-13 4
SCALE: 1/2"=1'-0"

NOTE:
PROVIDE #6@12" DOWELS FROM SLAB INTO WALL.



CONTROL PLATE DETAIL 1 S-13
SCALE: 3/4"=1'-0"



WELL SCREEN DETAIL 3 S-13
N.T.S.

NOTE:
1. U.S. FILTER, ST. PAUL, MINNESOTA, U.S.A.

RECORD DOCUMENT

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RECORD DOCUMENT

RECORD PLANS WERE PREPARED BASED ON INFORMATION PROVIDED BY JONES ENGINEERING ASSOCIATES, INC., 3/17/10

E08-027

JFS&T J.F. SATO AND ASSOCIATES
Engineering, Environmental, and Program Management Services
5898 South Rapp Street
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Phone 303.797.1200 • Fax 303.797.1187

NO.	BY	DATE	DESCRIPTION	COMMENTS
1	J.C.	4-13-09	INCORPORATE COMMENTS, REVISE TO ADD WQCV OUTLET	-
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4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CORNEJO 24996 PROFESSIONAL ENGINEER

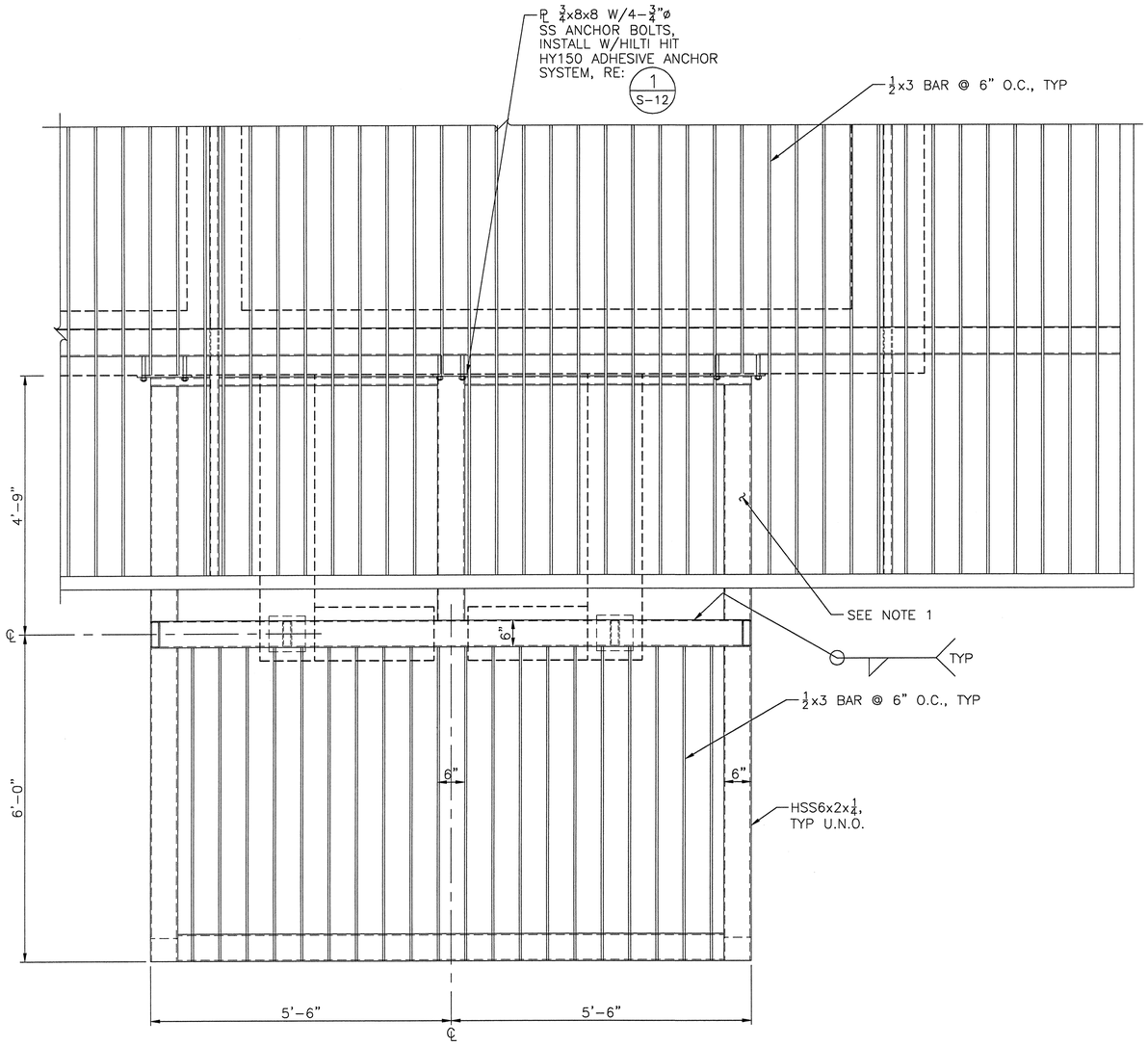
		DATE
DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-13.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

OUTLET STRUCTURE
TRASHRACK SECTIONS AND DETAILS

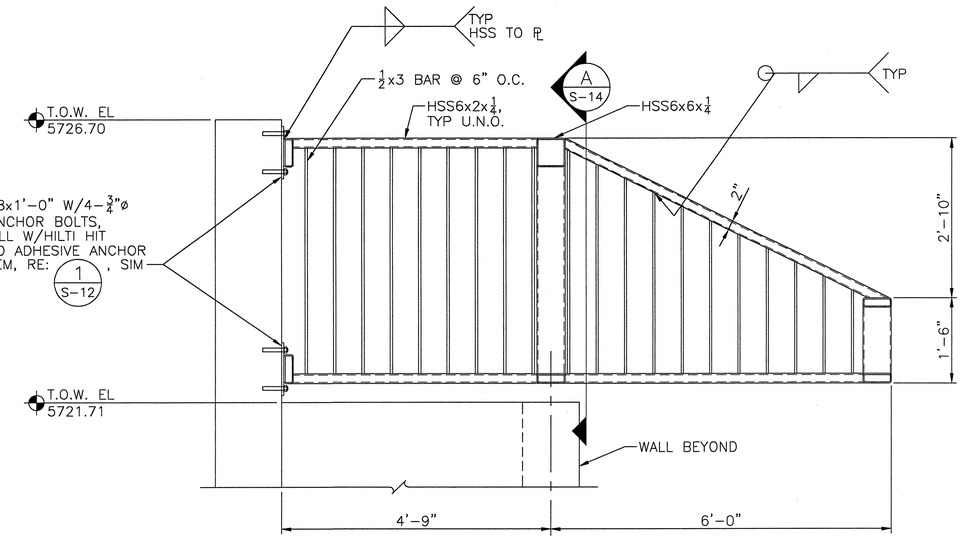
JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-13

6/29/10 16:20 ROD R17 H:\0800 JOBS\0819-DOVE CREEK OUTLET STRUCTURE\CURRENT\AS-BUILT JUNE 30, 2010\S-13.DWG



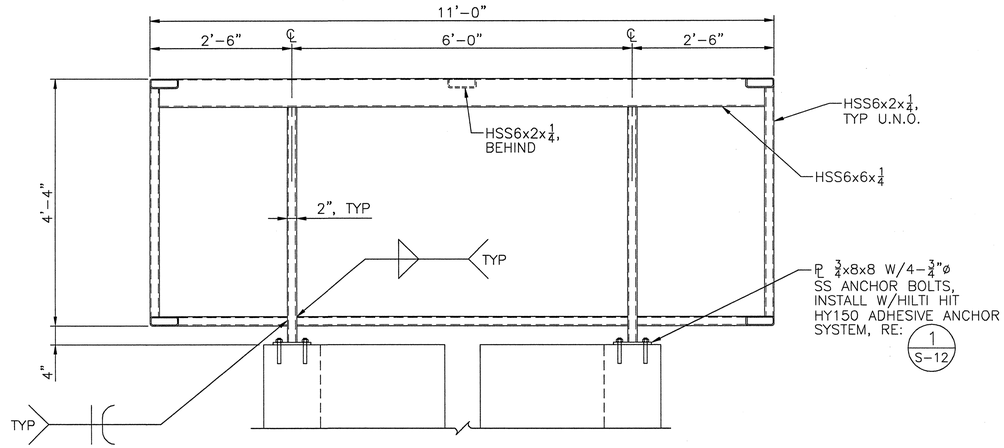
PLAN
SCALE: 3/4"=1'-0"

NOTES:
1. CONTRACTOR TO REMOVE ½" BARS FROM UPPER RACK TO ALLOW INSTALLATION OF LOWER RACK AS REQUIRED.
2. REFER TO TRASH RACK SHOP DRAWINGS FOR FINAL CONFIGURATION.



ELEVATION
SCALE: 3/4"=1'-0"

NOTE:
1. REFER TO TRASH RACK SHOP DRAWINGS FOR FINAL CONFIGURATION.



SECTION A/S-14
SCALE: 3/4"=1'-0"

RECORD DOCUMENT

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RECORD DOCUMENT

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E08-027

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REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	–
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4	D.B.	7-2-10	RECORD DRAWING	

COLORADO REGISTERED JOSE M. CORNEJO 24996, PROFESSIONAL ENGINEER

		DATE
DESIGN	J.C.	04/03/09
DETAIL	R.B.B.	04/03/09
CHECK	J.C.	04/03/09
APPROVAL		
SCALE	AS NOTED ON DRAWING	
S-14.DWG		

SOUTHEAST METRO STORMWATER AUTHORITY
DOVE CREEK DETENTION POND D-1
PHASE I WITH INTERIM WATER QUALITY OUTLET

OUTLET STRUCTURE
TRASHRACK SECTIONS AND DETAILS

JOB NO. 071-136.000
REVISION NO. 2
SHEET NO. S-14

6/29/10 16:48 ROD R17 H:\0800_JOBS\0819-DOVE CREEK OUTLET STRUCTURE\CURRENT\AS-BUILT JUNE 30, 2010\S-14.DWG

LONE TREE CREEK POND L-3
WATER QUALITY IMPROVEMENTS
OWNER: ARAPAHOE COUNTY WATER AND WASTEWATER PUBLIC IMPROVEMENT DISTRICT (PID) PROJECT NO. P-1

ARAPAHOE COUNTY, COLORADO

GENERAL NOTES

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR:

A. CONTACTING THE ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY'S INSPECTOR AT 303-790-4830 AT LEAST 48 HOURS PRIOR TO COMMENCING CONSTRUCTION.

B. CONTRACTOR SHALL OBTAIN AT HIS OWN EXPENSE, ALL PERMITS WHICH ARE NECESSARY TO PERFORM THE PROPOSED WORK.

C. IN CASE OF AN EMERGENCY AFTER WORKING HOURS, CALL THE AUTHORITY'S OFFICE AT 303-790-4830.

2. THE LOCATIONS OF EXISTING UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY AND NOT ALL UTILITIES MAY BE SHOWN THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY AND SOLELY RESPONSIBLE FOR ANY AND ALL DAMAGES AND COSTS WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES.

3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING ANY GROUNDWATER ENCOUNTERED DURING THE CONSTRUCTION OF ANY PORTION OF THIS PROJECT GROUNDWATER SHALL BE PUMPED, PIPED, REMOVED AND DISPOSED OF IN A MANNER WHICH DOES NOT CAUSE FLOODING OF EXISTING STREETS NOR EROSION ON ABUTTING PROPERTIES IN ORDER TO CONSTRUCT THE IMPROVEMENTS SHOWN ON THESE PLANS. NO CONCRETE SHALL BE PLACED WHERE GROUNDWATER IS VISIBLE OR UNTIL THE GROUNDWATER TABLE HAS BEEN LOWERED BELOW THE PROPOSED IMPROVEMENTS. ANY UNSTABLE AREAS, AS A RESULT OF GROUNDWATER, ENCOUNTERED DURING THE CONSTRUCTION OF THE PROPOSED IMPROVEMENTS SHALL BE STABILIZED AS AGREED UPON BY THE CONTRACTOR, AND THE DESIGN ENGINEER AT THE TIME OF THEIR OCCURRENCE.

4. ALL WORK SHALL CONFORM TO THE ARAPAHOE COUNTY STANDARD SPECIFICATIONS OR ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY SPECIFICATIONS OR COLORADO DEPARTMENT OF HIGHWAYS SPECIFICATIONS (ASPHALT).

5. THE CONTRACTOR SHALL CONTACT ALL APPROPRIATE UTILITY COMPANIES AND ARAPAHOE COUNTY AND ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY INSPECTORS PRIOR TO THE BEGINNING OF ANY CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR THE LOCATION (INCLUDING DEPTHS) AND RELOCATION OF ANY EXISTING UTILITIES (AT CONTRACTORS EXPENSE), WHICH MAY CONFLICT WITH THE PROPOSED CONSTRUCTION. ALL EXISTING UTILITIES SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. DAMAGED UTILITIES SHALL BE REPAIRED BY THE CONTRACTOR AT HIS OWN EXPENSE.

6. ALL ITEMS SHOWN ON THE PLANS AS EXISTING ARE SHOWN IN APPROXIMATE LOCATIONS ONLY. THE ACTUAL LOCATION MAY VARY FROM THE PLANS, ESPECIALLY IN THE CASE OF UTILITIES. WHENEVER CONTRACTOR DISCOVERS A DISCREPANCY IN LOCATIONS, HE SHALL CONTACT ENGINEER IMMEDIATELY.

7. ALL ELEVATIONS SHOWN ARE TO TOP OF GROUND EXCEPT WHEN OTHERWISE SPECIFICALLY NOTED.

8. CONTRACTOR SHALL BE RESPONSIBLE FOR RESTORING ALL SURFACES AND RELATED STRUCTURES SUCH AS DRIVEWAYS, CURBS GUTTERS, WALKS AND BITUMINOUS PAVEMENTS TO ORIGINAL CONDITIONS (OR BETTER) AND GRADES UNLESS DESIGNATED OTHERWISE ON THE DRAWINGS. THE ENGINEER AND THE CONTRACTOR SHALL TOGETHER COORDINATE THE DOCUMENTATION OF EXISTING GRADES AND OTHER INFORMATION PRIOR TO ALL CONSTRUCTION ACTIVITIES.

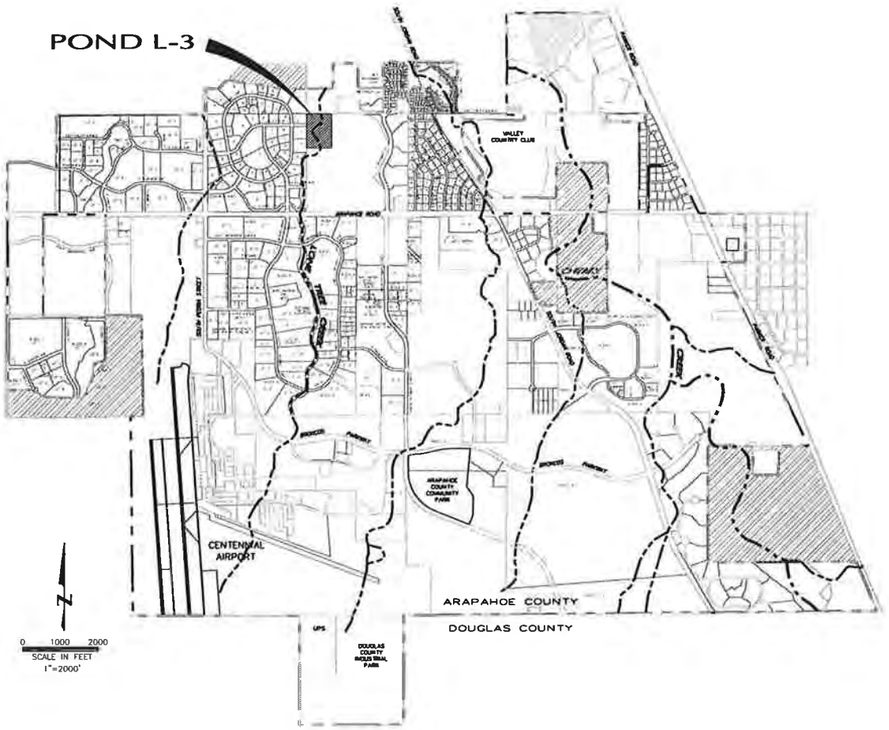
9. EXCAVATIONS SHALL BE KEPT FREE OF WATER AS PROVIDED IN THE WRITTEN SPECIFICATIONS.

10. BASE MAPS PROVIDED BY WRC ENGINEERING "AS BUILT" CONDITIONS

11. CONTRACTOR SHALL PROVIDE "RED LINED" RECORD DRAWINGS TO ENGINEER.

12. CONSTRUCTION STAGING AREA TO BE IDENTIFIED BY ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY.

LOCATION MAP



DRAWING INDEX

SHEET	TITLE
1	COVER SHEET (LOCATION MAP, DRAWING INDEX & GENERAL NOTES)
2	POND L-3 SITE PLAN
3	POND L-3 NEW OUTLET STRUCTURE AND WATER SAMPLING EQUIPMENT
4	POND L-3 EROSION CONTROL PLAN

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
OR **534-6700** FOR DENVER METRO AREA

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

ISSUED FOR BIDDING

WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	
1				

		DATE
DESIGN	DWF/WFL	12/18/03
DETAIL	KAW	12/18/03
CHECK	WFL	12/18/03
APPROVAL		
SCALE		
FILE	POND_L3_SHEET-1.DWG	

ARAPAHOE COUNTY WATER AND WASTEWATER PUBLIC IMPROVEMENT DISTRICT

LONE TREE CREEK - POND L-3 WATER QUALITY IMPROVEMENTS PROJECT NO. P-1

COVER SHEET

JOB NO. 021-048.070
REVISION NO. 0
SHEET NO. 1

12/18/03; WARHOE; E:\ACAD-DWG\021-048\070-KAW\POND_L3_SHEET-1.DWG

NEW OUTLET WATER QUALITY SAMPLING EQUIPMENT AND ENCLOSURE, SEE DETAIL 3/3

REMOVE AND DISPOSE EXISTING OUTLET STRUCTURE AND EXISTING 18" RCP 90° ELBOW. LOCATE NEW OUTLET STRUCTURE AT LOCATION APPROVED BY ENGINEER, SEE DETAIL 1/3

PROPOSED GRADING TO MAINTAIN 10' CLEARANCE TO MANHOLE

EXISTING SANITARY SEWER

DRAINAGE EASEMENT

NEW OUTLET MICROPOOL

NOTES:

1. MAINTAIN 4:1 SLOPES EXCEPT WHERE NOTED

EXISTING BOX CULVERT

EXISTING 18"ø RCP OUTLET PIPING

E. CALEY AVE.

EXISTING STORMWATER INLET

HP GAS LINE

EXISTING SANITARY SEWER

RESTORE 70' LONG CREST BY 10' WIDTH OF D = 12" RIPRAP TO ELEVATION 5644 ON EXISTING GRADE CONTROL STRUCTURE. PROVIDE 20' LONG PERPENDICULAR NOTCH ACROSS CENTER OF STRUCTURE AT ELEVATION 5643.5 RIPRAP SIDE SLOPES 3 HORIZONTAL TO 1 VERTICAL

EXISTING GRADE CONTROL STRUCTURE

EXCAVATE SEDIMENT FROM WITHIN CONCRETE TRICKLE CHANNEL

POND L-3 INLET CHANNEL WITH CONCRETE TRICKLE CHANNEL

EXISTING SANITARY SEWER

SEDIMENT FOREBAY OUTLET

MAINTENANCE ACCESS BERM WITH RIPRAP SEE SECTION A/2

EXCAVATE LARGER SEDIMENT FOREBAY ASSUME FULL OF SEDIMENT, SEE NOTE 2.

SLAB WEEP HOLES(TYP.) SEE DETAIL 2/2

CONCRETE SLAB

EXISTING ACCESS

CURB

ASPHALT

REMOVE AND DISPOSE OF EXISTING CONCRETE OUTLET STRUCTURE

PROTECT EXISTING 18" RCP W/FLARED END AND RIPRAP

HP GAS LINE

NEW INLET WATER QUALITY SAMPLING EQUIPMENT AND ENCLOSURE, SEE DETAIL 3/3

MAINTAIN EXISTING ACCESS, REGRADE AND APPLY NEW 6" AGGREGATE BASE COURSE LAYER AT END OF JOB.

6x6-W1.4xW1.4 WELDED WIRE FABRIC CHAIRED AT MID-DEPTH OF SLAB PROVIDE TYPICAL JOINTS AT 15' O.C.

12' WIDE ACCESS RAMP, 6" THICK CONCRETE ROADWAY WITH 6x6-W1.4xW1.4 WWF @ MID-DEPTH OVER COMPACTED SUBGRADE. PROVIDE TYPICAL JOINTS @ 15' O.C. USE 8" CDOT CLASS B BASE COARSE OVER COMPACTED SUBGRADE. COMPACT TO 98 MAXIMUM STANDARD PROCTOR DENSITY AS PER ASTM D698.

NOTES:

1. EXCAVATED SOIL FROM THE SEDIMENT FOREBAY AND NEW OUTLET MICROPOOL AREAS TO BE HAULED AND DISPOSED OF BY CONTRACTOR.
2. EXISTING CONTOURS SHOW ORIGINAL EXCAVATION WITH A SMALLER FOREBAY. CURRENT CONDITIONS (TOPO) VARY DUE TO SEDIMENT ACCUMULATION.

LEGEND

- PROPOSED 5' CONTOUR
- PROPOSED 1' CONTOUR
- EXISTING 5' CONTOUR
- EXISTING 1' CONTOUR
- UTILITY EASEMENT
- DRAINAGE EASEMENT
- PROPERTY LINE
- HP GAS LINE
- SANITARY SEWER
- BURIED ELECTRIC
- WETLAND BOUNDARY

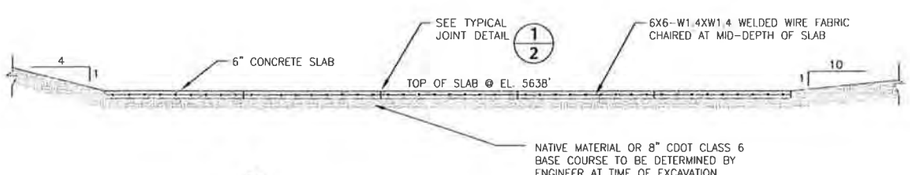
COORDINATES FOR EARTHWORK AND CONCRETE SLAB AND ACCESS RAMP AS INDICATED BY CROSS TICKS: x(10)

	NORTHING	EASTING
1.	27239.21,	25389.49
2.	27163.32,	25378.57
3.	27105.25,	25342.11
4.	27126.13,	25269.09
5.	27178.38,	25220.20
6.	27192.02,	25239.96
7.	27197.92,	25304.88
8.	27243.96,	25362.36
9.	27174.80,	25078.56
10.	27174.80,	25050.54
11.	27128.50,	25048.14
12.	27130.12,	25020.17
13.	26831.13,	25041.48
14.	26830.73,	25021.52
15.	26808.53,	25057.96
16.	26803.81,	25037.82
17.	26505.58,	25102.56
18.	26505.99,	25057.56
19.	26385.59,	25101.48
20.	26385.99,	25056.48
21.	26332.07,	25039.60
22.	26332.19,	25025.99
23.	27129.97,	25389.76
24.	27148.41,	25383.29
25.	26911.53,	25358.27
26.	26944.98,	25323.98

ISSUED FOR BIDDING

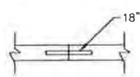
POND L-3 SITE PLAN

SCALE: 1"=50'



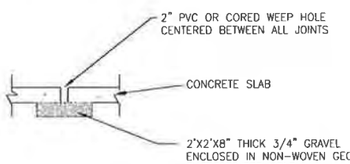
B/2 SEDIMENT FOREBAY SECTION

NOT TO SCALE



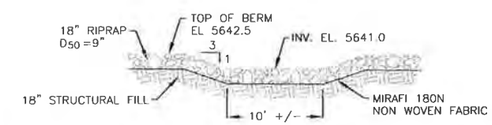
1/2 TYPICAL JOINT DETAIL

NOT TO SCALE



2/2 SLAB WEEP HOLES

NOT TO SCALE



A/2 SEDIMENT FOREBAY OUTLET

SCALE: 1"=4'

WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

REVISIONS			
NO.	BY	DATE	DESCRIPTION
1	DWF	04/02/04	WETLAND BOUNDARY AND GAS LINE LOCATE ADDED

COMMENTS

		DATE
DESIGN	DWF/WFL	04/02/04
DETAIL	KAW/KAL	04/02/04
CHECK	WFL	01/04/20
APPROVAL		
SCALE	AS NOTED	
FILE	POND_L3_SHEET-2.DWG	

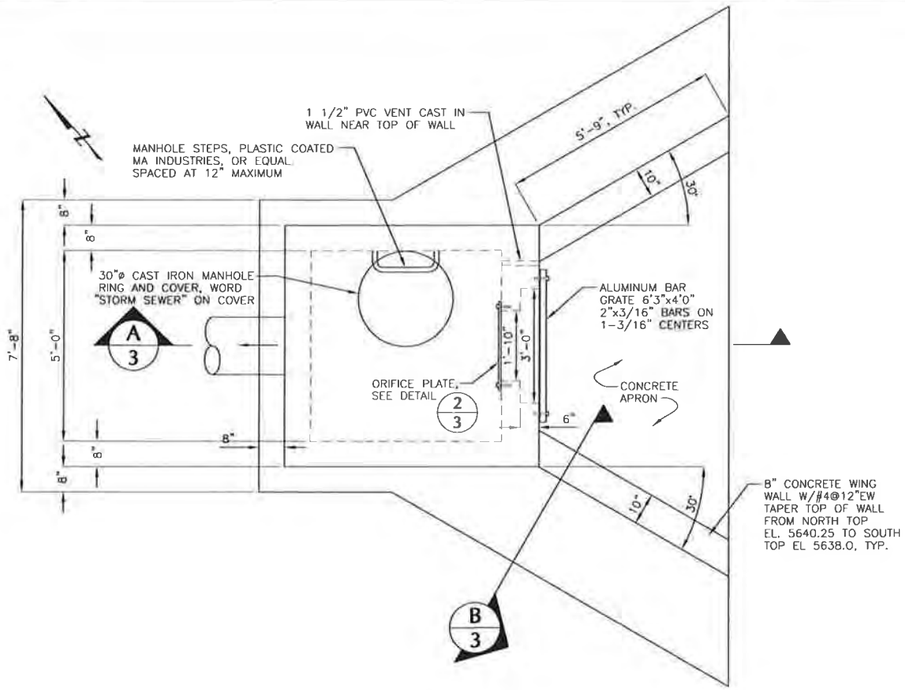
ARAPAHOE COUNTY WATER AND WASTEWATER PUBLIC IMPROVEMENT DISTRICT

LONE TREE CREEK - POND L-3 WATER QUALITY IMPROVEMENTS PROJECT NO. P-1

SITE PLAN

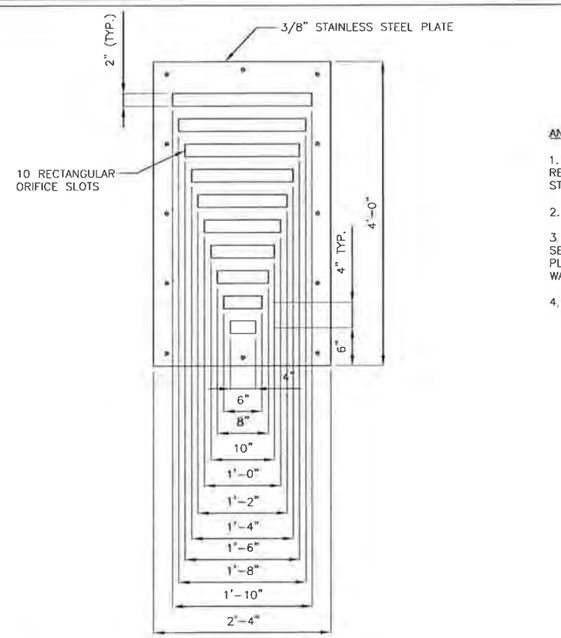
JOB NO. 021-048.070
REVISION NO. 1
SHEET NO. 2

04/02/04, WARHOE, E:\ACAD-DWG\021-048\070-KAW\POND_L3_DESIGN\POND_L3_SHEET-2.DWG



1/3 NEW OUTLET STRUCTURE PLAN

SCALE: 1/2"=1'-0"

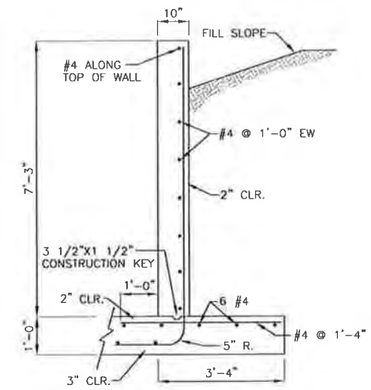


2/3 ORIFICE PLATE DETAIL

SCALE: 1"=1'-0"

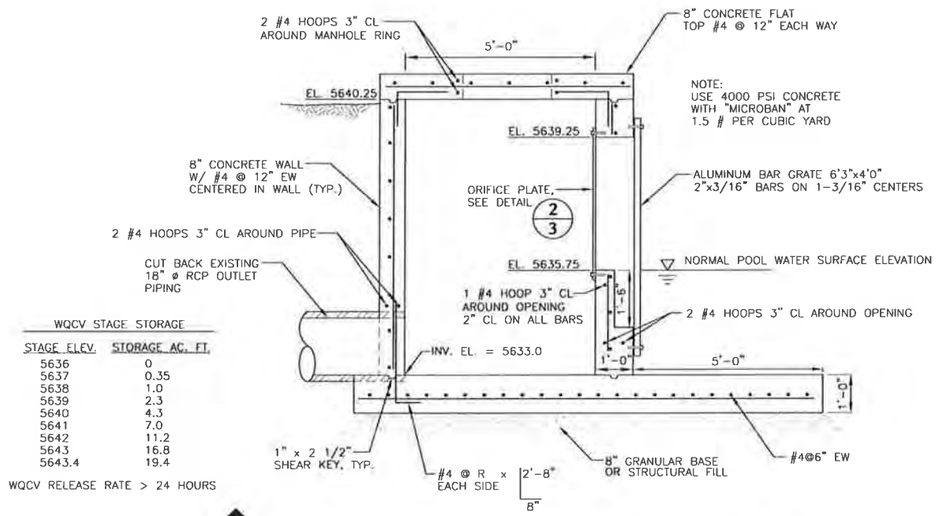
ANCHOR BOLT NOTES

1. 3/8" MIN. ø REMOVABLE STAINLESS STEEL ANCHOR BOLT.
2. 3" MIN. EMBEDMENT.
3. PROVIDE WATER TIGHT SEAL BETWEEN ORIFICE PLATE AND CONCRETE WALL.
4. MAX SPACING 12" O.C.



B/3 WING WALL SECTION

SCALE: 1/2"=1'-0"



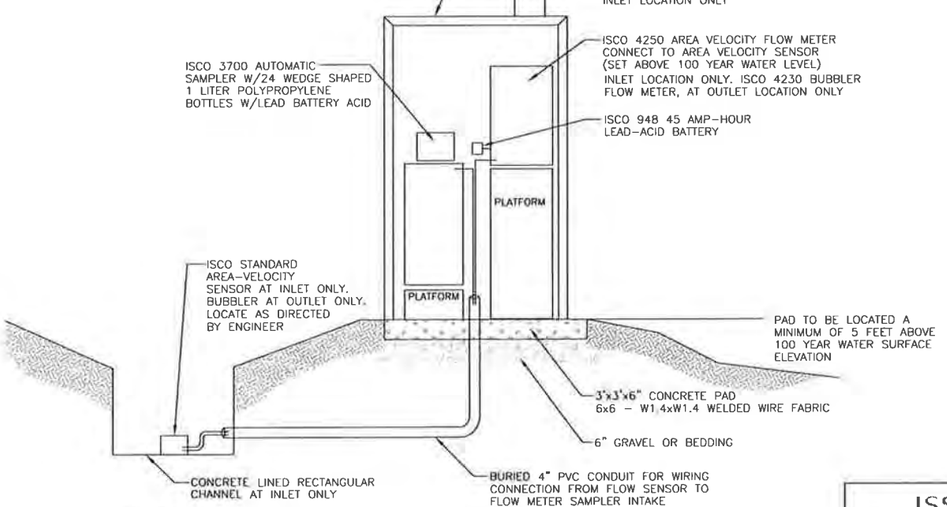
WQCV STAGE STORAGE

STAGE ELEV.	STORAGE AC. FT.
5636	0
5637	0.35
5638	1.0
5639	2.3
5640	4.3
5641	7.0
5642	11.2
5643	16.8
5643.4	19.4

WQCV RELEASE RATE > 24 HOURS

A/3 NEW OUTLET STRUCTURE SECTION

SCALE: 1/2"=1'-0"



3/3 WATER QUALITY SAMPLING EQUIPMENT DETAIL

NOT TO SCALE

ISSUED FOR BIDDING

WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

REVISIONS				COMMENTS
NO.	BY	DATE	DESCRIPTION	

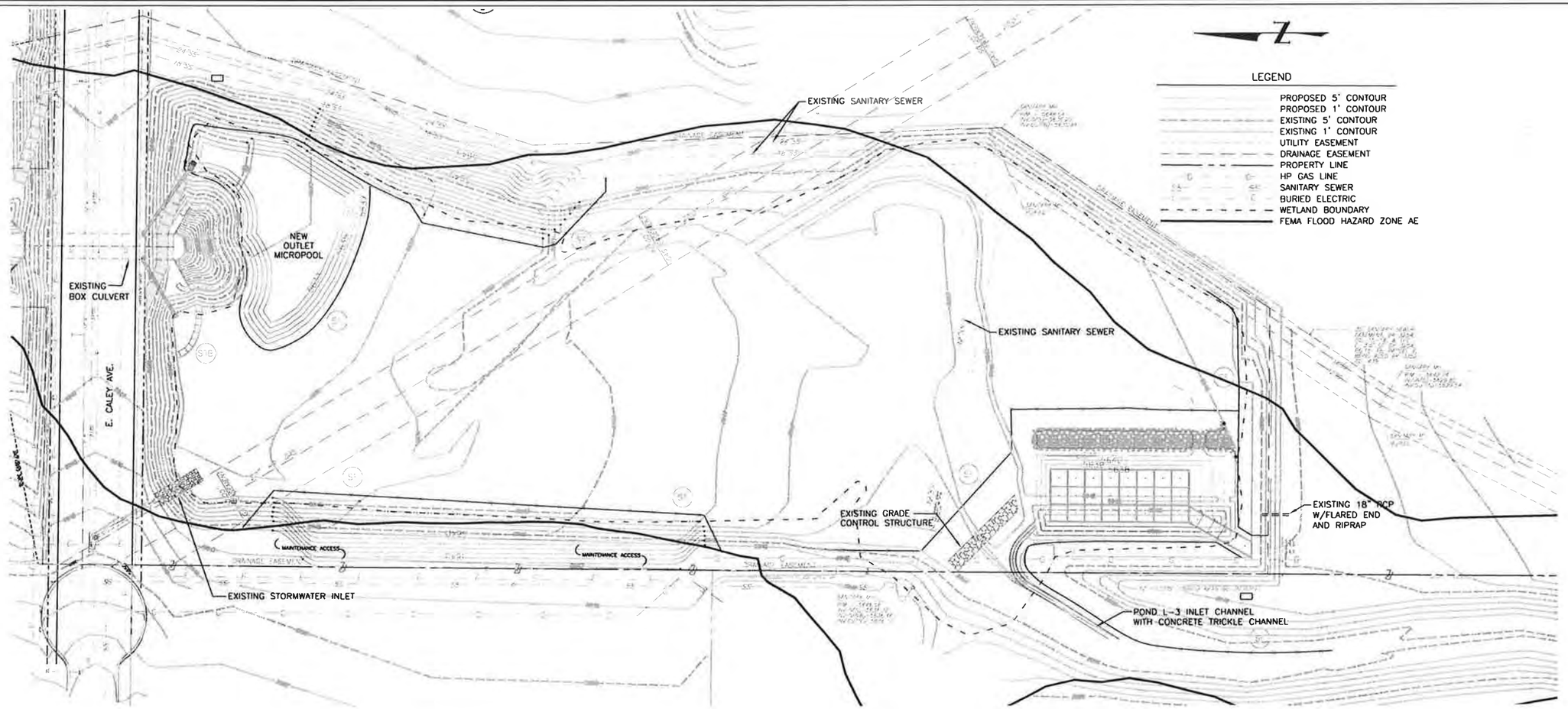
		DATE
DESIGN	DWF/WFL	12/18/03
DETAIL	KAW/KAL	12/18/03
CHECK	WFL	12/18/03
APPROVAL		
SCALE	AS NOTED	
FILE	POND_L3_SHEET-3.DWG	

ARAPAHOE COUNTY WATER AND WASTEWATER PUBLIC IMPROVEMENT DISTRICT

LONE TREE CREEK - POND L-3
WATER QUALITY IMPROVEMENTS
PROJECT NO. P-1
NEW OUTLET STRUCTURE AND WATER SAMPLING EQUIPMENT

JOB NO. 021-048.070
REVISION NO. 0
SHEET NO. 3

12/18/03: WARHOE: E:\CAD-DWG\021-048\070-KAW\POND_L3_DESIGN\POND_L3_SHEET-3.DWG



POND L-3 SITE EROSION CONTROL PLAN

SCALE: 1"=50'

SILT FENCE BARRIER AS PER CHERRY CREEK BASIN WATER QUALITY AUTHORITY.

STRAW BALE BARRIER AS PER CHERRY CREEK BASIN WATER QUALITY AUTHORITY.

1. THE CONTRACTOR SHALL REMOVE ALL SEDIMENT, MUD, CONSTRUCTION DEBRIS, OR OTHER POTENTIAL POLLUTANTS THAT MAY HAVE BEEN DISCHARGED TO OR, ACCUMULATE IN, THE FLOWLINES AND PUBLIC RIGHTS OF WAYS AS A RESULT OF CONSTRUCTION ACTIVITIES ASSOCIATED WITH THIS CONSTRUCTION PROJECT. SAID REMOVAL SHALL BE CONDUCTED IN A TIMELY MANNER.

2. THE CONTRACTOR SHALL PREVENT SEDIMENT, DEBRIS AND ALL OTHER POLLUTANTS FROM ENTERING THE STORM SEWER SYSTEM DURING ALL DEMOLITION, EXCAVATION, TRENCHING, GRADING OR OTHER CONSTRUCTION OPERATIONS THAT ARE PART OF THIS PROJECT.
THE CONTRACTOR SHALL BE HELD RESPONSIBLE FOR REMEDIATION OF ANY ADVERSE IMPACTS TO ADJACENT WATERWAYS, WETLANDS, ETC., RESULTING FROM WORK DONE AS PART OF THIS PROJECT.

3. A LAYER OF SUITABLE MULCH SHALL BE APPLIED TO ALL DISTURBED PORTIONS OF THE SITE WITHIN 14 DAYS OF THE COMPLETION OF OVERLOT GRADING. SAID MULCH SHALL BE APPLIED AT A RATE OF 2 TONS PER ACRE AND SHALL BE TACKED OR FASTENED BY AN APPROVED METHOD SUITABLE FOR THE TYPE OF MULCH USED.

4. THE CONTRACTOR SHALL LOCATE, INSTALL, AND MAINTAIN ALL EROSION CONTROL AND WATER QUALITY "BEST MANAGEMENT PRACTICES" AS INDICATED.

5. THE DEVELOPER, GENERAL CONTRACTOR, GRADING CONTRACTOR AND/OR THEIR AUTHORIZED AGENTS SHALL INSURE THAT ALL LOADS OF CUT AND FILL MATERIAL IMPORTED TO OR EXPORTED FROM THIS SITE SHALL BE PROPERLY COVERED AND CONTAINED SO AS TO PREVENT LOSS OF THE MATERIAL DURING TRANSPORT ON PUBLIC RIGHTS OF WAYS.

6. THE USE OF REBAR, STEEL STAKES, OR STEEL FENCE POSTS TO STAKE DOWN STRAW OR HAY BALES; OR TO SUPPORT SILT FENCING USED AS AN EROSION CONTROL MEASURE; IS PROHIBITED.

7. SOILS THAT WILL BE STOCKPILED FOR MORE THAN 30 DAYS SHALL BE PROTECTED FROM WIND AND WATER EROSION WITHIN 14 DAYS OF STOCKPILE CONSTRUCTION. STABILIZATION AND PROTECTION OF THE STOCKPILE MAY BE ACCOMPLISHED BY ANY OF THE FOLLOWING: MULCHING, TEMPORARY/PERMANENT REVEGETATION OPERATIONS, CHEMICAL SOIL STABILIZER APPLICATION (REQUIRES ARAPAHOE COUNTY WATER AND WASTEWATER PUBLIC IMPROVEMENT DISTRICT APPROVAL), OR EROSION CONTROL MATTING/GEOTEXTILES. IF STOCKPILES ARE LOCATED WITHIN 100 FEET OF A DRAINAGEWAY, ADDITIONAL SEDIMENT CONTROLS SUCH AS TEMPORARY DIKES OR SILT FENCE SHALL BE REQUIRED.

8. APPROVED EROSION AND SEDIMENT CONTROL "BEST MANAGEMENT PRACTICES" SHALL BE MAINTAINED AND KEPT IN GOOD REPAIR FOR THE DURATION OF THIS PROJECT.
AT A MINIMUM, THE CONTRACTOR OR HIS AGENT SHALL INSPECT ALL BMPS WEEKLY AND AFTER SIGNIFICANT PRECIPITATION EVENTS. ALL NECESSARY MAINTENANCE AND REPAIR SHALL BE COMPLETED IN A TIMELY MANNER. ACCUMULATED SEDIMENT AND DEBRIS SHALL BE REMOVED FROM A BMP WHEN THE SEDIMENT LEVEL REACHES ONE HALF THE HEIGHT OF THE BMP OR, AT ANY TIME THAT SEDIMENT OR DEBRIS ADVERSELY IMPACTS THE FUNCTIONING OF THE BMP.

9. MODIFICATION OF AN ACTIVE CONSTRUCTION ACTIVITIES STORMWATER DISCHARGE PERMIT BY THE DEVELOPER, CONTRACTOR OR THEIR AUTHORIZED AGENTS SHALL REQUIRE TIMELY NOTIFICATION OF AND APPROVAL BY ARAPAHOE COUNTY WATER AND WASTEWATER PUBLIC IMPROVEMENT DISTRICT.
TERMINATION OF AN ACTIVE CONSTRUCTION ACTIVITIES STORMWATER DISCHARGE PERMIT UPON COMPLETION OF THE PROJECT REQUIRES NOTIFICATION OF AND APPROVAL BY THE ARAPAHOE COUNTY WATER AND WASTEWATER PUBLIC IMPROVEMENT DISTRICT.

10. WATER USED IN THE CLEANING OF CEMENT TRUCK DELIVERY CHUTES SHALL BE DISCHARGED INTO A PREDEFINED, BERMED CONTAINMENT AREA ON THE JOB SITE. THE REQUIRED CONTAINMENT AREA IS TO BE BERMED SO THAT WASH WATER IS TOTALLY CONTAINED. WASH WATER DISCHARGED INTO THE CONTAINMENT AREA SHALL BE ALLOWED TO INFILTRATE OR EVAPORATE. DRIED CEMENT WASTE IS REMOVED FROM THE CONTAINMENT AREA AND PROPERLY DISPOSED OF.
SHOULD A PREDEFINED BERMED CONTAINMENT AREA NOT BE AVAILABLE DUE TO THE PROJECT SIZE, OR LACK OF AN AREA WITH A SUITABLE GROUND SURFACE FOR ESTABLISHING A CONTAINMENT AREA, PROPER DISPOSAL OF READY MIX WASHOUT AND RINSE OFF WATER AT THE JOB SITE SHALL CONFORM TO THE APPROVED TECHNIQUES AND PRACTICES IDENTIFIED IN THE COLORADO DEPARTMENT OF PUBLIC HEALTH & ENVIRONMENT'S TRAINING VIDEO ENTITLED "BUILDING FOR A CLEANER ENVIRONMENT - READY MIX WASHOUT PRACTICES", AND ITS ACCOMPANYING MANUAL ENTITLED, "READY MIX WASHOUT GUIDEBOOK, VEHICLE AND EQUIPMENT WASHOUT AT CONSTRUCTION SITES."
THE DIRECT OR INDIRECT DISCHARGE OF WATER CONTAINING WASTE CEMENT TO THE STORM SEWER SYSTEM IS PROHIBITED. INFORMATION ABOUT, OR COPIES OF THE VIDEO AND TRAINING MANUAL ARE AVAILABLE FROM THE WATER QUALITY CONTROL DIVISION, COLORADO DEPARTMENT OF PUBLIC HEALTH & ENVIRONMENT, 4300 CHERRY CREEK DRIVE SOUTH, DENVER, COLORADO 80222-1530, 303-692-3555.
ALTERNATIVELY, SHALL BE CONDUCTED OFF SITE.

EROSION CONTROL NOTES

ISSUED FOR BIDDING

WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

NO.	BY	DATE	REVISIONS DESCRIPTION	COMMENTS
1	DWF	06/17/04	ADDED FEMA FLOOD HAZARD ZONE AE	

		DATE
DESIGN	DWF/WFL	04/02/04
DETAIL	KAN/KAL	04/02/04
CHECK	WFL	04/02/04
APPROVAL		
SCALE	AS NOTED	
FILE	POND_L3_SHEET-4.DWG	

ARAPAHOE COUNTY WATER AND WASTEWATER PUBLIC IMPROVEMENT DISTRICT

LONE TREE CREEK - POND L-3
WATER QUALITY IMPROVEMENTS
PROJECT NO. P-1
EROSION CONTROL PLAN

JOB NO. 021-048.070
REVISION NO. 1
SHEET NO. 4

04/02/04; WARHOE; E:\ACAD-DWG\021-048\070-KAN\POND_L3_DESIGN\POND_L3_SHEET-4.DWG

imagery for drainageways viewable in an online touring platform, also developed and maintained by EarthViews, Inc. Post-processing of the data requires the leveling and reorientation of the images to compensate for the movement of the inspector in the field. Once the imagery has been post-processed then it is ready to be upload to the EarthViews website with privacy settings the match the clients' transparency needs. The final deliverable is a 360-degree slideshow style imagery tour from EarthViews and will be available on a SEMSWA district-wide URL arcgis.earthviews.com/semswahome.html

This URL allows for navigation to the reach locations and tracks (paths along each drainageway).

This report documents the findings from the data collection efforts that occurred from January 7, 2020, through April 30, 2021. Appendix A includes stream mileage summary tables that are organized by data collection phase.

Rapid Assessment Methods

This section discusses the purpose of the collected data and the data collection methodologies used in the field investigations and rapid assessments. References to assessment methodologies used by the project team is provided at the end of this report.

Guidelines and Principles

To ensure consistency and to provide guidance for this, and future, data collection efforts, the project team developed and followed a set of overarching principles for large-scale rapid baseline assessments. The guiding principles included:

1. Building the data collection and assessments upon proven and documented techniques from reputable sources for field work
    a. Natural Resource Conservation Service (NRCS), Federal Highway Administration (FHWA), Rosgen stream morphology, existing agency inspection forms
2. Developing repeatable steps and actions for the rapid assessment including:
    a. Providing guidance for each set of data collected
    b. Developing consistent data collection methodologies, but
    c. Allowing for other less modernized techniques when necessary for data collection
3. Solutions needed to be scalable for small and large efforts
4. Creating consistent data with pre-defined databases with restricted input
5. Minimizing data maintenance
    a. Develop quality control procedures
    b. Determine schedule for updates
    c. How is data collected and over what time scale?

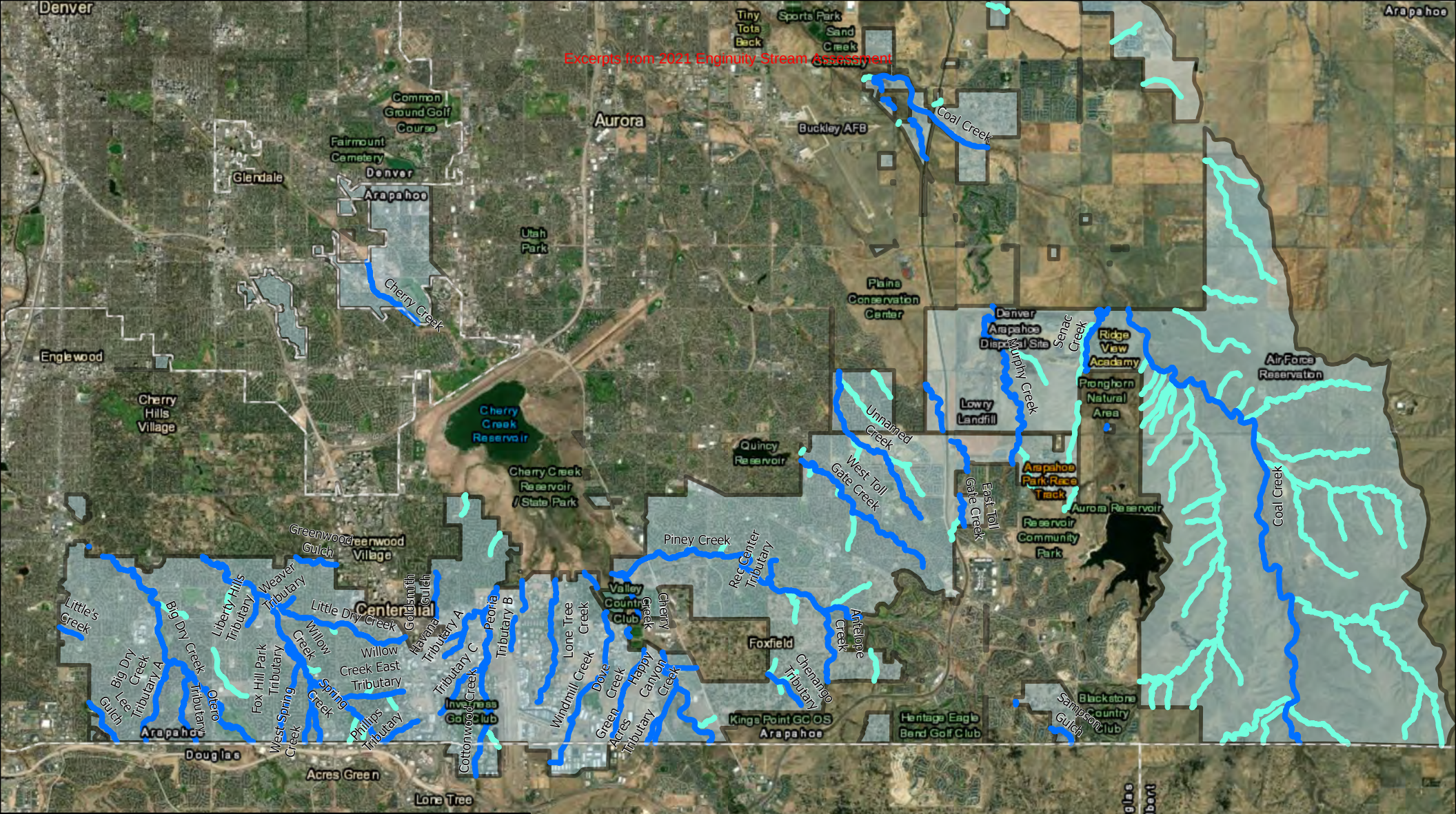


Figure 1 - Overview Map (Entire Scoped Drainageway Study)

SEMSWA Drainage Channels

EarthViews Conducted on Drainageway

- NO
- YES

SEMSWA Service Boundary

- SEMSWA Service Delineation Layer

Data Categorization

To improve understanding and use of the data, each data field is categorized as follows:

1. **[REF] – Reference Data:** Reference information such as reach identification, inspection dates, etc.
2. **[BASE] – Baseline Data:** Data measured or collected in the field related to stream characteristics, infrastructure sizing, etc. that either don't change over time or a meant to capture a baseline data point for future reference.
3. **[AMT] – Adaptive Management Triggers**. Those data that might indicate a need for follow-up or adaptive management implementation, further detail is provided regarding performance metrics, management triggers, suggested actions, and timing of data collection, i.e. how often it is recommended that SEMSWA revisit field conditions.
4. **[MAINT] – Maintenance.** These data reflect existing maintenance needs associated with infrastructure.

Items identified as either [AMT] or [MAINT] have been further described in an Adaptive Management and Maintenance Strategies Matrix that describes the data collected, performance standard, and what scoring metric or observation may trigger the need for further investigation or maintenance.

Feature Class Descriptions

The following sections describe in detail the data collected during the field investigations and rapid assessments. This data is collected by Survey123 and is used to populate the project database.

Stream Health Assessment

Purpose of Assessment: This assessment and data collection effort is meant to capture the current health and function of a stream specifically addressing hydraulics, ecological function, and habitat. Data within this layer will provide information of the current state of the riparian system and will assist in future hydraulic modeling and determinations of maintenance needs.

Methodology: The data collected for this assessment addresses some physical characteristics of the stream regarding floodplain and hydraulic function and stream health. The Natural Resource Conservation Service (NRCS) Stream Visual Assessment Protocol 2 (SVAP2) was used as the basis for assessing existing conditions along each drainageway. However, not all the assessment criteria from SVAP2 were collected during this effort. The following elements were excluded from this collection effort:

- Channel Condition,
- Hydrologic Alteration,
- Manure or Human Waste,
- Barriers to Aquatic Species Movement,
- Aquatic Habitat Complexity,
- Aquatic Invertebrate Community,
- Riffle Embeddedness, and
- Salinity.

These elements are not included because they were either difficult to estimate from a single point in the field and would require significant time to accurately assess. Since one of the goals of the rapid assessment was to be efficient and keep costs

low, these additional parameters were not considered during the data collection process. It is also noted here that photos supporting the Stream Conditions Assessment were not taken. The EarthViews imagery should be used for reference by those reviewing the stream conditions data. On streams where EarthViews data was not collected aerial imagery or site visits should be employed depending on the need.

This assessment was completed at least once for each stream reach, but often several locations along streams were assessed to record variations in stream conditions along the reach. Generally, a new stream assessment was conducted every time a significant change in the overall channel dynamics and condition occurred.

Data Collected: The data collected during the field walks is described below.

- **Reach_ID [REF]**: Unique reach identifier or stream name used to categorize all the data.
- **Date of Inspection [REF]**: Date of stream assessment.
- **Inspector [REF]**: Person completing the assessment.
- **Baseflow_W [BASE]**: Width of the active baseflow in the stream. Measured in field with a survey rod. Uncertainty = +/- 0.5 feet.
- **Baseflow_D [BASE]**: Depth of the active baseflow in the stream. Measured in field with a survey rod. Uncertainty = +/- 0.1 feet.
- **Channel Form [BASE]**: Stream form as a function of distance (Meandering, Straight, and Multiple Channels).
- **Overbank N [AMT]**: Manning's roughness coefficient of the overbank of the stream based on visual interpretation of field workers. Based on descriptions from Chow, 1959.
- **Channel N [AMT]:** Manning's roughness coefficient of the channel of the stream based on visual interpretation of field workers. Based on descriptions from Chow, 1959.
- **CEM Stage [BASE]:** Represents the stages of the Schumm Channel Evolution Model as described in the SVAP2. All non-natural channels were marked as Engineered (Engd) Channel. The diagram to the right is used to identify current stream evolution states. It shows the cycle of adaptation that a stream will go through overtime. When a disturbance occurs in the watershed, such as development increasing base flows and peak flows, the stream responds by first downcutting because of increased flow. Once the incision is severe enough to cause bank failure, the stream widens. The channel ultimately will achieve a new level stability or quasi stability once enough widening has occurred to reach a new stable channel width.

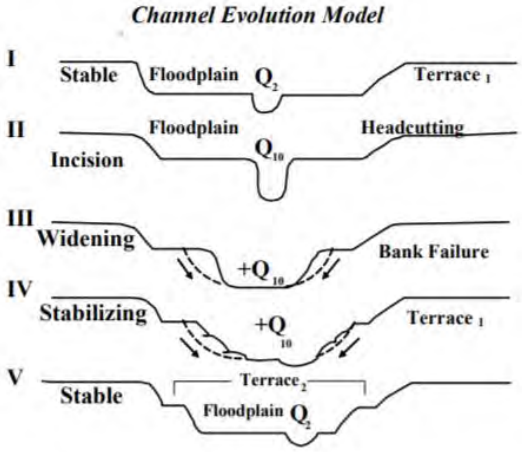


Figure 2 - Channel Evolution Model (Schumm, Harvey and Watson, 1984). Q2 indicates a flood interval of 2 yrs; Q10 indicates an interval of 10 yrs.

- **Floodplain Connectivity [AMT]:** Classification system used to assess the stream's connectivity to the floodplain (Good, Fair, Poor). The frequency in which the floodplain can be inundated. Good indicates that the bankfull flow is likely to overtop the lowflow channel spreading. Fair means that there is slight incision, but still good riparian connection, and poor means the channel is incised the water rarely can overflow to the overbanks during bankfull type flows.

- **Bank Stability [AMT]**: A score from 10 to 1 documenting the potential for the soil above the active and bankfull channel, on the upper and lower banks, to become unstable and slide or fall into the stream. This includes bank instabilities that are occurring because of downcutting (degradation), widening, and natural meander migration. (From SVAP2).

Table 1 - Bank Stability			
10-9	**8-6**	**5-3**	**2-0**
Banks are stable, protected by roots of natural vegetation, wood, and rock No fabricated structures present on bank No excessive erosion or bank failures No recreational or livestock access	Banks are moderately stable, protected by roots of natural vegetation, wood, or rock or a combination of materials Limited number of structures present on bank Evidence of erosion or bank failures, some with reestablishment of vegetation Recreational use and/or grazing do not negatively impact bank condition	Banks are moderately unstable, very little protection of banks by roots of natural wood, vegetation, or rock Fabricated structures cover more than half of reach or entire bank. Excessive bank erosion or active bank failures. Recreational and/or livestock use are contributing to bank instability.	Banks are unstable, no bank protection with roots, wood, rock, or vegetation Riprap and/or other structures dominate banks Numerous active bank failures Recreational and/or livestock use are contributing to bank instability

* Natural wood and rock do not mean riprap, gabions, log cribs, or other fabricated revetments.
**Bank failure refers to a section of streambank that collapses and falls into the stream, usually because of slope instability.

- **Riparian Quantity [AMT]**: A score from 10 to 1 summarizing the quantity of vegetation within the riparian zone based on the width, overbanks, and connected floodplain. (From SVAP2).

Table 2 - Riparian Quantity				
10-9	**8-7**	**6-5**	**4-2**	**1-0**
Natural plant community extends at least two bank-full widths or more than the entire active flood plain and is generally contiguous throughout property	Natural plant community extends at least one bankfull width or more than 1/2 to 2/3 of active flood plain and is generally contiguous throughout property Vegetation gaps do not exceed 10% of the estimated length of the stream on the property	Natural plant community extends at least 1/2 of the bank-full width or more than at least 1/2 of active flood plain Vegetation gaps do not exceed 30% of the estimated length of the stream on the property	Natural plant community extends at least 1/3 of the bank-full width or more than 1/4 of active flood plain Vegetation gaps exceed 30% of the estimated length of the stream on the property	Natural plant community extends less than 1/3 of the bankfull width or less than 1/4 of active flood plain Vegetation gaps exceed 30% of the estimated length of the stream on the property

- **Riparian Quality [AMT]**: A score from 10 to 1 summarizing the quality of vegetation within the riparian zone based on diversity, and age of the vegetation in the channel. (From SVAP2).

Table 3 - Riparian Quality			
10-9	**8-6**	**5-3**	**2-0**
Natural and diverse riparian vegetation with composition, density, and age structure appropriate for the site No invasive species or concentrated flows through area	Natural and diverse riparian vegetation with composition, density, and age structure appropriate for the site: Little or no evidence of concentrated flows through area Invasive species present in small numbers (20% cover or less)	Natural vegetation compromised Evidence of concentrated flows running through the riparian area. Invasive species common (>20% <50% cover)	Little or no natural vegetation Evidence of concentrated flows running through the riparian area Invasive species widespread (>50% cover)

- **Canopy Cover [BASE]**: A percentage from 100 to 0 representing the relative amount of shade is estimated by assuming that the sun is directly overhead, and the vegetation is in full leaf-out. To enhance accuracy of the

assessment, aerial photographs taken during full leaf-out should be used to supplement visual assessments. Figure 2 may be used as a guide for both visual and aerial estimates.



Figure 3 - Percent canopy cover. Numbers above the ovals refer to the percent black (=shade/cover). (SVAP2).

- **Water Appearance [BASE]:** A score from 10 to 1 summarizing the turbidity, color, and clarity. A survey rod was used and the depth to which it could be seen was used to evaluate the water appearance. Null values indicate a dry channel. (From SVAP2).

Table 4 - Water Appearance			
10-9	**8-6**	**5-3**	**2-0**
Water is very clear, or clarity appropriate to the site; submerged features in stream (rocks, wood) are visible at depths of 3 to 6 ft. No motor oil sheen on surface; no evidence of metal precipitates in streams	Water is slightly turbid, especially after storm event, but clears after weather clears; submerged features in stream (rocks, wood) are only visible at depths of 1.5 to 3 ft. No motor oil sheen on surface or evidence of metal precipitates in stream	Water is turbid most of the time; submerged features in stream (rocks, wood) are visible at depths of only .5 to 1.5 feet and/or Motor oil sheen is present on water surface or areas of slackwater and/or There is evidence of metal precipitates in stream	Very turbid water most of the time; submerged features instream (rocks, wood) are visible only within .5 ft below surface and/or Motor oil sheen is present on the water surface or areas of slackwater

- **Nutrient Enrichment [AMT]:** A score from 10 to 1 summarizing available nutrients in the water based on visual nutrient enrichment characteristics, including abundance of algae and floating and rooted macrophytes. This can also be seen in low dissolved oxygen levels. Null values indicate a dry channel. (From SVAP2).

Table 5 - Nutrient Enrichment			
10-8	**7-5**	**4-2**	**1-0**
Clearwater along entire reach Little algal growth present	Fairly clear or slightly greenish water Moderate algal growth on substrates	Greenish water particularly in slow sections. Abundant algal growth, especially during warmer months and/or Slight odor of ammonia or rotten eggs and/or Sporadic growth of aquatic plants within slack water areas	Pea-green color present; thick algal mats dominating stream and/or Strong odor of ammonia or rotten eggs and/or Dense stands of aquatic plants widely dispersed

- **Pools [BASE]:** A score from 1 to 10 summarizing the frequency of geomorphic pools along the reach. A geomorphic pool is typically present at the apex of meanders or downstream of riffles. Pool are important for aquatic habitat and must be at least 1/3 the bankfull width and as deep as the upstream riffle.

Table 6 - Pools			
10-9	**8-6**	**5-3**	**2-0**
More than 2 deep pools separated by riffles, each with greater than 30% of the pool bottom obscured by depth, wood, or other cover. Shallow pools also present.	One or 2 deep pools separated by riffles, each with greater than 30% of the pool bottom obscured by depth, wood, or other cover At least one shallow pool present.	Pools present but shallow (< 2 times maximum depth of the upstream riffle) Only 10 – 30% of pool bottoms are obscured due to depth or wood cover.	Pools absent, but some slow water habitat is available No cover discernible. or Reach is dominated by shallow continuous pools or slow water

- **Overall Quality SVAP2 [AMT]:** Quality score assessment assigned to the stream overall (Excellent, Good, Fair, Poor, Severely Degraded). These categorizations are based on the reach Total Score as follows:
    - 1 to 2.9 Severely Degraded
    - 3 to 4.9 Poor
    - 5 to 6.9 Fair
    - 7 to 8.9 Good
    - 9 to 10 Excellent
- **Total Score [BASE]:** An average score for all scored elements within SVAP2 (as an average). This value should be used to get an overall understanding of the stream conditions. To compute this value, the scores from the Bank Stability, Riparian Quality, Riparian Quantity, Water Appearance (not included for dry channels), Nutrient Enrichment (not included for dry channels), and assessments were all averaged into this total score. For all SVAP2 metrics, the lower the score the worse the condition within the reach.
- **Comments [REF]:** Additional comments related to that portion of the reach.
- **Editor [REF]:** Name of the last editor.
- **EditDate [REF]**: Date of the last edit.

Geomorphic Conditions

Purpose: This assessment is focused on gathering geomorphologic characteristics and quantitative data to assess the geomorphologic condition of the drainageways. Data from this assessment will aid in the determination of sediment flux and long-term stream stability.

Methodology: Selected field methodologies from Rosgen, 1996 were compiled to create this assessment. This assessment was conducted as a compliment to the Stream Conditions Assessment, at a representative location along each reach. Generally, a new assessment was conducted every time a significant change in the overall channel dynamics and condition occurred. Photos were not taken for this assessment and the EarthViews imagery should be used to supplement when available.

Data Collected: The data collected for each Geomorphic Conditions Assessment includes:

- **Reach ID [REF]**: Unique Reach ID or Stream Name used to categorize all the data.
- **Date of Inspection [REF]**: Date of Geomorphic Conditions Assessment.

- **Inspector [REF]**: Person Completing the Assessment.
- **Soil Type [BASE]**: Categorical description of the soil sediment type within the channel based on visual interpretation. (Silt/Clay, Sandy, Sandy-Gravel, Gravel, Cobble, Boulder, Bedrock).
- **Channel State [AMT]**: Assessment of the state of the stream based on exposed banks, channel form, and vegetation. The assessment was done in field. The categories are Erosional, Depositional, and Stable.
- **Bankfull Width and Depth [BASE]**: Bankfull width is the estimated width of flow based on a 1.5-year flood event and bankfull depth is the depth at the thalweg of the bankfull flow (measured with a survey rod). It is visually defined in the field as the elevation in which the floodwater begins expanding onto the overbank and floodplains. There are several field indicators identifying the elevation of bankfull depth: (From Rosgen, Fundamentals of Rosgen Stream Classification System) (Uncertainty = +/- 1 ft.); those indicators include:
    - The elevation of the top of the highest depositional feature, such as point bars and central bars.
    - Breaks in slopes of banks and change in particle size distribution.
    - Evidence of inundation features, such as small benches
    - Staining of rocks.
    - Exposed roots of stable vegetation
    - The presence of certain riparian species
- **Width to Depth Ratio [AMT]**: The bankfull width divided by the bankfull depth. This value gives a rapid visual assessment of channel stability, channel shape, and stream power. Typically, values should be greater than 12, however this is dependent on the specific stream dynamic. Using the channel state metric, a stable portion of the channel should be used as a reference reach for other portions of the stream. Values should be consistent with the reference reach within 20%. Engineered channels are generally more confined and should not be included in this analysis.
- **Connected Floodplain Top Width [BASE]**: Width of the connected floodplain. This width was derived in post-processing and is desktop based. The FEMA floodplain width was measured where available, and where not, the top of overbank width was measured. Uncertainty = +/- 10 feet.
- **Entrenchment 100-year [AMT]**: The entrenchment ratio is defined as vertical containment of the river. Rosgen calls for the floodplain width to be taken at twice the elevation of bankfull, approximately the 50-yr flood elevation. This effort used 100-yr floodplain with calculated during post-processing due to the limited field time and expansive collection area.
- **Comments [REF]**: Additional Comments made by editor.
- **Editor [REF]**: Name of last editor.
- **EditDate [REF]**: Date of last edit.

Outfalls

Purpose: Outfall locations indicate the downstream end of storm drain systems, i.e. where stormwater discharges into a drainageway or detention facility. An inventory of stormwater outfalls provides valuable information to support National Pollutant Discharge Elimination System requirements and will assist maintenance staff and water quality professionals in monitoring stormwater effluent, water quality, and infrastructure condition.

Methodology: All outfalls and pipes discharging into the drainageway were recorded, measured, and inspected. An image was also taken for reference.

Data Collected: The data collected for each Outfall includes:

- **Reach_ID [REF]:** Unique Reach ID or Stream Name used to categorize all the data.
- **Date of Inspection [REF]:** Date of Drainage Outfall Assessment.
- **Inspector [REF]:** Person Completing the Assessment.
- **Material [BASE]:** Pipe material. Categories consist of Metal, Concrete, Plastic Timber, and Masonry.
- **Rise [BASE]:** Vertical measurements of the pipe, not the flared end section if present. Uncertainty = +/- 0.5 ft.
- **Span [BASE]:** Horizontal measurements of the pipe, not the flared end section if present. Uncertainty = +/- 0.5 ft.
- **Discharge [BASE];** A Yes or No dropdown of whether the pipe is discharging water when inspected.
- **Appurtenance Type [BASE]:** The appurtenance type of the pipe determined in the field. Drop down categories are Projecting, Mitered, Headwall, Headwall Wingwall, Flared-end Section, and Other.
- **Armoring Type [BASE]:** Type of Armoring that protects the outfall from scour. Categories are None, Riprap, Concrete, Other.
- **Armoring Condition [MAINT]**: Assessment of the condition of the armoring done in the field. Categories are None, Functional, Needs Maintenance, Needs Repair. Maintenance refers to improvements within the scope of normal maintenance operations, like clearing vegetation or sediment and reconfiguring existing riprap. Repair refers to more extensive operations, like rebuilding and grouting riprap, adding additional-non-existing protections, or redesigning the protection completely.
- **Submerged [BASE]:** Yes/No dropdown based on an infield assessment of the Outfall being submerged or not.
- **Blockage [MAINT]:** Amount of debris blocking the pipe using a scale of 1/4, 1/2, 3/4, and Fully Blocked. If the amount of debris was less than 1/4 blocked, it was not recorded (None). Vegetation was considered if it would still block the pipe during large events with high flows and velocities.
- **Overall Condition [MAINT]:** The general quality of the pipe outfall: Good, Fair, Poor, Critical, Unknown. The conditions were determined by assessing the overall condition of the structure and included, scour, erosion, undercutting, piping, dislodged boulders, etc. If ¼ of the pipe is blocked a fair condition was given. If more than ½ the pipe was blocked a poor condition was given. If the armor was deemed to "Need Maintenance" a fair rating was given and if it was deemed the armor "Needs Repair" a poor rating was given.
- **Comments [REF]:** Additional comments related to the outfall.
- **Editor [REF]:** Name of last editor.
- **EditDate [REF]:** Date of last edit.

Grade Control Structures

Purpose: A grade control structure is a type of stream improvement that controls the slope and profile of the stream bed, dissipating energy contained within rapidly moving water. They are an important and common type of in-stream infrastructure in urban environments. An inventory of grade control structures will assist in monitoring the stream profile, overall bed slope, and condition of existing infrastructure.

Methodology: All vertical grade controls, including formal structures, informal riprap protection, and natural but stable knickpoints along the drainageway were recorded, measured, and inspected. Headcuts (areas of severe

degradation where the channel invert is rapidly lowering) were not included in this inventory. For each location, an image was also captured for reference.

Data Collected: The data collected for each Grade Control Structure includes:

- **Reach_ID [REF]:** Unique Reach ID used to categorize all the data.
- **Date of Inspection [REF]:** Date of the Grade Control Structure Assessment.
- **Inspector [REF]:** Person Completing the Assessment.
- **Type [BASE]:** The type of grade control structure: Check (a completely vertical drop face), Drop Structure (a sloped drop face), or Informal Riprap. Informal riprap is characterized by a drop in the channel that has been stabilized by imported riprap and rock.
- **Height [BASE]:** Height of the drop measured using a survey rod. Uncertainty = +/- 1 ft.
- **Overall Condition [AMT]**: The quality of the drop and its overall priority in terms of repair and replacement: Stable, Minor, Moderate, Severe, Urgent. The conditions were determined by assessing the overall condition of the structure and included, scour, erosion, undercutting, piping, dislodged boulders, etc. Informal riprap drops were never given a stable condition because they are mobile during high flow events over long time periods.
- **Comments [REF]:** Additional comments related to the erosional feature.

Erosion Hazards

Purpose: Erosional features are a generally caused by the natural migration of a stream both laterally and longitudinally (USFWS, 2015). However, these features can threaten infrastructure and private property when they encroach on structures. Cataloging these features will allow SEMSWA to monitor and mitigate small erosional features before they threaten infrastructure.

Methodology: A point with an attached image marking any erosional feature, excluding headcuts, was created when a feature was encountered in the field. Metrics collected are detailed below and include a hazard index developed by Rosgen to quantify failure risk on a cutbank.

Data Collected: The data collected for each identified erosion hazard includes:

- **Reach_ID [REF]:** Unique Reach ID used to categorize all the data.
- **Date of Inspection [REF]:** Date of the Erosion Hazard Assessment.
- **Inspector [REF]:** Person completing the assessment.
- **Type [BASE]:** Type of erosional feature; Cutbank, Avulsion, Other. Cutbanks are generally present at the outside of meanders because of lateral migration along a stream. Avulsions occur when a stream jumps its banks to form a new channel.
- **Erosional Length [BASE]:** The total length of the erosional feature. Uncertainty = +/- 10 ft.
- **Avg Erosional Height [BASE]:** The average height across the total length of the erosional feature. Uncertainty = +/- 2 ft.
- **Bank Angle [BASE]:** Angle that erosional feature makes with the bank. An overhanging bank has a value of great that 90 degrees. A vertical bank has a value of 90 degrees. A sloped bank has a value of less than 90 degrees.

- **Bankfull Height [BASE]:** Height of Bankfull flow on the opposite bank to erosional feature. Uncertainty = +/- 1 ft.
- **Root Density [BASE]:** Density of the roots within the erosional feature. Categories are <5%, 5-14%, 15-29%, 30-54%, 55-79%, 50-100%.
- **Root Depth [BASE]:** The depth that roots extend to in the erosional feature. Uncertainty = 1ft.



Vegetation Type	Root Depth (ft)	Vegetation Type	Root Depth (ft)
Annuals	0.16 - 0.25	Shrubs	0.67 - 1.00
Perennials	0.33 - 0.83	Trees	0.83 – 1.5
Turf grass	0.50 - 0.67		

Figure 4 - Left: A visual root density guide for exposed banks (Rosgen 1996).

Top: Average root depths by vegetation type (CSU cooperative extension newsletter).

- **Bank Material [BASE]:** Material that banks within the erosional feature are made of Bedrock, Boulder, Cobble, Gravel, Sand/Silt/Clay, Sandy Gravel, Sand
- **Bank Stratified [BASE]:** Yes/no dropdown determining if the bank of erosional feature is stratified. Stratified soils are those that are characterized by abrupt changes of material grain size and composition at various depths within the eroded bank. These changes in of soil types can affect the erodibility or stability of the channel bank.
- **Bank Erosion Hazard Index (BEHI) [AMT]:** This index is used to estimate the potential for a bank to erode. It is based on a series of field measurements that are described above. The variables are then input into an index table (USFWS, 2015). The final value (Bank Erosion Hazard Value) equates to a risk, Very Low, Low, Moderate, High, Very High, Extreme, detailed in the Bank Erosion Hazard Index field.

Bank Erosion Hazard Index							
			Bank Erosion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variable	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials
Bedrock (Bedrock banks have very low bank erosion potential)
Boulders (Banks composed of boulders have low bank erosion potential)
Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, do not adjust)
Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)
Sand/Silt/Clay loam (Add 5 points, where sand is 50-75% or the composition)
Sand (Add 10 points if sand comprises > 75 % and is exposed to erosional processes)
Silt/Clay (+ 0: no adjustment)

Stratification
Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	Low	Moderate	High	Very High	Extreme
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

Figure 5 - Bank Erosion Hazard Index Value and Index table (Rosgen, 1996).

- **Infra Dist [BASE]:** The distance in feet to the closest structure. This was determined using a buildings shapefile and a GIS script tool.
- **Threat to Infrastructure [AMT]:** Yes/no dropdown determining the threat of erosional features to infrastructure based on proximity. Anything within 100 ft of a building was deemed to be a threat to infrastructure.
- **Priority [AMT]:** The overall priority, in terms of remediation needs, of the erosional feature: Stable, Minor, Moderate, Severe, Urgent. This was primarily based on the proximity to infrastructure and Bank Erosion Hazard Index (BEHI). A BEHI greater than High was classified as Moderate regardless of its threat to infrastructure.
- **Comments [REF]:** Additional comments related to the erosional feature.
- **Editor [REF]:** Name of last editor.
- **EditDate [REF]:** Date of last edit.

Headcuts

Purpose: A headcut is an abrupt change in the channel profile. These features can propagate upstream resulting in an incised thalweg and entrenched channel (Rosgen, 1996). Identifying these features can help in mitigation in areas where downcutting, incision, and eventual widening of the channel could in danger infrastructure and property.

Methodology: Headcuts were identified with a point and attached image. Any headcut over 1-ft was recorded with the associated metrics detailed below.

Data Collected: The data collected for each headcut includes:

- **Reach_ID** [REF]: Unique Reach ID used to categorize all the data.

#	Related Goal (#)	Data	Description	Monitoring Metric	Method/ Protocol	Performance Standard	Management Trigger	Suggested Action	Timing	Frequency
Hydrologic, Hydraulic, and Geomorphic Conditions										
Stream Conditions										
1	Flood Conveyance	**Overbank N**	Manning's roughness coefficient of the overbank of the stream based on visual interpretation of field workers. Based on descriptions from Chow, 1959.	Visual observations based on references (Chow)	Photo monitoring or field walks.	Vegetation density and structure do not adversely impact flood conveyance resulting in increased flood depths and/or expanded flood inundation. **n-values less than 0.08**	Observations of the overbank vegetation to determine if vegetation may be having an adverse impact on flood water surface elevations, i.e. dense vegetation is limiting flood conveyance and increases flood depths and/or expanding limits of flooding that may cause damage to structures, infrastructure, or cause erosion within the flood overbanks. Observations indicate a significant increase in vegetation density for woody materials with a judgment that the observed n-value is greater than the designed or originally observed n-value. **n-values greater than 0.08**	-Determine if additional vegetation is resulting in increased flood risk. -Implement vegetative management strategies such as invasive species removal or vegetative management to reduce density of vegetation.	Oct-April	Once every 2-5 years
2	Flood Conveyance	**Channel N**	Manning's roughness coefficient of the overbank of the stream based on visual interpretation of field workers. Based on descriptions from Chow, 1959.	Visual observations based on references (Chow)	Photo monitoring or field walks.	Vegetation density and structure do not adversely impact flood conveyance resulting in increased flood depths and/or expanded flood inundation. **n-values less than 0.05**	Observations of the overbank vegetation to determine if vegetation may be having an adverse impact on flood water surface elevations, i.e. dense vegetation is limiting flood conveyance and increases flood depths and/or expanding limits of flooding that may cause damage to structures, infrastructure, or cause erosion within the flood overbanks. Observations indicate a significant increase in vegetation density for woody materials with a judgment that the observed n-value is greater than the designed or originally observed n-value. **n-values greater than 0.05**	-Determine if additional vegetation is resulting in increased flood risk. -Strongly consider removal of trees within bankfull channel. -Implement vegetative management strategies such as invasive species removal or vegetative management to reduce density of vegetation.	Oct-April	Once every 2-5 years
4	Stream Health	**Floodplain Connectivity**	Classification system used to assess the stream's connectivity to the floodplain (Good, Fair, Poor). The frequency in which the floodplain can be inundated.	Visual observations	Photo monitoring or field walks.	Regular flooding of area just above bankfull channel depth. **Visual observation rating Fair to Good**	Observations of floodplain show disconnectivity to wetted area. Signs of excessive channel incision, or erosion/ deposition near infrastructure. **Floodplain connectivity rating of poor.**	- Assess change in geomorphology using cross sections, LiDAR, and/or aerial photos. - Reconnect floodplain with possible adjustments to channel or bench height. - Improve resilience near infrastructure.	May-August	Once every 2-5 years
5	Hazard	**Bank Stability**	A score from 10 to 1 documenting the potential for the soil above the active and bankfull channel, on the upper and lower banks, to become unstable and slide or fall into the stream. This includes bank instabilities that are occurring as a result of downcutting (degradation), widening, and natural meander migration. (From SVAP2).	Visual observations	NRCS SVAP2	Stable to moderately stable channel banks, protected by roots of natural vegetation, wood, or rock or a combination of materials with little evidence of erosion or bank failures. If bank failures have occurred, reestablishment of vegetation has begun. **SVAP score of 6-10**	Observations showing banks are moderately unstable or completely unstable with very little natural vegetation or protective armoring from rock or woody materials. **SVAP Score of 0-5**	-Assess risk to life and property, specifically infrastructure or public safety. -Take action to remediate failing banks via revegetation for areas that are moderately unstable or provide engineered biostabilization to prevent continued bank failure.	Jan-Dec	Once every 2-5 years
6	Stream Health	**Riparian Quantity**	A score from 10 to 1 summarizing the quantity of vegetation within the riparian zone based on the width, overbanks, and connected floodplain. (From SVAP2).	Assessment score based on visual observations	NRCS SVAP2	A natural plant community extending out at least 1/2 bankfull width with vegetation gaps not exceeding 30%. **SVAP Score of 5-10**	Observations where vegetation extends no further than 1/3 to 1/4 of bankfull width and vegetative gaps exceeding 30%. **SVAP score of 0-4**	-assess cause of reduced riparian density such as floodplain connectivity. -if connectivity is adequate, consider revegetation and vegetative management projects to increase riparian density.	May-September	Once every 2-5 years
7	Stream Health	**Riparian Quality**	A score from 10 to 1 summarizing the quality of vegetation within the riparian zone based on diversity, and age of the vegetation in the channel. (From SVAP2).	Visual observations	NRCS SVAP2	Natural and diverse riparian vegetation with composition, density, and structure appropriate for the site. **SVAP Score of 6-10**	Observations of little to no vegetation, invasive species, or localized compromised areas showing evidence of concentrated flows. **SVAP score of 0-5**	-Assess causes of poor vegetative quality and diversity. -Consider vegetative management or revegetation projects, including removal of invasive.	May-September	Once every 2-5 years
9	Public Health	**Nutrient Enrichment**	A score from 10 to 1 summarizing the available nutrients in the water based on visual nutrient enrichment characteristics, including abundance of algae and floating and rooted macrophytes. This can also be seen in low dissolved oxygen levels. Null values indicate a dry channel. (From SVAP2).	Visual observations	NRCS SVAP2	Fairly clear to clear water with moderate or low algal growth. **SVAP Score of 5-10**	Greenish water with abundant algal growth and slight or strong odor. **SVAP Score of 0-4**	-Investigate source of nutrient enrichment. -If a score of less than 5 is determined, water quality testing and source tracing may be warranted. -Develop upstream strategies to improve water quality and reduce delivery of excess nutrients to the stream system.	May-September	Once every 2-5 years

10	Stream Health	**Overall Quality SVAP2**	An average score from 10-1 for all scored elements within SVAP2 (as an average).	Visual observations	NRCS SVAP2	Overall quality assessment of excellent, good, or fair/good **SVAP Score of 6-10**	Overall quality assessment of fair to poor. **SVAP score of 0-5.9**	-Review assessed elements under stream conditions and determine reason for low score. -Perform a more detailed reach assessment to determine causes of stream degradation or ecological impairment and provide recommendations for mitigation measures.	N/A	Once every 2-5 years
Geomorphic Conditions										
11	Stream Stability	**Channel State**	Assessment of the state of the stream based on exposed banks, channel form, and vegetation. The assessment was done in field. The categories are Erosional, Depositional, and Stable.	Visual observations	Observations from photo monitoring or field walks.	A channel that is generally showing dynamic stability, adequately passing typical sediment loads with no sign of significant aggradation (deposition) or degradation (erosion). **Stable**	Observation of local deposition that may be reducing flood conveyance or local degradation that is resulting in bank failure or channel headcutting. **Erosional or Depositional**	-Perform localized assessment to determine causes (upstream or downstream) of deposition or erosion. -Take steps to address reach dynamic instability with maintenance type projects or capital projects.	Jan-Dec	Once every 2-5 years
12	Stream Stability	**Width to Depth Ratio**	The width/depth (W/D) ratio is defined as the ratio of the bankfull surface width to the mean depth of the bankfull channel. The width/depth ratio is key to understanding the distribution of available energy within a channel, and the ability of various discharges occurring within the channel to move sediment. Determination of the width/depth ratio provides a rapid, visual assessment of channel stability.	Calculated value based on field measurements for bankfull width and depth.	Rosgen	Typically values should be greater than 12, however this is dependent on the specific stream dynamic. Using the channel state metric, a stable portion of the channel should be used as a reference reach for other portions of the stream. Values should be consistent with the reference reach within 20%. Engineered channels are generally more confined and should not be included in this analysis. **W/D >12**	When the W/D ratio is less than 50% of the reference reach or less than 6. Engineered channels are generally more confined and should not be included in this analysis. **W/D < 6**	- Assess change in geomorphology using cross sections, LiDAR, and/or aerial photos. - Reconnect floodplain with possible adjustments to channel or bench height. - If downcutting and incising is the issues, the sinuosity and channel slope should be reduces to reduce the sediment capacity of high flows.	Oct-April	Once every 2-5 years
13	Stream Stability	**Entrenchment**	The entrenchment ratio is defined as vertical containment of the river. Rosgen calls for the floodplain width to be taken at twice the elevation of bankfull, approximately the 50-yr flood elevation. This effort used 100-yr floodplain with calculated during post-processing due to the limited field time and expansive collection area.	Calculated value based on field measurements for 100-yr floodplain width and depth.	Rosgen	This effort used the 100-yr width instead of the 50-yr width in order to use published FEMA floodplains. This means that determining a reference reach is vital in determine the stable entrenchment ratio for each stream or stream type. Engineered channels are generally more confined and should not be included in this analysis.	When the entrenchment ratio is less than 50% of the reference reach. Engineered channels are generally more confined and should not be included in this analysis.	- Assess change in geomorphology using cross sections, LiDAR, and/or aerial photos. - Reconnect floodplain with possible adjustments to channel or bench height. - If downcutting and incising is the issues, the sinuosity and channel slope should be reduces to reduce the sediment capacity of high flows.	Oct-April	Once every 2-5 years
Erosion Hazards										
14	Hazard	**Bank Erosion Hazard Index**	This index is used to estimate the potential for a bank to erode. It is based on a series of field measurements that are described above. The variables are then input into an index table (USFWS, 2015). The final value (Bank Erosion Hazard Value) equates to a risk, Very Low, Low, Moderate, High, Very High, Extreme, detailed in the Bank Erosion Hazard Index field.	A collection of baseline measurements and observations on each erosional feature.	Function-Based Rapid Field Stream Assessment Methodology - USFWS, 2015	Cutbanks and erosional sources are a natural part of any functional stream system. Some cutbanks may be needed to maintain sediment balance within a system. Engineered channels tend to be stationary limiting the migration of the channel. **Very Low to Moderate**	Cutbanks that are deemed to be at high risk of failure that are also located within 100ft. of a insurable structure. **High to Extreme**	- Cutbanks that are deemed to be at high risk of failure should be monitored and incorporated into large-scale maintenance or CIP project depending on the reach. - Features within 100 feet of a structure should be stabilized with biostabilization, setback riprap, and other process based mitigation techniques that support riparian processes. - If proximity to infrastructure becomes a huge concern, more aggressive stabilizations should be explored.	Oct-April	Once every 2-5 years
15	Hazard	**Threat to Infrastructure**	Yes/no dropdown determining the threat of erosional features to infrastructure based on proximity. Anything within 100 ft of a building was deemed to be a threat to infrastructure.	Distance	GIS measurement and processing	The feature is greater than 100 ft from any insurable structure. **No**	The feature is less than 100 ft from any insurable structure . **Yes**		N/A	Once every 2 years
16	Hazard	**Priority**	The overall priority, in terms of remediation needs, of the erosional feature: Stable, Minor, Moderate, Severe, Urgent. This was primarily based on the proximity to infrastructure and Bank Erosion Hazard Index	Combination of the two above metrics.		Cutbanks and erosional sources are a natural part of any functional stream system. They should be below a High on the BEHI and greater than 100ft away from infrastructure. **Minor**	Cutbanks pose a hazard when they become unstable (Very High-Extreme) or encroach within 100 ft of a structures. **Moderate to Urgent**		N/A	Once every 2 years
Headcuts										
17	Hazard	**Incision Height**	Height of the headcut/incision from	Height	Field measurement	Headcuts or riffles that are not in the vicinity of infrastructure and are relatively small. **< 1 ft**	Headcuts or riffles that are in the vicinity of infrastructure and are greater than 1 foot in height. **> 1 ft**	- Headcuts should be monitored and incorporated into large-scale maintenance or CIP project depending on the reach	N/A	Once every 2 years

18	Hazard	**Threat to Infrastructure**	Yes/no dropdown determining the threat of headcut to infrastructure based on proximity. Anything within 100 ft of a building was deemed to be a threat to infrastructure.	Distance	GIS measurement and processing	The feature is greater than 100 ft from any insurable structure. **No**	The feature is less than 100 ft from any insurable structure . **Yes**	- Features within 100 feet of a structure should be stabilized with biostabilization, graded control structures, and other process based mitigation techniques that support riparian function. - If proximity to infrastructure, especially grade control structures and crossing upstream, becomes a huge concern, more aggressive stabilizations should be explored.	N/A	Once every 2 years
19	Hazard	**Priority**	The overall priority, in terms of remediation needs, of the erosional feature: Stable, Minor, Moderate, Severe, Urgent. This was primarily based on the proximity to infrastructure and Bank Erosion Hazard Index	Combination of the two above metrics.		Cutbanks and erosional sources are a natural part of any functional stream system. They should be below a High on the BEHI and greater than 100ft away from infrastructure. **Minor**	Cutbanks pose a hazard when they become unstable (Very High-Extreme) or encroach within 100 ft of a structures. **Moderate-Urgent**		N/A	Once every 2 years
Infrastructure										
Outfalls										
20	Asset Management	**Armoring Condition**	Assessment of the condition of the armoring done in the field	Visual assessment	Field observation of outfall.	No signs of riprap displacement, sediment deposition limiting pipe conveyance, excessive vegetation blocking outfall. **Functional**	Observation of localized erosion, displacement of riprap or armoring, sediment deposition within the stormwater pipe, or excessive vegetation at the outlet. **Needs Maintenance or Needs Repair**	-Determine if the armoring used is appropriate for the estimated flows. -Repair or replace the damaged portions of the amour.	Oct-April	Once every 2-5 years
21	Asset Management	**Blockage**	Amount of debris blocking the pipe using a scale of 1/4, 1/2, 3/4, and Fully Blocked. If the amount of debris was less than 1/4 blocked, it was not recorded (None). Vegetation was considered if it would still block the pipe during large events with high flows and velocities.	Visual assessment	Field observation of outfall.	No more than 1/4 of the total crossing cross-section being blocked by debris. **None - 1/4**	More than 1/4 of the total crossing cross-section being blocked by debris. **1/2 - Full**	-Determine if blockage is of significant concern, i.e. impairing hydraulic performance of the outfall. -Determine if outfall condition is resulting in poor hydraulic performance. -Determine appropriate maintenance action to address blockage.	Oct-April	Once every 2-5 years
22	Asset Management	**Overall Condition**	Any problems documented during the inventory of the structure are denoted in this overall quality, including armoring conditions, blockages, ponded water, or structure issues.	Visual assessment	Field observation of outfall.	At least a fair rating means that the outfall is performing, but has some long-term issues. **Good or Fair**	When the outfall is over 1/2 blocked, submerged or the structures or armoring is significantly damaged **Poor or Critical**	-Outfalls with fair quality should be reassessed more frequently. -Repair or replace the damaged portions of the outfall -Conduct regular maintenance to clear the outfall if blocked by vegetation or sediment.	Oct-April	Once every 2-5 years
Grade Control Structures										
23	Asset Management	**Overall Condition**	Any problems documented during the inventory of the structure are denoted in this overall quality, including armoring conditions, blockages, ponded water, or structure issues.	Visual assessment	Field observation of outfall.	At least a minor rating which means that the outfall is performing, but has some issues that should be addressed during routine maintenance. **Stable or Minor**	When the structure has some significant issues like scour, erosion, cracking, and failure of the structure. **Moderate or Urgent**	-Grade Control structures with minor quality concerns should be reassessed more frequently. -Repair or replace the damaged portions of the outfall. If failure has occurred, redesign the structure to replace the failing drop. -Conduct regular maintenance	Oct-April	Once every 2-5 years
Point of Interest										
24	Maintenance	**Priority**	The point of interest layer is meant to serve as a catch-all for anything of note encountered during the stream walks. They mark any general issue along the reaches, including a trash, obstruction, structure issues, or property problems.	Visual assessment	Field observation of item	The feature was worth identifying for the record or for monitoring, but may have some long-term issues. **Minor or Moderate**	The feature is an issues that needs to be addressed, usually via regular maintenance. **Severe or Critical**	-Repair, remove, or replace the issue. -Continue long-term monitoring for features that don't trigger action.	Oct-April	Once every 2-5 years
Crossings Inspections										
25	Asset Management	**Invert Deterioration**	Assessment of the invert, including scour, of the crossing on the upstream and downstream	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with invert deterioration. **Good or Fair**	When the invert has deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. **Poor or Critical**	-Determine the appropriate apron or improved scour protection needed for the estimated flows. -Repair the invert of the crossing and add protection.	Oct-April	Once every 2-5 years
26	Asset Management	**Joints_Seams**	Assessment of the joint between pipe or bridge segments of the crossing on the upstream and downstream. These are generally evident as gaps or misalignment of the segments.	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with joints and seams. **Good or Fair**	When the joints and seams have deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. **Poor or Critical**	-Determine the severity of the joint issues through field visits. -Consider repairing the joints with grout if the issues is mild. -If the issues is serve it may require replacement of the structure.	Oct-April	Once every 2-5 years

27	Asset Management	**Corrosion**	Assessment of corrosion on the structure. On applicable if metal is visible. This is only applicable for metal structures particularly corrugated metal pipes.	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with corrosion. **Good or Fair**	When corrosion within the crossing has caused it to deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. **Poor or Critical**	-Replace the corroded portions of the structure as needed. -Replace any corrugated metal pipe with concrete structure to increase structure life-span.	Oct-April	Once every 2-5 years
28	Asset Management	**Cross-section Deformation**	Assessment of cross-section profile of the structure. It denotes any compression or failure of the structure.	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with cross-section deformation. **Good or Fair**	When cross-section deformation within the crossing has caused it to deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. **Poor or Critical**	-Structural analysis should be completed on any structures that exhibit deformation. -If possible, structural supports should be added to prevent failure. -If adding support to the structure is untenable, replace the structure.	Oct-April	Once every 2-5 years
29	Asset Management	**Cracking**	Identification of any cracking in the structure.	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with cracking of the structure. **Good or Fair**	When cracking deformation within the crossing has caused it to deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. Poor or Critical	-Repair the cracking with grout and supports. -Determine the potential cause of the cracking in order to mitigate the issues long-term.	Oct-April	Once every 2-5 years
30	Asset Management	**Headwall/ Wingwall**	Assessment of the quality and condition of the headwall and wingwall, if they are present in the structure. If it's not present N/A was entered.	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with the headwall or wingwall. **Good or Fair**	When the headwall or wingwall has deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. **Poor or Critical**	-Determine the appropriate headwall and wingwall design for the estimated flows. -Repair existing structure if possible and replace if repair is not an options.	Oct-April	Once every 2-5 years
31	Asset Management	**Apron**	Assessment of the quality and condition of the apron, if they are present in the structure. Aprons can be concrete entrances, grade control structures, riprap, or grouted riprap.	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with the apron. **Good or Fair**	When the apron has deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. **Poor or Critical**	-Determine the appropriate apron design for the estimated flows. -Repair existing structure if possible and replace if repair is not an options. Consider adding additional scour protection.	Oct-April	Once every 2-5 years
32	Asset Management	**Flared-End Section**	Assessment of the quality and condition of the flared-end section, if they are present in the structure. If it's not present N/A was entered.	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with cross-section deformation. **Good or Fair**	When the flared-end section has deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. **Poor or Critical**	-Determine the appropriate flared-end section design for the estimated flows. -Repair existing structure if possible and replace if repair is not an options.	Oct-April	Once every 2-5 years
33	Asset Management	**Scour Protection**	Assessment of the quality and condition of scour protection, usually riprap	Visual assessment	Field observation of crossing.	At least a fair rating means that the crossing is functioning, but potentially has some long-term issues with cross-section deformation. **Good or Fair**	When the scour protection has deteriorated to a point that is not sustainable long-term and endangers the integrity of the crossing. **Poor or Critical**	-Determine the appropriate scour protection design for the estimated flows. -Repair existing protection if possible and replace if repair is not an options.	Oct-April	Once every 2-5 years
34	Asset Management	**Debris Blockage**	Debris blockages are denoted in 1/4 increments. The blockages were averaged across all the barrels.	Visual assessment	Field observation of crossing.	No more than 1/4 of the total crossing cross-section being blocked by debris. **None - 1/4**	More than 1/4 of the total crossing cross-section being blocked by debris. **1/2 - Full**	-Clear structure of debris and vegetation. -Implement a regular maintenance schedule to ensure functionality over the long-term.	Oct-April	Once every year
35	Asset Management	**Sediment Blockage**	Sediment blockages are denoted in 1/4 increments. The blockages were averaged across all the barrels.	Visual assessment	Field observation of crossing.	No more than 1/4 of the total crossing cross-section being blocked by debris. **None - 1/4**	More than 1/4 of the total crossing cross-section being blocked by debris. **1/2 - Full**	-Clear structure of debris and vegetation. -Implement a regular maintenance schedule to ensure functionality over the long-term.	Oct-April	Once every year
36	Asset Management	**Embankment Instability**	Embankment instability can present as piping, erosion, scour, or flaking of the structure.	Visual assessment	Field observation of crossing.	At least a mild rating which means that the embankment is stable. A mild rating likely points to scour or erosion and should be monitored over time. **None or Mild**	At least a mild rating which means that the embankment is stable. A mild rating likely points to scour or erosion and should be monitored over time. **None or Mild**	-Determine the cause of the embankment issues. Consider upsizing the structure if overtopping is the cause of the instability. -Repair the embankment and add additional protection, such as riprap, if necessary.	Oct-April	Once every 2-5 years
37	Asset Management	**Overall Condition**	All issues in the assessment fields described above are cataloged and summarized in this overall condition score. This field is equal to the lowest rating present in all the other assessment attributes.	Visual assessment	Field observation of crossing.	At least a fair rating means that the outfall is performing, but has some long-term issues. A fair rating in this field should be traced to the specific field and problem to determine the best long-term solution. **Good or Fair**	When any part of the crossing has been damaged or is failing to a point that is endangering the structure, it will be denoted here and in the applicable attribute field. **Poor or Critical**	-Crossings with fair quality should be reassessed more frequently. -Repair or replace the damaged portions of the crossing lists in the above attributes. -Conduct regular maintenance to clear the outfall if blocked by vegetation or sediment.	Oct-April	Once every 2-5 years

Appendix C – Legal Opinion

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January 19, 1998

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

BY HAND DELIVERY

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

Dear Ben:

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

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

I. GENERAL LEGAL DRAINAGE PRINCIPLES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

II. GENERAL COMMENTS ON COMMONLY PROPOSED FACILITIES AND CONSTRUCTION TECHNIQUES

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

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

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

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

4. If re-alignment of a channel is the selected alternative, careful consideration should be given to the channel's geometry, alignment and ability to carry flood flows so as not to create additional potential damages to surrounding landowners.

5. If the selected alternative is the collection of overland flows from a specific area and returning those flows to a drainage structure of some kind, care should be taken not to adversely impact landowners in the area.

6. If a selected alternative involves the redirection of flows from their historic path, prior to its finalization in the design process, caution should be taken that this redirection will not cause any increase in damage to those adjacent or downstream of the proposed redirection.

7. If any selected alternative, when it is finalized in the design process, is changed to include a plan for the diversion of runoff from one watershed to another; extreme caution should be used in implementing that portion of the selected alternative since the participants may be faced with the imposition of strict liability for any damage that occurs from any size storm event if it can be shown that the same would not have been suffered if the diversion had not occurred.

8. If the construction of crossing structures over irrigation canals are part of the selected alternative for the project, caution must be taken in regard to the capacity of those crossing structures. The structures, when designed for the design event, should not cause any more water than presently exists to flow into those canals.

9. The intentional routing, as opposed to inadvertent inflows, of flood flows into an irrigation ditch should be eliminated from any plan if at all possible unless a written agreement from the owner of the irrigation ditch is obtained permitting the use of the ditch to carry those flood flows. The participants have no control over the available capacity of the ditch at the time it would be necessary to carry flood flows so the ditch cannot realistically be used to control the flows downstream.

10. If an alternative is being selected that relies upon inadvertent detention and the participants do not intend to formalize such detention by written agreement, it is my opinion that the effect of that non-formalized inadvertent detention cannot be taken into consideration in the final design.

11. If a selected alternative includes the formalization of inadvertent detention it will be necessary for at least one of the participants to formalize that detention by entering into a written agreement with the owner of the facility causing the detention. The agreement must prohibit the owner from operating or modifying the facility in a way that would have the effect of lessening the inadvertent detention of the facility necessary to implement the selected alternative. Further, the owner must either agree to maintain the facility so that the same does not lose its current inadvertent detention or agree to permit at least one of the participants to maintain the facility.

12. If the owner of the facility will not agree to maintain the inadvertent detention facility, at least one of the participants should confirm in writing to all of the participants that the participant is committed to maintaining the inadvertent detention facility in a manner that assures the necessary inadvertent detention to implement the alternative. This should be done prior to the implementation of any of the alternatives involving inadvertent detention. The level of maintenance must at least permit the facility to function as relied upon in flooding events and not fail structurally during the design and larger events.

13. Any formalized detention facilities that are utilized in the final design of a project will need to be the subject of a written agreement between the owner and at least one participant that the facility will be maintained in a manner that assures the necessary flood storage to implement the design and that adequate maintenance will be performed by either the owner or the participant so that the facility will function as designed in flooding events and that it will not fail structurally during the design and larger events.

The participating entities must agree amongst themselves, in writing, that any one of the participants may enforce the terms of the agreement with the owner of the facility if the responsible participant does not. This agreement must include the maintenance of no more than

a certain level of water in the facility at any one time and that any one of the participants may, at their sole cost and expense, maintain the facility so that its effectiveness in the selected alternative will be continued in perpetuity.

14. The embankments of all detention facilities should be designed so that they will not fail during a design event.

15. If a potential wetland is involved in a design alternative, it will be necessary that a Section 404 Permit from the United States Army Corps of Engineers be applied for and obtained, if necessary. Such a Permit should be obtained before any construction is done on the recommended alternative.

16. During construction of the selected facilities, care should be taken in constructing those facilities so that downstream property is not adversely affected temporarily by such construction. Usually, with the exception of the construction of detention facilities, the best method to avoid that problem is construction from the downstream limit of the project in an upstream direction which would then have the effect of having the downstream facilities ready to accept any increased flows as a result of the project.

If you have any questions in regard to my comments and opinions contained in this letter, please feel free to telephone me to discuss the same.

Very truly yours,



Edward J. Krisor

Appendix D – Wetland and Riparian Inventory

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Environmental Consulting

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Cherry Creek Reservoir Southwest Tributaries: Cottonwood, Lone Tree, Windmill, and Dove Creeks

Environmental Assessment

February 28, 2024

On behalf of the Southeast Metro Stormwater Authority (SEMSWA), and as part of the Wright Water Engineers (WWE) team, IRIS Mitigation and Design (IRIS) completed wetland and riparian vegetation assessments during the summer of 2022 along Windmill, Lone Tree, and Cottonwood Creeks in the Project Area (see Figures 1 and 2 – Project Area). The purpose of the assessments was to determine wetland and vegetation conditions and hydrological connections of three of the four drainages to Cherry Creek Reservoir located in the Project Area. IRIS did not complete an assessment along Dove Creek as this creek was determined to be non-jurisdictional by the U.S. Army Corps of Engineers (Corps) in August 2021 (see Appendix A – Corps AJD Letter and Form). This designation means that any proposed project may be planned and completed along Dove Creek without any Section 404 Corps permit under the Clean Water Act (CWA) being required.

Windmill Creek

IRIS walked the entirety of Windmill Creek in June/July 2022 from the upland vegetated swales located just north of Highway E-470 and east of South Peoria Street to the north up to the Cherry Creek Reservoir State Park in the Project Area (see Figures 1 and 2 and Appendix B – photolog). The creek begins as a dry upland vegetated swale and picks up more hydrological flow just north of James E. Casey Avenue including being joined by a side wetland channel draining flows from the west. Windmill Creek is a healthy wetland channel north of James E. Casey Avenue with varying wetland widths between 10-75 feet wide (see Appendix B – photolog). Vegetation includes a cottonwood and willow overstory with an understory of bulrush, sedge, rush and other native and non-native wetland plants up to the Centennial Airport runway.

Windmill Creek continues north of the runway draining flows into Wetland Pond W-2 which is an approximately 300-foot wide well established wetland pond which drains into another wide wetland before narrowing into an approximately 35-60-foot-wide wetland channel up to South Blackhawk Street (see Appendix B – photolog). The creek then becomes a narrower wetland channel with widths of between 15 to 25 feet wide. Windmill Creek flows drain north onto the Cherry Creek Reservoir State Park and dissipate into an upland vegetated field located on state park land (see Figures 2 and 3 and Appendix B - photolog). Windmill Creek was erroneously mapped in this location as a fork of Lone Tree Creek connecting to Cherry Creek Reservoir. However, the connecting drainage is actually a fork of Lone Tree Creek to the west and is not Windmill Creek which dissipates its flows into an upland field (see Figures 2 and 3 and Appendix B - photolog).

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IRIS obtained approval from the Corps in January 2023 regarding Windmill Creek terminating into uplands through the Corps Approved Jurisdictional Determination (AJD) process (see Appendix C – Corps AJD Letter and Form). The Corps officially agreed to the IRIS findings and responded that Windmill Creek is a non-jurisdictional creek in the Project Area. The Corps agreed that as a result of development, and stormwater management features, the stream no longer contributes flow to Cherry Creek, instead, the stream terminates in uplands at approximately 39.6086165°N, 104.8332747°W. At this location, no OHWM physical indicators or wetlands exist. As such, the Corps has determined that Windmill Creek and its associated wetlands and tributaries, are not subject to federal regulation under Section 404 of the CWA.

In summary, the Corps has determined that both Dove Creek and Windmill Creek are non-jurisdictional waterbodies and that any proposed project work along either creeks will not require a Corps permit for wetland or other waters of the U.S (WOTUS) impact under the Section 404 permitting process.

Lone Tree Creek

IRIS walked the entirety of Lone Tree Creek in June/July 2022 from just north of the Centennial Airport runway to the Cherry Creek Reservoir State Park where the Lone Tree Creek joins Cottonwood Creek and both creeks drain into the Cherry Creek Reservoir to the north (see Figures 1 and 2 and Appendix B – photolog). Lone Tree Creek is a wetland channel that is first observed north of Centennial Airport and East Central Tower Road as a defined wetland channel. Flows from the airport runway and surrounding infrastructure are diverted into Lone Tree Creek where the wetland channel is initially an approximately 140-foot-wide healthy wetland pocket with willows, and a variety of native and non-native wetland plants (see Appendix B – photolog). The channel then narrows to between a 15 and 50-foot-wide wetland channel dominated by cattails.

Wetland Pond L-2 is also located in this part of the Lone Tree Creek drainage just north of Broncos Parkway and then becomes a concrete-lined channel for another approximately 7,000 linear feet flowing to the north. A narrow wetland channel tributary joins the creek at South Revere Parkway just south of East Briarwood Parkway. This concrete-lined channel is full of has algae with upland vegetated conditions on either side of the creek for the majority of the way (see Appendix B – photolog). There are occasional wetland pockets on either side of the concrete-lined channel, where spills from the channel have allowed a few wetland pockets to form.

Lone Tree Creek remains a concrete-lined channel for another 5,000 linear feet (7,000 linear feet total length of concrete-lined channel) before entering Wetland Pond L-3 in the northern part of the Project Area between East Peakview and East Caley Avenues. Pond L-3 is a healthy wetland pond surrounded by willows and other native and non-native wetland plants (see Appendix B – photolog). Lone Tree Creek then flows north of this wetland pond into an approximately 30-50-foot-wide natural wetland channel before entering Cherry Creek Reservoir State Park. Adjacent creek wetlands are generally narrow fringe wetlands on either side of the creek where the creek is more incised, up to 180-foot-wide adjacent wetlands where the creek widens, and spreads flows across the floodplain. Lone Tree Creek splits in the

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very northern portion of the Project Area into two wetland channels and then joins back to form one creek just north of an approximately 3-acre pond before flowing into Cottonwood Creek to the west.

Windmill Creek was erroneously mapped as flowing into Lone Tree Creek in the location where Lone Tree Creek splits just north of the 3-acre pond. There is no connection between Windmill Creek and Lone Tree Creek in this location. The Windmill Creek flow terminates into an upland vegetated field to the southeast (see Figures 2 and 3 and Appendix B - photolog).

Cottonwood Creek

IRIS walked the entirety of Cottonwood Creek in June/July 2022 beginning from a series of dry upland vegetated swales located south of Lincoln Avenue. There are a series of upland vegetated swales that merge approximately 2,500 feet to the north and create a well-defined creek with adjacent wetland and riparian vegetation along both banks for 10.25 miles to the north through the Project Area. IRIS assessed the creek in the Project Area north to the Cherry Creek Reservoir State Park where Lone Tree Creek joins Cottonwood Creek from the east and then drains into the Cherry Creek Reservoir (see Figures 1 and 2 and Appendix B – photolog). Cottonwood Creek flows for approximately 10.5 miles through the Project Area in its natural condition with well-established wetland and riparian vegetation along the entire course. The creek then flows through the remainder of Cherry Creek State Park and north into the Cherry Creek Reservoir.

Cottonwood Creek has well established native and non-native wetland and riparian vegetation along its course through the Project Area (see Appendix B - photolog). There are many large cottonwood trees and understory willows and herbaceous native and non-native wetland plants and grasses located along the creek. Adjacent wetlands are generally narrow fringe wetlands on either side of the creek where the creek is more incised, up to 420-foot-wide adjacent wetlands where the creek widens, and spreads flows across the floodplain. These wider wetland areas occur mainly in the northern half of Cottonwood Creek in the Project Area.

Two side drainages join the creek, one from the southeast at the Meridian Golf Club just south of E-470 and one from the southwest through the Inverness Golf Club just south of East Dry Creek Road. Cottonwood Creek meanders north and is joined by Lone Tree Creek from the east in the northern portion of the Project Area before leaving the Project Area.

Section 404 Permitting

Section 404 of the CWA establishes a program that regulates the discharge of dredged or fill material into WOTUS, including wetlands. The Corps administers the CWA including permit decisions, conducts/verifies jurisdictional determinations, develops policy and guidance, and enforces provisions.

The Section 404 permitting program requires applicants to assess the potential for WOTUS to occur, request that the Corps issue their opinion on the jurisdictional status of aquatic features (jurisdictional determination) and evaluate how impacts to WOTUS can be avoided and/or minimized while still

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attaining the purpose and need of the project. If impacts cannot be avoided, impacts must be minimized and mitigated if exceeding 0.1 acre for a single and complete project. There are three typical Corps permitting mechanisms that can be used when WOTUS impacts cannot be avoided including Nationwide Permits (NWPs), Regional General Permits (RGPs), and Individual Permits (IPs).

Neither Dove Creek nor Windmill Creek fall under Corps jurisdiction or permitting in the Project Area. This is because Dove Creek was historically an upland vegetated swale which became more of a wetland channel due to stormwater runoff from increasing residential and commercial development in the area. Windmill Creek flows dissipate into an upland vegetated field with no direct connection to either Cherry Creek or the Cherry Creek Reservoir.

The Corps does take jurisdiction over both Lone Tree Creek and Cottonwood Creek which flow through the Project Area. These two creeks join in the northern portion of the Project Area and connect directly north to the Cherry Creek Reservoir. Tributaries and wetlands associated with either Lone Tree or Cottonwood Creek are also under Corps jurisdiction and protection. Any projects that would impact these 2 creeks, their tributaries or adjacent wetlands would need to go through the Corps Section 404 permitting process.

An approximately 1.3-mile (7,000 linear feet) section of Lone Tree Creek (of the 3.24 miles of Lone Tree Creek in the Project Area) is currently concrete-lined. This section of the creek may be exempt from Corps Section 404 permitting due to being a concrete-lined channel. Any proposed project work along this section of Lone Tree Creek would need to be discussed with the Corps to determine if a Section 404 permit for the project is needed. However, an NWP (easier to obtain) would likely be feasible for impacts under 0.5 acres of wetland impact or 300 linear feet of creek impact. If proposed project impacts are greater than these detailed, but the project will allow concrete removal and return of natural channel bottom and wetland/riparian plant establishment, the project may qualify for permitting under NWP #27 for Aquatic, Habitat Restoration, Enhancement and Establishment Activities. If the proposed project work has greater impact than what can be covered under an NWP, the project may need to be permitted under an IP or RGP.

Proposed projects which occur along the remaining natural sections of Lone Tree Creek or the entirety of Cottonwood Creeks, their tributaries, on-line detention pond facilities, and adjacent wetland vegetated areas would need to be permitted either under a Corps NWP, IP, or the Mile High Flood District (MHFD) RGP #7 (if a MHFD-related project). The choice of Corps permit required would depend on project size, project purpose and need, amount of impact to the protected creek and associated wetland resources, alternatives analysis and project applicant.

Nationwide Permits

NWPs are one of the simplest Section 404 permits to obtain and are valid if a project complies with all relevant terms and conditions. NWPs are available for a variety of different types of projects that result in minimal impacts to wetlands and WOTUS (generally less than 0.5 acres wetland impact or 300 feet of

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channel impact). Some NWPs may not require Corps notification. Other NWPs require the submittal of a pre-construction notification to the Corps (PCN).

NWPs that may be useful for proposed project work along Lone Tree Creek and Cottonwood Creek include:

NWP #3 – Maintenance

> #3a – Repair, rehabilitation, or replacement of previously authorized, currently serviceable structures or fills.
>
> #3b – Discharges associated with removal of accumulated sediments and debris in the vicinity of existing structures, including intake and outfall structures and associated canals.
>
> #3c – Temporary structures, fills, and work necessary to conduct maintenance activity.

NWP #5 – Scientific Measurement Devices

NWP #7 – Outfall Structures and Associated Intake Structures

NWP #13 – Bank Stabilization

NWP #18 – Minor Discharges

NWP #19 – Minor Dredging

NWP #27 – Aquatic, Habitat Restoration, Enhancement and Establishment Activities

NWP #31 – Maintenance of Existing Flood Control Facilities

NPW #35 – Maintenance Dredging of Existing Basins

NWP #41 – Reshaping Existing Drainage and Irrigation Ditches

NWP #43 – Stormwater Management Facilities

NWP #46 – Discharges in Ditches

Regional General Permit #7

MHFD has an existing RGP #7 – Channel Maintenance and Construction on the South Platte River and Tributaries to the South Platte River involving MHFD. MHFD's RGP allows for construction and maintenance activities related to drainage, stream restoration, and similar activities. Coordination with the Corps is recommended to confirm the use of this RGP. A PCN typically needs to be submitted to the Corps in order to qualify for an RGP.

The MHFD RGP#7 authorizes dredge or fill activities performed in wetlands and WOTUS that are conducted to restore, improve, and maintain channel stability and resiliency, improve stream and wetland function and habitat, improve public safety, and/or protect existing infrastructure. The activities identified in this permit are substantially similar in nature and cause only minimal individual and

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bleisure@irismitigation.com

cumulative environmental impacts. This RGP pertains to the construction, repair, rehabilitation, maintenance and improvement of the following six categories of facilities in developed and undeveloped areas:

- Grade control/drop structures
- Bank stabilization controls
- Construction of high functioning, lower maintenance channel
- Culverts and bridges
- Storm sewer outfalls and channel rundowns
- Stormwater treatment, detention and management facilities

The proposed general limitations of using this RGP are:

- All activities shall be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on-site). The PCN shall include a discussion of the 2 avoidance and minimization measures that have been taken on-site to reduce impacts to the maximum extent practicable, including consideration of off-line/channel stormwater detention facilities, prior to consideration of any compensatory mitigation that may be necessary to ensure that the adverse environmental effects are no more than minimal.

- The total combined aerial footprint of impacts to waters of the U.S. for a single and complete project will not exceed 3 acres for tributaries to the South Platte River and 5 acres for the South Platte River. Projects authorized per RGP 7 will use the Urban Storm Drainage Criteria Manual as a basis for project design. Disturbed upland areas and adjacent riparian areas will be revegetated with grasses, shrubs, and trees according to Urban Storm Drainage Criteria Manual.

- MHFD shall propose a compensatory mitigation plan to be evaluated by the Corps if the proposed activity will result in the permanent loss of greater than 3/100 of an acre of stream bed or greater than 1/10-acre of wetlands. The compensatory mitigation plan will include all the required elements of a compensatory mitigation plan as specified by the Corps and will clearly identify anticipated stream and wetland debits and credits based off procedures identified in the 2020 Colorado Mitigation Procedures (COMP).

- For MHFD fee-in-lieu projects where the purpose of the project is to construct a high functioning, low maintenance channel in association with a residential or commercial development, no projects that would discharge dredged or fill material into waters of the United States and in doing so reduce the 100-year floodplain to maximize developable land are authorized by this RGP. To determine if the project would decrease the floodplain to increase developable land, the MHFD shall provide existing and post-construction floodplain maps

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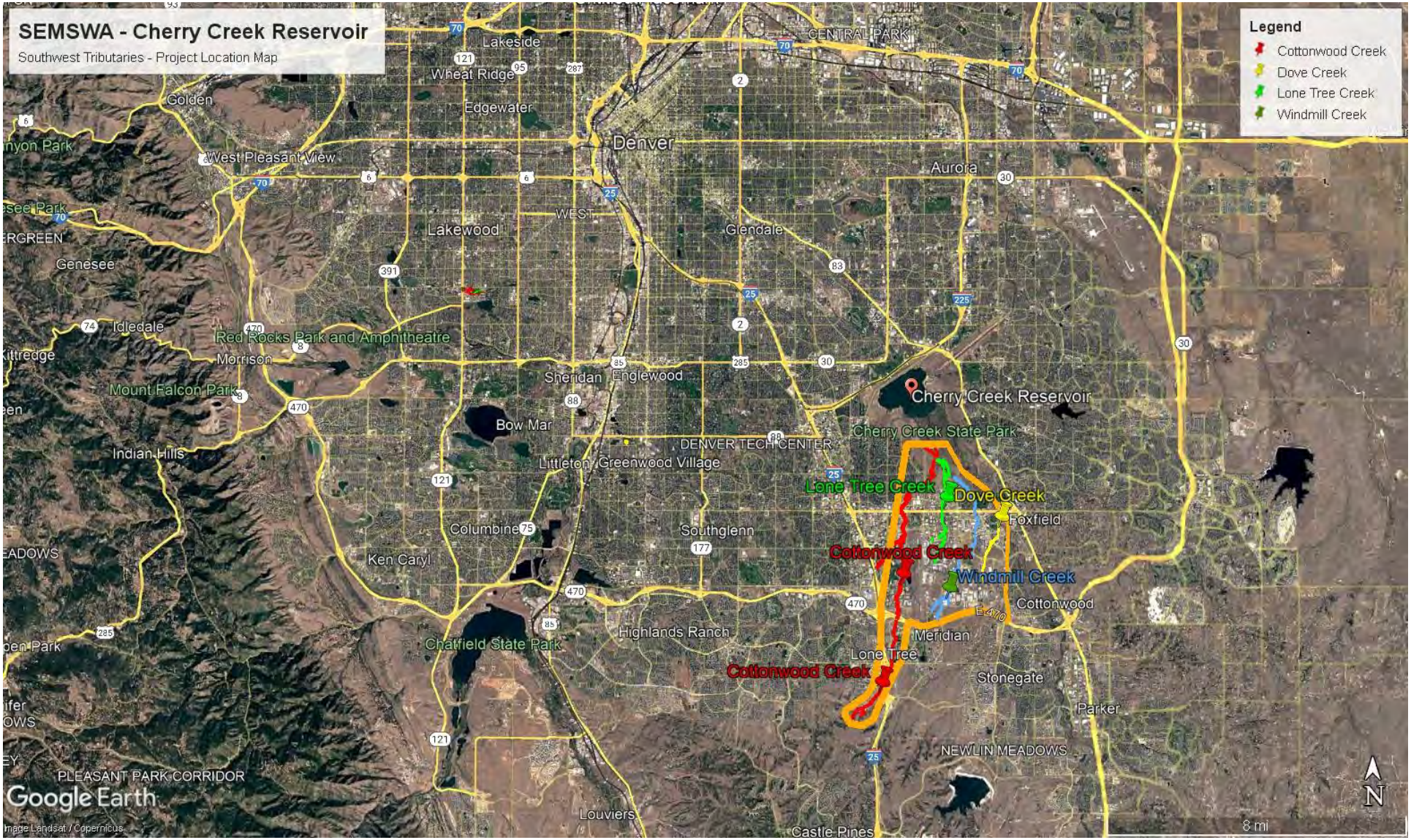
demonstrating that the 100-year floodplain has not been filled for the purpose of residential or commercial development. In circumstances where this cannot be demonstrated in advance, an Individual Permit is required, unless waived by the Corps if it is demonstrated the reduction in floodplain is not the purpose of the project, consistent with the Denver Regulatory Office Floodplain Policy.

Individual Permits

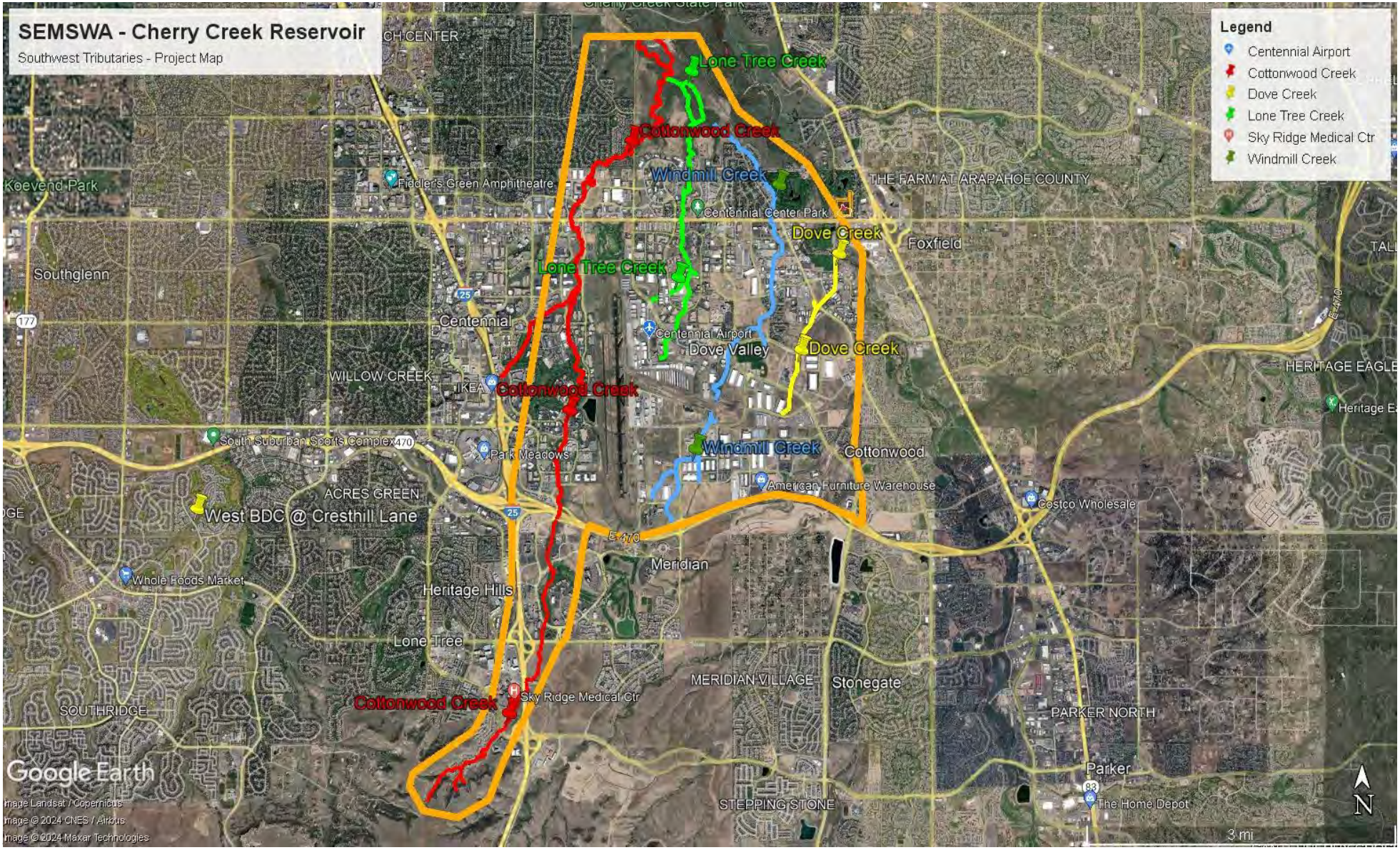
An IP is required when a project does not qualify for coverage under an existing NWP or RGP. IPs are generally used for project impacts with over 0.5 acres of wetland impact and/or greater than 300 linear feet of creek impact. The IP process is more extensive than the NWP process and may involve a pre-application meeting(s), public notice and comment period, and a Section 404(b)(1) guideline review. Section 404(b)(1) guideline reviews involve determining that the project is the least environmentally damaging practicable alternative (LEDPA) and does not violate applicable state or federal laws (e.g., ESA, NHPA) or result in significant degradation of WOTUS. In addition, it should be clear that the project includes steps to minimize adverse impacts on wetlands and water bodies. The Corps may request that the applicant further reduce impacts to support the Corps avoidance and minimization directive. It may take up to six months to prepare an IP application once a project is well defined and impacts can be assessed. The Corps may take up to a year or more to approve an IP.

Wetland mitigation is typically required for single and complete projects that exceed 0.1 acres of WOTUS impacts and are authorized under IPs as well as NWPs. If credits are purchased from a mitigation bank (such as a wetland mitigation bank), they are purchased prior to permit issuance. The mitigation bank issues a certificate which is provided to the applicant and the Corps. If a permittee decides to create wetlands on-site, a design, specifications, and performance standards are included in the permit application for agency review. Typical performance standards may include a dominance of wetland species, a percentage of desirable vegetation coverage, and control of Colorado noxious weed species. Mitigation construction (such as wetland construction) occurs prior to or during project construction. Annual monitoring of mitigation areas is typically required for three to five years or until the performance standards are met. Project signoff is received from the Corps after the performance standards are met.

FIGURES



IRIS **MITIGATION AND DESIGN, INC.** Environmental Consulting 2022 Arapahoe Street Golden, Colorado 80401 Phone: 720-272-1985	**FIGURE 1** **Project Location Map** **SEMSWA SW Tributaries** **to Cherry Creek Reservoir**	Google Earth September 2022



IRIS **MITIGATION AND DESIGN, INC.** Environmental Consulting 2022 Arapahoe Street Golden, Colorado 80401 Phone: 720-272-1985	**FIGURE 2** **Project Area Map** **SEMSWA SW Tributaries** **to Cherry Creek Reservoir**	Google Earth September 2022



IRIS **MITIGATION AND DESIGN, INC.** Environmental Consulting 2022 Arapahoe Street Golden Co 80401 Phone: 720-272-1985	**FIGURE 3** **SEMSWA** **Windmill Creek Terminating in Upland Vegetated Swale**	Google Earth October 2019

APPENDICES

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
DENVER REGULATORY OFFICE, 9307 SOUTH WADSWORTH BOULEVARD
LITTLETON, COLORADO 80128-6901

August 09, 2021

SUBJECT: Approved Jurisdictional Determination
Corps File No. NWO-2021-01321-DEN, Dove Creek, Arapahoe County, CO

Mr. Molly Trujillo
SEMSWA
7437 S. Fairplay St.
Centennial, CO 80112

Dear Ms. Trujillo,

This letter is in reference to the Dove Creek Project located within the Town of Dove Valley, at approximate latitude 39.577346°, longitude -104.817536°, in Arapahoe County, Colorado. We received a submittal which consists of a request for an Approved Jurisdictional Determination (JD) for aquatic resources located within the above project area. The delineated areas located on the subject property have been reviewed in accordance with Section 404 of the Clean Water Act under which the U.S. Army Corps of Engineers regulates the discharge of dredged and fill material, and any excavation activity associated with a dredge and fill project in waters of the United States.

At your request, a JD has been prepared for the approximate 439.9-acre area. Based on a review of available documentation, we have determined that Dove Creek is non-jurisdictional. The rationale for this determination is provided in the attached Approved Jurisdictional Determination form. Therefore, a Department of the Army permit is not required for the discharge of fill material into these aquatic resources under Section 404.

The JD is attached to this letter. If you are not in agreement with the JD decision, you may request an administrative appeal under regulation 33 CFR 331, by using the attached Appeal Form and Administrative Appeal Process form. The request for appeal must be received within 60 days from the date of this letter. It is not necessary to submit a Request for Appeal if you do not object to the JD.

This JD is valid for a period of five years from the date of this letter, unless new information warrants revisions of the JDs before the expiration date, or unless the Corps has identified, after a possible public notice and comment, that specific geographic areas with rapidly changing environmental conditions merit re-verification on a more frequent basis.

If there are any questions please feel free to contact Brent Sewell at (615) 417-0240 or by e-mail at brent.j.sewell@usace.army.mil, and reference **Corps File No. NWO-2021-01321-DEN**.

Sincerely,



Kiel Downing
Chief, Denver Regulatory Office

Enclosures (3):

Cc:

U.S. ARMY CORPS OF ENGINEERS
REGULATORY PROGRAM
APPROVED JURISDICTIONAL DETERMINATION FORM (INTERIM)
NAVIGABLE WATERS PROTECTION RULE

I. ADMINISTRATIVE INFORMATION

Completion Date of Approved Jurisdictional Determination (AJD): 8/9/2021
ORM Number: NWO-2021-01321-DEN
Associated JDs: N/A
Review Area Location[1]: State/Territory: CO City: Dove Valley County/Parish/Borough: Arapahoe
Center Coordinates of Review Area: Latitude 39.577346 Longitude -104.817536

II. FINDINGS

A. Summary: Check all that apply. At least one box from the following list MUST be selected. Complete the corresponding sections/tables and summarize data sources.

- ☐ The review area is comprised entirely of dry land (i.e., there are no waters or water features, including wetlands, of any kind in the entire review area). Rationale: N/A
- ☐ There are "navigable waters of the United States" within Rivers and Harbors Act jurisdiction within the review area (complete table in Section II.B).
- ☐ There are "waters of the United States" within Clean Water Act jurisdiction within the review area (complete appropriate tables in Section II.C).
- ☒ There are waters or water features excluded from Clean Water Act jurisdiction within the review area (complete table in Section II.D).

B. Rivers and Harbors Act of 1899 Section 10 (§ 10)[2]

§ 10 Name	§ 10 Size		§ 10 Criteria	Rationale for § 10 Determination
N/A.	N/A.	N/A	N/A.	N/A.

C. Clean Water Act Section 404

Territorial Seas and Traditional Navigable Waters ((a)(1) waters):[3]				
(a)(1) Name	(a)(1) Size		(a)(1) Criteria	Rationale for (a)(1) Determination
N/A.	N/A.	N/A.	N/A.	N/A.

Tributaries ((a)(2) waters):				
(a)(2) Name	(a)(2) Size		(a)(2) Criteria	Rationale for (a)(2) Determination
N/A.	N/A.	N/A.	N/A.	N/A.

Lakes and ponds, and impoundments of jurisdictional waters ((a)(3) waters):				
(a)(3) Name	(a)(3) Size		(a)(3) Criteria	Rationale for (a)(3) Determination
N/A.	N/A.	N/A.	N/A.	N/A.

Adjacent wetlands ((a)(4) waters):				
(a)(4) Name	(a)(4) Size		(a)(4) Criteria	Rationale for (a)(4) Determination
N/A.	N/A.	N/A.	N/A.	N/A.

[1] Map(s)/figure(s) are attached to the AJD provided to the requestor.
[2] If the navigable water is not subject to the ebb and flow of the tide or included on the District's list of Rivers and Harbors Act Section 10 navigable waters list, do NOT use this document to make the determination. The District must continue to follow the procedure outlined in 33 CFR part 329.14 to make a Rivers and Harbors Act Section 10 navigability determination.
[3] A stand-alone TNW determination is completed independently of a request for an AJD. A stand-alone TNW determination is conducted for a specific segment of river or stream or other type of waterbody, such as a lake, where upstream or downstream limits or lake borders are established. A stand-alone TNW determination should be completed following applicable guidance and should NOT be documented on the AJD Form.

D. Excluded Waters or Features

Excluded waters ((b)(1) – (b)(12)):[4]				
Exclusion Name	Exclusion Size		Exclusion[5]	Rationale for Exclusion Determination
Dove Creek	10,200	linear feet	(b)(10) Stormwater control feature constructed or excavated in upland or in a non-jurisdictional water to convey, treat, infiltrate, or store stormwater runoff.	Prior to development of the adjacent properties, these features existed as erosional rills or upland swales. As development occurred these features were incorporated into and utilized as stormwater control features to convey stormwater runoff.

III. SUPPORTING INFORMATION

A. Select/enter all resources that were used to aid in this determination and attach data/maps to this document and/or references/citations in the administrative record, as appropriate.

☒ Information submitted by, or on behalf of, the applicant/consultant: Request for an Approved Jurisdictional Determination (July 20, 2021), Dove Creek

This information is sufficient for purposes of this AJD.

Rationale: N/A or describe rationale for insufficiency (including partial insufficiency).

☐ Data sheets prepared by the Corps: Title(s) and/or date(s).

☐ Photographs: Select. Title(s) and/or date(s).

☐ Corps site visit(s) conducted on: N/A

☐ Previous Jurisdictional Determinations (AJDs or PJDs): ORM Number(s) and date(s).

☐ Antecedent Precipitation Tool: *provide detailed discussion in Section III.B*.

☐ USDA NRCS Soil Survey: Title(s) and/or date(s).

☐ USFWS NWI maps: Title(s) and/or date(s).

☒ USGS topographic maps: 7.5 & 15 Minute Topographic Maps, June 10. 2020

Other data sources used to aid in this determination:

Data Source (select)	Name and/or date and other relevant information
USGS Hydrologic Atlas	USGS TNM – National Hydrography Dataset. Data Refreshed April, 2021.
USDA Sources	N/A.
NOAA Sources	N/A.
USACE Sources	N/A.
State/Local/Tribal Sources	N/A.
Other Sources	Google Earth, Imagery 2003-2020

B. Typical year assessment(s): N/A or provide typical year assessment for each relevant data source used to support the conclusions in the AJD.

[4] Some excluded waters, such as (b)(2) and (b)(4), may not be specifically identified on the AJD form unless a requestor specifically asks a Corps district to do so. Corps districts may, in case-by-case instances, choose to identify some or all of these waters within the review area.
[5] Because of the broad nature of the (b)(1) exclusion and in an effort to collect data on specific types of waters that would be covered by the (b)(1) exclusion, four sub-categories of (b)(1) exclusions were administratively created for the purposes of the AJD Form. These four sub-categories are not new exclusions, but are simply administrative distinctions and remain (b)(1) exclusions as defined by the NWPR.

C. Additional comments to support AJD: N/A or provide additional discussion as appropriate.

Cherry Creek Reservoir Southwest Tributaries
Summer 2022 Photolog

Windmill Creek from South to North



Photograph 1: Windmill Creek wetland channel Located South of Centennial Airport – Looking South



Photograph 2: Windmill Creek concrete-lined channel through Detention Pond W-1
Located just South of Centennial Airport – Looking North



Photograph 3: Windmill Creek wetland formed in Detention Pond W-2
Located North of Centennial Airport – Looking Southeast



Photograph 4: Windmill Creek wetland channel just North of Pond W-2 – Looking East



Photograph 5: Windmill Creek wetland channel entering Detention Pond W-4 – Looking North



Photograph 6: Windmill Creek wetland channel at Broncos Parkway – Looking Northeast



Photograph 7: Windmill Creek at S. Blackhawk Street - Looking Northeast



Photograph 8: Windmill Creek wetland channel - Northeast of S. Blackhawk Street - Looking North



Photograph 9: Windmill Creek at Detention Pond W-7 Located South of E. Arapahoe Road with concrete-lined channel bottom – Looking South



Photograph 10: Windmill Creek wetland channel at S. Jordan Road just North of E. Arapahoe Road – Looking Southwest



Photograph 11: Windmill Creek upland vegetated swale at Detention Pond W-8 Located East of S. Jordan Road and North of E. Caley Ave. – Looking Southeast



Photograph 12: Windmill Creek upland vegetated swale Located North of E. Caley Ave. in the Cherry Creek Reservoir State Park – Looking North



Photograph 13: Windmill Creek North of E. Caley Ave. in the Cherry Creek Reservoir State Park Disappearing into Upland Field– Looking North

Lone Tree Creek from South to North



Photograph 14: Lone Tree Creek wetland channel just North of Centennial Airport – Looking South



Photograph 15: Lone Tree Creek wetland channel at E. Jamison Place – Looking North



Photograph 16: Lone Tree Creek entering Detention Pond L-2 and start of concrete-lined channel – Looking Northeast



Photograph 17: Lone Tree concrete-lined channel - North of S. Revere Parkway – Looking Southwest



Photograph 18: Lone Tree concrete-lined channel - South of E. Briarwood Ave. – Looking South



Photograph 19: Lone Tree concrete-lined channel - South of E. Arapahoe Road – Looking North



Photograph 20: Lone Tree Creek wetlands established in Detention Pond L-3 at E. Caley Avenue – Looking South



Photograph 21: Lone Tree Creek wetland channel at E. Caley Avenue – Looking North



Photograph 22: Lone Tree Creek wetland channel in Cherry Creek Reservoir State Park – Looking North

Cottonwood Creek from South to North



Photograph 23: Cottonwood Creek upland vegetated swale with wetland pockets – Looking South



Photograph 24: Cottonwood Creek wetland channel just South of Sky Ridge Medical Center – Looking Northeast



Photograph 25: Cottonwood Creek wetland channel - North of E. Lincoln Avenue – Looking Southeast



Photograph 26: Cottonwood Creek - North of E-470 - Looking South



Photograph 27: Cottonwood Creek wetland channel in detention basin just South of E. Easter Avenue – Looking Northwest



Photograph 28: Cottonwood Creek oxbow wetland at E. Caley Ave. – Looking Southeast



Photograph 29: Cottonwood Creek at E. Caley Ave. – Looking North



Photograph 30: Cottonwood Creek oxbow wetland Located Southwest of S. Peoria Street and North of E. Maplewood Avenue – Looking Southwest



Photograph 31: Cottonwood Creek and wetlands Located Northeast of S. Peoria Street and North of E. Maplewood Avenue – Looking Northeast

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
DENVER REGULATORY OFFICE, 9307 SOUTH WADSWORTH BOULEVARD
LITTLETON, COLORADO 80128-6901

January 09, 2023

SUBJECT: Approved Jurisdictional Determination
Corps File No. NWO-2022-01395-DEN, Windmill Creek
Arapahoe County, CO

Molly Trujillo
SEMSWA
7437 S. Fairplay St.
Centennial CO, 80112

Dear Ms. Trujillo

This letter is in reference to the approximate 285-acre project area at approximate latitude 39.579722°N longitude 104.825000°W, in Arapahoe County, Colorado. We received a request for an Approved Jurisdictional Determination (JD) for Windmill Creek located within the above project area. The project area has been reviewed in accordance with Section 404 of the Clean Water Act under which the U.S. Army Corps of Engineers regulates the discharge of dredged and fill material, and any excavation activity associated with a dredge and fill project in waters of the United States.

At your request, a JD has been prepared for the subject area. Based on a review of available documentation, we have determined that the resource labeled Windmill Creek on the attached Windmill Creek Review Map and its associated tributaries and wetlands, are isolated waters and do not meet the definition of waters of the United States. The attached JD form provides rationale for why no resources within the project area do not meet the definition of waters of the United States. Therefore, a Department of the Army permit is not required for the discharge of fill material into this site under Section 404.

The JD is attached to this letter. If you are not in agreement with the JD decision, you may request an administrative appeal under regulation 33 CFR 331, by using the attached Appeal Form and Administrative Appeal Process form. The request for appeal must be received within 60 days from the date of this letter. It is not necessary to submit a Request for Appeal if you do not object to the JD.

This JD is valid for a period of five years from the date of this letter, unless new information warrants revisions of the JDs before the expiration date, or unless the Corps has identified, after a possible public notice and comment, that specific geographic areas with rapidly changing environmental conditions merit re-verification on a more frequent basis.

If there are any questions please feel free to contact Daniel Ishmael at (720) 948-3266 or by e-mail at Daniel.C.Ishmael@usace.army.mil, and reference **Corps File No. NWO-2022-01395-DEN**.

Sincerely,



Kiel Downing
Chief, Denver Regulatory Office

Enclosure(s):

1) Approved Jurisdictional Determination Form
2) Notification of Administrative Appeal Options and Process and Request for Appeal
3) Windmill Creek Review Map

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD):
January 09, 2023

B. DISTRICT OFFICE, FILE NAME, AND NUMBER:
Omaha District
Denver Regulatory Office
Windmill Creek
NWO-2022-01395-DEN

C. PROJECT LOCATION AND BACKGROUND INFORMATION:
State: CO County/parish/borough: Arapahoe City: Centennial
Center coordinates of site (lat/long in degree decimal format): Lat. 39.579722 N; Long. -104.825000 W
Name of nearest waterbody: Cherry Creek
Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: N/A
Name of watershed or Hydrologic Unit Code (HUC): 10190003
☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☐ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):
☒ Office (Desk) Determination. Date: January 09, 2023
☒ Field Determination. Date(s): November 30, 2022 / December 06, 2022

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Are no** "*navigable waters of the U.S.*" within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]
☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Are not** "*waters of the U.S.*" within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
      ☐ TNWs, including territorial seas
      ☐ Wetlands adjacent to TNWs
      ☐ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
      ☐ Non-RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
      ☐ Impoundments of jurisdictional waters
      ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
      Non-wetland waters: linear feet:
      Wetlands:

   c. **Limits (boundaries) of jurisdiction** based on:
      Elevation of established OHWM (if known): .

2. **Non-regulated waters/wetlands (check if applicable):**[3]

---

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

☒ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional. Explain: Historically, Windmill Creek was an ephemeral stream with surface connection to Cherry Creek. Windmill Creek's current conditions consist of approximately 5.2 miles of wetland, stream, and upland swale complex. Windmill Creek currently originates near the intersection of E470 and S Peoria St, flowing north. Flows are predominantly contained within a stormwater detention basin located at approximately 39.5916746°N, 104.8207356°W. When the stormwater detention basin overflows, flows continue north, dissipating approximately 1.75 miles southeast of Cherry Creek Reservoir. As a result of development, and stormwater management features, the stream no longer contributes flow to Cherry Creek, instead, the stream terminates in uplands at approximately 39.6086165°N, 104.8332747°W. At this location, no OHWM physical indicators or wetlands exist.

Windmill Creek is not currently associated with affecting (i) interstate or foreign travelers for recreational purposes or other purposes or, (ii) fish or shellfish that could be taken and sold in interstate or foreign commerce or, (iii) current use or potential use for industrial purposes by industries in interstate commerce. Windmill Creek is isolated (as per federal regulation) and does not possess any known nexus to interstate commerce. As such, the Corps has determined that Windmill Creek and its associated wetlands and tributaries, are not subject to federal regulation under Section 404 of the Clean Water Act.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. TNW
Identify TNW: .

Summarize rationale supporting determination: .

2. Wetland adjacent to TNW
Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. Characteristics of non-TNWs that flow directly or indirectly into TNW

(i) General Area Conditions:
Watershed size: **Pick List**

[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.

Drainage area: Pick List
Average annual rainfall: inches
Average annual snowfall: inches

(ii) Physical Characteristics:

(a) Relationship with TNW:

☐ Tributary flows directly into TNW.
☐ Tributary flows through Pick List tributaries before entering TNW.

Project waters are Pick List river miles from TNW.
Project waters are Pick List river miles from RPW.
Project waters are Pick List aerial (straight) miles from TNW.
Project waters are Pick List aerial (straight) miles from RPW.
Project waters cross or serve as state boundaries. Explain: .

Identify flow route to TNW[5]: .
Tributary stream order, if known: .

(b) General Tributary Characteristics (check all that apply):

Tributary is: ☐ Natural
☐ Artificial (man-made). Explain: .
☐ Manipulated (man-altered). Explain: .

Tributary properties with respect to top of bank (estimate):
Average width: feet
Average depth: feet
Average side slopes: Pick List.

Primary tributary substrate composition (check all that apply):

☐ Silts ☐ Sands ☐ Concrete
☐ Cobbles ☐ Gravel ☐ Muck
☐ Bedrock ☐ Vegetation. Type/% cover:
☐ Other. Explain: .

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: .
Presence of run/riffle/pool complexes. Explain: .
Tributary geometry: Pick List
Tributary gradient (approximate average slope): %

(c) Flow:

Tributary provides for: Pick List
Estimate average number of flow events in review area/year: Pick List
Describe flow regime: .
Other information on duration and volume: .

Surface flow is: Pick List. Characteristics: .

Subsurface flow: Pick List. Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☐ Bed and banks
☐ OHWM[6] (check all indicators that apply):

☐ clear, natural line impressed on the bank
☐ changes in the character of soil
☐ shelving
☐ vegetation matted down, bent, or absent
☐ leaf litter disturbed or washed away
☐ sediment deposition
☐ water staining
☐ the presence of litter and debris
☐ destruction of terrestrial vegetation
☐ the presence of wrack line
☐ sediment sorting
☐ scour
☐ multiple observed or predicted flow events
☐ abrupt change in plant community

[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.
[6] A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.

☐ other (list):
☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction:
☒ High Tide Line indicated by: ☒ Mean High Water Mark indicated by:
☐ oil or scum line along shore objects ☐ survey to available datum;
☐ fine shell or debris deposits (foreshore) ☐ physical markings;
☐ physical markings/characteristics ☐ vegetation lines/changes in vegetation types.
☐ tidal gauges
☐ other (list):

(iii) Chemical Characteristics:
Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.). Explain: .
Identify specific pollutants, if known: .

(iv) Biological Characteristics. Channel supports (check all that apply):
☐ Riparian corridor. Characteristics (type, average width): .
☐ Wetland fringe. Characteristics: .
☐ Habitat for:
☐ Federally Listed species. Explain findings: .
☐ Fish/spawn areas. Explain findings: .
☐ Other environmentally-sensitive species. Explain findings: .
☐ Aquatic/wildlife diversity. Explain findings: .

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) Physical Characteristics:
(a) General Wetland Characteristics:
Properties:
Wetland size: acres
Wetland type. Explain: .
Wetland quality. Explain: .
Project wetlands cross or serve as state boundaries. Explain: .

(b) General Flow Relationship with Non-TNW:
Flow is: Pick List. Explain: .

Surface flow is: Pick List
Characteristics: .

Subsurface flow: Pick List. Explain findings: .
☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:
☐ Directly abutting
☐ Not directly abutting
☐ Discrete wetland hydrologic connection. Explain: .
☐ Ecological connection. Explain: .
☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW
Project wetlands are Pick List river miles from TNW.
Project waters are Pick List aerial (straight) miles from TNW.
Flow is from: Pick List.
Estimate approximate location of wetland as within the Pick List floodplain.

(ii) Chemical Characteristics:
Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: .
Identify specific pollutants, if known: .

(iii) Biological Characteristics. Wetland supports (check all that apply):
☐ Riparian buffer. Characteristics (type, average width): .

[7] Ibid.

☐ Vegetation type/percent cover. Explain: .
☐ Habitat for:
☐ Federally Listed species. Explain findings: .
☐ Fish/spawn areas. Explain findings: .
☐ Other environmentally-sensitive species. Explain findings: .
☐ Aquatic/wildlife diversity. Explain findings: .

3. **Characteristics of all wetlands adjacent to the tributary (if any)**
All wetland(s) being considered in the cumulative analysis: Pick List
Approximately ( ) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)

Summarize overall biological, chemical and physical functions being performed: .

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: .

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
☐ TNWs: linear feet width (ft), Or, acres.
☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**

☐ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial:

☐ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally:

Provide estimates for jurisdictional waters in the review area (check all that apply):

☐ Tributary waters: linear feet

☐ Other non-wetland waters: acres.

Identify type(s) of waters: .

3. Non-RPWs[8] that flow directly or indirectly into TNWs.

☐ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional waters within the review area (check all that apply):

☐ Tributary waters: linear feet width (ft).

☐ Other non-wetland waters: acres.

Identify type(s) of waters: .

4. Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.

☐ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.

☐ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW:

☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW:

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

5. Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.

☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.

☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. Impoundments of jurisdictional waters.[9]

As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.

☐ Demonstrate that impoundment was created from "waters of the U.S.," or

☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or

☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]

☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.

☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.

☐ which are or could be used for industrial purposes by industries in interstate commerce.

☐ Interstate isolated waters. Explain: .

---

[8]See Footnote # 3.

[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.

[10] Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.*

☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .
☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):
☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
☒ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
☒ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
☐ Other: (explain, if not covered above):

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
☒ Non-wetland waters (i.e., rivers, streams): **Approx. 27,456** linear feet Approx. **1-3** width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☒ Wetlands: Approx 4.74 (estimated from NWI) acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):
☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: AJD Request Packet. Submitted by applicant on November 2, 2022.
☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
☒ Office concurs with data sheets/delineation report.
☐ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☒ U.S. Geological Survey Hydrologic Atlas: .
☒ USGS NHD data.
☐ USGS 8 and 12 digit HUC maps.
☐ U.S. Geological Survey map(s). Cite scale & quad name:
☐ USDA Natural Resources Conservation Service Soil Survey. Citation: .
☒ National wetlands inventory map(s). Cite name: .
☐ State/Local wetland inventory map(s): .
☐ FEMA/FIRM maps: .
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date):Google Earth: 1937-2021. USGS Aerial Photos of Colorado: 1939, 1953, 1964, 1978.
or ☒ Other (Name & Date): .
☐ Previous determination(s). File no. and date of response letter: .
☒ Applicable/supporting case law:Rapanos and Carabell cases.
☐ Applicable/supporting scientific literature: .
☐ Other information (please specify):

B. ADDITIONAL COMMENTS TO SUPPORT JD:

Appendix E –Plan Correspondence

Cherry Creek Southwest Tributaries Major Drainageway Plan

Stakeholder Meeting

September 20, 2022

WWE WRIGHT WATER ENGINEERS, INC.

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

1



Sponsor Organizations

Southeast Metro Stormwater Authority (SEMSWA)

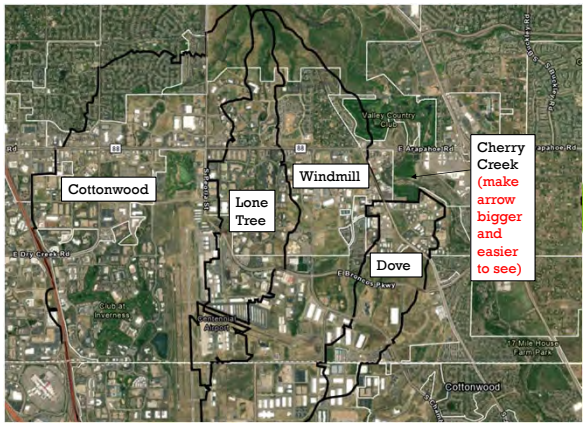
- Flood control and stormwater management services in Centennial and unincorporated Arapahoe County since 2006

Mile High Flood District (MHFD)(formerly UDFCD)

- Stormwater and watershed management in the Denver Metro area since 1969

2

Cherry Creek Southwest Tributaries



North

3

Objectives of this meeting

- Gather information on concerns that might be addressed or referenced in this Master Drainageway Plan (MDP) update
- Collaborate with stakeholders in developing alternatives
- Receive feedback on factors that will affect selection of alternatives
- Coordinate with other planning and design efforts

4

Did you get your survey?



- Any questions?
- There is a link to a shared OneDrive for uploading any relevant plans/reports
- You are allowed to complete the survey more than once if you think of any ideas after these meetings
- You can also email mlewis@wrightwater.com

5

Story Maps



- Should have received in same email as survey
- Intended to be used as a tool to show examples of types of issues the MDP will seek to address
- We want to incorporate your input into development of alternatives (explain that alternatives are potential solutions/resolutions to identified issues?)

6

The Cherry Creek SW Tributaries MDP includes:

- Regional stormwater quality facilities
- Public drainage infrastructure and waterways
- Floodplain planning
- Update to previous Outfall Systems Plan (OSP) and MDP studies from 2011 (2010?)
- Consideration of wetland, ecology, and community benefits

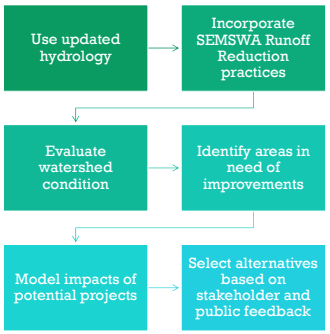
7

It does not include:

- Violations of drainage policy or permit requirements
- Policing individual behavior
- Final design of alternatives
- Usable water or wastewater infrastructure
- Floodplain delineation
- Update to hydrology (completed in 2020)

8

Methods



9

Factors used in evaluating and prioritizing alternatives

Economic Impact
- Cost of the project
- Cost of not doing the project
- Cost of postponing the project

Maintenance Impact
- Ease of maintenance
- Cost of maintenance

Flood Control Impact
- Reduce flood risk
- Reduce frequency of nuisance flooding

Water Quality Impact
- MS4 permit requirements
- Reduction in peak flow rates
- Other water quality benefits

Ecological Impact
- Maintenance of healthy riparian ecosystems

Community Value
- Maintain healthy stream corridors for public enjoyment
- Improve public access to ponds and stream corridors

10



Discussion

11

Cherry Creek Southwest Tributaries Master Plan

Agenda for Stakeholder Meeting September 2022

I. Introductions & Overview of Agenda (all) - 20 minutes
- MHFD (Jim Watt), SEMSWA (Ashley Byerley), and WWE (Maggie Lewis) describe their role in the project
- Stakeholder introductions

II. Master Plan Scope (WWE) – 15 minutes
- Brief PowerPoint presentation by WWE describing:
  - Partner organizations
  - Story Maps that everyone should have received prior to the meeting for drainageway issues and design alternatives
  - Intent of survey
  - What this masterplan does and does not include (ex: regional vs. private systems)
  - Methods for watershed assessment
  - Factors used in evaluating and prioritizing alternatives
  - Website for more information https://www.cherrycreekswtribs.com/

III. Key Questions for input - 15 minutes
  - Are there any other master plans, design, and/or construction projects that you think we should coordinate with? Can upload any documents here.
  - What issues are you experiencing with drainage and water quality?
  - What are your priorities for alternatives assessment?
  - How can we best engage the public?
  - What types of projects would you like to see considered?

IV. Break and interactive commenting – 30 minutes
- Provide feedback using Miroboard and Post-it sheets

V. Discussion - 30 minutes
- Give each entity time to share feedback and comments on questions

VI. Questions, Comments and Coordination (10 minutes)
- Next Steps:
  - Presentation and notes from this meeting – next few days
  - Final list of alternatives and public feedback form – next few months
  - Selected alternatives and draft final report - 2023

VII. Adjourn

Known Issues
What issues are you experiencing with drainage and water quality?

Water Quality

Flood Control

Stream Improvements
In what ways would you like this plan to focus on stream improvements?

Infrastructure
How do you think stormwater infrastructure should be improved in these watersheds?

Community Resources
How do you think these drainageways can be improved to be used as a community resource?

Priorities
How do you think we should prioritize projects?

A section of Cottonwood Creek within the District's boundary is known for lacking attention due to its geographic location. This channel is in Douglas County, between Liberty Blvd and Inverness Lane East (County Line). Inverness' responsibility for channel O&M and CIP extended from Liberty Blvd to Easter Ave – this responsibility was then conveyed to SEMSWA. The District requests that the Cottonwood Creek channel section and floodplain for the portion of the District within Douglas County between Liberty Blvd and Inverness Lane East (County Line) is included in the MP updated SOW.

Understanding this study session is not targeting new policies, we have some concerns with the growing use of artificial grass from both a water quality and flood control standpoint going forward. PFAS is already an issue for the quality of our local water supplies, including aquatic life and pretty much any living creature exposed to them. As far as flood control goes, if the installation of artificial grass is not properly done (i.e., gravel/sand subgrade prep), surface runoff will likely increase, which could result in further deterioration of the drainage ways, lack of hydraulic capacity in the existing infrastructure, and even bring more properties into the floodplain just to mention a few. I encourage all of us to start thinking of "future" policies to tackle this up front while we can and hopefully, we can avoid compounding the issues to the channels.

Example: Enhanced riparian buffer

If a site utilizes a regional facility, the channel between the site and regional facility must be stabilized prior to discharging developed flows from the site - would like to know the status of the channels and the recommendation to these channels

We would like to see a more active maintenance effort on drainage ways adjacent to developed land. This is a critical component to the District. Severe erosion has and continues to threaten critical infrastructure.

New trail connections

Lone Tree Creek Regional Bike Trail - complete from Broncos Pkway to Caley. The section from Caley into the State Park scheduled to be consructed by the end of 2023

- Consider additional channel improvements when working near parks or residential areas to allow for the integration of the floodplain into those amenities - in other words, have functional floodplains whenever possible.
- I will advise the group to involve all water and wastewater providers within the study limits. These entities maintain a direct relationship with the waterways as well as the communities they serve, so I envision that it shouldn't be too hard for us to convey any issues we see in our "backyards" to SEMSWA, MHFD, etc.
- Inverness bike lane loop – Arapahoe County & Inverness, expected opening in 2023

consider developing a simple ratingn'ranking criteria - 1 EMSWA CIP borrower/modified one de veloped by UDFCD for main tenance project requests. Ranks of Function, Safety, E xternal, Environment.

PLEASE POST NEW COMMENTS AT THE TOP OF THE BOARD. OLDER COMMENTS WILL BE MOVED DOWN. THANKS!

Roger Harvey 29 Sep, 14:49

All these drainageway's seem like constrained channelized culvert type streams with no naturalization, no natural elements, straight lines, private property abating. How do you plan on making these naturalized and useful habitat, They seem way too constrained. No room for increased riparian habitat? Has the floodplain been mapped? Why has floodplains not been required dedications by developers seeking land use approval?

·Inverness and Meridian are trying to fund a Parks Master Plan to construct more parks and improve the existing ones. There is a big push by these entities to offer a live-work-play environment within the next few years. One of the visions for the PMP (not the probable maximum precipitation...I always wanted to make this joke and I think this the right place to do it!) is for Inverness to integrate Cottonwood Creek in the overall theme of the John Derry Park (south of the County Line).
·Moderate erosion in Cottonwood Creek from Liberty Blvd and Inverness Drive East. Besides bank erosion, there is a real concern with loss of property within the Inverness hotel property.
·Violations...knowing this is not part of this MP update, we really need your help with enforcing the placement (more like dumping) of debris w\i the floodplain boundaries. We see this within the District's boundaries all the time and we'd be happy to help you enforce it..
·New policies for "reduction of irrigated blue grass areas" are in the horizon for Inverness. We need your help with alternative ground cover options that would not compromise targets for pervious areas for both existing and new developments
·On-going channel maintenance is critical in developed areas. Actual channel conditions may be "hidden" and/or inaccessible for on-going inspections and/or repairs.

City of Centennial has several projects along Lone Tree Creek:
1. Lone Tree Creek Regional Bike Trail - complete from Broncos Pkway to Caley. The section from Caley into the State Park scheduled to be consructed by the end of 2023.
2. Centennial - recently awarded design of LTCT Phase III Project - this would be an underpass beneath Arapahoe Rd just east of Revere for Lone Tree Creek and the bike trail.

- More active maintenance on existing outfall systems. Minor maintenance issues tend to fall behind schedule – then a lack of maintenance becomes large repair projects and harder to fund in the future.
- Understanding this study session is not targeting new policies – The existing infrastructure appears to be sized adequately for the latest hydrology and watershed perviousness. However, as we start shifting away from irrigated grasses and replace them with other types of ground cover (i.e. xeriscaping, artifical turf (L, etc.) we believe that new "perviousness" policies should be in the making (if they aren't already). New policies must be in place that a) protect the current storm infrastructure, b) are financially feasible for implementation by all of your customers, and c) avoid the exacerbation on "non-critical" items along the drainage systems.

Centennial - recently awarded design of LTCT Phase III Project - this would be an underpass beneath Arapahoe Rd just east of Revere for Lone Tree Creek and the bike trail

Example: Erosion near Chambers Road and Potomac Street

CCBWQA's monitoring on Cottonwood Creek shows high conductivity

Peoria Pond on Cottonwood Creek consider adding a forebay on main stem to improve maintenance.

Example: Rain gardens in public use areas

What is the benefit to converting pond on Lone Tree Creek in CCSP to include formal Water Quality?

Funding from CCBWQA to extend MDP into CCSP?

Example: Eliminate roadway overtopping

Example: Reconnect floodplain to channel by widening stream sections

Centennial is working on a trail project into CCSP which includes stream improvements on Lone Tree Creek between ACWWA discharge downstream to pond.

Inverness has maintenance inventory for Cottonwood Creek tributaries in golf course area.

CPW has looked a stream improvements on the Cottonwood Tributary through the shooting range.

Improvements on Lone Tree Creek Pond L-3. SEMSWA was interested in sediment removal and better approach for future maintenance.

Erosion on Lone Tree Creek in CCSP from ACWWA discharge downstream to confluence with Cottonwood Creek.

Example: Plan to have more easily maintainable storm pipes

Example: Providing better connectivity between residential areas and open space

Coordinate with Dove Valley Working group

Example: Impact to water quality

Nutrients and permanent water quality CMs ability to reduce N and P

The upper portion of the watershed (south of Lincoln) will be developing in the next 2-10 years. Flood detention and water quality will be provided in the development, but water QUANTITY will increase downstream

EDB's (Traditional) and LID practices

Second LID practices

Identifying appropriate corridor widths and road crossings

No other master plans for South of Lincoln other than MHFD authored plans and no flooding issues south of Lincoln

Coordination with the CCBWQA watershed model

Bank and Channel stabilization and estimating the sediment loading that could be immobilized

Stream improvements as a CM or BMP should be included for sure!

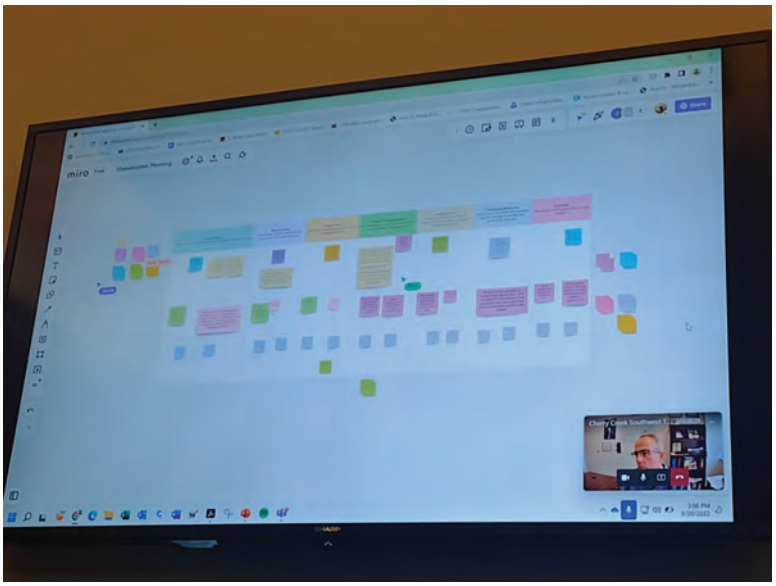
Not necessarily improved but maintain open channels and minimize storm pipes

Prioritize areas adjacent to future development sites to establish areas needed for improvements

Serve as a mulit-use facility by incorporating regional trails. Work with adjacent municipalities on trail connections and types/uses of the trails (i.e. bikes/peds) to inform trail surface

Most vulnerable to degradation and erosion first

Fluvial Hazard Zones and susceptibility to urban wildfire interface areas



STREAM IMPROVEMENTS

In what ways would you like this plan to focus on stream improvements?

↑ Green / soft structures

- HFLM - High Function / Low Maintenance

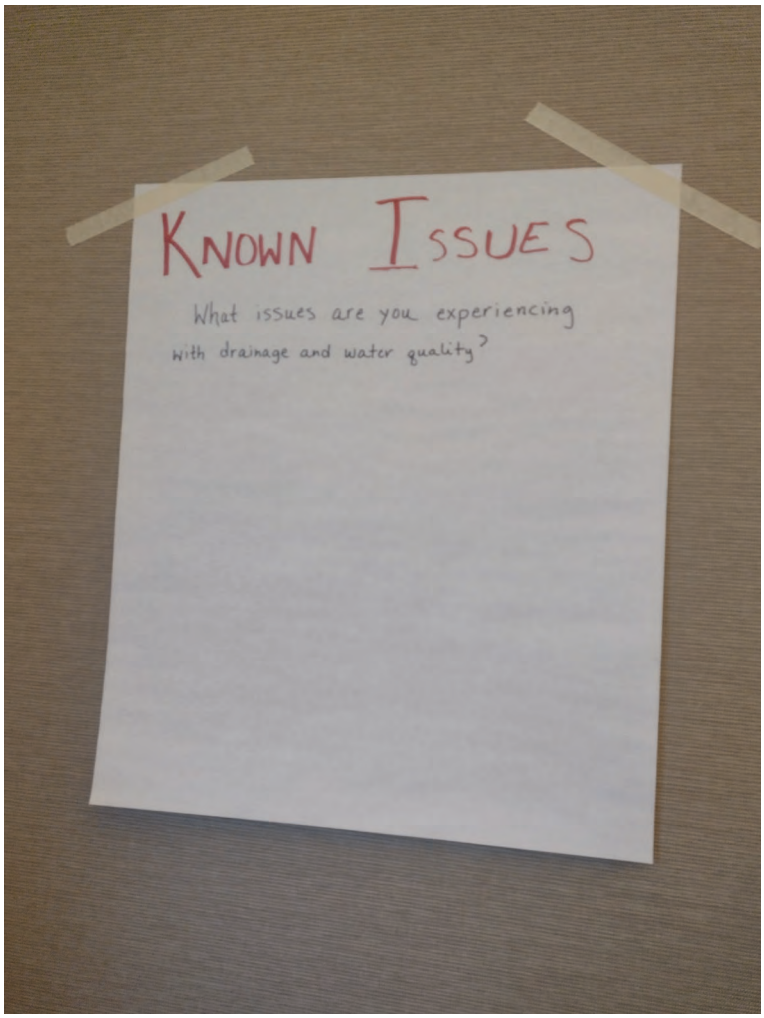
FLOOD CONTROL

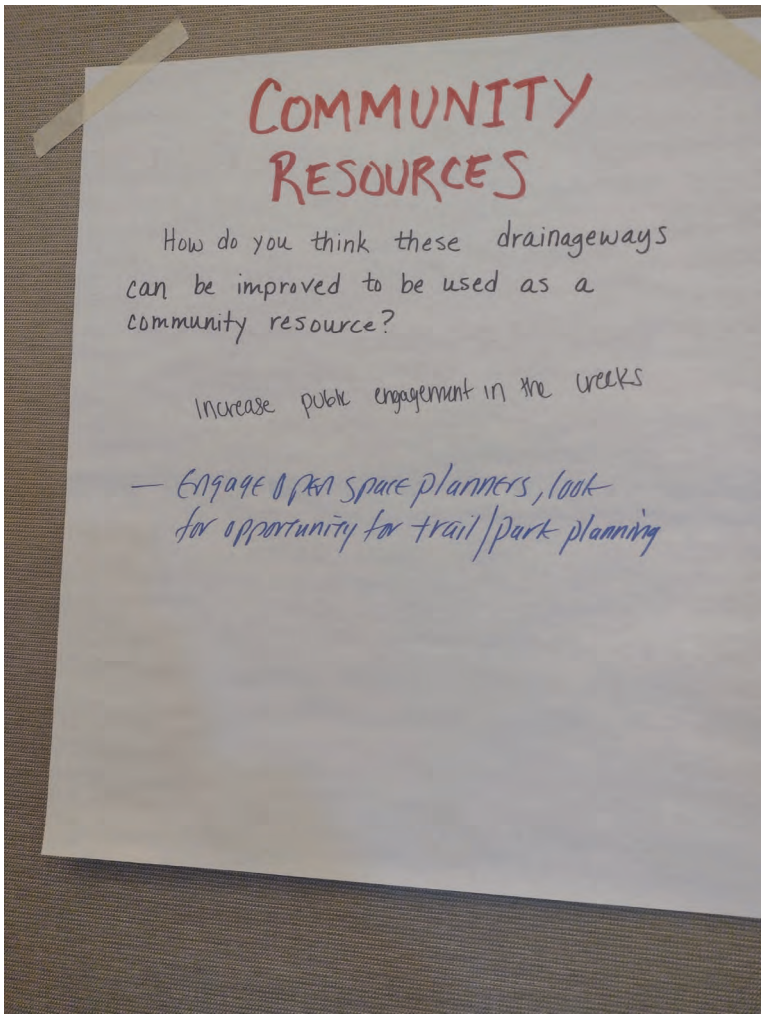
What flood control issues would you like to see examined?

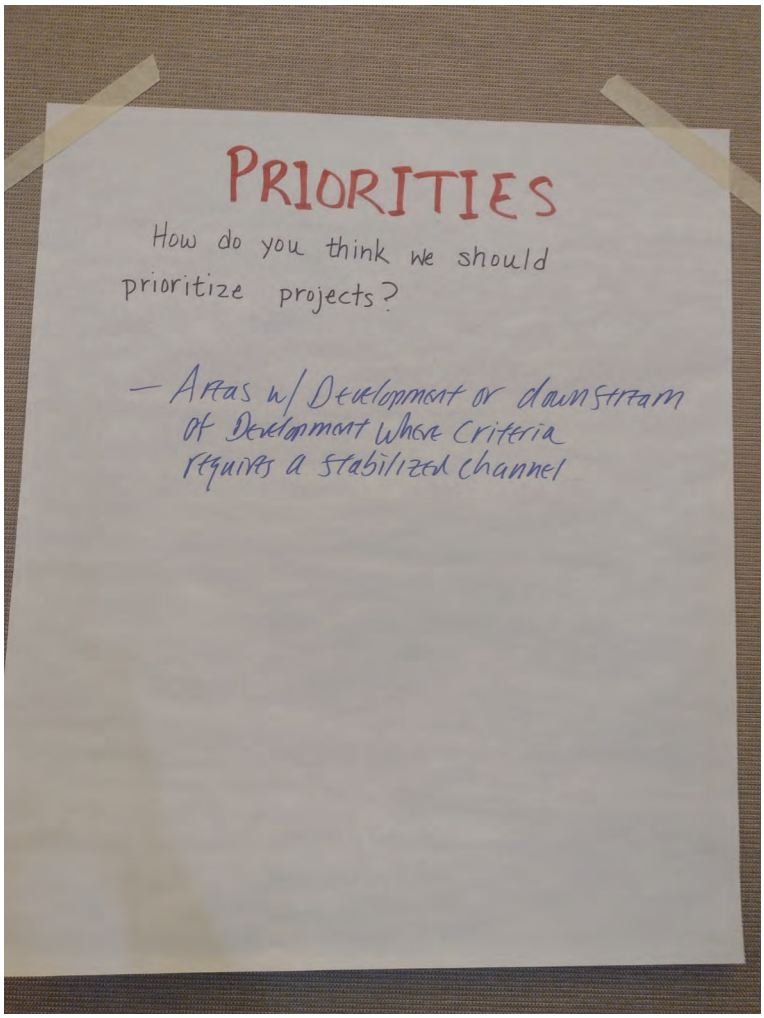
WATER QUALITY

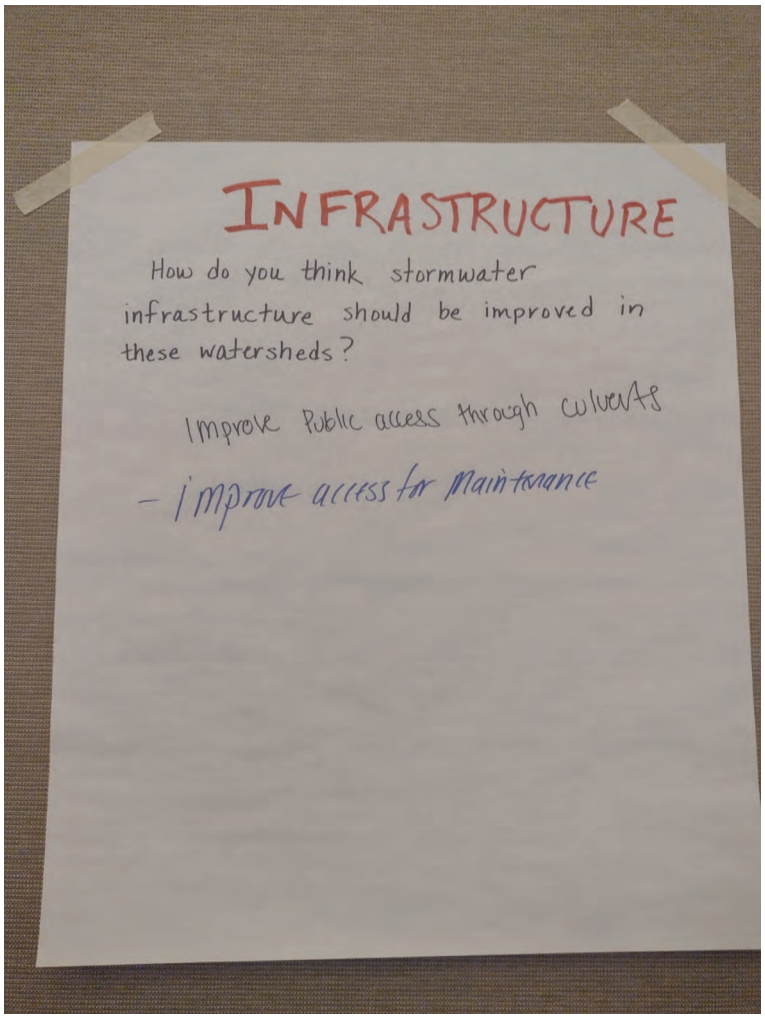
What types of water quality projects would you like to see considered?

- those that can be easily maintained with equipment, such as a vac truck


KNOWN ISSUES
What issues are you experiencing with drainage and water quality?


COMMUNITY RESOURCES
How do you think these drainageways can be improved to be used as a community resource?
Increase public engagement in the creeks
– Engage Open Space planners, look for opportunity for trail/park planning


PRIORITIES
How do you think we should prioritize projects?
– Areas w/ Development or downstream of Development where criteria requires a stabilized channel


INFRASTRUCTURE
How do you think stormwater infrastructure should be improved in these watersheds?
Improve Public access through culverts
– Improve access for Maintenance

SEMSWA SW Tributaries Master Plan
Correspondence List

Cherry Creek Southwest Tributaries Master Plan Stakeholder Meeting, 9/20/22

Name	Email	Organization	RSVP Status
S. Liu	SLiu@arapahoegov.com	Arapahoe County	Accepted
B. Weimer	bweimer@arapahoegov.com	Arapahoe County	None
R. Harvey	RHarvey@arapahoegov.com	Arapahoe County	Accepted
M. Frishman	MFrishman@arapahoegov.com	Arapahoe County	Accepted
Lauren Wiarda	lwiarda@centennialairport.com	Arapahoe County Public Airport Authority	None
Samanth Blymyer	sblymyer@centennialairport.com	Arapahoe County Public Airport Authority	None
J. Houlne	jhoulne@centennialco.gov	Centennial	Tentative
Jacob James	Jacob.James@cityoflonetree.com	City of Lonetree	None
Brad Robenstein	BRobenst@douglas.co.us	Douglas County	Accepted
Ann Woods	AWoods@greenwoodvillage.com	Greenwood Village	Accepted
Alexis Cook	ACook@greenwoodvillage.com	Greenwood Village	Accepted
David Vasquez	david.vasquez@sheaproperties.com	Meridian/Shea Properties	None
L. Hinds	lhinds@mhfd.org	MHFD	Accepted
Jim Watt	jwatt@mhfd.org	MHFD	Accepted
Luis	luis@mulhernmre.com	Mulhern MRE	Accepted
R. Borchardt	rborchardt@r2rengineers.com	R2R Engineers/Cherry Creek Basin Authority	Accepted
Molly Trujillo	mtrujillo@semswa.org	SEMSWA	Accepted
Tiffany Clark	tclark@semswa.org	SEMSWA	Accepted
Britni Kahler	bkahler@semswa.org	SEMSWA	Accepted
Ashley Byerley	Abyerley@semswa.org	SEMSWA	None
J. Traynor	jtraynor@semswa.org	SEMSWA	None
Maggie Lewis	mlewis@wrightwater.com	WWE	Organizer
Stacy Wilson	swilson@wrightwater.com	WWE	Accepted
Andrew Earles	aearles@wrightwater.com	WWE	Accepted

Cherry Creek Southwest Tributaries Master Plan Stakeholder Meeting, 9/29/22

Name	Email	Organization	RSVP Status
S. Liu	SLiu@arapahoegov.com	Arapahoe County	Accepted
B. Weimer	bweimer@arapahoegov.com	Arapahoe County	None
R. Harvey	RHarvey@arapahoegov.com	Arapahoe County	Accepted
M. Frishman	MFrishman@arapahoegov.com	Arapahoe County	Accepted
Lauren Wiarda	lwiarda@centennialairport.com	Arapahoe County Public Airport Authority	Accepted
Samanth Blymyer	sblymyer@centennialairport.com	Arapahoe County Public Airport Authority	None
J. Houlne	jhoulne@centennialco.gov	Centennial	Tentative
Jacob James	Jacob.James@cityoflonetree.com	City of Lonetree	None
Brad Robenstein	BRobenst@douglas.co.us	Douglas County	Accepted
Ann Woods	AWoods@greenwoodvillage.com	Greenwood Village	Accepted
Alexis Cook	ACook@greenwoodvillage.com	Greenwood Village	Accepted
David Vasquez	david.vasquez@sheaproperties.com	Meridian/Shea Properties	None
L. Hinds	lhinds@mhfd.org	MHFD	Accepted
Jim Watt	jwatt@mhfd.org	MHFD	Accepted
Luis Tovar	luis@mulhernmre.com	Mulhern MRE	Accepted
R. Borchardt	rborchardt@r2rengineers.com	R2R Engineers/Cherry Creek Basin Authority	Accepted
Molly Trujillo	mtrujillo@semswa.org	SEMSWA	Accepted
Tiffany Clark	tclark@semswa.org	SEMSWA	Accepted
Britni Kahler	bkahler@semswa.org	SEMSWA	Accepted
Ashley Byerley	Abyerley@semswa.org	SEMSWA	None
J. Traynor	jtraynor@semswa.org	SEMSWA	None
Maggie Lewis	mlewis@wrightwater.com	WWE	Organizer
Stacy Wilson	swilson@wrightwater.com	WWE	Accepted
Andrew Earles	aearles@wrightwater.com	WWE	Accepted

#1

COMPLETE

Collector:	Web Link 1 (Web Link)
Started:	Monday, September 19, 2022 8:49:39 AM
Last Modified:	Monday, September 19, 2022 8:52:31 AM
Time Spent:	00:02:52
IP Address:	209.96.199.106

Page 1: Cherry Creek Southwest Tributaries Major Drainageway Plan

Q1

Are you aware of any other potential or in-progress updates to master plans, studies, and/or designs, that may impact the Cherry Creek Southwest Tributaries? If yes, please describe and upload any available preliminary or final plans here.

No

Q2

Are you aware of any drainage and/or water quality issues within the plan boundary, or upstream or downstream? If yes, please describe and upload any photos you might have here.

No

Q3

What do you think is the best strategy for encouraging public engagement?

Do not know

Q4

What are your priorities in assessing alternatives?

do not know

Q5

On a scale of 1-6, how important are the following factors in prioritizing and evaluating alternatives? (6 being most important)

Water Quality Impacts	**1**
Flood Control Impacts (Example: Reducing flooding risk or frequency of nuisance flooding)	**2**
Ecological Impacts (Example: Maintaining healthy riparian ecosystems for wildlife)	**3**
Community Enhancement (Example: Improving public accessibility to waterways)	**4**
Cost	**6**
Ease of Maintenance	**5**

Q6

Are there any additional items you think should be evaluated as a component of this master plan?

None

Q7

Anything else you think we should know?

No

Q8

Contact Information

Name	**Ann K Woods**
Organization	**City of Greenwood Village**
Email Address	**awoods@greenwoodvillage.com**
Phone Number	**3034865784**

#2

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, September 19, 2022 8:57:49 AM
Last Modified: Monday, September 19, 2022 9:01:20 AM
Time Spent: 00:03:31
IP Address: 73.78.205.66

Page 1: Cherry Creek Southwest Tributaries Major Drainageway Plan

Q1

Are you aware of any other potential or in-progress updates to master plans, studies, and/or designs, that may impact the Cherry Creek Southwest Tributaries? If yes, please describe and upload any available preliminary or final plans here.

no

Q2

Are you aware of any drainage and/or water quality issues within the plan boundary, or upstream or downstream? If yes, please describe and upload any photos you might have here.

no additional issues

Q3

What do you think is the best strategy for encouraging public engagement?

engage with local NP or other community groups

Q4

What are your priorities in assessing alternatives?

Low maintenance long term.

Q5

On a scale of 1-6, how important are the following factors in prioritizing and evaluating alternatives? (6 being most important)

Water Quality Impacts	**6**
Flood Control Impacts (Example: Reducing flooding risk or frequency of nuisance flooding)	**1**
Ecological Impacts (Example: Maintaining healthy riparian ecosystems for wildlife)	**3**
Community Enhancement (Example: Improving public accessibility to waterways)	**4**
Cost	**5**
Ease of Maintenance	**2**

Q6

Are there any additional items you think should be evaluated as a component of this master plan?

no

Q7

Anything else you think we should know?

no

Q8

Respondent skipped this question

Contact Information

#3

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, September 20, 2022 7:54:11 AM
Last Modified: Tuesday, September 20, 2022 7:56:16 AM
Time Spent: 00:02:05
IP Address: 4.4.74.186

Page 1: Cherry Creek Southwest Tributaries Major Drainageway Plan

Q1

Are you aware of any other potential or in-progress updates to master plans, studies, and/or designs, that may impact the Cherry Creek Southwest Tributaries? If yes, please describe and upload any available preliminary or final plans here.

No

Q2

Are you aware of any drainage and/or water quality issues within the plan boundary, or upstream or downstream? If yes, please describe and upload any photos you might have here.

No

Q3

What do you think is the best strategy for encouraging public engagement?

Unsure

Q4

Respondent skipped this question

What are your priorities in assessing alternatives?

Q5

On a scale of 1-6, how important are the following factors in prioritizing and evaluating alternatives? (6 being most important)

Water Quality Impacts	**1**
Flood Control Impacts (Example: Reducing flooding risk or frequency of nuisance flooding)	**2**
Ecological Impacts (Example: Maintaining healthy riparian ecosystems for wildlife)	**6**
Community Enhancement (Example: Improving public accessibility to waterways)	**5**
Cost	**3**
Ease of Maintenance	**4**

Q6

Are there any additional items you think should be evaluated as a component of this master plan?

No

Q7

Anything else you think we should know?

No

Q8

Contact Information

Name	**Lauren Wiarda**
Organization	**Centennial Airport**
Email Address	**lwiarda@centennialairport.com**
Phone Number	**13037900598**

#4

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, September 20, 2022 9:56:32 AM
Last Modified: Tuesday, September 20, 2022 10:07:19 AM
Time Spent: 00:10:47
IP Address: 199.85.88.241

Page 1: Cherry Creek Southwest Tributaries Major Drainageway Plan

Q1

Are you aware of any other potential or in-progress updates to master plans, studies, and/or designs, that may impact the Cherry Creek Southwest Tributaries? If yes, please describe and upload any available preliminary or final plans here.

The City of Centennial has preliminary plans for Lone Tree Creek within the City's property west of the park. Attached is the letter provided by Jacobs on items required before construction.

Q2

Are you aware of any drainage and/or water quality issues within the plan boundary, or upstream or downstream? If yes, please describe and upload any photos you might have here.

No

Q3

What do you think is the best strategy for encouraging public engagement?

making sure there is virtual or online opportunities to give input.

Q4

What are your priorities in assessing alternatives?

Unknown

Q5

On a scale of 1-6, how important are the following factors in prioritizing and evaluating alternatives? (6 being most important)

Water Quality Impacts	**1**
Flood Control Impacts (Example: Reducing flooding risk or frequency of nuisance flooding)	**5**
Ecological Impacts (Example: Maintaining healthy riparian ecosystems for wildlife)	**4**
Community Enhancement (Example: Improving public accessibility to waterways)	**6**
Cost	**3**
Ease of Maintenance	**2**

Q6

Are there any additional items you think should be evaluated as a component of this master plan?

Unknown

Q7

Anything else you think we should know?

no

Q8

Contact Information

Name	**Jenny Houlne**
Organization	**City of Centennial**
Email Address	**jhoulne@centennialco.gov**
Phone Number	**303-754-3357**

#5

COMPLETE

Collector:	Web Link 1 (Web Link)
Started:	Tuesday, September 20, 2022 12:11:01 PM
Last Modified:	Tuesday, September 20, 2022 12:19:08 PM
Time Spent:	00:08:06
IP Address:	199.127.202.110

Page 1: Cherry Creek Southwest Tributaries Major Drainageway Plan

Q1

Are you aware of any other potential or in-progress updates to master plans, studies, and/or designs, that may impact the Cherry Creek Southwest Tributaries? If yes, please describe and upload any available preliminary or final plans here.

not at this time

Q2

Are you aware of any drainage and/or water quality issues within the plan boundary, or upstream or downstream? If yes, please describe and upload any photos you might have here.

nothing additional

Q3

What do you think is the best strategy for encouraging public engagement?

pictures/graphics! Anything engaging to emphasize the importance of flood control and water quality

Q4

What are your priorities in assessing alternatives?

1. Protection of people/property
2. Flood control/conveyance
3. Minimize maintenance
4. Improve water Quality

Q5

On a scale of 1-6, how important are the following factors in prioritizing and evaluating alternatives? (6 being most important)

Water Quality Impacts	**5**
Flood Control Impacts (Example: Reducing flooding risk or frequency of nuisance flooding)	**1**
Ecological Impacts (Example: Maintaining healthy riparian ecosystems for wildlife)	**2**
Community Enhancement (Example: Improving public accessibility to waterways)	**3**
Cost	**6**
Ease of Maintenance	**4**

Q6

Are there any additional items you think should be evaluated as a component of this master plan?

I like the focus on public engagement - the more time people spend in these waterways the more they will want to protect them

Q7

Anything else you think we should know?

THANK YOU! This is difficult but important work and appreciate the effort from all parties involved to make this come together.

Q8

Contact Information

Name	**Laura Hinds**
Organization	**MHFD**
Email Address	**lhinds@mhfd.org**
Phone Number	**3039298342**

#1

COMPLETE

Collector:	Embedded Survey 1 (Website Survey)
Started:	Monday, October 02, 2023 7:42:10 AM
Last Modified:	Monday, October 02, 2023 7:42:42 AM
Time Spent:	00:00:31
IP Address:	50.169.135.42

Page 1: Cherry Creek Southwest Tributaries - Lone Tree, Windmill, Dove, and Cottonwood Creeks

Q1

Do you have any concerns about Lone Tree, Windmill, Dove, and Cottonwood Creeks and if so, what are they?

Respondent skipped this question

Q2

What do you appreciate about these creeks that you would like to see preserved or expanded?

Respondent skipped this question

Q3

Are you aware of any flooding or water quality issues within the study area?

Respondent skipped this question

Q4

In your opinion, do the proposed projects adequately address the drainage and water quality needs of the four creeks? Are there additional projects you would like to see considered?

Respondent skipped this question

Q5

What are your priorities in selecting projects in the four creeks and their watersheds?

Respondent skipped this question

Q6

If you would like to receive email updates, please fill out your contact information:

Name	**Tessa Campbell**
Organization	**CEI**
Email Address	**tcampbell@ceiconstructors.com**

#2

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, November 20, 2023 2:14:11 PM
Last Modified: Monday, November 20, 2023 2:19:42 PM
Time Spent: 00:05:30
IP Address: 209.96.199.106

Page 1: Cherry Creek Southwest Tributaries - Lone Tree, Windmill, Dove, and Cottonwood Creeks

Q1

Do you have any concerns about Lone Tree, Windmill, Dove, and Cottonwood Creeks and if so, what are they?

Stabilizing stream and reducing floodplain impacts to homes is high priority.

Q2

What do you appreciate about these creeks that you would like to see preserved or expanded?

Connectivity and interface

Q3

Are you aware of any flooding or water quality issues within the study area?

No, appears that the drain time may be an issue based on fact sheets.

Q4

In your opinion, do the proposed projects adequately address the drainage and water quality needs of the four creeks? Are there additional projects you would like to see considered?

Yes, no additional projects within GV boundary currently.

Q5

What are your priorities in selecting projects in the four creeks and their watersheds?

GV Cottonwood - Improvements that reduce long term maintenance are ideal. Allowing unstable creek to meander over time or as they evolve where applicable.

Q6

If you would like to receive email updates, please fill out your contact information:

Name	**Matt Adams**
Organization	**Greenwood Village**
Email Address	**madams@greenwoodvillage.com**

#3

COMPLETE

Collector:	Embedded Survey 1 (Website Survey)
Started:	Wednesday, November 22, 2023 1:29:02 PM
Last Modified:	Wednesday, November 22, 2023 1:54:00 PM
Time Spent:	00:24:57
IP Address:	209.96.199.106

Page 1: Cherry Creek Southwest Tributaries - Lone Tree, Windmill, Dove, and Cottonwood Creeks

Q1

Do you have any concerns about Lone Tree, Windmill, Dove, and Cottonwood Creeks and if so, what are they?

Respondent skipped this question

Q2

What do you appreciate about these creeks that you would like to see preserved or expanded?

Respondent skipped this question

Q3

Are you aware of any flooding or water quality issues within the study area?

Respondent skipped this question

Q4

In your opinion, do the proposed projects adequately address the drainage and water quality needs of the four creeks? Are there additional projects you would like to see considered?

Respondent skipped this question

Q5

What are your priorities in selecting projects in the four creeks and their watersheds?

Respondent skipped this question

Q6

If you would like to receive email updates, please fill out your contact information:

Name	**Cayla Cappello**
Organization	**City of Greenwood Village**
Email Address	**ccappello@greenwoodvillage.com**

Search **Nextdoor**

Settings

- **Account**(/settings/account/)
- **Newsfeed Preferences**(/settings/newsfeed_preferences/)
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- **Add Business Page**()
- **Message Preferences**(/settings/messages/)

Neighborhoods you're following

Golf Villas at Vallagio (/neighborhood/golfvillasatvallagio--englewood--co/?source=settings)
Englewood, CO
Unfollow

Algonquin Acres (/neighborhood/algonquinacres--centennial--co/?source=settings)
Centennial, CO
Unfollow

Fox Run (/neighborhood/foxrunenglewood--englewood--co/?source=settings)
Englewood, CO
Unfollow

Centennial Airport (/neighborhood/centennialairport--englewood--co/?source=settings)
Englewood, CO
Unfollow

Vallagio (/neighborhood/vallagio--englewood--co/?source=settings)
Englewood, CO
Unfollow

Arapahoe Commons (/neighborhood/arapahoecommons--aurora--co/?source=settings)
Aurora, CO
Unfollow

Peakview Ave (/neighborhood/peakviewaveco--centennial--co/?source=settings)
Centennial, CO
Unfollow

Eagle Gate (/neighborhood/eaglegate--englewood--co/?source=settings)
Englewood, CO
Unfollow

Flats at Inverness (/neighborhood/amli--englewood--co/?source=settings)
Englewood, CO
Unfollow

Panorama Park (/neighborhood/panoramaparkco--centennial--co/?source=settings)
Centennial, CO
Unfollow

Zenith Meridian (/neighborhood/zenithmeridian--englewood--co/?source=settings)
Englewood, CO
Unfollow

South Cherry Creek Vista (/neighborhood/southcherrycreekvista--englewood--co/?source=settings)
Englewood, CO
Unfollow

Eddie Dean and I drove the areas of concern and made notes on the areas, we have also prioritized the projects that SEMSWA and the other agencies have selected for improvements.

Priority #1 (CC10 – Relocate Pond and covert to open channel to repair erosion) The pond in front of #13 green.

- This would be priority number 1 for us as the erosion from the creek keeps encroaching on the North face of the pond which is only 10-12 feet away from the front of the green. Due to Spring/Summer rains we have lost the retaining wall over time and the water keeps eroding the area between the pond and the green. As you see in the photos the water is running over the land bridge because of a cog/crushed pipe that ran from the creek to the pond. To make this an open channel would be good but we must keep in mind we have two main irrigation lines that run under this walking bridge.
-






Priority #2 (CC17 – Replace Headwall and Slipline Culvert) The pipe that runs from right of #14 fairway to the left of #14 fairway.

- This area is getting worse every year…the problem area is what we believe is the crushed culvert on the upside if the creek (right of #14 fairway. When we had the storm in June of 2023 that crushed culvert caused significant damage down stream (left side of #14 fairway) and caused multiple areas of erosion because that culvert couldn't handle the amount of water coming through. If you look at the photos you will see the damage.

  Left side – all new erosion area.




  Left side – no water coming through the concert culvert.




Priority #3 (Project IT2 – Removing concrete channel lining as erodes. Targeted grade control widens channel) The creek on #2

- This would be priority number 3 for us as we have significant erosion around the concert liner. We've had multiple people from SEMSWA come out and look at this project over the years and the latest conversation was to widen the creek and reuse the existing RepRap rocks but to also build a retention pond left of the cart path by to slow the flow of the creek. Our question to ownership is if they would do that, we would be losing turf area but not necessarily usable space.

Potential retention pond area





Priority #4 (Project CC11 – Install Scour Protection) This is the dam on #13 pond.

- This would be priority number 4 for us as there is a void to the East of the dam that has been caused by erosion which is about 4-5 feet deep.

o 

Priority #5 (CC19 – Widen Channel Near Building) Between #14 tee box and Burg Simpson Building

- This would be priority number 5 as this would help in heavy rains. The only concern is we have a main water line that runs through the creek under the tunnel just South of this project that we've had to repair and couple of times and that main water lines feeds the irrigation systems for hole #14 through #16.
-

Priority #6 (CC14 – Stream Reclamation and Rehabilitation From Inverness Drive East TO Carrie's Pond With Targeted Erosion And Infrastructure) The creek between #14 and #16

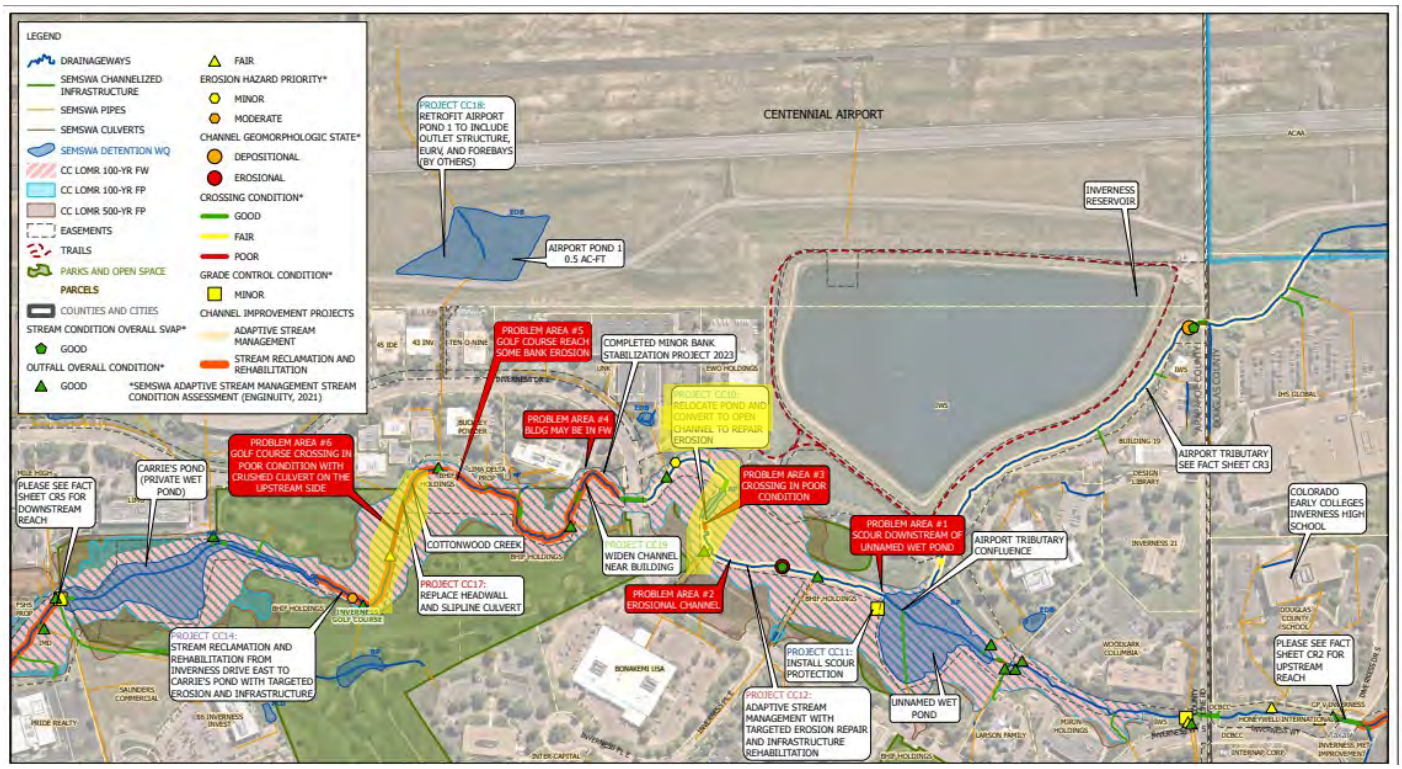
- This is an area that needs some help with bank mitigation and erosion.

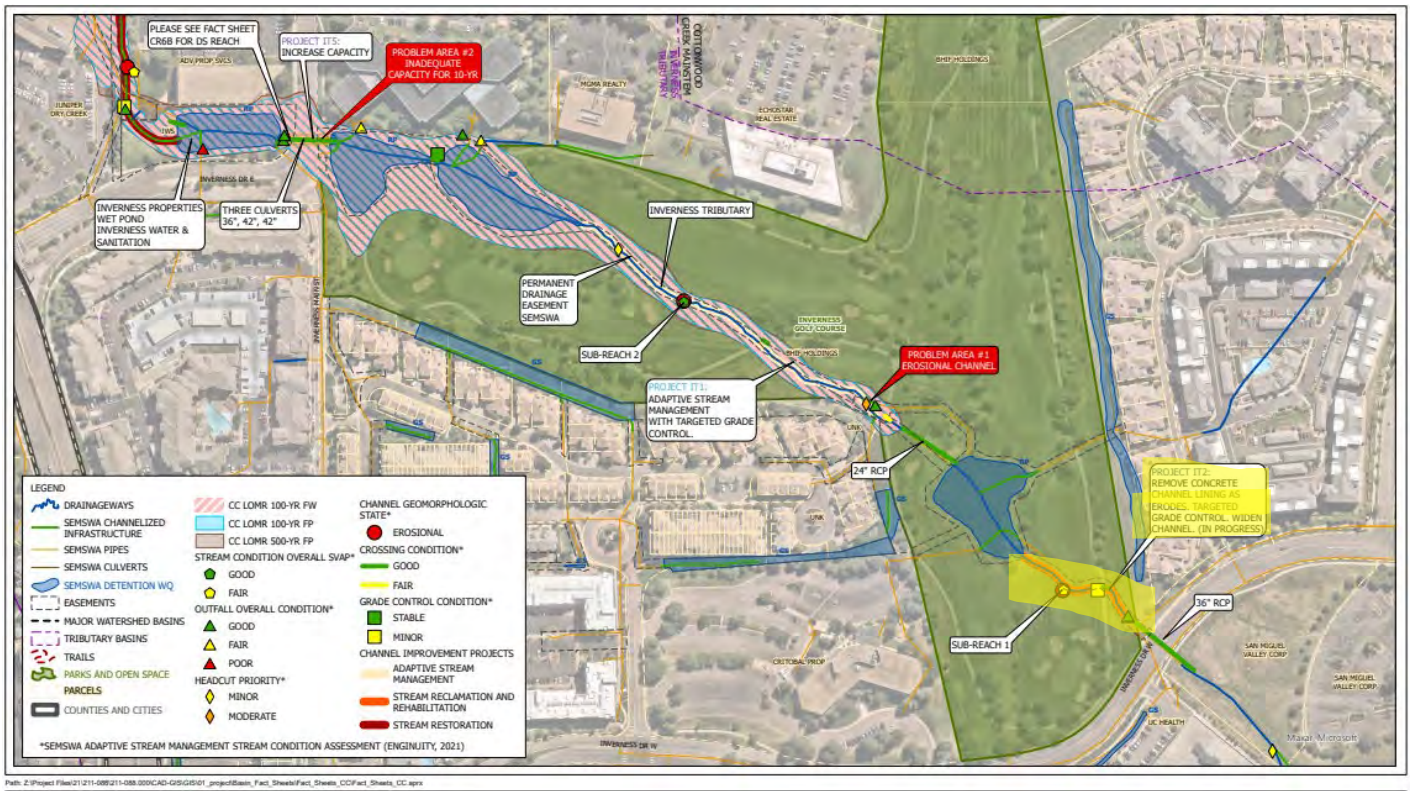
Priority #7 (IT1 – Adaptive Stream Management With Targeted Grade Control) The creek between #4 and #5

- This has been on the list for a couple of years, Joel our last Golf Course Superintendent was talking to someone about increasing the capacity of the creek to widen and controlling the flow to make small retention ponds.
-

Priority #8 (IT5 – Problem Area #2 – Inadequate Capacity for 10-Year) Back of #5 Blue Tee

- This wasn't much on our radar until we had the storm in June, and we saw that it's inadequate for the heavy rains.


LEGEND
DRAINAGEWAYS
SEMSWA CHANNELIZED INFRASTRUCTURE
SEMSWA PIPES
SEMSWA CULVERTS
SEMSWA DETENTION WQ
CC LOMR 100-YR FW
CC LOMR 100-YR FP
CC LOMR 500-YR FP
EASEMENTS
TRAILS
PARKS AND OPEN SPACE
PARCELS
COUNTIES AND CITIES
STREAM CONDITION OVERALL SVAP*
GOOD
OUTFALL OVERALL CONDITION*
GOOD
FAIR
EROSION HAZARD PRIORITY*
MINOR
MODERATE
CHANNEL GEOMORPHOLOGIC STATE*
DEPOSITIONAL
EROSIONAL
CROSSING CONDITION*
GOOD
FAIR
POOR
GRADE CONTROL CONDITION*
MINOR
CHANNEL IMPROVEMENT PROJECTS
ADAPTIVE STREAM MANAGEMENT
STREAM RECLAMATION AND REHABILITATION
*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)
PROJECT CC18: RETROFIT AIRPORT POND 1 TO INCLUDE OUTLET STRUCTURE, EURV, AND FOREBAYS (BY OTHERS)
CENTENNIAL AIRPORT
AIRPORT POND 1 0.5 AC-FT
INVERNESS RESERVOIR
PROBLEM AREA #5 GOLF COURSE REACH SOME BANK EROSION
COMPLETED MINOR BANK STABILIZATION PROJECT 2023
PROJECT CC10: RELOCATE POND AND CONVERT TO OPEN CHANNEL TO REPAIR EROSION
PROBLEM AREA #4 BLDG MAY BE IN FW
PROBLEM AREA #6 GOLF COURSE CROSSING IN POOR CONDITION WITH CRUSHED CULVERT ON THE UPSTREAM SIDE
PROBLEM AREA #3 CROSSING IN POOR CONDITION
AIRPORT TRIBUTARY SEE FACT SHEET CR3
PLEASE SEE FACT SHEET CR5 FOR DOWNSTREAM REACH
CARRIE'S POND (PRIVATE WET POND)
COTTONWOOD CREEK
PROJECT CC19: WIDEN CHANNEL NEAR BUILDING
PROBLEM AREA #1 SCOUR DOWNSTREAM OF UNNAMED WET POND
AIRPORT TRIBUTARY CONFLUENCE
COLORADO EARLY COLLEGES INVERNESS HIGH SCHOOL
PROJECT CC17: REPLACE HEADWALL AND SLIPLINE CULVERT
PROBLEM AREA #2 EROSIONAL CHANNEL
PROJECT CC14: STREAM RECLAMATION AND REHABILITATION FROM INVERNESS DRIVE EAST TO CARRIE'S POND WITH TARGETED EROSION AND INFRASTRUCTURE
PROJECT CC11: INSTALL SCOUR PROTECTION
PROJECT CC12: ADAPTIVE STREAM MANAGEMENT WITH TARGETED EROSION REPAIR AND INFRASTRUCTURE REHABILITATION
UNNAMED WET POND
PLEASE SEE FACT SHEET CR2 FOR UPSTREAM REACH


PLEASE SEE FACT SHEET CR6B FOR DS REACH
PROJECT IT5: INCREASE CAPACITY
PROBLEM AREA #2 INADEQUATE CAPACITY FOR 10-YR
INVERNESS PROPERTIES WET POND INVERNESS WATER & SANITATION
THREE CULVERTS 36", 42", 42"
INVERNESS TRIBUTARY
PERMANENT DRAINAGE EASEMENT SEMSWA
SUB-REACH 2
PROBLEM AREA #1 EROSIONAL CHANNEL
PROJECT IT1: ADAPTIVE STREAM MANAGEMENT WITH TARGETED GRADE CONTROL.
24" RCP
PROJECT IT2: REMOVE CONCRETE CHANNEL LINING AS ERODES. TARGETED GRADE CONTROL. WIDEN CHANNEL. (IN PROGRESS)
36" RCP
SUB-REACH 1
LEGEND
DRAINAGEWAYS
SEMSWA CHANNELIZED INFRASTRUCTURE
SEMSWA PIPES
SEMSWA CULVERTS
SEMSWA DETENTION WQ
EASEMENTS
MAJOR WATERSHED BASINS
TRIBUTARY BASINS
TRAILS
PARKS AND OPEN SPACE
PARCELS
COUNTIES AND CITIES
CC LOMR 100-YR FW
CC LOMR 100-YR FP
CC LOMR 500-YR FP
STREAM CONDITION OVERALL SVAP*
GOOD
FAIR
OUTFALL OVERALL CONDITION*
GOOD
FAIR
POOR
HEADCUT PRIORITY*
MINOR
MODERATE
CHANNEL GEOMORPHOLOGIC STATE*
EROSIONAL
CROSSING CONDITION*
GOOD
FAIR
GRADE CONTROL CONDITION*
STABLE
MINOR
CHANNEL IMPROVEMENT PROJECTS
ADAPTIVE STREAM MANAGEMENT
STREAM RECLAMATION AND REHABILITATION
STREAM RESTORATION
*SEMSWA ADAPTIVE STREAM MANAGEMENT STREAM CONDITION ASSESSMENT (ENGINUITY, 2021)

Lone Tree, Windmill, and Cottonwood Creek MDP in CCSP Progress Update

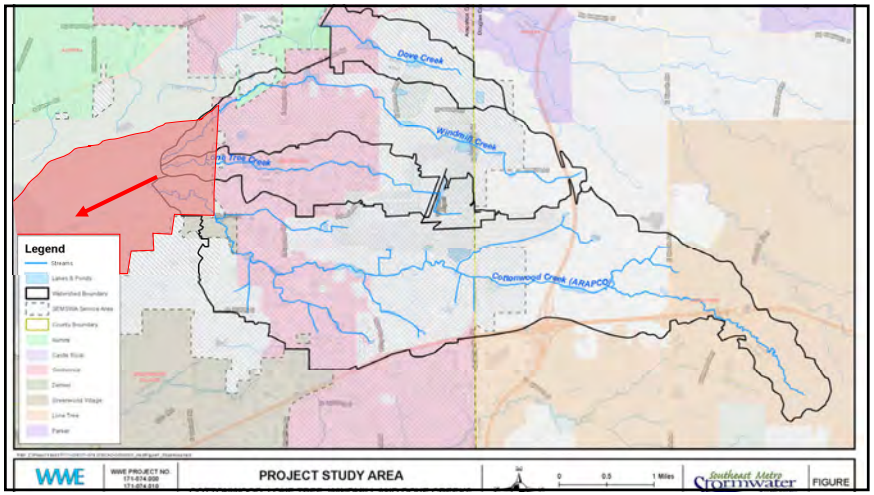
August TAC Meeting

1

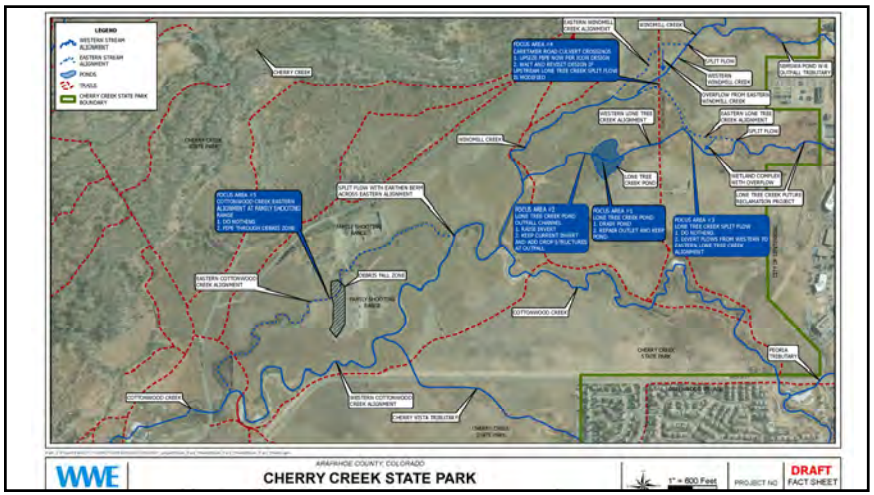


Lone Tree, Windmill and Cottonwood Creek watershed in Cherry Creek State Park

2



3



4



Lone Tree Creek Pond Erosion

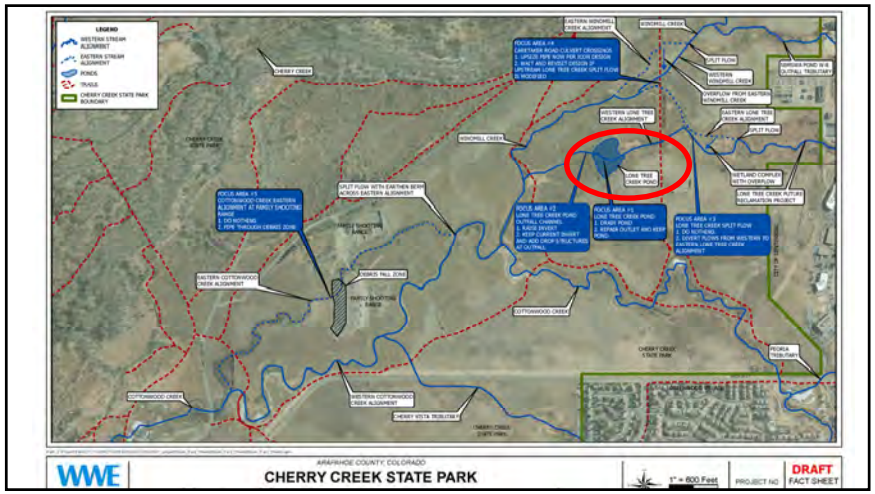
5

Complicating Factors:

- **Water Rights**
- **Wetlands**
- **Geotechnical**
- **Cost**
- **Safety**
- **Water Quality**
- **Habitat**



7



6

Outfall Channel Erosion

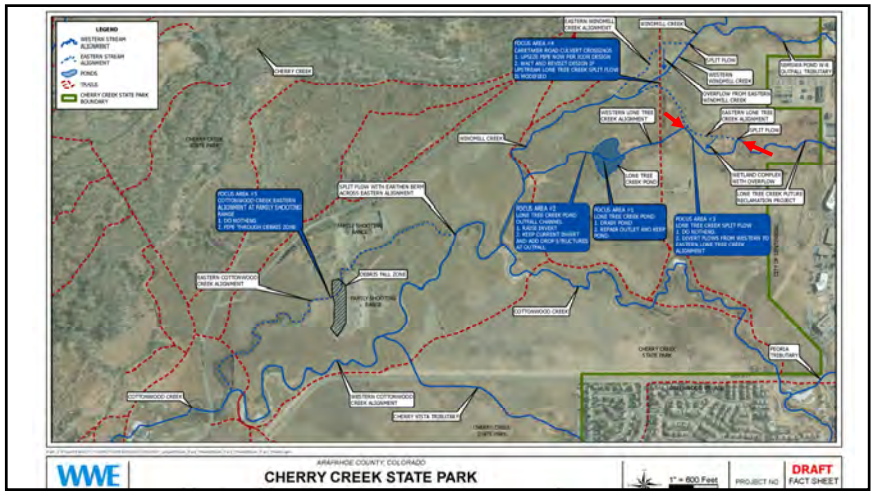


8



Downstream Wetlands

9



10

300+ feet Overflow

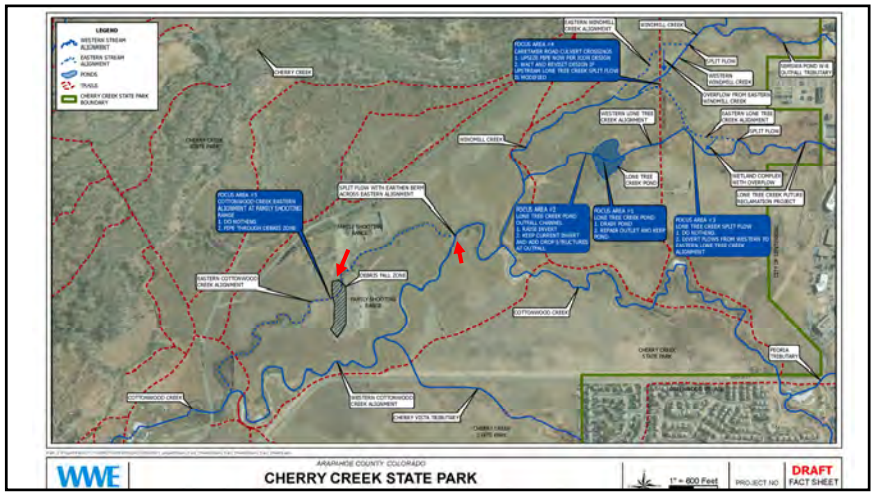


11

Caretaker Road Culvert (Lone Tree)



12



13

Shooting Center Previous Study

CHERRY CREEK SHOOTING CENTER
Cottonwood Creek Drainageway Rehabilitation

December 2019

Prepared for:
Colorado Parks and Wildlife
1313 Sherman Street
Denver, Colorado 80203

Prepared by:
Muller Engineering Company
777 South Wadsworth Boulevard
Suite 4-100
Lakewood, Colorado 80226
303.988.4939

- Objective of this 2019 report was to address water quality concerns from debris field
- This considered two alternatives, neither of which have been implemented
- We propose one additional alternative for this area

15



Shooting Center Debris Field

14

Next Steps

- CUHP and SWMM model for selected alternatives
- Stakeholder and public feedback process
- Revise and select alternatives based on feedback
- Incorporate into upstream MDP report

16

Discussion Questions

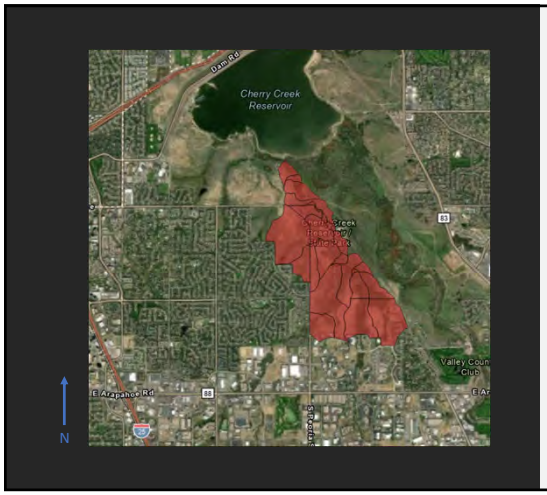
- What are next steps for TAC and Board input?
- Should there be a TAC working group specifically for this?
- Should the public feedback process follow the same format as the upstream MDP? i.e. Story Map of alternatives with survey outreach and Story Map on partner organization's website, NextDoor, etc.

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Lone Tree, Windmill, and Cottonwood Creek MDP in CCSP - Alternatives Selection

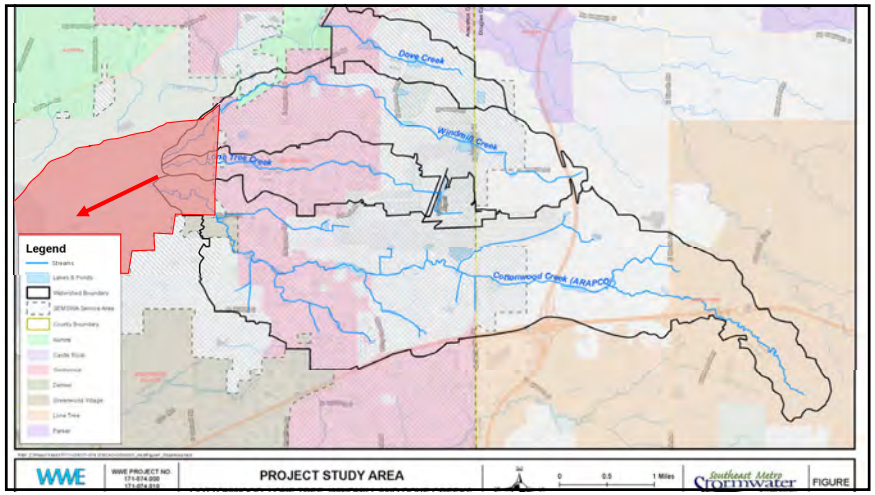
November 2023 TAC Working Group

1

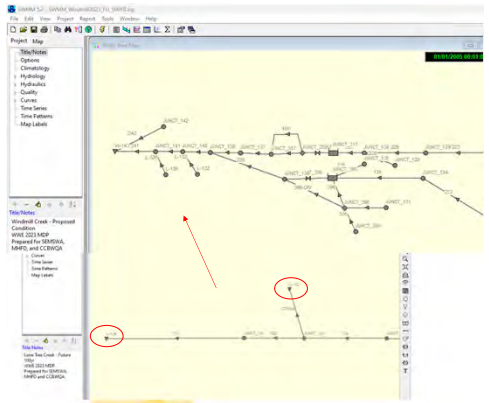


Lone Tree, Windmill and Cottonwood Creek watershed in Cherry Creek State Park

2



3



Hydrology Extension

- First time model was extended to the reservoir
- Delineated and modeled 32 additional subbasins and over 1.5 square miles in the park
- Integrated three SWMM models via Python script so future users can adjust storm duration and other parameters needed for projects

4

Peak Flow Rate Results (cfs)				
Location	Storm Event	2020 Hydrology Update (Upstream Node)	Current MDP Node	Current MDP Outfall
Lone Tree Creek Downstream Limit	2-year	420	130	130
	10-year	520	520	340
	100-year	1330	1530	1040
Windmill Creek Downstream Limit	2-year	250	250	420
	10-year	500	500	940
	100-year	1260	1240	2640
Cottonwood Creek Downstream Limit	2-year	1030	640	630
	10-year	1620	2010	2020
	100-year	4460	5930	6020

Results

5



The goal of this meeting is to select from alternatives!

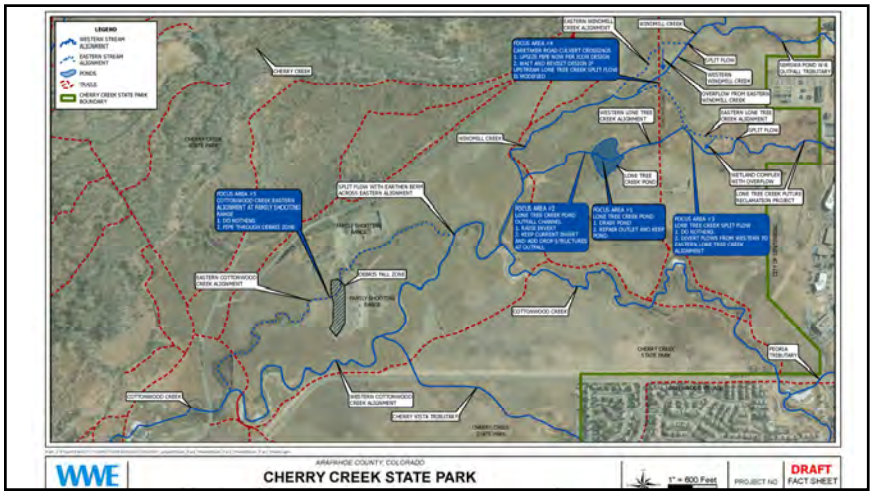
6



Public and Stakeholder Feedback:

- **Same process as upstream MDP portion**
- **Website and GIS Story Map were created**
- **Solicited feedback at Cherry Creek Basin conference, social media, and Next Door**
- **Total of four responses, all pertaining to areas outside of the park**

7



8

Focus Area 1. Lone Tree Creek Pond



9

Focus Area 2. Pond Outfall Channel



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Focus Area 3. Lone Tree Creek Split Flow



11

Focus Area 4. Caretaker Road Culvert

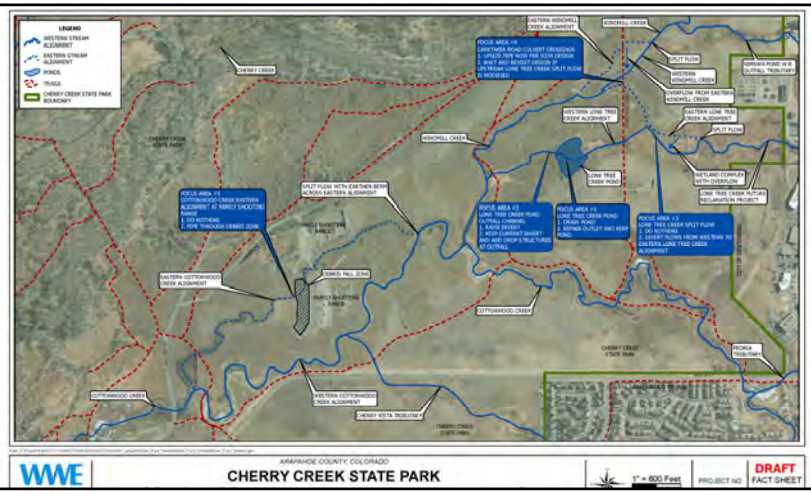


12

Focus Area 5. Family Shooting Center



13



14

Optional Tools

Scoring Parameters	Scoring Scale 1	2	3	4	5	Parameter Weight (%)
Project Cost	Over $1M	$500,000-$1M	$100,000-$500,000	$30,000-$100,000	<$30,000	35
Public Safety	Problem is severe or not addressed. Do nothing alternatives that do not address a public safety problem should score here.	Problem addressed minimally. Impacts drainageway health or public safety.	Problem addressed moderately. Impacts drainageway health or public safety.	Problem addressed significantly. Impacts multiple factors of public safety.	Project results in immediate and large improvement to public health, safety, and infrastructure.	15
Water Quality	Do nothing alternatives that will result in ongoing water quality degradation should go here.	Project does not consider aspects of water quality. Do nothing projects that wont have a significant effect for water quality should go here.	Minimally meets obligations of CCBWQA and Regulation 72	Addresses a water quality concern downstream	Improves aspects of multiple components of water quality	15
Stream Health	Alternative will not prevent current degradation or will exacerbate it.	Current degradation might continue but might lessen due to the project.	Project likely will prevent further degradation to channel and long-term monitoring will indicate if future improvements are necessary.	Project goal is to completely stabilize channel section for long-term function.	Planning for high functioning and low maintenance stream that will function for the future developed watershed.	10
Environmental	Completely removes and does not replace wetland or riparian area, adds concrete to drainageway, and/or includes a large land disturbance in waterway.	Major construction impacts to jurisdictional wetlands, major drainageways, and/or mature riparian area.	Minor construction impacts to mature riparian areas and non-jurisdictional wetlands. "Do nothing" alternatives that will result in ongoing moderate degradation to these environmental features should score here.	No impacts to wetlands or mature riparian areas or projects with moderate construction impacts but the final condition significantly improves upon the current environmental features.	Improves riparian buffer area or wetlands with minimal impacts to existing ecology	15
Community Value	Proposed project reduces recreation or aesthetic value.	Recreation or aethetics are lacking and not improved.	Public is able to view or access the improved areas, which might add recreational or aesthetic value.	Public is able to access the improvements which add aesthetic or recreational value and project can be considered an amenity.	Accessible walkways are possible with recreational features proposed and improved aesthetics. Project is in line with future community access planning.	10
					Total	100

15

MLO

DRAFT Alternatives Matrix

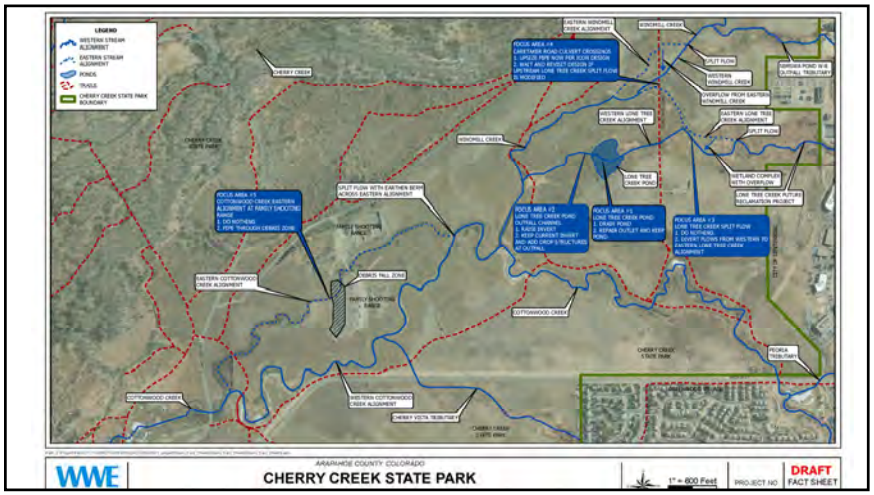
Focus Areas	Description	Project Cost	Public Safety	Water Quality	Stream Health	Environmental	Community Value	Total Score	Total Possible Points	Percent Score
#1 Lone Tree Creek Pond	Drain Pond	3	4	3	3	2	1	280	500	56%
	Repair outfall and keep pond	2	3	3	3	4	4	290	500	58%
#2 Channel Erosion downstream of Lone Tree Creek Pond	Raise Invert	2	3	3	3	2	3	250	500	50%
	Keep current invert and add drop structures at the outfall	2	3	3	4	3	3	275	500	55%
#3 Lone Tree Creek Split Flow	Do nothing.	5	3	2	3	3	3	355	500	71%
	Divert flows from western to eastern Lone Tree Creek Alignment	1	3	2	4	2	3	210	500	42%
#4 Caretaker road culvert crossing	Upsize pipe now per Icon design	3	4	2	3	3	3	300	500	60%
	Wait and revisit design if upstream Lone Tree Creek split flow is modified (selection of this alternative is contingent on upstream diversion)	1	3	2	4	2	3	210	500	42%
#5 Family Shooting Range	Do Nothing. Implement Muller alternative when appropriate.	3	3	2	2	3	3	275	500	55%
	Pipe through debris zone.	4	4	5	3	3	3	380	500	76%

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Discussion

- Focus Areas #1 and #2 related to the pond have extremely close scores.
- I'd like to go around and see if anyone has strong feelings about a particular alternative.
- Do we want to use selection matrix?
- If so, what adjustments do you have for the parameter weight or scores?

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Next Steps

- Present recommendations to the TAC – Next Week?
- Incorporate into upstream MDP - draft due end of year
- Report comments due January 2024
- Final report due March 2024

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2024 Hawk Walk

Saturday, January 27, 2024 9:00 AM

- These notes are related to public outreach that occurred at the annual Cherry Creek Hawk Walk event hosted by Casey Davenhill with the Cherry Creek Stewardship Partners. This even is often well attended by the birding community.
- CCBWQA members Jane Clary and Bill Ruzzo attended with Maggie Lewis of WWE. There were also 8-10 members of the birding community at the event.
- The group visited the Lone Tree Creek Pond and Maggie Lewis showed them the ongoing erosion at the outfall of the pond. She explained the regulatory requirements that could limit pond embankment rehabilitation.
- The group overwhelmingly supported keeping the pond and emphasized it's ecological importance especially as a water body that does not often freeze in the winter. Some attendees expressed concerns over construction environmental impacts associated with any repairs. They wanted appropriate revegetation and topsoil included in any construction project.
- Maggie explained that the selected alternative by the TAC was to leave the embankment in place and providing stabilization measures in the channel downstream. The attendees were generally in support of this alternative.
- After the event Casey Davenhill reached out to the attendees via email for any written comment on draft MDP and no one provided any follow-up comments.
- CPW staff Shawn Krier and Michelle Seubert have also provided feedback that they want the pond to remain in place. This is for the recreational and birding benefits expressed at this public outreach. They are also supportive of the MDP recommendation to stabilize the channel and monitor the embankment.

Appendix F – Conceptual Design Information

- **Pond Stage-Area-Discharge Tables**
- **Typical Channel Sections**
- **Dove Creek at Broncos Parkway Culvert Calculation**
- **Cost Estimates**

Note: Digital copies of spreadsheets can be found in the zipped "Digital Files" subfolder of Appendix G.

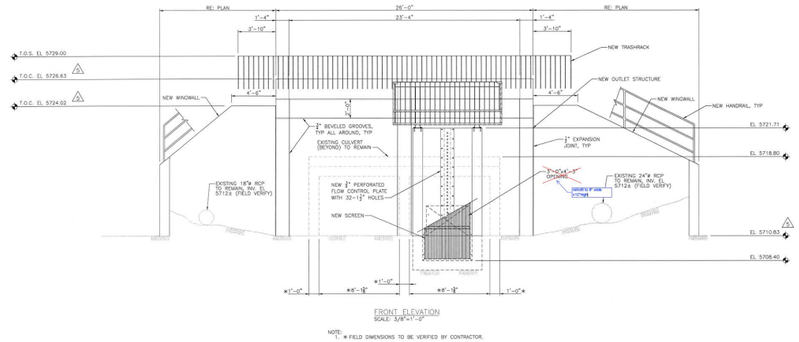
POND STAGE-AREA-DISCHARGE TABLES

Project No:	211-088.000
Date:	3/15/2024
Calculated:	MRL
Checked:	SP

Comments: Conceptual rating curve for Pond D-1 for 2023 MDP, Not for Construction

Outflow (cfs)

Notes	Stage (ft)	WQCV and EURV Outflow*	Lower Weir H (ft)	Lower Weir Effective L (ft) **	Small Box Weir Flow***	Small Box Orifice Flow****	Upper Weir H (ft)	Upper Weir Effective L (ft)**	Upper Box Weir Flow	Upper Box Orifice Flow****	Double Barrel Pipe Orifice**	Total Outflow
Top of Micropool 5710.83	0.00	0.00							0.0		0.0	0.00
	1.00	0.17							0.0		463.5	0.17
	2.00	0.35							0.0		655.5	0.35
	3.00	0.49							0.0		802.8	0.49
	4.00	0.77							0.0		927.0	0.77
	5.00	1.04							0.0		1036.4	1.04
	6.00	1.26							0.0		1135.3	1.26
	7.00	1.60							0.0		1226.3	1.60
	8.00	1.94							0.0		1310.9	1.94
	9.00	2.22							0.0		1390.5	2.22
	10.00	2.62							0.0		1465.7	2.62
lip of small box	10.77	2.92	0.00	11.8	0.0	0.0			0.0		1521.1	2.92
	11.00	7.08	0.23	11.7	4.3	29.4			0.0		1537.2	7.08
EURV orifice controls	12.00	10.89	1.23	11.3	51.2	68.1			0.0		1605.6	10.9
	13.00	11.35	2.23	10.9	120.7	91.7			0.0		1671.1	11.3
	14.00	11.79	3.23	10.5	202.6	110.3			0.0		1734.2	11.8
	15.00	12.22	4.23	10.1	292.0	126.3			0.0		1795.1	12.2
Lip of large box	15.80	12.56	5.03	9.8	366.6	137.7	0.0	64.8	0.0	0.0	1842.3	12.6
	15.90	12.60	5.13	9.7	376.1	139.0	0.1	64.8	6.8	281.4	1848.1	19.4
	16.00	12.64	5.23	9.7	385.5	140.4	0.2	64.7	19.3	397.9	1853.9	31.9
	16.20	12.72	5.43	9.6	404.5	143.1	0.4	64.6	54.5	562.8	1865.5	67.2
	16.40	12.80	5.63	9.5	423.5	145.7	0.6	64.6	99.9	689.2	1877.0	112.7
	16.60	12.88	5.83	9.4	442.5	148.2	0.8	64.5	153.6	795.9	1888.4	166.5
	16.70	12.88	5.93	9.4	452.0	149.5	0.9	64.4	183.2	844.1	1894.1	196.1
	16.80	12.96	6.03	9.4	461.5	150.8	1.0	64.4	214.5	889.8	1899.7	227.4
	17.00	13.04	6.23	9.3	480.5	153.2	1.2	64.3	281.6	974.7	1911.0	294.6
	18.00	13.43	7.23	8.9	574.9	165.1	2.2	63.9	694.6	1319.8	1966.4	708.0
Barrel restricts flow	19.00	13.81	8.23	8.5	666.7	176.1	3.2	63.5	1210.8	1591.7	2020.3	1224.6
Overtopping	20.00	13.87	9.23	8.1	754.5	186.5	4.2	63.1	1809.2	1823.6	2072.8	1823.1



FRONT ELEVATION
SCALE: 3/8"=1'-0"

NOTE:
1. * FIELD DIMENSIONS TO BE VERIFIED BY CONTRACTOR.

Outlet Structure Dimensions	
Front Length Lower Box (ft)	5.00
Side Length Lower Box (ft)	4.25
% Reduction Area for Grate Lower Box	40
% Reduction Length for Grate Lower Box	10
Front Length Upper Box (ft)	22.00
Side Length Upper Box (ft)	14
% Reduction Area for Grate Upper Box	40
% Reduction Length for Grate Upper Box	10
Barrel Pipe Height (ft)	5.92
Barrel Pipe Width (ft	8.13

Note: Percent reduction for length and area is for debris clogging

*from MHFD-Detention Spreadsheet for 5 square inches space 18 inches apart, i.e. eight rows and using EURV controlling orifice in lower riser box with the dimensions of 8 inches wide and 12 inches high
**From the Francis Formula, effective weir length - L-0.1*n*H where n=number of constrictions (in this case, sides); I also subtracted the % reduction length due to clogging in this formula; the lower weir subtracts 0.42 feet for the ten bars across the front, 0.5"x3" and 6 inches on center
***at stage H=11 this does not control flow because the WQCV orifice flow is 3.01 cfs from the MHFD-Detention Spreadsheet and 3.01+4.4>7.08 cfs
****Cd=0.60 square edge concrete (from 5.15.1 UDSCM)

The equation can be represented as:

$$Q = C_d A \sqrt{2gh}$$

where Q = flow (cubic metres per second)
C_d = coefficient of discharge
A = area of orifice (square metres)
g = acceleration from gravity (9.81 m/s^2)
h = head acting on the centreline (m)?

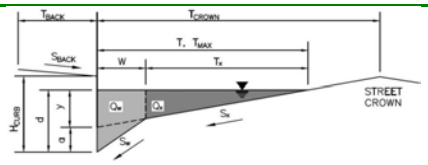
$$Q = C_w L H^{1.5}$$

Where:
Q = discharge over weir, cfs (cms)
L = length of the weir crest, ft (m)
H = distance between water surface and the crest, ft (m)
Cw = weir coefficient, typically 3.33 (1.84) for sharp-crested; 3.367 (1.83) for Cipolletti; 3.09 (1.7) for Broad-crested

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

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

Project: 2023 MDP Concept
Inlet ID: Sump Inlet DS D-0



Gutter Geometry:

	Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	10.0	ft
	Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.250	ft/ft
Warning 01	Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.035	
	Height of Curb at Gutter Flow Line	H_{CURB} =	23.00	inches
	Distance from Curb Face to Street Crown	T_{CROWN} =	45.0	ft
	Gutter Width	W =	2.00	ft
	Street Transverse Slope	S_X =	0.250	ft/ft
	Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.250	ft/ft
	Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Warning 01	Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.035	

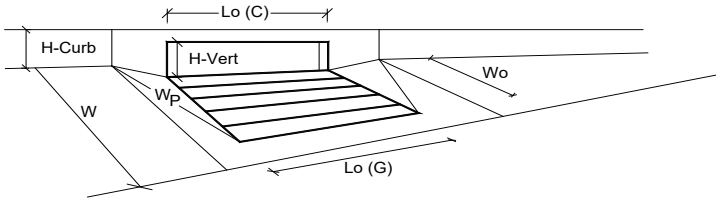
			Minor Storm	Major Storm	
	Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	45.0	45.0	ft
Warning 02	Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	24.0	24.0	inches
	Check boxes are not applicable in SUMP conditions		☐	☐	

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

Warning 01: Manning's n-value does not meet the USDCM recommended design range.

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.01 (April 2021)



			MINOR	MAJOR	
Design Information (Input)					
Type of Inlet		Type =	CDOT Type C Grate		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	0.00	0.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	24.0	24.0	inches
Grate Information			MINOR	MAJOR	Override Depths
Length of a Unit Grate		L_o (G) =	2.92	2.92	feet
Warning 5	Width of a Unit Grate	W_o =	2.92	2.92	feet
	Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	0.70	0.70	
	Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	0.50	0.50	
	Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	2.41	2.41	
	Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	0.67	0.67	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	N/A	N/A	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	N/A	N/A	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	N/A	N/A	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	N/A	N/A	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	N/A	N/A	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	N/A	N/A	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	N/A	N/A	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	N/A	N/A	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	1.635	1.635	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	N/A	N/A	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	N/A	N/A	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	1.00	1.00	
			MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		**Q_a =**	**18.5**	**18.5**	**cfs**
WARNING: Inlet Capacity less than Q Peak for Minor and Major Storr		$Q_{PEAK\ REQUIRED}$ =	23.0	45.0	cfs

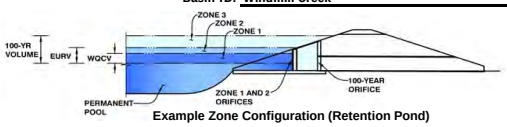
Warning 5: The width of unit is greater than the gutter width.

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Pond W-1/W-1 EURV Retrofit 2023 MDP Concept (SWMM Node 110, Top of Micropool Elev 5770.8)

Basin ID: Windmill Creek



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	490.00	acres
Watershed Length =	6,800	ft
Watershed Length to Centroid =	2,700	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	79.50%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	10.0%	percent
Percentage Hydrologic Soil Groups C/D =	90.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Centennial - Municipal Court	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	13.280	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	38.744	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	26.459	acre-feet	inches
5-yr Runoff Volume (P1 = 1.11 in.) =	36.476	acre-feet	inches
10-yr Runoff Volume (P1 = 1.35 in.) =	46.397	acre-feet	inches
25-yr Runoff Volume (P1 = 1.7 in.) =	62.244	acre-feet	inches
50-yr Runoff Volume (P1 = 2 in.) =	75.313	acre-feet	inches
100-yr Runoff Volume (P1 = 2.32 in.) =	89.898	acre-feet	inches
500-yr Runoff Volume (P1 = 3.15 in.) =	126.598	acre-feet	inches
Approximate 2-yr Detention Volume =	24.754	acre-feet	
Approximate 5-yr Detention Volume =	34.765	acre-feet	
Approximate 10-yr Detention Volume =	42.057	acre-feet	
Approximate 25-yr Detention Volume =	49.171	acre-feet	
Approximate 50-yr Detention Volume =	52.735	acre-feet	
Approximate 100-yr Detention Volume =	57.769	acre-feet	

Define Zones and Basin Geometry

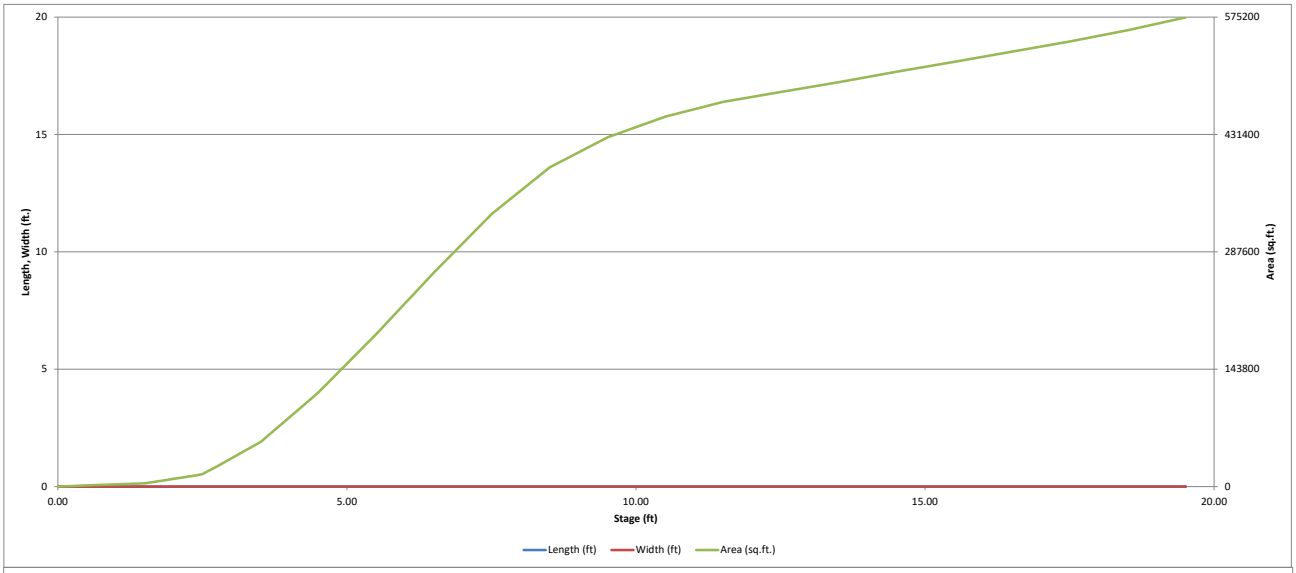
Zone 1 Volume (WQCV) =	13.280	acre-feet
Zone 2 Volume (EURV - Zone 1) =	25.464	acre-feet
Zone 3 Volume (User Defined - Zones 1 & 2) =	63.956	acre-feet
Total Detention Basin Volume =	102.700	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

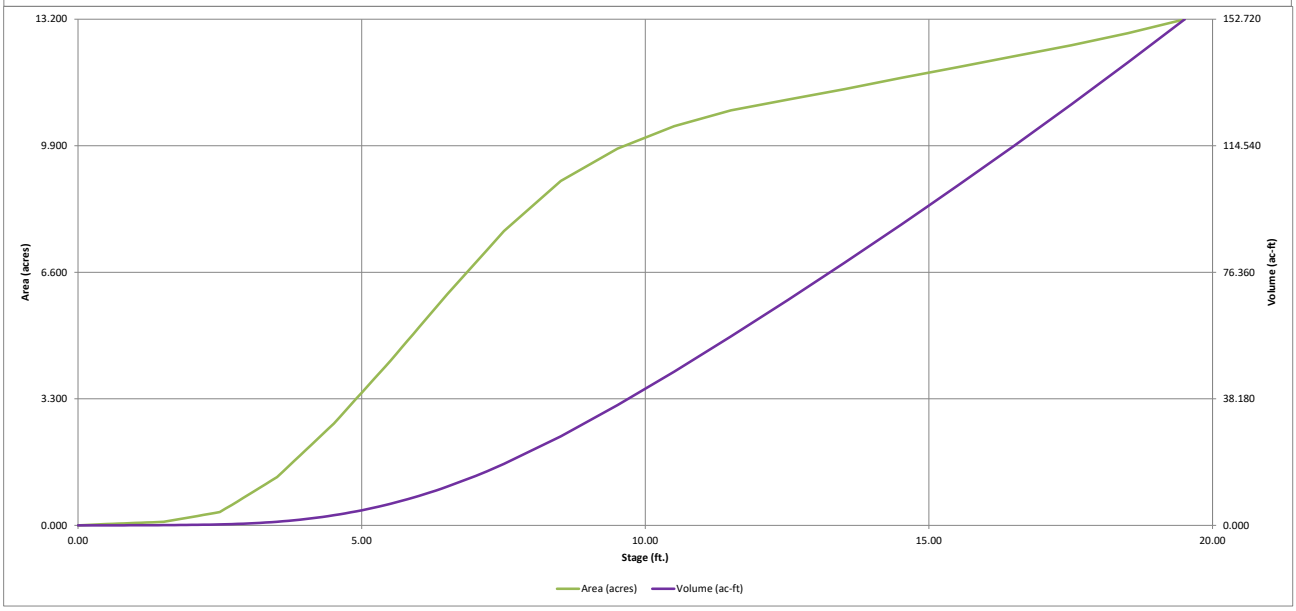
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
5570.6	--	0.11	--	--	--	322	0.007	18	0.000
5570.7	--	0.21	--	--	--	614	0.014	64	0.001
5570.8	--	0.31	--	--	--	907	0.021	140	0.003
5570.9	--	0.41	--	--	--	1,199	0.028	246	0.006
5571	--	0.51	--	--	--	1,492	0.034	380	0.009
5571.1	--	0.61	--	--	--	1,744	0.040	542	0.012
5571.2	--	0.71	--	--	--	1,996	0.046	729	0.017
5571.3	--	0.81	--	--	--	2,249	0.052	941	0.022
5571.4	--	0.91	--	--	--	2,501	0.057	1,179	0.027
5571.5	--	1.01	--	--	--	2,753	0.063	1,441	0.033
5571.6	--	1.11	--	--	--	3,006	0.069	1,729	0.040
5571.7	--	1.21	--	--	--	3,258	0.075	2,043	0.047
5571.8	--	1.31	--	--	--	3,510	0.081	2,381	0.055
5571.9	--	1.41	--	--	--	3,763	0.086	2,745	0.063
5572	--	1.51	--	--	--	4,015	0.092	3,133	0.072
5572.1	--	1.61	--	--	--	5,131	0.118	3,591	0.082
5572.2	--	1.71	--	--	--	6,246	0.143	4,160	0.095
5572.3	--	1.81	--	--	--	7,362	0.169	4,840	0.111
5572.4	--	1.91	--	--	--	8,477	0.195	5,632	0.129
5572.5	--	2.01	--	--	--	9,593	0.220	6,535	0.150
5572.6	--	2.11	--	--	--	10,708	0.246	7,550	0.173
5572.7	--	2.21	--	--	--	11,824	0.271	8,677	0.199
5572.8	--	2.31	--	--	--	12,940	0.297	9,915	0.228
5572.9	--	2.41	--	--	--	14,055	0.323	11,265	0.259
5573	--	2.50	--	--	--	15,171	0.348	12,580	0.289
5573.1	--	2.60	--	--	--	19,142	0.439	14,296	0.328
5573.2	--	2.71	--	--	--	23,112	0.531	16,620	0.382
5573.3	--	2.81	--	--	--	27,083	0.622	19,129	0.439
5573.4	--	2.91	--	--	--	31,053	0.713	22,036	0.506
5573.5	--	3.01	--	--	--	35,024	0.804	25,340	0.582
5573.6	--	3.11	--	--	--	38,995	0.895	29,041	0.667
5573.7	--	3.21	--	--	--	42,965	0.986	33,139	0.761
5573.8	--	3.31	--	--	--	46,936	1.078	37,634	0.864
5573.9	--	3.41	--	--	--	50,907	1.169	42,526	0.976
5574	--	3.51	--	--	--	54,877	1.260	47,815	1.098
5574.1	--	3.61	--	--	--	60,951	1.399	53,607	1.231
5574.2	--	3.71	--	--	--	67,025	1.539	60,006	1.378
5574.3	--	3.81	--	--	--	73,098	1.678	67,012	1.538
5574.4	--	3.91	--	--	--	79,172	1.818	74,625	1.713
5574.5	--	4.01	--	--	--	85,246	1.957	82,846	1.902
5574.6	--	4.11	--	--	--	91,320	2.096	91,674	2.105
5574.7	--	4.21	--	--	--	97,393	2.236	101,110	2.321
5574.8	--	4.31	--	--	--	103,467	2.375	111,153	2.552
5574.9	--	4.41	--	--	--	109,541	2.515	121,803	2.796
5575	--	4.51	--	--	--	115,614	2.654	133,061	3.055
5575.1	--	4.61	--	--	--	122,762	2.818	144,980	3.328
5575.2	--	4.71	--	--	--	129,909	2.982	157,613	3.618
5575.3	--	4.81	--	--	--	137,057	3.146	170,962	3.925
5575.4	--	4.91	--	--	--	144,204	3.310	185,025	4.248
5575.5	--	5.01	--	--	--	151,352	3.475	199,802	4.587
5575.6	--	5.11	--	--	--	158,499	3.639	215,295	4.942
5575.7	--	5.21	--	--	--	165,646	3.803	231,502	5.315
5575.8	--	5.31	--	--	--	172,794	3.967	248,424	5.703
5575.9	--	5.41	--	--	--	179,941	4.131	266,061	6.108
5576	--	5.51	--	--	--	187,089	4.295	284,412	6.529
5576.1	--	5.61	--	--	--	194,646	4.468	303,499	6.967
5576.2	--	5.71	--	--	--	202,204	4.642	323,342	7.423
5576.3	--	5.81	--	--	--	209,761	4.815	343,940	7.896
5576.4	--	5.91	--	--	--	217,318	4.989	365,294	8.386
5576.5	--	6.01	--	--	--	224,876	5.162	387,403	8.894
5576.6	--	6.11	--	--	--	232,433	5.336	410,269	9.418
5576.7	--	6.21	--	--	--	239,990	5.509	433,890	9.961
5576.8	--	6.31	--	--	--	247,548	5.683	458,267	10.520
5576.9	--	6.41	--	--	--	255,105	5.856	483,400	11.097
5577	--	6.51	--	--	--	262,663	6.030	509,288	11.692
5577.5	--	7.01	--	--	--	298,473	6.852	649,572	14.912
5577.7	--	7.21	--	--	--	312,797	7.181	710,699	16.315
5578	--	7.51	--	--	--	334,283	7.674	807,761	18.544
5579	--	8.51	--	--	--	391,212	8.981	1,170,508	26.871
5580	--	9.51	--	--	--	427,923	9.824	1,580,075	36.274
5581	--	10.51	--	--	--	453,400	10.409	2,020,737	46.390
5582	--	11.51	--	--	--	471,399	10.822	2,483,136	57.005
5583	--	12.51	--	--	--	483,594	11.102	2,960,633	67.967
5584	--	13.51	--	--	--	495,566	11.377	3,450,212	79.206
5585	--	14.51	--	--	--	508,371	11.671	3,952,180	90.730
5585.5	--	15.01	--	--	--	514,440	11.810	4,207,883	96.600
5586	--	15.51	--	--	--	520,508	11.949	4,466,620	102.539
5587	--	16.51	--	--	--	532,961	12.235	4,993,355	114.632
5588	--	17.51	--	--	--	545,338	12.519	5,532,504	127.009
5589	--	18.51	--	--	--	559,157	12.836	6,084,752	139.687
5590	--	19.51	--	--	--	574,892	13.198	6,651,776	152.704

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



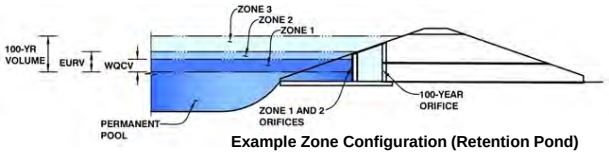


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Pond W-1/W-1 EURV Retrofit 2023 MDP Concept (SWMM Node 110, Top of Micropool Elev 5770.8)

Basin ID: Windmill Creek



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	6.77	13.280	Orifice Plate
Zone 2 (EURV)	9.76	25.464	Orifice Plate
Zone 3 (User)	15.53	63.956	Weir&Pipe (Rect.)
Total (all zones)		102.700	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.556E-02	ft^2
Depth at top of Zone using Orifice Plate =	7.00	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 =	8.00	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.60	1.20	1.80	2.40	3.00	3.60	4.20
Orifice Area (sq. inches)	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00

	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)	4.50	4.80	5.10	5.40	5.70	6.00	6.30	6.60
Orifice Area (sq. inches)	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			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				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.90	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.00	N/A	feet
Overflow Weir Front Edge Length =	14.50	N/A	feet	Overflow Weir Slope Length =	10.00	N/A	feet
Overflow Weir Grate Slope =	100.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	39.90	N/A	
Horiz. Length of Weir Sides =	10.00	N/A	feet	Overflow Grate Open Area w/o Debris =	114.70	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	57.35	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Rectangula	Not Selected			Zone 3 Rectangular	Not Selected	
Depth to Invert of Outlet Pipe =	0.18	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	2.88	N/A	ft^2
Rectangular Orifice Width =	27.60	N/A	inches	Outlet Orifice Centroid =	0.63	N/A	feet
Rectangular Orifice Height =	15.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=		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

Calculated Parameters for Spillway

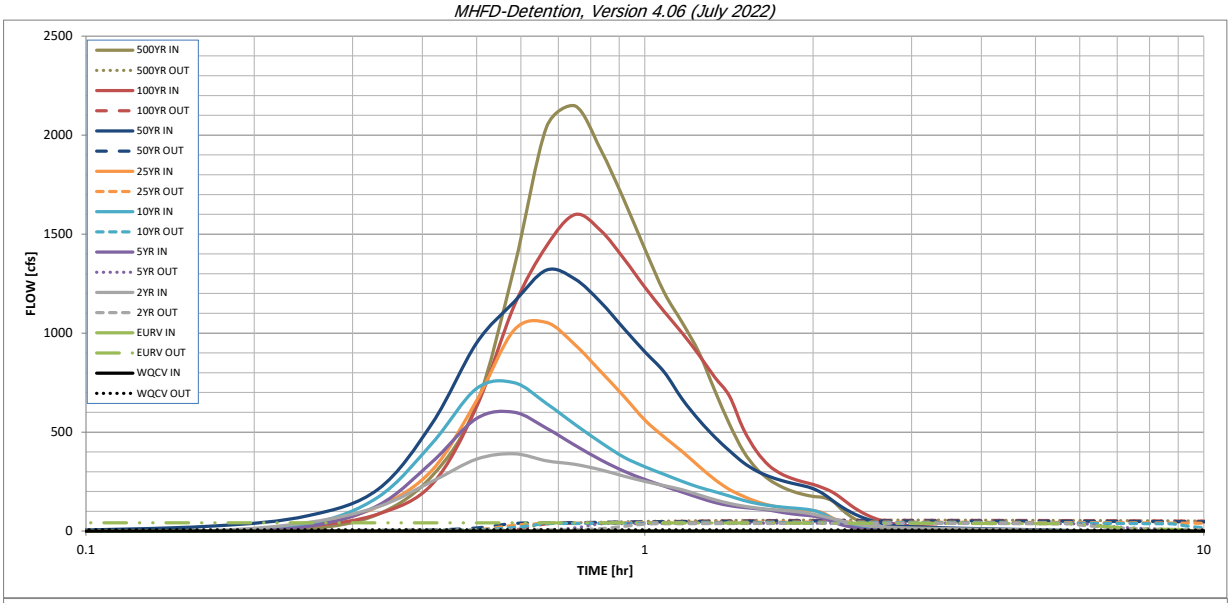
Routed Hydrograph Results

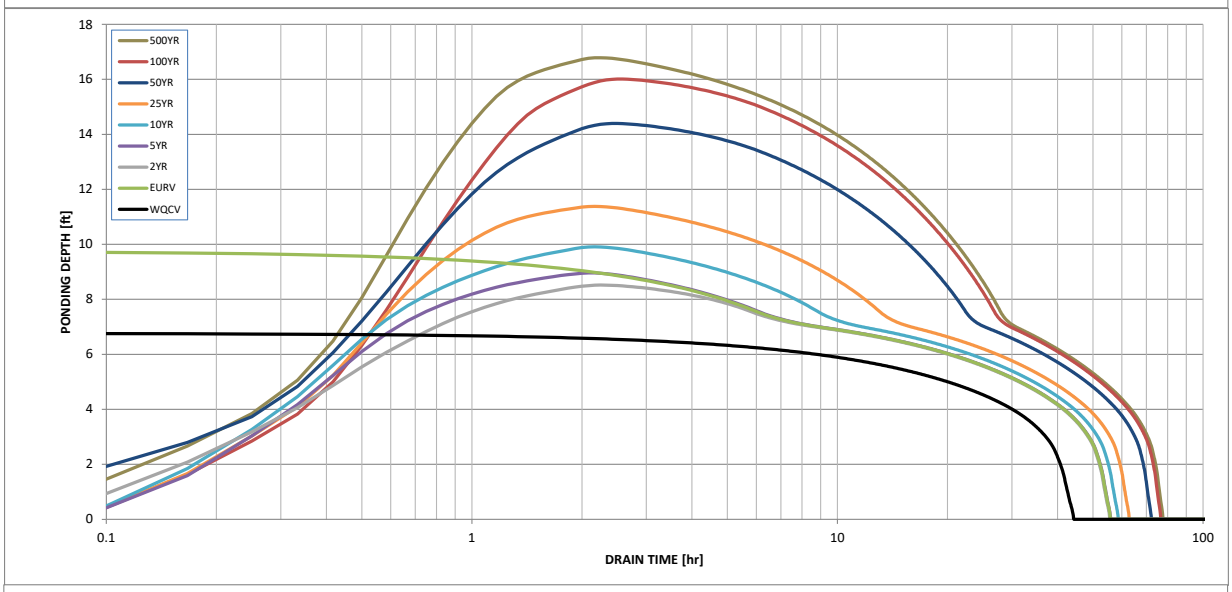
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

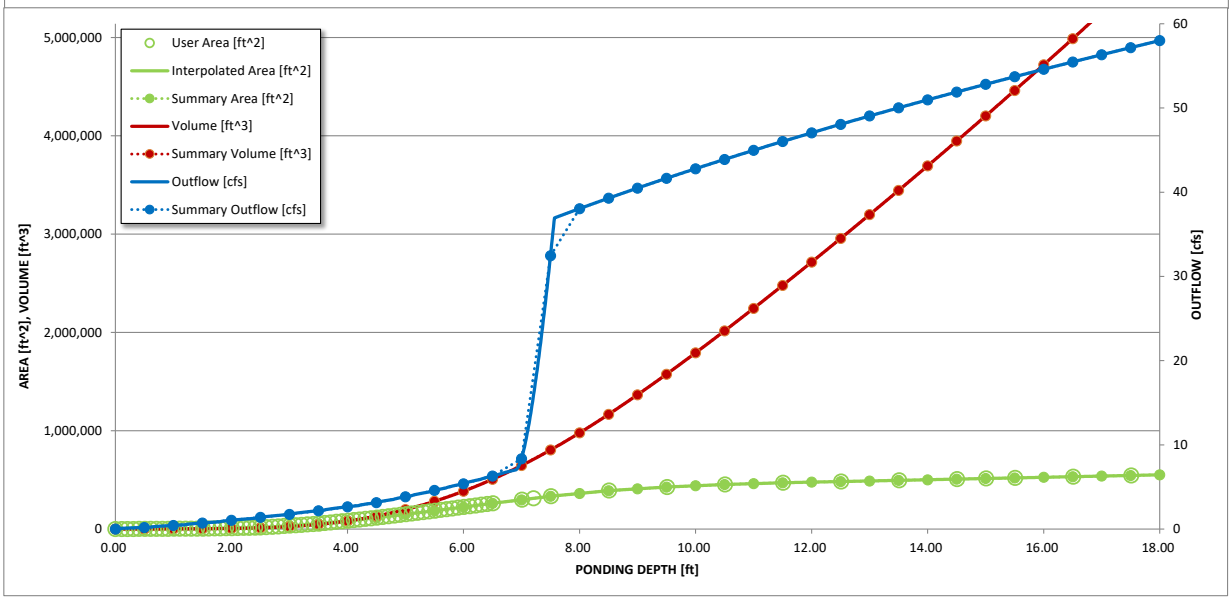
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.11	1.35	1.70	2.00	2.32	3.15
CUHP Runoff Volume (acre-ft) =	13.280	38.744	26.459	36.476	46.397	62.244	75.313	89.898	126.598
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	34.699	36.476	46.397	62.244	101.072	120.996	126.598
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	4.8	41.7	115.7	302.7	417.3	569.7	898.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						103.0	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.09	0.24	0.62	0.85	0.21	1.83
Peak Inflow Q (cfs) =	N/A	N/A	390.7	600.4	749.7	1053.8	1318.4	1598.9	2147.5
Peak Outflow Q (cfs) =	6.8	42.2	39.3	40.4	42.6	45.8	51.7	54.6	56.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.0	0.4	0.2	0.1	0.5	0.1
Structure Controlling Flow =	Plate	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	0.28	0.26	0.3	0.3	0.3	0.3	0.3	0.4
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	45	46	46	47	49	53	56	56
Time to Drain 99% of Inflow Volume (hours) =	**41**	50	50	50	52	55	63	66	67
Maximum Ponding Depth (ft) =	6.77	9.76	8.52	8.96	9.91	11.38	14.40	16.01	16.79
Area at Maximum Ponding Depth (acres) =	6.46	9.97	8.98	9.35	10.06	10.77	11.64	12.09	12.31
Maximum Volume Stored (acre-ft) =	13.315	38.748	26.871	30.904	40.250	55.602	89.331	108.550	117.945

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	USER	CUHP	CUHP	CUHP	USER	USER	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	2.89	0.00	0.00	0.00	24.90	0.00	10.46
	0:15:00	0.00	0.00	43.96	23.99	35.18	26.75	78.32	25.51	85.39
	0:20:00	0.00	0.00	123.11	130.06	172.16	123.79	211.96	86.44	280.32
	0:25:00	0.00	0.00	251.73	350.69	445.11	309.27	546.14	238.46	640.74
	0:30:00	0.00	0.00	363.77	569.16	720.43	659.62	950.34	628.74	1327.78
	0:35:00	0.00	0.00	390.68	600.43	749.69	1015.10	1157.13	1136.34	2039.51
	0:40:00	0.00	0.00	355.08	519.89	644.54	1053.76	1318.36	1439.26	2147.52
	0:45:00	0.00	0.00	337.10	433.35	538.75	941.15	1273.05	1598.86	1927.78
	0:50:00	0.00	0.00	309.87	360.18	448.31	806.79	1156.53	1518.64	1675.80
	0:55:00	0.00	0.00	277.99	303.24	373.96	681.49	1024.04	1376.96	1424.84
	1:00:00	0.00	0.00	251.15	261.04	325.08	560.98	905.56	1231.81	1204.35
	1:05:00	0.00	0.00	229.57	227.09	286.52	475.06	802.80	1108.22	1053.04
	1:10:00	0.00	0.00	208.83	196.79	251.17	401.70	666.44	999.89	901.56
	1:15:00	0.00	0.00	182.71	168.83	221.57	327.33	560.99	889.32	711.59
	1:20:00	0.00	0.00	158.68	144.77	199.21	261.22	475.69	777.71	541.00
	1:25:00	0.00	0.00	140.09	129.00	177.31	210.32	406.28	682.62	404.65
	1:30:00	0.00	0.00	126.66	119.58	155.71	176.22	346.53	516.68	316.20
	1:35:00	0.00	0.00	117.11	113.49	140.09	149.77	304.46	404.26	261.25
	1:40:00	0.00	0.00	110.40	106.31	129.49	131.66	276.73	331.82	226.03
	1:45:00	0.00	0.00	105.69	95.68	122.08	119.85	257.04	290.69	201.99
	1:50:00	0.00	0.00	100.63	87.17	117.04	112.18	241.83	266.15	186.01
	1:55:00	0.00	0.00	94.23	81.26	112.35	106.84	229.61	249.21	175.31
	2:00:00	0.00	0.00	85.32	76.14	104.63	103.61	214.60	235.88	169.87
	2:05:00	0.00	0.00	74.46	65.30	87.79	92.08	189.29	218.31	151.68
	2:10:00	0.00	0.00	63.08	46.79	62.37	66.26	154.72	196.78	109.53
	2:15:00	0.00	0.00	51.69	31.69	42.45	45.01	122.63	165.05	74.82
	2:20:00	0.00	0.00	41.57	21.29	28.84	30.70	96.73	131.08	51.19
	2:25:00	0.00	0.00	33.88	13.81	19.02	20.35	76.25	102.88	33.88
	2:30:00	0.00	0.00	28.40	8.82	12.21	13.17	60.40	80.86	21.90
	2:35:00	0.00	0.00	24.47	5.60	7.57	8.42	47.81	63.88	13.97
	2:40:00	0.00	0.00	21.68	3.11	4.06	4.74	38.33	51.30	7.82
	2:45:00	0.00	0.00	19.65	1.36	1.69	2.10	31.87	41.26	3.44
	2:50:00	0.00	0.00	18.12	0.33	0.40	0.52	27.50	34.15	0.83
	2:55:00	0.00	0.00	16.95	0.00	0.00	0.00	24.53	29.34	0.00
	3:00:00	0.00	0.00	16.04	0.00	0.00	0.00	22.47	26.08	0.00
	3:05:00	0.00	0.00	15.32	0.00	0.00	0.00	21.03	23.85	0.00
	3:10:00	0.00	0.00	14.63	0.00	0.00	0.00	19.84	22.28	0.00
	3:15:00	0.00	0.00	14.04	0.00	0.00	0.00	18.79	20.99	0.00
	3:20:00	0.00	0.00	13.48	0.00	0.00	0.00	17.86	19.85	0.00
	3:25:00	0.00	0.00	12.94	0.00	0.00	0.00	16.99	18.84	0.00
	3:30:00	0.00	0.00	12.43	0.00	0.00	0.00	16.16	17.88	0.00
	3:35:00	0.00	0.00	11.92	0.00	0.00	0.00	15.39	16.97	0.00
	3:40:00	0.00	0.00	11.45	0.00	0.00	0.00	14.66	16.13	0.00
	3:45:00	0.00	0.00	11.00	0.00	0.00	0.00	14.01	15.33	0.00
	3:50:00	0.00	0.00	10.57	0.00	0.00	0.00	13.42	14.63	0.00
	3:55:00	0.00	0.00	10.15	0.00	0.00	0.00	12.85	13.98	0.00
	4:00:00	0.00	0.00	9.74	0.00	0.00	0.00	12.32	13.38	0.00
	4:05:00	0.00	0.00	9.34	0.00	0.00	0.00	11.81	12.80	0.00
	4:10:00	0.00	0.00	8.94	0.00	0.00	0.00	11.31	12.25	0.00
	4:15:00	0.00	0.00	8.55	0.00	0.00	0.00	10.83	11.73	0.00
	4:20:00	0.00	0.00	8.16	0.00	0.00	0.00	10.36	11.22	0.00
	4:25:00	0.00	0.00	7.76	0.00	0.00	0.00	9.90	10.72	0.00
	4:30:00	0.00	0.00	7.37	0.00	0.00	0.00	9.44	10.23	0.00
	4:35:00	0.00	0.00	6.98	0.00	0.00	0.00	8.99	9.75	0.00
	4:40:00	0.00	0.00	6.59	0.00	0.00	0.00	8.55	9.28	0.00
	4:45:00	0.00	0.00	6.21	0.00	0.00	0.00	8.13	8.83	0.00
	4:50:00	0.00	0.00	5.82	0.00	0.00	0.00	7.72	8.40	0.00
	4:55:00	0.00	0.00	5.44	0.00	0.00	0.00	7.32	7.98	0.00
	5:00:00	0.00	0.00	5.03	0.00	0.00	0.00	6.92	7.56	0.00
	5:05:00	0.00	0.00	4.63	0.00	0.00	0.00	6.52	7.15	0.00
	5:10:00	0.00	0.00	4.25	0.00	0.00	0.00	6.14	6.76	0.00
	5:15:00	0.00	0.00	3.82	0.00	0.00	0.00	5.75	6.37	0.00
	5:20:00	0.00	0.00	3.13	0.00	0.00	0.00	5.37	5.98	0.00
	5:25:00	0.00	0.00	2.77	0.00	0.00	0.00	4.96	5.60	0.00
	5:30:00	0.00	0.00	2.29	0.00	0.00	0.00	4.56	5.21	0.00
	5:35:00	0.00	0.00	1.85	0.00	0.00	0.00	4.19	4.79	0.00
	5:40:00	0.00	0.00	1.48	0.00	0.00	0.00	3.74	4.41	0.00
	5:45:00	0.00	0.00	1.18	0.00	0.00	0.00	3.11	4.03	0.00
	5:50:00	0.00	0.00	0.99	0.00	0.00	0.00	2.70	3.53	0.00
	5:55:00	0.00	0.00	0.79	0.00	0.00	0.00	2.22	2.97	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	0	0.000	0	0.000	0.00
	0.50	1,462	0.034	365	0.008	0.19
	1.00	2,728	0.063	1,414	0.032	0.44
	1.50	3,990	0.092	3,093	0.071	0.73
	2.00	9,481	0.218	6,440	0.148	1.05
	2.50	15,171	0.348	12,580	0.289	1.41
	3.00	34,627	0.795	24,992	0.574	1.74
	3.50	54,480	1.251	47,269	1.085	2.18
	4.00	84,638	1.943	81,997	1.882	2.65
	4.50	115,007	2.640	131,908	3.028	3.14
	5.00	150,637	3.458	198,292	4.552	3.83
	5.50	186,374	4.279	282,545	6.486	4.60
	6.00	224,120	5.145	385,158	8.842	5.38
	6.50	261,907	6.013	506,665	11.631	6.30
	7.00	297,756	6.836	646,591	14.844	8.35
	7.50	333,566	7.658	804,421	18.467	32.47
	8.00	362,178	8.314	978,393	22.461	38.05
	8.50	390,642	8.968	1,166,598	26.781	39.29
	9.00	409,200	9.394	1,366,609	31.373	40.49
	9.50	427,556	9.815	1,575,798	36.175	41.66
	10.00	440,407	10.110	1,792,816	41.157	42.79
	10.50	453,146	10.403	2,016,204	46.286	43.90
	11.00	462,220	10.611	2,245,064	51.540	44.97
	11.50	471,219	10.818	2,478,423	56.897	46.03
	12.00	477,374	10.959	2,715,586	62.341	47.06
	12.50	483,472	11.099	2,955,797	67.856	48.06
	13.00	489,460	11.236	3,199,031	73.440	49.05
	13.50	495,446	11.374	3,445,257	79.092	50.02
	14.00	501,840	11.521	3,694,577	84.816	50.97
	14.50	508,243	11.668	3,947,097	90.613	51.90
	15.00	514,318	11.807	4,202,739	96.482	52.81
	15.50	520,387	11.946	4,461,416	102.420	53.71
	16.00	526,610	12.089	4,723,164	108.429	54.60
	16.50	532,837	12.232	4,988,026	114.509	55.47
	17.00	539,026	12.374	5,255,992	120.661	56.32
	17.50	545,214	12.516	5,527,051	126.884	57.17
	18.00	552,109	12.675	5,801,379	133.181	58.00
	18.50	559,019	12.833	6,079,161	139.558	58.82

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

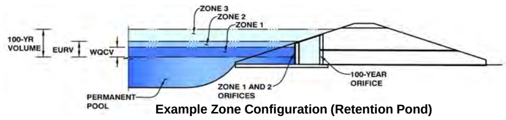
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Pond W-5 EURV Retrofit 2023 MDP Concept (SWMM Node 309, Top of Micropool 5720.37)**

Basin ID: **Windmill Creek**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	119.00	acres
Watershed Length =	3,050	ft
Watershed Length to Centroid =	1,185	ft
Watershed Slope =	0.028	ft/ft
Watershed Imperviousness =	35.20%	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 =	Centennial - Municipal Court	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.654	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	3.853	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	2.549	acre-feet		inches
5-yr Runoff Volume (P1 = 1.11 in.) =	4.139	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	6.121	acre-feet		inches
25-yr Runoff Volume (P1 = 1.7 in.) =	10.057	acre-feet		inches
50-yr Runoff Volume (P1 = 2 in.) =	13.041	acre-feet		inches
100-yr Runoff Volume (P1 = 2.32 in.) =	16.736	acre-feet		inches
500-yr Runoff Volume (P1 = 3.15 in.) =	25.331	acre-feet		inches
Approximate 2-yr Detention Volume =	2.389	acre-feet		
Approximate 5-yr Detention Volume =	3.972	acre-feet		
Approximate 10-yr Detention Volume =	4.762	acre-feet		
Approximate 25-yr Detention Volume =	5.824	acre-feet		
Approximate 50-yr Detention Volume =	6.354	acre-feet		
Approximate 100-yr Detention Volume =	7.882	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.654	acre-feet
Zone 2 Volume (EURV - Zone 1) =	2.199	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	4.029	acre-feet
Total Detention Basin Volume =	7.882	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

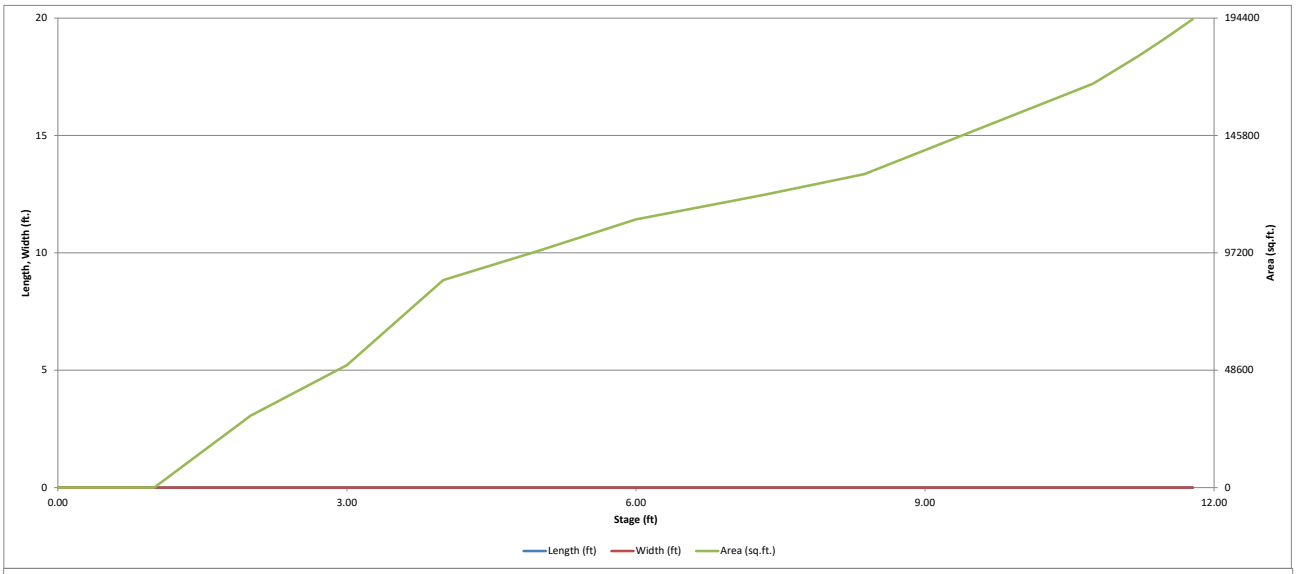
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

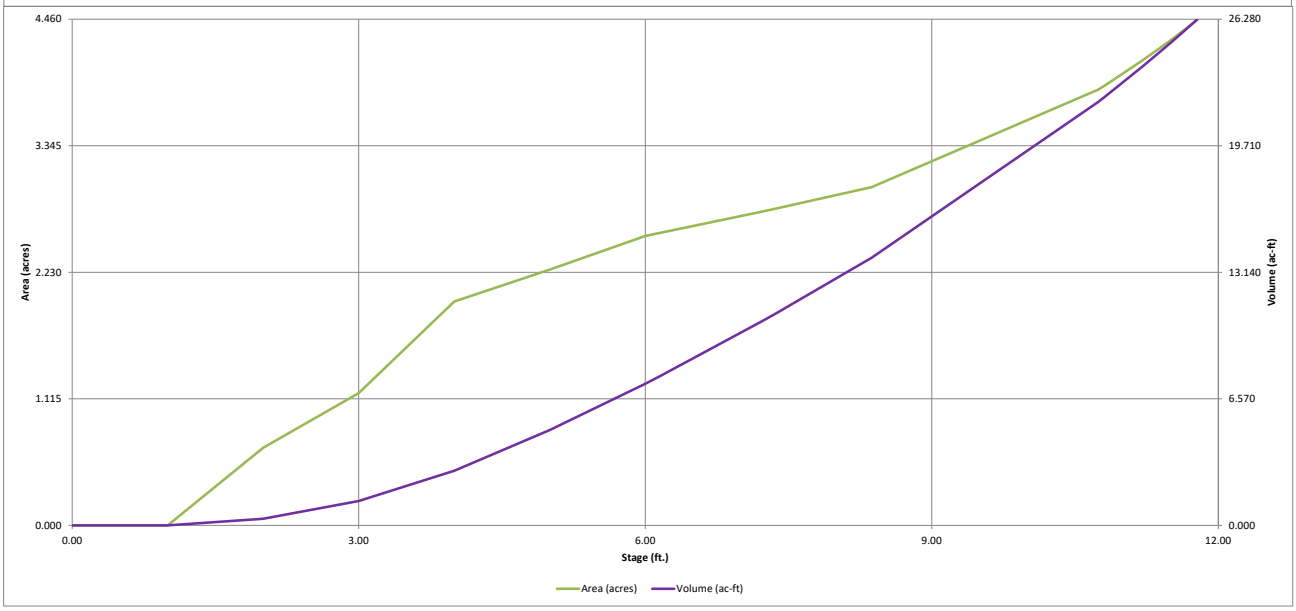
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
5721.37	--	1.00	--	--	--	20	0.000	10	0.000
5722.37	--	2.00	--	--	--	29,764	0.683	14,901	0.342
5723.37	--	3.00	--	--	--	50,752	1.165	55,159	1.266
5724.37	--	4.00	--	--	--	85,924	1.973	123,497	2.835
5725.37	--	5.00	--	--	--	98,207	2.255	215,562	4.949
5726.37	--	6.00	--	--	--	111,089	2.550	320,210	7.351
	--	6.15	--	--	--	112,225	2.576	336,959	7.736
	--	7.22	--	--	--	120,425	2.765	461,427	10.593
	--	7.36	--	--	--	121,510	2.789	478,362	10.982
	--	8.37	--	--	--	129,812	2.980	605,280	13.895
	--	10.74	--	--	--	167,191	3.838	957,229	21.975
	--	10.81	--	--	--	168,812	3.875	968,989	22.245
	--	11.21	--	--	--	178,590	4.100	1,038,469	23.840
	--	11.38	--	--	--	183,011	4.201	1,069,205	24.546
	--	11.50	--	--	--	186,227	4.275	1,091,360	25.054
	--	11.61	--	--	--	189,244	4.344	1,112,011	25.528
	--	11.70	--	--	--	191,762	4.402	1,129,156	25.922
	--	11.78	--	--	--	194,038	4.454	1,144,588	26.276
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DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



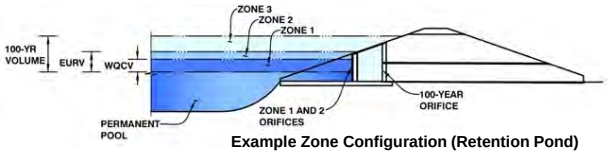


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Pond W-5 EURV Retrofit 2023 MDP Concept (SWMM Node 309, Top of Micropool 5720.37)

Basin ID: Windmill Creek



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.31	1.654	Orifice Plate
Zone 2 (EURV)	4.50	2.199	Rectangular Orifice
Zone 3 (100-year)	6.21	4.029	Weir&Pipe (Rect.)
Total (all zones)		7.882	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	8.333E-03	ft^2
Depth at top of Zone using Orifice Plate =	3.31	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	1.20	sq. inches (diameter = 1-1/4 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.30	0.60	0.90	1.20	1.50	1.80	2.10
Orifice Area (sq. inches)	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected			Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	3.31	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.69	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	4.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.42	N/A	feet
Vertical Orifice Height =	10.00	N/A	inches				
Vertical Orifice Width =	10.00		inches				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.59	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.59	N/A	feet
Overflow Weir Front Edge Length =	10.60	N/A	feet	Overflow Weir Slope Length =	4.13	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	17.55	N/A	
Horiz. Length of Weir Sides =	4.13	N/A	feet	Overflow Grate Open Area w/o Debris =	30.47	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	15.23	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Rectangular	Not Selected			Zone 3 Rectangular	Not Selected	
Depth to Invert of Outlet Pipe =	0.98	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.74	N/A	ft^2
Rectangular Orifice Width =	25.00	N/A	inches	Outlet Orifice Centroid =	0.42	N/A	feet
Rectangular Orifice Height =	10.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	8.03	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	4.10	feet
Spillway Crest Length =	10.60	feet	Stage at Top of Freeboard =	12.13	feet
Spillway End Slopes =	0.00	H:V	Basin Area at Top of Freeboard =	4.45	acres
Freeboard above Max Water Surface =	0.00	feet	Basin Volume at Top of Freeboard =	26.28	acre-ft

Calculated Parameters for Spillway

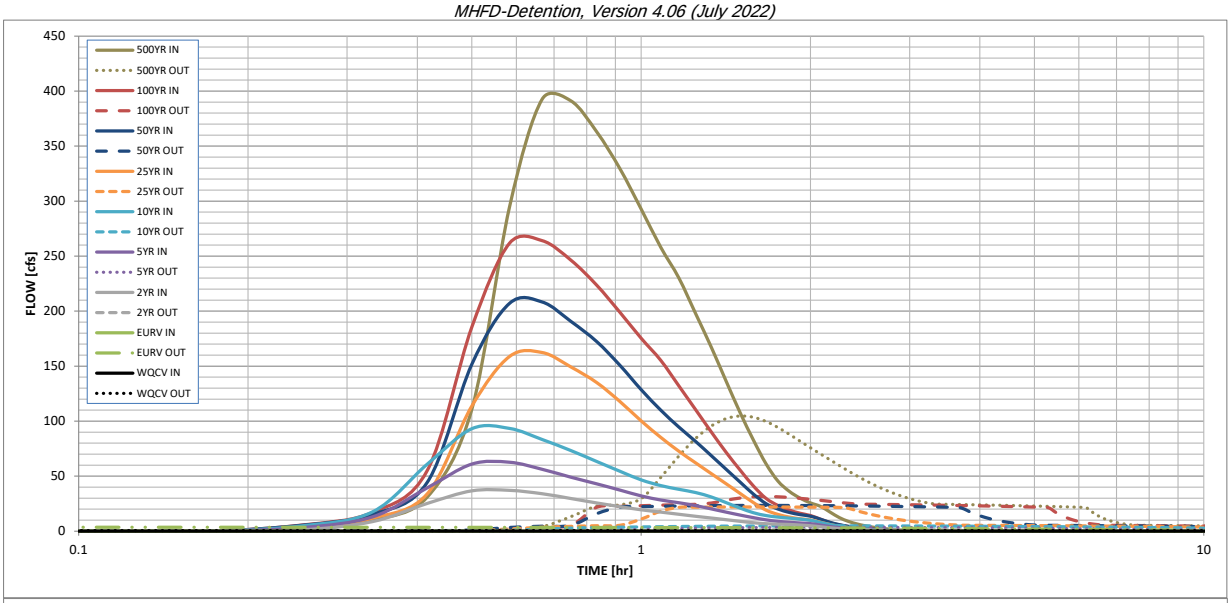
Routed Hydrograph Results

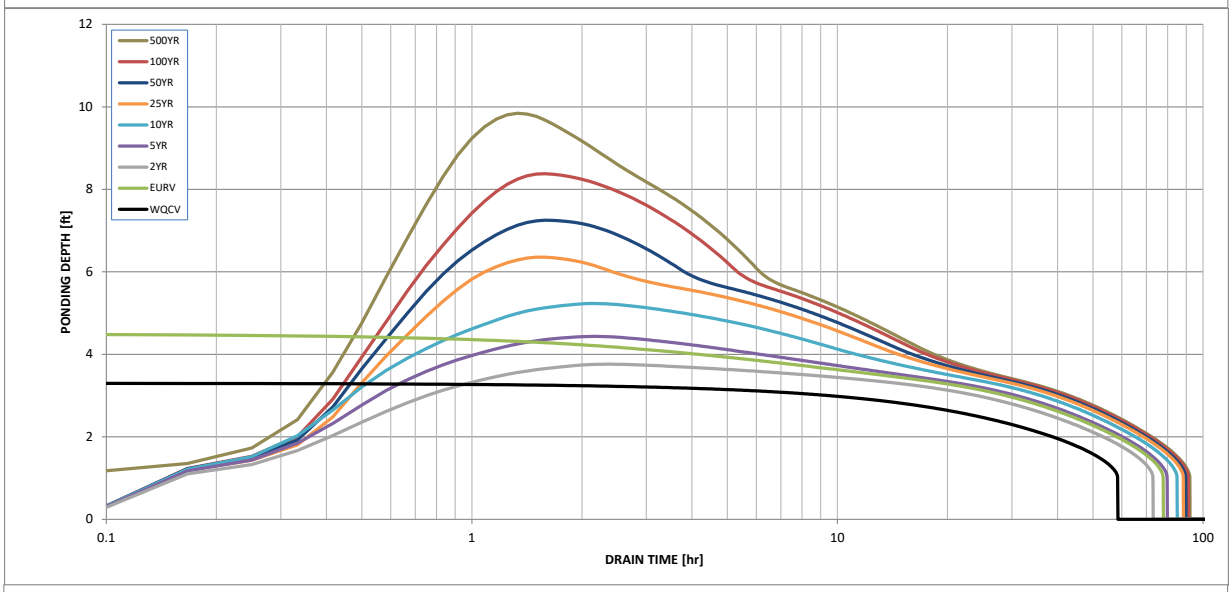
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

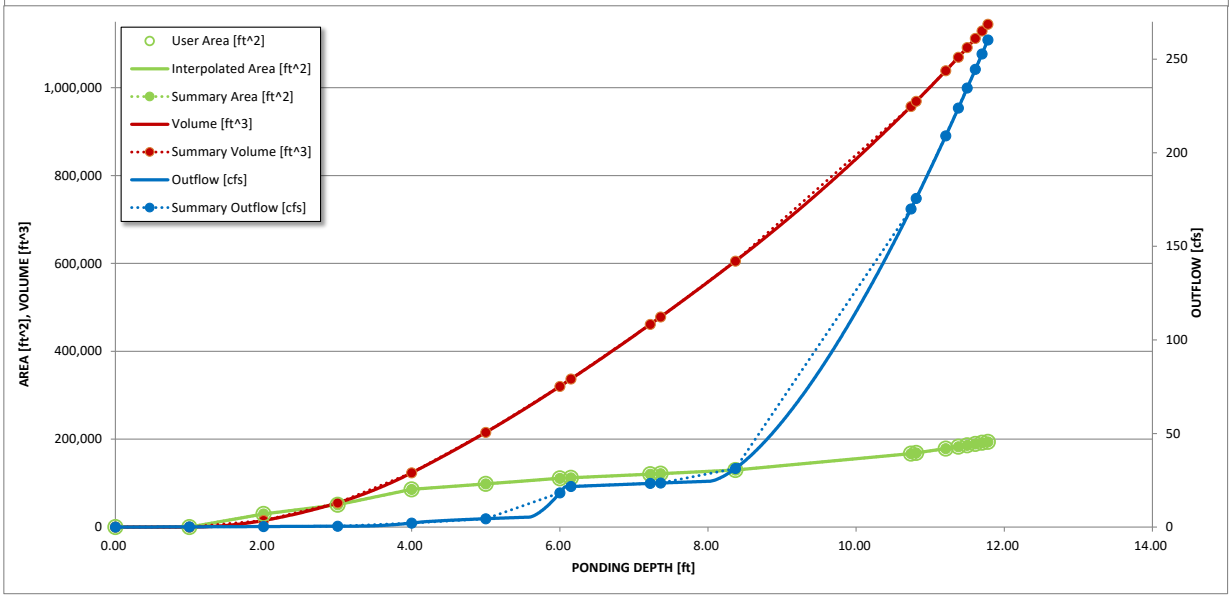
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.11	1.35	1.70	2.00	2.32	3.15
CUHP Runoff Volume (acre-ft) =	1.654	3.853	2.549	4.139	6.121	10.057	13.041	16.736	25.331
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.549	4.139	6.121	10.057	13.041	16.736	25.331
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.6	15.3	39.0	94.8	130.2	175.5	275.1
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	0.33	0.80	1.09	1.47	2.31
Peak Inflow Q (cfs) =	N/A	N/A	37.1	62.6	93.4	162.4	208.3	264.1	392.6
Peak Outflow Q (cfs) =	0.5	3.6	1.3	3.5	4.8	22.0	23.4	31.5	104.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.1	0.2	0.2	0.2	0.4
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.5	0.5	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) =	54	70	67	71	73	71	68	65	57
Time to Drain 99% of Inflow Volume (hours) =	**57**	75	71	76	80	81	81	80	76
Maximum Ponding Depth (ft) =	3.31	4.50	3.76	4.43	5.23	6.36	7.25	8.38	9.84
Area at Maximum Ponding Depth (acres) =	1.42	2.11	1.78	2.09	2.32	2.61	2.77	2.98	3.51
Maximum Volume Stored (acre-ft) =	1.666	3.857	2.385	3.709	5.475	8.254	10.676	13.895	18.667

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.48
	0:15:00	0.00	0.00	1.21	3.26	4.83	3.71	5.38	5.61	9.96
	0:20:00	0.00	0.00	8.72	13.07	17.65	11.90	15.23	17.13	31.05
	0:25:00	0.00	0.00	25.22	39.43	60.95	34.00	44.47	55.24	110.91
	0:30:00	0.00	0.00	36.64	60.97	93.12	113.79	151.76	185.62	294.75
	0:35:00	0.00	0.00	37.08	62.63	93.37	158.77	207.06	261.75	392.64
	0:40:00	0.00	0.00	34.00	56.20	83.29	162.37	208.31	264.06	391.13
	0:45:00	0.00	0.00	29.64	49.01	73.23	149.23	190.65	246.30	363.07
	0:50:00	0.00	0.00	25.63	43.01	63.33	135.08	172.34	223.62	329.45
	0:55:00	0.00	0.00	22.29	37.31	54.42	117.80	150.70	198.88	292.71
	1:00:00	0.00	0.00	19.38	32.03	46.58	100.18	128.57	175.30	258.04
	1:05:00	0.00	0.00	17.32	28.29	41.41	85.23	109.97	155.25	230.15
	1:10:00	0.00	0.00	15.33	25.81	38.03	72.65	94.62	132.03	197.57
	1:15:00	0.00	0.00	13.49	23.17	35.06	62.00	81.46	110.29	166.83
	1:20:00	0.00	0.00	11.89	20.17	30.99	52.15	68.44	89.91	135.97
	1:25:00	0.00	0.00	10.37	17.24	25.85	42.95	56.08	71.44	107.43
	1:30:00	0.00	0.00	8.92	14.57	20.92	34.18	44.46	55.35	82.68
	1:35:00	0.00	0.00	7.63	12.26	16.72	25.91	33.62	40.98	61.24
	1:40:00	0.00	0.00	6.75	10.25	14.17	19.09	24.99	29.79	45.53
	1:45:00	0.00	0.00	6.32	8.91	12.77	15.21	20.12	23.35	36.19
	1:50:00	0.00	0.00	6.10	8.04	11.82	12.77	17.01	19.15	29.97
	1:55:00	0.00	0.00	5.51	7.42	10.90	11.22	14.99	16.24	25.65
	2:00:00	0.00	0.00	4.89	6.81	9.81	10.13	13.56	14.16	22.50
	2:05:00	0.00	0.00	3.96	5.50	7.86	8.10	10.80	10.86	17.29
	2:10:00	0.00	0.00	3.05	4.18	5.95	6.00	7.98	7.73	12.33
	2:15:00	0.00	0.00	2.34	3.18	4.47	4.46	5.90	5.59	8.92
	2:20:00	0.00	0.00	1.79	2.40	3.32	3.32	4.38	4.17	6.59
	2:25:00	0.00	0.00	1.36	1.79	2.44	2.46	3.23	3.10	4.88
	2:30:00	0.00	0.00	1.03	1.32	1.79	1.79	2.36	2.29	3.60
	2:35:00	0.00	0.00	0.76	0.95	1.32	1.30	1.71	1.68	2.63
	2:40:00	0.00	0.00	0.55	0.69	0.97	0.97	1.27	1.25	1.94
	2:45:00	0.00	0.00	0.39	0.48	0.67	0.69	0.90	0.88	1.36
	2:50:00	0.00	0.00	0.25	0.32	0.43	0.46	0.59	0.57	0.88
	2:55:00	0.00	0.00	0.15	0.19	0.25	0.27	0.35	0.33	0.50
	3:00:00	0.00	0.00	0.07	0.10	0.11	0.13	0.17	0.16	0.23
	3:05:00	0.00	0.00	0.03	0.04	0.04	0.04	0.05	0.05	0.06
	3:10:00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	0	0.000	0	0.000	0.00
	1.00	20	0.000	10	0.000	0.11
	2.00	29,764	0.683	14,901	0.342	0.28
	3.00	50,752	1.165	55,159	1.266	0.47
	4.00	85,924	1.973	123,497	2.835	2.13
	5.00	98,207	2.255	215,562	4.949	4.47
	6.00	111,089	2.550	320,210	7.351	18.29
	6.15	112,225	2.576	336,959	7.736	21.66
	7.22	120,425	2.765	461,427	10.593	23.32
	7.36	121,510	2.789	478,362	10.982	23.53
	8.37	129,812	2.980	605,280	13.895	31.29
	10.74	167,191	3.838	957,229	21.975	169.97
	10.81	168,812	3.875	968,989	22.245	175.59
	11.21	178,590	4.100	1,038,469	23.840	209.01
	11.38	183,011	4.201	1,069,205	24.546	223.87
	11.50	186,227	4.275	1,091,360	25.054	234.59
	11.61	189,244	4.344	1,112,011	25.528	244.57
	11.70	191,762	4.402	1,129,156	25.922	252.85
	11.78	194,038	4.454	1,144,588	26.276	260.30

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

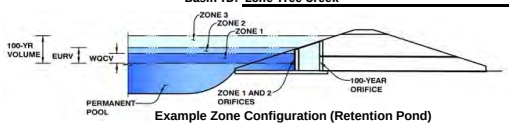
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Pond L-2 WQCV Retrofit (MDP Concept Node 301, regrade in area of access road turnaround)**

Basin ID: **Lone Tree Creek**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	256.00	acres
Watershed Length =	7,000	ft
Watershed Length to Centroid =	2,400	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	81.40%	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 =	Centennial - Municipal Court	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	6.960	acre-feet	6.960	acre-feet
Excess Urban Runoff Volume (EURV) =	20.498	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	14.219	acre-feet		inches
5-yr Runoff Volume (P1 = 1.11 in.) =	19.569	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	24.836	acre-feet		inches
25-yr Runoff Volume (P1 = 1.7 in.) =	33.089	acre-feet		inches
50-yr Runoff Volume (P1 = 2 in.) =	39.966	acre-feet		inches
100-yr Runoff Volume (P1 = 2.32 in.) =	47.585	acre-feet		inches
500-yr Runoff Volume (P1 = 3.15 in.) =	66.800	acre-feet		inches
Approximate 2-yr Detention Volume =	13.299	acre-feet		
Approximate 5-yr Detention Volume =	18.659	acre-feet		
Approximate 10-yr Detention Volume =	22.428	acre-feet		
Approximate 25-yr Detention Volume =	26.178	acre-feet		
Approximate 50-yr Detention Volume =	28.018	acre-feet		
Approximate 100-yr Detention Volume =	30.587	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	6.960	acre-feet
Zone 2 Volume (User Defined - Zone 1) =	6.600	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	13.560	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	

Total detention volume is less than 100-year volume.

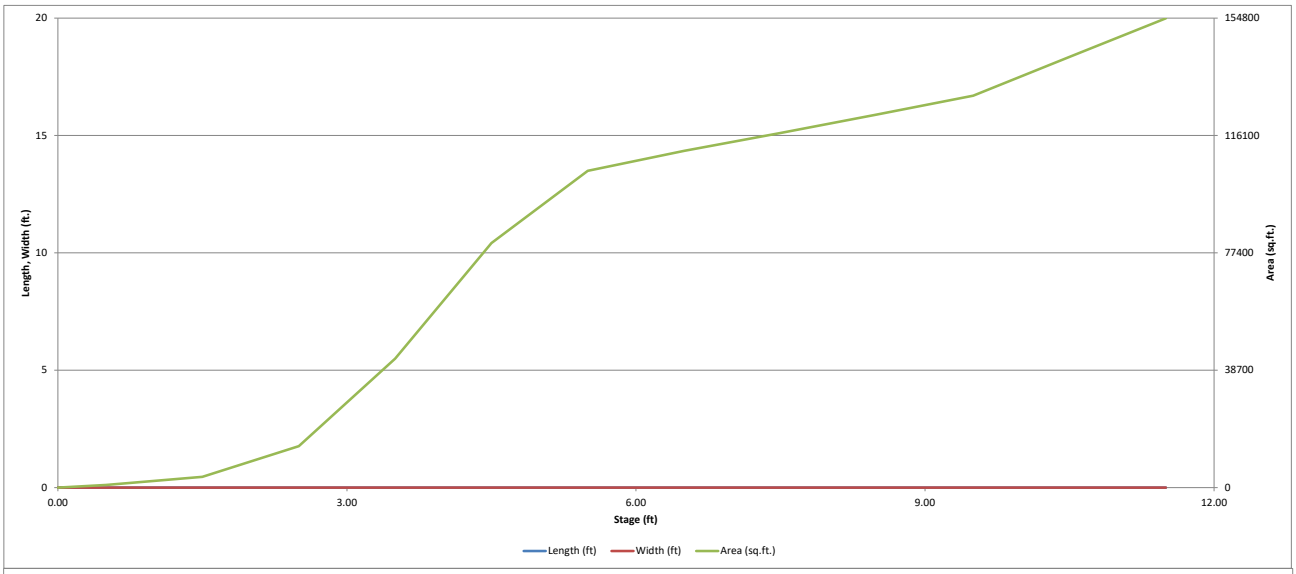
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

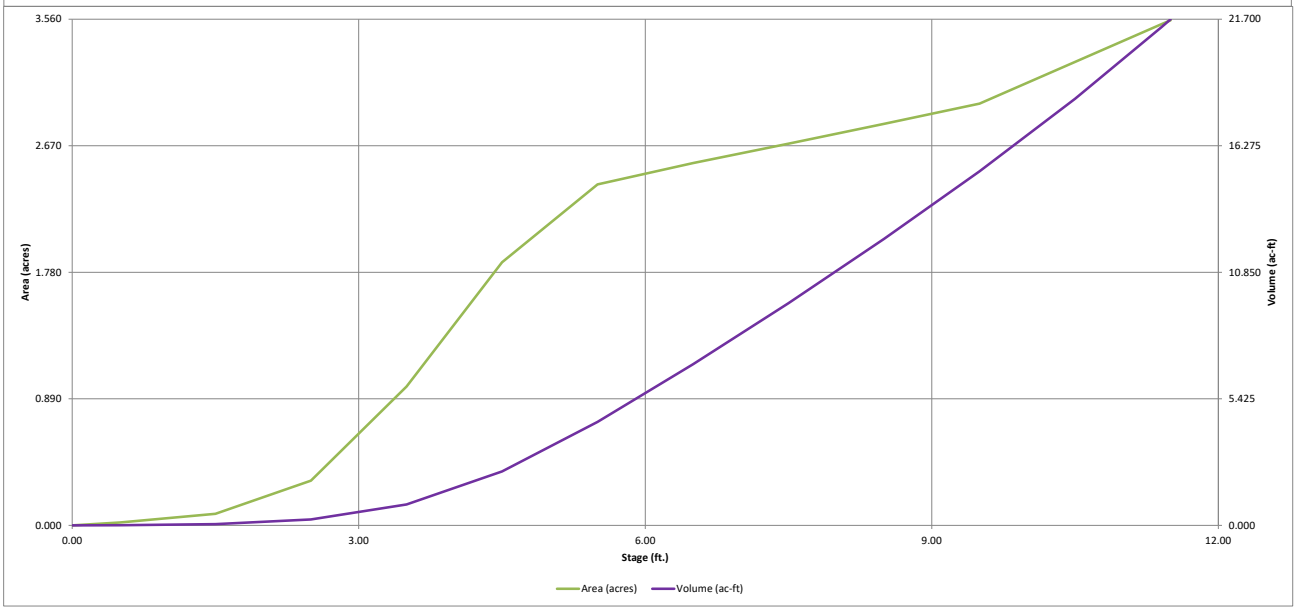
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
5715	--	0.50	--	--	--	875	0.020	219	0.005
5716	--	1.50	--	--	--	3,558	0.082	2,436	0.056
5717	--	2.50	--	--	--	13,690	0.314	11,060	0.254
5718	--	3.50	--	--	--	42,522	0.976	39,166	0.899
5719	--	4.50	--	--	--	80,624	1.851	100,738	2.313
5720	--	5.50	--	--	--	104,467	2.398	193,283	4.437
5721	--	6.50	--	--	--	111,021	2.549	301,027	6.911
5722	--	7.50	--	--	--	116,948	2.685	415,011	9.527
5723	--	8.50	--	--	--	123,002	2.824	534,986	12.282
5724	--	9.50	--	--	--	129,216	2.966	661,095	15.177
5725	--	10.50	--	--	--	142,004	3.260	796,705	18.290
5725.9	--	11.40	--	--	--	153,474	3.523	929,670	21.342
5726	--	11.50	--	--	--	154,748	3.553	945,081	21.696

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



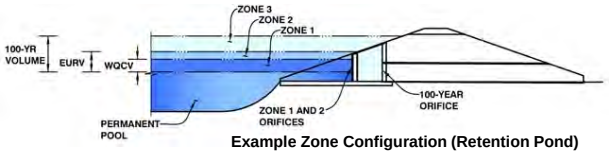


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Pond L-2 WQCV Retrofit (MDP Concept Node 301, regrade in area of access road turnaround)**

Basin ID: **Lone Tree Creek**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	6.52	6.960	Orifice Plate
Zone 2 (User)	8.95	6.600	Weir&Pipe (Restrict)
Zone 3			
Total (all zones)		13.560	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	6.62	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	26.50	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.21	4.41					
Orifice Area (sq. inches)	13.00	13.00	14.03					

	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			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

Calculated Parameters for Vertical Orifice

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

	Zone 2 Weir	Not Selected			Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.06		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	6.06		feet
Overflow Weir Front Edge Length =	18.00		feet	Overflow Weir Slope Length =	8.00		feet
Overflow Weir Grate Slope =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	2.57		
Horiz. Length of Weir Sides =	8.00		feet	Overflow Grate Open Area w/o Debris =	113.90		ft^2
Overflow Grate Type =	Close Mesh Grate			Overflow Grate Open Area w/ Debris =	56.95		ft^2
Debris Clogging % =	50%		%				

Calculated Parameters for Overflow Weir

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

	Zone 2 Restrictor	Not Selected			Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	44.34		ft^2
Outlet Pipe Diameter =	108.00		inches	Outlet Orifice Centroid =	3.33		feet
Restrictor Plate Height Above Pipe Invert =	71.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.89	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

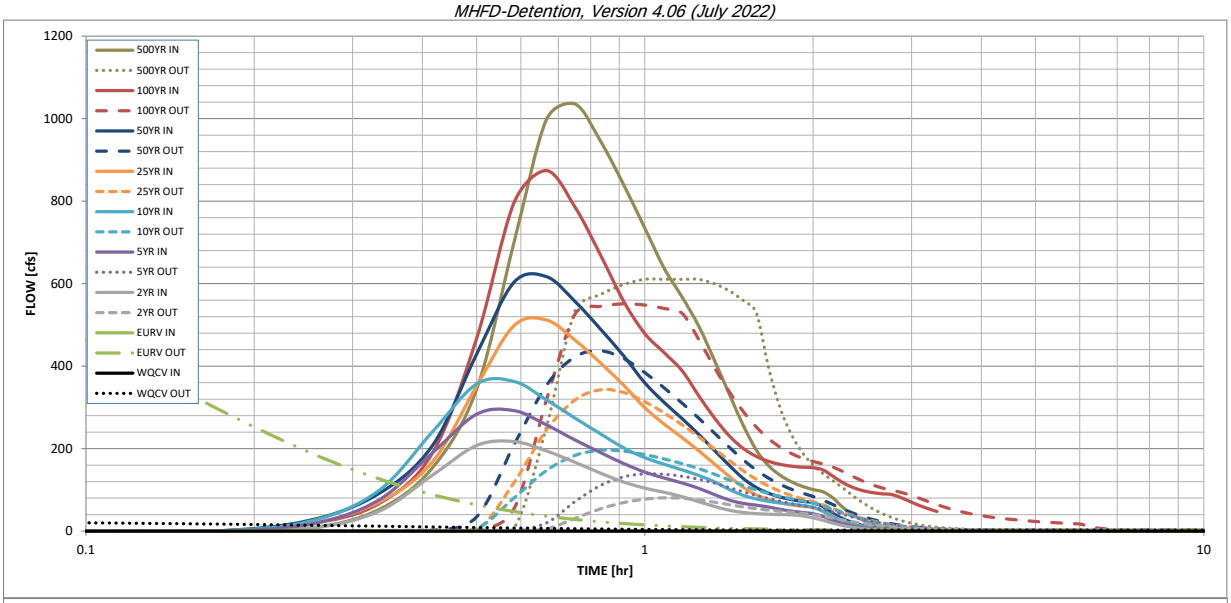
Routed Hydrograph Results

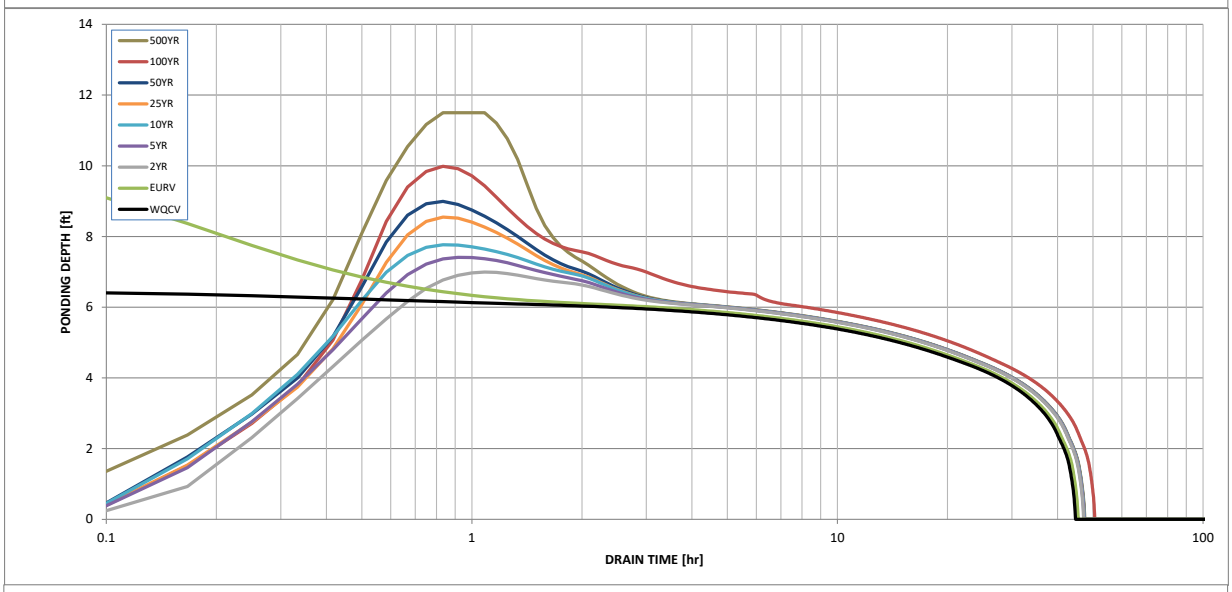
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

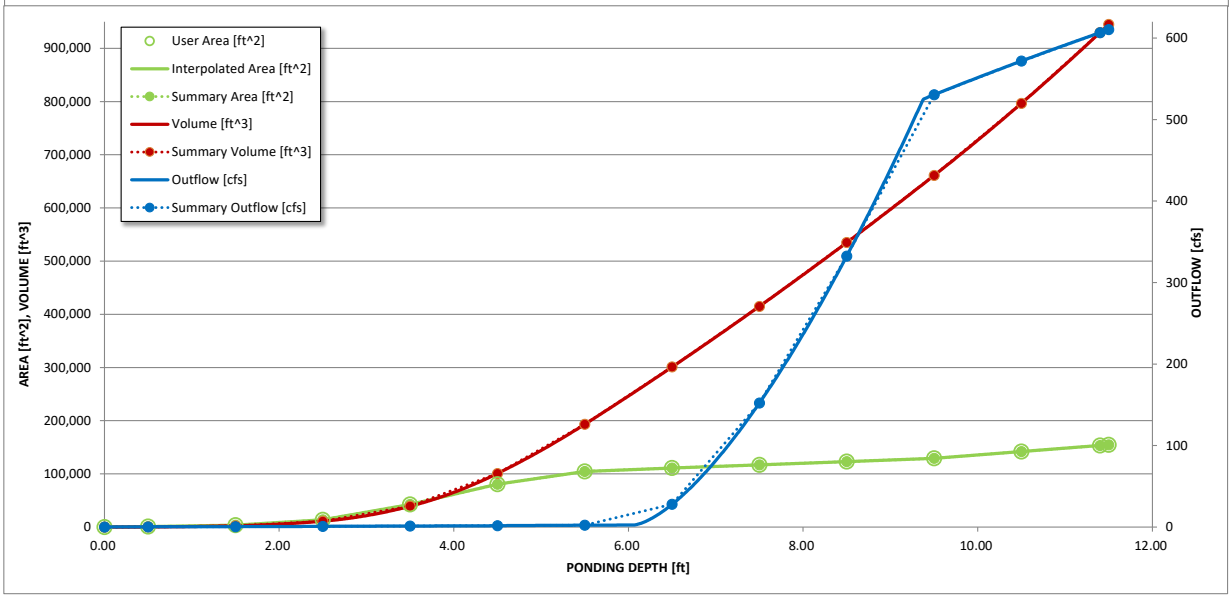
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.11	1.35	1.70	2.00	2.32	3.15
CUHP Runoff Volume (acre-ft) =	6.960	20.498	14.219	19.569	24.836	33.089	39.966	47.585	66.800
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	14.219	19.569	24.836	33.089	39.966	68.484	66.800
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.2	20.8	55.4	141.8	195.5	266.1	420.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						554.0	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.08	0.22	0.55	0.76	2.16	1.64
Peak Inflow Q (cfs) =	N/A	N/A	217.2	292.1	362.9	511.8	616.9	874.1	1035.5
Peak Outflow Q (cfs) =	26.5	574.6	80.7	138.7	195.9	342.7	436.9	550.9	610.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	6.7	3.5	2.4	2.2	1.0	1.5
Structure Controlling Flow =	Overflow Weir 1	Outlet Plate 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	0.24	5.21	0.68	1.2	1.7	3.0	3.8	4.8	5.3
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) =	40	37	40	38	37	35	33	29	26
Time to Drain 99% of Inflow Volume (hours) =	**43**	41	44	43	42	41	40	41	38
Maximum Ponding Depth (ft) =	6.52	11.16	6.99	7.41	7.77	8.55	8.99	9.99	11.50
Area at Maximum Ponding Depth (acres) =	2.55	3.45	2.62	2.67	2.72	2.83	2.89	3.11	3.55
Maximum Volume Stored (acre-ft) =	6.962	20.505	8.176	9.286	10.230	12.395	13.682	16.634	21.696

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	USER	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.92
	0:15:00	0.00	0.00	6.01	15.88	23.28	17.70	25.52	17.15	51.47
	0:20:00	0.00	0.00	47.32	74.64	97.15	69.14	90.13	65.56	153.29
	0:25:00	0.00	0.00	135.58	189.51	240.66	167.53	207.09	188.86	343.81
	0:30:00	0.00	0.00	207.63	283.41	356.70	352.01	429.02	467.06	699.93
	0:35:00	0.00	0.00	217.25	292.15	362.93	498.12	603.43	796.22	997.78
	0:40:00	0.00	0.00	194.33	257.52	318.25	511.80	616.92	874.08	1035.50
	0:45:00	0.00	0.00	166.89	220.88	273.93	463.10	556.72	785.51	945.05
	0:50:00	0.00	0.00	140.47	190.33	235.66	407.41	489.41	668.91	839.29
	0:55:00	0.00	0.00	118.95	163.74	201.76	353.47	424.57	556.85	734.30
	1:00:00	0.00	0.00	104.12	143.06	177.98	299.07	359.33	478.73	636.71
	1:05:00	0.00	0.00	94.10	128.64	162.02	259.27	311.71	432.45	566.82
	1:10:00	0.00	0.00	83.42	116.68	148.34	226.48	272.44	388.25	495.69
	1:15:00	0.00	0.00	71.13	103.48	134.79	194.19	233.66	327.19	412.71
	1:20:00	0.00	0.00	59.67	88.41	119.15	162.35	195.37	273.69	331.60
	1:25:00	0.00	0.00	50.63	75.16	100.92	132.34	159.06	230.67	256.32
	1:30:00	0.00	0.00	45.22	67.19	86.76	106.25	127.57	200.39	196.24
	1:35:00	0.00	0.00	42.45	62.95	77.96	87.91	105.60	180.98	157.92
	1:40:00	0.00	0.00	40.96	58.25	72.14	76.21	91.56	169.00	134.64
	1:45:00	0.00	0.00	40.11	52.68	67.97	68.66	82.47	161.60	119.00
	1:50:00	0.00	0.00	39.48	48.30	65.04	63.48	76.21	157.26	108.25
	1:55:00	0.00	0.00	36.75	45.18	62.19	60.03	72.04	154.85	100.72
	2:00:00	0.00	0.00	32.22	42.25	57.71	57.61	69.10	153.72	95.30
	2:05:00	0.00	0.00	26.27	35.54	47.91	49.59	59.46	148.34	81.29
	2:10:00	0.00	0.00	19.52	26.29	35.23	36.75	44.04	133.86	60.10
	2:15:00	0.00	0.00	14.12	18.90	25.19	26.28	31.48	119.23	43.07
	2:20:00	0.00	0.00	10.16	13.58	18.10	18.95	22.69	108.37	31.26
	2:25:00	0.00	0.00	7.25	9.57	12.91	13.51	16.17	100.75	22.43
	2:30:00	0.00	0.00	5.03	6.55	9.01	9.43	11.28	95.70	15.67
	2:35:00	0.00	0.00	3.40	4.47	6.24	6.60	7.89	92.51	10.96
	2:40:00	0.00	0.00	2.17	3.00	4.12	4.47	5.35	90.15	7.41
	2:45:00	0.00	0.00	1.23	1.83	2.45	2.76	3.30	89.34	4.56
	2:50:00	0.00	0.00	0.57	0.96	1.22	1.46	1.74	84.30	2.39
	2:55:00	0.00	0.00	0.21	0.36	0.44	0.56	0.67	77.41	0.91
	3:00:00	0.00	0.00	0.03	0.05	0.06	0.08	0.09	70.21	0.11
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.32	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.38	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.15	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.62	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.94	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.87	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.25	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.06	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.16	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.52	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.07	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.80	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.68	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.69	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.78	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.94	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.16	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.39	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.63	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.83	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.97	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.02	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.41	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.03	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.71	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.36	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.95	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.51	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.07	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.63	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.19	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.76	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.34	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.92	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.51	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.11	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	0	0.000	0	0.000	0.00
	0.50	875	0.020	219	0.005	0.31
	1.50	3,558	0.082	2,436	0.056	0.53
	2.50	13,690	0.314	11,060	0.254	0.92
	3.50	42,522	0.976	39,166	0.899	1.31
	4.50	80,624	1.851	100,738	2.313	1.72
	5.50	104,467	2.398	193,283	4.437	2.30
	6.50	111,021	2.549	301,027	6.911	27.90
	7.50	116,948	2.685	415,011	9.527	152.29
	8.50	123,002	2.824	534,986	12.282	332.56
	9.50	129,216	2.966	661,095	15.177	530.43
	10.50	142,004	3.260	796,705	18.290	571.79
	11.40	153,474	3.523	929,670	21.342	606.61
	11.50	154,748	3.553	945,081	21.696	610.36

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

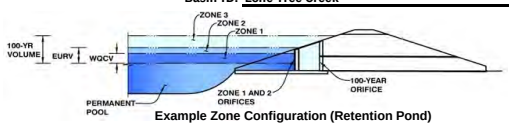
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Pond L-3 WQCV Reduction (MDP Concept Node 303, INV 5638.71 NAVD 88)**

Basin ID: **Lone Tree Creek**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**CWP**	
Watershed Area =	515.00	acres
Watershed Length =	6,200	ft
Watershed Length to Centroid =	4,900	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	75.40%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	31.0%	percent
Percentage Hydrologic Soil Groups C/D =	69.0%	percent
Target WQCV Drain Time =	24.0	hours
Location for 1-hr Rainfall Depths =	Centennial - Municipal Court	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	13.000	acre-feet	13.000	acre-feet
Excess Urban Runoff Volume (EURV) =	39.494	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	26.173	acre-feet		inches
5-yr Runoff Volume (P1 = 1.11 in.) =	36.146	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	46.286	acre-feet		inches
25-yr Runoff Volume (P1 = 1.7 in.) =	63.015	acre-feet		inches
50-yr Runoff Volume (P1 = 2 in.) =	76.577	acre-feet		inches
100-yr Runoff Volume (P1 = 2.32 in.) =	91.925	acre-feet		inches
500-yr Runoff Volume (P1 = 3.15 in.) =	130.373	acre-feet		inches
Approximate 2-yr Detention Volume =	24.422	acre-feet		
Approximate 5-yr Detention Volume =	34.339	acre-feet		
Approximate 10-yr Detention Volume =	42.220	acre-feet		
Approximate 25-yr Detention Volume =	49.539	acre-feet		
Approximate 50-yr Detention Volume =	53.351	acre-feet		
Approximate 100-yr Detention Volume =	58.861	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	13.000	acre-feet
Zone 2 Volume (User Defined - Zone 1) =	8.550	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	21.550	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}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Total detention volume is less than 100-year volume.

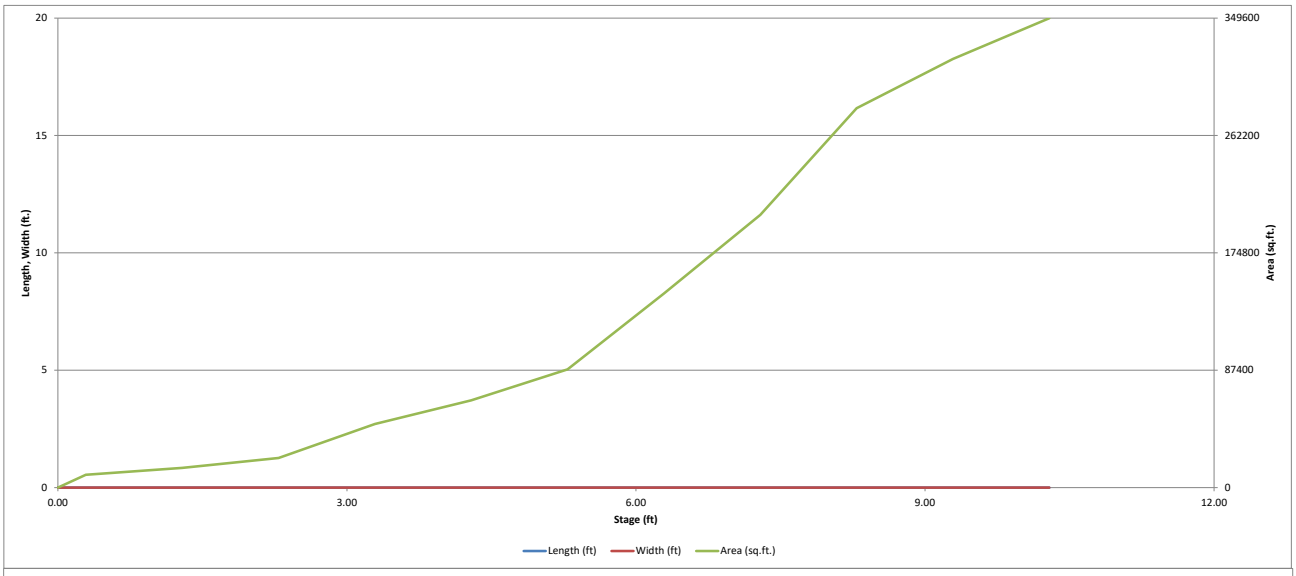
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

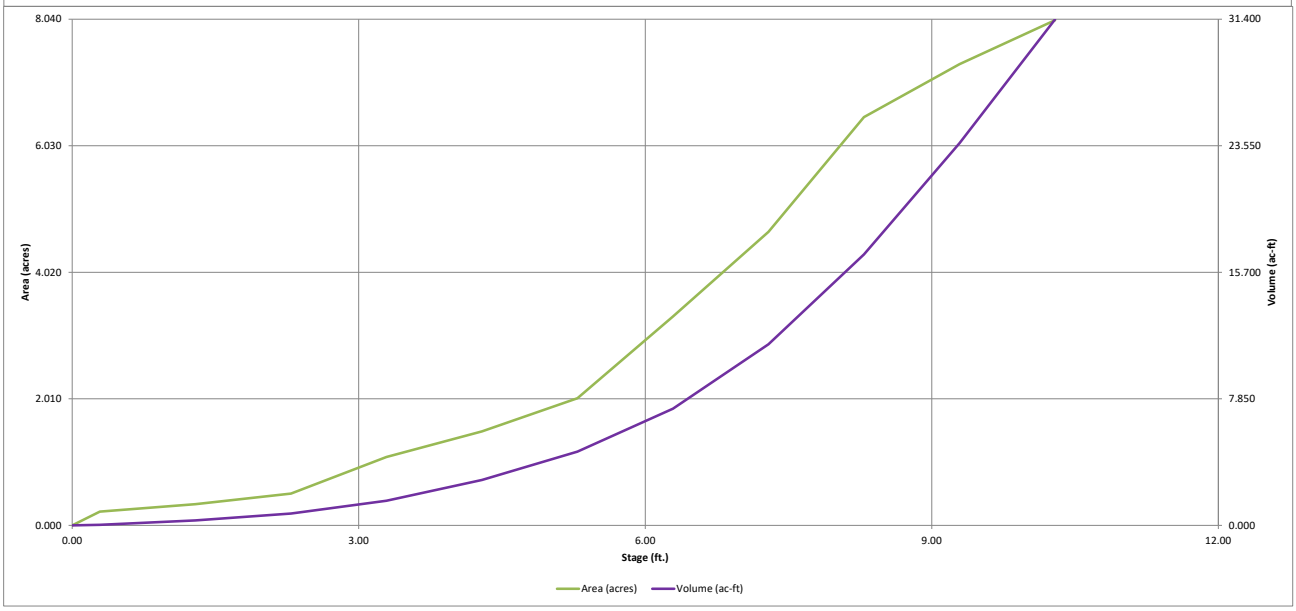
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Permanent Pool	--	0.00	--	--	--	0	0.000		
5639	--	0.29	--	--	--	9,539	0.219	1,382	0.032
5640	--	1.29	--	--	--	14,648	0.336	13,476	0.309
5641	--	2.29	--	--	--	22,015	0.505	31,807	0.730
5642	--	3.29	--	--	--	47,323	1.086	66,476	1.526
5643	--	4.29	--	--	--	65,041	1.493	122,658	2.816
5644	--	5.29	--	--	--	88,021	2.021	199,189	4.573
5645	--	6.29	--	--	--	144,482	3.317	315,440	7.242
5646	--	7.29	--	--	--	203,085	4.662	489,224	11.231
5647	--	8.29	--	--	--	282,502	6.485	732,017	16.805
5648	--	9.29	--	--	--	319,181	7.327	1,032,859	23.711
5649	--	10.29	--	--	--	349,530	8.024	1,367,214	31.387

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



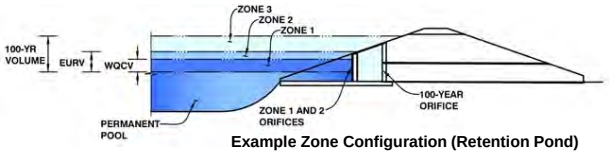


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Pond L-3 WQCV Reduction (MDP Concept Node 303, INV 5638.71 NAVD 88)**

Basin ID: **Lone Tree Creek**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	7.65	13.000	Orifice Plate
Zone 2 (User)	8.99	8.550	Weir&Pipe (Restrict)
Zone 3			
Total (all zones)		21.550	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.374E-01	ft^2
Depth at top of Zone using Orifice Plate =	6.62	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	26.50	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	19.78	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.21	4.41					
Orifice Area (sq. inches)	19.78	19.78	19.78					

	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			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

Calculated Parameters for Vertical Orifice

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

	Zone 2 Weir	Not Selected			Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	7.65		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.65		feet
Overflow Weir Front Edge Length =	178.00		feet	Overflow Weir Slope Length =	0.00		feet
Overflow Weir Grate Slope =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	0.00		
Horiz. Length of Weir Sides =	0.00		feet	Overflow Grate Open Area w/o Debris =	0.00		ft^2
Overflow Grate Type =	No Grate			Overflow Grate Open Area w/ Debris =	0.00		ft^2
Debris Clogging % =	10%		%				

Calculated Parameters for Overflow Weir

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

	Zone 2 Restrictor	Not Selected			Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	5.00		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	143.14		ft^2
Outlet Pipe Diameter =	162.00		inches	Outlet Orifice Centroid =	6.75		feet
Restrictor Plate Height Above Pipe Invert =	162.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

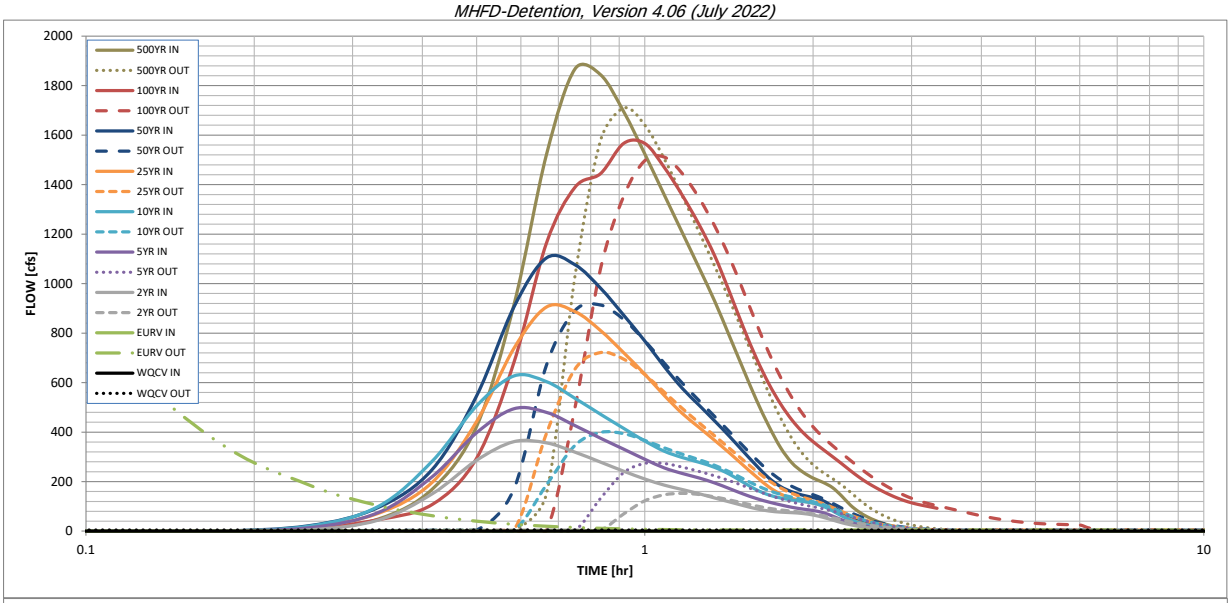
Routed Hydrograph Results

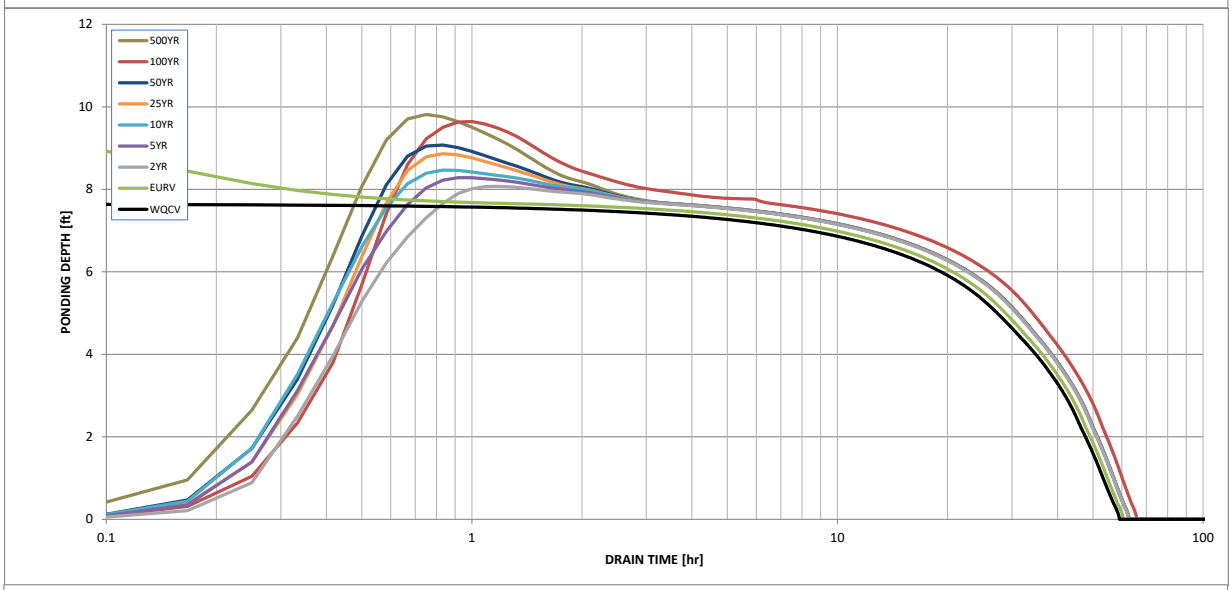
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

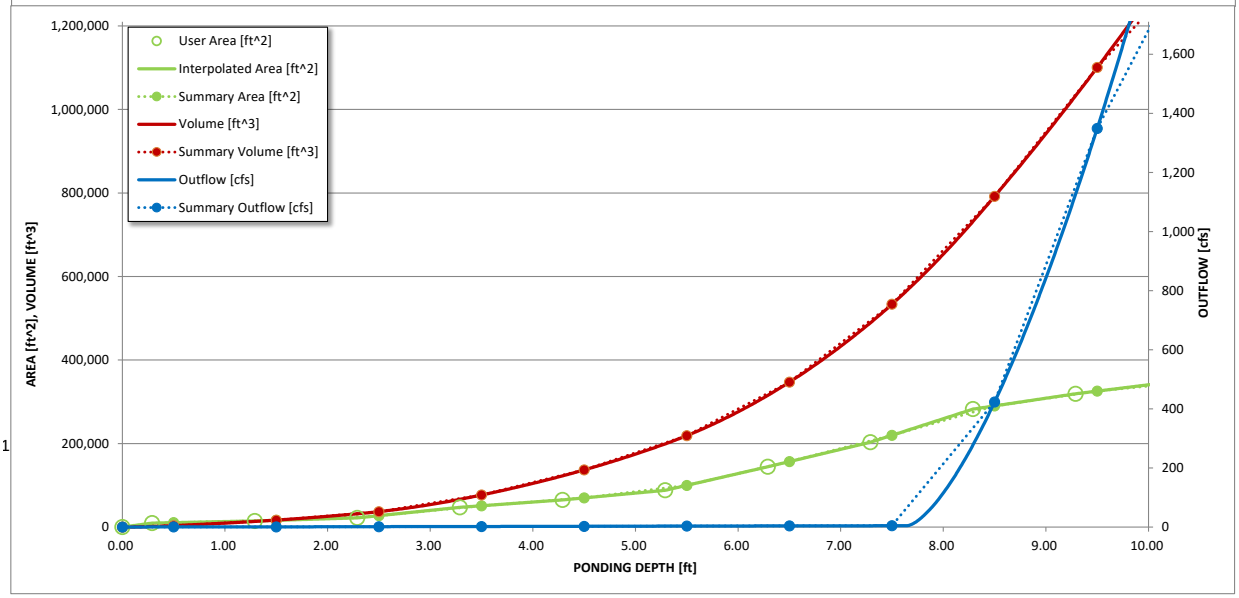
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.11	1.35	1.70	2.00	2.32	3.15
CUHP Runoff Volume (acre-ft) =	13.000	39.494	26.173	36.146	46.286	63.015	76.577	91.925	130.373
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	26.173	36.146	46.286	63.015	76.577	154.089	130.373
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	3.8	26.8	84.6	248.2	347.4	479.7	768.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						1268.0	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.05	0.16	0.48	0.67	2.46	1.49
Peak Inflow Q (cfs) =	N/A	N/A	361.6	494.5	627.1	905.3	1103.7	1566.8	1867.6
Peak Outflow Q (cfs) =	4.6	2014.1	152.6	273.7	398.8	721.5	913.5	1511.2	1709.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	10.2	4.7	2.9	2.6	1.2	2.2
Structure Controlling Flow =	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	51	45	49	47	45	41	39	32	32
Time to Drain 99% of Inflow Volume (hours) =	**55**	53	56	55	53	51	49	47	45
Maximum Ponding Depth (ft) =	7.65	9.11	8.07	8.28	8.47	8.87	9.07	9.65	9.82
Area at Maximum Ponding Depth (acres) =	5.32	7.17	6.08	6.47	6.63	6.97	7.14	7.57	7.69
Maximum Volume Stored (acre-ft) =	13.028	22.334	15.422	16.740	17.919	20.638	22.120	26.318	27.616

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	USER	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.84
	0:15:00	0.00	0.00	5.07	13.39	19.63	14.93	21.53	11.04	48.72
	0:20:00	0.00	0.00	44.41	74.95	99.58	71.78	95.48	46.20	169.99
	0:25:00	0.00	0.00	151.01	220.37	283.24	197.73	249.76	107.98	423.22
	0:30:00	0.00	0.00	286.33	397.59	506.09	442.90	546.58	294.54	915.76
	0:35:00	0.00	0.00	361.61	494.52	627.11	739.23	906.35	682.96	1520.95
	0:40:00	0.00	0.00	356.58	479.73	604.00	905.34	1103.69	1163.62	1867.63
	0:45:00	0.00	0.00	319.00	426.24	536.46	886.79	1076.17	1389.42	1843.86
	0:50:00	0.00	0.00	278.74	375.17	471.98	810.21	981.40	1444.67	1694.46
	0:55:00	0.00	0.00	241.99	331.06	415.05	720.55	872.29	1566.75	1523.49
	1:00:00	0.00	0.00	210.54	290.25	363.95	633.80	767.81	1566.27	1358.36
	1:05:00	0.00	0.00	185.82	255.32	322.86	548.02	664.38	1469.54	1206.17
	1:10:00	0.00	0.00	168.08	232.94	297.34	475.56	577.07	1357.03	1064.52
	1:15:00	0.00	0.00	151.22	214.87	278.24	419.26	509.12	1239.02	929.19
	1:20:00	0.00	0.00	133.84	194.62	257.45	366.67	445.08	1112.53	788.37
	1:25:00	0.00	0.00	118.16	171.92	229.90	316.14	383.25	967.43	654.46
	1:30:00	0.00	0.00	103.30	149.99	197.15	265.96	321.83	824.09	530.18
	1:35:00	0.00	0.00	90.35	131.69	167.11	219.64	265.10	698.69	424.50
	1:40:00	0.00	0.00	81.40	117.46	146.19	178.51	214.73	595.34	336.58
	1:45:00	0.00	0.00	76.79	106.00	134.00	149.74	179.77	513.18	275.58
	1:50:00	0.00	0.00	74.58	96.20	126.12	132.56	158.84	448.87	238.99
	1:55:00	0.00	0.00	71.29	89.13	119.86	121.36	145.10	399.09	214.27
	2:00:00	0.00	0.00	65.14	83.35	113.07	113.80	135.75	361.41	197.17
	2:05:00	0.00	0.00	55.89	74.70	100.79	103.20	122.89	330.20	175.77
	2:10:00	0.00	0.00	44.97	60.89	81.66	84.90	100.96	301.02	141.98
	2:15:00	0.00	0.00	34.07	45.90	61.49	63.64	75.59	272.53	104.72
	2:20:00	0.00	0.00	25.73	34.49	45.94	47.51	56.37	244.11	77.61
	2:25:00	0.00	0.00	19.30	25.77	34.10	35.40	41.95	218.24	57.88
	2:30:00	0.00	0.00	14.35	19.05	25.14	26.24	31.05	195.98	43.14
	2:35:00	0.00	0.00	10.57	13.73	18.34	19.08	22.56	177.08	31.62
	2:40:00	0.00	0.00	7.58	9.76	13.32	13.79	16.30	160.47	22.94
	2:45:00	0.00	0.00	5.36	6.97	9.63	10.13	11.97	145.88	16.81
	2:50:00	0.00	0.00	3.53	4.75	6.54	7.04	8.30	133.36	11.64
	2:55:00	0.00	0.00	2.10	3.02	4.06	4.50	5.30	122.91	7.41
	3:00:00	0.00	0.00	1.07	1.68	2.19	2.53	2.98	114.45	4.13
	3:05:00	0.00	0.00	0.43	0.74	0.91	1.13	1.32	107.82	1.81
	3:10:00	0.00	0.00	0.12	0.19	0.22	0.28	0.32	102.34	0.43
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	97.28	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	92.20	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	86.93	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	81.48	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.01	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	70.66	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.54	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.80	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56.46	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.49	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.93	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.75	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.90	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.33	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.04	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.01	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.22	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.65	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.21	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.93	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.99	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.35	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.90	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.54	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.20	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.85	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.48	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.10	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.72	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.33	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.94	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.55	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.16	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.77	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	0	0.000	0	0.000	0.00
	0.50	10,612	0.244	3,498	0.080	0.47
	1.50	16,195	0.372	16,714	0.384	0.81
	2.50	27,330	0.627	36,988	0.849	1.40
	3.50	51,044	1.172	76,805	1.763	1.99
	4.50	69,867	1.604	136,823	3.141	2.60
	5.50	99,878	2.293	218,918	5.026	3.44
	6.50	156,789	3.599	347,074	7.968	4.01
	7.50	219,763	5.045	533,623	12.250	4.50
	8.50	290,205	6.662	792,151	18.185	423.40
	9.50	325,554	7.474	1,100,556	25.265	1,349.01
	10.50	349,530	8.024	1,367,214	31.387	2,014.10
	11.40	349,530	8.024	1,367,214	31.387	2,014.10
	11.50	349,530	8.024	1,367,214	31.387	2,014.10

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

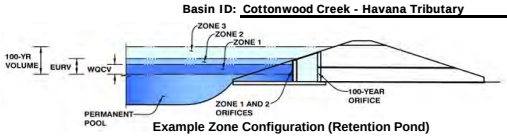
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Pond Airport South EURV Retrofit 2023 MDP Concept (SWMM Node 304, Top of Micropool 5790)**

Basin ID: **Cottonwood Creek - Havana Tributary**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	497.00	acres
Watershed Length =	8,532	ft
Watershed Length to Centroid =	4,200	ft
Watershed Slope =	0.028	ft/ft
Watershed Imperviousness =	31.00%	percent
Percentage Hydrologic Soil Group A =	1.2%	percent
Percentage Hydrologic Soil Group B =	1.2%	percent
Percentage Hydrologic Soil Groups C/D =	97.6%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Centennial - Municipal Court	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	6.401	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	14.069	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	9.110	acre-feet	inches
5-yr Runoff Volume (P1 = 1.11 in.) =	15.346	acre-feet	inches
10-yr Runoff Volume (P1 = 1.35 in.) =	23.391	acre-feet	inches
25-yr Runoff Volume (P1 = 1.7 in.) =	40.072	acre-feet	inches
50-yr Runoff Volume (P1 = 2 in.) =	52.431	acre-feet	inches
100-yr Runoff Volume (P1 = 2.32 in.) =	68.020	acre-feet	inches
500-yr Runoff Volume (P1 = 3.15 in.) =	103.945	acre-feet	inches
Approximate 2-yr Detention Volume =	8.614	acre-feet	
Approximate 5-yr Detention Volume =	14.711	acre-feet	
Approximate 10-yr Detention Volume =	17.811	acre-feet	
Approximate 25-yr Detention Volume =	22.037	acre-feet	
Approximate 50-yr Detention Volume =	24.114	acre-feet	
Approximate 100-yr Detention Volume =	30.430	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	6.401	acre-feet
Zone 2 Volume (EURV - Zone 1) =	7.668	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	14.069	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	

Total detention volume is less than 100-year volume.

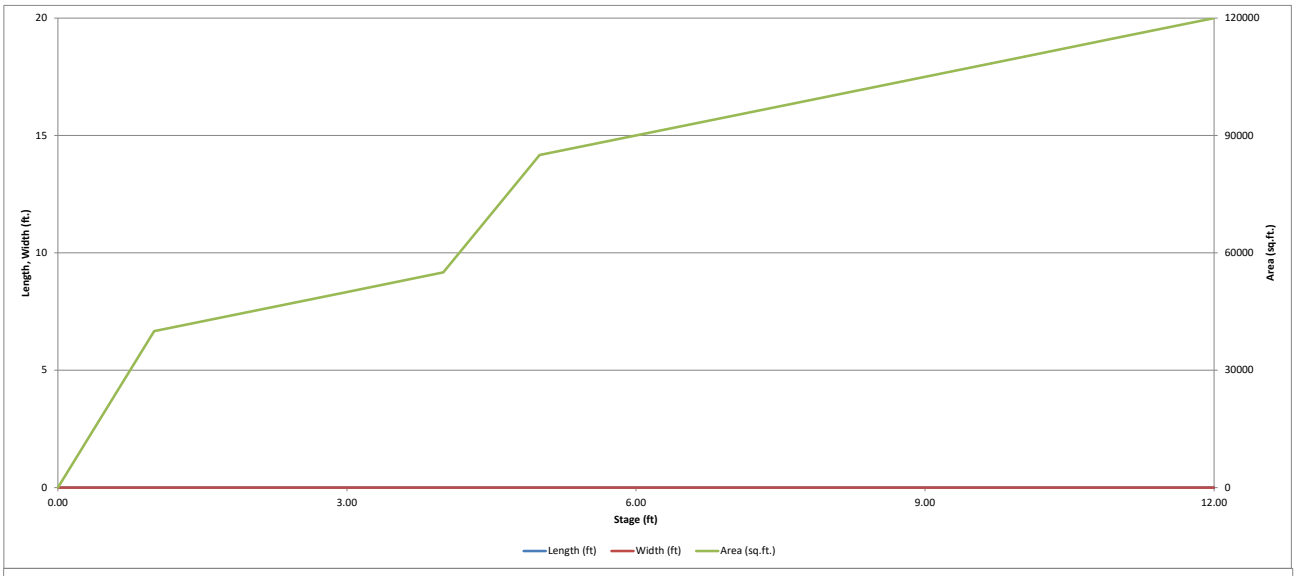
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

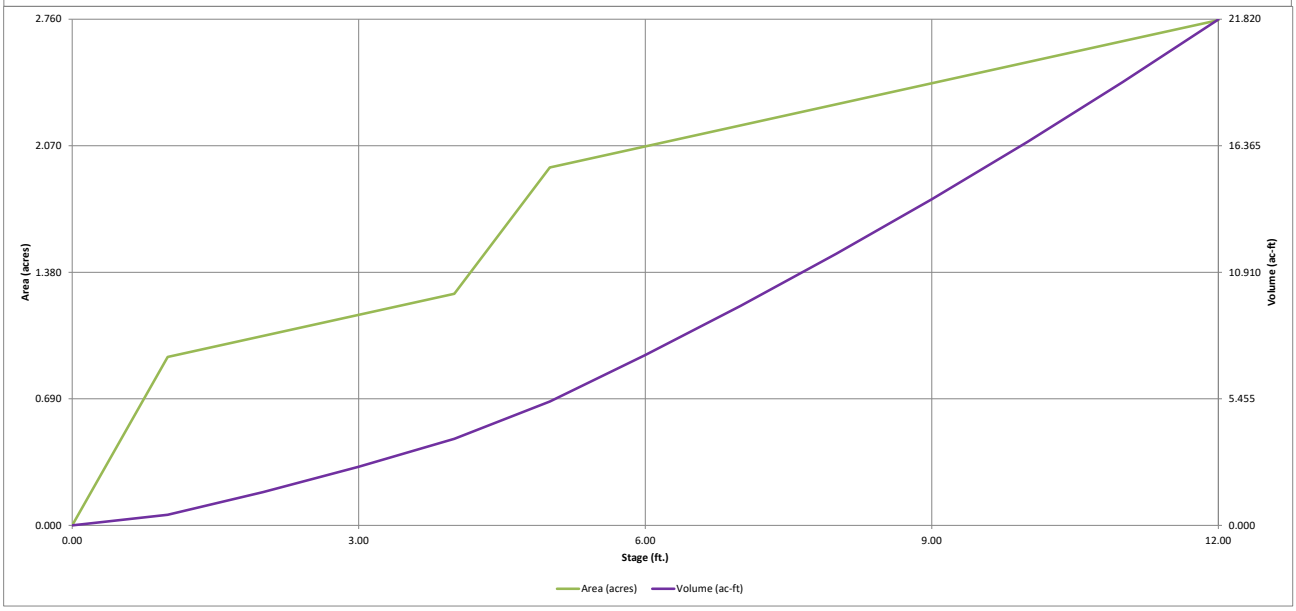
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
5793	--	1.00	--	--	--	40,000	0.918	19,999	0.459
5794	--	2.00	--	--	--	45,000	1.033	62,499	1.435
5795	--	3.00	--	--	--	50,000	1.148	109,999	2.525
5796	--	4.00	--	--	--	55,000	1.263	162,499	3.730
5797	--	5.00	--	--	--	85,000	1.951	232,499	5.337
5798	--	6.00	--	--	--	90,000	2.066	319,999	7.346
5799	--	7.00	--	--	--	95,000	2.181	412,499	9.470
5800	--	8.00	--	--	--	100,000	2.296	509,999	11.708
5801	--	9.00	--	--	--	105,000	2.410	612,499	14.061
5802	--	10.00	--	--	--	110,000	2.525	719,999	16.529
5803	--	11.00	--	--	--	115,000	2.640	832,499	19.112
5804	--	12.00	--	--	--	120,000	2.755	949,998	21.809

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



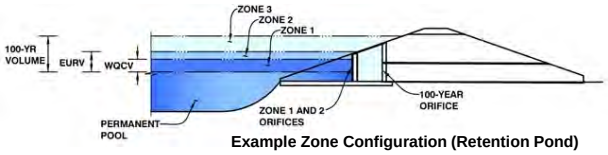


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Pond Airport South EURV Retrofit 2023 MDP Concept (SWMM Node 304, Top of Micropool 5790)**

Basin ID: **Cottonwood Creek - Havana Tributary**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	5.54	6.401	Orifice Plate
Zone 2 (EURV)	9.01	7.668	Circular Orifice
Zone 3			
Total (all zones)		14.069	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	1.528E-01	ft^2
Depth at top of Zone using Orifice Plate =	5.54	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	22.20	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	22.00	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.85	3.69					
Orifice Area (sq. inches)	22.00	22.00	22.00					

	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 Circular	Not Selected			Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	5.54	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =		N/A	ft^2
Depth at top of Zone using Vertical Orifice =	9.01	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =		N/A	feet
Vertical Orifice Diameter =		N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =	9.01	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	N/A	N/A	feet
Overflow Weir Front Edge Length =	80.00	N/A	feet	Overflow Weir Slope Length =	N/A	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	N/A	N/A	
Horiz. Length of Weir Sides =	N/A	N/A	feet	Overflow Grate Open Area w/o Debris =	N/A	N/A	ft^2
Overflow Grate Type =	N/A	N/A		Overflow Grate Open Area w/ Debris =	N/A	N/A	ft^2
Debris Clogging % =	N/A	N/A	%				

Calculated Parameters for Overflow Weir

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =	N/A	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	N/A	N/A	ft^2
Circular Orifice Diameter =	N/A	N/A	inches	Outlet Orifice Centroid =	N/A	N/A	feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=		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

Calculated Parameters for Spillway

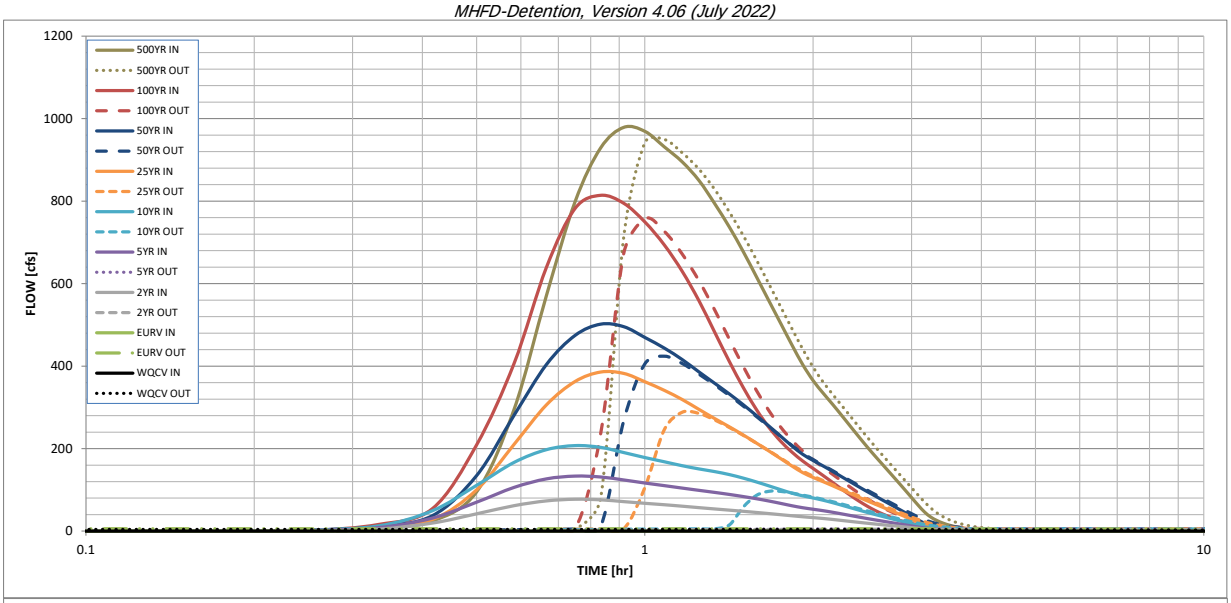
Routed Hydrograph Results

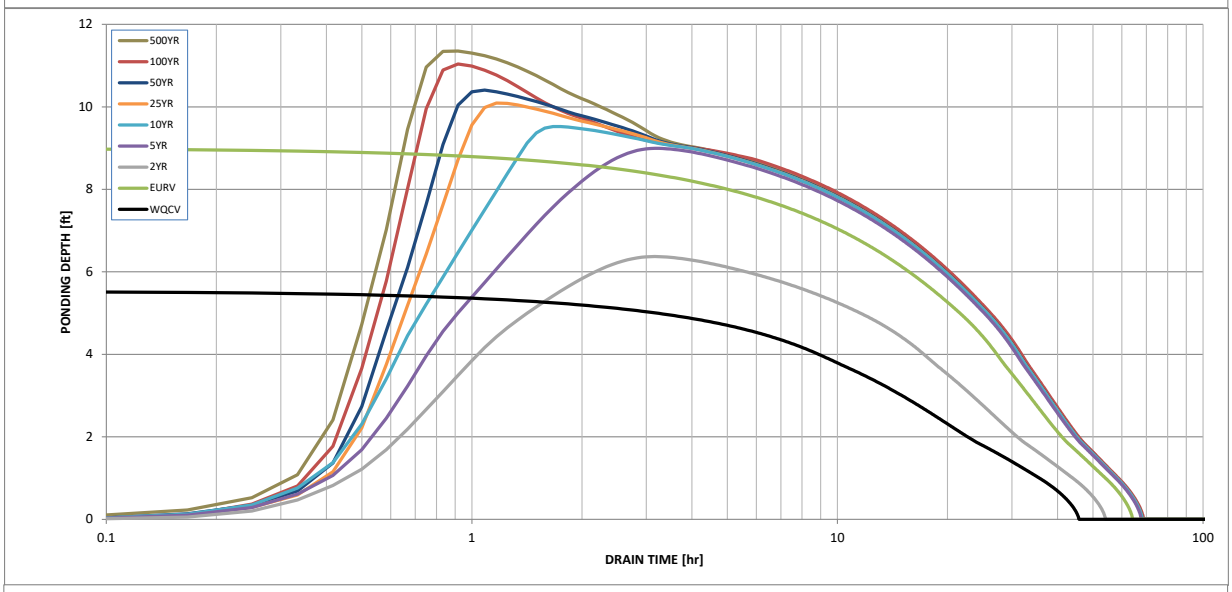
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

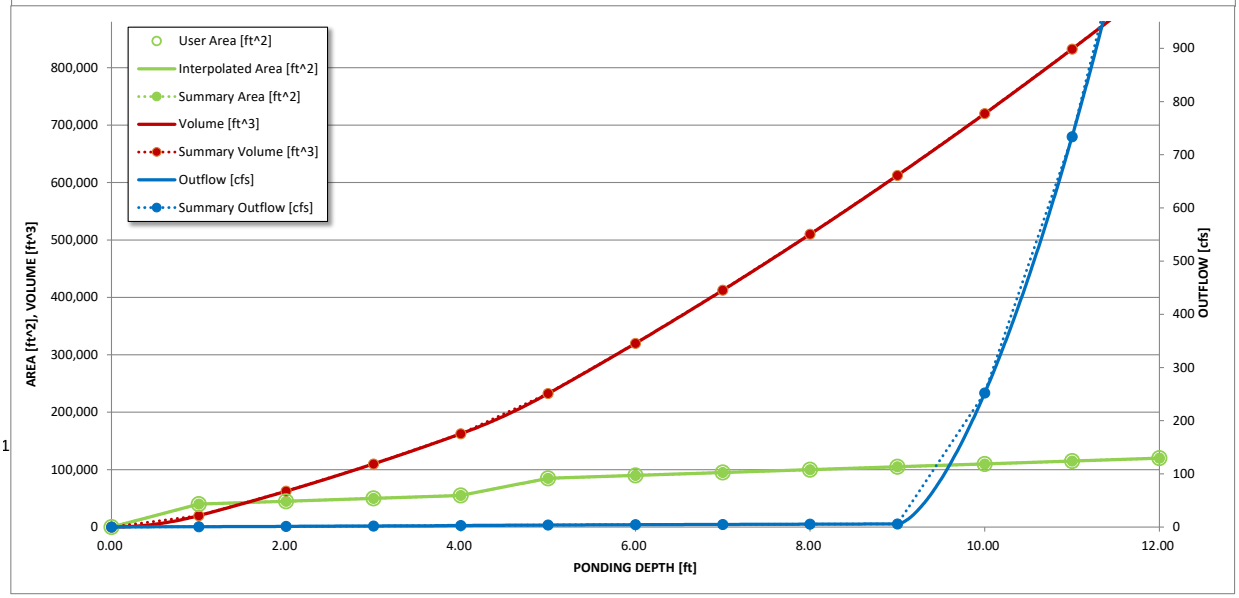
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.11	1.35	1.70	2.00	2.32	3.15
CUHP Runoff Volume (acre-ft) =	6.401	14.069	9.110	15.346	23.391	40.072	52.431	68.020	103.945
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	9.110	15.346	23.391	40.072	52.431	67.212	103.945
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	3.7	32.3	89.4	236.2	327.2	452.6	717.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	90.0	159.0	248.0	480.0	625.0	814.0	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.18	0.32	0.50	0.97	1.26	1.64	1.44
Peak Inflow Q (cfs) =	N/A	N/A	77.3	133.4	207.3	385.6	501.7	814.1	978.8
Peak Outflow Q (cfs) =	4.1	5.9	4.6	5.9	96.5	288.3	424.0	757.6	949.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.4	0.6	0.7	0.9	1.3
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	41	55	47	58	54	48	44	41	34
Time to Drain 99% of Inflow Volume (hours) =	**44**	60	51	63	62	59	57	55	50
Maximum Ponding Depth (ft) =	5.54	9.01	6.37	8.99	9.52	10.09	10.41	11.04	11.36
Area at Maximum Ponding Depth (acres) =	2.01	2.41	2.11	2.41	2.47	2.54	2.57	2.64	2.68
Maximum Volume Stored (acre-ft) =	6.408	14.085	8.118	14.037	15.330	16.757	17.548	19.217	20.043

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	USER	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74
	0:15:00	0.00	0.00	0.59	1.59	2.37	1.84	2.68	1.58	5.98
	0:20:00	0.00	0.00	4.99	8.51	12.48	8.33	11.13	16.00	24.48
	0:25:00	0.00	0.00	19.53	31.59	49.35	28.27	37.41	54.42	95.22
	0:30:00	0.00	0.00	41.97	70.19	111.07	100.10	134.65	209.12	294.82
	0:35:00	0.00	0.00	61.71	105.96	166.57	210.22	280.74	406.16	571.25
	0:40:00	0.00	0.00	73.28	126.66	197.48	306.12	403.93	639.56	798.21
	0:45:00	0.00	0.00	77.29	133.38	207.30	362.68	474.38	782.10	928.79
	0:50:00	0.00	0.00	75.84	131.24	203.05	385.64	501.72	814.05	978.78
	0:55:00	0.00	0.00	71.53	124.03	190.50	382.30	495.61	794.71	969.16
	1:00:00	0.00	0.00	67.44	116.63	178.37	362.11	469.49	749.51	931.58
	1:05:00	0.00	0.00	64.01	110.30	168.16	341.29	443.74	693.85	895.05
	1:10:00	0.00	0.00	60.43	104.31	158.54	318.91	415.79	629.58	849.92
	1:15:00	0.00	0.00	56.92	98.87	150.77	295.00	385.82	558.26	793.94
	1:20:00	0.00	0.00	53.76	93.88	144.33	272.87	358.36	482.30	736.97
	1:25:00	0.00	0.00	50.86	88.93	137.06	252.80	332.43	410.98	677.52
	1:30:00	0.00	0.00	48.03	83.79	128.49	233.09	306.37	348.06	616.93
	1:35:00	0.00	0.00	45.27	78.56	119.24	213.47	280.24	294.89	558.65
	1:40:00	0.00	0.00	42.56	73.04	109.76	194.39	254.84	251.71	503.70
	1:45:00	0.00	0.00	39.84	67.24	100.49	175.74	230.08	217.85	451.21
	1:50:00	0.00	0.00	37.23	61.51	91.97	157.83	206.54	191.49	403.53
	1:55:00	0.00	0.00	34.83	56.74	85.53	141.78	186.15	169.89	365.06
	2:00:00	0.00	0.00	32.77	53.08	80.38	130.15	171.32	151.95	334.92
	2:05:00	0.00	0.00	30.68	49.59	75.00	120.03	158.14	134.99	307.69
	2:10:00	0.00	0.00	28.34	45.79	69.05	110.11	144.97	118.17	280.50
	2:15:00	0.00	0.00	25.91	41.78	62.86	100.27	131.83	101.99	253.78
	2:20:00	0.00	0.00	23.51	37.83	56.74	90.90	119.25	86.60	228.16
	2:25:00	0.00	0.00	21.26	34.05	50.89	81.89	107.16	72.76	203.98
	2:30:00	0.00	0.00	19.13	30.50	45.39	73.37	95.76	60.50	181.58
	2:35:00	0.00	0.00	17.17	27.19	40.26	65.38	85.08	49.98	160.54
	2:40:00	0.00	0.00	15.32	24.04	35.39	57.63	74.77	41.27	140.16
	2:45:00	0.00	0.00	13.54	21.03	30.78	50.12	64.79	34.00	120.27
	2:50:00	0.00	0.00	11.83	18.15	26.36	42.80	55.06	27.71	100.75
	2:55:00	0.00	0.00	10.17	15.34	22.03	35.60	45.48	22.61	81.53
	3:00:00	0.00	0.00	8.56	12.61	17.83	28.53	36.14	18.56	62.88
	3:05:00	0.00	0.00	6.99	10.01	13.89	21.70	27.15	15.30	46.11
	3:10:00	0.00	0.00	5.51	7.67	10.70	15.46	19.32	12.61	33.84
	3:15:00	0.00	0.00	4.30	6.05	8.60	11.31	14.51	10.46	25.51
	3:20:00	0.00	0.00	3.49	5.01	7.15	8.56	11.16	8.79	19.39
	3:25:00	0.00	0.00	2.93	4.20	6.00	6.65	8.75	7.46	14.74
	3:30:00	0.00	0.00	2.50	3.54	5.05	5.21	6.89	6.40	11.17
	3:35:00	0.00	0.00	2.14	2.96	4.22	4.15	5.48	5.53	8.37
	3:40:00	0.00	0.00	1.81	2.45	3.47	3.29	4.32	4.82	6.25
	3:45:00	0.00	0.00	1.52	2.01	2.81	2.59	3.39	4.24	4.84
	3:50:00	0.00	0.00	1.26	1.62	2.24	2.06	2.68	3.77	3.82
	3:55:00	0.00	0.00	1.04	1.29	1.76	1.63	2.10	3.32	3.03
	4:00:00	0.00	0.00	0.85	1.01	1.37	1.27	1.65	2.92	2.39
	4:05:00	0.00	0.00	0.68	0.78	1.06	0.98	1.26	2.59	1.82
	4:10:00	0.00	0.00	0.52	0.58	0.80	0.74	0.94	2.33	1.32
	4:15:00	0.00	0.00	0.39	0.42	0.57	0.53	0.67	2.12	0.91
	4:20:00	0.00	0.00	0.28	0.29	0.38	0.36	0.44	1.96	0.57
	4:25:00	0.00	0.00	0.19	0.19	0.24	0.22	0.26	1.83	0.31
	4:30:00	0.00	0.00	0.11	0.11	0.12	0.11	0.13	1.72	0.13
	4:35:00	0.00	0.00	0.06	0.05	0.05	0.04	0.04	1.63	0.03
	4:40:00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	1.56	0.00
	4:45:00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.51	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.46	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.42	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.39	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.23	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.21	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.18	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	0	0.000	0	0.000	0.00
	1.00	40,000	0.918	19,999	0.459	0.74
	2.00	45,000	1.033	62,499	1.435	1.33
	3.00	50,000	1.148	109,999	2.525	2.06
	4.00	55,000	1.263	162,499	3.730	2.96
	5.00	85,000	1.951	232,499	5.337	3.79
	6.00	90,000	2.066	319,999	7.346	4.42
	7.00	95,000	2.181	412,499	9.470	4.95
	8.00	100,000	2.296	509,999	11.708	5.43
	9.00	105,000	2.410	612,499	14.061	5.87
	10.00	110,000	2.525	719,999	16.529	252.04
	11.00	115,000	2.640	832,499	19.112	734.02
	12.00	120,000	2.755	949,998	21.809	1,396.26

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

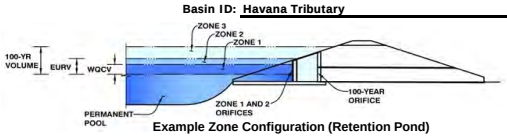
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Rampart Lower Pond MDP Based on Draft Outlet Configuration (Storafe Node 365 INV 5721.0 BFE 5725.86)**

Basin ID: **Havana Tributary**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	21.00	acres
Watershed Length =	1,214	ft
Watershed Length to Centroid =	472	ft
Watershed Slope =	0.045	ft/ft
Watershed Imperviousness =	77.30%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Centennial - Municipal Court	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.546	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	1.590	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	1.042	acre-feet	inches
5-yr Runoff Volume (P1 = 1.11 in.) =	1.444	acre-feet	inches
10-yr Runoff Volume (P1 = 1.35 in.) =	1.845	acre-feet	inches
25-yr Runoff Volume (P1 = 1.7 in.) =	2.488	acre-feet	inches
50-yr Runoff Volume (P1 = 2 in.) =	3.018	acre-feet	inches
100-yr Runoff Volume (P1 = 2.32 in.) =	3.611	acre-feet	inches
500-yr Runoff Volume (P1 = 3.15 in.) =	5.097	acre-feet	inches
Approximate 2-yr Detention Volume =	1.029	acre-feet	
Approximate 5-yr Detention Volume =	1.457	acre-feet	
Approximate 10-yr Detention Volume =	1.747	acre-feet	
Approximate 25-yr Detention Volume =	2.042	acre-feet	
Approximate 50-yr Detention Volume =	2.188	acre-feet	
Approximate 100-yr Detention Volume =	2.409	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.546	acre-feet
Zone 2 Volume (100-year - Zone 1) =	1.862	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	2.409	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

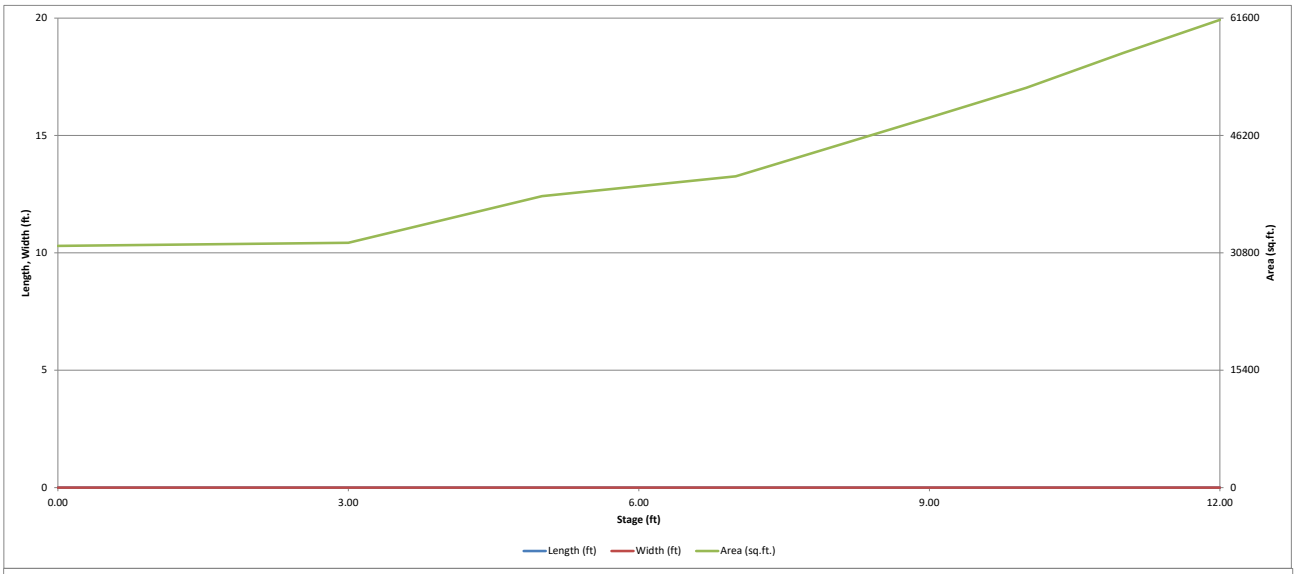
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

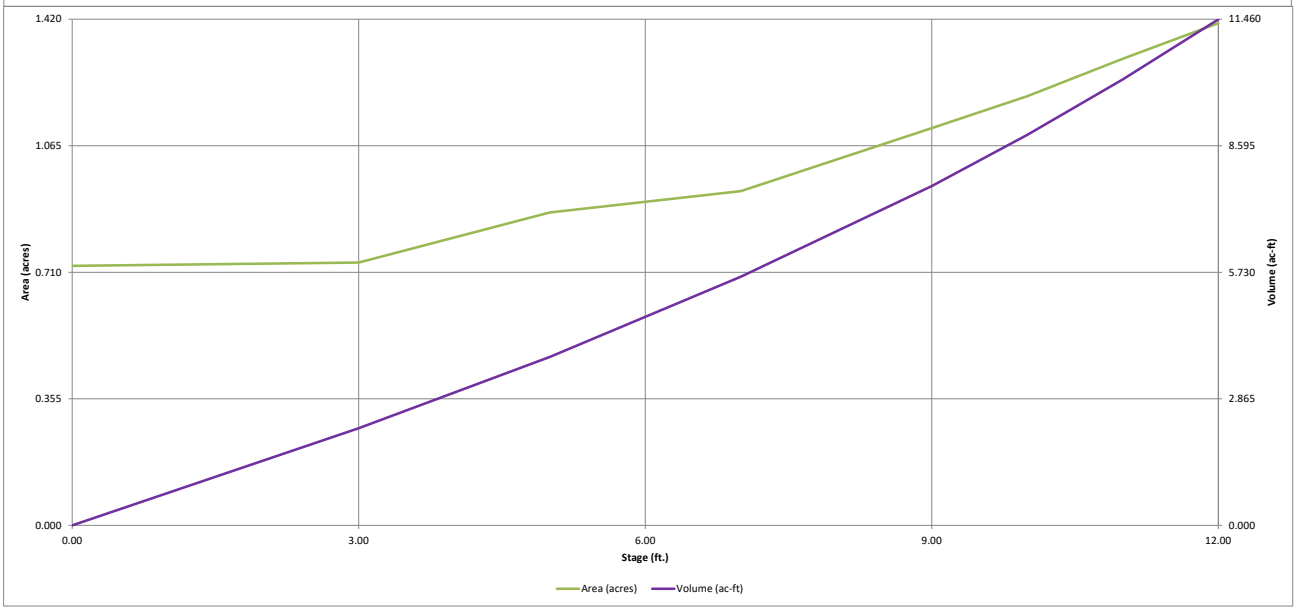
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	31,715	0.728		
5724	--	3.00	--	--	--	32,123	0.737	95,757	2.198
5726	--	5.00	--	--	--	38,238	0.878	166,118	3.814
5728	--	7.00	--	--	--	40,851	0.938	245,207	5.629
5730	--	9.00	--	--	--	48,549	1.115	334,607	7.682
5731	--	10.00	--	--	--	52,447	1.204	385,105	8.841
5732	--	11.00	--	--	--	57,024	1.309	439,840	10.097
5733	--	12.00	--	--	--	61,372	1.409	499,038	11.456

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



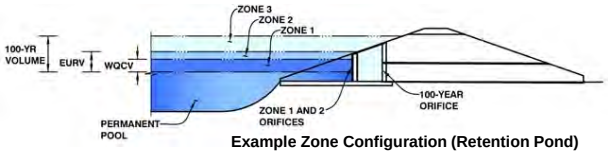


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Rampart Lower Pond MDP Based on Draft Outlet Configuration (Storafe Node 365 INV 5721.0 BFE 5725.86)**

Basin ID: **Havana Tributary**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.75	0.546	Orifice Plate
Zone 2 (100-year)	3.29	1.862	Weir&Pipe (Restrict)
Zone 3			
Total (all zones)		2.409	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	1.89	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	7.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.63	1.26					
Orifice Area (sq. inches)	9.00	10.00	11.00					

	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			Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =			ft^2
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =			feet
Vertical Orifice Diameter =			inches				

Calculated Parameters for Vertical Orifice

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

	Zone 2 Weir	Not Selected			Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.08		ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.08		feet
Overflow Weir Front Edge Length =	8.35		feet	Overflow Weir Slope Length =	2.70		feet
Overflow Weir Grate Slope =	0.00		H:V	Grate Open Area / 100-yr Orifice Area =	0.91		
Horiz. Length of Weir Sides =	2.70		feet	Overflow Grate Open Area w/o Debris =	17.83		ft^2
Overflow Grate Type =	Close Mesh Grate			Overflow Grate Open Area w/ Debris =	16.05		ft^2
Debris Clogging % =	10%		%				

Calculated Parameters for Overflow Weir

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

	Zone 2 Restrictor	Not Selected			Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.85		ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	19.63		ft^2
Outlet Pipe Diameter =	60.00		inches	Outlet Orifice Centroid =	2.50		feet
Restrictor Plate Height Above Pipe Invert =	60.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

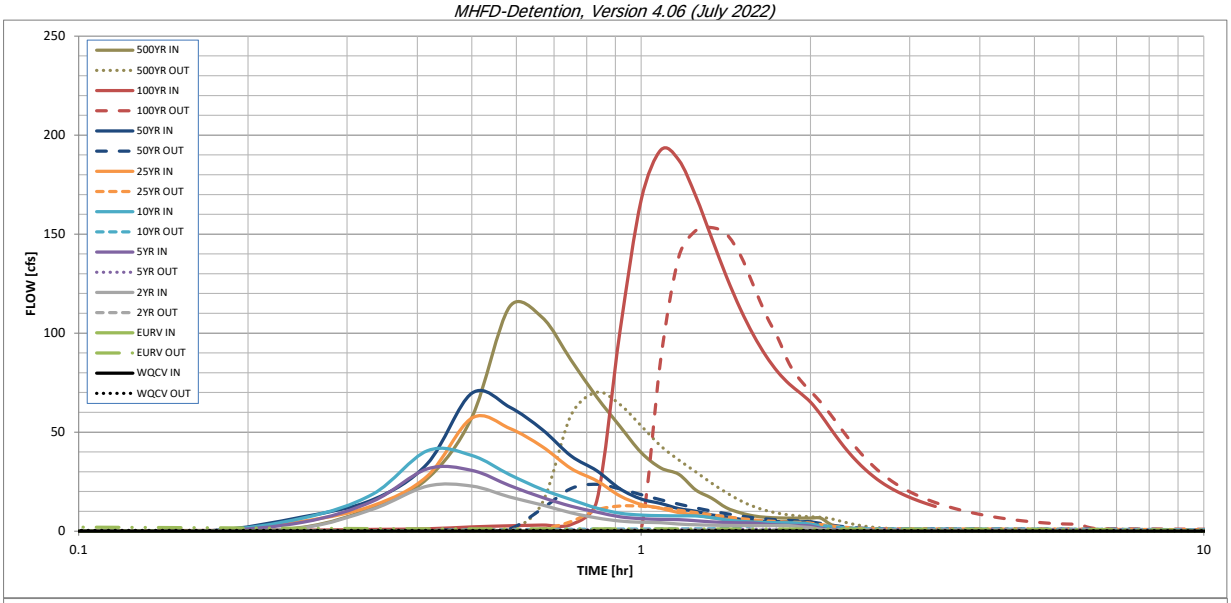
Routed Hydrograph Results

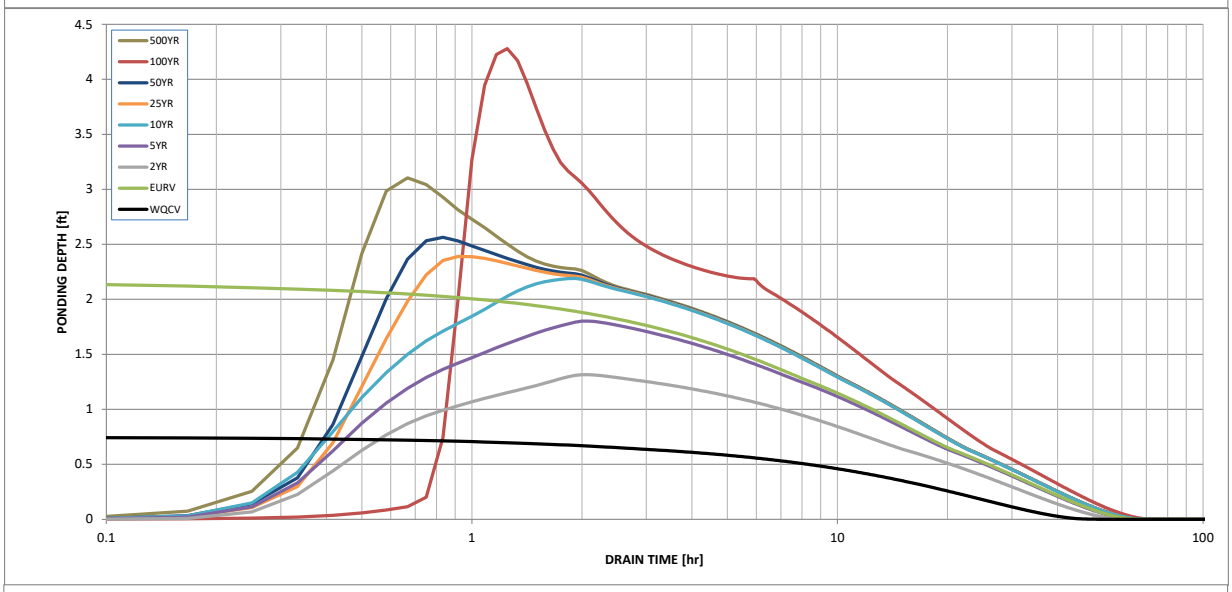
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

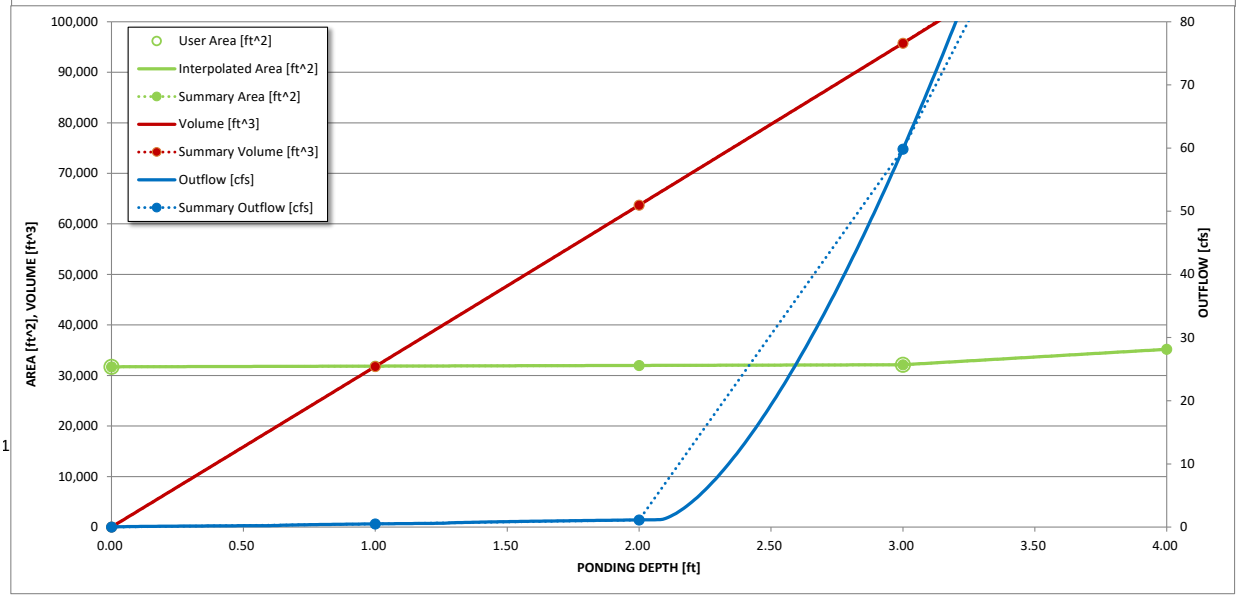
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.11	1.35	1.70	2.00	2.32	3.15
CUHP Runoff Volume (acre-ft) =	0.546	1.590	1.042	1.444	1.845	2.488	3.018	3.611	5.097
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.042	1.444	1.845	2.488	3.018	16.143	5.097
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.3	3.2	8.0	19.2	26.3	34.9	54.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						185.0	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.15	0.38	0.91	1.25	8.81	2.60
Peak Inflow Q (cfs) =	N/A	N/A	22.8	31.4	40.6	57.1	69.7	192.5	113.3
Peak Outflow Q (cfs) =	0.4	2.7	0.7	1.0	3.6	12.7	23.7	153.3	70.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.5	0.7	0.9	0.8	1.3
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	0.12	N/A	N/A	0.1	0.6	1.2	8.5	3.8
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	52	50	53	53	51	49	26	43
Time to Drain 99% of Inflow Volume (hours) =	**45**	59	55	59	60	59	58	46	54
Maximum Ponding Depth (ft) =	0.75	2.18	1.31	1.80	2.19	2.39	2.56	4.28	3.10
Area at Maximum Ponding Depth (acres) =	0.73	0.73	0.73	0.73	0.73	0.74	0.74	0.83	0.74
Maximum Volume Stored (acre-ft) =	0.547	1.595	0.956	1.316	1.602	1.742	1.874	3.191	2.272

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: FALSE

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	USER	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	1.95
	0:15:00	0.00	0.00	1.69	4.47	6.56	4.99	7.20	0.49	11.93
	0:20:00	0.00	0.00	11.09	15.12	18.71	12.89	15.89	0.89	26.52
	0:25:00	0.00	0.00	22.73	31.45	40.59	27.80	34.06	1.19	57.46
	0:30:00	0.00	0.00	22.76	30.68	38.20	57.11	69.66	2.15	113.26
	0:35:00	0.00	0.00	17.28	23.04	28.55	51.92	62.67	2.71	107.95
	0:40:00	0.00	0.00	13.23	17.05	21.09	42.71	51.33	3.07	86.49
	0:45:00	0.00	0.00	9.28	12.62	15.97	31.68	38.04	3.32	67.80
	0:50:00	0.00	0.00	6.69	9.65	11.64	25.45	30.55	15.06	52.94
	0:55:00	0.00	0.00	5.11	7.25	9.06	17.80	21.40	100.77	39.69
	1:00:00	0.00	0.00	4.48	6.29	8.11	13.45	16.22	167.29	31.92
	1:05:00	0.00	0.00	4.28	5.94	7.82	11.53	13.97	192.47	28.69
	1:10:00	0.00	0.00	3.58	5.81	7.71	9.34	11.37	187.36	20.81
	1:15:00	0.00	0.00	3.23	5.26	7.69	8.23	10.05	169.28	16.71
	1:20:00	0.00	0.00	3.02	4.68	6.83	6.74	8.19	148.30	11.84
	1:25:00	0.00	0.00	2.91	4.37	5.66	6.00	7.26	128.75	9.27
	1:30:00	0.00	0.00	2.84	4.19	4.99	4.97	5.99	112.32	7.71
	1:35:00	0.00	0.00	2.81	4.09	4.61	4.44	5.33	99.04	6.98
	1:40:00	0.00	0.00	2.81	3.45	4.39	4.15	4.98	88.49	6.70
	1:45:00	0.00	0.00	2.81	3.13	4.27	4.01	4.80	80.33	6.59
	1:50:00	0.00	0.00	2.81	2.94	4.24	3.94	4.72	74.30	6.59
	1:55:00	0.00	0.00	2.17	2.83	4.03	3.92	4.69	69.81	6.59
	2:00:00	0.00	0.00	1.83	2.60	3.51	3.92	4.69	65.16	6.59
	2:05:00	0.00	0.00	0.98	1.41	1.91	2.14	2.56	58.96	3.59
	2:10:00	0.00	0.00	0.52	0.77	1.03	1.17	1.40	52.11	1.96
	2:15:00	0.00	0.00	0.24	0.38	0.51	0.59	0.70	45.72	0.99
	2:20:00	0.00	0.00	0.10	0.17	0.22	0.27	0.32	40.11	0.45
	2:25:00	0.00	0.00	0.03	0.05	0.06	0.08	0.09	35.32	0.12
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.25	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.79	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.87	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.43	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.38	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.62	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.09	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.74	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.53	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.45	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.48	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.61	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.81	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.09	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.43	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.83	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.29	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.79	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.33	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.91	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.52	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.17	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.84	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.55	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.27	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.03	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.79	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.59	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.39	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.22	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.05	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.91	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.78	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.66	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.52	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.47	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.47	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.47	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.46	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.46	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.46	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.46	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	31,715	0.728	0	0.000	0.00
	1.00	31,851	0.731	31,783	0.730	0.50
	2.00	31,987	0.734	63,702	1.462	1.13
	3.00	32,123	0.737	95,757	2.198	59.84
	4.00	35,180	0.808	129,409	2.971	141.47
	5.00	38,238	0.878	166,118	3.814	173.04
	6.00	39,544	0.908	205,009	4.706	197.18
	7.00	40,851	0.938	245,207	5.629	218.68
	8.00	44,700	1.026	287,982	6.611	238.24
	9.00	48,549	1.115	334,607	7.682	256.31
	10.00	52,447	1.204	385,105	8.841	273.19
	11.00	57,024	1.309	439,840	10.097	289.09

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

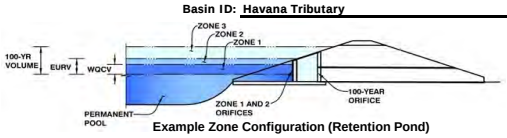
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Rampart Upper Pond MDP Concept EURV Retrofit (INV 5741.0, BFE 5750.47, buildings above 5758.0)**

Basin ID: **Havana Tributary**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	116.00	acres
Watershed Length =	3,160	ft
Watershed Length to Centroid =	1,538	ft
Watershed Slope =	0.028	ft/ft
Watershed Imperviousness =	81.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Centennial - Municipal Court	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	3.235	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	9.239	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.85 in.) =	6.328	acre-feet	inches
5-yr Runoff Volume (P1 = 1.11 in.) =	8.712	acre-feet	inches
10-yr Runoff Volume (P1 = 1.35 in.) =	11.063	acre-feet	inches
25-yr Runoff Volume (P1 = 1.7 in.) =	14.753	acre-feet	inches
50-yr Runoff Volume (P1 = 2 in.) =	17.824	acre-feet	inches
100-yr Runoff Volume (P1 = 2.32 in.) =	21.230	acre-feet	inches
500-yr Runoff Volume (P1 = 3.15 in.) =	29.779	acre-feet	inches
Approximate 2-yr Detention Volume =	5.993	acre-feet	
Approximate 5-yr Detention Volume =	8.415	acre-feet	
Approximate 10-yr Detention Volume =	10.113	acre-feet	
Approximate 25-yr Detention Volume =	11.805	acre-feet	
Approximate 50-yr Detention Volume =	12.636	acre-feet	
Approximate 100-yr Detention Volume =	13.805	acre-feet	

Define Zones and Basin Geometry

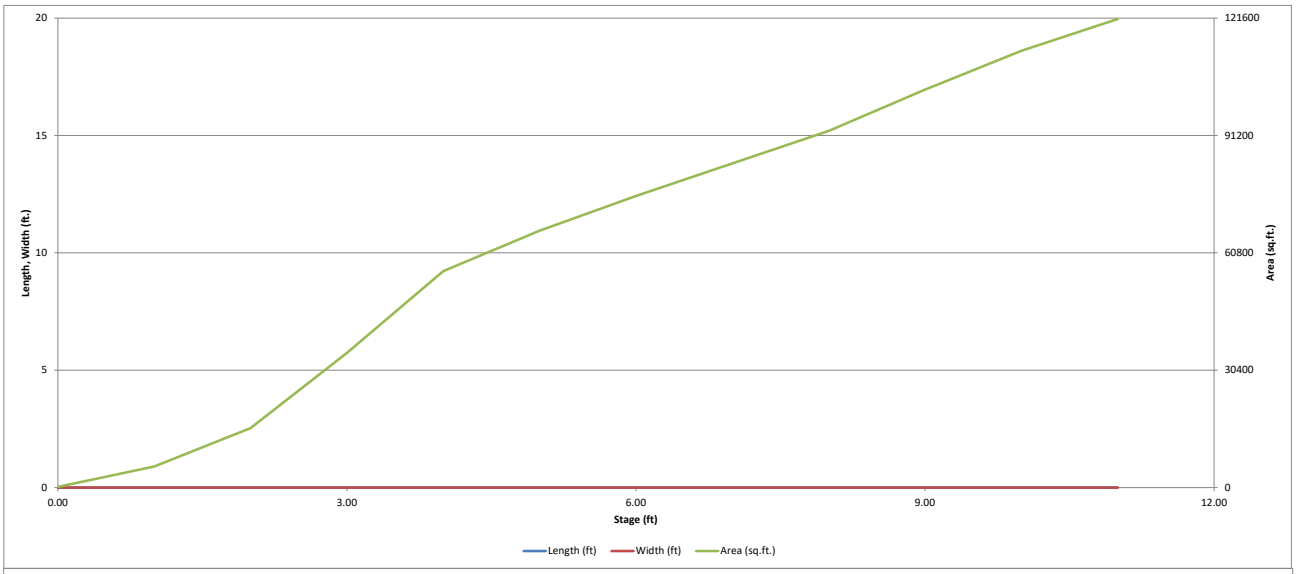
Zone 1 Volume (WQCV) =	3.235	acre-feet
Zone 2 Volume (EURV - Zone 1) =	6.004	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	4.566	acre-feet
Total Detention Basin Volume =	13.805	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

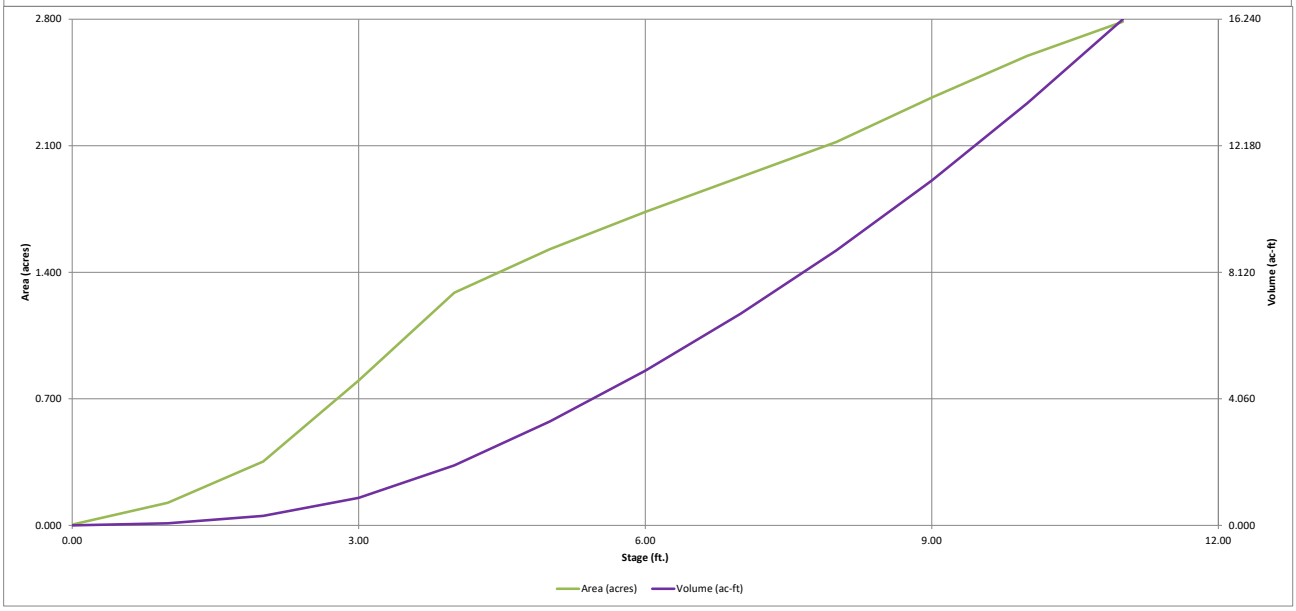
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	192	0.004		
5742	--	1.00	--	--	--	5,450	0.125	2,821	0.065
5743	--	2.00	--	--	--	15,402	0.354	13,247	0.304
5744	--	3.00	--	--	--	34,917	0.802	38,406	0.882
5745	--	4.00	--	--	--	56,062	1.287	83,896	1.926
5746	--	5.00	--	--	--	66,561	1.528	145,207	3.334
5747	--	6.00	--	--	--	75,521	1.734	216,248	4.964
5748	--	7.00	--	--	--	83,971	1.928	295,994	6.795
5749	--	8.00	--	--	--	92,385	2.121	384,172	8.819
5750	--	9.00	--	--	--	103,087	2.367	481,908	11.063
5751	--	10.00	--	--	--	113,127	2.597	590,015	13.545
5752	--	11.00	--	--	--	121,369	2.786	707,263	16.237

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



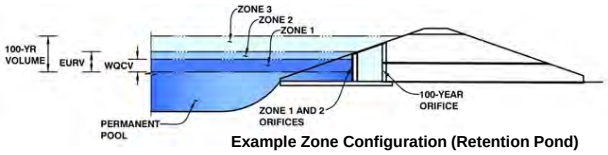


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Rampart Upper Pond MDP Concept EURV Retrofit (INV 5741.0, BFE 5750.47, buildings above 5758.0)

Basin ID: Havana Tributary



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.94	3.235	Orifice Plate
Zone 2 (EURV)	8.20	6.004	Orifice Plate
Zone 3 (100-year)	10.10	4.566	Weir (No Pipe)
Total (all zones)		13.805	

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

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	6.65	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	30.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.50	5.00					
Orifice Area (sq. inches)	10.00	10.00	20.00					

	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			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				

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	10.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	N/A	N/A	feet
Overflow Weir Bottom Length =	20.00	N/A	feet	Overflow Weir Slope Length =	N/A	N/A	feet
Overflow Weir Side Slopes =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	N/A	N/A	
Horiz. Length of Weir Sides =	N/A	N/A	feet	Overflow Grate Open Area w/o Debris =	N/A	N/A	ft^2
Overflow Grate Type =	N/A	N/A		Overflow Grate Open Area w/ Debris =	N/A	N/A	ft^2
Debris Clogging % =	N/A	N/A	%				

Calculated Parameters for Overflow Weir

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

	Not Selected	Not Selected			Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =	N/A	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	N/A	N/A	ft^2
Circular Orifice Diameter =	N/A	N/A	inches	Outlet Orifice Centroid =	N/A	N/A	feet
				Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	10.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.26	feet
Spillway Crest Length =	55.00	feet	Stage at Top of Freeboard =	12.26	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	2.79	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	16.24	acre-ft
Spillway position relative to Overflow Weir =	Overlapping				

Calculated Parameters for Spillway

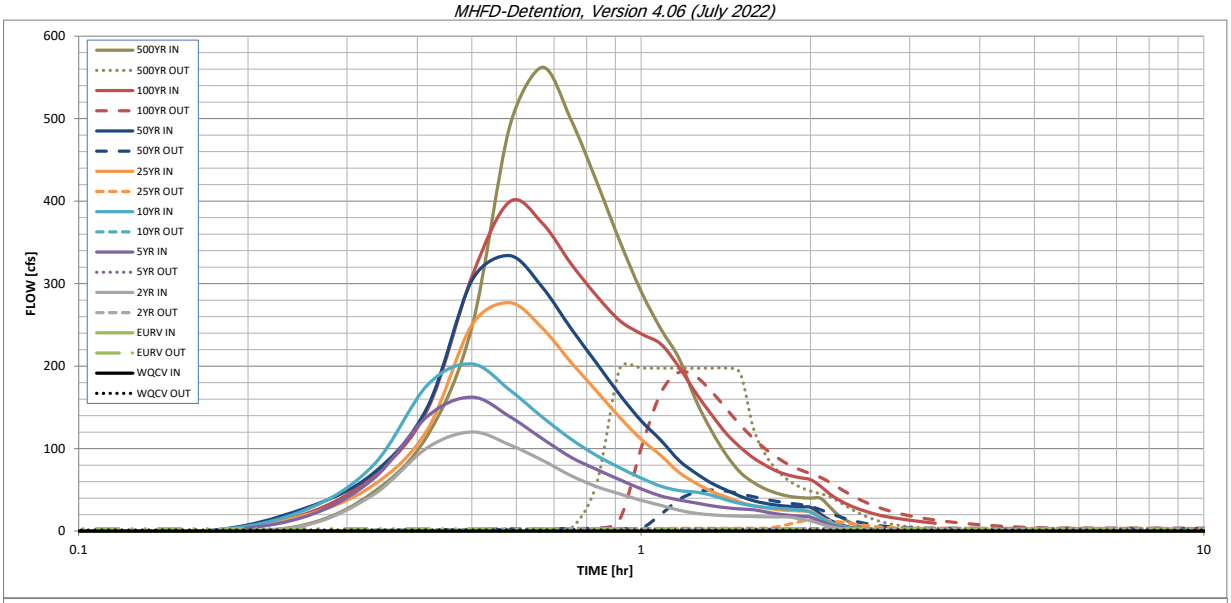
Routed Hydrograph Results

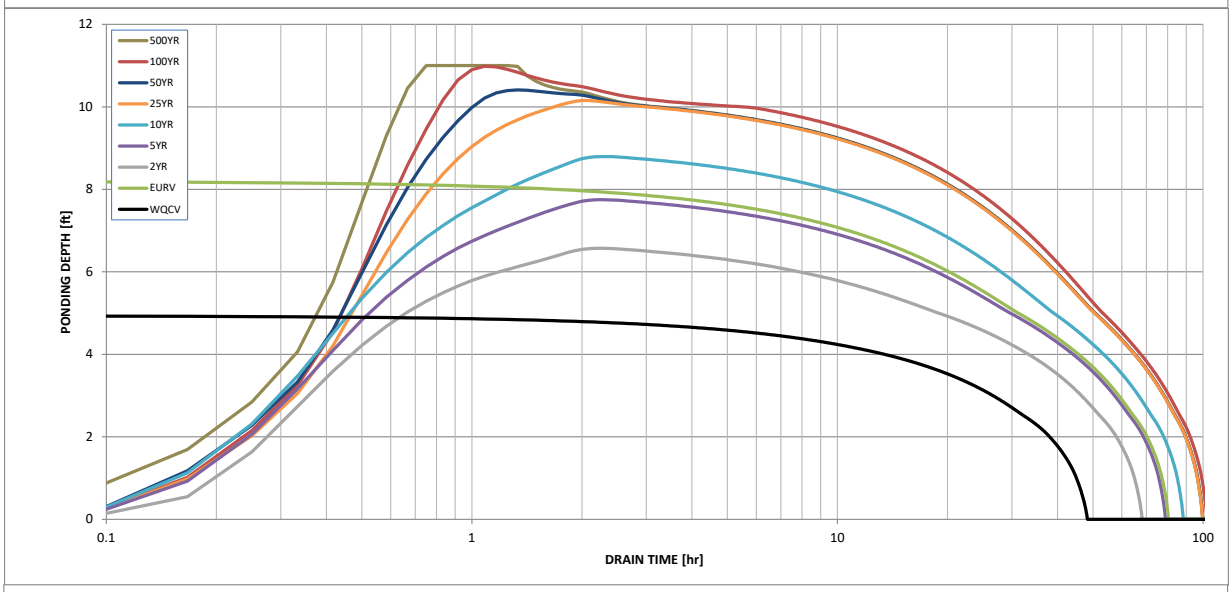
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

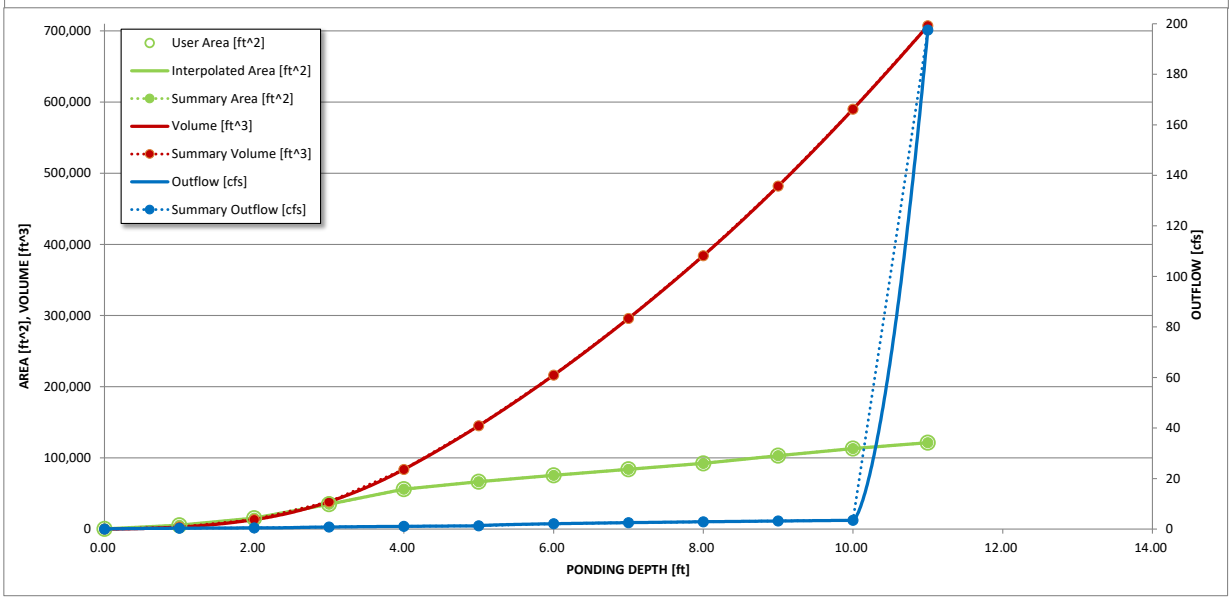
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.85	1.11	1.35	1.70	2.00	2.32	3.15
CUHP Runoff Volume (acre-ft) =	3.235	9.239	6.328	8.712	11.063	14.753	17.824	21.230	29.779
User Override Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.328	8.712	11.063	14.753	17.824	29.595	29.779
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.4	13.0	33.7	82.8	114.1	153.5	241.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						152.0	
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.11	0.29	0.71	0.98	1.31	2.08
Peak Inflow Q (cfs) =	N/A	N/A	120.2	162.4	202.6	276.9	334.0	399.1	562.3
Peak Outflow Q (cfs) =	1.3	2.9	2.4	2.8	3.1	13.8	49.8	192.5	197.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.1	0.2	0.4	1.3	0.8
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Spillway	Spillway	Spillway	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) =	44	71	61	70	77	86	84	81	78
Time to Drain 99% of Inflow Volume (hours) =	**46**	76	65	75	84	94	93	93	90
Maximum Ponding Depth (ft) =	4.94	8.20	6.57	7.75	8.80	10.15	10.41	10.98	11.00
Area at Maximum Ponding Depth (acres) =	1.51	2.17	1.84	2.07	2.31	2.63	2.67	2.78	2.79
Maximum Volume Stored (acre-ft) =	3.242	9.248	5.984	8.274	10.572	13.937	14.599	16.181	16.237

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: C:\Users\mlewis\Downloads\Outflow Hydrographs.xlsx

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	USER	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.13
	0:15:00	0.00	0.00	6.27	16.58	24.32	18.50	26.69	19.82	46.68
	0:20:00	0.00	0.00	43.65	62.80	79.24	55.31	69.75	66.93	115.68
	0:25:00	0.00	0.00	101.12	139.08	176.94	122.76	150.19	146.84	247.24
	0:30:00	0.00	0.00	120.16	162.37	202.65	249.93	303.82	308.51	489.68
	0:35:00	0.00	0.00	104.68	138.98	171.26	276.87	333.97	399.12	562.28
	0:40:00	0.00	0.00	85.99	112.20	138.38	246.31	295.92	373.52	498.89
	0:45:00	0.00	0.00	67.29	89.64	111.59	204.78	245.76	324.25	423.51
	0:50:00	0.00	0.00	53.97	74.73	91.58	169.72	203.41	285.14	350.92
	0:55:00	0.00	0.00	45.03	62.24	76.68	137.63	165.00	254.96	290.42
	1:00:00	0.00	0.00	37.31	51.22	64.34	111.41	133.70	239.11	245.22
	1:05:00	0.00	0.00	31.25	42.69	54.46	91.81	110.26	226.90	209.69
	1:10:00	0.00	0.00	25.36	37.81	49.18	71.38	85.87	199.05	159.07
	1:15:00	0.00	0.00	21.70	34.19	47.31	58.24	70.31	167.64	121.59
	1:20:00	0.00	0.00	19.82	30.75	43.59	48.21	58.19	141.30	92.42
	1:25:00	0.00	0.00	18.70	28.38	37.84	41.29	49.74	118.28	71.24
	1:30:00	0.00	0.00	18.09	26.86	33.53	35.16	42.30	101.66	58.98
	1:35:00	0.00	0.00	17.65	25.93	30.72	30.66	36.85	88.69	50.78
	1:40:00	0.00	0.00	17.34	23.18	28.86	27.94	33.55	79.44	45.54
	1:45:00	0.00	0.00	17.16	20.71	27.64	26.09	31.30	72.10	42.21
	1:50:00	0.00	0.00	17.11	19.17	26.77	25.04	30.02	67.69	40.66
	1:55:00	0.00	0.00	14.75	18.16	25.42	24.41	29.25	64.74	40.00
	2:00:00	0.00	0.00	12.51	16.97	22.91	24.07	28.84	62.39	39.84
	2:05:00	0.00	0.00	8.76	11.99	16.10	17.30	20.73	54.51	28.93
	2:10:00	0.00	0.00	5.53	7.56	10.26	11.00	13.17	44.73	18.33
	2:15:00	0.00	0.00	3.53	4.77	6.56	7.10	8.50	37.60	11.81
	2:20:00	0.00	0.00	2.10	2.90	3.99	4.34	5.20	32.03	7.20
	2:25:00	0.00	0.00	1.19	1.76	2.38	2.66	3.19	27.72	4.41
	2:30:00	0.00	0.00	0.58	0.95	1.23	1.46	1.74	24.29	2.40
	2:35:00	0.00	0.00	0.23	0.39	0.48	0.61	0.73	21.35	0.99
	2:40:00	0.00	0.00	0.05	0.08	0.09	0.12	0.15	18.98	0.19
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.15	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.73	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.45	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.26	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.21	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.26	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.37	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.58	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.87	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.23	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.63	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.07	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.59	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.15	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.75	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.38	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.04	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.71	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.41	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.15	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.92	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.71	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.51	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.32	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.14	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.97	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.81	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.65	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.39	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.28	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.18	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.93	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.85	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.78	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.71	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.64	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.57	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	192	0.004	0	0.000	0.00
	1.00	5,450	0.125	2,821	0.065	0.33
	2.00	15,402	0.354	13,247	0.304	0.47
	3.00	34,917	0.802	38,406	0.882	0.82
	4.00	56,062	1.287	83,896	1.926	1.08
	5.00	66,561	1.528	145,207	3.334	1.28
	6.00	75,521	1.734	216,248	4.964	2.11
	7.00	83,971	1.928	295,994	6.795	2.54
	8.00	92,385	2.121	384,172	8.819	2.89
	9.00	103,087	2.367	481,908	11.063	3.19
	10.00	113,127	2.597	590,015	13.545	3.47
	11.00	121,369	2.786	707,263	16.237	197.52

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

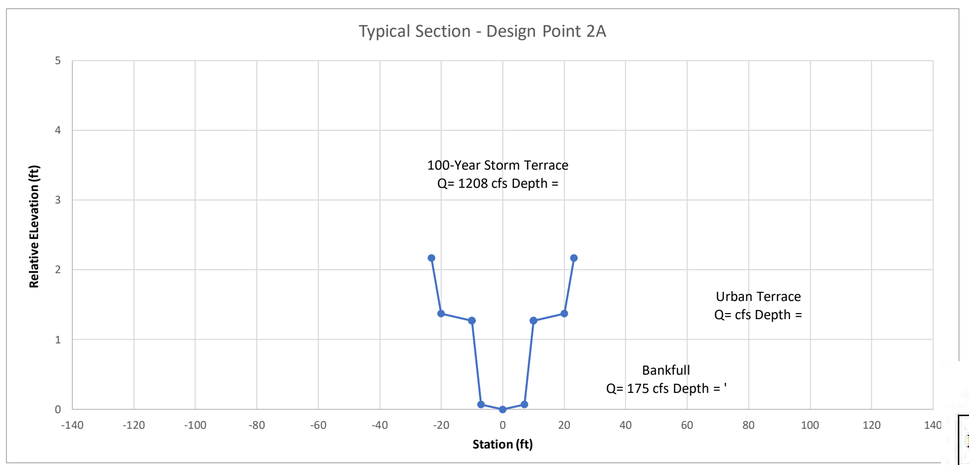
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

TYPICAL CHANNEL SECTIONS

	Dove Creek DC10 Node 107 lateral			
	Flow	Stage Depth	Terrace Width	Top Width
Bankfull Channel	46	1.2	N/A	20.0
Floodplain (100-yr)	159	0.8	10	46

***add 14' for maintenance

			Station	Elevation	Mannings
	Floodplain		-23.200	2.170	0.055
			-20.000	1.370	0.055
			-10.000	1.270	0.045
			-10.000	1.270	0.045
		Bankfull	-10.000	1.270	0.035
			-7.000	0.070	0.035
			0.000	0.000	0.035
			7.000	0.070	0.035
			10.000	1.270	0.035
			10.000	1.270	0.045
			10.000	1.270	0.045
			20.000	1.370	0.055
			23.200	2.170	0.055



Parameter	Bankfull	Floodplain	Units	5-YR
Flow	46	158	cfs	
Depth	1.212	2.112	ft	
Area of Flow	19.732	55.767	sq ft	
Wetted Perimeter	20.149	46.582	ft	
Hydraulic Radius	0.979	1.197	ft	
Average Velocity	2.331	2.833	fps	
Top Width (T)	19.708	45.935	ft	
Froude Number	0.411	0.453		
Critical Depth	0.706	1.564	ft	
Critical Velocity	4.418	4.965	fps	
Critical Slope	0.02151	0.01241	ft/ft	
Critical Top Width	17.182	41.556	ft	
Max Shear Stress	0.234	0.409	lb/ft^2	
Avg Shear Stress	0.189	0.232	lb/ft^2	
Composite Manning's n Equation	Lotter method	Lotter method		
Manning's Roughness	0.035	0.0426		

Stage	Discharge	Total Depth	Bottom Width	Top Width
	[cfs]	[ft]	[ft]	[ft]
Bankfull	46	1.212	14	20
Urban Terrace	0	1.270	-	0
Floodplain Terrace	158	2.11	-	46

Bankfull W/D Ratio	16.2

A useful parameter for quantifying the width of the floodplain terraces in streams not already altered by past channelization projects is entrenchment ratio, which should be similar to those of stable upstream or downstream reference reaches, ideally in the range of about three or greater. The entrenchment ratio, defined below, provides a measure related to the distribution of shear stress and the potential for erosion within the channel section (Rosgen 1996):

$$\text{Entrenchment Ratio} = \frac{\text{flood prone channel width}}{\text{bankfull channel width}} \qquad \text{Equation 8-4}$$

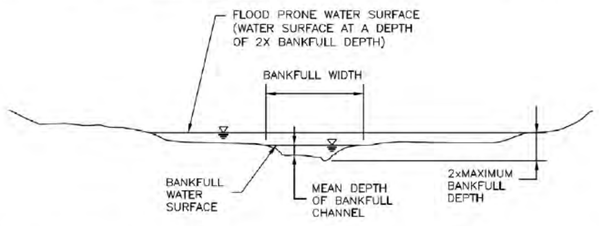


Figure 8-12. Channel cross section with bankfull and flood prone water surfaces (Rosgen 1996

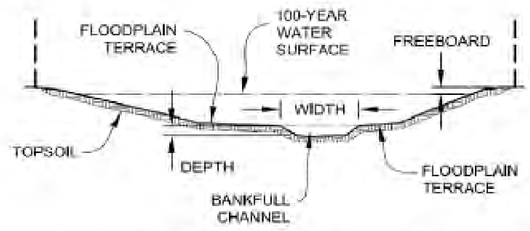


Figure 8-21. Typical naturalized channel geometry

The bankfull channel in naturalized channels should be sized to convey at least 70% of the future development 2-year flow or 10% of the future development 100-year flow, whichever is greater. In addition to the minimum dimensions shown in Table 8-2, a maintenance access path with a minimum per the geometry listed in Table 9-3 of the *Stream Access and Recreational Channels* chapter.

Table 8-3. Design parameters for naturalized channels

Design Parameter	Design Value
Maximum 100-year depth outside of bankfull channel	5 ft
Roughness values	Per Table 8-5
Maximum 5-year velocity, main channel (within bankfull channel width) (ft/s)	5 ft/s
Maximum 100-year velocity, main channel (within bankfull channel width) (ft/s)	7 ft/s
Froude No., 5-year, main channel (within bankfull channel width)	0.7
Froude No., 100-year, main channel (within bankfull channel width)	0.8
Maximum shear stress, 100-year, main channel (within bankfull channel width)	1.2 lb/sf
Minimum bankfull capacity of bankfull channel (based on future development conditions)	70% of 2-year discharge or 10% of 100-yr discharge, whichever is greater[1]
Minimum bankfull channel geometry	Per Table 8-2
Minimum bankfull channel width/depth ratio (Equation 8-3)	9
Minimum entrenchment ratio (Equation 8-4)	3
Maximum longitudinal slope of low flow channel (assuming unlined, unvegetated low flow channel)	0.2 percent
Bankfull channel sinuosity (Equation 8-5)	1.1 to 1.3
Maximum overbank side slope	4(H):1(V)
Maximum bankfull side slope	2.5(H):1(V)
Minimum radius of curvature	2.5 times top width

[1]Roughly equivalent to a 1.5-year event based on extrapolation of regional data

Table 8-1. Maximum prudent values for natural channel hydraulic parameters

Design Parameter	Non-Cohesive Soils or Poor Vegetation	Cohesive Soils and Vegetation
Maximum flow velocity (average of section)	5 ft/s	7 ft/s
Maximum Froude number	0.6	0.8
Maximum tractive force (average of section)	0.60 lb/sf	1.0 lb/sf
Maximum depth outside bankfull channel	5 ft	5 ft

Table 8-2. Minimum dimensions for naturalized channels[1]

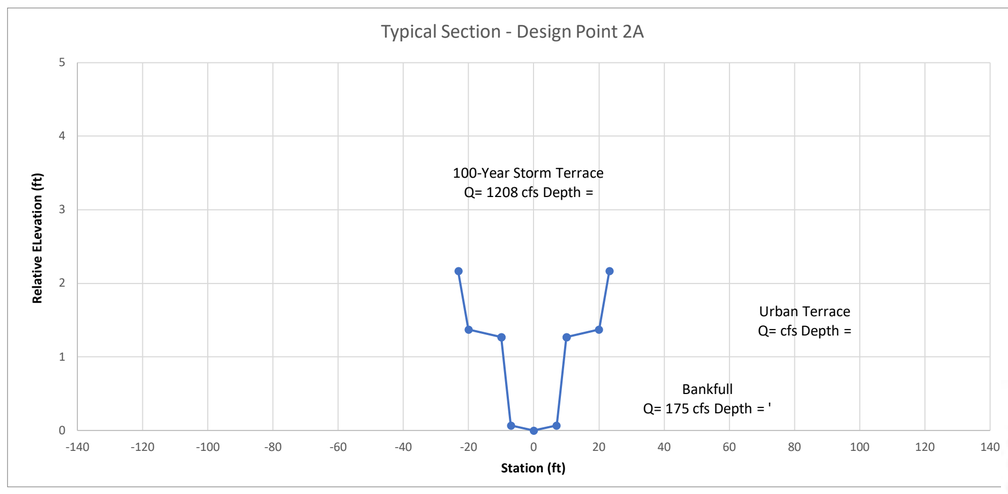
Bankfull Channel Depth, ft	Minimum Bankfull Channel Width, ft	Minimum Floodplain Terrace Width (average each side), ft
0.5	6	6
1.0	10	8
1.5	14	10
2.0	18	12
2.5	24	16
3.0	30	20

[1]Values are based on a desired entrenchment ratio between 3 and 4. Based on several scenarios modeled in HEC-RAS, the values in this table, when paired with the criteria in Table 8-3, produce generally favorable hydraulics.

	Dove Creek DC11 Node 110			
	Flow	Stage Depth	Terrace Width	Top Width
Bankfull Channel	36	1.2	N/A	20.0
Floodplain (100-yr)	136	0.8	10	46

***add 14' for maintenance

			Station	Elevation	Mannings
	Floodplain		-23.200	2.170	0.055
			-20.000	1.370	0.055
			-10.000	1.270	0.045
			-10.000	1.270	0.045
		Bankfull	-10.000	1.270	0.035
			-7.000	0.070	0.035
			0.000	0.000	0.035
			7.000	0.070	0.035
			10.000	1.270	0.035
			10.000	1.270	0.045
			10.000	1.270	0.045
			20.000	1.370	0.055
			23.200	2.170	0.055



Parameter	Bankfull	Floodplain	Units	5-YR
Flow	36	136	cfs	
Depth	1.057	1.978	ft	
Area of Flow	16.749	49.7	sq ft	
Wetted Perimeter	19.317	45.48	ft	
Hydraulic Radius	0.867	1.093	ft	
Average Velocity	2.149	2.736	fps	
Top Width (T)	18.936	44.866	ft	
Froude Number	0.403	0.458		
Critical Depth	0.609	1.488	ft	
Critical Velocity	4.11	4.747	fps	
Critical Slope	0.02252	0.01159	ft/ft	
Critical Top Width	16.694	40.941	ft	
Max Shear Stress	0.205	0.383	lb/ft^2	
Avg Shear Stress	0.168	0.211	lb/ft^2	
Composite Manning's n Equation	Lotter method	Lotter method		
Manning's Roughness	0.035	0.0426		

Stage	Discharge	Total Depth	Bottom Width	Top Width
	[cfs]	[ft]	[ft]	[ft]
Bankfull	36	1.057	14	20
Floodplain Terrace	136	1.98	-	46

Bankfull W/D Ratio	16.2

A useful parameter for quantifying the width of the floodplain terraces in streams not already altered by past channelization projects is entrenchment ratio, which should be similar to those of stable upstream or downstream reference reaches, ideally in the range of about three or greater. The entrenchment ratio, defined below, provides a measure related to the distribution of shear stress and the potential for erosion within the channel section (Rosgen 1996):

$$\text{Entrenchment Ratio} = \frac{\text{flood prone channel width}}{\text{bankfull channel width}} \qquad \text{Equation 8-4}$$

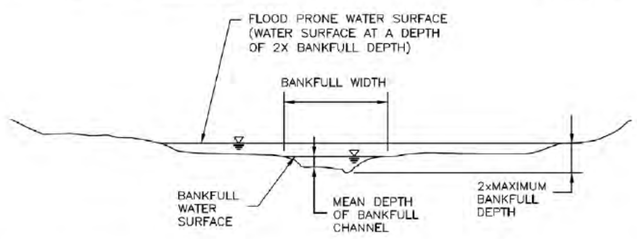


Figure 8-12. Channel cross section with bankfull and flood prone water surfaces (Rosgen 1996

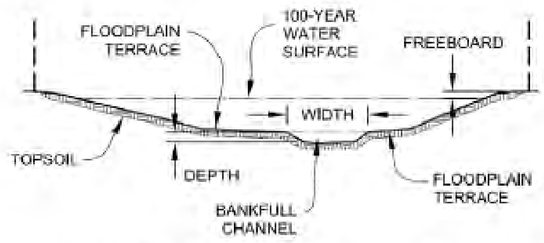


Figure 8-21. Typical naturalized channel geometry

The bankfull channel in naturalized channels should be sized to convey at least 70% of the future development 2-year flow or 10% of the future development 100-year flow, whichever is greater. In addition to the minimum dimensions shown in Table 8-2, a maintenance access path with a minimum per the geometry listed in Table 9-3 of the *Stream Access and Recreational Channels* chapter.

Table 8-3. Design parameters for naturalized channels

Design Parameter	Design Value
Maximum 100-year depth outside of bankfull channel	5 ft
Roughness values	Per Table 8-5
Maximum 5-year velocity, main channel (within bankfull channel width) (ft/s)	5 ft/s
Maximum 100-year velocity, main channel (within bankfull channel width) (ft/s)	7 ft/s
Froude No., 5-year, main channel (within bankfull channel width)	0.7
Froude No., 100-year, main channel (within bankfull channel width)	0.8
Maximum shear stress, 100-year, main channel (within bankfull channel width)	1.2 lb/sf
Minimum bankfull capacity of bankfull channel (based on future development conditions)	70% of 2-year discharge or 10% of 100-yr discharge, whichever is greater[1]
Minimum bankfull channel geometry	Per Table 8-2
Minimum bankfull channel width/depth ratio (Equation 8-3)	9
Minimum entrenchment ratio (Equation 8-4)	3
Maximum longitudinal slope of low flow channel (assuming unlined, unvegetated low flow channel)	0.2 percent
Bankfull channel sinuosity (Equation 8-5)	1.1 to 1.3
Maximum overbank side slope	4(H):1(V)
Maximum bankfull side slope	2.5(H):1(V)
Minimum radius of curvature	2.5 times top width

Table 8-1. Maximum prudent values for natural channel hydraulic parameters

Design Parameter	Non-Cohesive Soils or Poor Vegetation	Cohesive Soils and Vegetation
Maximum flow velocity (average of section)	5 ft/s	7 ft/s
Maximum Froude number	0.6	0.8
Maximum tractive force (average of section)	0.60 lb/sf	1.0 lb/sf
Maximum depth outside bankfull channel	5 ft	5 ft

Table 8-2. Minimum dimensions for naturalized channels[1]

Bankfull Channel Depth, ft	Minimum Bankfull Channel Width, ft	Minimum Floodplain Terrace Width (average each side), ft
0.5	6	6
1.0	10	8
1.5	14	10
2.0	18	12
2.5	24	16
3.0	30	20

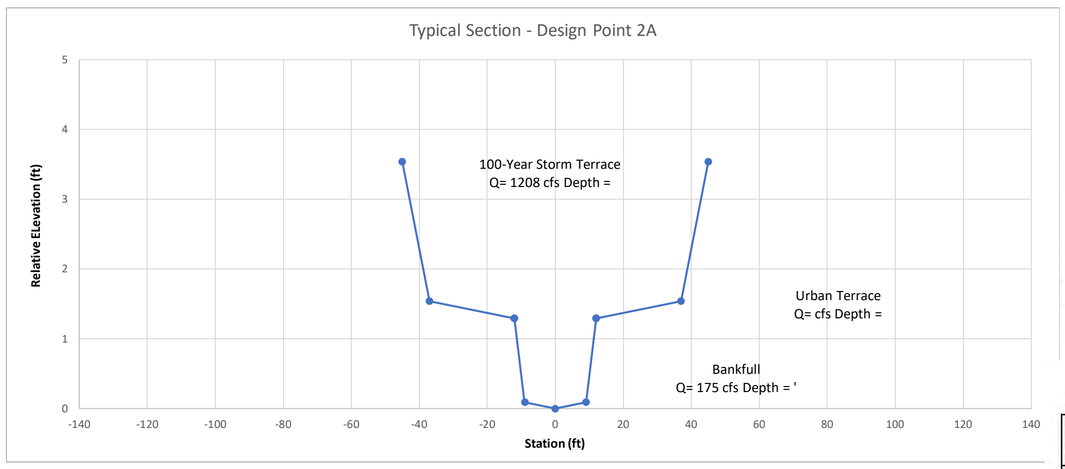
[1]Values are based on a desired entrenchment ratio between 3 and 4. Based on several scenarios modeled in HEC-RAS, the values in this table, when paired with the criteria in Table 8-3, produce generally favorable hydraulics.

*MHFD Stream Management Corridor is 175 ft
2010 MDP is 125 feet

	Dove Creek DC12 Node 107 total				
	Flow	Bottom Width	Stage Depth	Terrace Width	Top Width
Bankfull Channel	46	18	1.2	N/A	24.0
Floodplain (100-yr undetained)	300		2	25	90

***add 14' for maintenance

				Station	Elevation	Mannings
				-45.000	3.540	0.055
				-37.000	1.540	0.055
				-12.000	1.290	0.045
				-12.000	1.290	0.045
				-12.000	1.290	0.035
				-9.000	0.090	0.035
	Floodplain	Urban Terrace	Bankfull	0.000	0.000	0.035
				9.000	0.090	0.035
				12.000	1.290	0.035
				12.000	1.290	0.045
				12.000	1.290	0.045
				37.000	1.540	0.055
				45.000	3.540	0.055



Parameter	Bankfull	5-YEAR	Floodplain	Units	5-YR
Flow	50		300	cfs	
Depth	1.124		2.431	ft	
Area of Flow	22.086		107.388	sq ft	
Wetted Perimeter	23.567		81.815	ft	
Hydraulic Radius	0.937		1.313	ft	
Average Velocity	2.264		2.794	fps	
Top Width (T)	23.168		81.13	ft	
Froude Number	0.409		0.428		
Critical Depth	0.653		1.826	ft	
Critical Velocity	4.261		5.022	fps	
Critical Slope	0.02193		0.01343	ft/ft	
Critical Top Width	20.815		76.287	ft	
Max Shear Stress	0.217		0.47	lb/ft^2	
Avg Shear Stress	0.181		0.254	lb/ft^2	
Composite Manning's n Equation	Lotter method		Lotter method		
Manning's Roughness	0.035		0.0355		

Stage	Discharge	Stage Depth	Total Depth	Bottom Width	Top Width
	[cfs]	[ft]	[ft]	[ft]	[ft]
Bankfull	50	0	1.124	18	24
Floodplain Terrace	300	0	2.43	-	90

Entrenchment Ratio	3.4
Bankfull W/D Ratio	19.3

A useful parameter for quantifying the width of the floodplain terraces in streams not already altered by past channelization projects is entrenchment ratio, which should be similar to those of stable upstream or downstream reference reaches, ideally in the range of about three or greater. The entrenchment ratio, defined below, provides a measure related to the distribution of shear stress and the potential for erosion within the channel section (Rosgen 1996):

$$\text{Entrenchment Ratio} = \frac{\text{flood prone channel width}}{\text{bankfull channel width}} \qquad \text{Equation 8-4}$$

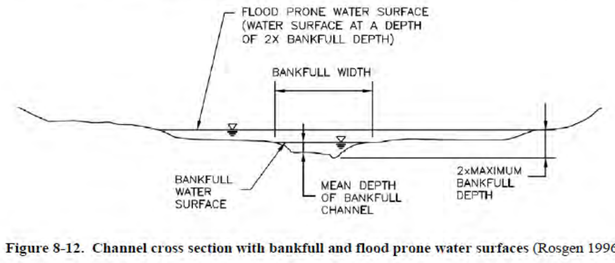


Figure 8-12. Channel cross section with bankfull and flood prone water surfaces (Rosgen 1996)

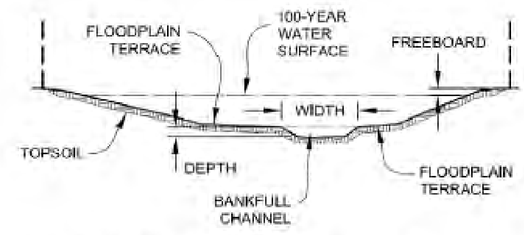


Figure 8-21. Typical naturalized channel geometry

The bankfull channel in naturalized channels should be sized to convey at least 70% of the future development 2-year flow or 10% of the future development 100-year flow, whichever is greater. In addition to the minimum dimensions shown in Table 8-2, a maintenance access path with a minimum per the geometry listed in Table 9-3 of the *Stream Access and Recreational Channels* chapter.

Table 8-3. Design parameters for naturalized channels

Design Parameter	Design Value
Maximum 100-year depth outside of bankfull channel	5 ft
Roughness values	Per Table 8-5
Maximum 5-year velocity, main channel (within bankfull channel width) (ft/s)	5 ft/s
Maximum 100-year velocity, main channel (within bankfull channel width) (ft/s)	7 ft/s
Froude No., 5-year, main channel (within bankfull channel width)	0.7
Froude No., 100-year, main channel (within bankfull channel width)	0.8
Maximum shear stress, 100-year, main channel (within bankfull channel width)	1.2 lb/sf
Minimum bankfull capacity of bankfull channel (based on future development conditions)	70% of 2-year discharge or 10% of 100-yr discharge, whichever is greater[1]
Minimum bankfull channel geometry	Per Table 8-2
Minimum bankfull channel width/depth ratio (Equation 8-3)	9
Minimum entrenchment ratio (Equation 8-4)	3
Maximum longitudinal slope of low flow channel (assuming unlined, unvegetated low flow channel)	0.2 percent
Bankfull channel sinuosity (Equation 8-5)	1.1 to 1.3
Maximum overbank side slope	4(H):1(V)
Maximum bankfull side slope	2.5(H):1(V)
Minimum radius of curvature	2.5 times top width

[1]Roughly equivalent to a 1.5-year event based on extrapolation of regional data

Table 8-1. Maximum prudent values for natural channel hydraulic parameters

Design Parameter	Non-Cohesive Soils or Poor Vegetation	Cohesive Soils and Vegetation
Maximum flow velocity (average of section)	5 ft/s	7 ft/s
Maximum Froude number	0.6	0.8
Maximum tractive force (average of section)	0.60 lb/sf	1.0 lb/sf
Maximum depth outside bankfull channel	5 ft	5 ft

Table 8-2. Minimum dimensions for naturalized channels[1]

Bankfull Channel Depth, ft	Minimum Bankfull Channel Width, ft	Minimum Floodplain Terrace Width (average each side), ft
0.5	6	6
1.0	10	8
1.5	14	10
2.0	18	12
2.5	24	16
3.0	30	20

[1]Values are based on a desired entrenchment ratio between 3 and 4. Based on several scenarios modeled in HEC-RAS, the values in this table, when paired with the criteria in Table 8-3, produce generally favorable hydraulics.

DOVE CREEK AT BRONCOS PARKWAY CULVERT CALCULATION

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Dove at Broncos Parkway

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5719.26	850.00	850.00	0.00	1
5718.88	855.00	855.00	0.00	1
5718.93	860.00	860.00	0.00	1
5718.98	865.00	865.00	0.00	1
5719.02	870.00	870.00	0.00	1
5719.07	875.00	875.00	0.00	1
5719.11	880.00	880.00	0.00	1
5719.16	885.00	885.00	0.00	1
5719.20	890.00	890.00	0.00	1
5719.92	895.00	895.00	0.00	1
5719.99	900.00	900.00	0.00	1
5729.00	1437.01	1437.01	0.00	Overtopping

for hw/D = 1.5 (MHFD V2 chapter 11) hw max = 5719.8' so pipe capacity is ~890 cfs

COST ESTIMATES

Channel Projects*			
Project ID	Channel Project Tier	Length (ft)	Cost
DC6	Stream Restoration	980	$1,862,000
DC12	Adaptive Stream Management	2080	$1,456,000
WC1	Adaptive Stream Management	1410	$987,000
WC7	Adaptive Stream Management	980	$686,000
WC15	Adaptive Stream Management	2020	$1,414,000
LC3	Stream Reclamation and Rehabilitation	1580	$1,896,000
LC12	Stream Reclamation and Rehabilitation	4870	$5,844,000
LC26	Adaptive Stream Management	940	$658,000
CC8	Stream Reclamation and Rehabilitation	1980	$2,376,000
CC12	Adaptive Stream Management	1320	$924,000
CC20	Stream Reclamation and Rehabilitation	1280	$1,536,000
CC14	Stream Reclamation and Rehabilitation	1730	$2,076,000
CC24	Stream Reclamation and Rehabilitation	2230	$2,676,000
CC30	Adaptive Stream Management	855	$598,500
CC32	Adaptive Stream Management	3065	$2,145,500
AT5	Adaptive Stream Management	1940	$1,358,000
IT1	Adaptive Stream Management	850	$595,000
IT2	Stream Reclamation and Rehabilitation	310	$372,000
IT8	Stream Restoration	340	$646,000
IT9	Adaptive Stream Management	1030	$721,000
HT13	Adaptive Stream Management	2440	$1,708,000
CCSP 2	Stream Restoration	400	$760,000
		Total	$33,295,000

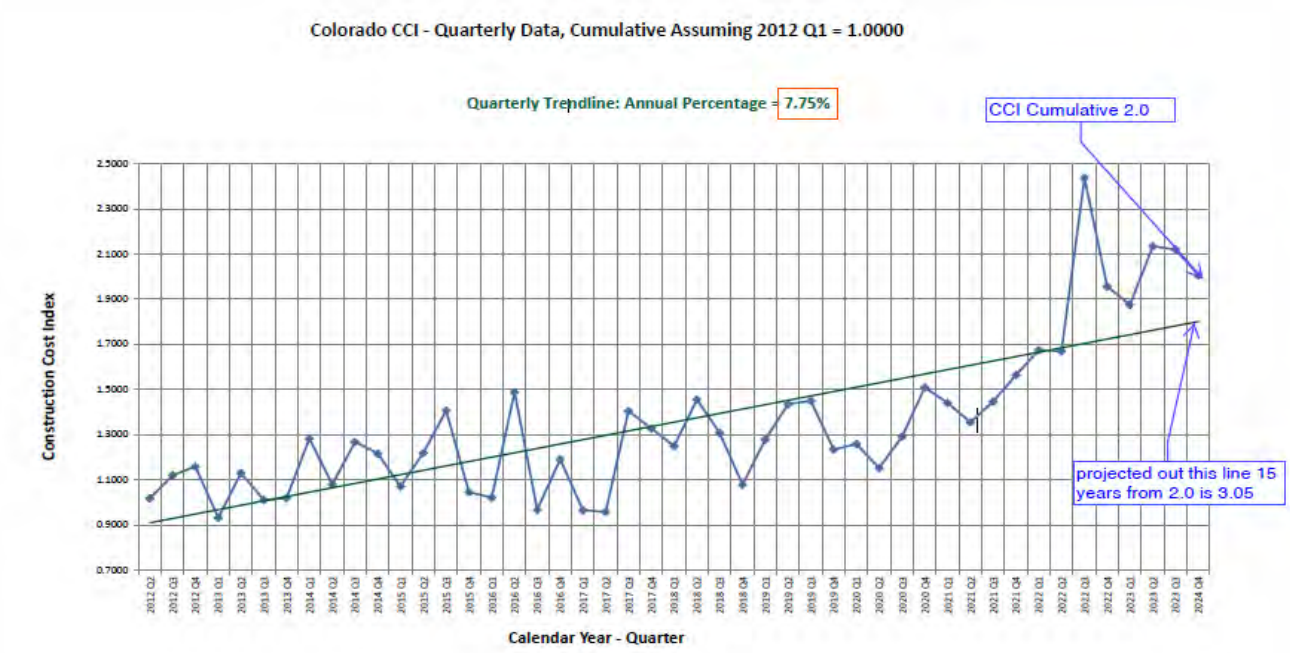
Other Project Types**	
Project ID	Cost
DC4	$278,000
WC3	$607,000
DC5	$611,000
WC10	$498,000
WC14	$408,000
WC18	$271,000
LC6	$578,000
LC10	$354,000
LC19-20	$615,000
CC10	$1,114,000
CC11	$153,000
CC17	$1,018,000
CC23	$900,000
CC29	$931,000
CC35	$321,000
CC36	$471,000
IT5	$873,000
IT14	$926,000
HT2	$1,304,000
HT3	$1,535,000
HT9	$755,000
AT3	$1,228,000
Total	$15,749,000

Channel Project Tier	Cost Per Linear Foot
Adaptive Stream Management	$700
Stream Reclamation and Rehabilitation	$1,200
Stream Restoration	$1,900

*Channel project costs are based on Channel Project Tier and cost per linear foot table provided.

**Other project types based on attached Unit Cost and Master Plan Cost Estimate tables derived from UD-MP-Cost Spreadsheet software provided by MHFD and the projected Consumer Cost Index (CCI).

CCI	7.75% Increase	Year
2.00	0.00	0
2.00	0.08	1
2.08	0.15	2
2.15	0.23	3
2.23	0.30	4
2.30	0.38	5
2.38	0.45	6
2.45	0.53	7
2.53	0.60	8
2.60	0.68	9
2.68	0.75	10
2.75	0.83	11
2.83	0.90	12
2.90	0.98	13
2.98	1.05	14
3.05	1.13	15



Cost Data

Item	Unit	Unit Cost 2012 Q1	Adjusted Unit Cost 2038 Q4
Circular Pipes			
12-inch	L.F.	$36.00	$110.00
18-inch	L.F.	$54.00	$165.00
24-inch	L.F.	$72.00	$220.00
30-inch	L.F.	$90.00	$275.00
36-inch	L.F.	$108.00	$329.00
42-inch	L.F.	$126.00	$384.00
48-inch	L.F.	$144.00	$439.00
54-inch	L.F.	$216.00	$659.00
60-inch	L.F.	$240.00	$732.00
66-inch	L.F.	$264.00	$805.00
72-inch	L.F.	$360.00	$1,098.00
78-inch	L.F.	$390.00	$1,190.00
84-inch	L.F.	$420.00	$1,281.00
90-inch	L.F.	$450.00	$1,373.00
96-inch	L.F.	$480.00	$1,464.00
102-inch	L.F.	$714.00	$2,178.00
108-inch	L.F.	$756.00	$2,306.00
120-inch	L.F.	$840.00	$2,562.00
Flared End Sections			
12-inch	EA	$710.00	$2,166.00
18-inch	EA	$920.00	$2,806.00
24-inch	EA	$970.00	$2,959.00
30-inch	EA	$1,570.00	$4,789.00
36-inch	EA	$1,610.00	$4,911.00
42-inch	EA	$1,700.00	$5,185.00
48-inch	EA	$2,060.00	$6,283.00
Manholes and Inlets			
Manhole, 4' Dia. (Pipe Dia. < 36"), Depth > 15-feet)	EA	$2,900.00	$8,845.00
Manhole, 5' Dia. (Pipe Dia. 36" - 42"), Depth > 15-feet)	EA	$3,900.00	$11,895.00
Manhole, 6' Dia. (Pipe Dia. , Depth > 15-feet)	EA	$4,300.00	$13,115.00
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)	EA	$12,000.00	$36,600.00
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)	EA	$15,000.00	$45,750.00
Storm Inlet, Type R/Type 14, 5-foot, 10-foot deep avg.	EA	$4,600.00	$14,030.00
Headwalls for Circular Pipes			
See Headwall Table			See Headwall Table
Wingwalls for Circular Pipes			
See Wingwall Table			See Wingwall Table
Box Culverts			
See Box Culvert Table			See Box Culvert Table
Hydraulic Structures			
Grouted Boulders, 36-inch	C.Y.	$190.00	$580.00
Soil Riprap, Type M	C.Y.	$70.00	$214.00
Excavation, Complete-in-Place	C.Y.	$11.00	$34.00
Bedding, Granular Type II	C.Y.	$58.00	$177.00
Grout	C.Y.	$240.00	$732.00
Check Structure, Concrete	L.F.	$270.00	$824.00
Channel Improvements			
Boulder Edging, 12" High	L.F.	$60.00	$183.00
Boulder Edging, 24" High	L.F.	$75.00	$229.00
Boulder Edging, 36" High	L.F.	$90.00	$275.00
Concrete Low Flow Channel	L.F.	$40.00	$122.00
Grouted Boulders, 12"	S.Y.	$130.00	$397.00
Grouted Boulders, 18"	S.Y.	$150.00	$458.00
Grouted Boulders, 24"	S.Y.	$170.00	$519.00
Grouted Boulders, 36"	S.Y.	$190.00	$580.00
Grouted Boulders, 48"	S.Y.	$200.00	$610.00
6-inch Riprap, Type VL	C.Y.	$45.00	$137.00
9-inch Riprap, Type L	C.Y.	$55.00	$168.00

12-inch Riprap, Type M	C.Y.	$60.00	$183.00
18-inch Riprap, Type H	C.Y.	$80.00	$244.00
24-inch Riprap, Type VH	C.Y.	$85.00	$259.00
Soil Riprap, Type VL	C.Y.	$50.00	$153.00
Soil Riprap, Type L	C.Y.	$60.00	$183.00
Soil Riprap, Type M	C.Y.	$70.00	$214.00
Soil Riprap, Type H	C.Y.	$80.00	$244.00
Soil Riprap, Type VH	C.Y.	$90.00	$275.00
Excavation, Low Range	C.Y.	$11.00	$34.00
Excavation, Mid Range	C.Y.	$24.00	$73.00
Excavation, High Range	C.Y.	$31.00	$95.00
Detention/Water Quality Facilities			
Excavation, Low Range	C.Y.	$11.00	$34.00
Excavation, Mid Range	C.Y.	$24.00	$73.00
Excavation, High Range	C.Y.	$31.00	$95.00
Outlet Works	EA	User Defined	User Defined
Water Quality Appurtenances	EA	User Defined	User Defined
Detention (Complete-in-Place)	AC-FT	$45,600.00	$139,080.00
Landscaping and Recreation Improvements			
Wetlands Plantings	ACRE	$25,000.00	$76,250.00
Reclamation & seeding (native grasses)	ACRE	$1,000.00	$3,050.00
Trail/Path, Concrete (10' Width)	L.F.	$44.00	$134.00
Trail/Path, Crusher Fines (10' Width)	L.F.	$11.00	$34.00
Removals			
Removal of culvert pipe (D<48")	L.F.	$20.00	$61.00
Removal of culvert pipe (48"<D<84")	L.F.	$50.00	$153.00
Removal of culvert pipe (D>84")	L.F.	$75.00	$229.00
Concrete Box Culvert	L.F./CELL	$100.00	$305.00
Land Acquisition			
Temporary Easements	EA	User Defined	User Defined
Easement/ROW Acquisition	ACRE	User Defined	User Defined
Concrete and Steel			
Concrete	C.Y.	$600.00	$1,830.00
Steel	LB.	$0.90	$3.00
Operation and Maintenance			
Culvert Maintenance	L.F.	$1.00	$3.00
Manhole and Inlet Maintenance	EA	$50.00	$153.00
Hydraulic Structure Maintenance	EA	$500.00	$1,525.00
Channel Maintenance	L.F.	$2.00	$6.00
Detention/WQ Maintenance	ACRE	$1,500.00	$4,575.00
Mowing	ACRE	$50.00	$153.00
Trail Maintenance	L.F.	$5.00	$15.00

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Dove Creek MDP Conceptual				
DRAINAGEWAY :	Dove Creek				
REACH :	PROJECT DC4				
JURISDICTION :	SEMSWA				
REACH ID:	PROJECT DC4	ESTIMATED BY :	MRL	DATE :	03.10.24

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manhole, 4' Dia. (Pipe Dia. < 36")			EA	$8,845.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			EA	$11,895.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")	1		EA	$13,115.00	$13,115.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			EA	$36,600.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			EA	$45,750.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot	2		EA	$14,030.00	$28,060.00	

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)					
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		
					L.F.	$0.00	$0.00		

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
				0.00	0.00	0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$824.00	$0.00	
Channel Improvements											
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$34.00	$0.00	
Excavation, Mid Range								C.Y.	$73.00	$0.00	
Excavation, High Range							100	C.Y.	$95.00	$9,500.00	
Outlet Works					**User Defined Unit Cost ---->**		1	EA	$50,000.00	$50,000.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**		1	EA	$20,000.00	$20,000.00	
Removals											
Removal of culvert pipe (D<48")							20	L.F.	$61.00	$1,220.00	
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00	
Concrete Box Culvert								L.F./CELL	$305.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings								ACRE	$76,250.00	$0.00	
Reclamation & seeding (native grasses)							1	ACRE	$3,050.00	$3,050.00	
Trail/Path, Concrete (10' Width)								L.F.	$134.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00	
Special Items (User Defined)											
Additional Engineering	**<----User Defined Items**				**User Defined Unit Cost ---->**		1	EA	$20,000.00	$20,000.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$41,175.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$79,500.00	
Removals				$1,220.00	
Landscaping and Maintenance Improvements				$3,050.00	
Special Items (User Defined)				$20,000.00	
Subtotal Capital Improvement Costs				**$144,945.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Mobilization		5%		$7,247.00	
Traffic Control	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Stormwater Management/Erosion Control		5%		$7,247.00	
Subtotal Additional Capital Improvement Costs				**$34,494.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$26,916.00	
Legal/Administrative		5%		$8,972.00	
Contract Admin/Construction Management		10%		$17,944.00	
Contingency		25%		$44,860.00	
Subtotal Other Costs				**$98,692.00**	
Total Capital Improvement Costs				**$278,131.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Dove Creek MDP Conceptual				
DRAINAGEWAY :	Dove Creek				
REACH :	PROJECT DC5				
JURISDICTION :	SEMSWA				
REACH ID:	PROJECT DC5	ESTIMATED BY :	MRL	DATE :	03.10.24

DESCRIPTION	SUPPORTING DATA (USER DEFINED AND CALCULATED)	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in) / Length (ft) / No. of Barrels						
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
	Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
Flare End Sections						
Diameter (in) / Applicable / No. of Barrels / U/S FES / D/S FES						
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
Headwalls						
Diameter (in) / Applicable / No. of Barrels / U/S Headwall / D/S Headwall / Concrete (C.Y.) / Steel (lbs)						
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
Wingwalls (includes concrete apron)						
Diameter (in) / No. of Barrels / Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
Manholes and Inlets						
Manhole, 4' Dia. (Pipe Dia. < 36")			EA	$8,845.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			EA	$11,895.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")			EA	$13,115.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			EA	$36,600.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			EA	$45,750.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot			EA	$14,030.00	$0.00	
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft) / Box Height (ft) / No. of Barrels / Length (ft)						
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
Headwall and Toewalls						
Individual Box Span (ft) / No. of Barrels / Total Span (ft) / Concrete (C.Y.) / Steel (lbs) / U/S Headwall / D/S Headwall						
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0.00 0.00	0	EA	$0.00	$0.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft) / Box Rise (ft) / No. of Barrels / Total Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
	0.00 0 0.00 0.00	0	EA	$0.00	$0.00	
Hydraulic Structures						
Sloping Drop Structures						
Height (ft) / Bottom Width (ft) / Yn (ft) / La (ft) / Hard Basin Length (ft) / Total Width (ft)						
	0.00 0.00 0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$824.00	$0.00	
Channel Improvements											
Concrete Low Flow Channel							60	L.F.	$122.00	$7,320.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
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									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
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									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)							1	AC-FT	$139,080.00	$139,080.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$34.00	$0.00	
Excavation, Mid Range								C.Y.	$73.00	$0.00	
Excavation, High Range								C.Y.	$95.00	$0.00	
Outlet Works					**User Defined Unit Cost ---->**		1	EA	$80,000.00	$80,000.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**		1	EA	$100,000.00	$100,000.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$61.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00	
Concrete Box Culvert								L.F./CELL	$305.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings								ACRE	$76,250.00	$0.00	
Reclamation & seeding (native grasses)							1.5	ACRE	$3,050.00	$4,575.00	
Trail/Path, Concrete (10' Width)								L.F.	$134.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$7,320.00	
Detention/Water Quality Facilities				$319,080.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$4,575.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$330,975.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Mobilization		5%		$16,549.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Stormwater Management/Erosion Control		5%		$16,549.00	
Subtotal Additional Capital Improvement Costs				**$63,098.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$59,111.00	
Legal/Administrative		5%		$19,704.00	
Contract Admin/Construction Management		10%		$39,407.00	
Contingency		25%		$98,518.00	
Subtotal Other Costs				**$216,740.00**	
Total Capital Improvement Costs				**$610,813.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Windmill Creek MDP Conceptual				
DRAINAGEWAY :	Windmill Creek				
REACH :	WC3				
JURISDICTION :	SEMSWA				
REACH ID:	WC3	ESTIMATED BY :	MRL	DATE :	12/27/2023

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")			0	EA	$8,845.00	$0.00		
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			0	EA	$11,895.00	$0.00		
Manhole, 6' Dia. (Pipe Dia. = 48")			0	EA	$13,115.00	$0.00		
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			0	EA	$36,600.00	$0.00		
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			0	EA	$45,750.00	$0.00		
Storm Inlet, Type R/Type 14, 5-foot			0	EA	$14,030.00	$0.00		

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
				0.00	0.00	0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$824.00	$0.00	
Channel Improvements											
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)							1	AC-FT	$139,080.00	$139,080.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$34.00	$0.00	
Excavation, Mid Range							200	C.Y.	$73.00	$14,600.00	
Excavation, High Range								C.Y.	$95.00	$0.00	
Outlet Works					**User Defined Unit Cost ---->**		1	EA	$80,000.00	$80,000.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**		1	EA	$40,000.00	$40,000.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$61.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00	
Concrete Box Culvert								L.F./CELL	$305.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings							1	ACRE	$76,250.00	$38,125.00	
Reclamation & seeding (native grasses)							1	ACRE	$3,050.00	$3,050.00	
Trail/Path, Concrete (10' Width)								L.F.	$134.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$273,680.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$41,175.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$314,855.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$30,000.00	L.S.	$30,000.00	
Mobilization		5%		$15,743.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Stormwater Management/Erosion Control		5%		$15,743.00	
Subtotal Additional Capital Improvement Costs				**$76,486.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$58,701.00	
Legal/Administrative		5%		$19,567.00	
Contract Admin/Construction Management		10%		$39,134.00	
Contingency		25%		$97,835.00	
Subtotal Other Costs				**$215,237.00**	
Total Capital Improvement Costs				**$606,578.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Windmill Creek MDP Conceptual				
DRAINAGEWAY :	Windmill Creek				
REACH :	WC10				
JURISDICTION :	SEMSWA				
REACH ID:	WC10	ESTIMATED BY :	MRL	DATE :	12/27/2023

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")				EA	$8,845.00	$0.00		
Manhole, 5' Dia. (Pipe Dia. 36" - 42")				EA	$11,895.00	$0.00		
Manhole, 6' Dia. (Pipe Dia. = 48")				EA	$13,115.00	$0.00		
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)				EA	$36,600.00	$0.00		
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)				EA	$45,750.00	$0.00		
Storm Inlet, Type R/Type 14, 5-foot				EA	$14,030.00	$0.00		

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
				0.00	0.00	0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$824.00	$0.00	
Channel Improvements											
Concrete Low Flow Channel							70	L.F.	$122.00	$8,540.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)							1	AC-FT	$139,080.00	$69,540.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range							50	C.Y.	$34.00	$1,700.00	
Excavation, Mid Range								C.Y.	$73.00	$0.00	
Excavation, High Range								C.Y.	$95.00	$0.00	
Outlet Works						**User Defined Unit Cost ---->**	1	EA	$50,000.00	$50,000.00	
Water Quality Appurtenances						**User Defined Unit Cost ---->**	1	EA	$150,000.00	$150,000.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$61.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00	
Concrete Box Culvert								L.F./CELL	$305.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings								ACRE	$76,250.00	$0.00	
Reclamation & seeding (native grasses)							1	ACRE	$3,050.00	$3,050.00	
Trail/Path, Concrete (10' Width)								L.F.	$134.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$8,540.00	
Detention/Water Quality Facilities				$271,240.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$3,050.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$282,830.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Mobilization		5%		$14,142.00	
Traffic Control	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Stormwater Management/Erosion Control		5%		$14,142.00	
Subtotal Additional Capital Improvement Costs				**$38,284.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$48,167.00	
Legal/Administrative		5%		$16,056.00	
Contract Admin/Construction Management		10%		$32,111.00	
Contingency		25%		$80,279.00	
Subtotal Other Costs				**$176,613.00**	
Total Capital Improvement Costs				**$497,727.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Windmill Creek MDP Conceptual				
DRAINAGEWAY :	Windmill Creek				
REACH :	WC14				
JURISDICTION :	SEMSWA				
REACH ID:	WC14	ESTIMATED BY :	MRL	DATE :	12/27/2023

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")			0	EA	$8,845.00	$0.00		
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			0	EA	$11,895.00	$0.00		
Manhole, 6' Dia. (Pipe Dia. = 48")			0	EA	$13,115.00	$0.00		
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			0	EA	$36,600.00	$0.00		
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			0	EA	$45,750.00	$0.00		
Storm Inlet, Type R/Type 14, 5-foot			0	EA	$14,030.00	$0.00		

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
3	30	2		5.00	48.00	46.00	1	EA	$178,520.52	$178,521.00	

				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
Check Structures												
Check Structure, Concrete								L.F.	$824.00	$0.00		
Channel Improvements												
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
Detention/Water Quality Facilities												
Detention (Complete-in-Place)												
Detention Facility 1 (Complete-in-Place)								AC-FT	$139,080.00	$0.00		
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00		
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00		
Detention (User Entered Quantities)												
Excavation, Low Range								C.Y.	$34.00	$0.00		
Excavation, Mid Range								C.Y.	$73.00	$0.00		
Excavation, High Range								C.Y.	$95.00	$0.00		
Outlet Works					**User Defined Unit Cost ---->**			EA		$0.00		
Water Quality Appurtenances					**User Defined Unit Cost ---->**		1	EA	$50,000.00	$50,000.00	sediment forebay	
Removals												
Removal of culvert pipe (D<48")								L.F.	$61.00	$0.00		
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00		
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00		
Concrete Box Culvert								L.F./CELL	$305.00	$0.00		
Landscaping and Maintenance Improvements												
Wetlands Plantings							0.1	ACRE	$76,250.00	$7,625.00		
Reclamation & seeding (native grasses)							1	ACRE	$3,050.00	$3,050.00		
Trail/Path, Concrete (10' Width)								L.F.	$134.00	$0.00		
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00		
Special Items (User Defined)												
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
Land Acquisition												
Temporary Easements								EA		$0.00		
Easement/ROW Acquisition								ACRE		$0.00		

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$178,521.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$50,000.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$10,675.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$239,196.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Mobilization		5%		$11,960.00	
Traffic Control	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Stormwater Management/Erosion Control		5%		$11,960.00	
Subtotal Additional Capital Improvement Costs				**$23,920.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$39,467.00	
Legal/Administrative		5%		$13,156.00	
Contract Admin/Construction Management		10%		$26,312.00	
Contingency		25%		$65,779.00	
Subtotal Other Costs				**$144,714.00**	
Total Capital Improvement Costs				**$407,830.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Windmill Creek MDP Conceptual				
DRAINAGEWAY :	Windmill Creek				
REACH :	WC18				
JURISDICTION :	SEMSWA				
REACH ID:	WC18	ESTIMATED BY :	MRL	DATE :	12/27/2023

DESCRIPTION	SUPPORTING DATA (USER DEFINED AND CALCULATED)	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in) / Length (ft) / No. of Barrels						
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
	Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
Flare End Sections						
Diameter (in) / Applicable / No. of Barrels / U/S FES / D/S FES						
No	No / No	0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
Headwalls						
Diameter (in) / Applicable / No. of Barrels / U/S Headwall / D/S Headwall / Concrete (C.Y.) / Steel (lbs)						
No	Yes / Yes / 0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
No	0.00 / 0.00	0	EA	$0.00	$0.00	
Wingwalls (includes concrete apron)						
Diameter (in) / No. of Barrels / Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Manholes and Inlets						
Manhole, 4' Dia. (Pipe Dia. < 36")			EA	$8,845.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			EA	$11,895.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")			EA	$13,115.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			EA	$36,600.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			EA	$45,750.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot			EA	$14,030.00	$0.00	
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft) / Box Height (ft) / No. of Barrels / Length (ft)						
6 / 4 / 1	35	L.F.	$1,749.60	$61,236.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
		L.F.	$0.00	$0.00		
Headwall and Toewalls						
Individual Box Span (ft) / No. of Barrels / Total Span (ft) / Concrete (C.Y.) / Steel (lbs) / U/S Headwall / D/S Headwall						
6 / 1 / 8.00 / 0.68 / 176.80 / Yes / Yes	2	EA	$1,774.80	$3,550.00		
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft) / Box Rise (ft) / No. of Barrels / Total Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
6 / 4 / 1 / 6.00 / 14 / 9.78 / 468.68	2	EA	$19,301.29	$38,602.60		
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Hydraulic Structures						
Sloping Drop Structures						
Height (ft) / Bottom Width (ft) / Yn (ft) / La (ft) / Hard Basin Length (ft) / Total Width (ft)						
1 / 20 / 1 / 5.00 / 40.00 / 28.00		EA	$93,482.98	$0.00		

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$824.00	$0.00	
Channel Improvements											
12-inch Riprap, Type M							50	C.Y.	$183.00	$9,150.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
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									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$34.00	$0.00	
Excavation, Mid Range								C.Y.	$73.00	$0.00	
Excavation, High Range							100	C.Y.	$95.00	$9,500.00	
Outlet Works					**User Defined Unit Cost ---->**			EA		$0.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**			EA		$0.00	
Removals											
Removal of culvert pipe (D<48")							35	L.F.	$61.00	$2,135.00	
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00	
Concrete Box Culvert								L.F./CELL	$305.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings								ACRE	$76,250.00	$0.00	
Reclamation & seeding (native grasses)							1.0	ACRE	$3,050.00	$3,050.00	
Trail/Path, Concrete (10' Width)								L.F.	$134.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$103,389.00	
Hydraulic Structures				$0.00	
Channel Improvements				$9,150.00	
Detention/Water Quality Facilities				$9,500.00	
Removals				$2,135.00	
Landscaping and Maintenance Improvements				$3,050.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$127,224.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Mobilization		5%		$6,361.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Stormwater Management/Erosion Control		5%		$6,361.00	
Subtotal Additional Capital Improvement Costs				**$47,722.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$26,242.00	
Legal/Administrative		5%		$8,747.00	
Contract Admin/Construction Management		10%		$17,495.00	
Contingency		25%		$43,737.00	
Subtotal Other Costs				**$96,221.00**	
Total Capital Improvement Costs				**$271,167.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Lone Tree Creek MDP Conceptual				
DRAINAGEWAY :	Lone Tree				
REACH :	LC6				
JURISDICTION :	SEMSWA				
REACH ID:	LC6	ESTIMATED BY :	MRL	DATE :	12.20.23

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")			0	EA	$8,845.00	$0.00		
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			0	EA	$11,895.00	$0.00		
Manhole, 6' Dia. (Pipe Dia. = 48")			0	EA	$13,115.00	$0.00		
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			0	EA	$36,600.00	$0.00		
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			0	EA	$45,750.00	$0.00		
Storm Inlet, Type R/Type 14, 5-foot			0	EA	$14,030.00	$0.00		

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
				0.00	0.00	0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$824.00	$0.00	
Channel Improvements											
Concrete Low Flow Channel							80	L.F.	$122.00	$9,760.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)							2	AC-FT	$139,080.00	$278,160.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$34.00	$0.00	
Excavation, Mid Range								C.Y.	$73.00	$0.00	
Excavation, High Range							200	C.Y.	$95.00	$19,000.00	
Outlet Works						**User Defined Unit Cost ---->**	100000	EA		$0.00	
Water Quality Appurtenances						**User Defined Unit Cost ---->**	100000	EA		$0.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$61.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00	
Concrete Box Culvert								L.F./CELL	$305.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings								ACRE	$76,250.00	$0.00	
Reclamation & seeding (native grasses)							2	ACRE	$3,050.00	$6,100.00	
Trail/Path, Concrete (10' Width)							60	L.F.	$134.00	$8,040.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$9,760.00	
Detention/Water Quality Facilities				$297,160.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$14,140.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$321,060.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Mobilization		5%		$16,053.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Stormwater Management/Erosion Control		5%		$16,053.00	
Subtotal Additional Capital Improvement Costs				**$52,106.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$55,975.00	
Legal/Administrative		5%		$18,658.00	
Contract Admin/Construction Management		10%		$37,317.00	
Contingency		25%		$93,292.00	
Subtotal Other Costs				**$205,242.00**	
Total Capital Improvement Costs				**$578,408.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Lone Tree Creek MDP Conceptual				
DRAINAGEWAY :	Lone Tree				
REACH :	LC10				
JURISDICTION :	SEMSWA				
REACH ID:	LC10	ESTIMATED BY :	MRL	DATE :	12.20.23

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
36-inch	50	1		50	L.F.	$329.00	$16,450.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
36-inch	Yes	1	Yes	Yes		2	EA	$4,911.00	$9,822.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)				
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")					EA	$8,845.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")					EA	$11,895.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")					EA	$13,115.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)					EA	$36,600.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)				2	EA	$45,750.00	$91,500.00	
Storm Inlet, Type R/Type 14, 5-foot					EA	$14,030.00	$0.00	

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall				
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)				
				0.00	0.00	0.00		EA	$0.00	$0.00

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$824.00	$0.00	
Channel Improvements											
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$34.00	$0.00	
Excavation, Mid Range								C.Y.	$73.00	$0.00	
Excavation, High Range							200	C.Y.	$95.00	$19,000.00	
Outlet Works					**User Defined Unit Cost ---->**			EA		$0.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**			EA		$0.00	
Removals											
Removal of culvert pipe (D<48")							50	L.F.	$61.00	$3,050.00	
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00	
Concrete Box Culvert								L.F./CELL	$305.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings								ACRE	$76,250.00	$0.00	
Reclamation & seeding (native grasses)							1	ACRE	$3,050.00	$1,525.00	
Trail/Path, Concrete (10' Width)								L.F.	$134.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00	
Special Items (User Defined)											
Additional Engineering	**<----User Defined Items**				**User Defined Unit Cost ---->**		1	LS	$30,000.00	$30,000.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$117,772.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$19,000.00	
Removals				$3,050.00	
Landscaping and Maintenance Improvements				$1,525.00	
Special Items (User Defined)				$30,000.00	
Subtotal Capital Improvement Costs				**$171,347.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Mobilization		5%		$8,567.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Stormwater Management/Erosion Control		5%		$8,567.00	
Subtotal Additional Capital Improvement Costs				**$57,134.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$34,272.00	
Legal/Administrative		5%		$11,424.00	
Contract Admin/Construction Management		10%		$22,848.00	
Contingency		25%		$57,120.00	
Subtotal Other Costs				**$125,664.00**	
Total Capital Improvement Costs				**$354,145.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Lone Tree Creek MDP Conceptual				
DRAINAGEWAY :	Lone Tree				
REACH :	LC19-20				
JURISDICTION :	SEMSWA				
REACH ID:	LC19-20	ESTIMATED BY :	MRL	DATE :	12.20.23

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
12-inch	100	1		100	L.F.	$110.00	$11,000.00	drain pipe may be smaller
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
12-inch	Yes	1	No	No		0	EA	$2,166.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)				
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")			EA	$8,845.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			EA	$11,895.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")			EA	$13,115.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			EA	$36,600.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			EA	$45,750.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot			EA	$14,030.00	$0.00	

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall				
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)				
				0.00	0.00	0.00		EA	$0.00	$0.00

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$824.00	$0.00	
Channel Improvements											
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$139,080.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$34.00	$0.00	
Excavation, Mid Range								C.Y.	$73.00	$0.00	
Excavation, High Range							200	C.Y.	$95.00	$19,000.00	
Outlet Works					**User Defined Unit Cost ---->**		1	EA	$100,000.00	$100,000.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**		1	EA	$100,000.00	$100,000.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$61.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$153.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$229.00	$0.00	
Concrete Box Culvert								L.F./CELL	$305.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings							1	ACRE	$76,250.00	$76,250.00	
Reclamation & seeding (native grasses)								ACRE	$3,050.00	$0.00	
Trail/Path, Concrete (10' Width)								L.F.	$134.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$34.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$11,000.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$219,000.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$76,250.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$306,250.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$40,000.00	L.S.	$40,000.00	
Mobilization		5%		$15,313.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Stormwater Management/Erosion Control		5%		$15,313.00	
Subtotal Additional Capital Improvement Costs				**$90,626.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$59,531.00	
Legal/Administrative		5%		$19,844.00	
Contract Admin/Construction Management		10%		$39,688.00	
Contingency		25%		$99,219.00	
Subtotal Other Costs				**$218,282.00**	
Total Capital Improvement Costs				**$615,158.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$3.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$153.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$1,525.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$6.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$4,575.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$153.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$15.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	CC10				
JURISDICTION :	SEMSWA				
REACH ID:	Project CC10	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
48-inch	20	1		20	L.F.	$593.00	$11,860.00	estimate depending on open channel or pond
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
48-inch	Yes	1	Yes	Yes		2	EA	$8,487.00	$16,974.00	estimate depending on open channel or pond
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")				EA	$11,948.00	$0.00		
Manhole, 5' Dia. (Pipe Dia. 36" - 42")				EA	$16,068.00	$0.00		
Manhole, 6' Dia. (Pipe Dia. = 48")				EA	$17,716.00	$0.00		
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)				EA	$49,440.00	$0.00		
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)				EA	$61,800.00	$0.00		
Storm Inlet, Type R/Type 14, 5-foot				EA	$18,952.00	$0.00		

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
4	20	1		5.00	52.00	28.00	2	EA	$156,923.55	$313,847.00	estimate depending on open channel or pond

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements											
Boulder Edging, 24" High							30	L.F.	$309.00	$9,270.00	estimate depending on open channel or pond
Excavation, Mid Range							280	C.Y.	$99.00	$27,720.00	estimate depending on open channel or pond
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)							1	AC-FT	$187,872.00	$93,936.00	relocate pond
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range								C.Y.	$99.00	$0.00	
Excavation, High Range							500	C.Y.	$128.00	$64,000.00	
Outlet Works						**User Defined Unit Cost ---->**		EA		$0.00	
Water Quality Appurtenances						**User Defined Unit Cost ---->**		EA		$0.00	
Removals											
Removal of culvert pipe (D<48")							30	L.F.	$82.00	$2,460.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings							0.1	ACRE	$103,000.00	$10,300.00	
Reclamation & seeding (native grasses)							0.5	ACRE	$4,120.00	$2,060.00	
Trail/Path, Concrete (10' Width)							30	L.F.	$181.00	$5,430.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00	
Special Items (User Defined)											
Additional Mobilization	**<----User Defined Items**					**User Defined Unit Cost ---->**	1	EA	$50,000.00	$50,000.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$28,834.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$313,847.00	
Channel Improvements				$36,990.00	
Detention/Water Quality Facilities				$157,936.00	
Removals				$2,460.00	
Landscaping and Maintenance Improvements				$17,790.00	
Special Items (User Defined)				$50,000.00	
Subtotal Capital Improvement Costs				**$607,857.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$30,000.00	L.S.	$30,000.00	
Mobilization		5%		$30,393.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Stormwater Management/Erosion Control		5%		$30,393.00	
Subtotal Additional Capital Improvement Costs				**$110,786.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$107,796.00	
Legal/Administrative		5%		$35,932.00	
Contract Admin/Construction Management		10%		$71,864.00	
Contingency		25%		$179,661.00	
Subtotal Other Costs				**$395,253.00**	
Total Capital Improvement Costs				**$1,113,896.00**	

Master Plan Operation and Maintenance Cost Summary							
Description		**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**			L.F.	$4.00	$0.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**			EA	$206.00	$0.00	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**			EA	$2,060.00	$0.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**			L.F.	$8.00	$0.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**			ACRE	$6,180.00	$0.00	
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**			ACRE	$206.00	$0.00	
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**			L.F.	$21.00	$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**				$0.00	
Total Annual Operation and Maintenance Cost						**$0.00**	
Effective Interest Rate						0.00%	
Total Operation and Maintenance Costs Over 50 Years						**$0.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	Project CC11				
JURISDICTION :	SEMSWA				
REACH ID:	Project CC11	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")			0	EA	$11,948.00	$0.00		
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			0	EA	$16,068.00	$0.00		
Manhole, 6' Dia. (Pipe Dia. = 48")			0	EA	$17,716.00	$0.00		
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			0	EA	$49,440.00	$0.00		
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			0	EA	$61,800.00	$0.00		
Storm Inlet, Type R/Type 14, 5-foot			0	EA	$18,952.00	$0.00		

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
				0.00	0.00	0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements											
9-inch Riprap, Type L							120	C.Y.	$227.00	$27,240.00	
Excavation, Mid Range							100	C.Y.	$99.00	$9,900.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
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									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range								C.Y.	$99.00	$0.00	
Excavation, High Range							100	C.Y.	$128.00	$12,800.00	
Outlet Works						**User Defined Unit Cost ---->**		EA		$0.00	
Water Quality Appurtenances						**User Defined Unit Cost ---->**		EA		$0.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings								ACRE	$103,000.00	$0.00	
Reclamation & seeding (native grasses)							1	ACRE	$4,120.00	$2,060.00	
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00	
Special Items (User Defined)											
Subgrade Prep	**<----User Defined Items**					**User Defined Unit Cost ---->**	1	EA	$15,000.00	$15,000.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$37,140.00	
Detention/Water Quality Facilities				$12,800.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$2,060.00	
Special Items (User Defined)				$15,000.00	
Subtotal Capital Improvement Costs				**$67,000.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$20,000.00	L.S.	$20,000.00	
Mobilization		5%		$3,350.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$0.00	L.S.	$0.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Stormwater Management/Erosion Control		5%		$3,350.00	
Subtotal Additional Capital Improvement Costs				**$31,700.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$14,805.00	
Legal/Administrative		5%		$4,935.00	
Contract Admin/Construction Management		10%		$9,870.00	
Contingency		25%		$24,675.00	
Subtotal Other Costs				**$54,285.00**	
Total Capital Improvement Costs				**$152,985.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	Project CC17				
JURISDICTION :	SEMSWA				
REACH ID:	Project CC17	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
48-inch	180	1		180	L.F.	$593.00	$106,740.00	Using in lieu of slipline
36-inch	180	1		180	L.F.	$445.00	$80,100.00	Using in lieu of slipline
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
48-inch	Yes	1	No	No		0	EA	$8,487.00	$0.00	
36-inch	Yes	1	No	No		0	EA	$6,633.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No		Yes	Yes	0.00	0.00	0	EA	$0.00	$0.00	
	No		Yes	Yes	0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")			0	EA	$11,948.00	$0.00		
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			0	EA	$16,068.00	$0.00		
Manhole, 6' Dia. (Pipe Dia. = 48")			0	EA	$17,716.00	$0.00		
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			0	EA	$49,440.00	$0.00		
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			0	EA	$61,800.00	$0.00		
Storm Inlet, Type R/Type 14, 5-foot			0	EA	$18,952.00	$0.00		

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
3	20	2		5.00	48.00	36.00	2	EA	$188,066.99	$376,134.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements											
Boulder Edging, 24" High							50	L.F.	$309.00	$15,450.00	
Excavation, Mid Range							40	C.Y.	$99.00	$3,960.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range								C.Y.	$99.00	$0.00	
Excavation, High Range								C.Y.	$128.00	$0.00	
Outlet Works					**User Defined Unit Cost ---->**			EA		$0.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**			EA		$0.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings							0.1	ACRE	$103,000.00	$10,300.00	
Reclamation & seeding (native grasses)							1	ACRE	$4,120.00	$4,120.00	
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$186,840.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$376,134.00	
Channel Improvements				$19,410.00	
Detention/Water Quality Facilities				$0.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$14,420.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$596,804.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Mobilization		5%		$29,840.00	
Traffic Control	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Stormwater Management/Erosion Control		5%		$29,840.00	
Subtotal Additional Capital Improvement Costs				**$59,680.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$98,473.00	
Legal/Administrative		5%		$32,824.00	
Contract Admin/Construction Management		10%		$65,648.00	
Contingency		25%		$164,121.00	
Subtotal Other Costs				**$361,066.00**	
Total Capital Improvement Costs				**$1,017,550.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	Project CC29				
JURISDICTION :	SEMSWA				
REACH ID:	Project CC29	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES					
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)				
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")					EA	$11,948.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")					EA	$16,068.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")					EA	$17,716.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)					EA	$49,440.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)					EA	$61,800.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot					EA	$18,952.00	$0.00	

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall				
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
20	20	2		8.00	119.00	36.00	1	EA	$485,228.99	$485,229.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures												
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements												
12-inch Riprap, Type M							90	C.Y.	$247.00	$22,230.00	This cost estimate combines CC28 and CC29
Detention/Water Quality Facilities												
Detention (Complete-in-Place)												
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)												
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range								C.Y.	$99.00	$0.00	
Excavation, High Range								C.Y.	$128.00	$0.00	
Outlet Works					**User Defined Unit Cost ---->**			EA		$0.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**			EA		$0.00	
Removals												
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements												
Wetlands Plantings								ACRE	$103,000.00	$0.00	
Reclamation & seeding (native grasses)								ACRE	$4,120.00	$0.00	
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00	
Special Items (User Defined)												
Maintenance	**<----User Defined Items**				**User Defined Unit Cost ---->**		1	EA	$11,400.00	$11,400.00	See calc below
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition												
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$485,229.00	
Channel Improvements				$22,230.00	
Detention/Water Quality Facilities				$0.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$0.00	
Special Items (User Defined)				$11,400.00	
Subtotal Capital Improvement Costs				**$518,859.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$20,000.00	L.S.	$20,000.00	
Mobilization		5%		$25,943.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Stormwater Management/Erosion Control		5%		$25,943.00	
Subtotal Additional Capital Improvement Costs				**$81,886.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$90,112.00	
Legal/Administrative		5%		$30,037.00	
Contract Admin/Construction Management		10%		$60,075.00	
Contingency		25%		$150,186.00	
Subtotal Other Costs				**$330,410.00**	
Total Capital Improvement Costs				**$931,155.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**	
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00	
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**		2	2	EA	$2,060.00	$8,240.00	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**		1	0.5	ACRE	$6,180.00	$3,090.00	
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00	
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00	
Total Annual Operation and Maintenance Cost							**$11,330.00**	
Effective Interest Rate							0.00%	
Total Operation and Maintenance Costs Over 50 Years							**$566,500.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	Project CC35				
JURISDICTION :	SEMSWA				
REACH ID:	Project CC35	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")			0	EA	$11,948.00	$0.00		
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			0	EA	$16,068.00	$0.00		
Manhole, 6' Dia. (Pipe Dia. = 48")			0	EA	$17,716.00	$0.00		
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			0	EA	$49,440.00	$0.00		
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			0	EA	$61,800.00	$0.00		
Storm Inlet, Type R/Type 14, 5-foot			0	EA	$18,952.00	$0.00		

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
				0.00	0.00	0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
Check Structures												
Check Structure, Concrete								L.F.	$1,112.00	$0.00		
Channel Improvements												
Excavation, Mid Range							50	C.Y.	$99.00	$4,950.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
Detention/Water Quality Facilities												
Detention (Complete-in-Place)												
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention (User Entered Quantities)												
Excavation, Low Range								C.Y.	$45.00	$0.00		
Excavation, Mid Range								C.Y.	$99.00	$0.00		
Excavation, High Range								C.Y.	$128.00	$0.00		
Outlet Works					**User Defined Unit Cost ---->**		1	EA	$20,000.00	$20,000.00		
Water Quality Appurtenances					**User Defined Unit Cost ---->**		1	EA	$10,000.00	$10,000.00		
Removals												
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00		
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00		
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00		
Concrete Box Culvert								L.F./CELL	$412.00	$0.00		
Landscaping and Maintenance Improvements												
Wetlands Plantings								ACRE	$103,000.00	$0.00		
Reclamation & seeding (native grasses)								ACRE	$4,120.00	$0.00		
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00		
Trail/Path, Crusher Fines (10' Width)							70	L.F.	$45.00	$3,150.00	Including this project from CC36	
Special Items (User Defined)												
Sediment Forebay - Large	**<----User Defined Items**				**User Defined Unit Cost ---->**		1	EA	$150,000.00	$150,000.00	Including this project from CC36	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
Land Acquisition												
Temporary Easements								EA		$0.00		
Easement/ROW Acquisition								ACRE		$0.00		

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$4,950.00	
Detention/Water Quality Facilities				$30,000.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$3,150.00	
Special Items (User Defined)				$150,000.00	
Subtotal Capital Improvement Costs				**$188,100.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Mobilization		5%		$9,405.00	
Traffic Control	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Stormwater Management/Erosion Control		5%		$9,405.00	
Subtotal Additional Capital Improvement Costs				**$18,810.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$31,037.00	
Legal/Administrative		5%		$10,346.00	
Contract Admin/Construction Management		10%		$20,691.00	
Contingency		25%		$51,728.00	
Subtotal Other Costs				**$113,802.00**	
Total Capital Improvement Costs				**$320,712.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	Project AT3				
JURISDICTION :	SEMSWA				
REACH ID:	Project AT3	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES					
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)				
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")					EA	$11,948.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")					EA	$16,068.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")					EA	$17,716.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)					EA	$49,440.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)					EA	$61,800.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot					EA	$18,952.00	$0.00	

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)				
				0.00	0.00	0.00		EA	$0.00	$0.00

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements											
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
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									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)							2	AC-FT	$187,872.00	$375,744.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range							400	C.Y.	$99.00	$39,600.00	
Excavation, High Range								C.Y.	$128.00	$0.00	
Outlet Works					**User Defined Unit Cost ---->**		1	EA	$50,000.00	$50,000.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**		1	EA	$50,000.00	$50,000.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings							1	ACRE	$103,000.00	$51,500.00	
Reclamation & seeding (native grasses)							1	ACRE	$4,120.00	$4,120.00	
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00	
Trail/Path, Crusher Fines (10' Width)							100	L.F.	$45.00	$4,500.00	
Special Items (User Defined)											
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements							1	EA	$100,000.00	$100,000.00	
Easement/ROW Acquisition							1.00	ACRE	$100,000.00	$100,000.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$515,344.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$60,120.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$575,464.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$20,000.00	L.S.	$20,000.00	
Mobilization		5%		$28,773.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Stormwater Management/Erosion Control		5%		$28,773.00	
Subtotal Additional Capital Improvement Costs				**$87,546.00**	
Land Acquisition Costs					
ROW/Easements				$200,000.00	
Subtotal Land Acquisition Costs				**$200,000.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$99,452.00	
Legal/Administrative		5%		$33,151.00	
Contract Admin/Construction Management		10%		$66,301.00	
Contingency		25%		$165,753.00	
Subtotal Other Costs				**$364,657.00**	
Total Capital Improvement Costs				**$1,227,667.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	Project CC36				
JURISDICTION :	SEMSWA				
REACH ID:	Project CC36	ESTIMATED BY :	MRL	DATE :	3/10/2024

DESCRIPTION	SUPPORTING DATA (USER DEFINED AND CALCULATED)	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in) / Length (ft) / No. of Barrels						
66-inch / 5 / 2		10	L.F.	$1,088.00	$10,880.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
	Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
Flare End Sections						
Diameter (in) / Applicable / No. of Barrels / U/S FES / D/S FES						
/ No / / / No		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
/ No / / /		0	EA	$0.00	$0.00	
Headwalls						
Diameter (in) / Applicable / No. of Barrels / U/S Headwall / D/S Headwall / Concrete (C.Y.) / Steel (lbs)						
66-inch / Yes / 2 / No / Yes / 4.44 / 453.00		1	EA	$12,787.68	$12,788.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ No / / / / 0.00 / 0.00		0	EA	$0.00	$0.00	
Wingwalls (includes concrete apron)						
Diameter (in) / / No. of Barrels / Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
66-inch / / 2 / 18.75 / 18 / 19.14 / 895.15		1	EA	$50,883.50	$50,884.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
Manholes and Inlets						
Manhole, 4' Dia. (Pipe Dia. < 36")			EA	$11,948.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			EA	$16,068.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")			EA	$17,716.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			EA	$49,440.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			EA	$61,800.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot			EA	$18,952.00	$0.00	
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft) / Box Height (ft) / No. of Barrels		Length (ft)				
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
/ /			L.F.	$0.00	$0.00	
Headwall and Toewalls						
Individual Box Span (ft) / No. of Barrels / Total Span (ft) / Concrete (C.Y.) / Steel (lbs) / U/S Headwall / D/S Headwall						
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
/ / 0.00 / 0.00 / 0.00 / /		0	EA	$0.00	$0.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft) / Box Rise (ft) / No. of Barrels / Total Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
/ / / 0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
Hydraulic Structures						
Sloping Drop Structures						
Height (ft) / Bottom Width (ft) / Yn (ft) / La (ft) / Hard Basin Length (ft) / Total Width (ft)						
2.5 / 30 / 0.5 / 5.00 / 46.00 / 34.00		1	EA	$172,216.78	$172,217.00	Concrete for sediment forebay

				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
Check Structures												
Check Structure, Concrete								L.F.	$1,112.00	$0.00		
Channel Improvements												
Excavation, High Range							50	C.Y.	$128.00	$6,400.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
Detention/Water Quality Facilities												
Detention (Complete-in-Place)												
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention (User Entered Quantities)												
Excavation, Low Range								C.Y.	$45.00	$0.00		
Excavation, Mid Range								C.Y.	$99.00	$0.00		
Excavation, High Range								C.Y.	$128.00	$0.00		
Outlet Works						**User Defined Unit Cost ---->**		EA		$0.00		
Water Quality Appurtenances						**User Defined Unit Cost ---->**		EA		$0.00		
Removals												
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00		
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00		
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00		
Concrete Box Culvert								L.F./CELL	$412.00	$0.00		
Landscaping and Maintenance Improvements												
Wetlands Plantings							0.1	ACRE	$103,000.00	$10,300.00		
Reclamation & seeding (native grasses)							0.1	ACRE	$4,120.00	$412.00		
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00		
Trail/Path, Crusher Fines (10' Width)							270	L.F.	$45.00	$12,150.00		
Special Items (User Defined)												
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
Land Acquisition												
Temporary Easements								EA		$0.00		
Easement/ROW Acquisition								ACRE		$0.00		

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$74,552.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$172,217.00	
Channel Improvements				$6,400.00	
Detention/Water Quality Facilities				$0.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$22,862.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$276,031.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Mobilization		5%		$13,802.00	
Traffic Control	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**		L.S.	$0.00	
Stormwater Management/Erosion Control		5%		$13,802.00	
Subtotal Additional Capital Improvement Costs				**$27,604.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$45,545.00	
Legal/Administrative		5%		$15,182.00	
Contract Admin/Construction Management		10%		$30,364.00	
Contingency		25%		$75,909.00	
Subtotal Other Costs				**$167,000.00**	
Total Capital Improvement Costs				**$470,635.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	CC23				
JURISDICTION :	SEMSWA				
REACH ID:	CC23	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)					
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	
	No				0.00	0.00	0	EA	$0.00	$0.00	

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")		EA	$11,948.00	$0.00			
Manhole, 5' Dia. (Pipe Dia. 36" - 42")		EA	$16,068.00	$0.00			
Manhole, 6' Dia. (Pipe Dia. = 48")		EA	$17,716.00	$0.00			
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)		EA	$49,440.00	$0.00			
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)		EA	$61,800.00	$0.00			
Storm Inlet, Type R/Type 14, 5-foot		EA	$18,952.00	$0.00			

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
3	20	2		5.00	48.00	36.00		EA	$188,066.99	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements											
Boulder Edging, 36" High							100	L.F.	$371.00	$37,100.00	
Grouted Boulders, 24"							50	S.Y.	$700.00	$35,000.00	
Excavation, High Range							2000	C.Y.	$128.00	$256,000.00	
12-inch Riprap, Type M							500	C.Y.	$247.00	$123,500.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range								C.Y.	$99.00	$0.00	
Excavation, High Range								C.Y.	$128.00	$0.00	
Outlet Works					**User Defined Unit Cost ---->**			EA		$0.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**			EA		$0.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings							0.5	ACRE	$103,000.00	$51,500.00	
Reclamation & seeding (native grasses)							0.5	ACRE	$4,120.00	$2,060.00	
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$451,600.00	
Detention/Water Quality Facilities				$0.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$53,560.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$505,160.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Mobilization		5%		$25,258.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Stormwater Management/Erosion Control		5%		$25,258.00	
Subtotal Additional Capital Improvement Costs				**$75,516.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$87,101.00	
Legal/Administrative		5%		$29,034.00	
Contract Admin/Construction Management		10%		$58,068.00	
Contingency		25%		$145,169.00	
Subtotal Other Costs				**$319,372.00**	
Total Capital Improvement Costs				**$900,048.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	IT5				
JURISDICTION :	SEMSWA				
REACH ID:	IT5	ESTIMATED BY :	MRL	DATE :	3/10/2024

DESCRIPTION	SUPPORTING DATA (USER DEFINED AND CALCULATED)	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in) / Length (ft) / No. of Barrels						
48-inch / 80 / 2		160	L.F.	$593.00	$94,880.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
	Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
Flare End Sections						
Diameter (in) / Applicable / No. of Barrels / U/S FES / D/S FES						
48-inch / Yes / 2 / Yes / Yes		4	EA	$8,487.00	$33,948.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
Headwalls						
Diameter (in) / Applicable / No. of Barrels / U/S Headwall / D/S Headwall / Concrete (C.Y.) / Steel (lbs)						
No / No / No / 0.00 / 0.00		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
No		0	EA	$0.00	$0.00	
Wingwalls (includes concrete apron)						
Diameter (in) / No. of Barrels / Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
Manholes and Inlets						
Manhole, 4' Dia. (Pipe Dia. < 36")			EA	$11,948.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			EA	$16,068.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")			EA	$17,716.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			EA	$49,440.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			EA	$61,800.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot		1	EA	$18,952.00	$18,952.00	
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft) / Box Height (ft) / No. of Barrels / Length (ft)						
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
Headwall and Toewalls						
Individual Box Span (ft) / No. of Barrels / Total Span (ft) / Concrete (C.Y.) / Steel (lbs) / U/S Headwall / D/S Headwall						
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0.00 / 0.00		0	EA	$0.00	$0.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft) / Box Rise (ft) / No. of Barrels / Total Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
0.00 / 0 / 0.00 / 0.00		0	EA	$0.00	$0.00	
Hydraulic Structures						
Sloping Drop Structures						
Height (ft) / Bottom Width (ft) / Yn (ft) / La (ft) / Hard Basin Length (ft) / Total Width (ft)						
0.00 / 0.00 / 0.00			EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures												
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements												
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
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									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities												
Detention (Complete-in-Place)												
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)												
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range								C.Y.	$99.00	$0.00	
Excavation, High Range							200	C.Y.	$128.00	$25,600.00	
Outlet Works					**User Defined Unit Cost ---->**		1	EA	$100,000.00	$100,000.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**			EA		$0.00	
Removals												
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements												
Wetlands Plantings							0	ACRE	$103,000.00	$10,300.00	
Reclamation & seeding (native grasses)							0.2	ACRE	$4,120.00	$824.00	
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00	
Special Items (User Defined)												
Additional Engineering	**<----User Defined Items**				**User Defined Unit Cost ---->**		1	EA	$150,000.00	$150,000.00	incl floodplain permitting
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition												
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$147,780.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$125,600.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$11,124.00	
Special Items (User Defined)				$150,000.00	
Subtotal Capital Improvement Costs				**$434,504.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$40,000.00	L.S.	$40,000.00	
Mobilization		5%		$21,725.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$30,000.00	L.S.	$30,000.00	
Stormwater Management/Erosion Control		5%		$21,725.00	
Subtotal Additional Capital Improvement Costs				**$128,450.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$84,443.00	
Legal/Administrative		5%		$28,148.00	
Contract Admin/Construction Management		10%		$56,295.00	
Contingency		25%		$140,739.00	
Subtotal Other Costs				**$309,625.00**	
Total Capital Improvement Costs				**$872,579.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	IT14				
JURISDICTION :	SEMSWA				
REACH ID:	IT14	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES					
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00
	No					0	EA	$0.00	$0.00

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)				
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")					EA	$11,948.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")					EA	$16,068.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")					EA	$17,716.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)					EA	$49,440.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)					EA	$61,800.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot					EA	$18,952.00	$0.00	

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall				
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00
		0.00	0.00	0.00			0	EA	$0.00	$0.00

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)				
				0.00	0.00	0.00		EA	$0.00	$0.00

				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
Check Structures												
Check Structure, Concrete								L.F.	$1,112.00	$0.00		
Channel Improvements												
Grouted Boulders, 12"							40	S.Y.	$536.00	$21,440.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
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									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
Detention/Water Quality Facilities												
Detention (Complete-in-Place)												
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention (User Entered Quantities)												
Excavation, Low Range								C.Y.	$45.00	$0.00		
Excavation, Mid Range								C.Y.	$99.00	$0.00		
Excavation, High Range							100	C.Y.	$128.00	$12,800.00		
Outlet Works						**User Defined Unit Cost ---->**	1	EA	$50,000.00	$50,000.00		
Water Quality Appurtenances						**User Defined Unit Cost ---->**	1	EA	$300,000.00	$300,000.00	Inflow structures	
Removals												
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00		
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00		
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00		
Concrete Box Culvert								L.F./CELL	$412.00	$0.00		
Landscaping and Maintenance Improvements												
Wetlands Plantings								ACRE	$103,000.00	$0.00		
Reclamation & seeding (native grasses)								ACRE	$4,120.00	$0.00		
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00		
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00		
Special Items (User Defined)												
Additional Engineering	**<----User Defined Items**					**User Defined Unit Cost ---->**	1	EA	$100,000.00	$100,000.00	needs floodplain permitting	
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
	<----User Defined Items					**User Defined Unit Cost ---->**				$0.00		
Land Acquisition												
Temporary Easements								EA		$0.00		
Easement/ROW Acquisition								ACRE		$0.00		

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$0.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$21,440.00	
Detention/Water Quality Facilities				$362,800.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$0.00	
Special Items (User Defined)				$100,000.00	
Subtotal Capital Improvement Costs				**$484,240.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$40,000.00	L.S.	$40,000.00	
Mobilization		5%		$24,212.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Stormwater Management/Erosion Control		5%		$24,212.00	
Subtotal Additional Capital Improvement Costs				**$113,424.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$89,650.00	
Legal/Administrative		5%		$29,883.00	
Contract Admin/Construction Management		10%		$59,766.00	
Contingency		25%		$149,416.00	
Subtotal Other Costs				**$328,715.00**	
Total Capital Improvement Costs				**$926,379.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	HT2				
JURISDICTION :	SEMSWA				
REACH ID:	HT2	ESTIMATED BY :	MRL	DATE :	3/10/2024

DESCRIPTION	SUPPORTING DATA (USER DEFINED AND CALCULATED)	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in) / Length (ft) / No. of Barrels						
72-inch / 150 / 2		300	L.F.	$1,483.00	$444,900.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
	Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
Flare End Sections						
Diameter (in) / Applicable / No. of Barrels / U/S FES / D/S FES						
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
Headwalls						
Diameter (in) / Applicable / No. of Barrels / U/S Headwall / D/S Headwall / Concrete (C.Y.) / Steel (lbs)						
72-inch / Yes / 2 / Yes / Yes / 4.91 / 476.00		2	EA	$14,041.52	$28,083.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
Wingwalls (includes concrete apron)						
Diameter (in) / / No. of Barrels / Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
72-inch /	2 / 20.00 / 18 / 21.32 / 967.14	2	EA	$56,575.50	$113,151.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Manholes and Inlets						
Manhole, 4' Dia. (Pipe Dia. < 36")			EA	$11,948.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			EA	$16,068.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")			EA	$17,716.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			EA	$49,440.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)		2	EA	$61,800.00	$123,600.00	
Storm Inlet, Type R/Type 14, 5-foot		1	EA	$18,952.00	$18,952.00	
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft) / Box Height (ft) / No. of Barrels		Length (ft)				
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
Headwall and Toewalls						
Individual Box Span (ft) / No. of Barrels / Total Span (ft) / Concrete (C.Y.) / Steel (lbs) / U/S Headwall / D/S Headwall						
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft) / Box Rise (ft) / No. of Barrels / Total Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Hydraulic Structures						
Sloping Drop Structures						
Height (ft) / Bottom Width (ft) / Yn (ft) / La (ft) / Hard Basin Length (ft) / Total Width (ft)						
	0.00 / 0.00 / 0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
				0.00	0.00	0.00		EA	$0.00	$0.00		
Check Structures												
Check Structure, Concrete								L.F.	$1,112.00	$0.00		
Channel Improvements												
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
									$0.00	$0.00		
Detention/Water Quality Facilities												
Detention (Complete-in-Place)												
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00		
Detention (User Entered Quantities)												
Excavation, Low Range								C.Y.	$45.00	$0.00		
Excavation, Mid Range								C.Y.	$99.00	$0.00		
Excavation, High Range								C.Y.	$128.00	$0.00		
Outlet Works					**User Defined Unit Cost ---->**			EA		$0.00		
Water Quality Appurtenances					**User Defined Unit Cost ---->**			EA		$0.00		
Removals												
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00		
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00		
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00		
Concrete Box Culvert								L.F./CELL	$412.00	$0.00		
Landscaping and Maintenance Improvements												
Wetlands Plantings								ACRE	$103,000.00	$0.00		
Reclamation & seeding (native grasses)								ACRE	$4,120.00	$0.00		
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00		
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00		
Special Items (User Defined)												
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00		
Land Acquisition												
Temporary Easements								EA		$0.00		
Easement/ROW Acquisition								ACRE		$0.00		

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$728,686.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$0.00	
Detention/Water Quality Facilities				$0.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$0.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$728,686.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Mobilization		5%		$36,434.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$20,000.00	L.S.	$20,000.00	
Stormwater Management/Erosion Control		5%		$36,434.00	
Subtotal Additional Capital Improvement Costs				**$112,868.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$126,233.00	
Legal/Administrative		5%		$42,078.00	
Contract Admin/Construction Management		10%		$84,155.00	
Contingency		25%		$210,389.00	
Subtotal Other Costs				**$462,855.00**	
Total Capital Improvement Costs				**$1,304,409.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	HT3				
JURISDICTION :	SEMSWA				
REACH ID:	HT3	ESTIMATED BY :	MRL	DATE :	3/10/2024

Pipe Culverts and Storm Drains

Circular Pipes

Diameter (in)	Length (ft)	No. of Barrels		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
90-inch	120	2		240	L.F.	$1,854.00	$444,960.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
			Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	
				0	L.F.	$0.00	$0.00	

Flare End Sections

Diameter (in)	Applicable	No. of Barrels	U/S FES	D/S FES						
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	
	No					0	EA	$0.00	$0.00	

Headwalls

Diameter (in)	Applicable	No. of Barrels	U/S Headwall	D/S Headwall	Concrete (C.Y.)	Steel (lbs)				
90-inch	Yes	2	Yes	Yes	6.08	593.00	2	EA	$17,401.76	$34,804.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00
	No				0.00	0.00	0	EA	$0.00	$0.00

Wingwalls (includes concrete apron)

Diameter (in)		No. of Barrels	Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)				
90-inch		2	23.75	22	30.25	1374.00	2	EA	$80,284.93	$160,570.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00

Manholes and Inlets

Manhole, 4' Dia. (Pipe Dia. < 36")					EA	$11,948.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")					EA	$16,068.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")					EA	$17,716.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)					EA	$49,440.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)				1	EA	$61,800.00	$61,800.00	
Storm Inlet, Type R/Type 14, 5-foot					EA	$18,952.00	$0.00	

Concrete Box Culverts

Box Culvert Pipe

Individual Box Span (ft)	Box Height (ft)	No. of Barrels		Length (ft)				
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	
					L.F.	$0.00	$0.00	

Headwall and Toewalls

Individual Box Span (ft)	No. of Barrels	Total Span (ft)	Concrete (C.Y.)	Steel (lbs)	U/S Headwall	D/S Headwall					
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	
		0.00	0.00	0.00			0	EA	$0.00	$0.00	

Wingwalls (includes wingwalls on either side of channel and concrete apron)

Individual Box Span (ft)	Box Rise (ft)	No. of Barrels	Total Interior Span (ft)	Length (ft)	Concrete (C.Y.)	Steel (lbs)					
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	
			0.00	0	0.00	0.00	0	EA	$0.00	$0.00	

Hydraulic Structures

Sloping Drop Structures

Height (ft)	Bottom Width (ft)	Yn (ft)		La (ft)	Hard Basin Length (ft)	Total Width (ft)					
				0.00	0.00	0.00		EA	$0.00	$0.00	

				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements											
Grouted Boulders, 24"							200	S.Y.	$700.00	$140,000.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range								C.Y.	$99.00	$0.00	
Excavation, High Range								C.Y.	$128.00	$0.00	
Outlet Works					**User Defined Unit Cost ---->**			EA		$0.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**			EA		$0.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings							0.3	ACRE	$103,000.00	$30,900.00	
Reclamation & seeding (native grasses)								ACRE	$4,120.00	$0.00	
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00	
Special Items (User Defined)											
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$702,134.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$140,000.00	
Detention/Water Quality Facilities				$0.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$30,900.00	
Special Items (User Defined)				$0.00	
Subtotal Capital Improvement Costs				**$873,034.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$10,000.00	L.S.	$10,000.00	
Mobilization		5%		$43,652.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$15,000.00	L.S.	$15,000.00	
Stormwater Management/Erosion Control		5%		$43,652.00	
Subtotal Additional Capital Improvement Costs				**$117,304.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$148,551.00	
Legal/Administrative		5%		$49,517.00	
Contract Admin/Construction Management		10%		$99,034.00	
Contingency		25%		$247,585.00	
Subtotal Other Costs				**$544,687.00**	
Total Capital Improvement Costs				**$1,535,025.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	Cottonwood Creek MDP Conceptual				
DRAINAGEWAY :	Cottonwood Creek				
REACH :	HT9				
JURISDICTION :	SEMSWA				
REACH ID:	HT9	ESTIMATED BY :	MRL	DATE :	3/10/2024

DESCRIPTION	SUPPORTING DATA (USER DEFINED AND CALCULATED)	QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains						
Circular Pipes						
Diameter (in) / Length (ft) / No. of Barrels						
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
	Note : Prices reflect circular reinforced concrete pipe. For arch or elliptical pipes, user shall use equivalent circular pipe diameter.	0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
		0	L.F.	$0.00	$0.00	
Flare End Sections						
Diameter (in) / Applicable / No. of Barrels / U/S FES / D/S FES						
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
Headwalls						
Diameter (in) / Applicable / No. of Barrels / U/S Headwall / D/S Headwall / Concrete (C.Y.) / Steel (lbs)						
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
	No	0	EA	$0.00	$0.00	
Wingwalls (includes concrete apron)						
Diameter (in) / No. of Barrels / Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Manholes and Inlets						
Manhole, 4' Dia. (Pipe Dia. < 36")			EA	$11,948.00	$0.00	
Manhole, 5' Dia. (Pipe Dia. 36" - 42")			EA	$16,068.00	$0.00	
Manhole, 6' Dia. (Pipe Dia. = 48")			EA	$17,716.00	$0.00	
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			EA	$49,440.00	$0.00	
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			EA	$61,800.00	$0.00	
Storm Inlet, Type R/Type 14, 5-foot		1	EA	$18,952.00	$18,952.00	
Concrete Box Culverts						
Box Culvert Pipe						
Individual Box Span (ft) / Box Height (ft) / No. of Barrels / Length (ft)						
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
			L.F.	$0.00	$0.00	
Headwall and Toewalls						
Individual Box Span (ft) / No. of Barrels / Total Span (ft) / Concrete (C.Y.) / Steel (lbs) / U/S Headwall / D/S Headwall						
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Wingwalls (includes wingwalls on either side of channel and concrete apron)						
Individual Box Span (ft) / Box Rise (ft) / No. of Barrels / Total Interior Span (ft) / Length (ft) / Concrete (C.Y.) / Steel (lbs)						
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
	0.00 / 0 / 0.00 / 0.00	0	EA	$0.00	$0.00	
Hydraulic Structures						
Sloping Drop Structures						
Height (ft) / Bottom Width (ft) / Yn (ft) / La (ft) / Hard Basin Length (ft) / Total Width (ft)						
	0.00 / 0.00 / 0.00		EA	$0.00	$0.00	

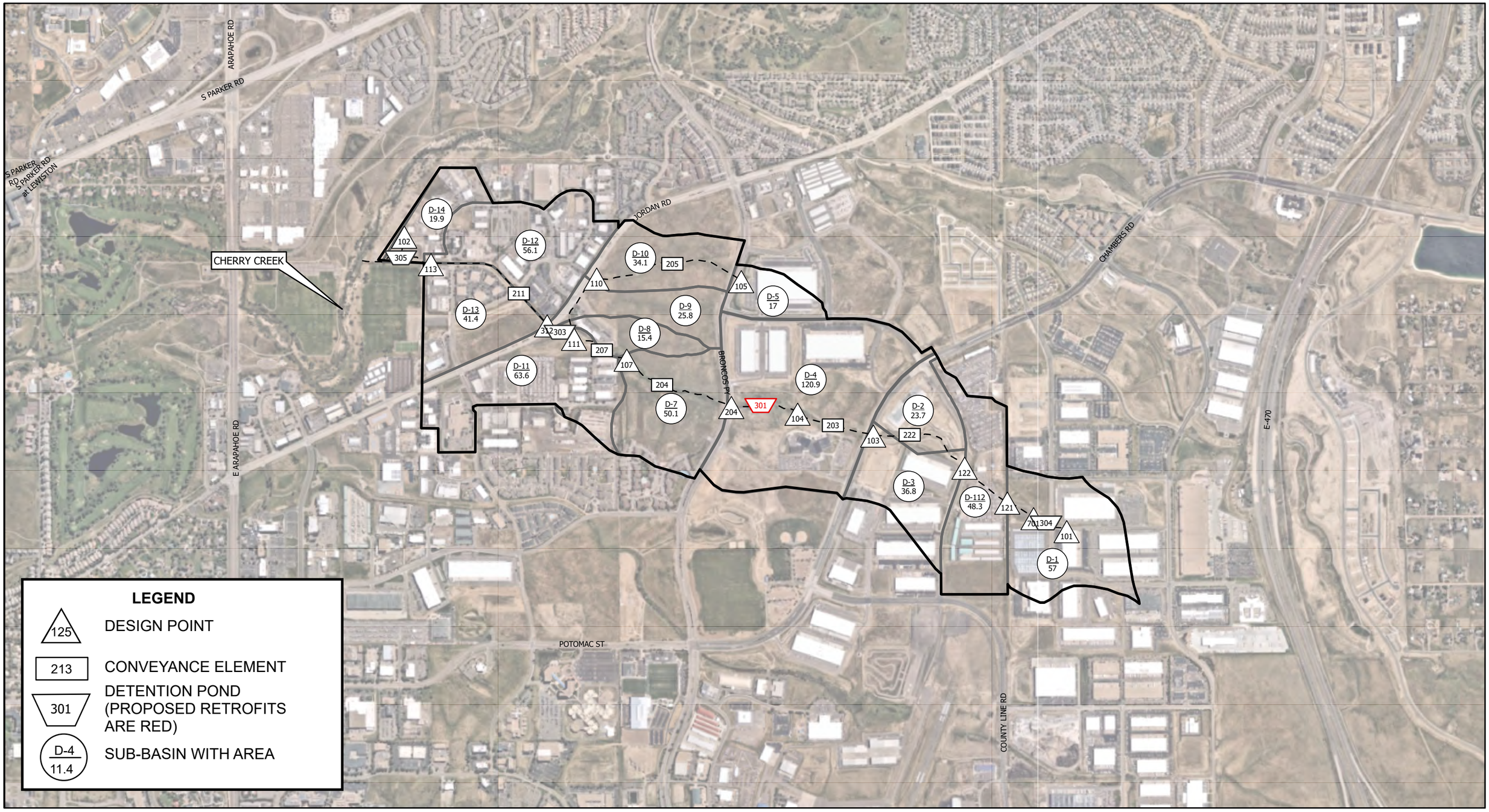
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
				0.00	0.00	0.00		EA	$0.00	$0.00	
Check Structures											
Check Structure, Concrete								L.F.	$1,112.00	$0.00	
Channel Improvements											
Grouted Boulders, 18"							50	S.Y.	$618.00	$30,900.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
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									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
									$0.00	$0.00	
Detention/Water Quality Facilities											
Detention (Complete-in-Place)											
Detention Facility 1 (Complete-in-Place)							1	AC-FT	$187,872.00	$187,872.00	
Detention Facility 2 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention Facility 3 (Complete-in-Place)								AC-FT	$187,872.00	$0.00	
Detention (User Entered Quantities)											
Excavation, Low Range								C.Y.	$45.00	$0.00	
Excavation, Mid Range							200	C.Y.	$99.00	$19,800.00	
Excavation, High Range								C.Y.	$128.00	$0.00	
Outlet Works					**User Defined Unit Cost ---->**		1	EA	$50,000.00	$50,000.00	
Water Quality Appurtenances					**User Defined Unit Cost ---->**		1	EA	$50,000.00	$50,000.00	
Removals											
Removal of culvert pipe (D<48")								L.F.	$82.00	$0.00	
Removal of culvert pipe (48"<D<84")								L.F.	$206.00	$0.00	
Removal of culvert pipe (D>84")								L.F.	$309.00	$0.00	
Concrete Box Culvert								L.F./CELL	$412.00	$0.00	
Landscaping and Maintenance Improvements											
Wetlands Plantings								ACRE	$103,000.00	$0.00	
Reclamation & seeding (native grasses)							2	ACRE	$4,120.00	$8,240.00	
Trail/Path, Concrete (10' Width)								L.F.	$181.00	$0.00	
Trail/Path, Crusher Fines (10' Width)								L.F.	$45.00	$0.00	
Special Items (User Defined)											
Additional Engineering	**<----User Defined Items**				**User Defined Unit Cost ---->**		1	EA	$50,000.00	$50,000.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
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	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
	<----User Defined Items				**User Defined Unit Cost ---->**					$0.00	
Land Acquisition											
Temporary Easements								EA		$0.00	
Easement/ROW Acquisition								ACRE		$0.00	

Master Plan Capital Improvement Cost Summary					
Capital Improvement Costs					
Pipe Culverts and Storm Drains				$18,952.00	
Concrete Box Culverts				$0.00	
Hydraulic Structures				$0.00	
Channel Improvements				$30,900.00	
Detention/Water Quality Facilities				$307,672.00	
Removals				$0.00	
Landscaping and Maintenance Improvements				$8,240.00	
Special Items (User Defined)				$50,000.00	
Subtotal Capital Improvement Costs				**$415,764.00**	
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost ---->**	$20,000.00	L.S.	$20,000.00	
Mobilization		5%		$20,788.00	
Traffic Control	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Utility Coordination/Relocation	**User Defined Lump Sum Cost ---->**	$5,000.00	L.S.	$5,000.00	
Stormwater Management/Erosion Control		5%		$20,788.00	
Subtotal Additional Capital Improvement Costs				**$71,576.00**	
Land Acquisition Costs					
ROW/Easements				$0.00	
Subtotal Land Acquisition Costs				**$0.00**	
Other Costs (percentage of Capital Improvement Costs)					
Engineering		15%		$73,101.00	
Legal/Administrative		5%		$24,367.00	
Contract Admin/Construction Management		10%		$48,734.00	
Contingency		25%		$121,835.00	
Subtotal Other Costs				**$268,037.00**	
Total Capital Improvement Costs				**$755,377.00**	

Master Plan Operation and Maintenance Cost Summary							
Description			**Frequency**	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$4.00	$0.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$206.00	$0.00
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				EA	$2,060.00	$0.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$8.00	$0.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, structural repairs, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$6,180.00	$0.00
Mowing (e.g. channels, ponds, etc.)	**Optional User Defined Unit Cost ---->**				ACRE	$206.00	$0.00
Trail Maintenance (e.g. structural repairs, crusher fines, etc.)	**Optional User Defined Unit Cost ---->**				L.F.	$21.00	$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
	<----User Defined Items	**User Defined Unit Cost ---->**					$0.00
Total Annual Operation and Maintenance Cost							**$0.00**
Effective Interest Rate							0.00%
Total Operation and Maintenance Costs Over 50 Years							**$0.00**

Appendix G – Hydrologic Calculations

SWMM SCHEMATIC



LEGEND

- 125 — DESIGN POINT
- 213 — CONVEYANCE ELEMENT
- 301 — DETENTION POND (PROPOSED RETROFITS ARE RED)
- D-4 / 11.4 — SUB-BASIN WITH AREA

Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\SWMM Schematic\SWMM Schematic.aprx

WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO. 211-088.000

DATE: 3/15/2024

SWMM SCHEMATIC

DOVE CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

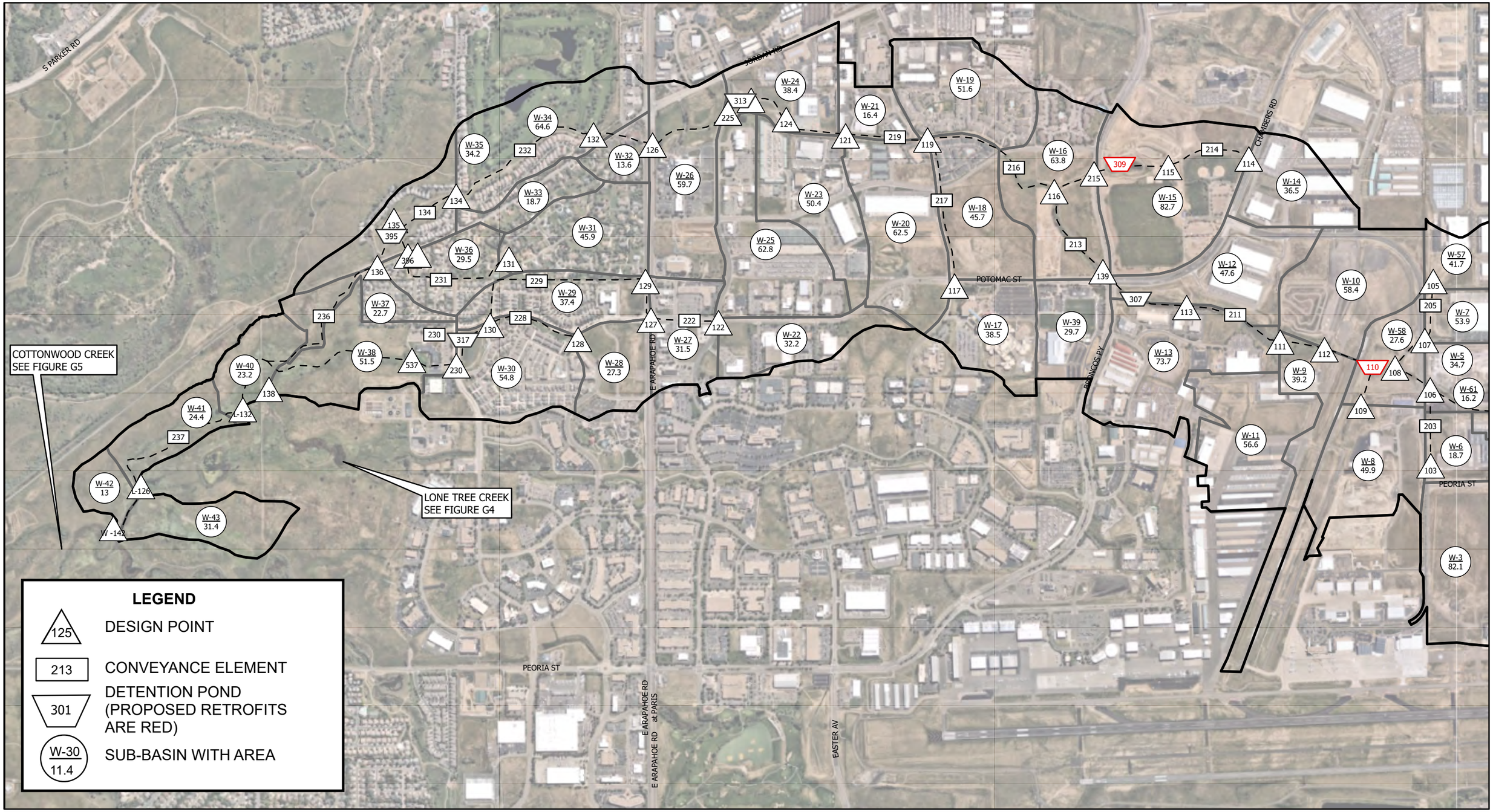
1 in = 1,250 ft

0 625 1,250

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE G1



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\SWMM Schematic\SWMM Schematic.aprx

WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO. 211-088.000

DATE: 3/15/2024

SWMM SCHEMATIC

WINDMILL CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

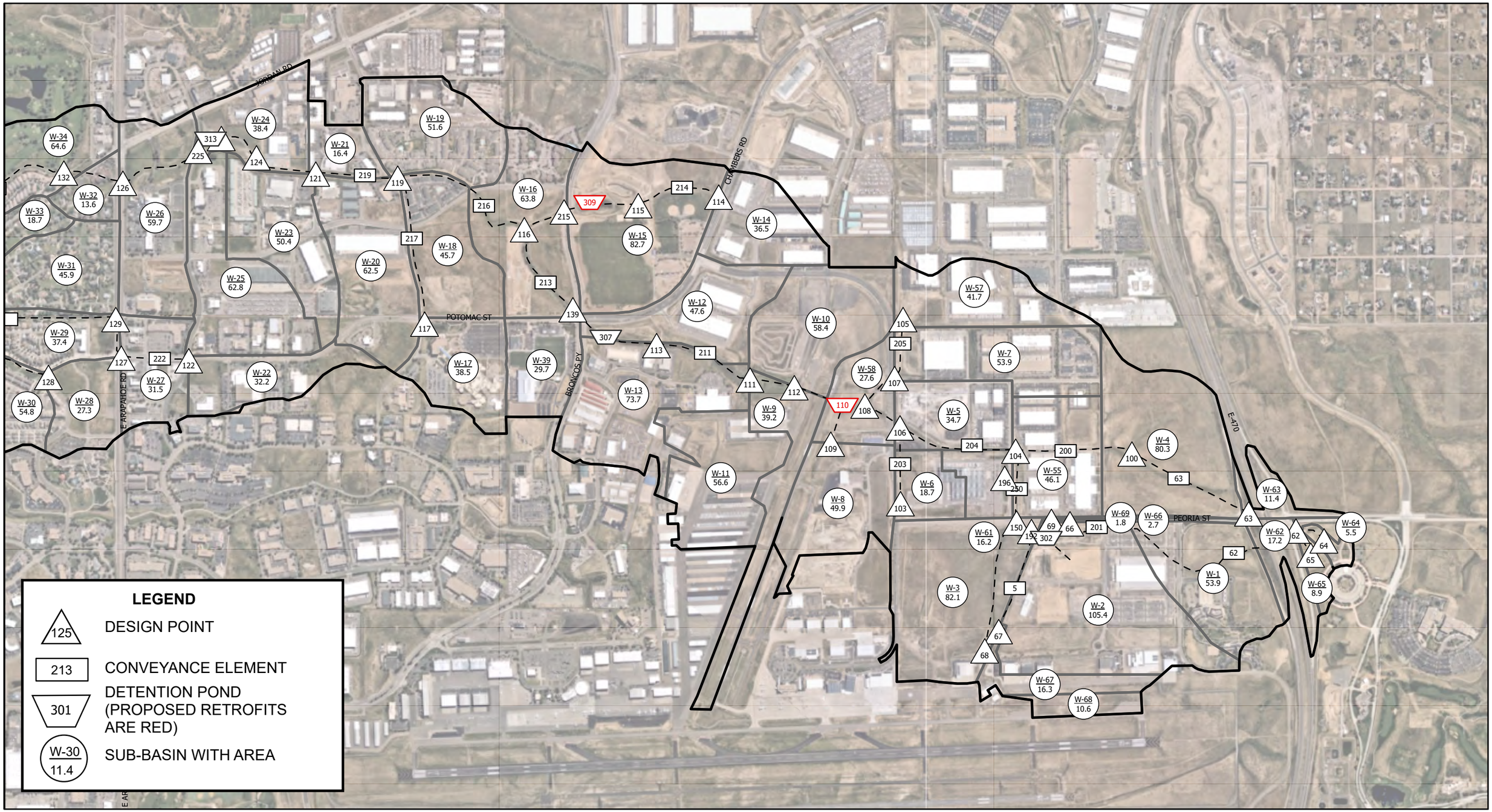
1 in = 1,250 ft

0 625 1,250

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE G2



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\SWMM Schematic\SWMM Schematic.aprx

WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO. 211-088.000

DATE: 3/15/2024

SWMM SCHEMATIC

WINDMILL CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

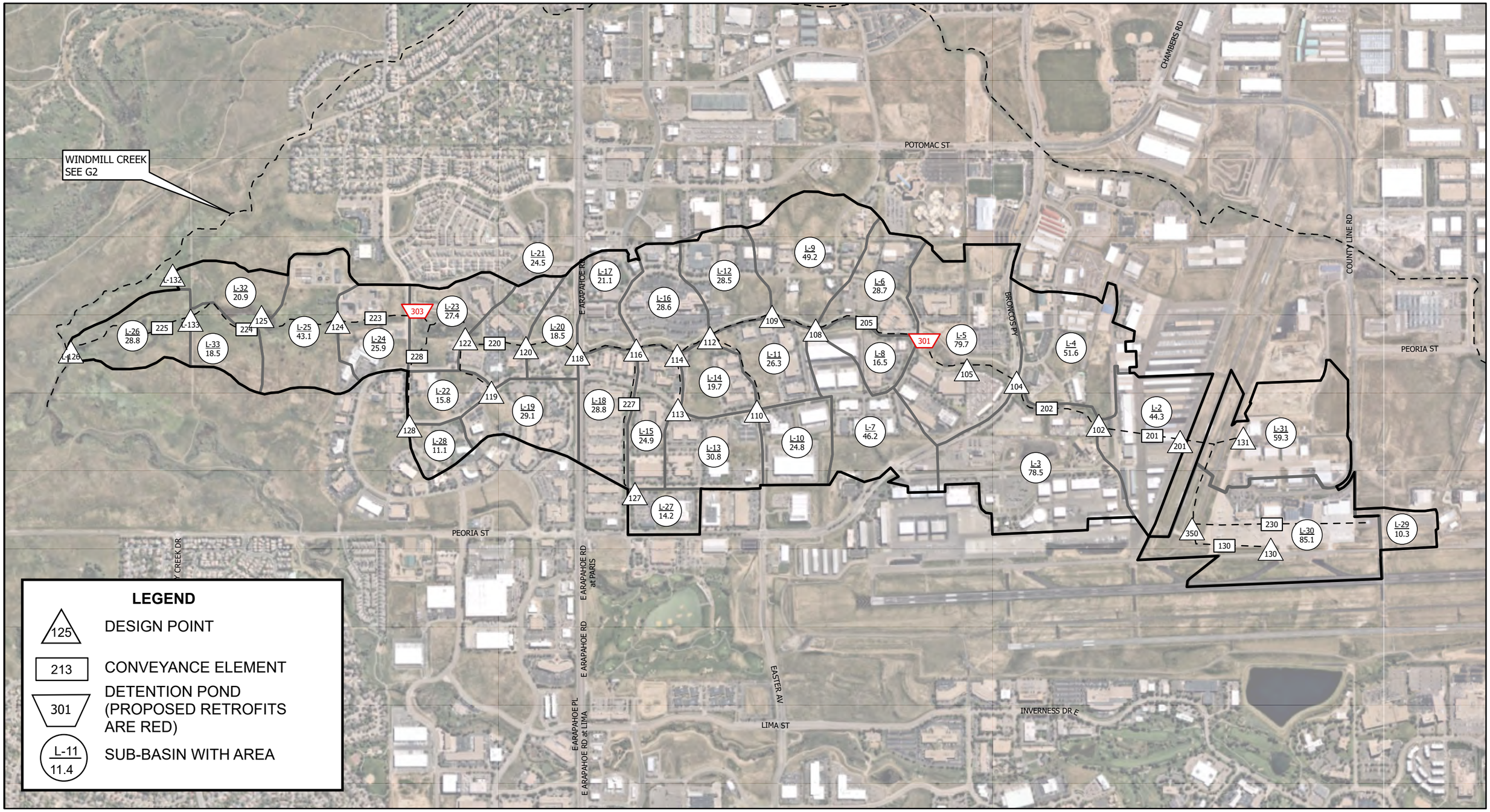
1 in = 1,250 ft

0 625 1,250

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE G3



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\SWMM Schematic\SWMM Schematic.aprx

WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO. 211-088.000

DATE: 3/15/2024

SWMM SCHEMATIC

LONE TREE CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

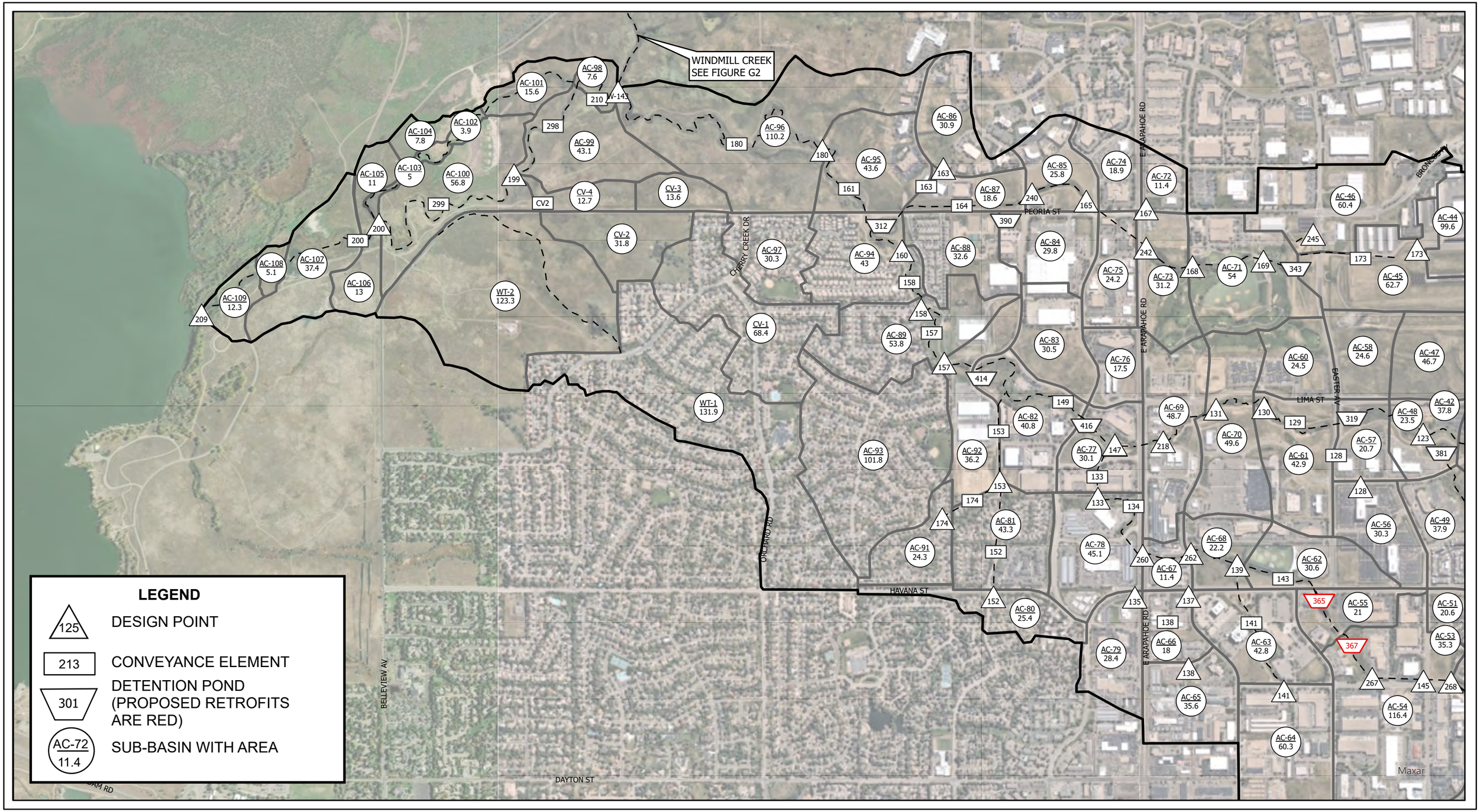
1 in = 1,250 ft

0 625 1,250

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE G4



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\SWMM Schematic\SWMM Schematic.aprx

WWE WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO. 211-088.000

DATE: 3/14/2024

SWMM SCHEMATIC

COTTONWOOD CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

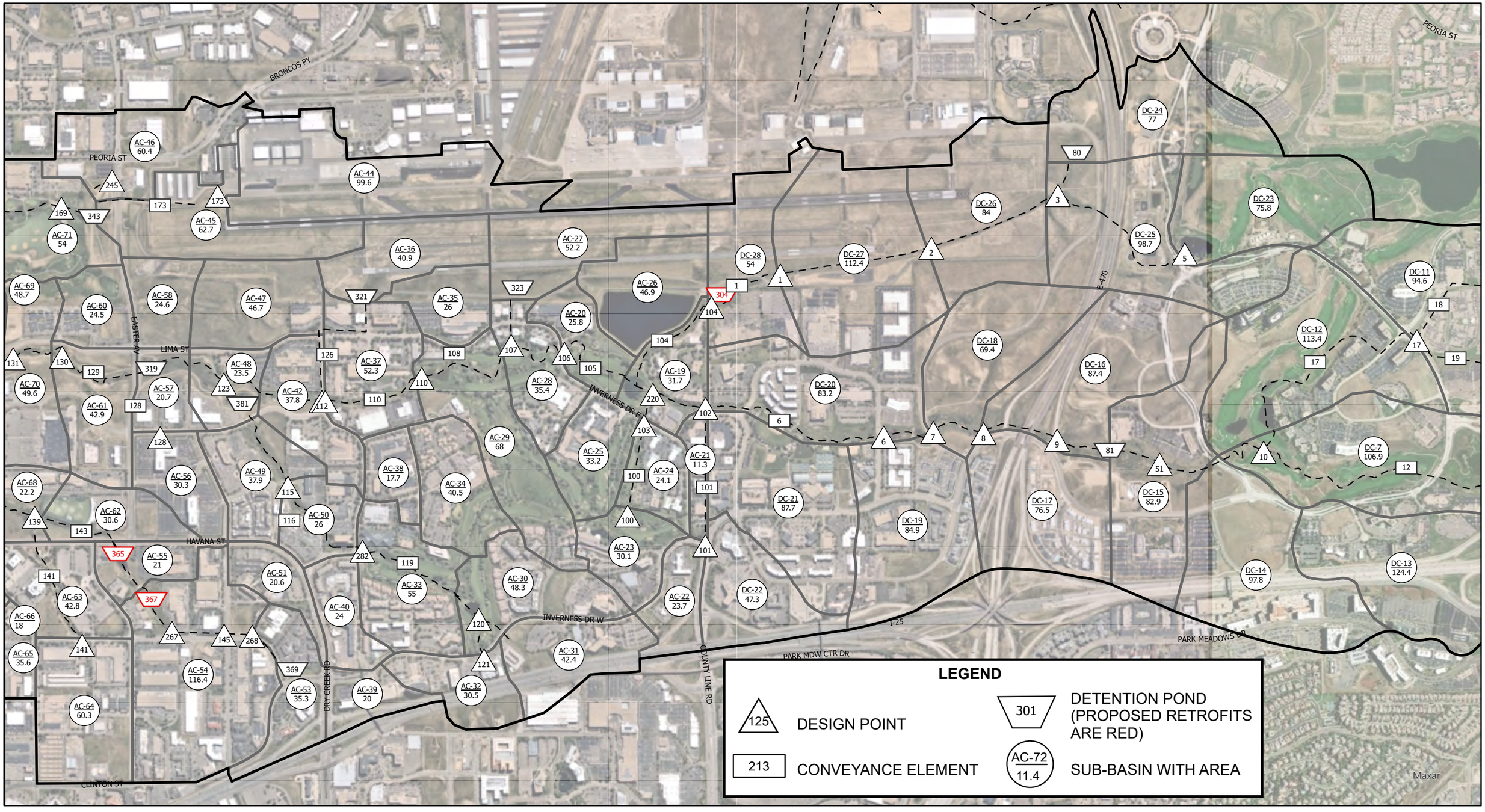
1 in = 1,250 Feet

0 625 1,250

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE G5



Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\SWMM Schematic\SWMM Schematic.aprx

WWE WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO. 211-088.000

DATE: 3/14/2024

SWMM SCHEMATIC

COTTONWOOD CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

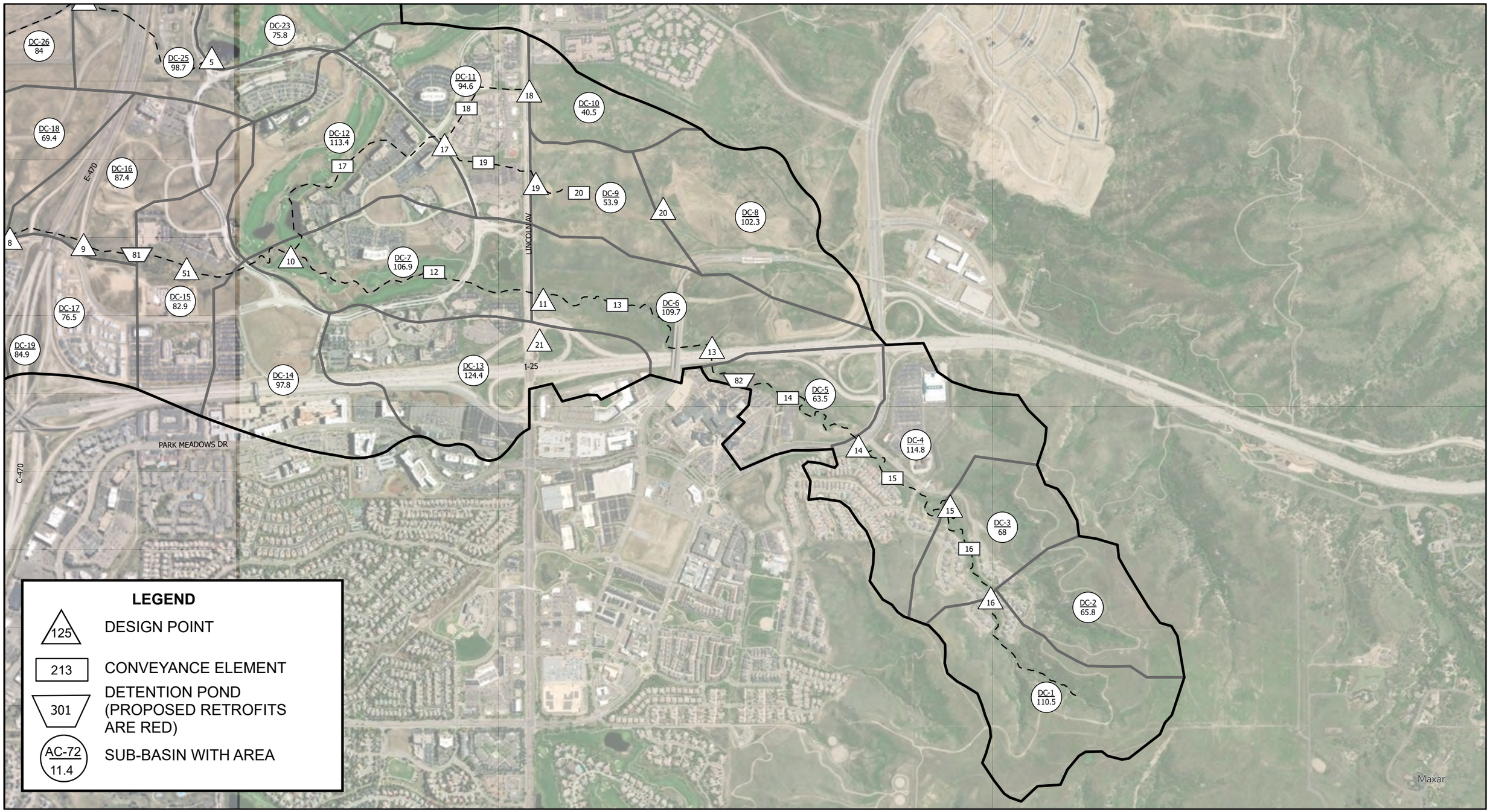
1 in = 1,250 Feet

0 625 1,250

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE G6



LEGEND

- 125 — DESIGN POINT
- 213 — CONVEYANCE ELEMENT
- 301 — DETENTION POND (PROPOSED RETROFITS ARE RED)
- AC-72 / 11.4 — SUB-BASIN WITH AREA

Path: Z:\Project Files\21\211-088\211-088.000\CAD-GIS\GIS\01_project\SWMM Schematic\SWMM Schematic.aprx

WWE WRIGHT WATER ENGINEERS, INC.

WWE PROJECT NO. 211-088.000

DATE: 3/14/2024

SWMM SCHEMATIC

COTTONWOOD CREEK

CHERRY CREEK SOUTHWEST TRIBUTARIES MAJOR DRAINAGEWAY PLAN

N

1 in = 1,250 Feet

0 625 1,250

Southeast Metro Stormwater Authority

MHFD MILE HIGH FLOOD DISTRICT

FIGURE

G7

CUHP Input Parameters

Table G1 - Dove Creek CUHP Input Parameters

		NOAA Atlas 14 One-Hour Point Precipitation Depths										Percent Imperviousness						
Subcatchment Name	EPA SWMM Target Node	2-year	5-year	10-yr	25-year	50-year	100-yr	Area (ac)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Existing (%)	Future (%)	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
D-1	JUNCT_101	2yr_0.84in	5yr_1.10in	10yr_1.33in	25yr_1.68in	50yr_1.98in	100yr_2.29in	56.977	997.920	2302.080	0.029	26.3	90.0	0.35	0.1	3.00	0.0018	0.50
D-2	JUNCT_103	2yr_0.84in	5yr_1.10in	10yr_1.33in	25yr_1.69in	50yr_1.98in	100yr_2.29in	23.722	749.760	1040.160	0.039	18.5	80.0	0.35	0.1	3.00	0.0018	0.50
D-3	JUNCT_103	2yr_0.84in	5yr_1.10in	10yr_1.33in	25yr_1.68in	50yr_1.98in	100yr_2.29in	36.752	1050.720	2302.080	0.028	8.2	80.0	0.35	0.1	3.00	0.0018	0.50
D-4	JUNCT_104	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.98in	100yr_2.30in	120.913	950.400	2597.760	0.019	18.2	80.0	0.35	0.1	3.00	0.0018	0.50
D-5	JUNCT_105	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.99in	100yr_2.30in	17.000	601.920	1800.480	0.038	17.4	80.0	0.35	0.1	3.00	0.0018	0.50
D-7	JUNCT_107	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.98in	100yr_2.30in	50.110	1161.600	2217.600	0.024	12.4	80.0	0.35	0.1	3.00	0.0018	0.50
D-8	JUNCT_111	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	15.366	1003.200	1953.600	0.031	19.0	80.0	0.35	0.1	3.15	0.0018	0.51
D-9	JUNCT_111	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	25.828	1214.400	2059.200	0.022	15.3	80.0	0.35	0.1	3.00	0.0018	0.50
D-10	JUNCT_110	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.99in	100yr_2.30in	34.128	1200.000	2200.000	0.019	9.0	80.0	0.35	0.1	3.00	0.0018	0.50
D-11	JUNCT_111	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	63.565	686.400	2059.200	0.037	49.8	80.0	0.35	0.1	3.08	0.0018	0.51
D-12	JUNCT_113	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_2.00in	100yr_2.31in	56.127	1795.200	3326.400	0.012	61.9	79.0	0.35	0.1	3.88	0.0017	0.60
D-13	JUNCT_113	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	41.434	1320.000	2376.000	0.018	43.0	78.2	0.35	0.1	3.50	0.0018	0.53
D-14	JUNCT_102	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_2.00in	100yr_2.31in	19.911	792.000	1964.160	0.022	28.5	69.3	0.35	0.1	4.50	0.0018	0.60
D-112	JUNCT_122	2yr_0.84in	5yr_1.10in	10yr_1.33in	25yr_1.69in	50yr_1.98in	100yr_2.29in	49.300	600.000	1800.000	0.025	33.7	80.0	0.35	0.1	3.00	0.0018	0.50

Table G2 - Windmill Creek CUHP Input Parameters

Subcatchment Name	EPA SWMM Target Node	NOAA Atlas 14 One-Hour Point Precipitation Depths			Area (ac)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Percent Imperviousness		Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
		2-year	10-yr	100-yr					Existing	Future					
W-1	JUNCT_101	2yr_0.84in	10yr_1.33in	100yr_2.28in	53.9	1490.0	1980.0	0.025	27.8	70.0	0.35	0.10	3.00	0.0018	0.50
W-2	JUNCT_102	2yr_0.84in	10yr_1.33in	100yr_2.28in	105.4	1485.3	2915.1	0.030	14.9	70.0	0.35	0.10	3.00	0.0018	0.50
W-3	JUNCT_150	2yr_0.84in	10yr_1.33in	100yr_2.29in	82.1	1246.1	2698.1	0.018	12.9	80.0	0.35	0.10	3.00	0.0018	0.50
W-4	JUNCT_100	2yr_0.84in	10yr_1.33in	100yr_2.28in	80.3	897.6	2302.1	0.037	5.3	90.0	0.35	0.10	3.00	0.0018	0.50
W-5	JUNCT_106	2yr_0.84in	10yr_1.33in	100yr_2.29in	34.7	844.8	1700.2	0.027	50.3	90.0	0.35	0.10	3.90	0.0018	0.57
W-6	JUNCT_103	2yr_0.84in	10yr_1.33in	100yr_2.29in	18.7	448.8	997.9	0.025	42.0	90.0	0.35	0.10	3.00	0.0018	0.50
W-7	JUNCT_107	2yr_0.84in	10yr_1.33in	100yr_2.28in	53.9	1452.0	3199.7	0.021	67.1	90.0	0.35	0.10	3.30	0.0018	0.52
W-8	JUNCT_109	2yr_0.84in	10yr_1.33in	100yr_2.29in	49.9	802.6	2001.1	0.021	18.5	73.0	0.35	0.10	3.00	0.0018	0.50
W-9	JUNCT_112	2yr_0.84in	10yr_1.34in	100yr_2.30in	39.2	2217.6	5137.4	0.008	32.5	40.0	0.35	0.10	3.00	0.0018	0.50
W-10	JUNCT_112	2yr_0.84in	10yr_1.33in	100yr_2.29in	58.4	1679.0	3199.7	0.039	18.3	44.3	0.35	0.10	4.00	0.0018	0.57
W-11	JUNCT_111	2yr_0.84in	10yr_1.34in	100yr_2.30in	56.6	1240.8	3178.6	0.013	65.8	90.0	0.35	0.10	3.00	0.0018	0.50
W-12	JUNCT_113	2yr_0.84in	10yr_1.34in	100yr_2.30in	47.6	2038.1	2962.1	0.024	19.2	80.0	0.35	0.10	4.10	0.0018	0.58
W-13	JUNCT_113	2yr_0.84in	10yr_1.34in	100yr_2.30in	73.7	1198.6	3241.9	0.023	45.8	80.0	0.35	0.10	3.10	0.0018	0.51
W-14	JUNCT_114	2yr_0.84in	10yr_1.34in	100yr_2.30in	36.5	638.9	1478.4	0.034	20.7	80.0	0.35	0.10	3.00	0.0018	0.50
W-15	JUNCT_115	2yr_0.84in	10yr_1.34in	100yr_2.30in	82.7	997.9	2518.6	0.022	10.5	15.5	0.35	0.10	3.20	0.0018	0.51
W-16	JUNCT_116	2yr_0.85in	10yr_1.34in	100yr_2.31in	63.8	839.5	2339.0	0.005	23.9	80.0	0.35	0.05	3.10	0.0018	0.51
W-17	JUNCT_117	2yr_0.85in	10yr_1.34in	100yr_2.31in	36.0	897.6	1821.6	0.022	69.5	80.0	0.35	0.10	3.00	0.0018	0.50
W-18	JUNCT_119	2yr_0.85in	10yr_1.34in	100yr_2.31in	45.7	1642.1	2798.4	0.013	23.6	80.0	0.35	0.10	3.00	0.0018	0.50
W-19	JUNCT_119	2yr_0.85in	10yr_1.34in	100yr_2.31in	51.6	918.7	2201.8	0.017	60.4	80.0	0.35	0.08	3.30	0.0018	0.52
W-20	JUNCT_121	2yr_0.85in	10yr_1.34in	100yr_2.31in	62.5	1742.4	3801.6	0.015	25.3	80.0	0.35	0.10	3.00	0.0018	0.50
W-21	JUNCT_121	2yr_0.85in	10yr_1.34in	100yr_2.31in	16.4	818.4	1520.6	0.013	44.2	80.0	0.35	0.10	3.40	0.0018	0.53
W-22	JUNCT_122	2yr_0.85in	10yr_1.35in	100yr_2.32in	32.2	961.0	2597.8	0.015	47.1	80.0	0.35	0.10	3.23	0.0018	0.52
W-23	JUNCT_124	2yr_0.85in	10yr_1.35in	100yr_2.31in	50.4	2001.1	2840.6	0.018	33.7	80.0	0.35	0.10	3.10	0.0018	0.51
W-24	JUNCT_124	2yr_0.85in	10yr_1.35in	100yr_2.32in	38.4	802.6	1758.2	0.010	40.3	80.0	0.35	0.10	3.20	0.0018	0.51
W-25	JUNCT_325	2yr_0.85in	10yr_1.35in	100yr_2.31in	62.8	2075.0	3548.2	0.014	52.8	80.0	0.35	0.10	3.15	0.0018	0.51
W-26	JUNCT_126	2yr_0.85in	10yr_1.35in	100yr_2.31in	59.7	1219.7	2682.2	0.016	40.6	80.0	0.35	0.10	3.23	0.0018	0.50
W-27	JUNCT_127	2yr_0.85in	10yr_1.35in	100yr_2.32in	31.5	718.1	1900.8	0.025	62.1	80.0	0.35	0.10	3.00	0.0018	0.50
W-28	JUNCT_128	2yr_0.86in	10yr_1.35in	100yr_2.33in	27.3	702.2	1298.9	0.031	36.6	80.0	0.35	0.10	3.00	0.0018	0.50
W-29	JUNCT_130	2yr_0.86in	10yr_1.35in	100yr_2.33in	37.4	1378.1	2798.4	0.016	46.7	61.4	0.35	0.05	3.00	0.0018	0.50
W-30	JUNCT_130	2yr_0.86in	10yr_1.35in	100yr_2.33in	54.4	1541.8	3120.5	0.020	33.2	72.2	0.35	0.10	3.00	0.0018	0.50
W-31	JUNCT_131	2yr_0.86in	10yr_1.35in	100yr_2.32in	45.9	1399.2	2539.7	0.017	31.1	40.6	0.35	0.05	3.00	0.0018	0.50
W-32	JUNCT_132	2yr_0.86in	10yr_1.35in	100yr_2.32in	13.6	237.6	982.1	0.014	42.6	49.7	0.35	0.05	3.00	0.0018	0.50
W-33	JUNCT_134	2yr_0.86in	10yr_1.35in	100yr_2.32in	18.7	1177.4	2302.1	0.014	30.2	40.0	0.35	0.05	3.00	0.0018	0.50
W-34	JUNCT_134	2yr_0.86in	10yr_1.35in	100yr_2.32in	64.6	1499.5	3241.9	0.011	24.4	35.1	0.35	0.05	3.20	0.0018	0.51
W-35	JUNCT_135	2yr_0.86in	10yr_1.35in	100yr_2.33in	34.2	517.4	2460.5	0.010	23.3	40.3	0.35	0.05	3.70	0.0018	0.55
W-36	JUNCT_336	2yr_0.86in	10yr_1.35in	100yr_2.32in	29.5	1040.2	1858.6	0.014	40.8	41.7	0.35	0.05	3.00	0.0018	0.50
W-37	JUNCT_137	2yr_0.86in	10yr_1.36in	100yr_2.33in	22.1	1427.0	2880.4	0.013	15.7	23.0	0.35	0.05	3.65	0.0017	0.58
W-38	JUNCT_138	2yr_0.86in	10yr_1.36in	100yr_2.33in	51.5	1416.8	3370.7	0.011	2.0	10.8	0.35	0.10	4.55	0.0015	0.70
W-39	JUNCT_139	2yr_0.85in	10yr_1.34in	100yr_2.31in	30.2	982.1	1800.5	0.022	54.8	80.0	0.35	0.10	3.10	0.0018	0.51
W-55	JUNCT_104	2yr_0.84in	10yr_1.33in	100yr_2.28in	46.1	749.8	1499.5	0.026	57.2	90.0	0.35	0.10	3.30	0.0018	0.50
W-57	JUNCT_105	2yr_0.84in	10yr_1.33in	100yr_2.29in	41.7	1399.2	2798.4	0.024	30.9	90.0	0.35	0.10	3.00	0.0018	0.50
W-58	JUNCT_108	2yr_0.84in	10yr_1.33in	100yr_2.29in	27.6	396.0	802.6	0.005	18.4	18.4	0.35	0.10	3.60	0.0018	0.54
W-61	JUNCT_196	2yr_0.84in	10yr_1.33in	100yr_2.29in	16.2	401.3	897.6	0.005	67.3	90.0	0.35	0.10	3.75	0.0018	0.55
W-62	JUNCT_62	2yr_0.83in	10yr_1.33in	100yr_2.27in	17.2	540.1	1915.1	0.012	34.5	34.5	0.35	0.10	3.00	0.0018	0.50
W-63	JUNCT_63	2yr_0.83in	10yr_1.33in	100yr_2.27in	11.4	871.2	1351.7	0.028	40.8	90.0	0.35	0.10	3.00	0.0018	0.50
W-64	JUNCT_64	2yr_0.83in	10yr_1.33in	100yr_2.27in	5.5	625.2	793.1	0.035	2.0	2.0	0.35	0.10	3.00	0.0018	0.50
W-65	JUNCT_65	2yr_0.83in	10yr_1.33in	100yr_2.27in	8.9	550.2	890.2	0.056	21.3	21.3	0.35	0.10	3.00	0.0018	0.50
W-66	JUNCT_66	2yr_0.84in	10yr_1.33in	100yr_2.28in	2.7	1269.8	2540.2	0.024	90.0	90.0	0.35	0.10	3.00	0.0018	0.50
W-67	JUNCT_67	2yr_0.84in	10yr_1.33in	100yr_2.28in	16.3	1400.3	2232.9	0.012	43.3	43.3	0.35	0.10	3.00	0.0018	0.50
W-68	JUNCT_68	2yr_0.84in	10yr_1.33in	100yr_2.28in	10.6	759.8	1445.1	0.008	20.8	20.8	0.35	0.10	3.00	0.0018	0.50
W-69	JUNCT_69	2yr_0.84in	10yr_1.33in	100yr_2.28in	1.8	1150.0	2014.8	0.011	90.0	90.0	0.35	0.10	3.00	0.0018	0.50
W-40	JUNCT_140	2yr_0.86in	10yr_1.36in	100yr_2.33in	27.7	920.2	1771.6	0.012	4.0	4.0	0.35	0.10	3.00	0.0018	0.5
W-41	JUNCT_141	2yr_0.86in	10yr_1.36in	100yr_2.33in	24.2	1157.8	2122.7	0.020	2.0	2.0	0.35	0.10	3.00	0.0018	0.5
W-42	JUNCT_142	2yr_0.86in	10yr_1.36in	100yr_2.33in	13.0	748.3	1179.2	0.015	2.0	2.0	0.35	0.10	3.00	0.0018	0.5
W-43	W-143	2yr_0.86in	10yr_1.36in	100yr_2.33in	31.4	1348.4	2859.4	0.016	3.0	3.0	0.35	0.10	3.00	0.0018	0.5

Table G3 - Lone Tree Creek CUHP Input Parameters

		NOAA Atlas 14 One-Hour Point Precipitation Depths										Percent Imperviousness						
Subcatchment Name	EPA SWMM Target Node	2-year	5-yr	10-yr	25-yr	50-yr	100-yr	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Existing	Future	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
L-2	JUNCT_102	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.98in	100yr_2.30in	44.288	681.120	1800.480	0.017	91.2	91.7	0.35	0.1	3.00	0.0018	0.50
L-3	JUNCT_104	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.98in	100yr_2.30in	78.506	1320.000	2719.200	0.026	68.4	80.0	0.35	0.1	3.00	0.0018	0.50
L-4	JUNCT_104	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.98in	100yr_2.30in	51.604	860.640	1800.480	0.028	48.2	80.0	0.35	0.1	3.00	0.0018	0.50
L-5	JUNCT_105	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	81.569	897.600	2001.120	0.031	45.6	78.1	0.35	0.1	3.20	0.0018	0.51
L-6	JUNCT_108	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	28.797	1198.560	2201.760	0.039	49.1	76.4	0.35	0.1	3.50	0.0018	0.53
L-7	JUNCT_108	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	46.182	1657.920	2402.400	0.033	38.8	80.0	0.35	0.1	3.00	0.0018	0.50
L-8	JUNCT_108	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	16.457	997.920	1599.840	0.025	49.8	77.0	0.35	0.1	3.10	0.0018	0.50
L-9	JUNCT_109	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	49.184	1198.560	2201.760	0.026	31.7	78.7	0.35	0.1	3.50	0.0018	0.53
L-10	JUNCT_110	2yr_0.85in	5yr_1.11in	10yr_1.34in	25yr_1.70in	50yr_1.99in	100yr_2.31in	24.783	739.200	1378.080	0.036	19.5	80.0	0.35	0.1	3.00	0.0018	0.50
L-11	JUNCT_112	2yr_0.85in	5yr_1.11in	10yr_1.35in	25yr_1.70in	50yr_2.00in	100yr_2.32in	26.331	1298.880	2180.640	0.028	43.5	68.3	0.35	0.1	3.00	0.0018	0.50
L-12	JUNCT_112	2yr_0.85in	5yr_1.11in	10yr_1.35in	25yr_1.70in	50yr_2.00in	100yr_2.32in	28.493	1050.720	2048.640	0.039	48.0	77.8	0.35	0.1	4.50	0.0018	0.60
L-13	JUNCT_113	2yr_0.85in	5yr_1.11in	10yr_1.35in	25yr_1.70in	50yr_2.00in	100yr_2.32in	30.782	1198.560	2101.440	0.021	60.6	80.0	0.35	0.1	3.00	0.0018	0.50
L-14	JUNCT_114	2yr_0.85in	5yr_1.11in	10yr_1.35in	25yr_1.70in	50yr_2.00in	100yr_2.32in	19.714	718.080	1399.200	0.037	44.7	79.1	0.35	0.1	3.20	0.0018	0.51
L-15	JUNCT_116	2yr_0.85in	5yr_1.11in	10yr_1.35in	25yr_1.70in	50yr_2.00in	100yr_2.32in	24.913	997.920	1995.840	0.028	71.0	78.1	0.35	0.1	3.20	0.0018	0.51
L-16	JUNCT_116	2yr_0.85in	5yr_1.11in	10yr_1.35in	25yr_1.70in	50yr_2.00in	100yr_2.32in	28.568	881.760	1679.040	0.038	71.8	74.1	0.35	0.1	4.55	0.0018	0.64
L-17	JUNCT_118	2yr_0.85in	5yr_1.11in	10yr_1.35in	25yr_1.70in	50yr_2.00in	100yr_2.32in	21.113	802.560	1657.920	0.041	53.7	75.1	0.35	0.1	4.35	0.0018	0.59
L-18	JUNCT_118	2yr_0.85in	5yr_1.11in	10yr_1.35in	25yr_1.70in	50yr_2.00in	100yr_2.32in	28.845	997.920	2101.440	0.029	77.2	79.1	0.35	0.1	3.08	0.0018	0.51
L-19	JUNCT_119	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	29.076	897.600	1900.800	0.020	62.5	78.2	0.35	0.1	3.00	0.0018	0.50
L-20	JUNCT_120	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	18.474	702.240	1499.520	0.040	38.1	66.6	0.35	0.1	4.05	0.0018	0.57
L-21	JUNCT_122	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	24.459	897.600	1800.480	0.025	49.6	71.7	0.35	0.1	4.05	0.0018	0.57
L-22	JUNCT_121	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	15.787	601.920	1251.360	0.014	45.5	80.0	0.35	0.1	3.00	0.0018	0.50
L-23	JUNCT_123	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	27.406	702.240	1599.840	0.025	33.7	80.0	0.35	0.1	4.1	0.0018	0.57
L-24	JUNCT_124	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	25.859	670.560	1499.520	0.019	41.7	64.6	0.35	0.1	3.4	0.0018	0.52
L-25	JUNCT_125	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.72in	50yr_2.02in	100yr_2.34in	43.100	877.747	1887.000	0.021	9.5	20.9	0.35	0.1	3.4	0.0018	0.52
L-26	L-126	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.72in	50yr_2.02in	100yr_2.34in	28.800	1156.850	2194.579	0.015	2.0	10.1	0.35	0.1	3.8	0.0018	0.55
L-27	JUNCT_127	2yr_0.86in	5yr_1.12in	10yr_1.35in	25yr_1.71in	50yr_2.00in	100yr_2.32in	14.186	850.080	1599.840	0.017	59.9	80.0	0.35	0.1	3.0	0.0018	0.50
L-28	JUNCT_128	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	11.105	601.920	1082.400	0.016	61.0	80.0	0.35	0.1	3.0	0.0018	0.50
L-29	JUNCT_129	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.98in	100yr_2.29in	10.327	707.520	1092.960	0.010	50.1	65.2	0.35	0.1	3.0	0.0018	0.50
L-30	JUNCT_130	2yr_0.84in	5yr_1.10in	10yr_1.34in	25yr_1.69in	50yr_1.98in	100yr_2.29in	85.055	1298.880	2703.360	0.010	52.1	52.1	0.35	0.1	3.0	0.0018	0.50
L-31	JUNCT_131	2yr_0.84in	5yr_1.10in	10yr_1.33in	25yr_1.68in	50yr_1.98in	100yr_2.29in	59.257	939.840	1927.200	0.010	34.0	69.6	0.35	0.1	3.0	0.0018	0.50
L-32	L-132	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	20.900	1147.000	1797.000	0.017	2.0	2.0	0.35	0.1	3.0	0.0018	0.50
L_33	JUNCT_133	2yr_0.86in	5yr_1.12in	10yr_1.36in	25yr_1.71in	50yr_2.01in	100yr_2.33in	18.500	809.000	1857.000	0.016	3.5	3.5	0.35	0.1	3.0	0.0018	0.50

Table G4 - Cottonwood Creek CUHP Input Parameters

		NOAA Atlas 14 One-Hour Point Precipitation Depths							Percent Imperviousness						
Subcatchment Name	EPA SWMM Target Node	2-year	10-yr	100-yr	Area (ac)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Existing	Future	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
DC 1	JUNCT_16	2yr_0.84in	10yr_1.33in	100yr_2.28in	110.535	1680.635	3625.420	0.047	2.0	5.0	0.35	0.1	3.00	0.0018	0.50
DC 2	JUNCT_16	2yr_0.83in	10yr_1.33in	100yr_2.27in	65.920	1440.648	2884.381	0.052	2.0	11.0	0.35	0.1	3.00	0.0018	0.50
DC 3	JUNCT_15	2yr_0.83in	10yr_1.33in	100yr_2.27in	67.840	819.410	2151.400	0.056	2.0	11.0	0.35	0.1	3.00	0.0018	0.50
DC 4	JUNCT_14	2yr_0.83in	10yr_1.33in	100yr_2.27in	114.770	1013.100	2721.260	0.058	29.6	51.0	0.35	0.1	3.00	0.0018	0.50
DC 5	JUNCT_52	2yr_0.84in	10yr_1.34in	100yr_2.29in	63.502	1278.028	2600.360	0.046	33.0	56.0	0.35	0.1	3.00	0.0018	0.50
DC 6	JUNCT_13	2yr_0.84in	10yr_1.34in	100yr_2.29in	109.739	1837.661	5141.514	0.035	11.8	85.0	0.35	0.1	3.00	0.0018	0.50
DC 7	JUNCT_10	2yr_0.84in	10yr_1.34in	100yr_2.29in	106.897	2481.797	4592.330	0.025	31.5	35.0	0.35	0.1	3.00	0.0018	0.50
DC 8	JUNCT_20	2yr_0.84in	10yr_1.33in	100yr_2.28in	102.251	1566.300	3879.660	0.039	2.2	89.0	0.35	0.1	3.00	0.0018	0.50
DC 9	JUNCT_19	2yr_0.84in	10yr_1.34in	100yr_2.29in	53.861	965.585	2803.910	0.032	2.7	88.0	0.35	0.1	3.00	0.0018	0.50
DC 10	JUNCT_18	2yr_0.84in	10yr_1.34in	100yr_2.29in	40.488	873.173	2439.941	0.027	5.7	85.0	0.35	0.1	3.00	0.0018	0.50
DC 11	JUNCT_17	2yr_0.84in	10yr_1.34in	100yr_2.29in	94.633	824.540	2113.930	0.024	52.0	52.0	0.35	0.1	3.00	0.0018	0.50
DC 12	JUNCT_10	2yr_0.84in	10yr_1.34in	100yr_2.29in	113.372	1955.960	3870.530	0.021	29.1	35.0	0.35	0.1	3.00	0.0018	0.50
DC 13	JUNCT_21	2yr_0.84in	10yr_1.34in	100yr_2.29in	124.446	1889.703	4544.858	0.024	53.1	60.0	0.35	0.1	3.00	0.0018	0.50
DC 14	JUNCT_10	2yr_0.85in	10yr_1.34in	100yr_2.30in	97.778	1706.179	3824.000	0.034	49.6	75.0	0.35	0.1	3.00	0.0018	0.50
DC 15	JUNCT_51	2yr_0.85in	10yr_1.34in	100yr_2.30in	82.876	492.670	2642.618	0.042	35.8	65.0	0.35	0.1	3.00	0.0018	0.50
DC 16	JUNCT_8	2yr_0.85in	10yr_1.34in	100yr_2.30in	87.429	2360.160	4102.560	0.051	22.9	70.0	0.35	0.1	3.00	0.0018	0.50
DC 17	JUNCT_8	2yr_0.85in	10yr_1.34in	100yr_2.30in	76.534	954.820	2651.319	0.034	18.5	70.0	0.35	0.1	3.00	0.0018	0.50
DC 18	JUNCT_7	2yr_0.85in	10yr_1.34in	100yr_2.30in	69.366	1547.485	3310.022	0.030	8.3	75.0	0.35	0.1	3.00	0.0018	0.50
DC 19	JUNCT_6	2yr_0.85in	10yr_1.34in	100yr_2.30in	84.944	1313.127	2715.884	0.033	45.1	75.0	0.35	0.1	3.00	0.0018	0.50
DC 20	JUNCT_102	2yr_0.85in	10yr_1.35in	100yr_2.31in	83.201	1947.248	4859.965	0.027	47.6	65.0	0.35	0.1	3.00	0.0018	0.50
DC 21	JUNCT_102	2yr_0.85in	10yr_1.35in	100yr_2.31in	87.666	2123.761	2702.394	0.041	62.4	75.0	0.35	0.1	3.00	0.0018	0.50
DC 22	JUNCT_101	2yr_0.85in	10yr_1.35in	100yr_2.31in	47.346	1266.188	2866.687	0.031	67.4	80.0	0.35	0.1	3.00	0.0018	0.50
DC 23	JUNCT_5	2yr_0.85in	10yr_1.35in	100yr_2.31in	75.774	1240.938	2972.976	0.029	6.9	15.0	0.35	0.1	3.00	0.0018	0.50
DC 24	JUNCT_50	2yr_0.85in	10yr_1.34in	100yr_2.30in	77.015	1378.537	3427.842	0.023	30.2	35.0	0.35	0.1	3.00	0.0018	0.50
DC 25	JUNCT_3	2yr_0.85in	10yr_1.34in	100yr_2.30in	98.718	1135.845	3098.164	0.042	28.8	43.8	0.35	0.1	3.00	0.0018	0.50
DC 26	JUNCT_2	2yr_0.85in	10yr_1.34in	100yr_2.30in	84.041	1064.615	2860.850	0.024	9.2	16.0	0.35	0.1	3.00	0.0018	0.50
DC 27	JUNCT_1	2yr_0.85in	10yr_1.34in	100yr_2.30in	112.391	1039.302	2103.898	0.048	34.3	35.0	0.35	0.1	3.00	0.0018	0.50
DC 28	JUNCT_104	2yr_0.85in	10yr_1.35in	100yr_2.31in	53.993	1553.105	3500.114	0.024	41.8	43.0	0.35	0.1	3.00	0.0018	0.50
AC 19	JUNCT_220	2yr_0.85in	10yr_1.35in	100yr_2.31in	31.700	601.920	1599.840	0.023	34.8	54.5	0.35	0.1	3.00	0.0018	0.50
AC 20	JUNCT_106	2yr_0.85in	10yr_1.35in	100yr_2.31in	25.781	300.960	1098.240	0.016	29.5	29.5	0.35	0.1	3.00	0.0018	0.50
AC 21	JUNCT_102	2yr_0.85in	10yr_1.35in	100yr_2.31in	11.261	649.968	1799.952	0.018	75.0	80.0	0.35	0.1	3.00	0.0018	0.50
AC 22	JUNCT_101	2yr_0.83in	10yr_1.33in	100yr_2.27in	23.675	799.920	1400.256	0.034	52.9	52.9	0.35	0.1	3.00	0.0018	0.50
AC 23	JUNCT_100	2yr_0.86in	10yr_1.35in	100yr_2.33in	30.123	599.808	1374.912	0.041	46.5	50.0	0.35	0.1	3.00	0.0018	0.50
AC 24	JUNCT_103	2yr_0.86in	10yr_1.35in	100yr_2.33in	24.135	799.920	1599.840	0.025	50.1	65.0	0.35	0.1	3.00	0.0018	0.50
AC 25	JUNCT_103	2yr_0.86in	10yr_1.35in	100yr_2.33in	33.250	700.128	1650.000	0.036	39.0	39.0	0.35	0.1	3.00	0.0018	0.50
AC 26		2yr_0.86in	10yr_1.36in	100yr_2.34in	46.910	700.128	2200.176	0.023	10.0	50.0	0.35	0.1	3.00	0.0018	0.50
AC 27	JUNCT_223	2yr_0.86in	10yr_1.36in	100yr_2.34in	52.249	1400.256	2799.984	0.009	23.1	23.1	0.35	0.1	3.00	0.0018	0.50
AC 28	JUNCT_107	2yr_0.86in	10yr_1.35in	100yr_2.33in	35.363	601.920	1800.480	0.030	49.0	50.0	0.35	0.1	3.00	0.0018	0.50
AC 29	JUNCT_110	2yr_0.86in	10yr_1.36in	100yr_2.33in	67.987	1599.840	3701.280	0.031	22.3	22.3	0.35	0.1	3.00	0.0018	0.50
AC 30	JUNCT_119	2yr_0.83in	10yr_1.33in	100yr_2.27in	45.020	1149.984	2200.176	0.036	43.3	65.0	0.35	0.1	3.00	0.0018	0.50
AC 31	JUNCT_122	2yr_0.86in	10yr_1.36in	100yr_2.33in	42.410	949.872	2249.808	0.028	61.3	65.0	0.35	0.1	3.00	0.0018	0.50
AC 32	JUNCT_121	2yr_0.86in	10yr_1.35in	100yr_2.33in	30.549	425.040	1099.824	0.029	52.5	65.0	0.35	0.1	3.00	0.0018	0.50
AC 33	JUNCT_282	2yr_0.86in	10yr_1.36in	100yr_2.34in	55.028	749.760	2299.968	0.027	50.6	50.6	0.35	0.1	3.00	0.0018	0.50
AC 34	JUNCT_118	2yr_0.83in	10yr_1.33in	100yr_2.27in	43.822	1599.840	2399.760	0.040	53.5	68.8	0.35	0.1	3.00	0.0018	0.50
AC 35	JUNCT_108	2yr_0.86in	10yr_1.36in	100yr_2.34in	25.998	550.176	1299.936	0.042	44.4	47.5	0.35	0.1	3.00	0.0018	0.50
AC 36	JUNCT_221	2yr_0.86in	10yr_1.36in	100yr_2.34in	40.916	1299.936	2350.128	0.014	22.9	22.9	0.35	0.1	3.00	0.0018	0.50
AC 37	JUNCT_112	2yr_0.86in	10yr_1.36in	100yr_2.34in	52.266	900.240	2150.016	0.016	65.2	76.7	0.35	0.1	3.00	0.0018	0.50
AC 38	JUNCT_111	2yr_0.86in	10yr_1.36in	100yr_2.34in	17.729	500.016	1700.160	0.010	77.5	80.0	0.35	0.1	3.00	0.0018	0.50
AC 39	JUNCT_269	2yr_0.86in	10yr_1.37in	100yr_2.35in	19.978	1098.240	2101.440	0.022	68.4	80.0	0.35	0.1	3.00	0.0018	0.50
AC 40	JUNCT_117	2yr_0.86in	10yr_1.36in	100yr_2.35in	24.022	874.896	1749.792	0.037	81.4	81.4	0.35	0.1	3.00	0.0018	0.50
AC 42	JUNCT_113	2yr_0.83in	10yr_1.33in	100yr_2.27in	37.754	400.224	1799.952	0.026	63.4	75.0	0.35	0.1	3.00	0.0018	0.50
AC 44	JUNCT_173	2yr_0.83in	10yr_1.33in	100yr_2.27in	99.587	1832.160	4598.880	0.020	65.0	65.0	0.35	0.1	3.00	0.0018	0.50
AC 45	JUNCT_243	2yr_0.86in	10yr_1.36in	100yr_2.34in	62.707	1188.000	3600.960	0.020	27.5	30.0	0.35	0.1	3.00	0.0018	0.50

AC 46	JUNCT_245	2yr_0.86in	10yr_1.36in	100yr_2.34in	60.438	997.920	2397.120	0.024	56.4	80.0	0.35	0.1	3.00	0.0018	0.50
AC 47	JUNCT_127	2yr_0.86in	10yr_1.36in	100yr_2.33in	46.732	897.600	1800.480	0.039	13.7	56.0	0.35	0.1	3.00	0.0018	0.50
AC 48	JUNCT_127	2yr_0.86in	10yr_1.36in	100yr_2.33in	23.488	60.192	1400.256	0.005	42.1	50.0	0.35	0.1	3.00	0.0018	0.50
AC 49	JUNCT_281	2yr_0.86in	10yr_1.35in	100yr_2.32in	37.927	749.760	2174.832	0.037	66.1	70.0	0.35	0.1	3.00	0.0018	0.50
AC 50	JUNCT_115	2yr_0.86in	10yr_1.35in	100yr_2.32in	26.004	702.240	1298.880	0.027	64.0	70.0	0.35	0.1	3.00	0.0018	0.50
AC 51	JUNCT_116	2yr_0.83in	10yr_1.33in	100yr_2.27in	20.631	700.128	2000.064	0.021	75.4	80.0	0.35	0.1	3.00	0.0018	0.50
AC 53	JUNCT_269	2yr_0.85in	10yr_1.34in	100yr_2.30in	35.323	599.808	1200.144	0.008	67.0	72.0	0.35	0.1	3.00	0.0018	0.50
AC 54	JUNCT_267	2yr_0.86in	10yr_1.36in	100yr_2.34in	116.408	1538.378	3160.321	0.028	77.2	81.3	0.35	0.1	3.00	0.0018	0.50
AC 55	JUNCT_265	2yr_0.83in	10yr_1.33in	100yr_2.27in	21.039	472.049	1214.954	0.045	58.0	77.3	0.35	0.1	3.00	0.0018	0.50
AC 56	JUNCT_128	2yr_0.86in	10yr_1.36in	100yr_2.34in	30.301	1099.824	2399.760	0.030	80.7	80.7	0.35	0.1	3.00	0.0018	0.50
AC 57	JUNCT_219	2yr_0.86in	10yr_1.36in	100yr_2.34in	20.711	599.808	1200.144	0.021	52.9	64.5	0.35	0.1	3.00	0.0018	0.50
AC 58	JUNCT_127	2yr_0.83in	10yr_1.33in	100yr_2.27in	24.642	649.968	1350.096	0.033	12.2	70.0	0.35	0.1	3.00	0.0018	0.50
AC 60	JUNCT_130	2yr_0.84in	10yr_1.33in	100yr_2.28in	24.493	802.032	1799.952	0.041	37.6	56.0	0.35	0.1	3.00	0.0018	0.50
AC 61	JUNCT_130	2yr_0.83in	10yr_1.33in	100yr_2.27in	42.892	1350.096	2650.032	0.023	38.2	60.0	0.35	0.1	3.00	0.0018	0.50
AC 62	JUNCT_142	2yr_0.83in	10yr_1.33in	100yr_2.27in	30.553	799.920	2099.856	0.027	49.1	70.0	0.35	0.1	3.00	0.0018	0.50
AC 63	JUNCT_263	2yr_0.86in	10yr_1.36in	100yr_2.34in	42.776	700.128	2000.064	0.026	57.3	75.0	0.35	0.1	3.00	0.0018	0.50
AC 64	JUNCT_141	2yr_0.86in	10yr_1.36in	100yr_2.35in	60.295	1099.824	2200.176	0.033	65.7	85.0	0.35	0.1	3.00	0.0018	0.50
AC 65	JUNCT_138	2yr_0.86in	10yr_1.36in	100yr_2.34in	35.570	799.920	1700.160	0.021	74.4	85.0	0.35	0.1	3.00	0.0018	0.50
AC 66	JUNCT_137	2yr_0.86in	10yr_1.36in	100yr_2.34in	17.999	500.016	1200.144	0.039	70.0	80.0	0.35	0.1	3.00	0.0018	0.50
AC 67	JUNCT_260	2yr_0.86in	10yr_1.35in	100yr_2.33in	11.426	449.856	1249.776	0.017	78.0	82.0	0.35	0.1	3.00	0.0018	0.50
AC 68	JUNCT_262	2yr_0.85in	10yr_1.35in	100yr_2.31in	22.175	500.016	1500.048	0.032	40.9	60.0	0.35	0.1	3.00	0.0018	0.50
AC 69	JUNCT_218	2yr_0.84in	10yr_1.34in	100yr_2.29in	48.662	500.016	2050.224	0.034	56.8	80.0	0.35	0.1	3.00	0.0018	0.50
AC 70	JUNCT_131	2yr_0.85in	10yr_1.34in	100yr_2.30in	49.572	850.080	2200.176	0.041	45.3	80.0	0.35	0.1	3.00	0.0018	0.50
AC 71	JUNCT_168	2yr_0.85in	10yr_1.34in	100yr_2.30in	54.047	802.560	2101.440	0.030	24.1	39.0	0.35	0.1	3.00	0.0018	0.50
AC 72	JUNCT_167	2yr_0.86in	10yr_1.36in	100yr_2.33in	11.419	500.016	1400.256	0.022	75.8	83.0	0.35	0.1	3.00	0.0018	0.50
AC 73	JUNCT_242	2yr_0.86in	10yr_1.35in	100yr_2.32in	31.195	850.080	1700.160	0.040	21.0	40.0	0.35	0.1	3.00	0.0018	0.50
AC 74	JUNCT_165	2yr_0.85in	10yr_1.35in	100yr_2.31in	18.946	997.920	1599.840	0.014	78.6	80.0	0.35	0.1	3.00	0.0018	0.50
AC 75	JUNCT_181	2yr_0.85in	10yr_1.35in	100yr_2.31in	24.199	987.360	1420.320	0.036	65.0	80.0	0.35	0.1	3.00	0.0018	0.50
AC 76	JUNCT_149	2yr_0.86in	10yr_1.35in	100yr_2.33in	17.475	625.152	1249.776	0.042	67.8	80.0	0.35	0.1	3.00	0.0018	0.50
AC 77	JUNCT_216	2yr_0.86in	10yr_1.35in	100yr_2.33in	30.073	649.968	1650.000	0.018	61.0	77.0	0.35	0.1	3.00	0.0018	0.50
AC 78	JUNCT_133	2yr_0.86in	10yr_1.35in	100yr_2.33in	45.139	1050.192	1850.112	0.026	67.3	80.0	0.35	0.1	3.00	0.0018	0.50
AC 79	JUNCT_135	2yr_0.85in	10yr_1.35in	100yr_2.31in	28.434	1249.776	2599.872	0.013	80.2	90.0	0.35	0.1	3.00	0.0018	0.50
AC 80	JUNCT_152	2yr_0.85in	10yr_1.35in	100yr_2.31in	25.449	200.112	1799.952	0.015	53.4	53.4	0.35	0.1	3.00	0.0018	0.50
AC 81	JUNCT_153	2yr_0.85in	10yr_1.34in	100yr_2.30in	43.250	900.240	1700.160	0.024	51.5	51.5	0.35	0.1	3.00	0.0018	0.50
AC 82	JUNCT_214	2yr_0.85in	10yr_1.35in	100yr_2.31in	40.814	1650.000	3200.208	0.010	53.4	60.0	0.35	0.1	3.00	0.0018	0.50
AC 83	JUNCT_151	2yr_0.85in	10yr_1.35in	100yr_2.31in	30.464	1099.824	2200.176	0.017	38.0	82.0	0.35	0.1	3.00	0.0018	0.50
AC 84	JUNCT_290	2yr_0.85in	10yr_1.34in	100yr_2.30in	29.816	599.808	1350.096	0.030	74.8	80.0	0.35	0.1	3.00	0.0018	0.50
AC 85	JUNCT_240	2yr_0.86in	10yr_1.36in	100yr_2.34in	25.790	439.824	880.176	0.023	38.7	73.0	0.35	0.1	3.00	0.0018	0.50
AC 86	JUNCT_163	2yr_0.83in	10yr_1.33in	100yr_2.27in	30.863	439.824	1560.240	0.012	38.1	80.0	0.35	0.1	3.00	0.0018	0.50
AC 87	JUNCT_162	2yr_0.83in	10yr_1.33in	100yr_2.27in	18.588	1050.192	2150.016	0.019	13.7	65.0	0.35	0.1	3.00	0.0018	0.50
AC 88	JUNCT_160	2yr_0.83in	10yr_1.33in	100yr_2.27in	32.600	899.712	1799.952	0.033	47.5	66.0	0.35	0.1	3.00	0.0018	0.50
AC 89	JUNCT_158	2yr_0.84in	10yr_1.33in	100yr_2.28in	53.754	897.600	2698.080	0.033	36.8	58.0	0.35	0.1	3.00	0.0018	0.50
AC 91	JUNCT_174	2yr_0.83in	10yr_1.33in	100yr_2.27in	24.307	700.128	2099.856	0.035	53.2	53.2	0.35	0.1	3.00	0.0018	0.50
AC 92	JUNCT_157	2yr_0.84in	10yr_1.33in	100yr_2.28in	36.169	1000.032	1799.952	0.029	11.0	76.0	0.35	0.1	3.00	0.0018	0.50
AC 93	JUNCT_157	2yr_0.84in	10yr_1.33in	100yr_2.28in	101.812	2048.640	3801.600	0.028	48.9	48.9	0.35	0.1	3.00	0.0018	0.50
AC 94	JUNCT_212	2yr_0.84in	10yr_1.33in	100yr_2.27in	43.047	1599.840	2698.080	0.010	40.3	45.0	0.35	0.1	3.00	0.0018	0.50
AC 95	JUNCT_180	2yr_0.84in	10yr_1.33in	100yr_2.28in	43.563	702.240	1499.520	0.044	15.7	33.2	0.35	0.1	3.00	0.0018	0.50
AC 96	JUNCT_210	2yr_0.84in	10yr_1.34in	100yr_2.29in	110.172	2101.440	4197.600	0.044	5.4	5.4	0.35	0.1	3.00	0.0018	0.50
AC 97	JUNCT_297	2yr_0.86in	10yr_1.36in	100yr_2.35in	30.342	877.033	2387.252	0.034	45.0	45.0	0.35	0.1	3.00	0.0018	0.50
AC 98	JUNCT_198	2yr_0.86in	10yr_1.36in	100yr_2.35in	7.621	446.220	1269.400	0.005	2.0	2.0	0.35	0.1	3.00	0.0018	0.50
AC 99	JUNCT_199	2yr_0.86in	10yr_1.36in	100yr_2.35in	43.118	1104.180	2694.920	0.020	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
AC 100	JUNCT_200	2yr_0.86in	10yr_1.36in	100yr_2.35in	56.850	1146.680	2797.000	0.009	8.0	8.0	0.35	0.1	3.00	0.0018	0.50
AC 101	JUNCT_201	2yr_0.86in	10yr_1.36in	100yr_2.35in	15.638	828.078	1732.000	0.015	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
AC102	JUNCT_202	2yr_0.86in	10yr_1.36in	100yr_2.35in	3.910	443.150	838.230	0.033	24.0	24.0	0.35	0.1	3.00	0.0018	0.50
AC 103	JUNCT_203	2yr_0.86in	10yr_1.36in	100yr_2.35in	5.000	1301.459	2421.444	0.006	12.0	12.0	0.35	0.1	3.00	0.0018	0.50
AC 104	JUNCT_204	2yr_0.86in	10yr_1.36in	100yr_2.35in	7.770	545.660	1139.850	0.021	11.0	11.0	0.35	0.1	3.00	0.0018	0.50
AC 105	JUNCT_205	2yr_0.86in	10yr_1.36in	100yr_2.35in	10.960	938.910	1631.560	0.007	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
AC 106	JUNCT_206	2yr_0.86in	10yr_1.36in	100yr_2.35in	13.029	725.770	1116.859	0.033	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
AC 107	JUNCT_207	2yr_0.86in	10yr_1.36in	100yr_2.35in	37.391	544.170	1299.401	0.024	4.0	4.0	0.35	0.1	3.00	0.0018	0.50

AC 108	JUNCT_208	2yr_0.86in	10yr_1.36in	100yr_2.35in	5.121	210.680	605.340	0.018	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
AC 109	JUNCT_209	2yr_0.86in	10yr_1.36in	100yr_2.35in	12.348	474.032	1007.820	0.023	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
CV 1	JUNCT_CV1	2yr_0.86in	10yr_1.36in	100yr_2.35in	68.374	1791.372	3094.262	0.035	45.0	45.0	0.35	0.1	3.00	0.0018	0.50
CV 2	JUNCT_CV2	2yr_0.86in	10yr_1.36in	100yr_2.35in	31.812	1215.159	2340.283	0.022	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
CV 3	JUNCT_CV3	2yr_0.86in	10yr_1.36in	100yr_2.35in	13.569	636.440	1482.680	0.023	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
CV-4	JUNCT_CV4	2yr_0.86in	10yr_1.36in	100yr_2.35in	12.747	1169.030	1897.730	0.017	3.0	3.0	0.35	0.1	3.00	0.0018	0.50
WT 1	JUNCT_WT1	2yr_0.86in	10yr_1.36in	100yr_2.35in	131.862	1701.799	5584.280	0.039	45.0	45.0	0.35	0.1	3.00	0.0018	0.50
WT 2	JUNCT_WT2	2yr_0.86in	10yr_1.36in	100yr_2.35in	123.325	2113.331	3805.578	0.019	5.0	5.0	0.35	0.1	3.00	0.0018	0.50

SWMM Results Comparison Tables

Table G5 - Dove Creek SWMM Results Summary

Location	SWMM ID	Existing Imperviosness Peak Flow Rates (cfs)																									
		1-yr		2-yr				5-yr				10-yr				25-yr				50-yr				100-yr				500-yr	
		2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	2024 MDP EC	2024 MDP PC
Confluence with Cherry Creek	JUNCT_115	23	23	69	33	33	33	135	47	47	47	203	63	97	63	476	158	230	110	501	244	292	159	687	335	303	244	571	447
	JUNCT_113	26	26	84	37	37	37	162	54	54	54	219	72	100	72	518	169	249	119	544	262	319	168	741	365	325	263	602	486
Pond D-2	JUNCT_303	9	1	84	9	13	7	162	15	23	12	219	38	80	19	518	145	214	65	544	223	265	110	741	301	279	174	454	320
	JUNCT_111	29	29	27	43	43	43	111	67	88	88	182	100	150	99	441	190	271	182	463	247	331	236	620	336	308	304	573	462
	JUNCT_107	17	2	8	7	29	3	86	16	62	62	140	44	102	17	341	119	180	36	358	172	201	48	474	212	222	64	279	252
Pond D-1	JUNCT_301	17	7	8	5	28	2	81	15	59	2	128	39	94	3	307	105	156	11	322	150	170	12	421	180	195	14	396	224
	JUNCT_104	17	17	9	24	28	28	88	53	59	59	141	95	95	95	343	205	217	217	360	272	287	287	471	361	378	378	585	585
South Chamber Road	JUNCT_103	12	12	3	15	19	19	58	31	37	37	90	52	52	52	205	105	117	117	215	139	152	152	276	180	195	195	299	299
East Otero Avenue	JUNCT_122	11	11	2	11	16	16	39	20	27	27	60	32	32	32	135	60	71	71	141	78	91	91	181	100	116	116	176	176

Location	SWMM ID	Future Imperviousness Peak Flow Rates (cfs)																									
		1-yr		2-yr				5-yr				10-yr				25-yr				50-yr				100-yr				500-yr	
		2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	2024 MDP EC	2024 MDP PC
Confluence with Cherry Creek	JUNCT_115	99	46	343	101	159	63	564	165	232	102	695	239	290	154	1210	364	399	267	1290	452	476	354	1590	558	576	475	834	750
	JUNCT_113	105	50	381	104	173	68	616	178	253	100	753	260	319	164	1276	399	437	290	1356	492	518	389	1650	602	623	516	804	734
Pond D-2	JUNCT_303	93	20	381	92	155	25	616	154	224	71	753	225	273	116	1276	332	360	210	1356	399	415	281	1650	479	487	369	612	581
	JUNCT_111	193	124	342	179	243	169	547	246	309	234	665	308	388	307	1095	441	522	419	1160	534	615	507	1397	645	726	613	989	862
	JUNCT_107	141	35	277	76	165	46	437	124	188	63	528	167	205	79	844	222	246	110	888	251	269	132	1060	311	300	191	421	505
Pond D-1	JUNCT_301	127	5	272	68	147	9	423	110	161	11	507	145	171	12	788	187	191	19	824	208	203	88	978	275	217	180	396	453
	JUNCT_104	139	139	337	192	191	191	544	268	268	268	665	341	341	341	1038	503	502	502	1093	612	611	611	1331	743	742	742	1059	1059
South Chamber Road	JUNCT_103	82	82	262	111	111	111	398	152	190	152	479	190	190	190	709	268	267	267	734	324	322	322	880	389	387	387	545	545
East Otero Avenue	JUNCT_122	43	43	185	58	58	58	276	79	78	78	335	98	98	98	486	139	137	137	500	167	165	165	596	198	196	196	274	274

Note: EC is for the model results without the proposed improvements and PC is with the proposed improvements.

Windmill Creek Table G6 - SWMM Summary Results

Existing Imperviousness Peak Flow Rate (cfs)

Location	SWMM ID	1-yr		2-yr				5-yr				10-yr				25-yr				50-yr				100-yr				500-yr	
		2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	2024 MDP EC	2024 MDP PC
Cottonwood Creek Confluence	W-143	136	84	94	98	340	280	213	184	361	357	315	278	563	558	289	502	1154	1138	728	661	1557	1548	998	922	2114	2120	2106	2105
Cherry Creek State Park	JUNCT_136	59	53	80	87	87	81	193	160	160	153	276	239	238	231	519	417	417	410	543	537	537	532	723	708	708	703	784	779
East Caley Avenue	JUNCT_134	58	51	81	87	87	80	195	159	159	152	268	227	227	220	485	392	392	385	505	501	501	495	662	651	651	646	732	727
South Jordan Road	JUNCT_132	56	49	79	83	83	77	189	152	152	144	259	215	215	207	453	367	367	359	471	464	464	458	611	600	599	594	679	674
East Arapahoe Road	JUNCT_126	56	49	79	83	83	76	189	151	151	143	258	214	213	206	452	365	365	358	469	462	462	456	609	597	597	591	674	670
East Briarwood Avenue	JUNCT_225	55	48	78	80	80	74	185	144	144	137	251	205	205	197	440	349	349	342	457	438	438	434	594	567	567	558	641	637
Pond W-6/W-7	JUNCT_313	51	45	76	74	74	67	179	132	132	124	241	188	188	179	406	322	322	314	422	401	401	397	550	522	522	511	1090	1006
	JUNCT_125	96	91	118	127	127	121	240	211	211	203	313	277	277	268	592	458	458	449	615	569	569	560	772	716	716	706	886	878
	JUNCT_124	96	91	119	127	127	121	240	211	211	203	313	277	277	268	593	459	459	450	616	569	569	560	773	717	717	707	888	880
East Fremont Avenue	JUNCT_119	84	78	111	109	109	102	207	177	177	168	255	226	226	216	438	354	354	344	453	428	428	419	551	523	524	514	627	618
	JUNCT_116	63	57	97	82	82	75	176	133	133	123	209	168	168	158	303	244	244	235	310	283	283	274	390	353	353	333	384	375
Pond W-4	JUNCT_307	47	44	87	61	61	58	144	96	96	94	167	122	122	120	218	174	174	172	220	199	199	195	266	222	222	217	579	581
	JUNCT_113	47	45	88	61	61	58	173	99	99	96	226	133	133	129	418	238	238	233	433	303	303	299	535	388	388	383	454	454
	JUNCT_111	33	30	82	42	42	39	140	65	65	61	110	84	84	80	286	141	141	136	295	186	186	174	354	247	248	231	277	259
	JUNCT_112	13	9	48	16	16	11	92	24	24	25	111	53	53	49	175	107	107	84	180	130	130	105	215	160	160	132	175	148
Pond W1/W2 Outflow	JUNCT_110	9	5	42	10	10	6	80	13	13	21	93	44	44	38	119	72	72	43	121	78	78	46	131	84	84	50	359	284
	JUNCT_108	79	79	57	104	104	104	188	179	179	179	286	248	248	248	666	476	476	476	697	664	664	664	909	930	930	930	1322	1322
East County Line Road	JUNCT_106	46	46	33	61	61	61	141	109	109	109	213	155	155	155	486	335	335	335	508	492	492	492	661	688	688	688	987	987
	JUNCT_104	35	35	32	45	45	45	132	85	85	85	197	133	133	133	440	304	303	303	460	448	448	448	595	621	621	621	903	903
South Peoria Street	JUNCT_150	13	13	25	16	16	16	93	49	49	49	134	92	91	91	287	207	207	207	299	299	298	298	385	401	400	400	545	545
Meridian Pond	JUNCT_302	8	8	25	10	10	10	77	35	35	35	107	64	64	64	219	144	143	143	228	204	203	203	290	270	270	270	617	617
	JUNCT_215	5	0	25	16	6	0	93	49	9	1	134	92	10	3	287	207	14	13	299	299	28	22	385	401	66	25	51	23
Pond W5 Outflow	JUNCT_309	5	53	4	6	6	0	10	9	9	1	11	10	10	3	35	14	14	13	41	28	28	22	80	67	66	25	203	99

Future Imperviouness Peak Flow Rate (cfs)

Location	SWMM ID	1-yr		2-yr				5-yr				10-yr				25-yr				50-yr				100-yr				500-yr	
		2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	2024 MDP EC	2024 MDP PC
Cottonwood Creek Confluence	W-143	136	362	311	251	429	422	500	384	708	702	636	502	972	954	1189	764	1647	1635	1226	1007	2106	2105	1483	1262	2651	2657	4093	4023
Cherry Creek State Park	JUNCT_136	59	165	281	225	225	217	431	336	335	329	537	429	429	422	930	628	628	622	962	784	784	779	1196	981	981	976	1398	1395
East Caley Avenue	JUNCT_134	58	169	276	223	222	216	420	325	325	318	518	411	411	404	885	591	590	584	916	732	732	727	1108	918	918	914	1269	1256
South Jordan Road	JUNCT_132	56	164	271	215	215	208	403	313	313	306	491	393	393	386	819	553	553	547	847	679	679	674	1004	844	844	839	1193	1124
East Arapahoe Road	JUNCT_126	56	163	269	214	214	207	401	311	311	3	487	391	391	384	813	551	551	544	840	675	674	670	994	838	838	833	1189	1109
East Briarwood Avenue	JUNCT_225	55	155	259	205	205	198	382	299	299	292	459	374	374	367	772	528	528	522	797	641	641	637	932	796	796	789	1159	1076
Pond W-6/W-7	JUNCT_313	51	144	248	191	191	184	357	278	278	270	425	345	345	337	697	483	483	477	720	584	584	580	864	725	725	714	1090	1006
	JUNCT_125	96	241	405	307	307	300	629	426	426	420	759	506	506	499	1234	739	739	731	1274	886	886	878	1522	1070	1070	1062	1498	1487
	JUNCT_124	96	242	406	307	307	301	632	427	427	420	762	506	506	499	1239	740	740	732	1279	888	888	880	1528	1072	1072	1063	1500	1489
East Fremont Avenue	JUNCT_119	84	191	320	241	242	234	475	326	326	319	563	379	379	371	866	532	532	523	891	627	627	618	1048	744	744	735	1101	1006
	JUNCT_116	63	144	237	181	181	173	324	231	231	223	370	260	260	251	513	337	337	327	526	384	384	375	700	461	461	430	922	796
Pond W-4	JUNCT_307	47	102	170	124	124	122	202	154	154	153	217	177	177	173	348	213	213	208	364	228	228	224	507	318	318	289	579	581
	JUNCT_113	47	107	251	138	138	135	381	200	200	196	458	243	243	239	734	373	373	365	757	454	454	454	901	573	573	567	845	848
	JUNCT_111	33	57	175	76	76	72	251	113	113	104	296	143	143	128	445	226	226	210	458	277	277	259	540	340	340	320	483	486
	JUNCT_112	13	43	113	66	66	50	153	89	89	66	178	104	104	80	266	149	149	123	273	175	175	148	339	208	208	180	449	331
Pond W1/W2 Outflow	JUNCT_110	9	37	102	60	60	39	118	71	71	42	126	75	75	45	196	82	82	49	211	87	87	52	312	103	103	55	359	284
	JUNCT_108	79	313	591	394	394	394	920	549	549	549	1112	670	671	671	1725	1074	1079	1079	1781	1317	1322	1322	2121	1599	1599	1599	2271	2271
East County Line Road	JUNCT_106	46	222	415	276	276	276	635	393	393	393	765	479	480	480	1183	815	819	819	1221	983	987	987	1452	1176	1176	1176	1636	1636
	JUNCT_104	35	199	388	246	246	246	586	345	345	345	702	435	436	436	1063	751	755	755	1097	899	903	903	1296	1062	1062	1062	1459	1459
South Peoria Street	JUNCT_150	13	106	190	132	132	132	294	204	206	206	351	287	288	288	547	485	487	487	564	543	545	545	667	607	607	607	927	927
Meridian Pond	JUNCT_302	8	70	143	81	82	82	218	138	139	139	259	191	192	192	401	316	317	317	415	336	336	336	505	366	366	366	617	617
	JUNCT_215	5	1	190	132	9	2	294	204	11	3	351	287	12	7	547	485	23	22	564	543	51	23	667	607	89	30	203	99
Pond W5 Outflow	JUNCT_309	5	1	9	9	9	2	12	11	11	3	14	12	12	7	63	23	23	22	69	52	51	23	113	89	89	30	203	99

Note: EC is for the model results without the proposed improvements and PC is with the proposed improvements.

Table G7 - Lone Tree Creek Summary SWMM Results

Location	SWMM ID	Existing Imperviousness – Peak Flow Rate (cfs)																									
		1-yr		2-yr				5-yr				10-yr				25-yr				50-yr				100-yr				500-yr	
		2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	2024 MDP EC	2024 MDP PC
Windmill Creek Confluence	L-126	133	20	269	252	173	52	569	380	262	129	759	516	357	218	1470	849	590	469	1532	1056	736	646	1930	1334	931	890	1381	1322
Cherry Creek State Park	JUNCT_124	208	35	309	268	266	86	631	402	401	200	819	533	531	325	1515	850	847	694	1573	1042	1039	936	1961	1299	1296	1260	1886	1804
Pond L-3 Outflow	JUNCT_303	207	36	311	265	264	86	630	398	396	198	815	525	524	321	1497	834	831	685	1555	1020	1017	921	1933	1268	1265	1237	1833	1760
Pond L-3 Inflow	JUNCT_123	228	135	354	293	291	181	691	419	417	271	895	549	547	378	1604	872	871	722	1664	1068	1065	967	2049	1316	1313	1294	1899	1916
Peakview Ave	JUNCT_120	210	112	334	268	267	150	644	379	377	222	828	491	490	315	1447	764	764	645	1500	926	924	861	1836	1130	1128	1144	1602	1657
East Arapahoe Road	JUNCT_118	208	109	331	265	263	145	636	373	372	216	816	483	481	309	1419	747	747	633	1471	903	901	843	1798	1099	1098	1118	1554	1612
East Briarwood Avenue	JUNCT_116	194	90	312	246	245	120	602	346	345	181	771	446	445	286	1329	686	685	590	1378	825	824	786	1679	1000	999	1040	1403	1473
	JUNCT_112	160	45	259	202	201	62	503	282	281	145	639	361	360	230	1093	541	540	483	1132	646	645	639	1377	774	774	844	1109	1137
	JUNCT_108	142	30	233	176	175	51	432	240	239	118	539	299	298	185	887	424	423	384	918	494	494	504	1105	581	581	660	843	831
Pond L-2 Outfall	JUNCT_301	123	25	206	151	151	40	364	202	201	94	446	246	246	146	706	335	335	304	730	385	385	399	872	444	444	519	648	626
	JUNCT_105	131	131	208	169	168	168	383	246	245	245	483	327	326	326	792	499	498	498	820	614	612	612	989	756	754	754	1111	1111
East Broncos Parkway	JUNCT_104	108	108	179	137	137	137	313	194	194	194	390	252	252	252	616	364	364	364	636	444	443	443	754	542	541	541	787	787
	JUNCT_102	45	45	86	55	55	55	125	73	73	73	151	89	89	89	215	119	120	120	221	142	142	142	253	169	169	169	239	239
Pond L1 East Outflow	JUNCT_351	9	9	8	11	11	11	16	16	16	16	20	20	20	20	76	55	55	55	80	81	81	81	89	89	89	89	127	127
Pond L1 West Outflow	JUNCT_999	18	18	20	21	21	21	26	24	24	24	28	27	27	27	66	53	53	53	67	65	65	65	71	69	69	69	216	216
	JUNCT_350	30	30	44	39	39	39	94	59	59	59	123	81	81	81	212	129	129	129	220	160	160	160	269	198	198	198	298	298
Overflow To Windmill Creek	L-132	62	10	269	252	79	25	569	380	121	60	759	516	163	100	1470	849	267	217	1532	1056	331	296	1930	1334	417	402	614	586

Location	SWMM ID	Future Imperviousness – Peak Flow Rate (cfs)																									
		1-yr		2-yr				5-yr				10-yr				25-yr				50-yr				100-yr				500-yr	
		2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MDP	2020 Update	2024 MDP EC	2024 MDP PC	2024 MDP EC	2024 MDP PC
Windmill Creek Confluence	L-126	226	86	581	421	290	134	953	580	402	240	1170	728	506	349	2007	1097	765	644	2078	1326	926	838	2532	1632	1142	1074	1652	1538
Cherry Creek State Park	JUNCT_124	360	131	668	457	455	207	1046	616	614	357	1275	761	759	525	2100	1110	1107	946	2170	1340	1336	1207	2614	1620	1617	1508	2295	2082
Pond L-3 Outflow	JUNCT_303	358	129	670	453	451	204	1043	608	606	353	1271	749	747	519	2081	1089	1087	932	2149	1312	1310	1187	2585	1583	1581	1477	2237	2029
Pond L-3 Inflow	JUNCT_123	385	282	749	481	481	363	1170	645	645	502	1411	799	799	638	2238	1162	1162	975	2311	1390	1390	1244	2770	1670	1670	1587	2350	2313
Peakview Ave	JUNCT_120	350	240	699	433	433	307	1081	573	573	421	1295	703	703	534	2013	1005	1005	870	2076	1194	1194	1107	2470	1422	1422	1399	1980	1990
East Arapahoe Road	JUNCT_118	344	233	690	425	425	297	1065	562	562	408	1274	687	687	515	1974	978	978	852	2036	1159	1159	1084	2420	1379	1379	1366	1916	1934
East Briarwood Avenue	JUNCT_116	324	207	655	398	398	264	1007	522	522	362	1201	635	635	457	1847	898	898	798	1905	1060	1060	1012	2261	1255	1255	1269	1732	1770
	JUNCT_112	271	139	551	329	329	176	836	424	424	255	997	510	510	365	1518	700	701	652	1565	817	817	827	1850	958	958	1019	1317	1363
	JUNCT_108	212	71	435	254	255	114	650	322	322	195	773	378	378	280	1161	502	502	495	1197	573	573	625	1402	659	659	743	977	928
Pond L-2 Outfall	JUNCT_301	169	54	336	201	201	85	497	251	251	148	590	292	292	215	869	375	375	380	896	423	423	479	1044	479	479	551	736	697
	JUNCT_105	194	194	353	245	245	245	550	338	338	338	664	425	425	425	1000	603	603	603	1032	727	727	727	1218	878	878	878	1261	1261
East Broncos Parkway	JUNCT_104	144	144	278	178	178	178	424	243	243	243	516	304	304	304	763	420	421	421	787	504	504	504	915	607	607	607	867	867
	JUNCT_102	46	46	88	56	56	56	128	75	75	75	154	91	91	91	221	123	123	123	227	146	146	146	259	174	174	174	244	244
Pond L1 East Outflow	JUNCT_351	13	13	16	15	15	15	33	20	20	20	46	35	34	34	88	67	67	67	89	88	88	88	91	90	90	90	149	149
Pond L1 West Outflow	JUNCT_999	19	19	22	21	21	21	27	24	24	24	36	27	27	27	68	55	55	55	68	65	65	65	111	70	70	70	223	223
	JUNCT_350	31	31	55	40	40	40	109	60	60	60	140	82	82	82	236	131	131	131	245	163	163	163	298	201	201	201	302	302
Overflow To Windmill Creek	L-132	107	39	581	421	135	62	953	580	185	109	1170	728	232	161	2007	1097	347	296	2078	1326	421	381	2532	1632	515	464	739	675

Note: EC is for the model results without the proposed improvements and PC is with the proposed improvements.

Table G8 - Cottonwood Creek Summary SWMM Results

Future Imperviousness Peak Flows (cfs)

Location	SWMM ID	1-yr			2-yr				5-yr				10-yr				25-yr				50-yr				100-yr				500-yr	
		2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	2024 MDP EC	2024 MDP PC
Downstream Study Limit	JUNCT_209	N/A	753	675	1230	N/A	2812	1349	2060	N/A	2306	2091	2610	N/A	2306	2091	3330	N/A	3965	3652	3910	N/A	5090	4716	4770	N/A	6613	6274	9559	9185
Peoria Street	POND_312	519	530	460	1230	1037	1045	915	2060	1621	1623	1422	2600	1621	1623	1422	3290	2817	2857	2586	3840	3513	3593	3308	4660	4420	4465	4259	6011	5735
Downstream of Peakview Avenue	JUNCT_149	522	536	465	1130	1023	1033	902	1870	1553	1556	1360	2300	1553	1556	1360	2910	2663	2708	2431	3350	3284	3359	3161	3870	4028	4063	3892	5362	5190
Inverness Regional Pond Outfall	POND_319	478	497	448	1010	934	953	848	1660	1421	1435	1267	2010	1421	1435	1267	2620	2491	2502	2311	2960	3020	3028	2910	3390	3663	3673	3555	4796	4714
Downstream of Airport Trib Confluence	JUNCT_105	672	672	619	952	1045	1045	938	1590	1419	1419	1243	1960	1419	1419	1243	2840	2344	2344	2099	3420	2902	2902	2778	4190	3637	3637	3590	5178	5175
E-470	JUNCT_9	441	441	441	662	643	643	643	973	832	832	832	1122	832	832	832	1474	1280	1280	1280	1694	1549	1548	1548	2146	1928	1927	1928	2720	2721
Lincoln Avenue	JUNCT_12	160	160	160	194	216	217	217	264	254	254	254	304	254	254	254	423	386	386	386	514	515	515	515	665	639	639	639	1120	1120
Lower Skyridge Pond	POND_82	84	84	84	113	115	115	115	139	133	133	133	185	133	133	133	346	279	278	278	416	376	376	376	541	471	471	471	865	865
Peoria Tributary Outfall	JUNCT_162	94	94	94	206	138	138	138	341	184	184	184	428	184	184	184	593	298	298	298	708	372	372	372	878	475	476	476	721	721
Peoria Tributary at Arapahoe Road	JUNCT_242	40	40	40	54	63	63	63	118	88	88	88	157	88	88	88	345	147	147	147	506	184	184	184	704	236	236	236	384	384
Havana Tributary Oufall	JUNCT_133	230	230	230	325	322	322	322	533	408	408	408	657	408	408	408	871	608	607	607	1080	738	738	739	1360	924	899	899	1264	1268
Rampart Lower Pond	POND_365	32	29	2	37	45	36	6	62	62	42	9	91	62	42	9	161	111	100	59	213	142	166	106	272	185	255	166	418	241
Inverness Trib C Pond	POND_381	61	103	103	87	139	183	183	264	218	261	261	381	218	261	261	621	425	458	458	799	551	578	578	1000	701	723	724	1064	1065
Inverness Tributary at Inverness Drive East	JUNCT_282	111	111	111	160	164	164	164	289	216	216	216	369	216	216	216	501	333	333	333	616	410	410	410	746	503	503	503	723	723
Airport Tributary Outfall	JUNCT_104	90	90	16	141	159	159	26	304	248	248	79	400	248	248	79	642	480	480	321	801	625	625	500	1040	814	814	720	1265	1195
Inverness Business Park Boundary	JUNCT_1	76	76	76	118	137	137	137	262	216	216	216	346	216	216	216	558	425	425	425	700	555	555	555	912	726	726	726	1134	1134
Meridian Tributary Outfall	JUNCT_17	187	187	187	294	266	266	266	441	341	341	341	524	341	341	341	717	518	518	518	851	631	631	631	1030	773	773	773	1100	1100
Meridian Tributary at Lincoln Avenue	JUNCT_19	157	157	157	225	215	215	215	324	264	264	264	379	264	264	264	586	363	363	363	570	431	431	431	681	515	515	515	707	707

Existing Imperviousness Peak Flows (cfs)

Location	SWMM ID	1-yr			2-yr				5-yr				10-yr				25-yr				50-yr				100-yr				500-yr	
		2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	Previous MP	2020 Update	2024 MDP EC	2024 MDP PC	2024 MDP EC	2024 MDP PC
Downstream Study Limit	JUNCT_209	N/A	142	103	628	N/A	344	301	1370	N/A	2166	621	1920	N/A	1364	1189	2740	N/A	2925	2619	3350	N/A	4170	3844	4210	N/A	5595	5222	8782	8356
Peoria Street	POND_312	38	48	36	628	175	184	137	1370	501	514	424	1900	956	967	806	2700	2059	2103	1818	3290	2895	2971	2711	4110	3815	3868	3636	5614	5321
Downstream of Peakview Avenue	JUNCT_149	76	84	74	554	183	196	153	1240	490	503	413	1680	918	929	769	2380	1946	1991	1696	2870	2666	2753	2495	3420	3472	3517	3335	4890	4699
Inverness Regional Pond Outfall	POND_319	58	72	64	474	167	174	153	1090	438	450	392	1460	818	832	709	2140	1817	1835	1605	2520	2455	2470	2292	2980	3109	3119	3003	4284	4210
Downstream of Airport Trib Confluence	JUNCT_105	250	254	236	440	352	330	312	951	615	611	527	1250	936	934	781	1990	1785	1784	1436	2440	2305	2305	1996	3080	2951	2951	2778	4331	4272
E-470	JUNCT_9	139	165	147	246	191	211	191	470	307	307	307	590	439	439	439	859	752	752	752	1030	953	953	953	1350	1313	1312	1313	2060	2060
Lincoln Avenue	JUNCT_12	28	31	31	47	43	42	43	139	92	92	92	170	141	141	141	343	271	271	271	452	397	397	397	591	530	530	530	932	932
Lower Skyridge Pond	POND_82	27	30	30	45	40	40	40	120	79	79	79	139	117	117	117	295	222	222	222	383	327	327	327	493	431	431	431	771	771
Peoria Tributary Outfall	JUNCT_162	36	36	36	101	50	50	50	204	82	82	82	274	121	121	121	420	217	217	217	543	277	277	277	775	377	377	377	606	606
Peoria Tributary at Arapahoe Road	JUNCT_242	15	15	15	35	21	21	21	74	37	37	37	132	57	57	57	276	105	105	105	434	140	140	140	626	228	228	228	374	374
Havana Tributary Outfall	JUNCT_133	124	124	124	230	167	167	167	390	245	245	245	501	325	325	325	695	521	521	521	867	641	640	640	1120	790	793	793	1141	1138
Rampart Lower Pond	POND_365	20	21	2	32	27	26	2	49	37	34	3	72	51	39	6	134	93	89	51	182	123	155	95	255	170	244	158	419	236
Inverness Trib C Pond	POND_381	16	47	47	20	42	80	81	127	113	154	154	220	187	228	228	425	385	416	417	571	507	532	533	741	652	672	673	999	999
Inverness Tributary at Inverness Drive East	JUNCT_282	64	65	65	79	87	87	87	177	133	133	133	238	181	181	181	350	294	294	294	441	368	368	368	547	455	455	455	664	664
Airport Tributary Outfall	JUNCT_104	40	42	12	79	57	57	16	205	115	115	25	283	195	195	37	492	412	412	260	622	547	547	435	815	722	723	648	1142	1083
Inverness Business Park Boundary	JUNCT_1	30	32	32	58	45	45	45	166	95	95	95	234	165	165	165	416	359	359	359	530	480	480	480	697	637	638	637	1015	1015
Meridian Tributary Outfall	JUNCT_17	45	48	48	40	61	61	61	83	91	91	91	112	127	127	127	211	195	195	195	275	241	241	241	377	331	331	331	526	526
Meridian Tributary at Lincoln Avenue	JUNCT_19	1	1	1	9	1	1	1	45	14	14	14	68	38	38	38	128	100	100	100	165	136	136	136	219	185	185	185	290	290

Note: EC is for the model results without the proposed improvements and PC is with the proposed improvements.

SWMM Results Tables

Table G9 - Dove Creek SWMM Results

	Dove Creek With Improvements - Peak Total Inflow (cfs)																	Dove Creek With Improvements - Peak Detention Pond Outflow (cfs)															
Node	ex2	ex10	ex100	fu2	fu10	fu100	ex5	ex25	ex50	fu5	fu25	fu50	ex1	fu1	ex500	fu500	Storage Node	ex2	ex10	ex100	fu2	fu10	fu100	ex5	ex25	ex50	fu5	fu25	fu50	ex1	fu1	ex500	fu500
JUNCT_101	10.2	29.6	92.5	67.0	108.1	206.2	18.8	55.7	72.7	89.0	145.7	174.3	6.7	51.0	141.7	285.2	JUNCT_301	2.0	2.8	14.4	9.5	11.9	179.9	2.3	11.2	11.8	11.3	18.6	88.4	1.7	4.9	224.1	453.4
JUNCT_121	2.2	6.1	23.1	8.7	14.3	44.4	3.9	10.9	14.3	11.7	24.7	33.4	1.5	6.7	44.9	85.2	JUNCT_303	7.5	19.5	174.3	25.3	116.3	369.4	12.5	65.3	109.8	71.4	209.6	281.3	5.3	19.5	320.2	581.3
JUNCT_122	15.9	31.9	116.1	57.8	98.5	196.1	27.0	71.4	91.4	78.5	137.3	165.4	10.5	43.1	175.6	274.2	JUNCT_304	2.2	6.1	23.1	8.7	14.3	44.4	3.9	10.9	14.3	11.7	24.7	33.4	1.5	6.7	44.9	85.2
JUNCT_103	19.3	51.8	195.3	110.5	190.4	387.3	37.1	116.7	152.3	151.7	266.9	322.3	12.4	81.7	298.7	544.9	JUNCT_305	11.8	24.0	55.2	24.9	47.3	83.7	17.1	42.6	49.7	37.6	54.3	58.2	8.2	18.3	96.8	146.0
JUNCT_104	28.4	94.8	377.6	191.2	340.6	741.7	59.2	217.0	286.9	267.7	502.0	610.9	17.3	139.1	585.1	1059.4																	
JUNCT_204	2.0	2.8	14.4	9.5	11.9	179.9	2.3	11.2	11.8	11.3	18.6	88.4	1.7	4.9	224.1	453.4																	
JUNCT_107	3.4	16.9	63.9	46.4	79.1	191.2	8.7	36.2	48.2	63.2	109.8	131.8	2.0	34.6	252.5	504.6																	
JUNCT_111	43.0	99.1	304.3	169.4	307.2	613.4	66.9	182.1	236.4	233.6	419.0	506.8	29.1	123.9	461.8	862.3																	
JUNCT_102	2.8	7.0	25.3	13.0	22.7	50.4	4.2	14.6	19.4	17.8	33.8	41.4	1.8	9.4	38.6	71.4																	
JUNCT_105	1.7	11.8	22.9	15.9	46.6	54.5	3.7	13.3	17.7	21.7	37.5	45.3	1.1	11.9	35.1	76.0																	
JUNCT_110	2.4	18.2	55.8	36.3	81.4	136.0	6.6	30.9	41.9	50.2	92.8	113.0	1.4	26.8	87.4	192.4																	
JUNCT_312	7.5	19.5	174.3	25.3	116.3	369.4	12.5	65.3	109.8	71.4	209.6	281.3	5.3	19.5	320.2	581.3																	
JUNCT_701	2.2	6.1	23.1	8.7	14.3	44.4	3.9	10.9	14.3	11.7	24.7	33.4	1.5	6.7	44.9	85.2																	
JUNCT_115	32.8	63.1	243.9	62.5	153.5	474.8	46.6	109.9	159.1	101.9	266.8	353.9	22.9	45.6	447.3	750.2																	
JUNCT_113	37.4	72.1	262.7	67.9	164.0	516.1	53.5	118.6	168.0	99.7	290.2	388.6	26.1	49.6	486.0	734.4																	
JUNCT_301	28.4	94.8	377.6	191.2	340.6	741.7	59.2	217.0	286.9	267.7	502.0	610.9	17.3	139.1	585.1	1059.4																	
JUNCT_303	43.0	99.1	304.3	169.4	307.2	613.4	66.9	182.1	236.4	233.6	419.0	506.8	29.1	123.9	461.8	862.3																	
JUNCT_304	10.2	29.6	92.5	67.0	108.1	206.2	18.8	55.7	72.7	89.0	145.7	174.3	6.7	51.0	141.7	285.2																	
JUNCT_305	15.9	32.2	88.2	36.7	65.3	129.6	22.9	56.1	71.2	49.8	90.8	110.6	10.9	26.6	126.4	165.0																	

	Dove Creek Without Improvements - Peak Total Inflow (cfs)																	Dove Creek Without Improvements - Peak Detention Pond Outflow (cfs)															
Node	ex2	ex10	ex100	fu2	fu10	fu100	ex5	ex25	ex50	fu5	fu25	fu50	ex1	fu1	ex500	fu500	Storage Node	ex2	ex10	ex100	fu2	fu10	fu100	ex5	ex25	ex50	fu5	fu25	fu50	ex1	fu1	ex500	fu500
JUNCT_101	10.2	29.6	92.5	67.0	108.1	206.2	18.8	55.7	72.7	89.0	145.7	174.3	6.7	51.0	141.7	285.2	JUNCT_301	28.4	93.6	194.7	146.6	171.2	216.8	59.1	156.4	170.4	161.3	191.2	202.8	17.3	127.1	217.7	395.9
JUNCT_121	2.2	6.1	23.1	8.7	14.3	44.4	3.9	10.9	14.3	11.7	24.7	33.4	1.5	6.7	44.9	85.2	JUNCT_303	12.7	80.1	278.9	155.4	272.8	486.8	22.7	213.8	264.7	223.6	360.5	415.5	8.7	92.9	453.8	611.7
JUNCT_122	15.9	31.9	116.1	57.8	98.5	196.1	27.0	71.4	91.4	78.5	137.3	165.4	10.5	43.1	175.6	274.2	JUNCT_304	2.2	6.1	23.1	8.7	14.3	44.4	3.9	10.9	14.3	11.7	24.7	33.4	1.5	6.7	44.9	85.2
JUNCT_103	19.3	51.8	195.3	110.5	190.4	387.3	37.1	116.7	152.3	151.7	266.9	322.3	12.4	81.7	298.7	544.9	JUNCT_305	11.7	33.7	58.8	45.3	55.7	109.4	17.2	51.8	57.1	51.1	59.6	87.2	8.2	33.9	117.9	151.8
JUNCT_104	28.4	94.8	377.6	191.2	340.6	741.7	59.2	217.0	286.9	267.7	502.0	610.9	17.3	139.1	585.1	1059.4																	
JUNCT_204	28.4	93.6	194.7	146.6	171.2	216.8	59.1	156.4	170.4	161.3	191.2	202.8	17.3	127.1	217.7	380.5																	
JUNCT_107	28.9	102.3	222.4	165.5	205.4	300.3	61.8	179.7	201.2	188.2	245.5	269.1	17.3	141.3	279.3	421.4																	
JUNCT_111	42.9	150.2	308.2	243.4	388.0	726.3	87.9	271.5	331.4	308.5	521.6	615.3	29.1	193.0	573.3	989.0																	
JUNCT_102	2.8	7.0	25.3	13.0	22.7	50.4	4.2	14.6	19.4	17.8	33.8	41.4	1.8	9.4	38.6	71.4																	
JUNCT_105	1.7	11.8	22.9	15.9	46.6	54.5	3.7	13.3	17.7	21.7	37.5	45.3	1.1	11.9	35.1	76.0																	
JUNCT_110	2.4	18.2	55.8	36.3	81.4	136.0	6.6	30.9	41.9	50.2	92.8	113.0	1.4	26.8	87.4	192.4																	
JUNCT_312	12.7	80.1	278.9	155.4	272.8	486.8	22.7	213.8	264.7	223.6	360.5	415.5	8.7	92.9	453.8	602.9																	
JUNCT_701	2.2	6.1	23.1	8.7	14.3	44.4	3.9	10.9	14.3	11.7	24.7	33.4	1.5	6.7	44.9	85.2																	
JUNCT_115	32.8	97.1	302.5	159.4	290.3	575.7	46.6	229.5	292.1	231.5	399.0	476.0	22.9	99.4	570.9	834.0																	
JUNCT_113	37.4	99.9	325.2	173.2	318.7	622.8	53.5	249.5	318.5	253.2	437.0	518.2	26.1	105.1	601.8	804.1																	
JUNCT_301	28.4	94.8	377.6	191.2	340.6	741.7	59.2	217.0	286.9	267.7	502.0	610.9	17.3	139.1	585.1	1059.4																	
JUNCT_303	42.9	150.2	308.2	243.4	388.0	726.3	87.9	271.5	331.4	308.5	521.6	615.3	29.1	193.0	573.3	989.0																	
JUNCT_304	10.2	29.6	92.5	67.0	108.1	206.2	18.8	55.7	72.7	89.0	145.7	174.3	6.7	51.0	141.7	285.2																	
JUNCT_305	15.9	37.7	88.9	60.7	86.3	136.0	22.9	74.4	88.1	73.9	107.4	120.1	10.9	39.1	134.0	169.5																	

Table G10 - Windmill Creek SWMM Results

	Windmill Creek With Improvements -Peak Total Inflow (cfs)															
Node	ex2	ex10	ex100	fu2	fu10	fu100	ex1	ex5	ex25	ex50	fu1	fu5	fu25	fu50	fu500	ex500
JUNCT_103	8.5	19.3	50.0	24.5	40.3	75.0	6.5	14.5	31.3	39.8	20.1	33.4	54.2	64.8	104.8	74.7
JUNCT_100	3.7	32.4	136.2	107.9	177.1	330.3	2.4	18.5	75.7	102.6	88.3	147.1	237.9	283.4	466.1	220.6
JUNCT_101	12.3	37.2	123.0	41.3	76.1	182.6	9.0	25.7	72.6	94.9	32.7	61.1	118.7	147.8	273.0	192.8
JUNCT_102	9.8	41.3	149.7	88.2	157.8	333.8	6.8	26.7	86.7	114.8	70.0	128.6	226.3	275.1	480.8	236.2
JUNCT_192	13.1	72.7	299.5	85.5	201.8	395.7	10.6	40.5	160.0	226.1	73.2	146.4	334.5	359.3	662.2	402.1
JUNCT_150	16.3	91.5	400.5	131.8	287.5	606.8	12.6	49.2	207.0	298.3	105.5	205.7	487.2	545.0	927.5	551.0
JUNCT_196	11.9	21.2	46.8	17.9	28.7	55.2	9.4	17.3	31.1	38.1	14.6	24.4	38.6	45.9	77.3	67.6
JUNCT_104	45.0	132.7	621.2	246.5	435.8	1062.4	34.9	85.3	303.3	448.2	199.1	345.3	754.6	902.7	1458.7	931.1
JUNCT_106	60.8	155.2	687.9	276.3	480.0	1176.3	46.0	108.6	335.2	492.2	222.4	393.5	819.2	986.5	1635.7	1055.5
JUNCT_109	6.1	22.0	75.9	45.3	79.4	165.3	4.4	14.7	44.5	59.0	36.2	65.4	112.2	136.6	236.0	118.3
JUNCT_108	104.4	247.6	929.7	394.3	670.6	1599.1	79.5	178.9	476.0	664.1	312.9	548.8	1079.0	1322.0	2270.7	1459.1
JUNCT_208	5.8	38.2	50.0	39.3	44.9	54.6	5.1	20.8	43.3	46.5	37.1	42.4	48.9	51.7	284.3	57.4
JUNCT_112	11.3	49.1	131.5	50.2	79.7	180.0	8.7	25.0	83.9	104.9	42.8	66.1	123.1	148.0	331.1	188.5
JUNCT_111	38.9	79.7	231.5	71.9	128.3	319.5	30.2	61.2	136.4	174.4	57.3	104.1	210.4	258.8	485.8	349.9
JUNCT_113	58.3	129.1	382.6	135.2	238.8	567.4	44.6	96.2	233.4	298.7	107.2	196.4	364.7	454.2	848.3	596.7
JUNCT_139	68.3	137.2	244.8	138.2	189.4	306.8	52.4	109.1	191.6	216.0	115.5	171.0	230.4	251.1	626.6	387.0
JUNCT_114	6.0	20.6	66.6	41.8	71.5	140.7	4.3	13.6	39.6	51.6	33.9	58.7	99.1	119.1	198.0	102.5
JUNCT_115	9.4	45.3	178.6	43.1	95.6	251.9	6.3	27.5	100.1	133.7	33.5	71.7	159.3	200.7	375.8	281.7
JUNCT_215	0.4	2.6	25.0	1.8	7.0	29.7	0.3	1.3	13.5	22.0	1.3	3.4	21.8	23.1	99.2	81.1
JUNCT_116	74.9	157.6	333.2	172.6	250.7	429.9	56.9	123.4	234.5	273.7	143.8	223.0	327.4	374.5	795.7	528.4
JUNCT_119	102.5	216.4	514.1	234.3	370.9	735.4	77.9	168.1	344.5	418.8	190.9	319.0	523.4	618.1	1006.0	723.0
JUNCT_121	110.9	239.9	600.4	270.6	439.3	902.5	83.7	184.6	392.9	483.4	218.8	374.3	632.8	753.1	1248.4	856.6
JUNCT_124	120.9	268.2	706.9	300.9	499.4	1063.2	90.9	203.2	449.8	560.2	241.7	420.3	732.4	879.7	1489.2	1025.0
JUNCT_125	120.7	268.0	706.3	300.4	498.6	1061.6	90.8	203.0	449.3	559.7	241.3	419.6	731.3	878.3	1487.4	1024.2
JUNCT_225	73.7	196.5	558.3	198.1	366.9	788.5	48.1	136.7	341.7	433.5	155.3	291.9	522.0	636.7	1075.7	828.4
JUNCT_126	76.5	205.7	591.3	207.2	383.8	833.3	49.4	143.2	357.6	456.4	162.8	3.4	544.2	669.9	1108.6	894.6
JUNCT_134	80.2	219.7	646.0	215.7	404.3	913.5	51.4	152.0	384.8	494.9	169.3	317.6	584.0	727.0	1256.2	994.0
JUNCT_136	81.0	230.7	702.7	217.3	422.2	976.4	53.2	153.3	409.7	531.7	165.2	328.5	622.1	779.0	1395.0	1086.8
JUNCT_137	40.5	90.1	238.4	82.8	152.9	247.2	29.9	68.2	165.5	212.3	64.4	124.0	223.6	241.4	484.7	317.6
JUNCT_122	11.0	23.3	60.0	24.9	42.2	86.1	8.3	17.8	38.3	48.3	19.7	35.1	59.2	71.5	120.5	88.1
JUNCT_127	31.5	62.1	146.8	54.7	93.2	188.5	24.1	48.6	95.6	119.0	43.4	77.1	129.6	156.5	263.9	212.8
JUNCT_129	31.4	62.0	146.8	54.6	93.1	188.4	24.0	48.6	95.6	119.0	43.3	77.0	129.5	156.4	263.8	212.8
JUNCT_128	9.5	23.0	62.8	30.1	50.1	100.2	6.8	17.1	38.9	49.7	23.7	42.2	69.4	83.8	138.8	92.9
JUNCT_130	60.5	131.4	348.1	131.6	230.7	492.7	45.0	101.4	220.2	278.6	102.2	190.7	335.0	407.1	694.1	511.2
JUNCT_537	39.9	87.3	224.1	81.9	149.5	230.1	29.5	66.7	158.4	202.1	63.9	122.1	214.6	229.5	464.9	303.2
JUNCT_135	4.8	13.3	46.1	11.4	24.4	67.1	3.3	9.3	27.0	35.5	8.4	18.5	42.1	53.4	98.9	70.1
JUNCT_336	9.1	19.9	52.5	9.4	20.4	53.4	6.7	15.0	33.5	42.0	7.0	15.5	34.1	42.8	78.6	77.4
JUNCT_131	8.5	21.5	64.4	13.6	29.9	79.3	6.2	15.7	39.2	50.2	10.1	22.6	50.5	63.4	117.0	96.8
JUNCT_117	28.5	50.7	108.6	34.6	58.1	117.2	22.3	41.6	73.3	88.9	27.5	48.8	81.0	97.1	164.2	154.3
JUNCT_105	6.9	18.3	56.5	37.8	61.3	119.2	5.1	13.3	33.9	44.1	30.9	52.2	83.6	100.1	167.1	86.8
JUNCT_107	35.8	69.9	175.2	82.9	135.7	267.5	27.9	55.4	113.1	141.5	67.2	115.1	187.8	224.7	377.3	261.1
JUNCT_62	4.8	14.4	45.4	4.8	14.4	45.4	3.7	9.9	27.5	35.7	3.7	9.9	27.5	35.7	71.0	71.0
JUNCT_63	3.1	7.1	19.1	10.3	16.9	32.5	2.4	5.3	12.2	15.4	8.5	14.2	23.0	27.3	46.0	29.1
JUNCT_66	1.0	1.7	3.5	1.0	1.7	3.5	0.8	1.4	2.4	2.9	0.8	1.4	2.4	2.9	4.9	4.9
JUNCT_69	0.6	1.0	2.0	0.6	1.0	2.0	0.5	0.8	1.4	1.7	0.5	0.8	1.4	1.7	2.8	2.8
JUNCT_64	0.1	1.2	5.7	0.1	1.2	5.7	0.0	0.6	3.1	4.2	0.0	0.6	3.1	4.2	9.3	9.3
JUNCT_65	1.3	4.3	13.9	1.3	4.3	13.9	0.9	2.8	8.4	10.9	0.9	2.8	8.4	10.9	21.8	21.8
JUNCT_68	0.8	2.7	9.5	0.8	2.7	9.5	0.6	1.8	5.5	7.3	0.6	1.8	5.5	7.3	14.9	14.9
JUNCT_67	3.4	7.3	20.2	3.4	7.3	20.2	2.6	5.7	12.6	15.9	2.6	5.7	12.6	15.9	30.4	30.4
JUNCT_142	0.1	2.9	13.3	0.1	2.9	13.3	0.1	1.6	7.2	9.9	0.1	1.6	7.2	9.9	20.9	20.9
JUNCT_141	280.5	555.5	2096.4	422.5	950.6	2650.9	84.1	356.1	1128.7	1532.5	361.8	700.5	1623.8	2088.6	3977.9	3198.4
JUNCT_140	158.1	342.1	1201.5	293.4	614.3	1585.0	77.0	226.7	656.9	877.9	232.2	463.6	976.4	1263.4	2418.3	1875.6
JUNCT_138	97.2	271.9	911.2	247.4	496.9	1233.8	74.9	179.4	493.2	650.6	188.1	379.8	757.9	1001.0	1775.7	1361.5
L-132	61.9	100.0	402.2	61.9	161.0	463.9	10.0	60.4	217.2	296.0	61.9	108.7	295.7	380.8	675.4	586.5
L-126	134.4	218.2	890.5	134.4	348.8	1074.1	20.2	129.0	469.0	646.1	134.4	240.2	644.2	837.6	1538.4	1321.9
W-143	280.2	558.2	2119.5	422.4	954.0	2657.0	84.0	356.9	1137.9	1547.7	361.6	701.7	1634.6	2105.4	4022.9	3238.0
JUNCT_396	15.6	37.9	112.4	21.1	46.7	128.8	11.3	27.7	68.7	87.6	15.6	35.4	80.6	101.7	191.0	168.8
JUNCT_230	39.9	87.3	224.1	81.9	149.5	230.0	29.5	66.7	158.4	202.1	63.9	122.1	214.6	229.5	465.8	287.4
JUNCT_110	104.4	247.6	929.7	394.3	670.6	1599.1	79.5	178.9	476.0	664.1	312.9	548.8	1079.0	1322.0	2270.7	1459.1
JUNCT_302	21.3	75.0	270.9	118.1	215.0	483.4	15.1	49.8	156.5	206.5	93.2	175.4	320.8	394.3	713.4	428.4
JUNCT_307	58.3	129.1	382.6	135.2	238.8	567.4	44.6	96.2	233.4	298.7	107.2	196.4	364.7	454.2	848.3	596.7
JUNCT_309	9.4	45.3	178.6	43.1	95.6	251.9	6.3	27.5	100.1	133.7	33.5	71.7	159.3	200.7	375.8	281.7
JUNCT_313	120.7	268.0	706.3	300.4	498.6	1061.6	90.8	203.0	449.3	559.7	241.3	419.6	731.3	878.3	1487.4	1024.2
JUNCT_317	60.5	131.4	348.1	131.6	230.7	492.7	45.0	101.4	220.2	278.6	102.2	190.7	335.0	407.1	694.1	511.2
JUNCT_325	22.1	44.4	109.7	41.7	70.8	145.6	16.9	34.8	71.3	89.1	33.1	59.0	100.8	121.8	204.9	160.2
JUNCT_395	85.1	236.9	714.1	226.2	430.0	995.3	55.7	163.1	417.4	542.1	177.3	334.5	633.7	797.9	1363.0	1084.8

	Windmill Creek With Improvements -Peak Detention Pond Outflow (cfs)															
Storage Node	ex2	ex10	ex100	fu2	fu10	fu100	ex1	ex5	ex25	ex50	fu1	fu5	fu25	fu50	fu 500	ex500
JUNCT_110	5.8	38.2	50.0	39.3	44.9	54.6	5.1	20.8	43.3	46.5	37.1	42.4	48.9	51.7	284.3	57.4
JUNCT_302	10.4	63.9	270.0	81.5	191.9	366.4	8.4	34.9	143.1	203.4	70.1	139.0	317.2	336.2	617.0	359.9
JUNCT_307	57.9	119.7	217.5	122.5	173.2	289.4	44.4	93.6	172.2	195.0	102.0	152.7	208.4	223.9	580.7	361.2
JUNCT_309	0.4	2.6	25.0	1.8	7.0	29.7	0.3	1.3	13.5	22.0	1.3	3.4	21.8	23.1	99.2	81.1
JUNCT_313	66.8	179.1	511.3	183.6	337.4	714.0	44.6	124.0	314.5	397.4	143.7	270.4	477.4	580.2	1005.6	756.2
JUNCT_317	39.9	87.3	224.1	81.9	149.5	230.0	29.5	66.7	158.4	202.1	63.9	122.1	214.6	229.5	465.8	287.4
JUNCT_325	19.6	38.9	104.1	35.6	62.6	136.3	15.0	30.6	66.3	83.5	28.3	50.9	93.2	113.0	194.4	153.8
JUNCT_395	81.0	230.7	702.7	217.3	422.2	972.1	53.2	153.3	409.7	531.7	165.2	328.5	622.1	779.0	1333.2	1064.1

Table G11 - Windmill Creek Results

Windmill Creek Without Improvements -Peak Total Inflow (cfs)																	
Node	ex2	ex10	ex100	fu2	fu10	fu100	ex1	ex5	ex25	ex50	fu1	fu5	fu25	fu50	fu500	ex500
JUNCT_103	8.5	19.3	50.0	24.5	40.3	75.0	6.5	14.5	31.3	39.8	20.1	33.4	54.2	64.8	104.8	74.7
JUNCT_100	3.7	32.4	136.2	107.9	177.1	330.3	2.4	18.5	75.7	102.6	88.3	147.1	237.9	283.4	466.1	220.6
JUNCT_101	12.3	37.2	123.0	41.3	76.1	182.6	9.0	25.7	72.6	94.9	32.7	61.1	118.7	147.8	273.0	192.8
JUNCT_102	9.8	41.3	149.7	88.2	157.8	333.8	6.8	26.7	86.7	114.8	70.0	128.6	226.3	275.1	480.8	236.2
JUNCT_192	13.1	72.7	299.5	85.5	201.8	395.7	10.6	40.5	160.0	226.1	73.2	146.4	334.5	359.3	662.2	402.1
JUNCT_150	16.3	91.5	400.5	131.8	287.5	606.8	12.6	49.2	207.0	298.3	105.5	205.7	487.2	545.0	927.5	551.0
JUNCT_196	11.9	21.2	46.8	17.9	28.7	55.2	9.4	17.3	31.1	38.1	14.6	24.4	38.6	45.9	77.3	67.6
JUNCT_104	45.0	132.7	621.2	246.5	435.8	1062.4	34.9	85.3	303.3	448.2	199.1	345.3	754.6	902.7	1458.7	931.1
JUNCT_106	60.8	155.2	687.9	276.3	480.0	1176.3	46.0	108.6	335.2	492.2	222.4	393.5	819.2	986.5	1635.7	1055.5
JUNCT_109	6.1	22.0	75.9	45.3	79.4	165.3	4.4	14.7	44.5	59.0	36.2	65.4	112.2	136.6	236.0	118.3
JUNCT_108	104.4	247.6	929.7	394.3	670.6	1599.1	79.5	178.9	476.0	664.1	312.9	548.8	1079.0	1322.0	2270.7	1459.1
JUNCT_112	15.5	52.9	159.7	66.4	104.2	208.1	12.8	24.5	107.1	129.8	42.9	89.5	149.0	174.9	448.9	219.3
JUNCT_111	42.1	83.6	247.6	75.9	142.7	339.7	33.3	64.9	141.0	185.7	61.1	113.0	226.3	276.6	483.0	369.9
JUNCT_113	61.0	132.7	388.3	138.1	242.9	573.0	47.1	99.4	237.9	302.9	109.8	200.1	372.9	453.7	844.5	604.6
JUNCT_139	70.6	139.5	245.2	139.5	190.1	335.1	54.6	111.2	193.1	216.5	117.1	171.9	231.6	251.5	625.7	412.6
JUNCT_114	6.0	20.6	66.6	41.8	71.5	140.7	4.3	13.6	39.6	51.6	33.9	58.7	99.1	119.1	198.0	102.5
JUNCT_115	9.4	45.3	178.6	43.1	95.6	251.9	6.3	27.5	100.1	133.7	33.5	71.7	159.3	200.7	375.8	281.7
JUNCT_215	5.8	10.3	66.5	9.2	12.3	89.3	4.7	8.6	13.7	28.4	8.5	10.9	22.8	51.5	202.7	169.2
JUNCT_116	82.2	168.0	352.9	180.9	259.6	461.4	63.3	132.5	244.3	282.8	151.5	231.4	336.8	384.0	922.3	645.4
JUNCT_119	109.1	226.0	523.5	241.5	378.7	744.4	83.6	176.5	353.9	428.3	197.9	326.3	532.0	626.9	1101.0	753.5
JUNCT_121	117.4	249.3	609.9	277.4	446.7	911.3	89.4	192.8	402.3	492.8	225.3	381.1	641.0	761.6	1260.8	868.4
JUNCT_124	127.1	277.3	716.6	307.3	506.4	1071.8	96.3	211.2	458.9	569.5	248.0	426.9	740.2	887.7	1500.3	1034.9
JUNCT_125	126.9	277.1	716.1	306.8	505.7	1070.4	96.2	211.0	458.4	568.9	247.6	426.2	739.0	886.3	1498.3	1033.6
JUNCT_225	80.3	204.7	567.0	205.0	374.0	795.6	55.0	144.4	349.0	438.3	162.1	299.1	528.0	640.5	1158.9	875.0
JUNCT_126	83.0	213.5	596.9	214.0	390.8	838.1	56.3	150.6	365.0	461.7	169.6	311.2	550.5	674.5	1189.4	913.8
JUNCT_132	83.3	214.9	599.4	215.1	392.8	843.9	56.4	151.6	366.6	463.9	170.5	312.7	553.2	678.8	1193.2	917.3
JUNCT_134	86.6	227.1	650.8	222.4	411.1	917.7	58.2	159.1	392.2	500.6	176.0	324.7	590.4	732.0	1269.2	1006.8
JUNCT_136	86.8	238.4	707.8	224.6	428.7	981.0	58.7	159.8	416.8	537.2	171.4	335.4	628.1	783.6	1398.3	1102.3
JUNCT_137	40.5	90.1	238.4	82.8	152.9	247.2	29.9	68.2	165.5	212.3	64.4	124.0	223.6	241.4	484.7	317.6
JUNCT_122	11.0	23.3	60.0	24.9	42.2	86.1	8.3	17.8	38.3	48.3	19.7	35.1	59.2	71.5	120.5	88.1
JUNCT_127	31.5	62.1	146.8	54.7	93.2	188.5	24.1	48.6	95.6	119.0	43.4	77.1	129.6	156.5	263.9	212.8
JUNCT_129	31.4	62.0	146.8	54.6	93.1	188.4	24.0	48.6	95.6	119.0	43.3	77.0	129.5	156.4	263.8	212.8
JUNCT_128	9.5	23.0	62.8	30.1	50.1	100.2	6.8	17.1	38.9	49.7	23.7	42.2	69.4	83.8	138.8	92.9
JUNCT_130	60.5	131.4	348.1	131.6	230.7	492.7	45.0	101.4	220.2	278.6	102.2	190.7	335.0	407.1	694.1	511.2
JUNCT_537	39.9	87.3	224.1	81.9	149.5	230.1	29.5	66.7	158.4	202.1	63.9	122.1	214.6	229.5	464.9	303.2
JUNCT_135	4.8	13.3	46.1	11.4	24.4	67.1	3.3	9.3	27.0	35.5	8.4	18.5	42.1	53.4	98.9	70.1
JUNCT_336	9.1	19.9	52.5	9.4	20.4	53.4	6.7	15.0	33.5	42.0	7.0	15.5	34.1	42.8	78.6	77.4
JUNCT_131	8.5	21.5	64.4	13.6	29.9	79.3	6.2	15.7	39.2	50.2	10.1	22.6	50.5	63.4	117.0	96.8
JUNCT_117	28.5	50.7	108.6	34.6	58.1	117.2	22.3	41.6	73.3	88.9	27.5	48.8	81.0	97.1	164.2	154.3
JUNCT_105	6.9	18.3	56.5	37.8	61.3	119.2	5.1	13.3	33.9	44.1	30.9	52.2	83.6	100.1	167.1	86.8
JUNCT_107	35.8	69.9	175.2	82.9	135.7	267.5	27.9	55.4	113.1	141.5	67.2	115.1	187.8	224.7	377.3	261.1
JUNCT_62	4.8	14.4	45.4	4.8	14.4	45.4	3.7	9.9	27.5	35.7	3.7	9.9	27.5	35.7	71.0	71.0
JUNCT_63	3.1	7.1	19.1	10.3	16.9	32.5	2.4	5.3	12.2	15.4	8.5	14.2	23.0	27.3	46.0	29.1
JUNCT_66	1.0	1.7	3.5	1.0	1.7	3.5	0.8	1.4	2.4	2.9	0.8	1.4	2.4	2.9	4.9	4.9
JUNCT_69	0.6	1.0	2.0	0.6	1.0	2.0	0.5	0.8	1.4	1.7	0.5	0.8	1.4	1.7	2.8	2.8
JUNCT_64	0.1	1.2	5.7	0.1	1.2	5.7	0.0	0.6	3.1	4.2	0.0	0.6	3.1	4.2	9.3	9.3
JUNCT_65	1.3	4.3	13.9	1.3	4.3	13.9	0.9	2.8	8.4	10.9	0.9	2.8	8.4	10.9	21.8	21.8
JUNCT_68	0.8	2.7	9.5	0.8	2.7	9.5	0.6	1.8	5.5	7.3	0.6	1.8	5.5	7.3	14.9	14.9
JUNCT_67	3.4	7.3	20.2	3.4	7.3	20.2	2.6	5.7	12.6	15.9	2.6	5.7	12.6	15.9	30.4	30.4
JUNCT_142	0.1	2.9	13.3	0.1	2.9	13.3	0.1	1.6	7.2	9.9	0.1	1.6	7.2	9.9	20.9	20.9
JUNCT_141	340.5	559.9	2091.0	428.8	968.8	2643.6	136.2	359.9	1144.8	1541.4	314.0	706.9	1635.7	2089.7	4045.6	3191.3
JUNCT_140	174.4	370.5	1206.4	301.5	625.2	1580.5	134.1	275.8	674.4	886.1	238.4	467.5	989.8	1272.7	2411.2	1867.2
JUNCT_138	99.2	279.1	916.0	254.4	502.9	1238.5	74.9	184.8	499.6	656.0	193.6	386.2	763.4	1005.6	1777.7	1375.5
L-132	79.4	162.9	417.4	135.4	231.9	515.4	61.8	120.7	267.0	330.8	106.8	185.2	346.8	421.3	738.5	614.3
L-126	172.9	218.2	890.5	134.4	348.8	1142.3	20.2	129.0	469.0	646.1	86.1	240.2	644.2	837.6	1652.2	1321.9
W-143	339.8	562.6	2113.7	428.8	972.1	2651.1	135.8	360.8	1154.2	1556.6	313.9	708.2	1646.5	2106.4	4093.4	3231.1
JUNCT_396	15.6	37.9	112.4	21.1	46.7	128.8	11.3	27.7	68.7	87.6	15.6	35.4	80.6	101.7	191.0	168.8
JUNCT_230	39.9	87.3	224.1	81.9	149.5	230.0	29.5	66.7	158.4	202.1	63.9	122.1	214.6	229.5	465.8	287.4
JUNCT_208	10.3	44.1	84.1	60.5	75.1	103.4	9.4	13.5	72.3	77.7	39.0	70.7	82.2	87.2	358.5	173.8
JUNCT_110	104.4	247.6	929.7	394.3	670.6	1599.1	79.5	178.9	476.0	664.1	312.9	548.8	1079.0	1322.0	2270.7	1459.1
JUNCT_302	21.3	75.0	270.9	118.1	215.0	483.4	15.1	49.8	156.5	206.5	93.2	175.4	320.8	394.3	713.4	428.4
JUNCT_307	61.0	132.7	388.3	138.1	242.9	573.0	47.1	99.4	237.9	302.9	109.8	200.1	372.9	453.7	844.5	604.6
JUNCT_309	9.4	45.3	178.6	43.1	95.6	251.9	6.3	27.5	100.1	133.7	33.5	71.7	159.3	200.7	375.8	281.7
JUNCT_313	126.9	277.1	716.1	306.8	505.7	1070.4	96.2	211.0	458.4	568.9	247.6	426.2	739.0	886.3	1498.3	1033.6
JUNCT_317	60.5	131.4	348.1	131.6	230.7	492.7	45.0	101.4	220.2	278.6	102.2	190.7	335.0	407.1	694.1	511.2
JUNCT_325	22.1	44.4	109.7	41.7	70.8	145.6	16.9	34.8	71.3	89.1	33.1	59.0	100.8	121.8	204.9	160.2
JUNCT_395	91.3	244.0	718.8	232.7	436.6	999.3	60.7	169.9	424.8	548.3	183.8	341.5	640.1	803.4	1366.5	1097.1

Windmill Creek With Improvements -Peak Detention Pond Outflow (cfs)																
Storage Node	ex2	ex10	ex100	fu2	fu10	fu100	ex1	ex5	ex25	ex50	fu1	fu5	fu25	fu50	fu 500	ex500
JUNCT_110	10.3	44.1	84.1	60.5	75.1	103.4	9.4	13.5	72.3	77.7	39.0	70.7	82.2	87.2	358.5	173.8
JUNCT_302	10.4	63.9	270.0	81.5	191.9	366.4	8.4	34.9	143.1	203.4	70.1	139.0	317.2	336.2	617.0	359.9
JUNCT_307	60.6	122.2	221.7	124.4	177.4	318.3	46.9	96.2	173.9	199.0	104.2	154.1	212.8	228.2	579.4	388.0
JUNCT_309	5.8	10.3	66.5	9.2	12.3	89.3	4.7	8.6	13.7	28.4	8.5	10.9	22.8	51.5	202.7	169.2
JUNCT_313	73.7	187.8	522.2	190.7	344.8	724.5	51.4	132.0	321.6	401.2	150.8	277.7	483.2	583.8	1090.0	820.8
JUNCT_317	39.9	87.3	224.1	81.9	149.5	230.0	29.5	66.7	158.4	202.1	63.9	122.1	214.6	229.5	465.8	287.4
JUNCT_325	19.6	38.9	104.1	35.6	62.6	136.3	15.0	30.6	66.3	83.5	28.3	50.9	93.2	113.0	194.4	153.8
JUNCT_395	86.8	238.4	707.8	224.6	428.7	977.2	58.7	159.8	416.8	537.2	171.4	335.4	628.1	783.6	1344.1	1083.1

Table G12 - Lone Tree Creek SWMM Results

	Lone Tree Creek With Improvements -Peak Total Inflow (cfs)															
Node	ex2	ex10	fu2	fu10	ex5	ex25	ex50	fu5	fu25	fu50	ex100	fu100	fu500	ex1	fu1	ex500
JUNCT_118	145.43	309.24	297.31	515.17	215.7	632.78	843.15	407.77	852	1083.53	1118.15	1366.24	1934.09	109.11	233.22	1612.34
JUNCT_120	149.72	314.79	307.17	533.73	222.42	645.39	860.91	421.49	869.52	1106.74	1143.6	1398.54	1990.46	112.16	240.42	1656.83
JUNCT_122	171.2	354.64	339.53	595.4	255.38	694.44	928.59	468.79	936.53	1194.21	1240.43	1516.85	2194.45	127.88	263.67	1822.9
JUNCT_123	181.42	377.5	362.97	638.49	271.03	721.69	966.7	502.09	975.01	1244.01	1294.05	1586.76	2312.76	135.18	281.56	1916.35
JUNCT_223	86.12	320.82	204.29	518.74	198.36	684.92	920.65	353.06	931.86	1187.28	1236.81	1476.97	2028.73	35.92	129.21	1760.4
JUNCT_124	86.31	325.1	206.6	525.22	200.19	693.93	935.54	357.47	945.59	1207.22	1259.73	1508.1	2081.85	35.12	131.24	1803.98
JUNCT_131	14.7	37.29	45.96	82.42	25.03	66.36	85.58	64.44	118.72	145.3	107.85	176.31	256.79	10.97	36.52	166.78
JUNCT_130	38.74	79.77	38.74	79.77	58.16	125.27	155.6	58.16	125.27	155.6	191.99	191.99	287.66	30.01	30.01	287.66
JUNCT_129	3.68	7.7	5.59	10.41	5.59	12.46	15.51	7.98	15.44	18.86	19.13	22.94	33.74	2.85	4.41	28.77
JUNCT_350	39.19	81.08	39.85	82.28	58.98	128.61	160.06	60.03	130.74	162.58	197.75	200.7	301.83	30.34	30.83	297.74
JUNCT_201	11.37	20.21	15.23	34.4	15.98	54.9	80.72	20.2	66.67	87.95	88.79	89.78	149.47	9.49	12.5	126.5
JUNCT_102	54.82	88.87	56.25	91.24	72.67	119.53	142.12	74.74	122.58	145.81	169.33	173.8	244.38	44.88	45.95	239.2
JUNCT_104	136.82	251.74	178.34	304.4	193.6	364.07	443.15	242.92	420.52	504.31	541.39	607.37	867.07	108.44	143.52	787.21
JUNCT_105	168.05	325.52	244.63	424.94	245.4	497.63	612.15	337.63	603	726.54	753.79	878.35	1261.13	131.2	194.38	1110.8
JUNCT_205	40.14	145.95	85.47	215.4	93.95	303.77	398.87	147.54	379.88	479.06	518.65	551.04	696.55	24.87	54.44	625.82
JUNCT_108	50.97	184.51	113.98	280.19	118.4	383.55	504.2	194.54	494.56	625.45	659.67	743.09	927.62	29.84	70.97	831.04
JUNCT_109	54.94	201.11	127.82	314.14	128.22	421.17	554.78	218.94	555.83	704.45	728.75	852.75	1090.1	32.34	92.85	944.2
JUNCT_112	62.12	229.83	176.08	365.08	145.47	482.74	638.99	255.15	651.58	826.68	844.3	1019.42	1362.65	45.29	138.67	1136.85
JUNCT_114	82.63	252.97	215.52	399.91	160.47	528.48	703.88	295.91	717.58	908.4	928.07	1128.08	1539.47	61.42	169.64	1278.92
JUNCT_116	119.71	285.8	263.6	456.87	181.39	589.87	786.23	361.73	797.5	1012.34	1039.55	1268.91	1769.67	89.55	207.09	1472.64
JUNCT_133	56.42	225.42	140.48	362.28	135.48	483.42	660.33	247.74	662.64	854.71	900.65	1082.05	1527.38	21.92	89.43	1315.96
L-126	52.45	218.24	134.38	348.82	128.95	468.95	646.13	240.17	644.17	837.62	890.48	1074.13	1538.42	20.23	86.05	1321.91
L-132	25.37	99.96	61.92	160.98	60.35	217.21	295.97	108.7	295.66	380.76	402.15	463.91	675.37	10.03	39.32	586.48
JUNCT_127	6.96	13.17	10.72	17.99	10.11	20.19	24.73	14.57	25.34	30.39	30.29	36.61	51.95	5.27	8.38	44.15
JUNCT_121	24.3	47.69	39.55	67.2	35.78	71.84	89.18	53.77	93.22	112.48	109.84	135.84	191.66	18.43	30.9	159.91
JUNCT_110	3.35	11.69	26.18	43.82	7.04	23.34	30.46	35.45	60.72	72.87	39.25	87.85	124.62	2.36	20.85	61.3
JUNCT_113	16.44	31.43	24.72	42.05	23.82	47.22	58.33	33.62	58.65	70.79	71.55	85.34	121	12.68	19.64	104.19
JUNCT_119	18.25	34.26	25.24	43.04	26.19	50.49	62.1	34.4	59.86	72.28	76.14	87.29	123.33	13.89	19.71	109.88
JUNCT_128	6.59	12.52	9.74	16.44	9.53	18.49	22.81	13.21	22.74	27.42	27.99	33.09	46.63	5	7.63	40.53
JUNCT_125	84.7	326.59	206.33	528.29	199.18	701.58	951.9	359.59	959.58	1230.47	1288.81	1547.15	2155.96	33.63	131.11	1864.59
JUNCT_301	168.05	325.52	244.63	424.94	245.4	497.63	612.15	337.63	603	726.54	753.79	878.35	1261.13	131.2	194.38	1110.8
JUNCT_301	181.42	377.5	362.97	638.49	271.03	721.69	966.7	502.09	975.01	1244.01	1294.05	1586.76	2312.76	135.18	281.56	1916.35
JUNCT_351	32.33	58.47	60.85	100.88	44.68	90.62	122.95	81.52	140.07	168.04	157.96	200.3	353.76	27.27	50.04	342.27
JUNCT_999	39.2	81.02	39.82	82.32	58.99	128.61	160.08	59.99	130.69	162.57	197.77	200.67	301.88	30.33	30.83	297.63

	Lone Tree Creek With Improvements - Peak Detention Pond Outflow (cfs)															
Storage Node	ex2	ex10	fu2	fu10	ex5	ex25	ex50	fu5	fu25	fu50	ex100	fu100	fu500	ex1	fu1	ex500
JUNCT_301	40.14	145.95	85.47	215.4	93.95	303.77	398.87	147.54	379.88	479.06	518.65	551.04	696.55	24.87	54.44	625.82
JUNCT_303	86.12	320.82	204.29	518.74	198.36	684.92	920.65	353.06	931.86	1187.28	1236.81	1476.97	2028.73	35.92	129.21	1760.4
JUNCT_351	11.37	20.21	15.23	34.4	15.98	54.9	80.72	20.2	66.67	87.95	88.79	89.78	149.47	9.49	12.5	126.5
JUNCT_999	20.62	26.81	20.93	27.03	24.16	53.24	64.97	24.43	54.81	65.25	69.4	69.7	222.58	18.4	18.74	215.93

	Lone Tree Creek Without Improvements -Peak Total Inflow (cfs)															
Node	ex2	ex10	fu2	fu10	ex5	ex25	ex50	fu5	fu25	fu50	ex100	fu100	fu500	ex1	fu1	ex500
JUNCT_118	263.23	481.39	425.2	686.8	371.64	746.52	901.31	561.61	977.72	1159.25	1097.55	1378.81	1915.5	208.02	344.33	1554.12
JUNCT_120	266.67	489.86	433.01	702.97	377.14	763.76	924.44	573.49	1004.84	1193.62	1128.07	1422.48	1980.38	210.33	350.08	1602.07
JUNCT_122	282.98	528.09	462.19	762.39	403.81	834.13	1016.24	617.61	1103.41	1316.46	1248.4	1576.98	2212.58	222.11	371.27	1795.89
JUNCT_123	291.02	547.08	481.17	799.14	416.6	871.28	1065.18	645.44	1161.93	1389.78	1312.82	1669.76	2349.98	228.02	385.49	1898.86
JUNCT_223	263.97	523.66	450.83	747.47	396.46	831.44	1016.82	606.28	1086.73	1310.05	1264.66	1580.63	2236.63	206.87	358.05	1833.19
JUNCT_124	266.43	531.06	454.71	758.51	400.64	847.28	1038.6	613.75	1107.11	1336.04	1296.06	1617.47	2294.92	208.38	360.3	1885.58
JUNCT_131	14.7	37.29	45.96	82.42	25.03	66.36	85.58	64.44	118.72	145.3	107.85	176.31	256.79	10.97	36.52	166.78
JUNCT_130	38.74	79.77	38.74	79.77	58.16	125.27	155.6	58.16	125.27	155.6	191.99	191.99	287.66	30.01	30.01	287.66
JUNCT_129	3.68	7.7	5.59	10.41	5.59	12.46	15.51	7.98	15.44	18.86	19.13	22.94	33.74	2.85	4.41	28.77
JUNCT_350	39.19	81.08	39.85	82.28	58.98	128.61	160.06	60.03	130.74	162.58	197.75	200.7	301.83	30.34	30.83	297.74
JUNCT_201	11.37	20.21	15.23	34.4	15.98	54.9	80.72	20.2	66.67	87.95	88.79	89.78	149.47	9.49	12.5	126.5
JUNCT_102	54.82	88.87	56.25	91.24	72.67	119.53	142.12	74.74	122.58	145.81	169.33	173.8	244.38	44.88	45.95	239.2
JUNCT_104	136.82	251.74	178.34	304.4	193.6	364.07	443.15	242.92	420.52	504.31	541.39	607.37	867.07	108.44	143.52	787.21
JUNCT_105	168.05	325.52	244.63	424.94	245.4	497.63	612.15	337.63	603	726.54	753.79	878.35	1261.13	131.2	194.38	1110.8
JUNCT_205	150.93	245.56	200.95	291.68	201.14	334.88	384.62	250.52	375.34	422.97	443.79	478.99	735.93	123.18	168.82	647.59
JUNCT_108	175.46	298.03	254.55	378.26	239.13	423.41	494.03	321.72	502.11	572.92	580.79	658.62	977.32	141.55	212.04	842.87
JUNCT_109	184.24	320.04	284.87	428.08	253.59	466.37	549.19	362.26	576.32	662.57	651.04	770.42	1106.74	147.89	236.19	943.7
JUNCT_112	200.92	359.76	329.18	509.96	280.57	540.2	645.27	424.47	700.54	817.21	773.62	958.4	1317.03	160.15	270.7	1108.93
JUNCT_114	217.89	394.32	359.64	564.46	305.93	601.59	719.66	467.43	786.4	922.65	866.94	1086.03	1483.1	173.16	294.43	1223.56
JUNCT_116	245.02	445.25	398.35	635.24	344.9	684.63	823.82	522.46	897.61	1059.59	998.52	1254.88	1731.86	194.15	324.1	1402.96
JUNCT_133	180.92	367.93	305.85	523.06	272.99	599.82	743.02	418.75	780.82	945.05	935.02	1156.22	1655.42	139.92	241.09	1375.16
L-126	172.85	356.82	289.88	505.93	262.08	589.94	735.73	401.77	764.88	926.28	930.69	1142.28	1652.21	132.51	226.04	1381.38
L-132	79.43	162.94	135.41	231.88	120.74	266.97	330.82	185.2	346.79	421.29	417.38	515.41	738.52	61.79	106.83	614.26
JUNCT_127	6.96	13.17	10.72	17.99	10.11	20.19	24.73	14.57	25.34	30.39	30.29	36.61	51.95	5.27	8.38	44.15
JUNCT_121	24.3	47.69	39.55	67.2	35.78	71.84	89.18	53.77	93.22	112.48	109.84	135.84	191.66	18.43	30.9	159.91
JUNCT_110	3.35	11.69	26.18	43.82	7.04	23.34	30.46	35.45	60.72	72.87	39.25	87.85	124.62	2.36	20.85	61.3
JUNCT_113	16.44	31.43	24.72	42.05	23.82	47.22	58.33	33.62	58.65	70.79	71.55	85.34	121	12.68	19.64	104.19
JUNCT_119	18.25	34.26	25.24	43.04	26.19	50.49	62.1	34.4	59.86	72.28	76.14	87.29	123.33	13.89	19.71	109.88
JUNCT_128	6.59	12.52	9.74	16.44	9.53	18.49	22.81	13.21	22.74	27.42	27.99	33.09	46.63	5	7.63	40.53
JUNCT_125	264.78	533.73	451.5	762.92	399.3	862.38	1063.05	613.68	1126.17	1362.01	1333.42	1657.8	2363.9	206.18	356.51	1951.48
JUNCT_301	168.05	325.52	244.63	424.94	245.4	497.63	612.15	337.63	603	726.54	753.79	878.35	1261.13	131.2	194.38	1110.8
JUNCT_303	291.02	547.08	481.17	799.14	416.6	871.28	1065.18	645.44	1161.93	1389.78	1312.82	1669.76	2349.98	228.02	385.49	1898.86
JUNCT_351	32.33	58.47	60.85	100.88	44.68	90.62	122.95	81.52	140.07	168.04	157.96	200.3	353.76	27.27	50.04	342.27
JUNCT_999	39.2	81.02	39.82	82.32	58.99	128.61	160.08	59.99	130.69	162.57	197.77	200.67	301.88	30.33	30.83	297.63

	Lone Tree Creek Without Improvements - Peak Detention Pond Outflow (cfs)															
Storage Node	ex2	ex10	fu2	fu10	ex5	ex25	ex50	fu5	fu25	fu50	ex100	fu100	fu500	ex1	fu1	ex500
JUNCT_301	150.93	245.56	200.95	291.68	201.14	334.88	384.62	250.52	375.34	422.97	443.79	478.99	735.93	123.18	168.82	647.59
JUNCT_303	263.97	523.66	450.83	747.47	396.46	831.44	1016.82	606.28	1086.73	1310.05	1264.66	1580.63	2236.63	206.87	358.05	1833.19
JUNCT_351	11.37	20.21	15.23	34.4	15.98	54.9	80.72	20.2	66.67	87.95	88.79	89.78	149.47	9.49	12.5	126.5
JUNCT_999	20.62	26.81	20.93	27.03	24.16	53.24	64.97	24.43	54.81	65.25	69.4	69.7	222.58	18.4	18.74	215.93

Table G13 - Cottonwood Creek SWMM Results With Improvements

Cottonwood Creek With Improvements -Peak Total Inflow (cfs)																	Cottonwood Creek With Improvements -Peak Detention Pond Outflow (cfs)															
Node	ex1	ex2	ex5	ex10	ex25	ex50	ex100	ex500	fu500	fu1	fu2	fu5	fu10	fu25	fu50	fu100	Storage Node	ex1	ex2	ex5	ex10	ex25	ex50	ex100	ex500	fu500	fu1	fu2	fu5	fu10	fu25	fu50	fu100
JUNCT_1	31.7	45.0	94.9	165.0	358.7	480.0	637.4	1015.4	1133.6	56.1	76.0	137.3	216.2	425.0	555.3	726.1	POND_312	35.9	137.2	423.7	805.6	1818.4	2711.3	3636.3	5320.7	5735.0	288.3	460.0	914.7	1422.0	2586.5	3308.4	4259.4
JUNCT_2	19.1	26.8	59.5	110.1	249.0	336.4	456.6	724.8	816.7	40.6	53.9	96.2	151.8	298.9	394.3	523.9	POND_319	63.8	153.4	392.2	709.2	1604.7	2292.5	3003.0	4210.3	4713.7	305.2	448.3	848.3	1266.9	2310.7	2909.8	3555.1
JUNCT_3	18.3	24.7	49.8	86.0	190.7	259.0	351.9	557.5	638.7	38.2	49.9	83.1	124.4	234.3	306.9	409.9	POND_321	3.0	4.0	6.1	7.7	9.6	10.4	21.4	52.1	52.1	3.0	4.0	6.1	7.7	9.6	10.4	21.4
JUNCT_4	3.7	6.1	14.3	24.7	53.8	75.8	103.1	162.3	179.4	5.7	8.6	17.9	29.2	62.8	86.5	115.4	POND_323	3.3	4.5	7.5	10.4	15.3	17.4	19.5	36.3	36.3	3.3	4.5	7.5	10.4	15.3	17.4	19.5
JUNCT_5	1.9	2.8	10.1	22.7	52.9	70.7	94.4	146.4	153.7	4.6	6.5	14.8	27.7	58.4	76.7	100.5	POND_343	2.8	5.9	14.9	25.4	62.5	110.8	179.8	245.5	247.7	4.5	8.7	18.7	29.8	75.0	123.5	193.8
JUNCT_6	165.5	218.8	371.7	553.0	1004.6	1283.7	1617.6	2462.8	3249.0	418.6	524.4	779.2	1017.9	1576.8	1901.8	2347.8	POND_365	1.6	2.3	2.9	6.0	50.9	94.8	157.8	235.8	240.8	2.0	2.5	5.6	9.3	58.6	105.5	165.7
JUNCT_7	155.9	205.5	346.0	513.1	919.9	1173.8	1522.6	2363.1	3113.2	406.7	507.3	749.3	975.3	1506.8	1815.7	2244.3	POND_367	2.0	2.4	2.9	3.3	51.2	96.3	173.3	269.3	278.4	2.1	2.5	3.0	3.4	58.3	105.9	184.6
JUNCT_8	155.3	204.1	338.7	496.6	878.3	1117.3	1463.1	2273.1	2976.8	389.4	484.9	714.8	929.4	1434.6	1729.0	2141.6	POND_369	1.6	4.1	9.6	15.7	30.1	42.1	68.6	123.9	130.9	2.9	5.6	11.6	18.1	32.9	46.8	74.0
JUNCT_9	146.9	190.5	306.7	439.1	752.3	952.8	1312.6	2060.2	2721.1	355.2	440.7	643.5	831.7	1279.6	1548.1	1928.0	POND_381	47.2	80.6	154.2	228.4	416.8	532.9	673.2	999.2	1065.1	63.2	102.6	182.8	260.8	458.1	578.3	723.8
JUNCT_10	133.1	171.2	271.2	383.5	683.6	904.0	1269.6	2041.2	2792.4	343.8	426.7	621.5	801.6	1255.0	1526.3	1914.6	POND_390	2.8	3.4	4.5	5.3	24.7	41.6	68.5	115.0	123.4	3.2	3.8	4.9	10.0	29.7	48.0	74.4
JUNCT_11	45.9	62.0	125.5	188.2	327.2	475.5	638.1	1100.4	1339.3	152.1	185.4	261.2	318.5	473.4	629.5	801.7	POND_414	31.6	137.8	406.5	769.2	1702.5	2507.8	3364.9	4788.4	5262.2	290.8	453.1	893.2	1359.7	2437.2	3125.0	3942.4
JUNCT_12	30.9	42.5	91.6	141.2	270.7	397.3	529.8	931.8	1120.4	135.1	160.5	216.5	254.5	386.0	515.0	639.2	POND_416	72.7	152.7	413.1	768.2	1692.7	2491.3	3331.0	4693.4	5183.6	307.3	465.4	901.1	1356.8	2427.5	3156.7	3887.6
JUNCT_13	33.5	45.6	92.6	142.1	272.7	399.7	531.5	938.3	1130.9	140.7	168.7	221.8	269.6	387.4	519.6	640.5	POND_80	3.7	6.1	14.3	24.7	53.8	75.8	103.1	162.3	179.4	5.7	8.6	17.9	29.2	62.8	86.5	115.4
JUNCT_14	23.9	31.9	65.0	133.9	306.4	412.4	545.2	842.0	921.4	59.5	76.1	117.5	177.5	357.0	470.9	607.0	POND_81	146.9	190.5	306.7	439.1	752.3	952.8	1312.6	2060.2	2721.1	355.2	440.7	643.5	831.7	1279.6	1548.1	1928.0
JUNCT_15	1.5	2.5	26.6	69.5	177.4	243.0	325.0	507.6	521.3	7.5	11.5	39.4	82.4	190.1	256.1	337.9	POND_82	29.7	39.8	78.7	117.1	222.5	326.8	431.3	771.3	865.2	72.8	84.3	114.7	133.0	278.5	375.6	471.1
JUNCT_16	1.3	2.0	19.1	48.1	120.8	165.3	220.4	343.6	350.9	4.8	7.1	26.1	55.2	127.7	172.3	227.3	POND_304	2.7	3.4	4.9	32.4	228.8	385.3	575.5	966.4	1073.7	3.6	4.2	5.4	68.1	284.4	445.4	643.8
JUNCT_17	48.2	61.2	91.3	127.2	194.7	240.9	330.6	525.9	1100.0	149.8	186.7	265.7	341.2	518.1	630.6	773.1																	
JUNCT_18	0.8	1.2	4.8	11.3	26.9	36.1	48.3	74.9	180.5	33.2	40.3	54.3	67.5	92.3	109.8	131.5																	
JUNCT_19	0.8	1.3	13.6	37.9	100.3	136.4	184.9	289.6	706.7	128.9	157.3	214.8	264.3	363.1	431.5	514.6																	
JUNCT_20	0.8	1.2	10.5	26.4	66.6	90.2	121.8	189.9	470.7	90.7	109.6	148.2	180.6	244.6	289.7	344.5																	
JUNCT_21	43.5	55.1	83.7	112.8	178.1	221.2	271.2	390.7	420.5	53.1	66.6	98.3	129.3	196.8	242.3	294.9																	
JUNCT_50	10.3	13.7	24.1	37.9	70.3	90.8	115.3	173.5	193.0	13.7	17.9	30.0	45.4	80.7	103.3	129.5																	
JUNCT_51	146.9	190.5	306.7	439.1	752.7	953.9	1330.5	2122.3	2951.1	355.2	440.7	643.5	832.6	1317.6	1609.3	2007.6																	
JUNCT_52	31.9	42.8	85.2	164.0	367.4	492.2	648.8	1000.0	1127.3	80.4	103.2	160.6	232.2	444.0	580.7	746.7																	
JUNCT_102	211.6	279.5	470.6	693.8	1262.6	1614.9	2048.9	2928.4	3769.8	464.5	587.2	883.3	1161.8	1813.0	2195.3	2713.5																	
JUNCT_103	30.4	39.8	62.3	88.8	140.3	177.1	221.8	325.9	343.7	36.3	47.1	71.2	96.1	151.3	189.7	236.1																	
JUNCT_105	235.9	311.9	527.4	780.7	1435.7	1995.6	2778.4	4272.1	5175.0	487.8	618.8	938.4	1242.6	2099.4	2778.1	3590.1																	
JUNCT_106	235.5	312.3	529.0	784.5	1448.6	2009.0	2804.3	4318.6	5224.0	488.0	619.8	941.6	1248.6	2109.6	2792.6	3617.4																	
JUNCT_107	240.9	320.3	544.0	806.0	1486.0	2044.7	2857.1	4404.7	5311.3	493.3	627.4	956.2	1269.9	2138.7	2830.8	3671.7																	
JUNCT_109	3.3	4.5	7.5	10.4	15.3	17.4	19.5	36.3	36.3	3.3	4.5	7.5	10.4	15.3	17.4	19.5																	
JUNCT_110	252.6	337.3	577.4	857.5	1590.7	2150.1	3020.0	4689.1	5601.0	505.7	645.5	992.0	1324.7	2218.6	2943.7	3840.6																	
JUNCT_112	260.6	348.6	598.9	887.9	1640.1	2193.0	3084.9	4803.6	5713.5	514.3	657.1	1012.9	1354.0	2252.0	2989.3	3905.9																	
JUNCT_113	262.6	351.1	603.8	895.7	1649.1	2205.2	3103.3	4846.1	5760.3	517.5	661.4	1020.7	1366.9	2262.5	3003.1	3926.6																	
JUNCT_115	92.4	122.7	184.1	248.1	405.1	504.6	624.9	911.2	976.5	113.4	148.7	217.0	284.8	450.9	552.1	677.2																	
JUNCT_117	79.9	105.5	158.3	214.0	342.6	426.2	525.9	763.6	824.3	100.3	130.8	190.4	249.7	382.5	470.3	575.0																	
JUNCT_119	50.7	66.6	99.8	135.0	209.8	260.2	321.5	464.0	519.9	70.3	90.7	129.1	167.2	246.3	300.7	366.6																	
JUNCT_120	38.4	50.0	73.3	97.4	146.9	180.8	222.7	318.2	335.4	46.4	59.6	84.6	109.1	159.4	194.5	237.2																	
JUNCT_121	17.2	22.5	33.7	45.5	69.3	86.2	106.2	152.0	166.8	23.3	29.8	42.2	54.6	81.1	99.5	117.8																	
JUNCT_122	21.6	28.0	40.4	52.8	78.8	96.7	118.2	168.5	173.7	23.7	30.5	43.4	56.0	82.4	100.5	122.5																	
JUNCT_123	307.4	416.3	716.9	1059.1	1951.0	2505.9	3512.4	5522.9	6465.3	566.9	728.4	1133.8	1525.0	2513.1	3298.3	4351.8																	
JUNCT_126	3.0	4.0	6.1	7.7	9.6	10.4	21.4	52.1	52.1	3.0	4.0	6.1	7.7	9.6	10.4	21.4																	
JUNCT_127	309.3	419.3	725.5	1077.5	1994.0	2570.4	3588.6	5670.5	6611.7	574.7	738.3	1151.0	1553.6	2569.4	3339.9	4417.7																	
JUNCT_128	20.3	25.5	34.7	43.3	60.1	72.4	86.7	121.0	121.0	20.3	25.5	34.7	43.3	60.1	72.4	86.7																	
JUNCT_129	63.8	153.4	392.2	709.2	1604.7	2292.5	3003.0	4210.3	4713.7	305.2	448.3	848.3	1266.9	2310.7	2909.8	3555.1																	
JUNCT_130	63.7	153.3	394.2	716.8	1620.1	2318.0	3038.4	4259.7	4748.4	305.2	449.8	854.5	1276.3	2326.9	2933.8	3581.4																	
JUNCT_131	63.6	153.1	394.9	721.1	1625.5	2326.8	3049.0	4274.6	4766.0	304.9	450.2	861.2	1286.6	2337.4	2947.6	3594.0																	
JUNCT_132	63.6	152.8	394.9	724.6	1630.8	2333.8	3056.7	4286.3	4782.2	304.5	450.0	866.6	1295.7	2346.3	2959.5	3605.1																	
JUNCT_134	113.8	151.7	220.5	290.2	457.1	562.2	690.7	987.3	1106.0	162.0	210.5	291.6	367.8	537.8	651.6	789.6																	
JUNCT_136	95.5	127.5	186.9	247.8	391.8	483.7	594.0	851.8	963.3	140.1	182.2	253.2	319.9	467.4	566.5	683.7																	
JUNCT_139	63.7	84.7	124.7	164.8	251.2	311.0	382.6	552.9	637.2	97.3	125.7	173.2	217.1	306.2	370.7	447.0																	
JUNCT_140	54.0	71.6	104.3	136.9	205.5	253.8	311.5	444.8	499.7	80.4	103.5	141.8	177.0	246.7	298.0	358.5																	
JUNCT_141	37.2	48.7	68.9	89.4	128.5	157.5	192.5	271.6	302.7	54.3	68.8	91.9	113.4	153.5	184.1	219.5																	
JUNCT_142	10.6	14.2	21.7	29.5	53.6	103.9	176.8	259.6	256.9	18.6	24.1	33.7	42.7	63.7	114.9	179.8																	
JUNCT_143	1.6	2.3	2.9	6.0	50.9	94.8	157.8	235.8	240.8	2.0	2.5	5.6	9.3	58.6	105.5	165.7																	
JUNCT_144	2.0	2.4	2.9	3.3	51.2	96.3	173.3	269.3	278.4	2.1	2.5	3.0	3.4	58.3	105.9	184.6																	
JUNCT_145	1.6	4.1	9.6	15.7	30.1	42.1	68.5	122.9	129.8	2.8	5.6	11.6	18.1	32.9	46.8	74.0																	
JUNCT_147	163.7	222.0	421.0	783.5	1720.7	2526.9	3352.5	4694.9	5183.3	318.0	477.0	923.4	1387.6	2461.3	3176.3	3901.3																	
JUNCT_149	74.5	152.7	413.2	769.2	1695.8	2495.1	3334.9	4699.1	5189.9	307.3	465.4	902.1	1360.4	2431.3	3161.3	3892.0																	
JUNCT_151	83.9	152.8	415.0	777.7	1715.6	2522.9	3369.4	4753.6	5233.1	307.4	466.8	910.3	1379.5	2452.5	3188.9	3921.7																	
JUNCT_152	13.8	18.4	27.5	37.3	55.9	69.4	86.3	123.7	123.7	13.8	18.4	27.5	37.3	55.9	69.4	86.3																	
JUNCT_156	31.6	137.8	406.5	769.2	1702.5	2507.8	3364.9	4788.4	5262.2	290.8	453.1	893.2	1359.7	2437.2	3125.0	3942.4																	
JUNCT_157	45.2	137.7	407.4	775.1	1720.4	2537.9	3404.7	4869.5	5322.4	290.8	453.8	898.2	1374.7	2461.3	3152.5	3984.3																	
JUNCT_158	52.0	137.0	407.2	775.2	1722.1	2542.5	3406.1	4888.6	5337.0	290.1	453.2	897.8	1376.2	2466.8	3151.1	3992.9																	
JUNCT_160	57.2	136.6	406.9	775.2	1723.2	2545.7	3408.0	4897.9	5346.5	289.7	452.9	897.6	1377.1	2470.5	3151.7	3998.7																	
JUNCT_161	35.9	137.2	423.7	805.6	1818.4	2711.3	3636.3	5320.7	5735.0	288.3	460.0	914.7	1422.0	2586.5	3308.4	4259.4																	
JUNCT_163	8.1	11.2	18.5	27.0	44.5	56.8	71.6	106.5	156.1	26.3	33.5	45.3	56.4	77.3	93.2	111.9																	
JUNCT_165	24.8	33.7	54.1	77.7	135.9	172.6	240.1	407.2	421.0	39.6	53.1	80.8	110.2	179.3	223.9	278.7																	
JUNCT_166	15.2	21.2	37.5	56.7	104.9	139.6	228.1	373.8	383.8	29.3	39.8	62.8	87.7	146.6	184.2	235.5																	
JUNCT_168	7.0	10.0	19.5	30.5	69.7	126.0	206.4	311.0	315.1	15.3	21.1	34.6	49.6	82.2	132.5	213.6																	
JUNCT_169	2.8	5.9	14.9	25.4	62.5	110.8	179.8	245.5	247.7	4.5	8.7	18.7	29.8	75.0	123.5	193.8																	
JUNCT_172	2.8	5.9	14.9	25.4	62.5	110.8	179.8	245.5	247.7	4.5	8.7	18.7	29.8	75.0	123.5	193.8																	
JUNCT_173	44.7	57.5	81.8	105.3	157.2	193.2	234.7	333.2	333.2	44.7	57.5	81.8	105.3	157.2	193.2	234.7																	
JUNCT_174	9.7	13.0	19.4	26.3	40.4	50.3	62.2	89.8	89.8	9.7	13.0	19.4	26.3	40.4	50.3	62.2																	
JUNCT_180	35.9	137.2	423.6	805.7	1818.9	2713.1	3639.1	5332.0	5743.0	288.2	460.0	914.7	1422.7	2588.4	3310.5	4263.6																	
JUNCT_210	102.4	298.0	620.5	1178.6	2578.2	3764.6	5088.6	8040.9	8807.8	411.6	680.7	1349.6	2081.8	3600.5	4610.3	6116.2																	
JUNCT_212	96.7	144.9	428.2	815.9	1830.6	2727.5	3663.3	5329.8	5737.1	297.2	466.4	929.3	1439.1	2602.8	3335.3	4273.2																	
JUNCT_214	88.7	153.0	416.9	783.9	1729.1	2541.7	3393.9	4791.2	5269.3	307.9	468.2	915.4	1389.7	2468.1	3209.1	3946.5																	
JUNCT_216	171.7	233.1	421.5	786.6	1725.7	2533.5	3360.2	4706.3	5194.8	317.9	477.3	927.0	1394.2	2468.1	3184.7	3909.6																	

Cottonwood Creek With Improvements (Continued) -Peak Total Inflow (cfs)																
Node	ex1	ex2	ex5	ex10	ex25	ex50	ex100	ex500	fu500	fu1	fu2	fu5	fu10	fu25	fu50	fu100
JUNCT_218	63.6	152.8	394.9	724.6	1630.8	2333.8	3056.7	4286.3	4782.2	304.5	450.0	866.6	1295.7	2346.3	2959.5	3605.1
JUNCT_219	313.8	425.5	737.4	1096.9	2024.7	2612.0	3635.0	5755.5	6702.2	580.1	745.7	1164.6	1575.5	2609.9	3371.3	4465.2
JUNCT_220	225.9	298.9	505.7	748.8	1378.3	1765.2	2236.3	3205.9	4005.5	477.5	605.4	916.7	1211.8	1907.3	2322.9	2874.8
JUNCT_221	3.2	4.4	8.6	13.7	27.1	35.6	46.2	70.0	70.0	3.2	4.4	8.6	13.7	27.1	35.6	46.2
JUNCT_223	3.7	5.3	9.8	16.2	32.2	42.3	54.9	83.2	83.2	3.7	5.3	9.8	16.2	32.2	42.3	54.9
JUNCT_240	28.9	39.7	64.6	93.9	167.1	213.4	272.3	429.4	502.2	48.0	65.1	97.8	132.7	217.1	272.3	341.2
JUNCT_242	15.2	21.2	37.5	56.7	104.9	139.6	228.1	373.8	383.8	29.3	39.8	62.8	87.7	146.6	184.2	235.5
JUNCT_243	50.3	65.5	97.2	130.1	205.6	256.3	315.9	457.2	466.4	51.3	67.0	99.5	133.2	210.2	261.9	322.6
JUNCT_245	28.3	36.9	54.4	73.1	110.1	136.0	168.0	241.4	285.1	48.3	60.7	82.3	103.1	141.9	170.1	204.9
JUNCT_260	113.8	151.7	220.5	290.2	457.1	562.2	690.7	987.3	1106.0	162.0	210.5	291.6	367.8	537.8	651.6	789.6
JUNCT_262	95.5	127.5	186.9	247.8	391.8	483.7	594.0	851.8	963.3	140.1	182.2	253.2	319.9	467.4	566.5	683.7
JUNCT_263	54.0	71.6	104.3	136.9	205.5	253.8	311.5	444.8	499.7	80.4	103.5	141.8	177.0	246.7	298.0	358.5
JUNCT_265	12.6	16.4	24.0	32.1	54.1	102.2	184.9	288.2	297.6	19.1	23.9	32.5	41.4	62.4	113.6	197.3
JUNCT_267	88.6	112.1	153.1	193.3	269.2	325.8	390.5	545.3	556.8	95.7	120.2	162.4	202.8	279.0	336.0	400.9
JUNCT_268	1.6	4.1	9.6	15.7	30.1	42.1	68.5	122.9	129.8	2.8	5.6	11.6	18.1	32.9	46.8	74.0
JUNCT_269	31.4	40.3	56.9	73.3	105.7	129.1	157.3	222.5	233.6	36.6	46.4	64.0	80.8	113.7	137.9	166.8
JUNCT_281	104.5	138.8	208.6	281.5	461.6	575.2	714.6	1044.1	1113.9	126.6	166.5	243.6	320.8	509.4	626.3	770.9
JUNCT_282	65.5	87.0	132.9	181.5	294.3	367.5	455.3	663.8	722.8	85.1	111.4	163.7	215.9	333.0	410.4	503.0
JUNCT_290	36.5	47.1	65.4	84.0	119.8	145.7	178.1	254.4	263.5	43.9	56.2	76.3	95.3	132.0	158.2	191.3
JUNCT_104	12.0	15.7	24.7	36.8	260.3	435.1	647.8	1082.9	1195.2	12.6	16.4	25.7	79.3	321.0	499.7	719.8
JUNCT_198	102.3	297.6	620.3	1178.3	2578.0	3764.8	5089.3	8044.3	8811.7	411.3	680.4	1348.9	2080.9	3600.1	4610.6	6117.6
JUNCT_199	103.3	304.9	622.6	1185.2	2597.8	3797.7	5138.6	8153.7	8939.8	411.6	681.6	1353.4	2091.1	3624.4	4646.7	6175.0
JUNCT_200	104.1	307.6	623.6	1193.2	2625.5	3849.1	5223.0	8341.0	9164.8	408.3	679.7	1355.4	2100.3	3659.6	4715.5	6272.5
JUNCT_206	104.2	307.8	624.0	1194.1	2628.8	3855.0	5232.2	8360.2	9186.2	408.3	679.8	1355.9	2101.6	3663.6	4721.8	6282.8
JUNCT_201	0.1	0.2	1.5	3.3	7.9	10.9	14.6	23.0	23.0	0.1	0.2	1.5	3.3	7.9	10.9	14.6
JUNCT_202	0.4	0.5	2.2	4.6	10.6	14.5	19.4	30.3	30.3	0.4	0.5	2.2	4.6	10.6	14.5	19.4
JUNCT_204	0.3	0.4	1.2	2.3	4.8	6.5	8.6	13.4	13.4	0.3	0.4	1.2	2.3	4.8	6.5	8.6
JUNCT_205	0.2	0.3	1.4	3.0	7.7	10.8	15.2	24.2	24.2	0.2	0.3	1.4	3.0	7.7	10.8	15.2
JUNCT_203	0.3	0.5	1.7	3.9	9.7	13.8	19.4	31.3	31.3	0.3	0.5	1.7	3.9	9.7	13.8	19.4
JUNCT_207	103.6	302.9	621.7	1190.4	2622.3	3847.7	5225.0	8355.4	9183.5	405.7	676.6	1351.0	2094.4	3655.6	4717.8	6276.0
JUNCT_208	103.5	302.9	621.7	1190.3	2622.2	3847.7	5225.0	8356.2	9184.8	405.7	676.6	1350.9	2094.4	3655.6	4717.8	6276.2
JUNCT_CV2	13.9	19.4	34.4	52.1	96.5	125.8	161.9	244.7	244.7	13.9	19.4	34.4	52.1	96.5	125.8	161.9
JUNCT_CV1	18.6	25.1	40.2	55.8	90.3	114.3	141.9	208.0	208.0	18.6	25.1	40.2	55.8	90.3	114.3	141.9
JUNCT_WT2	24.2	34.2	64.9	103.2	205.2	273.5	359.3	555.4	555.4	24.2	34.2	64.9	103.2	205.2	273.5	359.3
JUNCT_WT1	37.2	50.3	80.4	112.0	180.7	228.5	283.9	415.8	415.8	37.2	50.3	80.4	112.0	180.7	228.5	283.9
JUNCT_297	8.7	11.8	18.9	26.3	42.1	53.2	66.2	97.1	97.1	8.7	11.8	18.9	26.3	42.1	53.2	66.2
JUNCT_CV3	0.1	0.2	1.6	3.5	8.2	11.2	15.1	23.7	23.7	0.1	0.2	1.6	3.5	8.2	11.2	15.1
JUNCT_CV4	0.1	0.2	1.7	4.4	11.8	16.7	23.3	37.4	37.4	0.1	0.2	1.7	4.4	11.8	16.7	23.3
W-143	84.0	280.2	356.9	558.2	1137.8	1547.7	2119.5	3238.0	4022.6	361.6	422.3	701.7	954.0	1634.4	2105.2	2658.5
JUNCT_209	103.2	301.3	620.7	1188.6	2619.1	3844.2	5222.1	8355.8	9185.3	404.6	675.2	1348.6	2091.1	3651.7	4715.6	6273.8
JUNCT_100	12.6	16.4	25.4	36.0	56.2	70.4	87.9	127.8	132.7	14.1	18.3	27.7	38.6	59.3	73.8	91.8
JUNCT_101	35.2	44.6	64.2	84.7	125.5	153.8	188.2	268.3	284.8	42.7	53.5	74.6	96.0	137.4	166.7	201.9
JUNCT_108	10.1	13.5	21.3	29.7	47.0	59.6	74.5	108.9	112.9	11.3	14.9	23.1	31.8	49.5	62.3	77.6
JUNCT_111	11.4	14.4	19.8	24.6	34.8	41.8	50.4	70.6	71.7	12.0	15.1	20.5	25.4	35.6	42.7	51.3
JUNCT_116	12.8	16.3	22.4	28.3	39.9	48.4	58.3	81.9	84.2	14.0	17.7	24.0	30.0	41.7	50.3	60.4
JUNCT_118	15.9	20.9	31.2	41.7	65.4	81.0	99.7	144.5	166.9	23.9	30.6	42.9	54.7	79.9	97.0	117.7
JUNCT_133	124.4	167.0	245.4	324.9	520.9	640.4	792.9	1138.0	1267.6	175.5	230.3	321.9	408.4	607.3	738.5	898.6
JUNCT_135	15.1	19.3	26.3	32.7	46.5	56.0	67.2	93.8	99.3	17.9	22.7	30.1	36.7	50.6	60.4	71.9
JUNCT_137	38.4	49.5	68.4	86.7	119.7	146.5	178.2	250.2	264.1	46.6	59.1	79.3	97.9	131.4	158.7	190.5
JUNCT_138	25.4	32.7	45.0	56.9	79.5	96.3	116.7	163.0	172.2	30.8	39.0	52.1	64.3	86.9	104.1	124.8
JUNCT_146	1.6	4.1	9.6	15.7	30.1	42.1	68.6	123.9	130.9	2.9	5.6	11.6	18.1	32.9	46.8	74.0
JUNCT_153	40.2	54.0	80.6	111.2	171.4	213.3	264.8	382.9	382.9	40.2	54.0	80.6	111.2	171.4	213.3	264.8
JUNCT_162	36.4	50.0	82.4	120.7	217.2	277.3	376.6	605.9	721.4	69.8	94.1	138.0	184.2	297.6	372.2	475.5
JUNCT_164	30.8	42.0	67.5	97.3	171.8	220.1	305.3	529.0	581.1	50.1	67.5	100.8	136.2	221.8	277.5	366.2
JUNCT_167	7.5	9.6	13.2	16.4	23.2	27.9	33.8	47.5	49.5	8.5	10.8	14.6	17.9	24.7	29.6	35.5
JUNCT_181	13.5	17.7	25.2	32.7	47.7	57.9	71.4	101.2	111.3	18.5	23.6	32.0	39.9	55.2	66.1	80.0
POND_312	96.7	144.9	428.2	815.9	1830.6	2727.5	3663.3	5329.8	5737.1	297.2	466.4	929.3	1439.1	2602.8	3335.3	4273.2
POND_319	313.8	425.5	737.4	1096.9	2024.7	2612.0	3635.0	5755.5	6702.2	580.1	745.7	1164.6	1575.5	2609.9	3371.3	4465.2
POND_321	3.2	4.4	8.6	13.7	27.1	35.6	46.2	70.0	70.0	3.2	4.4	8.6	13.7	27.1	35.6	46.2
POND_323	3.7	5.3	9.8	16.2	32.2	42.3	54.9	83.2	83.2	3.7	5.3	9.8	16.2	32.2	42.3	54.9
POND_343	75.1	98.0	145.5	195.2	307.1	381.8	470.7	680.6	718.4	91.1	117.5	168.0	219.3	333.1	410.1	501.7
POND_365	12.6	16.4	24.0	32.1	54.1	102.2	184.9	288.2	297.6	19.1	23.9	32.5	41.4	62.4	113.6	197.3
POND_367	88.6	112.1	153.1	193.3	269.2	325.8	390.5	545.3	556.8	95.7	120.2	162.4	202.8	279.0	336.0	400.9
POND_369	31.4	40.3	56.9	73.3	105.7	129.1	157.3	222.5	233.6	36.6	46.4	64.0	80.8	113.7	137.9	166.8
POND_381	104.5	138.8	208.6	281.5	461.6	575.2	714.6	1044.1	1113.9	126.6	166.5	243.6	320.8	509.4	626.3	770.9
POND_390	36.5	47.1	65.4	84.0	119.8	145.7	178.1	254.4	263.5	43.9	56.2	76.3	95.3	132.0	158.2	191.3
POND_414	88.7	153.0	416.9	783.9	1729.1	2541.7	3393.9	4791.2	5269.3	307.9	468.2	915.4	1389.7	2468.1	3209.1	3946.5
POND_416	171.7	233.1	421.5	786.6	1725.7	2533.5	3360.2	4706.3	5194.8	317.9	477.3	927.0	1394.2	2468.1	3184.7	3909.6
POND_80	10.3	13.7	24.1	37.9	70.3	90.8	115.3	173.5	193.0	13.7	17.9	30.0	45.4	80.7	103.3	129.5
POND_81	146.9	190.5	306.7	439.1	752.7	953.9	1330.5	2122.3	2951.1	355.2	440.7	643.5	832.6	1317.6	1609.3	2007.6
POND_82	31.9	42.8	85.2	164.0	367.4	492.2	648.8	1000.0	1127.3	80.4	103.2	160.6	232.2	444.0	580.7	746.7
POND_304	31.7	45.0	94.9	164.9	358.5	479.7	637.3	1015.1	1133.4	56.0	75.9	137.1	216.0	424.8	555.1	725.9

Table G14 - Cottonwood Creel SWMM Results Without Improvements

	Cottonwood Creek Without Improvements -Peak Total Inflow (cfs)															
Node	ex1	ex2	ex5	ex10	ex25	ex50	ex100	ex500	fu500	fu1	fu2	fu5	fu10	fu25	fu50	fu100
JUNCT_1	31.7	45.0	94.9	165.1	358.7	480.0	637.6	1015.4	1133.8	56.1	76.0	137.3	216.2	425.0	555.3	726.2
JUNCT_2	19.1	26.8	59.5	110.2	249.1	336.4	456.6	724.8	816.8	40.6	53.9	96.2	151.8	298.9	394.3	524.0
JUNCT_3	18.3	24.7	49.8	86.1	190.7	259.1	351.8	557.5	638.8	38.2	49.9	83.1	124.4	234.3	306.9	410.0
JUNCT_4	3.7	6.1	14.3	24.7	53.7	75.7	103.0	162.3	179.2	5.7	8.6	17.9	29.2	62.8	86.5	115.3
JUNCT_5	1.9	2.8	10.1	22.7	52.9	70.7	94.4	146.4	153.7	4.6	6.5	14.8	27.7	58.4	76.7	100.5
JUNCT_6	166.2	203.7	370.3	552.3	1004.4	1283.5	1617.5	2462.8	3249.3	418.6	524.4	779.2	1017.9	1576.8	1901.8	2347.9
JUNCT_7	147.9	198.0	345.4	512.8	919.8	1173.6	1522.5	2363.1	3113.4	406.7	507.3	749.3	975.3	1506.8	1815.7	2244.2
JUNCT_8	188.5	207.6	338.2	496.4	878.2	1117.1	1463.0	2273.1	2976.9	389.4	484.9	714.8	929.4	1434.6	1729.0	2141.3
JUNCT_9	165.0	211.4	306.7	439.1	752.1	952.7	1312.4	2060.2	2720.4	355.2	440.7	643.5	831.7	1279.6	1548.1	1927.5
JUNCT_10	133.1	171.2	271.2	383.5	683.7	904.0	1269.6	2041.2	2792.5	343.8	426.7	621.5	801.6	1255.0	1526.3	1914.6
JUNCT_11	45.9	62.0	125.5	188.2	327.2	475.4	638.1	1100.4	1338.9	152.1	185.4	261.2	318.5	473.4	629.5	801.7
JUNCT_12	30.8	42.5	91.6	141.2	270.6	397.2	529.7	931.8	1120.1	135.1	160.5	216.5	254.5	386.0	515.0	639.2
JUNCT_13	33.5	45.5	92.5	142.1	272.7	399.6	531.4	938.3	1130.7	140.7	168.7	221.8	269.6	387.4	519.6	640.4
JUNCT_14	23.9	31.9	65.0	133.9	306.4	412.4	545.2	842.0	921.4	59.5	76.1	117.5	177.5	357.0	470.9	607.0
JUNCT_15	1.5	2.5	26.6	69.5	177.4	243.0	325.0	507.6	521.3	7.5	11.5	39.4	82.4	190.1	256.1	337.9
JUNCT_16	1.3	2.0	19.1	48.1	120.8	165.3	220.4	343.6	350.9	4.8	7.1	26.1	55.2	127.7	172.3	227.3
JUNCT_17	48.2	61.2	91.3	127.2	194.7	240.9	330.6	525.9	1100.0	149.8	186.7	265.7	341.2	518.1	630.6	773.1
JUNCT_18	0.8	1.2	4.8	11.3	26.9	36.1	48.3	74.9	180.5	33.2	40.3	54.3	67.5	92.3	109.8	131.5
JUNCT_19	0.8	1.3	13.6	37.9	100.3	136.4	184.9	289.6	706.7	128.9	157.3	214.8	264.3	363.1	431.5	514.6
JUNCT_20	0.8	1.2	10.5	26.4	66.6	90.2	121.8	189.9	470.7	90.7	109.6	148.2	180.6	244.6	289.7	344.5
JUNCT_21	43.5	55.1	83.7	112.8	178.1	221.2	271.2	390.7	420.5	53.1	66.6	98.3	129.3	196.8	242.3	294.9
JUNCT_50	10.3	13.7	24.1	37.9	70.3	90.8	115.3	173.5	193.0	13.7	17.9	30.0	45.4	80.7	103.3	129.5
JUNCT_51	146.9	190.5	306.7	439.1	752.7	954.0	1330.5	2122.3	2951.2	355.2	440.7	643.5	832.6	1317.6	1609.3	2007.6
JUNCT_52	31.9	42.8	85.2	164.0	367.4	492.2	648.8	1000.0	1127.3	80.4	103.2	160.6	232.2	444.0	580.7	746.7
JUNCT_102	203.2	260.1	467.8	692.2	1262.1	1614.6	2049.0	2928.4	3769.7	464.5	587.2	883.3	1161.8	1813.0	2195.3	2713.7
JUNCT_103	30.4	39.8	62.3	88.8	140.3	177.1	221.8	325.9	343.7	36.3	47.1	71.2	96.1	151.3	189.7	236.1
JUNCT_105	254.1	330.0	610.9	934.2	1784.0	2305.0	2951.1	4331.1	5178.4	525.2	671.7	1044.9	1418.9	2343.7	2902.1	3636.9
JUNCT_106	251.1	329.2	612.4	938.1	1796.6	2325.4	2985.0	4383.9	5233.8	525.6	672.8	1048.4	1425.5	2361.6	2926.9	3668.3
JUNCT_107	256.9	335.3	627.4	959.7	1834.2	2373.7	3049.0	4476.8	5328.9	531.0	680.7	1063.5	1447.6	2401.6	2977.6	3731.8
JUNCT_109	3.3	4.5	7.5	10.4	15.3	17.4	19.5	36.3	36.3	3.3	4.5	7.5	10.4	15.3	17.4	19.5
JUNCT_110	267.8	352.6	661.0	1011.7	1939.5	2516.1	3253.2	4782.4	5645.5	544.0	699.8	1100.9	1504.6	2517.0	3132.8	3937.8
JUNCT_112	275.7	363.9	682.8	1042.6	1989.8	2579.9	3335.6	4905.3	5773.3	552.7	711.7	1122.5	1535.1	2570.2	3202.3	4019.4
JUNCT_113	277.6	366.8	687.6	1050.2	2000.8	2597.9	3365.7	4958.7	5830.6	556.1	716.2	1130.8	1548.3	2588.7	3227.7	4055.5
JUNCT_115	92.4	122.7	184.1	248.1	405.1	504.6	624.9	911.2	976.5	113.4	148.7	217.0	284.8	450.9	552.1	677.2
JUNCT_117	79.9	105.5	158.3	214.0	342.6	426.2	525.9	763.6	824.3	100.3	130.8	190.4	249.7	382.5	470.3	575.0
JUNCT_119	50.7	66.6	99.8	135.0	209.8	260.2	321.5	464.0	519.9	70.3	90.7	129.1	167.2	246.3	300.7	366.6
JUNCT_120	38.4	50.0	73.3	97.4	146.9	180.8	222.7	318.2	335.4	46.4	59.6	84.6	109.1	159.4	194.5	237.2
JUNCT_121	17.2	22.5	33.7	45.5	69.3	86.2	106.2	152.0	166.8	23.3	29.8	42.2	54.6	81.1	99.5	117.8
JUNCT_122	21.6	28.0	40.4	52.8	78.8	96.7	118.2	168.5	173.7	23.7	30.5	43.4	56.0	82.4	100.5	122.5
JUNCT_123	321.2	432.0	802.3	1217.1	2308.6	2993.5	3875.7	5720.0	6672.9	607.1	785.9	1249.0	1717.0	2934.2	3685.6	4611.7
JUNCT_126	3.0	4.0	6.1	7.7	9.6	10.4	21.4	52.1	52.1	3.0	4.0	6.1	7.7	9.6	10.4	21.4
JUNCT_127	323.5	435.2	811.0	1235.7	2352.7	3059.1	3974.5	5885.1	6856.4	615.1	796.0	1267.3	1746.8	2992.8	3766.7	4728.9
JUNCT_128	20.3	25.5	34.7	43.3	60.1	72.4	86.7	121.0	121.0	20.3	25.5	34.7	43.3	60.1	72.4	86.7
JUNCT_129	71.9	174.5	450.3	832.2	1835.1	2469.8	3118.8	4283.9	4795.9	338.9	496.5	952.8	1434.9	2502.5	3028.5	3672.7
JUNCT_130	71.9	174.5	453.0	840.5	1852.4	2499.1	3158.0	4336.7	4833.7	339.1	497.9	958.1	1444.9	2521.7	3055.8	3702.0
JUNCT_131	71.8	174.3	453.9	845.6	1858.7	2509.8	3170.3	4352.9	4851.8	338.8	498.4	964.8	1455.4	2533.0	3070.5	3715.3
JUNCT_132	71.7	174.0	454.1	850.9	1863.7	2517.9	3178.7	4365.1	4868.1	338.4	498.2	970.6	1464.5	2542.1	3082.9	3726.4
JUNCT_134	113.8	151.7	220.5	290.2	457.1	562.2	690.8	1052.0	1102.3	162.0	210.5	291.6	367.8	537.8	651.6	789.7
JUNCT_136	95.5	127.5	186.9	247.8	391.8	483.7	594.0	951.1	981.4	140.1	182.2	253.2	319.9	467.4	566.5	683.8
JUNCT_139	63.7	84.7	124.7	164.8	251.2	311.0	431.9	771.4	792.5	97.3	125.7	173.2	217.1	306.2	370.8	448.0
JUNCT_140	54.0	71.6	104.3	136.9	205.5	253.8	311.5	444.8	499.7	80.4	103.5	141.8	177.0	246.7	298.0	358.5
JUNCT_141	37.2	48.7	68.9	89.4	128.5	157.5	192.5	271.6	302.7	54.3	68.8	91.9	113.4	153.5	184.1	219.5
JUNCT_142	21.9	27.4	36.0	42.8	100.8	177.5	281.9	489.4	492.4	24.6	31.0	39.8	47.8	112.1	189.9	295.5
JUNCT_143	21.4	26.5	33.6	39.1	89.0	154.6	243.8	418.8	418.1	23.8	28.8	35.9	41.6	100.5	166.1	255.3
JUNCT_144	25.8	28.2	32.3	36.5	85.6	147.3	223.7	374.1	374.1	26.4	28.9	33.3	37.4	95.3	156.2	235.4
JUNCT_145	1.6	4.1	9.6	15.6	30.1	42.1	68.5	122.9	129.7	2.8	5.6	11.6	18.1	32.9	46.8	73.9
JUNCT_147	163.7	222.0	512.5	945.0	2044.1	2803.5	3548.4	4896.7	5356.1	372.2	550.8	1058.5	1585.6	2752.5	3379.3	4072.5
JUNCT_149	84.2	195.7	503.1	928.8	1990.6	2752.8	3517.1	4890.0	5362.4	361.0	535.5	1033.4	1555.8	2707.6	3359.2	4063.1
JUNCT_151	84.4	195.8	505.5	939.8	2012.2	2784.3	3557.8	4964.4	5423.5	361.2	537.1	1043.1	1575.6	2730.5	3390.7	4098.2
JUNCT_152	13.8	18.4	27.5	37.3	55.9	69.4	86.3	123.7	123.7	13.8	18.4	27.5	37.3	55.9	69.4	86.3
JUNCT_156	44.6	183.2	498.9	927.4	1983.2	2753.8	3560.6	5003.8	5456.5	343.0	526.4	1019.9	1554.2	2703.4	3378.9	4120.5
JUNCT_157	45.2	183.1	500.3	934.5	2005.4	2790.1	3613.0	5116.3	5545.8	343.0	527.4	1025.7	1571.3	2730.3	3415.6	4172.3
JUNCT_158	52.0	182.5	499.8	934.9	2006.9	2795.2	3617.0	5145.7	5564.0	342.4	526.4	1025.4	1573.6	2735.5	3416.9	4181.7
JUNCT_160	57.2	182.2	499.5	935.1	2008.3	2798.5	3619.5	5157.4	5575.1	342.0	525.9	1025.2	1575.0	2739.5	3419.8	4187.8
JUNCT_161	47.7	183.7	514.3	967.3	2102.5	2970.8	3868.3	5613.6	6011.1	340.9	530.1	1045.2	1623.3	2857.3	3592.9	4465.0
JUNCT_163	8.1	11.2	18.5	27.0	44.5	56.8	71.6	106.5	156.1	26.3	33.5	45.3	56.4	77.3	93.2	111.9
JUNCT_165	24.8	33.7	54.1	77.7	135.9	172.6	240.0	407.2	421.2	39.6	53.1	80.8	110.2	179.3	223.9	278.7
JUNCT_166	15.2	21.2	37.5	56.7	104.9	139.6	228.0	373.8	384.0	29.3	39.8	62.8	87.7	146.6	184.2	235.5
JUNCT_168	7.0	10.0	19.5	30.5	69.6	125.9	206.3	311.0	315.2	15.3	21.1	34.6	49.6	82.2	132.5	213.5
JUNCT_169	2.8	5.9	14.9	25.4	62.5	110.7	179.6	245.5	247.7	4.5	8.7	18.7	29.8	75.0	123.5	193.7
JUNCT_172	2.8	5.9	14.9	25.4	62.5	110.7	179.6	245.5	247.7	4.5	8.7	18.7	29.8	75.0	123.5	193.7
JUNCT_173	44.7	57.5	81.8	105.3	157.2	193.2	234.7	333.2	333.2	44.7	57.5	81.8	105.3	157.2	193.2	234.7
JUNCT_174	9.7	13.0	19.4	26.3	40.4	50.3	62.2	89.8	89.8	9.7	13.0	19.4	26.3	40.4	50.3	62.2
JUNCT_180	47.7	183.7	514.3	967.4	2103.3	2973.5	3872.5	5631.3	6021.8	340.9	530.1	1045.4	1624.2	2859.7	3596.8	4469.7
JUNCT_210	146.1	355.0	2134.3	1358.6	2885.1	4085.2	5451.3	8443.7	9157.7	468.4	761.0	2763.7	2297.9	3913.4	4988.8	6446.4
JUNCT_212	96.7	190.8	521.5	977.6	2123.6	2991.1	3901.8	5635.6	6019.4	349.7	539.9	1058.3	1640.1	2874.9	3623.0	4482.7
JUNCT_214	89.2	196.1	507.9	947.0	2027.0	2804.9	3585.0	5010.3	5468.1	361.8	538.7	1048.8	1586.2	2747.3	3413.0	4125.7
JUNCT_216	171.7	233.1	513.3	949.1	2049.5	2811.5	3558.1	4914.8	5371.7	372.1	551.3	1062.6	1592.2	2759.6	3388.9	4082.0

	Cottonwood Creek Without Improvements -Peak Detention Pond Outflow (cfs)															
Storage Node	ex1	ex2	ex5	ex10	ex25	ex50	ex100	ex500	fu500	fu1	fu2	fu5	fu10	fu25	fu50	fu100
POND_312	47.7	183.7	514.3	967.3	2102.5	2970.8	3868.3	5613.6	6011.0	340.9	530.1	1045.2	1623.3	2857.3	3592.9	4465.0
POND_319	71.9	174.5	450.3	832.2	1835.1	2469.8	3118.8	4283.9	4795.9	338.9	496.5	952.8	1434.9	2502.5	3028.5	3672.7
POND_321	3.0	4.0	6.1	7.7	9.6	10.4	21.4	52.1	52.1	3.0	4.0	6.1	7.7	9.6	10.4	21.4
POND_323	3.3	4.5	7.5	10.4	15.3	17.4	19.5	36.3	36.3	3.3	4.5	7.5	10.4	15.3	17.4	19.5
POND_343	2.8	5.9	14.9	25.4	62.5	110.7	179.6	245.5	247.7	4.5	8.7	18.7	29.8	75.0	123.5	193.7
POND_365	21.4	26.5	33.6	39.1	89.0	154.6	243.8	418.8	418.1	23.8	28.8	35.9	41.6	100.5	166.1	255.3
POND_367	25.8	28.2	32.3	36.5	85.6	147.3	223.7	374.1	374.1	26.4	28.9	33.3	37.4	95.3	156.2	235.4
POND_369	1.6	4.1	9.6	15.6	30.1	42.1	68.5	123.9	130.8	2.9	5.6	11.6	18.1	32.9	46.8	74.0
POND_381	47.1	80.4	153.9	228.0	416.2	532.3	672.4	999.2	1064.1	63.2	102.6	182.8	260.8	458.1	578.3	722.9
POND_390	2.8	3.4	4.5	5.3	24.7	41.6	68.4	115.0	123.4	3.2	3.8	4.9	10.0	29.7	48.0	74.4
POND_414	44.6	183.2	498.9	927.4	1983.2	2753.8	3560.6	5003.8	5456.5	343.0	526.4	1019.9	1554.2	2703.4	3378.9	4120.5
POND_416	84.2	195.7	503.0	927.4	1987.4	2748.6	3512.8	4882.8	5355.1	361.0	535.5	1032.0	1552.0	2703.7	3354.2	4058.3
POND_80	3.7	6.1	14.3	24.7	53.7	75.7	103.0	162.3	179.2	5.7	8.6	17.9	29.2	62.8	86.5	115.3
POND_81	165.0	211.4	306.7	439.1	752.1	952.7	1312.4	2060.2	2720.4	355.2	440.7	643.5	831.7	1279.6	1548.1	1927.5
POND_82	29.6	39.8	78.6	117.0	222.4	326.7	431.2	771.3	864.8	72.8	84.3	114.7	133.0	278.5	375.6	471.0

Cottonwood Creek Without Improvements (continued) -Peak Total Inflow (cfs)																
Node	ex1	ex2	ex5	ex10	ex25	ex50	ex100	ex500	fu500	fu1	fu2	fu5	fu10	fu25	fu50	fu100
JUNCT_218	71.7	174.0	454.1	850.9	1863.7	2517.9	3178.7	4365.1	4868.1	338.4	498.2	970.6	1464.5	2542.1	3082.9	3726.4
JUNCT_219	328.3	441.7	823.1	1255.3	2384.2	3102.5	4036.9	5986.3	6968.0	620.7	804.0	1282.4	1770.9	3032.5	3818.8	4801.7
JUNCT_220	216.2	278.0	502.6	746.8	1377.6	1764.8	2236.3	3205.9	4005.4	477.5	605.4	916.7	1211.8	1907.3	2322.9	2874.8
JUNCT_221	3.2	4.4	8.6	13.7	27.1	35.6	46.2	70.0	70.0	3.2	4.4	8.6	13.7	27.1	35.6	46.2
JUNCT_223	3.7	5.3	9.8	16.2	32.2	42.3	54.9	83.2	83.2	3.7	5.3	9.8	16.2	32.2	42.3	54.9
JUNCT_240	28.9	39.7	64.6	93.9	167.1	213.3	272.3	429.4	502.0	48.0	65.1	97.8	132.7	217.1	272.3	341.1
JUNCT_242	15.2	21.2	37.5	56.7	104.9	139.6	228.0	373.8	384.0	29.3	39.8	62.8	87.7	146.6	184.2	235.5
JUNCT_243	50.3	65.5	97.2	130.1	205.6	256.3	315.9	457.2	466.4	51.3	67.0	99.5	133.2	210.2	261.9	322.6
JUNCT_245	28.3	36.9	54.4	73.1	110.1	136.0	168.0	241.4	285.1	48.3	60.7	82.3	103.1	141.9	170.1	204.9
JUNCT_260	113.8	151.7	220.5	290.2	457.1	562.2	690.8	1052.0	1102.3	162.0	210.5	291.6	367.8	537.8	651.6	789.7
JUNCT_262	95.5	127.5	186.9	247.8	391.8	483.7	594.0	951.1	981.4	140.1	182.2	253.2	319.9	467.4	566.5	683.8
JUNCT_263	54.0	71.6	104.3	136.9	205.5	253.8	311.5	444.8	499.7	80.4	103.5	141.8	177.0	246.7	298.0	358.5
JUNCT_265	29.4	33.5	41.3	49.4	91.3	159.5	247.4	426.7	427.8	32.2	37.4	46.6	56.0	103.0	169.7	258.0
JUNCT_267	88.6	112.1	153.1	193.3	269.2	325.8	390.5	545.3	556.8	95.7	120.2	162.4	202.8	279.0	336.0	400.9
JUNCT_268	1.6	4.1	9.6	15.6	30.1	42.1	68.5	122.9	129.7	2.8	5.6	11.6	18.1	32.9	46.8	73.9
JUNCT_269	31.4	40.3	56.9	73.3	105.7	129.1	157.3	222.5	233.6	36.6	46.4	64.0	80.8	113.7	137.9	166.8
JUNCT_281	104.5	138.8	208.6	281.5	461.6	575.2	714.6	1044.1	1113.9	126.6	166.5	243.6	320.8	509.4	626.3	770.9
JUNCT_282	65.5	87.0	132.9	181.5	294.3	367.5	455.3	663.8	722.8	85.1	111.4	163.7	215.9	333.0	410.4	503.0
JUNCT_290	36.5	47.1	65.4	84.0	119.8	145.7	178.1	254.4	263.5	43.9	56.2	76.3	95.3	132.0	158.2	191.3
JUNCT_104	42.2	57.4	115.2	194.7	411.7	547.2	722.6	1141.8	1264.8	66.3	89.5	159.1	247.7	480.2	625.4	814.3
JUNCT_198	145.7	354.3	2133.4	1358.1	2884.6	4085.2	5452.1	8446.9	9161.8	468.1	760.5	2763.1	2296.9	3912.6	4988.7	6447.4
JUNCT_199	153.3	363.7	2153.6	1365.2	2906.4	4122.0	5507.5	8566.2	9297.1	468.4	761.8	2786.6	2307.7	3938.7	5028.7	6509.8
JUNCT_200	150.2	359.2	2176.1	1370.9	2934.0	4176.9	5597.2	8767.8	9537.0	464.2	758.4	2820.9	2316.6	3974.3	5092.2	6612.0
JUNCT_206	150.3	359.5	2177.6	1371.9	2937.7	4183.3	5607.2	8788.2	9559.3	464.3	758.5	2822.5	2318.0	3978.7	5099.1	6622.9
JUNCT_201	0.1	0.2	1.5	3.3	7.9	10.9	14.6	23.0	23.0	0.1	0.2	1.5	3.3	7.9	10.9	14.6
JUNCT_202	0.4	0.5	2.2	4.6	10.6	14.5	19.4	30.3	30.3	0.4	0.5	2.2	4.6	10.6	14.5	19.4
JUNCT_204	0.3	0.4	1.2	2.3	4.8	6.5	8.6	13.4	13.4	0.3	0.4	1.2	2.3	4.8	6.5	8.6
JUNCT_205	0.2	0.3	1.4	3.0	7.7	10.8	15.2	24.2	24.2	0.2	0.3	1.4	3.0	7.7	10.8	15.2
JUNCT_203	0.3	0.5	1.7	3.9	9.7	13.8	19.4	31.3	31.3	0.3	0.5	1.7	3.9	9.7	13.8	19.4
JUNCT_207	144.1	348.3	2169.6	1366.8	2928.9	4174.0	5598.5	8782.0	9557.2	461.2	754.7	2815.8	2309.7	3969.6	5092.2	6615.7
JUNCT_208	144.0	348.3	2169.6	1366.7	2928.8	4174.0	5598.5	8783.0	9558.7	461.2	754.7	2815.9	2309.7	3969.5	5092.2	6615.9
JUNCT_CV2	13.9	19.4	34.4	52.1	96.5	125.8	161.9	244.7	244.7	13.9	19.4	34.4	52.1	96.5	125.8	161.9
JUNCT_CV1	18.6	25.1	40.2	55.8	90.3	114.3	141.9	208.0	208.0	18.6	25.1	40.2	55.8	90.3	114.3	141.9
JUNCT_WT2	24.2	34.2	64.9	103.2	205.2	273.5	359.3	555.4	555.4	24.2	34.2	64.9	103.2	205.2	273.5	359.3
JUNCT_WT1	37.2	50.3	80.4	112.0	180.7	228.5	283.9	415.8	415.8	37.2	50.3	80.4	112.0	180.7	228.5	283.9
JUNCT_297	8.7	11.8	18.9	26.3	42.1	53.2	66.2	97.1	97.1	8.7	11.8	18.9	26.3	42.1	53.2	66.2
JUNCT_CV3	0.1	0.2	1.6	3.5	8.2	11.2	15.1	23.7	23.7	0.1	0.2	1.6	3.5	8.2	11.2	15.1
JUNCT_CV4	0.1	0.2	1.7	4.4	11.8	16.7	23.3	37.4	37.4	0.1	0.2	1.7	4.4	11.8	16.7	23.3
W-143	135.8	339.8	2113.6	562.6	1154.1	1556.4	2113.6	3230.9	4093.1	313.8	428.8	2651.0	972.0	1646.3	2106.3	2651.0
JUNCT_209	141.9	343.7	2166.1	1364.4	2924.8	4169.8	5595.1	8781.9	9559.5	459.8	753.0	2812.3	2305.7	3965.3	5089.6	6613.5
JUNCT_100	12.6	16.4	25.4	36.0	56.2	70.4	87.9	127.8	132.7	14.1	18.3	27.7	38.6	59.3	73.8	91.8
JUNCT_101	35.2	44.6	64.2	84.7	125.5	153.8	188.2	268.3	284.8	42.7	53.5	74.6	96.0	137.4	166.7	201.9
JUNCT_108	10.1	13.5	21.3	29.7	47.0	59.6	74.5	108.9	112.9	11.3	14.9	23.1	31.8	49.5	62.3	77.6
JUNCT_111	11.4	14.4	19.8	24.6	34.8	41.8	50.4	70.6	71.7	12.0	15.1	20.5	25.4	35.6	42.7	51.3
JUNCT_116	12.8	16.3	22.4	28.3	39.9	48.4	58.3	81.9	84.2	14.0	17.7	24.0	30.0	41.7	50.3	60.4
JUNCT_118	15.9	20.9	31.2	41.7	65.4	81.0	99.7	144.5	166.9	23.9	30.6	42.9	54.7	79.9	97.0	117.7
JUNCT_133	124.4	167.0	245.4	324.9	520.8	640.4	792.8	1141.4	1263.5	175.5	230.3	321.9	408.3	607.4	738.4	899.1
JUNCT_135	15.1	19.3	26.3	32.7	46.5	56.0	67.2	93.8	99.3	17.9	22.7	30.1	36.7	50.6	60.4	71.9
JUNCT_137	38.4	49.5	68.4	86.7	119.7	146.5	178.2	250.2	264.1	46.6	59.1	79.3	97.9	131.4	158.7	190.5
JUNCT_138	25.4	32.7	45.0	56.9	79.5	96.3	116.7	163.0	172.2	30.8	39.0	52.1	64.3	86.9	104.1	124.8
JUNCT_146	1.6	4.1	9.6	15.6	30.1	42.1	68.5	123.9	130.8	2.9	5.6	11.6	18.1	32.9	46.8	74.0
JUNCT_153	40.2	54.0	80.6	111.2	171.4	213.3	264.8	382.9	382.9	40.2	54.0	80.6	111.2	171.4	213.3	264.8
JUNCT_162	36.4	50.0	82.4	120.7	217.1	277.2	376.6	605.9	721.3	69.8	94.1	138.0	184.2	297.6	372.2	475.5
JUNCT_164	30.8	42.0	67.5	97.3	171.8	220.1	305.4	529.0	581.0	50.1	67.5	100.8	136.2	221.8	277.5	366.3
JUNCT_167	7.5	9.6	13.2	16.4	23.2	27.9	33.8	47.5	49.5	8.5	10.8	14.6	17.9	24.7	29.6	35.5
JUNCT_181	13.5	17.7	25.2	32.7	47.7	57.9	71.4	101.2	111.3	18.5	23.6	32.0	39.9	55.2	66.1	80.0
POND_312	96.7	190.8	521.5	977.6	2123.6	2991.1	3901.8	5635.6	6019.4	349.7	539.9	1058.3	1640.1	2874.9	3623.0	4482.7
POND_319	328.3	441.7	823.1	1255.3	2384.2	3102.5	4036.9	5986.3	6968.0	620.7	804.0	1282.4	1770.9	3032.5	3818.8	4801.7
POND_321	3.2	4.4	8.6	13.7	27.1	35.6	46.2	70.0	70.0	3.2	4.4	8.6	13.7	27.1	35.6	46.2
POND_323	3.7	5.3	9.8	16.2	32.2	42.3	54.9	83.2	83.2	3.7	5.3	9.8	16.2	32.2	42.3	54.9
POND_343	75.1	98.0	145.5	195.2	307.1	381.8	470.7	680.6	718.4	91.1	117.5	168.0	219.3	333.1	410.1	501.7
POND_365	29.4	33.5	41.3	49.4	91.3	159.5	247.4	426.7	427.8	32.2	37.4	46.6	56.0	103.0	169.7	258.0
POND_367	88.6	112.1	153.1	193.3	269.2	325.8	390.5	545.3	556.8	95.7	120.2	162.4	202.8	279.0	336.0	400.9
POND_369	31.4	40.3	56.9	73.3	105.7	129.1	157.3	222.5	233.6	36.6	46.4	64.0	80.8	113.7	137.9	166.8
POND_381	104.5	138.8	208.6	281.5	461.6	575.2	714.6	1044.1	1113.9	126.6	166.5	243.6	320.8	509.4	626.3	770.9
POND_390	36.5	47.1	65.4	84.0	119.8	145.7	178.1	254.4	263.5	43.9	56.2	76.3	95.3	132.0	158.2	191.3
POND_414	89.2	196.1	507.9	947.0	2027.0	2804.9	3585.0	5010.3	5468.1	361.8	538.7	1048.8	1586.2	2747.3	3413.0	4125.7
POND_416	171.7	233.1	513.3	949.1	2049.5	2811.5	3558.1	4914.8	5371.7	372.1	551.3	1062.6	1592.2	2759.6	3388.9	4082.0
POND_80	10.3	13.7	24.1	37.9	70.3	90.8	115.3	173.5	193.0	13.7	17.9	30.0	45.4	80.7	103.3	129.5
POND_81	146.9	190.5	306.7	439.1	752.7	954.0	1330.5	2122.3	2951.2	355.2	440.7	643.5	832.6	1317.6	1609.3	2007.6
POND_82	31.9	42.8	85.2	164.0	367.4	492.2	648.8	1000.0	1127.3	80.4	103.2	160.6	232.2	444.0	580.7	746.7

POND VOLUME TABLES

Table G15 2024 MDP Pond Volumes (volumes are in acre-foot)

Watershed	Regional Water Quality Facility	Drainage Area (acre)	Existing Watershed Imperviousness (%)	Current Direct WQCV Needed	Future Watershed Imperviousness (%)	Future Direct WQCV Needed	Current Direct WQCV Provided	Proposed Additional WQCV Provided	Proposed Total WQCV Provided	Current Direct Runoff Reduction from 20-10 Rule - Considering 2012 Imperviousness	Current Direct WQCV Needed - Including Runoff Reduction Provided from 20-10 Rule	Future Direct Runoff Reduction from 20-10 Rule - Considering 2012 Imperviousness	Future Direct WQCV Needed - Including Runoff Reduction Provided from 20-10 Rule	Current Direct Deficit	Current Cumulative Deficit	Future Direct Deficit	Future Proposed Direct Deficit	Future Proposed Cumulative WQCV Deficit	EURV Direct Demand	Current Direct EURV Provided	Proposed Additional EURV Provided	100 Yr-SWMM Volume	Design 100-year volume	Source of Design 100-yr Volume
Lone Tree Creek	Pond L1 West	95	51.9	1.7	53.5	1.7	0.0	0.0	0.0	0.1	1.6	0.1	1.7	1.6	1.6	1.7	1.7	1.7	4.9	0.0	0.0	8.0	8.00	SWMM Volume
	Pond L1 East	59	34.0	0.8	69.6	1.3	3.8	0.0	3.8	0.0	0.8	0.0	1.3	-3.0	-1.4	-2.5	-2.5	-0.8	4.0	0.0	0.0	8.9	8.9	detains WQCV for L1 West
	Pond L2	256	61.0	5.1	81.4	7.2	0.0	7.0	7.0	0.2	4.9	0.2	7.0	4.9	4.9	7.0	0.0	0.0	20.5	0.0	0.0	13.8	18.0	sheet 1 of AB, 17.7 from previous MDP, WQCV not provided
	Pond L3	515	49.4	8.8	77.2	13.4	20.2	-7.2	13.0	0.3	8.5	0.4	12.9	-11.7	-11.7	-7.3	-0.1	-0.1	40.6	0.0	0.0	13.4	19.4	stage-storage curve from 2020 LiDAR
Windmill Creek	Meridian Pond	195	21.8	2.0	62.3	4.0	4.7	0.0	4.7	0.1	1.9	0.2	3.8	-2.8	-2.8	-0.9	-0.9	-0.9	11.9	0.0	0.0	6.0	15.4	as-built
	Pond W1/W2	490	31.6	6.4	79.5	13.3	16.3	0.0	16.3	0.3	6.1	0.7	12.6	-10.2	-10.2	-3.7	-3.7	-3.7	38.7	0.0	38.7	102.7	105.3	as-built
	Pond W4	275	37.6	4.0	68.8	6.2	0.0	0.0	0.0	0.2	3.8	0.3	5.9	3.8	3.8	5.9	5.9	5.9	19.1	0.0	0.0	19.7	23.1	2010 MDP
	Pond W5	119	13.6	0.9	35.3	1.7	2.3	0.0	2.3	0.0	0.8	0.1	1.6	-1.5	-1.5	-0.7	-0.7	-0.7	3.9	0.0	3.9	10.2	28.5	as-builts 2009
	Pond W6/W7	395	39.1	5.8	80.0	10.8	23.1	0.0	23.1	0.3	5.5	0.6	10.3	-17.6	-13.8	-12.8	-12.8	-7.0	31.3	0.0	0.0	33.1	33.1	SWMM Volume, detains WQCV for Pond W4
	Pond W8	329	36.1	4.6	54.6	6.0	8.0	0.0	8.0	0.2	4.4	0.3	5.7	-3.6	-3.6	-2.3	-2.3	-2.3	17.3	0.0	0.0	12.9	12.9	SWMM Volume
	Pond W9	183	43.9	2.9	73.9	4.5	0.0	4.3	4.3	0.1	2.8	0.2	4.3	2.8	2.8	4.3	0.0	0.0	13.2	0.0	0.0	11.9	11.9	SWMM Volume
Dove Creek	Highfield Pond	57	26.3	0.7	90.0	1.9	2.1	0.0	2.1	0.0	0.6	0.1	1.8	-1.5	-1.5	-0.3	-0.3	-0.3	5.1	0.0	0.0	7.5	7.5	SWMM Volume
	Pond D1	231	20.0	2.2	80.0	6.3	9.8	0.0	9.8	0.1	2.1	0.4	5.9	-7.7	-7.7	-3.9	-3.9	-3.9	18.1	0.0	18.1	34.0	34.6	2010 Record Drawings
	Pond D2	206	24.6	2.3	80.0	5.6	8.3	0.0	8.3	0.1	2.2	0.3	5.3	-6.1	-6.1	-3.0	-3.0	-3.0	16.2	0.0	0.0	18.4	25.3	record drawings
	Pond D3	117	49.6	2.0	77.1	3.0	4.1	0.0	4.1	0.1	1.9	0.2	2.9	-2.2	-2.2	-1.2	-1.2	-1.2	9.7	0.0	0.0	6.3	6.3	SWMM Volume
CC-Peoria Tributary	Airport Pond C3 C4	221	37.1	3.2	59.1	4.3	4.3	0.0	4.3	0.0	3.2	0.0	4.3	-1.1	-1.1	0.0	0.0	0.0	12.5	14.1	0.0	22.1	30.2	record drawings and drainage report
	Caley East	54	70.4	1.2	80.0	1.5	1.5	0.0	1.5	0.0	1.2	0.0	1.5	-0.3	-0.3	0.0	0.0	0.0	4.2	4.9	0.0	5.9	0.0	As-built, UHR, WQCV assumed within EURV;
	Peoria Trib Outfall	466	40.2	2.7	61.7	4.0	0.0	0.0	0.0	0.0	2.7	0.0	4.0	2.7	2.7	4.0	4.0	4.0	27.7	19.0	0.0	36.4	36.4	SWMM node inflow volume
CC-Airport Tributary	Meridian Northeast	77	30.2	1.0	35.0	1.1	0.5	*0.6*	*1.1*	0.0	1.0	0.0	1.1	*0.0*	*0.0*	0.0	*0.0*	0.0	2.5	0.0	*3.1*	2.2	2.5	2010 OSP
	Airport Pond #1	52	23.1	0.6	23.1	0.6	0.5	0.1	0.6	0.0	0.6	0.0	0.6	0.1	0.1	0.1	0.0	0.0	1.1	0.0	1.0	5.4	6.6	2010 OSP
	Airport Pond #2	41	22.9	0.4	22.9	0.4	0.4	0.0	0.4	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.8	0.0	1.0	2.9	2.6	2010 OSP
	New Airport South Pond	497	25.0	5.2	31	6.2	0.0	6.2	6.2	0.0	5.2	0.0	6.2	5.2	5.2	6.2	0.0	0.0	14.4	0.0	17.6	6.6	6.6	2024 MDP Concept
CC-Inverness Tributary	Fulton Street Pond	55	67.5	1.2	74.9	1.4	1.4	0.0	1.4	0.0	1.2	0.0	1.4	-0.2	-0.2	0.0	0.0	0.0	4.0	0.0	0.0	6.0	5.4	2010 OSP
	Upper Rampart Pond	81	71.3	2.7	83.0	3.3	0	3.3	3.3	0.0	2.7	0.0	3.3	2.7	2.7	3.3	0.0	0.0	9.3	0.0	7.6	10.9	15.4	2010 OSP
	Lower Rampart Pond	57	58.0	0.4	77.3	0.5	3.5	-3.0	0.5	0.0	0.4	0.0	0.5	-3.1	-0.4	-3.0	0.0	0.0	1.6	0.0	0.0	4.5	6.1	2010 OSP
	Inverness Trib C Pond	281	59.0	5.5	65.8	6.0	7.6	-1.6	6.0	0.0	5.5	0.0	6.0	-2.1	-2.1	-1.6	0.0	0.0	17.9	0.0	0.0	11.7	11.7	SWMM Volume
Cottonwood Creek - Main Stem	Lower Skyridge Pond	422	14.2	3.1	27.1	5.0	1.3	*3.7*	*5.0*	0.0	3.1	0.0	5.0	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	0.0	10.3	0.0	0.0	17.9	17.9	SWMM Volume
	Meridian Flashboard Dam	925	30.1	11.7	64.1	19.3	0	*19.3*	*19.3*	0.0	11.7	0.0	19.3	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	0.0	57.3	0.0	0.0	16.1	30.0	2010 OSP
	Inverness Regional Pond	1561	24.1	17.0	30.6	22.9	22.9	0.0	22.9	0.0	17.0	0.0	22.9	-5.9	-5.9	0.0	0.0	0.0	11.8	29.2	0.0	76.8	103.5	As-builts, 2016, UHR, WQCV provided equal to demand if less than EUR
	Lincoln Executive Center Pond	490	57.8	9.3	76.5	12.6	6.7	0.0	6.7	0.0	9.3	0.0	12.6	2.6	-3.3	5.9	5.9	5.9	36.7	6.7	0.0	37.4	37.4	SWMM Volume; note 6.7 ac-ft is total volume for WQCV and EURV
	Caley West Pond	182	51.7	3.2	61.8	3.7	6.6	0.0	6.6	0.0	3.2	0.0	3.7	-3.4	-6.7	-2.9	-2.9	2.9	10.8	19.0	0.0	49.8	49.8	SWMM Volume; WQCV provided equal to demand if less than EURV
	Peoria Street Pond	458	37.9	6.7	57.4	8.7	11.6	0.0	11.6	0.0	6.7	0.0	8.7	-4.9	-11.6	-2.9	-2.9	0.0	25.4	0.0	0.0	34.4	34.4	SWMM Volume

1. Negative values indicate a surplus in volume
2. Cumulative values do not account for overdetention
3. Cumulative values assume upstream entities adhere to their requirements to detain the WQCV
4. Allowable Runoff Reduction crediting for 20-10 Rule is 7%
5. Runoff Reduction considering 2008 Imperviousness is 3.3%, 5.1%, and 5.9% for Lone Tree, Windmill, and Dove Creeks, respectively. Cottonwood Creek was not credited with any reduction.

Upstream Municipality (by others)	*italics*
20-10 Rule Not Credited	
Upstream Private Entity (by others)	
Proposed Additional by SEMSWA	
WQCV Deficit	red

Table G16 Cottonwood Creek Subbasin Volumes

Cottonwood Creek					CURRENT DEMAND				FUTURE DEMAND				HSG, fraction				HSG, acres			EURV, Future Conditions			
Pond	SWMM	Basin	Area (ac)	Area (sq mi)	IA (%)	WQCV (w.s. incD)	WQCV (ac-ft)	Σ WQCV (ac-ft)	IA (%)	WQCV (w.s. incD)	WQCV (ac-ft)	Σ WQCV (ac-ft)	Basin	A	B	C/D	A	B	C/D	A	B	C/D	Total
Lower Skyridge Pond	82	DC 1	110	0.1726	2.0	0.02	0.14	3.1	5.0	0.04	0.33	5.0	DC-1	0.00	0.00	1.00	0	0	110	0	0	0.43	0.43
		DC 2	66	0.1028	2.0	0.02	0.08		11.0	0.07	0.40		DC-2	0.00	0.00	1.00	0	0	66	0	0	0.61	0.61
		DC 3	68	0.1062	2.0	0.02	0.09		11.0	0.07	0.41		DC-3	0.00	0.00	1.00	0	0	68	0	0	0.63	0.63
		DC 4	115	0.1792	29.6	0.15	1.44		51.0	0.21	2.00		DC-4	0.00	0.00	1.00	0	0	115	0	0	5.54	5.54
		DC 5	63	0.0991	33.0	0.16	0.85		56.0	0.22	1.18		DC-5	0.00	0.00	1.00	0	0	63	0	0	3.39	3.39
Totals			**422**	**0.6599**	**14.2**	**0.09**	**3.14**		**27.1**	**0.14**	**5.00**			**0.00**	**0.00**	**1.00**	0	0	422	**0**	0	**10.29**	**10.29**
Merdian Flashboard Dam	81	DC 6	109	0.1710	11.8	0.08	0.70	14.9	85.0	0.36	3.30	24.3	DC-6	0.00	0.00	1.00	0	0	109	0	0	9.18	9.18
		DC 7	107	0.1670	31.5	0.16	1.39		35.0	0.17	1.48		DC-7	0.00	0.00	1.00	0	0	107	0	0	3.44	3.44
		DC 8	102	0.1596	2.2	0.02	0.14		89.0	0.39	3.35		DC-8	0.00	0.00	1.00	0	0	102	0	0	9.01	9.01
		DC 9	54	0.0841	2.7	0.02	0.09		88.0	0.39	1.73		DC-9	0.00	0.00	1.00	0	0	54	0	0	4.69	4.69
		DC 10	40	0.0632	5.7	0.04	0.14		85.0	0.36	1.22		DC-10	0.00	0.00	1.00	0	0	40	0	0	3.39	3.39
		DC 11	95	0.1477	52.0	0.21	1.67		52.0	0.21	1.67		DC-11	0.00	0.00	1.00	0	0	95	0	0	4.67	4.67
		DC 12	113	0.1770	29.1	0.15	1.40		35.0	0.17	1.57		DC-12	0.00	0.00	1.00	0	0	113	0	0	3.65	3.65
		DC 13	124	0.1943	53.1	0.21	2.23		60.0	0.24	2.45		DC-13	0.00	0.00	1.00	0	0	124	0	0	7.16	7.16
		DC 14	98	0.1527	49.6	0.21	1.67		75.0	0.30	2.44		DC-14	0.00	0.00	1.00	0	0	98	0	0	7.16	7.16
		DC 15	83	0.1294	35.8	0.17	1.16		65.0	0.25	1.75		DC-15	0.00	0.00	1.00	0	0	83	0	0	5.20	5.20
Totals			**925**	**1.4461**	**30.1**	**0.15**	**11.71**		**64.1**	**0.25**	**19.35**			**0.00**	**0.00**	**1.00**	0	0	925	**0**	0	**57.29**	**57.29**
Inverness Regional Pond	319	DC 16	87	0.1365	22.9	0.13	0.93	43.9	70.0	0.28	2.00	60.7	DC-16	0.00	0.00	1.00	0	0	87	0	0	5.94	5.94
		DC 17	76	0.1195	18.5	0.11	0.70		70.0	0.28	1.75		DC-17	0.00	0.00	1.00	0	0	76	0	0	5.20	5.20
		DC 18	69	0.1083	8.3	0.06	0.33		75.0	0.30	1.73		DC-18	0.00	0.00	1.00	0	0	69	0	0	5.08	5.08
		DC 19	85	0.1326	45.1	0.19	1.37		75.0	0.30	2.12		DC-19	0.00	0.00	1.00	0	0	85	0	0	6.22	6.22
		DC 20	83	0.1296	47.6	0.20	1.38		65.0	0.25	1.76		DC-20	0.00	0.00	1.00	0	0	83	0	0	5.21	5.21
		DC 21	87	0.1367	62.4	0.24	1.78		75.0	0.30	2.18		DC-21	0.00	0.00	1.00	0	0	87	0	0	6.41	6.41
		DC 22	46	0.0718	67.4	0.26	1.01		80.0	0.33	1.26		DC-22	0.00	0.00	1.00	0	0	46	0	0	3.61	3.61
		AC 19	32	0.0495	34.8	0.17	0.44		54.5	0.22	0.58		AC-19	0.00	0.00	1.00	0	0	32	0	0	1.64	1.64
		AC 20	26	0.0403	29.5	0.15	0.32		29.5	0.15	0.32		AC-20	0.00	0.00	1.00	0	0	26	0	0	0.69	0.69
		AC 21	11	0.0176	75.0	0.30	0.28		80.0	0.33	0.31		AC-21	0.00	0.00	1.00	0	0	11	0	0	0.89	0.89
		AC 22	24	0.0370	52.9	0.21	0.42		52.9	0.21	0.42		AC-22	0.00	0.00	1.00	0	0	24	0	0	1.19	1.19
		AC 23	30	0.0470	46.5	0.20	0.49		50.0	0.21	0.52		AC-23	0.00	0.00	1.00	0	0	30	0	0	1.42	1.42
		AC 24	24	0.0377	50.1	0.21	0.42		65.0	0.25	0.51		AC-24	0.00	0.00	1.00	0	0	24	0	0	1.52	1.52
		AC 25	33	0.0519	39.0	0.18	0.49		39.0	0.18	0.49		AC-25	0.00	0.00	1.00	0	0	33	0	0	1.20	1.20
		AC 28	35	0.0552	49.0	0.20	0.60		50.0	0.21	0.61		AC-28	0.00	0.00	1.00	0	0	35	0	0	1.67	1.67
		AC 29	68	0.1061	22.3	0.12	0.71		22.3	0.12	0.71		AC-29	0.00	0.00	1.00	0	0	68	0	0	1.34	1.34
		AC 34	44	0.0684	53.5	0.22	0.79		68.8	0.27	0.98		AC-34	0.00	0.00	1.00	0	0	44	0	0	2.92	2.92
		AC 35	26	0.0406	44.4	0.19	0.41		47.5	0.20	0.43		AC-35	0.06	0.00	0.94	2	0	24	0	0	1.09	1.18
		AC 37	52	0.0816	65.2	0.25	1.11		76.7	0.31	1.34		AC-37	0.09	0.00	0.91	5	0	48	0	0	3.58	4.03
		AC 38	18	0.0277	77.5	0.31	0.46		80.0	0.33	0.49		AC-38	0.00	0.00	1.00	0	0	18	0	0	1.39	1.39
		AC 42	38	0.0590	63.4	0.25	0.78		75.0	0.30	0.94		AC-42	0.08	0.00	0.92	3	0	35	0	0	2.55	2.84
		AC 47	47	0.0730	13.7	0.09	0.34		56.0	0.22	0.87		AC-47	0.18	0.00	0.82	9	0	38	1	0	2.04	2.61
		AC 48	23	0.0367	42.1	0.19	0.36		50.0	0.21	0.40		AC-48	0.00	0.00	1.00	0	0	23	0	0	1.11	1.11
		AC 56	30	0.0473	80.7	0.33	0.84		80.7	0.33	0.84		AC-56	0.00	0.00	1.00	0	0	30	0	0	2.40	2.40
		AC 57	21	0.0323	52.9	0.21	0.37		64.5	0.25	0.43		AC-57	0.00	0.00	1.00	0	0	21	0	0	1.29	1.29
		AC 58	25	0.0385	12.2	0.08	0.16		70.0	0.28	0.56		AC-58	0.00	0.00	1.00	0	0	25	0	0	1.68	1.68
Totals			**1141**	**1.7824**	**39.6**	**0.18**	**16.99**		**61.3**	**0.24**	**22.87**			**0.02**	**0.00**	**0.98**	18	0	1123	**1**	0	**66.19**	**67.50**
Airport South Pond	From Airport Tributary to new Airport South Pond (previously to IRP)	DC 23	76	0.1180	6.9	0.05	0.30	26.9	15.0	0.09	0.59	31.8	DC-23	0.00	0.00	1.00	0	0	76	0	0	0.97	0.97
		DC 25	95	0.1478	28.8	0.15	1.16		43.8	0.19	1.50		DC-25	0.00	0.00	1.00	0	0	95	0	0	3.88	3.88
		DC 26	84	0.1312	9.2	0.06	0.44		16.0	0.10	0.69		DC-26	0.00	0.00	1.00	0	0	84	0	0	1.16	1.16
		DC 27	112	0.1755	34.3	0.16	1.54		35.0	0.17	1.56		DC-27	0.00	0.06	0.94	0	7	106	0	0	3.40	3.64
		DC 28	54	0.0843	41.8	0.18	0.83		43.0	0.19	0.84		DC-28	0.00	0.22	0.78	0	12	42	0	1	1.68	2.23
Totals			**420**	**0.6568**	**24.1**	**0.13**	**4.61**		**30.6**	**0.15**	**5.37**			**0.01**	**0.01**	**0.98**	0	19	402	**0**	1	**11.19**	**11.78**
Airport Pond #1	323	AC27	52	0.0814	23.1	0.13	0.56	0.56	23.1	0.13	0.56	0.56	AC-27	0.00	0.00	1.00	0	0	52	0	0	1.07	1.07
Totals			**52**	**0.0814**	**23.1**	**0.13**	**0.56**		**23.1**	**0.13**	**0.56**			**0.00**	**0.00**	**1.00**	0	0	52	**0**	0	**1.07**	**1.07**
Airport Pond #2	321	AC 36	41	0.0639	22.9	0.13	0.43	0.43	22.9	0.13	0.43	0.43	AC-36	0.03	0.00	0.97	1	0	40	0	0	0.81	0.83
Totals			**41**	**0.0639**	**22.9**	**0.13**	**0.43**		**22.9**	**0.13**	**0.43**			**0.03**	**0.00**	**0.97**	1	0	40	**0**	0	**0.81**	**0.83**
Meridian Northeast Pond	80	DC 24	77	0.1204	30.2	0.15	0.98	0.98	35.0	0.17	1.07	1.07	DC-24	0.00	0.00	1.00	0	0	77	0	0	2.48	2.48
Totals			**77**	**0.1204**	**30.2**	**0.15**	**0.98**		**35.0**	**0.17**	**1.07**			**0.00**	**0.00**	**1.00**	0	0	77	**0**	0	**2.48**	**2.48**
Cottonwood Creek (continued)					CURRENT DEMAND				FUTURE DEMAND														
Pond	SWMM	Basin	Area (ac)	Area (sq mi)	IA (%)	WQCV (w.s. incD)	WQCV (ac-ft)	Σ WQCV (ac-ft)	IA (%)	WQCV (w.s. incD)	WQCV (ac-ft)	Σ WQCV (ac-ft)											
Inverness Trib C WQ Pond (to IRP)	381	AC 30	45.0	0.070	43.3	0.19	0.71	5.46	65.0	0.25	0.95	6.03	AC-30	0.00	0.00	1.00	0	0	45	0	0	2.83	2.83
		AC 31	42.4	0.066	61.3	0.24	0.85		65.0	0.25	0.90		AC-31	0.00	0.00	1.00	0	0	42	0	0	2.66	2.66
		AC 32	30.5	0.048	52.5	0.21	0.54		65.0	0.25	0.65		AC-32	0.00	0.00	1.00	0	0	31	0	0	1.92	1.92
		AC 33	55.0	0.086	50.6	0.21	0.95		50.6	0.21	0.95		AC-33	0.00	0.00	1.00	0	0	55	0	0	2.63	2.63
		AC 49	37.9	0.059	66.1	0.26	0.82		70.0	0.28	0.87		AC-49	0.00	0.00	1.00	0	0	38	0	0	2.58	2.58
		AC 50	26.0	0.041	64.0	0.25	0.54		70.0	0.28	0.60		AC-50	0.00	0.00	1.00	0	0	26	0	0	1.77	1.77
		AC 51	20.6	0.032	75.4	0.30	0.52		80.0	0.33	0.56		AC-51	0.00	0.00	1.00	0	0	21	0	0	1.62	1.62
		AC 40	24.0	0.038	81.4	0.34	0.67		81.4	0.34	0.67		AC-40	0.00	0.00	1.00	0	0	24	0	0	1.92	1.92

Totals			**281.3**	**0.440**	**59.0**	**0.23**	**5.46**		**65.8**	**0.26**	**6.03**			**0.00**	**0.00**	**1.00**	0	0	281	**0**	0	**17.91**	**17.91**
To LEC	318	AC 60	24.4	0.038	37.6	0.17	0.35		56.0	0.22	0.46		AC-60	0.00	0.00	1.00	0	0	24	0	0	1.31	1.31
		AC 61	42.9	0.067	38.2	0.18	0.63		60.0	0.24	0.84		AC-61	0.00	0.00	1.00	0	0	43	0	0	2.47	2.47
		AC 69	48.6	0.076	56.8	0.23	0.92		80.0	0.33	1.33		AC-69	0.00	0.00	1.00	0	0	49	0	0	3.82	3.82
		AC 70	49.5	0.077	45.3	0.19	0.80		80.0	0.33	1.36		AC-70	0.00	0.00	1.00	0	0	50	0	0	3.89	3.89
LEC	416	AC 77	30.1	0.047	61.0	0.24	0.60		77.0	0.31	0.78		AC-77	0.00	0.00	1.00	0	0	30	0	0	2.27	2.27
	Direct from Havana Trib A	AC 62	30.5	0.048	49.1	0.20	0.52		70.0	0.28	0.70		AC-62	0.00	0.00	1.00	0	0	31	0	0	2.08	2.08
		AC 63	42.8	0.067	57.3	0.23	0.81	9.35	75.0	0.30	1.07	98.48	AC-63	0.00	0.00	1.00	0	0	43	0	0	3.13	3.13
		AC 64	60.2	0.094	65.7	0.26	1.29		85.0	0.36	1.82		AC-64	0.00	0.00	1.00	0	0	60	0	0	5.05	5.05
		AC 65	35.5	0.056	74.4	0.30	0.88		85.0	0.36	1.07		AC-65	0.00	0.00	1.00	0	0	36	0	0	2.98	2.98
		AC 66	18.0	0.028	70.0	0.28	0.41		80.0	0.33	0.49		AC-66	0.00	0.00	1.00	0	0	18	0	0	1.41	1.41
		AC 67	11.4	0.018	78.0	0.32	0.30		82.0	0.34	0.32		AC-67	0.00	0.00	1.00	0	0	11	0	0	0.92	0.92
		AC 68	22.1	0.035	40.9	0.18	0.34		60.0	0.24	0.44		AC-68	0.00	0.00	1.00	0	0	22	0	0	1.28	1.28
		AC 78	45.1	0.071	67.3	0.26	0.99		80.0	0.33	1.23		AC-78	0.00	0.00	1.00	0	0	45	0	0	3.55	3.55
		AC 79	28.4	0.044	80.2	0.33	0.78		90.0	0.40	0.95		AC-79	0.00	0.00	1.00	0	0	28	0	0	2.54	2.54
Totals			**489.7**	**0.765**	**57.8**	**0.23**	**9.35**		**76.5**	**0.31**	**12.56**			**0.00**	**0.00**	**1.00**	0	0	490	**0**	0	**36.67**	**36.67**
Fulton Street Pond	369	AC 39	20.0	0.031	68.4	0.27	0.45	1.22	80.0	0.33	0.55	1.38	AC-39	0.00	0.00	1.00	0	0	20	0	0	1.57	1.57
		AC 53	35.3	0.055	67.0	0.26	0.77		72.0	0.28	0.84		AC-53	0.00	0.00	1.00	0	0	35	0	0	2.47	2.47
Totals			**55.2**	**0.086**	**67.5**	**0.26**	**1.22**		**74.9**	**0.30**	**1.38**			**0.00**	**0.00**	**1.00**	0	0	55	**0**	0	**4.04**	**4.04**
Rampart South Upper Pond	367	AC 54	116.4	0.182	71.3	0.28	2.73	3.94	81.3	0.34	3.26	4.64	AC-54	0.00	0.00	1.00	0	0	116	0	0	9.30	9.30
Totals			**116.4**	**0.182**	**71.3**	**0.28**	**2.73**		**81.3**	**0.34**	**3.26**			**0.00**	**0.00**	**1.00**	0	0	116	**0**	0	**9.30**	**9.30**
Rampart South Lower Pond	365	AC 55	21.0	0.033	58.0	0.23	0.40	4.35	77.3	0.31	0.55	5.18	AC-55	0.00	0.00	1.00	0	0	21	0	0	1.59	1.59
Totals			**21.0**	**0.033**	**58.0**	**0.23**	**0.40**		**77.3**	**0.31**	**0.55**			**0.00**	**0.00**	**1.00**	0	0	21	**0**	0	**1.59**	**1.59**
Caley West Pond	414	AC 80	25.4	0.040	53.4	0.22	0.46		53.4	0.22	0.46		AC-80	0.00	0.00	1.00	0	0	25	0	0	1.29	1.29
		AC 81	43.2	0.068	51.5	0.21	0.76		51.5	0.21	0.76		AC-81	0.00	0.00	1.00	0	0	43	0	0	2.11	2.11
		AC 82	40.8	0.064	53.4	0.22	0.73	12.54	60.0	0.24	0.80	102.14	AC-82	0.00	0.00	1.00	0	0	41	0	0	2.35	2.35
		AC 83	30.5	0.048	38.0	0.17	0.44		82.0	0.34	0.87		AC-83	0.00	0.00	1.00	0	0	30	0	0	2.46	2.46
		AC 76	17.5	0.027	67.8	0.27	0.39		80.0	0.33	0.48		AC-76	0.00	0.00	1.00	0	0	17	0	0	1.37	1.37
		AC 91	24.3	0.038	53.2	0.22	0.44		53.2	0.22	0.44		AC-91	0.00	0.00	1.00	0	0	24	0	0	1.23	1.23
Totals			**181.6**	**0.284**	**51.7**	**0.21**	**3.19**		**61.8**	**0.24**	**3.67**			**0.00**	**0.00**	**1.00**	0	0	182	**0**	0	**10.79**	**10.79**
Peoria Street Pond	312	AC 92	36.2	0.057	11.0	0.07	0.22		76.0	0.30	0.92		AC-92	0.00	0.01	0.99	0	0	36	0	0	2.67	2.69
		AC 93	101.8	0.159	48.9	0.20	1.72		48.9	0.20	1.72		AC-93	0.00	0.02	0.98	0	2	99	0	0	4.59	4.71
		AC 94	43.0	0.067	40.3	0.18	0.65		45.0	0.19	0.69		AC-94	0.00	0.13	0.87	0	5	38	0	0	1.59	1.85
		AC 88	32.6	0.051	47.5	0.20	0.54		66.0	0.26	0.70		AC-88	0.00	0.41	0.59	0	13	19	0	1	1.22	2.19
		AC 89	53.7	0.084	36.8	0.17	0.77		58.0	0.23	1.03		AC-89	0.00	0.15	0.85	0	8	46	0	0	2.55	3.04
	Direct from Peoria Street Trib	AC 71	54.0	0.084	24.1	0.13	0.59	23.61	39.0	0.18	0.80	116.61	AC-71	0.00	0.00	1.00	0	0	54	0	0	1.95	1.95
		AC 72	11.4	0.018	75.8	0.30	0.29		83.0	0.35	0.33		AC-72	0.00	0.00	1.00	0	0	11	0	0	0.93	0.93
		AC 73	31.3	0.049	21.0	0.12	0.31		40.0	0.18	0.47		AC-73	0.00	0.00	1.00	0	0	31	0	0	1.16	1.16
		AC 74	18.9	0.030	78.6	0.32	0.50		80.0	0.33	0.52		AC-74	0.00	0.00	1.00	0	0	19	0	0	1.49	1.49
		AC 85	25.7	0.040	38.7	0.18	0.38		73.0	0.29	0.62		AC-85	0.00	0.00	1.00	0	0	26	0	0	1.83	1.83
		AC 86	30.8	0.048	38.1	0.17	0.45		80.0	0.33	0.84		AC-86	0.00	0.03	0.97	0	1	30	0	0	2.36	2.43
		AC 87	18.6	0.029	13.7	0.09	0.13		65.0	0.25	0.39		AC-87	0.00	0.14	0.86	0	3	16	0	0	1.01	1.19
Totals			**458.0**	**0.716**	**37.9**	**0.17**	**6.65**		**57.4**	**0.23**	**8.69**			**0.00**	**0.07**	**0.93**	0	33	425	**0**	2	**23.36**	**25.39**
Caley East Pond	390	AC 75	24.2	0.038	65.0	0.25	0.51	1.25	80.0	0.33	0.66	1.48	AC-75	0.00	0.00	1.00	0	0	24	0	0	1.90	1.901
		AC 84	29.8	0.047	74.8	0.30	0.74		80.0	0.33	0.82		AC-84	0.00	0.00	1.00	0	0	30	0	0	2.34	2.345
Totals			**54.0**	**0.084**	**70.4**	**0.28**	**1.25**		**80.0**	**0.33**	**1.48**			**0.00**	**0.00**	**1.00**	0	0	54	**0**	0	**4.24**	**4.246**
Airport East/West Dam (C3/C4)	343	AC 44	99.5	0.155	65.0	0.25	2.11		65.0	0.25	2.11		AC-44	0.00	0.00	1.00	0	0	99	0	0	6.25	6.246
		AC 45	62.7	0.098	27.5	0.14	0.75	3.17	30.0	0.15	0.79	4.29	AC-45	0.00	0.00	1.00	0	0	63	0	0	1.71	1.707
		AC 46	58.8	0.092	56.4	0.22	1.10		80.0	0.33	1.61		AC-46	0.00	0.00	1.00	0	0	59	0	0	4.62	4.622
Totals			**220.9**	**0.345**	**37.1**	**0.17**	**3.17**		**59.1**	**0.23**	**4.29**			**0.00**	**0.00**	**1.00**	0	0	221	**0**	0	**12.51**	**12.511**
No pond	-	AC 95	43.5	0.068	15.7	0.10	0.35	0.77	33.2	0.16	0.58	1.00	AC-95	0.00	0.02	0.98	0	1	42	0	0	1.29	1.327
		AC 96	130.0	0.203	5.4	0.04	0.42		5.4	0.04	0.42		AC-96	0.00	0.28	0.72	0	36	94	0	0	0.40	0.576
Totals			**173.5**	**0.271**	**8.0**	**0.06**	**0.80**		**12.4**	**0.08**	**1.16**			**0.00**	**0.21**	**0.79**	0	37	136	**0**	0	**1.43**	**1.868**

Table G17 Dove Creek Subbasin Volumes

			Existing Conditions					Future Conditions					HSG, fraction				HSG, acres			EURV, Future Conditions			
Pond	**SWMM Elements**	**Basin**	**Area (ac)**	**IA (%)**	**WQCV (w.s. inch)**	**WQCV (ac-ft)**	**Σ WQCV**	**Area (ac)**	**IA (%)**	**WQCV (w.s. inch)**	**WQCV (ac-ft)**	**Σ WQCV (ac-ft)**	**Basin**	**A**	**B**	**C/D**	**A**	**B**	**C/D**	**A**	**B**	**C/D**	**Total**
Highfield - Pond D0	304	D-1	57.0	26.3	0.1	0.7	0.7	57.0	90.0	0.4	1.9	1.9	D-1	0.00	0.00	1.00	0	0	57	0	0	5.06	5.09
Totals			**57.0**	**26.3**	**0.1**	**0.7**		**57.0**	**90.0**	**0.4**	**1.9**			**0.00**	**0.00**	**1.00**	**0**	**0**	**57**	**0**	**0**	**5.06**	**5.09**
Pond D1	301	D-2	23.7	18.5	0.1	0.2	2.9	23.7	80.0	0.3	0.6	8.2	D-2	0.00	0.00	1.00	0	0	24	0	0	1.86	1.86
		D-3	36.8	8.2	0.1	0.2		36.8	80.0	0.3	1.0		D-3	0.00	0.00	1.00	0	0	37	0	0	2.89	2.89
		D-4	120.9	18.2	0.1	1.1		120.9	80.0	0.3	3.3		D-4	0.00	0.00	1.00	0	0	121	0	0	9.50	9.50
		D-112	49.3	33.7	0.2	0.7		48.3	80.0	0.3	1.3		D-112	0.00	0.04	0.96	0	2	48	0	0	3.74	3.89
Totals			**230.7**	**20.0**	**0.1**	**2.2**		**229.7**	**80.0**	**0.3**	**6.3**			**0.00**	**0.01**	**0.99**	**0**	**2**	**229**	**0**	**0**	**17.99**	**18.15**
Pond D2	303	D-5	17.0	17.4	0.1	0.1	5.2	17.0	80.0	0.3	0.5	13.8	D-5	0.00	0.00	1.00	0	0	17	0	0	1.34	1.34
		D-7	50.1	12.4	0.1	0.3		50.1	80.0	0.3	1.4		D-7	0.00	0.00	1.00	0	0	50	0	0	3.94	3.94
		D-8	15.4	19.0	0.1	0.1		15.4	80.0	0.3	0.4		D-8	0.00	0.09	0.91	0	1	14	0	0	1.10	1.22
		D-9	25.8	15.3	0.1	0.2		25.8	80.0	0.3	0.7		D-9	0.00	0.02	0.98	0	1	25	0	0	1.98	2.04
		D-10	34.1	9.0	0.1	0.2		34.1	80.0	0.3	0.9		D-10	0.00	0.00	1.00	0	0	34	0	0	2.68	2.68
		D-11	63.6	49.8	0.2	1.1		63.6	80.0	0.3	1.7		D-11	0.00	0.04	0.96	0	2	61	0	0	4.82	5.02
Totals			**206.0**	**24.6**	**0.1**	**2.3**		**206.0**	**80.0**	**0.3**	**5.6**			**0.00**	**0.02**	**0.98**	**0**	**4**	**202**	**0**	**0**	**15.86**	**16.23**
Pond D3	305	D-12	56.1	61.9	0.2	1.1	7.2	56.1	79.0	0.3	1.5	16.9	D-12	0.07	0.56	0.37	4	31	21	0	3	1.61	4.78
		D-13	41.4	43.0	0.2	0.6		41.4	78.2	0.3	1.1		D-13	0.00	0.41	0.59	0	17	25	0	1	1.89	3.35
		D-14	19.9	28.5	0.1	0.2		19.9	69.3	0.3	0.5		D-14	0.00	1.00	0.00	0	20	0	0	2	0.00	1.52
Totals			**117.5**	**49.6**	**0.2**	**2.0**		**117.5**	**77.1**	**0.3**	**3.0**			**0.03**	**0.58**	**0.39**	**4**	**68**	**45**	**0**	**6**	**3.42**	**9.65**

Table G18 Windmill Creek Subbasin Volumes

			Existing Conditions					Future Conditions					HSG, fraction				HSG, acres			EURV, Future Conditions			
Pond	**SWMM Element**	**Basin**	**Area (ac)**	**IA (%)**	**WQCV (w.s. inch)**	**WQCV (ac-ft)**	**Σ WQCV (ac-ft)**	**Area (ac)**	**IA (%)**	**WQCV (w.s. inch)**	**WQCV (ac-ft)**	**Σ WQCV (ac-ft)**	**Basin**	**A**	**B**	**C/D**	**A**	**B**	**C/D**	**A**	**B**	**C/D**	**Total**
Meridian Pond (DougCo)	302	W-1	54	27.8	0.1	0.6		54	70.0	0.3	1.2		W-1	0.00	0.00	1.00	0	0	54	0	0	3.66	3.66
		W-2	105	14.9	0.1	0.8		105	70.0	0.3	2.4		W-2	0.00	0.00	1.00	0	0	105	0	0	7.17	7.17
		W-62	17	34.5	0.2	0.2		17	34.5	0.2	0.2		W-62	0.00	0.00	1.00	0	0	17	0	0	0.55	0.55
		W-65	9	21.3	0.1	0.1	2.0	9	21.3	0.1	0.1	4.0	W-65	0.00	0.00	1.00	0	0	9	0	0	0.17	0.17
		W-66	3	90.0	0.4	0.1		3	90.0	0.4	0.1		W-66	0.00	0.00	1.00	0	0	3	0	0	0.24	0.24
		W-69	2	90.0	0.4	0.1		2	90.0	0.4	0.1		W-69	0.00	0.00	1.00	0	0	2	0	0	0.16	0.16
	TP	W-64	5	2.0	0.0	0.0		5	2.0	0.0	0.0		W-64	0.00	0.00	1.00	0	0	5	0	0	0.01	0.01
Totals			**195**	**21.8**	**0.1**	**2.0**		**195**	**63.2**	**0.2**	**4.0**			**0.00**	**0.00**	**1.00**	**0**	**0**	**195**	**0**	**0**	**11.90**	**11.90**
Pond W1/W2	110	W-3	82	12.9	0.1	0.6		82	80.0	0.3	2.2		W-3	0.00	0.00	1.00	0	0	82	0	0	6.45	6.45
		W-4	80	5.3	0.0	0.3		80	90.0	0.4	2.7		W-4	0.00	0.00	1.00	0	0	80	0	0	7.17	7.17
		W-5	35	50.3	0.2	0.6		35	90.0	0.4	1.2		W-5	0.00	0.68	0.32	0	24	11	0	2	1.00	3.38
		W-6	19	42.0	0.2	0.3		19	90.0	0.4	0.6		W-6	0.00	0.02	0.98	0	0	18	0	0	1.64	1.67
		W-7	54	67.1	0.3	1.2		54	90.0	0.4	1.8		W-7	0.00	0.09	0.91	0	5	49	0	0	4.38	4.87
		W-8	50	18.5	0.1	0.5		50	73.0	0.3	1.2		W-8	0.00	0.00	1.00	0	0	50	0	0	3.55	3.55
		W-55	46	57.2	0.2	0.9	8.4	46	90.0	0.4	1.5	17.3	W-55	0.00	0.06	0.94	0	3	43	0	0	3.86	4.14
		W-57	42	30.9	0.2	0.5		42	90.0	0.4	1.4		W-57	0.00	0.00	1.00	0	0	42	0	0	3.72	3.72
		W-58	28	18.4	0.1	0.2		28	18.4	0.1	0.3		W-58	0.00	0.32	0.68	0	9	19	0	0	0.30	0.46
		W-61	16	67.3	0.3	0.4		16	90.0	0.4	0.5		W-61	0.00	0.48	0.52	0	8	8	0	1	0.75	1.54
		W-63	11	40.8	0.2	0.2		11	90.0	0.4	0.4		W-63	0.00	0.00	1.00	0	0	11	0	0	1.02	1.02
		W-67	16	43.3	0.2	0.3		16	43.3	0.2	0.3		W-67	0.00	0.00	1.00	0	0	16	0	0	0.66	0.66
		W-68	11	20.8	0.1	0.1		11	20.8	0.1	0.1		W-68	0.00	0.00	1.00	0	0	11	0	0	0.19	0.19
Totals			**490**	**31.6**	**0.2**	**6.4**		**490**	**79.5**	**0.3**	**13.3**			**0.00**	**0.10**	**0.90**	**0**	**48**	**441**	**0**	**4**	**34.45**	**38.71**
Pond W5	309	W-14	37	20.7	0.1	0.4	0.9	37	80.0	0.3	1.0	1.7	W-14	0.00	0.01	0.99	0	0	36	0	0	2.85	2.87
		W-15	83	10.5	0.1	0.5		83	15.5	0.1	0.7		W-15	0.00	0.10	0.90	0	9	74	0	0	0.99	1.12
Totals			**119**	**13.6**	**0.1**	**0.9**		**119**	**35.3**	**0.2**	**1.7**			**0.00**	**0.07**	**0.93**	**0**	**9**	**110**	**0**	**0**	**3.58**	**3.90**
Pond W6/W7	Pond W4 (307)	W-9	39	32.5	0.2	0.5		39	40.0	0.2	0.6		W-9	0.00	0.01	0.99	0	0	39	0	0	1.44	1.46
		W-10	58	18.3	0.1	0.5		58	44.3	0.2	0.9		W-10	0.00	0.72	0.28	0	42	16	0	2	0.67	2.66
		W-11	57	65.8	0.3	1.2		57	90.0	0.4	1.9		W-11	0.00	0.00	1.00	0	0	57	0	0	5.05	5.05
		W-12	48	19.2	0.1	0.4		48	80.0	0.3	1.3		W-12	0.00	0.73	0.27	0	35	13	0	3	1.00	4.11
		W-13	74	45.8	0.2	1.2		74	80.0	0.3	2.0		W-13	0.00	0.09	0.91	0	6	67	0	1	5.30	5.86
			275	**37.6**	**0.2**	**4.0**		**275**	**68.8**	**0.3**	**6.2**			**0.00**	**0.30**	**0.70**	**0**	**84**	**192**	**0**	**6**	**12.80**	**19.14**
		W-16	64	23.9	0.1	0.7		64	80.0	0.3	1.7		W-16	0.00	0.13	0.87	0	8	56	0	1	4.38	5.10
	313	W-39	30	54.8	0.2	0.6	19.1	30	80.0	0.3	0.8	36.0	W-39	0.00	0.02	0.98	0	0	30	0	0	2.34	2.38
		W-17	36	69.5	0.3	0.8		36	80.0	0.3	1.0		W-17	0.00	0.00	1.00	0	0	36	0	0	2.83	2.83
		W-18	46	23.6	0.1	0.5		46	80.0	0.3	1.3		W-18	0.00	0.03	0.97	0	1	45	0	0	3.50	3.61
		W-19	52	60.4	0.2	1.0		52	80.0	0.3	1.4		W-19	0.00	0.10	0.90	0	5	46	0	0	3.64	4.11
		W-20	62	25.3	0.1	0.7		62	80.0	0.3	1.7		W-20	0.00	0.00	1.00	0	0	62	0	0	4.91	4.91
		W-21	16	44.2	0.2	0.3		16	80.0	0.3	0.4		W-21	0.00	0.25	0.75	0	4	12	0	0	0.97	1.33
		W-23	50	33.7	0.2	0.7		50	80.0	0.3	1.4		W-23	0.00	0.04	0.96	0	2	48	0	0	3.79	3.98
		W-24	38	40.3	0.2	0.6		38	80.0	0.3	1.1		W-24	0.00	0.08	0.92	0	3	35	0	0	2.78	3.05
Totals			**395**	**39.1**	**0.2**	**5.8**		**395**	**80.0**	**0.3**	**10.8**			**0.00**	**0.06**	**0.94**	**0**	**24**	**371**	**0**	**2**	**29.13**	**31.30**
Pond W8	395	W-26	60	40.6	0.2	0.9		60	80.0	0.3	1.6		W-26	0.00	0.07	0.93	0	4	55	0	0	4.36	4.74
		W-31	46	31.1	0.2	0.6		46	40.6	0.2	0.7		W-31	0.00	0.00	1.00	0	0	46	0	0	1.73	1.73
		W-32	14	42.6	0.2	0.2		14	49.7	0.2	0.2		W-32	0.00	0.00	1.00	0	0	14	0	0	0.64	0.64
		W-33	19	30.2	0.2	0.2	23.7	19	40.0	0.2	0.3	42.0	W-33	0.00	0.00	1.00	0	0	19	0	0	0.69	0.69
		W-34	65	24.4	0.1	0.7		65	35.1	0.2	0.9		W-34	0.00	0.13	0.87	0	8	56	0	0	1.82	2.12
		W-35	34	23.3	0.1	0.4		34	40.3	0.2	0.5		W-35	0.00	0.36	0.64	0	12	22	0	1	0.82	1.34
		W-36	29	40.8	0.2	0.4		29	41.7	0.2	0.5		W-36	0.00	0.00	1.00	0	0	29	0	0	1.15	1.15
	325	W-25	63	52.8	0.2	1.1		63	80.0	0.3	1.7		W-25	0.00	0.02	0.98	0	1	61	0	0	4.82	4.95
Totals			**329**	**36.1**	**0.2**	**4.6**		**329**	**54.6**	**0.2**	**6.0**			**0.00**	**0.08**	**0.92**	**0**	**26**	**303**	**0**	**2**	**15.75**	**17.29**
Pond W9	317	W-22	32	47.1	0.2	0.5		32	80.0	0.3	0.9		W-22	0.00	0.07	0.93	0	2	30	0	0	2.36	2.55
		W-27	31	62.1	0.2	0.6		31	80.0	0.3	0.9		W-27	0.00	0.03	0.97	0	1	31	0	0	2.41	2.48
		W-28	27	36.6	0.2	0.4	2.9	27	80.0	0.3	0.7	4.5	W-28	0.00	0.01	0.99	0	0	27	0	0	2.11	2.15
		W-29	37	46.7	0.2	0.6		37	61.4	0.2	0.8		W-29	0.00	0.00	1.00	0	0	37	0	0	2.21	2.21
		W-30	55	33.2	0.2	0.7		55	72.2	0.3	1.3		W-30	0.00	0.00	1.00	0	0	55	0	0	3.84	3.85
Totals			**183**	**43.9**	0.2	**2.9**		**183**	**73.9**	**0.3**	**4.5**			**0.00**	**0.02**	**0.98**	**0**	**4**	**180**	**0**	**0**	**12.95**	**13.23**

Table G19 Lone Tree Creek Subbasin Volumes

			Existing Conditions					Future Conditions					HSG, fraction				HSG, acres			EURV, Future Conditions			
Pond	**SWMM Elements**	**Basin**	**Area (ac)**	**IA (%)**	**WQCV (w.s. inch)**	**WQCV (ac-ft)**	**Σ WQCV**	**Area (ac)**	**IA (%)**	**WQCV (w.s. inch)**	**WQCV (ac-ft)**	**Σ WQCV (ac-ft)**	**Basin**	**A**	**B**	**C/D**	**A**	**B**	**C/D**	**A**	**B**	**C/D**	**Total**
Pond L1 (East)	Pond L1 West (999)	L-29	10	50.1	0.21	0.2		10	65.2	0.25	0.2		L-29	0	0.00	1.00	0	0	10	0	0	0.65	0.65
		L-30	85	52.1	0.21	1.5		85	52.1	0.21	1.5		L-30	0.00	0.00	1.00	0	0	85	0	0	4.21	4.21
			95.4	**51.9**	**0.21**	**1.7**	2.5	**95.4**	**53.5**	**0.22**	**1.7**	3.1		**0.00**	**0.00**	**1.00**	**0**	**0**	**95**	**0**	**0**	**4.85**	**4.86**
	351	L-31	59	34.0	0.16	0.8		59	69.6	0.27	1.3		L-31	0.00	0.00	1.00	0	0	59	0	0	4.01	4.01
			59	**34.0**	**0.16**	**0.8**		**59**	**69.6**	**0.27**	**1.3**			**0.00**	**0.00**	**1.00**	**0**	**0**	**59**	**0**	**0**	**4.01**	**4.01**
Pond L3	Pond L2 (301)	L-2	44	91.2	0.41	1.5		44	91.7	0.42	1.5		L-2	0.00	0.00	1.00	0	0	44	0	0	4.03	4.03
		L-3	79	68.4	0.27	1.8		79	80.0	0.33	2.1		L-3	0.00	0.00	1.00	0	0	79	0	0	6.17	6.17
		L-4	52	48.2	0.20	0.9	7.6	52	80.0	0.33	1.4	10.3	L-4	0.00	0.00	1.00	0	0	52	0	0	4.06	4.06
		L-5	82	45.6	0.19	1.3		82	78.1	0.32	2.2		L-5	0.00	0.03	0.97	0	3	79	0	0	6.04	6.27
			256	**60.98**	**0.24**	**5.1**		**256**	**81.4**	**0.34**	**7.2**			**0.00**	**0.01**	**0.99**	**0**	**3**	**253**	**0**	**0**	**20.28**	**20.53**
	303	L-6	29	49.1	0.20	0.5		29	76.4	0.31	0.7		L-6	0.00	0.41	0.59	0	12	17	0	1	1.27	2.27
		L-7	46	38.8	0.18	0.7		46	80.0	0.33	1.3		L-7	0.00	0.00	1.00	0	0	46	0	0	3.63	3.63
		L-8	16	49.8	0.21	0.3		16	77.0	0.31	0.4		L-8	0.00	0.02	0.98	0	0	16	0	0	1.21	1.24
		L-9	49	31.7	0.16	0.6		49	78.7	0.32	1.3		L-9	0.00	0.39	0.61	0	19	30	0	2	2.30	4.00
		L-10	25	19.5	0.11	0.2		25	80.0	0.33	0.7		L-10	0.00	0.00	1.00	0	0	25	0	0	1.95	1.95
		L-11	26	43.5	0.19	0.4		26	68.3	0.27	0.6		L-11	0.00	0.02	0.98	0	1	26	0	0	1.71	1.75
		L-12	28	48.0	0.20	0.5		28	77.8	0.32	0.7		L-12	0.00	0.99	0.01	0	28	0	0	2	0.03	2.46
		L-13	31	60.6	0.24	0.6		31	80.0	0.33	0.8		L-13	0.00	0.00	1.00	0	0	31	0	0	2.42	2.42
		L-14	20	44.7	0.19	0.3		20	79.1	0.32	0.5		L-14	0.00	0.07	0.93	0	1	18	0	0	1.43	1.54
		L-15	25	71.0	0.28	0.6		25	78.1	0.32	0.7		L-15	0.00	0.07	0.93	0	2	23	0	0	1.78	1.92
		L-16	29	71.8	0.28	0.7	16.4	29	74.1	0.29	0.7	23.6	L-16	0.05	0.95	0.00	1	27	0	0	2	0.00	2.36
		L-17	21	53.7	0.22	0.4		21	75.1	0.30	0.5		L-17	0.00	0.93	0.07	0	20	1	0	2	0.11	1.74
		L-18	29	77.2	0.31	0.7		29	79.1	0.32	0.8		L-18	0.00	0.04	0.96	0	1	28	0	0	2.14	2.25
		L-19	29	62.5	0.24	0.6		29	78.2	0.32	0.8		L-19	0.00	0.00	1.00	0	0	29	0	0	2.23	2.23
		L-20	18	38.1	0.17	0.3		18	66.6	0.26	0.4		L-20	0.00	0.70	0.30	0	13	5	0	1	0.35	1.30
		L-21	24	49.6	0.21	0.4		24	71.7	0.28	0.6		L-21	0.00	0.72	0.28	0	18	7	0	1	0.47	1.87
		L-22	16	45.5	0.19	0.3		16	80.0	0.33	0.4		L-22	0.00	0.00	1.00	0	0	16	0	0	1.24	1.24
		L-23	27	33.7	0.16	0.4		27	80.0	0.33	0.7		L-23	0.00	0.67	0.33	0	18	9	0	2	0.71	2.35
		L-27	14	59.9	0.24	0.3		14	80.0	0.33	0.4		L-27	0.00	0.00	1.00	0	0	14	0	0	1.11	1.11
		L-28	11	61.0	0.24	0.2		11	80.0	0.33	0.3		L-28	0.00	0.00	1.00	0	0	11	0	0	0.87	0.87
Totals			**515**	**49.4**	**0.20**	**8.8**		**515**	**77.2**	**0.31**	**13.4**			**0.00**	**0.31**	**0.69**	**1**	**160**	**353**	**0**	**14**	**26.68**	**40.55**

Table G20 Roadway Crossing Inventory

Location	Culvert Size*	Fact Sheet Map	Capacity Issues	Comments
Lone Tree Creek				
East Caley Avenue (Pond L3)	2-10'x8' RCBC	LR2		
East Peakview Avenue	14.3'Hx8.2V' RCBC	LR2	**X**	Note SEMSWA GIS data says 8.5' height, dimension not field verified. Enginuity says 14'x8'.
East Arapahoe Road	14'Hx10'V RCBC	LR2		SEMSWA GIS says 15'x10', Enginuity says 14'x10'. Dimensions are not field verified
East Briarwood Avenue	13'Hx8'V RCBC	LR2		SEMSWA GIS says 13'x8', Enginuity says 14'x10'. Dimensions are not field verified
South Revere Parkway (Tributary)	24" RCP	LR2	**X**	Problem Area #1 on Fact Sheet LR2 for a western piped tributary storm system to Lone Tree Creek. MDP proposes prohect to increase capacity.
South Revere Parkway AND Tucson Way (Pond L2)	10'Hx8'V RCBC	LR2		
East Broncos Parkway	7'Hx4'V RCBC	LR1		
East Jamison Place	14'Hx6'V RCBC	LR1		
Windmill Creek				
Caley Ave (Pond W9)	36"x68" and 36"x80" HERCP	WR5	**X**	Capacity issues may be due to downstream private system through parking area, a detailed study should be performed to determine cause. SEMSWA GIS does not indicate which dimension is horizontal or vertical and provided only the dimensions in the order that is shown. measurements and orientation should be field verified prior to detailed study.
Jordan Road (Pond W8)	2-144H"x60"V RCBC	WR4		
East Caley Avenue	3-96"Hx48"V	WR4		
Jordan Road	3-10'x6' HRBC	WR4		
East Arapahoe Road	2-9'Hx6'V and 12'Hx6'V' RCBC	WR4		SEMSWA GIS says 4' height. Dimensions are not field verified.
Medical Center Access	72"Hx24"V RCBC	WR4	**X**	
East Briarwood Avenue (Pond W6/W7)	120"Hx96"V RCBC	WR3		
East Fremont Avenue	144"Hx72"V" RCBC	WR3		
South Blackhawk Street	2-12'Hx6'V RCBC	WR3		SEMSWA GIS says 5' height. Dimensions are not field verified.
East Broncos Parkway (Pond W4)	3-7'Hx4'V RCBC	WR2		SEMSWA GIS says 5' height. Dimensions are not field verified.
East County Line Road	2-10'Hx8.1'V RCBC	WR2		SEMSWA GIS says 8' height. Dimensions are not field verified
James E. Casey Avenue	2-10'Hx6'V RCBC	WR1		
South Peoria Street	2-10'Hx5.5'V RCBC	WR1		SEMSWA GIS says 6' height. Dimensions are not field verified
Dove Creek				
East Fremont Drive	3-9'Hx4'V RCBC	DR2		
South Fraser Street	3-12'Hx4.5'V RCBC	DR2		
South Jordan Road	2-7'Hx6'V RCBC	DR2		
East Broncos Parkway (Pond D1)	2-8'Hx6'V RCBC	DR2		
South Chambers Road	10'Hx8'V RCBC	DR1		
Otero Ave	60" RCP	DR1		SEMSWA GIS indicates this crossing includes a 60" to a 72", actual size should be field verified.

Location	Culvert Size*	Fact Sheet Map	Capacity Issues	Comments
Cottonwood Creek				
Peoria Street (Peoria Street Pond)	3-16'Hx10'V RCBC	CR9		
E Caley Ave (Caley West Pond)	2-13H'x10.2'V and 15'Hx10.2'V RCBC	CR9		
E Peakview Ave (LEC Pond)	bridge	CR7		
E Arapahoe Road	2-9'Hx10'V and 12'Hx10'V HRBC	CR7		
E Arapahoe Place	40'Hx15'V arch	CR7		
E Briarwood Ave	2-13'Hx7.82'V and 12'x10' RCBC	CR7		
E Easter Ave	2-10'Hx8'V and 8'Hx8'V RCBC	CR5		
Inverness Drive East (North Crossing)	bridge	CR5		
Inverness Drive East (South Crossing)	bridge	CR4		
County Line Road	bridge	CR4		
Inverness Drive South at John Derry Park (North)	bridge	CR2		
Inverness Drive South (South)	30'Hx8' RCBC	CR2		
Peoria Tributary				
Peoria Street	2-7.5'Hx4.8'V HERCP	CR10	**X**	500 year overtopping only. SEMSWA GIS indicates this is 72" high and size should be field verified.
E Caley Ave	10'Hx4'V RCBC	CR10		
E Arapahoe Road	90" RCP	CR10		
Havana Tributary				
S Kenton Street	6' RCP	CR8B	**X**	Area of shallow flooding through parking lot. SEMSWA GIS indicates this crossing includes a 78". Actual size should be field verified.
E Arapahoe Road	2-8'Hx5.9'V RCBC	CR8B	**X**	500-year overtopping only
E Briarwood Ave	2-10'Hx6'V RCBC	CR8B		
S Havana Street	6' RCP	CR8A		SEMSWA GIS indicates this crossing includes a 66". Actual size should be field verified.
Inverness Tributary				
S Joilet Street	3-72" RCP	CR6B		SEMSWA GIS indicates this crossing includes a 64". Actual size should be field verified.
S Iola Street	14'Hx6'V HRBC	CR6B		SEMSWA GIS indicates this crossing includes a 60" to a 72", actual size should be field verified.
Inverness Drive East	2-42" and one 36" RCP	CR6A	**X**	SEMSWA GIS indicates this crossing includes a 36" and 2-42" with a riser structure. LOMR HEC-RAS uses inline weir. Actual sizes and configuration should be field verified.

**Note: SEMSWA GIS data were used unless construction or record drawings were provided. There were many instances where GIS data was inaccurate when compared to design data. All values should be field verified. Dimensions are given with the span or horizontal being indicated as "H" and the rise or vertical being indicated as "V".*

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Dove at Broncos Parkway

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5719.26	850.00	850.00	0.00	1
5718.88	855.00	855.00	0.00	1
5718.93	860.00	860.00	0.00	1
5718.98	865.00	865.00	0.00	1
5719.02	870.00	870.00	0.00	1
5719.07	875.00	875.00	0.00	1
5719.11	880.00	880.00	0.00	1
5719.16	885.00	885.00	0.00	1
5719.20	890.00	890.00	0.00	1
5719.92	895.00	895.00	0.00	1
5719.99	900.00	900.00	0.00	1
5729.00	1437.01	1437.01	0.00	Overtopping

for hw/D = 1.5 (MHFD V2 chapter 11) hw max = 5719.8' so pipe capacity is ~890 cfs

Appendix H – Cherry Creek State Park

Appendix H. Cherry Creek Southwest Tributaries Major Drainageway Plan in Cherry Creek State Park

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Executive Summary

Wright Water Engineers, Inc. (WWE) has prepared this report as an appendix to the accompanying Mile High Flood District Major Drainageway Plan (MHFD MDP) for Cottonwood, Windmill, and Lone Tree Creeks to address areas within the boundaries of Cherry Creek State Park (CCSP) that are under the jurisdiction of the Cherry Creek Basin Water Quality Authority (CCBWQA). This plan in this appendix is referred to as the CCSP MDP. The MHFD MDP was developed concurrently for the upstream SEMSWA service area of the Lone Tree, Windmill, Dove, and Cottonwood Creek watersheds.

Details regarding the watershed area, hydrology, and hydraulic analysis that are provided in the main body of the MHFD MDP are not repeated in this appendix. The hydrologic modeling conducted for the MHFD MDP has been extended down into CCSP for the CCSP MDP. This allows for an integrated model for these drainageways from the upper watershed areas in the SEMSWA service area through the downstream boundary in CCSP and the Cherry Creek Reservoir. This appendix is focused only on the recommended projects within CCSP.

CCBWQA is tasked by Colorado's Legislature with preserving, protecting and enhancing the water quality of Cherry Creek and Cherry Creek Reservoir, and achieving and maintaining water quality standards for the reservoir and watershed in accordance with Regulation 72, also known as the Cherry Creek Reservoir Control Regulation. Regulation 72 establishes water quality standards for the Cherry Creek Basin to protect water quality in the reservoir. The CCBWQA is charged with ensuring that stormwater runoff complies with state regulations and water quality standards. The CCBWQA operates as a board with membership from various local agencies and organizations and individuals appointed by the Governor.

The alternatives considered for the CCSP MDP were developed in response to areas of known or predicted flooding, water quality concerns, and channel instability. Focus areas were identified based on the combined experience of the CCBWQA Technical Advisory Committee (TAC), previously completed studies, and field visits. WWE developed 11 project alternatives as a result of this study.

Each alternative was reviewed for advantages and disadvantages based on the following categories:

1. Project Cost
2. Public Safety
3. Water Quality
4. Stream Health
5. Environmental Benefits
6. Community Values

These categories and their relative importance were reviewed and discussed with members of the TAC. The selected plan proposes four projects in total with one in Cottonwood Creek and three in Lone Tree Creek. This MDP provides hydrologic calculations and cost estimates for the selected drainage and associated water quality improvements.

Implementation priorities are contingent on funding availability and opportunities for collaboration with other entities. Typically, this process is also informed opportunistically where grants or nearby development can move a project up in priority. In the alternatives assessment, this MDP considers the feasibility of implementation, which is at the discretion of CCBWQA, CCSP, and other partner organizations.

This work was funded and coordinated by the CBWQA. The primary objective was to extend the hydrologic models downstream to the Cherry Creek Reservoir and to integrate those models at the confluences of Lone Tree, Windmill, and Cottonwood Creeks. Other objectives include alternatives assessments and project recommendations. WWE was contracted to complete this MDP by the CCBWQA, identified hereafter as the Project Sponsors.

The scope of this MDP included these technical tasks:

1. Provide a companion to the MHFD MDP to incorporate contributing drainage areas from the CCSP previously not included in any models. This includes generating hydrology for several sub-basins that have been identified as needing routing and a review of the northwestern Cottonwood Creek tributaries. This hydrology does not include any additional scenarios for longer duration or area-corrected precipitation events. Review the revised hydrology with Board representatives and other stakeholders to identify priority areas for evaluation of the existing site condition, including a review of flood history and field work. Conduct field work including an evaluation of existing stream corridors, contributing watersheds, storm conveyance, and water quality control measures.

2. Develop plan alternatives based on the findings of the site visit and hydrology assessment and develop a list of potential improvement projects within the three watersheds to be considered for inclusion in the CCSP MDP. The alternatives development process considers stream restoration, flow conveyance, channel instability, wetland preservation, culvert capacity, adaptive stream management strategies, planning for recreational trail crossings of waterways, and management of pollution reduction facilities (PRFs).
3. Evaluate and select proposed projects from the list of alternatives, incorporating feedback from designated representatives of the Board, stakeholders, and the public.

The planning for this portion of the MDP followed a similar process to the upstream areas including public outreach and coordination with stakeholders. An additional outreach meeting with the bird watching community occurred at the annual CCSP Hawk Walk on January 27, 2024, which included a visit to the Lone Tree Creek Pond. Participants for this walk were asked to discuss the environmental value of this water body. Notes of this discussion can be found in Appendix E. The eleven Hawk Walk attendees unanimously supported keeping the water body for its bird and wildlife benefits. They also expressed preferences for plan alternatives which had low construction environmental impacts.

Project sponsors and participants met formally and informally during the start of the planning process through the development of project alternatives. This included two formal presentations to the TAC, three memos to the TAC, and many other smaller coordination meetings between members of the TAC and WWE. These meetings allowed for the CCSP MDP to be well coordinated and responsive to the needs of the users of the plan and allowed for a detailed review of watershed history and development that was more robust than typical master planning efforts. A subcommittee of the TAC was developed to provide a more detailed review and discussion of the MDP. Table H1 includes a list of the subcommittee and plan participants.

Table H1. Plan Participants

Project Participant	Affiliation
William Ruzzo, PE	CCBWQA Executive Committee
Casey Davenhill	Cherry Creek Stewardship Partners
Ashley Byerley	SEMSWA
Richard Borchardt, PE, CFM	R2R Engineers
Rick Goncalves, PE	RG Engineers
Jim Watt, PE, CFM	MHFD
Jane Clary, LEED AP, CPESC	WWE, participating as Technical Manager of CCBWQA
Shawn Krier	Colorado Division of Natural Resources
Michelle Seubert	Colorado Parks and Wildlife CCSP (Park Manager)
Jason Trujillo	Colorado Parks and Wildlife CCSP (Prior Park Manager)
Jon Erickson, PE	Colorado Parks and Wildlife
Andrew Earles, Ph.D, PE, PH, D. WRE	WWE
Maggie Lewis, PE	WWE

For the duration of this MDP planning process, a website was maintained and made available to the public, which included scope and background for the proposed study. As the project progressed, information and opportunities for feedback were added to the website pertinent to key meetings and milestones.

This MDP was completed in close coordination with representatives of the CCBWQA and CCSP and other partner organizations. The authors of this MDP would like to acknowledge the valuable contributions of various project stakeholders and the public including, but not limited to, Cherry Creek Stewardship Partners, SEMSWA, MHFD, Colorado Department of Natural Resources (DNR), and Colorado Parks and Wildlife (CPW).

H.1. Study Area Description

This plan encompasses portions of the three study watersheds, which were detailed in the main body of the MHFD MDP, within CCSP. The following study area descriptions are the result of field observations, interviews with project participants, and review of engineering reports and mapping. Land use in these watersheds within the park is recreational, with walking, horse, and biking trails throughout. The study area is not mapped in the regulatory FEMA floodplain because it is undeveloped government-owned land. Additionally, much of the park land is within the flood pool for Cherry Creek Reservoir. The drainageways are relatively unconstrained spatially, which has provided the opportunity for the natural evolution and movement of the channel. These factors informed the alternative analysis, given that there is not a large risk in allowing features to change slowly over time through natural geomorphic processes.

The accompanying MHFD MDP report provides details regarding data collection and methods for the CUHP and SWMM model updates. All focus areas, channel reaches, and the Lone Tree Pond were field assessed for this study. WWE walked the entire channel lengths in areas that needed additional information for the MDP. These MDP field assessments were qualitative in nature to evaluate general stability and options for improvement, as needed. The study also included a review of mapping and topography, which is explained in the main body of the MHFD MDP. WWE used LiDAR data made available by DRCOG in 2020 to delineate sub-basins in the CCSP to be added to the upstream study.

The Cottonwood Creek watershed has a drainage area of 8.1 square miles when it enters the Park and 14.2 square miles when it reaches the reservoir, including the Lone Tree and Windmill Creek tributaries. Cottonwood Creek exhibits an average slope of 1.4% for the full watershed length and just 0.4% in CCSP. In various portions of the watershed, Cottonwood Creek watershed is under the jurisdiction of CPW (and the U.S. Army Corps of Engineers), Arapahoe County, Greenwood Village, City of Centennial, City of Lone Tree, and Douglas County. A large portion of the watershed upstream of the park is managed by SEMSWA.

Due to the historical use of this area in the early part of the twentieth century for agriculture, there are a number of areas where the stream alignments were previously diverted and split. All three creeks show evidence of previous alignments that are different from the current flow paths as shown in Figure H1 (attached at the end of this appendix). For Cottonwood Creek, there is a split flow location upstream of CCBWQA's 2011 stream reclamation project. The 2011 reclaimed western alignment moved the creek to the valley floor as best as could be defined as supported by Google Earth 1937 aerial photography. Cottonwood Creek also has an eastern alignment that flows through the Family Shooting Range, which was blocked via an earthen berm in 2011. This earthen berm allows for most of the baseflow and flood flows to stay in the reclaimed western alignment. However, the eastern alignment continues to convey a small amount of direct runoff and baseflow from seepage.

For both Lone Tree and Windmill Creek, it is unclear which alignment was formed prior to the historical agricultural diversions. In Lone Tree Creek, the base flow from the Arapahoe County Water and Wastewater Authority (ACWWA) treated effluent and more frequent storm events currently flow to the Lone Tree Creek Pond via its western alignment, while the larger storm events flow to both the western and the eastern alignments. The eastern alignment is shown in Figure H1 and flows towards a confluence with Windmill Creek and the Lone Tree Creek eastern culvert crossing of the Caretaker Road. For Windmill Creek, the eastern alignment is blocked by the Caretaker Road (i.e. Orchard Road Alignment) and flows west via a roadside ditch to a culvert crossing along its western alignment.

Windmill Creek is a well-defined channel upstream of the confluence with its tributary from Pond W-8, becoming poorly defined by the time it reaches the Caretaker Road in CCSP. No erosional areas were noted in this reach as part of this study. Windmill Creek and the eastern alignment of Lone Tree Creek currently cross the Caretaker Road via two culvert crossings, approximately 180 feet from one another with a confluence north of the road. The western Lone Tree Creek alignment crosses the Caretaker Road approximately 780 feet west of its eastern alignment culvert crossing. WWE staff identified an overflow path along the Caretaker Road for Windmill Creek shown in Figure H1. The following Figure H2 depicts standing water at the Windmill Creek culverts crossing of the Caretaker Road.



Figure H2. Windmill Creek at Caretaker Road

The portion of Lone Tree Creek just upstream of CCSP is in the City of Centennial and the SEMSWA service area. An ACWWA wastewater treatment outfall discharges to Lone Tree Creek within CCSP. The wastewater effluent provides a steady source of baseflow for Lone Tree Creek that is valuable for the corridor. The stream is incised downstream of the ACWWA outfall, and a stream reclamation project is currently at a 95% design level by ICON engineering (ICON, 2022). The stream reclamation improvements for Lone Tree Creek end well upstream of the split flow path for Lone Tree Creek shown in Figure H1. This split flow area takes the majority of baseflow and more frequent storm events to the Lone Tree Creek Pond via the western alignment. During the field assessment, WWE observed many areas of overflow through the wetland complex from the eastern alignment up to 200 feet downstream of the split flow path.



Figure H3. Wetland Complex at Lone Tree Creek Split Flow

All three Windmill Creek and Lone Tree Creek culvert crossings of the Caretaker Road have planned future improvements including additional culverts and a pedestrian bridge (ICON, 2022).

Downstream of the Caretaker Road, the primary flows in Lone Tree Creek have been diverted to a relic pond that is referred to as Lone Tree Creek Pond in this MDP. In the early 2000s, ACWWA completed work on this existing pond to improve the outlet structure and create a grouted boulder rundown chute for the spillway as shown in Figure H4. The outlet appeared to be significantly clogged during the site visit and is not designed in accordance with a typical water quality outlet. Because of the small size of the pond relative to the upstream watershed and the difficulty of maintaining the pond, the water quality benefits of this pond are incidental. The pond provides habitat supporting recreational benefits such as bird watching and is an attraction in this portion of the park. Relative to the size of the watershed, this pond is unlikely to provide significant water quality benefits and likely could not be retrofit to meet MHFD criteria for an extended detention basin, constructed wetland basin, or retention pond without substantial and costly modifications. The creek loses considerable elevation from the spillway elevation in the pond to the creek below. The grouted boulder rundown that was constructed to provide stable conveyance in this area has

been undercut and has collapsed into the creek. There is significant channel erosion downstream from the failed spillway for at least several hundred feet. The condition of the grouted boulder chute is likely to worsen if repairs are not completed. Repair timeline and likelihood of failure were not assessed as part of this study, although it is not believed that the pond embankment is at immediate risk of failure at this time. Nonetheless, it is anticipated that eventually the erosion will progress to a point where the pond embankment would be compromised.



Figure H4. Embankment Erosion at Lone Tree Creek Pond

Downstream of the pond spillway, Lone Tree Creek is incised for at least several hundred feet. Several hundred feet further downstream, the channel is in better condition and does not exhibit signs of significant bank erosion. It also appears that the channel and the floodplain are better connected, and a wetland complex with open water was observed for the reach of stream that flows from the confluence of Windmill and Lone Tree Creek to the confluence with Cottonwood Creek.



Figure H5. Incised Channel at Lone Tree Creek Pond Outfall

There is a large wetland complex at the confluence of Lone Tree Creek and Cottonwood Creek, approximately a quarter mile downstream of the Lone Tree Creek Pond. This was constructed in 2011 as a part of the stream reclamation project in Cottonwood Creek. At the time of the study, wetland vegetation harvesting by the CCBWQA was taking place along a portion of Cottonwood Creek main stem. Beaver activity was observed in this area, a little upstream from the area that was harvested. Overall, many improvements have been implemented to Cottonwood Creek through the CCSP. These improvements include the installation of PRFs including wetland complexes.

A quarter mile downstream of the Windmill Creek and Cottonwood Creek confluence a constructed earthen berm prevents channel flow from entering the old artificial stream path through the Family Shooting Center and behind the shooting range. This berm was constructed as a part of the 2011 Cottonwood Creek project to prevent storm flows from flowing into the old, artificial channel through the Family Shooting Center. Staff at the Family Shooting Center have reported large amounts of water after storm events and have indicated that lead mitigation is sometimes performed in the debris fall zone. The artificial channel

flows through this debris fall zone with the surface of the banks primarily covered in shotgun shells. There is little vegetation in this area due to the need for a clear sight line for shooting purposes. At the time of the site visit on July 11, 2023, there was about six to twelve inches of baseflow in the channel through the debris zone. The Family Shooting Center complex occupies an area of approximately 12 acres in the Cottonwood Creek watershed. About half a mile downstream of the Shooting Center, the eastern and western channel alignments merge north of the Cottonwood Creek Trail crossing. This is also the downstream limit of the 2011 stream reclamation project. Cottonwood Creek continues downstream through stable wetland areas to Cherry Creek Reservoir.



Figure H6. Family Shooting Range Channel

H.2. Alternative Analysis

WWE developed project alternatives by reviewing information from previous planning efforts, input from stakeholder entities, field visits, and the revised hydrologic modeling. Updated information for the development of the alternatives was derived from the following engineering reports:

- Wright Water Engineers, Inc. 2020. Southeast Metropolitan Stormwater Authority Cottonwood, Lone Tree, Windmill & Dove Creeks Hydrology Update. Prepared for the Southeast Metropolitan Stormwater Authority. (WWE, 2020).
- Muller Engineering, 2019. Cherry Creek Shooting Center Cottonwood Creek Drainageway Rehabilitation. Prepared for Colorado Parks and Wildlife. (Muller, 2019).
- CCBWQA TAC, 2011. Cottonwood Creek Stream Reclamation Water Quality Benefit Evaluation – Interim Status Report. Prepared for CCBWQA (CCBWQA, 2011).
- Versar, 2011. Voluntary Lead Management Report Cherry Creek State Park, Family Shooting Center. Prepared for Colorado Division of Parks and Outdoor Recreation (Versar, 2005).
- ICON Engineering, 2022. Drainage Report – Phase 3 Lone Tree Creek Trail Phase II and Stream Improvements. Prepared for The City of Centennial (ICON, 2022).
- R2R Engineers, 2022. Action Item Memorandum to the CCBWQA Technical Advisory Committee Regarding Intergovernmental Agreement for the Lone Tree Creek Trail. July 7, 2022 (R2R Eng., 2022).
- Muller Engineering Company, 2019 - Cottonwood Creek Drainageway Rehabilitation. Prepared for CPW (Muller, 2019).

Appendix B includes a summary of findings and excerpts from documents that supported the CCBWQA TAC's and Board's decision-making processes.

Project alternatives addressed one or more "focus areas." Focus areas were identified by review of previous studies, consultation with CCSP and CCBWQA Board members and staff, and site visits to areas with known or suspected issues. Some of the focus areas considered a "do nothing" alternative to weigh against one or more project alternatives. This was an important consideration given the financial constraints and environmental impacts inherent in any construction project. The alternatives analysis developed 11 project alternatives for the study area, of which five were selected to be recommended and presented to the CCBWQA TAC.

The accompanying MHFD MDP includes improvements to the upstream reaches of Cottonwood, Lone Tree, and Windmill Creeks within the SEMSWA service area that are designed to provide adequate stormwater water quality detention before

runoff enters CCSP. The analysis of focus areas in CCSP assumes upstream problem areas will be addressed as described in the companion study.

For the portions of Cottonwood, Lone Tree, and Windmill Creek watersheds within CCSP, 2020 LiDAR from DRCOG were used to determine basin parameters for areas that had not been studied previously. Field observations were also used to evaluate areas draining to the eastern and western alignments of each of the creeks and determine appropriate routing of sub-basins. A table of basin parameters can be found in Appendix G. WWE included an overflow node for the Lone Tree Creek split flow area in the SWMM model with a rating curve matching the 2-year and 5-year flow rates provided in the two-dimensional modeling that accompanied the design of the Caretaker Road culvert improvements (ICON, 2022). To integrate the three watershed SWMM models, node outflow hydrographs data files were generated via a Python script and linked to downstream SWMM models using the time-series input file function. This Python script was developed for the CCSP MDP update and is included in Appendix G along with the time series files.

Hydrologic modeling is provided in Appendix G that provides scenarios both with and without the proposed upstream improvements for existing and future watershed imperviousness. Table H2 compares the SWMM results of these four scenarios for the 2-year and 100-year storm events.

Table H2. Comparison Peak Flow Rates

Location	Node	2-year Peak Flow Rate (cfs)				100-year Peak Flow Rate (cfs)			
		Existing Imperviousness without upstream improvements	Existing Imperviousness with upstream improvements	Future Imperviousness without upstream improvements	Future Imperviousness with upstream improvements	Existing Imperviousness without upstream improvements	Existing Imperviousness with upstream improvements	Future Imperviousness without upstream improvements	Future Imperviousness with upstream improvements
Lone Tree Creek Pond	133	134	56	305	141	935	901	1156	1082
Lone Tree Creek Pond Outfall Channel	L-126	62	52	290	134	930	890	1142	1074
Lone Tree Creek Split Flow	125	245	85	452	206	1333	1289	1658	1547
Caretaker Road Crossing	140	293	158	302	174	1206	1202	1581	1585
Cottonwood Creek at East Lake View Road	206	308	360	758	621	5607	5047	6623	6093

This comparison table shows that existing and future imperviousness values for the upstream watershed have a large effect on the peak flow rates within CCSP for these storm events. It also shows that proposed upstream detention improvements by SEMSWA have a significant effect for some focus areas in the park where future design projects are anticipated. For portions within the CCSP, this MDP recommends the use of the model scenarios using future imperviousness without upstream detention improvements for infrastructure sizing. This is recommended because it is the most conservative of the four model scenarios for the 2-year and 100-year storm events and is what has previously been used for design purposes. The decision on which model scenario to use should be re-evaluated at the time of project design and should be based on actual implementation of upstream projects.

Table H3 summarizes peak flow rates for a range of storm events for this recommended model scenario. Full results for other scenarios and return periods can be found in Appendix G.

Table H3. Recommended Scenario Peak Flow Rates

Location	Node	Future Undetained Peak Flow Rate (cfs)				
		2-year	5-year	10-year	50-year	100-year
Lone Tree Creek Pond	133	141	248	362	855	1156
Lone Tree Creek Pond Outfall Channel	L-126	134	240	345	838	1142
Lone Tree Creek Split Flow	125	206	360	528	1230	1658
Windmill Creek Caretaker Road Crossing	140	174	464	614	1263	1581
Cottonwood Creek at East Lake View Road	206	621	1279	2008	4569	6623

WWE developed alternatives in coordination with project sponsors and each project was evaluated for feasibility, impact, and value. Six categories were evaluated for each project alternative considered:

1. Project Cost: approximate project cost.
2. Public Safety: the degree to which adjacent properties are impacted by the problem or the project regarding public health, safety, and infrastructure.
3. Water Quality: spectrum of water quality benefits ranging from no benefit, minimally meeting MS4 requirements, and significant improvements to water quality.
4. Stream Health: measure of stream degradation that will occur with or without the project, as well as improvements to stream function and stability.
5. Environmental: impact to wetland and riparian areas.
6. Community Values: impact on aesthetics and the accessibility of an area for enjoyment by the public.

Project alternatives considered are shown in Figure H1. There are, in any given scenario, a variety of combinations of project alternatives for watershed master planning. However, the alternatives presented and evaluated in this MDP report are only those that were deemed feasible by the planning team. Rationale for infeasibility included circumstances such as cost, excessive permitting requirements, and unreasonable design challenges.

H.3. Recommended Plan

Four projects are recommended with this MDP in CCSP, three in the Lone Tree watershed and one in the Cottonwood Creek watershed. Recommended projects are summarized in Table H4.

Table H4. CCSP Recommended Projects in Cottonwood and Lone Tree Creek Watersheds

Focus Area	Watershed	Selected Alternative	Capital Cost Estimate
#1 Lone Tree Creek Pond	Lone Tree	The Lone Tree Creek Pond embankment is recommended to be left “as-is” with its condition allowed to evolve, using an adaptive management approach. Warning signs are recommended to notify the public about possible flash flooding downstream.	$5,000
#2 Lone Tree Creek Pond Outfall Channel	Lone Tree	Rock check dams are recommended in anticipation of how the pond upstream will evolve in the future.	$192,100
#3 Lone Tree Creek Split Flow	Lone Tree	The Lone Tree Creek split flow area and wetland complex upstream of the pond will remain as-is.	n/a
#4 Caretaker Road Crossing	Lone Tree	The ICON design is recommended for implementation in its entirety including at the Caretaker Road crossing.	By Others
#5 Cottonwood Creek Eastern Alignment at Family Shooting Range	Cottonwood	A 200-foot segment of 36” pipe in the Family Shooting Range debris fall zone is proposed.	$206,900

The recommended projects seek to address the primary threat to water quality to the Cottonwood Creek stream reclamation project, with the concern being mobilization of large amounts of sediment due to channel erosion or the failure of the Lone Tree Creek Pond embankment. This is mitigated by the implementation of rock check dams along the channel downstream of the Lone Tree Creek Pond. This concept is illustrated in the attached Figure H2 and should be considered as an interim control measure rather than a full stream reclamation. Check dams should be designed by an engineer prior to construction. The structure should be keyed in and extend at least 5 feet into the banks on either side and below the channel invert.

The recommended alternatives are intended to preserve the existing environmental character of the drainageways, while providing some protection against degradation. The alternatives selected do not include mass grading or disturbance in environmental features and preserve existing wetlands. Construction access to the relatively remote sites may be difficult and is considered in the mobilization cost component of the estimate. Safety components of the recommended plan include signage for recreational users and improvements to water quality.

The proposed pipe in the Family Shooting Range was previously eliminated as an alternative in this area due to permitting costs in the 2019 Muller study. However, based on recent regulatory changes to wetlands and high construction and materials costs, this MDP update reconsidered a modified approach to this potential project. It also proposes a shorter segment of pipe than the 2019 Muller study. Hydraulic calculations were performed using HY-8 for the 200-foot segment of 36” pipe using the Rational Method calculations provided in the 2019 study, which can be considered more conservative than the CUHP calculations provided in this MDP. The CCBWQA ultimately will not be responsible for selecting or implementing a project alternative at the Family Shooting Center as this is at the discretion of CPW and the vendor. This project should be considered as a supplement to the previous study for consideration by CPW and the vendor.

The timeline of implementation for selected alternatives will be contingent on funding availability and opportunities for collaboration with other entities. Recommended projects might be constrained by those factors and implemented at the discretion of CPW and other partner organizations. During the implementation of a MDP, opportunities for grants or demands for an accelerated project schedule often may arise that cause deviation from the recommendations presented in the MDP. This MDP recommends the use of the model scenarios using future imperviousness without upstream detention improvements for infrastructure sizing within the CCSP.

Channel stabilization measures downstream of the Lone Tree Creek Pond spillway should be installed as soon as possible to protect the downstream stream reclamation project from sedimentation. Safety signage should also be installed as soon as possible in that area warning of potential flash flooding. The Family Shooting Center storm pipe improvement project includes a new alternative to supplement the 2019 Muller study. Ultimately the selection and implementation of this alternative may depend on various financial and permitting factors such as the lease for the shooting range with CPW, which has recently been renewed.

H.4. References

CCBWQA TAC, 2011. Cottonwood Creek Stream Reclamation Water Quality Benefit Evaluation – Interim Status Report. Prepared for CCBWQA.

ICON Engineering, 2022. Drainage Report – Phase 3 Lone Tree Creek Trail Phase II and Stream Improvements. Prepared for The City of Centennial.

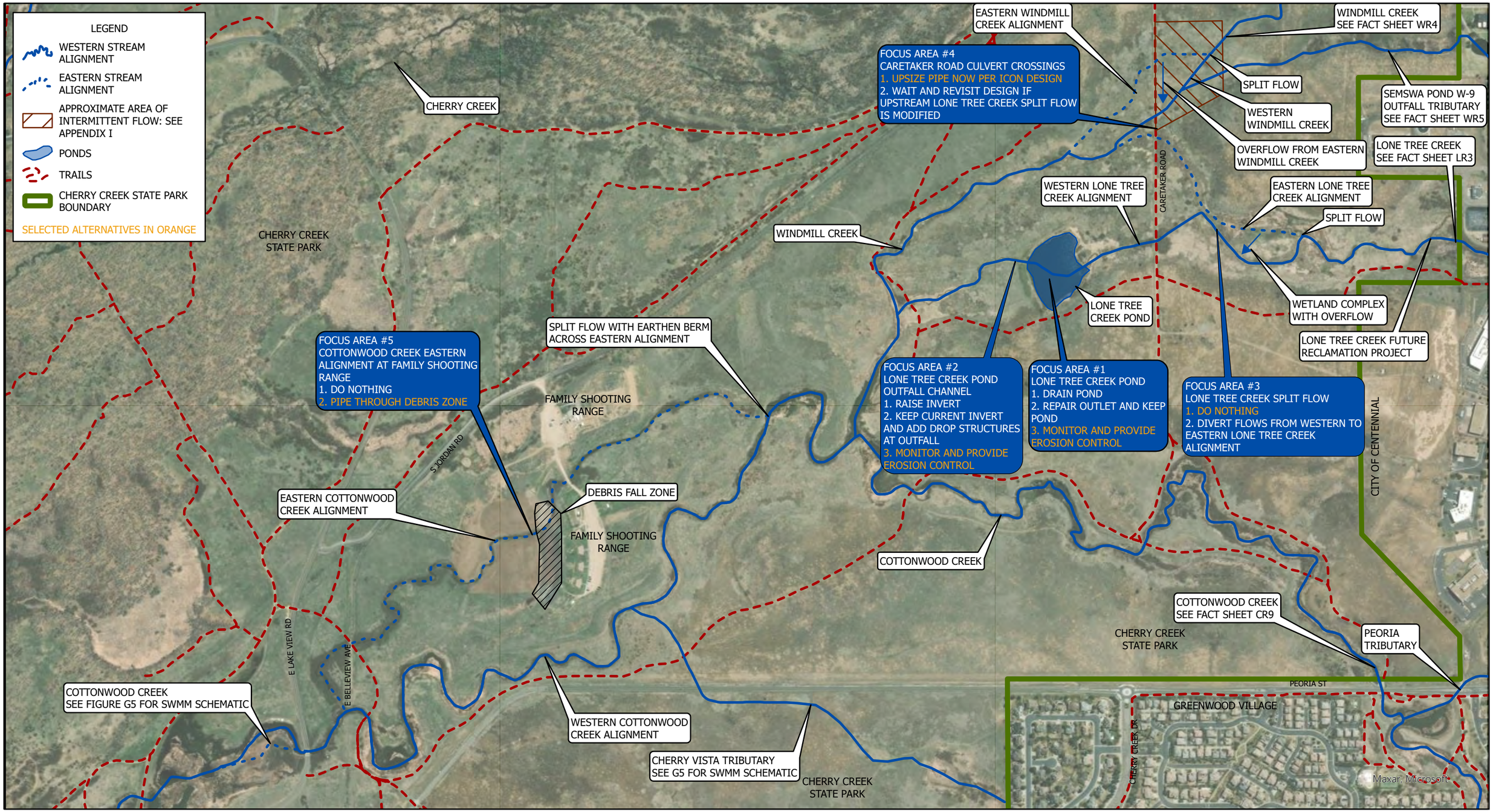
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R2R Engineers, 2022. Action Item Memorandum to the CCBWQA Technical Advisory Committee Regarding Intergovernmental Agreement for the Lone Tree Creek Trail. July 7, 2022.

Versar, 2011. Voluntary Lead Management Report Cherry Creek State Park, Family Shooting Center. Prepared for Colorado Division of Parks and Outdoor Recreation.

Wright Water Engineers, Inc. 2020. Southeast Metropolitan Stormwater Authority Cottonwood, Lone Tree, Windmill & Dove Creeks Hydrology Update. Prepared for the Southeast Metropolitan Stormwater Authority.



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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

CHERRY CREEK STATE PARK
COTTONWOOD, LONE TREE, AND WINDMILL CREEKS
CHERRY CREEK BASIN WATER QUALITY AUTHORITY

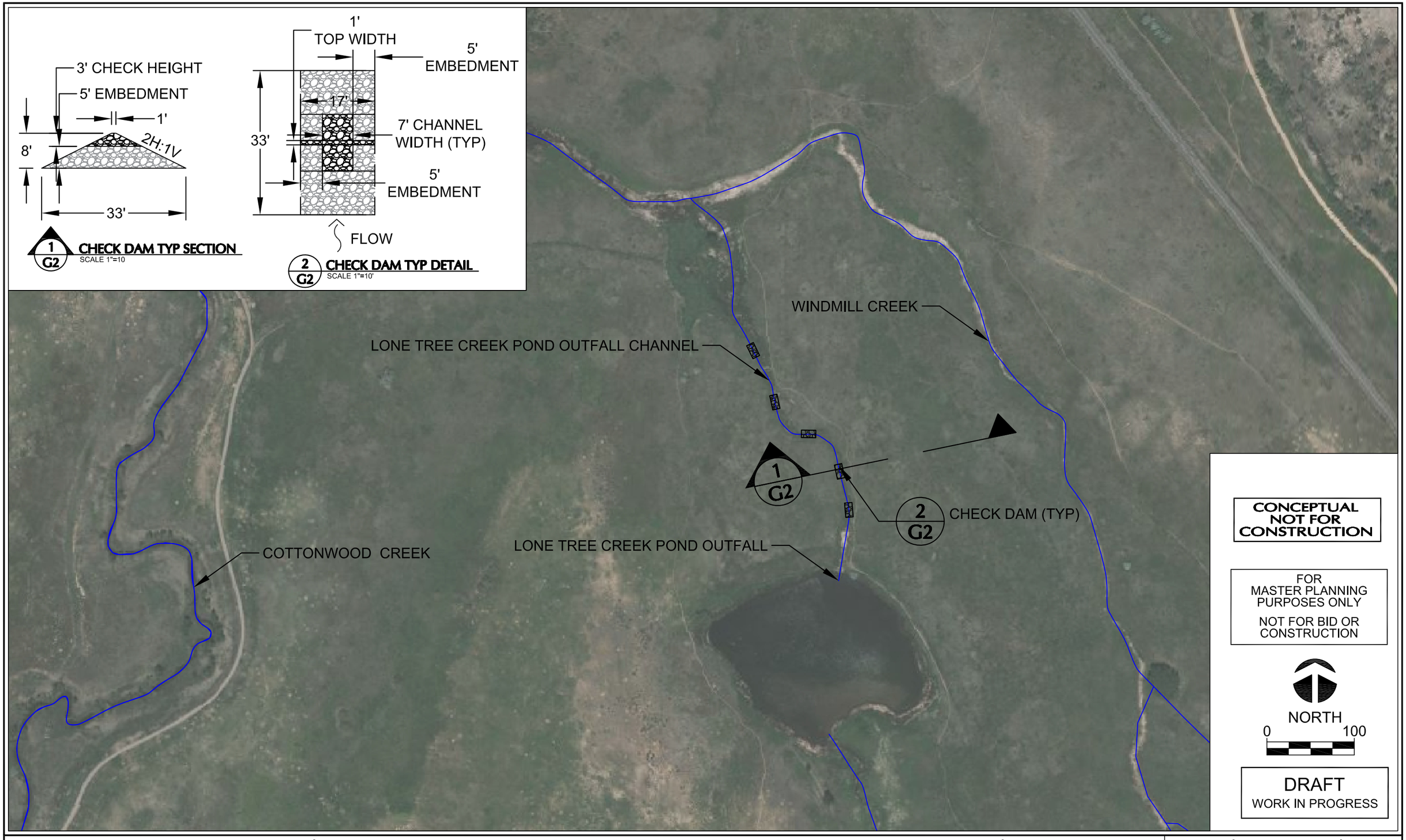
N

1" = 600 Feet

0 300 600

PROJECT NO. 211-013.040

FIGURE H1



CONCEPTUAL
NOT FOR
CONSTRUCTION

FOR
MASTER PLANNING
PURPOSES ONLY

NOT FOR BID OR
CONSTRUCTION

NORTH
0 100

DRAFT
WORK IN PROGRESS

WWE
WRIGHT WATER ENGINEERS, INC.
818 COLORADO AVE. P.O. BOX 219
GLENWOOD SPRINGS, CO 81602
(970)945-7755 FAX(970)945-9210

CCSP MAJOR DRAINAGEWAY PLAN

FOCUS AREA 2 CONCEPTUAL

		DATE
DRAFTING	MRL	01/31/24
CHECK	AE	01/31/24
SCALE		SHOWN

JOB NO. 211-013.040

FIGURE H2

Plot Date/Time:02/02/2024, 12:19:57 PM Z:\PROJECT FILES\211-013\211-013.000\ENGINEERING\2023 CCSP MASTER PLAN\CAD\CCSP REACH2 FIGURE.DWG-GENERAL SHEET LAYOUT

Project Info

Project Name :	**Cherry Creek State Park MDP Conceptual**
Estimator :	**MRL**
Date :	**02.01.24**

Project Drainageways :	**Drainageway Name**
	noted on project

CCI Base Year :	**2012**
CCI Base Quarter :	3
Base CCI :	1
Most Recent CCI Year :	2.13
Most Recent CCI Quarter :	2023

Effective Interest Rate (%):

SUMMARY BY REACH

Project Name :	**Cherry Creek State Park MDP Conceptual**
Estimator :	**MRL**
Data :	**02.01.24**

REACH	INITIAL CAPITAL	PLANNING, ENGINEERING, AND ADMIN	CONTINGENCY	TOTAL CAPITAL COST	ANNUAL O&M COST	50-YEAR O&M COST
CCSP 1	$3,000	$1,500	$500	$5,000	N/A	N/A
CCSP 2	$123,920	$37,176	$30,980	$192,076	$2,500	$125,000
CCSP 5	$133,450	$40,035	$33,363	$206,848	$1,517	$75,850
Totals	**$260,370**	**$78,711**	**$64,843**	**$403,924**	**$4,017**	**$200,850**

Conceptual Cost Estimate for Installation of Flood Safety Signage downstream of LTC Pon

Item	Unit Cost	Unit	No.	Cost	Notes
Flood safety sign	$1,500	EA	2	$3,000	Based on 2023 Big Dry Creek project sign cost from MHFD-Bid-Pricing-Database
Planning/Engineering/Admin	$1,500	EA	1	$1,500	Costs for determining sign locations and obtaining necessary approvals, based on T&M for approximately 1 day of consultant time
Subtotal				$4,500	
Contingency				$500	Account for recent inflation and unforeseen details
Total				$5,000	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

Cherry Creek State Park MDP Conceptual

CCSP-Focus Area 2	**ESTIMATED BY :**	**MRL**	**DATE :**	**02.01.24**

DRAINAGEWAY : Lone Tree Creek

DESCRIPTION	SUPPORTING DATA (USER DEFINED AND CALCULATED)		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Capital Improvement Costs							
Channel Improvements							
Excavation, High Range			130	C.Y.	$66	$8,580	Considers volume of excavation as riprap with reduction for placement above
12-inch Riprap, Type H			435	C.Y.	$170	$73,950	Assumes 1' Top Width, 3' Channel Depth, 5' Embeddment Into Bottom, 7' Channel Width, 5' Embeddment Into Banks (Each Side), 2H:1V Sideslope, Assumes Approximately 5 Structures
Landscaping and Maintenance Improvement:							
Wetlands Plantings			0.1	ACRE	$53,250	$5,325	Approximate disturbance area near channel.
Reclamation & seeding			0.5	ACRE	$2,130	$1,065	Approximate and includes staging.
Subtotal Capital Improvement Costs						**$88,920**	
Additional Capital Improvement Costs							
Water Management		**User Defined Lump Sum Cost >**	$20,000	L.S.		$20,000	Temporary diversion ditch for short duration project, increased from MHFD-bid tabs data for work on Inverness Regional Pond due to ~4 cfs baseflow. Assimes dewateriong not needed to install check dams.
Mobilization		**User Defined Lump Sum Cost >**	$5,000	L.S.		$5,000	
Stormwater		**User Defined Lump Sum Cost >**	$10,000	L.S.		$10,000	
Subtotal Additional Capital Improvement Costs						**$35,000**	
Engineering			15%			$18,588	
Legal/Administrative			5%			$6,196	
Contract Admin/Construction Management			10%			$12,392	
Contingency			25%			$30,980	
Subtotal Other Costs						**$68,156**	
Total Capital Improvement Costs						**$192,076**	

Master Plan Operation and Maintenance Cost Summary

Description		Frequency	Quantity	Unit	Unit Cost	Total Annual Cost	
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost >**	1	5	EA	$500	$2,500	
Total Annual Operation and Maintenance Cos						**$2,500**	
Total Operation and Maintenance Costs Over 50 Years						**$125,000**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

Cherry Creek State Park MDP Conceptual			
CCSP-Focus Area 5	ESTIMATED BY :	MRL	DATE : 02.01.24

DRAINAGEWAY : Cottonwood Creek Tributary at Family Shooting Center

DESCRIPTION	SUPPORTING DATA (USER DEFINED AND CALCULATED)					QUANTITY	UNIT	UNIT COST	TOTAL	USER COMMENTS
Pipe Culverts and Storm Drains										
Circular Pipes										
Diameter (in)	**Length (ft)**	**No. of Barrels**								
36-inch	205	1	Note : Prices reflect circular reinforced concrete pipe.			205	L.F.	$230	$47,150	Length measured through debris field, diameter from previous study by Muller
Inlet and Outlet Treatment (FES or Headwalls)										
Diameter (in)	**Applicable**	**No. of Barrels**	**U/S FES**	**D/S FES**						
36-inch	Yes	1	Yes	Yes		2	EA	$3,429	$6,858	From UD-MP cost data $3429 for FES and $3127 for Headwalls
Manholes and Inlets										
Manhole, 5' Dia. (Pipe Dia. 36" - 42")						1	EA	$8,307	$8,307	Manhole diameter is approximate and was not sized as a component of the MDP
Channel Improvements										
12-inch Riprap, Type M						20	C.Y.	$128	$2,560	Assumes typical inlet and outlet protection apron.
Excavation, High Range						320	C.Y.	$66	$21,120	Assumes 7' x 7' corridor of imported fill around 36" pipe.
Landscaping and Maintenance Improvements										
Wetlands Plantings						0.1	ACRE	$53,250	$5,325	
Reclamation & seeding (native						1	ACRE	$2,130	$2,130	Assumes revegetation including staging area.

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs					
Pipe Culverts and Storm Drains					$62,315
Channel Improvements					$23,680
Landscaping and Maintenance Improvements					$7,455
Subtotal Capital Improvement Costs					**$93,450**
Additional Capital Improvement Costs					
Dewatering	**User Defined Lump Sum Cost >**	$25,000	L.S.		$25,000
Mobilization	**User Defined Lump Sum Cost >**	$5,000	L.S.		$5,000
Stormwater Management/Erosion	**User Defined Lump Sum Cost >**	$10,000	L.S.		$10,000
Subtotal Additional Capital Improvement Costs					**$40,000**
Engineering		15%			$20,018
Legal/Administrative		5%			$6,673
Contract Admin/Construction Management		10%			$13,345
Contingency		25%			$33,363
Subtotal Other Costs					**$73,398**
Total Capital Improvement Costs					**$206,848**

Master Plan Operation and Maintenance Cost Summary

Description		Frequency	Quantity	Unit	Unit Cost	Total Annual
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	**Optional User Defined Unit Cost >**	1	205	L.F.	$2	$410
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	**Optional User Defined Unit Cost >**	1	1	EA	$107	$107
Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.)	**Optional User Defined Unit Cost >**	1	1	EA	$1,000	$1000
Total Annual Operation and Maintenance Cost						**$1517**
Total Operation and Maintenance Costs Over 50 Years						**$75850**

2024 Hawk Walk

Saturday, January 27, 2024 9:00 AM

- These notes are related to public outreach that occurred at the annual Cherry Creek Hawk Walk event hosted by Casey Davenhill with the Cherry Creek Stewardship Partners. This even is often well attended by the birding community.
- CCBWQA members Jane Clary and Bill Ruzzo attended with Maggie Lewis of WWE. There were also 8-10 members of the birding community at the event.
- The group visited the Lone Tree Creek Pond and Maggie Lewis showed them the ongoing erosion at the outfall of the pond. She explained the regulatory requirements that could limit pond embankment rehabilitation.
- The group overwhelmingly supported keeping the pond and emphasized it's ecological importance especially as a water body that does not often freeze in the winter. Some attendees expressed concerns over construction environmental impacts associated with any repairs. They wanted appropriate revegetation and topsoil included in any construction project.
- Maggie explained that the selected alternative by the TAC was to leave the embankment in place and providing stabilization measures in the channel downstream. The attendees were generally in support of this alternative.
- After the event Casey Davenhill reached out to the attendees via email for any written comment on draft MDP and no one provided any follow-up comments.
- CPW staff Shawn Krier and Michelle Seubert have also provided feedback that they want the pond to remain in place. This is for the recreational and birding benefits expressed at this public outreach. They are also supportive of the MDP recommendation to stabilize the channel and monitor the embankment.