

**PHASE III DRAINAGE REPORT  
FOR  
HILLCAMP DRIVE**

**Prepared for:**

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November 2025

Job Number 15950.18



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**CERTIFICATION**

“I hereby certify that this report for the Drainage Design of the Hillcamp Drive was prepared under my direct supervision in accordance with the provisions from the Douglas County Storm Drainage Criteria Design and Technical Criteria for the owners thereof. I understand that Douglas County does not and will not assume liability for drainage facilities designed by others.”

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Kevin Rohrbough, P.E.  
Colorado Registered Professional Engineer No. 48992  
For and On Behalf of JR Engineering

Rampart Range Metropolitan District No. 1 hereby certifies that the storm water drainage facilities for Hillcamp Drive shall be constructed according to the design presented in this report. I understand that the City of Lone Tree does not and will not assume liability for the drainage facilities designed and/or certified by engineer. I understand that the City of Lone Tree reviews drainage plans pursuant to Colorado Revised Statutes Title 30, Article 28; but cannot guarantee that final drainage design review will absolve Rampart Range Metropolitan District No. 1 and/or their successors and/or their assigns of future liability for improper design. I further understand that the approval does not imply approval of my engineer's drainage design.

Rampart Range Metropolitan District No. 1

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Authorized Signature

# 1 INTRODUCTION

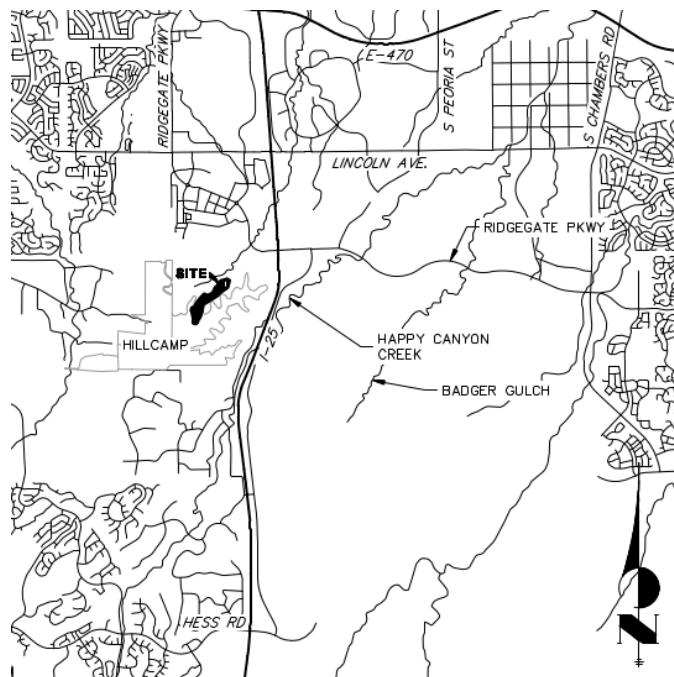
The purpose of this Phase III Drainage Report is to investigate the existing and proposed conditions drainage patterns, and to develop drainage improvements for the proposed Hillcamp Drive. The proposed drainage improvements are intended to maintain existing drainage patterns and minimize drainage impacts from the proposed development.

## 1.1 Site Location and Project Description

The Site is located in Sections 22, Township 6 South, Range 67 West of the 6th Principal Meridian, City of Lone Tree, Douglas County, Colorado. The site is located west of Interstate Highway 25 (I-25), south of existing open space and residential lots, and northeast of the proposed Hillcamp residential development. This project serves to be the main point of access for the proposed Hillcamp residential development. The site is shown on the Vicinity Map, see **Appendix A** as well as **Figure 1** below. The property is currently vacant and undeveloped, apart from several gravel recreational trails.

Along the north side of proposed Hillcamp Drive is a small single-family development, Retreat at Ridgeway. This development is downstream from the site and excerpts of the drainage report are included in **Appendix E**.

**Figure 1: Vicinity Map**



## 1.2 Geotechnical Description

The soils in the proposed development as classified by the Natural Resource Conservation Service (NRCS) include Hydrologic Groups C and D. Hydrologic Group C soils are described as “soils that have low infiltration rates when thoroughly wet and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.” Soils having very slow infiltration rates when thoroughly wetted, consisting chiefly of (1) clayey soils with high swelling capacity or potential, (2) soils with a high permanent water table, (3) soils with claypan or clay layer at or near the surface, and



(4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission. Hydrologic Soil Group D soils are characterized by very slow infiltration rates, even when thoroughly wetted, and have a high runoff potential. Excerpts from the NRCS soils report are provided in **Appendix A**.

### 1.3 Related Drainage Studies

The site is located in the Cottonwood Creek Watershed which is tributary to the Cherry Creek Reservoir. The site is located in Flood Zone X, areas determined outside the 500-year floodplain, as shown on Flood Insurance Rate Map Community Panels No. 08035C0044G, Effective September 4, 2020, which is included in **Appendix A**. This Site has an associated Master Drainage Plan (MDP) as well as numerous other Drainage Reports that amends this MDP. These reports are listed below.

Cottonwood Creek Drainage Studies:

- MASTER DRAINAGE PLAN FOR RIDGEGATE – COTTONWOOD CREEK DRAINAGE BASIN;– MERRICK AND COMPANY (JANUARY 2012)
- PHASE 3 DRAINAGE REPORT FOR TRACT O ACCESS ROAD (COTTONWOOD CREEK FLOW CONTROL STRUCTURE) RAMPART RANGE METRO DISTRICT;– MERRICK AND COMPANY (APRIL 2012)
- PHASE 3 DRAINAGE REPORT FOR DETENTION POND 311 RETROFIT RAMPART RANGE METRO DISTRICT;– MERRICK AND COMPANY (DECEMBER 2013)
- RIDEGATE-SECTIONN 22, FILING NO.1 PHASE 3 DRAINAGE REPORT;– CALIBRE ENGINEERING INC (JANUARY 2017)
- PHASE 3 DRAINAGE REPORT FOR HILLCAMP;– JR ENGINEERING (IN REVIEW AT TIME OF THIS REPORT)

No adverse downstream impacts will be produced by the proposed Hillcamp Drive development, as developed runoff will be at or below the assumed flow rates at relevant design points according to the 2017 Report by Calibre Engineering. References from these studies are included in **Appendix E**.

## 2 HISTORIC DRAINAGE SYSTEM

### 2.1 Major Drainage Basins Descriptions

The site is located within the Cottonwood Creek Major Drainage Basin.

#### 2.1.1 Cottonwood Creek

This drainage basin begins just northeast of the existing northern property line of the site, and is directly downstream of the proposed development. According to the **2012 MDP for Ridgeway - Cottonwood Creek Drainage Basin – Merrick and Company**, flows are to be conveyed down the existing slopes until they channelize in the steep existing slopes drainageways. Once channelized, the flows converge to one drainageway and ultimately in to Cottonwood Creek. These flows are then to be conveyed along this path until they reach Ridgeway Parkway where an existing 48” RCP culvert conveys flows under RidgeGate Parkway until eventually reaching the existing CDOT MS4 Pond 311 located near the intersection of Lincoln Ave and Interstate 25. The **Ridgeway – Section 22, Filing No. 1 Phase III Drainage Report – Calibre 2017** followed this MDP and added design for a small subdivision (Retreat at Ridgeway). When

this project was developed, the drainage patterns of the area were altered slightly to allow for development, and the existing 48" RCP Culvert at Ridgegate Parkway had a restrictor plate added to it to help attenuate the developed flows from Ridgegate – Section 22, Filing No. 1. This existing culvert lies within the newly improved Cottonwood Creek drainage channel as part of The Ridgegate – Section 22, Filing No. 1 improvements along with several other new culverts being used to attenuate flows through the development. These downstream drainageways will be unaffected by the construction of Hillcamp Drive. Developed flows will be conveyed to the locations as described by the 2017 Calibre Report, at or below their assumed flow rates. In addition to the **2012 MDP by Merrick**, the **2017 Calibre** report also used the design described within both the **Phase 3 Drainage Report for Pond 311 (Merrick December 2013)**, and also the **Phase 3 Drainage Report for Tract O Access Road (Merrick April 2012)** to prove downstream detention and water quality is possible within Pond 311. Excerpts from these reports can be found in **Appendix E**.

## 2.2 Sub-Basin Description

### 2.2.1 Cottonwood Creek

According to the **2012 MDP For Ridgegate - Merrick and Co**, there are six (4) existing Sub-Basins that the project will impact. These Proposed Sub-Basins are named according to the naming convention from the **2012 MDP For Ridgegate - Merrick and Co**; C15-A through C-15-G. This site is located directly within these existing Sub-Basins.

In addition to the **2012 MDP by Merrick and Co** there is also the **Ridgegate – Section 22 Filing 1 Phase III Drainage Report by Calibre – 2017**. This Drainage Report outlines improvements made by the construction of the Retreat at Ridgegate Subdivision, this report shows several offsite Sub-Basins and several on-site Sub-Basins that this development is capturing with swales, and then conveying to a central drainage channel within the development itself. This central channel (Sub-basin CH, **Calibre 2017**) is attenuated to historic release rates by use of an existing 48" RCP culvert located below Bluffside Drive; this culvert is referenced in the **Calibre** drainage report as the Ex-Cottonwood Creek Flow Control Structure. To help attenuate developed flows created by the Retreat at Ridgegate development's added imperviousness, a restrictor plate was installed on the Ex-Cottonwood Creek Flow Control Structure to restrict major flows to **325.17 CFS** based upon the studies performed on downstream Pond 311's (Previously mentioned CDOT MS4 Pond) allowable capacity.

The Sub-Basins 1-4 on the **Calibre** SWMM Map located in **Appendix E** will be altered by the proposed Hillcamp Drive construction. The downstream Retreat at Ridgegate storm infrastructure that is to convey flows from these sub-basins into the Retreat at Ridgegate central channel (Sub-Basin 9 – SWMM MAP, **Calibre 2017**), were designed using hydrology that reflected the assumed alignment, and added impervious of both this site (Hillcamp Drive), and the proposed Hillcamp Subdivision. The **2017 Calibre** Design Points that are potentially affected by the proposed Hillcamp Drive are named 15C, 15E, and 15F1.1, on the **Calibre SWMM Map**, and 1.1, 2.1, and 4.1 respectively on the **Calibre Proposed Drainage Plan**. Table 1 below summarizes the assumed flow rates that were calculated at these design points. See **Appendix E** for detailed Hydrology and routing from the **2017 Calibre Drainage Report**.

**Note that due to the March 2024 Updates to the USDCM Volume 1, Chapter 6, the percent impervious values have changed to become more conservative since the time that the referenced report was approved.**

**Table 1: Existing Calibre Design Point Assumed Flows**

| Ex Calibre Design Point | EX Q <sub>5</sub><br>(cfs) | EX Q <sub>100</sub><br>(cfs) |
|-------------------------|----------------------------|------------------------------|
| 1.1                     | 13.9                       | 82.1                         |
| 2.1                     | 2.5                        | 28.5                         |
| 4.1                     | 2.4                        | 24.6                         |
|                         |                            |                              |
| EX-B1                   | 3.6                        | 12.8                         |
| EX-B2                   | 3.0                        | 9.6                          |
| EX DP 4                 | 7.9                        | 47.0                         |

### 3 DRAINAGE DESIGN CRITERIA

This Drainage Report was prepared in accordance with the “Storm Drainage Design and Technical Criteria” by Douglas County, the “Urban Storm Drainage Criteria Manual” (USDCM) by Mile High Flood District (MHFD), the 2017 Report by Calibre Engineering, and associated Cottonwood Creek MDP that have been referenced throughout. Any tables, charts and graphs referenced from the drainage criteria manuals for this report are contained in **Appendix A**.

#### 3.1 Hydrology

The one-hour rainfall depth data was obtained from Chapter 6 of the “Storm Drainage Design and Technical Criteria” by Douglas County, which states a one-hour precipitation value for 5- and 100-year events in Zone 1 to be 1.43 inches and 2.60 inches respectively.

Colorado Urban Hydrograph Procedure was used to determine runoff values for the proposed site for a conservative planning stage. These flows were used to preliminarily plan infrastructure size and locations. The minor storm was analyzed as the 5-year event and the major storm was analyzed as the 100-year event.

CUHP Flows were used for all design on this site; this includes inlets, swales, pipes, culverts, and riprap. CUHP was used to mirror how the previous **2017 Calibre** flow rates were calculated for the final design of the Retreat at Ridgeway infrastructure downstream of the proposed Hillcamp Drive site.

Final Design CUHP results are provided in **Appendix B**. As well as the associated CUHP inputs.

#### 3.2 Hydraulics

All inlets, swales, culverts, and pipes have been designed for the 100-year storm. The latest version of Mile High Flood District’s workbook “MHFD-Inlet (Version 5.02, August 2022)” has been used to size the inlets and for street capacity. Street capacity is based on allowable spread and the maximum depth of flow at the curb.

The inflows at the inlets are based on the CUHP 5-year-minor/100-year-major storm results and can be referenced from the CUHP outputs in **Appendix B**. The proposed storm sewer pipes used to convey flows, are sized using Bentley’s StormCAD software. This Software is also being used to calculate the hydraulic grade lines, velocity, and Froude Number in the storm sewer pipes and results can be found in **Appendix C**.

Swales and concrete trickle channels have been sized to not overtop with the expected flows to each using Bentley's Flowmaster version 10.03. Flowmaster results can be found in **Appendix C**.

## **4 PROPOSED DRAINAGE FACILITY DESIGN**

### **4.1 General Concept**

This report uses the five aforementioned Reports as the general basis for determining the drainage design, with modifications to reflect the latest USDCM criteria manual in these Sub-Basins. Roadway flows are to be routed within the roadway to Type R inlets on either side of the street crown at 3 different locations. Offsite flows are to be routed via existing vegetated Swales towards the locations of the existing Retreat at Ridgeway Infrastructure. Where the proposed roadway bisects existing **Calibre** sub-basins, flared end sections or depressed type D inlets will convey flows beneath Hillcamp Drive to the existing Retreat at Ridgeway infrastructure.

### **4.2 Proposed Basin Descriptions**

#### **A Basins:**

Basins A1 – A2 are located on the southwest side of the Site within the Cottonwood Creek watershed and these basins will consist of small portions of single-family lots, asphalt roads, curb and gutter, landscaping, pedestrian bridge, concrete sidewalk, gravel trail, and natural vegetation. These Sub-Basins flows will be conveyed via curb and gutter to a pair of sump condition Type R Inlets located at DP's A1 and DP A2, respectively. These flows are then conveyed via storm sewer to DP B3.1, and ultimately through the storm sewer to the proposed Detention Pond at DP P.

#### **B Basins:**

Basins B1 – B2 are located on the central portion of the Site within the Cottonwood Creek watershed and these basins will consist of asphalt roads, curb and gutter, retaining walls, landscaping, concrete sidewalk, and natural vegetation. These Sub-Basins flows will be conveyed via curb and gutter to a pair of on-grade Type R Inlets located at DP B1 and DP B2 Respectively. These flows are then conveyed via storm sewer to DP B3.1, and ultimately through the storm sewer to the proposed Detention Pond at DP P.

#### **C Basins:**

Basins C1 – C2 are located on the northeast end portion of the Site within the Cottonwood Creek watershed and these basins will consist of asphalt roads, curb and gutter, retaining walls, landscaping, concrete sidewalk, and natural vegetation. These Sub-Basins flows will be conveyed via curb and gutter to a pair of on-grade Type R Inlets located at DP C1 and DP C2 Respectively. These flows are then conveyed via storm sewer to DP C4.1, this design point is meant to sum developed flows that are tributary to where they will outfall towards **Existing Calibre DP 4.1**.

**Sub-basin P** is the Sub-Basin that contains the Proposed Tract M Detention Pond. Flows from this Sub-Basin will sheet flow directly into the Proposed Detention Pond. Flows are then treated and released from DP P4.1 into the existing Retreat at Ridgeway Storm Facilities at **Existing Calibre DP 4.1**. From this point the flows continue through the existing Retreat at Ridgeway Storm Facilities until outfalling into Cottonwood Creek at **Existing Calibre DP 4**. (See **Appendix D for detailed Pond Calculations**, and **Appendix E for relevant Calibre references**.)

**OS Basins:**

**Sub-basin OS1.1** is located to the southeast of the proposed Hillcamp Drive roadway. Flows sheet flow down the existing slope away from the Hillcamp Development towards existing vegetated swales that will convey channelized flows to DP 1.1. At this point flows enter the proposed Hillcamp Drive storm sewer. Flows are piped from the FES at DP 1.1 until outfalling on the north side of proposed Hillcamp drive to DP P1.1, and ultimately enter the Retreat at Ridgeway Detention Facilities at **Existing Calibre DP 1.1**. Any developed flows leaving the Hillcamp Subdivision are to be treated for water quality before entering proposed Hillcamp Drive Sub-Basin OS1.1.

**Sub-basin OS1.2** is located to the south of the proposed Hillcamp Drive roadway. Flows sheet flow down the existing slope away from the Hillcamp Development towards existing vegetated swales that will convey channelized flows to DP 1.2 where a proposed 30" FES is located. At this point flows enter the proposed Hillcamp Drive storm infrastructure, flow is conveyed via storm sewer until outfalling to DP P1.1. At this point flows enter the Retreat at Ridgeway Detention Facilities at **Existing Calibre DP 1.1**. Any developed flows leaving the Hillcamp Subdivision are to be treated for water quality before entering Proposed Hillcamp Drive Sub-Basin OS1.2.

**Sub-basin OS1.3** is located to the north of the proposed Hillcamp Drive roadway. Flows sheet flow down the existing slope towards Hillcamp drive. Flows will be conveyed via a proposed swale to DP P1.1 At this point flows enter the Retreat at Ridgeway Detention Facilities at **Existing Calibre DP 1.1**.

**Sub-basin OS2** is located to the southeast of the proposed Hillcamp Drive roadway. Flows sheet flow down the existing slopes towards a proposed rear wall concrete swale that will convey channelized flows to DP OS2 where a proposed Type D inlet is located. At this point flows enter the proposed Hillcamp Drive Storm infrastructure, flow is conveyed via storm sewer until outfalling to DP P2.1. At this point flows enter the Retreat at Ridgeway Detention Facilities at **Existing Calibre DP 2.1**.

**Sub-basin OS2.1** is located to the north of the proposed Hillcamp Drive roadway. Flows sheet flow down the existing slope towards an existing vegetated swale that will convey channelized flows to DP P2.1. At this point flows enter the Retreat at Ridgeway Detention Facilities at **Existing Calibre DP 2.1**.

**Sub-basin OS4** is located to the east of the proposed Hillcamp Drive roadway, just south of the proposed intersection of Hillcamp Drive and Viewside Drive. Flows sheet flow down the existing slopes towards a proposed trickle channel above retaining walls that will convey channelized flows to DP OS4 where a proposed Type D inlet is located. At this point flows enter the proposed Hillcamp Drive storm infrastructure, flow is conveyed via storm sewer until outfalling to DP C4.1. and ultimately into the Proposed Detention Pond at DP P. Flows are then treated and released from DP P4.1 into the existing Retreat at Ridgeway Storm Facilities at **Existing Calibre DP 4.1**. From this point the flows continue through the existing Retreat at Ridgeway Storm Facilities until outfalling into Cottonwood Creek at **Existing Calibre DP 4**. (See **Appendix D for detailed Pond Calculations, and Appendix E for relevant Calibre references.**)

**Sub-basin OS4.1** is located to the north of the proposed Hillcamp Drive roadway, just west of the proposed intersection of Hillcamp Drive and Viewside Drive. Flows sheet flow down the existing slopes towards an existing vegetated swale that will convey channelized flows to DP OS4.1 where a reinforced rundown is located. At this point flows enter the proposed Hillcamp Drive Detention Pond, flows are treated within the detention pond and released from DP P4.1 into the existing Retreat at Ridgeway Storm Facilities at **Existing Calibre DP 4.1**. From this point the flows continue through the existing Retreat at Ridgeway Storm Facilities until outfalling into Cottonwood Creek at **Existing Calibre DP 4**. (See **Appendix D for detailed Pond Calculations, and Appendix E for relevant Calibre references.**)

All of the basins described above are a slightly modified version of the OS basins found in the 2017 Calibre Drainage report. The previous 2017 Calibre Phase III Drainage Report took these developed flows into account when designing the downstream infrastructure, and as shown in Table 2 below the calculated flow rates hitting the downstream Retreat at Ridgeway Storm infrastructure has been reduced overall. There is a small increase in the 5-year storm flows for **Ex Calibre Design Points 2.1**, this can be explained by slight variations in where flows are being routed to, as well as the overall increase in imperviousness according to the March 2025 USDCM Volume 1 Chapter 6 updates (**See Appendix E for complete updated imperviousness chart**). Overall, the sum of flows hitting the downstream Retreat at Ridgeway Storm infrastructure is less than calculated by the 2017 Calibre report for Existing Calibre DP's 1.1 and 2.1. Existing Calibre DP 4.1 is seeing an increase in total flows, because of this, JR Engineering is proposing a Full Spectrum Detention Pond in place of the existing attenuation basin.

Below in **Table 2** is a summary of the affected existing **Calibre Design Points** in comparison to the flow rates calculated JR Engineering for this report, showing an overall reduction in total flows reaching the central channel within the Retreat at Ridgeway Development for both the Minor and Major storm events. This means that no negative downstream effects will occur with the addition of the proposed detention pond measuring flows to the pre-developed flow rates for **EX DP 4.1**.

**Table 2: Existing Calibre Design Point Assumed Flow Rates vs. Proposed Flow Rates**

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## 5 WATER QUALITY ENHANCEMENT BEST MANAGEMENT PRACTICES

### 5.1 Non-Structural BMP's

In several locations surrounding the proposed Hillcamp Drive roadway, there are existing vegetated drainageways that are being altered by the proposed improvements. These existing drainageways have steep slopes and dense vegetation. JR Engineering has made an effort to minimize impacts to these existing drainageways by minimizing grading daylight where possible, and leaving the drainageways as close to existing as possible. Where these drainageways are being affected by the proposed roadway grading, JR is

proposing 14' wide TRM-Lined (Turf Reinforcement Mat) swales. With 14' of TRM being the minimum width to achieve 1' of reinforcement above the 100 year WSEL. This will allow for the affected drainageways to re-establish vegetation as well as providing increased shear resistance due to the high velocities being produced upstream by the steep slopes within the existing drainageways. These TRM-Lined swales are shown in proposed Sub-Basins OS1.2 and OS1.3 on the Proposed Detailed Drainage Maps found in **Appendix F**. Flowmaster results can be found in **Appendix C**. The swales' capacity were calculated using the total flow from each sub-basin, based on this approach and the physical locations of the swales, they will never reach their max capacity.

Where the grading required retaining walls, JR Engineering is proposing 2' wide 6" depth concrete trickle channels behind the top of wall. These have been sized to convey the expected amount of flows without overtopping. Flowmaster results can be found in **Appendix C**

## 5.2 MS4 Permit Requirements

The Hillcamp Drive Roadway Basins meets the requirements of the "WQCV Standard" in accordance with CDPS General Permit COR090000, Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems (MS4s). All proposed Sub-Basins' flows resulting in an increased runoff from predeveloped condition are routed through the proposed Hillcamp Drive Storm System to the proposed full spectrum detention pond where they are treated for Water Quality and then discharged to their historic location at 90% of the pre-developed flows calculated in the **2017 Calibre report (See Appendix E for Calibre Calculations)**

- WQCV Standard: The control measure(s) is designed to provide treatment and/or infiltration of the WQCV and:
  1. 100% of the applicable development site is captured, except the permittee may exclude up to 20 percent, not to exceed 1 acre, of the applicable development site area when the permittee has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. In addition, the permittee must also determine that the implementation of a separate control measure for that portion of the site is not practicable (e.g., driveway access that drains directly to street).
  2. Evaluation of the minimum drain time shall be based on the pollutant removal mechanism and functionality of the control measure implemented. Consideration of drain time shall include maintaining vegetation necessary for operation of the control measure (e.g., wetland vegetation).

The proposed Sub-Basins OS1-OS1.3, and OS2-OS2.1 are showing a reduction in flows compared to the **2017 Calibre report (See Appendix E for Calibre Calculations)**. Therefore, no additional treatment will be proposed for these locations.

The **2017 Calibre Report** shows calculations for the downstream MS4 pond 311 and Cottonwood Creek flood control structure. These calculations are being referenced from the previous **April 2012 and December 2013 Drainage Reports by Merrick**. Within the **Calibre** report it is described that the downstream Pond 311, will provide water quality and detention for the (at the time of approval **2017**) future developed flows coming from the construction of the Hillcamp Subdivision and Hillcamp Drive. (**See Appendix E for Pond 311 and Tract O Access Road Drainage Report Excerpts**). Since the time of

Approval in 2017, Regulation #72 from the Cherry Creek Reservoir Control Regulation has been updated, triggering the requirement for upstream water quality and detention in the proposed Detention Pond.

## 6 CONCLUSIONS

### 6.1 Impact of Improvements

This proposed Hillcamp Drive Roadway development follows the assumed/existing drainage patterns shown in the **2012 MDP for Ridgeway - Cottonwood Creek Drainage Basin by Merrick and Company**, and the **2017 Calibre Ridgeway – Section 22, Filing No. 1 Phase III Drainage Report**. As shown by the CUHP results in **Appendix B** as well as **Table 2** above, even with the higher impervious values due to the aforementioned updates to the USDCM Volume 1, flows hitting the existing Retreat at Ridgeway infrastructure have been reduced for existing DP's 1.1 and 2.1. Therefore, this proposed Hillcamp Drive Roadway development will have no adverse impact on quantity, quality, or timing of stormwater discharges to its downstream tributary historic drainage systems.

Existing Calibre DP 4.1 saw an increase in flows, however the proposed detention pond is designed to treat these flows for water quality, and release them at 90% of the pre-developed flows. **(See Appendix D for detailed Pond Calculations, and Appendix E for relevant Calibre references.)**

### 6.2 Compliance with Applicable Criteria

For the Hillcamp Drive Proposed Storm Sewer system there will be several exemptions requested. The Hillcamp Drive Storm Sewer System was primarily designed with the intent of reducing erosion at each outfall as much as possible to protect the downstream natural environment. The “Storm Drainage Design and Technical Criteria” by Douglas County states the following in Section 9.8.1.

- *Minimum Velocity – The need to maintain a self-cleaning storm sewer system is recognized as a goal to minimize the costs for maintenance of storm sewer facilities. Sediment deposits, once established, are generally difficult to remove even with pressure cleaning equipment. A minimum velocity of 4-fps is required when the storm sewer pipes convey runoff from frequently occurring storm events...*
- *Hydraulic and Energy Grade Lines – The Major storm energy grade line must not rise past 1-foot below the final grade along the storm sewer system...*

There are several locations where due to the steep slopes across the existing topography, in order to meet the maximum velocity constraint, the major storm EGL constraint, as well as reducing the velocity at the outfall of each storm system, the minimum velocity inside the storm pipes cannot meet the 4 feet per second (fps) minimum. Drop manholes are being used to reduce the velocities in the major event, once flows have reduced for the 5-year storm event, the resulting velocities are below the required minimum of 4 fps. The areas that will have associated variance requests are described below **(All relevant Stormcad profiles can be found in Appendix C).**

#### 6.2.1 Minor Storm Velocity Exemptions

The 5YR stormcad profile for DP-01, DP-A, DP-B, and DP-C show areas where the velocity inside the storm pipe falls below 4 fps. This is due to several conditions limiting the design of the storm sewer. In order to meet maximum velocity requirements, as well as containing the major EGL to 1' below grade, several drop manholes were required. These drop manholes paired with gradual downstream conduit slope in order to meet criteria, leaves sub-4-fps velocities when the flow inside the pipe drops from major to



minor flows. This as well as limited cover, and also limited horizontal clearance due to property lines, limited the options to meet all of the County's storm design criteria.

This hydrologic analysis indicates that the proposed improvements will comply with the applicable drainage criteria for the "Storm Drainage Design and Technical Criteria" by Douglas County sparing these aforementioned criteria variance requests, Mile High Flood District "Urban Storm Drainage Criteria Manual", and will be consistent with the two (2) Drainage Studies and Master Drainage Plan that have been referenced throughout the report.

### 6.2.2 Major Storm EGL Cover Exemptions

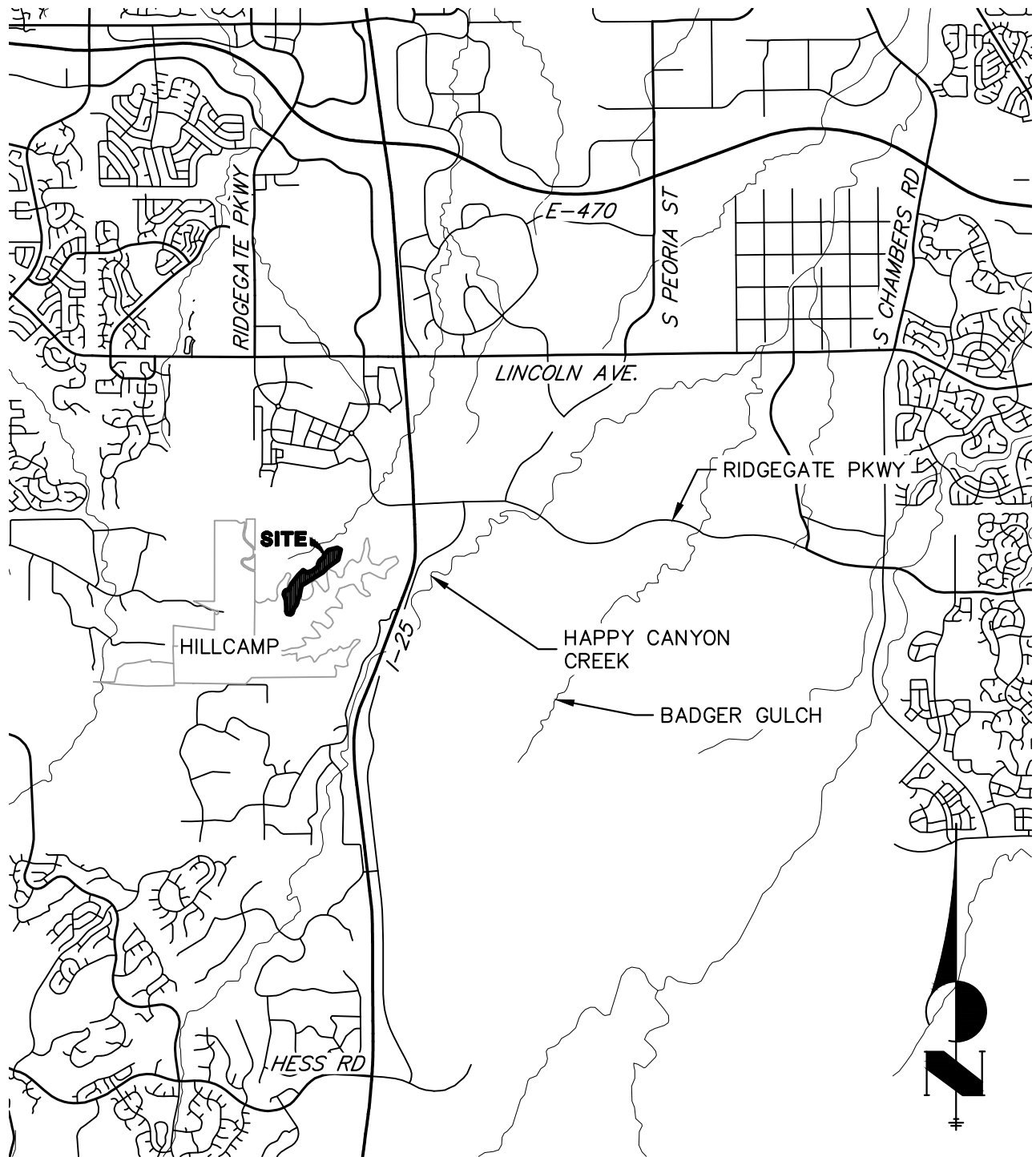
The 100YR stormcad profile for DP-OS2 shows an EGL elevation roughly 0.5' below the final grade along the storm sewer system. This is due to the lack of fall across this sewer system. In order to minimize cut and impacts to surrounding vegetation, this system is seeing a slight EGL rise. The inlet seeing these EGL's out of criteria, are located in a location that will pose no negative impacts upstream due to these EGL's.

## 7 REFERENCES

1. MASTER DRAINAGE PLAN FOR RIDGEGATE – COTTONWOOD CREEK DRAINAGE BASIN; Merrick and Company, January 2012.
2. Ridgegate – Section 22, Filing No.1 Phase 3 Drainage Report –; Calibre Engineering, January 2017.
3. PHASE 3 DRAINAGE REPORT FOR TRACT O ACCESS ROAD (COTTONWOOD CREEK FLOW CONTROL STRUCTURE) RAMPART RANGE METRO DISTRICT;– MERRICK AND COMPANY (APRIL 2012)
4. PHASE 3 DRAINAGE REPORT FOR HILLCAMP;– JR ENGINEERING (IN REVIEW AT TIME OF THIS REPORT)
5. PHASE 3 DRAINAGE REPORT FOR DETENTION POND 311 RETROFIT RAMPART RANGE METRO DISTRICT;– MERRICK AND COMPANY (DECEMBER 2013)
6. Storm Drainage Design and Technical Criteria; Douglas County, Updated June 2022.
7. Urban Storm Drainage Criteria Manual Volumes I, II and III; Mile High Flood District, Updated March 2024.
8. CDPS General Permit COR090000, Stormwater Discharges Associated With Municipal Separate Storm Sewers (MS4s), Authorization to Discharge Under the Colorado Discharge Permit System; Colorado Department of Public Health and Environment, Effective May 2018.

# **APPENDIX A**

## **FIGURES**



## VICINITY MAP

SCALE 1"=5000'

15950.02  
01/10/2022  
SHEET 1 OF 1

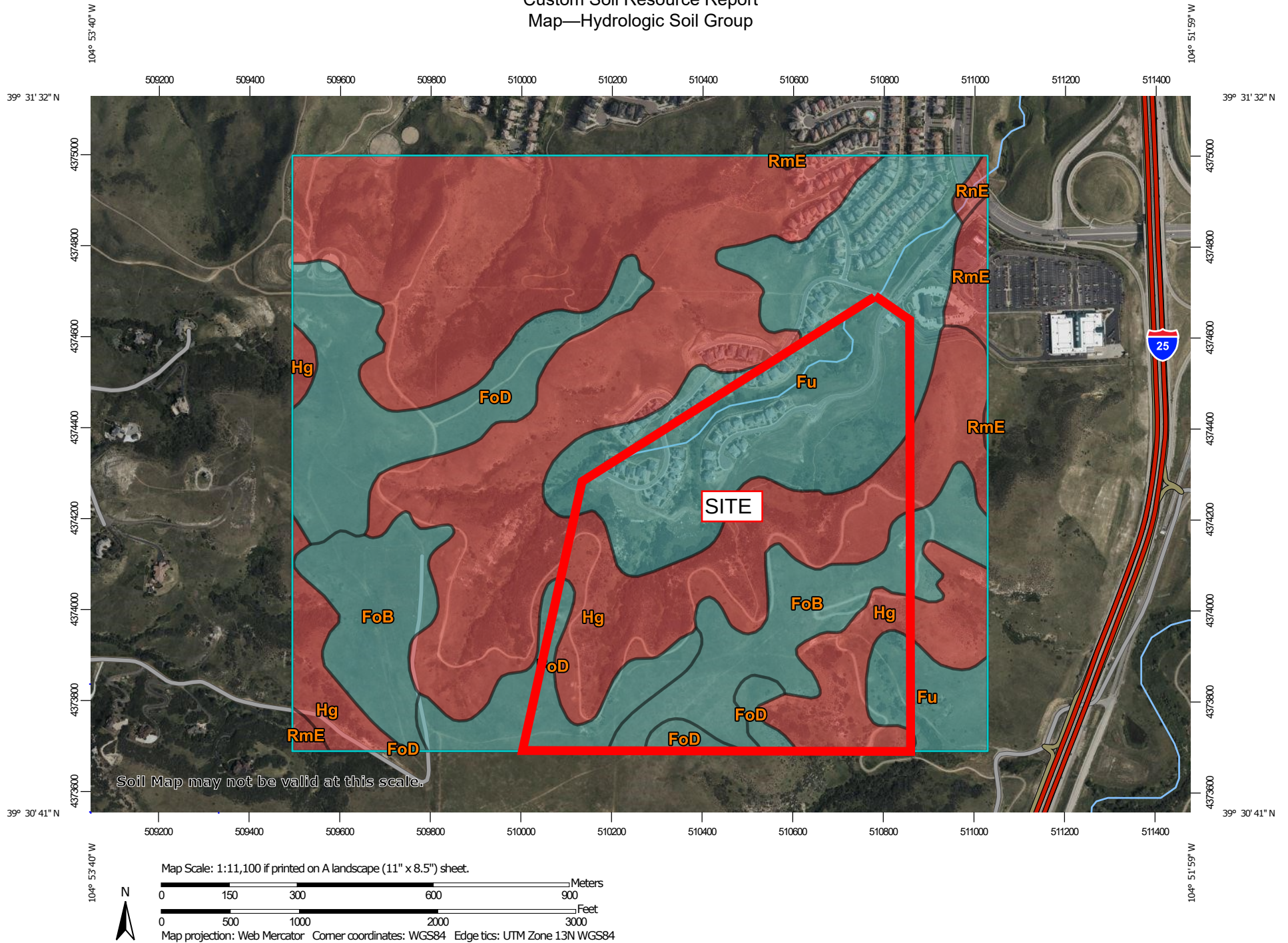


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# Custom Soil Resource Report Map—Hydrologic Soil Group



## Custom Soil Resource Report

### MAP LEGEND

#### Area of Interest (AOI)

 Area of Interest (AOI)

#### Soils

##### Soil Rating Polygons

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

##### Soil Rating Lines

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

##### Soil Rating Points

 A  
 A/D  
 B  
 B/D

 C  
 C/D  
 D  
 Not rated or not available

#### Water Features

 Streams and Canals

#### Transportation

 Rails  
 Interstate Highways  
 US Routes  
 Major Roads  
 Local Roads

#### Background

 Aerial Photography

### MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Castle Rock Area, Colorado  
Survey Area Data: Version 17, Aug 29, 2024

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

Date(s) aerial images were photographed: Mar 1, 2023—Sep 1, 2023

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

**Table—Hydrologic Soil Group**

| Map unit symbol                    | Map unit name                                         | Rating | Acres in AOI | Percent of AOI |
|------------------------------------|-------------------------------------------------------|--------|--------------|----------------|
| FoB                                | Fondis clay loam, 1 to 3 percent slopes               | C      | 57.8         | 11.6%          |
| FoD                                | Fondis clay loam, 3 to 9 percent slopes               | C      | 65.0         | 13.0%          |
| Fu                                 | Fondis-Kutch association                              | C      | 108.2        | 21.7%          |
| Hg                                 | Hilly gravelly land                                   | D      | 259.4        | 52.0%          |
| RmE                                | Renohill-Buick complex, 5 to 25 percent slopes        | D      | 6.9          | 1.4%           |
| RnE                                | Renohill-Manzanola clay loams, 3 to 20 percent slopes | D      | 1.5          | 0.3%           |
| <b>Totals for Area of Interest</b> |                                                       |        | <b>498.7</b> | <b>100.0%</b>  |

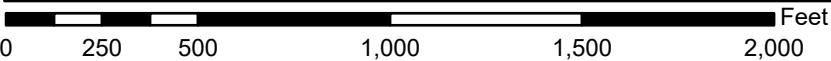
**Rating Options—Hydrologic Soil Group***Aggregation Method: Dominant Condition**Component Percent Cutoff: None Specified**Tie-break Rule: Higher*



# National Flood Hazard Layer FIRMette



104°52'58"W 39°31'20"N



1:6,000

104°52'21"W 39°30'52"N

Basemap Imagery Source: USGS National Map 2023

## Legend

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

|                             |  |                                                                                                                                                                          |
|-----------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SPECIAL FLOOD HAZARD AREAS  |  | Without Base Flood Elevation (BFE)<br><i>Zone A, V, A99</i>                                                                                                              |
|                             |  | With BFE or Depth <i>Zone AE, AO, AH, VE, AR</i>                                                                                                                         |
|                             |  | Regulatory Floodway                                                                                                                                                      |
| OTHER AREAS OF FLOOD HAZARD |  | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile <i>Zone X</i> |
|                             |  | Future Conditions 1% Annual Chance Flood Hazard <i>Zone X</i>                                                                                                            |
|                             |  | Area with Reduced Flood Risk due to Levee. See Notes. <i>Zone X</i>                                                                                                      |
|                             |  | Area with Flood Risk due to Levee <i>Zone D</i>                                                                                                                          |
| OTHER AREAS                 |  | NO SCREEN Area of Minimal Flood Hazard <i>Zone X</i>                                                                                                                     |
|                             |  | Effective LOMRs                                                                                                                                                          |
|                             |  | Area of Undetermined Flood Hazard <i>Zone D</i>                                                                                                                          |
| GENERAL STRUCTURES          |  | Channel, Culvert, or Storm Sewer                                                                                                                                         |
|                             |  | Levee, Dike, or Floodwall                                                                                                                                                |
| OTHER FEATURES              |  | 20.2 Cross Sections with 1% Annual Chance Water Surface Elevation                                                                                                        |
|                             |  | 17.5                                                                                                                                                                     |
|                             |  | Coastal Transect                                                                                                                                                         |
|                             |  | Base Flood Elevation Line (BFE)                                                                                                                                          |
|                             |  | Limit of Study                                                                                                                                                           |
|                             |  | Jurisdiction Boundary                                                                                                                                                    |
|                             |  | Coastal Transect Baseline                                                                                                                                                |
|                             |  | Profile Baseline                                                                                                                                                         |
| MAP PANELS                  |  | Digital Data Available                                                                                                                                                   |
|                             |  | No Digital Data Available                                                                                                                                                |
|                             |  | Unmapped                                                                                                                                                                 |



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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **3/18/2025 at 7:39 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

## **APPENDIX B**

### **HYDROLOGY**



COMPOSITE % IMPERVIOUS CALCULATIONS

Subdivision: Hillcamp Drive Extension  
Location: Lone Tree

| Basin ID                  | Total Area (ac) | SFH-Low |           |                 | SFH-Rural |           |                 | Asphalt/Walk |           |                 | Maintenance Path |           |                 | Receiving Pervious Area |           |                 | Undisturbed Native Grasses |           |                 | Extended Detention Basin |           |                 | Basins Total Weighted % Imp. |
|---------------------------|-----------------|---------|-----------|-----------------|-----------|-----------|-----------------|--------------|-----------|-----------------|------------------|-----------|-----------------|-------------------------|-----------|-----------------|----------------------------|-----------|-----------------|--------------------------|-----------|-----------------|------------------------------|
|                           |                 | % Imp.  | Area (ac) | Weighted % Imp. | % Imp.    | Area (ac) | Weighted % Imp. | % Imp.       | Area (ac) | Weighted % Imp. | % Imp.           | Area (ac) | Weighted % Imp. | % Imp.                  | Area (ac) | Weighted % Imp. | % Imp.                     | Area (ac) | Weighted % Imp. | % Imp.                   | Area (ac) | Weighted % Imp. |                              |
| A1                        | 9.76            | 55%     | 0.44      | 2.5%            | 35%       | 0.00      | 0.0%            | 95%          | 1.06      | 10.3%           | 60%              | 0.30      | 1.8%            | 20%                     | 0.00      | 0.0%            | 5%                         | 7.96      | 4.1%            | 25%                      | 0.00      | 0.0%            | 18.7%                        |
| A2                        | 2.30            | 55%     | 0.33      | 7.9%            | 35%       | 0.00      | 0.0%            | 95%          | 0.68      | 28.0%           | 60%              | 0.08      | 2.2%            | 20%                     | 0.00      | 0.0%            | 5%                         | 1.21      | 2.6%            | 25%                      | 0.00      | 0.0%            | 40.7%                        |
| B1                        | 0.32            | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.23      | 68.3%           | 60%              | 0.00      | 0.0%            | 20%                     | 0.00      | 0.0%            | 5%                         | 0.09      | 1.4%            | 25%                      | 0.00      | 0.0%            | 69.7%                        |
| B2                        | 0.40            | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.15      | 35.6%           | 60%              | 0.00      | 0.0%            | 20%                     | 0.00      | 0.0%            | 5%                         | 0.25      | 3.1%            | 25%                      | 0.00      | 0.0%            | 38.8%                        |
| C1                        | 1.20            | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.45      | 35.0%           | 60%              | 0.00      | 0.0%            | 20%                     | 0.00      | 0.0%            | 5%                         | 0.75      | 3.1%            | 25%                      | 0.00      | 0.0%            | 38.8%                        |
| C2                        | 1.26            | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.28      | 21.1%           | 60%              | 0.00      | 0.0%            | 20%                     | 0.00      | 0.0%            | 5%                         | 0.98      | 3.9%            | 25%                      | 0.00      | 0.0%            | 23.0%                        |
| OS1.1                     | 9.76            | 55%     | 0.41      | 2.3%            | 35%       | 0.00      | 0.0%            | 95%          | 0.02      | 0.2%            | 60%              | 0.23      | 1.4%            | 20%                     | 0.24      | 0.5%            | 5%                         | 8.87      | 4.5%            | 25%                      | 0.00      | 0.0%            | 8.9%                         |
| OS1.2                     | 13.12           | 55%     | 0.00      | 0.0%            | 35%       | 4.44      | 11.8%           | 95%          | 0.02      | 0.1%            | 60%              | 0.23      | 1.1%            | 20%                     | 0.03      | 0.0%            | 5%                         | 8.40      | 3.2%            | 25%                      | 0.00      | 0.0%            | 16.3%                        |
| OS1.3                     | 4.59            | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.05      | 0.2%            | 60%              | 0.04      | 0.5%            | 20%                     | 0.11      | 0.5%            | 5%                         | 4.43      | 4.8%            | 25%                      | 0.00      | 0.0%            | 6.0%                         |
| OS2                       | 12.51           | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.00      | 0.0%            | 60%              | 0.42      | 2.0%            | 20%                     | 0.00      | 0.0%            | 5%                         | 12.09     | 4.8%            | 25%                      | 0.00      | 0.0%            | 6.8%                         |
| OS2.1                     | 0.62            | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.00      | 0.0%            | 60%              | 0.00      | 0.0%            | 20%                     | 0.09      | 2.9%            | 5%                         | 0.53      | 4.3%            | 25%                      | 0.00      | 0.0%            | 7.2%                         |
| OS4                       | 12.68           | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.02      | 0.1%            | 60%              | 0.32      | 1.5%            | 20%                     | 0.00      | 0.0%            | 5%                         | 12.34     | 4.9%            | 25%                      | 0.00      | 0.0%            | 6.5%                         |
| OS4.1                     | 1.64            | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.00      | 0.0%            | 60%              | 0.00      | 0.0%            | 20%                     | 0.04      | 0.5%            | 5%                         | 1.60      | 4.9%            | 25%                      | 0.00      | 0.0%            | 5.4%                         |
| P                         | 1.20            | 55%     | 0.00      | 0.0%            | 35%       | 0.00      | 0.0%            | 95%          | 0.00      | 0.0%            | 60%              | 0.00      | 0.0%            | 20%                     | 0.00      | 0.0%            | 5%                         | 0.90      | 3.8%            | 25%                      | 0.30      | 6.3%            | 10.0%                        |
| Total                     | 71.36           |         |           |                 |           |           |                 |              |           |                 |                  |           |                 |                         |           |                 |                            |           |                 |                          |           |                 | 12.81%                       |
| OFFSITE TOTAL             | 40.60           |         |           |                 |           |           |                 |              |           |                 |                  |           |                 |                         |           |                 |                            |           |                 |                          |           |                 | 10.30%                       |
| MODIFIED EX WQ POND TOTAL | 30.76           |         |           |                 |           |           |                 |              |           |                 |                  |           |                 |                         |           |                 |                            |           |                 |                          |           |                 | 16.11%                       |

# COMPOSITE RUNOFF COEFFICIENT CALCULATIONS

Subdivision: Hillcamp Drive Extension

Location: Lone Tree

Project Name: Hillcamp Drive

Project No.: 15950.18

Calculated By: BMP

Checked By: BMP

Date: 11/11/25

| Basin ID | Total Area (ac) | Basins Total Weighted % Imp. | Hydrologic Soil Group |             |               | Hydrologic Soil Group |          |            | Minor Coefficients |                  |                    | Major Coefficients |                    |                      | Basins Total Weighted C <sub>5</sub> | Basins Total Weighted C <sub>100</sub> |
|----------|-----------------|------------------------------|-----------------------|-------------|---------------|-----------------------|----------|------------|--------------------|------------------|--------------------|--------------------|--------------------|----------------------|--------------------------------------|----------------------------------------|
|          |                 |                              | Area A (ac)           | Area B (ac) | Area C/D (ac) | % A (ac)              | % B (ac) | % C/D (ac) | C <sub>5,A</sub>   | C <sub>5,B</sub> | C <sub>5,C/D</sub> | C <sub>100,A</sub> | C <sub>100,B</sub> | C <sub>100,C/D</sub> |                                      |                                        |
| A1       | 9.76            | 18.7%                        | 0.00                  | 0.00        | 9.76          | 0%                    | 0%       | 100%       | 0.10               | 0.14             | 0.19               | 0.26               | 0.51               | 0.56                 | 0.19                                 | 0.56                                   |
| A2       | 2.30            | 40.7%                        | 0.00                  | 0.00        | 2.30          | 0%                    | 0%       | 100%       | 0.27               | 0.32             | 0.37               | 0.43               | 0.62               | 0.65                 | 0.37                                 | 0.65                                   |
| B1       | 0.32            | 69.7%                        | 0.00                  | 0.00        | 0.32          | 0%                    | 0%       | 100%       | 0.54               | 0.58             | 0.61               | 0.65               | 0.75               | 0.77                 | 0.61                                 | 0.77                                   |
| B2       | 0.40            | 38.8%                        | 0.00                  | 0.00        | 0.40          | 0%                    | 0%       | 100%       | 0.26               | 0.31             | 0.35               | 0.41               | 0.61               | 0.64                 | 0.35                                 | 0.64                                   |
| C1       | 1.20            | 38.8%                        | 0.00                  | 0.00        | 1.20          | 0%                    | 0%       | 100%       | 0.26               | 0.31             | 0.35               | 0.41               | 0.61               | 0.64                 | 0.35                                 | 0.64                                   |
| C2       | 1.26            | 25.0%                        | 0.00                  | 0.00        | 1.26          | 0%                    | 0%       | 100%       | 0.15               | 0.19             | 0.24               | 0.31               | 0.54               | 0.59                 | 0.24                                 | 0.59                                   |
| OS1.1    | 9.76            | 8.9%                         | 0.00                  | 0.00        | 9.76          | 0%                    | 0%       | 100%       | 0.04               | 0.06             | 0.11               | 0.18               | 0.47               | 0.52                 | 0.11                                 | 0.52                                   |
| OS1.2    | 13.12           | 16.3%                        | 0.00                  | 0.00        | 13.12         | 0%                    | 0%       | 100%       | 0.09               | 0.12             | 0.17               | 0.24               | 0.50               | 0.55                 | 0.17                                 | 0.55                                   |
| OS1.3    | 4.59            | 6.0%                         | 0.00                  | 0.00        | 4.59          | 0%                    | 0%       | 100%       | 0.02               | 0.04             | 0.08               | 0.16               | 0.45               | 0.51                 | 0.08                                 | 0.51                                   |
| OS2      | 12.51           | 6.8%                         | 0.00                  | 0.00        | 12.51         | 0%                    | 0%       | 100%       | 0.03               | 0.05             | 0.09               | 0.16               | 0.46               | 0.51                 | 0.09                                 | 0.51                                   |
| OS2.1    | 0.62            | 7.2%                         | 0.00                  | 0.00        | 0.62          | 0%                    | 0%       | 100%       | 0.03               | 0.05             | 0.09               | 0.17               | 0.46               | 0.51                 | 0.09                                 | 0.51                                   |
| OS4      | 12.68           | 6.5%                         | 0.00                  | 0.00        | 12.68         | 0%                    | 0%       | 100%       | 0.03               | 0.04             | 0.09               | 0.16               | 0.46               | 0.51                 | 0.09                                 | 0.51                                   |
| OS4.1    | 1.64            | 5.4%                         | 0.00                  | 0.00        | 1.64          | 0%                    | 0%       | 100%       | 0.02               | 0.04             | 0.08               | 0.15               | 0.45               | 0.51                 | 0.08                                 | 0.51                                   |
| P        | 1.20            | 10.0%                        | 0.00                  | 0.00        | 1.20          | 0%                    | 0%       | 100%       | 0.05               | 0.07             | 0.12               | 0.19               | 0.47               | 0.52                 | 0.12                                 | 0.52                                   |

SYR

**Summary of CUHP Input Parameters (Version 2.0.1)**

| Catchment Name/ID | SWMM Node/ID | Raingage Name/ID | Area<br>(sq.mi.) | Dist. to<br>Centroid<br>(miles) | Length<br>(miles) | Slope<br>(ft./ft.) | Percent<br>Imperv. | Depression Storage   |                     | Horton's Infiltration Parameters |                         |                             | DCIA Level and Fractions |                                    |                              | Percent Eff.<br>Imperv. |
|-------------------|--------------|------------------|------------------|---------------------------------|-------------------|--------------------|--------------------|----------------------|---------------------|----------------------------------|-------------------------|-----------------------------|--------------------------|------------------------------------|------------------------------|-------------------------|
|                   |              |                  |                  |                                 |                   |                    |                    | Pervious<br>(inches) | Imperv.<br>(inches) | Initial Rate<br>(in./hr.)        | Final Rate<br>(in./hr.) | Decay<br>Coeff.<br>(1/sec.) | DCIA Level               | Dir. Con'ct<br>Imperv.<br>Fraction | Receiv.<br>Perv.<br>Fraction |                         |
| A1                | S-A1         | LONE TREE 5      | 0.015            | 0.184                           | 0.341             | 0.070              | 18.7               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.37                               | 0.13                         | 16.15                   |
| A2                | S-A2         | LONE TREE 5      | 0.004            | 0.170                           | 0.343             | 0.057              | 40.1               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.80                               | 0.20                         | 38.06                   |
| B1                | S-B1         | LONE TREE 5      | 0.001            | 0.024                           | 0.085             | 0.057              | 69.7               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.92                               | 0.30                         | 68.24                   |
| B2                | S-B2         | LONE TREE 5      | 0.001            | 0.037                           | 0.086             | 0.057              | 38.8               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.78                               | 0.20                         | 36.63                   |
| C1                | S-C1         | LONE TREE 5      | 0.002            | 0.087                           | 0.169             | 0.057              | 38.8               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.78                               | 0.20                         | 36.63                   |
| C2                | S-C2         | LONE TREE 5      | 0.002            | 0.079                           | 0.170             | 0.057              | 25.0               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.50                               | 0.15                         | 22.26                   |
| OS1.1             | S-OS1.1      | LONE TREE 5      | 0.015            | 0.163                           | 0.196             | 0.077              | 8.9                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.10                               | 0.18                         | 6.70                    |
| OS1.2             | S-OS1.2      | LONE TREE 5      | 0.021            | 0.102                           | 0.313             | 0.086              | 16.3               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.19                               | 0.23                         | 12.97                   |
| OS1.3             | S-OS1.4      | LONE TREE 5      | 0.007            | 0.105                           | 0.200             | 0.133              | 6.0                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.07                               | 0.12                         | 4.47                    |
| OS2               | S-OS2        | LONE TREE 5      | 0.020            | 0.104                           | 0.191             | 0.097              | 6.8                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.07                               | 0.14                         | 5.08                    |
| OS2.1             | S-OS2.1      | LONE TREE 5      | 0.001            | 0.038                           | 0.152             | 0.160              | 7.2                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.00                               | 0.14                         | 5.27                    |
| OS4               | S-OS4        | LONE TREE 5      | 0.020            | 0.098                           | 0.227             | 0.100              | 6.5                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.07                               | 0.13                         | 4.85                    |
| OS4.1             | S-OS4.1      | LONE TREE 5      | 0.003            | 0.081                           | 0.161             | 0.050              | 5.4                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.00                               | 0.11                         | 3.94                    |
| P                 | S-P          | LONE TREE 5      | 0.002            | 0.033                           | 0.074             | 0.005              | 10.0               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.11                               | 0.20                         | 7.56                    |

5YR

**Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)**

| Catchment Name/ID | Unit Hydrograph Parameters and Results |       |               |                       |               |                       |                           |            |                 | Excess Precip.     |                  | Storm Hydrograph          |                    |                           |                                       |
|-------------------|----------------------------------------|-------|---------------|-----------------------|---------------|-----------------------|---------------------------|------------|-----------------|--------------------|------------------|---------------------------|--------------------|---------------------------|---------------------------------------|
|                   | CT                                     | Cp    | W50<br>(min.) | W50<br>Before<br>Peak | W75<br>(min.) | W75<br>Before<br>Peak | Time to<br>Peak<br>(min.) | Peak (cfs) | Volume<br>(c.f) | Excess<br>(inches) | Excess<br>(c.f.) | Time to<br>Peak<br>(min.) | Peak Flow<br>(cfs) | Total<br>Volume<br>(c.f.) | Runoff per<br>Unit Area<br>(cfs/acre) |
| A1                | 0.116                                  | 0.056 | 48.4          | 3.59                  | 25.2          | 2.54                  | 6.0                       | 9          | 35,429          | 0.24               | 8,529            | 40.0                      | 1.66               | 8,505                     | 0.17                                  |
| A2                | 0.094                                  | 0.037 | 60.1          | 3.22                  | 31.3          | 2.28                  | 5.4                       | 2          | 8,349           | 0.47               | 3,893            | 40.0                      | 0.55               | 3,880                     | 0.24                                  |
| B1                | 0.081                                  | 0.020 | 19.2          | 1.80                  | 10.0          | 1.27                  | 3.0                       | 1          | 1,162           | 0.78               | 908              | 30.0                      | 0.28               | 864                       | 0.87                                  |
| B2                | 0.095                                  | 0.017 | 33.7          | 1.93                  | 17.5          | 1.36                  | 3.2                       | 1          | 1,452           | 0.45               | 656              | 35.0                      | 0.15               | 638                       | 0.37                                  |
| C1                | 0.095                                  | 0.027 | 42.9          | 2.40                  | 22.3          | 1.69                  | 4.0                       | 1          | 4,356           | 0.45               | 1,967            | 35.0                      | 0.37               | 1,937                     | 0.30                                  |
| C2                | 0.108                                  | 0.022 | 57.7          | 2.47                  | 30.0          | 1.75                  | 4.1                       | 1          | 4,574           | 0.30               | 1,394            | 40.0                      | 0.22               | 1,380                     | 0.18                                  |
| OS1.1             | 0.138                                  | 0.064 | 36.0          | 3.26                  | 18.7          | 2.30                  | 5.4                       | 13         | 35,429          | 0.14               | 4,867            | 35.0                      | 1.44               | 4,842                     | 0.15                                  |
| OS1.2             | 0.121                                  | 0.066 | 29.7          | 3.00                  | 15.5          | 2.12                  | 5.0                       | 21         | 47,626          | 0.20               | 9,725            | 35.0                      | 3.10               | 9,630                     | 0.24                                  |
| OS1.3             | 0.146                                  | 0.048 | 36.6          | 2.84                  | 19.0          | 2.01                  | 4.7                       | 6          | 16,662          | 0.11               | 1,899            | 35.0                      | 0.57               | 1,880                     | 0.12                                  |
| OS2               | 0.144                                  | 0.074 | 24.4          | 2.89                  | 12.7          | 2.04                  | 4.8                       | 24         | 45,411          | 0.12               | 5,466            | 35.0                      | 2.29               | 5,383                     | 0.18                                  |
| OS2.1             | 0.143                                  | 0.019 | 46.1          | 2.17                  | 24.0          | 1.54                  | 3.6                       | 1          | 2,251           | 0.12               | 276              | 40.0                      | 0.07               | 271                       | 0.11                                  |
| OS4               | 0.145                                  | 0.075 | 25.5          | 2.96                  | 13.3          | 2.09                  | 4.9                       | 23         | 46,028          | 0.12               | 5,430            | 35.0                      | 2.22               | 5,362                     | 0.17                                  |
| OS4.1             | 0.148                                  | 0.030 | 58.7          | 2.87                  | 30.5          | 2.03                  | 4.8                       | 1          | 5,953           | 0.11               | 646              | 40.0                      | 0.13               | 642                       | 0.08                                  |
| P                 | 0.135                                  | 0.024 | 51.8          | 2.47                  | 26.9          | 1.74                  | 4.1                       | 1          | 4,356           | 0.15               | 638              | 40.0                      | 0.14               | 630                       | 0.11                                  |

| DESIGN POINT<br>TOTALS | Peak Flow<br>(cfs) |
|------------------------|--------------------|
| P1.1                   | 5.11               |
| P2.1                   | 2.36               |
| P4.1                   | 5.71               |

100YR

**Summary of CUHP Input Parameters (Version 2.0.1)**

| Catchment Name/ID | SWMM Node/ID | Raingage Name/ID | Area<br>(sq.mi.) | Dist. to<br>Centroid<br>(miles) | Length<br>(miles) | Slope<br>(ft./ft.) | Percent<br>Imperv. | Depression Storage   |                     | Horton's Infiltration Parameters |                         |                             | DCIA Level and Fractions |                                    |                              | Percent Eff.<br>Imperv. |
|-------------------|--------------|------------------|------------------|---------------------------------|-------------------|--------------------|--------------------|----------------------|---------------------|----------------------------------|-------------------------|-----------------------------|--------------------------|------------------------------------|------------------------------|-------------------------|
|                   |              |                  |                  |                                 |                   |                    |                    | Pervious<br>(inches) | Imperv.<br>(inches) | Initial Rate<br>(in./hr.)        | Final Rate<br>(in./hr.) | Decay<br>Coeff.<br>(1/sec.) | DCIA Level               | Dir. Con'ct<br>Imperv.<br>Fraction | Receiv.<br>Perv.<br>Fraction |                         |
| A1                | S-A1         | LONE TREE 100    | 0.015            | 0.184                           | 0.341             | 0.070              | 18.7               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.37                               | 0.13                         | 17.38                   |
| A2                | S-A2         | LONE TREE 100    | 0.004            | 0.170                           | 0.343             | 0.057              | 40.1               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.80                               | 0.20                         | 39.01                   |
| B1                | S-B1         | LONE TREE 100    | 0.001            | 0.024                           | 0.085             | 0.057              | 69.7               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.92                               | 0.30                         | 68.92                   |
| B2                | S-B2         | LONE TREE 100    | 0.001            | 0.037                           | 0.086             | 0.057              | 38.8               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.78                               | 0.20                         | 37.65                   |
| C1                | S-C1         | LONE TREE 100    | 0.002            | 0.087                           | 0.169             | 0.057              | 38.8               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.78                               | 0.20                         | 37.65                   |
| C2                | S-C2         | LONE TREE 100    | 0.002            | 0.079                           | 0.170             | 0.057              | 25.0               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 0.00                     | 0.50                               | 0.15                         | 23.58                   |
| OS1.1             | S-OS1.1      | LONE TREE 100    | 0.015            | 0.163                           | 0.196             | 0.077              | 8.9                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.10                               | 0.18                         | 7.71                    |
| OS1.2             | S-OS1.2      | LONE TREE 100    | 0.021            | 0.102                           | 0.313             | 0.086              | 16.3               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.19                               | 0.23                         | 14.52                   |
| OS1.3             | S-OS1.4      | LONE TREE 100    | 0.007            | 0.105                           | 0.200             | 0.133              | 6.0                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.07                               | 0.12                         | 5.17                    |
| OS2               | S-OS2        | LONE TREE 100    | 0.020            | 0.104                           | 0.191             | 0.097              | 6.8                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.07                               | 0.14                         | 5.87                    |
| OS2.1             | S-OS2.1      | LONE TREE 100    | 0.001            | 0.038                           | 0.152             | 0.160              | 7.2                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.00                               | 0.14                         | 6.15                    |
| OS4               | S-OS4        | LONE TREE 100    | 0.020            | 0.098                           | 0.227             | 0.100              | 6.5                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.07                               | 0.13                         | 5.60                    |
| OS4.1             | S-OS4.1      | LONE TREE 100    | 0.003            | 0.081                           | 0.161             | 0.050              | 5.4                | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.00                               | 0.11                         | 4.61                    |
| P                 | S-P          | LONE TREE 100    | 0.002            | 0.033                           | 0.074             | 0.005              | 10.0               | 0.35                 | 0.10                | 3.00                             | 0.50                    | 0.0018                      | 1.00                     | 0.11                               | 0.20                         | 8.68                    |

100YR

**Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)**

| Catchment Name/ID | Unit Hydrograph Parameters and Results |       |               |                       |               |                       |                           |            |                 | Excess Precip.     |                  | Storm Hydrograph          |                    |                           |                                       |
|-------------------|----------------------------------------|-------|---------------|-----------------------|---------------|-----------------------|---------------------------|------------|-----------------|--------------------|------------------|---------------------------|--------------------|---------------------------|---------------------------------------|
|                   | CT                                     | Cp    | W50<br>(min.) | W50<br>Before<br>Peak | W75<br>(min.) | W75<br>Before<br>Peak | Time to<br>Peak<br>(min.) | Peak (cfs) | Volume<br>(c.f) | Excess<br>(inches) | Excess<br>(c.f.) | Time to<br>Peak<br>(min.) | Peak Flow<br>(cfs) | Total<br>Volume<br>(c.f.) | Runoff per<br>Unit Area<br>(cfs/acre) |
| A1                | 0.114                                  | 0.056 | 47.9          | 3.56                  | 24.9          | 2.52                  | 5.9                       | 10         | 35,429          | 1.46               | 51,777           | 50.0                      | 10.28              | 51,632                    | 1.05                                  |
| A2                | 0.094                                  | 0.038 | 58.9          | 3.22                  | 30.6          | 2.27                  | 5.4                       | 2          | 8,349           | 1.70               | 14,211           | 50.0                      | 2.29               | 14,160                    | 1.00                                  |
| B1                | 0.080                                  | 0.020 | 19.1          | 1.80                  | 10.0          | 1.27                  | 3.0                       | 1          | 1,162           | 2.04               | 2,372            | 35.0                      | 0.76               | 2,256                     | 2.37                                  |
| B2                | 0.094                                  | 0.017 | 33.0          | 1.93                  | 17.2          | 1.36                  | 3.2                       | 1          | 1,452           | 1.69               | 2,450            | 40.0                      | 0.59               | 2,383                     | 1.47                                  |
| C1                | 0.094                                  | 0.028 | 42.0          | 2.39                  | 21.8          | 1.69                  | 4.0                       | 1          | 4,356           | 1.69               | 7,350            | 45.0                      | 1.51               | 7,239                     | 1.26                                  |
| C2                | 0.106                                  | 0.022 | 56.9          | 2.46                  | 29.6          | 1.74                  | 4.1                       | 1          | 4,574           | 1.53               | 7,006            | 50.0                      | 1.19               | 6,933                     | 0.95                                  |
| OS1.1             | 0.134                                  | 0.062 | 35.9          | 3.21                  | 18.7          | 2.27                  | 5.4                       | 13         | 35,429          | 1.34               | 47,644           | 45.0                      | 12.08              | 47,374                    | 1.24                                  |
| OS1.2             | 0.118                                  | 0.065 | 29.4          | 2.97                  | 15.3          | 2.10                  | 4.9                       | 21         | 47,626          | 1.42               | 67,772           | 40.0                      | 19.39              | 67,071                    | 1.48                                  |
| OS1.3             | 0.144                                  | 0.047 | 36.5          | 2.82                  | 19.0          | 1.99                  | 4.7                       | 6          | 16,662          | 1.32               | 21,952           | 45.0                      | 5.48               | 21,719                    | 1.19                                  |
| OS2               | 0.141                                  | 0.073 | 24.4          | 2.86                  | 12.7          | 2.02                  | 4.8                       | 24         | 45,411          | 1.32               | 60,169           | 40.0                      | 19.93              | 59,206                    | 1.59                                  |
| OS2.1             | 0.140                                  | 0.019 | 46.0          | 2.16                  | 23.9          | 1.52                  | 3.6                       | 1          | 2,251           | 1.33               | 2,987            | 45.0                      | 0.62               | 2,938                     | 1.00                                  |
| OS4               | 0.142                                  | 0.073 | 25.4          | 2.93                  | 13.2          | 2.07                  | 4.9                       | 23         | 46,028          | 1.32               | 60,858           | 40.0                      | 19.71              | 60,053                    | 1.55                                  |
| OS4.1             | 0.146                                  | 0.030 | 58.6          | 2.85                  | 30.5          | 2.01                  | 4.7                       | 1          | 5,953           | 1.31               | 7,806            | 50.0                      | 1.37               | 7,754                     | 0.84                                  |
| P                 | 0.131                                  | 0.024 | 51.5          | 2.44                  | 26.8          | 1.72                  | 4.1                       | 1          | 4,356           | 1.36               | 5,903            | 50.0                      | 1.13               | 5,833                     | 0.94                                  |

| DESIGN POINT<br>TOTALS | Peak Flow<br>(cfs) |
|------------------------|--------------------|
| P1.1                   | 36.95              |
| P2.1                   | 20.55              |
| P4.1                   | 38.83              |

**Subdivision:** Hillcamp Drive Extension**Project No.:** 15950.18**Location:** Lone Tree**Date:** 11/11/25**SUB-BASIN SUMMARY TABLE (CUHP-SWMM)**

| <b>Tributary<br/>Sub-basin</b>   | <b>Area<br/>(acres)</b> | <b>Percent<br/>Impervious</b> | <b>C<sub>5</sub></b> | <b>C<sub>100</sub></b> | <b>Q<sub>5</sub><br/>(cfs)</b> | <b>Q<sub>100</sub><br/>(cfs)</b> |
|----------------------------------|-------------------------|-------------------------------|----------------------|------------------------|--------------------------------|----------------------------------|
| A1                               | 9.76                    | 18.7%                         | 0.19                 | 0.56                   | 1.66                           | 10.28                            |
| A2                               | 2.30                    | 40.7%                         | 0.37                 | 0.65                   | 0.55                           | 2.29                             |
| B1                               | 0.32                    | 69.7%                         | 0.61                 | 0.77                   | 0.28                           | 0.76                             |
| B2                               | 0.40                    | 38.8%                         | 0.35                 | 0.64                   | 0.15                           | 0.59                             |
| C1                               | 1.20                    | 38.8%                         | 0.35                 | 0.64                   | 0.37                           | 1.51                             |
| C2                               | 1.26                    | 25.0%                         | 0.24                 | 0.59                   | 0.22                           | 1.19                             |
| OS1.1                            | 9.76                    | 8.9%                          | 0.11                 | 0.52                   | 1.44                           | 12.08                            |
| OS1.2                            | 13.12                   | 16.3%                         | 0.17                 | 0.55                   | 3.10                           | 19.39                            |
| OS1.3                            | 4.59                    | 6.0%                          | 0.08                 | 0.51                   | 0.57                           | 5.48                             |
| OS2                              | 12.51                   | 6.8%                          | 0.09                 | 0.51                   | 2.29                           | 19.93                            |
| OS2.1                            | 0.62                    | 7.2%                          | 0.09                 | 0.51                   | 0.07                           | 0.62                             |
| OS4                              | 12.68                   | 6.5%                          | 0.09                 | 0.51                   | 2.22                           | 19.71                            |
| OS4.1                            | 1.64                    | 5.4%                          | 0.08                 | 0.51                   | 0.13                           | 1.37                             |
| P                                | 1.20                    | 10.0%                         | 0.12                 | 0.52                   | 0.14                           | 1.13                             |
| *EX-B1                           | 2.92                    | 39.7%                         | 0.40                 | 0.69                   | 3.60                           | 12.80                            |
| *EX-B2                           | 2.33                    | 45.0%                         | 0.44                 | 0.71                   | 3.00                           | 9.60                             |
| <b>Total</b>                     | <b>76.61</b>            | <b>11.3%</b>                  | <b>---</b>           | <b>---</b>             | <b>19.79</b>                   | <b>118.73</b>                    |
| <b>PROPOSED TOTAL</b>            | <b>71.36</b>            | <b>12.8%</b>                  | <b>---</b>           | <b>---</b>             | <b>11.53</b>                   | <b>86.05</b>                     |
| <b>OFFSITE TOTAL</b>             | <b>40.60</b>            | <b>10.3%</b>                  | <b>---</b>           | <b>---</b>             | <b>9.82</b>                    | <b>78.58</b>                     |
| <b>MODIFIED EX WQ POND TOTAL</b> | <b>30.76</b>            | <b>16.1%</b>                  | <b>---</b>           | <b>---</b>             | <b>5.72</b>                    | <b>38.83</b>                     |

\*FLOWS FROM RETREAT AT RIDGEGATE DRAINAGE REPORT

## PROP DESIGN POINT TABLE (CUHP-SWMM)

| Design Point | Q <sub>5</sub><br>(cfs) | Q <sub>100</sub><br>(cfs) |
|--------------|-------------------------|---------------------------|
| A1           | 1.66                    | 10.28                     |
| A2           | 0.55                    | 2.29                      |
| A3.1         | 2.22                    | 12.58                     |
| OS1.1        | 1.44                    | 12.08                     |
| OS1.2        | 3.10                    | 19.39                     |
| 1.3          | 4.18                    | 30.85                     |
| 1.4          | 0.57                    | 5.48                      |
| P1.1         | 5.11                    | 36.95                     |
| OS2          | 2.29                    | 19.93                     |
| OS2.1        | 0.07                    | 0.62                      |
| P2.1         | 2.36                    | 20.55                     |
| B1           | 0.28                    | 0.76                      |
| B2           | 0.15                    | 0.59                      |
| B3.1         | 2.58                    | 13.75                     |
| OS4          | 2.22                    | 19.71                     |
| C2           | 0.22                    | 1.19                      |
| C1.1         | 4.68                    | 32.69                     |
| C1           | 0.37                    | 1.51                      |
| C3.1         | 4.90                    | 33.85                     |
| OS4.1        | 0.13                    | 1.37                      |
| C4.1         | 5.26                    | 35.36                     |
| P            | 0.14                    | 1.13                      |
| P4.1         | 5.71                    | 38.83                     |
| *EX-B1       | 3.60                    | 12.80                     |
| *EX-B2       | 3.00                    | 9.60                      |
| *EX-4        | 12.31                   | 61.23                     |

\*FLOWS FROM RETREAT AT RIDGEGATE DRAINAGE REPORT



|                                          |     |      |
|------------------------------------------|-----|------|
| <b>*PROP DETENTION POND RELEASE RATE</b> | 0.3 | 21.7 |
|------------------------------------------|-----|------|

### DESIGN POINT DELTA TABLE (CUHP-SWMM FLOWS)

FLOWS  
 ROUTED TO  
 PROPOSED  
 EDB

| Ex Calibre Design Point                | EX Q <sub>5</sub><br>(cfs) | EX Q <sub>100</sub><br>(cfs) | Prop JR Design Point        | PROP Q <sub>5</sub><br>(cfs) | PROP Q <sub>100</sub><br>(cfs) |
|----------------------------------------|----------------------------|------------------------------|-----------------------------|------------------------------|--------------------------------|
| 1.1                                    | 13.9                       | 82.1                         | P1.1                        | 5.1                          | 37.0                           |
| 2.1                                    | 2.5                        | 28.5                         | P2.1                        | 2.4                          | 20.6                           |
| 4.1                                    | 2.4                        | 24.6                         | P4.1                        | 5.7                          | 38.8                           |
| <b>EX TOTAL FLOWS</b>                  | <b>18.8</b>                | <b>135.2</b>                 | <b>PROPOSED TOTAL FLOWS</b> | <b>13.2</b>                  | <b>96.3</b>                    |
| *EX-B1                                 | 3.6                        | 12.8                         | NO CHANGE                   |                              |                                |
| *EX-B2                                 | 3.0                        | 9.6                          | NO CHANGE                   |                              |                                |
| EX DP 4                                | 7.9                        | 47.0                         | *DP P4.1                    | 6.9                          | 44.1                           |
| *INCLUDES DETENTION POND RELEASE RATES |                            |                              |                             |                              |                                |

## **APPENDIX C**

### **HYDRAULICS**

**INLET MANAGEMENT**

Worksheet Protected

| INLET NAME                         | A1                       | A2                       | B1                       |
|------------------------------------|--------------------------|--------------------------|--------------------------|
| Site Type (Urban or Rural)         | URBAN                    | URBAN                    | URBAN                    |
| Inlet Application (Street or Area) | STREET                   | STREET                   | STREET                   |
| Hydraulic Condition                | In Sump                  | In Sump                  | On Grade                 |
| Inlet Type                         | CDOT Type R Curb Opening | CDOT Type R Curb Opening | CDOT Type R Curb Opening |

**USER-DEFINED INPUT****User-Defined Design Flows**

|                         |      |     |     |
|-------------------------|------|-----|-----|
| Minor $Q_{Known}$ (cfs) | 1.7  | 0.6 | 0.3 |
| Major $Q_{Known}$ (cfs) | 10.3 | 2.3 | 0.8 |

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

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

**Watershed Characteristics**

|                           |  |  |  |
|---------------------------|--|--|--|
| Subcatchment Area (acres) |  |  |  |
| Percent Impervious        |  |  |  |
| NRCS Soil Type            |  |  |  |

**Watershed Profile**

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

**Minor Storm Rainfall Input**

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

**Major Storm Rainfall Input**

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

**CALCULATED OUTPUT**

|                                                           |             |            |            |
|-----------------------------------------------------------|-------------|------------|------------|
| <b>Minor Total Design Peak Flow, <math>Q</math> (cfs)</b> | <b>1.7</b>  | <b>0.6</b> | <b>0.3</b> |
| <b>Major Total Design Peak Flow, <math>Q</math> (cfs)</b> | <b>10.3</b> | <b>2.3</b> | <b>0.8</b> |
| Minor Flow Bypassed Downstream, $Q_b$ (cfs)               | N/A         | N/A        | 0.0        |
| Major Flow Bypassed Downstream, $Q_b$ (cfs)               | N/A         | N/A        | 0.0        |

**INLET MANAGEMENT**

Worksheet Protected

| INLET NAME                         | <u>B2</u>                | <u>C1</u>                | <u>C2</u>                |
|------------------------------------|--------------------------|--------------------------|--------------------------|
| Site Type (Urban or Rural)         | URBAN                    | URBAN                    | URBAN                    |
| Inlet Application (Street or Area) | STREET                   | STREET                   | STREET                   |
| Hydraulic Condition                | On Grade                 | On Grade                 | On Grade                 |
| Inlet Type                         | CDOT Type R Curb Opening | CDOT Type R Curb Opening | CDOT Type R Curb Opening |

**USER-DEFINED INPUT****User-Defined Design Flows**

|                         |     |     |     |
|-------------------------|-----|-----|-----|
| Minor $Q_{Known}$ (cfs) | 0.2 | 0.4 | 0.2 |
| Major $Q_{Known}$ (cfs) | 0.6 | 1.5 | 1.2 |

**Bypass (Carry-Over) Flow from Upstream**

|                                         |                         |     |     |
|-----------------------------------------|-------------------------|-----|-----|
| Receive Bypass Flow from:               | No Bypass Flow Received | B1  | B2  |
| Minor Bypass Flow Received, $Q_b$ (cfs) | 0.0                     | 0.0 | 0.0 |
| Major Bypass Flow Received, $Q_b$ (cfs) | 0.0                     | 0.0 | 0.0 |

**Watershed Characteristics**

|                           |  |  |  |
|---------------------------|--|--|--|
| Subcatchment Area (acres) |  |  |  |
| Percent Impervious        |  |  |  |
| NRCS Soil Type            |  |  |  |

**Watershed Profile**

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

**Minor Storm Rainfall Input**

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

**Major Storm Rainfall Input**

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

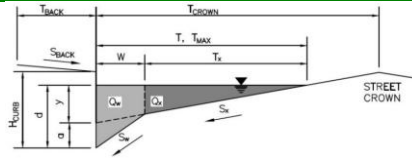
**CALCULATED OUTPUT**

|                                                           |            |            |            |
|-----------------------------------------------------------|------------|------------|------------|
| <b>Minor Total Design Peak Flow, <math>Q</math> (cfs)</b> | <b>0.2</b> | <b>0.4</b> | <b>0.2</b> |
| <b>Major Total Design Peak Flow, <math>Q</math> (cfs)</b> | <b>0.6</b> | <b>1.5</b> | <b>1.2</b> |
| Minor Flow Bypassed Downstream, $Q_b$ (cfs)               | 0.0        | 0.0        | 0.0        |
| Major Flow Bypassed Downstream, $Q_b$ (cfs)               | 0.0        | 0.0        | 0.0        |

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

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

Project:

Inlet ID: **A1****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb  
 Side Slope Behind Curb (leave blank for no conveyance credit behind curb)  
 Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$T_{BACK} = 8.0$  ft  
 $S_{BACK} = 0.020$  ft/ft  
 $n_{BACK} = 0.013$

Height of Curb at Gutter Flow Line  
 Distance from Curb Face to Street Crown  
 Gutter Width  
 Street Transverse Slope  
 Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)  
 Street Longitudinal Slope - Enter 0 for sump condition  
 Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$H_{CURB} = 6.00$  inches  
 $T_{CROWN} = 13.0$  ft  
 $W = 2.00$  ft  
 $S_x = 0.020$  ft/ft  
 $S_w = 0.083$  ft/ft  
 $S_o = 0.000$  ft/ft  
 $n_{STREET} = 0.016$

Max. Allowable Spread for Minor & Major Storm  
 Max. Allowable Depth at Gutter Flowline for Minor & Major Storm  
 Check boxes are not applicable in SUMP conditions

|           | Minor Storm | Major Storm |        |
|-----------|-------------|-------------|--------|
| $T_{MAX}$ | 8.0         | 13.0        | ft     |
| $d_{MAX}$ | 4.6         | 6.9         | inches |

**Maximum Capacity for 1/2 Street based On Allowable Spread**

Water Depth without Gutter Depression ( $T * S_x * 12$ )  
 Vertical Depth between Gutter Lip and Gutter Flowline ( $W * S_w * 12$ )  
 Gutter Depression ( $d_c - (W * S_x * 12)$ )  
 Water Depth at Gutter Flowline ( $y + a$ )  
 Allowable Spread for Discharge outside the Gutter Section ( $T - W$ )  
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)  
 Discharge outside the Gutter Section, carried in Section  $T_x$   
 Discharge within the Gutter Section ( $Q_T - Q_x - Q_{BACK}$ )  
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)  
 Maximum Flow Based On Allowable Spread  
 Flow Velocity within the Gutter Section  
 $V*d$  Product: Flow Velocity times Gutter Flowline Depth

|            | Minor Storm | Major Storm |        |
|------------|-------------|-------------|--------|
| $y$        | 1.92        | 3.12        | inches |
| $d_c$      | 2.0         | 2.0         | inches |
| $a$        | 1.51        | 1.51        | inches |
| $d$        | 3.43        | 4.63        | inches |
| $T_x$      | 6.0         | 11.0        | ft     |
| $E_o$      | 0.688       | 0.456       |        |
| $Q_x$      | 0.0         | 0.0         | cfs    |
| $Q_w$      | 0.0         | 0.0         | cfs    |
| $Q_{BACK}$ | 0.0         | 0.0         | cfs    |
| $Q_T$      | SUMP        | SUMP        | cfs    |
| $V$        | 0.0         | 0.0         | fps    |
| $V*d$      | 0.0         | 0.0         |        |

**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread  
 Theoretical Spread for Discharge outside the Gutter Section ( $T - W$ )  
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)  
 Theoretical Discharge outside the Gutter Section, carried in Section  $T_{XTH}$   
 Actual Discharge outside the Gutter Section, (limited by distance  $T_{CROWN}$ )  
 Discharge within the Gutter Section ( $Q_d - Q_x$ )  
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)  
 Total Discharge for Major & Minor Storm (Pre-Safety Factor)  
 Average Flow Velocity Within the Gutter Section  
 $V*d$  Product: Flow Velocity Times Gutter Flowline Depth  
 Slope-Based Safety Factor for Minor/Major Storm depth reduction,  $d \geq 6"$   
 Max Flow based on Allowable Depth (Safety Factor Applied)  
 Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)  
 Resultant Flow Depth at Street Crown (Safety Factor Applied)

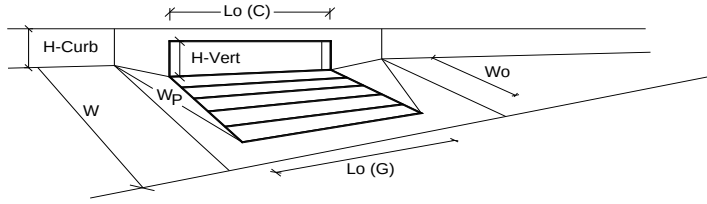
|             | Minor Storm | Major Storm |        |
|-------------|-------------|-------------|--------|
| $T_{TH}$    | 12.9        | 22.5        | ft     |
| $T_{XTH}$   | 10.9        | 20.5        | ft     |
| $E_o$       | 0.460       | 0.263       |        |
| $Q_{XTH}$   | 0.0         | 0.0         | cfs    |
| $Q_x$       | 0.0         | 0.0         | cfs    |
| $Q_w$       | 0.0         | 0.0         | cfs    |
| $Q_{BACK}$  | 0.0         | 0.0         | cfs    |
| $Q$         | SUMP        | SUMP        | cfs    |
| $V$         | 0.0         | 0.0         | fps    |
| $V*d$       | 0.0         | 0.0         |        |
| $R$         | SUMP        | SUMP        |        |
| $Q_d$       | SUMP        | SUMP        | cfs    |
| $d$         |             |             | inches |
| $d_{CROWN}$ |             |             | inches |

MINOR STORM Allowable Capacity is not applicable to Sump Condition  
 MAJOR STORM Allowable Capacity is not applicable to Sump Condition

|             | Minor Storm | Major Storm |     |
|-------------|-------------|-------------|-----|
| $Q_{allow}$ | SUMP        | SUMP        | cfs |

# INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)

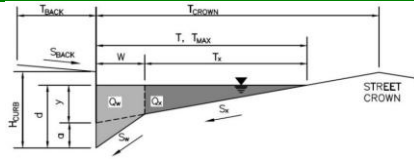


| Design Information (Input)                                                   |                          | MINOR                        |                          | MAJOR        |                                                     |
|------------------------------------------------------------------------------|--------------------------|------------------------------|--------------------------|--------------|-----------------------------------------------------|
| Type of Inlet                                                                | CDOT Type R Curb Opening | Type =                       | CDOT Type R Curb Opening |              |                                                     |
| Local Depression (additional to continuous gutter depression 'a' from above) |                          | a <sub>local</sub> =         | 3.00                     | 3.00         | inches                                              |
| Number of Unit Inlets (Grate or Curb Opening)                                |                          | No =                         | 1                        | 1            |                                                     |
| Water Depth at Flowline (outside of local depression)                        |                          | Ponding Depth =              | 6.0                      | 6.9          | inches                                              |
| <b>Grate Information</b>                                                     |                          |                              | MINOR                    | MAJOR        | <input checked="" type="checkbox"/> Override Depths |
| Length of a Unit Grate                                                       |                          | L <sub>o</sub> (G) =         | N/A                      | N/A          | feet                                                |
| Width of a Unit Grate                                                        |                          | W <sub>o</sub> =             | N/A                      | N/A          | feet                                                |
| Open Area Ratio for a Grate (typical values 0.15-0.90)                       |                          | A <sub>ratio</sub> =         | N/A                      | N/A          |                                                     |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70)               |                          | C <sub>f</sub> (G) =         | N/A                      | N/A          |                                                     |
| Grate Weir Coefficient (typical value 2.15 - 3.60)                           |                          | C <sub>w</sub> (G) =         | N/A                      | N/A          |                                                     |
| Grate Orifice Coefficient (typical value 0.60 - 0.80)                        |                          | C <sub>o</sub> (G) =         | N/A                      | N/A          |                                                     |
| <b>Curb Opening Information</b>                                              |                          |                              | MINOR                    | MAJOR        |                                                     |
| Length of a Unit Curb Opening                                                |                          | L <sub>o</sub> (C) =         | 10.00                    | 10.00        | feet                                                |
| Height of Vertical Curb Opening in Inches                                    |                          | H <sub>vert</sub> =          | 6.00                     | 6.00         | inches                                              |
| Height of Curb Orifice Throat in Inches                                      |                          | H <sub>throat</sub> =        | 6.00                     | 6.00         | inches                                              |
| Angle of Throat                                                              |                          | Theta =                      | 63.40                    | 63.40        | degrees                                             |
| Side Width for Depression Pan (typically the gutter width of 2 feet)         |                          | W <sub>p</sub> =             | 2.00                     | 2.00         | feet                                                |
| Clogging Factor for a Single Curb Opening (typical value 0.10)               |                          | C <sub>f</sub> (C) =         | 0.10                     | 0.10         |                                                     |
| Curb Opening Weir Coefficient (typical value 2.3-3.7)                        |                          | C <sub>w</sub> (C) =         | 3.60                     | 3.60         |                                                     |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)                 |                          | C <sub>o</sub> (C) =         | 0.67                     | 0.67         |                                                     |
| <b>Grate Flow Analysis (Calculated)</b>                                      |                          |                              | MINOR                    | MAJOR        |                                                     |
| Clogging Coefficient for Multiple Units                                      |                          | Coef =                       | N/A                      | N/A          |                                                     |
| Clogging Factor for Multiple Units                                           |                          | Clog =                       | N/A                      | N/A          |                                                     |
| Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)                    |                          |                              | MINOR                    | MAJOR        |                                                     |
| Interception without Clogging                                                |                          | Q <sub>wi</sub> =            | N/A                      | N/A          | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>wa</sub> =            | N/A                      | N/A          | cfs                                                 |
| Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)                |                          |                              | MINOR                    | MAJOR        |                                                     |
| Interception without Clogging                                                |                          | Q <sub>oi</sub> =            | N/A                      | N/A          | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>oa</sub> =            | N/A                      | N/A          | cfs                                                 |
| Grate Capacity as Mixed Flow                                                 |                          |                              | MINOR                    | MAJOR        |                                                     |
| Interception without Clogging                                                |                          | Q <sub>mi</sub> =            | N/A                      | N/A          | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>ma</sub> =            | N/A                      | N/A          | cfs                                                 |
| Resulting Grate Capacity (assumes clogged condition)                         |                          | <b>Q<sub>Grate</sub> =</b>   | <b>N/A</b>               | <b>N/A</b>   | <b>cfs</b>                                          |
| <b>Curb Opening Flow Analysis (Calculated)</b>                               |                          |                              | MINOR                    | MAJOR        |                                                     |
| Clogging Coefficient for Multiple Units                                      |                          | Coef =                       | 1.25                     | 1.25         |                                                     |
| Clogging Factor for Multiple Units                                           |                          | Clog =                       | 0.06                     | 0.06         |                                                     |
| Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)                     |                          |                              | MINOR                    | MAJOR        |                                                     |
| Interception without Clogging                                                |                          | Q <sub>wi</sub> =            | 8.8                      | 12.6         | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>wa</sub> =            | 8.3                      | 11.8         | cfs                                                 |
| Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)                 |                          |                              | MINOR                    | MAJOR        |                                                     |
| Interception without Clogging                                                |                          | Q <sub>oi</sub> =            | 19.5                     | 20.8         | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>oa</sub> =            | 18.3                     | 19.5         | cfs                                                 |
| Curb Opening Capacity as Mixed Flow                                          |                          |                              | MINOR                    | MAJOR        |                                                     |
| Interception without Clogging                                                |                          | Q <sub>mi</sub> =            | 12.2                     | 15.1         | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>ma</sub> =            | 11.4                     | 14.1         | cfs                                                 |
| Resulting Curb Opening Capacity (assumes clogged condition)                  |                          | <b>Q<sub>Curb</sub> =</b>    | <b>8.3</b>               | <b>11.8</b>  | <b>cfs</b>                                          |
| <b>Resultant Street Conditions</b>                                           |                          |                              | MINOR                    | MAJOR        |                                                     |
| Total Inlet Length                                                           |                          | L =                          | 10.00                    | 10.00        | feet                                                |
| Resultant Street Flow Spread (based on street geometry from above)           |                          | T =                          | 18.7                     | 22.5         | ft. >T-Crown                                        |
| Resultant Flow Depth at Street Crown                                         |                          | d <sub>CROWN</sub> =         | 1.4                      | 2.3          | inches                                              |
| <b>Low Head Performance Reduction (Calculated)</b>                           |                          |                              | MINOR                    | MAJOR        |                                                     |
| Depth for Grate Midwidth                                                     |                          | d <sub>Grate</sub> =         | N/A                      | N/A          | ft                                                  |
| Depth for Curb Opening Weir Equation                                         |                          | d <sub>Curb</sub> =          | 0.33                     | 0.41         | ft                                                  |
| Grated Inlet Performance Reduction Factor for Long Inlets                    |                          | RF <sub>Grate</sub> =        | N/A                      | N/A          |                                                     |
| Curb Opening Performance Reduction Factor for Long Inlets                    |                          | RF <sub>Curb</sub> =         | 0.93                     | 0.98         |                                                     |
| Combination Inlet Performance Reduction Factor for Long Inlets               |                          | RF <sub>Combination</sub> =  | N/A                      | N/A          |                                                     |
| <b>Total Inlet Interception Capacity (assumes clogged condition)</b>         |                          |                              | MINOR                    | MAJOR        |                                                     |
| <b>Inlet Capacity IS GOOD for Minor and Major Storms (&gt;Q Peak)</b>        |                          | <b>Q<sub>s</sub> =</b>       | <b>8.3</b>               | <b>11.80</b> | <b>cfs</b>                                          |
|                                                                              |                          | Q <sub>PEAK REQUIRED</sub> = | 1.7                      | 10.28        | cfs                                                 |

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

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

Project:

Inlet ID: **A2****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

|              |       |       |
|--------------|-------|-------|
| $T_{BACK} =$ | 8.0   | ft    |
| $S_{BACK} =$ | 0.020 | ft/ft |
| $n_{BACK} =$ | 0.013 |       |

|                |       |        |
|----------------|-------|--------|
| $H_{CURB} =$   | 6.00  | inches |
| $T_{CROWN} =$  | 13.0  | ft     |
| $W =$          | 2.00  | ft     |
| $S_x =$        | 0.020 | ft/ft  |
| $S_w =$        | 0.083 | ft/ft  |
| $S_o =$        | 0.000 | ft/ft  |
| $n_{STREET} =$ | 0.016 |        |

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Check boxes are not applicable in SUMP conditions

|             | Minor Storm              | Major Storm              |        |
|-------------|--------------------------|--------------------------|--------|
| $T_{MAX} =$ | 8.0                      | 13.0                     | ft     |
| $d_{MAX} =$ | 4.6                      | 6.9                      | inches |
|             | <input type="checkbox"/> | <input type="checkbox"/> |        |

**Maximum Capacity for 1/2 Street based On Allowable Spread**Water Depth without Gutter Depression ( $T * S_x * 12$ )Vertical Depth between Gutter Lip and Gutter Flowline ( $W * S_w * 12$ )Gutter Depression ( $d_c - (W * S_x * 12)$ )Water Depth at Gutter Flowline ( $y + a$ )Allowable Spread for Discharge outside the Gutter Section ( $T - W$ )

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)

Discharge outside the Gutter Section, carried in Section  $T_x$ Discharge within the Gutter Section ( $Q_T - Q_x - Q_{BACK}$ )

Discharge Behind the Curb (e.g., sidewalk, driveways, &amp; lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

 $V*d$  Product: Flow Velocity times Gutter Flowline Depth

|              | Minor Storm | Major Storm |        |
|--------------|-------------|-------------|--------|
| $y =$        | 1.92        | 3.12        | inches |
| $d_c =$      | 2.0         | 2.0         | inches |
| $a =$        | 1.51        | 1.51        | inches |
| $d =$        | 3.43        | 4.63        | inches |
| $T_x =$      | 6.0         | 11.0        | ft     |
| $E_o =$      | 0.688       | 0.456       |        |
| $Q_x =$      | 0.0         | 0.0         | cfs    |
| $Q_w =$      | 0.0         | 0.0         | cfs    |
| $Q_{BACK} =$ | 0.0         | 0.0         | cfs    |
| $Q_T =$      | SUMP        | SUMP        | cfs    |
| $V =$        | 0.0         | 0.0         | fps    |
| $V*d =$      | 0.0         | 0.0         |        |

**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section ( $T - W$ )

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)

Theoretical Discharge outside the Gutter Section, carried in Section  $T_{XTH}$ Actual Discharge outside the Gutter Section, (limited by distance  $T_{CROWN}$ )Discharge within the Gutter Section ( $Q_d - Q_x$ )

Discharge Behind the Curb (e.g., sidewalk, driveways, &amp; lawns)

Total Discharge for Major &amp; Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

 $V*d$  Product: Flow Velocity Times Gutter Flowline DepthSlope-Based Safety Factor for Minor/Major Storm depth reduction,  $d \geq 6"$ 

Max Flow based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

|               | Minor Storm | Major Storm |        |
|---------------|-------------|-------------|--------|
| $T_{TH} =$    | 12.9        | 22.5        | ft     |
| $T_{XTH} =$   | 10.9        | 20.5        | ft     |
| $E_o =$       | 0.460       | 0.263       |        |
| $Q_{XTH} =$   | 0.0         | 0.0         | cfs    |
| $Q_x =$       | 0.0         | 0.0         | cfs    |
| $Q_w =$       | 0.0         | 0.0         | cfs    |
| $Q_{BACK} =$  | 0.0         | 0.0         | cfs    |
| $Q =$         | SUMP        | SUMP        | cfs    |
| $V =$         | 0.0         | 0.0         | fps    |
| $V*d =$       | 0.0         | 0.0         |        |
| $R =$         | SUMP        | SUMP        |        |
| $Q_d =$       | SUMP        | SUMP        | cfs    |
| $d =$         |             |             | inches |
| $d_{CROWN} =$ |             |             | inches |

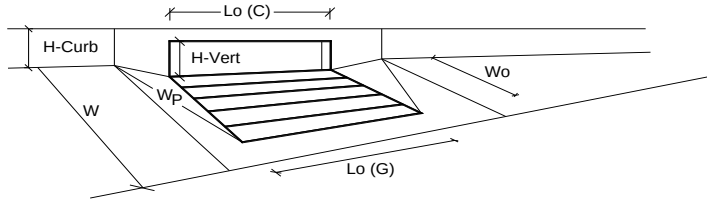
MINOR STORM Allowable Capacity is not applicable to Sump Condition

MAJOR STORM Allowable Capacity is not applicable to Sump Condition

|               | Minor Storm | Major Storm |     |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | SUMP        | SUMP        | cfs |

# INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.03 (August 2023)



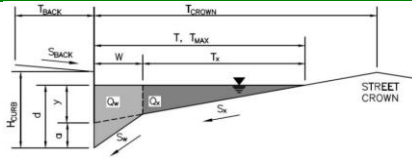
| Design Information (Input)                                                   |                          | MINOR                        |                          | MAJOR      |                                                     |
|------------------------------------------------------------------------------|--------------------------|------------------------------|--------------------------|------------|-----------------------------------------------------|
| Type of Inlet                                                                | CDOT Type R Curb Opening | Type =                       | CDOT Type R Curb Opening |            |                                                     |
| Local Depression (additional to continuous gutter depression 'a' from above) |                          | a <sub>local</sub> =         | 3.00                     | 3.00       | inches                                              |
| Number of Unit Inlets (Grate or Curb Opening)                                |                          | No =                         | 1                        | 1          |                                                     |
| Water Depth at Flowline (outside of local depression)                        |                          | Ponding Depth =              | 6.0                      | 6.9        | inches                                              |
| <b>Grate Information</b>                                                     |                          |                              | MINOR                    | MAJOR      | <input checked="" type="checkbox"/> Override Depths |
| Length of a Unit Grate                                                       |                          | L <sub>o</sub> (G) =         | N/A                      | N/A        | feet                                                |
| Width of a Unit Grate                                                        |                          | W <sub>o</sub> =             | N/A                      | N/A        | feet                                                |
| Open Area Ratio for a Grate (typical values 0.15-0.90)                       |                          | A <sub>ratio</sub> =         | N/A                      | N/A        |                                                     |
| Clogging Factor for a Single Grate (typical value 0.50 - 0.70)               |                          | C <sub>f</sub> (G) =         | N/A                      | N/A        |                                                     |
| Grate Weir Coefficient (typical value 2.15 - 3.60)                           |                          | C <sub>w</sub> (G) =         | N/A                      | N/A        |                                                     |
| Grate Orifice Coefficient (typical value 0.60 - 0.80)                        |                          | C <sub>o</sub> (G) =         | N/A                      | N/A        |                                                     |
| <b>Curb Opening Information</b>                                              |                          |                              | MINOR                    | MAJOR      |                                                     |
| Length of a Unit Curb Opening                                                |                          | L <sub>o</sub> (C) =         | 5.00                     | 5.00       | feet                                                |
| Height of Vertical Curb Opening in Inches                                    |                          | H <sub>vert</sub> =          | 6.00                     | 6.00       | inches                                              |
| Height of Curb Orifice Throat in Inches                                      |                          | H <sub>throat</sub> =        | 6.00                     | 6.00       | inches                                              |
| Angle of Throat                                                              |                          | Theta =                      | 63.40                    | 63.40      | degrees                                             |
| Side Width for Depression Pan (typically the gutter width of 2 feet)         |                          | W <sub>p</sub> =             | 2.00                     | 2.00       | feet                                                |
| Clogging Factor for a Single Curb Opening (typical value 0.10)               |                          | C <sub>f</sub> (C) =         | 0.10                     | 0.10       |                                                     |
| Curb Opening Weir Coefficient (typical value 2.3-3.7)                        |                          | C <sub>w</sub> (C) =         | 3.60                     | 3.60       |                                                     |
| Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)                 |                          | C <sub>o</sub> (C) =         | 0.67                     | 0.67       |                                                     |
| <b>Grate Flow Analysis (Calculated)</b>                                      |                          |                              | MINOR                    | MAJOR      |                                                     |
| Clogging Coefficient for Multiple Units                                      |                          | Coef =                       | N/A                      | N/A        |                                                     |
| Clogging Factor for Multiple Units                                           |                          | Clog =                       | N/A                      | N/A        |                                                     |
| Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)                    |                          |                              | MINOR                    | MAJOR      |                                                     |
| Interception without Clogging                                                |                          | Q <sub>wi</sub> =            | N/A                      | N/A        | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>wa</sub> =            | N/A                      | N/A        | cfs                                                 |
| Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)                |                          |                              | MINOR                    | MAJOR      |                                                     |
| Interception without Clogging                                                |                          | Q <sub>oi</sub> =            | N/A                      | N/A        | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>oa</sub> =            | N/A                      | N/A        | cfs                                                 |
| Grate Capacity as Mixed Flow                                                 |                          |                              | MINOR                    | MAJOR      |                                                     |
| Interception without Clogging                                                |                          | Q <sub>mi</sub> =            | N/A                      | N/A        | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>ma</sub> =            | N/A                      | N/A        | cfs                                                 |
| Resulting Grate Capacity (assumes clogged condition)                         |                          | <b>Q<sub>Grate</sub></b> =   | <b>N/A</b>               | <b>N/A</b> | <b>cfs</b>                                          |
| <b>Curb Opening Flow Analysis (Calculated)</b>                               |                          |                              | MINOR                    | MAJOR      |                                                     |
| Clogging Coefficient for Multiple Units                                      |                          | Coef =                       | 1.00                     | 1.00       |                                                     |
| Clogging Factor for Multiple Units                                           |                          | Clog =                       | 0.10                     | 0.10       |                                                     |
| Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)                     |                          |                              | MINOR                    | MAJOR      |                                                     |
| Interception without Clogging                                                |                          | Q <sub>wi</sub> =            | 6.0                      | 8.1        | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>wa</sub> =            | 5.4                      | 7.3        | cfs                                                 |
| Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)                 |                          |                              | MINOR                    | MAJOR      |                                                     |
| Interception without Clogging                                                |                          | Q <sub>oi</sub> =            | 9.8                      | 10.4       | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>oa</sub> =            | 8.8                      | 9.4        | cfs                                                 |
| Curb Opening Capacity as Mixed Flow                                          |                          |                              | MINOR                    | MAJOR      |                                                     |
| Interception without Clogging                                                |                          | Q <sub>mi</sub> =            | 7.1                      | 8.5        | cfs                                                 |
| Interception with Clogging                                                   |                          | Q <sub>ma</sub> =            | 6.4                      | 7.7        | cfs                                                 |
| Resulting Curb Opening Capacity (assumes clogged condition)                  |                          | <b>Q<sub>Curb</sub></b> =    | <b>5.4</b>               | <b>7.3</b> | <b>cfs</b>                                          |
| <b>Resultant Street Conditions</b>                                           |                          |                              | MINOR                    | MAJOR      |                                                     |
| Total Inlet Length                                                           |                          | L =                          | 5.00                     | 5.00       | feet                                                |
| Resultant Street Flow Spread (based on street geometry from above)           |                          | T =                          | 18.7                     | 22.5       | ft. >T-Crown                                        |
| Resultant Flow Depth at Street Crown                                         |                          | d <sub>CROWN</sub> =         | 1.4                      | 2.3        | inches                                              |
| <b>Low Head Performance Reduction (Calculated)</b>                           |                          |                              | MINOR                    | MAJOR      |                                                     |
| Depth for Grate Midwidth                                                     |                          | d <sub>Grate</sub> =         | N/A                      | N/A        | ft                                                  |
| Depth for Curb Opening Weir Equation                                         |                          | d <sub>Curb</sub> =          | 0.33                     | 0.41       | ft                                                  |
| Grated Inlet Performance Reduction Factor for Long Inlets                    |                          | RF <sub>Grate</sub> =        | N/A                      | N/A        |                                                     |
| Curb Opening Performance Reduction Factor for Long Inlets                    |                          | RF <sub>Curb</sub> =         | 1.00                     | 1.00       |                                                     |
| Combination Inlet Performance Reduction Factor for Long Inlets               |                          | RF <sub>Combination</sub> =  | N/A                      | N/A        |                                                     |
| <b>Total Inlet Interception Capacity (assumes clogged condition)</b>         |                          |                              | MINOR                    | MAJOR      |                                                     |
| <b>Inlet Capacity IS GOOD for Minor and Major Storms (&gt;Q Peak)</b>        |                          | <b>Q<sub>s</sub></b> =       | <b>5.4</b>               | <b>7.3</b> | <b>cfs</b>                                          |
|                                                                              |                          | Q <sub>PEAK REQUIRED</sub> = | 0.6                      | 2.3        | cfs                                                 |



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

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

Project:

Inlet ID: **B1****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

|              |       |       |
|--------------|-------|-------|
| $T_{BACK} =$ | 8.0   | ft    |
| $S_{BACK} =$ | 0.020 | ft/ft |
| $n_{BACK} =$ | 0.013 |       |

|                |       |        |
|----------------|-------|--------|
| $H_{CURB} =$   | 6.00  | inches |
| $T_{CROWN} =$  | 13.0  | ft     |
| $W =$          | 2.00  | ft     |
| $S_x =$        | 0.020 | ft/ft  |
| $S_w =$        | 0.083 | ft/ft  |
| $S_o =$        | 0.055 | ft/ft  |
| $n_{STREET} =$ | 0.016 |        |

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

|             | Minor Storm                         | Major Storm                         |        |
|-------------|-------------------------------------|-------------------------------------|--------|
| $T_{MAX} =$ | 8.0                                 | 13.0                                | ft     |
| $d_{MAX} =$ | 4.6                                 | 6.9                                 | inches |
|             | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |        |

**Maximum Capacity for 1/2 Street based On Allowable Spread**Water Depth without Gutter Depression ( $T * S_x * 12$ )Vertical Depth between Gutter Lip and Gutter Flowline ( $W * S_w * 12$ )Gutter Depression ( $d_c - (W * S_x * 12)$ )Water Depth at Gutter Flowline ( $y + a$ )Allowable Spread for Discharge outside the Gutter Section ( $T - W$ )

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)

Discharge outside the Gutter Section, carried in Section  $T_x$ Discharge within the Gutter Section ( $Q_T - Q_x - Q_{BACK}$ )

Discharge Behind the Curb (e.g., sidewalk, driveways, &amp; lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

 $V*d$  Product: Flow Velocity times Gutter Flowline Depth

|              | Minor Storm | Major Storm |        |
|--------------|-------------|-------------|--------|
| $y =$        | 1.92        | 3.12        | inches |
| $d_c =$      | 2.0         | 2.0         | inches |
| $a =$        | 1.51        | 1.51        | inches |
| $d =$        | 3.43        | 4.63        | inches |
| $T_x =$      | 6.0         | 11.0        | ft     |
| $E_o =$      | 0.688       | 0.456       |        |
| $Q_x =$      | 1.4         | 7.2         | cfs    |
| $Q_w =$      | 3.2         | 6.1         | cfs    |
| $Q_{BACK} =$ | 0.0         | 0.0         | cfs    |
| $Q_T =$      | 4.6         | 13.3        | cfs    |
| $V =$        | 7.8         | 10.0        | fps    |
| $V*d =$      | 2.2         | 3.9         |        |

**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section ( $T - W$ )

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)

Theoretical Discharge outside the Gutter Section, carried in Section  $T_{XTH}$ Actual Discharge outside the Gutter Section, (limited by distance  $T_{CROWN}$ )Discharge within the Gutter Section ( $Q_d - Q_x$ )

Discharge Behind the Curb (e.g., sidewalk, driveways, &amp; lawns)

Total Discharge for Major &amp; Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

 $V*d$  Product: Flow Velocity Times Gutter Flowline DepthSlope-Based Safety Factor for Minor/Major Storm depth reduction,  $d \geq 6"$ 

Max Flow based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

|               | Minor Storm | Major Storm |        |
|---------------|-------------|-------------|--------|
| $T_{TH} =$    | 12.9        | 22.5        | ft     |
| $T_{XTH} =$   | 10.9        | 20.5        | ft     |
| $E_o =$       | 0.460       | 0.263       |        |
| $Q_{XTH} =$   | 7.0         | 37.8        | cfs    |
| $Q_x =$       | 7.0         | 33.0        | cfs    |
| $Q_w =$       | 6.0         | 13.5        | cfs    |
| $Q_{BACK} =$  | 0.0         | 0.5         | cfs    |
| $Q =$         | 13.0        | 47.0        | cfs    |
| $V =$         | 10.0        | 13.7        | fps    |
| $V*d =$       | 3.8         | 7.9         |        |
| $R =$         | 1.00        | 0.37        |        |
| $Q_d =$       | 13.0        | 17.5        | cfs    |
| $d =$         | 4.60        | 5.01        | inches |
| $d_{CROWN} =$ | 0.00        | 0.38        | inches |

MINOR STORM Allowable Capacity is based on Depth Criterion

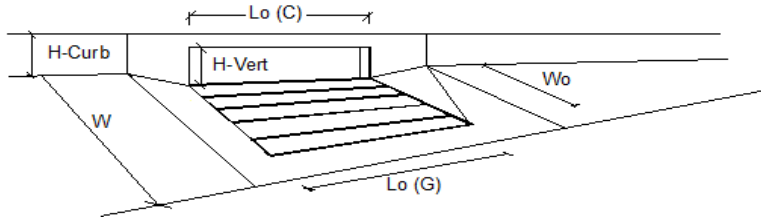
MAJOR STORM Allowable Capacity is based on Depth Criterion

**Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.28 cfs on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design peak flow of 0.76 cfs on sheet 'Inlet Management'**

|               | Minor Storm | Major Storm |     |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | 13.0        | 17.5        | cfs |

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)

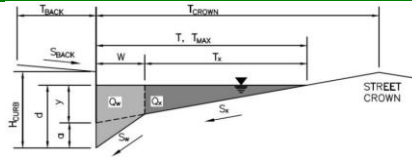


| Design Information (Input)                                                                         | MINOR                    | MAJOR                    |             |
|----------------------------------------------------------------------------------------------------|--------------------------|--------------------------|-------------|
| Type of Inlet                                                                                      | CDOT Type R Curb Opening |                          |             |
| Local Depression (additional to continuous gutter depression 'a')                                  | Type =                   | CDOT Type R Curb Opening |             |
| Total Number of Units in the Inlet (Grate or Curb Opening)                                         | a <sub>LOCAL</sub> =     | 3.0                      | 3.0 inches  |
| Length of a Single Unit Inlet (Grate or Curb Opening)                                              | No =                     | 1                        |             |
| Width of a Unit Grate (cannot be greater than W, Gutter Width)                                     | L <sub>o</sub> =         | 5.00                     | 5.00 ft     |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5)                                 | W <sub>o</sub> =         | N/A                      | N/A ft      |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)                          | C <sub>f</sub> (G) =     | N/A                      | N/A         |
| Street Hydraulics: OK - Q < Allowable Street Capacity                                              | C <sub>f</sub> (C) =     | 0.10                     | 0.10        |
| Design Discharge for Half of Street (from Inlet Management)                                        | Q <sub>o</sub> =         | 0.3                      | 0.8 cfs     |
| Water Spread Width                                                                                 | T =                      | 1.3                      | 2.0 ft      |
| Water Depth at Flowline (outside of local depression)                                              | d =                      | 1.8                      | 2.0 inches  |
| Water Depth at Street Crown (or at T <sub>MAX</sub> )                                              | d <sub>CROWN</sub> =     | 0.0                      | 0.0 inches  |
| Ratio of Gutter Flow to Design Flow                                                                | E <sub>o</sub> =         | 1.000                    | 1.000       |
| Discharge outside the Gutter Section W, carried in Section T <sub>x</sub>                          | Q <sub>x</sub> =         | 0.0                      | 0.0 cfs     |
| Discharge within the Gutter Section W                                                              | Q <sub>w</sub> =         | 0.3                      | 0.8 cfs     |
| Discharge Behind the Curb Face                                                                     | Q <sub>BACK</sub> =      | 0.0                      | 0.0 cfs     |
| Flow Area within the Gutter Section W                                                              | A <sub>w</sub> =         | 0.00                     | 0.00 sq ft  |
| Velocity within the Gutter Section W                                                               | V <sub>w</sub> =         | 0.0                      | 0.0 fps     |
| Water Depth for Design Condition                                                                   | d <sub>LOCAL</sub> =     | 4.8                      | 5.0 inches  |
| Grate Analysis (Calculated)                                                                        | L =                      | N/A                      | N/A ft      |
| Total Length of Inlet Grate Opening                                                                | E <sub>G-GRATE</sub> =   | N/A                      | N/A         |
| Ratio of Grate Flow to Design Flow                                                                 | MINOR                    | MAJOR                    |             |
| Under No-Clogging Condition                                                                        | V <sub>o</sub> =         | N/A                      | N/A fps     |
| Minimum Velocity Where Grate Splash-Over Begins                                                    | R <sub>f</sub> =         | N/A                      | N/A         |
| Interception Rate of Frontal Flow                                                                  | R <sub>x</sub> =         | N/A                      | N/A         |
| Interception Rate of Side Flow                                                                     | Q <sub>i</sub> =         | N/A                      | N/A cfs     |
| Interception Capacity                                                                              | MINOR                    | MAJOR                    |             |
| Under Clogging Condition                                                                           | GrateCoeff =             | N/A                      | N/A         |
| Clogging Coefficient for Multiple-unit Grate Inlet                                                 | GrateClog =              | N/A                      | N/A         |
| Clogging Factor for Multiple-unit Grate Inlet                                                      | L <sub>e</sub> =         | N/A                      | N/A ft      |
| Effective (unclogged) Length of Multiple-unit Grate Inlet                                          | V <sub>o</sub> =         | N/A                      | N/A fps     |
| Minimum Velocity Where Grate Splash-Over Begins                                                    | R <sub>f</sub> =         | N/A                      | N/A         |
| Interception Rate of Frontal Flow                                                                  | R <sub>x</sub> =         | N/A                      | N/A         |
| Interception Rate of Side Flow                                                                     | Q <sub>a</sub> =         | N/A                      | N/A cfs     |
| Actual Interception Capacity                                                                       | Q <sub>b</sub> =         | N/A                      | N/A cfs     |
| Carry-Over Flow = Q <sub>o</sub> -Q <sub>a</sub> (to be applied to curb opening or next d/s inlet) | MINOR                    | MAJOR                    |             |
| Curb Opening or Slotted Inlet Analysis (Calculated)                                                | S <sub>o</sub> =         | 0.208                    | 0.208 ft/ft |
| Equivalent Slope S <sub>o</sub>                                                                    | L <sub>T</sub> =         | 2.32                     | 3.85 ft     |
| Required Length L <sub>T</sub> to Have 100% Interception                                           | MINOR                    | MAJOR                    |             |
| Under No-Clogging Condition                                                                        | L =                      | 2.32                     | 3.85 ft     |
| Effective Length of Curb Opening or Slotted Inlet (minimum of L, L <sub>T</sub> )                  | Q <sub>i</sub> =         | 0.3                      | 0.8 cfs     |
| Interception Capacity                                                                              | MINOR                    | MAJOR                    |             |
| Under Clogging Condition                                                                           | CurbCoeff =              | 1.00                     | 1.00        |
| Clogging Coefficient                                                                               | CurbClog =               | 0.10                     | 0.10        |
| Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet                                    | L <sub>e</sub> =         | 2.32                     | 3.85 ft     |
| Effective (Unclogged) Length                                                                       | Q <sub>a</sub> =         | 0.3                      | 0.8 cfs     |
| Actual Interception Capacity                                                                       | Q <sub>b</sub> =         | 0.0                      | 0.0 cfs     |
| Carry-Over Flow = Q <sub>o</sub> (GRATE)-Q <sub>a</sub>                                            | MINOR                    | MAJOR                    |             |
| Summary                                                                                            | Q =                      | 0.3                      | 0.8 cfs     |
| Total Inlet Interception Capacity                                                                  | Q <sub>b</sub> =         | 0.00                     | 0.0 cfs     |
| Total Inlet Carry-Over Flow (flow bypassing inlet)                                                 | C% =                     | 100                      | 100 %       |
| Capture Percentage = Q <sub>a</sub> /Q <sub>o</sub>                                                |                          |                          |             |

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

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

Project:

Inlet ID: **B2****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

|              |       |       |
|--------------|-------|-------|
| $T_{BACK} =$ | 8.0   | ft    |
| $S_{BACK} =$ | 0.020 | ft/ft |
| $n_{BACK} =$ | 0.013 |       |

|                |       |        |
|----------------|-------|--------|
| $H_{CURB} =$   | 6.00  | inches |
| $T_{CROWN} =$  | 13.0  | ft     |
| $W =$          | 2.00  | ft     |
| $S_x =$        | 0.020 | ft/ft  |
| $S_w =$        | 0.083 | ft/ft  |
| $S_o =$        | 0.054 | ft/ft  |
| $n_{STREET} =$ | 0.016 |        |

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

|             | Minor Storm                         | Major Storm                         |        |
|-------------|-------------------------------------|-------------------------------------|--------|
| $T_{MAX} =$ | 8.0                                 | 13.0                                | ft     |
| $d_{MAX} =$ | 4.6                                 | 6.9                                 | inches |
|             | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |        |

**Maximum Capacity for 1/2 Street based On Allowable Spread**Water Depth without Gutter Depression ( $T * S_x * 12$ )Vertical Depth between Gutter Lip and Gutter Flowline ( $W * S_w * 12$ )Gutter Depression ( $d_c - (W * S_x * 12)$ )Water Depth at Gutter Flowline ( $y + a$ )Allowable Spread for Discharge outside the Gutter Section ( $T - W$ )

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)

Discharge outside the Gutter Section, carried in Section  $T_x$ Discharge within the Gutter Section ( $Q_T - Q_X - Q_{BACK}$ )

Discharge Behind the Curb (e.g., sidewalk, driveways, &amp; lawns)

Maximum Flow Based On Allowable Spread

Flow Velocity within the Gutter Section

 $V*d$  Product: Flow Velocity times Gutter Flowline Depth

|              | Minor Storm | Major Storm |        |
|--------------|-------------|-------------|--------|
| $y =$        | 1.92        | 3.12        | inches |
| $d_c =$      | 2.0         | 2.0         | inches |
| $a =$        | 1.51        | 1.51        | inches |
| $d =$        | 3.43        | 4.63        | inches |
| $T_x =$      | 6.0         | 11.0        | ft     |
| $E_o =$      | 0.688       | 0.456       |        |
| $Q_X =$      | 1.4         | 7.2         | cfs    |
| $Q_W =$      | 3.1         | 6.0         | cfs    |
| $Q_{BACK} =$ | 0.0         | 0.0         | cfs    |
| $Q_T =$      | 4.6         | 13.2        | cfs    |
| $V =$        | 7.7         | 9.9         | fps    |
| $V*d =$      | 2.2         | 3.8         |        |

**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section ( $T - W$ )

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)

Theoretical Discharge outside the Gutter Section, carried in Section  $T_{XTH}$ Actual Discharge outside the Gutter Section, (limited by distance  $T_{CROWN}$ )Discharge within the Gutter Section ( $Q_d - Q_X$ )

Discharge Behind the Curb (e.g., sidewalk, driveways, &amp; lawns)

Total Discharge for Major &amp; Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

 $V*d$  Product: Flow Velocity Times Gutter Flowline DepthSlope-Based Safety Factor for Minor/Major Storm depth reduction,  $d \geq 6"$ 

Max Flow based on Allowable Depth (Safety Factor Applied)

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

|               | Minor Storm | Major Storm |        |
|---------------|-------------|-------------|--------|
| $T_{TH} =$    | 12.9        | 22.5        | ft     |
| $T_{XTH} =$   | 10.9        | 20.5        | ft     |
| $E_o =$       | 0.460       | 0.263       |        |
| $Q_{XTH} =$   | 6.9         | 37.5        | cfs    |
| $Q_X =$       | 6.9         | 32.7        | cfs    |
| $Q_W =$       | 5.9         | 13.4        | cfs    |
| $Q_{BACK} =$  | 0.0         | 0.5         | cfs    |
| $Q =$         | 12.9        | 46.6        | cfs    |
| $V =$         | 9.9         | 13.6        | fps    |
| $V*d =$       | 3.8         | 7.8         |        |
| $R =$         | 1.00        | 0.38        |        |
| $Q_d =$       | 12.9        | 17.5        | cfs    |
| $d =$         | 4.60        | 5.04        | inches |
| $d_{CROWN} =$ | 0.00        | 0.40        | inches |

MINOR STORM Allowable Capacity is based on Depth Criterion

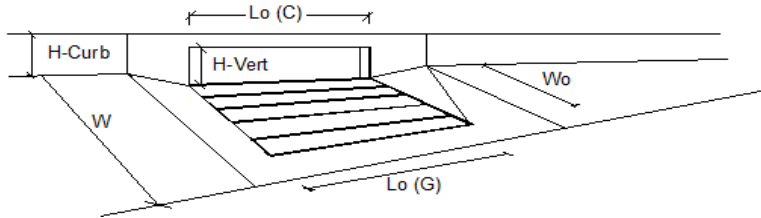
MAJOR STORM Allowable Capacity is based on Depth Criterion

**Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.15 cfs on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design peak flow of 0.59 cfs on sheet 'Inlet Management'**

|               | Minor Storm | Major Storm |     |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | 12.9        | 17.5        | cfs |

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)

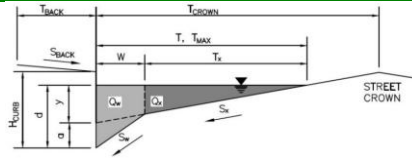


| Design Information (Input)                                                      |                          | MINOR           |                          | MAJOR |        |
|---------------------------------------------------------------------------------|--------------------------|-----------------|--------------------------|-------|--------|
| Type of Inlet                                                                   | CDOT Type R Curb Opening | Type =          | CDOT Type R Curb Opening |       |        |
| Local Depression (additional to continuous gutter depression 'a')               |                          | $a_{LOCAL}$ =   | 3.0                      | 3.0   | inches |
| Total Number of Units in the Inlet (Grate or Curb Opening)                      |                          | $N_o$ =         | 1                        | 1     |        |
| Length of a Single Unit Inlet (Grate or Curb Opening)                           |                          | $L_o$ =         | 5.00                     | 5.00  | ft     |
| Width of a Unit Grate (cannot be greater than W, Gutter Width)                  |                          | $W_o$ =         | N/A                      | N/A   | ft     |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5)              |                          | $C_f (G)$ =     | N/A                      | N/A   |        |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)       |                          | $C_f (C)$ =     | 0.10                     | 0.10  |        |
| Street Hydraulics: OK - $Q < \text{Allowable Street Capacity}$                  |                          |                 |                          |       |        |
| Design Discharge for Half of Street (from Inlet Management)                     |                          | $Q_o$ =         | 0.2                      | 0.6   | cfs    |
| Water Spread Width                                                              |                          | $T$ =           | 1.1                      | 1.8   | ft     |
| Water Depth at Flowline (outside of local depression)                           |                          | $d$ =           | 1.8                      | 1.9   | inches |
| Water Depth at Street Crown (or at $T_{MAX}$ )                                  |                          | $d_{CROWN}$ =   | 0.0                      | 0.0   | inches |
| Ratio of Gutter Flow to Design Flow                                             |                          | $E_o$ =         | 1.000                    | 1.000 |        |
| Discharge outside the Gutter Section W, carried in Section $T_x$                |                          | $Q_x$ =         | 0.0                      | 0.0   | cfs    |
| Discharge within the Gutter Section W                                           |                          | $Q_w$ =         | 0.2                      | 0.6   | cfs    |
| Discharge Behind the Curb Face                                                  |                          | $Q_{BACK}$ =    | 0.0                      | 0.0   | cfs    |
| Flow Area within the Gutter Section W                                           |                          | $A_w$ =         | 0.00                     | 0.00  | sq ft  |
| Velocity within the Gutter Section W                                            |                          | $V_w$ =         | 0.0                      | 0.0   | fps    |
| Water Depth for Design Condition                                                |                          | $d_{LOCAL}$ =   | 4.8                      | 4.9   | inches |
| Grate Analysis (Calculated)                                                     |                          |                 |                          |       |        |
| Total Length of Inlet Grate Opening                                             |                          | $L$ =           | N/A                      | N/A   | ft     |
| Ratio of Grate Flow to Design Flow                                              |                          | $E_{G-GRATE}$ = | N/A                      | N/A   |        |
| Under No-Clogging Condition                                                     |                          |                 |                          |       |        |
| Minimum Velocity Where Grate Splash-Over Begins                                 |                          | $V_o$ =         | N/A                      | N/A   | fps    |
| Interception Rate of Frontal Flow                                               |                          | $R_f$ =         | N/A                      | N/A   |        |
| Interception Rate of Side Flow                                                  |                          | $R_s$ =         | N/A                      | N/A   |        |
| Interception Capacity                                                           |                          | $Q_i$ =         | N/A                      | N/A   | cfs    |
| Under Clogging Condition                                                        |                          |                 |                          |       |        |
| Clogging Coefficient for Multiple-unit Grate Inlet                              |                          | GrateCoeff =    | N/A                      | N/A   |        |
| Clogging Factor for Multiple-unit Grate Inlet                                   |                          | GrateClog =     | N/A                      | N/A   |        |
| Effective (unclogged) Length of Multiple-unit Grate Inlet                       |                          | $L_e$ =         | N/A                      | N/A   | ft     |
| Minimum Velocity Where Grate Splash-Over Begins                                 |                          | $V_o$ =         | N/A                      | N/A   | fps    |
| Interception Rate of Frontal Flow                                               |                          | $R_f$ =         | N/A                      | N/A   |        |
| Interception Rate of Side Flow                                                  |                          | $R_s$ =         | N/A                      | N/A   |        |
| Actual Interception Capacity                                                    |                          | $Q_a$ =         | N/A                      | N/A   | cfs    |
| Carry-Over Flow = $Q_o - Q_a$ (to be applied to curb opening or next d/s inlet) |                          | $Q_b$ =         | N/A                      | N/A   | cfs    |
| Curb Opening or Slotted Inlet Analysis (Calculated)                             |                          |                 |                          |       |        |
| Equivalent Slope $S_e$                                                          |                          | $S_e$ =         | 0.208                    | 0.208 | ft/ft  |
| Required Length $L_T$ to Have 100% Interception                                 |                          | $L_T$ =         | 1.68                     | 3.38  | ft     |
| Under No-Clogging Condition                                                     |                          |                 |                          |       |        |
| Effective Length of Curb Opening or Slotted Inlet (minimum of $L$ , $L_T$ )     |                          | $L$ =           | 1.68                     | 3.38  | ft     |
| Interception Capacity                                                           |                          | $Q_i$ =         | 0.2                      | 0.6   | cfs    |
| Under Clogging Condition                                                        |                          |                 |                          |       |        |
| Clogging Coefficient                                                            |                          | CurbCoeff =     | 1.00                     | 1.00  |        |
| Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet                 |                          | CurbClog =      | 0.10                     | 0.10  |        |
| Effective (Unclogged) Length                                                    |                          | $L_e$ =         | 1.68                     | 3.38  | ft     |
| Actual Interception Capacity                                                    |                          | $Q_a$ =         | 0.2                      | 0.6   | cfs    |
| Carry-Over Flow = $Q_o - Q_a$                                                   |                          | $Q_b$ =         | 0.0                      | 0.0   | cfs    |
| Summary                                                                         |                          |                 |                          |       |        |
| Total Inlet Interception Capacity                                               |                          | $Q$ =           | 0.2                      | 0.6   | cfs    |
| Total Inlet Carry-Over Flow (flow bypassing inlet)                              |                          | $Q_b$ =         | 0.0                      | 0.0   | cfs    |
| Capture Percentage = $Q_a/Q_o$                                                  |                          | $C\%$ =         | 100                      | 100   | %      |

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

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

Project:

Inlet ID: **C1****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb  
 Side Slope Behind Curb (leave blank for no conveyance credit behind curb)  
 Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

|              |       |       |
|--------------|-------|-------|
| $T_{BACK} =$ | 8.0   | ft    |
| $S_{BACK} =$ | 0.020 | ft/ft |
| $n_{BACK} =$ | 0.013 |       |

Height of Curb at Gutter Flow Line  
 Distance from Curb Face to Street Crown  
 Gutter Width  
 Street Transverse Slope  
 Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)  
 Street Longitudinal Slope - Enter 0 for sump condition  
 Manning's Roughness for Street Section (typically between 0.012 and 0.020)

|                |       |        |
|----------------|-------|--------|
| $H_{CURB} =$   | 6.00  | inches |
| $T_{CROWN} =$  | 13.0  | ft     |
| $W =$          | 2.00  | ft     |
| $S_x =$        | 0.020 | ft/ft  |
| $S_w =$        | 0.083 | ft/ft  |
| $S_o =$        | 0.058 | ft/ft  |
| $n_{STREET} =$ | 0.016 |        |

Max. Allowable Spread for Minor & Major Storm  
 Max. Allowable Depth at Gutter Flowline for Minor & Major Storm  
 Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

|             | Minor Storm                         | Major Storm                         |        |
|-------------|-------------------------------------|-------------------------------------|--------|
| $T_{MAX} =$ | 8.0                                 | 13.0                                | ft     |
| $d_{MAX} =$ | 4.6                                 | 6.9                                 | inches |
|             | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |        |

**Maximum Capacity for 1/2 Street based On Allowable Spread**

Water Depth without Gutter Depression ( $T * S_x * 12$ )  
 Vertical Depth between Gutter Lip and Gutter Flowline ( $W * S_w * 12$ )  
 Gutter Depression ( $d_c - (W * S_x * 12)$ )  
 Water Depth at Gutter Flowline ( $y + a$ )  
 Allowable Spread for Discharge outside the Gutter Section ( $T - W$ )  
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)  
 Discharge outside the Gutter Section, carried in Section  $T_x$   
 Discharge within the Gutter Section ( $Q_T - Q_x - Q_{BACK}$ )  
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)  
 Maximum Flow Based On Allowable Spread  
 Flow Velocity within the Gutter Section  
 $V*d$  Product: Flow Velocity times Gutter Flowline Depth

|              | Minor Storm | Major Storm |        |
|--------------|-------------|-------------|--------|
| $y =$        | 1.92        | 3.12        | inches |
| $d_c =$      | 2.0         | 2.0         | inches |
| $a =$        | 1.51        | 1.51        | inches |
| $d =$        | 3.43        | 4.63        | inches |
| $T_x =$      | 6.0         | 11.0        | ft     |
| $E_o =$      | 0.688       | 0.456       |        |
| $Q_x =$      | 1.5         | 7.4         | cfs    |
| $Q_w =$      | 3.3         | 6.2         | cfs    |
| $Q_{BACK} =$ | 0.0         | 0.0         | cfs    |
| $Q_T =$      | 4.7         | 13.7        | cfs    |
| $V =$        | 8.0         | 10.3        | fps    |
| $V*d =$      | 2.3         | 4.0         |        |

**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread  
 Theoretical Spread for Discharge outside the Gutter Section ( $T - W$ )  
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)  
 Theoretical Discharge outside the Gutter Section, carried in Section  $T_{XTH}$   
 Actual Discharge outside the Gutter Section, (limited by distance  $T_{CROWN}$ )  
 Discharge within the Gutter Section ( $Q_d - Q_x$ )  
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)  
 Total Discharge for Major & Minor Storm (Pre-Safety Factor)  
 Average Flow Velocity Within the Gutter Section  
 $V*d$  Product: Flow Velocity Times Gutter Flowline Depth  
 Slope-Based Safety Factor for Minor/Major Storm depth reduction,  $d \geq 6"$   
 Max Flow based on Allowable Depth (Safety Factor Applied)  
 Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)  
 Resultant Flow Depth at Street Crown (Safety Factor Applied)

|               | Minor Storm | Major Storm |        |
|---------------|-------------|-------------|--------|
| $T_{TH} =$    | 12.9        | 22.5        | ft     |
| $T_{XTH} =$   | 10.9        | 20.5        | ft     |
| $E_o =$       | 0.460       | 0.263       |        |
| $Q_{XTH} =$   | 7.2         | 38.8        | cfs    |
| $Q_x =$       | 7.2         | 33.9        | cfs    |
| $Q_w =$       | 6.1         | 13.9        | cfs    |
| $Q_{BACK} =$  | 0.0         | 0.5         | cfs    |
| $Q =$         | 13.3        | 48.3        | cfs    |
| $V =$         | 10.2        | 14.1        | fps    |
| $V*d =$       | 3.9         | 8.1         |        |
| $R =$         | 1.00        | 0.36        |        |
| $Q_d =$       | 13.3        | 17.2        | cfs    |
| $d =$         | 4.60        | 4.95        | inches |
| $d_{CROWN} =$ | 0.00        | 0.32        | inches |

MINOR STORM Allowable Capacity is based on Depth Criterion

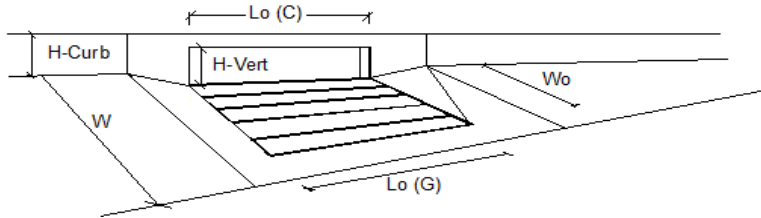
MAJOR STORM Allowable Capacity is based on Depth Criterion

**Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.37 cfs on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.51 cfs on sheet 'Inlet Management'**

|               | Minor Storm | Major Storm |     |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | 13.3        | 17.2        | cfs |

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)

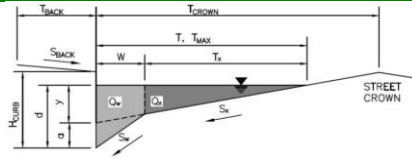


| Design Information (Input)                                                                         |                          | MINOR                  |                          | MAJOR |        |
|----------------------------------------------------------------------------------------------------|--------------------------|------------------------|--------------------------|-------|--------|
| Type of Inlet                                                                                      | CDOT Type R Curb Opening | Type =                 | CDOT Type R Curb Opening |       |        |
| Local Depression (additional to continuous gutter depression 'a')                                  |                          | a <sub>LOCAL</sub> =   | 3.0                      | 3.0   | inches |
| Total Number of Units in the Inlet (Grate or Curb Opening)                                         |                          | No =                   | 1                        | 1     |        |
| Length of a Single Unit Inlet (Grate or Curb Opening)                                              |                          | L <sub>o</sub> =       | 10.00                    | 10.00 | ft     |
| Width of a Unit Grate (cannot be greater than W, Gutter Width)                                     |                          | W <sub>o</sub> =       | N/A                      | N/A   | ft     |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5)                                 |                          | C <sub>f</sub> (G) =   | N/A                      | N/A   |        |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)                          |                          | C <sub>f</sub> (C) =   | 0.10                     | 0.10  |        |
| Street Hydraulics: OK - Q < Allowable Street Capacity                                              |                          |                        |                          |       |        |
| Design Discharge for Half of Street (from Inlet Management)                                        |                          | Q <sub>o</sub> =       | 0.4                      | 1.5   | cfs    |
| Water Spread Width                                                                                 |                          | T =                    | 1.5                      | 3.9   | ft     |
| Water Depth at Flowline (outside of local depression)                                              |                          | d =                    | 1.9                      | 2.4   | inches |
| Water Depth at Street Crown (or at T <sub>MAX</sub> )                                              |                          | d <sub>CROWN</sub> =   | 0.0                      | 0.0   | inches |
| Ratio of Gutter Flow to Design Flow                                                                |                          | E <sub>o</sub> =       | 1.000                    | 0.955 |        |
| Discharge outside the Gutter Section W, carried in Section T <sub>x</sub>                          |                          | Q <sub>x</sub> =       | 0.0                      | 0.1   | cfs    |
| Discharge within the Gutter Section W                                                              |                          | Q <sub>w</sub> =       | 0.4                      | 1.4   | cfs    |
| Discharge Behind the Curb Face                                                                     |                          | Q <sub>BACK</sub> =    | 0.0                      | 0.0   | cfs    |
| Flow Area within the Gutter Section W                                                              |                          | A <sub>w</sub> =       | 0.00                     | 0.24  | sq ft  |
| Velocity within the Gutter Section W                                                               |                          | V <sub>w</sub> =       | 0.0                      | 6.0   | fps    |
| Water Depth for Design Condition                                                                   |                          | d <sub>LOCAL</sub> =   | 4.9                      | 5.4   | inches |
| Grate Analysis (Calculated)                                                                        |                          |                        |                          |       |        |
| Total Length of Inlet Grate Opening                                                                |                          | L =                    | N/A                      | N/A   | ft     |
| Ratio of Grate Flow to Design Flow                                                                 |                          | E <sub>G-GRATE</sub> = | N/A                      | N/A   |        |
| Under No-Clogging Condition                                                                        |                          |                        |                          |       |        |
| Minimum Velocity Where Grate Splash-Over Begins                                                    |                          | V <sub>o</sub> =       | N/A                      | N/A   | fps    |
| Interception Rate of Frontal Flow                                                                  |                          | R <sub>f</sub> =       | N/A                      | N/A   |        |
| Interception Rate of Side Flow                                                                     |                          | R <sub>s</sub> =       | N/A                      | N/A   |        |
| Interception Capacity                                                                              |                          | Q <sub>i</sub> =       | N/A                      | N/A   | cfs    |
| Under Clogging Condition                                                                           |                          |                        |                          |       |        |
| Clogging Coefficient for Multiple-unit Grate Inlet                                                 |                          | GrateCoeff =           | N/A                      | N/A   |        |
| Clogging Factor for Multiple-unit Grate Inlet                                                      |                          | GrateClog =            | N/A                      | N/A   |        |
| Effective (unclogged) Length of Multiple-unit Grate Inlet                                          |                          | L <sub>e</sub> =       | N/A                      | N/A   | ft     |
| Minimum Velocity Where Grate Splash-Over Begins                                                    |                          | V <sub>o</sub> =       | N/A                      | N/A   | fps    |
| Interception Rate of Frontal Flow                                                                  |                          | R <sub>f</sub> =       | N/A                      | N/A   |        |
| Interception Rate of Side Flow                                                                     |                          | R <sub>s</sub> =       | N/A                      | N/A   |        |
| Actual Interception Capacity                                                                       |                          | Q <sub>a</sub> =       | N/A                      | N/A   | cfs    |
| Carry-Over Flow = Q <sub>o</sub> -Q <sub>a</sub> (to be applied to curb opening or next d/s inlet) |                          | Q <sub>b</sub> =       | N/A                      | N/A   | cfs    |
| Curb Opening or Slotted Inlet Analysis (Calculated)                                                |                          |                        |                          |       |        |
| Equivalent Slope S <sub>e</sub>                                                                    |                          | S <sub>e</sub> =       | 0.208                    | 0.200 | ft/ft  |
| Required Length L <sub>T</sub> to Have 100% Interception                                           |                          | L <sub>T</sub> =       | 2.68                     | 5.59  | ft     |
| Under No-Clogging Condition                                                                        |                          |                        |                          |       |        |
| Effective Length of Curb Opening or Slotted Inlet (minimum of L, L <sub>T</sub> )                  |                          | L =                    | 2.68                     | 5.59  | ft     |
| Interception Capacity                                                                              |                          | Q <sub>i</sub> =       | 0.4                      | 1.5   | cfs    |
| Under Clogging Condition                                                                           |                          |                        |                          |       |        |
| Clogging Coefficient                                                                               |                          | CurbCoeff =            | 1.25                     | 1.25  |        |
| Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet                                    |                          | CurbClog =             | 0.06                     | 0.06  |        |
| Effective (Unclogged) Length                                                                       |                          | L <sub>e</sub> =       | 2.68                     | 5.59  | ft     |
| Actual Interception Capacity                                                                       |                          | Q <sub>a</sub> =       | 0.4                      | 1.5   | cfs    |
| Carry-Over Flow = Q <sub>i</sub> (GRATE)-Q <sub>a</sub>                                            |                          | Q <sub>b</sub> =       | 0.0                      | 0.0   | cfs    |
| Summary                                                                                            |                          |                        |                          |       |        |
| Total Inlet Interception Capacity                                                                  |                          | Q =                    | 0.4                      | 1.5   | cfs    |
| Total Inlet Carry-Over Flow (flow bypassing inlet)                                                 |                          | Q <sub>b</sub> =       | 0.0                      | 0.0   | cfs    |
| Capture Percentage = Q <sub>a</sub> /Q <sub>o</sub>                                                |                          | C% =                   | 100                      | 100   | %      |

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

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

Project:

Inlet ID: **C2****Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb  
 Side Slope Behind Curb (leave blank for no conveyance credit behind curb)  
 Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

|              |       |       |
|--------------|-------|-------|
| $T_{BACK} =$ | 8.0   | ft    |
| $S_{BACK} =$ | 0.020 | ft/ft |
| $n_{BACK} =$ | 0.013 |       |

Height of Curb at Gutter Flow Line  
 Distance from Curb Face to Street Crown  
 Gutter Width  
 Street Transverse Slope  
 Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)  
 Street Longitudinal Slope - Enter 0 for sump condition  
 Manning's Roughness for Street Section (typically between 0.012 and 0.020)

|                |       |        |
|----------------|-------|--------|
| $H_{CURB} =$   | 6.00  | inches |
| $T_{CROWN} =$  | 13.0  | ft     |
| $W =$          | 2.00  | ft     |
| $S_x =$        | 0.020 | ft/ft  |
| $S_w =$        | 0.083 | ft/ft  |
| $S_o =$        | 0.058 | ft/ft  |
| $n_{STREET} =$ | 0.016 |        |

Max. Allowable Spread for Minor & Major Storm  
 Max. Allowable Depth at Gutter Flowline for Minor & Major Storm  
 Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

|             | Minor Storm                         | Major Storm                         |        |
|-------------|-------------------------------------|-------------------------------------|--------|
| $T_{MAX} =$ | 8.0                                 | 13.0                                | ft     |
| $d_{MAX} =$ | 4.6                                 | 6.9                                 | inches |
|             | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |        |

**Maximum Capacity for 1/2 Street based On Allowable Spread**

Water Depth without Gutter Depression ( $T * S_x * 12$ )  
 Vertical Depth between Gutter Lip and Gutter Flowline ( $W * S_w * 12$ )  
 Gutter Depression ( $d_c - (W * S_x * 12)$ )  
 Water Depth at Gutter Flowline ( $y + a$ )  
 Allowable Spread for Discharge outside the Gutter Section ( $T - W$ )  
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)  
 Discharge outside the Gutter Section, carried in Section  $T_x$   
 Discharge within the Gutter Section ( $Q_T - Q_x - Q_{BACK}$ )  
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)  
 Maximum Flow Based On Allowable Spread  
 Flow Velocity within the Gutter Section  
 $V*d$  Product: Flow Velocity times Gutter Flowline Depth

|              | Minor Storm | Major Storm |        |
|--------------|-------------|-------------|--------|
| $y =$        | 1.92        | 3.12        | inches |
| $d_c =$      | 2.0         | 2.0         | inches |
| $a =$        | 1.51        | 1.51        | inches |
| $d =$        | 3.43        | 4.63        | inches |
| $T_x =$      | 6.0         | 11.0        | ft     |
| $E_o =$      | 0.688       | 0.456       |        |
| $Q_x =$      | 1.5         | 7.4         | cfs    |
| $Q_w =$      | 3.3         | 6.2         | cfs    |
| $Q_{BACK} =$ | 0.0         | 0.0         | cfs    |
| $Q_T =$      | 4.7         | 13.7        | cfs    |
| $V =$        | 8.0         | 10.3        | fps    |
| $V*d =$      | 2.3         | 4.0         |        |

**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread  
 Theoretical Spread for Discharge outside the Gutter Section ( $T - W$ )  
 Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)  
 Theoretical Discharge outside the Gutter Section, carried in Section  $T_{XTH}$   
 Actual Discharge outside the Gutter Section, (limited by distance  $T_{CROWN}$ )  
 Discharge within the Gutter Section ( $Q_d - Q_x$ )  
 Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)  
 Total Discharge for Major & Minor Storm (Pre-Safety Factor)  
 Average Flow Velocity Within the Gutter Section  
 $V*d$  Product: Flow Velocity Times Gutter Flowline Depth  
 Slope-Based Safety Factor for Minor/Major Storm depth reduction,  $d \geq 6"$   
 Max Flow based on Allowable Depth (Safety Factor Applied)  
 Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)  
 Resultant Flow Depth at Street Crown (Safety Factor Applied)

|               | Minor Storm | Major Storm |        |
|---------------|-------------|-------------|--------|
| $T_{TH} =$    | 12.9        | 22.5        | ft     |
| $T_{XTH} =$   | 10.9        | 20.5        | ft     |
| $E_o =$       | 0.460       | 0.263       |        |
| $Q_{XTH} =$   | 7.2         | 38.8        | cfs    |
| $Q_x =$       | 7.2         | 33.9        | cfs    |
| $Q_w =$       | 6.1         | 13.9        | cfs    |
| $Q_{BACK} =$  | 0.0         | 0.5         | cfs    |
| $Q =$         | 13.3        | 48.3        | cfs    |
| $V =$         | 10.2        | 14.1        | fps    |
| $V*d =$       | 3.9         | 8.1         |        |
| $R =$         | 1.00        | 0.36        |        |
| $Q_d =$       | 13.3        | 17.2        | cfs    |
| $d =$         | 4.60        | 4.95        | inches |
| $d_{CROWN} =$ | 0.00        | 0.32        | inches |

MINOR STORM Allowable Capacity is based on Depth Criterion

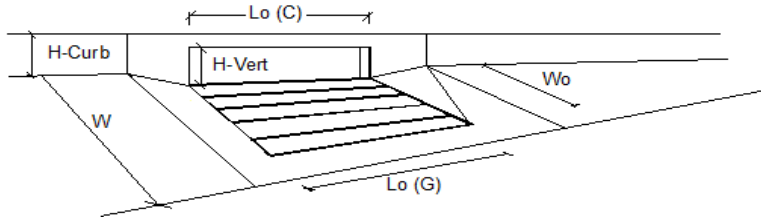
MAJOR STORM Allowable Capacity is based on Depth Criterion

**Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.22 cfs on sheet 'Inlet Management'****Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.19 cfs on sheet 'Inlet Management'**

|               | Minor Storm | Major Storm |     |
|---------------|-------------|-------------|-----|
| $Q_{allow} =$ | 13.3        | 17.2        | cfs |

# INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



| Design Information (Input)                                                      |                          | MINOR           |                          | MAJOR |        |
|---------------------------------------------------------------------------------|--------------------------|-----------------|--------------------------|-------|--------|
| Type of Inlet                                                                   | CDOT Type R Curb Opening | Type =          | CDOT Type R Curb Opening |       |        |
| Local Depression (additional to continuous gutter depression 'a')               |                          | $a_{LOCAL}$ =   | 3.0                      | 3.0   | inches |
| Total Number of Units in the Inlet (Grate or Curb Opening)                      |                          | No =            | 1                        | 1     |        |
| Length of a Single Unit Inlet (Grate or Curb Opening)                           |                          | $L_o$ =         | 5.00                     | 5.00  | ft     |
| Width of a Unit Grate (cannot be greater than W, Gutter Width)                  |                          | $W_o$ =         | N/A                      | N/A   | ft     |
| Clogging Factor for a Single Unit Grate (typical min. value = 0.5)              |                          | $C_f (G)$ =     | N/A                      | N/A   |        |
| Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)       |                          | $C_f (C)$ =     | 0.10                     | 0.10  |        |
| Street Hydraulics: OK - $Q < \text{Allowable Street Capacity}$                  |                          |                 |                          |       |        |
| Design Discharge for Half of Street (from Inlet Management)                     |                          | $Q_o$ =         | 0.2                      | 1.2   | cfs    |
| Water Spread Width                                                              |                          | T =             | 1.2                      | 2.3   | ft     |
| Water Depth at Flowline (outside of local depression)                           |                          | d =             | 1.8                      | 2.1   | inches |
| Water Depth at Street Crown (or at $T_{MAX}$ )                                  |                          | $d_{CROWN}$ =   | 0.0                      | 0.0   | inches |
| Ratio of Gutter Flow to Design Flow                                             |                          | $E_o$ =         | 1.000                    | 1.000 |        |
| Discharge outside the Gutter Section W, carried in Section $T_x$                |                          | $Q_x$ =         | 0.0                      | 0.0   | cfs    |
| Discharge within the Gutter Section W                                           |                          | $Q_w$ =         | 0.2                      | 1.2   | cfs    |
| Discharge Behind the Curb Face                                                  |                          | $Q_{BACK}$ =    | 0.0                      | 0.0   | cfs    |
| Flow Area within the Gutter Section W                                           |                          | $A_w$ =         | 0.00                     | 0.18  | sq ft  |
| Velocity within the Gutter Section W                                            |                          | $V_w$ =         | 0.0                      | 6.7   | fps    |
| Water Depth for Design Condition                                                |                          | $d_{LOCAL}$ =   | 4.8                      | 5.1   | inches |
| Grate Analysis (Calculated)                                                     |                          |                 |                          |       |        |
| Total Length of Inlet Grate Opening                                             |                          | L =             | N/A                      | N/A   | ft     |
| Ratio of Grate Flow to Design Flow                                              |                          | $E_{G-GRATE}$ = | N/A                      | N/A   |        |
| Under No-Clogging Condition                                                     |                          |                 |                          |       |        |
| Minimum Velocity Where Grate Splash-Over Begins                                 |                          | $V_o$ =         | N/A                      | N/A   | fps    |
| Interception Rate of Frontal Flow                                               |                          | $R_f$ =         | N/A                      | N/A   |        |
| Interception Rate of Side Flow                                                  |                          | $R_s$ =         | N/A                      | N/A   |        |
| Interception Capacity                                                           |                          | $Q_i$ =         | N/A                      | N/A   | cfs    |
| Under Clogging Condition                                                        |                          |                 |                          |       |        |
| Clogging Coefficient for Multiple-unit Grate Inlet                              |                          | GrateCoeff =    | N/A                      | N/A   |        |
| Clogging Factor for Multiple-unit Grate Inlet                                   |                          | GrateClog =     | N/A                      | N/A   |        |
| Effective (unclogged) Length of Multiple-unit Grate Inlet                       |                          | $L_e$ =         | N/A                      | N/A   | ft     |
| Minimum Velocity Where Grate Splash-Over Begins                                 |                          | $V_o$ =         | N/A                      | N/A   | fps    |
| Interception Rate of Frontal Flow                                               |                          | $R_f$ =         | N/A                      | N/A   |        |
| Interception Rate of Side Flow                                                  |                          | $R_s$ =         | N/A                      | N/A   |        |
| Actual Interception Capacity                                                    |                          | $Q_a$ =         | N/A                      | N/A   | cfs    |
| Carry-Over Flow = $Q_o - Q_a$ (to be applied to curb opening or next d/s inlet) |                          | $Q_b$ =         | N/A                      | N/A   | cfs    |
| Curb Opening or Slotted Inlet Analysis (Calculated)                             |                          |                 |                          |       |        |
| Equivalent Slope $S_e$                                                          |                          | $S_e$ =         | 0.208                    | 0.208 | ft/ft  |
| Required Length $L_T$ to Have 100% Interception                                 |                          | $L_T$ =         | 2.05                     | 4.86  | ft     |
| Under No-Clogging Condition                                                     |                          |                 |                          |       |        |
| Effective Length of Curb Opening or Slotted Inlet (minimum of $L$ , $L_T$ )     |                          | L =             | 2.05                     | 4.86  | ft     |
| Interception Capacity                                                           |                          | $Q_i$ =         | 0.2                      | 1.2   | cfs    |
| Under Clogging Condition                                                        |                          |                 |                          |       |        |
| Clogging Coefficient                                                            |                          | CurbCoeff =     | 1.00                     | 1.00  |        |
| Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet                 |                          | CurbClog =      | 0.10                     | 0.10  |        |
| Effective (Unclogged) Length                                                    |                          | $L_e$ =         | 2.05                     | 4.50  | ft     |
| Actual Interception Capacity                                                    |                          | $Q_a$ =         | 0.2                      | 1.2   | cfs    |
| Carry-Over Flow = $Q_o - Q_a$                                                   |                          | $Q_b$ =         | 0.0                      | 0.0   | cfs    |
| Summary                                                                         |                          |                 |                          |       |        |
| Total Inlet Interception Capacity                                               |                          | Q =             | 0.2                      | 1.2   | cfs    |
| Total Inlet Carry-Over Flow (flow bypassing inlet)                              |                          | $Q_b$ =         | 0.0                      | 0.01  | cfs    |
| Capture Percentage = $Q_a/Q_o$                                                  |                          | C% =            | 100                      | 99    | %      |



**INLET MANAGEMENT**

Worksheet Protected

|                                    |                         |                                     |                                     |
|------------------------------------|-------------------------|-------------------------------------|-------------------------------------|
| <b>INLET NAME</b>                  | <a href="#">OS1.1</a>   | <a href="#">OS2</a>                 | <a href="#">OS4</a>                 |
| Site Type (Urban or Rural)         | URBAN                   | URBAN                               | URBAN                               |
| Inlet Application (Street or Area) | AREA                    | AREA                                | AREA                                |
| Hydraulic Condition                | Swale                   | Swale                               | Swale                               |
| Inlet Type                         | CDOT Type D (In Series) | CDOT Type D (In Series & Depressed) | CDOT Type D (In Series & Depressed) |

**USER-DEFINED INPUT****User-Defined Design Flows**

|                         |      |      |      |
|-------------------------|------|------|------|
| Minor $Q_{Known}$ (cfs) | 1.4  | 2.3  | 2.2  |
| Major $Q_{Known}$ (cfs) | 12.1 | 19.9 | 19.7 |

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

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

**Watershed Characteristics**

|                           |  |  |  |
|---------------------------|--|--|--|
| Subcatchment Area (acres) |  |  |  |
| Percent Impervious        |  |  |  |
| NRCS Soil Type            |  |  |  |

**Watershed Profile**

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

**Minor Storm Rainfall Input**

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

**Major Storm Rainfall Input**

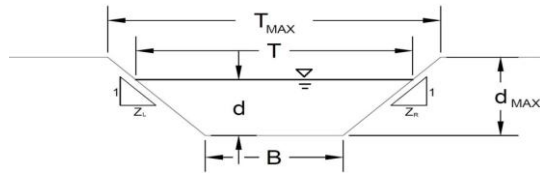
|                                           |  |  |  |
|-------------------------------------------|--|--|--|
| Design Storm Return Period, $T_r$ (years) |  |  |  |
| One-Hour Precipitation, $P_1$ (inches)    |  |  |  |

**CALCULATED OUTPUT**

|                                                           |             |             |             |
|-----------------------------------------------------------|-------------|-------------|-------------|
| <b>Minor Total Design Peak Flow, <math>Q</math> (cfs)</b> | <b>1.4</b>  | <b>2.3</b>  | <b>2.2</b>  |
| <b>Major Total Design Peak Flow, <math>Q</math> (cfs)</b> | <b>12.1</b> | <b>19.9</b> | <b>19.7</b> |
| Minor Flow Bypassed Downstream, $Q_b$ (cfs)               | 0.0         | 0.0         | 0.0         |
| Major Flow Bypassed Downstream, $Q_b$ (cfs)               | 0.0         | 0.0         | 0.0         |

## AREA INLET IN A SWALE

OS1.1



This worksheet uses the NRCS vegetal retardance method to determine Manning's n for grass-lined channels.

An override Manning's n can be entered for other channel materials.

## Analysis of Trapezoidal Channel (Grass-Lined uses SCS Method)

NRCS Vegetal Retardance (A, B, C, D, or E)

Manning's n (Leave cell D16 blank to manually enter an n value)

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

| Soil Type:   | Max. Velocity ( $V_{MAX}$ ) | Max Froude No. ( $F_{MAX}$ ) |
|--------------|-----------------------------|------------------------------|
| Non-Cohesive | 5.0 fps                     | 0.60                         |
| Cohesive     | 7.0 fps                     | 0.80                         |
| Paved        | N/A                         | N/A                          |

A, B, C, D, or E =

|         |              |
|---------|--------------|
| n =     | 0.040        |
| $S_o$ = | 0.0300 ft/ft |
| B =     | 2.00 ft      |
| Z1 =    | 3.00 ft/ft   |
| Z2 =    | 3.00 ft/ft   |

Choose One:

- ☐ Non-Cohesive  
☒ Cohesive  
☐ Paved

Maximum Allowable Top Width of Channel for Minor &amp; Major Storm

Maximum Allowable Water Depth in Channel for Minor &amp; Major Storm

|             | Minor Storm | Major Storm |    |
|-------------|-------------|-------------|----|
| $T_{MAX}$ = | 78.00       | 78.00       | ft |
| $d_{MAX}$ = | 6.00        | 6.00        | ft |

## Maximum Channel Capacity Based On Allowable Top Width

Maximum Allowable Top Width

Water Depth

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Maximum Flow Based on Allowable Water Depth

|             | Minor Storm | Major Storm |                    |
|-------------|-------------|-------------|--------------------|
| $T_{MAX}$ = | 78.00       | 78.00       | ft                 |
| d =         | 12.67       | 12.67       | ft                 |
| A =         | 506.67      | 506.67      | sq ft              |
| P =         | 82.11       | 82.11       | ft                 |
| R =         | 6.17        | 6.17        | ft                 |
| n =         | 0.040       | 0.040       |                    |
| V =         | 21.71       | 21.71       | fps                |
| VR =        | 133.93      | 133.93      | ft <sup>2</sup> /s |
| D =         | 6.50        | 6.50        | ft                 |
| Fr =        | 1.50        | 1.50        |                    |
| $Q_T$ =     | 10,997.4    | 10,997.4    | cfs                |

## Maximum Channel Capacity Based On Allowable Water Depth

Maximum Allowable Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Maximum Flow Based on Allowable Water Depth

|             | Minor Storm | Major Storm |                    |
|-------------|-------------|-------------|--------------------|
| $d_{MAX}$ = | 6.00        | 6.00        | ft                 |
| T =         | 38.00       | 38.00       | ft                 |
| A =         | 120.00      | 120.00      | sq ft              |
| P =         | 39.95       | 39.95       | ft                 |
| R =         | 3.00        | 3.00        | ft                 |
| n =         | 0.040       | 0.040       |                    |
| V =         | 13.43       | 13.43       | fps                |
| VR =        | 40.35       | 40.35       | ft <sup>2</sup> /s |
| D =         | 3.16        | 3.16        | ft                 |
| Fr =        | 1.33        | 1.33        |                    |
| $Q_d$ =     | 1,611.9     | 1,611.9     | cfs                |

## Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

## Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

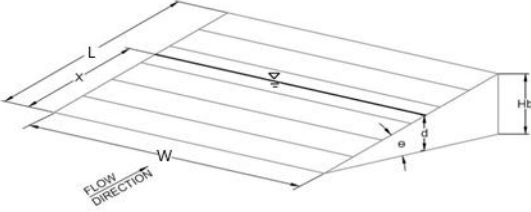
|         | Minor Storm | Major Storm |                    |
|---------|-------------|-------------|--------------------|
| $Q_o$ = | 1.4         | 12.1        | cfs                |
| d =     | 0.25        | 0.74        | ft                 |
| T =     | 3.48        | 6.43        | ft                 |
| A =     | 0.68        | 3.11        | sq ft              |
| P =     | 3.56        | 6.67        | ft                 |
| R =     | 0.19        | 0.47        | ft                 |
| n =     | 0.040       | 0.040       |                    |
| V =     | 2.13        | 3.88        | fps                |
| VR =    | 0.40        | 1.81        | ft <sup>2</sup> /s |
| D =     | 0.19        | 0.48        | ft                 |
| Fr =    | 0.85        | 0.98        |                    |

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

## AREA INLET IN A SWALE

## OS1.1

| Inlet Design Information (Input)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         | Inlet Type =                                                                                                                                                                      |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------|------------|-------|-------|------------|------|------|------------|-----|-----|------------|-----|------|------------|-----|------|
| Type of Inlet                                                                                                                                                                                                                                                                                                                                                                                                                                                        | CDOT Type D (In Series) | CDOT Type D (In Series)                                                                                                                                                           |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Angle of Inclined Grate (must be $\leq 30$ degrees)                                                                                                                                                                                                                                                                                                                                                                                                                  |                         | $\theta =$                                                                                                                                                                        | 0.00 degrees |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Width of Grate                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                         | $W =$                                                                                                                                                                             | 3.00 ft      |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Length of Grate                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                         | $L =$                                                                                                                                                                             | 6.00 ft      |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Open Area Ratio                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                         | $A_{\text{RATIO}} =$                                                                                                                                                              | 0.70         |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Height of Inclined Grate                                                                                                                                                                                                                                                                                                                                                                                                                                             |                         | $H_B =$                                                                                                                                                                           | 0.00 ft      |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Clogging Factor                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                         | $C_f =$                                                                                                                                                                           | 0.38         |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Grate Discharge Coefficient                                                                                                                                                                                                                                                                                                                                                                                                                                          |                         | $C_d =$                                                                                                                                                                           | 0.78         |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Orifice Coefficient                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         | $C_o =$                                                                                                                                                                           | 0.52         |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| Weir Coefficient                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         | $C_w =$                                                                                                                                                                           | 1.67         |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
|                                                                                                                                                                                                                                                                                                                                                                                     |                         | <table border="1"> <thead> <tr> <th></th> <th>MINOR</th> <th>MAJOR</th> </tr> </thead> <tbody> <tr> <td><math>d =</math></td> <td>0.25</td> <td>0.74</td> </tr> </tbody> </table> |              |       | MINOR      | MAJOR | $d =$ | 0.25       | 0.74 |      |            |     |     |            |     |      |            |     |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                         |                                                                                                                                                                                   | MINOR        | MAJOR |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $d =$                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 0.25                    | 0.74                                                                                                                                                                              |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| <table border="1"> <thead> <tr> <th></th> <th>MINOR</th> <th>MAJOR</th> </tr> </thead> <tbody> <tr> <td><math>X =</math></td> <td>6.00</td> <td>6.00</td> </tr> <tr> <td><math>Q_{ws} =</math></td> <td>2.1</td> <td>11.1</td> </tr> <tr> <td><math>Q_{wb} =</math></td> <td>1.5</td> <td>7.9</td> </tr> <tr> <td><math>Q_{wi} =</math></td> <td>5.8</td> <td>30.2</td> </tr> <tr> <td><math>Q_{wa} =</math></td> <td>3.6</td> <td>18.9</td> </tr> </tbody> </table> |                         |                                                                                                                                                                                   | MINOR        | MAJOR | $X =$      | 6.00  | 6.00  | $Q_{ws} =$ | 2.1  | 11.1 | $Q_{wb} =$ | 1.5 | 7.9 | $Q_{wi} =$ | 5.8 | 30.2 | $Q_{wa} =$ | 3.6 | 18.9 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | MINOR                   | MAJOR                                                                                                                                                                             |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $X =$                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 6.00                    | 6.00                                                                                                                                                                              |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $Q_{ws} =$                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2.1                     | 11.1                                                                                                                                                                              |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $Q_{wb} =$                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.5                     | 7.9                                                                                                                                                                               |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $Q_{wi} =$                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 5.8                     | 30.2                                                                                                                                                                              |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $Q_{wa} =$                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 3.6                     | 18.9                                                                                                                                                                              |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| <table border="1"> <thead> <tr> <th></th> <th>MINOR</th> <th>MAJOR</th> </tr> </thead> <tbody> <tr> <td><math>Q_{oi} =</math></td> <td>26.1</td> <td>45.2</td> </tr> <tr> <td><math>Q_{oa} =</math></td> <td>16.3</td> <td>28.2</td> </tr> </tbody> </table>                                                                                                                                                                                                         |                         |                                                                                                                                                                                   | MINOR        | MAJOR | $Q_{oi} =$ | 26.1  | 45.2  | $Q_{oa} =$ | 16.3 | 28.2 |            |     |     |            |     |      |            |     |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | MINOR                   | MAJOR                                                                                                                                                                             |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $Q_{oi} =$                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 26.1                    | 45.2                                                                                                                                                                              |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $Q_{oa} =$                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 16.3                    | 28.2                                                                                                                                                                              |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| <table border="1"> <thead> <tr> <th></th> <th>MINOR</th> <th>MAJOR</th> </tr> </thead> <tbody> <tr> <td><math>Q_a =</math></td> <td>3.6</td> <td>18.9</td> </tr> <tr> <td><math>Q_b =</math></td> <td>0.0</td> <td>0.0</td> </tr> <tr> <td><math>C\% =</math></td> <td>100</td> <td>100</td> </tr> </tbody> </table>                                                                                                                                                 |                         |                                                                                                                                                                                   | MINOR        | MAJOR | $Q_a =$    | 3.6   | 18.9  | $Q_b =$    | 0.0  | 0.0  | $C\% =$    | 100 | 100 |            |     |      |            |     |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | MINOR                   | MAJOR                                                                                                                                                                             |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $Q_a =$                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3.6                     | 18.9                                                                                                                                                                              |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $Q_b =$                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0.0                     | 0.0                                                                                                                                                                               |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |
| $C\% =$                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 100                     | 100                                                                                                                                                                               |              |       |            |       |       |            |      |      |            |     |     |            |     |      |            |     |      |

Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)

**Grate Capacity as a Weir**

Submerged Side Weir Length

Inclined Side Weir Flow

Base Weir Flow

Interception Without Clogging

Interception With Clogging

**Grate Capacity as an Orifice**

Interception Without Clogging

Interception With Clogging

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

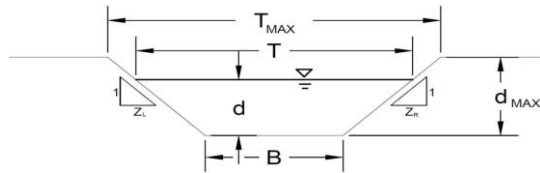
Capture Percentage =  $Q_a/Q_o$

Warning 02: Depth (d) exceeds USDCM Volume I recommendation.

Warning 04: Froude No. exceeds USDCM Volume I recommendation.

## AREA INLET IN A SWALE

OS2



This worksheet uses the NRCS vegetal retardance method to determine Manning's n for grass-lined channels.

An override Manning's n can be entered for other channel materials.

## Analysis of Trapezoidal Channel (Grass-Lined uses SCS Method)

NRCS Vegetal Retardance (A, B, C, D, or E)

Manning's n (Leave cell D16 blank to manually enter an n value)

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

| Soil Type:   | Max. Velocity ( $V_{MAX}$ ) | Max Froude No. ( $F_{MAX}$ ) |
|--------------|-----------------------------|------------------------------|
| Non-Cohesive | 5.0 fps                     | 0.60                         |
| Cohesive     | 7.0 fps                     | 0.80                         |
| Paved        | N/A                         | N/A                          |

A, B, C, D, or E =

|         |              |
|---------|--------------|
| n =     | 0.013        |
| $S_o$ = | 0.0400 ft/ft |
| B =     | 2.00 ft      |
| Z1 =    | 3.00 ft/ft   |
| Z2 =    | 3.00 ft/ft   |

Choose One:

- ☐ Non-Cohesive  
☐ Cohesive  
☐ Paved

Maximum Allowable Top Width of Channel for Minor &amp; Major Storm

Maximum Allowable Water Depth in Channel for Minor &amp; Major Storm

|             | Minor Storm | Major Storm |    |
|-------------|-------------|-------------|----|
| $T_{MAX}$ = | 34.00       | 34.00       | ft |
| $d_{MAX}$ = | 1.00        | 1.00        | ft |

## Maximum Channel Capacity Based On Allowable Top Width

Maximum Allowable Top Width

Water Depth

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Maximum Flow Based on Allowable Water Depth

|             | Minor Storm | Major Storm |                    |
|-------------|-------------|-------------|--------------------|
| $T_{MAX}$ = | 34.00       | 34.00       | ft                 |
| d =         | 5.33        | 5.33        | ft                 |
| A =         | 96.00       | 96.00       | sq ft              |
| P =         | 35.73       | 35.73       | ft                 |
| R =         | 2.69        | 2.69        | ft                 |
| n =         | 0.013       | 0.013       |                    |
| V =         | 44.30       | 44.30       | fps                |
| VR =        | 119.03      | 119.03      | ft <sup>2</sup> /s |
| D =         | 2.82        | 2.82        | ft                 |
| Fr =        | 4.65        | 4.65        |                    |
| $Q_T$ =     | 4,253.0     | 4,253.0     | cfs                |

## Maximum Channel Capacity Based On Allowable Water Depth

Maximum Allowable Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Maximum Flow Based On Allowable Water Depth

|             | Minor Storm | Major Storm |                    |
|-------------|-------------|-------------|--------------------|
| $d_{MAX}$ = | 1.00        | 1.00        | ft                 |
| T =         | 8.00        | 8.00        | ft                 |
| A =         | 5.00        | 5.00        | sq ft              |
| P =         | 8.32        | 8.32        | ft                 |
| R =         | 0.60        | 0.60        | ft                 |
| n =         | 0.013       | 0.013       |                    |
| V =         | 16.32       | 16.32       | fps                |
| VR =        | 9.80        | 9.80        | ft <sup>2</sup> /s |
| D =         | 0.63        | 0.63        | ft                 |
| Fr =        | 3.64        | 3.64        |                    |
| $Q_d$ =     | 81.6        | 81.6        | cfs                |

## Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

|               | Minor Storm | Major Storm |     |
|---------------|-------------|-------------|-----|
| $Q_{allow}$ = | 81.6        | 81.6        | cfs |
| $d_{allow}$ = | 1.00        | 1.00        | ft  |

## Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

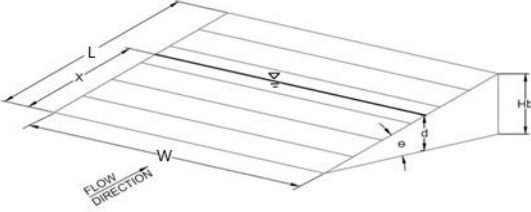
|         |       |       |                    |
|---------|-------|-------|--------------------|
| $Q_o$ = | 2.3   | 19.9  | cfs                |
| d =     | 0.16  | 0.51  | ft                 |
| T =     | 2.95  | 5.03  | ft                 |
| A =     | 0.39  | 1.78  | sq ft              |
| P =     | 3.00  | 5.19  | ft                 |
| R =     | 0.13  | 0.34  | ft                 |
| n =     | 0.013 | 0.013 |                    |
| V =     | 5.89  | 11.21 | fps                |
| VR =    | 0.77  | 3.83  | ft <sup>2</sup> /s |
| D =     | 0.13  | 0.35  | ft                 |
| Fr =    | 2.85  | 3.32  |                    |

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

## AREA INLET IN A SWALE

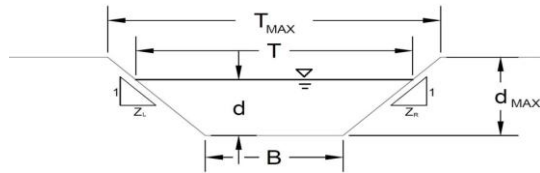
OS2

| Inlet Design Information (Input)                                                  |                                                                                                                                                                                   |       |       |       |       |      |      |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|-------|-------|------|------|
| Type of Inlet                                                                     | CDOT Type D (In Series & Depressed)                                                                                                                                               |       |       |       |       |      |      |
| Inlet Type = CDOT Type D (In Series & Depressed)                                  |                                                                                                                                                                                   |       |       |       |       |      |      |
| Angle of Inclined Grate (must be <= 30 degrees)                                   | $\theta = 0.00$ degrees                                                                                                                                                           |       |       |       |       |      |      |
| Width of Grate                                                                    | $W = 3.00$ ft                                                                                                                                                                     |       |       |       |       |      |      |
| Length of Grate                                                                   | $L = 6.00$ ft                                                                                                                                                                     |       |       |       |       |      |      |
| Open Area Ratio                                                                   | $A_{\text{RATIO}} = 0.70$                                                                                                                                                         |       |       |       |       |      |      |
| Height of Inclined Grate                                                          | $H_B = 0.00$ ft                                                                                                                                                                   |       |       |       |       |      |      |
| Clogging Factor                                                                   | $C_f = 0.38$                                                                                                                                                                      |       |       |       |       |      |      |
| Grate Discharge Coefficient                                                       | $C_d = 0.72$                                                                                                                                                                      |       |       |       |       |      |      |
| Orifice Coefficient                                                               | $C_o = 0.48$                                                                                                                                                                      |       |       |       |       |      |      |
| Weir Coefficient                                                                  | $C_w = 1.53$                                                                                                                                                                      |       |       |       |       |      |      |
|  |                                                                                                                                                                                   |       |       |       |       |      |      |
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)       | <table border="1"> <thead> <tr> <th></th> <th>MINOR</th> <th>MAJOR</th> </tr> </thead> <tbody> <tr> <td><math>d =</math></td> <td>1.16</td> <td>1.51</td> </tr> </tbody> </table> |       | MINOR | MAJOR | $d =$ | 1.16 | 1.51 |
|                                                                                   | MINOR                                                                                                                                                                             | MAJOR |       |       |       |      |      |
| $d =$                                                                             | 1.16                                                                                                                                                                              | 1.51  |       |       |       |      |      |
| <b>Grate Capacity as a Weir</b>                                                   |                                                                                                                                                                                   |       |       |       |       |      |      |
| Submerged Side Weir Length                                                        | $X = 6.00$ ft                                                                                                                                                                     |       |       |       |       |      |      |
| Inclined Side Weir Flow                                                           | $Q_{ws} = 20.0$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Base Weir Flow                                                                    | $Q_{wb} = 14.3$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Interception Without Clogging                                                     | $Q_{wi} = 54.4$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Interception With Clogging                                                        | $Q_{wa} = 34.0$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| <b>Grate Capacity as an Orifice</b>                                               |                                                                                                                                                                                   |       |       |       |       |      |      |
| Interception Without Clogging                                                     | $Q_{oi} = 51.9$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Interception With Clogging                                                        | $Q_{oa} = 32.4$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Total Inlet Interception Capacity (assumes clogged condition)                     | $Q_a = 32.4$ cfs                                                                                                                                                                  |       |       |       |       |      |      |
| Bypassed Flow                                                                     | $Q_b = 0.0$ cfs                                                                                                                                                                   |       |       |       |       |      |      |
| Capture Percentage = $Q_a/Q_o$                                                    | $C\% = 100$ %                                                                                                                                                                     |       |       |       |       |      |      |

Warning 02: Depth (d) exceeds USDCM Volume I recommendation.

## AREA INLET IN A SWALE

OS4



This worksheet uses the NRCS vegetal retardance method to determine Manning's n for grass-lined channels.

An override Manning's n can be entered for other channel materials.

## Analysis of Trapezoidal Channel (Grass-Lined uses SCS Method)

NRCS Vegetal Retardance (A, B, C, D, or E)

Manning's n (Leave cell D16 blank to manually enter an n value)

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

| Soil Type:   | Max. Velocity ( $V_{MAX}$ ) | Max Froude No. ( $F_{MAX}$ ) |
|--------------|-----------------------------|------------------------------|
| Non-Cohesive | 5.0 fps                     | 0.60                         |
| Cohesive     | 7.0 fps                     | 0.80                         |
| Paved        | N/A                         | N/A                          |

A, B, C, D, or E =

|         |        |       |
|---------|--------|-------|
| n =     | 0.013  |       |
| $S_o$ = | 0.1200 | ft/ft |
| B =     | 2.00   | ft    |
| Z1 =    | 5.00   | ft/ft |
| Z2 =    | 3.00   | ft/ft |

Choose One:

- ☐ Non-Cohesive  
☐ Cohesive  
☐ Paved

Maximum Allowable Top Width of Channel for Minor &amp; Major Storm

Maximum Allowable Water Depth in Channel for Minor &amp; Major Storm

|             | Minor Storm | Major Storm |    |
|-------------|-------------|-------------|----|
| $T_{MAX}$ = | 19.00       | 19.00       | ft |
| $d_{MAX}$ = | 1.00        | 1.00        | ft |

## Maximum Channel Capacity Based On Allowable Top Width

Maximum Allowable Top Width

Water Depth

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Maximum Flow Based on Allowable Water Depth

|             | Minor Storm | Major Storm |                    |
|-------------|-------------|-------------|--------------------|
| $T_{MAX}$ = | 19.00       | 19.00       | ft                 |
| d =         | 2.13        | 2.13        | ft                 |
| A =         | 22.31       | 22.31       | sq ft              |
| P =         | 19.56       | 19.56       | ft                 |
| R =         | 1.14        | 1.14        | ft                 |
| n =         | 0.013       | 0.013       |                    |
| V =         | 43.35       | 43.35       | fps                |
| VR =        | 49.47       | 49.47       | ft <sup>2</sup> /s |
| D =         | 1.17        | 1.17        | ft                 |
| Fr =        | 7.05        | 7.05        |                    |
| $Q_T$ =     | 967.3       | 967.3       | cfs                |

## Maximum Channel Capacity Based On Allowable Water Depth

Maximum Allowable Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

Maximum Flow Based On Allowable Water Depth

|             | Minor Storm | Major Storm |                    |
|-------------|-------------|-------------|--------------------|
| $d_{MAX}$ = | 1.00        | 1.00        | ft                 |
| T =         | 10.00       | 10.00       | ft                 |
| A =         | 6.00        | 6.00        | sq ft              |
| P =         | 10.26       | 10.26       | ft                 |
| R =         | 0.58        | 0.58        | ft                 |
| n =         | 0.013       | 0.013       |                    |
| V =         | 27.76       | 27.76       | fps                |
| VR =        | 16.23       | 16.23       | ft <sup>2</sup> /s |
| D =         | 0.60        | 0.60        | ft                 |
| Fr =        | 6.32        | 6.32        |                    |
| $Q_d$ =     | 166.6       | 166.6       | cfs                |

## Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

|               | Minor Storm | Major Storm |     |
|---------------|-------------|-------------|-----|
| $Q_{allow}$ = | 166.6       | 166.6       | cfs |
| $d_{allow}$ = | 1.00        | 1.00        | ft  |

## Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

Top Width

Flow Area

Wetted Perimeter

Hydraulic Radius

Manning's n

Flow Velocity

Velocity-Depth Product

Hydraulic Depth

Froude Number

|         | Minor Storm | Major Storm |                    |
|---------|-------------|-------------|--------------------|
| $Q_o$ = | 2.2         | 19.7        | cfs                |
| d =     | 0.11        | 0.36        | ft                 |
| T =     | 2.89        | 4.90        | ft                 |
| A =     | 0.27        | 1.25        | sq ft              |
| P =     | 2.91        | 4.99        | ft                 |
| R =     | 0.09        | 0.25        | ft                 |
| n =     | 0.013       | 0.013       |                    |
| V =     | 8.14        | 15.77       | fps                |
| VR =    | 0.75        | 3.95        | ft <sup>2</sup> /s |
| D =     | 0.09        | 0.26        | ft                 |
| Fr =    | 4.68        | 5.50        |                    |

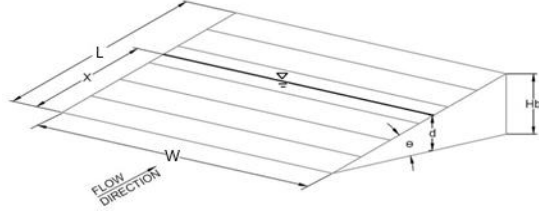
Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

MHFD-Inlet, Version 5.03 (August 2023)

## AREA INLET IN A SWALE

OS4

| Inlet Design Information (Input)                                                  |                                                                                                                                                                                   |       |       |       |       |      |      |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|-------|-------|------|------|
| Type of Inlet                                                                     | CDOT Type D (In Series & Depressed)                                                                                                                                               |       |       |       |       |      |      |
| Inlet Type =                                                                      | CDOT Type D (In Series & Depressed)                                                                                                                                               |       |       |       |       |      |      |
| Angle of Inclined Grate (must be <= 30 degrees)                                   | $\theta = 0.00$ degrees                                                                                                                                                           |       |       |       |       |      |      |
| Width of Grate                                                                    | $W = 3.00$ ft                                                                                                                                                                     |       |       |       |       |      |      |
| Length of Grate                                                                   | $L = 6.00$ ft                                                                                                                                                                     |       |       |       |       |      |      |
| Open Area Ratio                                                                   | $A_{\text{RATIO}} = 0.70$                                                                                                                                                         |       |       |       |       |      |      |
| Height of Inclined Grate                                                          | $H_B = 0.00$ ft                                                                                                                                                                   |       |       |       |       |      |      |
| Clogging Factor                                                                   | $C_f = 0.38$                                                                                                                                                                      |       |       |       |       |      |      |
| Grate Discharge Coefficient                                                       | $C_d = 0.72$                                                                                                                                                                      |       |       |       |       |      |      |
| Orifice Coefficient                                                               | $C_o = 0.48$                                                                                                                                                                      |       |       |       |       |      |      |
| Weir Coefficient                                                                  | $C_w = 1.53$                                                                                                                                                                      |       |       |       |       |      |      |
|  |                                                                                                                                                                                   |       |       |       |       |      |      |
| Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)       | <table border="1"> <thead> <tr> <th></th> <th>MINOR</th> <th>MAJOR</th> </tr> </thead> <tbody> <tr> <td><math>d =</math></td> <td>1.11</td> <td>1.36</td> </tr> </tbody> </table> |       | MINOR | MAJOR | $d =$ | 1.11 | 1.36 |
|                                                                                   | MINOR                                                                                                                                                                             | MAJOR |       |       |       |      |      |
| $d =$                                                                             | 1.11                                                                                                                                                                              | 1.36  |       |       |       |      |      |
| <b>Grate Capacity as a Weir</b>                                                   |                                                                                                                                                                                   |       |       |       |       |      |      |
| Submerged Side Weir Length                                                        | $X = 6.00$ ft                                                                                                                                                                     |       |       |       |       |      |      |
| Inclined Side Weir Flow                                                           | $Q_{ws} = 18.8$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Base Weir Flow                                                                    | $Q_{wb} = 13.4$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Interception Without Clogging                                                     | $Q_{wi} = 51.1$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Interception With Clogging                                                        | $Q_{wa} = 31.9$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| <b>Grate Capacity as an Orifice</b>                                               |                                                                                                                                                                                   |       |       |       |       |      |      |
| Interception Without Clogging                                                     | $Q_{oi} = 50.8$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Interception With Clogging                                                        | $Q_{oa} = 31.8$ cfs                                                                                                                                                               |       |       |       |       |      |      |
| Total Inlet Interception Capacity (assumes clogged condition)                     | $Q_a = 31.8$ cfs                                                                                                                                                                  |       |       |       |       |      |      |
| Bypassed Flow                                                                     | $Q_b = 0.0$ cfs                                                                                                                                                                   |       |       |       |       |      |      |
| Capture Percentage = $Q_a/Q_o$                                                    | $C\% = 100$ %                                                                                                                                                                     |       |       |       |       |      |      |

Warning 01: Sideslope steepness exceeds USDCM Volume I recommendation.

5 YEAR

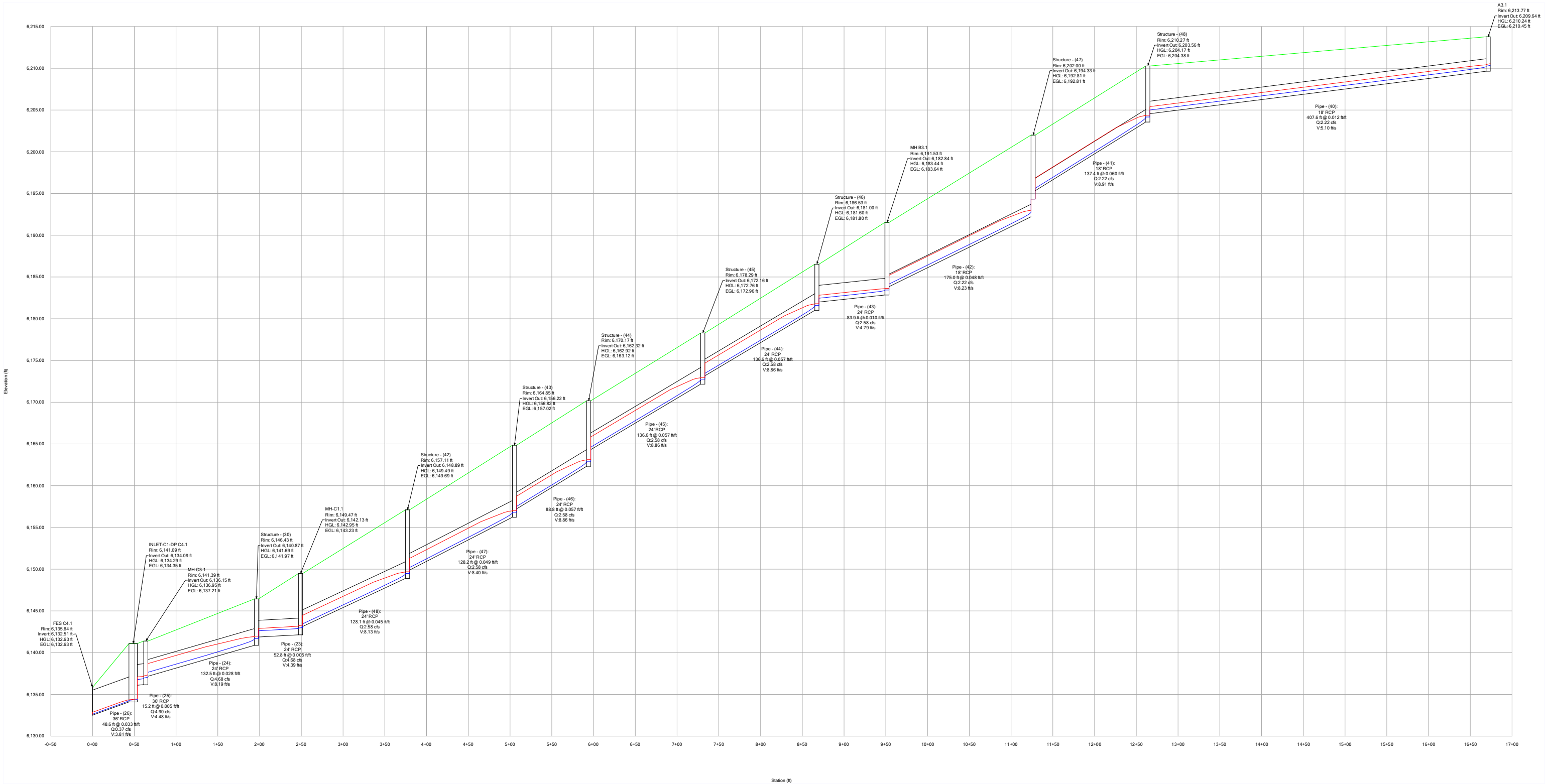
| CONDUIT FLEX TABLE 5 YEAR - STORMCAD |               |         |                            |                            |             |            |                 |                     |                    |                                |                                 |                             |                              |
|--------------------------------------|---------------|---------|----------------------------|----------------------------|-------------|------------|-----------------|---------------------|--------------------|--------------------------------|---------------------------------|-----------------------------|------------------------------|
| Label                                | Diameter (in) | Notes   | Length (User Defined) (ft) | Slope (Calculated) (ft/ft) | Manning's n | Flow (cfs) | Velocity (ft/s) | Invert (Start) (ft) | Invert (Stop) (ft) | Hydraulic Grade Line (In) (ft) | Hydraulic Grade Line (Out) (ft) | Energy Grade Line (In) (ft) | Energy Grade Line (Out) (ft) |
| CO-7                                 | 24            | 24" RCP | 86.9                       | 0.021                      | 0.013       | 2.29       | 6.05            | 6193.75             | 6191.89            | 6194.28                        | 6192.25                         | 6194.46                     | 6192.81                      |
| Pipe - (12)                          | 30            | 30" RCP | 94.3                       | 0.06                       | 0.019       | 4.18       | 10.1            | 6193.94             | 6187.68            | 6194.01                        | 6188.03                         | 6194.25                     | 6189.61                      |
| Pipe - (12)(1)                       | 30            | 30" RCP | 35.3                       | 0.008                      | 0.013       | 4.18       | 4.96            | 6196.7              | 6186.41            | 6187.37                        | 6186.99                         | 6187.61                     | 6187.36                      |
| Pipe - (13)                          | 30            | 30" RCP | 59.9                       | 0.014                      | 0.013       | 4.18       | 6               | 6195.16             | 6194.34            | 6195.83                        | 6194.84                         | 6196.07                     | 6195.4                       |
| Pipe - (18)                          | 18            | 18" RCP | 13.5                       | 0.06                       | 0.013       | 0.15       | 3.95            | 6184.7              | 6183.89            | 6184.84                        | 6183.97                         | 6184.89                     | 6184.22                      |
| Pipe - (18)(2)                       | 18            | 18" RCP | 16.9                       | 0.052                      | 0.019       | 0.38       | 4.57            | 6183.84             | 6184.72            | 6184.92                        | 6183.95                         | 6184.98                     | 6184.28                      |
| Pipe - (22)                          | 24            | 24" RCP | 18.3                       | 0.06                       | 0.013       | 2.22       | 8.61            | 6145.43             | 6143.13            | 6145.95                        | 6143.40                         | 6146.13                     | 6144.55                      |
| Pipe - (23)                          | 24            | 24" RCP | 52.8                       | 0.005                      | 0.013       | 4.68       | 4.39            | 6142.13             | 6141.87            | 6142.89                        | 6142.61                         | 6143.17                     | 6142.91                      |
| Pipe - (24)                          | 24            | 24" RCP | 132.5                      | 0.028                      | 0.013       | 4.68       | 8.19            | 6140.87             | 6137.17            | 6141.63                        | 6137.65                         | 6141.91                     | 6138.69                      |
| Pipe - (25)                          | 30            | 30" RCP | 15.2                       | 0.005                      | 0.013       | 4.9        | 4.48            | 6136.17             | 6136.09            | 6136.90                        | 6136.78                         | 6137.09                     | 6136.9                       |
| Pipe - (26)                          | 36            | 36" RCP | 48.6                       | 0.013                      | 0.013       | 0.37       | 3.81            | 6134.09             | 6132.51            | 6134.28                        | 6132.63                         | 6134.44                     | 6132.86                      |
| Pipe - (27)                          | 30            | 30" RCP | 15.2                       | 0.038                      | 0.013       | 0.22       | 3.51            | 6136.72             | 6136.15            | 6137.33                        | 6137.33                         | 6137.33                     | 6137.33                      |
| Pipe - (40)                          | 18            | 18" RCP | 407.6                      | 0.012                      | 0.013       | 2.22       | 5.1             | 6209.64             | 6204.56            | 6210.20                        | 6205.00                         | 6210.41                     | 6205.41                      |
| Pipe - (41)                          | 18            | 18" RCP | 137.4                      | 0.06                       | 0.013       | 2.22       | 8.91            | 6203.56             | 6195.33            | 6204.13                        | 6195.63                         | 6204.33                     | 6196.86                      |
| Pipe - (42)                          | 18            | 18" RCP | 175                        | 0.048                      | 0.013       | 2.22       | 8.23            | 6192.21             | 6183.84            | 6192.77                        | 6184.15                         | 6192.98                     | 6185.21                      |
| Pipe - (43)                          | 24            | 24" RCP | 83.9                       | 0.01                       | 0.013       | 2.58       | 4.79            | 6182.84             | 6182.00            | 6183.40                        | 6182.46                         | 6183.60                     | 6182.81                      |
| Pipe - (44)                          | 24            | 24" RCP | 136.6                      | 0.057                      | 0.013       | 2.58       | 8.86            | 6181                | 6173.16            | 6181.56                        | 6173.46                         | 6181.76                     | 6174.68                      |
| Pipe - (45)                          | 24            | 24" RCP | 136.6                      | 0.057                      | 0.013       | 2.58       | 8.86            | 6172.16             | 6164.32            | 6172.72                        | 6164.62                         | 6172.92                     | 6165.84                      |
| Pipe - (46)                          | 24            | 24" RCP | 88.8                       | 0.057                      | 0.013       | 2.58       | 8.86            | 6162.32             | 6157.22            | 6162.88                        | 6157.52                         | 6163.08                     | 6158.74                      |
| Pipe - (47)                          | 24            | 24" RCP | 128.2                      | 0.049                      | 0.013       | 2.58       | 8.4             | 6156.22             | 6149.89            | 6156.78                        | 6150.20                         | 6156.98                     | 6151.3                       |
| Pipe - (48)                          | 24            | 24" RCP | 128.1                      | 0.045                      | 0.013       | 2.58       | 8.13            | 6148.89             | 6143.13            | 6149.45                        | 6143.45                         | 6149.65                     | 6144.47                      |
| Pipe - (50)                          | 18            | 18" RCP | 15.1                       | 0.005                      | 0.013       | 0.55       | 2.51            | 6209.92             | 6209.84            | 6210.55                        | 6210.55                         | 6210.56                     | 6210.55                      |
| Pipe - (56)                          | 18            | 18" RCP | 15.2                       | 0.005                      | 0.013       | 1.66       | 3.45            | 6209.92             | 6209.84            | 6210.51                        | 6210.51                         | 6210.61                     | 6210.57                      |
| Pipe - (74)                          | 18            | 18" RCP | 49.8                       | 0.054                      | 0.013       | 0.13       | 3.66            | 6135.79             | 6133.10            | 6135.92                        | 6133.18                         | 6135.97                     | 6133.39                      |



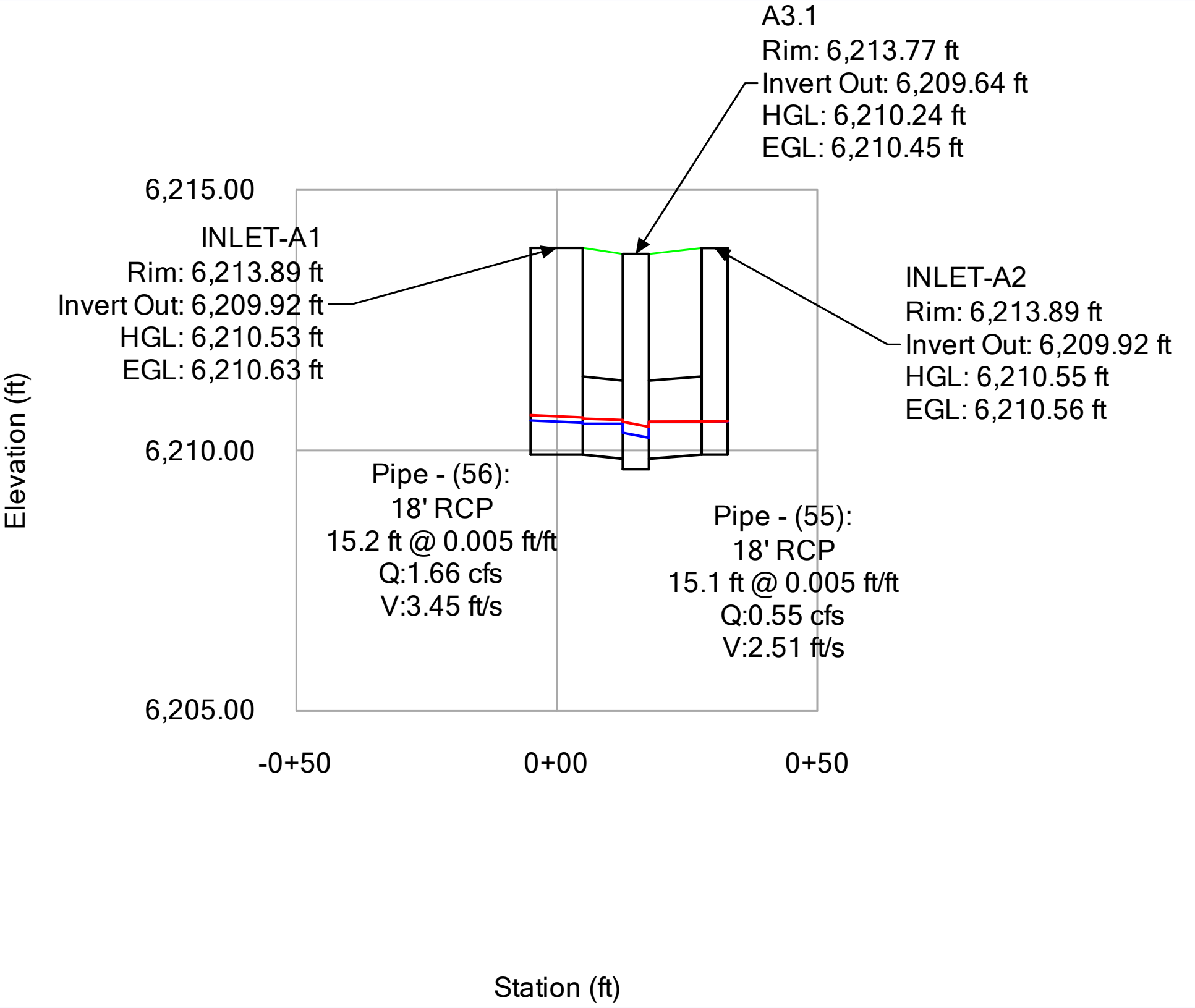
# 5 YEAR

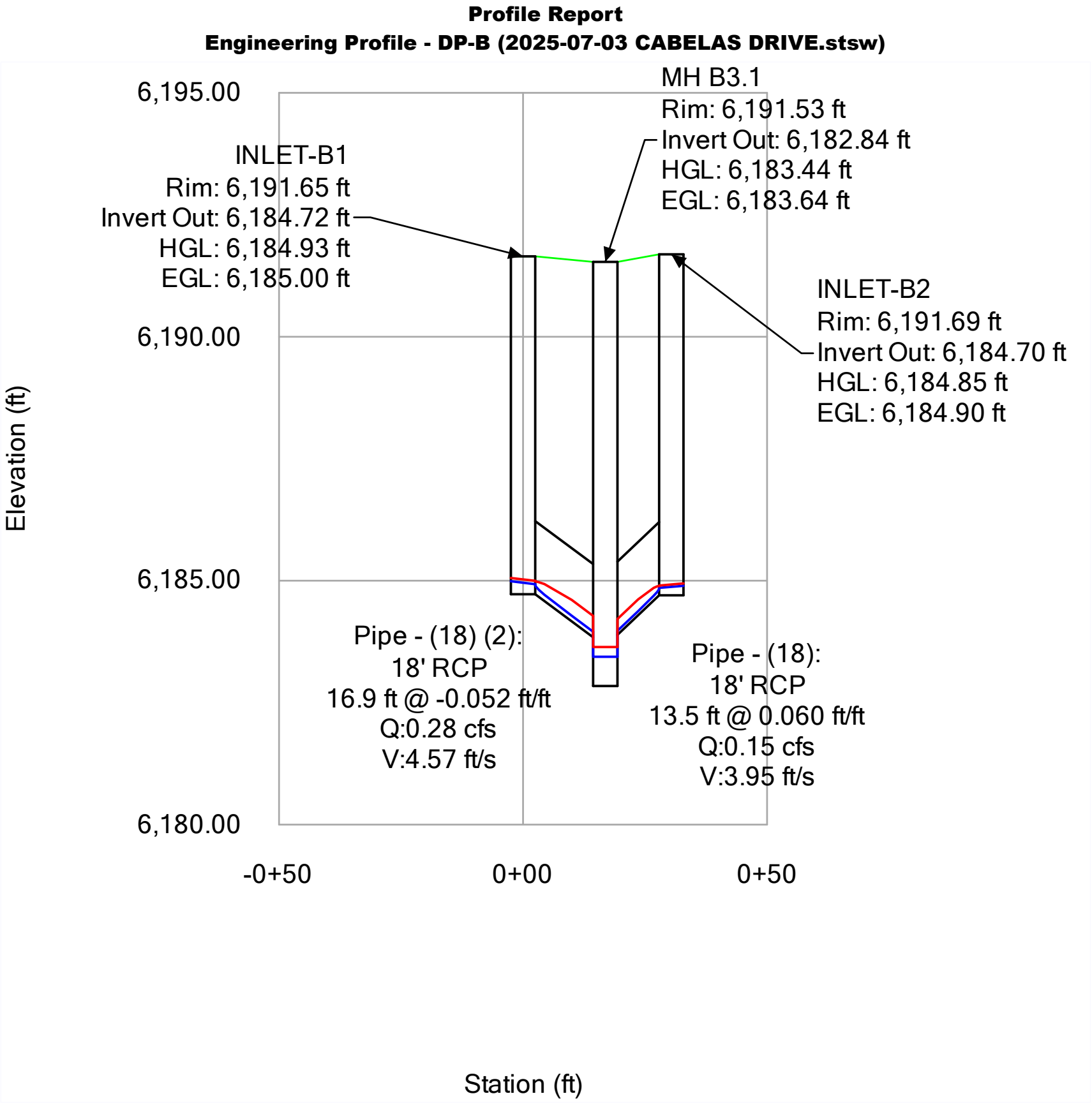
| MANHOLE FLEX TABLE 5 YEAR - STORMCAD |                                       |                    |                        |                         |                                |                                 |                             |                              |                                |                        |
|--------------------------------------|---------------------------------------|--------------------|------------------------|-------------------------|--------------------------------|---------------------------------|-----------------------------|------------------------------|--------------------------------|------------------------|
| Label                                | Notes                                 | Flow (Known) (cfs) | Flow (Total Out) (cfs) | Elevation (Ground) (ft) | Hydraulic Grade Line (In) (ft) | Hydraulic Grade Line (Out) (ft) | Energy Grade Line (In) (ft) | Energy Grade Line (Out) (ft) | Headloss Method                | HEC-22 Benching Method |
| A3.1                                 | 5%/Kc MH                              | 2.22               | 2.22                   | 6213.77                 | 6210.34                        | 6210.24                         | 6210.55                     | 6210.45                      | HEC-22 Energy (Third Edition)  | Half                   |
| INLET-OS4.1                          |                                       | 0.13               | 0.13                   | 6140.48                 | 6135.92                        | 6135.92                         | 6135.97                     | 6135.97                      | HEC-22 Energy (Second Edition) | Flat                   |
| INLET-A1                             | 10' Type R Inlet                      | 1.66               | 1.66                   | 6213.89                 | 6210.57                        | 6210.53                         | 6210.68                     | 6210.63                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-A2                             | 5' Type R Inlet                       | 0.55               | 0.55                   | 6213.89                 | 6210.55                        | 6210.55                         | 6210.56                     | 6210.56                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-B1                             | 5' Type R Inlet                       | 0.28               | 0.28                   | 6191.65                 | 6184.99                        | 6184.93                         | 6185.05                     | 6185                         | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-B2                             | 5' Type R Inlet                       | 0.15               | 0.15                   | 6191.69                 | 6184.9                         | 6184.85                         | 6184.94                     | 6184.9                       | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-C1-DP C4.1                     | 10' Type R Inlet                      | 0.37               | 0.37                   | 6141.09                 | 6134.39                        | 6134.29                         | 6134.45                     | 6134.35                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-C2                             | 10' Type R Inlet                      | 0.22               | 0.22                   | 6141.5                  | 6137.33                        | 6137.33                         | 6137.33                     | 6137.33                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-OS2                            | TYPE D INLET (DEPRESSED)              | 2.29               | 2.29                   | 6197                    | 6194.36                        | 6194.31                         | 6194.55                     | 6194.5                       | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-OS4                            | TYPE D INLET (DEPRESSED)              | 2.22               | 2.22                   | 6152.56                 | 6146.1                         | 6145.98                         | 6146.28                     | 6146.17                      | HEC-22 Energy (Third Edition)  | Flat                   |
| MH B3.1                              | 5%/Kc MH                              | 2.58               | 2.58                   | 6191.53                 | 6183.44                        | 6183.44                         | 6183.64                     | 6183.64                      | HEC-22 Energy (Third Edition)  | Half                   |
| MH C3.1                              | 5%/Kc MH                              | 4.9                | 4.9                    | 6141.39                 | 6137.07                        | 6136.95                         | 6137.33                     | 6137.21                      | HEC-22 Energy (Third Edition)  | Half                   |
| MH-1.3                               | 5%/Kc MH                              | 0                  | 4.18                   | 6213.93                 | 6194.06                        | 6194.06                         | 6194.3                      | 6194.3                       | HEC-22 Energy (Third Edition)  | Half                   |
| MH-C1.1                              | Slab Top Cylindrical Structure 60 dia | 4.68               | 4.68                   | 6149.47                 | 6143                           | 6142.95                         | 6143.28                     | 6143.23                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (30)                     | 5%/Kc MH                              | 0                  | 4.68                   | 6146.43                 | 6141.69                        | 6141.69                         | 6141.97                     | 6141.97                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (37)                     | 5%/Kc MH                              | 0                  | 4.18                   | 6196.62                 | 6187.42                        | 6187.42                         | 6187.66                     | 6187.66                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (42)                     | 5%/Kc MH                              | 0                  | 2.58                   | 6157.11                 | 6149.49                        | 6149.49                         | 6149.69                     | 6149.69                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (43)                     | 5%/Kc MH                              | 0                  | 2.58                   | 6164.85                 | 6156.82                        | 6156.82                         | 6157.02                     | 6157.02                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (44)                     | 5%/Kc MH                              | 0                  | 2.58                   | 6170.17                 | 6162.92                        | 6162.92                         | 6163.12                     | 6163.12                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (45)                     | 5%/Kc MH                              | 0                  | 2.58                   | 6178.29                 | 6172.76                        | 6172.76                         | 6172.96                     | 6172.96                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (46)                     | 5%/Kc MH                              | 0                  | 2.58                   | 6186.53                 | 6181.6                         | 6181.6                          | 6181.8                      | 6181.8                       | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (47)                     | 5%/Kc MH                              | 0                  | 2.22                   | 6202                    | 6192.84                        | 6192.81                         | 6193.05                     | 6193.02                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (48)                     | 5%/Kc MH                              | 0                  | 2.22                   | 6210.27                 | 6204.17                        | 6204.17                         | 6204.38                     | 6204.38                      | HEC-22 Energy (Third Edition)  | Half                   |
| TYPE D OS1.1                         | FES                                   | 4.18               | 4.18                   | 6201                    | 6195.97                        | 6195.88                         | 6196.21                     | 6196.12                      | HEC-22 Energy (Third Edition)  | Flat                   |

Profile Report  
Engineering Profile - DP-01 (2025-07-03 CABELAS DRIVE.stsw)

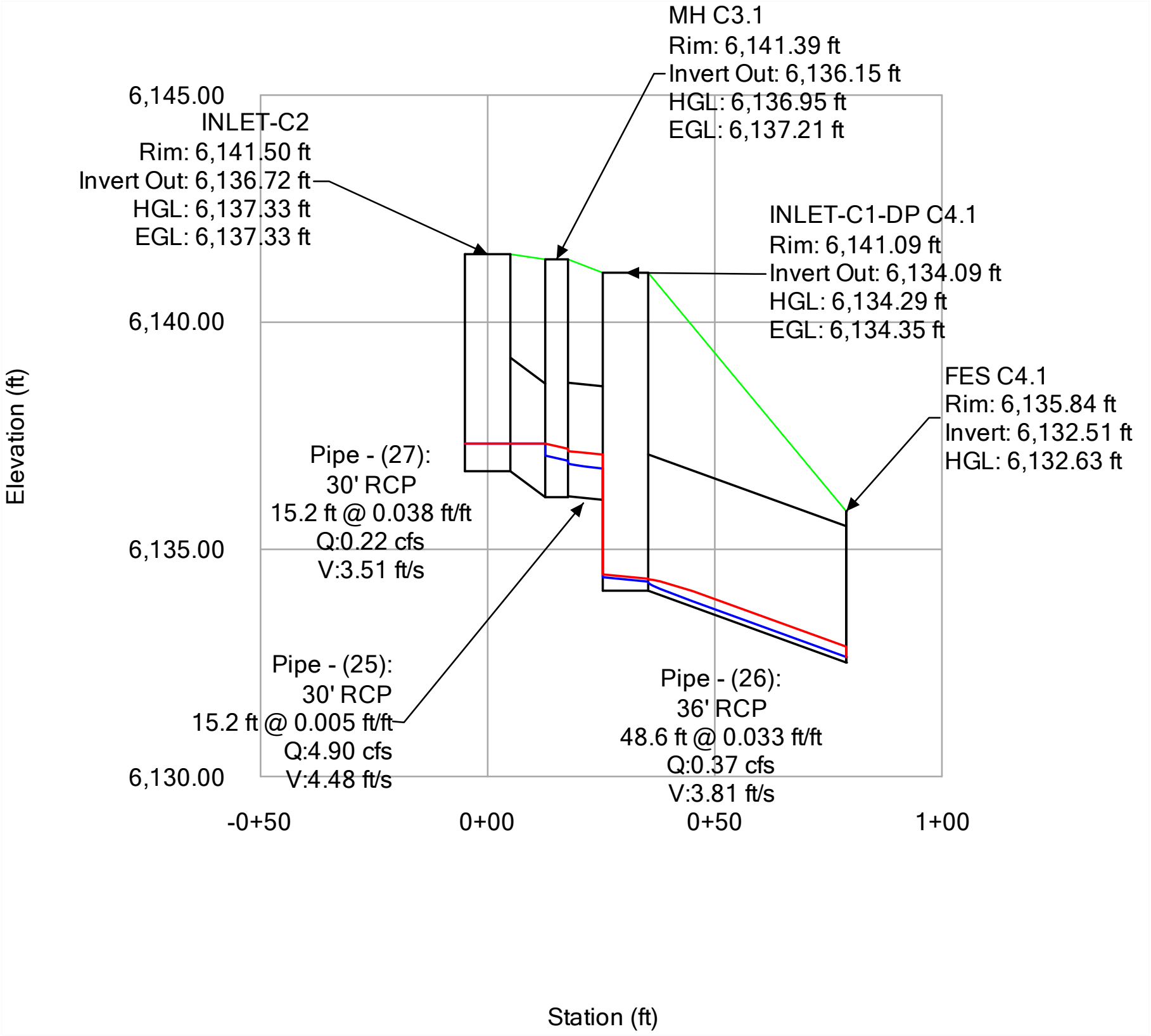


Profile Report  
Engineering Profile - DP-A (2025-07-03 CABELAS DRIVE.stsw)

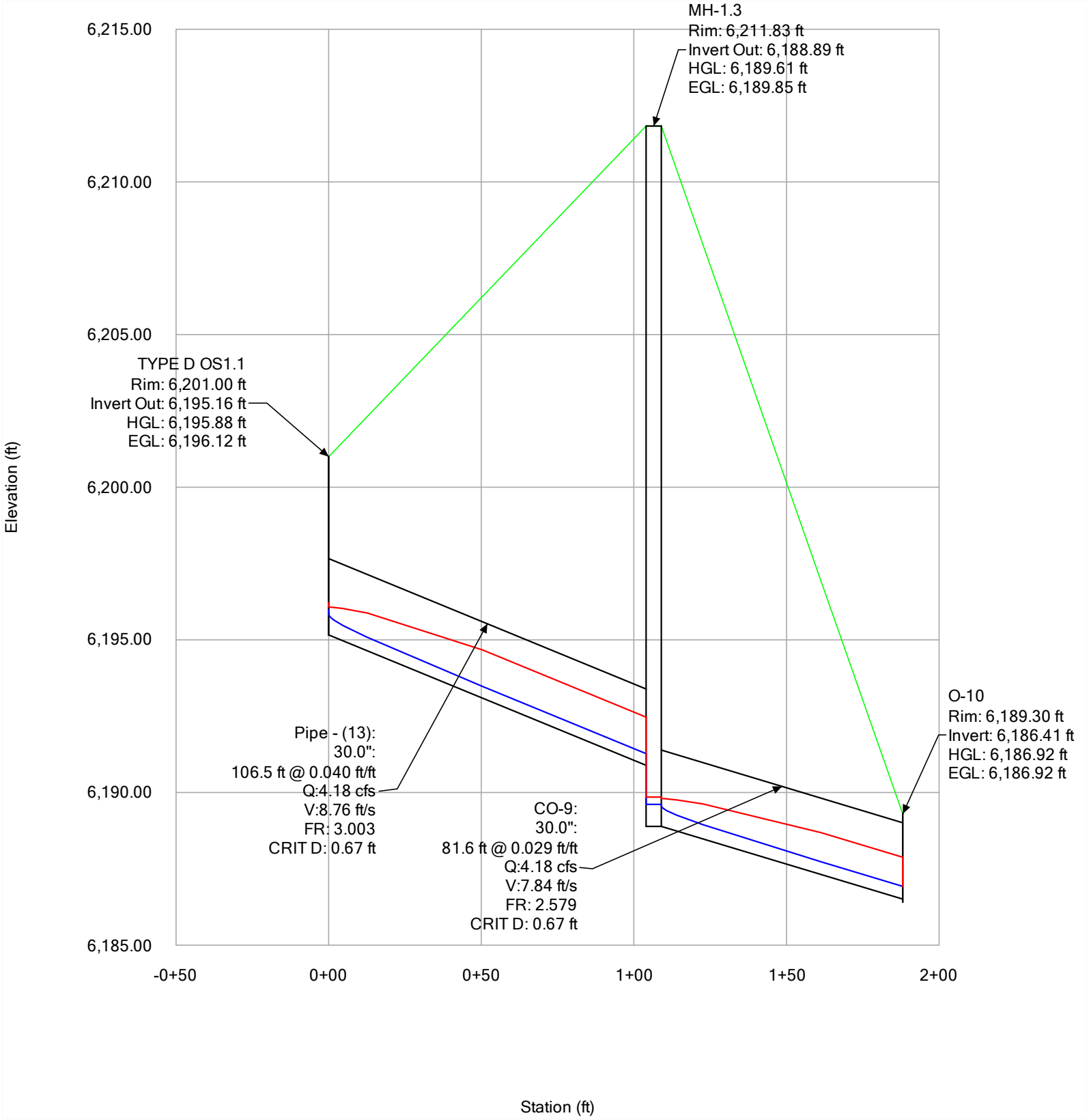




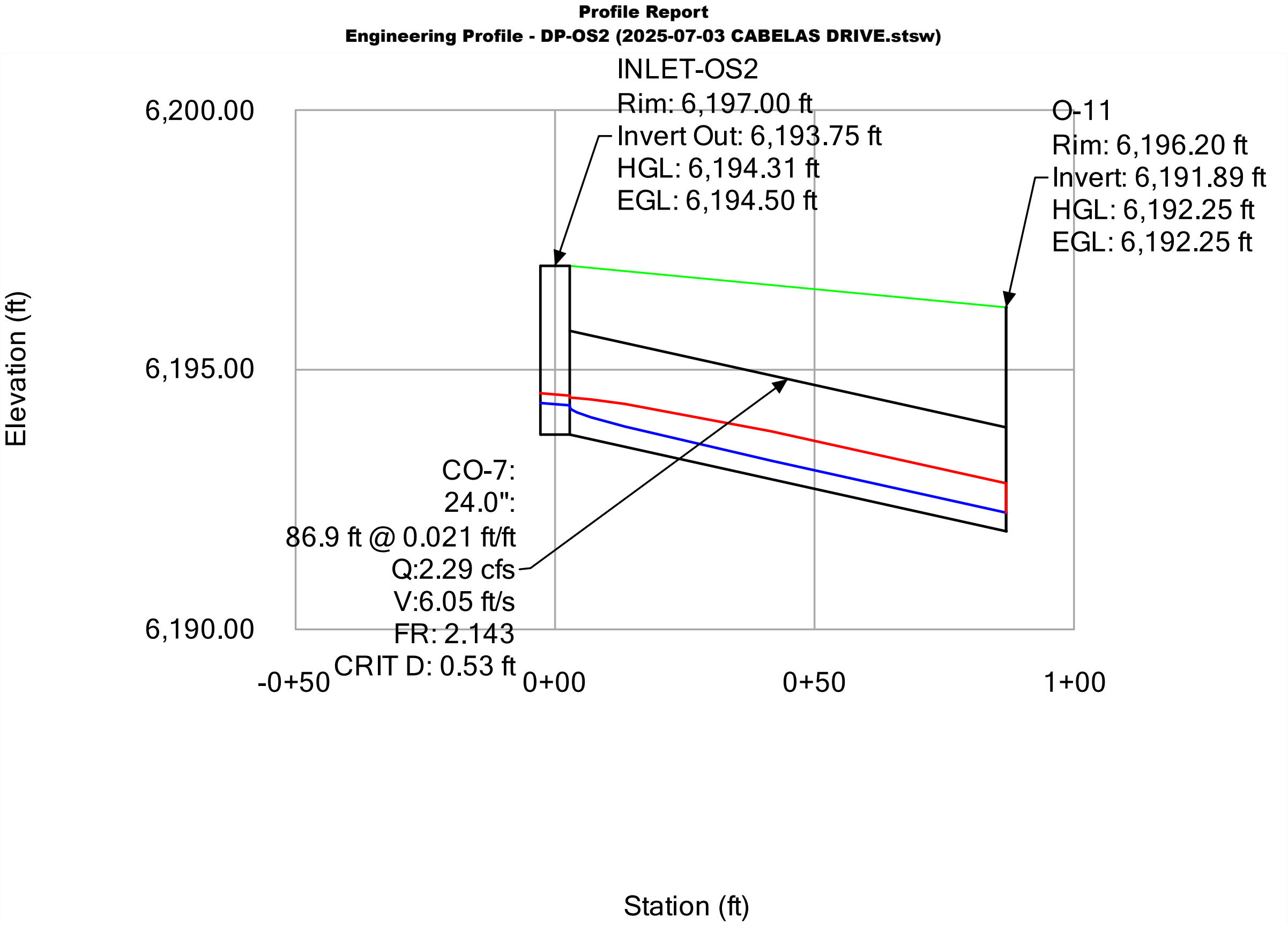
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Engineering Profile - DP-C (2025-07-03 CABELAS DRIVE.stsw)



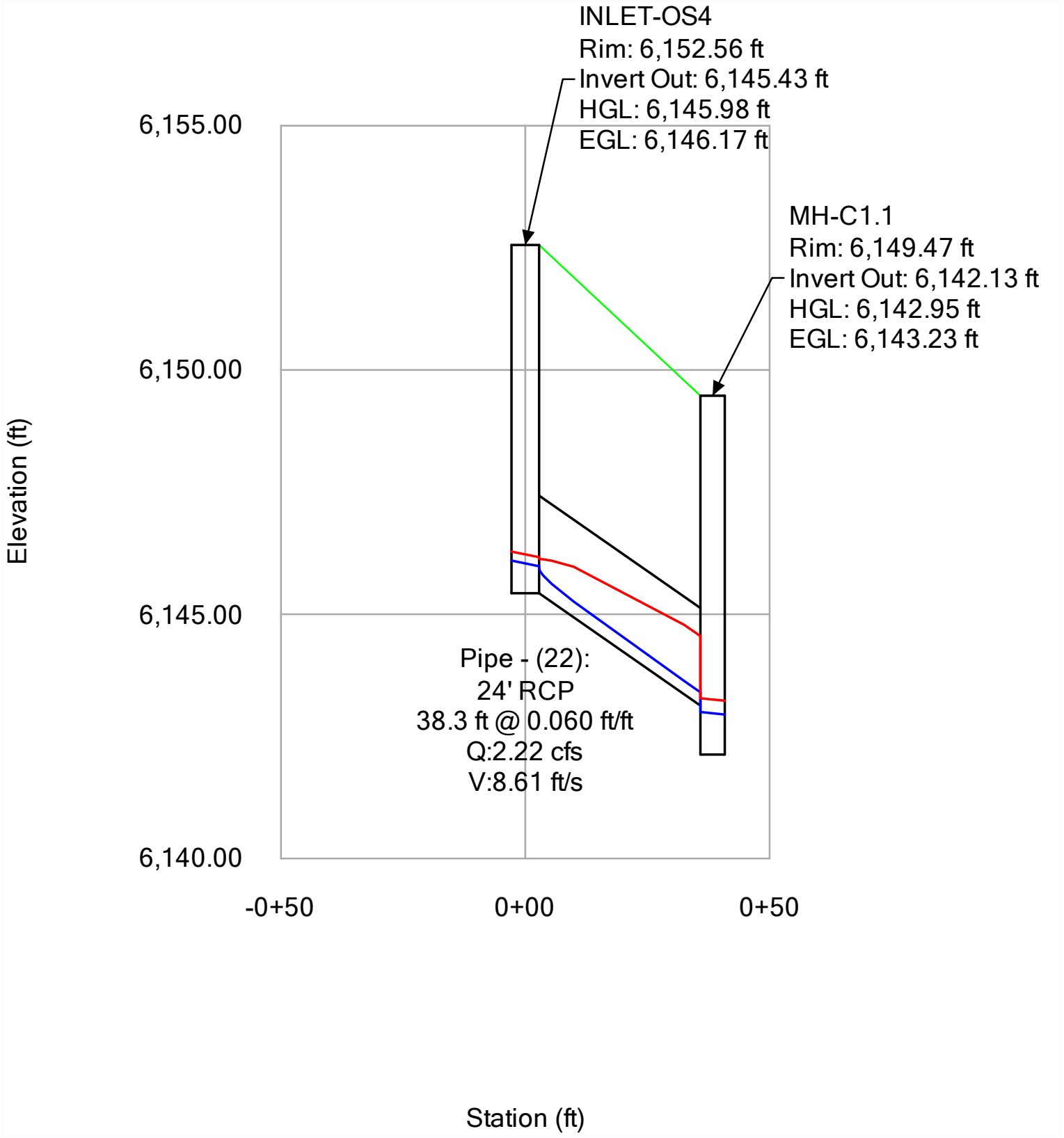
Profile Report  
Engineering Profile - DP-OS1 (2025-07-03 CABELAS DRIVE.stsw)



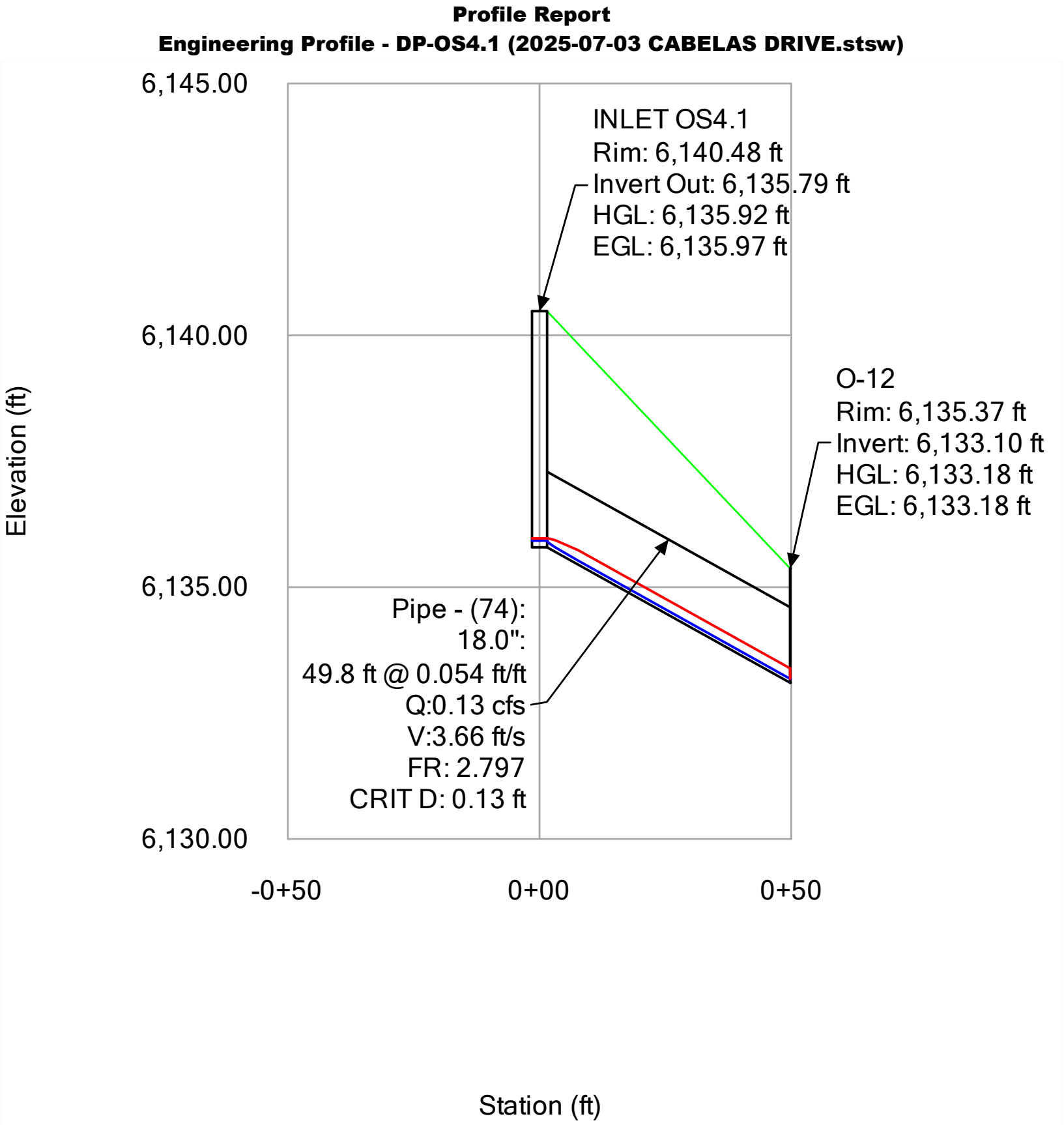




Profile Report  
Engineering Profile - DP-OS4 (2025-07-03 CABELAS DRIVE.stsw)







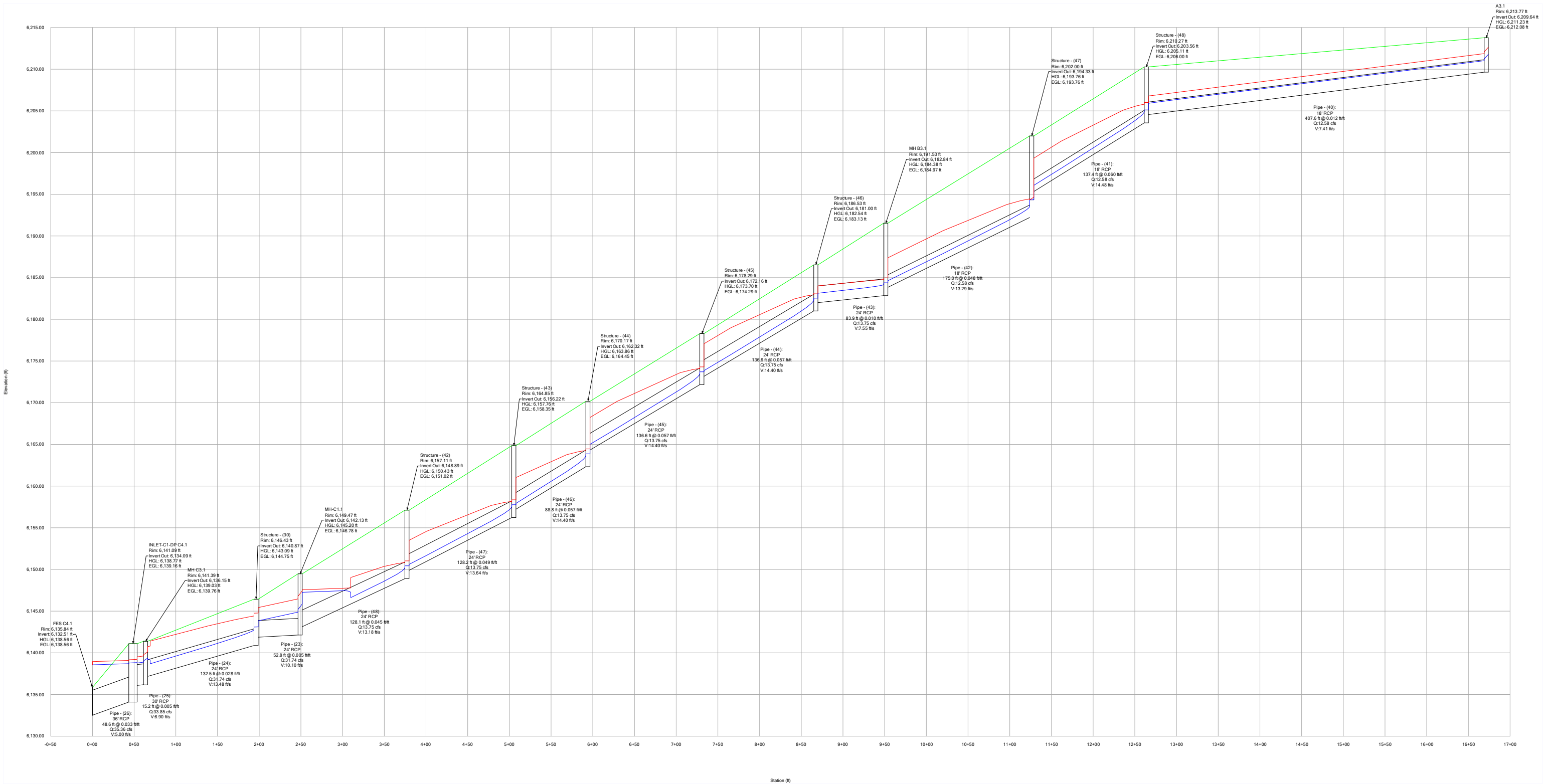
100 YEAR

| CONDUIT FLEX TABLE 100 YEAR - STORMCAD |               |         |                            |                            |             |            |                 |                     |                    |                                |                                 |                             |                              |
|----------------------------------------|---------------|---------|----------------------------|----------------------------|-------------|------------|-----------------|---------------------|--------------------|--------------------------------|---------------------------------|-----------------------------|------------------------------|
| Label                                  | Diameter (in) | Notes   | Length (User Defined) (ft) | Slope (Calculated) (ft/ft) | Manning's n | Flow (cfs) | Velocity (ft/s) | Invert (Start) (ft) | Invert (Stop) (ft) | Hydraulic Grade Line (In) (ft) | Hydraulic Grade Line (Out) (ft) | Energy Grade Line (In) (ft) | Energy Grade Line (Out) (ft) |
| C07                                    | 24            | 24" RCP | 86.9                       | 0.021                      | 0.013       | 19.93      | 11.02           | 6193.75             | 6191.89            | 6195.35                        | 6193.04                         | 6196.20                     | 6194.81                      |
| Pipe (12)                              | 30            | 30" RCP | 94.3                       | 0.06                       | 0.013       | 30.85      | 18              | 6193.34             | 6187.68            | 6195.23                        | 6188.68                         | 6196.16                     | 6190.14                      |
| Pipe (12) (1)                          | 30            | 30" RCP | 25.9                       | 0.008                      | 0.013       | 30.85      | 8.37            | 6186.7              | 6186.41            | 6188.99                        | 6188.19                         | 6189.52                     | 6189.25                      |
| Pipe (13)                              | 30            | 30" RCP | 59.9                       | 0.014                      | 0.013       | 30.85      | 10.38           | 6195.16             | 6194.34            | 6197.05                        | 6195.86                         | 6197.08                     | 6196.78                      |
| Pipe (18)                              | 18            | 18" RCP | 13.5                       | 0.06                       | 0.013       | 0.59       | 6               | 6184.7              | 6183.89            | 6184.98                        | 6184.97                         | 6185.08                     | 6184.97                      |
| Pipe (18) (2)                          | 18            | 18" RCP | 16.9                       | -0.052                     | 0.013       | 0.76       | 6.16            | 6183.84             | 6184.72            | 6185.04                        | 6184.97                         | 6185.16                     | 6184.97                      |
| Pipe (22)                              | 24            | 24" RCP | 38.3                       | 0.06                       | 0.013       | 19.71      | 16.15           | 6145.43             | 6143.13            | 6147.34                        | 6147.07                         | 6147.97                     | 6147.68                      |
| Pipe (23)                              | 24            | 24" RCP | 52.8                       | 0.005                      | 0.013       | 31.74      | 10.1            | 6142.13             | 6141.87            | 6144.88                        | 6143.82                         | 6146.46                     | 6145.41                      |
| Pipe (24)                              | 24            | 24" RCP | 132.5                      | 0.028                      | 0.013       | 31.74      | 13.48           | 6140.87             | 6137.17            | 6142.76                        | 6139.16                         | 6144.42                     | 6140.75                      |
| Pipe (25)                              | 30            | 30" RCP | 15.2                       | 0.005                      | 0.013       | 33.85      | 6.9             | 6136.17             | 6136.09            | 6138.88                        | 6138.77                         | 6139.62                     | 6139.51                      |
| Pipe (26)                              | 36            | 36" RCP | 48.6                       | 0.033                      | 0.013       | 35.36      | 5               | 6134.09             | 6132.51            | 6138.70                        | 6138.56                         | 6139.09                     | 6138.95                      |
| Pipe (27)                              | 30            | 30" RCP | 15.2                       | 0.038                      | 0.013       | 1.19       | 0.24            | 6136.72             | 6136.15            | 6140.11                        | 6140.11                         | 6140.11                     | 6140.11                      |
| Pipe (40)                              | 18            | 18" RCP | 407.6                      | 0.012                      | 0.013       | 12.58      | 7.41            | 6209.64             | 6204.56            | 6211.02                        | 6205.90                         | 6211.87                     | 6206.11                      |
| Pipe (41)                              | 18            | 18" RCP | 137.4                      | 0.06                       | 0.013       | 12.58      | 14.48           | 6203.56             | 6195.13            | 6196.07                        | 6196.07                         | 6205.79                     | 6199.13                      |
| Pipe (42)                              | 18            | 18" RCP | 175                        | 0.048                      | 0.013       | 12.58      | 13.29           | 6192.21             | 6183.84            | 6193.55                        | 6184.63                         | 6194.44                     | 6186.07                      |
| Pipe (43)                              | 24            | 24" RCP | 83.9                       | 0.01                       | 0.013       | 13.75      | 7.55            | 6182.84             | 6182.00            | 6184.18                        | 6183.13                         | 6184.77                     | 6183.93                      |
| Pipe (44)                              | 24            | 24" RCP | 136.6                      | 0.057                      | 0.013       | 13.75      | 14.4            | 6181                | 6173.16            | 6182.34                        | 6173.85                         | 6182.93                     | 6175.09                      |
| Pipe (45)                              | 24            | 24" RCP | 136.6                      | 0.057                      | 0.013       | 13.75      | 14.4            | 6172.16             | 6164.32            | 6173.50                        | 6165.01                         | 6174.09                     | 6168.23                      |
| Pipe (46)                              | 24            | 24" RCP | 88.8                       | 0.057                      | 0.013       | 13.75      | 14.4            | 6162.32             | 6157.22            | 6163.66                        | 6157.92                         | 6164.25                     | 6159.15                      |
| Pipe (47)                              | 24            | 24" RCP | 128.2                      | 0.049                      | 0.013       | 13.75      | 13.64           | 6156.22             | 6149.89            | 6157.96                        | 6150.80                         | 6158.15                     | 6151.82                      |
| Pipe (48)                              | 24            | 24" RCP | 128.1                      | 0.045                      | 0.013       | 13.75      | 13.18           | 6148.89             | 6143.13            | 6150.23                        | 6147.26                         | 6150.82                     | 6147.56                      |
| Pipe (55)                              | 18            | 18" RCP | 15.1                       | 0.005                      | 0.013       | 2.29       | 1.3             | 6209.92             | 6209.84            | 6212.62                        | 6212.62                         | 6212.65                     | 6212.64                      |
| Pipe (56)                              | 18            | 18" RCP | 15.2                       | 0.005                      | 0.013       | 10.28      | 5.82            | 6209.92             | 6209.84            | 6212.46                        | 6212.32                         | 6212.99                     | 6212.84                      |
| Pipe (74)                              | 18            | 18" RCP | 49.8                       | 0.054                      | 0.013       | 1.37       | 0.78            | 6135.79             | 6133.10            | 6138.57                        | 6138.56                         | 6138.58                     | 6138.57                      |

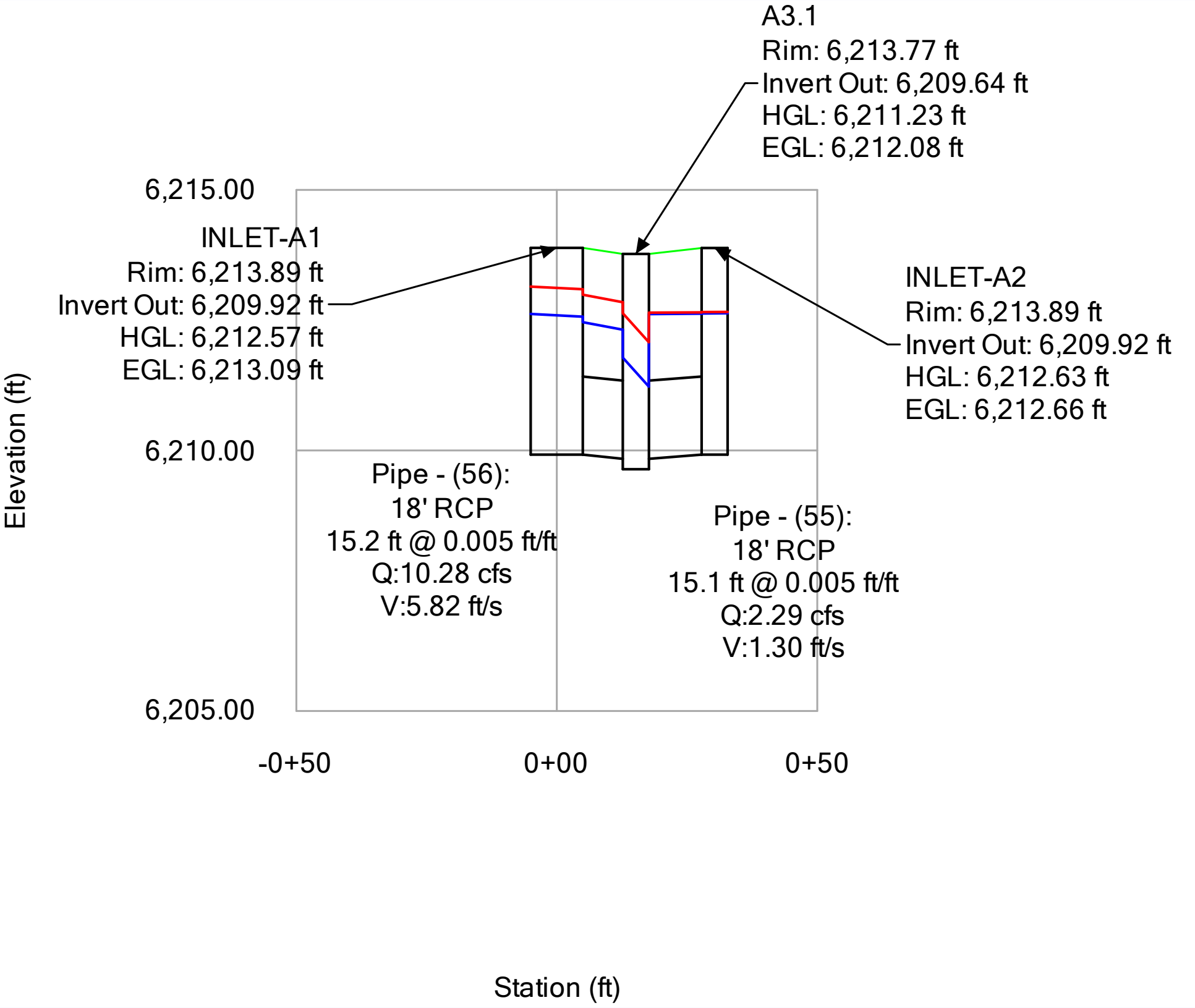
100 YEAR

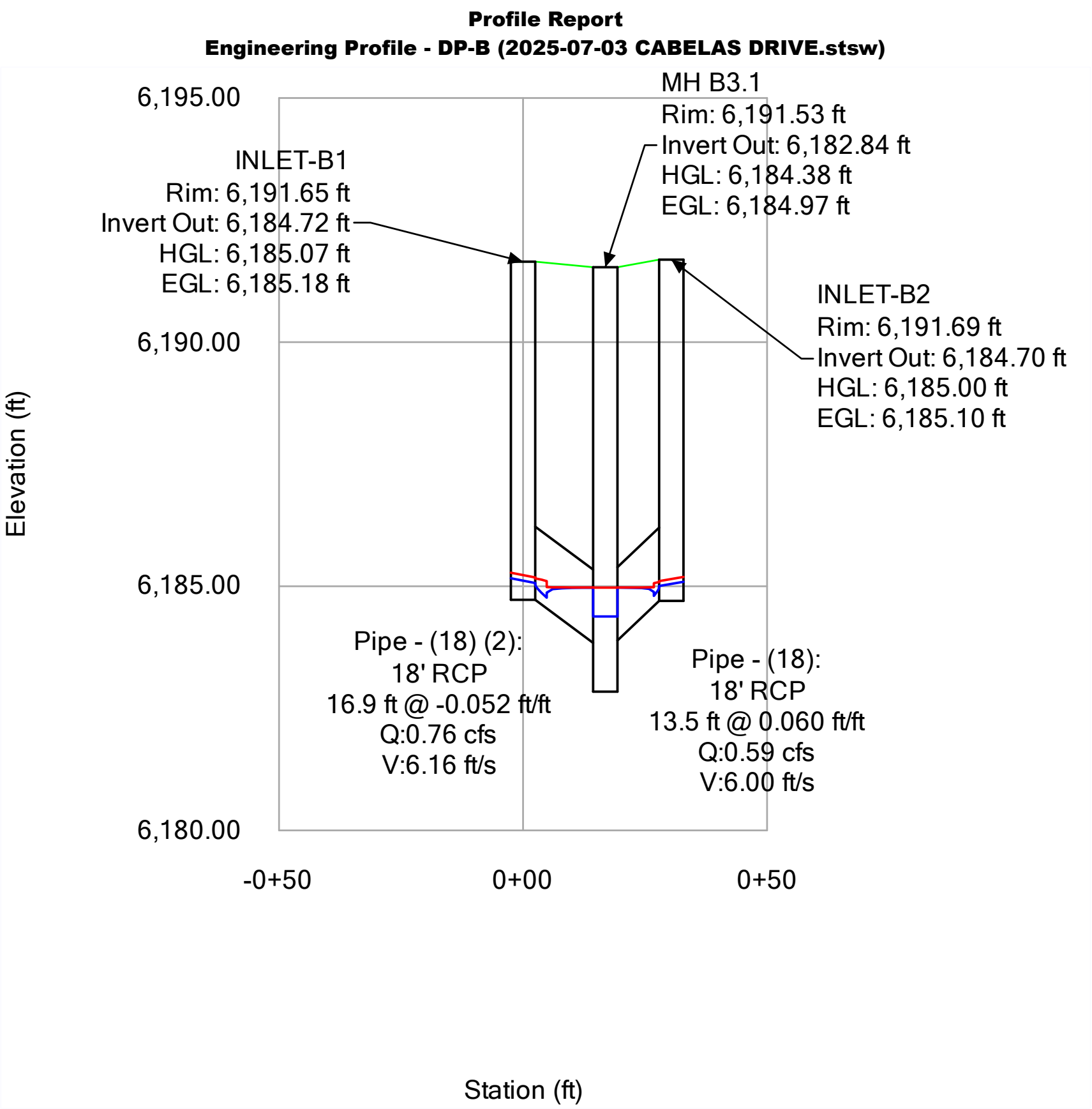
| MANHOLE FLEX TABLE 100 YEAR - STORMCAD |                                       |                    |                        |                         |                                |                                 |                             |                              |                                |                        |
|----------------------------------------|---------------------------------------|--------------------|------------------------|-------------------------|--------------------------------|---------------------------------|-----------------------------|------------------------------|--------------------------------|------------------------|
| Label                                  | Notes                                 | Flow (Known) (cfs) | Flow (Total Out) (cfs) | Elevation (Ground) (ft) | Hydraulic Grade Line (In) (ft) | Hydraulic Grade Line (Out) (ft) | Energy Grade Line (In) (ft) | Energy Grade Line (Out) (ft) | Headloss Method                | HEC-22 Benching Method |
| A3.1                                   | 5%Nc MH                               | 12.58              | 12.58                  | 6213.77                 | 6211.78                        | 6211.23                         | 6212.63                     | 6212.08                      | HEC-22 Energy (Third Edition)  | Half                   |
| INLET-OS4.1                            | TYPE D INLET (DEPRESSED)              | 1.37               | 1.37                   | 6140.48                 | 6138.57                        | 6138.57                         | 6138.58                     | 6138.58                      | HEC-22 Energy (Second Edition) | Flat                   |
| INLET-A1                               | 10' Type R Inlet                      | 10.28              | 10.28                  | 6213.89                 | 6212.62                        | 6212.57                         | 6213.14                     | 6213.09                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-A2                               | 5' Type R Inlet                       | 2.29               | 2.29                   | 6213.89                 | 6212.63                        | 6212.63                         | 6212.66                     | 6212.66                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-B1                               | 5' Type R Inlet                       | 0.76               | 0.76                   | 6191.65                 | 6185.16                        | 6185.07                         | 6185.28                     | 6185.18                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-B2                               | 5' Type R Inlet                       | 0.59               | 0.59                   | 6191.69                 | 6185.09                        | 6185                            | 6185.19                     | 6185.1                       | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-C1-DP C4.1                       | 10' Type R Inlet                      | 35.36              | 35.36                  | 6141.09                 | 6138.83                        | 6138.77                         | 6139.22                     | 6139.16                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-C2                               | 10' Type R Inlet                      | 1.19               | 1.19                   | 6141.5                  | 6140.11                        | 6140.11                         | 6140.11                     | 6140.11                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-OS2                              | TYPE D INLET (DEPRESSED)              | 19.93              | 19.93                  | 6197                    | 6195.7                         | 6195.64                         | 6196.54                     | 6196.48                      | HEC-22 Energy (Third Edition)  | Flat                   |
| INLET-OS4                              | TYPE D INLET (DEPRESSED)              | 19.71              | 19.71                  | 6152.56                 | 6147.88                        | 6147.51                         | 6148.52                     | 6148.14                      | HEC-22 Energy (Third Edition)  | Flat                   |
| MH B3.1                                | 5%Nc MH                               | 13.75              | 13.75                  | 6191.53                 | 6184.38                        | 6184.38                         | 6184.97                     | 6184.97                      | HEC-22 Energy (Third Edition)  | Half                   |
| MH C3.1                                | 5%Nc MH                               | 33.85              | 33.85                  | 6141.39                 | 6139.37                        | 6139.03                         | 6140.11                     | 6139.76                      | HEC-22 Energy (Third Edition)  | Half                   |
| MH-L3                                  | 5%Nc MH                               | 0                  | 30.85                  | 6213.93                 | 6195.56                        | 6195.56                         | 6196.49                     | 6196.49                      | HEC-22 Energy (Third Edition)  | Half                   |
| MH-C1.1                                | Slab Top Cylindrical Structure 60 dia | 31.74              | 31.74                  | 6149.47                 | 6145.85                        | 6145.2                          | 6147.44                     | 6146.78                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (30)                       | 5%Nc MH                               | 0                  | 31.74                  | 6146.43                 | 6143.11                        | 6143.09                         | 6144.77                     | 6144.75                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (37)                       | 5%Nc MH                               | 0                  | 30.85                  | 6196.62                 | 6188.92                        | 6188.92                         | 6189.85                     | 6189.85                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (42)                       | 5%Nc MH                               | 0                  | 13.75                  | 6157.11                 | 6150.43                        | 6150.43                         | 6151.02                     | 6151.02                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (43)                       | 5%Nc MH                               | 0                  | 13.75                  | 6164.85                 | 6157.76                        | 6157.76                         | 6158.35                     | 6158.35                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (44)                       | 5%Nc MH                               | 0                  | 13.75                  | 6170.17                 | 6163.86                        | 6163.86                         | 6164.45                     | 6164.45                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (45)                       | 5%Nc MH                               | 0                  | 13.75                  | 6178.29                 | 6173.7                         | 6173.7                          | 6174.29                     | 6174.29                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (46)                       | 5%Nc MH                               | 0                  | 13.75                  | 6186.53                 | 6182.54                        | 6182.54                         | 6183.13                     | 6183.13                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (47)                       | 5%Nc MH                               | 0                  | 12.58                  | 6202                    | 6193.76                        | 6193.76                         | 6194.65                     | 6194.65                      | HEC-22 Energy (Third Edition)  | Half                   |
| Structure - (48)                       | 5%Nc MH                               | 0                  | 12.58                  | 6210.27                 | 6205.11                        | 6205.11                         | 6206                        | 6206                         | HEC-22 Energy (Third Edition)  | Half                   |
| TYPE D OS1.1                           | FES                                   | 30.85              | 30.85                  | 6201                    | 6197.72                        | 6197.38                         | 6198.65                     | 6198.31                      | HEC-22 Energy (Third Edition)  | Flat                   |

Profile Report  
Engineering Profile - DP-01 (2025-07-03 CABELAS DRIVE.stsw)

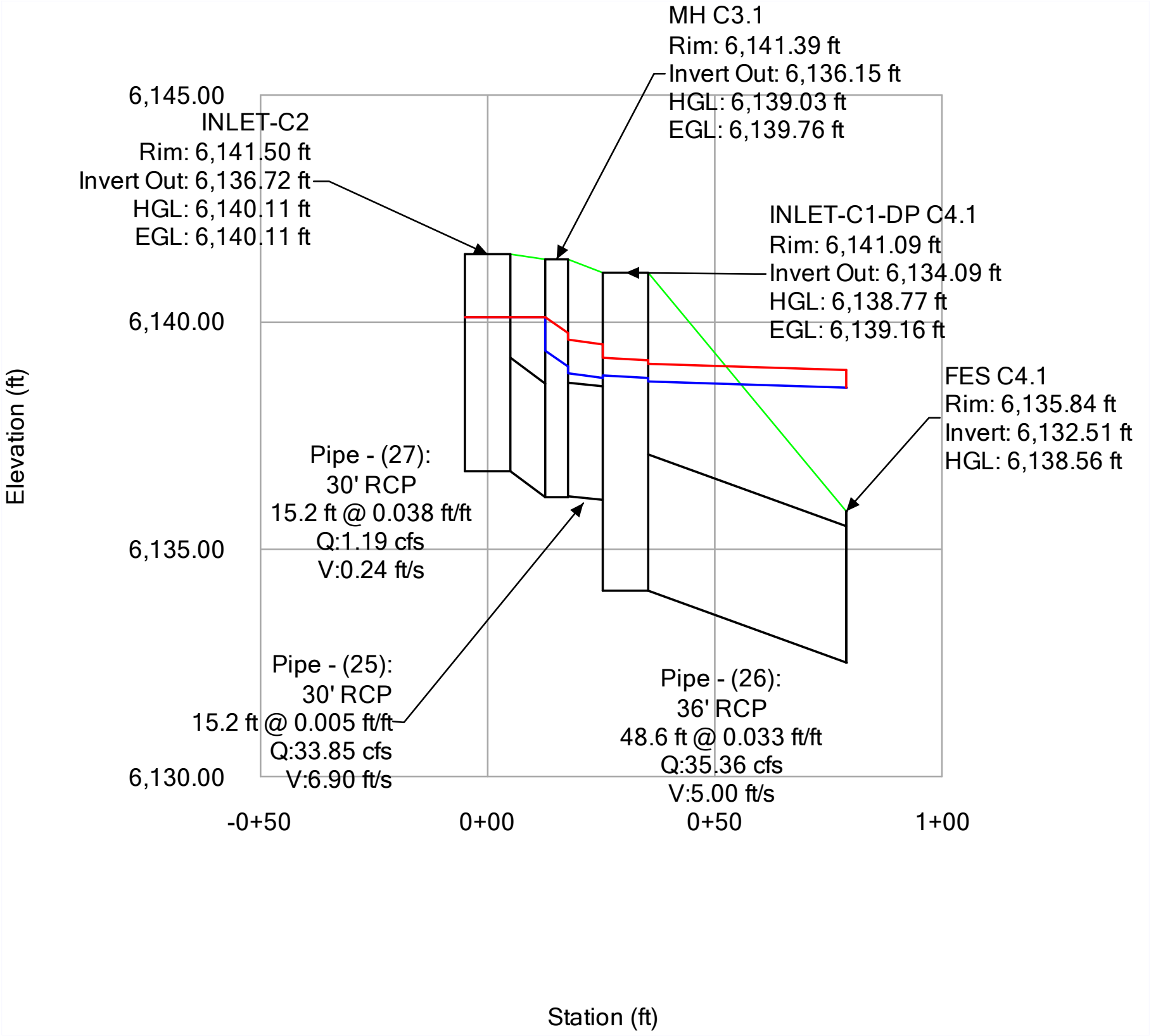


Profile Report  
Engineering Profile - DP-A (2025-07-03 CABELAS DRIVE.stsw)



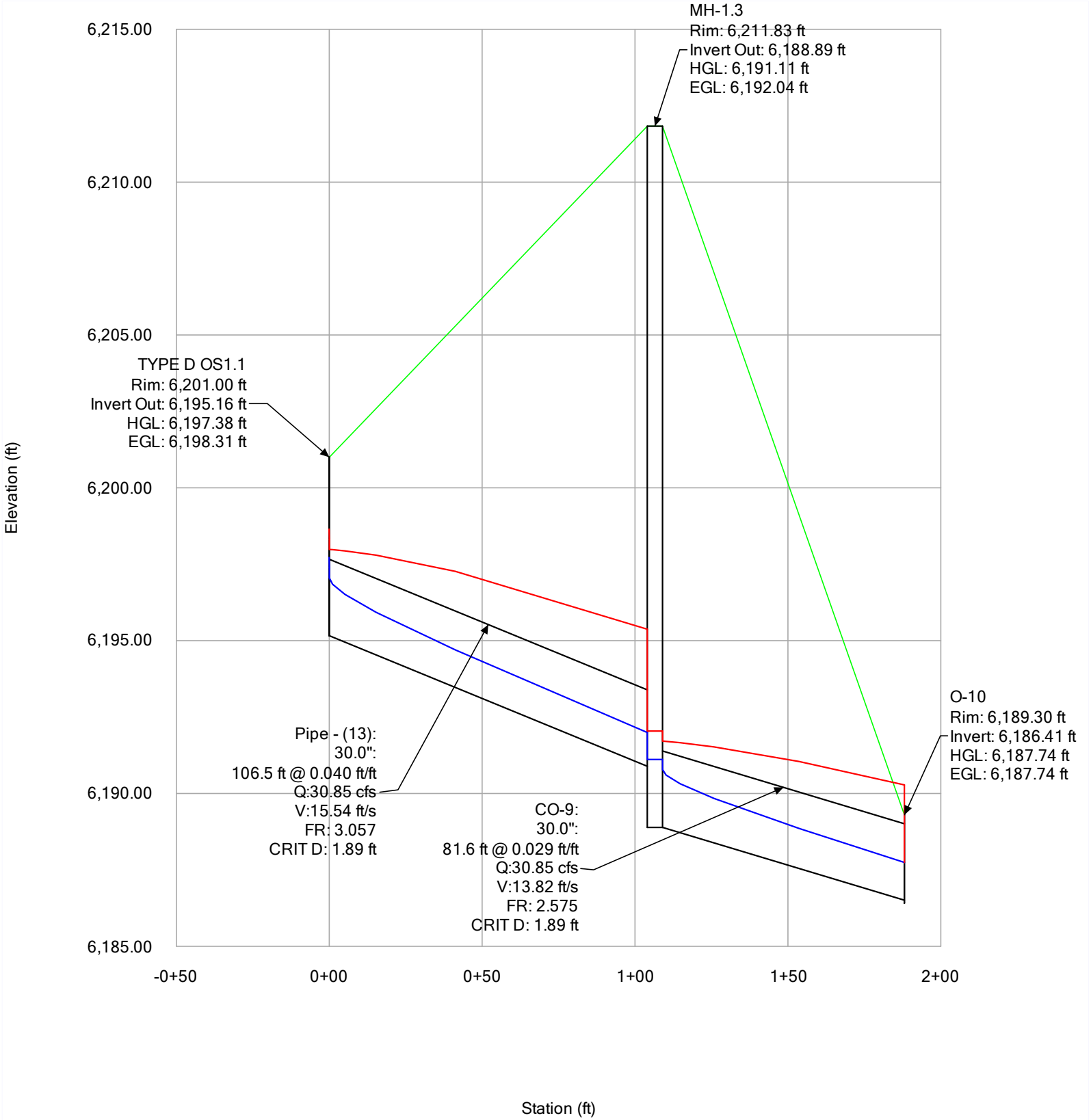


Profile Report  
Engineering Profile - DP-C (2025-07-03 CABELAS DRIVE.stsw)



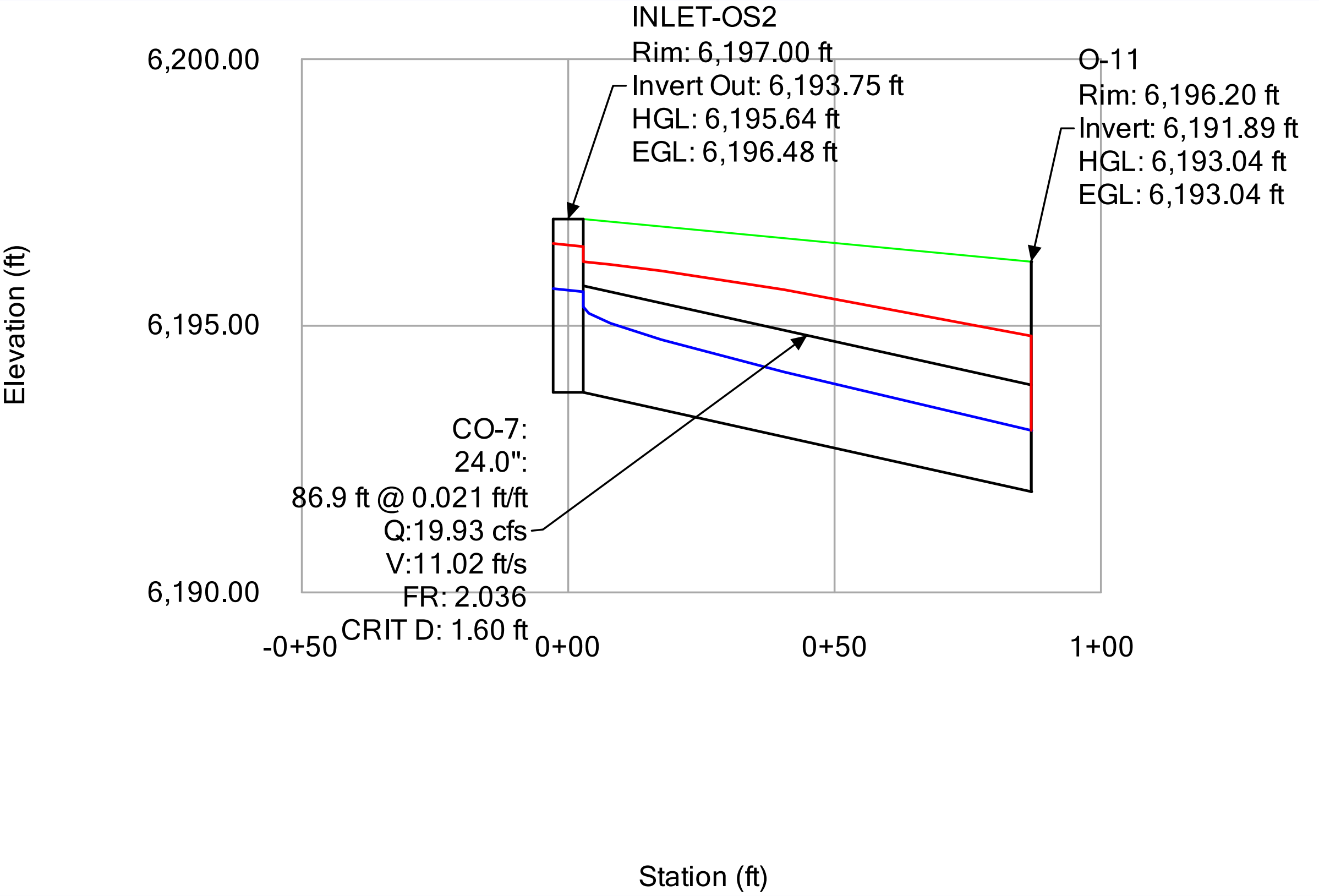


Profile Report  
Engineering Profile - DP-OS1 (2025-07-03 CABELAS DRIVE.stsw)

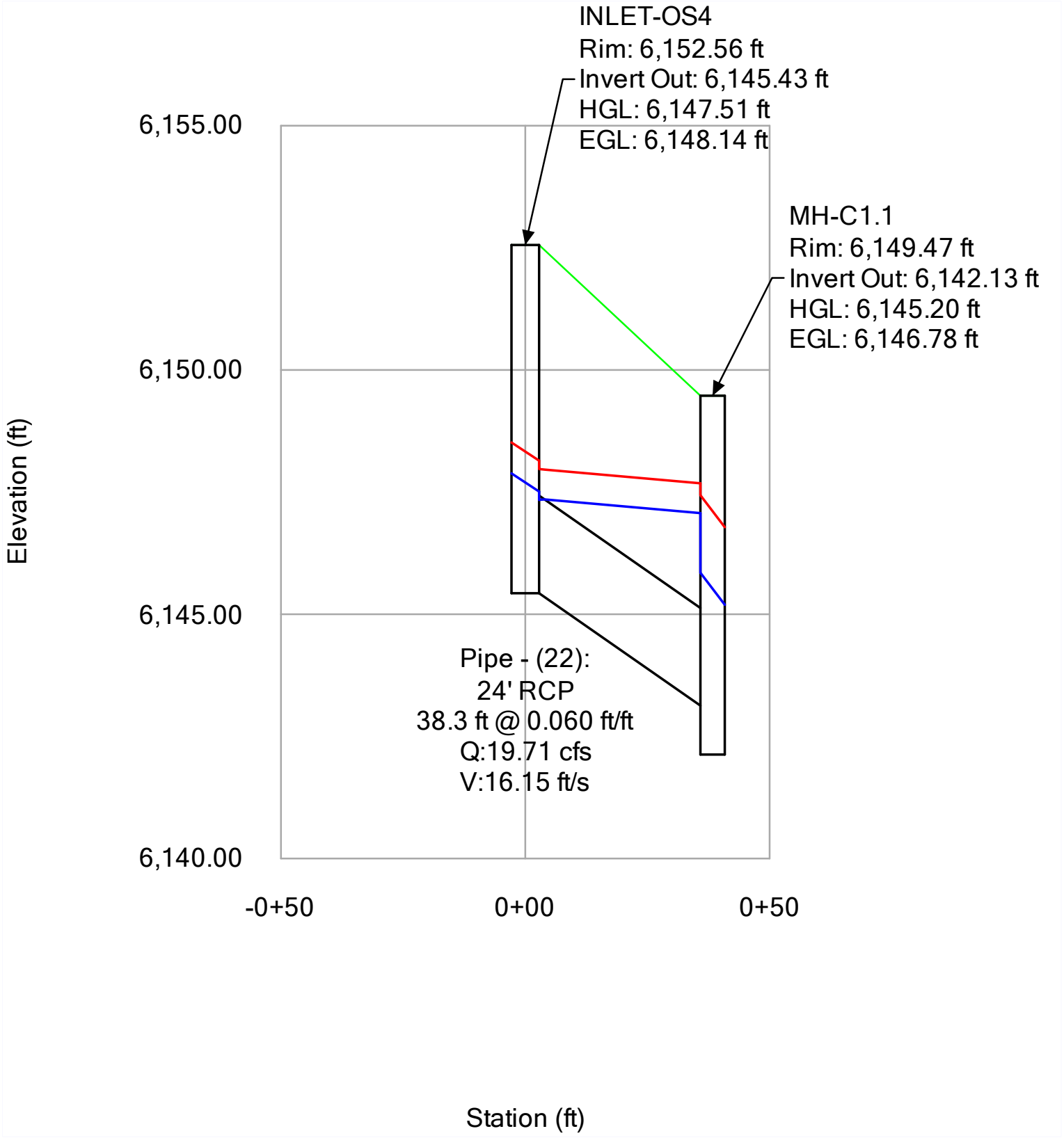




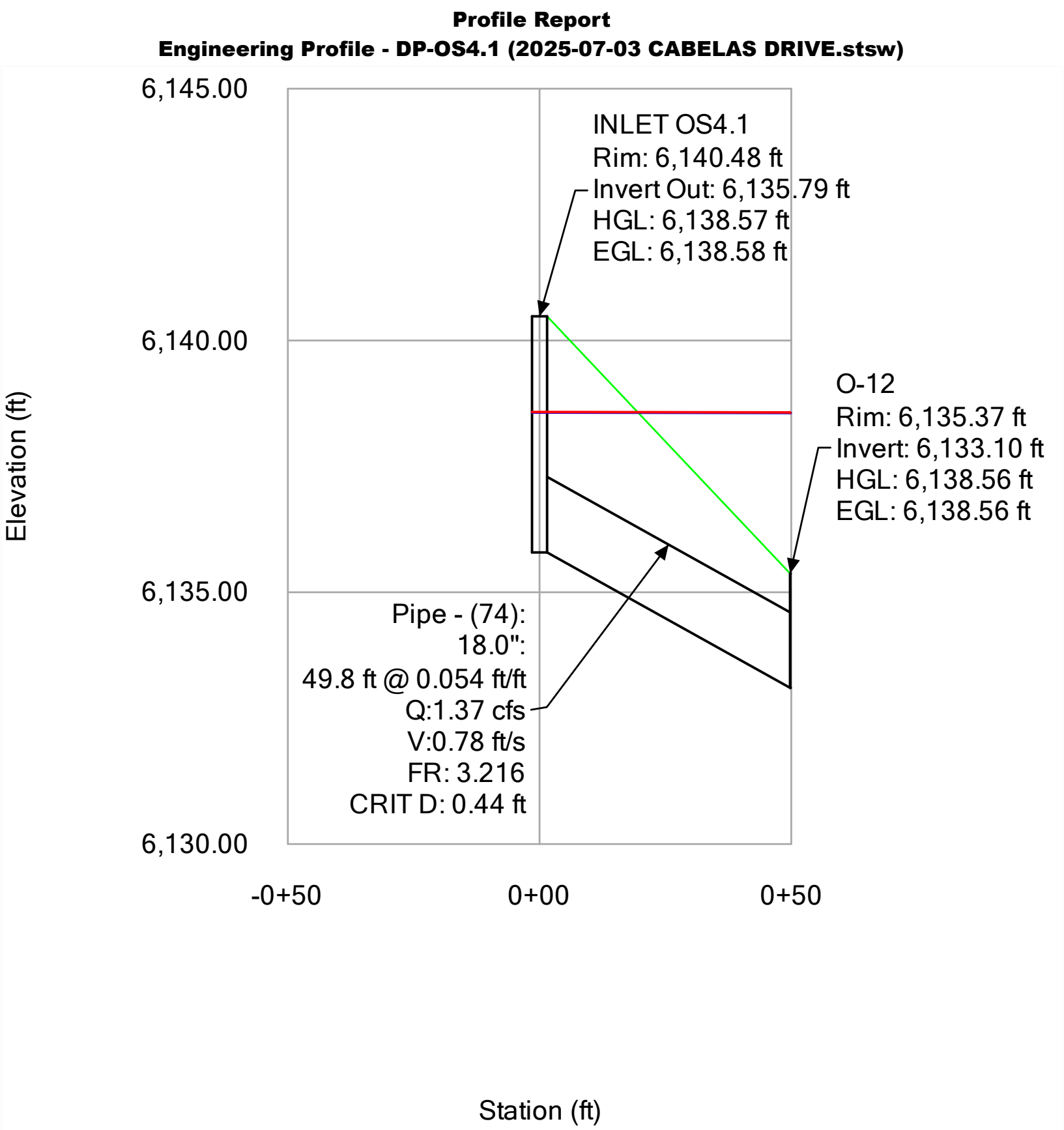
Profile Report  
Engineering Profile - DP-OS2 (2025-07-03 CABELAS DRIVE.stsw)



Profile Report  
Engineering Profile - DP-OS4 (2025-07-03 CABELAS DRIVE.stsw)

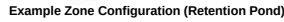


100 YEAR



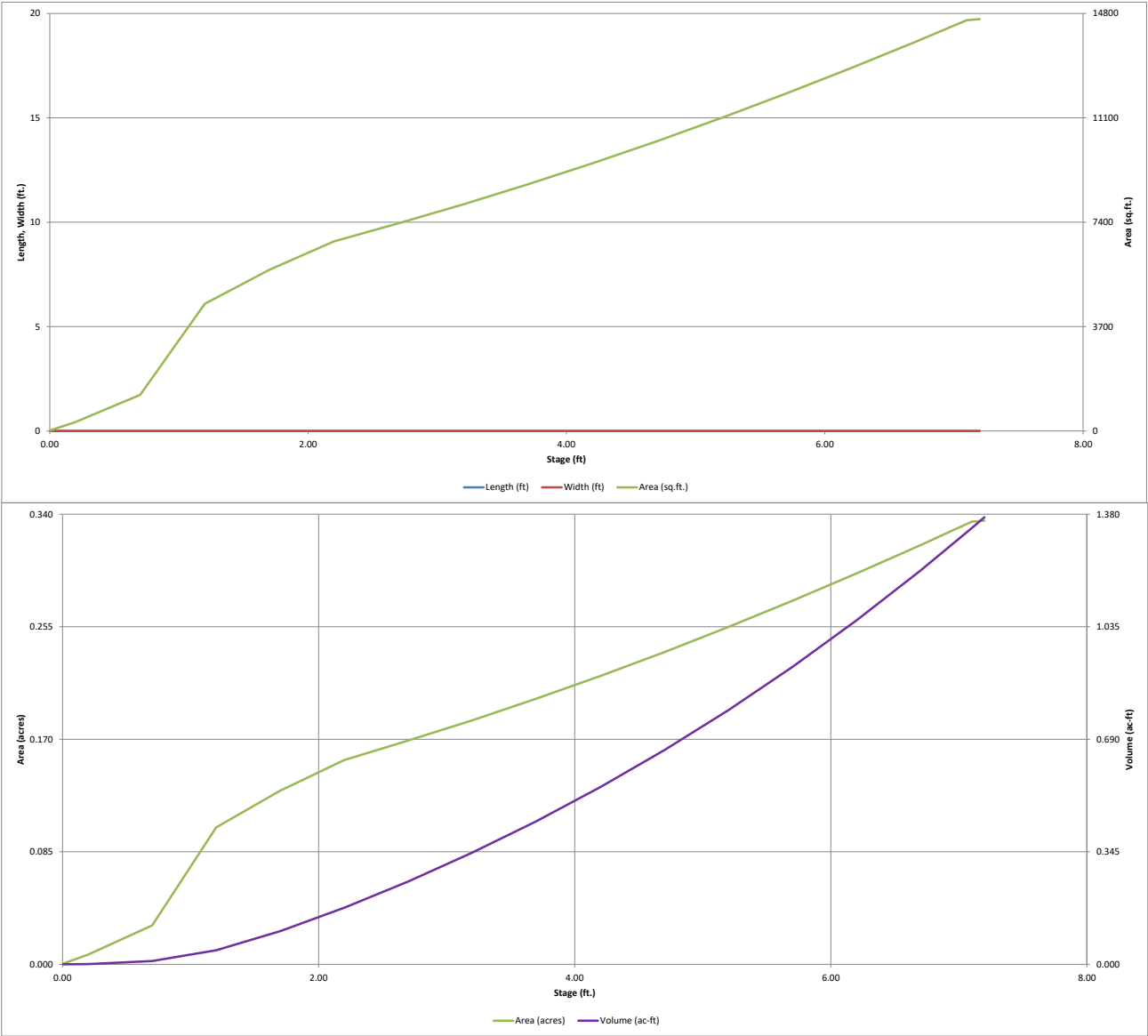
## MHFD-Detention, Version 4.06 (July 2022)

Basin ID: PROPOSED TRACT P EDB



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

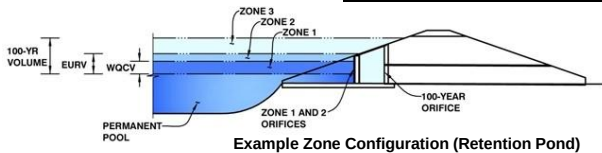


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **HILLCAMP DRIVE**

Basin ID: **PROPOSED TRACT P EDB**



Example Zone Configuration (Retention Pond)

|                   | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type          |
|-------------------|----------------------|--------------------------|----------------------|
| Zone 1 (WQCV)     | 2.70                 | 0.253                    | Orifice Plate        |
| Zone 2 (EURV)     | 3.65                 | 0.175                    | Circular Orifice     |
| Zone 3 (100-year) | 6.97                 | 0.865                    | Weir&Pipe (Restrict) |
| Total (all zones) |                      | 1.293                    |                      |

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

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

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

Centroid of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (diameter = 7/8 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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             | 0.50             | 1.00             |                  |                  |                  |                  |                  |
| Orifice Area (sq. inches)      | 0.65             | 0.65             | 0.65             |                  |                  |                  |                  |                  |

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

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice

Zone 2 Circular Not Selected  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Type =   
Debris Clogging % =  %

Calculated Parameters for Overflow Weir

Zone 3 Weir Not Selected  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Zone 3 Restrictor Not Selected  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

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

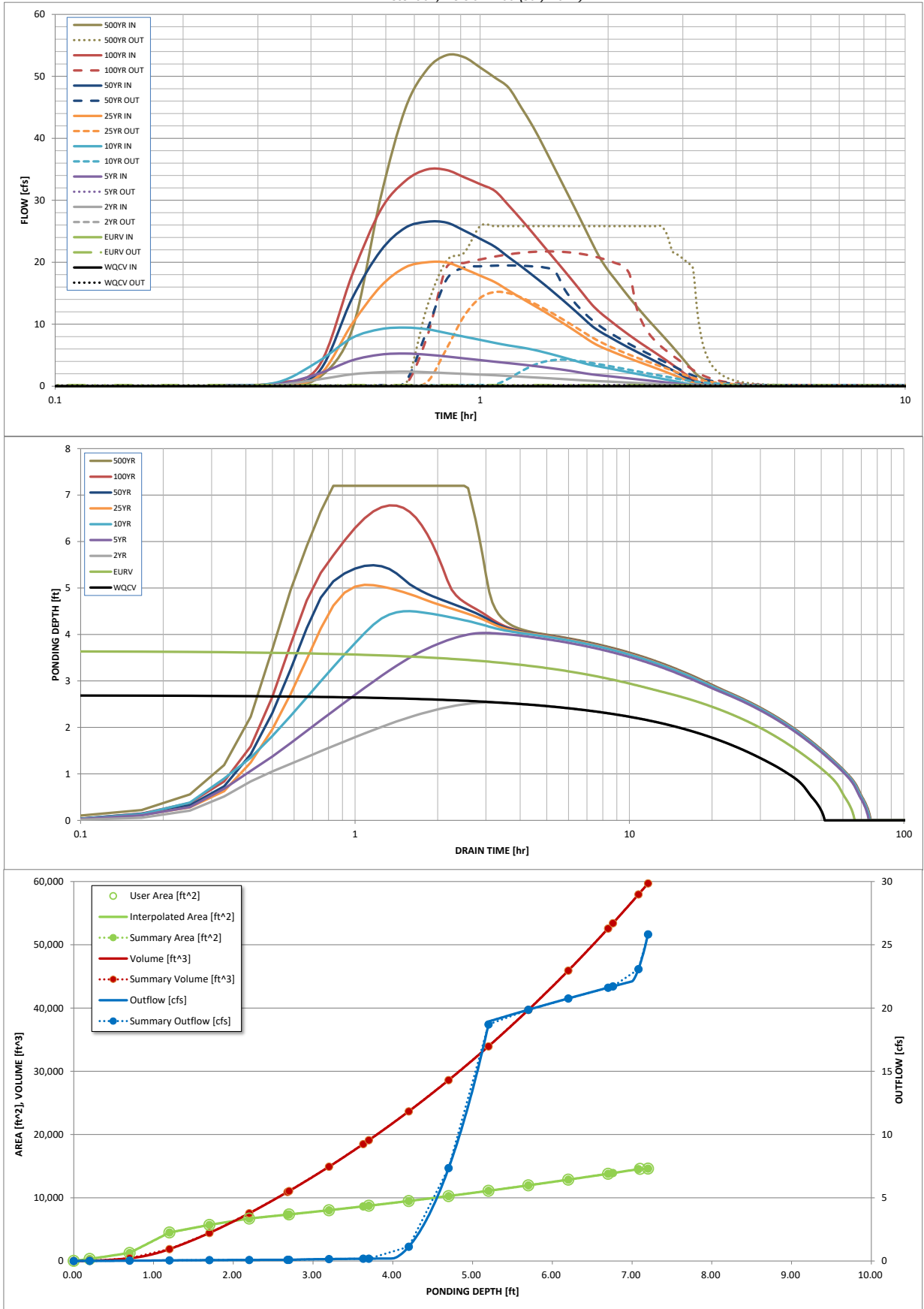
Routed Hydrograph Results

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

|                                                 | WQCV  | EURV               | 2 Year | 5 Year          | 10 Year         | 25 Year         | 50 Year        | 100 Year       | 500 Year |
|-------------------------------------------------|-------|--------------------|--------|-----------------|-----------------|-----------------|----------------|----------------|----------|
| Design Storm Return Period =                    | N/A   | N/A                | 0.84   | 1.10            | 1.33            | 1.68            | 1.97           | 2.28           | 3.07     |
| One-Hour Rainfall Depth (in) =                  | 0.253 | 0.428              | 0.247  | 0.549           | 0.983           | 2.025           | 2.741          | 3.691          | 5.773    |
| CUHP Runoff Volume (acre-ft) =                  | N/A   | N/A                | 0.247  | 0.549           | 0.983           | 2.025           | 2.741          | 3.691          | 5.773    |
| Inflow Hydrograph Volume (acre-ft) =            | N/A   | N/A                | 0.3    | 2.4             | 6.5             | 16.9            | 23.2           | 31.5           | 49.3     |
| CUHP Predevelopment Peak Q (cfs) =              | N/A   | N/A                | 0.01   | 0.08            | 0.21            | 0.55            | 0.75           | 0.80           | 1.60     |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A   | N/A                | 0.01   | 0.08            | 0.21            | 0.55            | 0.75           | 0.80           | 1.60     |
| Predevelopment Unit Peak Flow, q (cfs/acre) =   | N/A   | N/A                | 0.1    | 0.3             | 4.3             | 15.2            | 19.5           | 21.7           | 25.8     |
| Peak Inflow Q (cfs) =                           | N/A   | N/A                | 0.1    | 0.3             | 4.3             | 15.2            | 19.5           | 21.7           | 25.8     |
| Peak Outflow Q (cfs) =                          | N/A   | N/A                | 0.1    | 0.3             | 4.3             | 15.2            | 19.5           | 21.7           | 25.8     |
| Ratio Peak Outflow to Predevelopment Q =        | N/A   | N/A                | N/A    | 0.1             | 0.7             | 0.9             | 0.8            | 0.9            | 0.5      |
| Structure Controlling Flow =                    | Plate | Vertical Orifice 1 | Plate  | Overflow Weir 1 | Overflow Weir 1 | Overflow Weir 1 | Outlet Plate 1 | Outlet Plate 1 | N/A      |
| Max Velocity through Grate 1 (fps) =            | N/A   | N/A                | N/A    | 0.0             | 0.1             | 0.3             | 0.4            | 0.4            | 0.4      |
| Max Velocity through Grate 2 (fps) =            | N/A   | N/A                | N/A    | N/A             | N/A             | N/A             | N/A            | N/A            | N/A      |
| Time to Drain 97% of Inflow Volume (hours) =    | 45    | 57                 | 45     | 64              | 61              | 53              | 49             | 44             | 35       |
| Time to Drain 99% of Inflow Volume (hours) =    | 48    | 62                 | 48     | 69              | 67              | 64              | 61             | 59             | 54       |
| Maximum Ponding Depth (ft) =                    | 2.70  | 3.65               | 2.53   | 4.03            | 4.50            | 5.07            | 5.49           | 6.78           | 7.20     |
| Area at Maximum Ponding Depth (acres) =         | 0.17  | 0.20               | 0.16   | 0.21            | 0.23            | 0.25            | 0.27           | 0.32           | 0.34     |
| Maximum Volume Stored (acre-ft) =               | 0.254 | 0.429              | 0.226  | 0.507           | 0.610           | 0.744           | 0.855          | 1.229          | 1.371    |

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           | 0.03           |
|               | 0:15:00 | 0.00       | 0.00       | 0.03         | 0.08         | 0.11          | 0.09          | 0.13          | 0.13           | 0.23           |
|               | 0:20:00 | 0.00       | 0.00       | 0.21         | 0.32         | 0.63          | 0.29          | 0.36          | 0.56           | 1.34           |
|               | 0:25:00 | 0.00       | 0.00       | 1.09         | 2.02         | 4.02          | 1.63          | 2.27          | 3.17           | 9.15           |
|               | 0:30:00 | 0.00       | 0.00       | 1.93         | 4.17         | 7.80          | 10.08         | 14.19         | 17.99          | 30.45          |
|               | 0:35:00 | 0.00       | 0.00       | 2.25         | 5.10         | 9.21          | 16.10         | 21.84         | 28.43          | 44.78          |
|               | 0:40:00 | 0.00       | 0.00       | 2.35         | 5.27         | 9.46          | 19.18         | 25.56         | 33.12          | 51.11          |
|               | 0:45:00 | 0.00       | 0.00       | 2.26         | 5.08         | 9.19          | 20.00         | 26.53         | 34.98          | 53.41          |
|               | 0:50:00 | 0.00       | 0.00       | 2.11         | 4.79         | 8.58          | 19.96         | 26.40         | 34.88          | 53.09          |
|               | 0:55:00 | 0.00       | 0.00       | 1.99         | 4.49         | 7.99          | 18.94         | 25.12         | 33.72          | 51.43          |
|               | 1:00:00 | 0.00       | 0.00       | 1.87         | 4.21         | 7.48          | 17.84         | 23.79         | 32.60          | 49.79          |
|               | 1:05:00 | 0.00       | 0.00       | 1.77         | 3.95         | 6.99          | 16.79         | 22.50         | 31.51          | 48.17          |
|               | 1:10:00 | 0.00       | 0.00       | 1.64         | 3.72         | 6.57          | 15.44         | 20.82         | 29.19          | 44.96          |
|               | 1:15:00 | 0.00       | 0.00       | 1.53         | 3.50         | 6.25          | 14.21         | 19.32         | 26.88          | 41.82          |
|               | 1:20:00 | 0.00       | 0.00       | 1.42         | 3.28         | 5.89          | 13.08         | 17.83         | 24.62          | 38.42          |
|               | 1:25:00 | 0.00       | 0.00       | 1.32         | 3.05         | 5.46          | 12.03         | 16.39         | 22.46          | 35.06          |
|               | 1:30:00 | 0.00       | 0.00       | 1.23         | 2.83         | 5.01          | 10.99         | 14.97         | 20.43          | 31.90          |
|               | 1:35:00 | 0.00       | 0.00       | 1.13         | 2.61         | 4.57          | 9.98          | 13.60         | 18.51          | 28.87          |
|               | 1:40:00 | 0.00       | 0.00       | 1.03         | 2.36         | 4.14          | 8.99          | 12.26         | 16.65          | 25.95          |
|               | 1:45:00 | 0.00       | 0.00       | 0.94         | 2.11         | 3.72          | 8.02          | 10.95         | 14.84          | 23.15          |
|               | 1:50:00 | 0.00       | 0.00       | 0.87         | 1.91         | 3.39          | 7.10          | 9.71          | 13.15          | 20.62          |
|               | 1:55:00 | 0.00       | 0.00       | 0.81         | 1.75         | 3.14          | 6.40          | 8.79          | 11.87          | 18.70          |
|               | 2:00:00 | 0.00       | 0.00       | 0.75         | 1.63         | 2.91          | 5.86          | 8.07          | 10.85          | 17.14          |
|               | 2:05:00 | 0.00       | 0.00       | 0.69         | 1.50         | 2.67          | 5.36          | 7.38          | 9.89           | 15.63          |
|               | 2:10:00 | 0.00       | 0.00       | 0.63         | 1.37         | 2.44          | 4.89          | 6.73          | 9.00           | 14.21          |
|               | 2:15:00 | 0.00       | 0.00       | 0.57         | 1.24         | 2.21          | 4.46          | 6.14          | 8.18           | 12.90          |
|               | 2:20:00 | 0.00       | 0.00       | 0.52         | 1.12         | 2.00          | 4.06          | 5.57          | 7.42           | 11.67          |
|               | 2:25:00 | 0.00       | 0.00       | 0.47         | 1.01         | 1.80          | 3.67          | 5.03          | 6.70           | 10.52          |
|               | 2:30:00 | 0.00       | 0.00       | 0.42         | 0.90         | 1.60          | 3.30          | 4.52          | 6.03           | 9.45           |
|               | 2:35:00 | 0.00       | 0.00       | 0.37         | 0.80         | 1.41          | 2.94          | 4.03          | 5.39           | 8.41           |
|               | 2:40:00 | 0.00       | 0.00       | 0.32         | 0.70         | 1.23          | 2.59          | 3.54          | 4.75           | 7.41           |
|               | 2:45:00 | 0.00       | 0.00       | 0.28         | 0.60         | 1.06          | 2.24          | 3.07          | 4.12           | 6.41           |
|               | 2:50:00 | 0.00       | 0.00       | 0.24         | 0.50         | 0.88          | 1.90          | 2.60          | 3.49           | 5.41           |
|               | 2:55:00 | 0.00       | 0.00       | 0.19         | 0.41         | 0.71          | 1.55          | 2.13          | 2.86           | 4.43           |
|               | 3:00:00 | 0.00       | 0.00       | 0.15         | 0.32         | 0.54          | 1.21          | 1.67          | 2.24           | 3.45           |
|               | 3:05:00 | 0.00       | 0.00       | 0.11         | 0.23         | 0.39          | 0.88          | 1.21          | 1.63           | 2.52           |
|               | 3:10:00 | 0.00       | 0.00       | 0.08         | 0.16         | 0.28          | 0.57          | 0.80          | 1.10           | 1.75           |
|               | 3:15:00 | 0.00       | 0.00       | 0.06         | 0.13         | 0.22          | 0.39          | 0.57          | 0.77           | 1.26           |
|               | 3:20:00 | 0.00       | 0.00       | 0.05         | 0.10         | 0.18          | 0.27          | 0.41          | 0.55           | 0.92           |
|               | 3:25:00 | 0.00       | 0.00       | 0.04         | 0.08         | 0.15          | 0.20          | 0.31          | 0.39           | 0.67           |
|               | 3:30:00 | 0.00       | 0.00       | 0.04         | 0.07         | 0.12          | 0.14          | 0.23          | 0.27           | 0.48           |
|               | 3:35:00 | 0.00       | 0.00       | 0.03         | 0.06         | 0.10          | 0.11          | 0.17          | 0.19           | 0.34           |
|               | 3:40:00 | 0.00       | 0.00       | 0.02         | 0.04         | 0.08          | 0.08          | 0.13          | 0.12           | 0.23           |
|               | 3:45:00 | 0.00       | 0.00       | 0.02         | 0.03         | 0.06          | 0.06          | 0.09          | 0.08           | 0.16           |
|               | 3:50:00 | 0.00       | 0.00       | 0.02         | 0.03         | 0.05          | 0.05          | 0.07          | 0.07           | 0.12           |
|               | 3:55:00 | 0.00       | 0.00       | 0.01         | 0.02         | 0.04          | 0.04          | 0.05          | 0.05           | 0.09           |
|               | 4:00:00 | 0.00       | 0.00       | 0.01         | 0.02         | 0.03          | 0.03          | 0.04          | 0.04           | 0.07           |
|               | 4:05:00 | 0.00       | 0.00       | 0.01         | 0.01         | 0.02          | 0.02          | 0.03          | 0.03           | 0.06           |
|               | 4:10:00 | 0.00       | 0.00       | 0.01         | 0.01         | 0.01          | 0.02          | 0.02          | 0.02           | 0.04           |
|               | 4:15:00 | 0.00       | 0.00       | 0.00         | 0.01         | 0.01          | 0.01          | 0.02          | 0.02           | 0.03           |
|               | 4:20:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.01          | 0.01          | 0.01          | 0.01           | 0.02           |
|               | 4:25:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.01          | 0.01           | 0.01           |
|               | 4:30:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.01           |
|               | 4:35:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:40:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:45:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:50:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:55:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:00:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:05:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:10:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:15:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:20:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:25:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:30:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:35:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:40:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:45:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:50:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:55:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 6:00:00 | 0.00       | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |



*MHFD-Detention, Version 4.06 (July 2022)*

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.

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).

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).

## PIPE OUTFALL RIPRAP SIZING CALCULATIONS

Subdivision: Hillcamp Drive Extension  
 Location: Lone Tree

Project Name: Hillcamp Drive  
 Project No.: 15950.18  
 Calculated By: BMP  
 Checked By: BMP  
 Date: 11/11/25

|                                            | STORM DRAIN SYSTEM |      |      | Notes                                   |
|--------------------------------------------|--------------------|------|------|-----------------------------------------|
|                                            | OS1                |      |      |                                         |
| $Q_{100}$ (cfs):                           | 30.9               |      |      |                                         |
| Conduit                                    | Pipe               | Pipe | Pipe |                                         |
| $D_c$ , Pipe Diameter (in):                | 30                 | 24   | 18   |                                         |
| $W$ , Box Width (ft):                      | N/A                | N/A  | N/A  |                                         |
| $H$ , Box Height (ft):                     | N/A                | N/A  | N/A  |                                         |
| $Y_t$ , Tailwater Depth (ft):              | 0.40               | 0.40 | 0.40 | If unknown, use $Y_t/D_c$ (or $H$ )=0.4 |
| $Y_t/D_c$ or $Y_t/H$                       | 0.16               |      |      |                                         |
| $Q/D^{2.5}$ or $Q/(WH^{3/2})$              | 3.12               |      |      |                                         |
| Supercritical?                             | Yes                | No   | No   |                                         |
| $Y_n$ , Normal Depth (ft) [Supercritical]: | 1.85               | 1.67 | 1.10 |                                         |
| $D_o$ , $H_o$ (in) [Supercritical]:        | 2.18               |      |      | $D_o=(D_c+Y_n)/2$                       |
| Riprap $d_{50}$ (in) [Supercritical]:      | 20.25              |      |      |                                         |
| Riprap $d_{50}$ (in) [Subcritical]:        | N/A                |      |      |                                         |
| Required Riprap Size:                      | VH                 |      |      | Fig. 9-38 or Fig. 9-36                  |
| $d_{50}$ (in):                             | 18                 |      |      |                                         |
| Expansion Factor, $1/(2 \tan \theta)$ :    | 4.00               | 1.50 | 1.50 | Read from Fig. 9-35 or 9-36             |
| $\theta$ :                                 | 0.12               | 0.32 | 0.32 |                                         |
| Erosive Soils?                             | Yes                | Yes  | Yes  |                                         |
| Area of Flow, $A_t$ (ft <sup>2</sup> ):    | 6.17               | 0.00 | 0.00 | $A_t=Q/V$                               |
| Length of Protection, $L_p$ (ft):          | 51.7               | -3.0 | -2.3 | $L=(1/(2 \tan \theta))(A_t/Y_t - D)$    |
| Min Length (ft)                            | 7.5                | 6.0  | 4.5  | Min $L=3D$ or $3H$                      |
| Max Length (ft)                            | 25.0               | 20.0 | 15.0 | Max $L=10D$ or $10H$                    |
| Min Bottom Width, $T$ (ft):                | 15.4               |      |      | $T=2*(L_p*\tan \theta)+W$               |
| Design Length (ft)                         | 25.0               | 6.0  | 4.5  |                                         |
| Design Width (ft)                          | 15.4               |      |      |                                         |
| Riprap Depth (in)                          | 36                 |      |      | Depth=2( $d_{50}$ )                     |
| Type II Bedding Depth (in)*                | 8                  |      |      | *Not used if Soil Riprap                |
| Cutoff Wall                                | No                 | No   | No   |                                         |
| Cutoff Wall Depth (ft)                     | 36.0               | 36.0 |      | Depth of Riprap and Base                |
| Cutoff Wall Width (ft)                     |                    |      |      |                                         |

Note: No Type II Base to be used if Soil Riprap is specified within the plans

\* For use when the flow in the culvert is supercritical (and less than full).

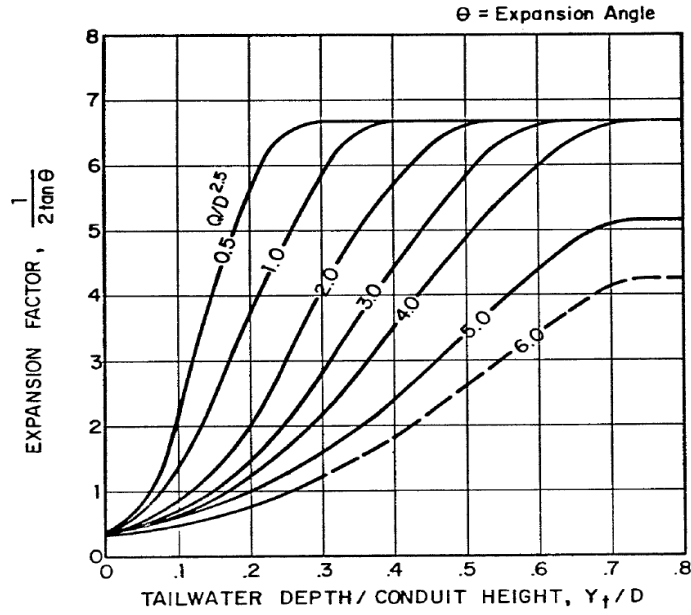


Figure 9-35. Expansion factor for circular conduits

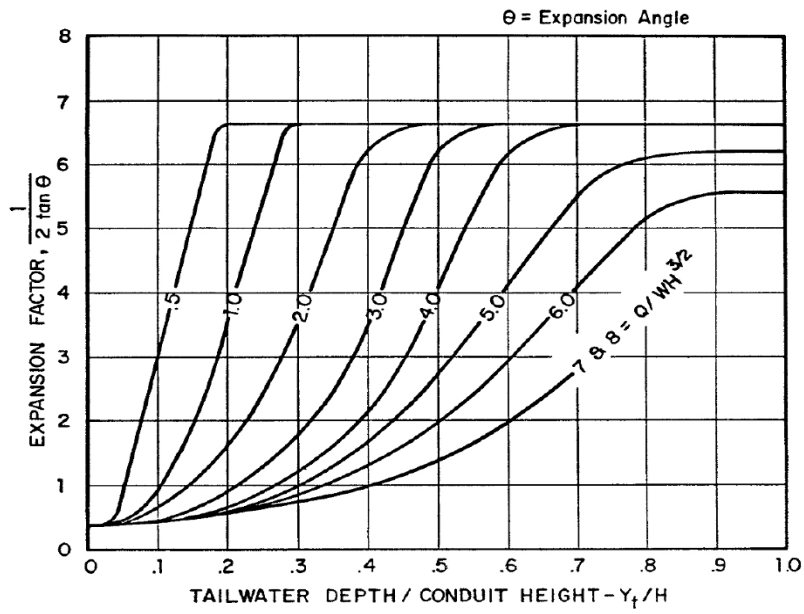


Figure 9-36. Expansion factor for rectangular conduits

\*COEFFICIENT A 1

| CALCULATION OF FOREBAY REQUIREMENTS |              |                    |          |                         |              |                 |
|-------------------------------------|--------------|--------------------|----------|-------------------------|--------------|-----------------|
| FOREBAY ID                          | Area (acres) | Percent Impervious | IA ACRES | WQCV (watershed-inches) | WQCV (ac-ft) | 1% WQCV (ac-ft) |
| SUBTOTAL FOREBAY A1                 | 30.76        | 16.1%              | 4.95236  | 0.099                   | 0.253        | 0.00253         |
| SUBTOTAL FOREBAY OS4.1              | 1.64         | 5.4%               | 0.08856  | 0.039                   | 0.005        | 0.00005         |

| CALCULATION OF FOREBAY VOLUME PROVIDED AND DRAIN TIME |                 |           |                  |                     |                      |                         |                      |                      |                       |
|-------------------------------------------------------|-----------------|-----------|------------------|---------------------|----------------------|-------------------------|----------------------|----------------------|-----------------------|
| FOREBAY ID                                            | 1% WQCV (ac-ft) | WQCV (CF) | *FOREBAY SA (SF) | *FOREBAY DEPTH (ft) | VOLUME PROVIDED (CF) | VOLUME PROVIDED (ac-ft) | DRAIN TIME (seconds) | DRAIN TIME (minutes) | WEIR NOTCH WIDTH (in) |
| SUBTOTAL FOREBAY A1                                   | 0.00253         | 110.02    | 198              | 1                   | 198                  | 0.00455                 | 300                  | 5                    | 6.09                  |
| SUBTOTAL FOREBAY OS4.1                                | 0.00005         | 2.31      | 49.5             | 1                   | 49.5                 | 0.00114                 | 300                  | 5                    | 1.52                  |

\*BASED ON CAD AREA

\*BASED ON TABLE 4-12  
1' MIN 1.25' MAX

**APPENDIX D**  
**EXCERPTS FROM REFERENCED MATERIAL**



# **RIDGEGATE – SECTION 22, FILING NO. 1**

## **PHASE III DRAINAGE REPORT**

**JANUARY 2017**

**For:**  
**Century Communities**  
**8390 E. Crescent Parkway, Suite 650**  
**Greenwood Village, CO 80111**

City of Lone Tree Review & Approval Is With Respect  
To General Conformance With City Standards. Responsibility  
For The Design Remains With The Professional(s) Submitting  
And Stamping The Document(s).



# RIDGEGATE – SECTION 22, FILING NO. 1

## PHASE III DRAINAGE REPORT

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### Outfall 1 (DP 1)

- Basins OS1.1 and OS1.2 are primarily undeveloped basins, with possibility of future rural residential use and a road. These basins contain an upper reach of Cottonwood Creek. Runoff generated in these basins follows an existing drainage channel to a proposed culvert at DP 1.1. The culvert outfalls to the main Cottonwood Creek Channel at DP 1. During the major event, inlet controlled flow will occur at this culvert, attenuating the flow to the Cottonwood Creek Channel.

### Outfall 2 (DP 2)

- Basin OS2.1-OS2.3 are primarily undeveloped basins, with possible future rural residential land use and road. Runoff generated in these basins follows an existing drainage channel to a proposed depressed Type-D inlet at DP 2.1. The culvert outfalls to the main Cottonwood Creek Channel at DP 2.

### Outfall 3 (DP 3)

- Runoff from Basins OS3.1 and Basins A1-A2.2 is captured in a proposed storm system which outfalls to Basin OS3.2 at DP 3.4.
  - o Basin OS3.1 is an undeveloped basin. Runoff generated in this basin is routed via a lined channel (SmartDitch or equivalent) to a low point at DP 3.1, where runoff is captured by an FES.
  - o Basin A1 is a developed basin. Runoff generated in this basin is routed via curb and gutter to a Type-R inlet in sump at DP 3.2.
  - o Basins A2.1 and A2.2 are developed basins. Runoff generated in these basins is captured at DP 3.3 by a Type-R inlet in sump.
- Basin OS3.2 is a large offsite basin containing an upper reach of Cottonwood Creek Channel. Runoff from this basin and Basins A1-A2.2 and Basin OS3.1 reaches a proposed culvert at DP 3.4, which outfalls to the main Cottonwood Creek Channel at DP 3. During the major event, inlet controlled flow will occur at this culvert, attenuating the flow to the Cottonwood Creek Channel.
- Basin A3 contains the back of lots. Runoff generated in this basin is routed via grass swales to landscape inlets in sump. Collected runoff is conveyed by a drain system along the back of the lots, which outfalls to the main channel at DP 3.5.

### Outfall 4 (DP 4)

- Basins OS4.1 and OS4.2 are undeveloped basins. Runoff generated in these basins follows an existing drainage channel and proposed swale to a proposed culvert at DP 4.1. The culvert outfalls to the main Cottonwood Creek Channel at DP 4.
- Basin B1 is a developed basin. Runoff generated in this basin is routed via curb and gutter to a Type-R inlet in sump at DP 4.2 on the north side of Viewside Way. Another Type-R inlet on the south side of Viewside Way captures nuisance flows on this side of the street, although it does not capture substantial flows during the minor or major event. These inlets outfall to the proposed culvert utilized by Basins OS4.1 and OS4.2.

### III. STORM DRAINAGE CRITERIA

#### A. Regulations:

- Criteria used in the development of this Phase III Drainage Report include:
  - o The Douglas County Storm Drainage Design and Technical Criteria Manual
  - o The Urban Drainage and Flood Control District's Urban Storm Drainage Criteria Manual was also used as a reference and guide for criteria

#### B. Drainage Studies, Outfall Systems Plans, Site Constraints

- The site is discussed but not included within:
  - o Flood Hazard Area Delineation, Cottonwood Creek by Muller Engineering Company Inc., August 2011
  - o "Cottonwood Creek (Downstream of Lincoln Avenue) Outfall Systems Plan" by Muller Engineering Company, August 2010.
- Existing drainage reports for the site and surrounding areas include:
  - o Master Drainage Plan for Ridgeway – Cottonwood Creek Drainage Basin by Merrick & Company, dated January 2012.
  - o Phase III Drainage Report for Tract O Access Road (Cottonwood Creek Flow Control Structure) Rampart Range Metropolitan District No. 1, Merrick & Company, April 2012.

Compliance with these studies is further discussed in Section IV.

#### C. Hydrology

- Peak storm runoff for the developed basins was determined using the Rational Formula:  $Q=CIA$ .
- The Colorado Urban Hydrograph Procedure (CUHP\_v1.4.4) was used in conjunction with SWMM 5.1 to determine the runoff for the master basins (including offsite basins upstream of the site), and routing within Cottonwood Creek.
- Rainfall intensities were taken from Figure 6-1, Zone 1, of the *Douglas County Storm Drainage Design and Technical Criteria Manual*.
- The 5-year storm was analyzed as the minor event.
- The 100-year storm was analyzed as the major event.
- There are no detention facilities on site. However, attenuated flow is expected behind the culverts/storm lines at DP 1, DP 3, and DP4 during the major event. The stored volume was calculated using SWMM 5.1. See Appendix C.



# RIDGEGATE – SECTION 22, FILING NO. 1

## PHASE III DRAINAGE REPORT

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- For large upstream basins, rational method is not an appropriate method to estimate runoff. To calculate pipe/inlet capacities, runoff calculated with CUHP for the entire corresponding major basin will be used. For example, for the system discharging at DP 4,  $Q_{100}$  used at DP4.1 will be 30.6 cfs. This is the  $Q_{100}$  from the CUHP basin 4, which corresponds to basins B1, B2, OS4.1, and OS4.2. For this reason, the estimated runoff at design points in the SWMM model will be lower than the Rational method calculations and Hydraflow calculations.
- Runoff to area inlets was determined by calculating the total runoff in the basin and dividing by the number of lots in that basin.
- See Appendix B for hydrologic calculations.

### D. Hydraulics

- All of the streets contained within the site are local streets.
- For the minor storm event, runoff may spread to back of sidewalk (mountable curb with attached sidewalk) / curb (for vertical curb) or to the crown of the street, whichever is less.
- For the major storm event, the depth of water at the flowline shall not exceed 12 inches or the depth up to the point where the water is no *longer* contained within the public road right-of-way, whichever is less.
- There are three street sections, which are described below. Section numbers (shown in parenthesis) correspond to the summary table which follows.
  - 42' R.O.W.-R.O.W., superelevated, with mountable curb and attached walk on the lower side of the street (1). The other side of the street will vertical curb with no walk.
  - 42' R.O.W.-R.O.W., crowned, with mountable curb and attached walk on the lower side of the street (2). There will be a transition to vertical curb at inlet locations (3). The other side of the street will not have walk, and will have mountable curb in front of lots (4) and vertical curb otherwise (5).
  - 46' R.O.W.-R.O.W., crowned, with vertical curb (6).
- Maximum flow depths at flowline are:

| Maximum Allowable Depth at Flowline |             |             |
|-------------------------------------|-------------|-------------|
| Section                             | Minor Event | Major Event |
| 1                                   | 4.96"       | 5.46"       |
| 2                                   | 5.12"       | 5.46"       |
| 3                                   | 5.12"       | 7.56"       |
| 4                                   | 4.00"       | 4.98"       |
| 5                                   | 5.12"       | 7.08"       |
| 6                                   | 4.64"       | 8.28"       |

- Street and inlet capacities were evaluated with the UDFCD's UD-Inlet\_v4.03 spreadsheet. See Appendix C for hydraulic calculations.

## RIDGEGATE – SECTION 22, FILING NO. 1

### PHASE III DRAINAGE REPORT

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- Hydraulic grade lines were calculated using Bentley Hydraflow Storm Sewers v10.40. Hydraulic Grade Lines for the minor event will be within the pipe. Hydraulic Grade Lines for major event flows will be a minimum of 1' below the proposed surface at the storm system structures.
- EPA SWMM 5.1 was used to model the hydraulics within Cottonwood Creek.
- Bentley FlowMaster V8.1 was used to calculate the swale capacities.
- UD-Culvert\_v3.05 was used to calculate the head vs. capacity for the culverts at DPs 1, 3, and 4.
- Hydraflow Express Extension for Autodesk Autocad Civil 3d was used to calculate the depth of flow during overtopping of the road at DPs 1,3, and 4 during an emergency condition where the culverts are completely plugged. To do this, a circular weir with the radius set to the vertical curve radius of the road was used.

#### IV. EXISTING STORMWATER CONVEYANCE OR STORAGE FACILITIES

##### A. Existing Stormwater Conveyance Facilities

###### Storm sewers

- There are two existing 5' Type R inlets, one on either side of Bluffside Drive, at DP 10.1 and DP 10.2. These inlets outfall to an existing storm system in Cabela Dr. (See Appendix E for excerpts from reports). A comparison of the previous design flows and current design flows are presented below:

| Contributing Runoff to Cabela St. Storm System |              |                        |         |              |                        |
|------------------------------------------------|--------------|------------------------|---------|--------------|------------------------|
| Tract O Drainage Report                        |              |                        | Current |              |                        |
| DP                                             | Basin        | Q <sub>100</sub> (cfs) | DP      | Basin        | Q <sub>100</sub> (cfs) |
| 0                                              | A2           | 2.3                    | 7.2*    | D1*          | 1.4                    |
| 1                                              | A1           | 14.5                   | 7.1     | OS7          | - **                   |
| 2                                              | B            | 1.7                    | 10.1    | F1           | 4.9                    |
| 3                                              | C            | 3.7                    | 10.2    | F2           | 7.2                    |
|                                                | <b>Total</b> | <b>22.2</b>            |         | <b>Total</b> | <b>13.5</b>            |

\* Q<sub>100</sub> presented is the overflow from DP 7.2 to the existing inlet identified at DP 0 in the *Tract O Drainage Report*. See Appendix E, pg. E5 for previous report inlet calculations.

\*\*Because the previous Basins A1, A2, and a portion of Basin C (current Basins OS7, D1, and D2) are now being conveyed directly to the Cottonwood Creek Channel, the total piped flow to the existing system in Cabela Drive is reduced.

###### Cottonwood Creek

- The site currently drains via the unimproved Cottonwood Creek. The site outfalls to an existing 48" RCP at current DP 9. This RCP outfalls to the "Cottonwood Creek Flow Control Structure" as identified in the *Tract O Drainage Report*.
- The SWMM model produced in the *Pond 311 Drainage Report* is the most recent. This model identifies storage unit "P" as the Cottonwood Creek Flow Control Structure. This

point had a maximum inflow of 412.38 cfs in the major event. The current design for Ridgeway – Section 22, Filing No. 1 will restrict runoff reaching DP 9 to 325.17 cfs.

B. Existing Stormwater Storage Facilities

- There are no existing stormwater storage facilities onsite. Ponding to 6093.58' within Cottonwood Creek channel behind the 48" RCP at DP 9 was expected with the *Tract O Drainage Report*. (Note that with this report, proposed ponding at DP 9 = 6092.60').
- There is the existing Full Spectrum Detention facility, Pond 311, east of Ridgeway Parkway. This will provide detention and water quality for the site (See Appendix E for excerpts from Pond 311 Drainage Report).

V. PROPOSED STORMWATER CONVEYANCE OR STORAGE FACILITIES

A. Proposed Stormwater Conveyance Facilities

- The proposed drainage will follow historic flow patterns as closely as possible.
- Storm Sewers
- Offsite basins are routed via existing drainage channels, grass swales, and lined channels to low points, where runoff is conveyed via proposed storm lines underneath the proposed roads to the main Cottonwood Creek Channel.
  - Runoff generated by developed areas will be routed via curb and gutter or rear-yard swales to inlets or FES. The lines will outfall to the main channel utilizing the same storm lines as the delineated offsite basins.
  - The back-of-wall drainage lines will be private and will be privately maintained. These systems will consist of 12"-18" smooth-interior pipes, connected by 12" Nyloplast Drain Basin with 12" Nyloplast standard grate inlet (or approved equivalent).
  - Two separate runoff calculations were used to size the back-of-lot drainage systems.
    - o To size the storm lines in the back-of-lot and back-of-wall systems, runoff calculated by rational method for drainage basins A3, B2, C5, and E was divided by the number of lots in that basin to determine the inflow to each inlet in each of those basins. Those inlet inflows were input to each landscape inlet within the Hydraflow model used to size the storm lines.
    - o To size the inlet grates, a separate and more conservative flow calculation was used. The runoff for an individual lot was determined using the rational method. Lot 30 was used as representative lot and represents the most conservative condition (shortest initial time of concentration, and 1% slope in the swale.) The individual runoff was determined to be 1.0 cfs (Appendix C, pg. C29). 12" Nyloplast dome grates and drain basins will be used, with a required ponding depth of 3". This head will be provided by depressing each landscape inlet 3".

# RIDGEGATE – SECTION 22, FILING NO. 1

## PHASE III DRAINAGE REPORT

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- All proposed storm systems will be public except for:
  - o Back-of-wall and back-of-lot drain lines with associated inlets.
  - o 24" Trapezoidal lined swales (SmartDitch or equivalent).
- Public infrastructure includes storm system within the street, proposed culverts, and outlet works.

### Swales

- 24" Trapezoidal lined swales (SmartDitch or equivalent) are proposed along the back of walls in Basin OS3.1 and OS5. See Appendix C for hydraulic calculations.
- Triangular swales protected with turf reinforcement mats (TRM) are proposed at various locations through the site. A manning's n of 0.025 was used for the day-one installed condition, and n=0.030 was used for the fully vegetated condition. See Appendix A for locations of swales, and Appendix C pgs C83 and C87-C210 for hydraulic calculations.

### Cottonwood Creek

- The unimproved Cottonwood Creek will be utilized to convey the runoff from the Ridgeway – Section 22, Filing No. 1 site to the outfall at DP 9. To achieve pre-development flows within the channel during the major event, runoff in upstream channels will be attenuated by a 36" culvert at DP 1, 30" culvert at DP 3, and an 18" RCP at DP 4.

A SWMM model for the system/network was produced to ensure that the current design is consistent with the model provided with the *Pond 311 Drainage Report* (the most recent for Cottonwood Creek). The results are presented below:

| Pond 311 Report |                      | Current Report |                      |
|-----------------|----------------------|----------------|----------------------|
| Design Point    | Maximum Inflow (cfs) | Design Point   | Maximum Inflow (cfs) |
| J2              | 111.68               | J2             | 110.61               |
| J3              | 232.7                | J3             | 202.83               |
| 15F             | 261.61               | 15F1.2         | 230.90               |
| 15G             | 296.86               | 15G            | 291.59               |
| P               | 412.38               | P              | 325.17               |

- The proposed peak runoff rates during the 100-year event are compared at the design points presented in the table above for current model and that presented in the *Pond 311 Drainage Report*.
- The proposed runoff at all compared nodes is lower than the runoffs expected in the *Pond 311 Drainage Report*. The current design is not anticipated to negatively impact the channel.
- See appendix A for current SWMM exhibit, Appendix C for current SWMM model output, and Appendix E for SWMM Model output from *Tract O Drainage Report*.

B. Proposed Stormwater Storage Facilities

- Detention and water quality for Ridgeway – Section 22, Filing No. 1 are provided for in Pond 311. The current proposed land use is consistent with that anticipated in the *Pond 311 Drainage Report*, therefore no improvements to Pond 311 are proposed with the construction of this filing.
- There are no proposed detention facilities on site. Attenuation is expected at the culverts at DPs 1, 3, 4, and 9. See Appendix C for the SWMM model results, and Appendix A for the drainage exhibits showing the extents of ponding anticipated.

VI. WATER QUALITY ENHANCEMENT BEST MANAGEMENT PRACTICES

A. Non-structural Best Management Practices

- Discussion of non-structural Best Management Practices is included in a separate stormwater management plan.

B. Structural Best Management Practices

- Discussion of structural Best Management Practices is included in a separate stormwater management plan.

VII. FLOODPLAIN MODIFICATIONS

A. Major Drainageway – Undesignated Floodplain

- No part of the project is anticipated to be in an undesignated floodplain.

B. Major Drainageway – Designated Floodplain

- The site is out of the floodplain as designated by FEMA Map Number 08035C0044F (See Appendix A), as well as the floodplain designated in the FHADs.

VIII. POTENTIAL PERMITTING REQUIREMENTS

- A GESC permit will be required before commencement of construction.
- There are wetlands present onsite, but they will not be disturbed with development. No wetlands permit will be required.
- There will be no additional permitting requirements at this time.

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## PHASE III DRAINAGE REPORT

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### IX. SUMMARY

- The proposed drainage plan is in general conformance with Douglas County Storm Drainage Standards and City of Lone Tree Standards.
- A variance is requested to the criteria set in *Douglas County Drainage Manual*, Section 9.8.1, requiring piped flows velocities < 18 fps. Velocities in the 100-year event in the 30" RCP culvert at DP 3 are calculated as 19.91 fps. Changes to the pipe to reduce velocities are not practical at this location; the pipe is sized to restrict flows within downstream Cottonwood Creek to allowable levels per the *Pond 311 Report*, and invert elevations are set to existing channel grades.

Summary of flows for the 100-year event are as follows:

- The runoff to the storm system in Cabela Drive will be reduced by **8.7 cfs** in the major event. The runoff reaching the existing 10' inlet on the south side of Cabela Drive, west of Bluffside Drive will be reduced by **0.9 cfs**.
- The maximum inflow reaching DP 9 at the Cottonwood Creek Flow Control Structure was calculated to be **412.38 cfs** in the *Pond 311 Drainage Report*. By attenuating runoff behind the culverts at DPs 1, 3, and 4 in the major event, the anticipated inflow at DP 9 in the current model is **325.17 cfs**.
- The expected inflows at the compared nodes within the portion of Cottonwood Creek contained within the site are less than those expected with the *Pond 311 Drainage Report*. It is proposed that the main portion of Cottonwood Creek remain unimproved.

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## PHASE III DRAINAGE REPORT

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### X. LIST OF REFERENCES

1. *Douglas County Storm Drainage Design and Technical Criteria*, amended July 8, 2008.
2. *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3*. Urban Drainage and Flood Control District, January 2016
3. *Flood Hazard Area Delineation, Cottonwood Creek*, Muller Engineering Company Inc., August 2011,
4. *Cottonwood Creek (Downstream of Lincoln Avenue) Outfall Systems Plan*, Muller Engineering Company, August 2010.
5. *Master Drainage Plan for Ridgeway – Cottonwood Creek Drainage Basin by Merrick & Company*, dated January 2012.
6. *Phase III Drainage Report for Tract O Access Road (Cottonwood Creek Flow Control Structure) Rampart Range Metropolitan District No. 1*, Merrick & Company, April 2012.
7. *Phase III Drainage Report for Detention Pond 311 Retrofit Rampart Range Metropolitan District No. 1*, Merrick & Company, December 2013.

|  |                |                  |          | *NOTE PERCENT IMPERVIOUS VALUES USED PER LAND TYPE ARE OUTDATED ACCORDING TO MARCH 2024 UPDATE TO MHFD CRITERIA MANUAL VOLUME 1 CHAPTER 6 |       |        |              |            |      |        |               |      |        |          |      |        |      |      |        |       |      |        |                |        |        |  |           |  |  |
|---------------------------------------------------------------------------------|----------------|------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------|-------|--------|--------------|------------|------|--------|---------------|------|--------|----------|------|--------|------|------|--------|-------|------|--------|----------------|--------|--------|--|-----------|--|--|
| COMPOSITE 'C' FACTORS                                                           |                |                  |          |                                                                                                                                           |       |        |              |            |      |        |               |      |        |          |      |        |      |      |        |       |      |        |                |        |        |  |           |  |  |
| LOCATION:                                                                       |                |                  |          | City of Lonetree                                                                                                                          |       |        |              |            |      |        |               |      |        |          |      |        |      |      |        |       |      |        |                | DATE : |        |  | 1/24/2017 |  |  |
| BASIN<br>DESIGNATION                                                            | UNDEV/L<br>AWN | SINGLE<br>FAMILY | RURAL SF | WALK                                                                                                                                      | PAVED | TOTAL  | SOIL<br>TYPE | UNDEV/LAWN |      |        | SINGLE FAMILY |      |        | RURAL SF |      |        | WALK |      |        | PAVED |      |        | COMP. C FACTOR |        |        |  |           |  |  |
|                                                                                 |                |                  |          |                                                                                                                                           |       |        |              | %I         | 5 YR | 100 YR | %I            | 5 YR | 100 YR | %I       | 5 YR | 100 YR | %I   | 5 YR | 100 YR | %I    | 5 YR | 100 YR | %I             | 5 YR   | 100 YR |  |           |  |  |
| OS1.1                                                                           | 0.98           |                  |          |                                                                                                                                           |       | 0.98   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |
| OS1.2                                                                           | 25.75          |                  | 16.65    |                                                                                                                                           | 1.88  | 44.28  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 12.9           | 0.16   | 0.57   |  |           |  |  |
| Outfall 1                                                                       | 26.73          |                  | 16.65    |                                                                                                                                           | 1.88  | 45.26  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 12.7           | 0.16   | 0.57   |  |           |  |  |
| OS2.1                                                                           | 0.86           |                  |          |                                                                                                                                           |       | 0.86   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |
| OS2.2                                                                           | 12.91          |                  | 2.39     |                                                                                                                                           | 0.17  | 15.47  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 5.9            | 0.10   | 0.53   |  |           |  |  |
| OS2.3                                                                           | 1.33           |                  |          |                                                                                                                                           |       | 1.33   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |
| Outfall 2                                                                       | 15.09          |                  | 2.39     |                                                                                                                                           | 0.17  | 17.65  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 5.4            | 0.10   | 0.53   |  |           |  |  |
| OS3.1                                                                           | 6.21           |                  |          |                                                                                                                                           |       | 6.21   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |
| A1                                                                              | 1.72           | 0.25             |          | 0.11                                                                                                                                      | 0.49  | 2.56   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 28.5           | 0.30   | 0.64   |  |           |  |  |
| A2.1                                                                            | 0.40           | 0.13             |          | 0.05                                                                                                                                      | 0.53  | 1.11   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 57.7           | 0.55   | 0.77   |  |           |  |  |
| A2.2                                                                            | 0.10           | 0.20             |          |                                                                                                                                           | 0.30  | 0.60   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 65.3           | 0.62   | 0.80   |  |           |  |  |
| OS3.2                                                                           | 88.88          |                  | 10.67    |                                                                                                                                           |       | 99.56  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 3.9            | 0.09   | 0.53   |  |           |  |  |
| A3                                                                              |                | 1.30             |          |                                                                                                                                           |       | 1.30   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 45.0           | 0.44   | 0.71   |  |           |  |  |
| Outfall 3                                                                       | 97.31          | 1.87             | 10.67    | 0.15                                                                                                                                      | 1.32  | 111.32 | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 5.7            | 0.10   | 0.53   |  |           |  |  |
| OS4.1                                                                           | 3.16           |                  |          |                                                                                                                                           | 0.32  | 3.48   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 11.0           | 0.15   | 0.56   |  |           |  |  |
| OS4.2                                                                           | 14.22          |                  |          |                                                                                                                                           | 0.31  | 14.53  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 4.1            | 0.09   | 0.53   |  |           |  |  |
| B1                                                                              | 1.34           | 0.81             |          |                                                                                                                                           | 0.77  | 2.92   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 39.7           | 0.40   | 0.69   |  |           |  |  |
| B2                                                                              |                | 2.33             |          |                                                                                                                                           |       | 2.33   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 45.0           | 0.44   | 0.71   |  |           |  |  |
| Outfall 4                                                                       | 18.72          | 3.14             |          |                                                                                                                                           | 1.40  | 23.27  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 13.7           | 0.17   | 0.57   |  |           |  |  |
| OS5                                                                             | 7.51           |                  |          |                                                                                                                                           |       | 7.51   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |
| C1.1                                                                            | 1.77           |                  |          |                                                                                                                                           | 0.30  | 2.07   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 16.0           | 0.19   | 0.58   |  |           |  |  |
| C1.2                                                                            | 0.36           | 0.76             |          |                                                                                                                                           |       | 1.12   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 31.2           | 0.32   | 0.65   |  |           |  |  |
| C2                                                                              | 0.66           | 0.37             |          | 0.05                                                                                                                                      | 0.47  | 1.56   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 45.0           | 0.44   | 0.71   |  |           |  |  |
| C3                                                                              | 1.05           |                  |          |                                                                                                                                           | 0.12  | 1.17   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 11.8           | 0.15   | 0.56   |  |           |  |  |
| C4                                                                              | 0.10           | 0.35             |          | 0.11                                                                                                                                      | 0.42  | 0.98   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 69.3           | 0.66   | 0.82   |  |           |  |  |
| C5                                                                              | 0.33           | 2.36             |          |                                                                                                                                           |       | 2.69   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 39.8           | 0.40   | 0.69   |  |           |  |  |
| Outfall 5                                                                       | 11.79          | 3.84             |          | 0.16                                                                                                                                      | 1.31  | 17.10  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 20.0           | 0.23   | 0.60   |  |           |  |  |
| OS6.1                                                                           | 6.87           |                  |          |                                                                                                                                           |       | 6.87   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |
| OS6.2                                                                           | 9.86           |                  |          |                                                                                                                                           |       | 9.86   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |
| OS6.3                                                                           | 2.11           |                  |          |                                                                                                                                           |       | 2.11   | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |
| Outfall 6                                                                       | 18.84          |                  |          |                                                                                                                                           |       | 18.84  | C            | 2          | 0.07 | 0.52   | 45            | 0.44 | 0.71   | 20       | 0.23 | 0.60   | 90   | 0.84 | 0.91   | 100   | 0.92 | 0.96   | 2.0            | 0.07   | 0.52   |  |           |  |  |



Site-specific conditions may vary from the representative values presented in this chapter. The engineer is responsible for assuring that the selected imperviousness values represent the imperviousness of the catchment or the proposed development. During master planning or in early stages of design, select imperviousness values that are unlikely to be exceeded as final design plans are developed to avoid the need to increase the size of infrastructure during later design stages.

TABLE 6-2. RECOMMENDED IMPERVIOUSNESS BY LAND USE

| LAND USE/DENSITY                                           | IMPERVIOUSNESS |
|------------------------------------------------------------|----------------|
| <b>Residential</b>                                         |                |
| Single-family Housing (SFH) – Rural (0 – 3 du/ac)          | 35%            |
| SFH – Low & Medium-density (3 – 5 du/ac)                   | 55%            |
| SFH – High-density (5 – 20 du/ac)                          | 65%            |
| Manufactured Housing ( $\geq 10$ du/ac)                    | 65%            |
| Multi-family Housing (MFH) – Medium-density (5 – 20 du/ac) | 65%            |
| MFH – High-density MFH ( $>20$ du/ac)                      | 70%            |
| <b>Commercial</b>                                          |                |
| Commercial – Low-density                                   | 65%            |
| Commercial – Medium- to High-density                       | 80%            |
| Commercial – Urban Core                                    | 90%            |
| <b>Industrial/Institutional</b>                            |                |
| Schools                                                    | 55%            |
| Office/institutional                                       | 65%            |
| Industrial Areas                                           | 75%            |
| Solar Fields, Gravel Cover <sup>1,2</sup>                  | 60%            |
| Solar Fields, Grass Cover <sup>1,2</sup>                   | 45%            |
| <b>Parks and Open Space</b>                                |                |
| Open Space, Undisturbed Native Grasses                     | 5%             |
| Community Parks                                            | 25%            |
| Neighborhood Parks                                         | 15%            |
| Golf Courses                                               | 30%            |
| Cemeteries                                                 | 25%            |

Note: Recommended imperviousness values shown in the table are the minimum imperviousness values for a specific land use. It is the engineer's responsibility to select imperviousness values that appropriately reflect the actual density of the proposed development.

<sup>1</sup> Use these values at the master planning scale or when the specific layout of panels is not known. Use values from the surface type (Table 6-3) at the site planning and design stage when panel width, panel spacing, and panel orientation relative to contours are known.

<sup>2</sup> Assumes 1:1 ratio of panels to aisles. See MHFD's technical memorandum regarding *Determination of Solar Panel Field Runoff Coefficients and Imperviousness Values* for additional information on procedures to reflect other impervious areas such as roads and pads that may be part of a solar field and layouts with wider inter-panel spacing.

TABLE 6-3. RECOMMENDED IMPERVIOUSNESS BY SURFACE TYPES

| SURFACE TYPES                                                                                                                                  |                                                                          | IMPERVIOUSNESS |
|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|----------------|
| Roadways and Paved Streets                                                                                                                     |                                                                          | 95%            |
| Concrete Driveways and Walks                                                                                                                   |                                                                          | 95%            |
| Roofs                                                                                                                                          |                                                                          | 95%            |
| Gravel                                                                                                                                         | No Traffic (Pedestrian Use)                                              | 40%            |
|                                                                                                                                                | Low-traffic Areas (Maintenance Paths and Substations)                    | 60%            |
|                                                                                                                                                | High-traffic Areas (Roadways and Parking)                                | 80%            |
| Disturbed Soil (Including Lawns, Managed/Active Turf, Landscaped Areas with Water-Wise Vegetation, and Uncompacted Gravel/Mulch Planting Beds) |                                                                          | 20%            |
| Undisturbed or Decompacted Soil (Native Grasses and Open Space Areas)                                                                          |                                                                          | 5%             |
| Artificial Turfs <sup>1</sup>                                                                                                                  | Landscape Applications (without Subgrade Drainage Layer)                 | 25% – 45%      |
|                                                                                                                                                | Sport Fields (with Underdrain Pipe System)                               | 60% – 80%      |
| Water Surfaces (Lakes/Reservoirs/Irrigation Ponds)                                                                                             |                                                                          | 100%           |
| Solar Fields <sup>2</sup>                                                                                                                      | Grass Cover (Varies with Panel Orientation Relative to Ground Contours)  | 10% – 45%      |
|                                                                                                                                                | Gravel Cover (Varies with Panel Orientation Relative to Ground Contours) | 50% – 75%      |
| Historic Flow Analysis, Greenbelts, Agricultural                                                                                               |                                                                          | 5%             |
| Newly Graded Areas                                                                                                                             |                                                                          | 65%            |
| Stormwater Control Measures <sup>3</sup>                                                                                                       | Retention Ponds & Constructed Wetland Ponds                              | 100%           |
|                                                                                                                                                | Rooftop Systems – Blue Roofs                                             | 95%            |
|                                                                                                                                                | Rooftop Systems – Green Roofs (extensive)                                | 65%            |
|                                                                                                                                                | Rooftop Systems – Green Roofs (intensive)                                | 50%            |
|                                                                                                                                                | Permeable Pavement – CGP/PGP/RGP                                         | 55%            |
|                                                                                                                                                | Permeable Pavement – PICP                                                | 45%            |
|                                                                                                                                                | Extended Detention Basins                                                | 25%            |
|                                                                                                                                                | Receiving Pervious Areas (incl. Grass Buffers & Grass Swales)            | 20%            |
|                                                                                                                                                | Bioretention & Sand Filters                                              | 10%            |

<sup>1</sup> Consult with the manufacturer to get a recommended value.

<sup>2</sup> Assumes 1:1 ratio of panels to aisles. See MHFD's technical memorandum regarding *Determination of Solar Panel Field Runoff Coefficients and Imperviousness Values* for additional information on procedures for determining percent imperviousness based on panel width, panel spacing, and panel orientation relative to ground contours and how to reflect other impervious areas such as roads and pads that may be part of a solar field and layouts with wider inter-panel spacing.

<sup>3</sup> See MHFD's technical memorandum regarding *Evaluation of Percent Imperviousness for Stormwater Control Measures* for background information.

STORM DRAINAGE SYSTEM DESIGN

BOXED GREEN VALUES ARE SUM OF ROUTED FLOWS TO EACH DESIGN POINT THAT CALIBRE USED FOR DESIGN. THESE VALUES ARE THE ONES JR ENGINEERING WILL BE COMPARING ROUTED FLOWS TO.



Calc. by: MAS

Chk'd by: KLH

Date: 1/24/2017

LOCATION: Ridggate Section 22 - Filing 1

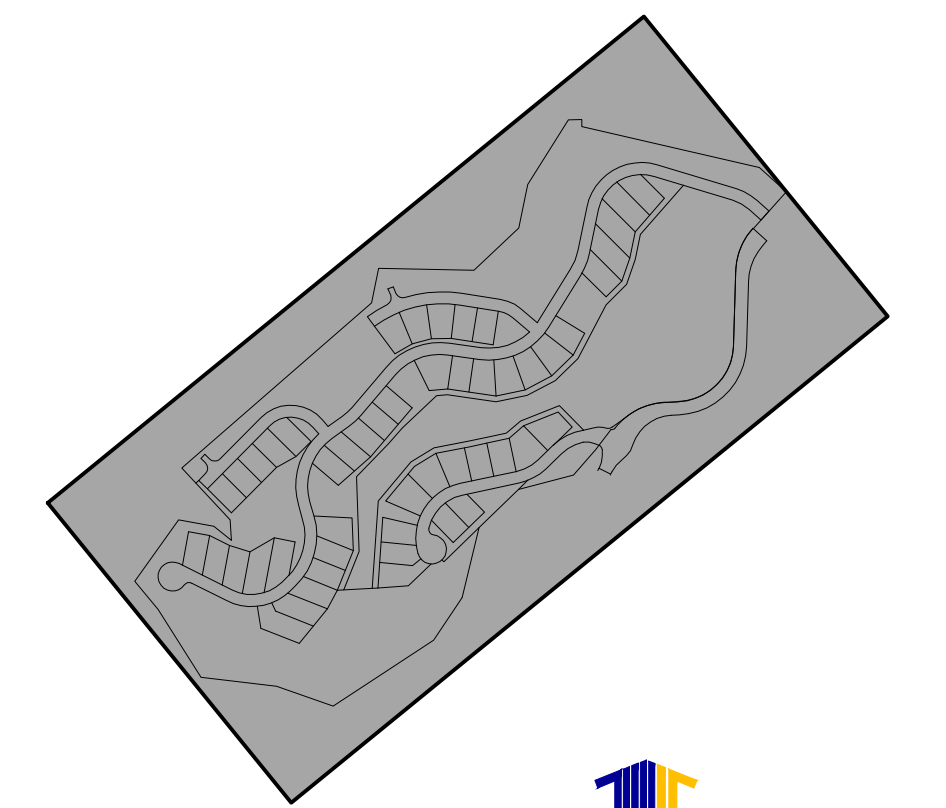
CITY OF: City of Lonetree

|              |           |                             |      |      |      | MINOR STORM EVENT (5YR)       |                      |                               |                                      | MAJOR STORM EVENT (100YR)       |                        |                                 |                                        |                  |                      |              |                                                                                                                                                                                 |
|--------------|-----------|-----------------------------|------|------|------|-------------------------------|----------------------|-------------------------------|--------------------------------------|---------------------------------|------------------------|---------------------------------|----------------------------------------|------------------|----------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Design Point | Basin     | Allowable Street Capacities |      |      |      | Q <sub>5</sub> (Direct) (cfs) | Q <sub>5</sub> (cfs) | Captured Q <sub>5</sub> (cfs) | Q <sub>5</sub> Flow Carry Over (cfs) | Q <sub>100</sub> (Direct) (cfs) | Q <sub>100</sub> (cfs) | Captured Q <sub>100</sub> (cfs) | Q <sub>100</sub> Flow Carry Over (cfs) | Structure Label  | Inlet Type (ft)      | Design Event | Comments                                                                                                                                                                        |
| 1.1          | OS1.1     | -                           | -    | -    | -    |                               | 0.1                  | 0.0                           | 0.1                                  |                                 | 3.0                    | 0.0                             | 3.0                                    |                  | -                    | 100-year     | Culvert attenuates runoff from Basin OS1.1&OS1.2; outfalls to Basin CH @ DP 1                                                                                                   |
|              | OS1.2     | -                           | -    | -    | -    |                               | 13.9                 | 13.9                          | 0.0                                  |                                 | 82.6 <sup>4</sup>      | 82.1 <sup>5</sup>               | -                                      | FES-1            | 36 " FES             | 100-year     |                                                                                                                                                                                 |
| 1            | Outfall 1 |                             |      |      |      |                               | 13.9 <sup>7</sup>    | 13.9 <sup>7</sup>             | -                                    |                                 | 82.6 <sup>4</sup>      | 82.1 <sup>5</sup>               | -                                      |                  |                      |              |                                                                                                                                                                                 |
| 2.1          | OS2.1     | -                           | -    | -    | -    |                               | 0.1                  | 0.0                           | 0.1                                  |                                 | 2.7                    | 0.0                             | 2.7                                    |                  | -                    | 100-year     | Culvert attenuates runoff from Basin OS2.1-OS2.3; outfalls to Basin CH @ DP 2                                                                                                   |
|              | OS2.2     | -                           | -    | -    | -    | 2.4                           | 2.5                  | 2.5                           | 0.0                                  | 28.5                            | 28.5 <sup>4</sup>      | 28.5                            | 0.0                                    | IN-9             | Single Type-D        | 100-year     |                                                                                                                                                                                 |
|              | OS2.3     | -                           | -    | -    | -    |                               | 0.1                  | 0.0                           | 0.1                                  |                                 | 4.0                    | 0.0                             | 4.0                                    |                  | -                    | 100-year     |                                                                                                                                                                                 |
| 2            | Outfall 2 |                             |      |      |      |                               | 2.5 <sup>7</sup>     | 2.5                           | -                                    |                                 | 28.5 <sup>4</sup>      | 28.5 <sup>5</sup>               | -                                      |                  |                      |              |                                                                                                                                                                                 |
| 3.1          | OS3.1     | -                           | -    | -    | -    |                               | 0.3                  | 0.3                           | 0.0                                  |                                 | 17.1                   | 17.1                            | 0.0                                    | FES-15           | 24 " FES             | 100-year     | FES captures runoff conveyed by 24" SmartDitch. Runoff conveyed to Basin CH @ DP 3                                                                                              |
| 3.2          | A1        | 5.5                         | 16.1 | 16.1 | 15.7 |                               | 2.2                  | 2.2                           | 0.0                                  |                                 | 10.2                   | 10.2                            | 0.0                                    | IN-1             | 10 ' Type-R          | 100-year     | Inlet in Sump. Runoff captured and conveyed to Basin OS3.2                                                                                                                      |
| 3.3          | A2.1      | 2.6                         | 11.8 | 16.2 | -    |                               | 2.3                  | 0.0                           | 2.3                                  |                                 | 6.4                    | 0.0                             | 6.4                                    |                  | -                    | 100-year     | Street capacity check. Runoff routed to DP 3.3                                                                                                                                  |
|              | A2.2      | 2.6                         | 5.4  | 12.0 | 13.3 | 1.5                           | 3.8                  | 3.8                           | 0.0                                  | 3.8                             | 10.0                   | 10.0                            | 0.0                                    | IN-2             | 10 ' Type-R          | 100-year     | Inlet in Sump. Runoff captured and conveyed to Basin OS3.2                                                                                                                      |
| 3.4          | OS3.2     | -                           | -    | -    | -    | 6.8                           | 10.0                 | 10.0                          | 0.0                                  | 197.8 <sup>4</sup>              | 197.8 <sup>4</sup>     | 97.7 <sup>5</sup>               | -                                      | FES-12           | 30 " FES             | 100-year     | Culvert attenuates runoff from Basins OS3.1, OS3.2, and A1-A2.2 ; outfalls to Basin CH @ DP 3                                                                                   |
| 3.5          | A3        | -                           | -    | -    | -    |                               | 2.0                  | 2.0                           | 0.0                                  |                                 | 6.6                    | 6.6                             | 0.0                                    | Landscape Inlets | Nyloplast Dome Grate | 100-year     | Back of lot drain system, landscape inlets in series. Capture by each inlet = total basin runoff/total number of landscape inlets in basin. Runoff conveyed to Basin CH at DP 3 |
| 3            | Outfall 3 |                             |      |      |      |                               | 11.0 <sup>7</sup>    | 11.0 <sup>7</sup>             | -                                    |                                 | 197.8 <sup>4</sup>     | 97.7 <sup>5</sup>               | -                                      |                  |                      |              |                                                                                                                                                                                 |
| 4.1          | OS4.1     | -                           | -    | -    | -    |                               | 1.0                  | 0.0                           | 1.0                                  |                                 | 10.5                   | 0.0                             | 10.5                                   |                  | -                    | 100-year     | Culvert attenuates runoff from Basins OS4.1&OS4.2; outfalls to Basin CH @ DP 4                                                                                                  |
|              | OS4.2     | -                           | -    | -    | -    | 1.5                           | 2.4                  | 2.4                           | 0.0                                  | 38.6                            | 47.0 <sup>4</sup>      | 30.6 <sup>5</sup>               | -                                      | FES-17           | 18 " FES             | 100-year     |                                                                                                                                                                                 |
| 4.2          | B1        | 4.5                         | 17.1 | 17.1 | 16.7 |                               | 3.6                  | 3.6                           | 0.0                                  |                                 | 12.8                   | 12.8                            | 0.0                                    | IN-3             | 10 ' Type-R          | 100 year     | Inlet in sump. Events captured and conveyed to Basin CH @ DP 4                                                                                                                  |
| 4.3          | B2        | -                           | -    | -    | -    |                               | 3.0                  | 3.0                           | 0.0                                  |                                 | 9.6                    | 9.6                             | 0.0                                    | Landscape Inlets | Nyloplast Dome Grate | 100-year     | Back of lot drain system, landscape inlets in series. Runoff conveyed to Basin CH at DP 4                                                                                       |
| 4            | Outfall 4 |                             |      |      |      |                               | 7.9 <sup>7</sup>     | 7.9 <sup>7</sup>              | -                                    |                                 | 47.0 <sup>4</sup>      | 30.6 <sup>6</sup>               | -                                      |                  |                      |              |                                                                                                                                                                                 |
| 5.1          | OS5       | -                           | -    | -    | -    |                               | 0.4                  | 0.4                           | 0.0                                  |                                 | 21.3                   | 21.3                            | 0.0                                    | FES-16           | 24 " FES             | 100-year     | FES captures runoff conveyed by 24" SmartDitch. Runoff conveyed to Basin CH @ DP 5                                                                                              |
| 5.2          | C1.1      | 2.7                         | 13.1 | 24.3 | 13.6 |                               | 0.9                  | 0.9                           | 0.0                                  |                                 | 6.6                    | 3.2                             | 3.4                                    | IN-6             | 5 ' Type-R           | 100-year     | Inlet on grade. Minor event captured, major event inlet bypass conveyed to Basin C3.                                                                                            |
| 5.3          | C1.2      | -                           | -    | -    | -    |                               | 1.2                  | 1.2                           | 0.0                                  |                                 | 4.9                    | 4.9                             | 0.0                                    | FES-14           | 18 " FES             | 100-year     | Inlet captures runoff conveyed by grassed swale.                                                                                                                                |
| 5.4          | C2        | 3.9                         | 14.5 | 14.5 | -    |                               | 2.8                  | 0.0                           | 2.8                                  |                                 | 9.1                    | 0.0                             | 9.1                                    |                  | -                    | 100-year     | Street capcity check. Runoff conveyed to Basin C3.                                                                                                                              |
| 5.5          | C3        | 2.1                         | 11.6 | 26.2 | 12.0 | 0.4                           | 2.6                  | 2.6                           | 0.0                                  | 4.1                             | 12.0 <sup>3</sup>      | 12.0                            | 0.0                                    | IN-4             | 10 ' Type-R          | 100-year     | Sump inlet. Events captured and conveyed to Basin CH @ DP 5. In major event, flow depth greater than crown conveyed over Bluffsides Drive to DP 5.6                             |
| 5.6          | C4        | 2.1                         | 12.0 | 15.4 | 12.0 | 2.5                           | 2.5                  | 2.5                           | 0.0                                  | 6.1                             | 8.6 <sup>3</sup>       | 8.6                             | 0.0                                    | IN-5             | 5 ' Type-R           | 100-year     | Sump inlet. Events captured and conveyed to Basin CH @ DP 5. In major event, flow depth greater than crown conveyed over Bluffsides Drive to DP 5.6 from DP 5.5.                |
| 5.7          | C5        | -                           | -    | -    | -    |                               | 3.1                  | 3.1                           | 0.0                                  |                                 | 11.1                   | 11.1                            | 0.0                                    | Landscape Inlets | Nyloplast Dome Grate | 100-year     | Back of lot drain system, landscape inlets in series. Capture by each inlet = total basin runoff/total number of landscape inlets in basin. Runoff conveyed to Basin CH at DP 5 |
| 5            | Outfall 5 |                             |      |      |      |                               | 9.2 <sup>7</sup>     | 9.2 <sup>7</sup>              | -                                    |                                 | 32.8 <sup>4</sup>      | 32.8 <sup>4</sup>               | -                                      |                  |                      |              |                                                                                                                                                                                 |



| DESIGN PT.      | TYPE |            | LENGTH & WIDTH(FT) | DEPTH (FT) |
|-----------------|------|------------|--------------------|------------|
| DP 1            | VL   | L.T. Basin | 20                 | 1          |
| DP 2            | L    | L.T. Basin | 15                 | 1.5        |
| DP 3            | L    | L.T. Basin | 20                 | 1.5        |
| DP 3.4 (outlet) | VL   | L.T. Basin | 15                 | 1          |
| DP 4            | VL   | L.T. Basin | 15                 | 1          |
| DP 5            | VL   | L.T. Basin | 20                 | 1          |
| DP 6            | VL   | L.T. Basin | 15                 | 1          |
| DP 7            | L    | Pad        | 15                 | 1.5        |
| DP 8            | L    | Pad        | 15                 | 1.5        |

| DESIGN PT. | BASIN | AREA    | ROUTED Q <sub>5</sub> | ROUTED Q <sub>100</sub> | DESIGN PT. | BASIN | AREA | ROUTED Q <sub>5</sub> | ROUTED Q <sub>10</sub> |
|------------|-------|---------|-----------------------|-------------------------|------------|-------|------|-----------------------|------------------------|
|            |       | (ACRES) | (CFS)                 | (CFS)                   |            |       |      |                       |                        |
| 1.1        | OS1.1 | 0.98    | 0.1                   | 3.0                     | 5.3        | C1.2  | 1.12 | 1.2                   | 4.9                    |
|            | OS1.2 | 44.3    | 13.9                  | 82.6 *                  | 5.4        | C2    | 1.56 | 2.8                   | 9.1                    |
|            | OS2.1 | 0.86    | 0.1                   | 2.7                     | 5.5        | C3    | 1.17 | 2.6                   | 11.0                   |
| 2.1        | OS2.2 | 15.5    | 2.5                   | 28.5 *                  | 5.6        | C4    | 0.98 | 2.5                   | 6.1                    |
|            | OS2.3 | 1.33    | 0.1                   | 4.0                     | 5.7        | C5    | 2.69 | 3.1                   | 11.1                   |
|            | OS3.1 | 6.21    | 0.3                   | 17.1                    | 6.1        | OS6.1 | 6.87 | 0.3                   | 17.2                   |
| 3.2        | A1    | 2.56    | 2.2                   | 10.2                    |            | OS6.2 | 9.86 | 0.8                   | 30.6 *                 |
| 3.3        | A2.1  | 1.11    | 2.3                   | 6.4                     |            | OS6.3 | 2.11 | 0.1                   | 6.4                    |
| 3.4        | A2.2  | 0.60    | 3.8                   | 10.0                    | 7.1        | OS7   | 4.55 | 0.8                   | 13.7                   |
| 3.5        | OS3.2 | 99.6    | 10.0                  | 197.8 *                 | 7.2        | D1    | 0.61 | 1.7                   | 4.0                    |
| 4.1        | A3    | 1.30    | 2.0                   | 6.6                     | 7.3        | D2    | 0.59 | 1.3                   | 3.5                    |
|            | OS4.1 | 3.48    | 1.0                   | 10.5                    | 8.1        | OS8   | 4.09 | 0.4                   | 11.2                   |
|            | OS4.2 | 14.53   | 2.4                   | 47.0 *                  | 8.2        | E     | 1.21 | 2.1                   | 6.8                    |
| 4.2        | B1    | 2.92    | 3.6                   | 12.8                    | 9          | CH    | 5.29 | 30.4                  | 321.0 *                |
| 4.3        | B2    | 2.33    | 3.0                   | 9.6                     | 10.1       | F1    | 0.84 | 1.6                   | 4.9                    |
| 5.1        | OS5   | 7.51    | 0.4                   | 21.3                    | 10.2       | F2    | 1.00 | 2.2                   | 7.2                    |



## KEYMAP

LEGEND

- 



 UNCC  
CALL BEFORE  
YOU DIG  
811  
OR  
1-800-922-1987  
Utility Notification  
Center of Colorado

City of Lone Tree

Date \_\_\_\_\_

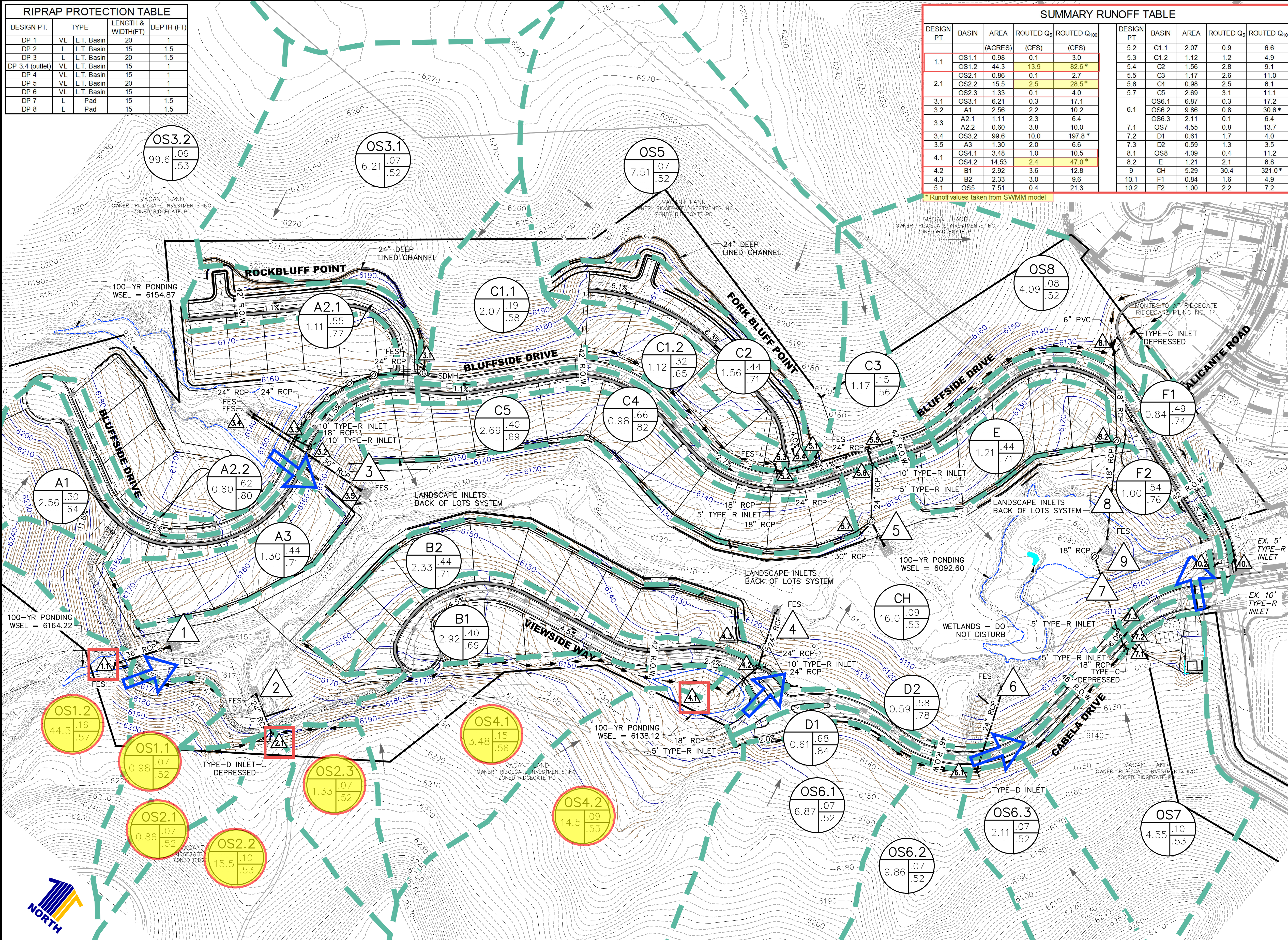
These construction plans have been reviewed by the City of Lone Tree for street and drainage improvements only.

Engineering Division Acceptance Block

Sheet

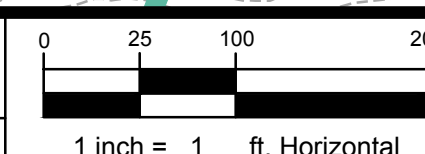
DR2

JANUARY 24, 2017



PATH: P:\CENTURY RG TGG\CADD\EXHIBITS\X-PDR.DWG  
 PLOTTED BY: MEGAN SAWYER PLOT DATE: 1/24/2017 7:57 AM

|              |           |
|--------------|-----------|
| Drawing Name | X-PDR.dwg |
| Job Number   |           |

Prepared For  
CENTURY

|          |         |         |
|----------|---------|---------|
| Designer | Drafter | Checker |
| KI H     | MAS     | TA.I    |

**Calibre**  
Calibre Engineering, Inc.  
9090 South Ridgeline Boulevard, Suite 105  
Highlands Ranch, CO 80129 (303) 730-0100  
[www.calibre-engineering.com](http://www.calibre-engineering.com)  
Construction Management Civil Engineering

# RIDGEGATE - SECTION 22, FILING 1

## PHASE III DRAINAGE REPORT

### PROPOSED DRAINAGE PLAN

Sheet

DR2

JANUARY 24, 2017

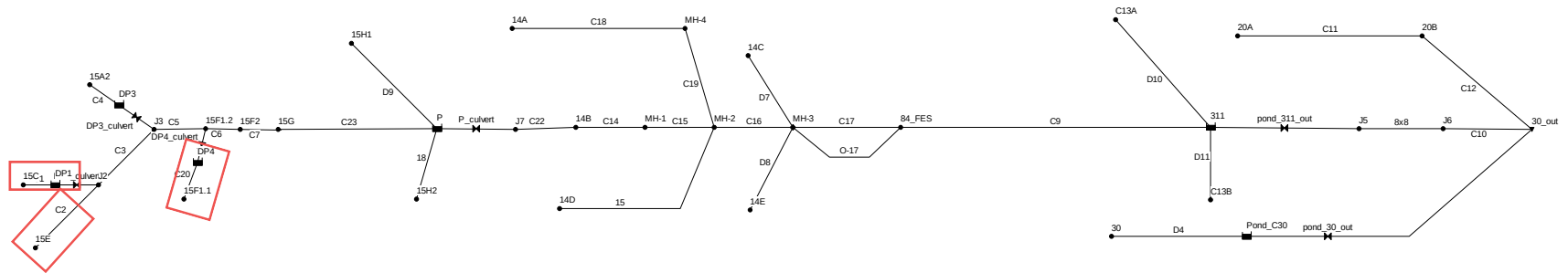






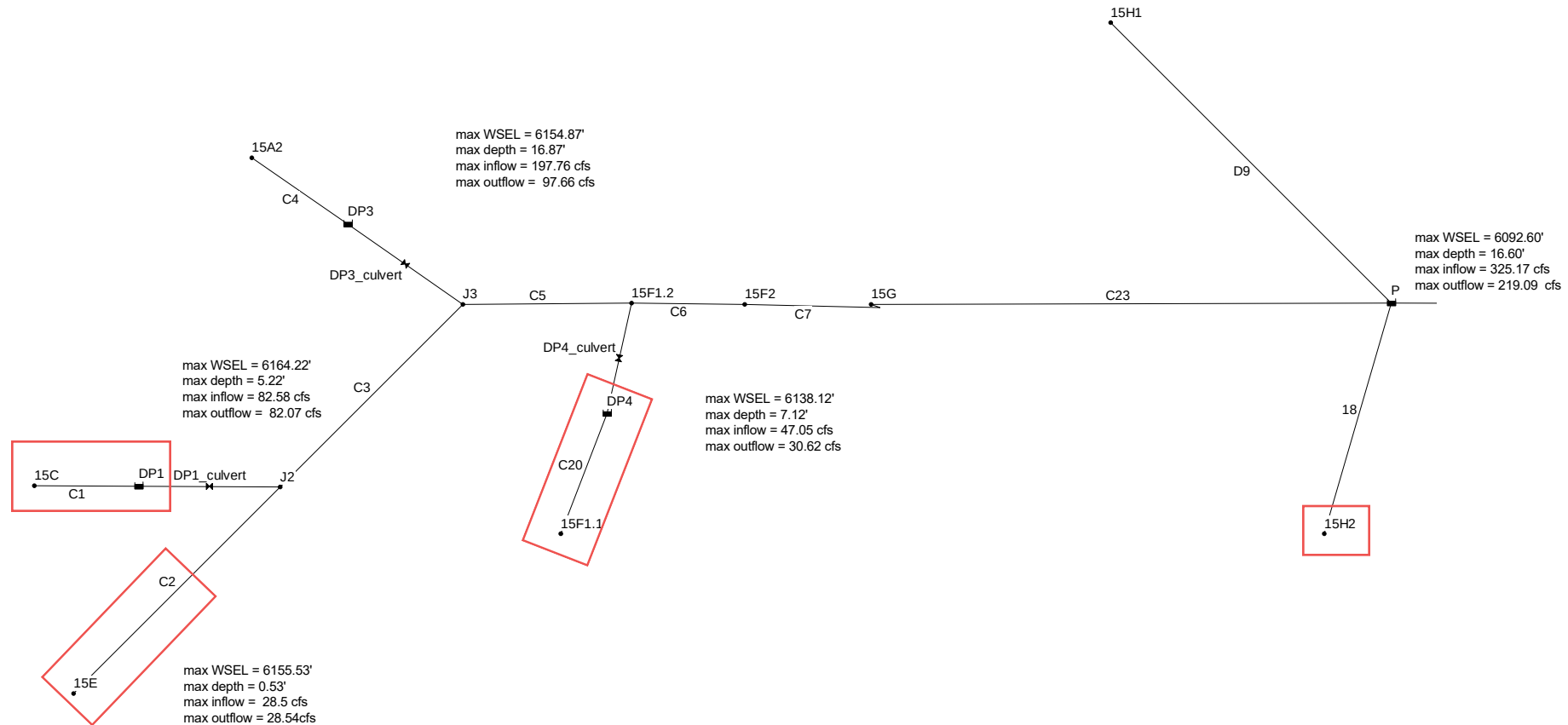
# COTTONWOOD CREEK MASTER: 100-YEAR DEVELOPED

01/01/2006 01:00:00



# COTTONWOOD CREEK MASTER: 100-YEAR DEVELOPED

01/01/2006 01:00:00



\*\*\*\*\*

Node Inflow Summary

\*\*\*\*\*

| Node     | Type     | Maximum<br>Lateral<br>Inflow<br>CFS | Maximum<br>Total<br>Inflow<br>CFS | Time of Max<br>Occurrence<br>days hr:min |       | Lateral<br>Inflow<br>Volume<br>10^6 gal | Total<br>Inflow<br>Volume<br>10^6 gal | Flow<br>Balance<br>Error<br>Percent |
|----------|----------|-------------------------------------|-----------------------------------|------------------------------------------|-------|-----------------------------------------|---------------------------------------|-------------------------------------|
| 14A      | JUNCTION | 115.40                              | 115.40                            | 0                                        | 00:40 | 1.8                                     | 1.8                                   | 0.000                               |
| 14B      | JUNCTION | 18.73                               | 221.69                            | 0                                        | 01:30 | 0.343                                   | 11.9                                  | 0.000                               |
| 14C      | JUNCTION | 0.00                                | 0.00                              | 0                                        | 00:00 | 0                                       | 0                                     | 0.000 gal                           |
| 14D      | JUNCTION | 160.17                              | 160.17                            | 0                                        | 00:45 | 3.34                                    | 3.34                                  | 0.000                               |
| 14E      | JUNCTION | 36.68                               | 36.68                             | 0                                        | 00:45 | 0.773                                   | 0.773                                 | 0.000                               |
| 15C      | JUNCTION | 82.58                               | 82.58                             | 0                                        | 00:45 | 2.07                                    | 2.07                                  | 0.000                               |
| 15E      | JUNCTION | 28.49                               | 28.49                             | 0                                        | 00:50 | 0.77                                    | 0.77                                  | 0.000                               |
| 15F1.2   | JUNCTION | 0.00                                | 230.90                            | 0                                        | 00:55 | 0                                       | 8.77                                  | 0.000                               |
| 15G      | JUNCTION | 30.64                               | 291.59                            | 0                                        | 00:55 | 0.802                                   | 10.4                                  | 0.000                               |
| 15H1     | JUNCTION | 11.20                               | 11.20                             | 0                                        | 00:45 | 0.241                                   | 0.241                                 | 0.000                               |
| 20A      | JUNCTION | 25.52                               | 25.52                             | 0                                        | 00:40 | 0.447                                   | 0.447                                 | 0.000                               |
| 20B      | JUNCTION | 31.36                               | 55.90                             | 0                                        | 00:45 | 0.788                                   | 1.23                                  | 0.000                               |
| 30       | JUNCTION | 458.44                              | 458.44                            | 0                                        | 00:40 | 6.34                                    | 6.34                                  | 0.000                               |
| 84_FES   | JUNCTION | 0.00                                | 440.90                            | 0                                        | 00:50 | 0                                       | 17.7                                  | 0.000                               |
| C13A     | JUNCTION | 167.39                              | 167.39                            | 0                                        | 00:45 | 2.86                                    | 2.86                                  | 0.000                               |
| C13B     | JUNCTION | 20.18                               | 20.18                             | 0                                        | 00:50 | 0.542                                   | 0.542                                 | 0.000                               |
| J2       | JUNCTION | 0.00                                | 110.61                            | 0                                        | 00:50 | 0                                       | 2.82                                  | 0.000                               |
| J3       | JUNCTION | 0.00                                | 202.83                            | 0                                        | 00:50 | 0                                       | 7.7                                   | 0.000                               |
| J5       | JUNCTION | 0.00                                | 391.36                            | 0                                        | 01:20 | 0                                       | 21.1                                  | 0.000                               |
| J6       | JUNCTION | 0.00                                | 391.73                            | 0                                        | 01:20 | 0                                       | 21.1                                  | 0.000                               |
| J7       | JUNCTION | 0.00                                | 219.09                            | 0                                        | 01:35 | 0                                       | 11.6                                  | 0.000                               |
| MH-1     | JUNCTION | 0.00                                | 221.70                            | 0                                        | 01:30 | 0                                       | 11.9                                  | 0.000                               |
| MH-2     | JUNCTION | 0.00                                | 406.11                            | 0                                        | 00:50 | 0                                       | 16.9                                  | 0.000                               |
| MH-4     | JUNCTION | 0.00                                | 80.51                             | 0                                        | 00:40 | 0                                       | 1.64                                  | -0.000                              |
| 15H2     | JUNCTION | 13.53                               | 13.53                             | 0                                        | 00:40 | 0.272                                   | 0.272                                 | 0.000                               |
| 15F2     | JUNCTION | 32.81                               | 261.96                            | 0                                        | 00:55 | 0.822                                   | 9.6                                   | 0.000                               |
| 15A2     | JUNCTION | 197.76                              | 197.76                            | 0                                        | 00:50 | 4.87                                    | 4.87                                  | 0.000                               |
| 15F1.1   | JUNCTION | 47.05                               | 47.05                             | 0                                        | 00:45 | 1.07                                    | 1.07                                  | 0.000                               |
| 30_out   | OUTFALL  | 0.00                                | 474.24                            | 0                                        | 01:15 | 0                                       | 28.6                                  | 0.000                               |
| MH-3     | DIVIDER  | 0.00                                | 440.74                            | 0                                        | 00:50 | 0                                       | 17.7                                  | 0.000                               |
| 311      | STORAGE  | 0.00                                | 595.03                            | 0                                        | 00:50 | 0                                       | 21.1                                  | 0.068                               |
| P        | STORAGE  | 13.69                               | 325.17                            | 0                                        | 00:55 | 0.695                                   | 11.6                                  | -0.005                              |
| Pond_C30 | STORAGE  | 0.00                                | 458.44                            | 0                                        | 00:40 | 0                                       | 6.34                                  | 0.092                               |
| DP3      | STORAGE  | 0.00                                | 197.76                            | 0                                        | 00:50 | 0                                       | 4.87                                  | -0.177                              |
| DP1      | STORAGE  | 0.00                                | 82.58                             | 0                                        | 00:45 | 0                                       | 2.07                                  | 1.065                               |
| DP4      | STORAGE  | 0.00                                | 47.05                             | 0                                        | 00:45 | 0                                       | 1.07                                  | -0.300                              |





# EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING

Project: COTTONWOOD CREEK MASTER DRAINAGE PLAN

Basin ID: POND 311 - EURV

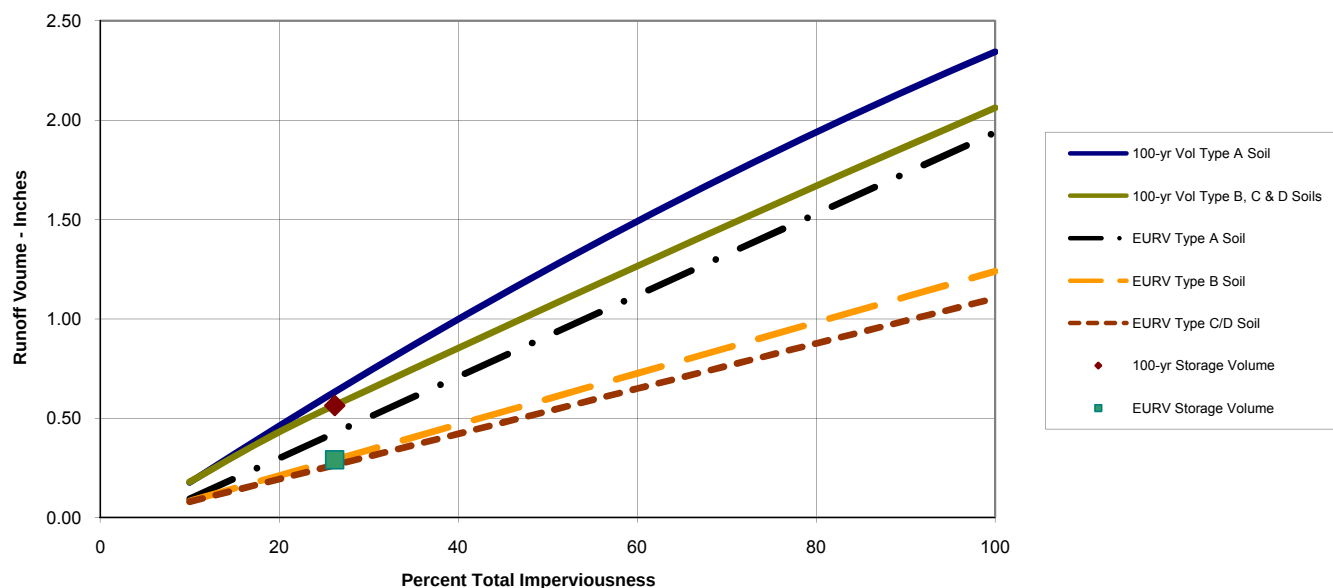
\* User input data  
shown in blue.

|                                                                   |                    |                                    |
|-------------------------------------------------------------------|--------------------|------------------------------------|
| Area of Watershed (acres)                                         | 420.90             |                                    |
| Subwatershed Imperviousness                                       | 26.2%              |                                    |
| Level of Minimizing Directly Connected<br>Impervious Area (MDCIA) | 0                  | <div><div>0</div><div></div></div> |
| Effective Imperviousness <sup>1</sup>                             | 26.2%              |                                    |
| Hydrologic Soil Type                                              | Percentage of Area | Area (acres)                       |
| Type A                                                            |                    | 0.0                                |
| Type B                                                            |                    | 0.0                                |
| Type C or D                                                       | 100.0%             | 420.9                              |

Note: Pond 311 will provide EURV only, 100-year detention is not necessary since the 100-year developed peak flow rate at I-25 is less than the 100-year historical release rate at I-25. Pond 311 will require some additional storage volume beyond the EURV volume to increase the discharge through the outlet structure. The additional volume will be a function of the outlet structure properties.

| Recommended Horton's Equation Parameters for CUHP |               |                                                     |
|---------------------------------------------------|---------------|-----------------------------------------------------|
| Infiltration (inches per hour)                    |               | Decay<br>Coefficient-- $\alpha$                     |
| Initial-- $f_i$                                   | Final-- $f_o$ |                                                     |
| 3                                                 | 0.5           | 0.0018                                              |
| Detention Volumes <sup>2,5</sup>                  |               | Maximum Allowable<br>Release Rate, cfs <sup>3</sup> |
| (watershed inches)                                | (acre-feet)   |                                                     |
| 0.29                                              | 10.20         | Design Outlet to Empty<br>EURV in 72 Hours          |
| 0.56                                              | 19.75         | 420.90                                              |

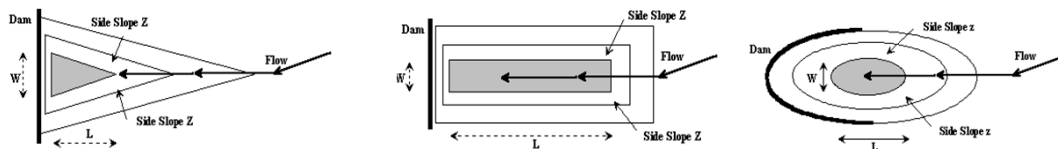
Excess Urban Runoff Volume<sup>4</sup>  
100-year Detention Volume Including WQCV<sup>5</sup>



## Notes:

- 1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
- 2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
- 3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
- 4) EURV approximates the difference between developed and pre-developed runoff volume.
- 5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

**Project: PHASE III DRAINAGE REPORT FOR POND 311 RETROFIT**  
**Basin ID: POND 311 - STAGE-STORAGE**



Width of Pond Bottom, W =  ft

Length of Pond Bottom, L =  ft

Dam Side-slope (H:V),  $Z_d$  =  ft/ft

|                   |   |                                        |
|-------------------|---|----------------------------------------|
| Right Triangle    |   | OR...                                  |
| Isoceles Triangle |   | OR...                                  |
| Rectangle         |   | OR...                                  |
| Circle / Ellipse  |   | OR...                                  |
| Irregular         | X | (Use Override values in cells G32:G52) |

Storage Requirement from Sheet 'Modified FAA':  
Storage Requirement from Sheet 'Hydrograph':  
~~Storage Requirement from Sheet 'Full Spectrum':~~

| MINOR | MAJOR |          |
|-------|-------|----------|
|       |       | acre-ft. |
|       |       | acre-ft. |
| 10.20 | 10.75 | acre-ft. |

~~Storage Requirement from Sheet 'Full Spectrum':~~

EURV of 10.20 ac-ft achieved at elevation 6005.90 (by interpolation).

PROJECT: PHASE III DRAINAGE REPORT FOR POND 311 RETROFIT  
PROJECT NO. 03016838

POND 311 WQ PLATE CALCULATOR

NOTE:      Shaded cells represent user input data. Other cells calculated from orifice equation.

Diameter of holes, D =1.625 in.

Number of holes per row, N =1

Vertical distance between rows, h =4 in.

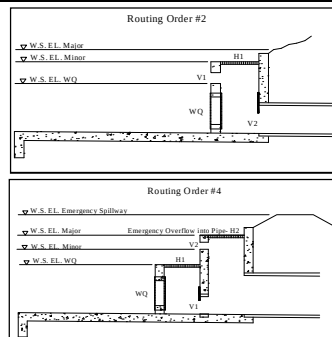
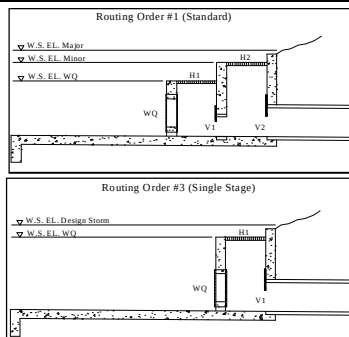
Orifice discharge coefficient0.6

Total open area at each row, A<sub>o</sub> =0.014 ft<sup>2</sup>

| Stage (ft) | Central Elevations of Rows of Holes in feet     |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         | Total Flow (cfs) |
|------------|-------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|------------------|
|            | Row 1                                           | Row 2   | Row 3   | Row 4   | Row 5   | Row 6   | Row 7   | Row 8   | Row 9   | Row 10  | Row 11  | Row 12  | Row 13  | Row 14  | Row 15  | Row 16  | Row 17  | Row 18  | Row 19  | Row 20  | Row 21  | Row 22  |                  |
|            | 5997.20                                         | 5997.53 | 5997.87 | 5998.20 | 5998.53 | 5998.87 | 5999.20 | 5999.53 | 5999.87 | 6000.20 | 6000.53 | 6000.87 | 6001.20 | 6001.53 | 6001.87 | 6002.20 | 6002.53 | 6002.87 | 6003.20 | 6003.53 | 6003.87 | 6004.20 |                  |
|            | Collection Capacity for Each Row of Holes (cfs) |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |                  |
| 5997.20    | 0.00                                            | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00             |
| 5998.00    | 0.06                                            | 0.05    | 0.03    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.13             |
| 5999.00    | 0.09                                            | 0.08    | 0.07    | 0.06    | 0.05    | 0.03    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.39             |
| 6000.00    | 0.12                                            | 0.11    | 0.10    | 0.09    | 0.08    | 0.07    | 0.06    | 0.05    | 0.03    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.71             |
| 6001.00    | 0.14                                            | 0.13    | 0.12    | 0.12    | 0.11    | 0.10    | 0.09    | 0.08    | 0.07    | 0.06    | 0.05    | 0.03    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 1.10             |
| 6002.00    | 0.15                                            | 0.15    | 0.14    | 0.14    | 0.13    | 0.12    | 0.12    | 0.11    | 0.10    | 0.09    | 0.08    | 0.07    | 0.06    | 0.05    | 0.03    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 1.54             |
| 6003.00    | 0.17                                            | 0.16    | 0.16    | 0.15    | 0.15    | 0.14    | 0.14    | 0.13    | 0.12    | 0.12    | 0.11    | 0.10    | 0.09    | 0.08    | 0.07    | 0.06    | 0.05    | 0.03    | 0.00    | 0.00    | 0.00    | 0.00    | 2.02             |
| 6004.00    | 0.18                                            | 0.18    | 0.17    | 0.17    | 0.16    | 0.16    | 0.15    | 0.15    | 0.14    | 0.14    | 0.13    | 0.12    | 0.12    | 0.11    | 0.10    | 0.09    | 0.08    | 0.07    | 0.06    | 0.05    | 0.03    | 0.00    | 2.55             |
| 6005.00    | 0.19                                            | 0.19    | 0.19    | 0.18    | 0.18    | 0.17    | 0.17    | 0.16    | 0.16    | 0.15    | 0.15    | 0.14    | 0.14    | 0.13    | 0.12    | 0.12    | 0.11    | 0.10    | 0.09    | 0.08    | 0.07    | 0.06    | 3.05             |
| 6006.00    | 0.21                                            | 0.20    | 0.20    | 0.19    | 0.19    | 0.19    | 0.18    | 0.18    | 0.17    | 0.17    | 0.16    | 0.16    | 0.15    | 0.15    | 0.14    | 0.14    | 0.13    | 0.12    | 0.12    | 0.11    | 0.10    | 0.09    | 3.43             |
| 6007.00    | 0.22                                            | 0.21    | 0.21    | 0.21    | 0.20    | 0.20    | 0.19    | 0.19    | 0.19    | 0.18    | 0.18    | 0.17    | 0.17    | 0.16    | 0.16    | 0.15    | 0.15    | 0.14    | 0.14    | 0.13    | 0.12    | 0.12    | 3.77             |
| 6008.00    | 0.23                                            | 0.22    | 0.22    | 0.22    | 0.21    | 0.21    | 0.21    | 0.20    | 0.20    | 0.19    | 0.19    | 0.19    | 0.18    | 0.18    | 0.17    | 0.17    | 0.16    | 0.16    | 0.15    | 0.15    | 0.14    | 0.14    | 4.08             |
| 6009.00    | 0.24                                            | 0.23    | 0.23    | 0.23    | 0.22    | 0.22    | 0.22    | 0.21    | 0.21    | 0.21    | 0.20    | 0.20    | 0.19    | 0.19    | 0.19    | 0.18    | 0.18    | 0.17    | 0.17    | 0.16    | 0.16    | 0.15    | 4.36             |
| 6010.00    | 0.25                                            | 0.24    | 0.24    | 0.24    | 0.23    | 0.23    | 0.23    | 0.22    | 0.22    | 0.22    | 0.21    | 0.21    | 0.21    | 0.20    | 0.20    | 0.19    | 0.19    | 0.19    | 0.18    | 0.18    | 0.17    | 0.17    | 4.62             |

### STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: COTTONWOOD CREEK MASTER DRAINAGE PLAN  
Basin ID: POND 311 REDESIGN



**Current Routing Order is #3**

### Design Information (Input):

|                                                    |                                         |
|----------------------------------------------------|-----------------------------------------|
| Circular Opening:                                  | Diameter in Inches                      |
| <b>OR</b>                                          |                                         |
| Rectangular Opening:                               | Width in Feet                           |
|                                                    | Length (Height for Vertical)            |
| Percentage of Open Area After Trash Rack Reduction |                                         |
|                                                    | Orifice Coefficient                     |
|                                                    | Weir Coefficient                        |
|                                                    | Orifice Elevation (Bottom for Vertical) |

|                  | #1 Horiz. | #2 Horiz. | #1 Vert. | #2 Vert. |        |
|------------------|-----------|-----------|----------|----------|--------|
| Dia. =           |           |           | 28.00    |          | inches |
| W =              | 6.75      |           |          |          | ft.    |
| L or H =         | 12.00     |           |          |          | ft.    |
| % open =         | 67        |           | 100      |          | %      |
| C <sub>o</sub> = | 0.60      |           | 0.60     |          |        |
| C <sub>w</sub> = | 3.33      |           |          |          |        |
| E <sub>o</sub> = | 6005.90   |           | 5,994.46 |          | ft.    |

**Calculation of Collection Capacity:**

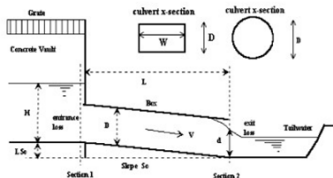
Net Opening Area (after Trash Rack Reduction)  
 OPTIONAL: User-Override Net Opening Area  
 Perimeter as Weir Length  
 OPTIONAL: User-Override Weir Length

$A_o = 54.27$  sq. ft.  
 $A_o =$  sq. ft.  
 $L_w = 33.05$  ft.  
 $L_w =$  ft.  
 Top Elevation of Vertical Orifice Opening, Top = 5996.79 ft.  
 Center Elevation of Vertical Orifice Opening, Cen = 5995.63 ft.

**Routing 3: Single Stage - Water flows through WQCV plate and #1 horizontal opening into #1 vertical opening. This flow will be applied to culvert sheet (#2 vertical & horizontal openings is not used).**

[illegible]

Project: **COTTONWOOD CREEK MASTER DRAINAGE PLAN**  
Basin ID: **POND 311 REDESIGN**



Circular Culvert: Barrel Diameter (in Inches)  
Circular Culvert: Inlet Edge Type (choose from pull-down list)  
**OR:**  
Box Culvert: Barrel Height (Rise) in Feet  
Box Culvert: Barrel Width (Span) in Feet  
Box Culvert: Inlet Edge Type (choose from pull-down list)

Square End with Headwall

OR:

Height (Rise) =  ft

Width (Span) =  ft

1.5 : 1 Bevel w/ 90 Deg. Headwall

Number of Barrels  
Inlet Elevation at Culvert Invert  
Outlet Elevation at Culvert Invert  
Culvert Length in Feet  
Manning's Roughness  
Bend Loss Coefficient  
Exit Loss Coefficient

|            |         |           |
|------------|---------|-----------|
| No =       | 1       |           |
| $I_{elev}$ | 5994.46 | ft. elev. |
| $O_{elev}$ | 5994.05 | ft. elev. |
| L =        | 111.8   | ft.       |
| n =        | 0.0130  |           |
| $K_b$      | 0.00    |           |
| $K_c$      | 1.00    |           |

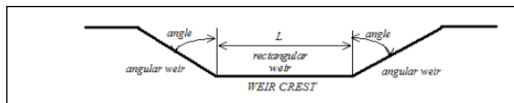
Entrance Loss Coefficient  
Friction Loss Coefficient  
Sum of All Loss Coefficients  
Orifice Inlet Condition Coefficient  
Minimum Energy Condition Coefficient

|             |         |
|-------------|---------|
| $K_e =$     | 0.50    |
| $K_f =$     | 0.32    |
| $K_s =$     | 1.82    |
| $C_d =$     | 0.85    |
| $E_{low} =$ | -0.0031 |

[illegible][illegible]



**Project:** COTTONWOOD CREEK MASTER DRAINAGE PLAN  
**Basin ID:** POND 311 - BYPASS CHANNEL



Bottom Length of Weir  
Angle of Side Slope Weir  
Elev. for Weir Crest  
Coef. for Rectangular Weir  
Coef. for Trapezoidal Weir

|                  |         |         |
|------------------|---------|---------|
| L =              | 10.00   | feet    |
| Angle =          | 0.00    | degrees |
| EL. Crest =      | 6006.00 | feet    |
| C <sub>w</sub> = | 3.33    |         |
| C <sub>t</sub> = | 3.33    |         |

[illegible]

**PROJECT: COTTONWOOD CREEK MASTER DRAINAGE PLAN**  
**PROJECT NO. 03016838**

**Pond 311 Final Stage-Discharge**

| Water Surface Elevation (ft) | Total WQCV Flow (cfs) | #1 Horiz. Weir Flow (cfs) | #1 Horiz. Orifice Flow (cfs) | #1 Vert. Collection Capacity (cfs) | Outlet Structure Collection Capacity (cfs) | Culvert Inlet-Control Flowrate (cfs) | Culvert Outlet-Control Flowrate (cfs) | Total Discharge from Outlet Structure (cfs) | Discharge from Bypass Channel (cfs) | Total Discharge from Pond 311 (cfs) |
|------------------------------|-----------------------|---------------------------|------------------------------|------------------------------------|--------------------------------------------|--------------------------------------|---------------------------------------|---------------------------------------------|-------------------------------------|-------------------------------------|
| 5997.20                      | 0.00                  | 0.00                      | 0.00                         | 25.83                              | 0.00                                       | 55.70                                | 1.00                                  | 0.00                                        | 0.00                                | <b>0.00</b>                         |
| 5998.00                      | 0.13                  | 0.00                      | 0.00                         | 31.72                              | 0.13                                       | 86.21                                | 38.60                                 | 0.13                                        | 0.00                                | <b>0.13</b>                         |
| 5999.00                      | 0.39                  | 0.00                      | 0.00                         | 37.82                              | 0.39                                       | 128.91                               | 100.90                                | 0.39                                        | 0.00                                | <b>0.39</b>                         |
| 6000.00                      | 0.71                  | 0.00                      | 0.00                         | 43.06                              | 0.71                                       | 177.11                               | 151.60                                | 0.71                                        | 0.00                                | <b>0.71</b>                         |
| 6001.00                      | 1.10                  | 0.00                      | 0.00                         | 47.73                              | 1.10                                       | 224.01                               | 189.60                                | 1.10                                        | 0.00                                | <b>1.10</b>                         |
| 6002.00                      | 1.54                  | 0.00                      | 0.00                         | 51.98                              | 1.54                                       | 265.91                               | 227.30                                | 1.54                                        | 0.00                                | <b>1.54</b>                         |
| 6003.00                      | 2.02                  | 0.00                      | 0.00                         | 55.91                              | 2.02                                       | 302.51                               | 259.80                                | 2.02                                        | 0.00                                | <b>2.02</b>                         |
| 6004.00                      | 2.55                  | 0.00                      | 0.00                         | 59.58                              | 2.55                                       | 334.91                               | 289.00                                | 2.55                                        | 0.00                                | <b>2.55</b>                         |
| 6005.00                      | 3.05                  | 0.00                      | 0.00                         | 63.04                              | 3.05                                       | 364.11                               | 315.70                                | 3.05                                        | 0.00                                | <b>3.05</b>                         |
| 6006.00                      | 3.43                  | 3.48                      | 82.63                        | 66.31                              | 6.91                                       | 390.81                               | 340.50                                | 6.91                                        | 0.00                                | <b>6.91</b>                         |
| 6007.00                      | 3.77                  | 126.95                    | 274.06                       | 69.44                              | 69.44                                      | 415.71                               | 366.40                                | 69.44                                       | 33.30                               | <b>102.74</b>                       |
| 6008.00                      | 4.08                  | 334.87                    | 378.67                       | 72.42                              | 72.42                                      | 439.01                               | 388.30                                | 72.42                                       | 94.19                               | <b>166.61</b>                       |
| 6009.00                      | 4.36                  | 600.61                    | 460.08                       | 75.29                              | 75.29                                      | 461.11                               | 411.10                                | 75.29                                       | 173.03                              | <b>248.32</b>                       |
| 6010.00                      | 4.62                  | 913.54                    | 529.11                       | 78.06                              | 78.06                                      | 482.21                               | 431.00                                | 78.06                                       | 266.40                              | <b>344.46</b>                       |

NOTE: THIS SPREADSHEET USED TO COMBINE FLOWS FROM POND 311 - WQ PLATE FLOW CALCULATOR AS WELL AS FLOW RATES FROM UD-DETENTION\_2.2 SPREADSHEET FOR POND 311. THE TOTAL DISCHARGE COLUMN REPRESENTS THE ULTIMATE STAGE-DISCHARGE FROM POND 311.

**PROJECT: PHASE III DRAINAGE REPORT FOR POND 311 RETROFIT**  
**PROJECT NO. 03016838**

**POND 311 - DEPTH AND VOLUME OUTPUTS FROM SWMM**

NOTE: The numbers below are from the SWMM Model, "COTTONWOOD CREEK 100-YR DEVELOPED" and represent the relationship between pond depth and volume per hour for retro-fitted Pond 311

| Hours | Depth (ft) | Volume (ft <sup>3</sup> ) |
|-------|------------|---------------------------|
| 1     | 12.0       | 869,106                   |
| 2     | 12.2       | 898,087                   |
| 3     | 10.5       | 663,056                   |
| 4     | 8.9        | 462,388                   |
| 5     | 8.7        | 437,813                   |
| 6     | 8.5        | 416,677                   |
| 7     | 8.3        | 397,749                   |
| 8     | 8.2        | 380,949                   |
| 9     | 8.0        | 366,097                   |
| 10    | 7.9        | 352,990                   |
| 11    | 7.8        | 341,437                   |
| 12    | 7.7        | 330,567                   |
| 13    | 7.6        | 319,876                   |
| 14    | 7.5        | 309,363                   |
| 15    | 7.4        | 299,026                   |
| 16    | 7.3        | 288,865                   |
| 17    | 7.2        | 278,877                   |
| 18    | 7.1        | 269,060                   |
| 19    | 7.0        | 259,414                   |
| 20    | 6.9        | 249,935                   |
| 21    | 6.8        | 240,624                   |
| 22    | 6.7        | 231,479                   |
| 23    | 6.6        | 222,509                   |
| 24    | 6.6        | 213,711                   |
| 25    | 6.5        | 205,087                   |
| 26    | 6.4        | 196,635                   |
| 27    | 6.3        | 188,356                   |
| 28    | 6.2        | 180,248                   |
| 29    | 6.1        | 172,310                   |
| 30    | 6.0        | 164,544                   |
| 31    | 5.9        | 156,947                   |
| 32    | 5.8        | 149,520                   |

| Hours | Depth (ft) | Volume (ft <sup>3</sup> ) |
|-------|------------|---------------------------|
| 33    | 5.8        | 142,258                   |
| 34    | 5.7        | 135,151                   |
| 35    | 5.6        | 128,198                   |
| 36    | 5.5        | 121,398                   |
| 37    | 5.4        | 114,753                   |
| 38    | 5.3        | 108,263                   |
| 39    | 5.2        | 101,930                   |
| 40    | 5.1        | 95,753                    |
| 41    | 5.0        | 89,733                    |
| 42    | 4.9        | 83,872                    |
| 43    | 4.8        | 78,171                    |
| 44    | 4.8        | 72,628                    |
| 45    | 4.7        | 67,236                    |
| 46    | 4.6        | 61,997                    |
| 47    | 4.5        | 56,918                    |
| 48    | 4.4        | 52,003                    |
| 49    | 4.2        | 47,259                    |
| 50    | 4.1        | 42,697                    |
| 51    | 4.0        | 38,326                    |
| 52    | 3.9        | 34,162                    |
| 53    | 3.7        | 30,220                    |
| 54    | 3.6        | 26,493                    |
| 55    | 3.4        | 22,979                    |
| 56    | 3.3        | 19,680                    |
| 57    | 3.1        | 16,599                    |
| 58    | 2.9        | 13,737                    |
| 59    | 2.8        | 11,095                    |
| 60    | 2.6        | 8,656                     |
| 61    | 2.4        | 6,418                     |
| 62    | 2.2        | 4,402                     |
| 63    | 2.0        | 2,656                     |
| 64    | 1.5        | 1,318                     |

| Hours | Depth (ft) | Volume (ft <sup>3</sup> ) |
|-------|------------|---------------------------|
| 65    | 0.8        | 515                       |
| 66    | 0.3        | 192                       |
| 67    | 0.1        | 70                        |
| 68    | 0.0        | 25                        |
| 69    | 0.0        | 9                         |
| 70    | 0.0        | 3                         |
| 71    | 0.0        | 1                         |
| 72    | 0.0        | 0                         |
| 73    | 0.0        | 0                         |
| 74    | 0.0        | 0                         |
| 75    | 0.0        | 0                         |
| 76    | 0.0        | 0                         |

# EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING

Project: COTTONWOOD CREEK MASTER DRAINAGE PLAN

Basin ID: POND C30

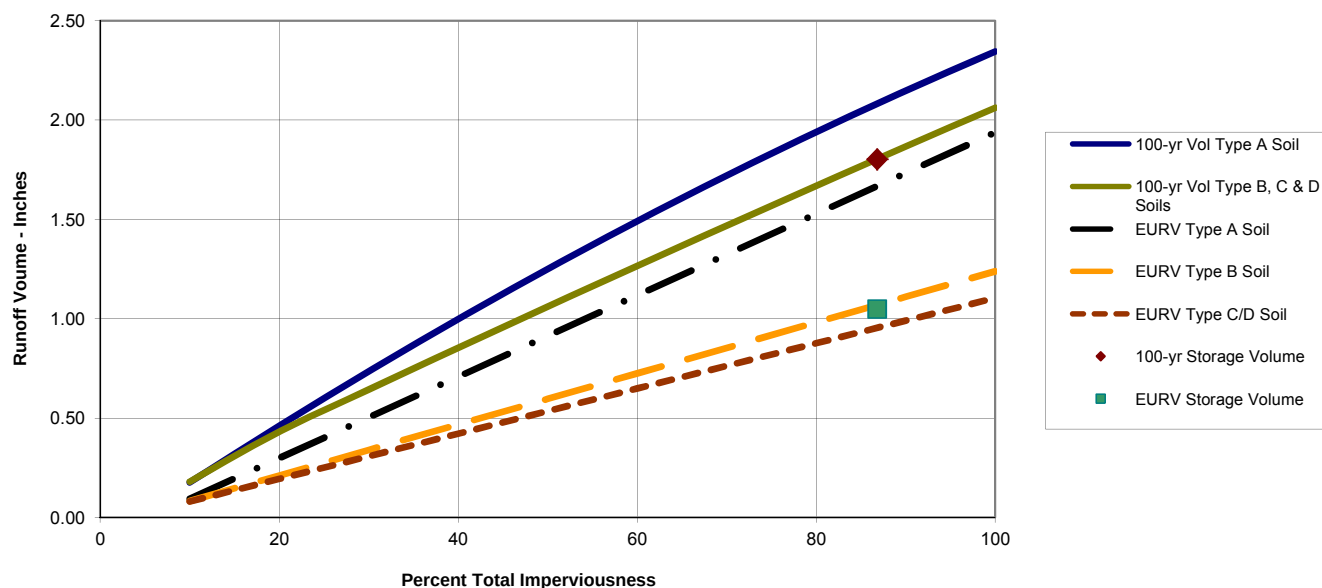
\* User input data  
shown in blue.

|                                                                   |                    |                                    |
|-------------------------------------------------------------------|--------------------|------------------------------------|
| Area of Watershed (acres)                                         | 91.40              |                                    |
| Subwatershed Imperviousness                                       | 86.8%              |                                    |
| Level of Minimizing Directly Connected<br>Impervious Area (MDCIA) | 0                  | <div><div>0</div><div></div></div> |
| Effective Imperviousness <sup>1</sup>                             | 86.8%              |                                    |
| Hydrologic Soil Type                                              | Percentage of Area | Area (acres)                       |
| Type A                                                            |                    | 0.0                                |
| Type B                                                            |                    | 0.0                                |
| Type C or D                                                       | 100.0%             | 91.4                               |

Note: Pond C30 will provide off-channel EURV only, 100-year detention is not necessary since the 100-year developed peak flow rate at Lincoln Avenue west channel is less than the 100-year historical release rate at the Lincoln Avenue west channel. Pond C30 will require some additional storage volume beyond the EURV volume to create the necessary head to increase the discharge through the outlet structure or provide the necessary bypass flow. The additional volume will be a function of the outlet structure properties.

Excess Urban Runoff Volume<sup>4</sup>-100-year Detention Volume Including WQCV<sup>5</sup>

| Recommended Horton's Equation Parameters for CUHP |               |                                                     |
|---------------------------------------------------|---------------|-----------------------------------------------------|
| Infiltration (inches per hour)                    |               | Decay<br>Coefficient-- $\alpha$                     |
| Initial-- $f_i$                                   | Final-- $f_o$ |                                                     |
| 3                                                 | 0.5           | 0.0018                                              |
| Detention Volumes <sup>2,5</sup>                  |               | Maximum Allowable<br>Release Rate, cfs <sup>3</sup> |
| (watershed inches)                                | (acre-feet)   |                                                     |
| 1.05                                              | 7.99          | Design Outlet to Empty<br>EURV in 72 Hours          |
| 1.80                                              | 13.74         | 91.40                                               |



## Notes:

- 1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
- 2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
- 3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
- 4) EURV approximates the difference between developed and pre-developed runoff volume.
- 5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

# EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING

Project: COTTONWOOD CREEK MASTER DRAINAGE PLAN

Basin ID: POND C40

\* User input data  
shown in blue.

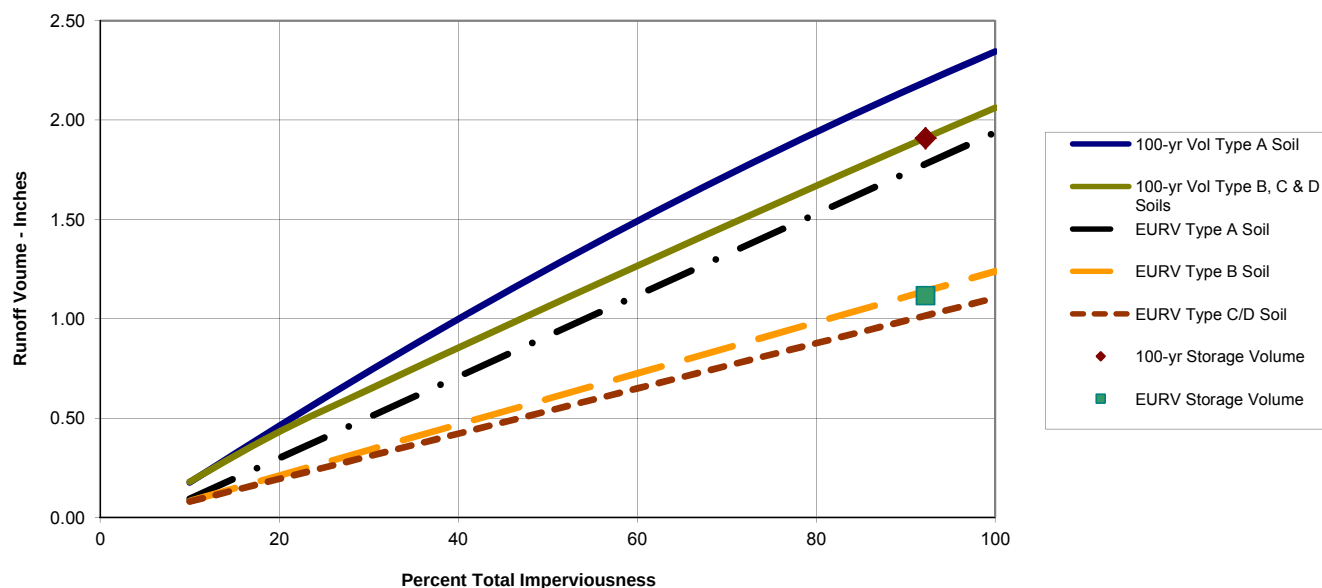
|                                                                |                    |              |
|----------------------------------------------------------------|--------------------|--------------|
| Area of Watershed (acres)                                      | 154.9              |              |
| Subwatershed Imperviousness                                    | 92.2%              |              |
| Level of Minimizing Directly Connected Impervious Area (MDCIA) | 0                  | 0 ▼          |
| Effective Imperviousness <sup>1</sup>                          | 92.2%              |              |
| Hydrologic Soil Type                                           | Percentage of Area | Area (acres) |
| Type A                                                         |                    | 0.0          |
| Type B                                                         |                    | 0.0          |
| Type C or D                                                    | 100.0%             | 154.9        |

Note: 100-year detention volume determined from  
SWMM Model

100-YR + WQCV (pg. D-10) = TOTAL POND VOLUME

20.41 + 5.43 = 25.84 AC-FT

| Recommended Horton's Equation Parameters for CUHP |               |                                                  |
|---------------------------------------------------|---------------|--------------------------------------------------|
| Infiltration (inches per hour)                    |               | Decay Coefficient-- $\alpha$                     |
| Initial-- $f_i$                                   | Final-- $f_o$ |                                                  |
| 3                                                 | 0.5           | 0.0018                                           |
| Detention Volumes <sup>2,5</sup>                  |               | Maximum Allowable Release Rate, cfs <sup>3</sup> |
| (watershed inches)                                | (acre-feet)   |                                                  |
| 1.12                                              | 14.42         | Design Outlet to Empty EURV in 72 Hours          |
| 1.91                                              | 24.65         | 154.90                                           |

Excess Urban Runoff Volume<sup>4</sup>100-year Detention Volume Including WQCV<sup>5</sup>

## Notes:

- 1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
- 2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
- 3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
- 4) EURV approximates the difference between developed and pre-developed runoff volume.
- 5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV





# **EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING**

Project: COTTONWOOD CREEK MASTER DRAINAGE PLAN

Basin ID: POND C50

\* User input data  
shown in blue.

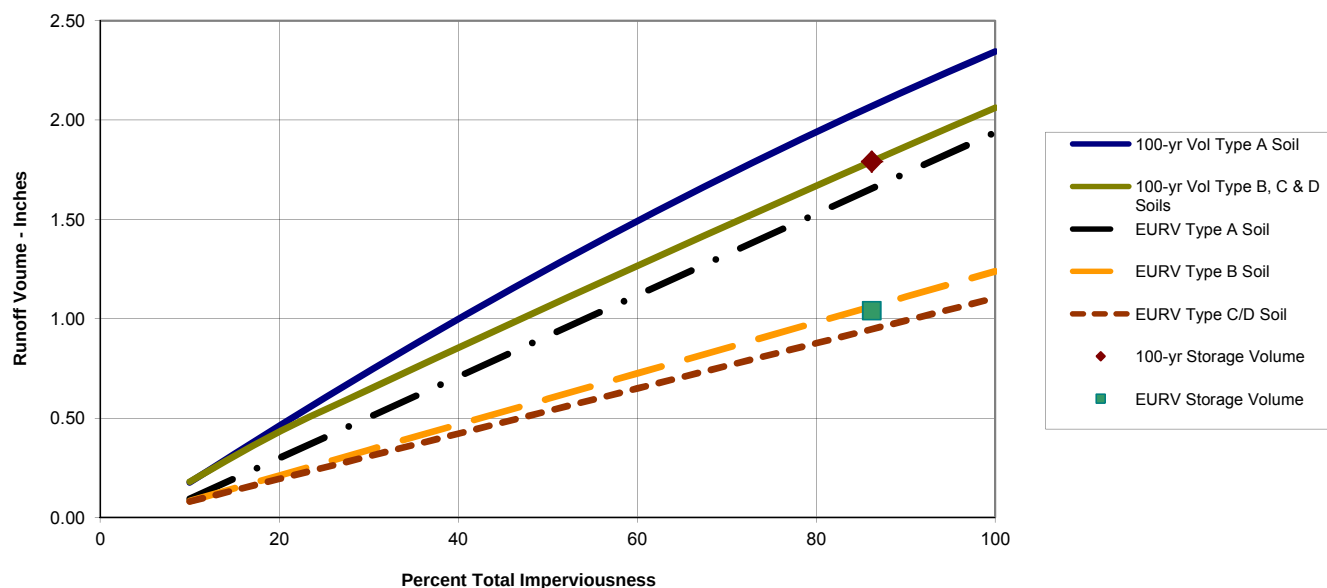
|                                                                |                    |                                    |
|----------------------------------------------------------------|--------------------|------------------------------------|
| Area of Watershed (acres)                                      | 54.1               |                                    |
| Subwatershed Imperviousness                                    | 86.2%              |                                    |
| Level of Minimizing Directly Connected Impervious Area (MDCIA) | 0                  | <div><div>0</div><div></div></div> |
| Effective Imperviousness <sup>1</sup>                          | 86.2%              |                                    |
| Hydrologic Soil Type                                           | Percentage of Area | Area (acres)                       |
| Type A                                                         |                    | 0.0                                |
| Type B                                                         |                    | 0.0                                |
| Type C or D                                                    | 100.0%             | 54.1                               |

Note: 100-year detention volume determined from  
SWMM Model

100-YR + WQCV (pg. D-12) = TOTAL POND VOLUME

7.04 + 1.67 = 8.71 AC-FT

| Recommended Horton's Equation Parameters for CUHP |               |                                                  |
|---------------------------------------------------|---------------|--------------------------------------------------|
| Infiltration (inches per hour)                    |               | Decay Coefficient-- $\alpha$                     |
| Initial-- $f_i$                                   | Final-- $f_o$ |                                                  |
| 3                                                 | 0.5           | 0.0018                                           |
| Detention Volumes <sup>2,5</sup>                  |               | Maximum Allowable Release Rate, cfs <sup>3</sup> |
| (watershed inches)                                | (acre-feet)   |                                                  |
| 1.04                                              | 4.70          | Design Outlet to Empty EURV in 72 Hours          |
| 1.79                                              | 8.08          | 54.10                                            |

Excess Urban Runoff Volume<sup>4</sup>100-year Detention Volume Including WQCV<sup>5</sup>

## **Notes:**

- 1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).
- 2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.
- 3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.
- 4) EURV approximates the difference between developed and pre-developed runoff volume.
- 5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

### STAGE-DISCHARGE SIZING OF THE WATER QUALITY CAPTURE VOLUME (WQCV) OUTLET

Project: COTTONWOOD CREEK MASTER DRAINAGE PLAN  
Basin ID: POND C50

**WQCV Design Volume (Input):**

|                                                      |      |
|------------------------------------------------------|------|
| Design volume input:                                 |      |
| Catchment Imperviousness, $I_p$ =                    | 86.2 |
| Catchment Area, $A$ =                                | 54.1 |
| Depth at WQCV outlet above lowest perforation, $H$ = |      |
| Vertical distance between rows, $h$ =                |      |
| Number of rows, $N_L$ =                              |      |
| Orifice discharge coefficient, $C_d$ =               |      |

Diameter of holes, D =  in.

Number of holes per row, N =

OR

Time to Drain the Pond =  hours

| OR                  |     |
|---------------------|-----|
| Height of slot, H = | in. |
| Width of slot, W =  | in. |

**Outlet Design Information (Output):**

Water Quality Capture Volume ( $1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I)$ ), WQCV = 0.371 watershed inches

|                                       |                |
|---------------------------------------|----------------|
| Water Quality Capture Volume (WQCV) = | 1.67 acre-feet |
|---------------------------------------|----------------|

Design Volume (WQCV / 12 \* Area \* 1.2) Vol = 2.01 acre-feet

Recommended maximum outlet area per row (based on 4" vertical spacing of rows),  $A_o =$  N/A square inches

Total opening area at each row based on user-input above,  $A_o =$

Total opening area at each row based on user-input above, A0 = 0.00 square inches

**Calculation of Collection Capacity:**

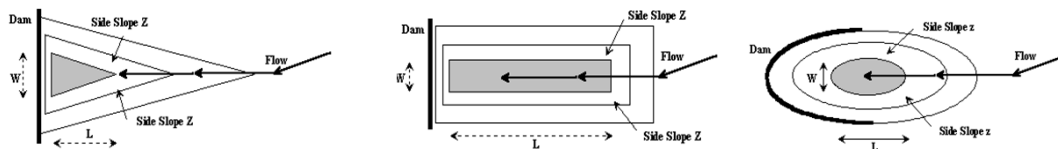
[illegible]

## **APPENDIX E – COTTONWOOD CREEK FLOW CONTROL STRUCTURE (CCFCS) CALCULATIONS**

A 48" culvert was initially analyzed in the SWMM model to determine the release rate at the CCFCS. The 48" culvert discharge created a higher discharge than the allowable peak inflow at the RidgeGate Parkway storm sewer system main pipe. A restrictor plate was analyzed on the upstream end of the CCFCS. The restrictor plate reduced the discharge from the CCFCS to 236.5 cfs and created a peak inflow at the RidgeGate Parkway storm sewer system main pipe to 240.8 cfs. Therefore, the CCFCS will consist of a 48" culvert with a restrictor plate on the upstream end of the culvert.

## Project: 03016838

Basin ID: COTTONWOOD CREEK FLOW CONTROL STRUCTURE STAGE-STORAGE



### Check Pond Shape

Width of Pond Bottom, W =  ft

Length of Pond Bottom, L =  ft

Dam Side-slope (H:V),  $Z_d$  =  ft/ft

|                   |   |                                        |
|-------------------|---|----------------------------------------|
| Right Triangle    |   | OR...                                  |
| Isoceles Triangle |   | OR...                                  |
| Rectangle         |   | OR...                                  |
| Circle / Ellipse  |   | OR...                                  |
| Irregular         | X | (Use Override values in cells G32:G52) |

Storage Requirement from Sheet 'Modified FAA':  
Storage Requirement from Sheet 'Hydrograph':  
Storage Requirement from Sheet 'Full-Spectrum':

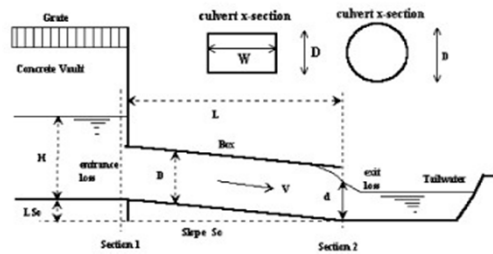
| MINOR | MAJOR |          |
|-------|-------|----------|
|       |       | acre-ft. |
|       |       | acre-ft. |
|       |       | acre-ft. |

Tract P Embankment Developed-UD Detention 2.2, Pond

## CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: 03016838

Basin ID: COTTONWOOD CREEK FLOW CONTROL STRUCTURE

**Design Information (Input):**

Circular Culvert: Barrel Diameter in Inches

Inlet Edge Type (choose from pull-down list)

D = 48.00 inches

Square End with Headwall

OR:

Box Culvert: Barrel Height (Rise) in Feet

Barrel Width (Span) in Feet

Inlet Edge Type (choose from pull-down list)

Height (Rise) = ft.

Width (Span) = ft.

1 : 1 Bevel w/ Headwall

Number of Barrels

Inlet Elevation at Culvert Invert

Outlet Elevation at Culvert Invert OR Slope of Culvert (ft v./ft h.)

Culvert Length in Feet

Manning's Roughness

Bend Loss Coefficient

Exit Loss Coefficient

No = 1

Inlet Elev = 6071.57 ft. elev.

Outlet Elev = 6065.21 ft. elev.

L = 268.12 ft.

n = 0.0150

K<sub>b</sub> = 0.00K<sub>x</sub> = 1.00**Design Information (calculated):**

Entrance Loss Coefficient

Friction Loss Coefficient

Sum of All Loss Coefficients

Orifice Inlet Condition Coefficient

Minimum Energy Condition Coefficient

K<sub>e</sub> = 0.50K<sub>f</sub> = 1.75K<sub>s</sub> = 3.25C<sub>d</sub> = 0.86KE<sub>low</sub> = -0.6400**Calculations of Culvert Capacity (output):**

| Water Surface Elevation<br>(ft., linked) | Tailwater Surface Elevation<br>ft<br>(input if known) | Culvert Inlet-Control Flowrate<br>cfs<br>(output) | Culvert Outlet-Control Flowrate<br>cfs<br>(output) | Controlling Culvert Flowrate<br>cfs<br>(output) | Inlet Equation Used:<br>(output) |
|------------------------------------------|-------------------------------------------------------|---------------------------------------------------|----------------------------------------------------|-------------------------------------------------|----------------------------------|
| 6071.57                                  |                                                       | 0.00                                              | 0.00                                               | 0.00                                            | No flow (WS < inlet)             |
| 6072.00                                  | 6065.30                                               | 1.50                                              | 88.69                                              | 1.50                                            | min. energy equation             |
| 6073.00                                  | 6065.61                                               | 18.16                                             | 100.29                                             | 18.16                                           | min. energy equation             |
| 6074.00                                  | 6065.80                                               | 33.59                                             | 110.75                                             | 33.59                                           | regression equation              |
| 6075.00                                  | 6066.05                                               | 58.30                                             | 121.08                                             | 58.30                                           | regression equation              |
| 6076.00                                  | 6066.28                                               | 83.91                                             | 129.94                                             | 83.91                                           | regression equation              |
| 6077.00                                  | 6066.46                                               | 105.47                                            | 138.29                                             | 105.47                                          | regression equation              |
| 6078.00                                  | 6066.60                                               | 123.30                                            | 146.69                                             | 123.30                                          | regression equation              |
| 6079.00                                  | 6066.72                                               | 138.62                                            | 154.20                                             | 138.62                                          | regression equation              |
| 6080.00                                  | 6066.82                                               | 152.25                                            | 161.78                                             | 152.25                                          | regression equation              |
| 6081.00                                  | 6066.91                                               | 164.66                                            | 168.68                                             | 164.66                                          | regression equation              |
| 6082.00                                  | 6066.99                                               | 176.19                                            | 175.63                                             | 175.63                                          | regression equation              |
| 6083.00                                  | 6067.04                                               | 187.02                                            | 182.32                                             | 182.32                                          | regression equation              |
| 6084.00                                  | 6067.08                                               | 197.06                                            | 188.53                                             | 188.53                                          | orifice equation                 |
| 6085.00                                  | 6067.13                                               | 206.29                                            | 194.77                                             | 194.77                                          | orifice equation                 |
| 6086.00                                  | 6067.17                                               | 215.12                                            | 200.82                                             | 200.82                                          | orifice equation                 |
| 6087.00                                  | 6067.21                                               | 223.61                                            | 206.69                                             | 206.69                                          | orifice equation                 |
| 6088.00                                  | 6067.25                                               | 231.78                                            | 212.41                                             | 212.41                                          | orifice equation                 |
| 6089.00                                  | 6067.29                                               | 239.68                                            | 217.81                                             | 217.81                                          | orifice equation                 |
| 6090.00                                  | 6067.32                                               | 247.32                                            | 223.24                                             | 223.24                                          | orifice equation                 |
| 6091.00                                  | 6067.36                                               | 254.74                                            | 228.53                                             | 228.53                                          | orifice equation                 |
| 6092.00                                  | 6067.39                                               | 261.94                                            | 233.71                                             | 233.71                                          | orifice equation                 |
| 6093.00                                  | 6067.43                                               | 268.96                                            | 238.78                                             | 238.78                                          | orifice equation                 |
|                                          |                                                       |                                                   |                                                    | 0.00                                            |                                  |
|                                          |                                                       |                                                   |                                                    | 0.00                                            |                                  |
|                                          |                                                       |                                                   |                                                    | 0.00                                            |                                  |
|                                          |                                                       |                                                   |                                                    | 0.00                                            |                                  |
|                                          |                                                       |                                                   |                                                    | 0.00                                            |                                  |
|                                          |                                                       |                                                   |                                                    | 0.00                                            |                                  |
|                                          |                                                       |                                                   |                                                    | 0.00                                            |                                  |

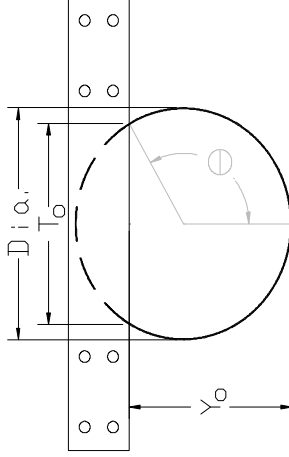
Processing Time: 11.2 seconds

## RESTRICTOR PLATE SIZING FOR CIRCULAR VERTICAL ORIFICES

Project: 03016838

Basin ID: COTTONWOOD CREEK FLOW CONTROL STRUCTURE

Note: The Q value and the water surface elevation at design depth on this page is based on a static water surface elevation and was an estimate of the discharge required at the CCFCS to obtain the maximum allowable flow at the main storm sewer pipe at the RidgeGate Parkway storm sewer system. Data from this sheet appears on Sheet E-5 to create a stage-discharge through the restrictor plate. The restrictor plate stage-discharge curve was then combined with the culvert stage-discharge to create the final stage-discharge from the CCFCS.



### Sizing the Restrictor Plate for Circular Vertical Orifices or Pipes (Input)

|                                                    |                     |
|----------------------------------------------------|---------------------|
| Water Surface Elevation at Design Depth            |                     |
| Pipe/Vertical Orifice Entrance Invert Elevation    |                     |
| Required Peak Flow through Orifice at Design Depth |                     |
| Pipe/Vertical Orifice Diameter (inches)            |                     |
| Orifice Coefficient                                |                     |
| Elev: WS =                                         | #1 Vertical Orifice |
| Elev: Invert =                                     |                     |
| Q =                                                |                     |
| Dia =                                              |                     |
| C <sub>o</sub> =                                   |                     |

### Full-flow Capacity (Calculated)

|                               |                          |       |       |
|-------------------------------|--------------------------|-------|-------|
| Full-flow area                | Af =                     | 12.57 | sq ft |
| Half Central Angle in Radians | Theta =                  | 3.14  | rad   |
| Full-flow capacity            | Qf =                     | 264.0 | cfs   |
|                               | Percent of Design Flow = | 112%  |       |

### Calculation of Orifice Flow Condition

|                                                         |                          |          |        |
|---------------------------------------------------------|--------------------------|----------|--------|
| Half Central Angle (0<Theta<3.1416)                     | Theta =                  | 2.28     | rad    |
| Flow area                                               | A <sub>o</sub> =         | 11.09    | sq ft  |
| Top width of Orifice (inches)                           | T <sub>o</sub> =         | 36.49    | inches |
| Height from Invert of Orifice to Bottom of Plate (feet) | Y <sub>o</sub> =         | 3.30     | feet   |
| Elevation of Bottom of Plate                            | Elev Plate Bottom Edge = | 6,074.87 | feet   |
| Resultant Peak Flow Through Orifice at Design Depth     | Q <sub>o</sub> =         | 235.0    | cfs    |

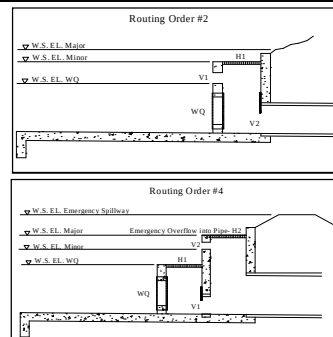
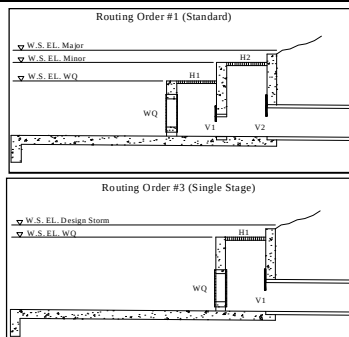
Width of Equivalent Rectangular Vertical Orifice  
Centroid Elevation of Equivalent Rectangular Vertical Orifice

|                       |          |      |
|-----------------------|----------|------|
| Equivalent Width =    | 3.36     | feet |
| Equiv. Centroid El. = | 6,073.22 | feet |

### STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: 18015087 RRMD

Basin ID: TRACT P EMBANKMENT CULVERT



**Current Routing Order is #5**

### Design Information (Input):

Circular Opening:

Diameter in Inches

|        | #1 Horiz. | #2 Horiz. | #1 Vert. | #2 Vert. |        |
|--------|-----------|-----------|----------|----------|--------|
| Dia. = |           |           |          |          | inches |

OR

Rectangular Opening:

Width in Feet

W = 

|  |  |      |  |
|--|--|------|--|
|  |  | 3.36 |  |
|--|--|------|--|

 ft.

|          |  |      |     |
|----------|--|------|-----|
| L or H = |  | 3.30 | ft. |
|----------|--|------|-----|

Percentage of Open Area After Trash Rack Reduction

|          |  |  |     |   |
|----------|--|--|-----|---|
| % open = |  |  | 100 | % |
|----------|--|--|-----|---|

Orifice Coefficient

|         |  |  |      |  |
|---------|--|--|------|--|
| open    |  |  | 100  |  |
| $C_0 =$ |  |  | 0.60 |  |

Weir Coefficient

|         |  |  |  |  |
|---------|--|--|--|--|
| $C_w =$ |  |  |  |  |
|---------|--|--|--|--|

Orifice Elevation (Bottom for Vertical)

|         |  |          |     |
|---------|--|----------|-----|
| $E_p =$ |  | 6,071.57 | ft. |
|---------|--|----------|-----|

**Calculation of Collection Capacity:**

Net Opening Area (after Trash Rack Reduction)

OPTIONAL: User-Override Net Opening Area

### Perimeter as Weir Length

OPTIONAL: User-Override Weir Length

$A_n =$  11.09 sq. ft.

$A_0 =$ 

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

 sq. ft.

$$L_w = \text{ft.}$$
$$L_w = \boxed{\phantom{000}} \boxed{\phantom{000}} \text{ ft}$$

Top Elevation of Vertical Orifice Opening, Top = 6074.87 ft

Center Elevation of Vertical Orifice Opening, Cen = 6073.22 ft.

Routing 5: Water flows separately through WQCV plate, #1 horizontal opening, #2 horizontal opening, #1 vertical opening, and #2 vertical opening. The sum of all four will be applied to culvert sheet.

[illegible]



**PROJECT: COTTONWOOD CREEK MASTER DRAINAGE PLAN**  
**PROJECT NO. 03016838****COTTONWOOD CREEK FLOW CONTROL STRUCTURE**  
**FINAL STAGE-DISCHARGE**

| STAGE<br>(ft) | CONTROLLING<br>CULVERT FLOW<br>RATE<br>(cfs) | RESTRICTOR<br>PLATE<br>DISCHARGE<br>(cfs) | FINAL<br>DISCHARGE<br>(cfs) |
|---------------|----------------------------------------------|-------------------------------------------|-----------------------------|
| 6071.57       | 0.00                                         | 0.00                                      | 0.00                        |
| 6072.00       | 1.50                                         | 3.23                                      | 1.50                        |
| 6073.00       | 18.16                                        | 19.57                                     | 18.16                       |
| 6074.00       | 33.59                                        | 43.34                                     | 33.59                       |
| 6075.00       | 58.30                                        | 71.24                                     | 58.30                       |
| 6076.00       | 83.91                                        | 89.03                                     | 83.91                       |
| 6077.00       | 105.47                                       | 103.82                                    | 103.82                      |
| 6078.00       | 123.30                                       | 116.75                                    | 116.75                      |
| 6079.00       | 138.62                                       | 128.38                                    | 128.38                      |
| 6080.00       | 152.25                                       | 139.04                                    | 139.04                      |
| 6081.00       | 164.66                                       | 148.94                                    | 148.94                      |
| 6082.00       | 175.63                                       | 158.22                                    | 158.22                      |
| 6083.00       | 182.32                                       | 166.99                                    | 166.99                      |
| 6084.00       | 188.53                                       | 175.32                                    | 175.32                      |
| 6085.00       | 194.77                                       | 183.27                                    | 183.27                      |
| 6086.00       | 200.82                                       | 190.89                                    | 190.89                      |
| 6087.00       | 206.69                                       | 198.22                                    | 198.22                      |
| 6088.00       | 212.41                                       | 205.29                                    | 205.29                      |
| 6089.00       | 217.81                                       | 212.12                                    | 212.12                      |
| 6090.00       | 223.24                                       | 218.74                                    | 218.74                      |
| 6091.00       | 228.53                                       | 225.16                                    | 225.16                      |
| 6092.00       | 233.71                                       | 231.41                                    | 231.41                      |
| 6093.00       | 238.78                                       | 237.49                                    | 237.49                      |

**PHASE III DRAINAGE REPORT  
FOR  
TRACT O ACCESS ROAD  
(COTTONWOOD CREEK FLOW CONTROL STRUCTURE)  
RAMPART RANGE METROPOLITAN DISTRICT NO. 1**

**April 2012**

Prepared For:

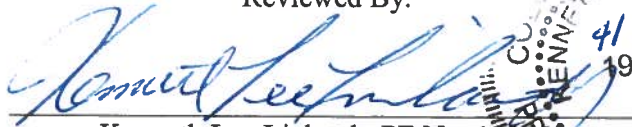
**Rampart Range Metropolitan District No. 1**  
8390 E. Crescent Parkway, Suite 500  
Greenwood Village, CO 80111  
Phone: (303) 779-4525  
Fax: (303) 773-2050

Prepared By:



Carson Besgrove, PE

Reviewed By:



Kenneth Lee Linhardt, PE No. 19366  
Senior Project Manager

Merrick Job No. 65117247

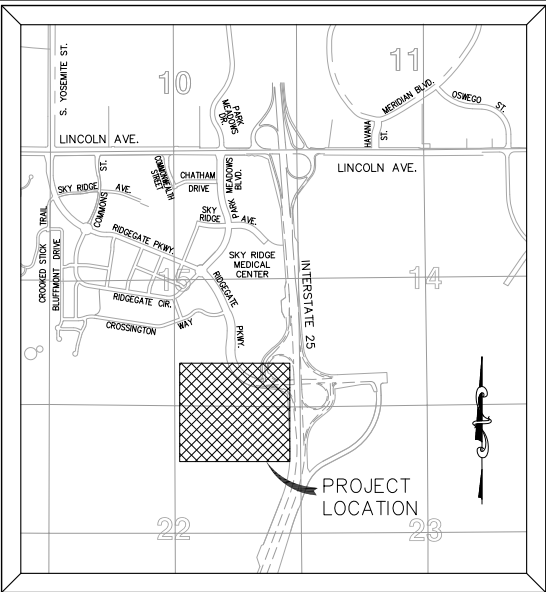
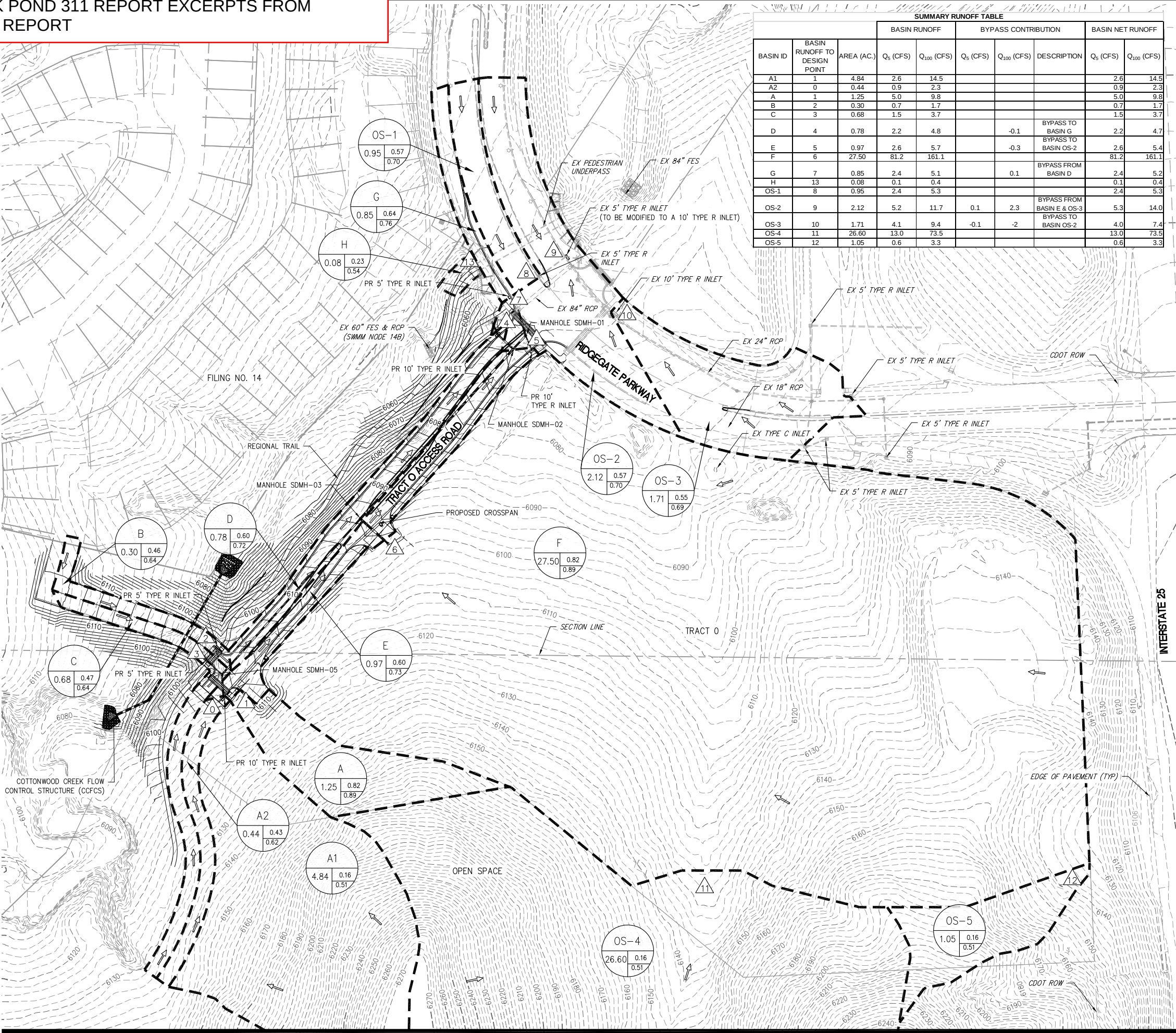


2450 South Peoria Street  
Aurora, CO 80014-5472  
Phone: (303) 751-0741  
Fax (303) 752-4451





MERRICK POND 311 REPORT EXCERPTS FROM CALIBRE REPORT



LEGEND

- BASIN DESIGNATION
- BASIN AREA (ACRES)
- 5-YR RUNOFF COEFFICIENT
- 100-YR RUNOFF COEFFICIENT
- DESIGN POINT
- DIRECTIONAL FLOW ARROWS
- DRAINAGE BASIN BOUNDARY
- EXISTING RIGHT-OF-WAY
- EXISTING PROPERTY LINE
- EXISTING EASEMENT
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING INLET, STORM SEWER, & MANHOLE
- PROPOSED INLET, STORM SEWER, & MANHOLE
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR

| DESIGN POINT | Q <sub>s</sub> (CFS) | Q <sub>100</sub> (CFS) |
|--------------|----------------------|------------------------|
| 0            | 0.9                  | 2.3                    |
| 1            | 18.4                 | 91.5                   |
| 2            | 0.7                  | 1.7                    |
| 3            | 2.2                  | 5.3                    |
| 4            | 2.2                  | 4.8                    |
| 5            | 2.6                  | 5.7                    |
| 6            | 73.1                 | 147.0                  |
| 7            | 2.4                  | 5.1                    |
| 8            | 2.4                  | 5.3                    |
| 9            | 5.2                  | 11.7                   |
| 10           | 4.1                  | 9.4                    |
| 11           | 13.0                 | 73.5                   |
| 12           | 0.6                  | 3.3                    |

Note: Design Point flows represent total flow at Design Point in the storm sewer pipe.



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BEFORE YOU DIG  
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UTILITY NOTIFICATION CENTER OF COLORADO

**MERRICK & COMPANY**

RAMPART RANGE METRO DISTRICT NO. 1

8390 E. CRESCENT PARKWAY, SUITE 500  
GREENWOOD VILLAGE, COLORADO 80111  
PH: 303-799-4525/FAX: 303-773-2050

|                  |         |
|------------------|---------|
| DESIGN BY: COB   | 2/14/12 |
| DRAWN BY: COB    | 2/14/12 |
| CHECKED BY: GCK  | 2/14/12 |
| APPROVED BY: KLL | 2/14/12 |

REVISIONS:

| REV | REVISION DESCRIPTION | DATE | DRAWN BY | CHECKED BY | APPROVED BY |
|-----|----------------------|------|----------|------------|-------------|
|     |                      |      |          |            |             |

TRACT 0 ACCESS ROAD

DEVELOPED DRAINAGE MAP (NORTH)

REGISTERED PROFESSIONAL ENGINEER  
No. 19366  
For and on Behalf of  
Merrick & Company  
Job No. 65117247

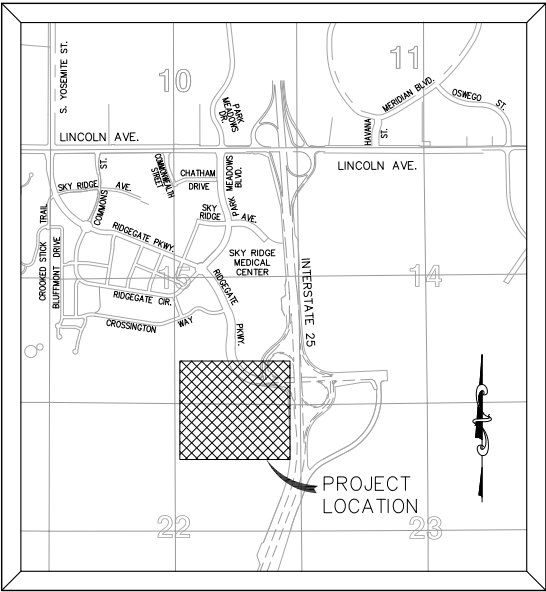
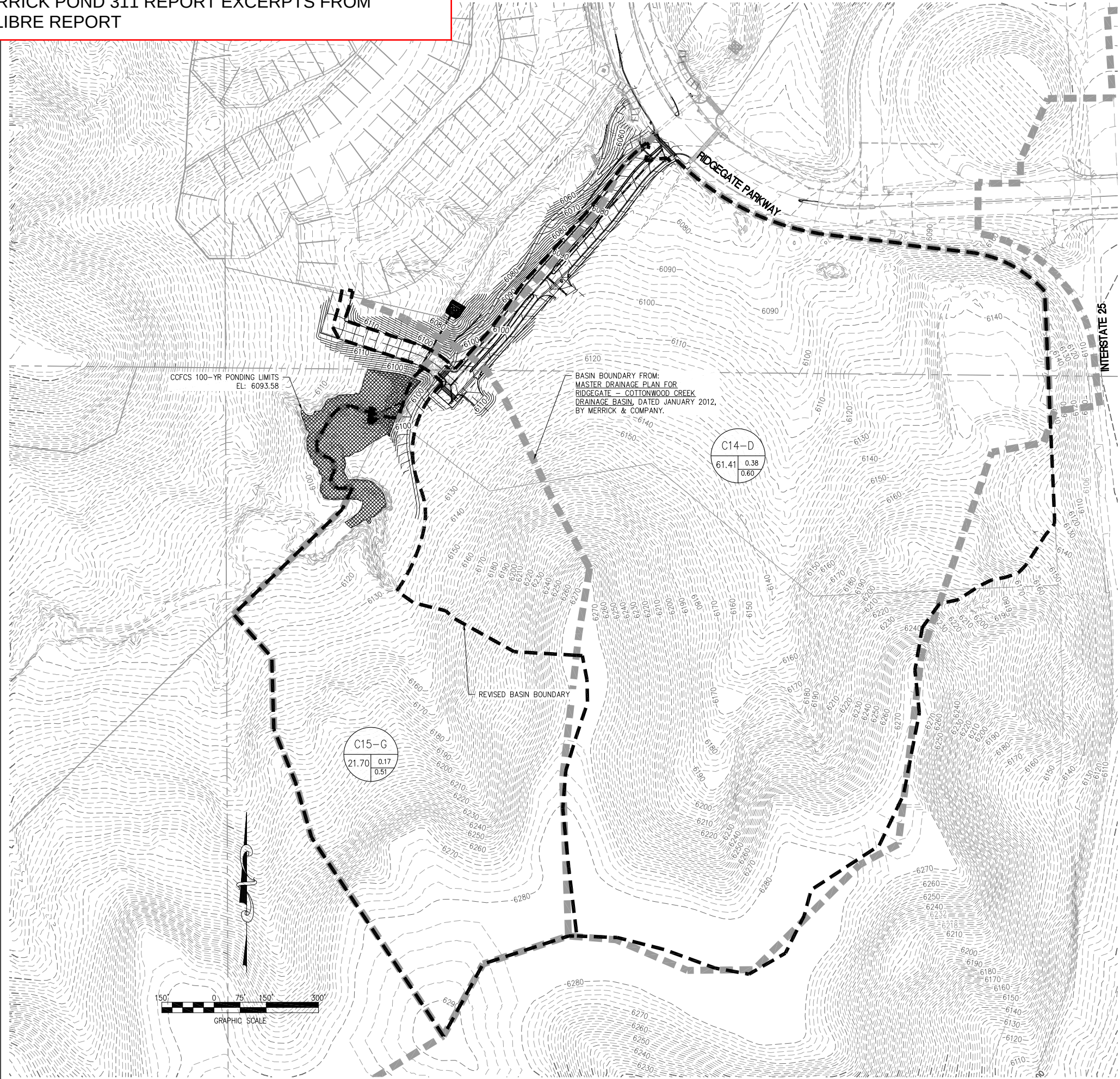
JOB NO: 65117247

DATE: 4/9/12

SHEET: 1 OF 2



MERRICK POND 311 REPORT EXCERPTS FROM CALIBRE REPORT



VICINITY MAP  
SCALE: 1" = 2000'

LEGEND

- BASIN DESIGNATION
- BASIN AREA (ACRES)
- 5-YR RUNOFF COEFFICIENT
- 100-YR RUNOFF COEFFICIENT
- DESIGN POINT
- DIRECTIONAL FLOW ARROWS
- DRAINAGE BASIN BOUNDARY
- EXISTING RIGHT-OF-WAY
- EXISTING PROPERTY LINE
- EXISTING EASEMENT
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING INLET, STORM SEWER, & MANHOLE
- PROPOSED INLET, STORM SEWER, & MANHOLE
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR

| Developed Composite C-Factor and Impervious Analysis |                                                     |              |       |      |      |      |                      |
|------------------------------------------------------|-----------------------------------------------------|--------------|-------|------|------|------|----------------------|
| $C_{CD} =$                                           | $K_{CD} + (0.858*i^3 - 0.786*i^2 + 0.774*i + 0.04)$ |              |       |      |      |      | (UDFCD Formula RO-7) |
| $K_{CD} =$                                           | 0                                                   | 2-yr         |       |      |      |      | (UDFCD Table RO-4)   |
|                                                      | $(-0.10*i + 0.11)$                                  | 5-yr         |       |      |      |      |                      |
|                                                      | $(-0.18*i + 0.21)$                                  | 10-yr        |       |      |      |      |                      |
|                                                      | $(-0.39*i + 0.46)$                                  | 100-yr       |       |      |      |      |                      |
| Basin                                                | Land Use                                            | Area (acres) | I (%) | C2   | C5   | C10  | C100                 |
| Basin C15-G                                          | Open Space                                          | 21.30        | 2     |      |      |      |                      |
|                                                      | Streets, Paved                                      | 0.40         | 100   |      |      |      |                      |
|                                                      | Total Area                                          | 21.70        | 3.8%  | 0.07 | 0.17 | 0.27 | 0.51                 |
| Basin                                                | Land Use                                            | Area (acres) | I (%) | C2   | C5   | C10  | C100                 |
| Basin C14-D                                          | Streets Paved                                       | 2.10         | 100   |      |      |      |                      |
|                                                      | Commercial Area                                     | 28.75        | 95    |      |      |      |                      |
|                                                      | Drives and Walks                                    | 0.10         | 90    |      |      |      |                      |
|                                                      | Boulevard/Landscaping                               | 0.97         | 2     |      |      |      |                      |
|                                                      | Open Space                                          | 32.49        | 2     |      |      |      |                      |
|                                                      | Total Area                                          | 64.41        | 46.8% | 0.32 | 0.38 | 0.44 | 0.60                 |

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RAMPART RANGE  
METRO DISTRICT  
NO. 1  
8390 E. CRESCENT PARKWAY, SUITE 500  
GREENWOOD VILLAGE, COLORADO 80111  
PH: 303-799-4525/FAX: 303-773-2050

| REVISIONS: | DATE | BY | DESCRIPTION | DATE | BY | DESCRIPTION |
|------------|------|----|-------------|------|----|-------------|
|            |      |    |             |      |    |             |
|            |      |    |             |      |    |             |
|            |      |    |             |      |    |             |
|            |      |    |             |      |    |             |

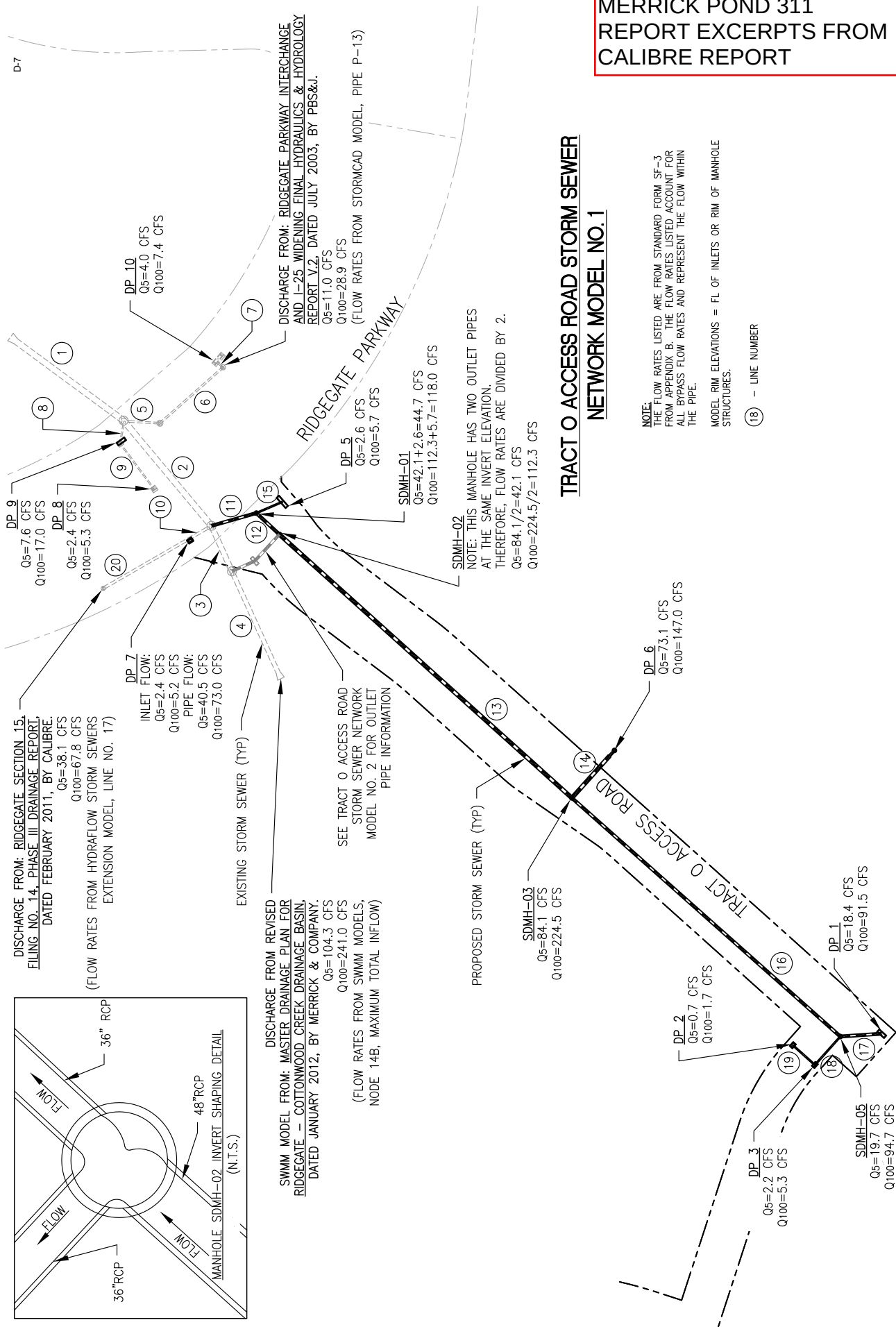
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|--------------|-------|---------|
| COB          |       |         |
| DRAWN BY:    | DATE: | 2/14/12 |
| COB          |       |         |
| CHECKED BY:  | DATE: | 2/14/12 |
| GRK          |       |         |
| APPROVED BY: | DATE: | 2/14/12 |
| KIL          |       |         |

TRACT 0 ACCESS ROAD  
MASTER DRAINAGE PLAN  
BASIN REVISIONS

REGISTERED PROFESSIONAL ENGINEER  
No. 19366  
STATE OF COLORADO  
For and on Behalf of  
Merrick & Company  
Merrick & Company Job No. 65117247

|                  |              |               |
|------------------|--------------|---------------|
| JOB NO: 65117247 | DATE: 4/9/12 | SHEET: 1 OF 1 |
|------------------|--------------|---------------|





MERRICK POND 311  
REPORT EXCERPTS FROM  
CALIBRE REPORT

TRACT O ACCESS ROAD STORM SEWER  
NETWORK MODEL NO. 1

NOTE:  
THE FLOW RATES LISTED ARE FROM STANDARD FORM SF-3  
FROM APPENDIX B. THE FLOW RATES LISTED ACCOUNT FOR  
ALL BYPASS FLOW RATES AND REPRESENT THE FLOW WITHIN  
THE PIPE.  
MODEL RIM ELEVATIONS = FL OF INLETS OR RIM OF MANHOLE  
STRUCTURES.  
(18) - LINE NUMBER

**PHASE III DRAINAGE REPORT  
FOR  
DETENTION POND 311 RETROFIT  
RAMPART RANGE METROPOLITAN DISTRICT NO. 1**

**December 2013**

Prepared For:

**Rampart Range Metropolitan District No. 1**  
6399 S. Fiddler's Green Circle, Suite #1  
Greenwood Village, CO 80111-4974  
Phone: (303) 779-4525  
Fax: (303) 773-2050

Prepared By:

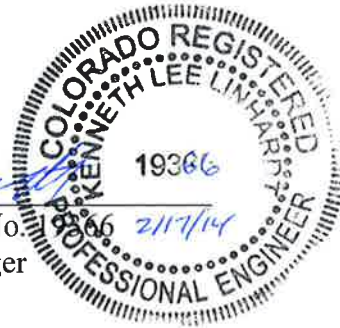


Carson Besgrove, PE

Reviewed By:



Kenneth Lee Linhardt, PE No. 19366  
Senior Project Manager



Merrick Job No. 65117773



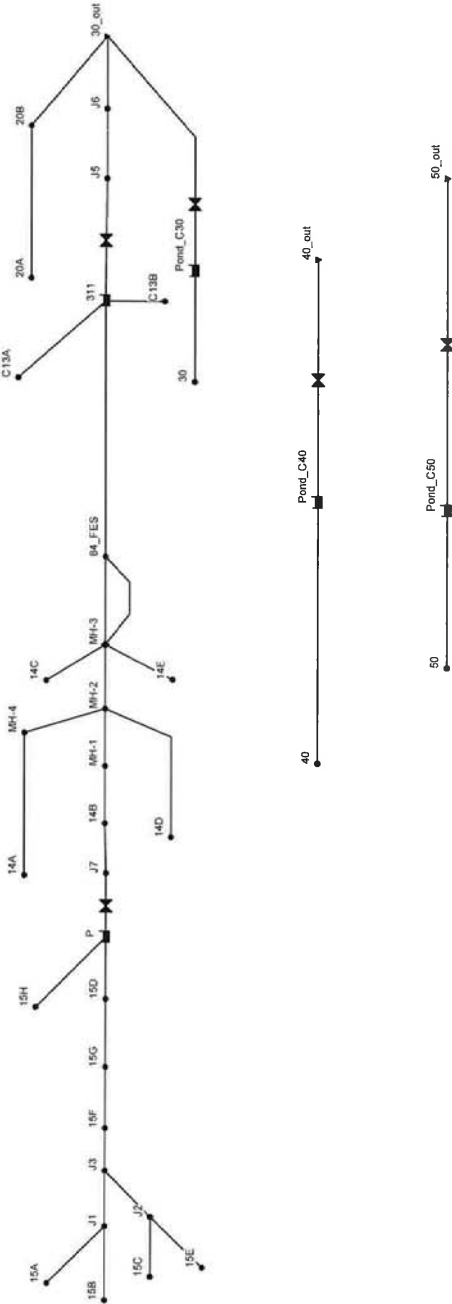
5970 Greenwood Plaza Blvd  
Greenwood Village, Colorado 80111  
Phone: (303) 751-0741  
Fax (303) 752-4451

City of Lone Tree Review & Approval Is With Respect  
To General Conformance With City Standards. Responsibility  
For The Design Remains With The Professional(s) Submitting  
And Stamping The Document(s).



SWMM NODE MAP

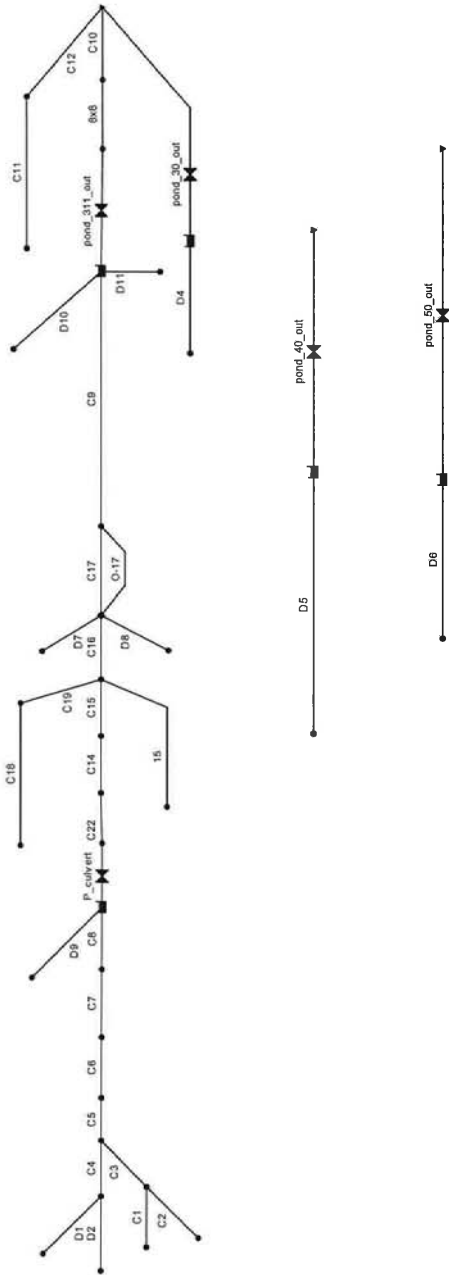
01/01/2005 01:00:00





SWMM LINK MAP

01/01/2005 01:00:00



## COTTONWOOD CRK 100-YEAR DEVELOPED

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)

COTTONWOOD CREEK MASTER: 100-YEAR DEVELOPED

\*\*\*\*\*  
NOTE: The summary statistics displayed in this report are  
based on results found at every computational time step,  
not just on results from each reporting time step.  
\*\*\*\*\*

### \*\*\*\*\* Analysis Options

\*\*\*\*\*  
Flow Units ..... CFS  
Process Models:  
  Rainfall/Runoff ..... NO  
  Snowmelt ..... NO  
  Groundwater ..... NO  
  Flow Routing ..... YES  
  Ponding Allowed ..... NO  
  Water Quality ..... NO  
Flow Routing Method ..... KINWAVE  
Starting Date ..... JAN-01-2005 00:00:00  
Ending Date ..... JAN-05-2005 23:30:00  
Antecedent Dry Days ..... 0.0  
Report Time Step ..... 01:00:00  
Routing Time Step ..... 30.00 sec

WARNING 08: elevation drop exceeds length for Conduit D10

| *****                      | Volume    | Volume   |
|----------------------------|-----------|----------|
| Flow Routing Continuity    | acre-feet | 10^6 gal |
| *****                      | -----     | -----    |
| Dry Weather Inflow .....   | 0.000     | 0.000    |
| Wet Weather Inflow .....   | 0.000     | 0.000    |
| Groundwater Inflow .....   | 0.000     | 0.000    |
| RDII Inflow .....          | 133.484   | 43.498   |
| External Inflow .....      | 0.000     | 0.000    |
| External Outflow .....     | 133.608   | 43.538   |
| Internal Outflow .....     | 0.000     | 0.000    |
| Storage Losses .....       | 0.000     | 0.000    |
| Initial Stored Volume .... | 0.000     | 0.000    |
| Final Stored Volume .....  | 0.000     | 0.000    |
| Continuity Error (%) ..... | -0.093    |          |

### \*\*\*\*\* Highest Flow Instability Indexes

\*\*\*\*\*  
Link C22 (3)  
Link C14 (3)  
Link P\_culvert (3)  
Link 15 (2)  
Link C16 (2)

### \*\*\*\*\* Routing Time Step Summary

\*\*\*\*\*  
Minimum Time Step : 30.00 sec  
Average Time Step : 30.00 sec  
Maximum Time Step : 30.00 sec  
Percent in Steady State : 0.00  
Average Iterations per Step : 1.01

### \*\*\*\*\* Node Depth Summary

## COTTONWOOD CRK 100-YEAR DEVELOPED

\*\*\*\*\*

| Node     | Type     | Average<br>Depth<br>Feet | Maximum<br>Depth<br>Feet | Maximum<br>HGL<br>Feet | Time of Max<br>Occurrence<br>days hr:min |
|----------|----------|--------------------------|--------------------------|------------------------|------------------------------------------|
| 14A      | JUNCTION | 0.02                     | 1.94                     | 6066.48                | 0 00:40                                  |
| 14B      | JUNCTION | 0.06                     | 3.18                     | 6053.73                | 0 01:24                                  |
| 14C      | JUNCTION | 0.00                     | 0.00                     | 6065.00                | 0 00:00                                  |
| 14D      | JUNCTION | 0.03                     | 2.70                     | 6045.70                | 0 00:40                                  |
| 14E      | JUNCTION | 0.00                     | 0.00                     | 6070.00                | 0 00:00                                  |
| 15A      | JUNCTION | 0.00                     | 0.00                     | 6160.00                | 0 00:00                                  |
| 15B      | JUNCTION | 0.00                     | 0.00                     | 6160.00                | 0 00:00                                  |
| 15C      | JUNCTION | 0.01                     | 1.13                     | 6156.13                | 0 00:40                                  |
| 15D      | JUNCTION | 0.04                     | 3.36                     | 6083.36                | 0 00:52                                  |
| 15E      | JUNCTION | 0.01                     | 0.55                     | 6155.55                | 0 00:45                                  |
| 15F      | JUNCTION | 0.03                     | 2.31                     | 6112.31                | 0 00:51                                  |
| 15G      | JUNCTION | 0.03                     | 2.46                     | 6090.46                | 0 00:51                                  |
| 15H      | JUNCTION | 0.00                     | 0.00                     | 6125.00                | 0 00:00                                  |
| 20A      | JUNCTION | 0.00                     | 0.62                     | 5985.62                | 0 00:35                                  |
| 20B      | JUNCTION | 0.01                     | 0.80                     | 5960.80                | 0 00:40                                  |
| 30       | JUNCTION | 0.00                     | 0.00                     | 5948.00                | 0 00:00                                  |
| 40       | JUNCTION | 0.00                     | 0.00                     | 5944.00                | 0 00:00                                  |
| 50       | JUNCTION | 0.00                     | 0.00                     | 5962.00                | 0 00:00                                  |
| 84_FES   | JUNCTION | 0.08                     | 4.77                     | 6042.14                | 0 00:49                                  |
| C13A     | JUNCTION | 0.00                     | 0.00                     | 0.00                   | 0 00:00                                  |
| C13B     | JUNCTION | 0.00                     | 0.00                     | 6060.00                | 0 00:00                                  |
| J1       | JUNCTION | 0.02                     | 1.56                     | 6156.56                | 0 00:50                                  |
| J2       | JUNCTION | 0.02                     | 1.42                     | 6141.42                | 0 00:45                                  |
| J3       | JUNCTION | 0.03                     | 2.31                     | 6132.31                | 0 00:49                                  |
| J5       | JUNCTION | 0.11                     | 3.60                     | 5997.65                | 0 01:21                                  |
| J6       | JUNCTION | 0.12                     | 3.60                     | 5995.60                | 0 01:22                                  |
| J7       | JUNCTION | 0.04                     | 2.24                     | 6069.24                | 0 01:30                                  |
| MH-1     | JUNCTION | 5.02                     | 8.14                     | 6050.50                | 0 01:24                                  |
| MH-2     | JUNCTION | 17.76                    | 19.77                    | 6061.31                | 0 00:36                                  |
| MH-4     | JUNCTION | 0.12                     | 2.08                     | 6064.25                | 0 00:35                                  |
| 30_out   | OUTFALL  | 0.11                     | 2.70                     | 5936.38                | 0 01:25                                  |
| 40_out   | OUTFALL  | 0.00                     | 0.00                     | 5932.72                | 0 00:00                                  |
| 50_out   | OUTFALL  | 0.00                     | 0.00                     | 5953.00                | 0 00:00                                  |
| MH-3     | DIVIDER  | 0.47                     | 4.77                     | 6043.92                | 0 00:49                                  |
| 311      | STORAGE  | 2.47                     | 12.02                    | 6009.35                | 0 01:21                                  |
| P        | STORAGE  | 0.27                     | 19.03                    | 6093.53                | 0 01:30                                  |
| Pond_C30 | STORAGE  | 3.35                     | 9.86                     | 5944.86                | 0 01:20                                  |
| Pond_C40 | STORAGE  | 0.51                     | 7.42                     | 5950.42                | 0 01:05                                  |
| Pond_C50 | STORAGE  | 0.46                     | 6.79                     | 5961.79                | 0 01:10                                  |

Pond 311 100-year  
WSE=6009.35

\*\*\*\*\*  
Node Inflow Summary  
\*\*\*\*\*

| Node | Type     | Maximum<br>Lateral<br>Inflow<br>CFS | Maximum<br>Total<br>Inflow<br>CFS | Time of Max<br>Occurrence<br>days hr:min | Lateral<br>Inflow<br>Volume<br>10^6 gal | Total<br>Inflow<br>Volume<br>10^6 gal |
|------|----------|-------------------------------------|-----------------------------------|------------------------------------------|-----------------------------------------|---------------------------------------|
| 14A  | JUNCTION | 60.41                               | 60.41                             | 0 00:40                                  | 1.130                                   | 1.130                                 |
| 14B  | JUNCTION | 19.31                               | 240.37                            | 0 01:24                                  | 0.354                                   | 12.313                                |
| 14C  | JUNCTION | 0.00                                | 0.00                              | 0 00:00                                  | 0.000                                   | 0.000                                 |
| 14D  | JUNCTION | 159.46                              | 159.46                            | 0 00:40                                  | 3.347                                   | 3.347                                 |
| 14E  | JUNCTION | 36.37                               | 36.37                             | 0 00:40                                  | 0.773                                   | 0.773                                 |
| 15A  | JUNCTION | 52.70                               | 52.70                             | 0 00:50                                  | 1.574                                   | 1.574                                 |
| 15B  | JUNCTION | 70.60                               | 70.60                             | 0 00:50                                  | 2.255                                   | 2.255                                 |
| 15C  | JUNCTION | 81.92                               | 81.92                             | 0 00:40                                  | 2.042                                   | 2.042                                 |
| 15D  | JUNCTION | 91.05                               | 386.29                            | 0 00:52                                  | 2.690                                   | 11.110                                |
| 15E  | JUNCTION | 30.37                               | 30.37                             | 0 00:45                                  | 0.810                                   | 0.810                                 |
| 15F  | JUNCTION | 30.00                               | 261.61                            | 0 00:51                                  | 0.786                                   | 7.481                                 |
| 15G  | JUNCTION | 36.95                               | 296.86                            | 0 00:51                                  | 0.935                                   | 8.420                                 |
| 15H  | JUNCTION | 26.21                               | 26.21                             | 0 00:50                                  | 0.847                                   | 0.847                                 |

## COTTONWOOD CRK 100-YEAR DEVELOPED

|          |          |        |        |   |       |        |        |
|----------|----------|--------|--------|---|-------|--------|--------|
| 20A      | JUNCTION | 25.32  | 25.32  | 0 | 00:35 | 0.447  | 0.447  |
| 20B      | JUNCTION | 30.92  | 56.11  | 0 | 00:40 | 0.788  | 1.235  |
| 30       | JUNCTION | 458.22 | 458.22 | 0 | 00:35 | 6.338  | 6.338  |
| 40       | JUNCTION | 785.87 | 785.87 | 0 | 00:35 | 11.345 | 11.345 |
| 50       | JUNCTION | 272.38 | 272.38 | 0 | 00:35 | 3.638  | 3.638  |
| 84_FES   | JUNCTION | 0.00   | 437.63 | 0 | 00:49 | 0.000  | 17.548 |
| C13A     | JUNCTION | 166.82 | 166.82 | 0 | 00:40 | 2.853  | 2.853  |
| C13B     | JUNCTION | 19.94  | 19.94  | 0 | 00:45 | 0.542  | 0.542  |
| J1       | JUNCTION | 0.00   | 123.30 | 0 | 00:50 | 0.000  | 3.829  |
| J2       | JUNCTION | 0.00   | 111.68 | 0 | 00:45 | 0.000  | 2.853  |
| J3       | JUNCTION | 0.00   | 232.70 | 0 | 00:49 | 0.000  | 6.690  |
| J5       | JUNCTION | 0.00   | 391.03 | 0 | 01:21 | 0.000  | 20.948 |
| J6       | JUNCTION | 0.00   | 391.02 | 0 | 01:22 | 0.000  | 20.948 |
| J7       | JUNCTION | 0.00   | 236.38 | 0 | 01:30 | 0.000  | 11.958 |
| MH-1     | JUNCTION | 0.00   | 240.34 | 0 | 01:24 | 0.000  | 12.310 |
| MH-2     | JUNCTION | 0.00   | 404.03 | 0 | 00:49 | 0.000  | 16.784 |
| MH-4     | JUNCTION | 0.00   | 62.44  | 0 | 00:35 | 0.000  | 1.130  |
| 30_out   | OUTFALL  | 0.00   | 475.42 | 0 | 01:14 | 0.000  | 28.550 |
| 40_out   | OUTFALL  | 0.00   | 214.00 | 0 | 00:43 | 0.000  | 11.349 |
| 50_out   | OUTFALL  | 0.00   | 54.00  | 0 | 00:39 | 0.000  | 3.636  |
| MH-3     | DIVIDER  | 0.00   | 438.20 | 0 | 00:49 | 0.000  | 17.553 |
| 311      | STORAGE  | 0.00   | 588.78 | 0 | 00:49 | 0.000  | 20.960 |
| P        | STORAGE  | 0.00   | 412.38 | 0 | 00:53 | 0.000  | 11.958 |
| Pond_C30 | STORAGE  | 0.00   | 458.22 | 0 | 00:35 | 0.000  | 6.338  |
| Pond_C40 | STORAGE  | 0.00   | 785.87 | 0 | 00:35 | 0.000  | 11.345 |
| Pond_C50 | STORAGE  | 0.00   | 272.38 | 0 | 00:35 | 0.000  | 3.638  |

\*\*\*\*\*  
Node Surcharge Summary  
\*\*\*\*\*

Pond 311 100-year  
Peak Inflow=588.8 cfs

Surcharging occurs when water rises above the top of the highest conduit.

| Node     | Type     | Hours<br>Surcharged | Max. Height         | Min. Depth        |
|----------|----------|---------------------|---------------------|-------------------|
|          |          |                     | Above Crown<br>Feet | Below Rim<br>Feet |
| 14C      | JUNCTION | 119.51              | 0.000               | 0.000             |
| 14E      | JUNCTION | 119.51              | 0.000               | 0.000             |
| 15A      | JUNCTION | 119.51              | 0.000               | 0.000             |
| 15B      | JUNCTION | 119.51              | 0.000               | 0.000             |
| 15H      | JUNCTION | 119.51              | 0.000               | 0.000             |
| 30       | JUNCTION | 119.51              | 0.000               | 0.000             |
| 40       | JUNCTION | 119.51              | 0.000               | 0.000             |
| 50       | JUNCTION | 119.51              | 0.000               | 0.000             |
| C13A     | JUNCTION | 119.51              | 0.000               | 0.000             |
| C13B     | JUNCTION | 119.51              | 0.000               | 0.000             |
| 311      | STORAGE  | 30.27               | 7.021               | 0.649             |
| P        | STORAGE  | 2.09                | 15.034              | 2.466             |
| Pond_C30 | STORAGE  | 119.51              | 9.860               | 2.640             |
| Pond_C40 | STORAGE  | 119.51              | 7.420               | 0.330             |
| Pond_C50 | STORAGE  | 119.51              | 6.788               | 0.212             |

\*\*\*\*\*  
Node Flooding Summary  
\*\*\*\*\*

No nodes were flooded.

\*\*\*\*\*  
Storage Volume Summary  
\*\*\*\*\*

| Storage Unit | Average<br>Volume<br>1000 ft3 | Avg<br>Pcnt<br>Full | E&I<br>Pcnt<br>Loss | Maximum<br>Volume<br>1000 ft3 | Max<br>Pcnt<br>Full | Time of Max<br>Occurrence<br>days hr:min | Maximum<br>Outflow<br>CFS |
|--------------|-------------------------------|---------------------|---------------------|-------------------------------|---------------------|------------------------------------------|---------------------------|
|--------------|-------------------------------|---------------------|---------------------|-------------------------------|---------------------|------------------------------------------|---------------------------|

## COTTONWOOD CRK 100-YEAR DEVELOPED

|          |         |    |   |         |    |   |       |        |
|----------|---------|----|---|---------|----|---|-------|--------|
| 311      | 73.352  | 8  | 0 | 796.421 | 89 | 0 | 01:21 | 391.03 |
| P        | 4.503   | 1  | 0 | 432.380 | 70 | 0 | 01:30 | 236.38 |
| Pond_C30 | 123.303 | 12 | 0 | 669.930 | 63 | 0 | 01:20 | 58.85  |
| Pond_C40 | 47.800  | 5  | 0 | 878.902 | 94 | 0 | 01:05 | 214.00 |
| Pond_C50 | 14.916  | 5  | 0 | 308.695 | 96 | 0 | 01:09 | 54.00  |

\*\*\*\*\*  
Outfall Loading Summary  
\*\*\*\*\*

Pond 311 100-year peak  
discharge=391.0 cfs

| Outfall Node | Flow<br>Freq.<br>Pcnt. | Avg.<br>Flow<br>CFS | Max.<br>Flow<br>CFS | Total<br>Volume<br>10^6 gal |
|--------------|------------------------|---------------------|---------------------|-----------------------------|
| 30_out       | 73.97                  | 11.99               | 475.42              | 28.550                      |
| 40_out       | 74.95                  | 4.71                | 214.00              | 11.349                      |
| 50_out       | 44.15                  | 2.56                | 54.00               | 3.636                       |
| System       | 64.36                  | 19.26               | 743.42              | 43.535                      |

\*\*\*\*\*  
Link Flow Summary  
\*\*\*\*\*

Maximum flow at the western channel  
less than the "Plan 100-year Release  
Rate" of 524 cfs identified in the MDP-12

| Link         | Type    | Maximum<br> Flow <br>CFS | Time of Max<br>Occurrence<br>days hr:min | Maximum<br> Veloc <br>ft/sec | Max/<br>Full<br>Flow | Max/<br>Full<br>Depth |
|--------------|---------|--------------------------|------------------------------------------|------------------------------|----------------------|-----------------------|
| 15           | CONDUIT | 160.48                   | 0 00:40                                  | 17.70                        | 0.80                 | 0.68                  |
| 8x8          | CONDUIT | 391.02                   | 0 01:22                                  | 13.58                        | 0.43                 | 0.45                  |
| C1           | CONDUIT | 81.92                    | 0 00:44                                  | 6.43                         | 0.05                 | 0.23                  |
| C10          | CONDUIT | 390.95                   | 0 01:25                                  | 8.04                         | 0.28                 | 0.54                  |
| C11          | CONDUIT | 25.32                    | 0 00:39                                  | 6.09                         | 0.01                 | 0.12                  |
| C12          | CONDUIT | 56.07                    | 0 00:40                                  | 9.46                         | 0.02                 | 0.16                  |
| C14          | CONDUIT | 240.34                   | 0 01:24                                  | 18.27                        | 0.73                 | 0.64                  |
| C15          | CONDUIT | 240.33                   | 0 01:24                                  | 14.68                        | 0.61                 | 0.56                  |
| C16          | CONDUIT | 403.99                   | 0 00:49                                  | 16.30                        | 0.70                 | 0.61                  |
| C17          | CONDUIT | 437.63                   | 0 00:49                                  | 15.71                        | 0.81                 | 0.68                  |
| C18          | CONDUIT | 62.44                    | 0 00:35                                  | 12.77                        | 0.78                 | 0.65                  |
| C19          | CONDUIT | 61.10                    | 0 00:36                                  | 12.18                        | 0.80                 | 0.68                  |
| C2           | CONDUIT | 30.37                    | 0 00:49                                  | 5.72                         | 0.01                 | 0.11                  |
| C22          | CONDUIT | 236.38                   | 0 01:31                                  | 7.15                         | 0.18                 | 0.45                  |
| C3           | CONDUIT | 111.65                   | 0 00:45                                  | 6.47                         | 0.08                 | 0.28                  |
| C4           | CONDUIT | 124.46                   | 0 00:55                                  | 6.35                         | 0.09                 | 0.31                  |
| C5           | CONDUIT | 232.65                   | 0 00:51                                  | 6.82                         | 0.20                 | 0.46                  |
| C6           | CONDUIT | 261.32                   | 0 00:51                                  | 7.78                         | 0.19                 | 0.45                  |
| C7           | CONDUIT | 296.80                   | 0 00:52                                  | 7.84                         | 0.22                 | 0.49                  |
| C8           | CONDUIT | 386.17                   | 0 00:53                                  | 6.39                         | 0.69                 | 0.84                  |
| C9           | CONDUIT | 435.59                   | 0 00:50                                  | 7.82                         | 0.38                 | 0.64                  |
| D1           | DUMMY   | 52.70                    | 0 00:50                                  |                              |                      |                       |
| D10          | DUMMY   | 166.82                   | 0 00:40                                  |                              |                      |                       |
| D11          | DUMMY   | 19.94                    | 0 00:45                                  |                              |                      |                       |
| D2           | DUMMY   | 70.60                    | 0 00:50                                  |                              |                      |                       |
| D4           | DUMMY   | 458.22                   | 0 00:35                                  |                              |                      |                       |
| D5           | DUMMY   | 785.87                   | 0 00:35                                  |                              |                      |                       |
| D6           | DUMMY   | 272.38                   | 0 00:35                                  |                              |                      |                       |
| D7           | DUMMY   | 0.00                     | 0 00:00                                  |                              |                      |                       |
| D8           | DUMMY   | 36.37                    | 0 00:40                                  |                              |                      |                       |
| D9           | DUMMY   | 26.21                    | 0 00:50                                  |                              |                      |                       |
| O-17         | CONDUIT | 0.00                     | 0 00:00                                  | 0.00                         | 0.00                 | 0.00                  |
| P_culvert    | DUMMY   | 236.38                   | 0 01:30                                  |                              |                      |                       |
| pond_30_out  | DUMMY   | 58.85                    | 0 01:20                                  |                              |                      |                       |
| pond_311_out | DUMMY   | 391.03                   | 0 01:21                                  |                              |                      |                       |
| pond_40_out  | DUMMY   | 214.00                   | 0 00:43                                  |                              |                      |                       |
| pond_50_out  | DUMMY   | 54.00                    | 0 00:39                                  |                              |                      |                       |

## COTTONWOOD CRK 100-YEAR DEVELOPED

\*\*\*\*\*  
Conduit Surcharge Summary  
\*\*\*\*\*

| Conduit | -----<br>Both Ends | Hours Full<br>Upstream | -----<br>Dnstream | Hours<br>Above Full<br>Normal Flow | Hours<br>Capacity<br>Limited |
|---------|--------------------|------------------------|-------------------|------------------------------------|------------------------------|
| D1      | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D10     | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D11     | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D2      | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D4      | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D5      | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D6      | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D7      | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D8      | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |
| D9      | 0.01               | 0.01                   | 0.01              | 119.51                             | 0.01                         |

Analysis begun on: Tue Dec 10 14:21:55 2013  
Analysis ended on: Tue Dec 10 14:21:55 2013  
Total elapsed time: < 1 sec



structure. The T-Base manhole shall be constructed per Douglas County Standard Detail SD-6. Horizontal or vertical alignment changes using a three piece elbow or bend in conjunction with a T-Base may be considered through the variance process for very large pipes where the base structure for a Box Base or Type P manhole would be excessively large.

3. Type "P" Manhole. This manhole is appropriate for 30 degree and 45 degree deflections (horizontal alignment changes) where the use of a box base manhole would result in excessive dimensions. The Type "P" Manhole shall be constructed per Douglas County Standard Detail SD-10.
4. Special Junction Structures. Special junction structures may have to be designed when pipe sizes and alignment changes exceed those that can be accommodated by standard manhole types.

**9.7.4 Steps and Platforms.** Steps are required in all manholes exceeding 3.5-feet in height and shall be in accordance with AASHTO M 199. The Occupational Health and Safety Administration has specific standards for fixed ladders used to ascend heights exceeding 20-feet. Cages and/or landing platforms may be required to satisfy these requirements in excessively deep manhole structures. It is the design engineer's responsibility to ensure that the appropriate measures are designed and construction details are developed and included in the construction drawings, as needed to comply with the Occupational Health and Safety Administration standards. When landing platforms are proposed, consideration shall be given to the potential maintenance activities and the expected loadings on the platforms.

**9.7.5 Drop Manholes.** The drop within a manhole from the upstream to downstream pipe invert should normally not exceed 1-foot. There are cases when a drop larger than 1-foot may be necessary to avoid a utility conflict, reduce the slope of the downstream pipe, or to account for the energy losses in the manhole. Drops that exceed 1-foot will be evaluated on a case-by-case basis and additional analysis may be required. The details referenced in Section 9.7.3 for the Box Base and Type P manholes do not accommodate a significant elevation difference between the pipes entering and exiting the manhole, therefore use of these manholes would require a special design.

**9.7.6 Energy Dissipation in Manholes for Small Storm Drainage Outfalls.** Small storm drainage outfalls are defined as outfall systems that have a design flow rate of 20 cubic feet per second or less at the outlet point into a drainageway or detention pond. Small storm drainage outfall systems are commonly proposed to drain cul-de-sacs or other small tributary areas. In many cases, a relatively steep slope is required for the pipe to outlet into an adjacent drainageway or detention pond. In the design of these systems, manholes will be allowed to have drops to a maximum of 4.5-feet in order to provide energy dissipation within the system. In order for a manhole to qualify as an energy dissipation structure upstream of the storm sewer outlet, the minor storm flow must have sufficient velocity to impact the opposite side of the manhole. These minimum velocities, based on the drop height, are provided in Figure 9-1. The information provided in Figure 9-1 is based on the use of a 4-foot manhole (inside diameter). The use of a 4-foot

manhole is acceptable and required when proposed for the purposes of energy dissipation in small outfall systems.

**9.7.7 Manhole Shaping.** All manholes shall be constructed with fill concrete to the top of the highest crown of the highest top of pipe entering or exiting the manhole. The shaping shall match the pipe section below pipe springline and consist of vertical walls above pipe springline. This shaping significantly reduces manhole losses. The appropriate loss coefficient can be determined using Figure ST-8 and Table ST-9 in Volume 1 of the *UDFCD Manual* for full shaping. Douglas County Standard Detail SD-6, provides construction details for channelization in slab base and box base manholes.

**9.7.8 Other Design Considerations.** The following design criteria shall also be met:

- The elevation of the pipe crowns shall be matched when the downstream pipe is larger than the upstream pipe. This will minimize the backwater effects on the upstream pipe.
- The invert of a manhole shall be constructed with a slope between the upstream and downstream pipes. The slope shall be the average of the upstream and downstream pipe slopes or based on a fall of 0.1-foot through the manhole.
- It is critical that gutter pans, curb heads, and any other problematic locations be avoided when determining the horizontal placement of manholes.

## 9.8 Hydraulic Design

Once the layout of the storm sewer system is determined, the peak flows in the system must be calculated followed by a hydraulic analysis to determine pipe capacity and size. The pipe size shall not decrease moving downstream (even if the capacity is available due to increased slope, etc.) in order to reduce clogging potential.

**9.8.1 Allowable Storm Sewer Velocity and Slope.** The allowable storm sewer velocity is dependent on many factors, including the type of pipe, the acceptable water level during the pipe design life, proposed flow conditions (open channel versus pressure flows), and the type and quality of construction of joints, manholes, and junctions.

1. **Maximum velocity.** In consideration of the above factors, the maximum velocity in all storm sewers shall be limited to 18-fps.
2. **Minimum velocity.** The need to maintain a self-cleaning storm sewer system is recognized as a goal to minimize the costs for maintenance of storm sewer facilities. Sediment deposits, once established, are generally difficult to remove even with pressure cleaning equipment. A minimum velocity of 4-fps is required when the storm sewer conveys runoff from frequently occurring storm events. Assuming that the pipe has been designed to near full flow, a flow depth equal to 25-percent of the pipe diameter and the corresponding flow rate shall be used to check the minimum velocity. If the pipe is not designed to flow near full, a flow depth equal to 25-percent of the design flow

2. Step 2 Pipe Capacity. In the major storm event it is acceptable to have a surcharge in the system. Therefore Manning's equation is not applicable for those pipes which are under pressure flow conditions. There may be cases where the major storm event does not result in a surcharge of the system. In these pipes the capacity can be calculated using Manning's equation, as described in Section 9.8.2.
3. Step 3 Hydraulic and Energy Grade Lines. Hydraulic grade line calculations for the storm sewer system shall be provided for the major storm event. **The major storm energy grade line must not rise past the elevation 1-foot below the final grade along the storm sewer system.** When a storm sewer is flowing under a pressure flow condition, the energy and hydraulic grade lines shall be calculated using the pressure-momentum theory. The capacity calculations generally proceed from the storm sewer outlet upstream, accounting for all energy losses. These losses are added to the energy grade line and accumulate to the upstream end of the storm sewer. The hydraulic grade line is then determined by subtracting the velocity head from the energy grade line at each change in the energy grade line slope. Refer to Section 4.4 in the Streets/Inlets/Storm Sewers chapter of Volume 1 of the *UDFCD Manual* as a guideline for completing hydraulic grade line and energy grade line calculations. The procedure described in the *UDFCD Manual* is based on the FHWA HEC-22 publication. All of the losses through a storm sewer system (at bends, junctions, transitions, entrances, and exits) are based upon coefficients recommended in the *UDFCD Manual*.

**9.8.4 Computer Programs.** It is recommended that a computer program be used for the design or as a calculation "check" of a storm sewer system. NeoUDSewer is the software created to supplement the *UDFCD Manual* and is an approved computer program for storm sewer analysis in the County. NeoUDSewer is a powerful tool which can calculate rainfall and runoff using the Rational Method and then size a circular storm sewer based on Manning's equation. Example 6.13 in the Streets/Inlets/Storm Sewers chapter of the *UDFCD Manual* is an example of sample project input and the resulting output from NeoUDSewer.

If an alternate computer program (i.e., StormCAD) is used, a calibration model based on Example 6.13 in the *UDFCD Manual* must be completed and provided to the County. This calibration model is generated by completing an analysis of Example 6.13 with the alternate computer model. The results of this alternate model must be comparable to the results from the NeoUDSewer analysis. It is not necessary to calibrate the hydrologic analysis as shown in Example 6.13; rather, the design engineer may input the peak flow directly to obtain a comparison of the resulting hydraulic and energy grade lines through the example system. The goal of this model calibration is to verify that the loss coefficients and other system assumptions used in the alternate computer program are equivalent to the methodology applied by NeoUDSewer, which is accepted by the County.

**TABLE 10-1  
EROSION PROTECTION AT CONDUIT OUTLETS**

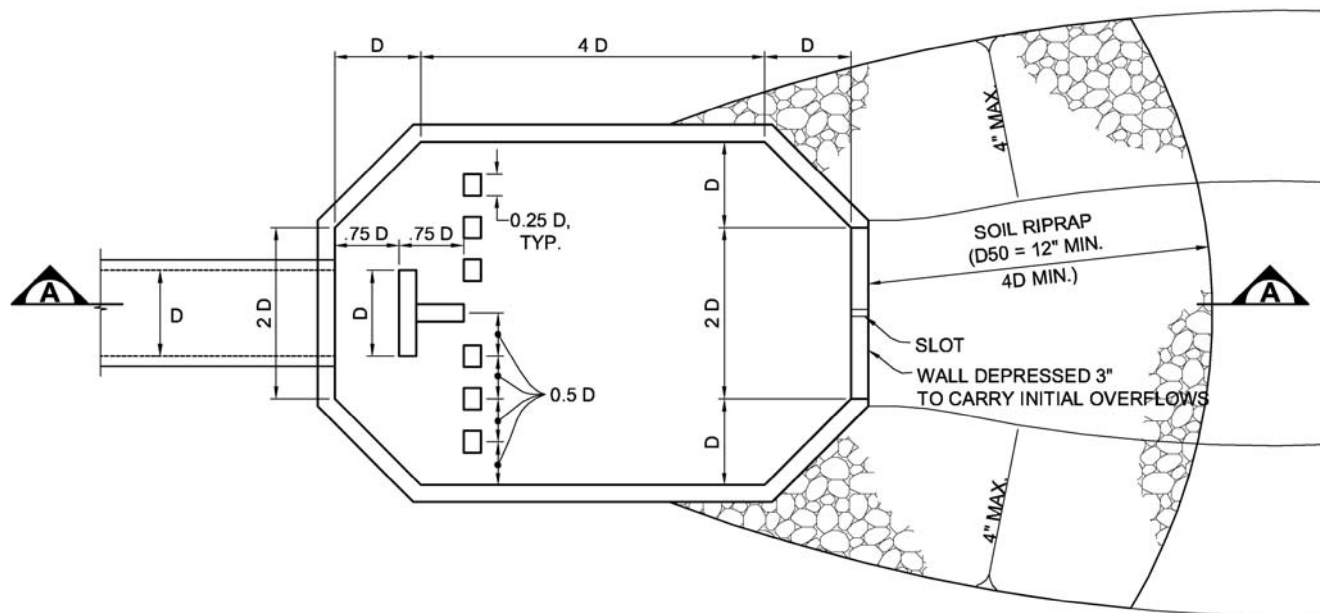
| <b>Erosion Protection Guidelines</b>                         | <b>UDFCD Manual Section</b>                   | <b>Use For</b>                                                                                                                                                                                                      | <b>Do Not Use For</b>                                                                                                                                                         |
|--------------------------------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1. Riprap Lining</b><br>(Section 10.3.1)                  | Section 7.0 of Major Drainage, Volume 1       | <ul style="list-style-type: none"> <li>Receiving channel on same line and grade</li> <li>Storm sewer and culvert outlets</li> <li>Velocities from 0-15 fps</li> <li>High tailwater</li> <li>Fish passage</li> </ul> | <ul style="list-style-type: none"> <li>Velocities above 15 fps</li> <li>Wetland channels</li> </ul>                                                                           |
| <b>2. Low Tailwater Stilling Basin</b><br>(Section 10.3.2)   | Section 3.4 of Hydraulic Structures, Volume 2 | <ul style="list-style-type: none"> <li>Storm sewer and culvert outlets</li> <li>Velocities from 0-15 fps</li> <li>Low tailwater</li> </ul>                                                                          | <ul style="list-style-type: none"> <li>Velocities above 15 fps</li> <li>Confined receiving area</li> <li>Major drainage Areas where standing water is unacceptable</li> </ul> |
| <b>3. Concrete Impact Stilling Basin</b><br>(Section 10.3.3) | Section 3.2 of Hydraulic Structures, Volume 2 | <ul style="list-style-type: none"> <li>Storm sewer outlets</li> <li>Velocities over 15 fps</li> <li>Low tailwater</li> </ul>                                                                                        | <ul style="list-style-type: none"> <li>In-line culvert outlets</li> <li>High visibility areas</li> </ul>                                                                      |
| <b>4. Concrete Baffle Chute</b><br>(Section 10.3.4)          | Section 3.3 of Hydraulic Structures, Volume 2 | <ul style="list-style-type: none"> <li>Storm sewer outlets</li> <li>Velocities over 5 fps</li> <li>Low tailwater</li> <li>Degrading channel</li> </ul>                                                              | <ul style="list-style-type: none"> <li>In-line culvert outlets</li> <li>High debris potential</li> <li>High visibility areas</li> </ul>                                       |
| <b>5. Drop Structures</b>                                    | Section 2.0 of Hydraulic Structures, Volume 2 | <ul style="list-style-type: none"> <li>Wetland channels</li> <li>Low rise box culverts or small diameter pipes where plugging is possible</li> </ul>                                                                | <ul style="list-style-type: none"> <li>Confined receiving area</li> <li>Fish passage</li> </ul>                                                                               |

Final design criteria is available in the *UDFCD Manuals*

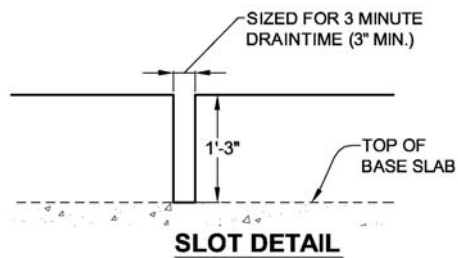
**10.2.2 Selecting Type of Erosion Protection.** Riprap protection downstream of culverts is considered for most situations where moderate outlet hydraulics govern. It is highly recommended that the designer use a low tailwater basin when a storm sewer enters a drainageway at an approximate right angle, and drop structures or riprap lining for in-line culvert outlets on major drainageways. The County strongly suggests drop structures or riprap lining for in-line culvert outlets on major drainageways.

Steep, high velocity conduits may be modified by providing a drop in a manhole and designing a larger diameter, flatter slope pipe from the manhole to the channel. This technique may also be used to reduce outlet velocities and the corresponding extents of riprap erosion protection. The use of drop manholes for this technique is discussed in Section 9.7.6.

**FIGURE 14-8**  
**CONCEPT FOR INTEGRAL FOREBAY AT PIPE OUTFALL**

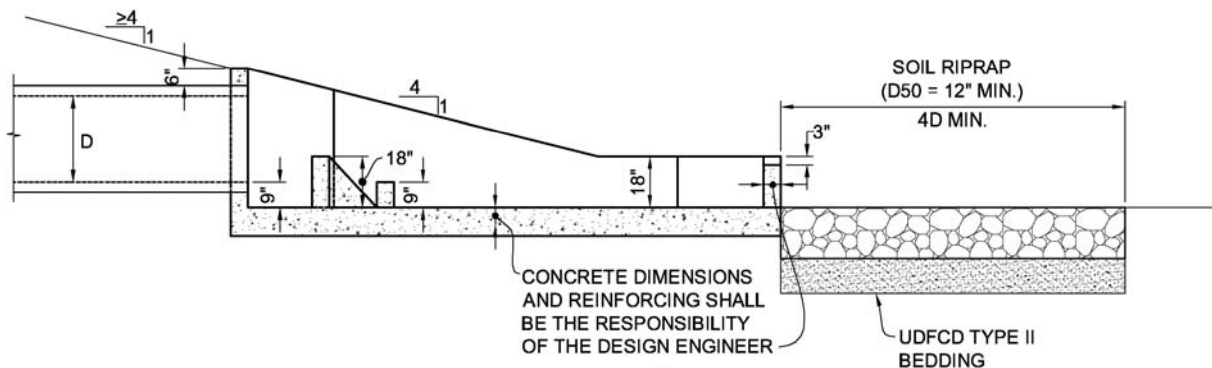


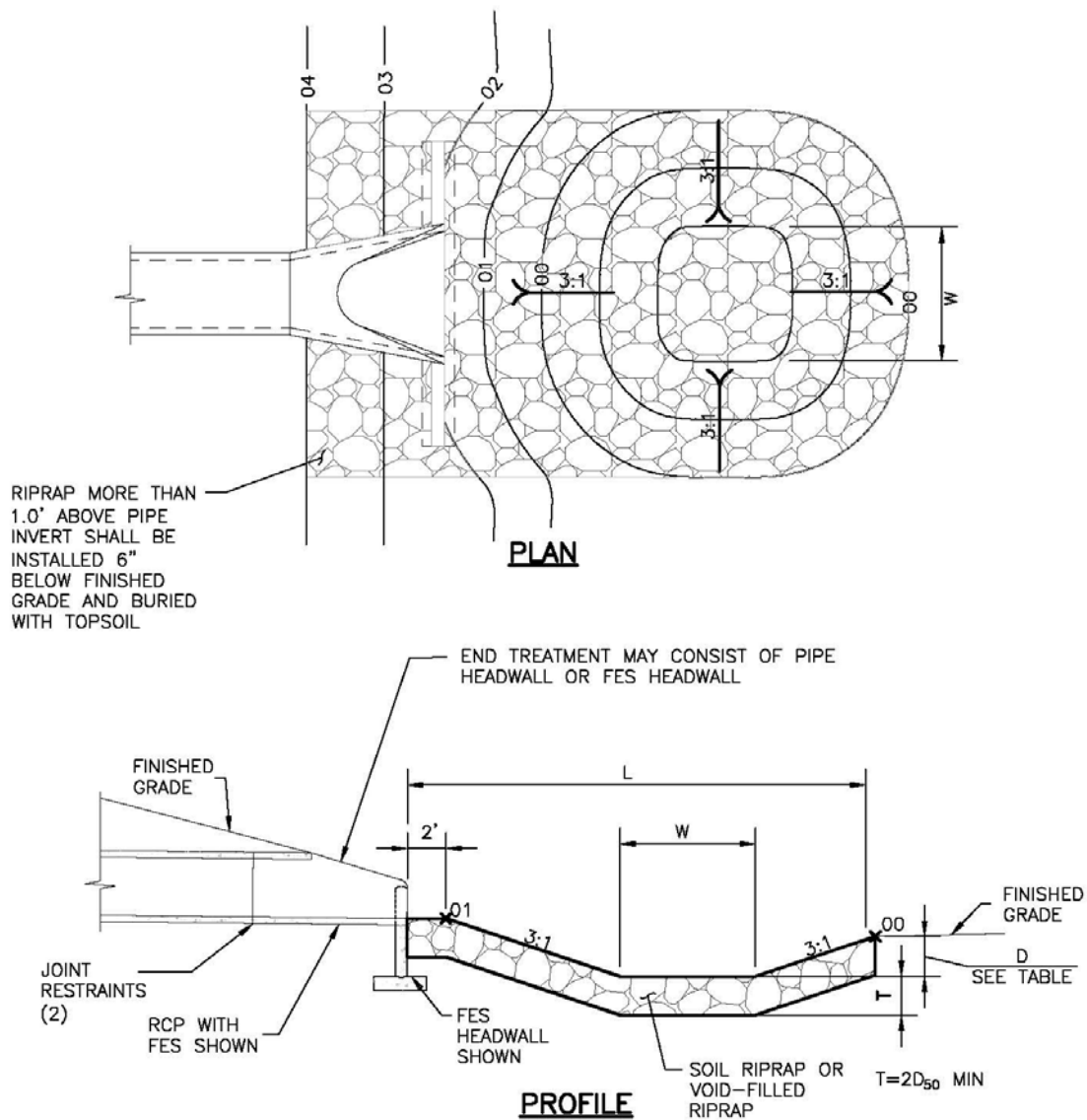
**PLAN**



**NOTES:**

1. DIMENSIONS SHOWN ARE MINIMUMS AND APPLY TO FOREBAYS WITHIN MODIFIED EXTENDED DETENTION BASINS. FOREBAYS IN STANDARD EXTENDED DETENTION BASINS SHALL BE SIZED BASED ON UDFCD CRITERIA.
2. FOR  $D \geq 2.5$ -FEET, FOREBAY REQUIRES RAMP INTO BOTTOM AND ACCESS ROAD LEADING TO STREET.





| PIPE SIZE OR BOX HEIGHT | D     | W* | L   |
|-------------------------|-------|----|-----|
| 18" - 24"               | 1'-0" | 4' | 15' |
| 30" - 36"               | 1'-6" | 6' | 20' |
| 42" - 48"               | 2'-0" | 7' | 24' |
| 54" - 60"               | 2'-6" | 8' | 28' |
| 66" - 72"               | 3'-0" | 9' | 32' |

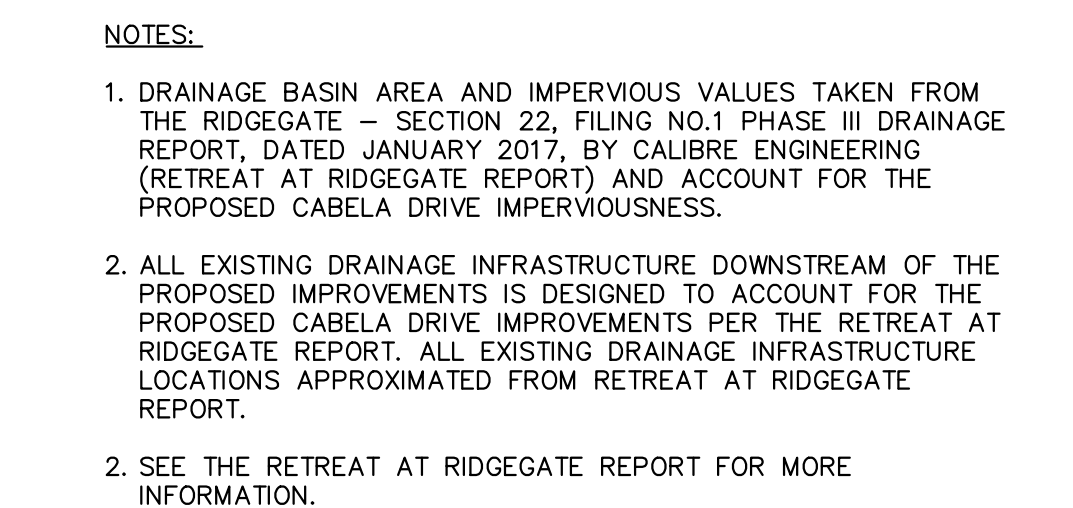
\* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

**Figure 9-37. Low tailwater riprap basin**



**APPENDIX E**  
**DRAINAGE MAPS**





200 100 0 200 400  
ORIGINAL SCALE: 1" = 200'

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**CAMPART RANCE METRO DISTRICT**  
 8390 E CRESCENT PKWY  
 SUITE 300  
 GREENWOOD VILLAGE, CO 80111  
 PHONE: 303-779-5710

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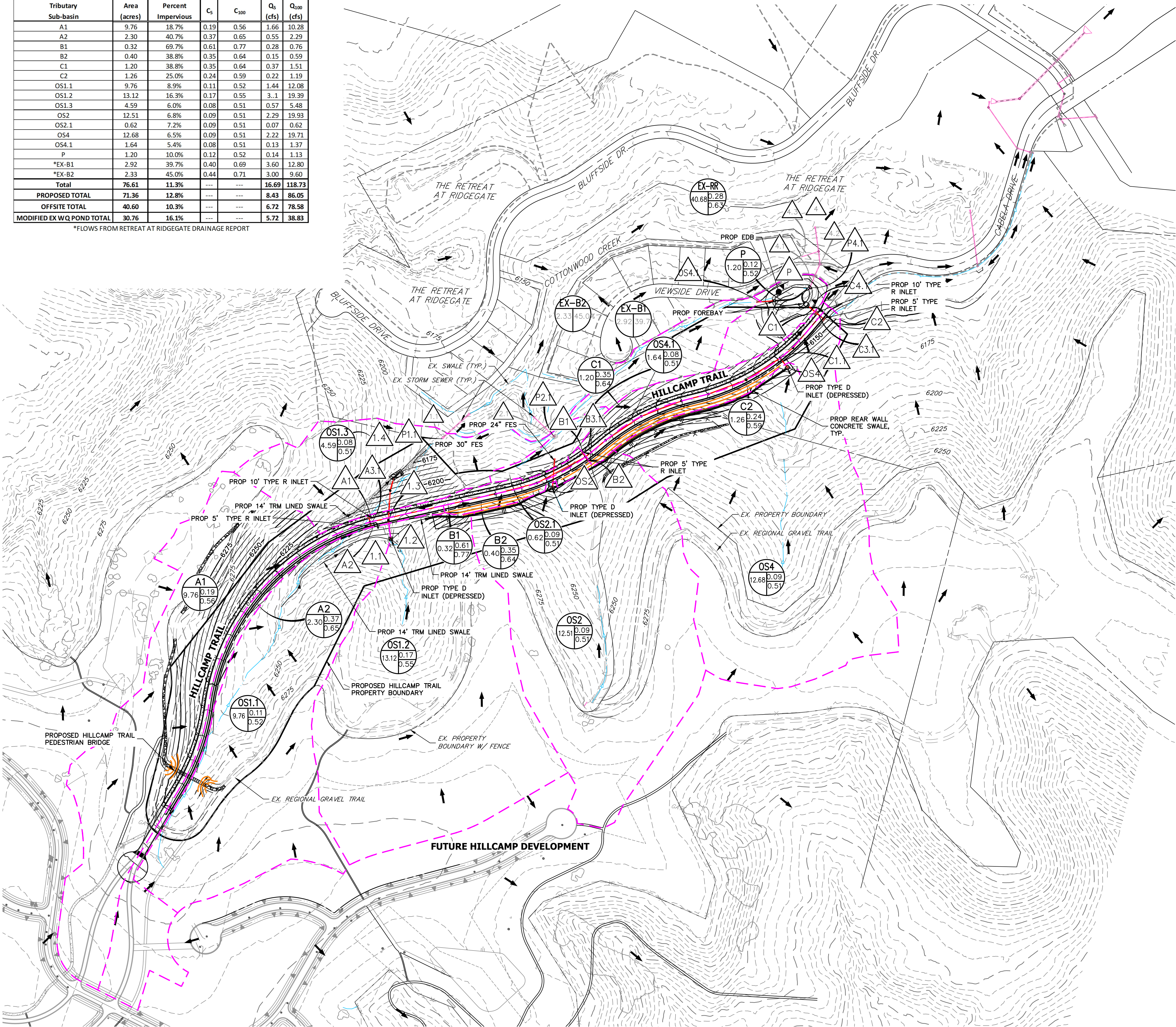
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|-------------|------------|-----|----------|----|------|
| V-SCALE     | N/A        |     |          |    |      |
| DATE        | 10/23/2023 |     |          |    |      |
| DESIGNED BY | KR         |     |          |    |      |
| DRAWN BY    | BP         |     |          |    |      |
| CHECKED BY  |            |     |          |    |      |

|                         |          |    |   |
|-------------------------|----------|----|---|
| SHEET                   | 1        | OF | 1 |
| JOB NO.                 | 15950.18 |    |   |
| HILLCAMP TRAIL          |          |    |   |
| EXISTING DRAINAGE MAPS  |          |    |   |
| EX OVERALL DRAINAGE MAP |          |    |   |



| SUB-BASIN SUMMARY TABLE (CUHP-SWMM) |              |                    |                |                  |                      |                        |
|-------------------------------------|--------------|--------------------|----------------|------------------|----------------------|------------------------|
| Tributary Sub-basin                 | Area (acres) | Percent Impervious | C <sub>s</sub> | C <sub>100</sub> | Q <sub>s</sub> (cfs) | Q <sub>100</sub> (cfs) |
| A1                                  | 9.76         | 18.7%              | 0.19           | 0.56             | 1.66                 | 10.28                  |
| A2                                  | 2.30         | 40.7%              | 0.37           | 0.65             | 0.55                 | 2.29                   |
| B1                                  | 0.32         | 69.7%              | 0.61           | 0.77             | 0.28                 | 0.76                   |
| B2                                  | 0.40         | 38.8%              | 0.35           | 0.64             | 0.15                 | 0.59                   |
| C1                                  | 1.20         | 38.8%              | 0.35           | 0.64             | 0.37                 | 1.51                   |
| C2                                  | 1.26         | 25.0%              | 0.24           | 0.59             | 0.22                 | 1.19                   |
| OS1.1                               | 9.76         | 8.9%               | 0.11           | 0.52             | 1.44                 | 12.08                  |
| OS1.2                               | 13.12        | 16.3%              | 0.17           | 0.55             | 3.1                  | 19.39                  |
| OS1.3                               | 4.59         | 6.0%               | 0.08           | 0.51             | 0.57                 | 5.48                   |
| OS2                                 | 12.51        | 6.8%               | 0.09           | 0.51             | 2.29                 | 19.93                  |
| OS2.1                               | 0.62         | 7.2%               | 0.09           | 0.51             | 0.07                 | 0.62                   |
| OS4                                 | 12.68        | 6.5%               | 0.09           | 0.51             | 2.22                 | 19.71                  |
| OS4.1                               | 1.64         | 5.4%               | 0.08           | 0.51             | 0.13                 | 1.37                   |
| P                                   | 1.20         | 10.0%              | 0.12           | 0.52             | 0.14                 | 1.13                   |
| *EX-B1                              | 2.92         | 39.7%              | 0.40           | 0.69             | 3.60                 | 12.80                  |
| *EX-B2                              | 2.33         | 45.0%              | 0.44           | 0.71             | 3.00                 | 9.60                   |
| Total                               | 76.61        | 11.3%              | ---            | ---              | 16.69                | 118.73                 |
| PROPOSED TOTAL                      | 71.36        | 12.8%              | ---            | ---              | 8.43                 | 86.05                  |
| OFFSITE TOTAL                       | 40.60        | 10.3%              | ---            | ---              | 6.72                 | 78.58                  |
| MODIFIED EX WQ POND TOTAL           | 30.76        | 16.1%              | ---            | ---              | 5.72                 | 38.83                  |

\*FLOWS FROM RETREAT AT RIDGEGATE DRAINAGE REPORT

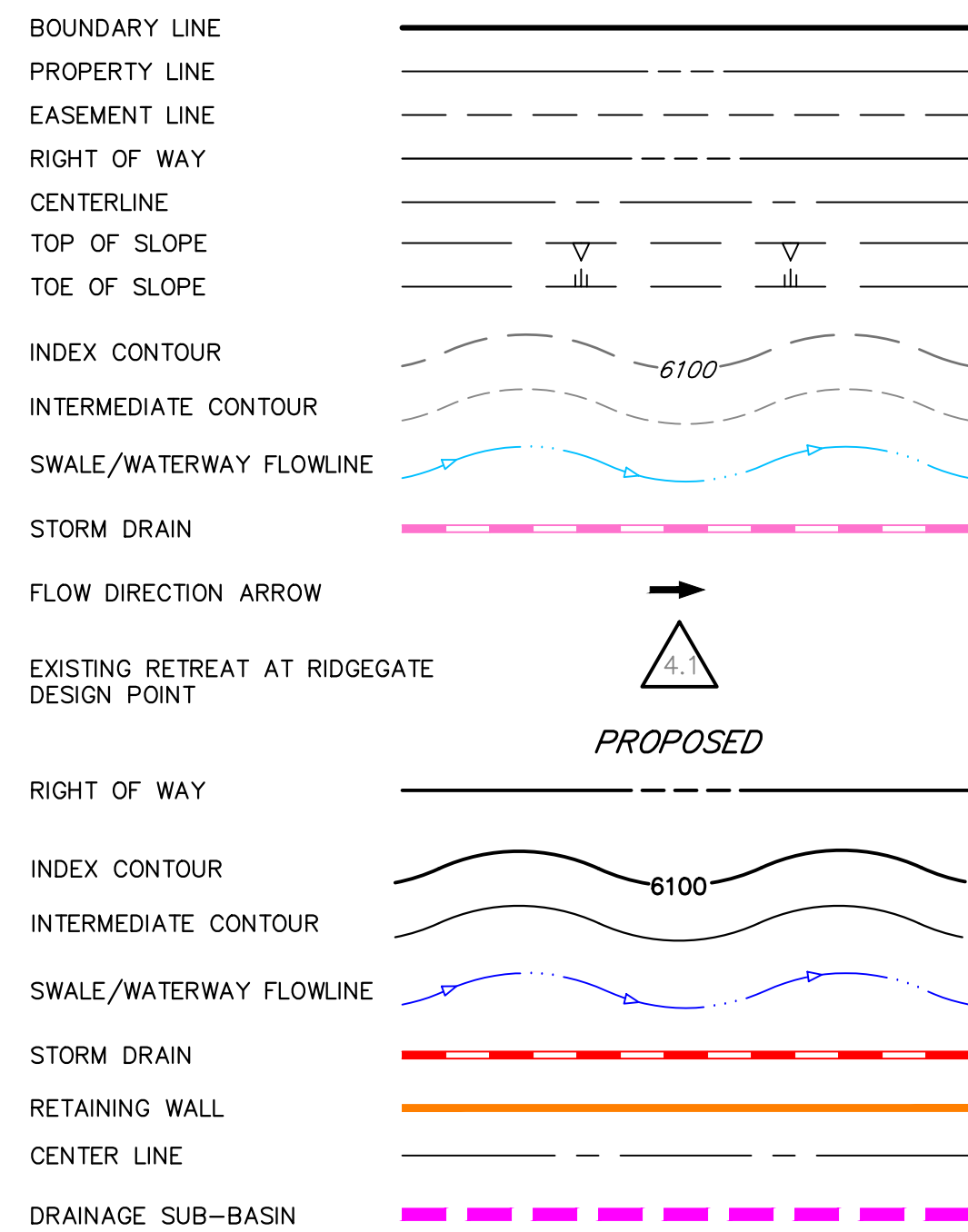


PROP DESIGN POINT TABLE (CUHP-SWMM)

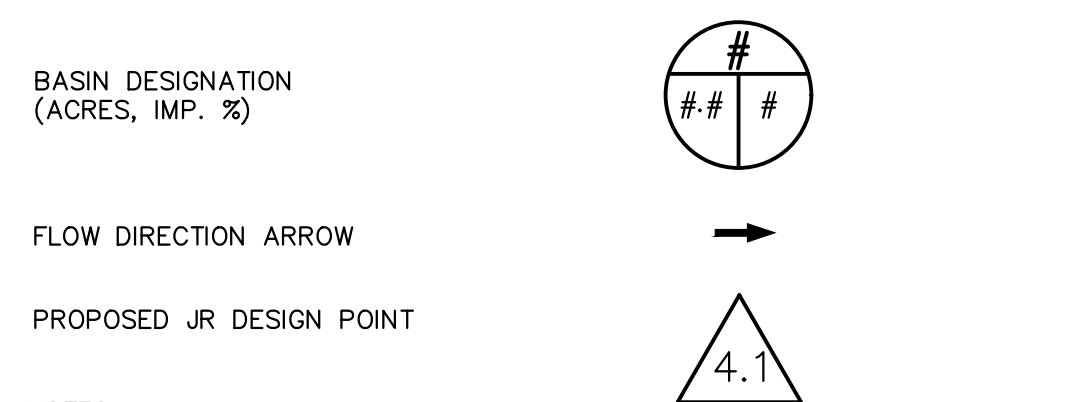
| Design Point | Q <sub>s</sub> (cfs) | Q <sub>100</sub> (cfs) |
|--------------|----------------------|------------------------|
| A1           | 1.66                 | 10.28                  |
| A2           | 0.55                 | 2.29                   |
| A3.1         | 2.22                 | 12.58                  |
| OS1.1        | 1.44                 | 12.08                  |
| 1.3          | 4.18                 | 30.85                  |
| OS1.2        | 3.1                  | 19.39                  |
| 1.4          | 0.57                 | 5.48                   |
| P1.1         | 5.11                 | 36.95                  |
| OS2          | 2.29                 | 19.93                  |
| OS2.1        | 0.07                 | 0.62                   |
| P2.1         | 2.36                 | 20.55                  |
| B1           | 0.28                 | 0.76                   |
| B2           | 0.15                 | 0.59                   |
| B3.1         | 2.58                 | 13.75                  |
| OS4          | 2.22                 | 19.71                  |
| C2           | 0.22                 | 1.19                   |
| C1.1         | 4.68                 | 32.69                  |
| C1           | 0.37                 | 1.51                   |
| C3.1         | 4.90                 | 33.85                  |
| OS4.1        | 0.13                 | 1.37                   |
| C4.1         | 5.26                 | 35.36                  |
| P            | 0.14                 | 1.13                   |
| P4.1         | 5.71                 | 38.83                  |
| *EX-B1       | 3.60                 | 12.80                  |
| *EX-B2       | 3.00                 | 9.60                   |
| *EX-4        | 12.31                | 61.23                  |

\*FLOWS FROM RETREAT AT RIDGEGATE DRAINAGE REPORT

LEGEND  
EXISTING

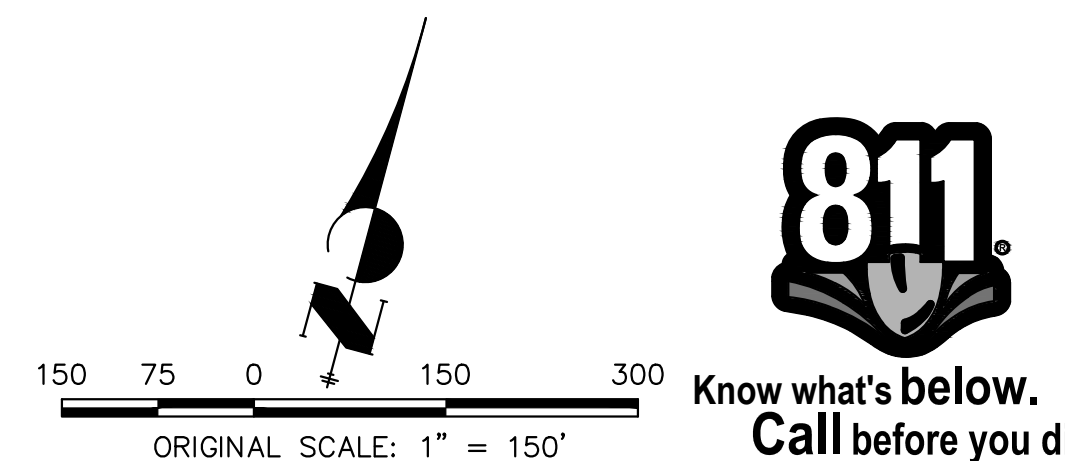


PROPOSED



NOTES:

- DRAINAGE BASIN AREA AND IMPERVIOUS VALUES TAKEN FROM THE RIDGEGATE - SECTION 22, FILING NO.1 PHASE III DRAINAGE REPORT, DATED JANUARY 2017, BY CALIBRE ENGINEERING (RETREAT AT RIDGEGATE REPORT) AND ACCOUNT FOR THE PROPOSED CABELA DRIVE IMPERVIOUSNESS.
- ALL EXISTING DRAINAGE INFRASTRUCTURE DOWNSTREAM OF THE PROPOSED IMPROVEMENTS IS DESIGNED TO ACCOUNT FOR THE PROPOSED CABELA DRIVE IMPROVEMENTS PER THE "RIDGEGATE - SECTION 22, FILING NO.1 PHASE III" DRAINAGE REPORT, DATED JANUARY 2017, BY CALIBRE ENGINEERING (RETREAT AT RIDGEGATE REPORT).
- SEE THE RETREAT AT RIDGEGATE REPORT FOR MORE INFORMATION.



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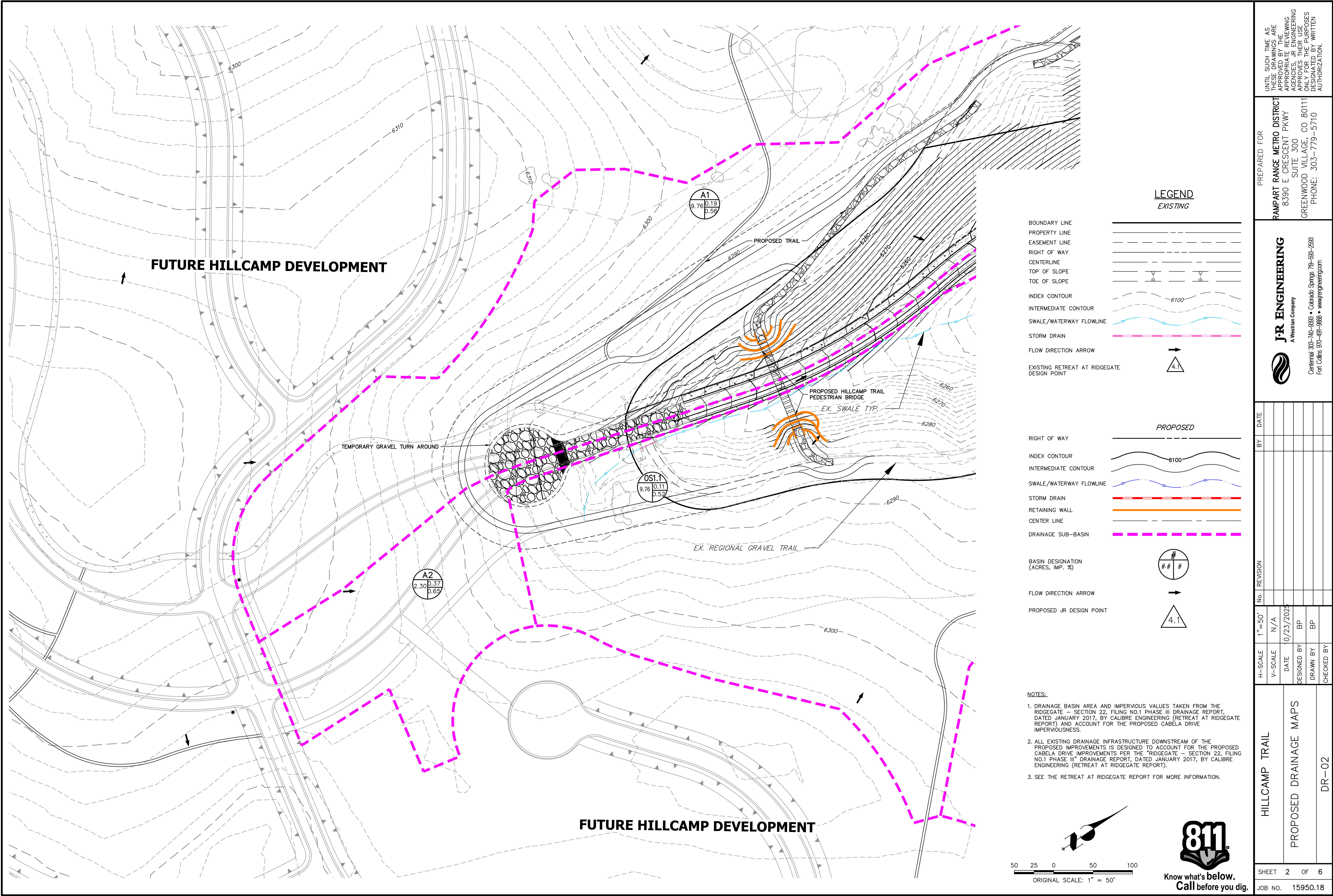
PREPARED FOR  
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8390 E CRESCENT PKWY  
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| BY          | DATE       | REVISION      | No. | 1"  | 150' |
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| CHECKED BY  |            |               |     |     |      |

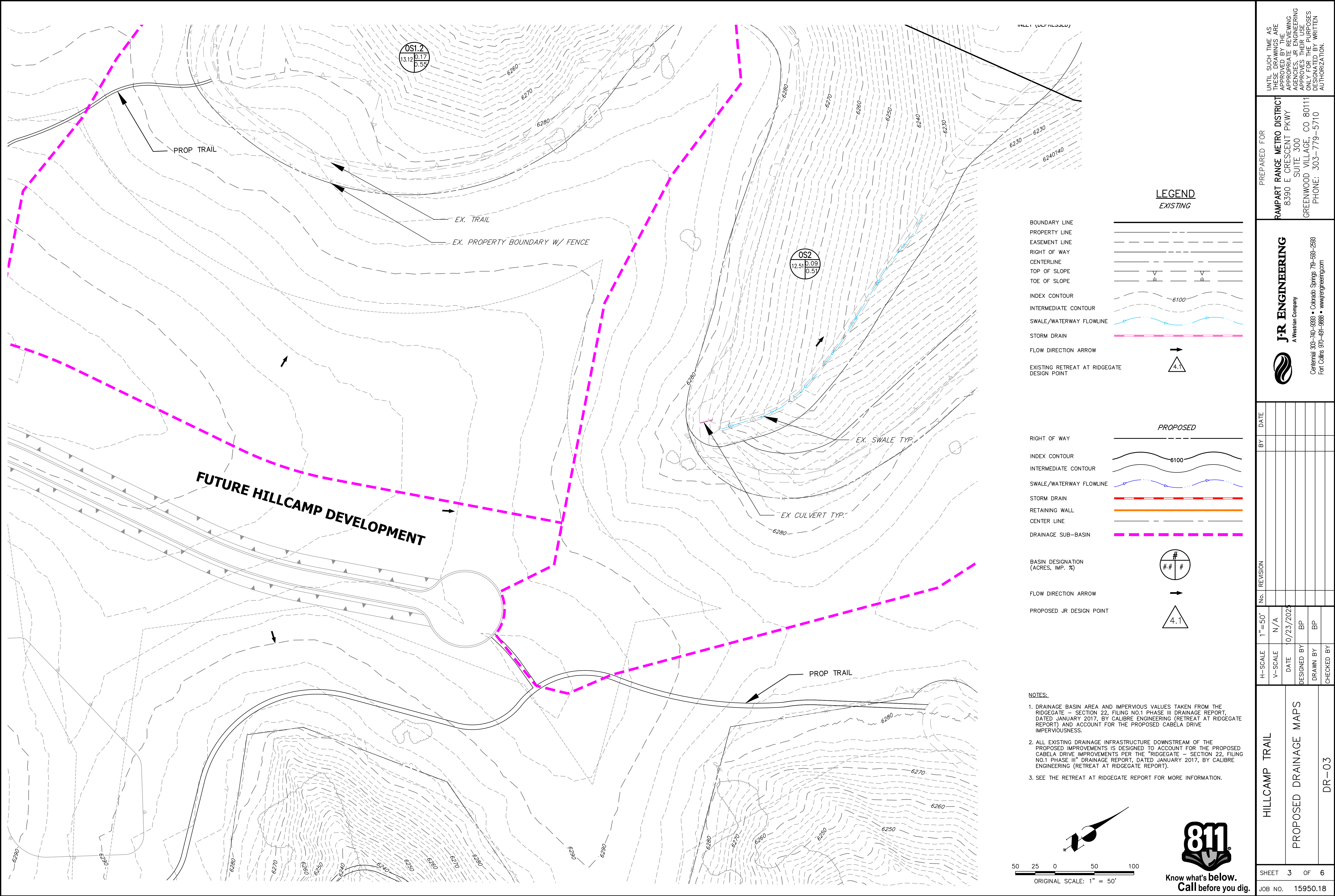
HILLCAMP TRAIL  
PROPOSED DRAINAGE MAPS  
DR-01





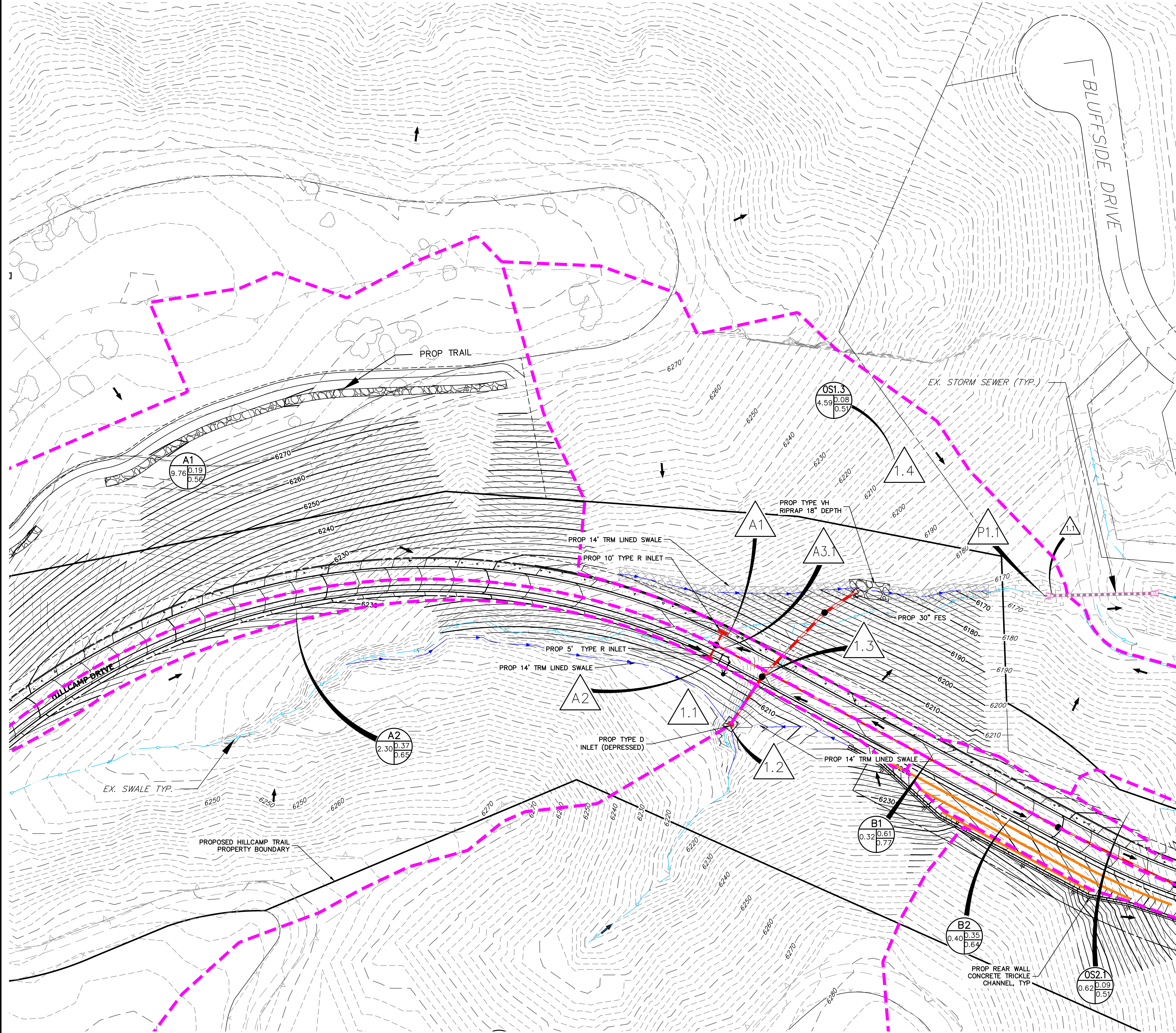
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| <br><b>J-R ENGINEERING</b><br>A Western Company<br><br>Central 303-740-9888 • Colorado Springs 719-583-2583<br>Fort Collins 970-491-9888 • <a href="http://www.jrengineering.com">www.jrengineering.com</a> |  |  |  |  |  |  | No.                                                                                                                                            |  |  |  |  |  |  | PREVISION   |  |  |  |  |  |  | BY |  |  |  |  |  |  | DATE |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  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| <b>HILLCAMP TRAIL</b>                                                                                                                                                                                                                                                                          |  |  |  |  |  |  | <b>PROPOSED DRAINAGE MAPS</b>                                                                                                                  |  |  |  |  |  |  | DESIGNED BY |  |  |  |  |  |  | BP |  |  |  |  |  |  |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  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|                        |  |                  |  |           |     |          |    |      |                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |                                                                                                                                                                                                        |
|------------------------|--|------------------|--|-----------|-----|----------|----|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HILLCAMP TRAIL         |  | H-SCALE          |  | 1"=50'    | No. | REVISION | BY | DATE | <div><div><b>J-R ENGINEERING</b><br/>A Western Company</div><div>Central 303-740-9888 • Colorado Springs 719-583-2583<br/>Fort Collins 970-491-9888 • <a href="http://www.jrengineering.com">www.jrengineering.com</a></div></div> | PREPARED FOR<br><b>RAMPART RANGE METRO DISTRICT</b><br>8390 E CRESCENT PKWY<br>SUITE 300<br>GREENWOOD VILLAGE, CO 80111<br>PHONE: 303-779-5710 | UNTIL SUCH TIME AS<br>THESE DRAWINGS ARE<br>APPROVED BY THE<br>LOCAL ENGINEERING<br>AGENCIES, JR ENGINEERING<br>APPROVES THEIR USE<br>ONLY FOR THE PURPOSES<br>DESIGNATED BY WRITTEN<br>AUTHORIZATION. |
| PROPOSED DRAINAGE MAPS |  | V-SCALE          |  | N/A       |     |          |    |      |                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |                                                                                                                                                                                                        |
|                        |  | DATE             |  | 0/23/2023 |     |          |    |      |                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |                                                                                                                                                                                                        |
|                        |  | DESIGNED BY      |  | BP        |     |          |    |      |                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |                                                                                                                                                                                                        |
|                        |  | DRAWN BY         |  | BP        |     |          |    |      |                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |                                                                                                                                                                                                        |
|                        |  | CHECKED BY       |  |           |     |          |    |      |                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |                                                                                                                                                                                                        |
| DR-03                  |  |                  |  |           |     |          |    |      |                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |                                                                                                                                                                                                        |
| SHEET 3 OF 6           |  | JOB NO. 15950.18 |  |           |     |          |    |      |                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |                                                                                                                                                                                                        |





**LEGEND**  
*EXISTING*

BOUNDARY LINE  
PROPERTY LINE  
EASEMENT LINE  
RIGHT OF WAY  
CENTERLINE  
TOP OF SLOPE  
TOE OF SLOPE

INDEX CONTOUR  
INTERMEDIATE CONTOUR  
SWALE/WATERWAY FLOWLINE  
STORM DRAIN  
FLOW DIRECTION ARROW  
EXISTING RETREAT AT RIDGEGATE  
DESIGN POINT

*PROPOSED*

RIGHT OF WAY  
INDEX CONTOUR  
INTERMEDIATE CONTOUR  
SWALE/WATERWAY FLOWLINE  
STORM DRAIN  
RETAINING WALL  
CENTER LINE  
DRAINAGE SUB-BASIN

BASIN DESIGNATION  
(ACRES, IMP. %)

FLOW DIRECTION ARROW  
PROPOSED JR DESIGN POINT

**NOTES:**

1. DRAINAGE BASIN AREA AND IMPERVIOUS VALUES TAKEN FROM THE RIDGEGATE - SECTION 22, FILING NO.1 PHASE III DRAINAGE REPORT, DATED JANUARY 2017, BY CALIBRE ENGINEERING (RETREAT AT RIDGEGATE REPORT) AND ACCOUNT FOR THE PROPOSED CABELA DRIVE IMPERVIOUSNESS.

2. ALL EXISTING DRAINAGE INFRASTRUCTURE DOWNSTREAM OF THE PROPOSED IMPROVEMENTS IS DESIGNED TO ACCOUNT FOR THE PROPOSED CABELA DRIVE IMPROVEMENTS PER THE "RIDGEGATE - SECTION 22, FILING NO.1 PHASE III" DRAINAGE REPORT, DATED JANUARY 2017, BY CALIBRE ENGINEERING (RETREAT AT RIDGEGATE REPORT).

3. SEE THE RETREAT AT RIDGEGATE REPORT FOR MORE INFORMATION.

ORIGINAL SCALE: 1" = 50'

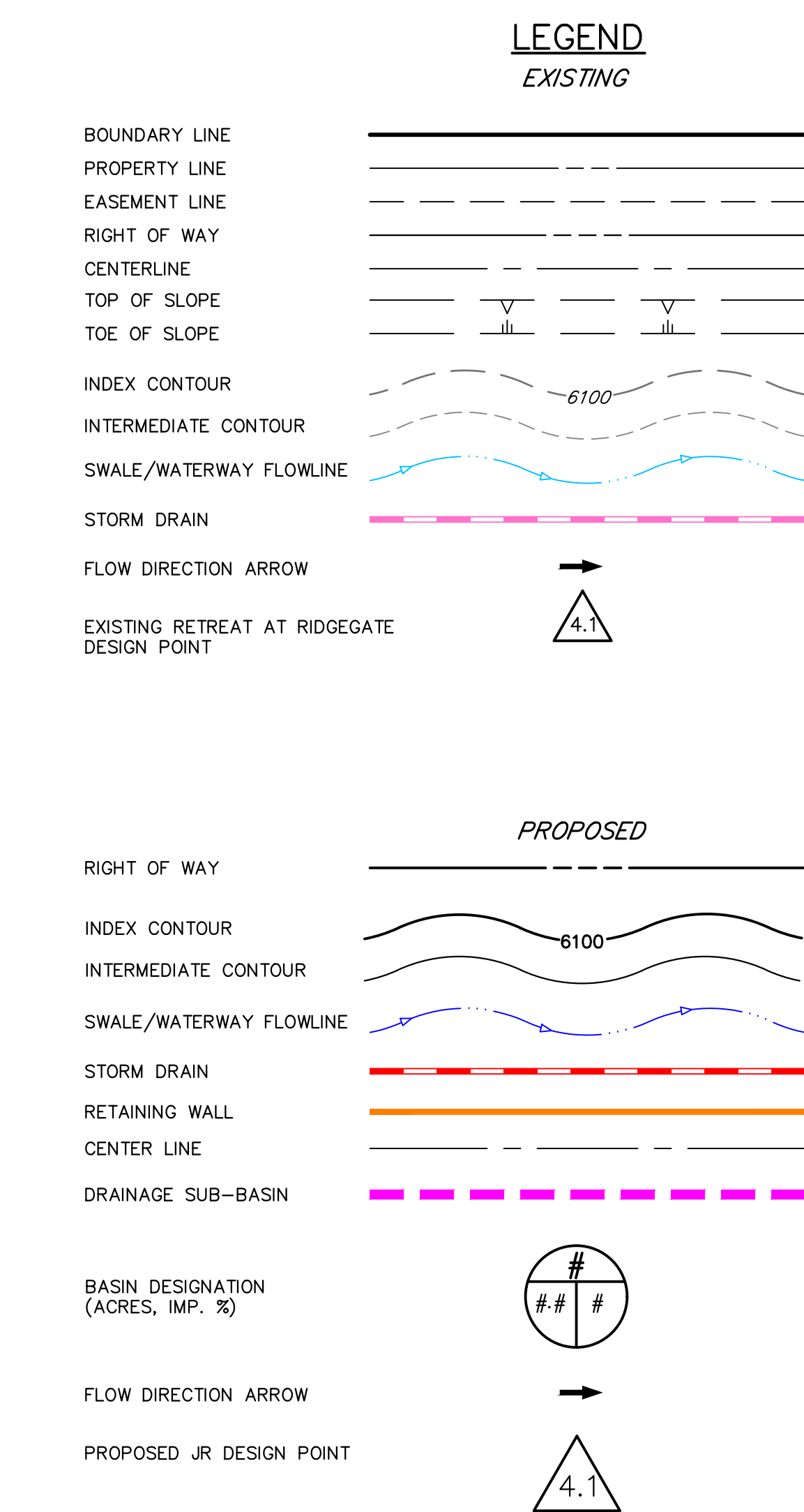
UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE AGENCIES, OR ENGINEERING APPROVES THEIR USE DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR  
**RAMPART RANGE METRO DISTRICT**  
8390 E CRESCENT PKWY  
SUITE 300  
GREENWOOD VILLAGE, CO 80111  
PHONE: 303-779-5710

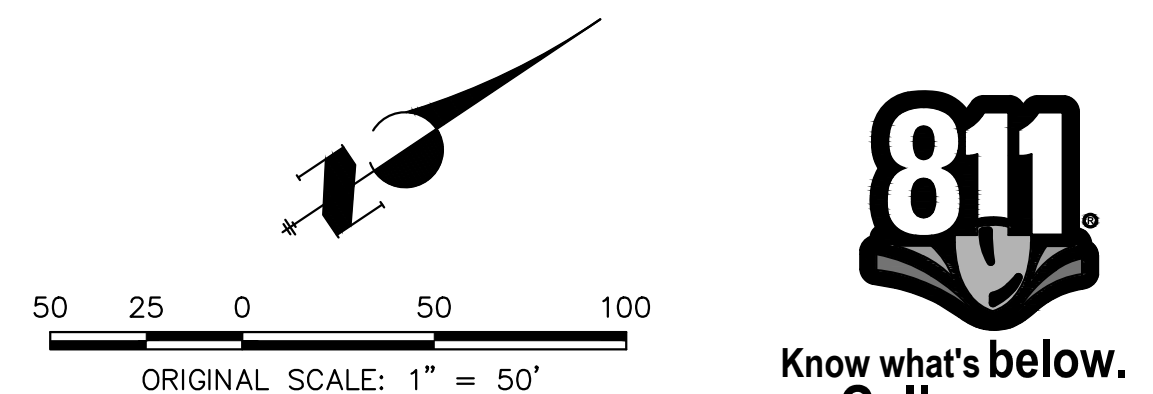
**J.R. ENGINEERING**  
A Westman Company  
Central 303-740-9888 • Colorado Springs 719-583-2583  
Fort Collins 970-491-9888 • [www.jrengineering.com](http://www.jrengineering.com)

| No.                    | REVISION | BY | DATE | H-SCALE<br>1"=50' | V-SCALE<br>N/A | DATE<br>10/23/2023 | DESIGNED BY<br>BP | DRAWN BY<br>BP | CHECKED BY |
|------------------------|----------|----|------|-------------------|----------------|--------------------|-------------------|----------------|------------|
|                        |          |    |      |                   |                |                    |                   |                |            |
| HILLCAMP TRAIL         |          |    |      |                   |                |                    |                   |                |            |
| PROPOSED DRAINAGE MAPS |          |    |      |                   |                |                    |                   |                |            |
| DR-04                  |          |    |      |                   |                |                    |                   |                |            |
| SHEET 4 OF 6           |          |    |      |                   |                |                    |                   |                |            |
| JOB NO. 15950.18       |          |    |      |                   |                |                    |                   |                |            |





1. DRAINAGE BASIN AREA AND IMPERVIOUS VALUES TAKEN FROM THE RIDGECATE – SECTION 22, FILING NO.1 PHASE III DRAINAGE REPORT, DATED JANUARY 2017, BY CALIBRE ENGINEERING (RETREAT AT RIDGECATE REPORT) AND ACCOUNT FOR THE PROPOSED CABELA DRIVE IMPERVIOUSNESS.
2. ALL EXISTING DRAINAGE INFRASTRUCTURE DOWNSTREAM OF THE PROPOSED IMPROVEMENTS IS DESIGNED TO ACCOUNT FOR THE PROPOSED CABELA DRIVE IMPROVEMENTS PER THE "RIDGECATE – SECTION 22, FILING NO.1 PHASE III" DRAINAGE REPORT, DATED JANUARY 2017, BY CALIBRE ENGINEERING (RETREAT AT RIDGECATE REPORT).
3. SEE THE RETREAT AT RIDGECATE REPORT FOR MORE INFORMATION.



|         |  |                |  |      |  |            |  |                        |  |      |  |                                                                                                                                                                                                                                                                                             |  |                                                                                                                                                |  |                                                                                                                                                                                                        |  |
|---------|--|----------------|--|------|--|------------|--|------------------------|--|------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| SHEET   |  | HILLCAMP TRAIL |  | No.  |  | 1"=50'     |  | BY                     |  | DATE |  |  <b>J-R ENGINEERING</b><br>A Westrair Company<br>Centennial 303-740-9883 • Colorado Springs 719-569-2983<br>Fort Collins 970-491-9888 • <a href="http://www.jrengineering.com">www.jrengineering.com</a> |  | PREPARED FOR<br><b>RAMPART RANGE METRO DISTRICT</b><br>8390 E CRESCENT PKWY<br>SUITE 300<br>GREENWOOD VILLAGE, CO 80111<br>PHONE: 303-779-5710 |  | UNTIL SUCH TIME AS<br>THESE DRAWINGS ARE<br>APPROVED BY THE<br>APPROPRIATE REVIEWING<br>AGENCIES, J-R ENGINEERING<br>APPROVES THEIR USE<br>FOR THE PROJECTS<br>DESIGNATED BY WRITTEN<br>AUTHORIZATION. |  |
| JOB NO. |  | 15950.18       |  | DATE |  | 10/23/2025 |  | DESIGNED BY            |  | BP   |  | DRAWN BY                                                                                                                                                                                                                                                                                    |  | BP                                                                                                                                             |  | CHECKED BY                                                                                                                                                                                             |  |
| 5       |  | OF             |  | 6    |  | DR-05      |  | PROPOSED DRAINAGE MAPS |  |      |  |                                                                                                                                                                                                                                                                                             |  |                                                                                                                                                |  |                                                                                                                                                                                                        |  |



