

**HAY CREEK VALLEY**  
**MDDP / PRELIMINARY DRAINAGE REPORT**

**Prepared for:**

**VIEW HOMES, INC.**  
555 Middle Creek Parkway Suite 500  
Colorado Springs, CO 80921  
(719) 382-9433

**Prepared by:**



2435 Research Parkway, Suite 300  
Colorado Springs, CO 80920  
(719) 575-0100  
fax (719) 572-0208

May 2023

Project No. 22.886.076

PCD File SP-23-01

**Engineer's Statement:**

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

\_\_\_\_\_  
Jesse Sullivan  
Registered Professional Engineer  
State of Colorado  
No. 55600

\_\_\_\_\_  
Date

**Owner/Developer's Statement:**

I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

**View Homes, Inc.**

Business Name

By: \_\_\_\_\_  
Timothy Buschar

\_\_\_\_\_  
Date

Title: Director of Land Acquisition and Development

Address: 555 Middle Creek Parkway Suite 500  
Colorado Springs, CO 80921

**El Paso County:**

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

\_\_\_\_\_  
Joshua Palmer, P.E.  
County Engineer / ECM Administrator  
Conditions:

\_\_\_\_\_  
Date



**TABLE OF CONTENTS**

CERTIFICATION ..... I

I. INTRODUCTION ..... 1

II. HYDROLOGIC METHODOLOGY ..... 2

III. PROJECT CHARACTERISTICS ..... 5

IV. BASIN HYDROLOGY ..... 6

V. HYDRAULIC ANALYSIS ..... 11

VI. STORM WATER QUALITY ..... 14

VII. EROSION CONTROL PLAN ..... 15

VIII. FLOODPLAINS ..... 15

IX. FEE DEVELOPMENT ..... 16

X. SUMMARY ..... 17

XI. REFERENCES ..... 18

6. APPENDICES ..... 19

**APPENDIX**

**A. Hydrologic and Hydraulic Calculations**

1. Rational Calculations

2. Pipe Sizing Calculations

3. Inlet Calculations

4. Culvert Calculations

5. Pond Calculations

6. HEC-HMS Results

7. Swale Calculations

**B. Standard Design Charts and Tables**

1. Runoff Coefficients

2. ECM Table 3-1

3. Shallow Flow Velocities

4. Basin Fee Schedule

5. ECM Table 10-4

**C. Report References**

1. HEC-2 Printout
2. FIRMette
3. Soil Survey

**D. Maps**

1. Vicinity Map
2. Offsite Basins Drainage Basin Map
3. Existing Conditions Drainage Basin Map
4. Proposed Conditions Drainage Basin Map

## I. INTRODUCTION

The Hay Creek Valley site is comprised of approximately 214.6 acres of unplatted and mostly undeveloped land. The site is located on Snow Mountain Heights approximately 700 feet south of its intersection with Hay Creek Road. The site is currently comprised of six (6) parcels which are to be subdivided into 20 lots and three (3) tracts. The existing access road will be replaced with a private road having a 60-foot right of way that will terminate with a cul-de-sac in the southwestern section of the site.

### *a. PURPOSE AND SCOPE OF STUDY*

The purpose of this Preliminary Drainage Report (FDR) is to evaluate the specific drainage infrastructure requirements which will provide compliance with the County Drainage Criteria Manual (DCM) and provide storm water conveyance for associated developments. This study will identify off-site, and on-site drainage patterns associated with respective land uses, provide hydrologic and hydraulic analysis of tributary basins and conveyance structures to a detention pond, and identify effective, safe routing to the downstream outfall. The improvements associated with this report maintain compliance with the DCM by providing full spectrum detention where necessary, which is to be constructed concurrently with the improvements associated with this FDR.

### *b. DBPS RELATED INVESTIGATIONS*

The proposed development is located within the Beaver Creek Drainage Basin. No Drainage Basin Planning Study (DBPS) has been completed for this basin.

### *c. GENERAL PROJECT DESCRIPTION*

The Hay Creek Valley Subdivision is located to the southwest of the intersection of Hay Creek Road and Snow Mountain Heights. The site is located as follows:

1. General Location: Southwest  $\frac{1}{4}$  of Section 34 and the Southeast  $\frac{1}{4}$  of Section 33, Township 11 South, Range 67 West of the 6<sup>th</sup> P.M. in the County of El Paso, State of Colorado.
2. Drainageway: The Hay Creek Subdivision is located on the southern edge of the Beaver Creek Drainage Basin. Most of the site drains north and into Hay Creek located approximately 200 feet north of the site. Hay Creek is a tributary to Beaver Creek which ultimately drains into Monument Creek. A small portion of the southeast corner of the site drains south into the Air Force Academy Major Drainage Basin.
3. Surrounding Developments: The site is bound Lots 1 through 8 Hay Creek Ranch Subdivision, and 4 unplatted parcels to the north, and by the Air Force Academy the south. The site is bound by Lot 2 Rush Subdivision and Lot 2 Block 1 Smiley Subdivision to the west, and an unplatted parcel to the east.
4. Lots to be Platted: The site is to be subdivided into 20 lots zoned RR-5 and 3 tracts.
5. Area of Disturbance: The Hay Creek Valley development is expected to disturb a total area of approximately 14.5 acres.
6. Streamside Zone: This project is not located within a streamside zone.
7. Vegetation: The Hay Creek Valley site contains a single-family residence, a barn and Snow Mountain Heights, a private road that provided access to the site from Hay Creek Road. The vegetation of the site consists of sparse, natural vegetative land cover in the form of grasses and shrubs with sparse trees throughout.

Refer to Appendix D for the Vicinity Map.

**d. SOILS CONDITIONS**

Soils can be classified in four different hydrologic groups, A, B, C, or D to help predict stormwater runoff rates. Hydrologic group “A” is characterized by deep, well-drained coarse-grained soils with a rapid infiltration rate when thoroughly wet and having a low runoff potential. Group “D” typically has a clay layer at or near to the surface, or a very shallow depth to impervious bedrock and has a very slow infiltration rate and a high runoff potential. See Soils Map, Appendix A. The following soil types are present in the Bradley Heights Metro District:

**Table 1.1 – NRCS Soil Survey for El Paso County – Hay Creek Valley**

<b>Soil ID Number</b>	<b>Soil</b>	<b>Hydrologic Classification</b>	<b>Drainage Class</b>	<b>Percent of Site</b>
38	Jarre-Tecolote Complex, 8 to 65 percent slopes	B	Well Drained	50.8%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	Well Drained	14.5%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	Well Drained	34.7%

**DATA SOURCES**

Topographical information for the district was found using a combination of *United States Geological Survey* (USGS) mapping as well as field surveying. The *Web Soil Survey*, created by the *Natural Resources Conservation Service*, was utilized to investigate the existing general soil types within the district. Offsite contours are taken from the *2018 El Paso County LIDAR* survey and/or USGS Quad Sheets.

**e. APPLICABLE CRITERIA AND STANDARDS**

This report has been prepared in accordance to the criteria set forth in the City of Colorado Springs and El Paso County DCM, El Paso County Engineering Criteria Manual (ECM) and El Paso County Resolutions 15-042 and 19-245. In addition to the DCM, the **Urban Storm Drainage Criteria Manuals, Volumes 1 through 3**, dated 2016 have been used to supplement the County’s Criteria Manual.

**II. Hydrologic Methodology**

**a. MAJOR BASINS AND SUBBASINS**

The majority of the Hay Creek Valley site is located within the Beaver Creek Drainage Basin with a small portion of the site tributary to the Air Force Academy Major Drainage Basin. Runoff presently flows overland until reaching an existing natural drainage swale located within the site. This drainage swale directs flows internally until discharging from near the northeastern corner of the site. Drainage from the developed road will be directed to pond 1, where the runoff will be treated for water quality and detained to maintain the historic major event discharge rate from the site.

**b. METHODOLOGY**

**i. UD Methods**

The hydrology for this project uses the both the **SCS Hydrograph Procedure** and the **Rational Method** as recommended by the Drainage Criteria Manual (DCM) for the minor and major storms. The Rational Method is used for drainage basins less than 100-acres in size. The Rational Method uses the following equation:

$$Q=C*i*A$$

Where:

- Q = Maximum runoff rate in cubic feet per second (cfs)
- C = Runoff coefficient
- i = Average rainfall intensity (inches per hour)
- A = Area of drainage sub-basin (acres)

Rational Method coefficients from 6-6 of the Drainage Criteria Manual for developed land were utilized in the Rational Method calculations. This method will be used primarily for sizing of storm sewer infrastructure. See Appendix B for more information.

**Time of Concentration**

The time of concentration consists of the initial time of overland flow and the travel time in a channel to the inlet or point of interest. A minimum time of concentrations of 5 minutes is utilized for urban areas. The Rational Calculation spreadsheet included in Appendix A shows an initial overland flow length, a channel or street flow length for each sub-basin, and also demonstrates the time of concentration calculations for initial (overland) and channel (or street) conditions. A maximum “True Initial” Flow Length of 300 feet will be used for pre-developed sub-basins and a maximum length of 100 feet will be used for Developed sub-basins for time of concentration calculations in compliance with the DCM.

**Rainfall Intensity**

The hypothetical rainfall depths for the 1-hour storm duration were derived using Table 6-2 of the Colorado Springs DCM (shown below). See Appendix B.

**Table 2.1 – Project Area 1-Hour Rainfall Depth**

Storm Recurrence Interval	Rainfall Depth (inches)
5-year	1.50
100-year	2.52

The rainfall intensity equation for the Rational Method was taken from Drainage Criteria Manual Volume 1 Figure 6-5.

**C-Factors**

C-factors for the Rational Method are based on anticipated land use and are taken from Table 6-6. Proposed single family residential is considered as the “1/8<sup>th</sup> Acre or Less” category. Anticipated multi-family areas are considered under the Business-Neighborhood Areas category and commercial areas under the Business-Commercial Areas category. Areas which will be future open spaces or

This is incorrect. Update. The development is single family residential property (5 ac or larger)

detention facilities are modeled under the Parks and Cemeteries category. Undeveloped or predevelopment areas are model under Undeveloped Areas-Historic Flow Analysis—Greenbelts, Agriculture category.

## ii. HEC-HMS Methods

The DCM requires the use of the SCS Hydrograph Procedure to compute storm water runoff quantities when the drainage area is greater than 100 acres. This report uses HEC-HMS for the routing and analysis of the site conditions.

### SCS Lag

The SCS lag calculations are completed as part of this report. Proposed development areas within the Hay Creek area are calculated based on the methodology indicated in the DCM Equations:

The Time of Concentration is the sum of overland flow time and the  $t_i$  values for the various consecutive flow segments:

$$t_c = t_i + t_{t1} + t_{t2} + t_{t3} \dots t_{tm} \quad (\text{Eq. 6-14})$$

Where:

$t_c$  = time of concentration ( hr)

$t_i$  = overland (initial) flow time (hr)

$t_{tm}$  = travel time for each flow segment (hr)

$m$  = number of flow segments

### Overland Flow:

$$T_i = 0.007(nL)^{0.8} / (P_2)^{0.5} S^{0.4} \quad (\text{Eq. 6-15})$$

Where:

$T_i$  = overland flow time (hr)

$n$  = Manning's roughness coefficient

$L$  = flow length (ft)

$P_2$  = 2-year, 24-hour rainfall (in)

$S$  = slope of hydraulic grade line (ft/ft)

### Concentrated Flow:

$$T_t = L / (3600 \cdot V) \quad (\text{Eq. 6-16})$$

Where:

$T_t$  = travel time (hr)

$L$  = flow length (ft)

$V$  = velocity (ft/s)

3,600 = conversion factor from seconds to hours

### Runoff Analysis

The site has been analyzed using HEC-HMS and the NRCS SCS method. The model indicates approximately 0.1 cfs decrease for Q100 event post development of the Hay Creek site. (**EX-Q5, EX-Q100, PR-Q5, and PR-Q100**) These models look at the 5, and 100-year events for onsite detention within the Hay Creek Site and demonstrate a slight reduction for the 100-year event. Print outs from each model can be found in Appendix A.

Hydrographs for the proposed pond 1 are taken from MHFD-Detention, where appropriate, and input to the model to represent the detention required within the development to maintain the historic flow discharge downstream of the site and provide water quality for the development in accordance with the DCM.

NRCS SCS curve numbers (CN) are taken from Table 6-10 of the DCM and weighted for each basin based on the soil and development types. As recommended in the DCM storms of 2-hour duration are used for the 5-year event. A 24-hour storm is used for the 100-year event. Lag times are calculated for the basins using the formulas from the DCM shown above.

### iii. HGL Profile Methods

Preliminary sizing of storm sewer has been completed using the Manning’s channel flow calculation.

Each future phase of development will be required to analyze the storm sewer to confirm DCM compliant capacity and velocity values. These future FDRs will provide HGL profiles modeled in Storm CAD using the Standard head loss method and head loss values taken from Table 9-4 of the DCM or via other methodology allowed by the DCM. HGL profiles may alternately be submitted with construction drawings as addenda to the appropriate Final Drainage Report as the project area is developed.

**Table 9-4. STORMCAD Standard Method Coefficients**

Bend Loss		
Bend Angle	K Coefficient	
0°	0.05	
22.5°	0.10	
45°	0.40	
60°	0.64	
90°	1.32	
LATERAL LOSS		
One Lateral K Coefficient		
Bend Angle	Non-surcharged	Surcharged
45°	0.27	0.47
60°	0.52	0.90
90°	1.02	1.77
Two Laterals K Coefficient		
45°	0.96	
60°	1.16	
90°	1.52	

## III. Project Characteristics

### a. BASIN LOCATION AND FLOWS

The Hay Creek Valley site is found on the southern border of the Beaver Creek Drainage Basin. In addition to the 214.6-acre site, there are off-site basins east, west, and south of the site that contribute a total tributary area of 98.5 acres. The Hay Creek Valley Road & Storm improvements are anticipated to disturb approximately 14.5 acres.

### b. MAJOR DRAINAGEWAYS

#### Beaver Creek

The majority of the Hay Creek Valley site is located within the Beaver Creek Drainage Basin. Runoff generated within this basin presently flows overland with slopes ranging from 5 to 50% until reaching

an existing natural drainage swale located within the site. This drainage swale directs the sites flows internally until discharging from the site near the northeastern corner. Drainage from the developed road will be directed to pond 1, where the runoff will be treated for water quality and detained to maintain the historic major event discharge rate from the site.

### **Air Force Academy**

The area along the southeastern border of the site drains southeast into the Air Force Academy Major Drainage Basin. Runoff generated within this basin presently flows overland with slopes ranging from 15 to 45% until exiting the site to the southeast into the adjacent property.

#### ***c. LAND USES***

Presently, the site is unplatted and consists mostly of undeveloped land. The 214.6-acre area is entirely zoned RR-5. The site will consist of residential lots containing 5-acres or more and three tracts, one containing the proposed pond 1, one containing the proposed roadway, and the other containing the Preble's mouse habitat which is undevelopable.

## **IV. BASIN HYDROLOGY**

- a. The *Pre-development conditions* for the Hay Creek Valley site have been analyzed and are presented by design points and are described as follows:

Predevelopment conditions have been analyzed using both the SCS Hydrograph Procedure and the routed Rational Method. The existing conditions will discuss the entry of runoff from off-site basins as it relates to the respective design point. Runoff generated, either on-site or off-site, drains overland towards the northeastern corner of the site where it is captured by the existing natural swale that runs northeast, exiting the site and releasing flows to be collected in Hay Creek. Generally, all undeveloped basins are considered to be vegetated with sparse grasses. A delineation of the basin boundaries can be found in Appendix D in drawings DR-01 and DR-02. Runoff calculations can be found in Appendix A. The existing runoff design points are described below:

**Design Point 1** (Rational ( $Q_5 = 3.5$  cfs,  $Q_{100} = 18.9$  cfs) HEC-HMS ( $Q_5 = 0.8$  cfs,  $Q_{100} = 4.1$  cfs)) (sub-basin: EX-OS1a; Area: 9.4 Ac.) (Slopes: 5 to 15%) This point represents the discharge from offsite sub-basin EX-OS1a into the site. Stormwater runoff will sheet flow to the east and into sub-basin EX-1.

**Design Point 2** (Rational ( $Q_5 = 12.3$  cfs,  $Q_{100} = 74.6$  cfs) HEC-HMS ( $Q_5 = 2.6$  cfs,  $Q_{100} = 15.7$  cfs)) (sub-basin: EX-OS1b; Area: 59.2 Ac.) (Slopes: 5 to 10%) This point represents the discharge from offsite sub-basin EX-OS1b into the site. Stormwater runoff will sheet flow to the east and into sub-basin EX-2.

**Design Point 3** (Rational ( $Q_5 = 7.8$  cfs,  $Q_{100} = 42.0$  cfs) HEC-HMS ( $Q_5 = 1.5$  cfs,  $Q_{100} = 8.0$  cfs)) (sub-basin: EX-OS2a; Area: 15.9 Ac.) (Slopes: 20 to 50%) This point represents the discharge from offsite sub-basin EX-OS2a into the site. Stormwater runoff will sheet flow to the north and into sub-basin EX-2.



**Design Point 4** (Rational ( $Q_5 = 1.3$  cfs,  $Q_{100} = 6.7$  cfs) HEC-HMS ( $Q_5 = 0.3$  cfs,  $Q_{100} = 1.4$  cfs)) (sub-basin: EX-OS2b; Area: 2.8 Ac.) (Slopes: 10 to 40%) This point represents the discharge from offsite sub-basin EX-OS2b into the site. Stormwater runoff will sheet flow to the north and into sub-basin EX-3.

**Design Point 5** (Rational ( $Q_5 = 1.6$  cfs,  $Q_{100} = 8.2$  cfs) HEC-HMS ( $Q_5 = 0.3$  cfs,  $Q_{100} = 1.6$  cfs)) (sub-basin: EX-OS2c; Area: 3.2 Ac.) (Slopes: 10 to 50%) This point represents the discharge from offsite sub-basin EX-OS2c into the site. Stormwater runoff will sheet flow to the north and into sub-basin EX-3.

**Design Point 6** (Rational ( $Q_5 = 2.7$  cfs,  $Q_{100} = 17.7$  cfs) HEC-HMS ( $Q_5 = 0.2$  cfs,  $Q_{100} = 2.0$  cfs)) (sub-basin: EX-OS3; Area: 8.2 Ac.) (Slopes: 10 to 45%) This point represents the discharge from offsite sub-basin EX-OS3 into the site. Stormwater runoff will sheet flow to the west and into sub-basin EX-5.

**Design Point 7** (Rational ( $Q_5 = 2.3$  cfs,  $Q_{100} = 15.6$  cfs) HEC-HMS ( $Q_5 = 2.3$  cfs,  $Q_{100} = 15.6$  cfs)) (sub-basin: EX-4; Area: 5.9 Ac.) (Slopes: 10 to 50%) This point represents the discharge from sub-basin EX-4 into the adjacent property. Stormwater runoff will sheet flow to the south and into the adjacent property then continue south along historic paths.

**Design Point 8** (Rational ( $Q_5 = 26.1$  cfs,  $Q_{100} = 153.1$  cfs) HEC-HMS ( $Q_5 = 5.4$  cfs,  $Q_{100} = 30.9$  cfs)) (sub-basins: EX-OS1b, EX-OS2a, EX-2; Area: 123.3 Ac.) (Slopes: 5 to 30%) This point represents the combined discharge from sub-basins EX-OS1b, EX-OS2a, and EX-2 into sub-basin EX-1. Stormwater runoff will sheet flow to the north to combine with the flows from sub-basin EX-1 before continuing along historic paths.

**Design Point 9** (Rational ( $Q_5 = 17.6$  cfs,  $Q_{100} = 106.5$  cfs) HEC-HMS ( $Q_5 = 2.9$  cfs,  $Q_{100} = 17.4$  cfs)) (sub-basins: EX-OS2b, EX-OS2c, EX-3; Area: 67.6 Ac.) (Slopes: 5 to 60%) This point represents the combined discharge from sub-basins EX-OS2b, EX-OS2c, and EX-3 into sub-basin EX-1. Stormwater runoff will sheet flow to the north to combine with the flows from sub-basin EX-1 before continuing along historic paths.

**Design Point 10** (Rational ( $Q_5 = 13.5$  cfs,  $Q_{100} = 85.3$  cfs) HEC-HMS ( $Q_5 = 1.8$  cfs,  $Q_{100} = 11.9$  cfs)) (sub-basins: EX-OS3, EX-5; Area: 51.0 Ac.) (Slopes: 5 to 50%) This point represents the combined discharge from sub-basins EX-OS3, and EX-5 into sub-basin EX-1. Stormwater runoff will sheet flow to the north to combine with the flows from sub-basin EX-1 before continuing along historic paths.

**Design Point 11** (Rational ( $Q_5 = 35.0$  cfs,  $Q_{100} = 210.9$  cfs) HEC-HMS ( $Q_5 = 11.2$  cfs,  $Q_{100} = 69.9$  cfs)) (sub-basins: EX-OS1a, EX-OS1b, EX-OS2a, EX-OS2b, EX-OS2c, EX-OS3, EX-1, EX-2, EX-3, EX-5; Area: 307.3 Ac.) (Slopes: 5 to 50%) This point represents the total discharge from the site. Stormwater runoff is collected in a natural swale and directed to the northeast. The channelized flow exits the site near the northeast corner of the site and continues north before draining into Hay Creek approximately 300 feet north of the site.

**Design Point HC** ( $Q_{100} = 127$  cfs) This point represents the stormwater flows in Hay Creek at the existing private 24"x36" culvert to the north of the site. The existing private 24"x36" culvert

conveys the flows in Hay Creek under the existing access road. The proposed flows in Hay Creek come from the HEC-2 analysis provided by the Regional Floodplain Administrator. The HEC-2 results are included in **appendix C**.

b. The ***fully developed conditions*** for the site are as follows:

Post development conditions have been analyzed using rational routed flow. The proposed conditions will discuss the entry of runoff from off-site basins as it relates to the respective design point. Runoff generated, either on-site or off-site, drains overland towards the northeastern corner of the site where it is captured by the existing natural swale that runs northeast, exiting the site and releasing flows to be collected in Hay Creek. Generally, the developed lots are considered to be residential lots containing 5 acres or more, having an imperviousness of 7.0%. Sub-basin PR-8, which contains the proposed roadway and ditch, has an imperviousness of 62.0%. Sub basins PR-9, and PR-10, containing the proposed pond 1 and open space are considered to have an imperviousness of 2.0%. A delineation of the basin boundaries can be found in Appendix D in drawing DR-03. Runoff calculations can be found in Appendix A. The existing runoff design points are described below:

**Design Point 1** (Rational ( $Q_5 = 3.5$  cfs,  $Q_{100} = 18.9$  cfs) HEC-HMS ( $Q_5 = 0.8$  cfs,  $Q_{100} = 3.6$  cfs)) (sub-basin: OS1a; Area: 9.4 Ac.) (Slopes: 5 to 15%) This point represents the discharge from offsite sub-basin OS1a into the site. Stormwater runoff will sheet flow to the east and into sub-basin PR-1.

**Design Point 2** (Rational ( $Q_5 = 12.3$  cfs,  $Q_{100} = 74.6$  cfs) HEC-HMS ( $Q_5 = 2.6$  cfs,  $Q_{100} = 14.2$  cfs)) (sub-basin: OS1b; Area: 59.2 Ac.) (Slopes: 5 to 10%) This point represents the discharge from offsite sub-basin OS1b into the site. Stormwater runoff will sheet flow to the east and into sub-basin PR-1.

**Design Point 3** (Rational ( $Q_5 = 2.2$  cfs,  $Q_{100} = 12.4$  cfs) HEC-HMS ( $Q_5 = 0.4$  cfs,  $Q_{100} = 1.8$  cfs)) (sub-basin: OS2a; Area: 5.0 Ac.) (Slopes: 20 to 50%) This point represents the discharge from offsite sub-basin OS2a into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-1.

**Design Point 4** (Rational ( $Q_5 = 4.0$  cfs,  $Q_{100} = 21.6$  cfs) HEC-HMS ( $Q_5 = 0.7$  cfs,  $Q_{100} = 3.2$  cfs)) (sub-basin: OS2b; Area: 8.6 Ac.) (Slopes: 20 to 50%) This point represents the discharge from offsite sub-basin OS2b into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-2.

**Design Point 5** (Rational ( $Q_5 = 1.3$  cfs,  $Q_{100} = 6.5$  cfs) HEC-HMS ( $Q_5 = 0.3$  cfs,  $Q_{100} = 1.2$  cfs)) (sub-basin: OS2c; Area: 2.3 Ac.) (Slopes: 20 to 50%) This point represents the discharge from offsite sub-basin OS2c into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-3.

**Design Point 6** (Rational ( $Q_5 = 2.9$  cfs,  $Q_{100} = 14.4$  cfs) HEC-HMS ( $Q_5 = 2.9$  cfs,  $Q_{100} = 14.4$  cfs)) (sub-basin: OS2d, OS2e; Area: 5.9 Ac.) (Slopes: 10 to 50%) This point represents the combined discharge from offsite sub-basins OS2d and OS2e into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-4.

**Design Point 7** (Rational ( $Q_5 = 1.5$  cfs,  $Q_{100} = 10.1$  cfs) HEC-HMS ( $Q_5 = 0.1$  cfs,  $Q_{100} = 0.9$  cfs)) (sub-basin: OS3a; Area: 4.9 Ac.) (Slopes: 5 to 40%) This point represents the discharge from sub-basin OS2f into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-6.

**Design Point 8** (Rational ( $Q_5 = 1.1$  cfs,  $Q_{100} = 7.6$  cfs) HEC-HMS ( $Q_5 = 0.1$  cfs,  $Q_{100} = 0.8$  cfs)) (sub-basins: OS3b; Area: 3.3 Ac.) (Slopes: 10 to 45%) This point represents the discharge from sub-basin OS3b into the site. Stormwater runoff will sheet flow to the west and into sub-basin PR-10.

**Design Point 9** (Rational ( $Q_5 = 3.1$  cfs,  $Q_{100} = 17.0$  cfs) HEC-HMS ( $Q_5 = 3.1$  cfs,  $Q_{100} = 17.0$  cfs)) (sub-basins: PR-5; Area: 5.9 Ac.) (Slopes: 10 to 50%) This point represents the discharge from sub-basin PR-5 into the adjacent property. Stormwater runoff will sheet flow to the south and into the adjacent property then continue south along historic paths.

**Design Point 10** (Rational ( $Q_5 = 9.0$  cfs,  $Q_{100} = 48.8$  cfs) HEC-HMS ( $Q_5 = 2.1$  cfs,  $Q_{100} = 9.6$  cfs)) (sub-basins: OS2b, PR-2; Area: 24.7 Ac.) (Slopes: 5 to 30%) This point represents the flows from sub-basins OS2b and PR-2 that have been collected in the roadside ditch that runs along the south side of the proposed roadway. The roadside ditch located upstream of Design Point 10 will be lined with Type M Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private 36-inch Flared End Section (FES) at Design Point 10 (DP-10). These flows are conveyed under the proposed roadway to the north, discharging via a proposed private 36-inch FES before continuing along historic paths.

**Design Point 11** (Rational ( $Q_5 = 4.5$  cfs,  $Q_{100} = 24.0$  cfs) HEC-HMS ( $Q_5 = 1.0$  cfs,  $Q_{100} = 4.6$  cfs)) (sub-basins: OS2c, PR-3; Area: 12.1 Ac.) (Slopes: 5 to 30%) This point represents the flows from sub-basins OS2c and PR-3 that have been collected in the roadside ditch that runs along the south side of the proposed roadway. The roadside ditch along this stretch will be protected with Type L Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private 30-inch FES at Design Point 11 (DP-11). These flows are conveyed under the proposed roadway to the north, discharging via a proposed private 30-inch FES before continuing along historic paths.

**Design Point 12** (Rational ( $Q_5 = 8.7$  cfs,  $Q_{100} = 46.8$  cfs) HEC-HMS ( $Q_5 = 2.7$  cfs,  $Q_{100} = 12.3$  cfs)) (sub-basins: OS2d, OS2e, PR-4; Area: 34.3 Ac.) (Slopes: 5 to 60%) This point represents the flows from sub-basins OS2d, OS2e and PR-4 that have been collected in the roadside ditch that runs along the south side of the proposed roadway. The roadside ditch along this stretch will be protected with Type L Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private 36-inch FES at Design Point 12 (DP-12). These flows are conveyed under the proposed roadway to the north, discharging via a proposed private 36-inch FES before continuing along historic paths.

**Design Point 13** (Rational ( $Q_5 = 14.4$  cfs,  $Q_{100} = 78.4$  cfs) HEC-HMS ( $Q_5 = 3.7$  cfs,  $Q_{100} = 17.0$  cfs)) (sub-basin: PR-6; Area: 44.7 Ac.) (Slopes: 5 to 60%) This point represents the flows from sub-basin PR-6a that has been collected in the roadside ditch that runs along the south side of the proposed roadway. The roadside ditch along this stretch will be protected with Type L Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private Type C Inlet at Design Point 13 (DP-13). These flows are conveyed under the proposed roadway to the north via proposed private 30" RCP, to be combined with the flows collected at Design Point 17 (DP-17).

**Design Point 14** (Rational ( $Q_5 = 5.6$  cfs,  $Q_{100} = 32.1$  cfs) HEC-HMS ( $Q_5 = 1.2$  cfs,  $Q_{100} = 6.1$  cfs)) (sub-basin: OS3a, PR-6b; Area: 18.4 Ac.) (Slopes: 5 to 10%) This point represents the flows from sub-basins OS3a, and PR-6b that have been collected in the roadside ditch that runs along the south side of the proposed roadway downstream of DP-13. The roadside ditch along this stretch will be protected with Type L Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private 30" FES at Design Point 14 (DP-14). These flows are conveyed under the proposed roadway to the west via proposed private 30" RCP.

**Design Point 15** (Rational ( $Q_5 = 27.4$  cfs,  $Q_{100} = 153.0$  cfs) HEC-HMS ( $Q_5 = 11.8$  cfs,  $Q_{100} = 58.1$  cfs)) (sub-basins: OS1a, OS1b, OS2a, OS2b, OS2c, OS2d, OS2e, PR-1, PR-2, PR-3, PR-4; Area: 215.4 Ac.) (Slopes: 5 to 50%) This point represents the outfall from the proposed private swale located along the northwestern border of the proposed private pond (pond 1). The combined flows from sub-basins OS1a, OS1b, OS2a, OS2b, OS2c, OS2d, OS2e, PR-1, PR-2, PR-3, and PR-4 are collected in the proposed swale and diverted around pond 1 toward the proposed stilling basin at Design Point 17. The proposed swale will be lined with Type L Rip Rap.

**Design Point 16a** (Rational ( $Q_5 = 5.3$  cfs,  $Q_{100} = 11.1$  cfs) HEC-HMS ( $Q_5 = 1.5$  cfs,  $Q_{100} = 5.6$  cfs)) (sub-basins: PR-8a; Area: 5.11 Ac.) (Slopes: 2.8 to 6%) This point represents the Proposed Private Type-C inlet located on the north side of the proposed roadway southwest of the proposed pond (pond 1). All flows from the proposed roadway will drain to the north and into the northern roadside ditch. All runoff from the proposed roadway will drain to the Type C inlet at Design Point 16a. The flows collected in the inlet will be conveyed downstream towards Design Point EDB-IN via proposed private 18-inch RCP pipe.

**Design Point 16b** (Rational ( $Q_5 = 13.8$  cfs,  $Q_{100} = 59.2$  cfs) HEC-HMS ( $Q_5 = 4.9$  cfs,  $Q_{100} = 22.0$  cfs)) (sub-basins: PR-6, PR-8a; Area: 49.88 Ac.) (Slopes: 2.8 to 6%) This point represents the combination of flows from design points 13 and 16a. The combined flows will be conveyed downstream towards Design Point EDB-IN via proposed private 18-inch RCP pipe.

**Design Point EDB-IN** (Rational ( $Q_5 = 14.8$  cfs,  $Q_{100} = 63.3$  cfs) HEC-HMS ( $Q_5 = 5.1$  cfs,  $Q_{100} = 22.4$  cfs)) (sub-basin: PR-6, PR-8a, PR-8b, PR-9; Area: 52.69 Ac.) (Slopes: 2.8 to 50%) This point represents the total discharge into the Proposed Private Extended Detention Basin (EDB). Flows will be treated for water quality and released at such a rate that the overall discharge from the site does not increase under proposed conditions.

**Design Point EDB-OUT** ( $Q_5 = 0.8$  cfs,  $Q_{100} = 3.5$  cfs) (sub-basins: PR-6, PR-8a, PR-8b, PR-9; Area: 52.69 Ac.) (Slopes: 2.8 to 50%) This point represents the discharge from the EDB. The discharge from pond 1 will be routed downstream via proposed private 18-inch RCP pipe that will convey the flows to the proposed private stilling basin located at Design Point 17.

**Design Point 17** ( $Q_5 = 31.7$  cfs,  $Q_{100} = 176.3$  cfs) (design points: DP-EDB-OUT, DP-14, DP-15; Area: 287.6 Ac.) (Slopes: 2.8 to 50%) This point represents the proposed private stilling basin located north of proposed pond 1. Flows from Design Points 13, 14, and EDB-OUT all discharge to the stilling basin which will release the flows at a velocity of 4.02 ft/sec.

**Design Point 18** (Rational ( $Q_5 = 37.5$  cfs,  $Q_{100} = 212.1$  cfs) HEC-HMS ( $Q_5 = 13.8$  cfs,  $Q_{100} = 69.8$  cfs)) (sub-basins: DP-18, OS3b, PR-10; Area: 307.3 Ac.) (Slopes: 2.8 to 60%) This point represents

the total discharge from the site. Stormwater runoff from the site will continue north in the existing channel before draining into Hay Creek, a tributary of Beaver Creek.

**Design Point HC** ( $Q_{100} = 127$  cfs) This point represents the stormwater flows in Hay Creek at the proposed private dual 42” culverts to the north of the site. The proposed private dual 42” culverts convey the flows in Hay Creek under the proposed access road. Culvert calculations for the existing and proposed culvert at DP-HC can be found in Appendix A. The proposed flows in Hay Creek come from the HEC-2 analysis provided by the Regional Floodplain Administrator. The HEC-2 results are included in **appendix C**.

**Notes:**

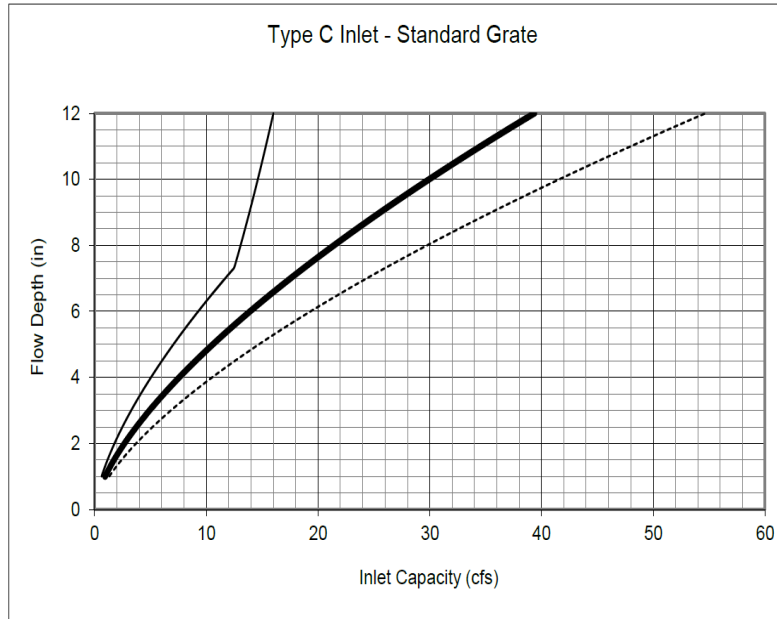
- **MHFD-Detention Analysis for the proposed detention pond (pond 1) which will be constructed as part of the Improvements associated with Hay Creek Valley can be found in Appendix A of this report.**
- **Tables summarizing inlet sizes and capacities, storm pipe sizes and capacities and swale capacities for the proposed improvements can be found in Appendix A and/or in the following section.**
- **All ponds and associated infrastructure are to be owned and maintained by the HOA.**
- **The ratio of the total site discharge in proposed conditions vs existing conditions is 1.0, representing no significant increase in flows in the proposed condition.**
- **The hydraulic model for Beaver Creek indicated approximately 127 cfs from the entire Hay Creek tributary basin which contains the development. We therefore believe the above hydrological analysis with the Rational Method to be quite conservative.**

## V. Hydraulic Analysis

### a. Proposed Inlets

<i>INLET SUMMARY</i>										
<i>HAY CREEK VALLEY</i>										
<i>DESIGN POINT or SUB-BASIN</i>	<i>SUB-BASINS/ DESCRIPTION</i>	<i>TOTAL AREA (AC)</i>	<i>INLET</i>			<i>Q(5) TOTAL INFLOW</i>	<i>Q5 INLET CAPACITY</i>	<i>Q(100) BYPASS FLOWS (cfs)</i>	<i>Q(100) TOTAL INFLOW (cfs)</i>	<i>MAX INLET CAPACITY</i>
			<i>SIZE (Ft.)</i>	<i>TYPE</i>	<i>CONDITION</i>					
16	PR-7, PR-8a	6.32	3	C	SUMP	5.4	5.4	0.0	12.3	12.3

Note: Inlet sizes indicated are minimums. Larger sizes may be used in the construction plans for conservative design.



Inlet Overflow Routing	
Inlet	Overflow Routing Under Sump Inlet Blockage Conditions
16	Blockage of this inlet will cause runoff to surcharge the sump and direct runoff into the proposed Extended Detention Basin.

**b. Swales**

The initial swale analysis was performed using Hydraflow Express to determine flow depths and velocities. Per the El Paso County DCM Volume 1, Chapter 6, section 6.5.2. Channel Velocity, **“Concrete, riprap, or soil cement linings as approved by the City/County shall be used where channel bottom velocities exceed 6.0 ft/sec.”** Table 10-4 is included in Appendix B for reference. Further analysis was performed using the Federal Highway Administration (FHWA) Hydraulic Toolbox for those sections having flow velocities initially calculated to be greater than 6 ft/sec. This tool helps determine the stability of each proposed swale cross section based on the flows, cross section, and type of material used for the swale. Concentrated stormwater flows that drain along the existing drainage path through sub-basin PR-1 will be collected in a proposed swale north of the proposed roadside ditch. A 25-foot drainage easement will extend from proposed lot 1 to lot 9 along the existing drainage path to ensure that future developments do not impede the flow of stormwater through the site. The swale calculations have been applied to the most critical swale scenarios for the Site. The table below summarizes the various swales included as part of these improvements.

<b>Swale Capacities HAY CREEK VALLEY</b>						
<b>Design Point</b>	<b>Armoring Type</b>	<b>Anticipated Slope %</b>	<b>CHANNEL CAPACITY MAJOR STORM (cfs)</b>	<b>Q(100) TOTAL FLOW (cfs)</b>	<b>Q(100) VELOCITY (FT/S)</b>	<b>Q100 Flow Depth (ft)</b>
10	Type L Rip Rap*	6.0%	9.6	9.6	2.92	0.97
11	Vegetation	2.8%	4.6	4.6	1.78	0.86
12	Type L Rip Rap*	4.8%	12.3	12.3	2.85	1.11
13	Type L Rip Rap*	3.6%	17.0	17.0	2.79	1.32
14	Type L Rip Rap*	2.8%	6.1	6.1	2.65	0.87
15	Type L Rip Rap*	4.5%	58.1	58.1	4.06	1.14
16 (2.8%)	Type L Rip Rap*	2.8%	5.6	5.6	1.93	0.91
16 (3.6%)	Type L Rip Rap*	3.6%	5.6	5.6	2.59	0.86
16 (4.8%)	Type L Rip Rap*	4.8%	5.6	5.6	2.24	0.80
16 (6.0%)	Type L Rip Rap*	6.0%	5.6	5.6	2.02	0.76

\*Turf Reinforcement Mat (TRM) may be used in place of Rip Rap.

**c. Driveway Culverts**

Upon the development of the proposed lots, it will be necessary to place culverts along the roadside ditches to convey flows through driveways. Initial calculations for driveway culvert sizing at each lot is summarized in the table below:

<b>Driveway Culvert Sizes HAY CREEK VALLEY</b>			
<b>Lot</b>	<b>Q(100) TOTAL FLOW IN DITCH (cfs)</b>	<b>Anticipated Slope %</b>	<b>Minimum Culvert Inside Diameter (in)</b>
1-10	12.3	2.8%	24
11-12	9.6	6.0%	18
13	4.6	2.8%	18
14-16	12.3	4.8%	24
17-19	17.0	2.8%	24
20	6.1	2.8%	18

**d. Detention**

Due to the development of the site and the resulting increase in imperviousness, detention will be required to limit the 100-year discharge to historic rates. Pond 1 has been designed to over detain stormwater flows to reduce the total site discharge to predevelopment levels. The proposed private Extended Detention Basin (EDB) will provide detention and water quality treatment for stormwater runoff generated within the Hay Creek Valley site. Pond 1 will outfall to a stilling basin to the north. Flows from the pond will combine with flows from Design Points 14 and 15 in the stilling basin which will release the flows with a velocity of 4.02 ft/sec during the 100-year storm event which is considered by the DCM to be stable for the major storm event in the context of open channel flows. The stilling basin will provide a suitable outfall for the concentrated flows into the existing natural swale. The proposed stilling basin has a depth of 24-inches and, when at max capacity, will infiltrate within 40 hours. Infiltration rates have been determined using the  $f_o$  value for type B soils in Table 6-7 of the MHFD Drainage Criteria Manual Volume 1 (below). Initial design information including calculations are included in Appendix A. Calculations will be finalized with the Final Drainage Report. The table below summarizes the detention provided for this development.

<b>Proposed Pond Summary HAY CREEK VALLEY</b>								
Pond	Tributary Area	% Impervious	Pre-Development Peak		Pond Outflow		Pre vs. Post Ratio	
			Q5	Q100	Q5	Q100	Q5	Q100
Pond 1	52.69	12.55	11.4	52.1	0.8	3.5	0.1	0.1

**Table 6-7. Recommended Horton’s equation parameters**

NRCS Hydrologic Soil Group	Infiltration (inches per hour)		Decay Coefficient— $a$
	Initial— $f_i$	Final— $f_o$	
A	5.0	1.0	0.0007
B	4.5	0.6	0.0018
C	3.0	0.5	0.0018
D	3.0	0.5	0.0018

**Emergency Overflow**

**Pond 1:** If the emergency overflow weir receives flows, these flows will continue downstream along the existing natural swale and drain into Hay Creek.

**VI. Storm Water Quality**

Per the DCM Volume 1, Chapter 7, Section 2, El Paso County recommends the MHFD Four Step Process for receiving water protection that focuses on reducing runoff by disconnecting impervious area, eliminating “unnecessary” impervious area and encouraging infiltration into soils that are suitable, treat and slowly release the WQCV, stabilize stream channels, and implement source controls. The four-step process has been completed below.



**Step 1:      Employ Runoff Reduction Practices.**

- The low-density nature of this development and the fact that none of the streets will have curb and gutter, means that most, if not all, runoff from impervious surfaces will sheet flow across pervious areas to grass lined swales.

**Step 2:      Stabilize Drainageways.**

- The site is in the Beaver Creek Drainage Fee Basin. Drainage fees, to be paid by the relevant Hay Creek Valley developers at the time of platting, will help fund proposed channel improvements. Information on planned future improvements to the Beaver Creek channel was unavailable for this report.

**Step 3:      Provide Water Quality Capture Volume (WQCV).**

- As required by the DCM, runoff from the proposed streets which is feasible to detain, is directed into a proposed detention pond (pond 1). The pond has been designed to meet the DCM standards for the release rates of Full Spectrum Detention Ponds for Water Quality Capture Volumes, and all of the other storm events listed in the MHFD-Detention spreadsheet. The lots containing large lot residential sites are excluded from WQ treatment per section I.7.1.b.5 of the ECM.

**Step 4:      Consider Need for Industrial and Commercial BMPs.**

- There are no commercial or industrial components of this development, therefore no BMPs of this nature are required.

## **VII. Erosion Control Plan**

A grading and erosion control plan (GEC) for the proposed improvements will be submitted for review as separate submittals by the various developments. These will incorporate straw wattles, straw bale check dams, silt fence, vehicle tracking control, inlet & outlet control, sedimentation basins and other best management practices (CMs) identified in the DCM Volume 2.

## **VIII. Floodplains**

Per the *Flood Insurance Rate Map (FIRM) 08041CO267 G*, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), Hay Creek, a Tributary to Beaver Creek runs along the northern bound of the Hay Creek Valley area and has designated 100-year floodplain. The developed portion of the site is generally not touched by the 100 year floodplain, however the road improvements associated with this site will cross the FEMA floodplain at the location where the site access easement crosses Hay Creek. Draft model backed BFEs for this area have been developed as part of Phase 1 for the ongoing El Paso County, CO, Risk MAP Project. The data have been reviewed and approved through FEMA's QA/QC process (May 11, 2022) and are currently in the MIP (Case No. 19-08-0037s). This data is considered "FEMA APPROVED BFEs" This will need to be shown on the prelim plan and plat. Refer to the map in Appendix C.

## IX. Fee Development

### a. UNDEVELOPED PLATTABLE LAND

The Hay Creek Valley site is located within the Beaver Creek Drainage Fee Basin and within previously unplatted land. The 2023 Drainage Basin Fees for the Beaver Creek Drainage Fee Basin are: \$13,797/impervious acre for the Drainage Fee and \$0.00/impervious acre for the Bridge Fee. Per the *El Paso County Engineering Criteria Manual*, Appendix L, Section 3.10.1a Fee Reductions for Low Density Lots, with the site being developed into 5-acre lots, drainage fees may be reduced by 25%.

Hay Creek Final Drainage Report 2023 Drainage and Bridge Fees							
	Platted Area (Acres)	Imperviousness (%)	Platted Area (Imp. ac.)	Fee/ Imp. Acre	Fee Due	Drainage Fee Reduction	Fee Due at Platting
Drainage Fee	214.63	8.11	17.406	\$13,797.00	\$240,150.58	\$60,037.65	\$180,112.93
Bridge Fee	214.63	8.11	17.406	\$0.00	\$0.00	\$0.00	\$0.00
<b>TOTAL</b>							<u>\$180,112.93</u>

### Cost Estimate

Table 12.1

<b>Engineer's Estimate of Probable Construction Costs</b>				
<b>BEAVER CREEK</b>				
<b>HAY CREEK VALLEY</b>				
<b>Private Non-Reimbursable</b>				
Item	Unit	Quantity	Unit Cost	Extension
18" RCP/HP	LF	185	\$76.00	\$14,060.00
30" RCP/HP	LF	575	\$114.00	\$65,550.00
36" RCP/HP	LF	385	\$140.00	\$53,900.00
18" FES	EA	1	\$456.00	\$456.00
30" FES	EA	6	\$684.00	\$4,104.00
36" FES	EA	4	\$840.00	\$3,360.00
Type C Inlet	EA	1	\$5,611.00	\$5,611.00
STM MH	EA	3	\$7,734.00	\$23,202.00
RIPRAP	CY	2,740	\$135.00	\$369,900.00
Sub Total				\$540,143.00
10% Contingency				\$54,014.30
<b>TOTAL:</b>				<b>\$594,157.30</b>

<i>Engineer's Estimate of Probable Construction Costs</i>				
<b>BEAVER CREEK</b>				
<b>HAY CREEK VALLEY</b>				
<b>Permanent BMP (EDB): Private Non-reimbursable</b>				
Item	Unit	Quantity	Unit Cost	Extension
DETENTION POND GRADING	EA	1	\$35,000.00	\$35,000.00
2' TRICKLE CHANNEL	LF	316	\$200.00	\$63,200.00
FOREBAY	EA	1	\$40,000.00	\$40,000.00
OUTLET STRUCTURE	EA	1	\$40,000.00	\$40,000.00
EMERGENCY SPILLWAY	EA	1	\$5,000.00	\$5,000.00
STILLING BASIN	EA	1	\$30,000.00	\$30,000.00

Sub Total           \$213,200.00

10% Contingency   \$21,320.00

<b>TOTAL:</b>	<b>\$234,520.00</b>
---------------	---------------------

<b>Overall Total</b>	<b>\$828,677.30</b>
----------------------	---------------------

Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, or over the contractor's method of determining prices, or over the competitive bidding or market conditions, the opinion of probable construction costs provided herein are made on the basis of the engineer's experience and qualifications and represents the best judgment as an experienced and qualified professional familiar with the construction industry. The engineer cannot, and does not guarantee that proposals, bid or actual construction costs will not vary from the opinion of probable costs.

## **X. Summary**

This report demonstrates that the proposed infrastructure associated with Hay Creek Valley is in conformance with the El Paso County Drainage Criteria Manual, Volumes 1 and 2, October 2018 and all previously approved studies related to the project site. Stormwater flows will generally remain the same in post-development conditions (Rational ( $Q_5 = 37.5$  cfs,  $Q_{100} = 212.1$  cfs) HEC-HMS ( $Q_5 = 13.8$  cfs,  $Q_{100} = 69.8$  cfs)) as in pre-development conditions (Rational ( $Q_5 = 35.0$  cfs,  $Q_{100} = 210.9$  cfs) HEC-HMS ( $Q_5 = 11.2$  cfs,  $Q_{100} = 69.9$  cfs)). These proposed improvements should not adversely affect downstream or surrounding developments and are in conformance with the pertinent studies for the area.

## **XI. References**

1. *El Paso County and City of Colorado Springs Drainage Criteria Manual, Volume 1 & 2*, El Paso County, May 2014
2. *El Paso County Engineering Criteria Manual*, El Paso County, Rev. December 2016
3. *Web Soil Survey of El Paso County Area, Colorado. Unites States Department of Agriculture Soil Conservation Service.*
4. *Flood Insurance Rate Maps for El Paso County, Colorado and Incorporated Areas, Panel 279 of 1275, Federal Emergency Management Agency*, Effective Date December 7, 2018.
5. *Urban Storm Drainage Criteria Manual, Vol. 1-3* by Urban Drainage and Flood Control District (UDFCD), January 2016

**6. Appendices**

## *APPENDIX A*

### *HYDROLOGIC AND HYDRAULIC CALCULATIONS*

Project Name: Hay Creek  
 Project Location: El Paso County, Colorado  
 Designer: WCG  
 Notes: EXISTING CONDITIONS

Channel Flow Type Key  
 Heavy Meadow 2  
 Tillage/Field 3  
 Short Pasture and Lawns 4  
 Nearly Bare Ground 5  
 Grassed Waterway 6  
 Paved Areas 7

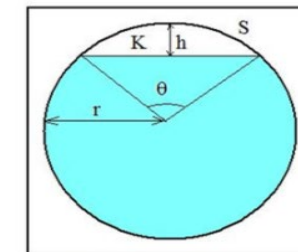
Avg. Channel Velocity 4 ft/s (If specific channel vel is used, this will be ignored)  
 Avg. Slope for Initial Flow 0.04 ft/ft (If Elevations are used, this will be ignored)

Sub-basin	Comments	Area		Soil Group	Rational 'C' Values										Flow Lengths						Tc (min)	Rainfall Intensity & Rational Flow Rate						Sub-basin							
		sf	acres		7%			100%			2%				Initial	True Initial	Channel	True Channel	Average (decimal)	Initial		Average (%)	Channel Flow Type (See Key above)	Velocity (ft/s)	Channel	Total	i5		Q5	HEC-HMS Q5	i100	Q100	HEC-HMS Q100		
					C5	C100	Area (SF)	C5	C100	Area (SF)	C5	C100	Area	C5																				C100	Area
EX-OS1a		407292	9.35	0.0146	B	0.12	0.39	407292	0.90	0.96		0.09	0.36		0.12	0.39	7.00%	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	3.5	0.8	5.15	18.9	4.1	EX-OS1a
EX-OS1b		2579029	59.21	0.0925	B	0.12	0.39	1173596	0.90	0.96		0.09	0.36	1405433	0.10	0.37	4.28%	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	12.3	2.6	3.34	74.6	15.7	EX-OS1b
EX-OS2a		692771	15.90	0.0248	B	0.12	0.39		0.90	0.96	25423	0.09	0.36	667348	0.12	0.38	5.60%	300	300	84	84	0.31	9.70	31.3	4	3.50	0.40	10.10	4.09	7.8	1.5	6.87	42.0	8.0	EX-OS2a
EX-OS2b		120503	2.77	0.0043	B	0.12	0.39		0.90	0.96	6033	0.09	0.36	114470	0.13	0.39	6.91%	300	300	113	113	0.15	12.31	14.8	4	2.69	0.70	13.00	3.69	1.3	0.3	6.20	6.7	1.4	EX-OS2b
EX-OS2c		137929	3.17	0.0049	B	0.12	0.39		0.90	0.96	6548	0.09	0.36	131381	0.13	0.39	6.65%	268	268	0	0	0.17	11.09	17.2	4	2.90	0.00	11.09	3.94	1.6	0.3	6.62	8.2	1.6	EX-OS2c
EX-OS3		354850	8.15	0.0127	B	0.12	0.39		0.90	0.96	475	0.09	0.36	354375	0.09	0.36	2.13%	300	300	265	265	0.16	12.54	15.8	4	2.78	1.59	14.12	3.56	2.7	0.2	5.98	17.7	2.0	EX-OS3
EX-1		2441168	56.04	0.0876	B	0.12	0.39		0.90	0.96	30061	0.09	0.36	2411107	0.10	0.37	3.21%	300	300	4763	4763	0.05	18.23	5.0	4	1.57	50.72	68.94	1.44	8.2	1.6	2.43	50.4	9.9	EX-1
EX-2		2100638	48.22	0.0754	B	0.12	0.39		0.90	0.96	46438	0.09	0.36	2054200	0.11	0.37	4.17%	300	300	2795	2795	0.06	16.66	6.4	4	1.77	26.31	42.96	1.96	10.3	2.0	3.29	59.7	11.2	EX-2
EX-3		2684942	61.64	0.0963	B	0.12	0.39		0.90	0.96	31890	0.09	0.36	2653052	0.10	0.37	3.16%	300	300	2002	2002	0.11	13.86	11.4	4	2.36	14.12	27.97	2.52	15.6	2.3	4.23	96.6	14.7	EX-3
EX-4		256265	5.88	0.0092	B	0.12	0.39		0.90	0.96	0	0.09	0.36	256265	0.09	0.36	2.00%	206	206	0	0	0.29	8.53	28.6	4	3.50	0.00	8.53	4.35	2.3		7.30	15.6	EX-4	
EX-5		1865454	42.82	0.0669	B	0.12	0.39		0.90	0.96	18117	0.09	0.36	1847337	0.10	0.37	2.95%	300	300	1427	1427	0.11	14.18	10.7	4	2.29	10.39	24.56	2.71	11.4	1.5	4.55	71.8	10.0	EX-5
DESIGN POINTS	Sub-basins																																		DESIGN POINTS
1	EX-OS1a	407292	9.35	0.0146	B	0.12	0.39	407292	0.90	0.96	0	0.09	0.36	0	0.12	0.39	7.0%	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	3.5	0.8	5.15	18.9	4.1	1
2	EX-OS1b	2579029	59.21	0.0925	B	0.12	0.39	1173596	0.90	0.96	0	0.09	0.36	1405433	0.10	0.37	4.3%	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	12.3	2.6	3.34	74.6	15.7	2
3	EX-OS2a	692771	15.90	0.0248	B	0.12	0.39		0.90	0.96	25423	0.09	0.36	667348	0.12	0.38	5.6%	300	300	84	84	0.31	9.70	31.3	4	3.50	0.40	10.10	4.09	7.8	1.5	6.87	42.0	8.0	3
4	EX-OS2b	120503	2.77	0.0043	B	0.12	0.39		0.90	0.96	6033	0.09	0.36	114470	0.13	0.39	6.9%	300	300	113	113	0.15	12.31	14.8	4	2.69	0.70	13.00	3.69	1.3	0.3	6.20	6.7	1.4	4
5	EX-OS2c	137929	3.17	0.0049	B	0.12	0.39		0.90	0.96	6548	0.09	0.36	131381	0.13	0.39	6.7%	268	268	0	0	0.17	11.09	17.2	4	2.90	0.00	11.09	3.94	1.6	0.3	6.62	8.2	1.6	5
6	EX-OS3	354850	8.15	0.0127	B	0.12	0.39		0.90	0.96	475	0.09	0.36	354375	0.09	0.36	2.1%	300	300	265	265	0.16	12.54	15.8	4	2.78	1.59	14.12	3.56	2.7	0.2	5.98	17.7	2.0	6
7	EX-4	256265	5.88	0.0092	B	0.12	0.39		0.90	0.96	0	0.09	0.36	256265	0.09	0.36	2.0%	206	206	0	0	0.29	8.53	28.6	4	3.50	0.00	8.53	4.35	2.3		7.30	15.6	7	
8	EX-OS1b, EX-OS2a, EX-2	5372438	123.33	0.1927	B	0.12	0.39	1173596	0.90	0.96	71861	0.09	0.36	4126981	0.11	0.37	4.4%	300	300	2795	2795	0.06	16.67	6.4	4	1.77	26.31	42.97	1.96	26.1	5.4	3.29	153.1	30.9	8
9	EX-OS2b, EX-OS2c, EX-3	2943374	67.57	0.1056	B	0.12	0.39		0.90	0.96	44471	0.09	0.36	2898903	0.10	0.37	3.5%	300	300	2002	2002	0.11	13.82	11.4	4	2.36	14.12	27.93	2.52	17.6	2.9	4.24	106.5	17.4	9
10	EX-OS3, EX-5	2220304	50.97	0.0796	B	0.12	0.39		0.90	0.96	18592	0.09	0.36	2201712	0.10	0.37	2.8%	300	300	1427	1427	0.11	14.19	10.7	4	2.29	10.39	24.58	2.71	13.5	1.8	4.55	85.3	11.9	10
11	DP-8, DP-9, DP-10, EX-OS1a, EX-1	13384576	307.27	0.4801	B	0.12	0.39	1580888	0.90	0.96	164985	0.09	0.36	11638703	0.10	0.37	3.8%	300	300	8062	8062	0.05	18.17	5.0	4	1.57	85.84	104.01	1.09	35.0	11.2	1.84	210.9	69.9	11



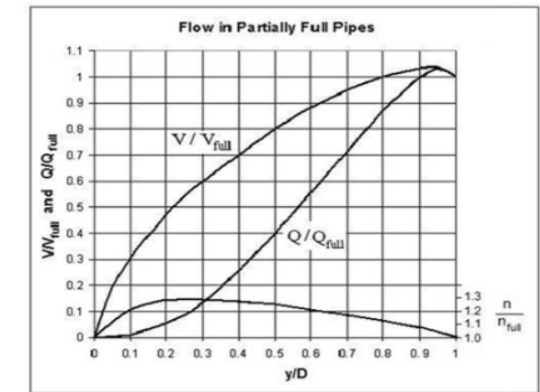


INITIAL STORM SEWER CAPACITY CALCULATIONS - MANNINGS CHANNEL FLOW METHOD																	
Design Point	Notes	Max Q (Q100) Proposed	Flow Type / Capacity Analysis	Storm Pipe Calculated Max Q for Pipe (CFS)	Percent of Pipe Channel Capacity Used	n(full)	Slope (ft/ft)	n	Pipe Diameter (ft)	Width (ft) Box Culvert Only	Pipe Depth (inches)	Optimum Flow Depth (+/- 0.94 x D)	Theta (Radians)	A (Sq. Ft.)	Wetted Perimeter (ft)	Velocity at Max Pipe Capacity	
10		9.6	Channel/Adequate	12.0	80%	0.013	0.012	0.013	1.5		18	1.41	0.990	1.724	3.970	6.99	
11		4.6	Channel/Adequate	12.5	37%	0.013	0.013	0.013	1.5		18	1.41	0.990	1.724	3.970	7.28	
12		12.3	Channel/Adequate	16.8	73%	0.013	0.005	0.013	2		24	1.88	0.990	3.065	5.293	5.47	
13		17.0	Channel/Adequate	22.0	77%	0.013	0.040	0.013	1.5		18	1.41	0.990	1.724	3.970	12.76	
14		6.1	Channel/Adequate	9.6	63%	0.013	0.008	0.013	1.5		18	1.41	0.990	1.724	3.970	5.59	
16b		22.0	Channel/Adequate	47.4	46%	0.013	0.040	0.013	2		24	1.88	0.990	3.065	5.293	15.46	



$r = D/2$   
 $h = 2r - y$   
 (hydraulic radius)  
 $R = A/P$   
 (Manning Equation)  
 $Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$   
 $V = Q/A$   
 $\theta = 2 \arccos \left( \frac{r-h}{r} \right)$   
 $A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$   
 $P = 2\pi r - r*\theta$

Equation used for n/n<sub>full</sub>:  $n/n_{full} = 1.25 - (y/D - 0.5)*0.5$  (for  $0.5 \leq y/D \leq 1$ )

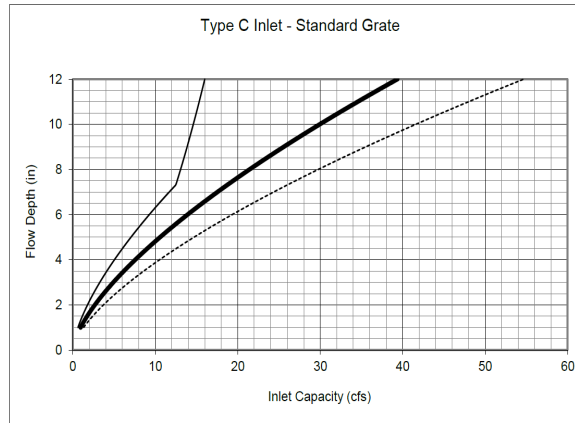


Flow in Partially Full Pipes

## INLET SUMMARY

### Hay Creek

DESIGN POINT or SUB-BASIN	SUB-BASINS	TOTAL AREA (AC)	INLET			Q(5) BYPASS FLOWS (cfs)	Q(5) TOTAL INFLOW	Q5 INLET CAPACITY	Q(100) BYPASS FLOWS (cfs)	Q(100) TOTAL INFLOW (cfs)	MAX INLET CAPACITY	NOTES:
			SIZE (Ft.)	TYPE	CONDITION							
13	PR-6	44.76	3x3	C	SUMP	0.0	3.70	3.7	0.0	17.00	17.0	
16a	PR-8a	5.11	3x3	C	SUMP	0.0	1.50	1.5	0.0	5.60	5.6	



# Culvert Report

## DP-10 Culvert

Invert Elev Dn (ft)	=	7030.00
Pipe Length (ft)	=	40.00
Slope (%)	=	6.00
Invert Elev Up (ft)	=	7032.40
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

### Embankment

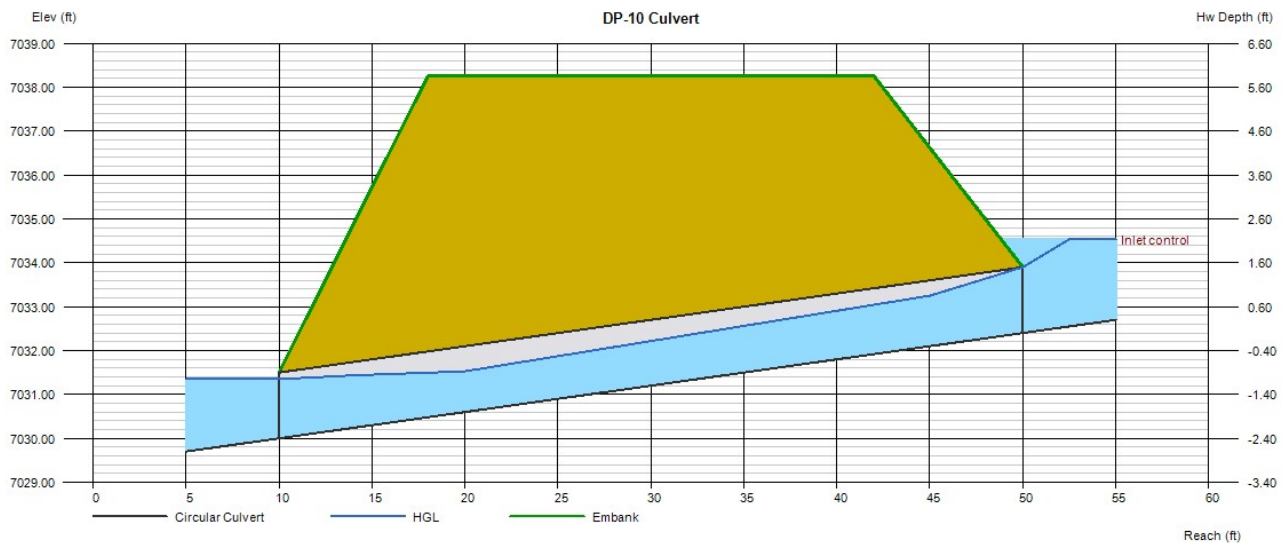
Top Elevation (ft)	=	7038.25
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

### Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	9.60
Tailwater Elev (ft)	=	(dc+D)/2

### Highlighted

Qtotal (cfs)	=	9.60
Qpipe (cfs)	=	9.60
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.74
Veloc Up (ft/s)	=	6.36
HGL Dn (ft)	=	7031.35
HGL Up (ft)	=	7033.60
Hw Elev (ft)	=	7034.54
Hw/D (ft)	=	1.42
Flow Regime	=	Inlet Control



# Culvert Report

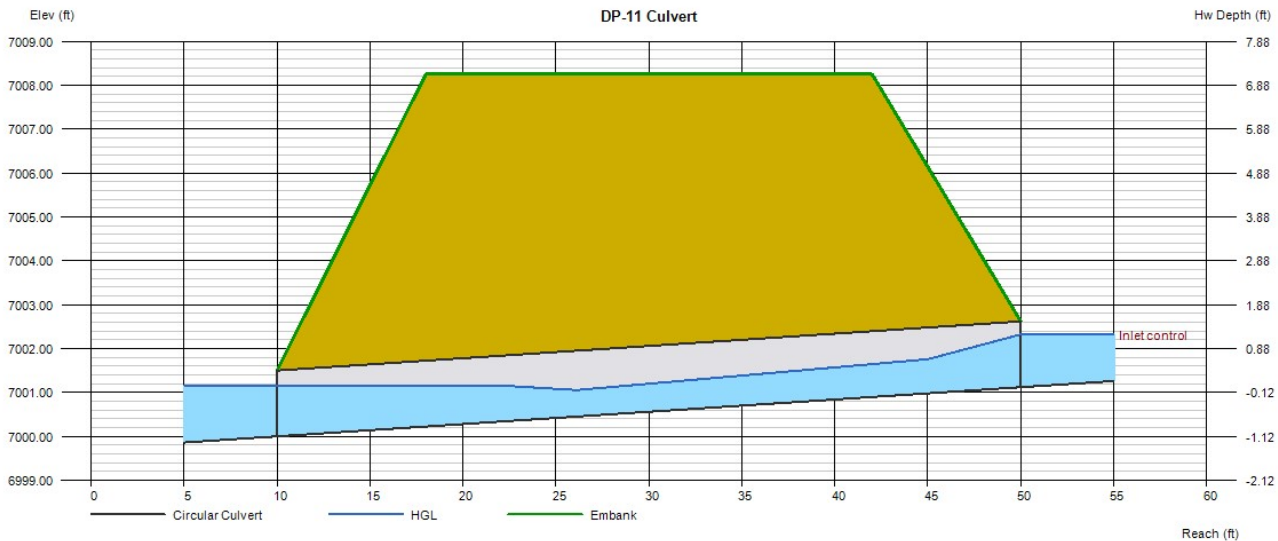
## DP-11 Culvert

Invert Elev Dn (ft)	= 7000.00
Pipe Length (ft)	= 40.00
Slope (%)	= 2.80
Invert Elev Up (ft)	= 7001.12
Rise (in)	= 18.0
Shape	= Circular
Span (in)	= 18.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

<b>Embankment</b>	
Top Elevation (ft)	= 7008.25
Top Width (ft)	= 24.00
Crest Width (ft)	= 30.00

<b>Calculations</b>	
Qmin (cfs)	= 0.00
Qmax (cfs)	= 4.60
Tailwater Elev (ft)	= (dc+D)/2

<b>Highlighted</b>	
Qtotal (cfs)	= 4.60
Qpipe (cfs)	= 4.60
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 3.13
Veloc Up (ft/s)	= 4.63
HGL Dn (ft)	= 7001.16
HGL Up (ft)	= 7001.94
Hw Elev (ft)	= 7002.32
Hw/D (ft)	= 0.80
Flow Regime	= Inlet Control



# Culvert Report

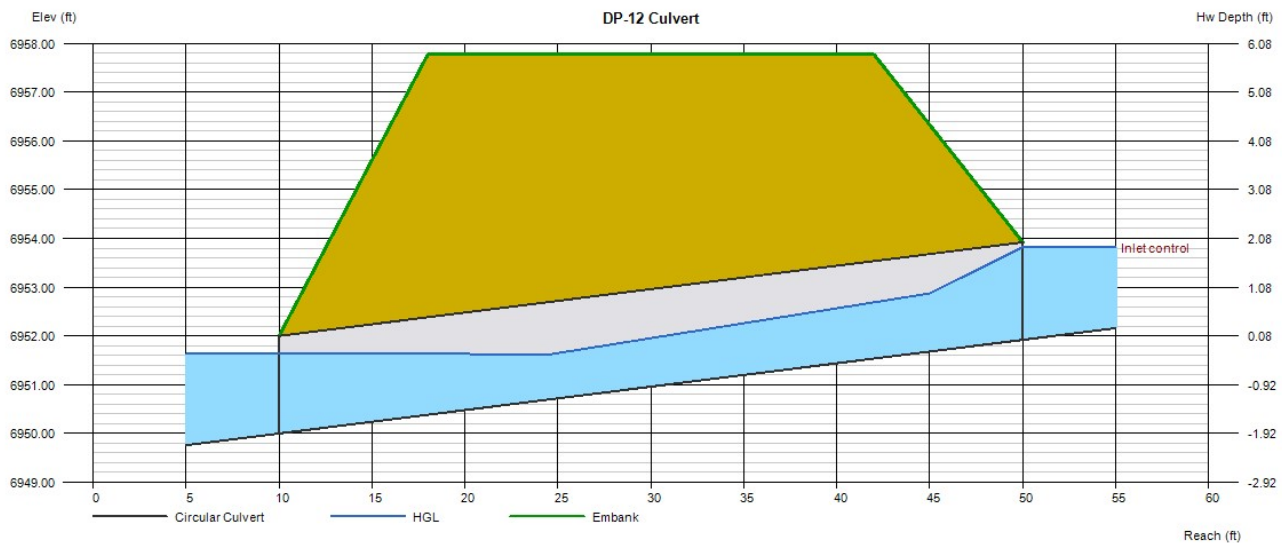
## DP-12 Culvert

Invert Elev Dn (ft)	= 6950.00
Pipe Length (ft)	= 40.00
Slope (%)	= 4.80
Invert Elev Up (ft)	= 6951.92
Rise (in)	= 24.0
Shape	= Circular
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

<b>Embankment</b>	
Top Elevation (ft)	= 6957.77
Top Width (ft)	= 24.00
Crest Width (ft)	= 30.00

<b>Calculations</b>	
Qmin (cfs)	= 0.00
Qmax (cfs)	= 12.30
Tailwater Elev (ft)	= (dc+D)/2

<b>Highlighted</b>	
Qtotal (cfs)	= 12.30
Qpipe (cfs)	= 12.30
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.49
Veloc Up (ft/s)	= 5.90
HGL Dn (ft)	= 6951.63
HGL Up (ft)	= 6953.18
Hw Elev (ft)	= 6953.82
Hw/D (ft)	= 0.95
Flow Regime	= Inlet Control



# Culvert Report

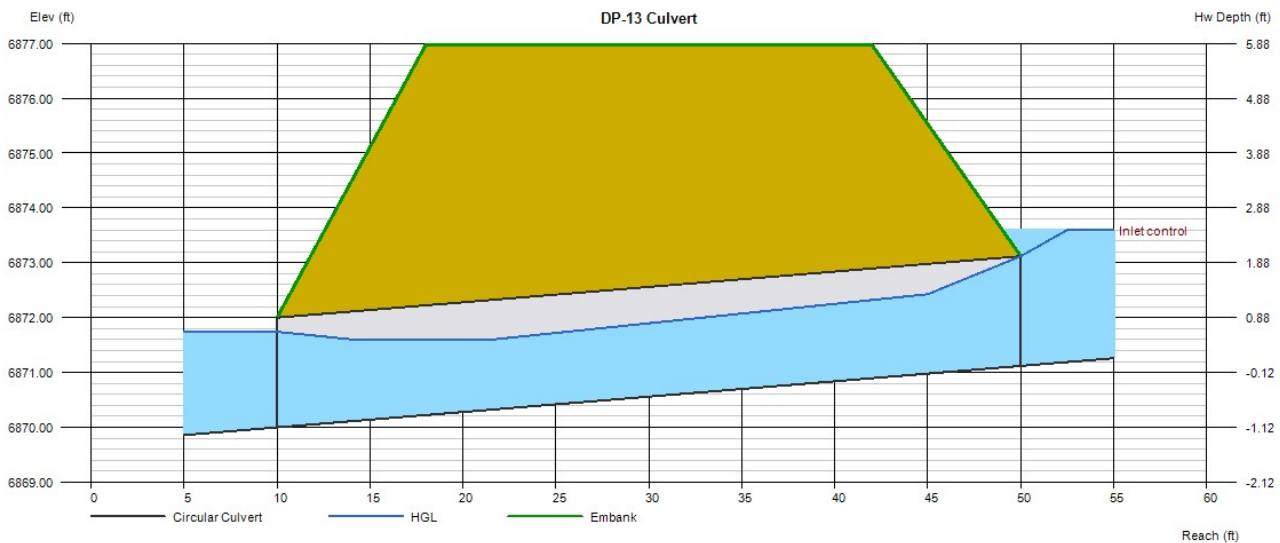
## DP-13 Culvert

Invert Elev Dn (ft)	= 6870.00
Pipe Length (ft)	= 40.00
Slope (%)	= 2.80
Invert Elev Up (ft)	= 6871.12
Rise (in)	= 24.0
Shape	= Circular
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

<b>Embankment</b>	
Top Elevation (ft)	= 6876.97
Top Width (ft)	= 24.00
Crest Width (ft)	= 30.00

<b>Calculations</b>	
Qmin (cfs)	= 0.00
Qmax (cfs)	= 17.00
Tailwater Elev (ft)	= (dc+D)/2

<b>Highlighted</b>	
Qtotal (cfs)	= 17.00
Qpipe (cfs)	= 17.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 5.85
Veloc Up (ft/s)	= 6.80
HGL Dn (ft)	= 6871.74
HGL Up (ft)	= 6872.61
Hw Elev (ft)	= 6873.60
Hw/D (ft)	= 1.24
Flow Regime	= Inlet Control



# Culvert Report

## DP-14 Culvert

Invert Elev Dn (ft)	= 6870.00
Pipe Length (ft)	= 40.00
Slope (%)	= 2.80
Invert Elev Up (ft)	= 6871.12
Rise (in)	= 18.0
Shape	= Circular
Span (in)	= 18.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

### Embankment

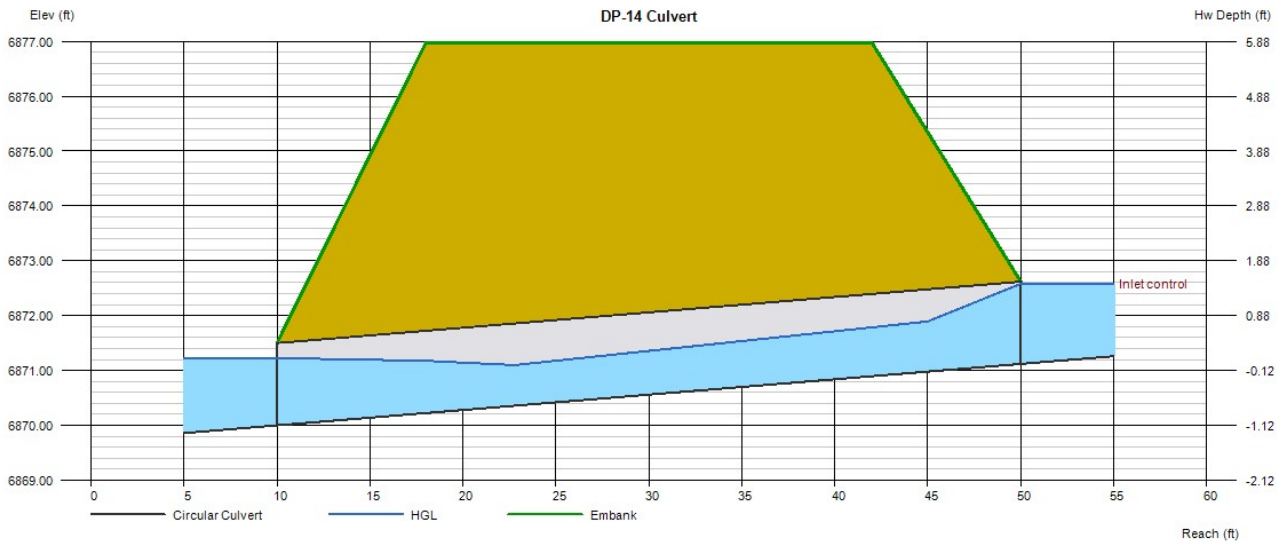
Top Elevation (ft)	= 6876.97
Top Width (ft)	= 24.00
Crest Width (ft)	= 30.00

### Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 6.10
Tailwater Elev (ft)	= (dc+D)/2

### Highlighted

Qtotal (cfs)	= 6.10
Qpipe (cfs)	= 6.10
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 3.94
Veloc Up (ft/s)	= 5.15
HGL Dn (ft)	= 6871.23
HGL Up (ft)	= 6872.07
Hw Elev (ft)	= 6872.58
Hw/D (ft)	= 0.97
Flow Regime	= Inlet Control



# Culvert Report

## DP-16 Culvert

Invert Elev Dn (ft)	= 6870.00
Pipe Length (ft)	= 40.00
Slope (%)	= 2.80
Invert Elev Up (ft)	= 6871.12
Rise (in)	= 24.0
Shape	= Circular
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

### Embankment

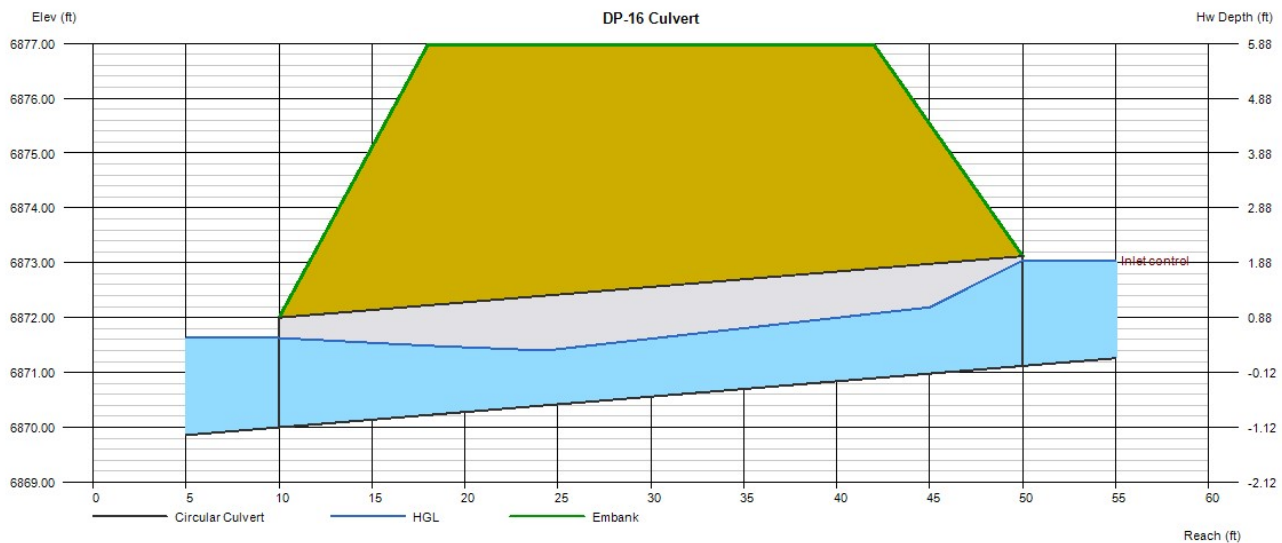
Top Elevation (ft)	= 6876.97
Top Width (ft)	= 24.00
Crest Width (ft)	= 30.00

### Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 12.30
Tailwater Elev (ft)	= (dc+D)/2

### Highlighted

Qtotal (cfs)	= 12.30
Qpipe (cfs)	= 12.30
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.49
Veloc Up (ft/s)	= 5.90
HGL Dn (ft)	= 6871.63
HGL Up (ft)	= 6872.38
Hw Elev (ft)	= 6873.04
Hw/D (ft)	= 0.96
Flow Regime	= Inlet Control





# Culvert Report

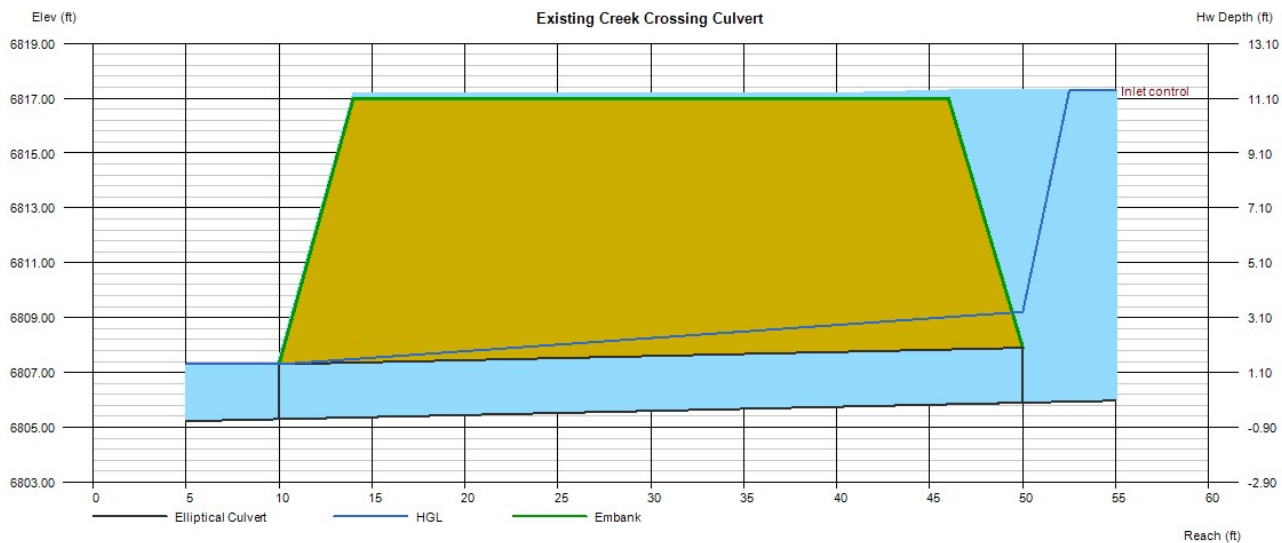
## Existing Creek Crossing Culvert

Invert Elev Dn (ft)	= 6805.30
Pipe Length (ft)	= 40.00
Slope (%)	= 1.50
Invert Elev Up (ft)	= 6805.90
Rise (in)	= 24.0
Shape	= Elliptical
Span (in)	= 36.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Horizontal Ellipse Concrete
Culvert Entrance	= Groove end projecting (H)
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.2

<b>Embankment</b>	
Top Elevation (ft)	= 6817.00
Top Width (ft)	= 32.00
Crest Width (ft)	= 100.00

<b>Calculations</b>	
Qmin (cfs)	= 127.00
Qmax (cfs)	= 127.00
Tailwater Elev (ft)	= (dc+D)/2

<b>Highlighted</b>	
Qtotal (cfs)	= 127.00
Qpipe (cfs)	= 83.74
Qovertop (cfs)	= 43.26
Veloc Dn (ft/s)	= 17.77
Veloc Up (ft/s)	= 17.77
HGL Dn (ft)	= 6807.30
HGL Up (ft)	= 6809.21
Hw Elev (ft)	= 6817.28
Hw/D (ft)	= 5.69
Flow Regime	= Inlet Control



# Culvert Report

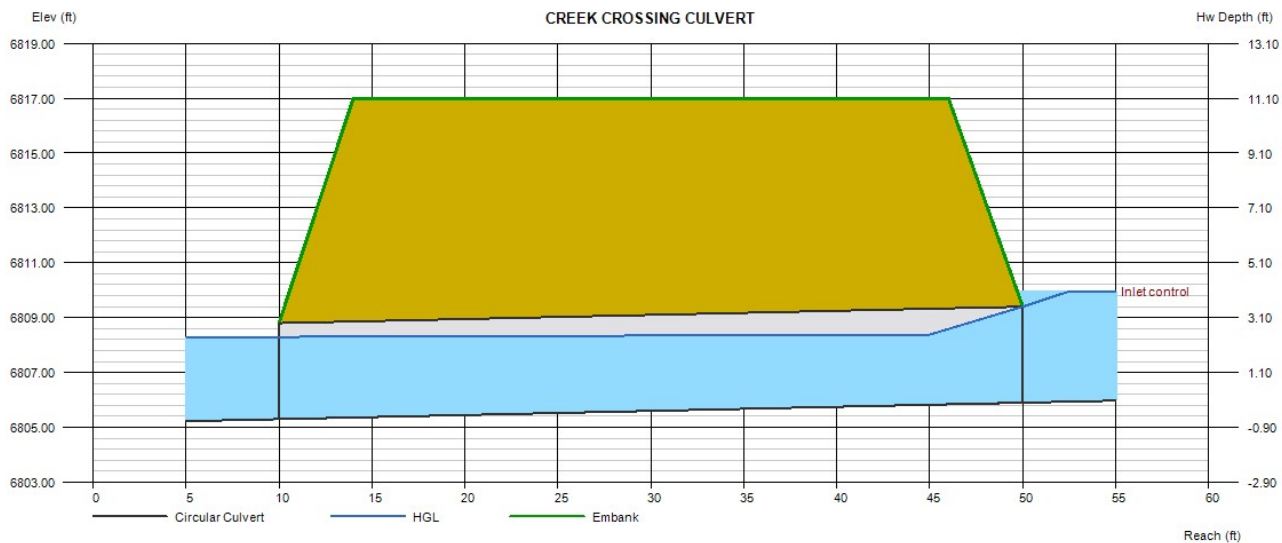
## CREEK CROSSING CULVERT

Invert Elev Dn (ft)	= 6805.30
Pipe Length (ft)	= 40.00
Slope (%)	= 1.50
Invert Elev Up (ft)	= 6805.90
Rise (in)	= 42.0
Shape	= Circular
Span (in)	= 42.0
No. Barrels	= 2
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

<b>Embankment</b>	
Top Elevation (ft)	= 6817.00
Top Width (ft)	= 32.00
Crest Width (ft)	= 100.00

<b>Calculations</b>	
Qmin (cfs)	= 127.00
Qmax (cfs)	= 127.00
Tailwater Elev (ft)	= (dc+D)/2

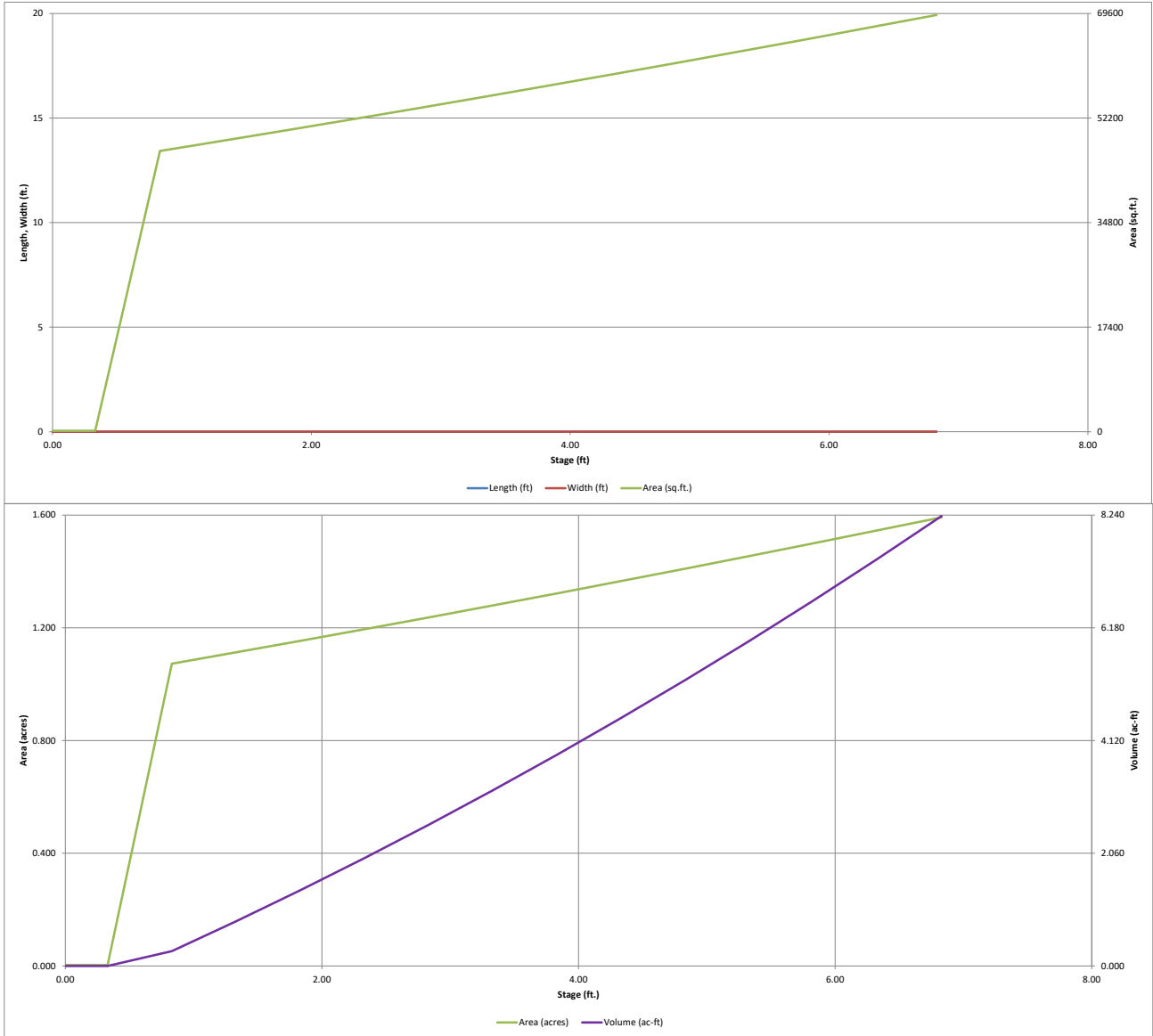
<b>Highlighted</b>	
Qtotal (cfs)	= 127.00
Qpipe (cfs)	= 127.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 7.24
Veloc Up (ft/s)	= 8.65
HGL Dn (ft)	= 6808.30
HGL Up (ft)	= 6808.40
Hw Elev (ft)	= 6809.96
Hw/D (ft)	= 1.16
Flow Regime	= Inlet Control





# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

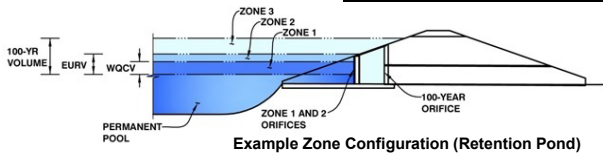
MHFD-*Detention*, Version 4.05 (January 2022)



# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

**Project:** Hay Creek Valley  
**Basin ID:** Beaver Creek



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.91	0.355	Orifice Plate
Zone 2 (EURV)	1.17	0.277	Circular Orifice
Zone 3 (100-year)	2.50	1.535	Weir&Pipe (Restrict)
<b>Total (all zones)</b>		<b>2.168</b>	

**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 = 1-3/4 inches)

**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	0.75					
Orifice Area (sq. inches)	2.52	2.52	2.52					
	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**  
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, Ho =    ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =    feet  
Overflow Weir Grate Slope =    H:V  
Horiz. Length of Weir Sides =    feet  
Overflow Grate Type =     
Debris Clogging % =    %

**Calculated Parameters for Overflow Weir**  
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**  
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

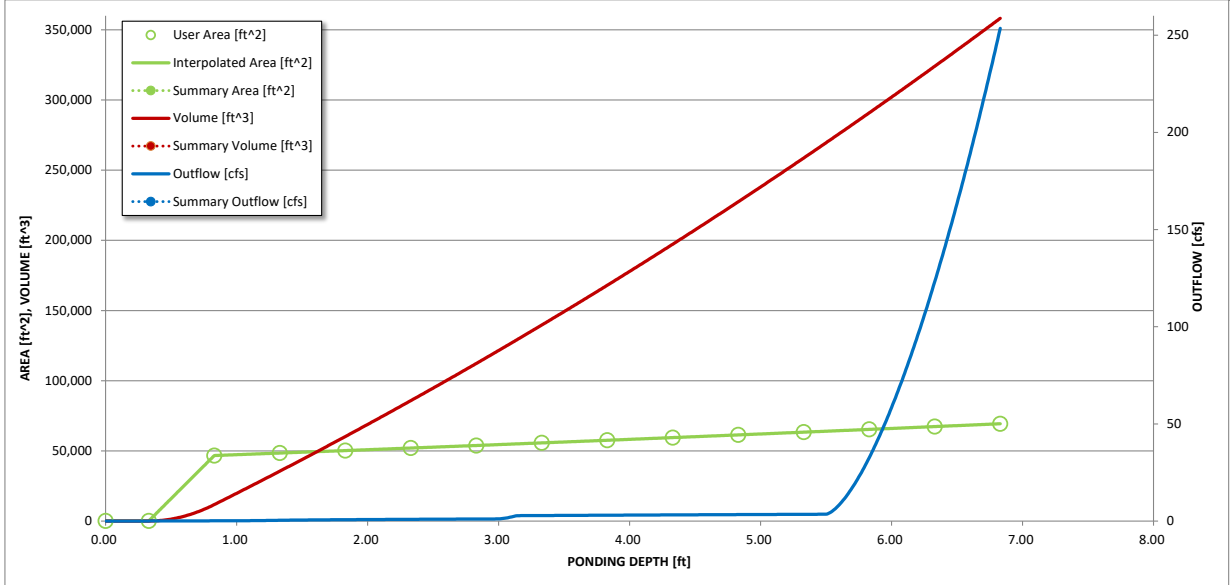
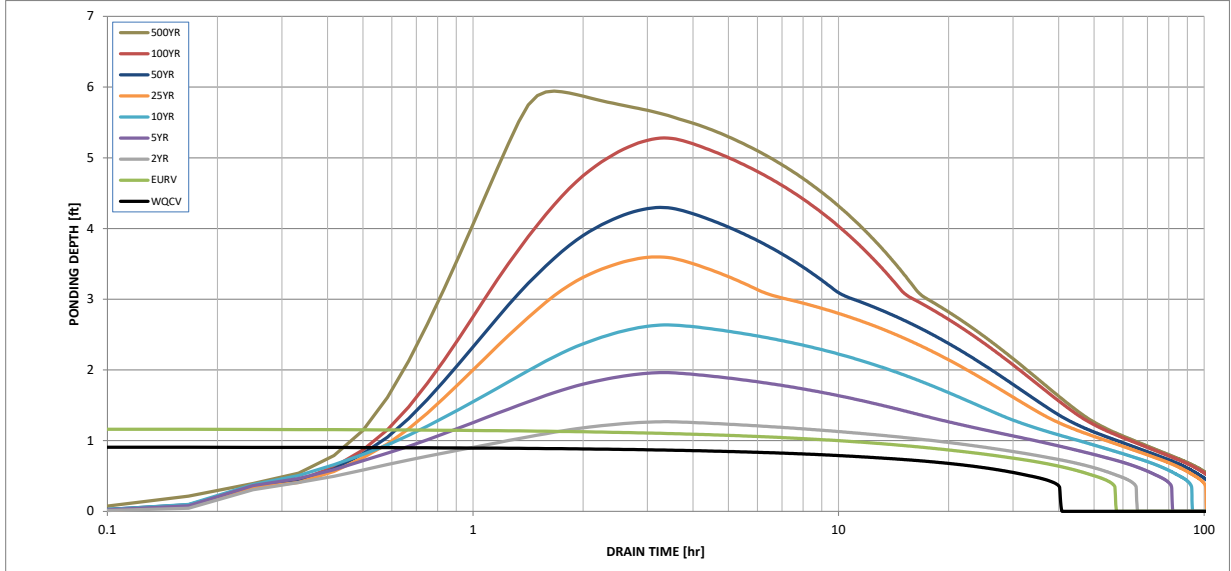
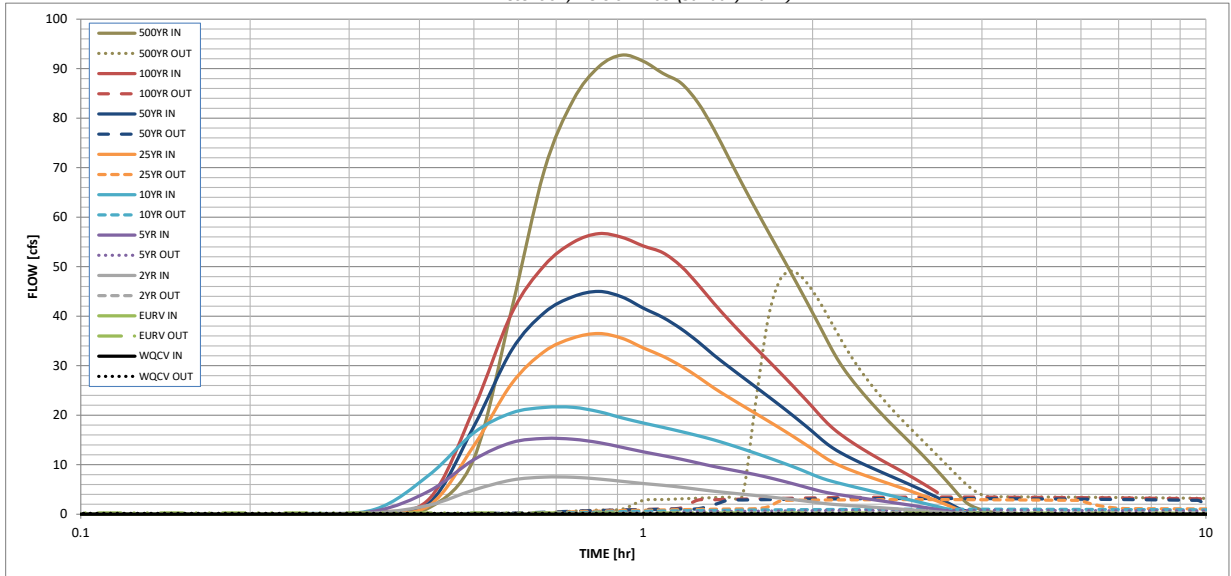
## Routed Hydrograph Results

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	1.19	1.50	1.75	2.00	2.25	2.52	3.55
One-Hour Rainfall Depth (in)	0.355	0.633	0.816	1.695	2.560	4.064	5.103	6.585	11.153
CUHP Runoff Volume (acre-ft)	N/A	N/A	0.816	1.695	2.560	4.064	5.103	6.585	11.153
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	4.0	11.4	17.6	32.3	40.6	52.1	87.4
CUHP Predevelopment Peak Q (cfs)	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.08	0.22	0.33	0.61	0.77	0.99	1.66
Peak Inflow Q (cfs)	N/A	N/A	7.5	15.3	21.6	36.5	45.0	56.7	92.7
Peak Outflow Q (cfs)	0.2	0.3	0.4	0.8	1.0	3.0	3.2	3.5	49.1
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.1	0.1	0.1	0.1	0.1	0.6
Structure Controlling Flow	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	0.1	0.1	0.1
Max Velocity through Grate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	38	53	60	72	79	82	82	83	73
Time to Drain 99% of Inflow Volume (hours)	40	56	64	78	87	93	95	98	94
Maximum Ponding Depth (ft)	0.91	1.17	1.27	1.96	2.64	3.60	4.30	5.28	5.94
Area at Maximum Ponding Depth (acres)	1.08	1.10	1.11	1.16	1.22	1.30	1.36	1.45	1.51
Maximum Volume Stored (acre-ft)	0.356	0.639	0.739	1.534	2.332	3.542	4.475	5.866	6.843

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.05 (January 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: .\Outflow Hydrographs - UPDATED BASINS.xlsx

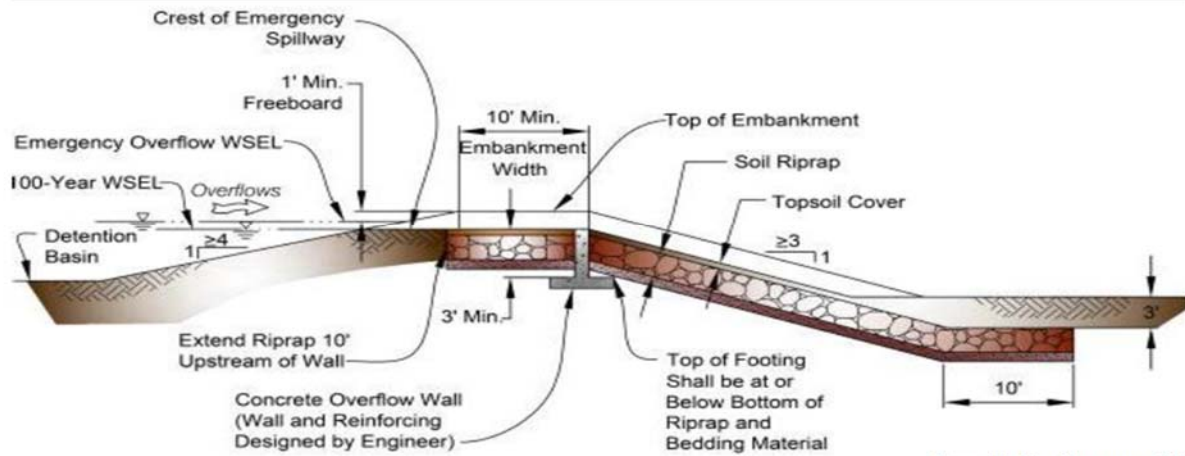
## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	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	0.01	0.00	0.04
	0:15:00	0.00	0.00	0.06	0.10	0.12	0.08	0.11	0.10	0.20
	0:20:00	0.00	0.00	0.27	0.64	0.99	0.28	0.33	0.43	1.33
	0:25:00	0.00	0.00	1.85	4.71	7.98	1.78	2.27	3.13	11.27
	0:30:00	0.00	0.00	4.91	11.03	16.46	13.86	17.78	21.38	41.38
	0:35:00	0.00	0.00	6.90	14.48	20.46	26.36	33.13	40.57	69.41
	0:40:00	0.00	0.00	7.49	15.30	21.56	32.85	40.70	50.22	83.57
	0:45:00	0.00	0.00	7.46	15.14	21.59	35.60	43.94	54.90	90.37
	0:50:00	0.00	0.00	7.11	14.47	20.71	36.49	45.00	56.67	92.74
	0:55:00	0.00	0.00	6.64	13.51	19.45	35.54	43.88	55.92	91.49
	1:00:00	0.00	0.00	6.20	12.60	18.42	33.58	41.62	54.18	89.05
	1:05:00	0.00	0.00	5.84	11.84	17.55	31.91	39.75	52.82	87.10
	1:10:00	0.00	0.00	5.45	11.11	16.69	29.94	37.46	50.10	83.16
	1:15:00	0.00	0.00	5.03	10.36	15.87	27.75	34.88	46.44	77.87
	1:20:00	0.00	0.00	4.65	9.65	15.02	25.54	32.18	42.66	72.10
	1:25:00	0.00	0.00	4.33	9.06	14.12	23.66	29.85	39.32	66.67
	1:30:00	0.00	0.00	4.05	8.52	13.21	21.95	27.72	36.34	61.71
	1:35:00	0.00	0.00	3.78	7.99	12.31	20.35	25.71	33.61	57.10
	1:40:00	0.00	0.00	3.52	7.43	11.43	18.83	23.80	31.06	52.78
	1:45:00	0.00	0.00	3.26	6.83	10.57	17.37	21.97	28.61	48.62
	1:50:00	0.00	0.00	3.00	6.24	9.72	15.93	20.17	26.22	44.60
	1:55:00	0.00	0.00	2.73	5.65	8.87	14.52	18.40	23.90	40.67
	2:00:00	0.00	0.00	2.46	5.07	7.99	13.13	16.66	21.63	36.86
	2:05:00	0.00	0.00	2.21	4.56	7.22	11.74	14.91	19.38	33.17
	2:10:00	0.00	0.00	2.01	4.17	6.63	10.56	13.45	17.48	30.07
	2:15:00	0.00	0.00	1.86	3.87	6.15	9.68	12.33	16.01	27.58
	2:20:00	0.00	0.00	1.73	3.60	5.70	8.94	11.39	14.75	25.41
	2:25:00	0.00	0.00	1.61	3.35	5.29	8.28	10.55	13.62	23.45
	2:30:00	0.00	0.00	1.50	3.11	4.89	7.68	9.77	12.60	21.65
	2:35:00	0.00	0.00	1.39	2.87	4.50	7.12	9.05	11.65	19.97
	2:40:00	0.00	0.00	1.28	2.64	4.14	6.59	8.36	10.75	18.40
	2:45:00	0.00	0.00	1.17	2.42	3.78	6.07	7.70	9.92	16.94
	2:50:00	0.00	0.00	1.07	2.20	3.44	5.57	7.06	9.11	15.53
	2:55:00	0.00	0.00	0.97	1.99	3.11	5.07	6.43	8.32	14.16
	3:00:00	0.00	0.00	0.87	1.78	2.79	4.58	5.81	7.53	12.80
	3:05:00	0.00	0.00	0.77	1.57	2.48	4.09	5.19	6.74	11.45
	3:10:00	0.00	0.00	0.67	1.37	2.16	3.61	4.58	5.95	10.10
	3:15:00	0.00	0.00	0.57	1.16	1.85	3.12	3.97	5.16	8.75
	3:20:00	0.00	0.00	0.47	0.96	1.54	2.64	3.36	4.38	7.41
	3:25:00	0.00	0.00	0.38	0.76	1.24	2.16	2.75	3.60	6.08
	3:30:00	0.00	0.00	0.28	0.56	0.93	1.68	2.14	2.82	4.75
	3:35:00	0.00	0.00	0.19	0.37	0.65	1.20	1.55	2.04	3.46
	3:40:00	0.00	0.00	0.12	0.24	0.47	0.75	0.98	1.32	2.37
	3:45:00	0.00	0.00	0.08	0.18	0.37	0.49	0.67	0.90	1.68
	3:50:00	0.00	0.00	0.06	0.14	0.30	0.33	0.47	0.62	1.22
	3:55:00	0.00	0.00	0.05	0.12	0.24	0.23	0.34	0.42	0.87
	4:00:00	0.00	0.00	0.04	0.09	0.19	0.16	0.24	0.28	0.61
	4:05:00	0.00	0.00	0.03	0.07	0.15	0.11	0.17	0.18	0.42
	4:10:00	0.00	0.00	0.03	0.06	0.12	0.08	0.12	0.11	0.27
	4:15:00	0.00	0.00	0.02	0.04	0.09	0.06	0.09	0.07	0.18
	4:20:00	0.00	0.00	0.02	0.03	0.06	0.04	0.07	0.05	0.13
	4:25:00	0.00	0.00	0.01	0.02	0.05	0.03	0.05	0.04	0.10
	4:30:00	0.00	0.00	0.01	0.02	0.04	0.02	0.04	0.03	0.08
	4:35:00	0.00	0.00	0.01	0.01	0.03	0.02	0.03	0.03	0.06
	4:40:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.05
	4:45:00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.03
	4:50:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	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	



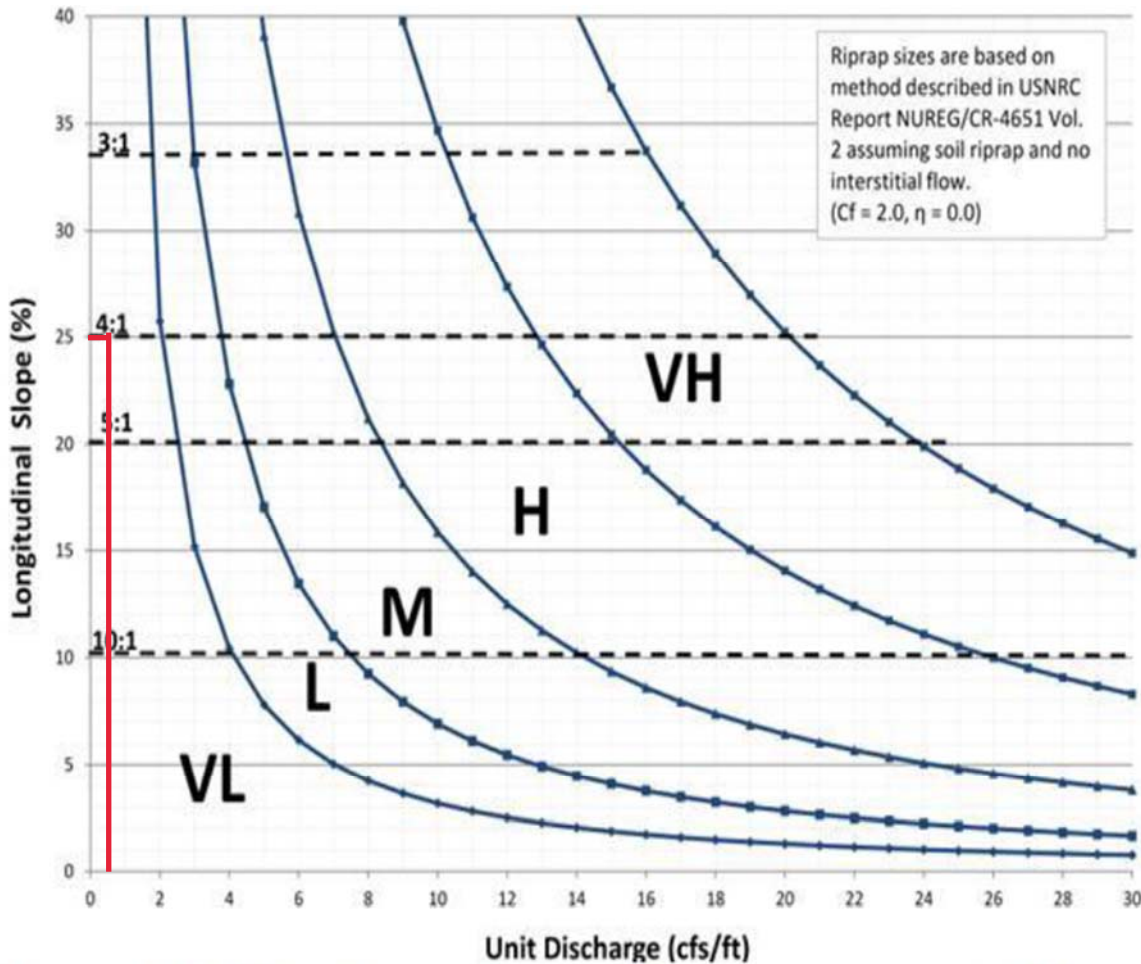
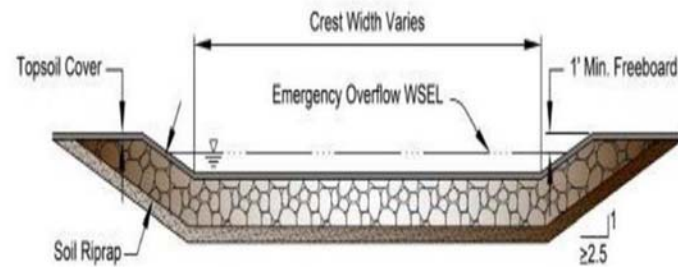
**Figure 13-12b. Emergency Spillway Profile at Embankment**



**Figure 13-12c. Emergency Spillway Protection**

Q=16.4 CFS  
 LENGTH=25 Feet  
 UNIT FLOW RATE: 0.66 CFS/FT

=> TYPE VL RIP RAP



**Figure 13-12d. Riprap Types for Emergency Spillway Protection**



# Weir Report

## Stilling Basin Outfall

### Trapezoidal Weir

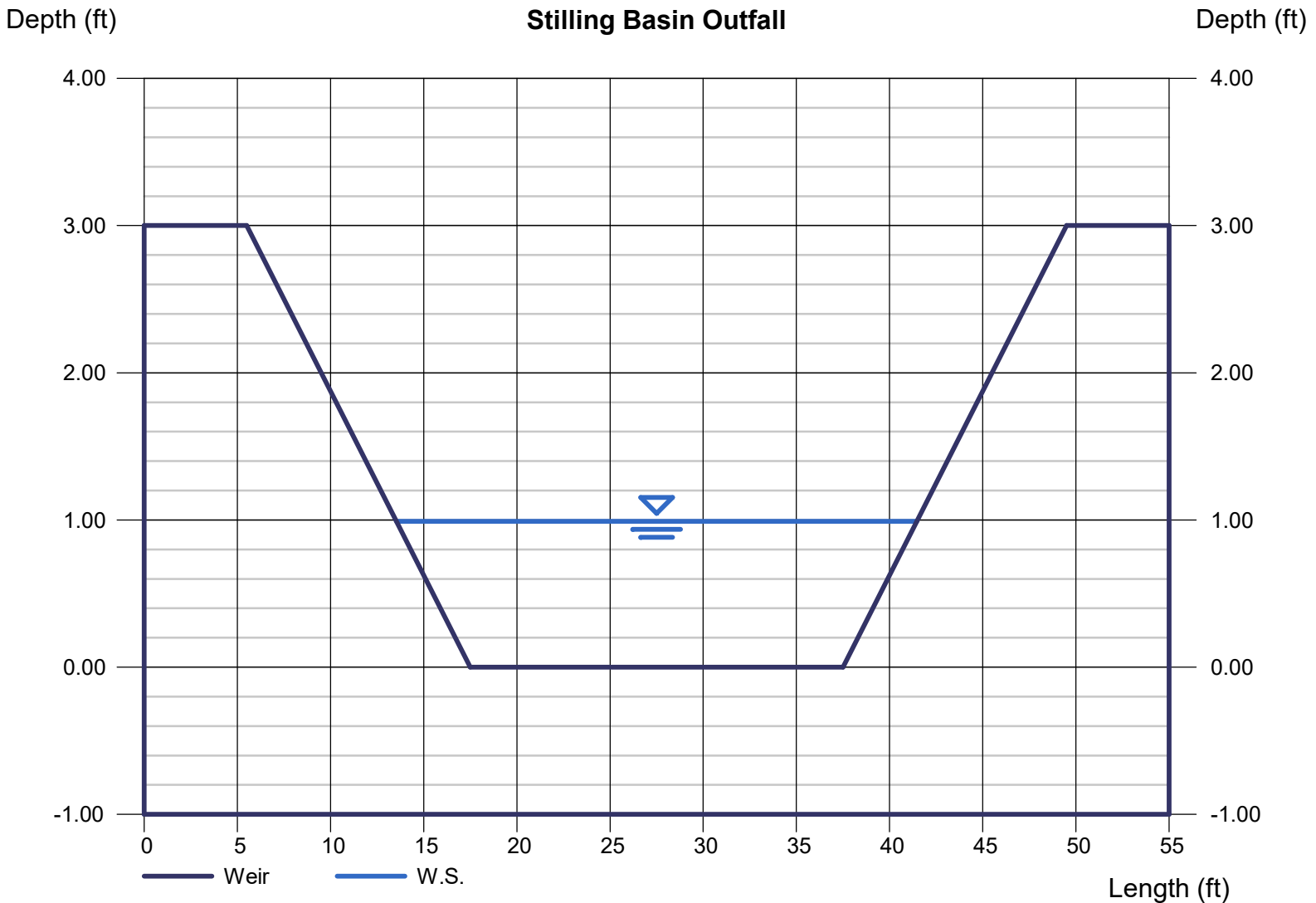
Crest = Sharp  
Bottom Length (ft) = 20.00  
Total Depth (ft) = 3.00  
Side Slope (z:1) = 4.00

### Highlighted

Depth (ft) = 0.99  
Q (cfs) = 69.80  
Area (sqft) = 23.72  
Velocity (ft/s) = 2.94  
Top Width (ft) = 27.92

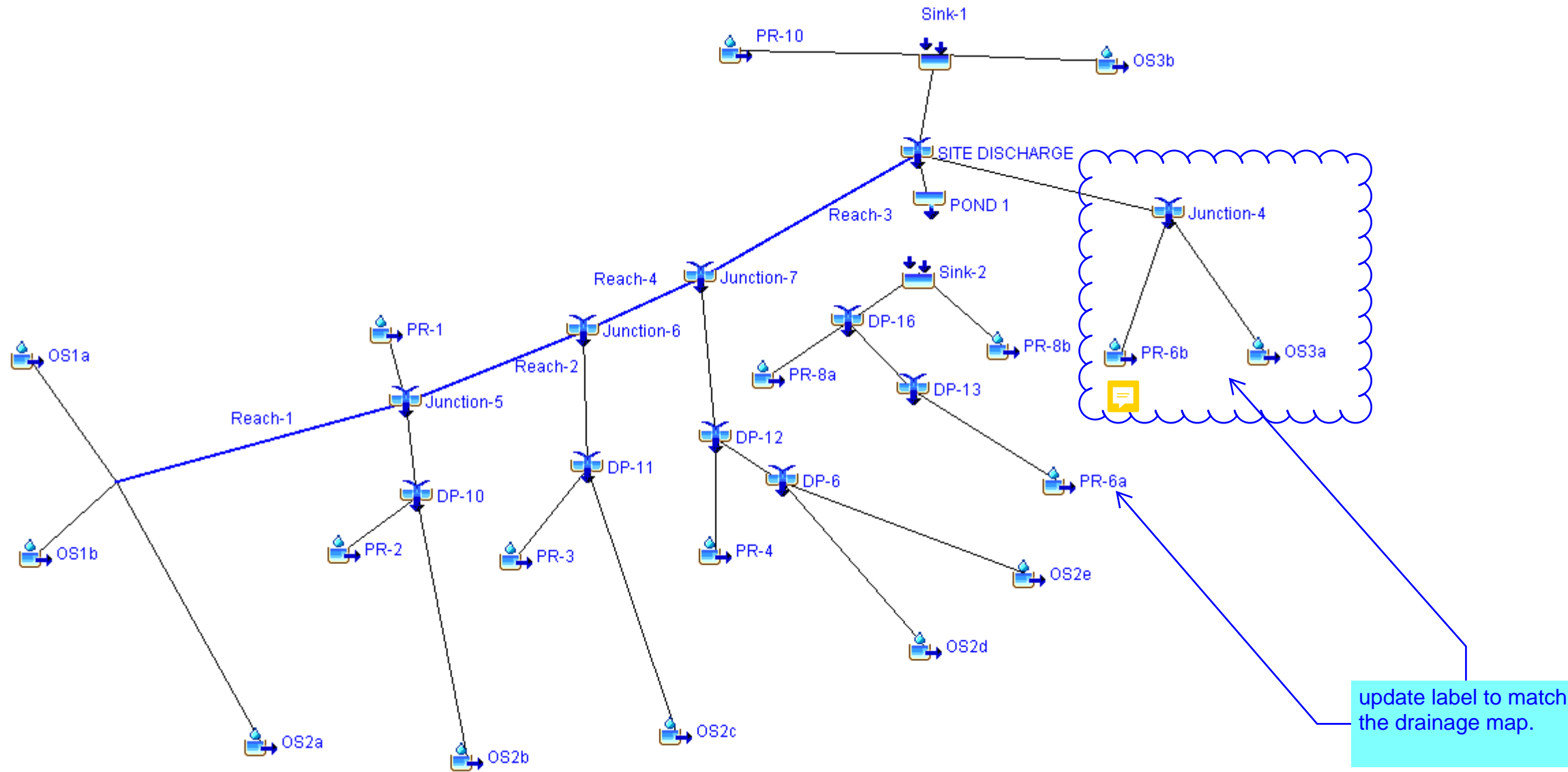
### Calculations

Weir Coeff. Cw = 3.10  
Compute by: Known Q  
Known Q (cfs) = 69.80



Model Name: **Hay\_Creek\_Forest\_Manor**

*These models reflect full development of the areas included in the Hay Creek development with full spectrum detention provided to maintain historic flows. Areas tributary to Pond 1 have been modeled to drain to "Sink 2" while the pond itself has been modeled using the outflow hydrographs from the MHFD-Detention Spreadsheet.*

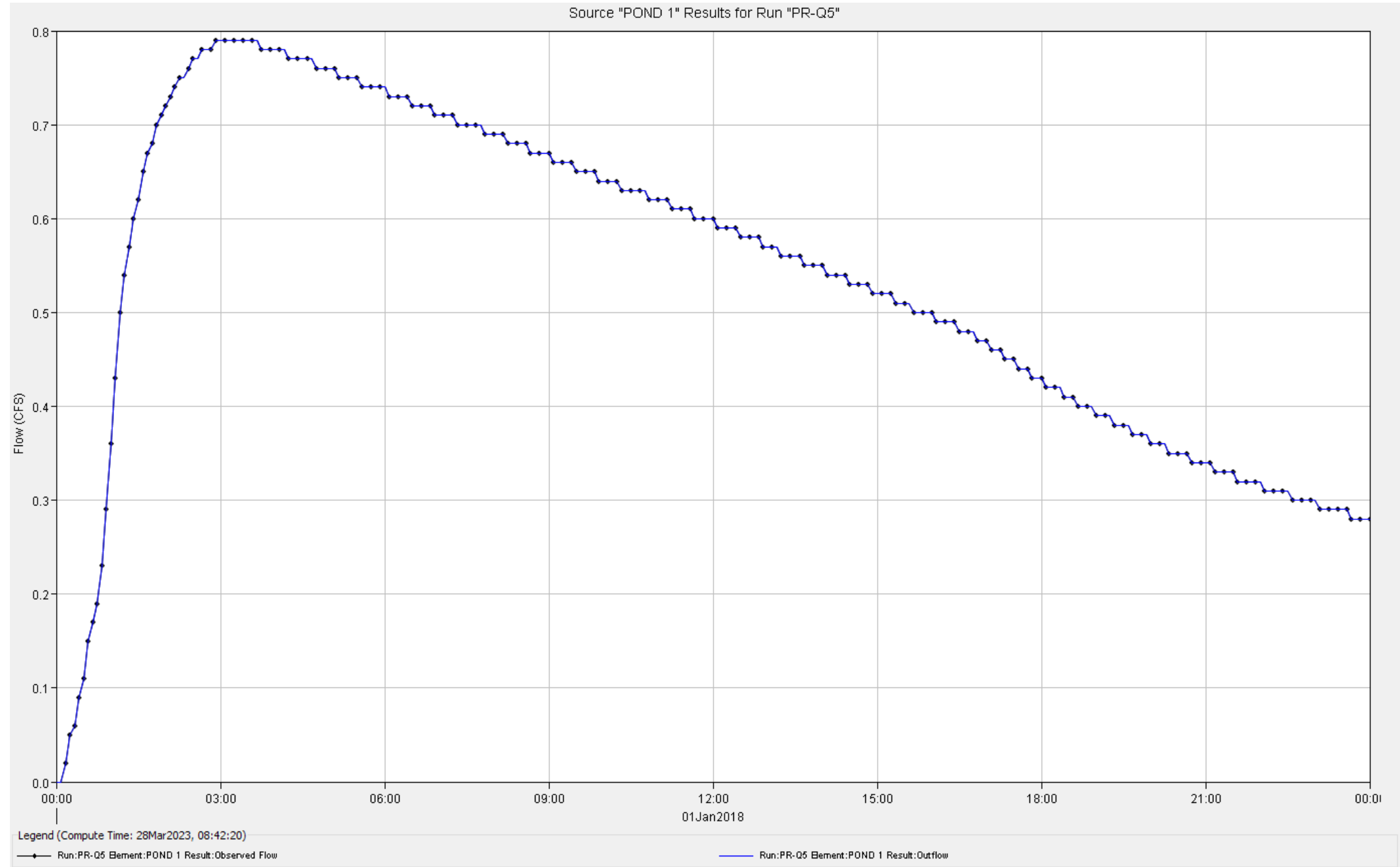


Project: HAY\_CREEK\_FOREST\_MANOR - UP Simulation Run: PR-Q5

Start of Run: 01Jan2018, 00:00 Basin Model: PR - HAY CREEK\_FM  
 End of Run: 02Jan2018, 00:00 Meteorologic Model: 5 YEAR EVENT  
 Compute Time: 28Mar2023, 08:50:04 Control Specifications: 1 DAY

Volume Units:  IN  AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP-10	0.0385	2.1	01Jan2018, 12:35	0.20
DP-11	0.0189	1.0	01Jan2018, 12:35	0.21
DP-12	0.0535	2.7	01Jan2018, 12:40	0.21
DP-13	0.0698	3.7	01Jan2018, 12:40	0.21
DP-16	0.0778	4.9	01Jan2018, 12:45	0.27
DP-6	0.0092	0.5	01Jan2018, 12:30	0.20
Junction-4	0.0288	1.2	01Jan2018, 12:40	0.17
Junction-5	0.2641	9.2	01Jan2018, 12:55	0.18
Junction-6	0.2830	9.8	01Jan2018, 13:00	0.18
Junction-7	0.3365	11.8	01Jan2018, 13:00	0.18
OS1a	0.0146	0.8	01Jan2018, 12:40	0.21
OS1b	0.0925	2.6	01Jan2018, 12:50	0.13
OS2a	0.0078	0.4	01Jan2018, 12:25	0.14
OS2b	0.0134	0.7	01Jan2018, 12:30	0.16
OS2c	0.0036	0.3	01Jan2018, 12:25	0.21
OS2d	0.0043	0.3	01Jan2018, 12:35	0.20
OS2e	0.0049	0.3	01Jan2018, 12:30	0.20
OS3a	0.0076	0.1	01Jan2018, 12:40	0.06
OS3b	0.0051	0.1	01Jan2018, 12:30	0.06
POND 1	0.0840	0.8	01Jan2018, 02:55	0.24
PR-1	0.1107	4.3	01Jan2018, 13:05	0.21
PR-10	0.0256	0.6	01Jan2018, 12:55	0.11
PR-2	0.0251	1.4	01Jan2018, 12:35	0.21
PR-3	0.0153	0.8	01Jan2018, 12:40	0.21
PR-4	0.0443	2.2	01Jan2018, 12:45	0.21
PR-6a	0.0698	3.7	01Jan2018, 12:40	0.21
PR-6b	0.0212	1.1	01Jan2018, 12:40	0.21
PR-8a	0.0080	1.5	01Jan2018, 13:05	0.76
PR-8b	0.0006	0.8	01Jan2018, 12:15	2.66
Reach-1	0.1149	3.5	01Jan2018, 12:55	0.14
Reach-2	0.2641	9.2	01Jan2018, 13:00	0.18
Reach-3	0.3365	11.8	01Jan2018, 13:05	0.18
Reach-4	0.2830	9.8	01Jan2018, 13:05	0.18
Sink-1	0.4800	13.8	01Jan2018, 13:05	0.19
Sink-2	0.0784	5.1	01Jan2018, 12:45	0.29
SITE DISCH...	0.4493	13.2	01Jan2018, 13:05	0.19

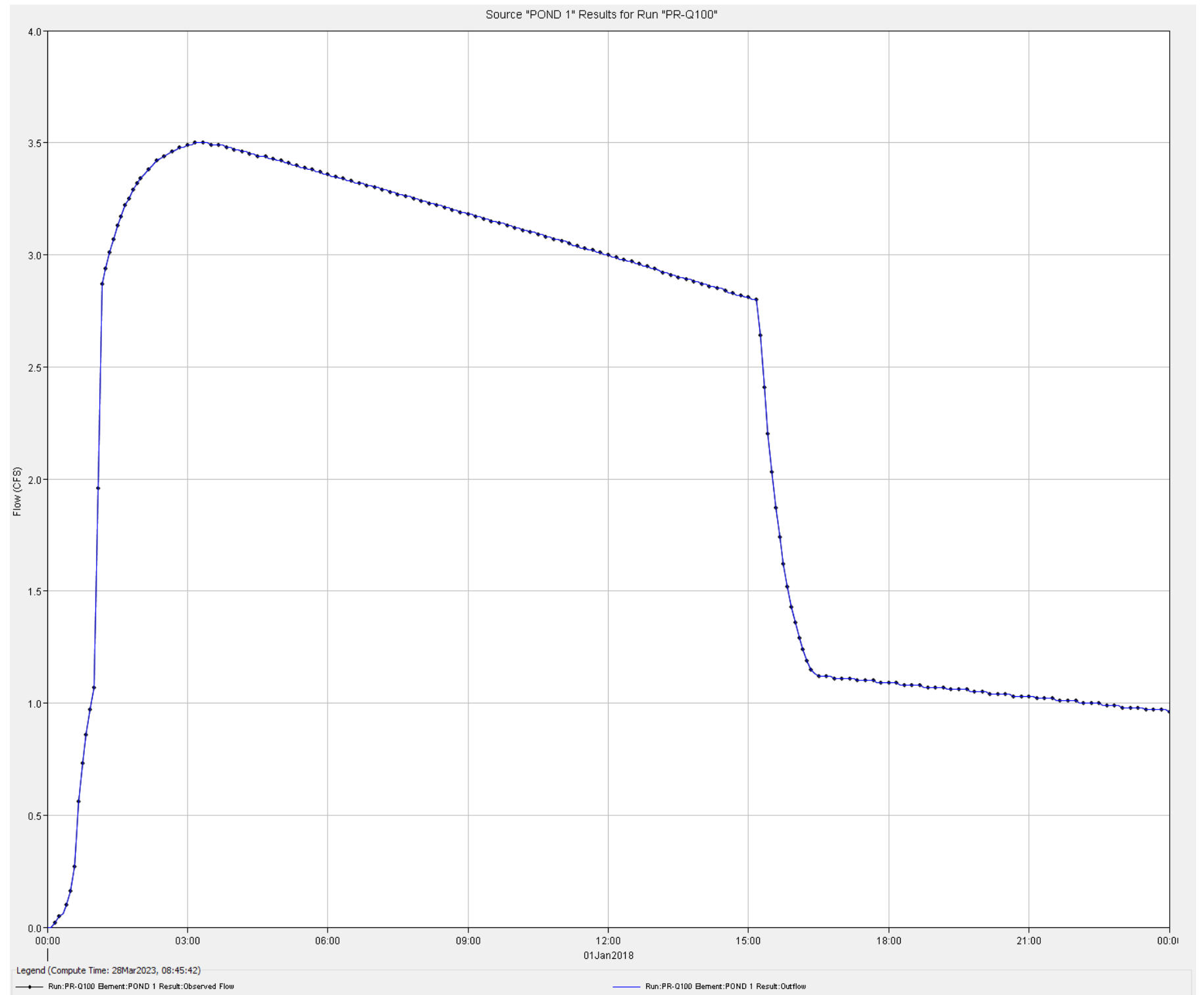


Project: HAY\_CREEK\_FOREST\_MANOR - UP Simulation Run: PR-Q100

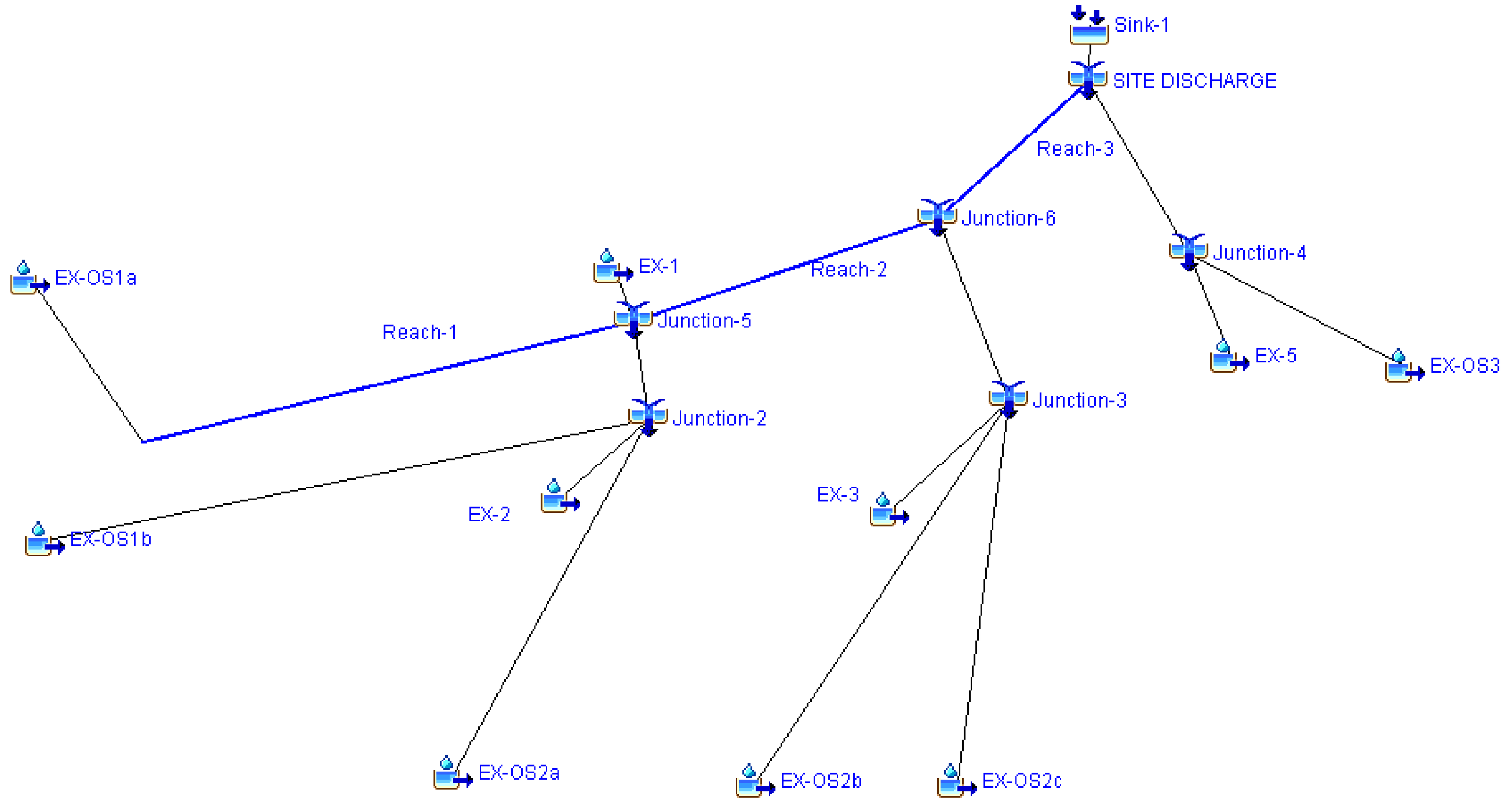
Start of Run: 01Jan2018, 00:00 Basin Model: PR - HAY CREEK\_FM  
 End of Run: 02Jan2018, 00:00 Meteorologic Model: 100 YEAR EVENT  
 Compute Time: 28Mar2023, 08:45:42 Control Specifications: 1 DAY

Volume Units:  IN  AC-FT

Hydrologic Element	Drainage Area (MI <sup>2</sup> )	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP-10	0.0385	9.6	01Jan2018, 12:40	0.87
DP-11	0.0189	4.6	01Jan2018, 12:40	0.91
DP-12	0.0535	12.3	01Jan2018, 12:45	0.91
DP-13	0.0698	17.0	01Jan2018, 12:45	0.92
DP-16	0.0778	22.0	01Jan2018, 12:50	1.11
DP-6	0.0092	2.3	01Jan2018, 12:35	0.85
Junction-4	0.0288	6.1	01Jan2018, 12:45	0.82
Junction-5	0.2641	44.5	01Jan2018, 13:00	0.82
Junction-6	0.2830	47.8	01Jan2018, 13:00	0.83
Junction-7	0.3365	58.1	01Jan2018, 13:05	0.83
OS1a	0.0146	3.6	01Jan2018, 12:45	0.92
OS1b	0.0925	14.2	01Jan2018, 13:00	0.70
OS2a	0.0078	1.8	01Jan2018, 12:30	0.71
OS2b	0.0134	3.2	01Jan2018, 12:35	0.76
OS2c	0.0036	1.2	01Jan2018, 12:25	0.89
OS2d	0.0043	1.1	01Jan2018, 12:40	0.86
OS2e	0.0049	1.3	01Jan2018, 12:35	0.84
OS3a	0.0076	0.9	01Jan2018, 12:50	0.53
OS3b	0.0051	0.8	01Jan2018, 12:35	0.53
POND 1	0.0840	3.5	01Jan2018, 03:10	1.02
PR-1	0.1107	19.8	01Jan2018, 13:10	0.91
PR-10	0.0256	3.4	01Jan2018, 13:05	0.65
PR-2	0.0251	6.5	01Jan2018, 12:40	0.92
PR-3	0.0153	3.8	01Jan2018, 12:45	0.92
PR-4	0.0443	10.3	01Jan2018, 12:50	0.92
PR-6a	0.0698	17.0	01Jan2018, 12:45	0.92
PR-6b	0.0212	5.2	01Jan2018, 12:45	0.92
PR-8a	0.0080	5.6	01Jan2018, 13:05	2.73
PR-8b	0.0006	1.7	01Jan2018, 12:15	5.49
Reach-1	0.1149	18.5	01Jan2018, 13:00	0.72
Reach-2	0.2641	44.4	01Jan2018, 13:05	0.82
Reach-3	0.3365	58.1	01Jan2018, 13:05	0.83
Reach-4	0.2830	47.7	01Jan2018, 13:05	0.82
Sink-1	0.4800	69.8	01Jan2018, 13:05	0.85
Sink-2	0.0784	22.4	01Jan2018, 12:50	1.14
SITE DISCH...	0.4493	66.0	01Jan2018, 13:05	0.87



Model Name: **Hay\_Creek\_Forest\_Manor**  
*These models reflect the existing conditions on the Hay Creek development.*



Project: HAY\_CREEK\_FOREST\_MANOR - UP Simulation Run: EX-Q5

Start of Run: 01Jan2018, 00:00 Basin Model: EX - HAY CREEK\_FM  
 End of Run: 02Jan2018, 00:00 Meteorologic Model: 5 YEAR EVENT  
 Compute Time: 28Mar2023, 08:56:35 Control Specifications: 1 DAY

Volume Units:  IN  AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
EX-1	0.0876	1.6	01Jan2018, 13:00	0.10
EX-2	0.0754	2.0	01Jan2018, 12:50	0.13
EX-3	0.0963	2.3	01Jan2018, 12:40	0.10
EX-5	0.0669	1.5	01Jan2018, 12:40	0.09
EX-OS1a	0.0146	0.8	01Jan2018, 12:40	0.23
EX-OS1b	0.0925	2.6	01Jan2018, 12:50	0.14
EX-OS2a	0.0248	1.5	01Jan2018, 12:25	0.18
EX-OS2b	0.0043	0.3	01Jan2018, 12:35	0.23
EX-OS2c	0.0049	0.3	01Jan2018, 12:30	0.22
EX-OS3	0.0127	0.2	01Jan2018, 12:30	0.07
Junction-2	0.1927	5.4	01Jan2018, 12:45	0.14
Junction-3	0.1055	2.9	01Jan2018, 12:35	0.11
Junction-4	0.0796	1.8	01Jan2018, 12:40	0.09
Junction-5	0.2949	7.5	01Jan2018, 12:50	0.13
Junction-6	0.4004	9.8	01Jan2018, 12:50	0.12
Reach-1	0.0146	0.8	01Jan2018, 13:00	0.23
Reach-2	0.2949	7.5	01Jan2018, 13:00	0.13
Reach-3	0.4004	9.8	01Jan2018, 12:55	0.12
Sink-1	0.4800	11.2	01Jan2018, 12:50	0.12
SITE DISCH...	0.4800	11.2	01Jan2018, 12:50	0.12

Project: HAY\_CREEK\_FOREST\_MANOR - UP Simulation Run: EX-Q100

Start of Run: 01Jan2018, 00:00 Basin Model: EX - HAY CREEK\_FM  
 End of Run: 02Jan2018, 00:00 Meteorologic Model: 100 YEAR EVENT  
 Compute Time: 28Mar2023, 08:57:29 Control Specifications: 1 DAY

Volume Units:  IN  AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
EX-1	0.0876	9.9	01Jan2018, 13:15	0.62
EX-2	0.0754	11.2	01Jan2018, 13:00	0.69
EX-3	0.0963	14.7	01Jan2018, 12:45	0.62
EX-5	0.0669	10.0	01Jan2018, 12:45	0.61
EX-OS1a	0.0146	4.1	01Jan2018, 12:45	1.01
EX-OS1b	0.0925	15.7	01Jan2018, 13:00	0.76
EX-OS2a	0.0248	8.0	01Jan2018, 12:30	0.89
EX-OS2b	0.0043	1.4	01Jan2018, 12:35	1.01
EX-OS2c	0.0049	1.6	01Jan2018, 12:30	0.99
EX-OS3	0.0127	2.0	01Jan2018, 12:40	0.57
Junction-2	0.1927	30.9	01Jan2018, 12:55	0.75
Junction-3	0.1055	17.4	01Jan2018, 12:45	0.65
Junction-4	0.0796	11.9	01Jan2018, 12:45	0.60
Junction-5	0.2949	43.9	01Jan2018, 13:00	0.72
Junction-6	0.4004	59.2	01Jan2018, 12:55	0.70
Reach-1	0.0146	4.1	01Jan2018, 12:55	1.00
Reach-2	0.2949	43.8	01Jan2018, 13:00	0.72
Reach-3	0.4004	59.1	01Jan2018, 13:00	0.70
Sink-1	0.4800	69.9	01Jan2018, 12:55	0.68
SITE DISCH...	0.4800	69.9	01Jan2018, 12:55	0.68

*SWALE*  
*CALCULATIONS*

# Channel Report

## DP-10

### Triangular

Side Slopes (z:1) = 4.00, 3.00  
Total Depth (ft) = 4.50

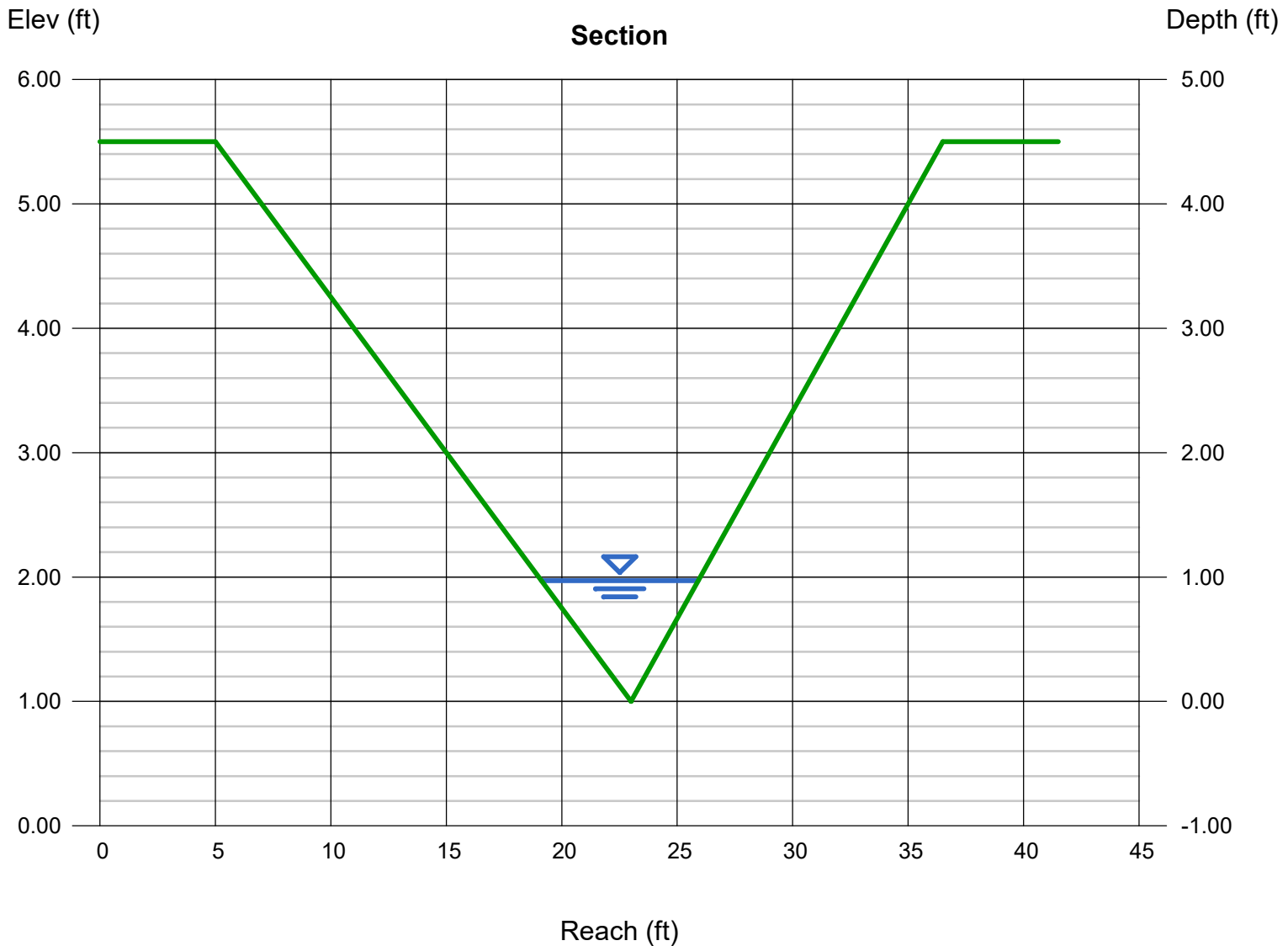
Invert Elev (ft) = 1.00  
Slope (%) = 6.00  
N-Value = 0.075

### Calculations

Compute by: Known Q  
Known Q (cfs) = 9.60

### Highlighted

Depth (ft) = 0.97  
Q (cfs) = 9.600  
Area (sqft) = 3.29  
Velocity (ft/s) = 2.92  
Wetted Perim (ft) = 7.07  
Crit Depth, Yc (ft) = 0.86  
Top Width (ft) = 6.79  
EGL (ft) = 1.10





# Channel Report

## DP-11

### Triangular

Side Slopes (z:1) = 4.00, 3.00  
Total Depth (ft) = 4.00

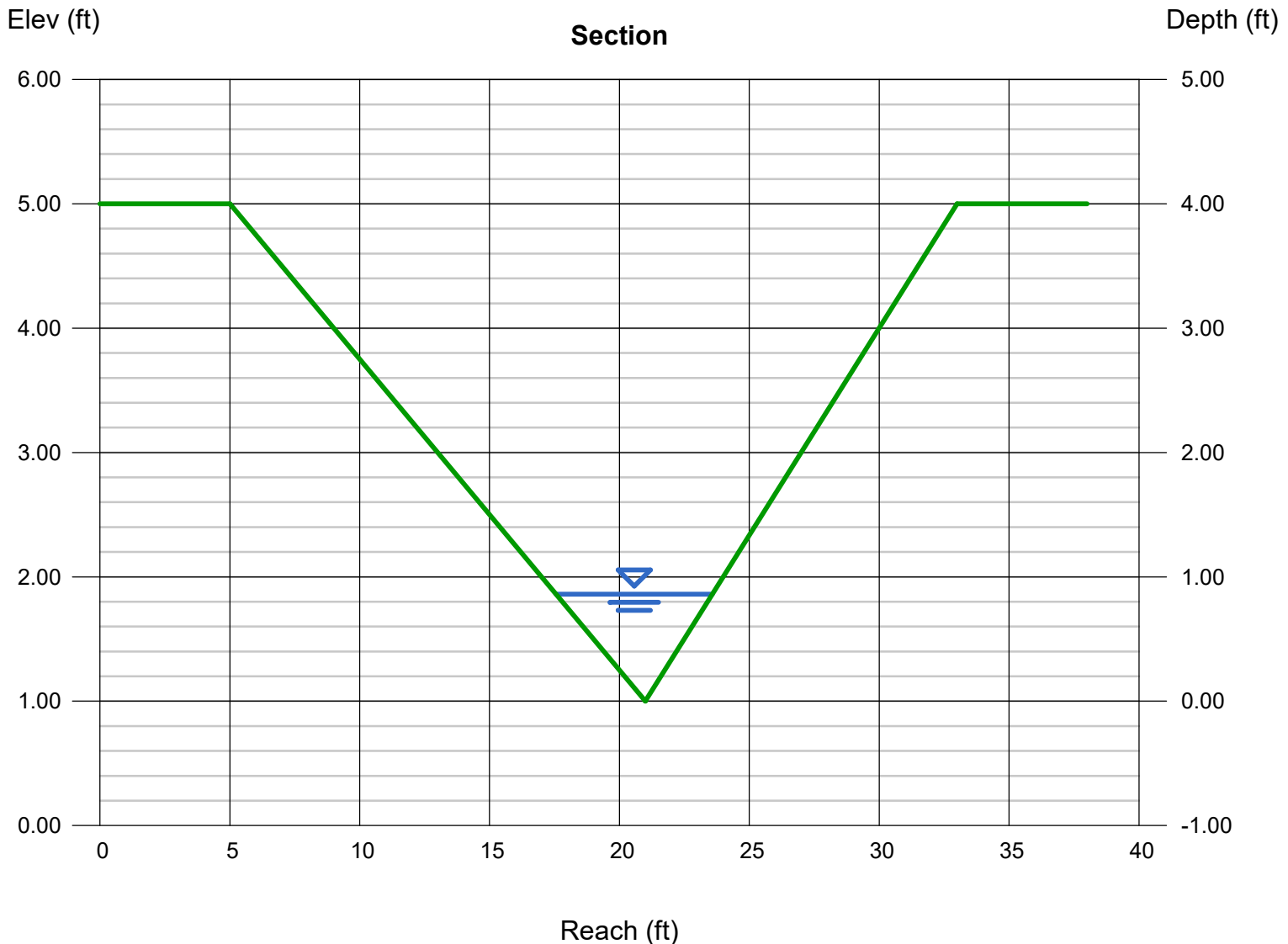
Invert Elev (ft) = 1.00  
Slope (%) = 2.80  
N-Value = 0.076

### Calculations

Compute by: Known Q  
Known Q (cfs) = 4.60

### Highlighted

Depth (ft) = 0.86  
Q (cfs) = 4.600  
Area (sqft) = 2.59  
Velocity (ft/s) = 1.78  
Wetted Perim (ft) = 6.27  
Crit Depth, Yc (ft) = 0.65  
Top Width (ft) = 6.02  
EGL (ft) = 0.91



# Channel Report

## DP-12

### Triangular

Side Slopes (z:1) = 4.00, 3.00

Total Depth (ft) = 4.00

Invert Elev (ft) = 1.00

Slope (%) = 4.80

N-Value = 0.075

### Calculations

Compute by: Known Q

Known Q (cfs) = 12.30

### Highlighted

Depth (ft) = 1.11

Q (cfs) = 12.30

Area (sqft) = 4.31

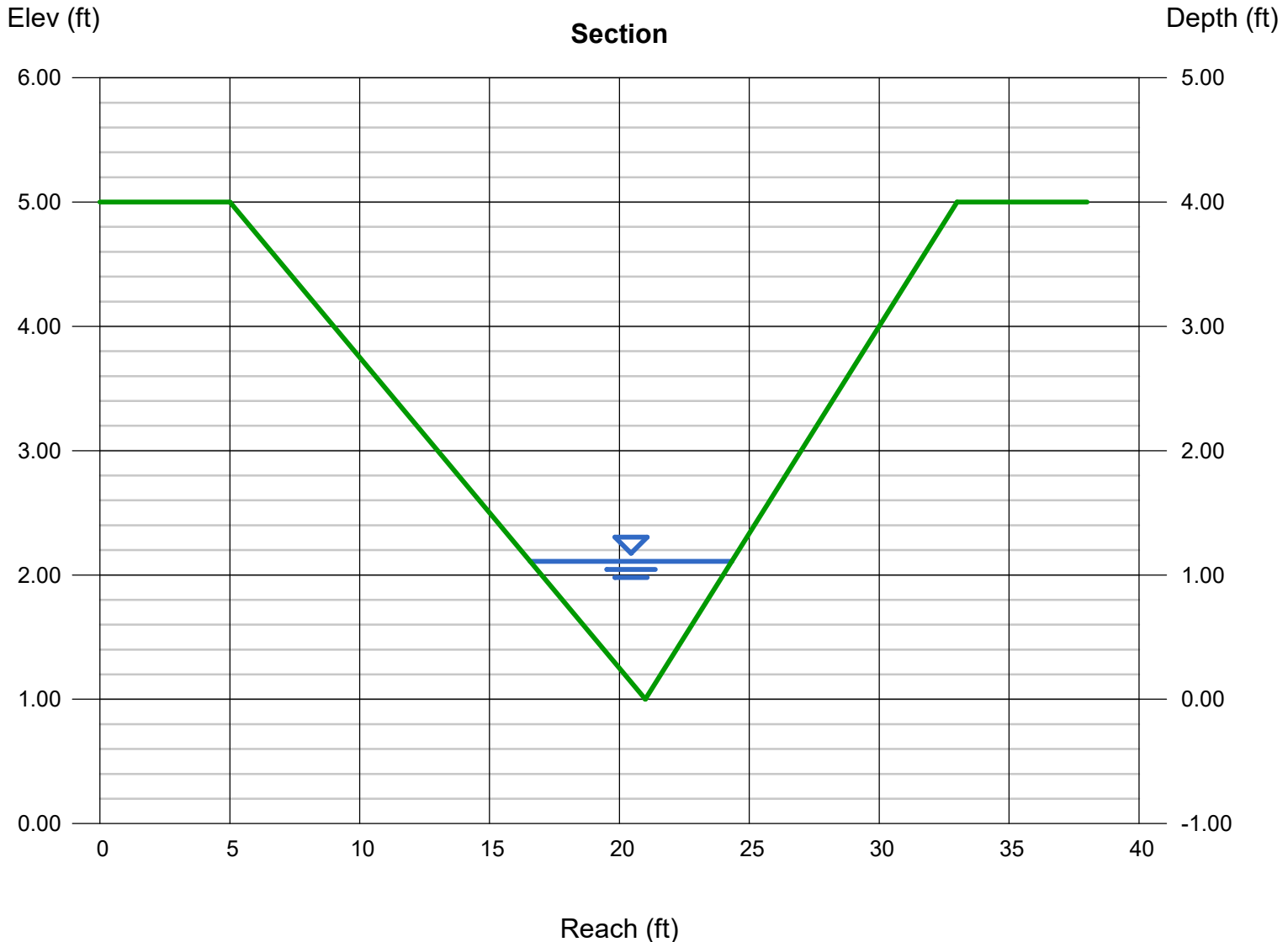
Velocity (ft/s) = 2.85

Wetted Perim (ft) = 8.09

Crit Depth,  $Y_c$  (ft) = 0.95

Top Width (ft) = 7.77

EGL (ft) = 1.24



# Channel Report

## DP-13 (3.6%)

### Triangular

Side Slopes (z:1) = 4.00, 3.00  
Total Depth (ft) = 4.00

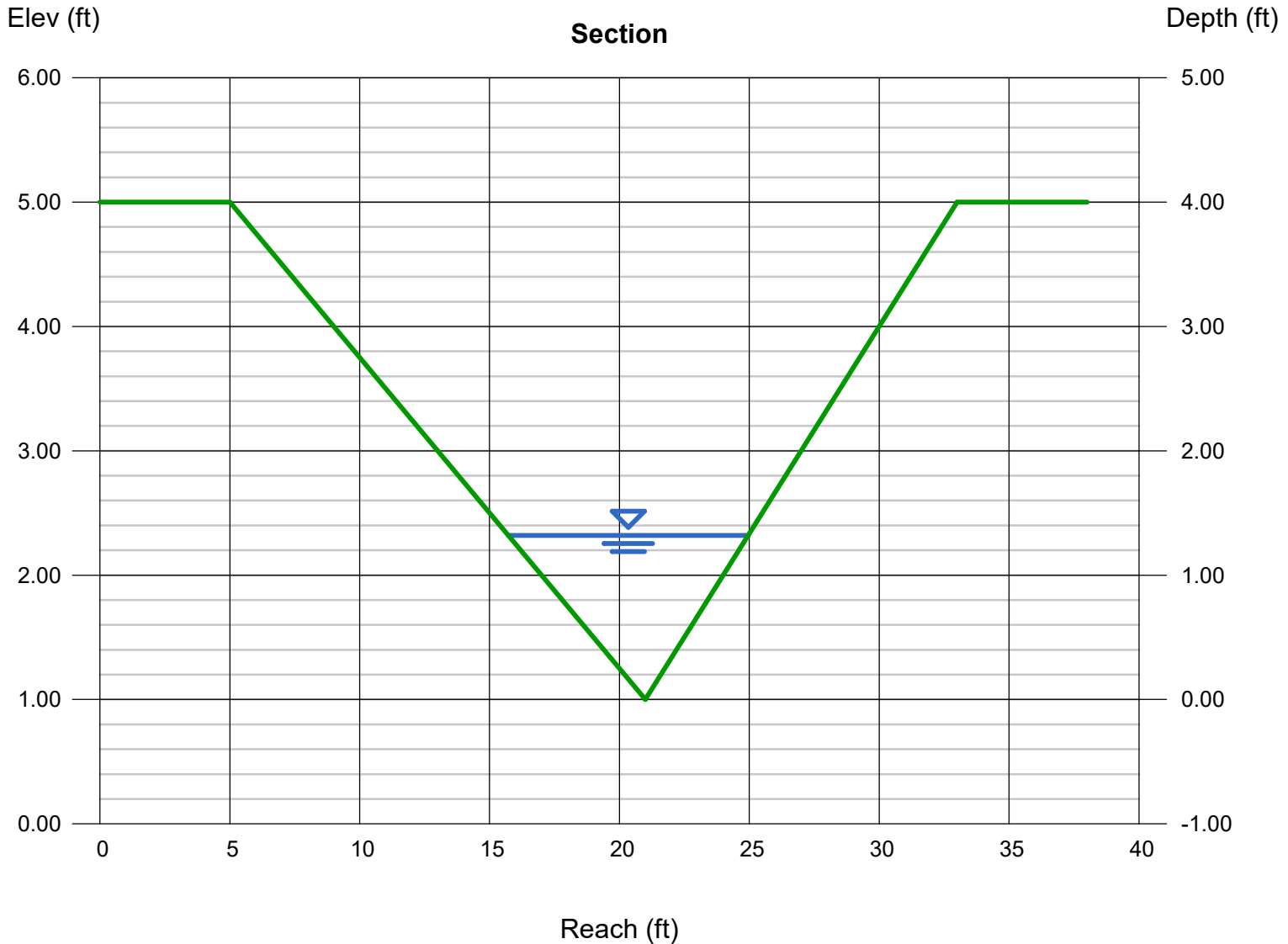
Invert Elev (ft) = 1.00  
Slope (%) = 3.60  
N-Value = 0.074

### Calculations

Compute by: Known Q  
Known Q (cfs) = 17.00

### Highlighted

Depth (ft) = 1.32  
Q (cfs) = 17.00  
Area (sqft) = 6.10  
Velocity (ft/s) = 2.79  
Wetted Perim (ft) = 9.62  
Crit Depth, Yc (ft) = 1.08  
Top Width (ft) = 9.24  
EGL (ft) = 1.44



# Channel Report

## DP-14

### Triangular

Side Slopes (z:1) = 4.00, 3.00  
Total Depth (ft) = 4.00

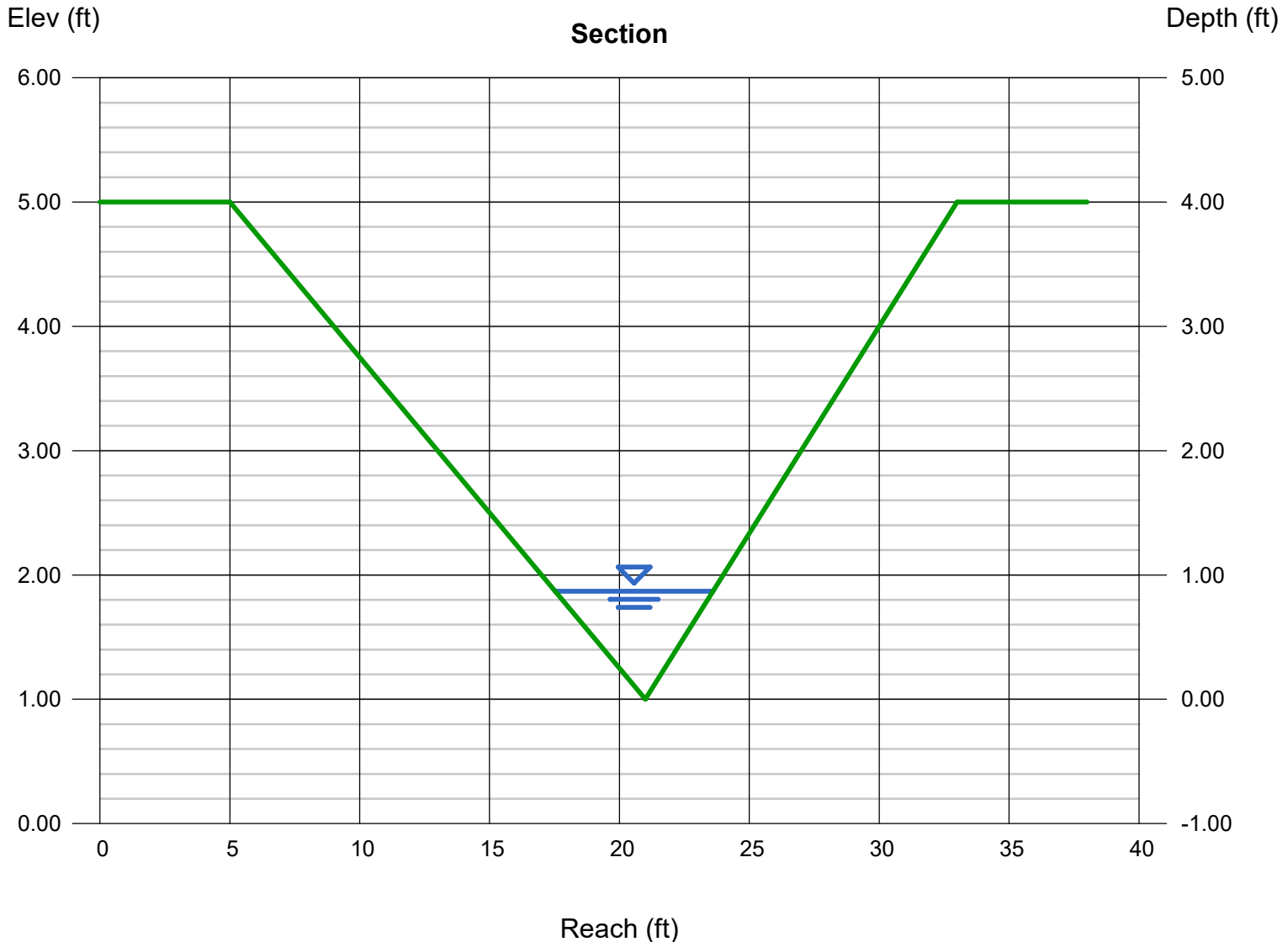
Invert Elev (ft) = 1.00  
Slope (%) = 2.80  
N-Value = 0.060

### Calculations

Compute by: Known Q  
Known Q (cfs) = 6.10

### Highlighted

Depth (ft) = 0.87  
Q (cfs) = 6.100  
Area (sqft) = 2.65  
Velocity (ft/s) = 2.30  
Wetted Perim (ft) = 6.34  
Crit Depth, Yc (ft) = 0.72  
Top Width (ft) = 6.09  
EGL (ft) = 0.95



# Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Monday, Mar 27 2023

## DP-15

### Trapezoidal

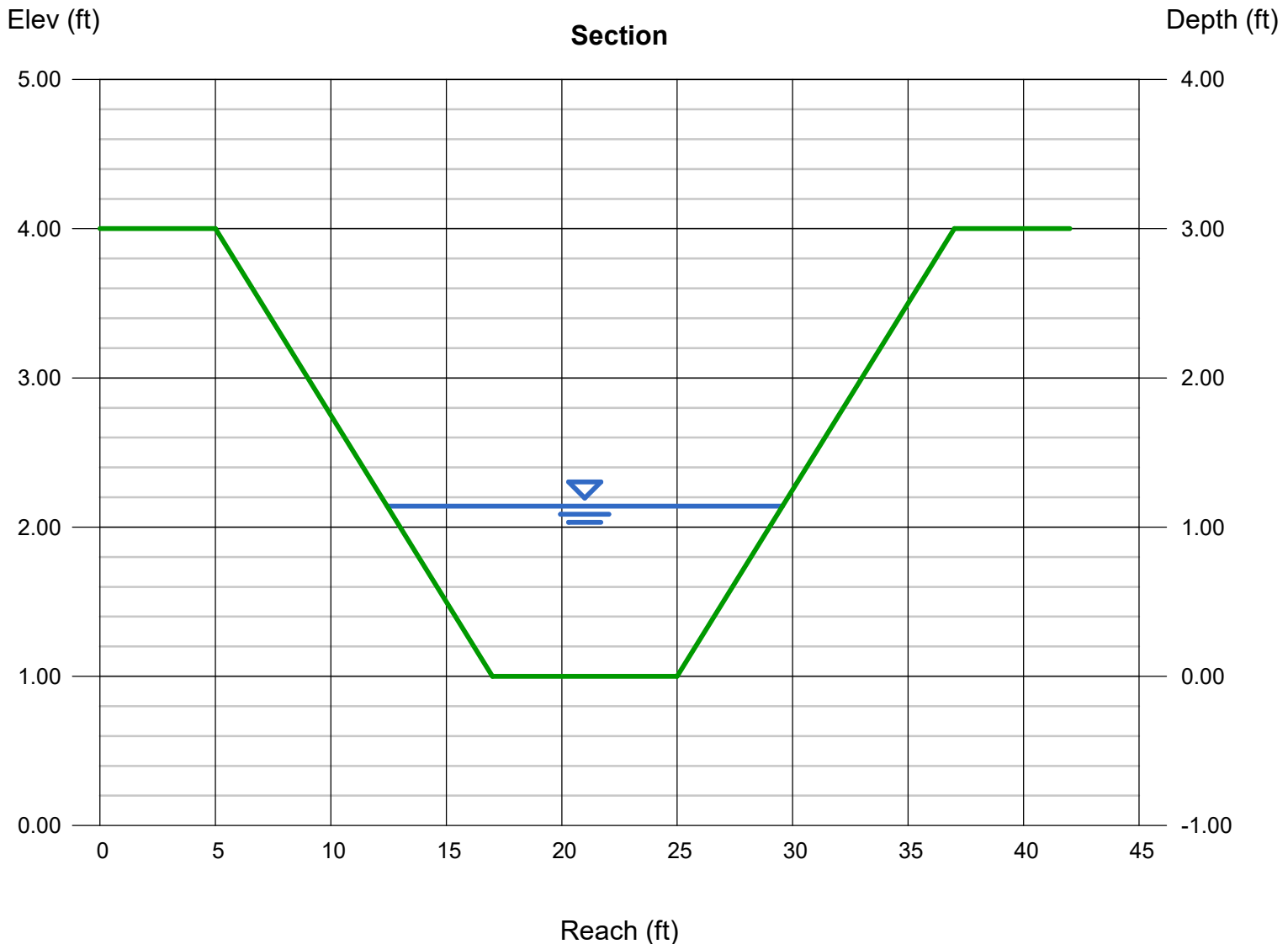
Bottom Width (ft) = 8.00  
Side Slopes (z:1) = 4.00, 4.00  
Total Depth (ft) = 3.00  
Invert Elev (ft) = 1.00  
Slope (%) = 4.50  
N-Value = 0.068

### Highlighted

Depth (ft) = 1.14  
Q (cfs) = 58.10  
Area (sqft) = 14.32  
Velocity (ft/s) = 4.06  
Wetted Perim (ft) = 17.40  
Crit Depth,  $Y_c$  (ft) = 1.00  
Top Width (ft) = 17.12  
EGL (ft) = 1.40

### Calculations

Compute by: Known Q  
Known Q (cfs) = 58.10



# Channel Report

## DP-16 (2.8%)

### Triangular

Side Slopes (z:1) = 4.00, 3.00

Total Depth (ft) = 2.00

Invert Elev (ft) = 1.00

Slope (%) = 2.80

N-Value = 0.074

### Calculations

Compute by: Known Q

Known Q (cfs) = 5.60

### Highlighted

Depth (ft) = 0.91

Q (cfs) = 5.600

Area (sqft) = 2.90

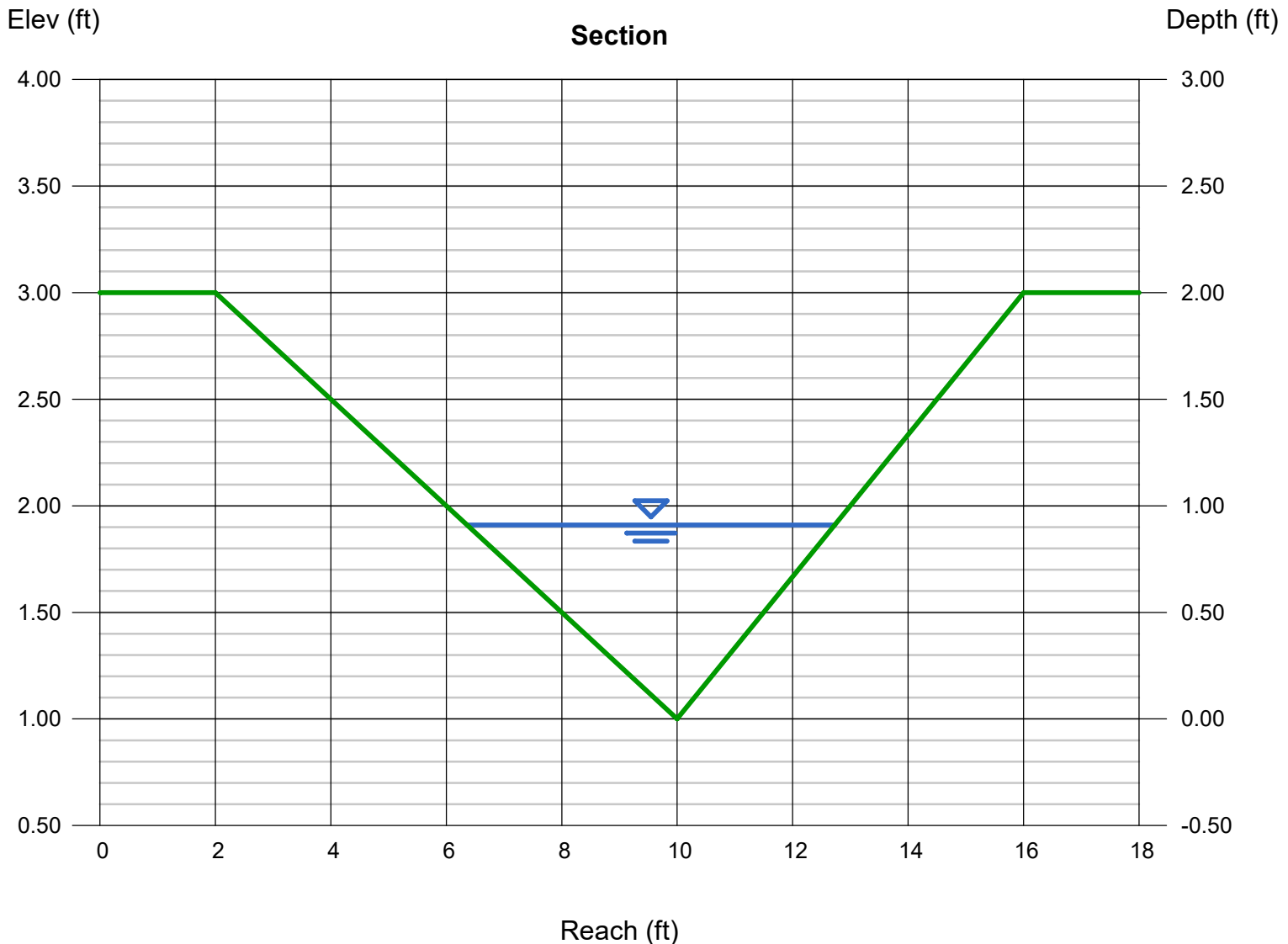
Velocity (ft/s) = 1.93

Wetted Perim (ft) = 6.63

Crit Depth, Yc (ft) = 0.70

Top Width (ft) = 6.37

EGL (ft) = 0.97



# Channel Report

## DP-16 (3.6%)

### Triangular

Side Slopes (z:1) = 4.00, 3.00

Total Depth (ft) = 2.00

Invert Elev (ft) = 1.00

Slope (%) = 3.60

N-Value = 0.071

### Calculations

Compute by: Known Q

Known Q (cfs) = 5.60

### Highlighted

Depth (ft) = 0.86

Q (cfs) = 5.600

Area (sqft) = 2.59

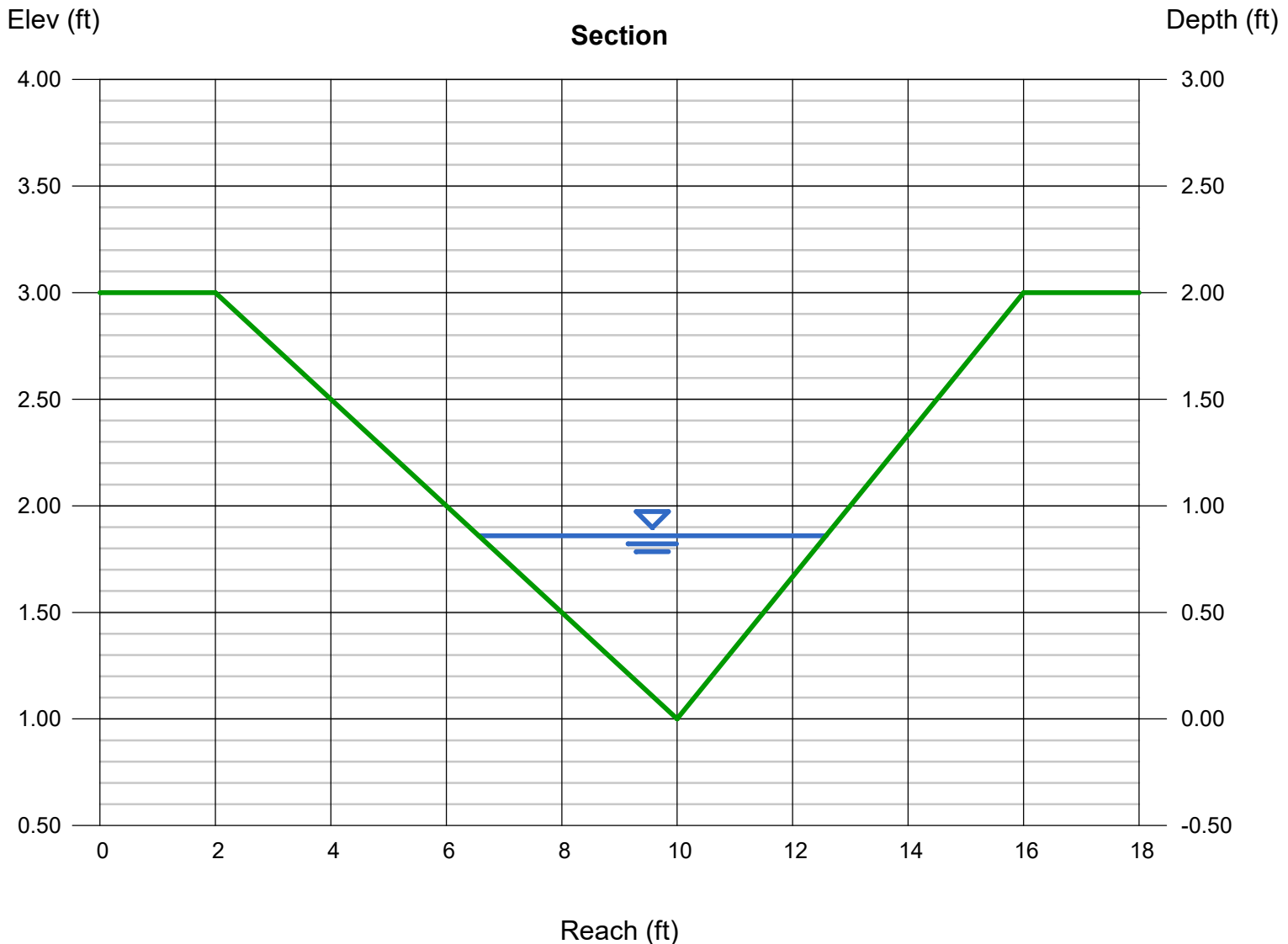
Velocity (ft/s) = 2.16

Wetted Perim (ft) = 6.27

Crit Depth, Yc (ft) = 0.70

Top Width (ft) = 6.02

EGL (ft) = 0.93



# Channel Report

## DP-16 (4.8%)

### Triangular

Side Slopes (z:1) = 4.00, 3.00

Total Depth (ft) = 2.00

Invert Elev (ft) = 1.00

Slope (%) = 4.80

N-Value = 0.068

### Calculations

Compute by: Known Q

Known Q (cfs) = 5.60

### Highlighted

Depth (ft) = 0.80

Q (cfs) = 5.600

Area (sqft) = 2.24

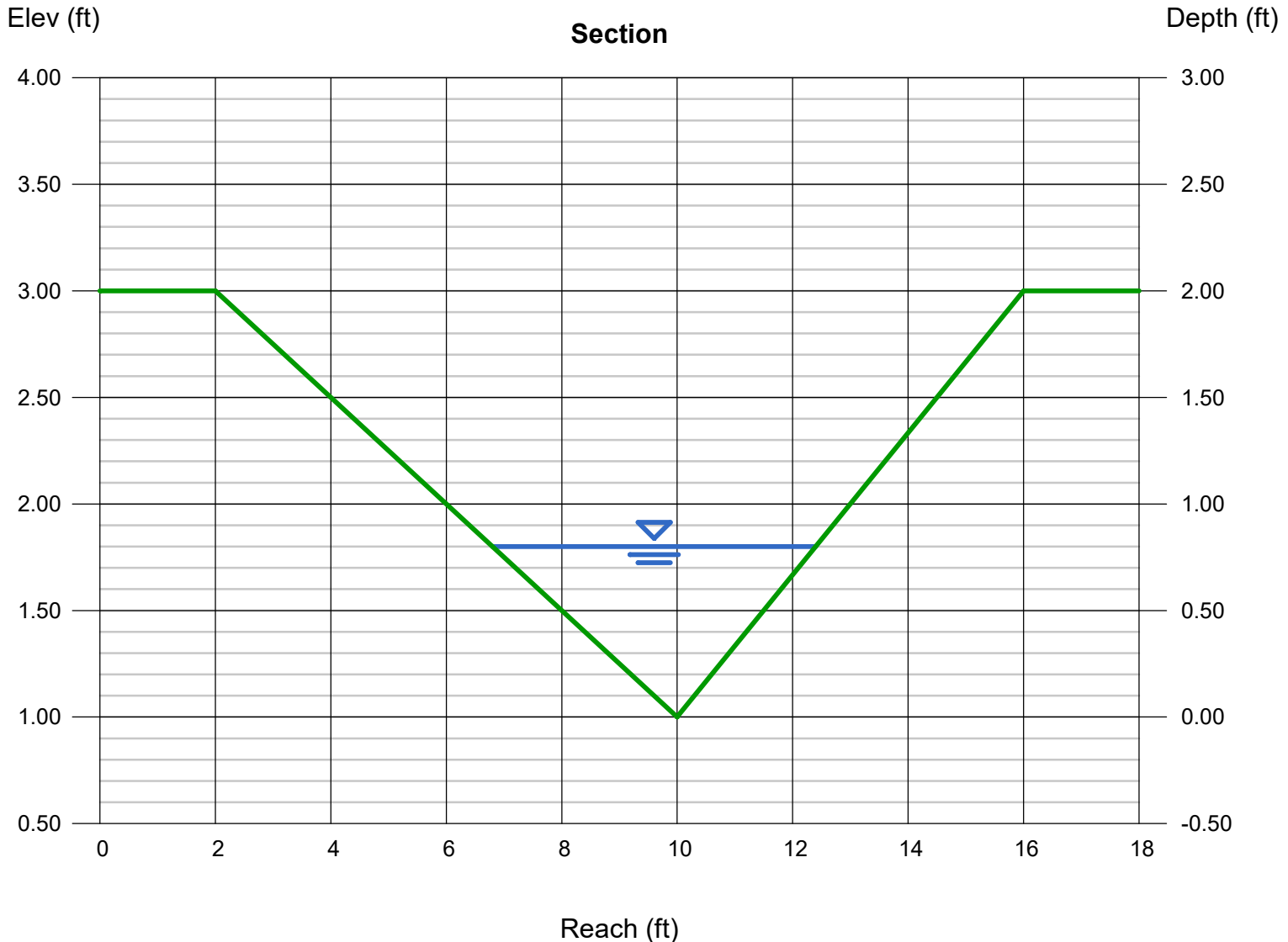
Velocity (ft/s) = 2.50

Wetted Perim (ft) = 5.83

Crit Depth, Yc (ft) = 0.70

Top Width (ft) = 5.60

EGL (ft) = 0.90





# Channel Report

## DP-16 (6.0%)

### Triangular

Side Slopes (z:1) = 4.00, 3.00  
Total Depth (ft) = 2.00

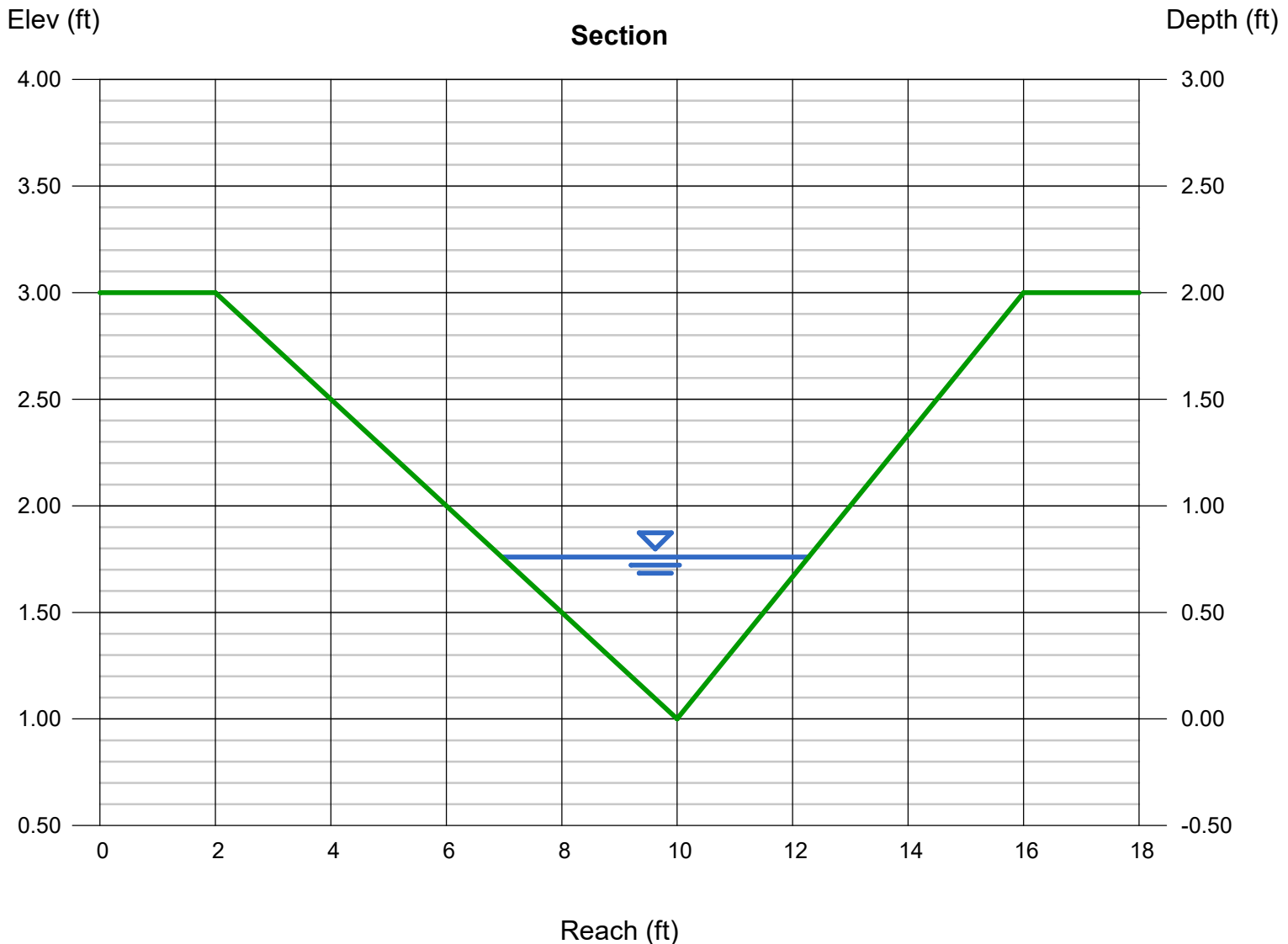
Invert Elev (ft) = 1.00  
Slope (%) = 6.00  
N-Value = 0.066

### Calculations

Compute by: Known Q  
Known Q (cfs) = 5.60

### Highlighted

Depth (ft) = 0.76  
Q (cfs) = 5.600  
Area (sqft) = 2.02  
Velocity (ft/s) = 2.77  
Wetted Perim (ft) = 5.54  
Crit Depth, Yc (ft) = 0.70  
Top Width (ft) = 5.32  
EGL (ft) = 0.88



# Channel Report

## Roadside Embankment

### Triangular

Side Slopes (z:1) = 5.00, 10.00  
Total Depth (ft) = 2.30

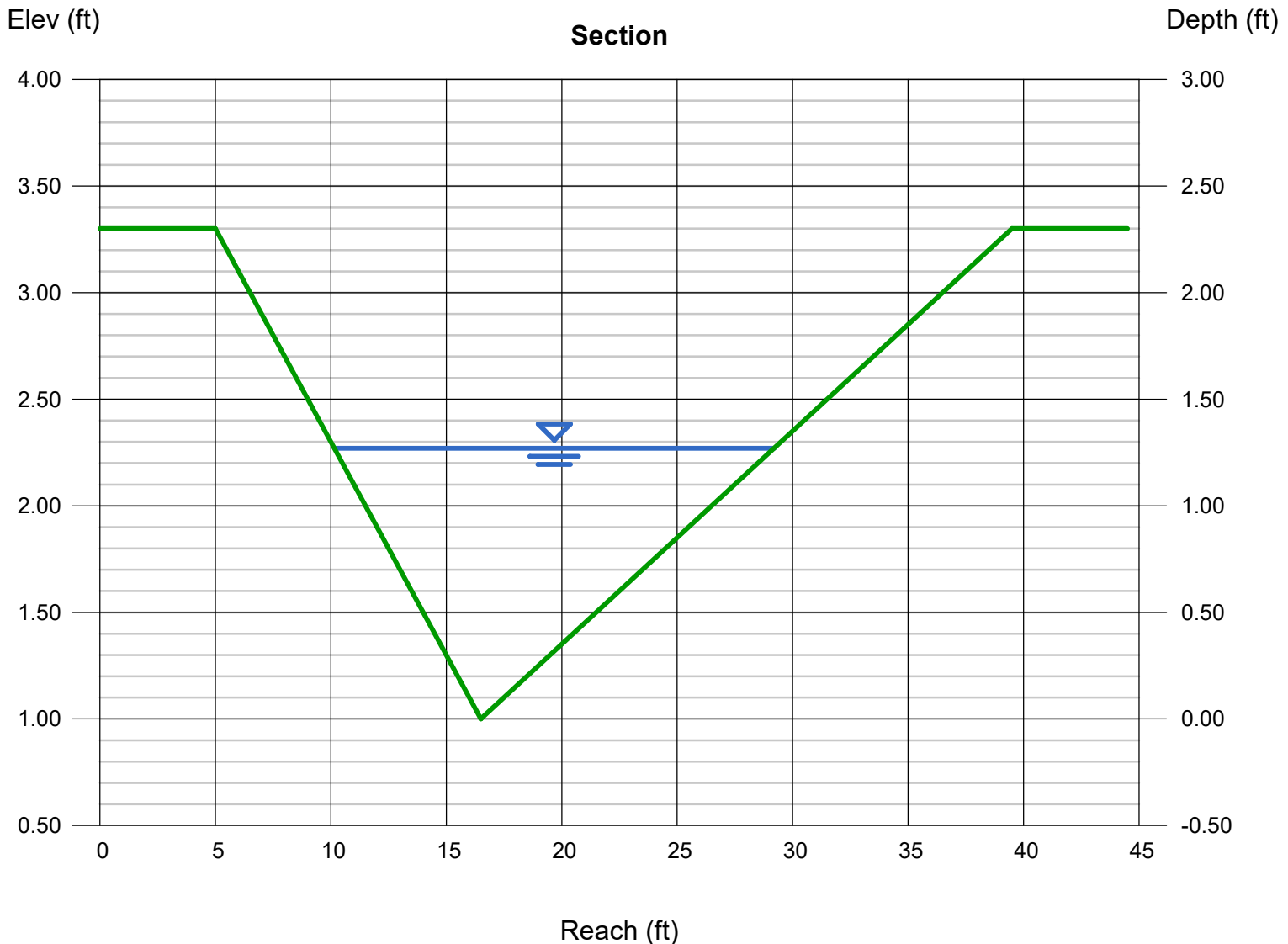
Invert Elev (ft) = 1.00  
Slope (%) = 2.00  
N-Value = 0.032

### Calculations

Compute by: Known Q  
Known Q (cfs) = 58.10

### Highlighted

Depth (ft) = 1.27  
Q (cfs) = 58.10  
Area (sqft) = 12.10  
Velocity (ft/s) = 4.80  
Wetted Perim (ft) = 19.24  
Crit Depth, Yc (ft) = 1.31  
Top Width (ft) = 19.05  
EGL (ft) = 1.63



# Hydraulic Analysis Report

## Project Data

Project Title: Hay Creek

Designer:

Project Date: Thursday, January 12, 2023

Project Units: U.S. Customary Units

Notes:

## Channel Analysis: DP-10

Notes:

## Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0748

Flow: 9.6000 cfs

## Result Parameters

Depth: 0.9687 ft

Area of Flow: 3.2840 ft<sup>2</sup>

Wetted Perimeter: 7.0570 ft

Hydraulic Radius: 0.4654 ft

Average Velocity: 2.9233 ft/s

Top Width: 6.7806 ft

Froude Number: 0.7402

Critical Depth: 0.8624 ft

Critical Velocity: 3.6880 ft/s

Critical Slope: 0.1115 ft/ft

Critical Top Width: 6.16 ft

Calculated Max Shear Stress: 3.6266 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 1.7423 lb/ft<sup>2</sup>

## Channel Lining Analysis: Channel Lining Design Analysis DP-10

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.13865

### Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.645971

Manning's n method: Bathurst

Manning's n: 0.0747751

### Channel Bottom Shear Results

V\*: 1.36822

Reynold's Number: 84319.2

Shield's Parameter: 0.0755305

shear stress on channel bottom: 3.62777 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 5.34519 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.579601 ft

### Channel Side Shear Results

K1: 0.934

K2: 1

Kb: 0

shear stress on side of channel: 3.62777 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 5.34519 lb/ft<sup>2</sup>

Stable Side D50: 0.541347 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-10

## Channel Analysis: DP-12

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0480 ft/ft

Manning's n: 0.0749

Flow: 12.3000 cfs

### Result Parameters

Depth: 1.1092 ft

Area of Flow: 4.3061 ft<sup>2</sup>

Wetted Perimeter: 8.0809 ft

Hydraulic Radius: 0.5329 ft

Average Velocity: 2.8564 ft/s

Top Width: 7.7644 ft

Froude Number: 0.6759

Critical Depth: 0.9523 ft

Critical Velocity: 3.8754 ft/s

Critical Slope: 0.1083 ft/ft

Critical Top Width: 6.80 ft

Calculated Max Shear Stress: 3.3223 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 1.5961 lb/ft<sup>2</sup>

## Channel Lining Analysis: Channel Lining Design Analysis DP-12

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.12738

### Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.739882

Manning's n method: Bathurst

Manning's n: 0.0749154

### Channel Bottom Shear Results

V\*: 1.30971

Reynold's Number: 80713.5

Shield's Parameter: 0.0732093

shear stress on channel bottom: 3.32414 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 5.63346 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.498928 ft

### Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 3.32414 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 5.2457 lb/ft<sup>2</sup>

Stable Side D50: 0.500445 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-12



## Channel Analysis: DP-13 (3.6%)

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0360 ft/ft

Manning's n: 0.0742

Flow: 17.0000 cfs

### Result Parameters

Depth: 1.3169 ft

Area of Flow: 6.0700 ft<sup>2</sup>

Wetted Perimeter: 9.5942 ft

Hydraulic Radius: 0.6327 ft

Average Velocity: 2.8007 ft/s

Top Width: 9.2184 ft

Froude Number: 0.6082

Critical Depth: 1.0839 ft

Critical Velocity: 4.1345 ft/s

Critical Slope: 0.1017 ft/ft

Critical Top Width: 7.75 ft

Calculated Max Shear Stress: 2.9583 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 1.4212 lb/ft<sup>2</sup>

## Channel Lining Analysis: Channel Lining Design Analysis DP-13 (3.6%)

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.11313

### Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.87817

Manning's n method: Bathurst

Manning's n: 0.074193

### Channel Bottom Shear Results

V\*: 1.2357

Reynold's Number: 76152.6

Shield's Parameter: 0.0702732

shear stress on channel bottom: 2.95908 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 5.40753 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.456842 ft

### Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 2.95908 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 5.03532 lb/ft<sup>2</sup>

Stable Side D50: 0.458231 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-13 (3.6%)

## Channel Analysis: DP-14 (2.8%)

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0719

Flow: 6.1000 cfs

### Result Parameters

Depth: 0.9292 ft

Area of Flow: 3.0218 ft<sup>2</sup>

Wetted Perimeter: 6.7694 ft

Hydraulic Radius: 0.4464 ft

Average Velocity: 2.0187 ft/s

Top Width: 6.5042 ft

Froude Number: 0.5219

Critical Depth: 0.7193 ft

Critical Velocity: 3.3682 ft/s

Critical Slope: 0.1097 ft/ft

Critical Top Width: 5.14 ft

Calculated Max Shear Stress: 1.6235 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.7799 lb/ft<sup>2</sup>

## Channel Lining Analysis: Channel Lining Design Analysis DP-14 (2.8%)

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

### Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.929871

Manning's n method: Bathurst

Manning's n: 0.0719463

### Channel Bottom Shear Results

V\*: 0.915626

Reynold's Number: 37618.2

Shield's Parameter: 0.047

shear stress on channel bottom: 1.62467 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 2.4111 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.336967 ft

### Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.62467 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 2.24135 lb/ft<sup>2</sup>

Stable Side D50: 0.338563 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-14 (2.8%)

## Channel Analysis: DP-15

Notes:

### Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0450 ft/ft

Manning's n: 0.0679

Flow: 58.1000 cfs

### Result Parameters

Depth: 1.1374 ft

Area of Flow: 14.2731 ft<sup>2</sup>

Wetted Perimeter: 17.3789 ft

Hydraulic Radius: 0.8213 ft

Average Velocity: 4.0706 ft/s

Top Width: 17.0988 ft

Froude Number: 0.7852

Critical Depth: 0.9917 ft

Critical Velocity: 4.8956 ft/s

Critical Slope: 0.0756 ft/ft

Critical Top Width: 15.93 ft

Calculated Max Shear Stress: 3.1937 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 2.3062 lb/ft<sup>2</sup>

## Channel Lining Analysis: Channel Lining Design Analysis DP-15

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.12239

### Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 1.11299

Manning's n method: Bathurst

Manning's n: 0.0678818

### Channel Bottom Shear Results

V\*: 1.28375

Reynold's Number: 79113.9

Shield's Parameter: 0.0721795

shear stress on channel bottom: 3.19369 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 5.55422 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.484031 ft

### Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 3.19369 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 5.17191 lb/ft<sup>2</sup>

Stable Side D50: 0.485503 lb/ft<sup>2</sup>

side of channel is stable



## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-15

## Channel Analysis: DP-11

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0758

Flow: 4.6000 cfs

### Result Parameters

Depth: 0.8526 ft

Area of Flow: 2.5441 ft<sup>2</sup>

Wetted Perimeter: 6.2113 ft

Hydraulic Radius: 0.4096 ft

Average Velocity: 1.8081 ft/s

Top Width: 5.9680 ft

Froude Number: 0.4880

Critical Depth: 0.6425 ft

Critical Velocity: 3.1834 ft/s

Critical Slope: 0.1265 ft/ft

Critical Top Width: 4.59 ft

Calculated Max Shear Stress: 1.4896 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.7156 lb/ft<sup>2</sup>

## Channel Lining Analysis: Channel Lining Design Analysis DP-11

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

### Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.853239

Manning's n method: Bathurst

Manning's n: 0.0758392

### Channel Bottom Shear Results

V\*: 0.877086

Reynold's Number: 36034.8

Shield's Parameter: 0.047

shear stress on channel bottom: 1.49078 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 2.4111 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.309197 ft

### Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.49078 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 2.24135 lb/ft<sup>2</sup>

Stable Side D50: 0.310662 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-11

## Channel Analysis: DP-16 2.8%

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0731

Flow: 5.6000 cfs

### Result Parameters

Depth: 0.9050 ft

Area of Flow: 2.8667 ft<sup>2</sup>

Wetted Perimeter: 6.5934 ft

Hydraulic Radius: 0.4348 ft

Average Velocity: 1.9535 ft/s

Top Width: 6.3351 ft

Froude Number: 0.5118

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1144 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 1.5813 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.7597 lb/ft<sup>2</sup>

## **Channel Lining Analysis: Channel Lining Design Analysis DP-16 2.8%**

Notes:

### **Lining Input Parameters**

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

### **Lining Results**

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.905928

Manning's n method: Bathurst

Manning's n: 0.0730949

### **Channel Bottom Shear Results**

V\*: 0.903762

Reynold's Number: 37130.7

Shield's Parameter: 0.047

shear stress on channel bottom: 1.58284 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 2.4111 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.328291 ft

### **Channel Side Shear Results**

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.58284 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 2.24135 lb/ft<sup>2</sup>

Stable Side D50: 0.329846 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-16 2.8%

## Channel Analysis: DP-16 3.6%

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0360 ft/ft

Manning's n: 0.0705

Flow: 5.6000 cfs

### Result Parameters

Depth: 0.8520 ft

Area of Flow: 2.5408 ft<sup>2</sup>

Wetted Perimeter: 6.2073 ft

Hydraulic Radius: 0.4093 ft

Average Velocity: 2.2041 ft/s

Top Width: 5.9641 ft

Froude Number: 0.5951

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1066 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 1.9140 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 0.9195 lb/ft<sup>2</sup>



## Channel Lining Analysis: Channel Lining Design Analysis DP-16 3.6%

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00277

### Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.852316

Manning's n method: Bathurst

Manning's n: 0.0705366

### Channel Bottom Shear Results

V\*: 0.993984

Reynold's Number: 40837.5

Shield's Parameter: 0.0475391

shear stress on channel bottom: 1.91464 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 2.43876 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.393633 ft

### Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.91464 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 2.26706 lb/ft<sup>2</sup>

Stable Side D50: 0.395497 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-16 3.6%

## Channel Analysis: DP-16 4.8%

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0480 ft/ft

Manning's n: 0.0674

Flow: 5.6000 cfs

### Result Parameters

Depth: 0.7936 ft

Area of Flow: 2.2041 ft<sup>2</sup>

Wetted Perimeter: 5.7815 ft

Hydraulic Radius: 0.3812 ft

Average Velocity: 2.5407 ft/s

Top Width: 5.5550 ft

Froude Number: 0.7108

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.0973 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 2.3769 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 1.1419 lb/ft<sup>2</sup>

## Channel Lining Analysis: Channel Lining Design Analysis DP-16 4.8%

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.01739

### Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.79406

Manning's n method: Bathurst

Manning's n: 0.067402

### Channel Bottom Shear Results

V\*: 1.10784

Reynold's Number: 45515

Shield's Parameter: 0.0505503

shear stress on channel bottom: 2.37837 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 2.59323 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.466547 ft

### Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 2.37837 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 2.41066 lb/ft<sup>2</sup>

Stable Side D50: 0.468757 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-16 4.8%

## Channel Analysis: DP-16 6.0%

Notes:

### Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0818

Flow: 5.6000 cfs

### Result Parameters

Depth: 0.8186 ft

Area of Flow: 2.3455 ft<sup>2</sup>

Wetted Perimeter: 5.9639 ft

Hydraulic Radius: 0.3933 ft

Average Velocity: 2.3876 ft/s

Top Width: 5.7303 ft

Froude Number: 0.6577

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1435 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 3.0649 lb/ft<sup>2</sup>

Calculated Avg Shear Stress: 1.4724 lb/ft<sup>2</sup>

## Channel Lining Analysis: Channel Lining Design Analysis DP-16 6.0%

Notes:

### Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft<sup>3</sup>

Water Specific Weight: 62.4 lb/ft<sup>3</sup>

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.11741

### Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.546015

Manning's n method: Bathurst

Manning's n: 0.0818682

### Channel Bottom Shear Results

V\*: 1.25792

Reynold's Number: 77521.5

Shield's Parameter: 0.0711545

shear stress on channel bottom: 3.06642 lb/ft<sup>2</sup>

Permissible shear stress for channel bottom: 5.09212 lb/ft<sup>2</sup>

channel bottom is stable

Stable D50: 0.504669 ft

### Channel Side Shear Results

K1: 0.934

K2: 1

Kb: 0

shear stress on side of channel: 3.06642 lb/ft<sup>2</sup>

Permissible shear stress for side of channel: 5.09212 lb/ft<sup>2</sup>

Stable Side D50: 0.471361 lb/ft<sup>2</sup>

side of channel is stable

## **Channel Lining Stability Results**

the channel is stable

## **Channel Summary**

Name of Selected Channel: DP-16 6.0%



**APPENDIX B**

*STANDARD DESIGN CHARTS AND TABLES*

**Table 6-6. Runoff Coefficients for Rational Method**  
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

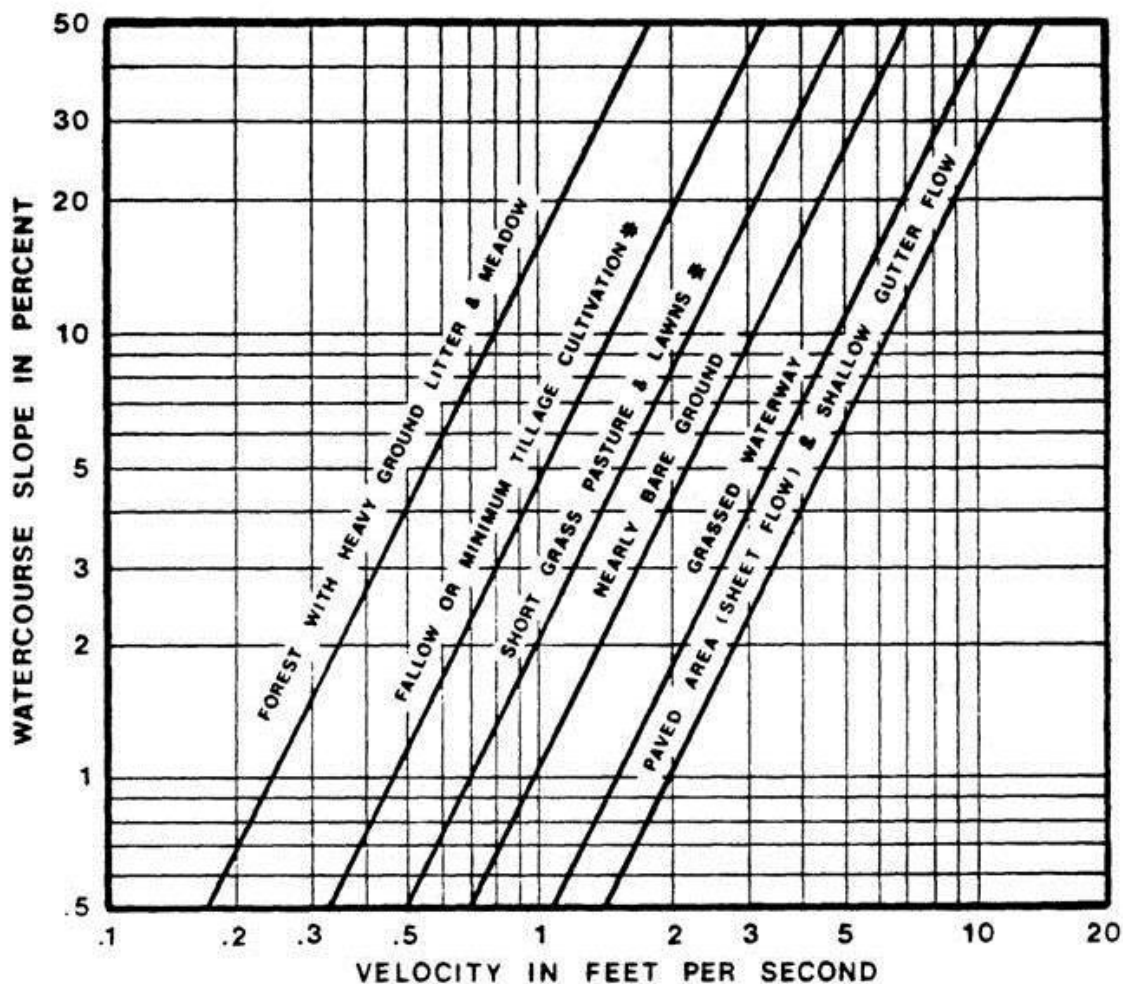
### 3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration ( $t_c$ ) consists of an initial time or overland flow time ( $t_i$ ) plus the travel time ( $t_t$ ) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time ( $t_i$ ) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion ( $t_t$ ) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

<b>Type of Development</b>	<b>Percent Impervious</b>
Commercial	95%
Industrial	85%
Multi-Family	65%
Single Family - 0.1377 acre lots (6,000 SF)	53%
Single-Family - 0.20 acre lots	43%
Single-Family - 0.25 acre lots	40%
Single-Family - 0.33 acre lots	30%
Single-Family - 0.5 acre lots	25%
Single-Family - 1.0 acre lots	20%
Single-Family - 2.5 acre lots	11%
Single-Family - 5 acre lots	7%

Figure 6-25. Estimate of Average Concentrated Shallow Flow



# El Paso County Drainage Basin Fees

Resolution No. 22-442

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2023 Drainage Fee (per Impervious Acre)	2023 Bridge Fee (per Impervious Acre)
<b><u>Drainage Basins with DBPS's:</u></b>					
CHMS0200	Chico Creek	2013	Haegler Ranch	\$12,985	\$1,916
CHWS1200	Chico Creek	2001	Bennett Ranch	\$14,536	\$5,576
CHWS1400	Chico Creek	2013	Falcon	\$37,256	\$5,118
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	\$15,802	\$4,675
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	\$23,078	\$2,980
FOFO2800	Fountain Creek	1988*	Widefield	\$23,078	\$0
FOFO2900	Fountain Creek	1988*	Security	\$23,078	\$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	\$23,078	\$346
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	\$14,077	\$0
FOFO3400	Fountain Creek	1984*	Peterson Field	\$16,646	\$1,262
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	\$23,078	\$0
FOFO4000	Fountain Creek	1996	Sand Creek	\$23,821	\$9,743
FOFO4200	Fountain Creek	1977	Spring Creek	\$11,969	\$0
FOFO4600	Fountain Creek	1984*	Southwest Area	\$23,078	\$0
FOFO4800	Fountain Creek	1991	Bear Creek	\$23,078	\$1,262
FOFO5800	Fountain Creek	1964	Camp Creek	\$2,557	\$0
FOMO1000	Monument Creek	1981	Douglas Creek	\$14,514	\$321
FOMO1200	Monument Creek	1977	Templeton Gap	\$14,900	\$346
FOMO2000	Monument Creek	1971	Pulpit Rock	\$7,653	\$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	\$23,078	\$1,262
FOMO2400	Monument Creek	1966	Dry Creek	\$18,219	\$660
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	\$10,478	\$660
FOMO3700	Monument Creek	1987*	Middle Tributary	\$19,259	\$0
FOMO3800	Monument Creek	1987*	Monument Branch	\$23,078	\$0
FOMO4000	Monument Creek	1996	Smith Creek	\$9,409	\$1,262
FOMO4200	Monument Creek	1989*	Black Forest	\$23,078	\$628
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	\$23,078	\$1,262
FOMO5300	Fountain Creek	1993*	Crystal Creek	\$23,078	\$1,262
<b><u>Miscellaneous Drainage Basins: <sup>1</sup></u></b>					
CHBS0800	Chico Creek		Book Ranch	\$21,654	\$3,135
CHEC0400	Chico Creek		Upper East Chico	\$11,797	\$342
CHWS0200	Chico Creek		Telephone Exchange	\$12,962	\$304
CHWS0400	Chico Creek		Livestock Company	\$21,351	\$254
CHWS0600	Chico Creek		West Squirrel	\$11,129	\$4,619
CHWS0800	Chico Creek		Solberg Ranch	\$23,078	\$0
FOFO1200	Fountain Creek		Crooked Canyon	\$6,968	\$0
FOFO1400	Fountain Creek		Calhan Reservoir	\$5,817	\$339
FOFO1600	Fountain Creek		Sand Canyon	\$4,203	\$0
FOFO2000	Fountain Creek		Jimmy Camp Creek <sup>3</sup>	\$23,078	\$1,079
FOFO2200	Fountain Creek		Fort Carson	\$18,219	\$660
FOFO2700	Fountain Creek		West Little Johnson	\$1,521	\$0
FOFO3800	Fountain Creek		Stratton	\$11,070	\$495
FOFO5000	Fountain Creek		Midland	\$18,219	\$660
FOFO6000	Fountain Creek		Palmer Trail	\$18,219	\$660
FOFO6800	Fountain Creek		Black Canyon	\$18,219	\$660
FOMO4600	Monument Creek		Beaver Creek	\$13,797	\$0
FOMO3000	Monument Creek		Kettle Creek	\$12,463	\$0
FOMO3400	Monument Creek		Elkhorn	\$2,094	\$0
FOMO5000	Monument Creek		Monument Rock	\$10,003	\$0
FOMO5400	Monument Creek		Palmer Lake	\$15,995	\$0
FOMO5600	Monument Creek		Raspberry Mountain	\$5,380	\$0
PLPL0200	Monument Creek		Bald Mountain	\$11,465	\$0
<b><u>Interim Drainage Basins: <sup>2</sup></u></b>					
FOFO1800	Fountain Creek		Little Fountain Creek	\$2,950	\$0
FOMO4400	Monument Creek		Jackson Creek	\$9,135	\$0
FOMO4800	Monument Creek		Teachout Creek	\$6,343	\$953

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies performed within the last 14 years.

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best available information suitable for setting a fee.)

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of \$7,285 per impervious acre shall be provided to secure payment of additional fees in the event that the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Resolution 16-320 (9/07/16).

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
0 - 5%	Sodded grass	7
	Bermudagrass	6
	Reed canarygrass	5
	Tall fescue	5
	Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10%	Sodded grass	6

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
	Bermudagrass	5
	Reed canarygrass	4
	Tall fescue	4
	Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Sodded grass	5
	Bermudagrass	4
	Reed canarygrass	3
	Tall fescue	3
	Kentucky bluegrass	3

\*For highly erodible soils, decrease permissible velocities by 25%.

\*Grass lined channels are dependent upon assurances of continuous growth and maintenance of grass.

**APPENDIX C**

***REPORT REFERENCES***



```

1*****
  *****
* WATER SURFACE PROFILES *
  * U.S. ARMY CORPS OF ENGINEERS *
* VERSION OF SEPTEMBER 1988 *
  * THE HYDROLOGIC ENGINEERING CENTER *
* ERROR: 01,02 *
  * 609 SECOND STREET, SUITE D *
* UPDATED: 4 APRIL 1989 *
  * DAVIS, CALIFORNIA 95616-4687 *
* RUN DATE 11/ 3/ 3 TIME 12:40:22 *
  * (916) 756-1104, (916) 551-1748 *
*****
  *****

```

THIS DOCUMENT IS THE HEC-2 MODEL PRINT OUT FOR THE 2003 LOMR FOR BEAVER CREEK. IT WAS SOURCED FROM THE REGIONAL FLOODPLAIN ADMINISTRATOR AT PIKES PEAK REGIONAL BUILDING DEPARTMENT (PPRBD).

```

XXXXXXXXX XXXXX
XXXXX
  X
  X
XXXXXXXX XXXX X XXXXX
XXXXX
  X X X X X
  X X X X X
  X X XXXXXXX XXXXX
XXXXXXXX
END OF BANNER

```

```

1
  11/ 3/ 3      12:40:22
                                PAGE 1

```

```

THIS RUN EXECUTED 11/ 3/ 3      12:40:22
*****
  HEC2 RELEASE DATED SEP 88 UPDATED APR 1989

```

```

  ERROR CORR - 01,02
  MODIFICATION -
*****

```

```

T1      BEAVER CREEK LOMR PROJECT NO. 03012
T2      BEAVER CREEK FROM MONUMENT CREEK CONFLUENCE THROUGH SOUTH FORK

```

T3 FILE NAME BVREFF.DAT  
 T3 100-YEAR FREQUENCY CROSS-SECTIONS L TO R FACING UPSTREAM

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q
WSEL	FQ							
	0	3	0	0	0	0	0	0

6733.2

J2	NPROF	IPLLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW
CHNIM	ITRACE							

THE QT ROW/CARD REPRESENTS THE FLOW VALUES USED IN THE HEC-2 MODELS. THIS QT CARD IS AT THE CONFLUENCE OF BEAVER AND MONUMENT CREEK WHICH IS LOCATED JUST DOWNSTREAM OF THE HAY AND BEAVER CREEK CONFLUENCE.

	1	0	-1					
QT	2	6317	20974					
NC	.07	.07	.05	.2	.4			

CONFLUENCE WITH MONUMENT CREEK

X1	60	15	1280	1360	0	0	0
GR	6752	1000	6750	1085	6740	1170	6735
	1235	6730	1250				
GR	6725	1280	6720	1295	6718	1305	6720
	1310	6725	1360				
GR	6730	1445	6735	1525	6740	1560	6745
	1670	6750	1810				

THIS QT CARD IS APPROXIMATELY AT THE HAY CREEK CONFLUENCE WITH BEAVER CREEK AND DEMONSTRATES A 127 CFS INCREASE OVER THE UPSTREAM QT CARD. (6915 CFS -6788 CFS=127 CFS). WE THEREFORE BELIEVE 127 CFS TO BE A REASONABLE FLOW TO USE FOR HAY CREEK.

QT	2	3507	6915				
NC	.07	.07	.05	.1	.3		
X1	1	14	1507	1545	1047	1047	1047
GR	6748	1000	6744	1163	6742	1193	6740
	1313	6740	1358				
GR	6738	1386	6736	1507	6734	1520	6732
	1526	6732	1541				
GR	6740	1548	6746	1563	6746	1748	6748
	1798						
NC	.07	.07	.05	.1	.3		
X1	2	11	1136	1195	759	759	759
GR	6758	1034	6756	1049	6750	1064	6748
	1076	6748	1136				
GR	6746	1147	6746	1184	6748	1195	6750
	1227	6756	1254				
GR	6758	1274					
QT	2	1847	5128				

NC .013 .013 .015 .1 .3

HAY CREEK ROAD 2-72", 1-78" AND 1-84" CMP'S  
CROSS SECTION MODELED FOR ROAD PROFILE  
FLOW OVER ROAD REDUCED FOR CULVERTS CAPACITY  
CULVERTS CALCULATED CAPACITY = 1660 cfs

NOTE THAT, ONCE THE FLOW THROUGH  
THE CULVERTS IS ACCOUNTED FOR, THE QT  
CARD MATCHES THE UPSTREAM QT CARD  
AT 6788 CFS. (5128 CFS + 1660 CFS = 6788 CFS)

X1	3	6	1130	1250	845	845	845
GR	6778	1000	6772	1130	6772	1250	6774
	1390	6776	1500				
GR	6778	1720					

1  
11/ 3/ 3 12:40:22

PAGE 2

THIS QT CARD IS AT THE HAY CREEK ROAD CULVERT  
JUST UPSTREAM OF THE CONFLUENCE WITH HAY  
CREEK.

NC	.025	.025	.025	.1	.3		
QT	2	3107	6788				

DELACROCE RANCH ROAD CROSSING 1-84" AND 1-72" CMP  
CROSS SECTION MODELED FOR ROAD PROFILE  
FLOW OVER ROAD REDUCED FOR CULVERTS CAPACITY  
CULVERTS CALCULATED CAPACITY = 400 cfs

X1	4	5	1070	1280	984	984	984
X4	1	6786	1000				
GR	6790	900	6784	1070	6784	1280	6790
	1420	6796	1520				
NC	.07	.07	.08				
X1	5	14	1243	1314	722	722	722
GR	6806	1188	6804	1198	6800	1211	6798
	1221	6786	1246				
GR	6786	1272	6788	1314	6790	1344	6796
	1391	6796	1427				
GR	6798	1428	6800	1435	6804	1475	6806
	1512						

NC .013 .013 .013 .1 .3

QT 2 3216 6154

NC .013 .013 .015 .1 .3

X1	6.1	9	1209	1230	1160	1160	1160
GR	6840	1000	6828	1091	6828	1209	6806.6
	1209	6806.6	1230				
GR	6828	1230	6828	1316	6830	1457	6840
	1619						

SB	1.05 0	1.25 6807.3	2.6 6806.6	0	20	1.0	210
NC	.013	.013	.015	.3	.5		
LONG VALLEY DRIVE, EXISITNG 2-10' x 10' CBC FACE							
X1	6.2	9	1209	1230	48	48	48
X2	0	0	1	6817.3	6828		
BT	9 1209	1000 6828	6840 6828	6840	1091	6828	6828
BT	1209 6828	6828 6828	6817.3 1316	1230	6828	6817.3	1230
BT	6828 6840	6828	1457	6830	6830	1619	6840
GR	6840 1209	1000 6807.3	6828 1230	1091	6828	1209	6807.3
GR	6828 1619	1230	6828	1316	6830	1457	6840
NC	.07	.07	.08	.1	.3		
X1	7	9	1146	1193	856	856	856
GR	6862 1146	1033 6854	6858 1193	1042	6856	1071	6854
GR	6856 1354	1279	6858	1312	6860	1326	6862
NC	.015	.015	.02				
BRISTLECONE LAKE CONCRETE SPILLWAY							
X1	8	8	1080	1520	1026	1026	1026
GR	6910 1080	1000 6889	6908 1090	1020	6900	1050	6890
GR	6889	1500	6890	1520	6908	1580	
QT	2	4860	8624				
NC	.07	.07	.05				
FLOW INTO BRISTLECONE LAKE							
X1	9	13	1484	1817	2638	2638	2638
GR	6910 1173	1000 6894	6908 1260	1050	6906	1135	6900
GR	6890 1845	1484 6900	6890 1871	1817	6894	1824	6894
GR	6902	1905	6908	1982	6910	1991	

X1	10	15	1169	1529	590	590	590
GR	6916	1000	6910	1044	6908	1064	6904
	1112	6900	1230				
GR	6898	1270	6898	1334	6896	1349	6896
	1361	6898	1379				
GR	6900	1392	6902	1530	6910	1614	6912
	1645	6916	1662				
NC	.1	.1	.08				
X1	11	13	1149	1363	701	701	701
GR	6924	1000	6920	1041	6918	1069	6916
	1077	6910	1149				
GR	6908	1165	6904	1177	6904	1216	6906
	1226	6906	1346				
GR	6916	1381	6918	1392	6924	1456	
X1	12	14	1213	1240	643	643	643
GR	6936	1000	6928	1110	6926	1162	6922
	1176	6922	1213				
GR	6916	1226	6916	1228	6922	1240	6922
	1246	6918	1256				
GR	6916	1317	6916	1447	6930	1486	6936
	1566						
X1	13	10	1139	1345	689	689	689
GR	6948	1000	6944	1053	6940	1139	6938
	1152	6928	1195				
GR	6928	1221	6930	1230	6932	1274	6934
	1321	6948	1429				
X1	14	11	1184	1401	834	834	834
GR	6964	1000	6956	1071	6954	1119	6948
	1234	6946	1305				
GR	6944	1316	6944	1342	6946	1392	6956
	1414	6958	1435				
GR	6964	1527					
X1	15	17	1091	1278	764	764	764
GR	6978	1000	6970	1047	6966	1081	6962
	1091	6962	1133				
GR	6960	1145	6958	1161	6958	1177	6960
	1219	6962	1278				
GR	6962	1312	6960	1319	6960	1333	6962
	1336	6970	1371				

GR	6974	1430	6978	1448			
X1	16	15	1266	1400	718	718	718
GR	6994	1000	6992	1025	6986	1193	6984
	1205	6980	1266				
GR	6974	1321	6974	1331	6976	1364	6980
	1400	6982	1505				
GR	6986	1572	6988	1584	6990	1609	6992
	1615	6994	1618				

QT 2 4772 8270

CONFLUENCE OF NORTH AND SOUTH BEAVER CREEK

X1	17	16	1101	1378	547	547	547
GR	7008	1000	7002	1072	6998	1101	6994
	1117	6992	1121				
GR	6988	1139	6988	1169	6990	1196	6992
	1213	6996	1277				
GR	6996	1324	6998	1378	7000	1410	7002
	1427	7004	1489				
GR	7008	1552					

QT 2 3757 6754

BEAVER CREEK SOUTH FORK

X1	18	10	1075	1269	598	598	598
GR	7022	1000	7018	1075	7016	1088	7004
	1122	7002	1128				
GR	7002	1151	7008	1187	7012	1237	7020
	1269	7022	1285				

1  
11/ 3/ 3 12:40:22

X1	19	16	1115	1341	800	800	800
GR	7046	1000	7044	1021	7038	1072	7034
	1115	7032	1129				
GR	7030	1177	7028	1198	7026	1207	7026
	1228	7030	1242				
GR	7032	1259	7034	1341	7038	1412	7040
	1473	7042	1536				
GR	7046	1578					

X1	20	14	1046	1295	625	625	625
GR	7068	1000	7062	1031	7058	1046	7056
	1061	7052	1072				



20974.	1400.	15429.	4145.	193.	921.	588.	0.	0.
6725.00								
.00	7.27	16.75	7.05	.070	.050	.070	.000	6718.00
1239.93								
.012557	0.	0.	0.	0	4	0	.00	258.76
1498.70								
0								
CCHV=	.100	CEHV=	.300					
*SECNO	1.000							

3301 HV CHANGED MORE THAN HVINS

1.00	11.87	6743.87	.00	.00	6744.18	.30	7.10	.31
6736.00								
6915.	4409.	2319.	187.	1514.	359.	74.	44.	8.
6732.00								
.07	2.91	6.46	2.53	.070	.050	.070	.000	6732.00
1164.88								
.002082	1047.	1047.	1047.	3	0	0	.00	392.81
1557.69								
0								
CCHV=	.100	CEHV=	.300					
*SECNO	2.000							

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL  
 3693 PROBABLE MINIMUM SPECIFIC ENERGY  
 3720 CRITICAL DEPTH ASSUMED

2.00	5.95	6751.95	6751.95	.00	6753.89	1.94	3.60	.49
6748.00								
6915.	1999.	4311.	605.	277.	329.	103.	67.	13.
6748.00								
.09	7.21	13.09	5.87	.070	.050	.070	.000	6746.00
1059.12								
.019770	759.	759.	759.	20	8	0	.00	176.67
1235.79								
0								
CCHV=	.100	CEHV=	.300					
*SECNO	3.000							

3301 HV CHANGED MORE THAN HVINS

1  
 11/ 3/ 3      12:40:22

PAGE 6

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS
BANK	ELEV							
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA
LEFT/RIGHT	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN
TIME								
SSTA								
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID
ENDST								



3685 20 TRIALS ATTEMPTED WSEL,CWSEL  
 3693 PROBABLE MINIMUM SPECIFIC ENERGY  
 3720 CRITICAL DEPTH ASSUMED

HAY CREEK ROAD 2-72", 1-78" AND 1-84" CMP'S  
 CROSS SECTION MODELED FOR ROAD PROFILE  
 FLOW OVER ROAD REDUCED FOR CULVERTS CAPACITY  
 CULVERTS CALCULATED CAPACITY = 1660 cfs

3.00	2.75	6774.75	6774.75	.00	6775.69	.94	4.43	.10
6772.00								
5128.	506.	2806.	1817.	82.	330.	260.	80.	18.
6772.00								
.12	6.18	8.51	6.99	.013	.015	.013	.000	6772.00
1070.47								
.001918	845.	845.	845.	20	14	0	.00	360.65
1431.12								
0								

CCHV= .100 CEHV= .300

\*SECNO 4.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL  
 3693 PROBABLE MINIMUM SPECIFIC ENERGY  
 3720 CRITICAL DEPTH ASSUMED

DELACROCE RANCH ROAD CROSSING 1-84" AND 1-72" CMP  
 CROSS SECTION MODELED FOR ROAD PROFILE  
 FLOW OVER ROAD REDUCED FOR CULVERTS CAPACITY  
 CULVERTS CALCULATED CAPACITY = 400 cfs

4.00	2.82	6786.82	6786.82	.00	6787.96	1.14	3.30	.06
6784.00								
6788.	884.	5375.	530.	136.	592.	93.	97.	26.
6784.00								
.15	6.52	9.08	5.72	.025	.025	.025	.000	6784.00
979.55								
.005866	984.	984.	984.	20	8	0	.00	366.20
1345.75								
0								

\*SECNO 5.000

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .54

5.00	7.93	6793.93	.00	.00	6795.16	1.23	7.17	.03
6798.00								
6788.	0.	5205.	1583.	0.	563.	208.	110.	30.
6788.00								
.18	.00	9.25	7.59	.000	.080	.070	.000	6786.00
1229.48								
.020365	722.	722.	722.	3	0	0	.00	145.32
1374.79								
0								

CCHV= .100 CEHV= .300

CCHV= .100 CEHV= .300

\*SECNO 6.100

1

11/ 3/ 3 12:40:22

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS
BANK ELEV								
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA
LEFT/RIGHT								
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN
SSTA								
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID
ENDST								

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL  
 3693 PROBABLE MINIMUM SPECIFIC ENERGY  
 3720 CRITICAL DEPTH ASSUMED

6.10	13.82	6820.42	6820.42	.00	6827.40	6.98	9.61	1.73
6828.00								
6154.	0.	6154.	0.	0.	290.	0.	125.	33.
6828.00								
.19	.00	21.20	.00	.000	.015	.000	.000	6806.60
1209.00								
.004232	1160.	1160.	1160.	20	14	0	.00	21.00
1230.00								
0								

SPECIAL BRIDGE

5227 DOWNSTREAM ELEV IS 6818.62 , NOT 6820.42 HYDRAULIC JUMP OCCURS  
 DOWNSTREAM (IF LOW FLOW CONTROLS)

SB	XK	XKOR	COFQ	RDLEN	BWC	BWP	BAREA	SS
ELCHU		ELCHD						
1.05		1.25	2.60	.00	20.00	1.00	210.00	.00
6807.30		6806.60						

CCHV= .300 CEHV= .500  
 \*SECNO 6.200

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.45

PRESSURE AND WEIR FLOW, Weir Submergence Based on TRAPEZOIDAL Shape

EGPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID	ELLC
ELTRD	WEIRLN						
6837.09	6829.67	.00	1566.	4591.	210.	AREA 190.	6817.30
6828.00	358.						

LONG VALLEY DRIVE, EXISITNG 2-10' x 10' CBC FACE

6.20	18.51	6825.81	.00	.00	6829.70	3.89	2.30	.00
6828.00								
6154.	0.	6154.	0.	0.	389.	0.	125.	33.
6828.00								
.19	.00	15.84	.00	.000	.015	.000	.000	6807.30
1209.00								
.002023	48.	48.	48.	6	0	5	.00	21.00
1230.00								
0								
CCHV=	.100	CEHV=	.300					

1 11/ 3/ 3 12:40:22

PAGE 8

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	
BANK ELEV	Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA
LEFT/RIGHT	TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN
SSTA	SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID
ENDST									

\*SECNO 7.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL  
 3693 PROBABLE MINIMUM SPECIFIC ENERGY  
 3720 CRITICAL DEPTH ASSUMED

7.00	3.79	6857.79	6857.79	.00	6859.09	1.29	4.78	.26
6854.00								
6154.	2041.	1773.	2340.	233.	178.	267.	135.	35.
6854.00								
.22	8.77	9.94	8.78	.070	.080	.070	.000	6854.00
1045.01								
.048456	856.	856.	856.	20	21	0	.00	263.57
1308.58								
0								

\*SECNO 8.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL  
 3693 PROBABLE MINIMUM SPECIFIC ENERGY  
 3720 CRITICAL DEPTH ASSUMED

BRISTLECONE LAKE CONCRETE SPILLWAY

8.00	1.86	6890.86	6890.86	.00	6891.77	.91	11.36	.04
6890.00								
6154.	4.	6145.	5.	1.	802.	1.	153.	44.
6890.00								
.26	3.76	7.66	3.78	.015	.020	.015	.000	6889.00
1077.43								
.004781	1026.	1026.	1026.	20	11	0	.00	445.42
1522.85								
0								

\*SECNO 9.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 3.00

FLOW INTO BRISTLECONE LAKE

9.00	6.25	6896.25	.00	.00	6896.39	.14	4.54	.08
6890.00								
8624.	1738.	6774.	112.	988.	2081.	88.	273.	76.
6890.00								
.51	1.76	3.26	1.28	.070	.050	.070	.000	6890.00
1227.40								
.001042	2638.	2638.	2638.	6	0	0	.00	627.35
1854.74								
0								

\*SECNO 10.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

1

11/ 3/ 3

12:40:22

PAGE 9

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	
BANK ELEV	Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA
LEFT/RIGHT	TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN
SSTA	SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID
ENDST									

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

10.00	6.42	6902.42	6902.42	.00	6903.79	1.37	1.64	.37
6904.00								
8624.	0.	7868.	756.	0.	806.	197.	301.	83.
6900.00								
.52	.00	9.76	3.84	.000	.050	.070	.000	6896.00
1158.67								
.020723	590.	590.	590.	20	8	0	.00	375.72
1534.39								
0								

\*SECNO 11.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.51

11.00	8.51	6912.51	.00	.00	6913.11	.60	9.25	.08
6910.00								

8624.	63.	8336.	226.	38.	1323.	74.	321.	88.
6906.00								
.55	1.65	6.30	3.04	.100	.080	.100	.000	6904.00
1118.82								
.009130	701.	701.	701.	5	0	0	.00	249.98
1368.80								
0								
*SECNO 12.000								

3265 DIVIDED FLOW

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .58

12.00	5.74	6921.74	.00	.00	6922.57	.83	9.39	.07
6922.00								
8624.	0.	489.	8135.	0.	80.	1101.	340.	92.
6922.00								
.58	.00	6.08	7.39	.000	.080	.100	.000	6916.00
1213.54								
.027002	643.	643.	643.	2	0	0	.00	242.34
1463.02								
0								

\*SECNO 13.000

13.00	9.37	6937.37	.00	.00	6938.49	1.12	15.83	.09
6940.00								
8624.	0.	8495.	129.	0.	993.	44.	357.	95.
6934.00								
.60	.00	8.55	2.94	.000	.080	.100	.000	6928.00
1154.72								
.019789	689.	689.	689.	3	0	0	.00	192.27
1346.98								
0								

\*SECNO 14.000

14.00	8.38	6952.38	.00	.00	6953.10	.72	14.57	.04
6954.00								
8624.	0.	8455.	169.	0.	1234.	45.	380.	100.
6946.00								
.64	.00	6.85	3.77	.000	.080	.100	.000	6944.00
1150.04								
.015530	834.	834.	834.	5	0	0	.00	255.99
1406.04								
0								

1

11/ 3/ 3 12:40:22

PAGE 10

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS
BANK ELEV								
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA
LEFT/RIGHT								
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN
SSTA								
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID
ENDST								



6754.	4.	6742.	7.	3.	890.	6.	460.	118.
7034.00								
.75	1.31	7.58	1.31	.100	.080	.100	.000	7026.00
1106.50								
.026968	800.	800.	800.	4	0	0	.00	248.53
1355.03								
0								
1								

11/ 3/ 3      12:40:22

PAGE 11

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS
BANK ELEV								
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA
LEFT/RIGHT								
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN
SSTA								
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID
ENDST								

\*SECNO 20.000

3301 HV CHANGED MORE THAN HVINS

20.00	6.36	7054.36	.00	.00	7055.81	1.45	19.96	.17
7058.00								
6754.	0.	6754.	0.	0.	698.	0.	472.	121.
7060.00								
.77	.00	9.67	.00	.000	.080	.000	.000	7048.00
1065.51								
.038415	625.	625.	625.	2	0	0	.00	160.28
1225.79								
0								

\*SECNO 21.000

21.00	8.56	7080.56	.00	.00	7081.53	.97	25.68	.05
7080.00								
6754.	1.	6752.	1.	1.	854.	1.	487.	125.
7080.00								
.80	.96	7.90	.96	.100	.080	.100	.000	7072.00
1061.22								
.022960	879.	879.	879.	5	0	0	.00	188.29
1249.51								
0								

\*SECNO 22.000

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .65

22.00	6.61	7098.61	7098.55	.00	7100.44	1.83	18.65	.26
7096.00								
6754.	55.	6570.	128.	14.	598.	31.	497.	127.
7096.00								

.82	4.05	10.98	4.11	.100	.080	.100	.000	7092.00
1021.54								
.054047	554.	554.	554.	6	19	0	.00	181.31
1202.86								
0								
*SECNO	23.000							

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 1.42

23.00	9.38	7117.38	.00	.00	7119.39	2.01	18.90	.05
7110.00								
6754.	1332.	5064.	358.	231.	398.	65.	505.	129.
7110.00								
.83	5.76	12.71	5.49	.100	.080	.100	.000	7108.00
1056.30								
.026617	514.	514.	514.	4	0	0	.00	126.40
1182.70								
0								
1								

11/ 3/ 3 12:40:22

PAGE 12

THIS RUN EXECUTED 11/ 3/ 3 12:40:22

\*\*\*\*\*

HEC2 RELEASE DATED SEP 88 UPDATED APR 1989

ERROR CORR - 01,02

MODIFICATION -

\*\*\*\*\*

NOTE- ASTERISK (\*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

100-YEAR FREQUENCY CROSS

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS
EG	10*KS	VCH	AREA	.01K			
* 60.000	.00	.00	.00	6718.00	20974.00	6733.36	6733.36
6736.77	125.57	16.75	1701.40	1871.69			
1.000	1047.00	.00	.00	6732.00	6915.00	6743.87	.00
6744.18	20.82	6.46	1946.76	1515.58			
* 2.000	759.00	.00	.00	6746.00	6915.00	6751.95	6751.95
6753.89	197.70	13.09	709.71	491.80			



*	3.000	845.00	.00	.00	6772.00	5128.00	6774.75	6774.75
	6775.69	19.18	8.51	671.52	1171.06			
*	4.000	984.00	.00	.00	6784.00	6788.00	6786.82	6786.82
	6787.96	58.66	9.08	820.00	886.28			
*	5.000	722.00	.00	.00	6786.00	6788.00	6793.93	.00
	6795.16	203.65	9.25	771.30	475.67			
*	6.100	1160.00	.00	.00	6806.60	6154.00	6820.42	6820.42
	6827.40	42.32	21.20	290.26	946.04			
*	6.200	48.00	6828.00	6817.30	6807.30	6154.00	6825.81	.00
	6829.70	20.23	15.84	388.61	1368.18			
*	7.000	856.00	.00	.00	6854.00	6154.00	6857.79	6857.79
	6859.09	484.56	9.94	677.64	279.57			
*	8.000	1026.00	.00	.00	6889.00	6154.00	6890.86	6890.86
	6891.77	47.81	7.66	804.16	890.04			
*	9.000	2638.00	.00	.00	6890.00	8624.00	6896.25	.00
	6896.39	10.42	3.26	3157.00	2671.12			
*	10.000	590.00	.00	.00	6896.00	8624.00	6902.42	6902.42
	6903.79	207.23	9.76	1002.54	599.08			
*	11.000	701.00	.00	.00	6904.00	8624.00	6912.51	.00
	6913.11	91.30	6.30	1435.60	902.54			
*	12.000	643.00	.00	.00	6916.00	8624.00	6921.74	.00
	6922.57	270.02	6.08	1181.02	524.82			
	13.000	689.00	.00	.00	6928.00	8624.00	6937.37	.00
	6938.49	197.89	8.55	1036.84	613.05			
	14.000	834.00	.00	.00	6944.00	8624.00	6952.38	.00
	6953.10	155.30	6.85	1278.76	692.03			
	15.000	764.00	.00	.00	6958.00	8624.00	6965.44	.00
	6966.26	191.28	7.60	1231.38	623.56			

1

11/ 3/ 3 12:40:22

PAGE 13

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS
EG	10*KS	VCH	AREA	.01K			
16.000	718.00	.00	.00	6974.00	8624.00	6982.28	6981.98
6983.91	317.27	10.55	940.80	484.16			
17.000	547.00	.00	.00	6988.00	8270.00	6997.53	.00
6998.36	219.38	7.28	1136.59	558.36			

18.000	598.00	.00	.00	7002.00	6754.00	7011.92	.00
7013.30	288.96	9.43	716.36	397.32			
19.000	800.00	.00	.00	7026.00	6754.00	7034.79	.00
7035.68	269.68	7.58	898.56	411.28			
20.000	625.00	.00	.00	7048.00	6754.00	7054.36	.00
7055.81	384.15	9.67	698.47	344.60			
21.000	879.00	.00	.00	7072.00	6754.00	7080.56	.00
7081.53	229.60	7.90	856.49	445.74			
* 22.000	554.00	.00	.00	7092.00	6754.00	7098.61	7098.55
7100.44	540.47	10.98	643.15	290.52			
* 23.000	514.00	.00	.00	7108.00	6754.00	7117.38	.00
7119.39	266.17	12.71	694.80	413.98			

1

11/ 3/ 3 12:40:22

PAGE 14

100-YEAR FREQUENCY CROSS

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	60.000	20974.00	6733.36	.00	.00	.16	258.76	.00
	1.000	6915.00	6743.87	.00	10.52	.00	392.81	1047.00
*	2.000	6915.00	6751.95	.00	8.08	.00	176.67	759.00
*	3.000	5128.00	6774.75	.00	22.79	.00	360.65	845.00
*	4.000	6788.00	6786.82	.00	12.07	.00	366.20	984.00
*	5.000	6788.00	6793.93	.00	7.11	.00	145.32	722.00
*	6.100	6154.00	6820.42	.00	26.49	.00	21.00	1160.00
*	6.200	6154.00	6825.81	.00	5.38	.00	21.00	48.00
*	7.000	6154.00	6857.79	.00	31.99	.00	263.57	856.00
*	8.000	6154.00	6890.86	.00	33.06	.00	445.42	1026.00
*	9.000	8624.00	6896.25	.00	5.39	.00	627.35	2638.00
*	10.000	8624.00	6902.42	.00	6.17	.00	375.72	590.00
*	11.000	8624.00	6912.51	.00	10.10	.00	249.98	701.00

*	12.000	8624.00	6921.74	.00	9.23	.00	242.34	643.00
	13.000	8624.00	6937.37	.00	15.63	.00	192.27	689.00
	14.000	8624.00	6952.38	.00	15.01	.00	255.99	834.00
	15.000	8624.00	6965.44	.00	13.06	.00	268.67	764.00
	16.000	8624.00	6982.28	.00	16.84	.00	278.30	718.00
	17.000	8270.00	6997.53	.00	15.26	.00	262.59	547.00
	18.000	6754.00	7011.92	.00	14.39	.00	136.51	598.00
	19.000	6754.00	7034.79	.00	22.87	.00	248.53	800.00
	20.000	6754.00	7054.36	.00	19.57	.00	160.28	625.00
	21.000	6754.00	7080.56	.00	26.21	.00	188.29	879.00
*	22.000	6754.00	7098.61	.00	18.05	.00	181.31	554.00

1

11/ 3/ 3 12:40:22

PAGE 15

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	23.000	6754.00	7117.38	.00	18.77	.00	126.40	514.00

1

11/ 3/ 3 12:40:22

PAGE 16

#### SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO= 60.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 2.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 2.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 2.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 3.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 3.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 3.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 4.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 4.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 4.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=	5.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=	6.100	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	6.100	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	6.100	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	6.200	PROFILE=	1	HYDRAULIC JUMP D.S.
WARNING SECNO=	6.200	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=	7.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	7.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	7.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=	8.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	8.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	8.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=	9.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
CAUTION SECNO=	10.000	PROFILE=	1	CRITICAL DEPTH ASSUMED
CAUTION SECNO=	10.000	PROFILE=	1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=	10.000	PROFILE=	1	20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=	11.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=	12.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=	22.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=	23.000	PROFILE=	1	CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

**NOTES TO USERS**

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where Base Flood Elevations (BFEs) and/or Floodways have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Contain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The horizontal datum was NAD83, GRS80 spheroid. Differences in datum, other projection or UTM zones between jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD88). These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

NGS Information Services  
NOAA, NNGS-1  
National Geodetic Survey  
SSMC-3, #5202  
1315 East-West Highway  
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for bench marks shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3202 or visit its website at <http://www.ngs.noaa.gov>.

**Base Map** information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date stream channel configurations and floodplain delineations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

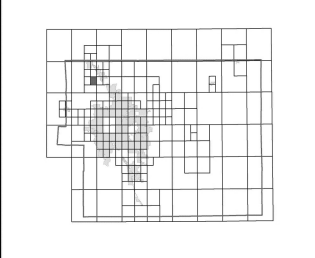
Contact **FEMA Map Service Center (MSC)** via the FEMA Map Information eXchange (FMIX) 1-877-336-3627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-368-9620 and its website at <http://www.msc.fema.gov>.

If you have questions about this map or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov>.

**El Paso County Vertical Datum Offset Table**

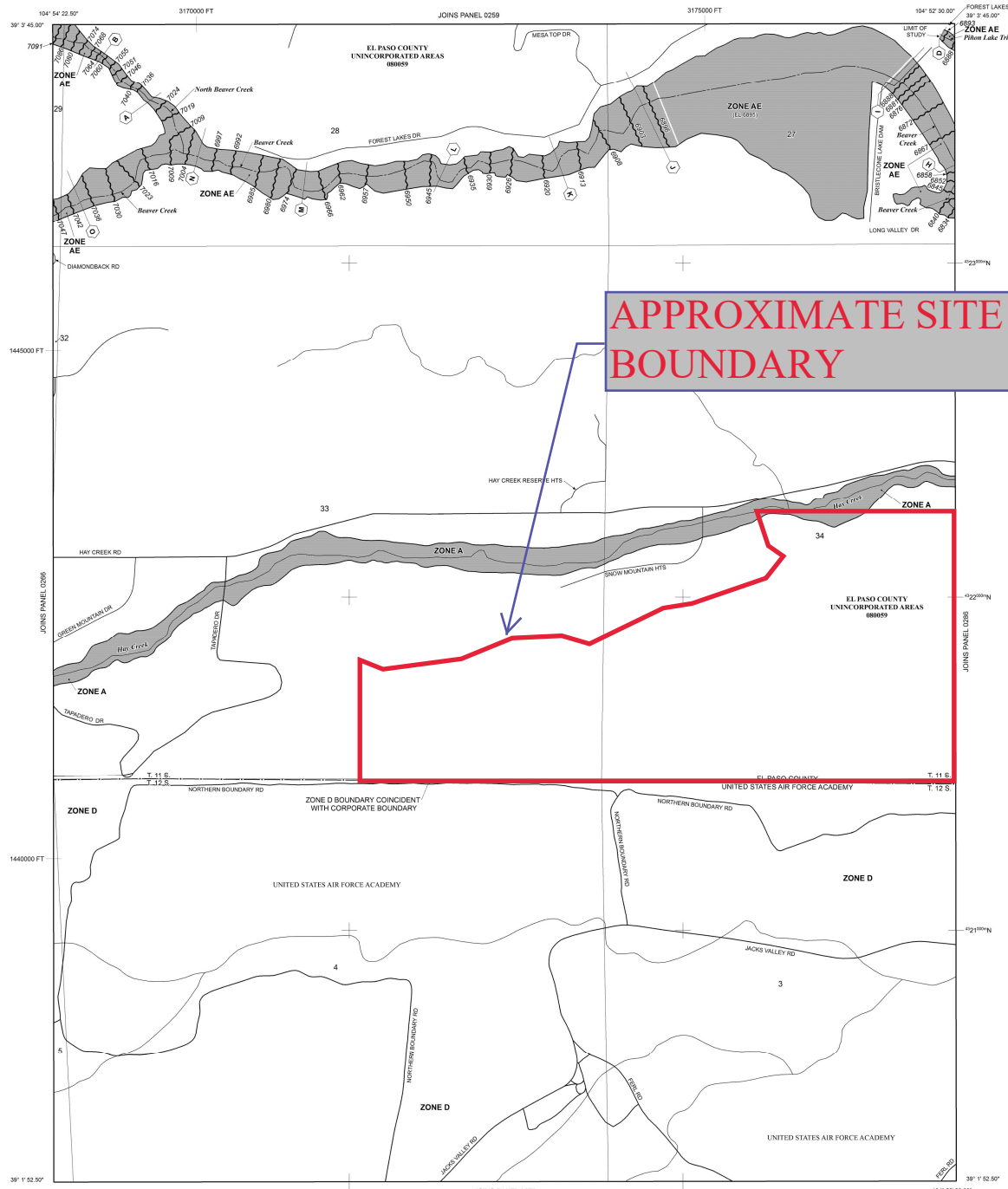
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM-BY-STREAM VERTICAL DATUM CONVERSION INFORMATION

**Panel Location Map**



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



**APPROXIMATE SITE BOUNDARY**

**LEGEND**

**SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include ZONE AE, AH, AR, AV, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined; Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of shallow fan flooding, vehicles also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that has been substantially destroyed. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE AV** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

**FLOODWAY AREAS IN ZONE AE**

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

**OTHER FLOOD AREAS**

- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or in open areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

**OTHER AREAS**

- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**

**OTHERWISE PROTECTED AREAS (OPAs)**

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodline boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations; flood depths or flood velocities.

Base Flood Elevation line and value; elevation in feet.

Base Flood Elevation value where uniform within zone; elevation in feet.

Referenced to the North American Vertical Datum of 1988 (NAVD 88)

Cross section line

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

1000-meter Universal Transverse Mercator grid ticks, zone 13

5000-foot grid ticks: Colorado State Plane coordinate system, central zone (SPROCK 090)

Lambert Conformal Conic Projection

Bench mark (see explanation in Notes to Users section of this FIRM panel)

River Mile

MAP REPOSITORIES  
Refer to Map Repositories List on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP  
MARCH 11, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL  
DECEMBER 2, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Tables located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-9620.

MAP SCALE 1" = 500'

250 500 1000 FEET  
150 300 METERS

**NFP**

**NATIONAL FLOOD INSURANCE PROGRAM**

**PANEL 0267G**

**FIRM**  
FLOOD INSURANCE RATE MAP  
EL PASO COUNTY,  
COLORADO  
AND INCORPORATED AREAS

PANEL 267 OF 1300  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:	COMMUNITY:	NUMBER:	PANEL:	SUFFIX:
EL PASO COUNTY	8808	027	G	

MAP NUMBER  
**08041C0267G**

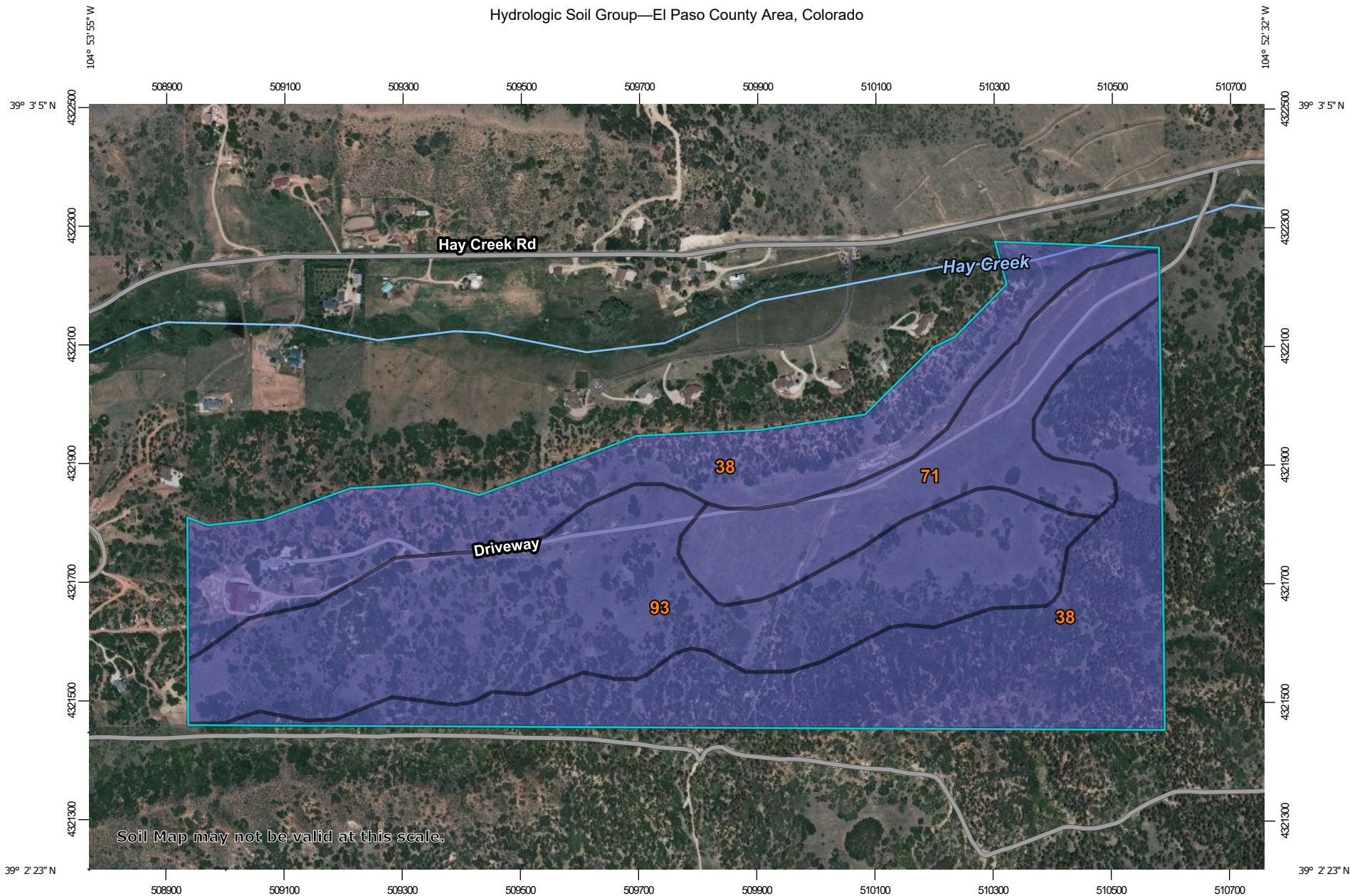
MAP REVISED  
**DECEMBER 7, 2018**

Federal Emergency Management Agency

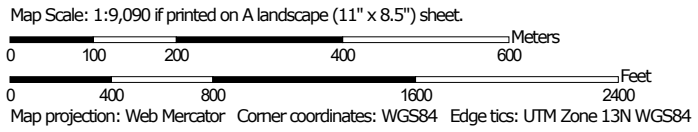
NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 11 SOUTH, RANGE 67 WEST, AND TOWNSHIP 12 SOUTH, RANGE 67 WEST.



Hydrologic Soil Group—El Paso County Area, Colorado



Soil Map may not be valid at this scale.



### 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 1:24,000.

**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: El Paso County Area, Colorado  
 Survey Area Data: Version 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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.

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
38	Jarre-Tecolote complex, 8 to 65 percent slopes	B	109.5	50.8%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	31.1	14.5%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	74.8	34.7%
<b>Totals for Area of Interest</b>			<b>215.4</b>	<b>100.0%</b>

### Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.



## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher



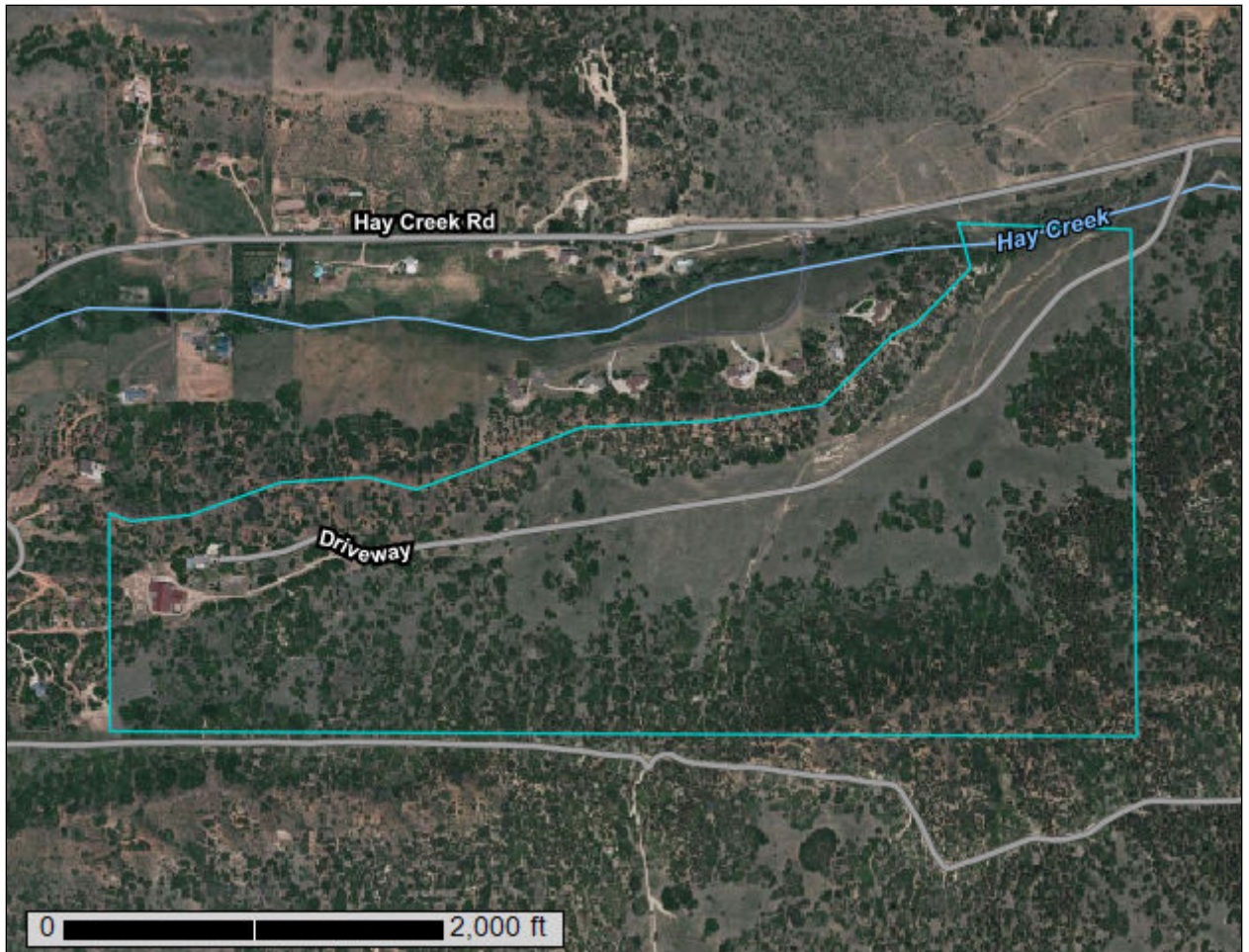
United States  
Department of  
Agriculture

**NRCS**

Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for El Paso County Area, Colorado



# Preface

---

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

# Contents

---

<b>Preface</b> .....	2
<b>How Soil Surveys Are Made</b> .....	5
<b>Soil Map</b> .....	8
Soil Map.....	9
Legend.....	10
Map Unit Legend.....	11
Map Unit Descriptions.....	11
El Paso County Area, Colorado.....	13
38—Jarre-Tecolote complex, 8 to 65 percent slopes.....	13
71—Pring coarse sandy loam, 3 to 8 percent slopes.....	14
93—Tomah-Crowfoot complex, 8 to 15 percent slopes.....	15
<b>References</b> .....	18

# How Soil Surveys Are Made

---

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

## Custom Soil Resource Report

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

## Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

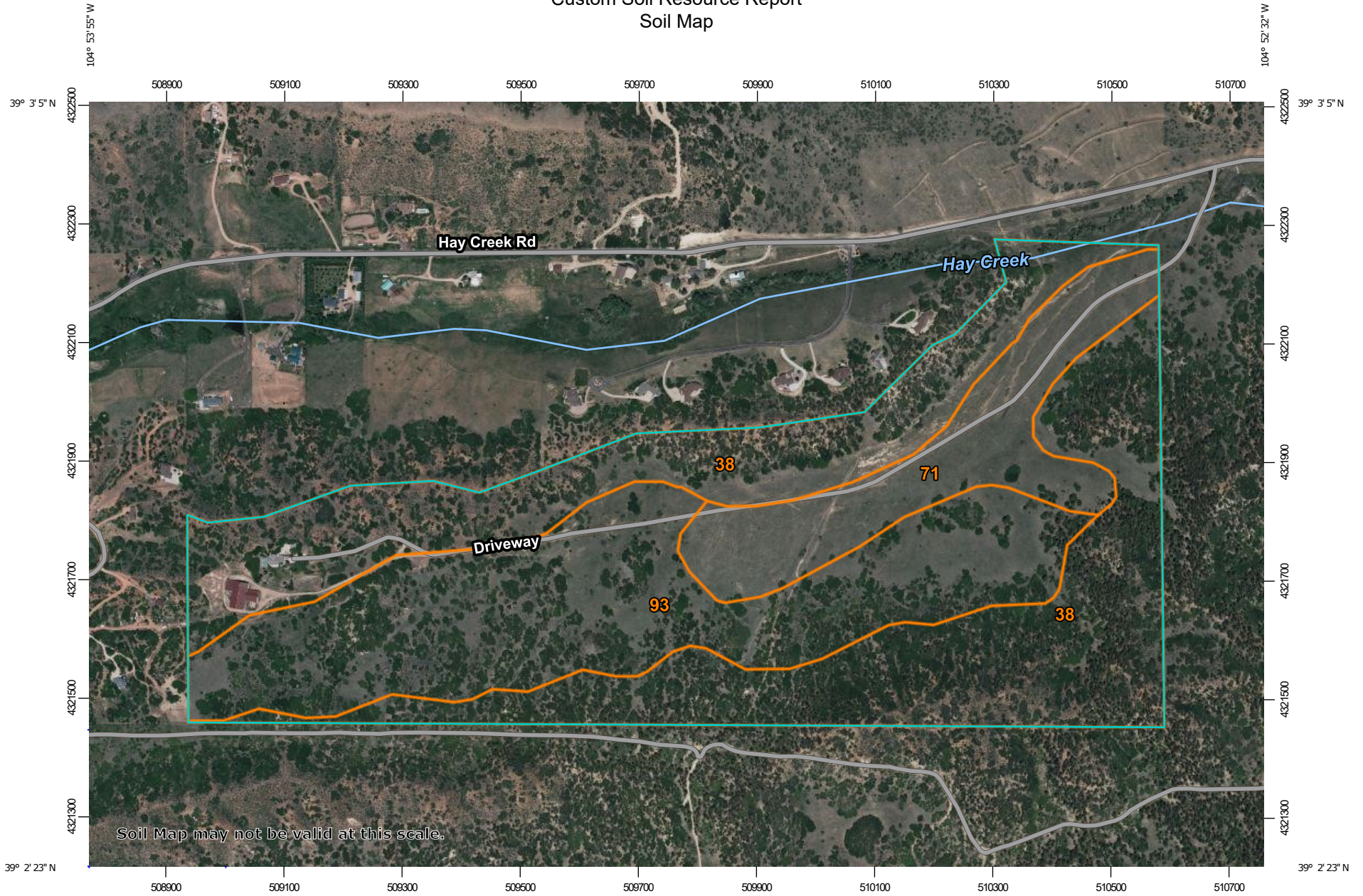


# Soil Map

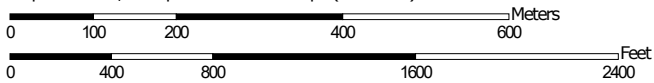
---

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report Soil Map




Map Scale: 1:9,090 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

### MAP LEGEND

**Area of Interest (AOI)**

 Area of Interest (AOI)

**Soils**

 Soil Map Unit Polygons

 Soil Map Unit Lines


 Soil Map Unit Points

**Special Point Features**






-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot

-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features


**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 1:24,000.

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: El Paso County Area, Colorado  
 Survey Area Data: Version 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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.

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
38	Jarre-Tecolote complex, 8 to 65 percent slopes	109.5	50.8%
71	Pring coarse sandy loam, 3 to 8 percent slopes	31.1	14.5%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	74.8	34.7%
<b>Totals for Area of Interest</b>		<b>215.4</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

## Custom Soil Resource Report

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## El Paso County Area, Colorado

### 38—Jarre-Tecolote complex, 8 to 65 percent slopes

#### Map Unit Setting

*National map unit symbol:* 368c  
*Elevation:* 6,700 to 7,500 feet  
*Frost-free period:* 90 to 125 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Jarre and similar soils:* 40 percent  
*Tecolote and similar soils:* 30 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Jarre

##### Setting

*Landform:* Alluvial fans  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium

##### Typical profile

*A - 0 to 5 inches:* gravelly sandy loam  
*Bt - 5 to 22 inches:* gravelly sandy clay loam  
*2C - 22 to 60 inches:* very gravelly sandy loam

##### Properties and qualities

*Slope:* 8 to 30 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Low (about 5.3 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* B  
*Ecological site:* R048AY222CO - Loamy Park  
*Hydric soil rating:* No

#### Description of Tecolote

##### Setting

*Landform:* Alluvial fans  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium



## Custom Soil Resource Report

### Typical profile

*A - 0 to 3 inches:* very stony loam  
*E - 3 to 12 inches:* very gravelly loamy sand  
*Bt - 12 to 45 inches:* extremely gravelly sandy clay loam  
*C - 45 to 60 inches:* extremely gravelly loamy sand

### Properties and qualities

*Slope:* 8 to 65 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* High  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.20 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Very low (about 2.7 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 7e  
*Hydrologic Soil Group:* B  
*Ecological site:* R048AY255CO - Pine Grasslands  
*Hydric soil rating:* No

### Minor Components

#### Other soils

*Percent of map unit:*  
*Hydric soil rating:* No

## 71—Pring coarse sandy loam, 3 to 8 percent slopes

### Map Unit Setting

*National map unit symbol:* 369k  
*Elevation:* 6,800 to 7,600 feet  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Pring and similar soils:* 85 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Pring

#### Setting

*Landform:* Hills  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear

## Custom Soil Resource Report

*Parent material:* Arkosic alluvium derived from sedimentary rock

### Typical profile

*A - 0 to 14 inches:* coarse sandy loam

*C - 14 to 60 inches:* gravelly sandy loam

### Properties and qualities

*Slope:* 3 to 8 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water supply, 0 to 60 inches:* Low (about 6.0 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3e

*Hydrologic Soil Group:* B

*Ecological site:* R048AY222CO - Loamy Park

*Hydric soil rating:* No

### Minor Components

#### Pleasant

*Percent of map unit:*

*Landform:* Depressions

*Hydric soil rating:* Yes

#### Other soils

*Percent of map unit:*

*Hydric soil rating:* No

## 93—Tomah-Crowfoot complex, 8 to 15 percent slopes

### Map Unit Setting

*National map unit symbol:* 36bb

*Elevation:* 7,300 to 7,600 feet

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Tomah and similar soils:* 50 percent

*Crowfoot and similar soils:* 30 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Tomah

#### Setting

*Landform:* Hills, alluvial fans



## Custom Soil Resource Report

*Landform position (three-dimensional):* Side slope, crest  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium derived from arkose and/or residuum weathered from arkose

### Typical profile

*A - 0 to 10 inches:* loamy sand  
*E - 10 to 22 inches:* coarse sand  
*Bt - 22 to 48 inches:* stratified coarse sand to sandy clay loam  
*C - 48 to 60 inches:* coarse sand

### Properties and qualities

*Slope:* 8 to 15 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Low (about 4.6 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* B  
*Ecological site:* R049XY216CO - Sandy Divide  
*Hydric soil rating:* No

## Description of Crowfoot

### Setting

*Landform:* Hills, alluvial fans  
*Landform position (three-dimensional):* Side slope, crest  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium

### Typical profile

*A - 0 to 12 inches:* loamy sand  
*E - 12 to 23 inches:* sand  
*Bt - 23 to 36 inches:* sandy clay loam  
*C - 36 to 60 inches:* coarse sand

### Properties and qualities

*Slope:* 8 to 15 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water supply, 0 to 60 inches:* Low (about 4.7 inches)

## Custom Soil Resource Report

### **Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* B

*Ecological site:* R049XY216CO - Sandy Divide

*Hydric soil rating:* No

### **Minor Components**

#### **Other soils**

*Percent of map unit:*

*Hydric soil rating:* No

#### **Pleasant**

*Percent of map unit:*

*Landform:* Depressions

*Hydric soil rating:* Yes

# References

---

- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_054262](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262)
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053577](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577)
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053580](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580)
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2\\_053374](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374)
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

## Custom Soil Resource Report

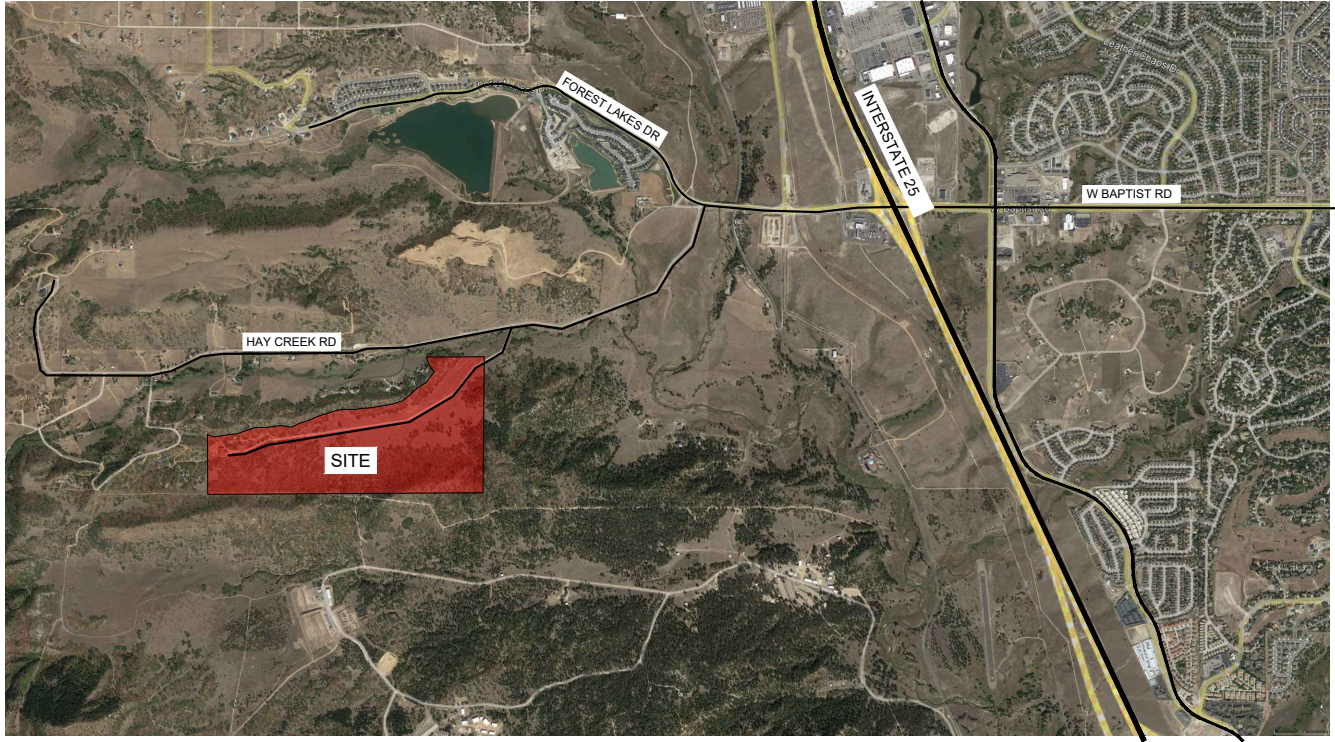
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2\\_054242](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242)

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053624](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624)

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. [http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs142p2\\_052290.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf)

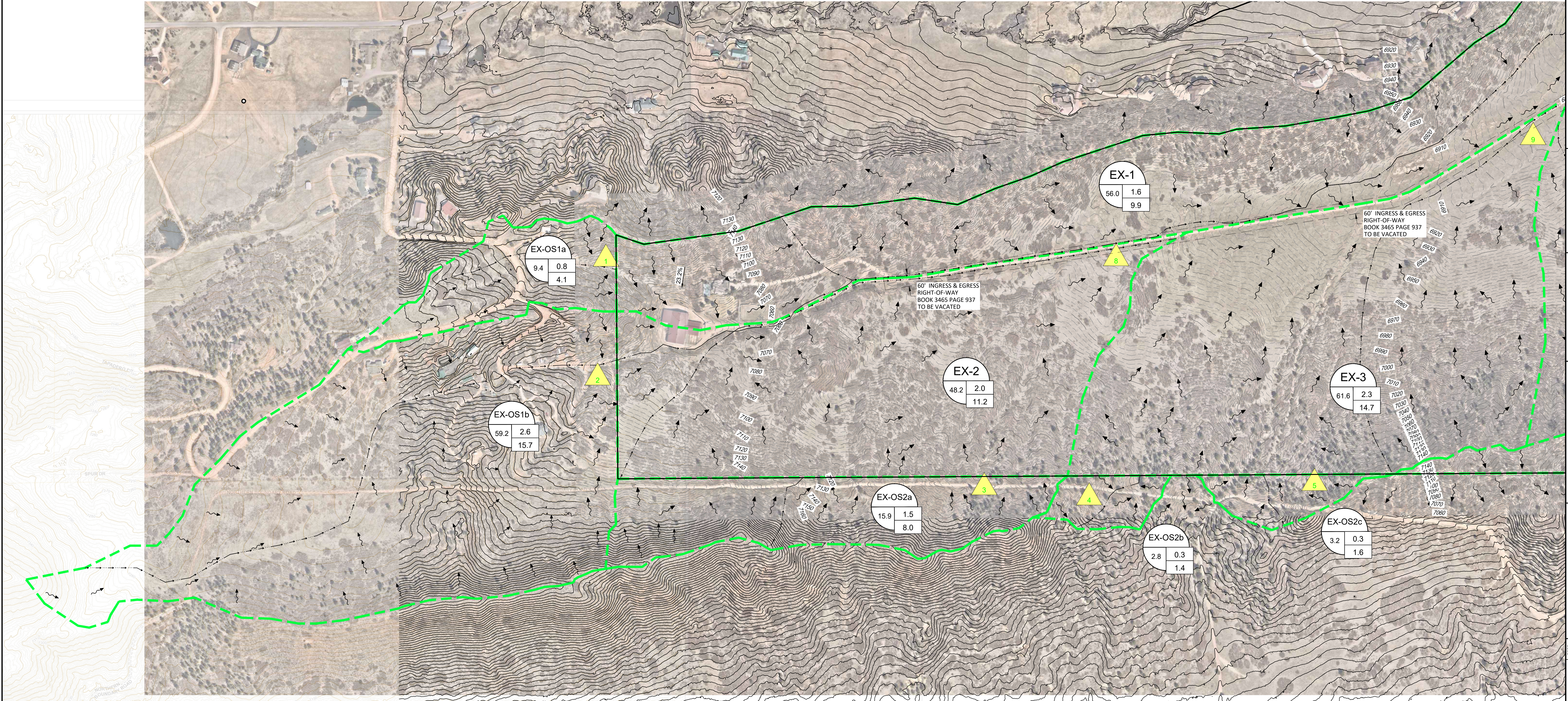
**APPENDIX D**

*MAPS*


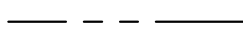



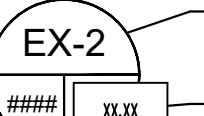
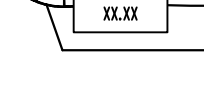
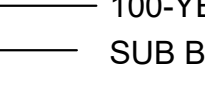
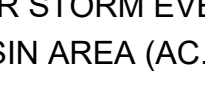


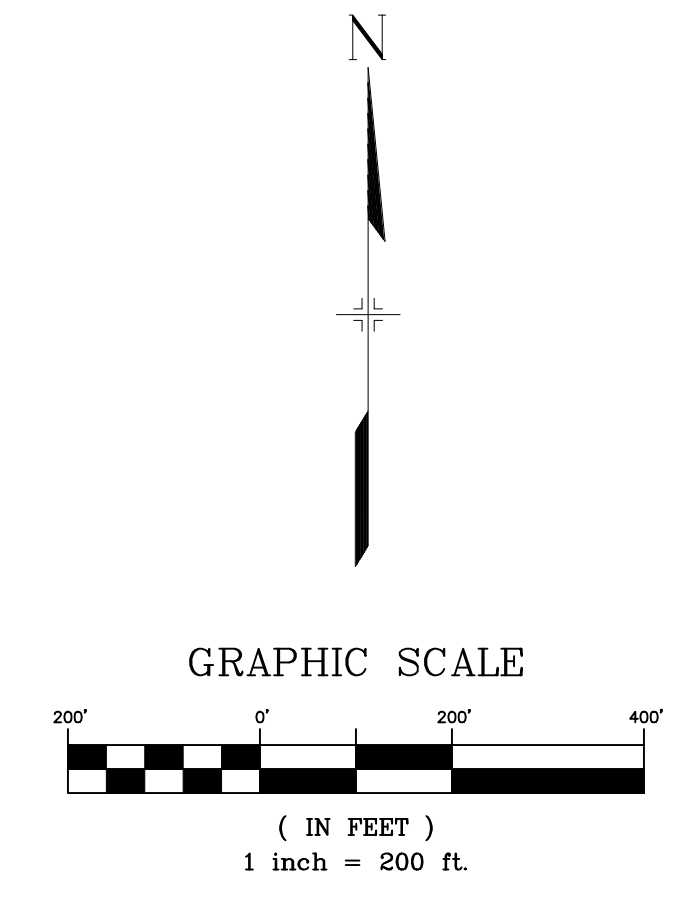
VICINITY MAP  
HAY CREEK VALLEY  
(NTS)





**LEGEND**

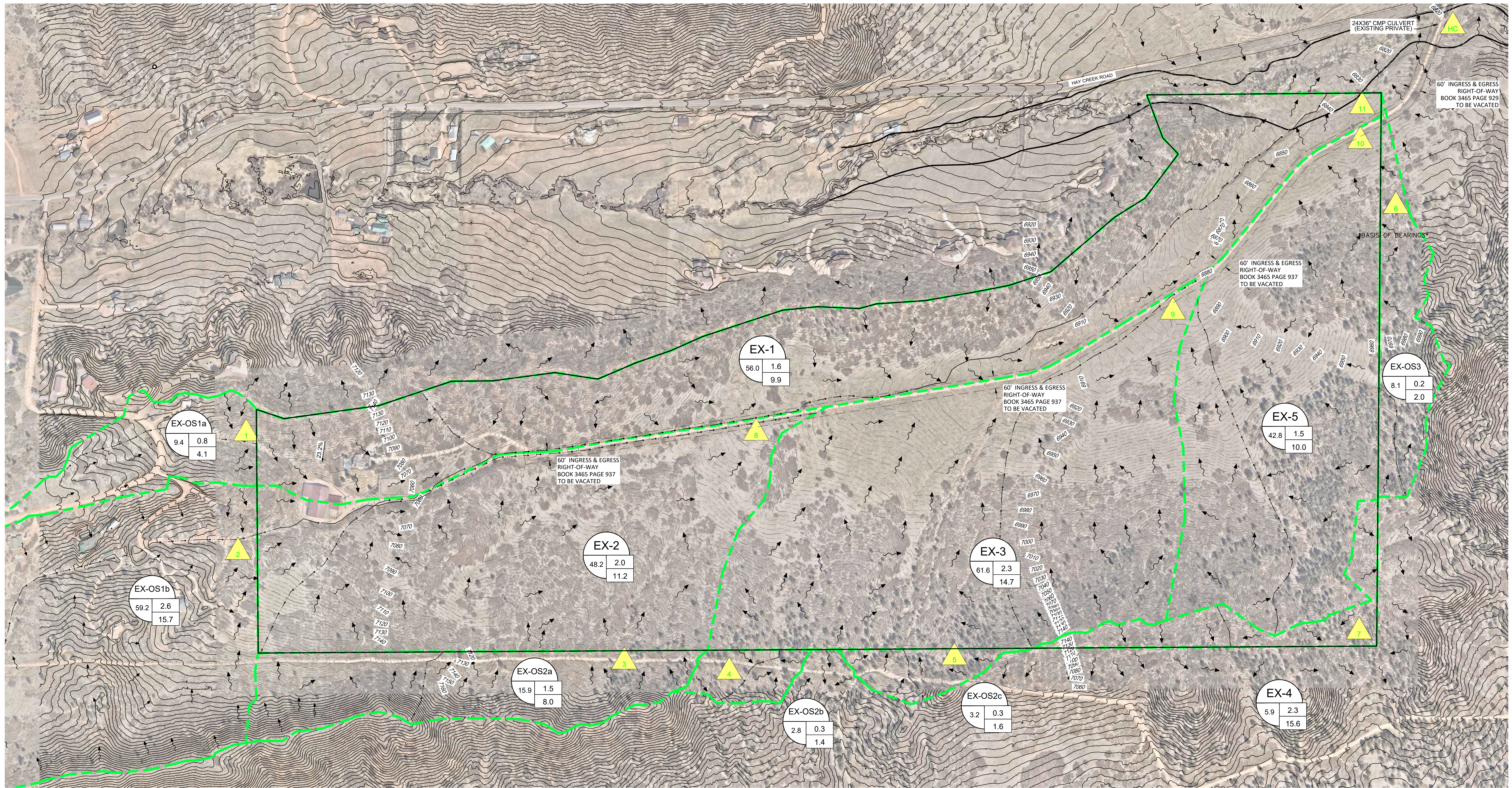
-  BASIN BOUNDARY
-  EXISTING PROPERTY LINE
-  EXISTING CONTOUR
-  FLOW DIRECTION
-  DESIGN POINT
-  SUB BASIN DESIGNATION
-  5-YEAR STORM EVENT PEAK FLOW (CFS)
-  100-YEAR STORM EVENT PEAK FLOW (CFS)
-  SUB BASIN AREA (AC.)



SHEET KEY

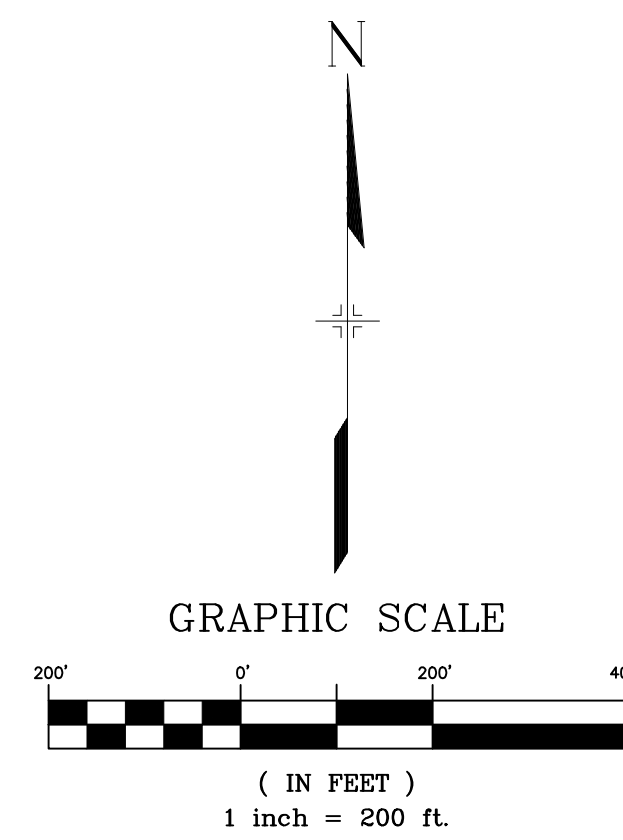
REFERENCE DRAWINGS		REVISIONS	
No.	DATE	No.	DESCRIPTION





**LEGEND**

- BASIN BOUNDARY
- EXISTING CONTOUR
- FLOW DIRECTION
- DESIGN POINT
- SUB BASIN DESIGNATION
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- SUB BASIN AREA (AC.)



Hay Creek Existing Conditions Sub-basin Summary			
Basin	Area	Q5	Q100
	acres	cfs	cfs
EX-OS1a	9.4	0.8	4.1
EX-OS1b	59.2	2.6	15.7
EX-OS2a	15.9	1.5	8.0
EX-OS2b	2.8	0.3	1.4
EX-OS2c	3.2	0.3	1.6
EX-OS3	8.1	0.2	2.0
EX-1	56.0	1.6	9.9
EX-2	48.2	2.0	11.2
EX-3	61.6	2.3	14.7
EX-4	5.9	2.3	15.6
EX-5	42.8	1.5	10.0

Existing Design Point Summary				
Hay Creek				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
1	EX-OS1a	9.35	0.80	4.10
2	EX-OS1b	59.21	2.60	15.70
3	EX-OS2a	15.90	1.50	8.00
4	EX-OS2b	2.77	0.30	1.40
5	EX-OS2c	3.17	0.30	1.60
6	EX-OS3	8.15	0.20	2.00
7	EX-4	5.88	2.30	15.60
8	EX-OS1b, EX-OS2a, EX-2	123.33	5.40	30.90
9	EX-OS2b, EX-OS2c, EX-3	67.57	2.90	17.40
10	EX-OS3, EX-5	50.97	1.80	11.90
11	DP-8, DP-9, DP-10, EX-OS1a, EX-1	307.27	11.20	69.90
HC	From PPRBD Regional floodplane Administrator			127.00

EL PASO COUNTY

HAY CREEK

PRELIMINARY DRAINAGE REPORT

PRE DEVELOPMENT DRAINAGE CONDITIONS

DATE ISSUED: MARCH 2023

SHEET: 2 OF 3

SCALE: NAD83

PROJECT NO: 22-886-076

FOR AND ON BEHALF OF

MATRIX DESIGN GROUP, INC.

PROJECT NO. 22-886-076

PRELIMINARY

DESIGN HAS NOT

BEEN APPROVED BY

GOVERNING AGENCIES AND

IS SUBJECT TO CHANGE

DESIGNED BY: WCC

DRAWN BY: WCC

CHECKED BY: JTS

SEAL

PREPARED BY:

**Matrix**

Excellence by Design

SHEET KEY

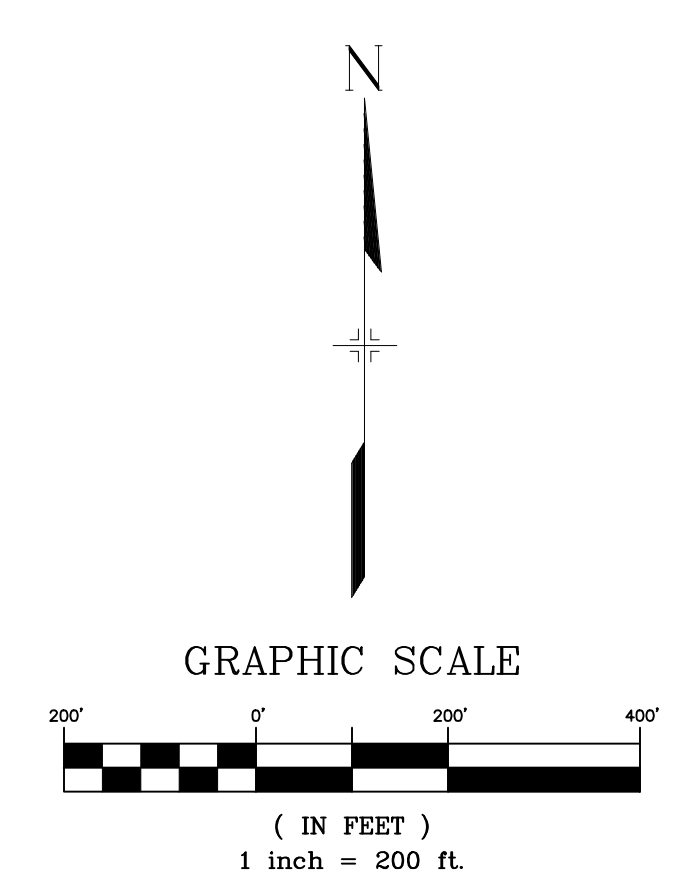
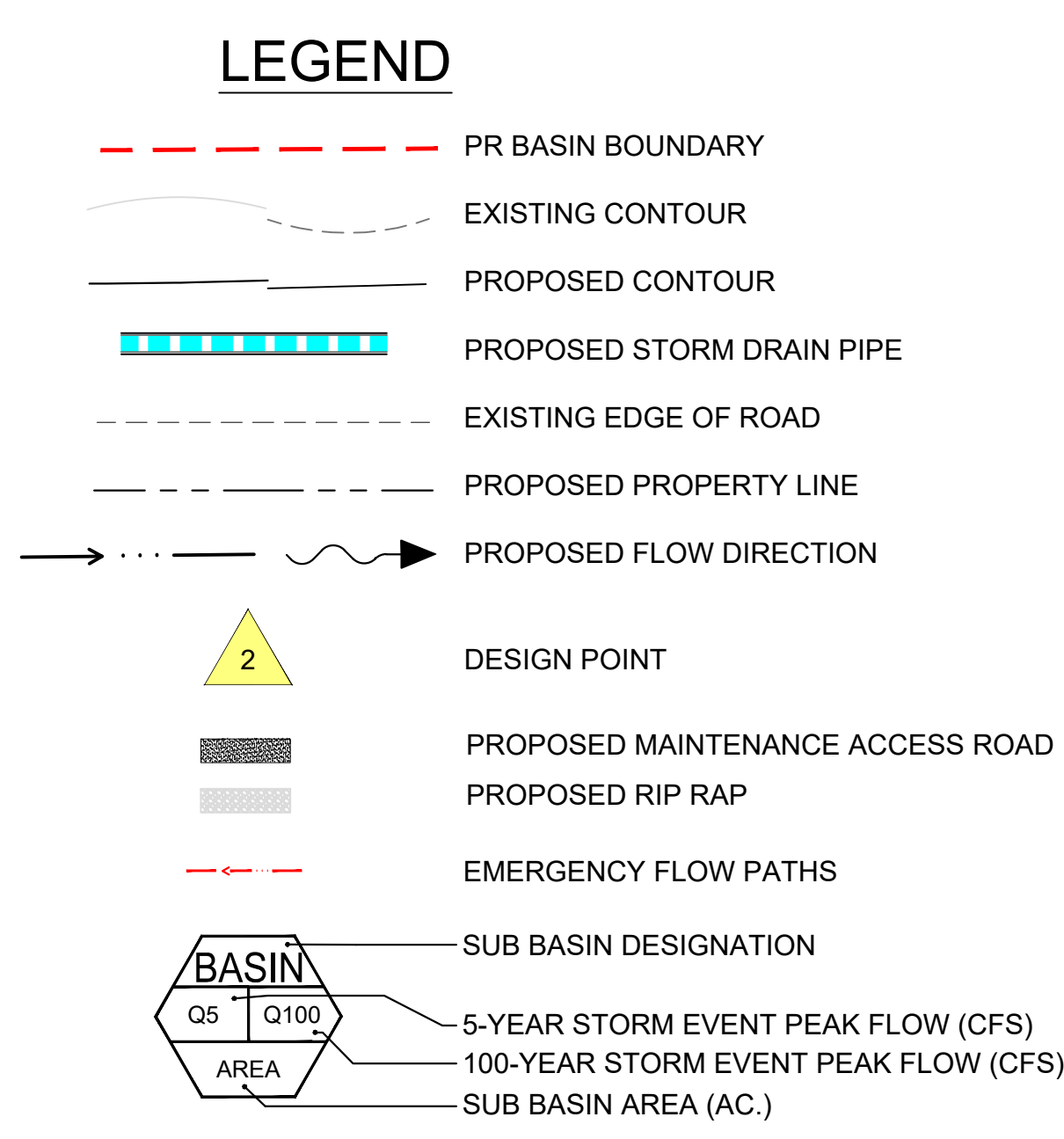
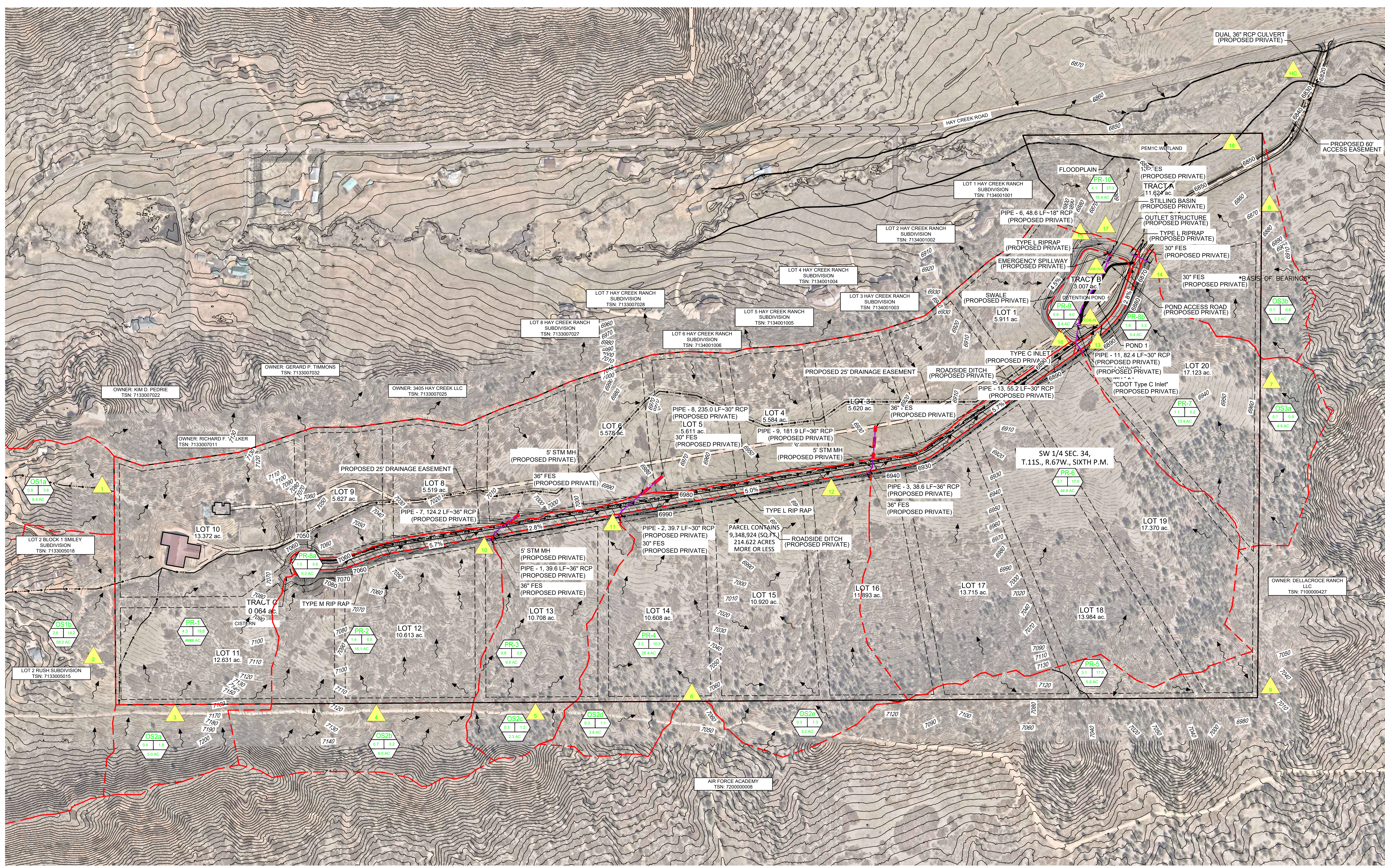
COMPUTER FILE MANAGEMENT

FILE NAME: S:\22-886-076 Hay Creek Forest Manor-O'Leary Properties\2020 Drainage-WR222 Reports\FDR\DWG\DR01 - HAY CREEK.dwg

PLOT DATE: March 20, 2023 3:51:25 PM

THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE

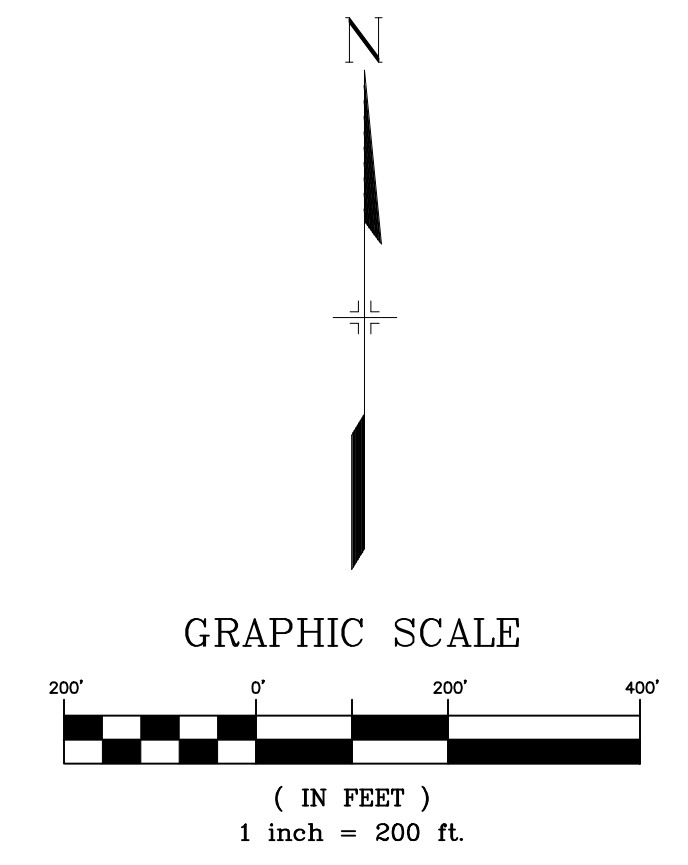
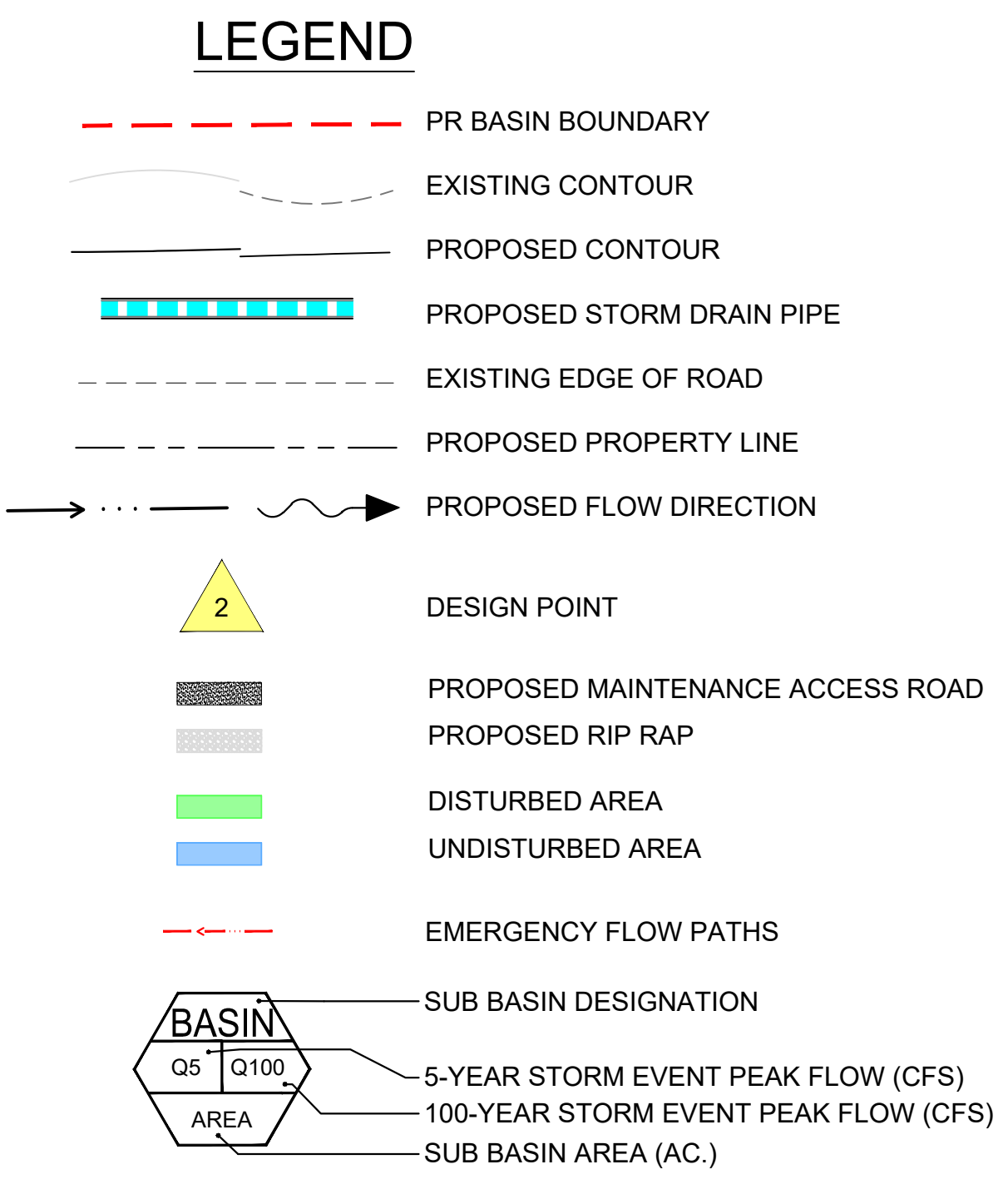
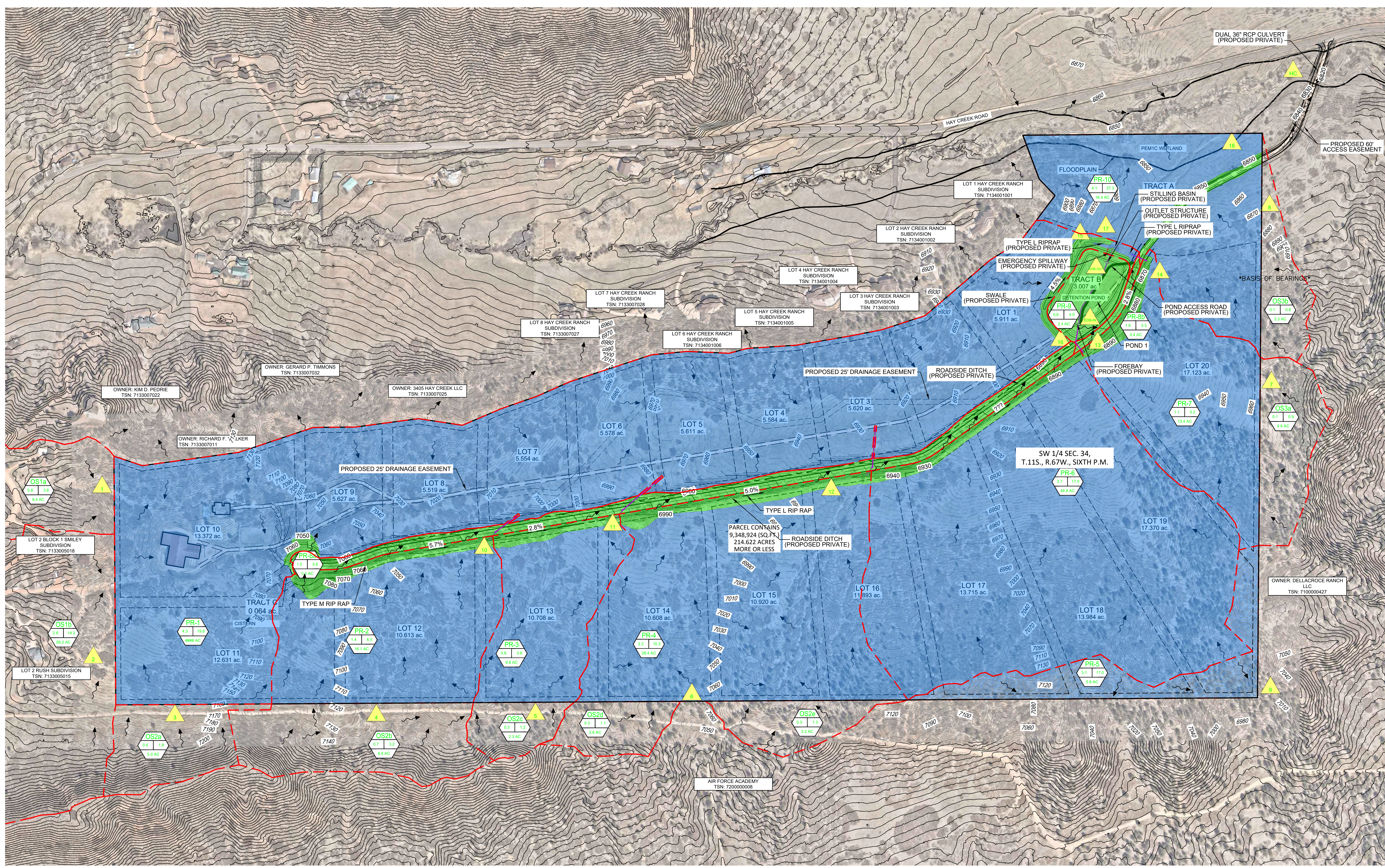




Basin	Area acres	Q5 cfs	Q100 cfs
OS1a	9.4	0.8	3.6
OS1b	59.2	2.6	14.2
OS2a	5.0	0.4	1.8
OS2b	8.6	0.7	3.2
OS2c	2.3	0.3	1.2
OS2d	2.8	0.3	1.1
OS2e	3.2	0.3	1.3
OS3a	4.9	0.1	0.9
OS3b	3.3	0.1	0.8
PR-1	70.9	4.3	19.8
PR-2	16.1	1.4	6.5
PR-3	9.8	0.8	3.8
PR-4	28.4	2.2	10.3
PR-5	5.9	0.0	0.0
PR-6	44.8	3.7	17.0
PR-7	13.4	1.1	5.2
PR-8a	5.1	1.5	5.6
PR-8b	0.4	0.8	1.7
PR-9	2.4	0.0	0.0
PR-10	16.4	0.6	3.4

Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
1	OS1a	9.35	0.80	3.60
2	OS1b	59.21	2.60	14.20
3	OS2a	5.01	0.40	1.80
4	OS2b	8.57	0.70	3.20
5	OS2c	2.28	0.30	1.20
6	OS2d, OS2e	5.93	0.50	2.30
7	OS3a	4.88	0.10	0.90
8	OS3b	3.29	0.10	0.80
9	PR-5	5.86	0.00	0.00
10	OS2b, PR-2	24.65	2.10	9.60
11	OS2c, PR-3	12.06	1.00	4.60
12	OS2d, OS2e, PR-4	34.29	2.70	12.30
13	PR-6	44.76	3.70	17.00
14	OS3a, PR-7	18.31	1.20	6.10
15	OS1a, OS1b, OS2a, PR-1, DP-10, DP-11, DP-12	215.41	11.80	58.10
16a	PR-8a	5.11	1.50	5.60
16b	PR-6, PR-8a	49.88	4.90	22.00
EDB-IN	PR-6, PR-8a, PR-8b, PR-9	52.69	5.10	22.40
EDB-OUT	PR-6, PR-8a, PR-8b, PR-9	52.69	0.80	3.50
17	EDB-OUT, DP-14, DP-15	286.41	13.20	66.00
18	DP-8, DP-18, PR-10	306.07	13.80	69.80





Basin ID	Total Area (ac)	Disturbed Area		Disturbed Area Excluded from WQ per ECM App 1.7.1, b.5 (ac)
		Total Proposed Disturbed Area (ac)	Disturbed Area Tributary to Pond 1 (ac)	
PR-1	71.97	1.02	0	1.02
PR-2	16.08	1.27	0	1.27
PR-3	9.78	0.75	0	0.75
PR-4	28.35	1.53	0	1.53
PR-5	5.86	0	0	0
PR-6	44.76	1.15	1.15	0
PR-7	13.43	0.87	0	0.87
PR-8a	5.20	5.2	5.2	0
PR-8b	0.40	0.4	0.4	0
PR-9	2.41	2.41	0	2.41
PR-10	16.38	0.73	0	0.73
Total	214.62	15.33	6.75	8.58

NOTE: FUTURE RESIDENTIAL CONSTRUCTION FALLS UNDER THE LARGE LOT EXCLUSION FROM WQ TREATMENT, HOWEVER MUCH, IF NOT ALL, OF THE IMPROVEMENTS ASSOCIATED WITH THE RESIDENCES WILL DRAIN ACROSS VEGETATED AREAS AND UNDER THE RUNOFF REDUCTION METHODOLOGY WILL HAVE THE REQUIRED WQ TREATMENT VOLUME REDUCED TO ZERO.