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Engineering Engineering are in blue text.



Final Drainage Report

# Overlook at Homestead Filing No. 1 El Paso County, Colorado

Prepared for:

**PT Overlook LLC**  
**1864 Woodmoor Drive, Suite 100**  
**Monument, CO 80132**

Prepared by:

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Project #: 196239003

SF2425

PCD Filing No.:

Prepared: September 18, 2024

**Kimley»»Horn**



**CERTIFICATION**

***DESIGN 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 master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparation of this report.

SIGNATURE (Affix Seal): \_\_\_\_\_  
Kevin Kofford, P.E. Date

***OWNER/DEVELOPER'S STATEMENT***

I, the developer, have read and will comply with all of the requirements specified in this Drainage Report and Plan.

PT Overlook LLC  
Name of Developer \_\_\_\_\_

\_\_\_\_\_  
Authorized Signature Date

Joe DesJardin  
Printed Name \_\_\_\_\_

Director of Entitlements  
Title \_\_\_\_\_

1864 Woodmoor Drive Suite 100, Monument, CO 80132  
Address \_\_\_\_\_

***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. Date  
County Engineer/ ECM Administrator

Conditions:

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## INTRODUCTION

### **PURPOSE AND SCOPE OF STUDY**

This project is for a final plat, not for early grading. Please revise accordingly.

The purpose of this Final Drainage Report (FDR) is to document the drainage design **in support of early grading improvements** for the proposed Overlook at Homestead Subdivision Filing No. 1 ("the Project") on behalf of PT Overlook LLC. The Project is located within the jurisdictional limits of El Paso County ("the County"). Therefore, the hydrologic and hydraulic design is based on the County's criteria which is described in further detail within the report.

### **LOCATION**

Make reference to the early grading project, EGP241 so it is acknowledged this came first, but otherwise the report shouldn't contain references to early grading.

The Project Site located east of Elbert Road within El Paso County, Colorado including parcels 4122000005, 4100000255, 4100000256. More specifically, the site is a Portion of Section 22 and a Portion of Section 27, Township 11 South, Range 64 West of the 6<sup>th</sup> PM, County of El Paso, State of Colorado. North of the project site is agricultural and rural residential land, to the east is Homestead Ranch Park owned and maintained by El Paso County, and to the south and west is Homestead Ranch subdivisions. Filing No.1 consists of 36, five acre lots and is located just south the Apex Ranch Subdivision and the large butte. A vicinity map has been provided in the **Appendix** of this report.

The Site is currently owned by PT Overlook LLC and will be developed by PT Overlook LLC.

### **DESCRIPTION OF PROPERTY**

The entire Overlook project is approximately 350.8 acres consisting of mostly vacant, undeveloped land with native vegetation and a rural single-family residential home situated in the northwest corner of the Site and is classified as Agricultural Grazing Land to be subdivided into 62 total lots. Filing No. 1 consists of approximately 202.72 acres which will be subdivided into 36 5-acre parcels. Vegetation within the site is characterized primarily by prairie grasses along with some area of scrub brush and trees. The Site does not currently provide water quality or detention for the Project area.

The existing topography consists of slopes ranging from 1% to 33% with an existing butte covering much of the northern portion of the Site. Filing No. 1 includes a roadway and temporary cul-de-sac on the top of the existing butte, but the majority of the site is located south of the butte. Flows in the existing conditions run off site into one of four major drainage basins. Filing No. 1 only discharges into the Upper Black Squirrel Creek and La Vega Ranch drainage basins, to the south. Detailed descriptions of the existing major drainage basins can be found later in the report.

According to NRCS soil mapping data, USCS Type B soils are the primary soil type within the site. Type 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. Soils mapping information has been provided in the **Appendix**.

The Filing No. 1 development of this site will consist of 36, five-acre residential lots with roadway improvements, roadway grading, three full spectrum detention ponds, roadside ditches, culverts, and drainage swales.



## FLOODPLAIN STATEMENT

The Site is located outside the 100-year floodplain and within Zone X (an area of minimal flood hazard) as noted on the FEMA FIRM Map No. 08041C0350G revised on December 7, 2018 (See **Appendix**).

## DRAINAGE BASINS

### MAJOR BASIN DESCRIPTIONS

The Project Site is tributary to four major drainage basins in the El Paso County Drainage Basin Map. Bijou Creek, East Kiowa Creek, Upper Black Squirrel, and La Vega Ranch Drainage Basins. These drainage basins are located in the north central portion of El Paso County. The northeast portion of the site is tributary to Bijou Creek Drainage Basin, the northwest portion of the site is tributary to East Kiowa Creek Drainage Basin, the southwest portion of the site is tributary to Upper Black Squirrel Drainage Basin, and the southeast portion of the site is tributary to La Vega Ranch Drainage Basin. Filing No. 1 only discharges into the Upper Black Squirrel Creek and La Vega Ranch Drainage Basins, to the south. In an effort to simplify basin nomenclature, the following naming conventions have been used for both existing and proposed drainage sub-basins labeling. Proposed Basins have been designed in effort to keep runoff within the same existing basins, as to not transfer runoff between basins.

- A - Upper Black Squirrel Drainage Basin (CHBS2000)
- B - La Vega Ranch Drainage Basin (CHBR0400)
- C - East Kiowa Creek Drainage Basin (KIKI0400)
- D - Bijou Creek Drainage Basin (BIBI0200)

El Paso County Drainage Basin map has been provided in the **Appendix**. A summary of flows in existing and proposed conditions has been added to the **Appendix**.

### COMPLIANCE WITH PREVIOUS FINAL DRAINAGE REPORT

A portion of the proposed Project Site falls within the existing approved "Final Drainage Report for Apex Ranch Estates" by Terra Nova Engineering, Inc. approval date September 3, 2008. Flows from these basins will be at or below history values. These flows are not included in the calculation for the existing detention facility for Filing No. 1. Excerpts from the previously approved FDR have been provided in the **Appendix**.

A Preliminary Drainage Report was submitted to the County as part of the SP238 Application for the Preliminary Plat.

### EXISTING SUB-BASIN DESCRIPTIONS

Historically the runoff from the Site drains into one of two major drainage basins for Filing No. 1 as described above. Slopes vary from 2-33% throughout the site with various natural features. The Site has been divided into 8 onsite basins A1-A2, B1-B3, and B3A, and 2 offsite basins OS-A1 and OS-A2. The offsite basins are located west of the Site and generally flow west towards to existing stormwater infrastructure. Descriptions of each individual sub-basin can be found below.

In the existing conditions flows within the existing sub-basins are conveyed and collected into

Pease include the name of the preparer and the approval date for SP238. Additionally, provide the Final Drainage Report for early grading, including the preparer's name and the approval date.

natural drainage channels. These channels can be found on the existing conditions drainage map, and hydraulic analysis of these channels in existing conditions have been completed. Both of these items can be found in the **Appendix**. Flows will generally follow historic drainage patterns with regards to the existing natural drainage channels.

#### **Sub-Basin A1**

This on-site sub-basin consists of an area of 19.92 acres, located in the southwest corner of the Site. Drainage flows overland from the northeast to the southwest where it is captured by an existing 36" CMP culvert at DP 1 and outfalls west of Elbert Rd. The weighted imperviousness for this sub-basin is 8%. Runoff during the 5-year and 100-year events are 8.43 cfs and 38.41 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

#### **Sub-Basin A2**

This on-site sub-basin consists of an area of 63.97 acres, located in the southwest corner of the Site. Drainage flows overland from the northeast to the southwest where it flows offsite at DP 2 into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 1%. Runoff during the 5-year and 100-year events are 13.47 cfs and 91.03 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

#### **Sub-Basin B1**

This on-site sub-basin consists of an area of 43.28 acres, located in the south-central portion of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 3 into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 0%. Runoff during the 5-year and 100-year events are 9.34 cfs and 68.56 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

#### **Sub-Basin B2**

This on-site sub-basin consists of an area of 42.42 acres, located in the south-central portion of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 4 into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 0%. Runoff during the 5-year and 100-year events are 9.41 cfs and 69.09 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

#### **Sub-Basin B3**

This on-site sub-basin consists of an area of 25.42 acres, located in the southeast portion of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 5 into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 0%. Runoff during the 5-year and 100-year events are 5.91 cfs and 43.40 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

#### **Sub-Basin B3A**

This on-site sub-basin consists of an area of 24.23 acres, located in the southeast corner of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 5A into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 0%. Runoff during the 5-year and 100-year events are 5.99 cfs and 43.98 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

#### **Sub-Basin OS-A1**

The off-site sub-basin consists of an area of 4.06 acres, located in the western central portion of the drainage study area. Drainage flows overland from the northeast to southwest where it is captured by an existing drainage culvert at DP 14 and directed west of Elbert Road. The weighted

imperviousness for this sub-basin is 19%. Runoff during the 5-year and 100-year events are 3.62 cfs and 12.02 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

### **Sub-Basin OS-A2**

The off-site sub-basin consists of an area of 4.45 acres, located in the central portion of the drainage study area. Drainage flows overland from the north to south where it enters sub-basin A2 at DP 15 and follows the patterns described in sub-basin A2. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 2.10 cfs and 11.46 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

### **PROPOSED SUB-BASIN DESCRIPTIONS**

For the proposed condition, stormwater will generally maintain historic flow patterns. The proposed roadways will alter some of the existing flow paths. The roadway ditches will capture runoff from the roadways and direct flows via proposed culverts back to the existing flow paths, which will ultimately follow historic patterns or be capture by one of the three (3) proposed storm water ponds. The proposed Site has been divided into 10 onsite basins A1-A2, B1-B3, B6-B8, and 2 offsite basins OS-A1 and OS-A2. Descriptions of each individual sub-basin can be found below. The off-site basins are fully developed and no changes to the upstream basins are anticipated. Per Final Drainage Report for Apex Ranch Estates by Terra Nova Engineering, dated September 3, 2008, the existing extended detention basin, on the northwest corner of Apex Ranch Road and Fletcherville Lane was designed and sized to provide water quality for the entire basins A-J of the Apex Ranch Estates Final Drainage Report. This area includes all the proposed roadway extensions through the ROW preservation within the Apex Ranch Estates Subdivision. This project does not rely on the water quality detention basin within Apex Ranch Estates.

please identify who will be responsible for maintaining the channels especially those with erosion protection.

In the proposed conditions flows within the proposed natural drainage channels. These channels can be found on the proposed conditions drainage map, and hydraulic analysis of these channels in proposed conditions have been completed. Both of these items can be found in the **Appendix**. Flows will generally follow historic drainage patterns with regards to the existing natural drainage channels. Due to the increase in site imperviousness some channels will see an increase in flows. All channels that have an increase of flows in proposed conditions currently have capacity to accept the additional flows. Hydraulic analysis was done to determine need for erosion control measures. Any channel with a proposed velocity greater than 5.0 ft/s shall have Turf Reinforcement Mat (TRM) added as a channel stabilization mitigation measure. Details regarding channel velocity and TRM can be found in the **Appendix**.

There are several drainage culverts proposed within Filing 1 of the Site. Locations of the proposed culverts were chosen to ensure historic drainage patterns are maintained. Culvert sizing including outlet protection analysis has been included in this report. Outlet protection will be installed with the culverts as part of the early grading portion of this development. Due to the steep topography of the Site, instead of a traditional riprap pad for outlet protection, a low tailwater basin design is being proposed. Intended to prevent scour downstream by providing a stilling basin, the low tailwater basin acts as an additional energy dissipation mechanism by having a determined depth to the riprap pad that slows down the water prior to overtopping. The detail is provided in the **Appendix** of this report.

The three proposed full spectrum extended detention basins (EDB) will be designed to release developed flows from Filing No. 1 at less than or equal to historic rates for this project before passing the property line. The full design of these full spectrum extended detention basins are provided in this Final Drainage Report. Erosion control measures are shown for pond outfall to

protect downstream properties and drainageways, a low tailwater stilling basin, based on the design provided by Mile High Flood District (MHFD), Urban Drainage and Flood Control District Drainage Criteria Manuals (UDFCDCM) Volume 2, Figure 9-37, will be installed at the outfall location of the proposed EDBs. The design helps prevent downstream scour and mitigates the concentrated flow, acting as a level spreader for concentrated flow in an existing drainageway. These measures are displayed and discussed in text and drainage maps. More detail regarding the proposed EDBs can be found in the detention basin section of this report.

### Sub-Basin A1

This on-site sub-basin consists of an area of 19.55 acres, located in the southwest corner of the Site. Drainage flows overland from the northeast to the southwest where it is captured by an existing 36" CMP culvert at DP 1 and outfalls west of Elbert Rd. There are no proposed improvements in sub-basin A1. The weighted imperviousness for this sub-basin is 15%. Runoff during the 5-year and 100-year events are 10.41 cfs and 41.24 cfs respectively. Due to the slight increase in sub-basin imperviousness, the 100-yr runoff increases from 38.41 to 41.24 cfs. The additional runoff will be accepted and mitigated through the nearly 1500 ft long, 50 ft wide existing drainage channel located within the sub-basin. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### Sub-Basin A2

This on-site sub-basin consists of an area of 61.98 acres, located in the southwest corner of the Site. Improvements within this sub-basin include proposed roads, roadside ditches, culverts, and proposed private full spectrum detention basin A2. Drainage flows overland from the northeast to the southwest where it flows into proposed roadside ditches, is conveyed through proposed stormwater culverts, and is ultimately captured by propose private full spectrum detention basin A2. Flows will be released at or below historic levels to the existing roadside ditch along Elbert Road located at DP 2. Flows will generally follow historic drainage patterns. The weighted imperviousness for this sub-basin is 10%. Runoff during the 5-year and 100-year events are 20.85 cfs and 97.07 cfs respectively. Due to the increase in sub-basin imperviousness, the 100-yr runoff for DP 2 is anticipated to increases from 91.03 cfs to 97.07 cfs. The additional runoff will be collected and released at less than historic rates via a proposed private full spectrum detention basin. Flows from this basin will not be released into the Reata subdivision south of the Site. They will be routed through an outfall pipe that will release into the roadside ditch within the County ROW. A downstream channel analysis of this roadside ditch will be provided in the Final Drainage Report, associated with the Final Plat. The minor increase in flows will be mitigated by the proposed full spectrum detention basin A2 and released a less than historic rates. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

this is the final drainage report.  
Please revise and provide analysis

### Sub-Basin B1

This on-site sub-basin consists of an area of 38.38 acres, located in the south-central portion of the Site. Improvements within this sub-basin include proposed roads, roadside ditches, culverts, and proposed private full spectrum detention basin B1. Drainage flows overland from the north to the south where it flows into proposed roadside ditches, is conveyed through proposed stormwater culverts, and is ultimately captured by propose private full spectrum detention basin B1 at DP 3. The weighted imperviousness for this sub-basin is 10%. Runoff during the 5-year and 100-year events are 16.38 cfs and 76.45 cfs respectively. Due to the increase in sub-basin imperviousness, the 100-yr runoff for DP 3 is anticipated to increases from 68.56 cfs to 76.45 cfs. The additional runoff will be collected and released at less than historic rates via a proposed private full spectrum detention basin with a proposed low tailwater basin. Flows from this basin will exit into the Reata subdivision south of the Site via existing, vegetated natural drainage channels and outfall to an existing stock pond within the adjacent property south of the Site. To

mitigate erosion and downstream impacts, a low tailwater basin is proposed at the outfall prior to flows entering the Reata Subdivision. The minor increase in flows will be mitigated by the proposed full spectrum detention basin B1 and released at less than historic rates. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B2**

This on-site sub-basin consists of an area of 15.81 acres, located in the south-central portion of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 4. Improvements within this sub-basin include proposed public roads. This sub-basin includes an approx. 14,351 sq ft improved area of roadway that will not be receiving water quality treatment. A detailed discussion regarding water quality treatment has been included in Step-2 of the Four Step Process. The weighted imperviousness for this sub-basin is 8%. Runoff during the 5-year and 100-year events are 7.46 cfs and 37.85 cfs respectively. It is anticipated in a 100-yr storm event the total runoff for DP 4 will reduce from 69.09 cfs to 37.85 cfs, as the proposed roadway will cut off much of the upstream portion of the existing drainage basin and route those flows to a proposed full spectrum detention basin. As such there are no anticipated downstream impacts. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B3**

This on-site sub-basin consists of an area of 19.11 acres, located in the southeastern portion of the Site. Drainage flows overland from the northwest to southeast where it flows off site at DP 5. There are no proposed public improvements within this sub-basin, but single-family homes will be constructed and excluded the large lot exclusion I.7.1.B.5 and discussed in step 2 of the four-step process. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 7.83 cfs and 42.71 cfs respectively. In the proposed conditions, it is anticipated in a 100-yr storm event the total runoff for DP 5A (DP 5 in proposed conditions) will reduce from 43.98 to 42.71, as such there are no anticipated downstream impacts. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B6**

This on-site sub-basin consists of an area of 52.15 acres, located in the central portion of the Site. Improvements within this sub-basin include proposed roads, roadside ditches, and culverts. Drainage flows overland from the northeast to the southwest where it flows into proposed roadside ditches, is conveyed through a proposed stormwater culvert at DP 8, and into sub-basin B8. From there, flows will follow path as described in sub-basin B8 where it will ultimately be captured in proposed full spectrum detention basin B8. The weighted imperviousness for this sub-basin is 11%. Runoff during the 5-year and 100-year events are 23.44 cfs and 106.32 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B7**

This on-site sub-basin consists of an area of 2.46 acres, located in the southern portion of the Site. Drainage flows overland from the north to south where it flows off site at DP 9. There are no proposed improvements within this sub-basin. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 1.13 cfs and 6.17 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B8**

This on-site sub-basin consists of an area of 9.52 acres, located in the southern portion of the Site. Drainage flows overland from the north to south where it is captured by proposed private full spectrum extended detention basin B8 at DP 10. It should be noted that sub-basin B8 accepts flows from sub-basin B6 at DP 8. Refer to sub-basin B6 for information regarding the proposed flows from sub-basin B6. Aside from the proposed extended detention basin there are no



proposed improvements within this sub-basin. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 4.22 cfs and 23.05 cfs respectively. In addition to the increase of imperviousness, sub-basin B8 is also accepting flows from sub-basin B6 to the north. The combination of these factors results in a proposed increase of flows at DP 10 (DP 5 in existing conditions) from 43.40 cfs to 130.00 cfs. The additional runoff will be collected and released at less than historic rates via a proposed private full spectrum detention basin. To mitigate erosion and downstream impacts, a low tailwater basin is proposed at the outfall prior to flows entering the Reata Subdivision. Flows from this basin will exit into the Reata subdivision south of the Site via existing, vegetated natural drainage channel and outfall to an existing established vegetated area within the adjacent property south of the Site. The increase in flows will be mitigated by the proposed full spectrum detention basin B8 and released a less than historic rates. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Sub-Basin OS-A1**

The off-site sub-basin consists of an area of 4.06 acres, located in the western central portion of the drainage study area. Drainage flows overland from the northeast to southwest where it is captured by an existing drainage culvert at DP 18 and directed west of Elbert Road. The weighted imperviousness for this sub-basin is 25%. Runoff during the 5-year and 100-year events are 4.12 cfs and 12.86 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Sub-Basin OS-A2**

The off-site sub-basin consists of an area of 3.14 acres, located in the central portion of the drainage study area. Drainage flows overland from the north to south where it enters sub-basin A2 at DP 19 and follows the patterns described in sub-basin A2. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 2.10 cfs and 11.46 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Sub-Basin OS-A3**

The off-site sub-basin consists of an area of 1.31 acres, located in the central portion of the drainage study area. Drainage flows overland from east to west where it enters into the proposed roadside ditch at DP 20 and follows the roadside ditches within Apex Ranch Subdivision, where is eventually routed into the existing detention basin. The weighted imperviousness for this sub-basin is 13%. Runoff during the 5-year and 100-year events are 0.87 cfs and 3.65 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Design Point 2**

Design Point 2 is located on the southwest corner of Sub-basin A2 and is at the outfall of proposed Full Spectrum Detention Pond A2 in the final condition. The outfall structure is designed to release flows from the EDB at less than or equal to historic rates. See **Appendix** for outlet structure design. In an effort to prevent erosion, a low tailwater stilling basin has been proposed to act as an energy dissipation mechanism. The low tailwater stilling basin will outfall to the existing roadside ditch within the Elbert Road ROW. Onsite observation and measurements show the existing roadside ditch has capacity with a minimum of 1 ft freeboard. A downstream analysis of this roadside ditch is provided in the **Appendix**. The roadside ditch travels approx. 1800 ft south along the east side of Elbert Rd where it enters an approximate 70 ft wide drainage channel. Due to the size of the downstream channel and the distance from the pond outfall, any change in flow into the drainage channel would be negligible. A table summarizing the existing historic flows and proposed flows in the final condition for the 100-year event, at Design Point 2 are presented here below.

Project Phase	Existing Rational Method Peak Inflow 100-YR (cfs)	Detained Outflow - 100 YR (cfs)	Notes
Final Condition	91.03	64.40	Outlet structure designed to regulate flows at less than historic

In the final conditions, the EDB will limit the peak flow at design point 2 to be less than the historic condition.

**Design Point 3**

Design Point 3 is located on the southern property edge, near the center of the Site, in the center of Subbasin B1 and is at the outfall of proposed Full Spectrum Detention Pond B1 in the final condition. The outfall structure is designed to release flows from the EDB at less than or equal to historic rates. See **Appendix** for outlet structure design. In an effort to prevent erosion, a low tailwater stilling basin has been proposed to act as an energy dissipation mechanism. The low tailwater stilling basin will outfall to the existing historical drainageway. A table summarizing the existing historic flows and proposed flows in the interim and final condition for the 100-year event, at Design Point 3 are presented here.

Project Phase	Existing Rational Method Peak Inflow 100-YR (cfs)	Detained Outflow -100 YR (cfs)	Notes
Final Condition	68.56	42.40	Outlet structure will be constructed to regulate flows at less that

In the final conditions, the EDB will limit the peak flow at design point 3 to be less than the historic condition.

**Design Point 10**

Design Point 10 is located on the southeast portion of the Site, in the center of Subbasin B8 and is at the outfall of proposed Full Spectrum Detention Pond B8 in the final condition. The outfall structure is designed to release flows from the EDB at less than or equal to historic rates. In an effort to prevent erosion, a low tailwater stilling basin has been proposed to act as an energy dissipation mechanism. The low tailwater stilling basin will outfall to the existing historical drainageway. A table summarizing the existing historic flows and proposed flows in the interim and final condition for the 100-year event, at Design Point 10 are presented here.

Project Phase	Existing Rational Method Peak Inflow 100-YR (cfs)	Detained Outflow -100 YR (cfs)	Notes
Final Condition	43.40	39.40	Outlet structure will be constructed to regulate flows at less that

In the final conditions, the EDB will limit the peak flow at design point 3 to be less than the historic condition.

## DRAINAGE DESIGN CRITERIA

### DEVELOPMENT CRITERIA REFERENCE

The proposed storm facilities are designed to be in compliance with El Paso County "Drainage Criteria Manual (DCM)" dated October 2018 ("the MANUAL"), El Paso County "Engineering Criteria Manual" ("the Engineering Manual"), Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014 ("the Colorado Springs MANUAL"), and Mile High Flood District (MHFD), Urban Drainage and Flood Control District Drainage Criteria Manuals (UDFCDM), (Volumes 1, 2 and 3), prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.

Site drainage is not significantly impacted by such constraints as utilities or existing development.

A Preliminary Drainage Report was completed for the overall Overlook Subdivision (SP238). This Final Drainage Report uses the Preliminary Drainage Report to assist with the drainage design for Filing No. 1.

### HYDROLOGIC CRITERIA

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the proposed drainage system per chapter 6 of the CRITERIA. Table 6-2 of the CRITERIA is the source for rainfall data for the 5-year and 100-year design storm events. Design runoff was calculated using the Rational Method for developed conditions as established in the CRITERIA and MANUAL. Runoff coefficients for the proposed development were determined using Table 6-6 of the CRITERIA by calculating weighted impervious values for each specific site basin as outlined and shown in the Preliminary Drainage Report.

### HYDRAULIC CRITERIA

Applicable design methods were utilized to analyze & size the proposed ponds, culverts, and existing drainage channels which includes the use of the UD-Detention spreadsheet, rational calculations spreadsheet, and FlowMaster, and UD-Culvert.

Proposed Drainage features on-site have been analyzed and sized for the following design storm events:

- Major Storm: 100-year Storm Event

Please indicate whether the roadside ditches comply with table 6-1 of the DCMV1

The existing natural drainage channels and proposed roadside ditches are designed to carry flows to the proposed EDBs. The natural channels have varying bottom widths, slopes, and side slopes. The Project intends on using existing natural drainage channels to convey flow where appropriate. Natural channels through Filing No. 1 have been labeled and identified on the Existing and Proposed Drainage Maps. Channel calculations and summary table have been provided in the **Appendix**. It is not anticipated channel upgrades or improvements will be required for this project. Proposed drainage easements have been proposed in locations where the natural channels convey a substantial amount of flow between properties.

Roadside ditches are provided along the proposed roadways to route flows to the proposed culverts. The roadside ditches are sized to convey the major event flow. The roadside ditches have been designed to have an average depth of 3 feet, a v-ditch, a left-side slope of 3:1, and a

the cross sections in the CD's indicate 4:1 on each side slope. Revise accordingly.



right-side slope of 4:1. Roadside ditch calculations and summary table has been provided in the **Appendix**.

Culverts were sized to convey flows from the ditches and channels, underneath the sites paved roads. The proposed culverts range from 18” to 36” and have been designed to convey the 100-year storm event. Culvert calculations and summary table has been provided in the **Appendix**.

**DETENTION**

identify who will maintain and own the ponds

Discuss how these were calculated and why these values were overridden in the spreadsheet

Three full spectrum ponds are proposed in order to maintain historic flows and water quality. Mile High Flood District UD-Detention Spreadsheet was utilized to design the pond outlet structures. Detailed pond and outlet structure design can be found in the **Appendix**. A pond summary table can be found below.

Pond	Contributing Basins	Total Contributing Basin Area (Acre)	WQCV (Ac-ft)	Total Volume Required (Ac-ft)	Total Volume Provided (Ac-ft)	100-YR Pond Outfall (CFS)
A2	A2	61.98	0.093	2.287	4.610	64.40
B1	B1	38.38	0.048	1.503	2.868	42.45
B8	B6+B8	67.96	0.069	2.207	4.741	39.40

**THE FOUR STEP PROCESS**

The Project was designed in accordance with the four-step process to minimize adverse impacts of urbanization, as outlined in the El Paso County Engineering Manual for BMP selection as noted below:

**Step 1. Employ Runoff Reduction Practices** – The project is proposing a low-density residential development that will be designed to minimize the impact to the current existing terrain. Per Section I.7.1B of Appendix I of the ECM, the single-family residences fall under the large lot exemption as the total impervious area is less than 10% of the area. Homes are typically placed in the center of the lot and provide long distances for infiltration across natural terrain. The Site’s proposed paved roadways will increase the Site’s impervious area; however, roadside ditches and channels will be constructed to slow down the runoff velocity and reduce runoff peaks. The three proposed detention ponds will be used to capture stormwater, provide water quality treatment, and maintain flows discharging off site at or below historic levels.

**Step 2. Provide a Water Quality Capture Volume** – Permanent water quality measures and detention facilities will be necessary for the Project. Three (3) Full Spectrum Extended Detention Basins will treat the areas not excluded with either the Large Lot or 20% exclusion. Per ECM Appendix I Section I.7.B.5: Large Lot Single Family exclusion, most of the proposed site will be excluded from water quality, lot imperviousness shall be limited to 10 percent or less. Per ECM Appendix I Section 1.7.C.1.a., 20% of the development site or less than 1 acre can be excluded from providing water quality. As mentioned, 0.99 acres (43,197 sq ft) of impervious area will not be able to be treated which is less than 20% of the overall site.

**Step 3 Stabilize Drainageways**– Stabilizing proposed roadside ditches, and channels by designing them with slopes that control the flow rates. Placement of riprap upstream and downstream of culverts to help reduce erosion of the roadside ditches. Additionally, low tailwater stilling basins will be constructed in the place of traditional riprap outlet protection. The design helps prevent downstream scour and mitigates the concentrated flow, acting as a level spreader for concentrated flow in an existing drainageway. Existing drainage ways will be graded to reduce the velocity of the water to minimize erosion. The existing natural channels have been analyzed for width and velocity for the 100-yr storm event. Easements are proposed to accommodate the full width of the major storm event.

**Step 4. Implement Site Specific and Other Source Control BMPs** – The erosion control construction BMPs of the Project were designed to reduce contamination. Source control BMPs include the use of vehicle tracking control, culvert protection, stockpile management, and stabilized staging areas.

## DRAINAGE FACILITY DESIGN

### GENERAL CONCEPT

The proposed drainage patterns will match the historic patterns. To maintain historic flows, three full spectrum detention ponds are being proposed and will capture and control the flows from the proposed development at less than or equal to historic rates.

### WQCV EXCLUSION AREAS

Areas within the site do not have water quality provided. Under the ECM's Appendix I, Section 1.7.C.A, 20% of the development site or less than 1 acre can be excluded from providing water quality. The combined exclusion areas for Phase 1 sum to 0.99 acres. WQCV exclusion locations are provided in the **Appendix**.

### DRIVEWAY CULVERTS

Culverts were analyzed and sized for driveway crossings at each ditch crossing from the roadways. Refer to **Appendix** for the driveway culvert calculations.

## DRAINAGE FEES

### FEES

The project is within the Upper Black Squirrel Drainage Basin (CHBS2000), Lower Black Squirrel Drainage Basin (CHBR0400), East Kiowa Creek Drainage Basin (KIKI0400), and West Kiowa Creek Drainage Basin (BIBI0200) all four of which are not part of the El Paso County Fee Program. As such, no drainage fees are due with this Project.

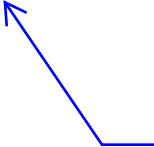
provide table with culvert driveway sizing as many of these ditches have large flows. Additionally, provide culvert sizes for lots that have drainage easements that will be crossed by driveways (example lot 34)

## SUMMARY

This report has been prepared in accordance with El Paso County stormwater criteria. It outlines the Site design for the 5-year and 100-year storm events drainage system. The drainage design presented within this report conforms to the criteria presented in the MANUAL. Additionally, as the proposed temporary sediment basin release rates are to be designed less than historic rates, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments.

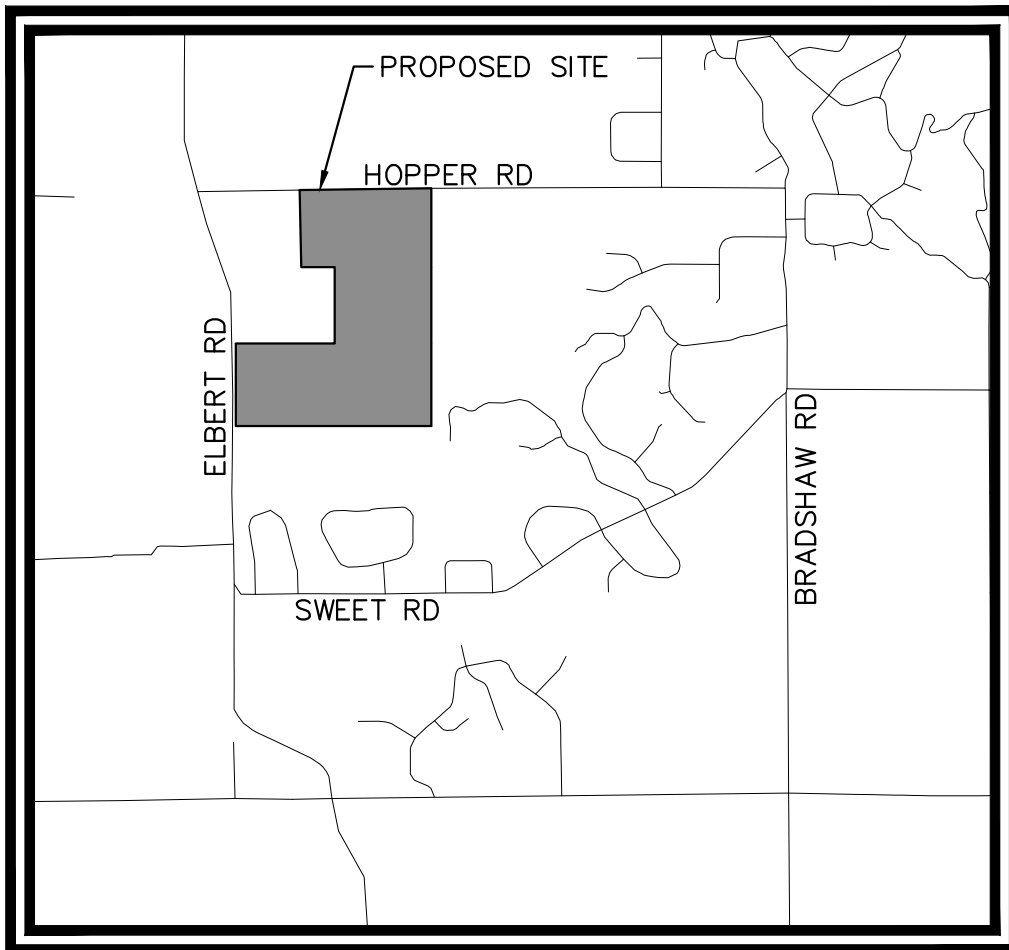
## REFERENCES

1. Final Drainage Report for Apex Ranch Estates by Terra Nova Engineering, Inc. dated September 3, 2008
2. El Paso County "Engineering Criteria Manual" Volumes 1 & 2, dated October 31, 2018
3. Natural Resources Conservation Service, Web Soil Survey, dated June 21, 2023.
4. Urban Drainage and Flood Control District Drainage Criteria Manuals (UDFCDCM), (Volumes 1, 2 and 3), prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.
5. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0350G, Effective Date December 7, 2018, prepared by the Federal Emergency Management Agency (FEMA).

 Please include preliminary and early grading projects' No., preparer, and approved date.

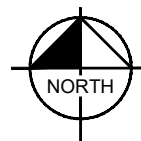
**APPENDIX**

***APPENDIX A: VICINITY MAP***



# VICINITY MAP

SCALE: 1":5000'



***APPENDIX B: FEMA MAP & SOILS REPORT***



**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 table 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.

Certain 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, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent 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, NUNCS12  
National Geodetic Survey  
SSMC-3, #9202  
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) 713-3242 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.

Please 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.

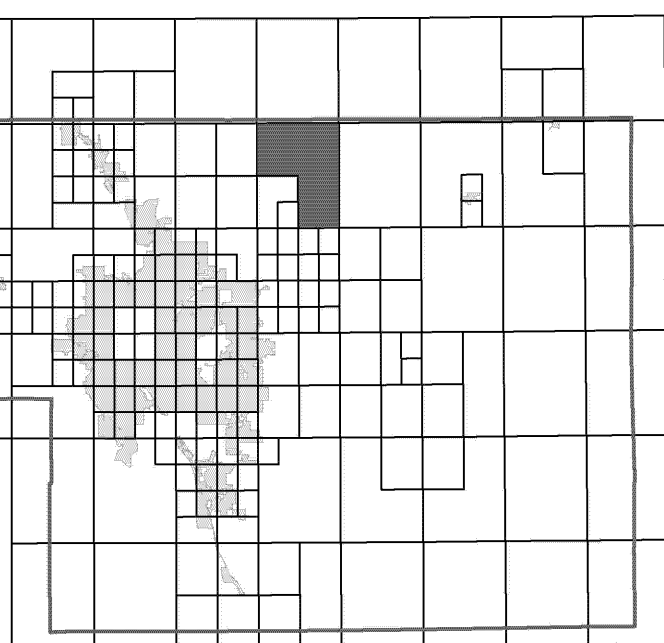
Contact **FEMA Map Service Center (MSC)** via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 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/business/nfp>.

**El Paso County Vertical Datum Offset Table**

Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

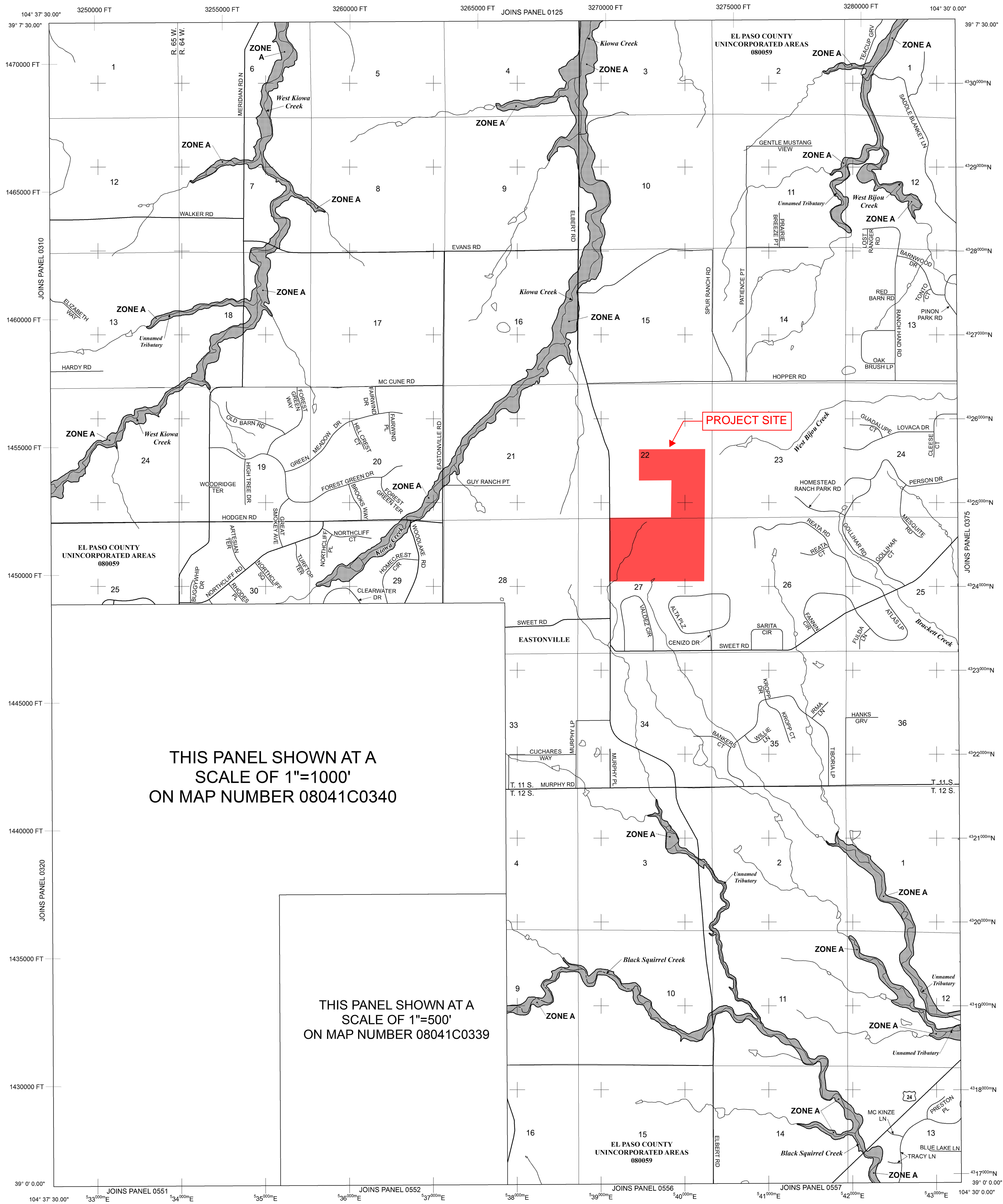
**Panel Location Map**



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.

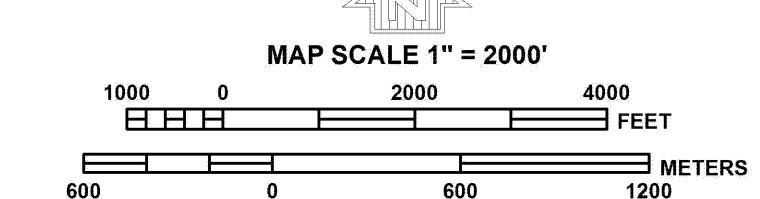


THIS PANEL SHOWN AT A  
SCALE OF 1"=1000'  
ON MAP NUMBER 08041C0340

THIS PANEL SHOWN AT A  
SCALE OF 1"=500'  
ON MAP NUMBER 08041C0339

**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 equalled 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 Zones A, AE, AH, AO, AR, A99, 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.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** 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 with drainage 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.
- Floodplain 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\* (EL 987)
- \* Referenced to the North American Vertical Datum of 1988 (NAVD 88)
- Cross section line
- Transsect line
- 57° 07' 30.00" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 42° 55' 00" 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 6000000 FT 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPS ZONE 0502), Lambert Conformal Conic Projection
- DX5510 Bench mark (see explanation in Notes to Users section of this FIRM map)
- M1.5 River Mile
- MAP REPOSITORIES**  
Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP**  
MARCH 17, 1997
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL**  
DECEMBER 7, 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 Table 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 1-800-638-6620.



**NFIP**

**PANEL 0350G**

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**FIRM**

**FLOOD INSURANCE RATE MAP**

**EL PASO COUNTY, COLORADO AND INCORPORATED AREAS**

**PANEL 350 OF 1300**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:	COMMUNITY	NUMBER	PANEL	SUFFIX
	EL PASO COUNTY	08059	0350	0

Notice to User: The Map Number shown below should be used when placing map orders. The Community Number shown above should be used on insurance applications for the subject community.

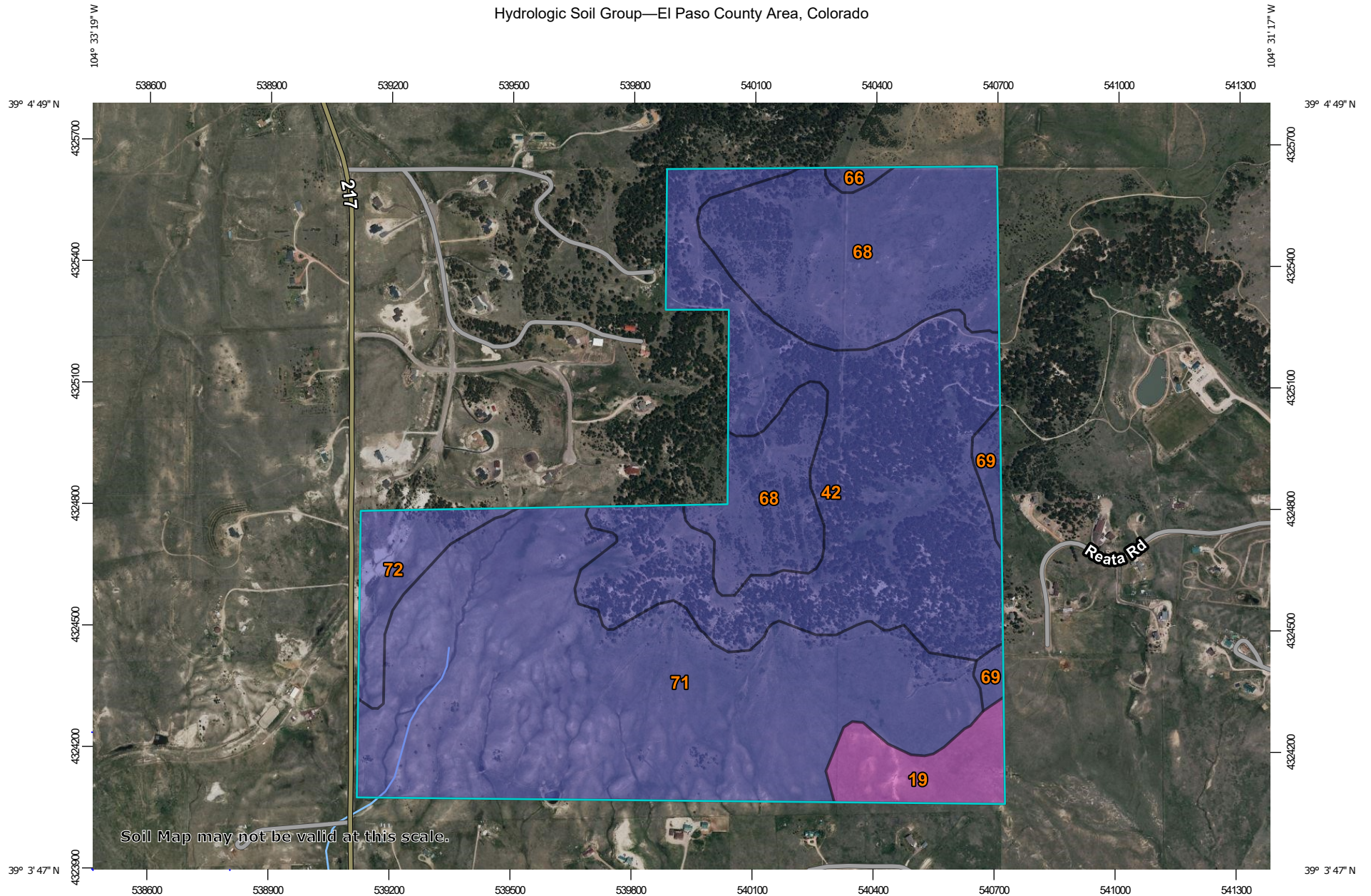
**MAP NUMBER**  
08041C0350G

**MAP REVISED**  
DECEMBER 7, 2018

Federal Emergency Management Agency

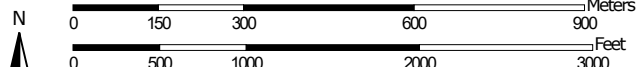


Hydrologic Soil Group—El Paso County Area, Colorado



Soil Map may not be valid at this scale.

Map Scale: 1:13,300 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 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
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	18.1	4.1%
42	Kettle-Rock outcrop complex	B	135.4	30.8%
66	Peyton sandy loam, 1 to 5 percent slopes	B	1.7	0.4%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	91.1	20.7%
69	Peyton-Pring complex, 8 to 15 percent slopes	B	5.6	1.3%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	171.8	39.0%
72	Pring coarse sandy loam, 8 to 15 percent slopes	B	16.2	3.7%
<b>Totals for Area of Interest</b>			<b>440.0</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

***APPENDIX C: HYDROLOGY***





**STANDARD FORM SF-1**  
**RUNOFF COEFFICIENTS - IMPERVIOUS CALCULATION**  
 EXISTING CONDITIONS

PROJECT NAME: Overlook  
 PROJECT NUMBER: 196239003  
 CALCULATED BY: GKS  
 CHECKED BY: KRK

DATE: 9/16/2024

SOIL: B		RESIDENTIAL (>5AC)	PASTURE/MEADOW (SOIL GROUP A/B)	PAVEMENT							
LAND USE:		AREA	AREA	AREA	AREA						
2-YEAR COEFF.		0.05	0.02	0.89							
5-YEAR COEFF.		0.12	0.08	0.90							
10-YEAR COEFF.		0.20	0.15	0.92							
100-YEAR COEFF.		0.39	0.35	0.96							
IMPERVIOUS %		7%	0%	100%							
DESIGN BASIN	DESIGN POINT	RESIDENTIAL (>5AC) AREA (AC)	PASTURE/MEADOW (SOIL GROUP A/B) AREA (AC)	PAVEMENT AREA (AC)	AREA (AC)	TOTAL AREA (AC)	C(2)	C(5)	C(10)	C(100)	Imp %
<b>FDR Basins</b>											
A1	1		18.28	1.64		19.92	0.09	0.15	0.21	0.40	8%
A2	2		63.31	0.66		63.97	0.03	0.09	0.16	0.36	1%
B1	3		43.28			43.28	0.02	0.08	0.15	0.35	0%
B2	4		42.42			42.42	0.02	0.08	0.15	0.35	0%
B3	5		25.42			25.42	0.02	0.08	0.15	0.35	0%
B3A	5A		24.23			24.23	0.02	0.08	0.15	0.35	0%
OS-A1	14		3.29	0.77		4.06	0.19	0.24	0.30	0.47	19%
OS-A2	15	4.45				4.45	0.05	0.12	0.20	0.39	7%
<b>TOTAL - OVERALL</b>		<b>4.45</b>	<b>220.23</b>	<b>3.07</b>	<b>0.00</b>	<b>227.75</b>	<b>0.03</b>	<b>0.09</b>	<b>0.16</b>	<b>0.36</b>	<b>1%</b>
		<b>2%</b>	<b>97%</b>	<b>1%</b>	<b>0%</b>	<b>100%</b>					

Note: Land use coefficients sourced from City of Colorado Springs Drainage Criteria Manual, Volume 1, Table 6-6.

**STANDARD FORM SF-2  
Time of Concentration**

PROJECT NAME: **Overlook**  
 PROJECT NUMBER: **196239003**  
 CALCULATED BY: **GKS**  
 CHECKED BY: **KRK**

EXISTING CONDITIONS

DATE: 9/16/2024

SUB-BASIN DATA			INITIAL TIME (T <sub>i</sub> )			TRAVEL TIME (T <sub>i</sub> )					T <sub>c</sub> CHECK (URBANIZED BASINS)				FINAL T <sub>c</sub>	
DESIGN BASIN (1)	AREA Ac (2)	C5 (3)	LENGTH Ft (4)	SLOPE % (5)	T <sub>i</sub> Min. (6)	LENGTH Ft. (7)	SLOPE % (8)	C <sub>v</sub> (9)	VEL fps (11)	T <sub>i</sub> Min. (12)	COMP. t <sub>c</sub> (13)	TOTAL LENGTH (14)	TOTAL SLOPE (15)	TOTAL IMP. (16)	T <sub>c</sub> Min. (17)	Min.
<b>FDR Basins</b>																
A1	19.92	0.15	300	18.0%	11.5	2,066	5.7%	2.5	0.6	57.7	69.2	2366	7.3%	8%	23.1	23.1
A2	63.97	0.09	300	18.0%	12.3	3,677	5.7%	2.5	0.6	102.7	114.9	3977	6.6%	1%	32.1	32.1
B1	43.28	0.08	300	25.0%	11.1	2,577	6.5%	2.5	0.6	67.4	78.5	2877	8.4%		26.0	26.0
B2	42.42	0.08	300	6.9%	17.0	2,347	10.3%	2.5	0.8	48.8	65.8	2647	9.9%		24.7	24.7
B3	25.42	0.08	300	23.0%	11.4	1,968	9.9%	2.5	0.8	41.7	53.1	2268	11.6%		22.6	22.6
B3A	24.23	0.08	300	20.0%	11.9	1,500	10.0%	2.5	0.8	31.6	43.6	1800	11.7%		20.0	20.0
OS-A1	4.06	0.24	300	5.0%	16.1	161	5.0%	2.5	0.6	4.8	20.9	461	5.0%	19%	12.6	12.6
OS-A2	4.45	0.12	250	10.0%	13.2			2.5			13.2	250	10.0%	7%	11.4	11.4

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_0^{0.33}} \quad t_c = \frac{L}{180} + 10 \quad V = C_v S_w^{0.5}$$

Note: Conveyance coefficient from Table 6-7 of DCM



**STANDARD FORM SF-3  
STORM DRAINAGE DESIGN - RATIONAL METHOD 2 YEAR EVENT**

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

EXISTING CONDITIONS

DATE: 9/16/2024

STORM LINE	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE		TRAVEL TIME			REMARKS	
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A (ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY		t <sub>t</sub> (min)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	1	A1	19.92	0.09	23.14	1.83	2.30	4.19													
	2	A2	63.97	0.03	32.09	1.85	1.91	3.54													
	3	B1	43.28	0.02	25.98	0.87	2.16	1.87													
	4	B2	42.42	0.02	24.71	0.85	2.22	1.88													
	5	B3	25.42	0.02	22.60	0.51	2.32	1.18													
	5A	B3A	24.23	0.02	20.00	0.48	2.47	1.20													
	14	OS-A1	4.06	0.19	12.56	0.75	3.02	2.27													
	15	OS-A2	4.45	0.05	11.39	0.22	3.14	0.70													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$$I_2 = -1.19 \ln(t_{c,min}) + 6.035$$





**STANDARD FORM SF-3  
STORM DRAINAGE DESIGN - RATIONAL METHOD 5 YEAR EVENT**

PROJECT NAME: Overlook  
 PROJECT NUMBER: 196239003  
 CALCULATED BY: GKS  
 CHECKED BY: KRK

EXISTING CONDITIONS

DATE: 9/16/2024

STORM LINE	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE		TRAVEL TIME			REMARKS	
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A (ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY		t <sub>t</sub> (min)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	1	A1	19.92	0.15	23.14	2.94	2.87	8.43													
	2	A2	63.97	0.09	32.09	5.66	2.38	13.47													
	3	B1	43.28	0.08	25.98	3.46	2.70	9.34													
	4	B2	42.42	0.08	24.71	3.39	2.77	9.41													
	5	B3	25.42	0.08	22.60	2.03	2.91	5.91													
	5A	B3A	24.23	0.08	20.00	1.94	3.09	5.99													
	14	OS-A1	4.06	0.24	12.56	0.96	3.79	3.62													
	15	OS-A2	4.45	0.12	11.39	0.53	3.93	2.10													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$$I_5 = -1.5 \ln(t_{c,min}) + 7.583$$



**STANDARD FORM SF-3  
STORM DRAINAGE DESIGN - RATIONAL METHOD 100 YEAR EVENT**

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

EXISTING CONDITIONS

DATE: 9/16/2024

STORM LINE	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A(ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCIT Y	t <sub>t</sub> (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	1	A1	19.92	0.40	23.14	7.97	4.82	38.41													
	2	A2	63.97	0.36	32.09	22.79	3.99	91.03													
	3	B1	43.28	0.35	25.98	15.15	4.53	68.56													
	4	B2	42.42	0.35	24.71	14.85	4.65	69.09													
	5	B3	25.42	0.35	22.60	8.90	4.88	43.40													
	5A	B3A	24.23	0.35	20.00	8.48	5.19	43.98													
	14	OS-A1	4.06	0.47	12.56	1.89	6.36	12.02													
	15	OS-A2	4.45	0.39	11.39	1.74	6.60	11.46													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$$I_{100} = -2.52 \ln(t_{c,min}) + 12.735$$



PROJECT NAME: Overlook  
 PROJECT NUMBER: 196239003  
 CALCULATED BY: GKS  
 CHECKED BY: KRK

9/16/2024

**EXISTING CONDITIONS RATIONAL CALCULATIONS SUMMARY**

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	CFS			% IMPERVIOUS
			Q2	Q5	Q100	
<b>FDR Basins</b>						
1	A1	19.92	4.19	8.43	38.41	8%
2	A2	63.97	3.54	13.47	91.03	1%
3	B1	43.28	1.87	9.34	68.56	0%
4	B2	42.42	1.88	9.41	69.09	0%
5	B3	25.42	1.18	5.91	43.40	0%
5A	B3A	24.23	1.20	5.99	43.98	0%
14	OS-A1	4.06	2.27	3.62	12.02	19%
15	OS-A2	4.45	0.70	2.10	11.46	7%
<b>ON-SITE BASIN TOTAL</b>						
BASIN A TOTAL		83.89	7.73	21.90	129.44	3%
BASIN B TOTAL		135.35	6.13	30.64	225.03	0%
<b>ON-SITE TOTAL</b>		<b>219.24</b>	<b>13.86</b>	<b>52.55</b>	<b>354.46</b>	<b>1%</b>
<b>OFF-SITE BASIN TOTAL</b>						
OFF-SITE BASIN A		8.51	2.97	5.72	23.48	13%
<b>OFF-SITE TOTAL</b>		<b>8.51</b>	<b>2.97</b>	<b>5.72</b>	<b>23.48</b>	<b>13%</b>
<b>SITE TOTAL</b>		<b>227.75</b>	<b>16.83</b>	<b>58.27</b>	<b>377.95</b>	<b>1%</b>



**STANDARD FORM SF-1**  
**RUNOFF COEFFICIENTS - IMPERVIOUS CALCULATION**  
 PROPOSED CONDITIONS

PROJECT NAME: Overlook  
 PROJECT NUMBER: 196239003  
 CALCULATED BY: GKS  
 CHECKED BY: KRK

DATE: 9/16/2024

SOIL: B											
		RESIDENTIAL (>5AC)	PASTURE/MEADOW (SOIL GROUP A/B)	PAVEMENT							
<u>LAND USE:</u>		<u>AREA</u>	<u>AREA</u>	<u>AREA</u>	<u>AREA</u>						
2-YEAR COEFF.		0.05	0.02	0.89							
5-YEAR COEFF.		0.12	0.08	0.90							
10-YEAR COEFF.		0.20	0.15	0.92							
100-YEAR COEFF.		0.39	0.35	0.96							
IMPERVIOUS %		7%	0%	100%							
DESIGN BASIN	DESIGN POINT	RESIDENTIAL (>5AC) <u>AREA</u> (AC)	PASTURE/MEADOW (SOIL GROUP A/B) <u>AREA</u> (AC)	PAVEMENT <u>AREA</u> (AC)	<u>AREA</u> (AC)	TOTAL AREA (AC)	C(2)	C(5)	C(10)	C(100)	Imp %
<b>FDR Basins</b>											
A1	1	17.91		1.64		<b>19.55</b>	0.12	0.19	0.26	0.44	15%
A2	2	59.76		2.22		<b>61.98</b>	0.08	0.15	0.23	0.41	10%
B1	3	37.03		1.35		<b>38.38</b>	0.08	0.15	0.23	0.41	10%
B2	4	15.57		0.24		<b>15.81</b>	0.06	0.13	0.21	0.40	8%
B3	5	19.11				<b>19.11</b>	0.05	0.12	0.20	0.39	7%
B6	8	49.92		2.23		<b>52.15</b>	0.09	0.15	0.23	0.41	11%
B7	9	2.46				<b>2.46</b>	0.05	0.12	0.20	0.39	7%
B8	10	9.52				<b>9.52</b>	0.05	0.12	0.20	0.39	7%
OS-A1	18	3.29		0.77		<b>4.06</b>	0.21	0.27	0.34	0.50	25%
OS-A2	19	3.14				<b>3.14</b>	0.05	0.12	0.20	0.39	7%
OS-A3	20	1.22		0.09		<b>1.31</b>	0.11	0.17	0.25	0.43	13%
<b>TOTAL - OVERALL</b>		<b>217.71</b>	<b>0.00</b>	<b>8.45</b>	<b>0.00</b>	<b>226.16</b>	0.08	0.15	0.23	0.41	10%
		<b>96%</b>	<b>0%</b>	<b>4%</b>	<b>0%</b>	<b>100%</b>					

Note: Land use coefficients sourced from City of Colorado Springs Drainage Criteria Manual, Volume 1, Table 6-6.

**STANDARD FORM SF-2  
Time of Concentration**

PROJECT NAME: **Overlook**  
 PROJECT NUMBER: **196239003**  
 CALCULATED BY: **GKS**  
 CHECKED BY: **KRK**

PROPOSED CONDITIONS

DATE: 9/16/2024

SUB-BASIN DATA			INITIAL TIME (T <sub>i</sub> )			TRAVEL TIME (T <sub>t</sub> )					T <sub>c</sub> CHECK (URBANIZED BASINS)				FINAL T <sub>c</sub>	
DESIGN BASIN (1)	AREA Ac (2)	C5 (3)	LENGTH Ft (4)	SLOPE % (5)	T <sub>i</sub> Min. (6)	LENGTH Ft (7)	SLOPE % (8)	C <sub>v</sub> (9)	VEL fps (11)	T <sub>t</sub> Min. (12)	COMP. t <sub>c</sub> (13)	TOTAL LENGTH (14)	TOTAL SLOPE (15)	TOTAL IMP. (16)	T <sub>c</sub> Min. (17)	Min.
<b>FDR Basins</b>																
A1	19.55	0.19	300	18.0%	11.1	2,066	5.0%	2.5	0.6	61.6	72.7	2366	6.6%	15%	23.1	23.1
A2	61.98	0.15	300	18.0%	11.5	4,100	4.0%	2.5	0.5	136.7	148.2	4400	5.0%	10%	34.4	34.4
B1	38.38	0.15	300	8.0%	15.1	2,000	4.5%	2.5	0.5	62.9	78.0	2300	5.0%	10%	22.8	22.8
B2	15.81	0.13	300	7.0%	16.1	500	6.0%	2.5	0.6	13.6	29.7	800	6.4%	8%	14.4	14.4
B3	19.11	0.12	300	21.0%	11.3	800	8.0%	2.5	0.7	18.9	30.1	1100	11.5%	7%	16.1	16.1
B6	52.15	0.15	300	22.0%	10.7	1,900	3.0%	2.5	0.4	73.1	83.9	2200	5.6%	11%	22.2	22.2
B7	2.46	0.12	300	6.0%	17.1	100	6.0%	2.2	0.5	3.1	20.2	400	6.0%	7%	12.2	12.2
B8	9.52	0.12	300	6.0%	17.1	300	10.0%	2.5	0.8	6.3	23.5	600	8.0%	7%	13.3	13.3
OS-A1	4.06	0.27	300	5.0%	15.5	161	5.0%	2.5	0.6	4.8	20.3	461	5.0%	25%	12.6	12.6
OS-A2	3.14	0.12	250	10.0%	13.2			2.5			13.2	250	10.0%	7%	11.4	11.4
OS-A3	1.31	0.17	300	13.0%	12.5			2.5			12.5	300	13.0%	13%	11.7	11.7

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_0^{0.33}} \quad t_c = \frac{L}{180} + 10 \quad V = C_v S_w^{0.5}$$

Note: Conveyance coefficient from Table 6-7 of DCM



**STANDARD FORM SF-3  
STORM DRAINAGE DESIGN - RATIONAL METHOD 2 YEAR EVENT**

PROJECT NAME: Overlook  
 PROJECT NUMBER: 196239003  
 CALCULATED BY: GKS  
 CHECKED BY: KRK

PROPOSED CONDITIONS

DATE: 9/16/2024

STORM LINE	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE		TRAVEL TIME			REMARKS	
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A(ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY		t <sub>t</sub> (min)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	1	A1	19.55	0.12	23.14	2.36	2.30	5.41													
	2	A2	61.98	0.08	34.44	4.96	1.82	9.05													
	3	B1	38.38	0.08	22.78	3.05	2.32	7.07													
	4	B2	15.81	0.06	14.44	0.99	2.86	2.83													
	5	B3	19.11	0.05	16.11	0.96	2.73	2.61													
	8	B6	52.15	0.09	22.22	4.48	2.34	10.51													
	9	B7	2.46	0.05	12.22	0.12	3.06	0.38													
	10	B8	9.52	0.05	13.33	0.48	2.95	1.41													
	18	OS-A1	4.06	0.21	12.56	0.85	3.02	2.57													
	19	OS-A2	3.14	0.05	11.39	0.16	3.14	0.49													
	20	OS-A3	1.31	0.11	11.67	0.14	3.11	0.43													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$$I_2 = -1.19 \ln(t_{c,min}) + 6.035$$



**STANDARD FORM SF-3  
STORM DRAINAGE DESIGN - RATIONAL METHOD 5 YEAR EVENT**

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

PROPOSED CONDITIONS

DATE: 9/16/2024

STORM LINE	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE		TRAVEL TIME			REMARKS	
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A(ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY		t <sub>t</sub> (min)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	1	A1	19.55	0.19	23.14	3.63	2.87	10.41													
	2	A2	61.98	0.15	34.44	9.17	2.27	20.85													
	3	B1	38.38	0.15	22.78	5.66	2.89	16.38													
	4	B2	15.81	0.13	14.44	2.08	3.58	7.46													
	5	B3	19.11	0.12	16.11	2.29	3.41	7.83													
	8	B6	52.15	0.15	22.22	8.00	2.93	23.44													
	9	B7	2.46	0.12	12.22	0.30	3.83	1.13													
	10	B8	9.52	0.12	13.33	1.14	3.70	4.22													
	18	OS-A1	4.06	0.27	12.56	1.09	3.79	4.12													
	19	OS-A2	3.14	0.12	11.39	0.38	3.93	1.48													
	20	OS-A3	1.31	0.17	11.67	0.22	3.90	0.87													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$$I_5 = -1.5 \ln(t_{c,min}) + 7.583$$



**STANDARD FORM SF-3  
STORM DRAINAGE DESIGN - RATIONAL METHOD 100 YEAR EVENT**

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

PROPOSED CONDITIONS

DATE: 9/16/2024

STORM LINE	DESIGN POINT	DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
		DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A(ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCIT Y	t <sub>t</sub> (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	1	A1	19.55	0.44	23.14	8.56	4.82	41.24													
	2	A2	61.98	0.41	34.44	25.44	3.82	97.07													
	3	B1	38.38	0.41	22.78	15.74	4.86	76.45													
	4	B2	15.81	0.40	14.44	6.30	6.01	37.85													
	5	B3	19.11	0.39	16.11	7.45	5.73	42.71													
	8	B6	52.15	0.41	22.22	21.61	4.92	106.32													
	9	B7	2.46	0.39	12.22	0.96	6.43	6.17													
	10	B8	9.52	0.39	13.33	3.71	6.21	23.05													
	18	OS-A1	4.06	0.50	12.56	2.02	6.36	12.86													
	19	OS-A2	3.14	0.39	11.39	1.22	6.60	8.09													
	20	OS-A3	1.31	0.43	11.67	0.56	6.54	3.65													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$$I_{100} = -2.52 \ln(t_{c,min}) + 12.735$$





PROJECT NAME: Overlook  
 PROJECT NUMBER: 196239003  
 CALCULATED BY: GKS  
 CHECKED BY: KRK

9/16/2024

**PROPOSED CONDITIONS RATIONAL CALCULATIONS SUMMARY**

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	CFS			% IMPERVIOUS	DETAINED 100 YR OUTFLOW (CFS)
			Q2	Q5	Q100		
<b>Basins</b>							
1	A1	19.55	5.41	10.41	41.24	15%	
2	A2	61.98	9.05	20.85	97.07	10%	
EDB A2	A2						64.40
3	B1	38.38	7.07	16.38	76.45	10%	
EDB B1	B1						42.45
4	B2	15.81	2.83	7.46	37.85	8%	
5	B3	19.11	2.61	7.83	42.71	7%	
8	B6	52.15	10.51	23.44	106.32	11%	
9	B7	2.46	0.38	1.13	6.17	7%	
10	B8	9.52	1.41	4.22	23.05	7%	
EDB B8	B6+B8						39.40
18	OS-A1	4.06	2.57	4.12	12.86	25%	
19	OS-A2	3.14	0.49	1.48	8.09	7%	
20	OS-A3	1.31	0.43	0.87	3.65	13%	
<b>ON-SITE BASIN TOTAL</b>							
BASIN A TOTAL		81.53	14.46	31.26	138.30	11%	
BASIN B TOTAL		137.43	24.80	60.46	292.55	10%	
<b>ON-SITE TOTAL</b>		<b>218.96</b>	<b>39.25</b>	<b>91.72</b>	<b>430.86</b>	<b>10%</b>	
<b>OFF-SITE BASIN TOTAL</b>							
OFF-SITE BASIN A		8.51	3.49	6.47	24.60	16%	
<b>OFF-SITE TOTAL</b>		<b>8.51</b>	<b>3.49</b>	<b>6.47</b>	<b>24.60</b>	<b>16%</b>	
<b>SITE TOTAL</b>		<b>8.51</b>	<b>42.74</b>	<b>98.19</b>	<b>455.46</b>	<b>10%</b>	

***APPENDIX D: HYDRUALICS***

Add calculations for forebays, forebay notches, trickle channel.

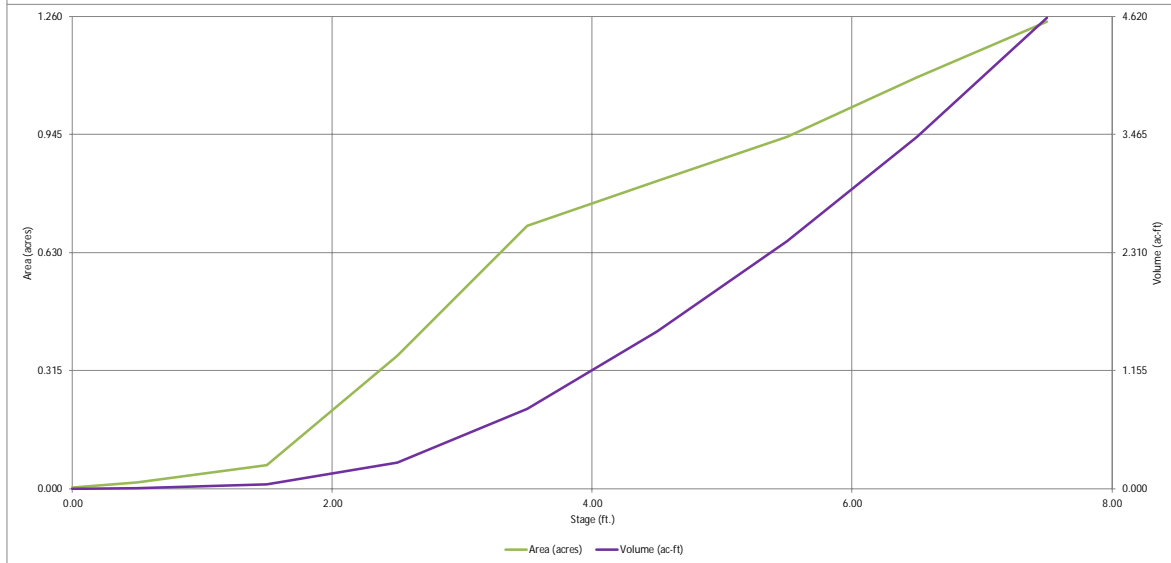
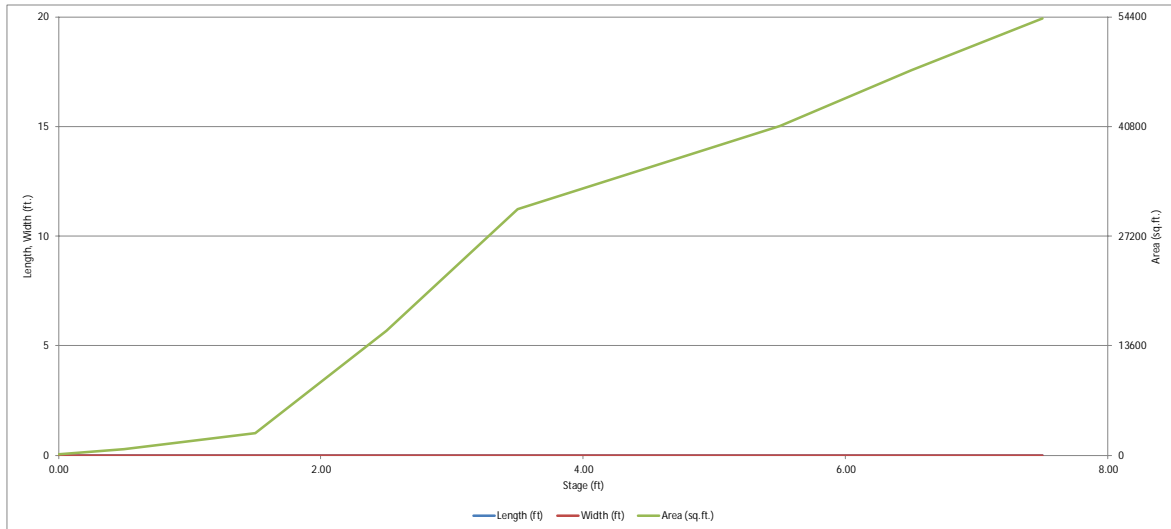
Please provide forebay design calculations. The minimum forebay volumes are shown on MHFD T-5 Table EDB-4. The minimum forebay volume should be 1-3% of the undetained peak 100-year discharge, depending on the tributary impervious acreage. And the forebay outlet should release 2% of the undetained peak 100-year discharge

Per DCMv2 – Chap 4.2, trickle channel should at a minimum provide capacity equal to twice the release capacity at the upstream forebay outlet. Provide these calcs in the drainage report and revise plans as needed.



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



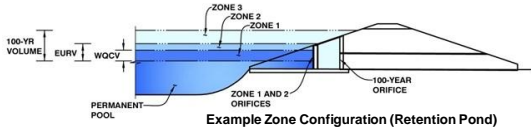
- ✓ = calcs match details in plans
- ✗ = calcs do not match details in plans

## DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD- Detention, Version 4.06 (July 2022)

Project: Overlook A2 Filling No. 1

Basin ID: \_\_\_\_\_



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WOCV)	1.91	0.093	Orifice Plate
Zone 2 (EURV)	3.20	0.490	Rectangular Orifice
Zone 3 (100-year)	5.36	1.704	Weir&Pipe (Restrict)
<b>Total (all zones)</b>	<b>2.287</b>		

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft <sup>2</sup>
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WO Orifice Area per Row =	N/A	ft <sup>2</sup>
Depth at top of Zone using Orifice Plate =	1.43	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft <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	0.25	1.00					
Orifice Area (sq. inches)	0.34	0.34	0.34					
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected		Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.05	ft <sup>2</sup>
Depth at top of Zone using Vertical Orifice =	3.20	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	feet
Vertical Orifice Height =	2.00	N/A	inches			
Vertical Orifice Width =	3.50	N/A	inches			

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

	Zone 3 Weir	Not Selected		Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.21	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Gate Upper Edge, H <sub>1</sub> =	3.21	feet
Overflow Weir Front Edge Length =	23.00	N/A	feet	Overflow Weir Slope Length =	5.00	feet
Overflow Weir Gate Slope =	0.00	N/A	H:V	Gate Open Area / 100-yr Orifice Area =	14.09	N/A
Horiz. Length of Weir Sides =	5.00	N/A	feet	Overflow Gate Open Area w/o Debris =	80.04	ft <sup>2</sup>
Overflow Gate Type =	Type C Gate	N/A		Overflow Gate Open Area w/ Debris =	40.02	ft <sup>2</sup>
Debris Clogging % =	50%	N/A	%			

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

	Zone 3 Restrictor	Not Selected		Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	5.68	ft <sup>2</sup>
Outlet Pipe Diameter =	42.00	N/A	inches	Outlet Orifice Centroid =	1.14	feet
Restrictor Plate Height Above Pipe Invert =	24.00	N/A	inches	Half-Central Angle of Restrictor Plate on Pipe =	1.71	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

				Zone 3 Restrictor	Not Selected	
Spillway Invert Stage =	5.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth =	0.91	feet	
Spillway Crest Length =	30.00	feet	Stage at Top of Freeboard =	7.41	feet	
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.23	acres	
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	4.50	acre-ft	

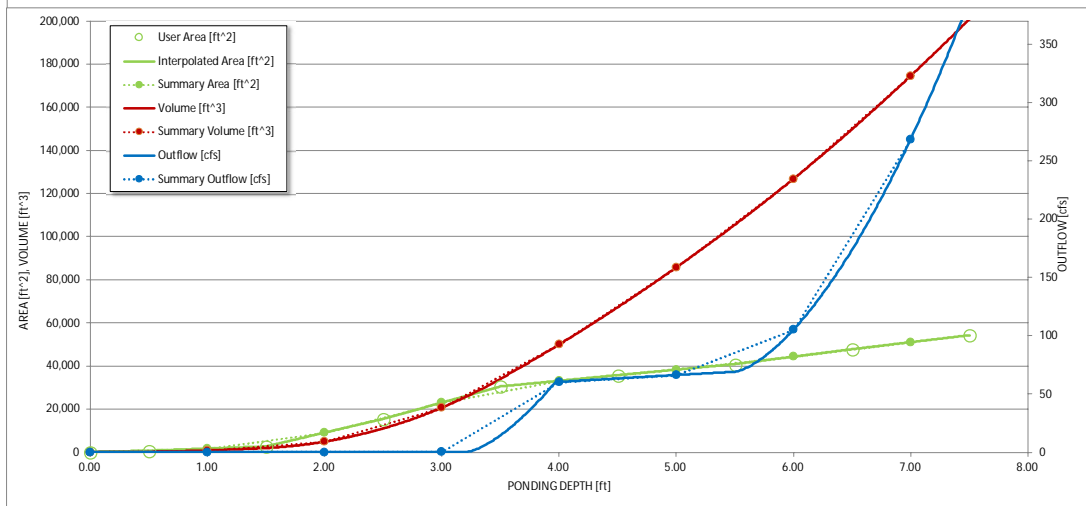
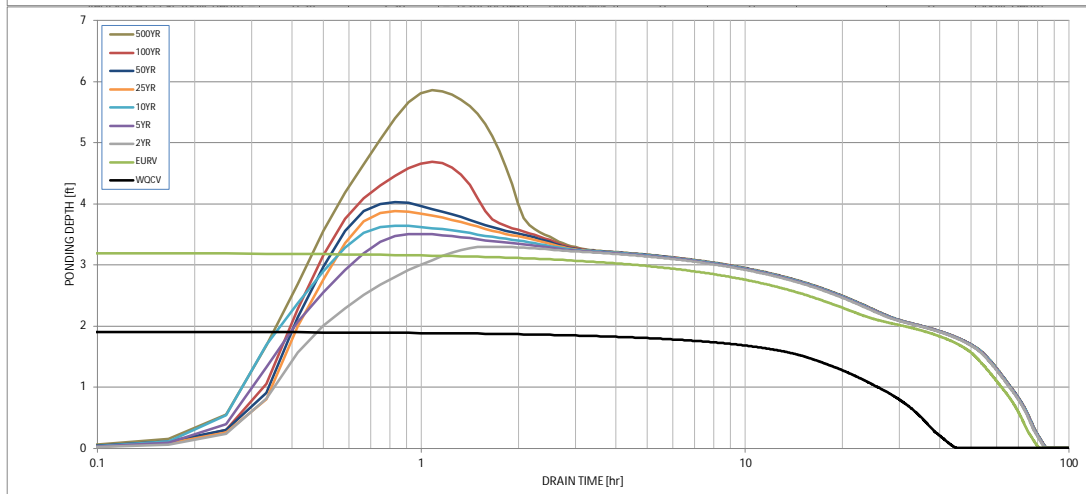
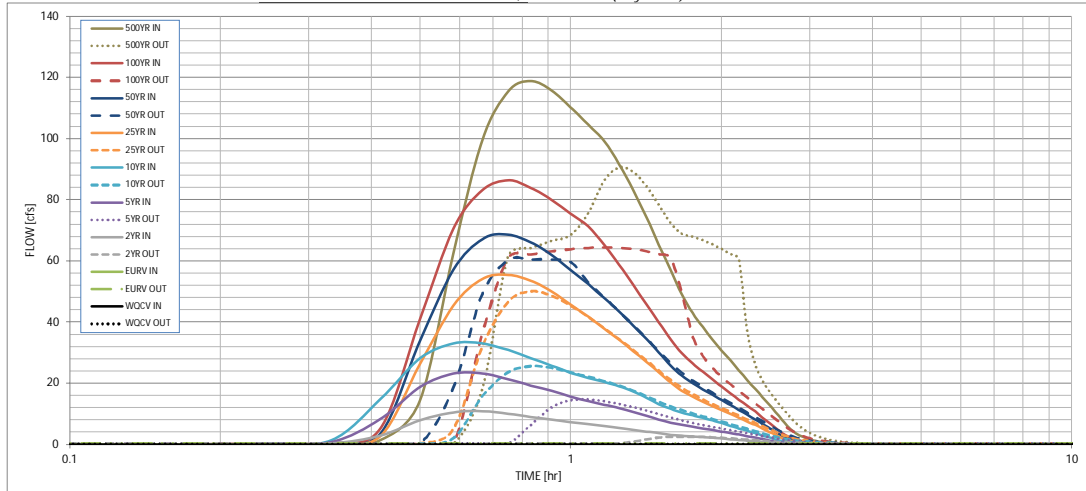
### Routed Hydrograph Results

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

	WOCV	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	3.14
One-Hour Rainfall Depth (in)	N/A	N/A	0.827	1.827	2.824	4.601	5.814	7.559	10.741
CUHP Runoff Volume (acre-ft)	0.093	0.583	0.827	1.827	2.824	4.601	5.814	7.559	10.741
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.827	1.827	2.824	4.601	5.814	7.559	10.741
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	6.8	18.9	28.6	51.3	64.4	81.9	114.1
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.11	0.30	0.46	0.83	1.04	1.32	1.84
Peak Inflow Q (cfs)	N/A	N/A	10.8	23.2	33.0	55.4	68.5	86.3	118.8
Peak Outflow Q (cfs)	0.0	0.3	2.6	14.7	25.5	50.0	60.5	64.4	90.5
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.8	0.9	1.0	0.9	0.8	0.8
Structure Controlling Flow	Plate	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps)	N/A	N/A	0.03	0.2	0.3	0.6	0.8	0.8	0.9
Max Velocity through Gate 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	63	63	52	43	29	25	21	16
Time to Drain 99% of Inflow Volume (hours)	41	71	73	66	62	55	51	46	36
Maximum Ponding Depth (ft)	1.91	3.20	3.30	3.50	3.64	3.88	4.02	4.68	5.85
Area at Maximum Ponding Depth (acres)	0.18	0.60	0.63	0.70	0.72	0.75	0.76	0.84	0.99
Maximum Volume Stored (acre-ft)	0.095	0.586	0.642	0.781	0.873	1.056	1.162	1.691	2.759

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			



## DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

### Inflow Hydrographs

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

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	0.03
	0:15:00	0.00	0.00	0.08	0.13	0.16	0.11	0.14	0.13	0.21
	0:20:00	0.00	0.00	0.32	0.78	1.38	0.33	0.39	0.41	1.32
	0:25:00	0.00	0.00	2.81	8.24	14.68	2.68	3.51	5.13	14.36
	0:30:00	0.00	0.00	7.86	18.77	28.11	26.22	33.92	40.85	62.27
	0:35:00	0.00	0.00	10.46	23.11	32.99	45.24	56.97	70.39	99.65
	0:40:00	0.00	0.00	10.84	23.20	32.96	54.09	67.15	83.11	115.36
	0:45:00	0.00	0.00	10.05	21.33	30.80	55.39	68.49	86.32	118.83
	0:50:00	0.00	0.00	8.97	19.26	28.17	53.50	66.07	83.88	115.59
	0:55:00	0.00	0.00	8.08	17.41	25.71	49.93	61.91	79.85	110.27
	1:00:00	0.00	0.00	7.26	15.60	23.43	45.70	56.98	75.42	104.47
	1:05:00	0.00	0.00	6.59	14.14	21.71	41.75	52.38	71.23	99.16
	1:10:00	0.00	0.00	5.98	12.98	20.34	37.85	47.82	65.25	91.57
	1:15:00	0.00	0.00	5.37	11.81	19.02	34.15	43.42	58.71	83.23
	1:20:00	0.00	0.00	4.78	10.57	17.27	30.51	38.89	52.13	74.21
	1:25:00	0.00	0.00	4.19	9.31	15.24	26.97	34.39	45.79	65.25
	1:30:00	0.00	0.00	3.62	8.08	13.18	23.50	30.00	39.85	56.80
	1:35:00	0.00	0.00	3.13	7.08	11.56	20.12	25.73	34.20	48.99
	1:40:00	0.00	0.00	2.80	6.35	10.41	17.52	22.50	29.86	42.99
	1:45:00	0.00	0.00	2.55	5.75	9.46	15.57	20.05	26.56	38.33
	1:50:00	0.00	0.00	2.34	5.20	8.61	13.95	18.01	23.74	34.32
	1:55:00	0.00	0.00	2.12	4.68	7.78	12.51	16.18	21.22	30.73
	2:00:00	0.00	0.00	1.90	4.18	6.94	11.21	14.51	18.92	27.43
	2:05:00	0.00	0.00	1.68	3.67	6.07	9.93	12.85	16.69	24.20
	2:10:00	0.00	0.00	1.45	3.16	5.23	8.68	11.23	14.58	21.10
	2:15:00	0.00	0.00	1.23	2.66	4.41	7.48	9.67	12.61	18.21
	2:20:00	0.00	0.00	1.01	2.18	3.63	6.29	8.15	10.69	15.40
	2:25:00	0.00	0.00	0.79	1.70	2.88	5.13	6.66	8.79	12.66
	2:30:00	0.00	0.00	0.58	1.23	2.16	3.98	5.19	6.89	9.94
	2:35:00	0.00	0.00	0.38	0.78	1.46	2.83	3.74	5.01	7.26
	2:40:00	0.00	0.00	0.22	0.48	1.02	1.74	2.35	3.23	4.85
	2:45:00	0.00	0.00	0.15	0.34	0.78	1.10	1.55	2.14	3.36
	2:50:00	0.00	0.00	0.11	0.26	0.61	0.71	1.05	1.45	2.37
	2:55:00	0.00	0.00	0.09	0.21	0.48	0.47	0.73	0.97	1.64
	3:00:00	0.00	0.00	0.07	0.16	0.38	0.30	0.49	0.62	1.11
	3:05:00	0.00	0.00	0.05	0.13	0.29	0.21	0.35	0.38	0.72
	3:10:00	0.00	0.00	0.04	0.10	0.22	0.14	0.23	0.21	0.44
	3:15:00	0.00	0.00	0.03	0.07	0.16	0.09	0.16	0.11	0.27
	3:20:00	0.00	0.00	0.03	0.05	0.11	0.06	0.12	0.08	0.19
	3:25:00	0.00	0.00	0.02	0.04	0.08	0.05	0.08	0.06	0.14
	3:30:00	0.00	0.00	0.02	0.03	0.06	0.03	0.06	0.05	0.11
	3:35:00	0.00	0.00	0.01	0.02	0.04	0.02	0.05	0.04	0.09
	3:40:00	0.00	0.00	0.01	0.01	0.03	0.02	0.04	0.03	0.07
	3:45:00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.02	0.05
	3:50:00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.03
	3:55:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



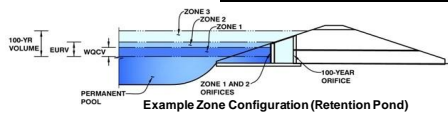
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Overlook B1 Filing No. 1

Basin ID: \_\_\_\_\_

See comments on previous pond calc sheet



Watershed Information

Selected BMP Type =	EDB
Watershed Area =	40.74 acres
Watershed Length =	3,000 ft
Watershed Length to Centroid =	1,500 ft
Watershed Slope =	0.045 ft/ft
Watershed Imperviousness =	10.00% percent
Percentage Hydrologic Soil Group A =	0.0% percent
Percentage Hydrologic Soil Group B =	100.0% percent
Percentage Hydrologic Soil Groups C/D =	0.0% percent
Target WQC Drain Time =	40.0 hours
Location for 1-hr Rainfall Depths =	User Input

After providing required inputs above including 1-hour rainfall depths, click "Run CUHP" to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

Water Quality Capture Volume (WOCV) =	0.048 acre-feet	0.048 acre-feet
Excess Urban Runoff Volume (EURV) =	0.383 acre-feet	0.383 acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.544 acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.202 acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.858 acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	3.027 acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.825 acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	4.973 acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	7.066 acre-feet	3.14 inches
Approximate 2-yr Detention Volume =	0.244 acre-feet	
Approximate 5-yr Detention Volume =	0.383 acre-feet	
Approximate 10-yr Detention Volume =	0.796 acre-feet	
Approximate 25-yr Detention Volume =	1.112 acre-feet	
Approximate 50-yr Detention Volume =	1.163 acre-feet	
Approximate 100-yr Detention Volume =	1.503 acre-feet	

Define Zones and Basin Geometry

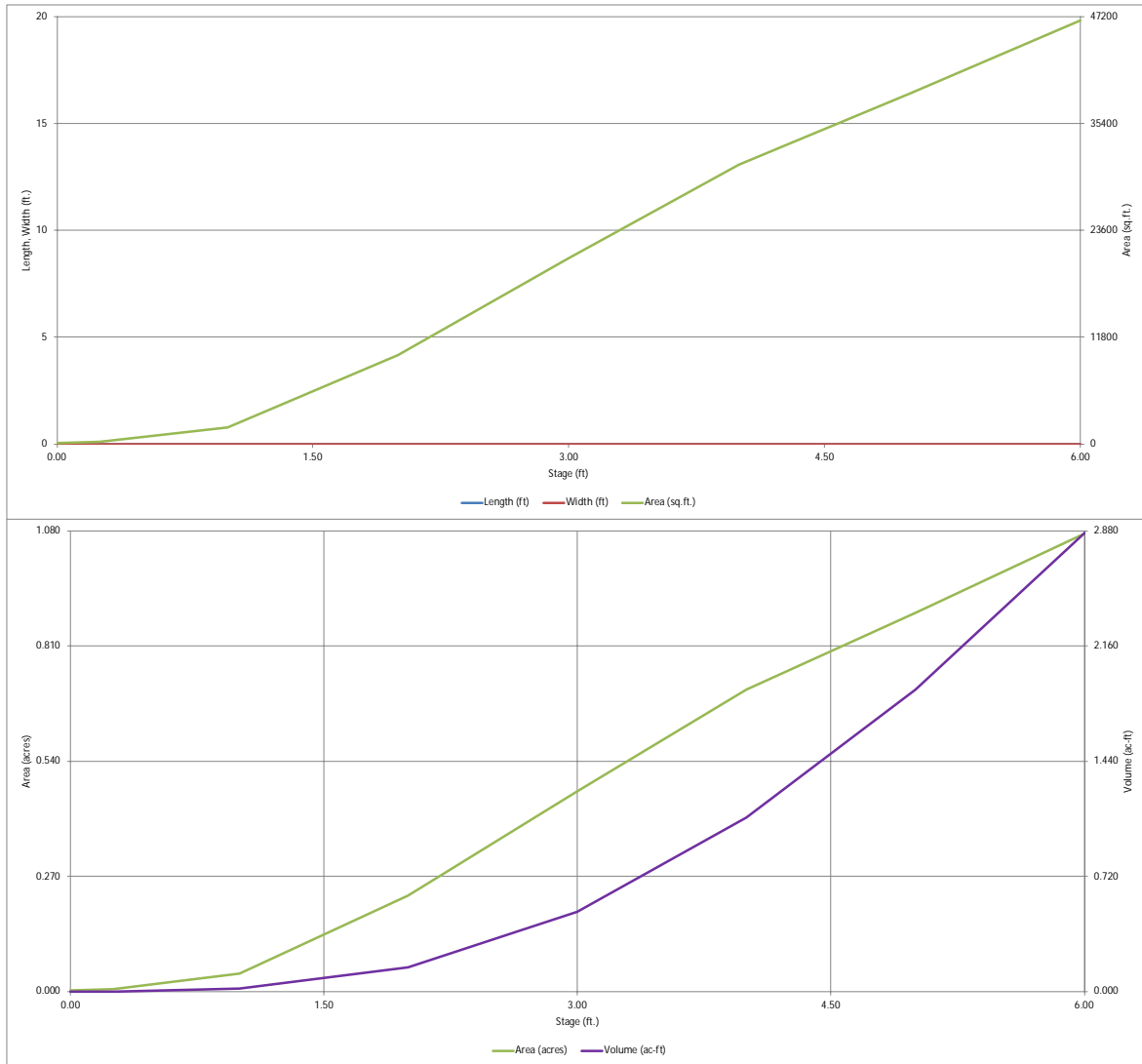
Zone 1 Volume (WOCV) =	0.048 acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.335 acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.120 acre-feet
Total Detention Basin Volume =	1.503 acre-feet
Initial Surcharge Volume (ISV) =	user ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	user ft
Total Available Detention Depth (H <sub>total</sub> ) =	user ft
Depth of Trickle Channel (H <sub>tc</sub> ) =	user ft
Slope of Trickle Channel (S <sub>tc</sub> ) =	user ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	user H:V
Basin Length-to-Width Ratio (R <sub>LRW</sub> ) =	user
Initial Surcharge Area (A <sub>ISV</sub> ) =	user ft <sup>2</sup>
Surcharge Volume Length (L <sub>ISV</sub> ) =	user ft
Surcharge Volume Width (W <sub>ISV</sub> ) =	user ft
Depth of Basin Floor (H <sub>FLOOR</sub> ) =	user ft
Length of Basin Floor (L <sub>FLOOR</sub> ) =	user ft
Width of Basin Floor (W <sub>FLOOR</sub> ) =	user ft
Area of Basin Floor (A <sub>FLOOR</sub> ) =	user ft <sup>2</sup>
Volume of Basin Floor (V <sub>FLOOR</sub> ) =	user ft <sup>3</sup>
Depth of Main Basin (H <sub>MAIN</sub> ) =	user ft
Length of Main Basin (L <sub>MAIN</sub> ) =	user ft
Width of Main Basin (W <sub>MAIN</sub> ) =	user ft
Area of Main Basin (A <sub>MAIN</sub> ) =	user ft <sup>2</sup>
Volume of Main Basin (V <sub>MAIN</sub> ) =	user ft <sup>3</sup>
Calculated Total Basin Volume (V <sub>total</sub> ) =	user acre-feet

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft <sup>2</sup> )	Optional Override Area (ft <sup>2</sup> )	Area (acre)	Volume (ft <sup>3</sup> )	Volume (ac-ft)
Top of Mainpool	--	0.00	--	--	--	139	0.003	--	--
		0.25				223	0.005	45	0.001
		1.00				1,816	0.042	810	0.019
		2.00				9,806	0.225	6,621	0.152
		3.00				20,473	0.470	21,760	0.500
		4.00				30,839	0.708	47,416	1.089
		5.00				38,709	0.889	82,190	1.887
		6.00				46,803	1.074	124,946	2.868

Fill out stage column

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

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

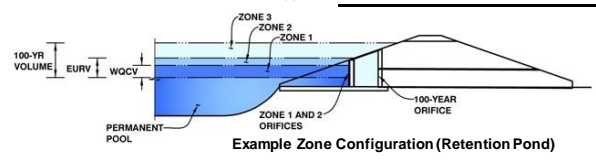


- ✓ = calcs match details in plans
- ✗ = calcs do not match details in plans

## DETENTION BASIN OUTLET STRUCTURE DESIGN

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

Project: Overlook B1 Filing No. 1  
 Basin ID: \_\_\_\_\_



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.39	0.048	Orifice Plate
Zone 2 (EURV)	2.74	0.335	Rectangular Orifice
Zone 3 (100-year)	4.55	1.120	Weir&Pipe (Restrict)
<b>Total (all zones)</b>		<b>1.503</b>	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft <sup>2</sup>
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WO Orifice Area per Row =	1.736E-03	ft <sup>2</sup>
Depth at top of Zone using Orifice Plate =	1.39	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	5.60	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.25	sq. inches (diameter = 9/16 inch)	Elliptical Slot Area =	N/A	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	0.46	0.93					
Orifice Area (sq. inches)	0.25	0.25	0.25					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected		Zone 2 Rectangular	Not Selected
Invert of Vertical Orifice =	1.39	N/A	ft (relative to basin bottom at Stage = 0 ft)	0.03	N/A
Depth at top of Zone using Vertical Orifice =	2.74	N/A	ft (relative to basin bottom at Stage = 0 ft)	0.08	N/A
Vertical Orifice Height =	2.00	N/A	inches		
Vertical Orifice Width =	2.25	N/A	inches		

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

	Zone 3 Weir	Not Selected		Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	2.75	N/A	ft (relative to basin bottom at Stage = 0 ft)	3.25	N/A
Overflow Weir Front Edge Length =	23.00	N/A	feet	5.02	N/A
Overflow Weir Gate Slope =	10.00	N/A	H:V	16.07	N/A
Horiz. Length of Weir Sides =	5.00	N/A	feet	80.44	N/A
Overflow Gate Type =	Type C Gate	N/A		40.22	N/A
Debris Clogging % =	50%	N/A	%		

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

	Zone 3 Restrictor	Not Selected		Zone 3 Restrictor	Not Selected
Depth to Invert of Outlet Pipe =	1.42	N/A	ft (distance below basin bottom at Stage = 0 ft)	5.01	N/A
Outlet Pipe Diameter =	36.00	N/A	inches	1.12	N/A
Restrictor Plate Height Above Pipe Invert =	24.00	N/A	inches	1.91	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	4.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth =	0.61	feet
Spillway Crest Length =	30.00	feet	Stage at Top of Freeboard =	5.61	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.00	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	2.46	acre-ft

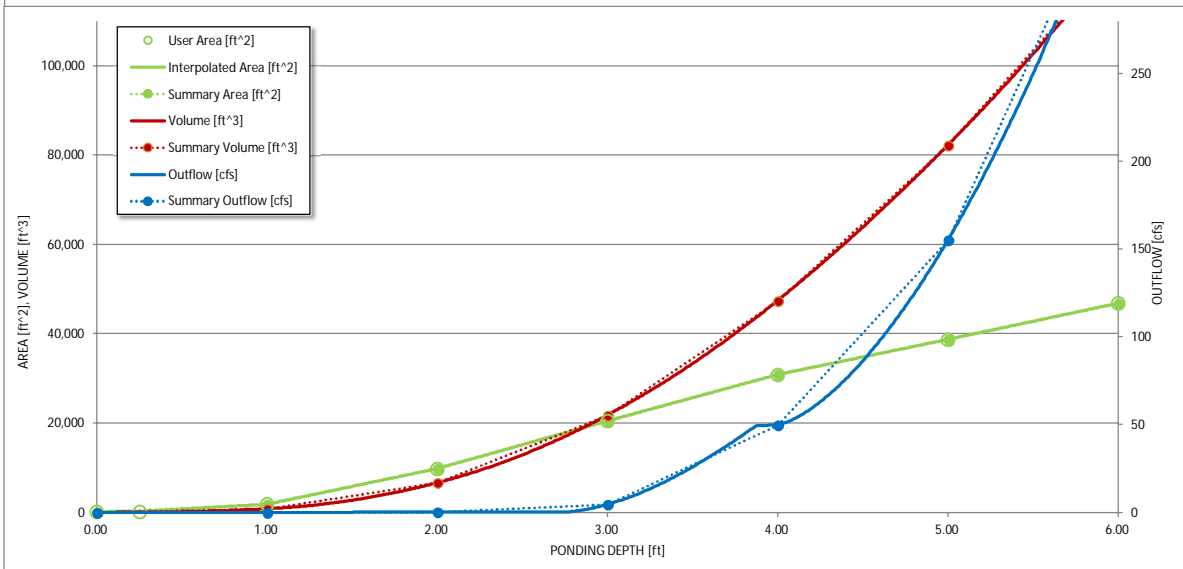
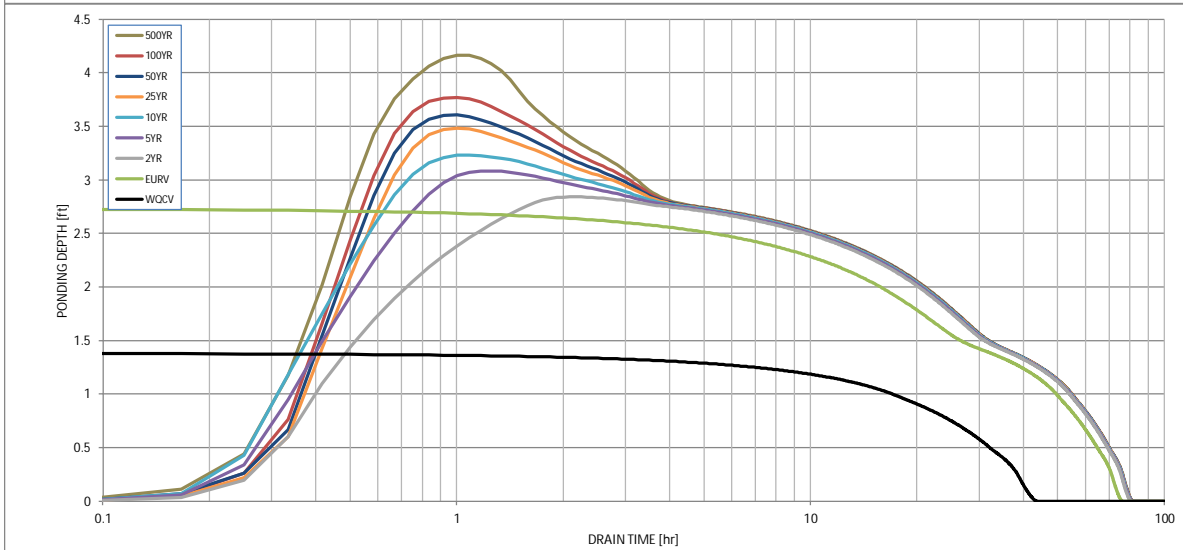
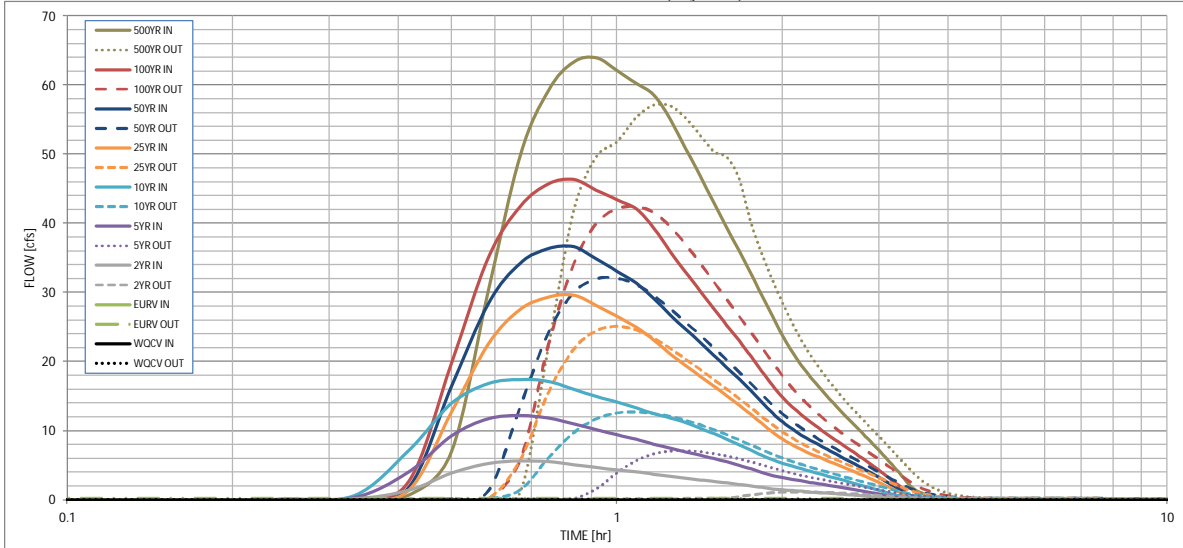
### Routed Hydrograph Results

*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	3.14
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft)	0.048	0.383	0.544	1.202	1.858	3.027	3.825	4.973	7.066
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.544	1.202	1.858	3.027	3.825	4.973	7.066
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	3.5	9.8	14.9	27.3	34.3	43.9	61.4
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.09	0.24	0.37	0.67	0.84	1.08	1.51
Peak Inflow Q (cfs)	N/A	N/A	5.7	12.2	17.4	29.6	36.6	46.3	64.0
Peak Outflow Q (cfs)	0.0	0.2	1.2	7.1	12.7	25.1	32.1	42.5	57.1
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.7	0.9	0.9	0.9	1.0	0.9
Structure Controlling Flow	Plate	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Gate 1 (fps)	N/A	N/A	0.01	0.1	0.2	0.3	0.4	0.5	0.6
Max Velocity through Gate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	37	56	56	44	34	27	24	21	16
Time to Drain 99% of Inflow Volume (hours)	40	65	67	60	55	47	43	37	30
Maximum Ponding Depth (ft)	1.39	2.74	2.84	3.09	3.23	3.49	3.61	3.77	4.17
Area at Maximum Ponding Depth (acres)	0.11	0.41	0.43	0.49	0.52	0.58	0.61	0.65	0.74
Maximum Volume Stored (acre-ft)	0.049	0.386	0.427	0.538	0.614	0.753	0.824	0.932	1.204

# DETENTION BASIN OUTLET STRUCTURE DESIGN

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



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

**Inflow Hydrographs**

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

Time Interval	SOURCE	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.04	0.06	0.08	0.05	0.07	0.06	0.10
	0:20:00	0.00	0.00	0.16	0.38	0.67	0.16	0.19	0.20	0.64
	0:25:00	0.00	0.00	1.35	3.97	7.07	1.29	1.70	2.47	6.93
	0:30:00	0.00	0.00	3.86	9.27	13.97	12.65	16.36	19.74	30.33
	0:35:00	0.00	0.00	5.29	11.75	16.83	22.58	28.46	35.13	49.93
	0:40:00	0.00	0.00	5.65	12.20	17.45	27.58	34.29	42.45	59.26
	0:45:00	0.00	0.00	5.51	11.82	17.14	29.34	36.35	45.72	63.33
	0:50:00	0.00	0.00	5.12	11.02	16.04	29.61	36.63	46.35	63.97
	0:55:00	0.00	0.00	4.70	10.15	14.99	28.14	34.89	44.84	62.10
	1:00:00	0.00	0.00	4.37	9.44	14.13	26.53	33.07	43.41	60.28
	1:05:00	0.00	0.00	4.07	8.75	13.30	25.01	31.34	42.11	58.61
	1:10:00	0.00	0.00	3.73	8.08	12.49	23.15	29.15	39.33	55.06
	1:15:00	0.00	0.00	3.41	7.48	11.88	21.13	26.76	35.96	50.87
	1:20:00	0.00	0.00	3.15	6.97	11.20	19.44	24.69	32.97	46.87
	1:25:00	0.00	0.00	2.91	6.47	10.40	17.91	22.77	30.21	43.02
	1:30:00	0.00	0.00	2.69	6.00	9.59	16.45	20.93	27.65	39.40
	1:35:00	0.00	0.00	2.47	5.52	8.78	15.05	19.16	25.29	36.03
	1:40:00	0.00	0.00	2.25	5.02	7.98	13.71	17.46	23.00	32.78
	1:45:00	0.00	0.00	2.03	4.50	7.21	12.38	15.79	20.79	29.64
	1:50:00	0.00	0.00	1.81	3.99	6.45	11.08	14.15	18.62	26.59
	1:55:00	0.00	0.00	1.61	3.55	5.80	9.81	12.56	16.55	23.72
	2:00:00	0.00	0.00	1.46	3.23	5.30	8.75	11.25	14.81	21.35
	2:05:00	0.00	0.00	1.35	2.98	4.89	7.95	10.24	13.46	19.44
	2:10:00	0.00	0.00	1.25	2.76	4.50	7.29	9.39	12.31	17.77
	2:15:00	0.00	0.00	1.15	2.54	4.14	6.70	8.62	11.27	16.27
	2:20:00	0.00	0.00	1.06	2.34	3.79	6.16	7.92	10.34	14.90
	2:25:00	0.00	0.00	0.97	2.14	3.46	5.66	7.27	9.46	13.62
	2:30:00	0.00	0.00	0.89	1.95	3.14	5.18	6.65	8.64	12.42
	2:35:00	0.00	0.00	0.80	1.76	2.83	4.72	6.05	7.88	11.31
	2:40:00	0.00	0.00	0.72	1.57	2.53	4.27	5.47	7.15	10.24
	2:45:00	0.00	0.00	0.64	1.39	2.25	3.83	4.90	6.42	9.19
	2:50:00	0.00	0.00	0.56	1.21	1.97	3.38	4.34	5.70	8.15
	2:55:00	0.00	0.00	0.48	1.03	1.69	2.94	3.78	4.98	7.12
	3:00:00	0.00	0.00	0.40	0.86	1.42	2.51	3.22	4.25	6.08
	3:05:00	0.00	0.00	0.32	0.68	1.15	2.07	2.67	3.53	5.05
	3:10:00	0.00	0.00	0.24	0.51	0.87	1.63	2.11	2.82	4.03
	3:15:00	0.00	0.00	0.16	0.34	0.61	1.20	1.56	2.10	3.01
	3:20:00	0.00	0.00	0.10	0.21	0.42	0.78	1.03	1.41	2.07
	3:25:00	0.00	0.00	0.06	0.14	0.31	0.48	0.66	0.92	1.41
	3:30:00	0.00	0.00	0.04	0.11	0.25	0.31	0.45	0.62	0.99
	3:35:00	0.00	0.00	0.03	0.08	0.20	0.20	0.31	0.42	0.69
	3:40:00	0.00	0.00	0.03	0.07	0.16	0.13	0.21	0.27	0.47
	3:45:00	0.00	0.00	0.02	0.05	0.12	0.09	0.15	0.17	0.32
	3:50:00	0.00	0.00	0.02	0.04	0.09	0.06	0.10	0.10	0.20
	3:55:00	0.00	0.00	0.01	0.03	0.07	0.04	0.07	0.05	0.12
	4:00:00	0.00	0.00	0.01	0.02	0.05	0.03	0.05	0.03	0.08
	4:05:00	0.00	0.00	0.01	0.02	0.03	0.02	0.04	0.03	0.06
	4:10:00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.02	0.05
	4:15:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.04
	4:20:00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.03
	4:25:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	4:30:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

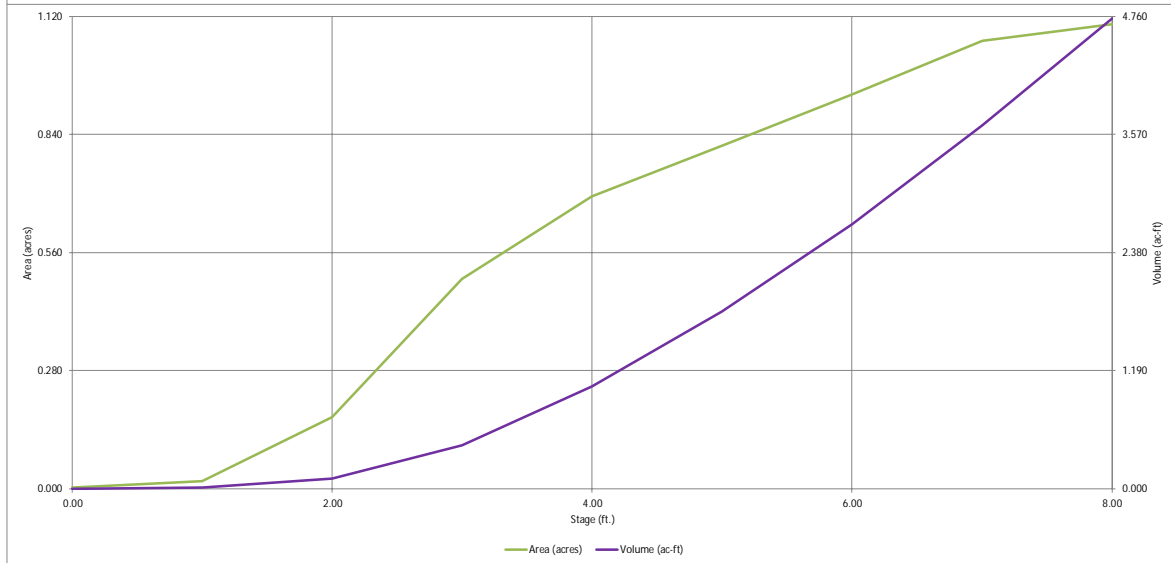
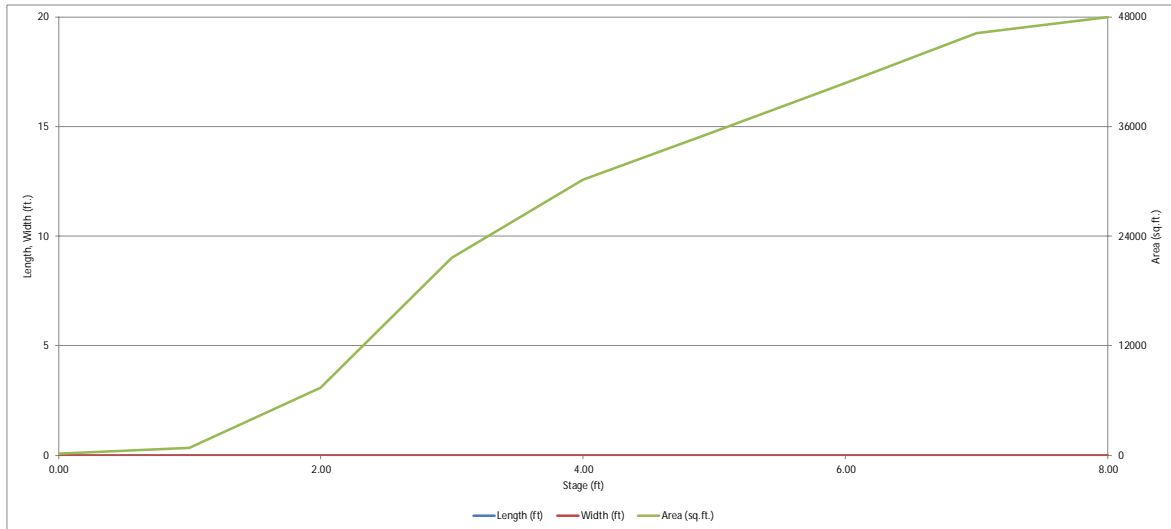






# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

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

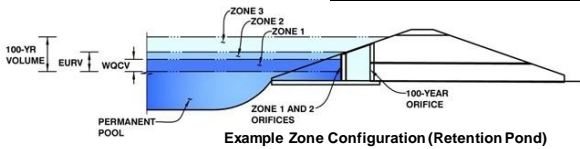


- ✓ = calcs match details in plans
- ✗ = calcs do not match details in plans

## DETENTION BASIN OUTLET STRUCTURE DESIGN

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

Project: Overlook Pond B8- Filing No. 1  
 Basin ID: B6 & B8



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.76	0.069	Orifice Plate
Zone 2 (EURV)	3.18	0.458	Rectangular Orifice
Zone 3 (100-year)	5.50	1.680	Weir&Pipe (Restrict)
<b>Total (all zones)</b>		<b>2.207</b>	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft <sup>2</sup>
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WO Orifice Area per Row =	2.153E-03	ft <sup>2</sup>
Depth at top of Zone using Orifice Plate =	1.76	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	12.70	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.31	sq. inches (diameter = 5/8 inch)	Elliptical Slot Area =	N/A	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	0.59	1.17					
Orifice Area (sq. inches)	0.31	0.31	0.31					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected		Zone 2 Rectangular	Not Selected		
Invert of Vertical Orifice =	1.76	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.04	N/A	ft <sup>2</sup>
Depth at top of Zone using Vertical Orifice =	3.18	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.08	N/A	feet
Vertical Orifice Height =	2.00	N/A	inches				
Vertical Orifice Width =	3.00	N/A	inches				

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

	Zone 3 Weir	Not Selected		Zone 3 Weir	Not Selected		
Overflow Weir Front Edge Height, Ho =	3.20	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Gate Upper Edge, H <sub>i</sub> =	3.70	N/A	feet
Overflow Weir Front Edge Length =	23.00	N/A	feet	Overflow Weir Slope Length =	5.02	N/A	feet
Overflow Weir Gate Slope =	10.00	N/A	H:V	Gate Open Area / 100-yr Orifice Area =	22.76	N/A	
Horiz. Length of Weir Sides =	5.00	N/A	feet	Overflow Gate Open Area w/o Debris =	80.44	N/A	ft <sup>2</sup>
Overflow Gate Type =	Type C Gate	N/A		Overflow Gate Open Area w/ Debris =	40.22	N/A	ft <sup>2</sup>
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Zone 3 Restrictor	Not Selected		
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	3.53	N/A	ft <sup>2</sup>
Outlet Pipe Diameter =	36.00	N/A	inches	Outlet Orifice Centroid =	0.86	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00	N/A	inches	Half-Central Angle of Restrictor Plate on Pipe =	1.57	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage =	5.80	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth =	0.78	feet
Spillway Crest Length =	30.00	feet	Stage at Top of Freeboard =	7.58	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.09	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	4.28	acre-ft

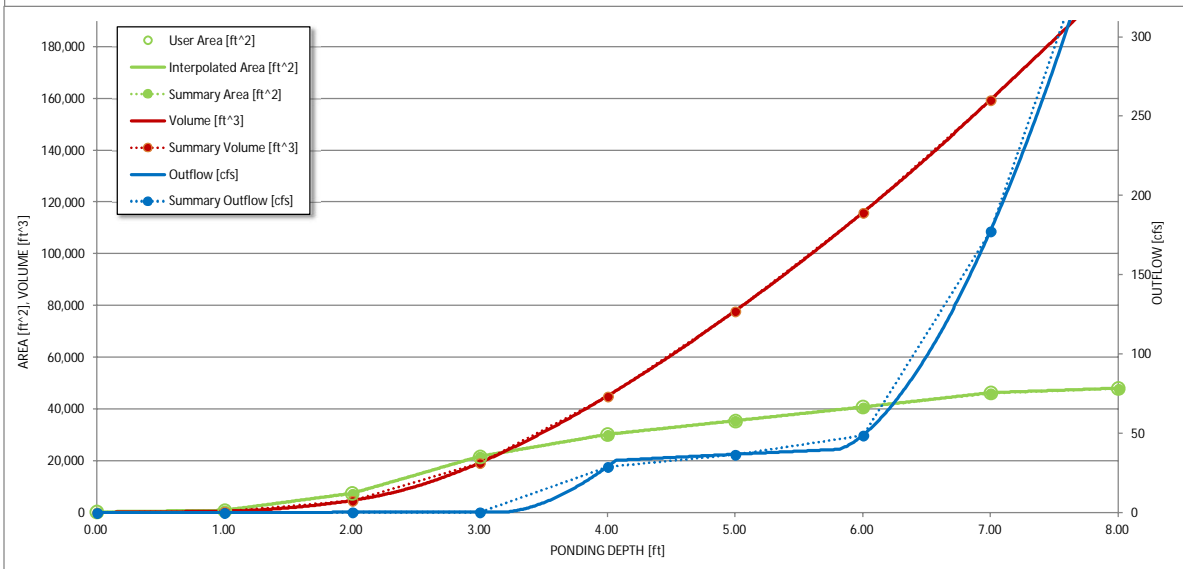
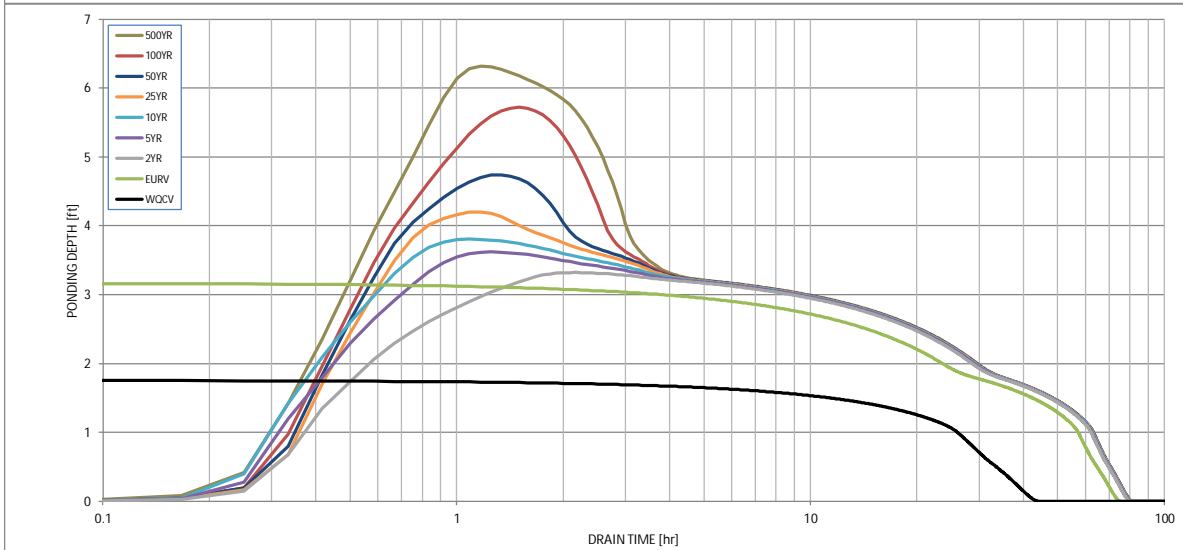
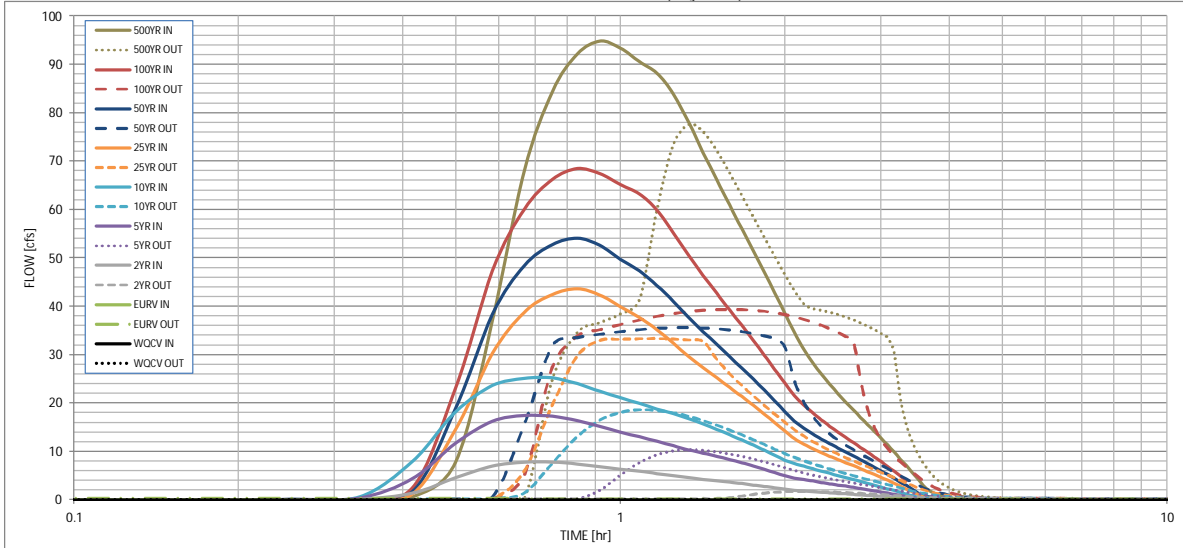
### Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period									
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft)	0.069	0.527	0.793	1.795	2.801	4.614	5.843	7.619	10.846
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.793	1.795	2.801	4.614	5.843	7.619	10.846
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	5.1	14.3	22.1	40.5	50.8	65.0	91.2
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.08	0.23	0.35	0.64	0.81	1.04	1.45
Peak Inflow Q (cfs)	N/A	N/A	7.8	17.5	25.2	43.6	54.1	68.5	94.8
Peak Outflow Q (cfs)	0.0	0.3	1.8	10.4	18.6	33.3	35.6	39.40	77.6
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.7	0.8	0.8	0.7	0.6	0.9
Structure Controlling Flow	Plate	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps)	N/A	N/A	0.02	0.1	0.2	0.4	0.4	0.5	0.5
Max Velocity through Gate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	37	54	55	42	32	26	24	21	15
Time to Drain 99% of Inflow Volume (hours)	40	62	65	58	53	46	41	34	29
Maximum Ponding Depth (ft)	1.76	3.18	3.32	3.62	3.81	4.20	4.74	5.72	6.32
Area at Maximum Ponding Depth (acres)	0.13	0.53	0.56	0.62	0.66	0.72	0.78	0.90	0.98
Maximum Volume Stored (acre-ft)	0.069	0.531	0.608	0.784	0.905	1.174	1.579	2.404	2.966

# DETENTION BASIN OUTLET STRUCTURE DESIGN

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



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

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

Time Interval	SOURCE	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.04	0.06	0.07	0.05	0.06	0.06	0.10
	0:20:00	0.00	0.00	0.16	0.40	0.70	0.17	0.20	0.21	0.68
	0:25:00	0.00	0.00	1.43	4.45	8.08	1.37	1.80	2.69	7.93
	0:30:00	0.00	0.00	4.60	11.74	18.28	14.67	19.05	23.23	37.07
	0:35:00	0.00	0.00	7.05	16.27	23.62	30.26	38.40	47.29	67.96
	0:40:00	0.00	0.00	7.84	17.46	25.17	38.80	48.42	60.09	84.34
	0:45:00	0.00	0.00	7.84	17.28	25.20	42.49	52.77	66.23	92.14
	0:50:00	0.00	0.00	7.44	16.39	24.06	43.62	54.09	68.49	94.83
	0:55:00	0.00	0.00	6.87	15.17	22.44	42.38	52.61	67.42	93.38
	1:00:00	0.00	0.00	6.34	14.02	21.10	39.90	49.76	65.14	90.55
	1:05:00	0.00	0.00	5.92	13.05	19.95	37.71	47.28	63.28	88.21
	1:10:00	0.00	0.00	5.47	12.12	18.83	35.19	44.35	59.88	83.89
	1:15:00	0.00	0.00	5.01	11.19	17.78	32.38	41.03	55.20	78.00
	1:20:00	0.00	0.00	4.59	10.37	16.78	29.63	37.68	50.51	71.86
	1:25:00	0.00	0.00	4.26	9.68	15.70	27.34	34.82	46.41	66.18
	1:30:00	0.00	0.00	3.96	9.03	14.58	25.24	32.17	42.69	60.94
	1:35:00	0.00	0.00	3.67	8.39	13.48	23.26	29.67	39.26	56.07
	1:40:00	0.00	0.00	3.38	7.72	12.39	21.37	27.27	36.05	51.49
	1:45:00	0.00	0.00	3.09	7.03	11.32	19.55	24.96	32.96	47.07
	1:50:00	0.00	0.00	2.80	6.34	10.27	17.75	22.69	29.94	42.79
	1:55:00	0.00	0.00	2.51	5.65	9.23	15.98	20.47	27.00	38.62
	2:00:00	0.00	0.00	2.24	5.02	8.26	14.25	18.29	24.15	34.64
	2:05:00	0.00	0.00	2.01	4.54	7.53	12.68	16.31	21.57	31.10
	2:10:00	0.00	0.00	1.86	4.21	6.96	11.53	14.86	19.61	28.34
	2:15:00	0.00	0.00	1.72	3.91	6.44	10.59	13.66	18.00	26.01
	2:20:00	0.00	0.00	1.60	3.63	5.95	9.79	12.61	16.56	23.92
	2:25:00	0.00	0.00	1.49	3.36	5.49	9.05	11.64	15.26	22.01
	2:30:00	0.00	0.00	1.37	3.10	5.05	8.37	10.75	14.06	20.25
	2:35:00	0.00	0.00	1.26	2.84	4.62	7.71	9.90	12.93	18.60
	2:40:00	0.00	0.00	1.15	2.59	4.20	7.08	9.08	11.88	17.05
	2:45:00	0.00	0.00	1.05	2.34	3.80	6.47	8.30	10.88	15.59
	2:50:00	0.00	0.00	0.94	2.10	3.42	5.87	7.52	9.89	14.16
	2:55:00	0.00	0.00	0.84	1.86	3.04	5.27	6.76	8.90	12.74
	3:00:00	0.00	0.00	0.73	1.63	2.67	4.67	6.00	7.91	11.33
	3:05:00	0.00	0.00	0.63	1.39	2.30	4.08	5.24	6.93	9.92
	3:10:00	0.00	0.00	0.52	1.16	1.94	3.48	4.48	5.95	8.51
	3:15:00	0.00	0.00	0.42	0.93	1.57	2.89	3.73	4.97	7.11
	3:20:00	0.00	0.00	0.32	0.70	1.21	2.30	2.98	3.99	5.71
	3:25:00	0.00	0.00	0.22	0.47	0.86	1.71	2.23	3.01	4.32
	3:30:00	0.00	0.00	0.13	0.29	0.58	1.13	1.50	2.06	3.01
	3:35:00	0.00	0.00	0.07	0.18	0.42	0.69	0.95	1.33	2.03
	3:40:00	0.00	0.00	0.05	0.13	0.33	0.44	0.63	0.89	1.42
	3:45:00	0.00	0.00	0.04	0.10	0.26	0.28	0.43	0.60	0.99
	3:50:00	0.00	0.00	0.03	0.08	0.21	0.18	0.29	0.39	0.68
	3:55:00	0.00	0.00	0.03	0.07	0.16	0.12	0.20	0.24	0.45
	4:00:00	0.00	0.00	0.02	0.05	0.12	0.08	0.14	0.14	0.28
	4:05:00	0.00	0.00	0.02	0.04	0.09	0.05	0.09	0.07	0.17
	4:10:00	0.00	0.00	0.01	0.03	0.06	0.03	0.06	0.04	0.11
	4:15:00	0.00	0.00	0.01	0.02	0.04	0.02	0.05	0.03	0.08
	4:20:00	0.00	0.00	0.01	0.02	0.03	0.02	0.03	0.03	0.06
	4:25:00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.02	0.05
	4:30:00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.04
	4:35:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.03
	4:40:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.02
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00





Existing Conditions Natural Channels Flow Summary							
Channel ID	Contributing Basins	Tributary Area (ac)	Basin Area (ac)	Basin 100-yr Flow (cfs)	Channel 100-yr Flow (cfs)	Velocity (ft/s)	Normal Depth (ft)
A1-1	A1	19.92	19.92	38.41	38.41	2.56	0.47
A2-3	A2, OS-A2	48.30 (A2) + 4.45 (OS-A2)	63.97 (A2) + 4.45 (OS-A2)	91.03(A2) + 11.46 (OS-A2)	79.02	4.88	0.89
A2-4	A2	2.73	63.97	91.03	2.71	1.49	0.23
A2-5	A2, B1	7.38 (A2) + 2.81 (B1)	63.97 (A2) + 43.28 (B1)	91.03(A2) + 72.48 (B1)	15.53	1.99	0.26
B1-2	B1	16.60	43.28	72.48	27.80	3.66	0.23
B1-3	B1	6.15	43.28	72.48	10.30	2.52	0.27
B1-6	B1	13.08	43.28	72.48	21.90	2.96	0.36
B2-1	B2	4.52	42.42	69.09	7.36	2.25	0.19
B2-2	B2	36.7	42.42	69.09	59.77	4.90	0.49
B7-1	B3	2.20	25.42	43.40	3.76	1.73	0.20
B8-1	B3	17.57	25.42	43.40	30.00	3.41	0.29

## Worksheet for A1-1

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### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.015 ft/ft
Discharge	38.41 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	41.00
	0+35	36.00
	0+64	36.00
	1+00	41.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 41.00)	(0+35, 36.00)	0.040
(0+35, 36.00)	(0+64, 36.00)	0.040
(0+64, 36.00)	(1+00, 41.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



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### Results

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Normal Depth	5.6 in
Roughness Coefficient	0.040
Elevation	36.47 ft
Elevation Range	36.0 to 41.0 ft
Flow Area	15.0 ft <sup>2</sup>
Wetted Perimeter	35.7 ft
Hydraulic Radius	5.1 in
Top Width	35.61 ft
Normal Depth	5.6 in
Critical Depth	4.4 in
Critical Slope	0.033 ft/ft
Velocity	2.56 ft/s
Velocity Head	0.10 ft
Specific Energy	0.57 ft
Froude Number	0.694

## Worksheet for A1-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	5.6 in
Critical Depth	4.4 in
Channel Slope	0.015 ft/ft
Critical Slope	0.033 ft/ft

## Worksheet for A2-3

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.030 ft/ft
Discharge	79.02 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	11.00
	0+51	4.00
	0+63	4.00
	0+98	9.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 11.00)	(0+51, 4.00)	0.040
(0+51, 4.00)	(0+63, 4.00)	0.040
(0+63, 4.00)	(0+98, 9.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



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### Results

---

Normal Depth	10.6 in
Roughness Coefficient	0.040
Elevation	4.89 ft
Elevation Range	4.0 to 11.0 ft
Flow Area	16.3 ft <sup>2</sup>
Wetted Perimeter	24.8 ft
Hydraulic Radius	7.9 in
Top Width	24.67 ft
Normal Depth	10.6 in
Critical Depth	11.0 in
Critical Slope	0.027 ft/ft
Velocity	4.86 ft/s
Velocity Head	0.37 ft
Specific Energy	1.25 ft
Froude Number	1.055
Flow Type	Supercritical

---

## Worksheet for A2-3

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	10.6 in
Critical Depth	11.0 in
Channel Slope	0.030 ft/ft
Critical Slope	0.027 ft/ft

---

## Worksheet for A2-4

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.029 ft/ft
Discharge	2.71 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+15	14.00
	0+32	12.75
	0+47	12.50
	0+98	18.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+15, 14.00)	(0+32, 12.75)	0.040
(0+32, 12.75)	(0+47, 12.50)	0.040
(0+47, 12.50)	(0+98, 18.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	2.7 in
Roughness Coefficient	0.040
Elevation	12.73 ft
Elevation Range	12.5 to 18.0 ft
Flow Area	1.8 ft <sup>2</sup>
Wetted Perimeter	15.9 ft
Hydraulic Radius	1.4 in
Top Width	15.86 ft
Normal Depth	2.7 in
Critical Depth	2.5 in
Critical Slope	0.050 ft/ft
Velocity	1.49 ft/s
Velocity Head	0.03 ft
Specific Energy	0.26 ft
Froude Number	0.778

## Worksheet for A2-4

---

### Results

---

Flow Type	Subcritical
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---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.7 in
Critical Depth	2.5 in
Channel Slope	0.029 ft/ft
Critical Slope	0.050 ft/ft

---



## Worksheet for A2-5

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

---

Input Data	
Channel Slope	0.020 ft/ft
Discharge	15.53 cfs

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	15.00
	0+43	12.00
	0+68	12.00
	1+25	16.75

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 15.00)	(0+43, 12.00)	0.040
(0+43, 12.00)	(0+68, 12.00)	0.040
(0+68, 12.00)	(1+25, 16.75)	0.040

### Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth	3.2 in
Roughness Coefficient	0.040
Elevation	12.27 ft
Elevation Range	12.0 to 16.8 ft
Flow Area	7.7 ft <sup>2</sup>
Wetted Perimeter	32.3 ft
Hydraulic Radius	2.9 in
Top Width	32.30 ft
Normal Depth	3.2 in
Critical Depth	2.6 in
Critical Slope	0.040 ft/ft
Velocity	2.02 ft/s
Velocity Head	0.06 ft
Specific Energy	0.33 ft
Froude Number	0.729

## Worksheet for A2-5

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.2 in
Critical Depth	2.6 in
Channel Slope	0.020 ft/ft
Critical Slope	0.040 ft/ft

## Worksheet for B1-2

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.075 ft/ft
Discharge	27.80 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		3.00
	0+31		0.00
	0+60		0.00
	1+00		4.84

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 3.00)	(0+31, 0.00)	0.040
(0+31, 0.00)	(0+60, 0.00)	0.040
(0+60, 0.00)	(1+00, 4.84)	0.040

---

### Options

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Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



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### Results

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Normal Depth	2.9 in
Roughness Coefficient	0.040
Elevation	0.24 ft
Elevation Range	0.0 to 4.8 ft
Flow Area	7.4 ft <sup>2</sup>
Wetted Perimeter	33.3 ft
Hydraulic Radius	2.7 in
Top Width	33.30 ft
Normal Depth	2.9 in
Critical Depth	3.6 in
Critical Slope	0.036 ft/ft
Velocity	3.73 ft/s
Velocity Head	0.22 ft
Specific Energy	0.46 ft
Froude Number	1.393
Flow Type	Supercritical

---

## Worksheet for B1-2

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.9 in
Critical Depth	3.6 in
Channel Slope	0.075 ft/ft
Critical Slope	0.036 ft/ft

---

## Worksheet for B1-3

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.033 ft/ft
Discharge	10.30 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	19.00
	0+45	14.00
	0+56	14.00
	0+98	18.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 19.00)	(0+45, 14.00)	0.040
(0+45, 14.00)	(0+56, 14.00)	0.040
(0+56, 14.00)	(0+98, 18.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	3.3 in
Roughness Coefficient	0.040
Elevation	14.28 ft
Elevation Range	14.0 to 19.0 ft
Flow Area	4.0 ft <sup>2</sup>
Wetted Perimeter	17.2 ft
Hydraulic Radius	2.8 in
Top Width	17.13 ft
Normal Depth	3.3 in
Critical Depth	3.2 in
Critical Slope	0.038 ft/ft
Velocity	2.56 ft/s
Velocity Head	0.10 ft
Specific Energy	0.38 ft
Froude Number	0.933

## Worksheet for B1-3

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.3 in
Critical Depth	3.2 in
Channel Slope	0.033 ft/ft
Critical Slope	0.038 ft/ft

## Worksheet for B1-6

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.030 ft/ft
Discharge	21.90 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	22.00
	0+35	18.00
	0+51	18.00
	0+92	23.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 22.00)	(0+35, 18.00)	0.040
(0+35, 18.00)	(0+51, 18.00)	0.040
(0+51, 18.00)	(0+92, 23.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	4.5 in
Roughness Coefficient	0.040
Elevation	18.37 ft
Elevation Range	18.0 to 23.0 ft
Flow Area	7.3 ft <sup>2</sup>
Wetted Perimeter	22.6 ft
Hydraulic Radius	3.9 in
Top Width	22.57 ft
Normal Depth	4.5 in
Critical Depth	4.3 in
Critical Slope	0.035 ft/ft
Velocity	3.01 ft/s
Velocity Head	0.14 ft
Specific Energy	0.52 ft
Froude Number	0.937

## Worksheet for B1-6

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	4.5 in
Critical Depth	4.3 in
Channel Slope	0.030 ft/ft
Critical Slope	0.035 ft/ft



## Worksheet for B2-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.037 ft/ft
Discharge	7.36 cfs

---

### Section Definitions

	Station (ft)		Elevation (ft)
	0+00		5.00
	0+42		0.00
	0+58		0.00
	0+75		4.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5.00)	(0+42, 0.00)	0.040
(0+42, 0.00)	(0+58, 0.00)	0.040
(0+58, 0.00)	(0+75, 4.50)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	2.3 in
Roughness Coefficient	0.040
Elevation	0.19 ft
Elevation Range	0.0 to 5.0 ft
Flow Area	3.3 ft <sup>2</sup>
Wetted Perimeter	18.4 ft
Hydraulic Radius	2.1 in
Top Width	18.32 ft
Normal Depth	2.3 in
Critical Depth	2.2 in
Critical Slope	0.042 ft/ft
Velocity	2.25 ft/s
Velocity Head	0.08 ft
Specific Energy	0.27 ft
Froude Number	0.942
Flow Type	Subcritical

---

## Worksheet for B2-1

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.3 in
Critical Depth	2.2 in
Channel Slope	0.037 ft/ft
Critical Slope	0.042 ft/ft

---

## Worksheet for B2-2

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.054 ft/ft
Discharge	59.77 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		13.00
	0+38		8.00
	0+59		8.00
	0+96		13.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient	
(0+00, 13.00)	(0+38, 8.00)	0.040	
(0+38, 8.00)	(0+59, 8.00)	0.040	
(0+59, 8.00)	(0+96, 13.00)	0.040	

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



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### Results

---

Normal Depth	5.9 in
Roughness Coefficient	0.040
Elevation	8.49 ft
Elevation Range	8.0 to 13.0 ft
Flow Area	12.2 ft <sup>2</sup>
Wetted Perimeter	28.5 ft
Hydraulic Radius	5.1 in
Top Width	28.40 ft
Normal Depth	5.9 in
Critical Depth	7.0 in
Critical Slope	0.029 ft/ft
Velocity	4.90 ft/s
Velocity Head	0.37 ft
Specific Energy	0.87 ft
Froude Number	1.320
Flow Type	Supercritical

---

## Worksheet for B2-2

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.9 in
Critical Depth	7.0 in
Channel Slope	0.054 ft/ft
Critical Slope	0.029 ft/ft

---

## Worksheet for B7-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.046 ft/ft
Discharge	3.76 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		95.00
	0+25		92.00
	0+50		91.75
	0+90		98.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient	
(0+00, 95.00)	(0+25, 92.00)	0.040	
(0+25, 92.00)	(0+50, 91.75)	0.040	
(0+50, 91.75)	(0+90, 98.00)	0.040	

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



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### Results

---

Normal Depth	2.4 in
Roughness Coefficient	0.040
Elevation	91.95 ft
Elevation Range	91.8 to 98.0 ft
Flow Area	2.2 ft <sup>2</sup>
Wetted Perimeter	21.5 ft
Hydraulic Radius	1.2 in
Top Width	21.51 ft
Normal Depth	2.4 in
Critical Depth	2.4 in
Critical Slope	0.050 ft/ft
Velocity	1.73 ft/s
Velocity Head	0.05 ft
Specific Energy	0.25 ft
Froude Number	0.959

## Worksheet for B7-1

---

### Results

---

Flow Type	Subcritical
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---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.4 in
Critical Depth	2.4 in
Channel Slope	0.046 ft/ft
Critical Slope	0.050 ft/ft

---

## Worksheet for B8-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.050 ft/ft
Discharge	30.00 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	202.00
	0+52	198.00
	0+79	198.00
	1+06	201.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 202.00)	(0+52, 198.00)	0.040
(0+52, 198.00)	(0+79, 198.00)	0.040
(0+79, 198.00)	(1+06, 201.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	3.5 in
Roughness Coefficient	0.040
Elevation	198.29 ft
Elevation Range	198.0 to 202.0 ft
Flow Area	8.8 ft <sup>2</sup>
Wetted Perimeter	33.4 ft
Hydraulic Radius	3.2 in
Top Width	33.41 ft
Normal Depth	3.5 in
Critical Depth	3.9 in
Critical Slope	0.035 ft/ft
Velocity	3.41 ft/s
Velocity Head	0.18 ft
Specific Energy	0.47 ft
Froude Number	1.172

## Worksheet for B8-1

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.5 in
Critical Depth	3.9 in
Channel Slope	0.050 ft/ft
Critical Slope	0.035 ft/ft



Proposed Conditions Natural Channels Flow Summary								
Channel ID	Contributing Basins	Tributary Area (ac)	Basin Area (ac)	Basin 100-yr Flow (cfs)	Channel 100-yr Flow (cfs)	Velocity (ft/s)	Normal Depth (ft)	Lining
A1-1	A1	19.55	19.55	41.24	41.24	2.62	0.48	
A2-1	A2, OS-A2	32.76 (A2) + 3.25 (OS-A2)	61.98 (A2) + 3.14 (OS-A2)	97.07 (A2) + 8.09(OS-A2)	58.15	3.78	0.58	
A2-2	A2	9.06	61.98	97.07	14.19	2.47	0.18	
A2-3	A2	11.45	61.98	97.07	17.93	3.07	0.39	
A2-4	A2	1.70	61.98	97.07	2.66	1.49	0.23	
A2-5	A2	11.27	61.98	97.07	17.65	2.18	0.30	
A2-6	A2	5.9	61.98	97.07	9.24	1.83	0.18	
A2-7	A2	1.74	58.27	97.07	2.90	0.97	0.10	
B1-1	B1	10.19	40.74	76.45	19.12	2.67	0.28	
B1-2	B1	14.29	40.74	76.45	26.82	3.69	0.23	
B1-3	B1	13.43	40.74	76.45	25.20	3.41	0.46	
B1-4	B1	4.03	40.74	76.45	7.56	2.47	0.14	
B1-5	B1	2.54	40.74	76.45	4.77	1.65	0.11	
B1-6	B1	2.72	40.74	76.45	5.10	1.81	0.16	
B2-1	B2	4.92	16.00	37.85	11.64	2.67	0.25	
B2-2	B2	9.77	16.00	37.85	23.11	3.52	0.28	
B6-1	B6	11.58	53.31	106.32	23.09	6.66	0.29	TRM
B7-1	B7	2.25	2.46	6.17	5.64	1.91	0.23	
B8-1	B8, B6	3.32 (B8) + 53.31 (B6)	9.52 (B8) + 52.15 (B6)	23.05 (B8) + 106.32 (B6)	118.80	5.44	0.64	TRM

Please provide cross-sectional views of all channels with a minimum 1-foot freeboard.

## Worksheet for A1-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

---

Input Data	
Channel Slope	0.015 ft/ft
Discharge	41.24 cfs

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	41.00
	0+35	36.00
	0+64	36.00
	1+00	41.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 41.00)	(0+35, 36.00)	0.040
(0+35, 36.00)	(0+64, 36.00)	0.040
(0+64, 36.00)	(1+00, 41.00)	0.040

### Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth	5.8 in
Roughness Coefficient	0.040
Elevation	36.48 ft
Elevation Range	36.0 to 41.0 ft
Flow Area	15.7 ft <sup>2</sup>
Wetted Perimeter	36.0 ft
Hydraulic Radius	5.3 in
Top Width	35.89 ft
Normal Depth	5.8 in
Critical Depth	4.6 in
Critical Slope	0.033 ft/ft
Velocity	2.62 ft/s
Velocity Head	0.11 ft
Specific Energy	0.59 ft
Froude Number	0.698

## Worksheet for A1-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	5.8 in
Critical Depth	4.6 in
Channel Slope	0.015 ft/ft
Critical Slope	0.033 ft/ft

## Worksheet for A2-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.028 ft/ft
Discharge	58.15 cfs

---

### Section Definitions

Station (ft)	Elevation (ft)
0+00	47.00
0+66	42.00
0+87	42.00
1+25	47.75

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 47.00)	(0+66, 42.00)	0.040
(0+66, 42.00)	(0+87, 42.00)	0.040
(0+87, 42.00)	(1+25, 47.75)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	6.9 in
Roughness Coefficient	0.040
Elevation	42.58 ft
Elevation Range	42.0 to 47.8 ft
Flow Area	15.4 ft <sup>2</sup>
Wetted Perimeter	32.5 ft
Hydraulic Radius	5.7 in
Top Width	32.42 ft
Normal Depth	6.9 in
Critical Depth	6.8 in
Critical Slope	0.030 ft/ft
Velocity	3.78 ft/s
Velocity Head	0.22 ft
Specific Energy	0.80 ft
Froude Number	0.966

## Worksheet for A2-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.9 in
Critical Depth	6.8 in
Channel Slope	0.028 ft/ft
Critical Slope	0.030 ft/ft

## Worksheet for A2-2

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.046 ft/ft
Discharge	14.19 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	23.00
	0+43	16.00
	0+72	16.00
	1+25	20.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 23.00)	(0+43, 16.00)	0.040
(0+43, 16.00)	(0+72, 16.00)	0.040
(0+72, 16.00)	(1+25, 20.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	2.2 in
Roughness Coefficient	0.040
Elevation	16.18 ft
Elevation Range	16.0 to 23.0 ft
Flow Area	5.7 ft <sup>2</sup>
Wetted Perimeter	33.3 ft
Hydraulic Radius	2.1 in
Top Width	33.26 ft
Normal Depth	2.2 in
Critical Depth	2.3 in
Critical Slope	0.042 ft/ft
Velocity	2.47 ft/s
Velocity Head	0.09 ft
Specific Energy	0.28 ft
Froude Number	1.047

## Worksheet for A2-2

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.2 in
Critical Depth	2.3 in
Channel Slope	0.046 ft/ft
Critical Slope	0.042 ft/ft

## Worksheet for A2-3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.030 ft/ft
Discharge	17.93 cfs

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	11.00
	0+51	4.00
	0+63	4.00
	0+98	9.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 11.00)	(0+51, 4.00)	0.040
(0+51, 4.00)	(0+63, 4.00)	0.040
(0+63, 4.00)	(0+98, 9.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	4.7 in
Roughness Coefficient	0.040
Elevation	4.39 ft
Elevation Range	4.0 to 11.0 ft
Flow Area	5.8 ft <sup>2</sup>
Wetted Perimeter	17.7 ft
Hydraulic Radius	4.0 in
Top Width	17.63 ft
Normal Depth	4.7 in
Critical Depth	4.6 in
Critical Slope	0.034 ft/ft
Velocity	3.07 ft/s
Velocity Head	0.15 ft
Specific Energy	0.54 ft
Froude Number	0.941
Flow Type	Subcritical



## Worksheet for A2-3

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	4.7 in
Critical Depth	4.6 in
Channel Slope	0.030 ft/ft
Critical Slope	0.034 ft/ft

---

## Worksheet for A2-4

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

---

Input Data	
Channel Slope	0.029 ft/ft
Discharge	2.66 cfs

### Section Definitions

	Station (ft)	Elevation (ft)
	0+15	14.00
	0+32	12.75
	0+47	12.50
	0+98	18.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+15, 14.00)	(0+32, 12.75)	0.040
(0+32, 12.75)	(0+47, 12.50)	0.040
(0+47, 12.50)	(0+98, 18.00)	0.040

### Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth	2.7 in
Roughness Coefficient	0.040
Elevation	12.73 ft
Elevation Range	12.5 to 18.0 ft
Flow Area	1.8 ft <sup>2</sup>
Wetted Perimeter	15.8 ft
Hydraulic Radius	1.4 in
Top Width	15.75 ft
Normal Depth	2.7 in
Critical Depth	2.5 in
Critical Slope	0.050 ft/ft
Velocity	1.49 ft/s
Velocity Head	0.03 ft
Specific Energy	0.26 ft
Froude Number	0.777

## Worksheet for A2-4

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.7 in
Critical Depth	2.5 in
Channel Slope	0.029 ft/ft
Critical Slope	0.050 ft/ft

## Worksheet for A2-5

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

---

Input Data	
Channel Slope	0.020 ft/ft
Discharge	19.34 cfs

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	15.00
	0+43	12.00
	0+68	12.00
	1+25	16.75

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 15.00)	(0+43, 12.00)	0.040
(0+43, 12.00)	(0+68, 12.00)	0.040
(0+68, 12.00)	(1+25, 16.75)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.6 in
Roughness Coefficient	0.040
Elevation	12.30 ft
Elevation Range	12.0 to 16.8 ft
Flow Area	8.9 ft <sup>2</sup>
Wetted Perimeter	33.3 ft
Hydraulic Radius	3.2 in
Top Width	33.25 ft
Normal Depth	3.6 in
Critical Depth	3.0 in
Critical Slope	0.038 ft/ft
Velocity	2.18 ft/s
Velocity Head	0.07 ft
Specific Energy	0.38 ft
Froude Number	0.743

## Worksheet for A2-5

---

### Results

---

Flow Type	Subcritical
-----------	-------------

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.6 in
Critical Depth	3.0 in
Channel Slope	0.020 ft/ft
Critical Slope	0.038 ft/ft

---

## Worksheet for A2-6

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

---

Input Data	
Channel Slope	0.027 ft/ft
Discharge	10.20 cfs

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	30.00
	0+31	28.00
	0+59	28.00
	0+94	30.25

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 30.00)	(0+31, 28.00)	0.040
(0+31, 28.00)	(0+59, 28.00)	0.040
(0+59, 28.00)	(0+94, 30.25)	0.040

### Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth	2.1 in
Roughness Coefficient	0.040
Elevation	28.18 ft
Elevation Range	28.0 to 30.3 ft
Flow Area	5.6 ft <sup>2</sup>
Wetted Perimeter	34.0 ft
Hydraulic Radius	2.0 in
Top Width	34.00 ft
Normal Depth	2.1 in
Critical Depth	1.8 in
Critical Slope	0.045 ft/ft
Velocity	1.83 ft/s
Velocity Head	0.05 ft
Specific Energy	0.23 ft
Froude Number	0.796

## Worksheet for A2-6

---

### Results

---

Flow Type	Subcritical
-----------	-------------

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.1 in
Critical Depth	1.8 in
Channel Slope	0.027 ft/ft
Critical Slope	0.045 ft/ft

---

## Worksheet for A2-7

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.015 ft/ft
Discharge	2.90 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		41.00
	0+35		36.00
	0+64		36.00
	1+00		41.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 41.00)	(0+35, 36.00)	0.040
(0+35, 36.00)	(0+64, 36.00)	0.040
(0+64, 36.00)	(1+00, 41.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	1.2 in
Roughness Coefficient	0.040
Elevation	36.10 ft
Elevation Range	36.0 to 41.0 ft
Flow Area	3.0 ft <sup>2</sup>
Wetted Perimeter	30.4 ft
Hydraulic Radius	1.2 in
Top Width	30.43 ft
Normal Depth	1.2 in
Critical Depth	0.8 in
Critical Slope	0.058 ft/ft
Velocity	0.97 ft/s
Velocity Head	0.01 ft
Specific Energy	0.12 ft
Froude Number	0.544



## Worksheet for A2-7

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	1.2 in
Critical Depth	0.8 in
Channel Slope	0.015 ft/ft
Critical Slope	0.058 ft/ft

## Worksheet for B1-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.034 ft/ft
Discharge	19.12 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	26.00
	0+54	20.00
	0+76	20.00
	1+25	22.75

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 26.00)	(0+54, 20.00)	0.040
(0+54, 20.00)	(0+76, 20.00)	0.040
(0+76, 20.00)	(1+25, 22.75)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	3.3 in
Roughness Coefficient	0.040
Elevation	20.28 ft
Elevation Range	20.0 to 26.0 ft
Flow Area	7.2 ft <sup>2</sup>
Wetted Perimeter	29.5 ft
Hydraulic Radius	2.9 in
Top Width	29.47 ft
Normal Depth	3.3 in
Critical Depth	3.2 in
Critical Slope	0.038 ft/ft
Velocity	2.67 ft/s
Velocity Head	0.11 ft
Specific Energy	0.39 ft
Froude Number	0.954

## Worksheet for B1-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.3 in
Critical Depth	3.2 in
Channel Slope	0.034 ft/ft
Critical Slope	0.038 ft/ft

## Worksheet for B1-2

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.075 ft/ft
Discharge	26.82 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		3.00
	0+31		0.00
	0+60		0.00
	1+00		4.84

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient	
(0+00, 3.00)	(0+31, 0.00)	0.040	
(0+31, 0.00)	(0+60, 0.00)	0.040	
(0+60, 0.00)	(1+00, 4.84)	0.040	

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	2.8 in
Roughness Coefficient	0.040
Elevation	0.23 ft
Elevation Range	0.0 to 4.8 ft
Flow Area	7.3 ft <sup>2</sup>
Wetted Perimeter	33.2 ft
Hydraulic Radius	2.6 in
Top Width	33.21 ft
Normal Depth	2.8 in
Critical Depth	3.5 in
Critical Slope	0.036 ft/ft
Velocity	3.69 ft/s
Velocity Head	0.21 ft
Specific Energy	0.45 ft
Froude Number	1.388
Flow Type	Supercritical

---

## Worksheet for B1-2

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.8 in
Critical Depth	3.5 in
Channel Slope	0.075 ft/ft
Critical Slope	0.036 ft/ft

---

## Worksheet for B1-3

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.033 ft/ft
Discharge	25.20 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	19.00
	0+45	14.00
	0+56	14.00
	0+98	18.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 19.00)	(0+45, 14.00)	0.040
(0+45, 14.00)	(0+56, 14.00)	0.040
(0+56, 14.00)	(0+98, 18.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	5.5 in
Roughness Coefficient	0.040
Elevation	14.46 ft
Elevation Range	14.0 to 19.0 ft
Flow Area	7.4 ft <sup>2</sup>
Wetted Perimeter	20.6 ft
Hydraulic Radius	4.3 in
Top Width	20.59 ft
Normal Depth	5.5 in
Critical Depth	5.5 in
Critical Slope	0.033 ft/ft
Velocity	3.41 ft/s
Velocity Head	0.18 ft
Specific Energy	0.64 ft
Froude Number	1.002

## Worksheet for B1-3

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.5 in
Critical Depth	5.5 in
Channel Slope	0.033 ft/ft
Critical Slope	0.033 ft/ft

## Worksheet for B1-4

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.063 ft/ft
Discharge	7.56 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	34.00
	0+26	30.00
	0+47	30.00
	0+75	35.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 34.00)	(0+26, 30.00)	0.040
(0+26, 30.00)	(0+47, 30.00)	0.040
(0+47, 30.00)	(0+75, 35.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	1.7 in
Roughness Coefficient	0.040
Elevation	30.14 ft
Elevation Range	30.0 to 35.0 ft
Flow Area	3.1 ft <sup>2</sup>
Wetted Perimeter	22.5 ft
Hydraulic Radius	1.6 in
Top Width	22.47 ft
Normal Depth	1.7 in
Critical Depth	1.9 in
Critical Slope	0.044 ft/ft
Velocity	2.47 ft/s
Velocity Head	0.09 ft
Specific Energy	0.24 ft
Froude Number	1.180



## Worksheet for B1-4

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.7 in
Critical Depth	1.9 in
Channel Slope	0.063 ft/ft
Critical Slope	0.044 ft/ft

## Worksheet for B1-5

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.039 ft/ft
Discharge	4.77 cfs

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		35.00
	0+29		32.00
	0+54		32.00
	0+73		35.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient	
(0+00, 35.00)	(0+29, 32.00)	0.040	
(0+29, 32.00)	(0+54, 32.00)	0.040	
(0+54, 32.00)	(0+73, 35.00)	0.040	

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	1.3 in
Roughness Coefficient	0.040
Elevation	32.11 ft
Elevation Range	32.0 to 35.0 ft
Flow Area	2.9 ft <sup>2</sup>
Wetted Perimeter	27.0 ft
Hydraulic Radius	1.3 in
Top Width	27.02 ft
Normal Depth	1.3 in
Critical Depth	1.2 in
Critical Slope	0.050 ft/ft
Velocity	1.65 ft/s
Velocity Head	0.04 ft
Specific Energy	0.15 ft
Froude Number	0.890

## Worksheet for B1-5

---

### Results

---

Flow Type	Subcritical
-----------	-------------

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	1.3 in
Critical Depth	1.2 in
Channel Slope	0.039 ft/ft
Critical Slope	0.050 ft/ft

---

## Worksheet for B1-6

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.030 ft/ft
Discharge	5.10 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		22.00
	0+35		18.00
	0+51		18.00
	0+92		23.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 22.00)	(0+35, 18.00)	0.040
(0+35, 18.00)	(0+51, 18.00)	0.040
(0+51, 18.00)	(0+92, 23.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	1.9 in
Roughness Coefficient	0.040
Elevation	18.16 ft
Elevation Range	18.0 to 23.0 ft
Flow Area	2.8 ft <sup>2</sup>
Wetted Perimeter	19.0 ft
Hydraulic Radius	1.8 in
Top Width	18.96 ft
Normal Depth	1.9 in
Critical Depth	1.7 in
Critical Slope	0.046 ft/ft
Velocity	1.81 ft/s
Velocity Head	0.05 ft
Specific Energy	0.21 ft
Froude Number	0.825

## Worksheet for B1-6

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	1.9 in
Critical Depth	1.7 in
Channel Slope	0.030 ft/ft
Critical Slope	0.046 ft/ft

## Worksheet for B2-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.037 ft/ft
Discharge	11.64 cfs

---

### Section Definitions

	Station (ft)		Elevation (ft)
	0+00		5.00
	0+42		0.00
	0+58		0.00
	0+75		4.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5.00)	(0+42, 0.00)	0.040
(0+42, 0.00)	(0+58, 0.00)	0.040
(0+58, 0.00)	(0+75, 4.50)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	3.0 in
Roughness Coefficient	0.040
Elevation	0.25 ft
Elevation Range	0.0 to 5.0 ft
Flow Area	4.4 ft <sup>2</sup>
Wetted Perimeter	19.1 ft
Hydraulic Radius	2.7 in
Top Width	19.03 ft
Normal Depth	3.0 in
Critical Depth	3.0 in
Critical Slope	0.038 ft/ft
Velocity	2.67 ft/s
Velocity Head	0.11 ft
Specific Energy	0.36 ft
Froude Number	0.982
Flow Type	Subcritical

---

## Worksheet for B2-1

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.0 in
Critical Depth	3.0 in
Channel Slope	0.037 ft/ft
Critical Slope	0.038 ft/ft

---

## Worksheet for B2-2

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.054 ft/ft
Discharge	23.11 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		13.00
	0+38		8.00
	0+59		8.00
	0+96		13.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 13.00)	(0+38, 8.00)	0.040
(0+38, 8.00)	(0+59, 8.00)	0.040
(0+59, 8.00)	(0+96, 13.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	3.4 in
Roughness Coefficient	0.040
Elevation	8.28 ft
Elevation Range	8.0 to 13.0 ft
Flow Area	6.6 ft <sup>2</sup>
Wetted Perimeter	25.3 ft
Hydraulic Radius	3.1 in
Top Width	25.26 ft
Normal Depth	3.4 in
Critical Depth	3.9 in
Critical Slope	0.035 ft/ft
Velocity	3.52 ft/s
Velocity Head	0.19 ft
Specific Energy	0.48 ft
Froude Number	1.215
Flow Type	Supercritical

---



## Worksheet for B2-2

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.4 in
Critical Depth	3.9 in
Channel Slope	0.054 ft/ft
Critical Slope	0.035 ft/ft

---

## Worksheet for B6-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.190 ft/ft
Discharge	23.09 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)	
	0+00		14.00
	0+39		6.00
	0+50		6.00
	0+63		11.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient	
(0+00, 14.00)	(0+39, 6.00)	0.040	
(0+39, 6.00)	(0+50, 6.00)	0.040	
(0+50, 6.00)	(0+63, 11.50)	0.040	

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	3.5 in
Roughness Coefficient	0.040
Elevation	6.29 ft
Elevation Range	6.0 to 14.0 ft
Flow Area	3.5 ft <sup>2</sup>
Wetted Perimeter	13.2 ft
Hydraulic Radius	3.2 in
Top Width	13.09 ft
Normal Depth	3.5 in
Critical Depth	5.9 in
Critical Slope	0.031 ft/ft
Velocity	6.66 ft/s
Velocity Head	0.69 ft
Specific Energy	0.98 ft
Froude Number	2.279
Flow Type	Supercritical

---

## Worksheet for B6-1

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.5 in
Critical Depth	5.9 in
Channel Slope	0.190 ft/ft
Critical Slope	0.031 ft/ft

---

## Worksheet for B7-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.046 ft/ft
Discharge	5.64 cfs

---

### Section Definitions

	Station (ft)	Elevation (ft)
	0+00	95.00
	0+25	92.00
	0+50	91.75
	0+90	98.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 95.00)	(0+25, 92.00)	0.040
(0+25, 92.00)	(0+50, 91.75)	0.040
(0+50, 91.75)	(0+90, 98.00)	0.040

---

### Options

---

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

---



---

### Results

---

Normal Depth	2.8 in
Roughness Coefficient	0.040
Elevation	91.99 ft
Elevation Range	91.8 to 98.0 ft
Flow Area	2.9 ft <sup>2</sup>
Wetted Perimeter	25.1 ft
Hydraulic Radius	1.4 in
Top Width	25.05 ft
Normal Depth	2.8 in
Critical Depth	2.8 in
Critical Slope	0.048 ft/ft
Velocity	1.91 ft/s
Velocity Head	0.06 ft
Specific Energy	0.29 ft
Froude Number	0.983

## Worksheet for B7-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.8 in
Critical Depth	2.8 in
Channel Slope	0.046 ft/ft
Critical Slope	0.048 ft/ft

## Worksheet for B8-1

---

### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

---

### Input Data

---

Channel Slope	0.050 ft/ft
Discharge	118.80 cfs

---

### Section Definitions

Station (ft)	Elevation (ft)
0+00	202.00
0+52	198.00
0+79	198.00
1+06	201.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 202.00)	(0+52, 198.00)	0.040
(0+52, 198.00)	(0+79, 198.00)	0.040
(0+79, 198.00)	(1+06, 201.00)	0.040

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### Options

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Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

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### Results

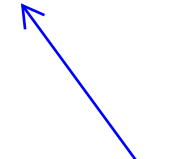
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Normal Depth	7.7 in
Roughness Coefficient	0.040
Elevation	198.64 ft
Elevation Range	198.0 to 202.0 ft
Flow Area	21.8 ft <sup>2</sup>
Wetted Perimeter	41.2 ft
Hydraulic Radius	6.4 in
Top Width	41.10 ft
Normal Depth	7.7 in
Critical Depth	9.1 in
Critical Slope	0.028 ft/ft
Velocity	5.44 ft/s
Velocity Head	0.46 ft
Specific Energy	1.10 ft
Froude Number	1.317

## Worksheet for B8-1

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.7 in
Critical Depth	9.1 in
Channel Slope	0.050 ft/ft
Critical Slope	0.028 ft/ft

Culvert & Riprap Summary														
Culvert Details							Riprap Details (Low Tailwater Basin Design)							
Culvert ID	Basin	Q100 flow (cfs)	Flow % of Basin	Flows (cfs)	HW/D Ratio	Diameter (in)	Top Length (ft)	Bottom Width (ft)	Top Width (ft)	D50 Type	D50 Size (in)	D50 Thickness (D) (in)	Normal Depth in Pipe (ft)	Upstream Headwater Elevation (ft)
A2-A	A2	93.46	10.00%	9.35	1.39	18	15	4	10	VL	6	12	0.75	7211.99
A2-B	A2	93.46	8.00%	7.48	1.12	18	15	4	10	VL	6	12	0.56	7221.58
A2-C	A2	93.46	49.00%	45.80	1.21	36	20	6	15	L	9	18	1.17	7224.11
A2-D	A2	93.46	11.00%	10.28	1.52	18	15	4	10	VL	6	12	0.60	7320.27
B1-A	B1	80.40	28.00%	22.51	0.99	30	20	6	15	L	9	18	0.85	7218.48
B1-B	B1	80.40	34.00%	27.34	1.14	30	20	6	15	L	9	18	0.90	7224.85
B6-A	B6	104.60	100.00%	104.60	1.39	36 (3 Barrels)	24	7	27	M	12	24	1.91	7233.42
B6-B	B6	104.60	2.00%	5.63	0.91	18	15	4	10	VL	6	12	0.47	7246.36
B6-C	B6	104.60	1.00%	3.26	1.28	12	15	4	10	VL	6	12	0.32	7340.58
EDB A2 OUTFALL	(Used pond outfall diameter sizing for final pond installation)					42	24	7	19	L	9	18		
EDB B1 OUTFALL	(Used pond outfall diameter sizing for final pond installation)					36	20	6	15	L	9	18		
EDB B6 OUTFALL	(Used pond outfall diameter sizing for final pond installation)					42	24	7	19	L	9	18		

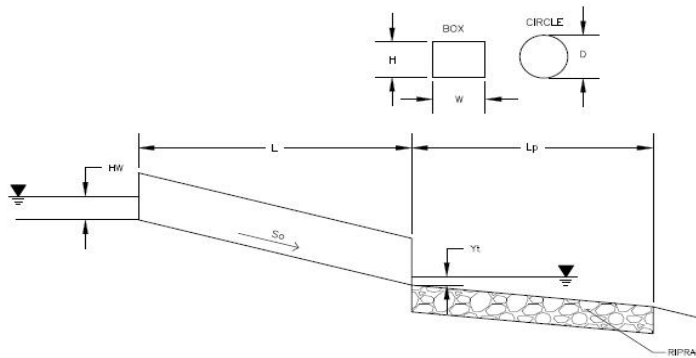

 Please include the normal velocity for both minor and major storms. Printed profiles with HGL5 and HGL100 are required.



# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

*MHFD-Culvert, Version 4.00 (May 2020)*

Project: OVERLOOK  
ID: CULVERT A1



Soil Type:

Choose One:

- Sandy  
 Non-Sandy

### Design Information:

Design Discharge	Q = <input style="width: 100px;" type="text" value="41.42"/> cfs
Circular Culvert:	
Barrel Diameter in Inches	D = <input style="width: 100px;" type="text" value="36"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<u>OR</u> :	
Box Culvert:	
Barrel Height (Rise) in Feet	H (Rise) = <input style="width: 100px;" type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input style="width: 100px;" type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input style="width: 100px;" type="text" value="1"/>
Inlet Elevation	Elev IN = <input style="width: 100px;" type="text" value="7204.67"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input style="width: 100px;" type="text" value="7204.42"/> ft
Culvert Length	L = <input style="width: 100px;" type="text" value="68.15"/> ft
Manning's Roughness	n = <input style="width: 100px;" type="text" value="0.012"/>
Bend Loss Coefficient	k <sub>b</sub> = <input style="width: 100px;" type="text" value="0"/>
Exit Loss Coefficient	k <sub>x</sub> = <input style="width: 100px;" type="text" value="1"/>
Tailwater Surface Elevation	Y <sub>t</sub> , Elevation = <input style="width: 100px;" type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input style="width: 100px;" type="text" value="5"/> ft/s

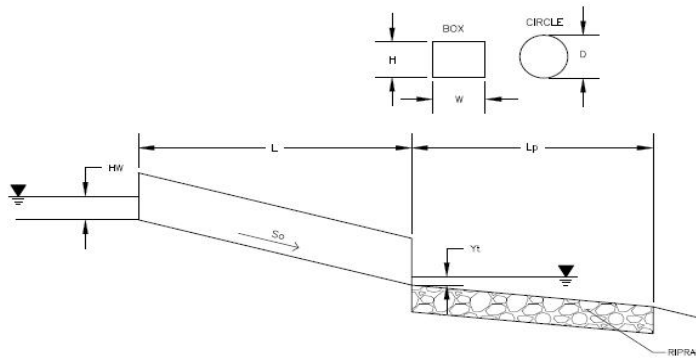
### Calculated Results:

Culvert Cross Sectional Area Available	A = <input style="width: 100px;" type="text" value="7.07"/> ft <sup>2</sup>
Culvert Normal Depth	Y <sub>n</sub> = <input style="width: 100px;" type="text" value="2.32"/> ft
Culvert Critical Depth	Y <sub>c</sub> = <input style="width: 100px;" type="text" value="2.10"/> ft
Froude Number	Fr = <input style="width: 100px;" type="text" value="0.81"/>
Entrance Loss Coefficient	k <sub>e</sub> = <input style="width: 100px;" type="text" value="0.50"/>
Friction Loss Coefficient	k <sub>f</sub> = <input style="width: 100px;" type="text" value="0.42"/>
Sum of All Loss Coefficients	k <sub>s</sub> = <input style="width: 100px;" type="text" value="1.92"/> ft
Headwater:	
Inlet Control Headwater	HW <sub>I</sub> = <input style="width: 100px;" type="text" value="3.39"/> ft
Outlet Control Headwater	HW <sub>O</sub> = <input style="width: 100px;" type="text" value="3.32"/> ft
Design Headwater Elevation	HW = <input style="width: 100px;" type="text" value="7208.06"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input style="width: 100px;" type="text" value="1.13"/>
Outlet Protection:	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input style="width: 100px;" type="text" value="2.66"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	Y <sub>t</sub> = <input style="width: 100px;" type="text" value="1.20"/> ft
Tailwater/Diameter	Y <sub>t</sub> /D = <input style="width: 100px;" type="text" value="0.40"/>
Expansion Factor	1/(2*tan(Θ)) = <input style="width: 100px;" type="text" value="4.85"/>
Flow Area at Max Channel Velocity	A <sub>t</sub> = <input style="width: 100px;" type="text" value="8.28"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	W <sub>eq</sub> = <input style="width: 100px;" type="text" value="-"/> ft
Length of Riprap Protection	L <sub>p</sub> = <input style="width: 100px;" type="text" value="19"/> ft
Width of Riprap Protection at Downstream End	T = <input style="width: 100px;" type="text" value="7"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input style="width: 100px;" type="text" value="-"/> ft
Minimum Theoretical Riprap Size	d <sub>50</sub> min = <input style="width: 100px;" type="text" value="7"/> in
Nominal Riprap Size	d <sub>50</sub> nominal = <input style="width: 100px;" type="text" value="9"/> in
MHFD Riprap Type	Type = <input style="width: 100px;" type="text" value="L"/>

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK  
ID: CULVERT A2-A



Soil Type:  
Choose One:

Sandy

Non-Sandy

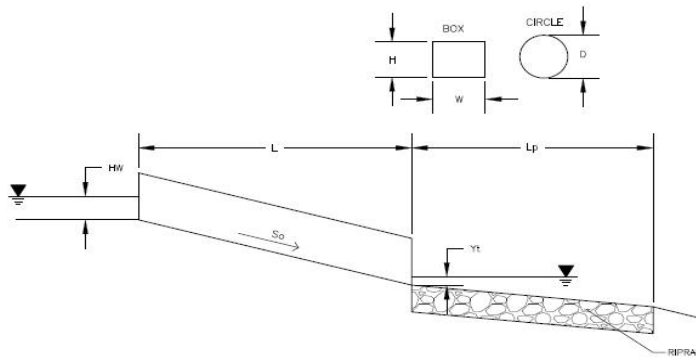
Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:	
Design Discharge	Q = <input type="text" value="9.3"/> cfs
<b>Circular Culvert:</b>	
Barrel Diameter in Inches	D = <input type="text" value="18"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<b>OR:</b>	
<b>Box Culvert:</b>	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="1"/>
Inlet Elevation	Elev IN = <input type="text" value="7209.75"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7207.31"/> ft
Culvert Length	L = <input type="text" value="93"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	k <sub>b</sub> = <input type="text" value="0"/>
Exit Loss Coefficient	k <sub>x</sub> = <input type="text" value="1"/>
Tailwater Surface Elevation	Y <sub>t</sub> , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="1.77"/> ft <sup>2</sup>
Culvert Normal Depth	Y <sub>n</sub> = <input type="text" value="0.75"/> ft
Culvert Critical Depth	Y <sub>c</sub> = <input type="text" value="1.18"/> ft
Froude Number	Fr = <input type="text" value="2.40"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	k <sub>e</sub> = <input type="text" value="0.50"/>
Friction Loss Coefficient	k <sub>f</sub> = <input type="text" value="1.44"/>
Sum of All Loss Coefficients	k <sub>s</sub> = <input type="text" value="2.94"/> ft
<b>Headwater:</b>	
Inlet Control Headwater	HW <sub>I</sub> = <input type="text" value="2.08"/> ft
Outlet Control Headwater	HW <sub>O</sub> = <input type="text" value="N/A"/> ft
Design Headwater Elevation	HW = <input type="text" value="7211.83"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="1.39"/>
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required	
<b>Outlet Protection:</b>	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input type="text" value="3.37"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	Y <sub>t</sub> = <input type="text" value="0.60"/> ft
Tailwater/Diameter	Y <sub>t</sub> /D = <input type="text" value="0.40"/>
Expansion Factor	1/(2*tan(Θ)) = <input type="text" value="4.05"/>
Flow Area at Max Channel Velocity	A <sub>t</sub> = <input type="text" value="1.86"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	W <sub>eq</sub> = <input type="text" value="-"/> ft
Length of Riprap Protection	L <sub>p</sub> = <input type="text" value="7"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="4"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="1.13"/> ft
Minimum Theoretical Riprap Size	d <sub>50</sub> min = <input type="text" value="5"/> in
Nominal Riprap Size	d <sub>50</sub> nominal = <input type="text" value="6"/> in
MHFD Riprap Type	Type = <input type="text" value="VL"/>

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK  
 ID: CULVERT A2-B



Soil Type:  
 Choose One:  
 Sandy  
 Non-Sandy

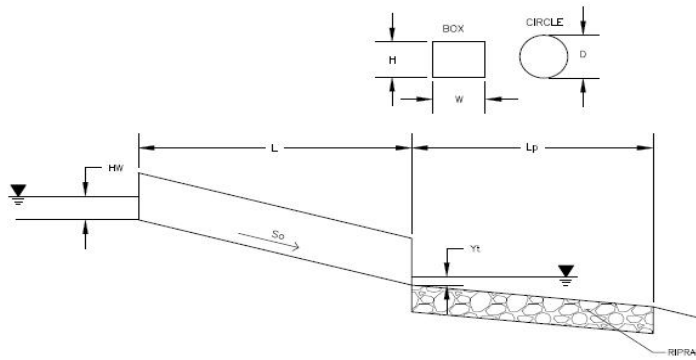
Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:	
Design Discharge	Q = <input type="text" value="7.44"/> cfs
<b>Circular Culvert:</b>	
Barrel Diameter in Inches	D = <input type="text" value="18"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<b>OR:</b>	
<b>Box Culvert:</b>	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="1"/>
Inlet Elevation	Elev IN = <input type="text" value="7219.6"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7215.35"/> ft
Culvert Length	L = <input type="text" value="87.8"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	k <sub>b</sub> = <input type="text" value="0"/>
Exit Loss Coefficient	k <sub>x</sub> = <input type="text" value="1"/>
Tailwater Surface Elevation	Y <sub>t</sub> , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="1.77"/> ft <sup>2</sup>
Culvert Normal Depth	Y <sub>n</sub> = <input type="text" value="0.56"/> ft
Culvert Critical Depth	Y <sub>c</sub> = <input type="text" value="1.06"/> ft
Froude Number	Fr = <input type="text" value="3.39"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	k <sub>e</sub> = <input type="text" value="0.50"/>
Friction Loss Coefficient	k <sub>f</sub> = <input type="text" value="1.36"/>
Sum of All Loss Coefficients	k <sub>s</sub> = <input type="text" value="2.86"/> ft
<b>Headwater:</b>	
Inlet Control Headwater	HW <sub>I</sub> = <input type="text" value="1.68"/> ft
Outlet Control Headwater	HW <sub>O</sub> = <input type="text" value="N/A"/> ft
Design Headwater Elevation	HW = <input type="text" value="7221.28"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="1.12"/>
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required	
<b>Outlet Protection:</b>	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input type="text" value="2.70"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	Y <sub>t</sub> = <input type="text" value="0.60"/> ft
Tailwater/Diameter	Y <sub>t</sub> /D = <input type="text" value="0.40"/>
Expansion Factor	1/(2*tan(Θ)) = <input type="text" value="4.79"/>
Flow Area at Max Channel Velocity	A <sub>t</sub> = <input type="text" value="1.49"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	W <sub>eq</sub> = <input type="text" value="-"/> ft
Length of Riprap Protection	L <sub>p</sub> = <input type="text" value="5"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="3"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="1.03"/> ft
Minimum Theoretical Riprap Size	d <sub>50</sub> min = <input type="text" value="4"/> in
Nominal Riprap Size	d <sub>50</sub> nominal = <input type="text" value="6"/> in
MHFD Riprap Type	Type = <input type="text" value="VL"/>

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK  
 ID: CULVERT A2-C



Soil Type:  
 Choose One:  
 Sandy  
 Non-Sandy

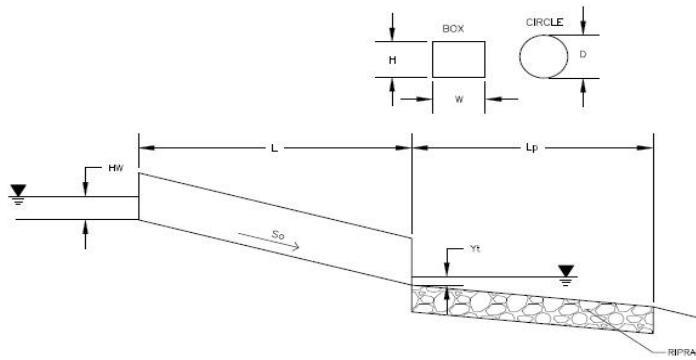
Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:	
Design Discharge	Q = <input type="text" value="45.55"/> cfs
<b>Circular Culvert:</b>	
Barrel Diameter in Inches	D = <input type="text" value="36"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<b>OR:</b>	
<b>Box Culvert:</b>	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="1"/>
Inlet Elevation	Elev IN = <input type="text" value="7220.18"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7216.35"/> ft
Culvert Length	L = <input type="text" value="101.4"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	k <sub>b</sub> = <input type="text" value="0"/>
Exit Loss Coefficient	k <sub>x</sub> = <input type="text" value="1"/>
Tailwater Surface Elevation	Y <sub>t</sub> , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="7.07"/> ft <sup>2</sup>
Culvert Normal Depth	Y <sub>n</sub> = <input type="text" value="1.17"/> ft
Culvert Critical Depth	Y <sub>c</sub> = <input type="text" value="2.20"/> ft
Froude Number	Fr = <input type="text" value="3.35"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	k <sub>e</sub> = <input type="text" value="0.50"/>
Friction Loss Coefficient	k <sub>f</sub> = <input type="text" value="0.62"/>
Sum of All Loss Coefficients	k <sub>s</sub> = <input type="text" value="2.12"/> ft
<b>Headwater:</b>	
Inlet Control Headwater	HW <sub>I</sub> = <input type="text" value="3.62"/> ft
Outlet Control Headwater	HW <sub>O</sub> = <input type="text" value="N/A"/> ft
Design Headwater Elevation	HW = <input type="text" value="7223.80"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="1.21"/>
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required	
<b>Outlet Protection:</b>	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input type="text" value="2.92"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	Y <sub>t</sub> = <input type="text" value="1.20"/> ft
Tailwater/Diameter	Y <sub>t</sub> /D = <input type="text" value="0.40"/>
Expansion Factor	1/(2*tan(Θ)) = <input type="text" value="4.49"/>
Flow Area at Max Channel Velocity	A <sub>t</sub> = <input type="text" value="9.11"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	W <sub>eq</sub> = <input type="text" value="-"/> ft
Length of Riprap Protection	L <sub>p</sub> = <input type="text" value="21"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="8"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="2.09"/> ft
Minimum Theoretical Riprap Size	d <sub>50</sub> min = <input type="text" value="8"/> in
Nominal Riprap Size	d <sub>50</sub> nominal = <input type="text" value="9"/> in
MHFD Riprap Type	Type = <input type="text" value="L"/>

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Overlook  
ID: A2-D



Soil Type:  
Choose One:  
 Sandy  
 Non-Sandy

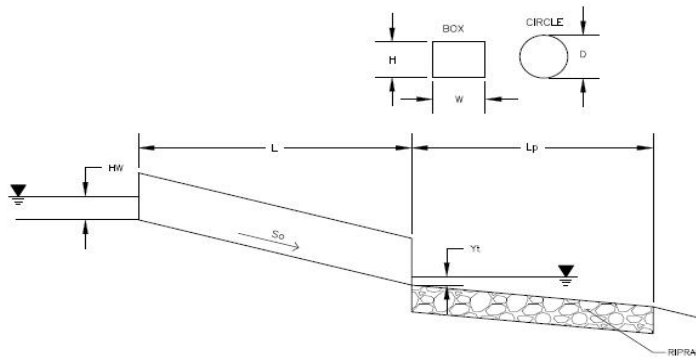
Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:	
Design Discharge	Q = <input type="text" value="10.23"/> cfs
Circular Culvert:	
Barrel Diameter in Inches	D = <input type="text" value="24"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<u>OR:</u>	
Box Culvert:	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="1"/>
Inlet Elevation	Elev IN = <input type="text" value="7313.3"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7312.4"/> ft
Culvert Length	L = <input type="text" value="86.6"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	k <sub>b</sub> = <input type="text" value="0"/>
Exit Loss Coefficient	k <sub>x</sub> = <input type="text" value="1"/>
Tailwater Surface Elevation	Y <sub>t</sub> , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="3.14"/> ft <sup>2</sup>
Culvert Normal Depth	Y <sub>n</sub> = <input type="text" value="0.89"/> ft
Culvert Critical Depth	Y <sub>c</sub> = <input type="text" value="1.14"/> ft
Froude Number	Fr = <input type="text" value="1.62"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	k <sub>e</sub> = <input type="text" value="0.50"/>
Friction Loss Coefficient	k <sub>f</sub> = <input type="text" value="0.91"/>
Sum of All Loss Coefficients	k <sub>s</sub> = <input type="text" value="2.41"/> ft
Headwater:	
Inlet Control Headwater	HW <sub>I</sub> = <input type="text" value="1.72"/> ft
Outlet Control Headwater	HW <sub>O</sub> = <input type="text" value="N/A"/> ft
Design Headwater Elevation	HW = <input type="text" value="7315.02"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="0.86"/>
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required	
Outlet Protection:	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input type="text" value="1.81"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	Y <sub>t</sub> = <input type="text" value="0.80"/> ft
Tailwater/Diameter	Y <sub>t</sub> /D = <input type="text" value="0.40"/>
Expansion Factor	1/(2*tan(Θ)) = <input type="text" value="5.93"/>
Flow Area at Max Channel Velocity	A <sub>t</sub> = <input type="text" value="2.05"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	W <sub>eq</sub> = <input type="text" value="-"/> ft
Length of Riprap Protection	L <sub>p</sub> = <input type="text" value="6"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="4"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="1.45"/> ft
Minimum Theoretical Riprap Size	d <sub>50</sub> min = <input type="text" value="3"/> in
Nominal Riprap Size	d <sub>50</sub> nominal = <input type="text" value="6"/> in
MHFD Riprap Type	Type = <input type="text" value="VL"/>

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK  
 ID: CULVERT B1-A



Soil Type:  
 Choose One:  
 Sandy  
 Non-Sandy

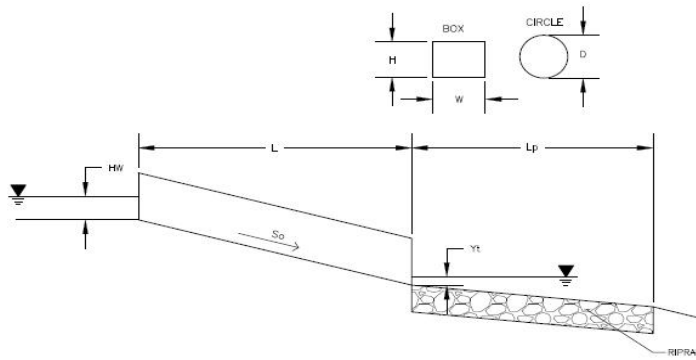
Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:	
Design Discharge	Q = <input type="text" value="22.51"/> cfs
<b>Circular Culvert:</b>	
Barrel Diameter in Inches	D = <input type="text" value="30"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<b>OR:</b>	
<b>Box Culvert:</b>	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="1"/>
Inlet Elevation	Elev IN = <input type="text" value="7215.76"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7210.52"/> ft
Culvert Length	L = <input type="text" value="125.2"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	k <sub>b</sub> = <input type="text" value="0"/>
Exit Loss Coefficient	k <sub>x</sub> = <input type="text" value="1"/>
Tailwater Surface Elevation	Y <sub>t</sub> , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="4.91"/> ft <sup>2</sup>
Culvert Normal Depth	Y <sub>n</sub> = <input type="text" value="0.85"/> ft
Culvert Critical Depth	Y <sub>c</sub> = <input type="text" value="1.61"/> ft
Froude Number	Fr = <input type="text" value="3.45"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	k <sub>e</sub> = <input type="text" value="0.50"/>
Friction Loss Coefficient	k <sub>f</sub> = <input type="text" value="0.98"/>
Sum of All Loss Coefficients	k <sub>s</sub> = <input type="text" value="2.48"/> ft
<b>Headwater:</b>	
Inlet Control Headwater	HW <sub>I</sub> = <input type="text" value="2.47"/> ft
Outlet Control Headwater	HW <sub>O</sub> = <input type="text" value="N/A"/> ft
Design Headwater Elevation	HW = <input type="text" value="7218.23"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="0.99"/>
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required	
<b>Outlet Protection:</b>	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input type="text" value="2.28"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	Y <sub>t</sub> = <input type="text" value="1.00"/> ft
Tailwater/Diameter	Y <sub>t</sub> /D = <input type="text" value="0.40"/>
Expansion Factor	1/(2*tan(Θ)) = <input type="text" value="5.36"/>
Flow Area at Max Channel Velocity	A <sub>t</sub> = <input type="text" value="4.50"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	W <sub>eq</sub> = <input type="text" value="-"/> ft
Length of Riprap Protection	L <sub>p</sub> = <input type="text" value="11"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="5"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="1.67"/> ft
Minimum Theoretical Riprap Size	d <sub>50</sub> min = <input type="text" value="5"/> in
Nominal Riprap Size	d <sub>50</sub> nominal = <input type="text" value="6"/> in
MHFD Riprap Type	Type = <input type="text" value="VL"/>

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK  
 ID: CULVERT B1-B



Soil Type:  
 Choose One:  
 Sandy  
 Non-Sandy

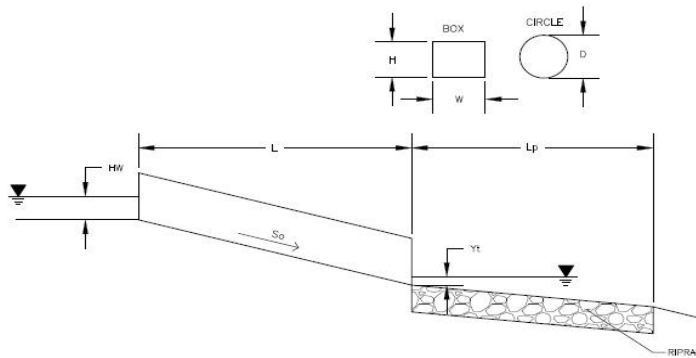
Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:	
Design Discharge	Q = <input type="text" value="27.34"/> cfs
Circular Culvert:	
Barrel Diameter in Inches	D = <input type="text" value="30"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
OR:	
Box Culvert:	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="1"/>
Inlet Elevation	Elev IN = <input type="text" value="7219.01"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7218.46"/> ft
Culvert Length	L = <input type="text" value="68.26"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	k <sub>b</sub> = <input type="text" value="0"/>
Exit Loss Coefficient	k <sub>x</sub> = <input type="text" value="1"/>
Tailwater Surface Elevation	Y <sub>t</sub> , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="4.91"/> ft <sup>2</sup>
Culvert Normal Depth	Y <sub>n</sub> = <input type="text" value="1.52"/> ft
Culvert Critical Depth	Y <sub>c</sub> = <input type="text" value="1.78"/> ft
Froude Number	Fr = <input type="text" value="1.37"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	k <sub>e</sub> = <input type="text" value="0.50"/>
Friction Loss Coefficient	k <sub>f</sub> = <input type="text" value="0.53"/>
Sum of All Loss Coefficients	k <sub>s</sub> = <input type="text" value="2.03"/> ft
Headwater:	
Inlet Control Headwater	HW <sub>i</sub> = <input type="text" value="2.91"/> ft
Outlet Control Headwater	HW <sub>o</sub> = <input type="text" value="2.57"/> ft
Design Headwater Elevation	HW = <input type="text" value="7221.92"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="1.16"/>
Outlet Protection:	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input type="text" value="2.77"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	Y <sub>t</sub> = <input type="text" value="1.00"/> ft
Tailwater/Diameter	Y <sub>t</sub> /D = <input type="text" value="0.40"/>
Expansion Factor	1/(2*tan(Θ)) = <input type="text" value="4.70"/>
Flow Area at Max Channel Velocity	A <sub>t</sub> = <input type="text" value="5.47"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	W <sub>eq</sub> = <input type="text" value="-"/> ft
Length of Riprap Protection	L <sub>p</sub> = <input type="text" value="14"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="6"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="2.01"/> ft
Minimum Theoretical Riprap Size	d <sub>50</sub> min = <input type="text" value="6"/> in
Nominal Riprap Size	d <sub>50</sub> nominal = <input type="text" value="9"/> in
MHFD Riprap Type	Type = <input type="text" value="L"/>

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Overlook  
 ID: CULVERT B6



Soil Type:  
 Choose One:  
 Sandy  
 Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

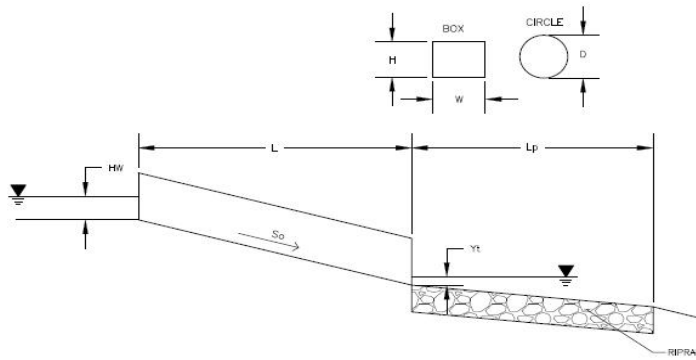
Design Information:	
Design Discharge	Q = <input type="text" value="106.95"/> cfs
<b>Circular Culvert:</b>	
Barrel Diameter in Inches	D = <input type="text" value="36"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<b>OR:</b>	
<b>Box Culvert:</b>	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="3"/>
Inlet Elevation	Elev IN = <input type="text" value="7228.05"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7227.55"/> ft
Culvert Length	L = <input type="text" value="51.93"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	$k_b$ = <input type="text" value="0"/>
Exit Loss Coefficient	$k_x$ = <input type="text" value="1"/>
Tailwater Surface Elevation	$Y_t$ , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="7.07"/> ft <sup>2</sup>
Culvert Normal Depth	$Y_n$ = <input type="text" value="1.50"/> ft
Culvert Critical Depth	$Y_c$ = <input type="text" value="1.94"/> ft
Froude Number	Fr = <input type="text" value="1.63"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	$k_e$ = <input type="text" value="0.50"/>
Friction Loss Coefficient	$k_f$ = <input type="text" value="0.32"/>
Sum of All Loss Coefficients	$k_s$ = <input type="text" value="1.82"/> ft
<b>Headwater:</b>	
Inlet Control Headwater	$HW_i$ = <input type="text" value="3.02"/> ft
Outlet Control Headwater	$HW_o$ = <input type="text" value="2.69"/> ft
Design Headwater Elevation	HW = <input type="text" value="7231.07"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="1.01"/>
<b>Outlet Protection:</b>	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input type="text" value="2.29"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	$Y_t$ = <input type="text" value="1.20"/> ft
Tailwater/Diameter	$Y_t/D$ = <input type="text" value="0.40"/>
Expansion Factor	$1/(2*\tan(\Theta))$ = <input type="text" value="5.35"/>
Flow Area at Max Channel Velocity	$A_t$ = <input type="text" value="21.39"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	$W_{eq}$ = <input type="text" value="9.00"/> ft
Length of Riprap Protection	$L_p$ = <input type="text" value="30"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="15"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="2.25"/> ft
Minimum Theoretical Riprap Size	$d_{50}$ min = <input type="text" value="6"/> in
Nominal Riprap Size	$d_{50}$ nominal = <input type="text" value="9"/> in
MHFD Riprap Type	Type = <input type="text" value="L"/>



# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: \_\_\_\_\_  
 ID: B6-A



Soil Type:  
 Choose One:  Sandy  
 Non-Sandy

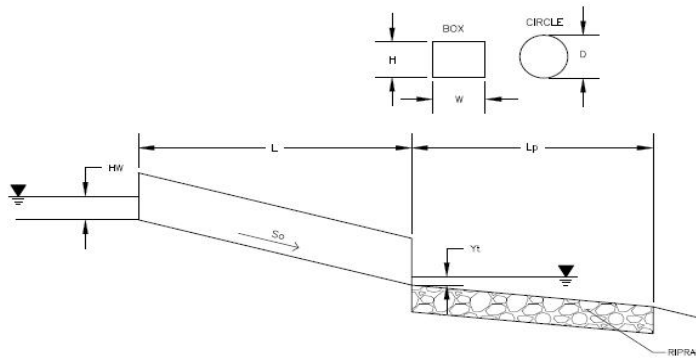
Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:	
Design Discharge	Q = <input type="text" value="5.63"/> cfs
<b>Circular Culvert:</b>	
Barrel Diameter in Inches	D = <input type="text" value="18"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<b>OR:</b>	
<b>Box Culvert:</b>	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="1"/>
Inlet Elevation	Elev IN = <input type="text" value="7245"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7244"/> ft
Culvert Length	L = <input type="text" value="18"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	k <sub>b</sub> = <input type="text" value="0"/>
Exit Loss Coefficient	k <sub>x</sub> = <input type="text" value="1"/>
Tailwater Surface Elevation	Y <sub>t</sub> , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="1.77"/> ft <sup>2</sup>
Culvert Normal Depth	Y <sub>n</sub> = <input type="text" value="0.47"/> ft
Culvert Critical Depth	Y <sub>c</sub> = <input type="text" value="0.92"/> ft
Froude Number	Fr = <input type="text" value="3.65"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	k <sub>e</sub> = <input type="text" value="0.50"/>
Friction Loss Coefficient	k <sub>f</sub> = <input type="text" value="0.28"/>
Sum of All Loss Coefficients	k <sub>s</sub> = <input type="text" value="1.78"/> ft
<b>Headwater:</b>	
Inlet Control Headwater	HW <sub>i</sub> = <input type="text" value="1.36"/> ft
Outlet Control Headwater	HW <sub>o</sub> = <input type="text" value="N/A"/> ft
Design Headwater Elevation	HW = <input type="text" value="7246.36"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="0.91"/>
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required	
<b>Outlet Protection:</b>	
Flow/(Diameter <sup>2.5</sup> )	Q/D <sup>2.5</sup> = <input type="text" value="2.04"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	Y <sub>t</sub> = <input type="text" value="0.60"/> ft
Tailwater/Diameter	Y <sub>t</sub> /D = <input type="text" value="0.40"/>
Expansion Factor	1/(2*tan(Θ)) = <input type="text" value="5.68"/>
Flow Area at Max Channel Velocity	A <sub>t</sub> = <input type="text" value="1.13"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	W <sub>eq</sub> = <input type="text" value="-"/> ft
Length of Riprap Protection	L <sub>p</sub> = <input type="text" value="5"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="3"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="0.98"/> ft
Minimum Theoretical Riprap Size	d <sub>50</sub> min = <input type="text" value="3"/> in
Nominal Riprap Size	d <sub>50</sub> nominal = <input type="text" value="6"/> in
MHFD Riprap Type	Type = <input type="text" value="VL"/>

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: \_\_\_\_\_  
 ID: B6-C



Soil Type:  
 Choose One:  
 Sandy  
 Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:	
Design Discharge	Q = <input type="text" value="3.26"/> cfs
<b>Circular Culvert:</b>	
Barrel Diameter in Inches	D = <input type="text" value="12"/> inches
Inlet Edge Type (Choose from pull-down list)	Square Edge with Headwall
<b>OR:</b>	
<b>Box Culvert:</b>	
Barrel Height (Rise) in Feet	H (Rise) = <input type="text" value="OR"/> ft
Barrel Width (Span) in Feet	W (Span) = <input type="text" value="OR"/> ft
Inlet Edge Type (Choose from pull-down list)	
Number of Barrels	# Barrels = <input type="text" value="1"/>
Inlet Elevation	Elev IN = <input type="text" value="7339.3"/> ft
Outlet Elevation <u>OR</u> Slope	Elev OUT = <input type="text" value="7329.5"/> ft
Culvert Length	L = <input type="text" value="68"/> ft
Manning's Roughness	n = <input type="text" value="0.012"/>
Bend Loss Coefficient	$k_b$ = <input type="text" value="0"/>
Exit Loss Coefficient	$k_x$ = <input type="text" value="1"/>
Tailwater Surface Elevation	$Y_t$ , Elevation = <input type="text" value=""/> ft
Max Allowable Channel Velocity	V = <input type="text" value="5"/> ft/s
Calculated Results:	
Culvert Cross Sectional Area Available	A = <input type="text" value="0.79"/> ft <sup>2</sup>
Culvert Normal Depth	$Y_n$ = <input type="text" value="0.32"/> ft
Culvert Critical Depth	$Y_c$ = <input type="text" value="0.77"/> ft
Froude Number	Fr = <input type="text" value="5.50"/> <span style="color: red;">Supercritical!</span>
Entrance Loss Coefficient	$k_e$ = <input type="text" value="0.50"/>
Friction Loss Coefficient	$k_f$ = <input type="text" value="1.80"/>
Sum of All Loss Coefficients	$k_s$ = <input type="text" value="3.30"/> ft
<b>Headwater:</b>	
Inlet Control Headwater	$HW_i$ = <input type="text" value="1.28"/> ft
Outlet Control Headwater	$HW_o$ = <input type="text" value="N/A"/> ft
Design Headwater Elevation	HW = <input type="text" value="7340.58"/> ft
Headwater/Diameter <u>OR</u> Headwater/Rise Ratio	HW/D = <input type="text" value="1.28"/>
Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required	
<b>Outlet Protection:</b>	
Flow/(Diameter <sup>2.5</sup> )	$Q/D^{2.5}$ = <input type="text" value="3.26"/> ft <sup>0.5</sup> /s
Tailwater Surface Height	$Y_t$ = <input type="text" value="0.40"/> ft
Tailwater/Diameter	$Y_t/D$ = <input type="text" value="0.40"/>
Expansion Factor	$1/(2*\tan(\Theta))$ = <input type="text" value="4.15"/>
Flow Area at Max Channel Velocity	$A_t$ = <input type="text" value="0.65"/> ft <sup>2</sup>
Width of Equivalent Conduit for Multiple Barrels	$W_{eq}$ = <input type="text" value="-"/> ft
Length of Riprap Protection	$L_p$ = <input type="text" value="3"/> ft
Width of Riprap Protection at Downstream End	T = <input type="text" value="2"/> ft
Adjusted Diameter for Supercritical Flow	Da = <input type="text" value="0.66"/> ft
Minimum Theoretical Riprap Size	$d_{50 \text{ min}}$ = <input type="text" value="3"/> in
Nominal Riprap Size	$d_{50 \text{ nominal}}$ = <input type="text" value="6"/> in
MHFD Riprap Type	Type = <input type="text" value="VL"/>

provide froude number in your analysis

ROADSIDE DITCH SUMMARY TABLE

ROADWAY	FROM STA	TO STA	PROPOSED SLOPE (%)	SIDE	SIDE SLOPE	CHANNEL DEPTH (FT)	FRICTION FACTOR	BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING	NOTES
HATBAND DRIVE	1+30	2+80	2.75%	LEFT	4:1/3:1	3	0.04	A1	41.29	100.0%	41.29	1.53	5.02	GRASS	
HATBAND DRIVE	1+30	3+40	2.75%	RIGHT	4:1/3:1	3	0.04	A2	92.96	1.0%	0.93	0.37	1.95	GRASS	
HATBAND DRIVE	2+80	3+80	2.75%	LEFT	4:1/3:1	3	0.04	A2	92.96	1.0%	0.93	0.37	1.95	GRASS	
HATBAND DRIVE	4+90	7+20	2.75%	LEFT	4:1/3:1	3	0.04	A2	92.96	1.0%	0.93	0.37	1.95	GRASS	
HATBAND DRIVE	6+13	7+20	2.75%	RIGHT	4:1/3:1	3	0.04	A2	92.96	1.0%	0.93	0.37	1.95	GRASS	
HATBAND DRIVE	12+60	15+00	1.00%	LEFT	4:1/3:1	3	0.04	B1	80.40	0.7%	0.56	0.37	1.17	GRASS	
HATBAND DRIVE	12+60	15+00	1.00%	RIGHT	4:1/3:1	3	0.04	B1	80.40	0.5%	0.40	0.33	1.08	GRASS	
HATBAND DRIVE	15+00	18+00	2.00%	LEFT	4:1/3:1	3	0.04	B1	80.40	25.0%	20.10	1.24	3.72	GRASS	
HATBAND DRIVE	15+00	18+00	2.00%	RIGHT	4:1/3:1	3	0.04	B1	80.40	0.6%	0.48	0.31	1.46	GRASS	
HATBAND DRIVE	19+75	20+45	3.00%	RIGHT	4:1/3:1	3	0.04	B1	80.40	0.1%	0.08	0.14	1.09	GRASS	
HATBAND DRIVE	20+45	22+00	2.00%	RIGHT	4:1/3:1	3	0.04	B2	38.64	1.0%	0.39	0.28	1.39	GRASS	
HATBAND DRIVE	20+20	22+75	2.40%	LEFT	4:1/3:1	3	0.04	B1	80.40	1.3%	1.05	0.40	1.90	GRASS	
SALOON DRIVE	3+30	5+70	1.25%	LEFT	4:1/3:1	3	0.04	A2	92.96	0.40%	0.37	0.30	1.15	GRASS	
SALOON DRIVE	3+30	6+10	1.50%	RIGHT	4:1/3:1	3	0.04	A2	92.96	45.0%	41.83	1.75	4.02	GRASS	
SALOON DRIVE	7+00	10+80	6.00%	LEFT	4:1/3:1	3	0.04	A2	92.96	2.0%	1.86	0.42	3.10	GRASS	
SALOON DRIVE	10+80	END	1.30%	LEFT	4:1/3:1	3	0.04	A2	92.96	1.0%	0.93	0.43	1.47	GRASS	
CAMPOUT DRIVE	7+95	8+90	9.50%	RIGHT	4:1/3:1	3	0.04	B1	80.40	0.2%	0.16	0.15	1.99	GRASS	
CAMPOUT DRIVE	11+10	12+40	7.75%	RIGHT	4:1/3:1	3	0.04	B1	80.40	0.4%	0.32	0.20	2.20	GRASS	
CAMPOUT DRIVE	11+20	14+50	5.15%	LEFT	4:1/3:1	3	0.04	B6	106.95	23.0%	24.60	1.13	5.58	GRASS	
CAMPOUT DRIVE	16+80	25+80	1.00%	LEFT	4:1/3:1	3	0.04	B6	106.95	85.0%	90.91	2.49	4.19	GRASS	
CAMPOUT DRIVE	25+80	END	1.00%	LEFT	4:1/3:1	3	0.04	B6	106.95	13.0%	13.90	1.23	2.62	GRASS	
CAMPOUT DRIVE	27+80	29+60	1.00%	RIGHT	4:1/3:1	3	0.04	B6	106.95	0.3%	0.28	0.28	0.99	GRASS	
APEX RANCH ROAD	START	3+65	2.20%	LEFT	4:1/3:1	3	0.04	OS-C1	59.93	4.3%	15.90*	1.12	3.64	GRASS	* INLCUDES FOLW FROM SUB-BASINS OS-C1, OS-A2, AND A2
APEX RANCH ROAD	3+65	4+85	4.65%	LEFT	4:1/3:1	3	0.04	OS-A2	11.46	27.0%	13.31*	0.91	4.62	GRASS	* INLCUDES FLOW FROM SUB-BASINS OS-A2, AND A2
APEX RANCH ROAD	3+70	4+30	4.20%	RIGHT	4:1/3:1	3	0.04	OS-A2	11.46	1.4%	0.16	0.18	1.47	GRASS	
APEX RANCH ROAD	12+20	16+60	10.00%	LEFT	4:1/3:1	3	0.04	A2	92.96	2.0%	1.86	0.38	3.75	GRASS	
APEX RANCH ROAD	16+60	18+30	5.15%	LEFT	4:1/3:1	3	0.04	A2	92.96	0.7%	0.65	0.28	2.25	GRASS	
APEX RANCH ROAD	12+65	16+60	10.00%	RIGHT	4:1/3:1	3	0.04	B6	106.95	2.0%	2.14	0.40	3.89	GRASS	
APEX RANCH ROAD	16+60	18+65	5.15%	RIGHT	4:1/3:1	3	0.04	B6	106.95	0.4%	0.43	0.25	2.03	GRASS	

the channel depth indicated in the roadway cross-section E is 1.75' and F is 8". revise accordingly.

exceeds permissible velocities in ECM. revise and/or provide necessary protection



# Design Data and Test Results

## Excel PP5-12™



## Specifications

A variety of test methods are utilized to determine performance and conformance values for Rolled Erosion Control Products (RECPs). Information within this document is presented to provide conformance values and recommended design values. Test results obtained for the Excel PP5-12 Turf Reinforcement Mat (TRM) and general design values are presented in Tables 1-4. For specific information detailing testing protocols, results and application of design values, refer to document number WE\_EXCEL\_PERF\_GEN.

Table 1 - Bench Scale Testing / NTPEP

Test Method	Condition	Result
ASTM D7101 Bench Scale Rainfall and Rainsplash Test	2 in per hour	14.53
	4 in per hour	5.59
	6 in per hour	4.82
ASTM D7207 Bench Scale Shear Resistance Test	3.0 psf (145 PA)	0.5 in (12 mm)
ASTM D7322 Bench Scale Vegetation Establishment Test	Top Soil, Fescue, 21 Day Incubation	661 %
NTPEP Report Number	ECP-2016-03-008	

Table 3 - Recommended Design Values\*

Design Value	Unvegetated	Vegetated
Typical RUSLE Cover Factor (C Factor)**	0.03	N/A
Maximum Slope Gradient (RUSLE)	1H : 1V	N/A
Max Allowable Velocity (0.5 in (12mm) soil loss)***	9.0 ft/s (2.7 m/s)	15.0 ft/s (4.6 m/s)
Max Allowable Shear Stress (0.5 in (12mm) soil loss)***	2.8 psf (134 PA)	12.0 psf (575 PA)
CF <sub>veg</sub> /CF <sub>TRM</sub>	N/A	0.26

\*\*C Factor value compliant with ASTM D6459. \*\*\* Shear Stress and Velocity values compliant with ASTM D6460.

Table 2 - Texas Transportation Institute (TTI) Results

Class	Test Condition	Result
A	< 3H:1 Clay Slope Test	N/A
B	< 3H:1 Sand Slope Test	N/A
C	> 3H:1 Clay Slope Test	N/A
D	> 3H:1 Sand Slope Test	N/A
E	2 psf Partially Vegetated Channel Test	Approved
F	4 psf Partially Vegetated Channel Test	Approved
G	6 psf Partially Vegetated Channel Test	Approved
H	8 psf Partially Vegetated Channel Test	Approved

Table 4 - HEC-15 Resistance to Flow Values

Design Value	Unvegetated
Manning's n @ Tau lower (0.7 psf (34 PA))	0.027
Manning's n @ Tau mid (1.4 psf (67 PA))	0.027
Manning's n @ Tau upper (2.8 psf (134 PA))	0.027

\*Recommended Design Values are based on results of standardized industry full-scale testing and may not be applicable for all field conditions. For most accurate computation of field performance, consult Excel Erosion Design (EED) at [www.westernexcelsior.com](http://www.westernexcelsior.com).

The information contained herein may represent product index data, performance ratings, bench scale testing or other material utility quantifications. Each representation may have unique utility and limitations. Every effort has been made to ensure accuracy, however, no warranty is claimed and no liability shall be assumed by Western Excelsior Corporation (WEC) or its affiliates regarding the completeness, accuracy or fitness of these values for any particular application or interpretation. While testing methods are provided for reference, values shown may be derived from interpolation or adjustment to be representative of intended use. For further information, please feel free to contact WEC.

## Elbert Rd Roadside Ditch

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### Project Description

---

Friction Method	Manning Formula
Solve For	Normal Depth

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### Input Data

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Channel Slope	0.020 ft/ft
Discharge	64.40 cfs

---

### Section Definitions

	Station (ft)		Elevation (ft)
	0+00		88.75
	0+05		86.30
	0+15		86.30
	0+20		88.75

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 88.75)	(0+05, 86.30)	0.025
(0+05, 86.30)	(0+15, 86.30)	0.025
(0+15, 86.30)	(0+20, 88.75)	0.025

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### Options

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Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

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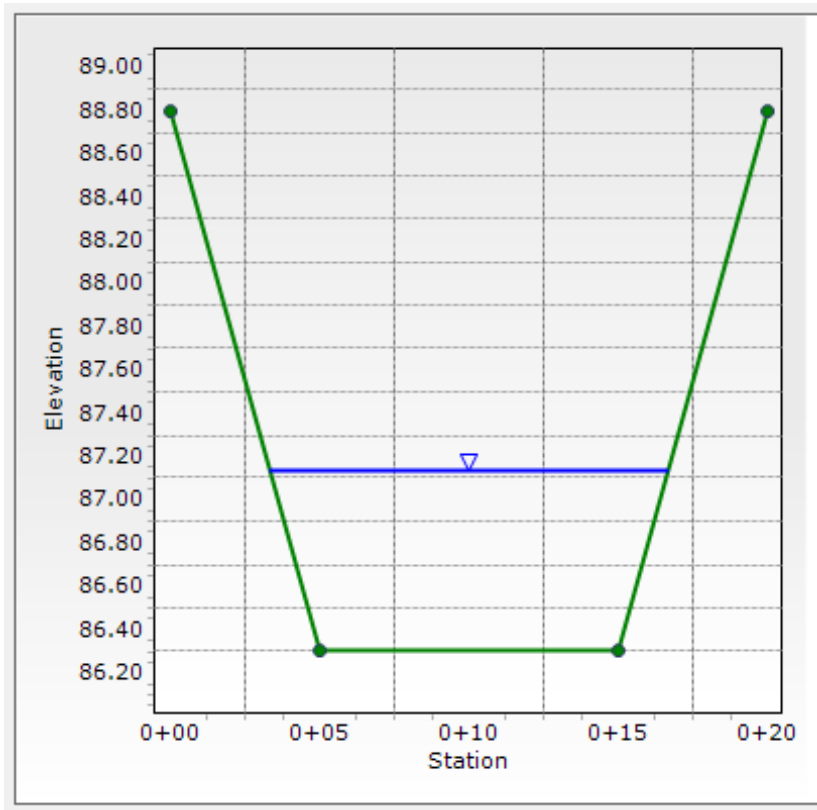
### Results

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Normal Depth	9.9 in
Roughness Coefficient	0.025
Elevation	87.13 ft
Elevation Range	86.3 to 88.8 ft
Flow Area	9.7 ft <sup>2</sup>
Wetted Perimeter	13.8 ft
Hydraulic Radius	8.4 in
Top Width	13.38 ft
Normal Depth	9.9 in
Critical Depth	12.1 in
Critical Slope	0.010 ft/ft
Velocity	6.65 ft/s
Velocity Head	0.69 ft
Specific Energy	1.52 ft
Froude Number	1.378

## Elbert Rd Roadside Ditch

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	9.9 in
Critical Depth	12.1 in
Channel Slope	0.020 ft/ft
Critical Slope	0.010 ft/ft



Rock Chute ID	Forebay ID	Rock Chute Location	Contributing Basins	Q100 Flow (cfs)	Upstream Inlet Apron Length (ft)	Drop (ft) ( <i>Inlet Apron to Outlet Apron</i> )	Chute Length (ft)	Downstream Outlet Apron Length (ft)	Chute Width (ft)	D50 (in)	Rock Chute Thickness (in)	Rock Chute Depth* (ft)	Top Width (ft)
A2-W	A2-W	Pond A2	A2	18	10	3	16	7	10	6	12	2.0	26.0
A2-C	A2-C	Pond A2	A2	3	10	8	36	7	10	6	12	1.5	22.0
A2-E	A2-E	Pond A2	A2	18	10	9	40	7	10	6	12	1.5	22.0
B1-E	B1-E	Pond B1	B1	5	10	3.75	19	10	10	6	12	2.0	26.0
B8-W	B8-W	Pond B8	B6, B8	119	13	8	36	17	10	18	36	3.0	34.0
B8-E	B8-E	Pond B8	B8	23	10	9	36	8	10	6	12	2.0	26.0

**NOTES:**

\*: Rock Chute Depth accounts for 0.5' of freeboard.

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

**Project:** Pond A2- East Chute  
**Designer:** KRK  
**Date:** April 30, 2024

**County:** El Paso County  
**Checked by:** \_\_\_\_\_  
**Date:** \_\_\_\_\_

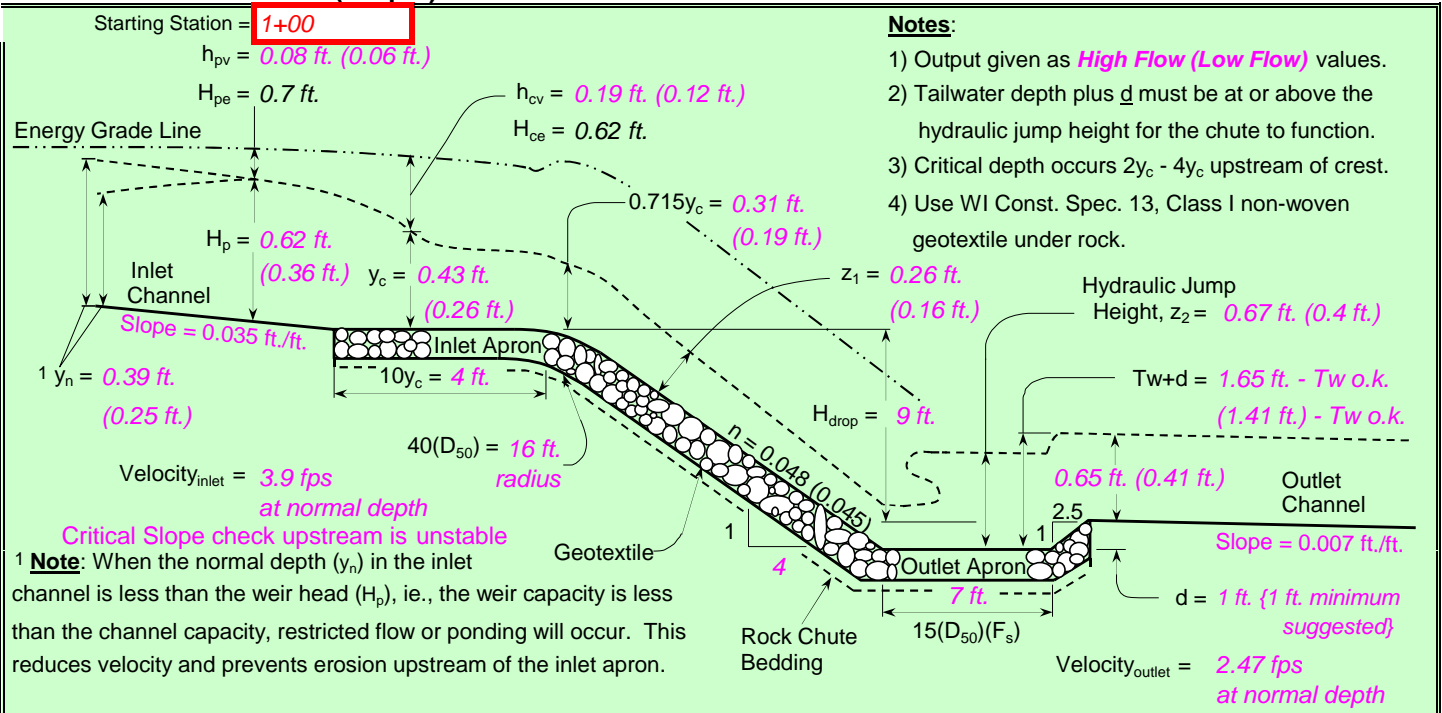
**Input Geometry:**

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ ) <b>1.2 Min</b>	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → <b>2.0:1 max.</b>	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → <b>3.0:1 max.</b>	Bed slope = 0.0070 ft./ft.
<i>Note: n value = a) velocity n from waterway program or b) computed manning's n for channel</i>	Freeboard = 0.5 ft. →	Base flow = 0.0 cfs
	Outlet apron depth, d = 1.0 ft.	

**Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):**

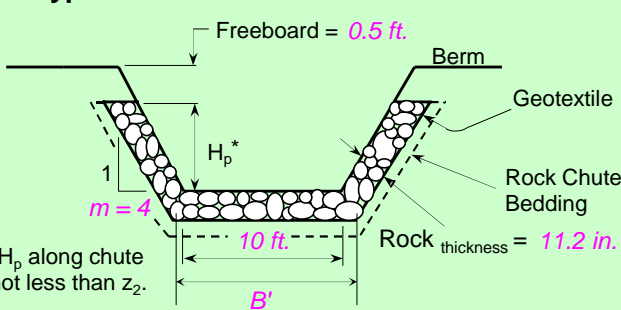
Apron elev. --- Inlet = 205.0 ft. ----- Outlet 195.0 ft. --- ( $H_{drop} = 9$ ft.)		<b>Note:</b> The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410		<b>Input tailwater (<math>T_w</math>):</b> 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.		
$Q_{high} = 17.7$ cfs High flow storm through chute	→ $T_w$ (ft.) = Program	
$Q_5 = 8.0$ cfs Low flow storm through chute	→ $T_w$ (ft.) = Program	

**Profile and Cross Section (Output):**



**Profile Along Centerline of Chute**

**Typical Cross Section**



$F_s =$ <u>1.20</u>	Factor of safety (multiplier)
$Z_1 =$ <u>0.26 ft.</u>	Normal depth in chute
n-value = <u>0.048</u>	Manning's roughness coefficient
$D_{50}(F_s) =$ <u>5.6 in.</u>	Minimum Design $D_{50}$ *
$2(D_{50})(F_s) =$ <u>11.2 in.</u>	Rock chute thickness
$T_w + d =$ <u>1.65 ft.</u>	Tailwater above outlet apron
$Z_2 =$ <u>0.67 ft.</u>	Hydraulic jump height
<b>*** The outlet will function adequately</b>	

**High Flow Storm Information**



# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

**Project:** Pond A2- Center Chute  
**Designer:** KRK  
**Date:** April 30, 2024

**County:** El Paso County  
**Checked by:** \_\_\_\_\_  
**Date:** \_\_\_\_\_

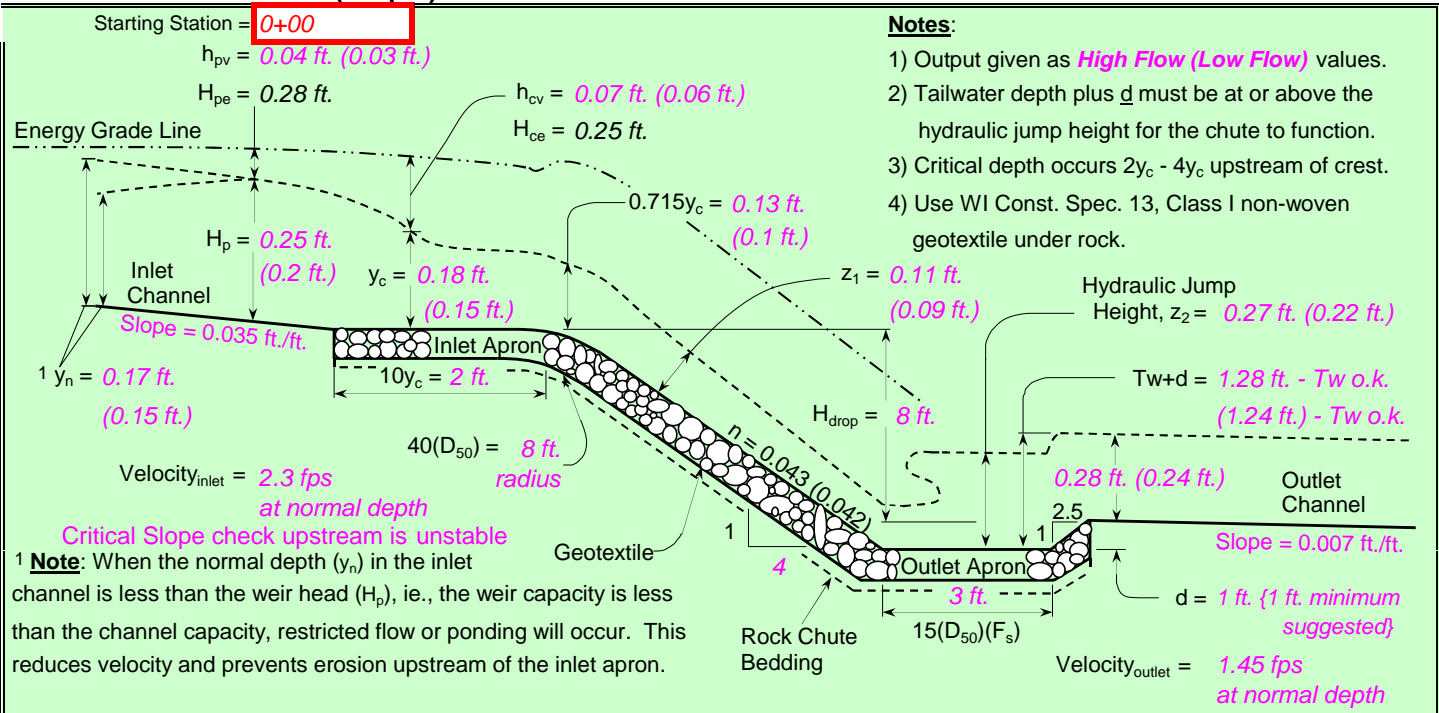
**Input Geometry:**

Upstream Channel	Chute	Downstream Channel
Bw = 6.0 ft.	Bw = 6.0 ft.	Bw = 6.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ ) <b>1.2 Min</b>	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → <b>2.0:1 max.</b>	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → <b>3.0:1 max.</b>	Bed slope = 0.0070 ft./ft.
<i>Note: n value = a) velocity n from waterway program or b) computed manning's n for channel</i>	Freeboard = 0.5 ft. →	Base flow = 0.0 cfs
	Outlet apron depth, d = 1.0 ft.	

**Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):**

Apron elev. --- Inlet = <b>204.0</b> ft. ----- Outlet <b>195.0</b> ft. --- ( $H_{drop} = 8$ ft.)		<b>Note:</b> The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410		<b>Input tailwater (<math>T_w</math>):</b> 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.		
$Q_{high} = 2.7$ cfs High flow storm <b>through chute</b>	→ $T_w$ (ft.) = <b>Program</b>	
$Q_5 = 2.0$ cfs Low flow storm <b>through chute</b>	→ $T_w$ (ft.) = <b>Program</b>	

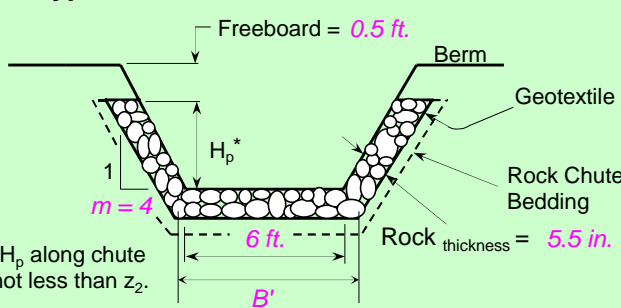
**Profile and Cross Section (Output):**



**1 Note:** When the normal depth ( $y_n$ ) in the inlet channel is less than the weir head ( $H_p$ ), i.e., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

**Profile Along Centerline of Chute**

**Typical Cross Section**



\* Use  $H_p$  along chute but not less than  $Z_2$ .

$F_s = 1.20$	Factor of safety (multiplier)
$n = 0.043$	Manning's roughness coefficient
$D_{50}(F_s) = 2.7$ in.	Minimum Design $D_{50}$ *
$2(D_{50})(F_s) = 5.5$ in.	Rock chute thickness
$T_w + d = 1.28$ ft.	Tailwater above outlet apron
$Z_2 = 0.27$ ft.	Hydraulic jump height
<b>*** The outlet will function adequately</b>	

**High Flow Storm Information**

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

**Project:** Pond A2- West Chute  
**Designer:** KRK  
**Date:** April 30, 2024

**County:** El Paso County  
**Checked by:** \_\_\_\_\_  
**Date:** \_\_\_\_\_

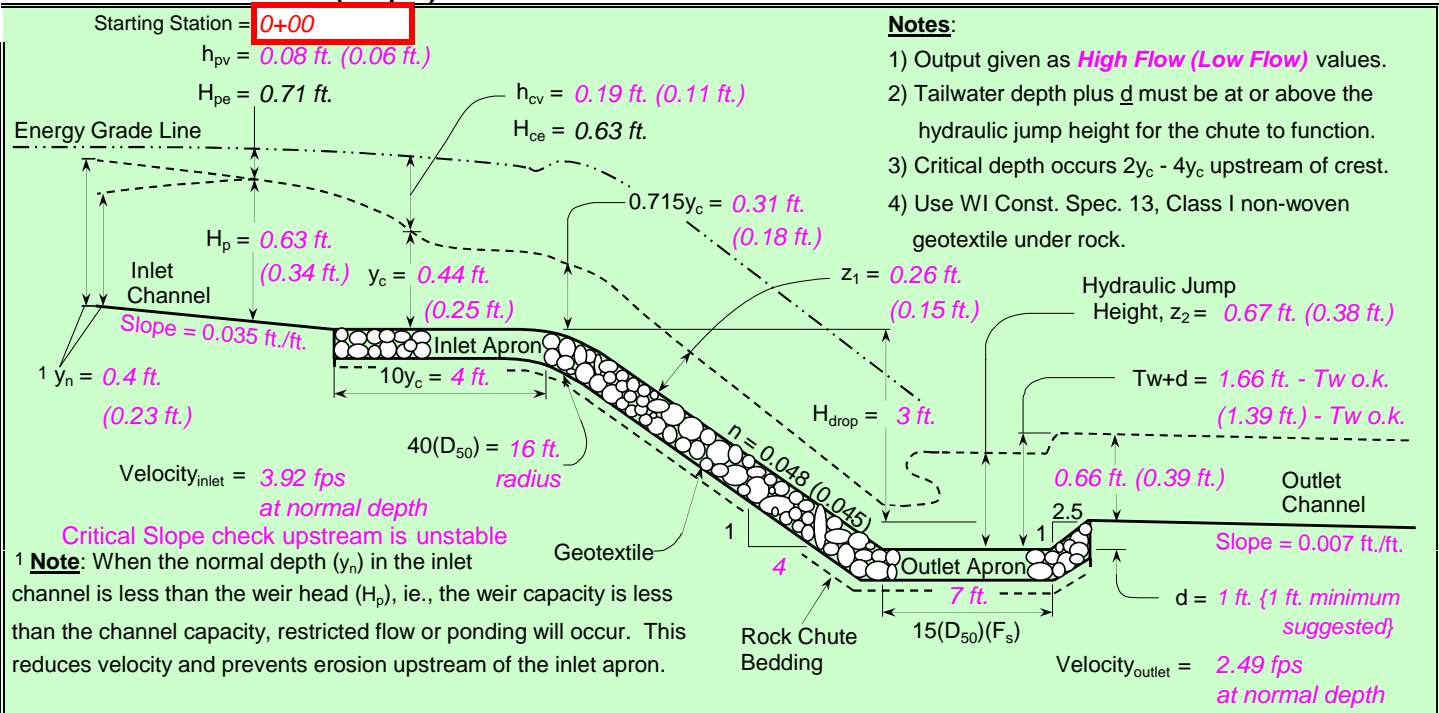
**Input Geometry:**

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ ) <b>1.2 Min</b>	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → <b>2.0:1 max.</b>	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → <b>3.0:1 max.</b>	Bed slope = 0.0070 ft./ft.
<i>Note: n value = a) velocity n from waterway program or b) computed manning's n for channel</i>	Freeboard = 0.5 ft. →	Base flow = 0.0 cfs
	Outlet apron depth, d = 1.0 ft.	

**Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):**

Apron elev. --- Inlet = 199.0 ft. ----- Outlet 195.0 ft. --- ( $H_{drop} = 3$ ft.)		<b>Note:</b> The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410		<b>Input tailwater (<math>T_w</math>):</b> 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.		
$Q_{high} = 17.9$ cfs High flow storm through chute	→ $T_w$ (ft.) = Program	
$Q_5 = 7.3$ cfs Low flow storm through chute	→ $T_w$ (ft.) = Program	

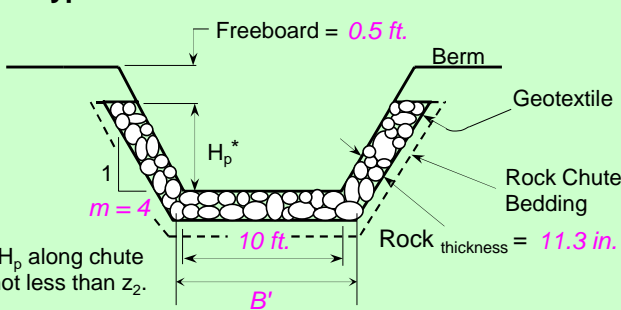
**Profile and Cross Section (Output):**



**1 Note:** When the normal depth ( $y_n$ ) in the inlet channel is less than the weir head ( $H_p$ ), i.e., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

**Profile Along Centerline of Chute**

**Typical Cross Section**



$F_s = 1.20$	Equivalent unit discharge
$Z_1 = 0.26$ ft.	Factor of safety (multiplier)
n-value = 0.048	Normal depth in chute
$D_{50}(F_s) = 5.6$ in.	Manning's roughness coefficient
$2(D_{50})(F_s) = 11.3$ in.	Minimum Design $D_{50}$ *
$T_w + d = 1.66$ ft.	Rock chute thickness
$Z_2 = 0.67$ ft.	Tailwater above outlet apron
<b>*** The outlet will function adequately</b>	Hydraulic jump height

**High Flow Storm Information**

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

**Project:** Pond B1- East Chute  
**Designer:** KRK  
**Date:** April 30, 2024

**County:** El Paso County  
**Checked by:** \_\_\_\_\_  
**Date:** \_\_\_\_\_

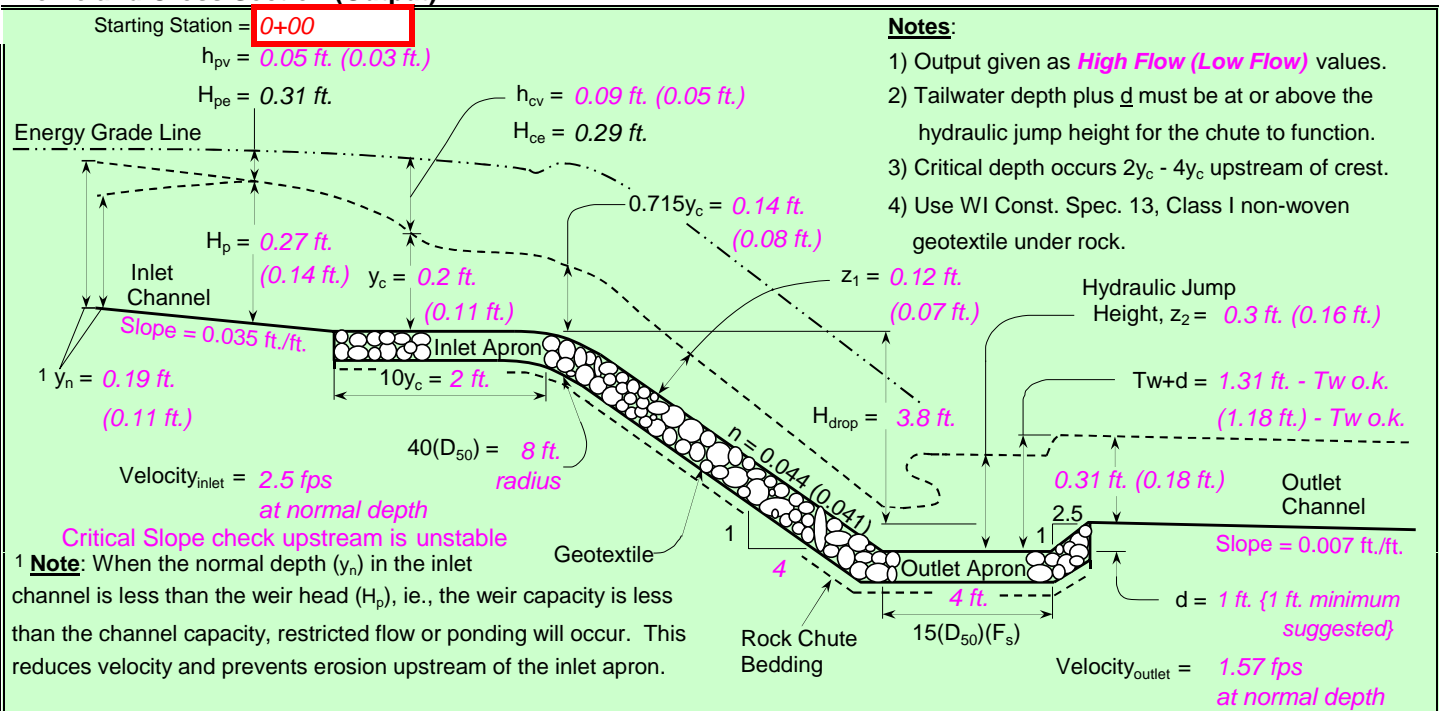
**Input Geometry:**

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ ) <b>1.2 Min</b>	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → <b>2.0:1 max.</b>	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → <b>3.0:1 max.</b>	Bed slope = 0.0070 ft./ft.
<i>Note: n value = a) velocity n from waterway program or b) computed manning's n for channel</i>	Freeboard = 0.5 ft. →	Base flow = 0.0 cfs
	Outlet apron depth, d = 1.0 ft.	

**Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):**

Apron elev. --- Inlet = 199.0 ft. ----- Outlet 194.3 ft. --- ( $H_{drop} = 3.8$ ft.)	<b>Note:</b> The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410	<b>Input tailwater (<math>T_w</math>):</b> 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.	
$Q_{high} = 5.1$ cfs High flow storm through chute → $T_w$ (ft.) = Program	
$Q_5 = 2.0$ cfs Low flow storm through chute → $T_w$ (ft.) = Program	

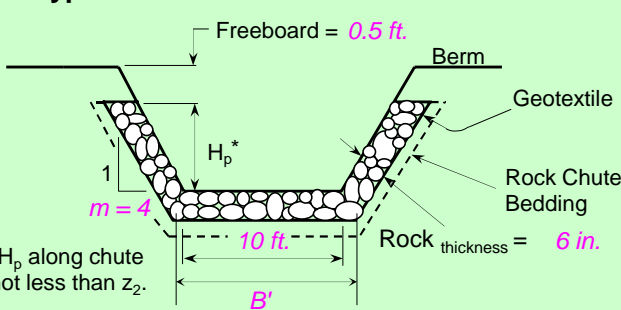
**Profile and Cross Section (Output):**



**1 Note:** When the normal depth ( $y_n$ ) in the inlet channel is less than the weir head ( $H_p$ ), i.e., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

**Profile Along Centerline of Chute**

**Typical Cross Section**



$F_s = 1.20$	Factor of safety (multiplier)
$n = 0.044$	Manning's roughness coefficient
$D_{50}(F_s) = 3$ in.	Minimum Design $D_{50}^*$
$2(D_{50})(F_s) = 6$ in.	Rock chute thickness
$T_w + d = 1.31$ ft.	Tailwater above outlet apron
$z_2 = 0.3$ ft.	Hydraulic jump height
<b>*** The outlet will function adequately</b>	

**High Flow Storm Information**

\* Use  $H_p$  along chute but not less than  $z_2$ .

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

**Project:** Pond B8- East Chute  
**Designer:** KRK  
**Date:** April 30, 2024

**County:** El Paso County  
**Checked by:** \_\_\_\_\_  
**Date:** \_\_\_\_\_

**Input Geometry:**

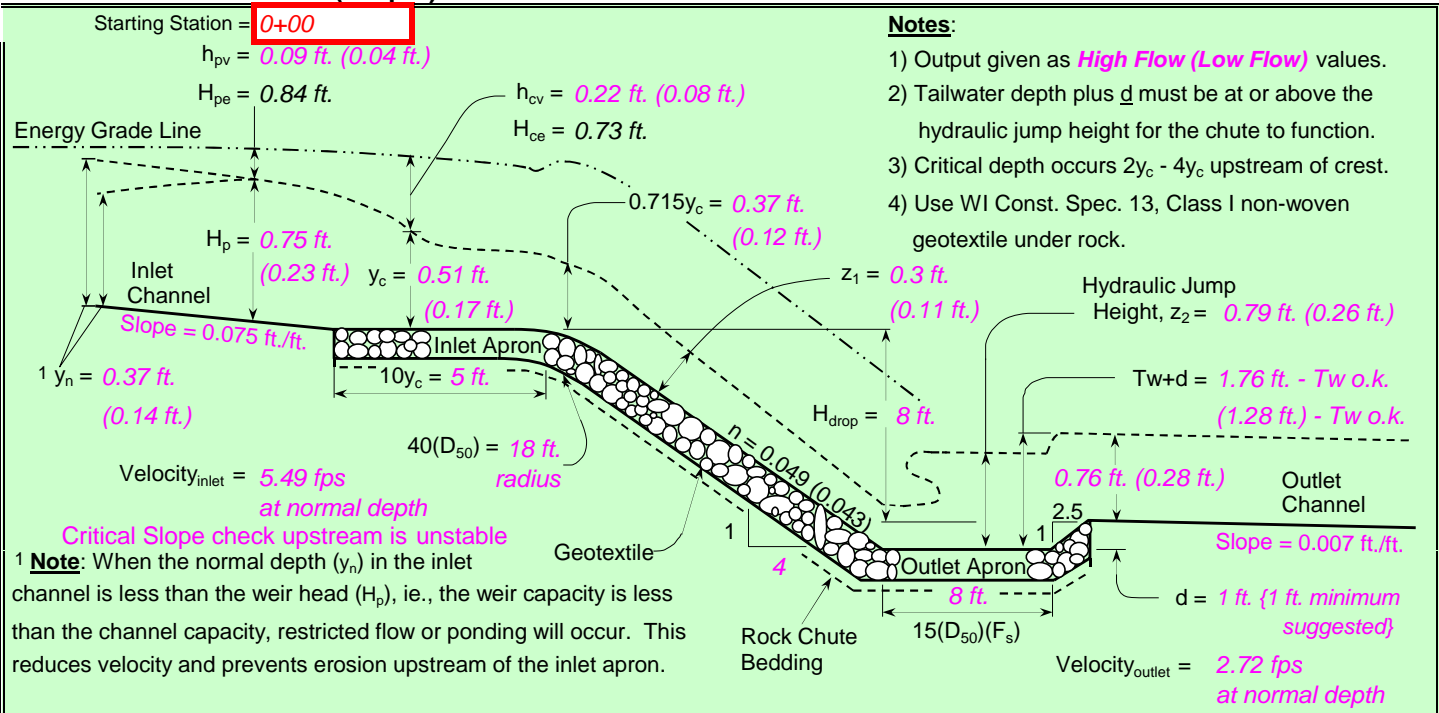
Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 (F <sub>s</sub> ) <b>1.2 Min</b>	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → <b>2.0:1 max.</b>	Velocity n-value = 0.035
Bed slope = 0.0750 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → <b>3.0:1 max.</b>	Bed slope = 0.0070 ft./ft.
	Freeboard = 0.5 ft. →	
	Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

*Note: n value = a) velocity n from waterway program  
 or b) computed manning's n for channel*

**Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):**

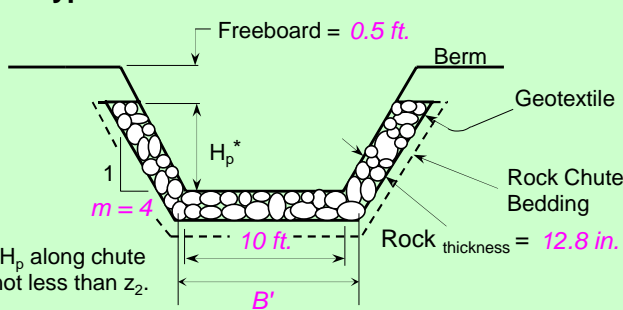
Apron elev. --- Inlet = 197.0 ft. ----- Outlet 188.0 ft. --- (H <sub>drop</sub> = 8 ft.)		<b>Note:</b> The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
Q <sub>high</sub> = Runoff from design storm capacity from Table 2, FOTG Standard 410		<b>Input tailwater (Tw):</b> 0.25 1.20
Q <sub>5</sub> = Runoff from a 5-year, 24-hour storm.		
Q <sub>high</sub> = 23.1 cfs	High flow storm through chute	Tw (ft.) = Program
Q <sub>5</sub> = 4.2 cfs	Low flow storm through chute	Tw (ft.) = Program

**Profile and Cross Section (Output):**



**Profile Along Centerline of Chute**

**Typical Cross Section**



$F_s =$ 1.20	Factor of safety (multiplier)
$Z_1 =$ 0.3 ft.	Normal depth in chute
n-value = 0.049	Manning's roughness coefficient
$D_{50}(F_s) =$ 6.4 in.	Minimum Design D50*
$2(D_{50})(F_s) =$ 12.8 in.	Rock chute thickness
Tw + d = 1.76 ft.	Tailwater above outlet apron
$Z_2 =$ 0.79 ft.	Hydraulic jump height
<b>*** The outlet will function adequately</b>	

**High Flow Storm Information**



# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

**Project:** Pond B8- West Chute  
**Designer:** KRK  
**Date:** April 30, 2024

**County:** El Paso County  
**Checked by:** \_\_\_\_\_  
**Date:** \_\_\_\_\_

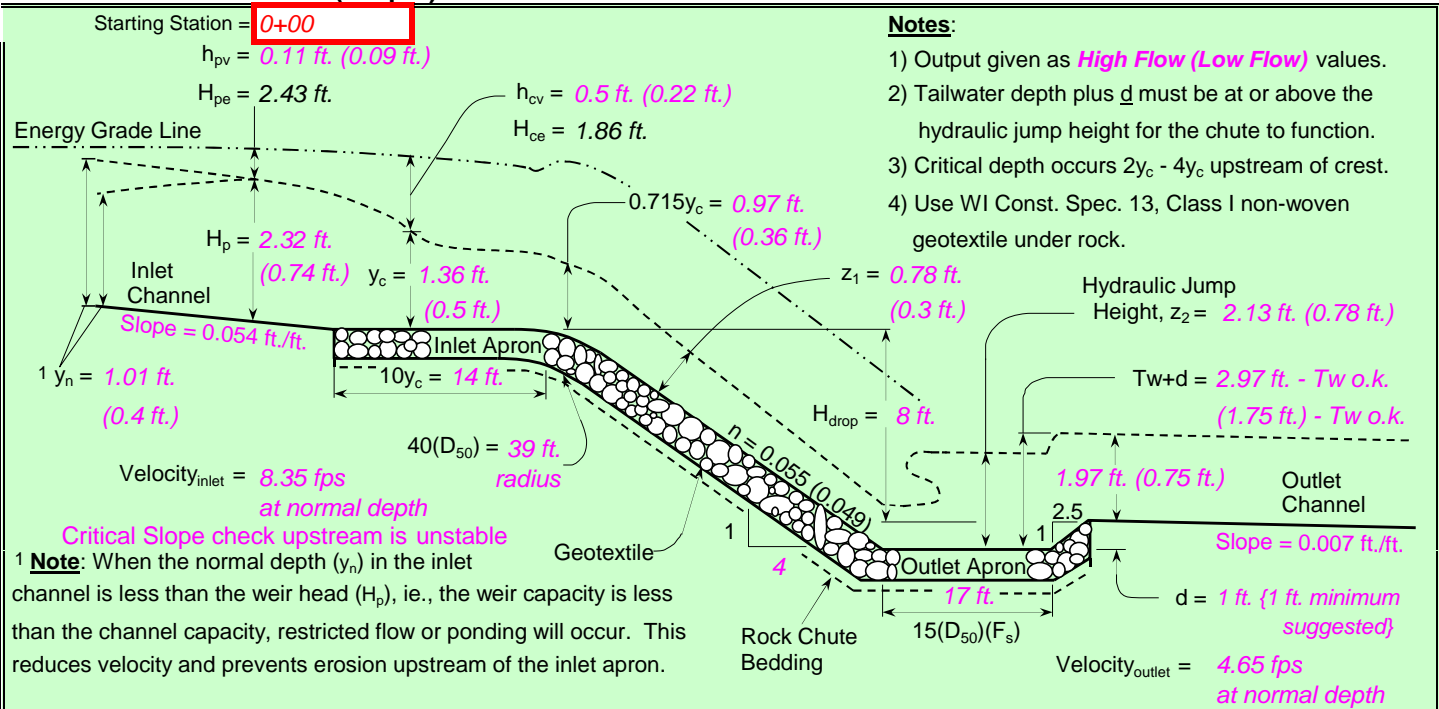
**Input Geometry:**

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ ) <b>1.2 Min</b>	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → <b>2.0:1 max.</b>	Velocity n-value = 0.035
Bed slope = 0.0540 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → <b>3.0:1 max.</b>	Bed slope = 0.0070 ft./ft.
<i>Note: n value = a) velocity n from waterway program or b) computed manning's n for channel</i>	Freeboard = 0.5 ft. →	Base flow = 0.0 cfs
	Outlet apron depth, d = 1.0 ft.	

**Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):**

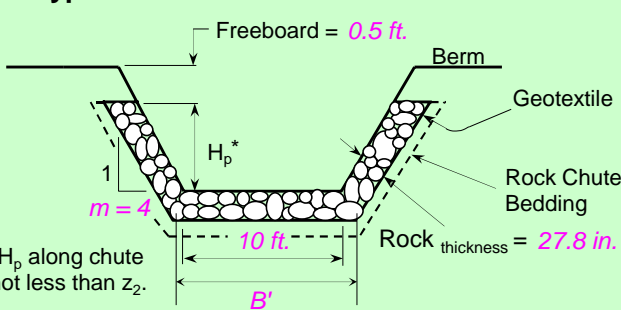
Apron elev. --- Inlet = 197.0 ft. ----- Outlet 188.0 ft. --- ( $H_{drop} = 8$ ft.)		<b>Note:</b> The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410		<b>Input tailwater (<math>T_w</math>):</b> 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.		
$Q_{high} = 119.0$ cfs High flow storm through chute	→ $T_w$ (ft.) = Program	
$Q_5 = 22.6$ cfs Low flow storm through chute	→ $T_w$ (ft.) = Program	

**Profile and Cross Section (Output):**



**Profile Along Centerline of Chute**

**Typical Cross Section**



$F_s =$ <u>1.20</u>	Factor of safety (multiplier)
$Z_1 =$ <u>0.78 ft.</u>	Normal depth in chute
n-value = <u>0.055</u>	Manning's roughness coefficient
$D_{50}(F_s) =$ <u>13.9 in.</u>	Minimum Design $D_{50}$ *
$2(D_{50})(F_s) =$ <u>27.8 in.</u>	Rock chute thickness
$T_w + d =$ <u>2.97 ft.</u>	Tailwater above outlet apron
$Z_2 =$ <u>2.13 ft.</u>	Hydraulic jump height
<b>*** The outlet will function adequately</b>	

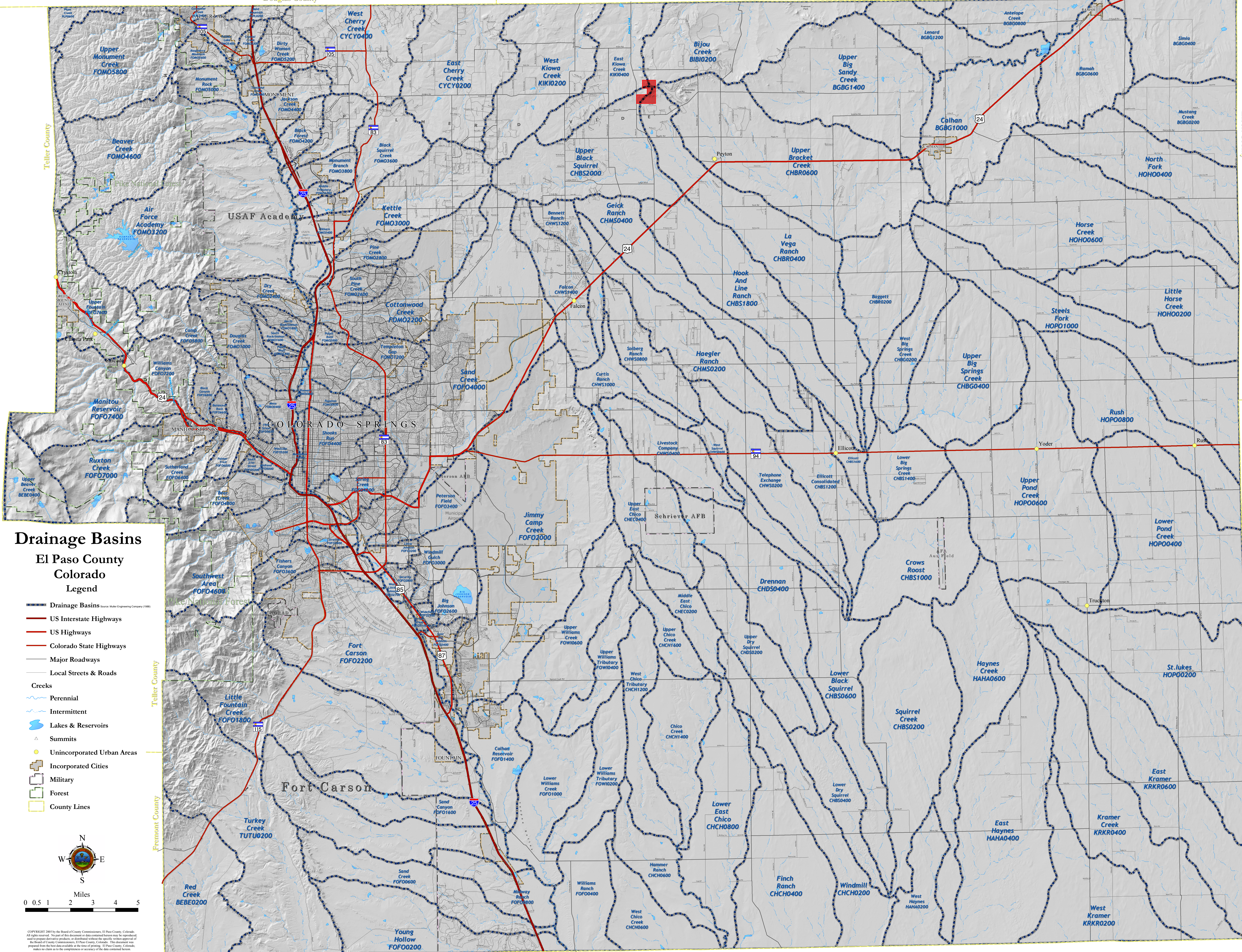
**High Flow Storm Information**

***APPENDIX E: EL PASO COUNTY DRAINAGE BASIN MAP***



Douglas County

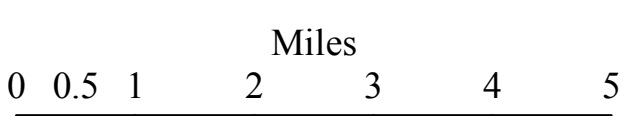
Elbert County



# Drainage Basins

## El Paso County Colorado Legend

- Drainage Basins (Source: Mule Engineering Company 1988)
- US Interstate Highways
- US Highways
- Colorado State Highways
- Major Roadways
- Local Streets & Roads
- Creeks**
- Perennial
- Intermittent
- Lakes & Reservoirs
- Summits
- Unincorporated Urban Areas
- Incorporated Cities
- Military
- Forest
- County Lines



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***APPENDIX F: APEX RANCH DRAINAGE REPORT***



# Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: QUENTIN ARMIJO  
 Company: TERRA NOVA ENG.  
 Date: April 2, 2008  
 Project: APEX RANCH ESTATES  
 Location: PEYTON, CO

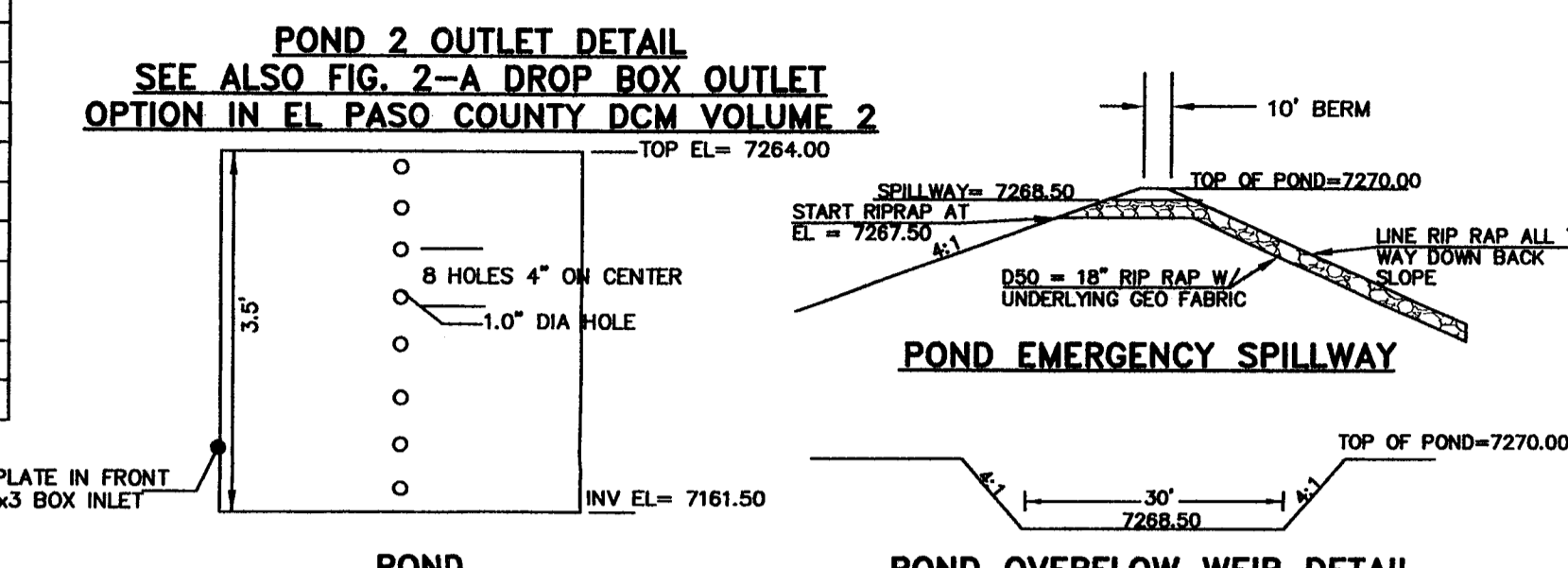
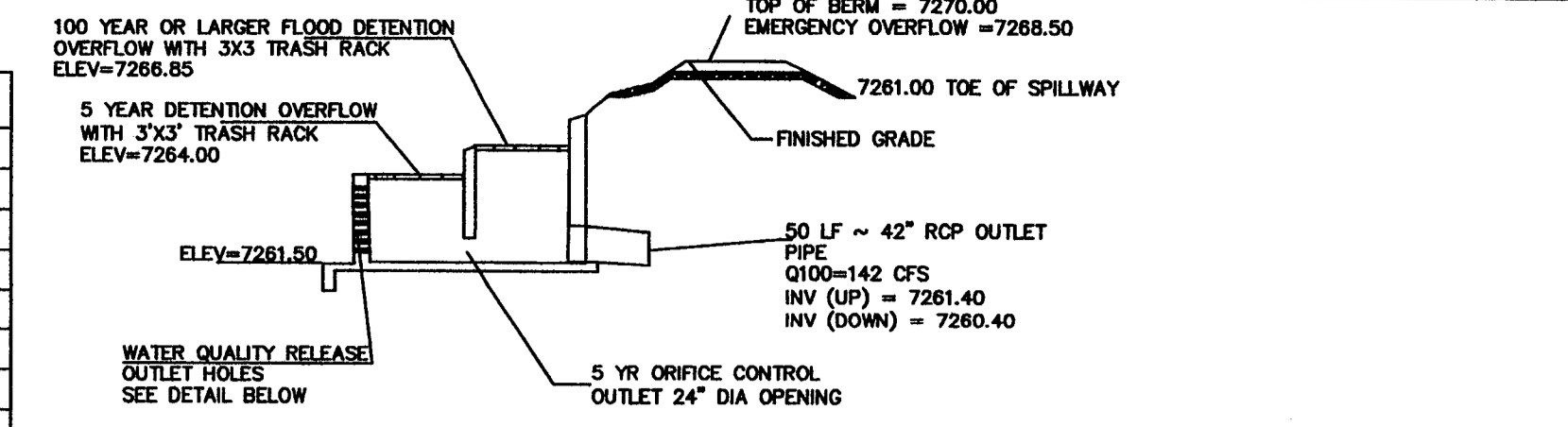
<p>1. Basin Storage Volume</p> <p>A) Tributary Area's Imperviousness Ratio (<math>i = I_a / 100</math>)</p> <p>B) Contributing Watershed Area (Area)</p> <p>C) Water Quality Capture Volume (WQCV) (<math>WQCV = 1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I)</math>)</p> <p>D) Design Volume: <math>Vol = (WQCV / 12) * Area * 1.2</math></p>	<p><math>I_a =</math> <u>10.00</u> %</p> <p><math>i =</math> <u>0.10</u></p> <p>Area = <u>76.80</u> acres</p> <p>WQCV = <u>0.07</u> watershed inches</p> <p>Vol = <u>0.515</u> acre-feet</p>
<p>2. Outlet Works</p> <p>A) Outlet Type (Check One)</p> <p>B) Depth at Outlet Above Lowest Perforation (H)</p> <p>C) Required Maximum Outlet Area per Row, (<math>A_o</math>)</p> <p>D) Perforation Dimensions (<b>enter one only</b>):            i) Circular Perforation Diameter <b>OR</b>            ii) 2" Height Rectangular Perforation Width</p> <p>E) Number of Columns (<math>nc</math>, See Table 6a-1 For Maximum)</p> <p>F) Actual Design Outlet Area per Row (<math>A_o</math>)</p> <p>G) Number of Rows (<math>nr</math>)</p> <p>H) Total Outlet Area (<math>A_{ot}</math>)</p>	<p><input checked="" type="checkbox"/> Orifice Plate</p> <p><input type="checkbox"/> Perforated Riser Pipe</p> <p>Other: _____</p> <hr/> <p>H = <u>2.50</u> feet</p> <p><math>A_o =</math> <u>0.81</u> square inches</p> <p>D = <u>1.0000</u> inches, <b>OR</b>            W = _____ inches</p> <p><math>nc =</math> <u>1</u> number</p> <p><math>A_o =</math> <u>0.79</u> square inches</p> <p><math>nr =</math> <u>8</u> number</p> <p><math>A_{ot} =</math> <u>5.89</u> square inches</p>
<p>3. Trash Rack</p> <p>A) Needed Open Area: <math>A_t = 0.5 * (\text{Figure 7 Value}) * A_{ot}</math></p> <p>B) Type of Outlet Opening (Check One)</p> <p>C) For 2", or Smaller, <b>Round Opening</b> (Ref.: Figure 6a):</p> <p style="margin-left: 20px;">i) Width of Trash Rack and Concrete Opening (<math>W_{conc}</math>) from Table 6a-1</p> <p style="margin-left: 20px;">ii) Height of Trash Rack Screen (<math>H_{TR}</math>)</p>	<p><math>A_t =</math> <u>200</u> square inches</p> <p><input checked="" type="checkbox"/> <b>&lt; 2" Diameter Round</b></p> <p><input type="checkbox"/> <b>2" High Rectangular</b></p> <p>Other: _____</p> <hr/> <p><math>W_{conc} =</math> <u>9</u> inches</p> <p><math>H_{TR} =</math> <u>54</u> inches</p>

# APEX RANCH ESTATES EL PASO COUNTY, COLORADO FINAL DRAINAGE MAP AUGUST 2008

412200006  
COLLEEN KRASOVICH  
3650 GARRISON ST  
WHEAT RIDGE, CO.  
ZONED A-35

### DEVELOPED CONDITIONS

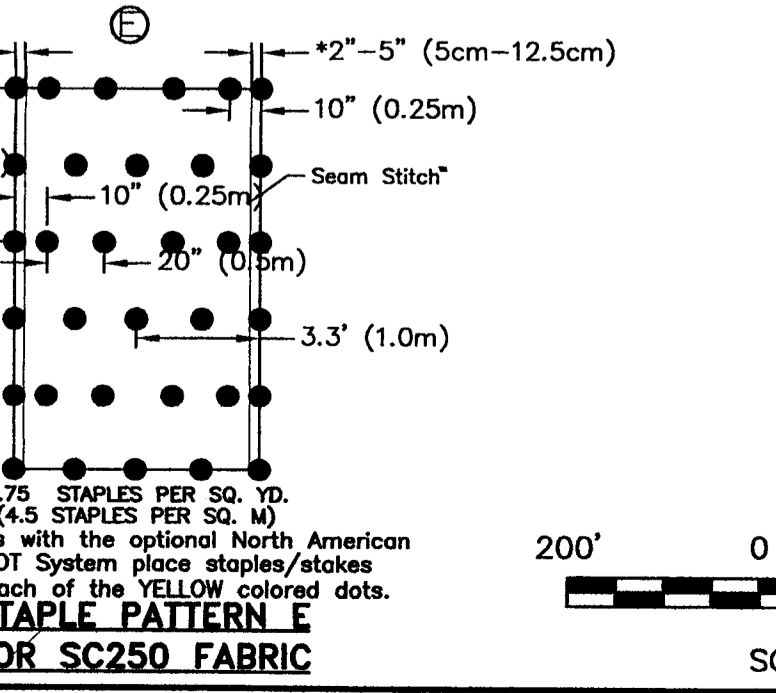
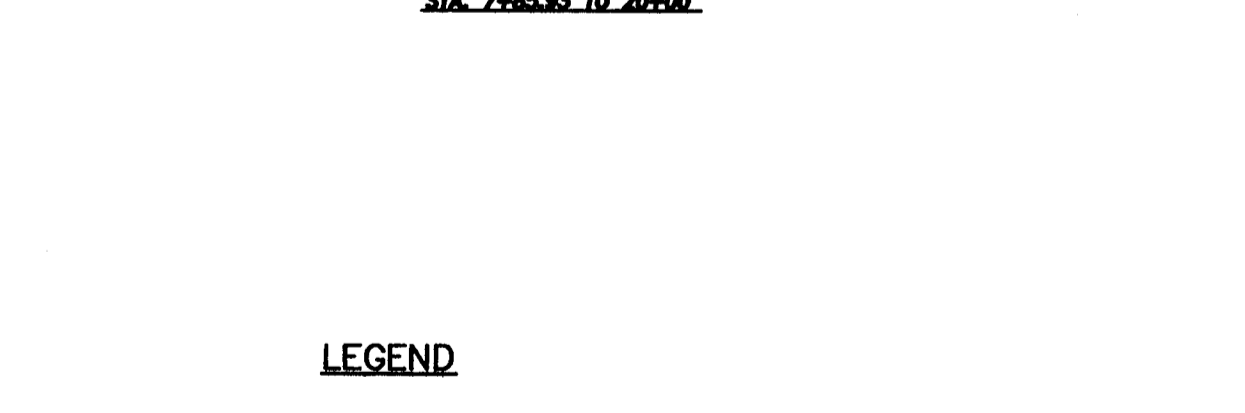
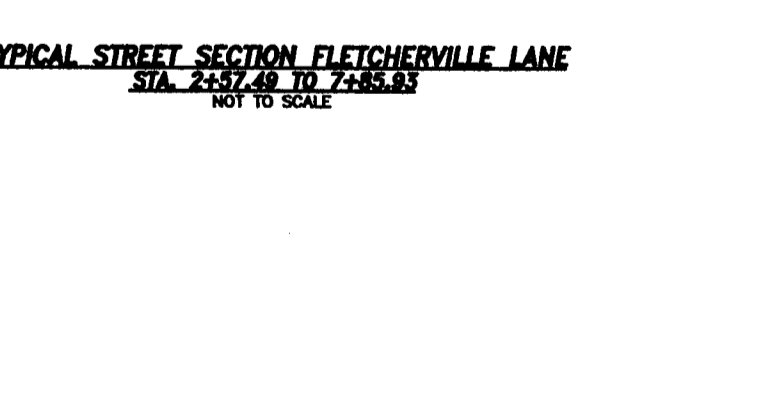
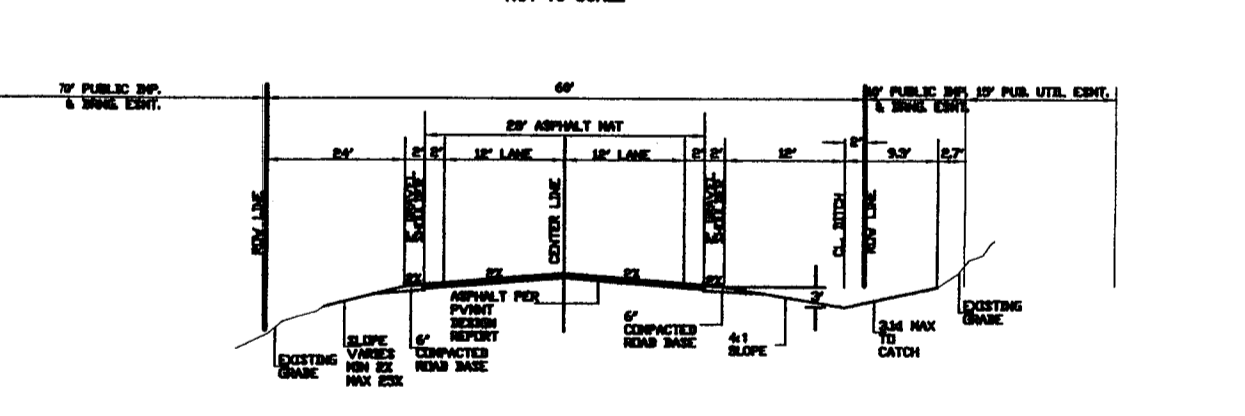
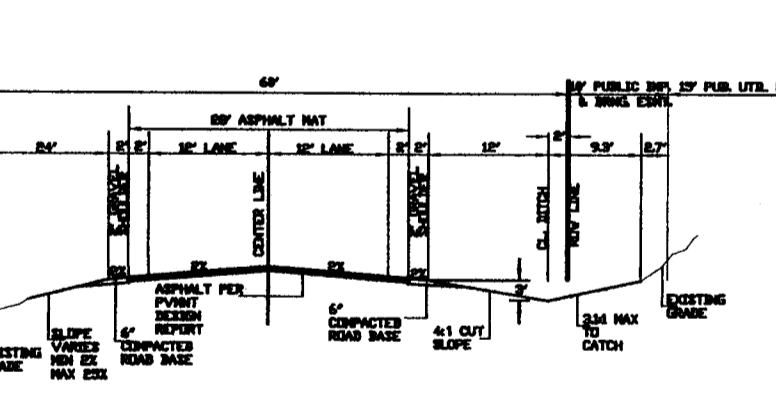
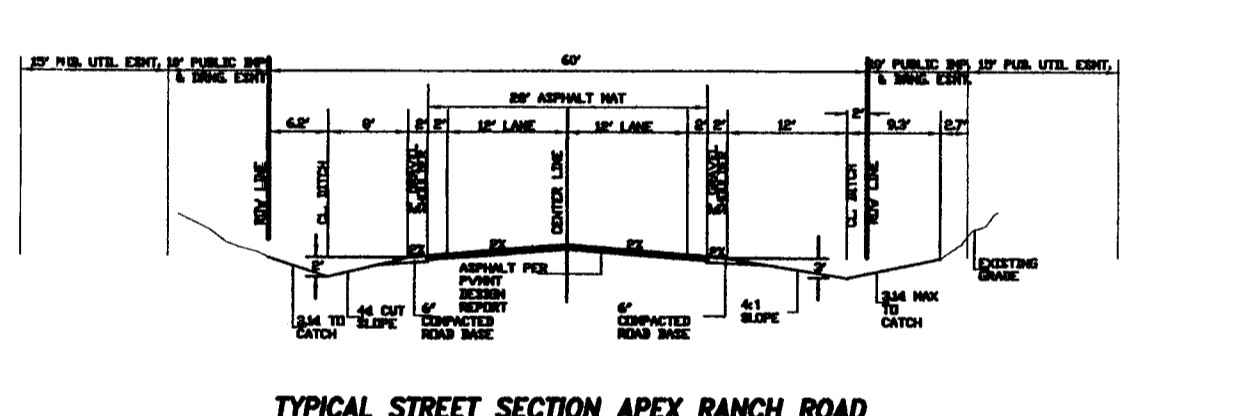
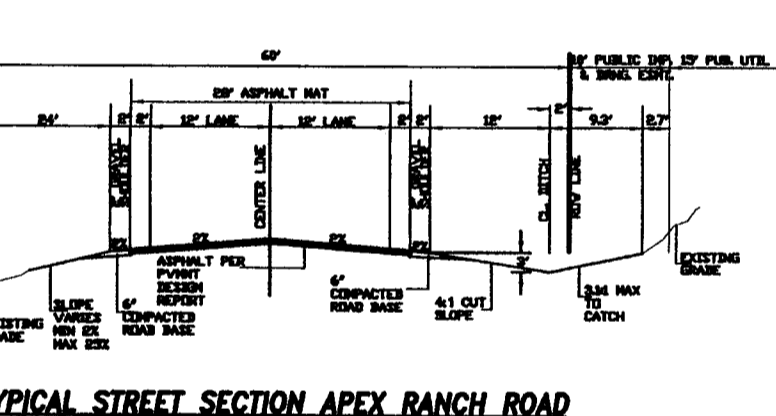
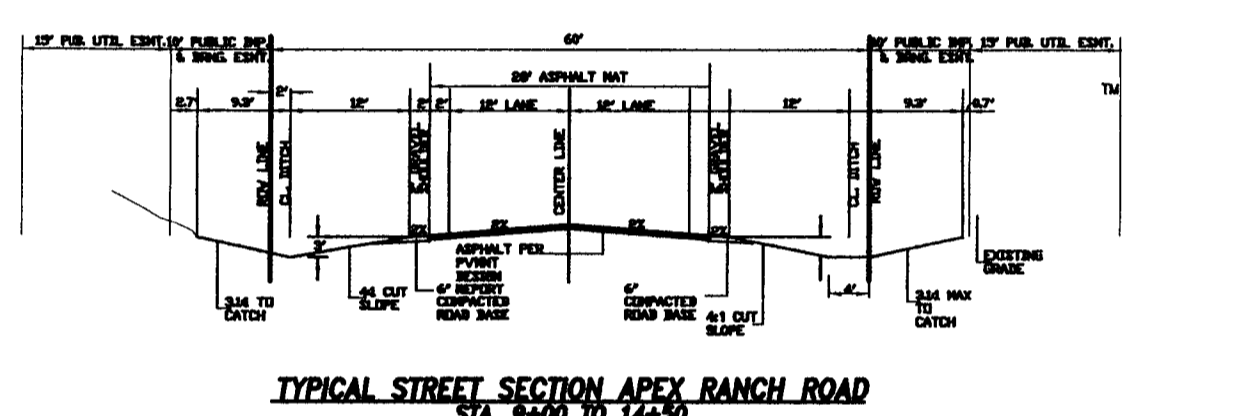
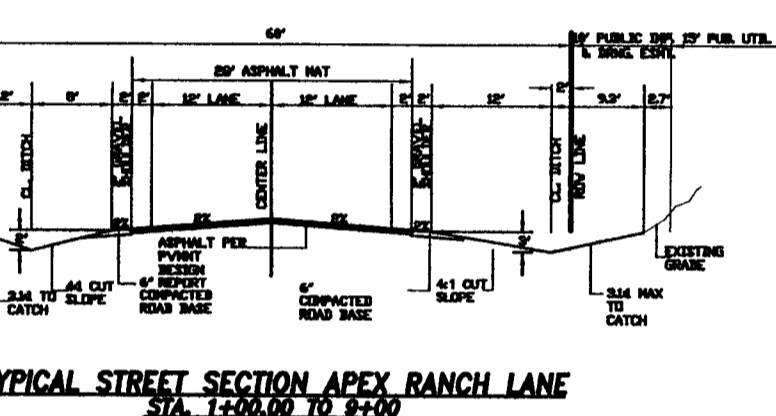
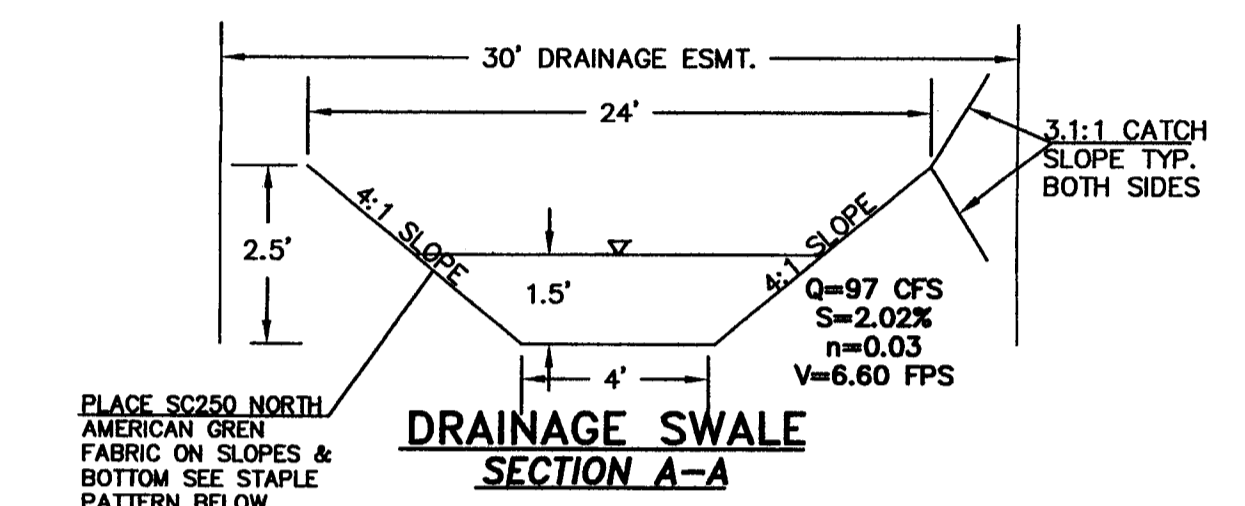
BASIN	ACRES	Q5 CFS	Q100 CFS
OS-1	72.1	45	102
OS-2	5.2	4	9
OS-3	21.9	13	29
OS-4	1.9	4	8
OS-5	0.7	1	3
A	28.2	29	64
B	0.6	2	3
C	6.9	6	12
D	4.7	4	9
E	10.0	8	18
G	4.7	5	10
H	13.0	10	22
I	4.2	4	8
J	4.4	5	11
K	23.2	22	50
M	18.2	15	33
N	4.2	5	10
O	4.0	4	9



### DESIGN POINT SUMMARY

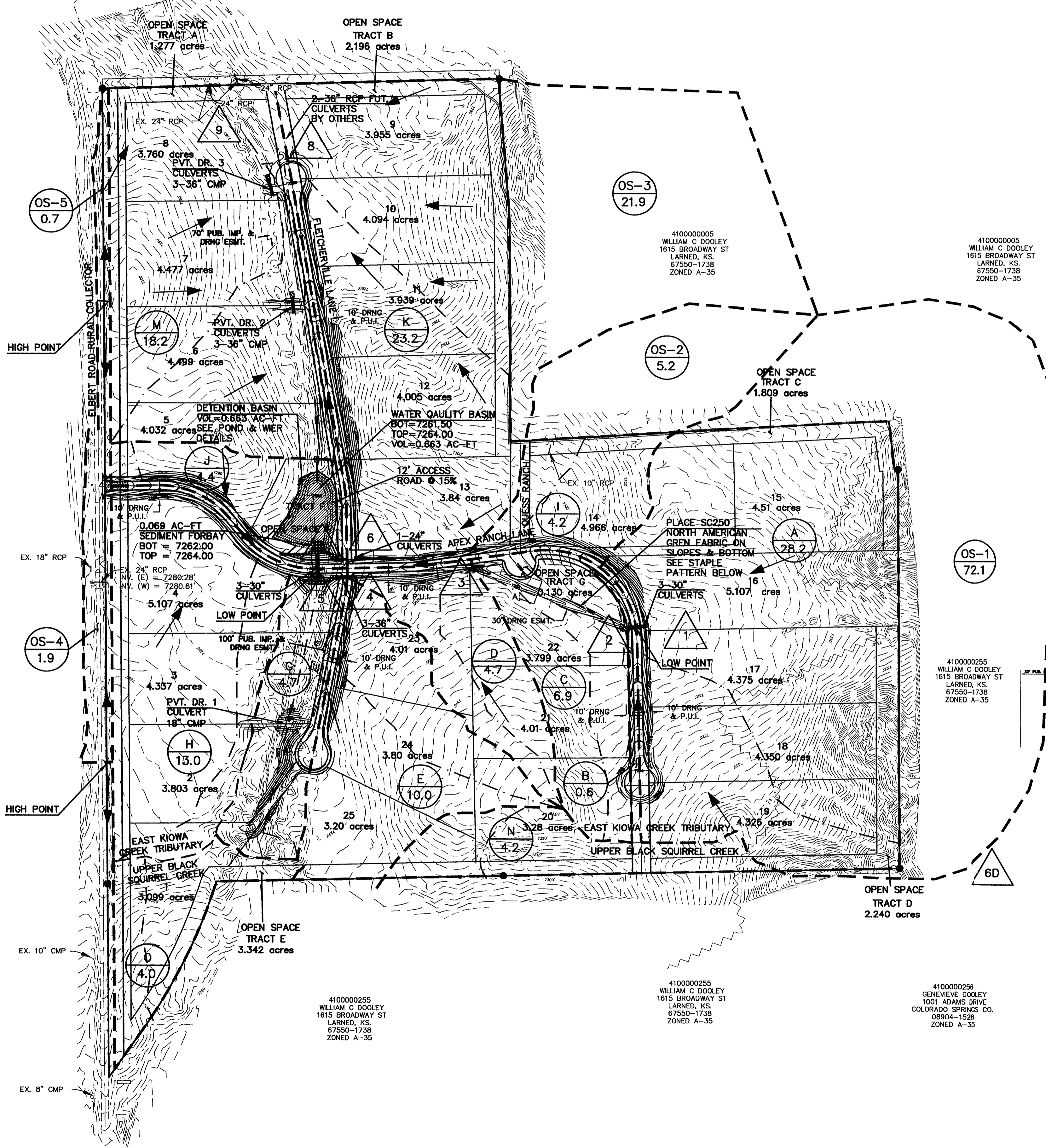
DP	CONTRIBUTING BASINS	Q5 CFS	Q100 CFS
1	OS-1 & A	58	130
2	DP-1 & B	59	131
3	DP-2 & C	61	134
4	DP-3, D & E	68	148
5	DP-4, G & H	78	170
6	OS-2 & I	8	18
7	DP-5, DP-6, J & OS-4	87	188
8	OS-3 & K	29	64
9	DP-8, L, M, OS-5 & POND RELEASE	102	227
10	N & O	8	19

### POND PERFORATED HOLE PATTERN



### LEGEND

- EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- PROPOSED CULVERT
- DIRECTION OF FLOW
- BASIN BOUNDARY
- TIME OF CONCENTRATION
- BASIN ID
- ACRES
- DESIGN POINT
- DETENTION AREA



<p>NO. 1.</p> <p>REVISIONS</p>	<p>DATE 11/9/07</p> <p>DESCRIPTION REVISED PER COUNTY COMMENTS</p>
<p>UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.</p>	
<p>PREPARED FOR: <b>APEX RANCH ESTATES, LLC</b> ATTN: CRAIG MCCONNELL P.O. BOX 267 PEYTON, COLORADO 80831</p>	
<p>125 N. WAHSATCH AVE., SUITE 101 COLORADO SPRINGS, CO. 80903 OFFICE: 719-635-6422 FAX: 719-635-6426 www.tnainc.com</p>	
<p><b>Terra Nova</b> Engineering, Inc. Professional Engineer</p>	
<p><b>APEX RANCH ESTATES</b></p> <p>FINAL DRAINAGE MAP DEVELOPED CONDITIONS</p>	
<p>DESIGNED BY QNA DRAWN BY LAE CHECKED BY LDR</p>	
<p>H=SCALE 1"=200' V=SCALE</p>	
<p>JOB NO. 0565.00 DATE ISSUED 8/26/08 SHEET NO. 1 OF 1</p>	

***APPENDIX G: DRAINAGE MAPS***



THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



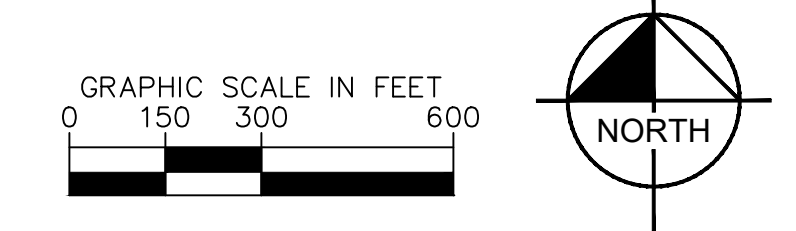
### LEGEND

- A A = BASIN DESIGNATION
- B B = AREA (ACRES)
- C C = BASIN IMPERVIOUSNESS
- D D = 100YR DESIGN STORM RUNOFF (CFS)
- # # = DESIGN POINT
- EXISTING FLOW DIRECTION
- PROPOSED PROPERTY LINE
- EXISTING PROPERTY LINE
- PROPOSED EASEMENT LINE
- DRAINAGE BASIN BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- FILING NO. 2

- A - Upper Black Squirrel Drainage Basin (CHBS2000)
- B - La Vega Ranch Drainage Basin (CHBR0400)
- C - East Kiowa Creek Drainage Basin (KIKI0400)
- D - Bijou Creek Drainage Basin (BIBI0200)

EXISTING CONDITIONS RATIONAL CALCULATIONS SUMMARY						
DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	CFS			% IMPERVIOUS
			Q2	Q5	Q100	
<b>FDR Basins</b>						
1	A1	19.92	4.19	8.43	38.41	8%
2	A2	63.97	3.54	13.47	91.03	1%
3	B1	43.28	1.87	9.34	68.56	0%
4	B2	42.42	1.88	9.41	69.09	0%
5	B3	25.42	1.18	5.91	43.40	0%
5A	B3A	24.23	1.20	5.99	43.98	0%
14	OS-A1	4.06	2.27	3.62	12.02	19%
15	OS-A2	4.45	0.70	2.10	11.46	7%
<b>ON-SITE BASIN TOTAL</b>						
BASIN A TOTAL		83.89	7.73	21.90	129.44	3%
BASIN B TOTAL		135.35	6.13	30.64	225.03	0%
<b>ON-SITE TOTAL</b>		<b>219.24</b>	<b>13.86</b>	<b>52.65</b>	<b>354.46</b>	<b>1%</b>
<b>OFF-SITE BASIN TOTAL</b>						
OFF-SITE BASIN A		8.51	2.97	5.72	23.48	13%
<b>OFF-SITE TOTAL</b>		<b>8.51</b>	<b>2.97</b>	<b>5.72</b>	<b>23.48</b>	<b>13%</b>
<b>SITE TOTAL</b>		<b>227.75</b>	<b>16.83</b>	<b>58.27</b>	<b>377.95</b>	<b>1%</b>

Existing Conditions Natural Channels Flow Summary							
Channel ID	Contributing Basins	Tributary Area (ac)	Basin Area (ac)	Basin 100-yr Flow (cfs)	Channel 100-yr Flow (cfs)	Velocity (ft/s)	Normal Depth (ft)
1	A1-1	A1	19.92	19.92	38.41	38.41	2.56
2	A2-3	A2, OS-A2	48.30 (A2) + 4.45 (OS-A2)	63.97 (A2) + 4.45 (OS-A2)	91.03 (A2) + 11.46 (OS-A2)	79.02	4.86
3	A2-4	A2	2.73	63.97	91.03	2.71	1.49
4	A2-5	A2, B1	7.38 (A2) + 2.81 (B1)	63.97 (A2) + 43.28 (B1)	91.03 (A2) + 72.48 (B1)	15.53	2.02
5	B1-2	B1	16.60	43.28	72.48	27.80	3.73
6	B1-3	B1	6.15	43.28	72.48	10.30	2.56
7	B1-6	B1	13.08	43.28	72.48	21.90	3.01
8	B2-1	B2	4.52	42.42	69.09	7.36	2.25
9	B2-2	B2	36.7	42.42	69.09	59.77	4.90
10	B7-1	B3	2.20	25.42	43.40	3.76	1.73
11	B8-1	B3	17.57	25.42	43.40	30.00	3.41



NO.	REVISION	BY	DATE	APPR

Kimley»Horn

2024 KIMLEY-HORN AND ASSOCIATES, INC.  
2 N NEVADA ST., SUITE 900  
COLORADO SPRINGS, CO 80903 719-453-0180

DESIGNED BY: KRK  
DRAWN BY: AJL  
CHECKED BY: KRK  
DATE: 09/10/24

OVERLOOK FILING NO. 1  
EL PASO COUNTY, COLORADO  
CONSTRUCTION DOCUMENTS  
EXISTING DRAINAGE MAP

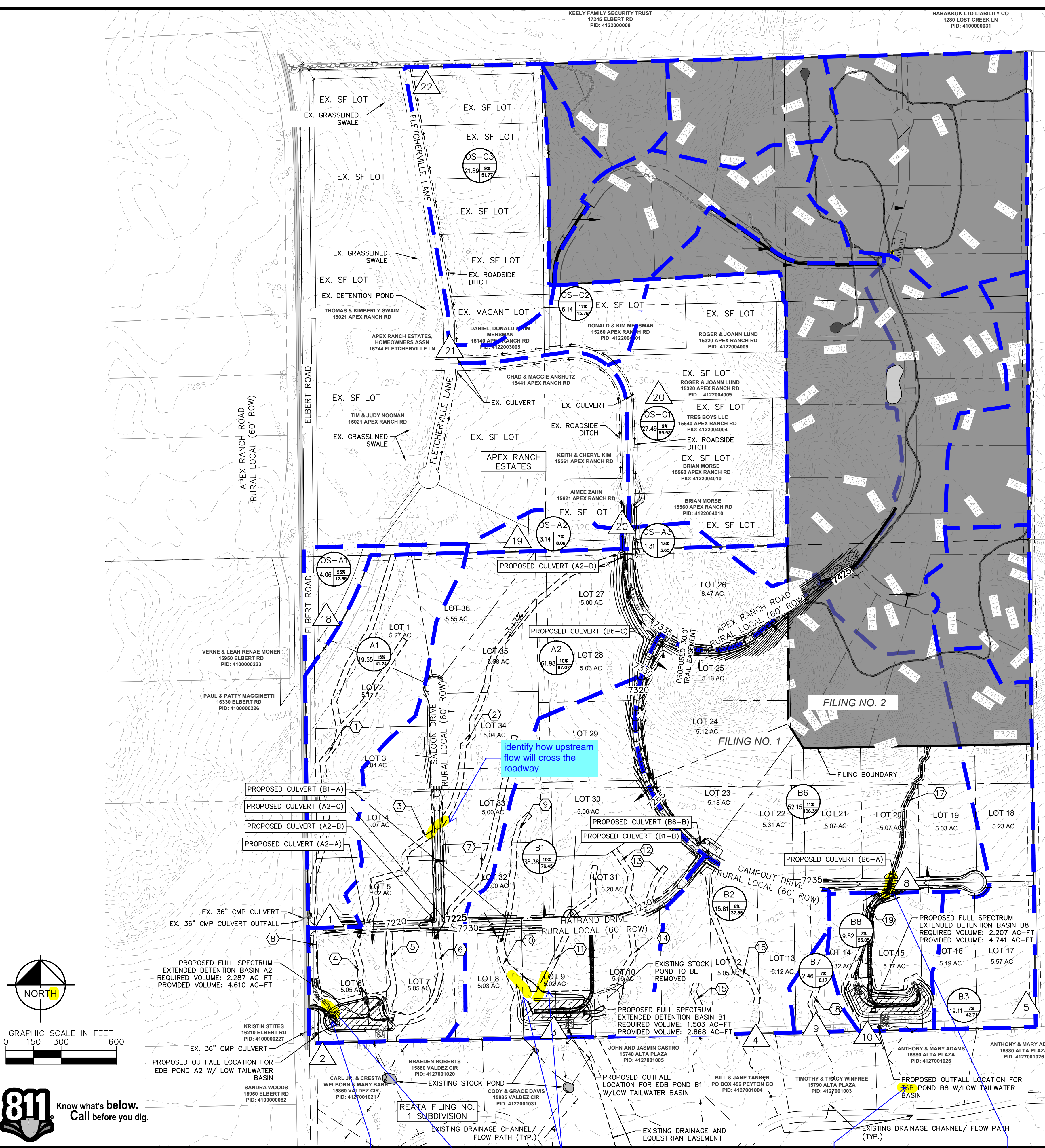
PRELIMINARY  
FOR REVIEW ONLY  
NOT FOR  
CONSTRUCTION

PROJECT NO.  
196239003

SHEET  
**EX-1**



THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



**LEGEND**

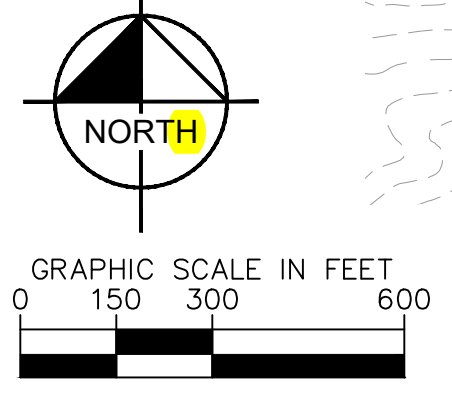
- A A = BASIN DESIGNATION
- B B = AREA (ACRES)
- C C = BASIN IMPERVIOUSNESS
- D D = 100YR DESIGN STORM RUNOFF (CFS)
- # # = DESIGN POINT
- PROPOSED FLOW DIRECTION
- PROPOSED PROPERTY LINE
- EXISTING PROPERTY LINE
- PROPOSED EASEMENT LINE
- DRAINAGE BASIN BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- FILING NO. 2
- EROSION CONTROL TRM MAT

**NOTES**

- ALL PROPOSED EASEMENTS ARE 30' DRAINAGE EASEMENTS UNLESS OTHERWISE NOTED
  - ALL PROPOSED CULVERTS ARE TO BE RCP UNLESS OTHERWISE NOTED.
- A - Upper Black Squirrel Drainage Basin (CHBS2000)  
 B - La Vega Ranch Drainage Basin (CHBR0400)  
 C - East Kiowa Creek Drainage Basin (KIKI0400)  
 D - Bijou Creek Drainage Basin (BIBI0200)

PROPOSED CONDITIONS RATIONAL CALCULATIONS SUMMARY						
DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	CFS			DETAINED 100 YR OUTFLOW (CFS)
			Q2	Q5	Q100	
<b>Basins</b>						
1	A1	19.55	5.41	10.41	41.24	15%
2	A2	61.98	9.05	20.85	97.07	10%
EDB A2						
3	B1	38.38	7.07	16.38	76.45	10%
EDB B1						
4	B2	15.81	2.83	7.46	37.85	8%
5	B3	19.11	2.61	7.83	42.71	7%
8	B6	52.15	10.51	23.44	106.32	11%
9	B7	2.46	0.38	1.13	6.17	7%
10	B8	9.52	1.41	4.22	23.05	7%
EDB B8						
18	OS-A1	4.06	2.57	4.12	12.86	25%
19	OS-A2	3.14	0.49	1.48	8.09	7%
20	OS-A3	1.31	0.43	0.87	3.65	13%
<b>ON-SITE BASIN TOTAL</b>						
BASIN A TOTAL		81.53	14.46	31.26	138.30	11%
BASIN B TOTAL		137.43	24.80	60.46	292.55	10%
<b>ON-SITE TOTAL</b>		<b>218.96</b>	<b>39.25</b>	<b>91.72</b>	<b>430.85</b>	<b>10%</b>
<b>OFF-SITE BASIN TOTAL</b>						
OFF-SITE BASIN A		8.51	3.49	6.47	24.60	16%
OFF-SITE TOTAL		8.51	3.49	6.47	24.60	16%
<b>SITE TOTAL</b>		<b>8.51</b>	<b>42.74</b>	<b>98.19</b>	<b>455.46</b>	<b>10%</b>

Proposed Conditions Natural Channels Flow Summary								
Channel ID	Contributing Basins	Tributary Area (ac)	Basin Area (ac)	Basin 100-yr Flow (cfs)	Channel 100-yr Flow (cfs)	Velocity (ft/s)	Normal Depth (ft)	Lining
①	A1-1	A1	19.55	19.55	41.24	41.24	2.62	0.48
②	A2-1	A2, OS-A2	32.76 (A2) + 3.25 (OS-A2)	61.98 (A2) + 3.14 (OS-A2)	97.07 (A2) + 8.09 (OS-A2)	58.15	3.78	0.58
③	A2-2	A2	9.06	61.98	97.07	14.19	2.47	0.18
④	A2-3	A2	11.45	61.98	97.07	17.93	3.07	0.39
⑤	A2-4	A2	1.70	61.98	97.07	2.66	1.49	0.23
⑥	A2-5	A2	11.27	61.98	97.07	17.65	2.18	0.30
⑦	A2-6	A2	5.9	61.98	97.07	9.24	1.83	0.18
⑧	A2-7	A2	1.74	58.27	97.07	2.90	0.97	0.10
⑨	B1-1	B1	10.19	40.74	76.45	19.12	2.67	0.28
⑩	B1-2	B1	14.29	40.74	76.45	26.82	3.69	0.23
⑪	B1-3	B1	13.43	40.74	76.45	25.20	3.41	0.46
⑫	B1-4	B1	4.03	40.74	76.45	7.56	2.47	0.14
⑬	B1-5	B1	2.54	40.74	76.45	4.77	1.65	0.11
⑭	B1-6	B1	2.72	40.74	76.45	5.10	1.81	0.16
⑮	B2-1	B2	4.92	16.00	37.85	11.64	2.67	0.25
⑯	B2-2	B2	9.77	16.00	37.85	23.11	3.52	0.28
⑰	B6-1	B6	11.58	53.31	106.32	23.09	6.66	0.29
⑱	B7-1	B7	2.25	2.46	6.17	5.64	1.91	0.23
⑳	B8-1	B8, B6	3.32 (B8) + 53.31 (B6)	9.52 (B8) + 52.15 (B6)	23.05 (B8) + 106.32 (B6)	118.80	5.44	0.64



Maintenance access must be located near all pond components to ensure they are accessible for maintenance and operation. Please extend the access accordingly.

An energy dissipator (rock chute-forebay) is required at all pond inlets.

No longer TSB, please remove.

Per ECM Chapter 2, Section 2.6.9.G, parallel culverts are not allowed due to maintenance concerns. Please revise the design accordingly. If this condition cannot be met, please submit a deviation request to the County Engineer for consideration.

BY: DATE: APPR

REVISION

NO.

2024 KIMLEY-HORN AND ASSOCIATES, INC.  
 2 N NEVADA ST., SUITE 900  
 COLORADO SPRINGS, CO 80903 719-453-0180

DESIGNED BY: KRK  
 DRAWN BY: AJL  
 CHECKED BY: KRK  
 DATE: 09/10/24

OVERLOOK FILING NO. 1  
 EL PASO COUNTY, COLORADO  
 CONSTRUCTION DOCUMENTS  
**PROPOSED DRAINAGE MAP**

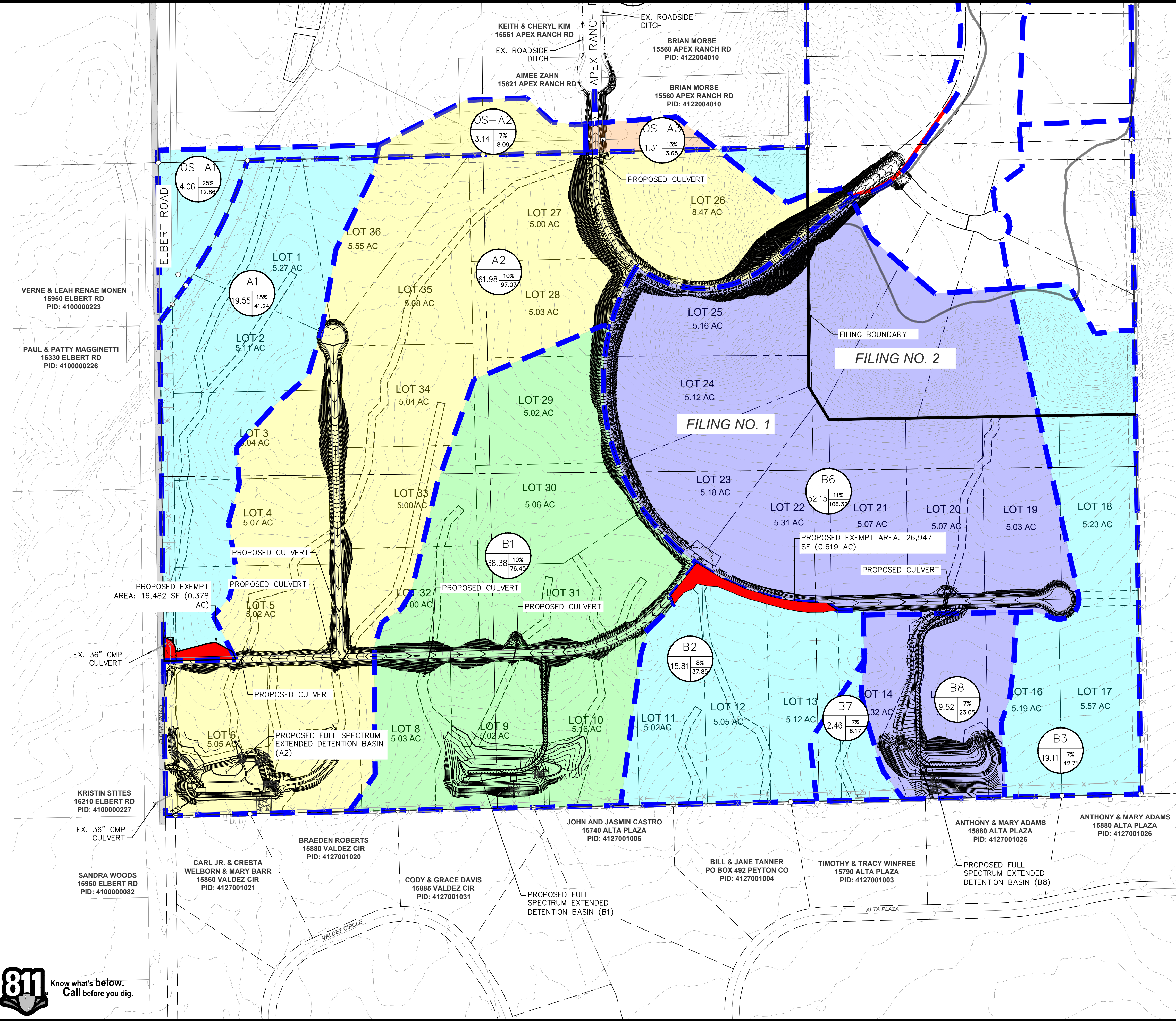
PRELIMINARY  
 FOR REVIEW ONLY  
 NOT FOR  
 CONSTRUCTION

PROJECT NO.  
196239003

SHEET  
**DB-1**



THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



**LEGEND**

	A = BASIN DESIGNATION
	B = AREA (ACRES)
	C = BASIN IMPERVIOUSNESS
	D = 100YR DESIGN STORM RUNOFF (CFS)

	PROPOSED PROPERTY LINE
	EXISTING PROPERTY LINE
	PROPOSED EASEMENT LINE
	DRAINAGE BASIN BOUNDARY
	THE LARGE LOT EXCLUSION I.7.1.B.5
	TRIBUTARY TO POND A2
	TRIBUTARY TO POND B1
	TRIBUTARY TO POND B8
	TRIBUTARY TO APEX RANCH POND
	PROPOSED EXEMPT AREA

**EXEMPT AREAS (ECM I.7.1.C.1)**

BASIN A1	= ±16,482 SF
BASIN B2	= ±26,947 SF
<b>TOTAL</b>	<b>= ±43,429 SF (0.99 ACRES)</b>

VERNE & LEAH RENAE MONEN  
15950 ELBERT RD  
PID: 4100000223

PAUL & PATTY MAGGINETTI  
16330 ELBERT RD  
PID: 4100000226

KRISTIN STITES  
16210 ELBERT RD  
PID: 4100000227

SANDRA WOODS  
15950 ELBERT RD  
PID: 4100000082

CARL JR. & CRESTA  
WELBORN & MARY BARR  
15860 VALDEZ CIR  
PID: 4127001021

BRAEDEN ROBERTS  
15880 VALDEZ CIR  
PID: 4127001020

CODY & GRACE DAVIS  
15885 VALDEZ CIR  
PID: 4127001031

JOHN AND JASMIN CASTRO  
15740 ALTA PLAZA  
PID: 4127001005

BILL & JANE TANNER  
PO BOX 492 PEYTON CO  
PID: 4127001004

TIMOTHY & TRACY WINFREE  
15790 ALTA PLAZA  
PID: 4127001003

ANTHONY & MARY ADAMS  
15880 ALTA PLAZA  
PID: 4127001026

ANTHONY & MARY ADAMS  
15880 ALTA PLAZA  
PID: 4127001026

KEITH & CHERYL KIM  
15561 APEX RANCH RD  
EX. ROADSIDE DITCH

BRIAN MORSE  
15560 APEX RANCH RD  
PID: 4122004010

BRIAN MORSE  
15560 APEX RANCH RD  
PID: 4122004010

A2  
61.98 10%  
97.07

OS-A3  
1.31 13%  
3.65

OS-A1  
4.06 25%  
12.86

A1  
19.55 15%  
41.24

B1  
38.38 10%  
76.44

B2  
15.81 8%  
37.85

B7  
2.46 7%  
6.17

B6  
52.15 11%  
106.37

B8  
9.52 7%  
23.05

B3  
19.11 7%  
42.77

NO.	REVISION	BY	DATE

**Kimley-Horn**  
2023 KIMLEY-HORN AND ASSOCIATES, INC.  
2 N NEVADA ST, SUITE 900  
COLORADO SPRINGS, CO 80903 719-453-0180

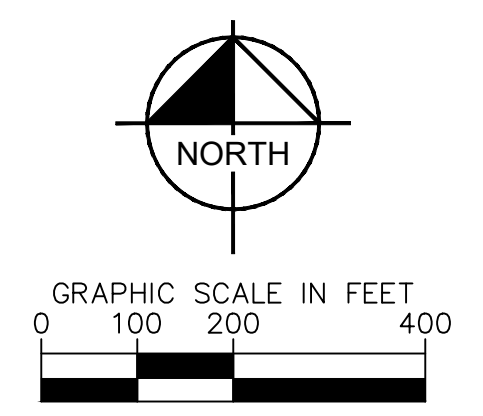
DESIGNED BY: KRK  
DRAWN BY: AJL  
CHECKED BY: KRK  
DATE: 11/27/23

OVERLOOK FILING NO. 1  
EL PASO COUNTY, COLORADO  
PRELIMINARY DESIGN PLANS  
EXCLUSION EXHIBIT DRAINAGE MAP-FILING NO. 1

PRELIMINARY  
FOR REVIEW ONLY  
NOT FOR  
CONSTRUCTION  
**Kimley-Horn**  
Kimley-Horn and Associates, Inc.

PROJECT NO.  
196239003

SHEET  
EX-3





***APPENDIX H: POND OPCC***

please also provide a cost estimate of the other storm facilities (i.e. culverts, channel protection etc.)

Project: Overlook Filing No. 1  
 Project Number: \_\_\_\_\_  
 Date: \_\_\_\_\_ September 17, 2024

Prepared By: KRK  
 Checked By: KRK

<b>Pond A2</b>					
	Item	Unit	Quantity	Unit Cost	Cost
	Rip Rap Chute #1 / Forebay	CY	36	\$ 210.00	\$7,560.00
	Rip Rap Chute #2/ Forebay	CY	45	\$ 210.00	\$9,450.00
	Rip Rap Chute #3/ Forebay	CY	48	\$ 210.00	\$10,080.00
	West Channel	CY	170	\$ 210.00	\$35,700.00
	Concrete Trickle Channel	LF	445	\$ 64.00	\$28,480.00
	Concrete Micropool	EA	1	\$ 12,000.00	\$12,000.00
	Concrete Outlet Structure	EA	1	\$ 8,500.00	\$8,500.00
	42" RCP Outfall Pipe	LF	100	\$ 201.00	\$20,100.00
	42" RCP FES	EA	1	\$ 1,206.00	\$1,206.00
	Toe Wall	EA	1	\$ 2,000.00	\$2,000.00
	Outfall Riprap Protection	CY	34	\$ 210.00	\$7,140.00
	Concrete Cut Off Wall	EA	1	\$ 8,000.00	\$8,000.00
	Rip Rap Emergency Spillway	CY	197	\$ 210.00	\$41,370.00
	Maintenance Road (6" Thick)	CY	47	\$ 56.00	\$2,632.00
	<b>Total</b>				<b>\$194,218.00</b>
<b>Pond B1</b>					
	Item	Unit	Quantity	Unit Cost	Cost
	Rip Rap Chute #1 / Forebay	CY	42	\$ 210.00	\$8,820.00
	Concrete Trickle Channel	LF	345	\$ 64.00	\$22,080.00
	Concrete Micropool	EA	1	\$ 12,000.00	\$12,000.00
	Concrete Outlet Structure	EA	1	\$ 8,500.00	\$8,500.00
	36" RCP Outfall Pipe	LF	59	\$ 151.00	\$8,909.00
	36" RCP FES	EA	1	\$ 906.00	\$906.00
	Toe Wall	EA	1	\$ 2,000.00	\$2,000.00
	Outfall Riprap Protection	CY	17	\$ 210.00	\$3,570.00
	Concrete Cut Off Wall	EA	1	\$ 8,000.00	\$8,000.00
	Rip Rap Emergency Spillway	CY	178	\$ 210.00	\$37,380.00
	Maintenance Road (6" Thick)	CY	198	\$ 56.00	\$11,088.00
	<b>Total</b>				<b>\$123,253.00</b>
<b>Pond B8</b>					
	Item	Unit	Quantity	Unit Cost	Cost
	Rip Rap Chute #1 / Forebay	CY	174	\$ 210.00	\$36,540.00
	Rip Rap Chute #2/ Forebay	CY	54	\$ 210.00	\$11,340.00
	Concrete Trickle Channel	LF	428	\$ 64.00	\$27,392.00
	Concrete Micropool	EA	1	\$ 12,000.00	\$12,000.00
	Concrete Outlet Structure	EA	1	\$ 8,500.00	\$8,500.00
	36" RCP Outfall Pipe	LF	68	\$ 151.00	\$10,268.00
	36" RCP FES	EA	1	\$ 906.00	\$906.00
	Toe Wall	EA	1	\$ 2,000.00	\$2,000.00
	Outfall Riprap Protection	CY	25	\$ 210.00	\$5,250.00
	Concrete Cut Off Wall	EA	1	\$ 8,000.00	\$8,000.00
	Rip Rap Emergency Spillway	CY	268	\$ 210.00	\$56,280.00
	Maintenance Road (6" Thick)	CY	98	\$ 56.00	\$5,488.00
	<b>Total</b>				<b>\$183,964.00</b>
<b>TOTAL COST =</b>					<b>\$501,435.00</b>

**Conceptual Opinion of Probable Construction Cost**

The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.