Final Drainage Report

Winsome Subdivision Filing No. 3
El Paso County, Colorado

Prepared for:
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Prepared by:
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PCD File No. SF-22-009

Project #: 196106001

Prepared: February 2, 2023

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): ____

Brice Hammersland, P.E.
Colorado P.E. No. 56012 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.

____
Name of Developer

____
Authorized Signature Date

____
Printed Name

____
Title

____
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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APPENDIX

INTRODUCTION

PURPOSE AND SCOPE OF STUDY

The purpose of this Final Drainage Report (FDR) is to provide the hydrologic and hydraulic calculations and to document and finalize the drainage design methodology in support of the proposed Winsome Subdivision ("the Project") Filing No. 3 ("the Site") for Winsome LLC. The Project is located within the jurisdictional limits of El Paso County ("the County"). Thus, the guidelines for the hydrologic and hydraulic design components were based on the criteria for the County and City of Colorado Springs, described below.

LOCATION

The Project is located approximately 17 miles west of Monument, Colorado within Township 11 South, Range 65 West of the 6th Principal Meridian, County of El Paso, State of Colorado (the "Site"). More specifically, the Site is located northwest of Winsome Filing No.2 which is located north of Hodgen Road, and west of Meridian Road. A vicinity map has been provided in the **Appendix A** of this report.

The Site is currently owned by Winsome, LLC and will be developed by Winsome, LLC.

DESCRIPTION OF PROPERTY

The Project is located on approximately 768 acres of land consisting of vacant land with native vegetation and is classified as "Pasture, grassland or range" per Table 6-6 of the City of Colorado Springs Drainage Criteria Manual. Filing No 3 consists of 38 5-acre residential lots. The Site does not currently provide water quality or detention for the Project area. The existing land use is undeveloped vacant land. This Filing consists of 349.5 acres and will have a disturbance of approximately 31.6 acres.

The existing topography consists of slopes ranging from 1% to 16%. The West Kiowa Creek ("the Creek") runs along the south side of Filing 3.

NRCS soil data is available for this Site and it has been noted that soils onsite are generally USCS Type B and Type C. The NRCS soil data can be found in **Appendix D**. There are no major drainage ways or irrigation facilities within the Site.

Improvements will consist of mowing, clearing and grubbing, weed control, paved access road construction, roadway grading, three detention ponds, roadside ditches, culverts, drainage swales, native seeding and a proposed channel to convey flows to the water quality pond.

The Site proposes to plat 38 lots for single family development, as well as, provide the grading, roadway and drainage improvements.

An updated Topographic field survey was completed for the Project by Edward-James Surveying, Inc. dated November 3th, 2020 and is the basis for design for the drainage improvements.

DRAINAGE BASINS

MAJOR BASIN DESCRIPTIONS

KHA RESPONSE:
Floodplain statement has been updated to reflect the RBD Floodplain review comment.

A preliminary drainage report was completed for the ov as previously completed by The Vertex Companies. This roved Preliminary Drainage Report prepared by The Vertex C 3 final design.

Update the flooplain statement section as needed based on RBD Floodplain's review comment.

The Site improvements are locate determined by the Flood Insurance December 7, 2018 (see **Appendix** submitted and approved under Wi **Appendix D**). The floodplain is located along the southeast side of Filing No. 3 and the site improvements which are within the floodplain limits include roads, culverts, and channel stabilization. Refer to **Appendix D** for the CLOMR application approval letter from FEMA for Case No. 19-08-0185R. After construction of the site improvements is completed, a LOMR will be completed and processed through FEMA to officially establish the floodplain and base flood elevations for the Site. The final plat for Filing No. 3 can be recorded before the approval of the LOMR through FEMA. However, five lots will be prohibited from sale until the LOMR is approved.

The Project is located within El Paso County's West Kiowa Creek Drainage Basin.

EXIST

RBD Floodplain	BFE's and floodplain extents from the CWCB risk map program accepted by FEMA to be shown on plat. contact Keith Curtis for approved BFE and floodplain extents shapefiles, "Roadway improvement across the creek" per note 7, require either a less than 6" rise certification per FEMA guidance, or an approved CLOMR from FEMA prior to requesting a local floodplain permit for this work .

Per the Site w southe existin

Sub-Basin A

Per the approved PDR sub-basin, A consists of an area of 915.4 acres, located in the southwest corner of the property. Drainage flows overland from the northwest to southeast and into the West Kiowa Creek. Runoff during the 5-year and 100-year events are 87.10 cfs and 585.9 cfs respectively. Refer to **Appendix D** for the Existing Conditions Drainage Map.

Sub-Basin G

Per the approved PDR sub-basin G consists of an on-site area of 107.6 acres, located in the center of the western portion of the property. Drainage flows overland from the northwest to southeast into the West Kiowa Creek. Runoff during the 5-year and 100-year events are 45.30 cfs and 199.0 cfs respectively. Refer to **Appendix D** for the Existing Conditions Drainage Map.

Sub-basin H

Per the approved PDR sub-basin H consists of an on-site area of 121.8 acres, located in the center of the north portion of the property. Drainage flows overland from northwest to southeast to the West Kiowa Creek. Runoff during the 5-year and 100-year events are 34.80 cfs and 197.2 cfs respectively. Refer to **Appendix D** for the Existing Conditions Drainage Map.

Sub-basin I

Per the approved PDR sub-basin I consists of an on-site area of 37.5 acres, located in the north portion of the property. Drainage flows overland from northwest to southeast to the West Kiowa Creek. Runoff during the 5-year and 100-year events are 26.40 cfs and 88.5 cfs respectively. Refer to **Appendix D** for the Existing Conditions Drainage Map.

Sub-basin J

Per the approved PDR sub-basin J consists of an on-site area of 10.1 acres, located in the northwest corner of the property. Drainage flows overland from south to north and outfall offsite. Runoff during the 5-year and 100-year events are 3.40 cfs and 19.9 cfs respectively. Refer to **Appendix D** for the Existing Conditions Drainage Map.

Sub-basin K

Per the approved PDR sub-basin K consists of an on-site area of 17.8 acres, located in the north portion of the property. Drainage flows overland from south to north and outfall offsite. Runoff during the 5-year and 100-year events are 12.90 cfs and 45.1 cfs respectively. Refer to **Appendix D** for the Existing Conditions Drainage Map.

Offsite flows entering the Site from sub-basin G will be conveyed through the Site following historical drainage paths and outfall to West Kiowa Creek. Offsite flows from sub-basin G will be routed to Water Quality Pond A and detained on site.

Excerpts from the approved PDR for the Existing Drainage Conditions are included in the **Appendix D** of this report for reference.

PROPOSED HEC-HMS SUB-BASIN DESCRIPTIONS

For the proposed condition, stormwater will generally maintain historic flow patterns from northwest to southeast. The proposed roadways will alter some of the existing flow paths. The roadway ditches will capture runoff from the roadways and direct flows back to the existing flow paths, which will ultimately outfall to Water Quality Pond A, Pond 1, Pond 2 or Pond 4. To determine the design flows for the proposed culverts the existing basins were broken out and design points were created at each culvert crossing location.

For Filing No.3 the proposed basins has been divided into 25 larger sub-basins for the HEC-HMS model.

Sub-Basin A2A is an offsite basin on the northwest side of Filing No. 3. Runoff from this basin will be directed to design point A2A where it will be directed to Basin A3B. This sub-basin has an area of 28.13 acres. The curve number for Sub-Basin A2A is 65.43. The basin will generate runoff of 5.3 cfs and 47.1 cfs in the minor and major storm event.

Sub-Basin A2B is an offsite basin on the northwest side of Filing No. 3. Runoff from this basin will be directed to design point A2B where it will be directed to Basin A3A. This sub-basin has an area of 8.87 acres. The curve number for Sub-Basin A2B is 69.78. The basin will generate runoff of 2.3 cfs and 20.3 cfs in the minor and major storm event.

Sub-Basin A3A consists of large residential lots and a portion of roadway. Runoff from this basin will be directed to design point A3A where it will be directed to Swale A3A and into the proposed culvert A3A to subbasin G2A. This sub-basin has an area of 8.25 acres. The curve number for

Sub-Basin A3A is 73.04. The basin will generate runoff of 5.7 cfs and 25.8 cfs in the minor and major storm event.

Sub-Basin A3B consists of large residential lots and a portion of roadway. Runoff from this basin will be directed to design point A3B where it outfalls into West Kiowa Creek. This sub-basin has an area of 13.22 acres. The curve number for Sub-Basin A3B is 74.30. The basin will generate runoff of 9.1 cfs and 42.6 cfs in the minor and major storm event. Area 4 in the Runoff Reduction Exhibit within Appendix C shows the roadway portion within this basin being accounted for in the runoff reduction calculation.

Sub-Basin A3C consists of large residential lots in the southwest corner of the site. Runoff from this basin will be directed to design point A3C where it will be directed to outfall in West Kiowa Creek. This sub-basin has an area of 11.66 acres. The curve number for Sub-Basin A3C is 77.23. The basin will generate runoff of 10.4 cfs and 40.5 cfs in the minor and major storm event. Flows from this sub-basin are not required to be conveyed to a water quality facility according to Appendix I Section 1.7.1.B of El Paso County's Engineering Construction Manual (ECM). The sub-basin is identified as a large lot single family area with an impervious cover under 20 percent under Section 1.7.1.B, number 5.

Sub-Basin G1 consists of large residential lots along the west boundary of the site. Runoff from this basin will be directed to design point G1 where it will be directed to the southeast in culvert G1 to subbasin G2A. This sub-basin has an area of 24.79 acres. The curve number for Sub-Basin G1 is 67.58. The basin will generate runoff of 3.1 cfs and 40.1 cfs in the minor and major storm event.

Sub-Basin G2A consists of portions of roadway and several portions of 4 large residential lots south of Alamar Way. Runoff from this basin will be directed to design point G2A where it will be directed to Water Quality Pond A which will outfall to West Kiowa Creek. This sub-basin has an area of 18.60 acres. The curve number for Sub-Basin G2A is 74.20. The basin will generate runoff of 12.9 cfs and 59.9 cfs in the minor and major storm event.

Sub-Basin G2B consists of portions of roadway and portions of 2 large residential lots east of Alamar Way. Runoff from this basin will be directed to the WQ Channel where it will drain into the Water Quality Pond A which will outfall into West Kiowa Creek. This sub-basin has an area of 2.77 acres. The curve number for Sub-Basin G2B is 74.24. The basin will generate runoff of 2.6 cfs and 9.6 cfs in the minor and major storm event.

Sub-Basin H1 consists of portions of roadway and portions of 2 large residential lots in the northwest corner of the site. Runoff from this basin will be directed to culvert H1 then to subbasin H4. This sub-basin has an area of 13.76 acres. The curve number for Sub-Basin H1 is 70.03. The basin will generate runoff of 4.6 cfs and 33.0 cfs in the minor and major storm event.

Sub-Basin H2 consists of portions of roadway and 8 large residential lots north of Alamar Way in the center of the northern portion of the site. Runoff from this basin will flow southeast to culvert H2 and into sub-basin H6B. This sub-basin has an area of 39.09 acres. The curve number for Sub-Basin H2 is 64.93. The basin will generate runoff of 8.9 cfs and 65.2 cfs in the minor and major storm event.

Sub-Basin H3A consists of portions of roadway and portions of large residential lots and of an undeveloped area north of the site. Runoff from this basin will be directed to culvert H3 and into sub-basin H7B. This sub-basin has an area of 3.08 acres. The curve number for Sub-Basin H3A is 71.60. The basin will generate runoff of 1.3 cfs and 8.0 cfs in the minor and major storm event.

Sub-Basin H3B consists of portions of roadway and portions of large residential lots and of an undeveloped area north of the site. Runoff from this basin will be directed to culvert I1 by a roadside ditch. This sub-basin has an area of 2.71 acres. The curve number for Sub-Basin H3B is 72.02. The basin will generate runoff of 1.4 cfs and 6.9cfs in the minor and major storm event.

Sub-Basin H4 consists of portions of roadway and portions of large residential lots. Runoff from this basin will be directed to Reach H1 and into Detention Pond 1 which outfalls to West Kiowa Creek. This sub-basin has an area of 27.00 acres. The curve number for Sub-Basin H4 is 74.44. The basin will generate runoff of 15.4 cfs and 73.6 cfs in the minor and major storm event.

Sub-Basin H5A consists of portions of large residential lots. Runoff from this basin will be directed to design point H5A and outfall to West Kiowa Creek. This sub-basin has an area of 9.03 acres. The curve number for Sub-Basin H5A is 75.95. The basin will generate runoff of 6.2 cfs and 27.0 cfs in the minor and major storm event. Flows from this sub-basin are not required to be conveyed to a water quality facility according to Appendix I Section 1.7.1.B of El Paso County's Engineering Construction Manual (ECM). The sub-basin is identified as a large lot single family area with an impervious cover under 20 percent under Section 1.7.1.B, number 5.

Sub-Basin H5B consists of portions of roadway and of large residential lots, south of Alamar Way in the center of the site. Runoff from this basin will be directed to design point H5B and outfall to West Kiowa Creek. This sub-basin has an area of 10.48 acres. The curve number for Sub-Basin H5B is 73.76. The basin will generate runoff of 5.6 cfs and 29.0 cfs in the minor and major storm event. Flows from this sub-basin are not required to be conveyed to a water quality facility according to Appendix I Section 1.7.1.B of El Paso County's Engineering Construction Manual (ECM). The sub-basin is identified as a large lot single family area with an impervious cover under 20 percent under Section 1.7.1.B, number 5. Flows from Basin H5B are conveyed to Sediment Basin H5B. The permanent Sediment Basin H5B will be installed within the Early Grading Phase.

Sub-Basin H6A consists of portions of large residential lots, south of Alamar Way. Runoff from this basin will be directed to design point H6A and outfall to West Kiowa Creek. This sub-basin has an area of 16.64 acres. The curve number for Sub-Basin H6A is 75.56. The basin will generate runoff of 11.6 cfs and 51.1 cfs in the minor and major storm event. Flows from this sub-basin are not required to be conveyed to a water quality facility according to Appendix I Section 1.7.1.B of El Paso County's Engineering Construction Manual (ECM). The sub-basin is identified as a large lot single family area with an impervious cover under 20 percent under Section 1.7.1.B, number 5.

Sub-Basin H6B consists of portions of roadway and portions of large residential lots, south of Alamar Way. Runoff from this basin will be directed through Reach H2 into Detention Pond 2 and outfall to West Kiowa Creek. This sub-basin has an area of 15.96 acres. The curve number for Sub-Basin H6B is 76.47. The basin will generate runoff of 15.5 cfs and 57.1 cfs in the minor and major storm event.

Sub-Basin H7A consists of portions of roadway and large residential lots, southwest of the intersection at Alamar Way and Twinkle Star Lane. Runoff from this basin will sheet flow into a roadside ditch to the Pond 4 Culvert. This sub-basin has an area of 8.50 acres. The curve number for Sub-Basin H7A is 72.92. The basin will generate runoff of 6.1 cfs and 27.1 cfs in the minor and major storm event.

Sub-Basin H7B consists of portions of roadway and large residential lots, south of Alamar Way. Runoff from this basin will be directed through Reach H3 to design point H7B to culvert Pond 4. This sub-basin has an area of 17.35 acres. The curve number for Sub-Basin H7B is 71.39. The basin will generate runoff of 7.8 cfs and 49.5 cfs in the minor and major storm event.

Sub-Basin H8A consists of portions of roadway and a portion of a large residential lot, east of Twinkling Star in the east portion of the site. Runoff from this basin will sheet flow to design point H8A and outfall to Detention Pond 4. This sub-basin has an area of 3.93 acres. The curve number for Sub-Basin H8 is 72.46. The basin will generate runoff of 6.7 cfs and 11.2 cfs in the minor and major storm event. The roadway portions within in this basin will be directed through a roadside ditch and drain to Detention Pond 4 to provide adequate water quality treatment.

Sub-Basin H8B consists of portions of roadway and a portion of a large residential lot, east of Twinkling Star in the east portion of the site. Runoff from this basin will sheet flow to design point H8B and outfall to West Kiowa Creek. This sub-basin has an area of 5.09 acres. The curve number for Sub-Basin H8B is 77.78. The basin will generate runoff of 6.7 cfs and 17.8 cfs in the minor and major storm event. The roadway portions within in this basin are accounted for in the runoff reduction areas.

Sub-Basin H9 consists of portions of 2 large residential lots, east of Twinkling Star in the east portion of the site. Runoff from this basin will be directed to design point H9 and outfall to West Kiowa Creek. This sub-basin has an area of 6.52 acres. The curve number for Sub-Basin H9 is 71.58. The basin will generate runoff of 2.3 cfs and 15.0 cfs in the minor and major storm event.1. Flows from this sub-basin are not required to be conveyed to a water quality facility according to Appendix I Section 1.7.1.B of El Paso County's Engineering Construction Manual (ECM). The sub-basin is identified as a large lot single family area with an impervious cover under 20 percent under Section 1.7.1.B, number 5.

Sub-Basin I1 consists of portions of roadway and portions of large residential lots, northwest of Alamar Way and Twinkle Star Lane intersection. Runoff from this basin will be directed to design point I1 into Culvert I1. Flows are conveyed to Pond 4 via the roadside ditch along Twinkling Star Lane. This sub-basin has an area of 6.82 acres. The curve number for Sub-Basin I1 is 74.72. The basin will generate runoff of 5.9 cfs and 20.3 cfs in the minor and major storm event.

Sub-Basin I2 consists of portions of roadway and portions of 3 large residential lots, east of Alamar Way in the northeast portion of the site. Runoff from this basin will be directed to design point I2 and will ultimately outfall to West Kiowa Creek. This sub-basin has an area of 14.59 acres. The curve number for Sub-Basin I2 is 72.48. The basin will generate runoff of 8.3 cfs and 39.1 cfs in the minor and major storm event. Runoff reduction is being accounted for to meet water quality requirements for the roadway runoff within this basin. Refer to the runoff reduction section for additional information.

Sub-Basin J1 consists of portions of 3 large residential lots, in the northwest corner of the site. Runoff from this basin will be directed to design point J1 and flow offsite. This sub-basin has an area of 10.14 acres. The curve number for Sub-Basin J1 is 60.00. The basin will generate runoff of 2.1 cfs and 13.0 cfs in the minor and major storm event for proposed conditions. Which is lower than the existing condition flows of 3.4 cfs and 19.9 cfs in the minor and major events. Therefore, flood control storage would not be required. Flows from this sub-basin are not required to be conveyed to a water quality facility according to Appendix I Section 1.7.1.B of El Paso County's Engineering Construction Manual (ECM). The sub-basin is identified as a large lot single family area with an impervious cover under 20 percent under Section 1.7.1.B, number

5.

Sub-Basin K1 consists of portions of 4 large residential lots, north of Alamar Way in the northeast portion of the site. Runoff from this basin will be directed to design point K1 and flow offsite. This sub-basin has an area of 17.50 acres. The curve number for Sub-Basin K1 is 69.56. The basin will generate runoff of 4.5 cfs and 40.7 cfs in the minor and major storm event for proposed conditions. Which is lower than the existing condition flows of 4.5 cfs and 40.7 cfs in the minor and major events. Therefore, flood control storage would not be required. Flows from this sub-basin are not required to be conveyed to a water quality facility according to Appendix I Section 1.7.1.B of El Paso County's Engineering Construction Manual (ECM). The sub-basin is identified as a large lot single family area with an impervious cover under 20 percent under Section 1.7.1.B, number 5.

Basin B3, B4, B2, C2, C3, C4, D5, and D6 are shown within the drainage map however were accounted for in Winsome Filing No.1 Final Drainage Report approved, May 15, 2019.

DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

The proposed storm facilities are designed to be in compliance with the City of Colorado Springs and 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").

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

A preliminary drainage report was completed for the overall Winsome subdivision. This was previously completed by The Vertex Companies. This Final Drainage Report used the approved Preliminary Drainage Report prepared by The Vertex Companies (PDR) for the Site's final design.

HYDROLOGIC CRITERIA

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the proposed drainage analysis per the MANUAL. Table 6-2 of the Colorado Springs MANUAL is the source for rainfall data for the 5-year and 100-year design storm events. Design runoff was calculated using the NRCS curve number method for developed conditions as established in the MANUAL. This aligns with what was completed in the PDR. The NRCS curve number method was used for existing conditions and proposed conditions due to the on-site and off-site basins containing more than 130 acres. Per the PDR the runoff curve numbers for the existing and proposed drainage basins used the curve numbers in DCM. The PDR developed the following values for the 5 acre lots in **Table 1** below. These values were also used for the final design in this report.

Table 1: *Values Extrapolated per the PDR*

		Soil Type			
Lot Size (Acres)	**% Imp**	**A**	**B**	**C**	**D**
5	7	N/A	60	72	77

The rainfall depths that were determined in the PDR were also used for the final design. The rainfall depths utilized the Frontal Storm which produced higher design flows. See **Table 2** below for the Frontal Storm rainfall values.

Table 2: *Frontal Storm Rainfall Depths*

	Duration (HRS)	
Storm Event	**1 HR**	**24 HR**
5 Year	1.5	2.7
100 Year	2.52	4.6

Calculations for the composite curve numbers are included in the **Appendix B**.

The proposed impervious values were determined in the PDR and were utilized in this report for the final design.

The Site is providing one water quality pond, one permanent sediment basin and three full spectrum detention ponds as the Site is not significantly increasing the imperviousness of the Site, the Project is maintaining the historic drainage patterns as much as possible and not significantly increasing developed flows.

There are no additional provisions selected or deviations from the criteria in both the MANUAL and Colorado Springs MANUAL.

HYDRAULIC CRITERIA

Applicable design methods were utilized to size the proposed pond, culverts, and drainage channels, which includes the use of the UD-Detention spreadsheet, rational calculations spreadsheet, UD-Culvert and FlowMaster, V8i software.

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

- Major Storm: 100-year Storm Event

For the stormwater modeling for the Site was completed utilizing the NRCS Curve Number Method as required by the City of Colorado Springs. The HEC-HMS peak flows were determined to size the proposed culverts and channels. The same assumptions were kept from the PDR for the time of concentration calculations. **Table 3** below outlines these assumptions from the PDR:

Table 3: ***Time of Concentration Assumptions***

	Shape	Side Slope	Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (sq. ft.)
< 100 Acre Basin Channels	Triangular	4:1	4	32.98	64
>100 Acre Basin Channels	Triangular	4:1	3	24.74	36

For the conveyance flow paths the same assumptions and method was carried through from the PDR. These flow paths were for between the basin and the main channels and used 3 profiles. Per the PDR the 3 profiles utilized are as follows: “triangular profiles were used for the majority of the conveyance channels, larger branching tributaries with an 8 ft bottom, and the main channels were modeled as trapezoidal with a 20 ft bottom.”

DETENTION

Three full spectrum detention ponds, and one water quality pond are proposed in order to maintain historic flows and water quality. Mile High Flood District’s UD-detention spreadsheet was utilized to design the pond outlet structure. The same methodology that was used and approved by the County on Filing 1 was used to calibrate the UD-detention spreadsheet for this Filing. The UD-detention spreadsheet has area limitations when large tributary areas are entered into the spreadsheet. The flows entering the pond and the volume entering the pond are lower than what the HEC-HMS model results reflected. Therefore, the UD-detention spreadsheet was calibrated to show a similar 100-year flow entering the pond. The following steps were completed for the UD-detention spreadsheet calibration:

1. A UD-detention spreadsheet was developed for each pond (Pond 1, Pond 2, Pond 4, and WQ Pond) that reflected the total area draining to the pond which reflected a lower 100-yr. The spreadsheet also developed the required water quality capture volume for each pond.

2. A second UD-detention spreadsheet was created for each pond with an adjusted basin area. This area was adjusted until the 100-year peak inflow matched the HEC-HMS model. All other parameters in the UD-detention basin input were held constant and reflect the proposed conditions.

3. Once the calibration was completed the calculated runoff volume was compared between the HEC-HMS model and the UD-detention spreadsheet. The UD-detention spreadsheet resulted in a larger runoff volume and ultimately confirming this as a conservative approach.

4. The water quality capture volume and excessive runoff volume from step one was manually entered into the second UD-detention spreadsheet where the outlet structure design was developed.

5. The pond discharge curve values from UD-detention were then input into the HEC-HMS model to match the outflow hydrographs.

Table 4: ***Pond Calculation Comparison Table***

Pond	Original Basin Area (Acres)	UD-Detention Adjusted Area Value (Acres)	WQCV Volume (Ac-ft)	100YR Volume (Ac-ft)	HEC-HMS In-Flow (Q100 cfs)	UD-Detention Adjusted In-Flow (Q100 cfs)	HEC-HMS In-Flow (Ac-Ft)	UD-Detention In-Flow (Ac-Ft)
1	41.0	60.0	0.174	1.3	105.0	104.7	4.2	7.87
2	55.0	67.9	0.268	1.5	110.8	110.4	4.8	9.06
4	42.4	64.0	0.250	1.9	108.2	107.7	4.5	8.60
WQ	63.4	94.5	0.047	N/A	N/A	148.8	N/A	12.10
H5B	10.5	N/A						1.34

HEC-HMS and Pond calculations are provided in **Appendix B** and **Appendix C**.

For Pond 1 a rock chute is proposed with a downstream stilling basin to dissipate the energy of the flow being conveyed into the pond through the rock chute. The stilling basin will have dual purposes one to assist in dissipating the energy before out falling into the pond bottom and two to serve as a forebay structure. The concrete lined trickle channels will convey flows to the outlet structures micro pool. The outlet structure is designed to provide full spectrum characteristics. The 100-year storm volume will be released via 36” RCP. An emergency spillway is proposed and designed to convey the 100-year flow with a depth of flow less than 1’. The emergency spillway has been designed to provide a minimum of 1’ of freeboard. A 15’ wide access road is proposed from the trail to the bottom of the pond for maintenance. The pond reduces proposed flows at the outfall below historic levels relative to the impact of Filing 3.

For Pond 2 a rock chute is proposed with a downstream stilling basin to dissipate the energy of the flow being conveyed into the pond through the rock chute. The stilling basin will have dual purposes one to assist in dissipating the energy before out falling into the pond bottom and two to serve as a forebay structure. The concrete lined trickle channels will convey flows to the outlet structures micro pool. The outlet structure is designed to provide full spectrum characteristics. The 100-year storm volume will be released via 48” RCP. An emergency spillway is proposed and designed to convey the 100-year flow with a depth of flow less than 1’. The emergency spillway has been designed to provide a minimum of 1’ of freeboard. A 15’ wide access road is proposed from the trail to the bottom of the pond for maintenance. The pond reduces proposed flows at the outfall below historic levels relative to the impact of Filing 3.

For Pond 4 a rock chute is proposed with a downstream stilling basin to dissipate the energy of the flow being conveyed into the pond through the rock chute. The stilling basin will have dual purposes one to assist in dissipating the energy before out falling into the pond bottom and two to serve as a forebay structure. The concrete lined trickle channels will convey flows to the outlet structures micro pool. A proposed 42” diameter RCP will convey flows to Pond 4 as well.

Clarify that per MHFD Detail T-5, forebays are only needed when >1ac of imperviousness is tributary to a pond inflow point. Since this threshold is not exceeding at either concentrated inflow point, actual concrete lined forebays with slow release notches are not required.

KHA RESPONSE: Clarification has been added to the report within this paragraph.

structure will be placed at the outfall of the culvert (Culvert Pond 4). The signed to provide full spectrum characteristics. The 100-year storm volume 2” RCP. An emergency spillway is proposed and designed to convey the depth of flow less than 1’. The emergency spillway has been designed to f 1’ of freeboard. A 15’ wide access road is proposed from the right-of-way to the bottom of the pond for maintenance. The pond reduces proposed flows at the main outfall below historic levels relative to the impact of Filing 3.

For Water Quality Pond A, two rock chutes are proposed with a downstream stilling basin to dissipate the energy of the flow being conveyed into the pond through the rock chutes. The stilling basins will have dual purposes one to assist in dissipating the energy before out falling into the pond bottom and two to serve as a forebay structure. The concrete lined trickle channels will convey flows to the outlet structures micro pool. The outlet structure is designed to provide water quality for the 1.12 acres of roadway area sending runoff to the pond. Larger storms will utilize the spillway. The spillway is designed to convey the 100-year flow with a depth of flow less than 1’. The spillway has been designed to provide a minimum of 1’ of freeboard. A 15’ wide access road is proposed from the trail to the bottom of the pond for maintenance.

For the Permanent Sediment Basin H5B no grading is proposed within the channel. The natural topography of the channel will be used as the sediment basin. The 100-year storm volume will be released via a CDOT Type C inlet. An emergency spillway is proposed and designed to convey the 100-year flow with a depth of flow less than 1’. The spillway has been designed to provide a minimum of 1’ of freeboard. The sediment basin meets drain time requirements with the 5-year design storm is released in 60 hours. See **Appendix C** of the Winsome Filing No. 3 Early Grading Final Drainage Report (EGP-21-005) for calculations associated with Permanent Sediment Basin H5B.

Each pond reduces proposed flows at the main outfall below historic levels relative to the impact of Filing 3. The proposed 100-year peak flow (1960 cfs) at Reach -6 Kiowa Outfall remains less than the existing conditions peak flow (2,470 cfs).

CHANNELS

Channels and roadside ditches are designed to carry flows to the temporary sediment basins. The channels have varying bottom widths, and slopes, with equal 4:1 side slopes. It should be mentioned that there are several head cuts occurring in existing onsite drainage channels. As part of this Filing mitigation measure will be implemented to stabilize the existing head cuts. In addition to the head cut mitigation measures additional channel improvements are proposed for channel H1-B, H4, H5B, and H3 to reduce the erosion potential to those channel sections. The proposed channel improvements include re-grading portions of the channels, rock sills, riprap rock chutes, and a permanent sediment basin. The approach with the proposed channel improvements presented in this report specifically for channels H1-B, H4, H1-A, and H5B allows for the least disturbance and removal of existing trees. For channel H5B which has a high density of trees, the head cuts will be stabilized, and the remaining length of the channel will remain as is, due to the large number of trees located within the reach. A permeant sediment basin for channel H5B is proposed prior to out falling into West Kiowa Creek. The other area with a high tree density is upstream of detention Pond 1 at channels (H1-B, H4, and H1-A). At this location the proposed channel improvements will include re-grading, rock sills and riprap rock chutes. The channel sizing and capacity calculations are provided in the **Appendix C** of the Winsome Filing No. 3 Early Grading Final Drainage Report (EGP-21-005) and channel design point are provided in the Proposed Drainage Maps. Refer to **Appendix C** for the rock chutes calculations for all rock chutes. Refer to **Appendix F** for the head cutting locations exhibit.

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 majority of the roadside ditches have been designed to have an average depth of approximately 3 feet, a v-ditch, with 4:1 side slopes. Refer to MHFD DCM Table 8-1 in **Appendix C** for permissible velocities for grass line channels for type C soils. All ditch velocities exceeding 7 feet per second will be lined with Turf Reinforcement Mat or approved equal to reduce the potential of erosion within the channel. The Turf Reinforcement Mat material and performance specifications reflect an unvegetated maximum allowable velocity of 9 fps. Refer to **Appendix C** for Turf Reinforcement Mat specifications. Roadside ditch sizing and capacity calculations are provided in the **Appendix C**.

Culverts were sized to convey flows from the ditches and channels, underneath the Site's paved roads. The proposed culverts range in diameter from 24" to 48" and have been designed to convey the 100-year storm event. Culvert calculations are provided in the **Appendix C** of the Winsome Filing No. 3 Early Grading Final Drainage Report (EGP-21-005) and culvert locations are provided in the Proposed Drainage Maps. Two 18" CMP culverts are located under the Pond 2 maintenance access path. Flows unable to be conveyed through the 18" will overtop the maintenance path. Maintenance path culvert calculations are located within **Appendix C**.

THE FOUR STEP PROCESS

The Project was designed in accordance with the four-step process to minimize adverse impacts of urbanization, as outlined in Engineering Criteria Manual Appendix I Section 1.7.2.

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. 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 full spectrum detention ponds will be used to capture stormwater and maintain flows discharging off site at or below historic levels. For portions of Alamar Way and Twinkling Star Lane runoff reduction has been employed by removing the ditch on the downhill side of the road and sending stormwater that contacts the road across a receiving previous area

Step 2. Stabilize Drainageways – Stabilizing proposed roadside ditches, swales, 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. Existing drainage ways have been 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-year storm event. Easements are proposed to accommodate the full width of the major storm event.

Step 3 Provide Water Quality Capture Volume (WQCV)–
Permanent water quality measures and detention facilities will be necessary for the Project. Temporary water quality and erosion control measures will be provided during construction to prevent sediment laden water from discharging from the Site. Water quality measures are being used for all stormwater that contacts roadways.

Step 4. Consider Need for Industrial or Commercial 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 and one water quality pond are being proposed and will capture and control the flows from the proposed development into a series of channels and culverts.

Provided in the **Appendix B** are hydrologic calculations utilizing the NRCS/HEC-HMS method for the proposed conditions. **Appendix C** in Winsome Filing No. 3 Early Grading Final Drainage Report (EGP-21-005) contains the hydraulic calculations for the proposed conditions UD-Culvert culvert calculations, Flowmaster details and cross sections for proposed drainage features. As previously mentioned, the existing drainage map can be found in **Appendix D** and the proposed drainage maps can be found in **Appendix F**.

SPECIFIC DETAILS

The existing condition of the Site have flows conveying from the northwest to southeast and discharging in the West Kiowa Creek. Runoff conditions for the Site were developed utilizing the previously referenced Hydrologic Criteria per the approved PDR for the Winsome subdivision. The proposed development looks to preserve the natural drainage patterns as much as possible.

A Proposed Drainage Conditions Map and hydrologic calculations are included in the **Appendix B, Appendix C,** and **Appendix F** of this report for reference.

The Site will disturb more than 1 acre and will require a Colorado Discharge Permit System (CDPS) General Permit for Stormwater Discharge Associated with Construction Activities from the Colorado Department of Public Health and Environment (CDPHE).

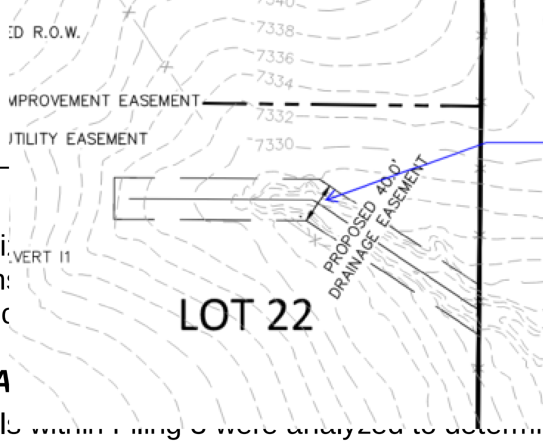
There are no current drainage and bridge fees for the Project as the West Kiowa Creek Drainage Basin is not part of the El Paso County Drainage Basin Fee Program.

RUNOFF REDUCTION

Runoff reduction was implemented in two select areas of the site. The south portion of Twinkling Star Lane, and the south portion of Alamar Way have the road travel perpendicular to grade, therefore the roadside ditch has been removed on the downhill side of the road. All roadway runoff at these sections can be treated using the receiving pervious area between the roadway boundary and property line. Runoff reduction calculations and locations are provided in the **Appendix C.**

WQCV EXCLUSION AREAS

Two 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 Filing 3 sum to 0.59 acres. WQCV exclusion locations are provided in the **Appendix C.**



Unresolved from Review #1. Headcutting mitigation did not include this segment. Is there no concerns for continued erosion? Address in the drainage report.

DRIVEWAY CULVERTS

Culverts were analyzed and si
roadways. Design assumption
Appendix C for the driveway c

EXISTING MINOR DRAINA

The existing drainage channels within Filing 3 were analyzed to determine top widths for proposed easements and velocities for erosion. Proposed regrading of existing drainage channels H1-A, H1-B, H3, and H4 will be proposed as part are fully vegetated and channels H1-A, H1-B, H3, and H4 w Four channels will require lining due to velocities exceeding H1-A, H1-B, H5B, and H3 will require additional improveme within the channels. These channels are discussed in the h Swale I1 and the Water Quality Channel will be lined with T equal to reduce the potential of erosion within the channel. and performance specifications reflect an unvegetated maximum allowable velocity of 9 fps. Refer to **Appendix C** for the channel calculations, maximum MHFD and Turf Reinforcement Mat. Refer to the Winsome Drainage Report (EGP-21-005) for detailed hydraulic analys

Address the above comment by providing a summary of Swale I2 result. The paragraph does not specifically state whether or not any additional improvements are necessary for Reach I2.

KHA RESPONSE: Clarification has been added to the Existing Minor Drainage Channels section to discuss Reach I2.

HEAD CUTTING CHANNELS

Channels H1, H5B and H3 required channel improvements within the reaches. Due to steep slopes, rock chutes were used to decrease slopes to generate velocities below 5 fps. Per El Paso County DCM Section 6.5.2, channels velocities for grass-lined channels cannot exceed 5 feet per second. NRCS's Rock Chute Design spreadsheet was used to design the rock chutes. Grading improvements will be completed within the channels, see Winsome Filing No 3 Construction Documents for grading details. Refer to **Appendix C** for the channel calculations, and rock chute designs.

EXISTING MAJOR DRAINAGE CHANNELS

The existing West Kiowa Creek was analyzed in the previously approved Preliminary Drainage Report (PDR) dated May 22, 2019. Further analysis was completed for this Filing that built off of the PDR analysis. This analysis was submitted as a separate technical memorandum "West Kiowa Creek Stability (Hydraulic and Geomorphic) Analysis". Refer to **Appendix E** for the West Kiowa Creek Stability (Hydraulic and Geomorphic) Analysis.

The analysis evaluated the creek and took a more comprehensive look at the way to manage this natural creek and adjacent riparian wetlands that are consistent with U.S. Army Corp of Engineers (USACE) Section 404 and 401 of the Clean Water Act. The analysis provides a detailed evaluation of hydraulics and geomorphology of West Kiowa Creek in relation to applicable regulations (Section 404/401 and FEMA) as well as El Paso County's Engineering Criteria Manual (ECM) and the DCM.

Based on the detailed evaluation no stabilization directly in West Kiowa Creek outside of the location of the proposed box culverts is recommended. The box culvert inlet and outlet protection will mitigate the high Froude numbers. The areas shown in Table 4 of the memorandum where the Froude number is above 0.9 will be mitigated by sloping back the valley wall terrace slope to a 3:1 to 4:1 slopes and revegetate with native vegetation. Temporary erosion control matting will be proposed following grading until vegetation can establish. As mentioned in this report additional channel stabilization will be done to several onsite channels as well. All detention and water quality pond outfall locations will have erosion protection proposed at the outfall locations.

Each full spectrum detention pond reduces proposed flows at the main outfall below historic levels relative to the impact of Filing 3. The proposed 5-year peak (420.7 cfs) and 100-year peak flow (1960 cfs) at Reach -6 Kiowa Outfall (downstream of project site) remains less than the existing conditions peak flows for the 5-year (447.4 cfs) and 100-year (2,470 cfs).

CONCURRENT REPORTS

Two reinforced bridge culvert crossings are proposed for the Site. The hydraulic analysis for the culverts is discussed in the Winsome Filing No.3 Hydraulic Report by Kimley-Horn, (PCD File No.CDR-21-012). The reinforced concrete box culverts will be submitted concurrently.

Portions of West Kiowa Creek within the Winsome Subdivision require channel stabilization measures. The West Kiowa Creek Stability Analysis – Winsome Subdivision Technical Memorandum by Kimley-Horn, dated May, 2021 provides analysis for designated sections of West Kiowa Creek. The report will be submitted concurrently and reviewed as a standalone project. The proposed improvements will be implemented in conjunction with the construction of the bridge culverts.

ENGINEER'S COST ESTIMATE

Total cost for drainage improvements on Winsome Filing No 3 are listed below in Table 5.

Table 5: *Engineer's Cost Estimate Table*

Completed under Early Grading Permit				
Description	***Quantity***	***Units***	***Unit Cost***	***Total***
Concrete Box Culvert (M Standard), Size (12'x7')	294	LF	$950.00	$279,300.00
18" Reinforced Concrete Pipe	87	LF	$76.00	$6,612.00
24" Reinforced Concrete Pipe	65	LF	$91.00	$5,915.00
30" Reinforced Concrete Pipe	164	LF	$114.00	$18,696.00
36" Reinforced Concrete Pipe	209	LF	$140.00	$29,260.00
42" Reinforced Concrete Pipe	136	LF	$187.00	$25,432.00
48" Reinforced Concrete Pipe	123	LF	$228.00	$28,044.00
18" Flared End Section	2	EA	$456.00	$912.00
24" Flared End Section	1	EA	$546.00	$546.00
30" Flared End Section	4	EA	$684.00	$2,736.00
36" Flared End Section	4	EA	$840.00	$3,360.00
42" Flared End Section	2	EA	$1,122.00	$2,244.00
48" Flared End Section	1	EA	$1,368.00	$1,368.00
Riprap, D50 from 6" to 24"	4284	TONS	$415,548.00	$415,548.00
Rock Chutes	6	EA	$18,000.00	$108,000.00
Rock Sill	13	EA	$8,000.00	$104,000.00
TOTAL (Early Grading Permit)				**$1,031,973.00**
Completed under Final Drainage Report				
18" Reinforced Concrete Pipe	3	LF	$76.00	$228.00
36" Reinforced Concrete Pipe	1	LF	$140.00	$140.00
42" Reinforced Concrete Pipe	1	LF	$187.00	$187.00

48" Reinforced Concrete Pipe	1	LF	$228.00	$228.00
18" Flared End Section	1	EA	$456.00	$456.00
36" Flared End Section	1	EA	$840.00	$840.00
42" Flared End Section	1	EA	$1,122.00	$1,122.00
48" Flared End Section	1	EA	$1,368.00	$1,368.00
Riprap, D50 from 6" to 24" (Pond Outfall & Spillway)	1,256	TONS	$97.00	$121,832.00
Rock Chutes	5	EA	$18,000.00	$90,000.00
Rock Sills	10	EA	$8,000.00	$80,000.00
Concrete Forebay	1	EA	$40,000	$40,000
Concrete Trickle Channel	771	LF	$45.00	$34,695.00
Outlet Structure	4	EA	$50,000.00	$200,000.00
Crestwall	4	EA	$15,000.00	$60,000.00
TOTAL (Final Drainage Report)				**$631,096.00**

DRAINAGE FEE

There are no current drainage and bridge fees for the Project as the West Kiowa Creek Drainage Basin is not part of the El Paso County Basin Fee Program.

SUMMARY

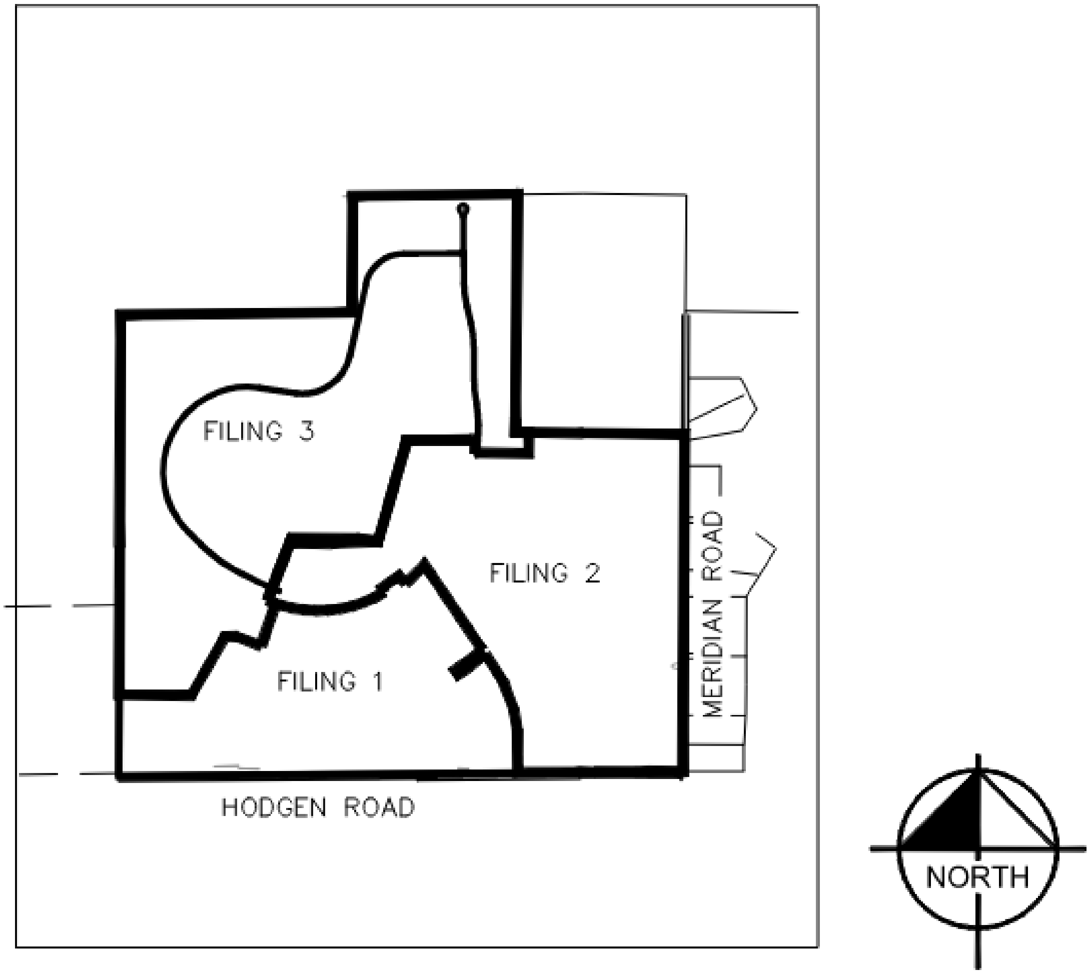
The proposed drainage design is to maintain the historic drainage patterns, the overall imperviousness and release rates for the Site. Runoff from the Site will flow overland to existing El Paso County drainage basins: The West Kiowa Creek Basin. The basin ultimately discharges to the West Kiowa Creek. The drainage design presented within this report conforms to the criteria presented in both the MANUAL and the Colorado Springs MANUAL. Additionally, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments, including West Kiowa Creek.

REFERENCES

1. City of Colorado Springs “Drainage Criteria Manual (DCM) Volume 1”, dated May, 2014
2. El Paso County “Drainage Criteria Manual”, dated October 31, 2018
3. El Paso County “Engineering Criteria Manual” Revision 6, dated December 13, 2016
4. Chapter 6 and Section 3.2.1. of Chapter 13-City of Colorado Springs Drainage Criteria Manual, May 2014.
5. Urban Drainage and Flood Control District Drainage Criteria Manual (UDFCDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.
6. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0507F and 08041C0530F, Effective Date March 17, 1997, prepared by the Federal Emergency Management Agency (FEMA).
7. Winsome Subdivision Preliminary Drainage Report (PDR), prepared by The Vertex Companies, Inc, May 15, 2019. PCD File No. SP-18-006.
8. Request For Conditional Letter of Map Revision For West Kiowa Creek, prepared by The Vertex Companies, Inc., July 1,2019. FEMA Case No. 19-08-0185R.
9. Winsome Subdivision Filing No. 3, Early Grading Permit – Final Drainage Report. Prepared by Kimley-Horn and Associates Inc. January 2023, PCD File No. EGP-21-005.
10. Winsome Subdivision Filing No. 3 Final Hydraulic & Hydraulic Section Report. Prepared by Kimley-Horn and Associates Inc. August 2022, PCD File No. CDR-21-012.

APPENDIX

APPENDIX A: FIGURES



VICINITY MAP

1"=2,000'

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, N/NGS12
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/.

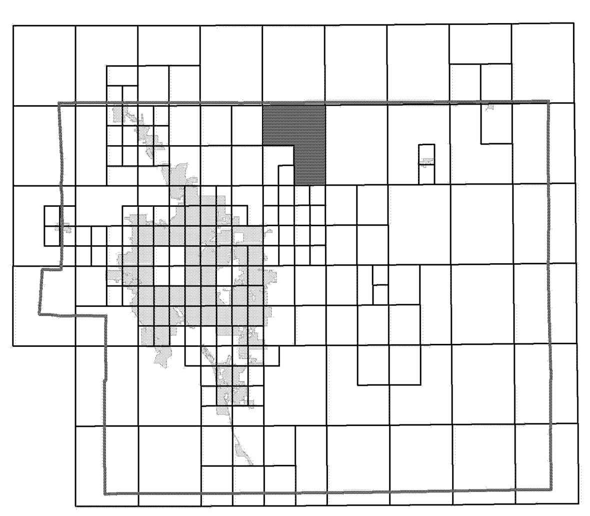
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

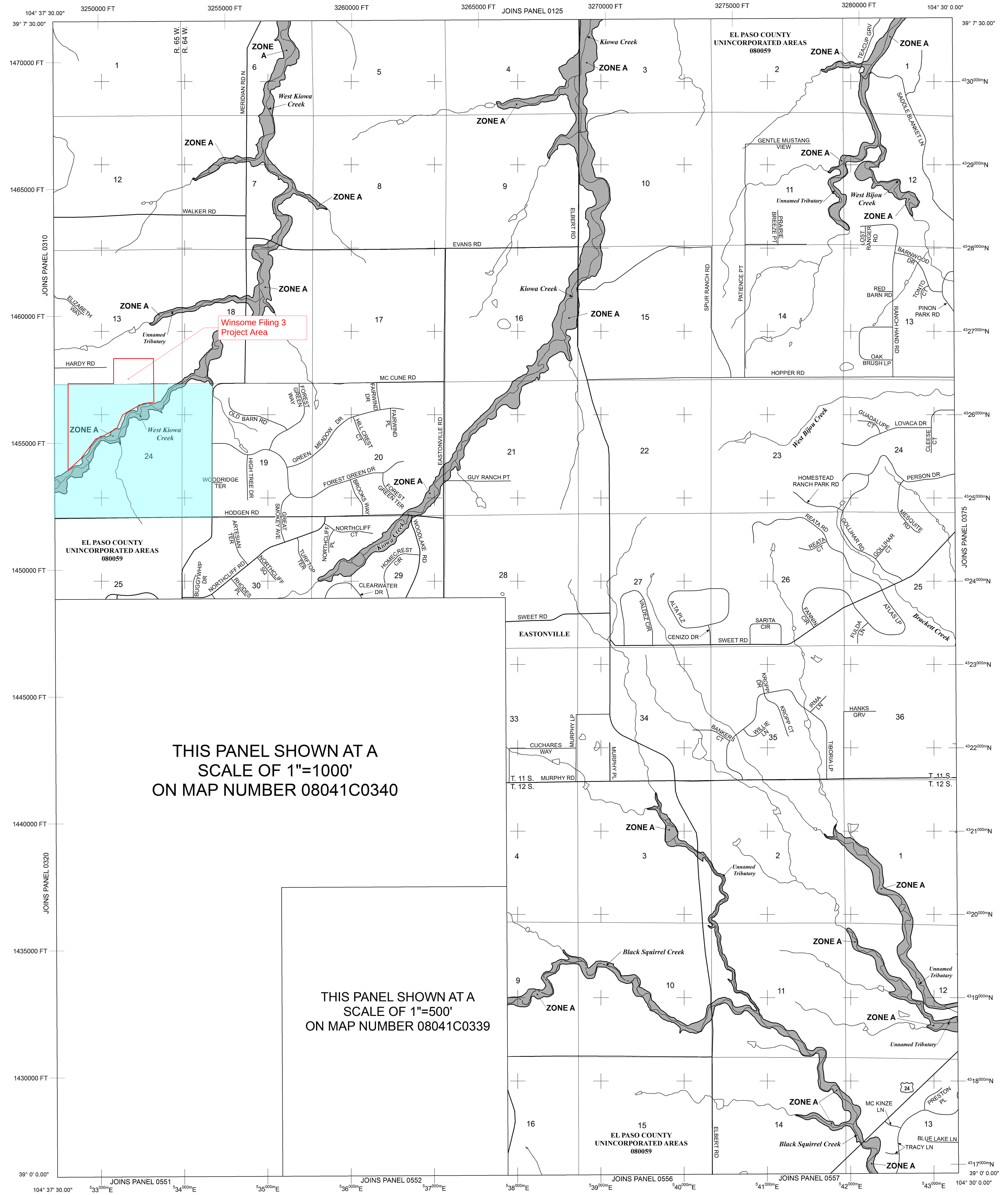
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

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.



LEGEND

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

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include 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.
- 513 — Base Flood Elevation line and elevation in feet*
- (EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

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

- (A)—(A) Cross section line
- (23)- - - -(23) Transect line
- 97° 07' 30.00", 32° 22' 30.00" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4275000mN 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 6000000 FT 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
- DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)
- • 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.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET
600 0 600 1200 METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0350G

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	080059	0350	G

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

United States Department of Agriculture

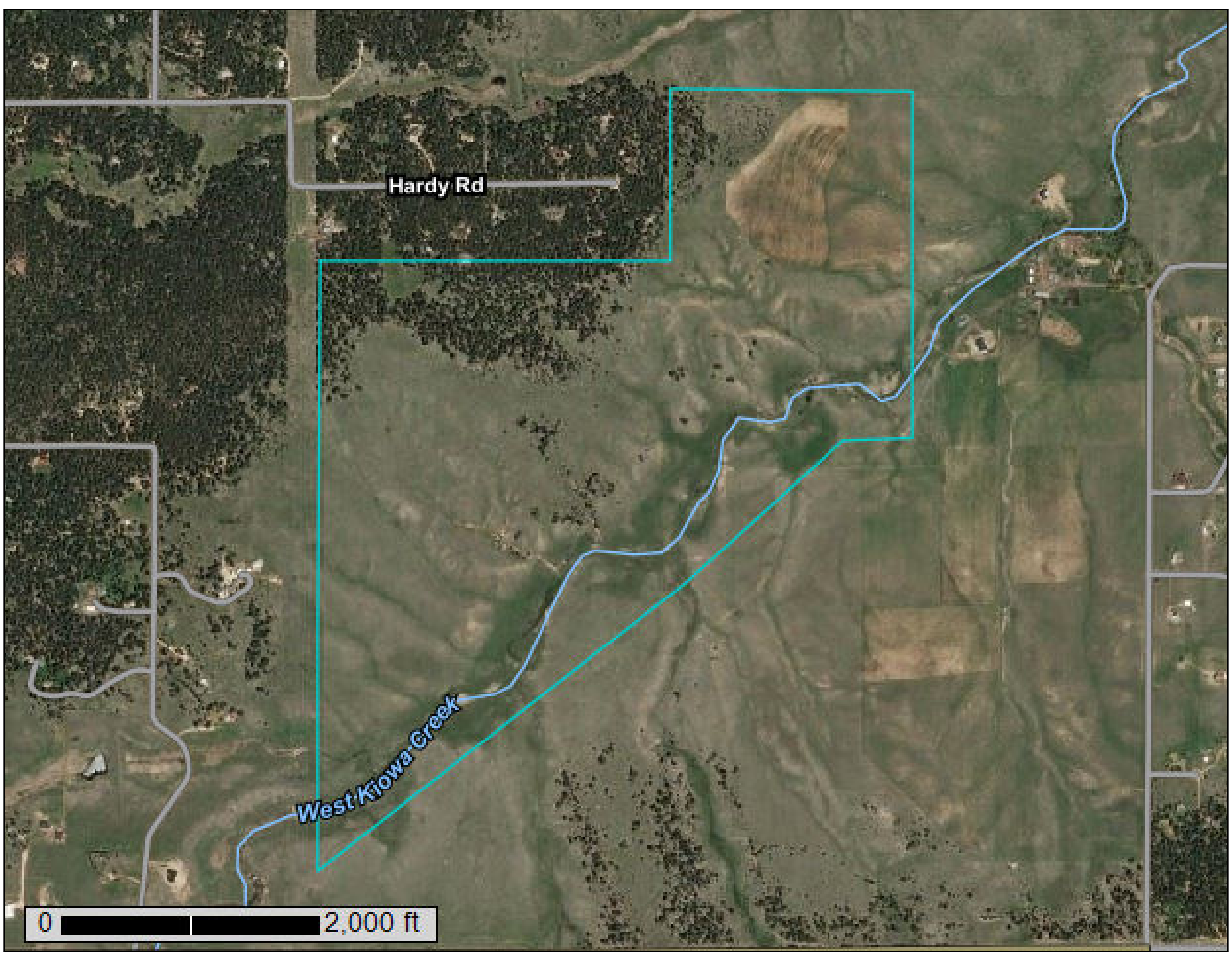
NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for

El Paso County Area, Colorado



September 30, 2021

Preface

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

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

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

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

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

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

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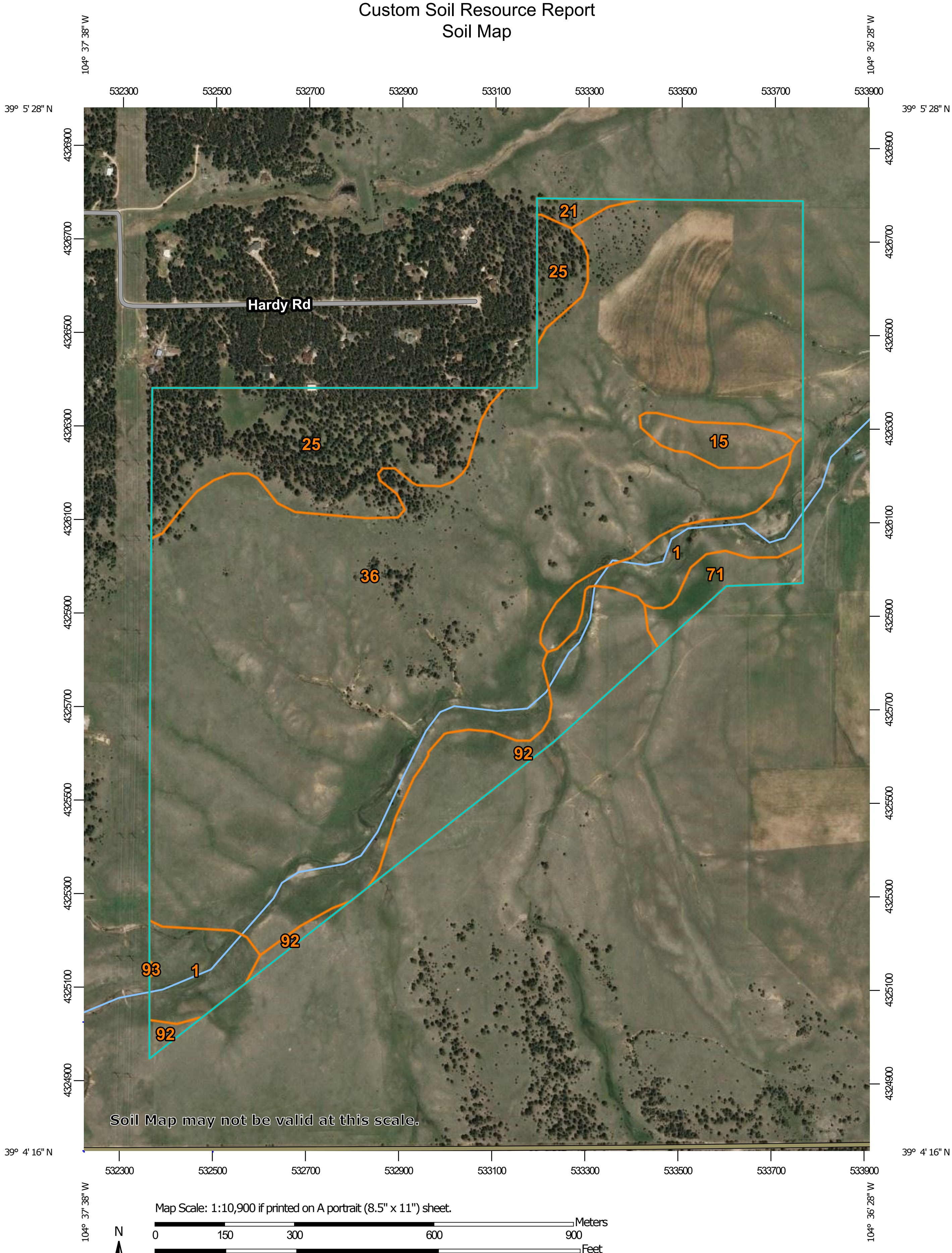
Contents

Soil Map

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

Custom Soil Resource Report
Soil Map



Map Scale: 1:10,900 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	23.6	6.5%
15	Brussett loam, 3 to 5 percent slopes	6.0	1.6%
21	Cruckton sandy loam, 1 to 9 percent slopes	1.8	0.5%
25	Elbeth sandy loam, 3 to 8 percent slopes	46.0	12.6%
36	Holderness loam, 8 to 15 percent slopes	255.9	70.3%
71	Pring coarse sandy loam, 3 to 8 percent slopes	6.3	1.7%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	24.2	6.7%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	0.1	0.0%
Totals for Area of Interest		**363.9**	**100.0%**

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

1—Alamosa loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3670
Elevation: 7,200 to 7,700 feet
Farmland classification: Prime farmland if irrigated and reclaimed of excess salts and sodium

Map Unit Composition

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

Description of Alamosa

Setting

Landform: Flood plains, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 6 inches: loam
Bt - 6 to 14 inches: clay loam
Btk - 14 to 33 inches: clay loam
Cg1 - 33 to 53 inches: sandy clay loam
Cg2 - 53 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 12 to 18 inches
Frequency of flooding: NoneFrequent
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Very slightly saline to strongly saline (2.0 to 16.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: R048AY241CO
Hydric soil rating: Yes

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

15—Brussett loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 367k
Elevation: 7,200 to 7,500 feet
Frost-free period: 115 to 125 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Brussett

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits

Typical profile

A - 0 to 8 inches: loam
BA - 8 to 12 inches: loam
Bt - 12 to 26 inches: clay loam
Bk - 26 to 60 inches: silt loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R048AY222CO
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

21—Cruckton sandy loam, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 367s
Elevation: 7,200 to 7,600 feet
Mean annual precipitation: 16 to 18 inches
Mean annual air temperature: 42 to 46 degrees F
Frost-free period: 110 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Cruckton

Setting

Landform: Flats, hills
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 28 inches: sandy loam
C - 28 to 60 inches: loamy coarse sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

Ecological site: R049XB216CO - Sandy Divide
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

25—Elbeth sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 367x
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Elbeth

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 3 inches: sandy loam
E - 3 to 23 inches: loamy sand
Bt - 23 to 68 inches: sandy clay loam
C - 68 to 74 inches: sandy clay loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B

Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

36—Holderness loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 3689
Elevation: 7,200 to 7,400 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Holderness

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium derived from arkose

Typical profile

A - 0 to 9 inches: loam
Bt - 9 to 43 inches: clay loam
C - 43 to 60 inches: gravelly sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C

Ecological site: R048AY222CO
Hydric soil rating: No

Minor Components

Other soils
Percent of map unit:
Hydric soil rating: No

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

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

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

Description of Pring

Setting
Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile
A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities
Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R048AY222CO
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Other soils

Percent of map unit:
Hydric soil rating: No

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b9
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

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

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
Hydric soil rating: No

Description of Crowfoot

Setting

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

Typical profile

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

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

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

Map Unit Setting

National map unit symbol: 36bb
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

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

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
Hydric soil rating: No

Description of Crowfoot

Setting

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

Typical profile

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

Properties and qualities

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

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

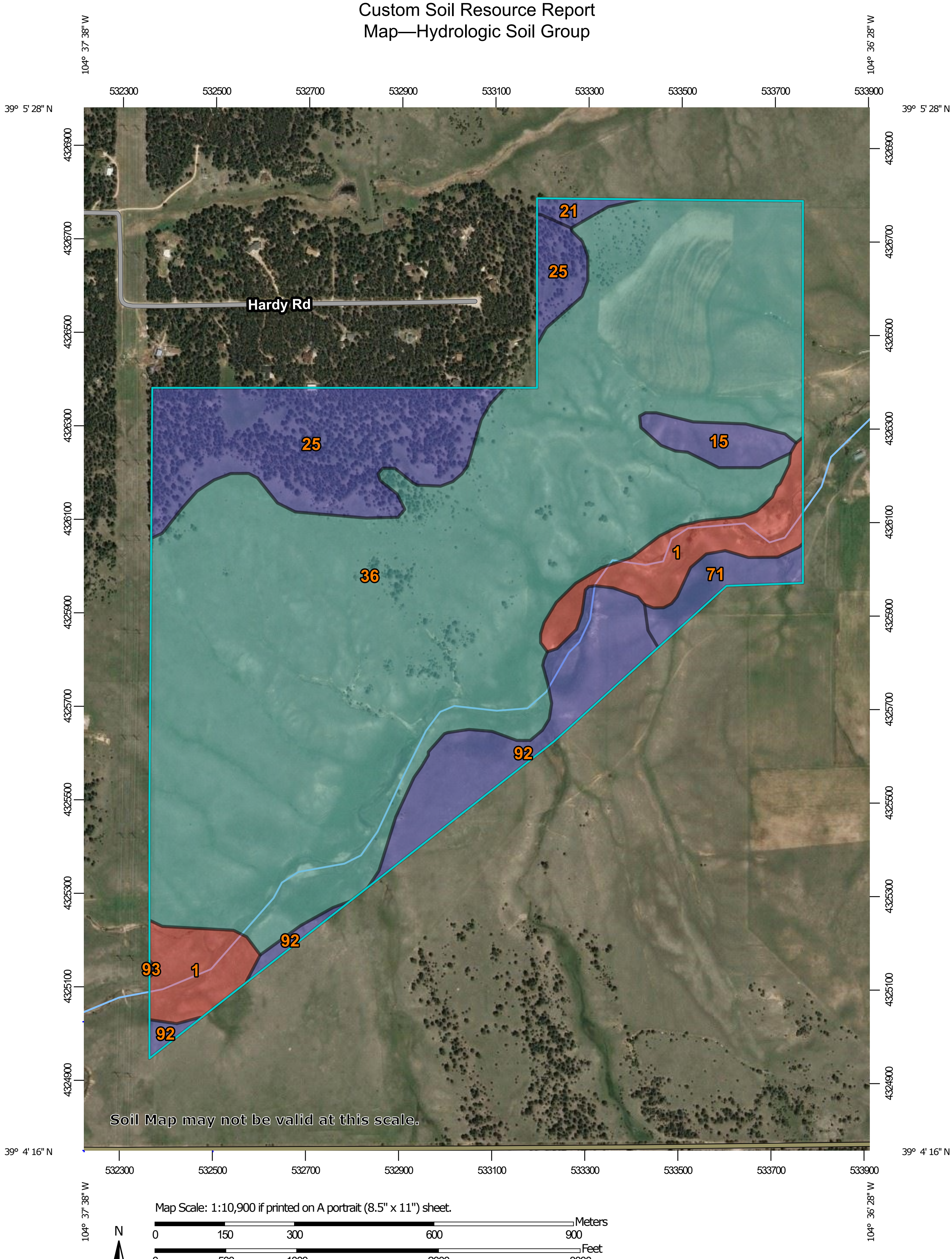
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Map—Hydrologic Soil Group



Map Scale: 1:10,900 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

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 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	D	23.6	6.5%
15	Brussett loam, 3 to 5 percent slopes	B	6.0	1.6%
21	Cruckton sandy loam, 1 to 9 percent slopes	B	1.8	0.5%
25	Elbeth sandy loam, 3 to 8 percent slopes	B	46.0	12.6%
36	Holderness loam, 8 to 15 percent slopes	C	255.9	70.3%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	6.3	1.7%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	24.2	6.7%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	0.1	0.0%
Totals for Area of Interest			**363.9**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

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APPENDIX B: HYDROLOGY

Kimley»Horn

Pre vs. Post Runoff Analysis
Time of Concentration

* NOTES TO USER

Project Information

Project Name: Winsome Filing 3
KHA Project #: 196106001

Designed by: TOS   Date: 9/14/2022
Revised by: Date:
Checked by: Date: 9/14/2022

Minimum Time of Concentration 5.0 minutes
2YR-24HR Rainfall, P2 2.10

Equations Used

CONCENTRATED FLOW EQN	LAG TIME EQN	MANNINGS EQN	SHEET FLOW EQN
$T_t = L / (3600 \cdot V)$	$t_{lag} = 0.6 \cdot t_c$	$V = 1.49\, R_h^{2/3}\, S^{1/2} / n$	$T_t = 0.007(n \cdot L)^{0.8} / (P_2)^{0.5}\, S^{0.4}$
City of Colorado Springs Drainage Criteria Manual Eqn. 6-16	City of Colorado Springs Drainage Criteria Manual Eqn. 6-13	City of Colorado Springs Drainage Criteria Manual Eqn. 6-17	City of Colorado Springs Drainage Criteria Manual Eqn. 6-15

Post-Development

Drainage Area: A2A

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	100.00	0.021	0.10	2.10						8.58	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	1284.00	0.029			U				2.75	7.79	
CHANNEL	T3 CHANNEL FLOW	200.00	0.03	0.04		U	64.00	32.98	1.94	9.87	0.34	
							Post-Development Time of Concentration, A2A				16.70	10.02

Post-Development

Drainage Area: A2B

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	100.00	0.021	0.10	2.10						8.58	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	940.00	0.029			U				2.75	5.70	
CHANNEL	T3 CHANNEL FLOW	404.00	0.03	0.04		U	64.00	32.98	1.94	9.87	0.68	
							Post-Development Time of Concentration, A2B				14.96	8.98

Post-Development

Drainage Area: A3A

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	100.00	0.057	0.10	2.10						5.74	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	890.00	0.050			U				3.61	4.11	
CHANNEL	T3 CHANNEL FLOW	520.00	0.04	0.04		U	64.00	32.98	1.94	11.59	0.75	
							Post-Development Time of Concentration, A3A				10.60	6.36

Post-Development

Drainage Area: A3B

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	100.00	0.070	0.10	2.10						5.30	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	150.00	0.070			U				4.27	0.59	
CHANNEL	T3 CHANNEL FLOW	960.00	0.05	0.04		U	64.00	32.98	1.94	12.96	1.23	
							Post-Development Time of Concentration, A3B				10.00	6.00

Kimley»Horn

Pre vs. Post Runoff Analysis
Time of Concentration

* NOTES TO USER

Project Information

Project Name: Winsome Filing 3
KHA Project #: 196106001

Designed by: TOS — Date: 9/14/2022
Revised by: — Date:
Checked by: — Date: 9/14/2022

Minimum Time of Concentration: 5.0 minutes
2YR-24HR Rainfall, P2: 2.10

Equations Used

CONCENTRATED FLOW EQN

$$T_t = L / (3600 \cdot V)$$

City of Colorado Springs Drainage Criteria Manual Eqn. 6-16

LAG TIME EQN

$$t_{lag} = 0.6 \cdot t_c$$

City of Colorado Springs Drainage Criteria Manual Eqn. 6-13

MANNINGS EQN

$$V = 1.49\, R_h^{2/3}\, S^{1/2} / n$$

City of Colorado Springs Drainage Criteria Manual Eqn. 6-17

SHEET FLOW EQN

$$T_t = 0.007(n \cdot L)^{0.8} / (P_2)^{0.5}\, S^{0.4}$$

City of Colorado Springs Drainage Criteria Manual Eqn. 6-15

Post-Development
Drainage Area: A3C

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	100.00	0.064	0.10	2.10						5.49	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	275.00	0.006			U				1.25	3.67	
CHANNEL	T3 CHANNEL FLOW	554.00	0.01	0.04		U	64.00	32.98	1.94	4.49	2.06	
							Post-Development Time of Concentration, A3C				11.22	6.73

Post-Development
Drainage Area: G1

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.030	0.10	2.10						17.91	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	539.00	0.048			U				3.52	2.56	
CHANNEL	T3 CHANNEL FLOW	620.00	0.04	0.04		U	64.00	32.98	1.94	11.74	0.88	
							Post-Development Time of Concentration, G1				21.34	12.80

Post-Development
Drainage Area: G2A

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	100.00	0.080	0.10	2.10						5.02	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	20.00	0.080			U				4.56	0.07	
CHANNEL	T3 CHANNEL FLOW	1240.00	0.04	0.04		U	64.00	32.98	1.94	11.59	1.78	
							Post-Development Time of Concentration, G2A				10.00	6.00

Post-Development
Drainage Area: G2B

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	67.00	0.040	0.10	2.10						4.81	
CHANNEL	T3 CHANNEL FLOW	750.00	0.06	0.04		U	64.00	32.98	1.94	14.20	0.88	
							Post-Development Time of Concentration, G2B				10.00	6.00

Post-Development
Drainage Area: H1

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	250.00	0.049	0.10	2.10						12.77	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	450.00	0.058			U				3.88	1.93	
CHANNEL	T3 CHANNEL FLOW	225.00	0.06	0.04		U	64.00	32.98	1.94	14.20	0.26	
							Post-Development Time of Concentration, H1				14.96	8.98

Kimley»Horn

Pre vs. Post Runoff Analysis
Time of Concentration

* NOTES TO USER

Project Information

Project Name: Winsome Filing 3
KHA Project #: 196106001

Designed by: TOS Date: 9/14/2022
Revised by: Date:
Checked by: Date: 9/14/2022

Minimum Time of Concentration 5.0 minutes
2YR-24HR Rainfall, P2 2.10

Equations Used

CONCENTRATED FLOW EQN	LAG TIME EQN	MANNINGS EQN	SHEET FLOW EQN
$T_t = L / (3600 \cdot V)$	$t_{lag} = 0.6 \cdot t_c$	$V = 1.49\ R_h^{2/3}\ S^{1/2} / n$	$T_i = 0.007(n \cdot L)^{0.8} / (P_2)^{0.5}\ S^{0.4}$
City of Colorado Springs Drainage Criteria Manual Eqn. 6-16	City of Colorado Springs Drainage Criteria Manual Eqn. 6-13	City of Colorado Springs Drainage Criteria Manual Eqn. 6-17	City of Colorado Springs Drainage Criteria Manual Eqn. 6-15

Post-Development

Drainage Area: H2

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.140	0.10	2.10						9.67	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	1000.00	0.030			U				2.79	5.97	
CHANNEL	T3 CHANNEL FLOW	516.00	0.04	0.04		U	64.00	32.98	1.94	10.84	0.79	
							Post-Development Time of Concentration, H2				16.43	9.86

Post-Development

Drainage Area: H3A

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.055	0.10	2.10						14.05	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	50.00	0.076			U				4.45	0.19	
							Post-Development Time of Concentration, H3A				14.24	8.54

Post-Development

Drainage Area: H3B

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	266.00	0.046	0.10	2.10						13.71	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	334.00	0.014			U				1.91	2.92	
							Post-Development Time of Concentration, H3B				16.62	9.97

Post-Development

Drainage Area: H4

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.050	0.10	2.10						14.60	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	270.00	0.045			U				3.42	1.32	
CHANNEL	T3 CHANNEL FLOW	802.00	0.05	0.04		U	64.00	32.98	1.94	13.22	1.01	
							Post-Development Time of Concentration, H4				16.92	10.15

Post-Development

Drainage Area: H5A

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.078	0.10	2.10						12.22	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	830.00	0.070			U				4.27	3.24	
CHANNEL	T3 CHANNEL FLOW		0.06	0.04		U	64.00	32.98	1.94	14.20	0.00	
							Post-Development Time of Concentration, H5A				15.46	9.28

Kimley»Horn

Pre vs. Post Runoff Analysis
Time of Concentration

* NOTES TO USER

Project Information

Project Name: Winsome Filing 3
KHA Project #: 196106001
Designed by: TOS Date: 9/14/2022
Revised by: Date:
Checked by: Date: 9/14/2022

Minimum Time of Concentration: 5.0 minutes
2YR-24HR Rainfall, P2: 2.10

Equations Used

CONCENTRATED FLOW EQN

$T_t = L / (3600 \cdot V)$

City of Colorado Springs Drainage Criteria Manual Eqn. 6-16

LAG TIME EQN

$t_{lag} = 0.6 \cdot t_c$

City of Colorado Springs Drainage Criteria Manual Eqn. 6-13

MANNINGS EQN

$V = 1.49\ R_h^{2/3}\ S^{1/2} / n$

City of Colorado Springs Drainage Criteria Manual Eqn. 6-17

SHEET FLOW EQN

$T_i = 0.007(n \cdot L)^{0.8} / (P_2)^{0.5}\ S^{0.4}$

City of Colorado Springs Drainage Criteria Manual Eqn. 6-15

Post-Development
Drainage Area: H5B

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.070	0.10	2.10						12.76	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	450.00	0.080			U				4.56	1.64	
CHANNEL	T3 CHANNEL FLOW	500.00	0.05	0.04		U	64.00	32.98	1.94	12.96	0.64	
							Post-Development Time of Concentration, H5B				15.05	9.03

Post-Development
Drainage Area: H6A

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.090	0.10	2.10						11.54	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	650.00	0.080			U				4.56	2.37	
							Post-Development Time of Concentration, H6A				13.91	8.35

Post-Development
Drainage Area: H6B

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	42.00	0.040	0.10	2.10						3.31	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	710.00	0.060			U				3.95	3.00	
CHANNEL	T3 CHANNEL FLOW	825.00	0.04	0.04		U	64.00	32.98	1.94	11.59	1.19	
							Post-Development Time of Concentration, H6B				10.00	6.00

Post-Development
Drainage Area: H7A

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	37.00	0.050	0.10	2.10						2.74	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	546.00	0.040			U				3.23	2.82	
CHANNEL	T3 CHANNEL FLOW	1177.00	0.05	0.04		U	64.00	32.98	1.94	12.96	1.51	
							Post-Development Time of Concentration, H7A				10.00	6.00

Post-Development
Drainage Area: H7B

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	100.00	0.076	0.10	2.10						5.13	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	180.00	0.076			U				4.45	0.67	
CHANNEL	T3 CHANNEL FLOW	1320.00	0.06	0.04		U	64.00	32.98	1.94	14.20	1.55	
							Post-Development Time of Concentration, H7B				10.00	6.00

Kimley»Horn

Pre vs. Post Runoff Analysis
Time of Concentration

* NOTES TO USER

Project Information

Project Name:	Winsome Filing 3		
KHA Project #:	196106001		
Designed by:	TOS	Date:	9/14/2022
Revised by:		Date:	
Checked by:		Date:	9/14/2022
Minimum Time of Concentration	5.0	minutes	
2YR-24HR Rainfall, P2	2.10		

Equations Used

CONCENTRATED FLOW EQN	LAG TIME EQN	MANNINGS EQN	SHEET FLOW EQN
$T_t = L / (3600 \cdot V)$	$t_{lag} = 0.6 \cdot t_c$	$V = 1.49 R_h^{2/3} S^{1/2} / n$	$T_t = 0.007(n \cdot L)^{0.8} / (P_2)^{0.5} S^{0.4}$
City of Colorado Springs Drainage Criteria Manual Eqn. 6-16	City of Colorado Springs Drainage Criteria Manual Eqn. 6-13	City of Colorado Springs Drainage Criteria Manual Eqn. 6-17	City of Colorado Springs Drainage Criteria Manual Eqn. 6-15

Post-Development

Drainage Area: H8A

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.080	0.10	2.10						12.09	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	600.00	0.080			U				4.56	2.19	
							Post-Development Time of Concentration, H8A				14.29	8.57

Post-Development

Drainage Area: H8B

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.080	0.10	2.10						12.09	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	80.00	0.080			U				4.56	0.29	
							Post-Development Time of Concentration, H8B				12.39	7.43

Post-Development

Drainage Area: H9

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.036	0.10	2.10						16.65	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	300.00	0.060			U				3.95	1.27	
CHANNEL	T3 CHANNEL FLOW	230.00	0.10	0.04		U	64.00	32.98	1.94	18.33	0.21	
							Post-Development Time of Concentration, H9				18.12	10.87

Post-Development

Drainage Area: I1

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.038	0.10	2.10						16.29	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	65.00	0.038			U				3.14	0.34	
CHANNEL	T3 CHANNEL FLOW	526.00	0.04	0.04		U	64.00	32.98	1.94	11.74	0.75	
							Post-Development Time of Concentration, I1				17.38	10.43

Post-Development

Drainage Area: I2

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.040	0.10	2.10						15.96	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	140.00	0.030			U				2.79	0.84	
							Post-Development Time of Concentration, I2				16.79	10.08

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Pre vs. Post Runoff Analysis
Time of Concentration

* NOTES TO USER

Project Information

Project Name: Winsome Filing 3
KHA Project #: 196106001
Designed by: TOS Date: 9/14/2022
Revised by: Date:
Checked by: Date: 9/14/2022

Minimum Time of Concentration 5.0 minutes
2YR-24HR Rainfall, P2 2.10

Equations Used

CONCENTRATED FLOW EQN	LAG TIME EQN	MANNINGS EQN	SHEET FLOW EQN
$T_t = L / (3600 \cdot V)$	$t_{lag} = 0.6 \cdot t_c$	$V = 1.49\ R_h^{2/3}\ S^{1/2} / n$	$T_i = 0.007(n \cdot L)^{0.8} / (P_2)^{0.5}\ S^{0.4}$
City of Colorado Springs Drainage Criteria Manual Eqn. 6-16	City of Colorado Springs Drainage Criteria Manual Eqn. 6-13	City of Colorado Springs Drainage Criteria Manual Eqn. 6-17	City of Colorado Springs Drainage Criteria Manual Eqn. 6-15

Post-Development
Drainage Area: J1

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	244.00	0.065	0.10	2.10						11.14	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	395.00	0.110			U				5.35	1.23	
CHANNEL	T3 CHANNEL FLOW		0.00	0.04		U	64.00	32.98	1.94	2.46	0.00	
							Post-Development Time of Concentration, J1				12.37	7.42

Post-Development
Drainage Area: K1

		Flow Length, L (ft)	Slope, s (ft/ft)	Manning's Roughness Coefficient, n	Two-year, 24-hr rainfall, P2 (in)	Paved or Unpaved	Cross Sectional Area of Flow, A (ft^2)	Wetted Perimeter, pw (ft)	Hydraulic radius, r (ft)	Average Velocity, V (ft/s)**	Travel Time, Tt (min)	Lag Time (min)
SHEET	T1 SHEET FLOW	300.00	0.083	0.10	2.10						11.92	
SHALLOW CONCENTRATED	T2 SHALLOW CONCENTRATED FLOW	390.00	0.043			U				3.34	1.94	
							Post-Development Time of Concentration, K1				13.86	8.32

Kimley»Horn

Pre vs. Post Runoff Analysis

Composite CN and Crat

Project Name: Winsome Filing 3
KHA Project #: 196106001
Designed by: TOS Date: 9/14/2022
Revised by: Date:
Revised by: Date:
Checked by: Date: 9/14/2022

Post-Development					
Drainage Area: A2A					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
RESIDENTIAL	5 acre (7% imp.)	B	60.00	15.39	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	12.74	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - A2A		65.43		28.13	0.528

Post-Development					
Drainage Area: A2B					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
RESIDENTIAL	5 acre (7% imp.)	B	60.00	1.64	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	7.23	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - A2B		69.78		8.87	0.433

Post-Development					
Drainage Area: A3A					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.43	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	7.82	
COMPOSITE SCS CURVE NUMBER - A3A		73.04		8.25	0.369

Post-Development					
Drainage Area: A3B					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.12	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	9.09	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	4.01	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - A3B		74.30		13.22	0.346

Post-Development					
Drainage Area: A3C					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.00	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	2.95	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	8.71	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - A3C		77.23		11.66	0.295

Post-Development					
Drainage Area: G1					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.24	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	10.03	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	0.83	
WOODS	WOODS, Fair condition (grass cover 50 to 75%)	B	60.00	9.08	
WOODS	WOODS, Fair condition (grass cover 50 to 75%)	C	73.00	4.61	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - G1		67.58		24.79	0.480

Kimley»Horn

Pre vs. Post Runoff Analysis

Composite CN and Crat

Project Name:	Winsome Filing 3		
KHA Project #:	196106001		
Designed by:	TOS	Date:	9/14/2022
Revised by:		Date:	
Revised by:		Date:	
Checked by:		Date:	9/14/2022

Post-Development					
Drainage Area: G2A					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.28	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	13.28	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	5.04	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - G2A		74.20		18.60	0.348

Post-Development					
Drainage Area: G2B					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.31	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	2.46	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.00	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - G2B		74.24		2.77	0.347

Post-Development					
Drainage Area: H1					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.32	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	10.65	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	2.79	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H1		70.03		13.76	0.428

Post-Development					
Drainage Area: H2					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.65	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	24.64	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	12.91	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.89	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H2		64.93		39.09	0.540

Post-Development					
Drainage Area: H3A					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.16	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	0.00	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	1.18	
WOODS	WOODS, Fair condition (grass cover 50 to 75%)	B	60.00	0.87	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.87	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H3A		71.60		3.08	0.397

Post-Development					
Drainage Area: H3B					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.18	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	0.00	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	1.16	
WOODS	WOODS, Fair condition (grass cover 50 to 75%)	B	60.00	0.69	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.69	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H3B		72.02		2.71	0.388

Kimley»Horn

Pre vs. Post Runoff Analysis

Composite CN and Crat

Project Name: Winsome Filing 3
KHA Project #: 196106001
Designed by: TOS Date: 9/14/2022
Revised by: Date:
Revised by: Date:
Checked by: Date: 9/14/2022

Post-Development

Drainage Area: H4

COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.25	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	18.06	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	8.69	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H4		74.44		27.00	0.343

Post-Development

Drainage Area: H5A

COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.00	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	3.93	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	5.10	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H5A		75.95		9.03	0.317

Post-Development

Drainage Area: H5B

COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.00	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	7.85	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	2.63	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H5B		73.76		10.48	0.356

Post-Development

Drainage Area: H6A

COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.00	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	8.17	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	8.47	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H6A		75.56		16.64	0.323

Post-Development

Drainage Area: H6B

COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.64	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	8.48	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	4.73	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	D	84.00	2.11	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H6B		76.47		15.96	0.308

Post-Development

Drainage Area: H7A

COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.63	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	6.17	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	0.88	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.82	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H7A		72.92		8.50	0.371

Kimley»Horn

Pre vs. Post Runoff Analysis

Composite CN and Crat

Project Name: Winsome Filing 3
KHA Project #: 196106001
Designed by: TOS Date: 9/14/2022
Revised by: Date:
Revised by: Date:
Checked by: Date: 9/14/2022

Post-Development					
Drainage Area: H7B					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.31	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	14.64	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	1.77	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.63	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H7B		71.39		17.35	0.401

Post-Development					
Drainage Area: H8A					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	B	89.00	0.13	
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.28	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	1.08	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	0.39	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	B	69.00	0.74	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	D	84.00	0.00	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	1.31	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H8A		72.46		3.93	0.380

Post-Development					
Drainage Area: H8B					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	B	89.00	0.00	
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.05	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	0.79	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	0.36	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	B	69.00	0.00	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	D	84.00	2.13	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	1.76	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H8B		77.78		5.09	0.286

Post-Development					
Drainage Area: H9					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
RESIDENTIAL	5 acre (7% imp.)	C	72.00	6.29	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	0.23	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - H9		71.58		6.52	0.397

Post-Development					
Drainage Area: I1					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.93	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	5.89	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.00	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - I1		74.72		6.82	0.338

Post-Development					
Drainage Area: I2					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	C	92.00	0.34	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	14.22	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.03	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - I2		72.48		14.59	0.380

Kimley»Horn

Pre vs. Post Runoff Analysis

Composite CN and Crat

Project Name: Winsome Filing 3
KHA Project #: 196106001
Designed by: TOS   Date: 9/14/2022
Revised by: Date:
Revised by: Date:
Checked by: Date: 9/14/2022

Post-Development					
Drainage Area: J1					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
IMPERVIOUS	Paved; open ditches (including right-of-way)	B	89.00	0.00	
RESIDENTIAL	5 acre (7% imp.)	B	60.00	10.14	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - J1		60.00		10.14	0.667

Post-Development					
Drainage Area: K1					
COVER DESCRIPTION	HYDROLOGIC CONDITION OR COVER TYPE	HYDROLOGIC SOIL GROUP	SCS CURVE NUMBER (CN)	AREA, A (ac.)	Initial Abstraction (in)
RESIDENTIAL	5 acre (7% imp.)	B	60.00	3.56	
RESIDENTIAL	5 acre (7% imp.)	C	72.00	13.94	
AGRICULTURAL	Pasture, grassland or range (Fair Condition)	C	79.00	0.00	
CUSTOM					
COMPOSITE SCS CURVE NUMBER - K1		69.56		17.50	0.438

C Value Table

Project Name: Winsome Filing 3
KHA Project #: 196106001
Designed by: TOS Date: 9/6/2022
Revised by: Date:
Revised by: Date:
Checked by: Date: 9/6/2022

		Hydrologic Soil Type				
Land Cover	Imp %	A	B	C	D	Source
5 acre Residential Lot	7%	51.0	60.0	72.0	77.0	Winsome PDR
Pasture, grassland or range (Fair Condition)	2%	49.0	69.0	79.0	84.0	City of Colorado Springs DCM Table 6-10
Woods (Fair Condition)	2%	36.0	60.0	73.0	79.0	City of Colorado Springs DCM Table 6-10
Roadway, paved w/ ROW	100%	83.0	89.0	92.0	93.0	City of Colorado Springs DCM Table 6-10

Imperviousness Table

Project Name: Winsome Filing 3

KHA Project #: 196106001

Designed by: TOS Date: 9/14/2022

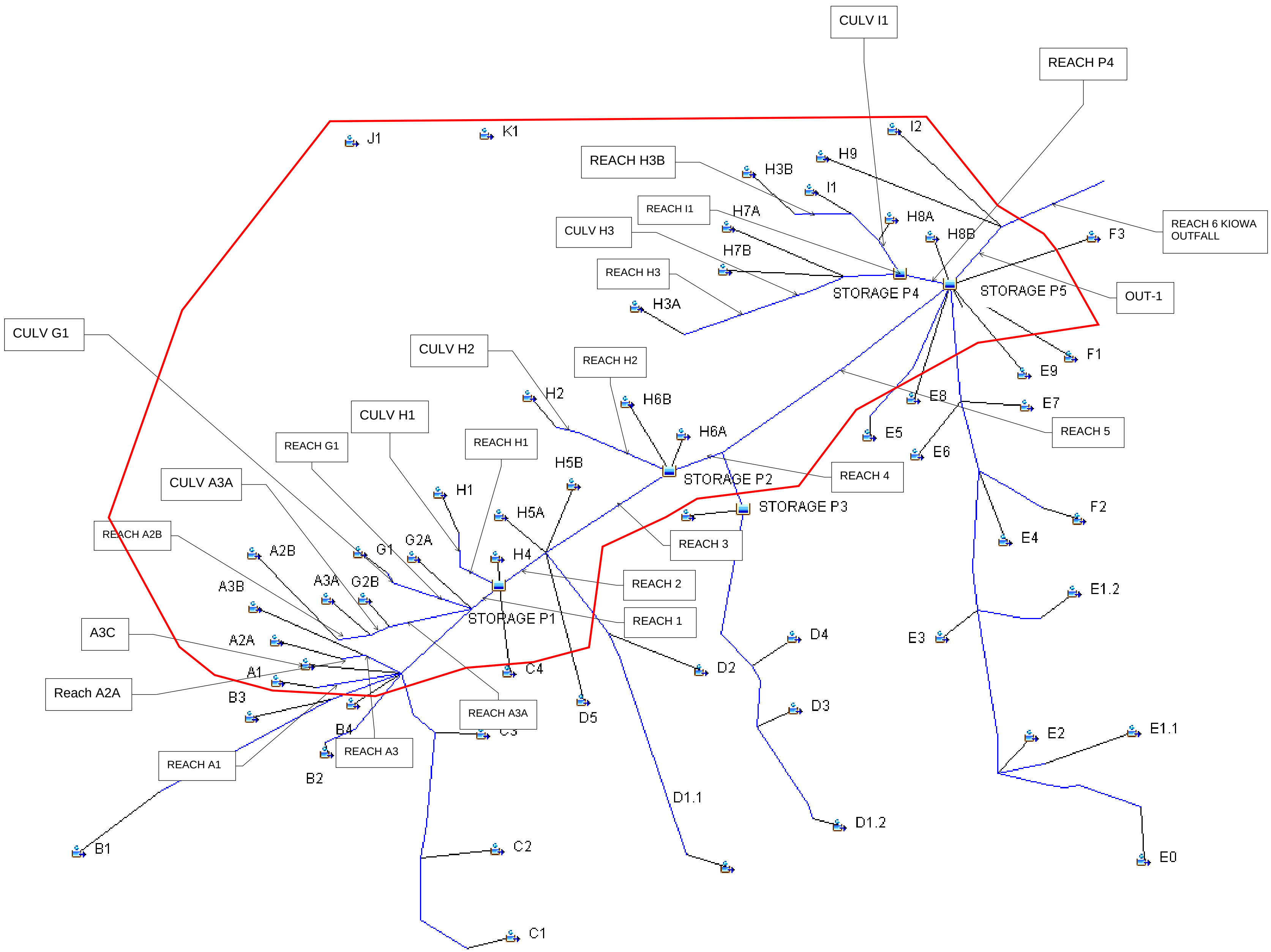
Checked by: Date: 9/14/2022

		Impervious Areas				
Basin	Area (ac)	*Historic Flow Analysis (2%)*	*5-acre Residential (7%)*	*Roadway (100%)*	Modified Area for UD-Detention	Imperviousness %
WQ Pond 1						
A2B	8.87	0.00	8.87	0.00		7.0%
A3A	8.25	0.00	7.82	0.43		11.8%
G2A	18.60	5.04	13.28	0.28		7.0%
G2B	2.77	0.00	2.46	0.31		17.4%
G1	24.79	13.69	10.85	0.24		5.1%
Total	63.28			1.26		2%*
Pond 1						
H1	13.76	0.0%	97.7%	2.3%	--	9.2%
H4	27.00	32.2%	66.9%	0.9%	--	6.3%
Total	40.76				45.5	7.2%
Pond 2						
H6B	15.96	42.8%	53.1%	4.0%	--	8.6%
H2	39.09	2.3%	96.1%	1.7%	--	8.4%
Total	55.05				67.90	8.5%
Pond 4						
H3A	3.08	56.6%	38.4%	5.1%	--	8.9%
H3B	2.71	50.9%	42.6%	6.5%		10.5%
H7A	8.50	9.6%	82.9%	7.4%	--	13.4%
H7B	17.35	3.6%	94.6%	1.8%	--	8.5%
I1	6.82	0.0%	86.4%	13.6%	--	19.6%
H8A	3.93	52.2%	37.4%	10.4%	--	14.1%
Total	42.38				64.00	11.9%

*: WQ Pond only treats roadway runoff.

Basin ID	Area	**Imperviousness %**
A2A	28.13	7.0%
A2B	8.87	7.0%
A3A	8.25	11.8%
A3B	13.22	6.3%
A3C	11.66	3.3%
G1	24.79	5.1%
G2A	18.60	7.0%
G2B	2.77	17.4%
H1	13.76	9.2%
H2	39.09	8.4%
H3A	3.08	8.9%
H3B	2.71	10.5%
H4	27.00	6.3%
H5A	9.03	4.2%
H5B	10.48	5.7%
H6A	16.64	4.5%
H6B	15.96	8.6%
H7A	8.50	13.4%
H7B	17.35	8.5%
H8A	3.93	14.1%
H8B	5.09	4.1%
H9	6.52	7.0%
I1	6.82	19.6%
I2	14.59	9.2%
J1	10.14	7.0%
K1	17.50	7.0%

PROPOSED CONDITIONS HEC-HMS LAYOUT
WINSOME FILING NO. 3



Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Start of Run: 26Feb2019, 00:00 Basin Model: Proposed B
End of Run: 27Feb2019, 12:00 Meteorologic Model: Prop Basins
Compute Time: DATA CHANGED, RECOMPUTE Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
A1	1.3529000	84.1	26Feb2019, 12:26	13.7
A2A	0.0439531	5.3	26Feb2019, 12:03	0.4
A2B	0.0138594	2.3	26Feb2019, 12:04	0.2
A3A	0.0128906	5.7	26Feb2019, 12:01	0.3
A3B	0.0206563	9.1	26Feb2019, 12:01	0.3
A3C	0.0182187	10.7	26Feb2019, 12:02	0.3
BOX CULVERT 1	7.8720139	370.1	26Feb2019, 12:43	80.0
BOX CULV 2	8.8550872	408.4	26Feb2019, 12:49	91.5
B1	5.9948000	286.7	26Feb2019, 12:42	60.5
B2	0.0204688	3.3	26Feb2019, 12:07	0.3
B3	0.0857813	6.8	26Feb2019, 12:15	0.9
B4	0.0648125	5.5	26Feb2019, 12:16	0.7
CLV E4	0.1670157	26.6	26Feb2019, 12:11	3.1
CULV A3A	0.0267500	7.0	26Feb2019, 12:03	0.4
CULV B2	0.0204688	3.3	26Feb2019, 12:07	0.3
CULV C2	0.2892200	23.8	26Feb2019, 12:16	2.9
CULV C3	0.3143763	26.5	26Feb2019, 12:18	3.3
CULV D2	0.3593700	31.5	26Feb2019, 12:18	3.9
CULV D3	0.1423438	13.2	26Feb2019, 12:19	1.8
CULV D4	0.1959376	18.8	26Feb2019, 12:19	2.7
CULV E1.1	0.0592188	4.9	26Feb2019, 12:16	0.6
CULV E1.2	0.0238750	5.0	26Feb2019, 12:08	0.5
CULV E1.5	0.0136094	2.7	26Feb2019, 12:08	0.2
CULV E2	0.0768907	7.3	26Feb2019, 12:13	1.0
CULV E5	0.0210938	3.9	26Feb2019, 12:08	0.4
CULV F2	0.0068750	2.2	26Feb2019, 12:03	0.2
CULV G1	0.0387188	3.1	26Feb2019, 12:05	0.3

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CULV H1	0.0217031	4.6	26Feb2019, 12:04	0.3
CULV H2	0.0610938	8.9	26Feb2019, 12:03	0.7
CULV H3	0.0048125	1.4	26Feb2019, 12:04	0.1
CULV I1	0.0148907	6.6	26Feb2019, 12:06	0.4
CULV-E3	0.1317032	18.6	26Feb2019, 12:09	2.2
CULV-Pond4	0.0452031	14.7	26Feb2019, 12:02	0.8
C1	0.2542200	21.0	26Feb2019, 12:14	2.6
C2	0.0350000	3.1	26Feb2019, 12:11	0.4
C3	0.0251563	3.8	26Feb2019, 12:09	0.4
C4	0.0371875	1.9	26Feb2019, 12:16	0.2
D1.1	0.2520300	20.8	26Feb2019, 12:14	2.5
D1.2	0.0779688	5.8	26Feb2019, 12:18	0.8
D2	0.1073400	11.8	26Feb2019, 12:12	1.4
D3	0.0643750	8.1	26Feb2019, 12:15	1.0
D4	0.0535938	7.8	26Feb2019, 12:10	0.9
D5	0.0200000	0.8	26Feb2019, 12:10	0.1
D6	0.0653125	4.4	26Feb2019, 12:15	0.6
EX CULV C1	0.2542200	21.0	26Feb2019, 12:14	2.6
EX CULV D1.1	0.2520300	20.8	26Feb2019, 12:14	2.5
EX CULV D1.2	0.0779688	5.8	26Feb2019, 12:18	0.8
EX CULV E0	0.0592188	4.9	26Feb2019, 12:14	0.6
E0	0.0592188	4.9	26Feb2019, 12:14	0.6
E1.1	0.0136094	2.7	26Feb2019, 12:08	0.2
E1.2	0.0238750	5.0	26Feb2019, 12:08	0.5
E2	0.0040625	2.3	26Feb2019, 11:56	0.1
E3	0.0309375	7.6	26Feb2019, 12:06	0.7
E4	0.0284375	6.3	26Feb2019, 12:09	0.7
E5	0.0210938	3.9	26Feb2019, 12:08	0.4
E6	0.0144609	2.7	26Feb2019, 12:03	0.2
E7	0.0159688	3.3	26Feb2019, 12:05	0.3
E8	0.0246594	5.2	26Feb2019, 11:59	0.4

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
E9	0.0059688	0.3	26Feb2019, 11:55	0.0
F1	0.0501563	8.1	26Feb2019, 12:07	0.8
F2	0.0068750	2.2	26Feb2019, 12:03	0.2
F3	0.0150313	3.4	26Feb2019, 12:04	0.3
G1	0.0387188	3.1	26Feb2019, 12:05	0.3
G2A	0.0290625	12.9	26Feb2019, 12:01	0.5
G2B	0.0043281	2.6	26Feb2019, 12:00	0.1
H1	0.0217031	4.6	26Feb2019, 12:04	0.3
H2	0.0610938	8.9	26Feb2019, 12:03	0.7
H3A	0.0048125	1.4	26Feb2019, 12:03	0.1
H3B	0.0042344	1.3	26Feb2019, 12:05	0.1
H4	0.0421875	15.4	26Feb2019, 12:05	0.6
H5A	0.0141094	6.2	26Feb2019, 12:04	0.2
H5B	0.0163750	5.6	26Feb2019, 12:04	0.2
H6A	0.0260000	11.6	26Feb2019, 12:03	0.4
H6B	0.0249375	15.5	26Feb2019, 12:01	0.5
H7A	0.0132812	6.2	26Feb2019, 12:01	0.3
H7B	0.0271094	8.0	26Feb2019, 12:01	0.4
H8A	0.0061406	2.5	26Feb2019, 12:03	0.1
H8B	0.0079531	4.9	26Feb2019, 12:02	0.1
H9	0.0102188	2.3	26Feb2019, 12:06	0.1
I1	0.0106563	6.0	26Feb2019, 12:05	0.4
I2	0.0231250	8.3	26Feb2019, 12:05	0.5
J1	0.0158438	2.1	26Feb2019, 12:00	0.2
K1	0.0273438	4.5	26Feb2019, 12:03	0.3
OUT-1	9.2436297	420.9	26Feb2019, 12:52	97.1
REACH A1	1.3529000	83.8	26Feb2019, 12:31	13.7
Reach E3.1	0.0238750	5.0	26Feb2019, 12:11	0.5
Reach H3	0.0048125	1.3	26Feb2019, 12:10	0.1
Reach-A2A	0.0439531	5.2	26Feb2019, 12:07	0.4
Reach-A2B	0.0138594	2.2	26Feb2019, 12:10	0.2

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Reach-A3	0.0439531	5.2	26Feb2019, 12:09	0.4
Reach-A3A	0.0310781	9.6	26Feb2019, 12:03	0.6
Reach-B1	5.9948000	286.6	26Feb2019, 12:46	60.5
Reach-B2	0.0204688	3.3	26Feb2019, 12:15	0.3
Reach-B3	6.0805813	288.7	26Feb2019, 12:50	61.4
Reach-B4-3	0.3143763	26.5	26Feb2019, 12:19	3.3
Reach-C1	0.2542200	20.9	26Feb2019, 12:17	2.6
Reach-C2	0.2892200	23.8	26Feb2019, 12:20	2.9
Reach-D1.1	0.2520300	20.7	26Feb2019, 12:20	2.5
Reach-D3	0.0779688	5.7	26Feb2019, 12:24	0.8
Reach-D4	0.1423438	13.2	26Feb2019, 12:24	1.8
Reach-D5	0.3593700	31.4	26Feb2019, 12:22	3.9
Reach-D6	0.1959376	18.7	26Feb2019, 12:23	2.7
Reach-E1.1	0.0592188	4.9	26Feb2019, 12:15	0.6
Reach-E2	0.0592188	4.9	26Feb2019, 12:18	0.6
Reach-E3	0.0768907	7.3	26Feb2019, 12:18	1.0
Reach-E4	0.1317032	18.6	26Feb2019, 12:13	2.2
Reach-E6	0.0210938	3.8	26Feb2019, 12:13	0.4
Reach-E6-2	0.1974454	30.3	26Feb2019, 12:15	3.6
Reach-E7	0.1670157	26.6	26Feb2019, 12:14	3.1
Reach-F2	0.0068750	2.2	26Feb2019, 12:08	0.2
Reach-G1	0.0387188	3.0	26Feb2019, 12:11	0.3
Reach-H1	0.0217031	4.6	26Feb2019, 12:09	0.3
Reach-H2	0.0610938	8.9	26Feb2019, 12:05	0.7
Reach-H3B	0.0042344	1.2	26Feb2019, 12:13	0.1
Reach-I1	0.0210313	8.9	26Feb2019, 12:09	0.6
Reach-P3	0.2612501	21.0	26Feb2019, 12:30	3.2
Reach-P4	0.0662344	8.7	26Feb2019, 12:18	1.2
Reach-1	7.9708733	371.6	26Feb2019, 12:45	81.3
Reach-2	8.0719514	376.2	26Feb2019, 12:48	82.4
Reach-3	8.4818058	390.9	26Feb2019, 12:48	86.8

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Reach-4	8.5938371	393.8	26Feb2019, 12:50	88.3
Reach-5	8.8550872	408.3	26Feb2019, 12:50	91.5
Reach-6 Kiowa Outfall	9.2769735	421.3	26Feb2019, 12:52	97.7
STORAGE P1	0.0638906	9.8	26Feb2019, 12:15	0.9
STORAGE P2	0.0860313	10.7	26Feb2019, 12:11	1.1
STORAGE P3	0.2612501	21.0	26Feb2019, 12:29	3.2
STORAGE P4	0.0662344	8.8	26Feb2019, 12:17	1.2
STORAGE P5	0.2431986	6.7	26Feb2019, 13:03	3.2

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: A1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	84.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12
Precipitation Volume:	195.2 (AC-FT)	Direct Runoff Volume:	13.7 (AC-FT)
Loss Volume:	181.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	13.7 (AC-FT)	Discharge Volume:	13.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: A2A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	5.3 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	6.3 (AC-FT)	Direct Runoff Volume:	0.4 (AC-FT)
Loss Volume:	5.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: A2B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	2.3 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:
Precipitation Volume	2.0 (AC-FT)	Direct Runoff Volume:	0.2 (AC-FT)
Loss Volume:	1.8 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.2 (AC-FT)	Discharge Volume:	0.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: A3A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	5.7 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.9 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	1.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: A3B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	9.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.0 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	2.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: A3C

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	10.7 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	2.6 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	2.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: CULV A3A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	7.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:01
Peak Discharge:	7.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:03
Inflow Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: CULV G1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	3.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:04
Peak Discharge:	3.1 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:05
Inflow Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: CULV H1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	4.6 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	4.6 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:04
Inflow Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: CULV H2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	8.9 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	8.9 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:03
Inflow Volume:	0.7 (AC-FT)	Discharge Volume:	0.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: CULV H3

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1.4 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	1.4 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:04
Inflow Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: CULV I1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	6.6 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:04
Peak Discharge:	6.6 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:06
Inflow Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: CULV-Pond4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	14.8 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:00
Peak Discharge:	14.7 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:02
Inflow Volume:	0.8 (AC-FT)	Discharge Volume:	0.8 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: G1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	3.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	5.6 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	5.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: G2A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	12.9 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	4.2 (AC-FT)	Direct Runoff Volume:	0.5 (AC-FT)
Loss Volume:	3.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.5 (AC-FT)	Discharge Volume:	0.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: G2B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	2.6 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	0.6 (AC-FT)	Direct Runoff Volume:	0.1 (AC-FT)
Loss Volume:	0.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	4.6 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.1 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	2.8 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: H2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	8.9 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	8.8 (AC-FT)	Direct Runoff Volume:	0.7 (AC-FT)
Loss Volume:	8.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.7 (AC-FT)	Discharge Volume:	0.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: H3A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	1.4 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	0.7 (AC-FT)	Direct Runoff Volume:	0.1 (AC-FT)
Loss Volume:	0.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: H3B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	1.3 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	0.6 (AC-FT)	Direct Runoff Volume:	0.1 (AC-FT)
Loss Volume:	0.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	15.4 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	6.1 (AC-FT)	Direct Runoff Volume:	0.6 (AC-FT)
Loss Volume:	5.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.6 (AC-FT)	Discharge Volume:	0.6 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: H5A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.2 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	2.0 (AC-FT)	Direct Runoff Volume:	0.2 (AC-FT)
Loss Volume:	1.8 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.2 (AC-FT)	Discharge Volume:	0.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H5B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	5.6 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	2.4 (AC-FT)	Direct Runoff Volume:	0.2 (AC-FT)
Loss Volume:	2.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.2 (AC-FT)	Discharge Volume:	0.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H6A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	11.6 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.8 (AC-FT)	Direct Runoff Volume:	0.4 (AC-FT)
Loss Volume:	3.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H6B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	15.5 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.6 (AC-FT)	Direct Runoff Volume:	0.5 (AC-FT)
Loss Volume:	3.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.5 (AC-FT)	Discharge Volume:	0.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H7A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.2 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.9 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	1.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H7B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	8.0 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.9 (AC-FT)	Direct Runoff Volume:	0.4 (AC-FT)
Loss Volume:	3.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H8A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	15Sep2022, 11:13:09	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	2.5 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	0.9 (AC-FT)	Direct Runoff Volume:	0.1 (AC-FT)
Loss Volume:	0.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: H8B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	15Sep2022, 11:13:09	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	4.9 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.1 (AC-FT)	Direct Runoff Volume:	0.1 (AC-FT)
Loss Volume:	1.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: H9

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	15Sep2022, 11:13:09	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	2.3 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.5 (AC-FT)	Direct Runoff Volume:	0.1 (AC-FT)
Loss Volume:	1.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: I1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.0 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.5 (AC-FT)	Direct Runoff Volume:	0.4 (AC-FT)
Loss Volume:	1.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: I2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	15Sep2022, 11:13:09	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	8.3 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.3 (AC-FT)	Direct Runoff Volume:	0.5 (AC-FT)
Loss Volume:	2.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.5 (AC-FT)	Discharge Volume:	0.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Subbasin: J1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	2.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	2.3 (AC-FT)	Direct Runoff Volume:	0.2 (AC-FT)
Loss Volume:	2.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.2 (AC-FT)	Discharge Volume:	0.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Subbasin: K1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	4.5 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.9 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	3.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: OUT-1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	421.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	420.9 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:5
Inflow Volume:	97.2 (AC-FT)	Discharge Volume:	97.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reservoir: STORAGE P1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	31Jan2023, 10:25:36	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	19.5 (CFS)	Date/Time of Peak Inflow:	26Feb2019, 12:0
Peak Discharge:	9.8 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:1
Inflow Volume:	0.9 (AC-FT)	Peak Storage:	0.5 (AC-FT)
Discharge Volume	0.9 (AC-FT)	Peak Elevation:	7319.2 (FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reservoir: STORAGE P2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	31Jan2023, 10:25:36	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	23.6 (CFS)	Date/Time of Peak Inflow:	26Feb2019, 12:0
Peak Discharge:	10.7 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:1
Inflow Volume:	1.3 (AC-FT)	Peak Storage:	0.6 (AC-FT)
Discharge Volume	1.1 (AC-FT)	Peak Elevation:	7303.6 (FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reservoir: STORAGE P4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	31Jan2023, 10:25:36	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	21.2 (CFS)	Date/Time of Peak Inflow:	26Feb2019, 12:0
Peak Discharge:	8.8 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:1
Inflow Volume:	1.4 (AC-FT)	Peak Storage:	0.7 (AC-FT)
Discharge Volume	1.2 (AC-FT)	Peak Elevation:	7293.7 (FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: Reach-1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	371.6 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	371.6 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	81.3 (AC-FT)	Discharge Volume:	81.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: Reach-2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	31Jan2023, 10:25:36	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	376.3 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:44
Peak Discharge:	376.2 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:48
Inflow Volume:	82.4 (AC-FT)	Discharge Volume:	82.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: Reach-3

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	31Jan2023, 10:25:36	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	390.9 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	390.9 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	86.8 (AC-FT)	Discharge Volume:	86.8 (AC-FT)

Project: Winsome_Fil_3   Simulation Run: Prop Basin 5yr

Reach: Reach-4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	31Jan2023, 10:25:36	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	393.9 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4(
Peak Discharge:	393.8 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:5(
Inflow Volume:	88.3 (AC-FT)	Discharge Volume:	88.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: Reach-5

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	31Jan2023, 10:25:36	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	408.4 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	408.3 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:5
Inflow Volume:	91.5 (AC-FT)	Discharge Volume:	91.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: Reach-6 Kiowa Outfall

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	421.4 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:5
Peak Discharge:	421.3 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:5
Inflow Volume:	97.7 (AC-FT)	Discharge Volume:	97.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: REACH A1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	30Nov2021, 13:26:30	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	84.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:2
Peak Discharge:	83.8 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:3
Inflow Volume:	13.7 (AC-FT)	Discharge Volume:	13.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: Reach-A2A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	5.3 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	5.2 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:07
Inflow Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: Reach-A2B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	2.3 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	2.2 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:10
Inflow Volume:	0.2 (AC-FT)	Discharge Volume:	0.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: Reach-A3

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	5.2 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:06
Peak Discharge:	5.2 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:09
Inflow Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: Reach-A3A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	9.6 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:01
Peak Discharge:	9.6 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:03
Inflow Volume:	0.6 (AC-FT)	Discharge Volume:	0.6 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: Reach-G1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	3.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:04
Peak Discharge:	3.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:11
Inflow Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3   Simulation Run: Prop Basin 5yr

Reach: Reach-H1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	4.6 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	4.6 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:09
Inflow Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reach: Reach-H2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	8.9 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	8.9 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:05
Inflow Volume:	0.7 (AC-FT)	Discharge Volume:	0.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: Reach H3

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1.4 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	1.3 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:10
Inflow Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: Reach-H3B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1.3 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:04
Peak Discharge:	1.2 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:13
Inflow Volume:	0.1 (AC-FT)	Discharge Volume:	0.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr
Reach: Reach-I1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	09Dec2021, 07:54:44	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	6.6 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:05
Peak Discharge:	6.5 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:10
Inflow Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basin 5yr

Reservoir: STORAGE P4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 5yr
Compute Time:	15Sep2022, 11:13:09	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	21.2 (CFS)	Date/Time of Peak Inflow:	26Feb2019, 12:0
Peak Discharge:	7.7 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:1
Inflow Volume:	1.4 (AC-FT)	Peak Storage:	0.7 (AC-FT)
Discharge Volume	1.1 (AC-FT)	Peak Elevation:	7293.7 (FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	30Jan2023, 16:24:56	Control Specifications:	Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
A1	1.3529000	402.8	26Feb2019, 12:28	40.2
A2A	0.0439531	47.1	26Feb2019, 12:04	1.7
A2B	0.0138594	20.3	26Feb2019, 12:03	0.7
A3A	0.0128906	25.8	26Feb2019, 12:00	0.9
A3B	0.0206563	42.6	26Feb2019, 11:59	1.5
A3C	0.0182187	40.8	26Feb2019, 12:00	1.6
BOX CULVERT 1	7.8720139	1689.6	26Feb2019, 12:42	237.8
BOX CULV 2	8.8550872	1871.9	26Feb2019, 12:44	279.2
B1	5.9948000	1289.0	26Feb2019, 12:44	178.0
B2	0.0204688	17.2	26Feb2019, 12:09	0.9
B3	0.0857813	49.3	26Feb2019, 12:17	3.2
B4	0.0648125	46.3	26Feb2019, 12:17	2.9
CLV E4	0.1670157	117.6	26Feb2019, 12:12	8.1
CULV A3A	0.0267500	40.9	26Feb2019, 12:03	1.6
CULV B2	0.0204688	17.2	26Feb2019, 12:09	0.9
CULV C2	0.2892200	120.4	26Feb2019, 12:18	8.4
CULV C3	0.3143763	134.2	26Feb2019, 12:19	9.6
CULV D2	0.3593700	170.8	26Feb2019, 12:18	11.8
CULV D3	0.1423438	64.0	26Feb2019, 12:20	5.1
CULV D4	0.1959376	92.3	26Feb2019, 12:19	7.5
CULV E1.1	0.0592188	24.6	26Feb2019, 12:17	1.7
CULV E1.2	0.0238750	21.4	26Feb2019, 12:10	1.3
CULV E1.5	0.0136094	16.6	26Feb2019, 12:08	0.8
CULV E2	0.0768907	36.6	26Feb2019, 12:14	2.8
CULV E5	0.0210938	18.4	26Feb2019, 12:10	1.1
CULV F2	0.0068750	8.6	26Feb2019, 12:05	0.4
CULV G1	0.0387188	40.0	26Feb2019, 12:07	1.5

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CULV H1	0.0217031	33.0	26Feb2019, 12:03	1.1
CULV H2	0.0610938	65.5	26Feb2019, 12:04	2.5
CULV H3	0.0048125	8.0	26Feb2019, 12:02	0.3
CULV I1	0.0148907	25.8	26Feb2019, 12:05	1.3
CULV-E3	0.1317032	84.6	26Feb2019, 12:11	6.0
CULV-Pond4	0.0452031	81.0	26Feb2019, 12:01	2.8
C1	0.2542200	105.6	26Feb2019, 12:16	7.4
C2	0.0350000	16.1	26Feb2019, 12:13	1.0
C3	0.0251563	19.1	26Feb2019, 12:11	1.1
C4	0.0371875	19.1	26Feb2019, 12:18	1.2
D1.1	0.2520300	105.2	26Feb2019, 12:16	7.4
D1.2	0.0779688	28.2	26Feb2019, 12:20	2.3
D2	0.1073400	69.8	26Feb2019, 12:14	4.4
D3	0.0643750	38.1	26Feb2019, 12:17	2.9
D4	0.0535938	38.6	26Feb2019, 12:12	2.4
D5	0.0200000	15.0	26Feb2019, 12:12	0.7
D6	0.0653125	28.1	26Feb2019, 12:17	1.9
EX CULV C1	0.2542200	105.6	26Feb2019, 12:16	7.4
EX CULV D1.1	0.2520300	105.2	26Feb2019, 12:16	7.4
EX CULV D1.2	0.0779688	28.2	26Feb2019, 12:20	2.3
EX CULV E0	0.0592188	24.6	26Feb2019, 12:16	1.7
E0	0.0592188	24.6	26Feb2019, 12:16	1.7
E1.1	0.0136094	16.6	26Feb2019, 12:08	0.8
E1.2	0.0238750	21.4	26Feb2019, 12:10	1.3
E2	0.0040625	8.9	26Feb2019, 11:56	0.3
E3	0.0309375	33.7	26Feb2019, 12:07	1.8
E4	0.0284375	27.0	26Feb2019, 12:10	1.7
E5	0.0210938	18.4	26Feb2019, 12:10	1.1
E6	0.0144609	14.1	26Feb2019, 12:05	0.6
E7	0.0159688	16.2	26Feb2019, 12:07	0.8
E8	0.0246594	25.6	26Feb2019, 12:01	1.0

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
E9	0.0059688	5.8	26Feb2019, 11:56	0.1
F1	0.0501563	36.6	26Feb2019, 12:09	2.1
F2	0.0068750	8.6	26Feb2019, 12:04	0.4
F3	0.0150313	14.5	26Feb2019, 12:06	0.7
G1	0.0387188	40.1	26Feb2019, 12:07	1.5
G2A	0.0290625	59.9	26Feb2019, 11:59	2.1
G2B	0.0043281	9.6	26Feb2019, 11:59	0.4
H1	0.0217031	33.0	26Feb2019, 12:03	1.1
H2	0.0610938	65.7	26Feb2019, 12:04	2.5
H3A	0.0048125	8.0	26Feb2019, 12:02	0.3
H3B	0.0042344	6.9	26Feb2019, 12:04	0.3
H4	0.0421875	73.6	26Feb2019, 12:04	3.0
H5A	0.0141094	27.0	26Feb2019, 12:03	1.1
H5B	0.0163750	29.0	26Feb2019, 12:03	1.1
H6A	0.0260000	51.1	26Feb2019, 12:02	2.0
H6B	0.0249375	57.1	26Feb2019, 11:59	2.3
H7A	0.0132812	27.1	26Feb2019, 11:59	1.0
H7B	0.0271094	49.8	26Feb2019, 12:00	1.5
H8A	0.0061406	11.2	26Feb2019, 12:02	0.4
H8B	0.0079531	17.8	26Feb2019, 12:01	0.8
H9	0.0102188	15.0	26Feb2019, 12:05	0.5
I1	0.0106563	20.3	26Feb2019, 12:04	1.0
I2	0.0231250	39.1	26Feb2019, 12:04	1.6
J1	0.0158438	13.0	26Feb2019, 12:02	0.5
K1	0.0273438	40.7	26Feb2019, 12:02	1.3
OUT-1	9.2436297	1958.9	26Feb2019, 12:45	297.5
REACH A1	1.3529000	402.3	26Feb2019, 12:31	40.2
Reach E3.1	0.0238750	21.4	26Feb2019, 12:12	1.3
Reach H3	0.0048125	8.0	26Feb2019, 12:07	0.3
Reach-A2A	0.0439531	47.1	26Feb2019, 12:07	1.7
Reach-A2B	0.0138594	20.1	26Feb2019, 12:07	0.7

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Reach-A3	0.0439531	46.9	26Feb2019, 12:08	1.7
Reach-A3A	0.0310781	49.3	26Feb2019, 12:04	2.0
Reach-B1	5.9948000	1288.9	26Feb2019, 12:46	178.0
Reach-B2	0.0204688	17.2	26Feb2019, 12:14	0.9
Reach-B3	6.0805813	1301.2	26Feb2019, 12:48	181.2
Reach-B4-3	0.3143763	134.2	26Feb2019, 12:19	9.6
Reach-C1	0.2542200	105.5	26Feb2019, 12:18	7.4
Reach-C2	0.2892200	120.3	26Feb2019, 12:20	8.4
Reach-D1.1	0.2520300	105.1	26Feb2019, 12:20	7.4
Reach-D3	0.0779688	28.2	26Feb2019, 12:24	2.3
Reach-D4	0.1423438	64.0	26Feb2019, 12:23	5.1
Reach-D5	0.3593700	170.6	26Feb2019, 12:20	11.8
Reach-D6	0.1959376	92.2	26Feb2019, 12:22	7.5
Reach-E1.1	0.0592188	24.6	26Feb2019, 12:17	1.7
Reach-E2	0.0592188	24.5	26Feb2019, 12:19	1.7
Reach-E3	0.0768907	36.6	26Feb2019, 12:17	2.8
Reach-E4	0.1317032	84.5	26Feb2019, 12:14	6.0
Reach-E6	0.0210938	18.4	26Feb2019, 12:13	1.1
Reach-E6-2	0.1974454	137.3	26Feb2019, 12:14	9.5
Reach-E7	0.1670157	117.5	26Feb2019, 12:14	8.1
Reach-F2	0.0068750	8.6	26Feb2019, 12:08	0.4
Reach-G1	0.0387188	40.0	26Feb2019, 12:10	1.5
Reach-H1	0.0217031	32.8	26Feb2019, 12:06	1.1
Reach-H2	0.0610938	65.4	26Feb2019, 12:06	2.5
Reach-H3B	0.0042344	6.8	26Feb2019, 12:09	0.3
Reach-I1	0.0210313	36.2	26Feb2019, 12:07	1.8
Reach-P3	0.2612501	79.0	26Feb2019, 12:37	9.4
Reach-P4	0.0662344	58.0	26Feb2019, 12:11	4.3
Reach-1	7.9708733	1694.5	26Feb2019, 12:43	243.3
Reach-2	8.0719514	1712.7	26Feb2019, 12:44	248.5
Reach-3	8.4818058	1781.7	26Feb2019, 12:43	263.2

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Reach-4	8.5938371	1795.5	26Feb2019, 12:44	269.8
Reach-5	8.8550872	1871.4	26Feb2019, 12:44	279.2
Reach-6 Kiowa Outfall	9.2769735	1960.0	26Feb2019, 12:45	299.6
STORAGE P1	0.0638906	72.1	26Feb2019, 12:11	4.1
STORAGE P2	0.0860313	78.6	26Feb2019, 12:09	4.6
STORAGE P3	0.2612501	79.0	26Feb2019, 12:36	9.4
STORAGE P4	0.0662344	58.0	26Feb2019, 12:11	4.3
STORAGE P5	0.2431986	73.4	26Feb2019, 12:32	10.3

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: A1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	402.8 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12
Precipitation Volume:	331.6 (AC-FT)	Direct Runoff Volume:	40.2 (AC-FT)
Loss Volume:	291.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	40.2 (AC-FT)	Discharge Volume:	40.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: A2A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	47.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12
Precipitation Volume:	10.8 (AC-FT)	Direct Runoff Volume:	1.7 (AC-FT)
Loss Volume:	9.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.7 (AC-FT)	Discharge Volume:	1.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: A2B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	20.3 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.4 (AC-FT)	Direct Runoff Volume:	0.7 (AC-FT)
Loss Volume:	2.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.7 (AC-FT)	Discharge Volume:	0.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: A3A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	25.8 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.2 (AC-FT)	Direct Runoff Volume:	0.9 (AC-FT)
Loss Volume:	2.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.9 (AC-FT)	Discharge Volume:	0.9 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: A3B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	42.6 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 11:
Precipitation Volume:	5.1 (AC-FT)	Direct Runoff Volume:	1.5 (AC-FT)
Loss Volume:	3.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.5 (AC-FT)	Discharge Volume:	1.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: A3C

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	40.8 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	4.5 (AC-FT)	Direct Runoff Volume:	1.6 (AC-FT)
Loss Volume:	2.8 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.6 (AC-FT)	Discharge Volume:	1.6 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: CULV A3A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	41.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	40.9 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:03
Inflow Volume:	1.6 (AC-FT)	Discharge Volume:	1.6 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: CULV G1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	40.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:06
Peak Discharge:	40.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:07
Inflow Volume:	1.5 (AC-FT)	Discharge Volume:	1.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: CULV H1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	33.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	33.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:03
Inflow Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: CULV H2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	65.7 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	65.5 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:04
Inflow Volume:	2.5 (AC-FT)	Discharge Volume:	2.5 (AC-FT)

Project: Winsome_Fil_3   Simulation Run: Prop Basins 100 yr

Reach: CULV H3

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	8.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:01
Peak Discharge:	8.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:02
Inflow Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: CULV I1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	25.8 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:04
Peak Discharge:	25.8 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:05
Inflow Volume:	1.3 (AC-FT)	Discharge Volume:	1.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: CULV-Pond4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	81.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 11:59
Peak Discharge:	81.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:01
Inflow Volume:	2.8 (AC-FT)	Discharge Volume:	2.8 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: G1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	40.1 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:
Precipitation Volume	9.5 (AC-FT)	Direct Runoff Volume:	1.5 (AC-FT)
Loss Volume:	8.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.5 (AC-FT)	Discharge Volume:	1.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Subbasin: G2A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	59.9 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 11:
Precipitation Volume:	7.1 (AC-FT)	Direct Runoff Volume:	2.1 (AC-FT)
Loss Volume:	5.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2.1 (AC-FT)	Discharge Volume:	2.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: G2B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	9.6 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 11:
Precipitation Volume:	1.1 (AC-FT)	Direct Runoff Volume:	0.4 (AC-FT)
Loss Volume:	0.7 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	33.0 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	5.3 (AC-FT)	Direct Runoff Volume:	1.1 (AC-FT)
Loss Volume:	4.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	65.7 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12
Precipitation Volume:	15.0 (AC-FT)	Direct Runoff Volume:	2.5 (AC-FT)
Loss Volume:	12.5 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2.5 (AC-FT)	Discharge Volume:	2.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H3A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	8.0 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.2 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	0.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H3B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	6.9 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.0 (AC-FT)	Direct Runoff Volume:	0.3 (AC-FT)
Loss Volume:	0.8 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	73.6 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12
Precipitation Volume:	10.3 (AC-FT)	Direct Runoff Volume:	3.0 (AC-FT)
Loss Volume:	7.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	3.0 (AC-FT)	Discharge Volume:	3.0 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H5A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	27.0 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.5 (AC-FT)	Direct Runoff Volume:	1.1 (AC-FT)
Loss Volume:	2.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H5B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	29.0 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	4.0 (AC-FT)	Direct Runoff Volume:	1.1 (AC-FT)
Loss Volume:	2.9 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Subbasin: H6A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	51.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	6.4 (AC-FT)	Direct Runoff Volume:	2.0 (AC-FT)
Loss Volume:	4.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2.0 (AC-FT)	Discharge Volume:	2.0 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Subbasin: H6B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	57.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 11:
Precipitation Volume:	6.1 (AC-FT)	Direct Runoff Volume:	2.3 (AC-FT)
Loss Volume:	3.8 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	2.3 (AC-FT)	Discharge Volume:	2.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H7A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	27.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 11:
Precipitation Volume:	3.3 (AC-FT)	Direct Runoff Volume:	1.0 (AC-FT)
Loss Volume:	2.3 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.0 (AC-FT)	Discharge Volume:	1.0 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H7B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	49.8 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	6.6 (AC-FT)	Direct Runoff Volume:	1.5 (AC-FT)
Loss Volume:	5.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.5 (AC-FT)	Discharge Volume:	1.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H8A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	15Sep2022, 11:04:07	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	11.2 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.5 (AC-FT)	Direct Runoff Volume:	0.4 (AC-FT)
Loss Volume:	1.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.4 (AC-FT)	Discharge Volume:	0.4 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H8B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	15Sep2022, 11:04:07	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	17.8 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	1.9 (AC-FT)	Direct Runoff Volume:	0.8 (AC-FT)
Loss Volume:	1.2 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.8 (AC-FT)	Discharge Volume:	0.8 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: H9

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	15Sep2022, 11:04:07	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	15.0 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	2.5 (AC-FT)	Direct Runoff Volume:	0.5 (AC-FT)
Loss Volume:	2.0 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.5 (AC-FT)	Discharge Volume:	0.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: I1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	20.3 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	2.6 (AC-FT)	Direct Runoff Volume:	1.0 (AC-FT)
Loss Volume:	1.6 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.0 (AC-FT)	Discharge Volume:	1.0 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Subbasin: I2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	15Sep2022, 11:04:07	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	39.1 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	5.7 (AC-FT)	Direct Runoff Volume:	1.6 (AC-FT)
Loss Volume:	4.1 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.6 (AC-FT)	Discharge Volume:	1.6 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: J1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	13.0 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	3.9 (AC-FT)	Direct Runoff Volume:	0.5 (AC-FT)
Loss Volume:	3.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	0.5 (AC-FT)	Discharge Volume:	0.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Subbasin: K1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Discharge:	40.7 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:
Precipitation Volume:	6.7 (AC-FT)	Direct Runoff Volume:	1.3 (AC-FT)
Loss Volume:	5.4 (AC-FT)	Baseflow Volume:	0.0 (AC-FT)
Excess Volume:	1.3 (AC-FT)	Discharge Volume:	1.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: OUT-1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1959.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	1958.9 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	297.5 (AC-FT)	Discharge Volume:	297.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reservoir: STORAGE P1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	30Jan2023, 16:24:56	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	105.0 (CFS)	Date/Time of Peak Inflow:	26Feb2019, 12:0
Peak Discharge:	72.1 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:1
Inflow Volume:	4.2 (AC-FT)	Peak Storage:	1.3 (AC-FT)
Discharge Volume	4.1 (AC-FT)	Peak Elevation:	7321.2 (FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reservoir: STORAGE P2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	30Jan2023, 16:24:56	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	110.8 (CFS)	Date/Time of Peak Inflow:	26Feb2019, 12:0
Peak Discharge:	78.6 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:0
Inflow Volume:	4.8 (AC-FT)	Peak Storage:	1.5 (AC-FT)
Discharge Volume	4.6 (AC-FT)	Peak Elevation:	7305.6 (FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reservoir: STORAGE P4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	30Jan2023, 16:24:56	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	108.2 (CFS)	Date/Time of Peak Inflow:	26Feb2019, 12:0
Peak Discharge:	58.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:1
Inflow Volume:	4.5 (AC-FT)	Peak Storage:	1.9 (AC-FT)
Discharge Volume	4.3 (AC-FT)	Peak Elevation:	7295.4 (FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: Reach-1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1694.6 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	1694.5 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	243.3 (AC-FT)	Discharge Volume:	243.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: Reach-2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	30Jan2023, 16:24:56	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1713.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	1712.7 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	248.6 (AC-FT)	Discharge Volume:	248.5 (AC-FT)

Project: Winsome_Fil_3   Simulation Run: Prop Basins 100 yr
Reach: Reach-3

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	30Jan2023, 16:24:56	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1781.8 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	1781.7 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	263.2 (AC-FT)	Discharge Volume:	263.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: Reach-4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	30Jan2023, 16:24:56	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1795.7 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	1795.5 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	269.8 (AC-FT)	Discharge Volume:	269.8 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: Reach-5

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	30Jan2023, 16:24:56	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1871.9 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	1871.4 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	279.2 (AC-FT)	Discharge Volume:	279.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: REACH A1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	402.8 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:2
Peak Discharge:	402.3 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:3
Inflow Volume:	40.2 (AC-FT)	Discharge Volume:	40.2 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: Reach-A2A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	47.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	47.1 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:07
Inflow Volume:	1.7 (AC-FT)	Discharge Volume:	1.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: Reach-A2B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	20.3 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	20.1 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:07
Inflow Volume:	0.7 (AC-FT)	Discharge Volume:	0.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: Reach-A3

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	47.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:06
Peak Discharge:	46.9 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:08
Inflow Volume:	1.7 (AC-FT)	Discharge Volume:	1.7 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: Reach-A3A

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	49.5 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	49.3 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:04
Inflow Volume:	2.0 (AC-FT)	Discharge Volume:	2.0 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr
Reach: Reach-G1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	40.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:06
Peak Discharge:	40.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:10
Inflow Volume:	1.5 (AC-FT)	Discharge Volume:	1.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: Reach-H1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	33.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:02
Peak Discharge:	32.8 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:06
Inflow Volume:	1.1 (AC-FT)	Discharge Volume:	1.1 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: Reach-H2

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	65.5 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	65.4 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:06
Inflow Volume:	2.5 (AC-FT)	Discharge Volume:	2.5 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: Reach H3

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	8.0 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:01
Peak Discharge:	8.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:07
Inflow Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: Reach-H3B

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	09Dec2021, 07:54:11	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	6.9 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	6.8 (CFS)	Date/Time of Peak Discharge:	26Feb2019, 12:09
Inflow Volume:	0.3 (AC-FT)	Discharge Volume:	0.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: Reach-I1

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	15Sep2022, 11:04:07	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	36.2 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:03
Peak Discharge:	36.2 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:07
Inflow Volume:	1.8 (AC-FT)	Discharge Volume:	1.8 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: Reach-P4

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	15Sep2022, 11:04:07	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	63.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:09
Peak Discharge:	63.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:11
Inflow Volume:	4.3 (AC-FT)	Discharge Volume:	4.3 (AC-FT)

Project: Winsome_Fil_3 Simulation Run: Prop Basins 100 yr

Reach: Reach-6 Kiowa Outfall

Start of Run:	26Feb2019, 00:00	Basin Model:	Proposed Basins
End of Run:	27Feb2019, 12:00	Meteorologic Model:	Prop Basins 100yr
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	1960.1 (CFS)	Date/Time of Peak Inflow	26Feb2019, 12:4
Peak Discharge:	1960.0 (CFS)	Date/Time of Peak Discharge	26Feb2019, 12:4
Inflow Volume:	299.6 (AC-FT)	Discharge Volume:	299.6 (AC-FT)

APPENDIX C: HYDRAULICS

DRIVEWAY CULVERT SIZING TABLE				
Lot	100 yr. Flow (cfs)	Culvert size (in)	Anticipated Driveway Location	Notes
1	N/A	N/A	N/A	N/A
2	41	36	East side of lot	Cross Swale A3A
3	41	36	East side of lot	Cross Swale A3A
4	<10	18	East side of lot	Cross roadside ditch
5	<10	18	South side of lot	Cross roadside ditch
6	<10	18	South side of lot	Cross roadside ditch
7	N/A	18	Shared driveway	Shared driveway
8	N/A	18	Shared driveway	Shared driveway
9	<10	18	South side of lot	Corss roadside ditch
10	<10	18	South side of lot	Cross roadside ditch
11	N/A	18	Shared driveway	Shared driveway
12	N/A	18	Shared driveway	Shared driveway
13	<10	18	South side of lot	Cross roadside ditch
14	<10	18	East side of lot	Cross roadside ditch
15	<10	18	East side of lot	Cross roadside ditch
16	<10	18	South side of lot	Cross roadside ditch
17	<10	18	South side of lot	Cross roadside ditch
18	<10	18	East side of lot	Cross roadside ditch
19	<10	18	East side of lot	N/A
20	<10	18	West side of lot	N/A
21	<10	18	West side of lot	N/A
22	<10	18	West side of lot	N/A
23	20	24	West side of lot	Cross roadside ditch
24	20	24	West side of lot	Cross roadside ditch
25	27	30	East side of lot	Cross roadside ditch
26	<10	18	North side of lot	Cross roadside ditch
27	<10	18	North side of lot	Cross roadside ditch
28	<10	18	West side of lot	Cross roadside ditch
29	<10	18	North side of lot	Cross roadside ditch
30	<10	18	North side of lot	Cross roadside ditch
31	<10	18	North side of lot	Cross roadside ditch

DRIVEWAY CULVERT SIZING TABLE				
Lot	100 yr. Flow (cfs)	Culvert size (in)	Anticipated Driveway Location	Notes
32	<10	18	North side of lot	Cross roadside ditch
33	<10	18	North side of lot	Cross roadside ditch
34	<10	18	North side of lot	Cross roadside ditch
35	<10	18	West side of lot	Cross roadside ditch
36	<10	18	West side of lot	Cross roadside ditch
36	100	2- 36"	East side of drainageway	Cross Channel G1
37	<10	18	West side of lot	Cross roadside ditch
37	100	2- 36"	East side of drainageway	Cross Channel G1
38	<10	18	West side of lot	Cross roadside ditch
38	100	2- 36"	East side of drainageway	Cross Channel G1

*Culvert sizing is based on flows in roadside ditch. If driveways cross natural channels an engineering site plan would be required.

Generic Driveway Culvert Sizing Table*

Culvert Diameter (in)	# of Barrels	Allowable Flow (cfs)
18	1	10
24	1	20
30	1	30
36	1	50
42	1	70
36	2	100

*See Generic Driveway Culvert Sizing calculations for Hw/D and culvert slope assumptions for each culvert size.

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 10 cfs

Maximum Flow: 100 cfs

Table 28 - Summary of Culvert Flows at Crossing: General Driveway-18in

Headwater Elevation (ft)	Total Discharge (cfs)	Driveway Culvert 18in Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7388.00	0.00	0.00	0.00	1
7390.26	10.00	10.00	0.00	1
7392.71	20.00	17.08	2.91	10
7393.05	30.00	17.78	12.20	5
7393.30	40.00	18.30	21.69	5
7393.52	50.00	18.73	31.22	4
7393.72	60.00	19.12	40.84	4
7393.90	70.00	19.48	50.50	4
7394.07	80.00	19.79	60.15	3
7394.23	90.00	20.09	69.87	3
7394.39	100.00	20.37	79.62	3
7392.50	16.61	16.61	0.00	Overtopping

Rating Curve Plot for Crossing: General Driveway-18in

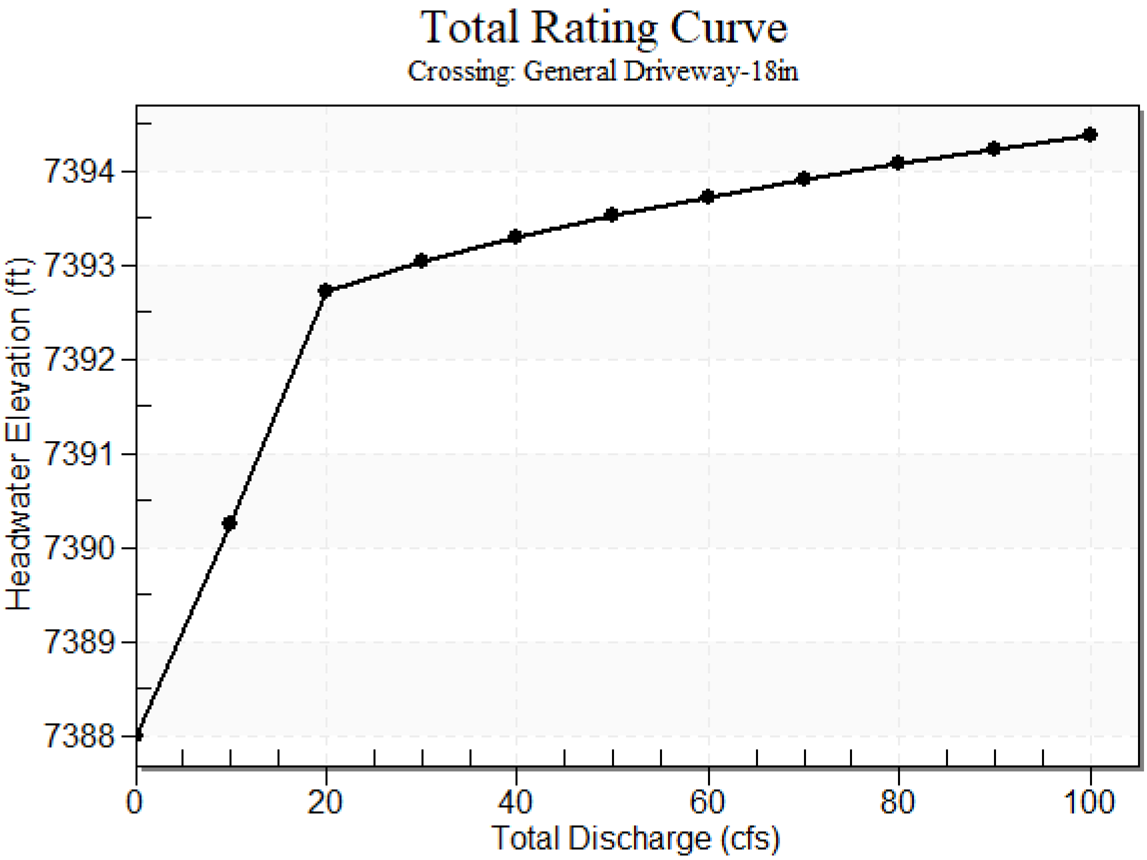


Table 29 - Culvert Summary Table: Driveway Culvert 18in

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7388.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.00	7390.26	2.256	1.995	5-S2n	0.900	1.219	1.033	0.907	7.709	3.039
20.00	17.08	7392.71	4.713	3.730	7-M2c	1.500	1.382	1.382	1.176	10.031	3.614
30.00	17.78	7393.05	5.046	3.943	7-M2t	1.500	1.308	1.369	1.369	10.507	4.000
40.00	18.30	7393.30	5.300	4.124	4-FFf	1.500	1.492	1.500	1.525	10.354	4.298
50.00	18.73	7393.52	5.520	4.393	4-FFf	1.500	1.500	1.500	1.658	10.601	4.544
60.00	19.12	7393.72	5.720	4.633	4-FFf	1.500	1.500	1.500	1.776	10.821	4.756
70.00	19.48	7393.90	5.905	4.853	4-FFf	1.500	1.500	1.500	1.882	11.021	4.943
80.00	19.79	7394.07	6.071	5.051	4-FFf	1.500	1.500	1.500	1.978	11.197	5.111
90.00	20.09	7394.23	6.233	5.240	4-FFf	1.500	1.500	1.500	2.067	11.367	5.264
100.00	20.37	7394.39	6.388	5.419	4-FFf	1.500	1.500	1.500	2.151	11.526	5.404

****

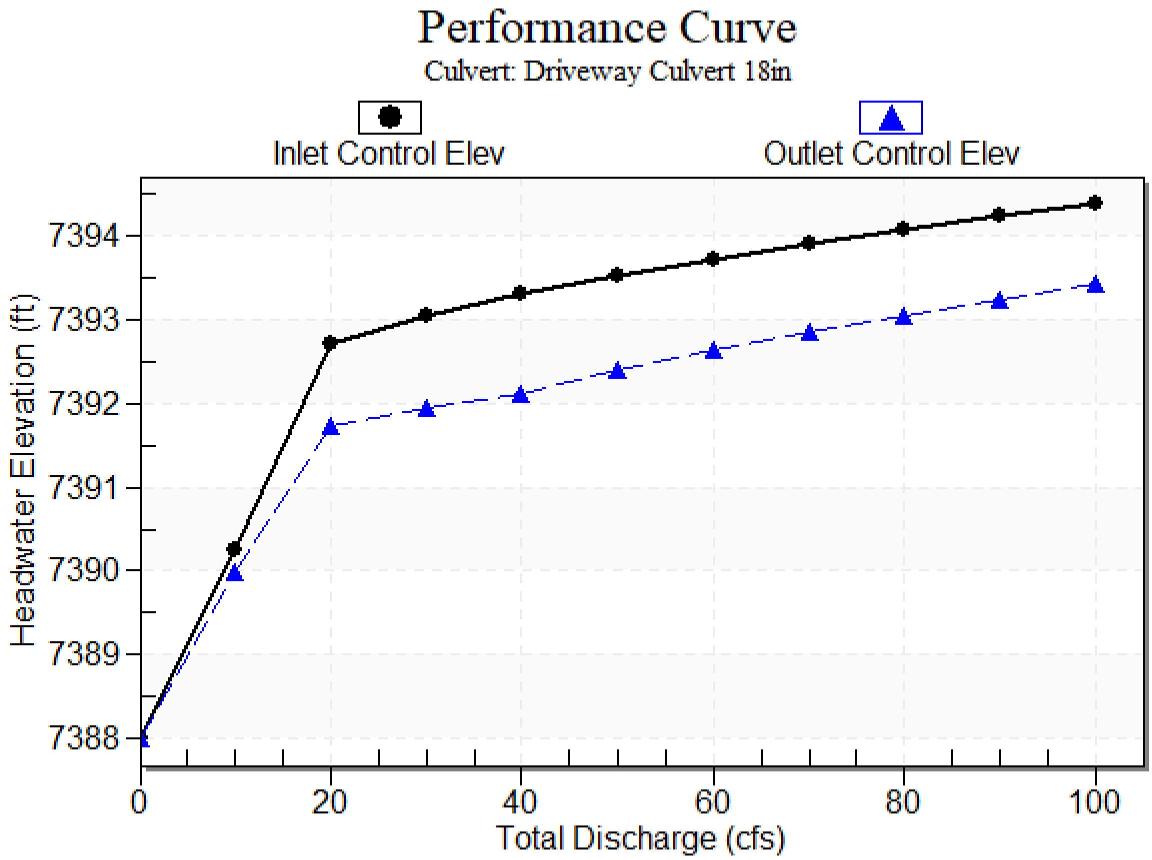
Straight Culvert

Inlet Elevation (invert): 7388.00 ft,   Outlet Elevation (invert): 7387.80 ft

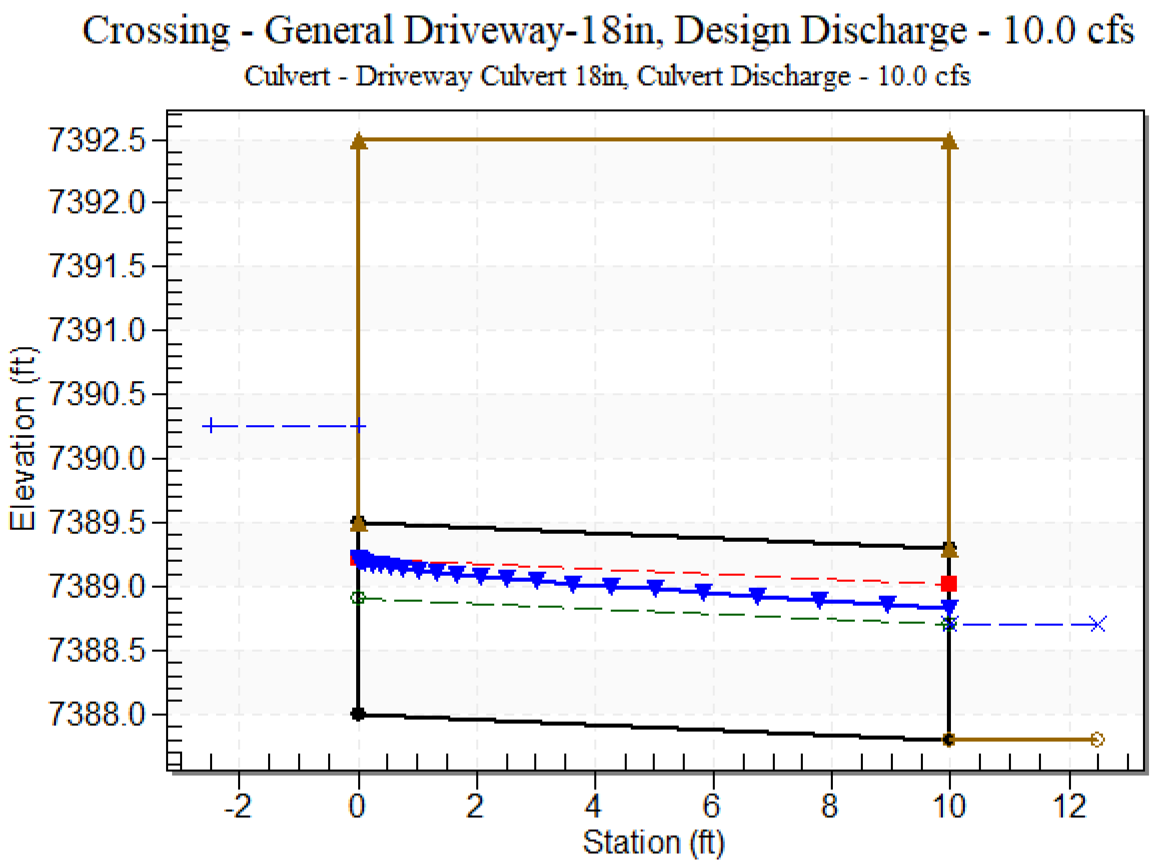
Culvert Length: 10.00 ft,   Culvert Slope: 0.0200

****

Culvert Performance Curve Plot: Driveway Culvert 18in



Water Surface Profile Plot for Culvert: Driveway Culvert 18in



Site Data - Driveway Culvert 18in

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7388.00 ft

Outlet Station: 10.00 ft

Outlet Elevation: 7387.80 ft

Number of Barrels: 1

Culvert Data Summary - Driveway Culvert 18in

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 30 - Downstream Channel Rating Curve (Crossing: General Driveway-18in)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7387.80	0.00	0.00	0.00	0.00
10.00	7388.71	0.91	3.04	1.13	0.80
20.00	7388.98	1.18	3.61	1.47	0.83
30.00	7389.17	1.37	4.00	1.71	0.85
40.00	7389.33	1.53	4.30	1.90	0.87
50.00	7389.46	1.66	4.54	2.07	0.88
60.00	7389.58	1.78	4.76	2.22	0.89
70.00	7389.68	1.88	4.94	2.35	0.90
80.00	7389.78	1.98	5.11	2.47	0.91
90.00	7389.87	2.07	5.26	2.58	0.91
100.00	7389.95	2.15	5.40	2.68	0.92

Tailwater Channel Data - General Driveway-18in

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0400

Channel Invert Elevation: 7387.80 ft

Roadway Data for Crossing: General Driveway-18in

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 7392.50 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 20 cfs

Maximum Flow: 100 cfs

Table 31 - Summary of Culvert Flows at Crossing: General Driveway-24in

Headwater Elevation (ft)	Total Discharge (cfs)	Driveway Culvert 24in Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7388.00	0.00	0.00	0.00	1
7389.69	10.00	10.00	0.00	1
7390.92	20.00	20.00	0.00	1
7392.93	30.00	30.00	0.00	1
7393.41	40.00	31.91	8.05	5
7393.68	50.00	32.92	17.07	5
7393.91	60.00	33.75	26.20	4
7394.11	70.00	34.48	35.49	4
7394.30	80.00	35.10	44.87	4
7394.47	90.00	35.68	54.30	4
7394.63	100.00	36.19	63.77	3
7393.00	30.27	30.27	0.00	Overtopping

Rating Curve Plot for Crossing: General Driveway-24in

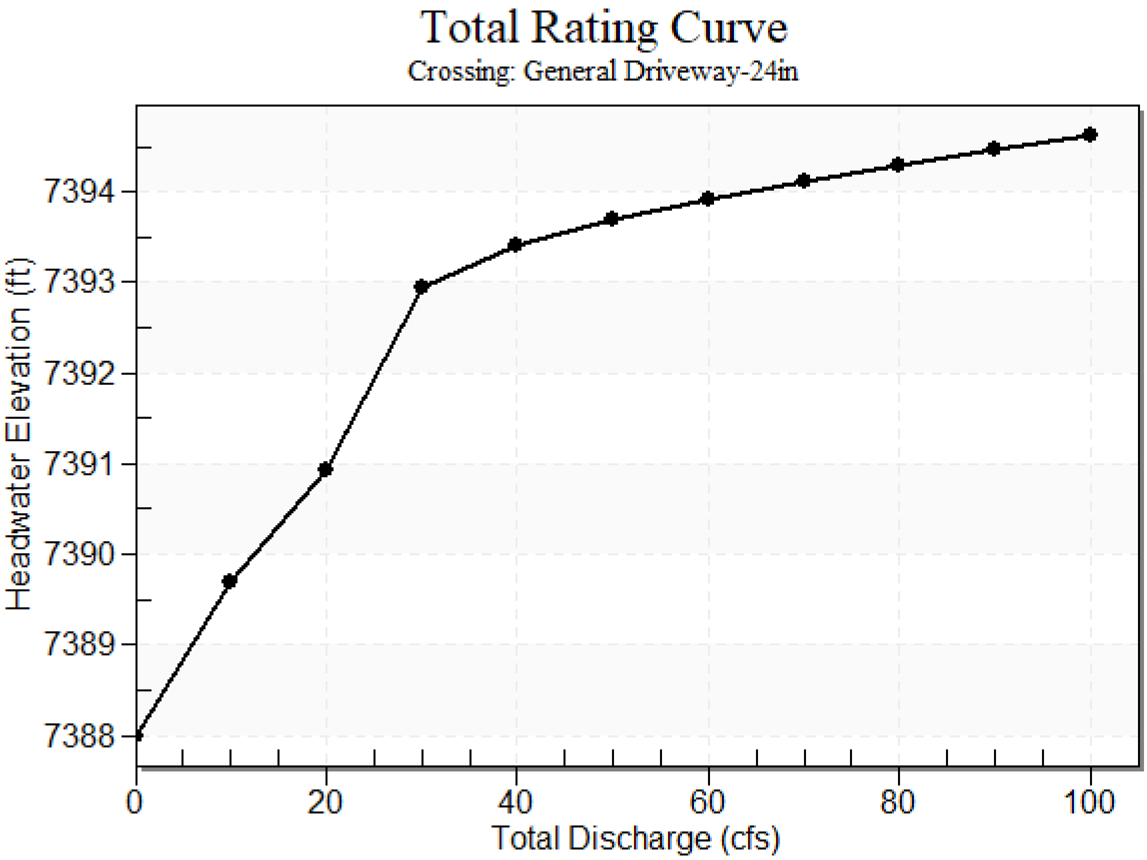


Table 32 - Culvert Summary Table: Driveway Culvert 24in

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7388.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.00	7389.69	1.686	1.187	1-S2n	0.767	1.131	0.915	0.907	7.140	3.039
20.00	20.00	7390.92	2.924	2.625	5-S2n	1.144	1.606	1.370	1.176	8.719	3.614
30.00	30.00	7392.93	4.934	4.030	5-S2n	1.535	1.862	1.724	1.369	10.421	4.000
40.00	31.91	7393.41	5.415	4.345	5-S2n	1.631	1.889	1.786	1.525	10.776	4.298
50.00	32.92	7393.68	5.682	4.518	5-S2n	1.692	1.900	1.822	1.658	10.961	4.544
60.00	33.75	7393.91	5.907	4.665	5-S2n	1.758	1.909	1.858	1.776	11.095	4.756
70.00	34.48	7394.11	6.111	4.794	3-M2t	2.000	1.874	1.882	1.882	11.244	4.943
80.00	35.10	7394.30	6.298	4.926	7-M2t	2.000	1.840	1.978	1.978	11.195	5.111
90.00	35.68	7394.47	6.474	5.119	4-FFf	2.000	1.817	2.000	2.067	11.357	5.264
100.00	36.19	7394.63	6.632	5.297	4-FFf	2.000	1.778	2.000	2.151	11.520	5.404

****

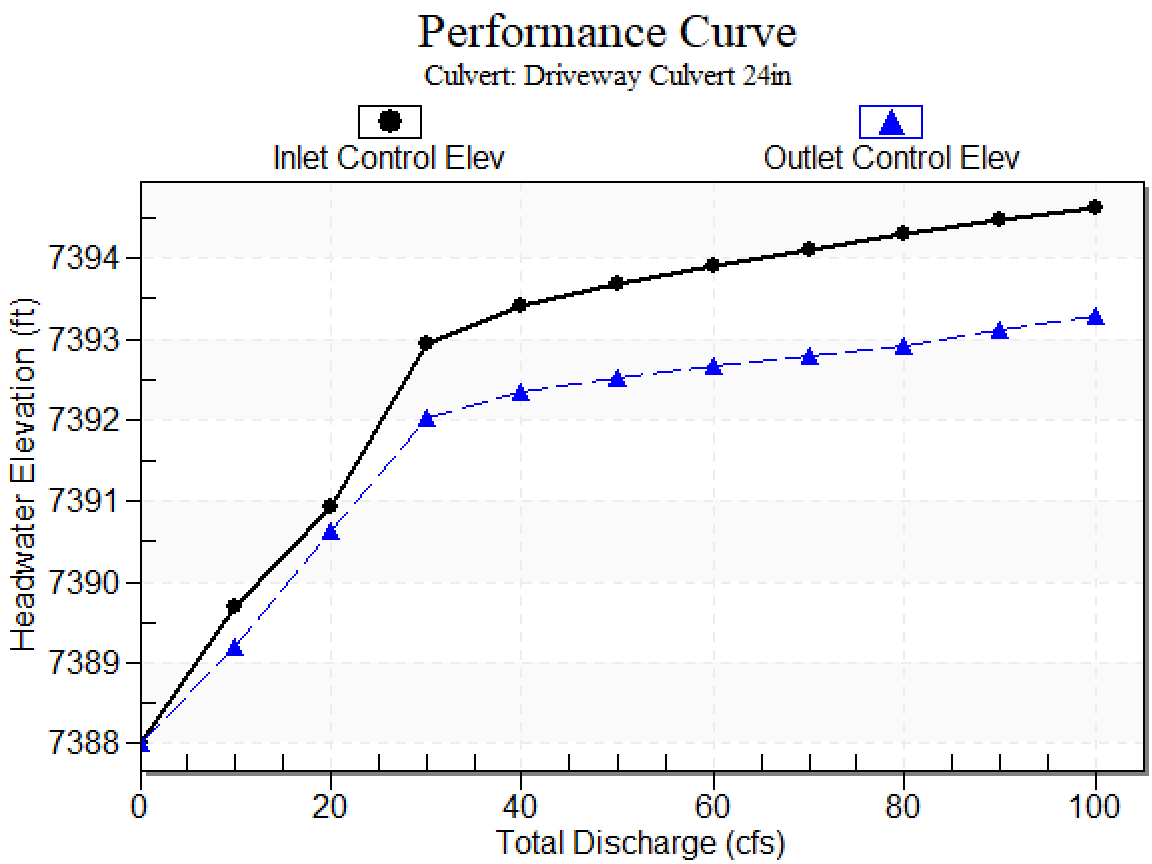
Straight Culvert

Inlet Elevation (invert): 7388.00 ft,   Outlet Elevation (invert): 7387.80 ft

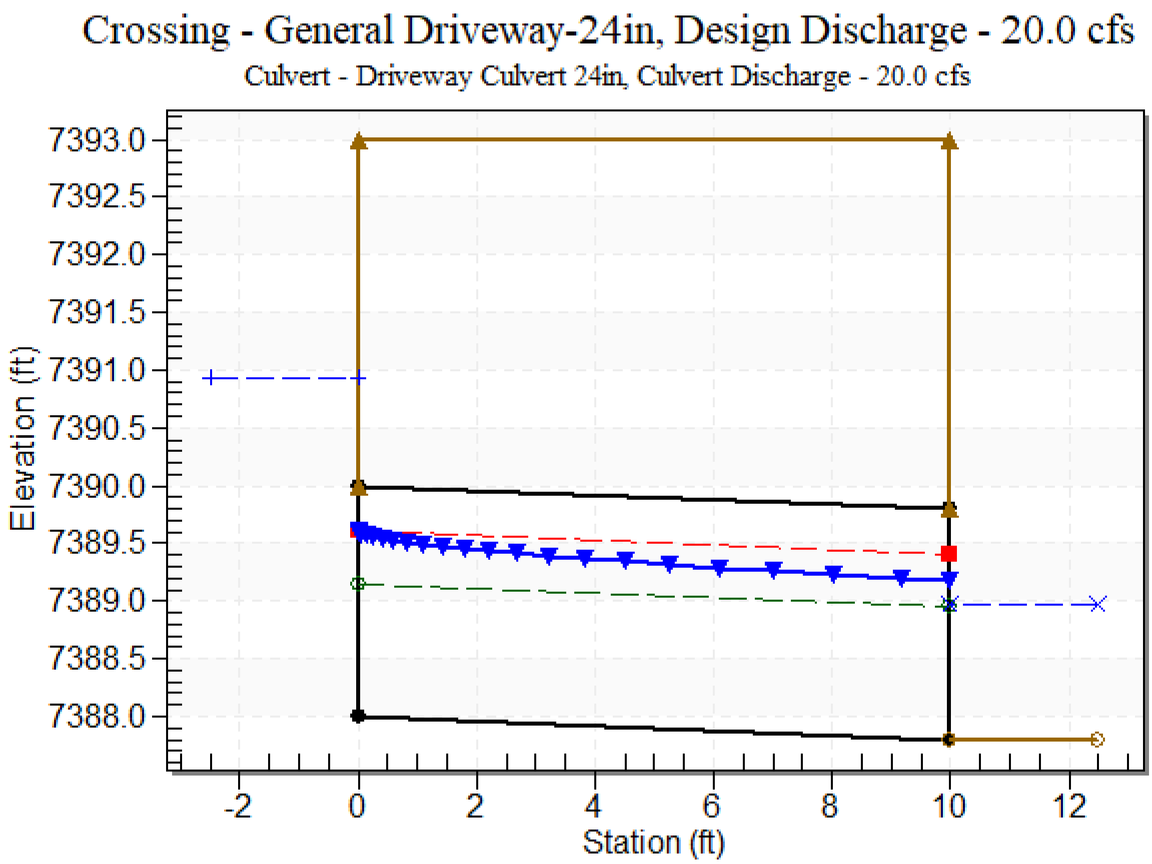
Culvert Length: 10.00 ft,   Culvert Slope: 0.0200

****

Culvert Performance Curve Plot: Driveway Culvert 24in



Water Surface Profile Plot for Culvert: Driveway Culvert 24in



Site Data - Driveway Culvert 24in

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7388.00 ft

Outlet Station: 10.00 ft

Outlet Elevation: 7387.80 ft

Number of Barrels: 1

Culvert Data Summary - Driveway Culvert 24in

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 33 - Downstream Channel Rating Curve (Crossing: General Driveway-24in)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7387.80	0.00	0.00	0.00	0.00
10.00	7388.71	0.91	3.04	1.13	0.80
20.00	7388.98	1.18	3.61	1.47	0.83
30.00	7389.17	1.37	4.00	1.71	0.85
40.00	7389.33	1.53	4.30	1.90	0.87
50.00	7389.46	1.66	4.54	2.07	0.88
60.00	7389.58	1.78	4.76	2.22	0.89
70.00	7389.68	1.88	4.94	2.35	0.90
80.00	7389.78	1.98	5.11	2.47	0.91
90.00	7389.87	2.07	5.26	2.58	0.91
100.00	7389.95	2.15	5.40	2.68	0.92

Tailwater Channel Data - General Driveway-24in

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0400

Channel Invert Elevation: 7387.80 ft

Roadway Data for Crossing: General Driveway-24in

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 7393.00 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 30 cfs

Maximum Flow: 100 cfs

Table 34 - Summary of Culvert Flows at Crossing: General Driveway-30in

Headwater Elevation (ft)	Total Discharge (cfs)	Driveway Culvert 30in Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7388.00	0.00	0.00	0.00	1
7389.49	10.00	10.00	0.00	1
7390.30	20.00	20.00	0.00	1
7391.14	30.00	30.00	0.00	1
7392.27	40.00	40.00	0.00	1
7393.60	50.00	49.05	0.92	10
7393.94	60.00	51.10	8.87	5
7394.19	70.00	52.55	17.44	5
7394.41	80.00	53.76	26.20	4
7394.60	90.00	54.84	35.13	4
7394.78	100.00	55.83	44.15	4
7393.50	48.44	48.44	0.00	Overtopping

Rating Curve Plot for Crossing: General Driveway-30in

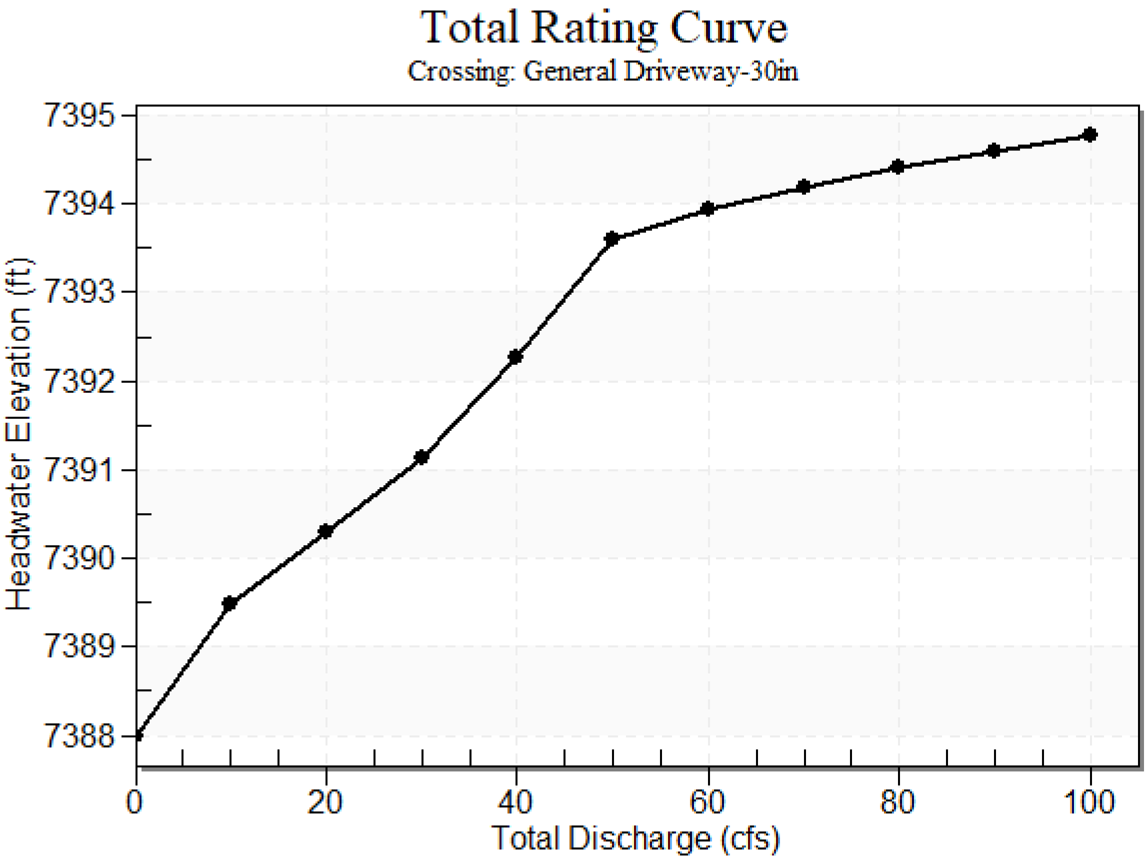


Table 35 - Culvert Summary Table: Driveway Culvert 30in

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7388.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.00	7389.49	1.489	0.959	1-S2n	0.702	1.056	0.843	0.907	6.874	3.039
20.00	20.00	7390.30	2.301	1.728	1-S2n	1.011	1.518	1.253	1.176	8.121	3.614
30.00	30.00	7391.14	3.142	2.590	5-S2n	1.274	1.867	1.585	1.369	9.144	4.000
40.00	40.00	7392.27	4.268	3.756	5-S2n	1.524	2.129	1.866	1.525	10.180	4.298
50.00	49.05	7393.60	5.599	4.662	5-S2n	1.761	2.287	2.082	1.658	11.232	4.544
60.00	51.10	7393.94	5.942	4.885	5-S2n	1.819	2.313	2.126	1.776	11.488	4.756
70.00	52.55	7394.19	6.192	5.047	5-S2n	1.861	2.330	2.156	1.882	11.674	4.943
80.00	53.76	7394.41	6.407	5.186	5-S2n	1.899	2.342	2.182	1.978	11.829	5.111
90.00	54.84	7394.60	6.603	5.311	5-S2n	1.933	2.353	2.204	2.067	11.974	5.264
100.00	55.83	7394.78	6.785	5.428	5-S2n	1.966	2.361	2.224	2.151	12.103	5.404

****

Straight Culvert

Inlet Elevation (invert): 7388.00 ft,   Outlet Elevation (invert): 7387.80 ft

Culvert Length: 10.00 ft,   Culvert Slope: 0.0200

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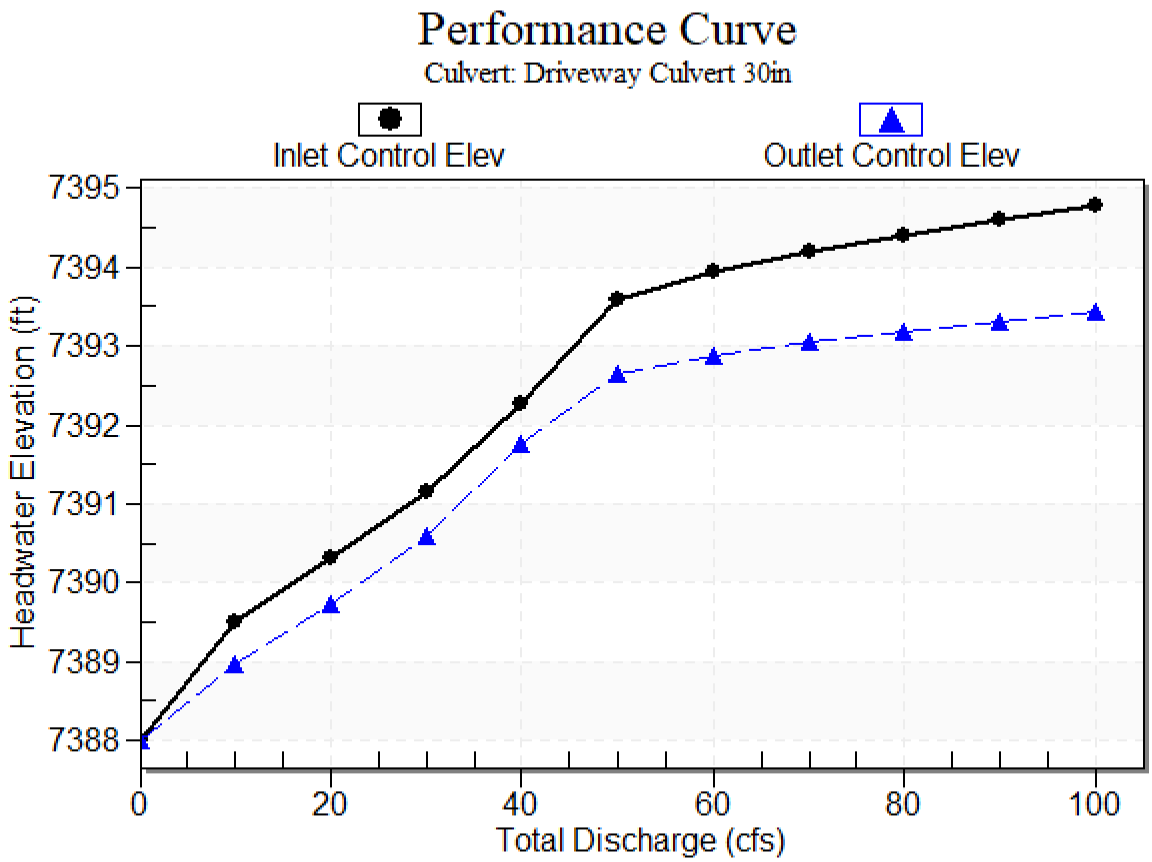
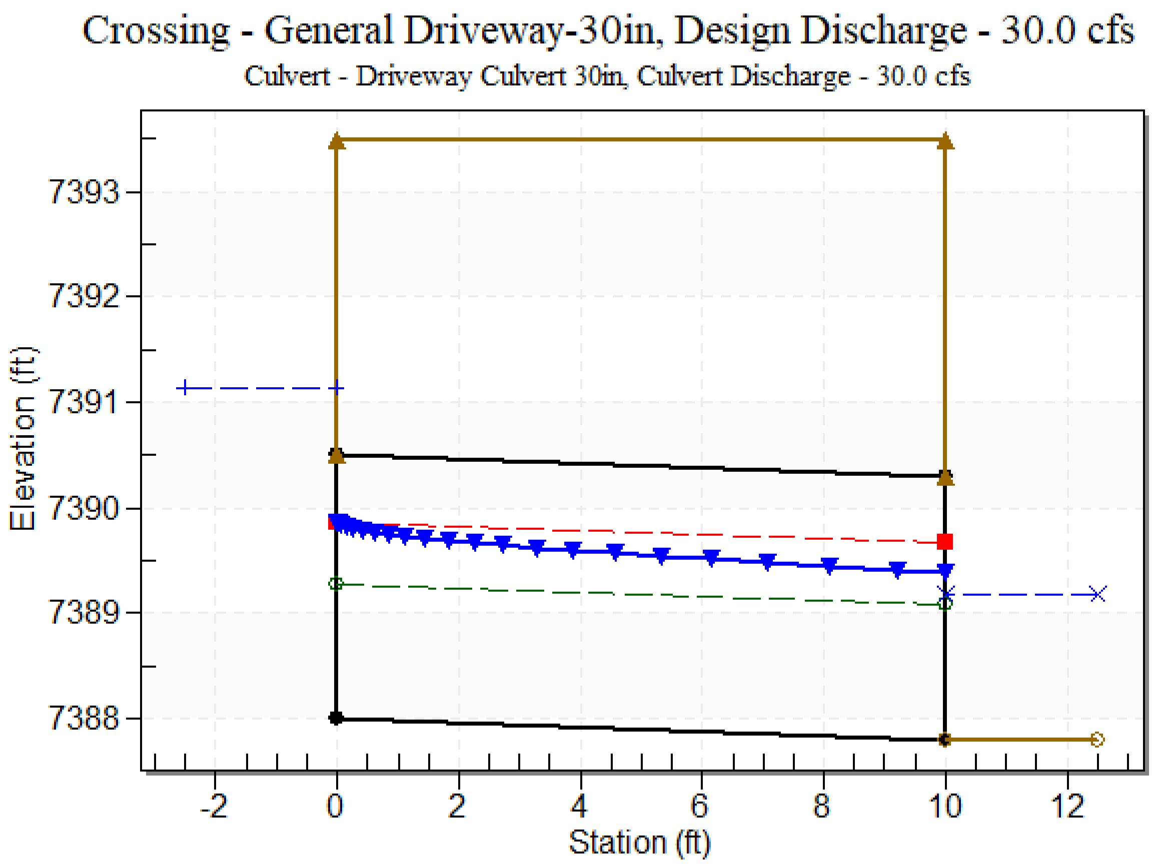
Culvert Performance Curve Plot: Driveway Culvert 30in



Water Surface Profile Plot for Culvert: Driveway Culvert 30in



Site Data - Driveway Culvert 30in

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7388.00 ft

Outlet Station: 10.00 ft

Outlet Elevation: 7387.80 ft

Number of Barrels: 1

Culvert Data Summary - Driveway Culvert 30in

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 36 - Downstream Channel Rating Curve (Crossing: General Driveway-30in)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7387.80	0.00	0.00	0.00	0.00
10.00	7388.71	0.91	3.04	1.13	0.80
20.00	7388.98	1.18	3.61	1.47	0.83
30.00	7389.17	1.37	4.00	1.71	0.85
40.00	7389.33	1.53	4.30	1.90	0.87
50.00	7389.46	1.66	4.54	2.07	0.88
60.00	7389.58	1.78	4.76	2.22	0.89
70.00	7389.68	1.88	4.94	2.35	0.90
80.00	7389.78	1.98	5.11	2.47	0.91
90.00	7389.87	2.07	5.26	2.58	0.91
100.00	7389.95	2.15	5.40	2.68	0.92

Tailwater Channel Data - General Driveway-30in

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0400

Channel Invert Elevation: 7387.80 ft

Roadway Data for Crossing: General Driveway-30in

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 7393.50 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 50 cfs

Maximum Flow: 100 cfs

Table 37 - Summary of Culvert Flows at Crossing: General Driveway-36in

Headwater Elevation (ft)	Total Discharge (cfs)	Driveway Culvert 36in Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7388.00	0.00	0.00	0.00	1
7389.36	10.00	10.00	0.00	1
7390.07	20.00	20.00	0.00	1
7390.67	30.00	30.00	0.00	1
7391.27	40.00	40.00	0.00	1
7391.97	50.00	50.00	0.00	1
7392.82	60.00	60.00	0.00	1
7393.85	70.00	70.00	0.00	1
7394.33	80.00	74.20	5.79	6
7394.59	90.00	76.31	13.68	5
7394.81	100.00	78.06	21.90	4
7394.00	71.34	71.34	0.00	Overtopping

Rating Curve Plot for Crossing: General Driveway-36in

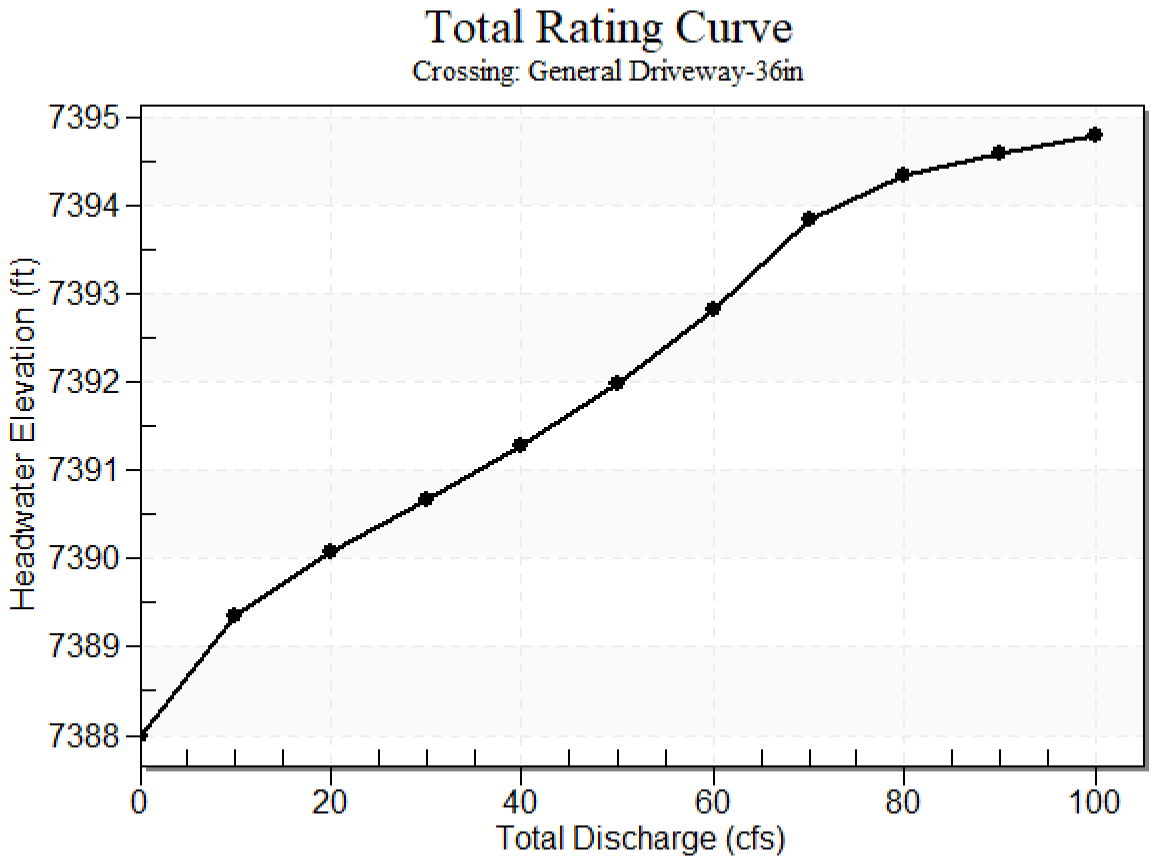


Table 38 - Culvert Summary Table: Driveway Culvert 36in

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7388.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.00	7389.36	1.359	0.849	1-S2n	0.658	1.000	0.792	0.907	6.697	3.039
20.00	20.00	7390.07	2.073	1.430	1-S2n	0.937	1.435	1.172	1.176	7.820	3.614
30.00	30.00	7390.67	2.671	2.014	1-S2n	1.161	1.774	1.478	1.369	8.653	4.000
40.00	40.00	7391.27	3.272	2.641	5-S2n	1.362	2.059	1.743	1.525	9.388	4.298
50.00	50.00	7391.97	3.971	3.672	5-S2n	1.551	2.301	1.981	1.658	10.100	4.544
60.00	60.00	7392.82	4.823	4.309	5-S2n	1.735	2.501	2.193	1.776	10.837	4.756
70.00	70.00	7393.85	5.849	5.023	5-S2n	1.922	2.657	2.382	1.882	11.631	4.943
80.00	74.20	7394.33	6.333	5.345	5-S2n	2.002	2.710	2.454	1.978	11.989	5.111
90.00	76.31	7394.59	6.588	5.512	5-S2n	2.044	2.733	2.489	2.067	12.176	5.264
100.00	78.06	7394.81	6.805	5.653	5-S2n	2.078	2.751	2.517	2.151	12.332	5.404

****

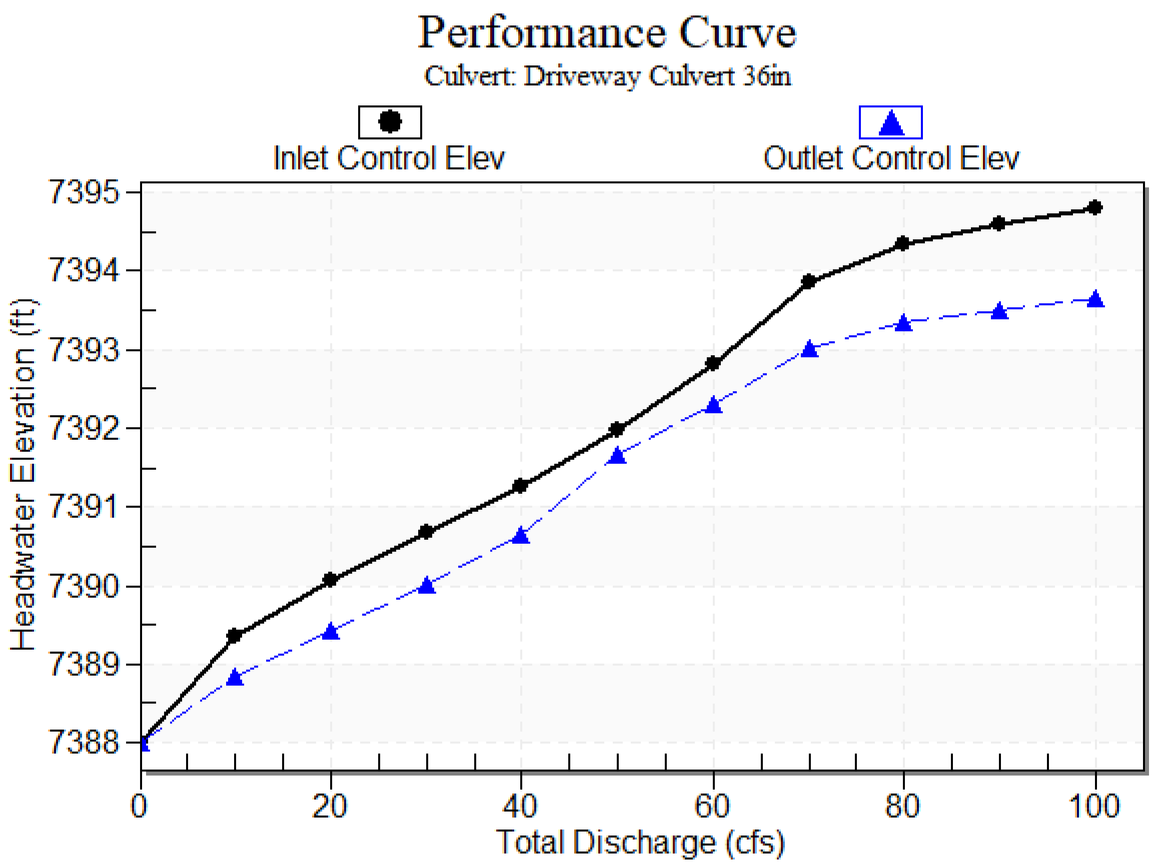
Straight Culvert

Inlet Elevation (invert): 7388.00 ft,   Outlet Elevation (invert): 7387.80 ft

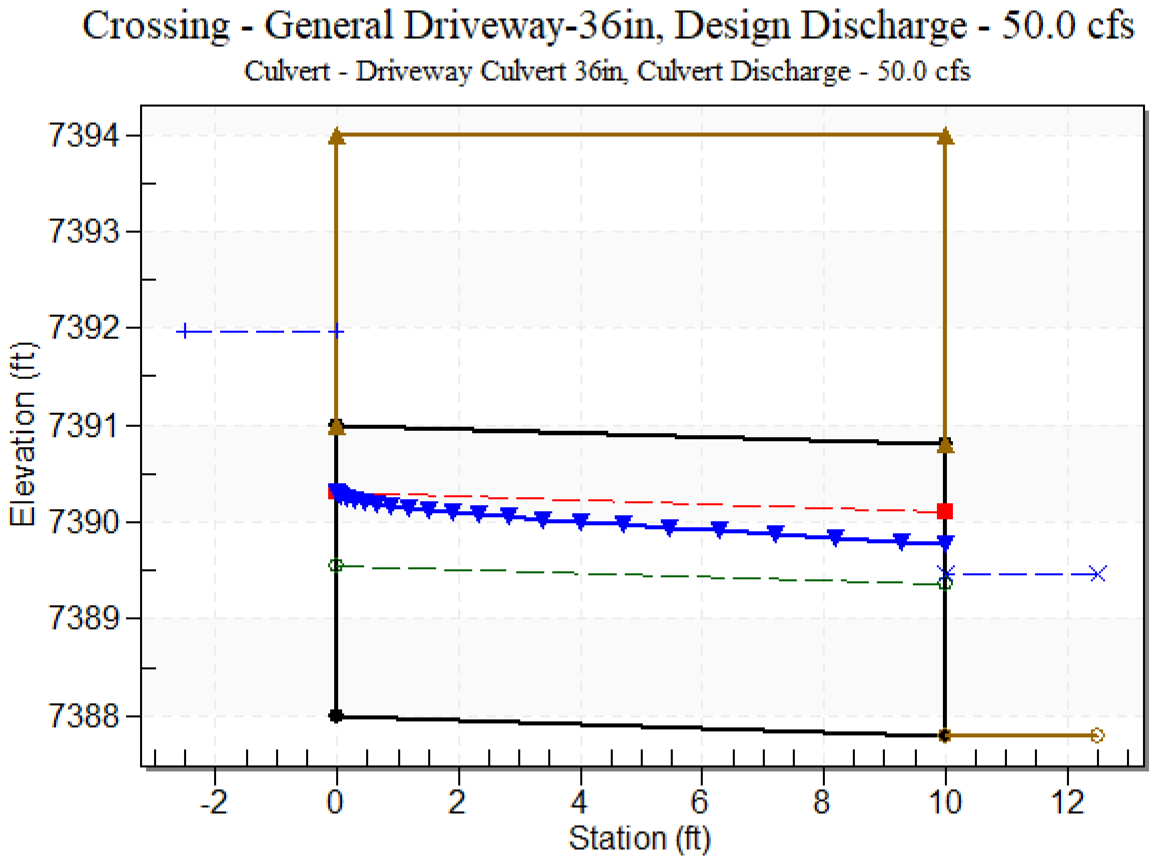
Culvert Length: 10.00 ft,   Culvert Slope: 0.0200

****

Culvert Performance Curve Plot: Driveway Culvert 36in



Water Surface Profile Plot for Culvert: Driveway Culvert 36in



Site Data - Driveway Culvert 36in

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7388.00 ft

Outlet Station: 10.00 ft

Outlet Elevation: 7387.80 ft

Number of Barrels: 1

Culvert Data Summary - Driveway Culvert 36in

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 39 - Downstream Channel Rating Curve (Crossing: General Driveway-36in)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7387.80	0.00	0.00	0.00	0.00
10.00	7388.71	0.91	3.04	1.13	0.80
20.00	7388.98	1.18	3.61	1.47	0.83
30.00	7389.17	1.37	4.00	1.71	0.85
40.00	7389.33	1.53	4.30	1.90	0.87
50.00	7389.46	1.66	4.54	2.07	0.88
60.00	7389.58	1.78	4.76	2.22	0.89
70.00	7389.68	1.88	4.94	2.35	0.90
80.00	7389.78	1.98	5.11	2.47	0.91
90.00	7389.87	2.07	5.26	2.58	0.91
100.00	7389.95	2.15	5.40	2.68	0.92

Tailwater Channel Data - General Driveway-36in

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0400

Channel Invert Elevation: 7387.80 ft

Roadway Data for Crossing: General Driveway-36in

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 7394.00 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 70 cfs

Maximum Flow: 100 cfs

Table 40 - Summary of Culvert Flows at Crossing: General Driveway-42in

Headwater Elevation (ft)	Total Discharge (cfs)	Driveway Culvert 42in Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7388.00	0.00	0.00	0.00	1
7389.29	10.00	10.00	0.00	1
7389.90	20.00	20.00	0.00	1
7390.45	30.00	30.00	0.00	1
7390.93	40.00	40.00	0.00	1
7391.39	50.00	50.00	0.00	1
7391.88	60.00	60.00	0.00	1
7392.42	70.00	70.00	0.00	1
7393.05	80.00	80.00	0.00	1
7393.76	90.00	90.00	0.00	1
7394.55	100.00	99.71	0.28	7
7394.50	99.18	99.18	0.00	Overtopping

Rating Curve Plot for Crossing: General Driveway-42in

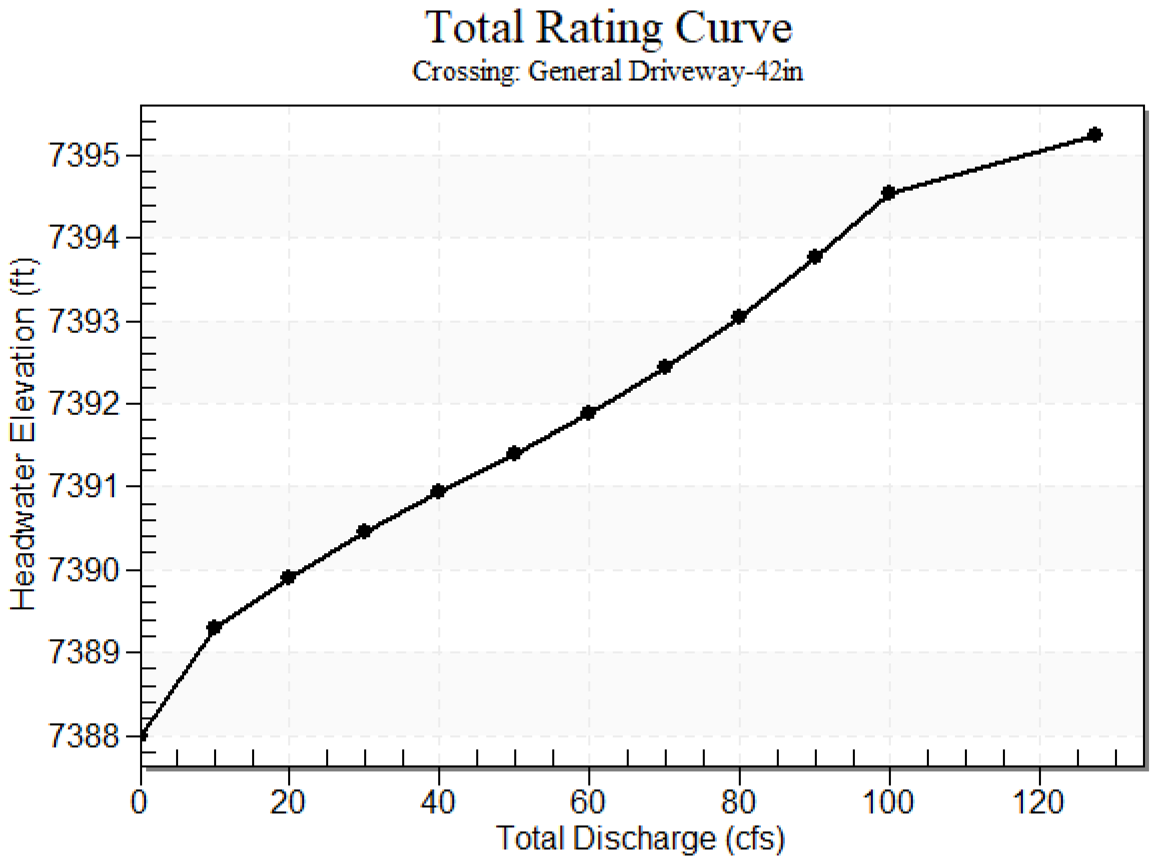


Table 41 - Culvert Summary Table: Driveway Culvert 42in

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7388.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
10.00	10.00	7389.29	1.292	0.783	1-S2n	0.628	0.957	0.754	0.907	6.564	3.039
20.00	20.00	7389.90	1.896	1.274	1-S2n	0.885	1.369	1.111	1.176	7.620	3.614
30.00	30.00	7390.45	2.448	1.727	1-S2n	1.089	1.692	1.397	1.369	8.370	4.000
40.00	40.00	7390.93	2.927	2.185	1-S2n	1.268	1.967	1.646	1.525	8.996	4.298
50.00	50.00	7391.39	3.390	2.663	1-S2n	1.431	2.210	1.870	1.658	9.561	4.544
60.00	60.00	7391.88	3.878	3.168	5-S2n	1.584	2.427	2.075	1.776	10.097	4.756
70.00	70.00	7392.42	4.424	3.703	5-S2n	1.731	2.622	2.265	1.882	10.628	4.943
80.00	80.00	7393.05	5.047	4.620	5-S2n	1.875	2.794	2.441	1.978	11.167	5.111
90.00	90.00	7393.76	5.761	5.139	5-S2n	2.017	2.943	2.603	2.067	11.729	5.264
100.00	99.71	7394.55	6.545	5.682	5-S2n	2.156	3.065	2.747	2.151	12.309	5.404

****

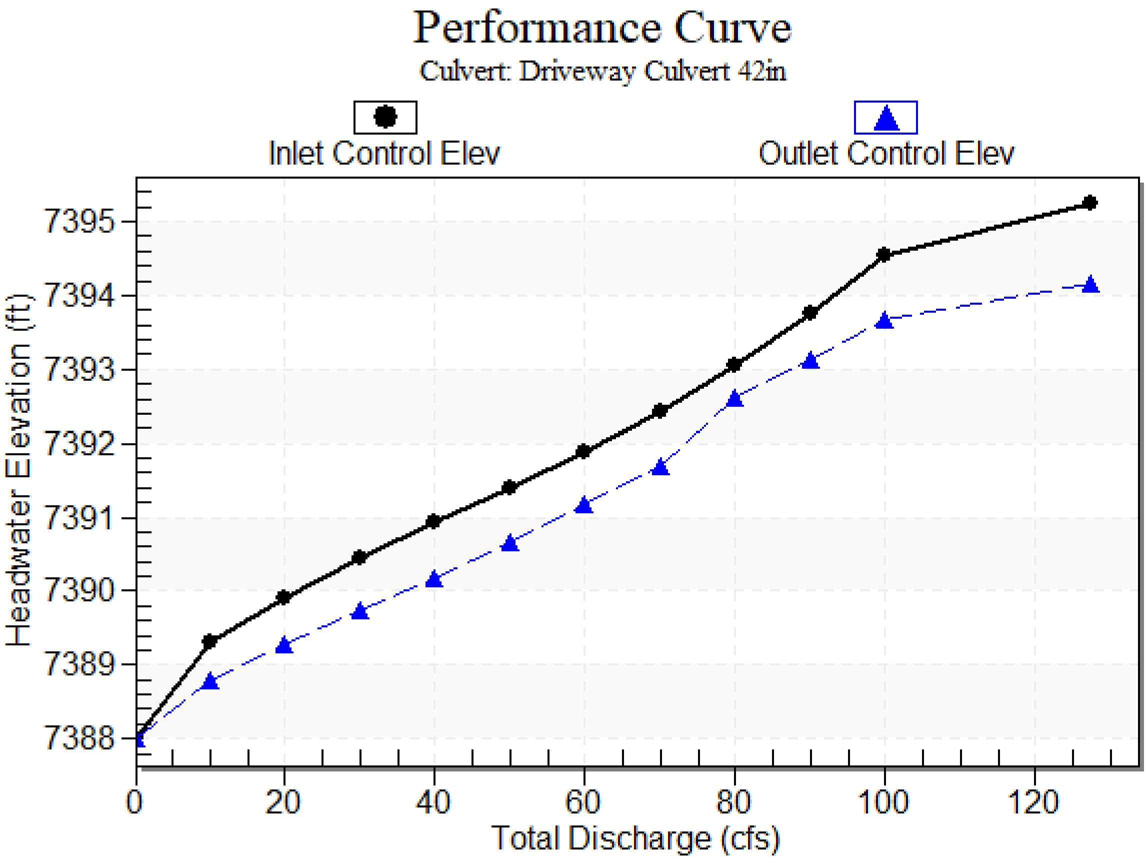
Straight Culvert

Inlet Elevation (invert): 7388.00 ft,   Outlet Elevation (invert): 7387.80 ft

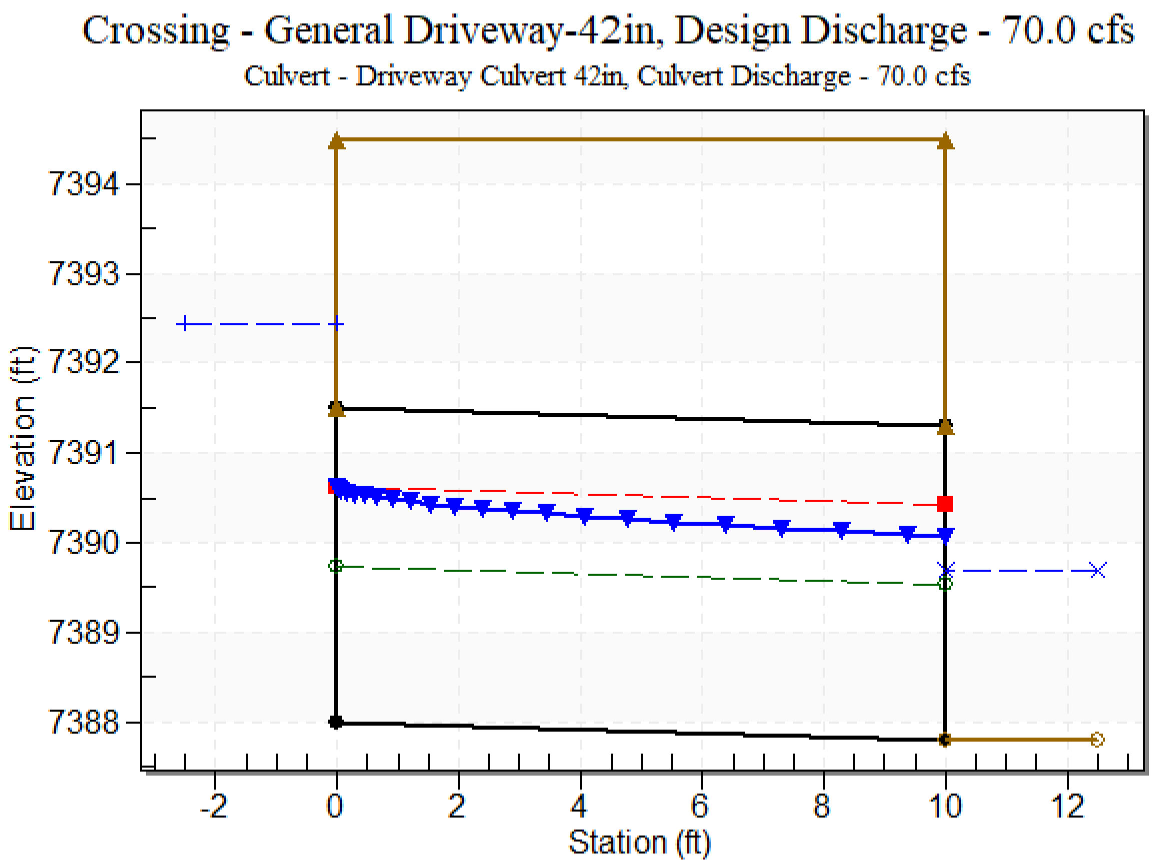
Culvert Length: 10.00 ft,   Culvert Slope: 0.0200

****

Culvert Performance Curve Plot: Driveway Culvert 42in



Water Surface Profile Plot for Culvert: Driveway Culvert 42in



Site Data - Driveway Culvert 42in

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7388.00 ft

Outlet Station: 10.00 ft

Outlet Elevation: 7387.80 ft

Number of Barrels: 1

Culvert Data Summary - Driveway Culvert 42in

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 42 - Downstream Channel Rating Curve (Crossing: General Driveway-42in)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7387.80	0.00	0.00	0.00	0.00
10.00	7388.71	0.91	3.04	1.13	0.80
20.00	7388.98	1.18	3.61	1.47	0.83
30.00	7389.17	1.37	4.00	1.71	0.85
40.00	7389.33	1.53	4.30	1.90	0.87
50.00	7389.46	1.66	4.54	2.07	0.88
60.00	7389.58	1.78	4.76	2.22	0.89
70.00	7389.68	1.88	4.94	2.35	0.90
80.00	7389.78	1.98	5.11	2.47	0.91
90.00	7389.87	2.07	5.26	2.58	0.91
100.00	7389.95	2.15	5.40	2.68	0.92

Tailwater Channel Data - General Driveway-42in

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0400

Channel Invert Elevation: 7387.80 ft

Roadway Data for Crossing: General Driveway-42in

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 7394.50 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 10 cfs

Design Flow: 100 cfs

Maximum Flow: 120 cfs

Table 1 - Summary of Culvert Flows at Crossing: Driveway Culvert-2- 36"

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7358.55	10.00	10.00	0.00	1
7359.01	21.00	21.00	0.00	1
7359.42	32.00	32.00	0.00	1
7359.78	43.00	43.00	0.00	1
7360.11	54.00	54.00	0.00	1
7360.43	65.00	65.00	0.00	1
7360.76	76.00	76.00	0.00	1
7361.12	87.00	87.00	0.00	1
7361.59	100.00	100.00	0.00	1
7361.95	109.00	109.00	0.00	1
7362.44	120.00	120.00	0.00	1
7367.00	192.69	192.69	0.00	Overtopping

Rating Curve Plot for Crossing: Driveway Culvert-2- 36"

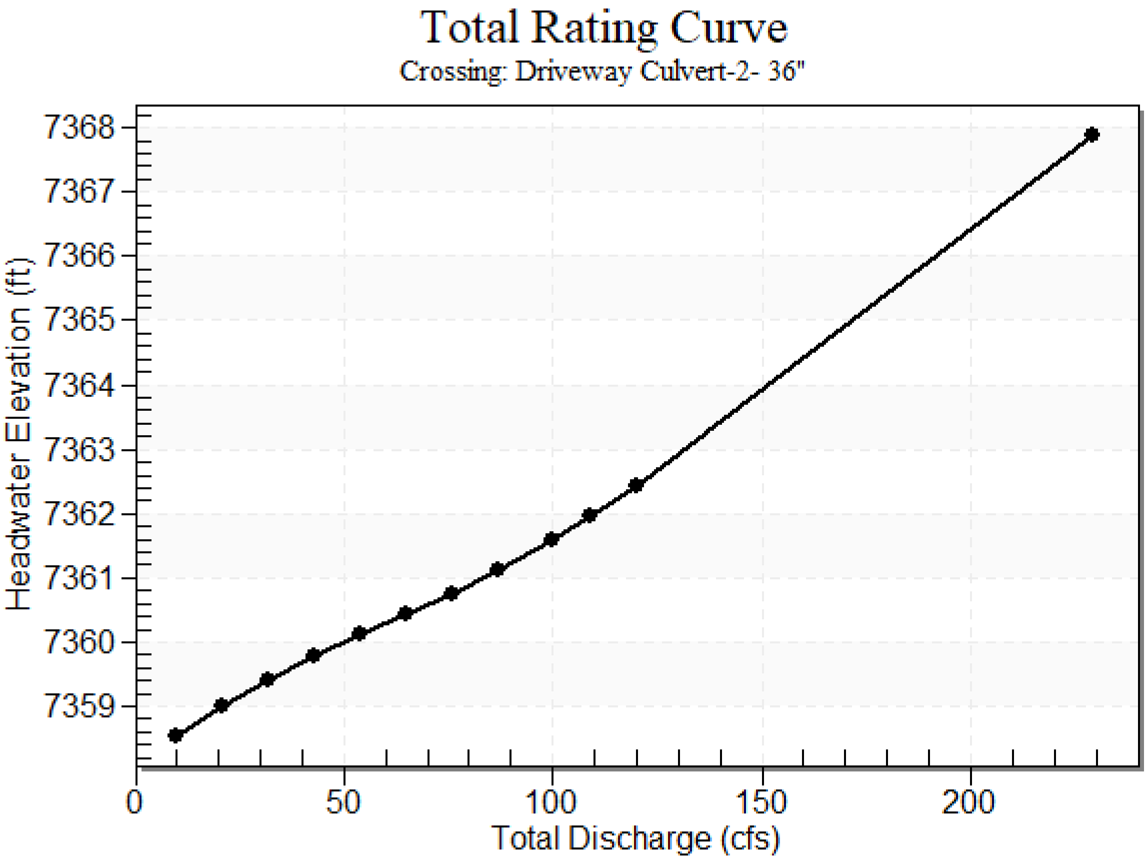


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10.00	10.00	7358.55	0.950	0.612	1-S2n	0.534	0.700	0.591	0.371	5.075	2.543
21.00	21.00	7359.01	1.406	0.979	1-S2n	0.772	1.026	0.883	0.494	6.044	3.190
32.00	32.00	7359.42	1.818	1.301	1-S2n	0.958	1.277	1.113	0.586	6.702	3.608
43.00	43.00	7359.78	2.182	1.615	1-S2n	1.120	1.490	1.312	0.663	7.235	3.925
54.00	54.00	7360.11	2.512	1.933	1-S2n	1.269	1.679	1.491	0.729	7.701	4.184
65.00	65.00	7360.43	2.832	2.262	1-S2n	1.409	1.850	1.655	0.788	8.129	4.405
76.00	76.00	7360.76	3.162	2.606	5-S2n	1.544	2.006	1.808	0.841	8.537	4.597
87.00	87.00	7361.12	3.517	2.967	5-S2n	1.676	2.148	1.952	0.891	8.934	4.770
100.00	100.00	7361.59	3.986	3.764	5-S2n	1.833	2.301	2.112	0.945	9.405	4.953
109.00	109.00	7361.95	4.348	4.039	5-S2n	1.944	2.397	2.216	0.979	9.735	5.069
120.00	120.00	7362.44	4.838	4.397	5-S2n	2.084	2.501	2.339	1.020	10.150	5.201

****

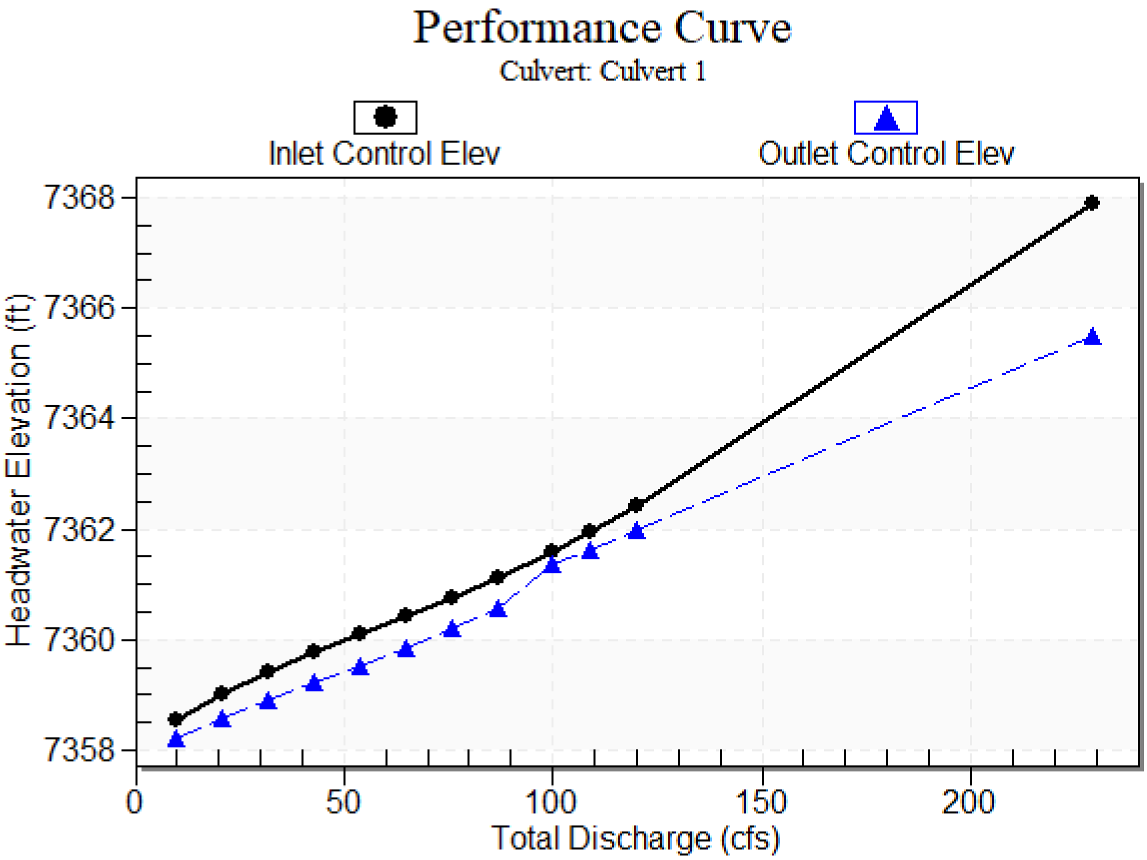
Straight Culvert

Inlet Elevation (invert): 7357.60 ft,   Outlet Elevation (invert): 7357.50 ft

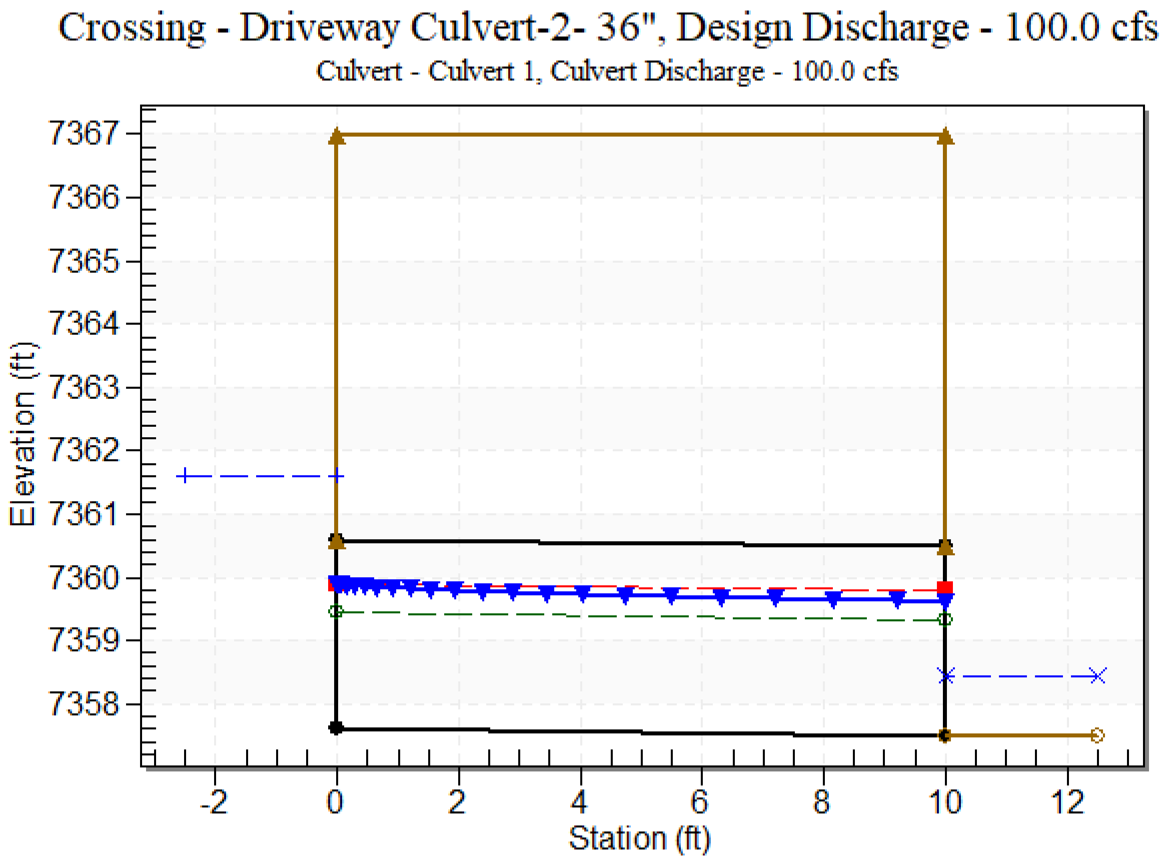
Culvert Length: 10.00 ft,   Culvert Slope: 0.0100

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7357.60 ft

Outlet Station: 10.00 ft

Outlet Elevation: 7357.50 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Driveway Culvert-2- 36")

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
10.00	7357.87	0.37	2.54	0.93	1.00
21.00	7357.99	0.49	3.19	1.23	1.06
32.00	7358.09	0.59	3.61	1.46	1.09
43.00	7358.16	0.66	3.93	1.65	1.12
54.00	7358.23	0.73	4.18	1.82	1.13
65.00	7358.29	0.79	4.40	1.97	1.15
76.00	7358.34	0.84	4.60	2.10	1.16
87.00	7358.39	0.89	4.77	2.22	1.17
100.00	7358.44	0.94	4.95	2.36	1.18
109.00	7358.48	0.98	5.07	2.44	1.19
120.00	7358.52	1.02	5.20	2.55	1.20

Tailwater Channel Data - Driveway Culvert-2- 36"

Tailwater Channel Option: Irregular Channel

Roadway Data for Crossing: Driveway Culvert-2- 36"

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 ft

Crest Elevation: 7367.00 ft

Roadway Surface: Paved

Roadway Top Width: 10.00 ft

CHANNEL FLOWS SUMMARY										
Reach/Channel ID	Slope (%)	Friction Factor	Channel Depth (ft)	Contributing Basins	Tributary Area (ac)	Q100 Flows (cfs)	Q100 Depth (ft)	Q100 Velocity (ft/s)	Lining	Headcutting
EX_Reach G1	4.00	0.04	10.5	G1+G2A	43.39	100.0	0.95	4.98	Grass	
EX_Reach H1-A	4.30	0.04	32.1	H1+H4	40.76	106.6	1.24	6.40	Grass	X
Prop_Reach H1-A	1.30	0.04	32.1	H1+H4	40.76	106.6	1.61	4.23	Grass	
EX_Reach H1-B	5.00	0.04	7.0	H1+29% of H4	21.59	54.3	1.45	6.57	Grass	X
Prop_Reach H1-B	2.70	0.04	7.0	H1+29% of H4	21.59	54.3	0.80	4.44	Grass	
EX_Reach H2	3.80	0.04	13.0	H2	16.00	57.1	0.92	4.71	Grass	
EX_Reach H3	6.00	0.04	17.0	H3A+H7B	18.77	57.8	1.06	5.92	Grass	X
Prop_Reach H3	4.86	0.04	9.0	H3A+H7B	18.77	57.8	0.70	5.67	Grass/TRM	X
Prop_Reach H3B	4.20	0.04	2.5	H3B+25% of I1	4.40	12.0	0.89	4.32	Grass	
EX_Reach H4	6.80	0.04	17.0	23% of H4	6.21	16.9	0.73	4.94	Grass	X
EX_Reach H5B	5.00	0.04	18.0	H5B	10.48	29.0	0.86	4.71	Grass	X
Prop_Reach I1	7.90	0.04	5.1	H3B+I1+H8A	13.40	38.4	1.23	7.32	Grass/TRM	
Prop_Swale A3A	4.20	0.04	6.5	A2B+A3A	17.20	46.1	1.18	5.29	Grass/TRM	
EX_Reach I2	2.43	0.04	7.8	I2	14.60	39.1	0.60	3.87	Grass	
Prop_WQ Channel	1.90	0.04	3.0	A2B+A3A+G2B	20.00	55.7	1.12	4.77	Grass	

Worksheet for EX_Reach G1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.040 ft/ft
Discharge	100.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+25	7,367.99
0+87	7,360.00
1+16	7,357.46
1+30	7,357.78
1+45	7,358.60
1+97	7,363.04
2+20	7,365.99

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+25, 7,367.99)	(2+20, 7,365.99)	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	11.4 in
Roughness Coefficient	0.040
Elevation	7,358.41 ft
Elevation Range	7,357.5 to 7,368.0 ft
Flow Area	20.1 ft²
Wetted Perimeter	36.5 ft
Hydraulic Radius	6.6 in
Top Width	36.48 ft
Normal Depth	11.4 in
Critical Depth	12.3 in
Critical Slope	0.028 ft/ft
Velocity	4.98 ft/s
Velocity Head	0.39 ft
Specific Energy	1.34 ft

Worksheet for EX_Reach G1

Results	
Froude Number	1.185
Flow Type	Supercritical

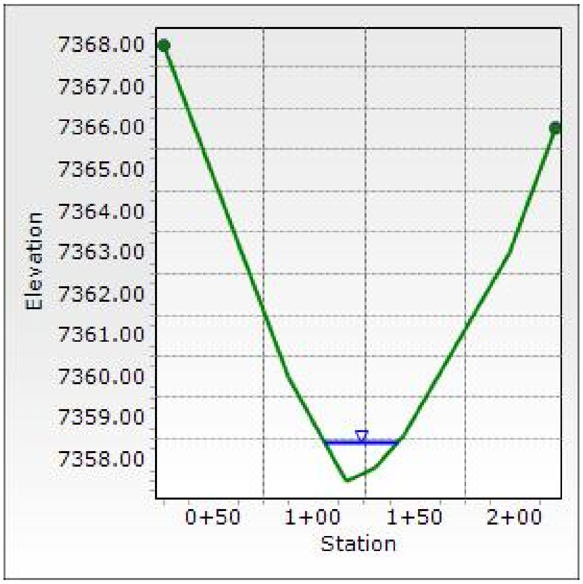
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

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	11.4 in
Critical Depth	12.3 in
Channel Slope	0.040 ft/ft
Critical Slope	0.028 ft/ft

Cross Section for EX_Reach G1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.040 ft/ft
Normal Depth	11.4 in
Discharge	100.00 cfs



Worksheet for EX_Reach H1-A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.043 ft/ft
Discharge	106.60 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	7,363.31
1+08	7,331.99
1+16	7,331.15
1+24	7,331.66
2+75	7,360.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 7,363.31)	(2+75, 7,360.00)	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	14.9 in
Roughness Coefficient	0.040
Elevation	7,332.39 ft
Elevation Range	7,331.2 to 7,363.3 ft
Flow Area	16.6 ft²
Wetted Perimeter	22.0 ft
Hydraulic Radius	9.1 in
Top Width	21.78 ft
Normal Depth	14.9 in
Critical Depth	16.8 in
Critical Slope	0.025 ft/ft
Velocity	6.40 ft/s
Velocity Head	0.64 ft
Specific Energy	1.88 ft
Froude Number	1.291
Flow Type	Supercritical

Worksheet for EX_Reach H1-A

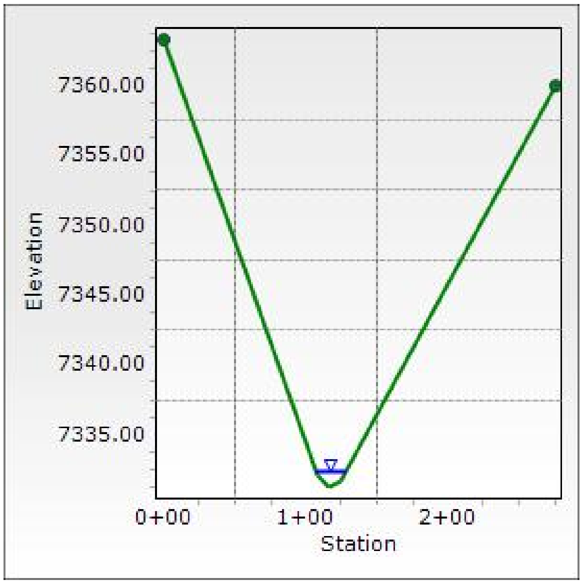
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

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	14.9 in
Critical Depth	16.8 in
Channel Slope	0.043 ft/ft
Critical Slope	0.025 ft/ft

Cross Section for EX_Reach H1-A

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.043 ft/ft
Normal Depth	14.9 in
Discharge	106.60 cfs



Worksheet for Prop_Reach H1-A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.013 ft/ft
Discharge	106.60 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	7,363.31
1+08	7,331.99
1+16	7,331.15
1+24	7,331.66
2+75	7,360.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 7,363.31)	(2+75, 7,360.00)	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	19.3 in
Roughness Coefficient	0.040
Elevation	7,332.76 ft
Elevation Range	7,331.2 to 7,363.3 ft
Flow Area	25.2 ft^2
Wetted Perimeter	25.3 ft
Hydraulic Radius	12.0 in
Top Width	24.99 ft
Normal Depth	19.3 in
Critical Depth	16.8 in
Critical Slope	0.025 ft/ft
Velocity	4.23 ft/s
Velocity Head	0.28 ft
Specific Energy	1.89 ft
Froude Number	0.743
Flow Type	Subcritical

Worksheet for Prop_Reach H1-A

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	19.3 in
Critical Depth	16.8 in
Channel Slope	0.013 ft/ft
Critical Slope	0.025 ft/ft

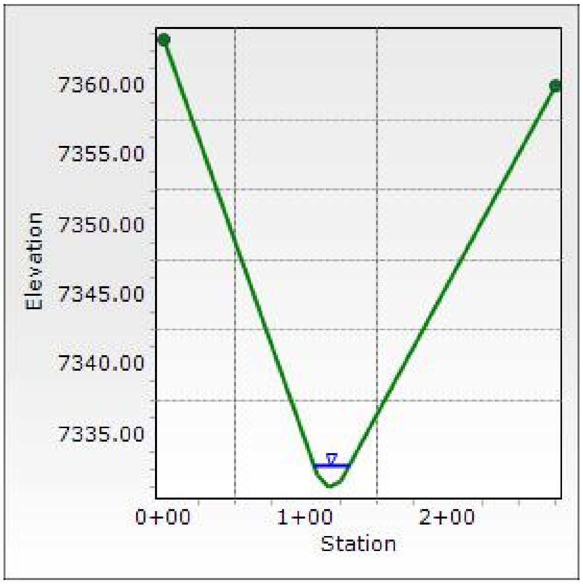
Cross Section for Prop_Reach H1-A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.013 ft/ft
Normal Depth	19.3 in
Discharge	106.60 cfs



Worksheet for EX_Reach H1-B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.050 ft/ft
Discharge	54.30 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+04	7,369.03
0+55	7,359.99
0+73	7,349.57
0+84	7,346.68
1+01	7,351.01
1+17	7,359.46
1+59	7,364.84

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+04, 7,369.03)	(1+59, 7,364.84)	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	17.4 in
Roughness Coefficient	0.040
Elevation	7,348.13 ft
Elevation Range	7,346.7 to 7,369.0 ft
Flow Area	8.3 ft²
Wetted Perimeter	11.7 ft
Hydraulic Radius	8.4 in
Top Width	11.38 ft
Normal Depth	17.4 in
Critical Depth	19.7 in
Critical Slope	0.026 ft/ft
Velocity	6.57 ft/s
Velocity Head	0.67 ft
Specific Energy	2.12 ft

Worksheet for EX_Reach H1-B

Results		
Froude Number	1.359	
Flow Type	Supercritical	

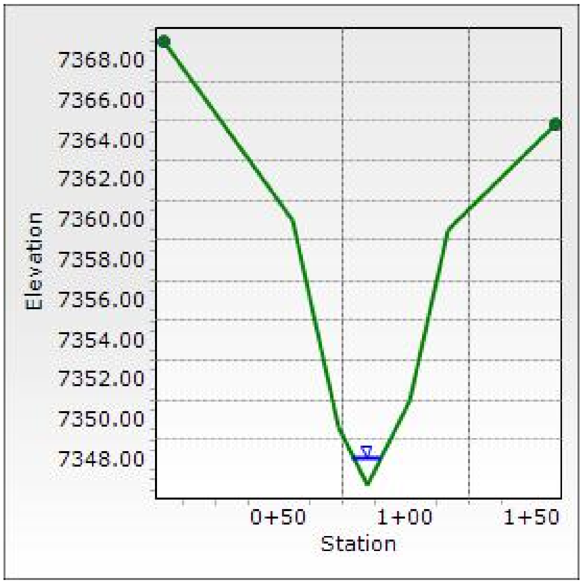
GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

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	17.4	in
Critical Depth	19.7	in
Channel Slope	0.050	ft/ft
Critical Slope	0.026	ft/ft

Cross Section for EX_Reach H1-B

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.050 ft/ft
Normal Depth	17.4 in
Discharge	54.30 cfs



Worksheet for Prop_Reach H1-B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040
Channel Slope	0.025 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Bottom Width	12.00 ft
Discharge	54.30 cfs

Results

Normal Depth	9.6 in
Flow Area	12.2 ft²
Wetted Perimeter	18.6 ft
Hydraulic Radius	7.9 in
Top Width	18.43 ft
Critical Depth	9.4 in
Critical Slope	0.027 ft/ft
Velocity	4.44 ft/s
Velocity Head	0.31 ft
Specific Energy	1.11 ft
Froude Number	0.960
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	9.6 in
Critical Depth	9.4 in
Channel Slope	0.025 ft/ft
Critical Slope	0.027 ft/ft

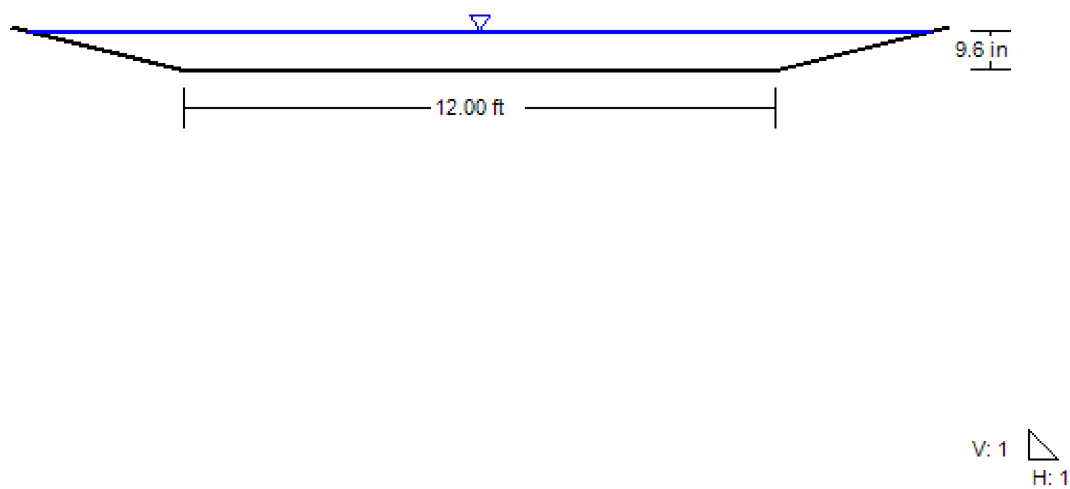
Cross Section for Prop_Reach H1-B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040
Channel Slope	0.025 ft/ft
Normal Depth	9.6 in
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Bottom Width	12.00 ft
Discharge	54.30 cfs



Worksheet for EX_Reach H2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.038 ft/ft
Discharge	57.10 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	7,329.99
0+43	7,321.99
0+68	7,319.99
0+93	7,316.97
0+99	7,316.75
1+14	7,317.99
1+79	7,329.38

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 7,329.99)	(1+79, 7,329.38)	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	11.0 in
Roughness Coefficient	0.040
Elevation	7,317.67 ft
Elevation Range	7,316.8 to 7,330.0 ft
Flow Area	12.1 ft²
Wetted Perimeter	23.2 ft
Hydraulic Radius	6.3 in
Top Width	23.07 ft
Normal Depth	11.0 in
Critical Depth	11.7 in
Critical Slope	0.028 ft/ft
Velocity	4.71 ft/s
Velocity Head	0.34 ft
Specific Energy	1.26 ft

Worksheet for EX_Reach H2

Results	
Froude Number	1.144
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	11.0 in
Critical Depth	11.7 in
Channel Slope	0.038 ft/ft
Critical Slope	0.028 ft/ft

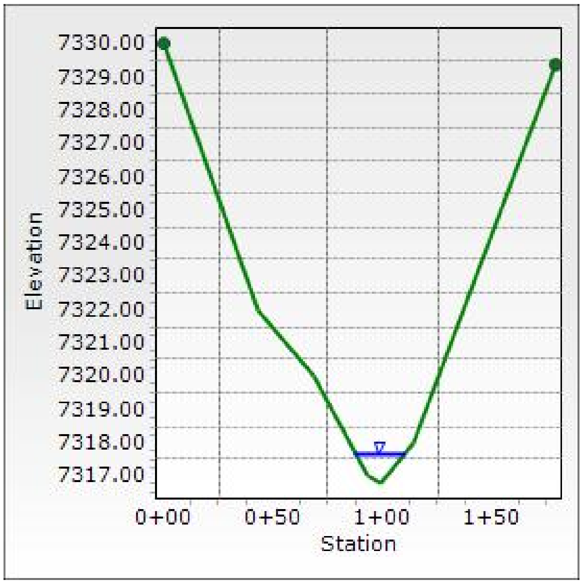
Cross Section for EX_Reach H2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.038 ft/ft
Normal Depth	11.0 in
Discharge	57.10 cfs



Worksheet for EX_Reach H3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.060 ft/ft
Discharge	57.80 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	7,323.16
0+25	7,319.99
0+51	7,312.54
0+58	7,310.46
0+70	7,309.11
0+79	7,310.18
0+94	7,316.14
1+12	7,319.73
1+76	7,326.41

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 7,323.16)	(1+76, 7,326.41)	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	12.7 in
Roughness Coefficient	0.040
Elevation	7,310.17 ft
Elevation Range	7,309.1 to 7,326.4 ft
Flow Area	9.8 ft^2
Wetted Perimeter	18.6 ft
Hydraulic Radius	6.3 in
Top Width	18.50 ft
Normal Depth	12.7 in
Critical Depth	14.6 in
Critical Slope	0.027 ft/ft
Velocity	5.92 ft/s

Worksheet for EX_Reach H3

Results		
Velocity Head	0.54	ft
Specific Energy	1.60	ft
Froude Number	1.436	
Flow Type	Supercritical	

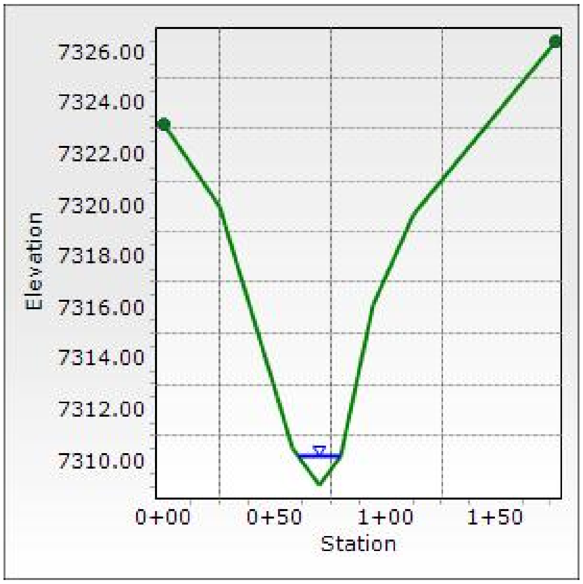
GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

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	12.7	in
Critical Depth	14.6	in
Channel Slope	0.060	ft/ft
Critical Slope	0.027	ft/ft

Cross Section for EX_Reach H3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.060 ft/ft
Normal Depth	12.7 in
Discharge	57.80 cfs



Worksheet for Prop_Reach H3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040
Channel Slope	4.860 %
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Bottom Width	12.00 ft
Discharge	57.80 cfs

Results

Normal Depth	0.7 ft
Flow Area	10.2 ft²
Wetted Perimeter	17.7 ft
Hydraulic Radius	0.6 ft
Top Width	17.52 ft
Critical Depth	0.8 ft
Critical Slope	2.701 %
Velocity	5.67 ft/s
Velocity Head	0.50 ft
Specific Energy	1.19 ft
Froude Number	1.311
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 ft
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.7 ft
Critical Depth	0.8 ft
Channel Slope	4.860 %
Critical Slope	2.701 %

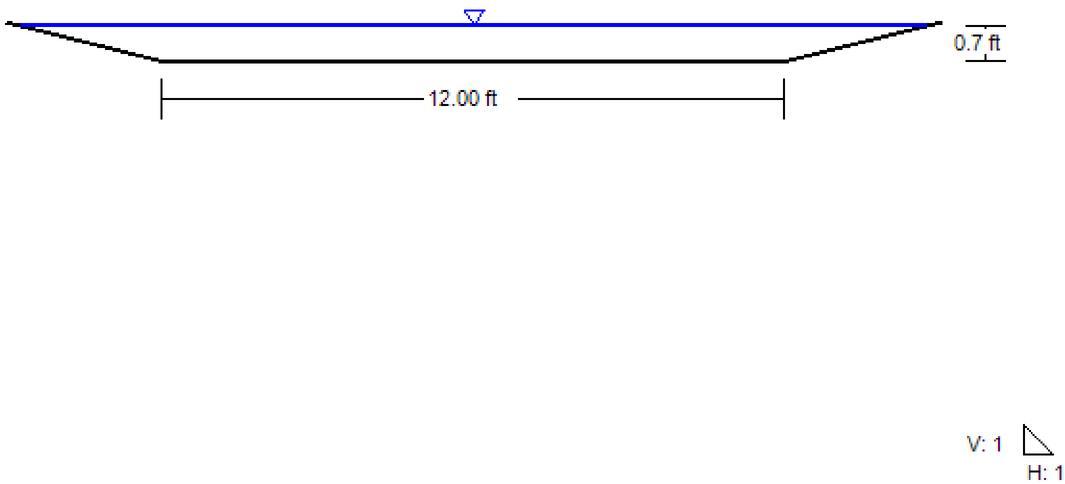
Cross Section for Prop_Reach H3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040
Channel Slope	4.860 %
Normal Depth	0.7 ft
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Bottom Width	12.00 ft
Discharge	57.80 cfs



Worksheet for PROP_Reach H3B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.042 ft/ft
Discharge	12.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+60	7,374.12
0+66	7,372.11
0+76	7,374.63

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+60, 7,374.12)	(0+76, 7,374.63)	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	10.7 in
Roughness Coefficient	0.040
Elevation	7,373.00 ft
Elevation Range	7,372.1 to 7,374.6 ft
Flow Area	2.8 ft²
Wetted Perimeter	6.5 ft
Hydraulic Radius	5.1 in
Top Width	6.24 ft
Normal Depth	10.7 in
Critical Depth	11.3 in
Critical Slope	0.032 ft/ft
Velocity	4.32 ft/s
Velocity Head	0.29 ft
Specific Energy	1.18 ft
Froude Number	1.142
Flow Type	Supercritical

GVF Input Data

Worksheet for PROP_Reach H3B

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

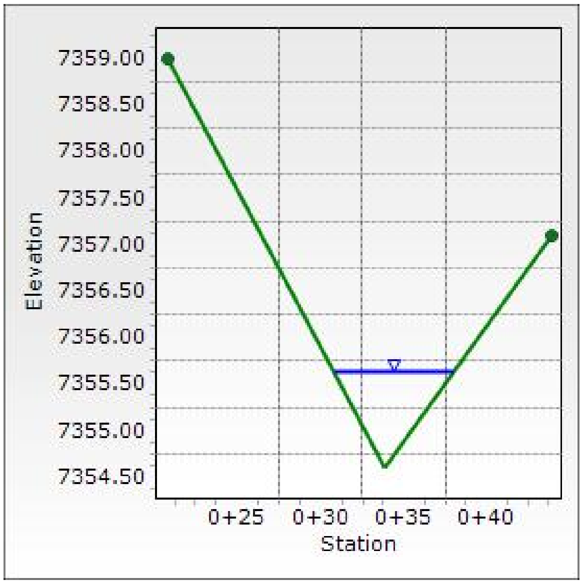
GVF Output Data

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	10.7 in
Critical Depth	11.3 in
Channel Slope	0.042 ft/ft
Critical Slope	0.032 ft/ft

Cross Section for PROP_Reach H3B

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.042 ft/ft
Normal Depth	12.2 in
Discharge	17.20 cfs



Worksheet for EX_Reach H4

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.068 ft/ft
Discharge	16.91 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+36	7,357.99
0+66	7,353.99
0+82	7,343.34
0+86	7,341.99
0+92	7,340.90
1+01	7,342.10
1+05	7,344.37
1+16	7,355.99
1+20	7,357.99

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+36, 7,357.99)	(1+20, 7,357.99)	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	8.8 in
Roughness Coefficient	0.040
Elevation	7,341.64 ft
Elevation Range	7,340.9 to 7,358.0 ft
Flow Area	3.4 ft²
Wetted Perimeter	9.4 ft
Hydraulic Radius	4.4 in
Top Width	9.29 ft
Normal Depth	8.8 in
Critical Depth	10.2 in
Critical Slope	0.032 ft/ft
Velocity	4.94 ft/s

Worksheet for EX_Reach H4

Results		
Velocity Head	0.38	ft
Specific Energy	1.12	ft
Froude Number	1.434	
Flow Type	Supercritical	

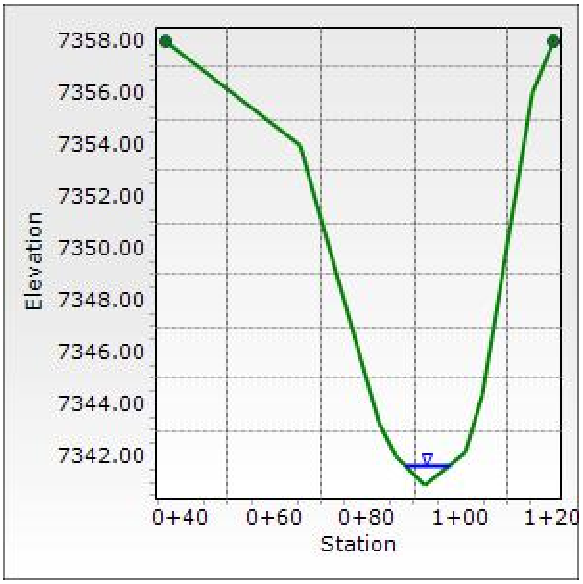
GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

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	8.8	in
Critical Depth	10.2	in
Channel Slope	0.068	ft/ft
Critical Slope	0.032	ft/ft

Cross Section for EX_Reach H4

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.068 ft/ft
Normal Depth	8.8 in
Discharge	16.91 cfs



Worksheet for EX_Reach H5B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.050 ft/ft
Discharge	29.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	7,342.00
0+35	7,337.99
0+42	7,335.99
0+58	7,327.33
0+64	7,325.99
0+74	7,323.97
0+90	7,325.33
1+02	7,329.70
1+16	7,337.99
1+34	7,341.97

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 7,342.00)	(1+34, 7,341.97)	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	10.3 in
Roughness Coefficient	0.040
Elevation	7,324.83 ft
Elevation Range	7,324.0 to 7,342.0 ft
Flow Area	6.2 ft²
Wetted Perimeter	14.4 ft
Hydraulic Radius	5.1 in
Top Width	14.29 ft
Normal Depth	10.3 in
Critical Depth	11.4 in
Critical Slope	0.030 ft/ft

Worksheet for EX_Reach H5B

Results	
Velocity	4.71 ft/s
Velocity Head	0.34 ft
Specific Energy	1.21 ft
Froude Number	1.265
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	10.3 in
Critical Depth	11.4 in
Channel Slope	0.050 ft/ft
Critical Slope	0.030 ft/ft

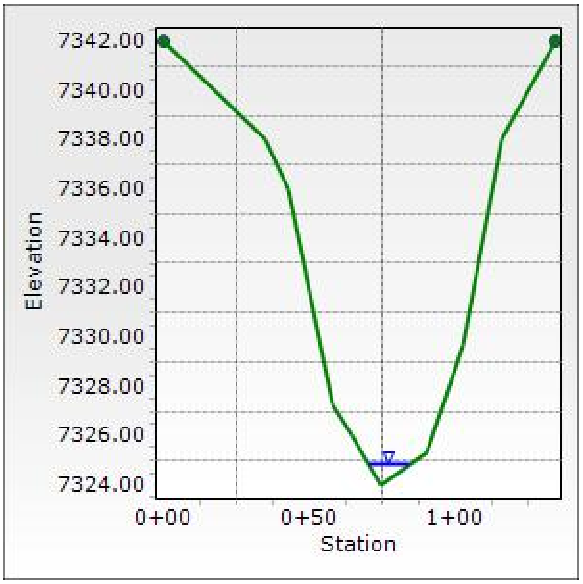
Cross Section for EX_Reach H5B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.050 ft/ft
Normal Depth	10.3 in
Discharge	29.00 cfs



Worksheet for Prop_Reach I1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.079 ft/ft
Discharge	38.40 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+75	7,330.96
0+85	7,328.37
1+01	7,333.54

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+75, 7,330.96)	(1+01, 7,333.54)	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	14.7 in
Roughness Coefficient	0.040
Elevation	7,329.59 ft
Elevation Range	7,328.4 to 7,333.5 ft
Flow Area	5.2 ft²
Wetted Perimeter	8.9 ft
Hydraulic Radius	7.0 in
Top Width	8.58 ft
Normal Depth	14.7 in
Critical Depth	17.9 in
Critical Slope	0.027 ft/ft
Velocity	7.32 ft/s
Velocity Head	0.83 ft
Specific Energy	2.05 ft
Froude Number	1.651
Flow Type	Supercritical

GVF Input Data

Worksheet for Prop_Reach I1

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	14.7	in
Critical Depth	17.9	in
Channel Slope	0.079	ft/ft
Critical Slope	0.027	ft/ft

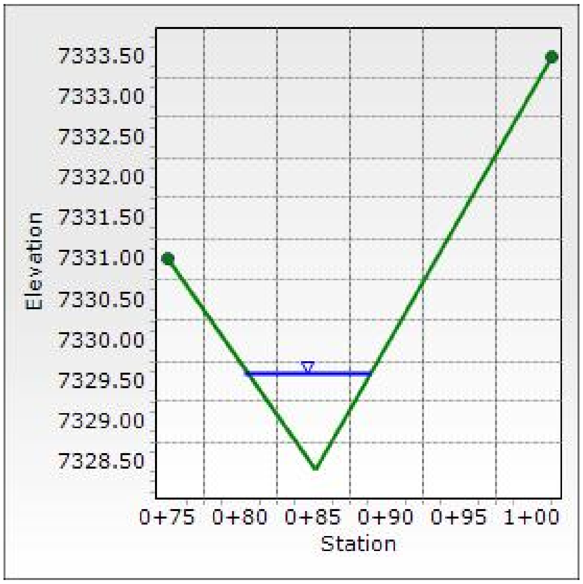
Cross Section for Prop_Reach I1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.079 ft/ft
Normal Depth	14.7 in
Discharge	38.40 cfs



Worksheet for Prop_Swale A3A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.042 ft/ft
Discharge	46.10 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+19	7,373.99
0+78	7,367.48
0+97	7,372.70

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+19, 7,373.99)	(0+97, 7,372.70)	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	14.1 in
Roughness Coefficient	0.040
Elevation	7,368.66 ft
Elevation Range	7,367.5 to 7,374.0 ft
Flow Area	8.7 ft²
Wetted Perimeter	15.1 ft
Hydraulic Radius	6.9 in
Top Width	14.84 ft
Normal Depth	14.1 in
Critical Depth	15.2 in
Critical Slope	0.028 ft/ft
Velocity	5.29 ft/s
Velocity Head	0.43 ft
Specific Energy	1.61 ft
Froude Number	1.216
Flow Type	Supercritical

GVF Input Data

Worksheet for Prop_Swale A3A

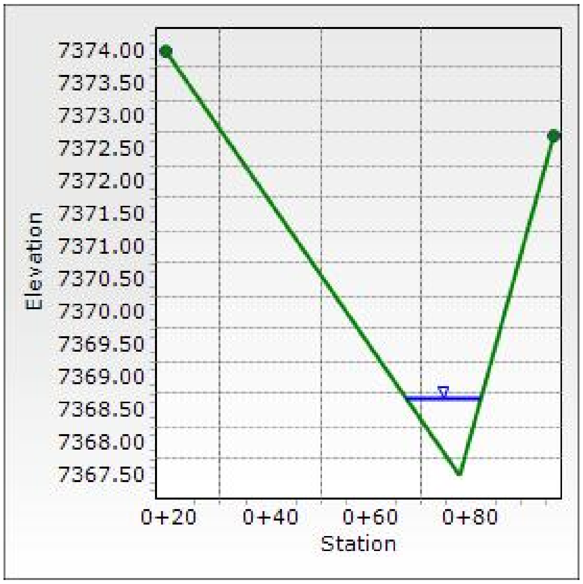
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

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	14.1 in
Critical Depth	15.2 in
Channel Slope	0.042 ft/ft
Critical Slope	0.028 ft/ft

Cross Section for Prop_Swale A3A

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.042 ft/ft
Normal Depth	14.1 in
Discharge	46.10 cfs



Worksheet for EX_Reach_I2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	2.430 %
Discharge	39.10 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+39	7,325.81
0+70	7,323.77
0+82	7,317.99
0+97	7,317.99
1+09	7,321.99
1+32	7,324.89

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+39, 7,325.81)	(1+32, 7,324.89)	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	0.6 ft
Roughness Coefficient	0.040
Elevation	7,318.59 ft
Elevation Range	7,318.0 to 7,325.8 ft
Flow Area	10.1 ft²
Wetted Perimeter	18.5 ft
Hydraulic Radius	0.5 ft
Top Width	18.27 ft
Normal Depth	0.6 ft
Critical Depth	0.6 ft
Critical Slope	2.937 %
Velocity	3.87 ft/s
Velocity Head	0.23 ft
Specific Energy	0.84 ft
Froude Number	0.917

Worksheet for EX_Reach_I2

Results	
Flow Type	Subcritical

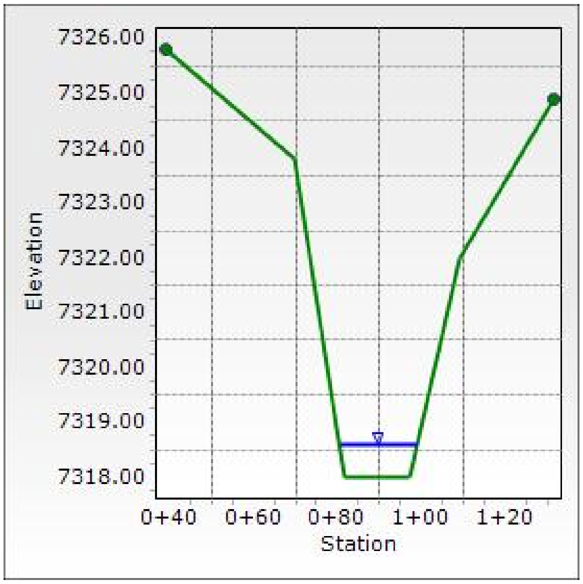
GVF Input Data	
Downstream Depth	0.0 ft
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	0.6 ft
Critical Depth	0.6 ft
Channel Slope	2.430 %
Critical Slope	2.937 %

Cross Section for EX_Reach_I2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data		
Channel Slope	2.430	%
Normal Depth	0.6	ft
Discharge	39.10	cfs



Worksheet for Prop_WQ Channel

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.036
Channel Slope	0.019 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Bottom Width	6.00 ft
Discharge	55.70 cfs

Results

Normal Depth	13.4 in
Flow Area	11.7 ft²
Wetted Perimeter	15.2 ft
Hydraulic Radius	9.2 in
Top Width	14.93 ft
Critical Depth	13.0 in
Critical Slope	0.021 ft/ft
Velocity	4.77 ft/s
Velocity Head	0.35 ft
Specific Energy	1.47 ft
Froude Number	0.951
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

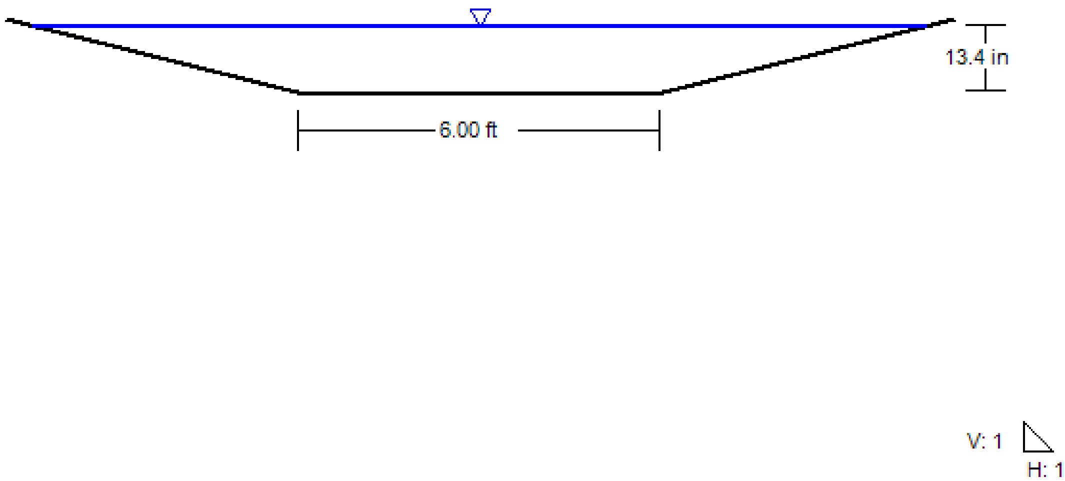
GVF Output Data

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	13.4 in
Critical Depth	13.0 in
Channel Slope	0.019 ft/ft
Critical Slope	0.021 ft/ft

Cross Section for Prop_WQ Channel

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.036
Channel Slope	0.019 ft/ft
Normal Depth	13.4 in
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Bottom Width	6.00 ft
Discharge	55.70 cfs



Design Data and Test Results

Excel PP5-12™

IECA Member

ECTC Directing Member

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 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 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_{veg}/CF_{TRM}	N/A	0.26

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

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.

possible for as much of the reach as possible to the maximum prudent values for the hydraulic parameters in the 100 year event. The designer should determine the return period where these parameters would be achieved and, with the owner and local jurisdiction, determine if the associated risks are acceptable.

On the other hand, if the recommendation to avoid floodplain filling is not followed and fill is proposed, this should only happen in floodplains where the maximum prudent values for the hydraulic parameters shown in Table 8-1 are not exceeded in the 100-year event.

Type B

Table 8-1. Maximum prudent values for natural channel hydraulic parameters

Design Parameter	**Non-Cohesive Soils or Poor Vegetation**	**Cohesive Soils and Vegetation**
Maximum flow velocity (average of section)	5 ft/s	7 ft/s
Maximum Froude number	0.6	0.8
Maximum tractive force (average of section)	0.60 lb/sf	1.0 lb/sf
Maximum depth outside bankfull channel	5 ft	5 ft

Stream Restoration Principle 8: Evaluate Hydraulics of Streams over a Range of Flows

<u>Representative Design Tasks and Deliverables</u>

1. Document hydraulic analyses of the project reach following the guidance of Section 7.0.
   2. Describe how hydraulic performance of the project reach compares to maximum prudent values for the hydraulic parameters shown in Table 8-1 for several return periods (including 2-, 10-, and 100-year events at a minimum). Describe any locations in the reach where these parameters are exceeded and discuss efforts made to improve hydraulics.
3. Confirm that hydraulic parameters of Table 8-1 are satisfied in for the100-year event in all locations where fill is proposed in the floodplain.

ROCK CHUTE DETAILS

Rock Chute ID	Channel Location	Flow (cfs)	Upstream Inlet Apron Length (ft)	Drop (ft) *(Inlet Apron to Outlet Apron)*	Chute Length (ft)	Downstream Outlet Apron Length (ft)	Chute Width (ft)	D50 (in)	Rock Chute Thickness (in)	Radius (ft)	Min Rock Chute Depth (ft)	Rock Chute Depth (ft)	Top Chute Width (ft)
4	Pond 1	107	10	6	24	15	24	18	36	50	1.27	2.00	40
6	Pond 2	110	10	8	32	18	17	18	36	50	1.57	2.00	33
11	Pond 4	26	10	10	40	11	10	9	18	25	0.85	2.00	26
12	WQ Pond	100	11	5	20	20	12	18	36	50	1.81	2.00	28
13	WQ Pond	57	10	3	12	16	10	18	36	50	1.38	2.00	26

Rock Chute Design Data

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

Project: Winsome Filing 3 - Rock Chute 4 (Pond 1) **County:** El Paso
Designer: TOS **Checked by:**
Date: December 21, 2021 **Date:**

Input Geometry:

Upstream Channel	Chute		Downstream Channel
Bw = 24.0 ft.	Bw = 24.0 ft.		Bw = 24.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.60 (F_s)	1.2 Min	Side slopes = 4.0 (m:1)
Velocity n-value = 0.040	Side slopes = 4.0 (m:1)	2.0:1 max.	Velocity n-value = 0.040
Bed slope = 0.0200 ft./ft.	Bed slope (4:1) = 0.250 ft./ft	3.0:1 max.	Bed slope = 0.0040 ft./ft.
Note: n value = a) velocity n from waterway program	Freeboard = 0.5 ft.		
or b) computed mannings n for channel	Outlet apron depth, d = 1.0 ft.		Base flow = 0.0 cfs

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

Apron elev. --- Inlet = 7322.0 ft. ------- Outlet 7316.0 ft. --- (H_{drop} = 5 ft.)

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

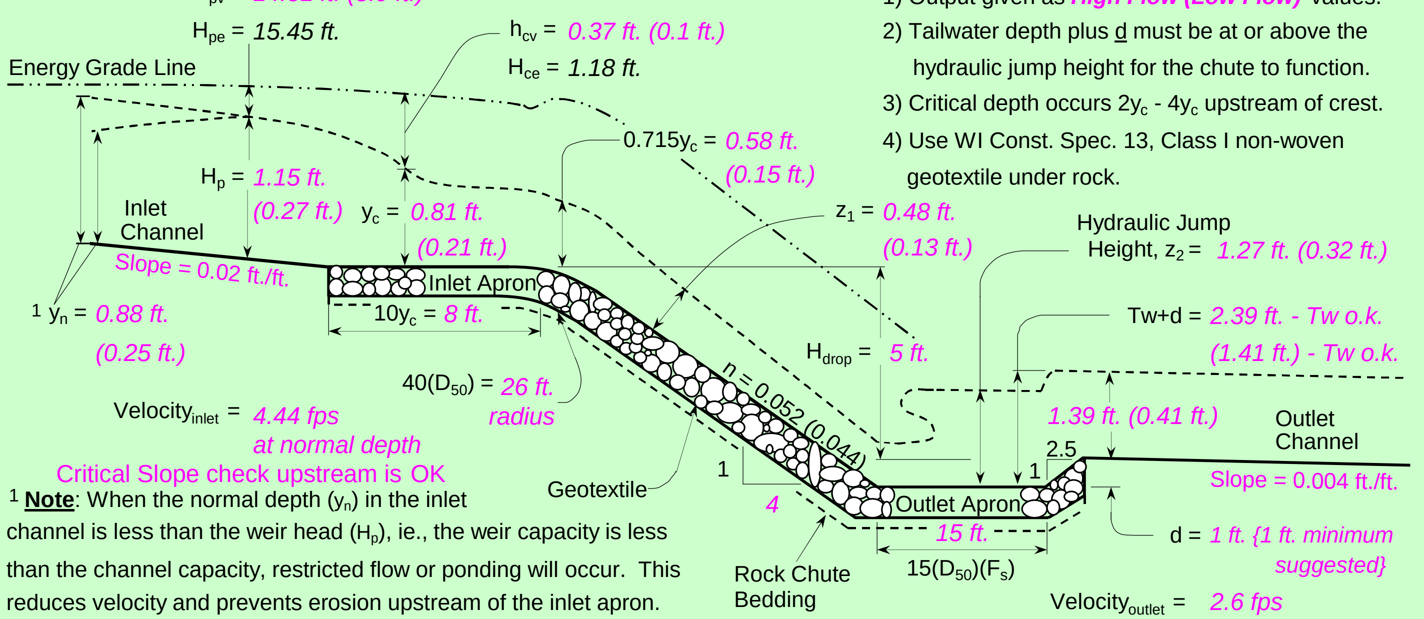
Q_{high} = Runoff from design storm capacity from Table 2, FOTG Standard 410
Q_5 = Runofff from a 5-year,24-hour storm.

Input tailwater (Tw): 0.25 1.60

Q_{high} = 107.0 cfs High flow storm through chute → Tw (ft.) = Program
Q_5 = 13.0 cfs Low flow storm through chute → Tw (ft.) = Program

Profile and Cross Section (Output):

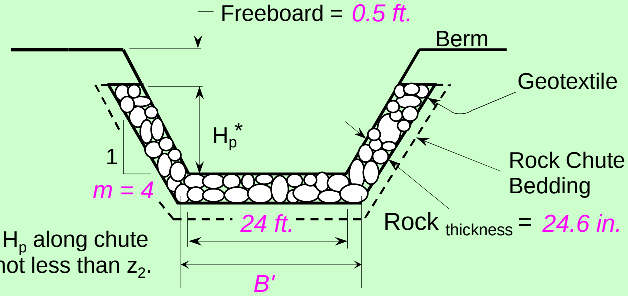
Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.
4) Use WI Const. Spec. 13, Class I non-woven geotextile under rock.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., 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.

	4.15 cfs/ft.	Equivalent unit discharge
F_S =	1.60	Factor of safety (multiplier)
z_1 =	0.48 ft.	Normal depth in chute
n-value =	0.052	Manning's roughness coefficient
$D_{50}(F_s)$ =	12.3 in.	Minimum Design D50*
$2(D_{50})(F_s)$ =	24.6 in.	Rock chute thickness
Tw + d =	2.39 ft.	Tailwater above outlet apron
z_2 =	1.27 ft.	Hydraulic jump height
****** The outlet***	***will***	***function adequately***

High Flow Storm Information

Rock Chute Design - Plan Sheet

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

Project: Winsome Filing 3 - Rock Chute 4 (Pond 1) **County:** El Paso
Designer: TOS **Checked by:**
Date: 12/21/2021 **Date:**

Minimum Design Values		***Enter Plan Values***	
12.3 in.	D_{50} dia. =	18.00	in.
24.6 in.	$Rock_{chute}$ thickness =	36.00	in.
8 ft.	Inlet apron length =	10.00	ft.
15 ft.	Outlet apron length =	15.00	ft.
26 ft.	Radius =	50	ft.

Will bedding be used? Yes ----------

Rock Gradation Envelope

% Passing		*Diameter, in. (weight, lbs.)*
D_{100}	---------	27 - 36 (1393 - 3302)
D_{85}	---------	23 - 32 (907 - 2407)
D_{50}	---------	18 - 27 (413 - 1393)
D_{10}	---------	14 - 23 (211 - 907)

Depth (in.) = 6.0

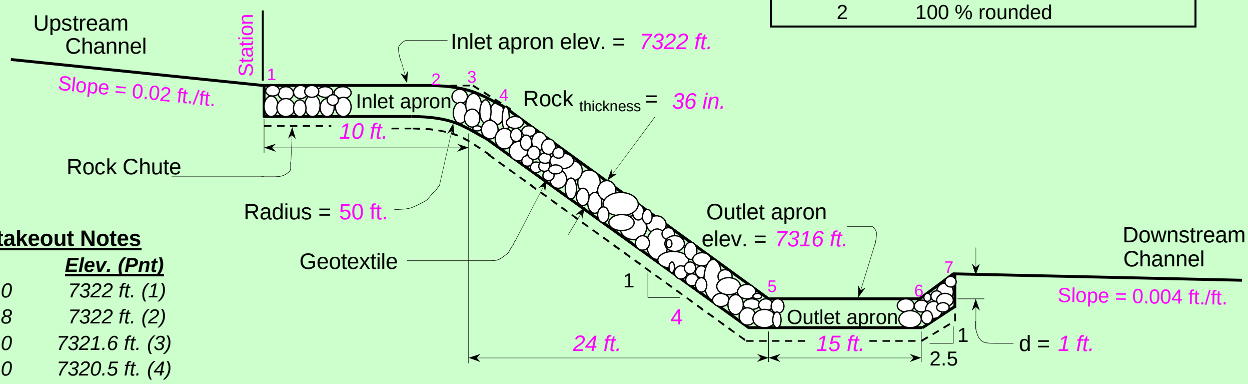
Quantities [a]

Rock =	275	yd^3
Geotextile (WCS-13)[b] =	349	yd^2
Bedding 6 in. =	61	yd^3
Excavation =	0	yd^3
Earthfill =	0	yd^3
Seeding =	0.0	acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from the x-section below (neglect radius).*
[b] *Geotextile Class I (non-woven) shall be overlapped and anchored (18-in. min. along sides and 24-in. min. on the ends).*

Degree of angularity = 1

1	50% angular, 50% rounded
2	100 % rounded



Profile Along Centerline of Rock Chute

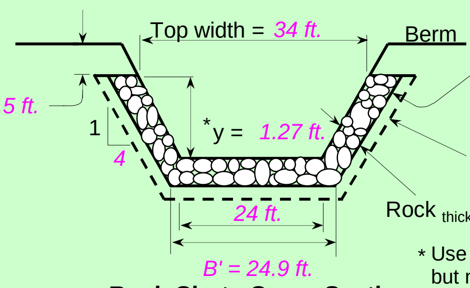
****Note**: *The outlet will function adequately***

Stakeout Notes

Sta.	*Elev. (Pnt)*
0+00.0	7322 ft. (1)
0+03.8	7322 ft. (2)
0+10.0	7321.6 ft. (3)
0+16.0	7320.5 ft. (4)
0+34.0	7316 ft. (5)
0+49.0	7316 ft. (6)
0+51.5	7317 ft. (7)

Class I non-woven

Rock gradation envelope can be met with Gradation printed



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Rock Chute Cost Estimate

Unit	*Unit Cost*	*Cost*
Rock	$10.00 /$yd^3$	$2,750.00
Geotextile	$12.00 /$yd^2$	$4,188.00
Bedding	$12.00 /$yd^3$	$732.00
Excavation	$12.00 /$yd^3$	$0.00
Earthfill	$1.00 /$yd^3$	$0.00
Seeding	$2.00 /ac.	$0.00
	Total	**$7,670.00**

Profile, Cross Sections, and Quantities

NRCS Natural Resources Conservation Service, United States Department of Agriculture

Winsome Filing 3 - Rock Chute 4 (Pond 1)
El Paso County

		Date
Designed	TOS	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet __ of __

Rock_Chute.xls
for construction plan

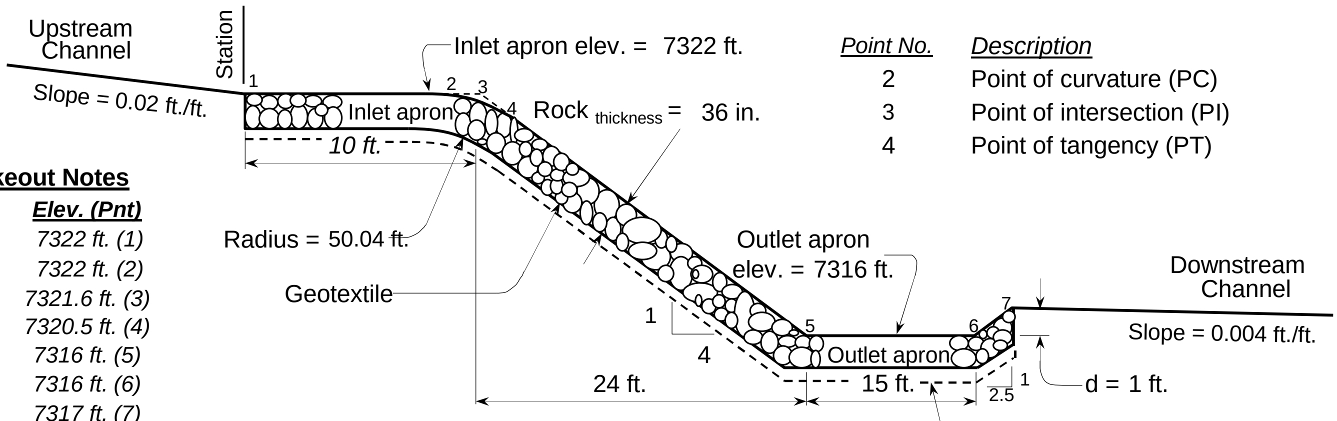
Rock Chute Design - Cut/Paste Plan

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

Project: Winsome Filing 3 - Rock Chute 4 (Pond 1) **County:** El Paso
Designer: TOS **Checked by:**
Date: 12/21/2021 **Date:**

Design Values	***Rock Gradation Envelope***		***Quantities*** [a]
D_{50} dia. = 18.0 in.	*% Passing*	*Diameter, in. (weight, lbs.)*	Rock = 275 yd^3
$Rock_{chute}$ thickness = 36.0 in.	D_{100} ---------	27 - 36 (1393 - 3302)	Geotextile (WCS-13)[b] = 349 yd^2
Inlet apron length = 10 ft.	D_{85} ---------	23 - 32 (907 - 2407)	Bedding 6 in. = 61 yd^3
Outlet apron length = 15 ft.	D_{50} ---------	18 - 27 (413 - 1393)	Excavation = 0 yd^3
Radius = 50 ft.	D_{10} ---------	14 - 23 (211 - 907)	Earthfill = 0 yd^3
Will bedding be used? Yes	*Coefficient of Uniformity, $(D_{60})/(D_{10}) < 1.7$*		Seeding = 0.0 acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*

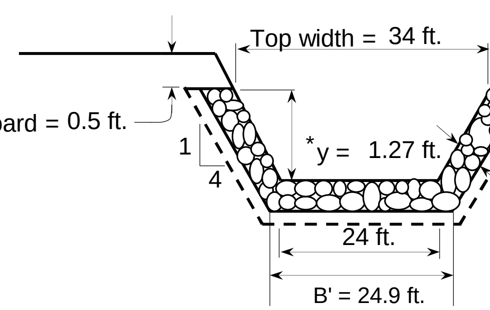


Point No.	*Description*
2	Point of curvature (PC)
3	Point of intersection (PI)
4	Point of tangency (PT)

Stakeout Notes

Sta.	***Elev. (Pnt)***
0+00.0	*7322 ft. (1)*
0+03.8	*7322 ft. (2)*
0+10.0	*7321.6 ft. (3)*
0+16.0	*7320.5 ft. (4)*
0+34.0	*7316 ft. (5)*
0+49.0	*7316 ft. (6)*
0+51.5	*7317 ft. (7)*

Profile Along Centerline of Rock Chute



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
Gradation printed

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Winsome Filing 3 - Rock Chute 4 (Pond 1)
El Paso County

		Date	
Designed	TOS		File Name
Drawn			Drawing Name
Checked			
Approved			Sheet __ of __

Rock Chute Design Data

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

Project: Winsome Filing 3- Rock Chute 6 (Pond 2) **County:** El Paso
Designer: TOS **Checked by:**
Date: Novemeber 8th, 2021 **Date:**

Input Geometry:

Upstream Channel		Chute		Downstream Channel	
Bw =	17.0 ft.	Bw =	17.0 ft.	Bw =	17.0 ft.
Side slopes =	4.0 (m:1)	Factor of safety =	1.60 (F_s) — 1.2 Min	Side slopes =	4.0 (m:1)
Velocity n-value =	0.040	Side slopes =	4.0 (m:1) → 2.0:1 max.	Velocity n-value =	0.040
Bed slope =	0.0200 ft./ft.	Bed slope (4:1) =	0.250 ft./ft → 3.0:1 max.	Bed slope =	0.0040 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 mannings n for channel

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

Apron elev. --- Inlet = 7309.0 ft. ------- Outlet 7301.0 ft. --- (H_{drop} = 7 ft.)

***Note**: 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

Q_5 = Runofff from a 5-year,24-hour storm.

***Input tailwater (Tw)**:* 0.25 1.60

Q_{high} = 110.0 cfs High flow storm through chute → Tw (ft.) = Program

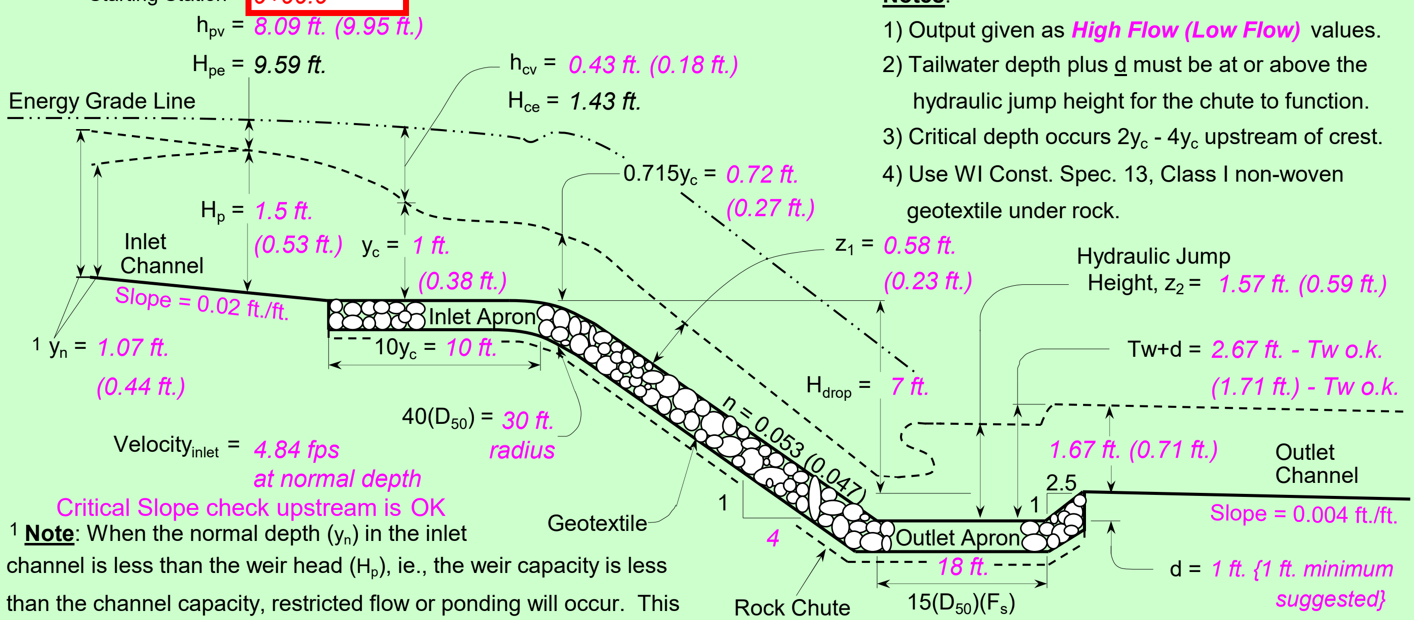
Q_5 = 24.0 cfs Low flow storm through chute → Tw (ft.) = Program

Profile and Cross Section (Output):

Starting Station = 0+00.0

Notes:

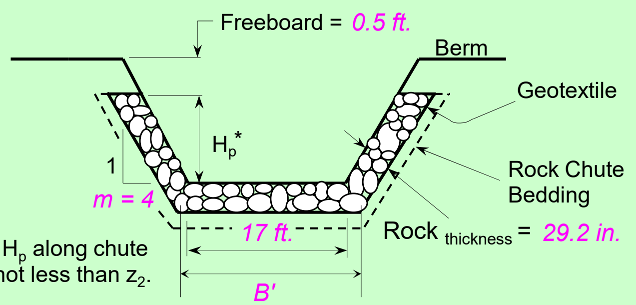
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.
4) Use WI Const. Spec. 13, Class I non-woven geotextile under rock.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., 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.

	5.71 cfs/ft.	Equivalent unit discharge
F_S =	1.60	Factor of safety (multiplier)
z_1 =	0.58 ft.	Normal depth in chute
n-value =	0.053	Manning's roughness coefficient
$D_{50}(F_s)$ =	14.6 in.	Minimum Design D50*
$2(D_{50})(F_s)$ =	29.2 in.	Rock chute thickness
Tw + d =	2.67 ft.	Tailwater above outlet apron
z_2 =	1.57 ft.	Hydraulic jump height
****** The outlet***	***will***	***function adequately***

High Flow Storm Information

Rock Chute Design - Plan Sheet

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

Project: Winsome Filing 3- Rock Chute 6 (Pond 2) **County:** El Paso
Designer: TOS **Checked by:**
Date: Novemeber 8t **Date:**

Minimum Design Values		Enter Plan Values	
14.6 in.	D_{50} dia. =	18.00	in.
29.2 in.	$Rock_{chute}$ thickness =	36.00	in.
10 ft.	Inlet apron length =	10.00	ft.
18 ft.	Outlet apron length =	18.00	ft.
30 ft.	Radius =	*50*	ft.

Will bedding be used? *Yes* ----------

Rock Gradation Envelope

% Passing		Diameter, in. (weight, lbs.)
D_{100}	---------	27 - 36 (1393 - 3302)
D_{85}	---------	23 - 32 (907 - 2407)
D_{50}	---------	18 - 27 (413 - 1393)
D_{10}	---------	14 - 23 (211 - 907)

Depth (in.) = *6.0*

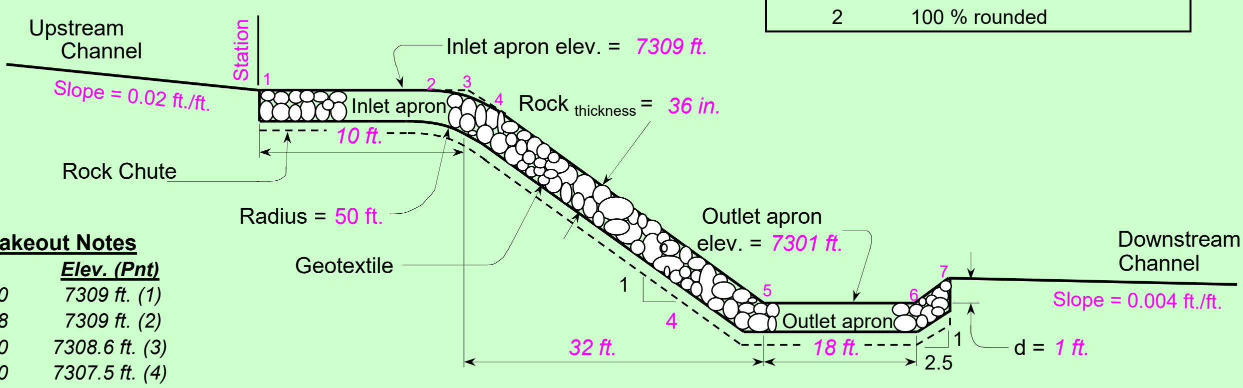
Quantities [a]

Rock =	302	yd^3
Geotextile (WCS-13)[b] =	392	yd^2
Bedding 6 in. =	68	yd^3
Excavation =	*0*	yd^3
Earthfill =	*0*	yd^3
Seeding =	*0.0*	acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from the x-section below (neglect radius).*
[b] *Geotextile Class I (non-woven) shall be overlapped and anchored (18-in. min. along sides and 24-in. min. on the ends).*

Degree of angularity = 1

1	50% angular, 50% rounded
2	100 % rounded



Profile Along Centerline of Rock Chute

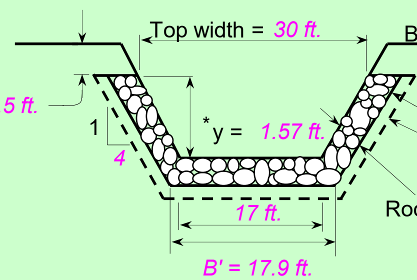
Note: *The outlet will function adequately*

Stakeout Notes

Sta.	Elev. (Pnt)
0+00.0	7309 ft. (1)
0+03.8	7309 ft. (2)
0+10.0	7308.6 ft. (3)
0+16.0	7307.5 ft. (4)
0+42.0	7301 ft. (5)
0+60.0	7301 ft. (6)
0+62.5	7302 ft. (7)

Class I non-woven

Rock gradation envelope can be met with Gradation printed



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Rock Chute Cost Estimate

Unit	Unit Cost	Cost
Rock	*$10.00* /$yd^3$	$3,020.00
Geotextile	*$12.00*/$yd^2$	$4,704.00
Bedding	*$12.00* /$yd^3$	$816.00
Excavation	*$12.00*/$yd^3$	$0.00
Earthfill	*$1.00* /$yd^3$	$0.00
Seeding	*$2.00* /ac.	$0.00
	Total	**$8,540.00**

Profile, Cross Sections, and Quantities

NRCS Natural Resources Conservation Service United States Department of Agriculture

Winsome Filing 3- Rock Chute 6 (Pond 2)
El Paso County

		Date
Designed	TOS	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet ___ of ___

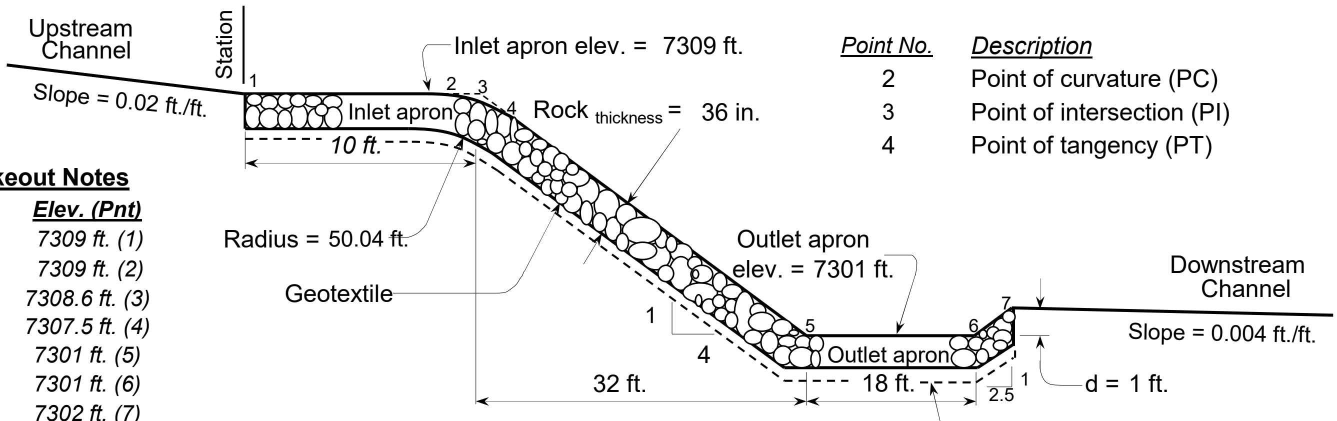
Rock Chute Design - Cut/Paste Plan

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

Project: Winsome Filing 3- Rock Chute 6 (Pond 2) **County:** El Paso
Designer: TOS **Checked by:**
Date: Novemeber 8t **Date:**

Design Values	***Rock Gradation Envelope***		***Quantities*** [a]
	% Passing	*Diameter, in. (weight, lbs.)*	
D_{50} dia. = 18.0 in.	D_{100} ---------	27 - 36 (1393 - 3302)	Rock = 302 yd^3
$Rock_{chute}$ thickness = 36.0 in.	D_{85} ---------	23 - 32 (907 - 2407)	Geotextile (WCS-13)[b] = 392 yd^2
Inlet apron length = 10 ft.	D_{50} ---------	18 - 27 (413 - 1393)	Bedding 6 in. = 68 yd^3
Outlet apron length = 18 ft.	D_{10} ---------	14 - 23 (211 - 907)	Excavation = 0 yd^3
Radius = 50 ft.	*Coefficient of Uniformity, $(D_{60})/(D_{10}) < 1.7$*		Earthfill = 0 yd^3
Will bedding be used? Yes			Seeding = 0.0 acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*

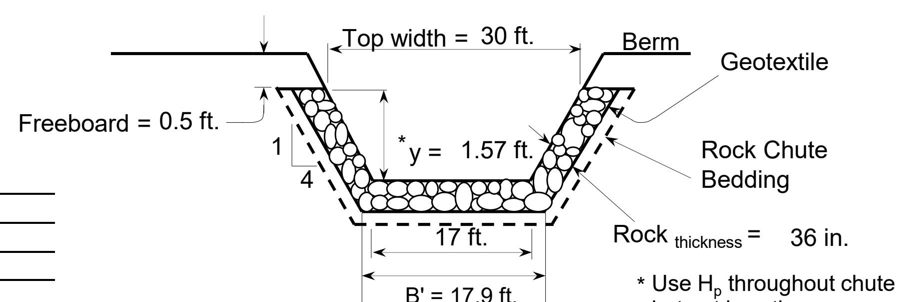


Point No.	*Description*
2	Point of curvature (PC)
3	Point of intersection (PI)
4	Point of tangency (PT)

Stakeout Notes

Sta.	***Elev. (Pnt)***
0+00.0	*7309 ft. (1)*
0+03.8	*7309 ft. (2)*
0+10.0	*7308.6 ft. (3)*
0+16.0	*7307.5 ft. (4)*
0+42.0	*7301 ft. (5)*
0+60.0	*7301 ft. (6)*
0+62.5	*7302 ft. (7)*

Profile Along Centerline of Rock Chute



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
Gradation printed

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Winsome Filing 3- Rock Chute 6 (Pond 2)
El Paso County

		Date
Designed	TOS	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet __ of __

Rock Chute Design Data

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

Project: Winsome Filing 3 Rock Chute 11 (Pond 4) **County:** El Paso
Designer: TOS **Checked by:**
Date: December 21, 2021 **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 = 1.60 (F_s) → **1.2 Min**	Side slopes = 4.0 (m:1)
Velocity n-value = 0.040	Side slopes = 4.0 (m:1) → **2.0:1 max.**	Velocity n-value = 0.040
Bed slope = 0.0200 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → **3.0:1 max.**	Bed slope = 0.0040 ft./ft.
Note: n value = a) velocity n from waterway program	Freeboard = 0.5 ft.	
or b) computed mannings n for channel	Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

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

Apron elev. --- Inlet = 7302.0 ft. ------- Outlet 7292.0 ft. --- (H_{drop} = 9 ft.)

Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.

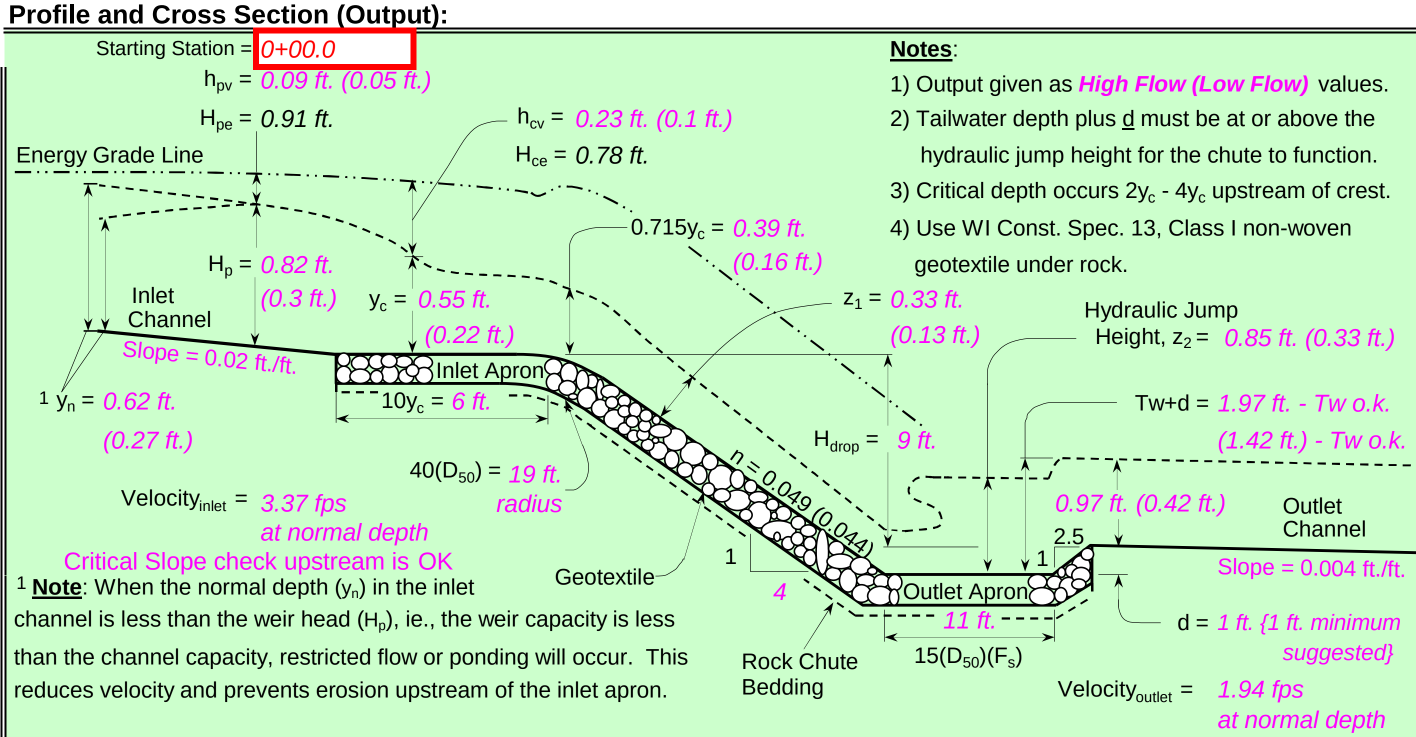
Q_{high} = Runoff from design storm capacity from Table 2, FOTG Standard 410
Q_5 = Runofff from a 5-year,24-hour storm.

***Input tailwater (Tw)*:** 0.25 1.60

Q_{high} = 26.0 cfs High flow storm through chute → Tw (ft.) = Program
Q_5 = 6.0 cfs Low flow storm through chute → Tw (ft.) = Program

Profile and Cross Section (Output):

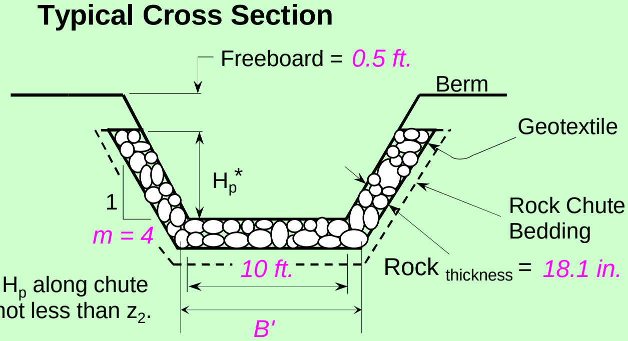
Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.
4) Use WI Const. Spec. 13, Class I non-woven geotextile under rock.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., 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.

	2.32 cfs/ft.	Equivalent unit discharge
F_S =	1.60	Factor of safety (multiplier)
z_1 =	0.33 ft.	Normal depth in chute
n-value =	0.049	Manning's roughness coefficient
$D_{50}(F_s)$ =	9 in.	Minimum Design D50*
$2(D_{50})(F_s)$ =	18.1 in.	Rock chute thickness
Tw + d =	1.97 ft.	Tailwater above outlet apron
z_2 =	0.85 ft.	Hydraulic jump height
****** The outlet***	***will***	***function adequately***

High Flow Storm Information

Rock Chute Design - Plan Sheet

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

Project: Winsome Filing 3 Rock Chute 11 (Pond 4) **County:** El Paso
Designer: TOS **Checked by:**
Date: 12/21/2021 **Date:**

Minimum Design Values		*Enter Plan Values*
9.0 in.	D_{50} dia. =	9.00 in.
18.1 in.	$Rock_{chute}$ thickness =	18.00 in.
6 ft.	Inlet apron length =	10.00 ft.
11 ft.	Outlet apron length =	11.00 ft.
19 ft.	Radius =	25 ft.

Will bedding be used? Yes ----------

Rock Gradation Envelope

% Passing		*Diameter, in. (weight, lbs.)*
D_{100}	---------	14 - 18 (174 - 413)
D_{85}	---------	12 - 16 (113 - 301)
D_{50}	---------	9 - 14 (52 - 174)
D_{10}	---------	7 - 12 (26 - 113)

Depth (in.) = 6.0

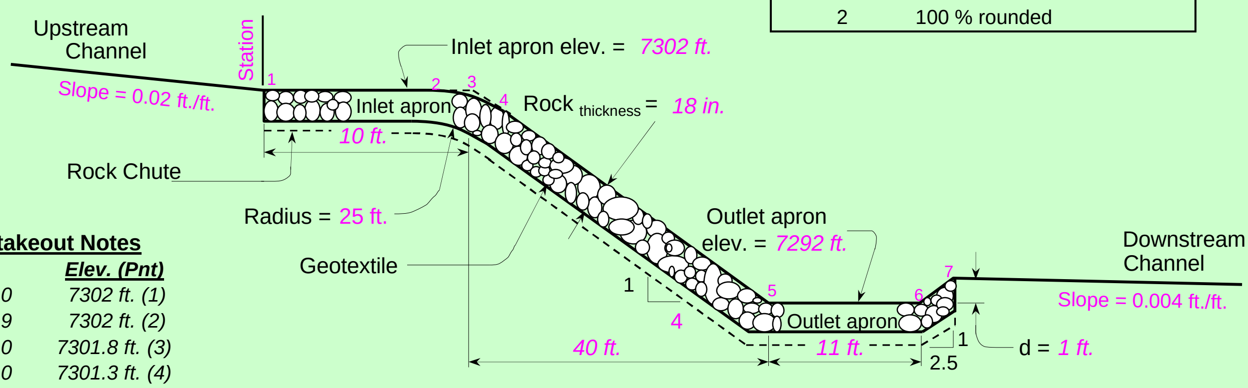
Quantities [a]

Rock =	85	yd^3
Geotextile (WCS-13)[b] =	215	yd^2
Bedding 6 in. =	39	yd^3
Excavation =	0	yd^3
Earthfill =	0	yd^3
Seeding =	0.0	acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from the x-section below (neglect radius).*
[b] *Geotextile Class I (non-woven) shall be overlapped and anchored (18-in. min. along sides and 24-in. min. on the ends).*

Degree of angularity = 1

1	50% angular, 50% rounded
2	100 % rounded



Profile Along Centerline of Rock Chute

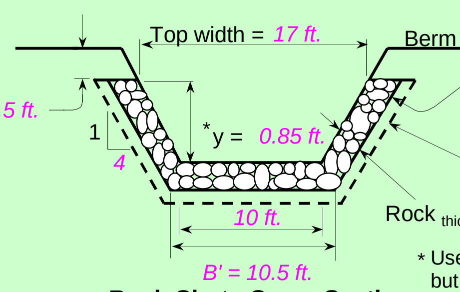
**** *Note*:** ***The outlet will function adequately***

Stakeout Notes

Sta.	*Elev. (Pnt)*
0+00.0	7302 ft. (1)
0+06.9	7302 ft. (2)
0+10.0	7301.8 ft. (3)
0+13.0	7301.3 ft. (4)
0+50.0	7292 ft. (5)
0+61.0	7292 ft. (6)
0+63.5	7293 ft. (7)

Class I non-woven

Rock gradation envelope can be met with DOT Heavy riprap Gradation



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Rock Chute Cost Estimate

Unit	Unit Cost	Cost
Rock	$10.00 /$yd^3$	$850.00
Geotextile	$12.00 /$yd^2$	$2,580.00
Bedding	$12.00 /$yd^3$	$468.00
Excavation	$12.00 /$yd^3$	$0.00
Earthfill	$1.00 /$yd^3$	$0.00
Seeding	$2.00 /ac.	$0.00
	Total	**$3,898.00**

Profile, Cross Sections, and Quantities

NRCS Natural Resources Conservation Service United States Department of Agriculture

Winsome Filing 3 Rock Chute 11 (Pond 4)

El Paso County

		Date
Designed	TOS	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet __ of __

Rock Chute Design - Cut/Paste Plan

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

Project: Winsome Filing 3 Rock Chute 11 (Pond 4) **County:** El Paso
Designer: TOS **Checked by:**
Date: 12/21/2021 **Date:**

Design Values

D_{50} dia. = 9.0 in.
$Rock_{chute}$ thickness = 18.0 in.
Inlet apron length = 10 ft.
Outlet apron length = 11 ft.
Radius = 25 ft.
Will bedding be used? Yes

Rock Gradation Envelope

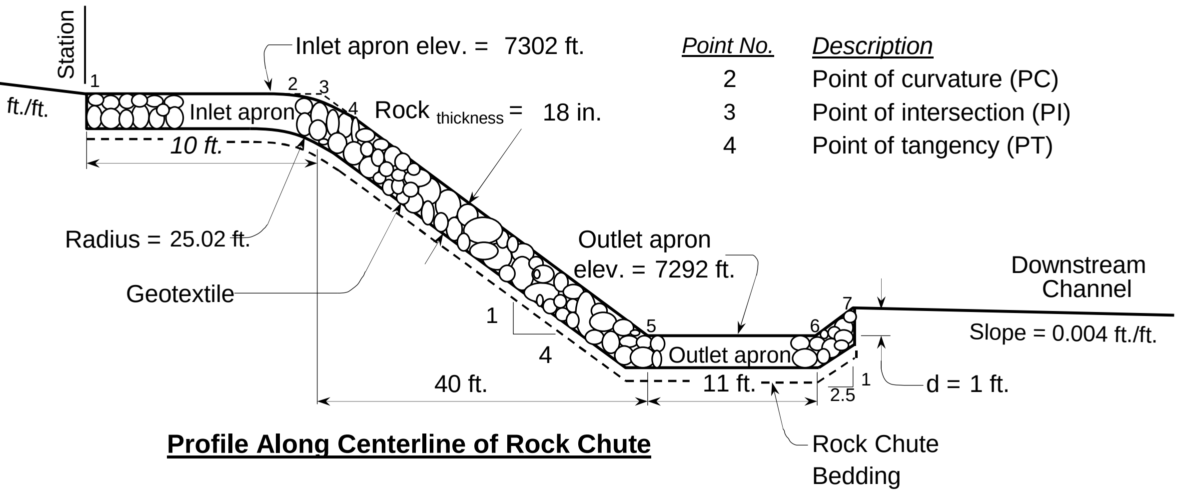
% Passing		*Diameter, in. (weight, lbs.)*
D_{100}	---------	14 - 18 (174 - 413)
D_{85}	---------	12 - 16 (113 - 301)
D_{50}	---------	9 - 14 (52 - 174)
D_{10}	---------	7 - 12 (26 - 113)

Coefficient of Uniformity, $(D_{60})/(D_{10}) < 1.7$

Quantities [a]

Rock = 85 yd^3
Geotextile (WCS-13)[b] = 215 yd^2
Bedding 6 in. = 39 yd^3
Excavation = 0 yd^3
Earthfill = 0 yd^3
Seeding = 0.0 acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*

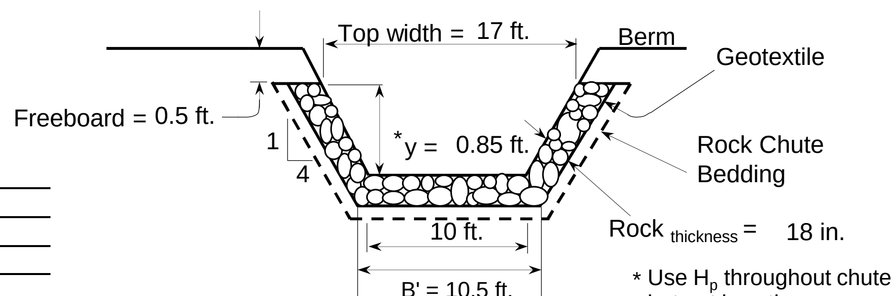


Point No.	*Description*
2	Point of curvature (PC)
3	Point of intersection (PI)
4	Point of tangency (PT)

Stakeout Notes

Sta.	***Elev. (Pnt)***
0+00.0	*7302 ft. (1)*
0+06.9	*7302 ft. (2)*
0+10.0	*7301.8 ft. (3)*
0+13.0	*7301.3 ft. (4)*
0+50.0	*7292 ft. (5)*
0+61.0	*7292 ft. (6)*
0+63.5	*7293 ft. (7)*

Profile Along Centerline of Rock Chute



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
DOT Heavy riprap Gradation

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Winsome Filing 3 Rock Chute 11 (Pond 4)

El Paso County

		Date
Designed	TOS	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet __ of __

Rock Chute Design Data

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

Project: *Winsome Filing 3- Rock Chute #12* **County:** *El Paso*
Designer: *TOS* **Checked by:**
Date: *December 15, 2021* **Date:**

Input Geometry:

Upstream Channel	Chute		Downstream Channel
Bw = *12.0* ft.	Bw = *12.0* ft.		Bw = *12.0* ft.
Side slopes = *4.0* (m:1)	Factor of safety = *1.60* (F_s)	***1.2 Min***	Side slopes = *4.0* (m:1)
Velocity n-value = *0.040*	Side slopes = *4.0* (m:1)	→ ***2.0:1 max.***	Velocity n-value = *0.040*
Bed slope = *0.0200* ft./ft.	Bed slope (4:1) = *0.250* ft./ft	→ ***3.0:1 max.***	Bed slope = *0.0040* ft./ft.
Note: n value = a) velocity n from waterway program	Freeboard = *0.5* ft.		
or b) computed mannings n for channel	Outlet apron depth, d = *1.0* ft.		Base flow = *0.0* cfs

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

Apron elev. --- Inlet = *7330.0* ft. ------- Outlet *7325.0* ft. --- (H_{drop} = 4 ft.)

Q_{high} = *Runoff from design storm capacity from Table 2, FOTG Standard 410*
Q_5 = *Runofff from a 5-year,24-hour storm.*

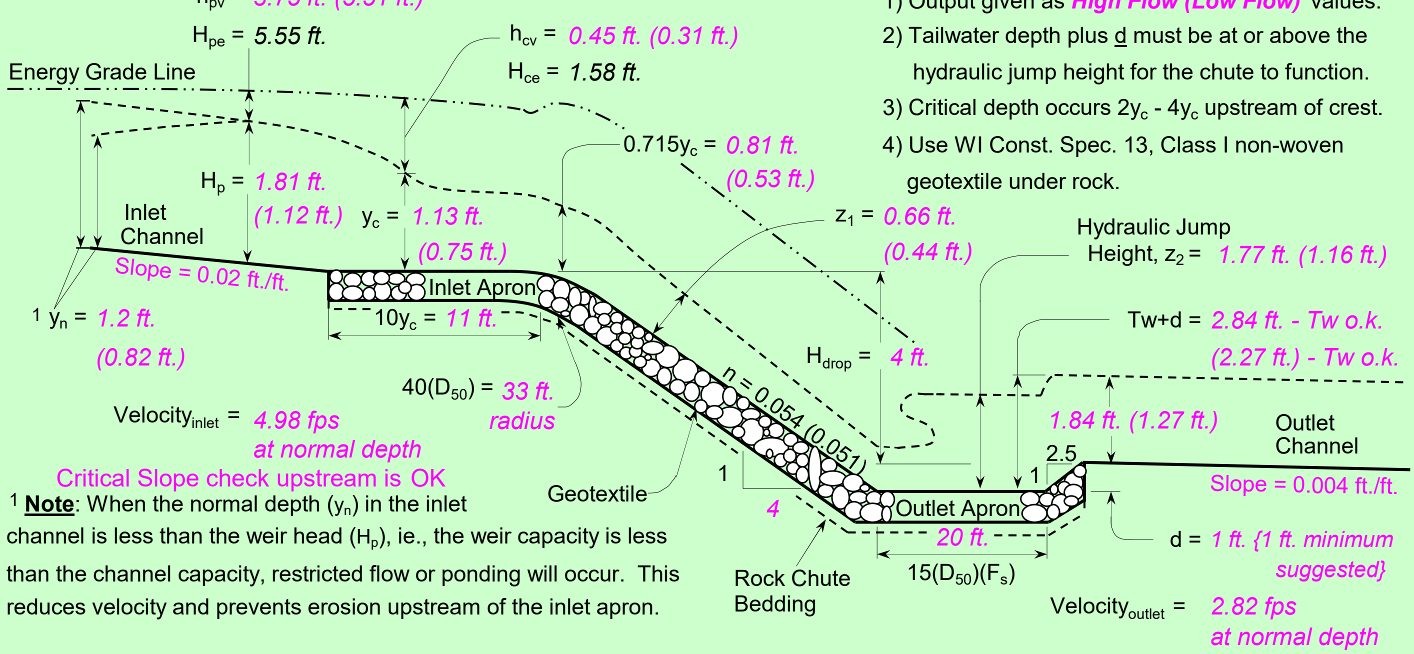
Note*: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*
Input tailwater (Tw)*:* 0.25 1.60

Q_{high} = *100.0* cfs High flow storm through chute → Tw (ft.) = *Program*
Q_5 = *50.0* cfs Low flow storm through chute → Tw (ft.) = *Program*

Profile and Cross Section (Output):

Starting Station = *0+00.0*

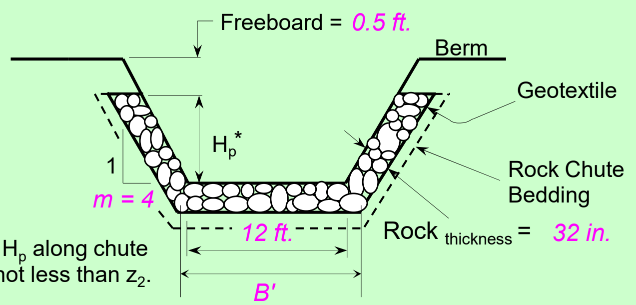
Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.
4) Use WI Const. Spec. 13, Class I non-woven geotextile under rock.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., 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.

	6.83 cfs/ft.	Equivalent unit discharge
F_S =	*1.60*	Factor of safety (multiplier)
z_1 =	*0.66 ft.*	Normal depth in chute
n-value =	*0.054*	Manning's roughness coefficient
$D_{50}(F_s)$ =	*16 in.*	Minimum Design D50*
$2(D_{50})(F_s)$ =	*32 in.*	Rock chute thickness
Tw + d =	*2.84 ft.*	Tailwater above outlet apron
z_2 =	*1.77 ft.*	Hydraulic jump height
****** The outlet***	***will***	***function adequately***

High Flow Storm Information

Rock Chute Design - Plan Sheet

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

Project: Winsome Filing 3- Rock Chute #12 **County:** El Paso
Designer: TOS **Checked by:**
Date: 12/15/2021 **Date:**

Minimum Design Values		Enter Plan Values
16.0 in.	D_{50} dia. =	18.00 in.
32.0 in.	$Rock_{chute}$ thickness =	36.00 in.
11 ft.	Inlet apron length =	11.00 ft.
20 ft.	Outlet apron length =	20.00 ft.
33 ft.	Radius =	50 ft.

Will bedding be used? Yes ---------- Depth (in.) = 6.0

Rock Gradation Envelope

% Passing		Diameter, in. (weight, lbs.)
D_{100}	---------	27 - 36 (1393 - 3302)
D_{85}	---------	23 - 32 (907 - 2407)
D_{50}	---------	18 - 27 (413 - 1393)
D_{10}	---------	14 - 23 (211 - 907)

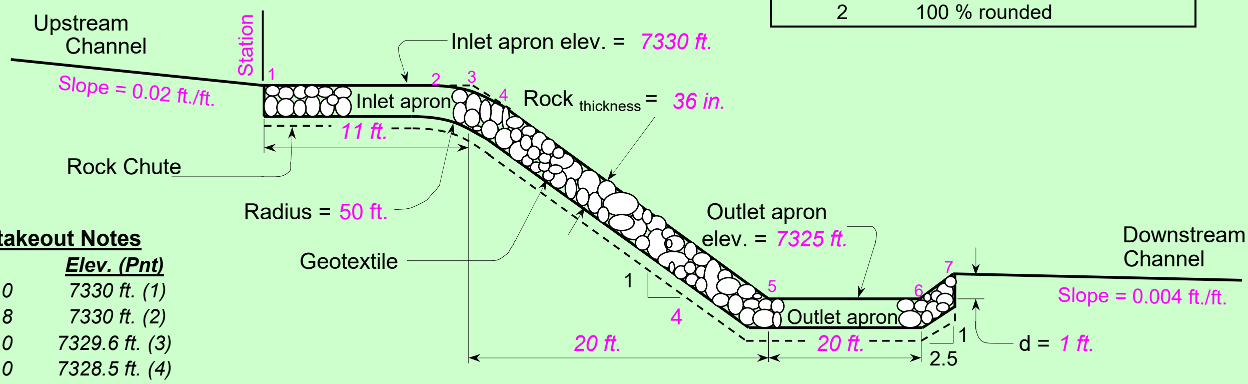
Quantities [a]

Rock =	240	yd^3
Geotextile (WCS-13)[b] =	316	yd^2
Bedding 6 in. =	55	yd^3
Excavation =	0	yd^3
Earthfill =	0	yd^3
Seeding =	0.0	acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from the x-section below (neglect radius).*
[b] *Geotextile Class I (non-woven) shall be overlapped and anchored (18-in. min. along sides and 24-in. min. on the ends).*

Degree of angularity = 1

1	50% angular, 50% rounded
2	100 % rounded



Profile Along Centerline of Rock Chute

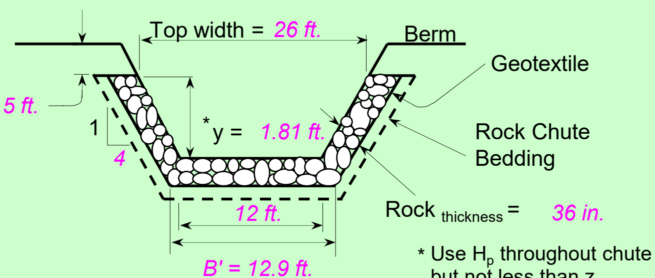
Stakeout Notes

Sta.	Elev. (Pnt)
0+00.0	7330 ft. (1)
0+04.8	7330 ft. (2)
0+11.0	7329.6 ft. (3)
0+17.0	7328.5 ft. (4)
0+31.0	7325 ft. (5)
0+51.0	7325 ft. (6)
0+53.5	7326 ft. (7)

****Note**: *The outlet will function adequately***

Class I non-woven

Rock gradation envelope can be met with Gradation printed



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Rock Chute Cost Estimate

Unit	Unit Cost	Cost
Rock	$10.00 /$yd^3$	$2,400.00
Geotextile	$12.00/$yd^2$	$3,792.00
Bedding	$12.00 /$yd^3$	$660.00
Excavation	$12.00/$yd^3$	$0.00
Earthfill	$1.00 /$yd^3$	$0.00
Seeding	$2.00 /ac.	$0.00
	Total	**$6,852.00**

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Winsome Filing 3- Rock Chute #12
El Paso County

		Date
Designed	TOS	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet ___ of ___

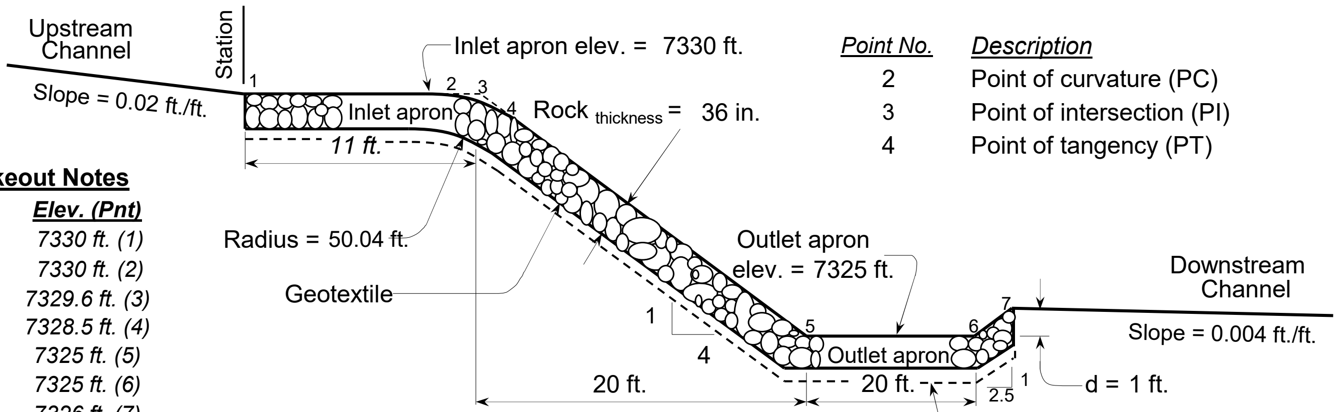
Rock Chute Design - Cut/Paste Plan

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

Project: Winsome Filing 3- Rock Chute #12 **County:** El Paso
Designer: TOS **Checked by:**
Date: 12/15/2021 **Date:**

Design Values	***Rock Gradation Envelope***		***Quantities*** [a]
	% Passing	*Diameter, in. (weight, lbs.)*	
D_{50} dia. = 18.0 in.	D_{100} ---------	27 - 36 (1393 - 3302)	Rock = 240 yd^3
$Rock_{chute}$ thickness = 36.0 in.	D_{85} ---------	23 - 32 (907 - 2407)	Geotextile (WCS-13)[b] = 316 yd^2
Inlet apron length = 11 ft.	D_{50} ---------	18 - 27 (413 - 1393)	Bedding 6 in. = 55 yd^3
Outlet apron length = 20 ft.	D_{10} ---------	14 - 23 (211 - 907)	Excavation = 0 yd^3
Radius = 50 ft.			Earthfill = 0 yd^3
Will bedding be used? Yes	*Coefficient of Uniformity, $(D_{60})/(D_{10}) < 1.7$*		Seeding = 0.0 acres

***Notes*:** [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*

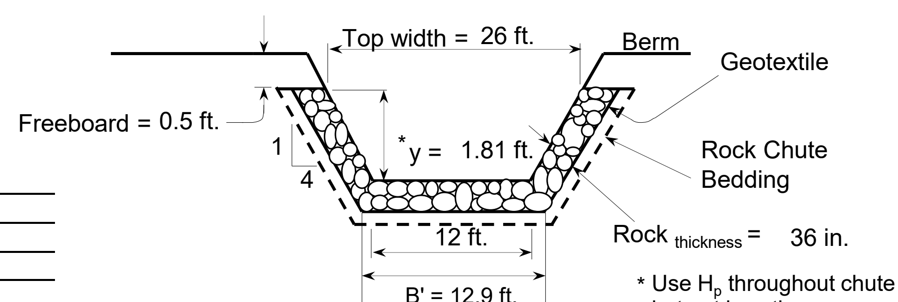


Point No.	*Description*
2	Point of curvature (PC)
3	Point of intersection (PI)
4	Point of tangency (PT)

Stakeout Notes

Sta.	*Elev. (Pnt)*
0+00.0	*7330 ft. (1)*
0+04.8	*7330 ft. (2)*
0+11.0	*7329.6 ft. (3)*
0+17.0	*7328.5 ft. (4)*
0+31.0	*7325 ft. (5)*
0+51.0	*7325 ft. (6)*
0+53.5	*7326 ft. (7)*

Profile Along Centerline of Rock Chute



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
Gradation printed

Profile, Cross Sections, and Quantities

NRCS Natural Resources Conservation Service United States Department of Agriculture	Winsome Filing 3- Rock Chute #12 El Paso County		Date	File Name
		Designed TOS		Drawing Name
		Drawn		
		Checked		Sheet __ of __
		Approved		

Rock Chute Design Data

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

Project: Winsome Filing 3- Rock Chute #13 **County:** El Paso
Designer: TOS **Checked by:**
Date: December 15, 2021 **Date:**

Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 6.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.60 (F_s) — 1.2 Min	Side slopes = 4.0 (m:1)
Velocity n-value = 0.040	Side slopes = 4.0 (m:1) → 2.0:1 max.	Velocity n-value = 0.040
Bed slope = 0.0200 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → 3.0:1 max.	Bed slope = 0.0040 ft./ft.
Note: n value = a) velocity n from waterway program	Freeboard = 0.5 ft.	
or b) computed mannings n for channel	Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

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

Apron elev. --- Inlet = 7328.0 ft. ------- Outlet 7325.0 ft. --- (H_{drop} = 2 ft.)

Q_{high} = Runoff from design storm capacity from Table 2, FOTG Standard 410

Q_5 = Runofff from a 5-year,24-hour storm.

Q_{high} = 57.0 cfs High flow storm through chute → Tw (ft.) = Program

Q_5 = 25.0 cfs Low flow storm through chute → Tw (ft.) = Program

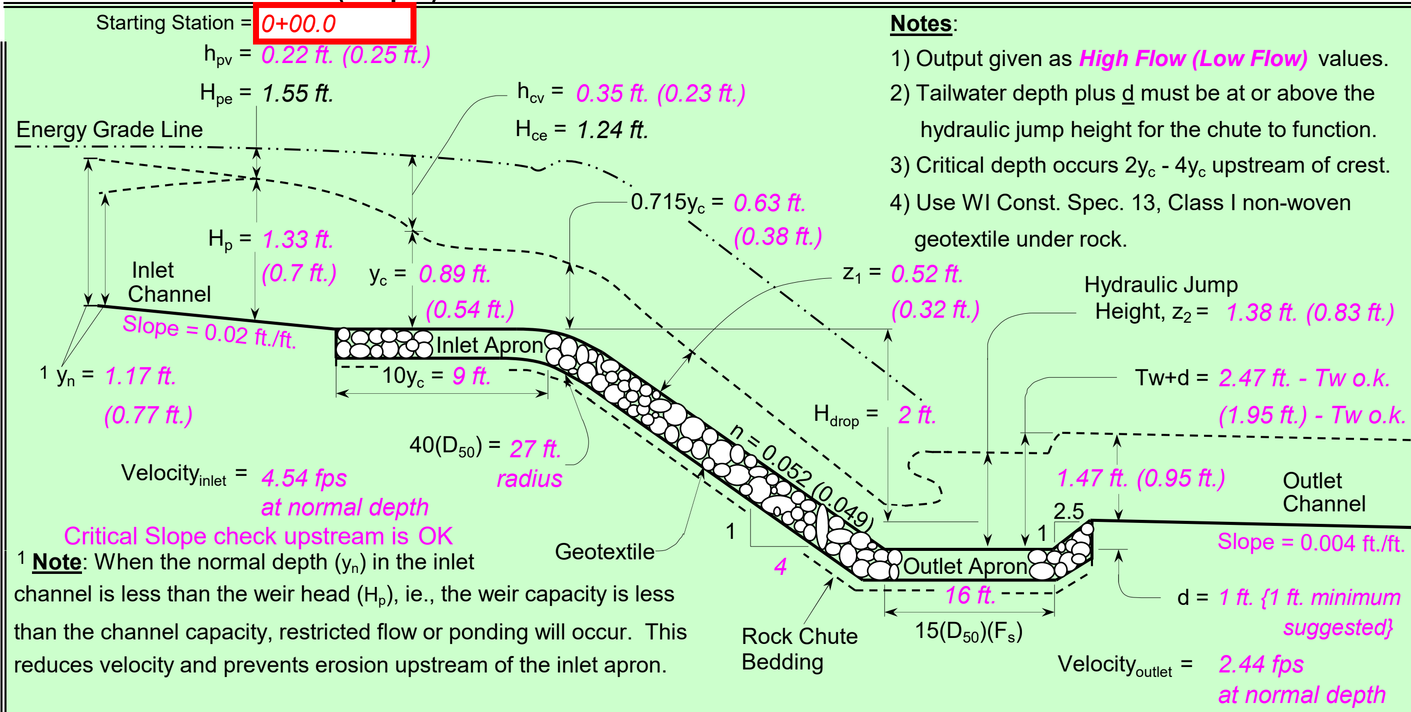
***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*

***Input tailwater (Tw)**:* 0.25 1.60

Profile and Cross Section (Output):

Notes:

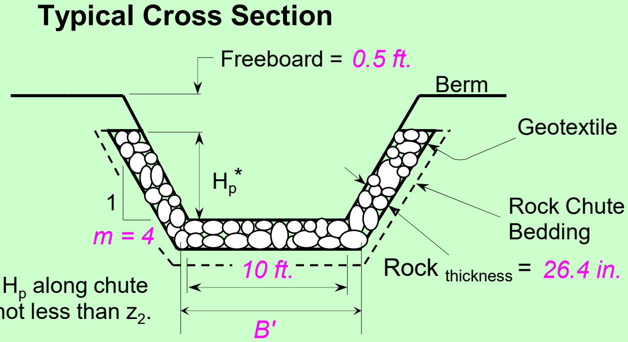
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.
4) Use WI Const. Spec. 13, Class I non-woven geotextile under rock.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., 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.

	4.73 cfs/ft.	Equivalent unit discharge
F_S =	1.60	Factor of safety (multiplier)
z_1 =	0.52 ft.	Normal depth in chute
n-value =	0.052	Manning's roughness coefficient
$D_{50}(F_s)$ =	13.2 in.	Minimum Design D50*
$2(D_{50})(F_s)$ =	26.4 in.	Rock chute thickness
Tw + d =	2.47 ft.	Tailwater above outlet apron
z_2 =	1.38 ft.	Hydraulic jump height
***** The outlet**	**will**	***function adequately***

High Flow Storm Information

Rock Chute Design - Plan Sheet

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

Project: Winsome Filing 3- Rock Chute #13 **County:** El Paso
Designer: TOS **Checked by:**
Date: 12/15/2021 **Date:**

Minimum Design Values		***Enter Plan Values***
13.2 in.	D_{50} dia. =	18.00 in.
26.4 in.	$Rock_{chute}$ thickness =	36.00 in.
9 ft.	Inlet apron length =	10.00 ft.
16 ft.	Outlet apron length =	16.00 ft.
27 ft.	Radius =	50 ft.

Will bedding be used? Yes ---------- Depth (in.) = 6.0

Rock Gradation Envelope

% Passing		*Diameter, in. (weight, lbs.)*
D_{100}	---------	27 - 36 (1393 - 3302)
D_{85}	---------	23 - 32 (907 - 2407)
D_{50}	---------	18 - 27 (413 - 1393)
D_{10}	---------	14 - 23 (211 - 907)

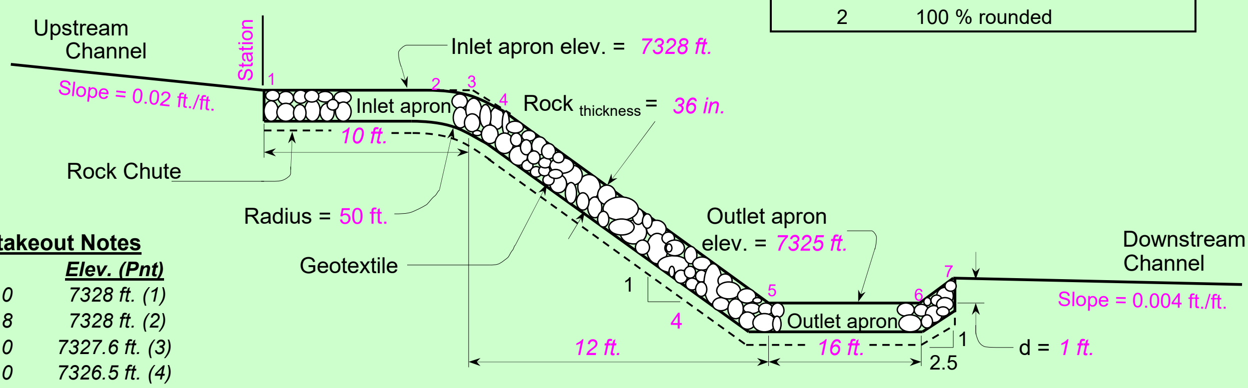
Quantities[a]

Rock =	156	yd^3
Geotextile (WCS-13)[b] =	214	yd^2
Bedding 6 in. =	38	yd^3
Excavation =	0	yd^3
Earthfill =	0	yd^3
Seeding =	0.0	acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from the x-section below (neglect radius).*
[b] *Geotextile Class I (non-woven) shall be overlapped and anchored (18-in. min. along sides and 24-in. min. on the ends).*

Degree of angularity = 1

1	50% angular, 50% rounded
2	100 % rounded



Profile Along Centerline of Rock Chute

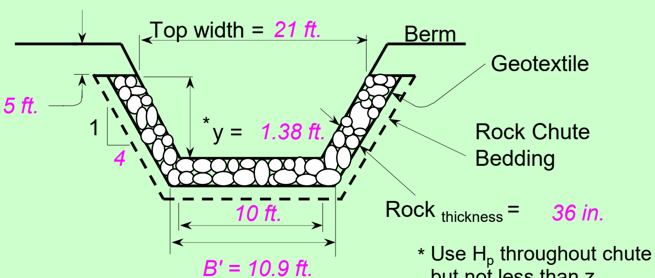
Stakeout Notes

Sta.	*Elev. (Pnt)*
0+00.0	7328 ft. (1)
0+03.8	7328 ft. (2)
0+10.0	7327.6 ft. (3)
0+16.0	7326.5 ft. (4)
0+22.0	7325 ft. (5)
0+38.0	7325 ft. (6)
0+40.5	7326 ft. (7)

Note: The outlet will function adequately

Class I non-woven

Rock gradation envelope can be met with Gradation printed



* Use H_p throughout chute but not less than z_2.

Rock Chute Cross Section

Rock Chute Cost Estimate

Unit	Unit Cost	Cost
Rock	$10.00 /$yd^3$	$1,560.00
Geotextile	$12.00/$yd^2$	$2,568.00
Bedding	$12.00 /$yd^3$	$456.00
Excavation	$12.00/$yd^3$	$0.00
Earthfill	$1.00 /$yd^3$	$0.00
Seeding	$2.00 /ac.	$0.00
Total		**$4,584.00**

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Winsome Filing 3- Rock Chute #13
El Paso County

		Date
Designed	TOS	
Drawn		
Checked		
Approved		

File Name
Drawing Name
Sheet ___ of ___

Rock_Chute.xls
for construction plan

Rock Chute Design - Cut/Paste Plan

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

Project: Winsome Filing 3- Rock Chute #13 **County:** El Paso
Designer: TOS **Checked by:**
Date: 12/15/2021 **Date:**

Design Values

D_{50} dia. = 18.0 in.
$Rock_{chute}$ thickness = 36.0 in.
Inlet apron length = 10 ft.
Outlet apron length = 16 ft.
Radius = 50 ft.
Will bedding be used? Yes

Rock Gradation Envelope

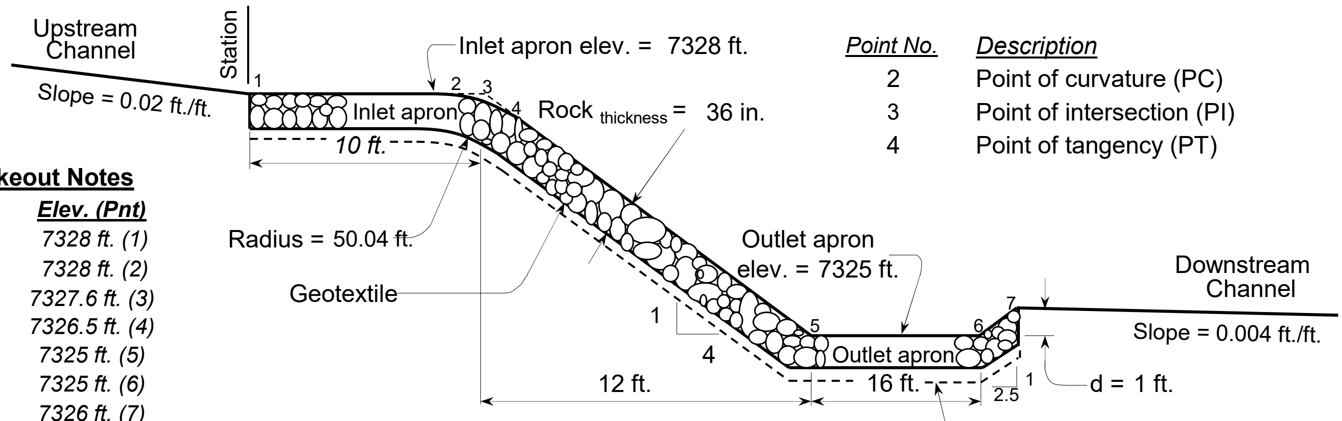
% Passing	*Diameter, in. (weight, lbs.)*
D_{100} ---------	27 - 36 (1393 - 3302)
D_{85} ---------	23 - 32 (907 - 2407)
D_{50} ---------	18 - 27 (413 - 1393)
D_{10} ---------	14 - 23 (211 - 907)

Coefficient of Uniformity, $(D_{60})/(D_{10})$ < 1.7

Quantities [a]

Rock = 156 yd^3
Geotextile (WCS-13)[b] = 214 yd^2
Bedding 6 in. = 38 yd^3
Excavation = 0 yd^3
Earthfill = 0 yd^3
Seeding = 0.0 acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from x-section below (neglect radius).*
[b] *Geotextile Class I (Non-woven) shall be overlapped and anchored (18-in. minimum along sides and 24-in. minimum on the ends) --- quantity not included.*

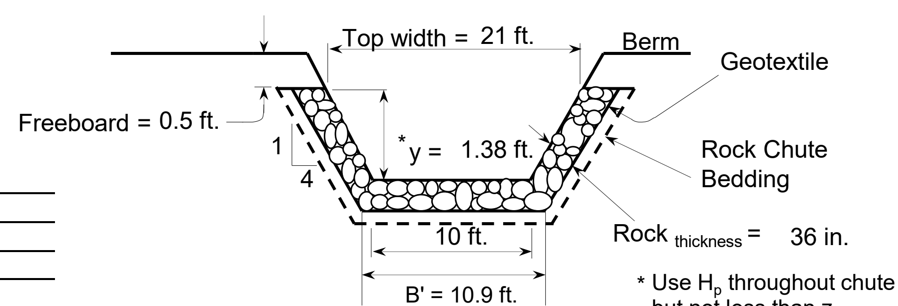


Point No.	*Description*
2	Point of curvature (PC)
3	Point of intersection (PI)
4	Point of tangency (PT)

Stakeout Notes

Sta.	Elev. (Pnt)
0+00.0	*7328 ft. (1)*
0+03.8	*7328 ft. (2)*
0+10.0	*7327.6 ft. (3)*
0+16.0	*7326.5 ft. (4)*
0+22.0	*7325 ft. (5)*
0+38.0	*7325 ft. (6)*
0+40.5	*7326 ft. (7)*

Profile Along Centerline of Rock Chute



Rock Chute Cross Section

Notes:
Rock gradation envelope can be met with
Gradation printed

Profile, Cross Sections, and Quantities

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Winsome Filing 3- Rock Chute #13

El Paso County

		Date
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Drawn		
Checked		
Approved		

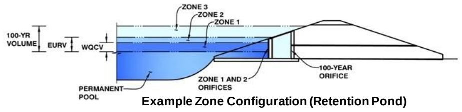
File Name
Drawing Name
Sheet __ of __

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 1 (BASIN H1+H4)_Modified Area



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB			
Watershed Area =	60.00	acres		
Watershed Length =	2,399	ft		
Watershed Length to Centroid =	960	ft		
Watershed Slope =	0.050	ft/ft		
Watershed Imperviousness =	7.20%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	6.9%	percent		
Percentage Hydrologic Soil Groups C/D =	93.1%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.172	acre-feet	0.172	acre-feet
Excess Urban Runoff Volume (EURV) =	0.241	acre-feet	0.241	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.063	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.245	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.366	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	4.924	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	6.155	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	7.866	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	11.014	acre-feet		inches
Approximate 2-yr Detention Volume =	0.276	acre-feet		
Approximate 5-yr Detention Volume =	0.741	acre-feet		
Approximate 10-yr Detention Volume =	1.072	acre-feet		
Approximate 25-yr Detention Volume =	1.301	acre-feet		
Approximate 50-yr Detention Volume =	1.333	acre-feet		
Approximate 100-yr Detention Volume =	1.903	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.172	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.069	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.662	acre-feet
Total Detention Basin Volume =	1.903	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	49	0.001		
7317	--	1.00	--	--	--	2,950	0.068	1,499	0.034
7318	--	2.00	--	--	--	8,352	0.192	7,150	0.164
7319	--	3.00	--	--	--	13,337	0.306	17,995	0.413
7320	--	4.00	--	--	--	16,699	0.383	33,013	0.758
7321	--	5.00	--	--	--	20,465	0.470	51,595	1.184
7322	--	6.00	--	--	--	24,598	0.565	74,126	1.702
7323	--	7.00	--	--	--	30,068	0.690	101,459	2.329
7324	--	8.00	--	--	--	35,153	0.807	134,070	3.078
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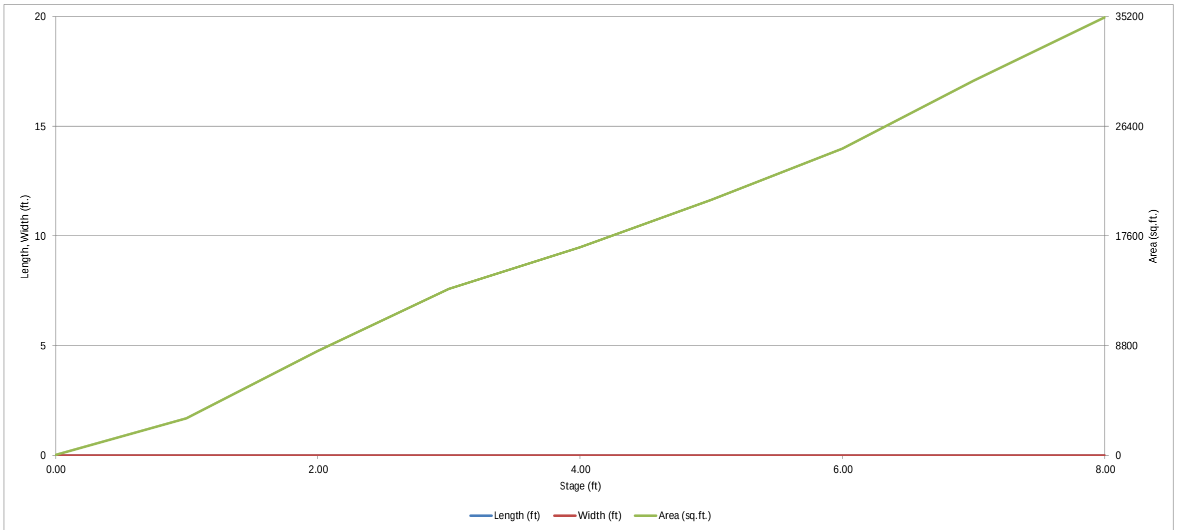
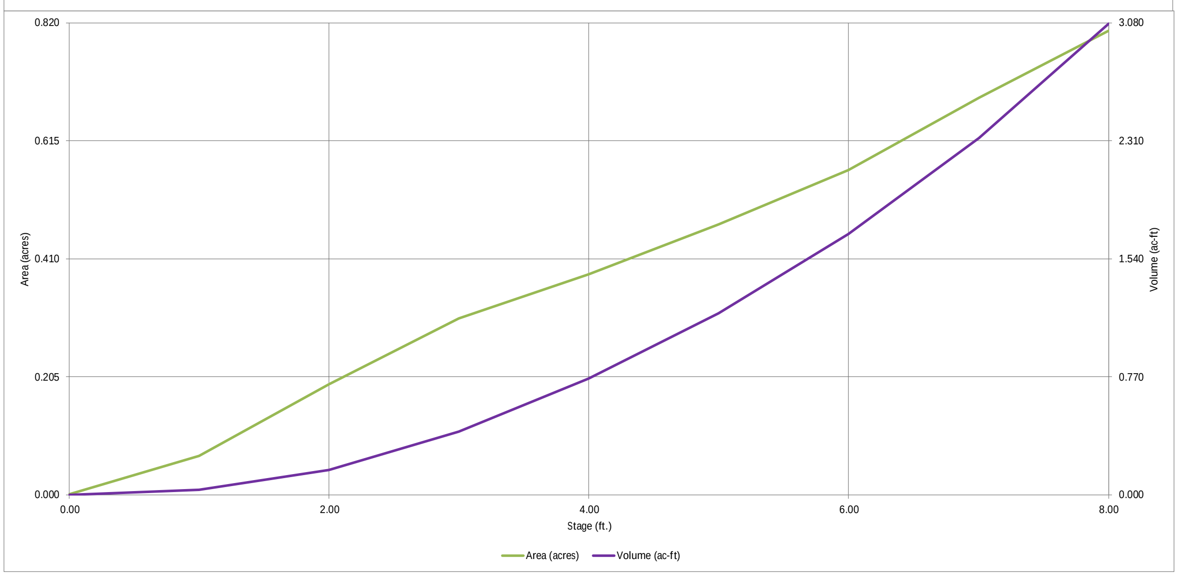
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



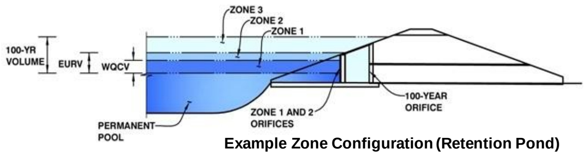


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 1 (BASIN H1+H4)_Modified Area



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.05	0.172	Orifice Plate
Zone 2 (EURV)	2.37	0.069	Orifice Plate
Zone 3 (100-year)	6.35	1.662	Weir&Pipe (Restrict)
Total (all zones)		1.903	

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

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

Calculated Parameters for Underdrain

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

Calculated Parameters for Plate

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.05	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	9.40	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (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	0.68	1.37					
Orifice Area (sq. inches)	0.75	0.80	0.80					

	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)

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

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

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.40	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.90	N/A	feet
Overflow Weir Front Edge Length =	12.00	N/A	feet	Overflow Weir Slope Length =	6.18	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	7.36	N/A	
Horiz. Length of Weir Sides =	6.00	N/A	feet	Overflow Grate Open Area w/o Debris =	51.65	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	25.83	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	7.01	N/A	ft^2
Outlet Pipe Diameter =	36.00	N/A	inches	Outlet Orifice Centroid =	1.49	N/A	feet
Restrictor Plate Height Above Pipe Invert =	35.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.81	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage=	6.10	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.68	feet
Spillway Crest Length =	60.00	feet	Stage at Top of Freeboard =	8.00	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.81	acres
Freeboard above Max Water Surface =	1.22	feet	Basin Volume at Top of Freeboard =	3.07	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.172	0.241	1.063	2.245	3.366	4.924	6.155	7.866	11.014
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.063	2.245	3.366	4.924	6.155	7.866	11.014
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	14.9	31.4	43.5	66.8	82.6	101.5	140.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.25	0.52	0.73	1.11	1.38	1.69	2.34
Peak Inflow Q (cfs) =	N/A	N/A	17.5	34.3	46.4	69.9	85.7	104.7	143.4
Peak Outflow Q (cfs) =	0.1	0.1	9.5	24.4	35.8	59.1	73.4	81.8	134.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.8	0.9	0.9	0.8	1.0
Structure Controlling Flow =	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.18	0.5	0.7	1.1	1.4	1.6	1.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	47	41	32	25	18	13	7	3
Time to Drain 99% of Inflow Volume (hours) =	43	51	50	44	41	36	33	30	24
Maximum Ponding Depth (ft) =	2.05	2.37	3.23	3.83	4.19	4.78	5.10	5.86	6.51
Area at Maximum Ponding Depth (acres) =	0.20	0.23	0.32	0.37	0.40	0.45	0.48	0.55	0.63
Maximum Volume Stored (acre-ft) =	0.174	0.243	0.482	0.694	0.828	1.079	1.232	1.618	2.000

DETENTION BASIN OUTLET STRUCTURE DESIGN

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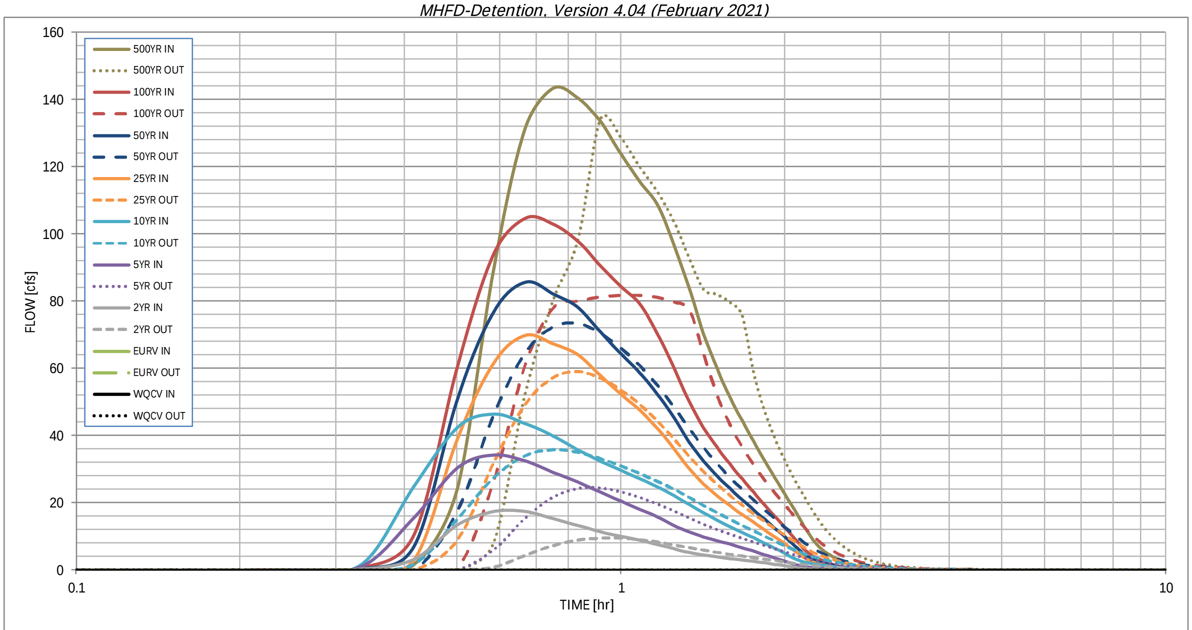

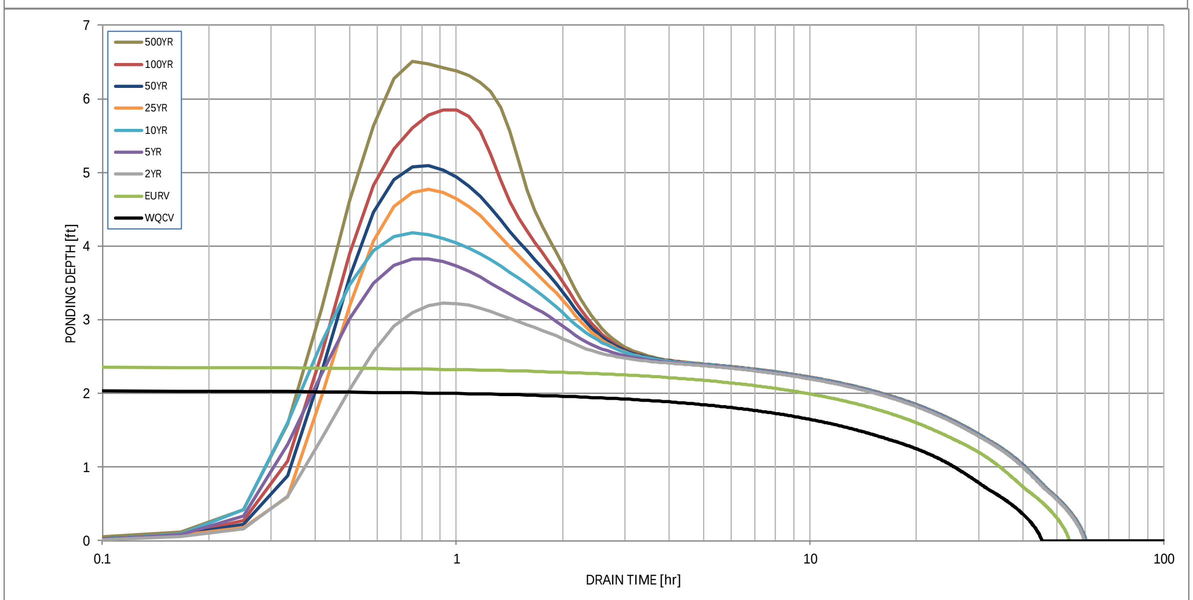

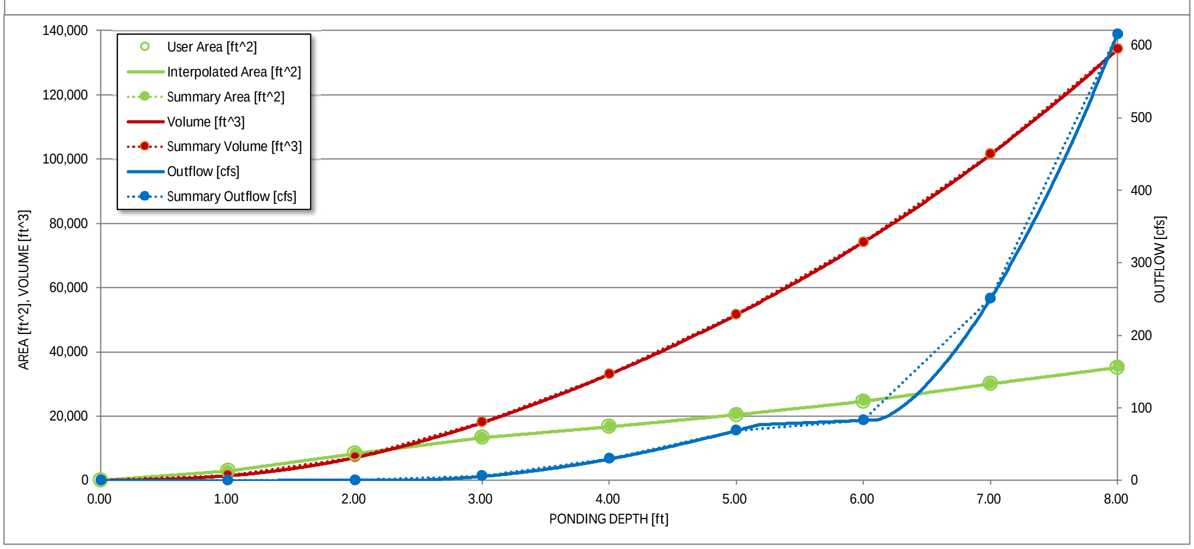

S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
	0:15:00	0.00	0.00	0.06	0.10	0.12	0.08	0.10	0.10	0.14
	0:20:00	0.00	0.00	0.23	1.06	1.67	0.23	0.39	0.67	1.58
	0:25:00	0.00	0.00	3.20	15.62	24.87	3.05	6.90	10.32	24.34
	0:30:00	0.00	0.00	13.38	30.35	42.43	39.03	50.84	60.51	89.91
	0:35:00	0.00	0.00	17.37	34.30	46.43	61.69	76.92	94.14	131.53
	0:40:00	0.00	0.00	17.51	32.49	43.63	69.90	85.68	104.70	143.39
	0:45:00	0.00	0.00	15.31	29.16	39.99	67.32	82.23	102.90	140.42
	0:50:00	0.00	0.00	13.26	26.17	35.82	64.04	78.13	97.91	133.39
	0:55:00	0.00	0.00	11.38	23.08	32.38	57.76	70.73	90.50	123.68
	1:00:00	0.00	0.00	10.01	20.46	29.66	52.22	64.26	84.23	115.46
	1:05:00	0.00	0.00	8.83	18.07	27.17	47.46	58.66	79.10	108.58
	1:10:00	0.00	0.00	7.58	15.82	24.68	41.93	52.17	70.10	96.82
	1:15:00	0.00	0.00	6.32	13.34	22.21	36.21	45.44	60.24	83.96
	1:20:00	0.00	0.00	5.17	11.32	19.53	30.22	38.12	50.19	70.48
	1:25:00	0.00	0.00	4.44	9.90	17.06	25.69	32.48	42.48	59.86
	1:30:00	0.00	0.00	3.90	8.75	14.86	22.10	27.97	36.44	51.41
	1:35:00	0.00	0.00	3.45	7.73	12.93	19.14	24.24	31.47	44.41
	1:40:00	0.00	0.00	3.01	6.64	11.18	16.51	20.91	27.08	38.20
	1:45:00	0.00	0.00	2.58	5.59	9.55	14.15	17.92	23.08	32.56
	1:50:00	0.00	0.00	2.15	4.57	8.00	11.92	15.10	19.34	27.29
	1:55:00	0.00	0.00	1.71	3.58	6.47	9.79	12.40	15.84	22.35
	2:00:00	0.00	0.00	1.27	2.61	4.91	7.75	9.83	12.59	17.75
	2:05:00	0.00	0.00	0.82	1.68	3.40	5.67	7.21	9.31	13.11
	2:10:00	0.00	0.00	0.44	1.04	2.43	3.66	4.75	6.24	8.98
	2:15:00	0.00	0.00	0.26	0.71	1.86	2.40	3.20	4.22	6.24
	2:20:00	0.00	0.00	0.17	0.52	1.45	1.62	2.22	2.91	4.42
	2:25:00	0.00	0.00	0.13	0.38	1.13	1.11	1.56	1.99	3.09
	2:30:00	0.00	0.00	0.10	0.28	0.86	0.75	1.08	1.32	2.10
	2:35:00	0.00	0.00	0.08	0.21	0.64	0.51	0.75	0.83	1.38
	2:40:00	0.00	0.00	0.06	0.15	0.46	0.33	0.50	0.48	0.84
	2:45:00	0.00	0.00	0.04	0.11	0.31	0.21	0.32	0.26	0.49
	2:50:00	0.00	0.00	0.03	0.07	0.21	0.14	0.21	0.17	0.32
	2:55:00	0.00	0.00	0.03	0.05	0.14	0.10	0.15	0.12	0.22
	3:00:00	0.00	0.00	0.02	0.04	0.10	0.08	0.11	0.10	0.17
	3:05:00	0.00	0.00	0.02	0.02	0.07	0.06	0.09	0.07	0.13
	3:10:00	0.00	0.00	0.01	0.01	0.05	0.04	0.06	0.06	0.10
	3:15:00	0.00	0.00	0.01	0.01	0.04	0.03	0.05	0.04	0.07
	3:20:00	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.03	0.05
	3:25:00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

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Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
7322	0.00	49	0.001	0	0.000	0.00
7323	1.00	2,950	0.068	1,499	0.034	0.04
7324	2.00	8,352	0.192	7,150	0.164	0.09
7325	3.00	13,337	0.306	17,995	0.413	5.65
7326	4.00	16,699	0.383	33,013	0.758	29.52
7327	5.00	20,465	0.470	51,595	1.184	68.80
7328	6.00	24,598	0.565	74,126	1.702	82.80
7329	7.00	30,068	0.690	101,459	2.329	250.48
7330	8.00	35,153	0.807	134,070	3.078	614.77

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

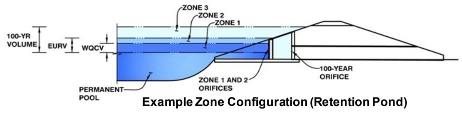
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 1 (BASIN H1+H4)_Original



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**			
Watershed Area =	41.00	acres		
Watershed Length =	2,399	ft		
Watershed Length to Centroid =	960	ft		
Watershed Slope =	0.050	ft/ft		
Watershed Imperviousness =	7.20%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	6.9%	percent		
Percentage Hydrologic Soil Groups C/D =	93.1%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.172	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.241	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.727	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.536	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.303	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	3.368	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	4.211	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	5.381	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	7.535	acre-feet		inches
Approximate 2-yr Detention Volume =	0.189	acre-feet		
Approximate 5-yr Detention Volume =	0.506	acre-feet		
Approximate 10-yr Detention Volume =	0.732	acre-feet		
Approximate 25-yr Detention Volume =	0.889	acre-feet		
Approximate 50-yr Detention Volume =	0.911	acre-feet		
Approximate 100-yr Detention Volume =	1.300	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.172	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.069	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.059	acre-feet
Total Detention Basin Volume =	1.300	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	300	0.007		
	--	1.00	--	--	--	3,300	0.076	1,800	0.041
	--	3.00	--	--	--	8,000	0.184	13,100	0.301
	--	5.00	--	--	--	15,000	0.344	36,100	0.829
	--	7.50	--	--	--	18,000	0.413	77,350	1.776
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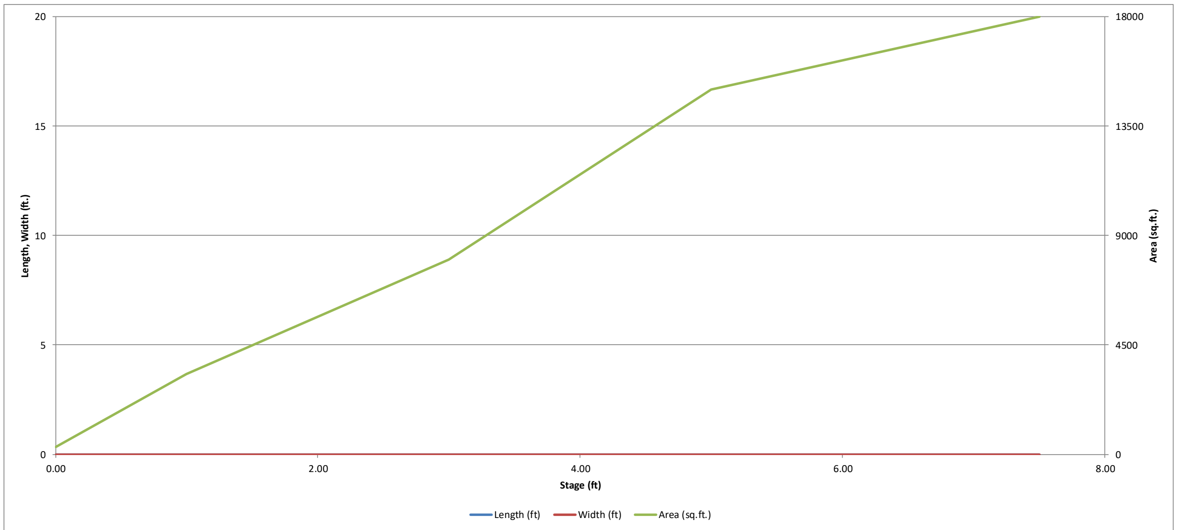
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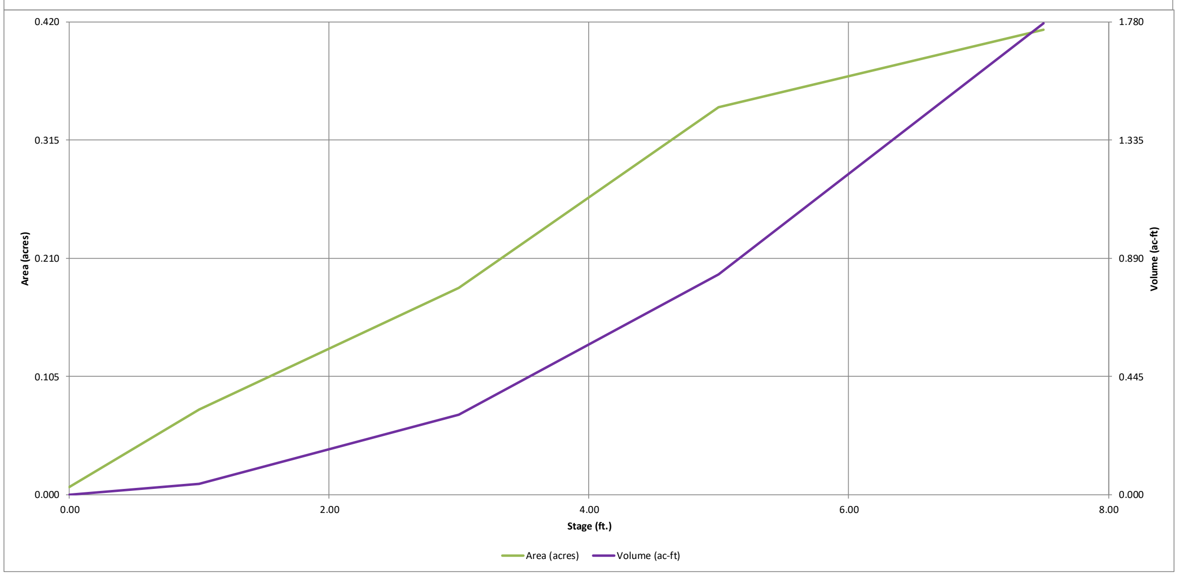
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)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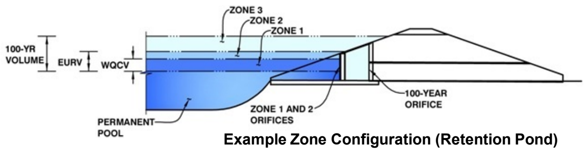
Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 1 (BASIN H1+H4)_Original



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.21	0.172	Orifice Plate
Zone 2 (EURV)	2.66	0.069	Orifice Plate
Zone 3 (100-year)	6.31	1.059	Weir&Pipe (Restrict)
Total (all zones)		1.300	

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

				Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)		Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches		Underdrain Orifice Centroid =	N/A	feet

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

				Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)		WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.13	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	inches		Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (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	0.71	1.42					
Orifice Area (sq. inches)	0.75	0.75	0.75					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orifice	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.60	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.10	N/A	feet
Overflow Weir Front Edge Length =	6.00	N/A	feet	Overflow Weir Slope Length =	6.18	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	5.63	N/A	
Horiz. Length of Weir Sides =	6.00	N/A	feet	Overflow Grate Open Area w/o Debris =	25.83	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	12.91	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	4.59	N/A	ft^2
Outlet Pipe Diameter =	30.00	N/A	inches	Outlet Orifice Centroid =	1.17	N/A	feet
Restrictor Plate Height Above Pipe Invert =	26.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	2.44	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.68	feet
Spillway Crest Length =	35.00	feet	Stage at Top of Freeboard =	7.50	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.41	acres
Freeboard above Max Water Surface =	0.82	feet	Basin Volume at Top of Freeboard =	1.78	acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.172	0.241	0.727	1.536	2.303	3.368	4.211	5.381	7.535
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.727	1.536	2.303	3.368	4.211	5.381	7.535
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	8.8	18.4	25.6	39.7	49.0	61.4	84.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.22	0.45	0.62	0.97	1.19	1.50	2.06
Peak Inflow Q (cfs) =	N/A	N/A	10.5	20.2	27.4	41.4	50.8	63.0	86.2
Peak Outflow Q (cfs) =	0.1	0.2	5.1	14.2	21.2	35.3	44.3	51.8	81.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.8	0.9	0.9	0.8	1.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.00	0.19	0.5	0.8	1.4	1.7	2.0	2.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	44	51	45	36	30	23	19	14	6
Time to Drain 99% of Inflow Volume (hours) =	**48**	55	54	49	45	40	38	34	29
Maximum Ponding Depth (ft) =	2.21	2.66	3.38	3.96	4.29	4.81	5.11	5.68	6.38
Area at Maximum Ponding Depth (acres) =	0.14	0.17	0.21	0.26	0.29	0.33	0.35	0.36	0.38
Maximum Volume Stored (acre-ft) =	0.172	0.241	0.374	0.511	0.602	0.765	0.863	1.069	1.330

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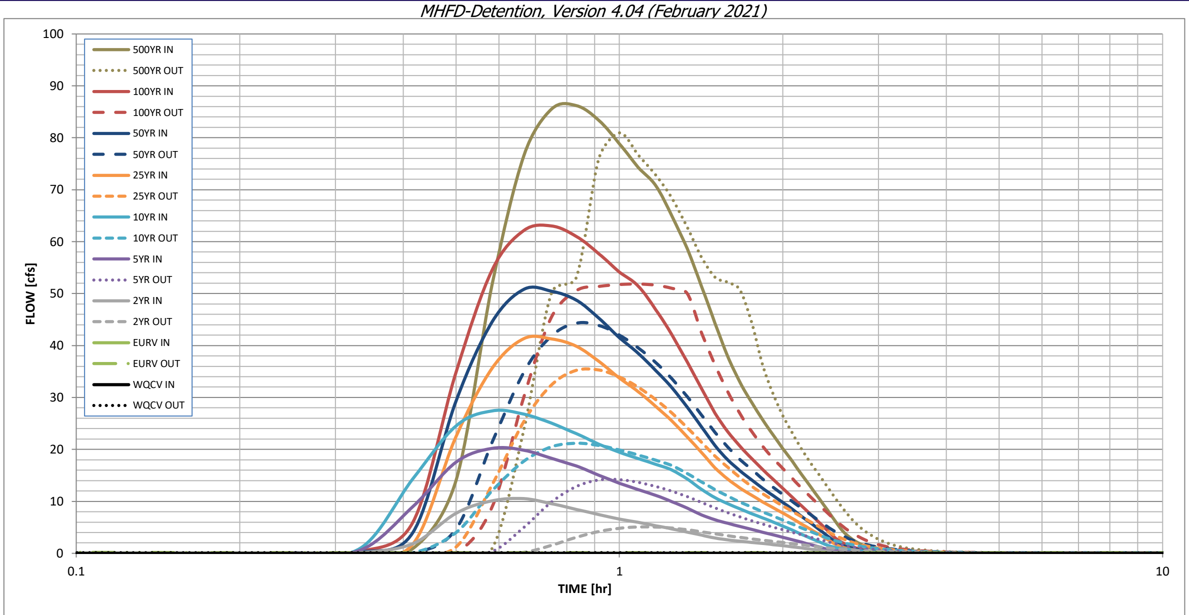

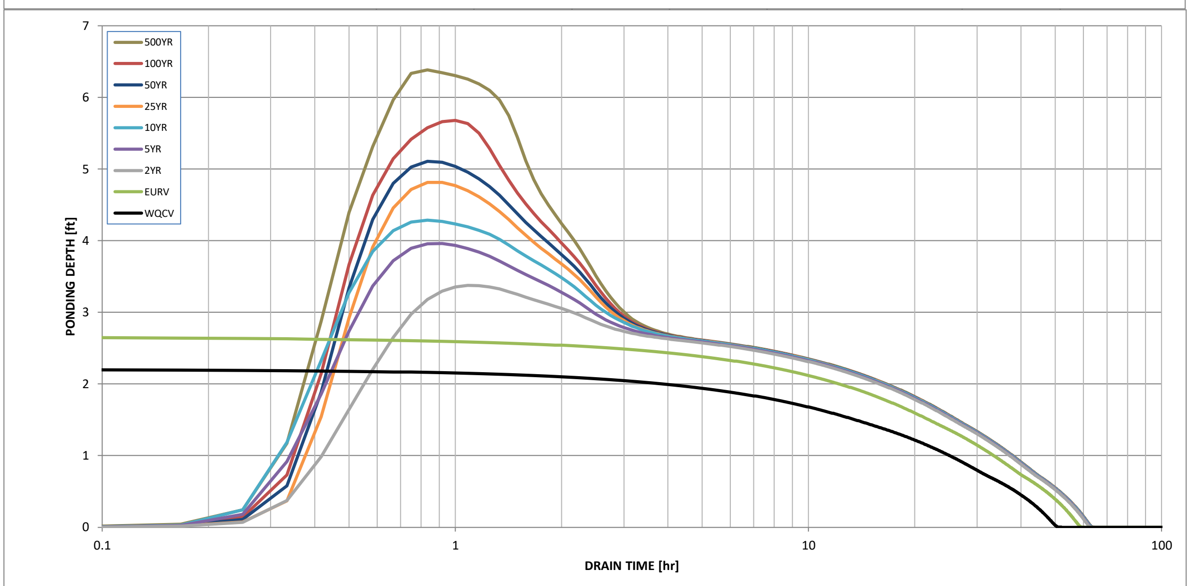

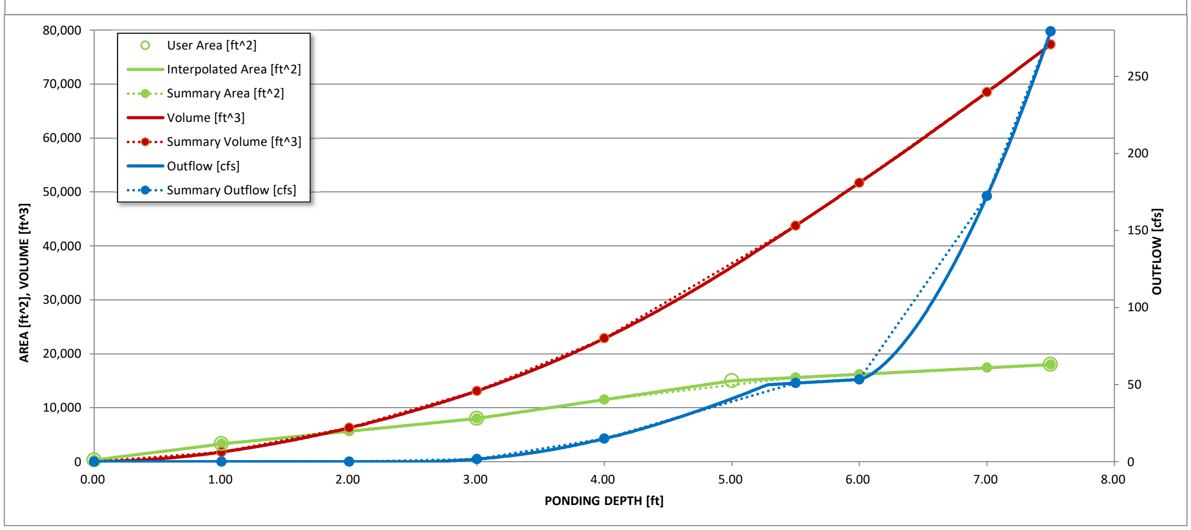

S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.03	0.05	0.07	0.05	0.06	0.06	0.08
	0:20:00	0.00	0.00	0.13	0.61	0.96	0.13	0.23	0.39	0.91
	0:25:00	0.00	0.00	1.85	9.00	14.33	1.76	3.97	5.95	14.02
	0:30:00	0.00	0.00	7.72	17.54	24.53	22.48	29.30	34.88	51.87
	0:35:00	0.00	0.00	10.11	20.20	27.44	35.69	44.58	54.60	76.55
	0:40:00	0.00	0.00	10.50	19.85	26.79	41.36	50.84	62.14	85.50
	0:45:00	0.00	0.00	9.56	18.28	25.04	41.25	50.48	63.03	86.18
	0:50:00	0.00	0.00	8.45	16.79	23.01	39.86	48.72	61.00	83.36
	0:55:00	0.00	0.00	7.48	15.05	21.03	36.95	45.27	57.67	78.87
	1:00:00	0.00	0.00	6.61	13.50	19.46	33.73	41.51	54.17	74.32
	1:05:00	0.00	0.00	5.95	12.26	18.24	31.13	38.49	51.46	70.78
	1:10:00	0.00	0.00	5.32	11.16	17.13	28.25	35.15	46.89	64.89
	1:15:00	0.00	0.00	4.70	9.94	16.01	25.43	31.87	41.99	58.57
	1:20:00	0.00	0.00	4.08	8.67	14.29	22.38	28.10	36.75	51.37
	1:25:00	0.00	0.00	3.48	7.42	12.30	19.39	24.34	31.69	44.29
	1:30:00	0.00	0.00	2.94	6.45	10.71	16.47	20.73	27.01	37.89
	1:35:00	0.00	0.00	2.58	5.78	9.52	14.27	18.00	23.41	32.96
	1:40:00	0.00	0.00	2.33	5.17	8.54	12.59	15.91	20.65	29.11
	1:45:00	0.00	0.00	2.11	4.60	7.65	11.19	14.15	18.29	25.81
	1:50:00	0.00	0.00	1.90	4.07	6.84	9.94	12.57	16.19	22.86
	1:55:00	0.00	0.00	1.68	3.56	6.04	8.81	11.14	14.27	20.15
	2:00:00	0.00	0.00	1.46	3.08	5.23	7.73	9.79	12.47	17.61
	2:05:00	0.00	0.00	1.23	2.59	4.42	6.66	8.42	10.73	15.13
	2:10:00	0.00	0.00	1.02	2.12	3.64	5.62	7.10	9.09	12.78
	2:15:00	0.00	0.00	0.80	1.66	2.90	4.61	5.82	7.49	10.51
	2:20:00	0.00	0.00	0.59	1.20	2.20	3.62	4.57	5.91	8.29
	2:25:00	0.00	0.00	0.37	0.76	1.54	2.64	3.34	4.36	6.10
	2:30:00	0.00	0.00	0.19	0.47	1.10	1.69	2.18	2.90	4.16
	2:35:00	0.00	0.00	0.11	0.32	0.85	1.11	1.47	1.96	2.89
	2:40:00	0.00	0.00	0.08	0.24	0.66	0.75	1.02	1.35	2.04
	2:45:00	0.00	0.00	0.06	0.18	0.52	0.51	0.72	0.92	1.43
	2:50:00	0.00	0.00	0.05	0.13	0.40	0.34	0.49	0.61	0.97
	2:55:00	0.00	0.00	0.03	0.10	0.30	0.23	0.34	0.38	0.63
	3:00:00	0.00	0.00	0.03	0.07	0.21	0.15	0.23	0.22	0.38
	3:05:00	0.00	0.00	0.02	0.05	0.15	0.10	0.15	0.12	0.22
	3:10:00	0.00	0.00	0.02	0.04	0.10	0.07	0.10	0.08	0.15
	3:15:00	0.00	0.00	0.01	0.02	0.06	0.05	0.07	0.06	0.10
	3:20:00	0.00	0.00	0.01	0.02	0.05	0.04	0.05	0.05	0.08
	3:25:00	0.00	0.00	0.01	0.01	0.03	0.03	0.04	0.04	0.06
	3:30:00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.05
	3:35:00	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.02	0.03
	3:40:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	3:45:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]
7310	0.00	300	0.007	0	0.000	0.00
7311	1.00	3,300	0.076	1,800	0.041	0.04
7312	2.00	5,650	0.130	6,275	0.144	0.08
7313	3.00	8,000	0.184	13,100	0.301	1.69
7314	4.00	11,500	0.264	22,850	0.525	14.99
7315.5	5.50	15,600	0.358	43,750	1.004	50.98
7316	6.00	16,200	0.372	51,700	1.187	53.32
7317	7.00	17,400	0.399	68,500	1.573	172.32
7317.50	7.50	18,000	0.413	77,350	1.776	279.15

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Kimley»Horn

Extended Detention Basin (EDB) Calculations

Project	Winsome Filing 3 - Pond 1		
Date	9/15/2022		Manual Input
Prepared By	TOS		Multipliers
Checked By			

Release Factor:	0.02

Forebay Release and Configuration: Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration				
Forebay	Incoming Pipe Diameter (in)	Undetained 100-year Peak Discharge (cfs)	Release Rate (cfs)	Forebay Notch Width (in)
A	N/A	104.70	2.09	7.7

Maximum Forebay Depth				
Forebay	Impervious Area in Watershed (ac)	Maximum Forebay Depth (in)	Design Forebay Depth (in)	Design Forebay Depth (ft)
A	2.93	18	18	1.5

Note: a forebay depth of 30" requires handrails by most City Standards

Volume Factor: 0.03

Minimum Forebay Volume Required: 3% WQCV						
Forebay	WQCV (ac-ft)	Required Volume (ac-ft)	Required Volume (cf)	Total Length (ft)	Total Width (ft)	Design Volume (cf)
A	0.172	0.01	225	15	23	517.5

Kimley»Horn

Project: Winsome Filing 3 -Pond 1
Date: 12/13/2021

Emergency Overflow Weir Calculation

Q (cfs) =	104.7	(100-yr peak inflow)
C_{BCW} =	3	
Z =	4	
H =	0.7	
L (ft) =	57.35	Rounded to 60

*orange cells require input

$$Q = C_{BCW} L H^{1.5} + 2\left[\left(\frac{2}{5}\right) C_{BCW} Z H^{2.5}\right]$$

rearrange to solve for length:

$$L = \frac{Q - \left(\frac{4}{5}\right) C_{BCW} Z H^{2.5}}{C_{BCW} H^{1.5}}$$

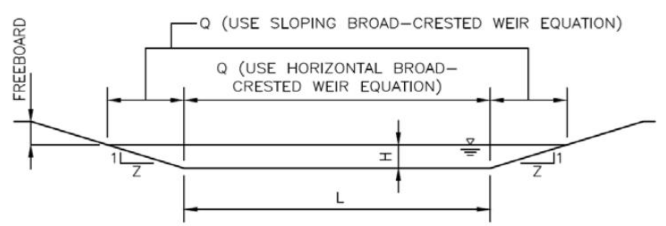


Figure 12-20. Sloping broad-crest weir

Horizontal Broad Crested Weir Equation (from USDCM Eqn. 12-8)

$$Q = C_{BCW} L H^{1.5} \qquad \text{Equation 12-8}$$

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

Sloping Broad Crested Weir Equation (from USDCM Eqn. 12-9)

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5} \qquad \text{Equation 12-9}$$

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

Z = side slope (horizontal: vertical)

H = head above weir crest (ft)

Note that in order to calculate the total flow over the weir depicted in Figure 12-20, the results from Equation 12-8 must be added to two times the results from Equation 12-9.

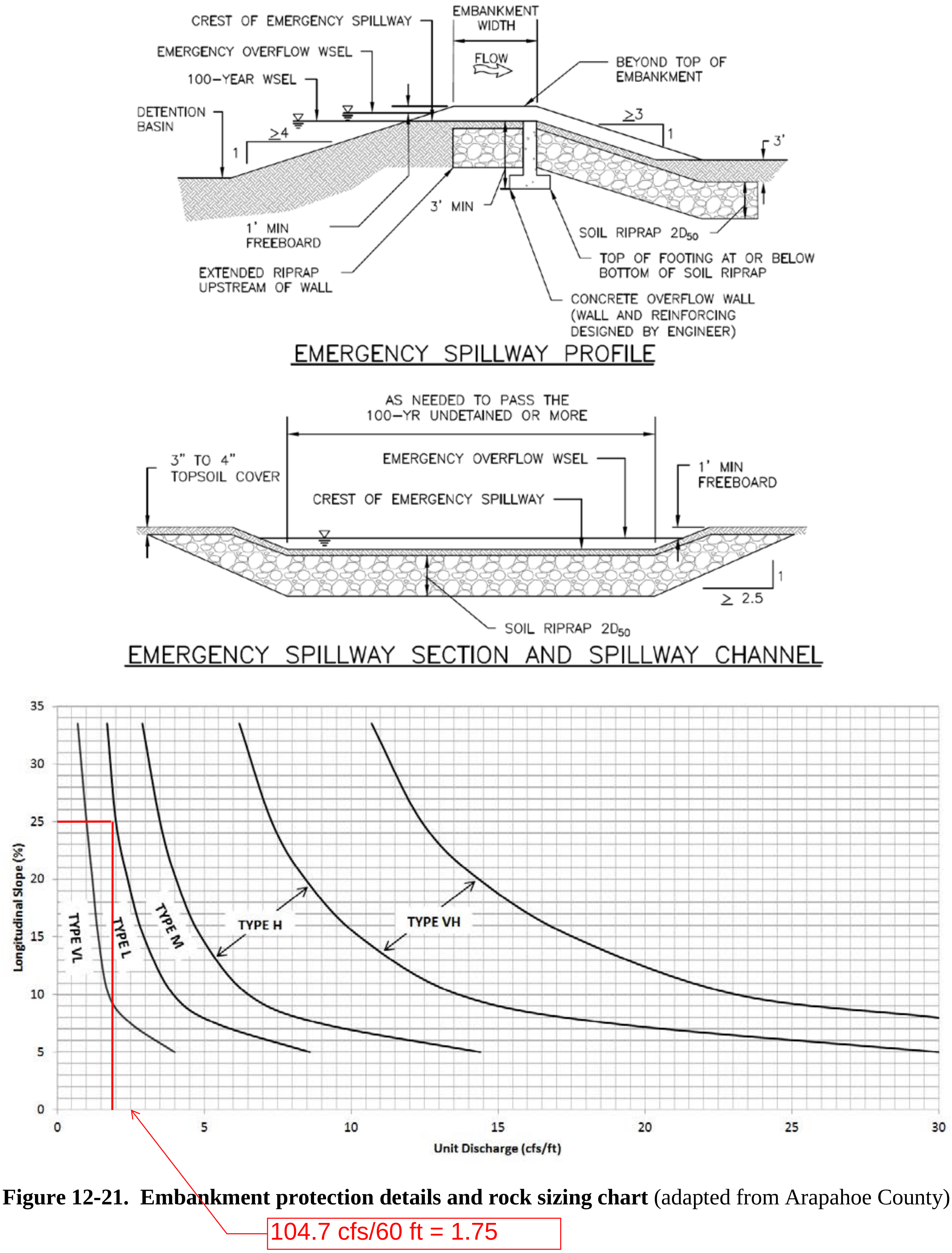


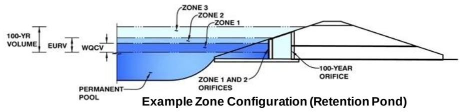
Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 2 (BASIN H6B+H2)_Modified Area



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	67.90	acres
Watershed Length =	2,639	ft
Watershed Length to Centroid =	1,158	ft
Watershed Slope =	0.043	ft/ft
Watershed Imperviousness =	8.50%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	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.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.267	acre-feet	0.267	acre-feet
Excess Urban Runoff Volume (EURV) =	0.384	acre-feet	0.384	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.313	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.686	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.969	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	5.724	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	7.125	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	9.058	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	12.632	acre-feet		inches
Approximate 2-yr Detention Volume =	0.380	acre-feet		
Approximate 5-yr Detention Volume =	0.970	acre-feet		
Approximate 10-yr Detention Volume =	1.328	acre-feet		
Approximate 25-yr Detention Volume =	1.593	acre-feet		
Approximate 50-yr Detention Volume =	1.641	acre-feet		
Approximate 100-yr Detention Volume =	2.320	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.267	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.117	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.936	acre-feet
Total Detention Basin Volume =	2.320	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	135	0.003		
7301	--	1.00	--	--	--	3,562	0.082	1,848	0.042
7302	--	2.00	--	--	--	8,486	0.195	7,872	0.181
7303	--	3.00	--	--	--	13,569	0.312	18,900	0.434
7304	--	4.00	--	--	--	18,029	0.414	34,699	0.797
7305	--	5.00	--	--	--	22,236	0.510	54,831	1.259
7306	--	6.00	--	--	--	26,181	0.601	79,040	1.815
7307	--	7.00	--	--	--	30,248	0.694	107,254	2.462
7308	--	8.00	--	--	--	34,723	0.797	139,740	3.208
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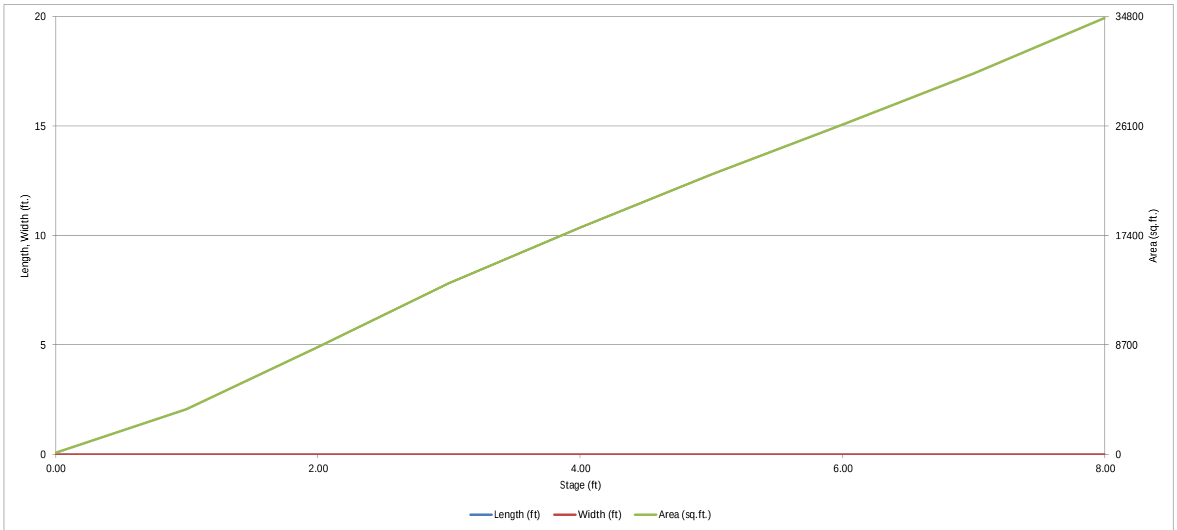
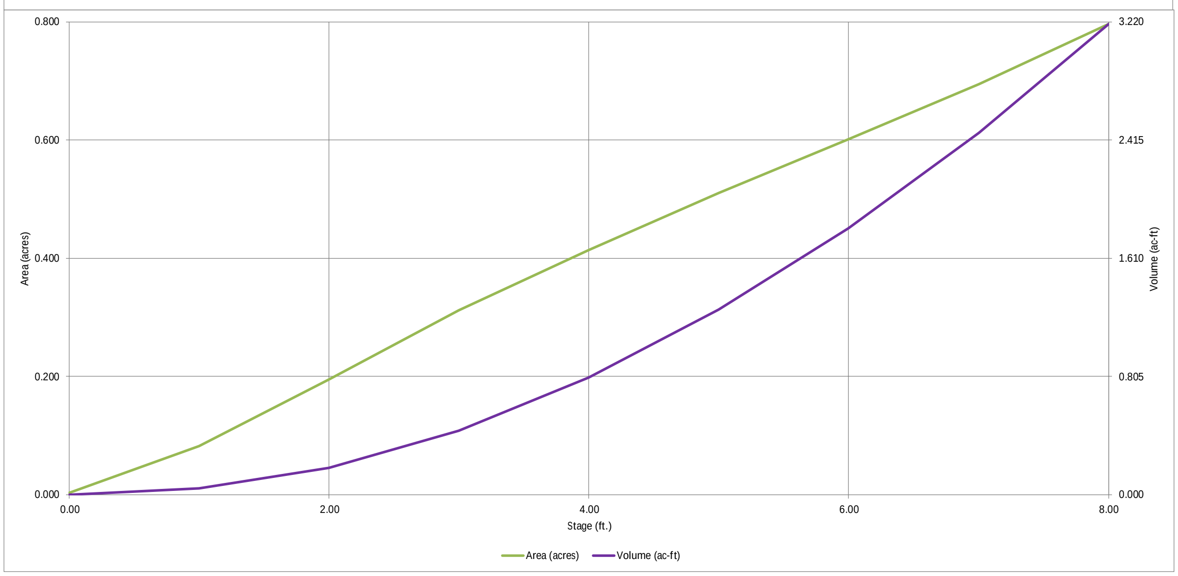
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



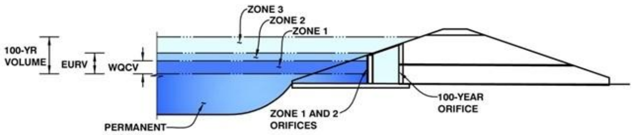


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 2 (BASIN H6B+H2)_Modified Area



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.40	0.267	Orifice Plate
Zone 2 (EURV)	2.84	0.117	Orifice Plate
Zone 3 (100-year)	6.80	1.936	Weir&Pipe (Restrict)
	Total (all zones)	2.320	

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

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

(Calculated Parameters for Underdrain)

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

			Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.40	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	inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (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	0.80	1.60					
Orifice Area (sq. inches)	1.10	1.10	1.20					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orific	Not Selected	Not Selected
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A
Vertical Orifice Diameter =	N/A	N/A	inches			

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Wei	Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	2.90	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.40	N/A
Overflow Weir Front Edge Length =	15.00	N/A	feet	Overflow Weir Slope Length =	6.18	N/A
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.87	N/A
Horiz. Length of Weir Sides =	6.00	N/A	feet	Overflow Grate Open Area w/o Debris =	64.57	N/A
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	32.28	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		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plat	Zone 3 Restrictor	Not Selected
Depth to Invert of Outlet Pipe =	3.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	7.28	N/A
Outlet Pipe Diameter =	48.00	N/A	inches	Outlet Orifice Centroid =	1.28	N/A
Restrictor Plate Height Above Pipe Invert =	27.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.70	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	6.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.70	feet
Spillway Crest Length =	60.00	feet	Stage at Top of Freeboard =	7.70	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.77	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	2.97	acre-ft

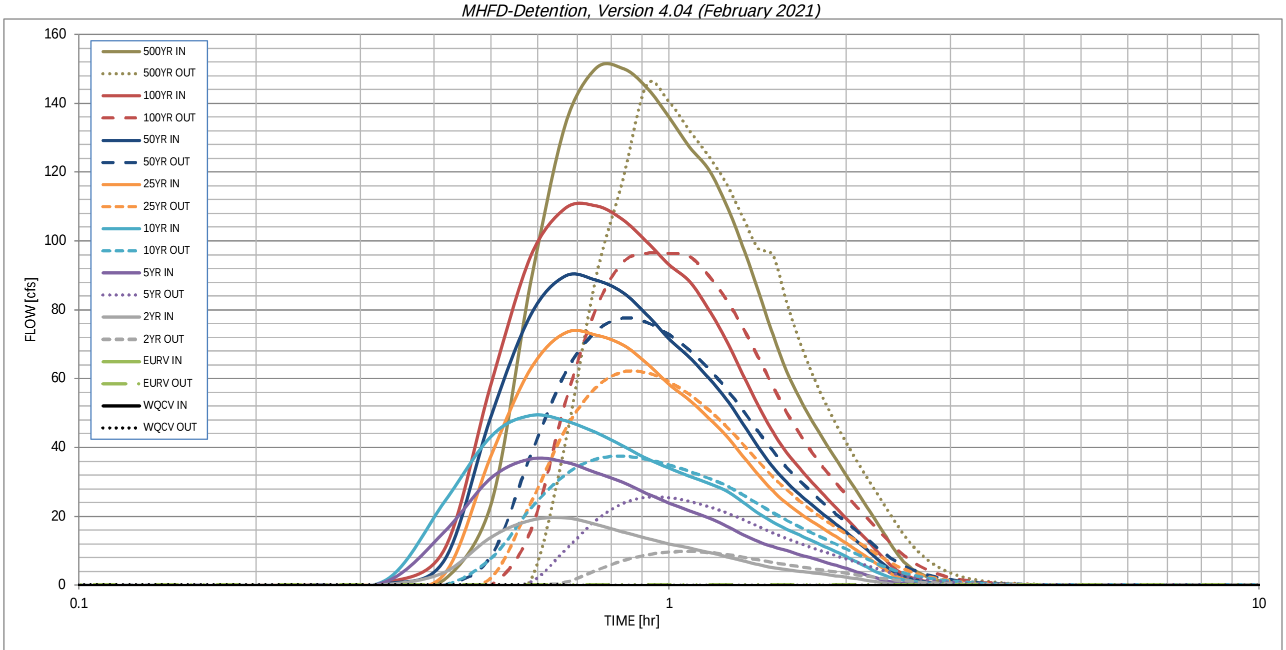
Routed Hydrograph Results

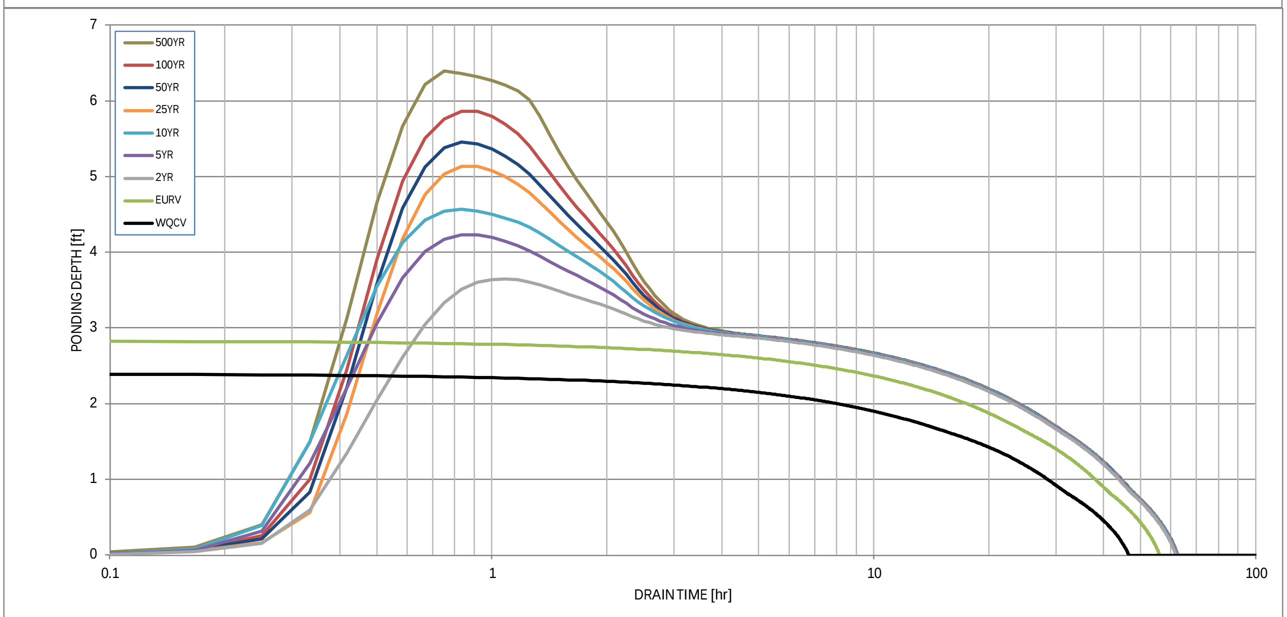
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

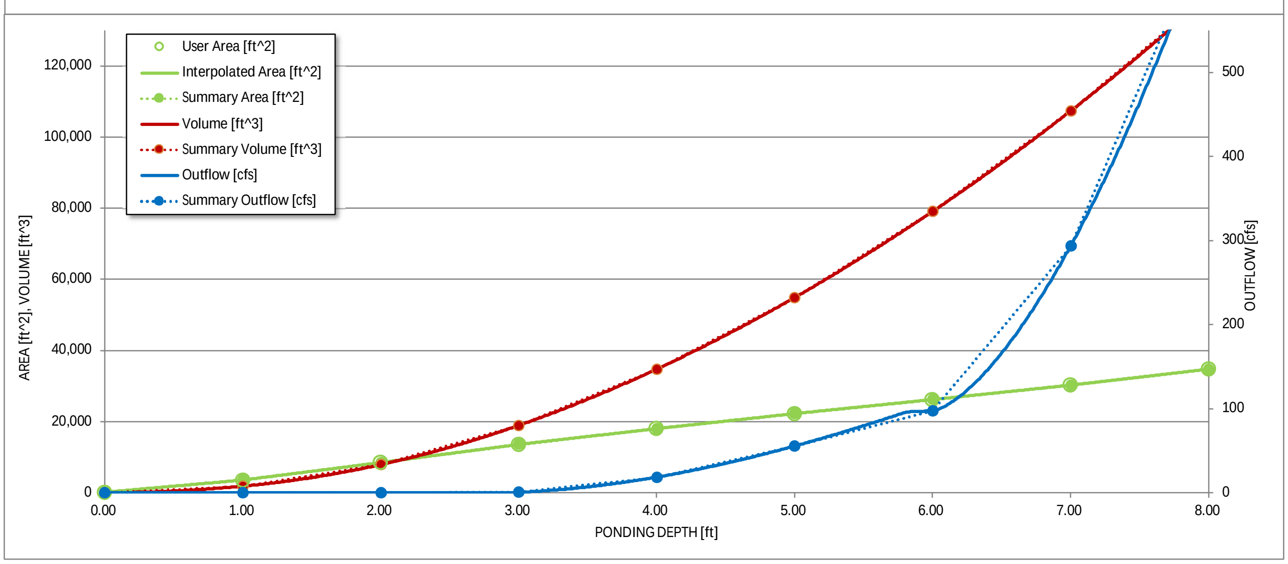
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.267	0.384	1.313	2.686	3.969	5.724	7.125	9.058
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.313	2.686	3.969	5.724	7.125	9.058
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	16.1	32.7	45.3	69.8	85.8	107.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.24	0.48	0.67	1.03	1.26	1.58
Peak Inflow Q (cfs) =	N/A	N/A	19.6	36.7	49.3	73.4	89.9	110.4
Peak Outflow Q (cfs) =	0.1	0.2	9.9	25.6	37.6	62.0	77.7	96.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	0.8	0.9	0.9	0.9
Structure Controlling Flow =	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.15	0.4	0.6	1.0	1.2	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	41	49	45	37	31	25	21	15
Time to Drain 99% of Inflow Volume (hours) =	44	53	54	48	45	41	39	35
Maximum Ponding Depth (ft) =	2.40	2.84	3.65	4.23	4.57	5.14	5.46	5.86
Area at Maximum Ponding Depth (acres) =	0.24	0.29	0.38	0.44	0.47	0.52	0.55	0.59
Maximum Volume Stored (acre-ft) =	0.268	0.386	0.658	0.894	1.048	1.331	1.503	1.731

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03
	0:15:00	0.00	0.00	0.08	0.12	0.15	0.10	0.13	0.13	0.19
	0:20:00	0.00	0.00	0.30	1.23	1.90	0.31	0.50	0.80	1.82
	0:25:00	0.00	0.00	3.94	15.71	24.46	3.45	7.51	10.76	24.03
	0:30:00	0.00	0.00	14.11	31.27	43.51	38.00	49.61	59.01	87.95
	0:35:00	0.00	0.00	18.98	36.68	49.33	63.02	78.48	95.59	133.66
	0:40:00	0.00	0.00	19.65	35.86	47.83	73.41	89.85	109.53	150.06
	0:45:00	0.00	0.00	17.81	32.86	44.47	72.87	88.77	110.38	150.35
	0:50:00	0.00	0.00	15.64	29.98	40.63	70.00	85.19	106.37	144.73
	0:55:00	0.00	0.00	13.70	26.74	36.84	64.56	78.72	99.93	136.06
	1:00:00	0.00	0.00	12.05	23.98	34.06	58.49	71.67	93.22	127.41
	1:05:00	0.00	0.00	10.86	21.73	31.81	53.86	66.28	88.31	120.96
	1:10:00	0.00	0.00	9.62	19.64	29.64	48.68	60.25	80.26	110.52
	1:15:00	0.00	0.00	8.37	17.30	27.44	43.42	54.11	71.13	98.70
	1:20:00	0.00	0.00	7.14	14.84	24.27	37.71	47.09	61.39	85.40
	1:25:00	0.00	0.00	6.00	12.72	20.99	32.12	40.17	52.13	72.71
	1:30:00	0.00	0.00	5.15	11.22	18.43	27.37	34.34	44.46	62.26
	1:35:00	0.00	0.00	4.60	10.09	16.36	23.85	29.98	38.69	54.29
	1:40:00	0.00	0.00	4.13	8.96	14.55	21.00	26.42	34.01	47.75
	1:45:00	0.00	0.00	3.70	7.87	12.90	18.51	23.29	29.86	41.95
	1:50:00	0.00	0.00	3.28	6.84	11.38	16.26	20.47	26.11	36.70
	1:55:00	0.00	0.00	2.83	5.85	9.88	14.17	17.84	22.62	31.81
	2:00:00	0.00	0.00	2.38	4.89	8.33	12.17	15.33	19.35	27.22
	2:05:00	0.00	0.00	1.93	3.94	6.78	10.16	12.79	16.17	22.71
	2:10:00	0.00	0.00	1.48	3.01	5.29	8.18	10.29	13.08	18.33
	2:15:00	0.00	0.00	1.04	2.10	3.89	6.24	7.85	10.05	14.06
	2:20:00	0.00	0.00	0.63	1.33	2.73	4.36	5.52	7.14	10.06
	2:25:00	0.00	0.00	0.34	0.87	2.05	2.79	3.64	4.76	6.89
	2:30:00	0.00	0.00	0.23	0.64	1.61	1.89	2.53	3.28	4.87
	2:35:00	0.00	0.00	0.17	0.48	1.26	1.30	1.79	2.28	3.46
	2:40:00	0.00	0.00	0.13	0.36	0.98	0.90	1.26	1.55	2.41
	2:45:00	0.00	0.00	0.10	0.27	0.75	0.62	0.88	1.02	1.63
	2:50:00	0.00	0.00	0.08	0.20	0.55	0.42	0.61	0.63	1.05
	2:55:00	0.00	0.00	0.06	0.15	0.40	0.28	0.41	0.37	0.64
	3:00:00	0.00	0.00	0.05	0.10	0.27	0.19	0.27	0.22	0.40
	3:05:00	0.00	0.00	0.04	0.07	0.18	0.13	0.19	0.16	0.28
	3:10:00	0.00	0.00	0.03	0.05	0.13	0.10	0.14	0.12	0.21
	3:15:00	0.00	0.00	0.02	0.03	0.09	0.07	0.11	0.09	0.17
	3:20:00	0.00	0.00	0.02	0.02	0.07	0.06	0.08	0.07	0.13
	3:25:00	0.00	0.00	0.01	0.01	0.05	0.04	0.06	0.05	0.09
	3:30:00	0.00	0.00	0.01	0.01	0.03	0.03	0.04	0.04	0.07
	3:35:00	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.02	0.04
	3:40:00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.02
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]
7300	0.00	135	0.003	0	0.000	0.00
7301	1.00	3,562	0.082	1,848	0.042	0.05
7302	2.00	8,486	0.195	7,872	0.181	0.12
7303	3.00	13,569	0.312	18,900	0.434	0.58
7304	4.00	18,029	0.414	34,699	0.797	18.49
7305	5.00	22,236	0.510	54,831	1.259	55.53
7306	6.00	26,181	0.601	79,040	1.815	97.37
7307	7.00	30,248	0.694	107,254	2.462	293.09
7308	8.00	34,723	0.797	139,740	3.208	672.69

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

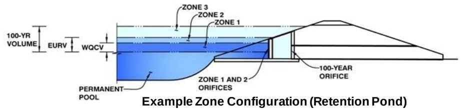
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 2 (BASIN H6B+H2)_ Orginal



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB			
Watershed Area =	55.06	acres		
Watershed Length =	2,639	ft		
Watershed Length to Centroid =	1,158	ft		
Watershed Slope =	0.043	ft/ft		
Watershed Imperviousness =	8.50%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	100.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	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.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.267	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.384	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.066	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.180	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.220	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	4.645	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	5.781	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	7.350	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	10.250	acre-feet		inches
Approximate 2-yr Detention Volume =	0.308	acre-feet		
Approximate 5-yr Detention Volume =	0.786	acre-feet		
Approximate 10-yr Detention Volume =	1.077	acre-feet		
Approximate 25-yr Detention Volume =	1.292	acre-feet		
Approximate 50-yr Detention Volume =	1.331	acre-feet		
Approximate 100-yr Detention Volume =	1.882	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.267	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.117	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.497	acre-feet
Total Detention Basin Volume =	1.882	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	300	0.007		
	--	1.00	--	--	--	5,000	0.115	2,650	0.061
	--	3.00	--	--	--	12,000	0.275	19,650	0.451
	--	5.50	--	--	--	18,000	0.413	57,150	1.312
	--	7.50	--	--	--	22,000	0.505	97,150	2.230
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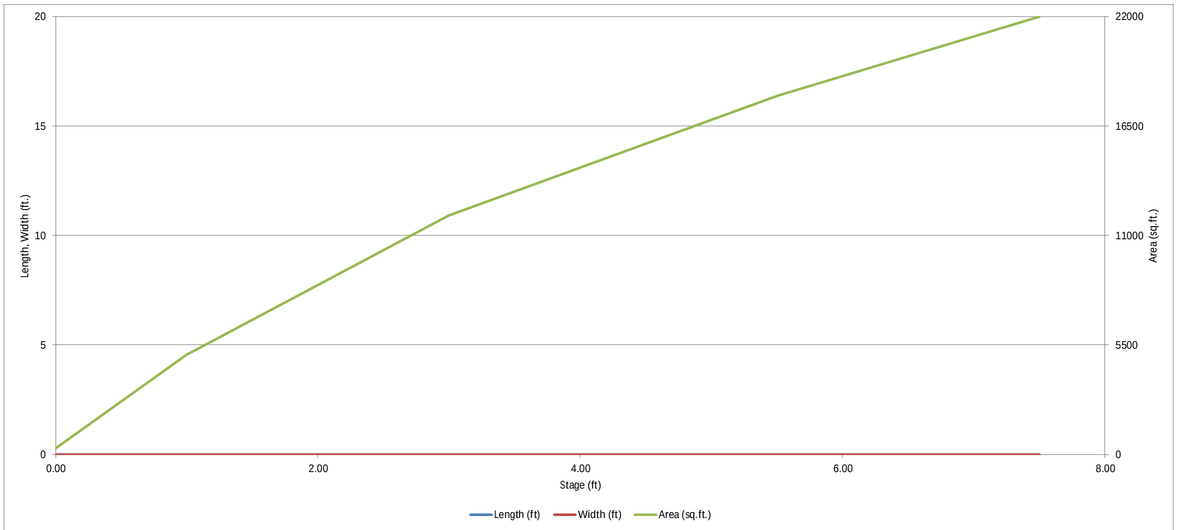
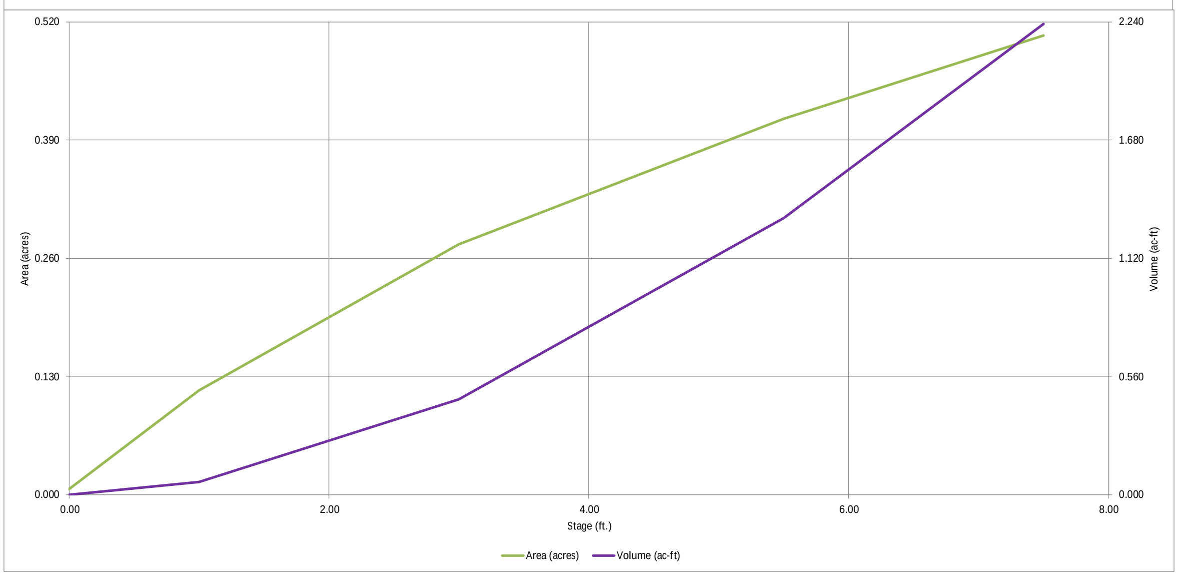
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

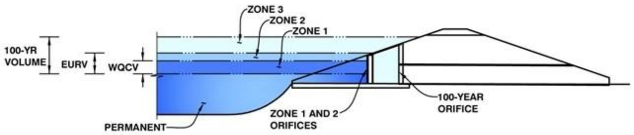




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3
Basin ID: POND 2 (BASIN H6B+H2)_ Orginal



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.26	0.267	Orifice Plate
Zone 2 (EURV)	2.75	0.117	Orifice Plate
Zone 3 (100-year)	6.79	1.497	Weir&Pipe (Restrict)
Total (all zones)		1.882	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.36	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	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	0.42	0.84					
Orifice Area (sq. inches)	3.30	3.50	4.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orific

	Not Selected	Not Selected
Vertical Orifice Area =	N/A	N/A
Vertical Orifice Centroid =	N/A	N/A

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	6.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Wei

	Zone 3 Weir	Not Selected
Height of Grate Upper Edge, H_t =	2.80	N/A
Overflow Weir Slope Length =	6.18	N/A
Grate Open Area / 100-yr Orifice Area =	5.71	N/A
Overflow Grate Open Area w/o Debris =	25.83	N/A
Overflow Grate Open Area w/ Debris =	12.91	N/A

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	36.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	22.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plat

	Zone 3 Restrictor	Not Selected
Outlet Orifice Area =	4.53	N/A
Outlet Orifice Centroid =	1.04	N/A
Half-Central Angle of Restrictor Plate on Pipe =	1.79	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	35.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.82	feet
Stage at Top of Freeboard =	7.32	feet
Basin Area at Top of Freeboard =	0.50	acres
Basin Volume at Top of Freeboard =	2.14	acre-ft

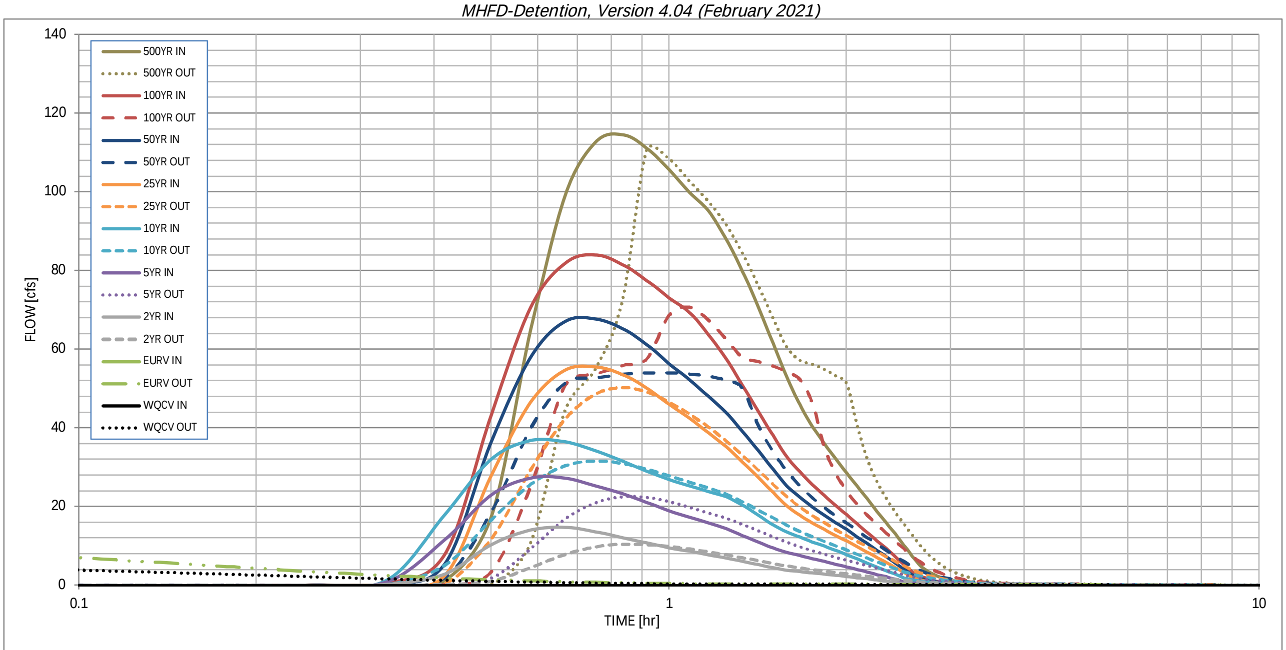
Routed Hydrograph Results

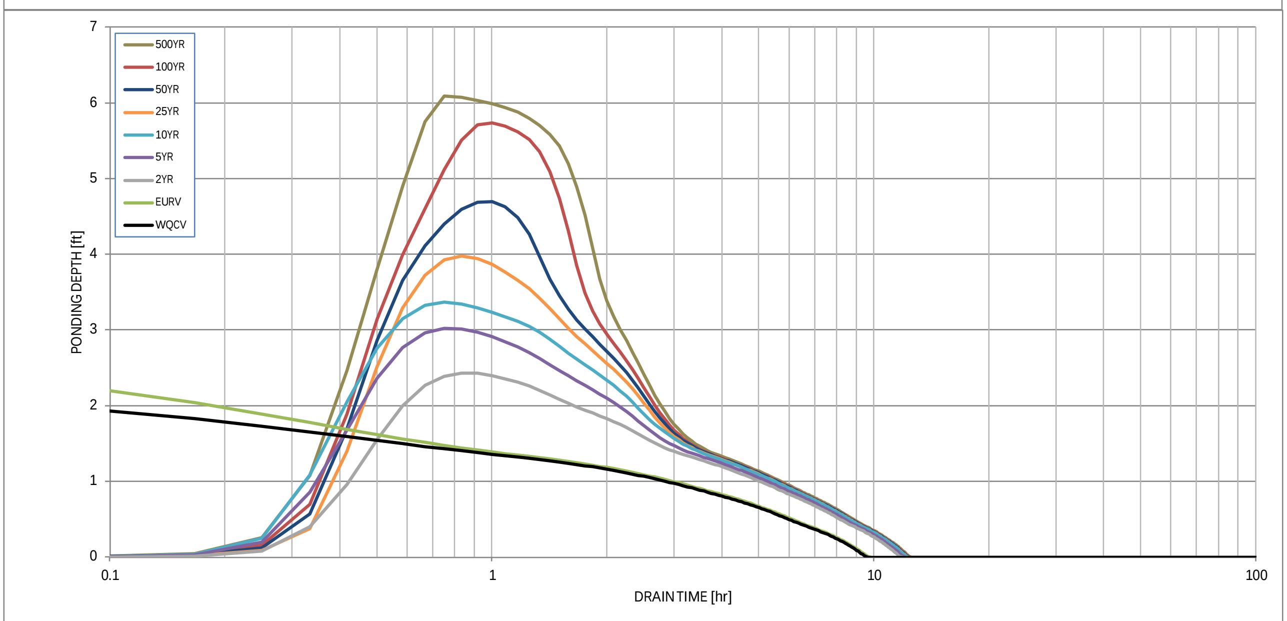
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

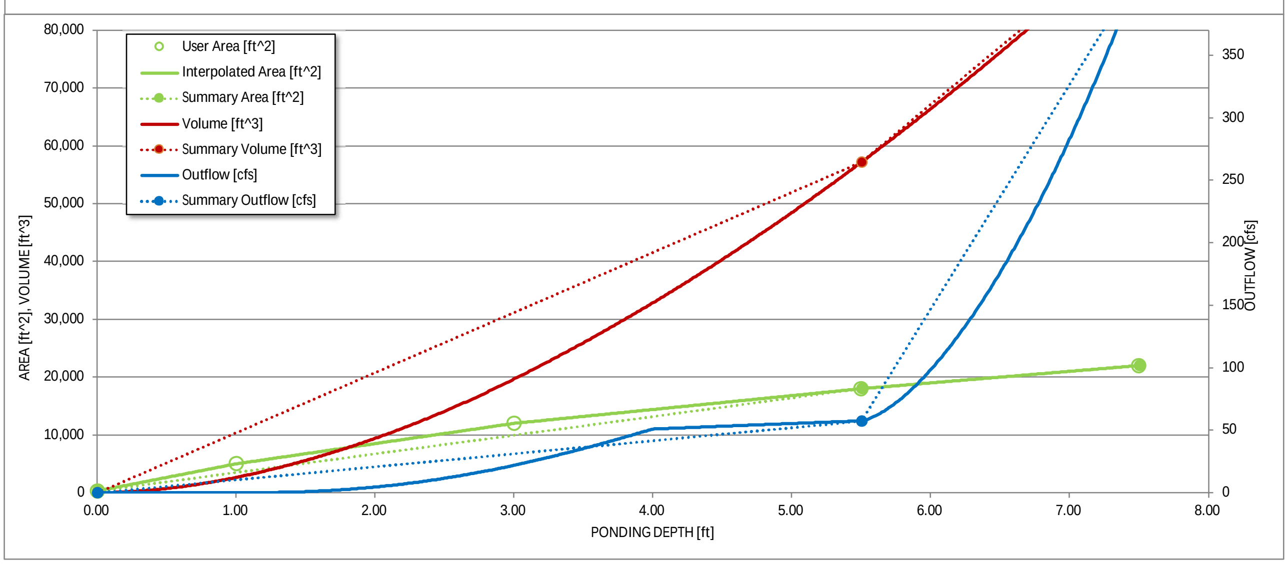
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.267	0.384	1.066	2.180	3.220	4.645	5.781	7.350
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.066	2.180	3.220	4.645	5.781	7.350
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	12.0	24.6	33.9	52.9	65.1	81.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.22	0.45	0.62	0.96	1.18	1.48
Peak Inflow Q (cfs) =	N/A	N/A	14.8	27.3	36.8	55.5	67.7	84.1
Peak Outflow Q (cfs) =	6.3	12.8	10.5	22.5	31.6	50.3	54.1	70.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.9	0.9	1.0	0.8	0.9
Structure Controlling Flow =	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	0.28	0.62	0.38	0.9	1.2	1.9	2.1	2.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	8	7	7	5	4	3	3	3
Time to Drain 99% of Inflow Volume (hours) =	9	9	9	8	7	6	6	5
Maximum Ponding Depth (ft) =	2.25	2.75	2.43	3.03	3.37	3.98	4.70	5.74
Area at Maximum Ponding Depth (acres) =	0.22	0.26	0.23	0.28	0.30	0.33	0.37	0.42
Maximum Volume Stored (acre-ft) =	0.267	0.385	0.307	0.457	0.557	0.744	0.995	1.408

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
	0:15:00	0.00	0.00	0.06	0.09	0.11	0.08	0.10	0.09	0.14
	0:20:00	0.00	0.00	0.22	0.91	1.40	0.23	0.37	0.59	1.34
	0:25:00	0.00	0.00	2.91	11.59	18.06	2.54	5.55	7.94	17.74
	0:30:00	0.00	0.00	10.42	23.10	32.15	28.05	36.63	43.57	64.95
	0:35:00	0.00	0.00	14.07	27.31	36.79	46.58	58.06	70.74	99.05
	0:40:00	0.00	0.00	14.79	27.26	36.47	54.78	67.18	81.91	112.55
	0:45:00	0.00	0.00	13.69	25.29	34.21	55.53	67.71	84.08	114.63
	0:50:00	0.00	0.00	12.12	23.31	31.61	53.67	65.38	81.62	111.22
	0:55:00	0.00	0.00	10.81	21.12	29.10	50.15	61.21	77.55	105.75
	1:00:00	0.00	0.00	9.62	19.03	26.92	46.07	56.43	73.17	99.99
	1:05:00	0.00	0.00	8.67	17.36	25.29	42.51	52.31	69.44	95.16
	1:10:00	0.00	0.00	7.80	15.93	23.89	38.80	48.03	63.74	87.84
	1:15:00	0.00	0.00	6.94	14.36	22.49	35.18	43.83	57.49	79.81
	1:20:00	0.00	0.00	6.11	12.69	20.37	31.29	39.06	50.81	70.70
	1:25:00	0.00	0.00	5.29	11.02	17.80	27.41	34.21	44.25	61.58
	1:30:00	0.00	0.00	4.51	9.53	15.40	23.62	29.49	38.11	53.10
	1:35:00	0.00	0.00	3.89	8.47	13.64	20.25	25.38	32.79	45.90
	1:40:00	0.00	0.00	3.51	7.61	12.28	17.84	22.41	28.87	40.51
	1:45:00	0.00	0.00	3.19	6.82	11.07	15.89	19.98	25.68	36.06
	1:50:00	0.00	0.00	2.90	6.08	9.98	14.21	17.87	22.86	32.14
	1:55:00	0.00	0.00	2.60	5.39	8.93	12.68	15.96	20.32	28.58
	2:00:00	0.00	0.00	2.29	4.73	7.85	11.27	14.19	17.96	25.27
	2:05:00	0.00	0.00	1.98	4.07	6.76	9.86	12.40	15.65	22.01
	2:10:00	0.00	0.00	1.67	3.42	5.70	8.47	10.65	13.47	18.90
	2:15:00	0.00	0.00	1.37	2.80	4.70	7.14	8.96	11.40	15.95
	2:20:00	0.00	0.00	1.08	2.19	3.75	5.84	7.33	9.36	13.08
	2:25:00	0.00	0.00	0.78	1.58	2.85	4.57	5.73	7.36	10.27
	2:30:00	0.00	0.00	0.50	1.00	1.98	3.30	4.16	5.37	7.50
	2:35:00	0.00	0.00	0.26	0.64	1.45	2.10	2.70	3.55	5.08
	2:40:00	0.00	0.00	0.17	0.46	1.14	1.40	1.86	2.43	3.57
	2:45:00	0.00	0.00	0.12	0.35	0.89	0.96	1.31	1.69	2.55
	2:50:00	0.00	0.00	0.09	0.26	0.70	0.67	0.93	1.16	1.78
	2:55:00	0.00	0.00	0.07	0.20	0.54	0.45	0.64	0.77	1.22
	3:00:00	0.00	0.00	0.06	0.15	0.41	0.32	0.45	0.49	0.80
	3:05:00	0.00	0.00	0.04	0.11	0.30	0.21	0.31	0.29	0.49
	3:10:00	0.00	0.00	0.03	0.08	0.21	0.14	0.21	0.16	0.30
	3:15:00	0.00	0.00	0.03	0.05	0.14	0.10	0.14	0.12	0.21
	3:20:00	0.00	0.00	0.02	0.04	0.09	0.07	0.10	0.09	0.15
	3:25:00	0.00	0.00	0.02	0.03	0.07	0.05	0.08	0.07	0.12
	3:30:00	0.00	0.00	0.01	0.02	0.05	0.04	0.06	0.05	0.09
	3:35:00	0.00	0.00	0.01	0.01	0.04	0.03	0.05	0.04	0.07
	3:40:00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.05
	3:45:00	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.02	0.03
	3:50:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Kimley»Horn

Extended Detention Basin (EDB) Calculations

Project	Winsome Filing 3 - Pond 2		
Date	9/15/2022		Manual Input
Prepared By	TOS		Multipliers
Checked By			

Release Factor:	0.02

Forebay Release and Configuration: Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration				
Forebay	Incoming Pipe Diameter (in)	Undetained 100-year Peak Discharge (cfs)	Release Rate (cfs)	Forebay Notch Width (in)
A	N/A	110.40	2.21	7.9

Maximum Forebay Depth				
Forebay	Impervious Area in Watershed (ac)	Maximum Forebay Depth (in)	Design Forebay Depth (in)	Design Forebay Depth (ft)
A	4.68	18	18	1.5

Note: a forebay depth of 30" requires handrails by most City Standards

Minimum Forebay Volume Required: 3% WQCV						
Forebay	WQCV (ac-ft)	Required Volume (ac-ft)	Required Volume (cf)	Total Length (ft)	Total Width (ft)	Design Volume (cf)
A	0.267	7.00	304920	18	19	513

Volume Factor:	0.03

Kimley»Horn

Project: Winsome Filing 3 -Pond 2
Date: 12/13/2021

Emergency Overflow Weir Calculation

Q (cfs) =	110.4	(100-yr peak inflow)
C_{BCW} =	3	
Z =	4	
H =	0.71	
L (ft) =	59.24	Rounded to 60

*orange cells require input

$$Q = C_{BCW} L H^{1.5} + 2\left[\left(2/5\right) C_{BCW} Z H^{2.5}\right]$$

rearrange to solve for length:

$$L = \frac{Q - \left(4/5\right) C_{BCW} Z H^{2.5}}{C_{BCW} H^{1.5}}$$

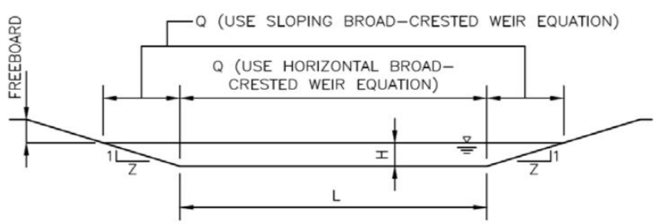


Figure 12-20. Sloping broad-crest weir

Horizontal Broad Crested Weir Equation (from USDCM Eqn. 12-8)

$$Q = C_{BCW} L H^{1.5} \qquad \text{Equation 12-8}$$

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

Sloping Broad Crested Weir Equation (from USDCM Eqn. 12-9)

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5} \qquad \text{Equation 12-9}$$

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

Z = side slope (horizontal: vertical)

H = head above weir crest (ft)

Note that in order to calculate the total flow over the weir depicted in Figure 12-20, the results from Equation 12-8 must be added to two times the results from Equation 12-9.

Pond 2 Spillway

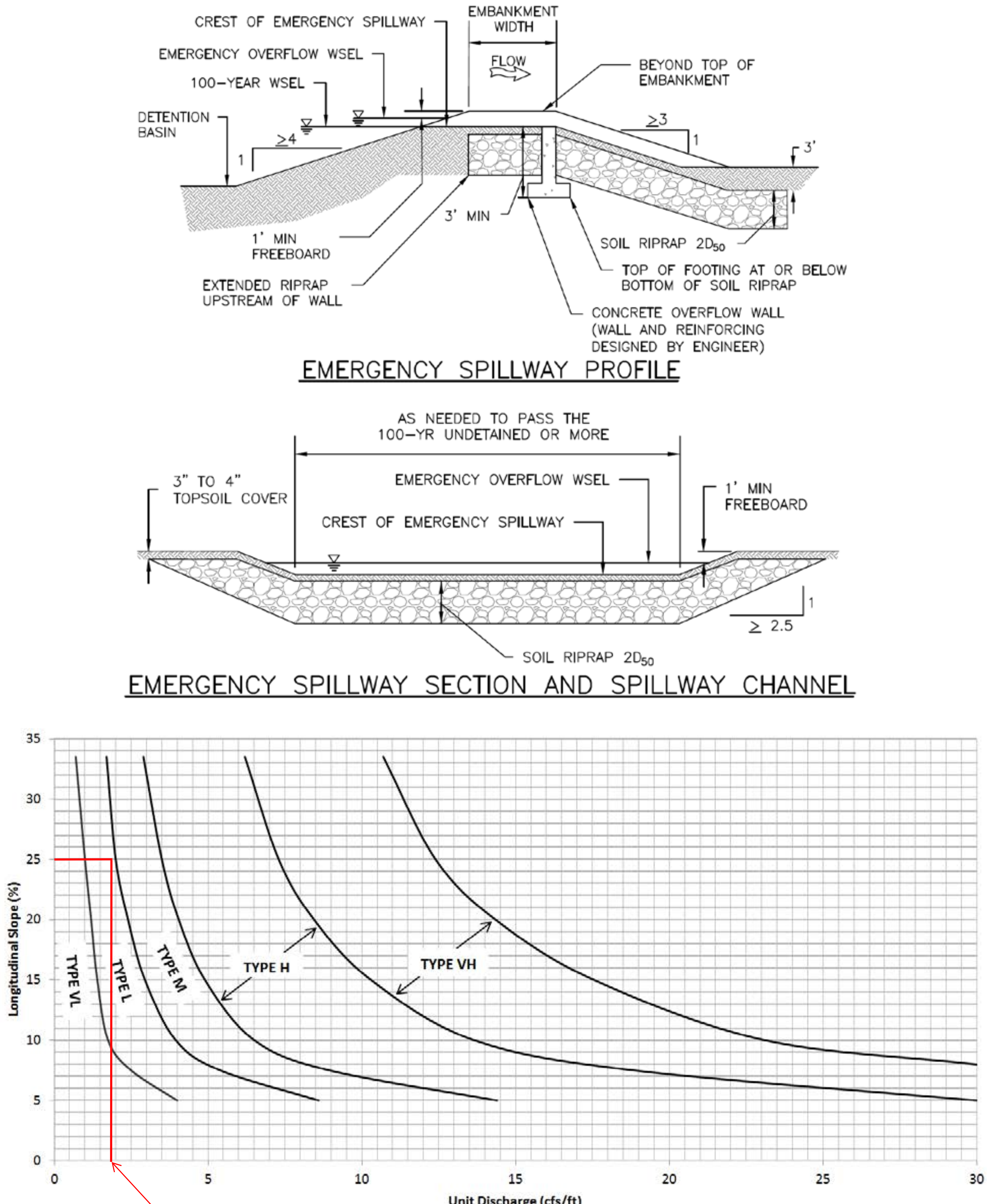


Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

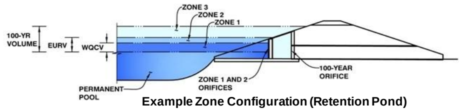
110.4 cfs/60 ft = 1.84

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 4 (BASIN H3 + H7A + H7B + I1)_Modified Area



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	64.00	acres
Watershed Length =	2,267	ft
Watershed Length to Centroid =	1,368	ft
Watershed Slope =	0.057	ft/ft
Watershed Imperviousness =	11.90%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	14.0%	percent
Percentage Hydrologic Soil Groups C/D =	86.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.247	acre-feet	0.247	acre-feet
Excess Urban Runoff Volume (EURV) =	0.433	acre-feet	0.433	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.333	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.607	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.819	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	5.479	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	6.792	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	8.600	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	11.978	acre-feet		inches
Approximate 2-yr Detention Volume =	0.517	acre-feet		
Approximate 5-yr Detention Volume =	1.104	acre-feet		
Approximate 10-yr Detention Volume =	1.494	acre-feet		
Approximate 25-yr Detention Volume =	1.815	acre-feet		
Approximate 50-yr Detention Volume =	1.891	acre-feet		
Approximate 100-yr Detention Volume =	2.561	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.247	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.186	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	2.128	acre-feet
Total Detention Basin Volume =	2.561	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	199	0.005		
7292	--	1.00	--	--	--	4,705	0.108	2,452	0.056
7293	--	2.00	--	--	--	19,328	0.444	14,468	0.332
7294	--	3.00	--	--	--	28,048	0.644	38,156	0.876
7295	--	4.00	--	--	--	31,430	0.722	67,895	1.559
7296	--	5.00	--	--	--	34,844	0.800	101,032	2.319
7295	--	6.00	--	--	--	38,298	0.879	137,603	3.159
7298	--	7.00	--	--	--	41,682	0.957	177,593	4.077
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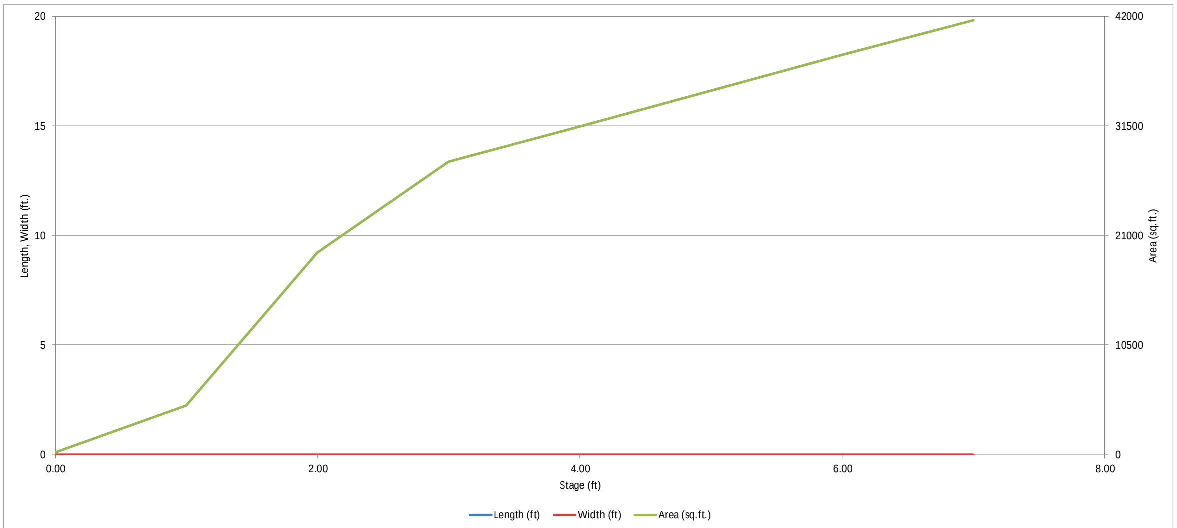
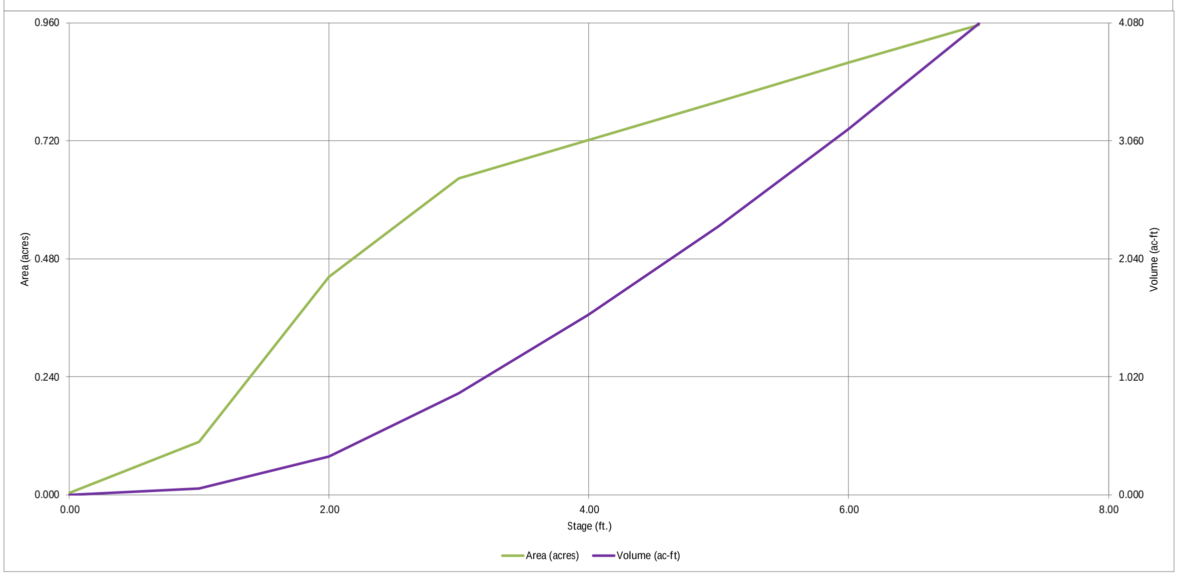
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



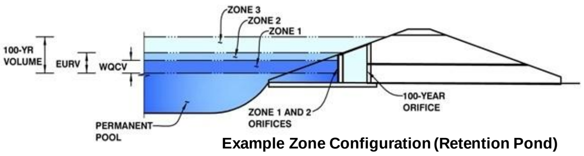


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 4 (BASIN H3 + H7A + H7B + I1)_Modified Area



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.80	0.247	Orifice Plate
Zone 2 (EURV)	2.22	0.186	Orifice Plate
Zone 3 (100-year)	5.30	2.128	Weir&Pipe (Restrict)
Total (all zones)		2.561	

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

				Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)		Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches		Underdrain Orifice Centroid =		feet

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

			Calculated Parameters for Plate		
Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	1.80	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	inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.60	1.20					
Orifice Area (sq. inches)	1.10	1.10	1.20					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orifice	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

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

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.50	N/A	feet
Overflow Weir Front Edge Length =	12.00	N/A	feet	Overflow Weir Slope Length =	6.18	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.26	N/A	
Horiz. Length of Weir Sides =	6.00	N/A	feet	Overflow Grate Open Area w/o Debris =	51.65	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	25.83	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	6.25	N/A	ft^2
Outlet Pipe Diameter =	42.00	N/A	inches	Outlet Orifice Centroid =	1.23	N/A	feet
Restrictor Plate Height Above Pipe Invert =	26.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.81	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	5.34	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.69	feet
Spillway Crest Length =	60.00	feet	Stage at Top of Freeboard =	7.03	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.96	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	4.08	acre-ft

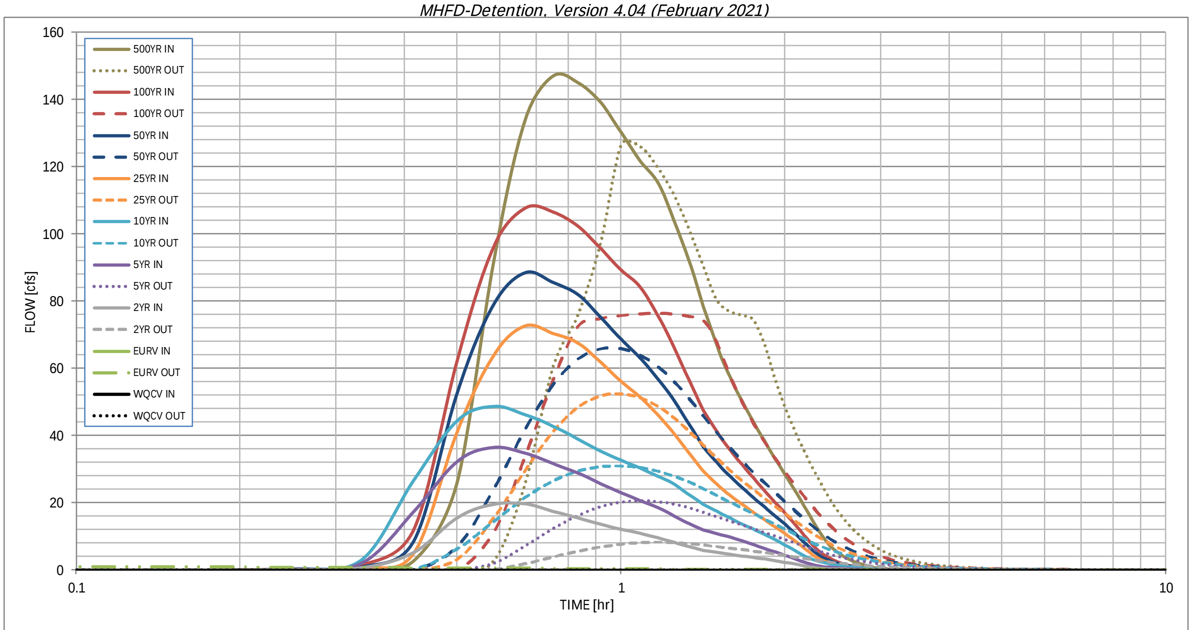
Routed Hydrograph Results

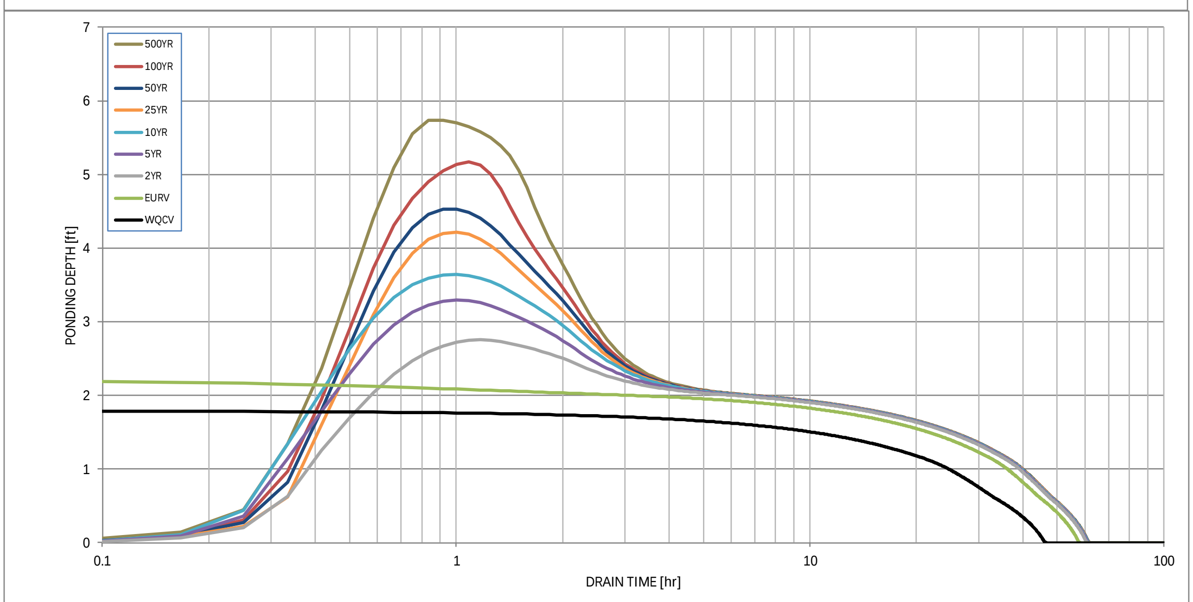
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

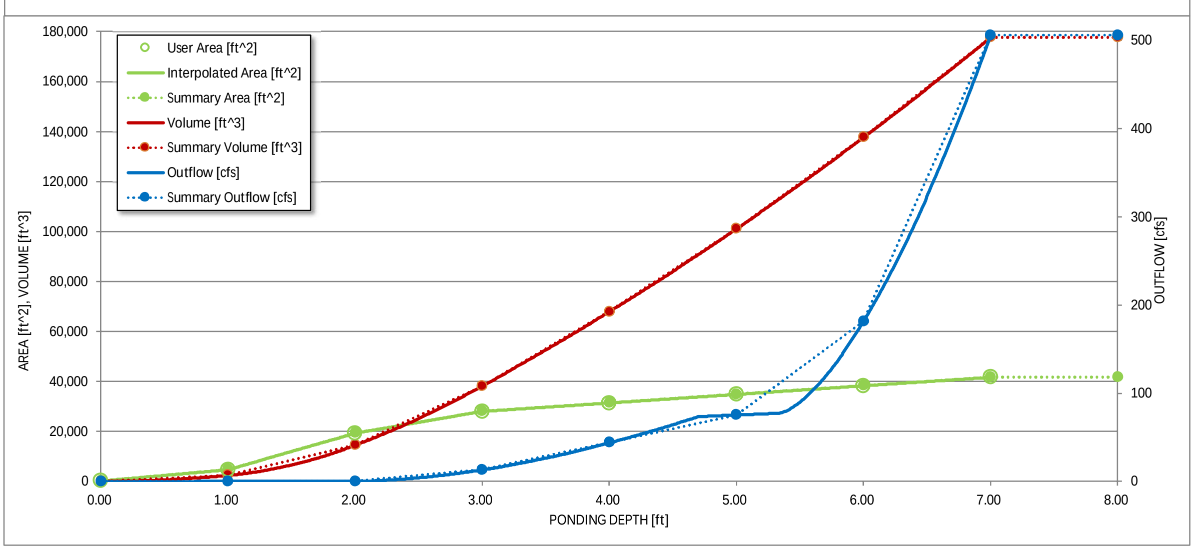
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.247	0.433	1.333	2.607	3.819	5.479	6.792	8.600	11.978
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.333	2.607	3.819	5.479	6.792	8.600	11.978
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	14.4	30.4	42.6	65.8	81.6	101.6	140.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.22	0.48	0.67	1.03	1.27	1.59	2.19
Peak Inflow Q (cfs) =	N/A	N/A	19.7	36.5	48.8	72.7	88.5	107.7	147.0
Peak Outflow Q (cfs) =	0.1	1.2	8.3	20.6	31.0	52.4	65.9	76.5	126.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.7	0.8	0.8	0.8	0.9
Structure Controlling Flow =	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.02	0.16	0.4	0.6	1.0	1.3	1.5	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	49	43	35	30	24	20	14	5
Time to Drain 99% of Inflow Volume (hours) =	43	54	52	47	44	40	38	34	30
Maximum Ponding Depth (ft) =	1.80	2.22	2.76	3.30	3.64	4.22	4.53	5.17	5.74
Area at Maximum Ponding Depth (acres) =	0.38	0.49	0.59	0.67	0.69	0.74	0.76	0.81	0.86
Maximum Volume Stored (acre-ft) =	0.250	0.435	0.721	1.066	1.304	1.712	1.952	2.457	2.933

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.06
	0:15:00	0.00	0.00	0.16	0.26	0.32	0.22	0.28	0.26	0.40
	0:20:00	0.00	0.00	0.63	1.98	2.92	0.62	0.98	1.40	2.83
	0:25:00	0.00	0.00	5.29	17.45	26.81	5.08	8.75	12.20	26.33
	0:30:00	0.00	0.00	15.64	32.36	44.49	41.35	52.95	62.61	92.03
	0:35:00	0.00	0.00	19.56	36.48	48.78	64.01	79.13	96.40	134.06
	0:40:00	0.00	0.00	19.67	34.84	46.23	72.65	88.52	107.73	147.03
	0:45:00	0.00	0.00	17.51	31.68	42.86	70.45	85.58	106.61	145.05
	0:50:00	0.00	0.00	15.49	28.89	38.98	67.63	82.09	102.38	139.08
	0:55:00	0.00	0.00	13.61	25.73	35.41	61.81	75.23	95.65	130.15
	1:00:00	0.00	0.00	12.12	23.06	32.68	56.12	68.60	89.28	121.88
	1:05:00	0.00	0.00	10.92	20.75	30.33	51.46	63.17	84.36	115.35
	1:10:00	0.00	0.00	9.60	18.58	28.00	46.12	56.95	75.79	104.20
	1:15:00	0.00	0.00	8.26	16.18	25.65	40.67	50.58	66.39	91.99
	1:20:00	0.00	0.00	6.95	13.77	22.41	34.83	43.42	56.47	78.48
	1:25:00	0.00	0.00	5.88	12.02	19.64	29.43	36.79	47.59	66.51
	1:30:00	0.00	0.00	5.22	10.81	17.39	25.46	31.89	41.00	57.43
	1:35:00	0.00	0.00	4.69	9.76	15.46	22.28	27.94	35.80	50.20
	1:40:00	0.00	0.00	4.22	8.62	13.71	19.58	24.57	31.33	43.95
	1:45:00	0.00	0.00	3.75	7.49	12.10	17.15	21.52	27.31	38.33
	1:50:00	0.00	0.00	3.30	6.42	10.58	14.94	18.75	23.61	33.16
	1:55:00	0.00	0.00	2.80	5.39	9.06	12.82	16.10	20.14	28.29
	2:00:00	0.00	0.00	2.29	4.38	7.45	10.79	13.56	16.89	23.74
	2:05:00	0.00	0.00	1.78	3.36	5.82	8.69	10.93	13.65	19.15
	2:10:00	0.00	0.00	1.27	2.37	4.28	6.60	8.31	10.43	14.60
	2:15:00	0.00	0.00	0.81	1.56	3.08	4.60	5.84	7.38	10.43
	2:20:00	0.00	0.00	0.51	1.08	2.35	3.03	3.94	5.00	7.26
	2:25:00	0.00	0.00	0.37	0.81	1.86	2.10	2.79	3.50	5.19
	2:30:00	0.00	0.00	0.28	0.62	1.47	1.48	2.01	2.46	3.73
	2:35:00	0.00	0.00	0.22	0.48	1.15	1.05	1.45	1.70	2.64
	2:40:00	0.00	0.00	0.17	0.37	0.89	0.74	1.04	1.14	1.82
	2:45:00	0.00	0.00	0.14	0.28	0.67	0.53	0.74	0.74	1.20
	2:50:00	0.00	0.00	0.11	0.21	0.49	0.37	0.52	0.45	0.77
	2:55:00	0.00	0.00	0.08	0.16	0.35	0.26	0.36	0.30	0.51
	3:00:00	0.00	0.00	0.07	0.11	0.25	0.19	0.27	0.22	0.38
	3:05:00	0.00	0.00	0.05	0.08	0.18	0.15	0.20	0.17	0.29
	3:10:00	0.00	0.00	0.04	0.06	0.14	0.11	0.16	0.14	0.23
	3:15:00	0.00	0.00	0.03	0.04	0.10	0.08	0.12	0.11	0.18
	3:20:00	0.00	0.00	0.02	0.02	0.07	0.06	0.09	0.08	0.13
	3:25:00	0.00	0.00	0.01	0.01	0.05	0.04	0.06	0.05	0.09
	3:30:00	0.00	0.00	0.01	0.01	0.03	0.03	0.04	0.03	0.06
	3:35:00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.03
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
7291	0.00	199	0.005	0	0.000	0.00
7292	1.00	4,705	0.108	2,452	0.056	0.06
7293	2.00	19,328	0.444	14,468	0.332	0.13
7294	3.00	28,048	0.644	38,156	0.876	13.18
7295	4.00	31,430	0.722	67,895	1.559	43.81
7296	5.00	34,844	0.800	101,032	2.319	75.43
7297	6.00	38,298	0.879	137,603	3.159	181.14
7298	7.00	41,682	0.957	177,593	4.077	505.69
7299	8.00	41,682	0.957	177,593	4.077	505.69

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

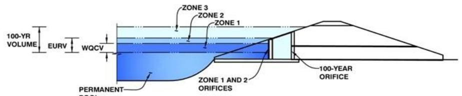
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 4 (BASIN H3 + H7A + H7B + I1)_Original



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB			
Watershed Area =	42.38	acres		
Watershed Length =	2,267	ft		
Watershed Length to Centroid =	1,368	ft		
Watershed Slope =	0.057	ft/ft		
Watershed Imperviousness =	11.90%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	14.0%	percent		
Percentage Hydrologic Soil Groups C/D =	86.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.274	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.433	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.000	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.000	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.000	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.000	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.000	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.000	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.000	acre-feet		inches
Approximate 2-yr Detention Volume =	0.343	acre-feet		
Approximate 5-yr Detention Volume =	0.731	acre-feet		
Approximate 10-yr Detention Volume =	0.989	acre-feet		
Approximate 25-yr Detention Volume =	1.202	acre-feet		
Approximate 50-yr Detention Volume =	1.253	acre-feet		
Approximate 100-yr Detention Volume =	1.696	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.274	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.159	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.263	acre-feet
Total Detention Basin Volume =	1.696	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	8,535	0.196		
	--	5.50	--	--	--	17,603	0.404	71,879	1.650
7308.5	--	7.50	--	--	--	21,697	0.498	111,179	2.552
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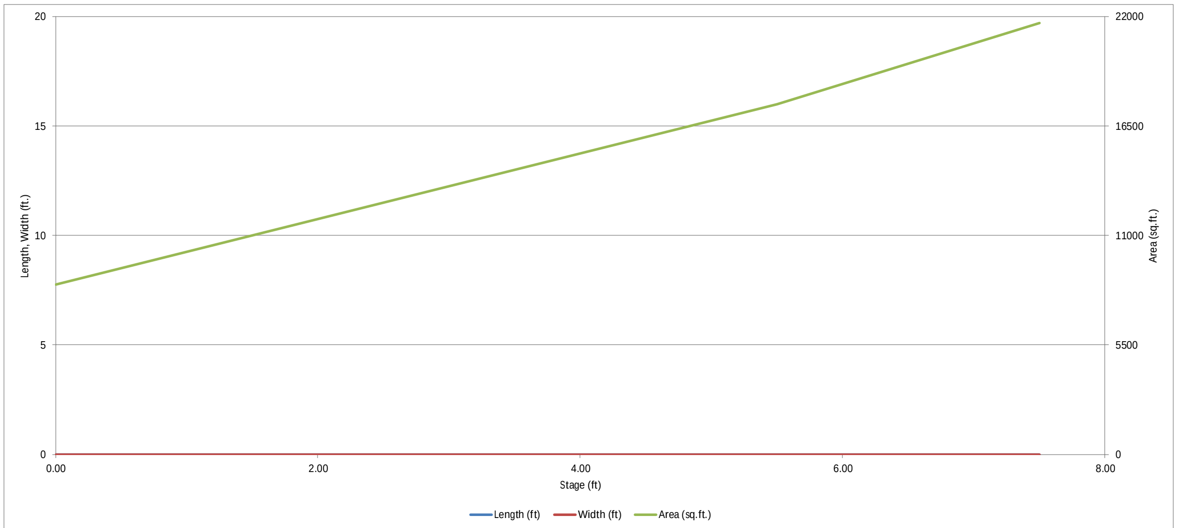
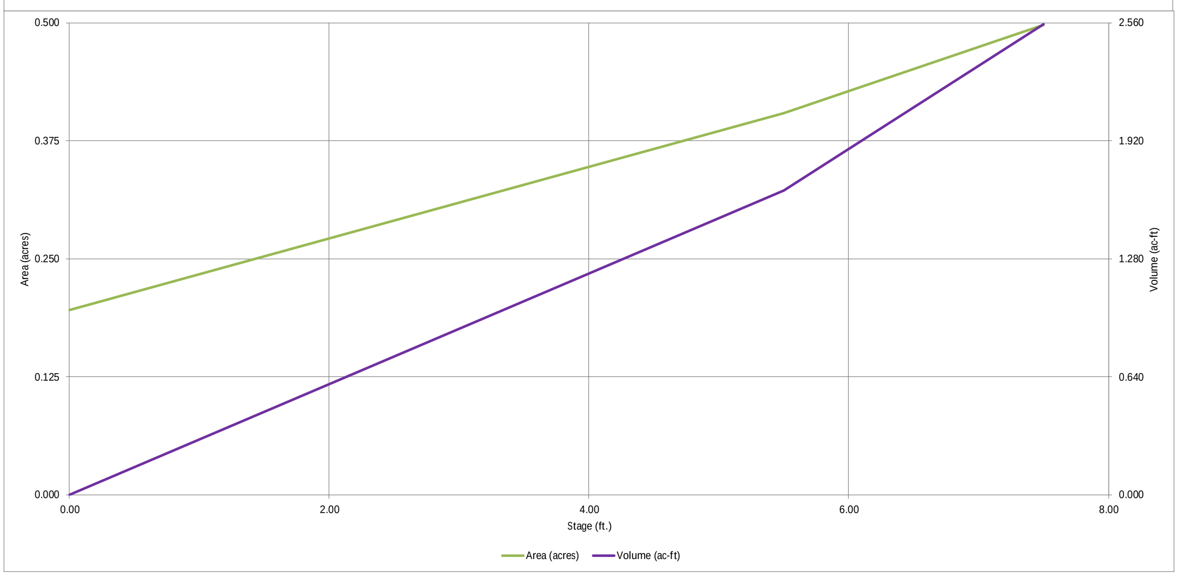
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



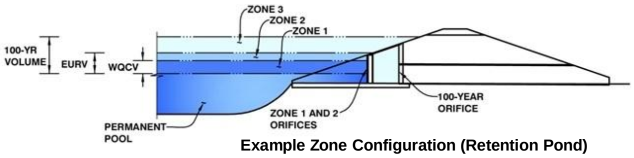


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: POND 4 (BASIN H3 + H7A + H7B + I1)_Original



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.25	0.274	Orifice Plate
Zone 2 (EURV)	1.88	0.159	Orifice Plate
Zone 3 (100-year)	5.62	1.263	Weir&Pipe (Restrict)
Total (all zones)		1.696	

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

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

Calculated Parameters for Underdrain

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

Calculated Parameters for Plate

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	1.70	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	6.80	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =		sq. inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (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	0.57	1.13					
Orifice Area (sq. inches)	0.00	0.00	0.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

Calculated Parameters for Vertical Orific

	Not Selected	Not Selected			Not Selected	Not Selected
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A
Vertical Orifice Diameter =	N/A	N/A	inches			

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

Calculated Parameters for Overflow Wei

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, Ho =	1.70	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =		N/A
Overflow Weir Front Edge Length =		N/A	feet	Overflow Weir Slope Length =		N/A
Overflow Weir Grate Slope =		N/A	H:V	Grate Open Area / 100-yr Orifice Area =		N/A
Horiz. Length of Weir Sides =		N/A	feet	Overflow Grate Open Area w/o Debris =		N/A
Overflow Grate Type =		N/A		Overflow Grate Open Area w/ Debris =		N/A
Debris Clogging % =		N/A	%			

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plat

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected
Depth to Invert of Outlet Pipe =		N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =		N/A
Outlet Pipe Diameter =		N/A	inches	Outlet Orifice Centroid =		N/A
Restrictor Plate Height Above Pipe Invert =			inches	Half-Central Angle of Restrictor Plate on Pipe =		N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

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

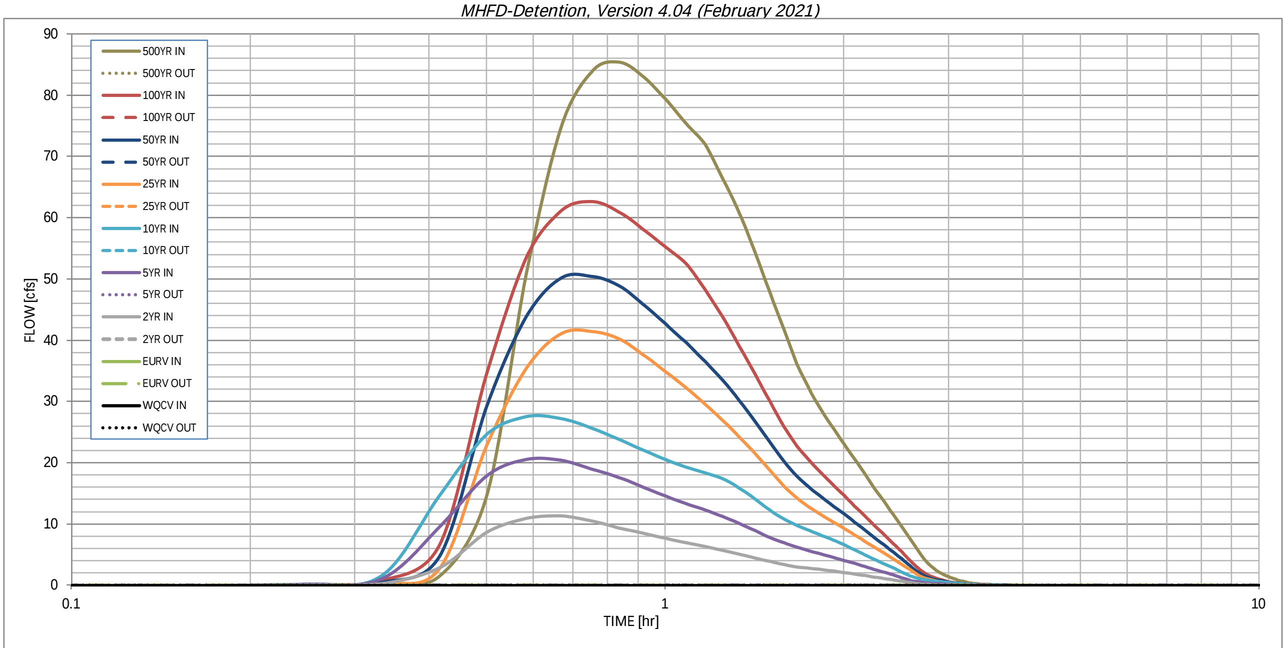
Routed Hydrograph Results

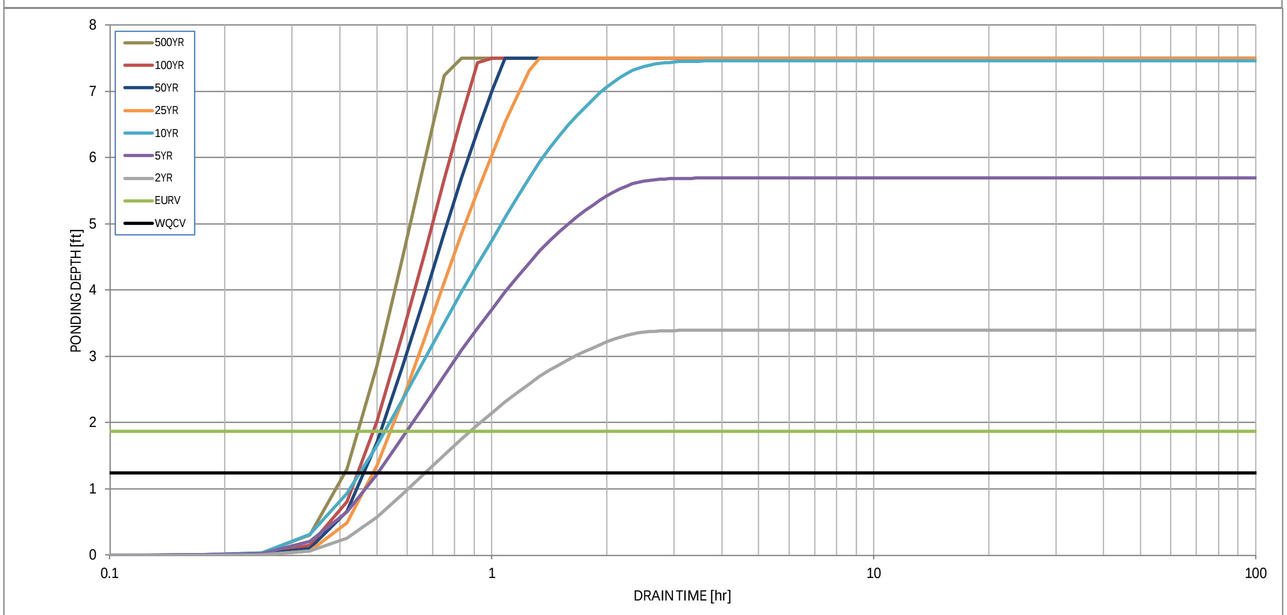
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

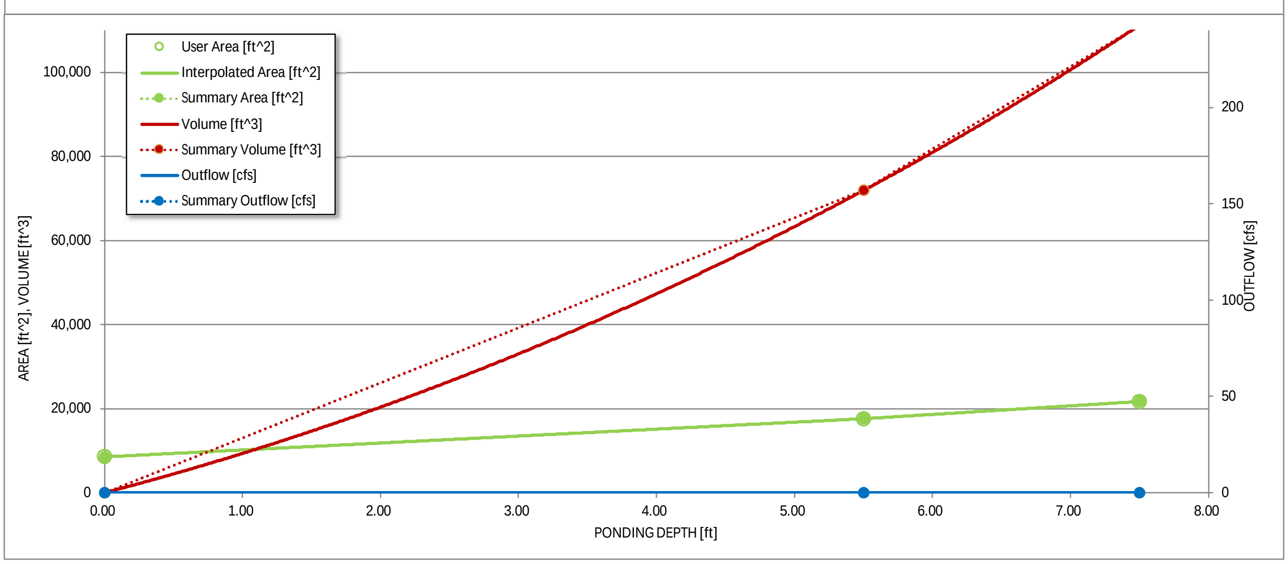
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.274	0.433	0.000	0.000	0.000	0.000	0.000	0.000
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.884	1.730	2.534	3.635	4.506	5.705
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00
Peak Inflow Q (cfs) =	N/A	N/A	11.3	20.5	27.5	41.5	50.5	62.7
Peak Outflow Q (cfs) =								
Ratio Peak Outflow to Predevelopment Q =								
Structure Controlling Flow =								
Max Velocity through Grate 1 (fps) =								
Max Velocity through Grate 2 (fps) =								
Time to Drain 97% of Inflow Volume (hours) =								
Time to Drain 99% of Inflow Volume (hours) =								
Maximum Ponding Depth (ft) =								
Area at Maximum Ponding Depth (acres) =								
Maximum Volume Stored (acre-ft) =								

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03
	0:15:00	0.00	0.00	0.09	0.14	0.18	0.12	0.15	0.15	0.22
	0:20:00	0.00	0.00	0.34	1.09	1.61	0.34	0.54	0.77	1.56
	0:25:00	0.00	0.00	2.91	9.61	14.76	2.80	4.82	6.72	14.50
	0:30:00	0.00	0.00	8.63	17.88	24.60	22.78	29.17	34.50	50.75
	0:35:00	0.00	0.00	10.91	20.54	27.54	35.42	43.84	53.44	74.55
	0:40:00	0.00	0.00	11.34	20.45	27.29	41.07	50.18	61.09	83.83
	0:45:00	0.00	0.00	10.51	19.04	25.71	41.51	50.50	62.72	85.46
	0:50:00	0.00	0.00	9.43	17.67	23.87	40.30	48.97	61.04	83.15
	0:55:00	0.00	0.00	8.53	16.11	22.13	37.75	45.98	58.23	79.38
	1:00:00	0.00	0.00	7.69	14.58	20.54	34.91	42.67	55.25	75.43
	1:05:00	0.00	0.00	7.00	13.36	19.36	32.30	39.64	52.53	71.94
	1:10:00	0.00	0.00	6.36	12.35	18.39	29.57	36.51	48.27	66.49
	1:15:00	0.00	0.00	5.73	11.25	17.42	26.99	33.54	43.83	60.80
	1:20:00	0.00	0.00	5.11	10.10	15.88	24.23	30.16	39.07	54.29
	1:25:00	0.00	0.00	4.51	8.94	14.07	21.51	26.76	34.43	47.85
	1:30:00	0.00	0.00	3.92	7.82	12.26	18.82	23.41	30.04	41.74
	1:35:00	0.00	0.00	3.40	6.95	10.85	16.22	20.22	25.95	36.18
	1:40:00	0.00	0.00	3.05	6.24	9.82	14.25	17.81	22.80	31.91
	1:45:00	0.00	0.00	2.80	5.64	8.95	12.74	15.95	20.36	28.55
	1:50:00	0.00	0.00	2.58	5.09	8.17	11.48	14.39	18.27	25.65
	1:55:00	0.00	0.00	2.34	4.57	7.42	10.35	12.98	16.40	23.04
	2:00:00	0.00	0.00	2.10	4.09	6.62	9.32	11.70	14.68	20.65
	2:05:00	0.00	0.00	1.85	3.59	5.81	8.27	10.37	12.97	18.23
	2:10:00	0.00	0.00	1.61	3.10	5.02	7.24	9.07	11.35	15.91
	2:15:00	0.00	0.00	1.37	2.63	4.26	6.26	7.83	9.83	13.75
	2:20:00	0.00	0.00	1.14	2.17	3.55	5.30	6.63	8.35	11.66
	2:25:00	0.00	0.00	0.91	1.72	2.87	4.37	5.47	6.91	9.63
	2:30:00	0.00	0.00	0.68	1.28	2.22	3.45	4.32	5.48	7.62
	2:35:00	0.00	0.00	0.46	0.86	1.59	2.55	3.20	4.07	5.65
	2:40:00	0.00	0.00	0.28	0.57	1.17	1.69	2.15	2.76	3.91
	2:45:00	0.00	0.00	0.19	0.41	0.92	1.14	1.49	1.90	2.76
	2:50:00	0.00	0.00	0.14	0.32	0.73	0.79	1.06	1.33	1.98
	2:55:00	0.00	0.00	0.11	0.25	0.58	0.56	0.77	0.93	1.41
	3:00:00	0.00	0.00	0.09	0.19	0.45	0.40	0.55	0.63	0.99
	3:05:00	0.00	0.00	0.07	0.15	0.35	0.28	0.40	0.42	0.67
	3:10:00	0.00	0.00	0.05	0.11	0.27	0.20	0.28	0.27	0.44
	3:15:00	0.00	0.00	0.04	0.09	0.19	0.14	0.20	0.17	0.29
	3:20:00	0.00	0.00	0.04	0.06	0.14	0.10	0.15	0.12	0.21
	3:25:00	0.00	0.00	0.03	0.05	0.10	0.08	0.11	0.09	0.15
	3:30:00	0.00	0.00	0.02	0.03	0.07	0.06	0.08	0.07	0.12
	3:35:00	0.00	0.00	0.02	0.02	0.06	0.05	0.06	0.06	0.09
	3:40:00	0.00	0.00	0.01	0.01	0.04	0.03	0.05	0.04	0.07
	3:45:00	0.00	0.00	0.01	0.01	0.03	0.02	0.03	0.03	0.05
	3:50:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	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	0.01	0.01	0.01	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 OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]
7301	0.00	8,535	0.196	0	0.000	0.00
7306.5	5.50	17,603	0.404	71,879	1.650	0.00
7308.5	7.50	21,697	0.498	111,179	2.552	0.00

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Kimley»Horn

Project: Winsome Filing 3 -Pond 4

Date: 9/14/2022

Emergency Overflow Weir Calculation

Q (cfs) =	107.7	(100-yr peak inflow)
C_{BCW} =	3	
Z =	4	
H =	0.70	
L (ft) =	59.06	Rounded to 60

*orange cells require input

$$Q = C_{BCW} L H^{1.5} + 2\left[\left({}^{2}/_{5}\right) C_{BCW} Z H^{2.5}\right]$$

rearrange to solve for length:

$$L = \frac{Q - \left({}^{4}/_{5}\right) C_{BCW} Z H^{2.5}}{C_{BCW} H^{1.5}}$$

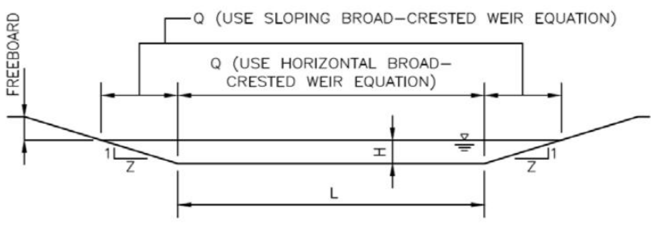


Figure 12-20. Sloping broad-crest weir

Horizontal Broad Crested Weir Equation (from USDCM Eqn. 12-8)

$$Q = C_{BCW} L H^{1.5} \qquad \text{Equation 12-8}$$

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

Sloping Broad Crested Weir Equation (from USDCM Eqn. 12-9)

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5} \qquad \text{Equation 12-9}$$

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

Z = side slope (horizontal: vertical)

H = head above weir crest (ft)

Note that in order to calculate the total flow over the weir depicted in Figure 12-20, the results from Equation 12-8 must be added to two times the results from Equation 12-9.

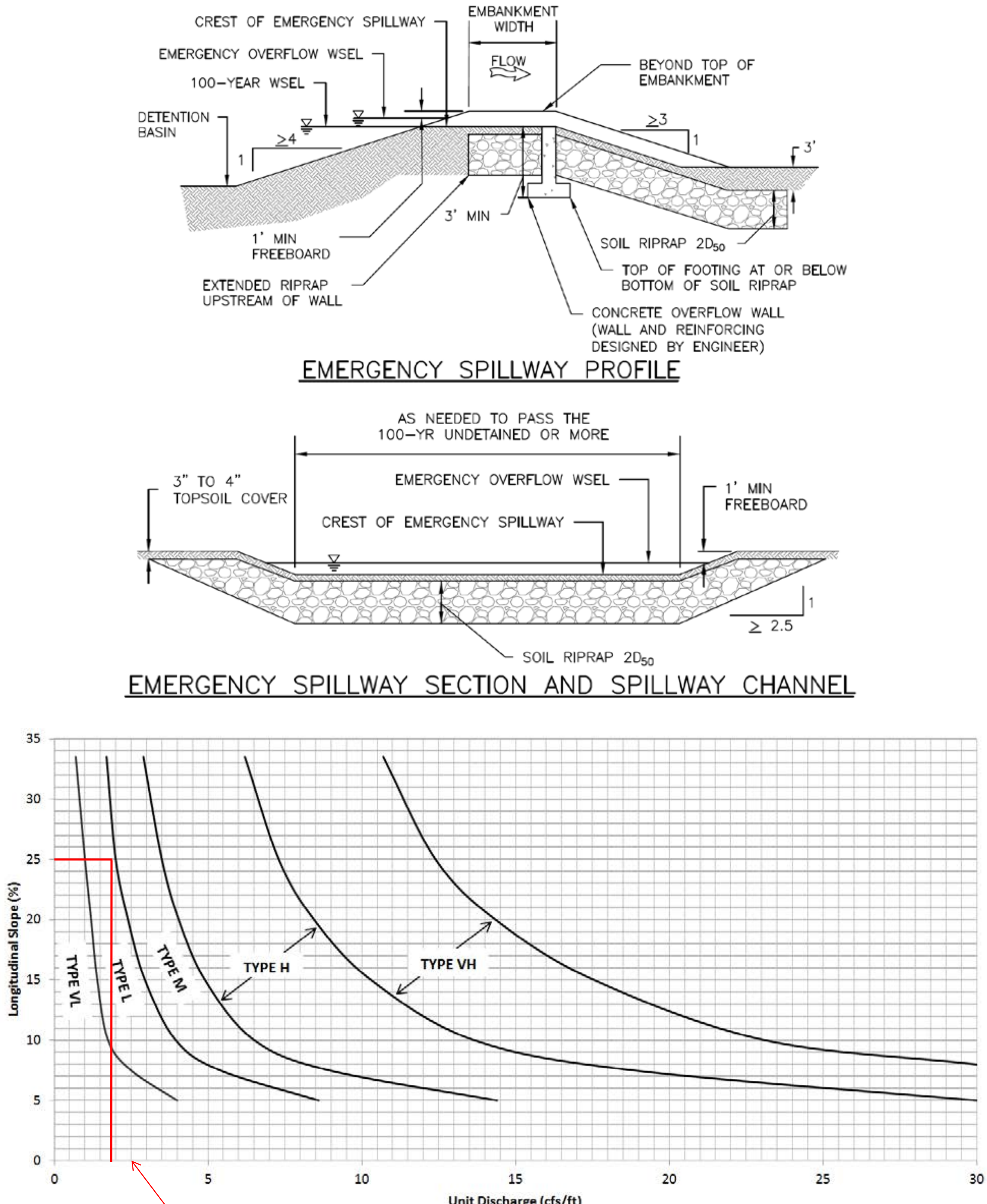


Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

107.7 cfs/60 ft = 1.80

Kimley»Horn

Extended Detention Basin (EDB) Calculations

Project	Winsome Filing 3 - Pond 4		
Date	12/20/2021		Manual Input
Prepared By	TOS		Multipliers
Checked By			

Release Factor:	0.02

Forebay Release and Configuration: Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration

Forebay	Incoming Pipe Diameter (in)	Undetained 100-year Peak Discharge (cfs)	Release Rate (cfs)	Forebay Notch Width (in)
A	42	96.00	1.92	7.4

Maximum Forebay Depth

Forebay	Impervious Area in Watershed (ac)	Maximum Forebay Depth (in)	Design Forebay Depth (in)	Design Forebay Depth (ft)
A	4.38	18	18	1.5

Note: a forebay depth of 30" requires handrails by most City Standards

Baffle Block Design

Forebay	Incoming Pipe Diameter (in)	1/4 of Diameter	Side length (in)	Height (in)
A	42	10.5	10.50	21

Minimum Forebay Volume Required: 3% WQCV

Volume Factor: 0.03

Forebay	WQCV (ac-ft)	Required Volume (ac-ft)	Required Volume (cf)	Total Length (ft)	Total Width (ft)	Corner Calculations			Design Volume (cf)
						Triangle Height (ft)	Triangle Base (ft)	Triangle Area (sf)	
A	0.245	0.01	320	16	16	6	3.5	10.5	321

Kimley»Horn

Extended Detention Basin (EDB) Calculations

Project	Winsome Filing 3 - Pond 4 North Rock Chute	
Date	9/15/2022	Manual Input
Prepared By	TOS	Multipliers
Checked By		

Release Factor:	0.02

Forebay Release and Configuration: Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration				
Forebay	Incoming Pipe Diameter (in)	Undetained 100-year Peak Discharge (cfs)	Release Rate (cfs)	Forebay Notch Width (in)
A	N/A	107.70	2.15	7.8

Maximum Forebay Depth				
Forebay	Impervious Area in Watershed (ac)	Maximum Forebay Depth (in)	Design Forebay Depth (in)	Design Forebay Depth (ft)
A	2.18	18	18	1.5

Note: a forebay depth of 30" requires handrails by most City Standards

Minimum Forebay Volume Required: 3% WQCV						
Forebay	WQCV (ac-ft)	Required Volume (ac-ft)	Required Volume (cf)	Total Length (ft)	Total Width (ft)	Design Volume (cf)
A	0.08	0.00	103	11	10	165

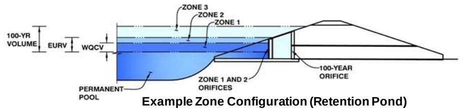
Volume Factor:	0.03

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: WQ Pond A_Modified Area (BASIN A2B+A3A+G2A+G2B+G1)



Example Zone Configuration (Retention Pond)

Depth Increement = ft

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	94.50	acres
Watershed Length =	2,895	ft
Watershed Length to Centroid =	1,447	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	2.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	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.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.047	acre-feet	0.047	acre-feet
Excess Urban Runoff Volume (EURV) =	0.138	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.393	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	3.212	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	4.950	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	7.434	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	9.361	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	12.096	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	17.035	acre-feet		inches
Approximate 2-yr Detention Volume =	0.103	acre-feet		
Approximate 5-yr Detention Volume =	0.641	acre-feet		
Approximate 10-yr Detention Volume =	1.065	acre-feet		
Approximate 25-yr Detention Volume =	1.143	acre-feet		
Approximate 50-yr Detention Volume =	1.094	acre-feet		
Approximate 100-yr Detention Volume =	1.745	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.047	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.091	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.607	acre-feet
Total Detention Basin Volume =	1.745	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	1,774	0.041		
7326	--	1.00	--	--	--	4,666	0.107	3,220	0.074
7327	--	2.00	--	--	--	6,983	0.160	9,044	0.208
7328	--	3.00	--	--	--	9,609	0.221	17,340	0.398
7329	--	4.00	--	--	--	13,970	0.321	29,130	0.669
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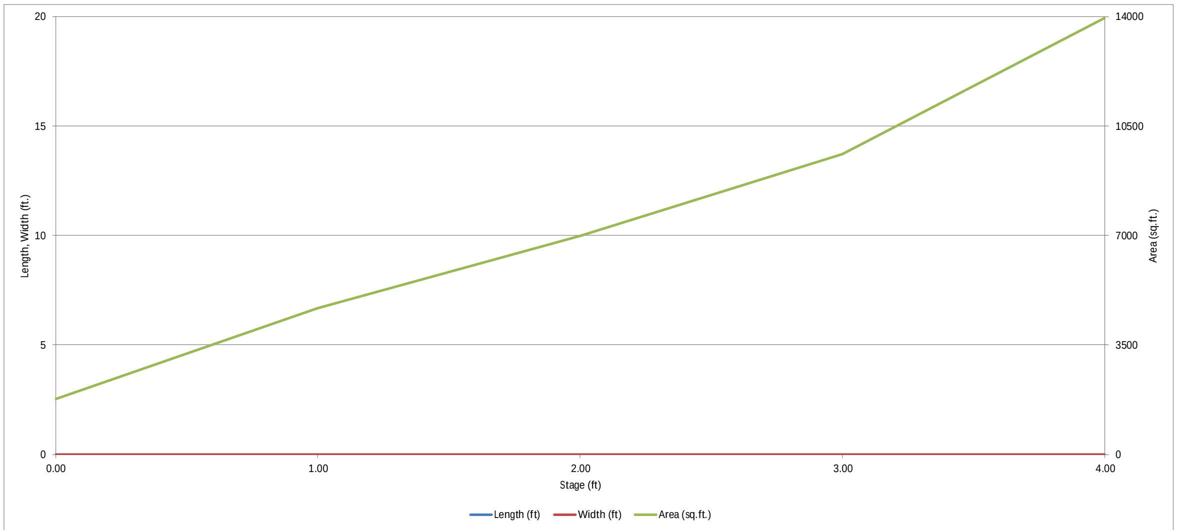
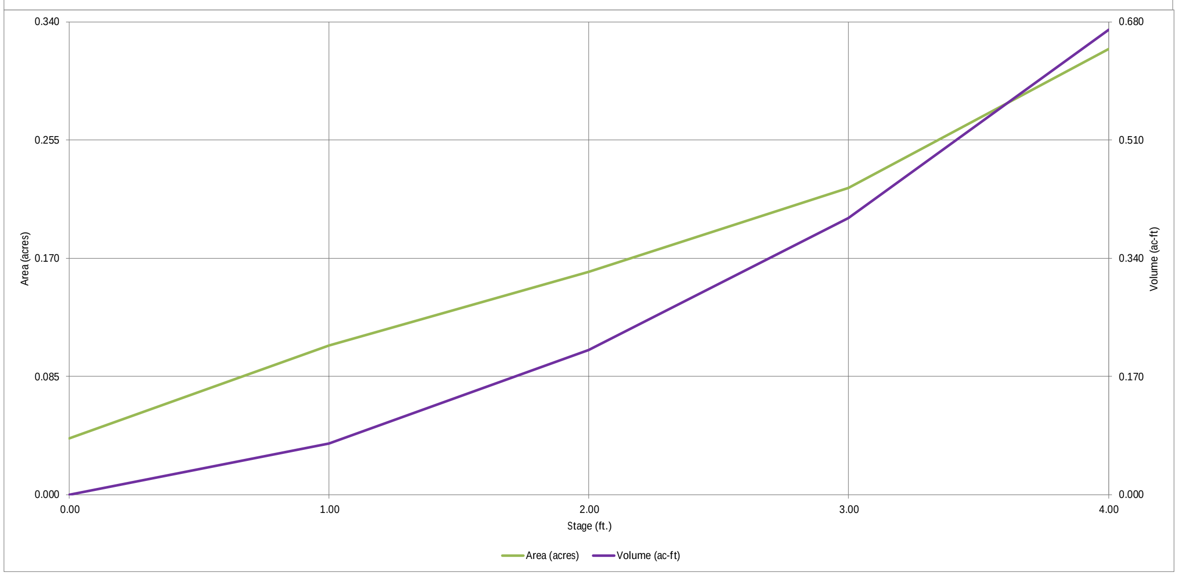
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



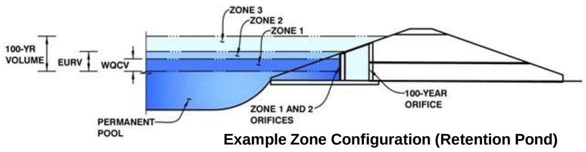


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: WQ Pond A_Modified Area (BASIN A2B+A3A+G2A+G2B+G1)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.73	0.047	Orifice Plate
Zone 2 (EURV)	1.54	0.091	Weir&Pipe (Restrict)
Zone 3 (100-year)	#VALUE!	1.607	Not Utilized
Total (all zones)		1.745	

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

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

Calculated Parameters for Underdrain

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

Calculated Parameters for Plate

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	1.67	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	inches	Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.63	1.27					
Orifice Area (sq. inches)	0.60	0.79	0.79					

	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)

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

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

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected			Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.70	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.00	N/A	feet
Overflow Weir Front Edge Length =	3.00	N/A	feet	Overflow Weir Slope Length =	3.01	N/A	feet
Overflow Weir Grate Slope =	10.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	3.56	N/A	
Horiz. Length of Weir Sides =	3.00	N/A	feet	Overflow Grate Open Area w/o Debris =	6.30	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	3.15	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Restrictor	Not Selected			Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.30	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage=	2.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.99	feet
Spillway Crest Length =	47.00	feet	Stage at Top of Freeboard =	3.99	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.32	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.67	acre-ft

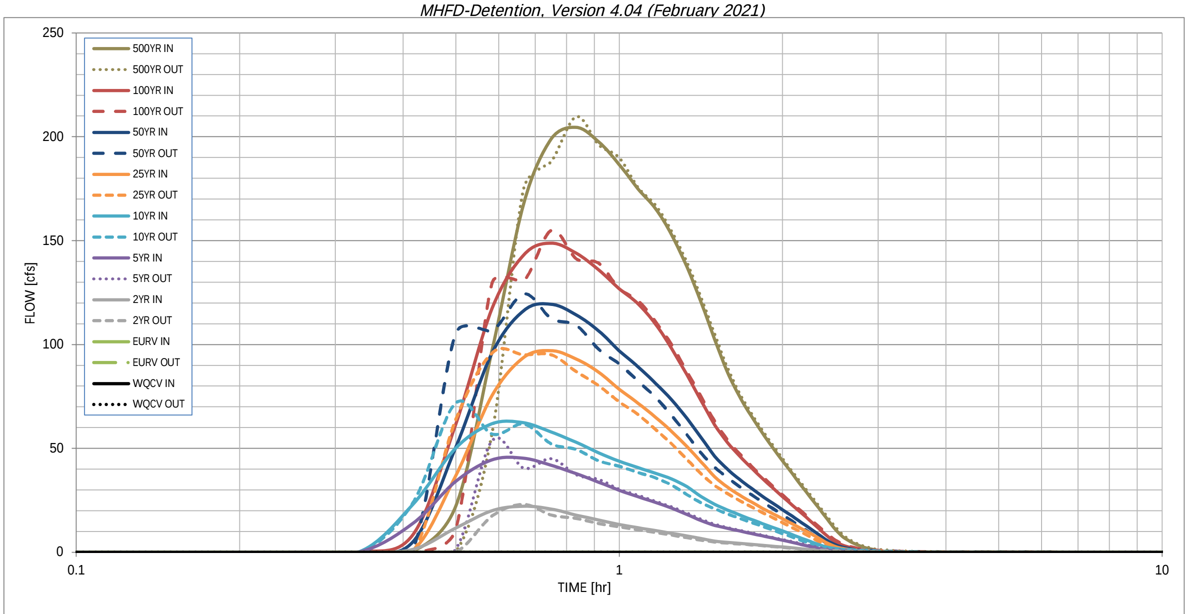
Routed Hydrograph Results

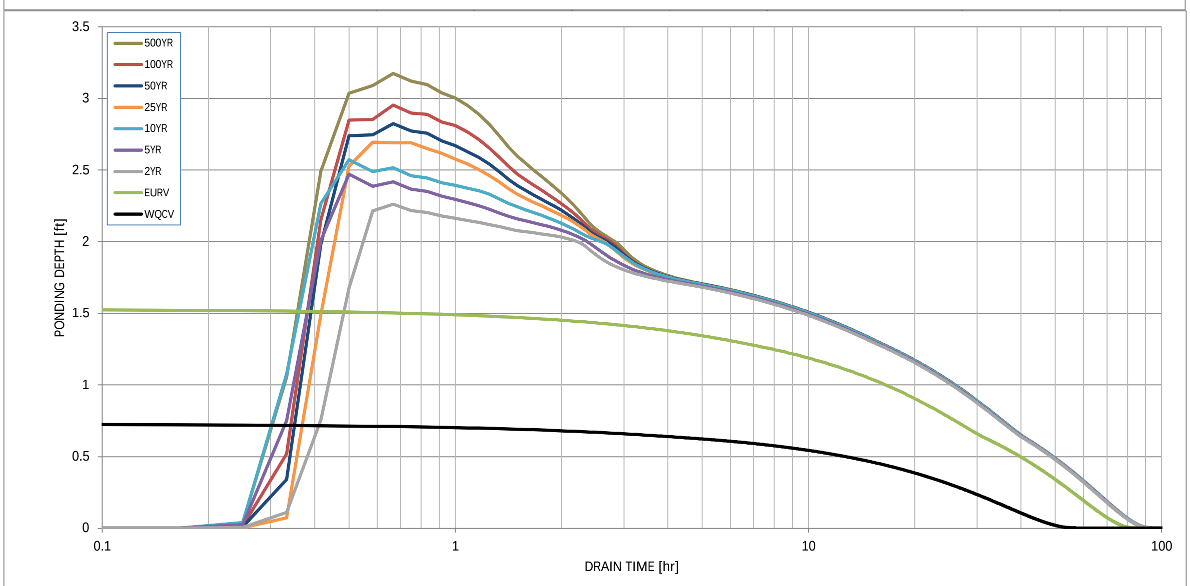
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

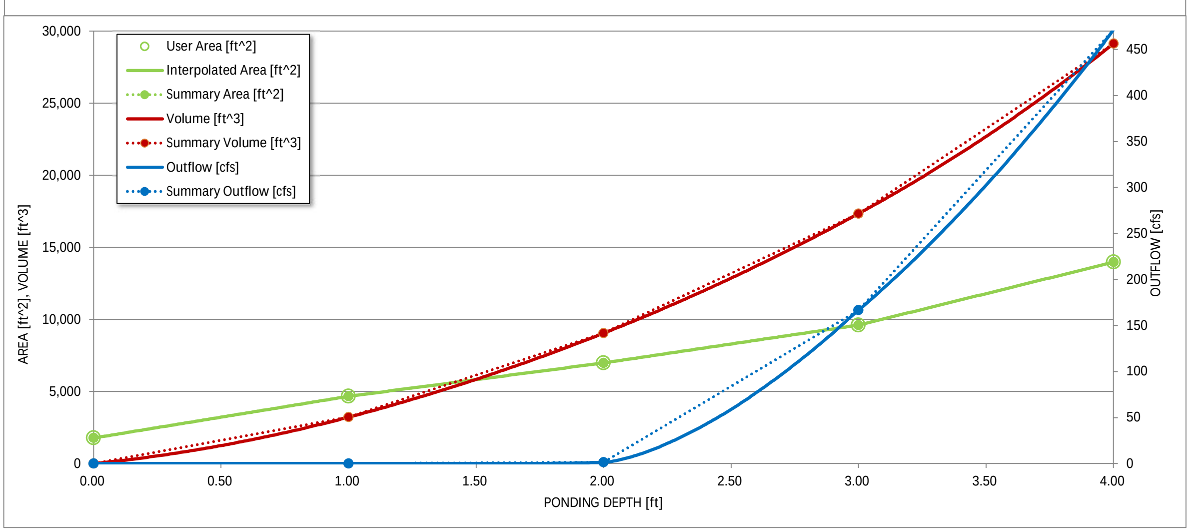
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.047	0.138	1.393	3.212	4.950	7.434	9.361	12.096	17.035
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.393	3.212	4.950	7.434	9.361	12.096	17.035
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	22.1	45.3	62.3	97.1	119.4	148.8	204.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.23	0.48	0.66	1.03	1.26	1.57	2.16
Peak Inflow Q (cfs) =	N/A	N/A	22.1	45.3	62.3	97.1	119.4	148.8	204.5
Peak Outflow Q (cfs) =	0.0	0.1	23.0	53.7	71.8	95.9	124.3	155.0	209.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.2	1.2	1.0	1.0	1.0	1.0
Structure Controlling Flow =	Plate	Plate	Spillway	Spillway	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	0.63	1.1	1.3	1.7	2.0	2.4	2.6
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	48	68	39	19	7	2	2	1	1
Time to Drain 99% of Inflow Volume (hours) =	52	75	63	46	35	26	20	13	4
Maximum Ponding Depth (ft) =	0.73	1.53	2.26	2.47	2.57	2.69	2.82	2.95	3.17
Area at Maximum Ponding Depth (acres) =	0.09	0.14	0.18	0.19	0.19	0.20	0.21	0.22	0.24
Maximum Volume Stored (acre-ft) =	0.047	0.138	0.250	0.288	0.309	0.333	0.359	0.387	0.437

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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: 5.00 min

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]
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	0.00
0:15:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
0:20:00	0.00	0.00	0.04	0.29	0.46	0.02	0.09	0.17	0.43
0:25:00	0.00	0.00	1.33	13.76	22.95	0.85	4.93	8.35	22.30
0:30:00	0.00	0.00	11.69	34.13	50.21	36.94	50.57	61.72	97.19
0:35:00	0.00	0.00	20.03	44.44	61.81	75.52	95.92	117.38	167.65
0:40:00	0.00	0.00	22.12	45.30	62.28	93.71	116.30	143.06	198.90
0:45:00	0.00	0.00	20.77	41.81	57.92	97.08	119.41	148.83	204.55
0:50:00	0.00	0.00	17.91	37.82	52.89	93.01	114.25	143.91	197.61
0:55:00	0.00	0.00	15.56	33.74	47.88	86.67	106.63	135.94	186.72
1:00:00	0.00	0.00	13.40	29.85	43.82	78.52	97.07	126.91	174.89
1:05:00	0.00	0.00	11.78	26.74	40.72	71.79	89.25	119.64	165.40
1:10:00	0.00	0.00	10.42	24.01	37.99	65.00	81.35	109.82	152.67
1:15:00	0.00	0.00	9.13	21.17	35.27	58.10	73.29	97.88	137.22
1:20:00	0.00	0.00	7.86	18.16	31.49	50.82	64.37	85.28	120.06
1:25:00	0.00	0.00	6.59	15.19	26.79	43.48	55.06	72.75	102.40
1:30:00	0.00	0.00	5.40	12.98	23.13	36.38	46.23	61.29	86.69
1:35:00	0.00	0.00	4.75	11.50	20.33	31.37	39.95	52.87	74.93
1:40:00	0.00	0.00	4.24	10.22	17.97	27.49	35.02	46.34	65.69
1:45:00	0.00	0.00	3.81	9.03	15.84	24.23	30.86	40.71	57.69
1:50:00	0.00	0.00	3.39	7.90	13.90	21.29	27.10	35.68	50.53
1:55:00	0.00	0.00	2.95	6.83	12.05	18.65	23.71	31.07	43.96
2:00:00	0.00	0.00	2.52	5.79	10.24	16.11	20.46	26.75	37.80
2:05:00	0.00	0.00	2.08	4.75	8.47	13.66	17.32	22.67	31.97
2:10:00	0.00	0.00	1.65	3.74	6.77	11.31	14.31	18.87	26.52
2:15:00	0.00	0.00	1.22	2.75	5.15	8.98	11.36	15.11	21.18
2:20:00	0.00	0.00	0.80	1.76	3.62	6.70	8.48	11.40	15.95
2:25:00	0.00	0.00	0.39	0.99	2.44	4.43	5.68	7.83	11.07
2:30:00	0.00	0.00	0.15	0.58	1.77	2.72	3.60	5.10	7.42
2:35:00	0.00	0.00	0.07	0.38	1.35	1.74	2.39	3.42	5.10
2:40:00	0.00	0.00	0.04	0.26	1.02	1.13	1.60	2.28	3.49
2:45:00	0.00	0.00	0.03	0.17	0.77	0.71	1.05	1.47	2.31
2:50:00	0.00	0.00	0.02	0.12	0.55	0.44	0.67	0.89	1.45
2:55:00	0.00	0.00	0.02	0.08	0.38	0.26	0.41	0.48	0.82
3:00:00	0.00	0.00	0.01	0.05	0.24	0.14	0.23	0.21	0.40
3:05:00	0.00	0.00	0.01	0.03	0.14	0.07	0.12	0.09	0.19
3:10:00	0.00	0.00	0.01	0.02	0.07	0.04	0.07	0.05	0.10
3:15:00	0.00	0.00	0.01	0.01	0.04	0.03	0.04	0.03	0.06
3:20:00	0.00	0.00	0.00	0.01	0.03	0.02	0.03	0.03	0.05
3:25:00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.04
3:30:00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.03
3:35:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	1,774	0.041	0	0.000	0.00
	1.00	4,666	0.107	3,220	0.074	0.04
	2.00	6,983	0.160	9,044	0.208	1.30
	3.00	9,609	0.221	17,340	0.398	166.63
	4.00	13,970	0.321	29,130	0.669	471.26

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

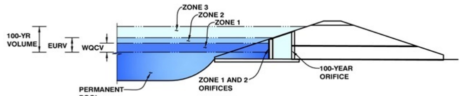
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: WQ Pond A_Original Area (BASIN A2B+A3A+G2A+G2B+G1)



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**			
Watershed Area =	63.40	acres		
Watershed Length =	2,895	ft		
Watershed Length to Centroid =	1,447	ft		
Watershed Slope =	0.040	ft/ft		
Watershed Imperviousness =	2.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	100.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	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.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.080	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.093	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.934	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	2.155	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.322	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	4.989	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	6.282	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	8.117	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	11.431	acre-feet		inches
Approximate 2-yr Detention Volume =	0.069	acre-feet		
Approximate 5-yr Detention Volume =	0.430	acre-feet		
Approximate 10-yr Detention Volume =	0.715	acre-feet		
Approximate 25-yr Detention Volume =	0.767	acre-feet		
Approximate 50-yr Detention Volume =	0.734	acre-feet		
Approximate 100-yr Detention Volume =	1.171	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.080	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.013	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.078	acre-feet
Total Detention Basin Volume =	1.171	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	270	0.006		
7326	--	1.00	--	--	--	798	0.018	534	0.012
7327	--	2.00	--	--	--	4,404	0.101	3,135	0.072
7328	--	3.00	--	--	--	5,720	0.131	8,197	0.188
7329	--	4.00	--	--	--	6,808	0.156	14,461	0.332
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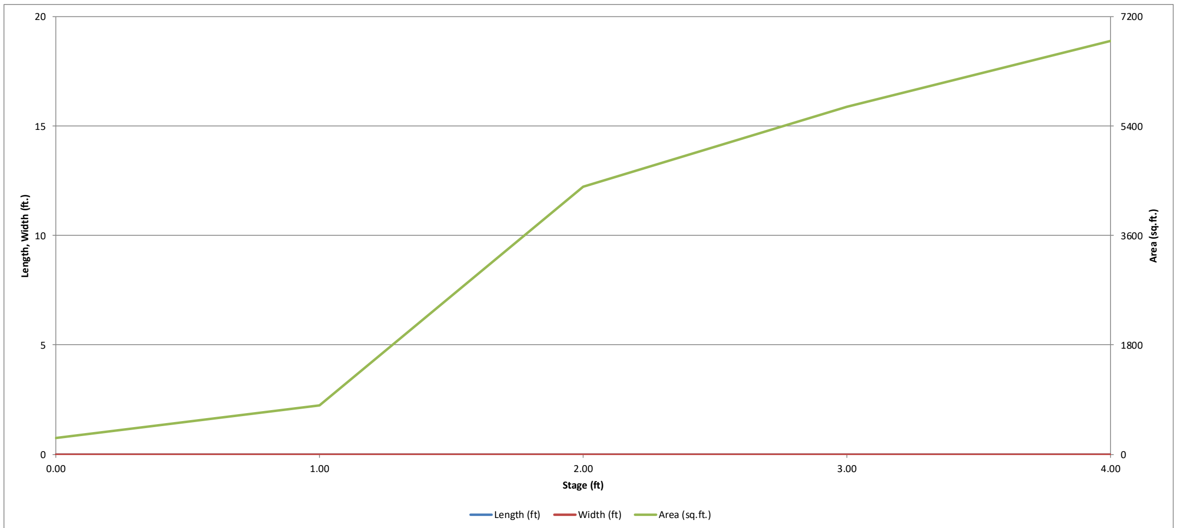
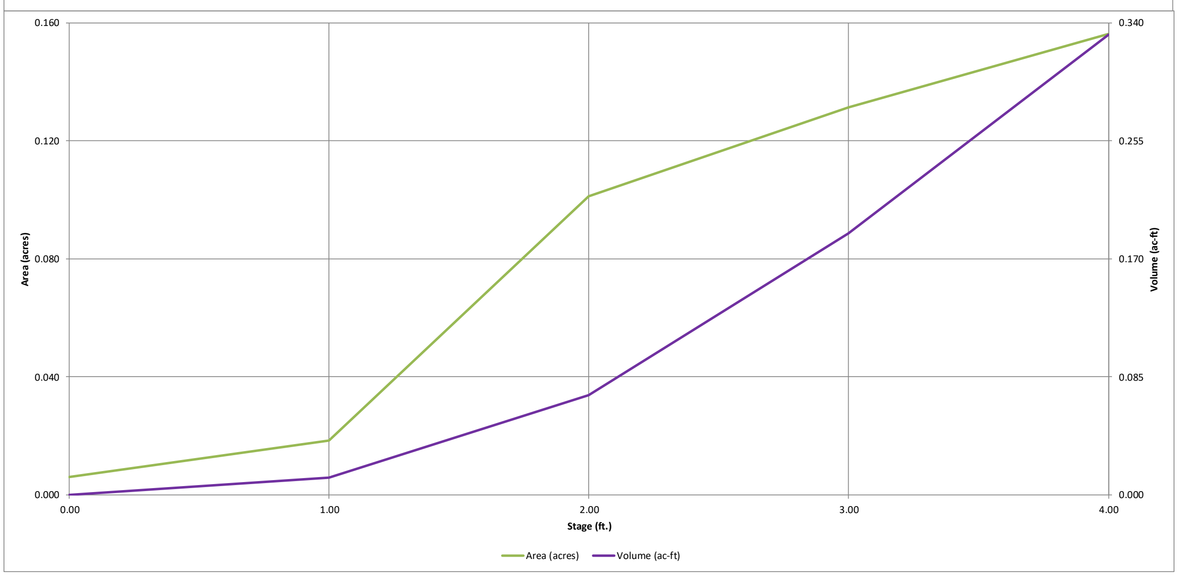

Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
Length (ft)
Width (ft)
Area (sq.ft.)

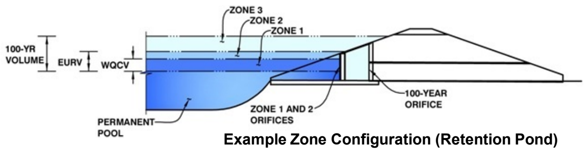

Area (acres)
Volume (ac-ft)
Stage (ft.)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: WQ Pond A_Original Area (BASIN A2B+A3A+G2A+G2B+G1)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.08	0.080	Orifice Plate
Zone 2 (EURV)	2.20	0.013	Weir&Pipe (Restrict)
Zone 3 (100-year)	#VALUE!	1.078	Not Utilized
Total (all zones)		1.171	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =		ft^2
Underdrain Orifice Centroid =		feet

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

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

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	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)								
Orifice Area (sq. inches)								

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.08	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =		N/A	feet
Overflow Weir Grate Slope =		N/A	H:V
Horiz. Length of Weir Sides =		N/A	feet
Overflow Grate Type =		N/A	
Debris Clogging % =		N/A	%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =		N/A	feet
Overflow Weir Slope Length =		N/A	feet
Grate Open Area / 100-yr Orifice Area =		N/A	
Overflow Grate Open Area w/o Debris =		N/A	ft^2
Overflow Grate Open Area w/ Debris =		N/A	ft^2

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

	Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =		N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =		N/A	inches
Restrictor Plate Height Above Pipe Invert =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

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

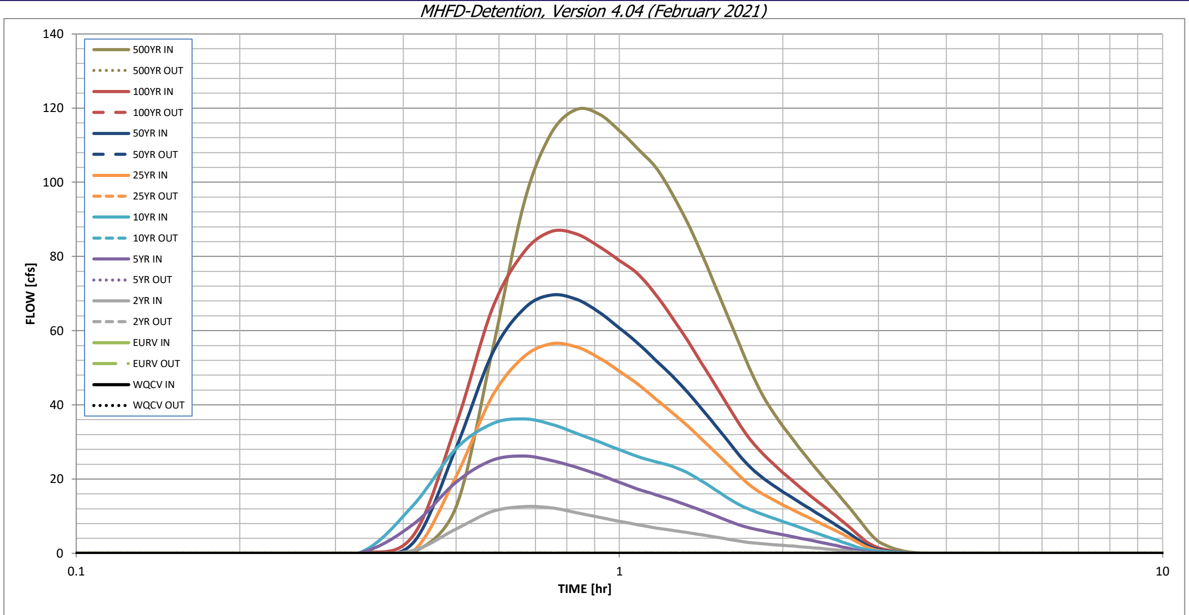
Routed Hydrograph Results

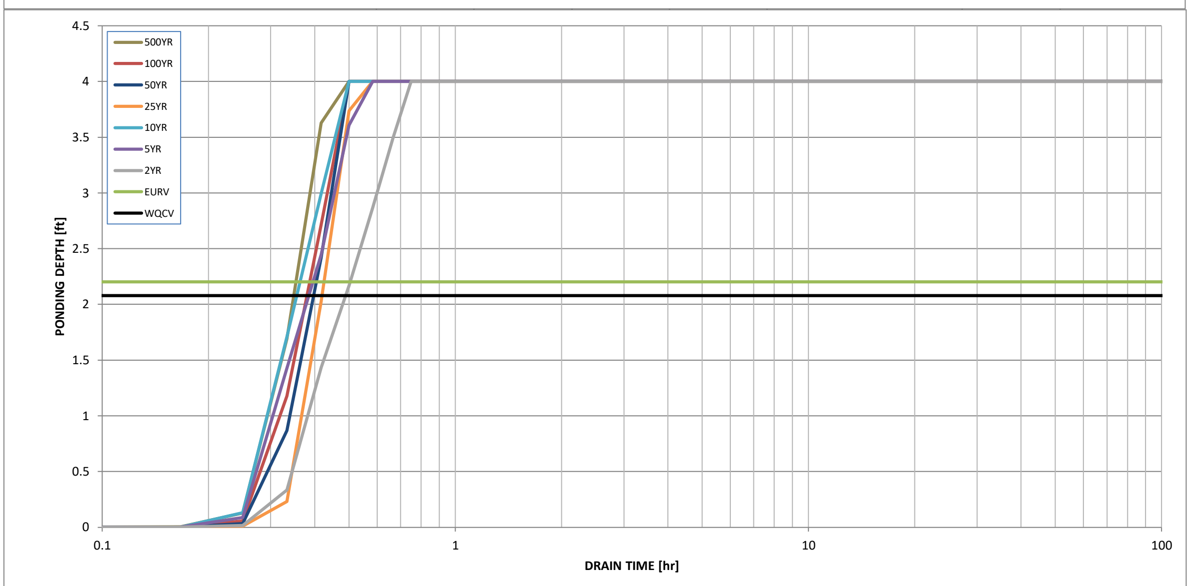
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

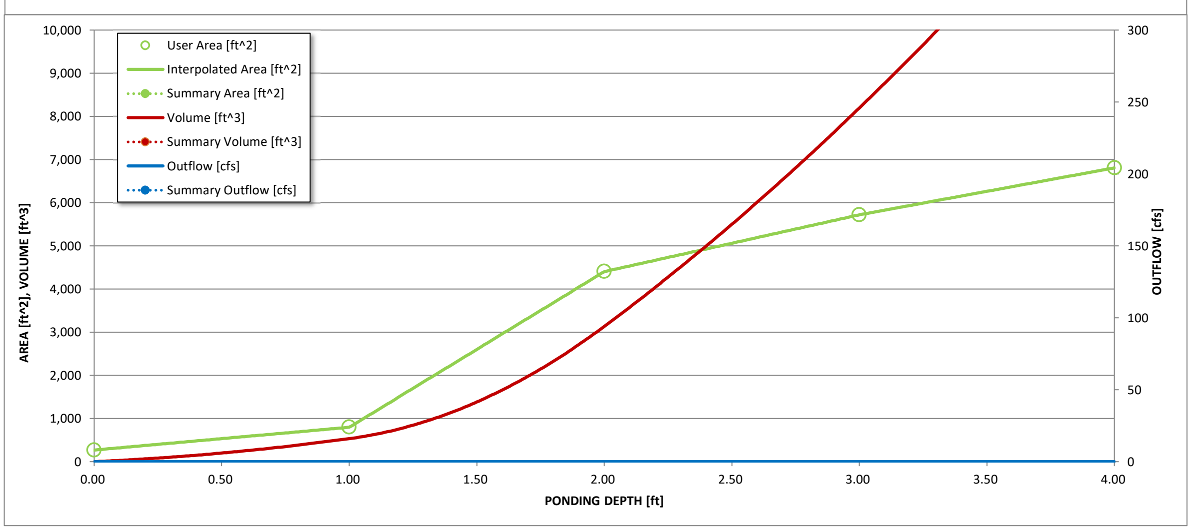
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.080	0.093	0.934	2.155	3.322	4.989	6.282	8.117	11.431
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.934	2.155	3.322	4.989	6.282	8.117	11.431
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	12.6	26.2	36.2	56.4	69.6	86.7	119.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.20	0.41	0.57	0.89	1.10	1.37	1.89
Peak Inflow Q (cfs) =	N/A	N/A	12.6	26.2	36.2	56.4	69.6	86.7	119.7
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	0:20:00	0.00	0.00	0.02	0.16	0.26	0.01	0.05	0.10	0.24
	0:25:00	0.00	0.00	0.75	7.72	12.87	0.48	2.77	4.68	12.51
	0:30:00	0.00	0.00	6.56	19.14	28.16	20.72	28.37	34.62	54.51
	0:35:00	0.00	0.00	11.25	25.07	34.92	42.35	53.83	65.91	94.25
	0:40:00	0.00	0.00	12.57	26.21	36.21	52.96	65.91	81.15	113.29
	0:45:00	0.00	0.00	12.24	25.03	34.77	56.45	69.63	86.72	119.66
	0:50:00	0.00	0.00	10.93	23.15	32.36	55.61	68.43	86.05	118.40
	0:55:00	0.00	0.00	9.70	21.18	30.06	52.72	64.99	82.70	113.93
	1:00:00	0.00	0.00	8.65	19.13	27.90	49.08	60.71	78.94	108.89
	1:05:00	0.00	0.00	7.68	17.27	26.01	45.50	56.51	75.22	103.98
	1:10:00	0.00	0.00	6.84	15.77	24.63	41.57	51.99	69.69	96.96
	1:15:00	0.00	0.00	6.18	14.38	23.45	37.96	47.85	63.59	89.20
	1:20:00	0.00	0.00	5.57	12.95	21.73	34.38	43.49	57.41	80.85
	1:25:00	0.00	0.00	4.98	11.53	19.51	30.78	38.95	51.22	72.16
	1:30:00	0.00	0.00	4.39	10.14	17.19	27.33	34.56	45.41	63.93
	1:35:00	0.00	0.00	3.81	8.78	14.90	23.99	30.31	39.86	56.03
	1:40:00	0.00	0.00	3.24	7.59	12.99	20.74	26.24	34.59	48.71
	1:45:00	0.00	0.00	2.82	6.74	11.61	18.04	22.90	30.23	42.73
	1:50:00	0.00	0.00	2.56	6.09	10.49	16.07	20.43	26.94	38.14
	1:55:00	0.00	0.00	2.34	5.52	9.50	14.46	18.38	24.19	34.25
	2:00:00	0.00	0.00	2.14	4.99	8.57	13.05	16.58	21.75	30.80
	2:05:00	0.00	0.00	1.93	4.48	7.67	11.75	14.92	19.51	27.60
	2:10:00	0.00	0.00	1.73	3.99	6.80	10.53	13.35	17.41	24.61
	2:15:00	0.00	0.00	1.53	3.50	5.96	9.36	11.85	15.45	21.80
	2:20:00	0.00	0.00	1.33	3.03	5.16	8.24	10.42	13.62	19.18
	2:25:00	0.00	0.00	1.13	2.57	4.40	7.16	9.04	11.87	16.68
	2:30:00	0.00	0.00	0.93	2.11	3.67	6.09	7.69	10.14	14.23
	2:35:00	0.00	0.00	0.73	1.65	2.96	5.03	6.36	8.43	11.81
	2:40:00	0.00	0.00	0.53	1.19	2.25	3.98	5.03	6.71	9.39
	2:45:00	0.00	0.00	0.33	0.74	1.55	2.92	3.70	5.00	6.98
	2:50:00	0.00	0.00	0.15	0.41	1.05	1.88	2.42	3.36	4.77
	2:55:00	0.00	0.00	0.06	0.25	0.78	1.16	1.55	2.20	3.21
	3:00:00	0.00	0.00	0.03	0.16	0.59	0.75	1.03	1.48	2.21
	3:05:00	0.00	0.00	0.02	0.11	0.45	0.48	0.69	0.98	1.51
	3:10:00	0.00	0.00	0.01	0.07	0.34	0.30	0.45	0.62	0.99
	3:15:00	0.00	0.00	0.01	0.05	0.24	0.19	0.29	0.37	0.61
	3:20:00	0.00	0.00	0.01	0.03	0.16	0.11	0.17	0.20	0.34
	3:25:00	0.00	0.00	0.01	0.02	0.10	0.06	0.10	0.08	0.16
	3:30:00	0.00	0.00	0.00	0.01	0.06	0.03	0.05	0.04	0.08
	3:35:00	0.00	0.00	0.00	0.01	0.03	0.02	0.03	0.02	0.04
	3:40:00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.03
	3:45:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	3:50:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	3:55:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
	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	0.01
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage	Area	Area	Volume	Volume	Total Outflow
	[ft]	[ft ^{2}]	[acres]	[ft ^{3}]	[ac-ft]	[cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

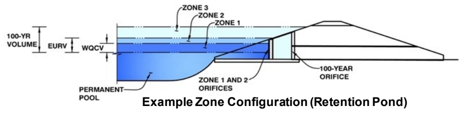
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: WQ Pond A_Water Quality Volume (BASIN A2B+A3A+G2A+G2B+G1)



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**		**Note: L / W Ratio > 8**	
Watershed Area =	1.12	acres	**L / W Ratio = 67.15**	
Watershed Length =	1,810	ft		
Watershed Length to Centroid =	905	ft		
Watershed Slope =	0.040	ft/ft		
Watershed Imperviousness =	100.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	100.0%	percent		
Target WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	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.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.047	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.112	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.112	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.144	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.170	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.195	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.220	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.248	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.311	acre-feet		inches
Approximate 2-yr Detention Volume =	0.103	acre-feet		
Approximate 5-yr Detention Volume =	0.134	acre-feet		
Approximate 10-yr Detention Volume =	0.157	acre-feet		
Approximate 25-yr Detention Volume =	0.166	acre-feet		
Approximate 50-yr Detention Volume =	0.169	acre-feet		
Approximate 100-yr Detention Volume =	0.172	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.047	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.065	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.060	acre-feet
Total Detention Basin Volume =	0.172	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	270	0.006		
7323	--	1.00	--	--	--	798	0.018	534	0.012
7324	--	2.00	--	--	--	4,404	0.101	3,135	0.072
7325	--	3.00	--	--	--	5,720	0.131	8,197	0.188
7326	--	4.00	--	--	--	6,808	0.156	14,461	0.332
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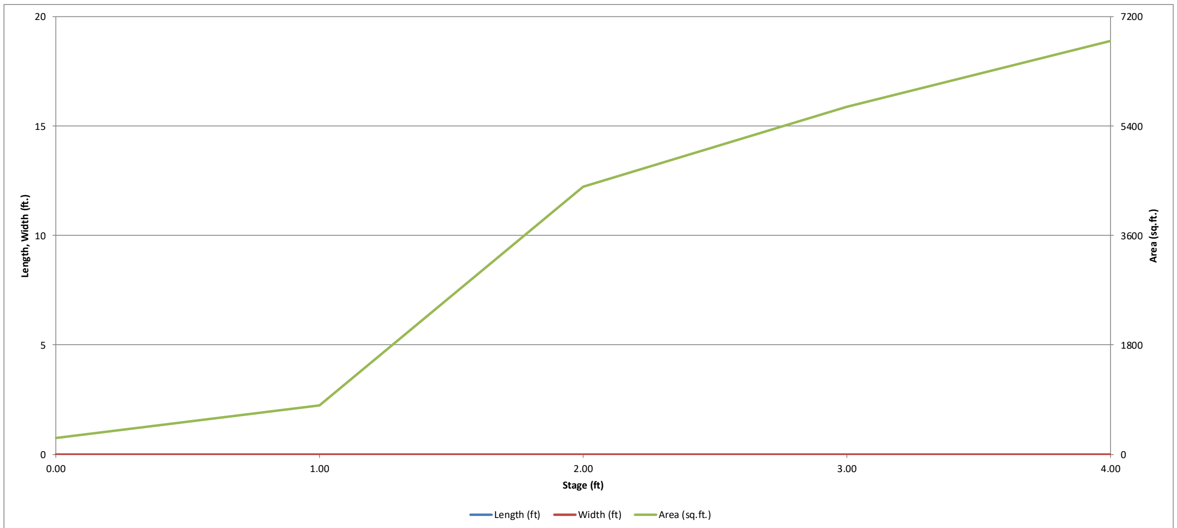
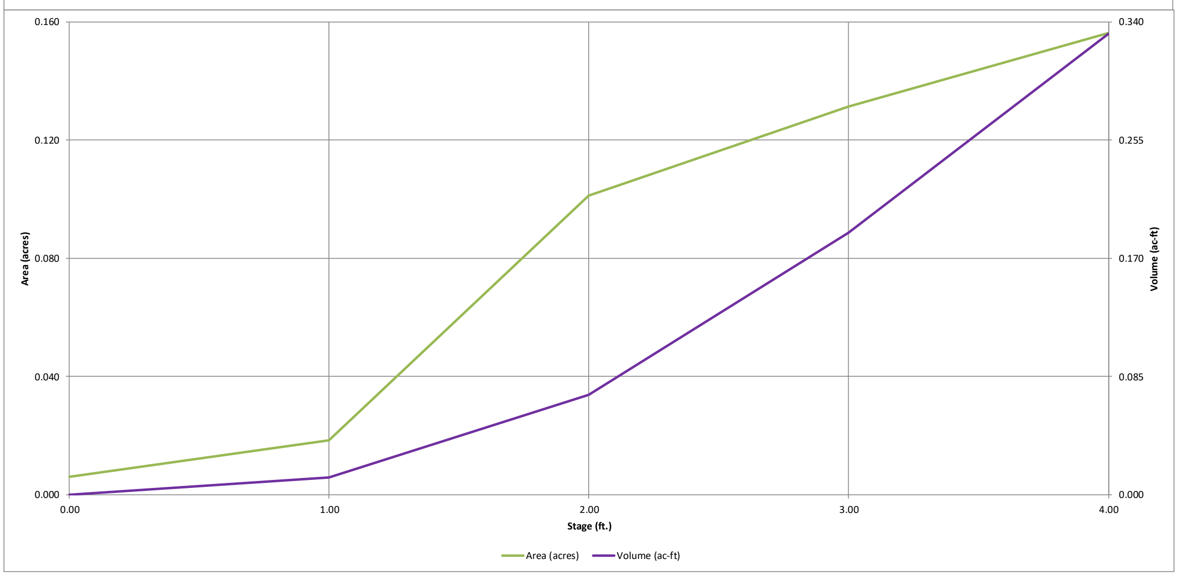

Length, Width (ft.)
Area (sq.ft.)
Stage (ft)
20
15
10
5
0
7200
5400
3600
1800
0
0.00
1.00
2.00
3.00
4.00
Length (ft)
Width (ft)
Area (sq.ft.)

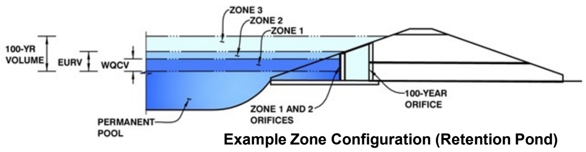

Area (acres)
Volume (ac-ft)
Stage (ft.)
0.160
0.120
0.080
0.040
0.000
0.340
0.255
0.170
0.085
0.000
0.00
1.00
2.00
3.00
4.00
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: WINSOME FILING 3

Basin ID: WQ Pond A_Water Quality Volume (BASIN A2B+A3A+G2A+G2B+G1)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.72	0.047	Orifice Plate
Zone 2 (EURV)	2.38	0.065	
Zone 3 (100-year)	2.88	0.060	
Total (all zones)		0.172	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =		ft^2
Underdrain Orifice Centroid =		feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.75	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	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	0.48	0.96					
Orifice Area (sq. inches)	0.20	0.24	0.24					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

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

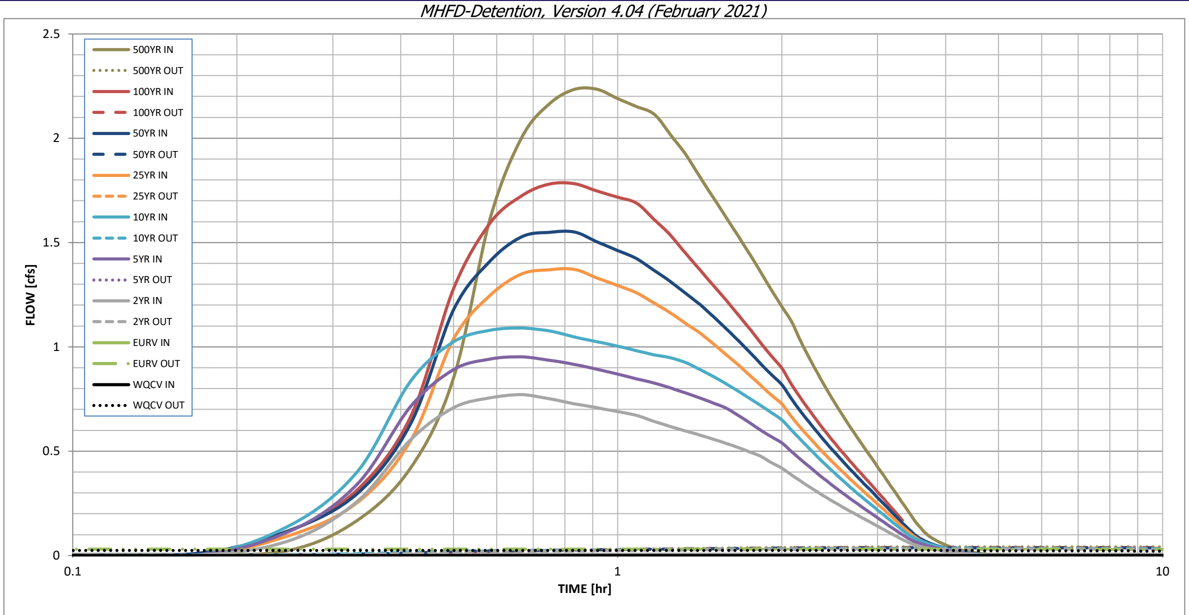
Routed Hydrograph Results

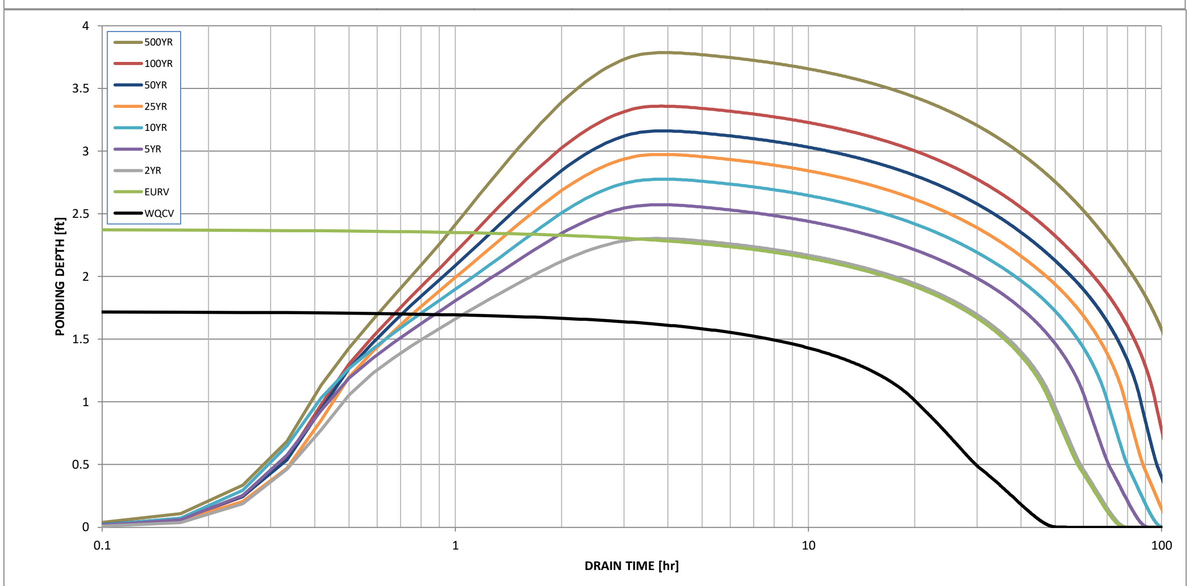
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

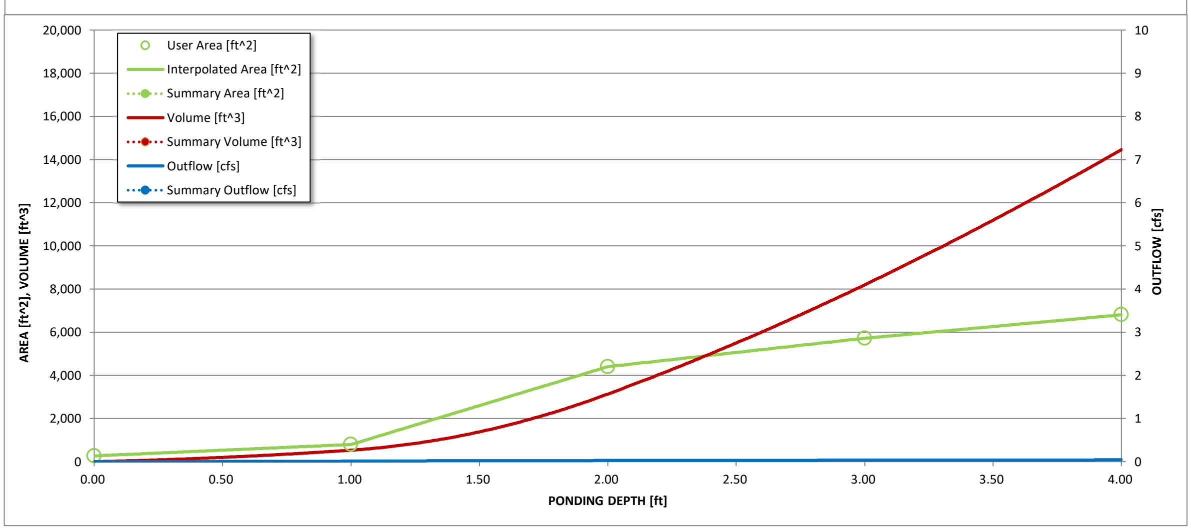
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.047	0.112	0.112	0.144	0.170	0.195	0.220	0.248	0.311
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.112	0.144	0.170	0.195	0.220	0.248	0.311
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.1	0.2	0.3	0.4	0.5	0.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.05	0.12	0.18	0.28	0.35	0.45	0.63
Peak Inflow Q (cfs) =	N/A	N/A	0.8	1.0	1.1	1.4	1.6	1.8	2.2
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.2	0.1	0.1	0.1	0.1
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	61	62	72	79	86	94	101	118
Time to Drain 99% of Inflow Volume (hours) =	**45**	69	70	81	89	96	104	112	>120
Maximum Ponding Depth (ft) =	1.73	2.38	2.30	2.57	2.78	2.97	3.16	3.36	3.79
Area at Maximum Ponding Depth (acres) =	0.08	0.11	0.11	0.12	0.12	0.13	0.14	0.14	0.15
Maximum Volume Stored (acre-ft) =	0.048	0.113	0.104	0.135	0.159	0.184	0.210	0.236	0.298

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







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: 5.00 min

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]
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	0.07	0.12	0.14	0.10	0.12	0.12	0.17
0:20:00	0.00	0.00	0.26	0.34	0.40	0.26	0.30	0.32	0.42
0:25:00	0.00	0.00	0.55	0.71	0.84	0.55	0.63	0.66	0.85
0:30:00	0.00	0.00	0.71	0.89	1.02	1.04	1.18	1.28	1.61
0:35:00	0.00	0.00	0.76	0.94	1.08	1.25	1.41	1.59	2.00
0:40:00	0.00	0.00	0.77	0.95	1.09	1.35	1.53	1.72	2.17
0:45:00	0.00	0.00	0.75	0.94	1.08	1.37	1.55	1.78	2.23
0:50:00	0.00	0.00	0.73	0.92	1.05	1.37	1.55	1.78	2.23
0:55:00	0.00	0.00	0.71	0.89	1.02	1.33	1.50	1.75	2.19
1:00:00	0.00	0.00	0.69	0.87	1.00	1.29	1.46	1.72	2.15
1:05:00	0.00	0.00	0.67	0.85	0.98	1.26	1.42	1.69	2.12
1:10:00	0.00	0.00	0.64	0.83	0.96	1.21	1.37	1.61	2.02
1:15:00	0.00	0.00	0.62	0.80	0.95	1.16	1.31	1.53	1.92
1:20:00	0.00	0.00	0.60	0.78	0.92	1.11	1.26	1.45	1.81
1:25:00	0.00	0.00	0.58	0.75	0.89	1.07	1.20	1.37	1.71
1:30:00	0.00	0.00	0.56	0.73	0.86	1.01	1.14	1.29	1.62
1:35:00	0.00	0.00	0.54	0.71	0.82	0.96	1.09	1.22	1.53
1:40:00	0.00	0.00	0.52	0.67	0.79	0.91	1.03	1.15	1.44
1:45:00	0.00	0.00	0.50	0.63	0.75	0.86	0.97	1.08	1.35
1:50:00	0.00	0.00	0.47	0.60	0.72	0.81	0.92	1.02	1.27
1:55:00	0.00	0.00	0.44	0.57	0.68	0.77	0.87	0.95	1.19
2:00:00	0.00	0.00	0.42	0.54	0.65	0.73	0.82	0.90	1.12
2:05:00	0.00	0.00	0.39	0.50	0.60	0.67	0.75	0.82	1.03
2:10:00	0.00	0.00	0.36	0.46	0.55	0.61	0.69	0.75	0.94
2:15:00	0.00	0.00	0.33	0.42	0.51	0.56	0.64	0.69	0.87
2:20:00	0.00	0.00	0.30	0.39	0.47	0.52	0.58	0.64	0.80
2:25:00	0.00	0.00	0.28	0.36	0.43	0.48	0.54	0.59	0.73
2:30:00	0.00	0.00	0.25	0.33	0.40	0.44	0.49	0.54	0.67
2:35:00	0.00	0.00	0.23	0.30	0.36	0.40	0.45	0.49	0.62
2:40:00	0.00	0.00	0.21	0.27	0.33	0.37	0.42	0.45	0.57
2:45:00	0.00	0.00	0.19	0.25	0.30	0.34	0.38	0.41	0.52
2:50:00	0.00	0.00	0.18	0.23	0.27	0.30	0.34	0.38	0.47
2:55:00	0.00	0.00	0.16	0.20	0.24	0.28	0.31	0.34	0.42
3:00:00	0.00	0.00	0.14	0.18	0.22	0.25	0.28	0.30	0.38
3:05:00	0.00	0.00	0.12	0.16	0.19	0.22	0.25	0.27	0.34
3:10:00	0.00	0.00	0.11	0.14	0.17	0.19	0.21	0.23	0.29
3:15:00	0.00	0.00	0.09	0.12	0.14	0.16	0.18	0.20	0.25
3:20:00	0.00	0.00	0.08	0.10	0.12	0.14	0.15	0.17	0.21
3:25:00	0.00	0.00	0.06	0.08	0.10	0.11	0.13	0.14	0.17
3:30:00	0.00	0.00	0.05	0.07	0.08	0.09	0.10	0.11	0.14
3:35:00	0.00	0.00	0.04	0.06	0.07	0.07	0.08	0.09	0.11
3:40:00	0.00	0.00	0.04	0.05	0.06	0.06	0.07	0.07	0.09
3:45:00	0.00	0.00	0.03	0.04	0.05	0.05	0.06	0.06	0.07
3:50:00	0.00	0.00	0.03	0.04	0.05	0.04	0.05	0.05	0.06
3:55:00	0.00	0.00	0.02	0.03	0.04	0.04	0.04	0.04	0.05
4:00:00	0.00	0.00	0.02	0.03	0.03	0.03	0.03	0.03	0.04
4:05:00	0.00	0.00	0.02	0.02	0.03	0.03	0.03	0.03	0.03
4:10:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03
4:15:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02
4:20:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.02
4:25:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4:30:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4:35:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Kimley»Horn

Project: Winsome Filing 3 -WQ Pond
Date: 12/13/2021

Emergency Overflow Weir Calculation

Q (cfs) =	148.8	(100-yr peak inflow)
C_{BCW} =	3	
Z =	4	
H =	1	
L (ft) =	46.40	Rounded to 47

*orange cells require input

$$Q = C_{BCW} L H^{1.5} + 2\left[\left(2/5\right) C_{BCW} Z H^{2.5}\right]$$

rearrange to solve for length:

$$L = \frac{Q - \left(4/5\right) C_{BCW} Z H^{2.5}}{C_{BCW} H^{1.5}}$$

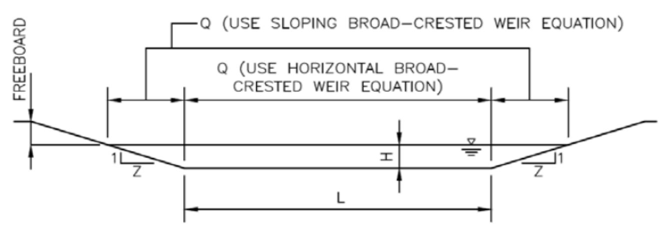


Figure 12-20. Sloping broad-crest weir

Horizontal Broad Crested Weir Equation (from USDCM Eqn. 12-8)

$$Q = C_{BCW} L H^{1.5}$$ Equation 12-8

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

L = broad-crested weir length (ft)

H = head above weir crest (ft)

Sloping Broad Crested Weir Equation (from USDCM Eqn. 12-9)

$$Q = \left(\frac{2}{5}\right) C_{BCW} Z H^{2.5}$$ Equation 12-9

Where:

Q = discharge (cfs)

C_{BCW} = broad-crested weir coefficient (This ranges from 2.6 to 3.0. A value of 3.0 is often used in practice.) See Hydraulic Engineering Circular No. 22 for additional information.

Z = side slope (horizontal: vertical)

H = head above weir crest (ft)

Note that in order to calculate the total flow over the weir depicted in Figure 12-20, the results from Equation 12-8 must be added to two times the results from Equation 12-9.

WQ Pond Spillway

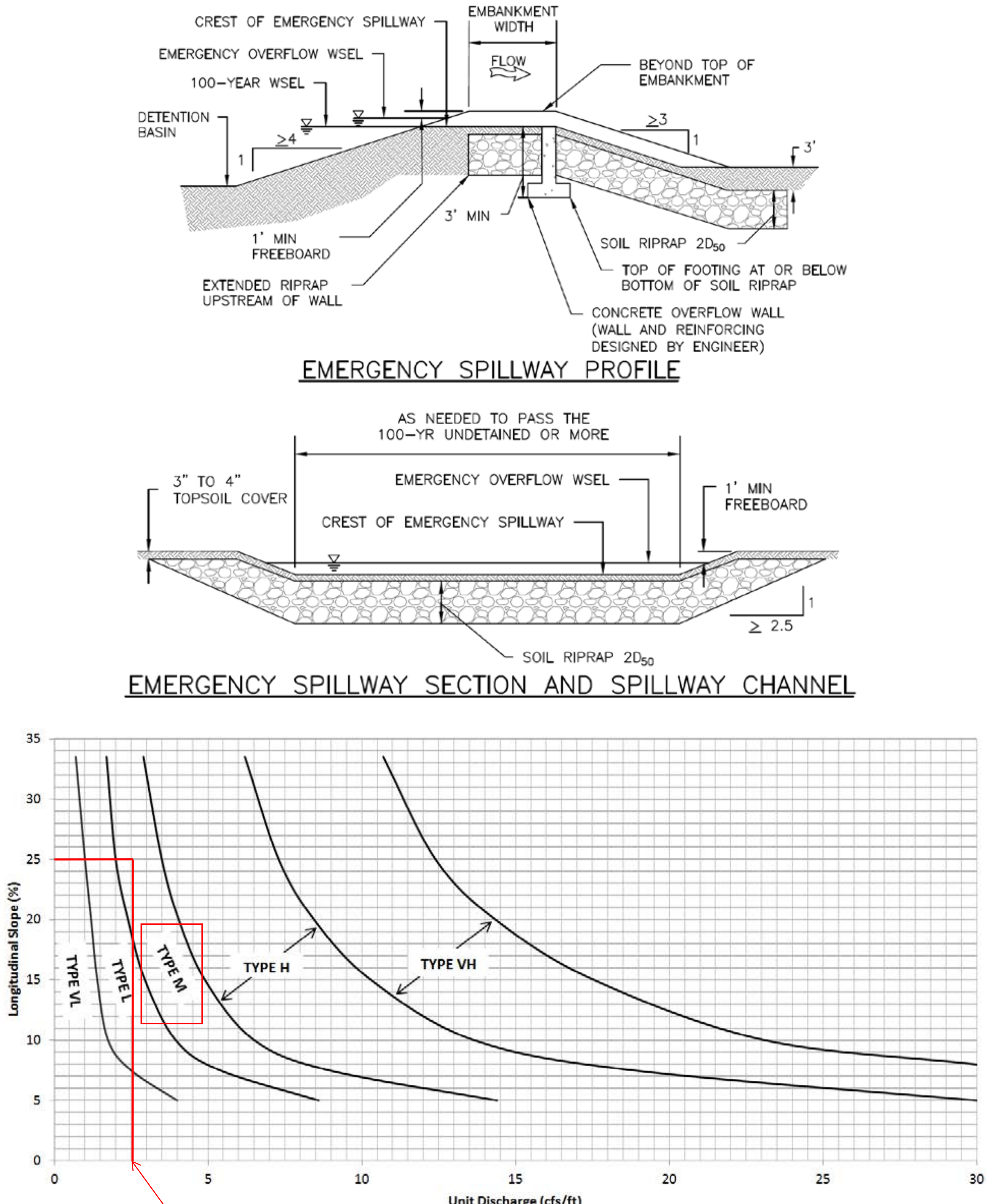
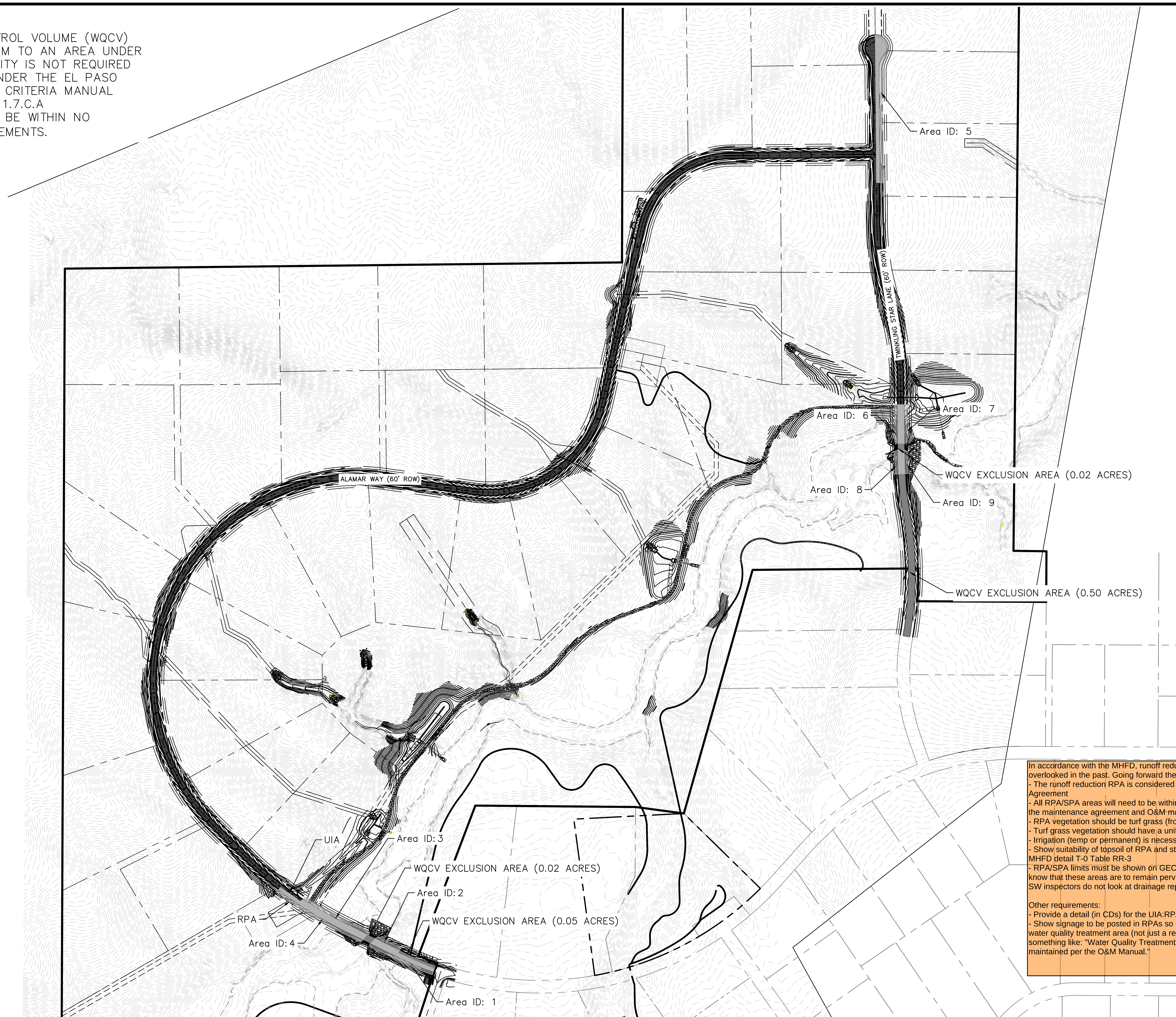


Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

148.8 cfs/47 ft = 3.16

NOTES:

1. WATER QUALITY CONTROL VOLUME (WQCV) EXCLUSION AREAS SUM TO AN AREA UNDER 1 ACRE. WATER QUALITY IS NOT REQUIRED FOR THESE AREAS UNDER THE EL PASO COUNTY ENGINEERING CRITERIA MANUAL APPENDIX I. SECTION 1.7.C.A
2. ALL RPA AREAS WILL BE WITHIN NO BUILD/DRAINAGE EASEMENTS.



KHA RESPONSE:
Exhibit has been updated per conservation with Glenn Reese on 4/18/2023.

In accordance with the MHFD, runoff reduction has vegetation requirements that have been overlooked in the past. Going forward the following will be required for runoff reduction:
- The runoff reduction RPA is considered a WQ Facility and requires a signed Maintenance Agreement
- All RPA/SPA areas will need to be within a no build/drainage easement (or tract) and discussed in the maintenance agreement and O&M manual.
- RPA vegetation should be turf grass (from seed [provide appropriate seed mix] or sod).
- Turf grass vegetation should have a uniform density of at least 80%.
- Irrigation (temp or permanent) is necessary to establish sufficient vegetation and not just weeds.
- Show suitability of topsoil of RPA and steps for proper preparation of topsoil per recommendations in MHFD detail T-0 Table RR-3
- RPA/SPA limits must be shown on GEC Plans (not just FDR) so our SW inspectors and the QSM know that these areas are to remain pervious, vegetated (80%), and irrigated post-construction. Our SW inspectors do not look at drainage reports.

Other requirements:
- Provide a detail (in CDs) for the UIA:RPA interface that shows the recommended vertical drop of 4”.
- Show signage to be posted in RPAs so maintenance personnel and owners know that the area is a water quality treatment area (not just a regular grassy area and/or an SPA). The signage should say something like: "Water Quality Treatment Area, do not pollute. Area to remain vegetated and properly maintained per the O&M Manual."

811 Know what's below. Call before you dig.

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

NORTH

GRAPHIC SCALE IN FEET
0 125 250 500

\\kimley-horn.com\mt_den1\COS_Civil\196106001_Winsome Filing No. 3\CADD\Exhibits\Drainage\Runoff_Reduction_Exhibit.dwg O'Donnell-Sloan, Theresa 2/2/2023 11:28 AM

NO.	REVISION	BY	DATE	APPR.

Kimley»Horn
© 2021 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 300
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
RUNOFF REDUCTION EXHIBIT

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

PROJECT NO.
196106001

SHEET

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 1

Designer:	**TOS**
Company:	**Kimley-Horn**
Date:	**November 22, 2022**
Project:	**Winsome Filing No. 3**
Location:	**El Paso County, CO**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth	0.60	inches
Depth of Average Runoff Producing Storm, d_6 =	0.43	inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA	UIA:RPA			
Area ID	1	2	3	4	5 (Basin I2)	6	7	8	9			
Downstream Design Point ID	1	2	3	4	5	6	7	8	9			
Downstream BMP Type	None	None	None	None	None	None	None	None	None			
DCIA (ft^2)	--	--	--	--	--	--	--	--	--			
UIA (ft^2)	4,965	1,772	4,906	6,665	12,523	2,602	2,576	1,617	1,640			
RPA (ft^2)	5,254	1,946	5,531	6,177	11,052	2,900	2,902	1,793	1,694			
SPA (ft^2)	--	--	--	--	--	--	--	--	--			
HSG A (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%			
HSG B (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%			
HSG C/D (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%			
Average Slope of RPA (ft/ft)	0.250	0.250	0.260	0.250	0.030	0.270	0.280	0.270	0.280			
UIA:RPA Interface Width (ft)	326.00	133.00	349.00	465.00	727.00	185.00	185.00	113.00	113.00			

CALCULATED RUNOFF RESULTS

Area ID	1	2	3	4	5 (Basin I2)	6	7	8	9			
UIA:RPA Area (ft^2)	10,219	3,718	10,437	12,842	23,575	5,502	5,478	3,410	3,334			
L / W Ratio	0.10	0.21	0.09	0.06	0.06	0.16	0.16	0.27	0.26			
UIA / Area	0.4859	0.4766	0.4701	0.5190	0.5312	0.4729	0.4702	0.4742	0.4919			
Runoff (in)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Runoff (ft^3)	0	0	0	0	0	0	0	0	0			
Runoff Reduction (ft^3)	207	74	204	278	522	108	107	67	68			

CALCULATED WQCV RESULTS

Area ID	1	2	3	4	5 (Basin I2)	6	7	8	9			
WQCV (ft^3)	207	74	204	278	522	108	107	67	68			
WQCV Reduction (ft^3)	207	74	204	278	522	108	107	67	68			
WQCV Reduction (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%			
Untreated WQCV (ft^3)	0	0	0	0	0	0	0	0	0			

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	1	2	3	4	5	6	7	8	9			
DCIA (ft^2)	0	0	0	0	0	0	0	0	0			
UIA (ft^2)	4,965	1,772	4,906	6,665	12,523	2,602	2,576	1,617	1,640			
RPA (ft^2)	5,254	1,946	5,531	6,177	11,052	2,900	2,902	1,793	1,694			
SPA (ft^2)	0	0	0	0	0	0	0	0	0			
Total Area (ft^2)	10,219	3,718	10,437	12,842	23,575	5,502	5,478	3,410	3,334			
Total Impervious Area (ft^2)	4,965	1,772	4,906	6,665	12,523	2,602	2,576	1,617	1,640			
WQCV (ft^3)	207	74	204	278	522	108	107	67	68			
WQCV Reduction (ft^3)	207	74	204	278	522	108	107	67	68			
WQCV Reduction (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%			
Untreated WQCV (ft^3)	0	0	0	0	0	0	0	0	0			

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	78,515
Total Impervious Area (ft^2)	39,266
WQCV (ft^3)	1,636
WQCV Reduction (ft^3)	1,636
WQCV Reduction (%)	100%
Untreated WQCV (ft^3)	0

APPENDIX D: REFERENCES

OCT 08 REC'D

Federal Emergency Management Agency

Washington, D.C. 20472

September 30, 2019

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
Case No.: 19-08-0185R

Community Name: El Paso County, CO
Community No.: 080059

104

The Honorable Mark Waller
President, El Paso County
Board of Commissioners
200 South Cascade Avenue, Suite 100
Colorado Springs, CO 80903

Dear Mr. Waller:

We are providing our comments with the enclosed Conditional Letter of Map Revision (CLOMR) on a proposed project within your community that, if constructed as proposed, could revise the effective Flood Insurance Study (FIS) report and Flood Insurance Rate Map (FIRM) for your community.

If you have any questions regarding the floodplain management regulations for your community, the National Flood Insurance Program (NFIP) in general, or technical questions regarding this CLOMR, please contact the Director, Mitigation Division of the Federal Emergency Management Agency (FEMA) Regional Office in Denver, at (303) 235-4830, or the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP). Additional information about the NFIP is available on our website at https://www.fema.gov/national-flood-insurance-program.

Sincerely,

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

List of Enclosures:
Conditional Letter of Map Revision Comment Document

cc: Mr. Keith Curtis, P.E., CFM
Floodplain Administrator
Pikes Peak Regional Building Department

Mr. Joe DesJardin, P.E.
Director of Projects
PT McCune, LLC

Mr. Lance VanDemark, P.E., MSCE
Vice President – Civil Engineering
The Vertex Companies, Inc.

 | Issue Date: September 30, 2019 | Case No.: 19-08-0185R | CLOMR-APP

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION COMMENT DOCUMENT

COMMUNITY INFORMATION		PROPOSED PROJECT DESCRIPTION	BASIS OF CONDITIONAL REQUEST
COMMUNITY	**El Paso County Colorado (Unincorporated Areas)** **COMMUNITY NO.: 080059**	CULVERT DETENTION BASIN FILL	BASE MAP CHANGES HYDROLOGIC ANALYSIS HYDRAULIC ANALYSIS UPDATED TOPOGRAPHIC DATA
IDENTIFIER	McCune Ranch Subdivision	**APPROXIMATE LATITUDE AND LONGITUDE:** 39.077, -104.621 **SOURCE:** USGS QUADRANGLE **DATUM:** NAD 83	

AFFECTED MAP PANELS

TYPE	NO.	DATE
FIRM*	08041C0310G	December 7, 2018
FIRM	08041C0350G	December 7, 2018

* FIRM - Flood Insurance Rate Map

FLOODING SOURCE AND REACH DESCRIPTION

West Kiowa Creek – from approximately 5,000 feet upstream of Meridian Road North to approximately 1,640 feet downstream of Hodgen Road

PROPOSED PROJECT DESCRIPTION

Flooding Source	Proposed Project	Location of Proposed Project
West Kiowa Creek	2 New Triple 10'x10' Box Culverts	At approximately 6,220 feet upstream and 10,380 feet upstream of Meridian Road North
	6 New Detention Basins	Located throughout the proposed subdivision centered approximately 2,690 feet northwest of the intersection of Meridian Road and Forest Green Drive
	Fill Placement	At the proposed box culverts approximately 6,220 feet upstream and 10,380 feet upstream of Meridian Road North

SUMMARY OF IMPACTS TO FLOOD HAZARD DATA

Flooding Source	Effective Flooding	Proposed Flooding	Increases	Decreases
West Kiowa Creek	No BFEs*	BFEs	Yes	None
	Zone A	Zone AE	Yes	Yes
	Zone A	Zone A	None	Yes

* BFEs - Base (1-percent-annual-chance) Flood Elevations

COMMENT

This document provides the Federal Emergency Management Agency's (FEMA's) comment regarding a request for a CLOMR for the project described above. This document is not a final determination; it only provides our comment on the proposed project in relation to the flood hazard information shown on the effective National Flood Insurance Program (NFIP) map. We reviewed the submitted data and the data used to prepare the effective flood hazard information for your community and determined that the proposed project meets the minimum floodplain management criteria of the NFIP. Your community is responsible for approving all floodplain development and for ensuring that all permits required by Federal or State/Commonwealth law have been received. State/Commonwealth, county, and community officials, based on their knowledge of local conditions and in the interest of safety, may set higher standards for construction in the Special Flood Hazard Area (SFHA), the area subject to inundation by the base flood). If the State/Commonwealth, county, or community has adopted more restrictive or comprehensive floodplain management criteria, these criteria take precedence over the minimum NFIP criteria.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION

To determine the changes in flood hazards that will be caused by the proposed project, we compared the hydraulic modeling reflecting the proposed project (referred to as the proposed conditions model) to the hydraulic modeling reflecting the existing conditions.

The table below shows the changes in the base flood water-surface elevations (WSELs).

Base Flood WSEL Comparison Table

Flooding Source: West Kiowa Creek		Base Flood WSEL Change (feet)	Location of maximum change
Proposed vs. Existing	Maximum increase	4.9	Approximately 6,260 feet upstream of Meridian Road North
	Maximum decrease	0.4	Approximately 11,160 feet upstream of Meridian Road North

NFIP regulations Subparagraph 60.3(b)(7) requires communities to ensure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management ordinances; therefore, responsibility for maintenance of the altered or relocated watercourse, including any related appurtenances such as bridges, culverts, and other drainage structures, rests with your community. We may request that your community submit a description and schedule of maintenance activities necessary to ensure this requirement.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

DATA REQUIRED FOR FOLLOW-UP LOMR

Upon completion of the project, your community must submit the data listed below and request that we make a final determination on revising the effective FIRM and FIS report. If the project is built as proposed and the data below are received, a revision to the FIRM and FIS report would be warranted.

• Detailed application and certification forms must be used for requesting final revisions to the maps. Therefore, when the map revision request for the area covered by this letter is submitted, Form 1, entitled "Overview and Concurrence Form," must be included. A copy of this form may be accessed at https://www.fema.gov/media-library/assets/documents/1343.

• The detailed application and certification forms listed below may be required if as-built conditions differ from the proposed plans. If required, please submit new forms, which may be accessed at https://www.fema.gov/media-library/assets/documents/1343, or annotated copies of the previously submitted forms showing the revised information.

Form 2, entitled "Riverine Hydrology and Hydraulics Form." Hydraulic analyses for as-built conditions of the base flood must be submitted with Form 2.

Form 3, entitled "Riverine Structures Form."

• A certified topographic work map showing the revised and effective base floodplain boundaries. Please ensure that the revised information ties in with the current effective information at the downstream and upstream ends of the revised reach.

• An annotated copy of the FIRM, at the scale of the effective FIRM, that shows the revised base floodplain boundary delineations shown on the submitted work map and how they tie-in to the base floodplain boundary delineations shown on the current effective FIRM at the downstream and upstream ends of the revised reach.

• As-built plans, certified by a registered Professional Engineer, of all proposed project elements.

• Documentation of the individual legal notices sent to property owners who will be affected by any widening or shifting of the base floodplain and/or any BFE establishment along West Kiowa Creek.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

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Engineering Services Branch
Federal Insurance and Mitigation Administration

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Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

DATA REQUIRED FOR FOLLOW-UP LOMR (continued)

• An officially adopted maintenance and operation plan for the six new detention basins within the subdivision. This plan, which may be in the form of a written statement from the community Chief Executive Officer, an ordinance, or other legislation, must describe the nature of the maintenance activities, the frequency with which they will be performed, and the title of the local community official who will be responsible for ensuring that the maintenance activities are accomplished.

• FEMA's fee schedule for reviewing and processing requests for conditional and final modifications to published flood information and maps may be accessed at https://www.fema.gov/forms-documents-and-software/flood-map-related-fees. The fee at the time of the map revision submittal must be received before we can begin processing the request. Payment of this fee can be made through a check or money order, made payable in U.S. funds to the National Flood Insurance Program, or by credit card (Visa or MasterCard only). Please either forward the payment, along with the revision application, to the following address:

LOMC Clearinghouse
Attention: LOMR Manager
3601 Eisenhower Avenue, Suite 500
Alexandria, Virginia 22304-6426

or submit the LOMR using the Online LOMC portal at: https://hazards.fema.gov/femaportal/onlinelomc/signin

After receiving appropriate documentation to show that the project has been completed, FEMA will initiate a revision to the FIRM and FIS report. Because the flood hazard information (i.e., base flood elevations, base flood depths, SFHAs, zone designations, and/or regulatory floodways) will change as a result of the project, a 90-day appeal period will be initiated for the revision, during which community officials and interested persons may appeal the revised flood hazard information based on scientific or technical data.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

COMMUNITY REMINDERS

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Jeanine P. Petterson
Director, Mitigation Division
Federal Emergency Management Agency, Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267
(303) 235-4830

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

VERTEX

McCune Ranch Subdivision
aka Winsome Subdivision
17480 Meridian Road North
Colorado Springs, Colorado 80924

REQUEST FOR CONDITIONAL LETTER OF MAP REVISION

FOR WEST KIOWA CREEK

COLORADO SPRINGS, COLORADO

JULY 1, 2019

PREPARED FOR:
PT McCune, LLC
Joseph W DesJardin
1864 Woodmoor Drive, Suite 100
Monument, Colorado 80132

PREPARED BY:
The Vertex Companies, Inc.
2420 W. 26th Avenue, Suite 100-D
Denver, Colorado 80211
PHONE: 303-623-9116

VERTEX Project: 49388
FEMA Case No: 19-08-0185R

Jason Priddy
Project Engineer

Lance VanDemark, P.E.
Project Manager

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1.0 INTRODUCTION

The purpose of this submittal is to request a Conditional Letter of Map Revision (CLOMR) for a flooding source in El Paso County, Colorado known as West Kiowa Creek. This request is requisite for a 760-acre property, known as the proposed McCune Ranch Subdivision (aka Winsome Subdidision). West Kiowa Creek, which flows across the property from west to east, is currently mapped as an approximate Zone A. Stormwater is directed from the contributing basins across the property along an approximate 1.25-mile flow path. The proposed development will affect FIRM map number 08041C0350G and 08041C0310G, effective December 7, 2018. Basin hydrology and hydraulics have been modeled and are included in this study to identify the Special Flood Hazard Area (SFHA). The basis of this request is to identify the floodplain boundary for the residential subdivision proposed for the site, and to assess the extent of flood risk relative to two proposed bridges.

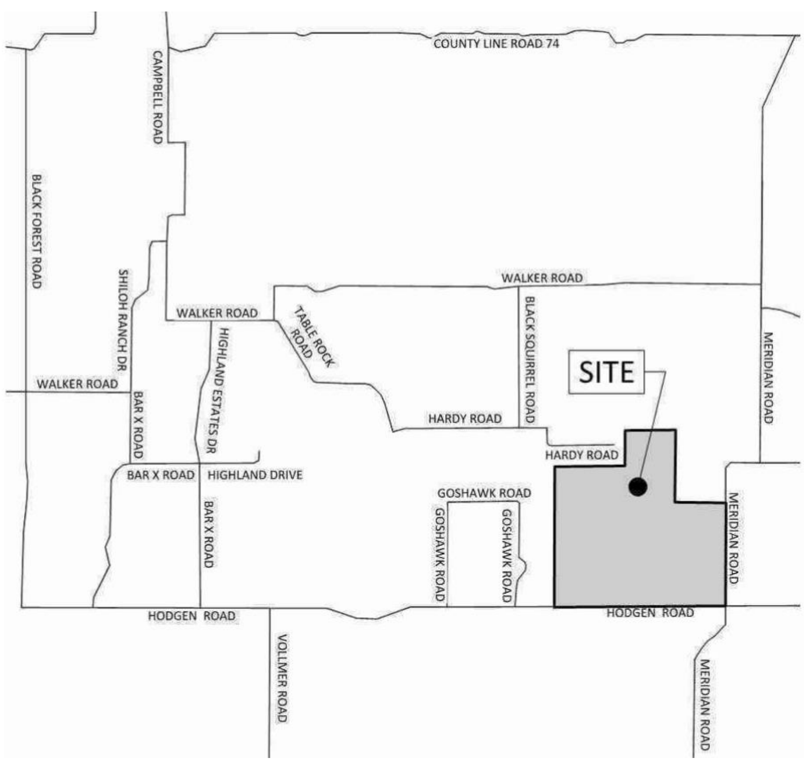
2.0 GENERAL LOCATION AND DESCRIPTION

The following report provides detailed drainage and floodplain information for existing and proposed conditions of the McCune Ranch Subdivision project. The intent of this report is to show the extent of flood risk through the proposed site, and the boundaries of the SFHA, as well as other storm events per FEMA requirements. The information given in this report is intended to provide data resulting from a detailed analysis of stormwater drainage and define the 100-year floodplain. Because the subject reach is currently an approximate Zone A, Base Flood Elevations (BFE's) will be defined. A floodway has not been delineated. This development is in a rural area and will consist of large-lot single family residential parcels, a small commercial area, preserved open space, as well as the roads and required utility infrastructure.

GENERAL LOCATION

The site is located at 17480 Meridian Road North or, more generally, at the northwest corner of Hodgen Road and Meridian Road North in unincorporated El Paso County. The subject property is undeveloped and situated in the West Half of Section 19, Township 11 South, Range 64 West of the 6th P.M., County of El Paso, State of Colorado.

The site is bounded to the south by Hodgen Road, to the east by Meridian Road North, and to the north and west by several parcels zoned primarily as Agricultural and Residential use with some Forest Land. On the east side of Median Road is Forest Green Subdivision, a low-density single-family development. On the south side of Hodgen Road is Bison Meadows Subdivision which is also a low-density single family residential subdivision. The remainder of properties surrounding the site have not yet been formally platted. The site has not been included in any previous drainage study.



DESCRIPTION OF PROPERTY

The existing site contains 766 acres of agricultural grazing land and dry farm land. Ground cover consists mainly of native grasses and shrubs and contains several stands of evergreen trees along its southern and northern boundary. Existing wetlands are present along West Kiowa Creek and its tributaries, wetland boundaries are located roughly 50 feet to either side of the thalweg of West Kiowa Creek and the drainageway way to the south of the creek on the property. There are no existing irrigation canals or ditches on the project site nor are there any major geologic features. The property generally slopes in a northeasterly direction with slopes ranging between 1-16%. Soils consist of Alamosa loam, Brussett loam, Cruckton sandy loam, Elbeth sandy loam, Holderness loam, Kettle gravelly loamy sands, Peyton sandy loam, Peyton-Pring complex, Pring course sandy loam, Tomah-Crowford loamy sands and Tomah-Crowfoot complex. Most of the site has soils classified in Hydrologic Soil Group B; however, the property also contains a mixture of soils from Hydrologic Soils Groups C and D located in the areas in and adjacent to West Kiowa Creek and its tributaries.

PROPOSED DEVELOPMENT

The development of this property will consist of 143 2.5 to 5-acre single family residential lots and the requisite public roads and stormwater infrastructure to serve them. Anticipated construction activities include earthwork and paving associated with the public roads, as well as the installation of culverts and detention ponds to convey and treat stormwater on the site. The primary access for the site will be from Hodgen Road and Meridian Road. A site plan for the project is included in the appendix.

3.0 PROPOSED DESIGN CONDITIONS

REGULATIONS

The hydrologic calculations in this report comply with the City of Colorado Springs/El Paso County Drainage Criteria Manuals, and FEMA drainage criteria. There are no previous drainage studies that cover this property.

EXISTING DRAINAGE

Historically, the runoff from the property flows into West Kiowa Creek, which bisects the site flowing from the southwest corner of the property to the northeast corner. There are 10 on-site sub-basins and 6 off-site sub-basin that contribute flows to West Kiowa Creek. The 10 on-site sub-basins correspond to the largest defined natural drainage channels that occur on site, while the 6 off-site basins are defined by the entire West Kiowa Creek watershed that is upstream from the subject property.

PROPOSED DRAINAGE

All existing drainage patterns will be maintained throughout the site to the extent possible. The path of the main thalweg is not altered, however 2 new box culverts are proposed at road crossings within the development. To calculate the design flows at points across the project, the existing basins were subdivided into 35 on-site sub-basins and 8 off-site sub-basins in the proposed condition. Stormwater detention ponds have been designed to control flow such that all flow off the site will be at or below historic averages.

PROPOSED BRIDGES

The project includes two triple box culverts at points where roads cross the floodplain. The culverts are sized at (3) 10’ wide x 10’ high totaling approximately 30’ wide x 10’ high of flow area. In the 100-year storm there is no overtopping of the road. This condition meets local requirements for this road category. The length of both box culverts is sized to accommodate 2 lanes of traffic and road shoulder. Details of the proposed culverts is included in the appendix.

The culverts will have flared end sections with a concrete apron that funnels the entering water in and spreads the exiting flow out. A rip-rap bed will be used at the culvert exit points to address potential erosion. The culverts will be installed at grade with 0.5% slope and allow the passage of aquatic life.

HYDROLOGICAL AND HYDRAULIC CRITERIA

Topographic mapping was developed from LiDAR and field mapping conducted in 2011, and obtained from the licensed GIS data service of El Paso County. El Paso County GIS Services projects the contours in the Colorado Central Zone in State Plane (Feet) units using the NAD83 horizontal datum. The vertical datum is NAVD.

Since this project contains sub-basins over 100 acres, times of concentration and peak runoff values were calculated using the SCS TR-55 Hydrograph method as required by the City of Colorado Springs/El Paso County Drainage Criteria Manuals. The model utilizes the SCS Type II 24-hr rainfall distribution and rain gauge data for the county.

Hydraulic modeling of the floodplain was performed using HEC-RAS version 5.0. Manning's n-values of 0.03 for in channel areas and 0.035 for overbank areas were used in the model based on site observation and referencing within Ven Te Chow's Open Channel Hydraulics. Contraction and expansion coefficients are 0.1 and 0.3 respectively, for all cross sections except for the two box culverts where 0.3 and 0.5 are used at the appropriate sections.

4.0 HYDRAULIC MODEL RESULTS

A HEC-RAS section analysis was performed to identify the floodplain width for the different storm events. Pertinent model information is included in the appendix. The following tables summarize the results:

COMPARATIVE EXISTING AND PROPOSED SECTION DATA						
CROSS SECTION	EC 100-YEAR WSEL	PC 100-YEAR WSEL	WSEL IMPACT	EC TOP WIDTH	PC TOP WIDTH	TOP WIDTH IMPACT
72+34	7337.98	7338.11	0.13	62.28	63.12	0.84
69+69	7335.41	7335.52	0.11	63.13	64.11	0.98
67+63	7333.50	7333.63	0.13	63.51	64.92	1.41
65+42	7331.02	7331.14	0.12	72.18	74.22	2.04
63+02	7328.83	7328.85	0.02	76.66	76.90	0.24
61+34	7327.64	7327.28	-0.36	135.78	131.11	-4.67
58+12	7325.32	7326.47	1.15	129.67	201.82	72.15
54+80	7323.11	7326.65	3.54	177.66	349.50	171.84
53+75	7322.89	7326.35	3.46	136.48	278.31	141.83
53+10			CULVERT			
52+56	7321.54	7321.50	-0.04	111.61	110.20	-1.41
51+58	7318.63	7318.71	0.08	102.69	103.09	0.40
48+10	7316.70	7316.81	0.11	178.97	179.90	0.93
47+01	7316.60	7316.71	0.11	145.65	146.50	0.85
44+67	7315.62	7315.70	0.08	112.95	114.47	1.52
43+12	7314.33	7314.40	0.07	115.02	115.43	0.41
40+58	7310.97	7311.05	0.08	98.36	99.53	1.17
37+56	7308.35	7308.45	0.10	84.42	86.18	1.76
36+71	7307.43	7307.52	0.09	95.71	96.89	1.18
33+13	7304.27	7304.40	0.13	98.47	102.90	4.43
30+53	7300.93	7301.03	0.10	68.96	69.79	0.83
29+16	7299.69	7299.80	0.11	66.66	67.41	0.75
25+59	7297.05	7297.13	0.08	117.36	118.75	1.39
23+56	7294.53	7294.61	0.08	88.27	88.75	0.48
21+15	7292.39	7292.45	0.06	99.33	99.93	0.60

18+26	7289.01	7289.14	0.13	84.94	86.77	1.83
16+18	7288.55	7289.44	0.89	266.32	299.59	33.27
15+15	7286.83	7289.46	2.63	166.37	425.09	258.72
13+21	7285.19	7289.40	4.21	154.03	291.86	137.83
12+24	7284.44	7289.09	4.65	157.81	255.05	97.24
11+60			CULVERT			
11+05	7284.18	7283.36	-0.82	145.88	124.12	-21.76
10+07	7282.77	7282.73	-0.04	89.32	88.93	-0.39
8+93	7281.41	7281.40	-0.01	243.26	243.18	-0.08
6+78	7278.50	7278.47	-0.03	265.74	265.53	-0.21
4+40	7276.47	7276.45	-0.02	146.63	146.38	-0.25

5.0 SEDIMENT TRANSPORT

After visual observation and examining historical records, there are no indications that sediment or debris transport will impact base flood elevations (BFE). The stream appears to be in a stable state with no evidence that the structure has been recently influenced by sediment deposition, degrading of the bank or stream bed, or vegetative cover in the flow path. Further, the proposed stormwater detention ponds will help address potential sediment before it reaches the floodplain area. As a result, sediment transport is not included in this analysis.

6.0 SCOUR ANALYSIS

The potential for scour of the floodway, and the associated impacts on water surface elevations, were considered as a part of this analysis. The two box culverts have been designed with characteristics to help address this in major storm events. At the exit point of the culvert, a combination of flared wing walls, a concrete apron, and a rip-rap bed are proposed to reduce the velocity of the water and the impacts of scour.

7.0 ESA COMPLIANCE

An environmental features study dated October 1, 2018 has been prepared by Ecosystem Services for this project and is included in the appendix. Ecos has also provided a letter of "No Take" addressing ESA requirements. Further, a letter of "No Concern" from the US Fish and Wildlife Department has also been obtained and is included.

8.0 OPERATION AND MAINTAINANCE REQUIREMENTS

Metropolitan districts are being created for the neighborhood that will have the responsibility of maintaining drainage facilities and the floodplain area.

9.0 PROPOSED CONDITION BFE INCREASE

The Base (1-percent-annual-chance) Flood Elevation (BFE) increases to greater than 1.0 foot within the current, effective approximate Zone A immediately upstream of each of the two bridges. Fulfillment of the requirements set forth in 44 CFR 65.12 are described below:

a) Certification that no structures are affected by the increased BFE: Please see stamped certification on the next page.
b) Documentation of individual legal notice to all affected property owners, explaining the impact of the proposed action on their property: The only affected property owner is the applicant of this LOMR request, thus the applicant is apprised of the impact of the proposed development, de facto.
c) An evaluation of alternatives that would not result in an increase in BFE has been conducted. To access over half of the project area, the floodplain of this site must be crossed. Other bridge configurations are being considered, but due to the significant

expense associated with a bridge of this size, box culverts are currently being specified. Further, alternative road alignments and ingress/egress locations were considered but deemed infeasible for the project.

Certification that no structures will be affected by the rises in Base Flood Elevations (BFEs) as a result of the proposed project subject to this request. There are no existing structures currently within the boundary of the project.

COLORADO LICENSED PROFESSIONAL ENGINEER
LANCE PATRICK VANDEMARK
43911

____

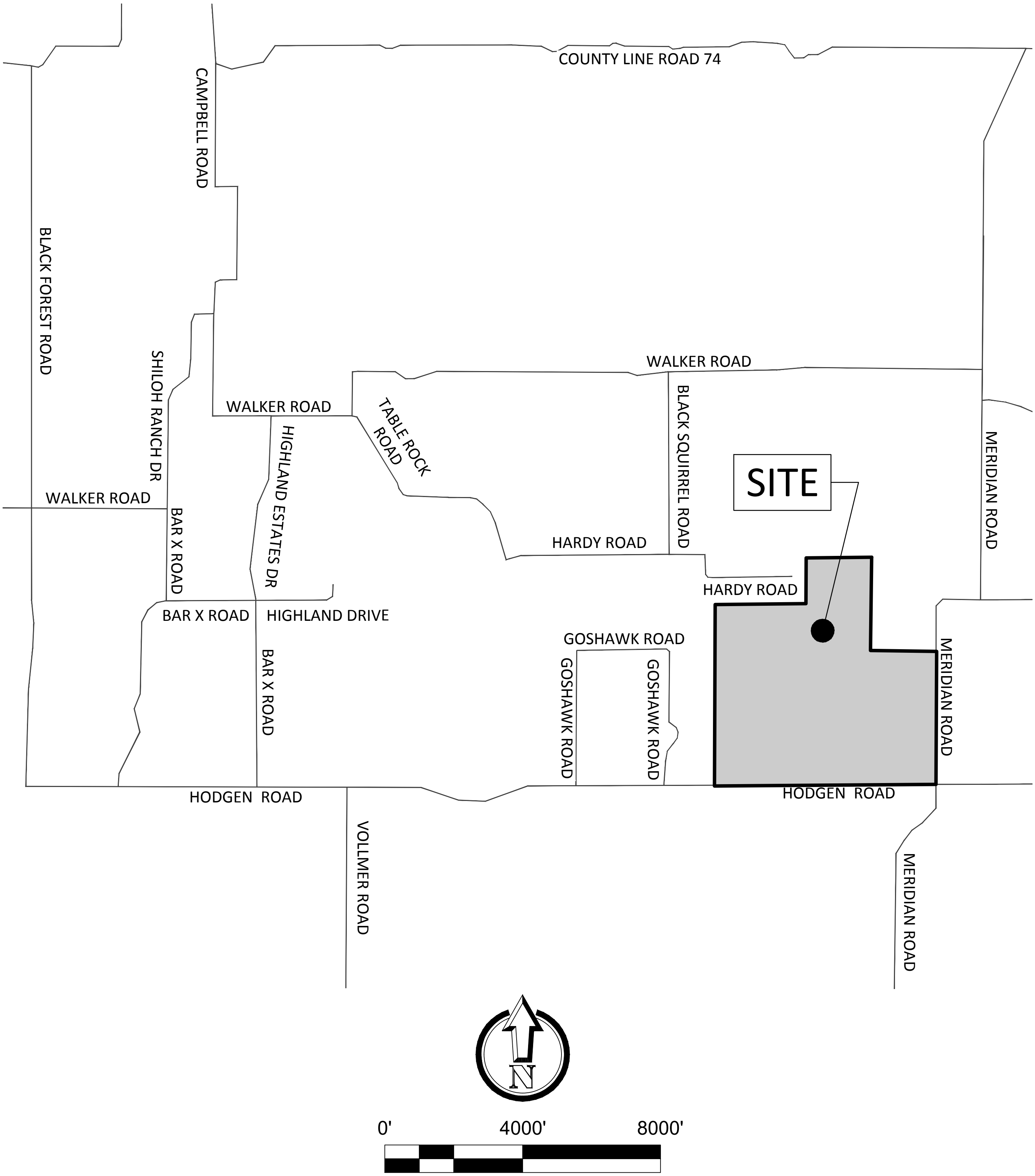
Lance P. VanDemark PE, MSCE
VICE PRESIDENT – CIVIL ENGINEERING
O: 303.623.9116 | D: 720.545.0459 | C: 303.263.3102 | VERTEXENG.COM

THE VERTEX COMPANIES, INC.
2420 W. 26TH AVE., SUITE 100-D
DENVER, CO 80211

A. REPRESENTATIVE PHOTOGRAPHS

B. <u>WORKING MAPS AND OTHER REQUIRED DOCUMENTS</u>

VICINITY MAP



VICINITY MAP

MCCUNE RANCH SUBDIVISION

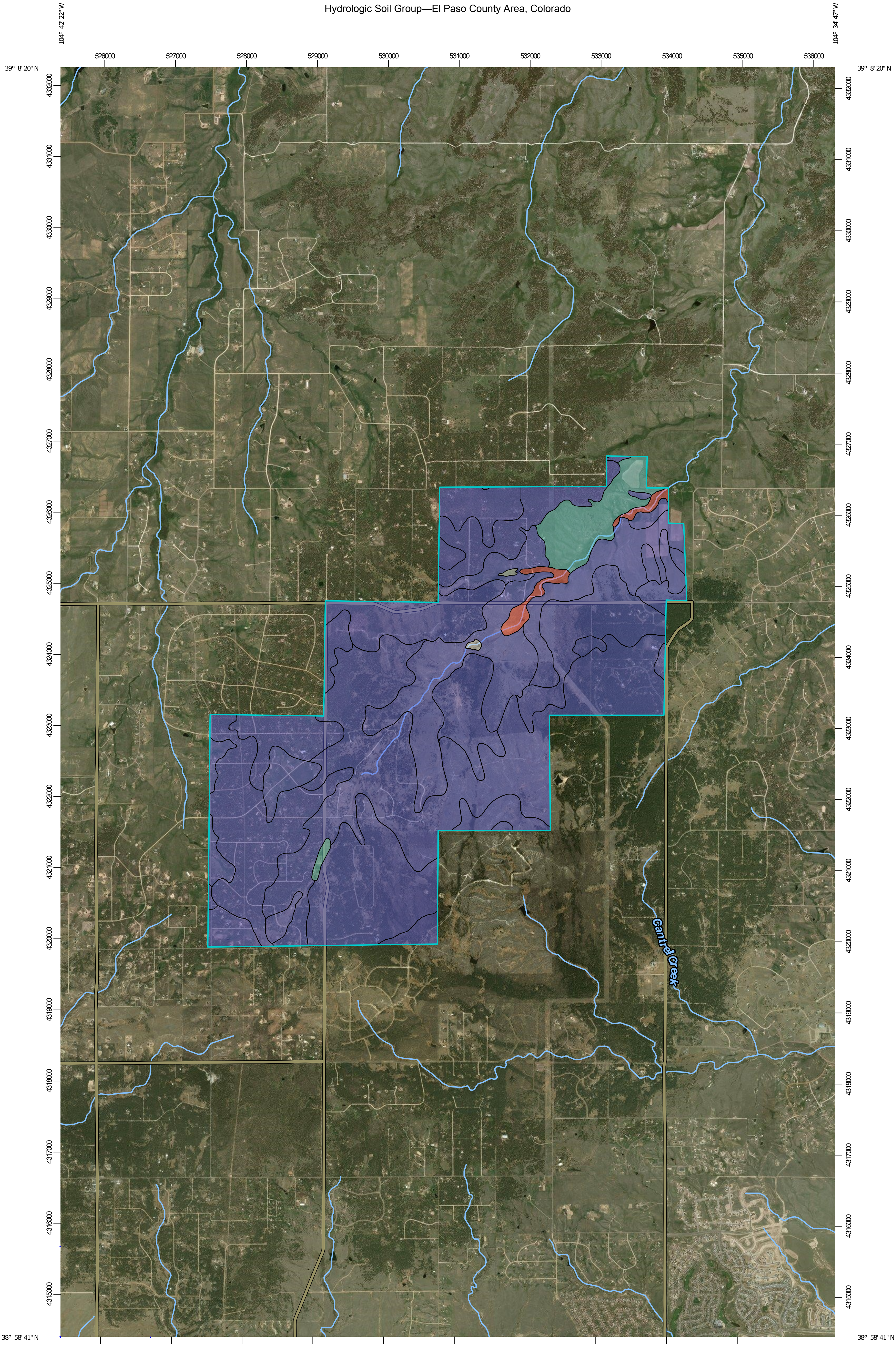
17480 MERIDIAN ROAD
ELBERT, COLORADO

File No.:	
Date:	10/04/2018
Drawn:	JCP
Checked:	LPV
Job No.:	49388

FIGURE 1

VERTEX®

P:\Shared\Projects\49000-49999\49300-49399\49388.McCune Ranch\06-Engineering\Vertex Drawings\Exhibits\49388_EXH_VinMap.dwg
Tuesday, October 02, 2018 12:59:57 PM



Map Scale: 1:50,000 if printed on B portrait (11" x 17") sheet.

Meters: 0 500 1000 2000 3000

Feet: 0 2000 4000 8000 12000

N

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

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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 15, Oct 10, 2017

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

Date(s) aerial images were photographed: May 22, 2016—Mar 9, 2017

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
1	Alamosa loam, 1 to 3 percent slopes	D	80.6	1.2%
15	Brussett loam, 3 to 5 percent slopes	B	6.0	0.1%
21	Cruckton sandy loam, 1 to 9 percent slopes	B	4.7	0.1%
25	Elbeth sandy loam, 3 to 8 percent slopes	B	2,081.3	31.8%
26	Elbeth sandy loam, 8 to 15 percent slopes	B	2,075.9	31.7%
34	Holderness loam, 1 to 5 percent slopes	C	15.5	0.2%
36	Holderness loam, 8 to 15 percent slopes	C	278.7	4.3%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	400.4	6.1%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	265.1	4.0%
67	Peyton sandy loam, 5 to 9 percent slopes	B	36.3	0.6%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	38.1	0.6%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	26.0	0.4%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	661.6	10.1%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	574.4	8.8%
111	Water		10.0	0.2%
Totals for Area of Interest			**6,554.4**	**100.0%**

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

C. STUDIED EXISTING CONDITION 100 YEAR FLOODPLAIN MAP

FEMA CLOMR SUBMITTAL

MCCUNE RANCH SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

CASE #: 19-08-0185R

WEST KIOWA CREEK EXISTING CONDITIONS 100-YEAR FLOOD DATA			
CROSS SECTION	100-YEAR EC WSEL	100-YEAR EC TOP WIDTH INCLUDING INEFFECTIVE FLOW	100-YEAR EC TOP WIDTH EXCLUDING INEFFECTIVE FLOW
72+34	7337.98	62.28	62.28
69+69	7335.41	63.13	63.13
67+63	7333.50	63.51	63.51
65+42	7331.02	72.18	72.18
63+02	7328.83	76.66	76.66
61+34	7327.64	135.78	135.78
58+12	7325.32	129.67	129.67
54+80	7323.11	177.66	139.36
53+75	7322.89	136.48	136.48
53+10			
52+56	7321.54	111.61	111.61
51+58	7318.63	102.69	102.69
48+10	7316.70	178.97	178.97
47+01	7316.60	145.65	145.65
44+67	7315.62	112.95	112.95
43+12	7314.33	115.02	115.02
40+58	7310.97	98.36	98.36
37+56	7308.35	84.42	84.42
36+71	7307.43	95.71	95.71
33+13	7304.27	98.47	98.47
30+53	7300.93	68.96	68.96
29+16	7299.69	66.66	66.66
25+59	7297.05	117.36	117.36
23+56	7294.53	88.27	88.27
21+15	7292.39	99.33	99.33
18+26	7289.01	84.94	84.94
16+18	7288.55	266.32	266.32
15+15	7286.83	166.37	82.16
13+21	7285.19	154.03	154.03
12+24	7284.44	157.81	157.81
11+60			
11+05	7284.18	145.88	145.88
10+07	7282.77	89.32	89.32
8+93	7281.41	243.26	243.26
6+78	7278.50	265.74	265.74
4+40	7276.47	146.63	146.63
SKEW ANGLE APPLIED IN HEC-RAS OF 55° @ 51+58 AND 45° @ 10+07. DASHED LINE AT THESE CROSS SECTIONS REPRESENTS ADJUSTED ANGLE.			

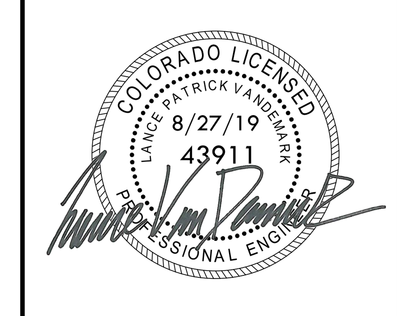
BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88

0' 300' 600'

VERTEX®
2420 W. 26th Avenue, Suite 100-D | Denver, CO 80211
Main: 303.623.9116 | VERTEXENG.COM



100Y EC FLOODPLAIN

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	REVISED PER REVIEW COMMENTS 3/26/19
2	REVISED PER REVIEW COMMENTS 4/2/19
3	REVISED PER REVIEW COMMENTS 6/3/19
4	REVISED PER REVIEW COMMENTS 7/1/19
5	
6	
7	
8	
9	
10	

DATE: 11/16/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

2

D. STUDIED PROPOSED CONDITION 100 YEAR FLOODPLAIN MAP

FEMA CLOMR SUBMITTAL

MCCUNE RANCH SUBDIVISION

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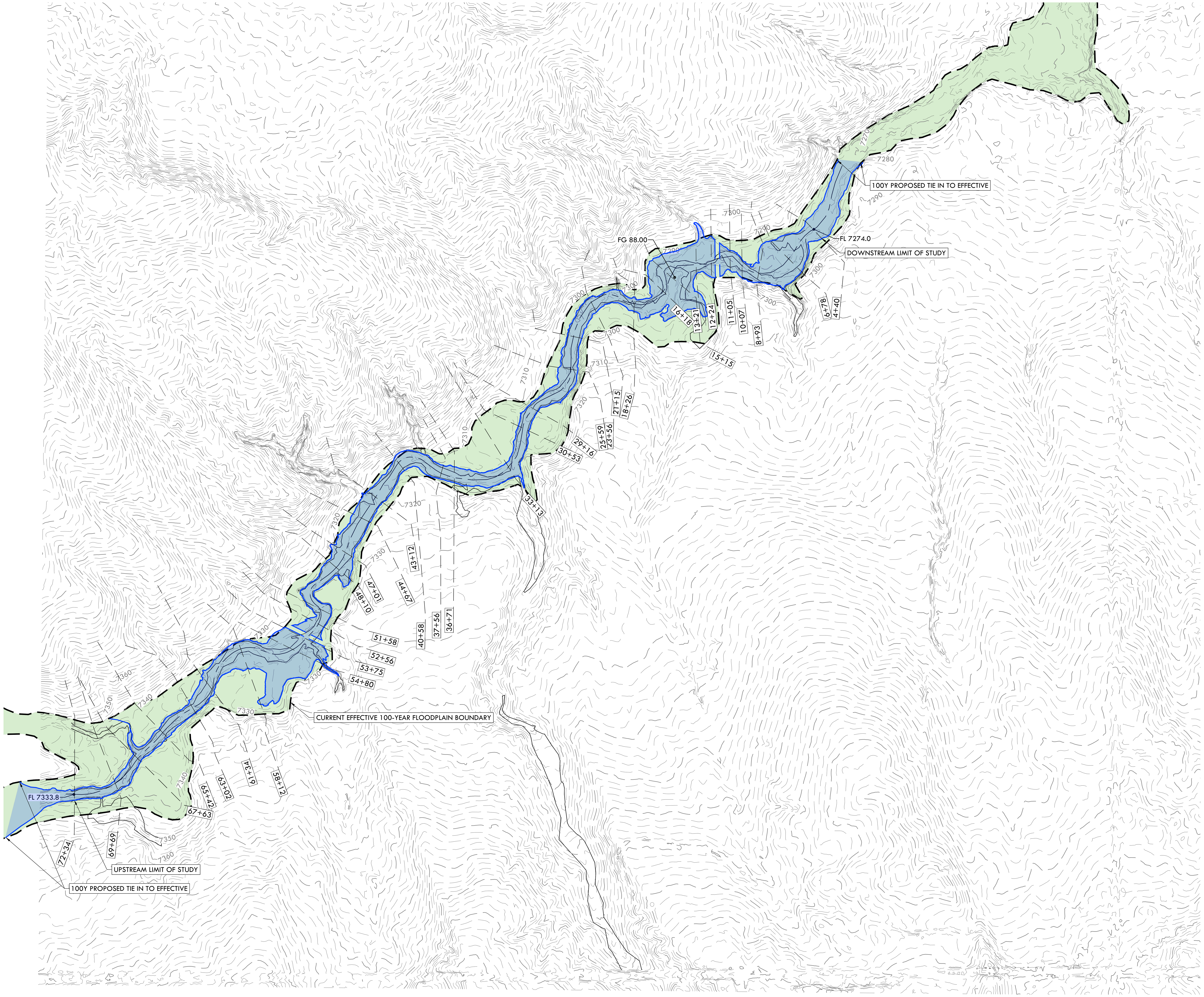
CASE #: 19-08-0185R



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63+02	7328.85	76.90	76.90
61+34	7327.28	131.11	131.11
58+12	7326.47	201.82	169.96
54+80	7326.65	349.50	322.44
53+75	7326.35	278.31	62.88
53+10	CULVERT		
52+56	7321.50	110.20	66.00
51+58	7318.71	103.09	103.09
48+10	7316.81	179.90	179.90
47+01	7316.71	146.50	146.50
44+67	7315.70	114.47	114.47
43+12	7314.40	115.43	115.43
40+58	7311.05	99.53	99.53
37+56	7308.45	86.18	86.18
36+71	7307.52	96.89	96.89
33+13	7304.40	102.90	102.90
30+53	7301.03	69.79	69.79
29+16	7299.80	67.41	67.41
25+59	7297.13	118.75	118.75
23+56	7294.61	88.75	88.75
21+15	7292.45	99.93	99.93
18+26	7289.14	86.77	86.77
16+18	7289.44	299.59	299.59
15+15	7289.46	425.09	425.09
13+21	7289.40	291.86	189.05
12+24	7289.09	255.05	62.76
11+60	CULVERT		
11+05	7283.36	124.12	60.69
10+07	7282.73	88.93	88.93
8+93	7281.40	243.18	243.18
6+78	7278.47	265.53	265.53
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100Y PC FLOODPLAIN

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3	REVISED PER REVIEW COMMENTS 6/5/19
4	REVISED PER REVIEW COMMENTS 7/1/19
5	
6	
7	
8	
9	
10	

DATE: 11/16/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

1

E. ANNOTATED FIRMETTE MAPS

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, N/NGS12
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.

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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.

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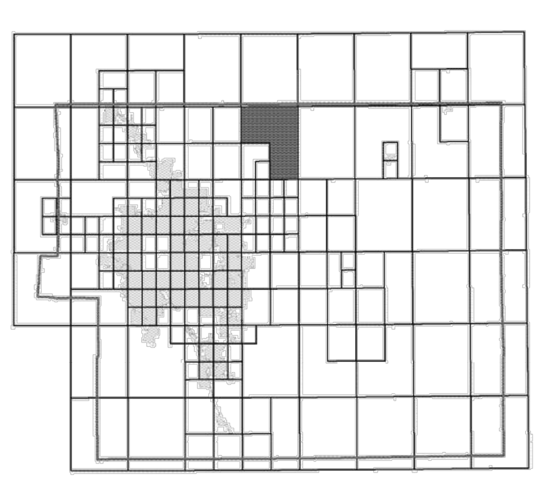
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

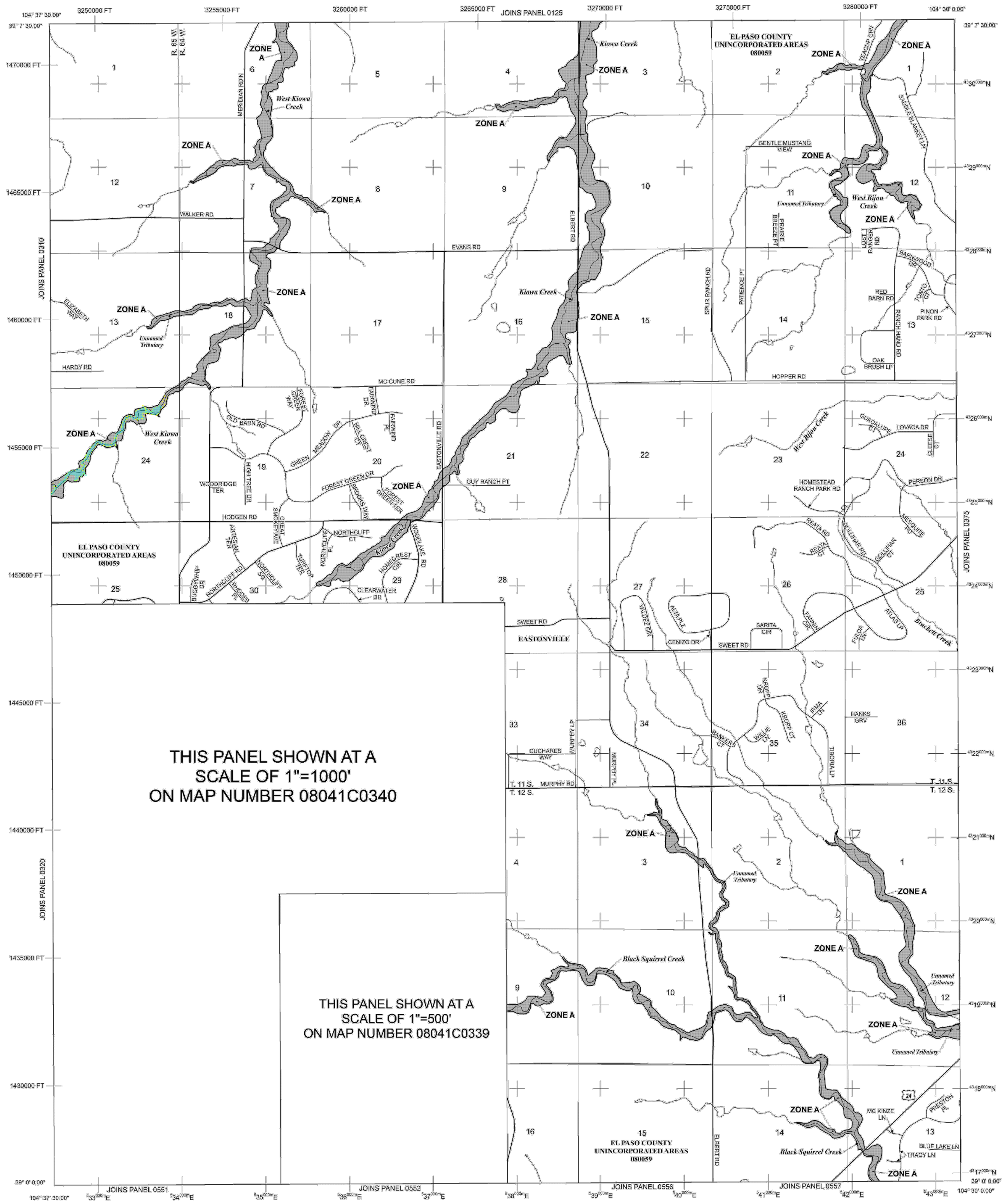
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

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.



LEGEND

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

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include 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.
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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.
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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.
~~ 513 ~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

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

(A)——(A)	Cross section line
(23)--------(23)	Transect line
97° 07' 30.00" 32° 22' 30.00"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT	5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• 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.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0350G

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	080059	0350	G

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

NOTES TO USERS

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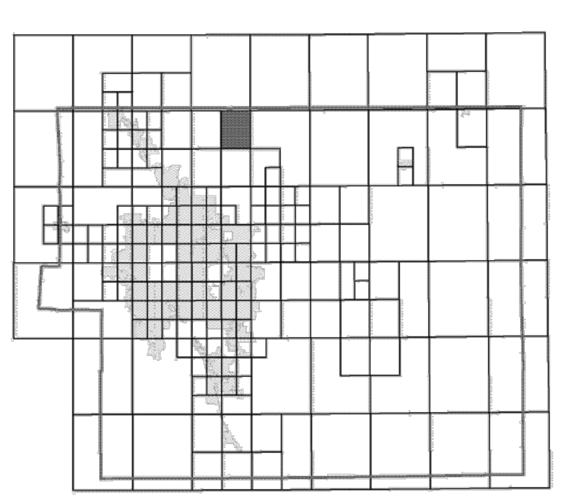

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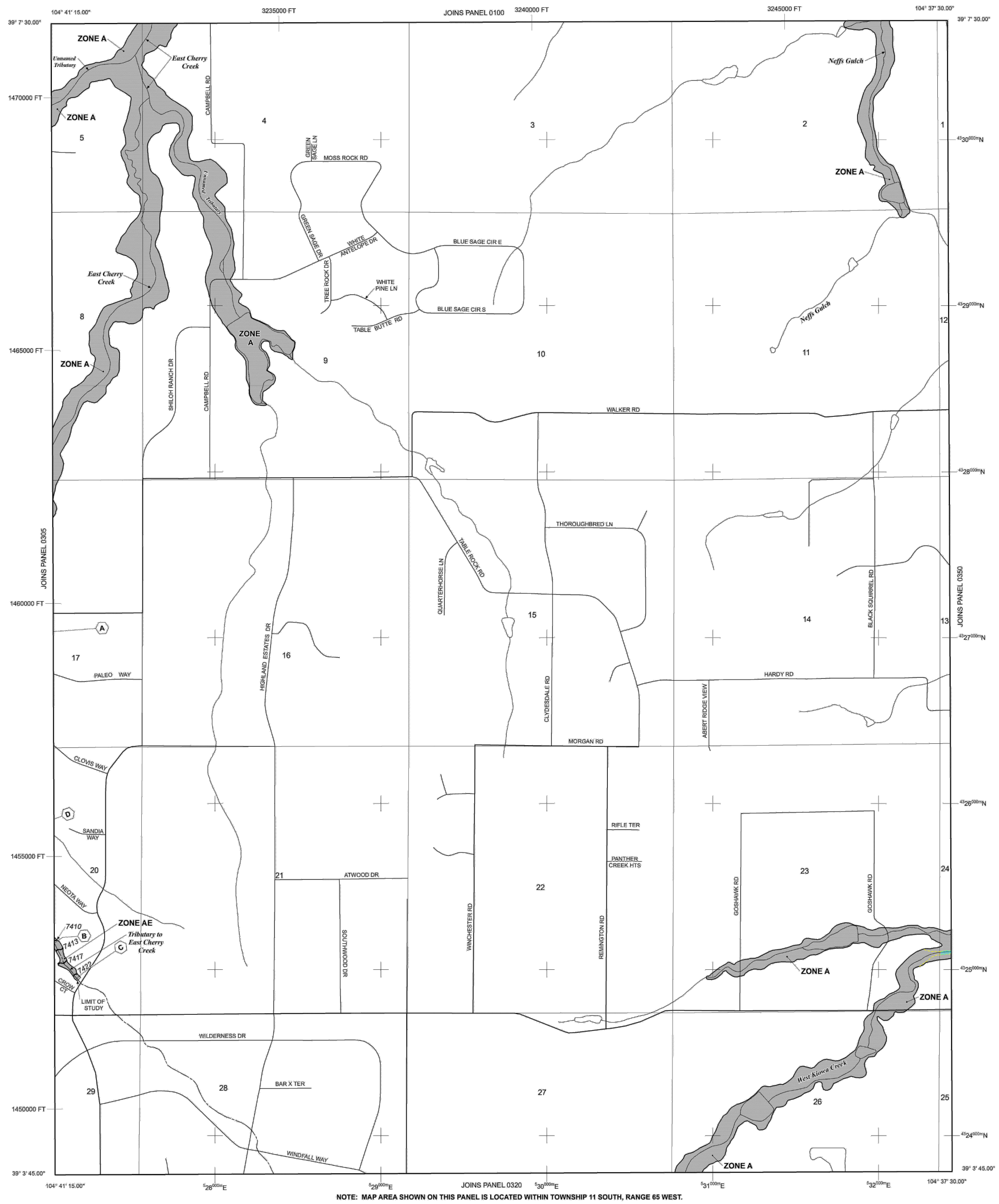

NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 11 SOUTH, RANGE 65 WEST.

LEGEND

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

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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)

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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.

~~ 513 ~~ Base Flood Elevation line and value; elevation in feet*
(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

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

(A)——(A) Cross section line
(23)--------(23) Transect line
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4275000mN 1000-meter Universal Transverse Mercator grid ticks, zone 13
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DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5 River Mile

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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.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

PANEL 0310G

NATIONAL FLOOD INSURANCE PROGRAM

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

PANEL 310 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0310	G

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
08041C0310G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

F. <u>HYDRAULIC ANALYSIS</u>

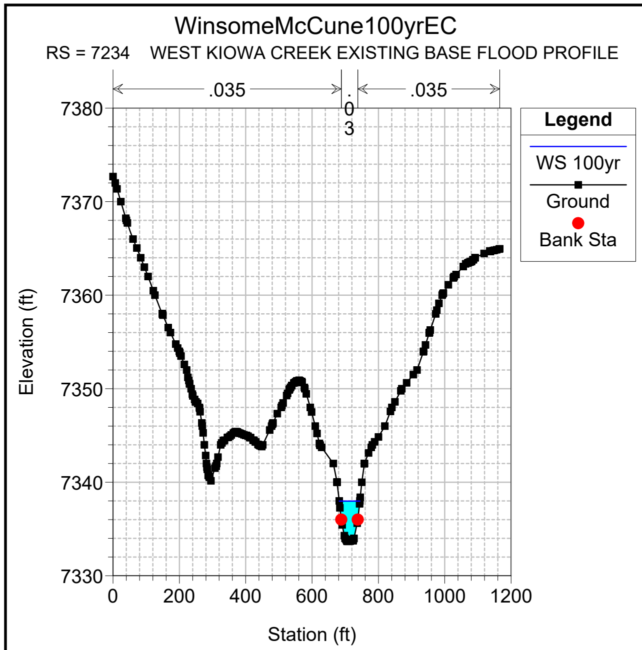
i. <u>STUDIED 100 YEAR FLOODPLAIN DATA</u>

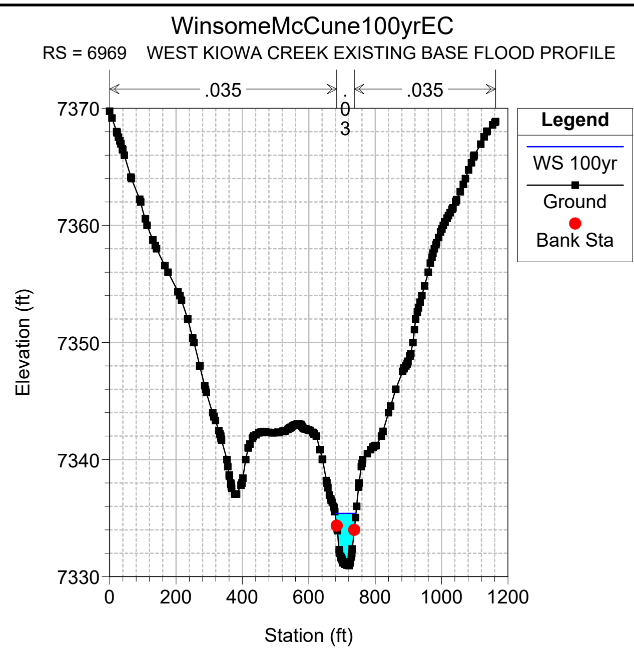
WEST KIOWA CREEK EXISTING CONDITIONS 100-YEAR FLOOD DATA			
CROSS SECTION	100-YEAR EC WSEL	100-YEAR EC TOP WIDTH INCLUDING INEFFECTIVE FLOW	100-YEAR EC TOP WIDTH EXCLUDING INEFFECTIVE FLOW
72+34	7337.98	62.28	62.28
69+69	7335.41	63.13	63.13
67+63	7333.50	63.51	63.51
65+42	7331.02	72.18	72.18
63+02	7328.83	76.66	76.66
61+34	7327.64	135.78	135.78
58+12	7325.32	129.67	129.67
54+80	7323.11	177.66	139.36
53+75	7322.89	136.48	136.48
53+10			
52+56	7321.54	111.61	111.61
51+58	7318.63	102.69	102.69
48+10	7316.70	178.97	178.97
47+01	7316.60	145.65	145.65
44+67	7315.62	112.95	112.95
43+12	7314.33	115.02	115.02
40+58	7310.97	98.36	98.36
37+56	7308.35	84.42	84.42
36+71	7307.43	95.71	95.71
33+13	7304.27	98.47	98.47
30+53	7300.93	68.96	68.96
29+16	7299.69	66.66	66.66
25+59	7297.05	117.36	117.36
23+56	7294.53	88.27	88.27
21+15	7292.39	99.33	99.33
18+26	7289.01	84.94	84.94
16+18	7288.55	266.32	266.32
15+15	7286.83	166.37	82.16
13+21	7285.19	154.03	154.03
12+24	7284.44	157.81	157.81
11+60			
11+05	7284.18	145.88	145.88
10+07	7282.77	89.32	89.32
8+93	7281.41	243.26	243.26
6+78	7278.50	265.74	265.74
4+40	7276.47	146.63	146.63
SKEW ANGLE APPLIED IN HEC-RAS OF 55° @ 51+58 AND 45° @ 10+07. DASHED LINE AT THESE CROSS SECTIONS REPRESENTS ADJUSTED ANGLE.			

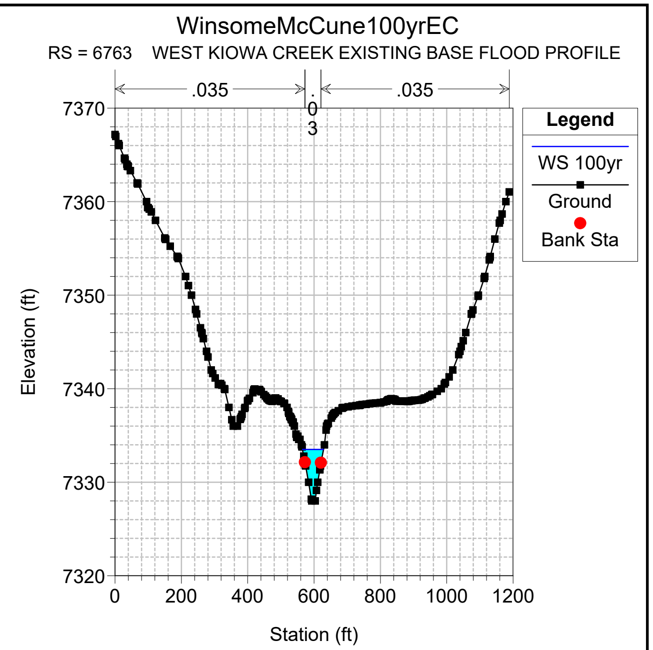
WEST KIOWA CREEK PROPOSED CONDITIONS 100-YEAR FLOOD DATA			
CROSS SECTION	100-YEAR PC WSEL	100-YEAR PC TOP WIDTH INCLUDING INEFFECTIVE FLOW	100-YEAR PC TOP WIDTH EXCLUDING INEFFECTIVE FLOW
72+34	7338.11	63.12	63.12
69+69	7335.52	64.11	64.11
67+63	7333.63	64.92	64.92
65+42	7331.14	74.22	74.22
63+02	7328.85	76.90	76.90
61+34	7327.28	131.11	131.11
58+12	7326.47	201.82	169.96
54+80	7326.65	349.50	322.44
53+75	7326.35	278.31	62.88
53+10	CULVERT		
52+56	7321.50	110.20	66.00
51+58	7318.71	103.09	103.09
48+10	7316.81	179.90	179.90
47+01	7316.71	146.50	146.50
44+67	7315.70	114.47	114.47
43+12	7314.40	115.43	115.43
40+58	7311.05	99.53	99.53
37+56	7308.45	86.18	86.18
36+71	7307.52	96.89	96.89
33+13	7304.40	102.90	102.90
30+53	7301.03	69.79	69.79
29+16	7299.80	67.41	67.41
25+59	7297.13	118.75	118.75
23+56	7294.61	88.75	88.75
21+15	7292.45	99.93	99.93
18+26	7289.14	86.77	86.77
16+18	7289.44	299.59	299.59
15+15	7289.46	425.09	425.09
13+21	7289.40	291.86	189.05
12+24	7289.09	255.05	62.76
11+60	CULVERT		
11+05	7283.36	124.12	60.69
10+07	7282.73	88.93	88.93
8+93	7281.40	243.18	243.18
6+78	7278.47	265.53	265.53
4+40	7276.45	146.38	146.38
SKEW ANGLE APPLIED IN HEC-RAS OF 55° @ 51+58 AND 45° @ 10+07. DASHED LINE AT THESE CROSS SECTIONS REPRESENTS ADJUSTED ANGLE.			

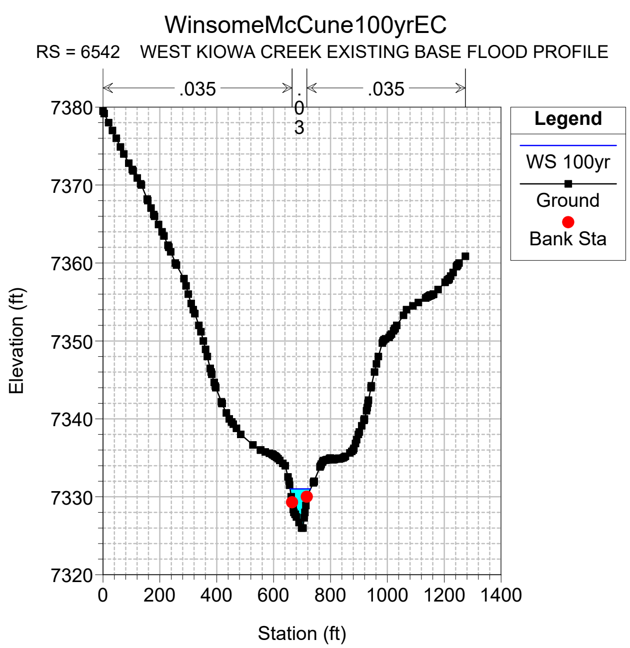
F. HYDRAULIC ANALYSIS

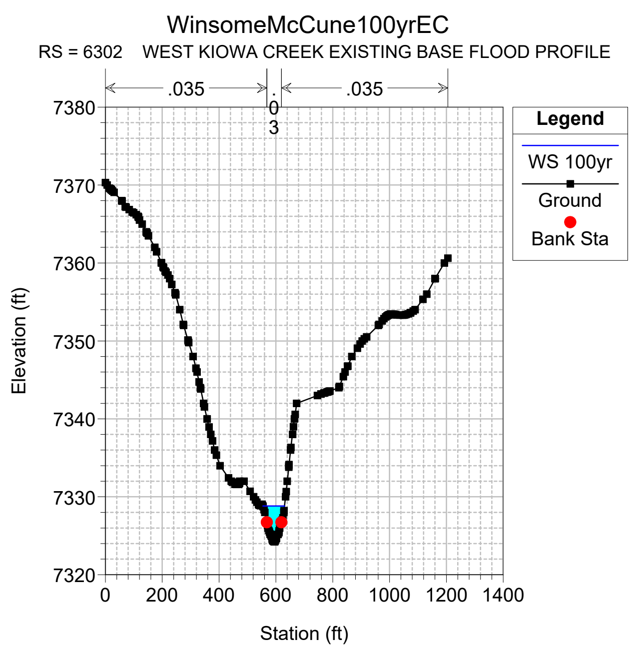
ii. STUDIED EXISTING CONDITION 100 YEAR FLOODPLAIN CROSS SECTIONS

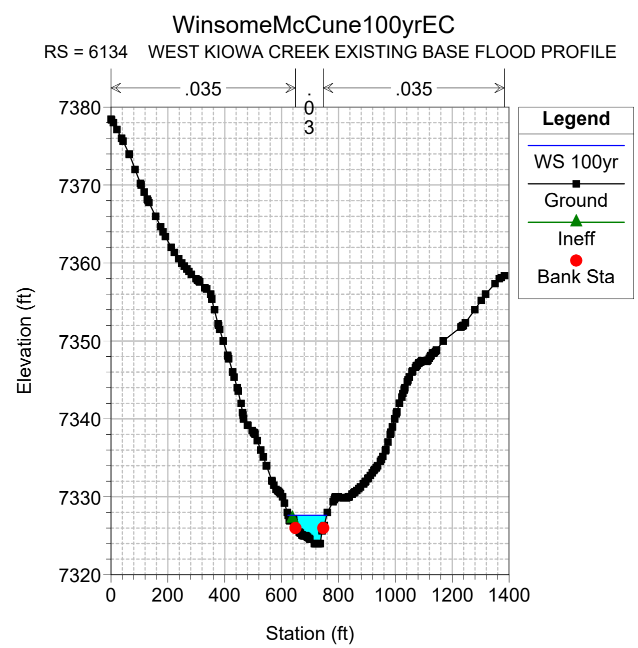

WinsomeMcCune100yrEC
RS = 7234 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

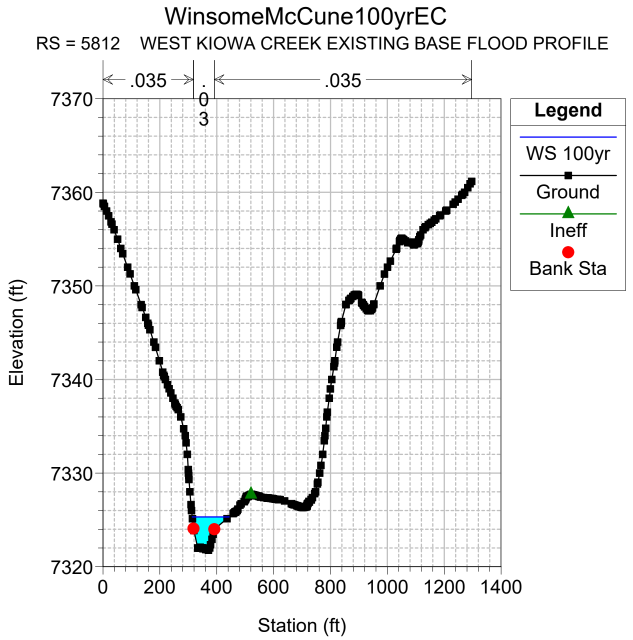

WinsomeMcCune100yrEC
RS = 6969 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

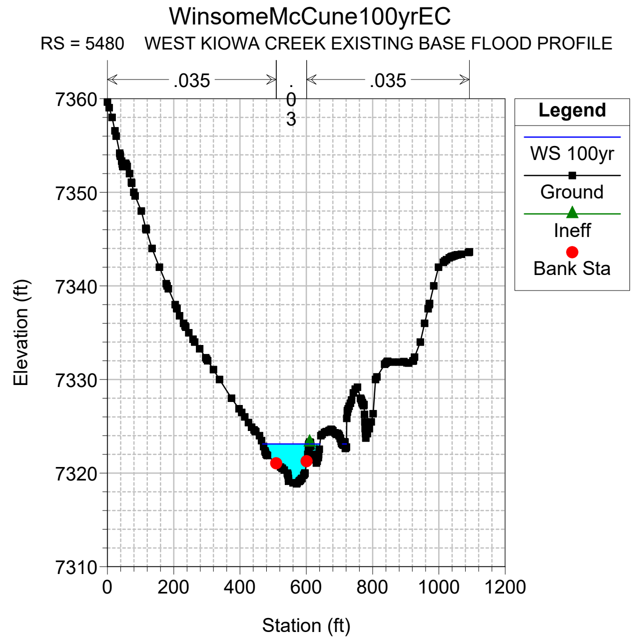

WinsomeMcCune100yrEC
RS = 6763 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

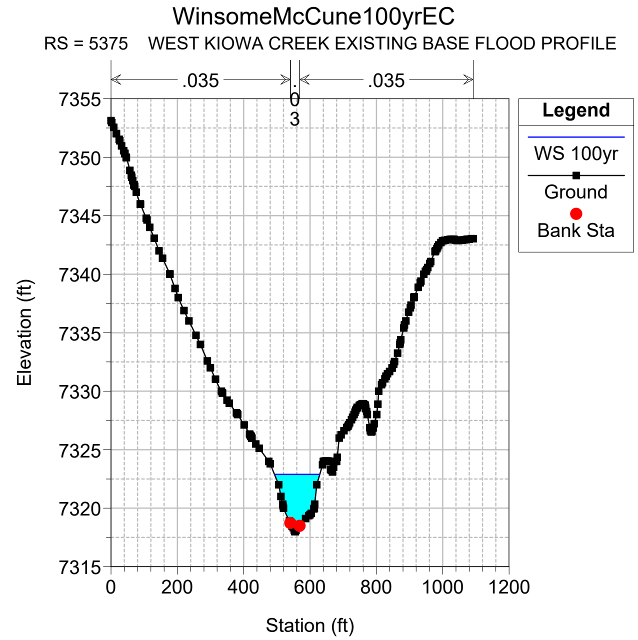

WinsomeMcCune100yrEC
RS = 6542 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

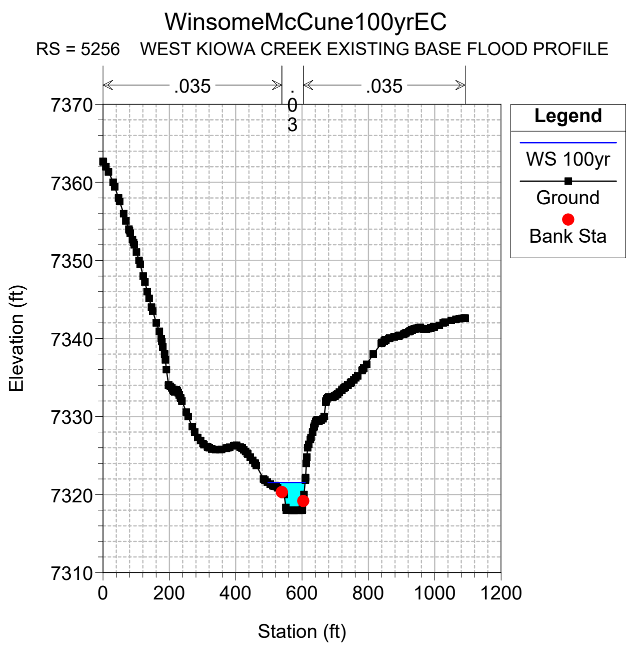

WinsomeMcCune100yrEC
RS = 6302 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

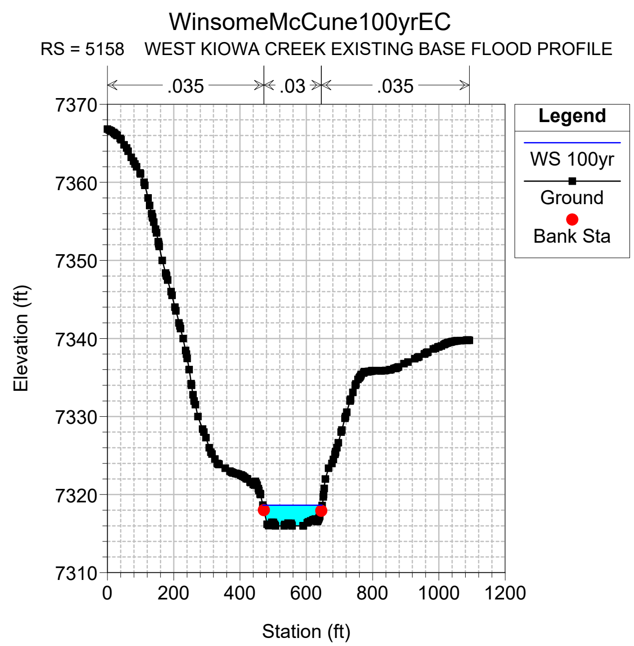

WinsomeMcCune100yrEC
RS = 6134 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

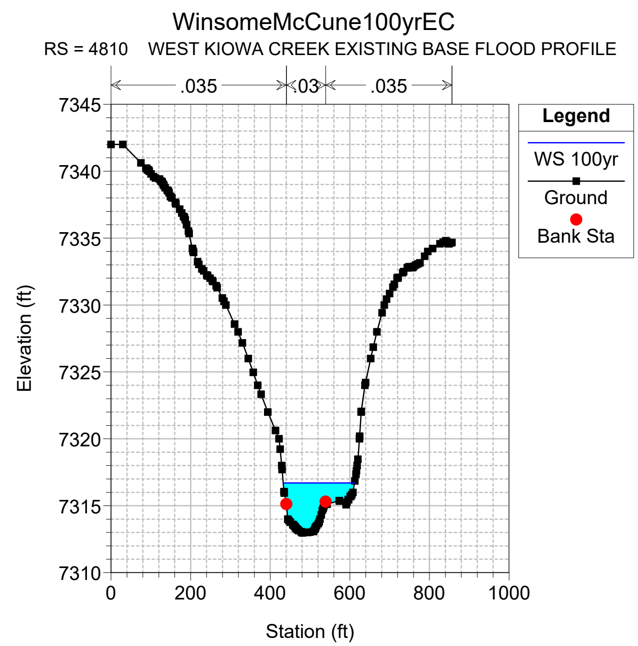

WinsomeMcCune100yrEC
RS = 5812 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Elevation (ft)
7320 7330 7340 7350 7360 7370
Station (ft)
0 200 400 600 800 1000 1200 1400
Legend
WS 100yr
Ground
Ineff
Bank Sta

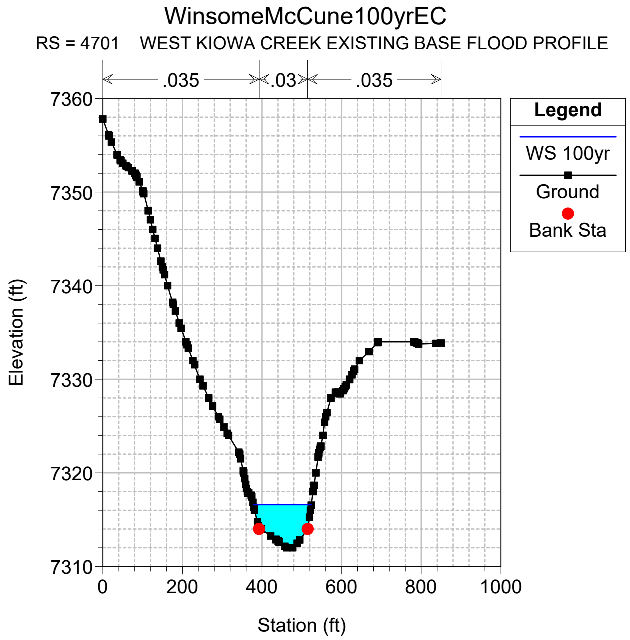

WinsomeMcCune100yrEC
RS = 5480 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Elevation (ft)
7310 7320 7330 7340 7350 7360
Station (ft)
0 200 400 600 800 1000 1200
Legend
WS 100yr
Ground
Ineff
Bank Sta

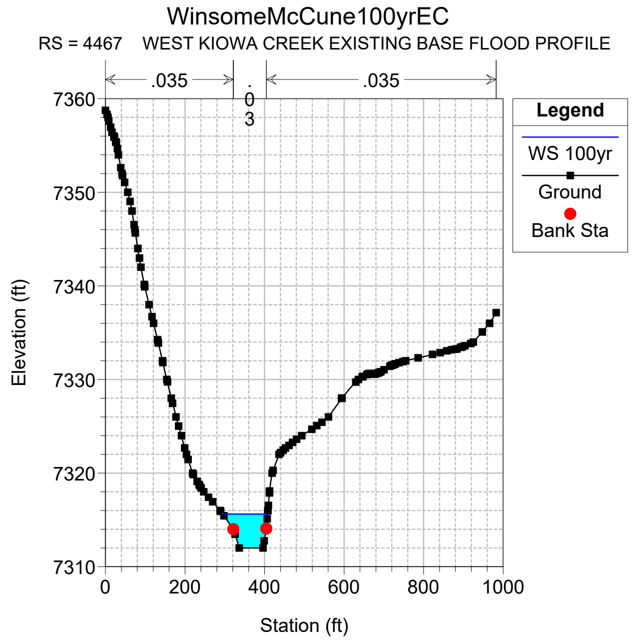

WinsomeMcCune100yrEC
RS = 5375 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Elevation (ft)
7315 7320 7325 7330 7335 7340 7345 7350 7355
Station (ft)
0 200 400 600 800 1000 1200
Legend
WS 100yr
Ground
Bank Sta

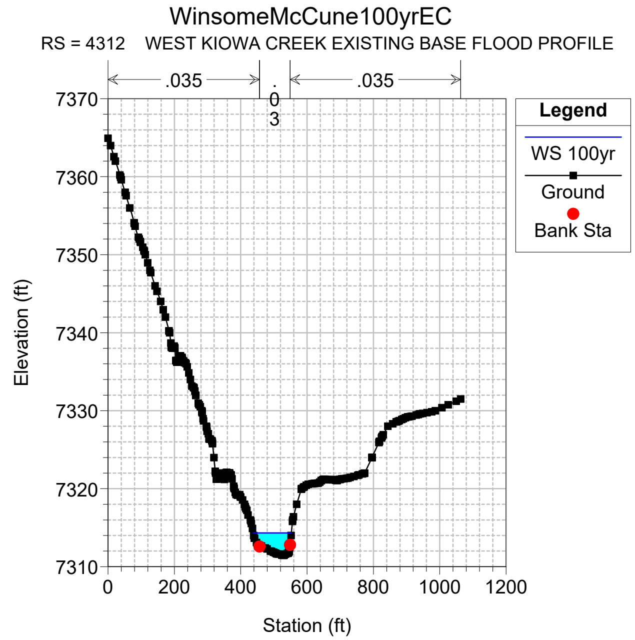

WinsomeMcCune100yrEC
RS = 5256 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Elevation (ft)
7310 7320 7330 7340 7350 7360 7370
Station (ft)
0 200 400 600 800 1000 1200
Legend
WS 100yr
Ground
Bank Sta

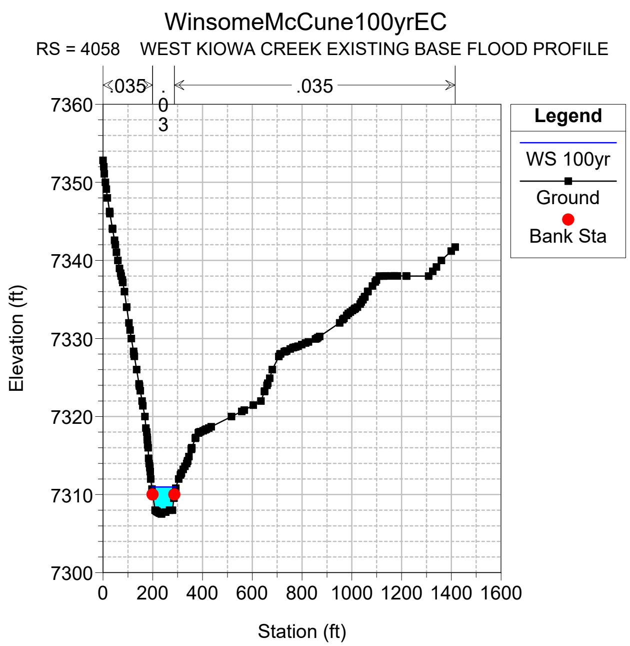

WinsomeMcCune100yrEC
RS = 5158 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Elevation (ft)
7310 7320 7330 7340 7350 7360 7370
Station (ft)
0 200 400 600 800 1000 1200
Legend
WS 100yr
Ground
Bank Sta

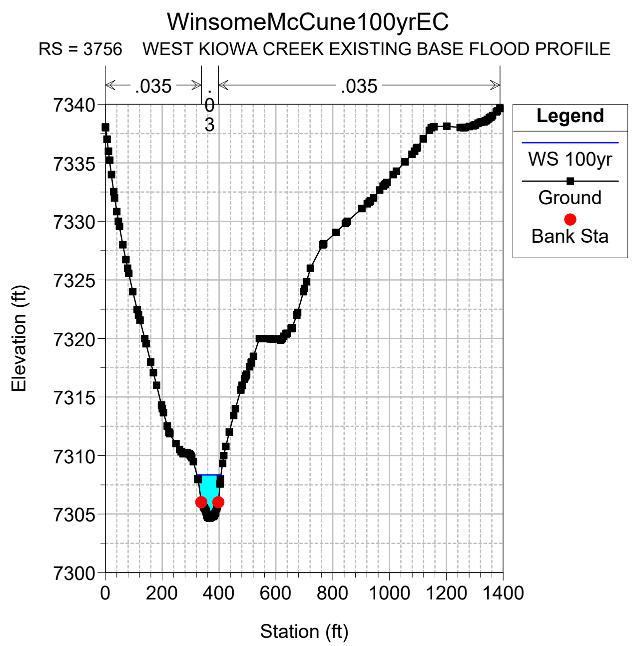

WinsomeMcCune100yrEC
RS = 4810 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Elevation (ft)
7310 7315 7320 7325 7330 7335 7340 7345
Station (ft)
0 200 400 600 800 1000
Legend
WS 100yr
Ground
Bank Sta

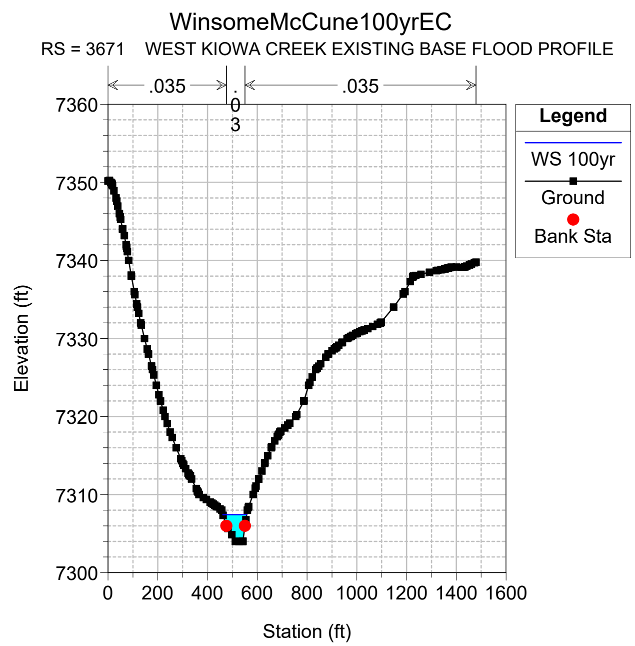

WinsomeMcCune100yrEC
RS = 4701 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
7360
7350
7340
7330
7320
7310
0
200
400
600
800
1000
Station (ft)

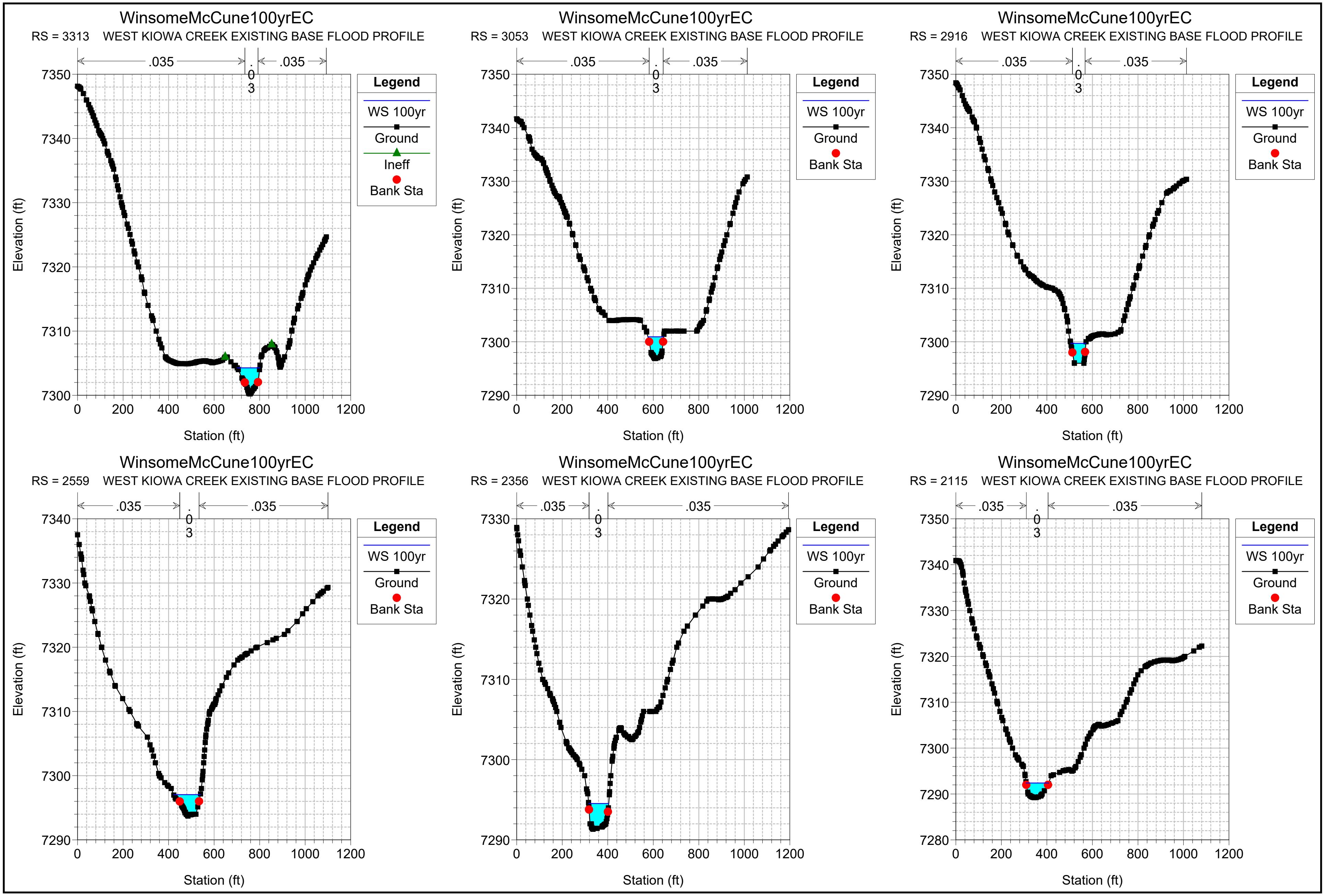

WinsomeMcCune100yrEC
RS = 4467 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
7360
7350
7340
7330
7320
7310
0
200
400
600
800
1000
Station (ft)

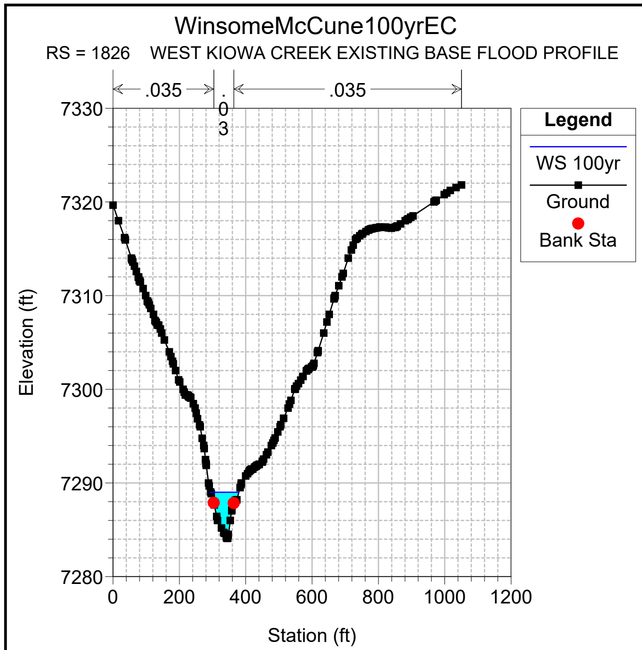

WinsomeMcCune100yrEC
RS = 4312 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
7370
7360
7350
7340
7330
7320
7310
0
200
400
600
800
1000
1200
Station (ft)

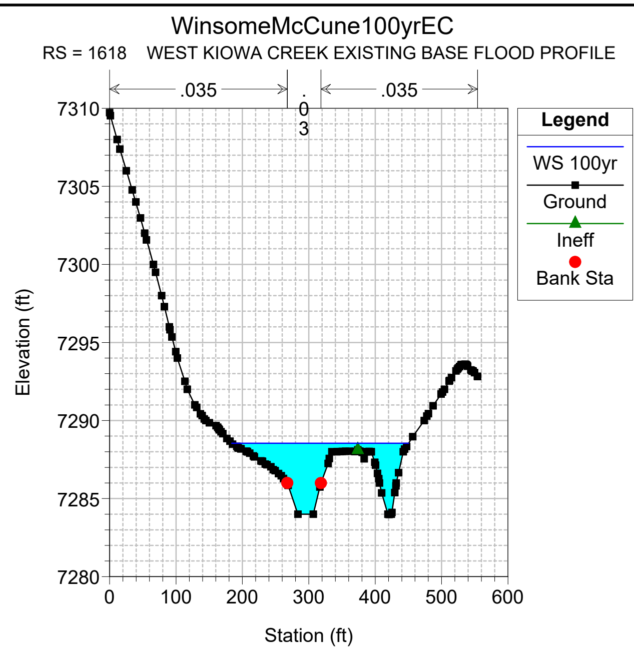

WinsomeMcCune100yrEC
RS = 4058 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
7360
7350
7340
7330
7320
7310
7300
0
200
400
600
800
1000
1200
1400
1600
Station (ft)

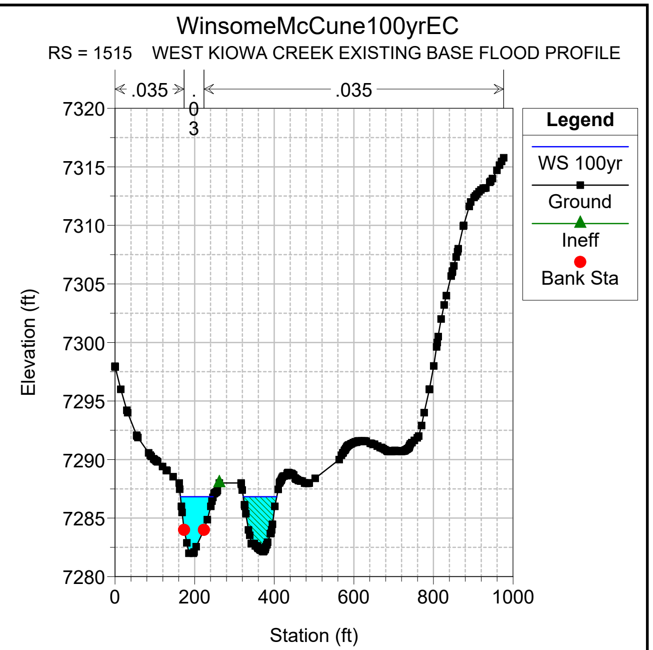

WinsomeMcCune100yrEC
RS = 3756 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
7340
7335
7330
7325
7320
7315
7310
7305
7300
0
200
400
600
800
1000
1200
1400
Station (ft)

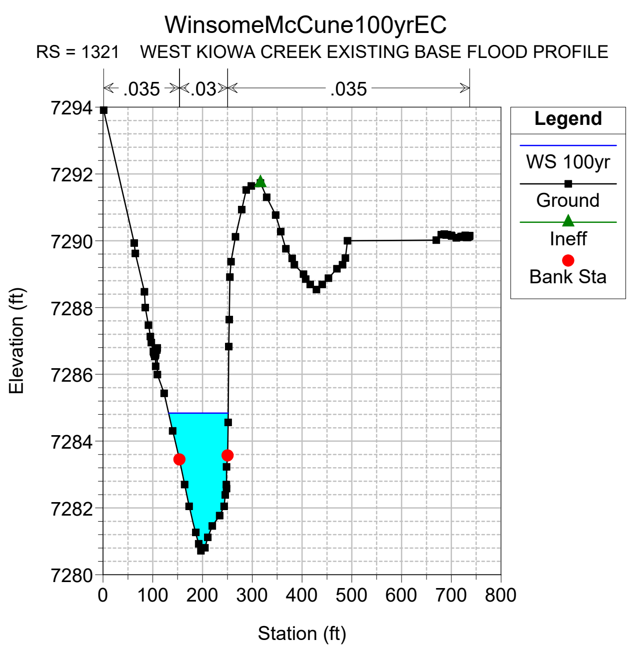

WinsomeMcCune100yrEC
RS = 3671 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
7360
7350
7340
7330
7320
7310
7300
0
200
400
600
800
1000
1200
1400
1600
Station (ft)

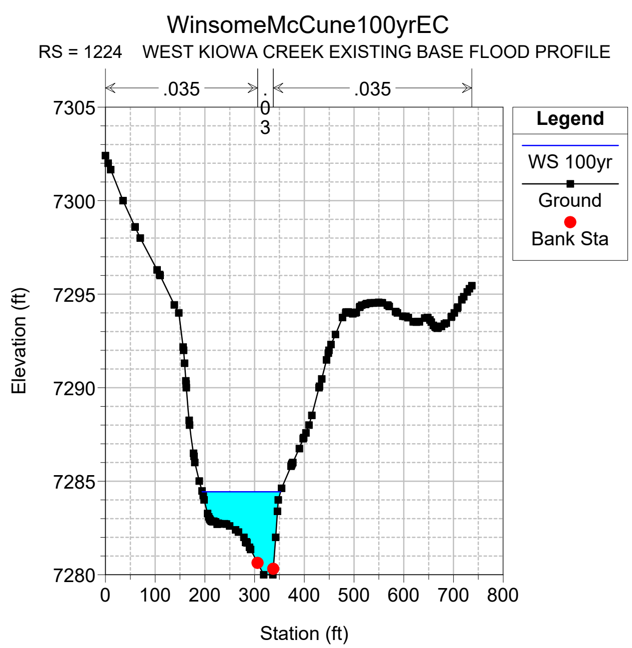

WinsomeMcCune100yrEC
RS = 3313 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
7300
7310
7320
7330
7340
7350
0
200
400
600
800
1000
1200
WinsomeMcCune100yrEC
RS = 3053 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7290
7300
7310
7320
7330
7340
7350
WinsomeMcCune100yrEC
RS = 2916 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 2559 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7290
7300
7310
7320
7330
7340
WinsomeMcCune100yrEC
RS = 2356 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7290
7300
7310
7320
7330
WinsomeMcCune100yrEC
RS = 2115 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7280
7290
7300
7310
7320
7330
7340
7350

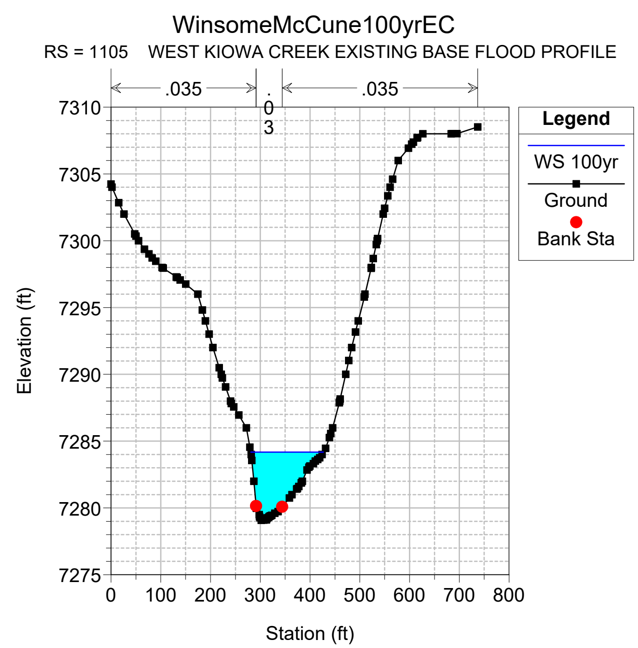

WinsomeMcCune100yrEC
RS = 1826 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

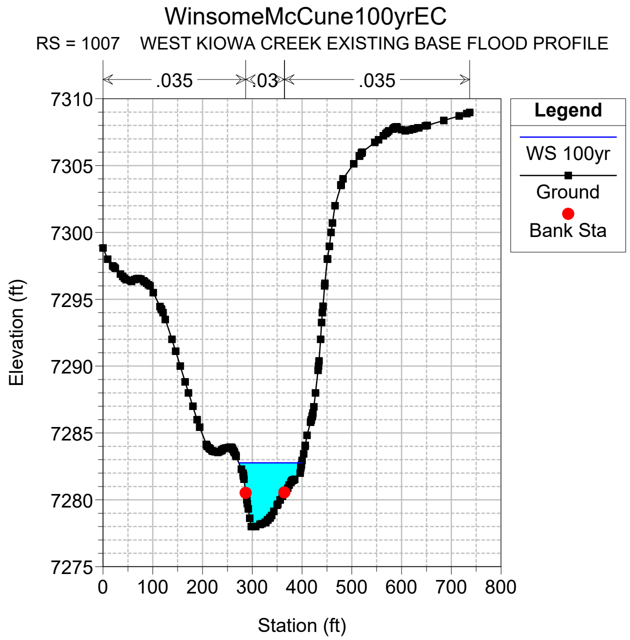

WinsomeMcCune100yrEC
RS = 1618 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

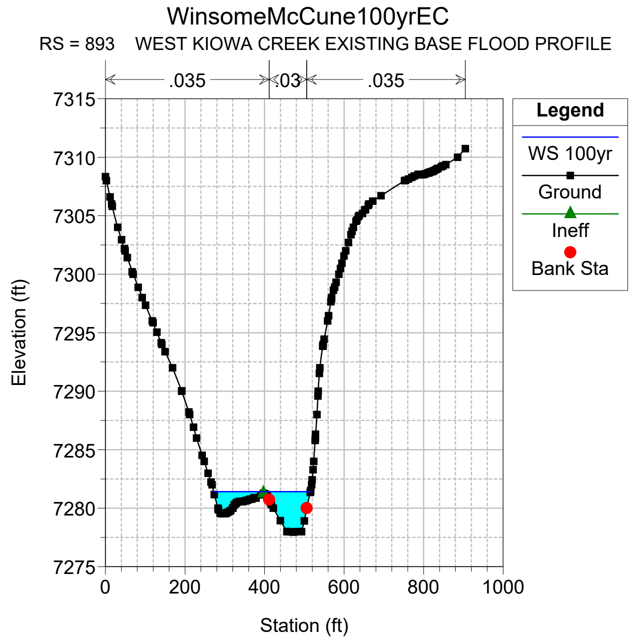

WinsomeMcCune100yrEC
RS = 1515 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

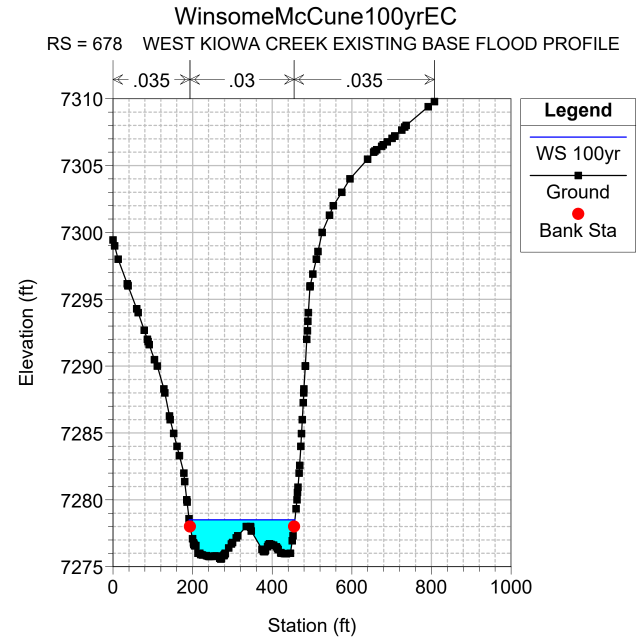

WinsomeMcCune100yrEC
RS = 1321 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

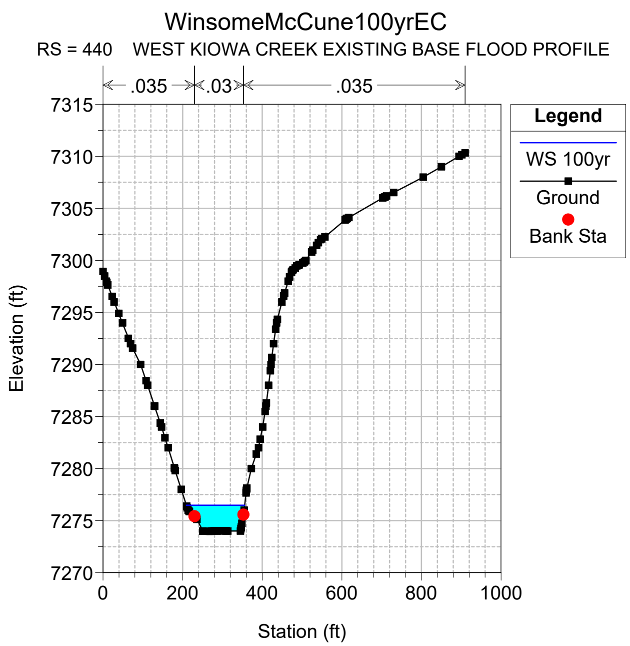

WinsomeMcCune100yrEC
RS = 1224 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrEC
RS = 1105 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrEC
RS = 1007 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7310
7305
7300
7295
7290
7285
7280
7275
0
100
200
300
400
500
600
700
800

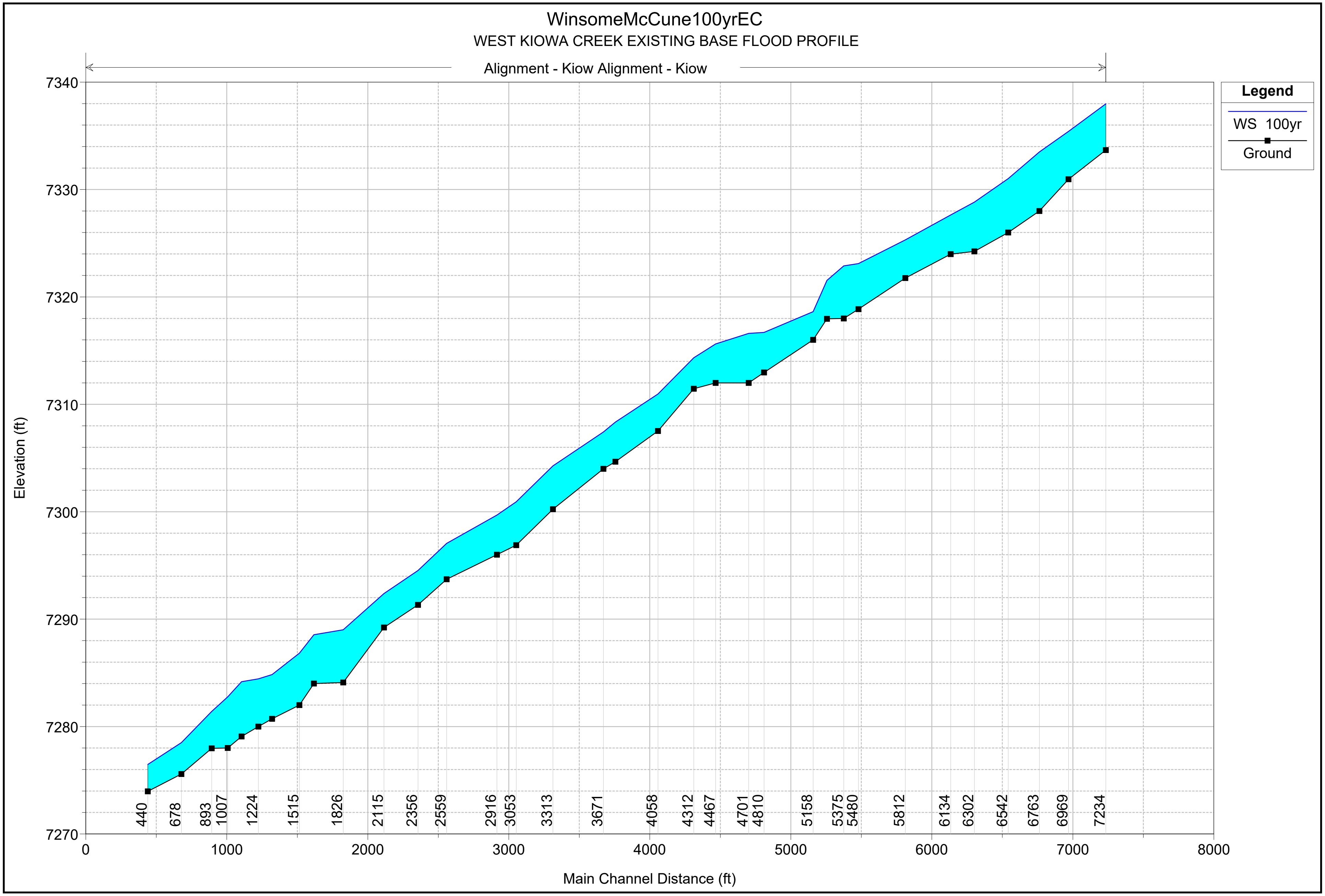

WinsomeMcCune100yrEC
RS = 893 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
7315
7310
7305
7300
7295
7290
7285
7280
7275
0
200
400
600
800
1000


WinsomeMcCune100yrEC
RS = 678 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7310
7305
7300
7295
7290
7285
7280
7275
0
200
400
600
800
1000


WinsomeMcCune100yrEC
RS = 440 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7315
7310
7305
7300
7295
7290
7285
7280
7275
7270
0
200
400
600
800
1000

F. HYDRAULIC ANALYSIS

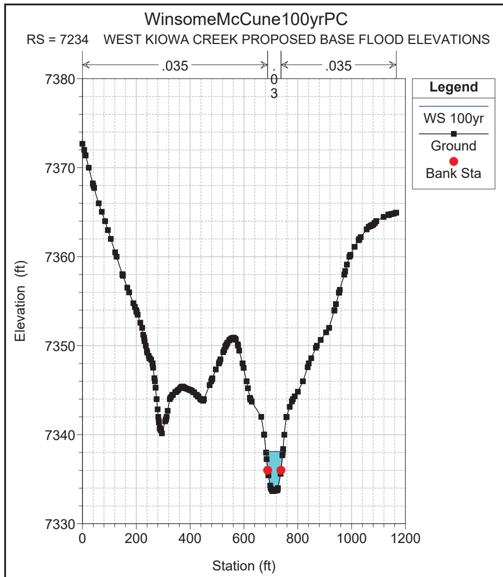
iii. STUDIED EXISTING CONDITION 100 YEAR FLOODPLAIN PROFILE



WinsomeMcCune100yrEC
WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
Alignment - Kiow Alignment - Kiow
Legend
WS 100yr
Ground
Elevation (ft)
7340
7330
7320
7310
7300
7290
7280
7270
440
678
893
1007
1224
1515
1826
2115
2356
2559
2916
3053
3313
3671
4058
4312
4467
4701
4810
5158
5375
5480
5812
6134
6302
6542
6763
6969
7234
0
1000
2000
3000
4000
5000
6000
7000
8000
Main Channel Distance (ft)

F. HYDRAULIC ANALYSIS

iv. STUDIED PROPOSED CONDITION 100 YEAR FLOODPLAIN CROSS SECTIONS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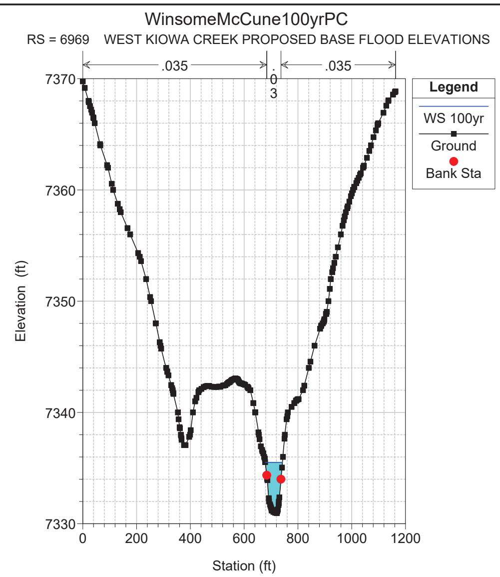
.035
0
3
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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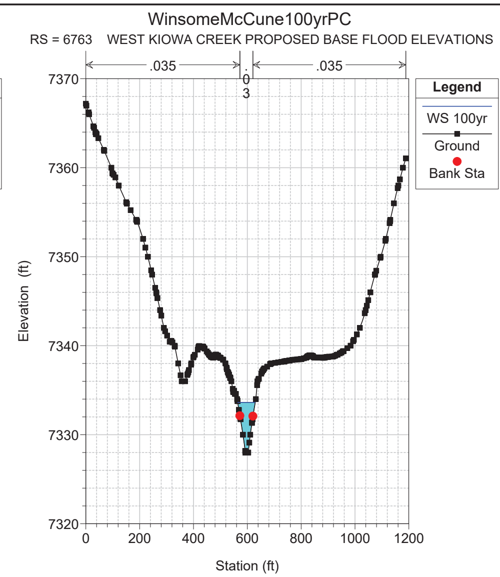
RS = 6969 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
0
3
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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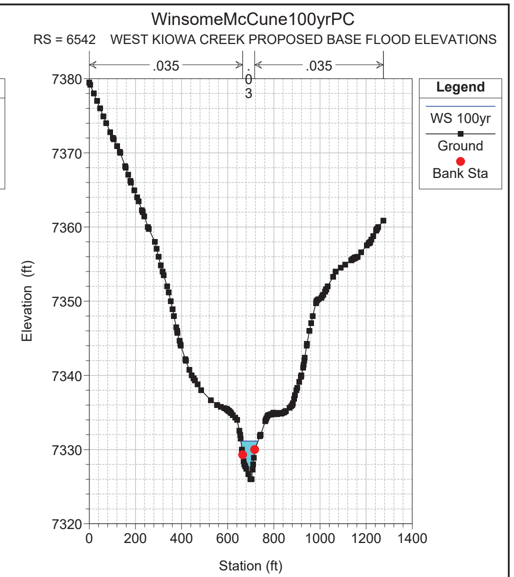
RS = 6763 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
0
3
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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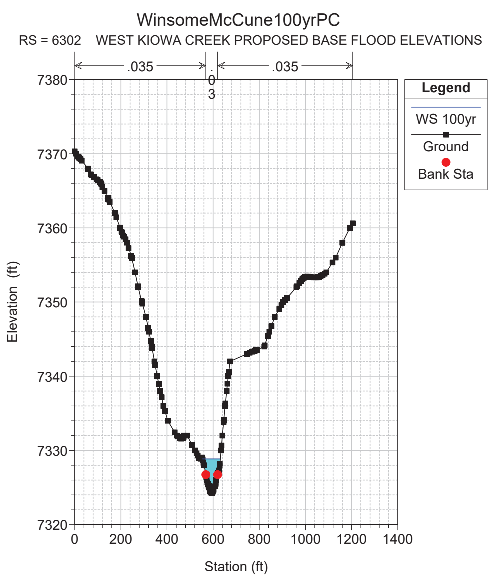
RS = 6542 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
0
3
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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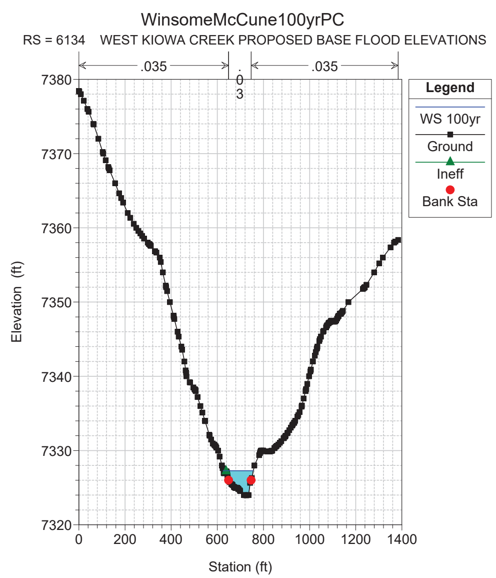
RS = 6302 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
0
3
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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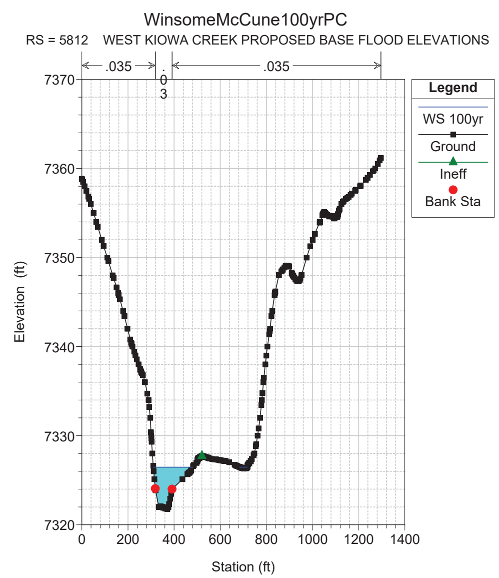
RS = 6134 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
0
3
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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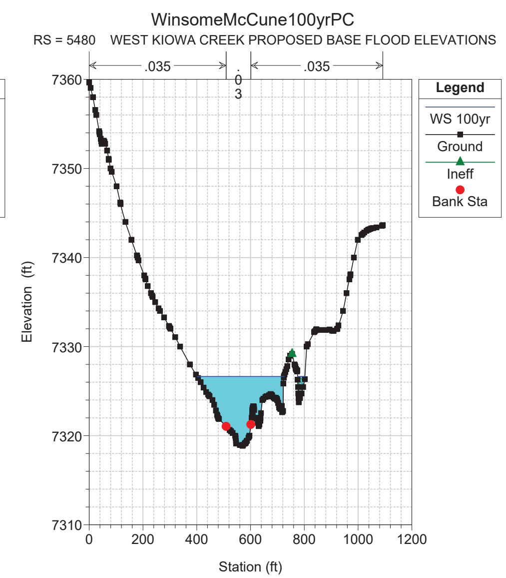
RS = 5812 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
0
3
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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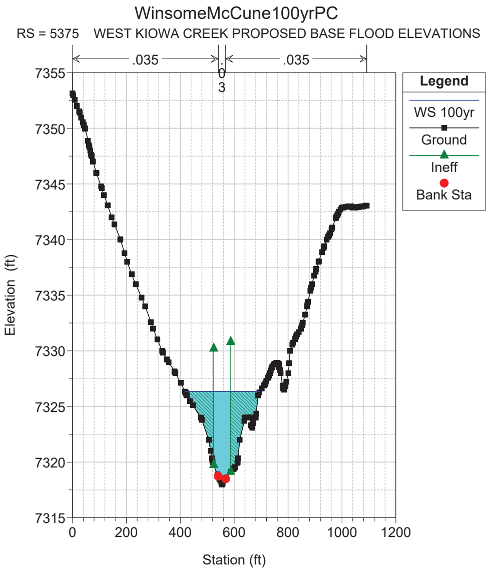
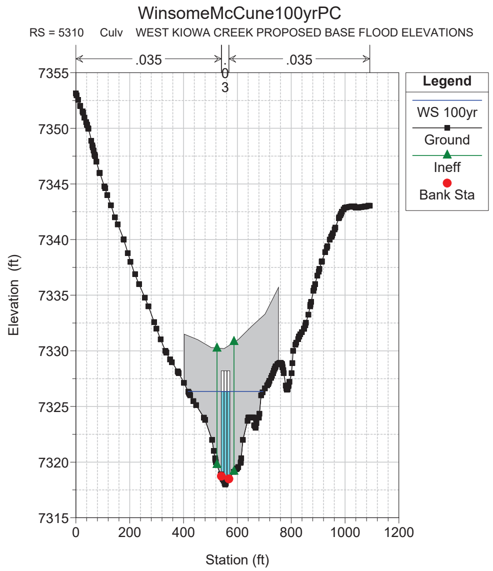
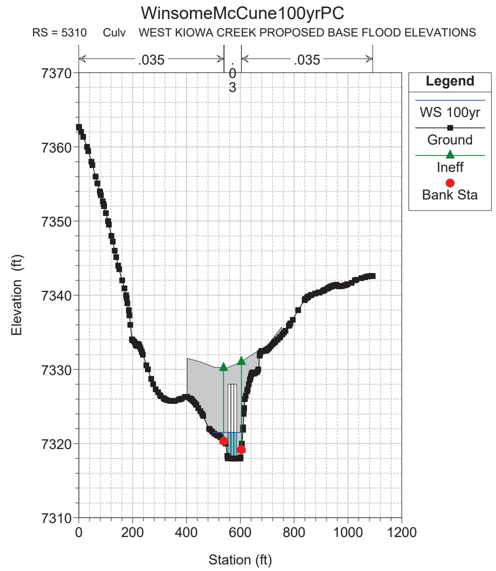
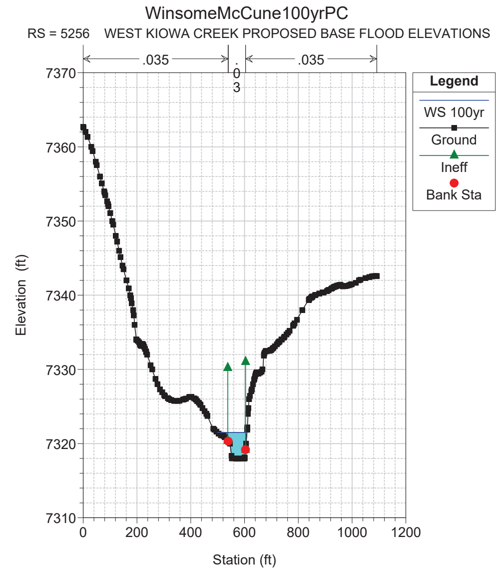
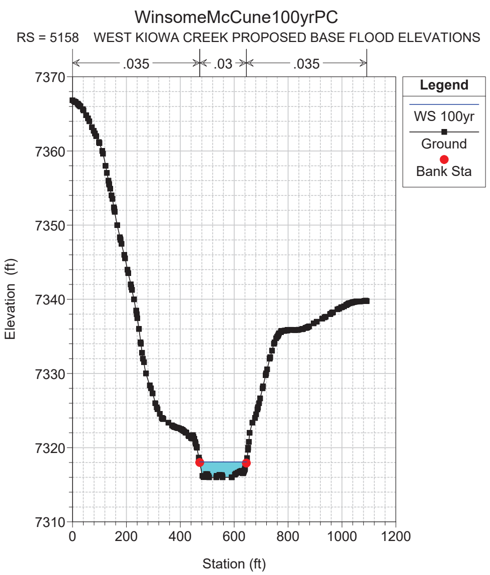
.035
0
3
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

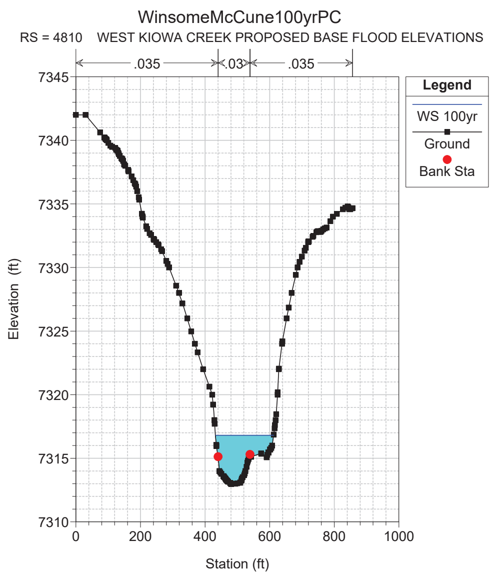

WinsomeMcCune100yrPC
RS = 5375 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

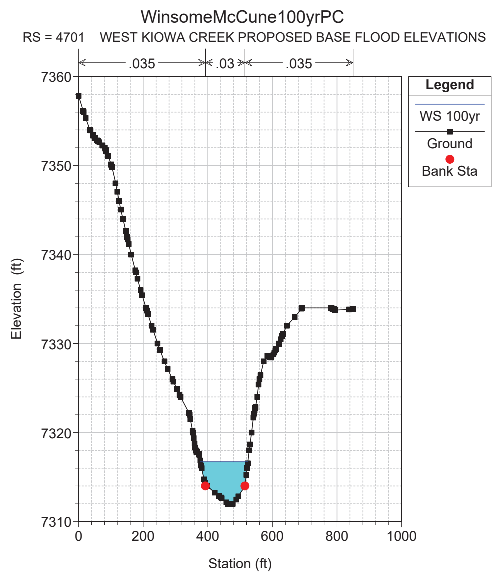

WinsomeMcCune100yrPC
RS = 5310 Culv WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

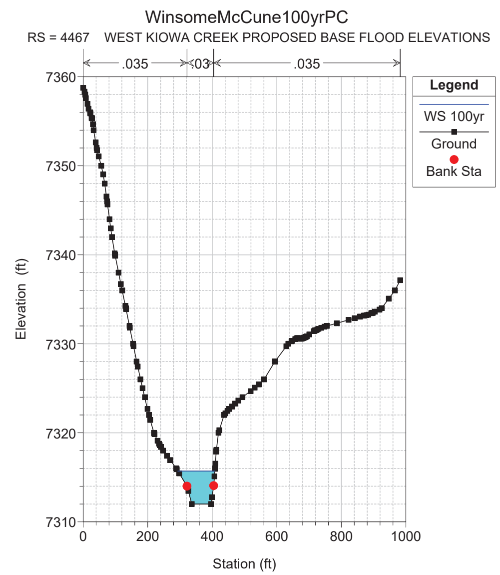

WinsomeMcCune100yrPC
RS = 5310 Culv WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

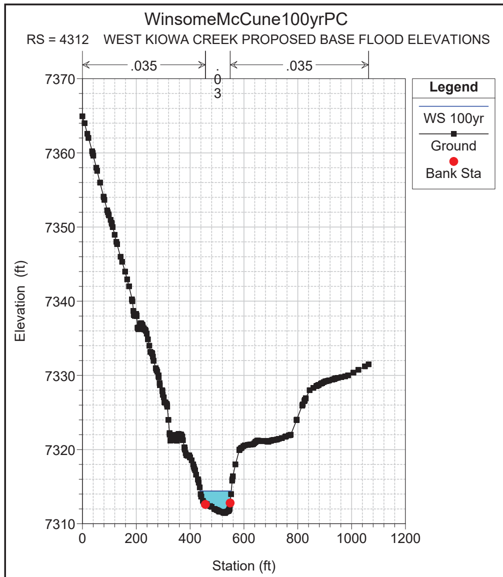

WinsomeMcCune100yrPC
RS = 5256 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

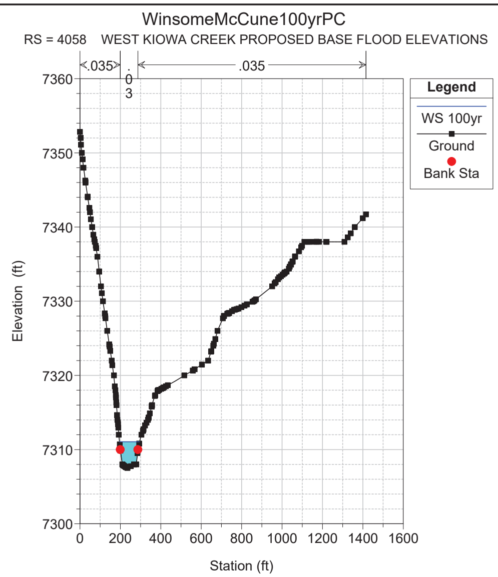

WinsomeMcCune100yrPC
RS = 5158 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

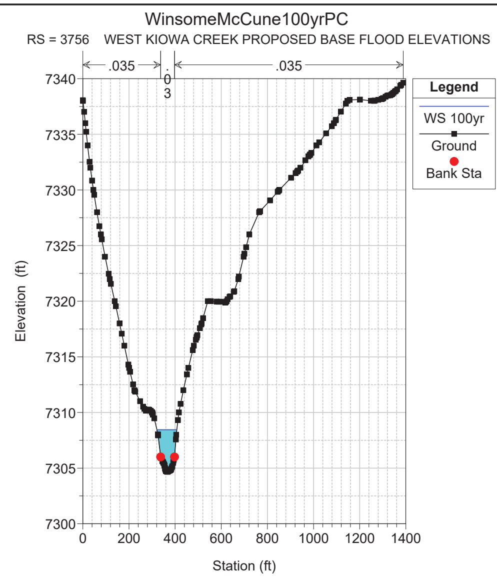

WinsomeMcCune100yrPC
RS = 4810 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

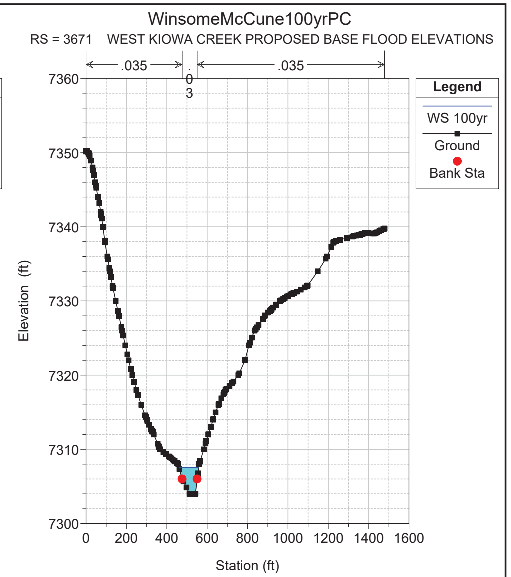

WinsomeMcCune100yrPC
RS = 4701 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

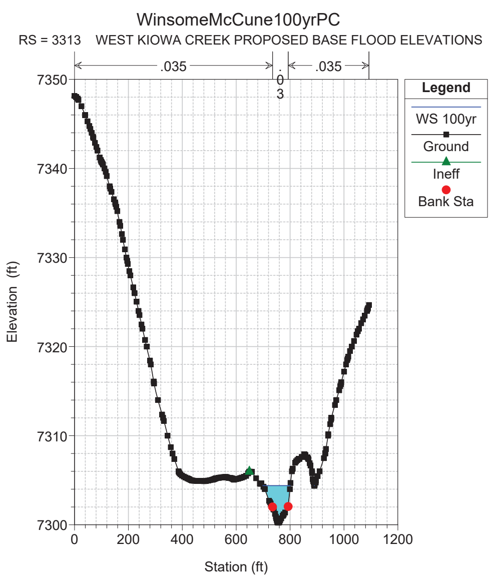

WinsomeMcCune100yrPC
RS = 4467 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

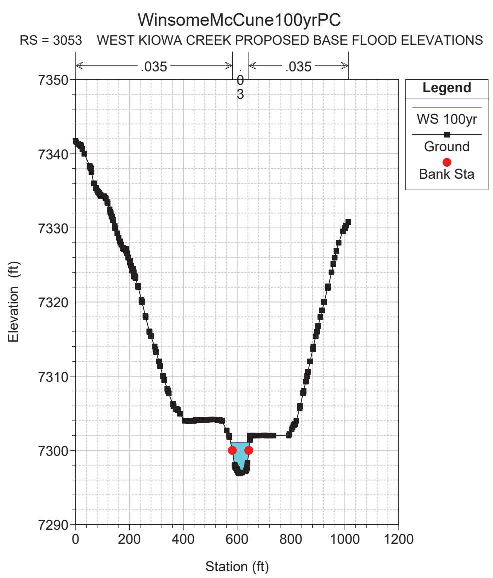

WinsomeMcCune100yrPC
RS = 4312 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

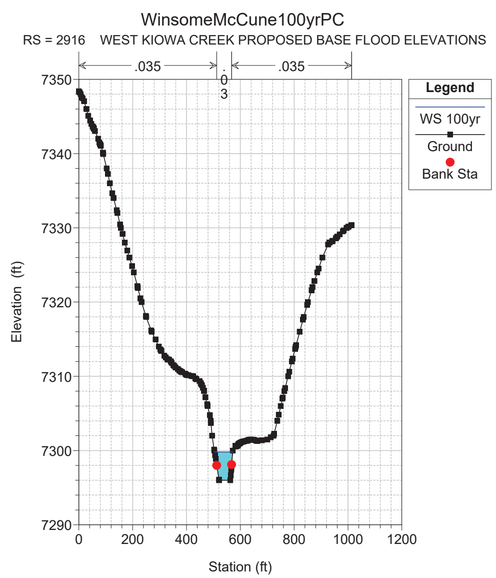

WinsomeMcCune100yrPC
RS = 4058 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

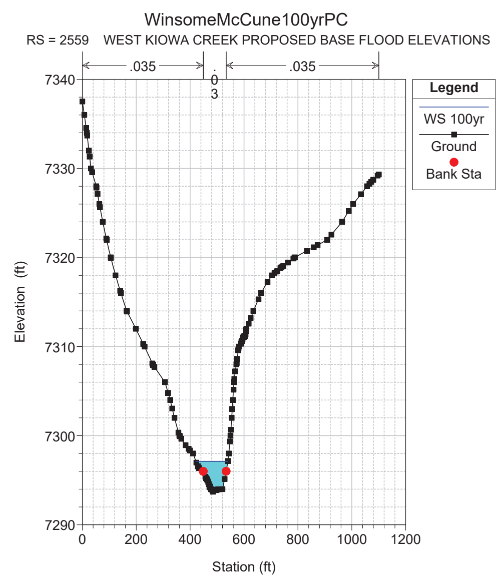

WinsomeMcCune100yrPC
RS = 3756 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 3671 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 3313 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 3053 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 2916 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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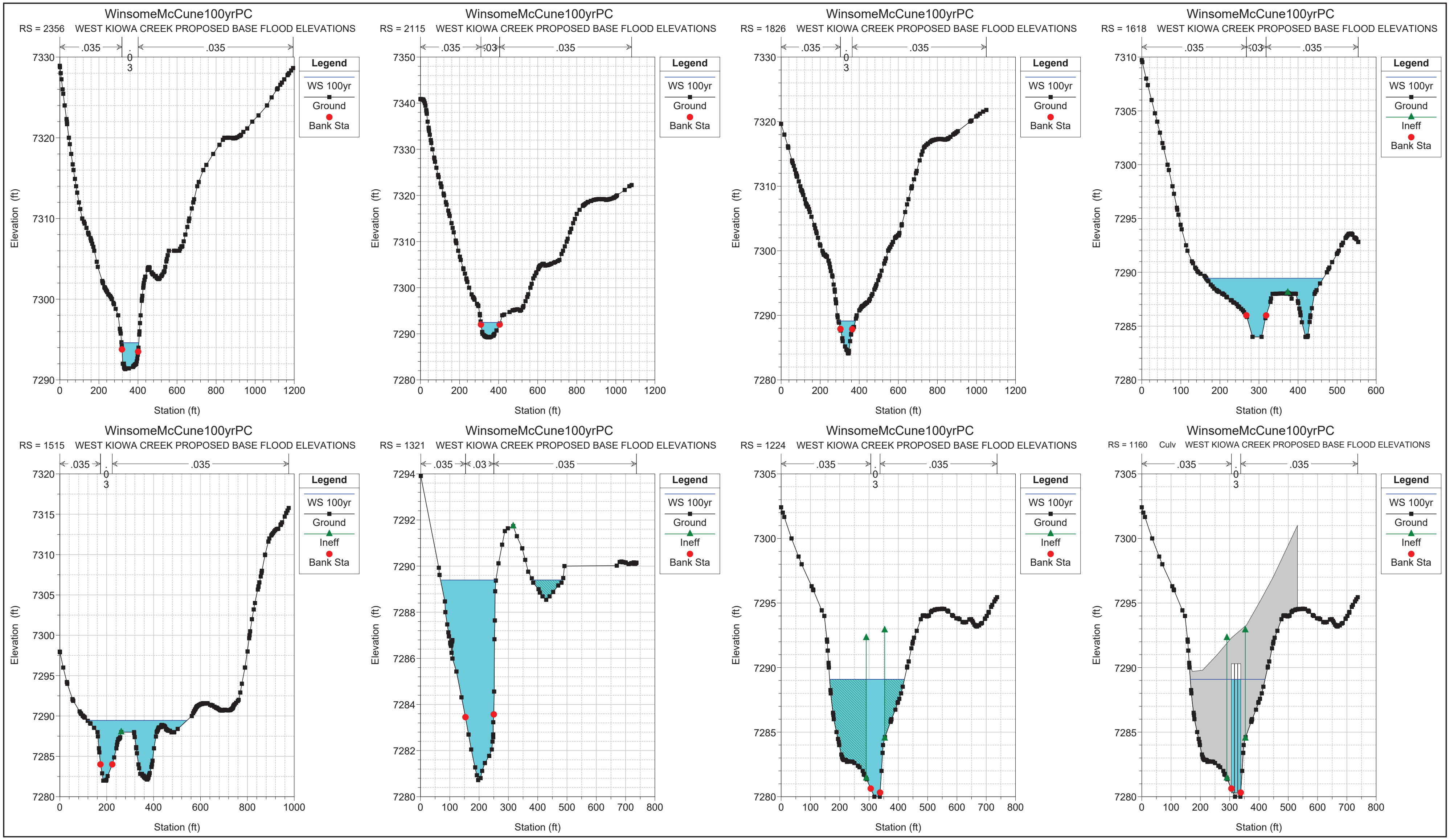
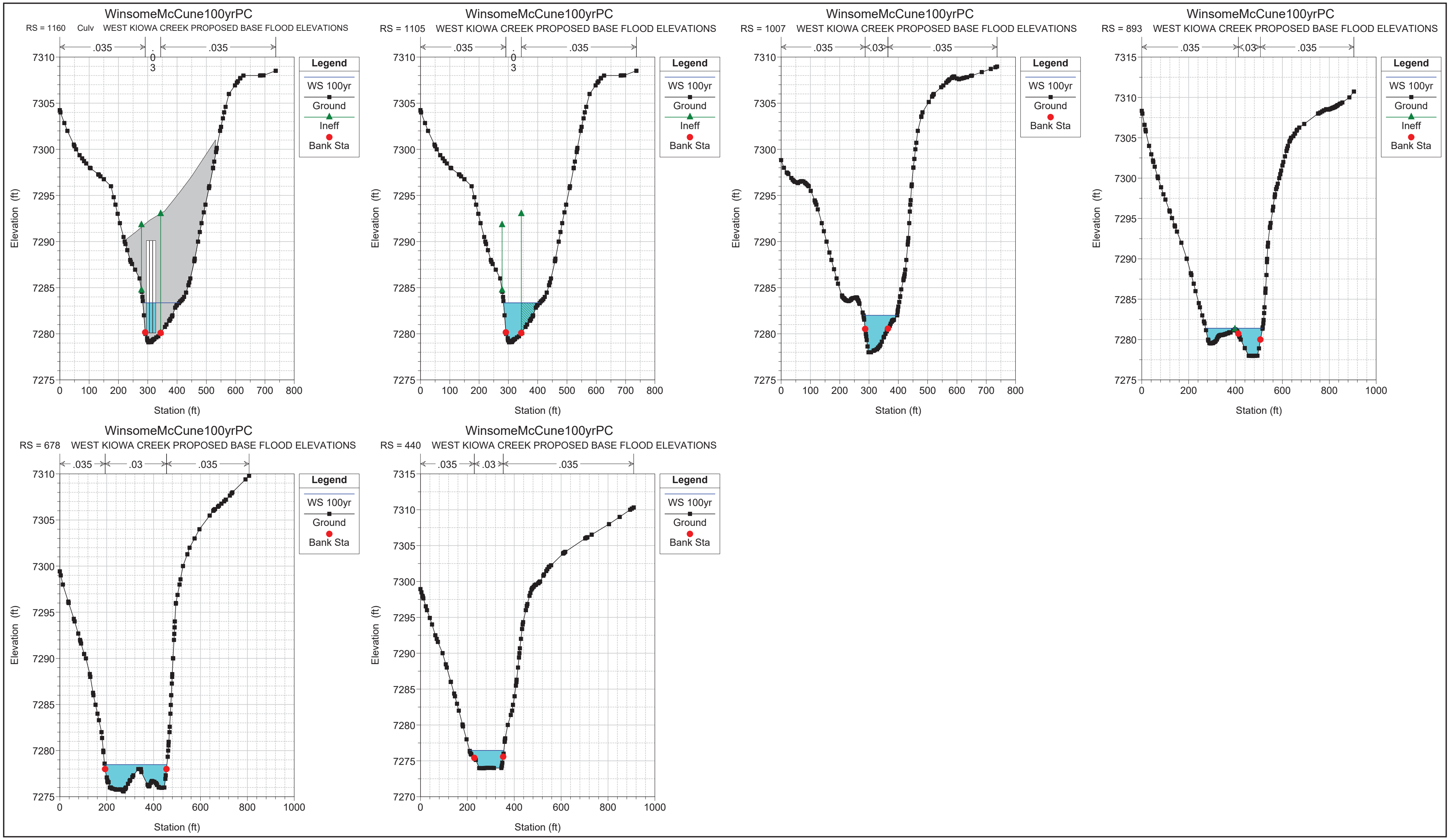
RS = 2559 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 2356 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 2115 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1826 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1618 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1515 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1321 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1224 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1160 Culv WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

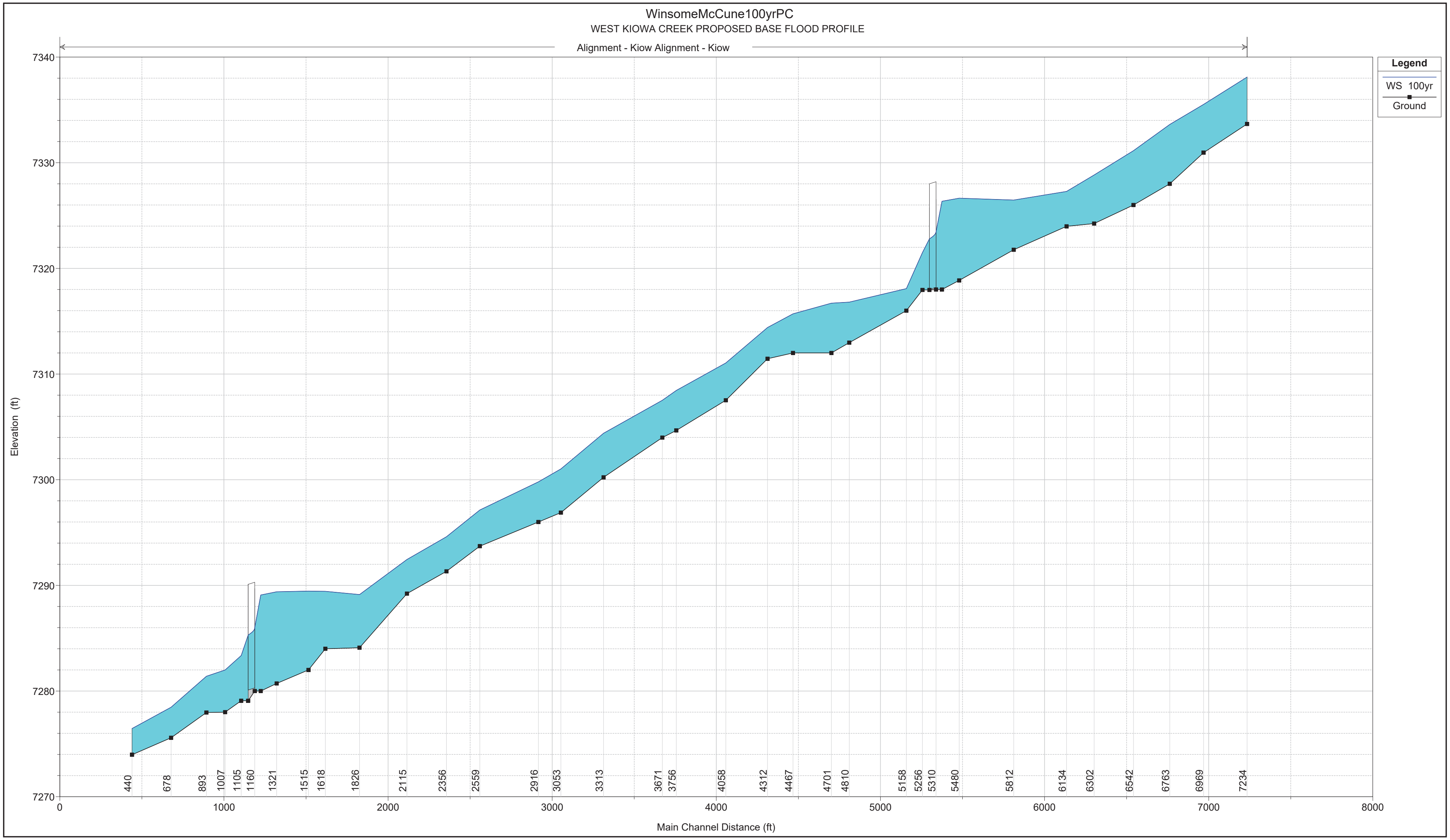

WinsomeMcCune100yrPC
RS = 1160 Culv WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1105 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1007 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 893 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 678 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 440 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

F. HYDRAULIC ANALYSIS

v. STUDIED PROPOSED CONDITION 100 YEAR FLOODPLAIN PROFILE

KHA RESPONSE:
The provided hydraulic analysis is from the approved CLOMR. Refer to Appendix E for Creek Stability Memo which discusses the hydraulic analysis and recommendations for the Creek.

Unresolved from review 1. Provide the complete hydraulic analysis to include the velocity and froude number results, the boundary conditions used.



WinsomeMcCune100yrPC
WEST KIOWA CREEK PROPOSED BASE FLOOD PROFILE
Alignment - Kiow Alignment - Kiow
Legend
WS 100yr
Ground
Elevation (ft)
Main Channel Distance (ft)
7340
7330
7320
7310
7300
7290
7280
7270
0
1000
2000
3000
4000
5000
6000
7000
8000
440
678
893
1007
1105
1160
1321
1515
1618
1826
2115
2356
2559
2916
3053
3313
3671
3756
4058
4312
4467
4701
4810
5158
5256
5310
5480
5812
6134
6302
6542
6763
6969
7234

G. PROJECT DRAINAGE REPORT

H. ENVIRONMENTAL ANALYSIS

i. ENDANGERED SPECIES “NO-TAKE” LETTER

ecos ecosystem services LLC

Proposal 2018-10-1

April 5, 2019

Joe Desjardin
ProTerra Properties, LLC
Director of Development
2475 Waynoka Place
Colorado Springs, Colorado 80915

RE: Winsome Ecological Report – Case #19-08-0185R, FEMA ESA Compliance

Dear Mr. Desjardin:

The U.S. Fish and Wildlife Service (USFWS) has completed their review of the Ecosystem Services, LLC (ecos) "Biological Assessment" presented in our *Natural Features and Wetland Report for the Winsome Property in El Paso County, Colorado* dated January 4, 2019 (Ecological Report) and concurs with our finding that this project will result in "no take" of threatened and endangered species regulated under the Endangered Species Act. To acknowledge their concurrence the USFWS placed a "stamp" on the cover of the Ecological Report indicating they have "No Concerns" which was signed by the USFWS and dated 4-2-2019. USFWS also wrote notes next to the stamp describing that the concurrence was based on the following facts:

1) the marginal Preble's meadow jumping mouse (PMJM) habitat onsite that is not connected to good habitat;
2) conservation measures will be implemented by the Project to protect riparian habitat; and
3) the Project committed to survey for Ute ladies-tresses orchid at wetland impact areas despite the presence of marginal habitat for this species.

Based on the findings of the Ecological Report as supported by the USFWS concurrence, ecos can confidently state that the Winsome Project presents no potential for take of threatened and endangered species listed under the Endangered Species Act.

Sincerely,

Ecosystem Services, LLC

Grant E. Gurnée

Grant E. Gurnée, P.W.S.
Restoration Ecologist – Wildlife Biologist

H. <u>ENVIRONMENTAL ANALYSIS</u>

ii. <u>US FISH AND WILDLIFE "NO CONCERN" LETTER</u>

ecos ecosystem services LLC

Informal Consultation Request

January 10, 2019

2019-TA-0422

U.S. FISH AND WILDLIFE SERVICE
☒ NO CONCERNS
☐ CONCUR NOT LIKELY TO ADVERSELY AFFECT
☐ NO COMMENT
Leslie Ellwood for 4-2-2019
Drue DeBerry DATE
Colorado and Nebraska Field Supervisor

• marginal Prmjm habitat; not connected to good habitat
• Conservation measures will protect riparian areas
• will survey for ULTO; marginal habitat

Mr. Drue DeBerry
Acting Colorado Field Supervisor
U.S. Fish and Wildlife Service
Colorado Ecological Services Field Office
134 Union Blvd., Suite 670
Lakewood, Colorado 80228

RE: Request for Technical Assistance Regarding the Likelihood of Take of Federally-listed Threatened and Endangered Species resulting from the proposed development of the Winsome Project in El Paso County, Colorado

Dear Mr. DeBerry:

Ecosystem Services, LLC (ecos) has prepared the enclosed habitat evaluation on behalf of PT McCune, LLC to describe the physical/ecological characteristics of the Winsome Property (Site) and evaluate the potential effects of the proposed development project (Project) on the Federally-listed threatened and endangered (T&E) species protected under the Endangered Species Act (ESA).

The El Paso County Environmental Division has completed its review of the Winsome project (Project) and has requested the following: "Documentation from the U.S. Fish and Wildlife Service (USFWS) shall be provided to the Planning and Community Development Department prior to project commencement where the project will result in ground disturbing activity in habitat occupied or potentially occupied by threatened or endangered species and/or where development will occur within 300 feet of the centerline of a stream or within 300 feet of the 100 year floodplain, whichever is greater."

At this time there is no Federal action and no Federal agency is making a formal effects determination under Section 7 (a)(2) of the ESA. Therefore, ecos is requesting technical assistance from USFWS regarding PT McCune, LLC's (i.e., the non-federal party) responsibilities under the ESA, and specifically the likelihood of the Project (described herein) resulting in take of listed species. If the USFWS concurs with the findings presented herein we request that you issue an informal letter of concurrence for use in the El Paso County Project review process.

1.0 PROJECT DESCRIPTION and SITE LOCATION

The Site is situated in the northeastern corner of the Black Forest approximately 12.5 miles east of Monument and 7.3 miles east of Highway 83, in El Paso County, Colorado. The Site is located in the northwest corner of Hodgen and Meridian Roads. The Site is specifically located within Section 24, the south ¼ of Section 13, and the west ½ of Section 19, Township 11 South, Range 65 West in El Paso County, Colorado (refer to Figure 1).

The Applicant proposes to form a metropolitan district within El Paso County and develop the 766.66-acre Site as a residential community consisting of 5-acre and 2.5 acre single-family detached rural-residential lots and one 7.9-acre commercial lot, including trails, utilities, and streets and cul-de-sacs that provide access to each lot; and preserve 148.6 acres of open space along West Kiowa Creek (refer to Figure 2).

2.0 METHODOLOGY

2.1 Office Assessment

Ecos performed an office assessment in which available databases, resources, literature and field guides on local flora and fauna were reviewed to gather background information on the environmental setting of the Site. We consulted several organizations, agencies, and their databases, including:

- Colorado Department of Agriculture (CDA) Noxious Weed List;
- Colorado Natural Heritage Program (CNHP);
- Colorado Oil and Gas Conservation Commission (COGCC) GIS Online;
- Colorado Parks and Wildlife (CPW);
- El Paso County Black Forest Preservation Plan Update;
- Google Earth current and historic aerial imagery;
- CNHP Survey of Critical Biological Resources, El Paso County, Colorado;
- CNHP Survey of Critical Wetlands and Riparian Areas in El Paso and Pueblo Counties, Colorado;
- U.S. Fish and Wildlife Service (USFWS) Region 6;
- USFWS National Wetland Inventory (NWI); and
- U.S. Geological Survey (USGS).

2.2 Onsite Assessments

Following the collection and review of existing data and background information, ecos conducted a field assessment of the Site on September 5, 2018 to identify any potential impacts to natural resources associated with the Project. Field reconnaissance concentrated on identification of wetland habitat, waters of the U.S. and on the presence of habitat suitable to support threatened and endangered wildlife. Ecos conducted a follow-up field assessment on September 20, 2018 to gather additional data. Wetland habitat and waters of the U.S. boundaries, wildlife habitat, and vegetation communities were sketched on topographic and aerial base maps and located using a hand-held Global Positioning System as deemed necessary. Representative photographs were taken to assist in describing and documenting Site conditions and potential ecological impacts.

H. ENVIRONMENTAL ANALYSIS

iii. MC CUNE RANCH - NATURAL FEATURES AND WETLAND REPORT

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Winsome Subdivision
17480 Meridian Road North
Colorado Springs, Colorado 80924

Preliminary Drainage Report

MAY 15, 2019

PREPARED FOR:
PT McCune, LLC
Joseph W DesJardin
1864 Woodmoor Drive
Suite 100
Monument, Colorado 80132

PREPARED BY:
The Vertex Companies, Inc.
2420 W. 26th Avenue, Suite 100-D
Denver, Colorado 80211
PHONE: 303-623-9116

VERTEX Project: 49388
PCD File No. SP-18-006
FEMA Case No: 19-08-0185R

Jason Priddy
Project Engineer

Lance VanDemark, P.E.
Project Manager

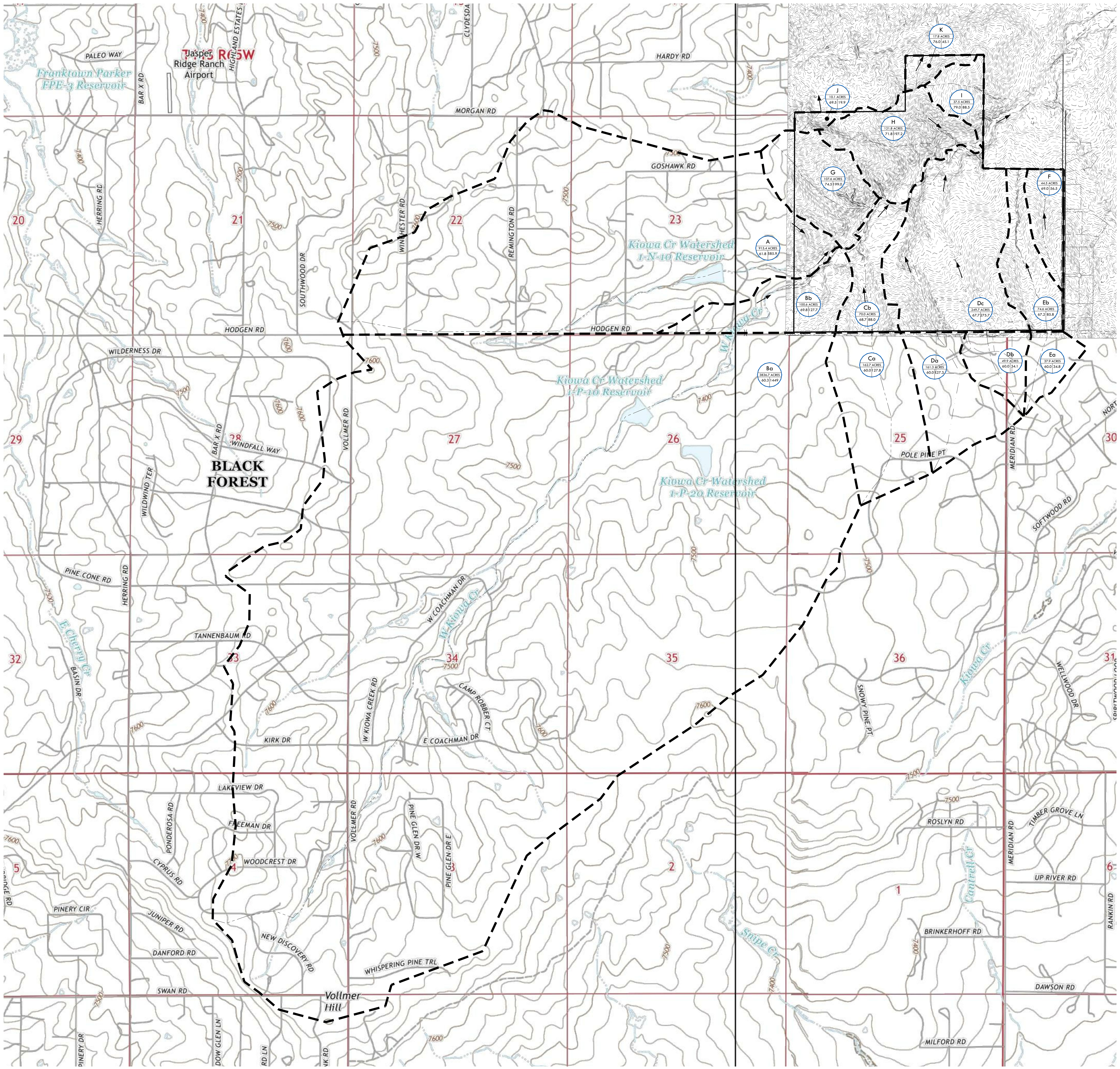
10.0 DRAINAGE PLANS

PRELIMINARY PLAN SET

WINSOME SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

0' 1000' 2000'



EXISTING STORMWATER RUNOFF TABLE			
BASIN	BASIN AREA (ACRES)	CURVE NUMBER	Q_{100}
A	915.4	61.8	585.9
Ba	3836.7	60.3	1448.9
Bb	100.6	69.8	127.7
Ca	162.7	60.0	127.8
Cb	70.0	68.7	88.0
Da	161.3	60.0	127.3
Db	49.9	60.0	34.1
Dc	249.7	67.7	275.7
Ea	37.9	60.0	34.8
Eb	74.6	67.2	85.8
F	44.5	69.0	56.6
G	107.6	74.5	199.0
H	121.8	71.8	197.2
I	37.5	79.0	88.5
J	10.1	69.5	19.9
K	17.8	76.0	45.1
	5998.1		

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LEGEND

- PROPERTY BOUNDARY LINE
- 5540 EXISTING CONTOUR
- DRAINAGE BASIN BOUNDARY
- DRAINAGE BASIN FLOW PATH
- A — BASIN NAME
- 4.09 ACRES — DRAINAGE BASIN SIZE
- 14.05 — 100-YEAR RUNOFF
- 4.73 — CURVE NUMBER
- FLOW ARROWS

PCD FILE NO SP-18-006

EXISTING DRAINAGE PLAN - OVERALL

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
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2	3/8/19 PRELIMINARY RESUBMITTAL
3	4/11/19 PRELIMINARY RESUBMITTAL
4	5/10/19 PRELIMINARY RESUBMITTAL
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JOB #: 49388

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PRELIMINARY PLAN SET

WINSOME SUBDIVISION

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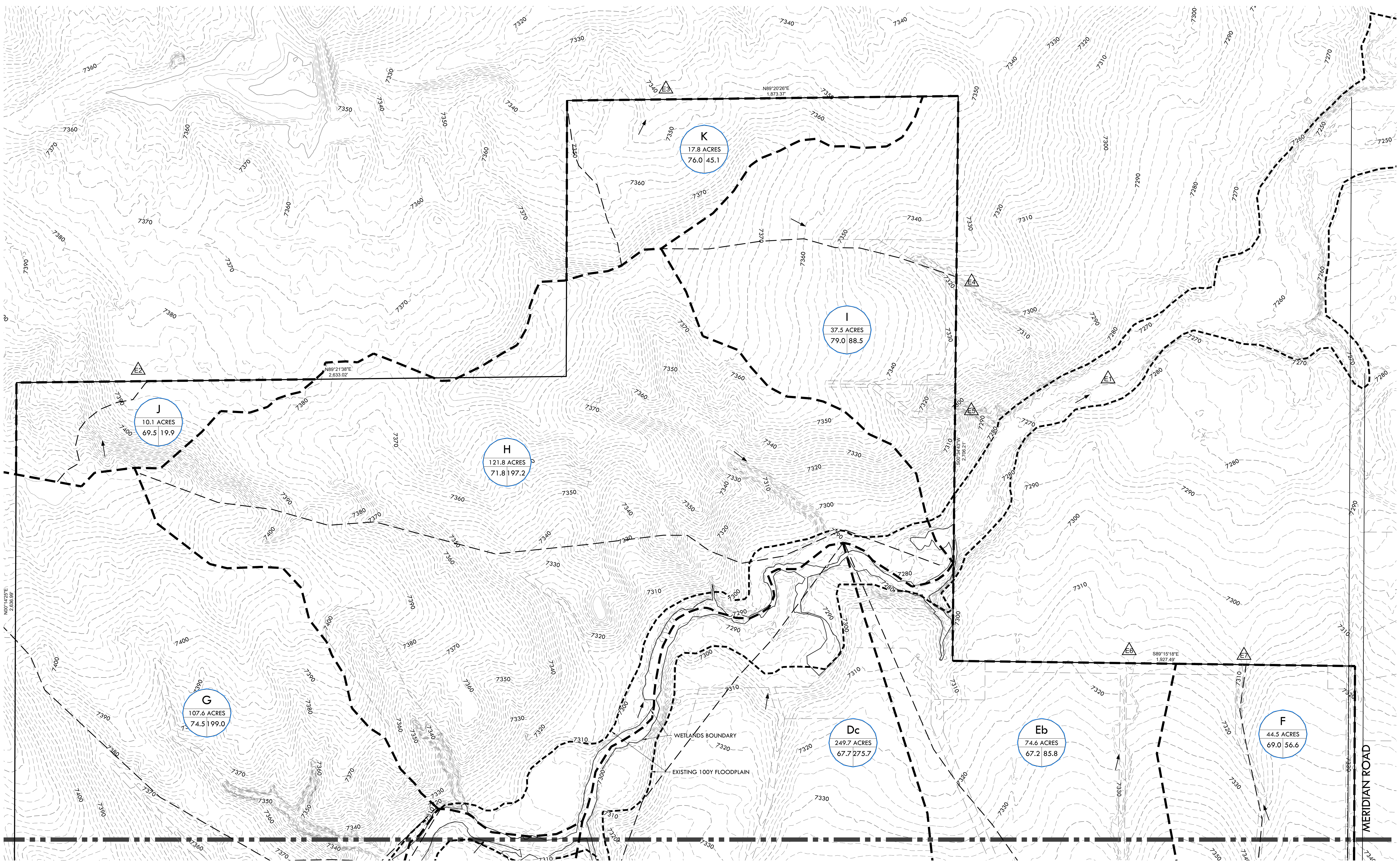
0' 200' 2000'

Symbol	Description
E1	MAIN OUTFALL+E5+E6+E7 Q5=408.6CFS Q100=2470.0CFS
E2	OFFSITE FLOW Q5=3.4CFS Q100=19.9CFS
E3	OFFSITE FLOW Q5=12.9CFS Q100=45.1CFS
E4 + E5	OFFSITE FLOW Q5=26.4CFS Q100=88.5CFS
E6	OFFSITE FLOW Q5=9.4CFS Q100=85.8CFS
E7	OFFSITE FLOW Q5=6.6CFS Q100=56.6CFS

NOTES:

1. EXISTING FLOODPLAIN AS SHOWN BASED ON FIRM MAP #08041C0350G PANEL 350 REVISED 12/7/2018, GENERATED BY GRAPHICAL OVERLAY.



MATCH LINE - SEE SHEET C1.3 - EXISTING DRAINAGE PLAN - SOUTH

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EXISTING DRAINAGE PLAN - NORTH

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1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

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0' 200' 400'

NOTES:

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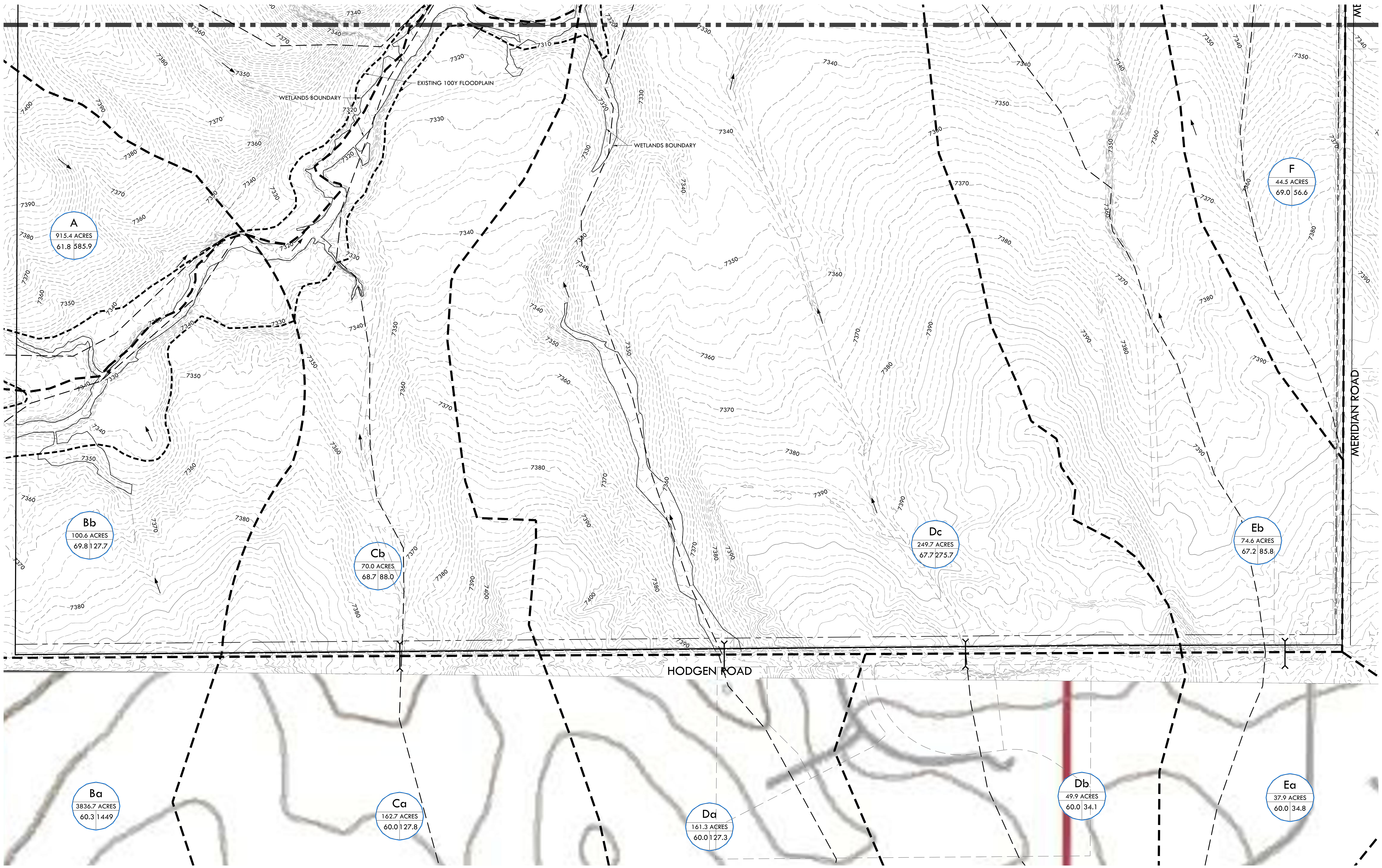
MATCH LINE - SEE SHEET C1.2 - EXISTING DRAINAGE PLAN - NORTH



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EXISTING DRAINAGE PLAN - SOUTH

SITE: 17480 MERIDIAN ROAD ELBERT, COLORADO 80106

FOR: PT MCCUNE, LLC 1864 WOODMORE DR, SUITE 100 MONUMENT, COLORADO 80132

NO.	REVISIONS
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4	5/10/19 PRELIMINARY RESUBMITTAL
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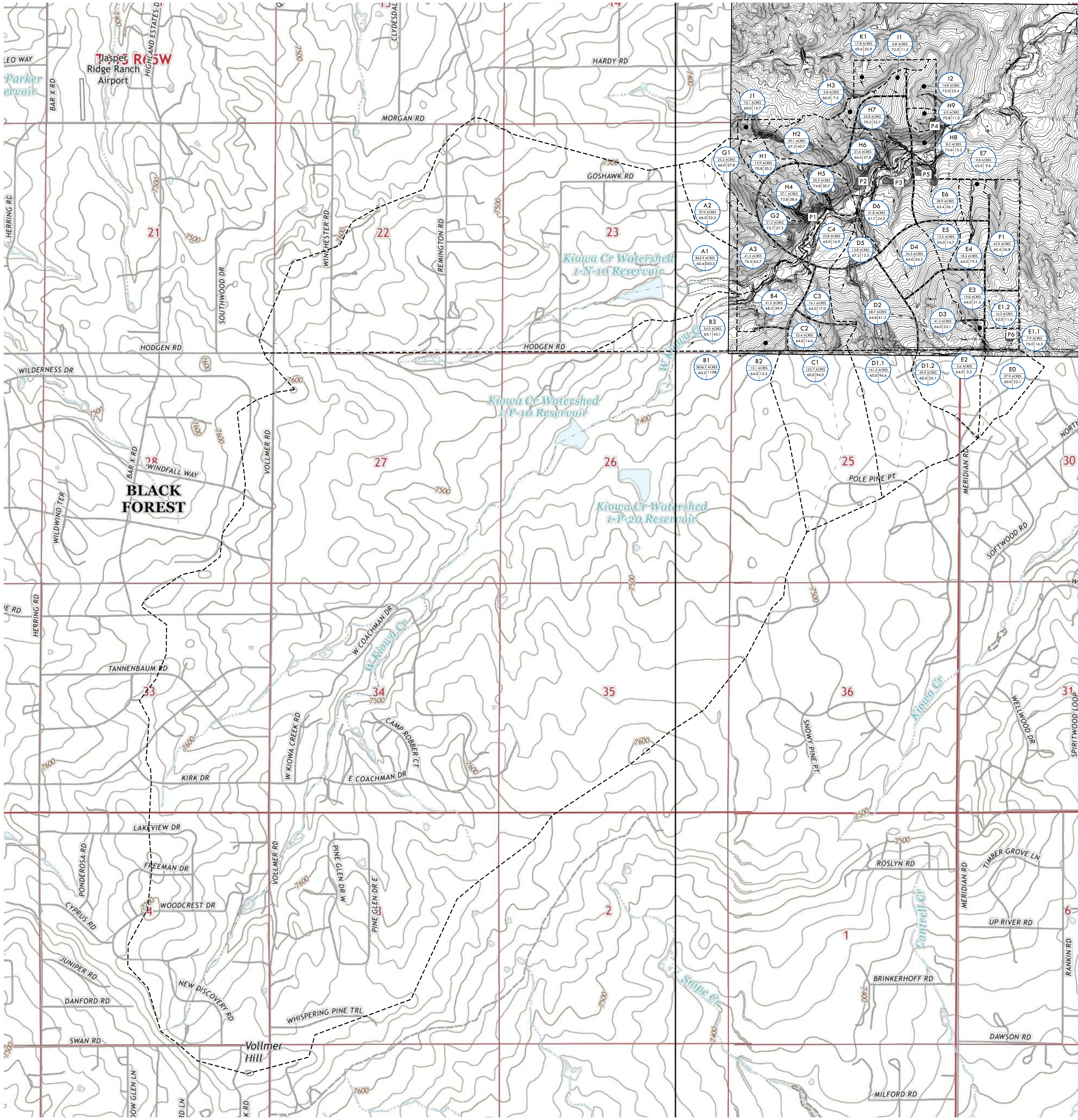

PROPOSED STORMWATER RUNOFF			
BASIN	BASIN AREA (ACRES)	CURVE NUMBER	Q_{100}
A1	865.9	60.4	350.3
A2	37.0	66.0	32.5
A3	41.5	76.5	65.7
B1	3836.7	60.3	1107.9
B2	13.1	64.0	15.5
B3	54.9	65.1	43.1
B4	41.5	68.5	39.9
C1	162.7	60.0	94.9
C2	22.4	64.0	14.6
C3	16.1	64.0	17.0
C4	23.8	65.0	16.9
D1.1	161.3	60.0	94.6
D1.2	49.9	60.0	25.1
D2	68.7	64.8	61.3
D3	41.2	64.0	33.1
D4	34.3	64.0	34.2
D5	12.8	67.2	13.3
D6	41.8	61.7	24.5
E0	37.9	60.0	22.1
E1.1	7.9	76.0	16.3
E1.2	16.3	62.0	11.6
E2	2.6	64.0	3.3
E3	19.8	64.0	21.5
E4	18.2	64.0	19.3
E5	13.5	64.0	14.7
E6	28.9	62.4	26.1
E7	9.8	62.0	9.6
F1	42.9	60.4	26.8
G1	25.2	66.0	27.8
G2	21.2	72.7	27.3
H1	13.9	70.8	20.3
H2	39.1	67.2	40.7
H3	5.8	66.0	7.5
H4	27.1	73.8	38.4
H5	20.2	74.8	30.7
H6	31.6	66.6	27.8
H7	25.8	70.5	32.7
H8	8.5	74.6	15.2
H9	6.9	70.8	11.0
I1	6.8	72.0	11.5
I2	14.8	72.0	25.4
J1	10.1	69.5	15.7
K1	17.8	76.0	35.9
	5998.2		

DETENTION POND SUMMARY		
POND NUMBER	PROPOSED VOLUME	FLOW EXITING POND
1	8.0 AC-FT	31.9 CFS
2	7.4 AC-FT	35.1 CFS
3	7.1 AC-FT	126.8 CFS
4	1.5 AC-FT	30.6 CFS
5	9.7 AC-FT	120.0 CFS
6	4.0 AC-FT	18.0 CFS

LEGEND

- PROPERTY BOUNDARY LINE
- 5540 PROPOSED CONTOUR
- 5540 EXISTING CONTOUR
- DRAINAGE BASIN BOUNDARY
- DRAINAGE BASIN FLOW PATH
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- 4.73 — CURVE NUMBER
- FLOW ARROWS

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PROPOSED DRAINAGE PLAN - OVERALL

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ELBERT, COLORADO 80106

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
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PRELIMINARY PLAN SET

WINSOME SUBDIVISION

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0' 200' 400'

P1	OUTFALL Q5=1.5CFS Q100=31.9CFS
P2	OUTFALL Q5=0.9CFS Q100=35.1CFS
P3	OUTFALL Q5=1.4CFS Q100=126.8CFS
P4	OUTFALL Q5=1.3CFS Q100=30.6CFS
P5	OUTFALL Q5=1.9CFS Q100=120.0CFS
P6	OUTFALL Q5=0.7CFS Q100=18.0CFS

1	MAIN OUTFALL Q5=447.4CFS Q100=2437.3CFS
2	OFFSITE FLOW Q5=3.1CFS Q100=19.9CFS
3	OFFSITE FLOW Q5=12.9CFS Q100=45.1CFS
4	OFFSITE FLOW DIRECTED TO POND P4
5	P4 OUTFALL Q5=1.3CFS Q100=30.6CFS
6	OFFSITE FLOW DIRECTED TO POND P5
7	OFFSITE FLOW DIRECTED TO POND P5
8	BOX CULVERT 2 Q100=2321.1CFS

NOTES:

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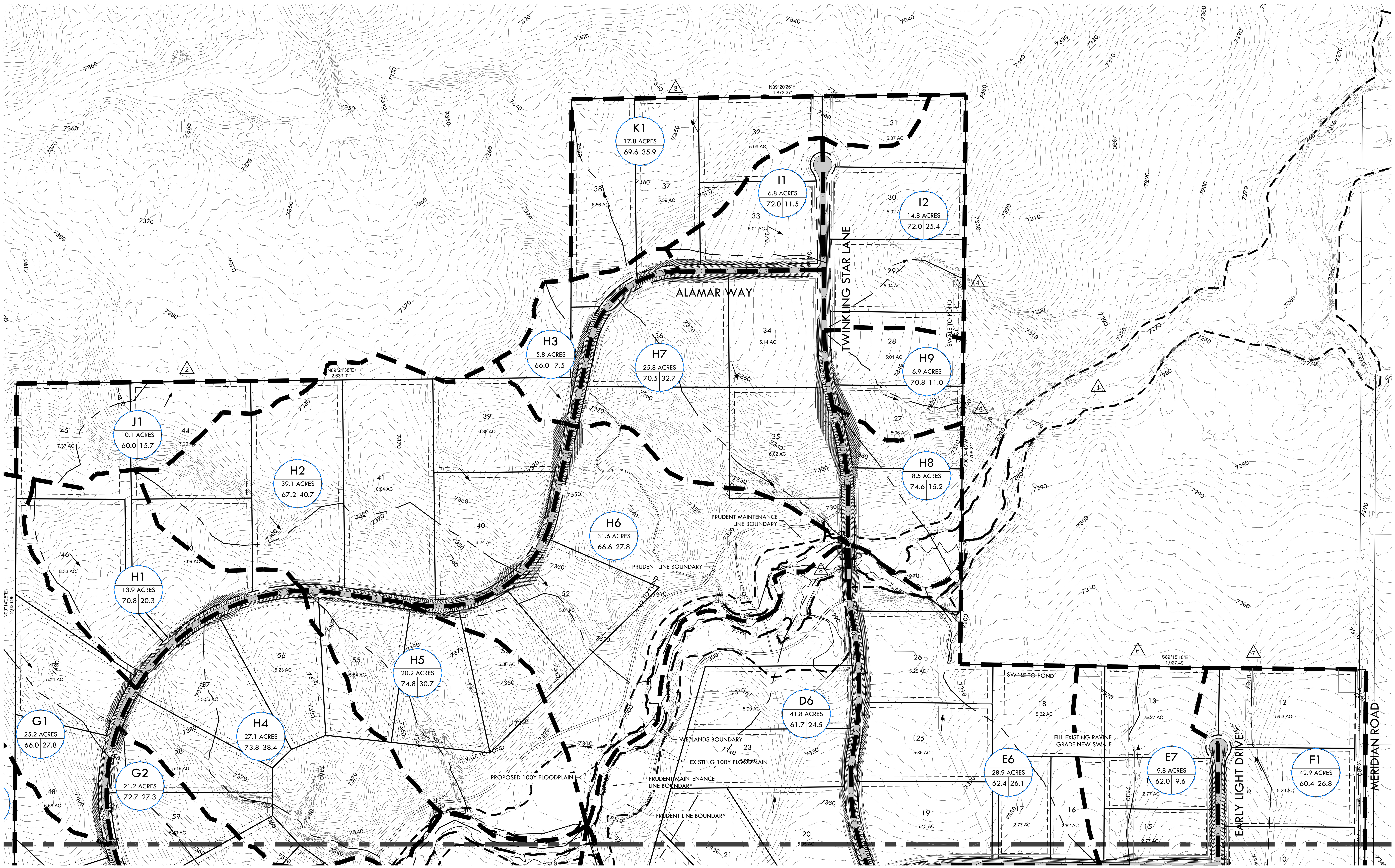

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PROPOSED DRAINAGE PLAN - NORTH

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ELBERT, COLORADO 80106

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

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PRELIMINARY PLAN SET

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P2 OUTFALL Q5=0.9CFS Q100=35.1CFS

P3 OUTFALL Q5=1.4CFS Q100=126.8CFS

P4 OUTFALL Q5=1.3CFS Q100=30.6CFS

P5 OUTFALL Q5=1.9CFS Q100=120.0CFS

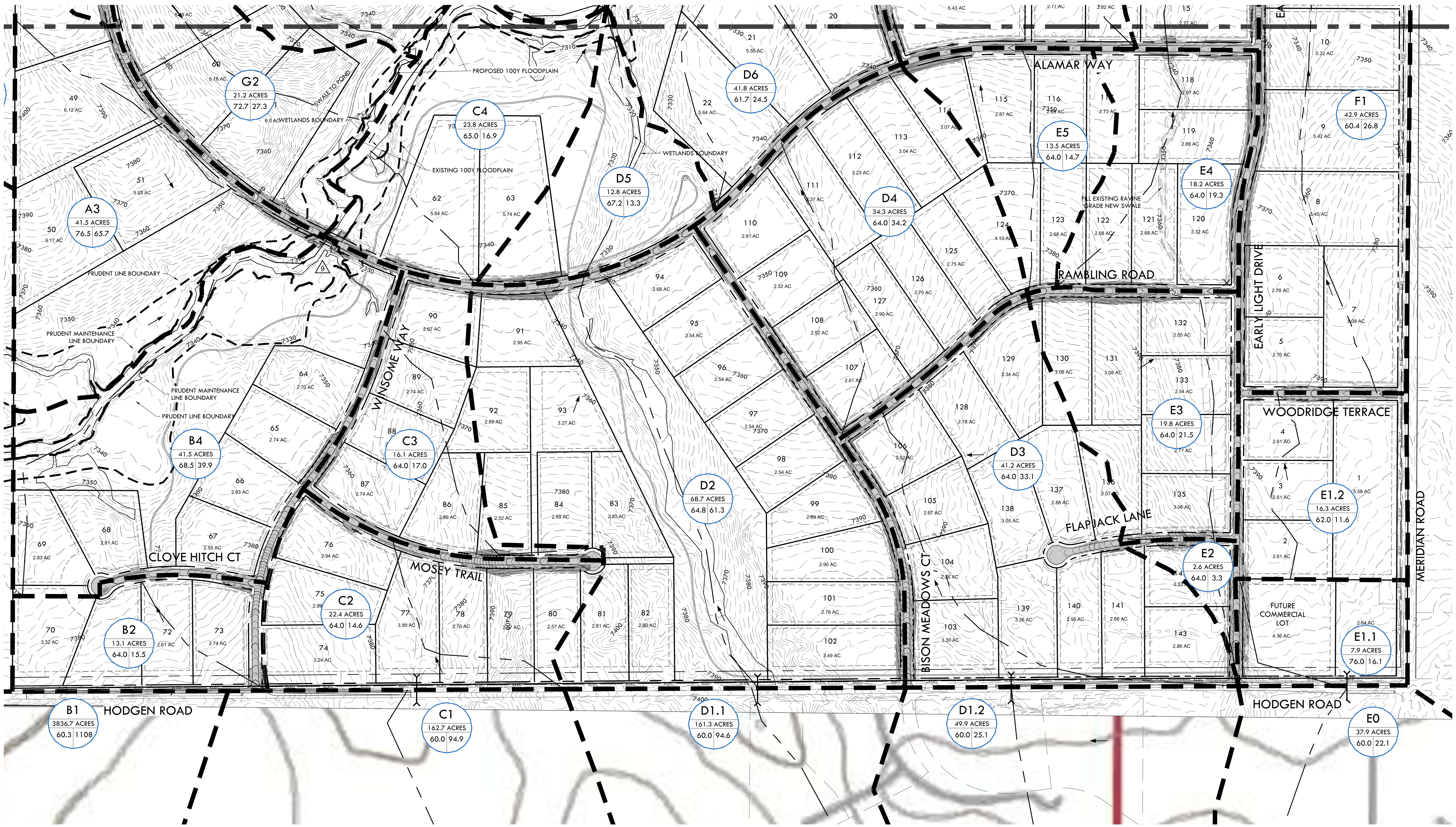
P6 OUTFALL Q5=0.7CFS Q100=18.0CFS

9 BOX CULVERT 1 Q100=2062.2CFS

NOTES:

1. EXISTING FLOODPLAIN AS SHOWN BASED ON FIRM MAP #08041C0350G PANEL 350 REVISED 12/7/2018, GENERATED BY GRAPHICAL OVERLAY.

MATCH LINE - SEE SHEET C2.2 - PROPOSED DRAINAGE PLAN - NORTH



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4.5. - Initial Abstraction

The initial abstraction (Ia) represents a volume of rainfall that must fall to satisfy losses in a drainage basin before runoff begins. The default value for Ia is 0.20 times the potential maximum retention (S). Through modeling of the Jimmy Camp Creek drainage basin using gage-adjusted, NEXRAD-generated rainfall input and comparing model results with recorded flow data, it was determined that a more appropriate value for Ia is 0.10·S. Therefore, this value shall replace the default value for any evaluations that apply the NRCS curve number method for rainfall losses. To apply this adjustment when using HEC-HMS it will be necessary to provide the initial abstraction as a depth in inches rather to a fraction of the potential maximum retention. The initial abstraction in inches is calculated using Equation 6-12.

$$Ia = 0.1[(1000/CN) - 10] \quad \text{(Eq. 6-12)}$$

Table 6-9. NRCS Curve Numbers for Pre-Development Thunderstorms Conditions (ARC I)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	% I	Pre-Development CN			
				HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)	—	—	—	47	61	72	77
Fair condition (grass cover 50% to 75%)	—	—	—	29	48	61	69
Good condition (grass cover > 75%)	—	—	—	21	40	54	63
Impervious areas:							

Paved parking lots, roofs, driveways, etc. (excluding right-of-way)	—	—	—	95	95	95	95
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	—	—	—	95	95	95	95
Paved; open ditches (including right-of-way)	—	—	—	67	77	83	85
Gravel (including right-of-way)	—	—	—	57	70	77	81
Dirt (including right-of-way)	—	—	—	52	66	74	77
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	—	—	—	42	58	70	75
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	—	—	—	91	91	91	91
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**

Newly graded areas (pervious areas only, no vegetation)	—	—	—	58	72	81	87
Cultivated Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Fallow	Bare soil	—	—	58	72	81	87
	Crop residue cover (CR)	Poor	—	57	70	79	85
		Good	—	54	67	75	79
Row crops	Straight row (SR)	Poor	—	52	64	75	81
		Good	—	46	60	70	77
	SR + CR	Poor	—	51	63	74	79
		Good	—	43	56	66	70
	Contoured (C)	Poor	—	49	61	69	75
		Good	—	44	56	66	72
	C + CR	Poor	—	48	60	67	74
		Good	—	43	54	64	70
	Contoured & terraced (C&T)	Poor	—	45	54	63	66
		Good	—	41	51	60	64
	C&T+ CR	Poor	—	44	53	61	64
		Good	—	40	49	58	63

Small grain	SR	Poor	—-	44	57	69	75
		Good	—-	42	56	67	74
	SR + CR	Poor	—-	43	56	67	72
		Good	—-	39	52	63	69
	C	Poor	—-	42	54	66	70
		Good	—-	40	53	64	69
	C + CR Poor	Poor	—-	41	53	64	69
		Good	—-	39	52	63	67
	C&T	Poor	—-	40	52	61	66
		Good	—-	38	49	60	64
	C&T+ CR	Poor	—-	39	51	60	64
		Good	—-	37	48	58	63
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	—-	45	58	70	77
		Good	—-	37	52	64	70
	C	Poor	—-	43	56	67	70
		Good	—-	34	48	60	67
	C&T	Poor	—-	42	53	63	67
		Good	—-	30	46	57	63
Pasture, grassland, or range-continuous forage	—	Poor	—	47	61	72	77

for grazing [4]	—	Fair	—	29	48	61	69
	—	Good	—	21	40	54	63
Meadow-continuous grass, protected from grazing and generally mowed for hay	—	—	—	15	37	51	60
Brush-brush-weed-grass mixture with brush the major element [5]	—	Poor	—	28	46	58	67
	—	Fair	—	18	35	49	58
	—	Good	—	15	28	44	53
Woods-grass combination (orchard or tree farm) [6]	—	Poor	—	36	53	66	72
	—	Fair	—	24	44	57	66
	—	Good	—	17	37	52	61
Woods [7]	—	Poor	—	26	45	58	67
	—	Fair	—	19	39	53	61
	—	Good	—	15	34	49	58
Farmsteads-buildings, lanes, driveways, and surrounding lots	—	—	—	38	54	66	72
Arid and Semi-arid Rangelands[1]	**Treatment**	**Hydrologic Condition[8]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Herbaceous-mixture of grass, weeds, and low-	—	Poor	—	—	63	74	85
	—	Fair	—	—	51	64	77

growing brush, with brush the minor element	—	Good	—	—	41	54	70
Oak-aspen-mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	—	Poor	—	—	45	54	61
	—	Fair	—	—	28	36	42
	—	Good	—	—	15	23	28
Pinyon-juniper-pinyon, juniper, or both; grass understory	—	Poor	—	—	56	70	77
	—	Fair	—	—	37	53	63
	—	Good	—	—	23	40	51
Sagebrush with grass understory	—	Poor	—	—	46	63	70
	—	Fair	—	—	30	42	49
	—	Good	—	—	18	27	34
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	—	Poor	—	42	58	70	75
	—	Fair	—	34	52	64	72
	—	Good	—	29	47	61	69
[1]. Average runoff condition, and Ia = 0.1S.							
[2]. Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.							

3. Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness. Poor: Factors impair infiltration and tend to increase runoff. Good: Factors encourage average and better than average infiltration and tend to decrease runoff.
4. Poor: <50%) ground cover or heavily grazed with no mulch. Fair: 50 to 75% ground cover and not heavily grazed. Good: > 75% ground cover and lightly or only occasionally grazed.
5. Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.
6. CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
7. Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning. Fair: Woods are grazed but not burned, and some forest litter covers the soil. Good: Woods are protected from grazing, and litter and brush adequately cover the soil.
8. Poor: <30% ground cover (litter, grass, and brush overstory). Fair: 30 to 70% ground cover. Good: > 70% ground cover.

TABLE 6-10. NRCS CURVE NUMBERS FOR FRONTAL STORMS & THUNDERSTORMS FOR DEVELOPED CONDITIONS (ARCII)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	% I	Pre-Development CN			
				HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							

Poor condition (grass cover < 50%)	——-	——-	—-	68	79	86	89
Fair condition (grass cover 50% to 75%)	——-	——-	—-	49	69	79	84
Good condition (grass cover > 75%)	——-	——-	—-	39	61	74	80
Impervious areas:							
Paved parking lots, roofs, driveways, etc. (excluding right-of-way	——-	——-	—-	98	98	98	98
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	——-	——-	—-	98	98	98	98
Paved; open ditches (including right-of-way)	——-	——-	—-	83	89	92	93
Gravel (including right-of-way)	——-	——-	—-	76	85	89	91
Dirt (including right-of-way)	——-	——-	—-	72	82	87	89
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	——-	——-	—-	63	77	85	88

Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	——-	——-	—-	96	96	96	96
Urban districts:							
Commercial and business	——-	——-	85	89	92	94	95
Industrial	——-	——-	72	81	88	91	93
Residential districts by average lot size:							
⅛ acre or less (town houses)	——-	——-	65	77	85	90	92
¼ acre	——-	——-	38	61	75	83	87
⅓ acre	——-	——-	30	57	72	81	86
½ acre	——-	——-	25	54	70	80	85
1 acre	——-	——-	20	51	68	79	84
2 acres	——-	——-	12	46	65	77	82
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Newly graded areas (pervious areas only, no vegetation)	——-	——-	—-	77	86	91	94

Cultivated Agricultural Lands[1]	Treatment	Hydrologic Condition	% I	HSG A	HSG B	HSG C	HSG D
Fallow	Bare soil	——-	—-	77	86	91	94
	Crop residue cover (CR)	Poor	—-	76	85	90	93
		Good	—-	74	83	88	90
Row crops	Straight row (SR)	Poor	—-	72	81	88	91
		Good	—-	67	78	85	89
	SR + CR	Poor	—-	71	80	87	90
		Good	—-	64	75	82	85
	Contoured (C)	Poor	—-	70	79	84	88
		Good	—-	65	75	82	86
	C + CR	Poor	—-	69	78	83	87
		Good	—-	64	74	81	85
	Contoured & terraced (C&T)	Poor	—-	66	74	80	82
		Good	—-	62	71	78	81
	C&T+ CR	Poor	—-	65	73	79	81
		Good	—-	61	70	77	80
Small grain	SR	Poor	—-	65	76	84	88
		Good	—-	63	75	83	87

	SR + CR	Poor	—-	64	75	83	86
		Good	—-	60	72	80	84
	C	Poor	—-	63	74	82	85
		Good	—-	61	73	81	84
	C + CR Poor	Poor	—-	62	73	81	84
		Good	—-	60	72	80	83
	C&T	Poor	—-	61	72	79	82
		Good	—-	59	70	78	81
	C&T+ CR	Poor	—-	60	71	78	81
		Good	—-	58	69	77	80
Pasture, grassland, or range—continuous forage for grazing [4]	——-	Poor	—-	68	79	86	89
	—	Fair	—-	49	69	79	84
	—	Good	—-	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay	——-	——-	—-	30	58	71	78
Brush-brush-weed-grass mixture with brush the major element [5]	——-	Poor	—-	48	67	77	83
	—	Fair	—-	35	56	70	77
	—	Good	—-	30	48	65	73

Woods-grass combination (orchard or tree farm) [6]	——-	Poor	—-	57	73	82	86
	—	Fair	—-	43	65	76	82
	—	Good	—-	32	58	72	79
Woods [7]	——-	Poor	—-	45	66	77	83
	—	Fair	—-	36	60	73	79
	—	Good	—-	30	55	70	77
Farmsteads-buildings, lanes, driveways, and surrounding lots	——-	——-	—-	59	74	82	86
Arid and Semi-arid Rangelands[1]	**Treatment**	**Hydrologic Condition[8]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Herbaceous-mixture of grass, weeds, and low-growing brush, with brush the minor element	——-	Poor	—-	——-	80	87	93
	—	Fair	—-	——-	71	81	89
	—	Good	—-	——-	62	74	85
Oak-aspen-mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	——-	Poor	—-	——-	66	74	79
	—	Fair	—-	——-	48	57	63
	—	Good	—-	——-	30	41	48
Pinyon-juniper-pinyon, juniper, or both; grass understory	——-	Poor	—-	——-	75	85	89
	—	Fair	—-	——-	58	73	80
	—	Good	—-	——-	41	61	71

Sagebrush with grass understory	——-	Poor	—-	——-	67	80	85
	—	Fair	—-	——-	51	63	70
	—	Good	—-	——-	35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	——-	Poor	—-	63	77	85	88
	—	Fair	—-	55	72	81	86
	—	Good	—-	49	68	79	84
[1] Ia = 0.1 S							
[2.] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.							
[3.] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness. Poor: Factors impair infiltration and tend to increase runoff. Good: Factors encourage average and better than average infiltration and tend to decrease runoff.							
[4.] Poor: <50%) ground cover or heavily grazed with no mulch. Fair: 50 to 75% ground cover and not heavily grazed. Good: > 75% ground cover and lightly or only occasional							
[5.] Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.							
[6.] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods							

7. Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning. Fair: Woods are grazed but not burned, and some forest litter covers the soil. Good: Woods are protected from grazing, and litter and brush adequately cover the soil.
8. Poor: <30% ground cover (litter, grass, and brush overstory). Fair: 30 to 70% ground cover. Good: > 70% ground cover.

_8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
LINED OR BUILT-UP CHANNELS			
a. Corrugated Metal	0.021	0.025	0.030
b. Concrete			
_1. Trowel finish	0.011	0.013	0.015
_2. Float finish	0.013	0.015	0.016
_3. Finished, with gravel on bottom	0.015	0.017	0.020
_4. Unfinished	0.014	0.017	0.020
_5. Gunite, good section	0.016	0.019	0.023
6. Gunite, wavy section	0.018	0.022	0.025
_7. On good excavated rock	0.017	0.020	
_8. On irregular excavated rock	0.022	0.027	
c. Concrete bottom float finished with sides of			
_1. Dressed stone in mortar	0.015	0.017	0.020
_2. Random stone in mortar	0.017	0.020	0.024
_3. Cement rubble masonry, plastered	0.016	0.020	0.024
_4. Cement rubble masonry	0.020	0.025	0.030
_5. Dry rubble or riprap	0.020	0.030	0.035
d. Gravel bottom with sides of			
_1. Formed concrete	0.017	0.020	0.025
_2. Random stone in mortar	0.020	0.023	0.026
_3. Dry rubble or riprap	0.023	0.033	0.036
e. Asphalt			
_1. Smooth		0.013	
_2. Rough		0.016	
f. Grassed	0.030	0.040	0.050

TABLE 10-3

MAXIMUM PERMISSIBLE DESIGN OPEN CHANNEL FLOW VELOCITIES IN EARTH*

Soil Types	Permissible Mean Channel Velocity (ft/sec)
Fine Sand (noncolloidal)	2.0
Coarse Sand (noncolloidal)	4.0
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Silty Clay	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5
Hard Shales and Hard Pans	6.0
Soft Shales	3.5
Soft Sandstone	8.0
Sound rock (usu. igneous or hard metamorphic)	20.0
*These velocities shall be used in conjunction with scour calculations and as approved by City/County.	

TABLE 10-4

MAXIMUM PERMISSIBLE VELOCITIES FOR EARTH CHANNELS WITH VARIED GRASS LININGS AND SLOPES

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
0 - 5%	Sodded grass	7
	Bermudagrass	6
	Reed canarygrass	5

	Tall fescue	5
	Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10%	Sodded grass	6
	Bermudagrass	5
	Reed canarygrass	4
	Tall fescue	4
	Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Sodded grass	5
	Bermudagrass	4
	Reed canarygrass	3
	Tall fescue	3
	Kentucky bluegrass	3
*For highly erodible soils, decrease permissible velocities by 25%.		
*Grass lined channels are dependent upon assurances of continuous growth and maintenance of grass.		

Except in horizontal curves, the flatter the open channel side slopes, the better. Side slopes for grass-lined channels shall be no steeper than 4H:1V, which is the practical limit for mowing equipment. Concrete-lined channels, or those which for other reasons require minimum or no slope maintenance, (i.e., channels lined with grouted riprap or soil cement), may have side slopes as steep as 2H:1V. Riprap lined channels may have slopes as steep as 2.5H:1V. Roadside ditches may have slopes as steep as 4H:1V.

For channels which are being constructed within existing site constraints including bridges and structures, concrete side slopes may be 1.5H:1V. These channels must have adequate fencing for general safety of the public.

10.5.2. Depth

Channel depth should not exceed 5.0' at the 100-year storm when the 100-year flow is approximately 1500 cfs or less. Excessive depths should be avoided to minimize high velocities and for other public safety considerations.

10.5.3. Bottom Width

I.7. - POST-CONSTRUCTION STORMWATER MANAGEMENT

I.7.1. Post-Construction Stormwater Management Planning

[Replaces DCM2 Section 4.1, pages 4-1 through "Other BMPs" continued on 4-5]

A. **Overview.** This chapter contains requirements and procedures for the selection, installation, implementation and maintenance of permanent stormwater quality control measures that will remain in operation after construction for new development and significant redevelopment. All applicable development sites must have operational permanent stormwater quality control measures at the completion of the site, unless excluded from the requirements of an applicable development site as described in Section I.7.1.C. All permanent control measures for applicable development sites shall meet one of the "base design standards" described in Section 1.71.D.

In the case where permanent water quality control measures are part of future phasing, the permittee must have a mechanism to ensure that all control measures will be implemented, regardless of completion of future phases or site ownership. In such cases, temporary water quality control measures must be implemented as feasible and maintained until removed or modified. All temporary water quality control measure must meet one of the "base design standards" described in Section I.7.1.D.

A procedure is provided within the context of a flow chart and a four-step process that shall be followed for all applicable development sites. Detailed descriptions, sizing and design criteria, and design procedures for control measures are provided in the New Development BMP Factsheets found in Section 4.2 of the DCMV2.

It is recommended that discussions and collaboration regarding proposed BMPs occur early in each project between the developer's planner and engineer, County Stormwater and County Planning and Community Development staff.

The analysis of the requirements, exclusions and base design standards presented in this Section I.7 shall be incorporated into existing ECM Administrator submittals for review and acceptance including Preliminary/Final Drainage Reports and construction plans, or as otherwise specified by the ECM Administrator.

B. **Applicable Development Sites: Excluded Sites.** The following types of sites and associated land disturbances are excluded from the requirements of this Section 1.7. Although a site may qualify for an exclusion to Section 1.7 below, the site may still be considered an applicable construction activity subject to the requirements of an ESQCP or BESQCP.

1. **Pavement Management Sites.** Sites, or portions of sites, for the rehabilitation, maintenance, and reconstruction of roadway pavement, which includes roadway resurfacing, mill and overlay, white topping, black topping, curb and gutter replacement, concrete panel replacement, and pothole repair. The purpose of the site must be to provide additional years of service life and optimize service and safety. The site also must be limited to the repair and replacement of pavement in a manner that does not result in an increased impervious area, and the infrastructure must not substantially change. The types of sites covered under this exclusion include day-to-day maintenance activities, rehabilitation, and reconstruction of pavement. "Roadways" include roads and bridges that are improved, designed or ordinarily used for vehicular travel and contiguous areas or that are improved, designed or ordinarily used for pedestrian or bicycle traffic, drainage for the roadway, and/or parking along the roadway. Areas primarily used for parking or access to parking are not roadways.

2. **Excluded Roadway Redevelopment.** Redevelopment sites for existing roadways, when 1 of the following cri
   1) The site adds less than 1 acre of paved area per mile of roadway to an existing roadway, or
   2) The site does not add more than 8.25 feet of paved width at any location to the existing roadway.
3. **Excluded Existing Roadway Areas.** For redevelopment sites for existing roadways, only the area of the existing roadway is excluded from the requirements of an applicable development site when the site does not increase the width by 2 times or more, on average, of the original roadway area. The entire site is not excluded from being considered an applicable development site for this exclusion. The area of the site that is part of the added new roadway area is still an applicable development site.
4. **Aboveground and Underground Utilities.** Activities for installation or maintenance of underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the construction activity. This exclusion includes, but is not limited to, activities to install, replace, or maintain utilities under roadways or other paved areas that return the surface to the same condition.
5. **Large Lot Single Family Sites.** A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent. A total lot imperviousness greater than 10 percent is allowed when a study specific to the watershed and/or MS4 shows that expected soil and vegetation conditions are suitable for infiltration/filtration of the WQCV for a typical site, and the permittee accepts such study as applicable within its MS4 boundaries. The maximum total lot impervious covered under this exclusion shall be 20 percent.
6. **Non-Residential and Non-Commercial Infiltration Conditions.** This exclusion does not apply to residential or commercial sites for buildings. This exclusion applies to applicable development sites for which post-development surface conditions do not result in concentrated stormwater flow during the 80th percentile stormwater runoff event. In addition, post-development surface conditions must not be projected to result in a surface water discharge from the 80th percentile stormwater runoff events. Specifically, the 80th percentile event must be infiltrated and not discharged as concentrated flow. For this exclusion to apply, a study specific to the site, watershed and/or MS4 must be conducted. The study must show rainfall and soil conditions present within the project area, must include allowable slopes, surface conditions, and ratios of impervious area to pervious area, and the County must accept such study as applicable within its MS4 boundaries.
7. **Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped.** Sites with land disturbance to undeveloped land (land with no human-made structures such as buildings or pavement) that will remain undeveloped after the site. Typical examples of this type of site are trails, parks and open space without structures.
8. **Stream Stabilization Sites.** Construction activity that is solely for the purpose of stream stabilization.
9. **Trails.** Bike and pedestrian trails. Bike lanes for roadways are not included in this exclusion, unless attached to a roadway that qualifies under another exclusion in this section.
10. **Oil and Gas Exploration.** Facilities associated with oil and gas exploration, production, processing, or treatment operations, or transmission facilities, including activities necessary to prepare a site for drilling and for the movement and placement of drilling equipment, whether or not such field activities or operations may be considered to be an applicable construction activity.
11. **County Growth Areas.** The County may exclude the following when they occur within the county growth areas:

a. Agricultural facilities and structures on agricultural zoned lands (e.g., barn, stables).
b. Residential development site or larger common plans of development for which associated construction activities results in a land disturbance of less than or equal to 10 acres and have a proposed density of less than 1,000 people per square mile.
c. Commercial or industrial development site or larger common plans of development for which associated construction activities results in a land disturbance of less than or equal to 10 acres.

C. **Base Design Standard Requirements.** The "base design standard" is the minimum design standard for new and redevelopment before applying any exclusions or alternative standards. The control measures for applicable development sites shall meet one of the following base design standards:

1. **Water Quality Capture Volume (WQCV) Standard.** The control measures is designed to provide treatment and/or infiltration of the WQCV and:
   a. 100% of the applicable development site is captured, except the County may exclude up to 20 percent, not to exceed 1 acre, of the applicable development site area when the County has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. In addition, the County must also determine that the implementation of a separate control measure for that portion of the site is not practicable (e.g., driveway access that drains directly to street).
   b. Evaluation of the minimum drain time shall be based on the pollutant removal mechanism and functionality of the control measure implemented. Consideration of drain time shall include maintaining vegetation necessary for operation of the control measure (e.g., wetland vegetation).
2. **Pollutant Removal Standard.** The control measures is designed to treat at a minimum the 80th percentile storm event. The control measures shall be designed to treat stormwater runoff in a manner expected to reduce the event mean concentration of total suspended solids (TSS) to a median value of 30 mg/L or less.

   100% of the applicable development site must be captured, except the County may exclude up to 20 percent not to exceed 1 acre of the applicable development site area when the County has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. In addition, the County must also determine that the implementation of a separate control measure for that portion of the site is not practicable (e.g., driveway access that drains directly to street).
3. **Runoff Reduction Standard.** The control measures is designed to infiltrate into the ground where site geology permits, evaporate, or evapotranspire a quantity of water equal to 60% of what the calculated WQCV would be if all impervious area for the applicable development site discharged without infiltration. This base design standard can be met through practices such as green infrastructure. "Green infrastructure" generally refers to control measures that use vegetation, soils, and natural processes or mimic natural processes to manage stormwater. Green infrastructure can be used in place of or in addition to low impact development principles.
4. **Applicable Development Site Draining to a Regional WQCV Control Measure.** The regional WQCV control measure must be designed to accept the drainage from the applicable development site. Stormwater from the site must not discharge to a water of the state before being discharged to the regional WQCV control measure. The regional WQCV control measure must meet the requirements of the WQCV in Part I.7.C.1.
5. **Applicable Development Site Draining to a Regional WQCV Facility.** The regional WQCV facility is

designed to accept drainage from the applicable development site. Stormwater from the site may discharge to a water of the state before being discharged to the regional WQCV facility. Before discharging to a water of the state, at least 20 percent of the upstream imperviousness of the applicable development site must be disconnected from the storm drainage system and drain through a receiving pervious area control measure comprising a footprint of at least 10 percent of the upstream disconnected impervious area of the applicable development site. The control measure must be designed in accordance with a design manual identified by the permittee. In addition, the stream channel between the discharge point of the applicable development site and the regional WQCV facility must be stabilized. The regional WQCV facility must meet the following requirements:

a. The regional WQCV facility must be implemented, functional, and maintained following good engineering, hydrologic and pollution control practices.
b. The regional WQCV facility must be designed and maintained for 100% WQCV for its entire drainage area.
c. The regional WQCV facility must have capacity to accommodate the drainage from the applicable development site.
d. The regional WQCV facility must be designed and built to comply with all assumptions for the development activities planned by the County within its drainage area, including the imperviousness of its drainage area and the applicable development site.
e. Evaluation of the minimum drain time shall be based on the pollutant removal mechanism and functionality of the facility. Consideration of drain time shall include maintaining vegetation necessary for operation of the facility (e.g., wetland vegetation).
f. The County shall require site plans and perform a site plan review consistent with the requirements of this ECM to ensure the regional WQCV facility and control measures for the applicable development site plans include:
    i. Design details for all structural control measures implemented to meet the requirements of Part I.E.4.
    ii. A narrative reference for all non-structural control measures for the site, if applicable. "Non-structural control measures" are control measures that are not structural control measures and include, but are not limited to, control measures that prevent or reduce pollutants being introduced to water or that prevent or reduce the generation of runoff or illicit discharges.
    iii. Documentation of operation and maintenance procedures to ensure the long term observation, maintenance, and operation of the control measures. The documentation shall include frequencies for routine inspections and maintenance activities.
    iv. Documentation regarding easements or other legal means for access of the control measure sites for operation, maintenance, and inspection of control measures.
    v. Confirmation that control measures meet the requirements of section I.7.C
    vi. Confirmation that site plans meet the requirements of County's site plan review and approval requirements
g. The regional WQCV facility must be subject to the County's authority consistent with requirements and actions for a Control Measure in accordance with a base design standard.
h. Regional Facilities must be designed and implemented with flood control or water quality as the primary use. Recreational ponds and reservoirs may not be considered Regional Facilities. Water

bodies listed by name in surface water quality classifications and standards regulations (5 CCR 1002-32 through 5 CCR 1002-38) may not be considered regional facilities.

6. **Constrained Redevelopment Sites Design Standard.** The constrained redevelopment sites standard applies to redevelopment sites meeting the following criteria:
   (a) The applicable redevelopment site is for a site that has greater than 75% impervious area, and
   (b) The County must determine that it is not practicable to meet any of the base design standards in section I.7.1.C (1), (2), or (3). The County's determination shall include an evaluation of the applicable redevelopment site's ability to install a control measure without reducing surface area covered with the structures.

   The control measures is designed to meet one of the following:

   (a) Provide treatment of the WQCV for the area captured. The captured area shall be 50% or more of the impervious area of the applicable redevelopment site. Evaluation of the minimum drain time shall be based on the pollutant removal mechanism and functionality of the control measure implemented,
   (b) The control measures is designed to provide for treatment of the 80th percentile storm event. The control measures shall be designed to treat stormwater runoff in a manner expected to reduce the event mean concentration of total suspended solids (TSS) to a median value of 30 mg/L or less.

   A minimum of 50% of the applicable development area including 50% or more of the impervious area of the applicable development area shall drain to the control measures. This standard does not require that 100% of the applicable redevelopment site area be directed to a control measures as long as the overall removal goal is met or exceeded (e.g., providing increased removal for a smaller area), or

   (c) Infiltrate, evaporate, or evapotranspirate, through practices such as green infrastructure, a quantity of water equal to 30% of what the calculated WQCV would be if all impervious area for the applicable redevelopment site discharged without infiltration.

I.7.2. BMP Selection

The selection of appropriate BMPs is based on the characteristics of the site and potential pollutants. The Four-Step Process provides a method of going through the selection process. Figure I.1 and Figure I.2 with annotations covers site-specific issues to be considered in selecting an effective BMP for each site.

A. **Four-Step Process.** The following four-step process is recommended for selecting structural BMPs in newly developing and redeveloping urban areas:

Step 1: Employ Runoff Reduction Practices

To reduce runoff peaks and volumes from urbanizing areas, employ a practice generally termed "minimizing directly connected impervious areas" (MDCIA). The principal behind MDCIA is twofold — to reduce impervious areas and to route runoff from impervious surfaces over grassy areas to slow down runoff and promote infiltration. The benefits are less runoff, less stormwater pollution, and less cost for drainage infrastructure. There are several approaches to reduce the effective imperviousness of a development site:

Reduced Pavement Area

Sometimes, creative site layout can reduce the extent of paved areas including parking, thereby saving on initial capital cost of pavement and then saving on pavement maintenance, repair, and replacement over time.

Porous Pavement

The use of modular block porous pavement or reinforced turf in low-traffic zones such as parking areas and low use service drives such as fire lanes can significantly reduce site imperviousness. This practice may reduce the extent and size of the downstream storm sewers and detention.

Grass Buffers

Draining impervious areas over grass buffers slows down runoff and encourages infiltration, in effect reducing the impact of the impervious area.

Grass Swales

The use of grass swales instead of storm sewers slows down runoff, promotes infiltration, and also reducing effective imperviousness. It also may reduce the size and cost of downstream storm sewers and detention.

Implementing these approaches on a new development site is discussed further in the DCM2 section titled Employing Runoff Reduction Techniques. This section provides a procedure for estimating a reduced imperviousness based on the use of grass buffers and swales. The latter three of the approaches for reducing imperviousness are structural BMPs and are described in detail in Section 4.2 of DCM2 (New Development BMP Factsheets):

- Grass Buffer.
- Grass Swale.
- Modular Block Porous Pavement (or Stabilized-Grass Porous Pavement).

Step 2: Stabilize Drainageways

Drainageway, natural and manmade, erosion can be a major source of sediment and associated constituents, such as phosphorus. Natural drainageways are often subject to bed and bank erosion when urbanizing areas increase the frequency, rate, and volume of runoff. Therefore, drainageways are required to be stabilized. One of three basic methods of stabilization may be selected.

Constructed Grass, Riprap, or Concrete-Lined Channel

These methods of channel stabilization have been in practice for some time. The water quality benefit associated with these channels is the reduction of severe bed and bank erosion that can occur in the absence of a stabilized channel. On the other hand, the hard-lined low flow channels that are often used do not offer much in the way of water quality enhancement or wetland habitat. The use of riprap or concrete lined flood conveyance channels is not recommended, unless hydraulic or physical conditions require such an alternative. Rock lined low-flow channels in many cases may be a better alternative.

Stabilized Natural Channel

In practice, many natural drainageways in and adjacent to new developments are frequently left in an undisturbed condition. While this may be positive in terms of retaining desirable riparian vegetation and habitat, urban development may cause the channel to become destabilized. When degradation occurs in these drainageways, significant erosion, loss of riparian and aquatic habitat, and elevated levels of sediment and associated pollutants can result. Therefore, it is recommended that some level of stream stabilization always be considered. Small grade control structures sized for a 5-year or larger runoff event are often an effective means of establishing a mild slope for the baseflow channel and arresting stream degradation. Severe bends or cut banks may also need to be stabilized. Such efforts to stabilize a natural waterway also preserve and promote natural riparian vegetation which can provide paybacks in terms of enhanced aesthetics, habitat, and water quality.

One additional method of drainageway stabilization gives special attention to stormwater quality and is described in Section 4.2 (New Development BMP Factsheets):

- Constructed Wetland Channel.

Step 3: Provide Water Quality Capture Volume (WQCV)

All applicable development sites must have operational permanent stormwater quality control measures at the completion of construction. Designing structures that provide the WQCV is a common preferred approach in El Paso County. Other base design standards discussed earlier may be used if applicable, however. One or more of six types of water quality basins, each draining slowly to provide for long-term settling of sediment particles, may be selected. Information on selecting and configuring for a site one or more of the WQCV facilities listed below is provided in the Section 4.2 of the DCMV2. These six BMPs are also described in detail in the New Development BMP Factsheets found in the DCMV2 Section 4.2.

- Porous Pavement Detention.
- Porous Landscape Detention.
- Extended Detention Basin.
- Sand Filter Extended Detention Basin.
- Constructed Wetland Basin.
- Retention Pond.

Full Spectrum Detention is a newer approach to providing the WQCV. Details on the use, sizing, configuration and maintenance of Full Spectrum Detention structures are located in the DCMV1 update of 2014, sections of which are incorporated by reference into this ECM.

Step 4: Consider Need for Industrial and Commercial BMPs

If a new development or significant redevelopment activity is planned for an industrial or commercial site, the need for specialized BMPs must be considered. Two approaches are described in the New Development BMP Factsheets:

- Covering of Storage/Handling Areas
- Spill Containment and Control

Other Specialized BMPs may also be required

B. **Other Specialized BMPs.** The Technical Advisory Committee (TAC) selected the above structural BMPs after a comprehensive screening of known structural BMPs. The members of TAC included representatives from many County agencies and individuals from the development community. Final selection by TAC was based on the rev documentation on potential effectiveness in a semiarid climate, local applicability, maintenance considerations,

Development and evaluation of permanent BMPs are continuing processes. Better designs of the BMPs included in DCM2 and designs of new BMPs, including manufactured (proprietary) BMPs, will be developed and tested. To allow for this progress, additional BMPs will be considered on a case-by-case basis by County Stormwater Staff. Design and sizing details and results of independent testing of the BMP in conditions similar to those at the site will be submitted demonstrating that the BMP will meet or exceed the performance of approved BMPs for the site.

To promote improvement in stormwater protection, County Stormwater Staff may approve promising BMPs on an experimental basis. A performance monitoring program to be pre-approved by County Stormwater Staff and an agreement to replace the Experimental System with an approved system should it not function to the required level of performance, both at the owner's expense, will be required. A request to use an "experimental system" must be submitted to El Paso County in the form of a Request for a Deviation from these standards, submitted consistent with the criteria and process described Chapters 1 and 5, respectively. Design of any "experimental system" shall not commence until a Request for Deviation is submitted to and approved by the County.

C. **Guidance for Selecting and Locating WQCV Facilities.**

[The following section replaces DCM2 Section 4.1 pages 4-19 through 4-23]

Laying out WQCV facilities within a development site and watershed requires thought and planning. This planning and decision-making should occur during a master drainage planning process (Drainage Basin Planning Study or Master Development Drainage Plan) undertaken by local jurisdictions or a developer's engineer. Such plans, studies or other reports may depict a recommended approach for implementing WQCV on a watershed basis. Such reports may call for a few large regional WQCV facilities, smaller sub-regional facilities, or alternatively an onsite approach. It is always a good idea to find out if a master planning study has been completed that addresses water quality and to attempt to follow the Plan's recommendations.

If the master drainage planning process addresses water quality, the following provides supplemental information on the BMPs. If the existing master drainage planning process has not addressed water quality, or if a new master drainage process is underway, this will direct the water quality evaluation.

D. **Post-Construction Stormwater Quality Control Measure Selection Process.** The BMP selection process is illustrated in Figure I-1 and Figure I-2. These two figures shall be used for all projects except those that are strictly highway/roadway projects; that is, projects with no plans for building pad sites. Projects that are strictly highway/roadway projects are discussed in a separate section below.

The following process references the use of the permanent control measures (BMPs) and other practices outlined in DCM2 and this Appendix. The use of DCM2 BMPs will promote consistency between the City and County. These BMPs are commonly found in manuals and other literature from municipalities across the country, and they are the accepted best industry practices in stormwater quality control.

As described below, other control measures (which may be relatively new to the field of stormwater management) are acceptable if they can be shown to meet performance criteria provided in this Section 1.7. A Request for a Deviation from these standards submitted consistent with the criteria and process described

Chapters 1 and 5, respectively, must be submitted and approved by the County prior to the use of an permanent control measure not included in this ECM, DCMV1, DCMV2 and the DCMV1 Update of 2014.

The following items explain the decision points (i.e., the Boxes) in Figure I-1 and Figure I-2:

Box 1: For all sites, the possibility of incorporating runoff reduction practices must be investigated. Impervious area should be reduced to the maximum extent practicable, per DCM2. DCM2 also provides guidance for MDCIA by routing runoff to pervious areas. This is Step 1 in the Four-Step Process.

Box 2: All drainageways, ditches, and channels shall be stabilized with one of three methods included in Step 2, which include the use of appropriate methods for the type of drainageway as described in the DCM1. Drainageways include:

- Tributaries to creeks that have been left in a relatively natural state,
- Tributaries, channels, and drainageways that are graded or regraded and may include drop or check structures, side slope stabilization, and low-flow channels.
- Roadside ditches that are completely man-made and should only be used to convey runoff from roads and roadway right-of-ways (ROWs).

Box 3: It must be determined if the development and/or redevelopment disturbs an area of land that is 1 acre or larger (or planned to be 1 acre or larger) when all phases are complete.

Box 4: Sites tributary to sensitive waters should consider specialized BMPs to address the parameter of concern as shown in Table I-5. At this time, no special BMPs are required until the County develops an overall strategy to address the parameters of concern, probably if and when a Total Maximum Daily Load (TMDL) is determined.

Figure I-1. BMP Requirements Flowchart for New Development and Redevelopment Sites—For Selecting Post-Construction BMPs in Compliance with El Paso County's Stormwater NPDES Permit

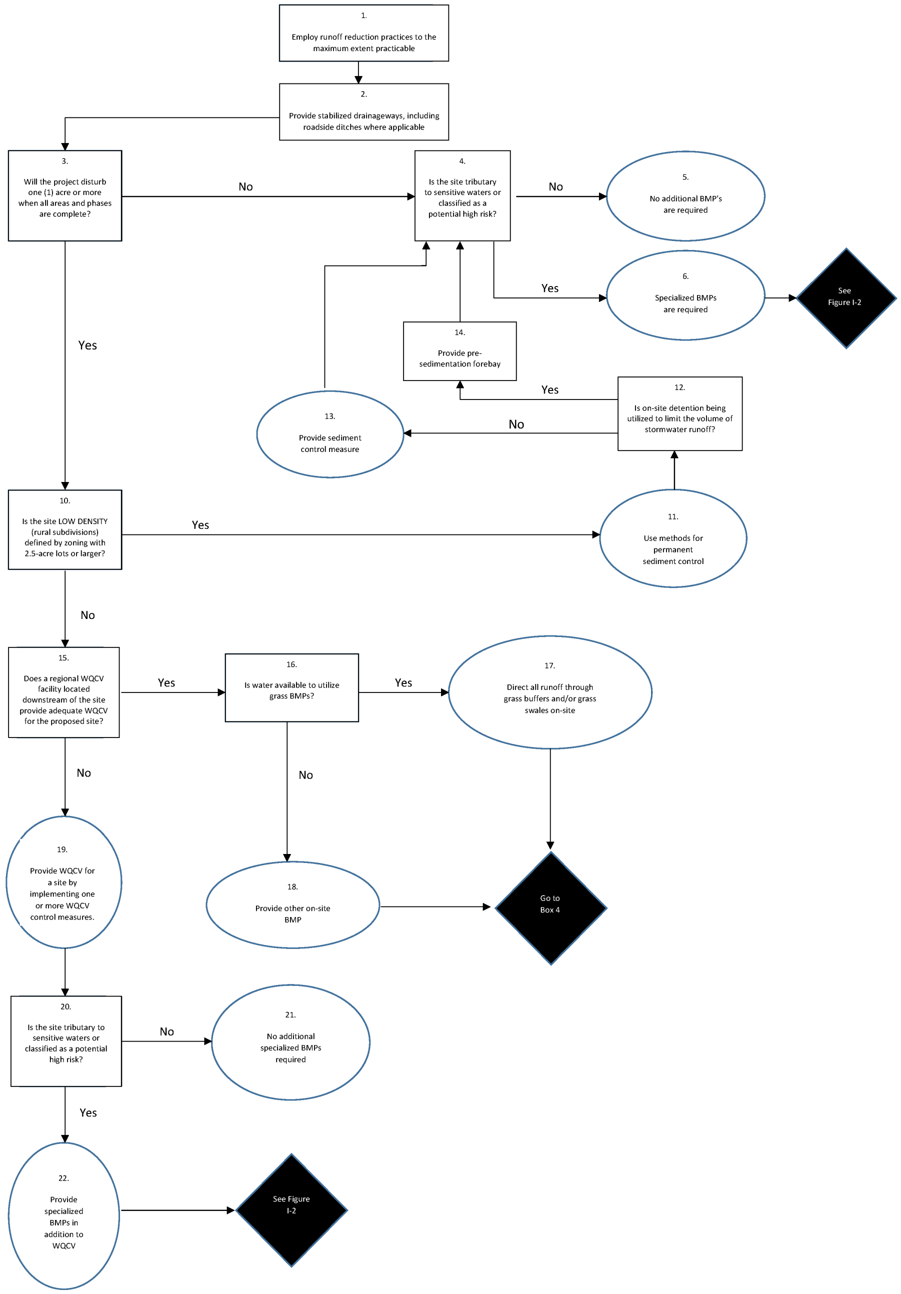
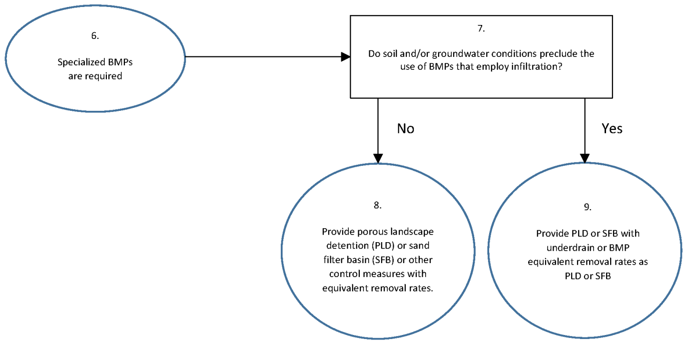


Figure I-2. BMP Requirements Flowchart for New Development and Redevelopment Sites—For Selecting Post-Construction BMPs in Compliance with El Paso County's Stormwater NPDES Permit



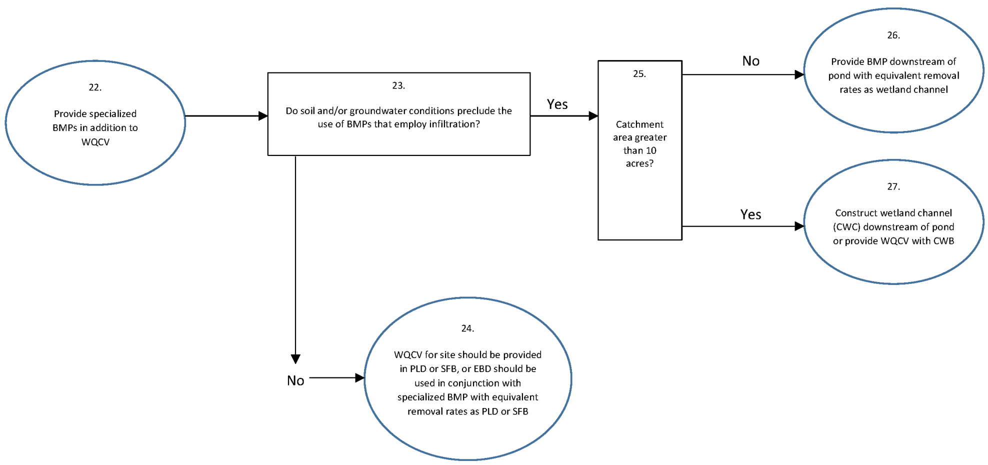


Table I-4. Best Management Practices Abbreviations

Abbreviation	Best Management Practice
CWB	Constructed Wetlands Basin
CWC	Constructed Wetlands Channel - Sedimentation Facility
EDB	Extended Detention Basin - Sedimentation Facility
PLD	Porous Landscape Detention
RP	Retention Pond - Sedimentation Facility
SFB	Sand Filter Extended Detention Basin
WQCV	Water Quality Capture Volume
GB	Grass Buffer
GS	Grass Swale

MBP	Modular Block Porous Pavement
PPD	Porous Pavement Detention

Table I-5. El Paso County Sensitive[1]Waters

Stream and Segment	Parameter of Concern	Specialized BMPs Required
Fountain Creek and tributaries above Monument Creek	E. coli and Se	None at this time
Fountain Creek from Monument Creek to Highway 47	E. coli	None at this time
Monument Creek from National Forest to Fountain Creek	Se	None at this time
Willow Springs Pond #1 and #2	PCE	None at this time
[1] CDPHE 2006 303(d) list. Standard agreement forms for Private Detention Basins are in Appendix G. [This list may change in the future. The 303(d) list or equivalent in effect at the time of permitting will apply.]		

Potential high-risk sites must also incorporate specialized BMPs. High-risk sites are defined by two factors:

- Sites with land uses involving the potential for significant deposition of pollutants.
- Sites without practices to eliminate exposure of pollutants to stormwater.

Land uses involving the potential for significant deposition of pollutants include, but are not limited to:

- Vehicle maintenance facilities,
- Gas stations,
- Automobile salvage yards and junk yards,
- Commercial sites with high levels of "in and out" traffic such as fast-food restaurants and convenience stores.

Many industrial facilities are required to obtain coverage under an industrial stormwater permit; these facilities include automobile salvage yards. Practices to eliminate exposure of pollutants to stormwater may or may not be part of an industrial stormwater permit. These practices include coverage of material storage areas, berms around tanks, spill control plans, and other "good housekeeping" measures. For industrial sites where stormwater is not exposed to pollutants, structural BMPs, including detention ponds for water quality and other BMPs discussed below, may not be required.

Because stormwater pollutants are often transported with sediment, erosion protection and sediment control are necessary for stormwater quality protection. This is very important in the County because of the sandy soils in the region. In particular, discharges that may impact sensitive waters or that come from potentially high-risk sites should have a high level of sediment protection. Thus, in addition to the specialized BMPs, sediment control practices such as revegetation, grading to prevent steep side slopes, check dams, slope drains, and sediment basins should be employed where practical.

Box 5: No BMPs are required other than stabilized drainageways and possibly MDCIA.

Box 6: Specialized BMPs are required and therefore proceed to Box 7 on Table I-1.

Box 7: BMPs that employ infiltration include porous landscape detention and sand filter basins without underdrains. Certain conditions preclude the use of these types of BMPs, including close proximity of groundwater or relatively impervious soils to the bottom of the facility. Groundwater levels should be characterized during the season with the highest levels (often late Spring or early Summer). Impervious soils include bedrock as well as soil types C and D. The term "close proximity" means 5 feet or less. If there is less than 5 feet, a study of the hydraulic conductivity of the soils must be conducted to show that excessive groundwater mounding or direct groundwater contamination will not result from the use of BMPs that employ infiltration.

Box 8: If groundwater or relatively impervious soils are not within 5 feet of the surface, implement porous landscape detention (PLD) or a sand filter basin (SFB) from DCM2. Alternative BMPs can be used if shown to be equally effective as PLD or SFB (see discussion below).

Box 9: Implement PLDs or SFBs with underdrains, or implement a BMP with removal rates equivalent to PLDs or SFBs, including qualifying manufactured BMPs. Qualifying manufactured BMPs are those that have undergone independent tests to verify that the installation, flow volumes, and removal rates will work for the site under consideration.

Box 10: If the site disturbance is larger than one acre and is low density residential, then no WQCV may be required provided the site meets criteria presented in Section I.7.1. If WQCV is not required, the need for a permanent sediment control measure must still be evaluated. If the site is located near and will discharge to a sensitive water, then a "jump" to Box 4 is required for continued evaluation.

Box 11: Sediment is best controlled at the source. That is, rather than using structures to collect soil after it is suspended in stormwater, it is preferable to stabilize soil to prevent suspension from occurring. Sediment source controls must be implemented for all low-density developments and include (but are not limited to):

- Adequately established vegetation per DCM1 criteria,
- Side slopes that are 3 horizontal to 1 vertical or flatter or the use of benched side slopes when slopes are steeper than 3 horizontal to 1 vertical,
- The use of erosion control blankets to aid establishment of vegetation,
- Check dams,

- Slope drains.

Temporary irrigation and maintenance of vegetation until adequately established may be required.

Box 12: In low density (rural) subdivisions, a method for permanent sediment control must be provided. If a detention pond is used, the forebay is to be sized according to the criteria for Extended Detention Basins. If a detention pond/Extended Detention Pond is not required, a sediment basin as described in DCM2, page 3-32 may be used. It should be sized to collect 1,800 cubic feet per acre of disturbed area. Drainage area above a sediment basin can be reduced by use of vegetated swales, buffers, or contour berms.

Box 13: If there are no detention ponds, separate sediment control measure must be located to catch all runoff leaving the disturbed area of the site.

Box 14: In cases where a detention pond is already required for controlling the volume of runoff, a sediment basin can take the form of a forebay to this pond.

Box 15: Regional WQCV facilities may only be used if they meet the requirements of Section I.7.1.C.

Box 16: The site is required to direct all runoff through grass buffers and/or grass swales or provide a similar BMP. (Note that this is required in accordance with the CDPHE guidance manual to afford some protection to state waters in between the site and the downstream WQCV BMP.)

Box 17: Grass buffers require irrigation in almost all cases in the County; swales sometimes require irrigation.

Box 18: "Dry" alternatives may be used if they are shown to have equivalent removal rates as buffers and swales. All of the structural treatment BMPs in DCM2 (Section 4.2) have equivalent removal rates and may be used. The covering of storage/handling areas and spill containment and control are not structural treatment BMPs, and thus are not substitutes for grass buffers and swales.

Box 19: If there is no regional WQCV facility downstream with adequate capacity to provide the WQCV for the proposed site, then a WQCV control measure must be provided for the site. Examples of potentially acceptable control measures include Extended Detention Basin, Full Spectrum Detention Basin, Sand Filter Basin, Constructed Wetland Basin, or a Retention Pond. For all ponds, issues related to dam construction and potential groundwater infiltration must be considered. Retention Ponds must be considered in the context of additional issues including safety and health (e.g., drowning and mosquito/West Nile virus) and water rights. For all structures that may hold water for more than 72 hours with an exposed water surface, water storage rights must be obtained before a structure (e.g. retention pond) can be proposed for a site. See Sections 3.2.5.F and 3.3.7 of this ECM for additional information regarding water right and permanent stormwater quality control measures.

Box 20: Sites tributary to sensitive waters must meet the requirements as outlined in Table I-5, and potential high-risk sites must have specialized BMPs.

Box 21: No additional BMPs are required other than WQCV-based BMPs. Also, as always, drainageways must be stabilized and runoff should be reduced as much as possible (Boxes 1 and 2).

Box 22: When specialized BMPs are required, proceed to Box 23 on Figure I-2.

Box 23: Two situations apply, one where conditions preclude the installation of BMPS that employ infiltration, and one where they do not. (See Box 7.) If conditions preclude the installation of BMPS that employ infiltration then proceed to Box 25; otherwise proceed to Box 24.

Box 24: Where soil and groundwater conditions are not prohibitive (that is, groundwater or relatively impervious soils are not within 5 feet of the surface), implement PLD or SFB from DCM2. Alternative BMPs can be used if shown to be equally effective as PLD or SFB (see discussion below).

Box 25: Constructed wetlands (either channels or basins) are an effective BMP for sites with drainage areas greater than 10 acres.

Box 26: Provide a BMP downstream of the pond with equivalent removal rates as a wetland channel; this could be a qualifying manufactured BMP or other BMP that meets the criteria below.

Box 27: If the catchment area is greater than 10 acres, provide a constructed wetland channel (CWC) downstream of pond or provide WQCV with CWB.

E. **Projects that are Strictly Roadway Construction.** For projects that entail highway or other roadway construction, there are three basic questions for the applicant:

- Is the road urban or rural?
- That is, does the road have curb and gutter or does it utilize roadside ditches?
- For rural roads, do the ditches require "water turnouts"?
- Is the road a "hot spot" or does it discharge to sensitive waters?

For road construction projects, the applicant must determine if the roadway project is an applicable development site as defined in Section I.7.1.B. Excluded sites do not need to comply with the requirements of this Section I.7. If a roadway construction project is an applicable development site, then the owner must determine which base design standard is appropriate for the project and must design and implement water quality improvement with the project. Requirements for roadway projects included in the DCMV1 may be used provided they do not conflict with other provisions of this Section I.7.

Rural roads, i.e. those roads which utilize roadside ditches for conveyance of runoff from the roadway, do not have sufficient capacity in the roadside ditches to convey much more runoff than that which runs off the road itself. Rural roads (which by definition have roadside ditches) must be stabilized with one of three methods included in DCM2 on pages 4-3 and 4-4. These methods are described in DCMV1. "Water turnouts," which function as spillways which direct flow out of the ditches onto property adjacent to the ROW, are frequently required as a result. Design for the "water turnout" should ensure the turnout discharges into a "suitable outfall" as described in DCM1 along the roadway such as a natural swale. A drainage easement for this runoff must be acquired at these locations. A possible consequence of "water turnouts" is the loading of sediment onto private property. If "water turnouts" will be utilized for the ditches, sediment basins shall be used at these locations. However, there must be sufficient space in the ROW for both the structure itself and for maintenance access, or a specific drainage easement must be provided for the feature and access. Sediment basins can be designed in accordance with the guidelines in DCM2 in the section for construction BMPs. The basin shall be sized to collect 1,800 cubic feet of sediment per acre of drainage area of the roadway.

The term "high risk site" can be defined by traffic volume for a section of roadway. If the road will experience traffic volume of 30,000 average daily traffic (ADT) or more it is likely to contribute high levels of pollutants. For these situations, additional BMPs are required and selection must follow Boxes 6, 7, 8, and 9 in Figure 1b. Additional BMPs may also be required for discharge to sensitive waters. As described above for the general developments (with building pads), these additional requirements will depend on the TMDL process.

F. **Additional Guidelines for BMP Selection.** Additional Guidelines for selecting among the appropriate BMPs dete from Figure I-1 and Figure I-2. Figure I-3 (Figure ND-7 in DCM2) depicts a decision tree for selecting one of the si BMPs based on drainage catchment area and whether water is available to satisfy evapotranspiration requirem Porous pavement and porous landscape detention are generally suited for small drainage areas (i.e. much less t acres); however, larger subwatersheds can be subdivided into individual drainage sub-catchment areas meeting criteria shown in Figure I-3 for these BMPs.

WQCV control measures and Regional WQCV control measures shall be located prior to the stormwater runoff being discharged to State Waters. When using a Regional WQCV facility for a site, the site may discharge to a water of the state before being discharged to the Regional WQCV facility; however, the conditions in Section I.7.1.C.5 shall be met.

Figure I-4 (Figure ND-8 in DCM2) provides an illustration of selection and location options for WQCV facilities based on the principles discussed above.

Figure I-6 (Table ND-1 in DCM2) indicates the BMP options for the four watershed areas shown in Figure I-4.

I.7.3. Incorporating WQCV into Stormwater Detention Structures

Wherever possible, it is recommended that WQCV facilities be incorporated into stormwater quantity detention facilities. This is relatively straightforward for an extended detention basin, constructed wetland basin, and a retention pond. When combined, the 2, 5, 10, and 100-year detention levels are provided above the WQCV and the outlet structure is designed to control two or three different releases. Stormwater quantity detention could be provided above the WQCV for porous pavement and landscape detention provided the drain times for the larger events are kept short.

The following approaches are to be implemented when incorporating WQCV into stormwater quantity detention facilities:

1. **Water Quality.** The full WQCV is to be provided according to the design procedures documented in the New Development BMP Factsheets.
2. **Minor Storm.** The full WQCV plus the full minor storm quantity detention volume is to be provided.
3. **100-Year Storm.** One-half the WQCV plus the full 100-year detention volume is to be provided.

For linear projects and projects with limited space available for permanent water quality control measures, WQCV may be included in the design of underground detention structures such as sand filter basins (SFB) and proprietary underground detention structures. These systems rely on appropriate soil conditions to infiltrate or evapotranspire the WQCV.

It is extremely important that high sediment loading and compaction of underlying soils in the area to be used for infiltration be controlled to the maximum extent practicable. These structures are best suited to being brought on line at the end of the construction phase where disturbed ground has been stabilized with pavement or vegetation.

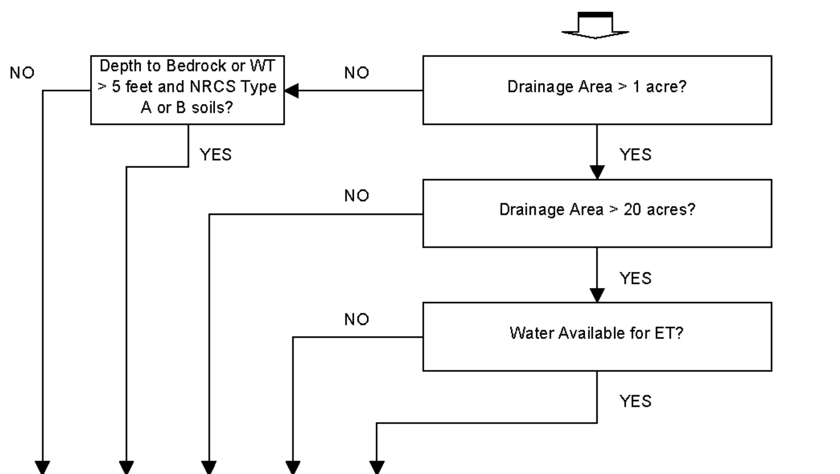
Any underground detention facilities proposed for use in the County must meet the good engineering, hydrologic and pollution control practices as defined in this Section I.7. The design of underground detention that incorporates WQCV shall not commence until a Request for Deviation is submitted for review and approved by the ECM Administrator. In addition to the approval criteria for a deviation request provide in Chapters 1 and 5 of this ECM, the owner or authorized agent must provide a structure-specific Operation and Maintenance (O&M)

Manual and maintenance agreement for the structures. The Operation and Maintenance Manual shall include specific procedures and equipment that will be used by the owner or authorized representative to operate and maintain the structures. A specification sheet or generic O&M manual provided by the vendor will not satisfy the O&M Manual requirement.

I.7.4. Separate Presedimentation Facilities

The design criteria shown in the New Development BMP Factsheets section shows presedimentation forebays at the upstream end of the extended detention basin, constructed wetland basin, and retention pond. The purpose of the forebay is to settle out coarse sediment and skim off floatables prior to the main body of the facility. An option to this approach is to install a separate facility upstream from the main WQCV facility. If this option is selected, the recommended size is at least 20 percent of the WQCV and the recommended drain time is 1 hour for the presedimentation forebay volume only. Using this approach, any requirement for sediment storage in the main facility may be reduced consistent with the storage capacity of the separated presedimentation forebay, and the forebay within the main facility may be eliminated.

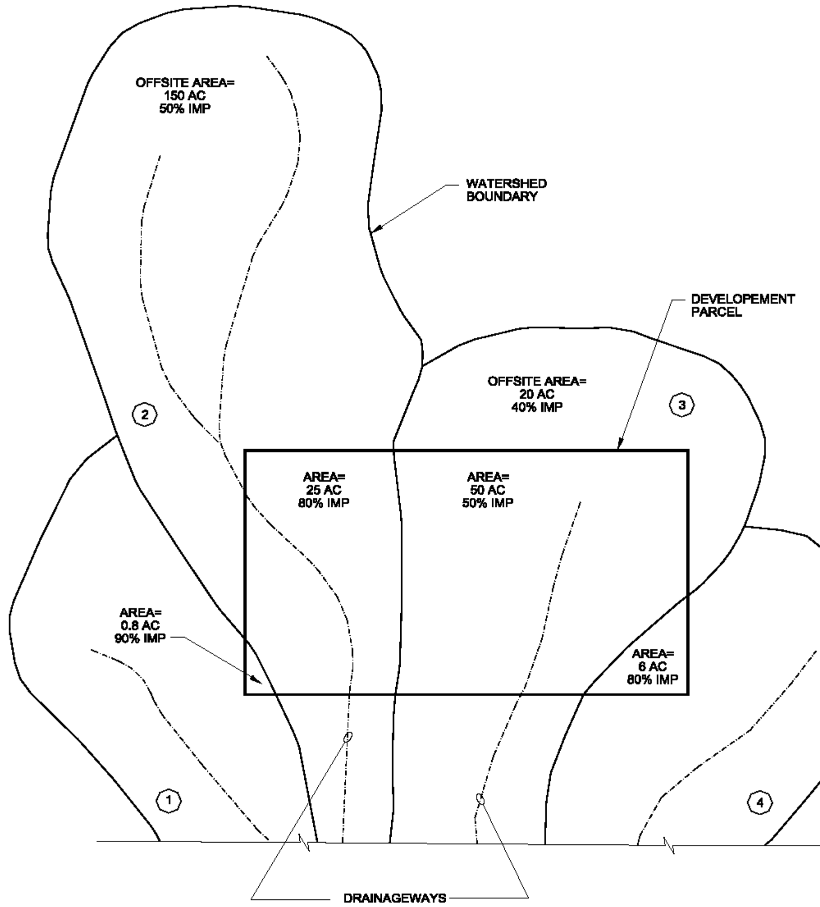
Figure I-3. Decision Tree for WQCV BMP Selection



					Suitable WQCV BMP
o					Porous Pavement Detention (PPD) with Underdrain
	o				Porous Pavement Detention (PPD) with Infiltration
o					Porous Landscape Detention (PLD) with Underdrain
	o				Porous Landscape Detention (PLD) with Infiltration
		o	o	o	Extended Detention Basin (EDB)
		o			Sand Filter Extended Detention Basin (SFB)
				o	Construction Wetland Basin (CWB)
				o	Retention Pond (RP)

Note: Large drainage areas may be subdivided into areas < 20 acres for use of SFB or < 1 acre for use of PPD or PLD.

Figure I-4. Illustration of Selection and Location Options for WQCV Facilities



Note: For this example, sufficient make-up water exists for constructed wetlands and retention pond for the watershed areas > 50 acres through irrigation return flows.

Table I-7. Illustration of Selection and Location Options for WQCV Facilities for the Development Parcel on Figure I.4

Watershed Number	Onstream or Offstream	BMP Options	Minimum Number of BMP Installations	Average Drainage Area for Sizing each BMP, acre
1	Offstream	Porous Pavement Detention Porous Landscape Detention	1 1	0.8 0.8
2	Offstream	Porous Pavement Detention Porous Landscape Detention Extended Detention Basin Sand Filter Extended Detention Basin	24 24 2 2	1 1 12 12

3	Offstream	Porous Pavement Detention Porous Landscape Detention Extended Detention Basin Sand Filter Extended Detention Basin	49 49 2 3	1 1 24 16
	Onstream	Extended Detention Basin Constructed Wetland Basin Retention Pond	1 1 1	70 70 70
4	Offstream	Porous Pavement Detention Porous Landscape Detention Extended Detention Basin Sand Filter Extended Detention Basin	6 6 1 1	1 1 6 6

I.7.5. Structural BMP Effectiveness

Table I-7 (Table ND-2 in DCM2) indicates ranges of removal efficiencies reported in literature for a number of structural BMPs. Although combinations of nonstructural/structural BMPs can improve the overall water quality of the runoff, the effectiveness of several BMPs in their ability to reduce influent pollutant concentrations as a group are not directly additive. Table I-7 also shows a most probable range of removal efficiencies for structural BMPs.

I.7.6. Separation Distances

To reduce potential for surface and ground water contamination, permanent water quality BMPs will be located away from wells and Individual Sewage Disposal Systems (ISDS). Rules for separation distances and grouting depths for wells and BMPs will be based on distances between wells and "sources of contamination" in Colorado's Rules and Regulations for Water Well Construction, Pump Installation, and Monitoring and Observation Hole/Well Construction. Permanent BMPs and ISDS will be separated by the same distances specified between the components of the ISDS and "waterways" in the El Paso County ISDS regulations. Additional separation distance may be required when a permanent stormwater quality control measure is located near a water of the state and relies on a vegetated buffer strip as part of the strategy to address WQCV prior to discharge to waters of the state.

Table I-8. BMP Pollutant Removal Ranges for Stormwater Runoff and Most Probable Range for BMPs

Type of BMP	(1)	TSS	TP	TN	TZ	TPb	BOD	Bacteria

Grass Buffer	LRR: EPR	10-50 10-20	0-30 0-10	0-10 0-10	0-10 0-10	N/A N/A	N/A N/A	N/A N/A
Grass Swale	LRR: EPR	20-60 20-40	0-40 0-15	0-30 0-15	0-40 0-20	N/A N/A	N/A N/A	N/A N/A
Modular Block Porous Pavement	LRR: EPR	80-95 70-90	65 40-55	75-85 10-20	98 40-80	80 60-70	80 N/A	N/A N/A
Porous Pavement Detention	LRR: EPR	8-96 70-90	5-92 40-55	-130-85 10-20	10-98 40-80	60-80 60-70	60-80 N/A	N/A N/A
Porous Landscape Detention	LRR: EPR	8-96 70-90	5-92 40-55	-100-85 20-55	10-98 50-80	60-90 60-80	60-80 N/A	N/A N/A
Extended Detention Basin	LRR: EPR	50-70 55-75	10-20 45-55	10-20 10-20	30-60 30-60	75-90 55-80	N/A N/A	50-90 N/A
Constructed Wetland Basin	LRR: EPR	40-94 50-60	-4-90 40-80	21 20-50	-29-82 30-80	27-94 40-80	18 N/A	N/A N/A
Retention Pond	LRR: EPR	70-91 80-90	0-79 45-70	0-80 20-60	0-71 20-60	9-95 60-80	0-69 N/A	N/A N/A
Sand Filter Extended Detention	LRR: EPR	8-96 80-90	5-92 45-55	-129-84 35-55	10-98 50-80	60-80 60-80	60-80 60-80	N/A N/A
Constructed Wetland Channel*	LRR: EPR	20-60 30-50	0-40 20-40	0-30 10-30	0-40 20-40	N/A 20-40	N/A N/A	N/A N/A
Ref: Bell et al. (1996), Colorado (1990), Harper & Herr (1992), Lakatos & McNemer (1987), Schueler (1987), Southwest (1995), Strecker et al. (1990), USGS (1986), US EPA (1983), Veenhuis et al. (1989), Whipple and Hunter (1981), Urbonas (1997.								
(1) LRR Literature reported range, EPR—expected probable range of annual performance by DCM2 BMPs.								
N/A Insufficient data to make an assessment.								

* The EPR rates for a Constructed Wetland Channel assume the wetland surface area is equal or greater than 0.5% of the tributary total impervious area.

I.7.7. Operation and Maintenance of Best Management Practices

A. **Long-term Operation and Maintenance of Post-Construction Stormwater Management Structures.** The El Paso County Phase II MS4 Permit requires the County to ensure the long-term operation and maintenance of all post-construction stormwater management control measures constructed by an applicable development site. Part I E.4.a.vi of MS4 permit states:

"vi. Construction Inspection and Acceptance: The County must implement inspection and acceptance procedures to ensure that control measures are installed and implemented in accordance with the site plan and include the following:

(A) Confirmation that the completed control measure operates in accordance with the approved site plan.

(B) All applicable development sites must have operational permanent water quality control measures at the completion of the site. In the case where permanent water quality control measures are part of future phasing, the County must have a mechanism to ensure that all control measures will be implemented, regardless of completion of future phases or site ownership. In such cases, temporary water quality control measures must be implemented as feasible and maintained until removed or modified. All temporary water quality control measure must meet one of the design standards in Part I.E.4.a.iv.

For the purpose of this section, completion of a site or phase shall be determined by the issuance of a certificate of occupancy, use of the completed site area according to the site plan, payment marking the completion of a site control measure, the nature of the selected control measure or equivalent determination of completion as appropriate to the nature of the site."

For all structures approved by El Paso County which are not public improvements, the property owner or authorized agent shall be responsible for the operation and maintenance of all permanent stormwater quality control measures. All temporary control measures required during construction shall be removed after construction activity on the site has been completed and final stabilization of the site is achieved.

Prior to approval of a subdivision, issuance of a Certificate of Occupancy, or closure of the ESQCP for sites that did not go through the subdivision review process that have permanent post-construction stormwater quality control measures, a signed private maintenance agreement for permanent BMPs must be submitted to and recorded by the County. El Paso County uses these agreements as the primary mechanism to ensure the long-term operation and maintenance of post construction stormwater quality control measures. Agreement templates are found in Appendix G.

During construction a County Stormwater Inspector will inspect structures for conformance with approved construction plans and the SWMP. Once the structure has been accepted into the County Permanent Stormwater Quality Control Measure Inventory consistent with Chapter 5, control measures will be inspected at minimum once every five (5) years. All inspections will be conducted as described in Section I.5.

Confirmation that post-construction stormwater quality control measures operate according to approved plans occurs through the use of an inflow hydrograph routed through a basin model. This analysis and the resulting hydrograph shall be performed by the Engineer of Record for the owner or authorized agent of the applicable development site and provided with Final Drainage Report included in the development plan submitted to the County. If the ECM Administrator determines that significant changes to the approved plans are identified in the "as-built" drawings provided in conformance with Section 5.10.6, an additional inflow hydrograph based on the "as-built" changes shall be provided to the County to confirm that the changes made during construction did not negatively alter the effective operation of the control measure.

If during an inspection of a post-construction stormwater quality control structure it is determined and documented by a County Stormwater Inspector that any owner or authorized agent failed to adequately operate and maintain a permanent stormwater quality control measures or remove the temporary control measures, an enforcement action described in Section I.6 shall be pursued.

B. **Operation and Maintenance Manual.** A detailed Operation and Maintenance Manual covering inspections, operation and maintenance of permanent BMPs will be provided to the party who holds the Private Maintenance Agreement for Permanent BMPs. The Operation and Maintenance Manual will include specifics on frequency of inspections and maintenance; standards for vegetation or structures, such as species of vegetation, mowing height, revegetation of worn or eroded areas, cleaning methods; depth of sediment requiring removal; replacement frequencies; and other relevant topics.

(Res. No. 19-245 , 7-2-19)

possible for as much of the reach as possible to the maximum prudent values for the hydraulic parameters in the 100 year event. The designer should determine the return period where these parameters would be achieved and, with the owner and local jurisdiction, determine if the associated risks are acceptable.

On the other hand, if the recommendation to avoid floodplain filling is not followed and fill is proposed, this should only happen in floodplains where the maximum prudent values for the hydraulic parameters shown in Table 8-1 are not exceeded in the 100-year event.

Type B

Table 8-1. Maximum prudent values for natural channel hydraulic parameters

Design Parameter	**Non-Cohesive Soils or Poor Vegetation**	**Cohesive Soils and Vegetation**
Maximum flow velocity (average of section)	5 ft/s	7 ft/s
Maximum Froude number	0.6	0.8
Maximum tractive force (average of section)	0.60 lb/sf	1.0 lb/sf
Maximum depth outside bankfull channel	5 ft	5 ft

Stream Restoration Principle 8: Evaluate Hydraulics of Streams over a Range of Flows

<u>Representative Design Tasks and Deliverables</u>

1. Document hydraulic analyses of the project reach following the guidance of Section 7.0.
2. Describe how hydraulic performance of the project reach compares to maximum prudent values for the hydraulic parameters shown in Table 8-1 for several return periods (including 2-, 10-, and 100-year events at a minimum). Describe any locations in the reach where these parameters are exceeded and discuss efforts made to improve hydraulics.
3. Confirm that hydraulic parameters of Table 8-1 are satisfied in for the100-year event in all locations where fill is proposed in the floodplain.

APPENDIX E: WEST KIOWA CREEK STABILITY ANALYSIS

Kimley»Horn

TECHNICAL MEMORANDUM

From: Kimley-Horn

Will Wilhelm, P.E., CFM, CPESC

To: Winsome, LLC

1864 Woodmoor Drive, Suite 100

Monument, Colorado 80132

Date: May 10, 2021

Subject: West Kiowa Creek Stability (Hydraulic and Geomorphic) Analysis – Winsome Subdivision

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Kimley-Horn and Associates, Inc. (Kimley-Horn) is submitting this detailed hydraulic and geomorphic analysis for West Kiowa Creek that flows through the Winsome Subdivision on behalf or Winsome, LLC. This study builds on a the previously approved Preliminary Drainage Report (PDR) (May 22, 2019) and CLOMR (September 30, 2019). This evaluation provides a more detailed hydraulic analysis of channel stability based on actual site conditions as well as adds a geomorphic (a.k.a. river mechanic) evaluation of West Kiowa Creek.

This evaluation takes a more comprehensive look at a way to manage this natural creek (West Kiowa Creek) and adjacent riparian wetlands that are consistent with U.S. Army Corp of Engineers (USACE) Section 404 and 401 of the Clean Water Act. Additionally, West Kiowa Creek has a regulated floodplain as mapped by the Federal Emergency Management (FEMA) Flood Insurance Rate Map (FIRM) panels(s) 08041C0310G and 08041C0350G (December 2018) and the recommendations are consistent with FEMA guidance.

This study provides a detailed evaluation of hydraulics, geomorphology (a.k.a. river mechanics) of West Kiowa Creek in relation to applicable regulations (Section 404/401 and FEMA). In addition, this study is based on the El Paso County's Engineering Criteria Manual (ECM) Drainage Criteria Manual (DCM).

WATERSHED AND STUDY REACH

The study reach is 1.25 miles of West Kiowa Creek through the Winsome Development Subdivision located in the Section 24, Township 11 South, Range 65 West of the 6th P.M of El Paso County. The study reach starts approximately 1,100 feet downstream (north) of Hodgen Road and then flows through the Site (Winsome Subdivision) to the north/northeast for approximately 1.25 miles where it flows off property.

The watershed contains multiple upstream flood control reservoirs/dams. These reservoirs help control the 100-year hydrology and the sediment budgets coming from the watershed as whole.

HYDROLOGY

The Hydrology (100-year) runoff came directly the previously approved FEMA CLOMR and are summarized below in Table 1. Refer to **Appendix A** for Figure 1 an excerpt from the approved Conditional Letter of Map Revision (CLOMR) dated September 30, 2019 and completed by The Vertex Companies, Inc.

Table 1 – Peak Flows West Kiowa Creek

Return Period	Reach Station	Peak Flow (cfs)
100-year	1515	2,311
100-year	7234	2,062

Full spectrum detention is proposed for this low-density (2.5 to 5+ acres lots) subdivision. Therefore, there is no expected significant changes to the above peak flows or sediment budgets post development.

HYDRAULIC ANALYSIS

The hydraulic analysis is based on El Paso County's Drainage Criteria Manual (DCM). Per Section 2.2.1 of the DCM "A stable channel reaches "equilibrium" over many years. Therefore, channel modifications should be minimal. The hydraulic properties of natural channel are general irregular. A comprehensive study of flow in natural channels requires consideration of sediment transport and river morphology." This report is that analysis.

Using table 10-1 (Composite Roughness Coefficients for Unlined Channels) from the DCM a more detailed evaluation of Manning's N was determined. Table 2 summarized the inputs to that composite Curve numbers per the DCM.

Table 2 Composite Roughness Main Channel (Per Table 10-1 in El Paso Co DCM).

Coefficient	Represents	Condition	Value
n0	Material Type	Course Gravel	0.028
n1	Degree of Irregularity	Minor	0.000
n2	Variation in Channel Cross-Section	Alternating Occasionally	0.005
n3	Effective of Obstructions	No Obstructions	0.000
n4	Vegetation	Low/Medium	0.010
m	Degree of Meandering	Minor	1.15
Manning's N	**N= (n0+n1+n2+n3+n4)m**		**0.0495**

The Manning N from Chow tables (1959) was also used for the floodplain areas and is summarized in Table 3.

Table 3 – Manning's N for Floodplain (Chow 1959)

Floodplain Vegetation	Min	Max	Site Observation
Pasture High Grass	0.030	0.050	Native Grass, more dense/rough than "pasture"
Scattered Brush, Heavy Weeds	0.035	0.070	Minimal brush (~20% of length light brush)
Chosen N value for Floodplains			**0.050**

The photos below (taken winter of 2021) are of the study reach and represent typical channel conditions to support the above calculations and decisions.

Photo 1 Meandering channel with dense native riparian/wetland vegetation in floodplain

Photo 2 Meandering channel with scattered brush and heavy weeds

Using the above Manning's n, a hydraulic model of the reach was performed using HEC-RAS version 5.0.7. The purpose of this analysis was to determine Froude number. The results of the model are summarized below in Table 4 below and against the maximum Froude number (<0.9), discussed in Section 6.5.2 in the DCM.

Photo 3 - Stable section of West Kiowa Creek

Table 4 – Results of Hydraulic (HEC-RAS) Analysis

Cross-Section[1]	100-year Froude Number
7234	0.68
6969	0.62
6763	0.76
6542	0.62
6302	0.78
6134	0.52
5812	0.44
5480	0.13
5375	0.28
5310 (culvert)	
5256	1.00
5158	0.50
4810	0.34
4701	0.29
4467	0.46
4312	0.97
4058	0.52
3756	0.68
3671	0.57
3313	0.77
3053	0.61
2916	0.59
2559	0.74
2356	0.59
2115	0.70
1826	0.65
1618	0.29
1515	0.18
1321	0.16
1224	0.29
1160 (culvert)	
1105	0.98
1007	0.63
893	0.82
678	0.40
440	0.60

1. See Figure 1 in Appendix A for Cross Section Locations

GEOMORPHIC (RIVER MECHANICS) EVALUATION

West Kiowa Creek through the site is a moderately sinuous channel located in a moderately confined valley (See Photo 3). The channel has access to an active flood-prone area (i.e. geomorphic floodplain) as evident by adjacent wetlands and dense riparian/wetland vegetation (See Photos). This vegetation forms densely rooted sod mats from grasses and grass like plants. The channel exhibits predominately gravel and sand bed with slopes generally 0.5-2%. There are no visible signs of channel incision or head-cuts in the main stem of Kiowa Creek. The channel has good depth variability (i.e. pools and riffles) with riffles generally occurring in tangent sections and deeper pools in the outer bend of the radius. Coarser large gravel and cobble can be found in the riffles.

This type of morphological channel is hydraulically efficient channel and maintains a high sediment transport capacity. The narrow and relatively deep base flow channel maintains a high resistance to plan form adjustment, which results in channel stability without significant downcutting. This channel type is very stable unless the stream banks are disturbed (not planned), and significant changes in sediment supply and/or streamflow occurs. With the upstream flood control structures (upstream of Hodges road), the planned low density/large lot development combined with full-spectrum detention, no major change to sediment supply or hydrology are anticipated to impact this current stability.

The only observed instability (i.e. visible erosion) in this system is outside the channel and active flood prone area. It is in on the slope transition from the wetland/flood prone area up to the terrace. These areas are outside of geomorphic floodplain but partially inside the 100-year FEMA regulated floodplain – See Photo 4 below.

There are multiple drainage channels/draws that flow into Kiowa Creek inside the property. All are small non-jurisdictional channels and are wholly contained on property. All but two (2) of these channels are hydraulically and morphologically stable. The two unstable channels tie into Kiowa Creek at River State 4312 and 3756 and flow in from the northwest side. These two channels are incised with active head-cuts moving upstream. These channels bed and banks will be stabilized per DCM. The bed and bank stabilization of this smaller non-jurisdictional channels will occur outside of Kiowa Creek stream and wetland avoiding the need for a 404 permit from the USACE. Stabilizing these channels and reducing the large amount of sediment being transported downstream to Kiowa Creek will benefit the stream and wetland functions of Kiowa Creek including stability.

Photo 4 - Erosion on valley/terrace transition (slope on right). Note: Stable channel and floodplain

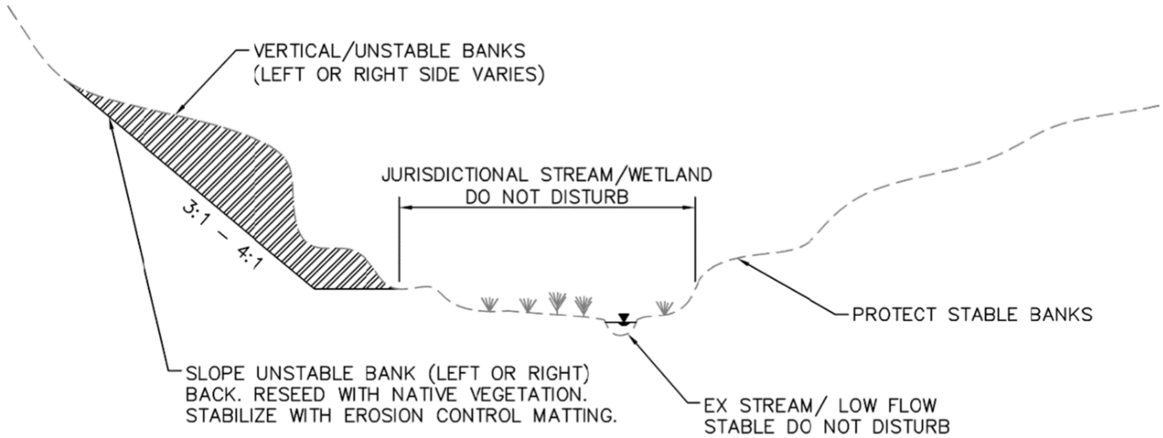
This slope erosion is likely due historic land use (cattle and vegetation management) and not from the channel's hydraulic geometry. A plan to address these areas is discussed below.

RECOMMENDATIONS

Based on the existing channel condition (See Photo 1-4) and the hydraulic and geomorphic evaluation summarized above, our professional opinion is no stabilization directly in West Kiowa Creek outside the location of the proposed box culvert is recommended. The box culvert and outlet protection will mitigate the high Froude numbers. The area shown in Table 4 where the Froude number is above 0.9 can be reduced by sloping back the valley wall terrace slope to a 3:1 to 4:1 slope, revegetated with native vegetation. Temporary erosion control (i.e. coir and straw) matting can be placed down following grading until vegetation can establish.

In addition, the two unstable non-jurisdictional channels (outside of Kiowa Creek) with active bed and bank erosion that tie river STA 4312 and 3756 (discussed above) will also be stabilized. This stabilization will be per the DCM and will likely include grading, rock, erosion control blankets, and temporary and permanent vegetation.

This stabilization identified as needed in this memo (culvert with energy dissipation, Kiowa Creek bank grading (one location), and two non-jurisdiction channels that flow into Kiowa Creek) will be detailed out in the final drainage report and submitted for County review and approval.



CHANNEL CROSS– SECTIONS
PROPOSED STABILIZATION
N.T.S

Table 5 summarizes the proposed Froude numbers after stabilization of the cross-sections from Table 4 that exceeded a maximum Froude number of 0.9.

Table 5 – Proposed Hydraulic Condition with Stabilization/Sloping

Cross-Section[1]	100-year Froude Number	Comments
5256	1.00	Proposed condition – Box culvert + energy dissipator will mitigate
4312	0.72	Right valley bank sloped to 4:1
1160	0.98	Proposed condition – Box culvert + energy dissipator will mitigate

Photo 5 - Erosion at Cross-Section 4312 (slope on right).

The above approach is preferred in that it:

- Is consistent with the USACE 404 permit to avoid and minimize impacts to jurisdictional streams and wetlands.
  - The proposed grading discussed above and shown in Table 5 is all outside jurisdiction features (i.e. wetlands or ordinary normal high water)
- Is a nature based solution that meets the following City/County Goals defined in the ECM and DCM
  - Environmental preservation and enhancement (Section 1.2.1)
  - Ideal open channel is developed by nature over time (Section 10.1)
- Has the following benefits (defined by Section 10.1 or the USACE Stream Quantification Tool (SQT).
  - Low maintenance (10.1)
  - Available channel storage decreasing downstream peaks (10.1)
  - Depth Variability (pools and riffles) (SQT)
  - Floodplain connectivity (SQT)
  - Natural subsurface infiltration of flows provided (10.1)
  - Native vegetation and wildlife not disturbed (10.1)
  - Channel can provide a desirable green belt and recreation area (10.1)

SIGNATURE:

[signature]

Will Wilhelm, P.E., CFM, CPESC
Registered Professional Engineer
State of Colorado No. 56499

APPENDIX A – FIGURE

Figure 1

CASE #: 19-08-0185R

FEMA CLOMR SUBMITTAL

MCCUNE RANCH SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

WEST KIOWA CREEK PROPOSED CONDITIONS
100-YEAR FLOOD DATA

CROSS SECTION	100-YEAR WSEL	100-YEAR TOP WIDTH INCLUDING INEFFECTIVE FLOW	100-YEAR TOP WIDTH EXCLUDING INEFFECTIVE FLOW
72+34	7338.11	63.12	63.12
69+69	7335.52	64.11	64.11
67+63	7333.63	64.92	64.92
65+42	7331.14	74.22	74.22
63+02	7328.85	76.90	76.90
61+34	7327.28	131.11	131.11
58+12	7326.51	205.39	170.72
54+80	7326.64	314.42	314.42
53+75	7326.35	278.31	62.88
53+10		CULVERT	
52+56	7321.50	110.25	66.00
51+58	7318.09	174.44	174.44
48+10	7316.81	179.90	179.90
47+01	7316.71	146.50	146.50
44+67	7315.70	114.47	114.47
43+12	7314.40	115.43	115.43
40+58	7311.05	99.53	99.53
37+56	7308.45	86.18	86.18
36+71	7307.52	96.89	96.89
33+13	7304.40	102.90	102.90
30+53	7301.03	69.79	69.79
29+16	7299.80	67.41	67.41
25+59	7297.13	118.75	118.75
23+56	7294.61	88.75	88.75
21+15	7292.45	99.93	99.93
18+26	7289.14	86.77	86.77
16+18	7289.46	300.23	300.23
15+15	7289.48	426.41	426.41
13+21	7289.45	185.54	185.54
12+24	7289.12	255.40	62.76
11+60		CULVERT	
11+05	7283.37	124.27	60.70
10+07	7282.01	114.85	114.85
8+93	7281.40	243.18	243.18
6+78	7278.48	265.58	265.58
4+40	7276.46	146.44	146.44

* SOME TOP WIDTHS HAVE BEEN ADJUSTED DUE TO ISLANDS, INEFFECTIVE FLOW, AND SECTION LOCATION RELATIVE TO CULVERT. SEE NOTES IN THE SUPPORTING HEC-RAS MODEL REGARDING THE 100-YEAR TOP WIDTH FOR THESE SECTIONS.

PROPOSED GRADING CROSS SECTIONS (CORRECT SIDE DEPICTED)

PROPOSED CULVERT MODIFICATIONS

BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88

0' 300' 600'

VERTEX®
2420 W. 26th Avenue, Suite 100-D | Denver, CO 80211
Main: 303.623.9116 | VERTEXENG.COM

COLORADO LICENSED PROFESSIONAL ENGINEER 7/8/19 43911

100Y PC FLOODPLAIN

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	REVISED PER REVIEW COMMENTS 3/26/19
2	REVISED PER REVIEW COMMENTS 4/2/19
3	REVISED PER REVIEW COMMENTS 6/5/19
4	REVISED PER REVIEW COMMENTS 7/1/19
5	
6	
7	
8	
9	
10	

DATE: 11/16/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

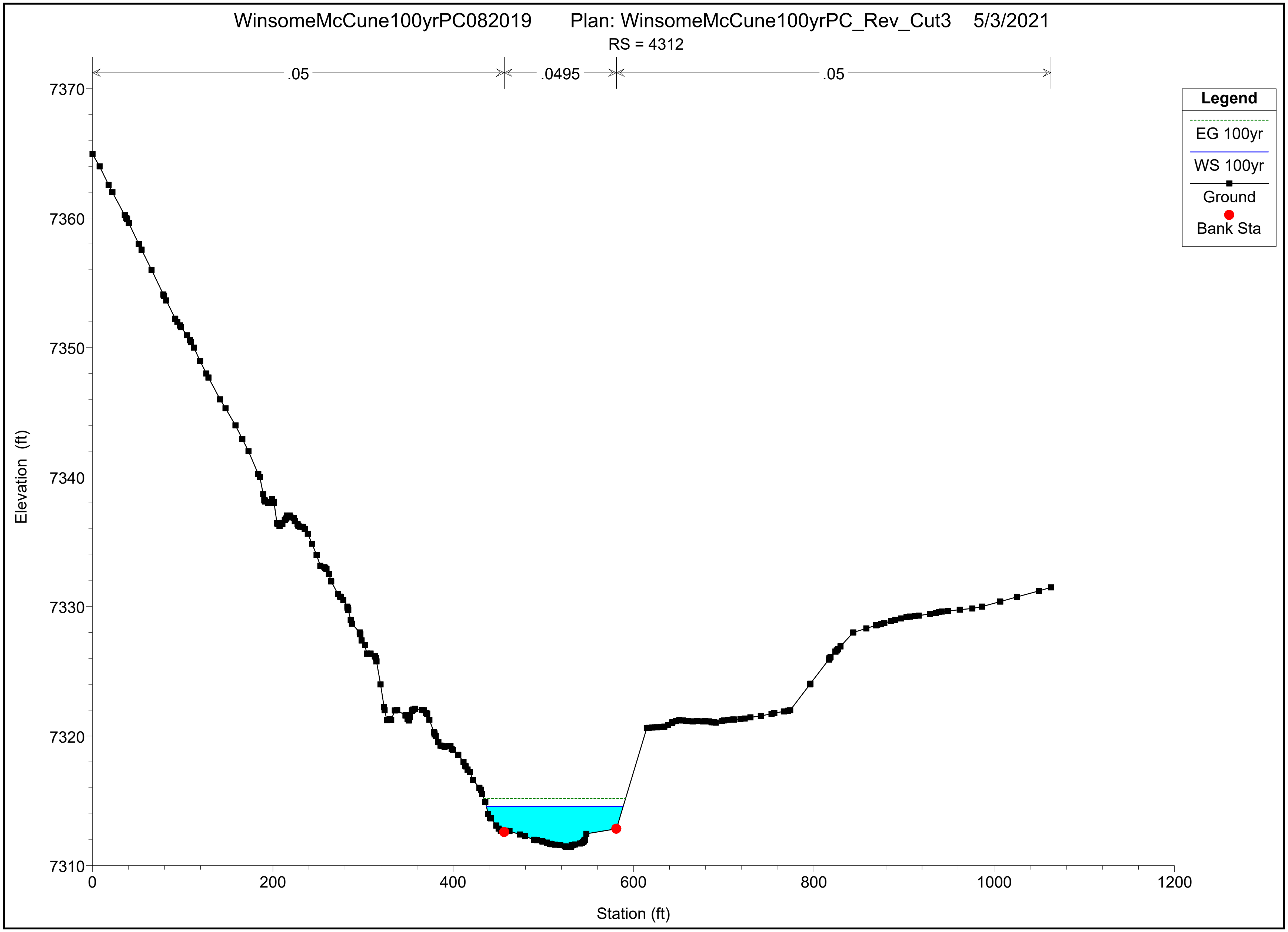
1

APPENDIX B – HYDRAULICS

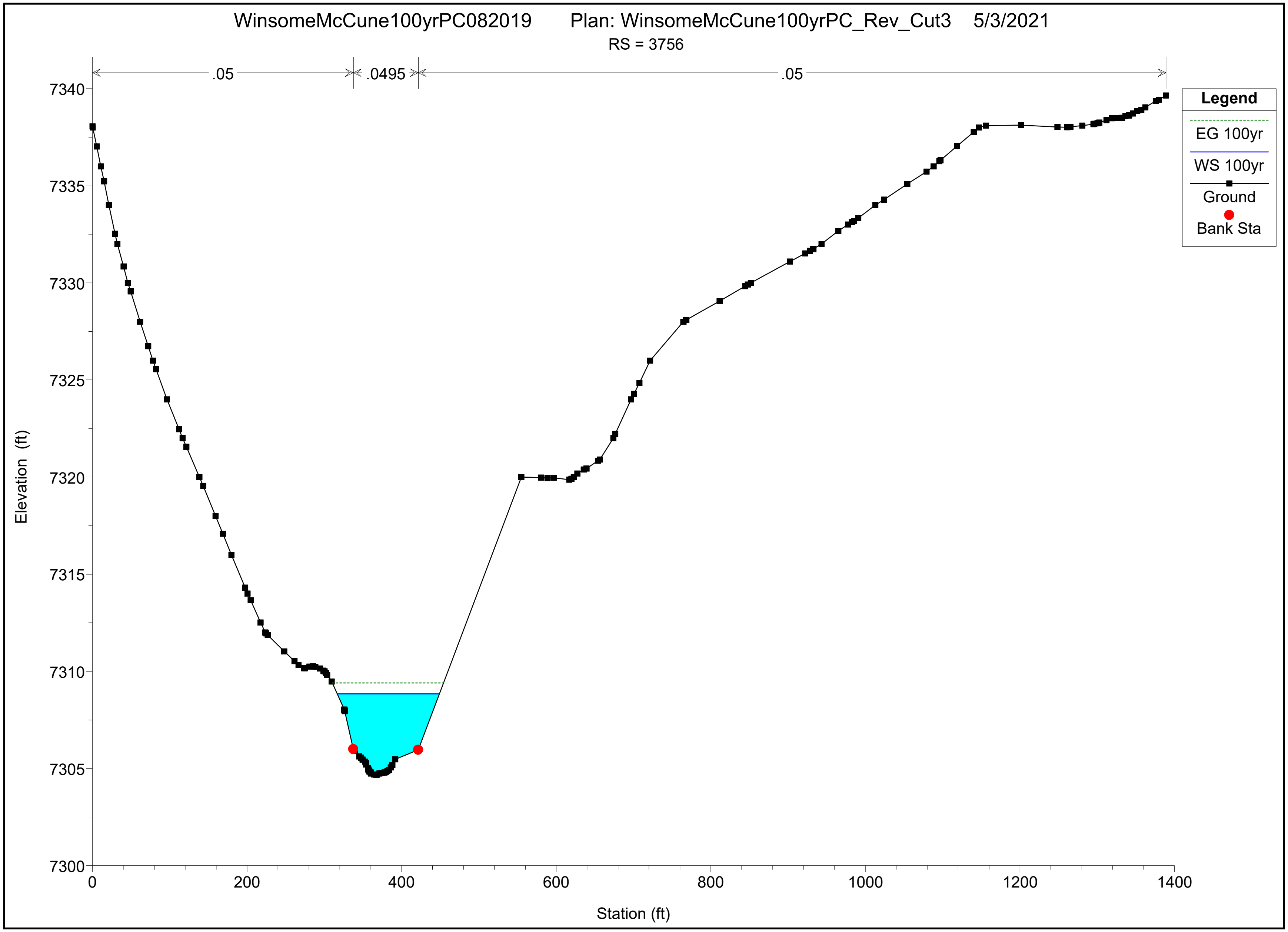
HEC-RAS Profile Output Summary Table

HEC-RAS Plan: REV_CUT3 River: Alignment - Kiow Reach: Alignment - Kiow Profile: 100yr

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - Kiow	7234	100yr	2062.00	7333.67	7337.85		7338.58	0.010862	6.94	304.11	101.09	0.67
Alignment - Kiow	6969	100yr	2062.00	7330.95	7334.91		7335.62	0.011438	6.77	306.60	105.40	0.68
Alignment - Kiow	6763	100yr	2062.00	7328.00	7332.79		7333.49	0.009383	6.70	309.93	94.10	0.63
Alignment - Kiow	6542	100yr	2062.00	7326.00	7330.80		7331.49	0.008682	6.68	315.34	94.74	0.61
Alignment - Kiow	6302	100yr	2062.00	7324.24	7329.30		7329.78	0.005590	5.68	388.17	131.72	0.50
Alignment - Kiow	6134	100yr	2062.00	7323.98	7328.31	7327.30	7328.77	0.006411	5.55	402.17	147.76	0.52
Alignment - Kiow	5812	100yr	2062.00	7321.76	7326.73	7325.40	7327.10	0.004305	5.25	473.66	233.76	0.44
Alignment - Kiow	5480	100yr	2062.00	7318.86	7326.69	7322.37	7326.73	0.000330	1.98	1348.58	350.55	0.13
Alignment - Kiow	5375	100yr	2062.00	7318.00	7326.36	7321.95	7326.65	0.001360	4.44	481.57	278.77	0.28
Alignment - Kiow	5310		Culvert									
Alignment - Kiow	5256	100yr	2062.00	7317.96	7321.50	7321.50	7323.07	0.024647	10.08	205.38	110.20	1.00
Alignment - Kiow	5158	100yr	2062.00	7316.00	7318.92		7319.25	0.006641	4.60	451.16	181.49	0.50
Alignment - Kiow	4810	100yr	2062.00	7312.97	7317.57		7317.80	0.002874	4.06	573.41	186.25	0.36
Alignment - Kiow	4701	100yr	2062.00	7312.00	7317.32		7317.52	0.002036	3.64	589.86	151.45	0.31
Alignment - Kiow	4467	100yr	2062.00	7312.00	7316.11		7316.68	0.007095	6.17	358.59	122.61	0.56
Alignment - Kiow	4312	100yr	2062.00	7311.45	7314.57		7315.18	0.013975	6.41	334.17	151.58	0.72
Alignment - Kiow	4058	100yr	2062.00	7307.52	7311.45		7312.17	0.010152	6.83	309.97	104.84	0.65
Alignment - Kiow	3756	100yr	2062.00	7304.66	7308.84		7309.41	0.008131	6.26	360.44	132.39	0.59
Alignment - Kiow	3671	100yr	2062.00	7303.99	7307.93		7308.60	0.010371	6.88	323.81	116.90	0.66
Alignment - Kiow	3313	100yr	2062.00	7300.23	7303.85	7303.26	7304.57	0.011514	6.85	313.16	119.53	0.68
Alignment - Kiow	3053	100yr	2062.00	7296.89	7301.65		7302.26	0.006890	6.32	336.25	96.59	0.55
Alignment - Kiow	2916	100yr	2062.00	7296.00	7300.55		7301.24	0.007847	6.78	317.48	95.27	0.59
Alignment - Kiow	2559	100yr	2062.00	7293.71	7297.53		7298.09	0.009867	6.11	356.85	146.78	0.63
Alignment - Kiow	2356	100yr	2062.00	7291.33	7295.37		7296.10	0.009611	6.87	306.21	93.26	0.64
Alignment - Kiow	2115	100yr	2062.00	7289.22	7292.64		7293.36	0.013601	6.80	305.10	118.32	0.73
Alignment - Kiow	1826	100yr	2062.00	7284.10	7289.97		7290.64	0.006813	6.68	332.54	100.43	0.56
Alignment - Kiow	1618	100yr	2062.00	7284.00	7289.64	7287.99	7289.77	0.001744	3.70	799.16	306.67	0.29
Alignment - Kiow	1515	100yr	2311.00	7282.00	7289.58	7286.74	7289.65	0.000648	2.73	1307.64	433.71	0.18
Alignment - Kiow	1321	100yr	2311.00	7280.72	7289.45	7284.42	7289.54	0.000489	2.57	1032.04	296.02	0.16
Alignment - Kiow	1224	100yr	2311.00	7280.00	7289.11	7284.63	7289.44	0.001421	4.88	506.76	255.26	0.29
Alignment - Kiow	1160		Culvert									
Alignment - Kiow	1105	100yr	2311.00	7279.08	7283.36	7283.36	7285.19	0.022053	10.98	216.57	124.06	0.98
Alignment - Kiow	1007	100yr	2311.00	7278.00	7282.10	7281.26	7282.72	0.009688	6.33	369.92	126.10	0.63
Alignment - Kiow	893	100yr	2311.00	7277.97	7280.44	7280.35	7281.09	0.021909	6.72	369.59	238.35	0.87
Alignment - Kiow	678	100yr	2311.00	7275.58	7278.99		7279.19	0.004343	3.59	645.76	269.50	0.40
Alignment - Kiow	440	100yr	2311.00	7273.97	7277.20	7276.42	7277.73	0.009014	5.94	406.15	154.80	0.60



WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Rev_Cut3 5/3/2021
RS = 4312
.05
.0495
.05
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Elevation (ft)
7370
7360
7350
7340
7330
7320
7310
0
200
400
600
800
1000
1200
Station (ft)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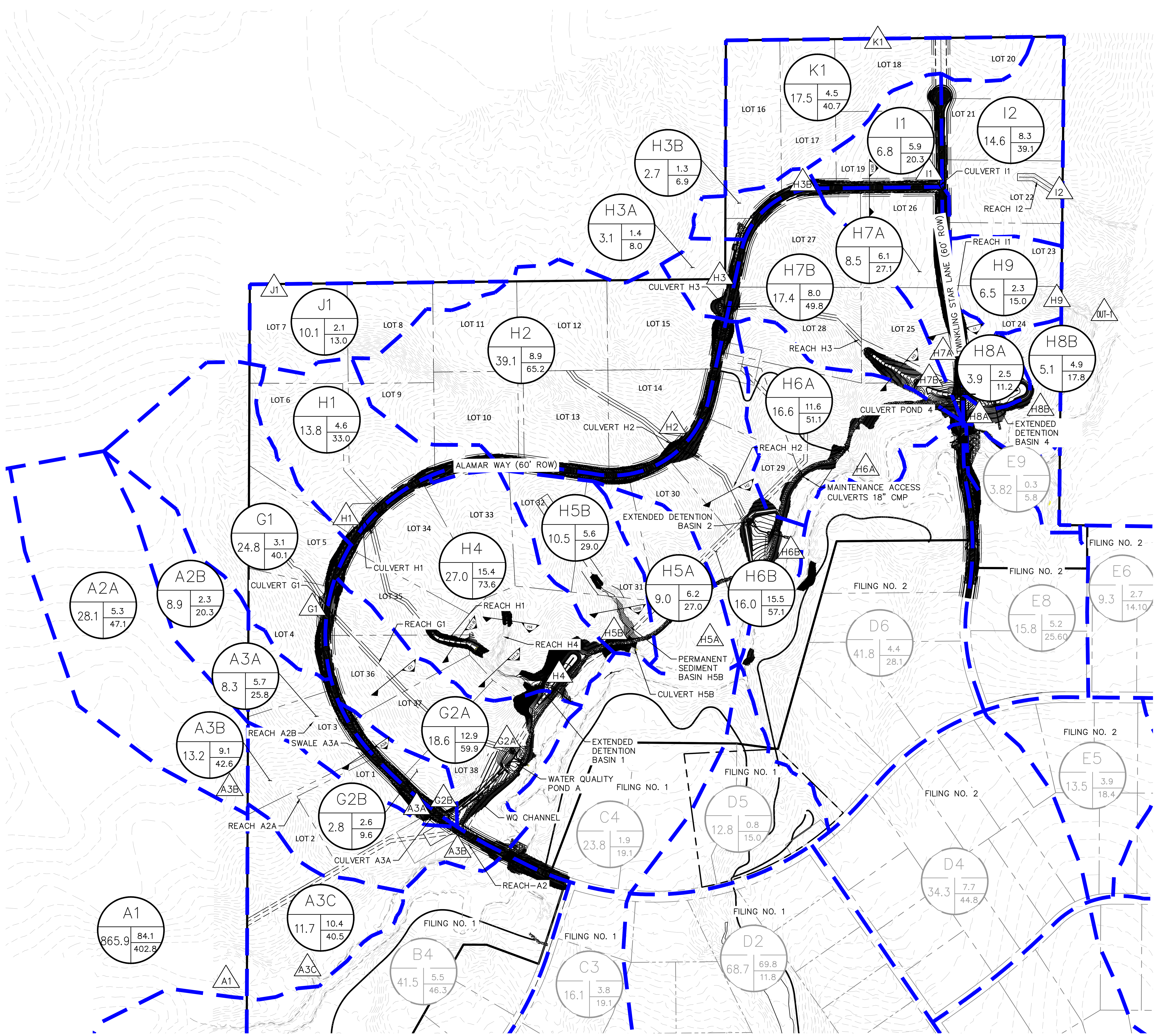
RS = 3756
.05
.0495
.05
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7340
7335
7330
7325
7320
7315
7310
7305
7300
0
200
400
600
800
1000
1200
1400

APPENDIX F: DRAINAGE MAPS

\\kimley-horn.com\mt_den1\COS_Civil\196106001_Winsome Filing No. 3\CADD\Exhibits\Drainage\Proposed_DRN_Map-Updated.dwg O'Donnell-Sloan, Theresa 2/2/2023 10:19 AM



LEGEND

DRAINAGE BASIN AREAS

FILING 3 BASINS
A – HEC-HMS BASINS
B – BASIN ACREAGE
C – 5-YR RUNOFF
D – 100-YR RUNOFF

FILING 1&2 BASINS
A – HEC-HMS BASINS
B – BASIN ACREAGE
C – 5-YR RUNOFF
D – 100-YR RUNOFF

E0 CULVERT DESIGN POINT

EXISTING CONTOURS

PROPOSED CONTOURS

FLOW ARROW

E4 CHANNEL CROSS SECTION

DEVELOPED RUNOFF

Design Point	Basin	Direct Runoff (CFS)		Routed Flowrates (CFS)	
		Q5	*Q100*	*Q5*	*Q100*
A2A	A2A	5.3	47.1		
A3B	A2A+A3B	9.1	42.6		
A2B	A2B	2.3	20.3		
A3A	A3A+A2B	5.7	25.6	8.0	45.9
G2B	G2B	2.6	9.6		
G1	G1	3.1	40.1		
G2A	G2A+G1	12.9	59.9	16.0	100
WQ Pond	DP_G2B+DP_G2A+DP_A3A			24.0	145.9
H1	H1	4.6	33		
H4	H1+H4	15.4	73.6	20.0	106.6
Pond 1				20.0	106.6
H5B	H5B	5.6	29		
H5A	H5A	6.2	27		
H2	H2	8.9	65.7		
H6B	H6B+H2	15.5	57.1	24.4	122.8
Pond 2				24.4	122.8
H6A	H6A	11.6	51.1		
H3A	H3A	1.4	8.0		
H7B	H3A+H7B	8.0	49.8	9.4	57.8
H3B	H3B	1.3	6.9		
I1	I1+H3B	5.9	20.3	7.2	27.2
H7A	H7A	6.1	27.1		
H8A	H8A	2.5	11.2		
Pond 4	DP_H7A+DP_H7B+DP_I1+DP_H8A			22.5	108.4
I2	I2	8.3	39.1	8.3	39.1
H9	H9	2.3	15.0	2.3	15.0
OUT-1				420	1959
Reach 6-Kiowa				420	1960

NORTH

GRAPHIC SCALE IN FEET
0 150 300 600

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CHECKED BY: KRK
DATE: 9/3/2021

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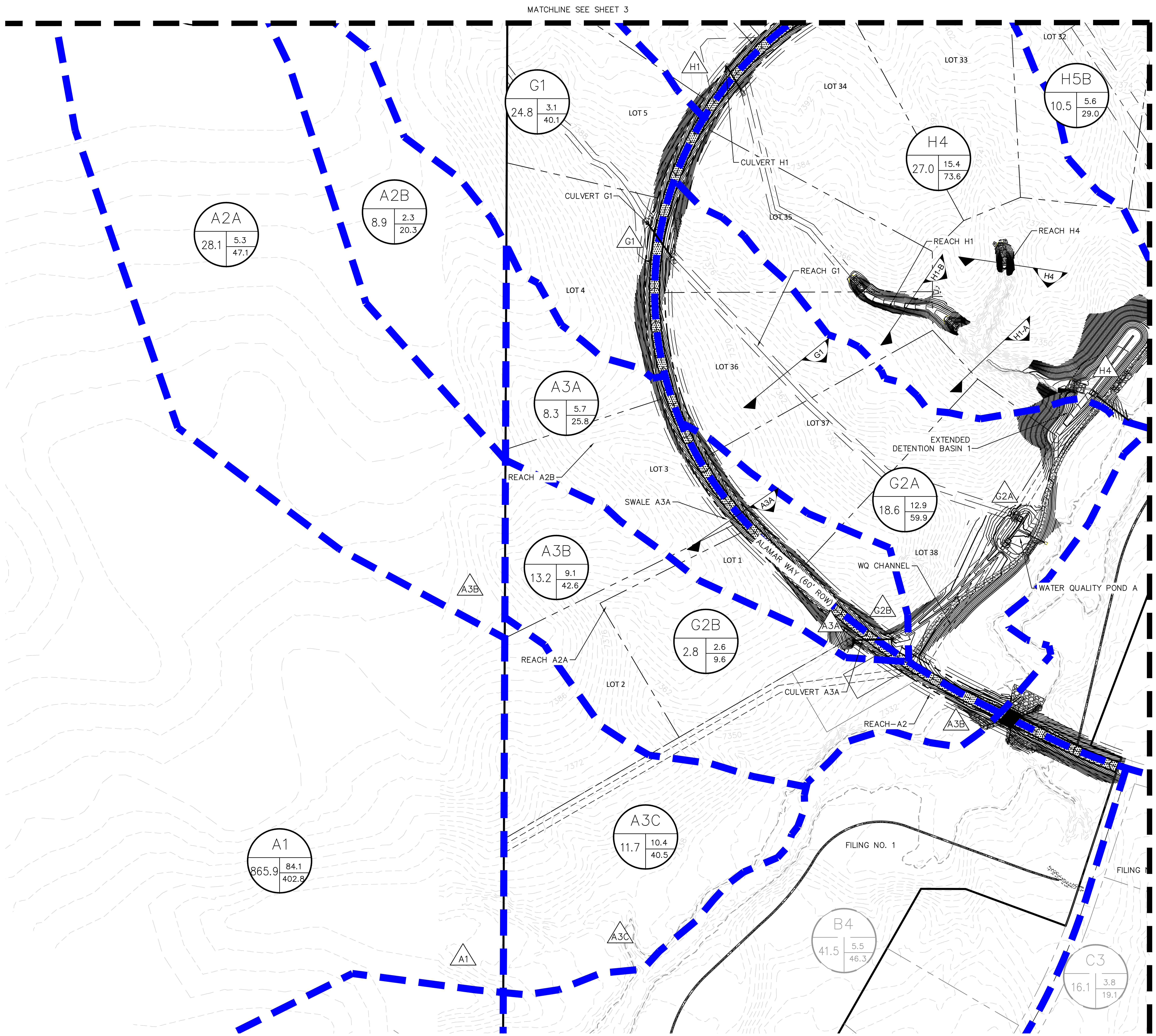
SHEET
1



LEGEND

DRAINAGE BASIN AREAS

FILING 3 BASINS
A – HEC–HMS BASINS
B – BASIN ACREAGE
C – 5–YR RUNOFF
D – 100–YR RUNOFF

FILING 1&2 BASINS
A – HEC–HMS BASINS
B – BASIN ACREAGE
C – 5–YR RUNOFF
D – 100–YR RUNOFF

CULVERT DESIGN POINT

EXISTING CONTOURS

PROPOSED CONTOURS

FLOW ARROW

CHANNEL CROSS SECTION

DEVELOPED RUNOFF

Design Point	Basin	Direct Runoff (CFS) Q5	Direct Runoff (CFS) Q100	Routed Flowrates (CFS) Q5	Routed Flowrates (CFS) Q100
A2A	A2A	5.3	47.1		
A3B	A2A+A3B	9.1	42.6		
A2B	A2B	2.3	20.3		
A3A	A3A+A2B	5.7	25.6	8.0	45.9
G2B	G2B	2.6	9.6		
G1	G1	3.1	40.1		
G2A	G2A+G1	12.9	59.9	16.0	100
WQ Pond	DP_G2B+DP_G2A+DP_A3A			24.0	145.9
H1	H1	4.6	33		
H4	H1+H4	15.4	73.6	20.0	106.6
Pond 1				20.0	106.6
H5B	H5B	5.6	29		
H5A	H5A	6.2	27		
H2	H2	8.9	65.7		
H6B	H6B+H2	15.5	57.1	24.4	122.8
Pond 2				24.4	122.8
H6A	H6A	11.6	51.1		
H3A	H3A	1.4	8.0		
H7B	H3A+H7B	8.0	49.8	9.4	57.8
H3B	H3B	1.3	6.9		
I1	I1+H3B	5.9	20.3	7.2	27.2
H7A	H7A	6.1	27.1		
H8A	H8A	2.5	11.2		
Pond 4	DP_H7A+DP_H7B+DP_I1+DP_H8A			22.5	108.4
I2	I2	8.3	39.1	8.3	39.1
H9	H9	2.3	15.0	2.3	15.0
OUT-1				420	1959
Reach 6-Kiowa				420	1960

NORTH

GRAPHIC SCALE IN FEET
0 75 150 300

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SHEET
2

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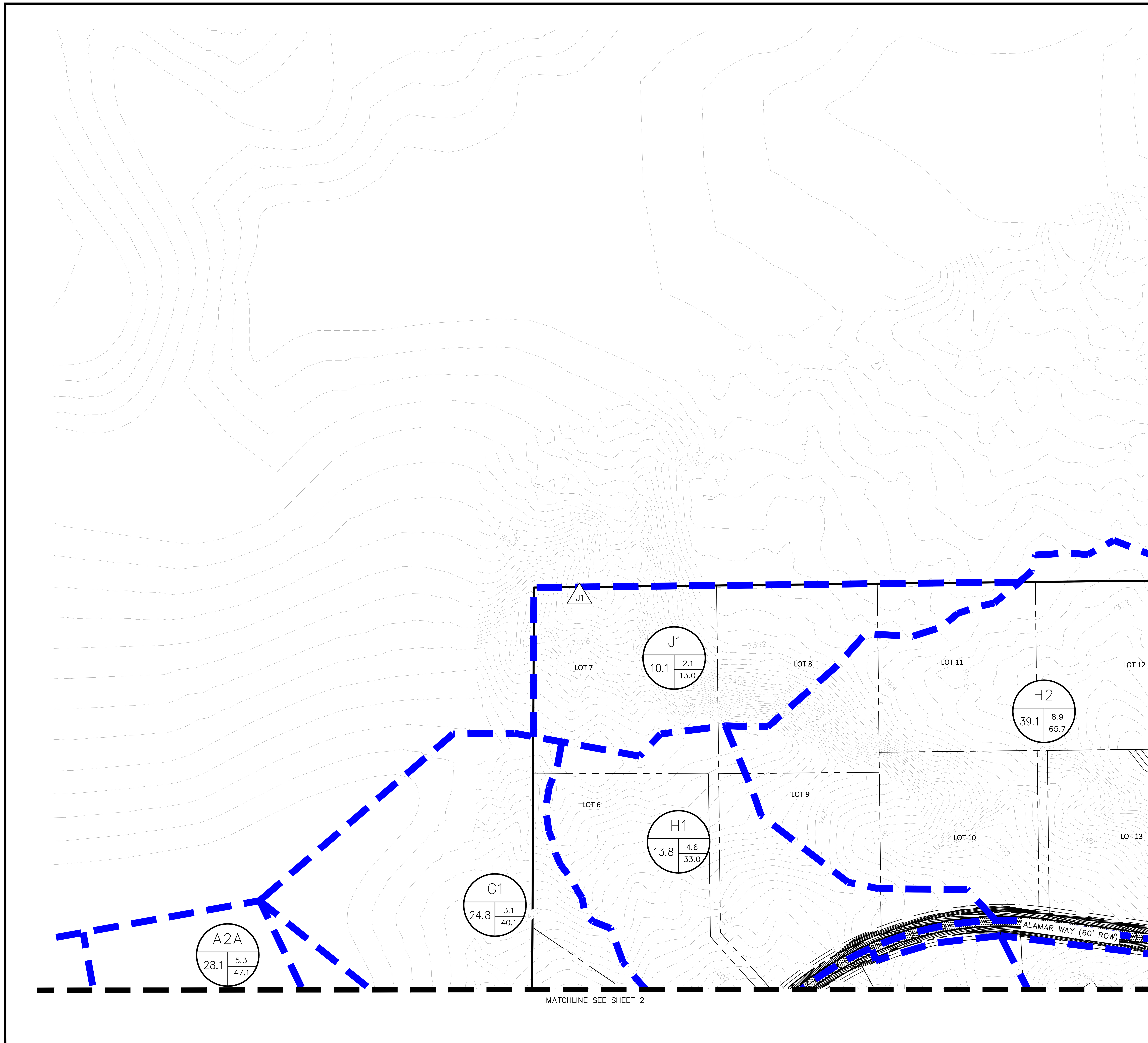

LEGEND

DRAINAGE BASIN AREAS

FILING 3 BASINS
A – HEC–HMS BASINS
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C – 5–YR RUNOFF
D – 100–YR RUNOFF

FILING 1&2 BASINS
A – HEC–HMS BASINS
B – BASIN ACREAGE
C – 5–YR RUNOFF
D – 100–YR RUNOFF

E0 CULVERT DESIGN POINT

EXISTING CONTOURS

PROPOSED CONTOURS

FLOW ARROW

E4 CHANNEL CROSS SECTION

DEVELOPED RUNOFF

Design Point	Basin	Direct Runoff (CFS)		Routed Flowrates (CFS)	
		Q5	*Q100*	*Q5*	*Q100*
A2A	A2A	5.3	47.1		
A3B	A2A+A3B	9.1	42.6		
A2B	A2B	2.3	20.3		
A3A	A3A+A2B	5.7	25.6	8.0	45.9
G2B	G2B	2.6	9.6		
G1	G1	3.1	40.1		
G2A	G2A+G1	12.9	59.9	16.0	100
WQ Pond	DP_G2B+DP_G2A+DP_A3A			24.0	145.9
H1	H1	4.6	33		
H4	H1+H4	15.4	73.6	20.0	106.6
Pond 1				20.0	106.6
H5B	H5B	5.6	29		
H5A	H5A	6.2	27		
H2	H2	8.9	65.7		
H6B	H6B+H2	15.5	57.1	24.4	122.8
Pond 2				24.4	122.8
H6A	H6A	11.6	51.1		
H3A	H3A	1.4	8.0		
H7B	H3A+H7B	8.0	49.8	9.4	57.8
H3B	H3B	1.3	6.9		
I1	I1+H3B	5.9	20.3	7.2	27.2
H7A	H7A	6.1	27.1		
H8A	H8A	2.5	11.2		
Pond 4	DP_H7A+DP_H7B+DP_I1+DP_H8A			22.5	108.4
I2	I2	8.3	39.1	8.3	39.1
H9	H9	2.3	15.0	2.3	15.0
OUT-1				420	1959
Reach 6-Kiowa				420	1960

NORTH

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0 75 150 300

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196106001

SHEET
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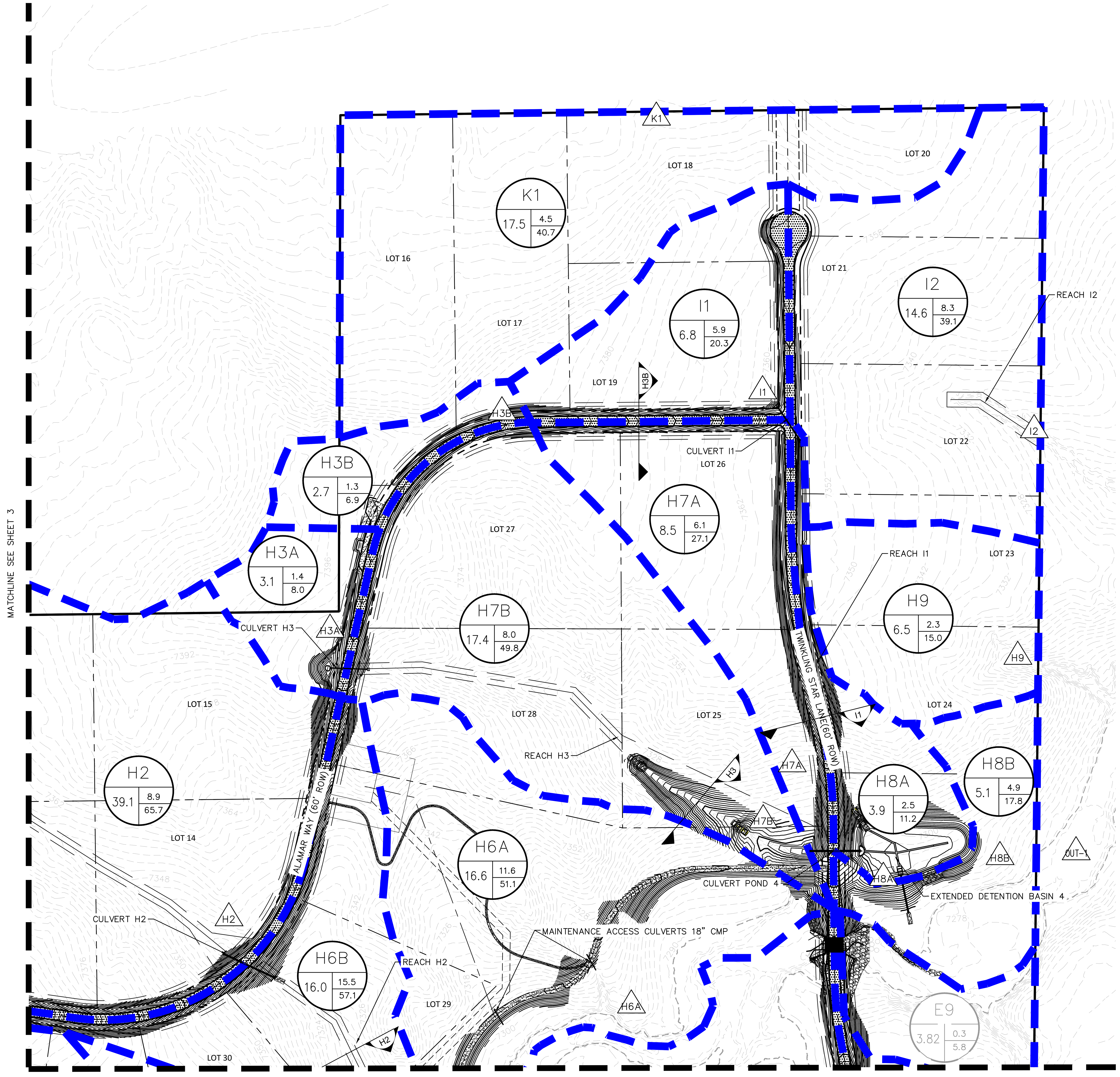

LEGEND

DRAINAGE BASIN AREAS

FILING 3 BASINS
A – HEC–HMS BASINS
B – BASIN ACREAGE
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D – 100–YR RUNOFF

FILING 1&2 BASINS
A – HEC–HMS BASINS
B – BASIN ACREAGE
C – 5–YR RUNOFF
D – 100–YR RUNOFF

E0 CULVERT DESIGN POINT

EXISTING CONTOURS

PROPOSED CONTOURS

FLOW ARROW

E4 CHANNEL CROSS SECTION

DEVELOPED RUNOFF					
Design Point	Basin	Direct Runoff (CFS)		Routed Flowrates (CFS)	
		Q5	Q100	Q5	Q100
A2A	A2A	5.3	47.1		
A3B	A2A+A3B	9.1	42.6		
A2B	A2B	2.3	20.3		
A3A	A3A+A2B	5.7	25.6	8.0	45.9
G2B	G2B	2.6	9.6		
G1	G1	3.1	40.1		
G2A	G2A+G1	12.9	59.9	16.0	100
WQ Pond	DP_G2B+DP_G2A+DP_A3A			24.0	145.9
H1	H1	4.6	33		
H4	H1+H4	15.4	73.6	20.0	106.6
Pond 1				20.0	106.6
H5B	H5B	5.6	29		
H5A	H5A	6.2	27		
H2	H2	8.9	65.7		
H6B	H6B+H2	15.5	57.1	24.4	122.8
Pond 2				24.4	122.8
H6A	H6A	11.6	51.1		
H3A	H3A	1.4	8.0		
H7B	H3A+H7B	8.0	49.8	9.4	57.8
H3B	H3B	1.3	6.9		
I1	I1+H3B	5.9	20.3	7.2	27.2
H7A	H7A	6.1	27.1		
H8A	H8A	2.5	11.2		
Pond 4	DP_H7A+DP_H7B+DP_I1+DP_H8A			22.5	108.4
I2	I2	8.3	39.1	8.3	39.1
H9	H9	2.3	15.0	2.3	15.0
OUT-1				420	1959
Reach 6-Kiowa				420	1960

NORTH

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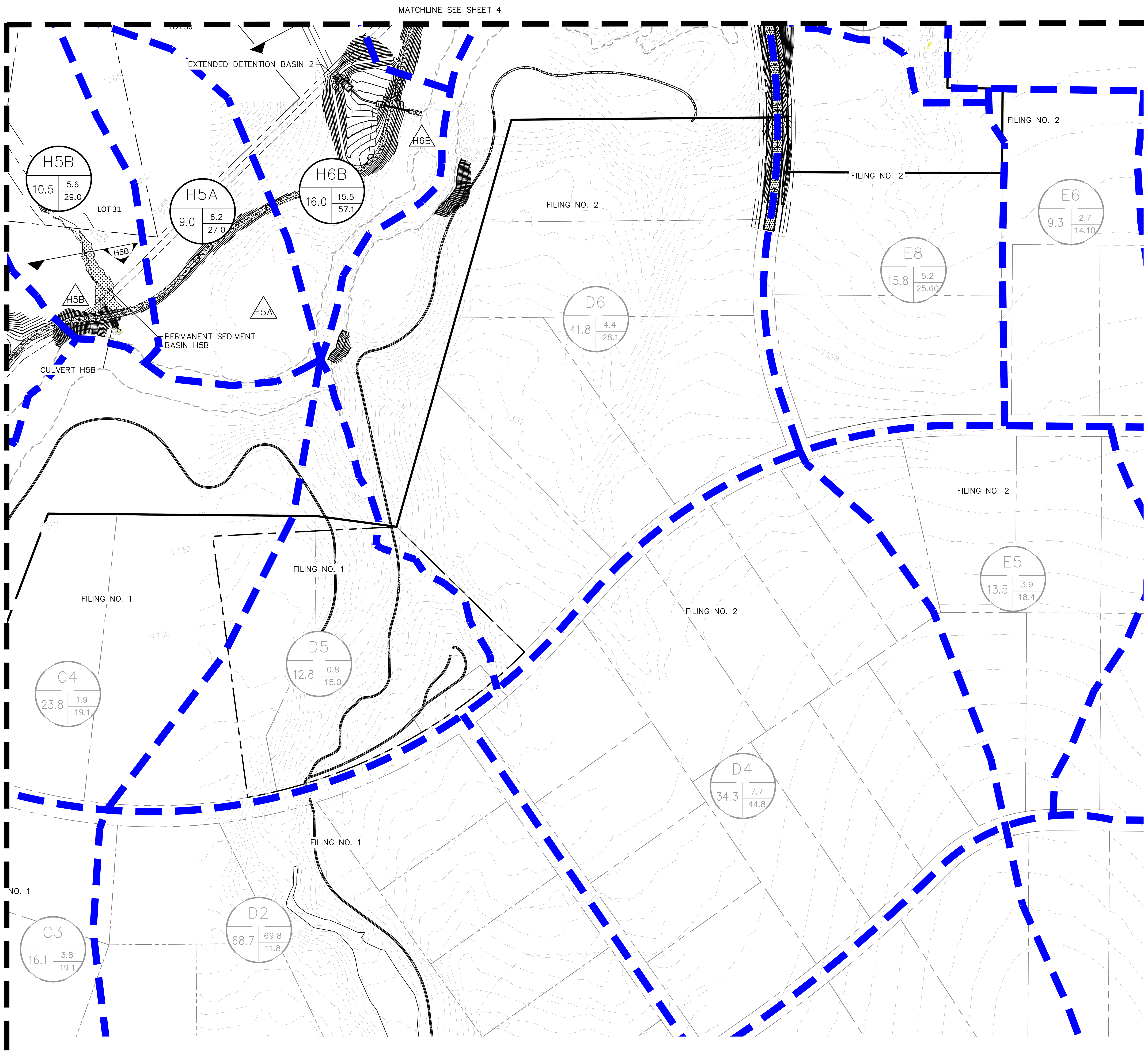

LEGEND

DRAINAGE BASIN AREAS

FILING 3 BASINS
A – HEC–HMS BASINS
B – BASIN ACREAGE
C – 5–YR RUNOFF
D – 100–YR RUNOFF

FILING 1&2 BASINS
A – HEC–HMS BASINS
B – BASIN ACREAGE
C – 5–YR RUNOFF
D – 100–YR RUNOFF

E0 CULVERT DESIGN POINT

EXISTING CONTOURS

PROPOSED CONTOURS

FLOW ARROW

E4 CHANNEL CROSS SECTION

DEVELOPED RUNOFF

Design Point	Basin	Direct Runoff (CFS)		Routed Flowrates (CFS)	
		Q5	Q100	Q5	Q100
A2A	A2A	5.3	47.1		
A3B	A2A+A3B	9.1	42.6		
A2B	A2B	2.3	20.3		
A3A	A3A+A2B	5.7	25.6	8.0	45.9
G2B	G2B	2.6	9.6		
G1	G1	3.1	40.1		
G2A	G2A+G1	12.9	59.9	16.0	100
WQ Pond	DP_G2B+DP_G2A+DP_A3A			24.0	145.9
H1	H1	4.6	33		
H4	H1+H4	15.4	73.6	20.0	106.6
Pond 1				20.0	106.6
H5B	H5B	5.6	29		
H5A	H5A	6.2	27		
H2	H2	8.9	65.7		
H6B	H6B+H2	15.5	57.1	24.4	122.8
Pond 2				24.4	122.8
H6A	H6A	11.6	51.1		
H3A	H3A	1.4	8.0		
H7B	H3A+H7B	8.0	49.8	9.4	57.8
H3B	H3B	1.3	6.9		
I1	I1+H3B	5.9	20.3	7.2	27.2
H7A	H7A	6.1	27.1		
H8A	H8A	2.5	11.2		
Pond 4	DP_H7A+DP_H7B+DP_I1+DP_H8A			22.5	108.4
I2	I2	8.3	39.1	8.3	39.1
H9	H9	2.3	15.0	2.3	15.0
OUT-1				420	1959
Reach 6-Kiowa				420	1960

NORTH

GRAPHIC SCALE IN FEET
0 75 150 300

NO.	REVISION	BY	DATE	APPR.

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DATE: 9/3/2021

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EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
PROPOSED DRAINAGE MAP

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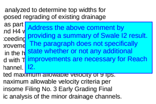
PROJECT NO.
196106001

SHEET
5

Drainage Report - Final_V2-redline.pdf Markup Summary

dsdlaforce (4)



Subject: Text Box
Page Label: 18
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Author: dsdlaforce
Date: 4/6/2023 5:01:52 PM
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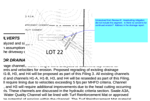
Address the above comment by providing a summary of Swale I2 result. The paragraph does not specifically state whether or not any additional improvements are necessary for Reach I2.



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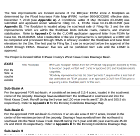

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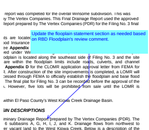

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Author: dsdlaforce
Date: 4/6/2023 5:11:18 PM
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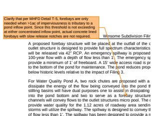
Update the flooplain statement section as needed based on RBD Floodplain's review comment.

Glenn Reese - EPC Stormwater (2)



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Page Label: 15
Lock: Unlocked
Author: Glenn Reese - EPC Stormwater
Date: 4/7/2023 1:23:40 PM
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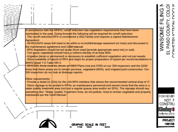
Color: ■
Layer:
Space:

Clarify that per MHFD Detail T-5, forebays are only needed when >1ac of imperviousness is tributary to a pond inflow point. Since this threshold is not exceeding at either concentrated inflow point, actual concrete lined forebays with slow release notches are not required.



Subject: SW - Textbox
Page Label: [1] Runoff_Reduction_Exhibit-RR-OVERALL
Lock: Unlocked
Author: Glenn Reese - EPC Stormwater
Date: 4/7/2023 1:45:52 PM
Status:
Color: ■
Layer:
Space:

In accordance with the MHFD, runoff reduction has vegetation requirements that have been overlooked in the past. Going forward the following will be required for runoff reduction:
- The runoff reduction RPA is considered a WQ Facility and requires a signed Maintenance Agreement
- All RPA/SPA areas will need to be within a no build/drainage easement (or tract) and discussed in the maintenance agreement and O&M manual.
- RPA vegetation should be turf grass (from seed [provide appropriate seed mix] or sod).
- Turf grass vegetation should have a uniform density of at least 80%.
- Irrigation (temp or permanent) is necessary to establish sufficient vegetation and not just weeds.
- Show suitability of topsoil of RPA and steps for proper preparation of topsoil per recommendations in MHFD detail T-0 Table RR-3
- RPA/SPA limits must be shown on GEC Plans (not just FDR) so our SW inspectors and the QSM know that these areas are to remain pervious, vegetated (80%), and irrigated post-construction. Our SW inspectors do not look at drainage reports.

Other requirements:
- Provide a detail (in CDs) for the UIA:RPA interface that shows the recommended vertical drop of 4”.
- Show signage to be posted in RPAs so maintenance personnel and owners know that the area is a water quality treatment area (not just a regular grassy area and/or an SPA). The signage should say something like: "Water Quality Treatment Area, do not pollute. Area to remain vegetated and properly maintained per the O&M Manual."

lpackman (1)

Subject: Text Box
Page Label: 431
Lock: Unlocked
Author: lpackman
Date: 4/4/2023 3:40:35 PM
Status:
Color: ■
Layer:
Space:

Unresolved from review 1. Provide the complete hydraulic analysis to include the velocity and froude number results, the boundary conditions used.