

PRELIMINARY DRAINAGE REPORT
FOR
GRANDWOOD RANCH

Prepared for:
EL PASO COUNTY
Engineering Development Review Team
2880 International Circle
Colorado Springs, CO 80910

On Behalf of:
Grandwood Enterprises, LLC
270 Lodgepole Way
Monument, CO 80132



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April 2020

Project No. 19.866.008

PCD File No. SP195

Engineer's Statement:

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

Jesse Sullivan
Registered Professional Engineer
State of Colorado
No. 55600

Date

SEAL

Developer's Statement:

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

GRANDWOOD ENTERPRISES, LLC

Business Name

By: _____

Date

Title: _____

Address: 270 Lodgepole Way
Monument, CO 80132

El Paso County:

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

Jennifer Irvine, P.E.
County Engineer / ECM Administrator

Date

Conditions:

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I. Introduction

The Grandwood Ranch subdivision is within El Paso County jurisdiction and is comprised of a total of 147 acres of 2.5-acre single-family residential (121 acres), open space (18 acres), and public right-of-way (5920 feet).

A. PURPOSE AND SCOPE OF STUDY

The purpose of this Preliminary Drainage Report is to identify and evaluate the offsite and onsite drainage patterns associated with the Grandwood Ranch development and to provide updated hydrologic and hydraulic analyses of this area to ensure compliance with the El Paso County Drainage Criteria Manual (DCM), as well as provide effective, safe routing to downstream outfalls. This report will include breach analysis of upstream offsite detention basins within the Timberview and Bent III subdivisions.

There are no previous applicable DBPS or MDDP reports covering the proposed development.

B. DBPS-RELATED INVESTIGATIONS

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

C. STAKEHOLDER PROCESS

As there are no Drainage Basin Planning Studies to amend or otherwise modify, there is no required stakeholder process.

D. AGENCY JURISDICTIONS

This project is located within El Paso County and is subject to the design criteria set forth in the *City of Colorado Springs & El Paso County Drainage Criteria Manual, Volumes I and II, dated May 2014 (DCM)* as well as the *El Paso County DCM, El Paso County Engineering Criteria Manual (ECM)* and *El Paso County Resolutions 15-042 and 19-245*.

E. GENERAL PROJECT DESCRIPTION

Grandwood Ranch extends from Higby Road on the south boundary north approximately ¼ mile to the north boundary. East to west the site is just under a mile (5136 feet) in length. The approximately 147-acre site is currently made up of sparsely grassed areas and areas of mature conifers/pine trees. The site slopes to the south with slopes from 2 percent up to in excess of 30 percent. The site is divided near the middle by a natural ridge with two locations with large and has two non-draining small basins along Higby Road on the downhill portion of the ridge dividing the site.

More specifically, the study area is located as follows:

1. General Location: The south half of the north half of Section 19, Township 11 South, Range 65 West of the 6th P.M. in the County of El Paso, State of Colorado.

2. Surrounding Streets and Developments:

- a. North: The properties to the north are within several different developments. These developments from west to east include: Timberview Subdivision Filings No. 2 and 3, Mills Timber Subdivision, Arrowood I, and Bent Tree III at the northeast corner.
- b. East: This boundary of the development adjoins Bent Tree III for the entire length
- c. South: Higby Road: Undeveloped property for the majority of the length and Higby Estates Filing No. 2 for the east roughly 20% of the border.
- d. West: Fairplay Drive: Woodmoor Summit makes up the entire length of the west boundary

Refer to Appendix D for the Vicinity Map.

F. DATA SOURCES

Topographical information for the site was found using a combination of *United States Geological Survey* (USGS) LIDAR as well as field surveying. The *Web Soil Survey* created by the *Natural Resources Conservation Service* was utilized to investigate the existing general soil types within the site and the USGS *StreamStats* website was used to determine the overall drainage basins.

DBPS CONSIDERATIONS

There are no approved DBPS studies for this region.

EXISTING DRAINAGE STUDIES

There are two adjacent developments with drainage studies, however:

Final Drainage Report for Timberview Subdivision Phase II, by Premier Engineering Inc., June 5, 2001.

Final Drainage Report for Bent Tree Subdivision Filing No. 3, by RTW Professional Engineers and Consultants, Inc. March 1993.

G. APPLICABLE CRITERIA AND STANDARDS

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

Add Mills Timber
Drainage Letter
mentioned on pg 3

II. Project Characteristics

A. BASIN LOCATION AND FLOWS

As mentioned in Section I. E. 3., the Grandwood Ranch project is divided between two major drainage basins and one minor basin.

1. Jackson Creek:

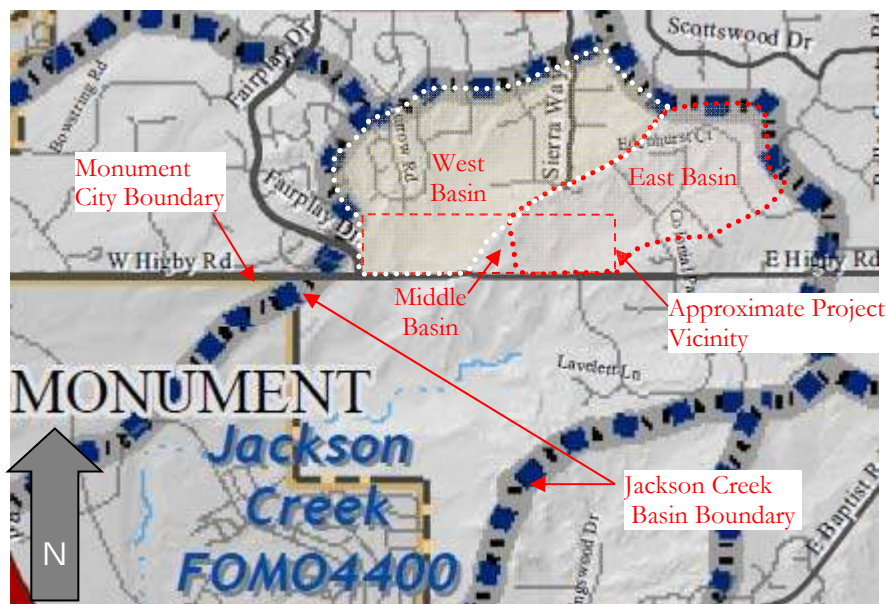


Figure 1 - Project Vicinity: Jackson Creek Drainage Basin

- a. West Basin: The 361-acre West Basin is made up of undeveloped land and 1 or 2-acre single family developments. Upstream of the proposed development this basin is divided into two other drainage basins. Runoff from the basin sheet flows off the residential lots and drains via grassed road ditches towards the site. The westernmost of the two basins drains into an existing sediment pond in the Timberview development. This basin is conveyed through the proposed development area via a broad undefined drainage way and crosses Higby Road via a 12-inch culvert. The second basin drains to a large open area upstream of Minglewood Trail and discharges via a 30-inch crossroad pipe to a broad undefined drainage way running through the site. The flows are eventually discharged to a wetland area and from there conveyed across Higby Road via a 26x48-inch elliptical culvert.

Runoff from the second basin to the east, sheet flows off residential lots to several vegetated swales. The swales direct the runoff to south and into the proposed development. A short section of Drainage Easement in the Mills Timber Subdivision exists just north of the property boundary. According to the Drainage Letter for Mills Timber Subdivision, the 100-foot wide section corresponds with a natural spring and associated pond. This pond does not appear to have any embankment, so breach analysis was not required. The narrower section of easement appears to have aligned with one of the swales through the Mills Timber Subdivision, but, according to the 2018 LIDAR used in this report to identify the offsite basins, the drainage easement no longer appears to follow a defined swale. Once reaching the site flows from this drainage area are

directed south via natural swales. The offsite flows will be conveyed under the proposed roadway and will eventually discharge to the natural wetland on the south end of the project. As much as possible, the offsite and 2.5-acre lot runoff will not be allowed to mix with runoff from the proposed streets in order to reduce the detention requirements for the proposed development.

b. East Basin: The 266-acre East Basin is made up of undeveloped land and 1-acre plus single-family development. Much of the offsite portion of this basin is within the Bent Tree III subdivision. Bent Tree III is required to detain and discharge runoff from the development at rates as indicated in the Drainage Criteria governing in 1993 when the drainage report for the site was approved.

c. Minor Central Basin

The Minor Central Basin is 6.4 acres. This basin is on the front side of the ridge dividing the Grandwood Ranch development. Flows in this basin sheet flow south towards Higby Road and into an existing 18-inch culvert crossing Higby Road. Some flow is captured in two low spots adjacent to Higby Road. There do not appear to be any culverts draining the two low spots. The soils in this area (described in the following section) are highly permeable and runoff to the low spots will infiltrate quickly. A site visit did not note any signs of ponding or wetland plants in these low points, so it is likely that the highly permeable soil removes runoff faster than it can accumulate. If the low areas did happen to fill up beyond the natural infiltration capacity, the surcharge would continue west along the Higby Road ditch to existing culvert.

B. GEOLOGY

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

Table 1.1 – NRCS Soil Survey for El Paso County

<i>SOIL ID NUMBER</i>	<i>SOIL</i>	<i>HYDROLOGIC CLASSIFICATION</i>	<i>SATURATED CONDUCTIVITY (IN/HR)</i>	<i>PERCENT ON SITE</i>
1	Alamosa loam, 1 to 3 percent slopes	D	1.28	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	13.04	57.5%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	3.97	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	13.04	15.2%

Jackson Creek - Saturated Conductivity of Soils in the Grandwood Ranch Subdivision						
Soil Type	1	41	71	93	Total Area (Sq. Mi.)	Weighted Hydraulic conductivity in/hr
Grandwood Ranch	0.016	0.143	0.052	0.038	0.25	10.39
Conductivity						
um/s	9	92	28	92	From Soil Survey Report	
Inches/Hour	1.28	13.04	3.97	13.04		

Pre-project site conditions are undeveloped and ground cover consists of sparse natural vegetative land cover.

C. LAND USES

The site is currently zoned RR5 (min. 5-acre lot sizes) but is being rezoned to RR2.5 to allow the development to provide 48 single-family lots of at least 2.5 acres.

III. Hydrologic Analysis

A. MAJOR BASINS AND SUBBASINS

As mentioned in previous sections, the Grandwood Ranch development must be broken into two major basins and one minor basin to reflect areas within three general drainage paths through the site. These basins are all within the larger Jackson Creek Drainage Basin which is tributary to Fountain Creek.

Generally, under proposed conditions, offsite flows will be routed around or under the proposed roads. Culvert sizing for each lot will be provided so that drainage is maintained as the individual lots are developed. More channelized flow paths through the proposed lots have had drainage easements defined to maintain the drainage. Lots receiving these flows, but not currently possessing a defined flow path for a drainage easement to follow will require engineered site plans.

B. METHODOLOGY

The DCM requires SCS runoff method for drainage areas larger than 130 acres. Additionally, for these larger areas, two different storm durations must be considered (2-hour and 24-hour), and the more conservative of the two options will be utilized for design of infrastructure. In this case the 24-hour event was the more conservative.

The hypothetical rainfall depths for the 1-hour storm duration were derived using Table 2.1 of the DCM (shown below). These 1-hour rainfall depths were used to calculate the 2-hour design storm using Table 6-2 from the DCM which lists the “2-Hour Storm Distribution” (see Appendix B). This design storm is input to HEC-HMS via a time-series relationship. 24-hour storm events are modeled using a Type II storm distribution under the “Hypothetical Storm” option in HEC-HMS. Rainfall depths for this event were taken from Table 6-2 of the DCM.

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where $Z = 6,840 \text{ ft}/100$

Revise to 11% per
ECM Appendix L
Table 3-1

Water quality and storm detention for the proposed roads is modeled in UD-Detention. Detention ponds are placed throughout the site to balance the use of space with the need to treat and detain runoff from the proposed streets and, also, maintain the historic discharge from the property.

Site permeability is based on Tables 5-4 through 5-6 of the DCM and/or Table 6-10 of the Colorado Springs DCM. The proposed site will have an estimated 10% impervious for the 2.5-acre lots. Offsite areas upstream are modeled as approximately 1 acre lots.

Under proposed conditions, the portions of the development treated and detained within the proposed detention ponds is addressed in the HMS model by inputting an outflow hydrograph derived from the MHFD-Detention model of each proposed pond.

Existing detention ponds are modeled within HEC-HMS by stage-storage relationship information and the model attempts to match the drainage report.

Update narrative to discuss if this the conservative approach to calibrate based on the original drainage report's versus running the existing condition using current criteria to determine a new pond discharge?

C. BASIN HYDROLOGY

- a. The ***undeveloped conditions*** for the site have been analyzed and are presented by design points (Table 3.2) and are described as follows:

1. **West Basin:**

Under existing conditions, the developments directly north of Grandwood Ranch have several discharge points onto the proposed development. One of these is an existing detention pond for Timberview Subdivision Phase II ($Q_5 = 19.4 \text{ cfs}$, $Q_{100} = 32.0 \text{ cfs}$). The next development to the east, Timberview Subdivision Filing No. 3, provides a second discharge point with $Q_{100} = 29 \text{ cfs}$. Additionally, a swale runs along the south boundary of Arrowwood Filing No. 1 and past Mills Timber Subdivision and discharges ($Q_5 = 15.6 \text{ cfs}$, $Q_{100} = 39.0 \text{ cfs}$) to this same basin. The total existing discharge from the adjacent and proposed developments at Higby Road is approximately 75.8 cfs for the Q_5 event and 183.6 cfs for the Q_{100} event.

Update the narrative to reference the specific design point or sub-basin.

2. **East Basin:**

This basin also has a significant drainage area upstream of the proposed development site. Flows from the Bent Tree Subdivision discharge to the Grandwood Ranch property. These

flows include the discharge from the Bent Tree III detention pond as well as undetained flows from other portions of the subdivision. Offsite flows tributary to this sub-basin are approximately: $Q_5 = 64.5$ cfs, $Q_{100} = 162.3$ cfs. The existing detention pond reduces these flows to $Q_5 = 13.9$ cfs, $Q_{100} = 68.0$ cfs

Total discharge from the East Basin across Higby Road is approximately 19.1 cfs for the Q_5 event and 65.7 cfs for the Q_{100} event.

3. Minor Central Basin:

Under existing conditions this basin has a total discharge of $Q_5 = 0$ cfs, $Q_{100} = 1.3$ cfs. This basin is not affected by offsite flows.

Existing conditions consider all the on-site areas as undeveloped. Sub-basins and Design Points are summarized in the following tables:

Table 3.1 Grandwood Ranch Existing Conditions Sub-Basin Summary Table			
Area ID	Area (Acres)	Q5 (cfs)	Q100 (cfs)
EX-1A	80.6	18.8	53.7
EX-1B	8.1	1.7	5.2
EX-1C	5.8	0	0.5
EX-1D	25.0	9.6	24.5
EX-1E	37.1	13	33.2
EX-1F	1.3	0.4	1.1
EX-1G	62.5	20.9	53.2
EX-2A	14.1	5.7	14.6
EX-2B	33.9	0.4	5.4
EX-2C1	13.4	5.2	13.1
EX-2C2	33.3	0.2	3.9
EX-2C3	6.4	0.1	1
EX-2D	21.8	8.7	20.8
EX-2D1	16.3	11.1	19.2
EX-2D2	12.7	5.1	12.8
EX-2D3	16.4	6.2	15.9
EX-2E	12.2	5.3	13.4
EX-2F	19.8	6.3	16.1
EX-2G	12.2	4.5	11.5
EX-2H	31.4	11.5	29.2
EX-2I	13.4	4.8	12.3
EX-2J	48.6	16.5	42
EX-3	19.3	7	17.4
EX-3A	40.6	14.9	37.8
EX-4	6.4	0	1.3

Table 3.2 Grandwood Ranch Existing Design Point Summary				
Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
1	EX-3A	40.6	13.3	29.1
2	EX-2D1, EX-2D2, EX-2D	50.8	21	43.6
3	EX-2E, EX-2F, EX-2G, EX-2H, EX-2I, EX-2J	137.6	44.9	114.3
4	Design Point 5, EX-1B, EX-1C	139.8	9.9	60.5
5	Design Point 6	125.9	9.7	59.8
6	EX-1D, EX-1E, EX-1F, EX-1G	139.8	37.4	95
EX-1	Design Point 1, EX-3	220.4	19.1	65.7
EX-2	EX-2A, EX-2B, Design Point 2, EX-2D3, Design Point 3, EX-2C1, EX-2C2, EX-2C3	305.9	59.4	148
EX-3	Design Point 5, EX-3	59.9	16.4	35.6
EX-4	EX-4	6.4	0	1.3

HEC-HMS outfall values for the Predevelopment Q₅ and Q₁₀₀ storms are shown below:

add explanation why DP 5 is DP 6 with smaller total area.

Q5 Runoff

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Basin EX-1B	0.0126	1.7	01Jan2020, 12:45	0.56
Basin EX-1C	0.0091	0.0	01Jan2020, 15:50	0.03
Basin EX-1D	0.0390	9.6	01Jan2020, 12:35	0.85
Basin EX-1E	0.0579	13.0	01Jan2020, 12:40	0.85
Basin EX-1F	0.0021	0.4	01Jan2020, 12:50	0.85
Basin EX-1G	0.0977	20.9	01Jan2020, 12:45	0.85
Design Point 4	0.2184	9.9	01Jan2020, 16:35	0.31
EX-1A	0.1260	18.8	01Jan2020, 12:45	0.63
EX-2A	0.0220	5.7	01Jan2020, 12:30	0.86
EX-2B	0.0530	0.4	01Jan2020, 13:20	0.07
EX-2C1	0.0210	0.0	01Jan2020, 15:45	0.03
EX-2C2	0.0520	0.0	01Jan2020, 00:00	0.00
EX-2C3	0.0100	0.0	01Jan2020, 00:00	0.00
EX-2D	0.0340	8.7	01Jan2020, 12:45	0.99
EX-2D1	0.0255	11.1	01Jan2020, 12:40	1.71
EX-2D2	0.0198	5.1	01Jan2020, 12:30	0.84
EX-2D3	0.0256	6.2	01Jan2020, 12:35	0.85
EX-2E	0.0190	5.3	01Jan2020, 12:30	0.86
EX-2F	0.0310	6.3	01Jan2020, 12:50	0.85
EX-2G	0.0190	4.5	01Jan2020, 12:40	0.85
EX-2H	0.0490	11.5	01Jan2020, 12:40	0.85
EX-2I	0.0210	4.8	01Jan2020, 12:40	0.85
EX-2J	0.0760	16.5	01Jan2020, 12:45	0.85
EX-3	0.0302	7.0	01Jan2020, 12:45	0.90
EX-3A	0.0634	14.9	01Jan2020, 12:40	0.85
EX-4	0.0100	0.0	01Jan2020, 13:50	0.03
Junction EX-2D	0.0793	21.0	01Jan2020, 13:20	1.18
Reservoir OS-1	0.0634	13.3	01Jan2020, 12:55	0.85
Reservoir OS-5	0.1967	9.7	01Jan2020, 15:45	0.31
Route DP 1	0.0190	5.3	01Jan2020, 14:05	0.83
Route DP 2	0.0310	6.3	01Jan2020, 13:40	0.84
Route DP 3	0.0190	4.5	01Jan2020, 14:15	0.83
Route DP 5	0.0210	4.8	01Jan2020, 14:15	0.83
Route DP 6	0.0760	16.4	01Jan2020, 14:25	0.82
Route ex	0.0490	11.5	01Jan2020, 14:20	0.82
Route EX-1E	0.0579	13.0	01Jan2020, 13:30	0.84
Route EX-1F	0.0021	0.4	01Jan2020, 13:45	0.83
Route EX-1G	0.0977	20.9	01Jan2020, 13:40	0.84
Route EX-2A	0.0220	5.7	01Jan2020, 13:15	0.84
Route EX-2C1	0.0210	0.0	01Jan2020, 16:40	0.02
Route EX-2C2	0.0520	0.0	01Jan2020, 00:00	0.00
Route EX-2D	0.0793	21.0	01Jan2020, 14:05	1.16
Route EX-2D1	0.0255	11.0	01Jan2020, 13:30	1.69
Route EX-2D2	0.0198	5.0	01Jan2020, 13:20	0.83
Route EX-2D3	0.0256	6.2	01Jan2020, 14:05	0.83
Route Res OS-1	0.0634	13.3	01Jan2020, 13:40	0.84
Route Res OS-5	0.1967	9.7	01Jan2020, 16:35	0.31
Route Upper Basin	0.2184	9.9	01Jan2020, 17:25	0.30
Route Upper Junction	0.2150	44.9	01Jan2020, 15:00	0.81
Sink EX-1	0.3444	19.1	01Jan2020, 12:45	0.42
Sink EX-2	0.4779	58.0	01Jan2020, 14:50	0.65
Sink EX-3	0.0936	16.4	01Jan2020, 13:30	0.86
Sink EX-4	0.0100	0.0	01Jan2020, 13:45	0.03
Upper Junction	0.2150	44.9	01Jan2020, 14:15	0.83

Q100 Runoff

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Basin EX-1B	0.0126	5.2	01Jan2020, 12:40	1.51
Basin EX-1C	0.0091	0.5	01Jan2020, 12:55	0.31
Basin EX-1D	0.0390	24.5	01Jan2020, 12:35	2.06
Basin EX-1E	0.0579	33.2	01Jan2020, 12:40	2.05
Basin EX-1F	0.0021	1.1	01Jan2020, 12:50	2.05
Basin EX-1G	0.0977	53.2	01Jan2020, 12:45	2.05
Design Point 4	0.2184	60.5	01Jan2020, 16:20	1.37
EX-1A	0.1260	53.7	01Jan2020, 12:45	1.64
EX-2A	0.0220	14.6	01Jan2020, 12:30	2.06
EX-2B	0.0530	5.4	01Jan2020, 12:50	0.47
EX-2C1	0.0210	1.3	01Jan2020, 12:45	0.31
EX-2C2	0.0520	0.1	01Jan2020, 16:05	0.04
EX-2C3	0.0100	0.0	01Jan2020, 00:00	0.00
EX-2D	0.0340	20.8	01Jan2020, 12:45	2.27
EX-2D1	0.0255	19.2	01Jan2020, 12:40	2.96
EX-2D2	0.0198	12.8	01Jan2020, 12:30	2.02
EX-2D3	0.0256	15.9	01Jan2020, 12:35	2.06
EX-2E	0.0190	13.4	01Jan2020, 12:30	2.06
EX-2F	0.0310	16.1	01Jan2020, 12:50	2.05
EX-2G	0.0190	11.5	01Jan2020, 12:35	2.06
EX-2H	0.0490	29.2	01Jan2020, 12:40	2.06
EX-2I	0.0210	12.3	01Jan2020, 12:40	2.05
EX-2J	0.0760	42.0	01Jan2020, 12:45	2.05
EX-3	0.0302	17.4	01Jan2020, 12:45	2.13
EX-3A	0.0634	37.8	01Jan2020, 12:40	2.06
EX-4	0.0100	1.3	01Jan2020, 12:10	0.33
Junction EX-2D	0.0793	43.6	01Jan2020, 13:20	2.41
Reservoir OS-1	0.0634	29.1	01Jan2020, 13:00	2.05
Reservoir OS-5	0.1967	59.8	01Jan2020, 15:30	1.42
Route DP 1	0.0190	13.4	01Jan2020, 14:05	2.00
Route DP 2	0.0310	16.0	01Jan2020, 13:35	2.02
Route DP 3	0.0190	11.5	01Jan2020, 14:10	2.00
Route DP 5	0.0210	12.3	01Jan2020, 14:15	1.99
Route DP 6	0.0760	41.9	01Jan2020, 14:25	1.99
Route ex	0.0490	29.2	01Jan2020, 14:20	1.99
Route EX-1E	0.0579	33.2	01Jan2020, 13:30	2.02
Route EX-1F	0.0021	1.1	01Jan2020, 13:40	2.01
Route EX-1G	0.0977	53.1	01Jan2020, 13:40	2.02
Route EX-2A	0.0220	14.6	01Jan2020, 13:15	2.03
Route EX-2C1	0.0210	1.3	01Jan2020, 13:40	0.30
Route EX-2C2	0.0520	0.1	01Jan2020, 16:55	0.04
Route EX-2D	0.0793	43.6	01Jan2020, 14:05	2.38
Route EX-2D1	0.0255	19.1	01Jan2020, 13:30	2.93
Route EX-2D2	0.0198	12.8	01Jan2020, 13:20	1.99
Route EX-2D3	0.0256	15.9	01Jan2020, 14:05	2.00
Route Res OS-1	0.0634	29.1	01Jan2020, 13:50	2.02
Route Res OS-5	0.1967	59.8	01Jan2020, 16:20	1.41
Route Upper Basin	0.2184	60.5	01Jan2020, 17:10	1.35
Route Upper Junction	0.2150	114.3	01Jan2020, 15:00	1.96
Sink EX-1	0.3444	65.7	01Jan2020, 17:00	1.46
Sink EX-2	0.4779	143.6	01Jan2020, 14:50	1.55
Sink EX-3	0.0936	35.6	01Jan2020, 13:35	2.06
Sink EX-4	0.0100	1.3	01Jan2020, 12:05	0.33
Upper Junction	0.2150	114.3	01Jan2020, 14:15	1.99

Update the first sentence to reference ECM I.7.1.B.5 for the Large Lot Single Family exclusion criteria.

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

Generally, runoff will sheet flow off of the various highpoints within each sub-basin. These flows will be directed towards natural swales and/or road ditches. More specific flow descriptions can be found in the Design Point description tables in the following sections.

• **West Basin:**

Because of the very low density of the development, the residential areas are only detained as necessary to prevent an increase in the total flow discharge from the property. The proposed streets, however, do require detention. (As much as 1 acre (Total: 0.96 Acres) of this impervious surface may be excluded from Water Quality Treatment if it is infeasible (Sub-basins W-1: 0.28 Acres, & W-7: 0.27 Acres) to provide per ECM Section 1.7.1.C.1). Sub-basins and Design Points within this major basin are summarized in Tables 3.3, 3.4, and 3.5 below:

Table 3.3a
Sub-basins and Design Points

Before using the referenced exclusion, update the report to include calculations from UD-BMP Runoff Reduction Tab for basins W-1 and W-7 and include the corresponding exhibit (See example exhibit below).

The UD-BMP runoff reduction calculation may result in meeting the criteria defined in ECM Section I.7.1.C.3 for Runoff Reduction which is one of the "base design standards" for permanent water quality control measure. Caveat of this section is that you will need to place the areas identified as receiving pervious area (RPA) in the lots in a drainage easement to ensure it remains open space for WQ treatment.

Similar comment for the East Basin

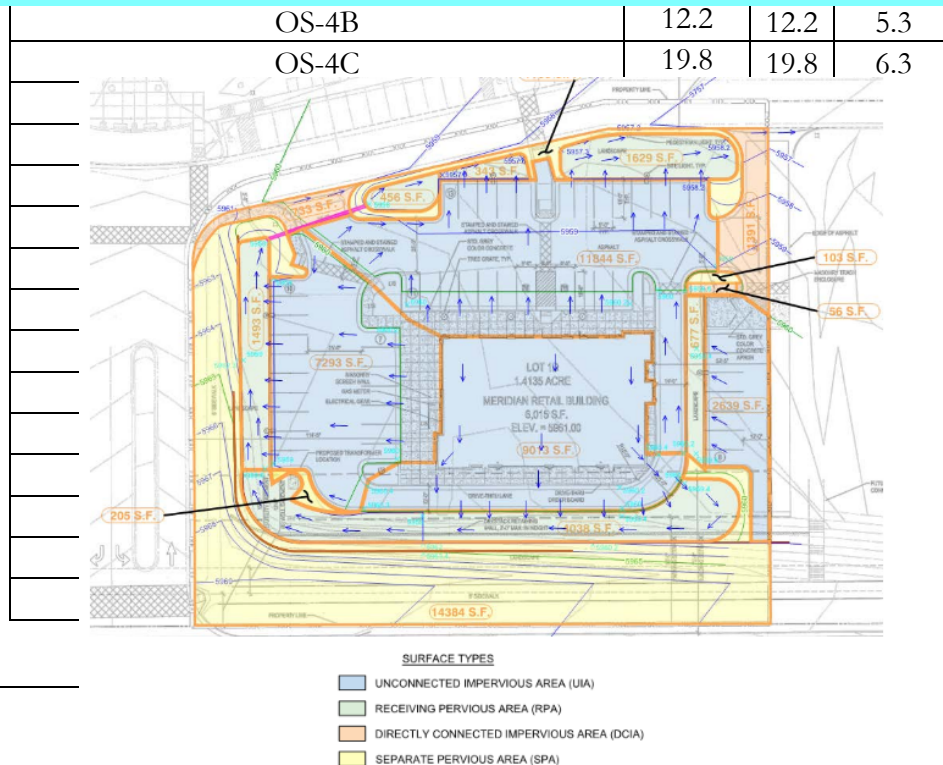


Figure RR-6. Example site runoff reduction configuration.

Table 3.3 b Grandwood Ranch West Basin Proposed Conditions - Sub-basin Summary			
Basin	Area	Q5	Q100
	acres	cfs	cfs
W-9	1.9	1.9	0.7
D-1	12.8	12.8	6.7
D-2	6.4	6.4	6

Table 3.4 Grandwood Ranch West Basin Proposed Design Point Summary					
Design Point	Sub-Basins	Downstream Design Point	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
1	OS-1	EX-3	40.6	13.3	29.1
2	OS-3A, OS-3B, OS-3C	C-2	48.8	15.6	39
3	OS-4B, OS-4C, OS-4D, OS-4E, OS-4F, OS-4G	C-2	137.6	44.9	114.3
C-1	OS-2A, OS-2B, W-3	C-3	25.6	7.1	18
C-2	W-4, Design Point 2, OS-4A, Design Point 3, OS-4H, W-5	C-3	225.9	53.9	136
C-3	W-8, Design Point C-1, Design Point C-2, W,6, W-7	EX-2	270.7	56.7	142.5
C-4	D-1	EX-2	12.8	6.7	15.1
C-5	D-1	EX-2	12.8	6.7	15.1
C-6	D-2	EX-2	6.4	6.0	11.5
C-7	W-9	EX-2	1.9	0.7	1.7
EX-2	W-2, Pond 1, Design Point C-3, Pond 2, W-9	N/A	295.0	58.0	143.7
EX-3	Design Point 1, W-1	N/A	59.9	16.3	35.6
Total West Basin Discharge Across Higby Road				74.3	179.3

Table 3.5 <u>Grandwood Ranch</u> West Basin Proposed Design Point Flow Description	
Design Point	Description
1	Flows from this Design Point originate from the offsite detention basin located on Timberview Subdivision Phase II. These flows are conveyed onsite through overland flows through sub-basin W-1 and proceed to drain into culvert EX-3. Flow for this Design Point does not follow a defined channel through the site.
2	The flows at this point represent the offsite flows from a series of sub-basins concentrating at an existing drainage easement. These sub-basins are consistent between the pre- and post-development conditions. As the flows proceed onsite, there is some existing channelization on the boundary of sub-basins W-3 and W-4, towards culvert C-2, however the predominant flow mechanism is overland flow.
3	This Design Point captures the overland flows for a series of offsite sub-basins that are consistent between the pre- and post- development conditions. These flows travel overland to the culvert at Design Point C-2 and avoid the existing drainage easement.
C-1	This design point crosses the proposed east-west road. Flows follow the existing site topology and road embankment to concentrate at this location. Flows will be discharged into sub-basin W-8.
C-2	This design point is a culvert crossing the east-west road. Flows come from Design Points 2 and 3, across sub-basin W-4. Culvert C-2 discharges into sub-basin W-8 where flow proceeds as overland flow.
C-3	This design point captures the overland flows from the majority of the south-east area of the West Basin as well as the incoming flows from culverts C-1 and C-2 and conveys them across the north-south road and into sub-basin W-2 for discharge from the site.
C-4	This Design Point captures the overland flow from a section of sub-basin D-1 and the runoff from a section of the road for routing to Pond 1. The culvert passes these flows under a small section of road that does not require detention.
C-5	This Design Point captures the overland flow from sub-basin D-1 for transport under the east-west road to Pond 1.
C-6	This Design Point captures the overland flow from a section of sub-basin D-2 and the runoff from the east-west road for conveyance across a small section of roadway (0.27 ac.) that does not require detention.
C-7	This design point captures the overland flow from basin W-9 for passage through a culvert under the north-south road and into sub-basin W-2 for discharge from the site.

Drawings of these sub-basins and design points are illustrated in Drawing DR-02 in Appendix D.

- **East Basin:**

Because of the very low density of the development, the residential areas are only detained as necessary to prevent an increase in the total flow discharge from the property. The proposed streets, however, do require detention. (As much as 1 acre (Total: 0.96 Acres) of this impervious surface (Sub-basin E2: 0.41 Acres) may be excluded from Water Quality Treatment if it is infeasible to provide per ECM Section 1.7.1.C.1.). Sub-basins and Design Points within this major basin are summarized in Q₅ and Q₁₀₀ HMS tables and Tables 3.6, 3.7, and 3.8 on the following pages:

Table 3.6 Grandwood Ranch East Basin Proposed Conditions - Sub-basin Summary			
Basin	Area	Q5	Q100
	acres	cfs	cfs
OS-5	15.6	4.2	8.7
OS-6A	24.7	9.5	24.3
OS-6B	37.0	13	33.2
OS-6C	52.7	16.9	42.9
OS-6D	62.5	20.9	53.2
E-1	5.1	1.7	4.7
E-2	6.8	2.8	6.6
E-3	21.5	3.1	9.7
E-4A	8.0	2.8	7.2
E-4B	5.8	2.3	6
D-3	19.2	4.3	13.6
D-4A	4.4	1.3	3.4
D-4B	6.6	2.7	6.6

Table 3.7 Grandwood Ranch East Basin Proposed Design Point Summary					
Design Point	Sub-Basins	Downstream Design Point	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
4	OS-6A, OS-6B, OS-6C, OS-6D	5	177.1	9.7	59.3
5	Design Point 4 (Offsite reservoir)	C-10	177.1	52.3	132.7
C-8	E-1	EX-3	13.2	1.7	4.7
C-9	D-3	EX-3	19.2	4.3	13.6
C-10	OS-5, E-2	EX-3	22.4	6.7	17.1
C-11	Design Point 4, E-4A, E-4B	EX-3	191.0	10.2	61
C-12	D-4A, D-4B	EX-3	11.0	4.0	10.0
EX-1	E-1, Pond 3, Pond 4, E-3	N/A	270.3	17.4	65.6

Table 3.8 Grandwood Ranch East Basin Proposed Design Point Flow Description	
Design Point	Description
4	This Design Point measures the outflow from the offsite detention basin in sub-basin OS-6A. Flows discharged from the reservoir travel overland onto the site to Design Point C-10.
5	The Design Point measures the incoming flow to the offsite reservoir on basin OS-6A. These flows are described in the Bent Tree III Drainage Report. Once detained in the offsite detention basin, their peak is attenuated, and the detention basin discharges to Design Point 4.
C-8	This Design Point measures the overland flow from sub-basin E-1 and into culvert C-8. This culvert directs flows across the road, around Pond 3, and into sub-basin E-3 for discharge off site.
C-9	This Design Point measures the overland flow from sub-basin D-3 and into the culvert. This flow is directed across the road where it flows into Pond 3.
C-10	This Design Point measures the overland flow from sub-basin E-2 and directs the flow across the road and into sub-basin E-3. Sub-basin E-2 includes a small section of road (0.41 ac.) that does not require detention and is discharged into sub-basin E-3.
C-11	This Design Point measures the flow from the offsite detention basin in Bent Tree III and overland flow from two onsite sub-basins. This flow is conducted through a culvert and into sub-basin E-3 for discharge from the site.
C-12	This design point describes a low point in the roadside swale in sub-basin D-4B. Runoff will sheet flow from this sub-basin until it is captured in the road side swale and directed to the 18-inch culvert.

- **Minor Central Basin:**

Under proposed conditions flows for this small basin towards the middle of the study area will sheet flow towards two low points near Higby Road. Sub-basins and Design Points within this major basin are summarized and described in Tables 3.9, 3.10, and 3.11 on the following pages:

Need further explanation why surface runoff in the developed condition is half the existing condition (0.6 vs 1.3 cfs).

Table 3.9 Grandwood Ranch Minor Central Basin Proposed Conditions - Sub-basin Summary			
Basin	Area	Q5	Q100
	(ac.)	(cfs)	(cfs)
W-10	6.4	0	0.6

Table 3.10 Grandwood Ranch Minor Central Basin Proposed Design Point Summary					
Design Point	Sub-Basins	Downstream Design Point	Total Area (ac.)	Q5 (cfs)	Q100 (cfs)
EX-4	Basin W-10	N/A	6.4	0.0	0.6

Note that the total discharge across Higby Road for each Basin is essentially equal to the predevelopment values. Therefore, no negative downstream affects are anticipated to result from this project.

c. Detention

A summation of the proposed detention and water quality ponds is found below. These numbers are preliminary and will be finalized in the Final Drainage Report, as will the pond outfall structures. UD-Detention spreadsheets for each detention pond can be found in Appendix A. Detention ponds will be privately owned and maintained by the HOA.

Table 3.12 Pond Summary Table Jackson Creek										
Major Basin	Pond ID	Analysis Method	Contributing Basins	Approximate Detention Volumes			EX	PR	EX	PR
				WQCV	EURV	Q100	5-YR	5-YR	100 YR	100 YR
				Ac.-Ft.	Ac.-Ft.	Ac.-Ft.	(CFS)	(CFS)	(CFS)	(CFS)
West	Pond 1	UD-Detention (EDB)	D-1	0.138	0.430	1.325	1.5	1.1	6.9	6.3
West	Pond 2	UD-Detention (EDB)	D-2	0.082	0.168	1.096	3.4	1.9	14.1	13.5
East	Pond 3	UD-Detention (EDB)	D-3	0.176	0.329	2.873	7.0	4.9	30.1	28.4
East	Pond 4	UD-Detention (EDB)	D-4	0.059	0.106	1.051	3.2	1.9	13.1	12.2

Emergency Overflows

**Table 3.13
Emergency Overflow Weirs**

Major Basin	Pond ID	Description of Emergency Overflow Weir
West	Pond 1	In the case of blockage, the emergency overflow weir will direct flows into the adjacent wetland area. From here flows will continue to follow historic paths.
West	Pond 2	In the case of blockage, the emergency overflow weir will direct flows into the adjacent wetland area. From here flows will continue to follow historic paths.
East	Pond 3	In the case of blockage, the emergency overflow weir will direct the surcharge into the adjacent Higby Road ditch. From here flows are directed into the adjacent wetland area. Flows will continue to follow historic paths.
East	Pond 4	In the case of blockage, the emergency overflow weir will direct flows into the adjacent wetland area. From here flows will continue to follow historic paths.

Outfall Analysis

Outfall analysis will be completed with the Final Drainage report. The discharges will need to comply with the criteria indicated for erosive soils in Table 12-3 (shown below) of the DCM regarding Hydraulic Design Criteria for natural unlined channels.

Table 12-3. Hydraulic Design Criteria for Natural Unlined Channels

Design Parameter	Erosive Soils or Poor Vegetation	Erosion Resistant Soils and Vegetation
Maximum Low-flow Velocity (ft/sec)	3.5 ft/sec	5.0 ft/sec
Maximum 100-year Velocity (ft/sec)	5.0 ft/sec	7.0 ft/sec
Froude No., Low-flow	0.5	0.7
Froude No., 100-year	0.6	0.8
Maximum Tractive Force, 100-year	0.60 lb/sf	1.0 lb/sf

¹ Velocities, Froude numbers and tractive force values listed are average values for the cross section.

² "Erosion resistant" soils are those with 30% or greater clay content. Soils with less than 30% clay content shall be considered "erosive soils."

The Web Soil Survey for the site indicates that the Soils for the receiving swale are are classified as gravelly or sandy loams which are erosive soils.

Further analysis will be completed with the Final Drainage Report.

Phasing:

Ponds will be constructed as required to provide treatment and detention for the proposed development.

Jurisdictional Dam Determination-On Site:

All proposed detention ponds have been specifically designed to be under the criteria for a jurisdictional Dam.

Analysis of Off-site Upstream Dams:

There are two existing detention ponds upstream of the proposed development:

Timberview Subdivision Phase II:

This detention pond is located near the northwest corner of the proposed development. This pond is briefly described in the FDR for Timberview Subdivision Phase II. Based on the anticipated discharge from the pond and the contours shown in the Phase II FDR drainage map the pond is estimated to detain water at a depth of approximately 3 feet and a volume of approximately 0.5 Acre-feet. Using these values in the Colorado Division of Water Resources “Estimation of Dam Breach Parameters Using the Froehlich 2008 Method”, the peak discharge during a breach event is estimated to be approximately 73 cfs. This flow is small enough that downstream infrastructure, including driveway culverts will be able to handle the flow with little to no damage and no loss or endangerment of life is anticipated. Therefore, the embankment of this pond should be considered a “No Public Hazard” Dam (NPH)

Bent Tree Filing No. 3:

Detention for Bent Tree Filing No. 3 is provided in a detention pond just east of the proposed development. According to the FDR the Bent Tree Filing No. 3 the detention pond is anticipated to be approximately 10.07 feet deep (just over Jurisdictional Dam Criteria) with a volume of 3.8 Acre-Feet. Using these values in the Colorado Division of Water Resources “Estimation of Dam Breach Parameters Using the Froehlich 2008 Method”, a peak discharge during a breach event is estimated to be approximately 807 cfs.

To accommodate this flow and minimize the hazard of the embankment, proposed lots (Lot 9) within the Grandwood Ranch development have been configured to allow the natural swale currently carrying the pond discharge to fall close to the lot lines. This swale will terminate just before the proposed roadway at an inlet or FES where normal flows will be captured and directed across the proposed road and back into natural drainage ways. The proposed roadway at this location will receive armoring to prevent failure in the case of an upstream dam breach. Lot 9 will have a designated “No Build” area at least 90 feet wide along the north property line to provide a clear conveyance and reduce the likelihood of damage to private property in the case of a breach. The above factors allow the offsite basin hazard classification to remain at “Low Hazard.”

Correspondence with the State of Colorado Division of Water Resources regarding hazard classifications and steps take to minimize the hazard has been included in Appendix C.

IV. Drainage Facilities

A worst-case roadside ditch capacity calculation is included in the appendix. More detailed Swale and roadside ditch capacities will be included in the FDR. Crossroad culvert sizing is summarized in the table below:

Cross Road Culvert Sizing

Manning's n	0.013 (reinforced concrete)	<u>Allowable Velocities in Culverts</u>	
Min D	18 inches	Min v	3 fps
		Max V	15 fps

*Dam breach flow used

	Design Point	Peak Discharge (cfs)	Max Slope (%)	Culvert Diameter (ft)	Velocity (ft/s)	Stormwater Treatment
West Basin	C-1	18	5	1.5	14.51	Bypass of Historic Flow
	C-1	11.5	7.5	2	14.8	Treated Developed Flow
	C-2	136	2	3	14.48	Bypass of Historic Flow
	C-3	142.6	0.8	3.5	10.35	Bypass of Historic Flow
	C-4	15.1	2	1.5	14.71	Treated Developed Flow
	C-5	15.1	2	3	14.71	Treated Developed Flow
	C-6	>11.5	7	1.5	14.71	Treated Developed Flow
East Basin	C-7**	1.7	0.4	1.5	3.12	Bypass of Historic Flow
	C-8	4.7	6.5	1.5	11.23	Bypass of Historic Flow
	C-9	13.6	6.5	2	15	Treated Developed Flow
	C-10	17.1	5	1.5	14.44	Bypass of Historic Flow
	C-11	61	2.5	2.5	14.97	Bypass of Historic Flow
	C-12	6.6	10	1.5	14.75	Treated Developed Flow

The preliminary plan for this development lays out several proposed drainage easements along areas of defined or concentrated flow. For areas where these flows disperse to an undefined flow path, an engineered site plan will be required for each affected lot. This will require the consideration of these flows in the design of each lot and will allow the builder to choose the optimal solution to convey these flows through each lot.

V. STRUCTURE IMPROVEMENTS

Because all flows from Grandwood Ranch, which require treatment, are to be treated for water quality and detention onsite and the proposed project will not increase peak flows from the property, additional construction in any downstream Regional Detention Pond and/or improvements to the channel downstream will not be required.

VI. FLOODPLAINS

Per the *Flood Insurance Rate Map (FIRM) 08041C 0279-G*, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), no portion of Grandwood Ranch (Waterview East) lies within any designated 100-year floodplain. This map can be found in Appendix C.

VII. Environmental Evaluations

A. WETLAND IMPACTS

Wetlands and protected wildlife habitats within the project area will not be affected by the proposed development.

B. STORMWATER QUALITY

All on-site detention facilities shall be designed to accommodate water quality requirements. As the development of each parcel progresses, the detention guidelines outlined in this report are to be upheld.

Per Chapter 1, Section 4, of the El Paso County DCM, the DCM requires the UDFCD Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

Step 1: Employ Runoff Reduction Practices

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

Step 2: Stabilize Drainageways.

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

Step 3: Provide Water Quality Capture Volume

- As required by the DCM, runoff from the proposed streets which is feasible to detain, is directed into proposed detention ponds. Each pond, or series of ponds, will be designed to meet the DCM standards for the release rates of Full Spectrum Detention Ponds for Water Quality Capture Volumes.

Step 4: Consider Need for Industrial and Commercial BMPs

- There are no commercial or industrial components of this development, therefore no BMPs of this nature are required. The Full Spectrum Detention BMP is provided for the proposed Development by the East Pond.

A. PERMITTING REQUIREMENTS

No additional permitting requirements are expected at this time.

VIII. Selected Plan (Implementation of DBPS)

A. PLAN HYDROLOGY

The hydrology for the site has been provided above and complies with the DCM. There is no DBPS for the proposed development.

Provide calculation and update the narrative regarding the hydraulic adequacy of the existing culverts for the developed flows. Describe the condition of the existing culverts .

B. SYSTEM IMPROVEMENTS

No improvements to the existing system are anticipated.

C. SYSTEM PRIORITIES/PHASING

No phasing of the development beyond Filing No. 1 has been provided at this time. Once development of any portion of the site begins, the owner will be responsible for providing detention and water quality in accordance with this MDDP, before releasing downstream.

D. GOVERNMENTAL AGENCY REQUIREMENTS

There are no governmental agency requirements for this development.

E. MAINTENANCE REQUIREMENTS

Maintenance requirements for all stormwater quality and erosion control procedures will be outlined in the Erosion Control and Storm Water Management Plans. The detention and water quality treatment ponds proposed in this report will be privately owned and maintained by the Grandwood Ranch Home Owners Association.

F. RECOMMENDATION FOR IMPLEMENTATION

It is recommended that any development of the site initiates the implementation of the detention and water quality procedures that have been detailed in this report. In order to maintain the developed condition of the site, which will allow the site to continue to adhere to the DCM and protect downstream owners and the facilities.

Update to state Jackson Creek is included in the El Paso County Drainage Basin Fee program. Drainage fee will be calculated with the final drainage report and paid at the time of plat recordation.

IX. Fee Development

A. UNDEVELOPED PLATTABLE LAND

The Grandwood Ranch Subdivision is made up entirely of undeveloped and unplatted land.

X. Construction Cost Opinion

Specific construction costs will be provided in an FDR for the development.

XI. References

1. *El Paso County and City of Colorado Springs Drainage Criteria Manual, Volume 1 & 2*, El Paso County, May 2014
2. *El Paso County Engineering Criteria Manual*, El Paso County, Rev. December 2016
3. *Web Soil Survey of El Paso County Area, Colorado. United States Department of Agriculture Soil Conservation Service.*
4. *Flood Insurance Rate Maps for El Paso County, Colorado and Incorporated Areas, Panel 279 of 1275, Federal Emergency Management Agency*, Effective Date December 7, 2018.
5. *Urban Storm Drainage Criteria Manual, Vol. 1-3* by Urban Drainage and Flood Control District (UDFCD), January 2016
6. *Final Drainage Report for Timberview Subdivision Phase II*, by Premier Engineering Inc., June 5, 2001.
7. *Final Drainage Report for Bent Tree Subdivision Filing No. 3*, by RTW Professional Engineers and Consultants, Inc. March 1993.

XII. Appendices

APPENDIX A

HYDROLOGIC AND HYDRAULIC CALCULATIONS

SCS Composite Curve Number

Existing Conditions

Remove the residential component for EX-1A. The entire basin is undeveloped. The small portion offsite does not contain the dwelling units within the basin.

Basin	Land Type	Area (AC)	CN	% I	Weighted CN	Weighted % I
EX-1A	2 AC Residential	59.5	65	12	58.66	8.83
	Herbaceous, good	21.4	41	0		
EX-1B	2 AC Residential	5.2	65	12	36.65	7.83
	Herbaceous, good	2.8	41	0		
EX-1C	Woods	5.8	65	12		
EX-1D	2 AC Residential	24.7	65	12		
EX-1E	2 AC Residential	37.0	65	12		
EX-1F	2 AC Residential	52.7	65	12		
EX-1G	2 AC Residential	62.5	65	12		
EX-2A	2 AC Residential	14.4	65	12		
EX-2B	Woods, good	18.3	34	0	38.70	0
	Herbaceous, good	13.8	41	0		
	2 AC Residential	2.1	65	12		
EX-2C1	2 AC Residential	13.3	65	12		
EX-2C2	Woods, good	23.2	34	0	36.10	0
	Herbaceous, good	10.1	41	0		
EX-2C3	Woods, good	3.0	34	0	37.50	0
	Herbaceous, good	3.1	41	0		
EX-2D1	2 AC Residential	14.4	65	12		
EX-2D2	2 AC Residential	12.7	65	12		
EX-2D3	2 AC Residential	16.4	65	12		
EX-2E	2 AC Residential	12.4	65	12		
EX-2F	2 AC Residential	19.7	65	12		
EX-2G	2 AC Residential	12.4	65	12		
EX-2H	2 AC Residential	31.6	65	12		
EX-2I	2 AC Residential	13.3	65	12		
EX-2J	2 AC Residential	48.4	65	12		
EX-3	2 AC Residential	19.0	65	12	65.6	13.6
	Road	0.4	98	100		
EX-3A	2 AC Residential	40.56619	65	12		
EX-4	Woods, good	8.45	34	0		

Staff is calculating only 1.9 ac of residential lots offsite.

Revise to 11% per ECM Appendix L Table 3-1 for 2.5 acre residential

remove the residential component for EX-2B

Revise EX-3. The majority of the site is undeveloped. Offsite residential is only approx. 1 ac of the sub-basin. Remove the road component

Explain the difference between the columns highlighted in blue versus the true initial length and true channel length.

Lag Time Calculations

Existing Conditions

	Flow			Initial Flow				Channel Flow						Time of Concentration Tc (hr)	Time of Concentration Tc (min)	Lag Time t lag (min)
	Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel			
	ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)			
EX-1A	2600.8	300	0	2300.8	7409	7269	0.05	1.2	7409	7269	0.07	4.3	0.1	1.4	83.8	50.3
EX-1B	1746.9	300	0	1446.9	7426	7323	0.06	1.2	7426	7323	0.08	4.6	0.1	1.3	77.4	46.4
EX-1C	1099.9	300	0	799.9	7401	7303	0.09	1.0	7401	7303	0.13	5.8	0.0	1.1	63.4	38.1
EX-1D	1334.2	300	0	1034.2	7432	7329	0.08	1.1	7432	7329	0.1	5.1	0.1	1.1	68.1	40.8
EX-1E	2105.6	300	0	1805.6	7484	7354	0.06	1.2	7484	7354	0.08	4.6	0.1	1.3	77.4	46.5
EX-1F	2718.3	300	0	2418.3	7505	7375	0.05	1.3	7505	7375	0.06	4.0	0.2	1.5	88.6	53.2
EX-1G	2446.8	300	0	2146.8	7506	7375	0.05	1.2	7506	7375	0.07	4.3	0.1	1.4	83.3	50.0
EX-2A	1451.2	300	0	1151.2	7409	7269	0.10	1.0	7409	7269	0.13	5.8	0.1	1.0	62.5	37.5
EX-2B	1720.2	300	0	1420.2	7264	7159	0.06	1.2	7264	7159	0.08	4.6	0.1	1.3	76.5	45.9
EX-2C1	1391.1	300	0	1091.1	7365	7258	0.08	1.1	7365	7258	0.1	5.1	0.1	1.1	68.5	41.1
EX-2C2	2561.1	300	0	2261.1	7350	7182	0.07	1.2	7350	7182	0.08	4.6	0.1	1.3	77.4	46.4
EX-2C3	882.9	300	0	582.9	7235	7156	0.09	1.0	7235	7156	0.14	6.0	0.0	1.0	62.7	37.6
EX-2D	2587.1	300	0	2287.1	7400	7248	0.06	1.2	7400	7248	0.07	4.3	0.1	1.4	81.2	48.7
EX-2D1	1280.5	300	0	980.5	7411	7316	0.07	1.1	7411	7316	0.1	5.1	0.1	1.2	69.0	41.4
EX-2D2	1192.4	300	0	892.4	7430	7317	0.10	1.0	7430	7317	0.13	5.8	0.0	1.0	62.1	37.3
EX-2D3	1794.6	300	0	1494.6	7429	7289	0.08	1.1	7429	7289	0.1	5.1	0.1	1.2	69.4	41.6
EX-2E	1338.1	300	0	1038.1	7410	7249	0.12	0.9	7410	7249	0.16	6.5	0.0	0.9	57.0	34.2
EX-2F	2590.9	300	0	2290.9	7379	7259	0.05	1.3	7379	7259	0.06	4.0	0.2	1.5	89.1	53.5
EX-2G	1700.5	300	0	1400.5	7432	7309	0.07	1.1	7432	7309	0.09	4.8	0.1	1.2	71.3	42.8
EX-2H	2113.0	300	0	1813.0	7477	7328	0.07	1.1	7477	7328	0.09	4.8	0.1	1.2	73.4	44.0
EX-2I	1793.7	300	0	1493.7	7425	7309	0.06	1.2	7425	7309	0.08	4.6	0.1	1.2	75.0	45.0
EX-2J	1636.1	300	0	1336.1	7466	7382	0.05	1.3	7466	7382	0.07	4.3	0.1	1.4	81.4	48.9
EX-3	1543.1	300	0	1243.1	7251	7171	0.05	1.3	7251	7171	0.07	4.3	0.1	1.3	81.0	48.6
EX-3A	2132.5	300	0	1832.5	7403	7251	0.07	1.1	7403	7251	0.09	4.8	0.1	1.2	73.2	43.9
EX-4	1094.6	300	0	794.6	7340	7244	0.09	0.1	7340	7244	0.087703	1.2	0.2	0.3	19.9	11.9

Flowpath Routing

Existing Conditions

Routing calculations were completed through a combination of flow path calculations and known flow path lengths through sub-basins. These methods are noted below.

By Basin Path	Flow Path	Lag Time
EX-1A		
DP 4 to DP EX-1	EX-1A	50.3
EX-1D		
EX-1E	EX-1D	40.8
EX-1F	Flow Path 6	54.5
EX-1G	Flow Path 6	54.5
EX-2A	EX-2B	45.9
EX-2B		
EX-2C1	Flow Path 3	53.1
EX-2C2	Flow Path 4	50.1
EX-2C3		
EX-2D	EX-2B	45.9
EX-2D1	EX-2D	48.7
EX-2D2	EX-2D	48.7
EX-2D3		90.0
EX-2E		96.2
EX-2F	These basins match proposed basins and routing calculations match	48.3
EX-2G		95.6
EX-2H		100.1
EX-2I		95.6
EX-2J		102.7
EX-3		
EX-3A	EX-3	48.6

EX-4 missing.

By Path Length

Flow Path Number	Description	Flow Lengths				Initial Flow				Channel Flow					Time of Concentration Tc (hr)	Time of Concentration Tc (min)	Lag Time t lag (min)
		Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel			
		ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)			
1	Design Point 5 to Design Point 4	461	300	0	161	7323	7304	0.04	1.40	7323	7304	0.12	5.6	0.0	1.4	84.5	50.7
2	EX-1F/EX-1G to DP 6	1231.3	300	0	931	7375	7329	0.04	1.44	7375	7329	0.05	3.6	0.1	1.5	90.9	54.5
3	EX-2C1 to Culvert C-2	2198.7	300	0	1899	7258.61	7160	0.04	1.34	7259	7160	0.06	4.0	0.1	1.5	88.5	53.1
4	EX-2C2 to Culvert C-2	528.2	300	0	228	7182.147	7160	0.04	1.38	7182	7160	0.10	5.1	0.0	1.4	83.5	50.1
5	DP 3 to EX-2B	720	300	0	420	7298	7249.39	0.07	1.14	7298	7249	0.12	5.6	0.0	1.2	69.6	41.7
6	Junction of EX-1F/EX-1G to Reservoir OS-6	1231.3	300	0	931	7375	7329	0.04	1.44	7375	7329	0.05	3.6	0.1	1.5	90.9	54.5

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	-----	Poor	---	-----	66	74	79

SCS Composite Curve Number

Add a column for the calculated initial abstraction.

Update Herbaceous-Good CN to match Table 6-10

Basin	Land Type	Area (AC)	CN	% I	Weighted CN	Weighted %
W-1	2 ac Residential	18.9	65	12	65.6	11.8
	Road	0.4	98	1		
W-2	Wetland	0.3	86	0	45.4	0.0
	Herbaceous, good	2.8	41	0		

Woods ⁷	Treatment	Hydrologic Condition ⁸	% I	HSG A	HSG B	HSG C	HSG D
-----	Poor	---	45	66	77	83	
	Fair	---	36	60	73	79	
	Good	---	30	55	70	77	

Spot check W7. HMS model note 13.45 %. Double check all values

Not a part of the drainage map. May be mislabeled. The map identifies OS-4# which are missing from this table

Update Woods CN to match Table 6-10

All offsite basins inputs must match the existing condition. Example the equivalent basin in the existing condition model for OS-3A is basin EX-2D1. Ex-2D1 does not specify a road component. Remove the road component from OS-3A.

update to 100

-3 is missing in the table

Remove Herbaceous. These are all residential

remove road for E-1. E-1B is missing from map

Drainage map shows less than 1 ac of the basin is residential lots for basin D-2. The CN in Table 6-10 for the road includes open ditches in ROW

W-5	2 ac Residential	9.3	65	12		
W-6	2 ac Residential	1.8	65	12		
W-7	2 ac Residential	16.1	65	12	65.5	11.8
	Road	0.3	98	1		
W-8	2 ac Residential	2.5	65	12		
W-9	2		65	12		
W-10	2		34	0		
OS-1	2		65	12		
OS-2A	2		65	12		
OS-2B	2		65	12		
OS-3A	2		65	12	65.8	13.5
	Road	0.4	98	100		
OS-3A2	2 ac Residential	16.4	65	12		
OS-3A3	2 ac Residential	13.4	65	12	63.1	13.6
	Road	0.4	98	100		
OS-3A4	2 ac Residential	11.8	65	12	63.2	
	Road	0.4	98	100		
OS-3B	2 ac Residential	12.4	65	12		
OS-3C	2 ac Residential	16.1	65	12		
OS-3D	2 ac Residential	12.4	65	12		
OS-3E	2 ac Residential	31.6	65	12		
OS-3F	2 ac Residential	13.3	65	12		
OS-3G	2 ac Residential	48.4	65	12		
D-1	2 ac Residential	13.3	65	12	68.4	10.4
	Road	1.3	98	1		
D-2	Herbaceous, good	0.3	41	0	79.0	
	2 ac Residential	9.2	65	12		
E-1	2 ac Residential	4.3	65	12	68.1	0.6
	Road	3.2	98	1		
E-1B	Road	0.5	98	1	62.6	0.5
	2 ac Residential	4.6	65	0.54		
	2 ac Residential	6.8	65	0.54		
E-1B	2 ac Residential	0.4	98	1		
	Herbaceous, good	1.4	41	0		

100. Double check all other basins.

Basin	Land Type	Area (AC)	CN	% I	Weighted CN	weighted % I
E-2	2 ac Residential	6.8	65	12	68.1	11.0
	Road	0.7	98	1		
E-3	Wetland	0.0	86	0	54.5	6.7
	Herbaceous, good	9.4	41	0		
	2 ac Residential	12.0	65	12		
E-4A	2 ac Residential	4.4	65	12		
E-4B	2 ac Residential	6.6	65	12		
E-5A	2 ac Residential	8.0	65	12		
E-5B	2 ac Residential	5.8	65	12		
OS-4	2 ac Residential	15.6	65	12		
OS-5A	2 ac Residential	24.7	65	12		
OS-5B	2 ac Residential	37.0	65	12		
OS-5C	2 ac Residential	52.7	65	12		
OS-5D	2 ac Residential	62.5	65	12		

Lag Time Calculations

Proposed Conditions - West and Central Basins

	Flow Lengths				Initial Flow				Channel Flow					Time of Concentration	Time of Concentration	Lag Time
	Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel			
	ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)			
W-1	1536.2	300	0	1236.2	7251	7172	0.051	1.270	7251	7172	0.07	4.3	0.1	1.4	81.0	48.6
W-2	279.0	279.0	207.3	207.3	7202	7169	0.117	0.862	7202	7156	0.23	7.7	0.0	0.9	52.2	31.3
W-3	490.2	300	0	190.2	7274	7205	0.141	0.849	7274	7205	0.37	9.8	0.0	0.9	51.3	30.8
W-4	525.6	300	0	225.6	7245	7221	0.046	1.330	7245	7221	0.11	5.4	0.0	1.3	80.5	48.3
W-5	1368.1	300	179.9	1248.0	7356	7276	0.058	1.206	7276	7272	0.01	1.6	0.2	1.4	85.3	51.2
W-6	723.5	300	0	423.5	7338	7261	0.107	0.949	7338	7261	0.19	7.0	0.0	1.0	57.9	34.8
W-7	1679.1	300	0	1379.1	7281	7186	0.056	1.223	7281	7186	0.07	4.3	0.1	1.3	78.8	47.3
W-8	584.0	300	0	284.0	7228	7169	0.100	0.972	7228	7169	0.21	7.4	0.0	1.0	59.0	35.4
W-9	503.4	300	0	203.4	7213	7186	0.053	1.256	7213	7186	0.14	6.0	0.0	1.3	75.9	45.6
W-10	1094.6	300	0	794.6	7340	7244	0.088	0.146	7340	7244	0.087703	1.2	0.2	0.3	19.9	11.9
D-1	1089.2	300	166.7	955.9	7287	7200	0.080	1.066	7200	7170	0.04	3.2	0.1	1.1	68.9	41.3
D-2	538.2	300	644.3	882.5	7262	7206	0.104	0.959	7206	7161	0.06	4.0	0.1	1.0	61.3	36.8
OS-1	2132.5	300	0	1832.5	7403	7251	0.071	1.115	7403	7251	0.09	4.8	0.1	1.2	73.2	43.9
OS-2A	1451.0	300	0	1151.0	7405	7273	0.091	1.011	7405	7273	0.12	5.6	0.1	1.1	64.1	38.5
OS-2B	300.0	300	0	0.0	7274	7238	0.121	0.902	7274	7238	0	0.0	0.0	0.9	54.1	32.5
OS-3A	1285.8	300	0	985.8	7317	7245	0.056	1.230	7317	7245	0.08	4.6	0.1	1.3	77.4	46.4
OS-3A2	1794.6	300	0	1494.6	7429	7289	0.078	1.075	7429	7289	0.1	5.1	0.1	1.2	69.4	41.6
OS-3A3	1280.5	300	0	980.5	7411	7316	0.074	1.097	7411	7316	0.1	5.1	0.1	1.2	69.0	41.4
OS-3A4	1192.4	300	0	892.4	7430	7317	0.095	0.993	7430	7317	0.13	5.8	0.0	1.0	62.1	37.3
OS-3B	1338.1	300	0	1038.1	7410	7249	0.120	0.905	7410	7249	0.16	6.5	0.0	0.9	57.0	34.2
OS-3C	2590.9	300	0	2290.9	7379	7259	0.046	1.324	7379	7259	0.06	4.0	0.2	1.5	89.1	53.5
OS-3D	1700.5	300	0	1400.5	7432	7309	0.072	1.108	7432	7309	0.09	4.8	0.1	1.2	71.3	42.8
OS-3E	2113.0	300	0	1813.0	7477	7328	0.071	1.119	7477	7328	0.09	4.8	0.1	1.2	73.4	44.0
OS-3F	1793.7	300	0	1493.7	7425	7309	0.065	1.158	7425	7309	0.08	4.6	0.1	1.2	75.0	45.0
OS-3G	1636.1	300	0	1336.1	7466	7382	0.051	1.270	7466	7382	0.07	4.3	0.1	1.4	81.4	48.9
OS-3H	1420.6	300	0	1120.6	7371	7258	0.080	1.066	7371	7258	0.11	5.4	0.1	1.1	67.5	40.5

Lag Time Calculations

Proposed Conditions - East Basin

	Flow Lengths				Initial Flow				Channel Flow					Time of Concentration Tc (hr)	Time of Concentration Tc (min)	Lag Time t lag (min)
	Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel			
	ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)			
E-1	632.6	300	1052.6	1385.133	7357	7302	0.087	1.0	7304	7270	0.03	2.8	0.1	1.2	70.0	42.0
E-2	613.8	300	0	313.823	7339	7300	0.063	1.2	7339	7300	0.13	5.8	0.0	1.2	71.1	42.7
E-3	1502.6	300	0	1202.637	7339	7300	0.026	1.7	7339	7300	0.04	3.2	0.1	1.8	106.6	64.0
E-4A	1746.9	300	0	1446.865	7426	7323	0.059	1.2	7426	7323	0.08	4.6	0.1	1.3	77.4	46.4
E-4B	1099.9	300	0	799.911	7401	7303	0.089	1.0	7401	7303	0.13	5.8	0.0	1.1	63.4	38.1
D-3	885.3	300	0	585.281	7299	7251	0.055	1.2	7299	7251	0.09	4.8	0.0	1.3	76.3	45.8
D-4A	1168.3	300	0	868.343	7339	7300	0.033	1.5	7339	7300	0.05	3.6	0.1	1.6	94.8	56.9
D-4B	1052.9	300	0	752.923	7394	7300	0.089	1.0	7394	7300	0.13	5.8	0.0	1.1	63.3	38.0
OS-5	3949.9	300	0	3649.897	7423	7308	0.029	1.6	7423	7308	0.04	3.2	0.3	1.9	114.5	68.7
OS-6A	1334.2	300	0	1034.166	7432	7329	0.077	1.1	7432	7329	0.10	5.1	0.1	1.1	68.1	40.8
OS-6B	2105.6	300	0	1805.604	7484	7354	0.062	1.2	7484	7354	0.08	4.6	0.1	1.3	77.4	46.5
OS-6C	2718.3	300	0	2418.312	7505	7375	0.048	1.3	7505	7375	0.06	4.0	0.2	1.5	88.6	53.2
OS-6D	2446.8	300	0	2146.783	7506	7375	0.054	1.2	7506	7375	0.07	4.3	0.1	1.4	83.3	50.0

Flowpath Routing

Existing Conditions

Routing calculations were completed through a combination of flow path calculations and known flow path lengths through sub-basins. These methods are noted below.

By Basin Path	Flow Path	Lag Time
OS-1		
OS-2A	Flow Path 6	43.9
OS-2B	W-3	30.8
OS-3A	W-4	48.3
OS-3B	W-4, Flow Path 5	90.0
OS-3C	OS-3A	46.4
OS-4A	OS-3A	46.4
OS-4B	W-4, Flow Path 4	96.2
OS-4C	W-4	48.3
OS-4D	W-4, Flow Path 1	95.6
OS-4E	W-4, Flow Path 3	100.1
OS-4F	W-4, Flow Path 1	95.6
OS-4G	W-4, Flow Path 2	102.7
OS-4H	W-4	48.3
OS-5	E-2, E-3	45.8
OS-6A		
OS-6B	OS-6A	40.8
OS-6C	Flow Path 7	54.5
OS-6D	Flow Path 7	54.5
W-1		
W-2		
W-3		
W-4		
W-5		
W-6	W-7	47.3
W-7		
W-8		
W-9	W-2	31.3
C-1		
E-1	D-3	45.8
E-2	E-3	64.0
E-3		
E-4A		
E-4B		
Pond 1	W-2	31.3
Pond 2	W-2	31.3
Pond 3	E-3	64.0
Pond 4	E-3	64.0

Flow Path

Flow Path Number	Description	Flow Lengths				Initial Flow				Channel Flow					Time of Concentration Tc (hr)	Time of Concentration Tc (min)	Lag Time t lag (min)
		Initial	True Initial Length	Channel	True Channel Length	High Point	Low Point	Average	Initial	High Point	Low Point	Average	Velocity	Channel			
		ft	ft	ft	ft	Elevation	Elevation	Slope	Tt (hr)	Elevation	Elevation	Slope	(ft/s)	Tt (hr)			
1	Junction of OS-3D/OS-3F to DP 3	1159.7	300	0	860	7310	7249	0.05	1.3	7310	7249	0.08	4.6	0.1	1.3	78.8	47.3
2	OS-4G to W-4	2891.0	300	0	2591	7382.02	7249	0.05	1.3	7382	7249	0.06	4.0	0.2	1.5	90.7	54.4
3	OS-4E to DP	1959.6	300	0	1660	7340	7249	0.05	1.3	7340	7249	0.06	4.0	0.1	1.4	86.4	51.8
4	OS-4B to W-4	981.1	300	0	681	7298	7249	0.05	1.3	7298	7249	0.08	4.6	0.0	1.3	79.8	47.9
5	DP 3 to W-4	720.0	300	0	420	7298	7249	0.07	1.1	7298	7249	0.12	5.6	0.0	1.2	69.6	41.7
6	OS-2A to Culvert 2	1483.1	300	0	1183	7274	7177	0.07	1.2	7274	7177	0.09	4.8	0.1	1.2	73.2	43.9
7	Junction of OS-6C/OS-6D to Reservoir OS-6	1231.3	300	0	931	7375	7329	0.04	1.4	7375	7329	0.05	3.6	0.1	1.5	90.9	54.5
8	Reservoir OS-6 to C-10	484.9	300	0	185	7332	7305	0.06	1.2	7332	7305	0.15	6.2	0.0	1.2	74.2	44.5
9	OS-6B to Reservoir OS-6	398.4	300	0	98	7353	7329	0.06	1.2	7353	7329	0.25	8.1	0.0	1.2	71.8	43.1

Provide a schematic exhibit of the HEC-HMS Model with the hydrologic elements labeled

EX_GWR.basin

Basin: EX GWR

Last Modified Date: 8 April 2020
Last Modified Time: 18:37:32
Version: 4.3
Filepath Separator: \
Unit System: English
Missing Flow To Zero: No
Enable Flow Ratio: No
Compute Local Flow At Junctions: No

Enable Sediment Routing: No

Enable Quality Routing: No

End:

Subbasin: EX-2D

Last Modified Date: 6 April 2020
Last Modified Time: 20:34:23
Canvas X: -104.8242829194121
Canvas Y: 39.084432502226434
From Canvas X: -104.82256126505573
From Canvas Y: 39.083317512170844
Area: 0.034
Downstream: Junction EX-2D

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 16.64
Curve Number: 66.74
Initial Abstraction: 0.5

Transform: SCS
Lag: 48.7
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: EX-2I

Last Modified Date: 3 April 2020
Last Modified Time: 16:12:29
Canvas X: -104.81782596518133
Canvas Y: 39.086409535460234

EX_GWR.basin

From Canvas X: -104.81770300010537
From Canvas Y: 39.08618912602626
Area: 0.021
Downstream: Route DP 5

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 45
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: EX-2H

Last Modified Date: 3 April 2020
Last Modified Time: 16:12:12
Canvas X: -104.81772639141457
Canvas Y: 39.08747995345288
From Canvas X: -104.81819063264685
From Canvas Y: 39.08727275389623
Label X: -1.0
Label Y: 0.0
Area: 0.049
Downstream: Route ex

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 44

EX_GWR.basin

Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: EX-2J

Last Modified Date: 2 April 2020

Last Modified Time: 16:05:31

Canvas X: -104.81768493964087

Canvas Y: 39.08539446558829

From Canvas X: -104.81768493964087

From Canvas Y: 39.08539446558829

Area: 0.076

Downstream: Route DP 6

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 48.9

Unitgraph Type: STANDARD

Baseflow: None

End:

Junction: Upper Junction

Description: Sub-basin divided using design points

Last Modified Date: 3 April 2020

Last Modified Time: 16:55:37

Canvas X: -104.82149569765026

Canvas Y: 39.0849429539758

From Canvas X: -104.82149569765026

From Canvas Y: 39.0849429539758

Downstream: Route Upper Junction

End:

Reach: Route DP 6

Last Modified Date: 3 April 2020

Last Modified Time: 14:50:47

Canvas X: -104.82149569765026

EX_GWR.basin

Canvas Y: 39.0849429539758
From Canvas X: -104.81822675357586
From Canvas Y: 39.085033256298296
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 102.7
Channel Loss: None

End:

Reach: Route DP 5

Last Modified Date: 3 April 2020
Last Modified Time: 14:50:39
Canvas X: -104.82149569765026
Canvas Y: 39.0849429539758
From Canvas X: -104.81813645125335
From Canvas Y: 39.085864037665274
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 95.59
Channel Loss: None

End:

Subbasin: EX-2E

Last Modified Date: 3 April 2020
Last Modified Time: 16:12:32
Canvas X: -104.82228189124373
Canvas Y: 39.08805250261174
From Canvas X: -104.82248902319773
From Canvas Y: 39.08772426550872
Area: 0.019
Downstream: Route DP 1

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS

EX_GWR.basin

Lag: 34.2
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: EX-2G

Last Modified Date: 2 April 2020
Last Modified Time: 19:15:55
Canvas X: -104.8189286826048
Canvas Y: 39.087790017111175
From Canvas X: -104.81896723262034
From Canvas Y: 39.08772426550872
Area: 0.019
Downstream: Route DP 3

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 42.8
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: EX-2F

Last Modified Date: 2 April 2020
Last Modified Time: 16:05:01
Canvas X: -104.82057461396079
Canvas Y: 39.08770620504422
From Canvas X: -104.82057461396079
From Canvas Y: 39.08770620504422
Area: 0.031
Downstream: Route DP 2

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

EX_GWR.basin

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 53.5

Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route ex

Last Modified Date: 8 April 2020

Last Modified Time: 14:30:00

Canvas X: -104.82149569765026

Canvas Y: 39.0849429539758

From Canvas X: -104.82001658805

From Canvas Y: 39.08583698630137

Downstream: Upper Junction

Route: Lag

Initial Variable: Combined Inflow

Lag: 100.14

Channel Loss: None

End:

Reach: Route DP 3

Last Modified Date: 3 April 2020

Last Modified Time: 14:50:28

Canvas X: -104.82149569765026

Canvas Y: 39.0849429539758

From Canvas X: -104.81918395819433

From Canvas Y: 39.08712827018024

Downstream: Upper Junction

Route: Lag

Initial Variable: Combined Inflow

Lag: 95.59

Channel Loss: None

End:

Reach: Route DP 2

Last Modified Date: 2 April 2020

Last Modified Time: 16:43:03

Canvas X: -104.82149569765026

EX_GWR.basin

Canvas Y: 39.0849429539758
From Canvas X: -104.82056817382905
From Canvas Y: 39.086834154708086
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 48.3
Channel Loss: None

End:

Reach: Route DP 1

Last Modified Date: 3 April 2020
Last Modified Time: 16:55:37
Canvas X: -104.82149569765026
Canvas Y: 39.0849429539758
From Canvas X: -104.82193807142886
From Canvas Y: 39.08644263441573
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 96.18
Channel Loss: None

End:

Reach: Route Upper Junction

Last Modified Date: 6 April 2020
Last Modified Time: 21:48:48
Canvas X: -104.82611916757496
Canvas Y: 39.075437029351406
From Canvas X: -104.82149569765026
From Canvas Y: 39.0849429539758
Downstream: Sink EX-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 45.9
Channel Loss: None

End:

Subbasin: EX-2D1

Last Modified Date: 6 April 2020
Last Modified Time: 20:26:26
Canvas X: -104.8256371281945
Canvas Y: 39.086422453126914
From Canvas X: -104.82518045930776
From Canvas Y: 39.086549305595454

EX_GWR.basin

Area: 0.0255
Downstream: Route EX-2D1

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 63.07
Curve Number: 13.64
Initial Abstraction: 0.59

Transform: SCS
Lag: 48.7
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route EX-2D1

Last Modified Date: 6 April 2020
Last Modified Time: 20:34:13
Canvas X: -104.82512645260917
Canvas Y: 39.082417395144546
From Canvas X: -104.82558638720708
From Canvas Y: 39.0857374497968
Downstream: Junction EX-2D

Route: Lag
Initial Variable: Combined Inflow
Lag: 48.7
Channel Loss: None

End:

Subbasin: EX-2D2

Last Modified Date: 6 April 2020
Last Modified Time: 20:27:55
Canvas X: -104.82479990190214
Canvas Y: 39.08528078091006
From Canvas X: -104.82406415758462
From Canvas Y: 39.087132826950736
Area: 0.0198
Downstream: Route EX-2D2

Canopy: None
Allow Simultaneous Precip Et: No

EX_GWR.basin

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 13.64

Curve Number: 63.17

Initial Abstraction: 0.58

Transform: SCS

Lag: 37.3

Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route EX-2D2

Last Modified Date: 6 April 2020

Last Modified Time: 20:34:13

Canvas X: -104.82512645260917

Canvas Y: 39.082417395144546

From Canvas X: -104.8249774953581

From Canvas Y: 39.08469725955478

Downstream: Junction EX-2D

Route: Lag

Initial Variable: Combined Inflow

Lag: 48.7

Channel Loss: None

End:

Junction: Junction EX-2D

Last Modified Date: 8 April 2020

Last Modified Time: 18:37:31

Canvas X: -104.82512645260917

Canvas Y: 39.082417395144546

From Canvas X: -104.82419101005316

From Canvas Y: 39.08112001994197

Label X: -52.0

Label Y: -19.0

Downstream: Route EX-2D

End:

Reach: Route EX-2D

Description: EX-2B

Last Modified Date: 6 April 2020

Last Modified Time: 21:48:48

Canvas X: -104.82611916757496

EX_GWR.basin

Canvas Y: 39.075437029351406
From Canvas X: -104.82512645260917
From Canvas Y: 39.082417395144546
Downstream: Sink EX-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 45.9
Channel Loss: None

End:

Subbasin: EX-2C2

Last Modified Date: 10 April 2020
Last Modified Time: 19:08:42
Canvas X: -104.8230493378363
Canvas Y: 39.07642647860602
From Canvas X: -104.82375060430341
From Canvas Y: 39.078363151905414
Area: 0.052
Downstream: Route EX-2C2

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 0
Curve Number: 36.1
Initial Abstraction: 1.77

Transform: SCS
Lag: 46.4
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route EX-2C2

Last Modified Date: 6 April 2020
Last Modified Time: 21:48:48
Canvas X: -104.82611916757496
Canvas Y: 39.075437029351406
From Canvas X: -104.82381045264754
From Canvas Y: 39.07616643578142
Downstream: Sink EX-2

EX_GWR.basin

Route: Lag
Initial Variable: Combined Inflow
Lag: 50.1
Channel Loss: None

End:

Subbasin: EX-2D3

Last Modified Date: 6 April 2020
Last Modified Time: 20:31:32
Canvas X: -104.82261803944327
Canvas Y: 39.08609263670871
From Canvas X: -104.82269415092439
From Canvas Y: 39.085813561277924
Area: 0.0256
Downstream: Route EX-2D3

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 41.6
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route EX-2D3

Last Modified Date: 6 April 2020
Last Modified Time: 21:48:48
Canvas X: -104.82611916757496
Canvas Y: 39.075437029351406
From Canvas X: -104.82279563289923
From Canvas Y: 39.0844435546177
Downstream: Sink EX-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 90
Channel Loss: None

End:

EX_GWR.basin

Subbasin: EX-2A

Description: Culvert at outlet. Max flow 29 cfs
Last Modified Date: 6 April 2020
Last Modified Time: 20:22:26
Canvas X: -104.82817417756529
Canvas Y: 39.082997436476354
From Canvas X: -104.82572184634314
From Canvas Y: 39.08447338189881
Area: 0.022
Downstream: Route EX-2A

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 37.5
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: EX-2B

Last Modified Date: 6 April 2020
Last Modified Time: 21:46:22
Canvas X: -104.82731158077922
Canvas Y: 39.08416447918692
From Canvas X: -104.82476464172467
From Canvas Y: 39.08393156796382
Label X: 5.0
Label Y: 1.0
Area: 0.053
Downstream: Sink EX-2

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

EX_GWR.basin

LossRate: SCS
Percent Impervious Area: 0.00
Curve Number: 38.8
Initial Abstraction: 1.58

Transform: SCS
Lag: 45.9
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route EX-2A

Last Modified Date: 6 April 2020
Last Modified Time: 21:48:48
Canvas X: -104.82611916757496
Canvas Y: 39.075437029351406
From Canvas X: -104.82774287917226
From Canvas Y: 39.08226169215882
Downstream: Sink EX-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 45.9
Channel Loss: None

End:

Subbasin: EX-2C1

Last Modified Date: 10 April 2020
Last Modified Time: 19:11:58
Canvas X: -104.82391193462237
Canvas Y: 39.07781551787243
From Canvas X: -104.8242733665789
From Canvas Y: 39.07898548794765
Area: 0.021
Downstream: Route EX-2C1

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12
Curve Number: 65
Initial Abstraction: 0.54

EX_GWR.basin

Transform: SCS
Lag: 41.1
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route EX-2C1

Last Modified Date: 6 April 2020
Last Modified Time: 21:48:48
Canvas X: -104.82611916757496
Canvas Y: 39.075437029351406
From Canvas X: -104.82449545597765
From Canvas Y: 39.07695292108636
Downstream: Sink EX-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 53.1
Channel Loss: None

End:

Subbasin: EX-2C3

Last Modified Date: 10 April 2020
Last Modified Time: 19:10:39
Canvas X: -104.82322693129225
Canvas Y: 39.07472031764007
From Canvas X: -104.82350166988653
From Canvas Y: 39.077541668329665
Area: 0.01
Downstream: Sink EX-2

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 0
Curve Number: 37.5
Initial Abstraction: 1.66

Transform: SCS
Lag: 37.6
Unitgraph Type: STANDARD

Baseflow: None

EX_GWR.basin

End:

Sink: Sink EX-2

Description: Existing culvert
Last Modified Date: 6 April 2020
Last Modified Time: 21:48:48
Canvas X: -104.82611916757496
Canvas Y: 39.075437029351406
From Canvas X: -104.82853083687779
From Canvas Y: 39.07687179389039

End:

Reach: Route EX-1G

Last Modified Date: 8 April 2020
Last Modified Time: 17:22:20
Canvas X: -104.80559443816529
Canvas Y: 39.08200798722174
From Canvas X: -104.80288471191857
From Canvas Y: 39.081030770530596
Downstream: Reservoir OS-5

Route: Lag
Initial Variable: Combined Inflow
Lag: 54.5
Channel Loss: None

End:

Junction: Design Point 4

Last Modified Date: 8 April 2020
Last Modified Time: 18:37:16
Canvas X: -104.81193706159225
Canvas Y: 39.07997834772512
From Canvas X: -104.81161214714145
From Canvas Y: 39.07932492247949
Downstream: Route Upper Basin

End:

Reach: Route EX-1F

Last Modified Date: 8 April 2020
Last Modified Time: 17:22:20
Canvas X: -104.80559443816529
Canvas Y: 39.08200798722174
From Canvas X: -104.80313072206603
From Canvas Y: 39.08183908958656
Downstream: Reservoir OS-5

Route: Lag
Initial Variable: Combined Inflow

EX_GWR.basin

Lag: 54.5
Channel Loss: None

End:

Reach: Route EX-1E

Last Modified Date: 8 April 2020
Last Modified Time: 17:22:20
Canvas X: -104.80559443816529
Canvas Y: 39.08200798722174
From Canvas X: -104.80470647088549
From Canvas Y: 39.082515397095904
Downstream: Reservoir OS-5

Route: Lag
Initial Variable: Combined Inflow
Lag: 50
Channel Loss: None

End:

Reach: Route Res OS-5

Last Modified Date: 8 April 2020
Last Modified Time: 18:37:07
Canvas X: -104.81193706159225
Canvas Y: 39.07997834772512
From Canvas X: -104.80559443816529
From Canvas Y: 39.08200798722174
Downstream: Design Point 4

Route: Lag
Initial Variable: Combined Inflow
Lag: 50.7
Channel Loss: None

End:

Subbasin: Basin EX-1C

Description: EX-1C
Last Modified Date: 8 April 2020
Last Modified Time: 14:31:39
Canvas X: -104.80929853024664
Canvas Y: 39.0802320526622
From Canvas X: -104.80816187456509
From Canvas Y: 39.07952068262567
Area: 0.0091
Downstream: Design Point 4

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

EX_GWR.basin

Surface: None

LossRate: SCS
Percent Impervious Area: 0
Curve Number: 34
Initial Abstraction: 1.94

Transform: SCS
Lag: 46.4
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin EX-1B

Description: EX-1B
Last Modified Date: 8 April 2020
Last Modified Time: 14:30:29
Canvas X: -104.8106822864471
Canvas Y: 39.081892742707595
From Canvas X: -104.81026629613649
From Canvas Y: 39.08118464386818
Area: 0.0126
Downstream: Design Point 4

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 7.83
Curve Number: 56.65
Initial Abstraction: 0.77

Transform: SCS
Lag: 46.4
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin EX-1D

Description: EX-1D
Last Modified Date: 8 April 2020
Last Modified Time: 14:31:23

EX_GWR.basin

Canvas X: -104.80440202496102
Canvas Y: 39.08418984968062
From Canvas X: -104.80436077280338
From Canvas Y: 39.0841937581409
Area: 0.039
Downstream: Reservoir OS-5

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 40.8
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin EX-1E

Description: EX-1E
Last Modified Date: 8 April 2020
Last Modified Time: 14:32:00
Canvas X: -104.8034881010751
Canvas Y: 39.08333647378565
From Canvas X: -104.8035524537474
From Canvas Y: 39.083420583391714
Area: 0.0579
Downstream: Route EX-1E

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS

EX_GWR.basin

Lag: 46.5
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin EX-1F

Last Modified Date: 8 April 2020
Last Modified Time: 14:33:11
Canvas X: -104.80239269162362
Canvas Y: 39.08212024404081
From Canvas X: -104.80239269162362
From Canvas Y: 39.08212024404081
Area: 0.0021
Downstream: Route EX-1F

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 53.2
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin EX-1G

Last Modified Date: 8 April 2020
Last Modified Time: 14:34:51
Canvas X: -104.8020933100336
Canvas Y: 39.08086500194017
From Canvas X: -104.80197095994225
From Canvas Y: 39.08085504899669
Area: 0.0977
Downstream: Route EX-1G

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

EX_GWR.basin

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 50

Unitgraph Type: STANDARD

Baseflow: None

End:

Reservoir: Reservoir OS-5

Description: Reservoir is existing and will not be impacted by dev.

Last Modified Date: 8 April 2020

Last Modified Time: 17:22:20

Canvas X: -104.80559443816529

Canvas Y: 39.08200798722174

From Canvas X: -104.80583683368818

From Canvas Y: 39.08180394527978

Downstream: Route Res OS-5

Route: Specified Outflow

Routing Curve: Elevation-Storage

Initial Elevation: 19

Elevation-Storage Table: Reservoir OS-5

Outflow Gage Name: OS-5 - Q10

Maximum Allowable Discharge: 51.17

Storage Capacity: 3.8

End:

Reach: Route Upper Basin

Last Modified Date: 8 April 2020

Last Modified Time: 18:37:07

Canvas X: -104.81738113287233

Canvas Y: 39.07830933434392

From Canvas X: -104.81193706159225

From Canvas Y: 39.07997834772512

Downstream: Sink EX-1

Route: Lag

Initial Variable: Combined Inflow

Lag: 50.3

Channel Loss: None

End:

EX_GWR.basin

Subbasin: EX-1A

Last Modified Date: 2 April 2020
Last Modified Time: 20:37:11
Canvas X: -104.81501347968127
Canvas Y: 39.08052242168436
From Canvas X: -104.80709271634949
From Canvas Y: 39.08411208955269
Area: 0.126
Downstream: Sink EX-1

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 8.8
Curve Number: 58.7
Initial Abstraction: 0.7

Transform: SCS
Lag: 50.3
Unitgraph Type: STANDARD

Baseflow: None

End:

Sink: Sink EX-1

Description: Existing culvert
Last Modified Date: 1 April 2020
Last Modified Time: 14:39:57
Canvas X: -104.81738113287233
Canvas Y: 39.07830933434392
From Canvas X: -104.81738113287233
From Canvas Y: 39.07830933434392

End:

Reach: Route Res OS-1

Last Modified Date: 6 April 2020
Last Modified Time: 19:27:22
Canvas X: -104.82842788250237
Canvas Y: 39.076014212819175
From Canvas X: -104.83067098109308
From Canvas Y: 39.081798446858556
Downstream: Sink EX-3

Route: Lag

EX_GWR.basin

Initial Variable: Combined Inflow

Lag: 48.6

Channel Loss: None

End:

Subbasin: EX-3

Last Modified Date: 6 April 2020

Last Modified Time: 19:46:30

Canvas X: -104.82931584978215

Canvas Y: 39.080048121318725

From Canvas X: -104.82989382670279

From Canvas Y: 39.083728070852004

Area: 0.0302

Downstream: Sink EX-3

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 13.59

Curve Number: 65.6

Initial Abstraction: 0.52

Transform: SCS

Lag: 48.4

Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: EX-3A

Description: Same as PR Basin OS-1

Last Modified Date: 6 April 2020

Last Modified Time: 19:23:05

Canvas X: -104.83121863681023

Canvas Y: 39.085457782786904

From Canvas X: -104.83134310401869

From Canvas Y: 39.085457782786904

Area: 0.0634

Downstream: Reservoir OS-1

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

EX_GWR.basin

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 43.9

Unitgraph Type: STANDARD

Baseflow: None

End:

Reservoir: Reservoir OS-1

Description: Same as in PR model

Last Modified Date: 8 April 2020

Last Modified Time: 15:27:43

Canvas X: -104.83067098109308

Canvas Y: 39.081798446858556

From Canvas X: -104.83126842369361

From Canvas Y: 39.08391438940216

Downstream: Route Res OS-1

Route: Modified Puls

Routing Curve: Storage-Outflow

Initial Outflow: 0

Storage-Outflow Table: OS-1

End:

Sink: Sink EX-3

Description: Existing culvert

Last Modified Date: 6 April 2020

Last Modified Time: 19:27:24

Canvas X: -104.82842788250237

Canvas Y: 39.076014212819175

From Canvas X: -104.8292671380857

From Canvas Y: 39.078379458268486

Label X: -36.0

Label Y: -28.0

End:

Subbasin: EX-4

Last Modified Date: 23 March 2020

Last Modified Time: 17:37:34

Canvas X: -104.82064189536449

Canvas Y: 39.080518237967645

From Canvas X: -104.82053670947764

EX_GWR.basin

From Canvas Y: 39.08055329992993

Area: 0.01

Downstream: Sink EX-4

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 0.0

Curve Number: 34

Initial Abstraction: 1.9

Transform: SCS

Lag: 11.7

Unitgraph Type: STANDARD

Baseflow: None

End:

Sink: Sink EX-4

Last Modified Date: 23 March 2020

Last Modified Time: 17:34:54

Canvas X: -104.82204703883946

Canvas Y: 39.07744627004672

From Canvas X: -104.82204703883946

From Canvas Y: 39.07744627004672

End:

Basin Layer Properties:

Element Layer:

Name: Icons

Layer shown: Yes

End Layer:

Element Layer:

Name: Subbasins

Layer shown: No

End Layer:

End:

Basin Spatial Properties:

Coordinate System:

GEOGCS["GCS_WGS_1984",DATUM["WGS_1984",SPHEROID["WGS_84",6378137,298.257223563]],PR
IMEM["Greenwich",0],UNIT["Degree",0.017453292519943295]]

End:

EX_GWR.basin

Basin Schematic Properties:

Last View N: 64.08265578047579
Last View S: 14.082655780475783
Last View W: -129.81009012756982
Last View E: -79.81009012756984
Maximum View N: 64.08265578047579
Maximum View S: 14.082655780475783
Maximum View W: -129.81009012756982
Maximum View E: -79.81009012756984
Extent Method: Elements
Buffer: 0
Draw Icons: Yes
Draw Icon Labels: Name
Draw Map Objects: No
Draw Gridlines: No
Draw Flow Direction: No
Draw HillShade Layer: Yes
Draw Elevation Layer: Yes
Elevation Layer Color Palette: Default
Ignore Elevation Color Ramp Scale: No
Use Interpolated Color Ramp for Elevation Layer: Yes
Color Ramp Opacity Level for Elevation Layer: 33.0
Fix Element Locations: No
Fix Hydrologic Order: No

End:

Project: 100YR GWR Final Simulation Run: EX 24 HR 100-YR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
 End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 10
 Compute Time: 10Apr2020, 13:15:57 Control Specifications: GR Contr

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
EX-2D	0.0340	20.8	01Jan2020, 12:45	2.27
EX-2I	0.0210	12.3	01Jan2020, 12:40	2.05
EX-2H	0.0490	29.2	01Jan2020, 12:40	2.06
EX-2J	0.0760	42.0	01Jan2020, 12:45	2.05
Upper Junction	0.2150	114.3	01Jan2020, 14:15	1.99
Route DP 6	0.0760	41.9	01Jan2020, 14:25	1.99
Route DP 5	0.0210	12.3	01Jan2020, 14:15	1.99
EX-2E	0.0190	13.4	01Jan2020, 12:30	2.06
EX-2G	0.0190	11.5	01Jan2020, 12:35	2.06
EX-2F	0.0310	16.1	01Jan2020, 12:50	2.05
Route ex	0.0490	29.2	01Jan2020, 14:20	1.99
Route DP 3	0.0190	11.5	01Jan2020, 14:10	2.00
Route DP 2	0.0310	16.0	01Jan2020, 13:35	2.02
Route DP 1	0.0190	13.4	01Jan2020, 14:05	2.00
Route Upper Junction	0.2150	114.3	01Jan2020, 15:00	1.96
EX-2D1	0.0255	19.2	01Jan2020, 12:40	2.96
Route EX-2D1	0.0255	19.1	01Jan2020, 13:30	2.93
EX-2D2	0.0198	12.8	01Jan2020, 12:30	2.02
Route EX-2D2	0.0198	12.8	01Jan2020, 13:20	1.99
Junction EX-2D	0.0793	43.6	01Jan2020, 13:20	2.41
Route EX-2D	0.0793	43.6	01Jan2020, 14:05	2.38
EX-2C2	0.0520	3.9	01Jan2020, 12:50	0.38
Route EX-2C2	0.0520	3.9	01Jan2020, 13:40	0.37
EX-2D3	0.0256	15.9	01Jan2020, 12:35	2.06
Route EX-2D3	0.0256	15.9	01Jan2020, 14:05	2.00
EX-2A	0.0220	14.6	01Jan2020, 12:30	2.06

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
EX-2B	0.0530	5.4	01Jan2020, 12:50	0.47
Route EX-2A	0.0220	14.6	01Jan2020, 13:15	2.03
EX-2C1	0.0210	13.1	01Jan2020, 12:35	2.06
Route EX-2C1	0.0210	13.0	01Jan2020, 13:30	2.02
EX-2C3	0.0100	1.0	01Jan2020, 12:40	0.43
Sink EX-2	0.4779	148.0	01Jan2020, 14:50	1.67
Route EX-1G	0.0977	53.1	01Jan2020, 13:40	2.02
Design Point 4	0.2184	60.5	01Jan2020, 16:20	1.37
Route EX-1F	0.0021	1.1	01Jan2020, 13:40	2.01
Route EX-1E	0.0579	33.2	01Jan2020, 13:30	2.02
Route Res OS-5	0.1967	59.8	01Jan2020, 16:20	1.41
Basin EX-1C	0.0091	0.5	01Jan2020, 12:55	0.31
Basin EX-1B	0.0126	5.2	01Jan2020, 12:40	1.51
Basin EX-1D	0.0390	24.5	01Jan2020, 12:35	2.06
Basin EX-1E	0.0579	33.2	01Jan2020, 12:40	2.05
Basin EX-1F	0.0021	1.1	01Jan2020, 12:50	2.05
Basin EX-1G	0.0977	53.2	01Jan2020, 12:45	2.05
Reservoir OS-5	0.1967	59.8	01Jan2020, 15:30	1.42
Route Upper Basin	0.2184	60.5	01Jan2020, 17:10	1.35
EX-1A	0.1260	53.7	01Jan2020, 12:45	1.64
Sink EX-1	0.3444	65.7	01Jan2020, 17:00	1.46
Route Res OS-1	0.0634	29.1	01Jan2020, 13:50	2.02
EX-3	0.0302	17.4	01Jan2020, 12:45	2.13
EX-3A	0.0634	37.8	01Jan2020, 12:40	2.06
Reservoir OS-1	0.0634	29.1	01Jan2020, 13:00	2.05
Sink EX-3	0.0936	35.6	01Jan2020, 13:35	2.06
EX-4	0.0100	1.3	01Jan2020, 12:10	0.33
Sink EX-4	0.0100	1.3	01Jan2020, 12:05	0.33

Project: 5 yr GWR FINAL Simulation Run: EX 24 HR 5-YR

Start of Run: 01Jan2020, 00:00 Basin Model: EX GWR
 End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 5`
 Compute Time: 10Apr2020, 14:20:33 Control Specifications: GR Contr

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
EX-2D	0.0340	8.7	01Jan2020, 12:45	0.99
EX-2I	0.0210	4.8	01Jan2020, 12:40	0.85
EX-2H	0.0490	11.5	01Jan2020, 12:40	0.85
EX-2J	0.0760	16.5	01Jan2020, 12:45	0.85
Upper Junction	0.2150	44.9	01Jan2020, 14:15	0.83
Route DP 6	0.0760	16.4	01Jan2020, 14:25	0.82
Route DP 5	0.0210	4.8	01Jan2020, 14:15	0.83
EX-2E	0.0190	5.3	01Jan2020, 12:30	0.86
EX-2G	0.0190	4.5	01Jan2020, 12:40	0.85
EX-2F	0.0310	6.3	01Jan2020, 12:50	0.85
Route ex	0.0490	11.5	01Jan2020, 14:20	0.82
Route DP 3	0.0190	4.5	01Jan2020, 14:15	0.83
Route DP 2	0.0310	6.3	01Jan2020, 13:40	0.84
Route DP 1	0.0190	5.3	01Jan2020, 14:05	0.83
Route Upper Junction	0.2150	44.9	01Jan2020, 15:00	0.81
EX-2D1	0.0255	11.1	01Jan2020, 12:40	1.71
Route EX-2D1	0.0255	11.0	01Jan2020, 13:30	1.69
EX-2D2	0.0198	5.1	01Jan2020, 12:30	0.84
Route EX-2D2	0.0198	5.0	01Jan2020, 13:20	0.83
Junction EX-2D	0.0793	21.0	01Jan2020, 13:20	1.18
Route EX-2D	0.0793	21.0	01Jan2020, 14:05	1.16
EX-2C2	0.0520	0.2	01Jan2020, 14:05	0.04
Route EX-2C2	0.0520	0.2	01Jan2020, 14:55	0.04
EX-2D3	0.0256	6.2	01Jan2020, 12:35	0.85
Route EX-2D3	0.0256	6.2	01Jan2020, 14:05	0.83
EX-2A	0.0220	5.7	01Jan2020, 12:30	0.86

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
EX-2B	0.0530	0.4	01Jan2020, 13:20	0.07
Route EX-2A	0.0220	5.7	01Jan2020, 13:15	0.84
EX-2C1	0.0210	5.2	01Jan2020, 12:35	0.85
Route EX-2C1	0.0210	5.1	01Jan2020, 13:30	0.84
EX-2C3	0.0100	0.1	01Jan2020, 13:20	0.06
Sink EX-2	0.4779	59.4	01Jan2020, 14:50	0.69
Route EX-1G	0.0977	20.9	01Jan2020, 13:40	0.84
Design Point 4	0.2184	9.9	01Jan2020, 16:35	0.31
Route EX-1F	0.0021	0.4	01Jan2020, 13:45	0.83
Route EX-1E	0.0579	13.0	01Jan2020, 13:30	0.84
Route Res OS-5	0.1967	9.7	01Jan2020, 16:35	0.31
Basin EX-1C	0.0091	0.0	01Jan2020, 15:50	0.03
Basin EX-1B	0.0126	1.7	01Jan2020, 12:45	0.56
Basin EX-1D	0.0390	9.6	01Jan2020, 12:35	0.85
Basin EX-1E	0.0579	13.0	01Jan2020, 12:40	0.85
Basin EX-1F	0.0021	0.4	01Jan2020, 12:50	0.85
Basin EX-1G	0.0977	20.9	01Jan2020, 12:45	0.85
Reservoir OS-5	0.1967	9.7	01Jan2020, 15:45	0.31
Route Upper Basin	0.2184	9.9	01Jan2020, 17:25	0.30
EX-1A	0.1260	18.8	01Jan2020, 12:45	0.63
Sink EX-1	0.3444	19.1	01Jan2020, 12:45	0.42
Route Res OS-1	0.0634	13.3	01Jan2020, 13:40	0.84
EX-3	0.0302	7.0	01Jan2020, 12:45	0.90
EX-3A	0.0634	14.9	01Jan2020, 12:40	0.85
Reservoir OS-1	0.0634	13.3	01Jan2020, 12:55	0.85
Sink EX-3	0.0936	16.4	01Jan2020, 13:30	0.86
EX-4	0.0100	0.0	01Jan2020, 13:50	0.03
Sink EX-4	0.0100	0.0	01Jan2020, 13:45	0.03

PR_West_Basin_GWR.basin

Basin: PR West Basin GWR

Last Modified Date: 8 April 2020

Last Modified Time: 20:10:55

Version: 4.3

Filepath Separator: \

Unit System: English

Missing Flow To Zero: No

Enable Flow Ratio: No

Compute Local Flow At Junctions: No

Enable Sediment Routing: No

Enable Quality Routing: No

End:

Subbasin: D-1

Last Modified Date: 7 April 2020

Last Modified Time: 17:50:40

Canvas X: 3190762.221851185

Canvas Y: 1455062.9875702623

From Canvas X: 3190677.102419148

From Canvas Y: 1455211.3929495476

Area: 0.02

Downstream: Pond 1

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 22.31

Curve Number: 68.37

Initial Abstraction: 0.46

Transform: SCS

Lag: 41.3

Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route Pond 1

Last Modified Date: 6 April 2020

Last Modified Time: 22:21:48

Canvas X: 3190813.116114436

Canvas Y: 1454115.2773730543

PR_West_Basin_GWR.basin

From Canvas X: 3190788.6775098434
From Canvas Y: 1454841.7546350043
Downstream: Sink-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 31
Channel Loss: None

End:

Subbasin: W-7

Last Modified Date: 7 April 2020
Last Modified Time: 17:50:40
Canvas X: 3191588.062197299
Canvas Y: 1454558.061469289
From Canvas X: 3191726.0696871458
From Canvas Y: 1454578.2102340478
Label X: -1.0
Label Y: 0.0
Area: 0.027
Downstream: Junction C-3

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 13.45
Curve Number: 65.5
Initial Abstraction: 0.53

Transform: SCS
Lag: 47.3
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: W-6

Last Modified Date: 7 April 2020
Last Modified Time: 17:50:28
Canvas X: 3191787.2788931862
Canvas Y: 1454806.7233097618
From Canvas X: 3192492.046785609
From Canvas Y: 1454929.1016958833
Area: 0.003

PR_West_Basin_GWR.basin

Downstream: Route W-6

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 35
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: W-8

Description: Drainage Easement across lot
Last Modified Date: 9 April 2020
Last Modified Time: 16:19:53
Canvas X: 3191046.9812794775
Canvas Y: 1454826.8102695316
From Canvas X: 3191390.648482099
From Canvas Y: 1454613.8680979477
Area: 0.00386
Downstream: Junction C-3

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 46
Unitgraph Type: STANDARD

Baseflow: None

End:

PR_West_Basin_GWR.basin

Reach: Route to C-3

Description: Combined junction C-1 and C-2 to Junction C-3
Last Modified Date: 6 April 2020
Last Modified Time: 22:00:34
Canvas X: 3191125.8142608823
Canvas Y: 1454636.8944506934
From Canvas X: 3191740.132405288
From Canvas Y: 1455102.301558766
Downstream: Junction C-3

Route: Lag
Initial Variable: Combined Inflow
Lag: 35.4
Channel Loss: None

End:

Reach: Route OS-4A

Last Modified Date: 8 April 2020
Last Modified Time: 15:10:30
Canvas X: 3191740.132405288
Canvas Y: 1455102.301558766
From Canvas X: 3191821.555858512
From Canvas Y: 1455495.3148196193
Downstream: Junction C-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 47.3
Channel Loss: None

End:

Junction: Upper Junction

Description: Combining design points into final basin flow
Last Modified Date: 6 April 2020
Last Modified Time: 16:04:39
Canvas X: 3192064.58176487
Canvas Y: 1455689.0141506763
From Canvas X: 3192059.549422635
From Canvas Y: 1455656.9537690468
Downstream: Route OS-3B

End:

Reach: Route W-5

Last Modified Date: 6 April 2020
Last Modified Time: 16:05:38
Canvas X: 3191740.132405288
Canvas Y: 1455102.301558766

PR_West_Basin_GWR.basin

From Canvas X: 3192053.9995084023
From Canvas Y: 1455254.1730524607
Downstream: Junction C-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 48.3
Channel Loss: None

End:

Reach: Route W-6

Last Modified Date: 6 April 2020
Last Modified Time: 22:20:54
Canvas X: 3191125.8142608823
Canvas Y: 1454636.8944506934
From Canvas X: 3191630.8269565273
From Canvas Y: 1454769.633909035
Downstream: Junction C-3

Route: Lag
Initial Variable: Combined Inflow
Lag: 47
Channel Loss: None

End:

Reach: Route OS-3A

Last Modified Date: 8 April 2020
Last Modified Time: 20:02:16
Canvas X: 3191620.2620947743
Canvas Y: 1455576.2974092974
From Canvas X: 3191610.741291508
From Canvas Y: 1455715.037744202
Downstream: Junction OS-3

Route: Lag
Initial Variable: Combined Inflow
Lag: 46.4
Channel Loss: None

End:

Junction: Junction C-1

Last Modified Date: 6 April 2020
Last Modified Time: 20:34:48
Canvas X: 3191197.8710940355
Canvas Y: 1455077.2244736233
From Canvas X: 3191049.172513107
From Canvas Y: 1455596.382345375
Label X: -84.0

PR_West_Basin_GWR.basin

Label Y: -3.0
Downstream: Route C-1

End:

Reach: Route OS-3B

Last Modified Date: 6 April 2020
Last Modified Time: 22:18:54
Canvas X: 3191740.132405288
Canvas Y: 1455102.301558766
From Canvas X: 3192064.58176487
From Canvas Y: 1455689.0141506763
Downstream: Junction C-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 47
Channel Loss: None

End:

Subbasin: Basin OS-3C

Last Modified Date: 8 April 2020
Last Modified Time: 15:09:11
Canvas X: 3191732.837927499
Canvas Y: 1455795.0234726786
From Canvas X: 3191732.837927499
From Canvas Y: 1455795.0234726786
Area: 0.0198
Downstream: Route OS-3C

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 13.93
Curve Number: 63.17
Initial Abstraction: 0.58

Transform: SCS
Lag: 37.3
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-3C

PR_West_Basin_GWR.basin

Last Modified Date: 8 April 2020
Last Modified Time: 20:02:16
Canvas X: 3191620.2620947743
Canvas Y: 1455576.2974092974
From Canvas X: 3191701.8574730195
From Canvas Y: 1455717.8851248743
Downstream: Junction OS-3

Route: Lag
Initial Variable: Combined Inflow
Lag: 46.4
Channel Loss: None

End:

Subbasin: Basin OS-3B

Last Modified Date: 8 April 2020
Last Modified Time: 19:47:18
Canvas X: 3191454.1353545357
Canvas Y: 1455638.1584660518
From Canvas X: 3191808.881599231
From Canvas Y: 1455981.4348019836
Label X: -51.0
Label Y: 27.0
Area: 0.034
Downstream: Junction OS-3

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 13.49
Curve Number: 65.84
Initial Abstraction: 0.52

Transform: SCS
Lag: 48.7
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin OS-3A

Last Modified Date: 8 April 2020
Last Modified Time: 15:07:55
Canvas X: 3191585.114865458

PR_West_Basin_GWR.basin

Canvas Y: 1455846.0172551244
From Canvas X: 3191525.184704565
From Canvas Y: 1455763.7332610039
Area: 0.0225
Downstream: Route OS-3A

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 13.64
Curve Number: 63.07
Initial Abstraction: 0.59

Transform: SCS
Lag: 41.4
Unitgraph Type: STANDARD

Baseflow: None

End:

Junction: Junction C-3
Last Modified Date: 6 April 2020
Last Modified Time: 18:40:14
Canvas X: 3191125.8142608823
Canvas Y: 1454636.8944506934
From Canvas X: 3191239.226172219
From Canvas Y: 1454613.8680979477
Downstream: Route C-3

End:

Junction: Junction C-2
Last Modified Date: 6 April 2020
Last Modified Time: 16:05:38
Canvas X: 3191740.132405288
Canvas Y: 1455102.301558766
From Canvas X: 3191601.3307882836
From Canvas Y: 1454899.3142550313
Downstream: Route to C-3

End:

Subbasin: Basin OS-4A
Last Modified Date: 8 April 2020
Last Modified Time: 15:10:12
Canvas X: 3191816.144480269

PR_West_Basin_GWR.basin

Canvas Y: 1455608.9537627215
From Canvas X: 3191816.144480269
From Canvas Y: 1455608.9537627215
Area: 0.0256
Downstream: Route OS-4A

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 41.6
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: OS-2B

Description: Overland flow. Flows into basin W-3
Last Modified Date: 6 April 2020
Last Modified Time: 21:49:39
Canvas X: 3191192.176332691
Canvas Y: 1455473.0103870628
From Canvas X: 3191079.159717601
From Canvas Y: 1455778.8719525808
Area: 0.01
Downstream: Route OS-2B

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 32.5

PR_West_Basin_GWR.basin

Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: OS-2A

Description: Existing Basin on Timberview Filing 1. All flow routed to Culvert
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Last Modified Date: 6 April 2020

Last Modified Time: 21:49:38

Canvas X: 3191075.43372513

Canvas Y: 1455652.395369413

From Canvas X: 3190635.01570008

From Canvas Y: 1456266.8411205618

Area: 0.02

Downstream: Route OS-2A

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 38.5

Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route C-1

Last Modified Date: 6 April 2020

Last Modified Time: 22:00:20

Canvas X: 3191125.8142608823

Canvas Y: 1454636.8944506934

From Canvas X: 3191197.8710940355

From Canvas Y: 1455077.2244736233

Downstream: Junction C-3

Route: Lag

Initial Variable: Combined Inflow

Lag: 35.4

Channel Loss: None

PR_West_Basin_GWR.basin

End:

Subbasin: Basin OS-4E

Description: OS-3B
Last Modified Date: 8 April 2020
Last Modified Time: 15:13:01
Canvas X: 3192707.2299209572
Canvas Y: 1455857.660741784
From Canvas X: 3193024.4086084175
From Canvas Y: 1456017.9537466252
Area: 0.049
Downstream: Route OS-4E

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 44
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-4B

Last Modified Date: 8 April 2020
Last Modified Time: 15:11:14
Canvas X: 3192064.58176487
Canvas Y: 1455689.0141506763
From Canvas X: 3192097.536148903
From Canvas Y: 1455817.2918250756
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 96.2
Channel Loss: None

End:

Subbasin: Basin OS-4D

Description: OS-3B

PR_West_Basin_GWR.basin

Last Modified Date: 8 April 2020
Last Modified Time: 15:12:22
Canvas X: 3192731.2547275363
Canvas Y: 1455991.5132355825
From Canvas X: 3192803.614351975
From Canvas Y: 1456110.2858902286
Area: 0.019
Downstream: Route OS-4D

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 42.8
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-4C

Last Modified Date: 8 April 2020
Last Modified Time: 15:11:56
Canvas X: 3192064.58176487
Canvas Y: 1455689.0141506763
From Canvas X: 3192259.8774961918
From Canvas Y: 1455863.288540141
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 48.3
Channel Loss: None

End:

Reach: Route Basin OS-3A

Last Modified Date: 8 April 2020
Last Modified Time: 20:02:16
Canvas X: 3191740.132405288
Canvas Y: 1455102.301558766
From Canvas X: 3191620.2620947743

PR_West_Basin_GWR.basin

From Canvas Y: 1455576.2974092974
Downstream: Junction C-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 48
Channel Loss: None

End:

Reach: Route OS-2A

Last Modified Date: 6 April 2020
Last Modified Time: 20:34:48
Canvas X: 3191197.8710940355
Canvas Y: 1455077.2244736233
From Canvas X: 3191121.592686727
From Canvas Y: 1455311.9544209125
Downstream: Junction C-1

Route: Lag
Initial Variable: Combined Inflow
Lag: 63.2
Channel Loss: None

End:

Reach: Route OS-4D

Last Modified Date: 8 April 2020
Last Modified Time: 15:12:43
Canvas X: 3192064.58176487
Canvas Y: 1455689.0141506763
From Canvas X: 3192408.6358963293
From Canvas Y: 1455885.1176635888
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 95.6
Channel Loss: None

End:

Subbasin: Basin OS-4C

Description: OS-3B
Last Modified Date: 8 April 2020
Last Modified Time: 15:11:32
Canvas X: 3192549.3526205793
Canvas Y: 1456056.7234248691
From Canvas X: 3192434.285777561
From Canvas Y: 1456074.1559209926
Area: 0.031

PR_West_Basin_GWR.basin

Downstream: Route OS-4C

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 53.5
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-2B

Last Modified Date: 6 April 2020
Last Modified Time: 21:56:42
Canvas X: 3191197.8710940355
Canvas Y: 1455077.2244736233
From Canvas X: 3191198.059764327
From Canvas Y: 1455243.1779213208
Downstream: Junction C-1

Route: Lag
Initial Variable: Combined Inflow
Lag: 31
Channel Loss: None

End:

Reach: Route OS-4E

Last Modified Date: 8 April 2020
Last Modified Time: 15:13:32
Canvas X: 3192064.58176487
Canvas Y: 1455689.0141506763
From Canvas X: 3192392.4562631445
From Canvas Y: 1455779.412177375
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 100.1
Channel Loss: None

PR_West_Basin_GWR.basin

End:

Subbasin: Basin OS-4B

Description: OS-3B
Last Modified Date: 8 April 2020
Last Modified Time: 15:10:53
Canvas X: 3192160.285761248
Canvas Y: 1456065.2655668857
From Canvas X: 3192165.318228803
From Canvas Y: 1456058.0981568876
Label X: 0.0
Label Y: 1.0
Area: 0.019
Downstream: Route OS-4B

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 34.2
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-4F

Last Modified Date: 8 April 2020
Last Modified Time: 15:14:06
Canvas X: 3192064.58176487
Canvas Y: 1455689.0141506763
From Canvas X: 3192563.0810814817
From Canvas Y: 1455734.104593662
Downstream: Upper Junction

Route: Lag
Initial Variable: Combined Inflow
Lag: 95.6
Channel Loss: None

End:

PR_West_Basin_GWR.basin

Junction: Junction OS-3

Last Modified Date: 8 April 2020
Last Modified Time: 20:02:16
Canvas X: 3191620.2620947743
Canvas Y: 1455576.2974092974
From Canvas X: 3191030.2304471615
From Canvas Y: 1455857.6038960286
Downstream: Route Basin OS-3A

End:

Subbasin: W-3

Last Modified Date: 2 April 2020
Last Modified Time: 15:24:53
Canvas X: 3191274.205299845
Canvas Y: 1455232.9233677052
From Canvas X: 3191024.0629101307
From Canvas Y: 1455607.9918769917
Area: 0.01
Downstream: Junction C-1

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 31.0
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-4G

Last Modified Date: 8 April 2020
Last Modified Time: 15:14:46
Canvas X: 3192064.58176487
Canvas Y: 1455689.0141506763
From Canvas X: 3192316.0300185457
From Canvas Y: 1455651.1617253919
Downstream: Upper Junction

Route: Lag

PR_West_Basin_GWR.basin

Initial Variable: Combined Inflow

Lag: 102.7

Channel Loss: None

End:

Subbasin: Basin OS-4H

Last Modified Date: 8 April 2020

Last Modified Time: 15:15:21

Canvas X: 3192191.6069486425

Canvas Y: 1455441.6891996684

From Canvas X: 3192188.156768472

From Canvas Y: 1455449.7392372065

Area: 0.02

Downstream: Route OS-4H

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 40.5

Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: W-5

Description: All overland flow for watershed. Used to size swale DP 5-4

Last Modified Date: 6 April 2020

Last Modified Time: 21:51:01

Canvas X: 3192181.679638902

Canvas Y: 1455275.5631039173

From Canvas X: 3192157.565279063

From Canvas Y: 1455254.8641652972

Label X: 1.0

Label Y: 0.0

Area: 0.01

Downstream: Route W-5

Canopy: None

Allow Simultaneous Precip Et: No

PR_West_Basin_GWR.basin

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 12

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 51.2

Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin OS-4G

Description: OS-3B

Last Modified Date: 8 April 2020

Last Modified Time: 15:14:25

Canvas X: 3192660.319486171

Canvas Y: 1455549.4286020491

From Canvas X: 3193180.971808441

From Canvas Y: 1455688.769582474

Area: 0.076

Downstream: Route OS-4G

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 48.9

Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-4H

Last Modified Date: 8 April 2020

Last Modified Time: 15:15:37

PR_West_Basin_GWR.basin

Canvas X: 3191740.132405288
Canvas Y: 1455102.301558766
From Canvas X: 3192057.7800570475
From Canvas Y: 1455344.8782568125
Downstream: Junction C-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 48
Channel Loss: None

End:

Subbasin: Basin OS-4F

Description: OS-3B
Last Modified Date: 8 April 2020
Last Modified Time: 15:13:48
Canvas X: 3192736.0787815726
Canvas Y: 1455736.1211514312
From Canvas X: 3193108.7118699686
From Canvas Y: 1455873.4338696809
Area: 0.021
Downstream: Route OS-4F

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 45
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: W-4

Last Modified Date: 6 April 2020
Last Modified Time: 21:51:06
Canvas X: 3191593.657007475
Canvas Y: 1455287.930643368
From Canvas X: 3191663.9790399233
From Canvas Y: 1455200.9491771364

PR_West_Basin_GWR.basin

Label X: 0.0
Label Y: 1.0
Area: 0.006
Downstream: Junction C-2

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 48.3
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route C-3

Last Modified Date: 6 April 2020
Last Modified Time: 22:26:01
Canvas X: 3190813.116114436
Canvas Y: 1454115.2773730543
From Canvas X: 3191125.8142608823
From Canvas Y: 1454636.8944506934
Downstream: Sink-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 32
Channel Loss: None

End:

Reservoir: Pond 1

Last Modified Date: 2 April 2020
Last Modified Time: 17:59:59
Canvas X: 3190788.6775098434
Canvas Y: 1454841.7546350043
From Canvas X: 3190512.093450769
From Canvas Y: 1455477.2407319362
Downstream: Route Pond 1

Route: Specified Outflow

PR_West_Basin_GWR.basin

Routing Curve: Elevation-Storage
Initial Elevation: 0
Elevation-Storage Table: Pond 1
Outflow Gage Name: Pond 1 - Q100

End:

Reservoir: Pond 2

Last Modified Date: 6 April 2020
Last Modified Time: 16:41:33
Canvas X: 3191286.3342175563
Canvas Y: 1454354.3942729682
From Canvas X: 3191195.8916458623
From Canvas Y: 1454392.14754045
Label X: -6.0
Label Y: -16.0
Downstream: Route Pond 2

Route: Specified Outflow
Routing Curve: Elevation-Storage
Initial Elevation: 0
Elevation-Storage Table: Pond 2
Outflow Gage Name: Pond 2 - Q100

End:

Subbasin: D-2

Last Modified Date: 6 April 2020
Last Modified Time: 22:22:26
Canvas X: 3191663.866892373
Canvas Y: 1454378.4190795475
From Canvas X: 3191628.3381642886
From Canvas Y: 1454443.6292688341
Area: 0.01
Downstream: Pond 2

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 49.3
Curve Number: 78.99
Initial Abstraction: 0.27

Transform: SCS
Lag: 37
Unitgraph Type: STANDARD

PR_West_Basin_GWR.basin

Baseflow: None

End:

Reach: Route Pond 2

Last Modified Date: 6 April 2020
Last Modified Time: 22:22:39
Canvas X: 3190813.116114436
Canvas Y: 1454115.2773730543
From Canvas X: 3191286.3342175563
From Canvas Y: 1454354.3942729682
Downstream: Sink-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 31
Channel Loss: None

End:

Subbasin: W-2

Last Modified Date: 6 April 2020
Last Modified Time: 22:24:02
Canvas X: 3190671.1056696735
Canvas Y: 1454493.511435817
From Canvas X: 3190858.8970014188
From Canvas Y: 1454517.375669532
Area: 0.005
Downstream: Sink-2

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 0.0
Curve Number: 45.4
Initial Abstraction: 1.2

Transform: SCS
Lag: 31
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: W-9

PR_West_Basin_GWR.basin

Last Modified Date: 6 April 2020
Last Modified Time: 23:21:10
Canvas X: 3191400.0351217636
Canvas Y: 1454154.673135822
From Canvas X: 3191046.078595636
From Canvas Y: 1454207.1248628749
Area: 0.003
Downstream: Route W-9

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 46
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route W-9

Last Modified Date: 8 April 2020
Last Modified Time: 20:09:27
Canvas X: 3190813.116114436
Canvas Y: 1454115.2773730543
From Canvas X: 3191049.3886176376
From Canvas Y: 1454148.438426135
Downstream: Sink-2

Route: Lag
Initial Variable: Combined Inflow
Lag: 31
Channel Loss: None

End:

Sink: Sink-2

Description: Wetlands. Central drainage.
Last Modified Date: 6 April 2020
Last Modified Time: 22:21:48
Canvas X: 3190813.116114436
Canvas Y: 1454115.2773730543

PR_West_Basin_GWR.basin

From Canvas X: 3190880.4929359066
From Canvas Y: 1454338.8286808033
Label X: -28.0
Label Y: -25.0

End:

Subbasin: OS-1

Description: Part of Timberview. Fully detained in sedimentation basin
Last Modified Date: 2 April 2020
Last Modified Time: 15:23:09
Canvas X: 3189944.377164344
Canvas Y: 1454944.7180917726
From Canvas X: 3189604.487770659
From Canvas Y: 1455611.2295709252
Area: 0.0634
Downstream: Reservoir OS-1

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 43.9
Unitgraph Type: STANDARD

Baseflow: None

End:

Reservoir: Reservoir OS-1

Description: All flows from OS-1 are collected by and detained by a sedimentation pond on Timberview. Reservoir table are available in this report.
Last Modified Date: 8 April 2020
Last Modified Time: 15:27:43
Canvas X: 3190056.135883074
Canvas Y: 1454678.4260555971
From Canvas X: 3189388.7751533836
From Canvas Y: 1455874.4720869225
Downstream: Route OS-1

Route: Modified Puls
Routing Curve: Storage-Outflow

PR_West_Basin_GWR.basin

Initial Outflow: 0
Storage-Outflow Table: OS-1

End:

Reach: Route OS-1

Last Modified Date: 8 April 2020
Last Modified Time: 15:27:11
Canvas X: 3190397.3472748916
Canvas Y: 1454043.6252896052
From Canvas X: 3190056.135883074
From Canvas Y: 1454678.4260555971
Downstream: Sink-3

Route: Lag
Initial Variable: Combined Inflow
Lag: 48.6
Channel Loss: None

End:

Subbasin: W-1

Last Modified Date: 6 April 2020
Last Modified Time: 19:33:31
Canvas X: 3190284.2284092726
Canvas Y: 1454535.9859811317
From Canvas X: 3190143.3967487137
From Canvas Y: 1454903.4863893862
Area: 0.0302
Downstream: Sink-3

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 11.8
Curve Number: 65.5
Initial Abstraction: 0.52

Transform: SCS
Lag: 48.6
Unitgraph Type: STANDARD

Baseflow: None

End:

Sink: Sink-3

PR_West_Basin_GWR.basin

Description: West-most drainage - Culvert 3

Last Modified Date: 8 April 2020

Last Modified Time: 16:28:55

Canvas X: 3190397.3472748916

Canvas Y: 1454043.6252896052

From Canvas X: 3190265.471714283

From Canvas Y: 1454199.949087816

Label X: -31.0

Label Y: -20.0

End:

Subbasin: W-10

Last Modified Date: 9 April 2020

Last Modified Time: 00:27:26

Canvas X: 3192832.9140338055

Canvas Y: 1454753.0347040498

From Canvas X: 3192832.9140338055

From Canvas Y: 1454753.0347040498

Area: 0.01

Downstream: Sink-4

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 0

Curve Number: 34

Initial Abstraction: 1.9

Transform: SCS

Lag: 40.6

Unitgraph Type: STANDARD

Baseflow: None

End:

Sink: Sink-4

Description: EX culvert 4

Last Modified Date: 25 March 2020

Last Modified Time: 18:50:24

Canvas X: 3192640.4035706962

Canvas Y: 1454413.8496023817

From Canvas X: 3192640.4035706962

From Canvas Y: 1454413.8496023817

End:

PR_West_Basin_GWR.basin

Basin Layer Properties:

Element Layer:

Name: Icons

Layer shown: Yes

End Layer:

End:

Basin Spatial Properties:

End:

Basin Schematic Properties:

Last View N: 1455607.9918769917

Last View S: 1454940.6937600982

Last View W: 3191024.0629101307

Last View E: 3191102.8411600417

Maximum View N: 1455607.9918769917

Maximum View S: 1454940.6937600982

Maximum View W: 3191024.0629101307

Maximum View E: 3191102.8411600417

Extent Method: Manual

Buffer: 0

Draw Icons: Yes

Draw Icon Labels: Name

Draw Map Objects: No

Draw Gridlines: No

Draw Flow Direction: No

Draw HillShade Layer: Yes

Draw Elevation Layer: Yes

Elevation Layer Color Palette: Default

Ignore Elevation Color Ramp Scale: No

Use Interpolated Color Ramp for Elevation Layer: Yes

Color Ramp Opacity Level for Elevation Layer: 33.0

Fix Element Locations: No

Fix Hydrologic Order: No

End:

Project: 100YR GWR Final Simulation Run: PR 24 HR 100-YR

Start of Run: 01Jan2020, 00:00 Basin Model: PR West Basin GWR
 End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 100 YR
 Compute Time: 09Apr2020, 09:34:05 Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
D-1	0.020000	15.1	01Jan2020, 12:35	2.51
Route Pond 1	0.020000	12.5	01Jan2020, 13:30	1.43
W-7	0.027000	15.8	01Jan2020, 12:40	2.12
Basin OS-4H	0.020000	12.6	01Jan2020, 12:35	2.06
W-6	0.003000	2.1	01Jan2020, 12:30	2.06
Basin OS-4G	0.076000	42.0	01Jan2020, 12:45	2.05
Basin OS-4F	0.021000	12.3	01Jan2020, 12:40	2.05
Route OS-3C	0.019800	12.8	01Jan2020, 13:15	2.00
W-8	0.000017	0.0	01Jan2020, 12:40	2.05
Basin OS-4E	0.049000	29.2	01Jan2020, 12:40	2.06
Route OS-3A	0.022500	13.5	01Jan2020, 13:20	1.98
Route to C-3	0.352900	136.0	01Jan2020, 15:35	1.96
Route OS-4A	0.025600	15.7	01Jan2020, 13:25	2.03
Basin OS-4D	0.019000	11.5	01Jan2020, 12:35	2.06
Basin OS-4C	0.031000	16.1	01Jan2020, 12:50	2.05
Basin OS-4B	0.019000	13.4	01Jan2020, 12:30	2.06
Upper Junction	0.215000	114.3	01Jan2020, 14:15	1.99
Basin OS-3B	0.034000	19.6	01Jan2020, 12:45	2.14
Route W-5	0.010000	5.3	01Jan2020, 13:35	2.02
Route W-6	0.003000	2.1	01Jan2020, 13:15	2.03
Junction C-1	0.040000	18.0	01Jan2020, 13:30	2.04
Route OS-4G	0.076000	41.9	01Jan2020, 14:25	1.99
Route OS-3B	0.215000	113.9	01Jan2020, 15:05	1.96
Route OS-4F	0.021000	12.3	01Jan2020, 14:15	1.99
Route OS-4E	0.049000	29.2	01Jan2020, 14:20	1.99
Junction C-3	0.422917	142.5	01Jan2020, 15:35	1.98
Route OS-4H	0.020000	12.5	01Jan2020, 13:20	2.03
Junction C-2	0.352900	136.0	01Jan2020, 15:00	1.99
Route OS-4D	0.019000	11.5	01Jan2020, 14:10	2.00
Route OS-4C	0.031000	16.0	01Jan2020, 13:35	2.02
Route OS-4B	0.019000	13.4	01Jan2020, 14:05	2.00
OS-2B	0.010000	7.3	01Jan2020, 12:25	2.06

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
OS-2A	0.020000	13.0	01Jan2020, 12:30	2.06
Basin OS-3C	0.019800	12.9	01Jan2020, 12:30	2.03
Route C-1	0.040000	18.0	01Jan2020, 14:05	2.02
Basin OS-3A	0.022500	13.5	01Jan2020, 12:35	2.01
Basin OS-4A	0.025600	15.9	01Jan2020, 12:35	2.06
Junction Basin OS-3A	0.076300	39.0	01Jan2020, 13:10	2.05
Route Basin OS-3A	0.076300	39.0	01Jan2020, 14:00	2.02
Route OS-2A	0.020000	13.0	01Jan2020, 13:35	2.02
Route OS-2B	0.010000	7.3	01Jan2020, 12:55	2.05
W-3	0.010000	7.6	01Jan2020, 12:25	2.07
W-5	0.010000	5.4	01Jan2020, 12:45	2.05
W-4	0.006000	3.3	01Jan2020, 12:45	2.05
Route C-3	0.422917	141.8	01Jan2020, 16:05	1.96
Pond 1	0.020000	12.5	01Jan2020, 13:00	1.44
Pond 2	0.010000	4.8	01Jan2020, 12:30	1.84
D-2	0.010000	11.5	01Jan2020, 12:30	3.59
Route Pond 2	0.010000	4.8	01Jan2020, 13:05	1.82
W-2	0.005000	1.2	01Jan2020, 12:30	0.74
W-9	0.003000	1.7	01Jan2020, 12:40	2.05
Route W-9	0.003000	1.7	01Jan2020, 13:10	2.03
Sink-2	0.460917	143.4	01Jan2020, 16:00	1.92
OS-1	0.063400	37.8	01Jan2020, 12:40	2.06
Reservoir OS-1	0.063400	29.1	01Jan2020, 13:00	2.05
Route OS-1	0.063400	29.1	01Jan2020, 13:50	2.02
W-1	0.030200	17.0	01Jan2020, 12:45	2.08
Sink-3	0.093600	35.6	01Jan2020, 13:40	2.04
W-10	0.010000	0.6	01Jan2020, 12:45	0.31
Sink-4	0.010000	0.6	01Jan2020, 12:40	0.31

Project: 5 yr GWR FINAL Simulation Run: PR 24 HR 5-YR - West

Start of Run: 01Jan2020, 00:00 Basin Model: PR West
 End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 5`
 Compute Time: 10Apr2020, 14:21:56 Control Specifications: GR Contr

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
D-1	0.02000	6.7	01Jan2020, 12:35	1.15
Route Pond 1	0.02000	12.5	01Jan2020, 13:30	1.43
W-7	0.02700	6.3	01Jan2020, 12:45	0.89
W-6	0.00300	0.8	01Jan2020, 12:30	0.86
W-8	0.00386	0.9	01Jan2020, 12:40	0.85
Route to C-3	0.35290	53.9	01Jan2020, 15:35	0.81
Route OS-4A	0.02560	6.2	01Jan2020, 13:25	0.84
Upper Junction	0.21500	44.9	01Jan2020, 14:15	0.83
Route W-5	0.01000	2.1	01Jan2020, 13:35	0.84
Route W-6	0.00300	0.8	01Jan2020, 13:15	0.84
Route OS-3A	0.02250	5.3	01Jan2020, 13:20	0.83
Junction C-1	0.04000	7.1	01Jan2020, 13:30	0.85
Route OS-3B	0.21500	44.8	01Jan2020, 15:05	0.81
Basin OS-3C	0.01980	5.1	01Jan2020, 12:30	0.85
Route OS-3C	0.01980	5.1	01Jan2020, 13:20	0.84
Basin OS-3B	0.03400	7.9	01Jan2020, 12:45	0.91
Basin OS-3A	0.02250	5.3	01Jan2020, 12:35	0.84
Junction C-3	0.42676	56.8	01Jan2020, 15:35	0.82
Junction C-2	0.35290	53.9	01Jan2020, 15:00	0.83
Basin OS-4A	0.02560	6.2	01Jan2020, 12:35	0.85
OS-2B	0.01000	2.9	01Jan2020, 12:25	0.86
OS-2A	0.02000	5.1	01Jan2020, 12:35	0.86
Route C-1	0.04000	7.1	01Jan2020, 14:05	0.84
Basin OS-4E	0.04900	11.5	01Jan2020, 12:40	0.85
Route OS-4B	0.01900	5.3	01Jan2020, 14:05	0.83
Basin OS-4D	0.01900	4.5	01Jan2020, 12:40	0.85

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route OS-4C	0.03100	6.3	01Jan2020, 13:40	0.84
Route Basin OS-3A	0.07630	15.5	01Jan2020, 14:00	0.85
Route OS-2A	0.02000	5.1	01Jan2020, 13:35	0.84
Route OS-4D	0.01900	4.5	01Jan2020, 14:15	0.83
Basin OS-4C	0.03100	6.3	01Jan2020, 12:50	0.85
Route OS-2B	0.01000	2.8	01Jan2020, 13:00	0.85
Route OS-4E	0.04900	11.5	01Jan2020, 14:20	0.82
Basin OS-4B	0.01900	5.3	01Jan2020, 12:30	0.86
Route OS-4F	0.02100	4.8	01Jan2020, 14:15	0.83
Junction OS-3	0.07630	15.6	01Jan2020, 13:15	0.86
W-3	0.01000	3.0	01Jan2020, 12:25	0.86
Route OS-4G	0.07600	16.4	01Jan2020, 14:25	0.82
Basin OS-4H	0.02000	5.0	01Jan2020, 12:35	0.85
W-5	0.01000	2.1	01Jan2020, 12:45	0.85
Basin OS-4G	0.07600	16.5	01Jan2020, 12:45	0.85
Route OS-4H	0.02000	4.9	01Jan2020, 13:25	0.84
Basin OS-4F	0.02100	4.8	01Jan2020, 12:40	0.85
W-4	0.00600	1.3	01Jan2020, 12:45	0.85
Route C-3	0.42676	56.6	01Jan2020, 16:10	0.81
Pond 1	0.02000	12.5	01Jan2020, 13:00	1.44
Pond 2	0.01000	4.8	01Jan2020, 12:30	1.84
D-2	0.01000	6.0	01Jan2020, 12:30	1.90
Route Pond 2	0.01000	4.8	01Jan2020, 13:05	1.82
W-2	0.00500	0.2	01Jan2020, 12:35	0.16
W-9	0.00300	0.7	01Jan2020, 12:40	0.85
Route W-9	0.00300	0.7	01Jan2020, 13:10	0.84
Sink-2	0.46476	58.0	01Jan2020, 16:05	0.85
OS-1	0.06340	14.9	01Jan2020, 12:40	0.85
Reservoir OS-1	0.06340	13.3	01Jan2020, 12:55	0.85
Route OS-1	0.06340	13.3	01Jan2020, 13:40	0.84
W-1	0.03020	6.7	01Jan2020, 12:45	0.86

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Sink-3	0.09360	16.3	01Jan2020, 13:30	0.85
W-10	0.01000	0.0	01Jan2020, 15:30	0.03
Sink-4	0.01000	0.0	01Jan2020, 15:25	0.03

PR_East_Basin_GWR.basin

Basin: PR East Basin GWR

Last Modified Date: 8 April 2020
Last Modified Time: 19:04:56
Version: 4.3
Filepath Separator: \
Unit System: English
Missing Flow To Zero: Yes
Enable Flow Ratio: No
Compute Local Flow At Junctions: No

Enable Sediment Routing: No

Enable Quality Routing: No

End:

Reach: Route E-7

Last Modified Date: 1 April 2020
Last Modified Time: 15:05:59
Canvas X: -1036.777206597014
Canvas Y: 381.8963731125066
From Canvas X: 324.24823149222857
From Canvas Y: 1424.908662565677
Downstream: Sink EX-1

Route: Lag
Initial Variable: Combined Inflow
Lag: 64
Channel Loss: None

End:

Subbasin: Basin D-3

Last Modified Date: 8 April 2020
Last Modified Time: 14:56:28
Canvas X: -1818.3597961754886
Canvas Y: 1593.6807966465158
From Canvas X: -1639.7683601942304
From Canvas Y: 944.1038795993522
Label X: 0.0
Label Y: 1.0
Area: 0.03
Downstream: Pond 3

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

PR_East_Basin_GWR.basin

LossRate: SCS
Percent Impervious Area: 0.47
Curve Number: 62.64
Initial Abstraction: 0.6

Transform: SCS
Lag: 45.8
Unitgraph Type: STANDARD

Baseflow: None

End:

Reservoir: Pond 3

Last Modified Date: 8 April 2020
Last Modified Time: 16:31:10
Canvas X: -1610.5705112252363
Canvas Y: 1239.0817475485915
From Canvas X: -1511.7339678911565
From Canvas Y: 640.2004812966065
Label X: 0.0
Label Y: 1.0
Downstream: Sink EX-1

Route: Specified Outflow
Routing Curve: Elevation-Storage
Initial Elevation: 0
Elevation-Storage Table: Pond 3
Outflow Gage Name: Pond 3 - Q5

End:

Subbasin: E-3

Last Modified Date: 30 March 2020
Last Modified Time: 22:27:51
Canvas X: -980.1932294772773
Canvas Y: 970.7434576307428
From Canvas X: -1009.5588556422545
From Canvas Y: 1006.5570737441426
Area: 0.0336
Downstream: Sink EX-1

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 6.7

PR_East_Basin_GWR.basin

Curve Number: 54.5
Initial Abstraction: 0.83

Transform: SCS
Lag: 64
Unitgraph Type: STANDARD

Baseflow: None

End:

Junction: C-7

Last Modified Date: 31 March 2020
Last Modified Time: 21:24:04
Canvas X: 324.24823149222857
Canvas Y: 1424.908662565677
From Canvas X: -84.11606967854232
From Canvas Y: 1597.0236365676153
Downstream: Route E-7

End:

Subbasin: Basin OS-5

Last Modified Date: 8 April 2020
Last Modified Time: 15:05:02
Canvas X: -1910.9889810178615
Canvas Y: 2730.049713289869
From Canvas X: -1895.2586998774636
From Canvas Y: 2743.89138359013
Area: 0.0244
Downstream: Route OS-5

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 68.7
Unitgraph Type: STANDARD

Baseflow: None

End:

PR_East_Basin_GWR.basin

Reach: Route OS-5

Last Modified Date: 8 April 2020
Last Modified Time: 15:05:40
Canvas X: -1036.777206597014
Canvas Y: 381.8963731125066
From Canvas X: -1883.90357366932
From Canvas Y: 2573.564490467974
Downstream: Sink EX-1

Route: Lag
Initial Variable: Combined Inflow
Lag: 106.6
Channel Loss: None

End:

Subbasin: Basin D-4B

Last Modified Date: 8 April 2020
Last Modified Time: 14:57:45
Canvas X: 77.17075639610812
Canvas Y: 2378.1178945307097
From Canvas X: 778.873522140379
From Canvas Y: 773.7769864771967
Area: 0.0103
Downstream: Pond 4

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 38
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin D-4A

Last Modified Date: 8 April 2020
Last Modified Time: 14:56:57
Canvas X: -360.964130568138
Canvas Y: 2409.983054835778

PR_East_Basin_GWR.basin

From Canvas X: 18.080066194750998
From Canvas Y: 2352.1395294091717
Area: 0.0069
Downstream: Pond 4

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 56.9
Unitgraph Type: STANDARD

Baseflow: None

End:

Reservoir: Pond 4

Last Modified Date: 8 April 2020
Last Modified Time: 16:31:13
Canvas X: -260.0285318811434
Canvas Y: 1875.104502058163
From Canvas X: 539.8540713480625
From Canvas Y: 1066.6296604004497
Downstream: Route C-8

Route: Specified Outflow
Routing Curve: Elevation-Storage
Initial Elevation: 0
Elevation-Storage Table: Pond 4
Outflow Gage Name: Pond 4 - Q5

End:

Reach: Route C-8

Last Modified Date: 1 April 2020
Last Modified Time: 15:03:21
Canvas X: -1036.777206597014
Canvas Y: 381.8963731125066
From Canvas X: -260.0285318811434
From Canvas Y: 1875.104502058163
Downstream: Sink EX-1

PR_East_Basin_GWR.basin

Route: Lag
Initial Variable: Combined Inflow
Lag: 64
Channel Loss: None

End:

Subbasin: E-2

Last Modified Date: 2 April 2020
Last Modified Time: 20:40:40
Canvas X: -1374.5346247724785
Canvas Y: 2101.1205836886966
From Canvas X: -1372.9228943028534
From Canvas Y: 2108.004315934082
Area: 0.0107
Downstream: Route C-6

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 42.7
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route C-6

Last Modified Date: 2 April 2020
Last Modified Time: 20:40:17
Canvas X: -1036.777206597014
Canvas Y: 381.8963731125066
From Canvas X: -1359.5742100536092
From Canvas Y: 1618.6472090051623
Downstream: Sink EX-1

Route: Lag
Initial Variable: Combined Inflow
Lag: 64
Channel Loss: None

End:

PR_East_Basin_GWR.basin

Subbasin: E-1A

Last Modified Date: 8 April 2020
Last Modified Time: 23:50:45
Canvas X: -2223.6065770428545
Canvas Y: 1591.0098594068538
From Canvas X: -2463.015010284649
From Canvas Y: 2073.938937309651
Label X: 0.0
Label Y: 1.0
Area: 0.0079
Downstream: Route E-1A

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 0.58
Curve Number: 68.1
Initial Abstraction: 0.47

Transform: SCS
Lag: 42.0
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route E-1A

Last Modified Date: 8 April 2020
Last Modified Time: 14:56:11
Canvas X: -1036.777206597014
Canvas Y: 381.8963731125066
From Canvas X: -2015.4770485245274
From Canvas Y: 1441.6776770609135
Downstream: Sink EX-1

Route: Lag
Initial Variable: Combined Inflow
Lag: 45.8
Channel Loss: None

End:

Subbasin: Basin OS-6D

Last Modified Date: 8 April 2020

PR_East_Basin_GWR.basin

Last Modified Time: 15:02:59
Canvas X: 1874.6530481452974
Canvas Y: 2417.431218187936
From Canvas X: 1874.6530481452974
From Canvas Y: 2417.431218187936
Area: 0.0977
Downstream: Route OS-6D

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 50
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-6D

Last Modified Date: 8 April 2020
Last Modified Time: 15:03:31
Canvas X: 1272.1119983500157
Canvas Y: 2271.544640919317
From Canvas X: 1594.6242279570024
From Canvas Y: 2355.412855055983
Downstream: Reservoir OS-5

Route: Lag
Initial Variable: Combined Inflow
Lag: 54.5
Channel Loss: None

End:

Subbasin: Basin OS-6C

Description: OS-5C
Last Modified Date: 8 April 2020
Last Modified Time: 15:01:53
Canvas X: 1862.9572697904414
Canvas Y: 2655.2453780700125
From Canvas X: 1862.9572697904414

PR_East_Basin_GWR.basin

From Canvas Y: 2655.2453780700125

Area: 0.0824

Downstream: Route OS-6C

Canopy: None

Allow Simultaneous Precip Et: No

Plant Uptake Method: None

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 53.2

Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-6C

Last Modified Date: 8 April 2020

Last Modified Time: 15:02:12

Canvas X: 1272.1119983500157

Canvas Y: 2271.544640919317

From Canvas X: 1491.2771662334803

From Canvas Y: 2451.188221151665

Downstream: Reservoir OS-5

Route: Lag

Initial Variable: Combined Inflow

Lag: 54.5

Channel Loss: None

End:

Subbasin: Basin OS-6B

Description: OS-5B

Last Modified Date: 8 April 2020

Last Modified Time: 15:00:13

Canvas X: 1597.8529604137002

Canvas Y: 2830.682053392856

From Canvas X: 1597.8529604137002

From Canvas Y: 2830.682053392856

Area: 0.0579

Downstream: Route OS-6B

PR_East_Basin_GWR.basin

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 46.5
Unitgraph Type: STANDARD

Baseflow: None

End:

Reach: Route OS-6B

Last Modified Date: 8 April 2020
Last Modified Time: 15:00:37
Canvas X: 1272.1119983500157
Canvas Y: 2271.544640919317
From Canvas X: 1416.7680854049777
From Canvas Y: 2520.167052110427
Downstream: Reservoir OS-5

Route: Lag
Initial Variable: Combined Inflow
Lag: 40.8
Channel Loss: None

End:

Subbasin: Basin OS-6A

Description: OS-5A
Last Modified Date: 8 April 2020
Last Modified Time: 14:59:46
Canvas X: 1037.832248645193
Canvas Y: 2834.180904913291
From Canvas X: 1044.252784950505
From Canvas Y: 2822.884867822952
Area: 0.0387
Downstream: Reservoir OS-5

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

PR_East_Basin_GWR.basin

Surface: None

LossRate: SCS

Percent Impervious Area: 12.0

Curve Number: 65

Initial Abstraction: 0.54

Transform: SCS

Lag: 40.8

Unitgraph Type: STANDARD

Baseflow: None

End:

Reservoir: Reservoir OS-5

Last Modified Date: 8 April 2020

Last Modified Time: 16:17:04

Canvas X: 1272.1119983500157

Canvas Y: 2271.544640919317

From Canvas X: 1258.6753881228692

From Canvas Y: 2210.8058005854755

Downstream: Reservoir Route

Route: Specified Outflow

Routing Curve: Elevation-Storage

Initial Elevation: 19

Elevation-Storage Table: Reservoir OS-5

Outflow Gage Name: OS-5 - Q10

Maximum Allowable Discharge: 51.17

Storage Capacity: 3.8

End:

Reach: Reservoir Route

Last Modified Date: 2 April 2020

Last Modified Time: 20:19:52

Canvas X: 324.24823149222857

Canvas Y: 1424.908662565677

From Canvas X: 1272.1119983500157

From Canvas Y: 2271.544640919317

Downstream: C-7

Route: Lag

Initial Variable: Combined Inflow

Lag: 44.5

Channel Loss: None

End:

Subbasin: Basin E-4A

PR_East_Basin_GWR.basin

Last Modified Date: 8 April 2020
Last Modified Time: 19:04:34
Canvas X: 705.3435151968774
Canvas Y: 2306.218602860742
From Canvas X: 676.6773862670857
From Canvas Y: 2255.6209566399502
Area: 0.0126
Downstream: C-7

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65
Initial Abstraction: 0.54

Transform: SCS
Lag: 46.4
Unitgraph Type: STANDARD

Baseflow: None

End:

Subbasin: Basin E-4B

Last Modified Date: 8 April 2020
Last Modified Time: 19:04:49
Canvas X: 1192.7997481357697
Canvas Y: 1913.2661633627133
From Canvas X: 1312.564453923134
From Canvas Y: 1483.4723744861783
Label X: 3.0
Label Y: -7.0
Area: 0.0091
Downstream: C-7

Canopy: None
Allow Simultaneous Precip Et: No
Plant Uptake Method: None

Surface: None

LossRate: SCS
Percent Impervious Area: 12.0
Curve Number: 65

PR_East_Basin_GWR.basin

Initial Abstraction: 0.54

Transform: SCS

Lag: 38.1

Unitgraph Type: STANDARD

Baseflow: None

End:

Sink: Sink EX-1

Last Modified Date: 8 April 2020

Last Modified Time: 14:56:11

Canvas X: -1036.777206597014

Canvas Y: 381.8963731125066

From Canvas X: -1043.6242342666856

From Canvas Y: 370.67000608809485

End:

Basin Layer Properties:

Element Layer:

Name: Icons

Layer shown: Yes

End Layer:

End:

Basin Spatial Properties:

End:

Basin Schematic Properties:

Last View N: 3600.2886002886

Last View S: 829.7258297258295

Last View W: -1868.6868686868684

Last View E: 1233.766233766235

Maximum View N: 3600.2886002886

Maximum View S: 829.7258297258295

Maximum View W: -1868.6868686868684

Maximum View E: 1233.766233766235

Extent Method: Manual

Buffer: 0

Draw Icons: Yes

Draw Icon Labels: Name

Draw Map Objects: No

Draw Gridlines: No

Draw Flow Direction: No

Draw HillShade Layer: Yes

Draw Elevation Layer: Yes

Elevation Layer Color Palette: Default

Ignore Elevation Color Ramp Scale: No

PR_East_Basin_GWR.basin

Use Interpolated Color Ramp for Elevation Layer: Yes

Color Ramp Opacity Level for Elevation Layer: 33.0

Fix Element Locations: No

Fix Hydrologic Order: No

End:

Project: 100YR GWR Final Simulation Run: PR 24 HR 100-YR - East

Start of Run: 01Jan2020, 00:00

Basin Model: PR East Basin GWR

End of Run: 02Jan2020, 00:05

Meteorologic Model: 24 HR 100 YR

Compute Time: 09Apr2020, 09:37:30

Control Specifications: GR Control - PR

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route E-7	0.2974	60.9	01Jan2020, 17:15	1.06
E-3	0.0330	9.7	01Jan2020, 13:00	1.36
Basin D-3	0.0300	13.6	01Jan2020, 12:40	1.59
Pond 3	0.0300	26.5	01Jan2020, 12:55	1.75
C-7	0.2974	60.9	01Jan2020, 16:10	1.08
Basin OS-5	0.0200	8.7	01Jan2020, 13:05	2.04
Route OS-5	0.0200	8.7	01Jan2020, 14:50	1.97
Basin D-4B	0.0100	6.6	01Jan2020, 12:30	2.06
Basin D-4A	0.0069	3.4	01Jan2020, 12:50	2.04
Pond 4	0.0169	11.2	01Jan2020, 12:30	1.09
Route C-8	0.0169	11.2	01Jan2020, 13:35	1.08
E-2	0.0100	6.1	01Jan2020, 12:35	2.06
Route C-6	0.0100	6.1	01Jan2020, 13:40	2.02
E-1A	0.0079	4.7	01Jan2020, 12:35	1.92
Route E-1A	0.0079	4.7	01Jan2020, 13:20	1.89
Basin OS-6D	0.0977	53.2	01Jan2020, 12:45	2.05
Route OS-6D	0.0977	53.1	01Jan2020, 13:40	2.02
Basin OS-6C	0.0820	42.7	01Jan2020, 12:50	2.05
Route OS-6C	0.0820	42.6	01Jan2020, 13:40	2.01
Basin OS-6B	0.0579	33.2	01Jan2020, 12:40	2.05
Route OS-6B	0.0579	33.2	01Jan2020, 13:20	2.03
Basin OS-6A	0.0387	24.3	01Jan2020, 12:35	2.06
Reservoir OS-5	0.2763	59.8	01Jan2020, 15:30	1.01
Reservoir Route	0.2763	59.7	01Jan2020, 16:10	1.01
Basin E-5A	0.0120	6.9	01Jan2020, 12:40	2.05
Basin E-5B	0.0091	6.0	01Jan2020, 12:30	2.06
Sink EX-1	0.4152	65.5	01Jan2020, 17:10	1.22

Project: 5 yr GWR FINAL Simulation Run: PR 24 HR 5-YR - East

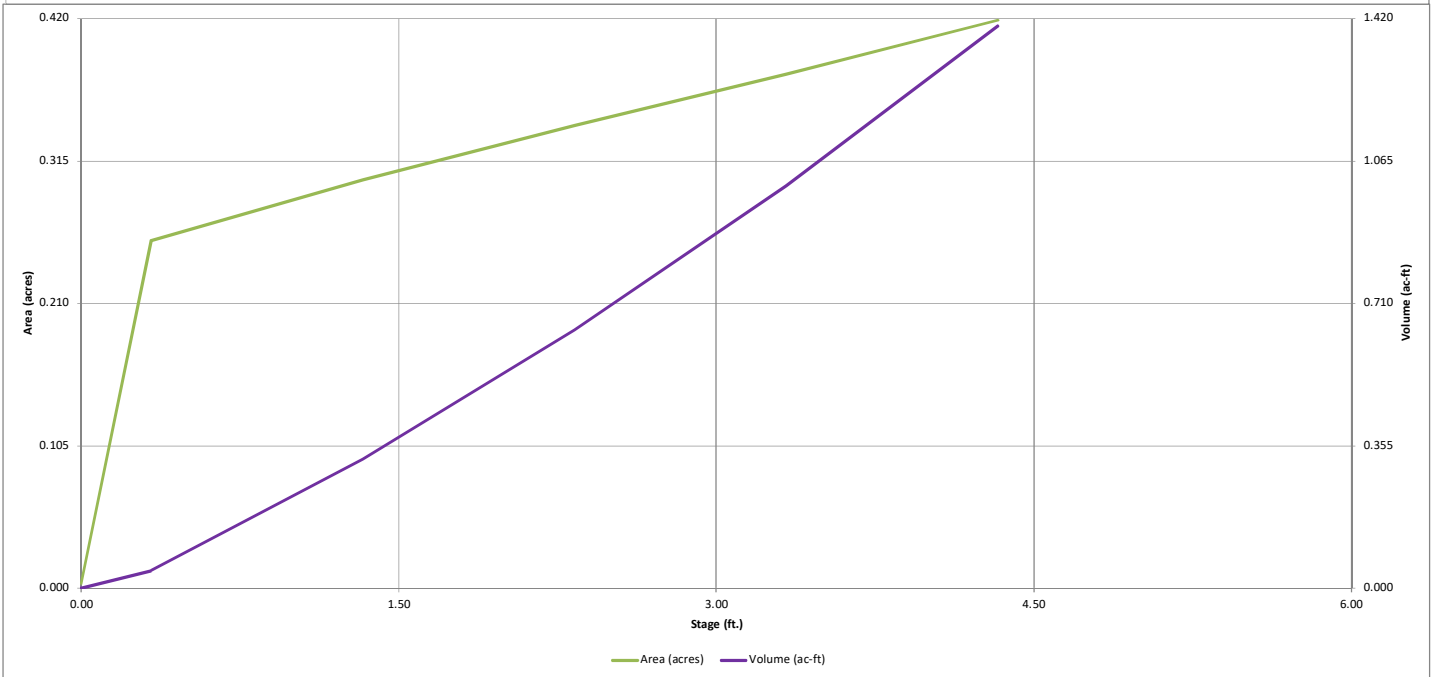
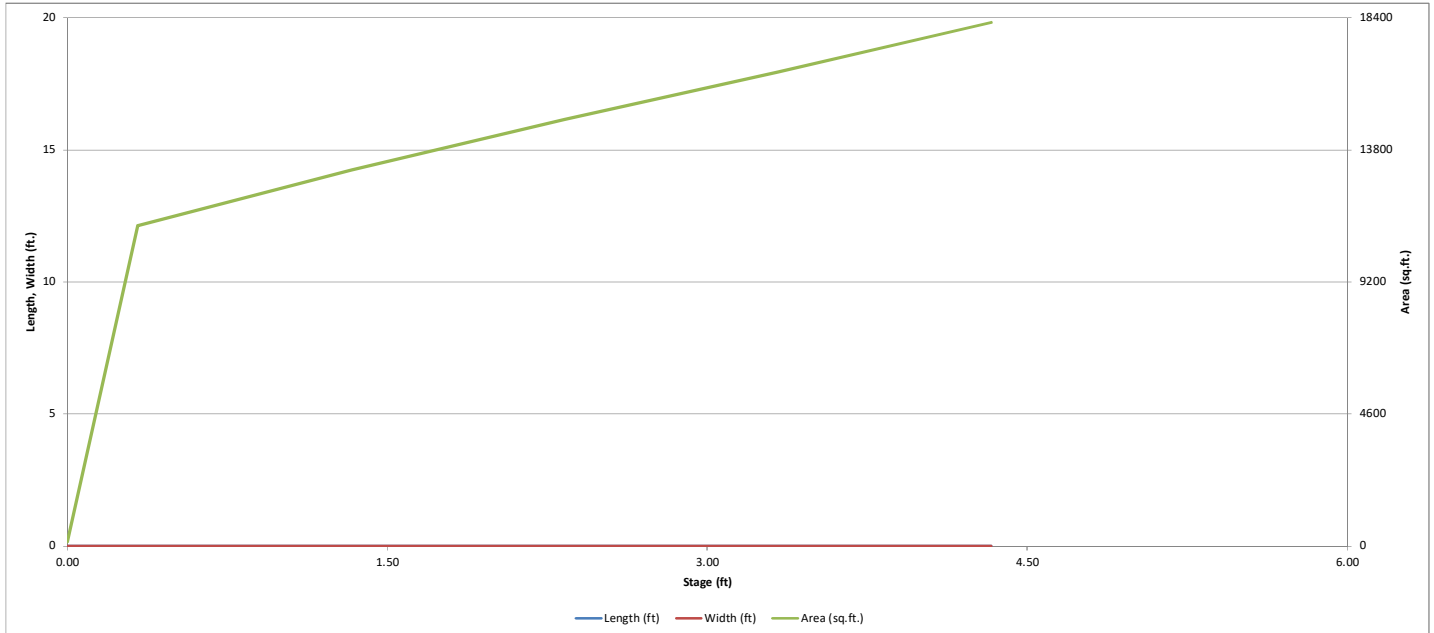
Start of Run: 01Jan2020, 00:00 Basin Model: PR East I
 End of Run: 02Jan2020, 00:05 Meteorologic Model: 24 HR 5 '
 Compute Time: 10Apr2020, 14:22:59 Control Specifications: GR Contr

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Route E-7	0.2984	10.1	01Jan2020, 17:35	0.26
Basin D-3	0.0300	4.3	01Jan2020, 12:45	0.54
Pond 3	0.0300	6.1	01Jan2020, 13:05	0.47
E-3	0.0336	3.1	01Jan2020, 13:05	0.49
C-10	0.2984	10.2	01Jan2020, 16:30	0.27
Basin OS-5	0.0244	4.2	01Jan2020, 13:05	0.84
Route OS-5	0.0244	4.1	01Jan2020, 14:55	0.81
Basin D-4B	0.0103	2.7	01Jan2020, 12:35	0.86
Basin D-4A	0.0069	1.3	01Jan2020, 12:55	0.85
Pond 4	0.0172	2.3	01Jan2020, 12:40	0.22
Route C-8	0.0172	2.3	01Jan2020, 13:45	0.22
E-2	0.0107	2.8	01Jan2020, 12:40	0.92
Route C-6	0.0107	2.8	01Jan2020, 13:40	0.90
E-1A	0.0079	1.7	01Jan2020, 12:40	0.72
Route E-1A	0.0079	1.7	01Jan2020, 13:25	0.70
Basin OS-6D	0.0977	20.9	01Jan2020, 12:45	0.85
Route OS-6D	0.0977	20.9	01Jan2020, 13:40	0.84
Basin OS-6C	0.0824	16.9	01Jan2020, 12:50	0.85
Route OS-6C	0.0824	16.8	01Jan2020, 13:45	0.83
Basin OS-6B	0.0579	13.0	01Jan2020, 12:40	0.85
Route OS-6B	0.0579	13.0	01Jan2020, 13:20	0.84
Basin OS-6A	0.0387	9.5	01Jan2020, 12:35	0.85
Reservoir OS-5	0.2767	9.7	01Jan2020, 15:45	0.22
Reservoir Route	0.2767	9.7	01Jan2020, 16:30	0.22
Basin E-4A	0.0126	2.8	01Jan2020, 12:40	0.85
Basin E-4B	0.0091	2.3	01Jan2020, 12:35	0.86

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Sink EX-1	0.4222	17.4	01Jan2020, 13:35	0.35

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

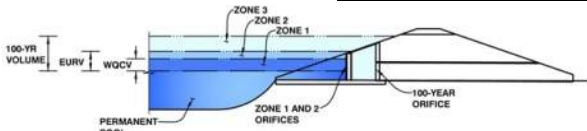


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: **Grandwood Ranch**

Basin ID: **Pond 1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.70	0.138	Orifice Plate
Zone 2 (EURV)	1.69	0.292	Circular Orifice
Zone 3 (100-year)	2.65	0.322	Weir&Pipe (Restrict)
Total (all zones)		0.752	

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 = ft²
 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 (diameter = 1-5/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
 Elliptical Half-Width = feet
 Elliptical Slot Centroid = feet
 Elliptical Slot Area = ft²

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	0.23	0.47					
Orifice Area (sq. inches)	1.35	1.35	1.35					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	0.70	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	1.69	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	3.37	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.06	N/A	ft ²
Vertical Orifice Centroid =	0.14	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.69	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00	N/A	feet
Overflow Weir Gate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Gate Open Area % =	70%	N/A	%, gate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Gate Upper Edge, H ₁ =	2.69	N/A	feet
Overflow Weir Slope Length =	4.12	N/A	feet
Gate Open Area / 100-yr Orifice Area =	21.75	N/A	
Overflow Gate Open Area w/o Debris =	17.32	N/A	ft ²
Overflow Gate Open Area w/ Debris =	8.66	N/A	ft ²

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 =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	8.30		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.80	N/A	ft ²
Outlet Orifice Centroid =	0.40	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.49	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	2.80	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.37	feet
Stage at Top of Freeboard =	4.17	feet
Basin Area at Top of Freeboard =	0.41	acres
Basin Volume at Top of Freeboard =	1.34	acre-ft

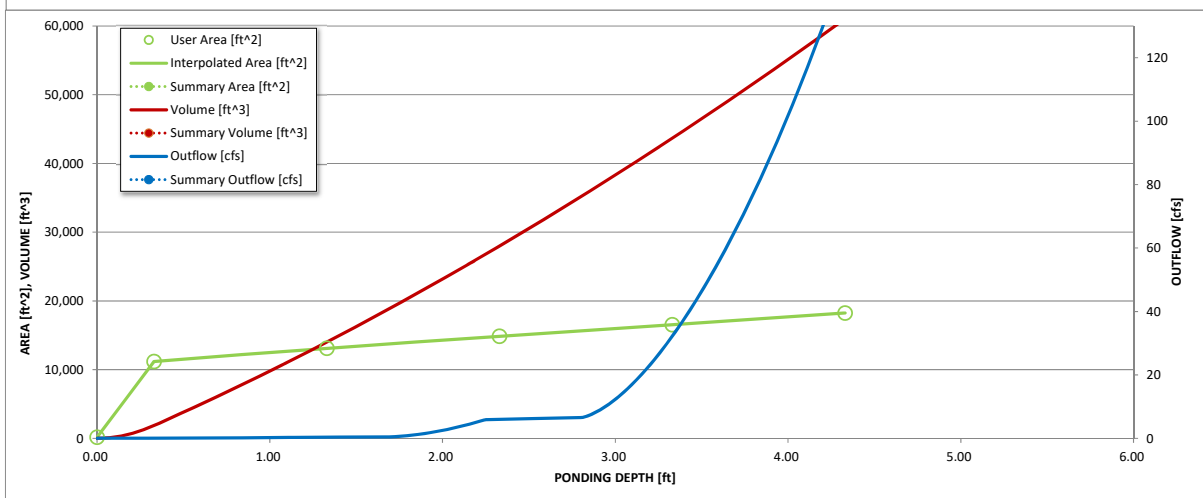
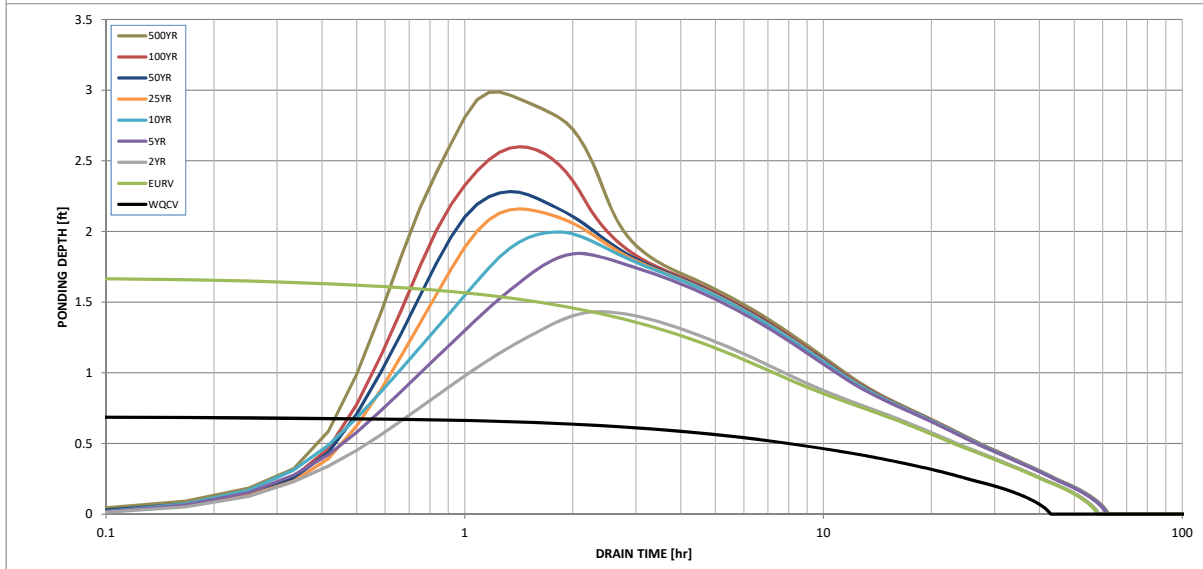
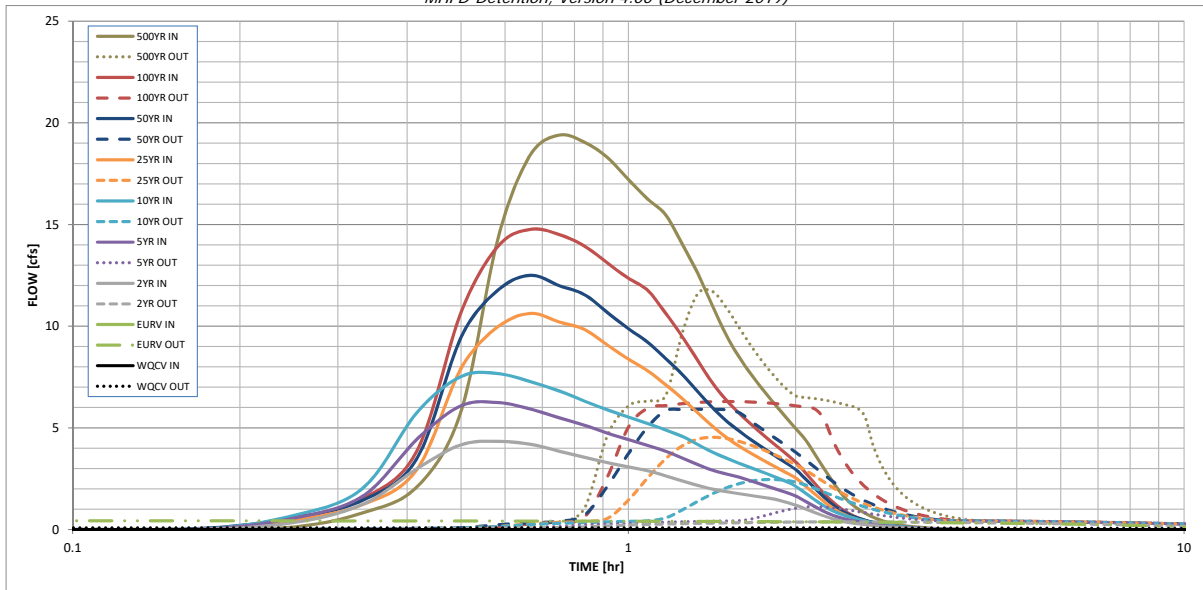
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.138	0.430	0.409	0.584	0.738	0.945	1.113	1.325	1.758
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.409	0.584	0.738	0.945	1.113	1.325	1.758
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.5	1.5	2.3	4.3	5.3	6.9	9.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.07	0.18	0.28	0.53	0.66	0.85	1.20
Peak Inflow Q (cfs) =	N/A	N/A	4.3	6.2	7.7	10.6	12.5	14.8	19.4
Peak Outflow Q (cfs) =	0.1	0.4	0.4	1.1	2.5	4.5	5.9	6.3	11.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	1.1	1.1	1.1	0.9	1.2
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.1	0.2	0.3	0.3	0.4
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	47	48	48	45	43	41	39	36
Time to Drain 99% of Inflow Volume (hours) =	41	53	54	55	55	53	52	51	48
Maximum Ponding Depth (ft) =	0.69	1.69	1.43	1.85	2.00	2.16	2.28	2.60	2.99
Area at Maximum Ponding Depth (acres) =	0.27	0.32	0.30	0.32	0.33	0.33	0.34	0.35	0.37
Maximum Volume Stored (acre-ft) =	0.138	0.432	0.352	0.480	0.529	0.582	0.625	0.736	0.872

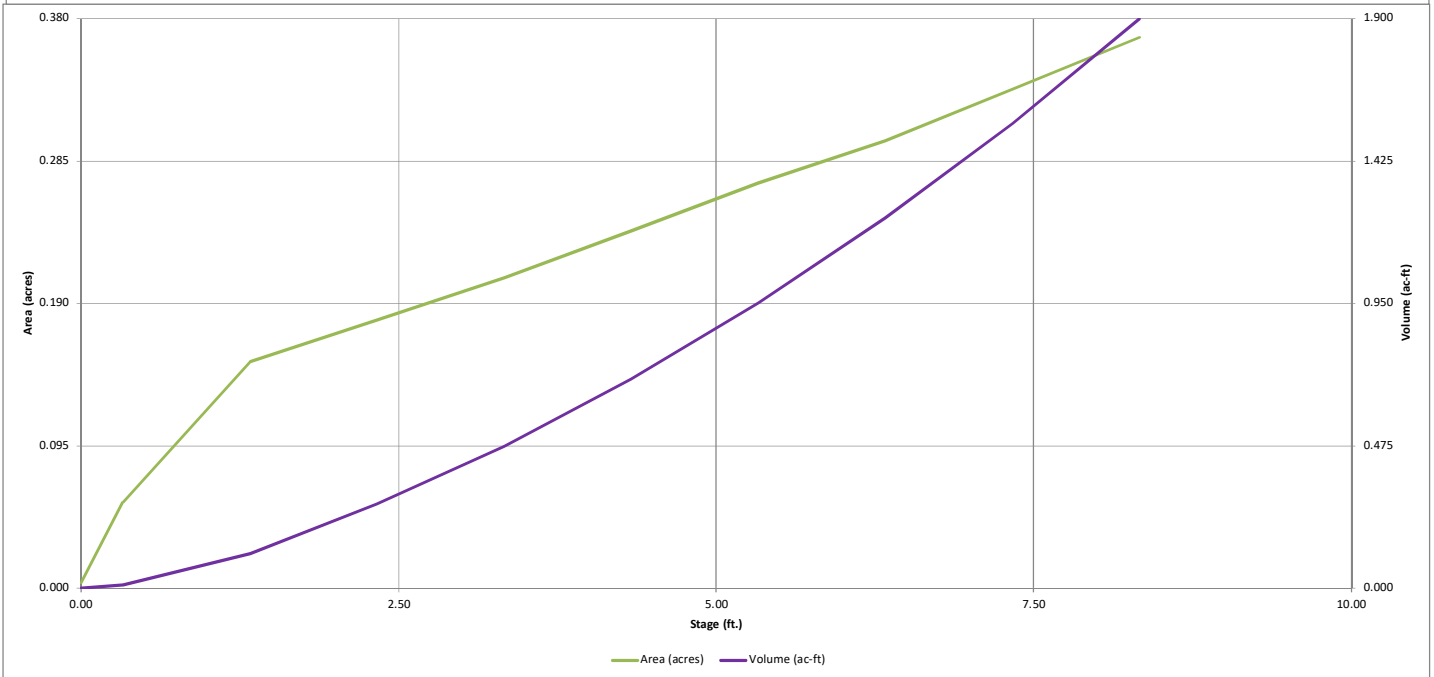
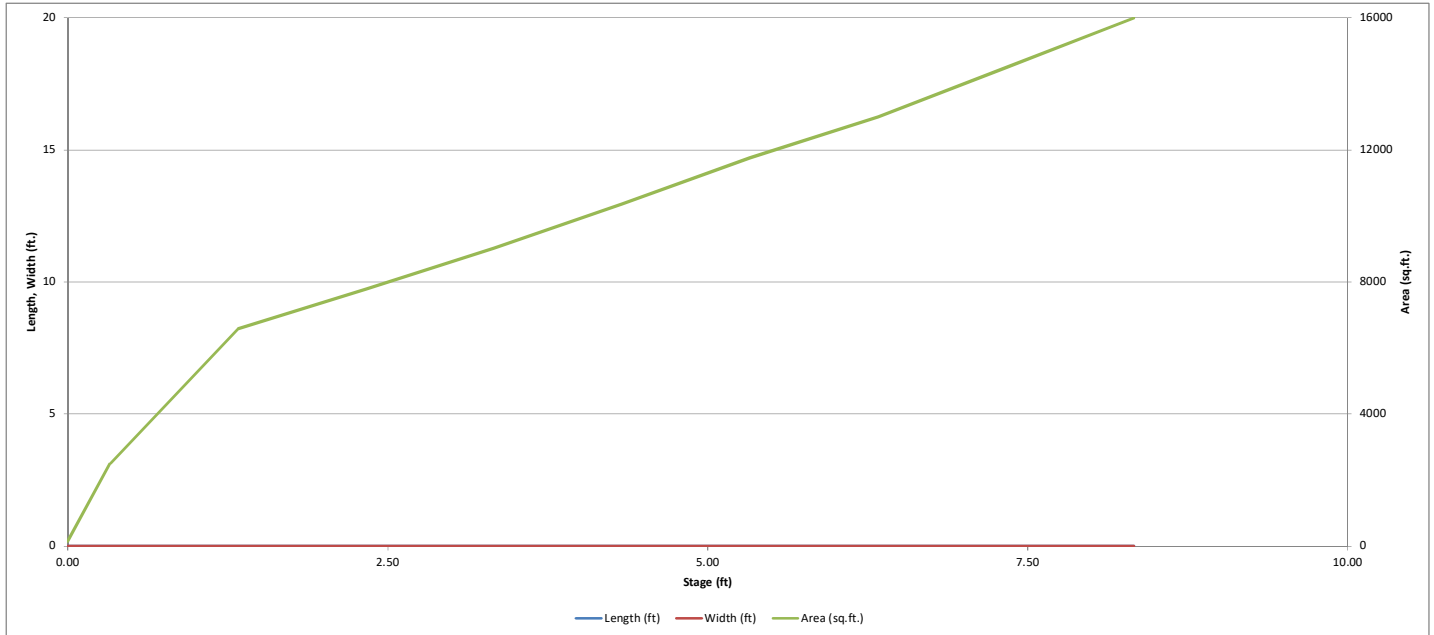
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

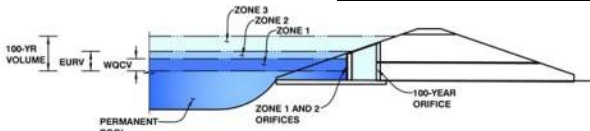
MHFD-Detention, Version 4.02 (February 2020)



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-*Detention, Version 4.02 (February 2020)*

Project: Grandwood Ranch
Basin ID: Pond 2 (Lot 41)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.10	0.082	Orifice Plate
Zone 2 (EURV)	1.68	0.087	Circular Orifice
Zone 3 (100-year)	3.20	0.276	Weir&Pipe (Restrict)
Total (all zones)		0.445	

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 =	4.167E-03	ft ²
Depth at top of Zone using Orifice Plate =	1.10	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	4.40	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.60	sq. inches (diameter = 7/8 inch)	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	0.37	0.73					
Orifice Area (sq. inches)	0.60	0.60	0.60					

	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

	Zone 2 Circular	Not Selected		Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.10	N/A	ft (relative to basin bottom at Stage = 0 ft)	0.01	N/A	ft ²
Depth at top of Zone using Vertical Orifice =	1.68	N/A	ft (relative to basin bottom at Stage = 0 ft)	0.05	N/A	feet
Vertical Orifice Diameter =	1.27	N/A	inches			

User Input: Overflow Weir (Dropbox with Flat or Sloped Gate 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 =	1.68	N/A	ft (relative to basin bottom at Stage = 0 ft)	2.68	N/A	feet
Overflow Weir Front Edge Length =	6.00	N/A	feet	4.12	N/A	feet
Overflow Weir Gate Slope =	4.00	N/A	H:V	9.63	N/A	
Horiz. Length of Weir Sides =	4.00	N/A	feet	17.32	N/A	ft ²
Overflow Gate Open Area % =	70%	N/A	%, gate open area/total area	8.66	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 =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	1.80	N/A	ft ²
Outlet Pipe Diameter =	21.00	N/A	inches	0.68	N/A	feet
Restrictor Plate Height Above Pipe Invert =	14.70		inches	1.98	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage =	3.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth =	0.79	feet
Spillway Crest Length =	5.00	feet	Stage at Top of Freeboard =	5.29	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.27	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.94	acre-ft

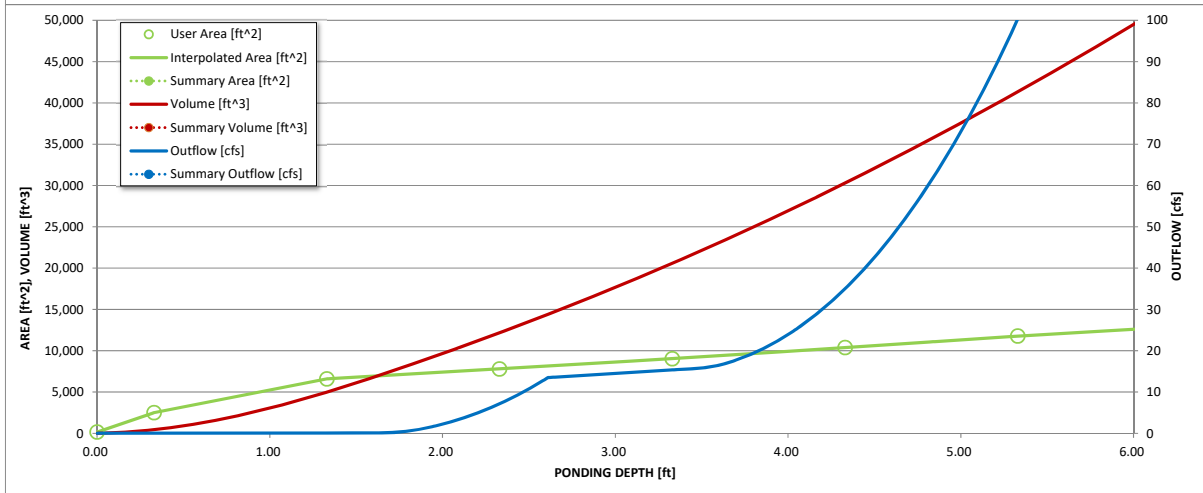
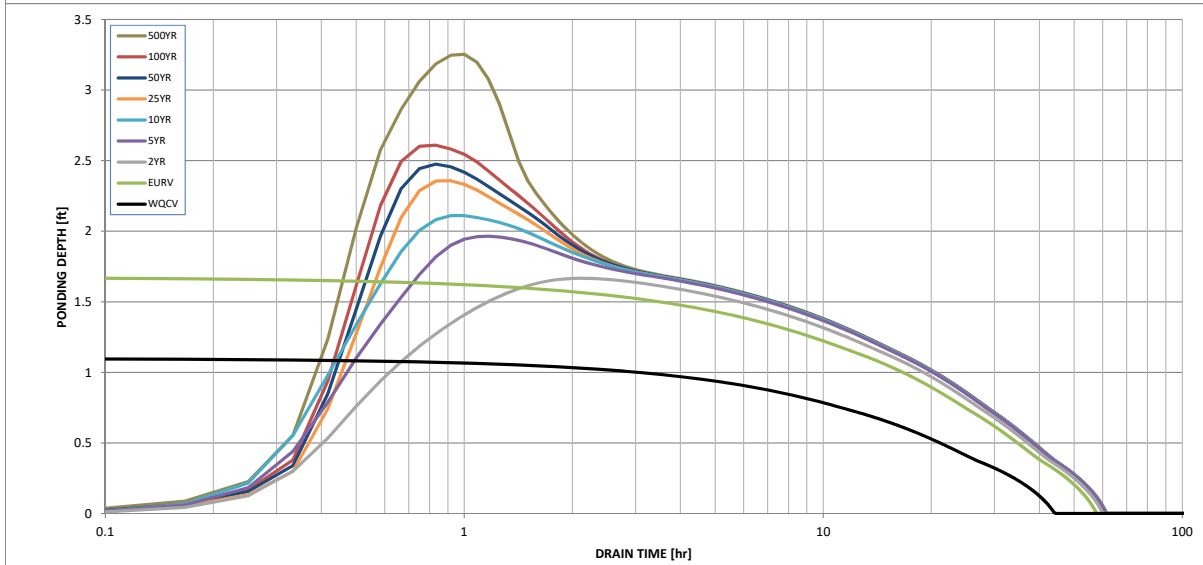
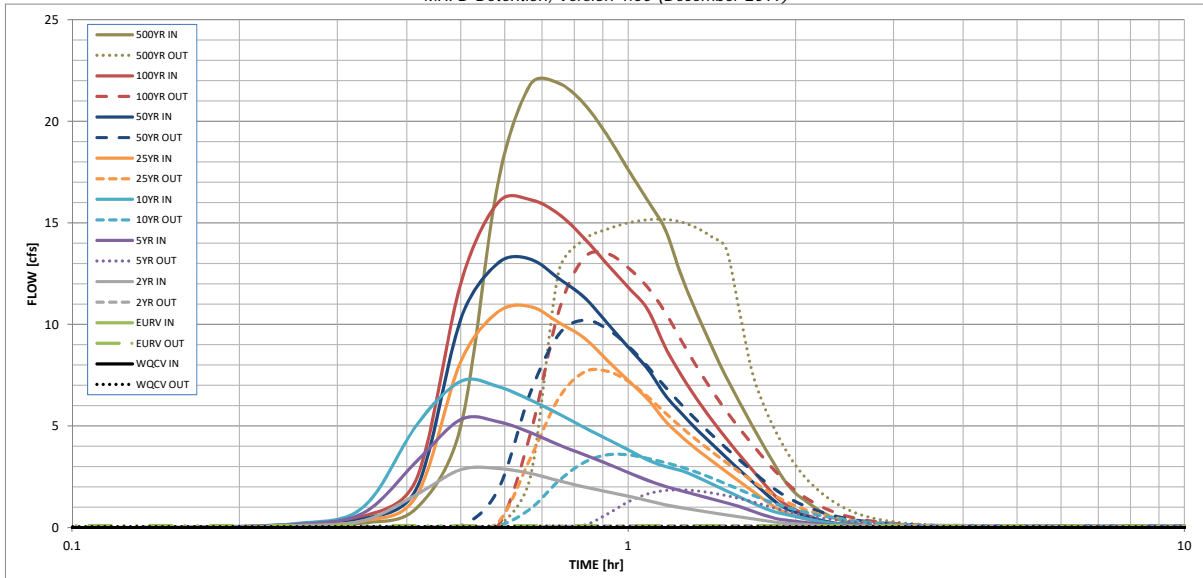
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.082	0.168	0.181	0.330	0.471	0.702	0.867	1.096	1.525
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.181	0.330	0.471	0.702	0.867	1.096	1.525
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.3	3.4	5.1	9.0	11.3	14.1	19.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.15	0.41	0.60	1.06	1.33	1.66	2.31
Peak Inflow Q (cfs) =	N/A	N/A	2.9	5.3	7.2	10.9	13.2	16.1	21.9
Peak Outflow Q (cfs) =	0.1	0.1	0.1	1.9	3.6	7.7	10.2	13.5	15.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.7	0.9	0.9	1.0	0.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.2	0.4	0.6	0.8	0.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	49	51	47	43	39	36	33	28
Time to Drain 99% of Inflow Volume (hours) =	42	54	56	55	53	50	48	46	42
Maximum Ponding Depth (ft) =	1.10	1.68	1.67	1.96	2.11	2.36	2.48	2.61	3.25
Area at Maximum Ponding Depth (acres) =	0.13	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.20
Maximum Volume Stored (acre-ft) =	0.082	0.169	0.166	0.215	0.241	0.283	0.305	0.331	0.456

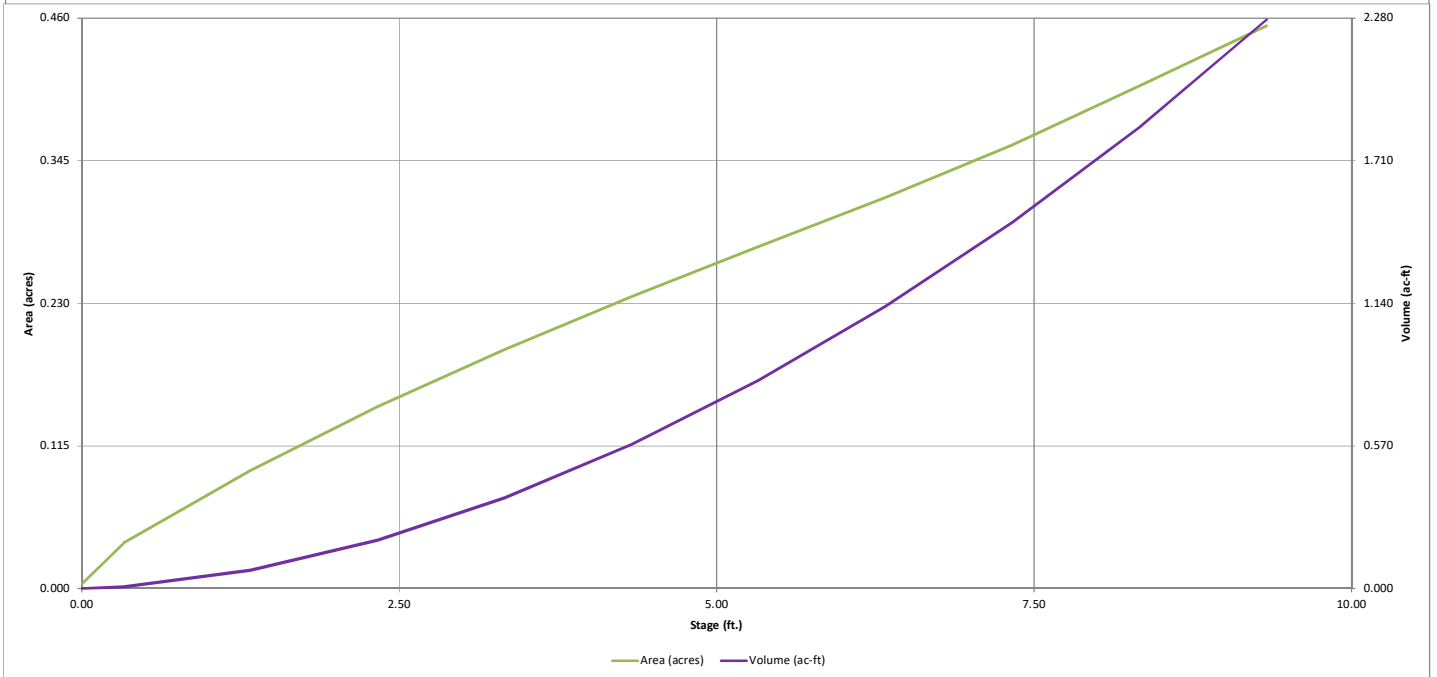
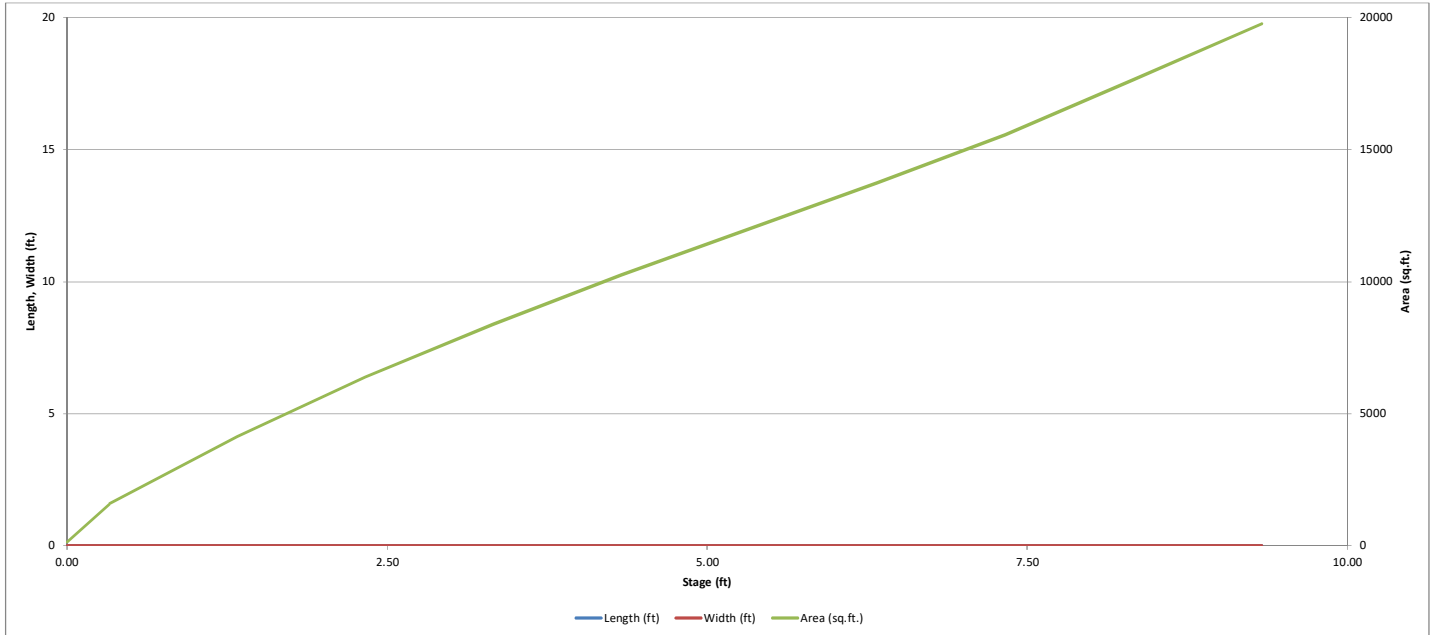
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

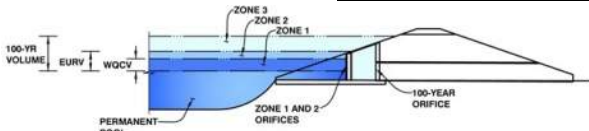
MHFD-Detention, Version 4.02 (February 2020)



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch
Basin ID: Pond 3 (Adjacent to Lot 1)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.22	0.176	Orifice Plate
Zone 2 (EURV)	3.16	0.153	Circular Orifice
Zone 3 (100-year)	5.98	0.688	Weir&Pipe (Restrict)
Total (all zones)		1.017	

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 = ft²
 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 (diameter = 1-1/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
 Elliptical Half-Width = feet
 Elliptical Slot Centroid = feet
 Elliptical Slot Area = ft²

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	0.74	1.48					
Orifice Area (sq. inches)	0.90	0.90	0.90					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	2.22	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.16	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	1.67	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.02	N/A	ft ²
Vertical Orifice Centroid =	0.07	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.16	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00	N/A	feet
Overflow Weir Gate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Gate Open Area % =	70%	N/A	%, gate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Gate Upper Edge, H ₁ =	4.16	N/A	feet
Overflow Weir Slope Length =	4.12	N/A	feet
Gate Open Area / 100-yr Orifice Area =	6.11	N/A	
Overflow Gate Open Area w/o Debris =	17.32	N/A	ft ²
Overflow Gate Open Area w/ Debris =	8.66	N/A	ft ²

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 =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	27.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	18.10		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.83	N/A	ft ²
Outlet Orifice Centroid =	0.85	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.92	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	6.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	11.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.86	feet
Stage at Top of Freeboard =	7.86	feet
Basin Area at Top of Freeboard =	0.38	acres
Basin Volume at Top of Freeboard =	1.66	acre-ft

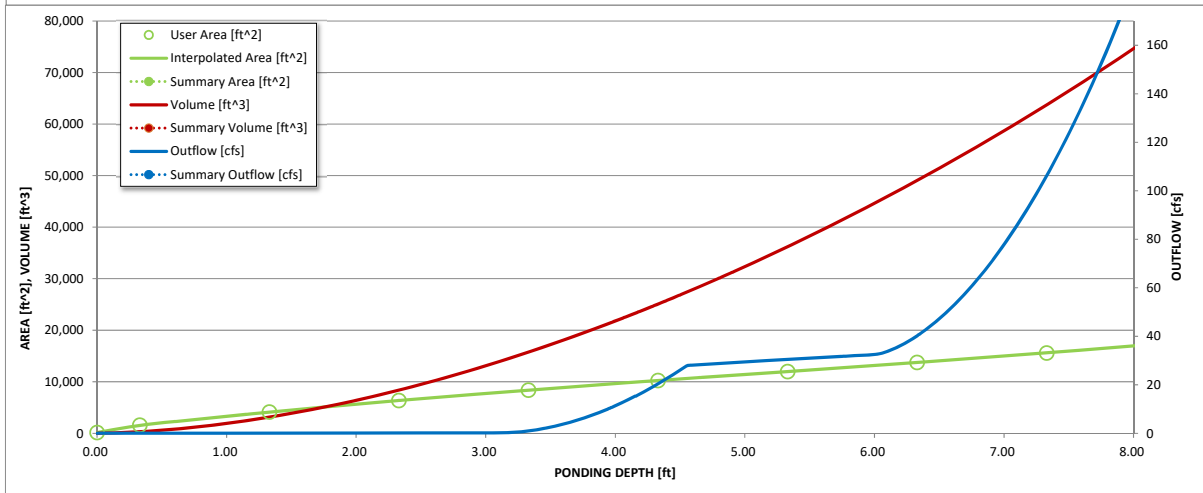
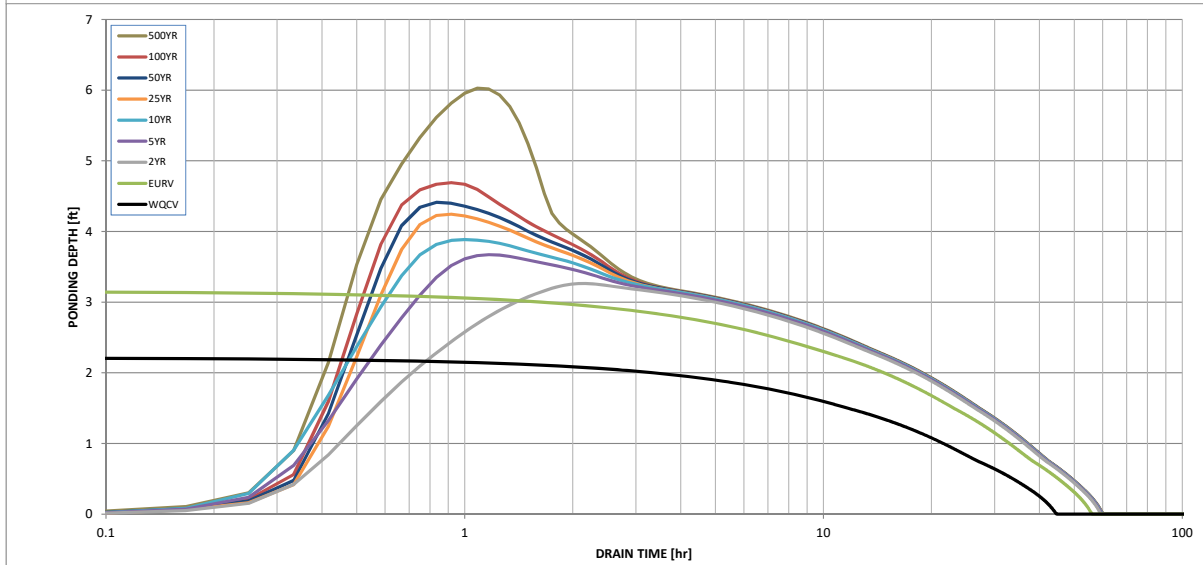
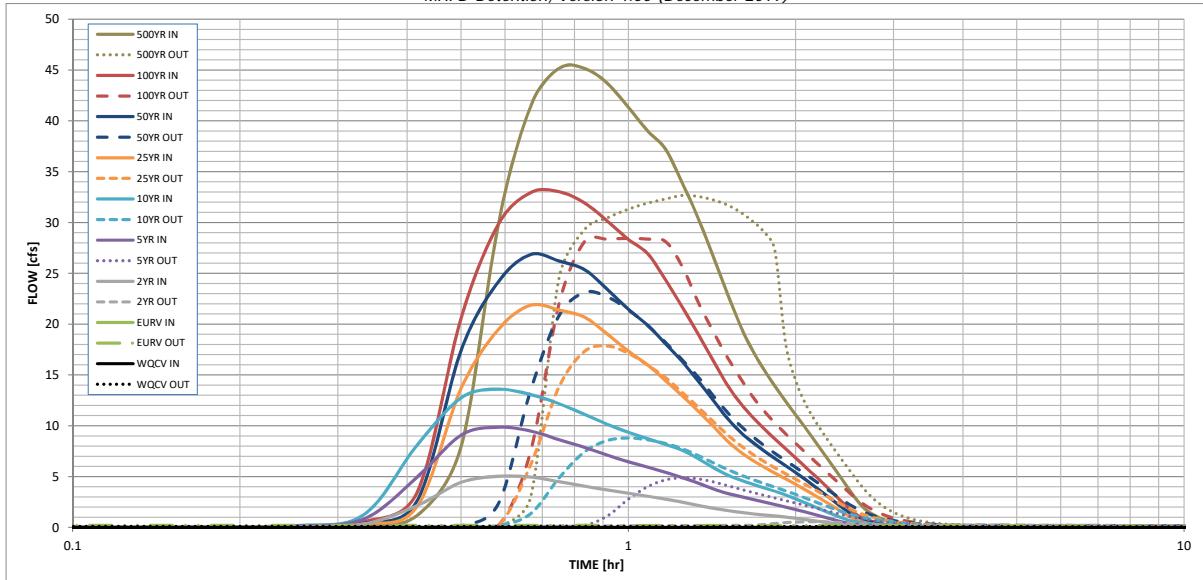
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.176	0.329	0.396	0.782	1.157	1.796	2.242	2.873	4.038
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.396	0.782	1.157	1.796	2.242	2.873	4.038
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	2.5	7.0	10.6	18.7	23.5	30.1	42.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.11	0.31	0.47	0.83	1.04	1.33	1.86
Peak Inflow Q (cfs) =	N/A	N/A	5.0	9.9	13.6	21.9	26.9	33.0	45.2
Peak Outflow Q (cfs) =	0.1	0.2	0.6	4.9	8.8	17.8	23.1	28.4	32.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.8	1.0	1.0	0.9	0.8
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	N/A	0.02	0.3	0.5	1.0	1.3	1.6	1.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	47	50	44	40	34	32	28	22
Time to Drain 99% of Inflow Volume (hours) =	42	52	55	52	50	47	45	42	38
Maximum Ponding Depth (ft) =	2.22	3.16	3.26	3.67	3.89	4.25	4.41	4.69	6.03
Area at Maximum Ponding Depth (acres) =	0.14	0.18	0.19	0.21	0.22	0.23	0.24	0.25	0.30
Maximum Volume Stored (acre-ft) =	0.177	0.330	0.349	0.430	0.474	0.555	0.595	0.663	1.031

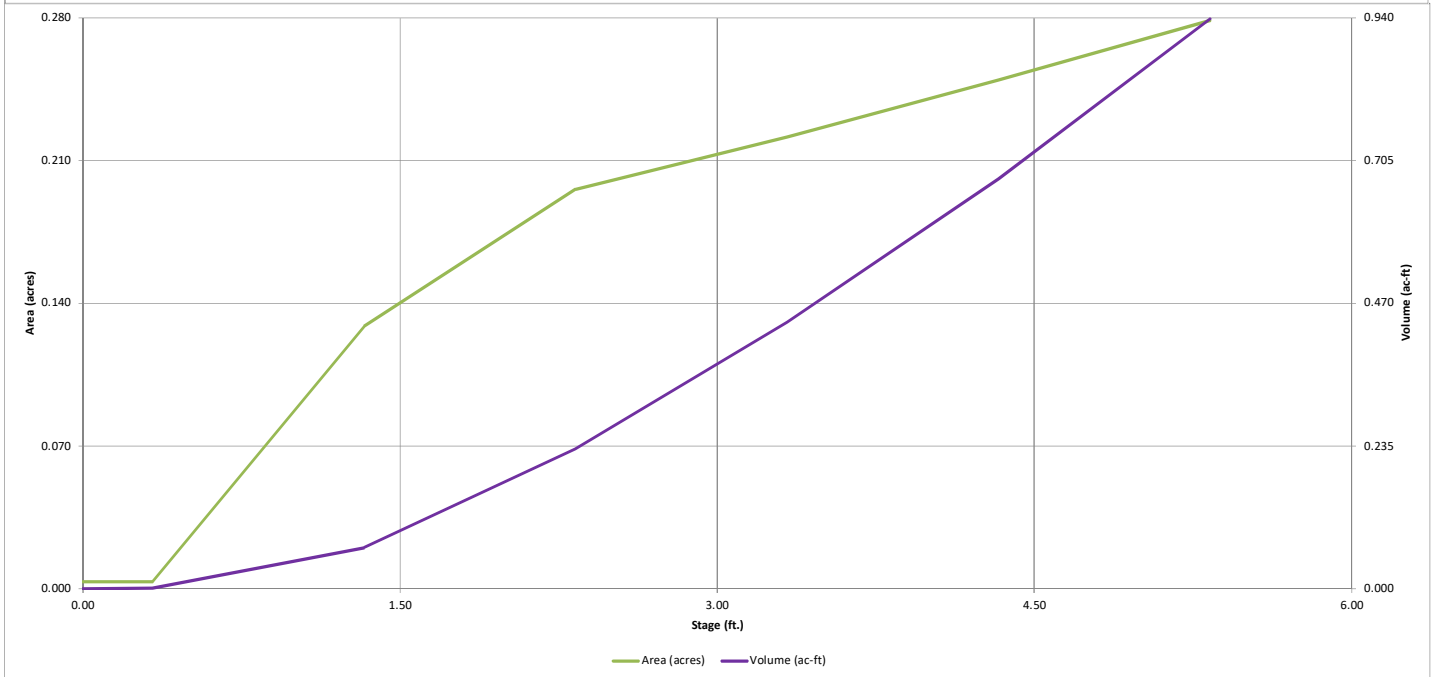
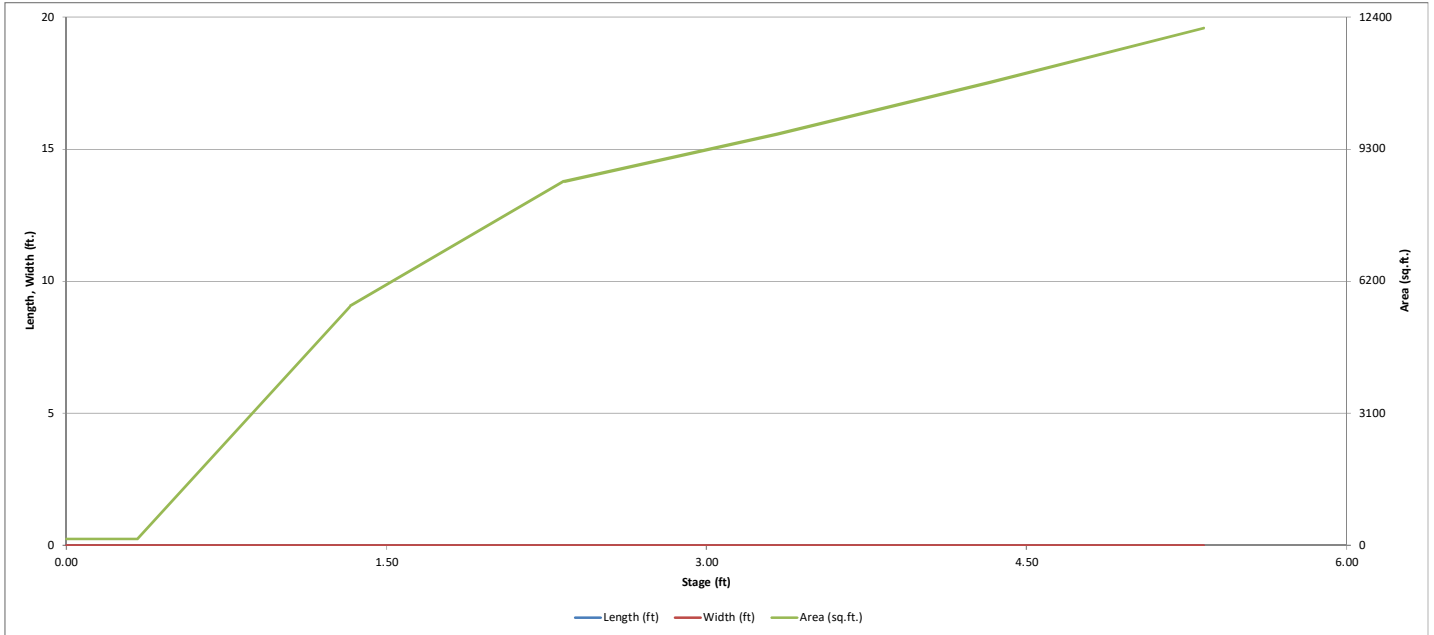
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

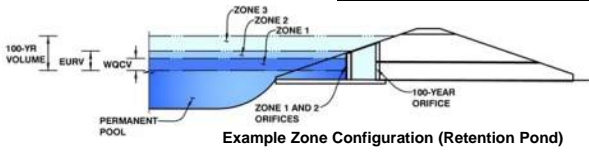
MHFD-Detention, Version 4.02 (February 2020)



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Grandwood Ranch
Basin ID: Pond 4 (East)



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.27	0.059	Orifice Plate
Zone 2 (EURV)	1.62	0.047	Circular Orifice
Zone 3 (100-year)	2.96	0.251	Weir&Pipe (Restrict)
Total (all zones)		0.357	

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 = ft²
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 (diameter = 5/8 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
Elliptical Half-Width = feet
Elliptical Slot Centroid = feet
Elliptical Slot Area = ft²

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	0.85					
Orifice Area (sq. inches)	0.30	0.30	0.30					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	1.27	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	1.62	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	1.65	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.01	N/A	ft ²
Vertical Orifice Centroid =	0.07	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.62	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00	N/A	feet
Overflow Weir Gate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Gate Open Area % =	70%	N/A	%, gate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Gate Upper Edge, H ₁ =	2.62	N/A	feet
Overflow Weir Slope Length =	4.12	N/A	feet
Gate Open Area / 100-yr Orifice Area =	9.93	N/A	
Overflow Gate Open Area w/o Debris =	17.32	N/A	ft ²
Overflow Gate Open Area w/ Debris =	8.66	N/A	ft ²

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 =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	21.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	14.30		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.74	N/A	ft ²
Outlet Orifice Centroid =	0.67	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.94	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	3.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	5.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.74	feet
Stage at Top of Freeboard =	5.24	feet
Basin Area at Top of Freeboard =	0.28	acres
Basin Volume at Top of Freeboard =	0.91	acre-ft

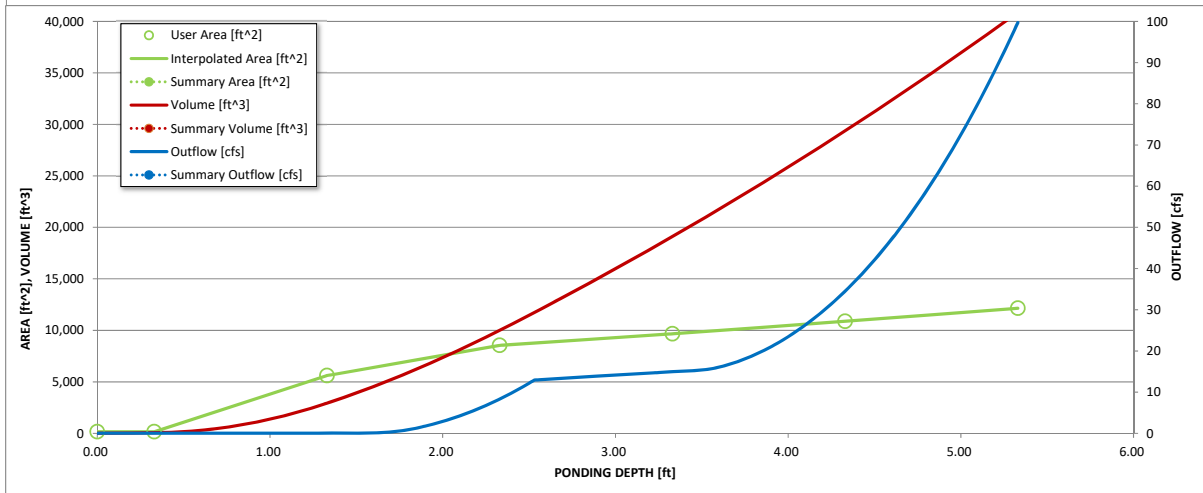
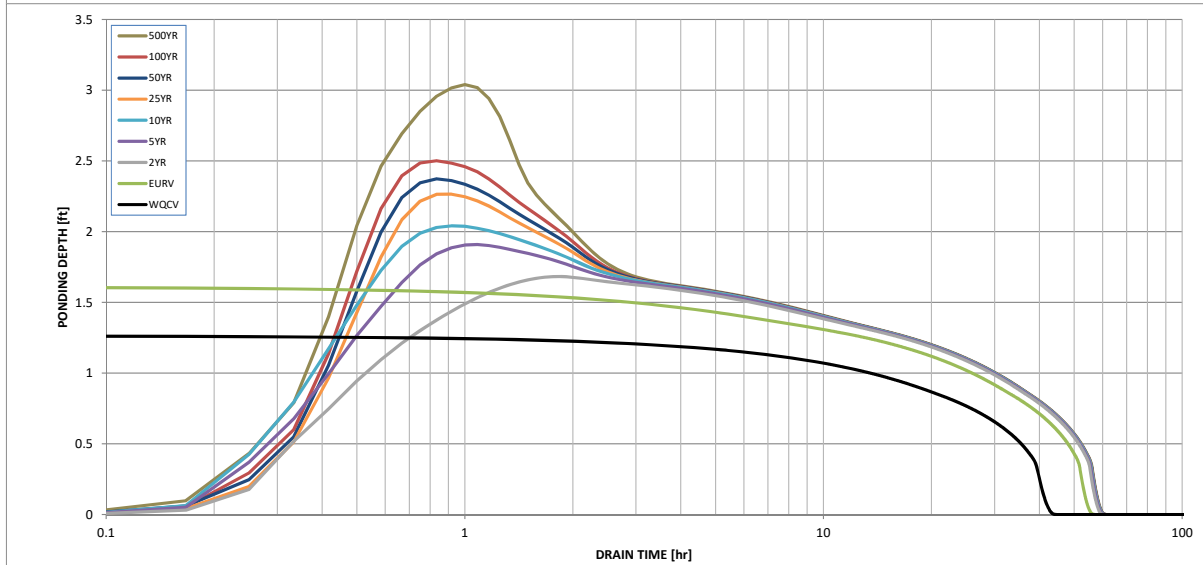
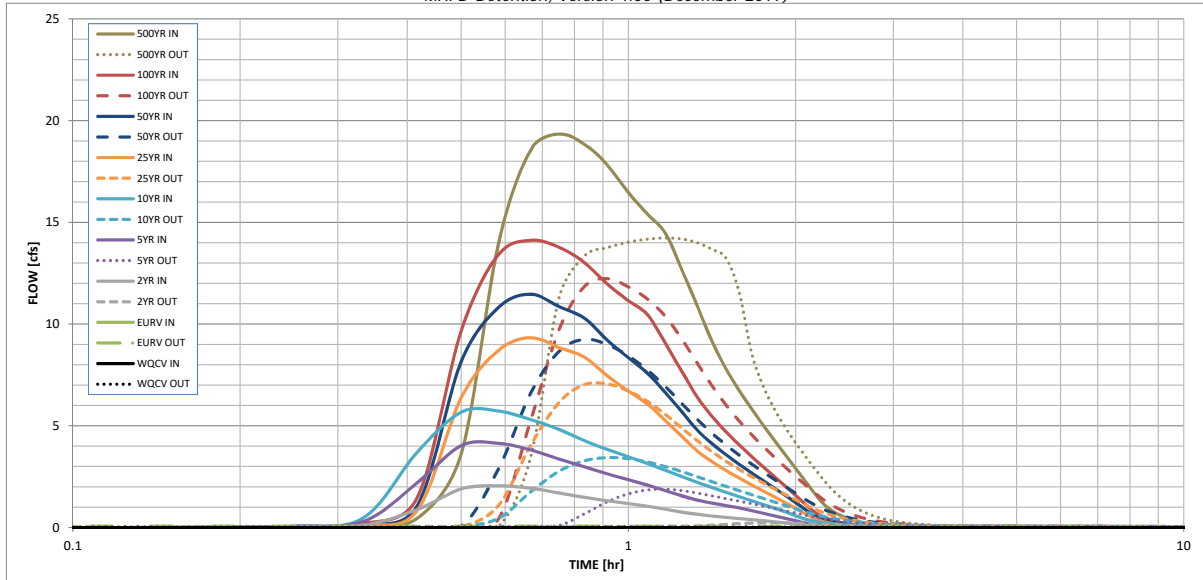
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.059	0.106	0.133	0.273	0.411	0.650	0.816	1.051	1.483
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.133	0.273	0.411	0.650	0.816	1.051	1.483
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	3.2	4.7	8.4	10.5	13.1	18.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.13	0.37	0.55	0.98	1.23	1.54	2.14
Peak Inflow Q (cfs) =	N/A	N/A	2.1	4.1	5.7	9.3	11.5	14.1	19.3
Peak Outflow Q (cfs) =	0.0	0.1	0.2	1.9	3.4	7.1	9.3	12.2	14.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.7	0.8	0.9	0.9	0.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Overflow Weir 1	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	0.01	0.1	0.2	0.4	0.5	0.7	0.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	49	51	47	43	38	34	30	24
Time to Drain 99% of Inflow Volume (hours) =	41	52	55	53	51	49	47	45	42
Maximum Ponding Depth (ft) =	1.27	1.62	1.68	1.91	2.04	2.27	2.37	2.50	3.04
Area at Maximum Ponding Depth (acres) =	0.12	0.15	0.15	0.17	0.18	0.19	0.20	0.20	0.21
Maximum Volume Stored (acre-ft) =	0.060	0.107	0.116	0.152	0.176	0.216	0.238	0.263	0.375

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



Channel Report

Design Point C1

Circular

Diameter (ft) = 1.50

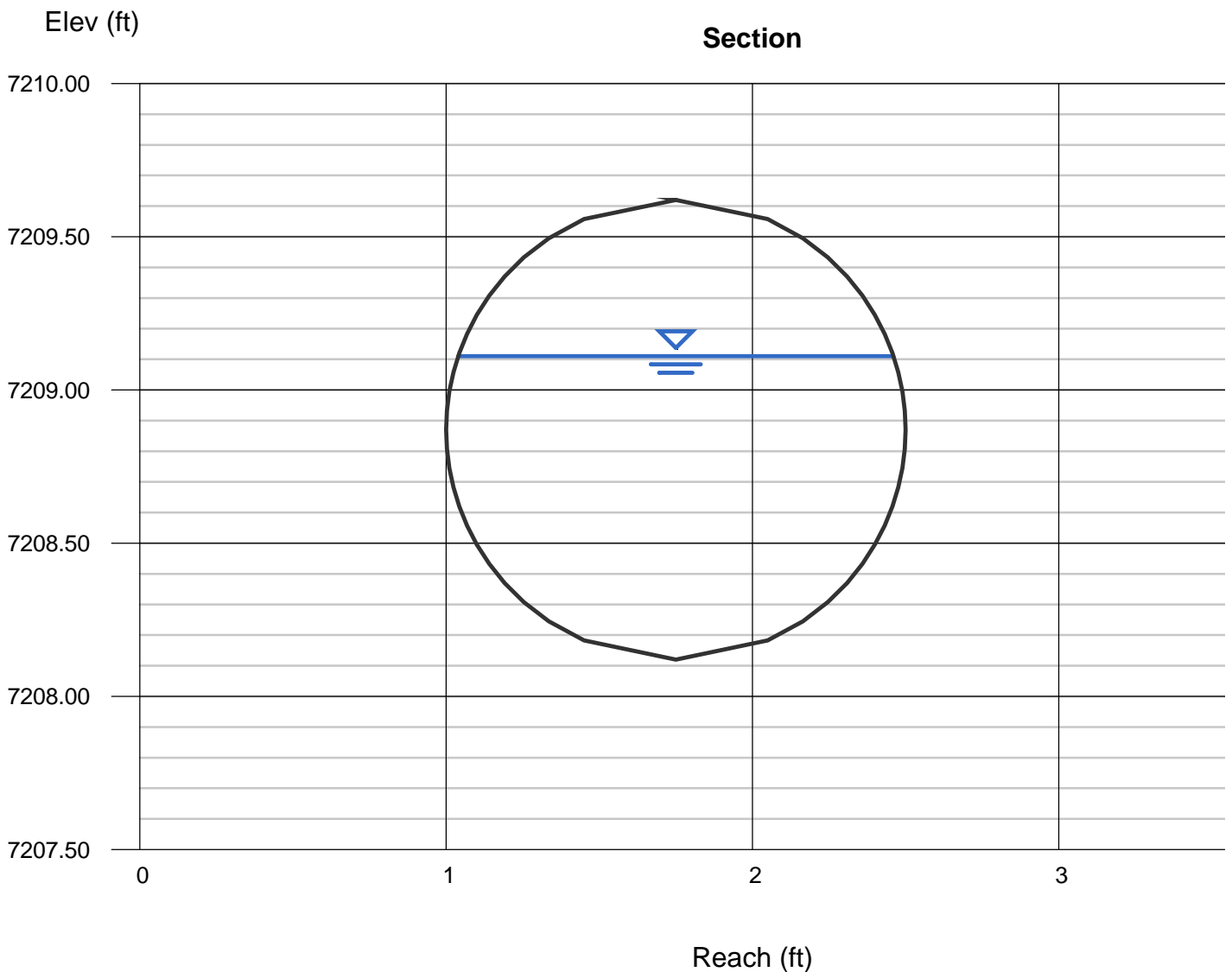
Invert Elev (ft) = 7208.12
Slope (%) = 5.00
N-Value = 0.013

Highlighted

Depth (ft) = 0.99
Q (cfs) = 18.00
Area (sqft) = 1.24
Velocity (ft/s) = 14.51
Wetted Perim (ft) = 2.85
Crit Depth, Yc (ft) = 1.46
Top Width (ft) = 1.42
EGL (ft) = 4.26

Calculations

Compute by: Known Q
Known Q (cfs) = 18.00



Channel Report

Design Point C-2 (2 Culverts)

Circular

Diameter (ft) = 3.00

Invert Elev (ft) = 7217.05

Slope (%) = 2.00

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 68.00

Highlighted

Depth (ft) = 1.89

Q (cfs) = 68.00

Area (sqft) = 4.70

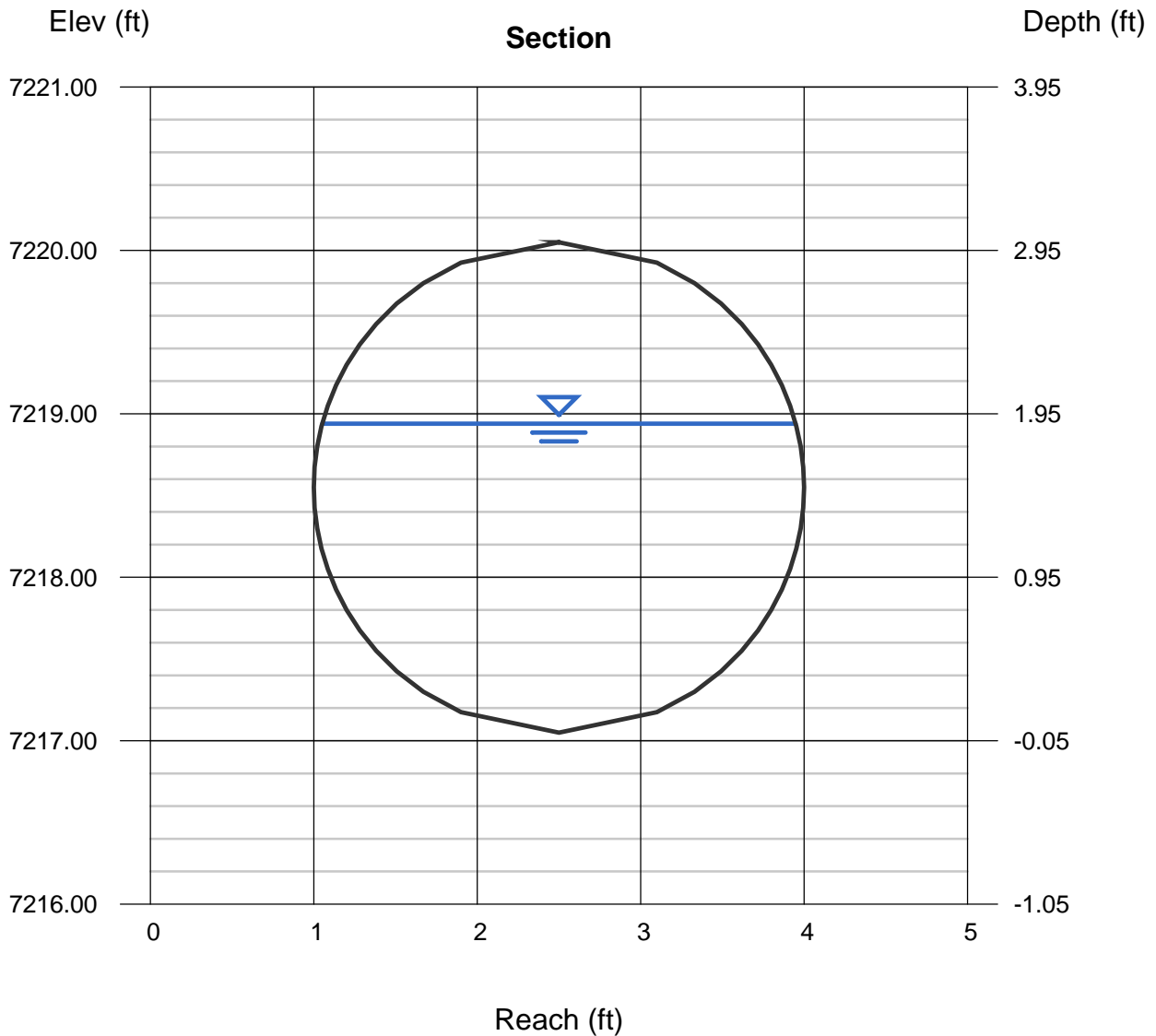
Velocity (ft/s) = 14.48

Wetted Perim (ft) = 5.50

Crit Depth, Y_c (ft) = 2.63

Top Width (ft) = 2.90

EGL (ft) = 5.15



Channel Report

Culvert C-3 (2 Culverts)

Circular

Diameter (ft) = 3.50

Invert Elev (ft) = 7192.98

Slope (%) = 0.80

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 71.30

Highlighted

Depth (ft) = 2.35

Q (cfs) = 71.30

Area (sqft) = 6.89

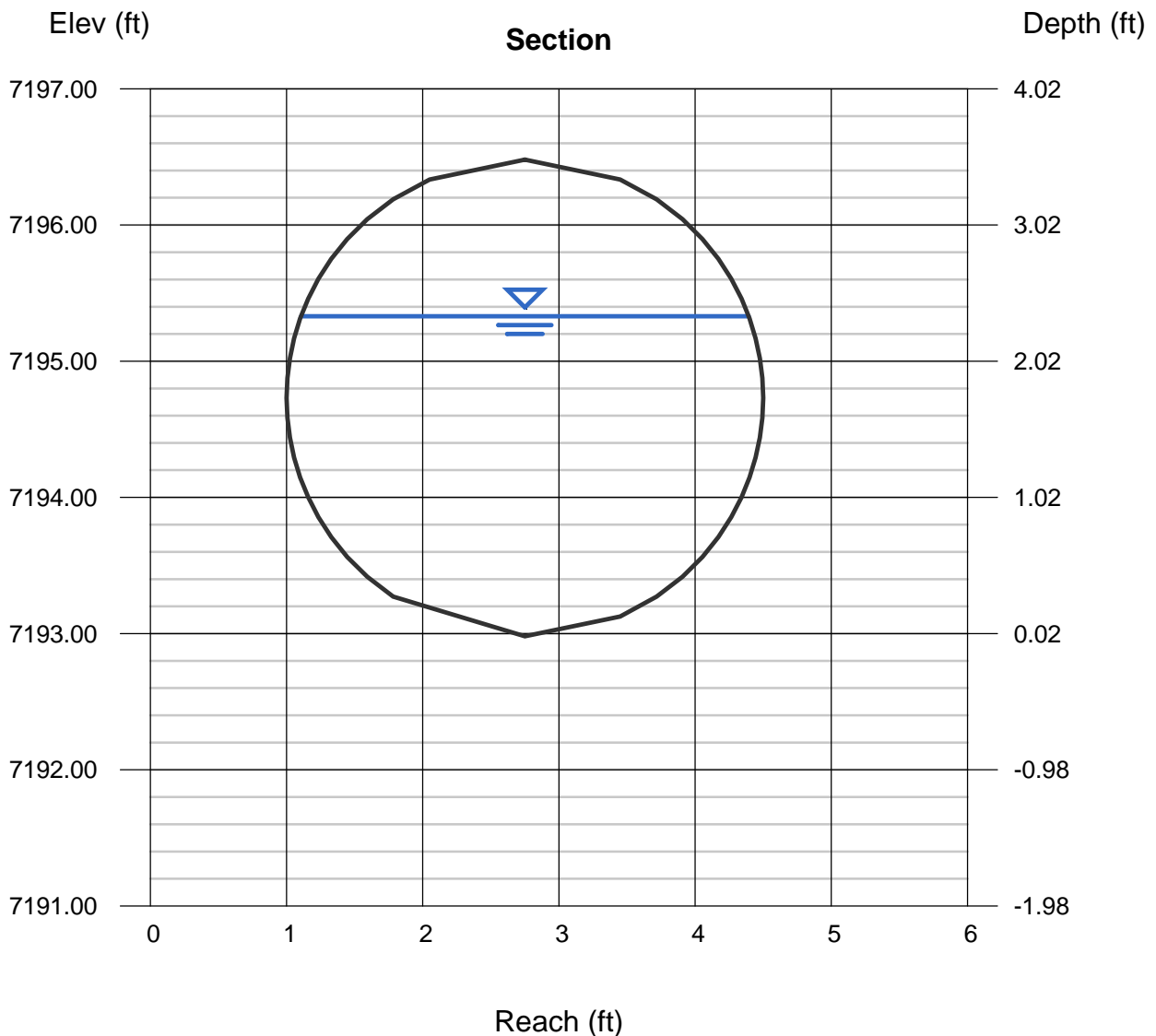
Velocity (ft/s) = 10.35

Wetted Perim (ft) = 6.74

Crit Depth, Yc (ft) = 2.65

Top Width (ft) = 3.28

EGL (ft) = 4.01



Channel Report

Design Point C-4

Circular

Diameter (ft) = 1.50

Invert Elev (ft) = 7201.30

Slope (%) = 5.00

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 15.10

Highlighted

Depth (ft) = 0.88

Q (cfs) = 15.10

Area (sqft) = 1.08

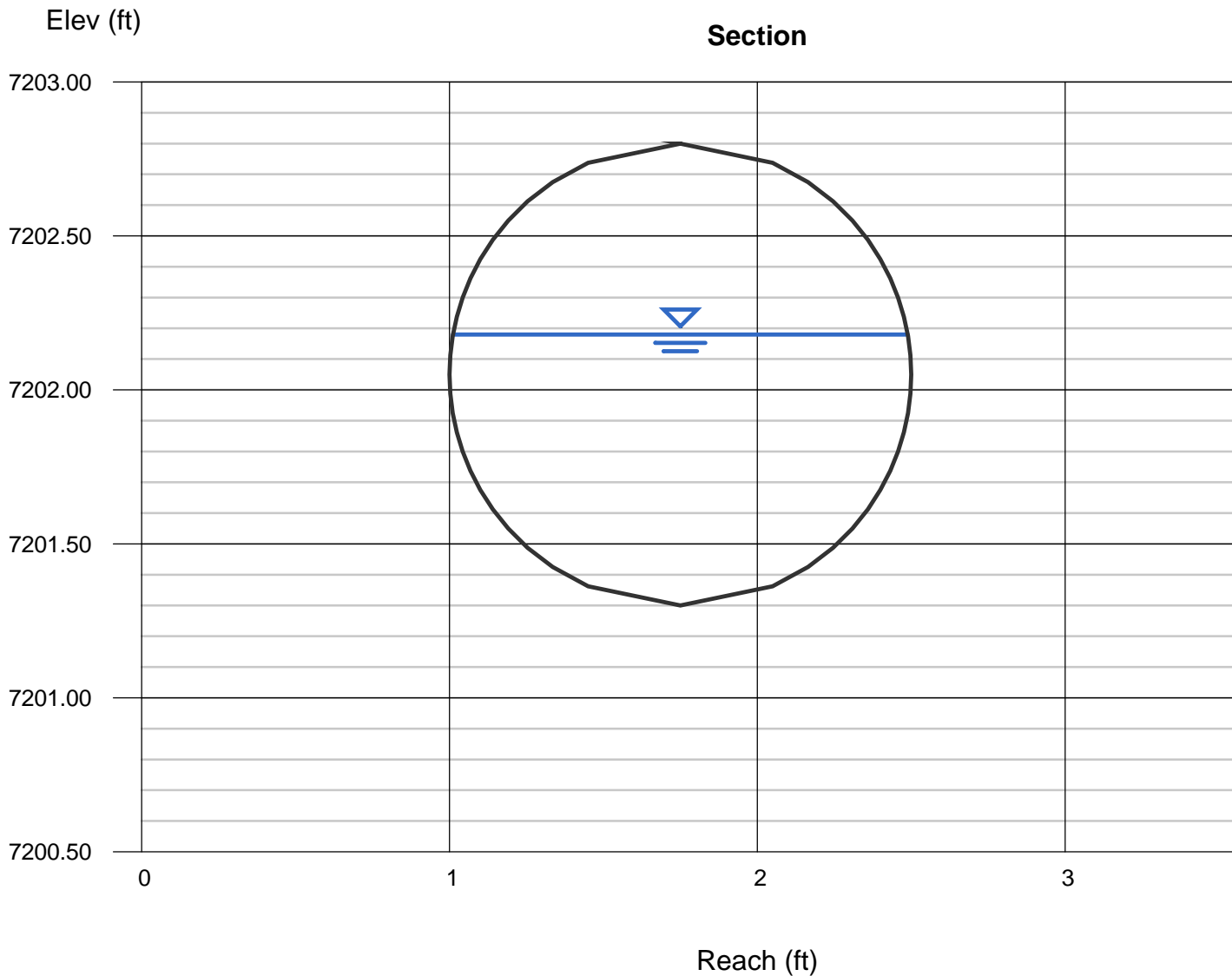
Velocity (ft/s) = 13.94

Wetted Perim (ft) = 2.62

Crit Depth, Y_c (ft) = 1.41

Top Width (ft) = 1.48

EGL (ft) = 3.90



Channel Report

Design Point C-5

Circular

Diameter (ft) = 1.50

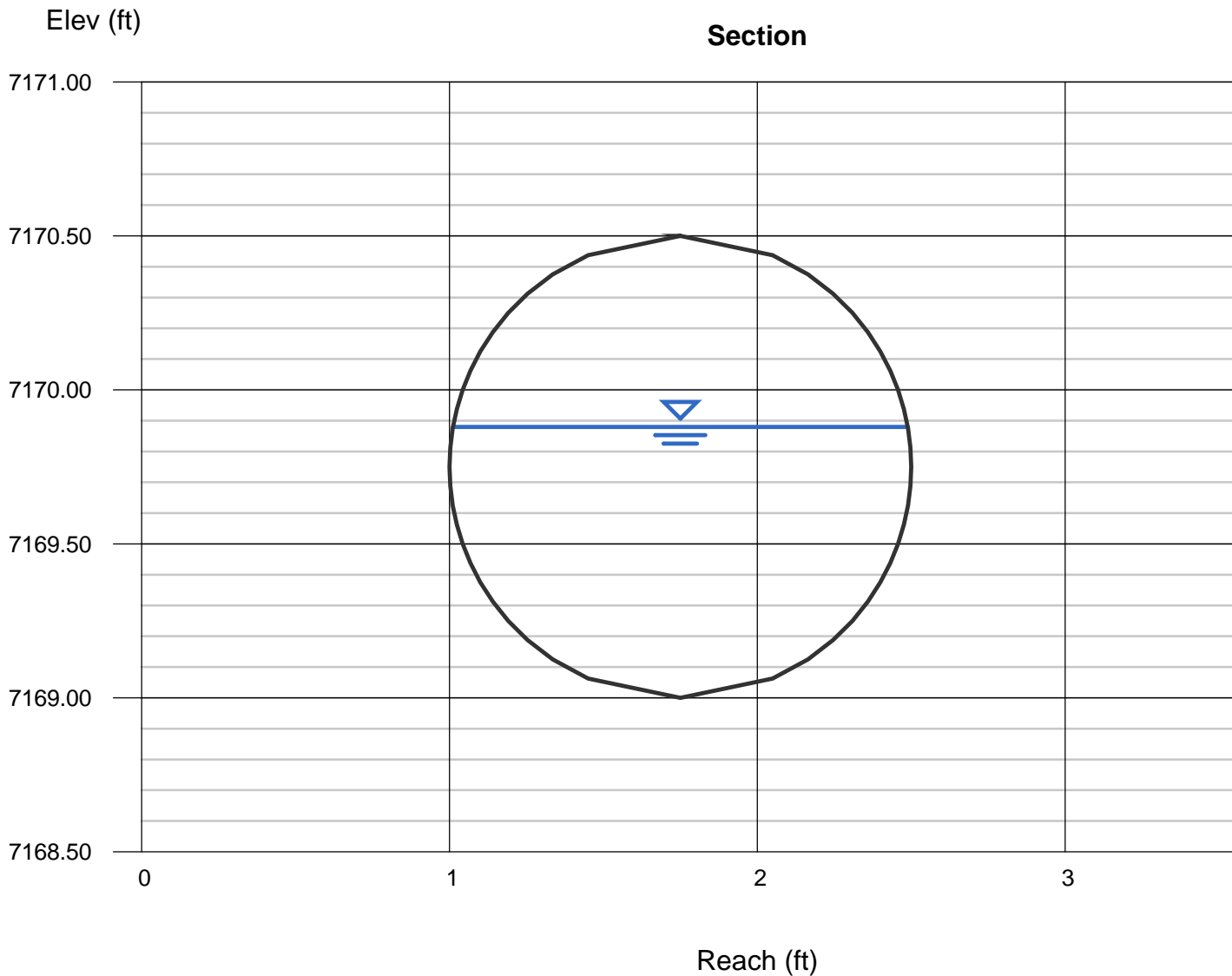
Invert Elev (ft) = 7169.00
Slope (%) = 5.00
N-Value = 0.013

Calculations

Compute by: Known Q
Known Q (cfs) = 15.10

Highlighted

Depth (ft) = 0.88
Q (cfs) = 15.10
Area (sqft) = 1.08
Velocity (ft/s) = 13.94
Wetted Perim (ft) = 2.62
Crit Depth, Yc (ft) = 1.41
Top Width (ft) = 1.48
EGL (ft) = 3.90



Channel Report

Design Point C-6

Circular

Diameter (ft) = 1.50

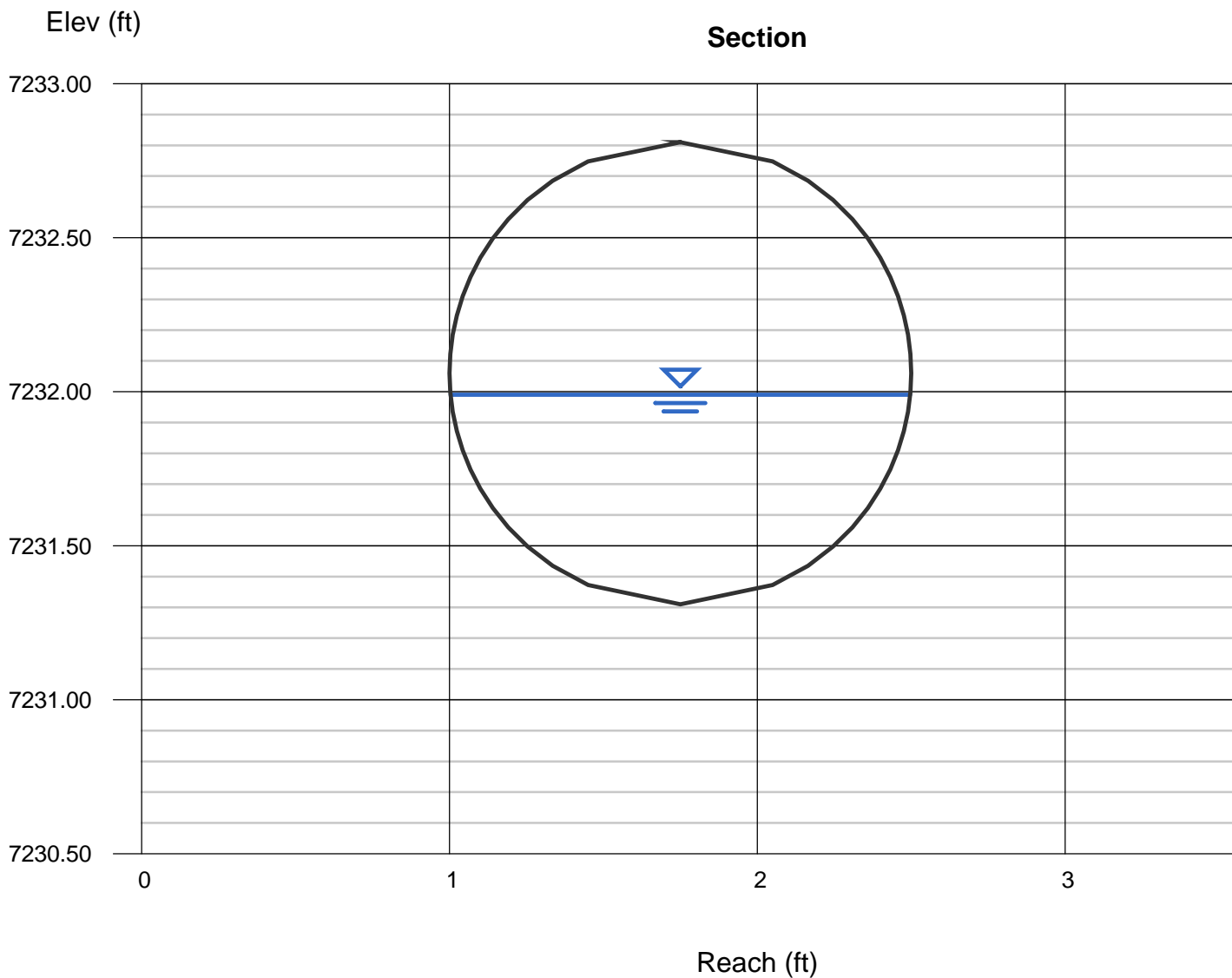
Invert Elev (ft) = 7231.31
Slope (%) = 7.00
N-Value = 0.013

Calculations

Compute by: Known Q
Known Q (cfs) = 11.50

Highlighted

Depth (ft) = 0.68
Q (cfs) = 11.50
Area (sqft) = 0.78
Velocity (ft/s) = 14.71
Wetted Perim (ft) = 2.22
Crit Depth, Yc (ft) = 1.30
Top Width (ft) = 1.49
EGL (ft) = 4.04



Channel Report

Design Point C-7

Circular

Diameter (ft) = 1.50

Invert Elev (ft) = 7165.00

Slope (%) = 0.40

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 1.70

Highlighted

Depth (ft) = 0.52

Q (cfs) = 1.700

Area (sqft) = 0.54

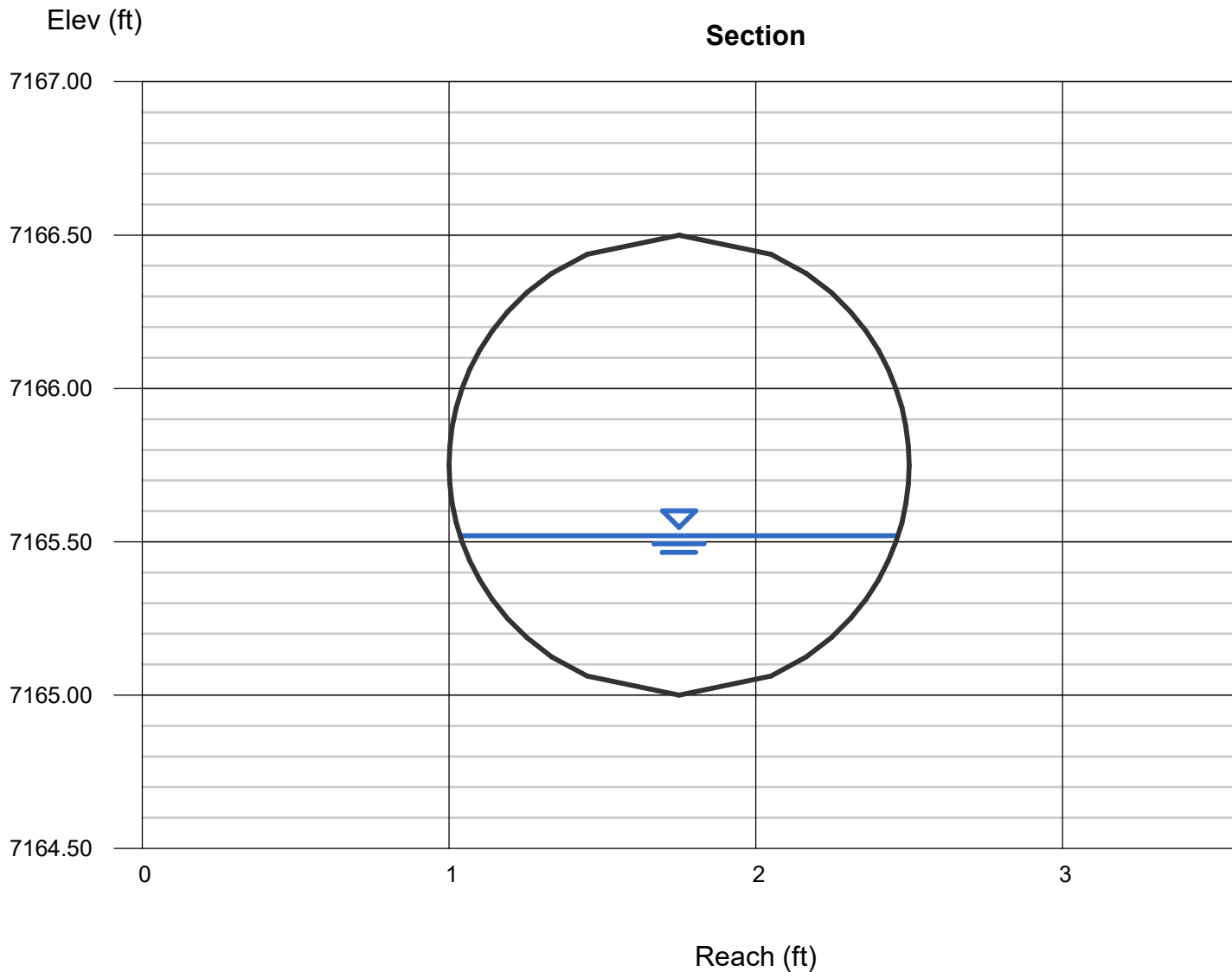
Velocity (ft/s) = 3.12

Wetted Perim (ft) = 1.89

Crit Depth, Y_c (ft) = 0.49

Top Width (ft) = 1.43

EGL (ft) = 0.67



Channel Report

Design Point C-8

Circular

Diameter (ft) = 1.50

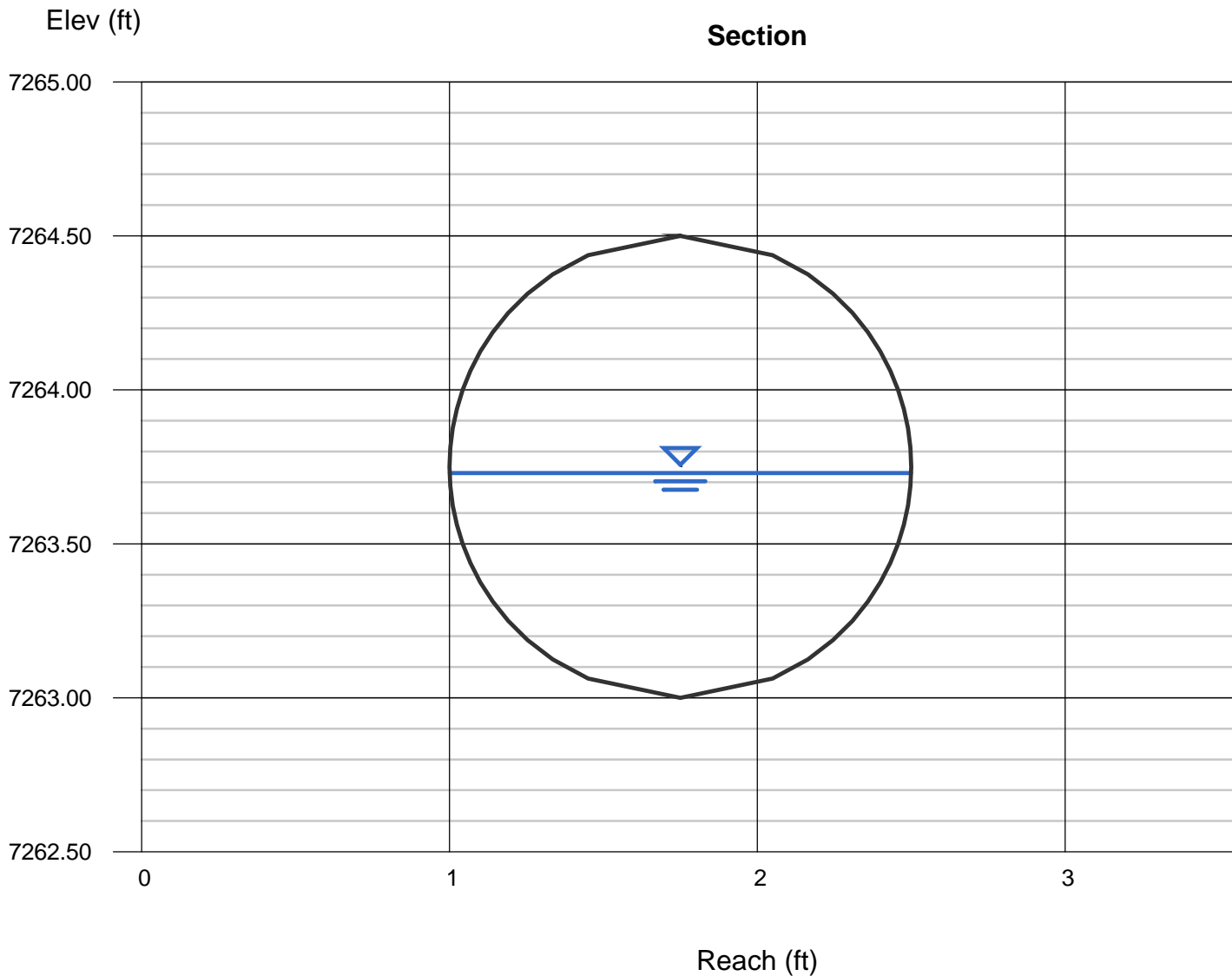
Invert Elev (ft) = 7263.00
Slope (%) = 6.50
N-Value = 0.013

Highlighted

Depth (ft) = 0.73
Q (cfs) = 12.80
Area (sqft) = 0.85
Velocity (ft/s) = 14.98
Wetted Perim (ft) = 2.32
Crit Depth, Yc (ft) = 1.35
Top Width (ft) = 1.50
EGL (ft) = 4.22

Calculations

Compute by: Known Q
Known Q (cfs) = 12.80



Channel Report

Design Point C-10

Circular

Diameter (ft) = 1.50

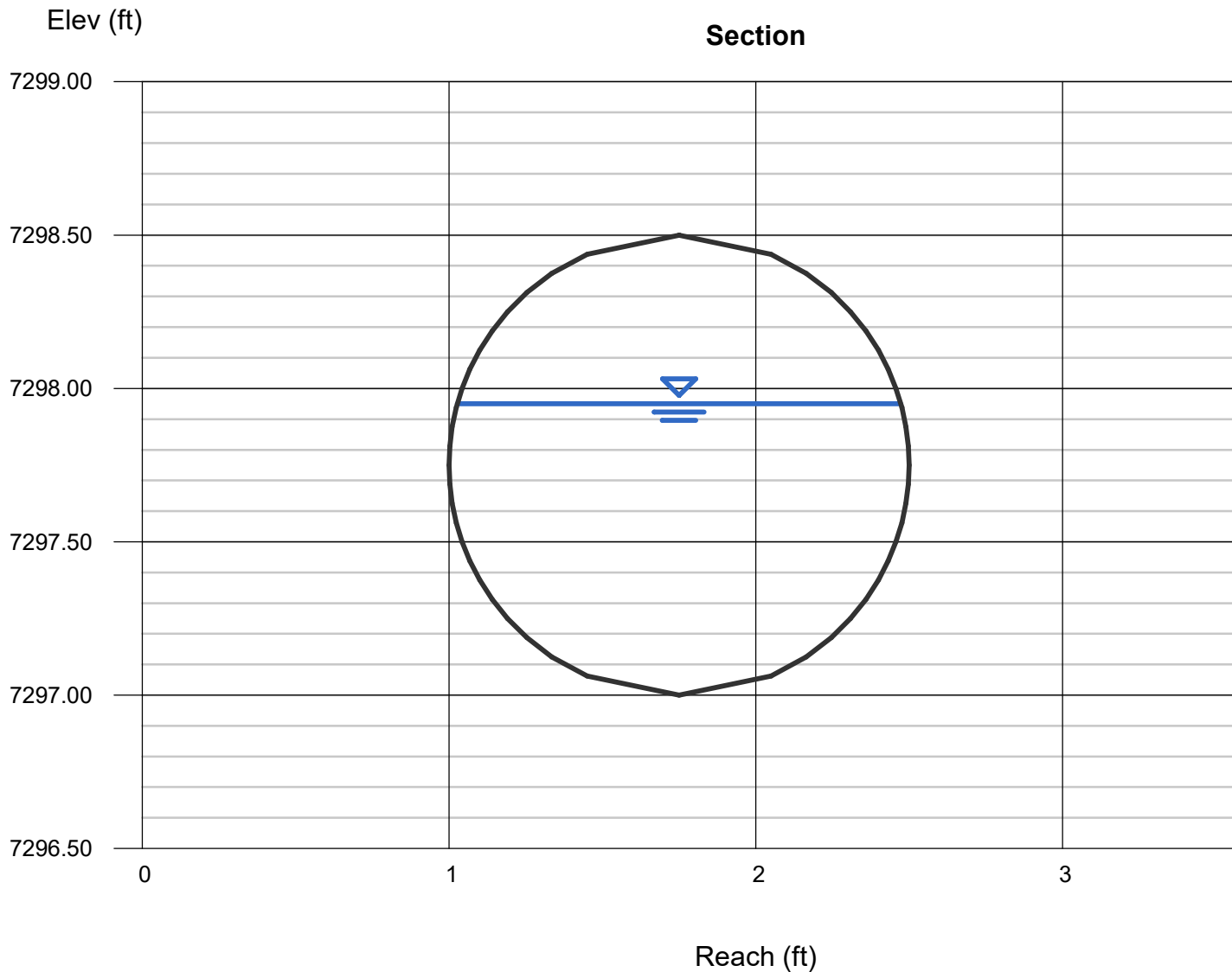
Invert Elev (ft) = 7297.00
Slope (%) = 5.00
N-Value = 0.013

Highlighted

Depth (ft) = 0.95
Q (cfs) = 17.10
Area (sqft) = 1.18
Velocity (ft/s) = 14.44
Wetted Perim (ft) = 2.77
Crit Depth, Yc (ft) = 1.45
Top Width (ft) = 1.44
EGL (ft) = 4.19

Calculations

Compute by: Known Q
Known Q (cfs) = 17.10



Channel Report

Design Point C-11

Circular

Diameter (ft) = 2.50

Invert Elev (ft) = 7300.00

Slope (%) = 2.50

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 61.00

Highlighted

Depth (ft) = 1.93

Q (cfs) = 61.00

Area (sqft) = 4.08

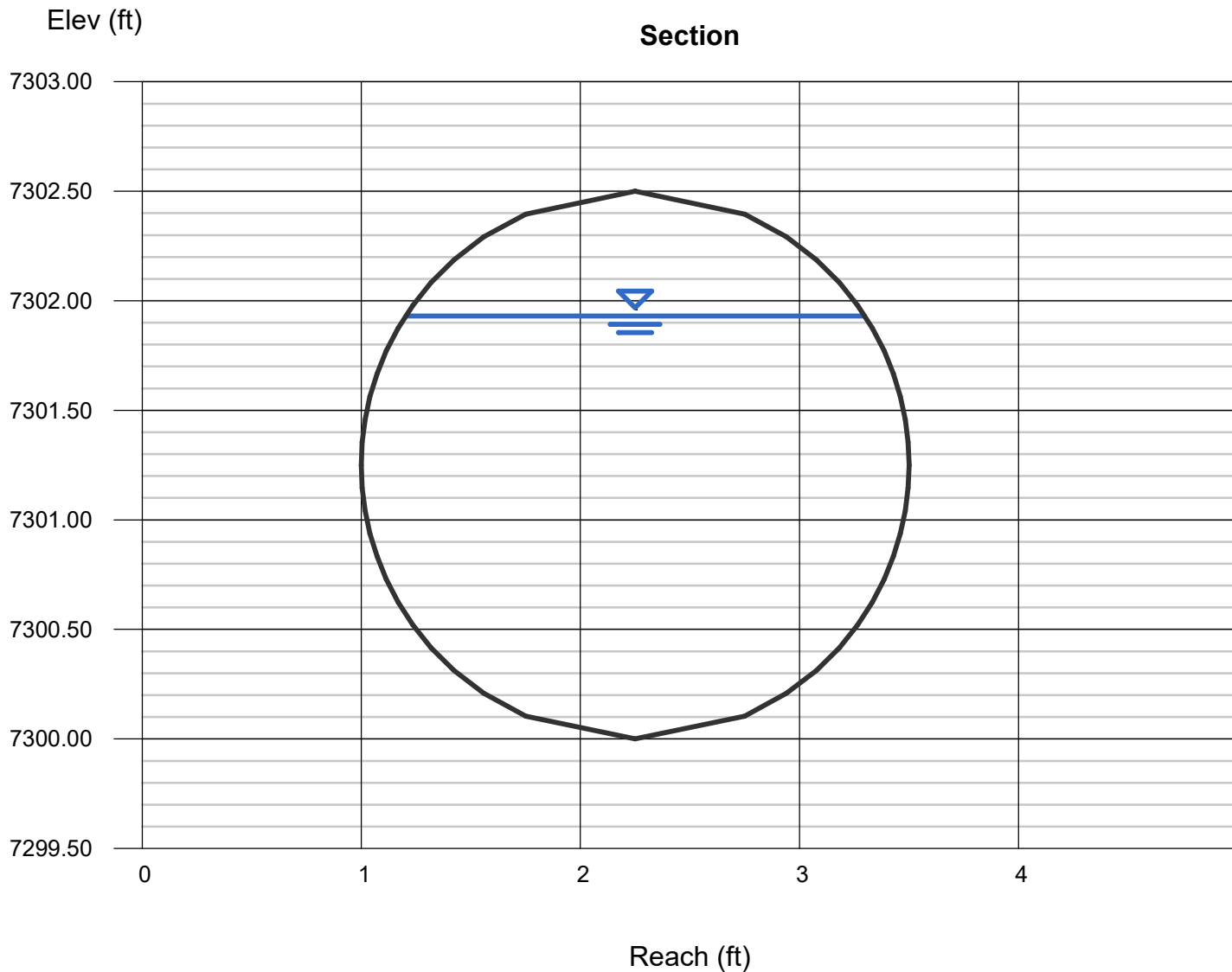
Velocity (ft/s) = 14.97

Wetted Perim (ft) = 5.38

Crit Depth, Y_c (ft) = 2.40

Top Width (ft) = 2.09

EGL (ft) = 5.41



Channel Report

Basin D-2 Storm Sewer - Max Slope

Circular

Diameter (ft) = 2.00

Invert Elev (ft) = 0.01

Slope (%) = 7.50

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 11.50

Highlighted

Depth (ft) = 0.59

Q (cfs) = 11.50

Area (sqft) = 0.78

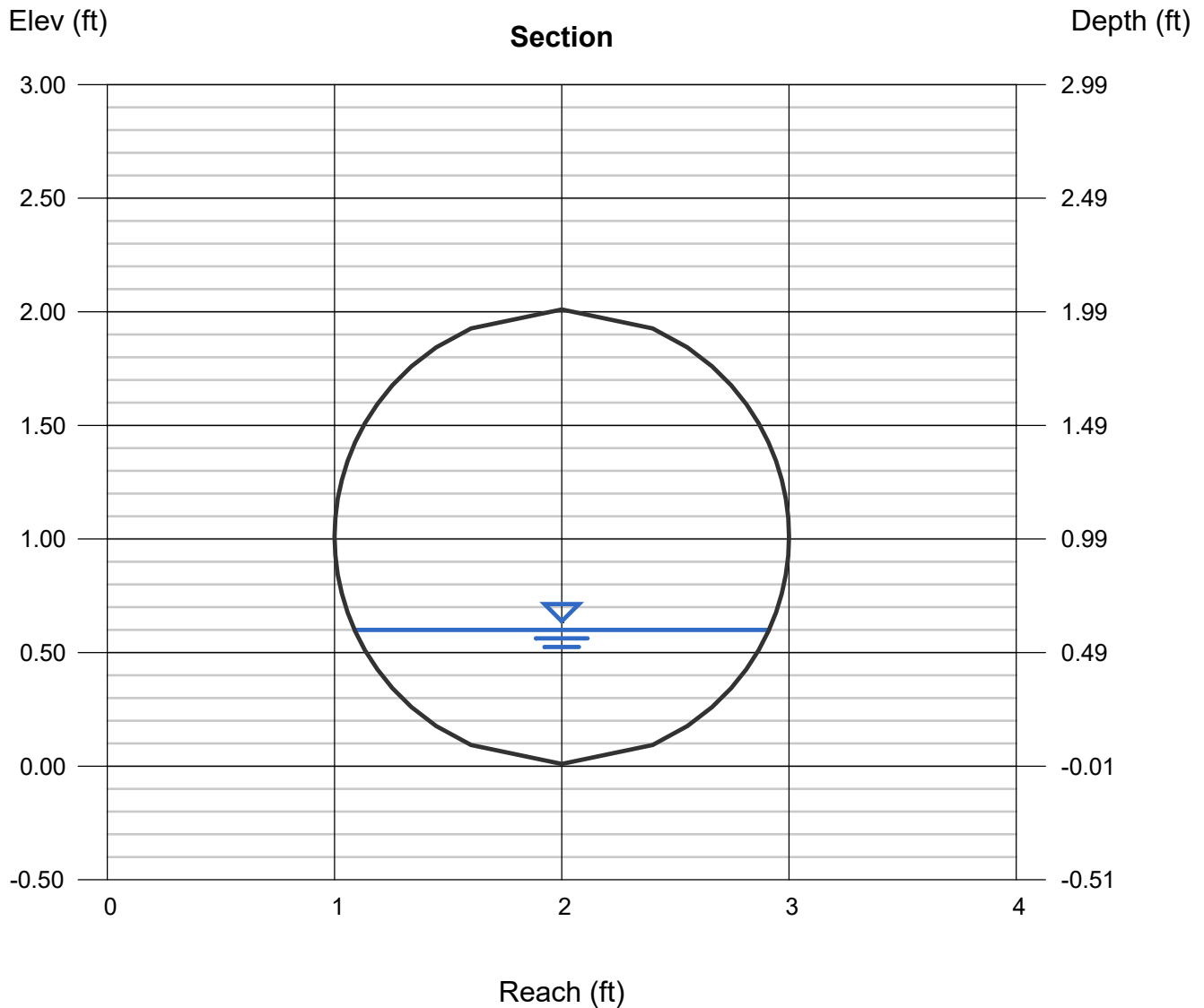
Velocity (ft/s) = 14.80

Wetted Perim (ft) = 2.30

Crit Depth, Y_c (ft) = 1.22

Top Width (ft) = 1.83

EGL (ft) = 3.99



Channel Report

Basin D-2 Storm Sewer - Min Slope

Circular

Diameter (ft) = 2.00

Invert Elev (ft) = 0.01

Slope (%) = 0.50

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 11.50

Highlighted

Depth (ft) = 1.26

Q (cfs) = 11.50

Area (sqft) = 2.09

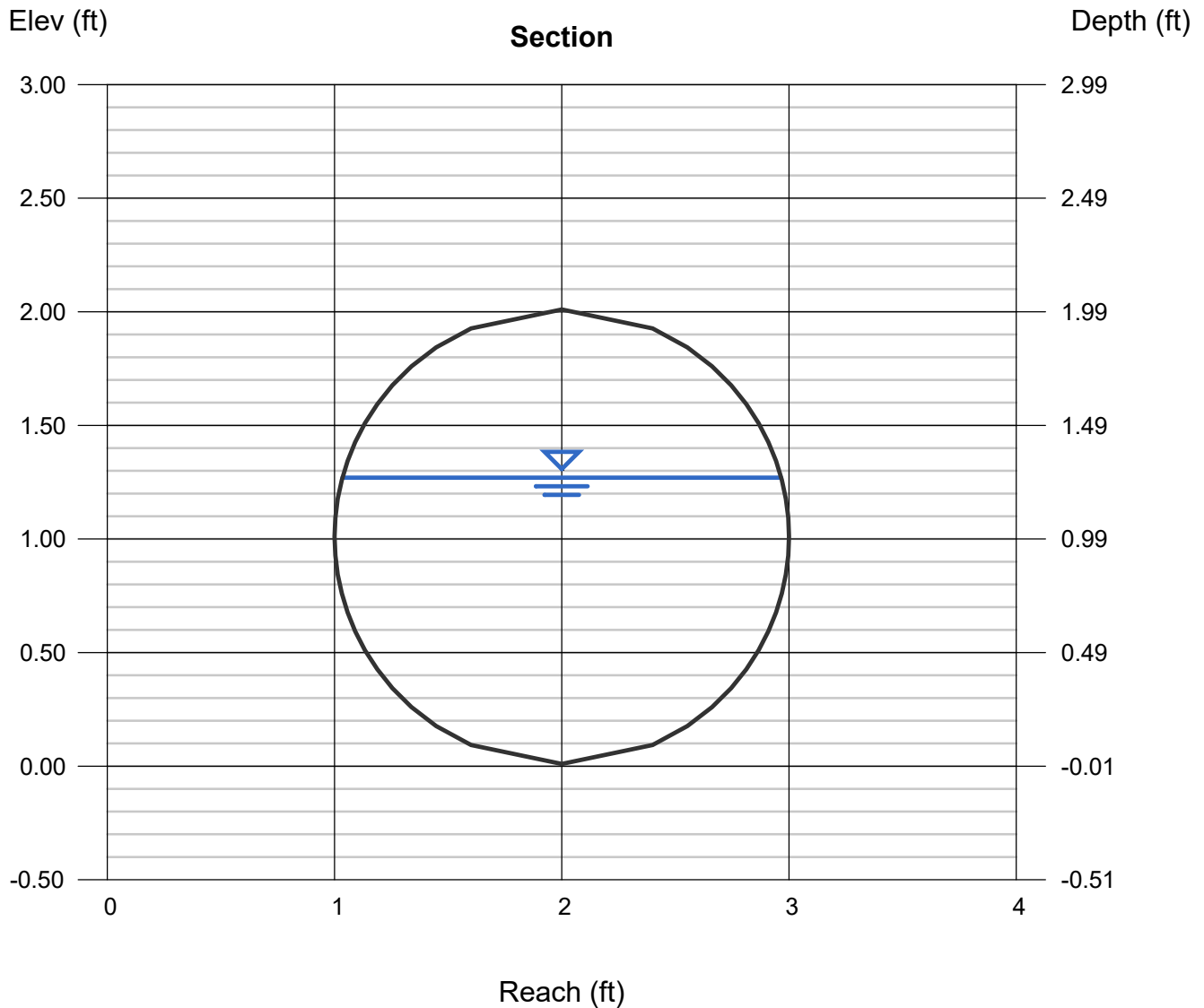
Velocity (ft/s) = 5.51

Wetted Perim (ft) = 3.67

Crit Depth, Y_c (ft) = 1.22

Top Width (ft) = 1.93

EGL (ft) = 1.73



Channel Report

Culvert Sizing-Timberview Breach Flow

Circular

Diameter (ft) = 2.50

Invert Elev (ft) = 1.00

Slope (%) = 3.00

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 73.00

Highlighted

Depth (ft) = 2.12

Q (cfs) = 73.00

Area (sqft) = 4.45

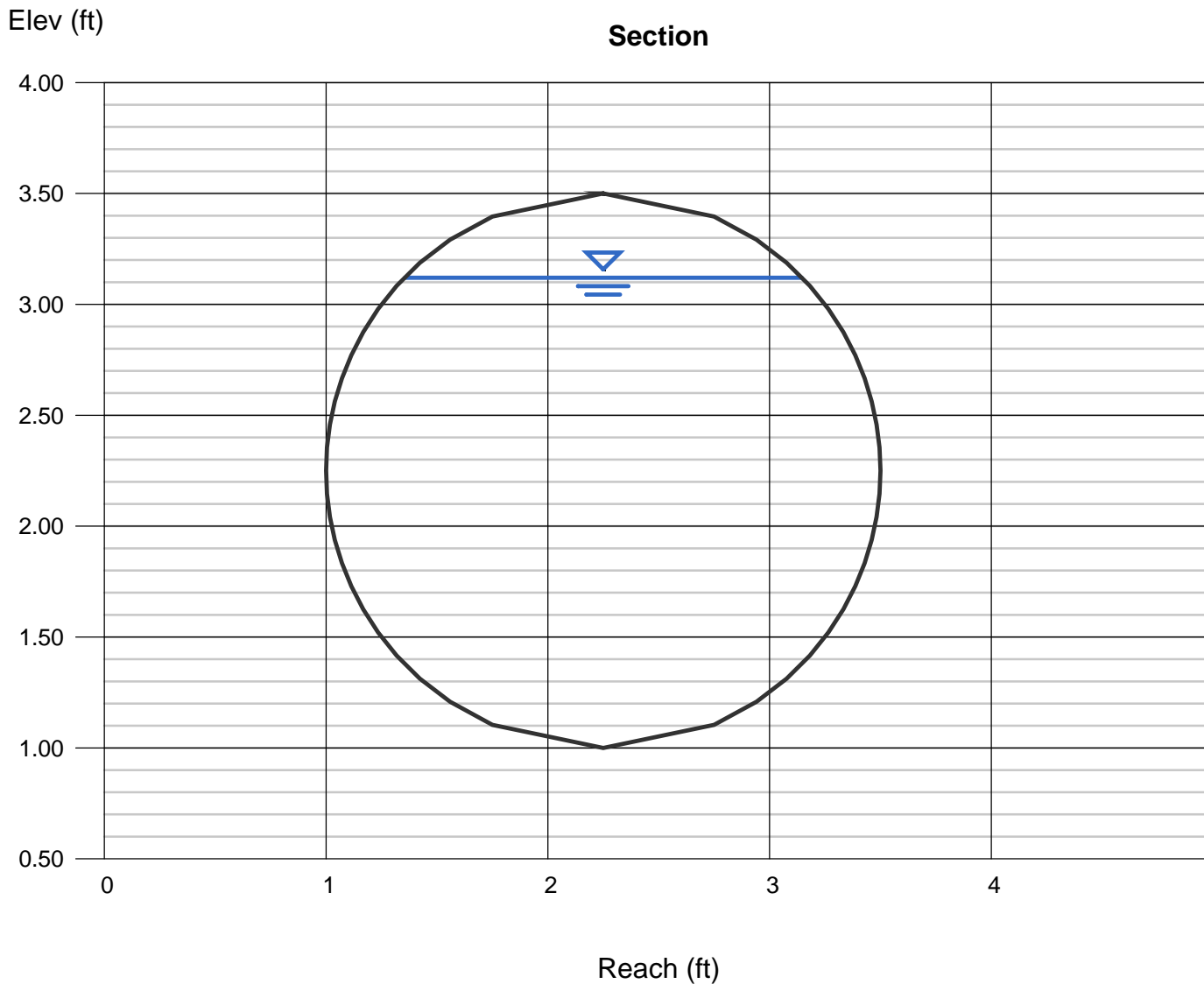
Velocity (ft/s) = 16.42

Wetted Perim (ft) = 5.86

Crit Depth, Y_c (ft) = 2.45

Top Width (ft) = 1.79

EGL (ft) = 6.31



Channel Report

Basin D-3 Storm Sewer - Max Slope

Circular

Diameter (ft) = 2.00

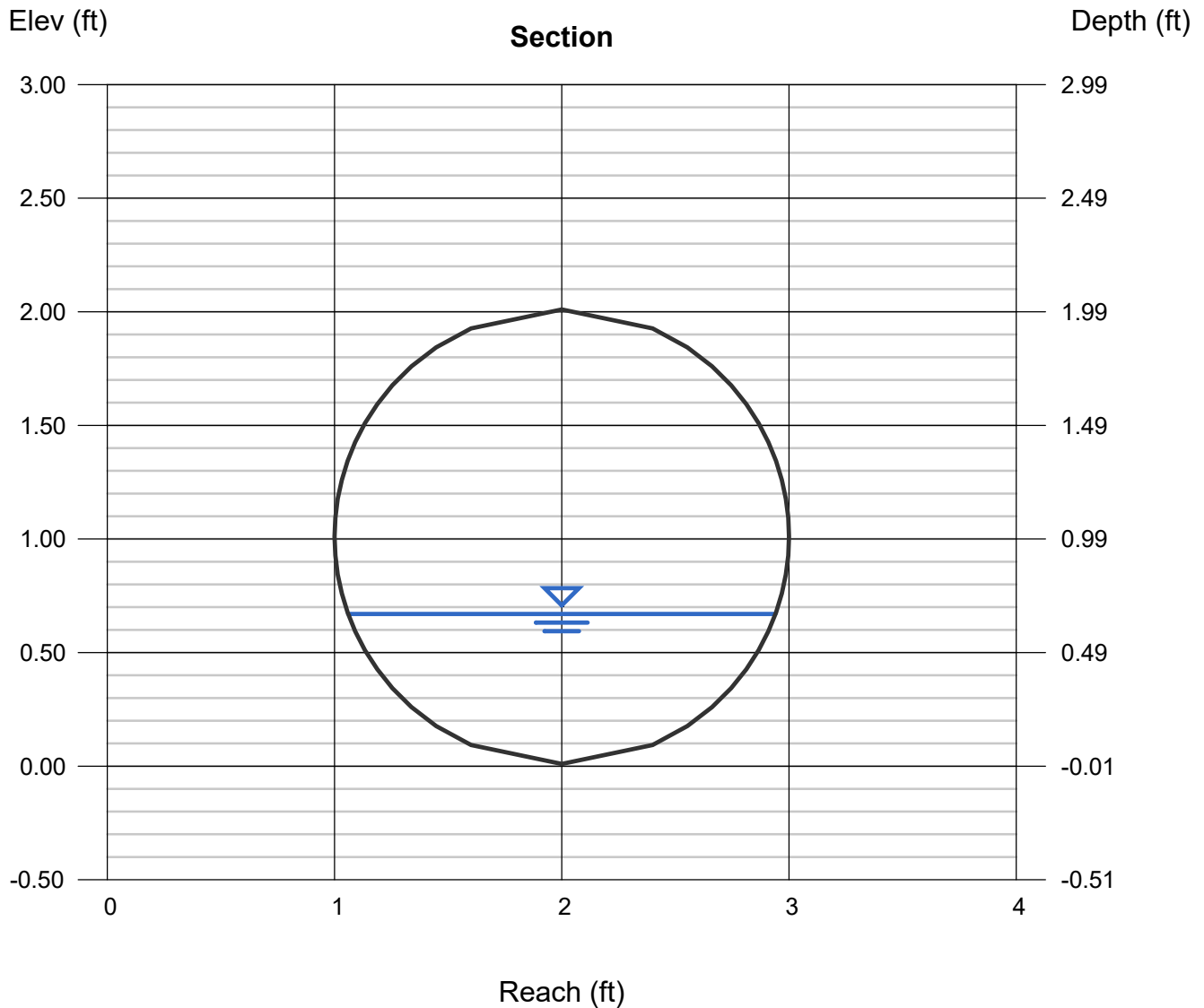
Invert Elev (ft) = 0.01
Slope (%) = 6.50
N-Value = 0.013

Highlighted

Depth (ft) = 0.66
Q (cfs) = 13.60
Area (sqft) = 0.91
Velocity (ft/s) = 15.01
Wetted Perim (ft) = 2.45
Crit Depth, Yc (ft) = 1.33
Top Width (ft) = 1.88
EGL (ft) = 4.16

Calculations

Compute by: Known Q
Known Q (cfs) = 13.60



Channel Report

Basin D-3 Storm Sewer - Min Slope

Circular

Diameter (ft) = 2.00

Invert Elev (ft) = 0.01

Slope (%) = 0.50

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 13.60

Highlighted

Depth (ft) = 1.42

Q (cfs) = 13.60

Area (sqft) = 2.39

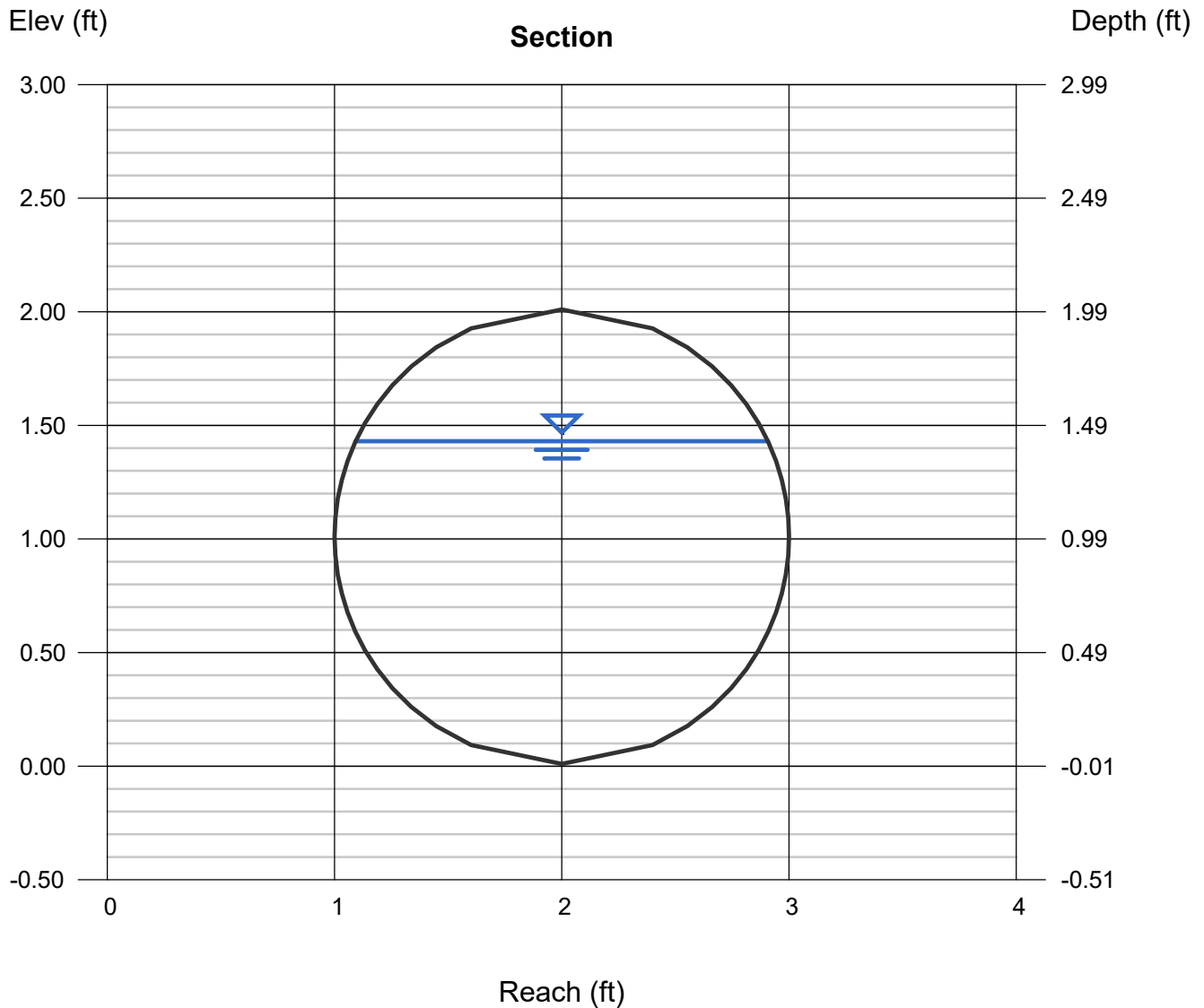
Velocity (ft/s) = 5.70

Wetted Perim (ft) = 4.01

Crit Depth, Yc (ft) = 1.33

Top Width (ft) = 1.81

EGL (ft) = 1.92



Channel Report

Basin D-3 Storm Sewer - Max Slope

Circular

Diameter (ft) = 1.50

Invert Elev (ft) = 0.01

Slope (%) = 10.00

N-Value = 0.013

Calculations

Compute by: Known Q

Known Q (cfs) = 6.80

Highlighted

Depth (ft) = 0.46

Q (cfs) = 6.800

Area (sqft) = 0.46

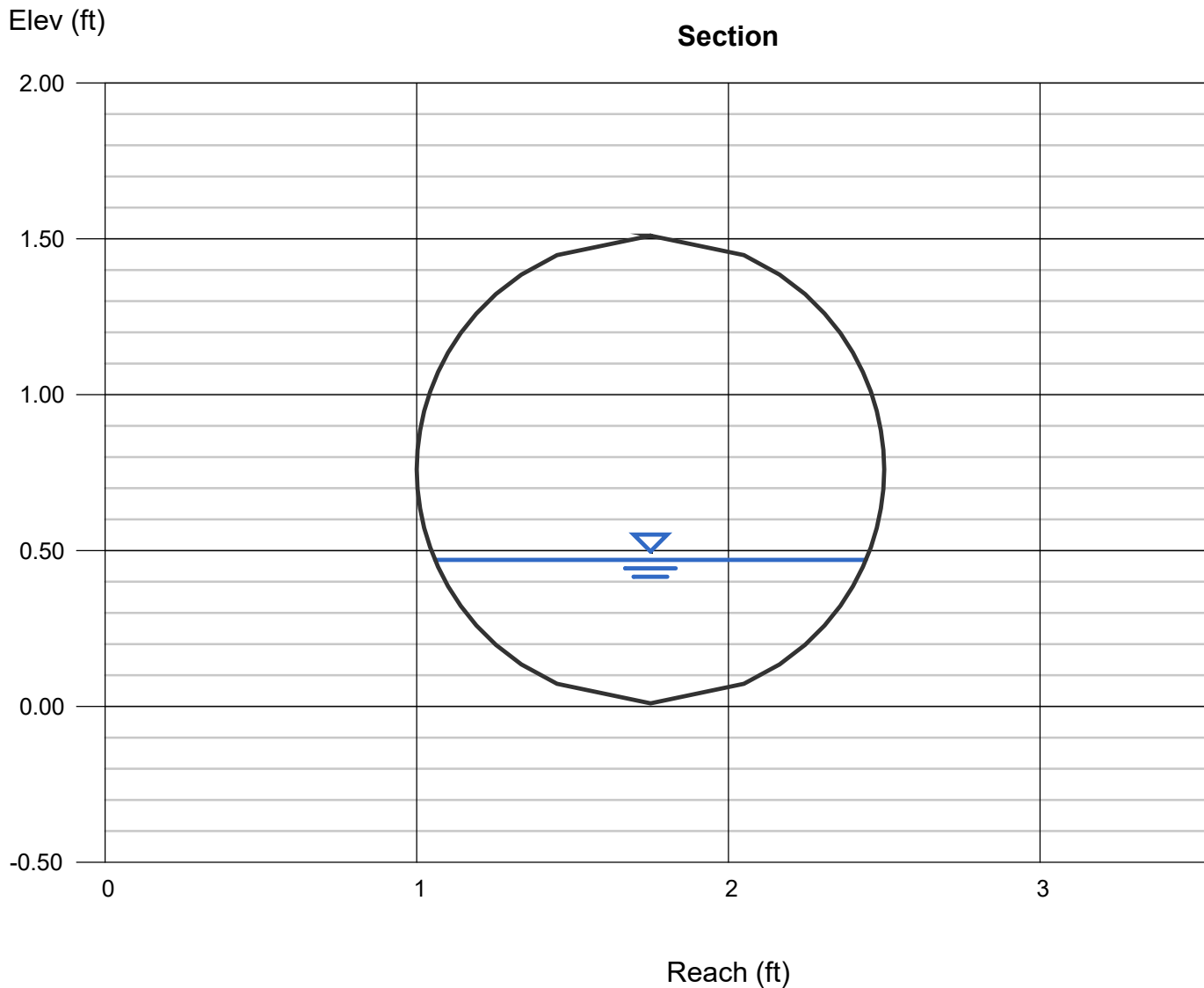
Velocity (ft/s) = 14.76

Wetted Perim (ft) = 1.76

Crit Depth, Yc (ft) = 1.01

Top Width (ft) = 1.38

EGL (ft) = 3.85



Channel Report

Basin D-3 Storm Sewer - Max Slope

Circular

Diameter (ft) = 1.50

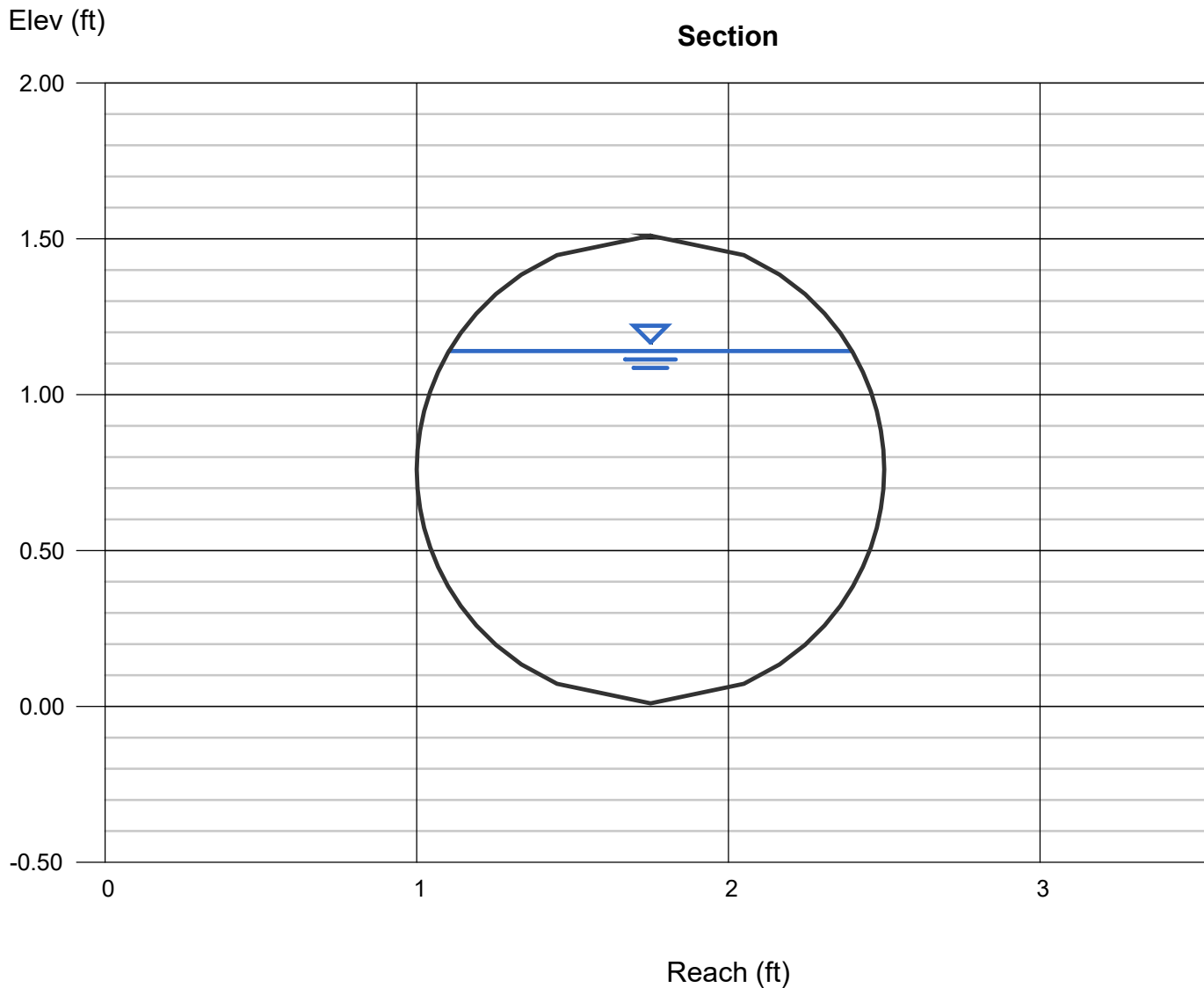
Invert Elev (ft) = 0.01
Slope (%) = 0.50
N-Value = 0.013

Highlighted

Depth (ft) = 1.13
Q (cfs) = 6.800
Area (sqft) = 1.43
Velocity (ft/s) = 4.75
Wetted Perim (ft) = 3.16
Crit Depth, Yc (ft) = 1.01
Top Width (ft) = 1.29
EGL (ft) = 1.48

Calculations

Compute by: Known Q
Known Q (cfs) = 6.80



Channel Report

Swale from DP 4 to Culvert 1

Triangular

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

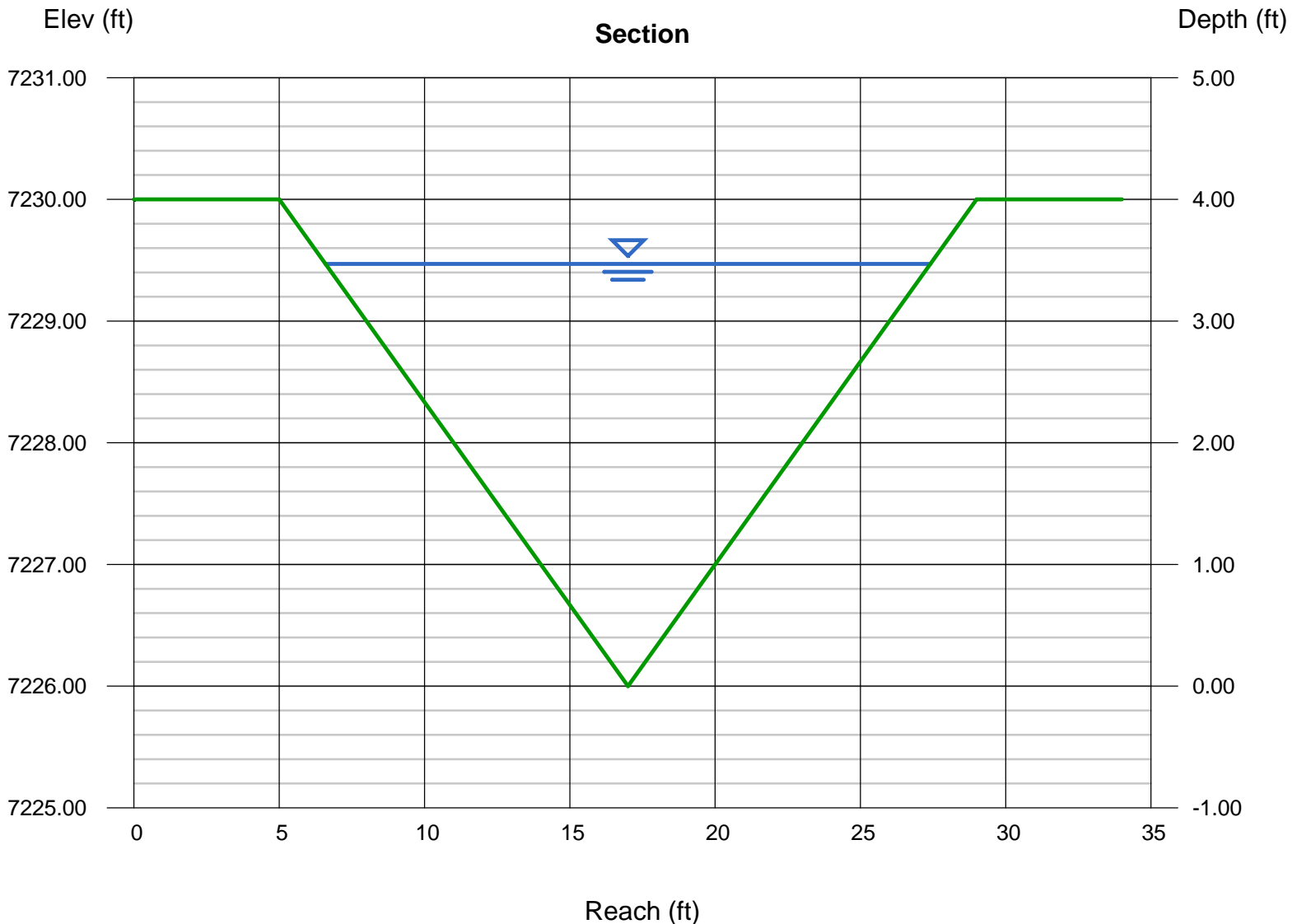
Invert Elev (ft) = 7226.00
Slope (%) = 0.02
N-Value = 0.025

Calculations

Compute by: Known Q
Known Q (cfs) = 42.20

Highlighted

Depth (ft) = 3.47
Q (cfs) = 42.20
Area (sqft) = 36.12
Velocity (ft/s) = 1.17
Wetted Perim (ft) = 21.95
Crit Depth, Yc (ft) = 1.66
Top Width (ft) = 20.82
EGL (ft) = 3.49



Hydraulic Analysis Report

Project Data

Project Title: Grandwood Ranch

Designer: Matrix Design Group

Project Date: Tuesday, March 31, 2020

Project Units: U.S. Customary Units

Notes: Worst Case Capacity. More detailed calculations, including armoring considerations will be included in FDR.

Channel Analysis: Channel Analysis

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0800 ft/ft

Manning's n: 0.0300

Flow: 20.0000 cfs

Result Parameters

Depth: 0.8581 ft

Area of Flow: 2.5772 ft²

Wetted Perimeter: 6.2516 ft

Hydraulic Radius: 0.4122 ft

Average Velocity: 7.7603 ft/s

Top Width: 6.0067 ft

Froude Number: 2.0878

Critical Depth: 1.1567 ft

Critical Velocity: 4.2711 ft/s

Critical Slope: 0.0163 ft/ft

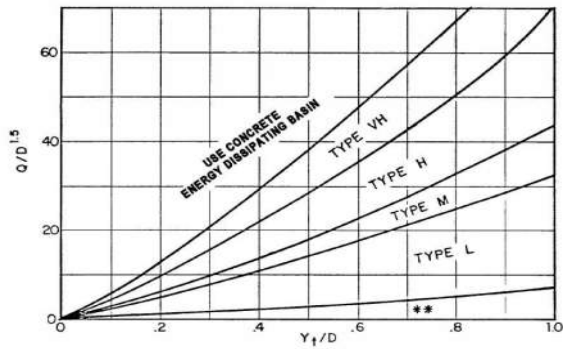
Critical Top Width: 8.27 ft

Calculated Max Shear Stress: 4.2837 lb/ft²

Calculated Avg Shear Stress: 2.0579 lb/ft²

Cross Road Culverts - Outfall Protection

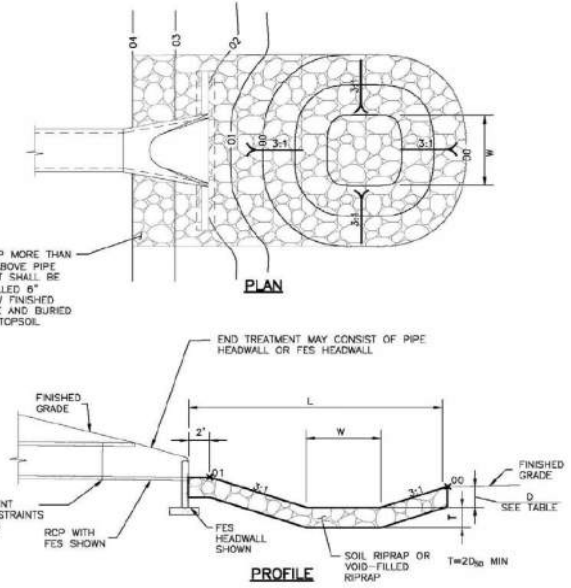
	C-1		C-2		C-3		C-4		C-5		C-6		C-7		C-8		C-9		C-10		C-11	
Pipe Size (D)	18	Inches	36	Inches	42	Inches	36	Inches	36	Inches	18	Inches	18	Inches	18	Inches	24	Inches	18	Inches	30	Inches
Q	18	cfs	68	cfs	71.3	cfs	73	cfs	73	cfs	11.5	cfs	1.7	cfs	4.7	cfs	13.6	cfs	17.1	cfs	61	cfs
L	4.5	Feet	20	Feet	10.5	Feet	20	Feet	20	Feet	4.5	Feet	4.5	Feet	4.5	Feet	6	Feet	4.5	Feet	7.5	Feet
W	4.5	Feet	6	Feet	10.5	Feet	6	Feet	6	Feet	4.5	Feet	4.5	Feet	4.5	Feet	6	Feet	4.5	Feet	7.5	Feet
D	0	Feet	1.5	Feet	0	Feet	1.5	Feet	1.5	Feet	0	Feet	0	Feet	0	Feet	0	Feet	0	Feet	0	Feet
d ₅₀	0.37	Feet	0.52	Feet	0.40	Feet	0.53	Feet	0.53	Feet	0.37	Feet	0.08	Feet	0.26	Feet	0.42	Feet	0.37	Feet	0.48	Feet
Depth of Flow	4.40	Inches	6.29	Inches	4.85	Inches	6.38	Inches	6.38	Inches	4.46	Inches	0.91	Inches	3.16	Inches	5.02	Inches	4.44	Inches	5.81	Inches
Q/D ^{1.5}	1		1.89		2.4		2.0		2.0		0.7		0.5		0.4		0.7		1.0		1.9	
Yt/D	0.667		0.630		0.671		0.66		0.66		0.45333333		0.34666667		0.28666667		0.33		0.63333333		0.772	
Rip Rap	Type L for 3 x Pipe Dia Downstream		Type L		Type L for 3 x Pipe Dia Downstream		Type L		Type L		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream		Type L for 3 x Pipe Dia Downstream	
Length of Rock	4.5	Feet	20	Feet	10.5	Feet	20	Feet	20	Feet	4.5	Feet	4.5	Feet	4.5	Feet	6	Feet	4.5	Feet	7.5	Feet
Width of Rock	4.5	Feet	15.0	Feet	10.5	Feet	15.0	Feet	15.0	Feet	4.5	Feet	4.5	Feet	4.5	Feet	6.0	Feet	4.5	Feet	7.5	Feet



Use D_0 instead of D whenever flow is supercritical in the barrel.
 ** Use Type L for a distance of $3D$ downstream.

CLASSIFICATION AND GRADATION OF ORDINARY RIP RAP			
Rip Rap Designation by Weight	% Smaller Than Given Size (Inches)	Intermediate Rock Dimension	d ₅₀ * (Inches)
Type VL	70 - 100	12	6**
	50 - 70	9	
	35 - 50	6	
Type L	70 - 100	15	9**
	50 - 70	12	
	35 - 50	9	
Type M	70 - 100	21	12
	50 - 70	18	
	35 - 50	12	
Type H	70 - 100	30	18
	50 - 70	24	
	35 - 50	18	
Type VH	70 - 100	42	24
	50 - 70	33	
	35 - 50	24	

* d₅₀ = Mean particle size
 ** Bury types VL and L with native top soil and revegetate to protect from vandalism.



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

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

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for $Q/D2.5 \leq 6.0$)

Figure 9-37. Low tailwater riprap basin

Cross Road Culverts - Outfall Protection

3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{2.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D_c^{1.5}$ or $Q/WH^{1.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.
2. Y_r/D_c or Y_r/H in which Y_r is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_r is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_r/D_c = Y_r/H = 0.40$ when using Figures 9-38 and 9-39.
3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_w = \frac{0.023Q}{Y_r^{1.2} D_c^{0.3}} \quad \text{Equation 9-16}$$

Rectangular culvert:

$$d_w = \frac{0.014H^{0.2}Q}{Y_r W} \quad \text{Equation 9-17}$$

3.2.2 Low Tailwater Basin

The design of low tailwater riprap basins is necessary when the receiving channel may have little or no flow or tailwater at time when the pipe or culvert is in operation. Figure 9-37 provides a plan and profile view of a typical low tailwater riprap basin.

By providing a low tailwater basin at the end of a storm drain conduit or culvert, the kinetic energy of the discharge dissipates under controlled conditions without causing scour at the channel bottom.

Low tailwater is defined as being equal to or less than $\frac{1}{3}$ of the height of the storm drain, that is:

$$Y_r \leq \frac{D}{3} \quad \text{or} \quad Y_r \leq \frac{H}{3}$$

Where:

y_r = tailwater depth at design flow (feet)

D = diameter of circular pipe (feet)

H = height of rectangular pipe (feet)

Rock Size

The procedure for determining the required riprap size downstream of a conduit outlet is in Section 3.2.3.

After selecting the riprap size, the minimum thickness of the riprap layer, T , in feet, in the basin is defined as:

$$T = 2D_{50} \quad \text{Equation 9-15}$$

APPENDIX B

STANDARD DESIGN CHARTS AND TABLES

depths over the duration of the storm as a fraction of the 1-hour depth and is also shown in Figure 6-19. By applying the 1-hour depths shown in Table 6-2 to the values shown in Table 6-3, a short-duration project design storm can be developed for any return period storm from a 2-year up to 100-year frequency. By applying the appropriate 1-hour depth for other project locations, a project design storm can be created for any location.

Table 6-3. 2-Hour Design Storm Distribution, $\leq 1 \text{ mi}^2$

Time (minutes)	Fraction of 1-Hour Rainfall Depth	Time (minutes)	Fraction of 1-Hour Rainfall Depth
5	0.014	65	1.004
10	0.046	70	1.018
15	0.079	75	1.030
20	0.120	80	1.041
25	0.179	85	1.052
30	0.258	90	1.063
35	0.421	95	1.072
40	0.712	100	1.082
45	0.824	105	1.091
50	0.892	110	1.100
55	0.935	115	1.109
60	0.972	120	1.119

- Frontal Storms:** The characteristics of longer-duration “frontal storms” (general) is less well understood than the shorter duration thunderstorms and should be studied further. However, some events of this nature have been observed, such as the April 1999 storm which produced flooding on Fountain Creek, showing that these types of events do occur and tend to produce hazardous flood flows. In addition, modeling of the Jimmy Camp Creek drainage basin using the 24-hour, Type II distribution shows that it produces results reasonably comparably to recorded flow data. Therefore, the NRCS 24-hour Type II distribution has replaced the Type IIa distribution as the standard, long-duration design storm. This distribution can be applied to drainage basins up to 10 square miles without a DARF correction and is shown in Table 6-4. This distribution is included as a standard storm option in the HEC-HMS program.

Figure 6-25. Estimate of Average Concentrated Shallow Flow

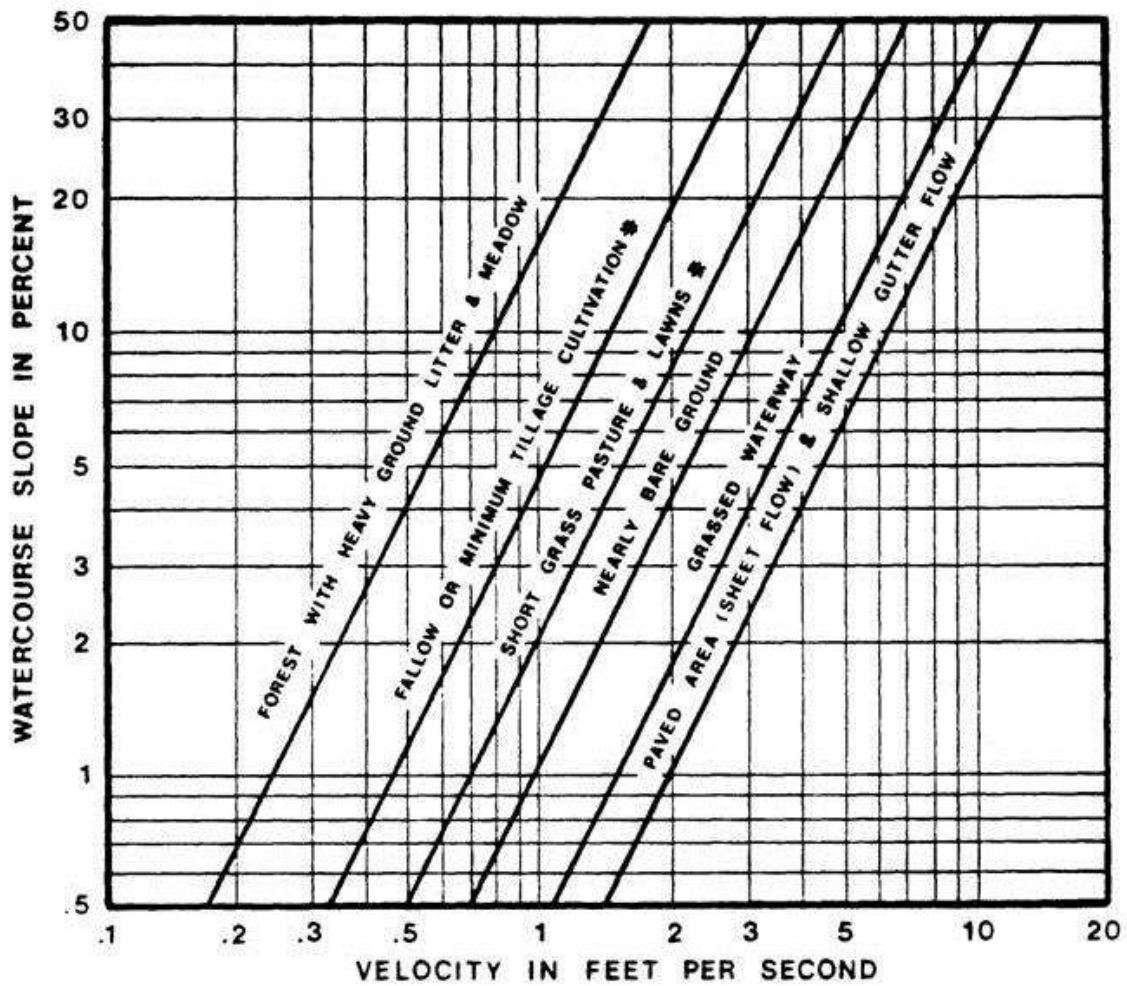


Table 6-9. NRCS Curve Numbers for Pre-Development Thunderstorms Conditions (ARC I)

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 Areas¹	Treatment²	Hydrologic Condition³	% I	HSG A	HSG B	HSG C	HSG D	
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	58	72	81	87	
Cultivated Agricultural Lands¹	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	
Row crops	Straight row (SR)	Good	---	54	67	75	79	
		Poor	---	52	64	75	81	
	SR + CR	Good	---	46	60	70	77	
		Poor	---	51	63	74	79	
	Contoured (C)	Good	---	43	56	66	70	
		Poor	---	49	61	69	75	
	C + CR	Good	---	44	56	66	72	
		Poor	---	48	60	67	74	
	Contoured & terraced (C&T)	Good	---	43	54	64	70	
		Poor	---	45	54	63	66	
	C&T+ CR	Good	---	41	51	60	64	
		Poor	---	44	53	61	64	
	Small grain	SR	Good	---	40	49	58	63
			Poor	---	44	57	69	75
SR + CR		Good	---	42	56	67	74	
		Poor	---	43	56	67	72	
C		Good	---	39	52	63	69	
		Poor	---	42	54	66	70	
C + CR Poor		Good	---	40	53	64	69	
		Poor	---	41	53	64	69	
C&T		Good	---	39	52	63	67	
		Poor	---	40	52	61	66	
C&T+ CR		Good	---	38	49	60	64	
		Poor	---	39	51	60	64	
Close-seeded or broadcast legumes or rotation meadow		SR	Good	---	37	48	58	63
			Poor	---	45	58	70	77
	C	Good	---	37	52	64	70	
		Poor	---	43	56	67	70	
	C&T	Good	---	34	48	60	67	
		Poor	---	42	53	63	67	
Good	---	30	46	57	63			

Table 6-9. (continued)

Other Agricultural Lands ¹	Treatment	Hydrologic Condition	% I	HSG A	HSG B	HSG C	HSG D
Pasture, grassland, or range—continuous forage for grazing ⁴	----	Poor	---	47	61	72	77
	----	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-growing brush, with brush the minor element	----	Poor	---	----	63	74	85
	----	Fair	---	----	51	64	77
	----	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:								
1/8 acre or less (town houses)	-----	-----	65	77	85	90	92	
1/4 acre	-----	-----	38	61	75	83	87	
1/3 acre	-----	-----	30	57	72	81	86	
1/2 acre	-----	-----	25	54	70	80	85	
1 acre	-----	-----	20	51	68	79	84	
2 acres	-----	-----	12	46	65	77	82	
Developing Urban Areas¹	Treatment²	Hydrologic Condition³	% I	HSG A	HSG B	HSG C	HSG D	
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	77	86	91	94	
Cultivated Agricultural Lands¹	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	
Row crops	Straight row (SR)	Good	---	74	83	88	90	
		Poor	---	72	81	88	91	
	SR + CR	Good	---	67	78	85	89	
		Poor	---	71	80	87	90	
	Contoured (C)	Good	---	64	75	82	85	
		Poor	---	70	79	84	88	
	C + CR	Good	---	65	75	82	86	
		Poor	---	69	78	83	87	
	Contoured & terraced (C&T)	Good	---	64	74	81	85	
		Poor	---	66	74	80	82	
	C&T+ CR	Good	---	62	71	78	81	
		Poor	---	65	73	79	81	
	Small grain	SR	Good	---	61	70	77	80
			Poor	---	65	76	84	88
SR + CR		Good	---	63	75	83	87	
		Poor	---	64	75	83	86	
C		Good	---	60	72	80	84	
		Poor	---	63	74	82	85	
C + CR Poor		Good	---	61	73	81	84	
		Poor	---	62	73	81	84	
C&T		Good	---	60	72	80	83	
		Poor	---	61	72	79	82	
C&T+ CR		Good	---	59	70	78	81	
		Poor	---	60	71	78	81	
				---	58	69	77	80

Table 6-10. (continued)

Other Agricultural Lands ¹	Treatment	Hydrologic Condition	% I	HSG A	HSG B	HSG C	HSG D
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

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 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 grass.

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.

4.6 Lag Time

While the NRCS curve numbers are used to calculate the volume of runoff and magnitude of losses, to transform the volume of runoff into a hydrograph using the NRCS dimensionless unit hydrograph, the lag time must be specified. The lag time is defined as the time from the centroid of the rainfall distribution of a storm to the peak discharge produced by the watershed. For this Manual, the lag time is defined as a fraction of the time of concentration (t_c) as shown in Equation 6-13.

$$t_{lag} = 0.6 \cdot t_c \tag{Eq. 6-13}$$

TABLE 5-4
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL
COVER COMPLEXES - RURAL CONDITIONS
(Antecedent Moisture Condition II, and Ia = 0.2 S)
 (From: U.S. Dept. of Agriculture,
 Soil Conservation Service, 1977)

<u>Land Use</u>	<u>Cover Treatment or Practice</u>	<u>Hydrologic Condition</u>	<u>Runoff Curve Number by Hydrologic Soil Group</u>			
			<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Fallow	Straight Row	----	77	86	91	94
Row Crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Cont. & Terraced	Poor	66	74	80	82
	Cont. & Terraced	Good	62	71	78	81
Small Grain	Straight Row	Poor	65	76	84	88
	Straight Row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Cont. & Terraced	Poor	61	72	79	82
	Cont. & Terraced	Good	59	70	78	81
Close-seeded legumes <u>1/</u> or rotation meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Cont. & Terraced	Poor	63	73	80	83
	Cont. & Terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) <u>2/</u> (hard surface) <u>2/</u>		----	72	82	87	89
		----	74	84	90	92

1/ Close-drilled or broadcast
2/ Including right-of-way

TABLE 5-5
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL
COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition II)
 (From: U.S. Dept. of Agriculture,
 Soil Conservation Service, 1977)

<u>Land Use</u>	<u>Hydrologic Soil Group</u>			
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Open spaces, lawns, parks, golf courses, cemeteries, etc.				
Good condition: grass cover on 75% or more of the area	39*	61	74	80
Fair condition: grass cover on 50% to 75% of the area	49*	69	79	84
Commercial and Business areas (85% Impervious)	89*	92	94	95
Industrial Districts 72% Impervious)	81*	88	91	93
Residential: <u>2/</u>				
<u>Acres per Dwelling Unit</u>	<u>Average %</u>			
	<u>Impervious</u>	<u>3/</u>		
1/8 acre or less	65	77*	85	90
1/4 acre	38	61*	75	83
1/3 acre	30	57*	72	81
1/2 acre	25	54*	70	80
1 acre	20	51*	68	79
Paved parking lots, roofs, driveways, etc.	98	98	98	98
Streets and Roads:				
paved with curbs and storm sewers	98	98	98	98
gravel	76*	85	89	91
dirt	72*	82	87	89

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).

2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

* Not to be used wherever overlot grading or filling is to occur.

TABLE 5-6
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL
COVER COMPLEXES - RURAL CONDITIONS
(Antecedent Moisture Condition III, and Ia = 0.2 S)
(From: U.S. Dept. of Agriculture,
Soil Conservation Service, 1977)

NOTE: THIS TABLE TO BE USED FOR INFORMATION ONLY

<u>Land Use</u>	<u>Cover Treatment or Practice</u>	<u>Hydrologic Condition</u>	<u>Runoff Curve Number by Hydrologic Soil Group</u>			
			<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Fallow	Straight Row	----	89	94	97	98
Row Crops	Straight Row	Poor	86	92	95	97
	Straight Row	Good	83	90	94	96
	Contoured	Poor	85	91	93	95
	Contoured	Good	82	88	92	94
	Cont. & Terraced	Poor	82	88	91	92
	Cont. & Terraced	Good	79	86	90	92
Small Grain	Straight Row	Poor	82	89	93	95
	Straight Row	Good	80	88	93	95
	Contoured	Poor	80	88	92	94
	Contoured	Good	78	87	92	93
	Cont. & Terraced	Poor	78	86	91	92
	Cont. & Terraced	Good	77	85	90	92
Close-seeded legumes <u>1/</u> or rotation meadow	Straight Row	Poor	82	89	94	96
	Straight Row	Good	76	86	92	94
	Contoured	Poor	81	88	93	94
	Contoured	Good	74	84	90	93
	Cont. & Terraced	Poor	80	87	91	93
	Cont. & Terraced	Good	70	83	89	91
Pasture or range		Poor	84	91	94	96
		Fair	69	84	91	93
		Good	59	78	88	91
	Contoured	Poor	67	83	92	95
	Contoured	Fair	64	77	88	93
	Contoured	Good	15	55	85	91
Meadow		Good	50	76	86	90
Woods		Poor	65	82	89	93
		Fair	56	78	87	91
		Good	43	74	85	89
Farmsteads		----	77	88	92	94
Roads (dirt) <u>2/</u> (hard surface) <u>2/</u>		----	86	92	95	96
		----	88	93	96	97

1/ Close-drilled or broadcast
2/ Including right-of-way

TABLE 5-7
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL
COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition III)
 (From: U.S. Dept. of Agriculture,
 Soil Conservation Service, 1977)

NOTE: THIS TABLE TO BE USED FOR INFORMATION ONLY

<u>Land Use</u>	<u>Hydrologic Soil Group</u>			
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
Open spaces, lawns, parks, golf courses, cemeteries, etc.				
Good condition: grass cover on 75% or more of the area	59*	78	88	91
Fair condition: grass cover on 50% to 75% of the area	69*	84	91	93
Commercial and Business areas (85% Impervious)	96*	97	98	98
Industrial Districts 72% Impervious)	92*	95	97	98
Residential: <u>2/</u>				
<u>Acres per Dwelling Unit</u>	<u>Average %</u>			
	<u>Impervious</u> ^{3/}			
1/8 acre or less	65	89*	94	96
1/4 acre	38	78*	88	93
1/3 acre	30	75*	86	92
1/2 acre	25	73*	85	91
1 acre	20	70*	84	91
Paved parking lots, roofs, driveways, etc.	99	99	99	99
Streets and Roads:				
paved with curbs and storm sewers	99	99	99	99
gravel	89*	94	96	97
dirt	86*	92	95	96

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).

2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

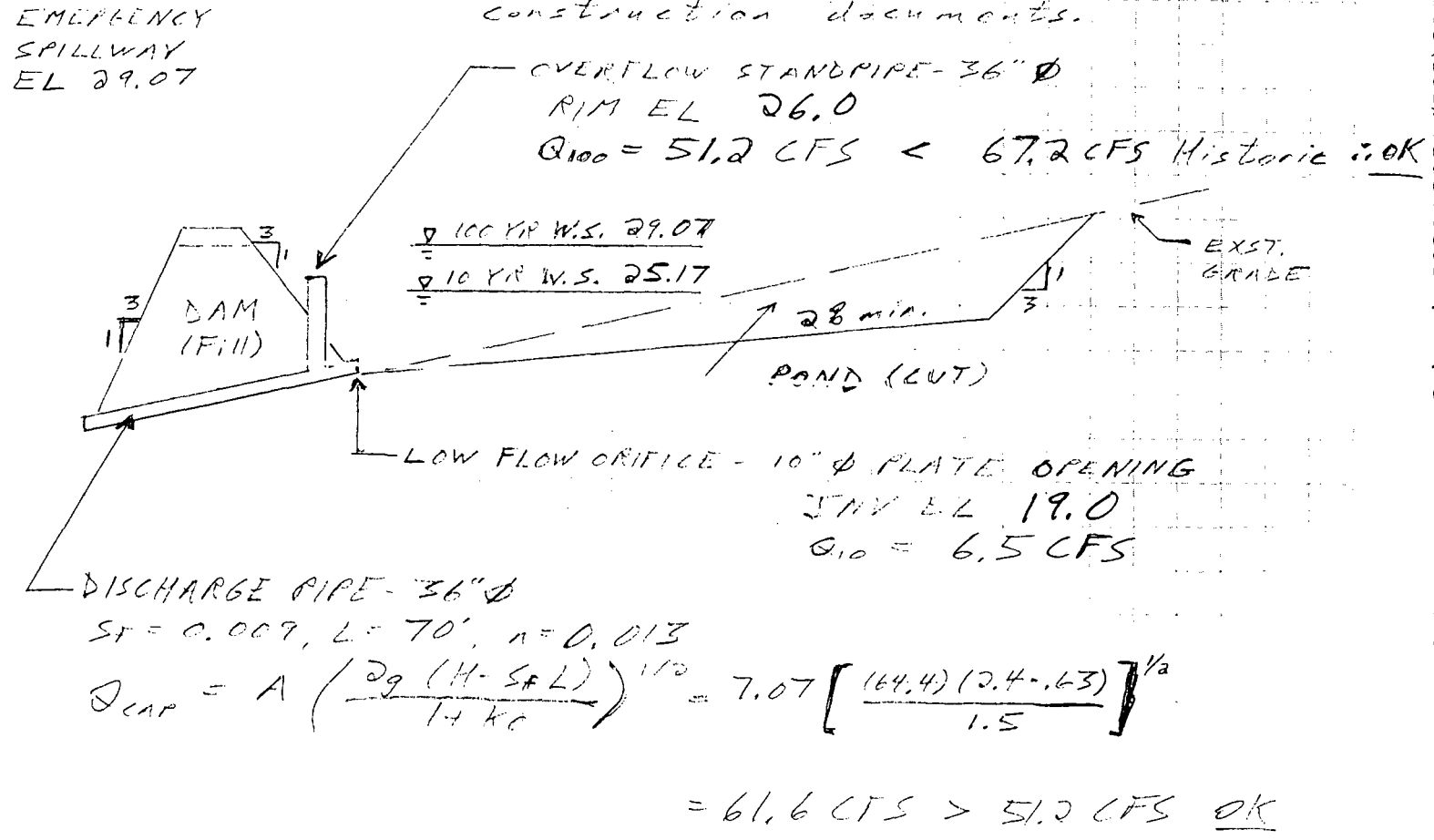
* Not to be used wherever overlot grading or filling is to occur.

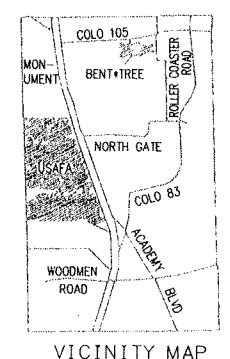
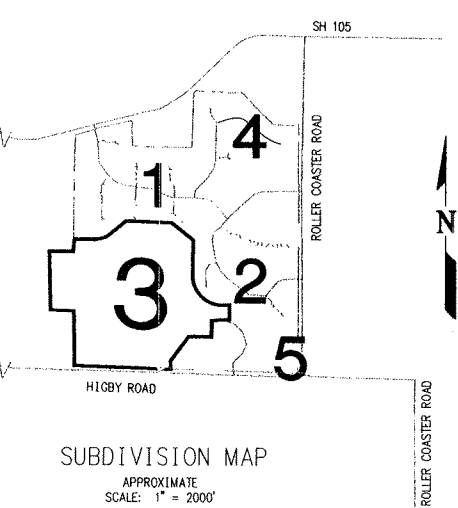
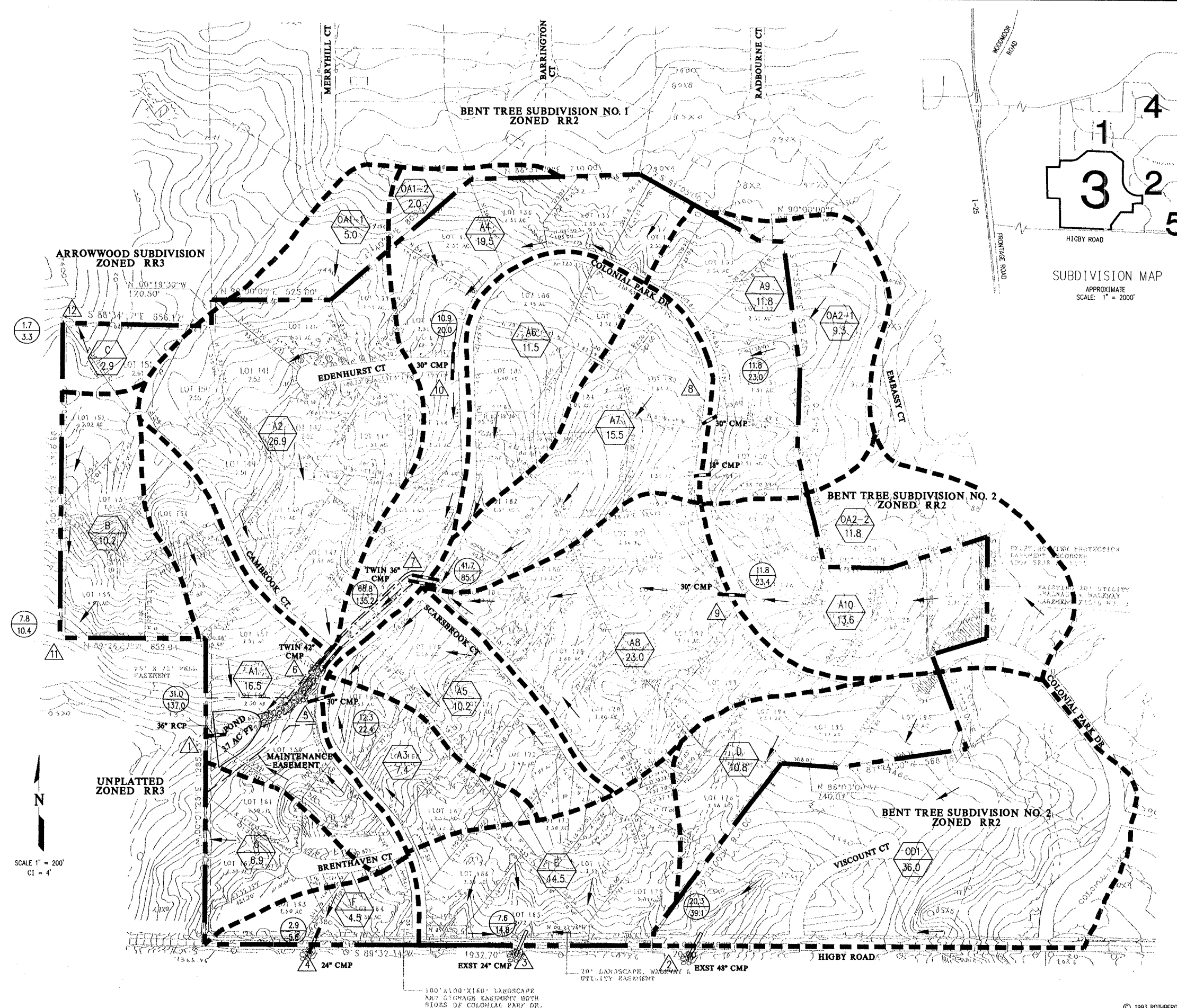
APPENDIX C

REPORT REFERENCES

Project: Bent Tree III - Drainage Report
 Work: Detention Pond Section - Revised 4/2/93

- Notes:
1. Elevations noted above datum of 7300'
 2. See POND-2 output for storage area and outflows
 3. See map of developed conditions for limits of pond in plan view
 4. Details of emergency spillway, outlet works, energy dissipation, and inlet check structures will be addressed in the construction documents.





- LEGEND**
- BASIN BOUNDARY
 - BASIN AREA
 - DESIGN POINT
 - DIRECTION OF FLOW
 - 100 YEAR FLOODPLAIN LIMIT
 - DRAINAGE EASEMENT
 - EXISTING CULVERT
 - PROPOSED CULVERT
 - 10 YR DESIGN FLOW
 - 100 YEAR



SCALE 1" = 200'
 CI = 4'

APR. 01, 1993 - 10:41:06
 TREE

ROTHBERG, TAMBURINI & WINSOR, INC.			
Professional Engineers & Consultants		Denver, CO	
BENT TREE SUBDIVISION - FILING NO. 3			
FINAL DRAINAGE REPORT			
DEVELOPED CONDITIONS			SHEET NO.
DESIGNED BY:	SMB	DRAWN BY:	RLH
CHECKED BY:	KAT	DATE:	MARCH, 1993
PROJECT NO.:	61-2030-CC		
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			OF
			2

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 TAMBURINI & WINSOR, INC.

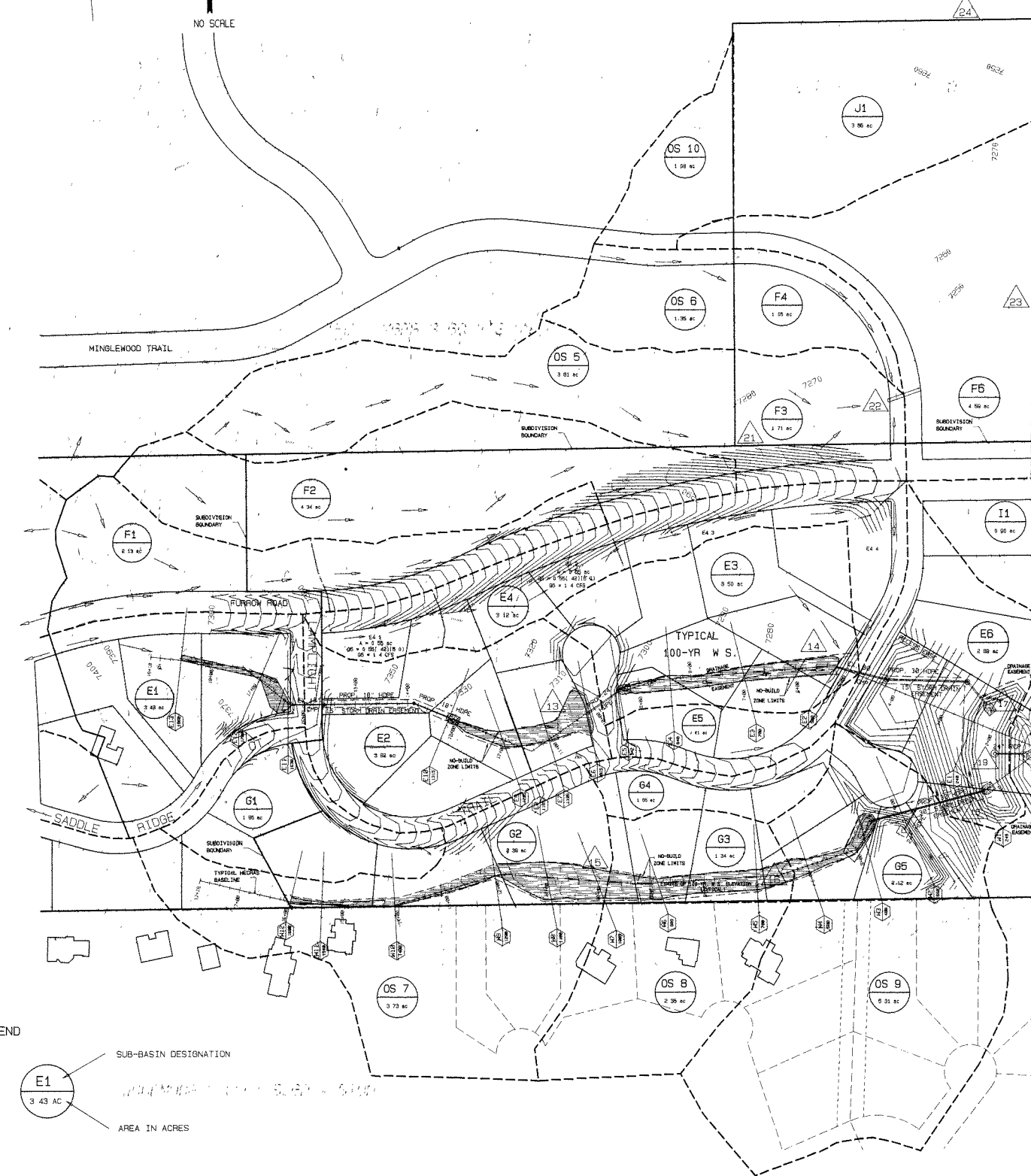
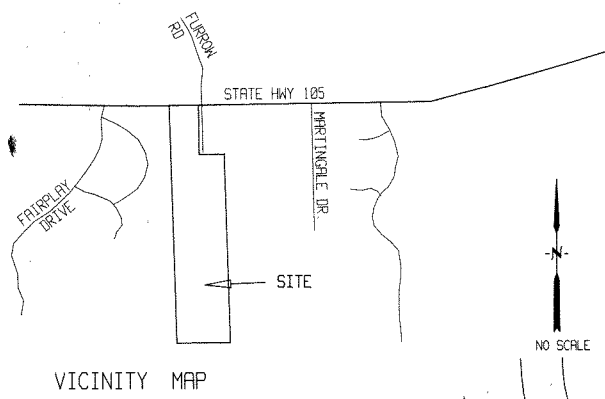
TIMBERVIEW FINAL DRAINAGE BASIN MAP PROPOSED CONDITIONS

PHASE II

Peak Flow Rate Summary Table

Proposed Conditions

Sub-basin	Design Point	Peak Flow Rate	
		5 Year cfs	100 Year cfs
OS 5		3.4	7.5
OS 6		1.4	3.1
OS 7		3.4	7.3
OS 8		2.2	4.8
OS 9		4.8	10.5
E 1		3.9	7.6
E 2		3.8	7.9
E 3		3.3	6.8
E 4		3.2	6.6
E 5		1.0	2.2
E 6		2.8	5.9
F 1		2.1	4.5
F 2		3.5	7.7
F 3		1.1	2.5
F 4		0.6	1.4
F 5		2.6	6.0
G 1		2.2	4.6
G 2		2.3	4.8
G 3		1.3	2.6
G 4		1.1	2.2
G 5		2.1	4.3
OS 10		1.0	2.2
I 1		1.0	2.0
J 1		2.6	6.0
	13	7.2	14.5
	14	14.0	28.8
	15	7.6	16.0
	16	10.5	22.5
	17	16.8	34.6
	18	16.7	38.1
	19	34.4	72.4
	20	19.3	31.9
	21	8.1	17.7
	22	10.4	23.0
	23	12.5	23.4
	24	3.0	6.9



NO SCALE

SCALE 1" = 120'

LEGEND

- PROPOSED BASIN BOUNDARY
- DIRECTION OF FLOW
- (7290) EXISTING CONTOUR
- DESIGN POINT
- PROPOSED CMP CULVERT
- BASELINE FOR HECRAS ANALYSIS
- SUB-BASIN DESIGNATION
AREA IN ACRES

TIMBERVIEW SUBDIVISION
PHASE II
FINAL DRAINAGE BASIN MAP
PROPOSED CONDITIONS

PREMIER ENGINEERING, INC.
Professional Civil Engineers
2110 Vickers Drive
Colorado Springs, CO 80918
(719) 598-6981
PremierEng@aol.com

Jesse Sullivan

From: Hunyadi - DNR, John <john.hunyadi@state.co.us>
Sent: Tuesday, March 31, 2020 1:27 PM
To: Jesse Sullivan
Cc: Corey Petersen
Subject: Re: Grandwood Ranch: Existing Offsite Detention Embankments and Proposed Onsite Detention

Hi Jesse,

Sorry for not getting back to you sooner. I concur with your analyses and conclusions for the off-site detention ponds Bent Tree III (Low haz) and Timberview II (NPH). I agree with your initial discussions for the ones that will be part of the Grandwood Ranch and look forward to the submittal package when those become available.

I truly appreciate your efforts to work with the County and myself to plan the development with these dam safety concerns in mind!

Thank you .

John H.
John Hunyadi, PE
Dam Safety Engineer



T: 719.227.5294 | C: 719.258.0859
4255 Sinton Road, Colorado Springs, CO 80907
john.hunyadi@state.co.us

On Tue, Mar 31, 2020 at 12:11 PM Jesse Sullivan <jesse_sullivan@matrixdesigngroup.com> wrote:

John,

Just checking in to see if you received the memo regarding the offsite detention upstream of the Grandwood Ranch subdivision. The file size may have been a bit large, so I wanted to confirm it made it through.

If you received it and have any questions feel free to contact me.

Thanks,

Matrix Design Group
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
Ph: (719) 575-0100

Date: March 26, 2020

To: John Hunyadi
Dam Safety Engineer
State of Colorado
4255 Sinton Road
Colorado Springs, CO 80919

From: Jesse Sullivan, P.E.

Subject: Existing Embankment Hazard Classification
Bent Tree III Detention Pond &
Timberview Phase II Detention Pond

Introduction:

We are providing a Hazard Classification for the two subject detention ponds in order to provide safe design for the proposed, downstream, Grandwood Ranch development. The two subject ponds are located just offsite of the proposed development. For the purposes of this memorandum the ponds are referred to as the Bent Tree III Pond and the Timberview II Pond.

Criteria:

The State of Colorado DWR publication “Guidelines for Hazard Classification” dated January 21, 2019 were utilized in determining the hazard classification for the two embankments. The study also utilized the state of Colorado DWR “Spreadsheet for Estimating Dam Breach Parameters Using the Froehlich Method” to estimate dam breach flows and designate “no-build” regions where necessary to maintain as minimal hazard from the existing embankments as possible.

Bent Tree III Pond (Existing & Offsite):

This existing detention pond is located in Lots 158 and 159 of the Bent Tree III subdivision just east of the proposed Grandwood Ranch development. The Grandwood Ranch lot lines have been adjusted so that the discharge of the pond and the potential breach flow will run just inside the north boundary of Lot 9 within the development within a designated “No-Build” area. Once passing through Lot 9, the breach flow will surcharge the proposed road and follow historic flow patterns to dissipate within an existing wetland. From this point waters will cross Higby Road via the existing culverts and eventually discharge to Jackson Creek.

Detention Basin Data:

Drainage Area:	162.9	Acres
Max Storage Depth:	8.1	Feet
Max Storage Volume:	3.7	Acre-Feet
Est. Breach Discharge Q:	807	CFS
Crest Width of Embankment:	8	Feet

Vertical Fall from Spillway to Exterior Toe of Embankment:	11	Feet
Exterior Embankment Slope:	2.5:1	Feet Horizontal : Feet Vertical
Interior Embankment Slope:	4:1	Feet Horizontal : Feet Vertical
Width of Breach Flow:	90	Feet
Dam Size Class:		Minor

Hazard Classification:

Relevant Information:

- Breach flows will be conveyed through the adjacent residential, 2.5-acre, Lot 9 via a “No-Build” area centered on the natural flow path which the breach flow would be anticipated to follow.
- The downstream road will be armored at the location the breach flow is anticipated to cross.
 - The armoring should minimize damage to the road.
- Emergency access is provided for the lots possibly cut off from the primary road in the unlikely case of failure of both the armoring and the primary road.
- No developed lots across the road from the “No-Build” conveyance area.
- Downstream detention pond proposed for Grandwood Ranch has been located such that the direct Breach Flow should not impact the detention
 - It is possible that some dispersed waters could reach the detention.
 - Such flows will have lost much of the original energy from the Breach and are not anticipated to cause issues within the Grandwood Ranch detention pond.
 - The Grandwood Detention Pond does not utilize embankment and is thus not a failure risk.
 - No developed parcels downstream of the Grandwood Ranch Detention Pond.
- Past the Grandwood Ranch Detention Pond a natural, heavily vegetated water way will disperse the remaining energy of the breach.
- The above factors minimize the likelihood of loss of human life associated with a Breach.

Based on the above factors, this existing offsite detention pond is classified as “Low Hazard”

Timberview II Pond (Existing & Offsite):

This existing pond is located north of the northwestern corner of the proposed Grandwood Ranch development within Lots 47 and 48 of the Timberview Subdivision Phase II. the breach flow will surcharge the proposed road and follow historic flow patterns to dissipate within an existing wetland. From this point waters will cross Higby Road via the existing culverts and eventually discharge to Jackson Creek.

Detention Basin Data:

Drainage Area:	36	Acres
Max Depth:	3	Feet
Max Storage Volume:	0.5	Acre-Feet
Est. Breach Discharge Q:	73	CFS
Crest Width of Embankment:	50	Feet

Vertical Fall from Spillway to Exterior Toe of Embankment:	3	Feet
Exterior Embankment Slope:	4:1	Feet Horizontal : Feet Vertical
Interior Embankment Slope:	3:1	Feet Horizontal : Feet Vertical
Width of Breach Flow:	35	Feet
Dam Size Class:	Minor	

Hazard Classification:

Relevant Information:

- Very minimal Breach Flow of 73 CFS
- Driveway Culvert Sizing will accommodate 73 cfs discharge flow
- Natural Discharge Path will route around proposed roads
- No/minimal anticipated damage from Breach
 - Possibly minor erosion associated with Breach flow
- Broad, heavily vegetated drainage way receiving Breach flows
- Very Small detained volume of 0.5 Acre-Feet
- Due to very minor flows no loss of human life is anticipated
- Conveyance through driveways via 30” culvert.

Based on the above factors this embankment is classified as No Public Hazard (NPH). No or very minor damage is anticipated as a result of a breach and no loss of human life is anticipated either.

Grandwood Ranch Detention Ponds (Proposed & Onsite):

The Grandwood Ranch Subdivision will have several of its own detention ponds to provide treatment and detention for the roads associated with the proposed development. These ponds will all be below the jurisdictional dam criteria.

Detention Basin Data:

Drainage Area:	8.5-22.3	Acres
Max Storage Depth:	10	Feet
Max Storage Volume:	3.7	Acre-Feet
Max Breach Discharge Q:	317	CFS
Crest Width of Embankment:	8	Feet

Vertical Fall from Spillway to Exterior Toe of Embankment:	<7	Feet
Exterior Embankment Slope:	3:1	Feet Horizontal : Feet Vertical
Interior Embankment Slope:	3:1	Feet Horizontal : Feet Vertical
Dam Size Class:	Minor	

Hazard Classification:

The Grandwood Ranch ponds will all fall in either No Public Hazard or Low Hazard because they will all be located downhill of the developed areas. In the case of a breach flows from the ponds will

discharge to an undeveloped, heavily vegetated low-lying area where the velocities will decrease to below 7 ft/s. The low-lying areas then drain to Higby Road crossroad culverts, surcharge the paved road and from there channel flow through the undeveloped downstream areas towards Jackson Creek. Further information will be submitted on the proposed ponds (including the SDI sheet) after the design process has been completed.

**ESTIMATION OF DAM BREACH PARAMETERS
USING THE FROELICH 2008 METHOD**

PROJECT: Timberview Subdivision Phase II Detention Pond Embankment

BREACH INPUT PARAMETERS:

Select Failure Mode From Drop-Down Menu: **OVERTOPPING**

Height of water over base elevation of breach (H_w) =	3.0	Feet
Volume of water in the reservoir at the time of failure (V_w) =	0.5	Acre-Feet
Reservoir Surface Area at H_w (A_s) =	0.4	Acres
Height of breach (H_b) =	3.0	Feet
Failure Mode Factor (K_o) =	1.3	
Breach Side-Slope Ratio (Z_b) =	0.7	Z(H):1(V)
Dam Size Class:	Minor	Assumes Full Reservoir At Time of Breach.

CALCULATED BREACH CHARACTERISTICS:

Average Breach Width (B_{avg}) =	8.9	Feet
Bottom Width of Breach (B_b) =	6.8	Feet
Breach Formation Time (T_f) =	0.15	Hours
Storage Intensity (SI) =	0.2	Acre Feet/Foot
Predicted Peak Flow (Q_p) =	73	Cubic Feet per Second

RESULTS CHECK:

Average Breach Width Divided by Height of Breach (B_{avg}/H_b) =	2.96	If (B_{avg}/H_b) > 0.6, Full Breach Development is Anticipated
Erosion Rate (ER), Calculated as (B_{avg}/T_f) =	59.2	
Erosion Rate Divided by Height of Water Over Base of Breach (ER/H_w) =	19.7	If $1.6 < (ER/H_w) < 21$, Erosion Rate is Assumed Reasonable

Note: Storage volume of reservoir is outside the data set used to generate the empirical equations used in the Froehlich Method

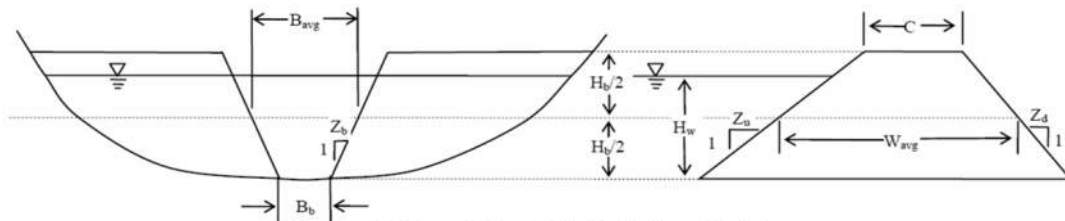


Figure 1- Breach Variable Definition Sketch

Channel Report

Timberview Breach Flow into Grandwood drainage easement

User-defined

Invert Elev (ft) = 7241.60
Slope (%) = 5.00
N-Value = 0.030

Highlighted

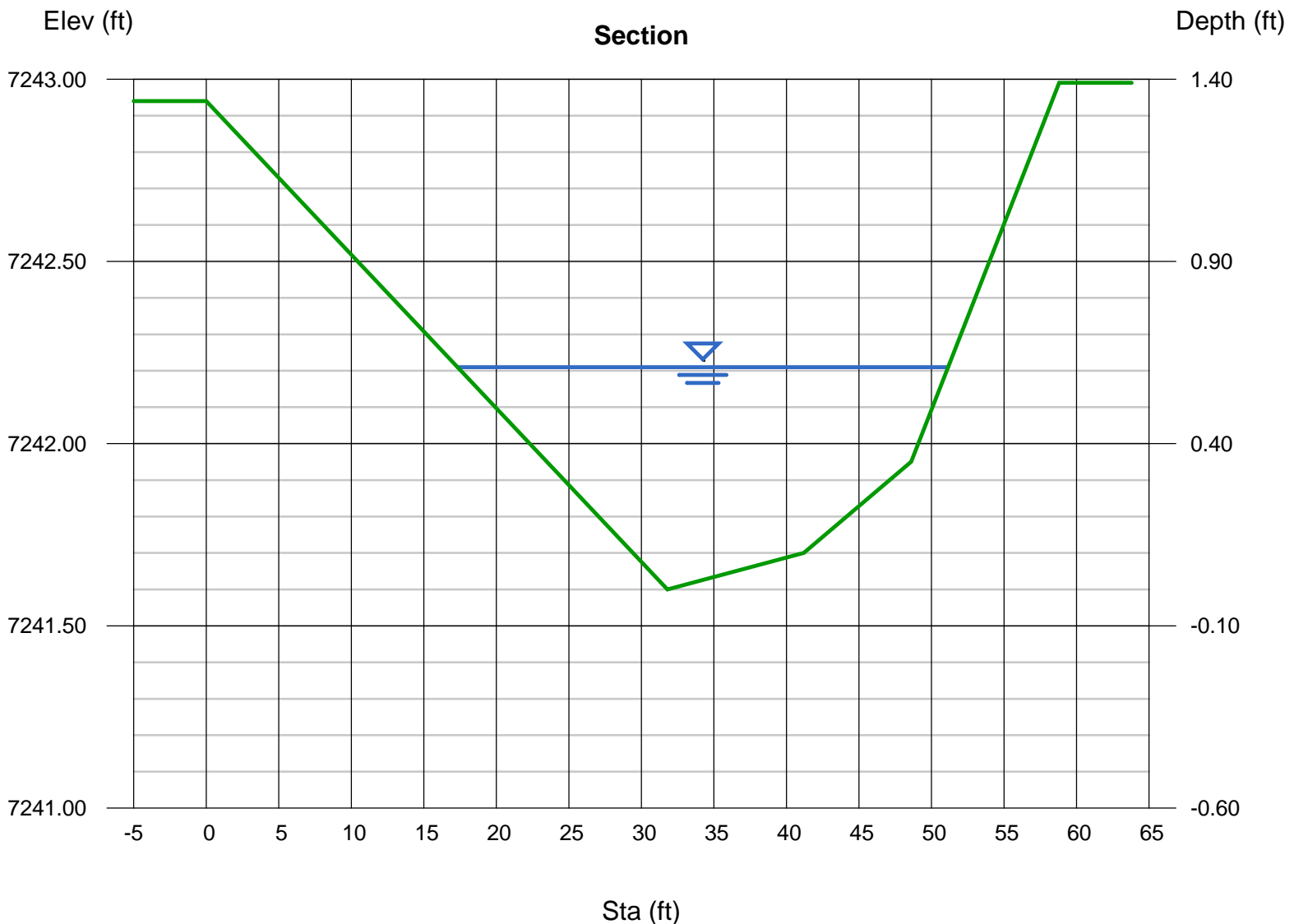
Depth (ft) = 0.61
Q (cfs) = 73.00
Area (sqft) = 12.85
Velocity (ft/s) = 5.68
Wetted Perim (ft) = 33.85
Crit Depth, Yc (ft) = 0.77
Top Width (ft) = 33.82
EGL (ft) = 1.11

Calculations

Compute by: Known Q
Known Q (cfs) = 73.00

(Sta, El, n)-(Sta, El, n)...

(0.00, 7242.94)-(31.80, 7241.60, 0.030)-(41.20, 7241.70, 0.030)-(48.60, 7241.95, 0.030)-(58.80, 7242.99, 0.030)



**ESTIMATION OF DAM BREACH PARAMETERS
USING THE FROELICH 2008 METHOD**

PROJECT: Bent Tree III Detention Pond

BREACH INPUT PARAMETERS:

Select Failure Mode From Drop-Down Menu: **OVERTOPPING**

Height of water over base elevation of breach (H_w) =	10.1	Feet
Volume of water in the reservoir at the time of failure (V_w) =	3.8	Acre-Feet
Reservoir Surface Area at H_w (A_w) =	1.0	Acres
Height of breach (H_b) =	10.1	Feet
Failure Mode Factor (K_o) =	1.3	
Breach Side-Slope Ratio (Z_b) =	0.7	Z(H):1(V)
Dam Size Class:	Minor	Assumes Full Reservoir At Time of Breach.

CALCULATED BREACH CHARACTERISTICS:

Average Breach Width (B_{avg}) =	18.0	Feet
Bottom Width of Breach (B_b) =	10.9	Feet
Breach Formation Time (T_f) =	0.12	Hours
Storage Intensity (SI) =	0.4	Acre Feet/Foot
Predicted Peak Flow (Q_p) =	807	Cubic Feet per Second

RESULTS CHECK:

Average Breach Width Divided by Height of Breach (B_{avg}/H_b) =	1.78	If (B_{avg}/H_b) > 0.6, Full Breach Development is Anticipated
Erosion Rate (ER), Calculated as (B_{avg}/T_f) =	144.5	
Erosion Rate Divided by Height of Water Over Base of Breach (ER/H_w) =	14.3	If $1.6 < (ER/H_w) < 21$, Erosion Rate is Assumed Reasonable

Note: Storage volume of reservoir is outside the data set used to generate the empirical equations used in the Froehlich Method

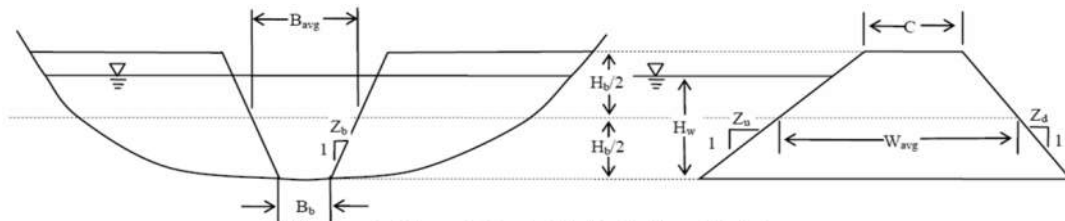


Figure 1- Breach Variable Definition Sketch

Channel Report

Bent Tree III Dam Breach - No Build Width in Lot 9 Based on Natural Flow Path

User-defined

Invert Elev (ft) = 7306.00
Slope (%) = 4.20
N-Value = 0.040

Highlighted

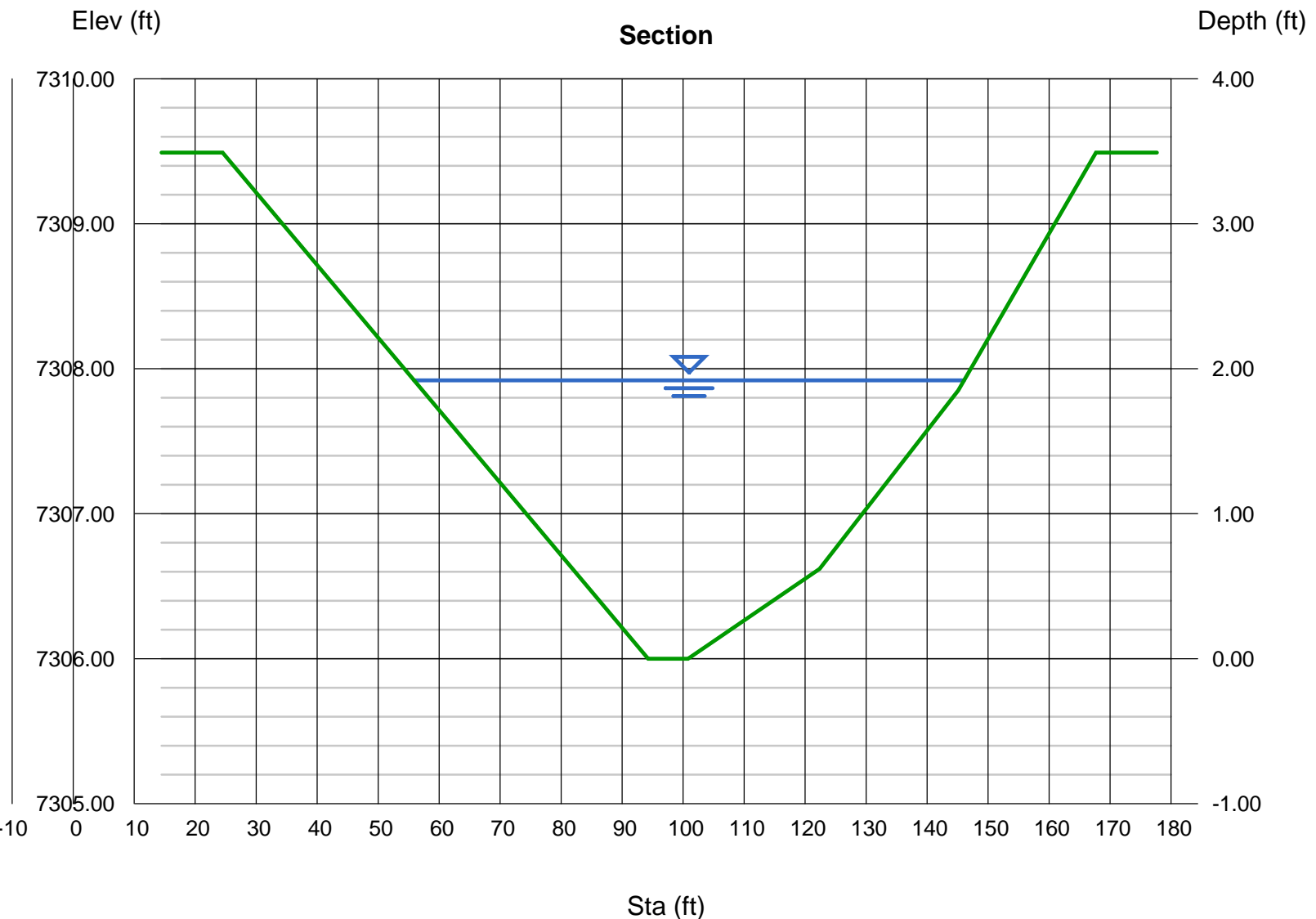
Depth (ft) = 1.92
Q (cfs) = 807.00
Area (sqft) = 99.72
Velocity (ft/s) = 8.09
Wetted Perim (ft) = 90.27
Crit Depth, Yc (ft) = 2.21
Top Width (ft) = 90.18
EGL (ft) = 2.94

Calculations

Compute by: Known Q
Known Q (cfs) = 807.00

(Sta, El, n)-(Sta, El, n)...

(24.49, 7309.49)-(94.27, 7306.00, 0.040)-(100.80, 7306.00, 0.040)-(122.38, 7306.62, 0.040)-(145.10, 7307.85, 0.040)-(167.68, 7309.49, 0.040)



Channel Report

Bewnt Tree III - Downstream Road Crossing

User-defined

Invert Elev (ft) = 7302.00
Slope (%) = 2.00
N-Value = 0.013

Calculations

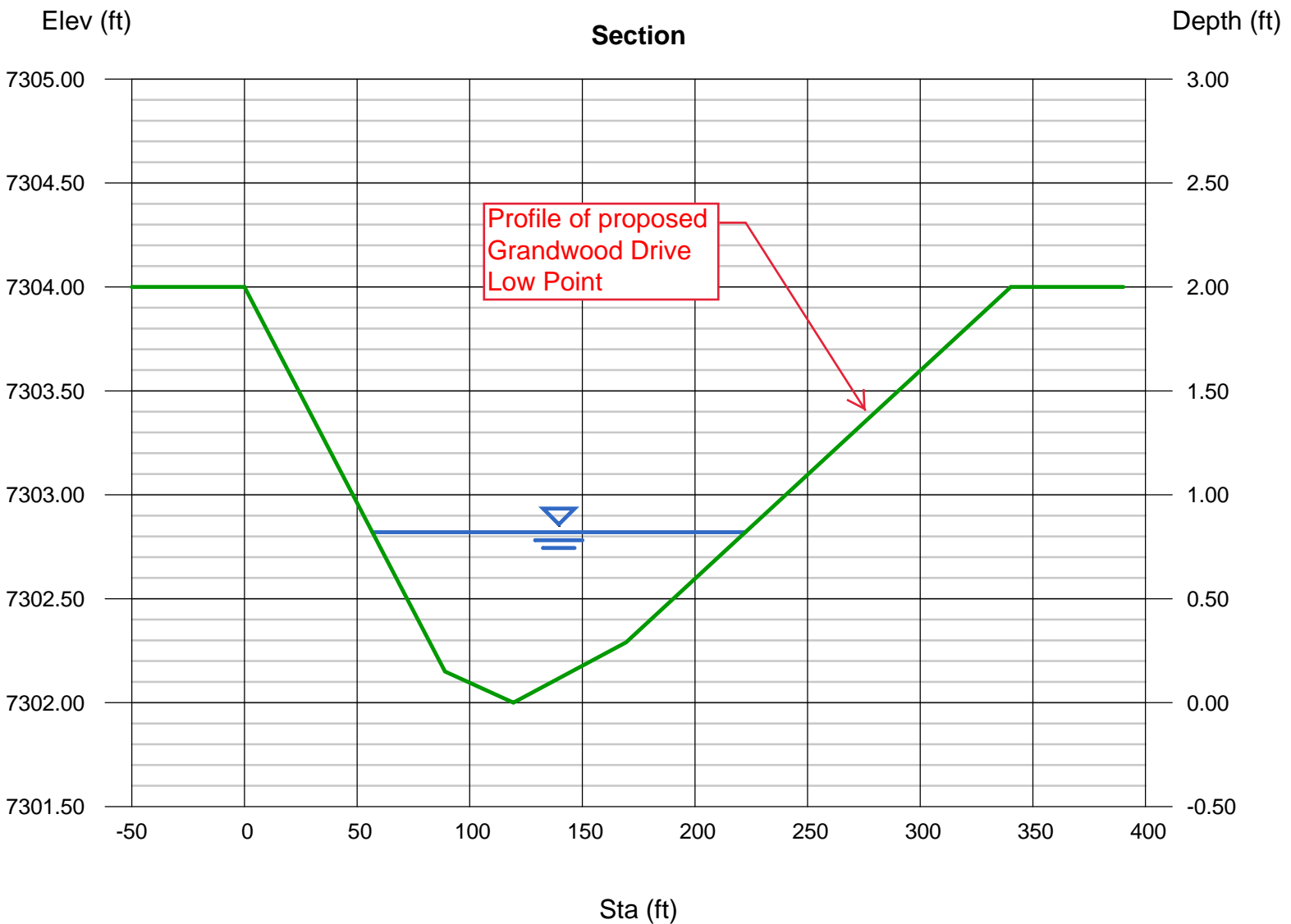
Compute by: Known Q
Known Q (cfs) = 807.00

Highlighted

Depth (ft) = 0.82
Q (cfs) = 807.00
Area (sqft) = 81.20
Velocity (ft/s) = 9.94
Wetted Perim (ft) = 165.56
Crit Depth, Yc (ft) = 1.26
Top Width (ft) = 165.54
EGL (ft) = 2.36

(Sta, El, n)-(Sta, El, n)...

(0.00, 7304.00)-(89.00, 7302.15, 0.013)-(119.40, 7302.00, 0.013)-(169.40, 7302.29, 0.013)-(340.20, 7304.00, 0.013)



Channel Report

Bent Tree III Dam Breach -Wetland Flow

User-defined

Invert Elev (ft) = 7242.00
Slope (%) = 3.30
N-Value = 0.048

Highlighted

Depth (ft) = 3.24
Q (cfs) = 807.00
Area (sqft) = 99.92
Velocity (ft/s) = 8.08
Wetted Perim (ft) = 58.47
Crit Depth, Yc (ft) = 3.36
Top Width (ft) = 57.98
EGL (ft) = 4.25

Calculations

Compute by: Known Q
Known Q (cfs) = 807.00

(Sta, El, n)-(Sta, El, n)...

(12.60, 7247.44)-(52.51, 7245.88, 0.040)-(91.95, 7245.60, 0.040)-(112.00, 7244.00, 0.050)-(122.00, 7242.00, 0.050)-(128.00, 7242.00, 0.050)-(136.00, 7242.96, 0.050)-(141.00, 7243.00, 0.050)-(159.00, 7246.00, 0.040)-(178.40, 7247.57, 0.040)

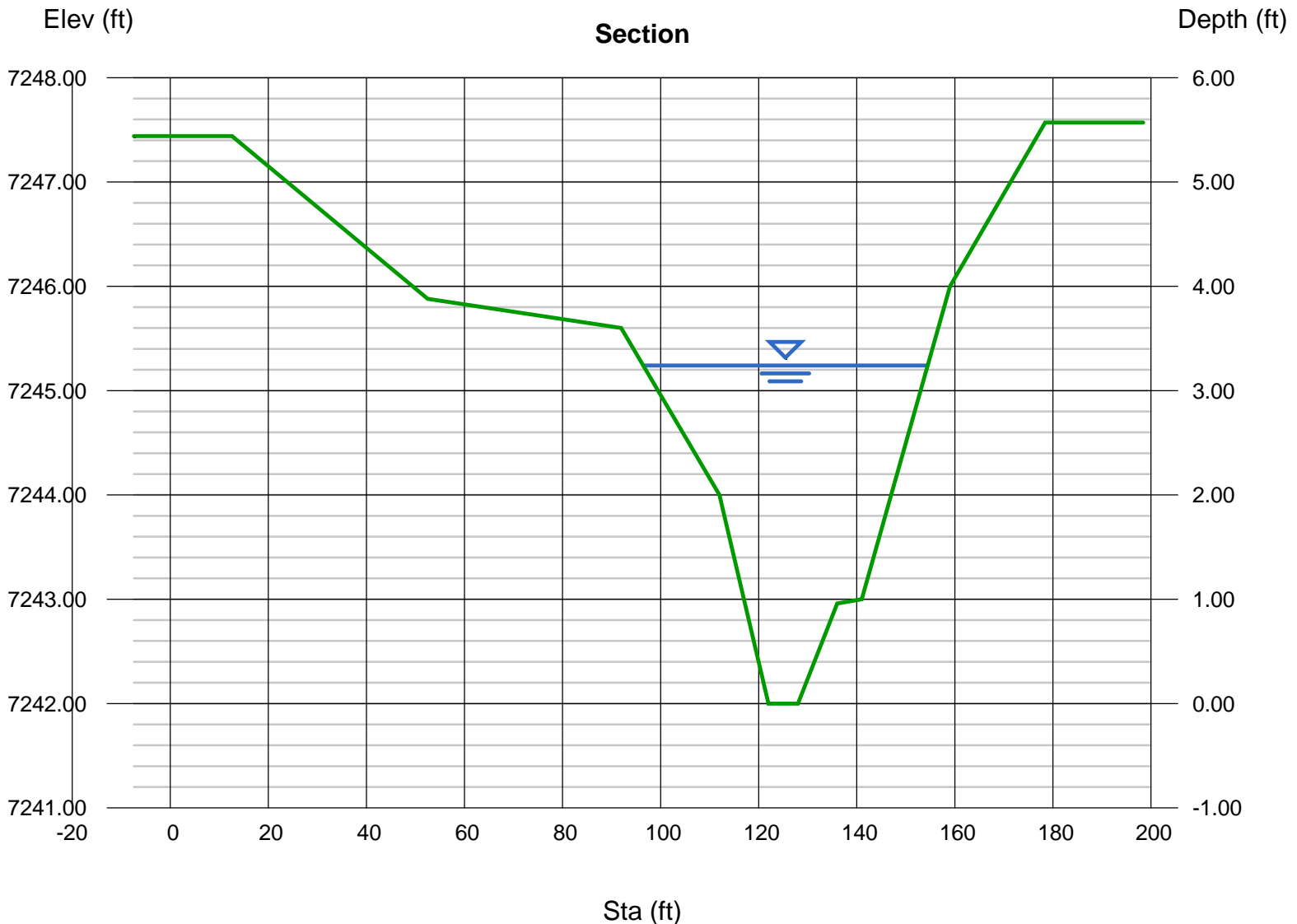


Figure 13-12b. Emergency Spillway Profile at Embankment

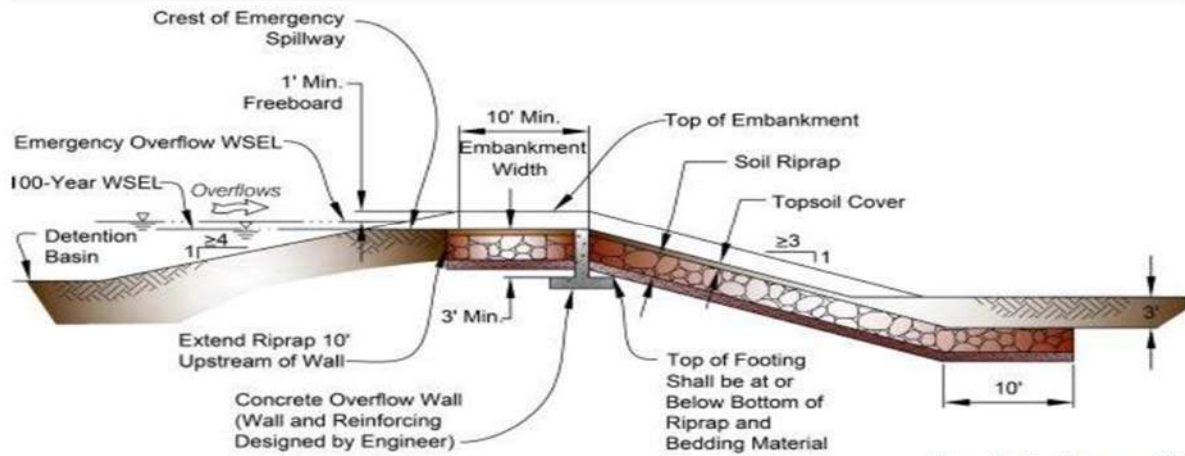


Figure 13-12c. Emergency Spillway Protection

ROAD EMBANKMENT PROTECTION CALCULATION

Q=807 CFS

LENGTH=167

UNIT FLOW RATE: 4.8 CFS/FT

=> TYPE M RIP RAP

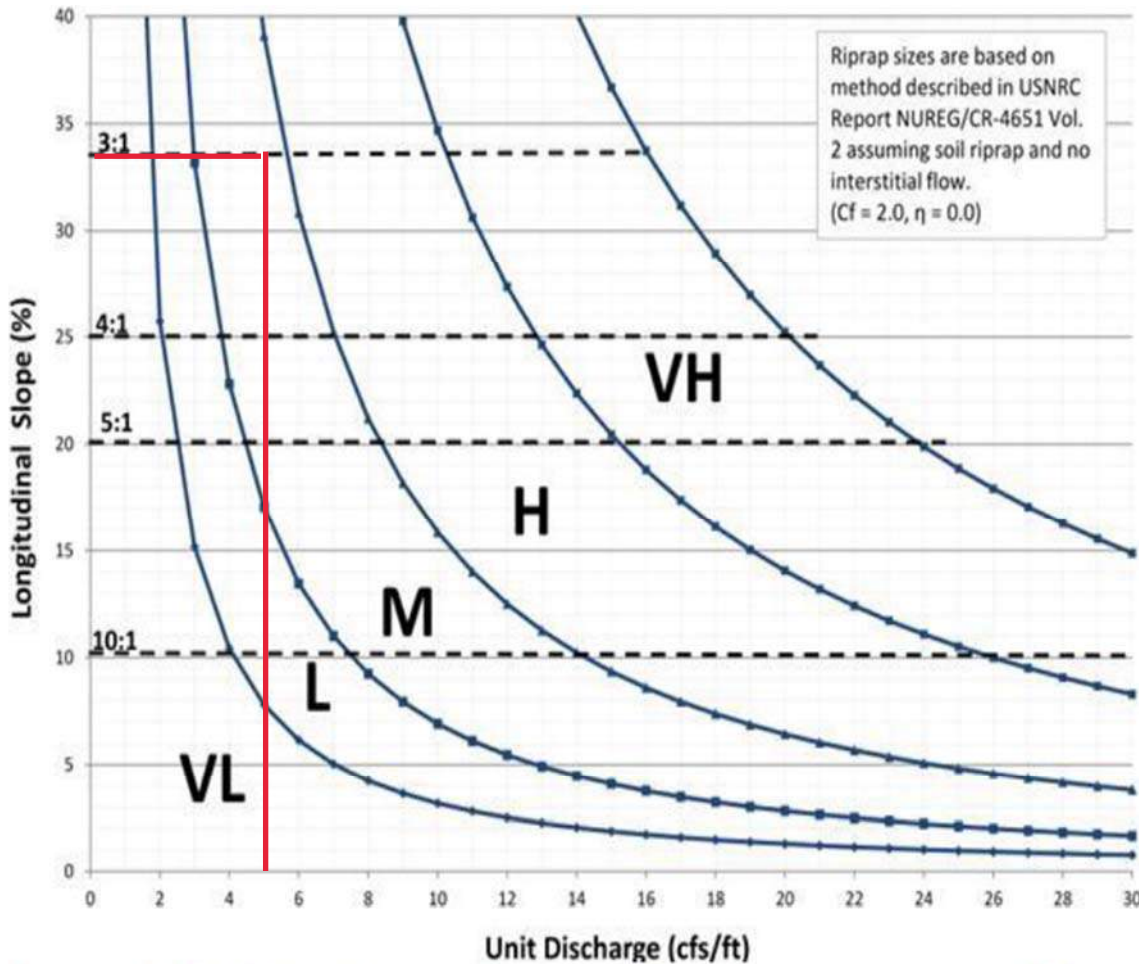
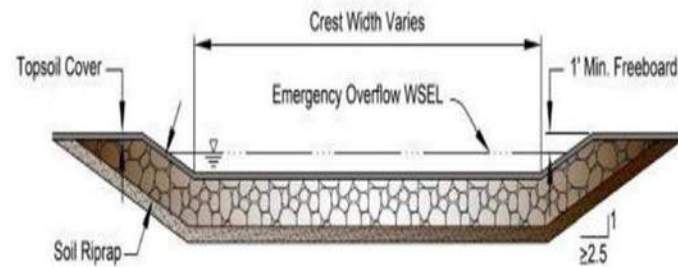


Figure 13-12d. Riprap Types for Emergency Spillway Protection

Channel Report

Onsite Worst Case Dam Breach - Wetland Flow

User-defined

Invert Elev (ft) = 7242.00
Slope (%) = 3.30
N-Value = 0.048

Highlighted

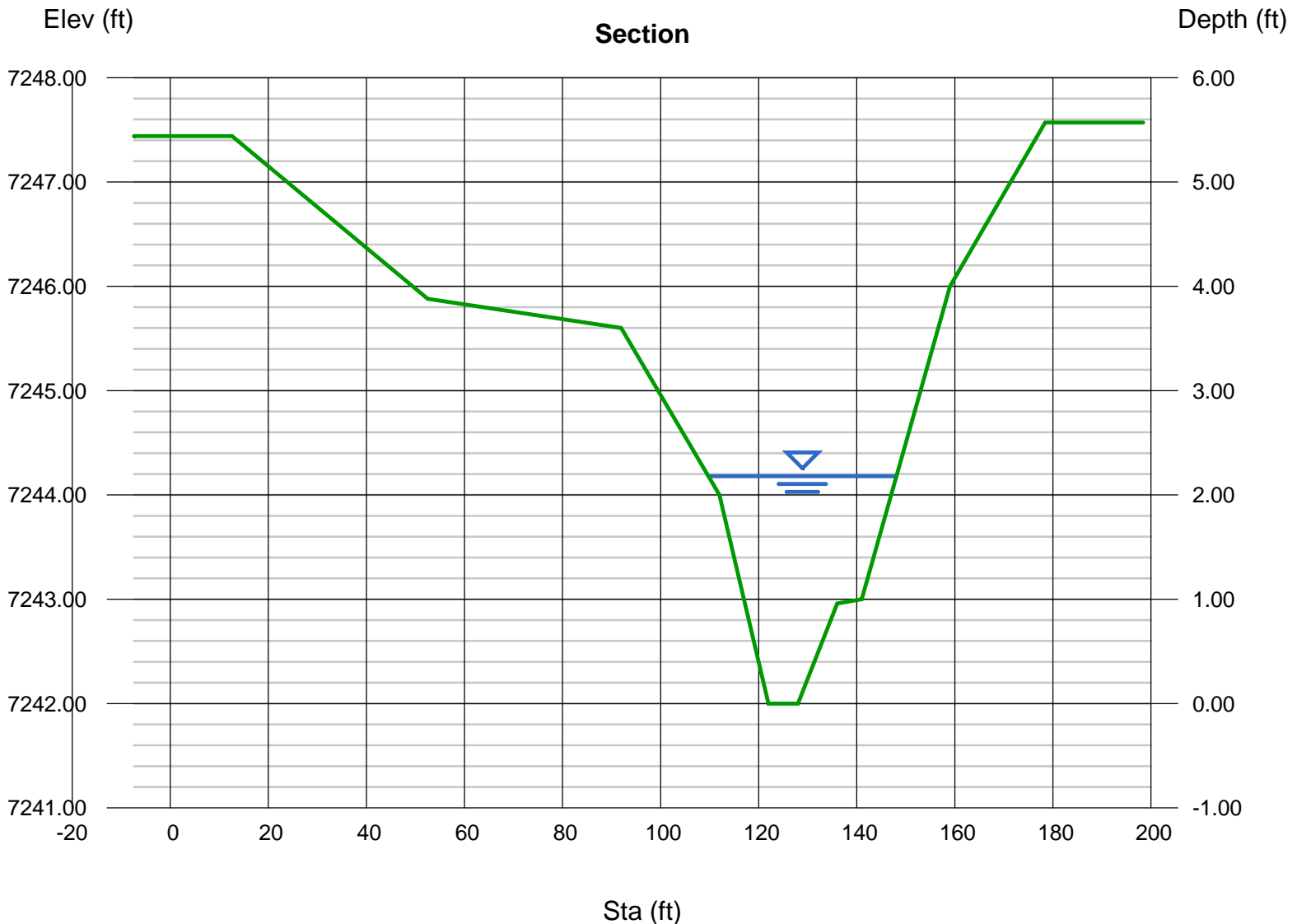
Depth (ft) = 2.18
Q (cfs) = 317.00
Area (sqft) = 48.87
Velocity (ft/s) = 6.49
Wetted Perim (ft) = 38.70
Crit Depth, Yc (ft) = 2.20
Top Width (ft) = 38.34
EGL (ft) = 2.83

Calculations

Compute by: Known Q
Known Q (cfs) = 317.00

(Sta, El, n)-(Sta, El, n)...

(12.60, 7247.44)-(52.51, 7245.88, 0.040)-(91.95, 7245.60, 0.040)-(112.00, 7244.00, 0.050)-(122.00, 7242.00, 0.050)-(128.00, 7242.00, 0.050)-(136.00, 7242.96, 0.050)-(141.00, 7243.00, 0.050)-(159.00, 7246.00, 0.040)-(178.40, 7247.57, 0.040)

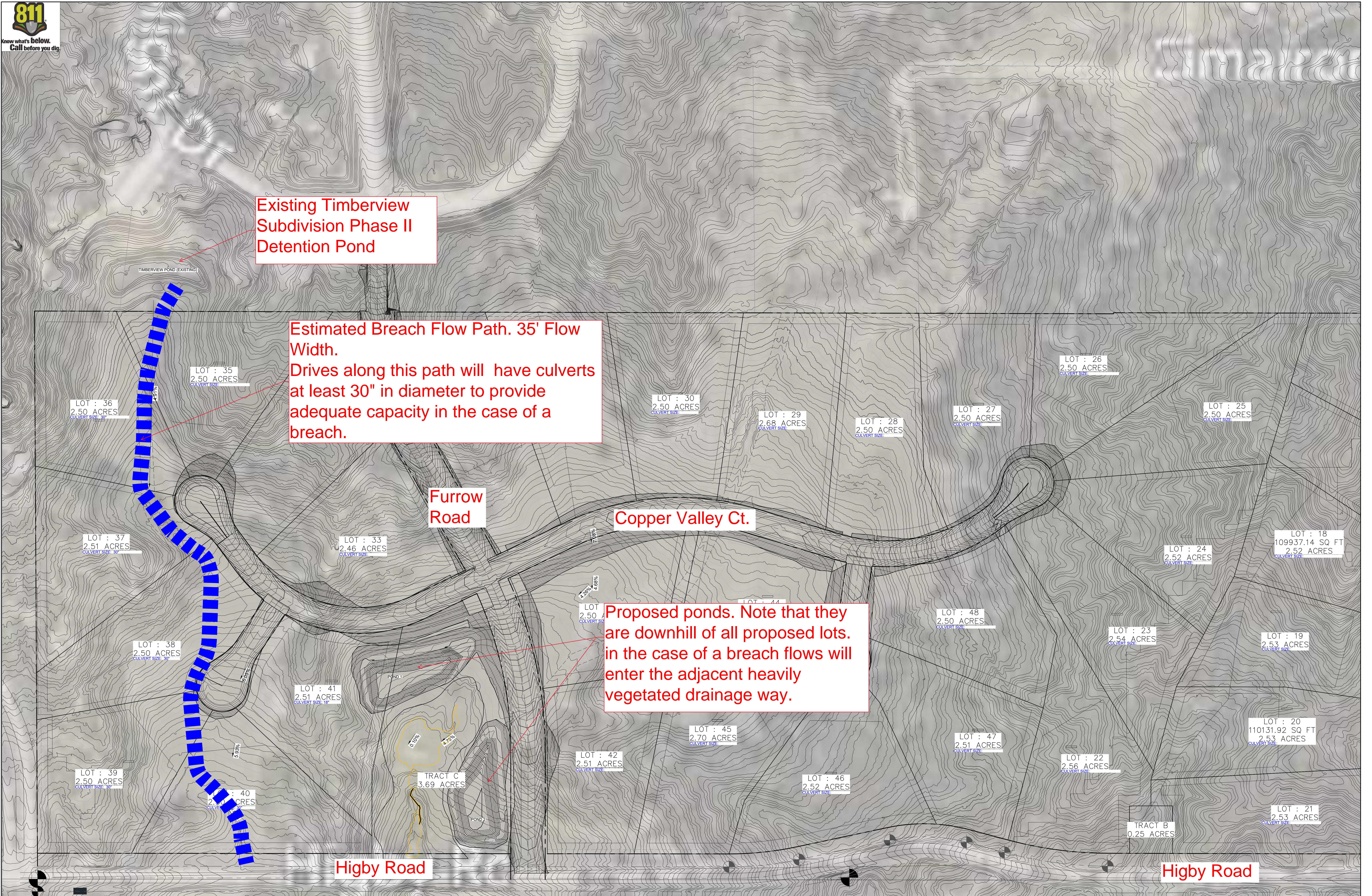




Existing Timberview
Subdivision Phase II
Detention Pond

Estimated Breach Flow Path. 35' Flow
Width.
Drives along this path will have culverts
at least 30" in diameter to provide
adequate capacity in the case of a
breach.

Proposed ponds. Note that they
are downhill of all proposed lots.
in the case of a breach flows will
enter the adjacent heavily
vegetated drainage way.



NO.	DATE	DESCRIPTION	BY
REVISIONS			
BENCHMARK DATA (ELEV.)			
(DATUM)			
(DESCRIPTION/LOCATION)			

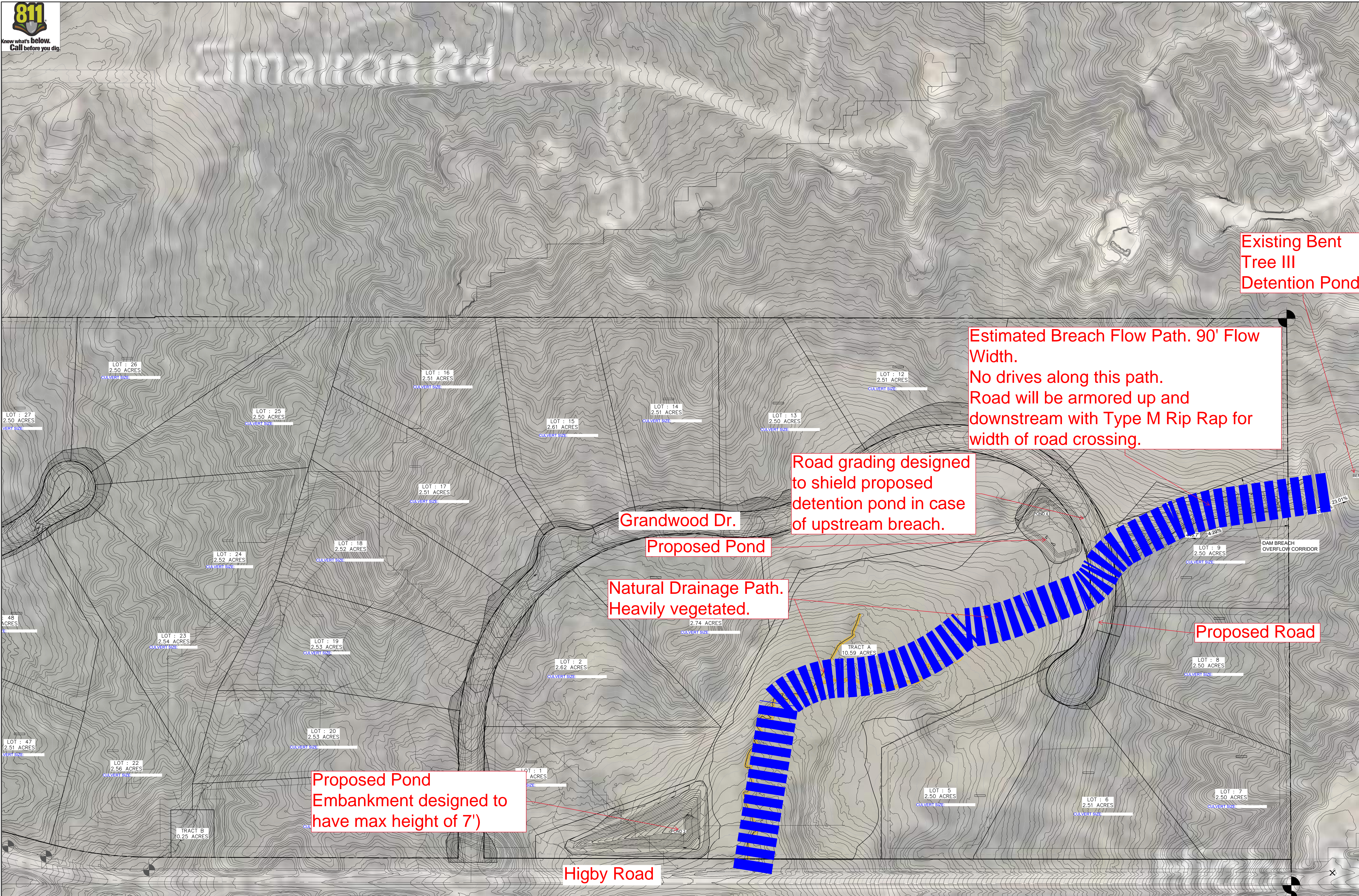
VERTICAL BENCHMARK:
BASIS OF BEARING:

PREPARED UNDER MY
DIRECT SUPERVISION, FOR
AND ON BEHALF OF MATRIX
DESIGN GROUP, INC.

2435 Research Parkway, Suite
300 Colorado Springs, CO 80920
Phone: 719-575-0100
Fax: 719-575-0208

Grandwood Ranch Subdivision	
Potential Breach locations in Western Portion of Development	
DESIGNED BY: JTS	SCALE: _____
DRAWN BY: JTS	HORIZ: _____
CHECKED BY: _____	VERT: _____
DATE ISSUED: MARCH 2020	SHEET NO. 1 OF 2 SHEETS

NAME: S:\201105.004 Grandwood Ranch\100 Dwg\106 Working\UTS Basins.dwg
PCP: Matrix.cdb
PLOT DATE: Thu Mar 26, 2020 1:46pm



Existing Bent Tree III Detention Pond

Estimated Breach Flow Path. 90' Flow Width. No drives along this path. Road will be armored up and downstream with Type M Rip Rap for width of road crossing.

Road grading designed to shield proposed detention pond in case of upstream breach.

Grandwood Dr. Proposed Pond

Natural Drainage Path. Heavily vegetated.

Proposed Road

Proposed Pond Embankment designed to have max height of 7'

Higby Road

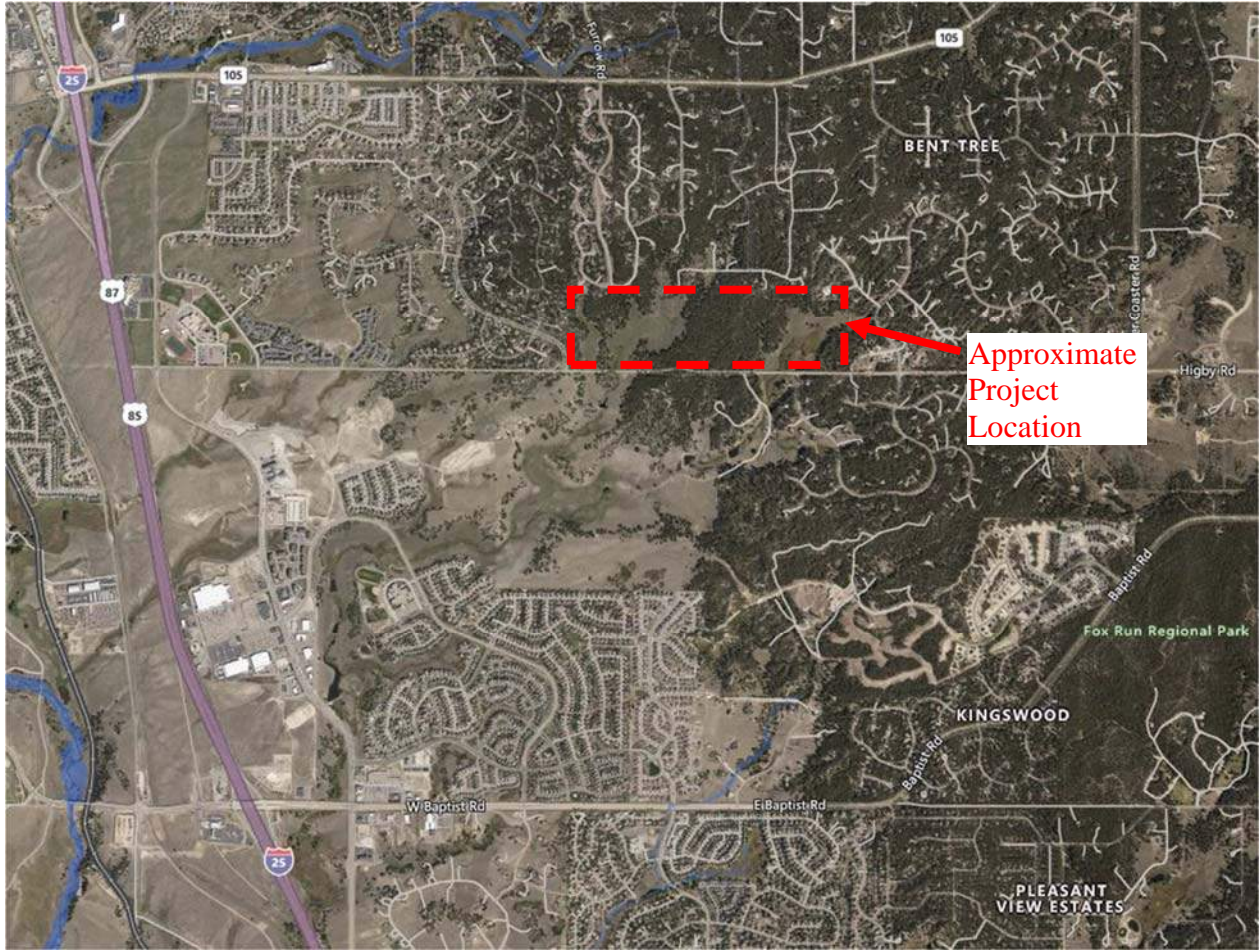
REFERENCE DRAWINGS	
NO.	DATE
DESCRIPTION	
BY	
REVISIONS	
BENCHMARK DATA (ELEV.)	
(DATUM)	
(DESCRIPTION/LOCATION)	
NAME: S:\201105.004 Grandwood Ranch\100 Dwg\106 Working\UTS Basins.dwg	
PCP: Matrix.ctb	
PLOT DATE: Thu Mar 26, 2020 3:33pm	

VERTICAL BENCHMARK:
BASIS OF BEARING:

PREPARED UNDER MY DIRECT SUPERVISION, FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.

2435 Research Parkway, Suite 300
 Colorado Springs, CO 80920
 Phone: 719-575-0100
 Fax: 719-575-0208

GRANDWOOD RANCH SUBDIVISION			
Potential Breach locations in Eastern Portion of Development			
DESIGNED BY: JTS	SCALE:	DATE ISSUED:	MARCH 2020
DRAWN BY: JTS	HORIZ:	SHEET NO. OF SHEETS	
CHECKED BY:	VERT:		



Vicinity Map
Grandwood Ranch Subdivision

El Paso County Drainage Basin Fees

Resolution No. 19-441

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2020 Drainage Fee (per Impervious Acre)	2020 Bridge Fee (per Impervious Acre)
<u>Drainage Basins with DBPS's:</u>					
CHMS0200	Chico Creek	2013	Haegler Ranch	\$10,737	\$1,585
CHWS1200	Chico Creek	2001	Bennett Ranch	\$12,020	\$4,611
CHWS1400	Chico Creek	2013	Falcon	\$30,807	\$4,232
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	\$13,066	\$3,866
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	\$19,084	\$2,464
FOFO2800	Fountain Creek	1988*	Widefield	\$19,084	\$0
FOFO2900	Fountain Creek	1988*	Security	\$19,084	\$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	\$19,084	\$286
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	\$11,640	\$0
FOFO3400	Fountain Creek	1984*	Peterson Field	\$13,764	\$1,044
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	\$19,084	\$0
FOFO4000	Fountain Creek	1996	Sand Creek	\$19,698	\$8,057
FOFO4200	Fountain Creek	1977	Spring Creek	\$9,897	\$0
FOFO4600	Fountain Creek	1984*	Southwest Area	\$19,084	\$0
FOFO4800	Fountain Creek	1991	Bear Creek	\$19,084	\$1,044
FOFO5400	Fountain Creek	1977	21st Street	\$5,742	\$0
FOFO5600	Fountain Creek	1964	19th Street	\$3,756	\$0
FOFO5800	Fountain Creek	1964	Camp Creek	\$2,115	\$0
FOMO0400	Monument Creek	1986*	Mesa	\$9,982	\$0
FOMO1000	Monument Creek	1981	Douglas Creek	\$12,001	\$265
FOMO1200	Monument Creek	1977	Templeton Gap	\$12,320	\$286
FOMO1400	Monument Creek	1976	Pope's Bluff	\$3,823	\$652
FOMO1600	Monument Creek	1976	South Rockrimmon	\$4,486	\$0
FOMO1800	Monument Creek	1973	North Rockrimmon	\$5,742	\$0
FOMO2000	Monument Creek	1971	Pulpit Rock	\$6,328	\$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	\$19,084	\$1,044
FOMO2400	Monument Creek	1966	Dry Creek	\$15,065	\$545
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	\$8,664	\$545
FOMO3700	Monument Creek	1987*	Middle Tributary	\$15,925	\$0
FOMO3800	Monument Creek	1987*	Monument Branch	\$19,084	\$0
FOMO4000	Monument Creek	1996	Smith Creek	\$7,780	\$1,044
FOMO4200	Monument Creek	1989*	Black Forest	\$19,084	\$520
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	\$19,084	\$1,044
FOMO5300	Fountain Creek	1993*	Crystal Creek	\$19,084	\$1,044
<u>Miscellaneous Drainage Basins: ¹</u>					
CHBS0800	Chico Creek		Book Ranch	\$17,906	\$2,592
CHEC0400	Chico Creek		Upper East Chico	\$9,755	\$283
CHWS0200	Chico Creek		Telephone Exchange	\$10,718	\$251
CHWS0400	Chico Creek		Livestock Company	\$17,655	\$210
CHWS0600	Chico Creek		West Squirrel	\$9,203	\$3,819
CHWS0800	Chico Creek		Solberg Ranch	\$19,084	\$0
FOFO1200	Fountain Creek		Crooked Canyon	\$5,761	\$0
FOFO1400	Fountain Creek		Calhan Reservoir	\$4,810	\$280
FOFO1600	Fountain Creek		Sand Canyon	\$3,475	\$0
FOFO2000	Fountain Creek		Jimmy Camp Creek ³	\$19,084	\$893
FOFO2200	Fountain Creek		Fort Carson	\$15,065	\$545
FOFO2700	Fountain Creek		West Little Johnson	\$1,257	\$0
FOFO3800	Fountain Creek		Stratton	\$9,154	\$409
FOFO5000	Fountain Creek		Midland	\$15,065	\$545
FOFO6000	Fountain Creek		Palmer Trail	\$15,065	\$545
FOFO6800	Fountain Creek		Black Canyon	\$15,065	\$545
FOMO4600	Monument Creek		Beaver Creek	\$11,409	\$0
FOMO3000	Monument Creek		Kettle Creek	\$10,305	\$0
FOMO3400	Monument Creek		Elkhorn	\$1,731	\$0
FOMO5000	Monument Creek		Monument Rock	\$8,272	\$0
FOMO5400	Monument Creek		Palmer Lake	\$13,226	\$0
FOMO5600	Monument Creek		Raspberry Mountain	\$4,449	\$0
PLPL0200	Monument Creek		Bald Mountain	\$9,481	\$0
<u>Interim Drainage Basins: ²</u>					
FOFO1800	Fountain Creek		Little Fountain Creek	\$2,440	\$0
FOMO4400	Monument Creek		Jackson Creek	\$7,554	\$0
FOMO4800	Monument Creek		Teachout Creek	\$5,245	\$788

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

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

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

**ARTICLES OF INCORPORATION
OF
THE GRANDWOOD RANCH HOMEOWNERS ASSOCIATION, INC.**

The undersigned person acting as incorporator, registered agent, and person filing these Articles of Incorporation under the Colorado Revised Nonprofit Corporation Act (the “Nonprofit Act”), hereby signs and acknowledges the following Articles of Incorporation for the following Corporation:

ARTICLE I

Name

The name of this Corporation shall be THE GRANDWOOD RANCH HOMEOWNERS ASSOCIATION, INC.

ARTICLE II

Duration

The term of existence of this Corporation is perpetual.

ARTICLE III

Purposes

The business, objects and purposes for which the Corporation is formed are as follows:

1. To be and constitute the “Association” to which reference is made in the Declaration of Covenants, Conditions, Restrictions and Easements for Grandwood Ranch Subdivision, and any amendment or supplement thereto (hereinafter called the “Covenants” and the definitions and provisions thereof are incorporated herein by this reference as if set forth at length) which has been or will be recorded in the records of the Clerk and Recorder of the County of El Paso, Colorado, and to perform all obligations and duties of the Association and to exercise all rights and powers of the Association. The Covenants consist of beneficial property restrictions which are mutually enforceable by all Owners within the Subdivision. The Association’s governing documents (hereinafter called the “Association Documents”) shall consist of the Association’s Covenants, these Articles of Incorporation, the Bylaws and the Rules. Any terms used in these Articles of Incorporation shall have the same meaning as set forth in the Covenants.

2. To provide an entity for the furtherance of the interests of all of the Owners, including the Declarant named in the Covenants, of Lots with the objectives of establishing and maintaining the Grandwood Ranch Subdivision (the “Subdivision”), as a project of substantial quality and value; enhancing and protecting its value, desirability and attractiveness; promoting the

health and welfare of the residents of said Subdivision and providing for any other purposes as set forth in the Covenants, including any maintenance, preservation, and architectural control of the Lots and any property owned by the Association within said Subdivision.

3. To perform any governmental requirements, including any requirements related to the Detention Basin Agreement, any water augmentation plan, or other planning or zoning requirements of El Paso County, to the extent applicable.

ARTICLE IV

Powers

In furtherance of its purposes, this Corporation shall have all of the powers conferred upon non-profit corporations by the statutes and common law of the State of Colorado in effect from time to time, shall have all rights and powers conferred upon owners' associations by Colorado laws and statutes as now or hereafter enacted, provided however, the Corporation, the Subdivision and the Owners shall not be subject to the Colorado Common Interest Ownership Act (C.R.S. §38-33.3-101 et seq. "CCIOA") as provided by C.R.S. §38-33.3-116. The Corporation shall have all of the powers necessary or desirable to perform the obligations and duties and exercise the rights and powers of the Association under the Covenants which shall include the following, which shall be subject to the limitations, requirements, restrictions and provisions of the Covenants and the Association's Bylaws:

(a) To fix, levy, collect and enforce payment by any lawful means, all charges, fines, other sums, or assessments pursuant to the terms of the Covenants, and by law and statute; to pay all expenses in connection therewith and all other expenses incident to the conduct of the business of the Association, including all licenses, taxes or governmental charges levied or imposed against the Association or its property, and including any expenses related to the Common Area, the Water Decree, the Development Plan and any other governmental requirements set forth in the Covenants;

(b) To acquire (by gift, purchase or otherwise), own, hold, improve, build upon, operate, maintain, convey, sell, lease, transfer, dedicate for public use or otherwise dispose of real or personal property in connection with the affairs of the Association;

(c) To borrow money, mortgage, pledge, deed in trust, or hypothecate any or all of its real or personal property as security for money borrowed or debts incurred;

(d) To dedicate, convey, sell or transfer all or any part of any common real or personal property owned by the Association;

(e) To participate in mergers and consolidations with other non-profit corporations organized for the same purposes;

(f) To manage, control, operate, maintain, repair and improve any property owned by the Association;

(g) To enforce the covenants, restrictions and conditions contained in the Association Documents as provided therein and to have all rights, powers, duties, and interests of the Association under the Association Documents;

(h) To engage in activities which will foster, promote and advance the common interests of Owners of Lots, including the interest of the Declarant during its marketing of the Subdivision;

(i) To fulfill any obligations of the Association under the Water Decree, as described in Exhibit "C" to the Covenants, including the augmentation plan, and obligations under any Detention Basin Agreement and the Development Plan or any other governmental plan or requirements set forth in the Covenants;

(j) To enter into, make, perform or enforce contracts of every kind and description and to do all other acts necessary, appropriate or advisable in carrying out any purposes of this Association, with or in association with any person, firm, association, corporation or other entity or agency, public or private, subject to the requirements of the Covenants; and

(k) To adopt, alter and amend or repeal such Bylaws and Rules as may be necessary or desirable for the proper management of the affairs of the Association.

ARTICLE V

Non-Liability and Indemnity of Officers and Directors

1. No Officer or Director of the Corporation shall be personally liable to the Corporation or to its Members for monetary damages for breach of fiduciary duty as a Director to the fullest extent of the Nonprofit Act, including C.R.S. §7-128-402, or other law or statute. If the Nonprofit Act hereafter is amended to further eliminate or limit the liability of an Officer or Director, then such Officer or Director shall not be liable to the fullest extent permitted by the amended Nonprofit Act, in addition to the other provisions of these Articles of Incorporation. No Officer or Director shall be liable to any creditor of the Corporation, including as provided by C.R.S. §7-128-401(5).

2. No Officer or Director of the Corporation shall be personally liable for any contract or claim against the Corporation nor for any injury to person or property arising out of a tort committed by such person unless such Officer or Director committed a criminal offense or committed a wanton and willful wrongful act or omission. The protections afforded by these Articles shall not restrict other common law and statutory protections and rights that such Officer or Director may have and shall not reduce or impair any insurance coverage of such persons.

3. Unless otherwise specifically provided herein, or in the Nonprofit Act, or the Covenants, no Officer or Director shall be held liable for actions taken or omissions made in the performance of his or her duties as an Officer or Director except for gross negligence or wanton and willful wrongful acts or omissions.

4. A Director or Officer is not liable as such to the Corporation or its Members for any action taken or omitted to be taken as a Director or Officer in the performance of the duties of such position in compliance with C.R.S. §7-128-401(2).

5. The Corporation may purchase and maintain insurance on behalf of any person who is or was a Director, Officer, employee, fiduciary, or agent of the Corporation against any liability asserted against or incurred by him or her in any such capacity or arising out of his or her status as such, whether or not the Corporation would have the power to indemnify him or her against such liability under the Nonprofit Act or the Covenants or otherwise.

6. Each Officer and Director of the Corporation, before, now or hereinafter serving in any such capacity, shall be indemnified by the Corporation against any and all claims and liabilities to which he or she has or shall become subject by reason of serving or having served in any such capacity, or by reason of any action alleged to have been taken, omitted, or neglected by him or her in any such capacity, to the fullest extent allowable by law and statute, including the Nonprofit Act. The right of indemnification herein provided shall not be exclusive of any rights to which any Director or Officer of the Corporation may otherwise be entitled by law or statute, provided however, this indemnification shall not reduce or impair any insurance coverage of the Corporation, nor any Officer, Director, or any other person described in this Article.

7. Notwithstanding any provision hereof, each Officer, Director, and committee person shall be considered to be volunteers under C.R.S. §13-21-115.5, 13-21-115.7 and 13-21-116 (and any related Colorado or Federal statutes) and individuals serving as Officers, Directors and/or committee members shall, to the fullest extent permitted by such statutes, be protected from personal liability and indemnified by the Association.

8. Any repeal or modification of any of the foregoing paragraphs shall not adversely affect any right or protection of a Director, Officer, nor any other person described in this Article existing on or before such repeal or modification.

ARTICLE VI

Conflicts of Interest

No contract, transaction, or other financial relationship shall be void or voidable or be enjoined, set aside, or give rise to an award of damages or other sanctions in a proceeding by a Member of the Corporation or by or in the right of the Corporation, solely because of any conflicting interest so long as the contract, transaction, or other financial relationship complies with the Nonprofit Act, including C.R.S. §7-128-501. Common or interested Directors may be counted in determining the presence of a quorum at a meeting of the Board of Directors or of a committee which authorizes, approves or ratifies such contract or transaction.

ARTICLE VII

Membership

1. This Corporation shall be a membership corporation without certificates or shares of stock. As more fully provided in the Covenants and the Bylaws, every person or entity, who is a record owner of a fee or undivided fee interest in any Lot which is subject to the Covenants, including contract sellers, shall be a voting Member of the Corporation, but subject to the provisions of the Association Documents. The foregoing is not intended to include persons or entities who hold an interest merely as security for the performance of an obligation.

2. A membership in this Corporation and the share of a Member in the assets of this Corporation shall not be assigned, encumbered or transferred in any manner except as appurtenant to the transfer of title to the Lot to which the membership pertains; provided, however, that the rights of membership may be assigned to the holder of a mortgage, deed of trust or other security instrument on a Lot as further security for a loan secured by a lien on such Lot; foreclosure of a membership interest shall not be considered a purchase of such interest under C.R.S. §7-126-303.

3. A transfer of membership shall occur automatically upon the transfer of title to the Lot to which the membership pertains; provided however, that the Bylaws of this Corporation may contain reasonable provisions and requirements with respect to recording such transfers on the books and records of this Corporation.

4. Members shall have the right to purchase other Lots and to exercise the membership rights appurtenant thereto as provided in the Covenants.

5. This Corporation may suspend the voting rights of a Member for failure to comply with the Covenants, Bylaws or Rules of the Corporation or with any other obligations of the

Owners of a Lot under the Covenants. All Members who are in good standing shall be entitled to vote on all matters, except any Members who are in default in any obligations to the Corporation, which default shall also subject them to the remedies set forth in the Covenants, or as provided by law or statute. Cumulative voting is prohibited.

6. The Bylaws may contain additional provisions setting forth the rights, privileges, duties and responsibilities of the Members; provided however, the provisions of these Articles of Incorporation and the Bylaws shall be subject to the covenants, terms and provisions of the Covenants which shall control in the event of any conflict, and the provisions of these Articles of Incorporation shall control over any conflicting provisions in the Bylaws.

ARTICLE VIII

Voting Rights

1. During the Period of Declarant Rights, the Declarant shall have all voting and other membership rights in the Association. During the Period of Declarant Rights, the Declarant or Persons appointed by the Declarant may appoint all Officers and members of the Board of Directors, and may remove all Officers and members of the Board of Directors which have been appointed by the Declarant. The Declarant may voluntarily surrender in writing the right to appoint and remove all or a portion of the Officers and members of the Board of Directors before termination of the Period of Declarant Rights; but, in that event, the Declarant may require, for the duration of the Period of Declarant Rights, that specified actions of the Association or Board of Directors, as described in a recorded instrument executed by the Declarant, be approved by the Declarant before they become effective.

2. After the termination of the Period of Declarant Rights, but subject to the provisions of the Covenants and Bylaws, each Lot shall have one (1) vote as set forth in the Covenants, and the affirmative vote of a majority of Members, present at any meeting in person or by proxy, shall be required for decisions and action by the Corporation, unless otherwise provided herein or in the Association's Covenants or Bylaws. If only one of the multiple Owners of a Lot is present at a meeting of the Corporation, such Owner is entitled to cast the vote allocated to that Lot. Alternatively, if more than one person holds an interest in a Lot, they may appoint one of their co-owners as proxy to cast the vote for that Lot. The vote for such Lot shall be cast as the Owners holding a majority interest in thereof agree, but in no event shall they cast more than one vote for that Lot on any one question. If such Owners of such Lot cannot agree as to the manner in which their vote shall be cast when called upon to vote, then they will be treated as having abstained; during any such period, each Owner shall retain all other rights and obligations of membership in the Corporation.

3. The Bylaws may contain additional provisions regarding the voting rights of Members.

ARTICLE IX

Board of Directors

1. The business and affairs of the Corporation shall be conducted, managed and controlled by a Board of Directors. The initial Board of Directors shall consist of three (3) Directors, and thereafter the specific number shall be set forth as provided in the Bylaws of the Corporation. As set forth in the Covenants, the Declarant shall have the right to appoint the Board as set forth therein. Except for Directors appointed by the Declarant, Directors shall be Owners as defined in the Covenants and must be Members in good standing. The Declarant may, until January 1, 2040, appoint or remove any member of the Board of Directors of the Association. Following the termination of the Declarant's right to appoint the Board, the Owners shall elect the Board of Directors as provided in the Covenants, the Articles of Incorporation and the Bylaws.

2. The initial Board of Directors shall be appointed and removed by the Declarant and shall serve until their successors are duly elected and qualified.

3. Directors shall be elected, replaced and removed and vacancies of the Board of Directors shall be filled in the manner and for the terms as provided in these Articles of Incorporation and the Bylaws.

4. As set forth above, Directors shall have no liability to the Corporation or its Members for monetary damages for breach of any duty as a Director except as otherwise provided by law or statute. The Corporation shall indemnify its Directors and other persons pursuant to C.R.S. §7-22-101.5 and its Bylaws, but such indemnity shall not affect, impair, or reduce insurance coverage of its Directors and other persons.

ARTICLE X

Officers

The Board of Directors may appoint a President, one or more Vice-Presidents, a Secretary, a Treasurer and such other officers as the Board believes will be in the best interest of the Corporation. The Officers shall have such duties as may be prescribed in the Bylaws of the Corporation and shall serve at the pleasure of the Board of Directors.

ARTICLE XI

Dissolution, Merger or Consolidation

The Corporation may be dissolved, merged or consolidated as provided by the Nonprofit Act but subject to the Covenants. Upon dissolution of the Corporation other than incident to a merger or consolidation, the assets of the Corporation shall be distributed and transferred as the Members may direct, subject to the requirements, limitations and other provisions of the Covenants. In such event, the assets may be granted, conveyed and assigned to any public agency, non-profit corporation, association, trust or other organization to be devoted to purposes similar to those for which this Corporation was created.

ARTICLE XII

Initial Registered Office, Agent and Address

The street address of the initial registered office of the Corporation shall be 270 Lodge Pole Way, Monument, CO 80132. The initial registered agent shall be Bill Herebic, whose street address is the same as the initial registered office and whose consent is shown by his signature of these Articles of Incorporation. The address of the Corporation's initial principal office is the same as its initial registered office.

ARTICLE XIII

Amendment

These Articles of Incorporation may be amended by the Members at a regular or special meeting, with a quorum present, by a vote of at least sixty-seven percent (67%) of the Members voting (one vote per Lot) who are present in person or by proxy, provided however, notwithstanding the foregoing, any amendment of these Articles of Incorporation shall require the prior written approval of the Declarant during the Period of Declarant Rights and furthermore, the Declarant reserves the following rights, until January 1, 2040 but without the vote of the Owners, to make amendments to these Articles of Incorporation: (i) as may be necessary or desirable to implement the Declarant's rights or privileges under the Association Documents or otherwise in the Declarant's sole discretion; (ii) to correct typographical errors or make clarifications in these Articles of Incorporation; or (iii) as may be approved in writing by Federal National Mortgage Association, Federal Home Loan Mortgage Corporation, Federal Housing Administration or Department of Veterans Affairs, so as to induce any of such lenders or secondary lending entity to make, purchase, sell, issue, or guarantee First Mortgages in the Subdivision, and each Owner, by accepting a deed, mortgage or other instrument affecting a Lot appoints Declarant as his or her attorney-in-fact for purposes of executing in said Owner's name and filing or recording any such

amendments to these Articles of Incorporation, the Covenants and the Bylaws, and each deed, mortgage, trust deed, other evidence of obligation or other instrument affecting a Lot and the acceptance thereof shall be deemed to be a grant and acknowledgment of and a consent to the reservation of the power to the Declarant to make, execute and record any such amendments. The Secretary shall retain all ballots for at least one year after approval. Any legal action or other challenge to any amendment shall be barred if not filed in the El Paso County District Court within one (1) year of the date on which the amendment was approved. The Association's President is authorized to certify that the amendment has been duly approved; filing or recording of the ballots is not required. Upon such certification, the amendment shall be deemed to be duly adopted, fully valid and fully enforceable.

Notwithstanding the above, any provisions regarding the obligations of the Declarant, the Association and the Lot Owners with respect to the Development Plan or the Water Decree or the Detention Basin Agreement shall not be terminated except by written agreement of the Board of County Commissioners of El Paso County, Colorado, or except as otherwise provided in said documents.

ARTICLE XIV

Nonprofit Purposes

This Corporation is formed under the Nonprofit Act and not for pecuniary profit or financial gain. The Corporation is organized and operated to provide for the acquisition, construction, management, maintenance and care of property of the Subdivision as provided in the Association Documents.

ARTICLE XV

Incorporator and Filer

The incorporator of the Corporation and person filing this document is Bill Herebic, whose street address is 270 Lodge Pole Way, Monument, CO 80132.

ARTICLE XVI

Exemption from CCIOA

The Corporation and the Subdivision shall be exempt from the provisions of the CCIOA (C.R.S. §38-33.3-101, et seq.) pursuant to the provisions of C.R.S. §38-33.3-116 which exempt planned communities from the provisions of CCIOA if the annual common expense assessments do not exceed Five Hundred Dollars (\$500.00) per year. Notwithstanding this exemption, this

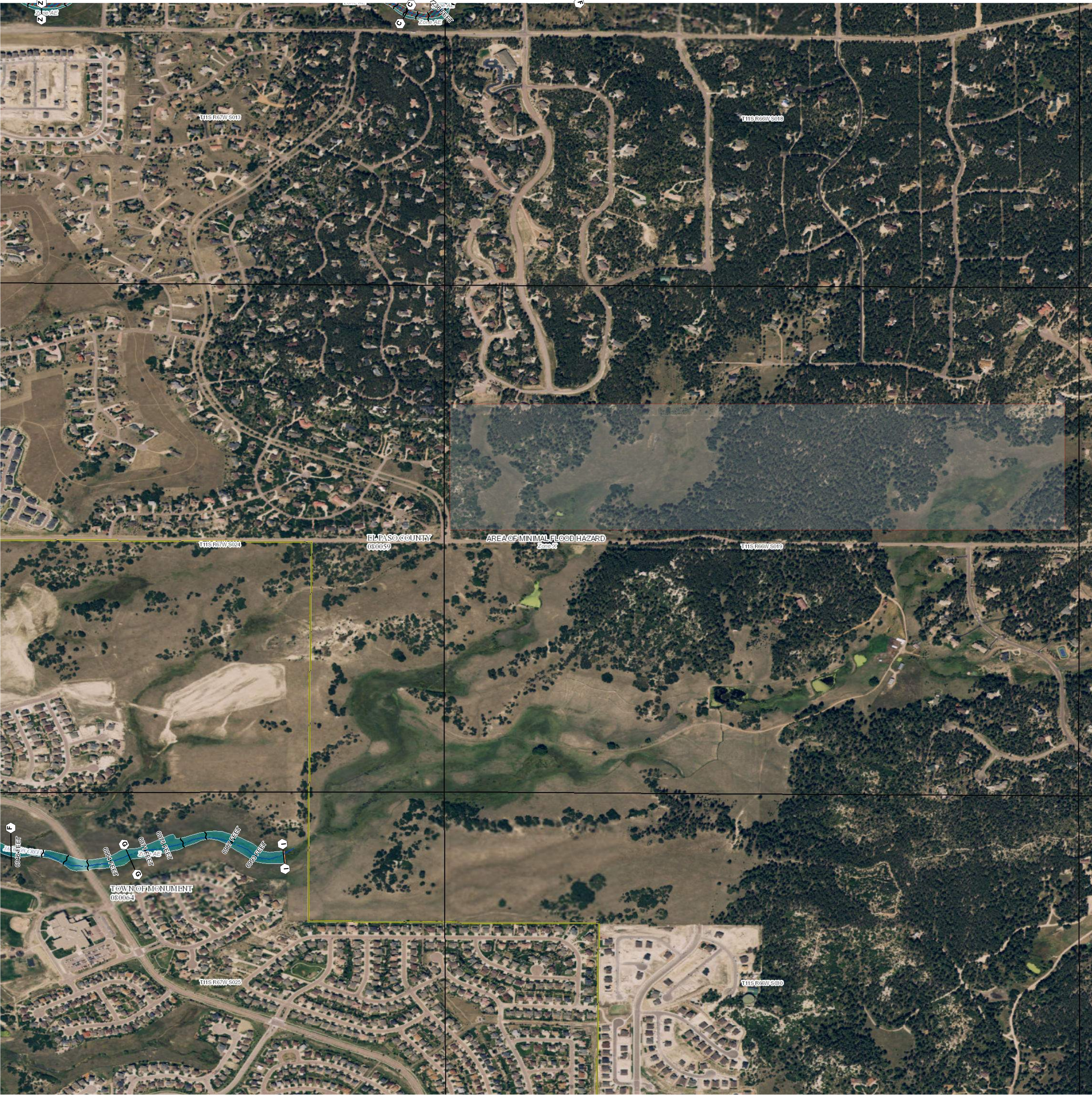
Corporation and the Subdivision are subject to the provisions of C.R.S. §§ 38-33.3-105, 38-33.3-106 and 38-33.3-107 of CCIOA.

IN WITNESS WHEREOF, for the purposes of forming this Corporation under the laws of the State of Colorado, the undersigned, constituting the Incorporator and Registered Agent of this Corporation and person filing this document and to whom notice may be delivered, has executed these Articles of Incorporation on the date shown below. The name and mailing address of the individual who caused this document to be delivered for filing, and to whom the Secretary of State may deliver notice if filing of this document is refused, is the above-named incorporator.

Dated: _____

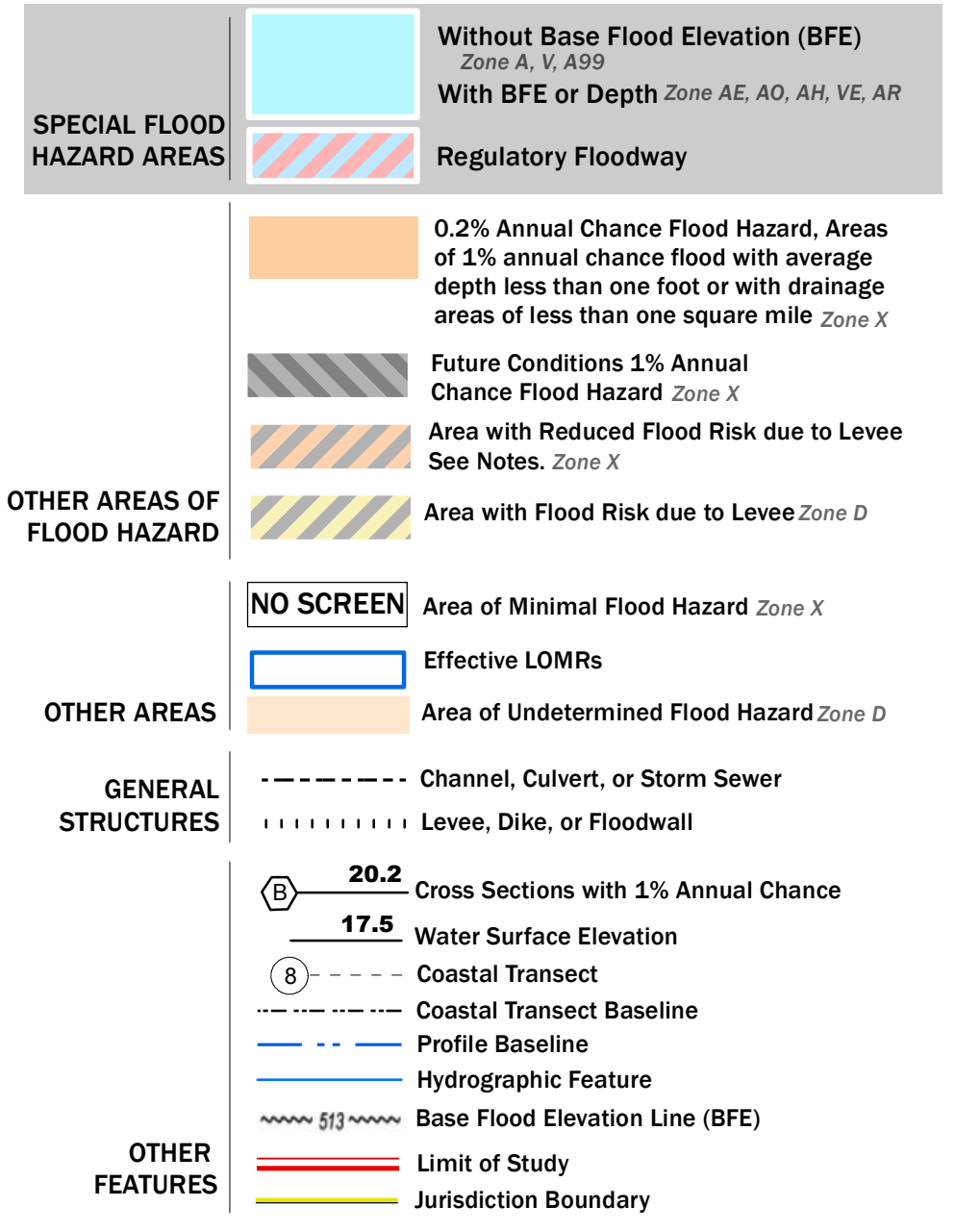
Bill Herebic
Address: 270 Lodge Pole Way
Monument, CO 80132

FIRMETTE



FLOOD HAZARD INFORMATION

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



NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to 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.

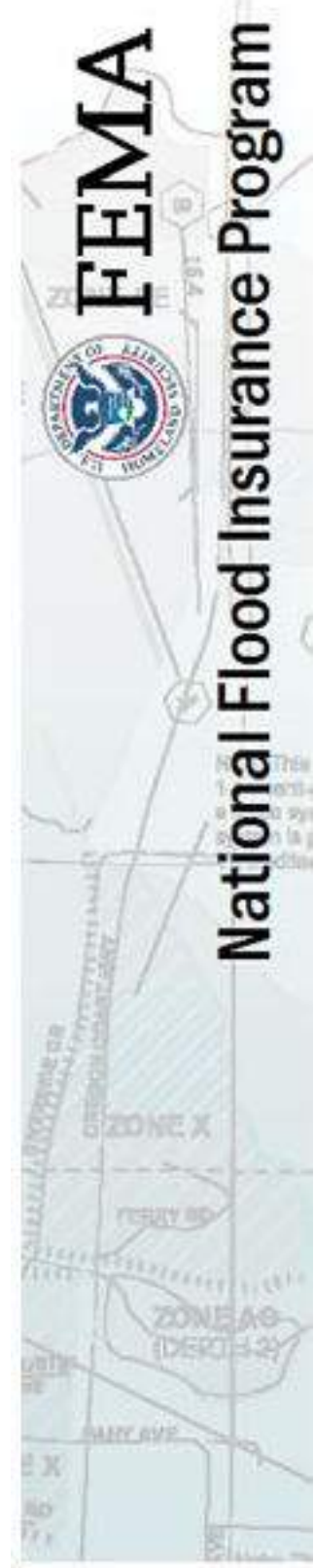
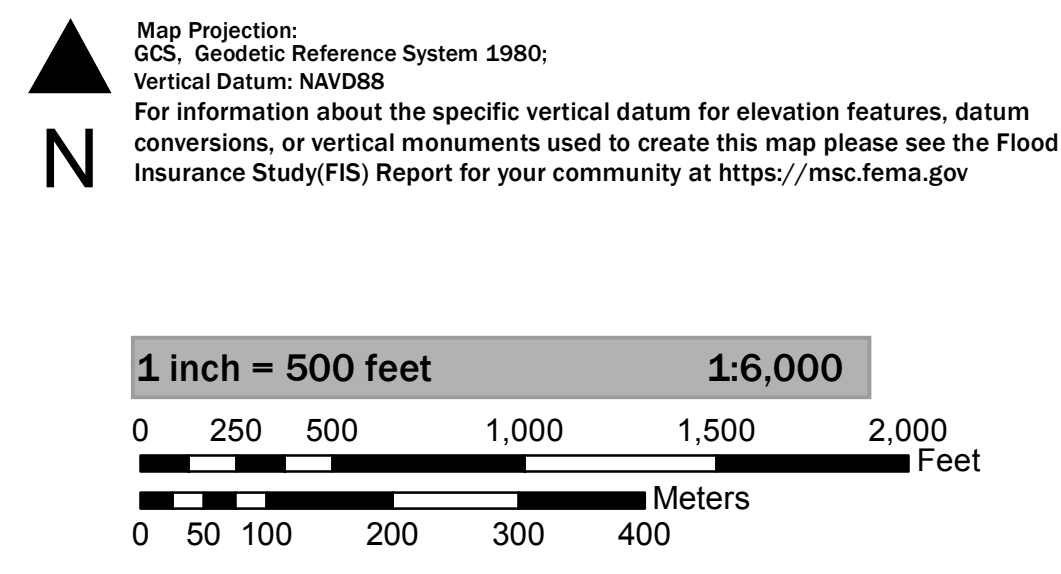
Basemap information shown on this FIRM was provided in digital format by USDA, Farm Service Agency (FSA). This information was derived from NAIP, dated April 11, 2018.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on 3/8/2019 10:41:59 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at <https://www.fema.gov/media-library/assets/documents/118418>.

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

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

SCALE



NATIONAL FLOOD INSURANCE PROGRAM FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS
PANEL 279 OF 1275

Panel Contains:

COMMUNITY	NUMBER	PANEL
EL PASO COUNTY	080059	0279
COLORADO		
TOWN OF MONUMENT	080064	0279
COLORADO		

USDA NRCS WEB SOIL SURVEY REPORT



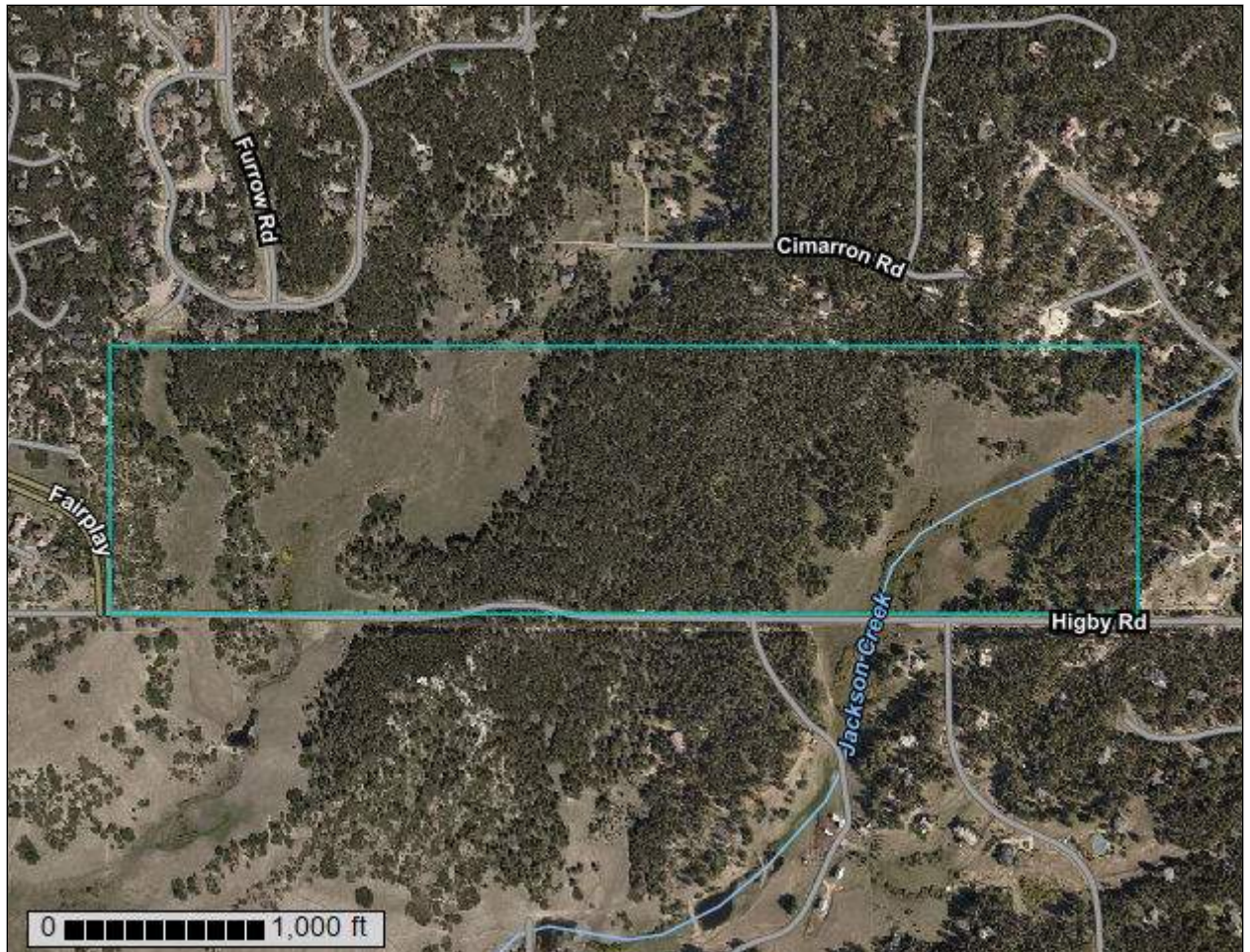
United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

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

Custom Soil Resource Report for El Paso County Area, Colorado



Preface

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

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

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

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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How Soil Surveys Are Made

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

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

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

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

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

Custom Soil Resource Report

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

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

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

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

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

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

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

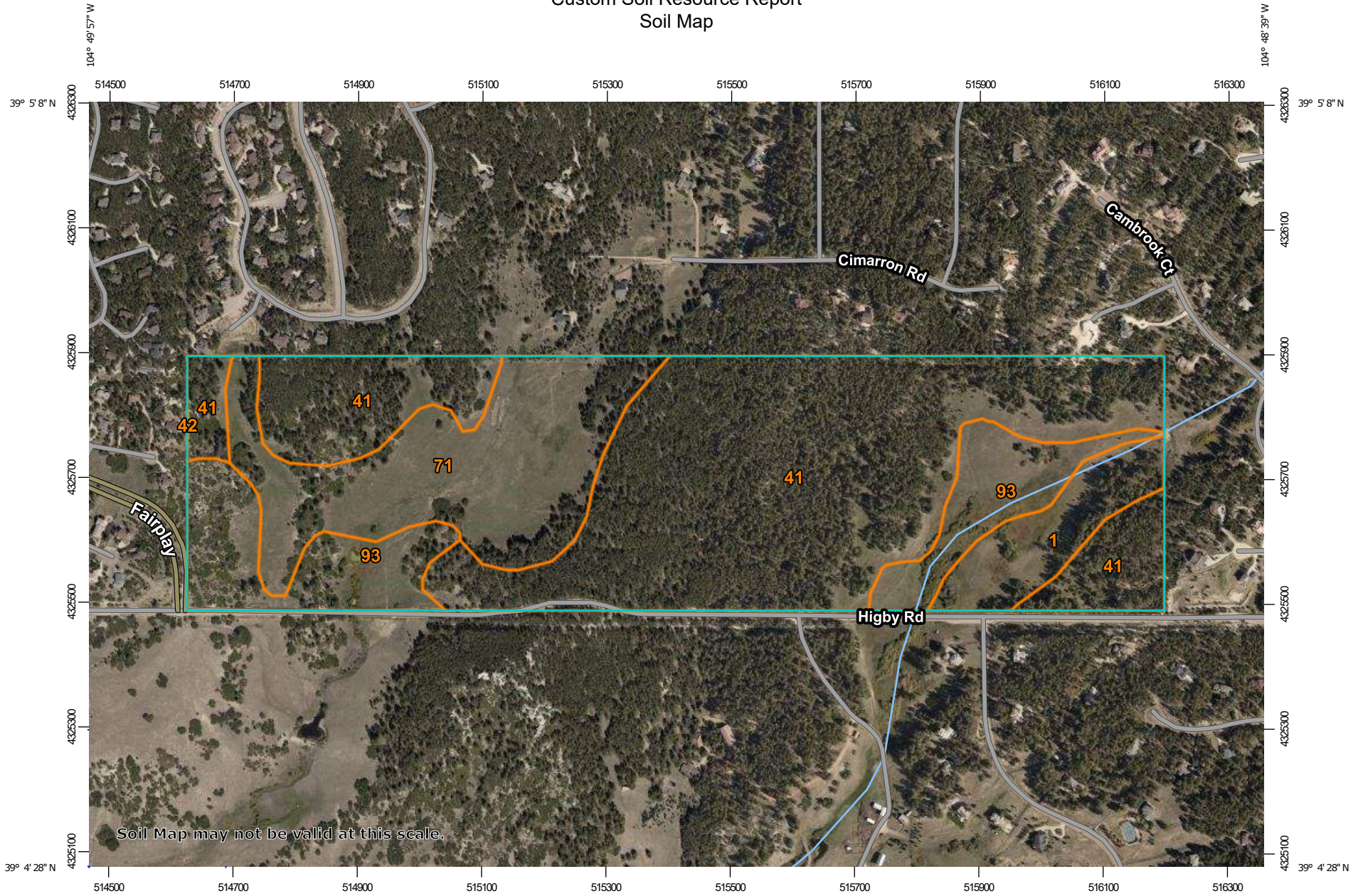
Custom Soil Resource Report

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

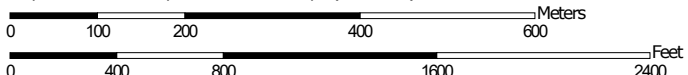
Soil Map

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

Custom Soil Resource Report Soil Map






































Map Scale: 1:8,640 if printed on A landscape (11" x 8.5") sheet.



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

MAP LEGEND

Area of Interest (AOI)			Spoil Area
	Area of Interest (AOI)		Stony Spot
Soils			Very Stony Spot
	Soil Map Unit Polygons		Wet Spot
	Soil Map Unit Lines		Other
	Soil Map Unit Points		Special Line Features
Special Point Features		Water Features	
	Blowout		Streams and Canals
	Borrow Pit	Transportation	
	Clay Spot		Rails
	Closed Depression		Interstate Highways
	Gravel Pit		US Routes
	Gravelly Spot		Major Roads
	Landfill		Local Roads
	Lava Flow	Background	
	Marsh or swamp		Aerial Photography
	Mine or Quarry		
	Miscellaneous Water		
	Perennial Water		
	Rock Outcrop		
	Saline Spot		
	Sandy Spot		
	Severely Eroded Spot		
	Sinkhole		
	Slide or Slip		
	Sodic Spot		

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 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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	10.1	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	91.6	57.5%
42	Kettle-Rock outcrop complex	0.0	0.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	33.4	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	24.2	15.2%
Totals for Area of Interest		159.3	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.

Custom Soil Resource Report

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

Natural 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: Frequent

Frequency of ponding: None

Calcium carbonate, maximum in profile: 5 percent

Salinity, maximum in profile: Very slightly saline to strongly saline (2.0 to 16.0 mmhos/cm)

Available water storage in profile: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 5w

Hydrologic Soil Group: D

Ecological site: Mountain Meadow (R048AY241CO)

Hydric soil rating: Yes

Minor Components

Other soils

Percent of map unit:

Hydric soil rating: No

41—Kettle gravelly loamy sand, 8 to 40 percent slopes

Map Unit Setting

National map unit symbol: 368h
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Kettle

Setting

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

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
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 storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:

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Landform: Depressions
Hydric soil rating: Yes

42—Kettle-Rock outcrop complex

Map Unit Setting

National map unit symbol: 368j
Elevation: 6,800 to 7,700 feet
Frost-free period: 110 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 60 percent
Rock outcrop: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

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

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
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 storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Description of Rock Outcrop

Typical profile

R - 0 to 60 inches: unweathered bedrock

Properties and qualities

Slope: 8 to 60 percent

Depth to restrictive feature: 0 inches to lithic bedrock

Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 8s

Hydrologic Soil Group: D

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

Natural drainage class: Well drained

Custom Soil Resource Report

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 storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B

Ecological site: Loamy Park (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

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

Custom Soil Resource Report

C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural 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 storage in profile: 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: Sandy Divide (R049BY216CO)

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: 8 to 15 percent

Depth to restrictive feature: More than 80 inches

Natural 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 storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: B

Ecological site: Sandy Divide (R049BY216CO)

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 Physical Properties

Soil Physical Properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

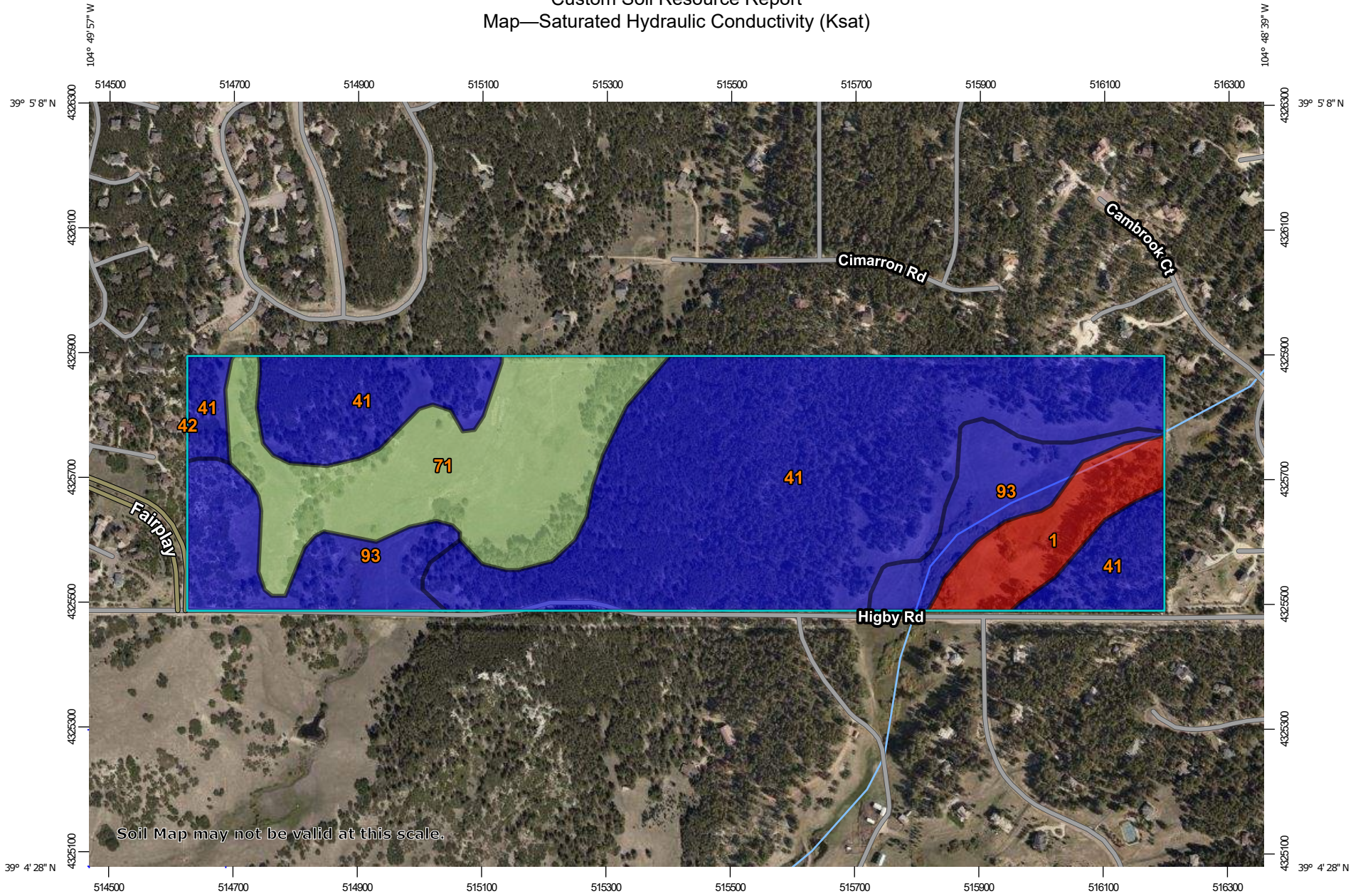
Saturated Hydraulic Conductivity (Ksat)

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Custom Soil Resource Report Map—Saturated Hydraulic Conductivity (Ksat)



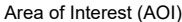



















Map Scale: 1:8,640 if printed on A landscape (11" x 8.5") sheet.

0 100 200 400 600 Meters

0 400 800 1600 2400 Feet

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

MAP LEGEND

- Area of Interest (AOI)**
 Area of Interest (AOI)
- Background**
 Aerial Photography
- Soils**
 - Soil Rating Polygons**
 -  <= 9.0000
 -  > 9.0000 and <= 28.0000
 -  > 28.0000 and <= 92.0000
 -  Not rated or not available
 - Soil Rating Lines**
 -  <= 9.0000
 -  > 9.0000 and <= 28.0000
 -  > 28.0000 and <= 92.0000
 -  Not rated or not available
 - Soil Rating Points**
 -  <= 9.0000
 -  > 9.0000 and <= 28.0000
 -  > 28.0000 and <= 92.0000
 -  Not rated or not available
- Water Features**
 Streams and Canals
- Transportation**
 -  Rails
 -  Interstate Highways
 -  US Routes
 -  Major Roads
 -  Local Roads

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 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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—Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	9.0000	10.1	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	92.0000	91.6	57.5%
42	Kettle-Rock outcrop complex	92.0000	0.0	0.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	28.0000	33.4	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	92.0000	24.2	15.2%
Totals for Area of Interest			159.3	100.0%

Rating Options—Saturated Hydraulic Conductivity (Ksat)

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

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.

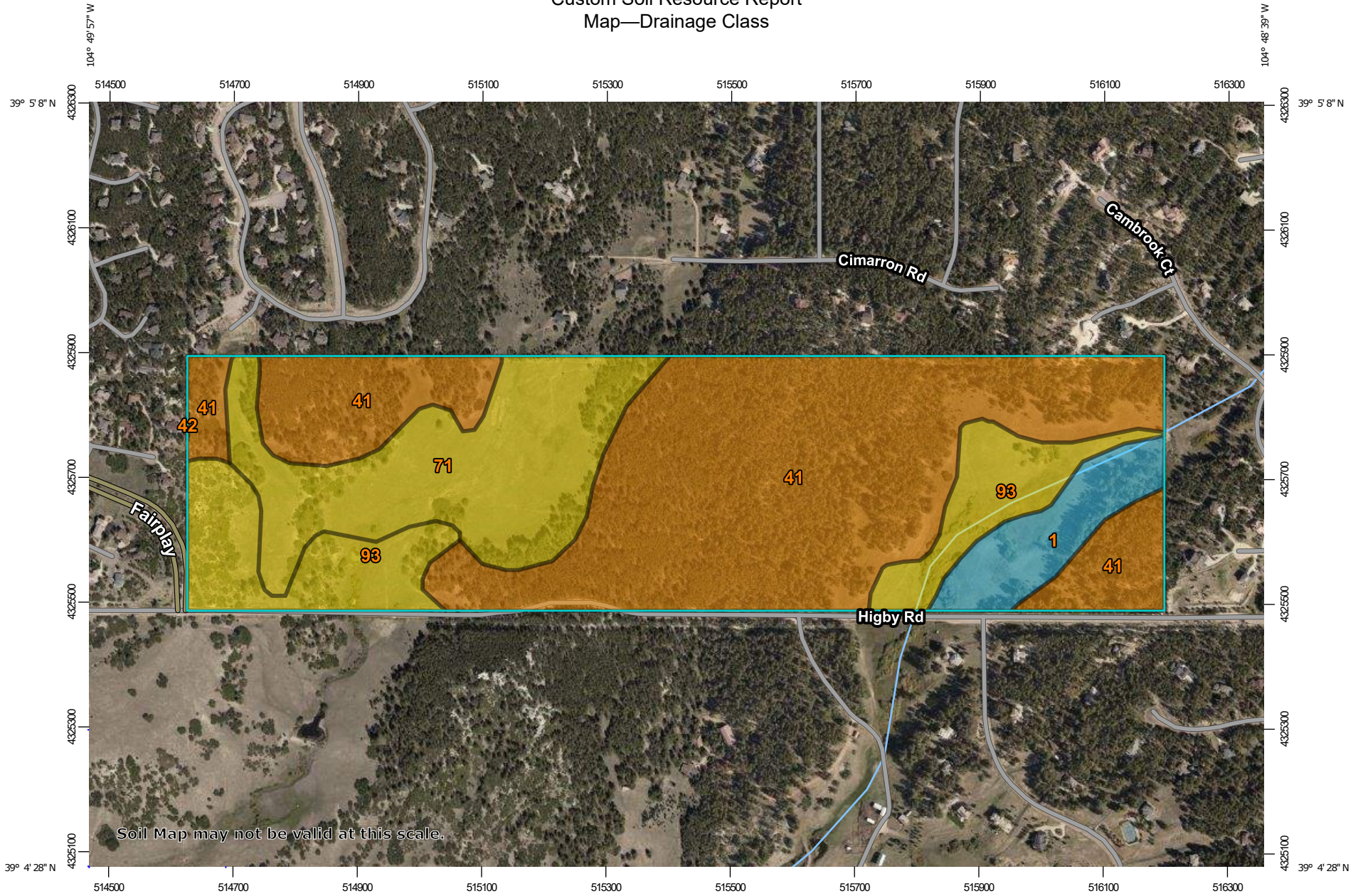
Drainage Class

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained,

Custom Soil Resource Report

somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Custom Soil Resource Report Map—Drainage Class



Map Scale: 1:8,640 if printed on A landscape (11" x 8.5") sheet.




































0 100 200 400 600 Meters

0 400 800 1600 2400 Feet

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**
 -  Excessively drained
 -  Somewhat excessively drained
 -  Well drained
 -  Moderately well drained
 -  Somewhat poorly drained
 -  Poorly drained
 -  Very poorly drained
 -  Subaqueous
 -  Not rated or not available
 - Soil Rating Lines**
 -  Excessively drained
 -  Somewhat excessively drained
 -  Well drained
 -  Moderately well drained
 -  Somewhat poorly drained
 -  Poorly drained
 -  Very poorly drained
 -  Subaqueous
 -  Not rated or not available
 - Soil Rating Points**
 -  Excessively drained
 -  Somewhat excessively drained
 -  Well drained
 -  Moderately well drained
 -  Somewhat poorly drained
 -  Poorly drained
 -  Very poorly drained
 -  Subaqueous
 -  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.

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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)

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Soil Survey Area: El Paso County Area, Colorado
 Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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Table—Drainage Class

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	Poorly drained	10.1	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	Somewhat excessively drained	91.6	57.5%
42	Kettle-Rock outcrop complex	Somewhat excessively drained	0.0	0.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	Well drained	33.4	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	Well drained	24.2	15.2%
Totals for Area of Interest			159.3	100.0%

Rating Options—Drainage Class

Aggregation Method: Dominant Condition
Component Percent Cutoff: None Specified
Tie-break Rule: Higher

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

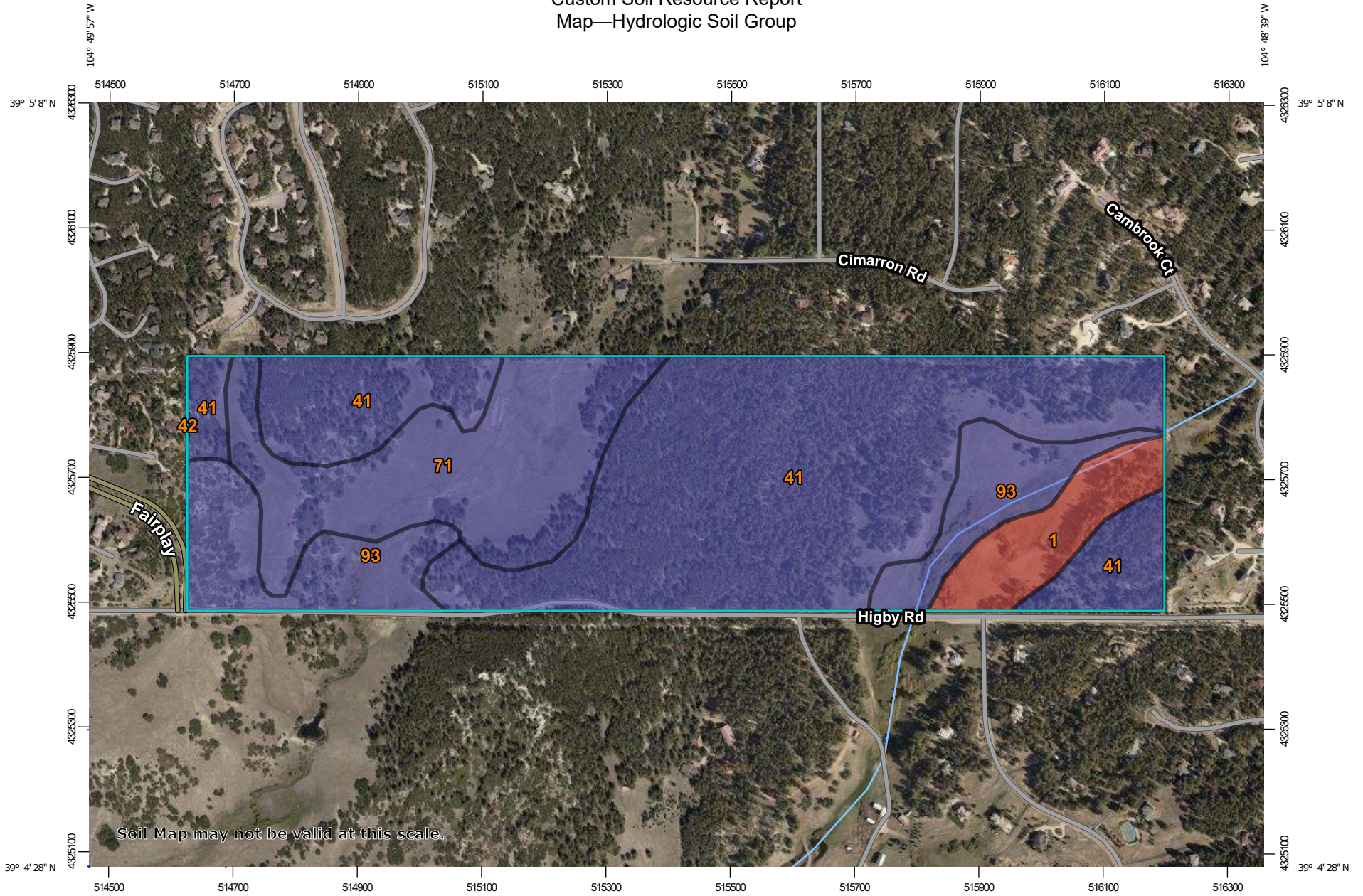
Custom Soil Resource Report

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.

Custom Soil Resource Report Map—Hydrologic Soil Group


































Map Scale: 1:8,640 if printed on A landscape (11" x 8.5") sheet.



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



MAP LEGEND

- Area of Interest (AOI)**
 -  C
 -  C/D
 -  D
 -  Not rated or not available
- 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
- Water Features**
 -  Streams and Canals
- Transportation**
 -  Rails
 -  Interstate Highways
 -  US Routes
 -  Major Roads
 -  Local Roads
- Background**
 -  Aerial Photography

MAP INFORMATION

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 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

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 Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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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	10.1	6.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	91.6	57.5%
42	Kettle-Rock outcrop complex	B	0.0	0.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	33.4	20.9%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	24.2	15.2%
Totals for Area of Interest			159.3	100.0%

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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Custom Soil Resource Report

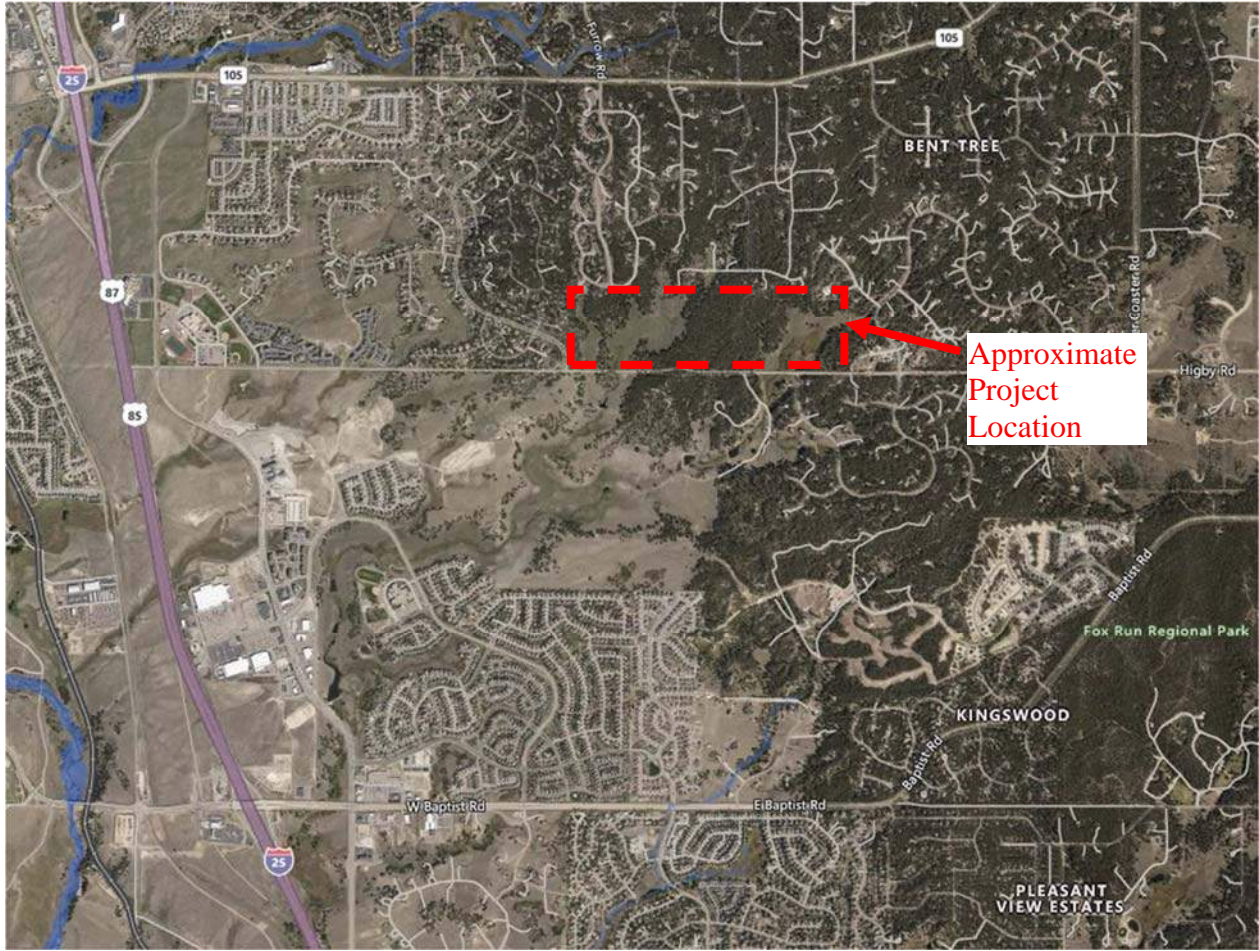
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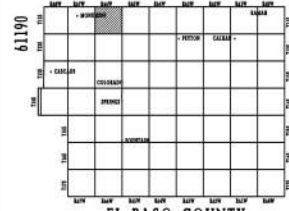
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APPENDIX D

MAPS



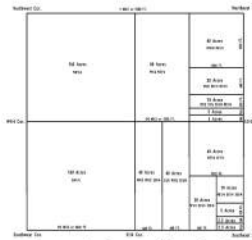
Vicinity Map
Grandwood Ranch Subdivision



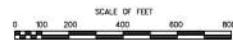
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7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36

ONE TOWNSHIP

ASSESSOR



December 30, 2019

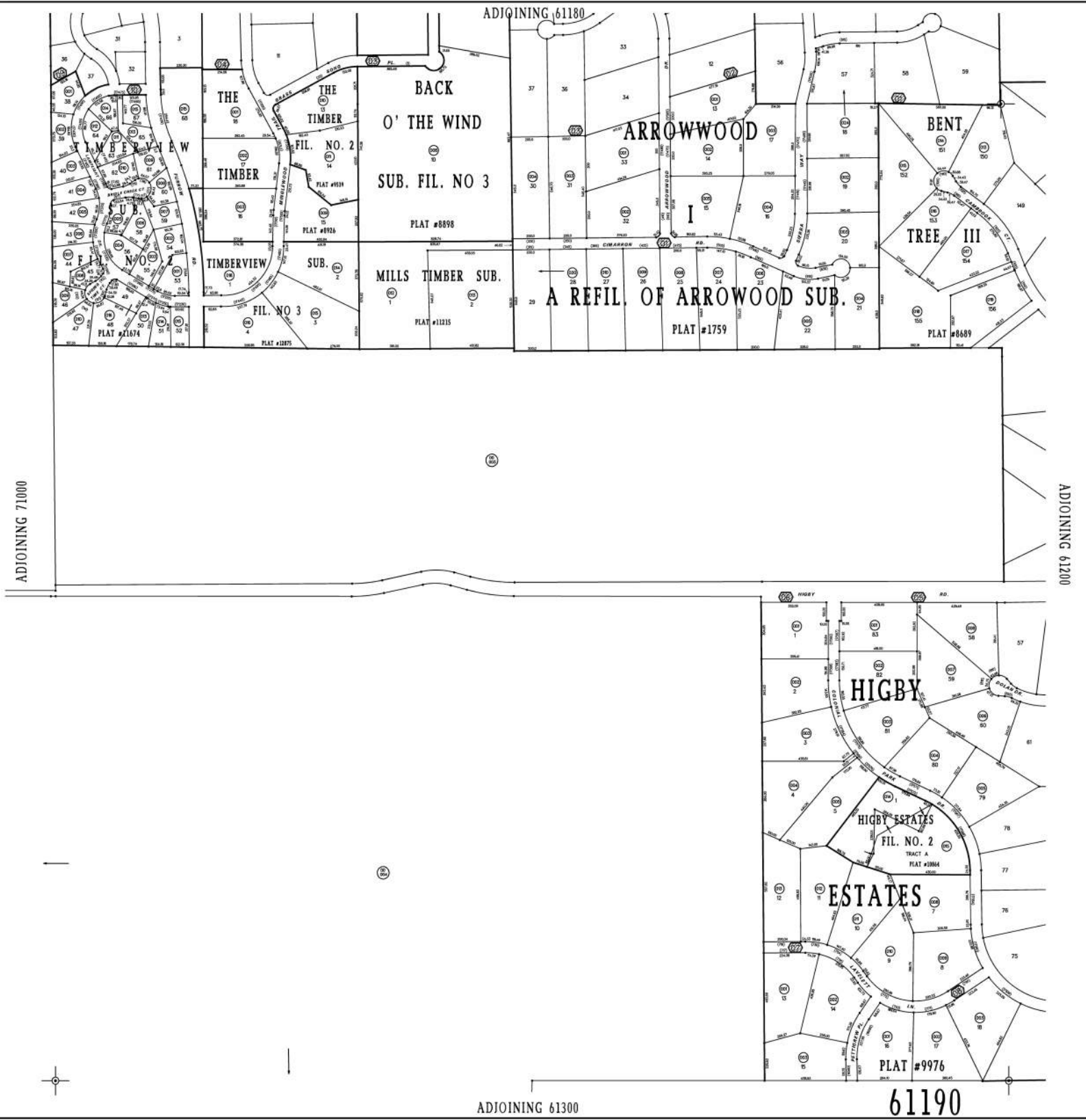


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 IS SUBJECT TO CHANGE



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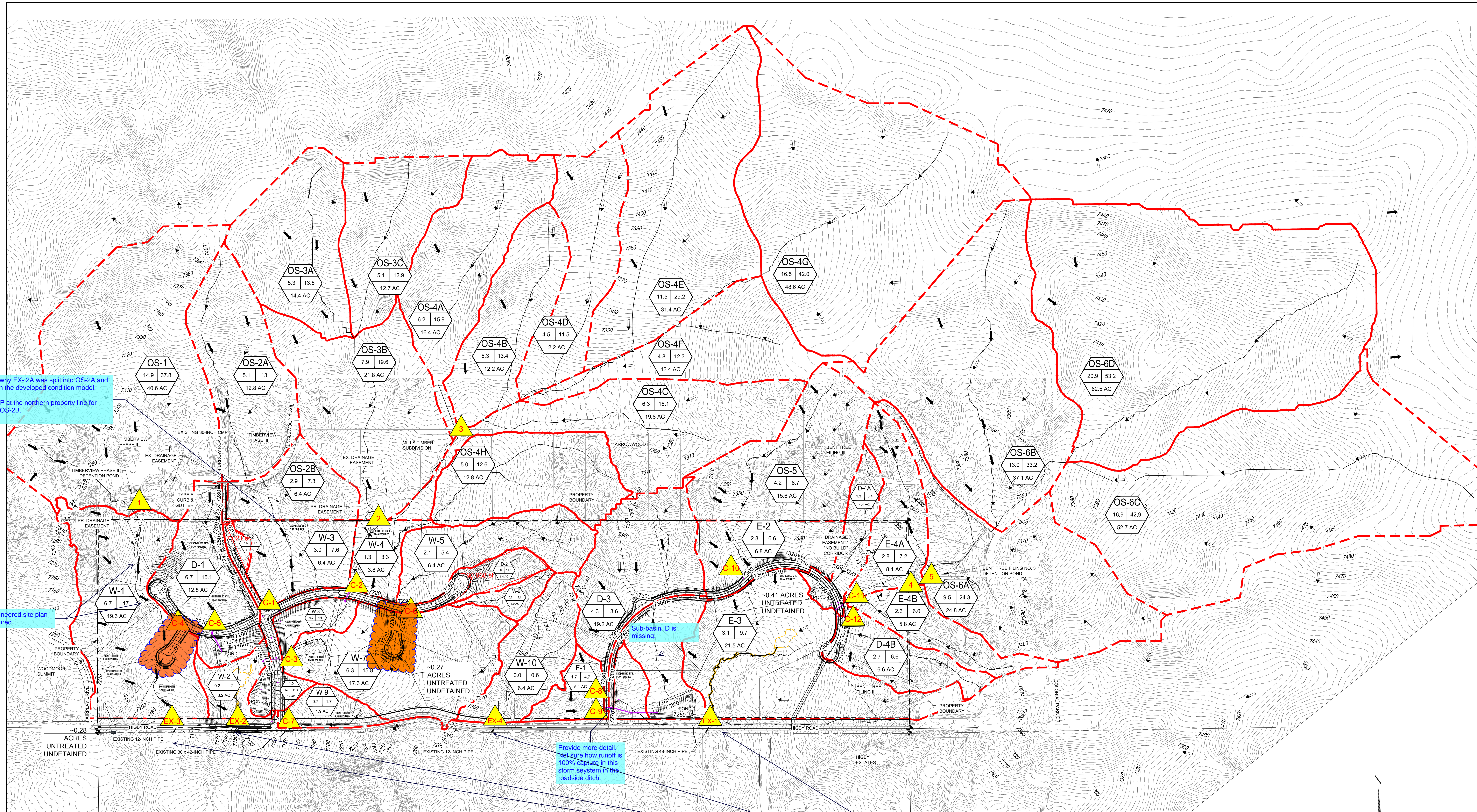
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FILE NAME: S:\20.1105.004 Grandwood Ranch\200 Drainage\Reports\FDR\Working\20.1105-FR-DRAINAGE EXHIBIT PR Paths CHECK.dwg
CTB FILE: April 10, 2020 3:51:50 PM
PLOT DATE: April 10, 2020 3:51:50 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.



Explain why EX- 2A was split into OS-2A and OS-2B in the developed condition model.
Add a DP at the northern property line for OS-2A+OS-2B.

Engineered site plan required.

Provide more detail. Make sure how runoff is 100% captured in this storm system in the roadside ditch.

Revise DP2 to include BP 3. Flows from DP 3 merges near the northern property. Hydraulic analysis for the existing swale downstream of DP2 should be the combined flow of DP2+DP3.

Main concern for staff is that large portions of the site is undetained. Provide computation and summary table in the drainage report for the culverts along Higby Road for both the existing and developed condition. The summary table shall identify the flow rates at these design points for the full range of design storms. The purpose is to show release rate downstream remains equal to or less than pre-development.

Double check drainage model. Developed condition for DP-3 is likely to be an increase in runoff from historic condition given the assumed 11% imperviousness of the cul-de-sac road. Similar comment for EX1 and EX4.

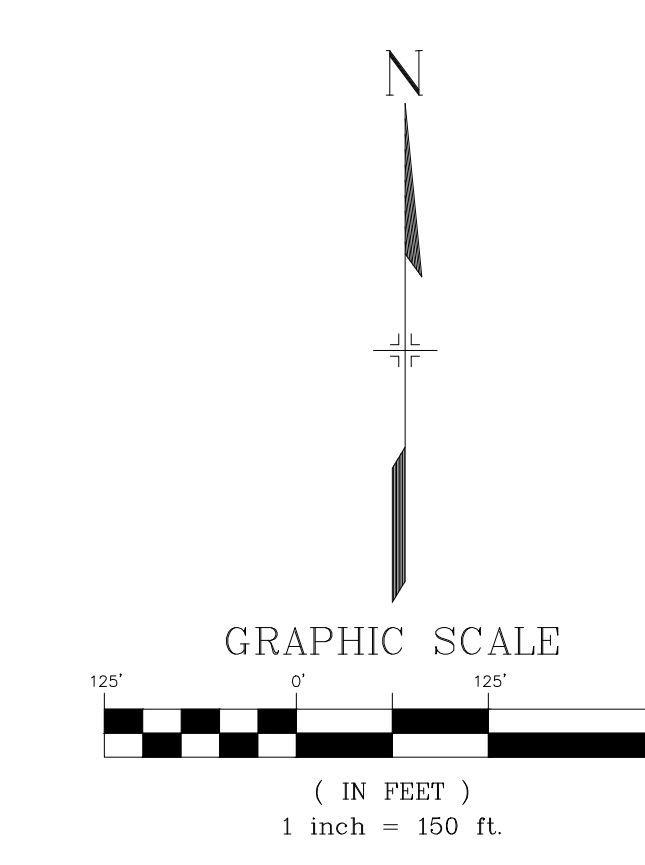
Discharge from the development must be at or below historic at all the ultimate design points along Higby Rd

Sub Basins - West			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
OS-1	40.6	14.9	37.8
OS-2A	12.8	5.1	13
OS-2B	6.4	2.9	7.3
OS-3A	14.4	5.3	13.5
OS-3B	21.8	7.9	19.6
OS-3C	12.7	5.1	12.9
OS-4A	16.4	6.2	15.9
OS-4B	12.2	5.3	13.4
OS-4C	19.8	6.3	16.1
OS-4D	12.2	4.5	11.5
OS-4E	11.5	4.8	12.3
OS-4F	13.4	5.3	13.4
OS-4G	48.6	16.5	42
OS-4H	12.8	5.0	12.6
OS-5	15.6	4.2	8.7
OS-6A	37.1	13	33.2
OS-6B	16.9	42.9	52.7
OS-6C	20.9	53.2	62.5
OS-6D	62.5	20.9	53.2
W-1	19.3	6.7	17
W-2	3.2	0.2	1.2
W-3	6.4	3	7.6
W-4	3.8	1.3	3.3
W-5	6.4	2.1	5.4
W-6	1.9	0.8	2.1
W-7	17.3	6.3	15.8
W-8	2.5	0.9	4.6
W-9	1.9	0.7	1.7
W-10	12.8	6.7	15.1
D-1	12.8	6.7	15.1
D-2	6.4	6	11.5

Sub Basins - East			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
OS-5	15.6	4.2	8.7
OS-6A	24.7	9.5	24.3
OS-6B	37.0	13	33.2
OS-6C	52.7	16.9	42.9
OS-6D	62.5	20.9	53.2
E-1	5.1	1.7	4.7
E-2	6.8	2.8	6.6
E-3	21.5	3.1	9.7
E-4A	8.0	2.8	7.2
E-4B	5.8	2.3	6
D-3	19.2	4.3	13.6
D-4A	4.4	1.3	3.4
D-4B	6.6	2.7	6.6

Sub Basins - Central			
Sub-Basin	Area (Acres)	Q5 (cfs)	Q100 (cfs)
W-10	6.4	0	0.6

Design Point	Name in HMS	Sub-Basins	Downstream Design Point	Total Area (Ac)	Q5	Q100
1	Reservoir OS-1	OS-1	EX-3	40.6	13.3	29.1
2	Junction OS-3	OS-3A, OS-3B, OS-3C	C-2	48.8	15.6	39
3	Upper Junction	OS-4B, OS-4C, OS-4D, OS-4E, OS-4F, OS-4G	C-2	137.6	44.9	114.3
4	Reservoir OS-5			177.1	9.7	59.3
5	OS-5 inflow			177.1	52.3	132.7
C-1	Junction C-1	OS-2A, OS-2B, W-3	C-3	25.6	7.1	18
C-2	Junction C-2	W-4, Design Point 2, OS-4A, Design Point 3, OS-4H, W-5	C-3	225.9	53.9	136
C-3	Junction C-3	W-8, Design Point C-1, Design Point C-2, W-6, W-7	EX-2	270.7	56.7	142.5
C-4		D-1	EX-2	12.8	6.7	15.1
C-5		D-1	EX-2	12.8	6.7	15.1
C-6		D-2	EX-2	6.4	6	11.5
C-7		W-9	EX-2	1.9	0.7	1.7
C-8		E-1	EX-3	13.2	1.7	4.7
C-9		D-3	EX-3	19.2	4.3	13.6
C-10		OS-5, E-2	EX-3	22.5	6.7	17.1
C-11		E-4A, E-4B, Design Point 4	EX-3	191.0	10.2	61
C-12		D-4B	EX-1	6.6	2.7	6.6
EX-1	Sink-1	E-1A, Pond 3, C-10	Existing Swale	270.3	17.4	65.6
EX-2	Sink-2	W-2, Pond 1, Design Point C-3, Pond 2, W-9	Existing Swale	295.0	58	143.7
EX-3	Sink-3	Design Point 1, W-1	Existing Swale	59.9	16.3	35.6
EX-4	Sink-4	Basin C-1	Existing Swale	6.4	2.5	6.3



LEGEND

- DESIGN POINT IDENTIFIER:
- BASIN IDENTIFICATION:
- BASIN AREA:
- BASIN BOUNDARY:
- FLOW PATH:
- EXISTING CONTOURS:
- PROPOSED CONTOURS:

