



Timbers of Black Forest Subdivision No. 1

Final Drainage Report

PCD File No:

All Terrain Engineering Project No: 25021

July 2026

Prepared for:

Timbers of Black Forest Subdivision 2025, LLC

Attn: Michael Turner

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Prepared by:

All Terrain Engineering LLC

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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.

07/31/2026

Nicholas Q. Jokerst, PE

Date

State of Colorado No. 59273

For and on behalf of All Terrain Engineering LLC

DEVELOPER'S STATEMENT

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

Michael Turner

Date

EL PASO COUNTY ONLY

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

Joshua J. Palmer, P.E.

Date

County Engineer/ECM Administrator

Conditions:



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I. General Purpose, Location & Description

a. Purpose & Project Description

The purpose of the Final Drainage Report (FDR) for the Timbers of Black Forest Subdivision No. 1 is to describe the site's onsite and offsite drainage patterns, existing and proposed storm infrastructure, and to safely route developed stormwater to adequate outfalls.

b. Location

Timbers of Black Forest Subdivision No. 1, referred to as 'the site' herein, is Parcel 2 of Timberline East being a portion of the Southwest Quarter of Section 22, Township 12 South, Range 65 West of the 6th P.M. The site is bound by unplatted land to the north and west, Retreat at Timberridge Filing 4 to the east and Arroyo Lane to the south. A vicinity map is presented in Appendix A.

c. Description of Property

- d. The Timbers of Black Forest Subdivision No. 1, referred to as the site herein, is a 55.7 acre parcel in El Paso County, CO. The project will subdivide the site into (21) 2.5 acre lots. To support the addition, a private, paved road, drainage infrastructure and a full spectrum water quality and detention pond are proposed. The current property includes a single residence and associated structures.

In general, the site slopes south and west towards Sand Creek. Onsite elevations range from 7240' – 7380' with slopes ranging 1 – 50%. Per an NRCS soil survey, the site is made up of Type B Kettle gravelly loamy sand and Pring coarse sandy loam. Sand Creek is located along the site's western boundary. On-site, existing utilities include water, sewer, irrigation, gas, communications and electric. An existing drainage map is presented in Appendix F.

The ultimate receiving waters for the site are Sand Creek.

e. Floodplain Statement

Based on FEMA Firm map 08041C0535G dated December 7, 2018, the site is Zone X, which are areas determined to be outside the 0.2% annual chance flood.

II. Drainage Basins

a. Major Basin Description

The site is located within the Sand Creek Drainage Basin. The DBPS determined the need for 6' x 12' concrete box culverts at the Arroyo Lane and Sand Creek crossing. These improvements have been completed.

b. Existing Subbasin Description

The existing site's drainage patterns are south and west. The existing site is divided into 6 existing drainage basins.

Basin OS1 is 345.6 acres of offsite area. Due to the large extents of this basin, USGS Streamstats is utilized to determine stormwater flow from Basin OS1. The Streamstats report is presented in Appendix E. Basin OS1 stormwater ($Q_5 = 24.3$ cfs $Q_{100} = 149$ cfs) is captured in an offsite channel and discharges into the existing stock pond at DP1. Based on field survey, there is not an outlet structure located within the stock pond. If the stock pond fills, flow overtops the western berm to an existing channel towards Sand Creek.

Basin EXA1 is 18.16 acres of onsite and offsite undeveloped area. Basin EXA1 stormwater ($Q_5 = 4.0$ cfs $Q_{100} = 27.0$ cfs) is conveyed west to the existing stock pond via an offsite channel to the north of the site. At DP1 ($Q_5 = 29.7$ cfs $Q_{100} = 184$ cfs), Basin EXA1, Basin EXA2 and Basin OS1 combine within the stock pond. DP1 flows west in an existing channel to DP2.

Basin EXA2 is 10.68 acres of onsite undeveloped area, gravel driveway and structures. Basin EXA2 stormwater ($Q_5 = 2.1$ cfs $Q_{100} = 13.1$ cfs) is conveyed west to the existing stock pond via an existing drainage swale. At DP1 ($Q_5 = 29.7$ cfs $Q_{100} = 184$ cfs), Basin EXA1, Basin EXA2 and Basin OS1 combine within the stock pond. DP1 flows west in an existing channel to DP2.

Basin EXB is 7.10 acres of undeveloped area. Basin EXB stormwater ($Q_5 = 1.9$ cfs $Q_{100} = 13.0$ cfs) is conveyed west in an existing channel to DP2 ($Q_5 = 28.3$ cfs $Q_{100} = 181$ cfs) at the confluence with Sand Creek. At DP2, Basin EXB combines with DP1 flow. DP2 continues south within Sand Creek towards Arroyo Lane.

Basin EXC is 22.32 acres of undeveloped area, existing gravel roadway and existing structures. Basin EXC stormwater ($Q_5 = 4.1$ cfs $Q_{100} = 23.8$ cfs) sheet flows south across the basin to DP3 ($Q_5 = 28.7$ cfs $Q_{100} = 180.1$ cfs) within Sand Creek. At DP3, Basin EXC combines with DP2 flow. DP3 flows south within Sand Creek under Arroyo Lane in existing, twin 6' x 12' concrete box culverts.

Basin EXD is 3.44 acres of onsite and offsite undeveloped area. Basin EXD stormwater ($Q_5 = 0.7$ cfs $Q_{100} = 5.0$ cfs) collects in an existing swale and flows south to DP4 ($Q_5 = 0.7$ cfs $Q_{100} = 5.0$ cfs). DP4 continues south into Basin EXE.

Basin EXE is 5.47 acres of onsite and offsite undeveloped area. Basin EXE stormwater ($Q_5 = 1.2$ cfs $Q_{100} = 7.7$ cfs) collects in an existing swale and flows south to DP5 ($Q_5 = 1.8$ cfs $Q_{100} = 12.3$ cfs) where it combines with DP4. DP5 continues south into Basin EXF.

Basin EXF is 2.71 acres of onsite and offsite undeveloped area. Basin EXF stormwater ($Q_5 = 0.6$ cfs $Q_{100} = 4.0$ cfs) collects in an existing swale and flows south to DP6 ($Q_5 = 2.3$ cfs $Q_{100} = 15.2$ cfs) where it combines with DP5. DP6 follows historic drainage patterns into Retreat at Timberridge Filing 4. In the FDR for Retreat at Timberridge Filing 4, Basins EXD-EXF were identified as Basin OS-2. Basin OS-2 flow was calculated at $Q_5 = 3.0$ cfs $Q_{100} = 16.0$ cfs.

Basin EXG is 6.33 acres of onsite undeveloped area. Basin EXG stormwater ($Q_5 = 1.3$ cfs $Q_{100} = 8.8$ cfs) collects in an existing swale and flows south to DP7 ($Q_5 = 1.3$ cfs $Q_{100} = 8.8$ cfs) where it combines with DP5. DP7 follows historic drainage patterns into Retreat at Timberridge Filing 4. In the FDR for Retreat at Timberridge Filing 4, Basins EXG was identified as Basin OS-1A. Basin OS1-A flow was calculated at $Q_5 = 1$ cfs $Q_{100} = 9$ cfs.

Basin EXF2 is 0.30 acres of offsite, undeveloped area. Basin EXF2 stormwater ($Q_5 = 0.1$ cfs $Q_{100} = 0.2$ cfs) flows south to DP12 ($Q_5 = 0.2$ cfs $Q_{100} = 0.3$ cfs). DP12 follows historic drainage patterns south to Retreat at Timber Ridge Filing 4.

c. Proposed Subbasin Description

Basin A1 is 18.16 acres of proposed 2.5 acre lots and offsite undeveloped area. Basin A1 stormwater ($Q_5 = 4.5$ cfs $Q_{100} = 28.0$ cfs) is conveyed west to the existing stock pond via an offsite channel to the north of the site. At DP1 ($Q_5 = 30.4$ cfs $Q_{100} = 185.5$ cfs), Basin A1, Basin A2 and Basin OS1 combine within the stock pond. Assuming the stock pond overtops, DP1 continues west in an existing channel to DP2.

Basin A2 is 10.79 acres of proposed 2.5 acre lots. Basin A2 stormwater ($Q_5 = 2.4$ cfs $Q_{100} = 13.9$ cfs) is conveyed west to the existing stock pond via an existing drainage swale. At DP1 ($Q_5 = 30.4$ cfs $Q_{100} = 185.5$ cfs), Basin A1, Basin A2 and Basin OS1 combine within the stock pond. Assuming the stock pond overtops, DP1 continues west in an existing channel to DP2.

Basin B is 7.08 acres of proposed 2.5 acre lots. Basin EXB stormwater ($Q_5 = 2.6$ cfs $Q_{100} = 4.2$ cfs) is conveyed west in an existing channel to DP2 ($Q_5 = 30.1$ cfs $Q_{100} = 182.7$ cfs) at the confluence with Sand Creek. At DP2, Basin B combines with DP1 flow. DP2 continues south within Sand Creek to DP3 at Arroyo Lane.

Basin C is 8.65 acres of proposed 2.5 acre lots and undeveloped portions of Sand Creek. Basin C stormwater ($Q_5 = 2.4$ cfs $Q_{100} = 13.1$ cfs) is captured directly in Sand Creek at DP3 ($Q_5 = 29.4$ cfs $Q_{100} = 199.5$ cfs). At DP3, Basin E combines with DP2 flow. DP3 flows south within Sand Creek under Arroyo Lane in existing, twin 6' x 12' concrete box culverts.

Basin D is 3.43 acres of proposed 2.5 acre lots and offsite, undeveloped area. Basin D stormwater ($Q_5 = 0.9$ cfs $Q_{100} = 5.3$ cfs) collects in an existing swale and flows south to DP4 ($Q_5 = 0.9$ cfs $Q_{100} = 5.3$ cfs). DP4 continues south into Basin E towards DP5.

Basin E is 5.47 acres of proposed 2.5 acre lots and offsite, undeveloped area. Basin E stormwater ($Q_5 = 1.4$ cfs $Q_{100} = 8.1$ cfs) collects in an existing swale and flows south to DP5 ($Q_5 = 2.2$ cfs $Q_{100} = 13.03$ cfs) where it combines with DP4. DP5 continues south into Basin F towards DP6.

Basin F is 2.65 acres of proposed 2.5 acre lots and offsite, undeveloped area. Basin F stormwater ($Q_5 = 0.8$ cfs $Q_{100} = 4.3$ cfs) collects in an existing swale and flows south to DP6 ($Q_5 = 2.7$ cfs $Q_{100} = 16.1$ cfs) where it combines with DP5. DP6 continues southwest in a proposed, grass lined swale to DP7.

Basin F2 is 0.30 acres of offsite, undeveloped area. Basin F2 stormwater ($Q_5 = 0.2$ cfs $Q_{100} = 0.3$ cfs) flows south to DP12 ($Q_5 = 0.2$ cfs $Q_{100} = 0.3$ cfs). DP12 follows historic drainage patterns south to Retreat at Timber Ridge Filing 4. Basin F2 is in conformance with The Retreat at Timber Ridge Filing 4 Basin OS-3 ($Q_5 = 1$ cfs $Q_{100} = 5$ cfs).

Basin G is 8.22 acres of proposed 2.5 acre lots. Basin G stormwater ($Q_5 = 2.0$ cfs $Q_{100} = 11.1$ cfs) collects in a proposed, grass lined swale to DP7 ($Q_5 = 4.6$ cfs $Q_{100} = 23.2$ cfs) and combines with DP6 & Basin I. DP7 continues south into Basin K towards DP8.

Basin H is 3.22 acres of proposed 2.5 acre lots and private roadway. Basin H stormwater ($Q_5 = 1.3$ cfs $Q_{100} = 8.8$ cfs) collects in a proposed, roadside swale to DP7 ($Q_5 = 4.6$ cfs $Q_{100} = 23.2$ cfs) and combines with DP6 & Basin I. DP7 continues south into Basin K towards DP8.

Basin I is 1.51 acres of proposed 2.5 acre lots and private roadway. Basin I stormwater ($Q_5 = 1.6$ cfs $Q_{100} = 3.9$ cfs) collects in a proposed, roadside swale to DP7 ($Q_5 = 4.6$ cfs $Q_{100} = 23.2$ cfs) and combines with DP6 & Basin I. DP7 continues south into Basin K towards DP8.

Basin J is 1.11 acres of proposed 2.5 acre lots and Pond 1. Basin J stormwater ($Q_5 = 0.8$ cfs $Q_{100} = 3.0$ cfs) collects in Pond 1 at DP10 ($Q_5 = 6.1$ cfs $Q_{100} = 25.9$ cfs).

Basin K is 1.81 acres of proposed 2.5 acre lots and private roadway. Basin K stormwater ($Q_5 = 1.3$ cfs $Q_{100} = 4.4$ cfs) collects in a proposed, roadside swale to DP8 ($Q_5 = 4.6$ cfs $Q_{100} = 22.1$ cfs) and combines with DP7. DP8 is captured by a private, Type D inlet and piped to DP9.1.

Basin L is 4.00 acres of proposed 2.5 acre lots and private roadway. Basin L stormwater ($Q_5 = 1.5$ cfs $Q_{100} = 2.6$ cfs) collects in a proposed, roadside swale to DP11 ($Q_5 = 2.0$ cfs $Q_{100} = 4.1$ cfs) and combines with Retreat at Timber Ridge Filing 4 Basin OEX-4. DP11 is captured by a private 18" RCP culvert and piped under the private roadway towards DP3.

The site's existing composite impervious is 3%. In the proposed condition, the impervious increases to 8.0%. See below for a comparison of the site's increase in stormwater discharge.

EXISTING V. PROPOSED FLOW COMPARISON				
LOCATION	Ex Q_{5-YR}	Ex Q_{100-YR}	Pr Q_{5-YR}	Pr Q_{100-YR}
Ex DP3/Pr DP3	28.7	180.1	29.4	199.5
Ex DP8/Pr DP12	0.1	0.2	0.2	0.3

At DP3, the proposed condition represents a 2.4% and 7.6% increase in flow for the 5-year and 100-year scenarios, respectively. The increase in flow will have a negligible impact to downstream infrastructure.

At Existing DP8/Proposed DP12, the proposed conditions has a 100% and 50% increase in flow for the 5-year and 100-year scenarios, respectively. However, The Retreat at Timber Ridge Filing 4 Basin OS-3 accounted for this increase in flow in the developed condition.

Drainage Design Criteria

a. Development Criteria Reference

The drainage analysis follows the criteria from the “Drainage Criteria Manual County of El Paso, Colorado” Volumes 1 and 2,” as amended.

b. Hydrologic Criteria

Onsite drainage analysis included the 5-year storm (minor event) and 100-year storm (major event). Runoff is calculated per EPCDCM Chapter 5 – Storm Runoff Method of Analysis.

d. Hydraulic Criteria

Hydraulic criteria for channel analysis are obtained from EPCDCM Chapter 10 - Open Channels and Structures.

III. Drainage Facility Design

a. General Concept

The proposed site will be subdivided into (21) 2.5 acre lots served by a paved, private roadway. Stormwater will be collected via open channels and conveyed to Type D inlets. Captured stormwater will be piped to Pond 1. Pond 1 provides water quality & detention will for Basins D – K. All proposed storm sewer and appurtenances will be privately owned and maintained.

b. Water Quality & Detention

Water quality and detention for Basins D-K is provided in Pond 1. Pond 1 is an onsite, private, full spectrum detention pond located along adjacent to Sand Creek near the site’s entrance. A total of 27.71 acres at 12.4% composite imperviousness will be detained. The WQCV is 0.185 ac-ft, the EURV is 0.143 ac-ft, and the 100-year volume is 0.809 ac-ft. The WQCV, EURV and 100-year storms are released in 40, 58 and 58 hours, respectively. A concrete forebay is located at the outfall into the pond and a 2.0’ concrete trickle channel conveys flow towards the private outlet structure. A 10’ access and maintenance road is provided to the bottom of the pond to facilitate future maintenance. A 20’ emergency overflow spillway is provided that conveys the developed, peak 100-yr flow rate with 1.0’ of freeboard towards Sand Creek. The spillway and downstream outfall will be lined with Type VL riprap. The pond outlet structure discharges into private 30” RCP storm sewer that discharges to Sand Creek. Pond design calculations are presented in Appendix D.

c. Inspections & Maintenance

An Inspection and Maintenance Manual for Pond 1 will be provided with a subsequent submittal.

d. Grading & Erosion Control Plan

A Grading & Erosion Control Plan will be provided with a subsequent submittal.

e. Four Step Method

Step 1 – Employ Runoff Reduction Practices: Roof drains will discharge to landscaped areas. Implementation of landscaping and open space throughout the site will help slow runoff and increase infiltration. Additionally,

grass-lined swales are used as the primary stormwater conveyance method. Grass-lined swales allow for infiltration and reduce runoff velocities compared to storm sewer.

Step 2 – Stabilize Drainageways: All new and re-development projects are required to construct or participate in the funding of channel stabilization measures. Drainage basin fees paid, at the time of platting, go towards channel stabilization with the drainage basin. Refer to Section F below.

Step 3 – Provide WQCV: Water quality treatment is provided for Basin D - K in Pond 1. The water quality volume will be captured and released over a period of 40 hours.

Step 4 – Consider the need for source controls: No industrial uses are proposed within this development and therefore no source controls are proposed.

f. Drainage Basin & Bridge Fees

The site is within the Sand Creek Drainage Basin. Drainage basin and bridge fees are due at time of platting. The 2026 Sand Creek Basin Fee per impervious acre is \$28,160. The 2026 Sand Creek Bridge Fee is \$11,528. The total impervious site area is 4.5 acres.

Basin Fee: 4.5 acres x \$28,160/ac = \$126,720

Bridge Fee: 4.5 acres x \$11,528 = \$51,876

g. Engineer's Opinion of Probable Cost

An El Paso County 2026 Financial Assurance estimate is included in Appendix E.

IV. Summary

Timbers of Black Forest Subdivision No. 1 remains consistent with pre-development drainage conditions. The proposed development will not adversely affect downstream stormwater infrastructure or surrounding developments. This report is in accordance with the latest El Paso County Drainage criteria.

V. References

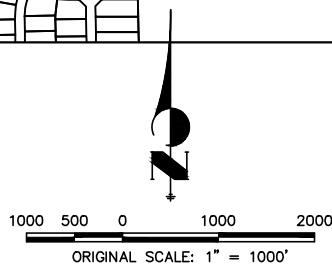
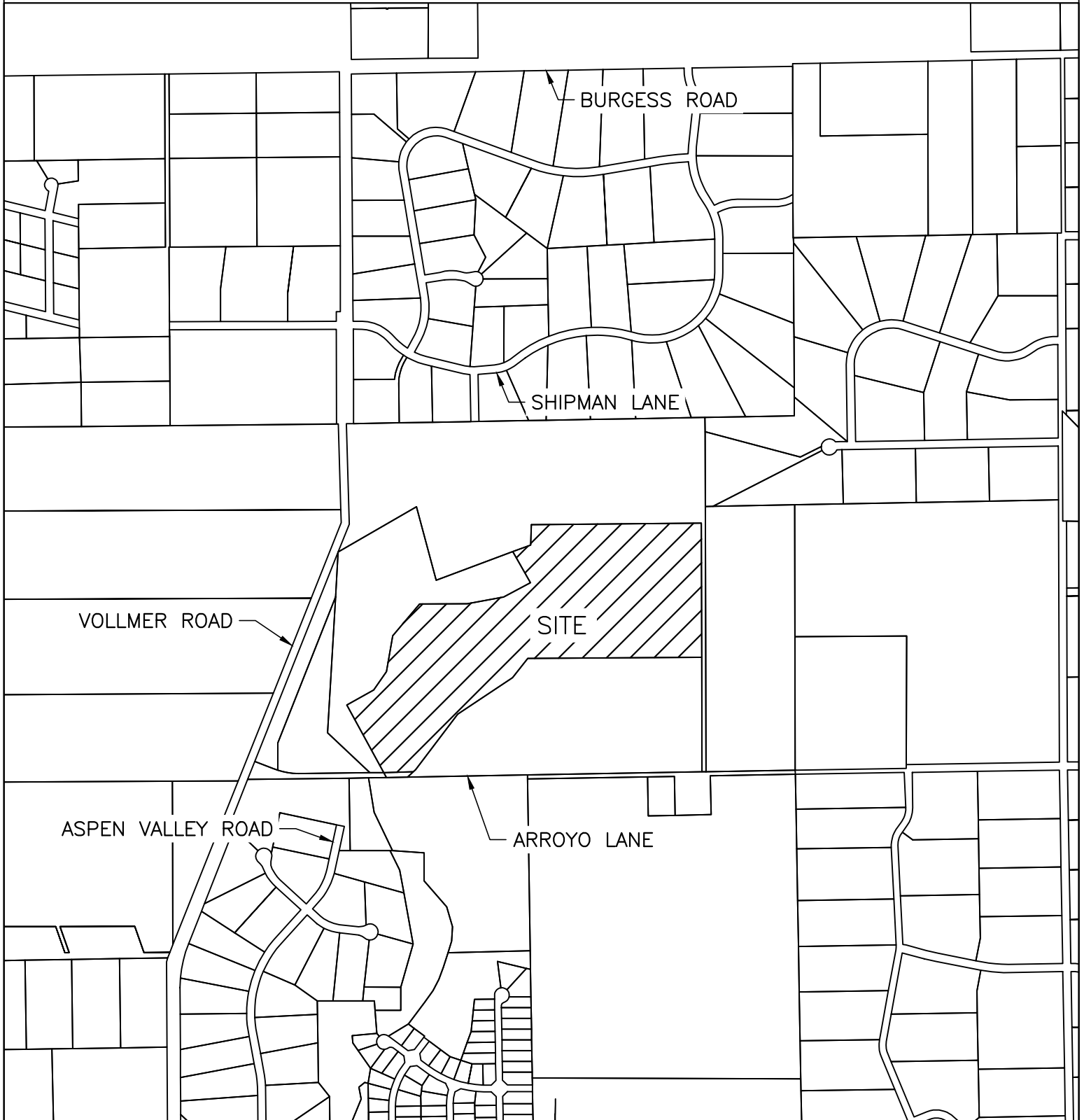
1. El Paso County – Drainage Criteria Manual, 2018 as amended.
2. Urban Storm Drainage Criteria Manual, Mile High Flood District, March 2024.
3. Federal Emergency Management Agency, Flood Map Service Center - <https://msc.fema.gov/portal/home>, September 2024.
4. Web Soil Survey, Natural Resources Conservation Service - <https://websoilsurvey.nrcs.usda.gov/app/>, September 2024.



APPENDIX A – VICINITY MAP, FEMA MAP, NRCS WEB SOIL SURVEY

TIMBERS SUBDIVISION

VICINITY MAP



VICINITY MAP

TIMBERS SUBDIVISION

JOB NO. 25021

LOCATION: EPC

06/29/2026

SHEET

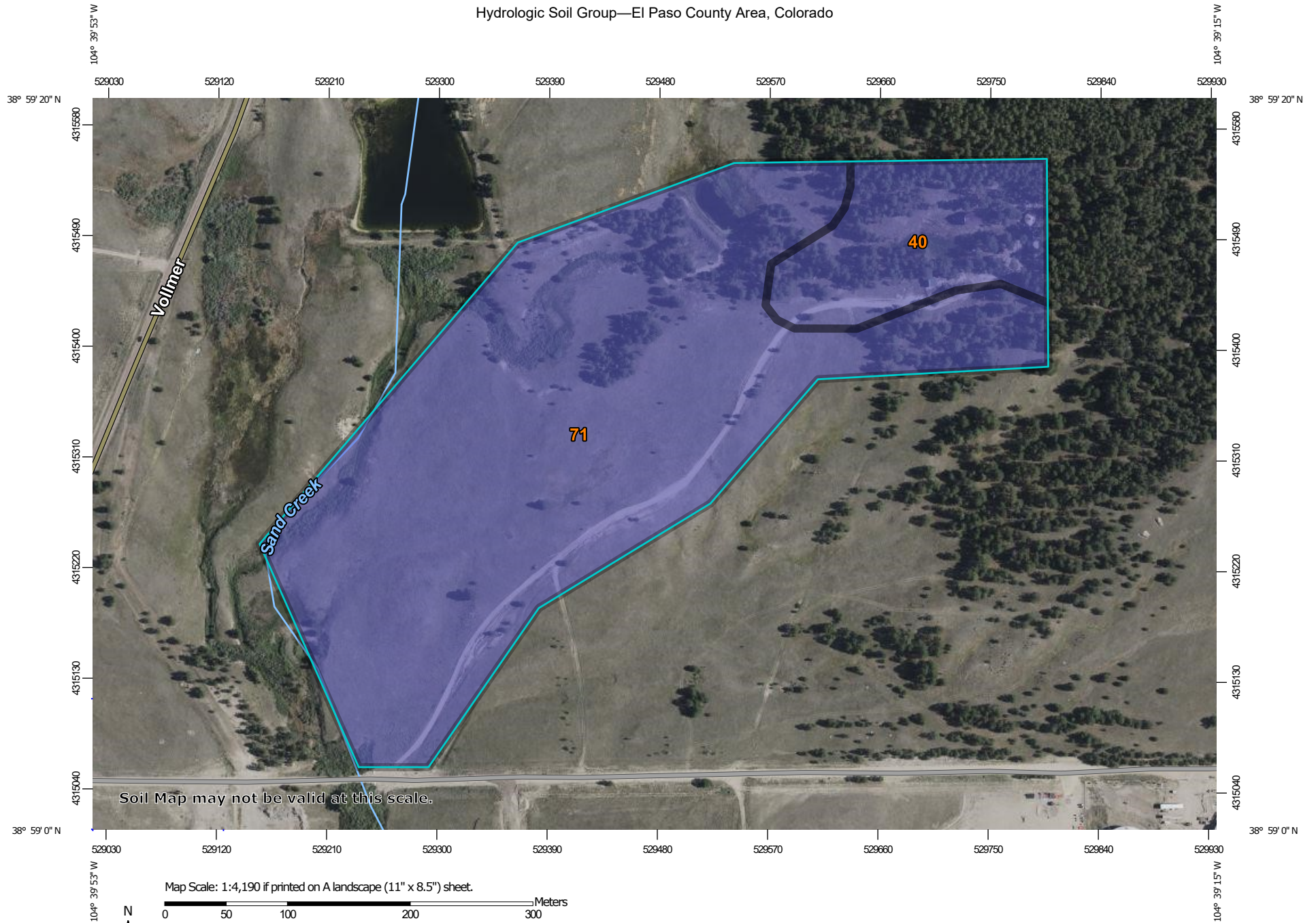
1



ENGINEERING

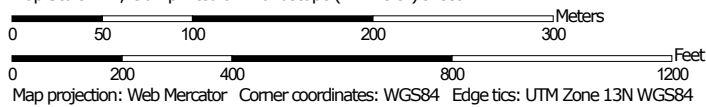
1004 WEST VAN BUREN STREET
COLORADO SPRINGS, CO 80907

Hydrologic Soil Group—El Paso County Area, Colorado



Soil Map may not be valid at this scale.

Map Scale: 1:4,190 if printed on A landscape (11" x 8.5") sheet.



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

2/12/2026
Page 1 of 4

MAP LEGEND**Area of Interest (AOI)**
 Area of Interest (AOI)
Soils**Soil Rating Polygons**

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

Soil Rating Lines

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

Soil Rating Points

-  A
-  A/D
-  B
-  B/D

-  C
-  C/D
-  D
-  Not rated or not available

Water Features
 Streams and Canals
Transportation

-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads

Background
 Aerial Photography
MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 23, Aug 29, 2025

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

Date(s) aerial images were photographed: Jul 23, 2024—Aug 4, 2024

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	5.8	15.4%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	31.6	84.6%
Totals for Area of Interest			37.4	100.0%

Description

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

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

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

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

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

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

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



NOAA Atlas 14, Volume 8, Version 2
Location name: Colorado Springs, Colorado, USA*
Latitude: 38.988°, Longitude: -104.6566°
Elevation: 7336 ft**

* source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.238 (0.193-0.295)	0.290 (0.235-0.360)	0.380 (0.307-0.474)	0.460 (0.369-0.575)	0.576 (0.449-0.753)	0.672 (0.510-0.887)	0.772 (0.565-1.04)	0.878 (0.615-1.22)	1.03 (0.690-1.46)	1.14 (0.747-1.65)
10-min	0.348 (0.282-0.432)	0.425 (0.344-0.527)	0.557 (0.449-0.693)	0.673 (0.540-0.842)	0.844 (0.657-1.10)	0.983 (0.746-1.30)	1.13 (0.827-1.53)	1.29 (0.901-1.79)	1.50 (1.01-2.14)	1.68 (1.09-2.42)
15-min	0.425 (0.344-0.527)	0.518 (0.419-0.643)	0.679 (0.548-0.846)	0.821 (0.659-1.03)	1.03 (0.802-1.34)	1.20 (0.910-1.58)	1.38 (1.01-1.86)	1.57 (1.10-2.18)	1.83 (1.23-2.62)	2.04 (1.34-2.94)
30-min	0.610 (0.495-0.757)	0.743 (0.602-0.923)	0.974 (0.786-1.21)	1.18 (0.945-1.47)	1.47 (1.15-1.92)	1.72 (1.30-2.27)	1.97 (1.44-2.67)	2.24 (1.57-3.11)	2.62 (1.76-3.73)	2.92 (1.90-4.20)
60-min	0.784 (0.636-0.973)	0.938 (0.760-1.17)	1.22 (0.982-1.52)	1.47 (1.18-1.84)	1.86 (1.45-2.44)	2.18 (1.66-2.89)	2.53 (1.85-3.43)	2.90 (2.04-4.05)	3.44 (2.32-4.92)	3.87 (2.53-5.58)
2-hr	0.957 (0.782-1.18)	1.13 (0.925-1.40)	1.46 (1.19-1.80)	1.76 (1.43-2.19)	2.24 (1.77-2.93)	2.64 (2.03-3.49)	3.08 (2.28-4.17)	3.56 (2.53-4.95)	4.26 (2.90-6.07)	4.83 (3.18-6.91)
3-hr	1.05 (0.864-1.29)	1.23 (1.01-1.51)	1.57 (1.28-1.93)	1.90 (1.54-2.34)	2.42 (1.93-3.17)	2.88 (2.22-3.80)	3.38 (2.52-4.57)	3.94 (2.82-5.47)	4.76 (3.26-6.77)	5.44 (3.60-7.76)
6-hr	1.23 (1.02-1.49)	1.42 (1.17-1.72)	1.79 (1.47-2.18)	2.16 (1.77-2.65)	2.76 (2.23-3.62)	3.31 (2.58-4.35)	3.91 (2.95-5.27)	4.60 (3.31-6.35)	5.60 (3.87-7.92)	6.44 (4.29-9.12)
12-hr	1.43 (1.19-1.72)	1.65 (1.37-1.99)	2.08 (1.73-2.52)	2.51 (2.07-3.06)	3.20 (2.60-4.15)	3.82 (3.00-4.97)	4.50 (3.41-6.00)	5.26 (3.82-7.20)	6.38 (4.44-8.96)	7.31 (4.91-10.3)
24-hr	1.66 (1.39-1.98)	1.94 (1.63-2.32)	2.47 (2.06-2.96)	2.96 (2.46-3.58)	3.74 (3.04-4.77)	4.40 (3.48-5.67)	5.13 (3.91-6.77)	5.93 (4.33-8.04)	7.09 (4.97-9.86)	8.04 (5.45-11.2)
2-day	1.93 (1.63-2.29)	2.28 (1.93-2.71)	2.92 (2.46-3.47)	3.49 (2.92-4.17)	4.34 (3.54-5.46)	5.06 (4.02-6.42)	5.82 (4.46-7.58)	6.64 (4.87-8.89)	7.80 (5.50-10.7)	8.74 (5.97-12.1)
3-day	2.12 (1.80-2.51)	2.51 (2.13-2.96)	3.19 (2.69-3.78)	3.79 (3.19-4.52)	4.70 (3.85-5.86)	5.45 (4.34-6.88)	6.24 (4.80-8.09)	7.10 (5.23-9.46)	8.31 (5.88-11.4)	9.28 (6.37-12.8)
4-day	2.29 (1.95-2.69)	2.69 (2.29-3.16)	3.39 (2.87-4.00)	4.01 (3.38-4.76)	4.95 (4.06-6.16)	5.73 (4.58-7.21)	6.55 (5.06-8.46)	7.44 (5.50-9.88)	8.69 (6.17-11.9)	9.70 (6.68-13.4)
7-day	2.70 (2.32-3.16)	3.12 (2.68-3.66)	3.86 (3.30-4.53)	4.53 (3.84-5.34)	5.52 (4.56-6.82)	6.35 (5.11-7.94)	7.23 (5.62-9.27)	8.17 (6.09-10.8)	9.51 (6.80-12.9)	10.6 (7.34-14.5)
10-day	3.07 (2.65-3.58)	3.53 (3.03-4.11)	4.32 (3.70-5.05)	5.03 (4.29-5.91)	6.08 (5.04-7.47)	6.95 (5.62-8.65)	7.87 (6.14-10.1)	8.86 (6.62-11.6)	10.2 (7.36-13.9)	11.4 (7.92-15.5)
20-day	4.12 (3.58-4.76)	4.73 (4.10-5.47)	5.76 (4.98-6.68)	6.64 (5.71-7.74)	7.91 (6.58-9.56)	8.91 (7.24-10.9)	9.95 (7.81-12.5)	11.0 (8.30-14.3)	12.5 (9.05-16.8)	13.7 (9.62-18.6)
30-day	4.97 (4.34-5.71)	5.72 (4.98-6.58)	6.95 (6.03-8.02)	7.98 (6.88-9.25)	9.41 (7.84-11.3)	10.5 (8.57-12.8)	11.6 (9.16-14.6)	12.8 (9.64-16.5)	14.3 (10.4-19.0)	15.5 (10.9-20.9)
45-day	6.02 (5.28-6.88)	6.93 (6.07-7.93)	8.40 (7.32-9.64)	9.59 (8.32-11.1)	11.2 (9.36-13.3)	12.4 (10.1-15.0)	13.6 (10.7-16.9)	14.8 (11.2-18.9)	16.4 (11.9-21.6)	17.5 (12.4-23.6)
60-day	6.90 (6.06-7.86)	7.94 (6.97-9.05)	9.58 (8.38-11.0)	10.9 (9.48-12.5)	12.6 (10.6-14.9)	13.9 (11.4-16.7)	15.2 (12.0-18.7)	16.4 (12.4-20.9)	17.9 (13.1-23.5)	19.0 (13.6-25.6)

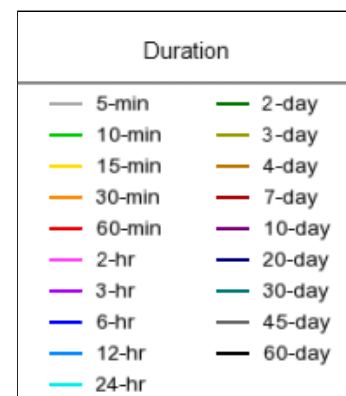
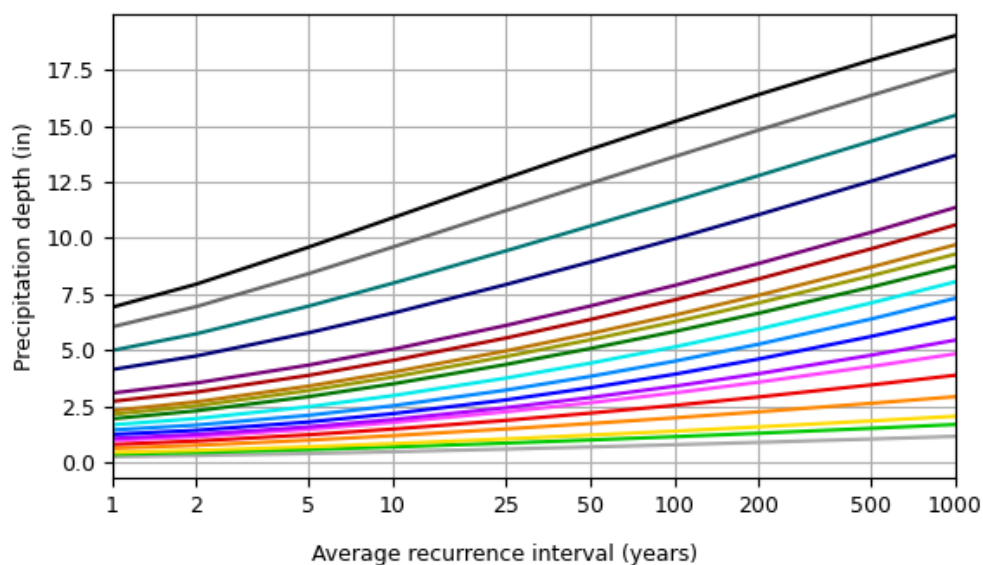
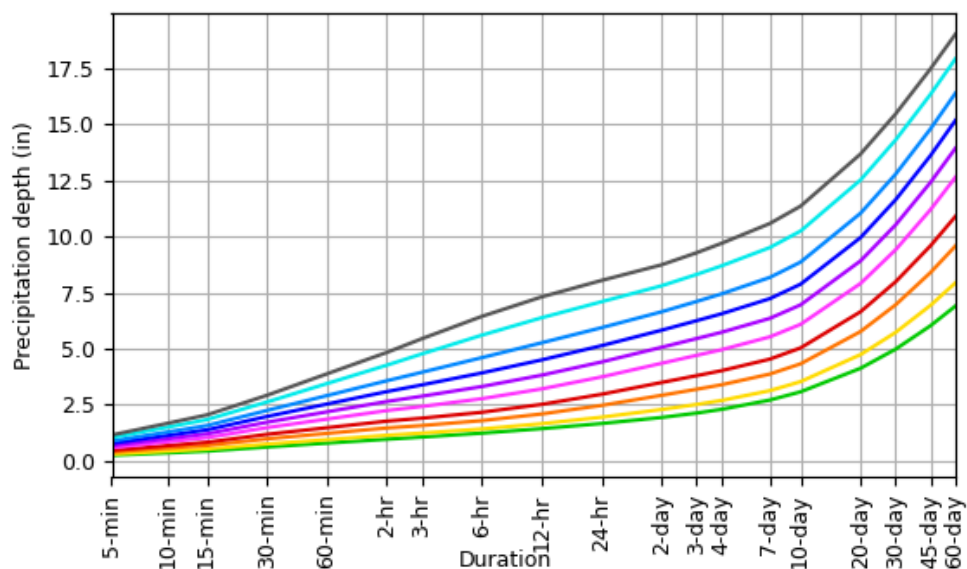
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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PF graphical

PDS-based depth-duration-frequency (DDF) curves

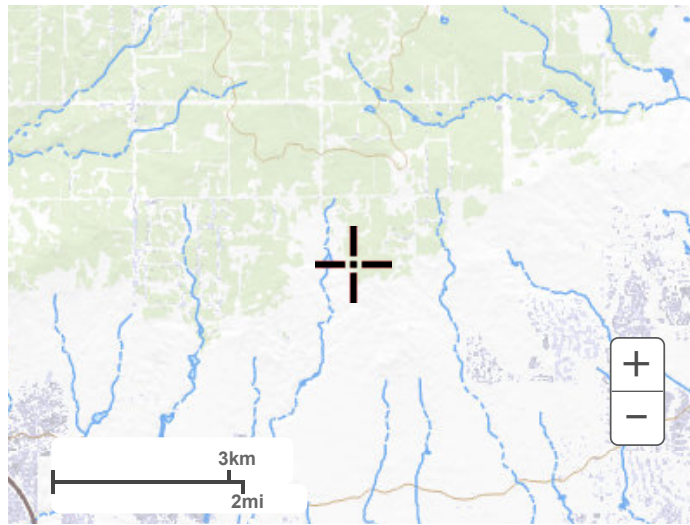
Latitude: 38.9880°, Longitude: -104.6566°



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APPENDIX B – HYDROLOGIC CALCULATIONS

Subdivision: Timbers Subdivision
Location: El Paso County
Project Name: Timbers Subdivision
Project Number: 25021
Calculated By: NQJ
Checked By: REB
Date: 6/30/2026

EXISTING CONDITIONS - BASIN SUMMARY TABLE							
Basin	Area (ac)	Impervious	C ₅	C ₁₀₀	t _c (min)	Q _{5-YR} (cfs)	Q _{100-YR} (cfs)
EXA1	18.16	2%	0.09	0.36	30.3	4.0	27.0
EXA2	10.68	3%	0.10	0.37	41.5	2.1	13.1
EXB	7.10	2%	0.09	0.36	20.8	1.9	13.0
EXC	22.32	5%	0.11	0.37	50.1	4.1	23.8
EXD	3.44	2%	0.09	0.36	31.5	0.7	5.0
EXE	5.47	2%	0.09	0.36	33.0	1.2	7.7
EXF	2.71	2%	0.09	0.36	31.3	0.6	4.0
EXF2	0.30	2%	0.09	0.36	8.9	0.1	0.2
EXG	6.33	2%	0.09	0.36	34.1	1.3	8.8

EXISTING CONDITIONS - DESIGN POINT SUMMARY TABLE		
DP#	Q _{5-YR}	Q _{100-YR}
1	29.7	184.0
2	28.3	181.0
3	28.7	180.1
4	0.7	5.0
5	1.8	12.3
6	2.3	15.2
7	1.3	8.8
8	0.1	0.2

COMPOSITE % IMPERVIOUS CALCULATIONS - EXISTING CONDITIONS

Subdivision: Timbers Subdivision
Location: El Paso County

Project Name: Timbers Subdivision
Project No.: 25021.00
Calculated By: NQJ
Checked By: REB
Date: 6/30/26

Basin ID	Total Area (ac)	Gravel Drives				2.5+ Acre Lots				Roofs				Undeveloped				Weighted C ₅ & C ₁₀₀		Basins Total Weighted % Imp.
		C ₅	C ₁₀₀	Area (ac)	% Imp.	C ₅	C ₁₀₀	Area (ac)	% Imp.	C ₅	C ₁₀₀	Area (ac)	% Imp.	C ₅	C ₁₀₀	Area (ac)	% Imp.			
		C ₅	C ₁₀₀	C ₅	C ₁₀₀	C ₅	C ₁₀₀	C ₅	C ₁₀₀	C ₅	C ₁₀₀	C ₅	C ₁₀₀	C ₅	C ₁₀₀					
EXA1	18.16	0.59	0.70	0.00	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.00	90.0%	0.09	0.36	18.16	2.0%	0.09	0.36	2.0%
EXA2	10.68	0.59	0.70	0.01	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.15	90.0%	0.09	0.36	10.52	2.0%	0.10	0.37	3.3%
EXB	7.10	0.59	0.70	0.00	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.00	90.0%	0.09	0.36	7.10	2.0%	0.09	0.36	2.0%
EXC	22.32	0.59	0.70	0.71	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.06	90.0%	0.09	0.36	21.55	2.0%	0.11	0.37	4.7%
EXD	3.44	0.59	0.70	0.00	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.00	90.0%	0.09	0.36	3.44	2.0%	0.09	0.36	2.0%
EXE	5.47	0.59	0.70	0.00	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.00	90.0%	0.09	0.36	5.47	2.0%	0.09	0.36	2.0%
EXF	2.71	0.59	0.70	0.00	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.00	90.0%	0.09	0.36	2.71	2.0%	0.09	0.36	2.0%
EXF2	0.30	0.59	0.70	0.00	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.00	90.0%	0.09	0.36	0.30	2.0%	0.09	0.36	2.0%
EXG	6.33	0.59	0.70	0.00	80.0%	0.12	0.39	0.00	7.0%	0.73	0.81	0.00	90.0%	0.09	0.36	6.33	2.0%	0.09	0.36	2.0%
Total	76.51																			3.0%

STANDARD FORM SF-2 - EXISTING CONDITIONS

TIME OF CONCENTRATION

Subdivision: Timbers Subdivision
Location: El Paso County

Project Name: Timbers Subdivision
Project No.: 25021.00
Calculated By: NQJ
Checked By: REB
Date: 6/30/26

SUB-BASIN						INITIAL/OVERLAND			TRAVEL TIME					tc CHECK			FINAL
DATA						(Ti)			(Tt)					(URBANIZED BASINS)			
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Weighted C5	Weighted C100	Impervious (%)	L (ft)	So (%)	ti (min)	Lt (ft)	St (%)	K	VEL. (ft/s)	tt (min)	COMP. tc (min)	TOTAL LENGTH (ft)	Urbanized tc (min)	
EXA1	18.16	B	0.09	0.36	2.0%	300	7.3%	16.4	2379	3.6%	15.0	2.8	13.9	30.3	2679.0	48.2	30.3
EXA2	10.68	B	0.10	0.37	3.3%	300	4.6%	18.9	1925	4.1%	7.0	1.4	22.6	41.5	2225.0	42.2	41.5
EXB	7.10	B	0.09	0.36	2.0%	194	15.4%	10.3	1333	2.0%	15.0	2.1	10.5	20.8	1527.0	42.6	20.8
EXC	22.32	B	0.11	0.37	4.7%	300	6.7%	16.6	2740	3.6%	2.5	0.5	96.3	112.8	3040.0	50.1	50.1
EXD	3.44	B	0.09	0.36	2.0%	300	3.3%	21.3	700	4.7%	2.5	0.5	21.5	42.8	1000.0	31.5	31.5
EXE	5.47	B	0.09	0.36	2.0%	300	7.0%	16.6	821	4.0%	2.5	0.5	27.4	44.0	1121.0	33.0	33.0
EXF	2.71	B	0.09	0.36	2.0%	300	8.0%	15.9	691	4.8%	2.5	0.5	21.0	36.9	991.0	31.3	31.3
EXF2	0.30	B	0.09	0.36	2.0%	50	10.0%	6.0	105	6.0%	2.5	0.6	2.9	8.9	155.0	26.4	8.9
EXG	6.33	B	0.09	0.36	2.0%	200	7.5%	13.3	960	4.2%	2.5	0.5	31.2	44.5	1160.0	34.1	34.1

NOTES:

$$t_c = t_i + t_t$$

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

t_t = channelized flow time (minutes).

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

Where:

t_t = channelized flow time (travel time, min)

L_t = waterway length (ft)

S_o = waterway slope (ft/ft)

V_t = travel time velocity (ft/sec) = K√S_o

K = NRCS conveyance factor (see Table 6-2).

$$Eq \quad t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$

Where:

t_i = overland (initial) flow time (minutes)

C₅ = runoff coefficient for 5-year frequency (from Table 6-4)

L_i = length of overland flow (ft)

S_o = average slope along the overland flow path (ft/ft).

$$Equation \ 6-4: t_c = 16 - 17t_i + \frac{L_t}{60(14t_i + 9)\sqrt{S_t}}$$

or:

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.

L_t = length of channelized flow path (ft)

t = imperviousness (expressed as a decimal)

S_t = slope of the channelized flow path (ft/ft).

Equation 6-3

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Equation 6-5

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

STANDARD FORM SF-3 - EXISTING CONDITIONS

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Timbers Subdivision

Location: El Paso County

Design Storm: 5-Year

Project Name: Timbers Subdivision

Project No.: 25021.00

Calculated By: NOJ

Checked By: REB

Date: 6/30/26

DESCRIPTION	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				OVERLAND			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{overland}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
		EXA1	18.16	0.09	30.3	1.63	2.47	4.0															BASIN EXA1 @ DP1
		EXA2	10.68	0.10	41.5	1.06	1.99	2.1															BASIN EXA2 @ DP1
		OS1	345.60	-	143.4	-	-	24.3															BASIN OS1 @ DP1
	1								41.5	2.70	1.99	29.7	29.7	2.70	2.7					1200	1.2	17.4	COMBINED BASIN EXA1, EXA2 & OS1 @ DP1, CONTINUE TO DP2
		EXB	7.10	0.09	20.8	0.64	3.03	1.9															BASIN EXB @ DP2
	2								58.9	3.34	1.47	29.2	29.2	3.34	1.6					1535	0.9	28.9	COMBINED DP1 & BASIN EXB @ DP2, CONTINUE TO DP3
		EXC	22.32	0.11	50.1	2.40	1.71	4.1															BASIN EXC @ DP3
	3								87.8	5.74	0.87	29.3											COMBINED DP2 & BASIN EXC @ DP3, EX CULVERT UNDER ARROYO LANE
	4	EXD	3.44	0.09	31.5	0.31	2.41	0.7					0.7	0.31	4					220	1.4	2.6	BASIN EXD @ DP4
	5	EXE	5.47	0.09	33.0	0.49	2.34	1.2	34.1	0.80	2.29	1.8	1.8	0.80	3.8					243	1.4	3.0	COMBINED BASIN EXE & DP4 @ DP5, CONTINUE TO DP6
	6	EXF	2.71	0.09	31.3	0.24	2.42	0.6	37.0	1.05	2.16	2.3											COMBINED BASIN EXF & DP5 @ DP6, FOLLOWS HISTORIC PATTERNS OFFSITE
	7	EXG	6.33	0.09	34.1	0.57	2.29	1.3															BASIN EXG @ DP7, FOLLOWS HISTORIC PATTERNS OFFSITE
	8	EXF2	0.30	0.09	8.9	0.03	4.31	0.1															BASIN EXF2 @ DP9, HISTORIC PATTERNS OFFSITE

Notes:

Street and Pipe C*A values are determined by Q/I using the catchment's intensity value.

STANDARD FORM SF-3 - EXISTING CONDITIONS
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Subdivision: Timbers Subdivision
Location: El Paso County
Design Storm: 100-Year

Project Name: Timbers Subdivision
Project No.: 25021.00
Calculated By: NJQ
Checked By: REB
Date: 6/30/26

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				OVERLAND			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{OVERLAND}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
		EXA1	18.16	0.36	30.3	6.54	4.14	27.0															BASIN EXA1 @ DP1
		EXA2	10.68	0.37	41.5	3.92	3.34	13.1															BASIN EXA2 @ DP1
		OS1	345.60	-	143.4	-	-	149.0															BASIN OS1 @ DP1
	1								41.5	10.45	3.34	184.0	184.0	10.45	2.7					1200	1.2	17.4	COMBINED BASIN EXA1, EXA2 & OS1 @ DP1, CONTINUE TO DP2
		EXB	7.10	0.36	20.8	2.56	5.09	13.0															BASIN EXB @ DP2
	2								58.9	13.01	2.46	181.0	181.0	13.01	1.6					1535	0.9	28.9	COMBINED DP1 & BASIN EXB @ DP2, CONTINUE TO DP3
		EXC	22.32	0.37	50.1	8.30	2.87	23.8															BASIN EXC @ DP3
	3								87.8	21.31	1.46	180.1											COMBINED DP2 & BASIN EXC @ DP3, EX CULVERT UNDER ARROYO LANE
	4	EXD	3.44	0.36	31.5	1.24	4.04	5.0					5.0	1.24	4					220	1.4	2.6	BASIN EXD @ DP4
	5	EXE	5.47	0.36	33.0	1.97	3.92	7.7	34.1	3.21	3.84	12.3	12.3	3.21	3.8					243	1.4	3.0	COMBINED BASIN EXE & DP4 @ DP5, CONTINUE TO DP6
	6	EXF	2.71	0.36	31.3	0.98	4.06	4.0	37.0	4.18	3.63	15.2											COMBINED BASIN EXF & DP5 @ DP6, FOLLOWS HISTORIC PATTERNS OFFSITE
	7	EXG	6.33	0.36	34.1	2.28	3.84	8.8															BASIN EXG @ DP7, FOLLOWS HISTORIC PATTERNS OFFSITE
	8	EXF2	0.30	0.09	8.9	0.03	7.23	0.2															BASIN EXF2 @ DP9, HISTORIC PATTERNS OFFSITE

Notes:
Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

Subdivision: Timbers Subdivision
Location: El Paso County
Project Name: Timbers Subdivision
Project Number: 25021
Calculated By: NQJ
Checked By: REB
Date: 7/31/2026

PROPOSED CONDITIONS - BASIN SUMMARY TABLE							
Sub-basin	Area (ac)	Impervious	C ₅	C ₁₀₀	t _c (min)	Q _{5-YR} (cfs)	Q _{100-YR} (cfs)
A1	18.16	4%	0.10	0.37	30.1	4.5	28.0
A2	10.79	6%	0.11	0.38	41.2	2.4	13.9
B	7.08	7%	0.12	0.39	20.5	2.6	14.2
C	8.65	7%	0.12	0.39	33.1	2.4	13.1
D	3.43	5%	0.11	0.38	30.8	0.9	5.3
E	5.47	4%	0.10	0.37	32.4	1.4	8.1
F	2.65	7%	0.12	0.39	30.1	0.8	4.3
F2	0.30	7%	0.12	0.39	8.7	0.2	0.3
G	8.22	6%	0.12	0.39	39.0	2.0	11.1
H	3.21	33%	0.34	0.55	34.5	2.5	6.7
I	1.51	41%	0.41	0.59	27.9	1.6	3.9
J	1.11	16%	0.19	0.43	13.5	0.8	3.0
K	1.81	19%	0.22	0.46	19.7	1.3	4.4
L	4.00	9%	0.13	0.40	23.8	1.5	2.6

PROPOSED CONDITIONS - DESIGN POINT SUMMARY TABLE		
DP#	Q _{5-YR}	Q _{100-YR}
1	30.4	185.5
2	30.1	182.7
3	29.4	193.7
4	0.9	5.3
5	2.2	13.0
6	2.7	16.1
7	4.6	23.2
8	4.6	22.1
9	2.5	6.7
9.1	6.1	26.3
10	6.1	25.9
11	2.0	4.1
12	0.2	0.3

COMPOSITE % IMPERVIOUS CALCULATIONS - PROPOSED CONDITIONS

Subdivision: Timbers Subdivision
 Location: El Paso County

Project Name: Timbers Subdivision
 Project No.: 25021.00
 Calculated By: NQJ
 Checked By: REB
 Date: 7/31/26

Basin ID	Total Area (ac)	Gravel				2.5+ Acre Lots				Paved				Undeveloped				Weighted C ₅ & C ₁₀₀		Basins Total Weighted % Imp.
		C ₅	C ₁₀₀	Area (ac)	% Imp.	C ₅	C ₁₀₀	Area (ac)	% Imp.	C ₅	C ₁₀₀	Area (ac)	% Imp.	C ₅	C ₁₀₀	Area (ac)	% Imp.	C ₅	C ₁₀₀	
																		C ₅	C ₁₀₀	
A1	18.16	0.59	0.70	0.00	80.0%	0.12	0.39	6.80	7.0%	0.90	0.96	0.00	100.0%	0.09	0.36	11.36	2.0%	0.10	0.37	3.9%
A2	10.79	0.59	0.70	0.00	80.0%	0.12	0.39	7.92	7.0%	0.90	0.96	0.00	100.0%	0.09	0.36	2.87	2.0%	0.11	0.38	5.7%
B	7.08	0.59	0.70	0.00	80.0%	0.12	0.39	7.05	7.0%	0.90	0.96	0.00	100.0%	0.09	0.36	0.03	2.0%	0.12	0.39	7.0%
C	8.65	0.59	0.70	0.00	80.0%	0.12	0.39	7.04	7.0%	0.90	0.96	0.04	100.0%	0.09	0.36	1.57	2.0%	0.12	0.39	6.5%
D	3.43	0.59	0.70	0.00	80.0%	0.12	0.39	1.85	7.0%	0.90	0.96	0.00	100.0%	0.09	0.36	1.58	2.0%	0.11	0.38	4.7%
E	5.47	0.59	0.70	0.00	80.0%	0.12	0.39	2.62	7.0%	0.90	0.96	0.00	100.0%	0.09	0.36	2.85	2.0%	0.10	0.37	4.4%
F	2.65	0.59	0.70	0.00	80.0%	0.12	0.39	2.63	7.0%	0.90	0.96	0.00	100.0%	0.09	0.36	0.02	2.0%	0.12	0.39	7.0%
F2	0.30	0.59	0.70	0.00	80.0%	0.12	0.39	0.30	7.0%	0.90	0.96	0.00	100.0%	0.09	0.36	0.00	2.0%	0.12	0.39	7.0%
G	8.22	0.59	0.70	0.00	80.0%	0.12	0.39	7.21	7.0%	0.90	0.96	0.00	100.0%	0.09	0.36	1.01	2.0%	0.12	0.39	6.4%
H	3.21	0.59	0.70	0.11	80.0%	0.12	0.39	0.99	7.0%	0.90	0.96	0.89	100.0%	0.09	0.36	1.22	2.0%	0.34	0.55	33.4%
I	1.51	0.59	0.70	0.07	80.0%	0.12	0.39	0.00	7.0%	0.90	0.96	0.55	100.0%	0.09	0.36	0.89	2.0%	0.41	0.59	41.3%
J	1.11	0.59	0.70	0.10	80.0%	0.12	0.39	0.50	7.0%	0.90	0.96	0.05	100.0%	0.09	0.36	0.46	2.0%	0.19	0.43	15.7%
K	1.81	0.59	0.70	0.03	80.0%	0.12	0.39	1.00	7.0%	0.90	0.96	0.24	100.0%	0.09	0.36	0.54	2.0%	0.22	0.46	19.0%
L	4.00	0.59	0.70	0.01	80.0%	0.12	0.39	3.92	7.0%	0.90	0.96	0.07	100.0%	0.09	0.36	0.00	2.0%	0.13	0.40	8.8%
M	0.04	0.59	0.70	0.01	80.0%	0.12	0.39	0.00	7.0%	0.90	0.96	0.02	100.0%	0.09	0.36	0.01	2.0%	0.62	0.75	70.5%
Pond (D-K)	27.71																			12.1%
Total	76.43																			8.0%

STANDARD FORM SF-2 - PROPOSED CONDITIONS TIME OF CONCENTRATION

Subdivision: Timbers Subdivision
Location: El Paso County

Project Name: Timbers Subdivision
Project No.: 25021.00
Calculated By: NQJ
Checked By: REB
Date: 7/31/26

SUB-BASIN						INITIAL/OVERLAND			TRAVEL TIME					tc CHECK			FINAL
DATA						(T _i)			(T _t)					(URBANIZED BASINS)			
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Weighted C ₅	Weighted C ₁₀₀	Impervious (%)	L (ft)	S _o (%)	t _i (min)	L _t (ft)	S _t (%)	K	VEL. (ft/s)	t _t (min)	COMP. t _c (min)	TOTAL LENGTH (ft)	Urbanized t _c (min)	
A1	18.16	B	0.10	0.37	3.9%	300	7.3%	16.2	2379	3.6%	15.0	2.8	13.9	30.1	2679.0	47.2	30.1
A2	10.79	B	0.11	0.38	5.7%	300	4.6%	18.7	1925	4.1%	7.0	1.4	22.6	41.3	2225.0	41.2	41.2
B	7.08	B	0.12	0.39	7.0%	194	15.4%	10.0	1333	2.0%	15.0	2.1	10.5	20.5	1527.0	40.6	20.5
C	8.65	B	0.12	0.39	6.5%	300	7.3%	15.9	1105	5.1%	2.5	0.6	32.6	48.6	1405.0	33.1	33.1
D	3.43	B	0.11	0.38	4.7%	300	3.3%	21.0	700	4.7%	2.5	0.5	21.5	42.5	1000.0	30.8	30.8
E	5.47	B	0.10	0.37	4.4%	300	7.0%	16.4	821	4.0%	2.5	0.5	27.4	43.7	1121.0	32.4	32.4
F	2.65	B	0.12	0.39	7.0%	300	8.0%	15.4	691	4.8%	2.5	0.5	21.0	36.5	991.0	30.1	30.1
F2	0.30	B	0.12	0.39	7.0%	50	10.0%	5.9	105	6.0%	2.5	0.6	2.9	8.7	155.0	25.5	8.7
G	8.22	B	0.12	0.39	6.4%	300	5.6%	17.4	1474	3.1%	2.5	0.4	55.8	73.2	1774.0	39.0	39.0
H	3.21	B	0.34	0.55	33.4%	55	33.0%	3.2	2355	4.1%	3.5	0.7	55.4	58.6	2410.0	34.5	34.5
I	1.51	B	0.41	0.59	41.3%	55	33.0%	2.9	1549	3.8%	4.5	0.9	29.4	32.4	1604.0	27.9	27.9
J	1.11	B	0.19	0.43	15.7%	105	7.6%	8.7	344	4.6%	5.5	1.2	4.9	13.5	449.0	25.7	13.5
K	1.81	B	0.22	0.46	19.0%	300	7.0%	14.4	573	7.9%	6.5	1.8	5.2	19.7	873.0	25.7	19.7
L	4.00	B	0.13	0.40	8.8%	300	5.0%	17.7	605	4.9%	7.5	1.7	6.1	23.8	905.0	29.0	23.8
M	0.04	B	0.62	0.75	70.5%	16	2.0%	2.8	32	1.0%	8.5	0.9	0.6	3.4	48.0	14.3	5.0

NOTES:

$$t_c = t_i + t_t$$

Where:

t_c = computed time of concentration (minutes)

t_i = overland (initial) flow time (minutes)

t_t = channelized flow time (minutes).

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

Where:

t_t = channelized flow time (travel time, min)

L_t = waterway length (ft)

S_o = waterway slope (ft/ft)

V_t = travel time velocity (ft/sec) = K√S_o

K = NRCS conveyance factor (see Table 6-2).

$$\text{Eq} \quad t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_o^{0.33}}$$

Where:

t_i = overland (initial) flow time (minutes)

C₅ = runoff coefficient for 5-year frequency (from Table 6-4)

L_i = length of overland flow (ft)

S_o = average slope along the overland flow path (ft/ft).

$$\text{Equation 6-4 } t_c = (6 - 17t_i) + \frac{L_t}{60(14t_i + 9)\sqrt{S_o}}$$

∴

t_c = minimum time of concentration for first design point when less than t_c from Equation 6-1.

L_t = length of channelized flow path (ft)

i = imperviousness (expressed as a decimal)

S_o = slope of the channelized flow path (ft/ft).

Equation 6-3

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Equation 6-5

Use a minimum t_c value of 5 minutes for urbanized areas and a minimum t_c value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

STANDARD FORM SF-3 - PROPOSED CONDITIONS

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Timbers Subdivision

Location: El Paso County

Design Storm: 5-Year

Project Name: Timbers Subdivision

Project No.: 25021.00

Calculated By: NOJ

Checked By: REB

Date: 7/31/26

DESCRIPTION	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				OVERLAND			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t _c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	t _c (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q _{overland} (cfs)	C*A (ac)	Slope (%)	Q _{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t _t (min)	
		A1	18.16	0.10	30.1	1.84	2.47	4.5															BASIN A1 @ DP1
		A2	10.79	0.11	41.2	1.21	2.00	2.4															BASIN A2 @ DP1
		OS1	345.60	-	143.4	-	-	24.3															BASIN OS1 @ DP1
	1								41.2	3.05	2.00	30.4	30.4	3.05	2.7					1200	1.2	17.4	COMBINED BASIN A1, A2 & OS1 @ DP1, CONTINUE TO DP2
		B	7.08	0.12	20.5	0.85	3.05	2.6															BASIN B @ DP2
	2								58.6	3.90	1.48	30.1	30.1	3.90	1.6					1535	0.9	28.9	COMBINED DP1 & BASIN B @ DP2, CONTINUE TO DP3
		C	8.65	0.12	33.1	1.02	2.33	2.4															BASIN C @ DP3
	4	D	3.43	0.11	30.8	0.36	2.44	0.9					0.9	0.36	4					220	1.4	2.6	BASIN D @ DP4
	5	E	5.47	0.10	32.4	0.57	2.37	1.4	33.4	0.94	2.32	2.2	2.2	0.94	3.8					243	1.4	3.0	COMBINED BASIN E & DP4 @ DP5, CONTINUE TO DP6
	6	F	2.65	0.12	30.1	0.32	2.48	0.8	36.4	1.25	2.19	2.7	2.7	1.25	3					1192	1.2	16.4	COMBINED BASIN F & DP5 @ DP6, CONTINUE TO DP7
		G	8.22	0.12	39.0	0.96	2.09	2.0															BASIN G @ DP7
		H	3.21	0.34	34.5	1.09	2.27	2.5															BASIN H @ DP9
		I	1.51	0.41	27.9	0.62	2.59	1.6															BASIN I @ DP7
	7								52.7	2.83	1.63	4.6	4.6	2.83	4.8					745	1.5	8.1	COMBINED DP6, BASIN G & BASIN I @ DP7, CONTINUES TO DP8
		J	1.11	0.19	13.5	0.21	3.68	0.8															BASIN J @ DP10
		K	1.81	0.22	19.7	0.40	3.11	1.3															BASIN K @ DP8
	8								60.8	3.23	1.42	4.6				4.6	3.23	2.0	18	52	7.3	0.1	COMBINED DP7 & BASIN K @ DP8, CONTINUE TO DP9.1
	9								34.5	1.09	2.27	2.5											BASIN H CAPTURED IN TYPE D INLET @ DP9, CONTINUE TO DP9.1

STANDARD FORM SF-3 - PROPOSED CONDITIONS

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Timbers Subdivision

Location: El Paso County

Design Storm: 5-Year

Project Name: Timbers Subdivision

Project No.: 25021.00

Calculated By: NOJ

Checked By: REB

Date: 7/31/26

DESCRIPTION	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				OVERLAND			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t_c (min)	C*A (Ac)	I (in/hr)	Q (cfs)	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{overland}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	9.1								61.0	4.32	1.42	6.1	6.1	4.32	2					185	1.0	3.1	COMBINED DP8 & DP9 @ DP9.1, CONTINUE TO DP10
	10								64.1	4.53	1.34	6.1											TOTAL SITE FLOW ENTERING POND 1 @ DP10
	11	L	4.00	0.13	23.8	0.54	2.83	1.5	23.8	0.54	2.83	2.0											BASIN L & BASIN EX-4 @ DP11, CULVERT UNDER PRIVATE ROADWAY, CONTINUES TO DP3
	3								87.5	5.46	0.88	29.4											COMBINED DP2, DP11, BASIN C & POND 1 DISCHARGE @ DP3, EX CULVERT UNDER ARROYO LANE
	12	F2	0.30	0.12	8.7	0.04	4.34	0.2															BASIN F2 FLOW @ DP12, FOLLOW HISTORIC DRAINAGE PATTERN SOUTH

Notes:

Street and Pipe C*A values are determined by Q/I using the catchment's intensity value.

STANDARD FORM SF-3 - PROPOSED CONDITIONS

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Timbers Subdivision

Location: El Paso County

Design Storm: 100-Year

Project Name: Timbers Subdivision

Project No.: 25021.00

Calculated By: NJQ

Checked By: REB

Date: 7/31/26

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				OVERLAND			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{OVERLAND}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
		A1	18.16	0.37	30.1	6.74	4.15	28.0															BASIN A1 @ DP1
		A2	10.79	0.38	41.2	4.12	3.36	13.9															BASIN A2 @ DP1
		OS1	345.60	-	143.4	-	-	149.0															BASIN OS1 @ DP1
	1								41.2	10.86	3.36	185.5	185.5	10.86	2.7					1200	1.2	17.4	COMBINED BASIN A1, A2 & OS1 @ DP1, CONTINUE TO DP2
		B	7.08	0.39	20.5	2.76	5.13	14.2															BASIN B @ DP2
	2								58.6	13.62	2.48	182.7	182.7	13.62	1.6					1535	0.9	28.9	COMBINED DP1 & BASIN B @ DP2, CONTINUE TO DP3
		C	8.65	0.39	33.1	3.35	3.91	13.1															BASIN C @ DP3
	4	D	3.43	0.38	30.8	1.29	4.10	5.3					5.3	1.29	4					220	1.4	2.6	BASIN D @ DP4
	5	E	5.47	0.37	32.4	2.05	3.97	8.1	33.4	3.34	3.89	13.0	13.0	3.34	3.8					243	1.4	3.0	COMBINED BASIN E & DP4 @ DP5, CONTINUE TO DP6
	6	F	2.65	0.39	30.1	1.03	4.16	4.3	36.4	4.37	3.68	16.1	16.1	4.37	3					1192	1.2	16.4	COMBINED BASIN F & DP5 @ DP6, CONTINUE TO DP7
		G	8.22	0.39	39.0	3.18	3.50	11.1															BASIN G @ DP7
		H	3.21	0.55	34.5	1.76	3.81	6.7															BASIN H @ DP9
		I	1.51	0.59	27.9	0.90	4.34	3.9															BASIN I @ DP7
	7								52.7	8.44	2.74	23.2	23.2	8.44	4.8					745	1.5	8.1	COMBINED DP6, BASIN G & BASIN I @ DP7, CONTINUES TO DP8
		J	1.11	0.43	13.5	0.48	6.17	3.0															BASIN J @ DP10
		K	1.81	0.46	19.7	0.84	5.23	4.4															BASIN K @ DP8
	8								60.8	9.28	2.38	22.1				22.1	9.28	2.0	18	52	12.5	0.1	COMBINED DP7 & BASIN K @ DP8, CONTINUE TO DP9.1
	9								34.5	1.76	3.81	6.7											BASIN H CAPTURED IN TYPE D INLET @ DP9, CONTINUE TO DP9.1

STANDARD FORM SF-3 - PROPOSED CONDITIONS

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Timbers Subdivision

Location: El Paso County

Design Storm: 100-Year

Project Name: Timbers Subdivision

Project No.: 25021.00

Calculated By: NQJ

Checked By: REB

Date: 7/31/26

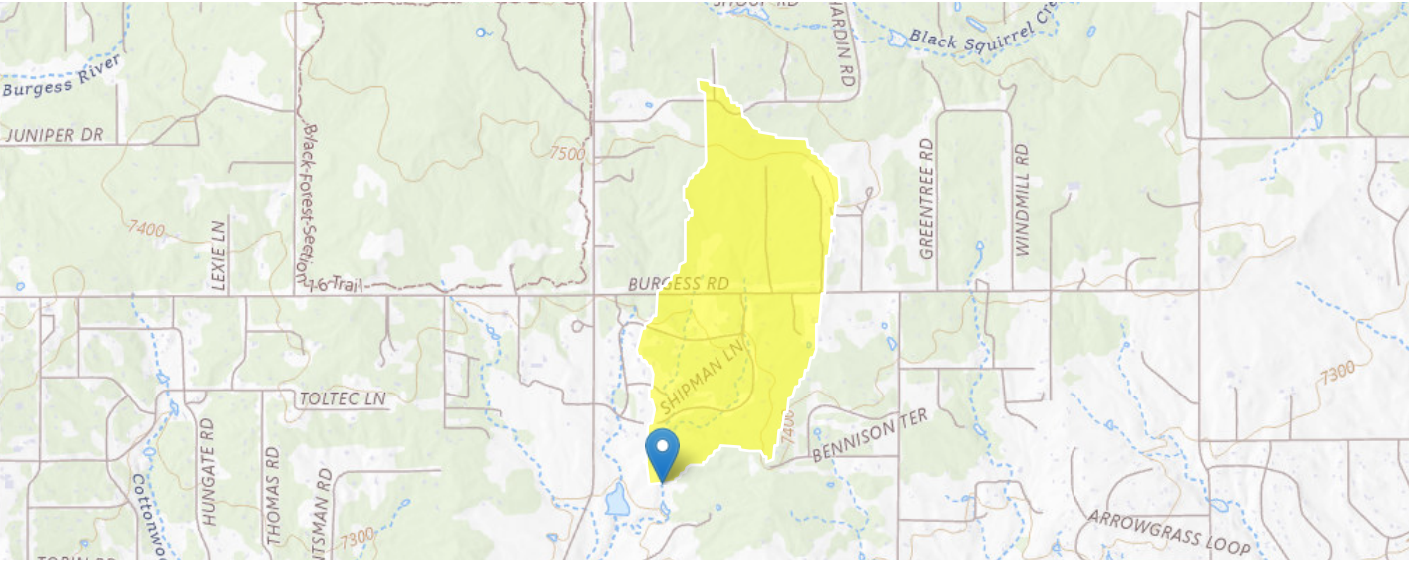
STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				OVERLAND			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	t_c (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{OVERLAND}$ (cfs)	C*A (ac)	Slope (%)	Q_{pipe} (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t_t (min)	
	9.1								60.9	11.04	2.38	26.3	26.3	11.04	2					185	1.0	3.1	COMBINED DP8 & DP9 @ DP9.1, CONTINUE TO DP10
	10								64.0	11.52	2.25	25.9											TOTAL SITE FLOW ENTERING POND 1 @ DP10
	11	L	4.00	0.13	23.8	0.54	4.75	2.6	23.8	0.54	4.75	4.1											BASIN L & BASIN EX-4 @ DP11, CULVERT UNDER PRIVATE ROADWAY, CONTINUES TO DP3
	3								87.5	17.51	1.47	193.7											COMBINED DP2, DP11, BASIN C & POND 1 DISCHARGE @ DP3, EX CULVERT UNDER ARROYO LANE
	12	F2	0.30	0.12	8.7	0.04	7.28	0.3															BASIN F2 FLOW @ DP12, FOLLOW HISTORIC DRAINAGE PATTERN SOUTH

Notes:

Street and Pipe C*A values are determined by Q/i using the catchment's intensity value.

Basin OS1 - StreamStats Report

Region ID: CO
Clicked Point (Latitude, Longitude): 38.98942, -104.65922
Time: 2026-06-30 10:37:46 -0600



StreamStats Update

Starting with version 4.30.0, the StreamStats application uses services that were redeveloped with open-source software components. Users may observe minor variations in computed results when compared to those from previous versions. These differences are expected and do not reflect errors in the underlying data or analytical methods. Users are advised to consider these potential variations when interpreting or comparing results generated across different versions of StreamStats. Please email streamstats@usgs.gov with any questions or concerns. A full list of changes can be found at <https://www.usgs.gov/streamstats/news/streamstats-data-updates-open-source-code-release> (<https://www.usgs.gov/streamstats/news/streamstats-data-updates-open-source-code-release>) .

+ Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	5.22	percent
CSL1085LFP	Change in elevation divided by length between points 10 and 85 percent of distance along the longest flow path to the basin divide, LFP from 2D grid	154.84	feet per mi
DRNAREA	Area that drains to a point on a stream	0.54	square miles
EL7500	Percent of area above 7500 ft	8.28	percent
ELEV	Mean Basin Elevation	7427.74	feet
ELEVMAX	Maximum basin elevation	7565.04	feet
I24H100Y	Maximum 24-hour precipitation that occurs on average once in 100 years	5.096	inches
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years	1.927	inches
I6H100Y	6-hour precipitation that is expected to occur on average once in 100 years	3.892	inches
I6H2Y	Maximum 6-hour precipitation that occurs on average once in 2 years	1.405	inches
LAT_OUT	Latitude of Basin Outlet	38.989395	decimal degrees

Parameter Code	Parameter Description	Value	Unit
LC11BARE	Percentage of barren from NLCD 2011 class 31	0	percent
LC11CRPHAY	Percentage of cultivated crops and hay, classes 81 and 82, from NLCD 2011	0	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	7.409	percent
LC11FOREST	Percentage of forest from NLCD 2011 classes 41-43	85.57	percent
LC11GRASS	Percent of area covered by grassland/herbaceous using 2011 NLCD	5.314	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	7.374	percent
LC11SHRUB	Percent of area covered by shrubland using 2011 NLCD	1.705	percent
LC11SNOIC	Percent snow and ice from NLCD 2011 class 12	0	percent
LC11WATER	Percent of open water, class 11, from NLCD 2011	0	percent
LC11WETLND	Percentage of wetlands, classes 90 and 95, from NLCD 2011	0	percent
LFPLENGTH	Length of longest flow path	1.552	miles
LONG_OUT	Longitude of Basin Outlet	-104.659199	decimal degrees
MINBELEV	Minimum basin elevation	7304.05	feet
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88	7304.05	feet
PRECIP	Mean Annual Precipitation	19.93	inches
RCN	Runoff-curve number as defined by NRCS (http://policy.nrcs.usda.gov/OpenNonWebContent.aspx?content=17758.wba)	55.918	dimensionless
RUNCO_CO	Soil runoff coefficient as defined by Verdin and Gross (2017)	0.459	dimensionless
SSURGOA	Percentage of area of Hydrologic Soil Type A from SSURGO	0	percent
SSURGOB	Percentage of area of Hydrologic Soil Type B from SSURGO	100	percent
SSURGOC	Percentage of area of Hydrologic Soil Type C from SSURGO	0	percent
SSURGOD	Percentage of area of Hydrologic Soil Type D from SSURGO	0	percent
STATSCLAY	Percentage of clay soils from STATSGO	16.3	percent
STORNHD	Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0.043	percent
TOC	Time of concentration in hours	2.39	hours

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Foothills Region Peak Flow 2016 5099]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.54	square miles	0.6	2850
I6H100Y	6 Hour 100 Year Precipitation	3.892	inches	2.38	4.89
OUTLETELEV	Elevation of Gage	7304.05	feet	4290	8270
STATSCLAY	STATSGO Percentage of Clay Soils	16.3	percent	9.87	37.5

Peak-Flow Statistics Disclaimers [Foothills Region Peak Flow 2016 5099]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [Foothills Region Peak Flow 2016 5099]

Statistic	Value	Unit
50-percent AEP flood	8.08	ft^3/s
20-percent AEP flood	24.3	ft^3/s

Statistic	Value	Unit
10-percent AEP flood	42	ft ³ /s
4-percent AEP flood	74.1	ft ³ /s
2-percent AEP flood	106	ft ³ /s
1-percent AEP flood	149	ft ³ /s
0.5-percent AEP flood	199	ft ³ /s
0.2-percent AEP flood	281	ft ³ /s
<i>Peak-Flow Statistics Citations</i>		
Kohn, M.S., Stevens, M.R., Harden, T.M., Godaire, J.E., Klinger, R.E., and Mommandi, A., 2016, Paleoflood investigations to improve peak-streamflow regional-regression equations for natural streamflow in eastern Colorado, 2015: U.S. Geological Survey Scientific Investigations Report 2016–5099, 58 p. (http://dx.doi.org/10.3133/sir20165099)		

USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

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USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.34.0

SSHydro Services Version: 1.3.0

SSDelineate Services Version: 1.2.0

NSS Services Version: 2.2.1

GageStats Services Version: 1.2.1

Pourpoint Services Version: 1.2.0

Batch Processor Version: 1.6.1



APPENDIX C – HYDRAULIC CALCULATIONS

INLET MANAGEMENT

Worksheet Protected

INLET NAME	DP8	DP9
Site Type (Urban or Rural)	RURAL	RURAL
Inlet Application (Street or Area)	AREA	AREA
Hydraulic Condition	Swale	Swale
Inlet Type	CDOT Type D (In Series)	CDOT Type D (In Series)

USER-DEFINED INPUT

User-Defined Design Flows		
Minor Q_{Known} (cfs)	4.8	2.5
Major Q_{Known} (cfs)	22.6	6.8

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

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

Watershed Characteristics

Subcatchment Area (acres)		
Percent Impervious		
NRCS Soil Type		

Watershed Profile

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

Minor Storm Rainfall Input

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

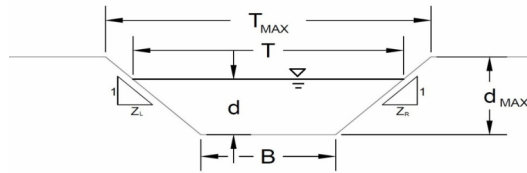
Major Storm Rainfall Input

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

CALCULATED OUTPUT

Minor Total Design Peak Flow, Q (cfs)	4.8	2.5
Major Total Design Peak Flow, Q (cfs)	22.6	6.8
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.0	0.0

AREA INLET IN A SWALE

RETREAT AT TIMBERRIDGE FILING NO. 1
DP8

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

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

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

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

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

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

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

A, B, C, D, or E =

n =	0.030
S_0 =	0.0575 ft/ft
B =	0.00 ft
Z1 =	4.00 ft/ft
Z2 =	3.00 ft/ft

Choose One:

- ☐ Non-Cohesive
☐ Cohesive
☐ Paved

Maximum Allowable Top Width of Channel for Minor & Major Storm

Maximum Allowable Water Depth in Channel for Minor & Major Storm

	Minor Storm	Major Storm
T_{MAX} =	17.50	17.50
d_{MAX} =	2.50	2.50

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm
Q_{allow} =	294.4	294.4
d_{allow} =	2.50	2.50

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

	Minor Storm	Major Storm
Q_o =	4.8	22.6
d =	0.53	0.95

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

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

Inlet Design Information (Input)

Type of Inlet

CDOT Type D (In Series)

Inlet Type =

CDOT Type D (In Series)

Angle of Inclined Grate (must be ≤ 30 degrees)

Width of Grate

Length of Grate

Open Area Ratio

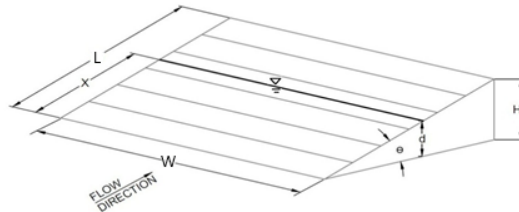
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



θ =	0.00	degrees
W =	3.00	ft
L =	6.00	ft
A_{RATIO} =	0.70	
H_B =	0.00	ft
C_f =	0.38	
C_d =	0.78	
C_o =	0.52	
C_w =	1.67	

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

Total Inlet Interception Capacity (assumes clogged condition)

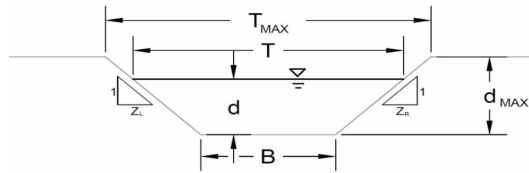
Bypassed Flow

Capture Percentage = Q_a/Q_o

	MINOR	MAJOR
d =	0.53	0.95
Q_a =	11.6	27.7
Q_b =	0.0	0.0
C% =	100	100

AREA INLET IN A SWALE

RETREAT AT TIMBERRIDGE FILING NO. 1
DP9



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

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

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

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

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

Channel Invert Slope

Bottom Width

Left Side Slope

Right Side Slope

Check one of the following soil types:

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

A, B, C, D, or E =

n =	0.030
S_0 =	0.0575 ft/ft
B =	0.00 ft
Z1 =	4.00 ft/ft
Z2 =	3.00 ft/ft

Choose One:

- ☐ Non-Cohesive
☒ Cohesive
☐ Paved

Maximum Allowable Top Width of Channel for Minor & Major Storm

Maximum Allowable Water Depth in Channel for Minor & Major Storm

	Minor Storm	Major Storm
T_{MAX} =	17.50	17.50
d_{MAX} =	2.50	2.50

Allowable Channel Capacity Based On Channel Geometry

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm
Q_{allow} =	294.4	294.4
d_{allow} =	2.50	2.50

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow

Water Depth

	Minor Storm	Major Storm
Q_o =	2.5	6.8
d =	0.42	0.61

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

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

Inlet Design Information (Input)

Type of Inlet

CDOT Type D (In Series)

Inlet Type =

CDOT Type D (In Series)

Angle of Inclined Grate (must be ≤ 30 degrees)

Width of Grate

Length of Grate

Open Area Ratio

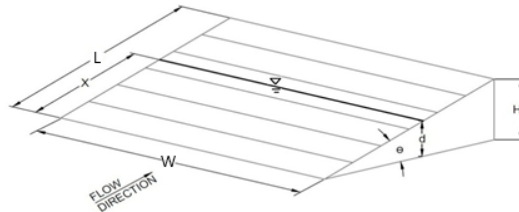
Height of Inclined Grate

Clogging Factor

Grate Discharge Coefficient

Orifice Coefficient

Weir Coefficient



θ =	0.00	degrees
W =	3.00	ft
L =	6.00	ft
A_{RATIO} =	0.70	
H_B =	0.00	ft
C_f =	0.38	
C_d =	0.78	
C_o =	0.52	
C_w =	1.67	

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

Total Inlet Interception Capacity (assumes clogged condition)

Bypassed Flow

Capture Percentage = Q_a/Q_o

	MINOR	MAJOR
d =	0.42	0.61
Q_a =	8.0	14.1
Q_b =	0.0	0.0
C% =	100	100

Channel Report

DP8 - 24in RCP (Q5 = 4.6 cfs, Q100 = 22.1 cfs)

Circular

Diameter (ft) = 2.00

Invert Elev (ft) = 7242.52

Slope (%) = 2.00

N-Value = 0.016

Calculations

Compute by: Known Q

Known Q (cfs) = 22.10

Highlighted

Depth (ft) = 1.42

Q (cfs) = 22.10

Area (sqft) = 2.39

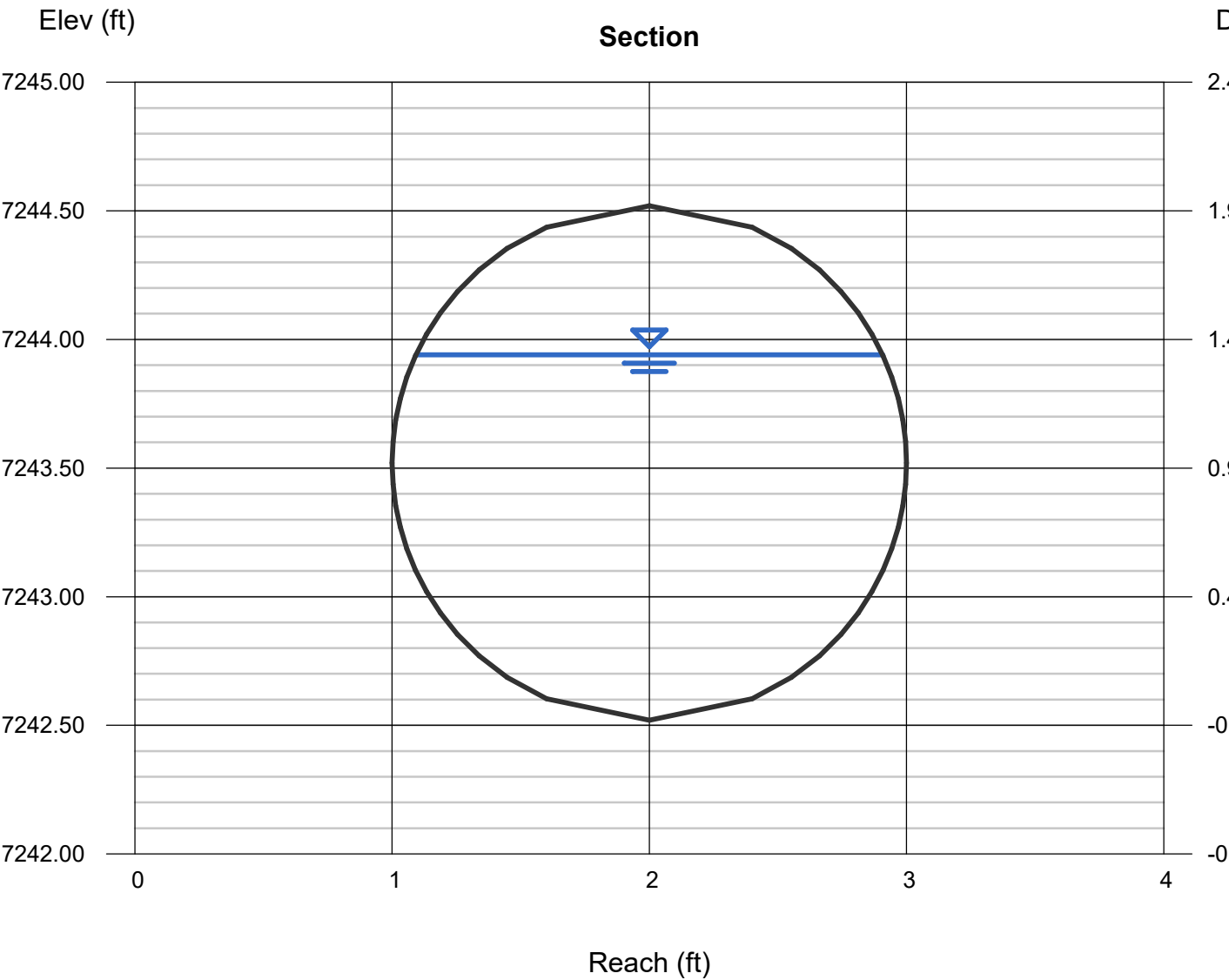
Velocity (ft/s) = 9.26

Wetted Perim (ft) = 4.01

Crit Depth, Yc (ft) = 1.68

Top Width (ft) = 1.81

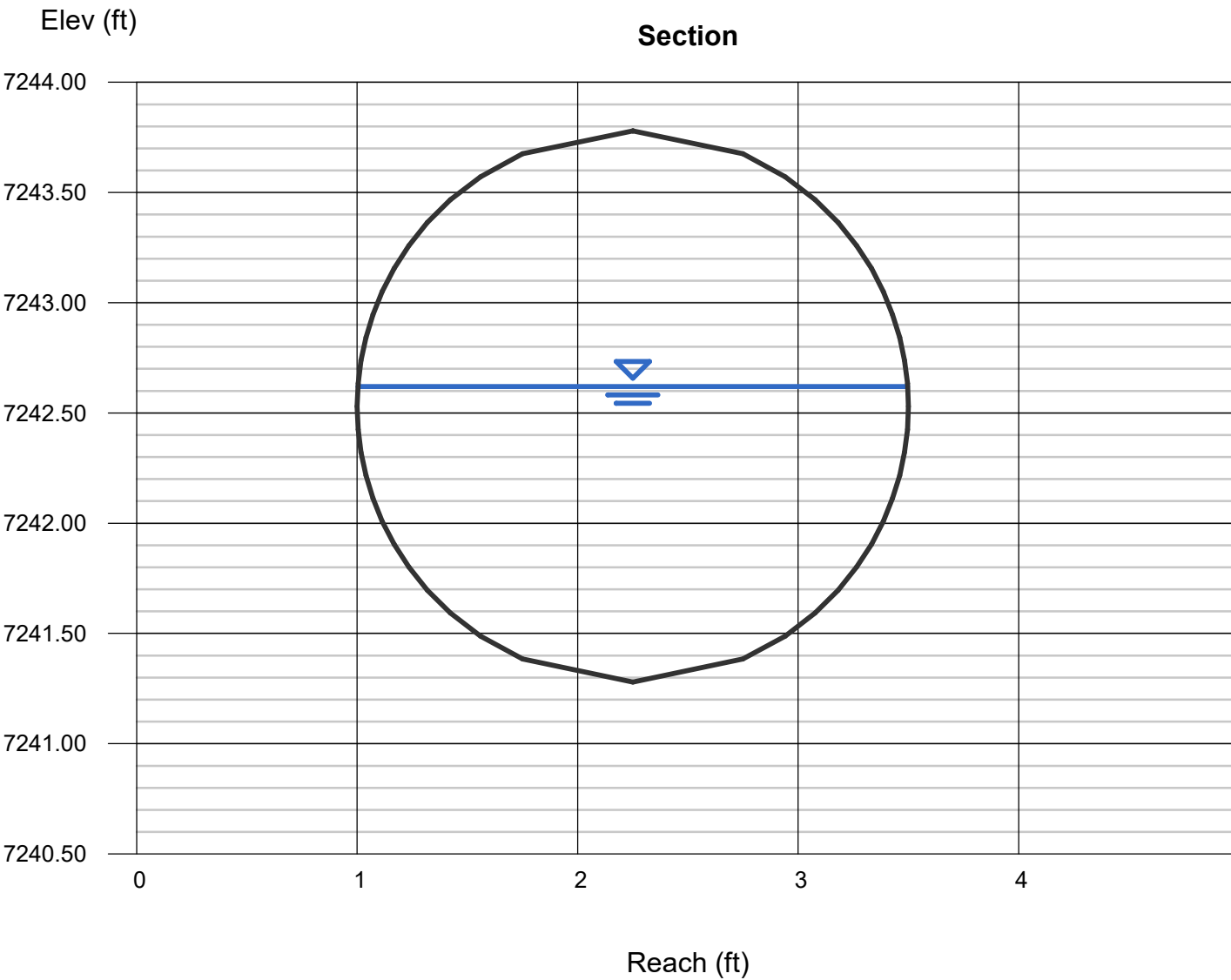
EGL (ft) = 2.75



Channel Report

DP9.1 - 30in RCP (Q5= 6.4 cfs, Q100 = 26.8 cfs)

Circular		Highlighted	
Diameter (ft)	= 2.50	Depth (ft)	= 1.34
		Q (cfs)	= 26.80
		Area (sqft)	= 2.69
Invert Elev (ft)	= 7241.28	Velocity (ft/s)	= 9.98
Slope (%)	= 2.05	Wetted Perim (ft)	= 4.11
N-Value	= 0.016	Crit Depth, Yc (ft)	= 1.77
		Top Width (ft)	= 2.49
		EGL (ft)	= 2.89
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 26.80		



Culvert Report

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

Thursday, Jul 30 2026

DP11 Culvert (Q5 = 2.1 cfs, Q100 = 3.1 cfs)

Invert Elev Dn (ft) = 7238.43
Pipe Length (ft) = 98.30
Slope (%) = 2.79
Invert Elev Up (ft) = 7241.17
Rise (in) = 18.0
Shape = Circular
Span (in) = 18.0
No. Barrels = 1
n-Value = 0.012
Culvert Type = Circular Concrete
Culvert Entrance = Groove end projecting (C)
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

Embankment

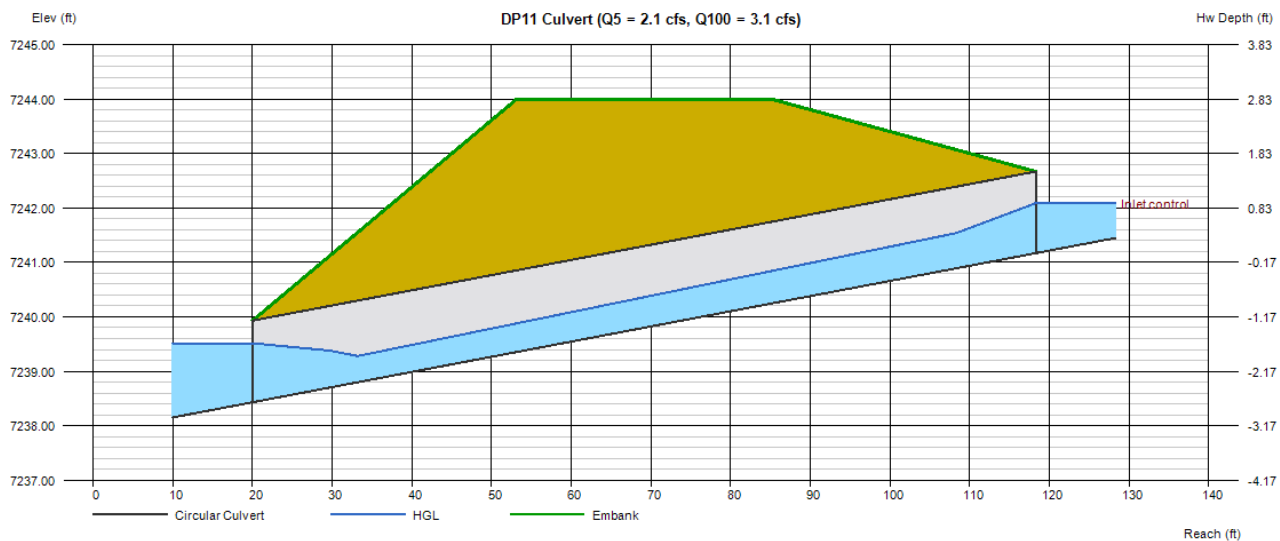
Top Elevation (ft) = 7244.00
Top Width (ft) = 32.00
Crest Width (ft) = 50.00

Calculations

Qmin (cfs) = 2.10
Qmax (cfs) = 3.10
Tailwater Elev (ft) = (dc+D)/2

Highlighted

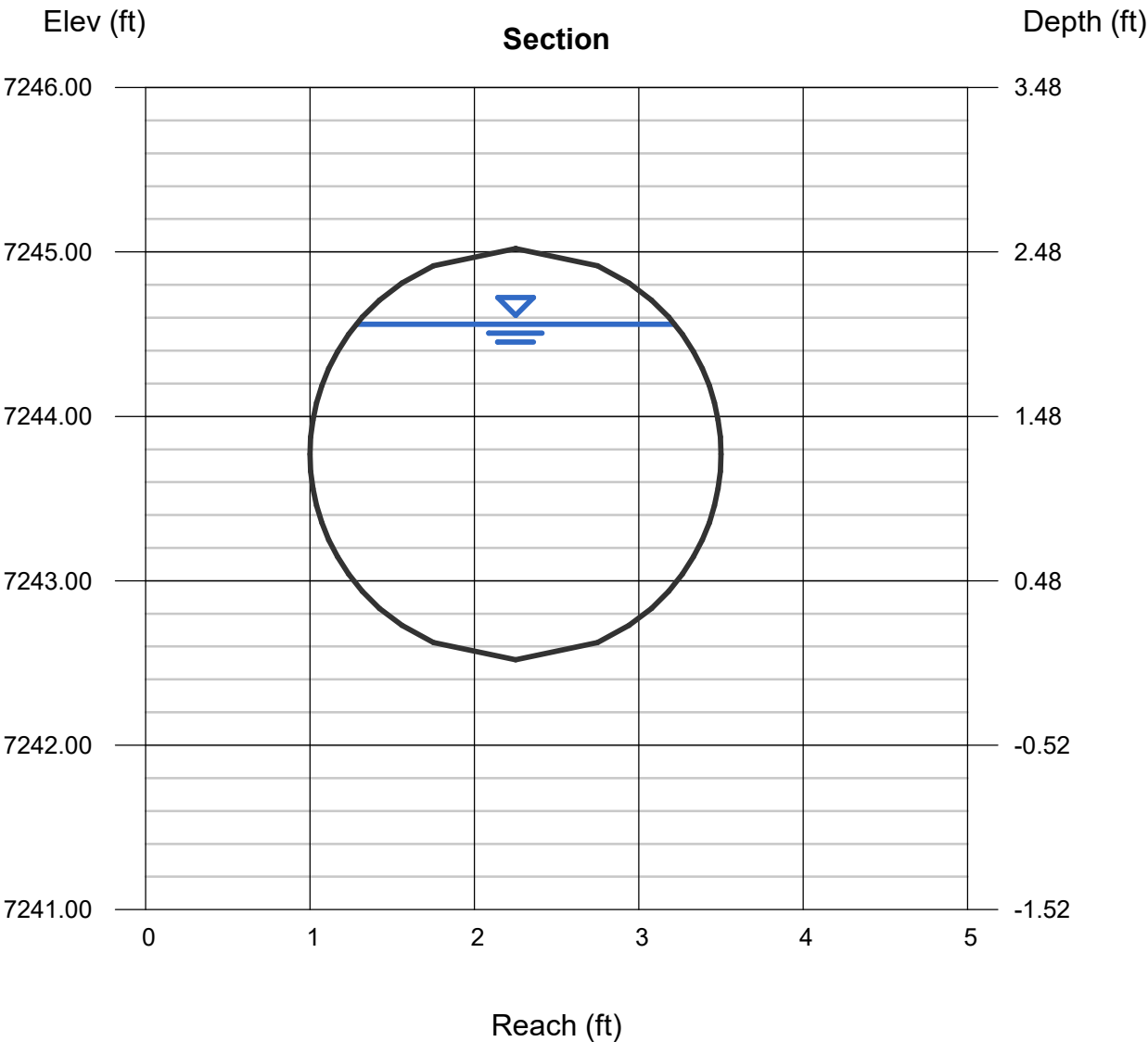
Qtotal (cfs) = 3.10
Qpipe (cfs) = 3.10
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 2.27
Veloc Up (ft/s) = 4.06
HGL Dn (ft) = 7239.52
HGL Up (ft) = 7241.84
Hw Elev (ft) = 7242.09
Hw/D (ft) = 0.61
Flow Regime = Inlet Control



Channel Report

Pond 1 Outfall - 30in RCP (Q5= 0.3 cfs, Q100 = 24.8 cfs)

Circular		Highlighted	
Diameter (ft)	= 2.50	Depth (ft)	= 2.04
		Q (cfs)	= 24.80
		Area (sqft)	= 4.29
Invert Elev (ft)	= 7242.52	Velocity (ft/s)	= 5.78
Slope (%)	= 0.56	Wetted Perim (ft)	= 5.64
N-Value	= 0.016	Crit Depth, Yc (ft)	= 1.70
		Top Width (ft)	= 1.94
		EGL (ft)	= 2.56
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 24.80		



Channel Report

DP8 Swale - Min. Slope (Q100 = 22.1 cfs)

Triangular

Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.50

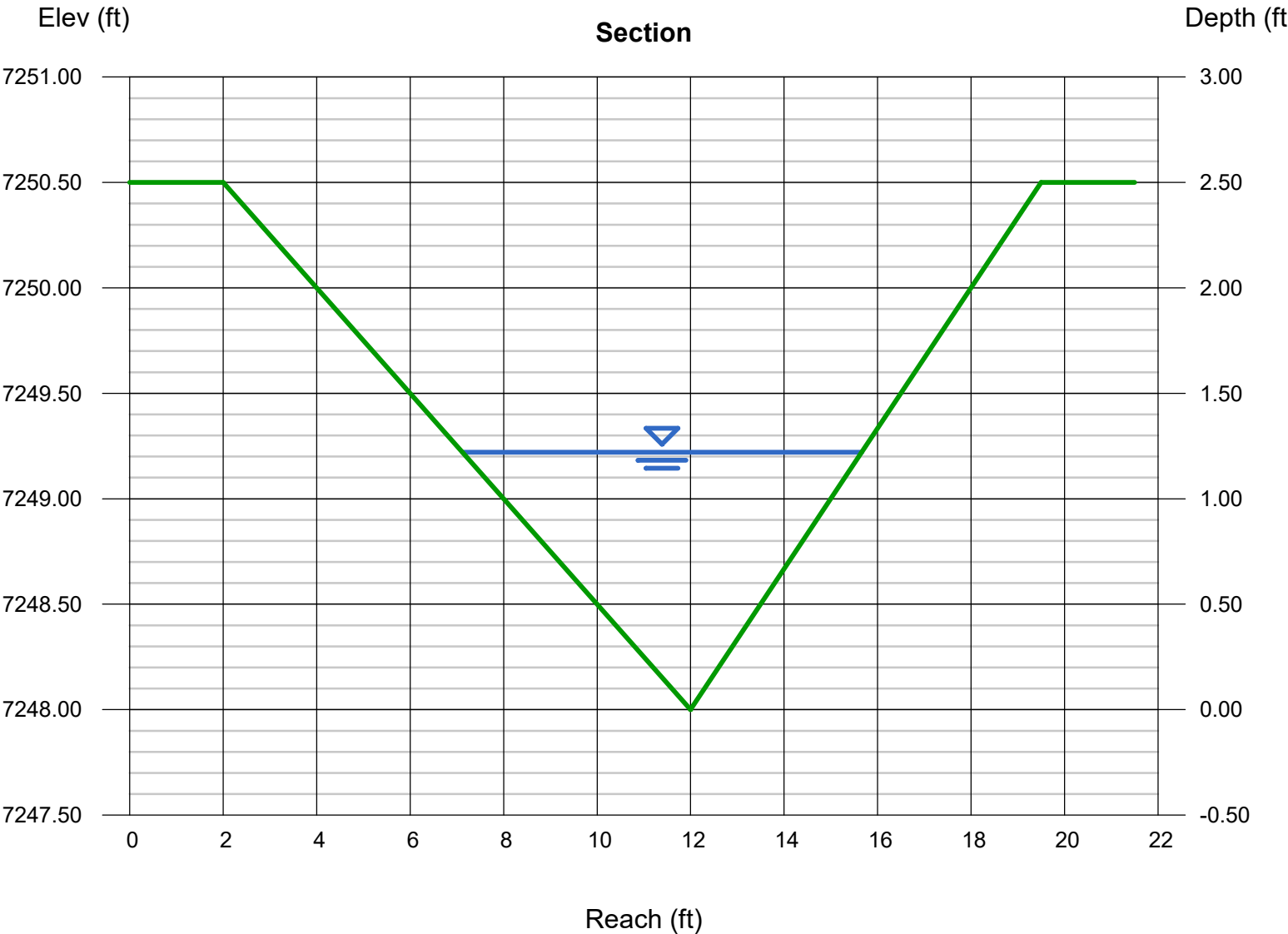
Invert Elev (ft) = 7248.00
Slope (%) = 1.50
N-Value = 0.030

Calculations

Compute by: Known Q
Known Q (cfs) = 22.10

Highlighted

Depth (ft) = 1.22
Q (cfs) = 22.10
Area (sqft) = 5.21
Velocity (ft/s) = 4.24
Wetted Perim (ft) = 8.89
Crit Depth, Yc (ft) = 1.20
Top Width (ft) = 8.54
EGL (ft) = 1.50



Channel Report

DP9 Swale - Min. Slope (Q100 = 6.7 cfs)

Triangular

Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.50

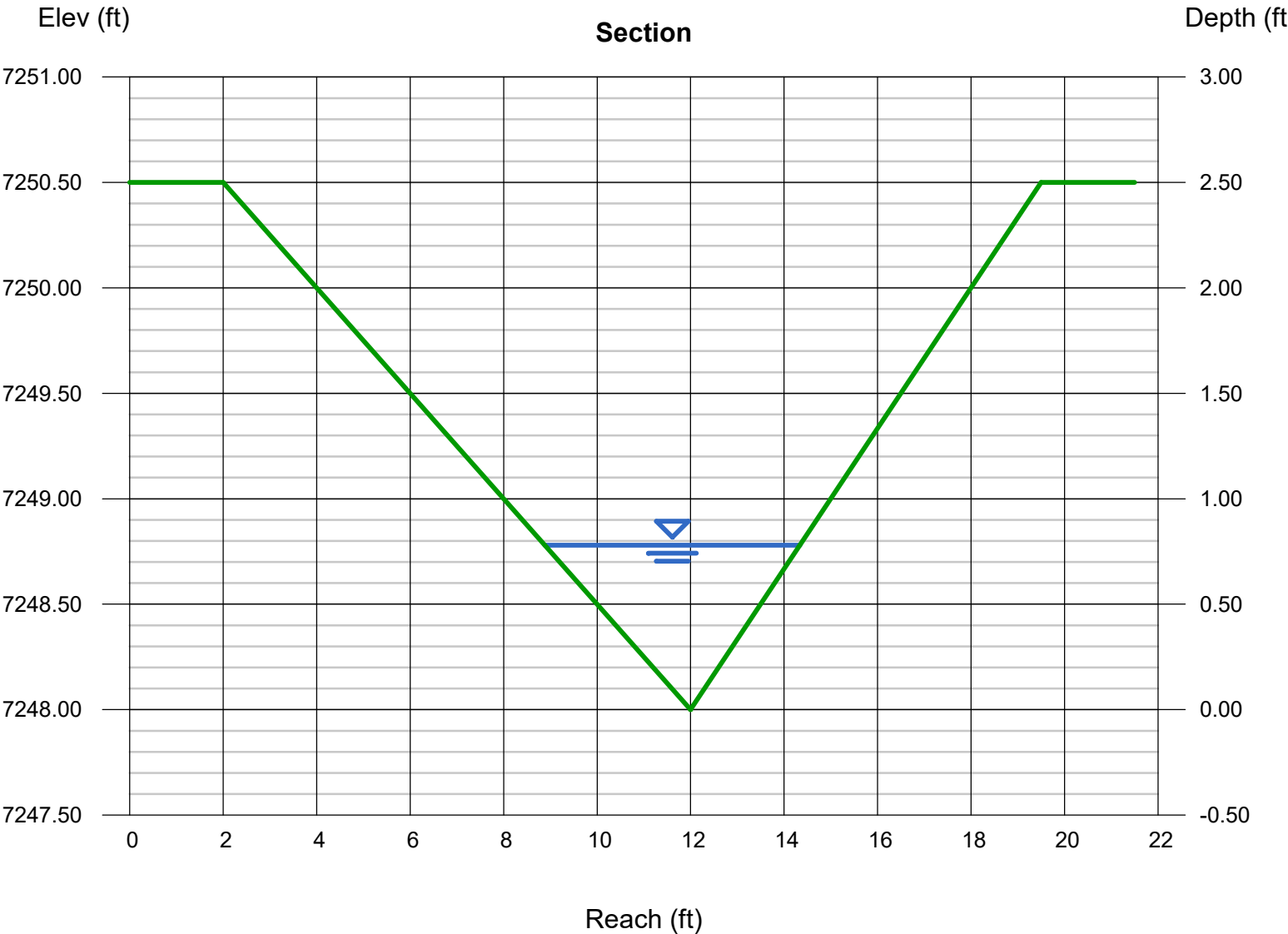
Invert Elev (ft) = 7248.00
Slope (%) = 1.50
N-Value = 0.030

Calculations

Compute by: Known Q
Known Q (cfs) = 6.70

Highlighted

Depth (ft) = 0.78
Q (cfs) = 6.700
Area (sqft) = 2.13
Velocity (ft/s) = 3.15
Wetted Perim (ft) = 5.68
Crit Depth, Yc (ft) = 0.75
Top Width (ft) = 5.46
EGL (ft) = 0.93



Channel Report

DP8 Swale - Max. Slope (Q100 = 22.1 cfs)

Triangular

Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.50

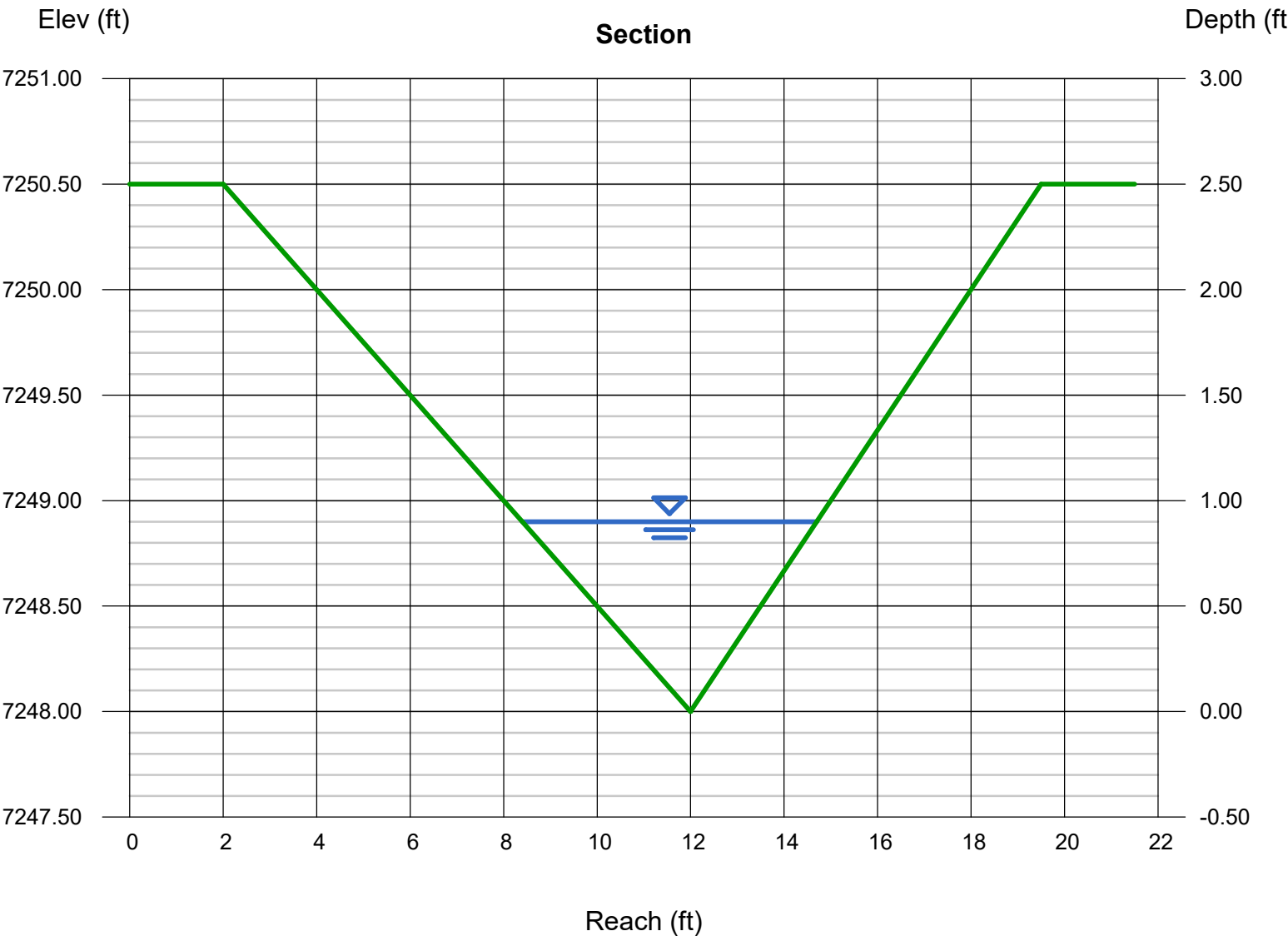
Invert Elev (ft) = 7248.00
Slope (%) = 8.00
N-Value = 0.030

Calculations

Compute by: Known Q
Known Q (cfs) = 22.10

Highlighted

Depth (ft) = 0.90
Q (cfs) = 22.10
Area (sqft) = 2.83
Velocity (ft/s) = 7.80
Wetted Perim (ft) = 6.56
Crit Depth, Yc (ft) = 1.20
Top Width (ft) = 6.30
EGL (ft) = 1.84



Channel Report

DP9 Swale - Max. Slope (Q100 = 6.7 cfs)

Triangular

Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.50

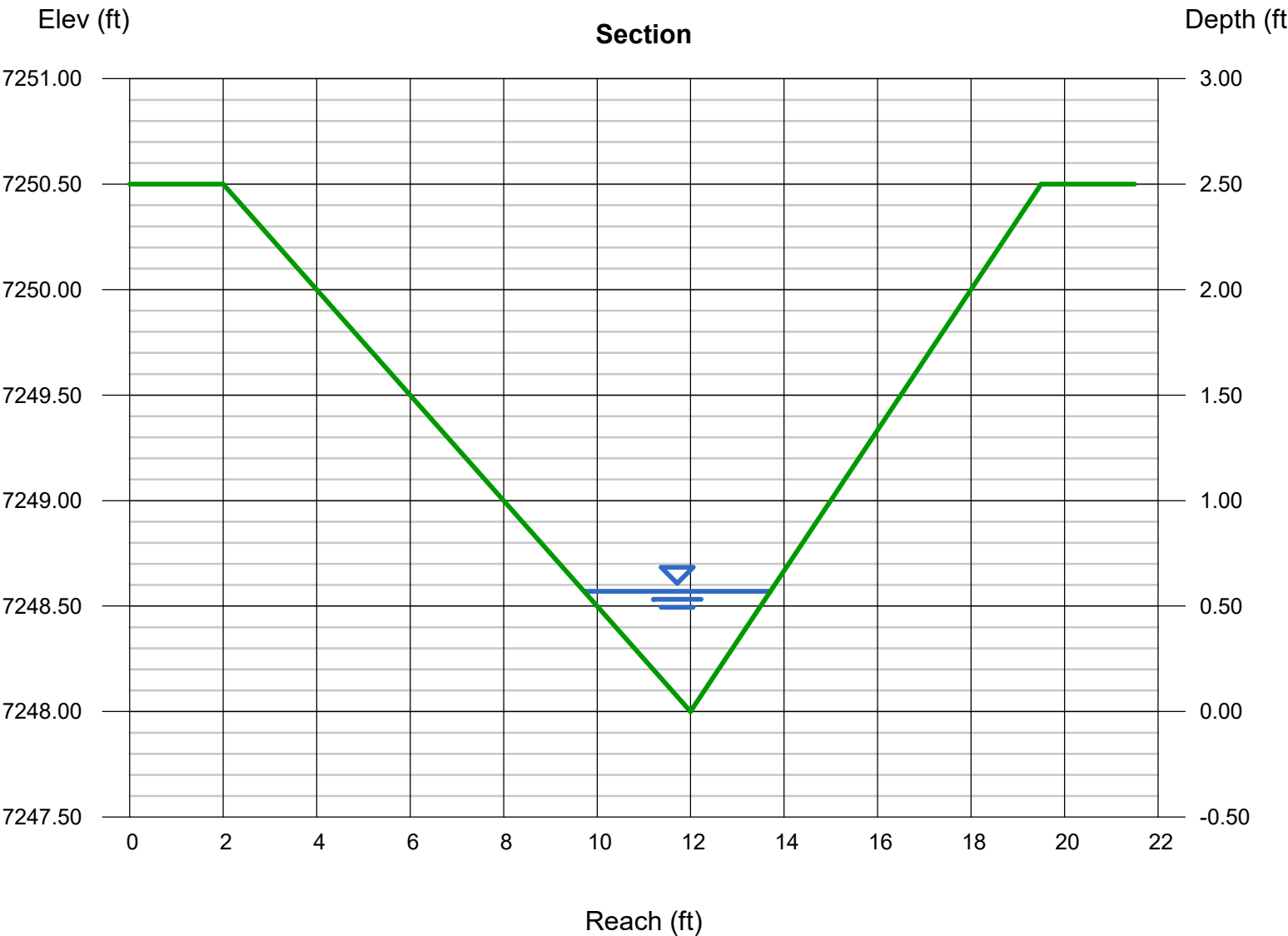
Invert Elev (ft) = 7248.00
Slope (%) = 8.00
N-Value = 0.030

Calculations

Compute by: Known Q
Known Q (cfs) = 6.70

Highlighted

Depth (ft) = 0.57
Q (cfs) = 6.700
Area (sqft) = 1.14
Velocity (ft/s) = 5.89
Wetted Perim (ft) = 4.15
Crit Depth, Yc (ft) = 0.75
Top Width (ft) = 3.99
EGL (ft) = 1.11



Channel Report

DP6 Swale - Max. Slope (Q100 = 16.1 cfs)

Triangular

Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.50

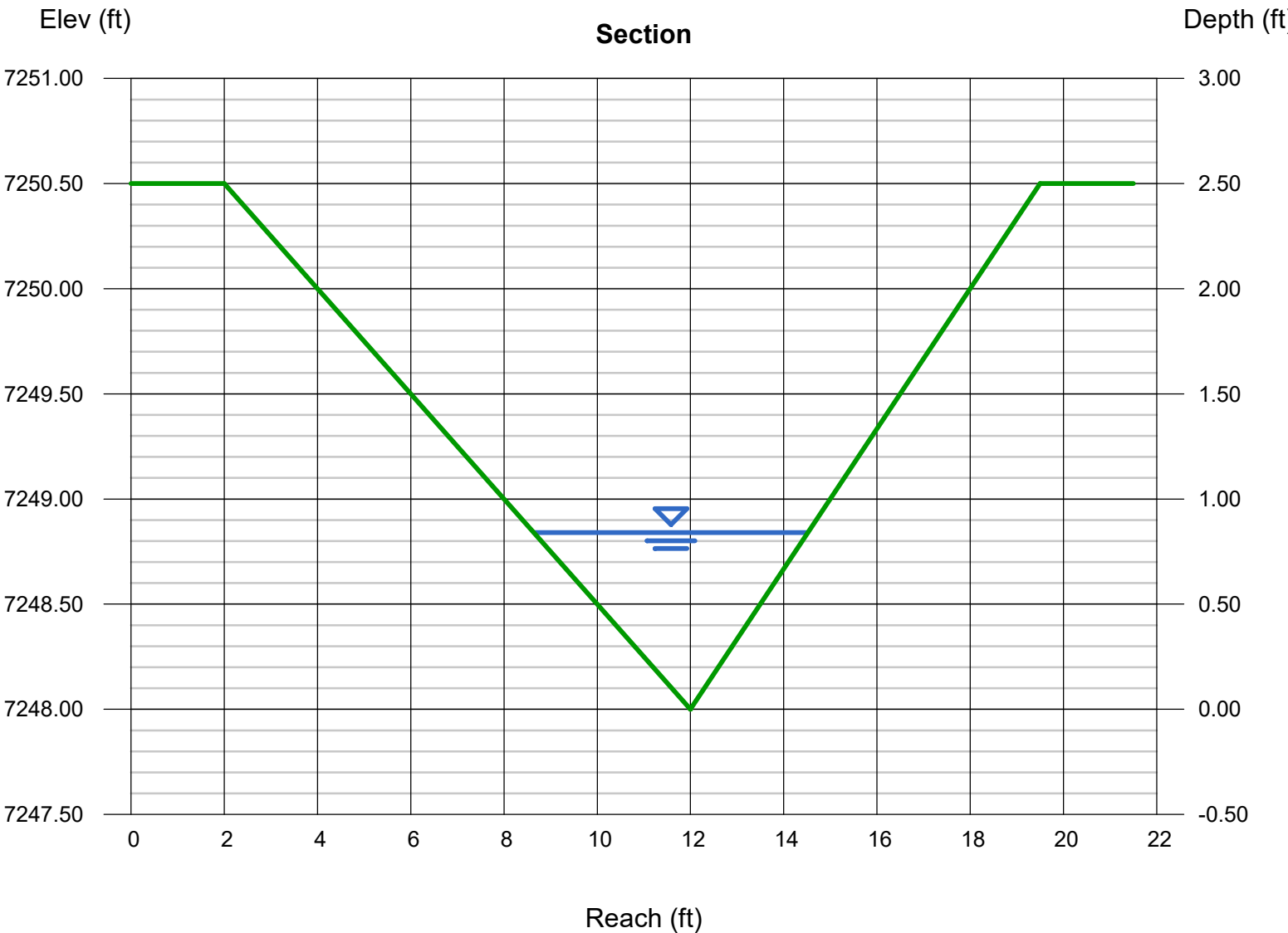
Invert Elev (ft) = 7248.00
Slope (%) = 5.84
N-Value = 0.030

Calculations

Compute by: Known Q
Known Q (cfs) = 16.10

Highlighted

Depth (ft) = 0.84
Q (cfs) = 16.10
Area (sqft) = 2.47
Velocity (ft/s) = 6.52
Wetted Perim (ft) = 6.12
Crit Depth, Yc (ft) = 1.06
Top Width (ft) = 5.88
EGL (ft) = 1.50



Channel Report

DP6 Swale - Min. Slope (Q100 = 16.1 cfs)

Triangular

Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.50

Invert Elev (ft) = 7248.00
Slope (%) = 0.60
N-Value = 0.030

Calculations

Compute by: Known Q
Known Q (cfs) = 16.10

Highlighted

Depth (ft) = 1.29
Q (cfs) = 16.10
Area (sqft) = 5.82
Velocity (ft/s) = 2.76
Wetted Perim (ft) = 9.40
Crit Depth, Yc (ft) = 1.06
Top Width (ft) = 9.03
EGL (ft) = 1.41

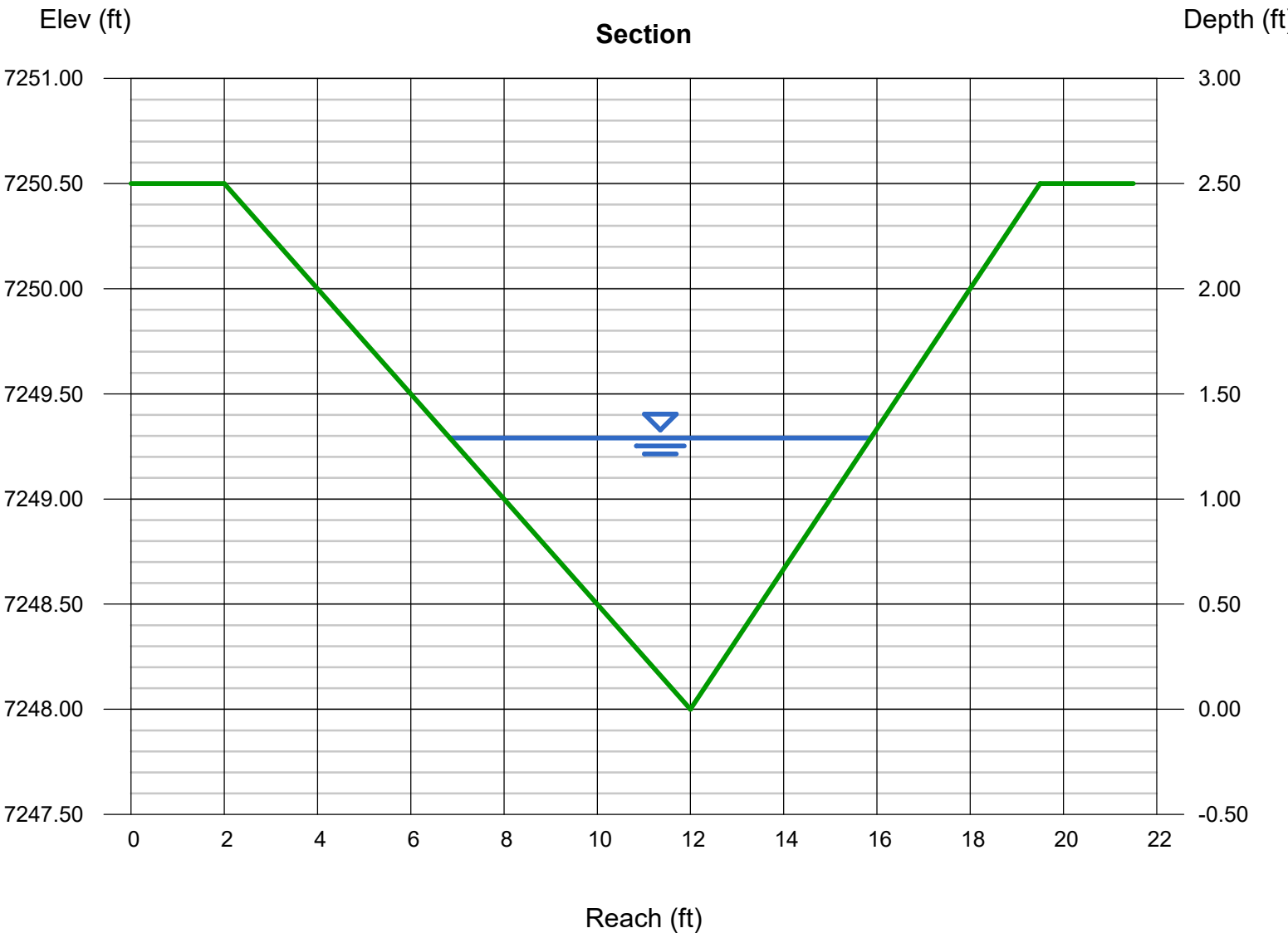


Figure 13-12c. Emergency Spillway Protection

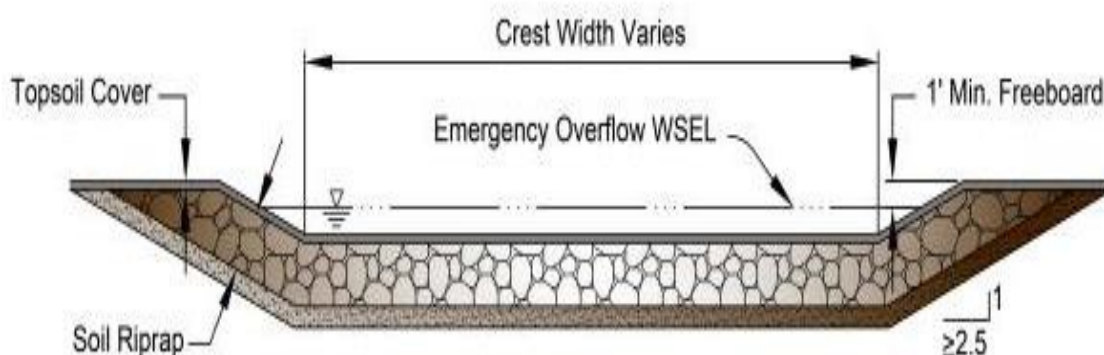
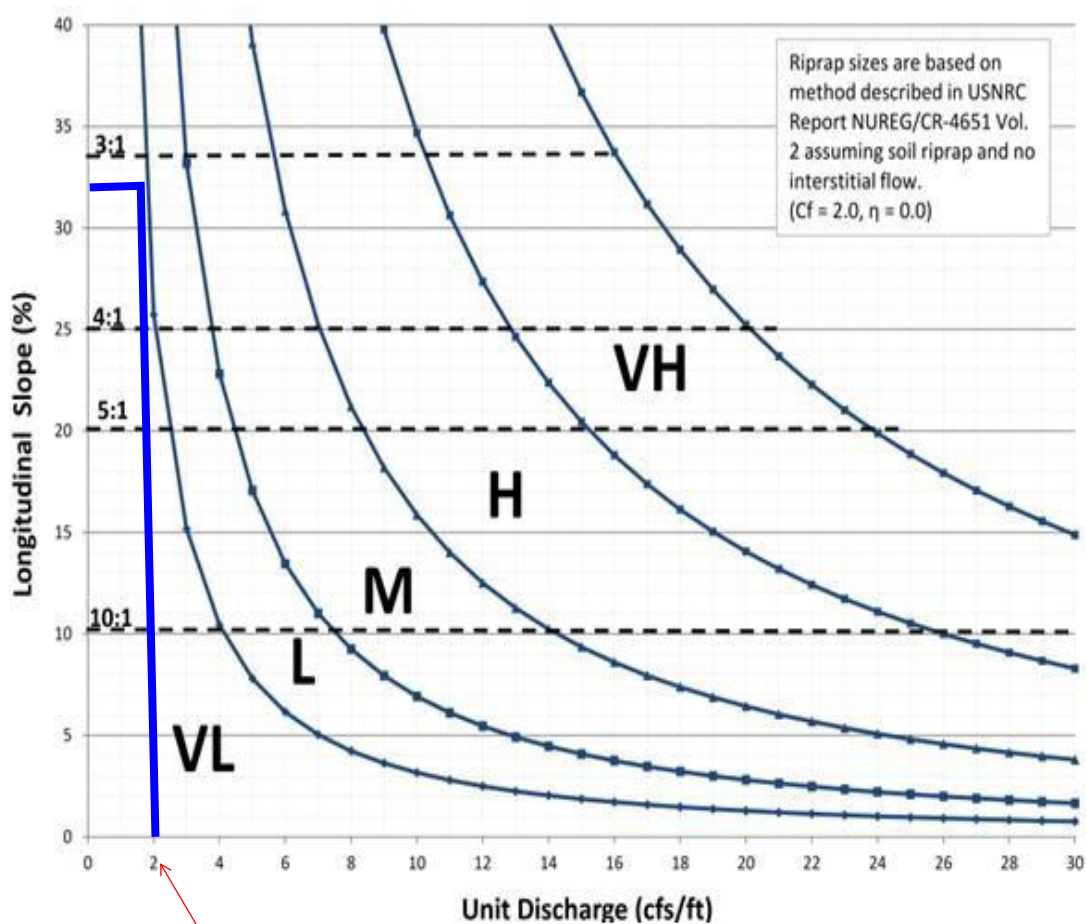


Figure 13-12d. Riprap Types for Emergency Spillway Protection

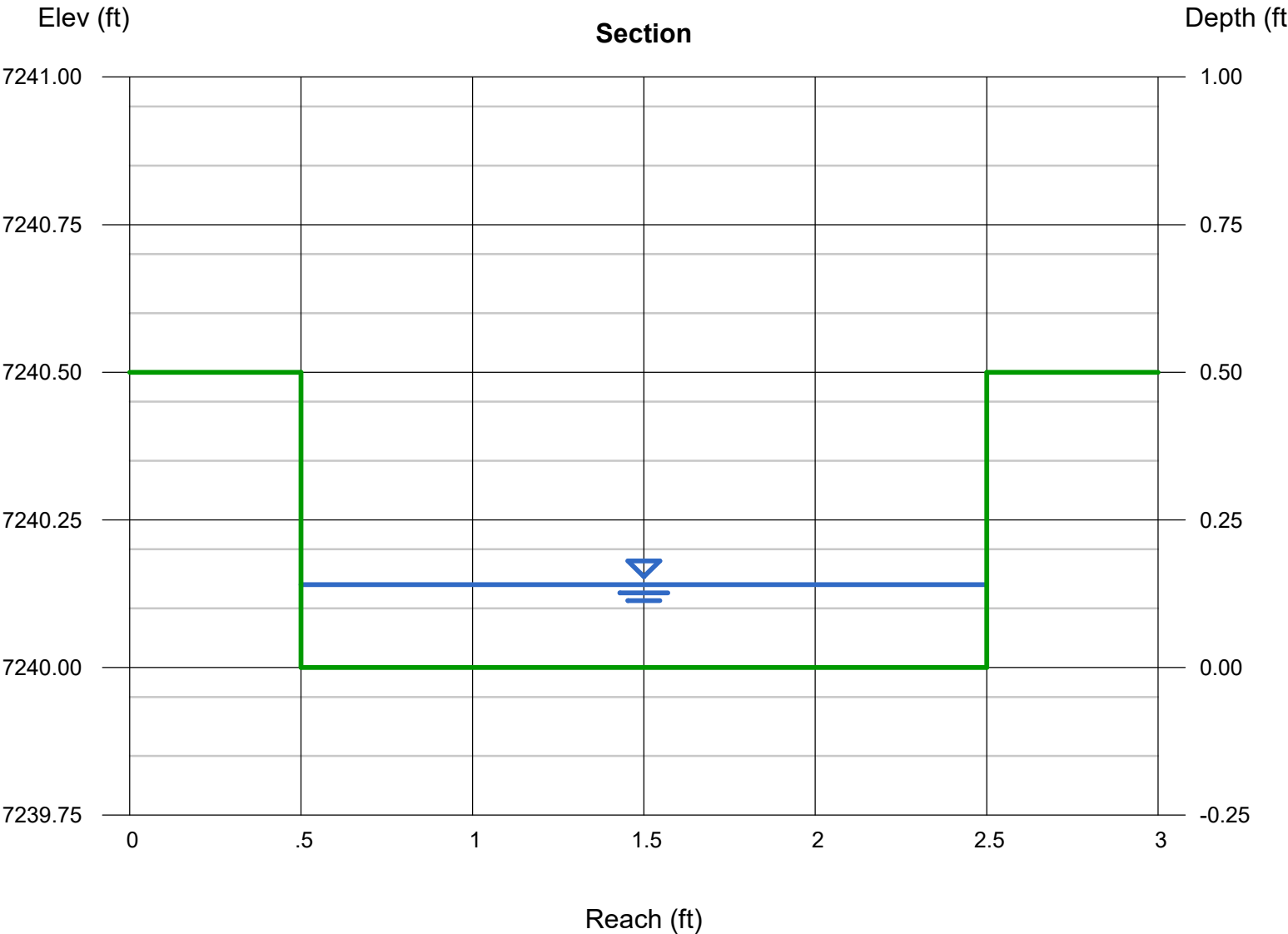


SPILLWAY CREST WIDTH = 20'
PEAK 100 YEAR INFLOW = 41.2 CFS

Channel Report

Pond 1 Trickle Channel (Q= 1% of Peak 100-year Inflow = 0.41 cfs)

Rectangular		Highlighted	
Bottom Width (ft)	= 2.00	Depth (ft)	= 0.14
Total Depth (ft)	= 0.50	Q (cfs)	= 0.410
		Area (sqft)	= 0.28
Invert Elev (ft)	= 7240.00	Velocity (ft/s)	= 1.46
Slope (%)	= 0.50	Wetted Perim (ft)	= 2.28
N-Value	= 0.016	Crit Depth, Yc (ft)	= 0.11
		Top Width (ft)	= 2.00
		EGL (ft)	= 0.17
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 0.41		



Timbers of Black Forest No. 1 - Riprap Sizing

Location	Ss	Velocity (ft/s)	Slope (ft/ft)	d ₅₀ (calc) (in)	d ₅₀ (selected) (in)	Designation	Depth
Pond 1 Outfall	2.5	5	0.12	2.7	6"	TYPE VL	12"
DP11 Culvert Outfall	2.5	2.27	0.33	1.4	6"	TYPE VL	12"

$$\frac{v_s^{0.17}}{(S_s - 1)^{0.66}} = 1.0$$

Where:

V = mean channel flow velocity, in fps;

S = longitudinal channel slope, in feet per foot (ft/ft); and

S_s = specific gravity of stone (minimum S_s = 2.50)

RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D ₅₀ * (INCHES)
TYPE VL	70 - 100 50 - 70 35 - 50 2 - 10	12 9 6 2	6
TYPE L	70 - 100 50 - 70 35 - 50 2 - 10	15 12 9 3	9
TYPE M	70 - 100 50 - 70 35 - 50 2 - 10	21 18 12 4	12
TYPE H	70 - 100 50 - 70 35 - 50 2 - 10	30 24 18 6	18
*D ₅₀ = MEAN ROCK SIZE			

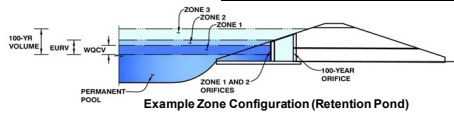
Figure 8-34. Riprap and soil riprap placement and gradation (part 1 of 3)



APPENDIX D – WATER QUALITY & DETENTION

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: Basin D - K



Example Zone Configuration (Retention Pond)

Selected BMP Type =	EDB	
Watershed Area =	27.71	acres
Watershed Length =	2,500	ft
Watershed Length to Centroid =	670	ft
Watershed Slope =	0.055	ft/ft
Watershed Imperviousness =	12.40%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Group C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

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

Water Quality Capture Volume (WQCV)	0.185	acre-feet
Excess Urban Runoff Volume (EURV)	0.329	acre-feet
2-yr Runoff Volume ($P1 = 0.94$ in.)	0.176	acre-feet
5-yr Runoff Volume ($P1 = 1.22$ in.)	0.417	acre-feet
10-yr Runoff Volume ($P1 = 1.47$ in.)	0.785	acre-feet
25-yr Runoff Volume ($P1 = 1.86$ in.)	1.825	acre-feet
50-yr Runoff Volume ($P1 = 2.18$ in.)	2.513	acre-feet
100-yr Runoff Volume ($P1 = 2.53$ in.)	3.466	acre-feet
500-yr Runoff Volume ($P1 = 3.44$ in.)	5.575	acre-feet
Approximate 2-yr Detention Volume	0.169	acre-feet
Approximate 5-yr Detention Volume	0.269	acre-feet
Approximate 10-yr Detention Volume	0.527	acre-feet
Approximate 25-yr Detention Volume	0.786	acre-feet
Approximate 50-yr Detention Volume	0.861	acre-feet
Approximate 100-yr Detention Volume	1.138	acre-feet

Zone 1 Volume (WQCV) =	0.185	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.143	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.809	acre-feet
Total Detention Basin Volume =	1.138	acre-feet
Initial Surcharge Volume (ISV) =	user	ft. ³
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

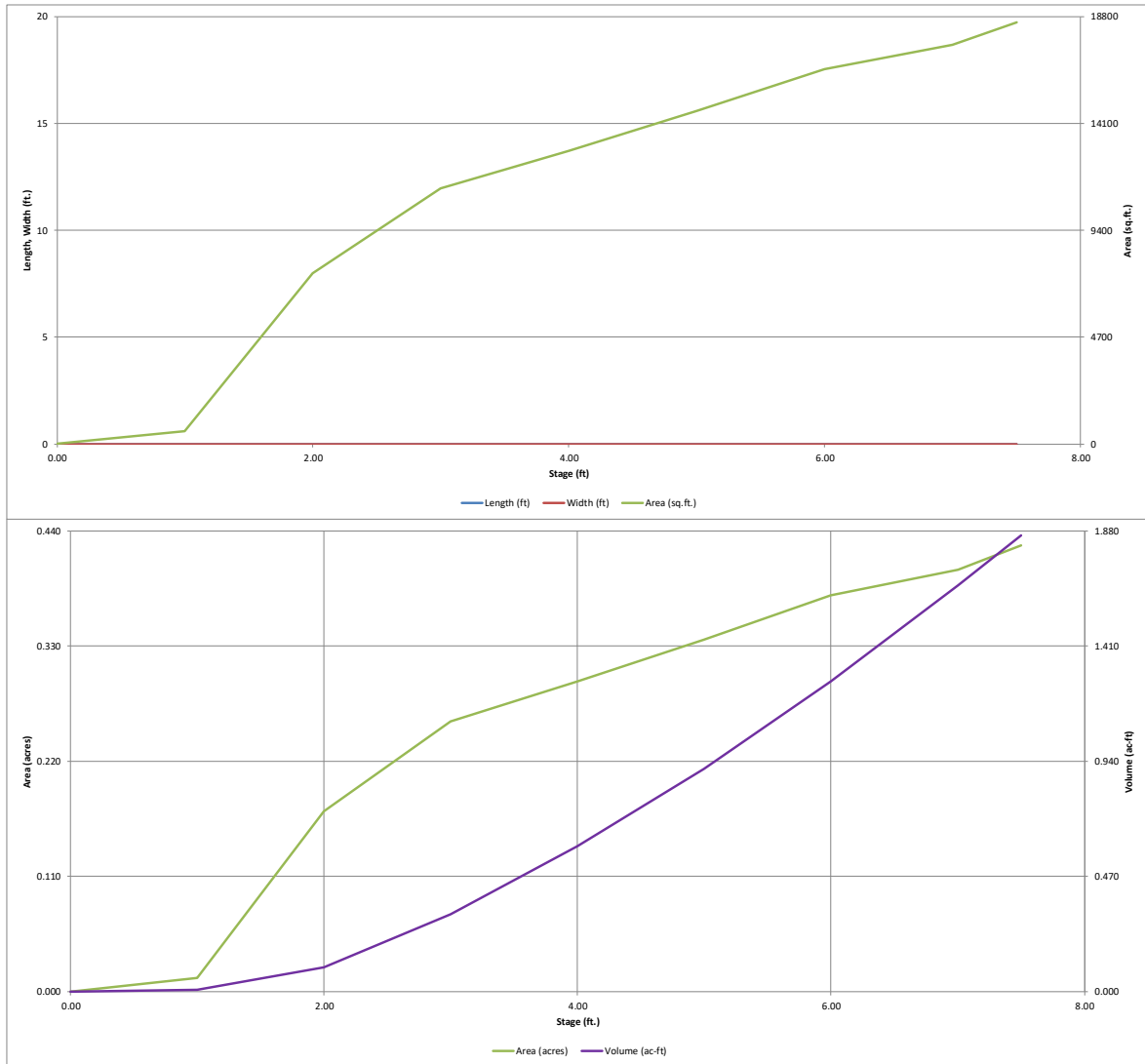
Initial Surcharge Area (A_{S1})	=	user	ft ²
Surcharge Volume Length (L_{S1})	=	user	ft
Surcharge Volume Width (W_{S1})	=	user	ft
Depth of Basin Floor (H_{FLOOR})	=	user	ft
Length of Basin Floor (L_{FLOOR})	=	user	ft
Width of Basin Floor (W_{FLOOR})	=	user	ft
Area of Basin Floor (A_{FLOOR})	=	user	ft ²
Volume of Basin Floor (V_{FLOOR})	=	user	ft ³
Depth of Main Basin (H_{MAIN})	=	user	ft
Length of Main Basin (L_{MAIN})	=	user	ft
Width of Main Basin (W_{MAIN})	=	user	ft
Area of Main Basin (A_{MAIN})	=	user	ft ²
Volume of Main Basin (V_{MAIN})	=	user	ft ³
Calculated Total Basin Volume (V_{TOTAL})	=	user	acre-feet

	acre-feet
	acre-feet
0.94	inches
1.22	inches
1.47	inches
1.86	inches
2.18	inches
2.53	inches
3.44	inches

Depth Increment =		ft								
	Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft ²)	Optional Override Area (ft ²)	Area (acre)	Volume (ft ³)	Volume (ac-ft)
7239	Top of Micropool	--	0.00	--	--	--	10	0.000		
	7240	--	1.00	--	--	--	570	0.013	290	0.007
	7241	--	2.00	--	--	--	7,511	0.172	4,330	0.099
	7242	--	3.00	--	--	--	11,252	0.258	13,712	0.315
	7243	--	4.00	--	--	--	12,902	0.296	25,789	0.592
	7244	--	5.00	--	--	--	14,648	0.336	39,564	0.908
	7245	--	6.00	--	--	--	16,490	0.379	55,133	1.266
	7246	--	7.00	--	--	--	17,560	0.403	72,158	1.657
	7246.5	--	7.50	--	--	--	18,574	0.426	81,191	1.864
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DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

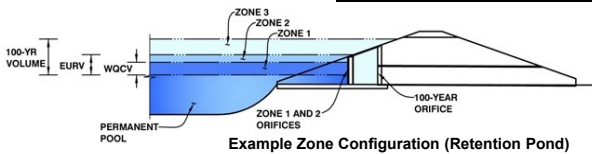


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Timber at Black Forest

Basin ID: Basin D - K



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.45	0.185	Orifice Plate
Zone 2 (EURV)	3.06	0.143	Orifice Plate
Zone 3 (100-year)	5.66	0.809	Weir&Pipe (Restrict)
Total (all zones)		1.138	

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

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

Calculated Parameters for Underdrain
Underdrain Orifice Area = N/A ft²
Underdrain Orifice Centroid = N/A feet

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

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = 3.22 ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = 12.90 inches
Orifice Plate: Orifice Area per Row = 0.75 sq. inches (diameter = 15/16 inch)

Calculated Parameters for Plate
WQ Orifice Area per Row = 5.208E-03 ft²
Elliptical Half-Width = N/A feet
Elliptical Slot Centroid = N/A feet
Elliptical Slot Area = N/A 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	1.07	2.15					
Orifice Area (sq. inches)	0.75	0.75	0.75					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice
Vertical Orifice Area = N/A ft²
Vertical Orifice Centroid = N/A feet

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

Overflow Weir Front Edge Height, H_o = 3.25 ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = 5.00 feet
Overflow Weir Gate Slope = 0.00 H:V
Horiz. Length of Weir Sides = 5.00 feet
Overflow Gate Type = Type C Gate
Debris Clogging % = 50%

Calculated Parameters for Overflow Weir
Height of Gate Upper Edge, H_t = 3.25 feet
Overflow Weir Slope Length = 5.00 feet
Gate Open Area / 100-yr Orifice Area = 8.96
Overflow Gate Open Area w/o Debris = 17.40 ft²
Overflow Gate Open Area w/ Debris = 8.70 ft²

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

Depth to Invert of Outlet Pipe = 2.00 ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = 27.00 inches
Restrictor Plate Height Above Pipe Invert = 13.25 inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate
Outlet Orifice Area = 1.94 ft²
Outlet Orifice Centroid = 0.64 feet
Half-Central Angle of Restrictor Plate on Pipe = 1.55 radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = 5.70 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 = 0.73 feet
Stage at Top of Freeboard = 7.43 feet
Basin Area at Top of Freeboard = 0.42 acres
Basin Volume at Top of Freeboard = 1.83 acre-ft

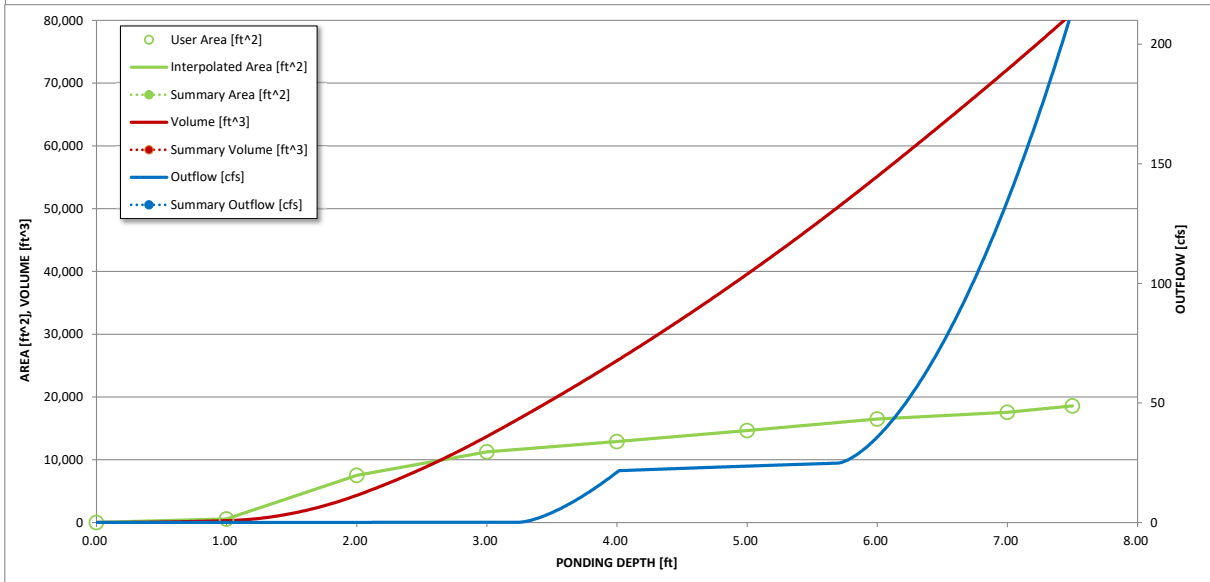
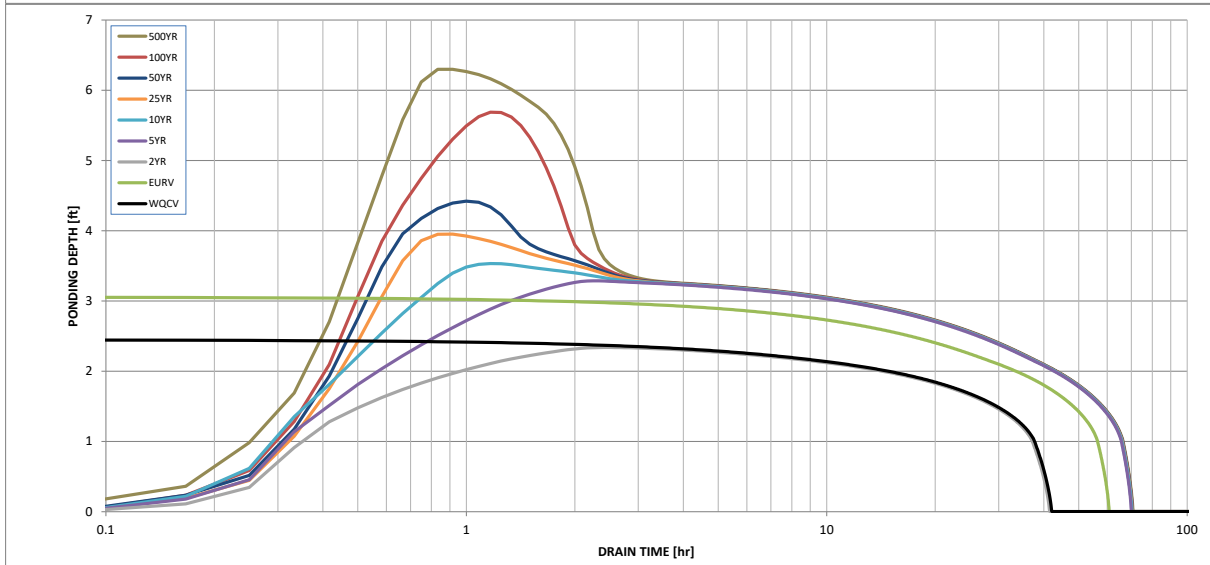
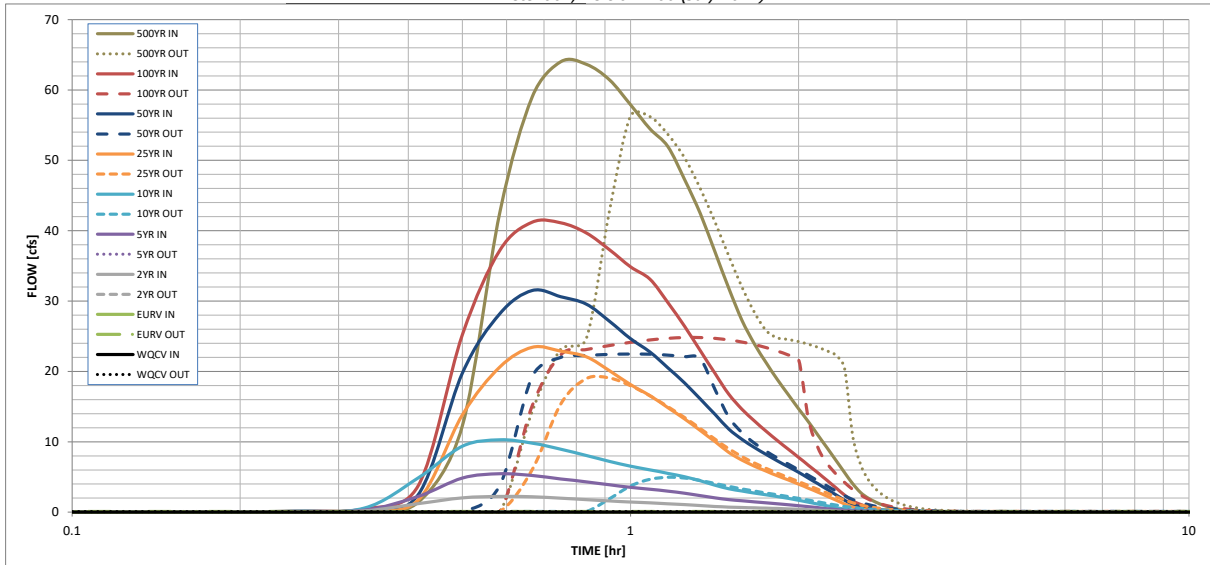
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.94	1.22	1.47	1.86	2.18	2.53	3.44
One-Hour Rainfall Depth (in) =	0.185	0.329	0.176	0.417	0.785	1.825	2.513	3.466	5.575
CUHP Runoff Volume (acre-ft) =	N/A	N/A	0.176	0.417	0.785	1.825	2.513	3.466	5.575
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.3	2.9	7.5	20.5	28.3	38.5	60.8
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.01	0.10	0.27	0.74	1.02	1.39	2.19
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	2.2	5.5	10.3	23.4	31.5	41.2	64.0
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.1	0.3	5.0	19.1	22.5	24.8	56.3
Peak Inflow Q (cfs) =	N/A	N/A	0.1	0.3	5.0	19.1	22.5	24.8	56.3
Peak Outflow Q (cfs) =	N/A	N/A	0.1	0.3	5.0	19.1	22.5	24.8	56.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.7	0.9	0.8	0.6	0.9
Structure Controlling Flow =	Plate	Plate	Plate	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	0.3	1.1	1.3	1.4	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	55	38	63	60	53	48	42	31
Time to Drain 99% of Inflow Volume (hours) =	40	58	40	67	65	62	60	58	53
Maximum Ponding Depth (ft) =	2.45	3.06	2.34	3.29	3.53	3.95	4.42	5.69	6.30
Area at Maximum Ponding Depth (acres) =	0.21	0.26	0.20	0.27	0.28	0.29	0.31	0.37	0.39
Maximum Volume Stored (acre-ft) =	0.186	0.330	0.161	0.389	0.457	0.577	0.720	1.147	1.376

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04
	0:15:00	0.00	0.00	0.04	0.08	0.11	0.09	0.12	0.13	0.22
	0:20:00	0.00	0.00	0.20	0.29	0.57	0.26	0.32	0.47	1.42
	0:25:00	0.00	0.00	1.21	2.24	4.87	1.73	2.50	3.76	12.28
	0:30:00	0.00	0.00	2.04	4.85	9.37	13.83	19.77	25.23	42.59
	0:35:00	0.00	0.00	2.24	5.46	10.28	20.63	28.20	37.20	58.99
	0:40:00	0.00	0.00	2.20	5.21	9.82	23.44	31.51	41.20	64.02
	0:45:00	0.00	0.00	1.98	4.72	8.95	22.87	30.62	41.12	63.66
	0:50:00	0.00	0.00	1.78	4.31	8.06	22.08	29.57	39.68	61.44
	0:55:00	0.00	0.00	1.59	3.89	7.22	20.11	27.13	37.30	57.90
	1:00:00	0.00	0.00	1.45	3.53	6.54	18.13	24.66	34.86	54.48
	1:05:00	0.00	0.00	1.33	3.25	6.02	16.56	22.77	33.12	51.97
	1:10:00	0.00	0.00	1.20	3.00	5.52	14.86	20.53	29.79	47.26
	1:15:00	0.00	0.00	1.07	2.69	5.03	13.25	18.36	26.40	42.43
	1:20:00	0.00	0.00	0.94	2.36	4.45	11.60	16.07	22.95	36.97
	1:25:00	0.00	0.00	0.81	2.03	3.82	10.02	13.90	19.71	31.81
	1:30:00	0.00	0.00	0.72	1.78	3.34	8.50	11.82	16.77	27.27
	1:35:00	0.00	0.00	0.66	1.62	3.01	7.40	10.35	14.63	23.91
	1:40:00	0.00	0.00	0.61	1.47	2.72	6.54	9.19	12.96	21.21
	1:45:00	0.00	0.00	0.57	1.32	2.46	5.82	8.19	11.49	18.83
	1:50:00	0.00	0.00	0.52	1.18	2.22	5.16	7.28	10.17	16.69
	1:55:00	0.00	0.00	0.47	1.05	1.96	4.57	6.46	8.94	14.70
	2:00:00	0.00	0.00	0.41	0.92	1.70	3.99	5.66	7.80	12.84
	2:05:00	0.00	0.00	0.35	0.78	1.42	3.40	4.83	6.65	10.93
	2:10:00	0.00	0.00	0.29	0.63	1.15	2.83	4.02	5.57	9.13
	2:15:00	0.00	0.00	0.23	0.50	0.90	2.27	3.23	4.51	7.36
	2:20:00	0.00	0.00	0.17	0.37	0.65	1.71	2.46	3.46	5.65
	2:25:00	0.00	0.00	0.12	0.25	0.44	1.18	1.71	2.44	4.04
	2:30:00	0.00	0.00	0.09	0.17	0.30	0.73	1.10	1.60	2.79
	2:35:00	0.00	0.00	0.07	0.13	0.24	0.47	0.75	1.09	1.99
	2:40:00	0.00	0.00	0.05	0.11	0.19	0.31	0.52	0.75	1.43
	2:45:00	0.00	0.00	0.04	0.08	0.15	0.21	0.37	0.51	1.00
	2:50:00	0.00	0.00	0.04	0.07	0.12	0.14	0.26	0.33	0.69
	2:55:00	0.00	0.00	0.03	0.05	0.09	0.10	0.18	0.21	0.46
	3:00:00	0.00	0.00	0.02	0.04	0.07	0.07	0.13	0.12	0.30
	3:05:00	0.00	0.00	0.02	0.03	0.05	0.05	0.09	0.08	0.20
	3:10:00	0.00	0.00	0.02	0.02	0.04	0.04	0.07	0.06	0.15
	3:15:00	0.00	0.00	0.01	0.02	0.03	0.03	0.05	0.05	0.11
	3:20:00	0.00	0.00	0.01	0.01	0.02	0.02	0.04	0.04	0.09
	3:25:00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.03	0.07
	3:30:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.05
	3:35:00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.04
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]



2880 International Circle, Suite 110
Colorado Springs, CO 80910
Phone: 719-520-6300
Email: Stormwater@elpasoco.com
publicworks.elpasoco.com/stormwater/

EL PASO COUNTY PCM APPLICABILITY FORM

EPC Project Number: _____

This form is to be used by the Engineer of Record to determine if the proposed construction activities are eligible for an exclusion to stormwater quality permanent control measure (PCM) requirements. All “applicable construction activity” within El Paso County (EPC) must comply with the post-construction stormwater management criteria. Reference ECM Appendix I for information about PCMs.

Note that this form only addresses stormwater quality for the site. Even if the site is fully excluded from needing a stormwater quality PCM, the site may still need to address stormwater detention (per DCMv1 Chap 1.5 and ECM Chap 3.2.8.B). However, if the site requires stormwater detention, then it must also address stormwater quality (per DCMv2 Chap 4.1 and ECM Appendix I.7.3). Refer to the Reference Information pages below for more guidance.

Part I. Project Summary			
Project Name:			
Is Stormwater Detention Required?	☐ Yes ☐ No	Is Water Quality Treatment Required? (i.e.: non-excluded disturbance >1ac)	☐ Yes ☐ No
Is an ESQCP Required? If “No,” Check Applicable Reason	☐ Yes ☐ No	☐ Not an Applicable Construction Activity ☐ Oil & Gas ☐ R-Factor	
Engineer of Record Email Address:			

Part II. PCM Exclusions				
Note: Questions A through K directly correlate to Part I.E.4.a.i (A) to (K) on page 27 of the 2016 CDPS Statewide Standard MS4 General Permit COR090000 (i.e.: the MS4 Permit), as amended. Document exclusions that apply to the whole project or parts of it.				
Questions	Excluded Acreage	Yes	No	Notes
A. Is this project a “Pavement Management Site?”				This exclusion applies to the maintenance, rehabilitation, and reconstruction of pavement on existing roads, bridges, bike lanes, and parking along roads. Areas used primarily for parking (i.e.: separate lots not along roadway) or access to parking are not included. No increase in impervious area is allowable.
B. Review two options below to see if project is an “Excluded Roadway Development.”				Does <u>not</u> include sidewalks. Does include curb & gutter.
• Does the project include improvements to an existing roadway that adds < 1 acre of paved or gravel area per mile of roadway?				If selected, list the proposed additional acreage per mile in Part IV Notes below.
• Does the project include improvements to an existing roadway that adds ≤ 8.25 ft of paved width at any location?				If selected, list the proposed additional width in Part IV Notes below.



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EL PASO COUNTY PCM APPLICABILITY FORM

EPC Project Number: _____

Part II. PCM Exclusions (continued)

Questions	Excluded Acreage	Yes	No	Notes
C. Does the project include "Excluded Existing Roadway Areas?"				For redevelopment of <u>existing</u> roadways. This exclusion only excludes the original roadway area, it does NOT apply to the entire project. This exclusion applies only when the proposed project will expand the existing roadway width by <2x on average. If selected, list the proposed expanded width in Part IV Notes below.
D. Is the project considered an Aboveground or Underground Utilities activity?				Activity can <u>not</u> permanently alter the terrain, ground cover, or drainage patterns from existing conditions.
E. Is the project considered a "Large Lot Single-Family Site"? <i>This exclusion only pertains to the lots and does not include roadways.</i>				Must be a single-family residential lot or agricultural zoned land with ≥ 2.5 acres per dwelling and total lot impervious area < 10%. If "Yes," notate the percent impervious below in Part IV: Notes.
F. Do Non-Residential or Non-Commercial Infiltration Conditions exist? <i>Post-development surface conditions do not result in concentrated stormwater flow or surface water discharge during an 80th percentile stormwater runoff event, and the 80th percentile event must be infiltrated.</i>				Exclusion does not apply to residential or commercial sites for buildings. A site-specific study is required and must show rainfall and soil conditions, allowable slopes, surface conditions, and ratios of imperviousness area to pervious area.
G. Is the project land disturbance to Undeveloped Land where undeveloped land remains undeveloped following the activity?				Project must be on land with no human made structures such as buildings or pavement. The proposed development must return the disturbed area to its historical condition. See CDPHE's "Standard MS4 Permit FAQ" for more detail on how this exclusion applies.
H. Is the project a Stream Stabilization Site?				
I. Is the project a Bike or Pedestrian Trail?				Bike lanes for roadways are not included in this exclusion but may qualify if attached to a larger roadway activity that is excluded in A, B or C above. Pedestrian trails (e.g. sidewalks) that are attached to a roadway do not apply.
J. Is the project Oil and Gas Exploration?				Activities and facilities associated with oil and gas exploration are excluded.
K. Is the project in a County Growth Area?				El Paso County does not apply this exclusion.
If any exclusions above apply (via a "Yes" for any row), runoff from those areas is excluded from stormwater quality treatment requirements. All runoff from remaining non-excluded disturbed areas will need to be treated by a stormwater quality PCM, unless remaining area is <1ac. If remaining area is >1ac, select at least one Design Standard on the next page.				



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EL PASO COUNTY PCM APPLICABILITY FORM

EPC Project Number: _____

Part III: PCM Information

Questions	Yes	No
1. Which of the following Design Standard(s) will the project utilize? <i>(If a PCM is required, you must select at least one. See Control Measure Requirements identified in MS4 Permit Part I.E.4.a.iv on page 29.)</i>		
A. Water Quality Capture Volume (WQCV) Standard		
B. Pollutant Removal Standard - 80% Total Suspended Solids Removal (TSS) <i>(must treat runoff to <30mg/L of TSS)</i>		
C. Runoff Reduction Standard		
D. Applicable Development Site Draining to a Regional WQCV Control Measure <i>(no conveyance via "Waters of the State")</i>		
E. Applicable Development Site Draining to a Regional WQCV Facility <i>(conveyance allowable via "Waters of the State," if the 8 conditions in the MS4 permit are met and documented in the drainage report)</i>		
F. Constrained Redevelopment Sites Standard <i>(must be pre-approved by ECM Administrator)</i>		
G. Previous Permit Term Standard		
2. Will any of the PCMs be located within any other jurisdiction besides EPC?		

Part IV: Notes

Provide info regarding all applicable PCM(s) and PCM Exclusion(s) including location, PCM name(s)/number(s), and additional relevant filings or reports or maintenance agreements, etc. Attach an additional sheet if you need more space. Attaching a detailed summary table would replace the need for any notes here.



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EL PASO COUNTY PCM APPLICABILITY FORM

EPC Project Number: _____

Part V: Signatures

Applicant: This PCM Applicability Form was prepared under my direction and supervision and is correct to the best of my knowledge and belief. It was prepared along with the project design, construction plans, drainage report, specifications, and maintenance and access agreements as required. And it has been reviewed for compliance with the Post Construction Stormwater Management criteria and MS4 Permit requirements.



Signature and Stamp of Engineer or Recorder

(If the project is not an Applicable Construction Activity, this line can be signed by the Applicant or their rep, they do not have to be an engineer)

Date

El Paso County: This PCM Applicability Form has been reviewed and the project design, construction plans, drainage report, specifications, and maintenance and access agreements as required, have been reviewed for compliance with the Post Construction Stormwater Management process and MS4 Permit requirements.

Signature of El Paso County Project Engineer

Date



APPENDIX E – REFENCE MATERIAL

SAND CREEK
DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN REPORT

Prepared for:

City of Colorado Springs
Department of Comprehensive Planning, Development And Finance
Engineering Division - MAIL CODE 435
P.O. Box 1575
Colorado Springs, CO 80901-1575

Prepared by:

Kiowa Engineering Corporation
1001 North Weber #200
Colorado Springs, CO 80903

KIOWA Project No. 90.04.09
DXX/R185

JANUARY 1993
Revised APRIL 1993
Revised FEBRUARY 1995
Revised APRIL 1995
Revised OCTOBER 1995

I. INTRODUCTION

Authorization

The preliminary design of the drainageway and roadway crossing facilities within the Sand Creek Drainage Basin was authorized under the terms of Agreement Number 90-85 between the City of Colorado Springs (City) and Kiowa Engineering Corporation. The agreement was approved by the Colorado Springs City Council, April 10, 1990. Subsequent to this agreement, a change order to the contract to allow for the inclusion of technical information contained in the draft East Fork Sand Creek Drainage Basin Planning Study was approved July, 1993.

Purpose and Scope

The purpose of the study is to identify feasible stormwater management plans to satisfy the existing and future needs within the Sand Creek Drainage Basin. The Sand Creek basin is to be referred to throughout this study and is inclusive of the Sand Creek mainstem and East Fork Sand Creek watersheds. The specific scope of work for this study included the following tasks:

1. Meet with the City to: insure compliance with the services required by this agreement, obtain existing data and general information from participating entities, solicit desires of plans, procure current information relative to development plans in the basin, procure information relative to right-of-way limitations, proposed stormwater projects, potential hazards due to flooding, and avoid duplication of effort whenever possible by utilizing existing information available from other agencies.

2. Contact the City, County, individuals, and other agencies who have knowledge and/or interest in the study area.
3. Utilize City policies and criteria and applicable information wherever possible.
4. Perform hydraulic and hydrologic analyses within the study area.
5. Identify environmental setting of basin.
6. Identify existing and potential drainage and/or flooding problems.
7. Develop improvement alternatives to reduce existing and potential flooding problems, and to mitigate the impact of stormwater runoff upon environmentally significant areas along the drainageway(s).
8. Examine the operation and maintenance aspects of feasible alternatives.

9. Conduct an economic analysis of each alternative.
10. Recommend and prepare a preliminary design for a selected alternative plan.
11. Develop drainage and bridge fees for the basin.
12. Prepare a written report discussing all items examined in the study.
13. Conduct presentations to public and private entities in order to define project goals, and to involve agencies with specific interest to help define feasible alternatives.

Summary of Data Obtained

Listed below are the technical reports collected for the review as part of preparing this study:

1. Soil Survey for El Paso County, Colorado, dated June 1981.
2. "City of Colorado Springs/El Paso County Drainage Criteria Manual", prepared by City of Colorado Springs, El Paso County, and HDR Infrastructure, Inc., dated May 1987.
3. "Flood Insurance Studies for Colorado Springs, and El Paso County, Colorado", prepared by the Federal Emergency Management Agency (FEMA), revised 1989.
4. Flood Insurance Restudy, Hydrology Report and Hydrologic Analyses, prepared by RCI, Inc., 1989.
5. Sand Creek Drainage Basin Planning Study prepared by Simons, Li & Associates, Inc., dated July, 1985.
6. Flood Hazard Analysis, Sand Creek, City of Colorado Springs and El Paso County, Colorado, prepared by the Soil Conservation Service, dated December, 1973.
7. Banning-Lewis Ranch Master Drainage Plan, prepared by MSM Consultants, Inc., dated June 1981.
8. Sand Creek Drainage Basin Study, prepared by United Planning and Engineering Company, October, 1977.
9. Draft East Fork Sand Creek Drainage Basin Planning Study, prepared by Kiowa Engineering Corporation, January, 1989.
10. Drainage Basin Inventory, Sand Creek Drainage Basin, prepared by Oliver E. Watts, P.E., June 1990.

In addition to the above listed reports there were a number of drainage study reports, sketch plans, preliminary and final design drawings, land use and zoning maps, development

plans, and existing drainage facility maps that were collected from the City, County, and other local agencies.

Reports which were prepared previous to the preliminary design report include the "Sand Creek Drainage Basin Planning Study Hydrology Report," and the "Sand Creek Drainage Basin Planning Study Development of Alternatives Report." These reports were prepared as part of the overall planning effort and have been referred to throughout this report. The Hydrology Report summarized peak flow data for existing and future basin development conditions without improvements in the basin, and established the base line hydrologic conditions from which the alternative planning then proceeded. The Development of Alternatives report evaluated the various combinations of drainage way improvements for the basin, taking into account environmental, cost, construction, right-of-way, maintenance and implementation factors for each feasible alternate plan. These reports are on file with the City Engineering Division, as well as technical addenda for each report. Both of these reports covered only the mainstem of the Sand Creek Basin. The similar information prepared for the draft East Fork Sand Creek Drainage Basin Planning Study has been summarized in this preliminary design report.

Mapping and Surveying

Mapping used in the planning effort for the mainstem of Sand Creek consisted of USGS 7-1/2 minute quadrangles, and 2-foot contour interval, 1-inch to 200-foot scale planimetric topographic maps. For the area of the basin north of Woodmen Road, aerial topographic mapping was compiled in May 1990. For the balance of the basin, the City of Colorado Springs Department of Public Utilities provided topographic mapping compiled from aerial photographs dated 1989. This mapping has been prepared as part of the Facility Inventory Management System (FIMS). The aerial topographic mapping was used in the drainage inventory, hydrologic/hydraulic analyses, and in the alternative planning phases of this project. All topographic mapping was based upon USGS vertical datum.

For the East Fork Sand Creek basin, mapping from the FIMS office and two-foot contour interval topography prepared in 1987 for the Banning-Lewis Ranch property were used in the preparation of the preliminary design. Where topographic mapping was not available, USGS quadrangle maps were used.

Stream cross-section data was obtained from the aerial mapping described above. These sections were verified against the cross-sections compiled in the 1986 City of Colorado Springs Flood Insurance Study (FIS), wherever possible.

Drainage way site inspections were conducted throughout the study area, and photographs were taken documenting the key drainage features.

The following general conditions have been placed upon the use of the FIMS topographic mapping:

- Use of these products is restricted to the project for which the FIMS products are provided.
- Only the body content found within the neckline of the borrowed maps may appear in any report/publication developed for your study. Also, the labeling that appears on any photographs provided shall not appear in any such report/publication.
- All FIMS' products provided to contractors involved in the subject study shall be retrieved by your department upon conclusion of the study and either returned to FIMS or destroyed.
- The report(s) developed in which the FIMS' products are used shall include the following disclaimer statement:

"The maps and photographs included in this report were developed for purposes of the Colorado Springs Department of Utilities and are for internal use only. The Colorado Springs Department of Utilities makes no warranty, expressed or implied, as to the completeness, accuracy, or content of such products or any reproductions thereof. Any other use is not recommended and occurs at the risk of the user; such user is solely responsible and/or liable for the use of such products.

Original maps and photographs are the property of the Colorado Springs Department of Utilities. All rights are reserved. These maps and photographs or any associated record may not, wholly or in part, be reproduced, stored, or transmitted in any form or by any means, electronic, mechanical, photocopying, or otherwise, without the express prior written permission of the Colorado Springs Department of Utilities.

Regardless of the existence of purported copies of these official maps and photographs which may from time to time be made or published, there is only one set of official maps and photographs, which are those kept and maintained by the Colorado Springs Department of Utilities."

Project Coordination

Throughout the course of the study, meetings were held with representatives of City, County, State, and Federal agencies with an interest in drainage planning in general. The primary reason for the coordination effort was to obtain technical information and to identify concerns with regard to the development of drainage facilities within the basin. During the course of preparing the Development of Alternatives report, the planning constraints and concepts were discussed with the agencies and interested individuals and their input used to refine the feasible alternatives and to eventually identify a recommended drainage plan for further design evaluation. The complete mailing list and project correspondence is contained in Appendix A of this report.

Coordination with a similar list of agencies and individuals was conducted during the preparation of the draft East Fork Sand Creek Drainage Basin Planning study. This study was authorized and conducted for Aries Properties, Inc. Meetings with state and federal agencies, the City and the County were involved in a series of meetings during the development of the alternative planning concepts and the preliminary design for the East Fork Sand Creek basin.

Acknowledgements

During the preparation of the study, several government agencies and interested individuals were routinely involved in the coordination activities. Representatives from the Colorado Division of Wildlife, U.S. Army Corps of Engineers (COE), and various City Departments provided valuable commentary during the development of the alternative plans. A listing of the individuals and agencies routinely coordinated with during the study has been presented below:

Name	Agency
Alan Morrice	El Paso County Department of Public Works
John Fisher	El Paso County Land Use Department
Sue Johnson	El Paso County Parks Department
Rick O'Connor	El Paso County Planning Department
Hugh King	City of Colorado Springs Street Division
Gary Haynes	City Engineering Division
Bruce Thorson	City Engineering Division
Ken Sampley	City Engineering Division
Steve Jacobson	City Engineering Division
Christine Lytle	City Engineering Division
Bruce Goforth	Colorado Division of Wildlife
Dan Bunting	Regional Building Department
Sarah Fowler	Environmental Protection Agency
John Liou	Federal Emergency Management Agency
Dave Frick	RCL, Inc., Fort Collins, Colorado
Bill Noonan	U.S. Fish and Wildlife
Anita Culp	U.S. Army Corps of Engineers
John Maynard	Aiken/Audobon Society
John Covert	Palmer Foundation
Peter Kernkamp	City Planning Department
Jim Rees	Department of Planning and Development
Fred Mais	City Parks and Recreation
Diana Medina	City of Colorado Springs
Dan Tippie	Department of Public Utilities Gas Division
Russ Nicklin	City of Colorado Springs
Wes Tyson	Department of Public Utilities Wastewater Division
	City of Colorado Springs
	City Attorney's Office

II. STUDY AREA DESCRIPTION

The Sand Creek drainage basin is a left-bank tributary to the Fountain Creek lying in the west-central portions of El Paso County. Sand Creek's drainage area at Fountain Creek is approximately 54 square miles of which approximately 18.8 square miles are inside the City of Colorado Springs corporate limits. The basin is divided into five major sub-basins, the Sand Creek mainstem, the East Fork Sand Creek, the Central Tributary to East Fork, the West Fork, and the East Fork Subtributary. Figure II-1 shows the location of the Sand Creek basin.

Basin Description

The Sand Creek basin covers a total of 54 square miles in unincorporated El Paso County and Colorado Springs, Colorado. Of this total, approximately 28 square miles is encompassed by the Sand Creek basin, and 26 square miles for the East Fork Sand Creek basin. The basin trends in generally a south to southwesterly direction, entering the Fountain Creek approximately two miles upstream of the Academy Boulevard bridge over Fountain Creek. Two main tributaries drain the basin, those being the mainstem of Sand Creek and East Fork Sand Creek. Development presence in most evident along the mainstem. At this time, approximately 25 percent of the basin is developed. This alternative evaluation focuses upon the Sand Creek basin only.

The maximum basin elevation is approximately 7,620 feet above mean sea level, and falls to approximately 5,790 feet at the confluence with Fountain Creek. The headwaters of the basin originate in the conifer covered areas of The Black Forest. The middle eastern portions of the basin are typified by rolling range land with fair to good vegetative cover associated with semi-arid climates.

Climate

This area of El Paso County can be described, in general as high plains, with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry. Precipitation ranges from 14 to 16 inches per year, with the majority of this precipitation occurring in spring and summer in the form of rainfall. Thunderstorms are common during the summer months, and are typified by quick-moving low pressure cells which draw moisture from the Gulf of Mexico into the region. Average temperatures range from about 30°F in the winter

to 75° in the summer. The relative humidity ranges from about 25 percent in the summer to 45 percent in the winter.

Soils and Geology

Soils within the Sand Creek basin vary between soil types A through D, as identified by the U. S. Department of Agriculture, Soil Conservation Service. The predominant soil groupings are in the Truckton and Bresser soil associations. The soils consist of deep, well drained soils that formed in alluvium and residuum, derived from sedimentary rock. The soils have high to moderate infiltration rates, and are extremely susceptible to wind and water erosion where poor vegetation cover exists. In undeveloped areas, the predominance of Type A and B soils give this basin a lower runoff per unit area as compared to basins with soils dominated by Types C and D. Presented on Figure II-2 is the Hydrologic Soil distribution map for the Sand Creek basin.

Property Ownership and Impervious Land Densities

Property ownership along the major drainage within the Sand Creek basin vary from public to private. Along the developed reaches, drainage right-of-ways and greenbelts have been dedicated during the development of the adjacent residential and commercial land. Where development has not occurred, the drainageways remain under private ownership with no delineated drainage right-of-way or easements. There are several public parks which about the mainstem of Sand Creek. Roadway and utility easements abutting or crossing the major drainageways occur most frequently in the developed portions of the basin.

Land use information for the existing and future conditions were reviewed as part of the planning effort. This information is used in the hydrologic analysis to predict runoff rates and volumes for the purposes of facility evaluation. The identification of land uses abutting the drainageways is also useful in the identification of feasible plans for stabilization and aesthetic treatment of the creek. Presented on Figure II-3 is the proposed land use map used in the evaluation of impervious land densities discussed in the hydrologic section of this report. Figure II-3 is not intended to reflect the future zoning or land use policies of the City or the County.

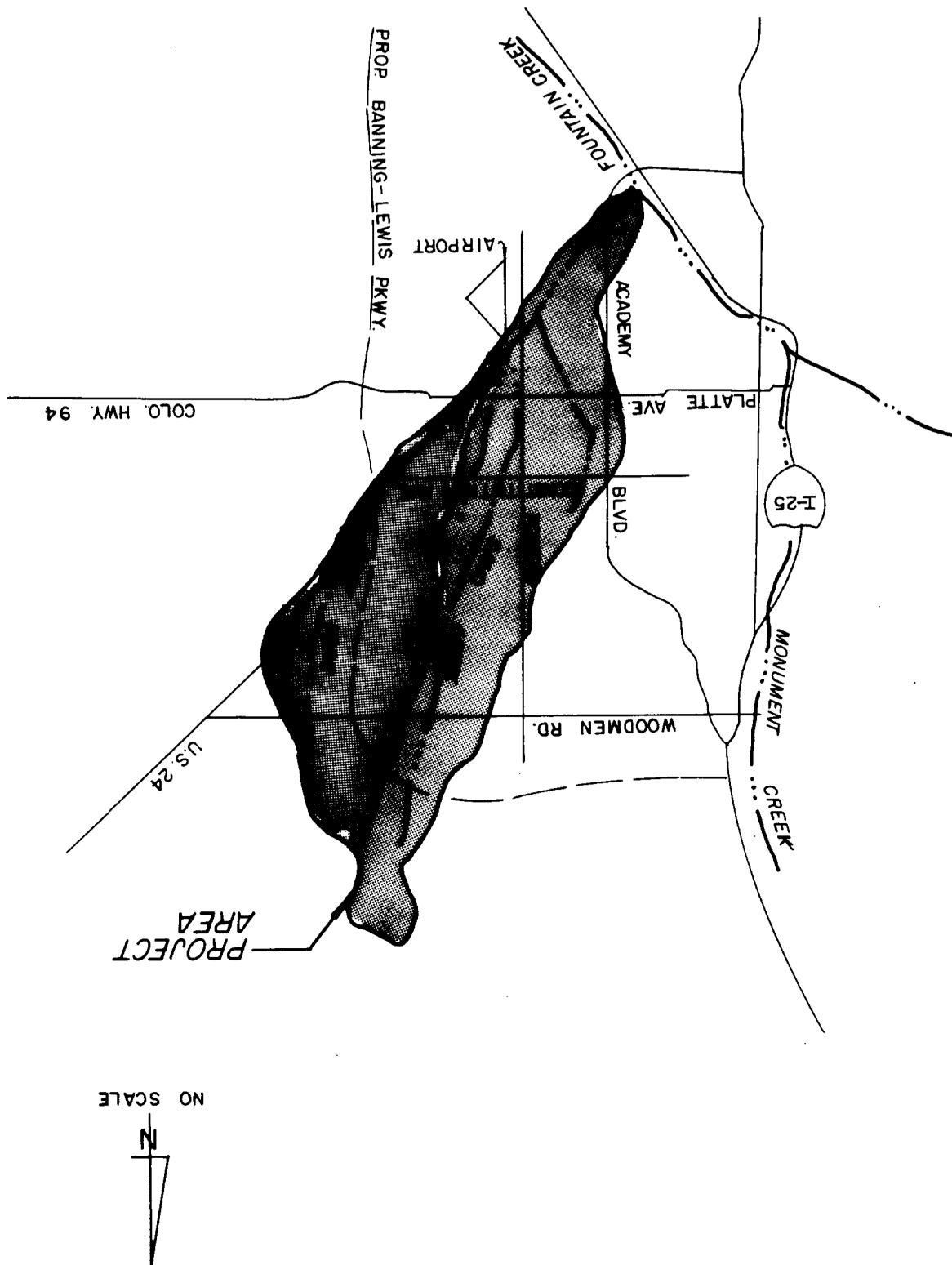
The land use information within the Banning-Lewis Ranch property was obtained from Aries Properties during the time the draft East Fork Sand Creek Drainage Basin Planning Study was being prepared. The land use information was again reviewed with the City of Colorado Springs Department of Planning and was found to be appropriate for use in the estimation of hydrology for the East Fork Basin. The location of future arterial streets and roadways within

the Banning Lewis property were obtained from the Banning-Lewis Ranch master plan. The location of roadways offsite from the Banning Lewis-Ranch were obtained from the El Paso County Major Transportation Plan dated 1988.

Park Land and Open Space

An inventory of park land and public open space was prepared. Many times, the combination of the drainage way and adjacent park lands can be used to visually extend the limits of a park or open space. The drainage way can also act to link parks and other land uses within the basin if multiple use trails are incorporated into the channel section(s). The Sand Creek drainage way has been identified as a major trail corridor within the City of Colorado Springs Trails Plan. Park land designated within the Banning-Lewis Ranch master plan were taken into account during the siting of stormwater facilities within the Banning-Lewis property.

VICINITY MAP
FIGURE II-1



SAND CREEK DRAINAGE BASIN PLANNING STUDY

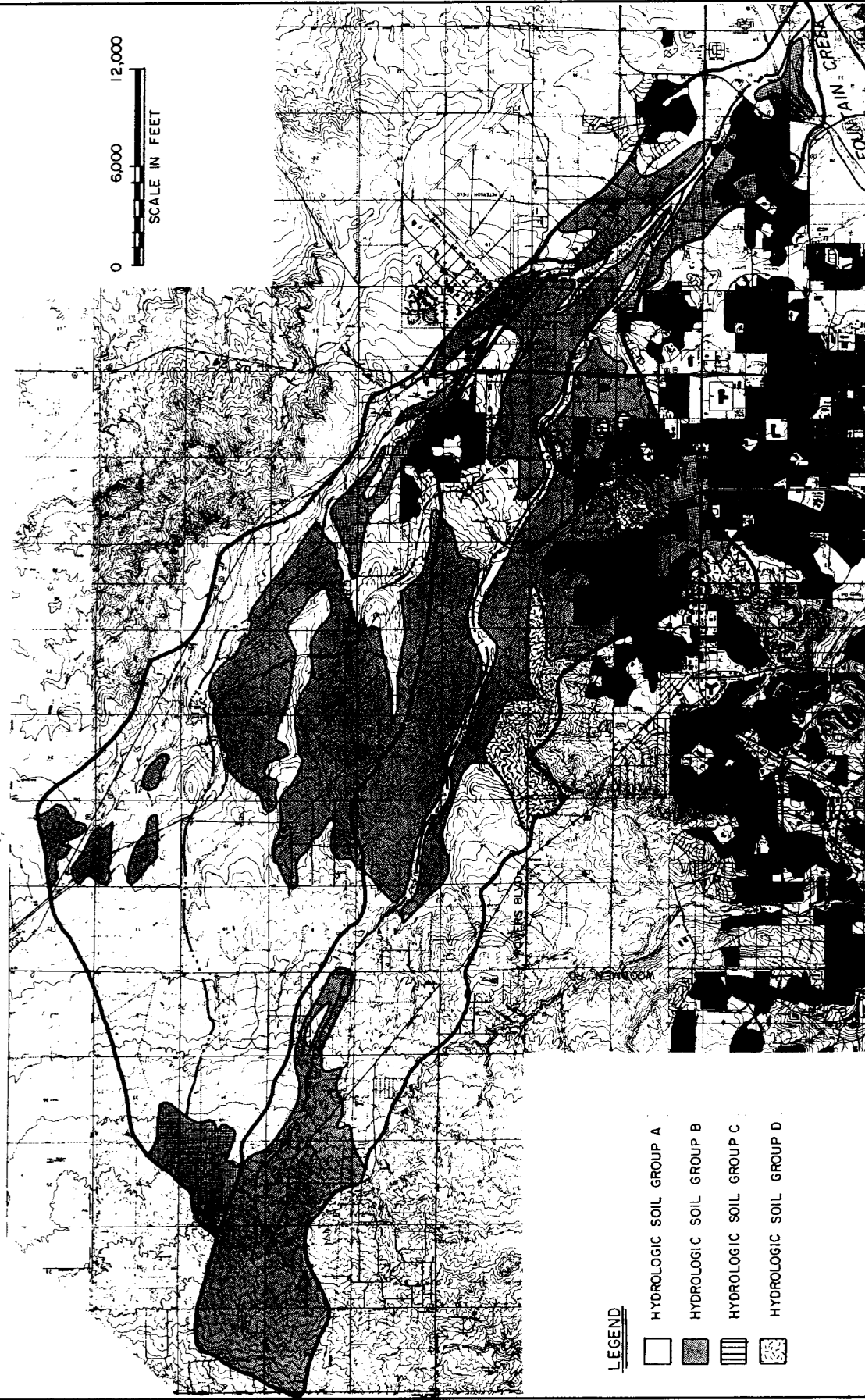
HYDROLOGIC SOIL S MAP

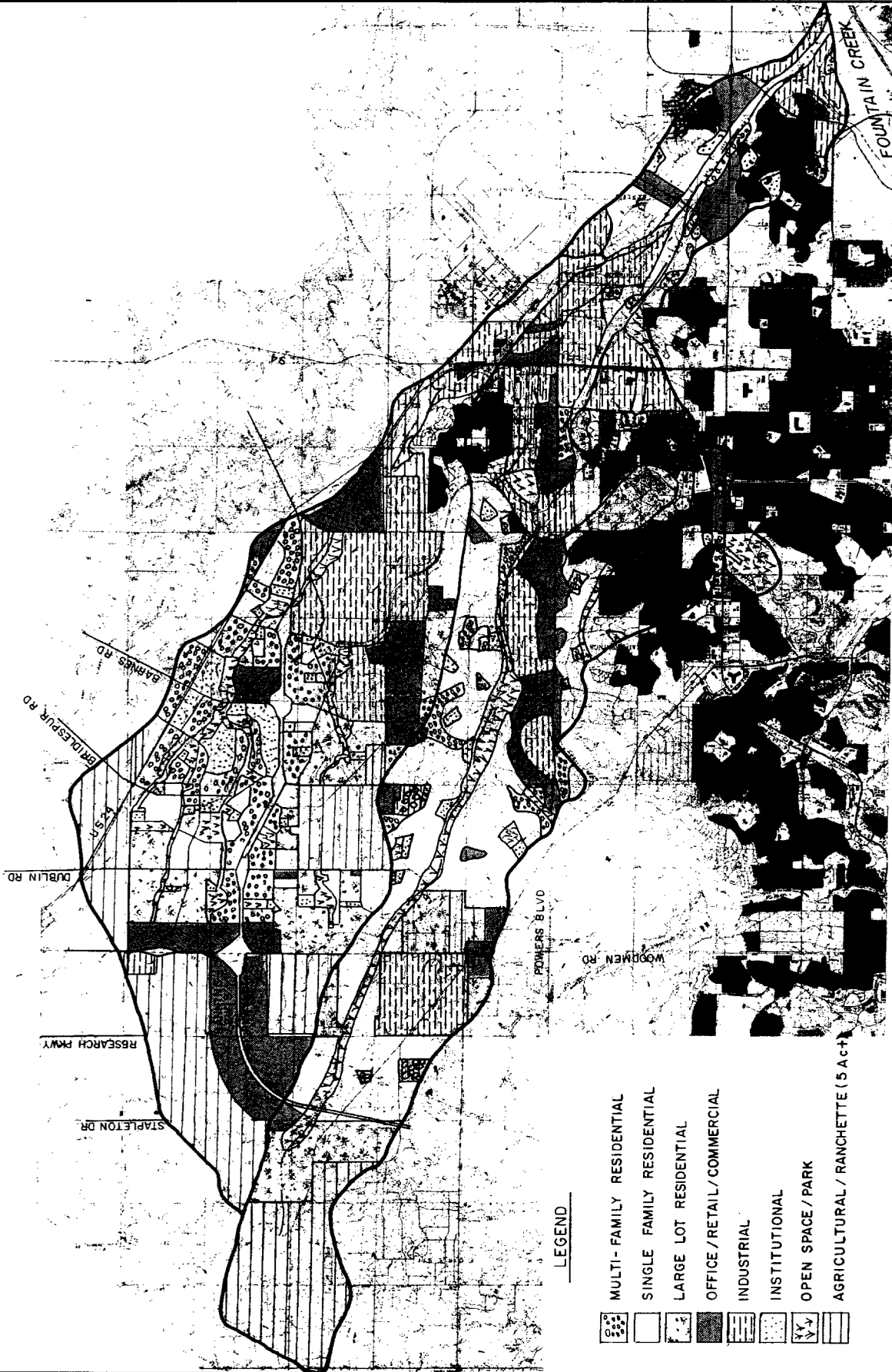
Kiowa Engineering Corporation

419 W. Blinn Street
Colorado Springs, Colorado
80905-1308

Project No. 20-04
Date: 10/70
Design:
Drawn: EAK
Check:
Reviewed:

FIG. II-2





LEGEND

- MULTI-FAMILY RESIDENTIAL
- SINGLE FAMILY RESIDENTIAL
- LARGE LOT RESIDENTIAL
- OFFICE / RETAIL / COMMERCIAL
- INDUSTRIAL
- INSTITUTIONAL
- OPEN SPACE / PARK
- AGRICULTURAL / RANCHETTE (5 ac+)

III. HYDROLOGIC ANALYSIS

A hydrologic analysis was conducted in order to determine peak discharges and runoff volumes for various storm types, and basin development conditions. This data was used in the evaluation of existing flood problems, and in the evaluation of alternative plans. A detailed Hydrology Report has been prepared under a separate cover, complete with a technical addendum for the mainstem Sand Creek watershed. Detailed information with respect to the hydrologic analysis is contained within this Sand Creek Drainage Basin Planning Study. The Hydrology Report and the draft East Fork Sand Creek Drainage Basin Planning Study. The hydrology information contained within these reports were reviewed by the City, County, and the Federal Emergency Management Agency (FEMA).

Runoff Model

The runoff model used to determine the peak flows and volumes within the study area is the Soil Conservation Service (SCS) Computer Program for the Project Formulation Hydrology (TR20). The version is available for the IBM personal computer (PC) "XT" and "AT" or a compatible PC. The use of this hydrological model is in compliance with the City of Colorado Springs/El Paso County Drainage Criteria Manual.

Basin Characteristics

The study area subject to the hydrologic evaluation is the Sand Creek Basin. The mainstem Sand Creek Basin was divided into four regional basins for analysis purposes. The Lower Sand Creek Basin includes the Center Tributary of Sand Creek, which actually outfalls to the East Fork of Sand Creek. The East Fork Sand Creek basin was divided into five regional basins, namely the East Fork Sand Creek, East and West Bierstadt Creek, West Tributary, and the Toy Ranches watersheds. The major regional basins are shown in Figure III-1.

Because of the size of the total hydrologic model, it was necessary to input the East Fork Sand Creek Hydrologic results using an inflow hydrograph. The East Fork Sand Creek hydrograph was input the river Sand Creek hydrologic model at the East Fork and Center Tributary confluence. The complete description of the East Fork hydrology modeling is contained within the draft East Fork Sand Creek Drainage Basin Planning Study. This report was reviewed by the City and the County, and found to be in general conformance with City/County criteria. This report has not been approved as yet by either the City or the County.

Both the existing and future "preferred plan" condition hydrology for the East Fork Sand Creek was considered in this analysis. Portions of the hydrology summarized in the East Fork Sand Creek study was used in the preparation of the Colorado Springs/El Paso County Flood Insurance Study Restudy conducted by FEMA (1989).

Basin characteristics such as size, curve numbers (CN-values), basin slope, soils flow path, time of concentration (T_c), channel type, slope and size, channel routing coefficient "X" and "M" values, and velocity were estimated. These parameters were determined from available topographic, land use and soils maps, and field investigation. Basin characteristic summary tables and TR20 computer input and output are contained within the Sand Creek and East Fork Sand Creek Hydrology Report Technical Addenda.

Previous Studies

Various floodplain and master drainage planning studies have been prepared for the Sand Creek basin. Three studies were referenced earlier. This planning effort will update the 1985 Sand Creek Master Drainage Plan. Since 1985, the City and County revised their drainage criteria manual. Because of this, peak discharges between this study and the 1985 Master Plan vary. Land use planning assumptions also vary between the two reports.

FEMA has conducted a Flood Insurance Study (FIS) update for portions of the West Fork, mainstem, Center Tributary, and the East Fork. A hydrology report was prepared as part of the FIS restudy and submittal to the City and County for review and approval. The hydrologic methodology employed in the restudy is similar to the method used in the 1985 study and this study. Comparisons of the hydrologic results has been presented and discussed in the Sand Creek Hydrology Report.

Impervious Land Density

Land use for existing and future basin conditions were determined using a combination of zoning maps, City/County Comprehensive Plan(s), aerial photographs, transportation plan(s), and other related land use documents. Land use density and corresponding curve numbers were determined in accordance with the City/County Drainage Criteria Manual. Presented on Figure II-3 are the proposed land uses assumed for hydrologic modeling purposes. Table III-1 shows the percent of imperviousness assigned for each of the land use categories presented on Figure II-3. Soil Conservation Service (SCS) curve numbers for both the existing and future conditions for the mainstem of Sand Creek, Center Tributary, and the West Fork Sand Creek are

presented in the Hydrology Report. Similar information for the East Fork Sand Creek watershed is presented in the draft East Fork Sand Creek Drainage Basin Planning Study.

Design Rainfall

In accordance with the City/County Drainage Criteria Manual the 24-hour Type II-A storm with an antecedent moisture condition (AMC) of II was applied in the hydrologic modeling. The 24-hour duration storm events for the 10-year and 100-year recurrence intervals were evaluated. Rainfall depths are 4.4 inches and 3.0 inches for the 100-year and 10-year frequencies, respectively. For smaller basins (i.e., less than 100 acres), the 2-hour duration storm with an antecedent moisture condition III may yield a higher peak runoff. The final design of drainageway and storm sewer systems will require that the most applicable storm pattern be applied, depending upon the specific basin characteristics. For basins the size of Sand Creek, it was determined that the 24-hour duration should be used in the estimation of peak discharges.

Hydrologic Modeling

The hydrologic model is a series of sub-basins, ranging in size from 80 to 200 acres, linked by drainageways or "reaches." Presented on Exhibit 1 (in map pocket) is the Hydrologic Basin Map. Hydrographs are accumulated at design points along the major drainages. For this study, separate hydrologic models were prepared for each of the regional sub-basins. Hydrographs from the Upper Sand Creek, West Fork, and East Fork regional sub-basins were input to the Lower Sand Creek hydrologic model. No channel improvements have been assumed for the future condition hydrologic model.

As mentioned above, the hydrology for the East Fork Sand Creek basin was obtained from the East Fork Sand Creek Drainage Basin Planning Study report. This report was prepared for the City and the County by Aries Properties, Inc., as required by an annexation agreement for the area known as the Banning-Lewis Ranch property. An assumption used in the planning for the future major drainage improvements was that the existing undeveloped basin discharge rate within the East Fork Sand Creek basin would be maintained at the Banning-Lewis Ranch property limit. Accordingly, the preferred plan for the major drainage improvements within the Banning-Lewis Ranch included detention basins to limit peak discharges to existing conditions. The future condition 10- and 100-year hydrographs input to the lower Sand Creek Basin model reflects the detention basin alternative proposed for implementation within the Banning-Lewis Ranch property.

Results

The results of the baseline hydrologic analysis have been presented in several formats. A basin hydrologic map which contains the basin boundary, channel routing elements, sub-basin boundaries, and design points are shown on Exhibit 1 in the Map Pocket. A summary of flow rates for key design points is presented on Table III-2. Flood discharge profiles are shown on Figure III-2 through III-7.

The peak discharge data presented in this section of the report and on Exhibit 1 represents the baseline hydrologic condition, and does not reflect improvements within the basin such as detention or drainageway facilities. Presented in Section VI of this report is peak discharge data for the recommended plan which incorporates the selected detention and drainageway improvement schemes. Peak discharge data for the selected plan is also presented on the preliminary design plans contained at the rear of this report.

The hydrology contained in this report is not intended to be applied when sizing storm drainageway facilities draining areas less than 100 acres in size. Hydrology for areas with less than 100 acres should be determined using the procedures outlined in the City/County Drainage Criteria Manual. The sub-basin boundaries shown on Exhibit 1 need to be verified using more definitive topographic mapping whenever possible so the more exact limits of a basin smaller than 100 acres can be more accurately estimated.

Table III-1. Percent Impervious Values.

Land Use	Density	Percent Impervious	Land Use Classification
Multi-Family Residential	10-24 DU/AC	65-80	
Single-Family Residential	6-10 DU/AC	45-65	
Low Density Residential	1-6 DU/AC	30-45	
Large Lot Residential/ Agricultural	1 DU/AC	5-20	
Office/Commercial		80-90	
Industrial		85-95	
Institutional		50-75	
Dedicated Open Space/Park		5-10	
Rangeland - Poor to Good Condition		5-20	

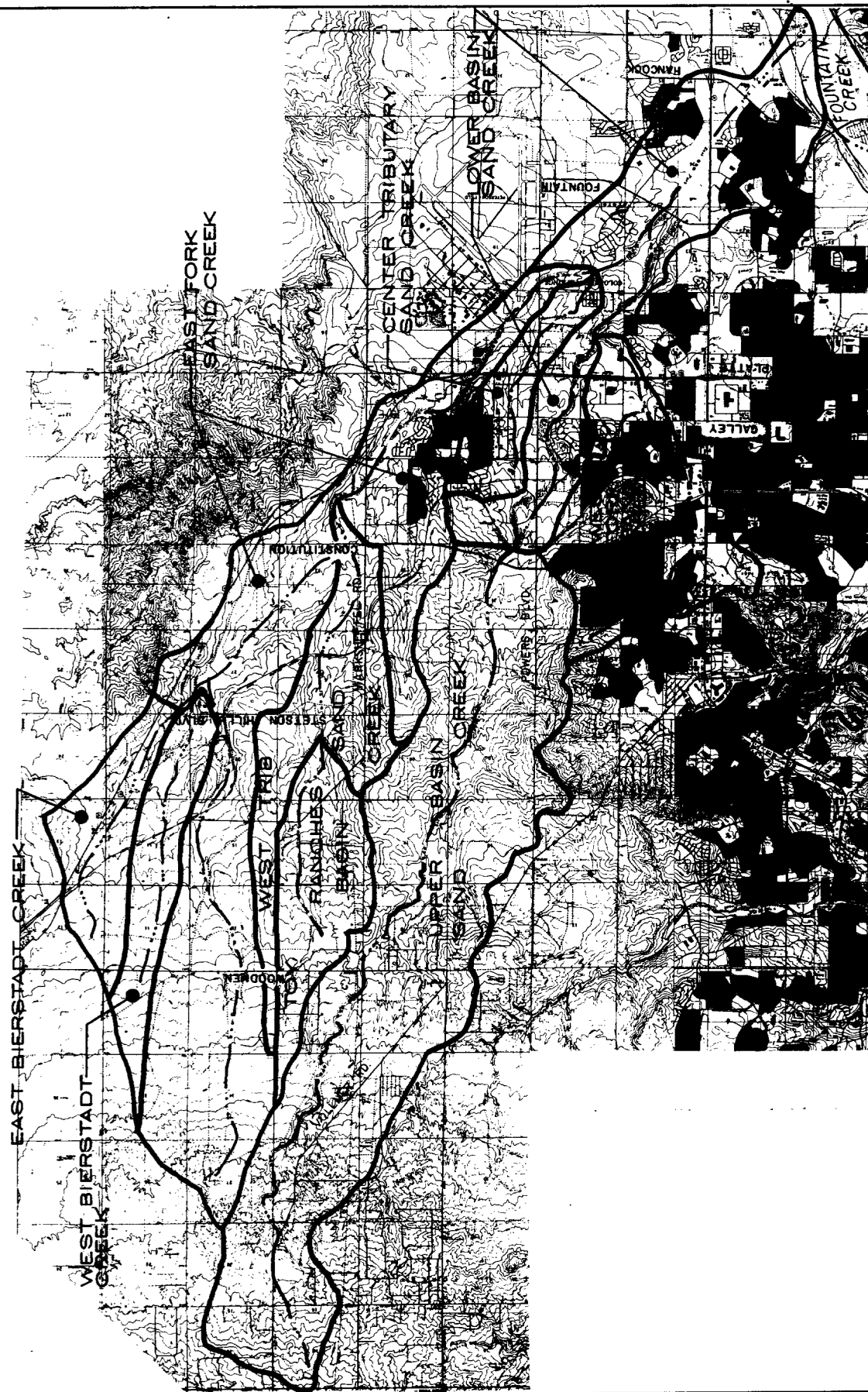
NOTE: The above data was used in the preparation of the hydrologic analysis for the Sand Creek Drainage Basin Planning Study. These data are not intended to reflect future land use planning within the City or the County.

Table III-2:

**Summary of Peak Discharges
24-hour Duration Storm, AMC-II
Baseline Hydrologic Conditions**

Design Point	Location	Area s.m.	Existing 100-year (cfs)	Future	Existing 10-year (cfs)	Future
SAND CREEK (1)						
1	@ Fountain Creek	54.1	16900	25800	7470	11800
12	Hancock Blvd.	53.1	16100	25000	7250	11600
19	Fountain Blvd.	50.7	13600	22100	6230	10800
27	West Fork Sand Creek	23.0	11300	18900	5920	8790
99	C.R.I. & P. RR	16.0	5820	14530	2360	7400
20	North Carefree	13.5	4030	10260	1520	4810
37	Stetson Hills Blvd.	10.0	3230	6690	840	3060
60	Woodmen Road	5.4	2630	3300	760	950
75	Black Forest Road	1.4	1000	1030	320	350
WEST FORK SAND CREEK						
27	@ Sand Creek	5.0	6840	6840	3200	3200
52	U. S. 24	4.8	6860	6860	3230	3230
59	Constitution Ave.	2.1	3450	3450	1680	1680
69	South Carefree	1.0	1630	1630	810	810
CENTER TRIBUTARY SAND CREEK						
42	Airport Road	1.6	1530	2010	650	1200
43	Powers Blvd.	1.3	1300	1710	590	980
44	U. S. 24	1.1	1200	1680	580	960
45	Galley Road	0.8	1180	1340	530	650
EAST FORK SAND CREEK						
1	@ Center Tributary	24.3	3970	15600	700	6530
9	@ East Fork Sub. Tributary	19.8	3730	13990	650	6050
29	@ W. Bierstadt Creek	10.6	2080	7460	400	3330
40	@ Tamlin Road	4.6	950	3570	210	1820
52	@ Woodmen Road	1.7	460	2120	80	1210
EAST FORK SUB-TRIBUTARY SAND CREEK						
11	@ Constitution Avenue	5.9	1330	4100	240	1630
15	@ Chicago & Rock Island RR	5.2	1250	3540	230	1370
26	@ Confluence w/Toy Ranch	1.0	220	820	50	370
47	@ Proposed Dublin Blvd.	0.4	100	300	20	140
WEST BIERSTADT CREEK						
31	@ Confluence w/ East Fork	1.8	480	1590	80	600
39	@ Tamlin Road	0.8	270	680	50	290
54	@ Woodmen Road	0.5	230	420	55	150
EAST BIERSTADT CREEK						
32	@ Cont. w/W Bierstadt	2.4	520	1520	90	580
38	@ Chicago & Rock Island RR	0.4	120	350	15	130

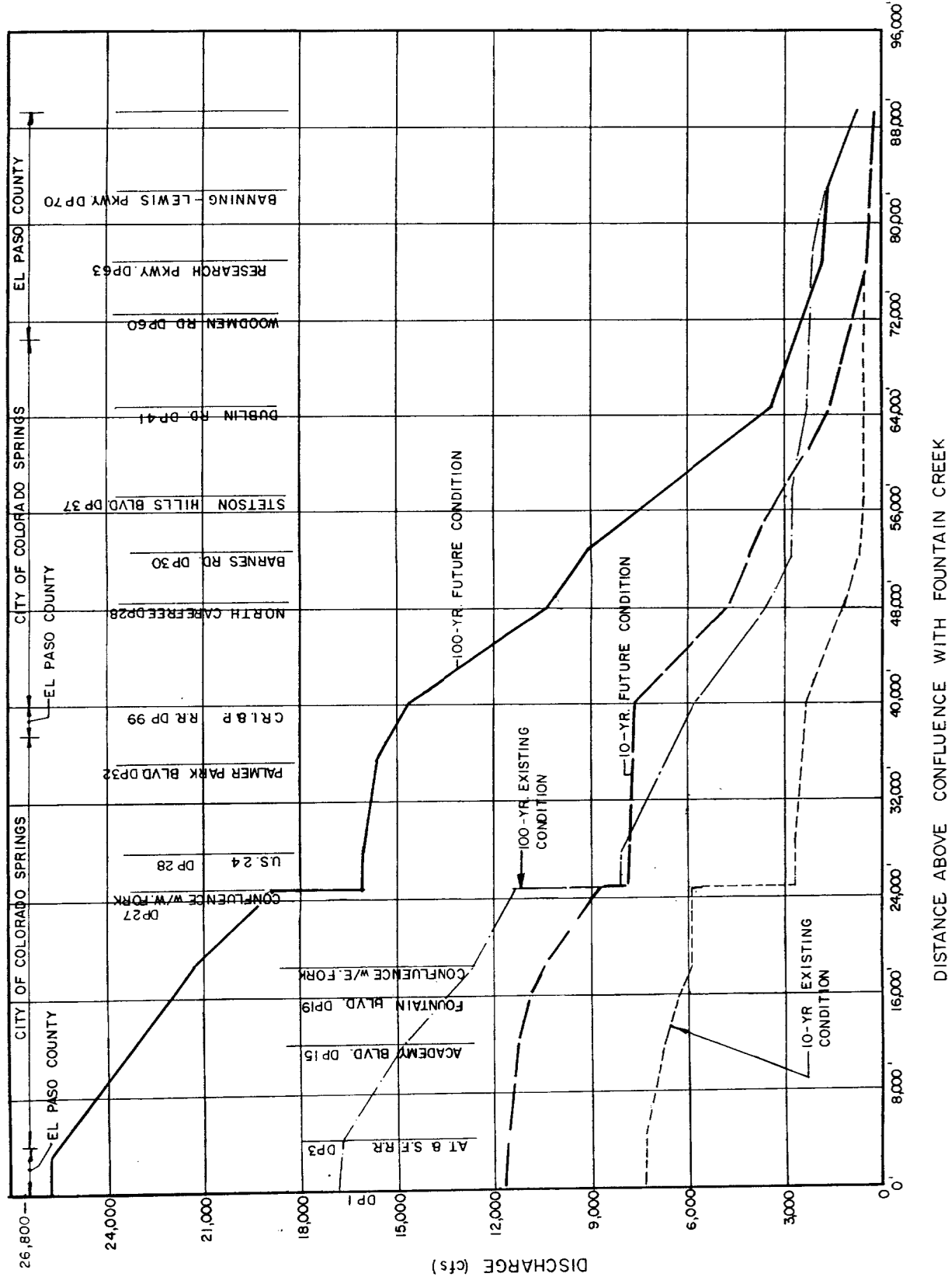
(1) Future baseline condition discharges for Sand Creek compiled with the assumption that the discharges from the East Fork Sand Creek basin are maintained at existing rates as shown on this Table.



SAND CREEK DRAINAGE BASIN PLANNING STUDY FLOOD DISCHARGE PROFILE

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Date: 10/90
Sheet: 1 of 1
Scale: 1" = 1000'
Drawn: JAK
Checked: JAK
Reviewed: JAK

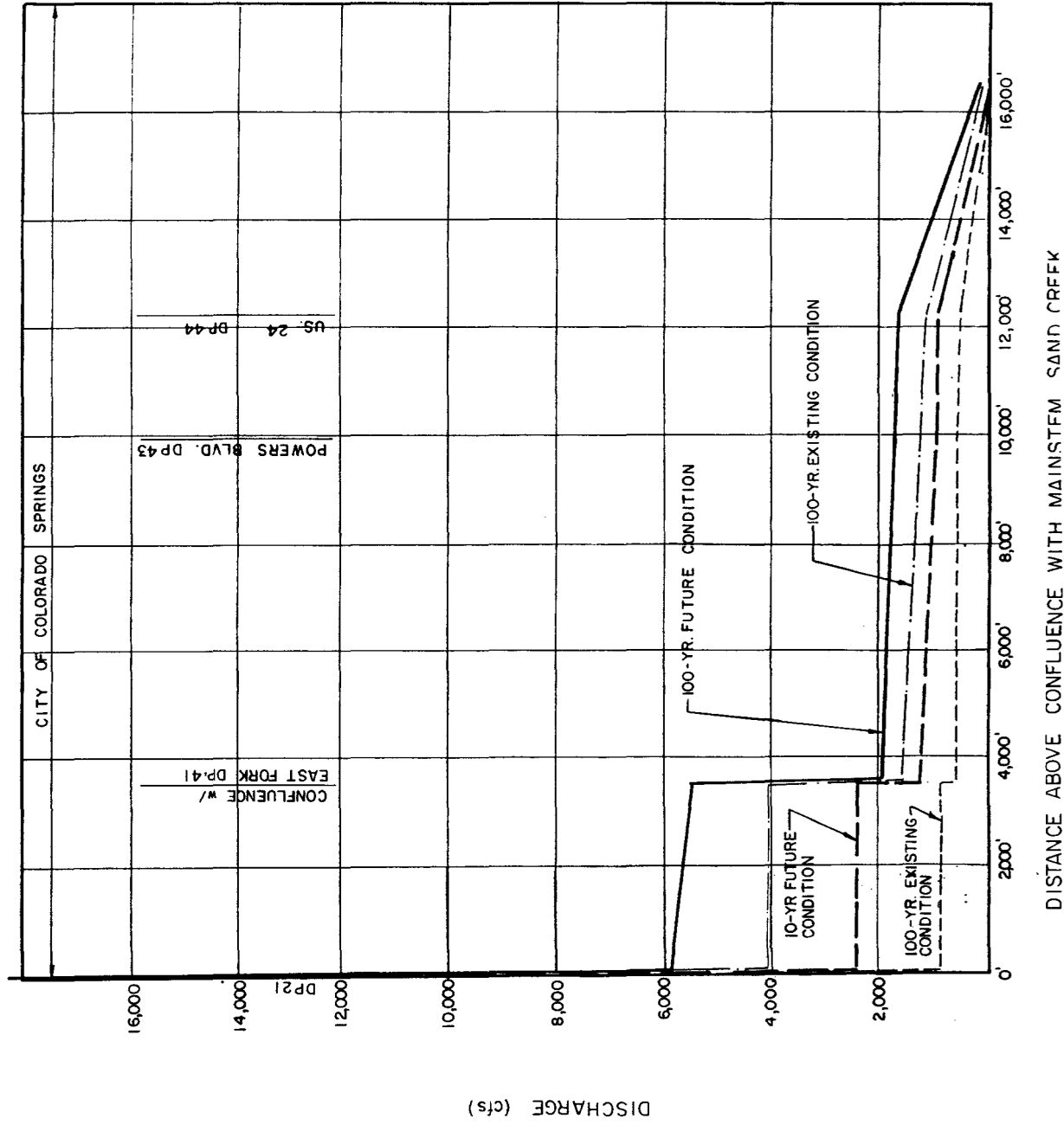
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308



**SAND CREEK DRAINAGE
BASIN PLANNING STUDY
CENTER TRIBUTARY SAND CREEK
FLOOD DISCHARGE PROFILE**

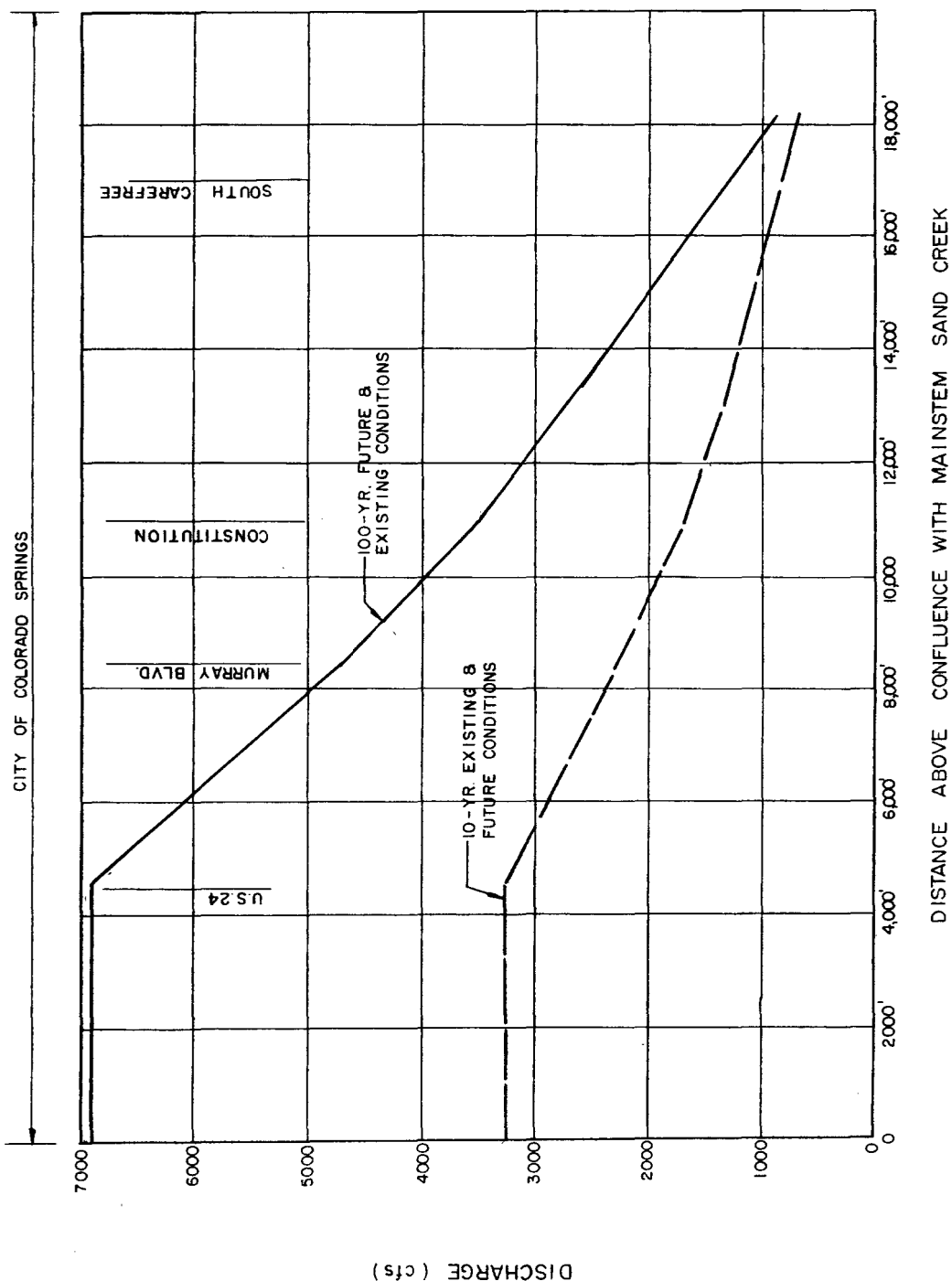
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Date	11/75
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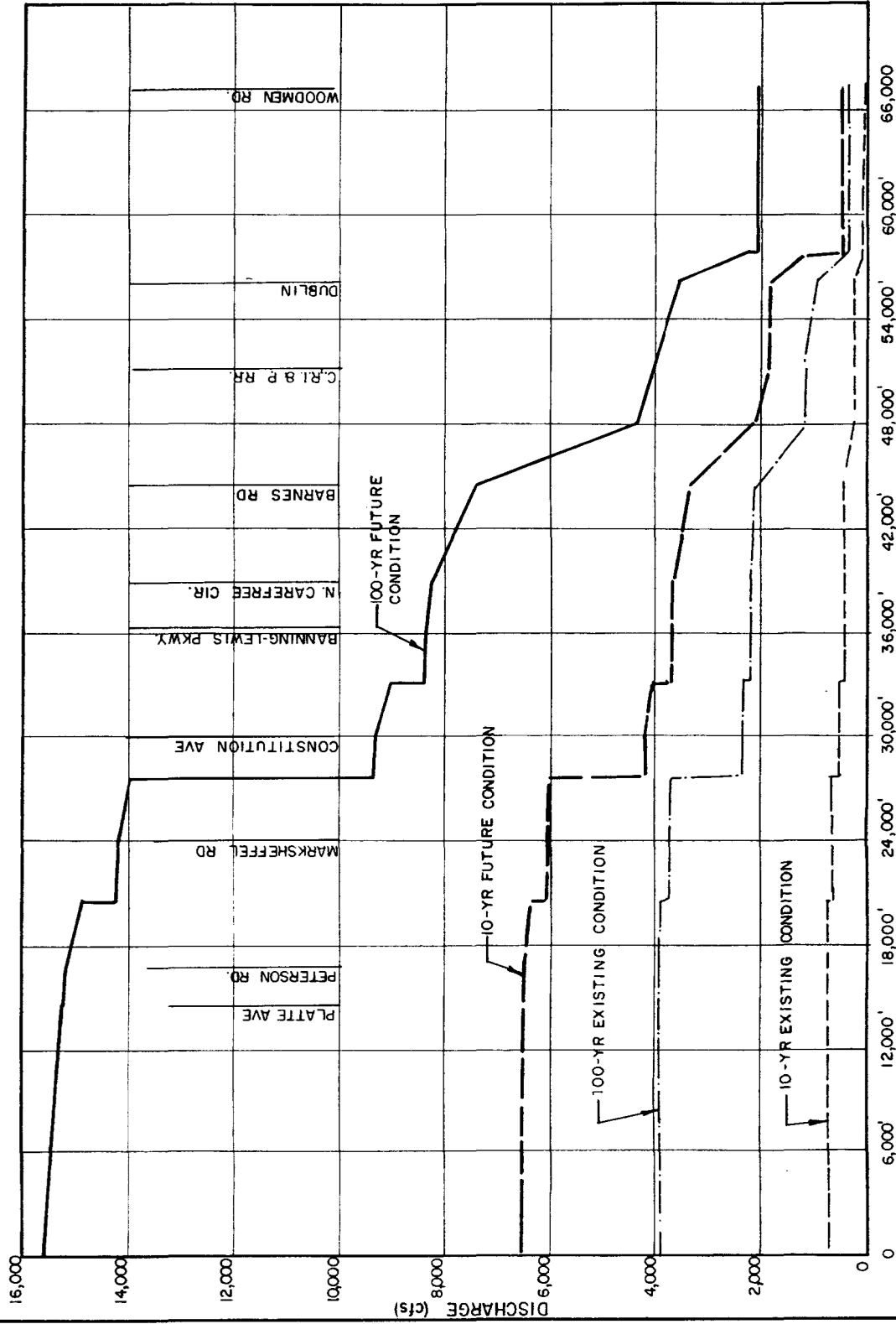
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308



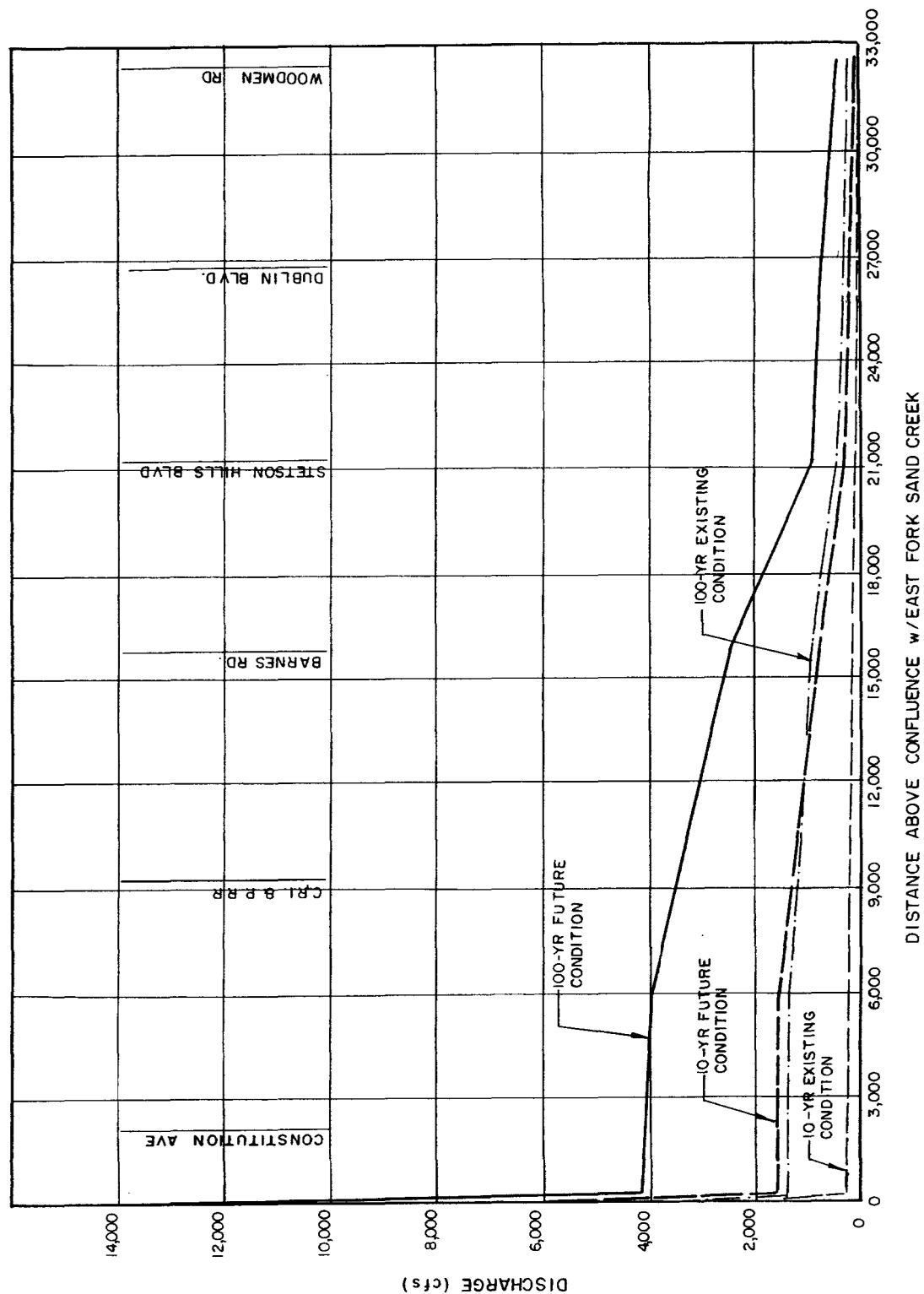
DISCHARGE (cfs)

DISTANCE ABOVE CONFLUENCE WITH MAINSTEM SAND CREEK





DISTANCE ABOVE CONFLUENCE WITH MAINSTEM SAND CREEK

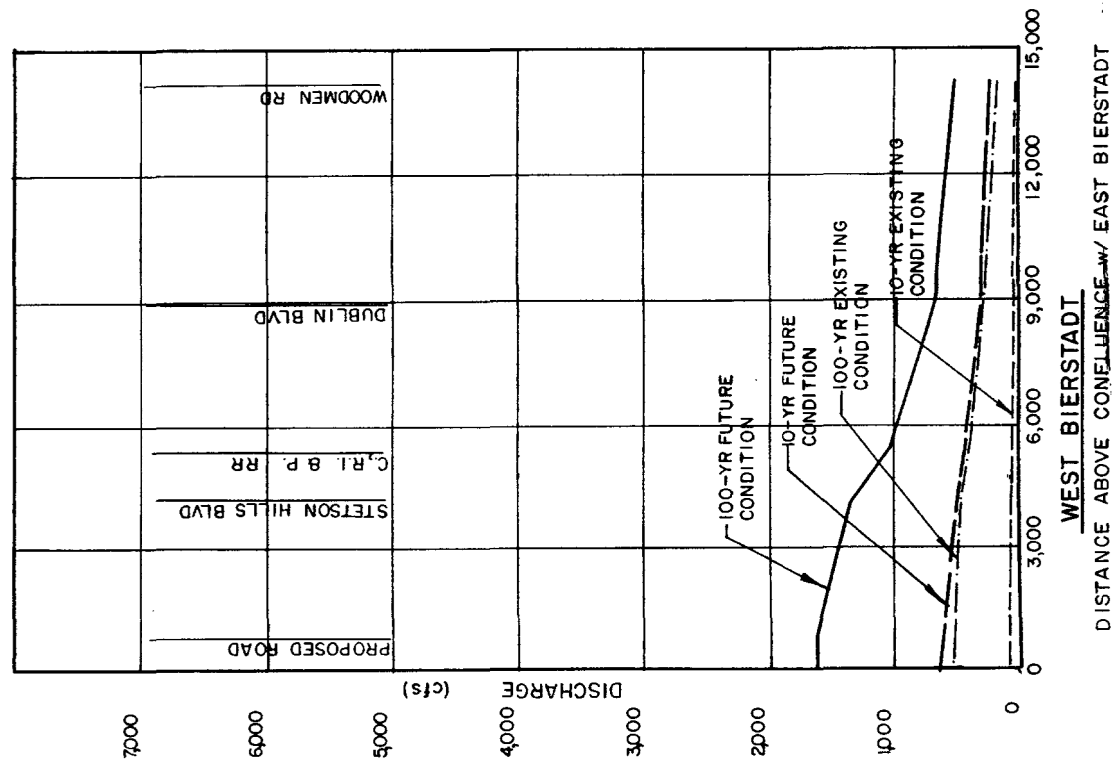
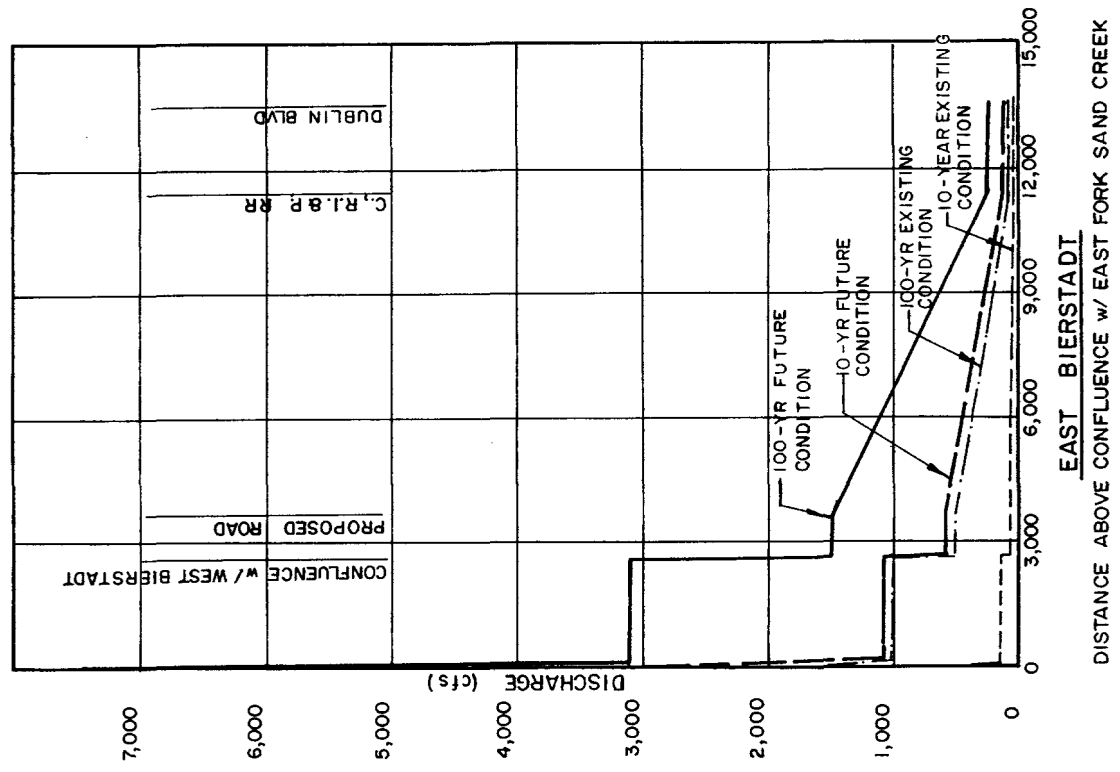


**SAND CREEK DRAINAGE
BASIN PLANNING STUDY
EAST & WEST BIERSTADT CREEK
FLOOD DISCHARGE PROFILES**

Project No. 90-0409
Date 12/93
Drawn EAK
Checked
Reviewed

FIG. III-7

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308



IV. HYDRAULIC ANALYSIS AND FLOODPLAIN DESCRIPTION

A hydraulic analysis was conducted to ascertain the conveyance capacity of hydraulic structures along the major drainageways of the Sand Creek Basin. Field verifications of major roadway crossing and channel improvements were conducted and the general physical condition of the structure(s) noted. A hydraulic analysis was conducted using the U. S. Army Corps of Engineers (COE) HEC-2 water surface profiles program. Cross section data for the analysis was obtained by using the two-foot contour interval planimetric topographic mapping referenced earlier in this report. The capacity of the major roadway crossing structures were estimated using the HEC-2 water surface profile data.

Shown on the preliminary design plans is the 100-year floodplain for the existing development hydrologic condition. The floodplains have been delineated for the mainstem of Sand Creek, from the confluence with Fountain Creek to approximately one mile north of Woodmen Road. The 100-year floodplain for the West Fork Sand Creek has been delineated from the confluence with Sand Creek to North Carefree Circle. Floodplain information for the East Fork Sand Creek has been presented from the confluence with mainstem Sand Creek to Woodmen Road. The floodplain information shown on the preliminary design plans has been used primarily for the identification of flood prone areas along the major drainageways and to aid in the evaluation of alternative plans. The floodplain data contained herein is not intended to replace the information presented in the City of Colorado Springs and El Paso County Flood Insurance studies, but should be used as a planning tool for urban drainageway development projects.

Along many reaches of the mainstem and particularly within the undeveloped portions of the drainageway, floodplain preservation has been recommended in combination with selective channel and invert stabilization as the selected plan. Because of this, the location of the 100-year floodplain is important since it denotes the limit of allowable encroachment. Often times the 100-year floodplain zone contains the higher quality riparian and wetland habitat areas which were determined to be desirable areas to preserve during the alternative planning process. It is recommended that at the time of development, land which contains the main channels of Sand Creek watershed should have the 100-year floodplain limits verified using the hydrology summarized herein as part of the initial steps of the land development planning. For areas where no floodplains have been delineated either in this report or in the Flood Insurance Study, the

100-year floodplain should be required to be determined using methods similar to those applied in this study.

Reach Delineation

Reaches were delineated for various segments of Sand Creek, the Center Tributary, the West Fork, the East Fork and its major tributaries. The reaches were determined based upon the existing physical condition of the low flow, floodplain, and overbanks along the drainageways. The reach limits are shown on Figure IV-1. Descriptions have been prepared for each reach by means of field visits which were conducted to ascertain more site specific information related to the existing drainageway conditions. An environmental review of the major reaches was also conducted. This information is presented in the Sand Creek Drainage Basin Planning Study Development of Alternatives Report and in the draft East Fork Sand Creek Drainage Basin Planning Study.

Flood History

The July, 1970, flood event on Sand Creek was caused by a brief but intense rainfall. Estimates were that 1-1/4 inches fell in a two-hour period. Damage included culvert washouts, and damage to roadway embankments at Powers and Fountain Boulevards. One life was lost in this flood. This flood event clearly shows that the potential for severe flooding is present in the Sand Creek basin. Such events will have the ability to cause extensive transport of sediment. The cost of clean up of such sediment flows will be substantially higher (assuming the same size of storm event), as the basin moves towards full development. The potential for debris flow damage is presently most pronounced in the lower reaches.

Annual flooding occurs at Galley Road and Sand Creek and at the Center Tributary and Powers Boulevard. Repair of the roadway and adjacent channels is needed after these overtopping events.

The potential for flash flooding will increase as urbanization continues in the Sand Creek basin. Urban development tends to shorten the time to peak and increase the volume of runoff as compared to existing conditions. This is particularly true for the West Fork Sand Creek. Conversely, the potential for sediment transport in a brief, but intense rainfall event, is high with the basin and channel in its current condition. As urban development continues, the sediment supply will tend to decrease if stable channel sections are constructed to counteract stream degradation. The change in development characteristics will result in channel degradation and bank erosion being the most common type of damages if stabilization measures are not implemented.

Hydraulic Structure Inventory

As part of the field investigation, the existing drainage facilities were verified and inventoried. The size, type, and condition was recorded for all the bridges, culverts, channels, inlets, pipes, and miscellaneous drainage features in the basin. Hydraulic capacities were estimated for the culverts and bridges over the major drainageways. An inventory of the major structures is presented on Tables IV-1 and IV-2. Hydraulic capacity of crossings were assumed to be reached when the hydraulic grade line equals the road surface. Channel capacity adequacy was assumed to be reached when the 100-year, future condition undetained discharge overtopped the unimproved or improved channel banks.

In addition to the bridge and culvert inventory, the existing storm sewer facilities within the mainstem Sand Creek basin were field verified and tabulated. The structures were measured and their condition noted. A database was prepared showing the storm sewer system was compiled. Maps showing the facilities have been prepared and are contained under a separate cover. The 100-year channel capacities were estimated using the HEC-2 computer program. A structure's adequacy is based upon the channel's ability to convey the 100-year discharge without overtopping the existing banks. No such inventory was conducted for the East Fork Sand Creek basin.

Floodplains

Floodplains for the 100-year existing condition discharge have been delineated for Sand Creek, East Fork Sand Creek, and West Fork Sand Creek. The floodplain was estimated in order to assess where hydraulic inadequacies exist along the major drainageways. This analysis assumed rigid boundary conditions to exist along the channel cross sections. The field inventory supplied roughness and bridge opening data for use in the HEC-2 modeling.

The most significant areas of existing flood hazard occur within mainstem Sand Creek reaches 1 through 3 and West Fork Sand Creek Reach 2. In Reach 1, the floodplain is generally confined to the existing channel banks, however, these banks are unlined in some locations of the reach. Bank erosion is prevalent downstream of Hancock Boulevard. In Reach 2, between Fountain Boulevard and Airport Road, flooding could occur within subdivisions lying along the west overbank. Approximately 40 single-family structures are within the 100-year floodplain. As in Reach 1, unlined banks occur in several locations where development has not occurred. Within Reach 3, a recently completed bridge project has resulted in removing an office building and private residence which were within the 100-year floodplain caused by the inadequacy of the

previously existing Galley Road culverts over Sand Creek. Severe erosion is occurring where the channel banks have been disturbed or left unprotected. Along the West Fork, single-family residence and commercial structures have been estimated to be within the 100-year flood plain. This situation is primarily caused by inadequate bridges at Galley Road and Palmer Park Boulevard. Much of the riprap lining has been washed away within Reach 2 of the West Fork. At Galley Road the existing culverts cause flow to be forced away from the drainageway and into the local streets. A recently completed project at Murray Boulevard and West Fork Sand Creek has resulted in the removal of numerous structures which were within the 100-year floodplain in this segment of the West Fork.

Within the upper reaches of Sand Creek, the floodplain widths vary from 200 feet to as much as 800 feet, wherever the natural flood plain overbanks have been left undisturbed. No habitable structures are currently within the 100-year flood plain. With the exception of Reach 4 and 5, the remaining reaches are stable and showing little evidence of degradation.

Very few flooding problems currently exist along the East Fork Sand Creek and its major tributaries. This is mainly because there is very little development along the drainageways and there are few roadway crossings. Recently completed construction at the East Fork Sand Creek and Powers Boulevard has eliminated the only insufficient capacity culvert along the main stem of East Fork Sand Creek.

FEMA has conducted a restudy of the Sand Creek within the Center Tributary, West Fork, Reach 5 of Sand Creek and along the East Fork Sand Creek Sub-tributary. This information has been reviewed as part of this study and found to be in general agreement with the flood plains described above. Flood plains for the majority of the reaches are presented in the City of Colorado Springs and El Paso County Flood Insurance Studies (1989).

TABLE IV-1: SUMMARY OF HYDRAULIC STRUCTURES - CROSSINGS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	REACH #	SIZE	TYPE	CAPACITY EXISTING	CAPACITY FUTURE (1)	COMMENTS
Mustang Place	SC-9	36"x48"	ELLIP. METAL PIPE	INADEQUATE	INADEQUATE	
Arroyo Lane	SC-9	60"	METAL PIPE	INADEQUATE	INADEQUATE	
Vollmer Road	SC-9	60"	METAL PIPE	INADEQUATE	INADEQUATE	
Wooten Road	WF-1	2-10'X11' 1-10'X14'	BOX CULVERT	ADEQUATE	ADEQUATE	CULVERT ERODED ON OUTLET SIDE.
Platte Ave. (US 24)	WF-1	2-6'X16' 1-6'X19'	BOX CULVERT	ADEQUATE	ADEQUATE	DOWNSTREAM CHANNEL DEGRADED AT OUT-LET OF CULVERTS
Galley Road	WF-2	5-5'x10'	BOX CULVERT	INADEQUATE	INADEQUATE	
Murray Blvd.	WF-2	54'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	NEW BRIDGE
Palmer Park Blvd.	WF-2	5-4'x10'	BOX CULVERT	INADEQUATE	INADEQUATE	OUTLET SIDE OF CBC'S SEVERELY ERODED.
Constitution Ave.	WF-3	4-8'x6'	BOX CULVERT	INADEQUATE	INADEQUATE	"
Maizeland Road	WF-3	3-9'x5'	BOX CULVERT	INADEQUATE	INADEQUATE	
South Carefree	WF-3	15'x9'	METAL ARCH PIPE	INADEQUATE	INADEQUATE	
Oro Blanco	WF-3	10'x10'	METAL ARCH PIPE	ADEQUATE	ADEQUATE	

TABLE IV-2: SUMMARY OF HYDRAULIC STRUCTURES - CHANNELS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	REACH #	DIMENSIONS			TYPE	CAPACITY (I)		COMMENTS
		TW (ft)	SS	DEPTH (ft)		ADQ	INADQ	
Fountain Creek to AT & SF RR	SC-1	300	varies	8	Unimproved, no bank linings or grade controls. Sloughing banks common.			
AT & SF RR to Fountain Blvd.	SC-1	225	2:1	7	Trapezoidal with localized riprap linings. Some slopes > 2:1.		X	Channel and toe banks are vegetated section is stable. Several ex. grade controls in this segment.
Fountain Blvd. to W. Fork Sand Creek	SC-2	175	2:1	7	Trapezoidal with riprap bank linings. Portion of reach unimproved.		X	Section is presently stable. Residential flooding possible in this segment.
W. Fork Sand Creek to Galley Rd.	SC-3	150-350	varies	4-5	Intermittently lined with riprap. Remnants of historic floodplain and creek banks exist.		X	Channel banks and invert are unstable at Galley road. Wide floodplain south of US 24.
Galley Rd. to Powers Blvd.	SC-3	150-300	varies	5-9	Intermittently lined with riprap. Most of segment unimproved. Historic floodplain remains.		X	Area of riparian habitat value present near Palmer Park Blvd.
Powers Blvd. to Waynoka Rd.	SC-4	220	2:1	5	Intermittently lined with soil cement and riprap.	X		Reach is generally stable except at Waynoka Rd. crossing. Headcutting has undermined bank and toe vegetation.
Waynoka Rd. to Constitution Ave.	SC-4/5	330	varies	5	Unimproved upstream of RR crossing. Riprap banks downstream of RR.	X		
Constitution Ave. to Barnes Rd.	SC-5	100-400	varies	3-7	Unimproved for approx. 1/2 or Reach, upstream of No. Carefree. Soil cement and riprap d/s of No. Carefree of adequate capacity.	X		Channel is presently stable.
Barnes Rd. to Woodmen Rd.	SC6/7				Natural, unimproved channel section. Historic floodplain unencroached.			Channel has zones on heavy vegetation along invert and overbanks. Base flow present.

TABLE IV-1: SUMMARY OF HYDRAULIC STRUCTURES - CROSSINGS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	REACH #	SIZE	TYPE	CAPACITY EXISTING	CAPACITY FUTURE (1)	COMMENTS
Waynoka Road	SC-4	36" & 30'	METAL PIPE	INADEQUATE	INADEQUATE	FLOW PASSES OVER ROADWAY. DOWN- STREAM SIDE OF ROAD SEVERELY ERODED.
CRI&P RR	SC-5	240'	STEEL BRIDGE	ADEQUATE	ADEQUATE	
Constitution Ave	SC-5	4-11'X10' 2-14'X10'	BOX CULVERTS	ADEQUATE	INADEQUATE	CULVERTS CLOGGED WITH SAND
North Carefree Cr.	SC-5	5-12'X12' 1-9'X9'	BOX CULVERT	ADEQUATE	ADEQUATE	NEW CULVERT, 1988
Barnes Road	SC-6	110'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	NEW BRIDGE, 1988
Stetson Blvd.	SC-6	NONE		INADEQUATE	INADEQUATE	EMBANKMENT HAS CREATED PONDING AREA UPSTREAM OF ROADWAY.
Peterson Road	SC-6	NONE		INADEQUATE	INADEQUATE	PROPOSED ROADWAY
Dublin Blvd.	SC-7	NONE		INADEQUATE	INADEQUATE	PROPOSED ROADWAY
Woodmen Road	SC-8	80'	STEEL BRIDGE	ADEQUATE	ADEQUATE	

TABLE IV-1: SUMMARY OF HYDRAULIC STRUCTURES - CROSSINGS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	REACH #	SIZE	TYPE	CAPACITY EXISTING	CAPACITY FUTURE (1)	COMMENTS
Las Vegas Street	SC-1	250'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	NEW BRIDGE REPLACED IN 1994 CHANNEL NEEDS STABILIZATION
AT & SF RR	SC-1	420'	STEEL BRIDGE	"	"	INVERT DEGRADATION HAS EXPOSED PILES WITHIN THE CREEK
Hancock Blvd.	SC-1	10-8'x12'	BOX CULVERT	ADEQUATE	INADEQUATE	OVERBANK FLOODING UPSTREAM OF ROADWAY CAUSED BY BRIDGE BACKWATER
Academy Blvd.	SC-1	300'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	
Chelton Road	SC-1	12-8'x12'	BOX CULVERT	INADEQUATE	INADEQUATE	OUTLET SIDE OF BRIDGE SEVERELY ERODED. OVERBANK FLOODING CAUSED BY BACKWATER OF CULVERT.
Fountain Blvd.	SC-2	185'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	
Airport Road	SC-2	160'	CONCRETE BRIDGE	ADEQUATE	INADEQUATE	
Platte Ave. (US 24)	SC-3	355'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	
Galley Road	SC-3	110', 2-span	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	NEW BRIDGE
Palmer Park Blvd.	SC-3	150'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	
Powers Blvd.	SC-3	6-12'x12'	BOX CULVERT	ADEQUATE	INADEQUATE	NEW CULVERT, 1989

TABLE IV-1: SUMMARY OF HYDRAULIC STRUCTURES - CROSSINGS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	REACH #	SIZE	TYPE	CAPACITY EXISTING	CAPACITY FUTURE (1)	COMMENTS
Airport Road	CT-1	5-6'x8'	BOX CULVERT	ADEQUATE	ADEQUATE	
Pikes Peak Ave.	CT-1	NONE		INADEQUATE	INADEQUATE	POWERS BLVD. OVERTOPPED FREQUENTLY BETWEEN BIJOU ST. AND PIKES PEAK AVE.
Powers Blvd.	CT-1	VARIOUS	METAL PIPE	INADEQUATE	INADEQUATE	
Platte Ave (US 24)	CT-1	8'x4'	BOX CULVERT	INADEQUATE	INADEQUATE	APPROACH CHANNEL IN NEED OF REALIGNMENT
Terminal Avenue	CT-2	2-4'x8'	BOX CULVERT	INADEQUATE	INADEQUATE	
Galley Road	CT-2	3-42"x72"	METAL ARCH PIPE	INADEQUATE	INADEQUATE	
Omaha Boulevard	CT-2	2-36"x57"	METAL ARCH PIPE	INADEQUATE	INADEQUATE	
Powers Boulevard	EFSC-2	90' clear span	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	NEW BRIDGE
Stewart Street	EFSC-2	140'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	
US 24/Platte Ave	EFSC-2	290'	CONCRETE AND TIMBER BRIDGE	ADEQUATE	ADEQUATE	LIMITED BANK PROTECTION AT INLET AND OUTLET OF BRIDGE
Peterson Road	EFSC-2	4-36"	METAL PIPE	INADEQUATE	INADEQUATE	
Markscheffel Road	EFSC-2	2-36"	METAL PIPE	INADEQUATE	INADEQUATE	

TABLE IV-1: SUMMARY OF HYDRAULIC STRUCTURES - CROSSINGS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	REACH #	SIZE	TYPE	CAPACITY EXISTING	CAPACITY FUTURE (1)	COMMENTS
Constitution Avenue	EFSC-3	4-8'Hx12'W 5-8'Hx15'W	CONCRETE BOX CULVERTS	ADEQUATE	ADEQUATE	
Chicago and Rock Island Railroad	EFSC-7	30'	STEEL BRIDGE	ADEQUATE	ADEQUATE	RAILROAD IS ABANDONED
Tamlin Road	EFSC-7	30'	CONCRETE BRIDGE	ADEQUATE	ADEQUATE	
Woodmen Road	EFSC-8	36"x52"	METAL ARCH PIPE	INADEQUATE	INADEQUATE	
Constitution Avenue	EFST-1	2-6'H x 11'W 2-6'H x 14'W	CONCRETE BOX CULVERTS	ADEQUATE	ADEQUATE	
Genoa Drive	EFST-1	3-36"	METAL PIPES	INADEQUATE	INADEQUATE	100-YEAR FLOW WOULD OVERTOP ROADWAY
Industry Drive	EFST-1	2-8'H x 12'W 1-8'H x 16'W	CONCRETE BOX CULVERTS	ADEQUATE	ADEQUATE	
Chicago & Rock Island Railroad	EFST-2	100'	STEEL BRIDGE	ADEQUATE	ADEQUATE	RAILROAD IS ABANDONED
Woodmen Road	EFST-2	2-18"	METAL PIPES	INADEQUATE	INADEQUATE	
Huber Road	TR-1	2-52" x 36"	METAL ARCHES	ADEQUATE	ADEQUATE	
Luther Road	TR-1	42" x 30"	METAL ARCHES	ADEQUATE	ADEQUATE	

TABLE IV-2: SUMMARY OF HYDRAULIC STRUCTURES - CHANNELS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION FROM / TO	REACH #	DIMENSIONS			TYPE	CAPACITY (1)		COMMENTS
		TW (ft)	SS	DEPTH (ft)		ADQ	INADQ	
EAST FORK SAND CREEK								
Sand Creek to Center Trib. confluence	EF-1	100	1:1 TO 2:	8	Partially lined riprap trapezoidal channel	X	X	Riprap lining needs to be reconstructed along outside bend of drainageway.
SC = SAND CREEK MAINSTEM EFSC = EAST FORK SAND CREEK						CT= Center Tributary Sand Creek		

(1) Structure adequacy has been based upon the 100-year, existing condition HGL, using the existing condition flows listed in Table 2.

TABLE IV-1: SUMMARY OF HYDRAULIC STRUCTURES - CROSSINGS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION	REACH #	SIZE	TYPE	CAPACITY EXISTING	CAPACITY FUTURE (1)	COMMENTS
Tamlin Road	TR-2	72"	METAL PIPE	ADEQUATE	ADEQUATE	
Woodmen Road	TR-3	2-36"	METAL PIPES	ADEQUATE	ADEQUATE	
Chicago & Rock Island Railroad	WB-2	UNKNOWN				RAILROAD IS ABANDONED
Tamlin Road	WB-2	2-36"	METAL PIPES	ADEQUATE	ADEQUATE	
Chicago & Rock Island Railroad	EB-1	UNKNOWN				RAILROAD IS ABANDONED
Tamlin Road	EB-1	UNKNOWN				

TABLE IV-2: SUMMARY OF HYDRAULIC STRUCTURES - CHANNELS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

LOCATION FROM / TO	REACH #	DIMENSIONS			TYPE	CAPACITY (1)		COMMENTS
		TW (ft)	SS	DEPTH (ft)		ADQ	INADQ	
Woodmen Rd. to u/s study limit	SC8/9			N/A	Natural, unimproved channel section. Historic flood-plain unencroached.			Base flow exists in this reach.
W FORK SAND CK Sand Creek to Platte Ave.	WF-1	80	2:1	8-12	Riprap lined u/s of Wooten Rd, adequate capacity. Unlined d/s of Wooten Rd.	X		Channel section is presently stable u/s of Wooten Rd. Culverts are eroded at outlet sides.
Platte Ave. to Galley Rd.	WF-1	80-120	1:1	8-10	Intermittently lined with riprap.		X	Channel section is presently stable u/s of Wooten Rd. Culverts are eroded at outlet sides.
Galley Rd. to Palmer Park Blvd.	WF-2	100	1:1	6-8	Trapezoidal with localized riprap and rubble linings.		X	Channel confined to small right-of-way. Culverts eroded on outlet sides. Residential flooding possible in this segment.
Palmer Park Blvd. to Constitution	WF-2	80	2:1	8-10	Trapezoidal, concrete lined for majority of segment.	X		Channel linings degrading at some locations.
Constitution Ave. to Maizeland	WF-3	55	1:1	6	Concrete lined; some locations with rubble invert.	X		Channel is of adequate capacity except at crossings.
Maizeland to to So. Carefree	WF-3	33-43	1:1	6-9	Concrete lined	X		Maizeland crossing causes banks to be overtopped.
So. Carefree to Oro Blanco	WF-3	36	1:1	3-4	Concrete lined.		X	So. Carefree crossing causes channel to be overtopped.
Oro Blanco to No. Carefree	WF-3	9-20	varies	4	Portion of segment has rectangular channel section. Concrete lined.	X		Inadequate downstream of No. Carefree for 700'.

TABLE IV-2: SUMMARY OF HYDRAULIC STRUCTURES - CHANNELS
SAND CREEK DRAINAGE BASIN PLANNING STUDY

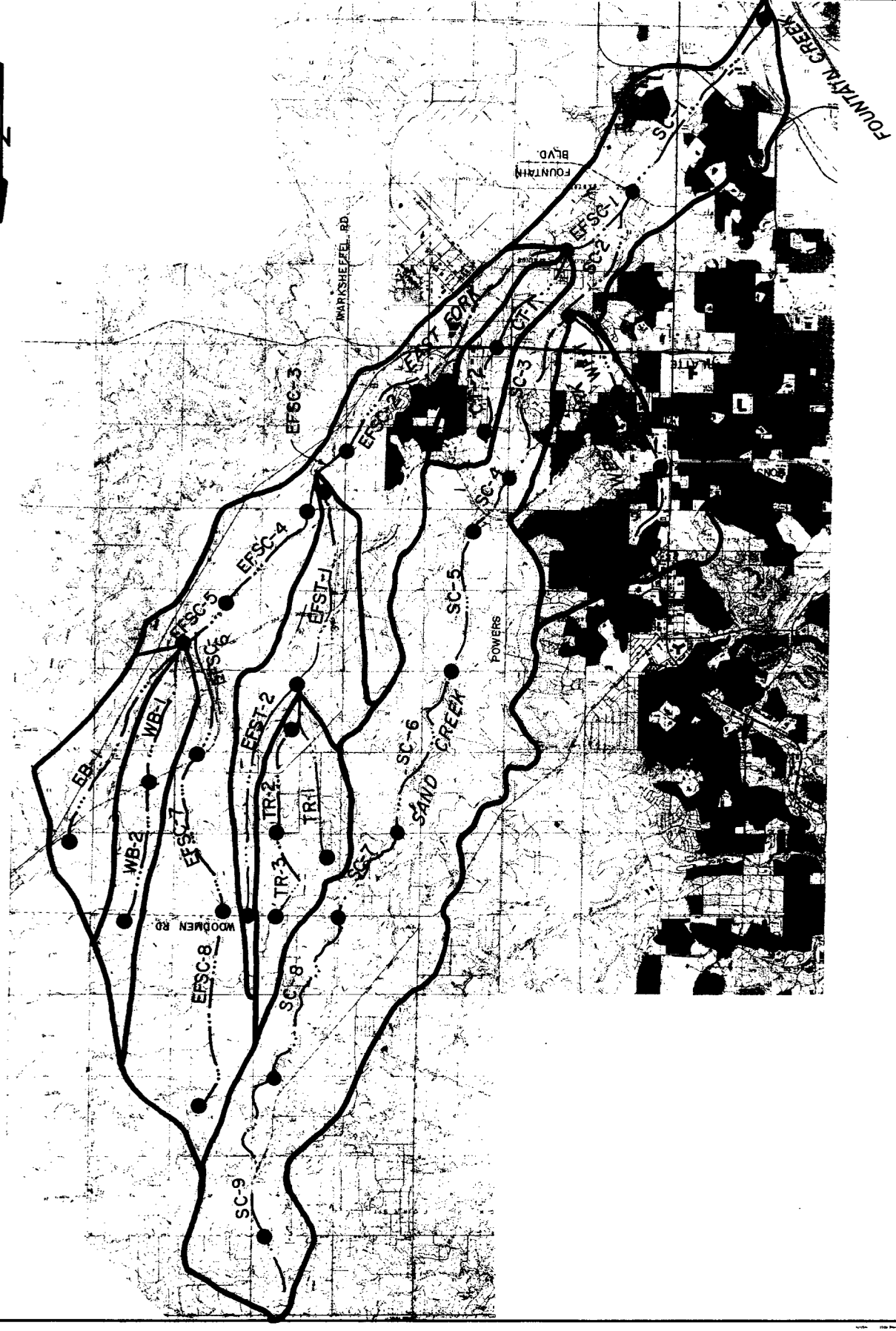
LOCATION FROM / TO	REACH #	DIMENSIONS			TYPE	CAPACITY (1)		COMMENTS
		TW (ft)	SS	DEPTH (ft)		ADQ	INADQ	
CENTER TRIBUTARY								
East Fork Sand Creek to Airport Road	CT-1	45	2:1	6	Riprap lined trapezoidal channel	X	X	Riprap has failed or is non-existent along some portions of this segment of the Center Tributary
Pikes Peak to Bijou St.	CT-1			N/A	Rubble lined ditches along Powers Blvd.			Flow passes over and along Powers Blvd. street section on a frequent basis. Road closures common.
Bijou St. to Platte Ave.	CT-1			N/A	Unlined, natural.			Overbanks vegetated, channel dry with sand invert, no vegetation. Channel eroded at outlet of US24 culvert.
Platte Ave. to Terminal Ave.	CT-2	15-25	1:1	4-6	Trapezoidal concrete lined.	X		Channel has adequate capacity.
Terminal Avenue to Galley Road	CT-2	21	1:1	5	Trapezoidal concrete lined.	X		Channel has adequate capacity.
Galley Road to Paonia Ct. (ext)	CT-2	30-40	varies	4-5	Unimproved segment.		X	Channel is degraded and filled with debris. Poor maintenance access.
Paonia Ct. to Omaha Blvd.	CT-2	21	1:1	5	Trapezoidal concrete lined channel.	X		Maintenance access poor. Debris and trash in channel.
Omaha Blvd. to Palmer Park Blvd.	CT-2	19	1:1	4	"	X		Storm sewers outfall to channel near Palmer Park.

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 419 W. Bijou Street
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SAND CREEK DRAINAGE BASIN PLANNING STUDY REACH DELINEATIONS

Project No.	80-04-03
Date	1-91
Design	RWW
Drawn	EAK
Checked	
Reviewed	

FIG. IV-1



-	Flood Control
-	Erosion Control
-	Operation and Maintenance
-	Recreation
-	Right-of-Way
-	Transportation - Roadway and
-	Trails
-	Open Space/Aesthetics
-	Land Use
-	Water Quality
-	Habitat
-	Construction Cost
-	Administration and
-	Implementation

By reviewing the relative impact of future storm water runoff upon the major drainageways, each of the evaluation parameters were ranked. A minimal impact was assumed wherever the future flows were considered to cause little physical change with respect to a specific parameter. Neutral impact upon a given parameter was considered wherever the negative effects of future flows could be planned for and mitigated. High impact was considered wherever the existing channel section would be rendered unsuitable to provide for a given parameter in the future flow condition. Using the input from the individuals and agencies who participated in the meetings and field reviews, flood hazard, habitat, erosion control, open space, transportation (more specifically trails), and right-of-way were consistently judged to be of high concern in the Sand Creek Basin.

Environmental Review of the Mainstem Sand Creek Drainage Basin

The environmental review conducted for this study consisted of a description and compilation of the biological and land use resources in the basin, their present condition, and an analysis of abiotic and human factors affecting the environment. A reconnaissance survey was conducted during which the environmental conditions were studied by driving and walking the areas and drainages in the basin. The area was mapped and interpreted in the field based on 7-1/2 minute topographic maps and ortho-corrected aerial photographs at a scale of 1"=400'. Particular attention to conditions in the drainages and spring/seep areas for biological resources in the riparian zones and wetlands.

The Sand Creek drainage basin trends in a south-southwest direction from the headwaters in the Black Forest extending about 17 miles to its confluence with Fountain Creek. There are approximately nine miles of secondary channels in the middle portion of the basin. Sand Creek is an intermittent stream which flows after storms and during the spring runoff for a short period of time. Short stretches where the bedrock is near the surface are semi-permanent or with a permanent high water table. The bedrock geology is flat-lying sandstones and siltstones some of which is covered with recent alluvium. The main vegetation type is a short- to mid-grass prairie grassland with ponderosa pine open forest in the upper one and a half mile of shallow, indistinct drainages that grades into the prairie grassland. Dry channel, riparian zones, and wetlands occur in the main and secondary drainages. Wetlands occur outside the drainages in the upper third of

the basin where springs and seeps provide moisture at about the 6,700 to 7,200 foot level. Wildlife and animal species common to the open plains and pine forests inhabit the open upper portions of the basin. They consist of deer, antelope, small mammals, birds, and predators that tolerate roads and the presence of people.

Land use in the basin has altered the conditions of the biological resources and drainages. Flat and gently sloping land in the lower one-half of the basin has been used for commercial and residential development, and the channels of the drainages have been extensively altered by grading, straightening, concrete lining, and riprapping for flood and erosion control. Some open, undeveloped fields have some ungraded portions left, but most of these are disturbed and have revegetated to a weedy grassland type of vegetation. Past dumping of commercial and residential wastes has occurred in this part of the basin in the floodplain and along the banks of the channels. The main and secondary channels of Sand Creek in this lower developed portion consists of concrete lined or dry natural or straightened channels, and about two zones of good and some poor quality riparian zones and small degraded wetlands still exist in the floodplains.

The upper portion of the basin has less development and consists of a few commercial developments, and large lot residential. Most of the open grassland is used as rangeland and portions are heavily grazed by domestic livestock, mostly cattle and some horses. The area of the basin in the Black Forest is mostly platted for large lot residential but still has some open space left. There is a zone of extensive wetlands in the shallow drainages and spring/seep areas in the upper one-third of the basin around Woodmen Road and north. These wetlands have been disturbed to establish stockpounds and are heavily grazed in some of the rangeland pastures, however, a few on private land and in the Black Forest are in good to excellent condition. A more thorough description of the environmental resources identified during the preparation of the planning study is contained within the Sand Creek Drainage Basin Planning Study Development of Alternatives report. Both qualitative and quantitative assessments are presented which were used in the determination of relative impact for each feasible plan identified in the alternative evaluation process.

Environmental Review for the East Fork Sand Creek Drainage Basin

An environmental review of the East Fork basin was conducted in order to characterize the existing environmental features. The sensitivity of wetland and riparian areas to stormwater runoff, sedimentation and erosion must be evaluated and planned for in a reasonable way. A description of the existing environmental features follows.

East Fork Sand Creek has intermittent streams throughout most of the basin. Flow develops in the drainageways only after heavy runoff events. The basin tends to drain in a southwesterly direction. The predominate existing land use is mostly livestock ranching and

grazing with some commercial and large lot residential development. Only near its confluence with the mainstem of Sand Creek and at roadway crossings has the drainageways been channelized. Very little single-family residential uses now exist.

The topography is similar to the mainstem Sand Creek basin, with gently rolling rangeland and with shallow drainages. This area is in the High Plains shortgrass prairie region of Colorado that is characterized as short and mid-grasses with a few shrubs in the drainageways. A few willows and cottonwoods can be found along the deeper drainages where groundwater surfaces or where active stock ponds exist nearby. The drainages are mostly intermittent, except where groundwater seeps and springs provide short perennial reaches. Upland grass is the predominate vegetation type interspersed with drainages and springs that support wetland or riparian vegetation. Small ponds for livestock water have been created around the springs at many locations, such as nearby the Banning-Lewis ranch property. The major biotic or habitat types in this ecosystem are the dominant upland grasses and the minor wetland-riparian zones. This area is unusual in the number of springs and seeps that are present in an east/west orientation a few hundreds yard south of Woodmen Road. These springs provide moisture for wetlands and short reaches of perennial streams. A few springs do appear in the central portions of the basin.

Wetland and riparian areas are scattered throughout the basin. This type of habitat occurs along dry or sandy creek beds, low lying riparian zones along intermittent streams, and perennial wetlands in springs and seeps with associated short reaches of flowing streams. Dry creeks occupy about six percent of the basin, and wetlands about 3 percent, and open water ponds less than 1 percent. These areas are neither large nor extensive, and are mostly discontinuous. In their present condition they are not a significant habitat resource within the basin. The low lying drainages and wetland seeps are extensively used by livestock for grazing and bedding grounds. As a result, the wetlands and riparian drainages have been degraded in vegetative cover and productivity.

The vegetation in the dry drainageway is a sandy sparse grassland with widely spaced trees in a few locations. The wetlands have marsh plants with rushes, sedges, reeds and cattails in the wetter portions. Salt grass is common in the seeps that have developed salty or alkaline conditions. Due to the small size and scattering of the wetlands, the wildlife species using these areas are similar to those using the uplands with some concentration of birds such as killdeer and red-winged blackbirds.

The wetland and riparian area have a potential for development and maintenance as a habitat resource during the drainage planning. These areas can be maintained and enhanced for better vegetative productivity and some small open water bodies that will be shallow enough for

waterfowl to use. The drainages could have a more diverse habitat structure with shrubs and trees that could support some wildlife.

Summary of Drainageway Habitat Zones

Using the field information, summarized on the ortho- photographs, measurements of the dominant riparian and wetlands habitats were made along the major drainageways of the mainstem, Sand Creek basin. These data are summarized on Table V-1. The acreages presented on Table V-1 were used during the evaluation of drainageway channel treatments within the mainstem Sand Creek basin. Wherever Classes I or II were present, the channel sections were evaluated assuming the existing vegetation to remain in place. In reaches where the existing habitat was extremely poor or non-existent, opportunities for enhancement of the natural habitat were considered. In general, along the undeveloped reaches containing Class I or II, preservation of these areas through floodplain regulation and open space dedication was identified as an alternative.

Preliminary Matrix of Conceptual Alternatives

The alternative planning process began with the evaluation of general drainageway planning alternatives. Alternatives which are generally available when planning urban drainageways include:

1. Floodplain preservation (do nothing alternative),
2. Channelization, using various materials and of varying capacity,
3. Detention, on-site or regional,
4. Selective stabilization, and
5. Combinations of the above.

These concepts were qualitatively evaluated for each reach of the basin. The qualitative assessments were made using the information gathered in the field, and using input provided by the various agencies and individuals who participated in the coordination meetings.

Drainageway System Alternatives

A review of each drainageway alternative with respect to the evaluation parameters listed earlier was conducted. Based upon the technical work, field visits, and meetings with the interested agencies and individuals, the alternative drainage concepts were developed. Alternatives for floodplain and channel sections and detention facilities have been evaluated and are discussed in detail in the Sand Creek Drainage Basin Planning Study Development of Alternatives Report and the draft East Fork Sand Creek Drainage Basin Planning Study.

Detention

As presented in the Hydrology Section of this report, it has been estimated that peak discharges and volumes will increase along the mainstem of Sand Creek as a result of urbanization within the basin. Another impact that urbanization will have upon the basin hydrology is that "everyday" flows will increase in their peak, frequency, and duration. This will create greater instability in the existing channel sections as well as increase flood hazards if the runoff is allowed to flow through the basin in the developed condition. Detention schemes were analyzed in the alternative planning process in order to address this situation. Because Sand Creek Reaches 1 through 4 are substantially developed, there were no sites found of sufficient size to accommodate a regional detention basin. Potential detention sites were identified within Sand Creek Reaches 5 through 8 which could control the peak discharges from areas tributary to these reaches to existing levels. The majority of the future development within the basin is anticipated to occur in areas east of Powers Boulevard, predominantly in areas tributary to Reaches 5, 6, and 7.

In the East Fork Sand Creek basin, the greatest potential for regional detention exists within reaches 6 and 7 of East Fork, and along East and West Bierstadt creeks. This is primarily because of the physical nature of these stream segments which are conducive to the construction of embankments. Also, there are several existing embankments which could be modified along reaches 6 and 7. Finally, the possible sites are central to the proposed development, and are located near the centroid of the basin. Detention basins located within the central portions of the basin will have the greatest capability to create the needed developed flow attenuation at the outfall to Sand Creek.

Presented on Figures V-2 and V-3 are drawings showing the various regional detention sites which were evaluated during the alternative planning stages within the Sand Creek and East Fork Sand Creek basins. The sites were chosen primarily based upon their physical characteristics, location along the major drainageways, and the anticipated future land uses upstream of a proposed sites. Three alternative detention schemes were analyzed within the mainstem Sand Creek basin, each of which having the capability of reducing future peak flows at Constitution Avenue to existing levels. Three Detention schemes were also evaluated for the East Fork Sand Creek basin.

Detention within the West Fork Sand Creek and the Center Tributary Sand Creek basins was judged to be unfeasible primarily because no sites exist of sufficient size to reduce flows to existing levels. The preferred alternative for the East Fork Sand Creek basin includes regional detention along the East Fork so that peak discharges would be maintained to existing levels.

Conclusions

Based upon the alternative evaluation process discussed above and summarized in the Sand Creek Drainage Basin Planning Study Development of Alternatives Report and in the draft East Fork Sand Creek Drainage Basin Planning Study, the following findings were established:

1. Detention is a desirable and feasible alternative to addressing the future stormwater management needs of the basin. The primary advantages of the implementation of a regional detention concept are in the area of floodplain hazard, damage reduction, reduction in channel and roadway crossing costs, habitat preservation, and in open space. Disadvantages with the concept are in the areas of implementation and detention pond right-of-way or land acquisition issues. Detention in the upper reaches of Sand Creek renders each of the alternate channel concepts more feasible.
2. Feasible channel section alternatives for the mainstem of Sand Creek and the East Fork Sand Creek range from the floodplain preservation, or "do nothing" alternate to riprap bank linings. In Sand Creek reaches 1 through 3 a lined or trapezoidal section is feasible, primarily from the standpoint of floodplain hazard and damage reduction. In Reaches 4 through 9, floodplain preservation or a number of selected improvement concepts are feasible primarily because of the potential favorable impact upon costs, habitat preservation, and open space considerations. Within reaches 1 through 3 of the East Fork, a trapezoidal shaped riprap channel is most feasible since a large portion of these reaches have already been altered from its historic section to a trapezoidal section in order to accommodate the numerous roadways crossings and adjacent development. Within reaches 4 through 8, intermittent bank linings with check structures to limit long-term degradation is the preferred alternative, along with floodplain regulation and preservation. Similar treatments are feasible for East and West Bierstadt creeks, and for the East Fork Subtributary.
3. Concepts for the West Fork of Sand Creek is limited to channelization. This is primarily driven by the extensive flood damage potential along the West Fork and right-of-way issues. Existing land development has left a limited area for flood conveyance. Habitat lost as a result of channelization would have to be mitigated for, possibly along the channel invert or on the overbank of the channelized drainageway. There is, however, a limited amount of natural habitat which exists along the West Fork of Sand Creek.
4. Drainageway concepts for the Center Tributary of Sand Creek is limited to channelization. Adjacent land uses, limited right-of-way, future transportation projects (i.e., U.S. 24 Bypass Phase II), and the absence of natural habitat make channelization a generally feasible concept to follow.
5. Habitat disturbances due to channelization of the Sand Creek drainageway would be greatest in Reaches 6 through 9. Accordingly, channelization projects within these reaches would have to mitigate for any loss of vegetative or wildlife habitat. Since limited development currently encroaches into the natural floodplain, it appears that a floodplain and habitat preservation scheme accomplished through property acquisition or floodplain regulation is feasible in Reaches 6 through 9 of Sand Creek.

Habitat disturbances within the East Fork Sand Creek basin due to drainage development is most possible within reaches 5 through 8. The creation of detention basins has the potential to damage existing wetland and riparian areas, however ample area to mitigate for such losses. Disturbances to wetland habitat could occur with the construction of channels wherever the perennial segments occur.

V. EVALUATION OF CONCEPTUAL ALTERNATIVES

Introduction

Alternative drainage improvement concepts have been examined that address the existing and future stormwater management needs of the basin. Alternatives have been identified for each reach of the drainage. Quantitative and qualitative comparisons are presented, and a recommendation made as to which concepts are most feasible to advance to preliminary design and eventually implementation. The majority of the alternative analysis is presented in the Development of Alternatives Report.

The general planning goals to be achieved during the alternative evaluation phase were:

1. Identify stormwater facilities which will reduce existing floodplains and flooding problems within urbanized areas;
2. Provide stormwater management within developing areas of the basin in order to reduce the detrimental effects of runoff and sedimentation from disturbed areas;
3. Provide stormwater facilities which preserve and/or enhance the existing drainage area and areas adjacent to the drainage which provide an environmental resource in the
4. Identify facilities which will minimize future operations and maintenance costs; and
5. Provide stormwater management facilities which will at least maintain and/or enhance the water quality characteristics of the basin.

The City/County Drainage Criteria Manual was used as a guide in the conceptual sizing of facilities. Planning goals were developed through the agency/individual coordination process. Common and/or mutual goals of the interested agencies were identified prior to the initiation of the alternative evaluation phase.

Evaluation Parameters

Coordination meetings were held throughout the planning process in order to discuss the overall goals of the study and to solicit specific concerns from governmental agencies, individuals, and private community groups. One result of this coordination effort was the development of the following list of parameters which should be considered when evaluating alternatives.

Table V-1: Summary of Wildlife Habitat Acreages

Reach No.	Class I	Class II	Class III	Class IV	Class V
SC-1	36.0			5.9	
SC-2		14.0		5.0	
SC-3	14.5	23.3		2.3	
SC-4				2.3	
SC-5		6.7	3.0	1.0	
SC-6	24.5	6.7	12.0		
Reach Tributary to					
SC-7	54.2				
SC-7	19.7		5.6		
SC-8	32.3		20.8		
SC-9	20.1		10.3		
WF-1				2.7	
WF-2				4.2	
WF-3					3.0
CT-1			2.0		
CT-2					1.5

Zones designated as W and P have been included in the Class I acreages.

CLASS DESCRIPTION

I GOOD QUALITY RIPARIAN/WETLAND

These areas are sections of the riparian zone which contain vegetation that is desirable and with a high percentage of ground cover. No attempt was made to distinguish between wetland vegetation areas (sedges, rushes) and good quality riparian (cottonwood/willow) in these sections.

II POOR QUALITY RIPARIAN

These areas are sections of the riparian zone which contain less quantity or desirable types of vegetation. They may be of a poorer quality naturally, due to substrate material and/or moisture availability, or they may be degraded due to disturbance.

III DRY CHANNEL

These are natural stream or floodplain areas where the stream is dry or not perennial and therefore riparian vegetation is absent, in very low abundance, or of a dry land type.

IV GRADED/CHANNELIZED

These are areas of the riparian zone which have been graded and/or channelized and therefore do not follow the original stream path. Some of these areas were channelized years ago and have developed some degree of vegetation, others are continuously or recently disturbed and have no vegetative value. Wetland shrub toe vegetation occurs along more established riprap lined drainageways where the invert is stable.

V CONCRETE CHANNEL

Portions of drainage channel (such as the West Fork) have been lined with concrete. Where the concrete is present, no vegetation exists, and only the upper dry bank have revegetated. The concrete channel was not verified along the entire length of the West Fork and should be verified. If sections marked V are not actually concreted, these sections should be labeled IV.

W WETLAND

These are areas of wetland vegetation outside major drainages. They are delineated and mapped in the upper portions of the drainage basin where the drainages are too shallow and indistinct to be part of a riparian zone. Some of these areas were not ground truthed due to problems with access.

P PONDS

These ponds are all stock ponds in the upper portions of the drainage basin. They were all man-made. They support wetland and good quality vegetation when they are not grazed excessively.

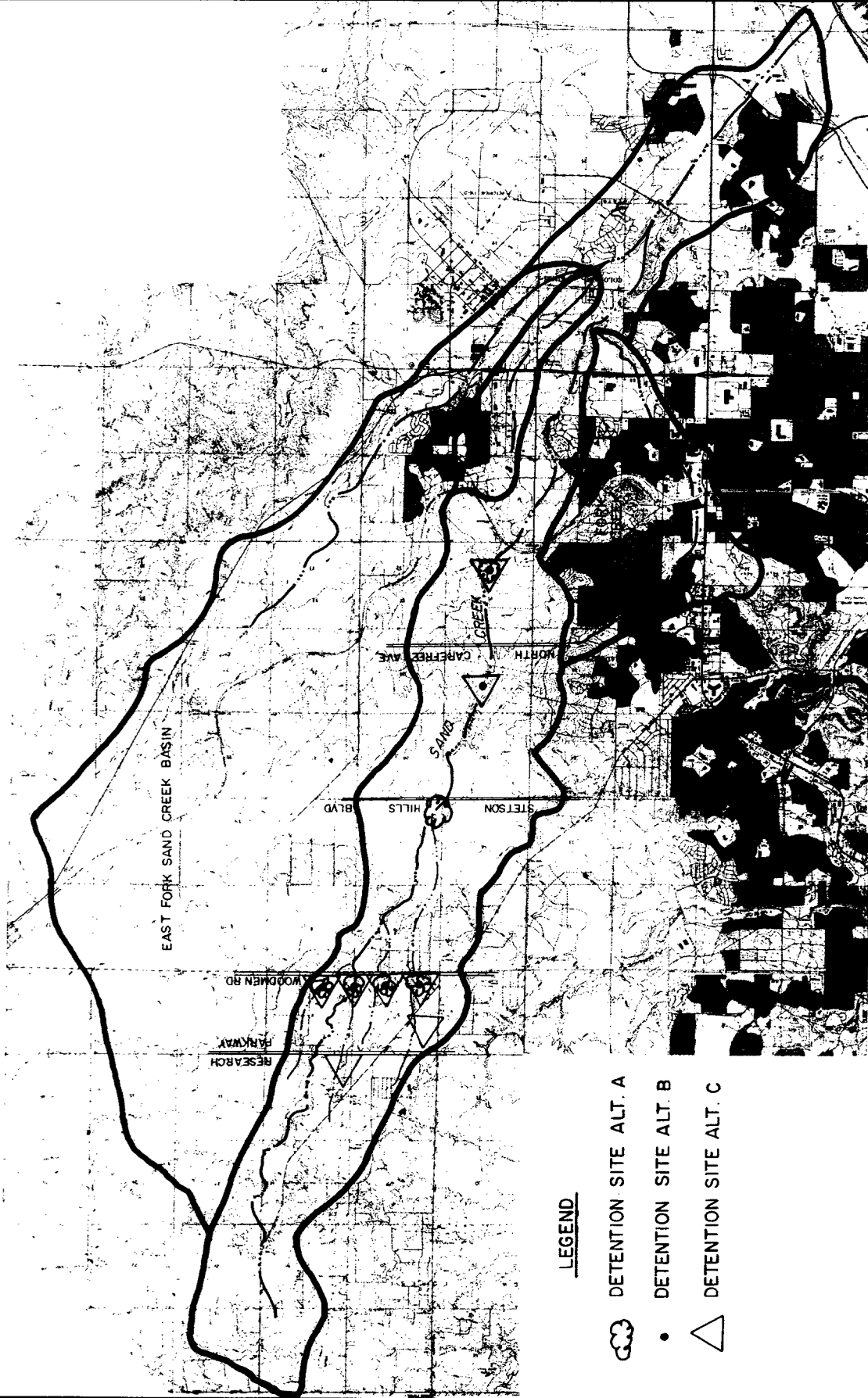
SAND CREEK DRAINAGE BASIN PLANNING STUDY DETENTION BASIN ALTERNATIVES

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80905-1308

Project No.	SD-204-022
Date	9/2/01
Design	RAK
Drawn	EAK
Checked	
Reviewed	

FIG 2-1

SCALE : 1" = 6000'



LEGEND

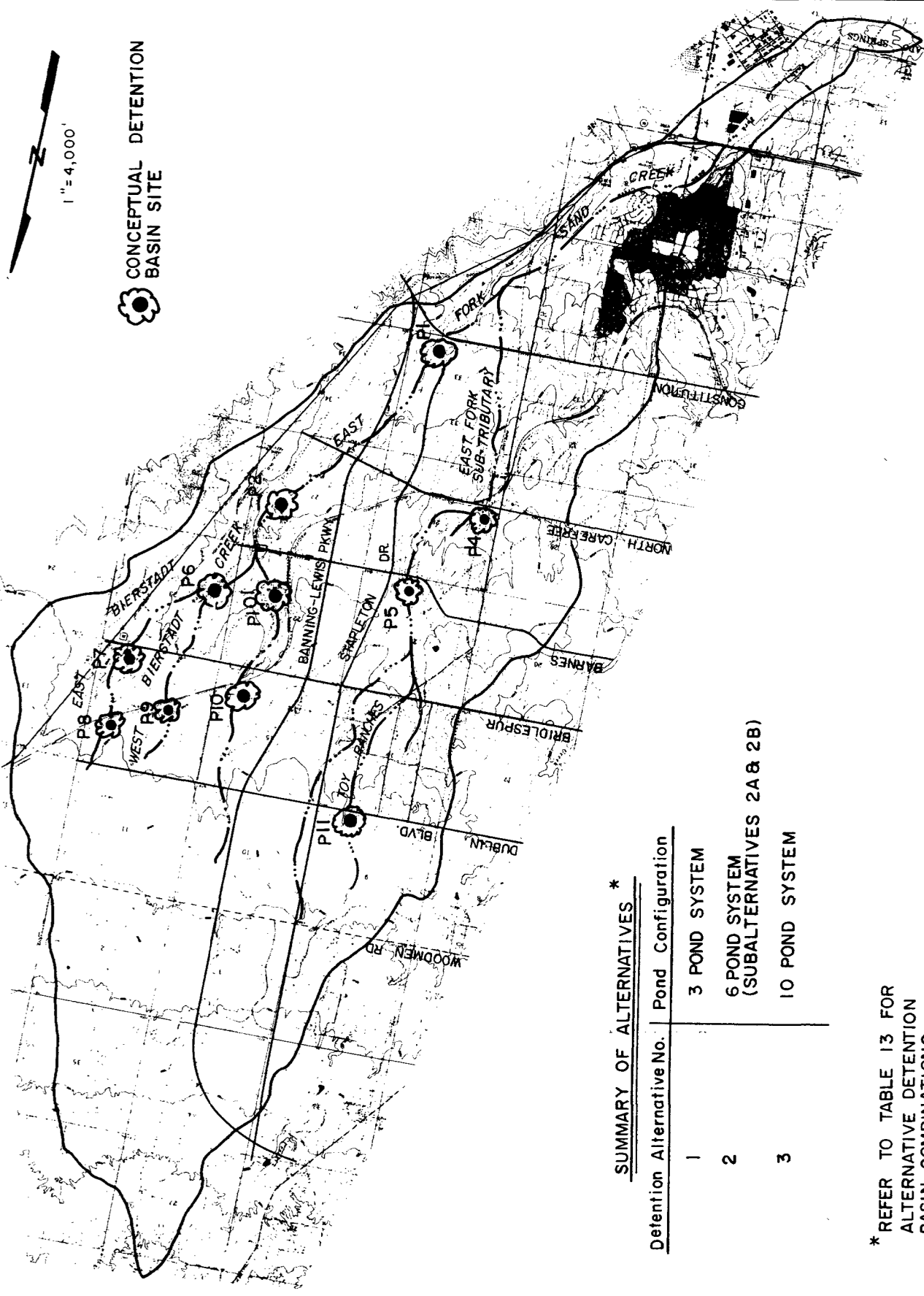
- ☁ DETENTION SITE ALT. A
- DETENTION SITE ALT. B
- △ DETENTION SITE ALT. C

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SAND CREEK
DRAINAGE BASIN PLANNING STUDY
DEFENTION BASIN ALTERNATIVES

Project No.	88-11-23
Date	4/89
Design	R N W
Drawn	E A V
Checked	
Reviewed	

FIG V-2



SUMMARY OF ALTERNATIVES *

Detention Alternative No.	Pond Configuration
1	3 POND SYSTEM
2	6 POND SYSTEM (SUBALTERNATIVES 2A & 2B)
3	10 POND SYSTEM

* REFER TO TABLE 13 FOR ALTERNATIVE DETENTION BASIN COMBINATIONS

VI. DEVELOPMENT OF ALTERNATIVES AND RECOMMENDED PLAN

The concepts which are available for handling stormwater runoff within the Sand Creek basin have been presented and discussed in detail in the Sand Creek Drainage Basin Planning Study Development of Alternatives Report and the draft East Sand Creek Drainage Basin Planning Study. The process of combining the various channel treatment options, detention schemes and roadway crossing structures into a contiguous plan for all of the reaches is presented in this chapter of the report. As a result of the evaluation of the flood control, environmental, open space, operations and maintenance, and implementation concerns within the Sand Creek basin, the following concepts were identified as having sufficient feasibility to warrant further evaluation and review:

Channel Concepts:	Floodplain Preservation Channelization, 10- or 100-year Selective Improvements
Detention:	Regional detention systems

Channel Concepts: The channel concepts listed above have been evaluated with respect to the parameters listed in the previous chapter. A concept's feasibility depends upon its impact, positive or negative, upon the evaluation parameters. *The floodplain preservation* concept has been considered to be the same as the "do-nothing" alternative. The floodplain preservation concept would involve the regulation of the floodplain limits, generally as depicted on the effective City of Colorado Springs and El Paso County Flood Insurance Rate Maps. Regulation of the floodplain so that future encroachments are minimized and the floodproofing of structures which are currently within the 100-year floodplain would presumably be the methods used to address the flood hazard concerns along Sand Creek. In the upper reaches of Sand Creek, the ownership or easements associated with the 100-year floodplain (or greater limits to allow for an erosion buffer zone) would be a primary issue in regards to implementation of such a concept. Detention in the upper reaches of the basin Sand Creek basin and in the East Fork Sand Creek basin will maintain the 100-year floodplain at existing limits within the lower reaches of Sand Creek. The "do-nothing" concept is feasible wherever

the existing drainageway improvements are of adequate capacity to convey flood flows. *Channelization* would involve the lining of the Creek into a more confined flow area, and could be done for either the *100-year or 10-year* flood discharges. Several typical channel concepts have been presented. The primary bank lining material would probably be riprap. Grade control and/or drop structures would be required in a channelization concept so that the flood velocities could be controlled to a level requiring medium to heavy riprap. Soil cement offers an alternative to riprap and concrete for the construction of drops or grade control structures. Revegetation would occur wherever the native vegetation was disturbed by the channel construction. Willows at the toe of the riprap banks would be a minimum replacement. *Selective linings* would involve the construction of grade controls, drop structures, bank linings, storm sewer outlet control structures selectively sited to resist stream erosion or to reduce potential flooding damages. Areas of future concern such as at the outside bends of the creek, or at the outlets of bridges or culverts which will cross the drainageway would be subject to selective improvements.

Detention Concepts: The two general detention concepts evaluated were onsite versus regional detention. During the evaluation process, it was determined that the onsite detention concept has a low feasibility relative to a regional concept. This is because, (1) onsite detention has a unpredictable impact upon lowering peak discharges from urbanized areas to historic conditions (reference, Urbanas and Glidden, "Effect of Detention on Flows in Major Drainageways" ASCE Water Forum '81, 1981), (2) an onsite concept has little impact upon maintaining or enhancing water quality, (3) the number of onsite detention basins, their locations and size cannot be accurately determined in the undeveloped portions of the basin at this time, and (4) onsite detention would present a substantial maintenance responsibility to the jurisdictions involved. For these reasons the onsite detention concept was eliminated and regional detention basin concepts were developed. In the analysis of the channel concepts, regional detention facilities were assumed to be in place.

Channel Alternatives

Presented on Table VI-1 is a matrix of channel alternatives which were evaluated. All reaches of Sand Creek and the East Fork of Sand Creek had at least three alternatives analyzed. Presented on Tables VI-2 through VI-6 are comparative evaluations of the floodplain preservation (do-nothing), channelization and selective lining concepts, for the mainstem Sand Creek basin, by reach. The purpose of the evaluation process was to identify the relative advantages and disadvantages of each concept within each reach.

Presented on Figure VI-1 are the alternative channel concept plans for each reach

of the East Fork Sand Creek Basin. Alternative 1, "prismatic or composite" channel shown on Figure VI-1 is synonymous with the "channelization" concept developed for the mainstem Sand Creek basin. Alternative 2, "stabilized floodplain section" shown on Figure VI-1 is synonymous with the "selective improvement" concept developed for the mainstem of Sand Creek. Floodplain preservation or the "do-nothing" concept was evaluated for all reaches of the East Fork.

For the channelization and selective improvement concepts, cost comparisons have been completed. Similarly, cost estimates for each of the detention concepts were developed. The cost of property acquisition for land lying outside of the 100-year floodplain limits and for detention basins will have to be accounted for during the calculation of the drainage basin fee for the Sand Creek basin. The cost evaluation and detailed discussion related to the various channelization and detention concepts are contained within the Sand Creek Drainage Basin Planning Study Development of Alternatives Report and the draft East Fork Sand Creek Drainage Basin Planning Study.

Impact Upon Habitat

For each of the channel alternatives evaluated within the mainstem Sand Creek basin an estimate of each alternative's potential for disturbance of the habitat was made. The acreages presented previously on Table 5 for the Class I and Class II habitat zones were used in determining the extent of disturbance which a particular alternative may entail if implemented within a given reach. Since it is the goal of planning process to identify concepts which will avoid disturbances to the existing habitat wherever practical, alternatives which would have a greater level of disturbance compared to another must have provisions for mitigating the disturbance. Typical disturbances caused by channelization would include loss of native toe and/or bank vegetation, filling of historic floodplains which may contain wetland or riparian habitat, or degradation of water quality to downstream areas resulting from flow concentrations within unlined areas. Selective improvements could create very similar disturbances as channelization, however because the improvements can be selectively sited, avoidance of disturbances is easier to achieve. The floodplain preservation concept has the potential for disturbance to habitat. The loss of toe and bank vegetation can occur over time from natural erosion of the invert and banks which are unlined. This is currently the situation in Reach 1 of Sand Creek.

For those concepts requiring mitigation, the cost of habitat mitigation needs to be included in the total cost for a particular concept if a fair comparison is to be made. A

comparison of the estimated potential disturbance acreages of the Class I and II habitat was made for each of the alternative channelization schemes. From this evaluation it was determined that the greatest total Class I and Class II habitat disturbance would result from the implementation of the 100-year channelization concept. The disturbances to the habitat could be mitigated by the re-establishment of the toe vegetation, and by replacing riparian habitat along the overbanks of the channel. The total disturbance for a 10-year channel concept is reduced from the case of the 100-year channel. Greater opportunities for habitat preservation and replacement are afforded by a 10-year concept since a residual 100-year floodplain would remain.

The least total disturbance occurs for the floodplain preservation or a selective improvement concept. Some loss of habitat would occur naturally, mainly along the toe and at low channel benches due to the long-term degradation of the invert, and localized bank erosion. Water quality for the downstream reaches would not be improved by a floodplain preservation concept alone because of increasing rates of sediment transport due to increasing low flows and unlined banks and/or inverts. After a bank or invert failure, it would be anticipated that the native vegetation would eventually replace itself over a period of years.

Implementation of a selective improvement plan would result in a slight reduction in potential disturbance area as compared to the floodplain preservation concept. This is because selective improvements, if constructed prior to the onset of active bank and invert erosion, would prevent the loss of native habitat along the existing low flow banks and in floodplain areas. Disturbances due to construction could be better controlled with a selective improvement concept.

Though the above impacts were not specifically quantified for the East Fork basin, the relative advantages and disadvantages between the channelization concepts with regard to habitat impact for the East Fork are basically the same as for the mainstem Sand Creek. Since the East Fork basin is mostly undeveloped and the drainageways relatively unencroached at this time, there is an opportunity to select channel concepts which will result in little or no adverse impact to the existing habitat. In fact, some opportunity for enhancement of the habitat areas is possible in the future by developing channelization plans which will take advantage of the flood control, erosion control and water quality benefits that can be afforded by the natural floodplain zones and detention areas.

Development of the Recommended Plan

Presented on Table V-7 is a matrix representing the recommended plan for each major drainage reach. The selection of a recommended channel treatment scheme has been based upon the qualitative and quantitative information presented in the Sand Creek Drainage Basin Planning Study Development of Alternatives report and the draft East Fork Sand Creek Drainage Basin Planning Study. Contained within the Technical Addendum to the Sand Creek Drainage Basin Planning Study Development of Alternatives report, is the alternative hydrologic, hydraulic and conceptual cost data used in the evaluation and comparison of each of the alternatives within the mainstem Sand Creek basin.

Discussion of Recommended Plan

The recommendation of a particular channel treatment or detention scheme has been based upon the qualitative and quantitative data presented. For each reach the flood hazard, environmental, cost, operations and maintenance and open space aspects of the drainage way were weighed for each alternative concept.

Reach SC-1: For this reach a 10-year channel section was recommended for further evaluation. With the implementation of regional detention in the upper basin, the 100-year floodplain will generally be confined within the existing banks, excepting at roadway crossings lacking 100-year capacity. It is recommended that a 10-year low flow channel be constructed within the invert of the existing channel through the construction of benches and sand bars. As urbanization continues towards the full development scenario, the base flow and annual flows will increase in volume and frequency. For this reason, the low flow area must be stabilized to protect the existing channel banks from undermining and subsequent bank sloughing. The benched areas offer an opportunity for habitat replacement and enhancement. At some locations within this reach, a residual 100-year floodplain will remain which will have to be regulated. The residual 100-year floodplain offers some potential for open space preservation and enhancement. This is particularly true in the portion of the reach downstream of Hancock Expressway.

Reaches SC-2 through SC-4: A 100-year channel concept has been recommended primarily because of the potential for flooding damages which exists in these reaches. Habitat disturbed by the construction of channel linings and grade control structures could be replaced along the channel toes and on the overbanks. The replacement of the Galley and Waynoka road crossings will reduce the potential for flood damages in areas adjacent to these roadways. The detention within the upper reaches

will limit the 100-year peak discharge to levels. This will allow for the channel improvements to be constructed within the existing right-of way.

Reaches SC-5 and SC-6: A selective channel improvement concept has been recommended for these reaches. Detention in Reach SC-8 of the basin will maintain flows to historic peak discharge levels, however the low flows will increase in frequency and volume. For this reason it has been recommended to provide riprap channel linings at selective locations to at least the 10-year water surface and install grade controls. This will prevent the long-term degradation of the invert. A residual 100-year floodplain will remain and will offer opportunities for habitat replacement and open space preservation. Land adjacent to the drainage way is currently undeveloped or unplatted at this time which makes the feasibility of implementing this concept greater in comparison to the urbanized reaches of the creek.

Reaches SC-7 and SC-8: A selective improvement concept involving the localized lining of channel banks and grade control construction has been recommended for these reaches. The feasibility of this concept stems from the fact that flows will be reduced because of detention. Numerous individual rural ownerships cross the drainage way, however no habitable structures lie within the 100-year floodplain. Because of this, the economic feasibility of channelization concepts is low. Non-structural measures can be used to limit encroachments into floodprone areas. Additionally, the City of Colorado Springs Comprehensive plan recommends that the floodplains be maintained as open space. Potential habitat disturbances can be avoided with a selective plan, or simply replaced as part of the particular construction activity which caused the disturbance.

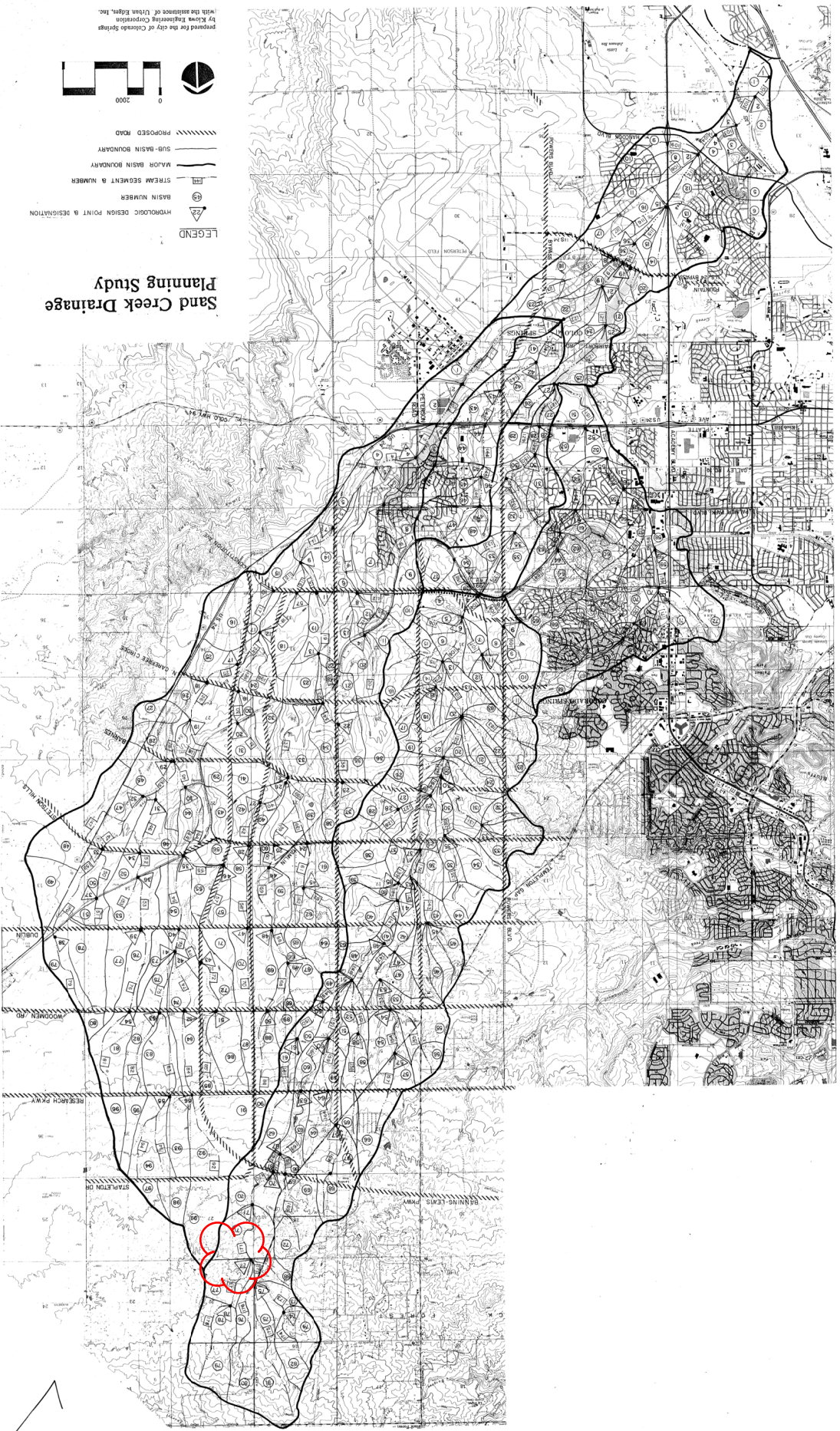
Reach SC-9: A floodplain preservation concept has been recommended for this reach. Little increase in urbanization is anticipated in this reach, and for this reason the existing drainage way is expected to remain stable. Localized improvements may be necessary to limit erosion caused by flow concentrations at culverts or storm sewers. Private ownership of the drainage way is anticipated to continue which lower the feasibility of channel concepts which require permanent right-of-ways or easements for construction and maintenance.

Reaches WF-1 through WF-3: A 100-year channel concept has been recommended for these reaches primarily because of the potential for flooding damages. Several roadway crossings are in need of replacement because of the flood hazard the obstructions create. Some open space enhancement potential exists for this concept since these reaches have been degraded visually by debris accumulation, bank sloughing and sedimentation. Little opportunity exists for widening the drainage way because the

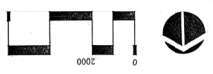
TABLE VIII-4: SAND CREEK DRAINAGE BASIN PLANNING STUDY
ROADWAY CULVERT CROSSING COST ESTIMATE
SAND CREEK BASINS

ROADWAY	REACH NUMBER	DRAINAGEWAY SEGMENT	CROSSING TYPE	LENGTH	UNIT	UNIT COST	TOTAL COST	TOTAL REIMBURSABLE COST
BANNING-LEWIS PKWY	SC-8	186	6'Hx10'W CBC	120	LF	\$390	\$46,800	\$46,800
ARROYO LANE	SC-9	171	6'Hx12'W CBC	80	LF	\$510	\$40,800	\$0
VOLUME ROAD	SC-8	169	60-INCH CMP	80	LF	\$120	\$9,600	\$0
"	SC-9	173	"	80	LF	\$120	\$9,600	\$0
BURGESS ROAD	SC-9	176	42-INCH CMP	80	LF	\$75	\$6,000	\$0
"	SC-9	178	2-42-INCH CMP	80	LF	\$150	\$12,000	\$0
CENTER TRIBUTARY								
TERMINAL AVENUE	CT-2	144	4-5'Hx8'W CBC	60	LF	\$1,200	\$72,000	\$0
OMAHA BOULEVARD	CT-2	146-2	3-4'Hx9'W CBC	80	LF	\$900	\$72,000	\$0
WEST FORK SAND CREEK								
WOOTEN ROAD	WF-1	153	2-4'Hx6'W CBC	100	LF	\$480	\$48,000	\$0
EDISON AVENUE	WF-1	153	2-4'Hx6'W CBC	60	LF	\$240	\$14,400	\$0
PALMER PARK BLVD.	WF-1	154-2	2-4'Hx10'W CBC	80	LF	\$540	\$43,200	\$0
CHICAGO RIRR	WF-1	165-1	4'Hx8'W CBC	220	LF	\$270	\$59,400	\$0
HALF MOON DRIVE	WF-1	165-2	4'Hx6'W CBC	60	LF	\$240	\$14,400	\$0

TOTAL CULVERT CONSTRUCTION COSTS, SAND CREEK \$1,902,600 \$1,111,000



- LEGEND**
- HYDROLOGIC DESIGN POINT & DESIGNATION
 - BASIN NUMBER
 - STREAM SEGMENT & NUMBER
 - MAJOR BASIN BOUNDARY
 - SUB-BASIN BOUNDARY
 - PROPOSED ROAD



Sand Creek Drainage Planning Study

THIS DRAWING IS A PRELIMINARY DESIGN STUDY. IT IS NOT TO BE USED FOR CONSTRUCTION. THE DESIGNER HAS NOT BEEN ADVISED OF ANY CHANGES TO THE DATA SINCE THE DATE OF THE LAST REVISION. THE DESIGNER HAS NOT BEEN ADVISED OF ANY CHANGES TO THE DATA SINCE THE DATE OF THE LAST REVISION. THE DESIGNER HAS NOT BEEN ADVISED OF ANY CHANGES TO THE DATA SINCE THE DATE OF THE LAST REVISION.



INNOVATIVE DESIGN. CLASSIC RESULTS.

**FINAL DRAINAGE REPORT
FOR
RETREAT AT TIMBERRIDGE
FILING NO. 4**

Prepared for:
TIMBERRIDGE DEVELOPMENT GROUP, LLC
2138 FLYING HORSE CLUB DRIVE
COLORADO SPRINGS CO 80921
(719) 592-9333

Prepared by:
CLASSIC CONSULTING
619 N. CASCADE AVE SUITE 200
COLORADO SPRINGS CO 80903
(719) 785-0790

Job No. 1185.31

PCD Project No. SF-1827



JOB NAME: RETREAT AT TIMBERIDGE FILING NO. 4
JOB NUMBER: 1185.31
DATE: 05/17/24
CALCULATED BY: MAM

BASIN RUNOFF COEFFICIENT SUMMARY

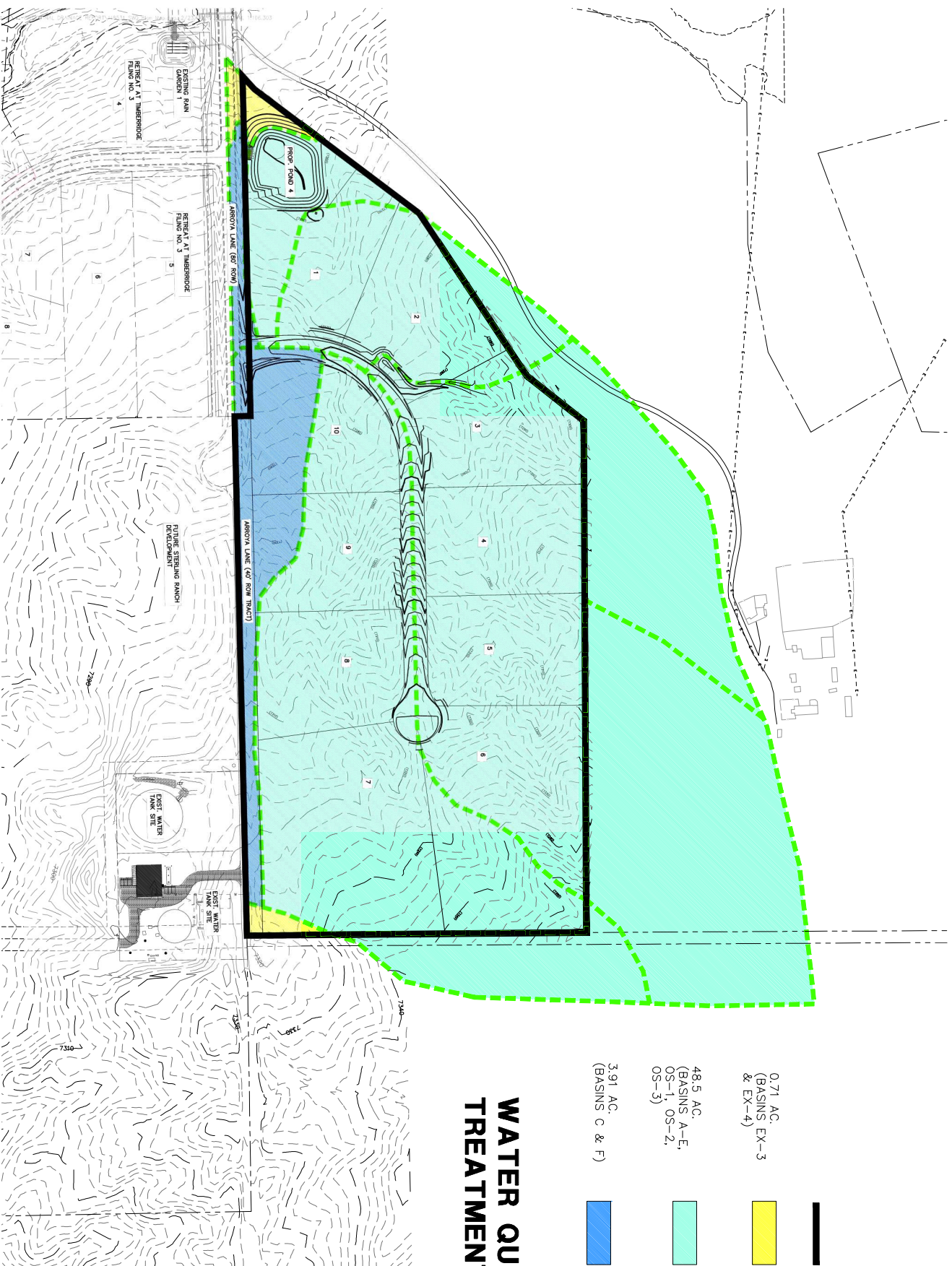
BASIN	TOTAL AREA (AC)	C VALUE DCM TABLE 6-6					C VALUE DCM TABLE 6-6					WEIGHTED "C" VALUE					WEIGHTED CA			WEIGHTED IMP.
		LAND USE	PERCENT IMP.	AREA (AC)	C(2)	C(5)	C(100)	LAND USE	PERCENT IMP.	AREA (AC)	C(2)	C(5)	C(100)	C(2)	C(5)	C(100)	CA(2)	CA(5)	CA(100)	
OS-1A	4.70	5 AC+ RES.	5.0%	4.70	0.04	0.11	0.38			0.00	0.02	0.08	0.35	0.04	0.11	0.38	0.19	0.49	1.76	5.0%
OS-1B	0.80	5 AC+ RES.	5.0%	0.80	0.04	0.11	0.38			0.00	0.02	0.08	0.35	0.04	0.11	0.38	0.03	0.08	0.30	5.0%
OS-2	9.60	5 AC+ RES.	5.0%	9.60	0.04	0.11	0.38			0.00	0.02	0.08	0.35	0.04	0.11	0.38	0.38	1.01	3.60	5.0%
OS-3	2.50	5 AC+ RES.	5.0%	2.50	0.04	0.11	0.38			0.00	0.02	0.08	0.35	0.04	0.11	0.38	0.10	0.26	0.94	5.0%
A	11.20	RES. 2.5 AC.	10.0%	8.10	0.06	0.13	0.40	RES. 5 AC.	5.0%	3.10	0.04	0.11	0.38	0.05	0.12	0.39	0.61	1.38	4.40	8.6%
B	13.40	RES. 2.5 AC.	10.0%	6.50	0.06	0.13	0.40	RES. 5 AC.	5.0%	6.90	0.04	0.11	0.38	0.05	0.12	0.39	0.67	1.57	5.19	7.4%
C	2.80	RES. 2.5 AC.	10.0%	2.45	0.06	0.13	0.40	PAVED ROAD	100.0%	0.35	0.99	0.90	0.96	0.16	0.23	0.47	0.46	0.63	1.32	21.3%
D	4.30	RES. 2.5 AC.	10.0%	4.30	0.06	0.13	0.40	POND TRACT	7.0%	0.00	0.05	0.12	0.39	0.06	0.13	0.40	0.26	0.56	1.72	10.0%
E	2.00	RES. 2.5 AC.	10.0%	0.85	0.06	0.13	0.40	POND TRACT	7.0%	1.15	0.05	0.12	0.39	0.05	0.12	0.39	0.11	0.25	0.79	8.3%
F	0.50	RURAL ROW	13.0%	0.40	0.07	0.16	0.41	PAVED ROAD	100.0%	0.10	0.05	0.12	0.39	0.07	0.15	0.41	0.03	0.08	0.20	30.4%

TOTAL AREA
TRIBUTARY TO
PROP. ON-SITE
POND

48.50

7.1%

Basins tributary to proposed on-site Pond
Basin tributary to exist. Rain Garden within RTR Fl. 3



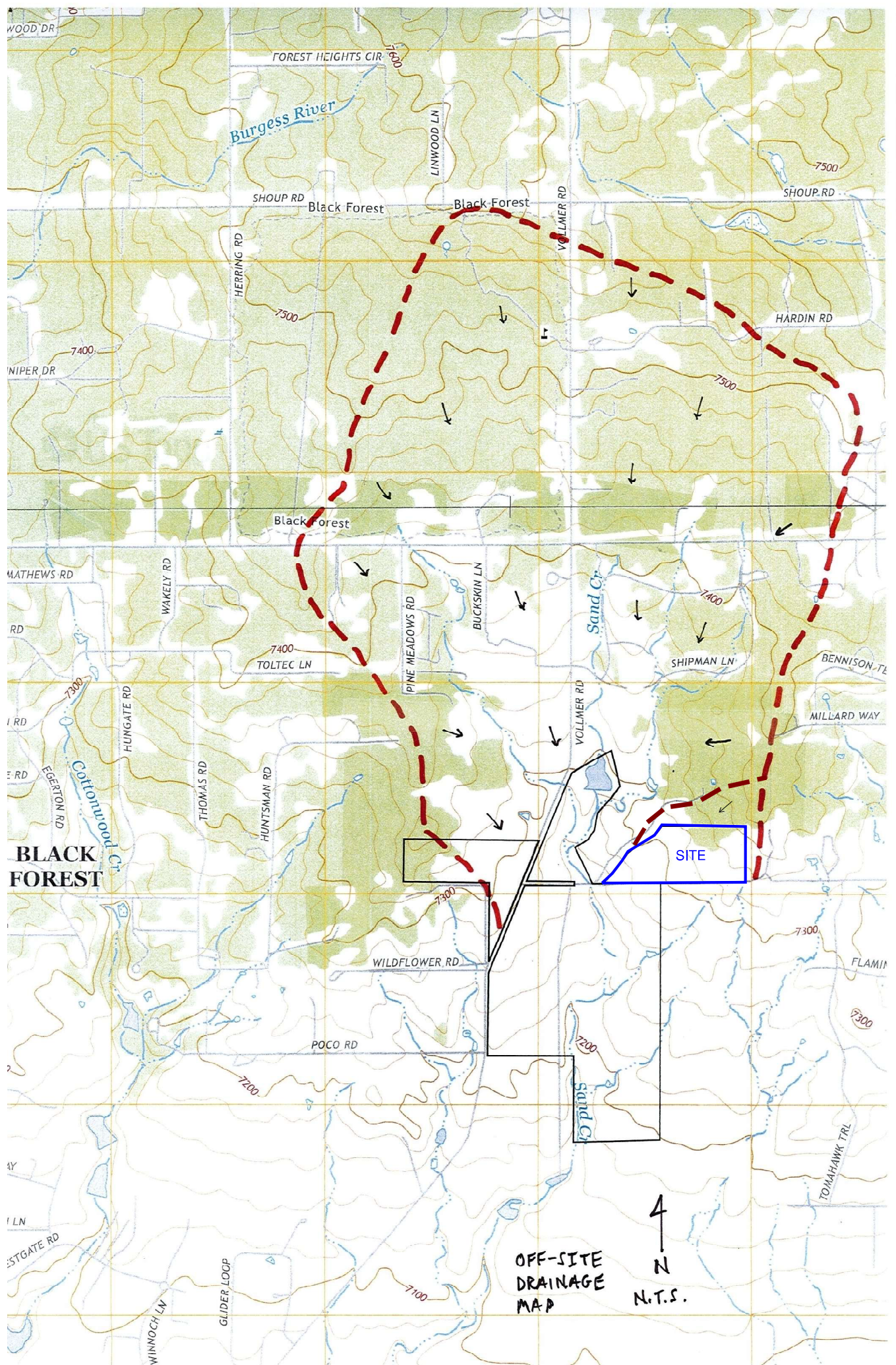
FILING 4 BOUNDARY LINE

0.71 AC.
(BASINS EX-3
& EX-4)
AREA QUALIFIES FOR
EXCLUSION 1.7.1.C.1 (ECM)
ALLOWS 20% NOT TO EXCEED
1.0 AC.

48.5 AC.
(BASINS A-E,
OS-1, OS-2,
OS-3)
AREA TREATED IN PROPOSED
PERMANENT POND 4 FACILITY

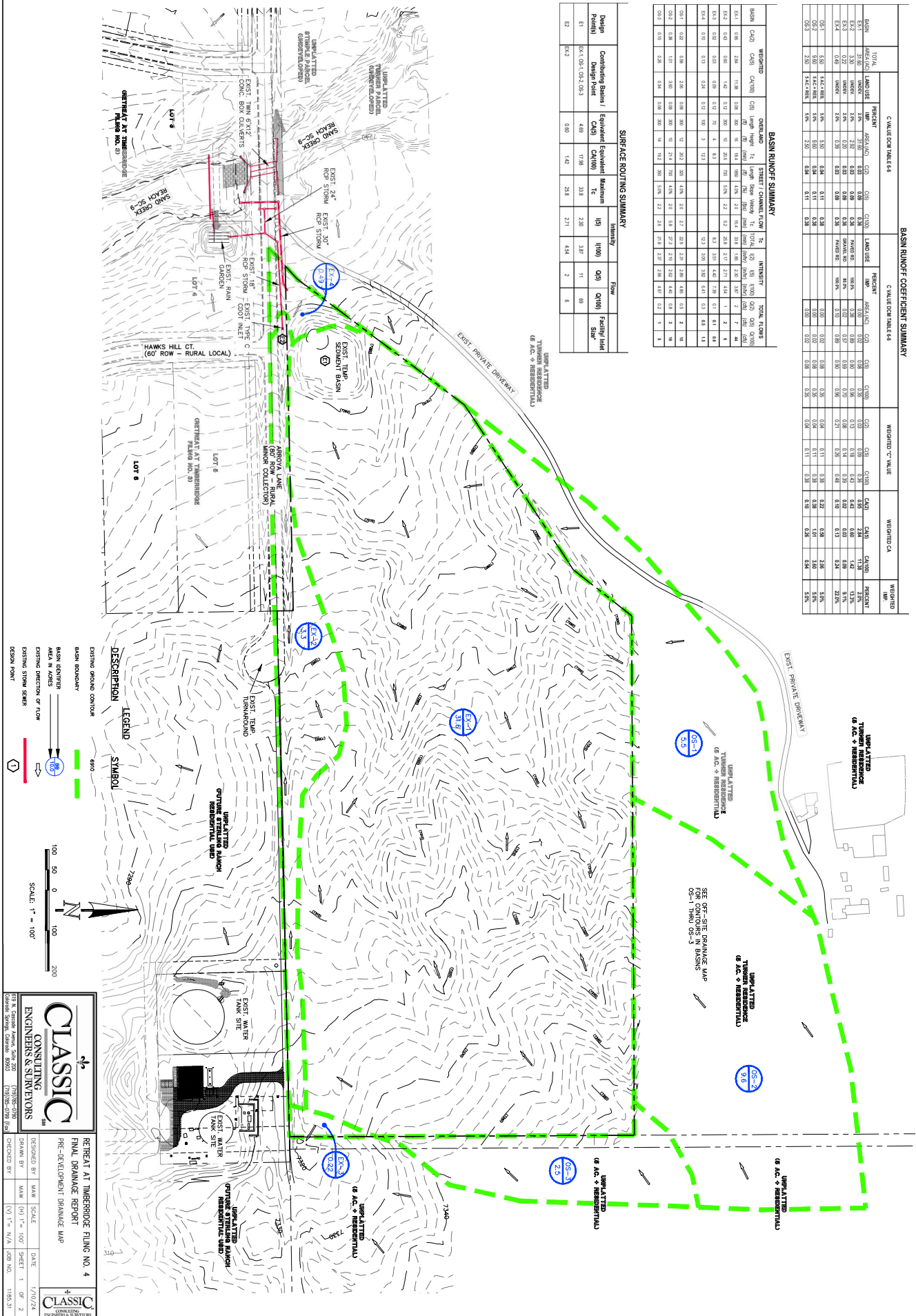
3.91 AC.
(BASINS C & F)
AREAS TREATED IN EXISTING
RAIN GARDEN 1 FACILITY

WATER QUALITY TREATMENT PLAN MAP



[illegible][illegible]

SURFACE ROLLING SUMMARY								
Design Points	Coating Base / Design Point	Equivalent C400 (C400)	Inertness		Flow			
			Maximum Tc	IG	IG00	Q05	Q1000	
E1	BA-05 / (0-2, 0-3)	4.00	17.48	33.8	2.30	3.67	11	69
E2	0-2	0.00	14.2	29.8	2.71	4.94	2	6



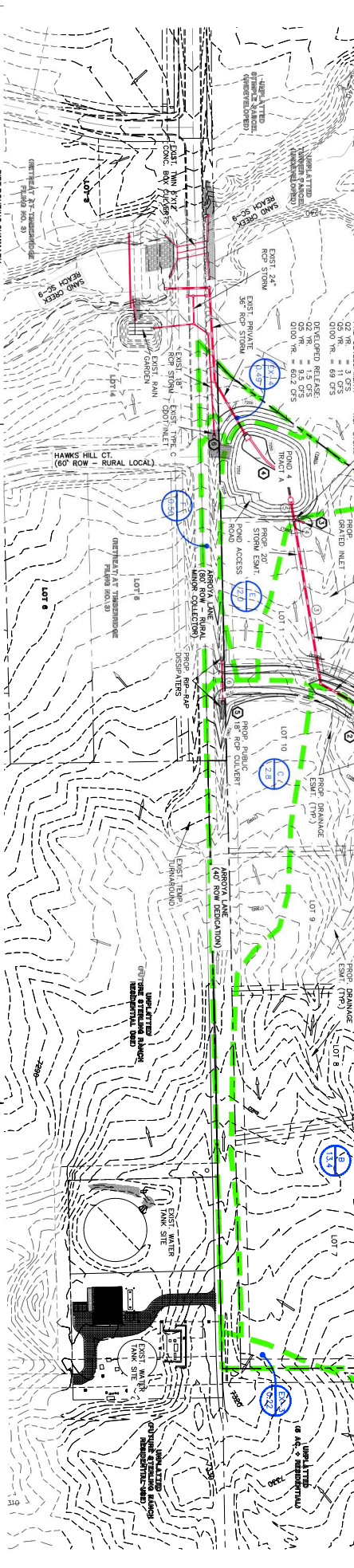
PROP. ON-SITE	48.50	7.1%
POND		

[illegible][illegible]

6	DP-6, F	0.71	1.52	25.8	2.71	4.55	2	6	EXIST TYPE C COOTINLET
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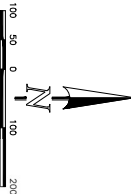


PROPOSED FUND *
PRE-DEVELOPMENT:



Pipes Run	Combing Data Drain Pipe Run	Estimated CAGI	Estimated CAGI/1000	Estimated Tc	100' H2O	Flow Q10'	Flow Q100'	Pipe Size
1	Dr#1	2.68	0.95	30.7	2.64	4.30	5	16" HDPE
2	Dr#2	1.63	0.53	30.0	2.48	4.30	5	20" HDPE
3	Dr#1, Dr#2	4.17	15.88	31.3	2.62	4.50	11	16" HDPE
4	Dr#3	0.65	2.03	22.9	2.48	4.68	3	16" HDPE
5	Dr#4 (not on layout)	5.36	17.41	31.3	2.62	4.68	13	16" HDPE

SYMBOL	DESCRIPTION
	EXISTING GROUND CONTOUR
	PROPOSED FINISHED CONTOUR
	BASIN BOUNDARY
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CLASSIC

CLASSIC CONSULTING & SURVEYORS

2026 Financial Assurance Estimate Form (with pre-plat construction)

Updated: 2/2026

PROJECT INFORMATION			
Project Name: Timbers Subdivision	Date: 07/30/2026	PCD File No.	

Description	Quantity	Units	Unit Cost		Total	(with Pre-Plat Construction) % Complete	Remaining
SECTION 1 - GRADING AND EROSION CONTROL (Construction and Permanent BMPs)							
Earthwork							
less than 5,000; \$8,000 min		CY	\$ 7.50	=	\$ -		\$ -
5,001-20,000; \$30,000 min		CY	\$ 6.50	=	\$ -		\$ -
20,001-50,000; \$100,000 min		CY	\$ 4.50	=	\$ -		\$ -
50,001-200,000; \$175,000 min		CY	\$ 3.00	=	\$ -		\$ -
greater than 200,000; \$500,000 min		CY	\$ 2.50	=	\$ -		\$ -
Erosion Control Blanket		SY	\$ 6.00	=	\$ -		\$ -
Seeding (inc. noxious weed mgmnt.) & Mulching		AC	\$ 2,037.00	=	\$ -		\$ -
Permanent Pond/PCM (provide engineer's estimate)	1.	EA	\$ 63,994.00	=	\$ 63,994.00		\$ 63,994.00
					\$ -		\$ -
					\$ -		\$ -
[insert items not listed but part of construction plans]					\$ -		\$ -
Safety Fence		LF	\$ 5.00	=	\$ -		\$ -
Inlet Protection		EA	\$ 322.00	=	\$ -		\$ -
Rock Check Dam		EA	\$ 908.00	=	\$ -		\$ -
Concrete Washout Basin		EA	\$ 1,790.00	=	\$ -		\$ -
Sediment Basin		EA	\$ 3,483.00	=	\$ -		\$ -
Sediment Trap		EA	\$ 877.00	=	\$ -		\$ -
Silt Fence		LF	\$ 3.00	=	\$ -		\$ -
Slope Drain		LF	\$ 30.00	=	\$ -		\$ -
Straw Bale		EA	\$ 56.00	=	\$ -		\$ -
Straw Wattle/Rock Sock		LF	\$ 11.00	=	\$ -		\$ -
Surface Roughening		AC	\$ 507.00	=	\$ -		\$ -
Vehicle Tracking Control		EA	\$ 3,840.00	=	\$ -		\$ -
				=	\$ -		\$ -
				=	\$ -		\$ -
[insert items not listed but part of construction plans]				=	\$ -		\$ -
MAINTENANCE (35% of Construction BMPs)				=	\$ -		\$ -
* - Subject to defect warranty financial assurance. A minimum of 20% shall be retained until final acceptance (MAXIMUM OF 80% COMPLETE ALLOWED)							
Section 1 Subtotal				=	\$ 63,994.00		\$ 63,994.00
SECTION 2 - PUBLIC IMPROVEMENTS *							
ROADWAY IMPROVEMENTS							
Construction Traffic Control		LS		=	\$ -		\$ -
Aggregate Base Course (135 lbs/cf)		Tons	\$ 42.00	=	\$ -		\$ -
Aggregate Base Course (135 lbs/cf)	52.	CY	\$ 81.00	=	\$ 4,212.00		\$ 4,212.00
Asphalt Pavement (3" thick)		SY	\$ 22.00	=	\$ -		\$ -
Asphalt Pavement (4" thick)	50.	SY	\$ 31.00	=	\$ 1,550.00		\$ 1,550.00
Asphalt Pavement (6" thick)		SY	\$ 47.00	=	\$ -		\$ -
Asphalt Pavement (147 lbs/cf) _" thick		Tons	\$ 140.00	=	\$ -		\$ -
Raised Median, Paved		SF	\$ 15.00	=	\$ -		\$ -
Signs (regulatory/advisory/guide/street)		EA	\$ 293.00	=	\$ -		\$ -
Epoxy Pavement Marking		SF	\$ 19.00	=	\$ -		\$ -
Thermoplastic Pavement Marking		SF	\$ 29.00	=	\$ -		\$ -
Barricade - Type 3		EA	\$ 380.00	=	\$ -		\$ -
Delineator - Type I		EA	\$ 38.00	=	\$ -		\$ -
Curb and Gutter, Type A (6" Vertical)		LF	\$ 49.00	=	\$ -		\$ -
Curb and Gutter, Type B (Median)		LF	\$ 50.00	=	\$ -		\$ -
Curb and Gutter, Type C (Ramp)		LF	\$ 51.00	=	\$ -		\$ -
4" Sidewalk (common areas only)		SY	\$ 69.00	=	\$ -		\$ -
5" Sidewalk		SY	\$ 85.00	=	\$ -		\$ -
6" Sidewalk		SY	\$ 113.00	=	\$ -		\$ -
8" Sidewalk		SY	\$ 141.00	=	\$ -		\$ -
Pedestrian Ramp		EA	\$ 1,961.00	=	\$ -		\$ -
Cross Pan, local (8" thick, 6' wide to include return)		LF	\$ 87.00	=	\$ -		\$ -
Cross Pan, collector (9" thick, 8' wide to include return)	78.	LF	\$ 131.00	=	\$ 10,218.00		\$ 10,218.00
Curb Opening with Drainage Chase		EA	\$ 2,341.00	=	\$ -		\$ -
Guardrail Type 3 (W-Beam)		LF	\$ 87.00	=	\$ -		\$ -
Guardrail Type 7 (Concrete)		LF	\$ 104.00	=	\$ -		\$ -
Guardrail End Anchorage		EA	\$ 2,485.00	=	\$ -		\$ -
Guardrail Impact Attenuator		EA	\$ 22,568.00	=	\$ -		\$ -
Sound Barrier Fence (CMU block, 6' high)		LF	\$ 113.00	=	\$ -		\$ -
Sound Barrier Fence (panels, 6' high)		LF	\$ 115.00	=	\$ -		\$ -
Electrical Conduit, Size =		LF	\$ 33.00	=	\$ -		\$ -
Traffic Signal, (provide engineer's estimate)		EA		=	\$ -		\$ -
Survey Monumentation		EA	\$ 638.00	=	\$ -		\$ -
				=	\$ -		\$ -

PROJECT INFORMATION			
Project Name: Timbers Subdivision	Date: 07/30/2026	PCD File No.	

Description	Quantity	Units	Unit Cost		Total	(with Pre-Plat Construction)	
						% Complete	Remaining
				=	\$ -		\$ -
				=	\$ -		\$ -
<i>[insert items not listed but part of construction plans]</i>				=	\$ -		\$ -
STORM DRAIN IMPROVEMENTS							
Concrete Box Culvert (M Standard), Size (W x H)		LF		=	\$ -		\$ -
18" Reinforced Concrete Pipe		LF	\$ 111.00	=	\$ -		\$ -
24" Reinforced Concrete Pipe		LF	\$ 161.00	=	\$ -		\$ -
30" Reinforced Concrete Pipe		LF	\$ 167.00	=	\$ -		\$ -
36" Reinforced Concrete Pipe		LF	\$ 191.00	=	\$ -		\$ -
42" Reinforced Concrete Pipe		LF	\$ 275.00	=	\$ -		\$ -
48" Reinforced Concrete Pipe		LF	\$ 349.00	=	\$ -		\$ -
54" Reinforced Concrete Pipe		LF	\$ 465.00	=	\$ -		\$ -
60" Reinforced Concrete Pipe		LF	\$ 476.00	=	\$ -		\$ -
66" Reinforced Concrete Pipe		LF	\$ 550.00	=	\$ -		\$ -
72" Reinforced Concrete Pipe		LF	\$ 616.00	=	\$ -		\$ -
18" Corrugated Steel Pipe		LF	\$ 136.00	=	\$ -		\$ -
24" Corrugated Steel Pipe		LF	\$ 229.00	=	\$ -		\$ -
30" Corrugated Steel Pipe		LF	\$ 244.00	=	\$ -		\$ -
36" Corrugated Steel Pipe		LF	\$ 244.00	=	\$ -		\$ -
42" Corrugated Steel Pipe		LF	\$ 226.00	=	\$ -		\$ -
48" Corrugated Steel Pipe		LF	\$ 465.00	=	\$ -		\$ -
54" Corrugated Steel Pipe		LF	\$ 459.00	=	\$ -		\$ -
60" Corrugated Steel Pipe		LF	\$ 501.00	=	\$ -		\$ -
66" Corrugated Steel Pipe		LF	\$ 580.00	=	\$ -		\$ -
72" Corrugated Steel Pipe		LF	\$ 654.00	=	\$ -		\$ -
78" Corrugated Steel Pipe		LF	\$ 728.00	=	\$ -		\$ -
84" Corrugated Steel Pipe		LF	\$ 901.00	=	\$ -		\$ -
Flared End Section (FES) RCP Size = (unit cost = 6x pipe unit cost)		EA		=	\$ -		\$ -
Flared End Section (FES) CSP Size = (unit cost = 6x pipe unit cost)		EA		=	\$ -		\$ -
				=	\$ -		\$ -
<i>[insert items not listed but part of construction plans]</i>				=	\$ -		\$ -
End Treatment- Headwall		EA		=	\$ -		\$ -
End Treatment- Wingwall		EA		=	\$ -		\$ -
End Treatment - Cutoff Wall		EA		=	\$ -		\$ -
Curb Inlet (Type R) L=5', Depth < 5'		EA	\$ 8,814.00	=	\$ -		\$ -
Curb Inlet (Type R) L=5', 5' ≤ Depth < 10'		EA	\$ 10,835.00	=	\$ -		\$ -
Curb Inlet (Type R) L =5', 10' ≤ Depth < 15'		EA	\$ 12,206.00	=	\$ -		\$ -
Curb Inlet (Type R) L =10', Depth < 5'		EA	\$ 11,438.00	=	\$ -		\$ -
Curb Inlet (Type R) L =10', 5' ≤ Depth < 10'		EA	\$ 12,689.00	=	\$ -		\$ -
Curb Inlet (Type R) L =10', 10' ≤ Depth < 15'		EA	\$ 16,174.00	=	\$ -		\$ -
Curb Inlet (Type R) L =15', Depth < 5'		EA	\$ 14,452.00	=	\$ -		\$ -
Curb Inlet (Type R) L =15', 5' ≤ Depth < 10'		EA	\$ 17,237.00	=	\$ -		\$ -
Curb Inlet (Type R) L =15', 10' ≤ Depth < 15'		EA	\$ 21,610.00	=	\$ -		\$ -
Curb Inlet (Type R) L =20', Depth < 5'		EA	\$ 16,499.00	=	\$ -		\$ -
Curb Inlet (Type R) L =20', 5' ≤ Depth < 10'		EA	\$ 20,012.00	=	\$ -		\$ -
Grated Inlet (Type C), Depth < 5'		EA	\$ 8,156.00	=	\$ -		\$ -
Grated Inlet (Type D), Depth < 5'		EA	\$ 11,435.00	=	\$ -		\$ -
Storm Sewer Manhole, Box Base		EA	\$ 18,950.00	=	\$ -		\$ -
Storm Sewer Manhole, Slab Base		EA	\$ 9,314.00	=	\$ -		\$ -
Geotextile (Erosion Control)		SY	\$ 6.00	=	\$ -		\$ -
Rip Rap, d50 size from 6" to 24"		Tons	\$ 102.00	=	\$ -		\$ -
Rip Rap, Grouted		Tons	\$ 136.00	=	\$ -		\$ -
Drainage Channel Construction, Size (W x H)		LF		=	\$ -		\$ -
Drainage Channel Lining, Concrete		CY	\$ 815.00	=	\$ -		\$ -
Drainage Channel Lining, Rip Rap		CY	\$ 234.00	=	\$ -		\$ -
Drainage Channel Lining, Grass		AC	\$ 2,100.00	=	\$ -		\$ -
Permanent Drainage Channel Lining or Roadside Ditch TRM		SY	\$ 13.00	=	\$ -		\$ -
				=	\$ -		\$ -
				=	\$ -		\$ -
<i>[insert items not listed but part of construction plans]</i>				=	\$ -		\$ -
Section 2 Subtotal					= \$ 15,980.00		\$ 15,980.00

* - Subject to defect warranty financial assurance. A minimum of 20% shall be retained until final acceptance (MAXIMUM OF 80% COMPLETE ALLOWED)

PROJECT INFORMATION			
Project Name: Timbers Subdivision	Date: 07/30/2026	PCD File No.	

Description	Quantity	Units	Unit Cost		Total	(with Pre-Plat Construction)	Remaining
SECTION 3 - COMMON DEVELOPMENT IMPROVEMENTS (Private or District and NOT Maintained by EPC)**							
ROADWAY IMPROVEMENTS							
Aggregate Base Course (135 lbs/cf)	2803.	CY	\$ 81.00	=	\$ 227,043.00		\$ 227,043.00
Asphalt Pavement (4" thick)	8409.	SY	\$ 31.00	=	\$ 260,679.00		\$ 260,679.00
20,001-50,000; \$100,000 min	21810.	CY	\$ 4.50	=	\$ 98,145.00		\$ 98,145.00
				=	\$ -		\$ -
				=	\$ -		\$ -
				=	\$ -		\$ -
STORM DRAIN IMPROVEMENTS (Exception: Permanent Pond/BMP shall be itemized under Section 1)							
18" Reinforced Concrete Pipe	100.	LF	\$ 111.00	=	\$ 11,100.00		\$ 11,100.00
24" Reinforced Concrete Pipe	47.	LF	\$ 161.00	=	\$ 7,567.00		\$ 7,567.00
30" Reinforced Concrete Pipe	90.	LF	\$ 167.00	=	\$ 15,030.00		\$ 15,030.00
Grated Inlet (Type D), Depth < 5'	2.	EA	\$ 11,435.00	=	\$ 22,870.00		\$ 22,870.00
Flared End Section (FES) RCP Size = 18" (unit cost = 6x pipe unit cost)	2.	EA	\$ 666.00	=	\$ 1,332.00		\$ 1,332.00
Flared End Section (FES) RCP Size = 30" (unit cost = 6x pipe unit cost)	1.	EA	\$ 1,002.00	=	\$ 1,002.00		\$ 1,002.00
WATER SYSTEM IMPROVEMENTS							
Water Main Pipe (PVC), Size 8"		LF	\$ 90.00	=	\$ -		\$ -
Water Main Pipe (Ductile Iron), Size 8"		LF	\$ 105.00	=	\$ -		\$ -
Gate Valves, 8"		EA	\$ 2,599.00	=	\$ -		\$ -
Fire Hydrant Assembly, w/ all valves		EA	\$ 9,228.00	=	\$ -		\$ -
Water Service Line Installation, inc. tap and valves		EA	\$ 1,852.00	=	\$ -		\$ -
Fire Cistern Installation, complete		EA		=	\$ -		\$ -
				=	\$ -		\$ -
[insert items not listed but part of construction plans]				=	\$ -		\$ -
SANITARY SEWER IMPROVEMENTS							
Sewer Main Pipe (PVC), Size 8"		LF	\$ 90.00	=	\$ -		\$ -
Sanitary Sewer Manhole, Depth < 15 feet		EA	\$ 6,136.00	=	\$ -		\$ -
Sanitary Service Line Installation, complete		EA	\$ 1,962.00	=	\$ -		\$ -
Sanitary Sewer Lift Station, complete		EA		=	\$ -		\$ -
				=	\$ -		\$ -
[insert items not listed but part of construction plans]				=	\$ -		\$ -
LANDSCAPING IMPROVEMENTS (For subdivision specific condition of approval, or PUD)							
		EA		=	\$ -		\$ -
		EA		=	\$ -		\$ -
		EA		=	\$ -		\$ -
		EA		=	\$ -		\$ -
		EA		=	\$ -		\$ -
** - Section 3 is not subject to defect warranty requirements				Section 3 Subtotal	= \$ 644,768.00		\$ 644,768.00
AS-BUILT PLANS (Public Improvements inc. Permanent WQCV BMPs)		LS	\$ 500.00	=	\$ 500.00		\$ 500.00
POND/BMP CERTIFICATION (inc. elevations and volume calculations)		LS	\$ 500.00	=	\$ 500.00		\$ 500.00

Total Construction Financial Assurance \$ 725,742.00

(Sum of all section subtotals plus as-builts and pond/BMP certification)

Total Remaining Construction Financial Assurance (with Pre-Plat Construction) \$ 725,742.00

(Sum of all section totals less credit for items complete plus as-builts and pond/BMP certification)

Total Defect Warranty Financial Assurance \$ 15,994.80

(20% of all items identified as (*). To be collateralized at time of preliminary acceptance)

Approvals

I hereby certify that this is an accurate and complete estimate of costs for the work as shown on the Grading and Erosion Control Plan and Construction Drawings associated with the Project.

Engineer (P.E. Seal Required)

Approved by Owner / Applicant

Date

Approved by El Paso County Engineer / ECM Administrator

Date



Project: Timbers Subdivision

Project No: 25021

7/30/2026

Engineer's Opinion of Probable Cost

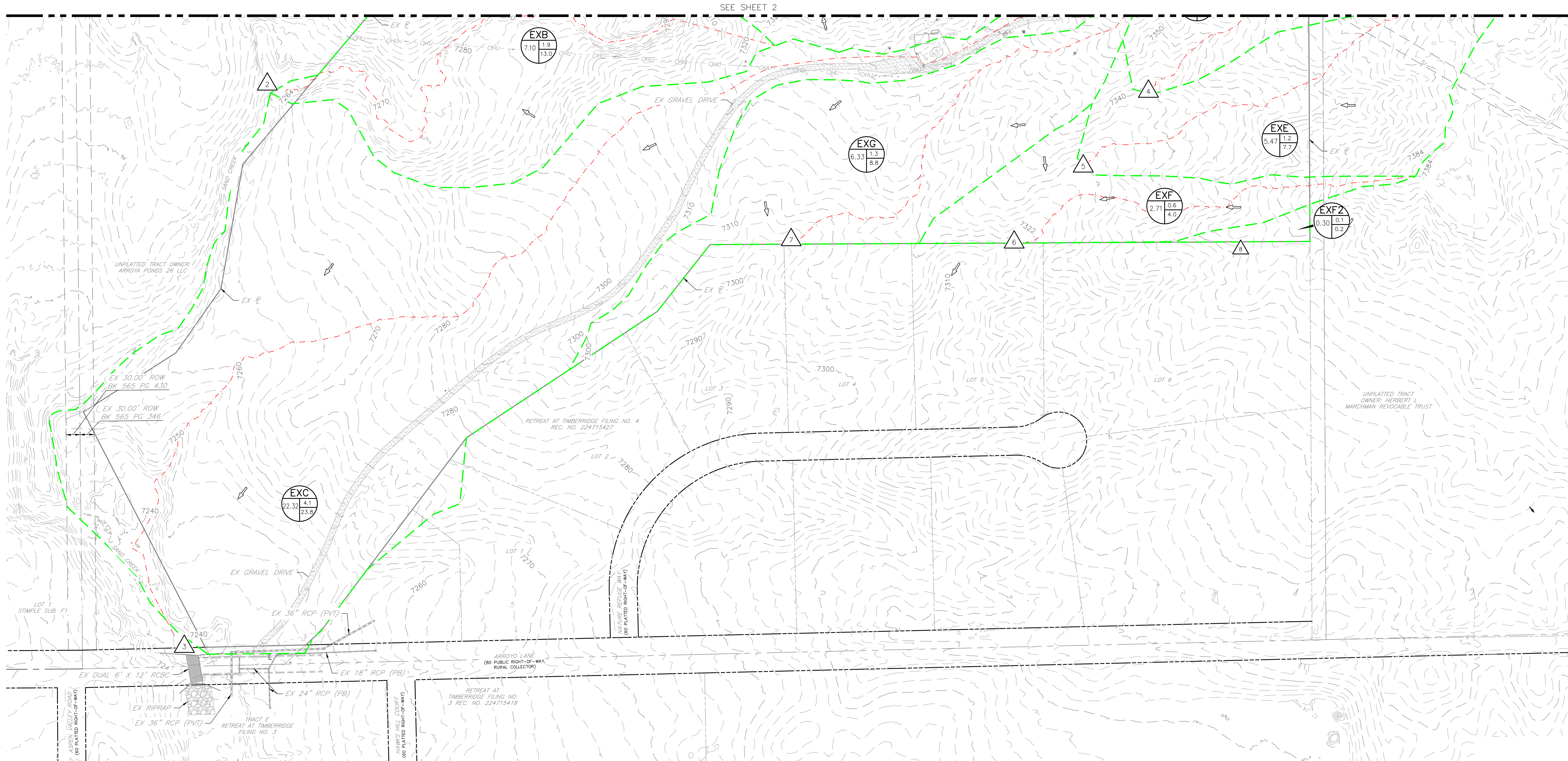
Item	Quantity	Unit	Unit Cost	Cost
Pond Earthwork	3520	CY	\$7.50	\$26,400.00
Concrete Forebay	1	LS	\$5,000.00	\$5,000.00
Outlet Structure	1	LS	\$15,000.00	\$15,000.00
Concrete Trickle Channel	130	LF	\$25.00	\$3,250.00
Type VL Spillway Riprap	33	TON	\$102.00	\$3,366.00
Maintenance Access Road	215	SY	\$24.00	\$5,160.00
			Subtotal	\$58,176.00
			10% Contingency	\$5,817.60
			Total:	\$63,993.60



APPENDIX F – DRAINAGE MAPS

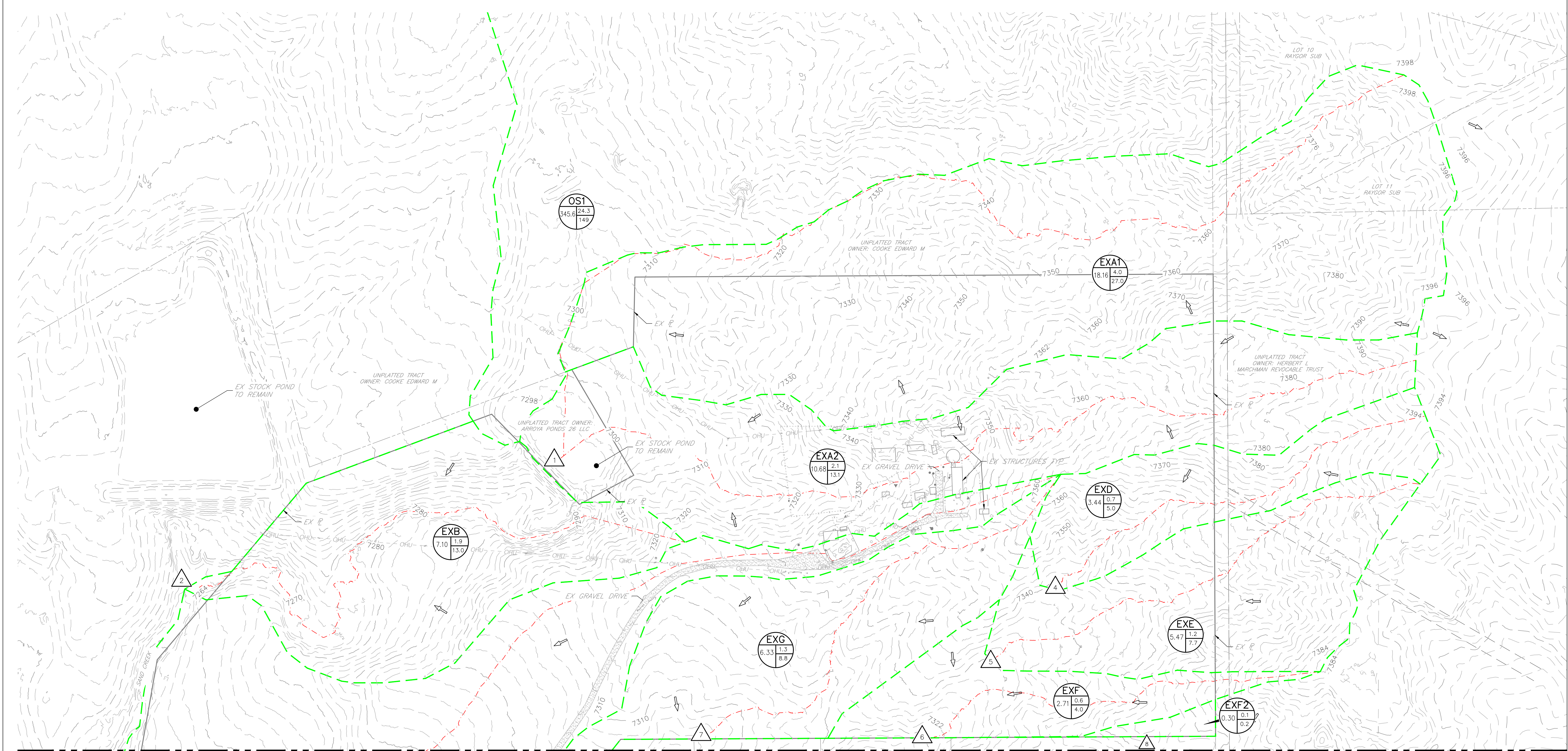
TIMBERS OF BLACK FOREST SUBDIVISION NO. 1

EXISTING DRAINAGE MAP



TIMBERS OF BLACK FOREST SUBDIVISION NO. 1

EXISTING DRAINAGE MAP



SEE SHEET 1

LEGEND

BOUNDARY LINE

PROPERTY LINE

EASEMENT LINE

RIGHT OF WAY

STORM SEWER

SWALE/WATERWAY FLOWLINE

INDEX CONTOUR

INTERMEDIATE CONTOUR

FLOW DIRECTION

BASIN ID

DRAINAGE BASIN

TC PATH

EXISTING

PROPOSED

ID

AC

Q5

Q100

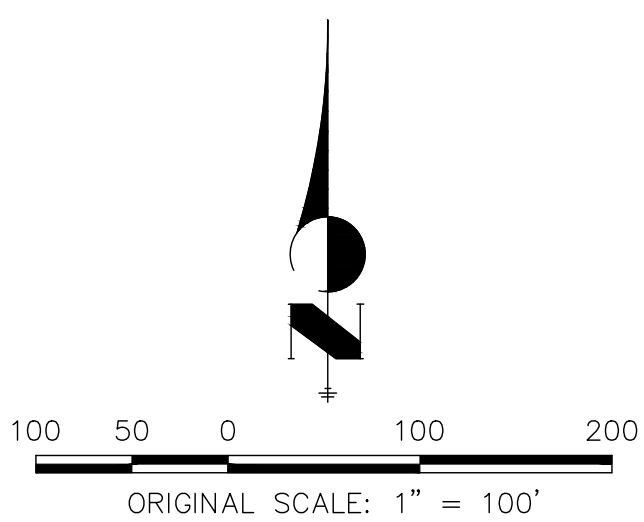
DESIGN POINT

DESIGNATION

1

EXISTING CONDITIONS - BASIN SUMMARY TABLE							
Basin	Area (ac)	Impervious	C _s	C ₁₀₀	t _c (min)	Q _{5-yr} (cfs)	Q _{100-yr} (cfs)
EXA1	18.16	2%	0.09	0.36	30.3	4.0	27.0
EXA2	10.68	3%	0.10	0.37	41.5	2.1	13.1
EXB	7.10	2%	0.09	0.36	20.8	1.9	13.0
EXC	22.32	5%	0.11	0.37	50.1	4.1	23.8
EXD	3.44	2%	0.09	0.36	31.5	0.7	5.0
EXE	5.47	2%	0.09	0.36	33.0	1.2	7.7
EXF	2.71	2%	0.09	0.36	31.3	0.6	4.0
EXF2	0.30	2%	0.09	0.36	8.9	0.1	0.2
EXG	6.33	2%	0.09	0.36	34.1	1.3	8.8

EXISTING CONDITIONS - DESIGN POINT SUMMARY TABLE		
DP#	Q _{5-yr}	Q _{100-yr}
1	29.7	184.0
2	28.3	181.0
3	28.7	180.1
4	0.7	5.0
5	1.8	12.3
6	2.3	15.2
7	1.3	8.8
8	0.1	0.2



EXISTING DRAINAGE MAP

TIMBERS SUBDIVISION

JOB NO. 25021

LOCATION: EPC

06/30/26

SHEET 2

ALL TERRAIN ENGINEERING

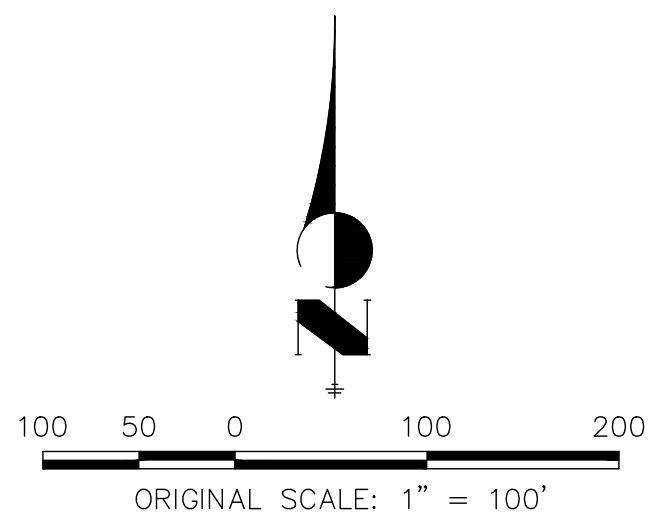
SEE SHEET 2



PROPOSED CONDITIONS - BASIN SUMMARY TABLE

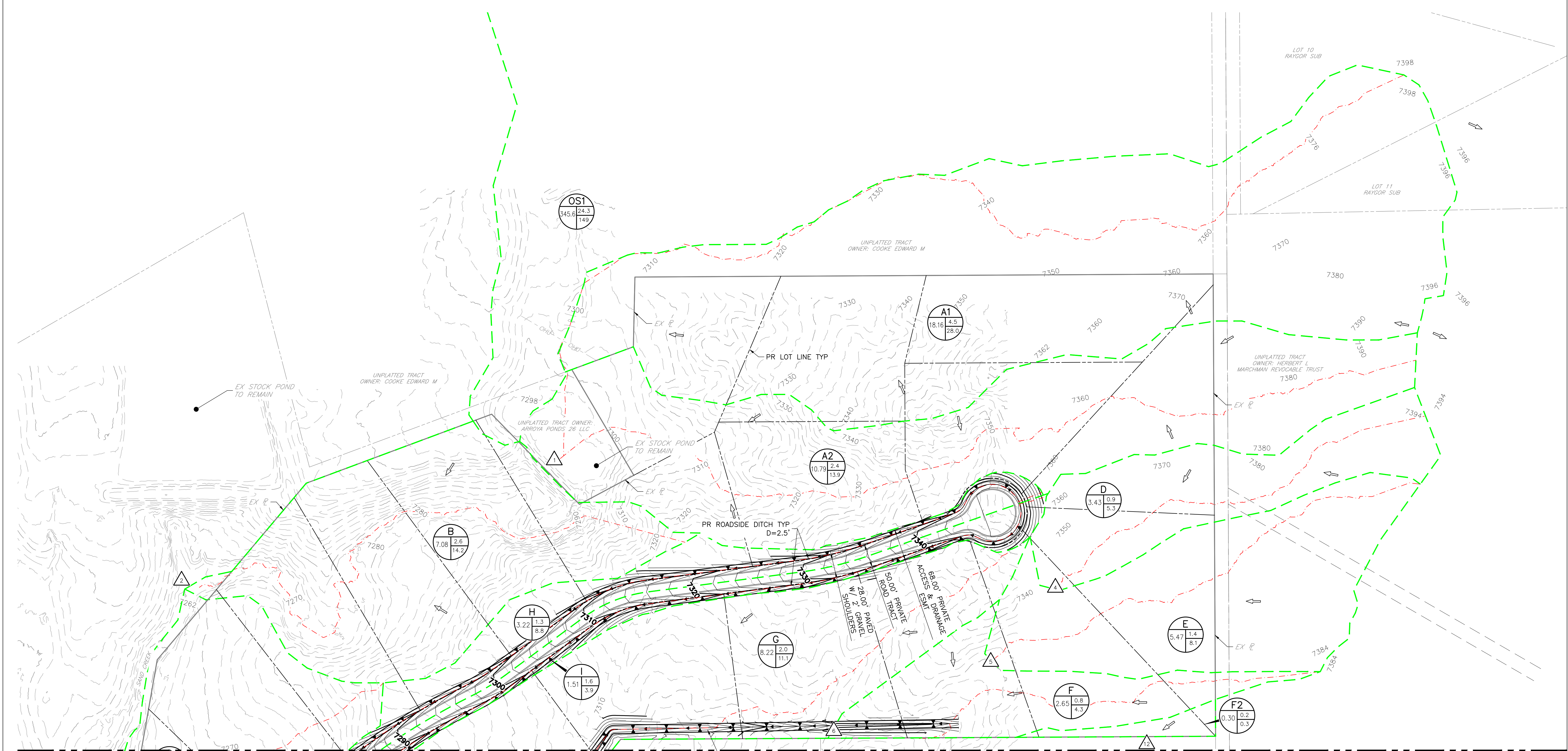
PROPOSED CONDITIONS - DESIGN POINT SUMMARY TABLE

DP#	Q _{5-YR}	Q _{100-YR}
1	30.4	185.5
2	30.1	182.7
3	29.4	193.7
4	0.9	5.3
5	2.2	13.0
6	2.7	16.1
7	4.6	23.2
8	4.6	22.1
9	2.5	6.7
9.1	6.1	26.3
10	6.1	25.9
11	2.0	4.1
12	0.2	0.3



TIMBERS OF BLACK FOREST SUBDIVISION NO. 1

PROPOSED DRAINAGE MAP



SEE SHEET 1

LEGEND

BOUNDARY LINE

PROPERTY LINE

EASEMENT LINE

RIGHT OF WAY

STORM SEWER

SWALE/WATERWAY FLOWLINE

INDEX CONTOUR

INTERMEDIATE CONTOUR

FLOW DIRECTION

BASIN ID

DRAINAGE BASIN

TC PATH

EXISTING

PROPOSED

6100

6100

1

1

ID

AC

Q5

Q100

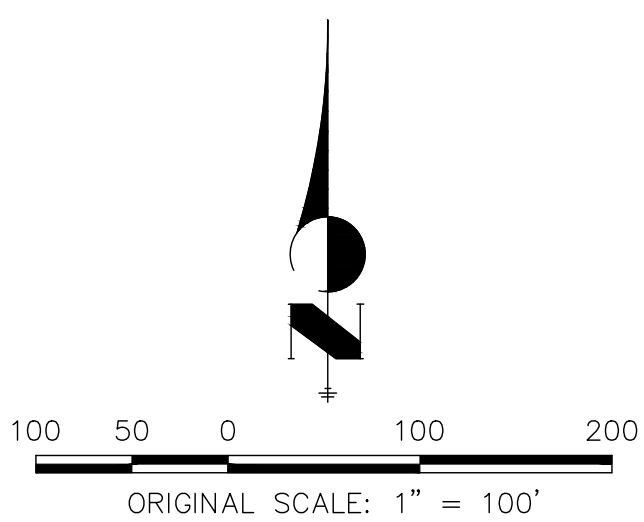
DESIGN POINT

DESIGNATION

1

PROPOSED CONDITIONS - BASIN SUMMARY TABLE							
Sub-basin	Area (ac)	Impervious	C _s	C ₁₀₀	t _c (min)	Q _{5-YR} (cfs)	Q _{100-YR} (cfs)
A1	18.16	4%	0.10	0.37	30.1	4.5	28.0
A2	10.79	6%	0.11	0.38	41.2	2.4	13.9
B	7.08	7%	0.12	0.39	20.5	2.6	14.2
C	8.65	7%	0.12	0.39	33.1	2.4	13.1
D	3.43	5%	0.11	0.38	30.8	0.9	5.3
E	5.47	4%	0.10	0.37	32.4	1.4	8.1
F	2.65	7%	0.12	0.39	30.1	0.8	4.3
F2	0.30	7%	0.12	0.39	8.7	0.2	0.3
G	8.22	6%	0.12	0.39	39.0	2.0	11.1
H	3.21	33%	0.34	0.55	34.5	2.5	6.7
I	1.51	41%	0.41	0.59	27.9	1.6	3.9
J	1.11	16%	0.19	0.43	13.5	0.8	3.0
K	1.81	19%	0.22	0.46	19.7	1.3	4.4
L	4.00	9%	0.13	0.40	23.8	1.5	2.6

PROPOSED CONDITIONS - DESIGN POINT SUMMARY TABLE		
DP#	Q _{5-YR}	Q _{100-YR}
1	30.4	185.5
2	30.1	182.7
3	29.4	193.7
4	0.9	5.3
5	2.2	13.0
6	2.7	16.1
7	4.6	23.2
8	4.6	22.1
9	2.5	6.7
9.1	6.1	26.3
10	6.1	25.9
11	2.0	4.1
12	0.2	0.3



PROPOSED DRAINAGE MAP

TIMBERS SUBDIVISION

JOB NO. 25021

LOCATION: EPC

06/30/26

SHEET 2

ALL TERRAIN ENGINEERING