PRELIMINARY/FINAL DRAINAGE REPORT

FOR

JUDGE ORR ROAD RV PARK & STORAGE DEVELOPMENT

Prepared For:
Prairie Stone, LLC
9476 Dakota Dunes Lane
Peyton, CO 80831-4138

Prepared By:
Associated Design Professionals, Inc.
3520 Austin Bluffs Parkway
Colorado Springs, CO 80918
719.266-5212

ADP Project No.160301
June 14, 2019

PCD Project #PPR-16-040

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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 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.

Michael A. Bartusek, P.E. #23329

DEVELOPER'S STATEMENT:

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

By: Andrea Minnich

Title: President

Address: Prairie Stone, LLC
9476 Dakota Dunes Lane
Peyton, CO 80831-4138

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

Jennifer Irvine, County Engineer/ECM Administrator   Date

Conditions:

TABLE OF CONTENTS

PRELIMINARY/FINAL DRAINAGE REPORT
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GENERAL

The Judge Orr Road RV Park & Storage project consists of 35.0 acres located along Judge Orr Road just east of US 24 and approximately two miles northeast of Falcon, Colorado. The project is located within the previously approved Meadowlake Commons Master Plan area. The site is further described as being located in central El Paso County within the Southwest Quarter of Section 33, Township 12 South, Range 64 West of the 6th Principal Meridian, El Paso County, Colorado.

The proposed development lies within the Haegler Ranch Drainage Basin Planning Study area, prepared by URS Corporation in 2007. It is also included in the Meadowlake Commons MDDP, prepared by Springs Engineering in 2008. For this report, the existing flows for this project utilize the findings of the Meadowlake Commons MDDP.

SOILS

The Soil Conservation Service (NRCS) soil survey for El Paso County has identified the soil type in this study area as follows:

Map Symbol No.	Soil Name	Hydrologic Soil Group
19	Columbine Gravelly Sandy Loam	A

FLOODPLAIN STATEMENT

A small portion of the site is located within a Zone A floodplain as determined by FEMA on the Flood Insurance Rate Map (FIRM) Panel 08041C0575G, dated December 7, 2018.

METHOD OF COMPUTATION

The methodology used for this report is in accordance with the *City/County Drainage Criteria Manual*. The Rational Method for computation of runoff was used for local basin design.

$$Q = cia$$

Where	Q	=	Maximum rate of runoff in cubic feet per second
	c	=	Runoff coefficient representing drainage area characteristics
	i	=	Average rainfall intensity, in inches per hour, for the duration required for the runoff to become established
	a	=	Drainage basin size in acres

The overall drainage for the area including off-site flows was calculated using the US Army Corp of Engineers Hydrologic Engineering Center – Hydrologic Modeling System, Version 3.1.0 (HEC-HMS). The Soil Conservation Service (SCS) (since renamed National Resources Conservation Service - NRCS) curve number method was selected for calculating the runoff volumes from the drainage basins per the DCM. Runoff rates for the five-year minor storm and 100-year major design storm were calculated.

Times of concentration were estimated using the SCS procedures described in the DCM based upon the hydrologic soil type, the natural conditions found in the basins and the runoff curve numbers (CN) chart from Table 5-4 of the DCM.

The 100-year, 24-hour storm precipitation selected from the NOAA isopluvial map in Figure 5-4e from the DCM was 4.6 inches. The ten-year, 24-hour storm precipitation selected from the rainfall depth-duration relationship chart in Figure 5-6 from the DCM was 3.1 inches. The five-year, 24-hour storm precipitation was derived from Figure 5-6 of the *City/County Drainage Criteria Manual.* The calculated rainfall amount was 2.6 inches. These numbers, along with SCS information, were used as input.

WATER QUALITY/DETENTION CONCEPTS

In accordance with current NPDES requirements, stormwater quality BMPs will be incorporated into the development of this project. Water quality facilities will be included in all proposed full spectrum detention facilities.

EXISTING DRAINAGE CONDITIONS

The existing site is only minimally developed with some gravel roads and two existing structures. The site is covered with Rangeland grasses and generally drains to the southeast at an average slope of three percent. An existing channel and a Zone A floodplain exist within the far northeastern corner of the project area. An existing, broad swale bisects the site and travels through an abandoned stock pond prior to exiting the site. All flows from Judge Orr Road are intercepted by a roadside ditch which continues past the site to the east.

There are currently two culvert crossings running under US 24. One crossing is a 24-inch CMP culvert located approximately 1,000 feet northeast of the US 24/Judge Orr Road intersection. This pipe is estimated to accommodate flows of 12.9 cfs for the five-year storm and 54.1 cfs for the 100-year storm. The second crossing consists of twin 54-inch CMP culverts. These pipes are located approximately 2,900 ft northeast of the intersection. The twin culverts carry offsite flows of 44.2 cfs for the five-year storm and 192.7 cfs for the 100-year storm and enter the project in the northeast corner, enter the existing channel located in the far northeast corner of the site and cross the property north of the project site.

The existing area located northwest of the parcel is designated as Sub-Basin OS1. This sub-basin drains existing pasture land and produces flows of 3.3 cfs for the 5-year storm and 15.2 cfs for the 100-year storm. These flows are intercepted by an existing ditch which carries the flows south along the property line to a low point from Sub-Basin OS2.

Sub-Basin OS2 drains the area just west of the parcel. This area is currently vacant and produces flows of 4.0 cfs and 28.0 cfs respectively. These flows combine with the flows from Sub-Basin OS1 at DP1 for total flows of 6.4 cfs for the 5-year storm and 39.0 cfs for the 100-year storm. These flows travel east through a broad swale located in Sub-Basin A2 and into an existing stock pond within Sub-Basin A2

Sub-Basin A1 drains the northeastern portion of the site. It is currently vacant and covered with rangeland grasses. This sub-basin produces flows of 2.2 cfs for the 5-year storm and 16.5 cfs for the 100-year storm. These flows leave the site in a southeasterly direction approximately 600 ft north of the main channel. These flows eventually join the main channel about 500 ft east of the site.

Sub-Basin A2 drains the major portion of the site and contains the stock pond and farm residence. The site also contains an existing stock pond which has been breached and is covered with rangeland grasses. This sub-basin produces flows of 3.1 cfs and 24.0 cfs respectively. These flows combine with the flows from DP1 at DP2 to produce total flows of 7.9 cfs for the 5-

year storm and 52.1 cfs for the 100-year storm. These flows leave the site in the southeast area of the site.

Sub-Basin OS3 drains an area west of SH24 and drains to the east into Sub-Basin OS4 through a 24" CMP. This area is currently zoned A-35 and is primarily open range. This sub-basin produces flows of 17.8 cfs and 62.0 cfs respectively.

Sub-Basin OS4 drains an area west of the parcel. The area is vacant and covered with rangeland grasses. It slopes to the southeast and flows east along Judge Orr Road. It produces flows of 8.2 cfs and 36.7 cfs respectively. These flows combine with the flows from OS3 at DP3 to produce flows of 24.8 cfs for the 5-year storm and 94.8 cfs for the 100-year storm.

Sub-Basin A3 drains the southern area of the site and is mostly vacant with a barn and some gravel drives located in the western portion of the site. It produces flows of 1.1 cfs and 5.3 cfs respectively and drains into the roadside ditch. OS5 drains the area between the property line and the center line of Judge Orr Road. This area produces flows of 1.3 and 3.3 respectively, and combines with the flows from A3 at DP4 within the Judge Orr roadside ditch to produce total flows of 2.0 cfs for the 5-year storm and 7.6 cfs for the 100-year storm. These flows combine with the flows from DP3 at DP4 to produce total flows of 23.3 cfs for the 5-year storm and 89.0 cfs for the 100-year storm within the roadside ditch. These flows leave the site in a northeasterly direction and join with the main channel about 300 ft east of the property. These flows eventually combine with the flows from DP2 and Sub-Basin A1 at DP6 to produce total flows in the main channel of 33.3 cfs for the 5-year storm and 156.2 cfs for the 100-year storm.

Sub-Basin B drains a small portion of the site in the northern corner. It produces flows of 0.2 cfs for the 5-year storm and 1.6 cfs for the 100-year storm.

The estimated runoff amounts produced for the project under existing conditions are shown in Table 1 below.

TABLE 1 – EXISTING CONDITIONS		
Sub-Basin	Q_5CFS	Q_{100} CFS
OS1	3.3	15.3
OS2	4.0	28.0
OS3	17.8	62.0
OS4	8.2	36.7
OS5	1.3	3.3
A1	2.2	16.5
A2	3.1	24.0
A3	1.1	5.3
B	0.2	1.6
DP1 (OS1 + OS2)	6.4	39.0
DP2 (DP1 + A2)	7.9	52.1
DP3 (OS3 + OS4)	24.8	94.8
DP4 (DP3+OS5 + A3)	23.3	89.0
DP5 (DP2 + DP4 + A1)	33.3	156.2

DEVELOPED DRAINAGE CONDITIONS

The development of the site will include an RV storage area in the northern portion of the site with RV pads located in the southern portion of the site. The northern area will be covered by 4 inches of loose gravel. The southern area will have 120 gravel RV pad sites with asphalt roads connecting the sites and vegetated areas between the pads.

Flows amounts from the area west of SH 24 will remain the same as delineated in the existing conditions portion of the report. Currently these flows travel east in a swale toward the RV development. In the future these flows will be intercepted by a storm sewer and routed directly into the Judge Orr Road ditch as delineated on the Developed Conditions Map.

Existing historic flows from the property to the west will be transported through the site by way of a 30" HDPE storm sewer. The proposed 30" HDPE storm sewer will be located near the west property line to facilitate the connection from a future detention facility once the property to the west has been developed. The overflow spillway will also be directed to the 30" storm sewer along the west property line. This design has been coordinated with the current property owner, as has the proposed swale within the west property. OS1 and OS2 will flow down the existing swale on the west property and into a 4' wide swale which outlets at the same location as detention Pond 2. In the future a new detention pond will replace the swale and will tie directly into the 30" private HDPE storm sewer, with the portion of the storm sewer which will run under the future Right of Way constructed with RCP. This storm sewer will direct the flows around the RV storage site and outlet onto the adjacent property to the east adjacent to the Pond 2 outlet and will be maintained by the owner of the west property. The storm sewer will be placed within a drainage easement in the future when the property is platted. A conceptual 4.6 acre foot pond (Pond 1) was calculated for the future neighborhood commercial site with an estimated outflow of 0.1 cfs for the 5-year storm and 50.7 cfs for the 100-year storm, however the current flows are 6.4 cfs and 39.0 cfs respectively.

Sub-Basin A1 will drain the northern part of the site. This area will be used for RV storage and will be covered by 4 inches of loose gravel. This area will produce flows of 12.3 cfs and 26.0 cfs for the five- and 100-year storms. A 12" berm will keep the flows within the sub-basin. The flows will travel along the berm, cross the drive in a concrete pan and flow into a ditch which will take the flows into Pond 2.

Sub-Basin A2A drains the area between the west property line and the RV storage from the north boundary line to a high point in Range Flower Way. This area will contain the future public road. It will produce flows of 5.7 cfs and 12.0 cfs respectively and will flow into Sub-Basin A3 through a 24" RCP storm sewer.

Sub-basin A3 drains the central area of the site between the gravel parking area to the north and the storm sewer to the south. Flows from this RV park area will sheet flow toward a proposed swale. It will produce of 6.9 cfs and 18.0 cfs respectively. These flows will combine with the flows from Sub-Basin A2A at DP2 to produce flows of 11.2 cfs and 27.1 cfs respectively which will be intercepted by a Type D inlet and a 24" private HDPE storm sewer and transported into Pond 2.

Sub-Basin A4 drains the western and southern part of the developed parcel. This area will be developed as an RV park with private streets and gravel parking areas for RV's. The RV Park area will have asphalt roads with natural grass areas between the parking pads. Flows will travel to the southeast and be intercepted by a main road and transported into the detention basin. It will produce flows of 11.8 cfs and 30.0 cfs respectively.

The total flows into Pond 2 at DP3 will be 29.6 cfs and 70.0cfs for the five- and 100-year storms. The proposed 2.53 AF detention basin will release these flows through an outlet structure with a 36 inch RCP pipe at a rate of 0.5 cfs for the 5-year storm and 34.1 cfs for the 100-year storm.

Sub-Basin A2B drains the lower portion of Range Flower Way. This area will contain the future public road. It will produce flows of 2.4 cfs and 4.8 cfs respectively. These flows will be directed into the Judge Orr Road ditch and into Sub-Basin A5.

Sub-Basin A5 drains the western and southernmost area of the site. This area contains a proposed cinder trail and 75 ft future Judge Orr Road right-of-way. This area will produce flows of 0.4 cfs and 2.9 cfs respectively. Sub-Basin OS5 drains the area between the property line and the centerline of Judge Orr Road. This area produces flows of 1.0 cfs and 2.6 cfs respectively and combines with the flows from A5 and DP5 at DP6 to produce total flows in this area of 22.8 cfs for the 5-year storm and 87.5 cfs for the 100-year storm. These flows will combine with the detained flows at DP7 to produce total flows of 28.9 cfs for the 5-year storm and 150.6 cfs for the 100-year storm.

Sub-Basin B in the northeastern portion of the site will contain a landscaped area and produce flows of 0.2 cfs for the 5-year storm and 1.6 cfs for the 100-year storm.

Table 2 shows the estimated runoff which will be produced for the project under developed conditions.

TABLE 2 – PHASE I DEVELOPED CONDITIONS		
Sub-Basin	Q_5CFS	Q_{100} CFS
OS1	3.3	15.3
OS2	7.2	54.9
OS3	17.8	62.0
OS4	3.7	10.1
OS5	1.0	2.6
A1	12.3	26.0
A2A	5.7	12.0
A2B	2.4	4.8
A3	6.9	18.0
A4	11.8	30.0
A5	0.4	2.9
B	0.2	1.6
DP1 (OS1+OS2)	9.7	66.4
DPD1 (Existing DP1)	6.4	39.0
DP2 (A2A+A3)	11.2	27.1
DP3 (DP2+A1+A4)	29.6	70.0
DPD2 (Detained DP2)	0.5	34.1
DP4(DPD2+DPD1)	6.5	67.4
DP5 (OS3+OS4 Existing)	24.8	94.8
DP6 (A2B+A5+OS5+DP5)	22.8	87.5
DP7 (DP5+DP6)	28.9	150.6

WATER QUALITY

The water quality basin for this project is incorporated with the detention basin for this project and is designed with current NPDES requirements as provided by the El Paso County Drainage Criteria Manual as amended for an EDB. The required water quality capture volume is 0.470 AC-FT. The basin will be constructed with a 2.5-foot permanent micro-pool and a forebay. Design forms for this basin can be found in Appendix B. The design summary is below.

TABLE 3 –WATER QUALITY DESIGN SUMMARY				
Location	**Depth**	**Size (CF)**	**Depth (FT)**	**Size (IN)**
Pond 2	2.84	20,470	0,1.99,3.97	2.92,2.92,2.92

DETENTION

Developed flows from this project will be reduced to historic levels by using a privately owned and maintained detention facility. The *UDFCD Design for Full Spectrum Detention Basins* is used for the basin. Since a neighborhood commercial development is proposed for the property to the west, a conceptual detention basin, Pond 1, was designed for the area and routed around the site. The site detention for the RV project was routed through Pond 2 with the flows from Ponds 1 & 2 combined at the outlet structure for Pond 2.

TABLE 4 DETENTION BASIN DETAILS				
Location	**Size (AF)**	**Pipe Outlet**	**Outlet Structure**	**Riprap Weir Width**
2	2.532	36″	Typical Outlet Structure OS-2	40′

Flows from the detention basins drain into a broad grasses swale. The swale is located within an existing pasture area with an existing slope of approximately 1.7%. It has an average bottom width of 8 ft. with 8:1 side slopes. The detention basin outflow of 34.7 cfs plus the future Pond 1 flows of 50.7 cfs will only produce a flow depth of 1.2 ft. and a velocity of 4.1 fps. Once the Judge Orr ditch flows combine with the detained flows, the 150.6 cfs, approximately 300 ft. east of the project, will produce a flow depth of 1.6 ft and a velocity of 4.80 fps. These flows are below the existing condition flows and the existing grassed swale is hydraulically adequate with a Froude number at 0.85. There are no downstream manmade drainage systems in the area to tie into.

Should a 20 ft. breach occur in the detention embankment, the outflow would be approximately 199.5 cfs and would produce an initial wave of approximately 1.7 ft., a velocity of 5.1 fps and a Froude number at 0.86. This wave would dissipate within the 850 ft. prior to flows crossing Judge Orr Road. No structures exist prior to this crossing.

PRIVATE DRAINAGE FACILITIES

Item	Unit	Quantity	Unit Cost	Total Cost
30″ HDPE FES	EA	1	$650	$650.00
18″ HDPE FES	EA	1	$500	$500.00
36″ RCP FES	EA	1	$1000	$1,000.00
24″ RCP FES	EA	2	$750	$1,500.00
30″ HDPE	LF	1607	$75	$120,525.00
24″ HDPE	LF	120	$69	$8,280.00
38″ x 24″ RCEP	LF	570	$94	$53,580.00
24″ RCP	LF	250	$84	$21,000.00

Concrete HDWL	EA	4	$2,500	$10,000.00
Type D Inlet	EA	1	$3,908	$3,908.00
Storm MH Type II	EA	4	$4,575	$18,300.00
Riprap	CY	380	$98	$37,240.00
Detention Outlet Structure	EA	1	$8,000	$8,000.00
Emergency Spillway	EA	1	$2,500	$2,500.00
			Sub-Total	$286,983.00
			15% Contingency & Engineering	$ 43,047.50
			TOTAL	**$330,030.45**

DRAINAGE BASIN FEES

The entire project lies within the Haegler Ranch Drainage Basin. However, the parcel is not being platted at this time, so no fees are due. In the future when this site is platted the drainage and bridge fees will be determined based on the percent of imperviousness of the platted subdivision.

CONCLUSION

The proposed development and subsequent lot developments follow the "Four Step Process" as mandated by the EPA as follows:

Step 1: Employ runoff reduction practices

Runoff has been reduced by disconnecting impervious areas where possible, eliminating "unnecessary" impervious areas and encouraging infiltration into suitable soils.

- Impervious areas have been directed to earth swales to encourage infiltration.
- Gravel will be used throughout the site to reduce the impervious of the areas.

Step 2: Stabilize drainageways

All drainageways, ditches and channels have been stabilized by the following methods:

- Tributaries have been left in their relatively natural state where possible.
- New drainageways and swales have been stabilized with either riprap or erosion control fabric depending on the erosion potential.

New roadside ditches have been designed to be stable and handle the design capacity.

Step 3: Provide water quality capture volume (WQCV)

The proposed development will disturb approximately **30** acres, a WQCV of **0.470** ac-ft will be provided.

Step 4: Consider need for industrial and commercial BMP's.

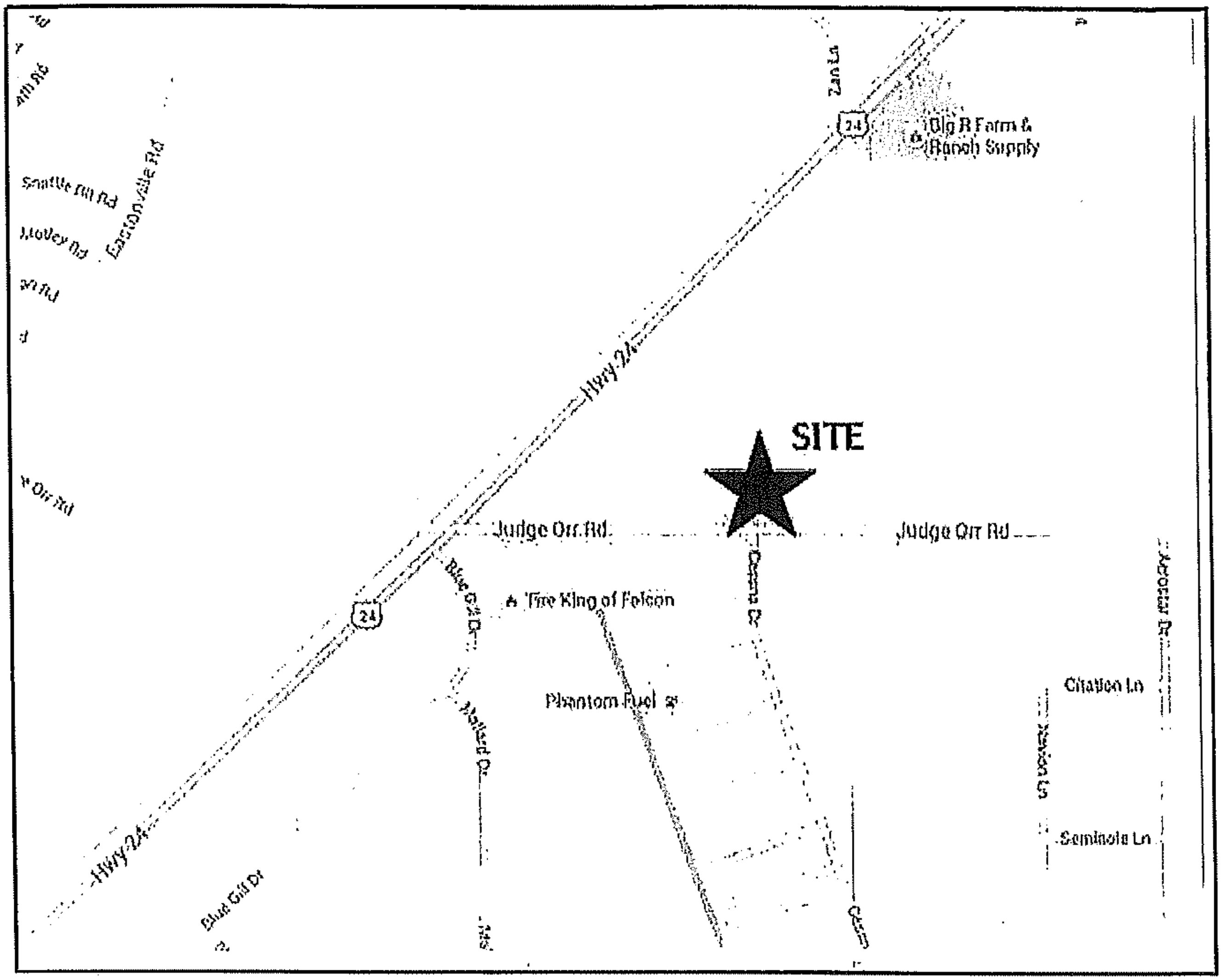
The site is being developed as an RV Park with minimal impervious area therefore no industrial or commercial BMP's are required.

REFERENCES

1. City of Colorado Springs and El Paso County (1994). ***Drainage Criteria Manual Volume 1*** (DCM).
2. City of Colorado Springs and El Paso County (1994). ***Drainage Criteria Manual Volume II*** (DCM).
3. Soil Survey of El Paso County Area, Colorado by USDA, NRCS.
4. ***El Paso County (January 2006) Engineering Criteria Manual.***
5. Urban Drainage and Flood Control District (June 2011). ***Urban Storm Drainage Criteria Manual, Volume 1-3.***
6. Meadowlake Commons MDDP by Springs Engineering, dated July, 2008.
7. Heagler DBPS by URS Corporation dated July, 2007.

APPENDIX A

MAPS



VICINITY MAP

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3520 Austin Bluffs Pkwy, Suite 102
Colorado Springs, CO 80918
(719) 266-5212
fax: (719) 266-5341

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SOILS MAP

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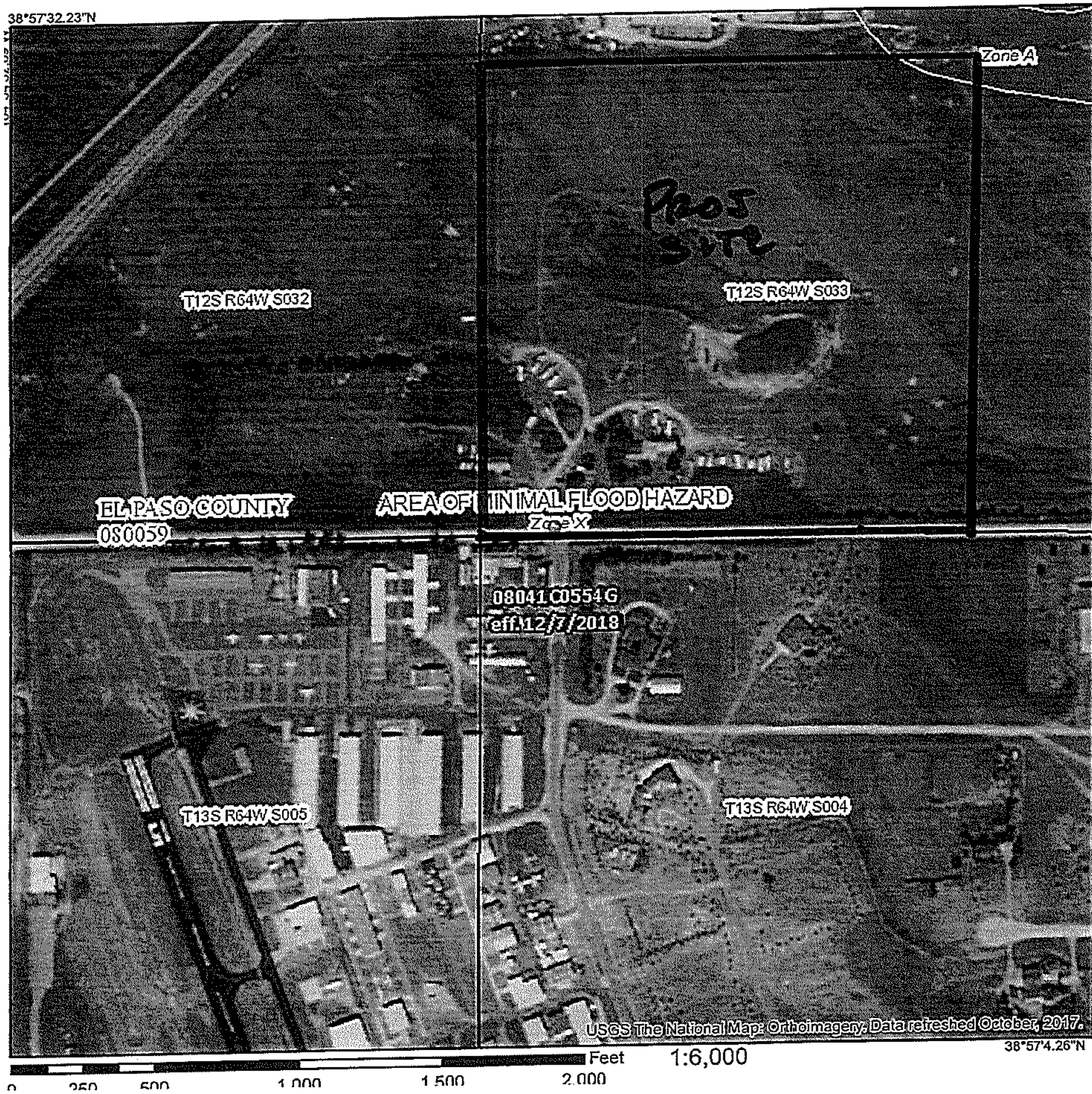
3520 Austin Bluffs Pkwy, Suite 200
Colorado Springs, CO 80918
(719) 266-5212
fax: (719) 266-5341

National Flood Hazard Layer FIRMette

FEMA



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Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

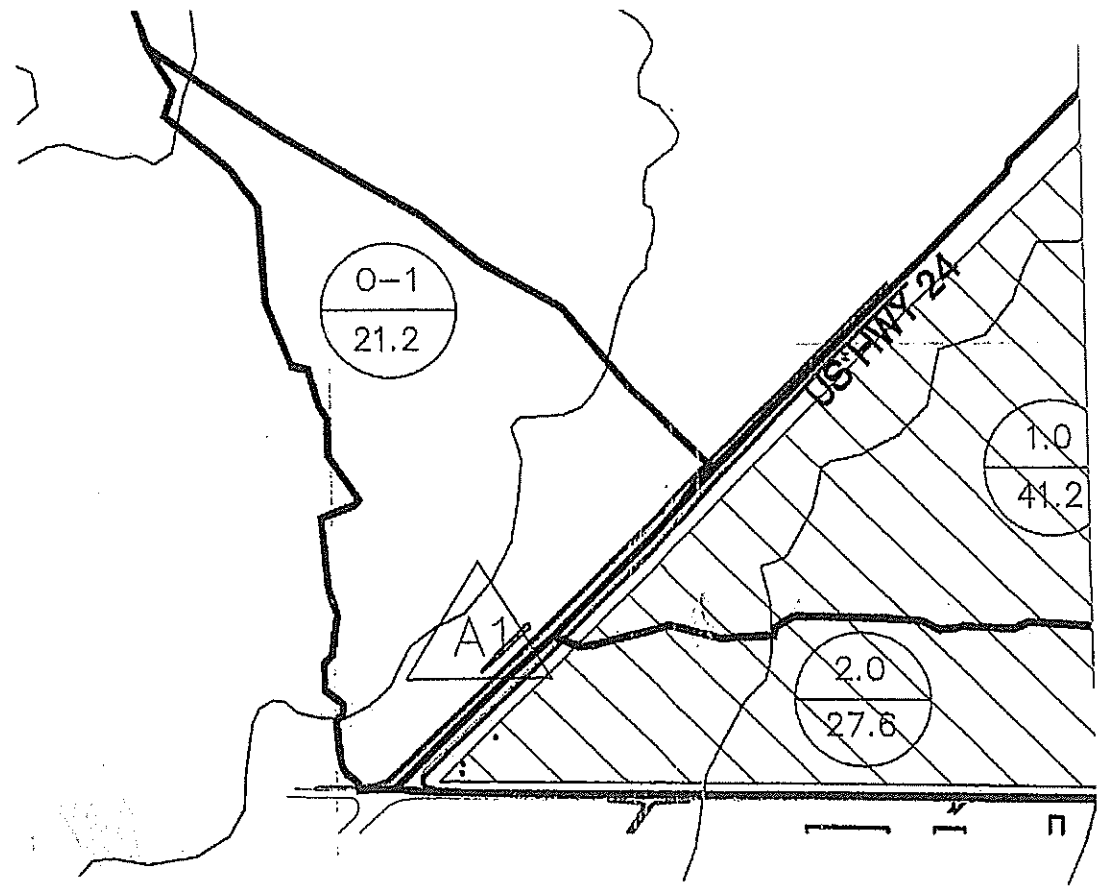
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 5/1/2019 at 4:13:20 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX B

DESIGN CALCULATIONS



NOTE: SUBBASIN O-1* RENAMED AS SUBBASIN OS3 IN THIS REPORT

* FROM MEADOWLAKE COMMONS MDDP BY SPRINGS ENGINEERING, DATED JULY 2008

OFFSITE DRAINAGE MAP

SCALE: 1" = 500'

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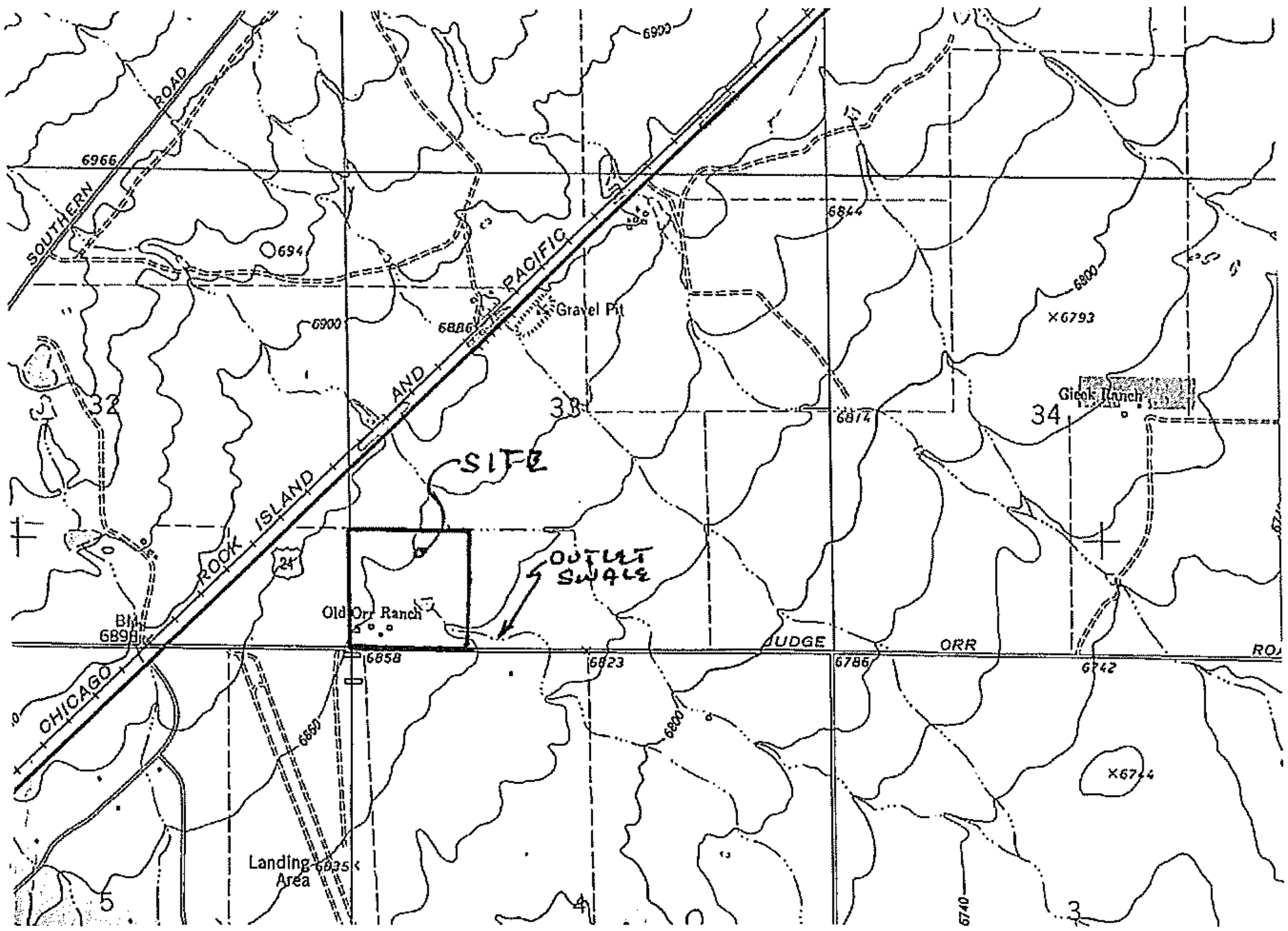
3520 Austin Bluffs Pkwy, Suite 102
Colorado Springs, CO 80918
(719) 266-5212
fax: (719) 266-5341



OFFSITE DRAINAGE MAP

SCALE; 1'=2000'

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3520 Austin Bluffs Pkwy, Suite 102
Colorado Springs, CO 80918
(719) 266-5212
fax: (719) 266-5341

JUDGE ORR ROAD RV PARK & STORAGE DEVELOPMENT

C FACTOR CALCULATION SHEET

RUNOFF COEFICIENT

TYPE A/B SOILS

LAND USE	5 YR	100 YR	IMPERV. %
UNDEV	0.08	0.35	0
LOOSE GRAVEL	0.59	0.7	80
GRAVEL ROADS	0.59	0.7	80
GRAVEL RV PARKING PAD	0.59	0.7	80
PAVED ROADS/BUILDINGS	0.9	0.96	100

Historic Conditions

	TOTAL	SURFACE CONDITION AREAS				CALCULATED C	
AREA	AREA	GRASSED	LOOSE	GRAVEL	BUILDINGS	5	100
		SURFACE	GRAVEL	ROADS	OR PAVED		
DESIG.	(acre)				ROADS	YR	YR
A1	11.75	11.75	0.00	0.00	0.00	0.08	0.35
A2	20.75	20.60	0.00	0.10	0.05	0.08	0.35
A3	4.36	3.91	0.00	0.35	0.10	0.14	0.39
	36.86	36.26	0.00	0.45	0.15	0.09	0.36
% Impervious		0%	80%	80%	100%		
Imp x A		0	0	0.36	0.15		
Total I x A	0.51						
Total Imp	0.51/36.86 = 1.4%						
B	0.87	0.87	0.00	0.00	0.00	0.08	0.35
OS1	7.81	7.19	0.00	0.00	0.62	0.15	0.40
OS2	36.41	35.96	0.00	0.00	0.45	0.09	0.36
OS3	27.21	From Heagler DBPS				0.30	0.60
OS4	13.73	12.37	0.00	0.00	1.36	0.16	0.41
OS5	0.71	0.42	0.00	0.00	0.29	0.41	0.60

Developed Conditions							
	TOTAL	SURFACE CONDITION AREAS				CALCULATED C	
AREA	AREA	GRASSED	LOOSE	GRAVEL	PAVED	5	100
		SURFACE	GRAVEL	RV	ROADS		
DESIG.	(acre)			PARKING		YR	YR
A1	8.30	0.61	7.69	0.00	0.00	0.55	0.67
A2A	2.58	0.86	0.00	0.00	1.72	0.63	0.76
A3	6.85	3.88	0.00	1.15	1.82	0.38	0.57
A4	11.92	9.18	0.00	1.49	1.25	0.23	0.46
Total @Pond	29.65	14.53	7.69	2.64	4.79	0.39	0.57
A2B	0.70	0.16	0.00	0.00	0.54	0.71	0.82
A5	1.80	1.72	0.00	0.00	0.08	0.08	0.38
% Impervious		0%	80%	80%	100%		
Imp x A		0	6.15	2.11	4.79		
Total I x A	13.05						
Total Imp	13.05/29.65 = 44.0%						
B	0.87	0.87	0.00	0.00	0.00	0.08	0.35
OS1	7.81	7.19	0.00	0.00	0.62	0.15	0.40
OS2	42.70	19.20	0.00	0.00	23.50	0.53	0.69
OS3	27.21	From Heagler DBPS				0.30	0.60
OS4	4.18	2.82	0.00	0.00	1.36	0.35	0.55
OS5	0.70	0.42	0.00	0.00	0.28	0.41	0.59
Pond 1							
% Impervious							
	TOTAL	GRASSED	NEIGHBORHOOD				
	AREA	SURFACE	COMMERCIAL				
OS1	7.81	7.81					
OS2	42.70	1.65	41.05				
	50.51	9.46	41.05				
% Impervious		0%	70%				
Imp x A		0	28.74				
Total I x A	28.74						
Total Imp	28.74/50.51 = 56.9%						

JUDGE ORR ROAD RV PARK & STORAGE DEVELOPMENT
PROJ. #160301
DRAINAGE CALCULATION SHEET
file:judge orr rv1 dr
04/25/19

AREA DESIG.	AREA (acre)	C5 (5 yr)	C100 (100 yr)	C5 X A	C100 X A	Initial Tci L (ft)	Initial Tci Slope (%)	Initial Tci ti (min)	Travel Time L (ft)	Travel Time Slope (%)	Travel Time V (fps)	Tt (min)	TC (min)	I5 (in/hr	I100 (in/hr	Q5 (cfs)	Q100 (cfs)	length L (feet)	vel. V (fps)	^t (min)	AREA DESIG.
EXISTING CONDITIONS																					
A1	11.75	0.08	0.35	0.94	4.11	200	2.00	21.46	1150	1.90	2.10	9.13	30.59	2.29	4.00	2.15	16.47				A1
OS1	7.81	0.15	0.40	1.17	3.12	150	2.00	17.31	600	1.18	2.35	4.26	21.56	2.80	4.89	3.28	15.27	450	4.50	1.67	OS1
OS2	22.10	0.09	0.36	1.99	7.96	150	2.00	18.40	1400	1.20	1.20	19.44	37.85	2.01	3.52	4.00	27.97				OS2
DP1	29.91			3.16	11.08								37.85	2.01	3.52	6.36	38.95	1250	2.10	9.92	DP1
A2	17.47	0.08	0.35	1.40	6.11	250	3.20	20.55	1400	1.90	2.10	11.11	31.66	2.25	3.92	3.14	23.98				A2
DP2	47.38			4.56	17.19								47.77	1.73	3.03	7.91	52.10				DP2
OS3	27.21	0.30	0.60	8.16	16.33	250	2.00	18.82	1570	2.90	1.80	14.54	33.35	2.18	3.80	17.76	62.04	1800	4.00	7.50	OS3
OS4	25.14	0.16	0.41	4.02	10.31	250	2.00	22.11	1800	1.00	2.00	15.00	37.11	2.04	3.56	8.20	36.68				OS4
DP3	52.35			12.19	26.63								37.11	2.04	3.56	24.83	94.79	1050	2.25	7.78	DP3
A3	2.80	0.14	0.39	0.39	1.09	100	2.00	14.28	1050	1.23	2.25	7.78	22.06	2.76	4.83	1.08	5.27				A3
OS5	0.82	0.41	0.60	0.34	0.49	10	2.00	3.25	1050	1.23	2.25	7.78	11.02	3.89	6.79	1.31	3.34				OS5
DP4	55.97			12.91	28.22								44.89	1.81	3.15	23.32	89.02				DP4
DP5	115.10			18.41	49.52								44.89	1.81	3.15	33.25	156.23				DP5
B	0.87	0.08	0.35	0.07	0.30	80	2.00	13.57	650	1.30	2.30	4.71	18.28	3.05	5.34	0.21	1.62				B
DEVELOPED CONDITIONS																					
OS1	7.81	0.15	0.40	1.17	3.12	150	2.00	17.31	600	1.18	2.35	4.26	21.56	2.80	4.89	3.28	15.27	450	4.50	1.67	OS1
OS2	22.10	0.09	0.36	1.99	7.96	150	2.00	18.40	1400	1.20	1.20	19.44	37.85	2.01	3.52	4.00	27.97				OS2
DP1	29.91			3.16	11.08								37.85	2.01	3.52	6.36	38.95	1594	10.00	2.66	DP1
A1	8.30	0.56	0.68	4.65	5.64	100	2.00	8.03	1150	1.50	1.20	15.97	24.01	2.64	4.61	12.26	26.00	650	1.20	9.03	A1
A2A	2.58	0.63	0.76	1.63	1.96	35	2.00	4.14	700	1.50	1.20	9.72	13.86	3.50	6.12	5.69	12.00	675	1.20	9.38	A2A
A3	6.85	0.38	0.57	2.60	3.90	100	2.00	10.71	950	1.50	1.20	13.19	23.91	2.64	4.62	6.88	18.03				A3
DP2	9.43			4.23	5.87								23.91	2.64	4.62	11.18	27.08	230	1.20	3.19	DP2
A4	11.92	0.39	0.57	4.65	6.79	100	2.00	10.56	1100	1.50	1.20	15.28	25.84	2.53	4.42	11.76	30.02				A4
DP3	29.65			13.53	18.30								33.03	2.19	3.82	29.60	69.97	150	5.00	0.50	DP3
DPD2	29.65			0.23	8.93	*Adjusted C Factor for Detention Basin							33.03	2.19	3.82	0.50	34.10				DPD2
DP4	59.56			3.39	20.01								40.50	1.93	3.37	6.54	67.41				DP4
OS3	27.21	0.30	0.60	8.16	16.33	250	2.00	18.82	1570	2.90	1.80	14.54	33.35	2.18	3.80	17.76	62.04	1800	4.00	7.50	OS3
OS4	25.14	0.16	0.41	4.02	10.31	250	2.00	22.11	1800	1.00	2.00	15.00	37.11	2.04	3.56	8.20	36.68				OS4
DP5	52.35			12.19	26.63								37.11	2.04	3.56	24.83	94.79	1050	2.25	7.78	DP5

A2B	0.69	0.71	0.82	0.49	0.57	35	2.00	3.43	200	1.50	1.20	2.78	6.21	4.84	8.46	2.37	4.79	110	1.20	1.53	A2B
A5	1.80	0.08	0.38	0.14	0.68	180	2.00	20.36	1050	1.23	2.25	7.78	28.14	2.41	4.21	0.35	2.88				A5
OS5	0.70	0.41	0.59	0.29	0.42	10	2.00	3.26	1300	1.23	2.25	9.63	12.89	3.62	6.33	1.04	2.63				OS5
DP6	55.54			12.62	27.73								44.89	1.81	3.15	22.78	87.49				DP6
DP7	115.10			16.00	47.74								44.89	1.81	3.15	28.90	150.61				DP7
B	0.87	0.08	0.35	0.07	0.30	80	2.00	13.57	650	1.30	2.30	4.71	18.28	3.05	5.34	0.21	1.62				B

* C Factor Adjusted to Model Flows from Detention Model into Rational Method Design

DITCH CAPACITY CALCULATION SHEET

Swale Location	Q5 cfs	Q100 cfs	S %	B ft	n	Z	D ft	d100 ft	V fps	Froude #	Riprap Size ft	Riprap Size in
Swale A	6.4	39.0	1.00	4.00	0.035	3:1	3.00	1.30	3.70	0.71		
Swale B	3.0	10.0	1.00	0.00	0.035	3:1	1.50	1.10	2.75	0.65		
Swale C	12.3	26.0	1.40	0.00	0.035	3:1, 1%	1.00	0.50	2.00	0.71		
Swale D	12.3	26.0	1.50	0.00	0.035	3:1	2.00	1.50	4.10	0.84		
Swale E	11.1	27.1	1.40	4.00	0.035	0.42	1.00	0.80	3.00	0.78		
Swale F	11.8	30.0	1.50	0.00	0.015	56:1	0.25	0.3*	3.10	1.52	asphalt road	
								*d5				
Judge Orr Rd												
Ditch G	24.8	94.8	1.60	4.00	0.035	3:1/4:1	2.00	1.70	5.50	0.94		
Ditch H	22.8	87.5	1.60	4.00	0.035	3:1/4:1	2.50	1.70	5.40	0.93		
Spillwy K	24.6*	73.0*	5.00	40.00	0.040	3:1	2.00	0.40	4.40	1.25	0.20	Use 12"
	*Undetained Flows from UD-Det											
Spillway Swale L	36.1*	109.0*	0.30	10.00	0.040	3:1	3.00	2.30	2.80	0.38	0.38	Use 12"
	*Undetained Flows from UD-Det+ Storm Sewer Flows											
Exist Swale At E PL Line	6.5*	67.4*	1.70	8.00	0.040	8:1	6.00	1.10	3.80	0.80		
	*Detained Flows + Storm Sewer Flows											
*Swale 300' E of PL	28.9	150.6	1.70	8.00	0.040	8:1	6.00	1.60	4.70	0.85		
	*From Spreadsheet											
*Det Breach Flow	---	199.5	1.70	8.00	0.040	8:1	6.00	1.80	5.10	0.86		

*Flows from the development travel within a natural swale covered with rangeland grasses. No downstream manmade facilities exist.

STORM SEWER HYDRAULIC GRADELINE CALCULATION SHEET

Location	Pipe Size	Slope %	Q5	Q100	Pipe Cap	Critical d	Invert	Q/D^1.5	Yt	Riprap Size	Riprap Used
DPD1	30"	1.3	6.4	39.0	54.5	2.3	6855.5	9.9	0.68	Type L*	Type M
A2A	24"	0.4	5.7	12.0	15.4	1.24	6856.0	4.2	0.8	Type L*	Type M
DP2	24"	5.7	11.2	27.1	58.1	1.82	6842.1				
DP5	(3)38"x24"	1.0	24.8	94.8	44	1.36	6855.4	8.0	0.68	Type L*	Type M
DP6	(3)38"x24"	1.0	22.8	87.5	44	1.36	6841.6	7.4	0.68	Type L*	Type M
										* Per Figure 5-7	

FOREBAY CALCULATIONS	
Total for Basin	
2% OF WQV	
0.02 X 0.470 = 0.0094 AF = 409 CF	
Total Flows at Forebays = 83.1 CFS (Without Time of Concentration Adjustment)	
At Swale D-D	**FOREBAY NOTCH CALCULATIONS**
Flow at Swale D-D = 26.0 CFS	0.02 OF 100YR FLOW
Forebay Size = (26.0/83.1)x409 = 128 CF	0.02 X 26 = 0.52 CFS
	W =Q/(D^1.5XC)
	W=0.52/(1X3.0)=0.17 FT
At DP2	
Flow at DP2 = 27.1 CFS	0.02 OF 100YR FLOW
Forebay Size = (27.1/83.8)x409 = 133 CF	0.02 X 27.1 = 0.54 CFS
	W =Q/(D^1.5XC)
	W=0.54/(1X3.0)=0.18 FT
At Sub-Basin A4	
Flow at Sub-Basin A4 = 30.0 CFS	0.02 OF 100YR FLOW
Forebay Size = (30.0/83.1)x409 = 148 CF	0.02 X 30.0 = 0.60 CFS
	W =Q/(D^1.5XC)
	W=0.60/(1X3.0)=0.20 FT

A2B	0.69	0.71	0.82	0.49	0.57	35	2.00	3.43	200	1.50	1.20	2.78	6.21	4.84	8.46	2.37	4.79	110	1.20	1.53	A2B
A5	1.80	0.08	0.38	0.14	0.68	180	2.00	20.36	1050	1.23	2.25	7.78	28.14	2.41	4.21	0.35	2.88				A5
OS5	0.70	0.41	0.59	0.29	0.42	10	2.00	3.26	1300	1.23	2.25	9.63	12.89	3.62	6.33	1.04	2.63				OS5
DP6	55.54			12.62	27.73								44.89	1.81	3.15	22.78	87.49				DP6
DP7	115.10			16.00	47.74								44.89	1.81	3.15	28.90	150.61				DP7
B	0.87	0.08	0.35	0.07	0.30	80	2.00	13.57	650	1.30	2.30	4.71	18.28	3.05	5.34	0.21	1.62				B

* C Factor Adjusted to Model Flows from Detention Model into Rational Method Design

DITCH CAPACITY CALCULATION SHEET

Swale Location	Q5 cfs	Q100 cfs	S %	B ft	n	Z	D ft	d100 ft	V fps	Froude #	Riprap Size ft	Riprap Size in
Swale A	6.4	39.0	1.00	4.00	0.035	3:1	3.00	1.30	3.70	0.71		
Swale B	3.0	10.0	1.00	0.00	0.035	3:1	1.50	1.10	2.75	0.65		
Swale C	12.3	26.0	1.40	0.00	0.035	3:1, 1%	1.00	0.50	2.00	0.71		
Swale D	12.3	26.0	1.50	0.00	0.035	3:1	2.00	1.50	4.10	0.84		
Swale E	11.1	27.1	1.40	4.00	0.035	0.42	1.00	0.80	3.00	0.78		
Swale F	11.8	30.0	1.50	0.00	0.015	56:1	0.25	0.3*	3.10	1.52	asphalt road	
								*d5				
Judge Orr Rd												
Ditch G	24.8	94.8	1.60	4.00	0.035	3:1/4:1	2.00	1.70	5.50	0.94		
Ditch H	22.8	87.5	1.60	4.00	0.035	3:1/4:1	2.50	1.70	5.40	0.93		
Spillwy K	24.6*	73.0*	5.00	40.00	0.040	3:1	2.00	0.40	4.40	1.25	0.20	Use 12"
	*Undetained Flows from UD-Det											
Spillway												
Swale L	36.1*	109.0*	0.30	10.00	0.040	3:1	3.00	2.30	2.80	0.38	0.38	Use 12"
	*Undetained Flows from UD-Det+ Storm Sewer Flows											
Exist Swale At												
E PL Line	6.5*	67.4*	1.70	8.00	0.040	8:1	6.00	1.10	3.80	0.80		
	*Detained Flows + Storm Sewer Flows											
*Swale 300'												
E of PL	28.9	150.6	1.70	8.00	0.040	8:1	6.00	1.60	4.70	0.85		
	*From Spreadsheet											
*Det Breach												
Flow	---	199.5	1.70	8.00	0.040	8:1	6.00	1.80	5.10	0.86		

*Flows from the development travel within a natural swale covered with rangeland grasses. No downstream manmade facilities exist.

STORM SEWER HYDRAULIC GRADELINE CALCULATION SHEET

Location	Pipe Size	Slope %	Q5	Q100	Pipe Cap	Critical d	Invert	
DPD1	30"	1.3	0.1	50.7	54.5	2.3	6855.5	Future Pond Flows
A2A	24"	0.4	5.7	12.0	15.4	1.24	6856.0	
DP2	24"	5.7	11.2	27.1	58.1	1.82	6842.1	
DP5	(3)38"x24"	1.0	24.8	94.8	44	1.36	6855.4	
DP6	(3)38"x24"	1.0	22.8	87.5	44	1.36	6841.6	

FOREBAY CALCULATIONS	
Total for Basin	
2% OF WQV	
0.02 X 0.470 = 0.0094 AF = 409 CF	
Total Flows at Forebays = 83.1 CFS (Without Time of Concentration Adjustment)	
At Swale D-D	**FOREBAY NOTCH CALCULATIONS**
Flow at Swale D-D = 26.0 CFS	0.02 OF 100YR FLOW
Forebay Size = (26.0/83.1)x409 = 128 CF	0.02 X 26 = 0.52 CFS
	W =Q/(D^1.5XC)
	W=0.52/(1X3.0)=0.17 FT
At DP2	
Flow at DP2 = 27.1 CFS	0.02 OF 100YR FLOW
Forebay Size = (27.1/83.8)x409 = 133 CF	0.02 X 27.1 = 0.54 CFS
	W =Q/(D^1.5XC)
	W=0.54/(1X3.0)=0.18 FT
At Sub-Basin A4	
Flow at Sub-Basin A4 = 30.0 CFS	0.02 OF 100YR FLOW
Forebay Size = (30.0/83.1)x409 = 148 CF	0.02 X 30.0 = 0.60 CFS
	W =Q/(D^1.5XC)
	W=0.60/(1X3.0)=0.20 FT

CULVERT DESIGN FORM

PROJECT: Judge Orr Rd Ex Pass Culvert At DP1

STATION: ________ SHEET ____ OF ____

DESIGNER / DATE: MNB / 2/7/19

REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

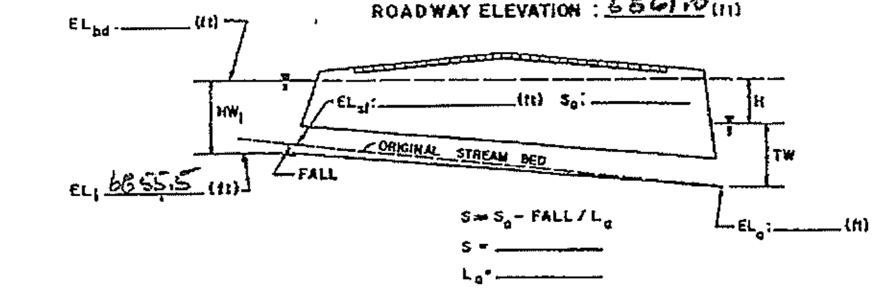
(SEE ADD'L SHTS.)

- ☐ METHOD: RATIONAL
- ☐ DRAINAGE AREA: 29.91 ☐ STREAM SLOPE: 1%
- ☐ CHANNEL SHAPE: TRAP
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
100	39.0 (EXIST)	

ROADWAY ELEVATION: 6861.0 (ft)



$S = S_o - FALL / L_a$

S = ____

L_a = ____

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS — INLET CONTROL: HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL: TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
HDPE 30" w/FES	39.0	39.0	1.48	3.70		59.2								61.75	2.4	

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

PIPE INLET DESIGNED FOR EXIST. COND.
PIPE WILL BE CONNECTED IN THE FUTURE
TO AN EXTENDED DETENTION BASIN

CULVERT BARREL SELECTED:

SIZE: ____

SHAPE: ____

MATERIAL: ____ n ____

ENTRANCE: ____

HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date OCT. 1987

Figure 9-44

REFERENCE : Federal Highway Administration, Hydraulic Design of Highway Culverts : Hydraulic Design Series No. 5 1985

PROJECT: Judge Orr Rd RV Park Basin A2A Pipe	**STATION:** ______ **SHEET** ____ **OF** ____

CULVERT DESIGN FORM

DESIGNER / DATE: A/AB / 4/30/19

REVIEWER / DATE: ______ / ______

HYDROLOGICAL DATA

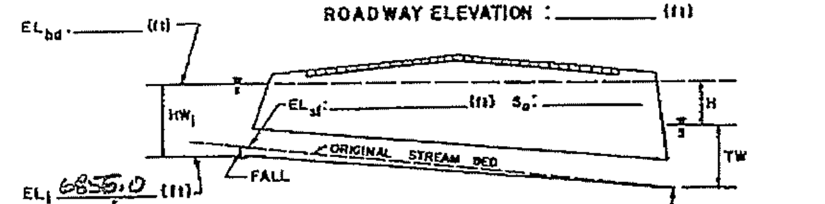
SEE ADD'L SHTS.

- ☐ METHOD: Rational
- ☐ DRAINAGE AREA: 2.58 ☐ STREAM SLOPE: 1.3%
- ☐ CHANNEL SHAPE: 'V' Shape Swale
- ☐ ROUTING: ______ ☐ OTHER: ______

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
5	5.7	0.5
10	12.0	0.6

ROADWAY ELEVATION: ______ (ft)



$S = S_o - FALL / L_o$

S = 0.4%

L_o = 250

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW$_i$/D (2)	HW$_i$	FALL (3)	EL$_{hi}$ (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL$_{ho}$ (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
24" RCP w/FES	12.0	12.0	0.9	1.8		57.8										
	5.7	5.7	0.57	1.14		57.14									5.9	

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i / D = HW / D$ OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L) / R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: ______

SHAPE: ______

MATERIAL: ______ n ______

ENTRANCE: ______

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Drainage Criteria Manual

Date: OCT. 1987

Figure 9-44

REFERENCE: Federal Highway Administration, Hydraulic Design of Highway Culverts; Hydraulic Design Series No. 5 1985

PROJECT: Judge Orr Rd RV Park West Culvert - Range Flower	STATION: ______ SHEET ____ OF ____	**CULVERT DESIGN FORM** DESIGNER / DATE: MAB / 9/30/19 REVIEWER / DATE: ____ / ____

HYDROLOGICAL DATA

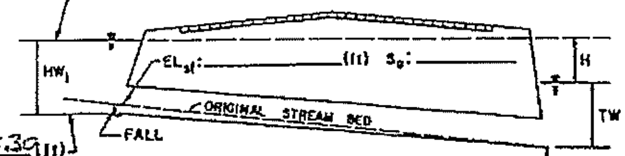
SEE ADD'L SHTS.

- ☐ METHOD: Rational
- ☐ DRAINAGE AREA: 52.4 ☐ STREAM SLOPE: 1.6%
- ☐ CHANNEL SHAPE: Trap.
- ☐ ROUTING: ______ ☐ OTHER: ______

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
5	24.8	0.9
100	94.8	1.7

ROADWAY ELEVATION: 58.29 (ft)



$S = S_o - FALL / L_a$

S = 0.01

L_a = 130

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
RCE.P. (3) 38"x24" w/ Adwl	94.8	31.6	1.22	2.44		58.74	1.7	1.6	1.4	1.85	0.2	3.15	57.15	58.74	8.8	
" "	24.8	8.3	0.55	1.10		56.4	0.9	0.9	0.9	0.3	0.2	1.20	55.2	56.4		

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29 n^2 L) / R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: ______

SHAPE: ______

MATERIAL: ______ n: ______

ENTRANCE: ______

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Drainage Criteria Manual

Date: OCT. 1987

Figure 9-44

REFERENCE: Federal Highway Administration, Hydraulic Design of Highway Culverts; Hydraulic Design Series No. 5 1985

CULVERT DESIGN FORM

PROJECT: Judge Orr Rd RV Park
East Culvert - Fire Access

STATION: ______
SHEET ____ OF ____

DESIGNER / DATE: M/AB / 4/30/?
REVIEWER / DATE: ____ / ____

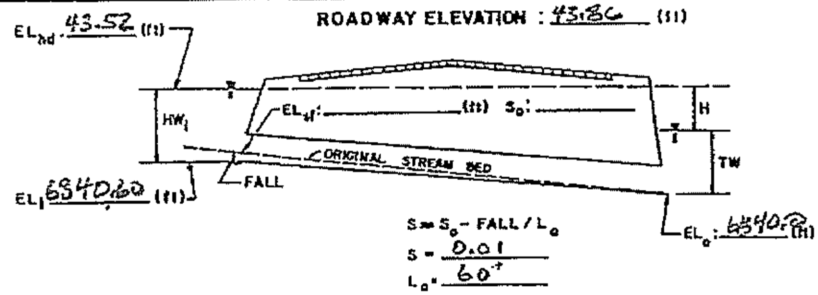
HYDROLOGICAL DATA

SEE ADD'L SHTS.

- ☐ METHOD: Rational
- ☐ DRAINAGE AREA: [illegible] ☐ STREAM SLOPE: 1.6%
- ☐ CHANNEL SHAPE: Trap
- ☐ ROUTING: ____ ☐ OTHER: ____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
5	22.8	0.9
100	87.5	1.7



CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
RCEP-(3) 38"X24" w/HDW:	87.5	29.2	1.15	2.30		42.9	1.7	1.6	1.4	1.25	0.2	2.98	42.98	42.98	8.4	
	22.8	7.6	0.52	1.04		41.64	0.9	0.9	0.9	0.3	0.2	1.20	41.20	41.64		

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho. HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

CULVERT BARREL SELECTED:

SIZE: ____
SHAPE: ____
MATERIAL: ____ n ____
ENTRANCE: ____

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Drainage Criteria Manual

Date: OCT. 1987

Figure 9-44

REFERENCE: Federal Highway Administration, Hydraulic Design of Highway Culverts; Hydraulic Design Series No. 5 1985

Project Judge Orr Road RV Park & Storage
By AJL
Date 6/17/2019

Descriptior HGL for the 5-year and 100-year events generated using UD-SEWER 2009, Version 1.4

5-Year Results

Element	Q100	DIA (IN)	Material	Manning's n	LENGTH (FT)	DS INV	US INV	DS HGL	US HGL	Slope	Notes
Outfall	6.4	30	HDPE	0.012	-	-	6,833.70	-	6,834.28	0.003	TW = 0.50'
P1	6.4	30	HDPE	0.012	80	6,833.73	6,835.25	6,834.28	6,836.09	0.019	
P2	6.4	30	HDPE	0.012	448	6,835.35	6,841.17	6,836.10	6,842.01	0.013	
P3	6.4	30	HDPE	0.012	500	6,841.27	6,847.77	6,842.02	6,848.61	0.013	
P4	6.4	30	RCP	0.013	289	6,847.87	6,851.63	6,848.62	6,852.47	0.013	
P5	6.4	30	HDPE	0.012	277	6,851.73	6,855.33	6,852.48	6,856.17	0.013	
P6	6.4	30	HDPE	0.012	13	6,855.33	6,855.50	6,856.18	6,856.55	0.013	

100-Year Results

Element	Q100	DIA (IN)	Material	Manning's n	LENGTH (FT)	DS INV	US INV	DS HGL	US HGL	Slope	Notes
Outfall	39.0	30	HDPE	0.012	-	-	6,833.70	-	6,835.18	0.003	TW = 1.83'
P1	39.0	30	HDPE	0.012	80	6,833.73	6,835.25	6,835.18	6,837.36	0.019	
P2	39.0	30	HDPE	0.012	448	6,835.35	6,841.17	6,837.73	6,843.28	0.013	
P3	39.0	30	HDPE	0.012	500	6,841.27	6,847.77	6,843.33	6,849.88	0.013	
P4	39.0	30	RCP	0.013	289	6,847.87	6,851.63	6,850.48	6,853.74	0.013	
P5	39.0	30	HDPE	0.012	277	6,851.73	6,855.33	6,854.11	6,857.44	0.013	
P6	39.0	30	HDPE	0.012	13	6,855.33	6,855.50	6,858.04	6,858.14	0.013	

Project Judge Orr Road RV Park & Storage
By AJL
Date 6/17/2019

Descriptioi HGL for the 5-year and 100-year events generated using UD-SEWER 2009, Version 1.4

5-Year Results

Element	Q5	DIA (IN)	Material	Manning's n	LENGTH (FT)	DS INV	US INV	DS HGL	US HGL	Slope	Notes
Outfall	11.2	24	HDPE	0.012	-	-	6,835.41	-	6,836.02	-	TW EL = 6,839.60 (5-year Pond WSEL); Depth = 4.19'
P10	11.2	24	HDPE	0.012	17	6,835.41	6,836.29	6,836.02	6,838.82	0.052	
P11	11.2	24	HDPE	0.012	113	6,836.29	6,842.14	6,838.90	6,843.34	0.052	

100-Year Results

Element	Q100	DIA (IN)	Material	Manning's n	LENGTH (FT)	DS INV	US INV	DS HGL	US HGL	Slope	Notes
Outfall	27.1	24	HDPE	0.012	-	-	6,835.41	-	6,836.72	-	TW EL = 6,841.50 (100-year Pond WSEL); Depth = 6.09'
P10	27.1	24	HDPE	0.012	17	6,835.41	6,836.29	6,836.72	6,838.10	0.052	
P11	27.1	24	HDPE	0.012	113	6,836.29	6,842.14	6,838.66	6,843.95	0.052	

Project	Judge Orr Road RV Park & Storage
By	AJL
Date	6/17/2019

Description: HGL for the 5-year and 100-year events generated using HY-8 Version 7.50

Flower Way

Event	Flow	US INV	DS INV	US HGL	DS HGL	Outlet Velocity
Yr	cfs	ft	ft	ft	ft	ft/sec
5	24.8	6855.30	6854.00	6856.38	6855.70	1.75
100	94.8	6855.30	6854.00	6858.13	6855.70	8.84

S. Fire Access Rd

Event	Flow	US INV	DS INV	US HGL	DS HGL	Outlet Velocity
Yr	cfs	ft	ft	ft	ft	ft/sec
5	22.8	6840.45	6839.85	6841.68	6841.55	1.61
100	87.5	6840.45	6839.85	6843.06	6841.11	8.39

24" RCP

Event	Flow	US INV	DS INV	US HGL	DS HGL	Outlet Velocity
Yr	cfs	ft	ft	ft	ft	ft/sec
5	5.7	6856.00	6855.00	6857.32	6856.32	4.54
100	12.00	6856.00	6855.00	6858.01	6857.00	5.87

Mainline 30" HDPE

V	2.381 ft/s
S	0.003 ft/ft
Gs	2.5
D50	0.023 ft

Manning's

S	0.003 ft/ft
R	1.313 ft
n	0.041

Riprap Basin Length for 30" HDPE

Pipe Diameter	30 in	
Pipe Diameter	*2.5* ft	
Total Q	39 cfs	
Froude Parameter	*3.9*	
TW Depth	1.83 ft	
Conduit Height	*2.5* ft	
Yt/D	0.732	
Expansion Factor	6.7	See Figure 9-35
1/(2*Exp. Factor)	0.0746	
Expansion Angle	0.1	
At	5.57 sq ft	
Lp	3.65	
3*D Check	7.5 ft	Use this Length
Min Width, T	3.04 ft	

Flower Way 3-38"x24" RECP

V	8.84 ft/s
S	0.01 ft/ft
Gs	2.5
D50	0.472 ft

S. Fire Access 3-38"x24" RECP

V	8.39 ft/s
S	0.01 ft/ft
Gs	2.5
top	3.834969911
bottom	5.880750372
D50	0.425 ft

Only from 30" and does not include the detention release. Per DP4 combined flow is 67.48 cfs

Outlet protection calculation is incomplete.
Show the variables used.
Additionally, this only provides the riprap sizing, but not the required length for the protection. Use the UD-Culvert worksheet. The length of outlet protection appears to be inadequate.

Unresolved. Variables used for Q, D, Yt, D is not provided. Update calculation. This chart is still the same chart from the previous design when the future pond drained into Pond 2 (Pond-in-a-series). Values are unlikely to remain the same. The current drainage has since been revised to discharge this offsite flow separate form Pond 2 at the same spillway location. Riprap sizing must account for the combined flow.

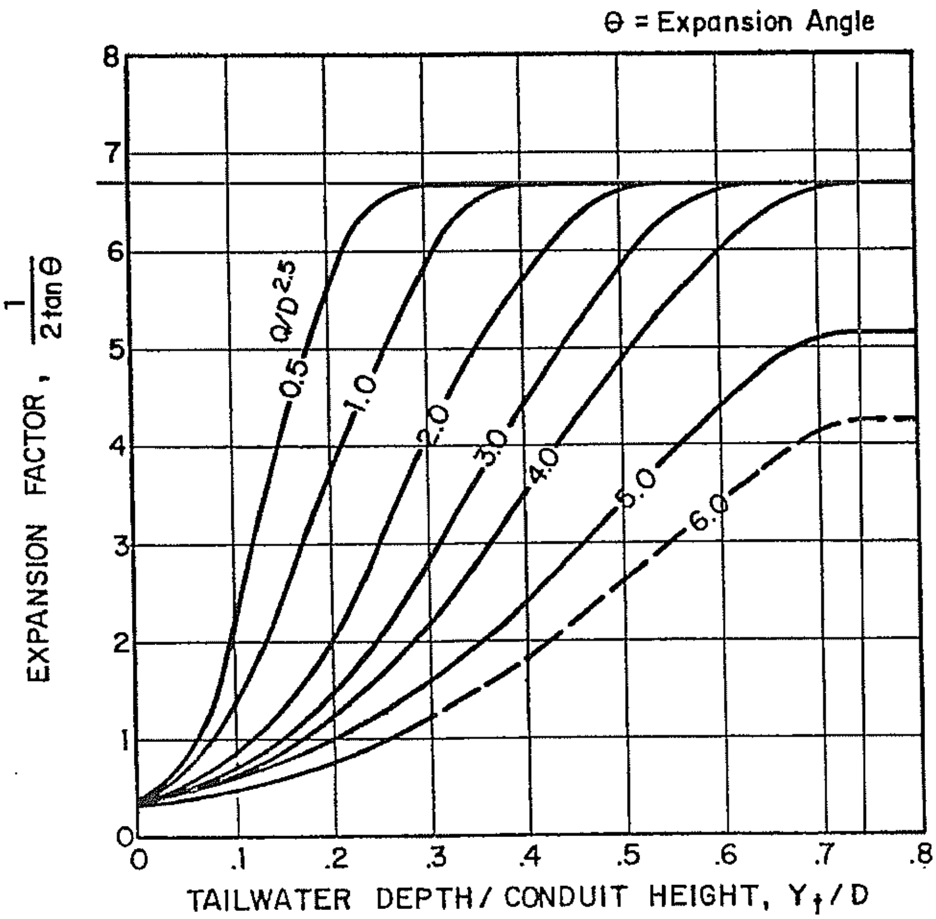


Figure 9-35. Expansion factor for circular conduits

HY-8 Analysis Results

Culvert Summary Table - 24" RCP

Culvert Crossing: Crossing 3

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.70	5.70	6857.32	1.20	1.32	2-M2c	0.85	0.84	0.84	0.38	4.54	1.94
6.33	6.33	6857.39	1.29	1.39	2-M2c	0.91	0.89	0.89	0.40	4.68	1.99
6.96	6.96	6857.47	1.36	1.47	2-M2c	0.96	0.94	0.94	0.42	4.82	2.05
7.59	7.59	6857.54	1.44	1.54	2-M2c	1.01	0.98	0.98	0.43	4.96	2.09
8.22	8.22	6857.61	1.51	1.61	2-M2c	1.06	1.02	1.02	0.45	5.10	2.14
8.85	8.85	6857.68	1.58	1.68	2-M2c	1.11	1.06	1.06	0.47	5.24	2.18
9.48	9.48	6857.75	1.65	1.75	2-M2c	1.16	1.10	1.10	0.48	5.37	2.22
10.11	10.11	6857.81	1.71	1.81	2-M2c	1.21	1.13	1.13	0.50	5.51	2.26
10.74	10.74	6857.88	1.78	1.88	2-M2c	1.26	1.17	1.17	0.51	5.62	2.30
11.37	11.37	6857.94	1.85	1.94	2-M2c	1.31	1.21	1.21	0.53	5.74	2.33
12.00	12.00	6858.01	1.92	2.01	7-M2c	1.36	1.24	1.24	0.54	5.87	2.37

HY-8 Analysis Results

Culvert Summary Table - Flower Way 3-38"x24" RECP

Culvert Crossing: Flower Way

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
24.80	24.80	6856.38	1.08	0.51	1-JS1t	0.59	0.78	1.70	1.70	1.75	0.00
31.80	31.80	6856.56	1.26	0.58	1-JS1t	0.67	0.89	1.70	1.70	2.24	0.00
38.80	38.80	6856.73	1.43	0.67	1-JS1t	0.74	0.99	1.70	1.70	2.73	0.00
45.80	45.80	6856.89	1.59	0.77	1-JS1t	0.81	1.08	1.70	1.70	3.23	0.00
52.80	52.80	6857.05	1.75	0.90	1-JS1t	0.88	1.17	1.70	1.70	3.72	0.00
59.80	59.80	6857.21	1.91	1.04	1-S2n	0.94	1.25	0.97	1.70	7.78	0.00
66.80	66.80	6857.37	2.07	1.20	5-S2n	1.00	1.33	1.04	1.70	8.03	0.00
73.80	73.80	6857.54	2.24	1.37	5-S2n	1.06	1.40	1.10	1.70	8.25	0.00
80.80	80.80	6857.73	2.43	1.57	5-S2n	1.12	1.47	1.17	1.70	8.47	0.00
87.80	87.80	6857.92	2.62	1.78	5-S2n	1.18	1.53	1.23	1.70	8.67	0.00
94.80	94.80	6858.13	2.83	2.00	5-S2n	1.24	1.59	1.29	1.70	8.84	0.00

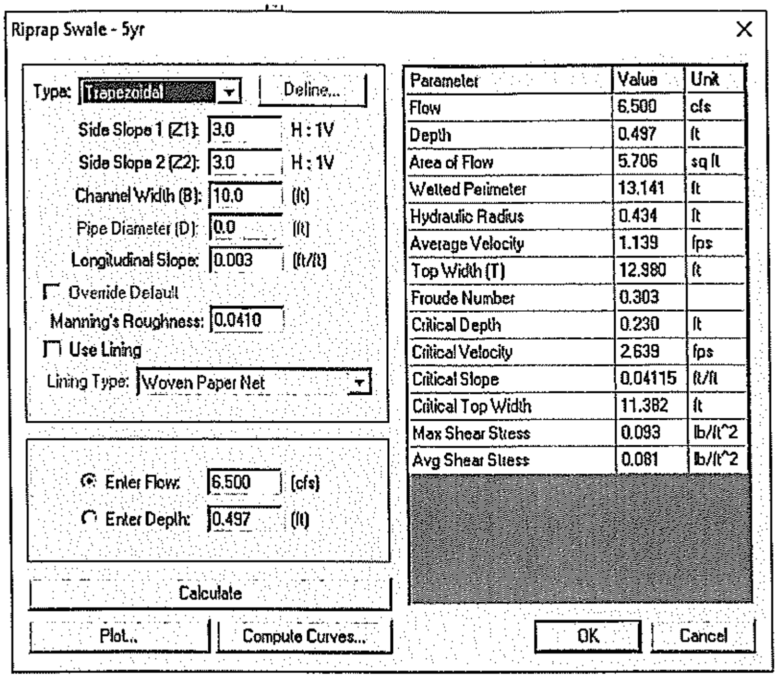
HY-8 Analysis Results

Culvert Summary Table - Fire Access 3-38"x24" RECP

Culvert Crossing: S. Fire Access Rd

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
22.80	22.80	6841.68	1.03	1.23	1-S1t	0.56	0.74	1.70	1.70	1.61	0.00
29.27	29.27	6841.79	1.20	1.34	1-S1t	0.64	0.85	1.70	1.70	2.06	0.00
35.74	35.74	6841.81	1.36	1.27	1-JS1t	0.71	0.95	1.70	1.70	2.52	0.00
42.21	42.21	6841.96	1.51	1.34	1-JS1t	0.77	1.04	1.70	1.70	2.97	0.00
48.68	48.68	6842.10	1.65	1.42	1-JS1t	0.84	1.12	1.70	1.70	3.43	0.00
55.15	55.15	6842.25	1.80	1.51	1-JS1t	0.90	1.20	1.70	1.70	3.89	0.00
61.62	61.62	6842.40	1.95	1.61	1-JS1t	0.96	1.27	1.70	1.70	4.34	0.00
68.09	68.09	6842.55	2.10	1.73	5-S2n	1.01	1.34	1.08	1.70	7.84	0.00
74.56	74.56	6842.71	2.26	1.85	5-S2n	1.07	1.41	1.14	1.70	8.03	0.00
81.03	81.03	6842.88	2.43	1.99	5-S2n	1.13	1.47	1.20	1.70	8.22	0.00
87.50	87.50	6843.06	2.61	2.14	5-S2n	1.18	1.53	1.26	1.70	8.39	0.00

Riprap Swale Calculations



Riprap Swale - 5yr

Type: Trapezoidal | Define...

Side Slope 1 (Z1): 3.0 H : 1V

Side Slope 2 (Z2): 3.0 H : 1V

Channel Width (B): 10.0 (ft)

Pipe Diameter (D): 0.0 (ft)

Longitudinal Slope: 0.003 (ft/ft)

Override Default

Manning's Roughness: 0.0410

Use Lining

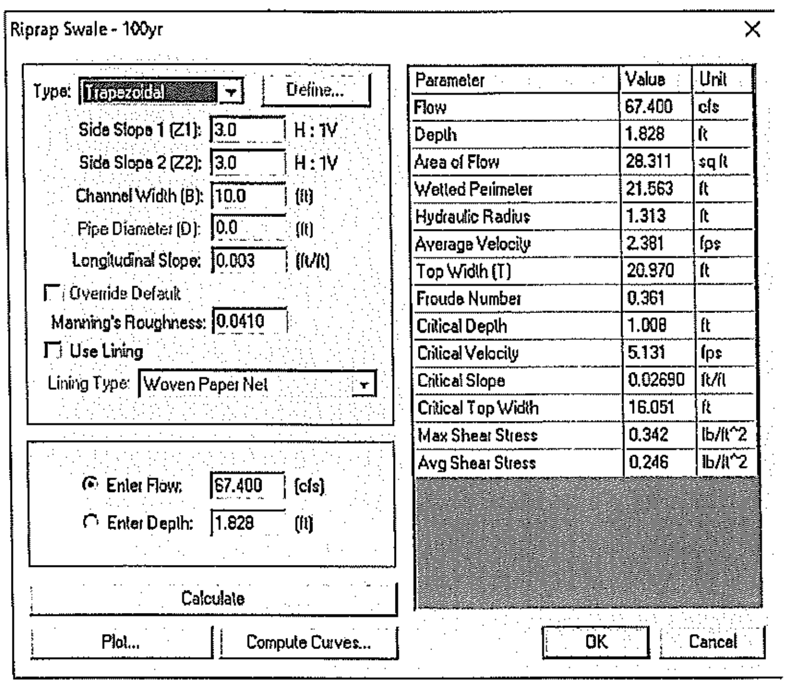
Lining Type: Woven Paper Net

Enter Flow: 6.500 (cfs)

Enter Depth: 0.497 (ft)

Calculate | Plot... | Compute Curves... | OK | Cancel

Parameter	Value	Unit
Flow	6.500	cfs
Depth	0.497	ft
Area of Flow	5.706	sq ft
Wetted Perimeter	13.141	ft
Hydraulic Radius	0.434	ft
Average Velocity	1.139	fps
Top Width (T)	12.980	ft
Froude Number	0.303	
Critical Depth	0.230	ft
Critical Velocity	2.639	fps
Critical Slope	0.04115	ft/ft
Critical Top Width	11.382	ft
Max Shear Stress	0.093	lb/ft^2
Avg Shear Stress	0.081	lb/ft^2



Riprap Swale - 100yr

Type: Trapezoidal | Define...

Side Slope 1 (Z1): 3.0 H : 1V

Side Slope 2 (Z2): 3.0 H : 1V

Channel Width (B): 10.0 (ft)

Pipe Diameter (D): 0.0 (ft)

Longitudinal Slope: 0.003 (ft/ft)

Override Default

Manning's Roughness: 0.0410

Use Lining

Lining Type: Woven Paper Net

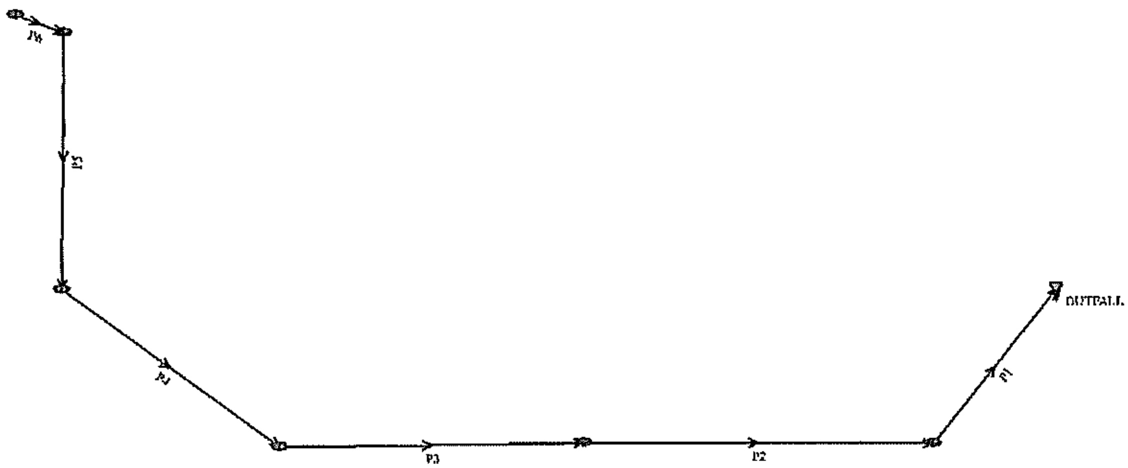
Enter Flow: 67.400 (cfs)

Enter Depth: 1.828 (ft)

Calculate | Plot... | Compute Curves... | OK | Cancel

Parameter	Value	Unit
Flow	67.400	cfs
Depth	1.828	ft
Area of Flow	28.311	sq ft
Wetted Perimeter	21.563	ft
Hydraulic Radius	1.313	ft
Average Velocity	2.381	fps
Top Width (T)	20.970	ft
Froude Number	0.361	
Critical Depth	1.008	ft
Critical Velocity	5.131	fps
Critical Slope	0.02690	ft/ft
Critical Top Width	16.051	ft
Max Shear Stress	0.342	lb/ft^2
Avg Shear Stress	0.246	lb/ft^2

Mainline UD-SEWER Layout



Mainline System Input Summary – 5-Year Event

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

One Hour Depth (in): 1.00
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 0.50

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6845.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

P1	6845.34	6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P2	6850.00	6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P3	6860.40	6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P4	6860.40	6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P5	6860.00	6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P6	6860.00	6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	1.50	4.33	1.01	6.50	
P1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.50	
P2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.50	
P3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.50	
P4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.50	
P5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.50	
P6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.50	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft

										or in)
P1	80.00	6833.73	1.9	6835.25	0.012	0.03	0.25	CIRCULAR	30.00 in	30.00 in
P2	448.00	6835.35	1.3	6841.17	0.012	0.38	0.00	CIRCULAR	30.00 in	30.00 in
P3	500.00	6841.27	1.3	6847.77	0.012	0.05	0.00	CIRCULAR	30.00 in	30.00 in
P4	289.00	6847.87	1.3	6851.63	0.013	0.38	0.00	CIRCULAR	30.00 in	30.00 in
P5	277.00	6851.73	1.3	6855.33	0.012	0.38	0.00	CIRCULAR	30.00 in	30.00 in
P6	13.00	6855.33	1.3	6855.50	0.012	0.38	0.00	CIRCULAR	30.00 in	30.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
P1	61.42	12.51	10.13	4.46	6.59	8.13	2.31	Supercritical	6.50	0.00	
P2	50.78	10.35	10.13	4.46	7.25	7.11	1.92	Supercritical	6.50	0.00	
P3	50.80	10.35	10.13	4.46	7.25	7.11	1.92	Supercritical	6.50	0.00	
P4	46.91	9.56	10.13	4.46	7.54	6.72	1.77	Supercritical	6.50	0.00	
P5	50.79	10.35	10.13	4.46	7.25	7.11	1.92	Supercritical	6.50	0.00	
P6	50.94	10.38	10.13	4.46	7.24	7.12	1.92	Supercritical	6.50	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.

- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
P1	6.50	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
P2	6.50	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
P3	6.50	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
P4	6.50	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
P5	6.50	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
P6	6.50	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 0.50

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)

P1	6833.73	6835.25	0.00	0.00	6834.28	6836.09	6835.31	1.10	6836.40
P2	6835.35	6841.17	0.01	0.00	6836.10	6842.01	6836.74	5.58	6842.32
P3	6841.27	6847.77	0.00	0.00	6842.02	6848.61	6842.66	6.26	6848.92
P4	6847.87	6851.63	0.01	0.00	6848.62	6852.47	6849.20	3.58	6852.78
P5	6851.73	6855.33	0.01	0.00	6852.48	6856.17	6853.12	3.36	6856.48
P6	6855.33	6855.50	0.01	0.00	6856.18	6856.55	6856.72	0.00	6856.72

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**
P1	80.00	3.50	6.00	6.08	21.04	12.06	8.48	18.68	10.88	7.30	348.40	
P2	448.00	3.50	6.00	6.08	18.48	10.78	7.20	16.16	9.62	6.04	1559.05	
P3	500.00	3.50	6.00	6.08	15.96	9.52	5.94	23.76	13.42	9.84	2241.44	
P4	289.00	3.50	6.00	6.08	23.56	13.32	9.74	16.04	9.56	5.98	1286.28	
P5	277.00	3.50	6.00	6.08	15.84	9.46	5.88	7.84	5.46	1.88	591.73	Sewer Too Shallow
P6	13.00	3.50	6.00	6.08	7.84	5.46	1.88	7.50	5.29	1.71	16.05	Sewer Too Shallow

Total earth volume for sewer trenches = 6043 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
    - Four inches for pipes less than 33 inches.
    - Six inches for pipes less than 60 inches.
    - Eight inches for all larger sizes.

Mainline System Input Summary – 100-Year Event

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in): 1.00
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 1.83

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6845.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

P1	6845.34	39.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P2	6850.00	39.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P3	6860.40	39.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P4	6860.40	39.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P5	6860.00	39.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P6	6860.00	39.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	8.47	4.60	0.17	39.00	
P1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.00	
P2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.00	
P3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.00	
P4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.00	
P5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.00	
P6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.00	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
P1	80.00	6833.73	1.9	6835.25	0.012	0.03	0.25	CIRCULAR	30.00 in	30.00 in
P2	448.00	6835.35	1.3	6841.17	0.012	0.38	0.00	CIRCULAR	30.00 in	30.00 in
P3	500.00	6841.27	1.3	6847.77	0.012	0.05	0.00	CIRCULAR	30.00 in	30.00 in
P4	289.00	6847.87	1.3	6851.63	0.013	0.38	0.00	CIRCULAR	30.00 in	30.00 in
P5	277.00	6851.73	1.3	6855.33	0.012	0.38	0.00	CIRCULAR	30.00 in	30.00 in
P6	13.00	6855.33	1.3	6855.50	0.012	0.38	0.00	CIRCULAR	30.00 in	30.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
P1	61.41	12.51	25.28	8.84	17.36	13.25	2.14	Supercritical	39.00	0.00	
P2	50.80	10.35	25.28	8.84	19.70	11.41	1.68	Supercritical	39.00	0.00	
P3	50.80	10.35	25.28	8.84	19.70	11.41	1.68	Supercritical	39.00	0.00	
P4	46.89	9.55	25.28	8.84	20.89	10.69	1.49	Supercritical Jump	39.00	27.00	
P5	50.80	10.35	25.28	8.84	19.70	11.41	1.68	Supercritical	39.00	0.00	

P6	50.80	10.35	25.28	8.84	19.70	11.41	1.68	Pressurized	39.00	13.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
P1	39.00	CIRCULAR	30.00 in	30.00 in	27.00 in	27.00 in	30.00 in	30.00 in	4.91	
P2	39.00	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
P3	39.00	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
P4	39.00	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
P5	39.00	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
P6	39.00	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 1.83

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
P1	6833.73	6835.25	0.00	0.00	6835.18	6837.36	6837.90	0.67	6838.57
P2	6835.35	6841.17	0.37	0.00	6837.73	6843.28	6839.01	5.48	6844.49
P3	6841.27	6847.77	0.05	0.00	6843.33	6849.88	6844.93	6.16	6851.09
P4	6847.87	6851.63	0.37	0.00	6850.48	6853.74	6851.46	3.49	6854.95
P5	6851.73	6855.33	0.37	0.00	6854.11	6857.44	6855.39	3.26	6858.65
P6	6855.33	6855.50	0.37	0.00	6858.04	6858.14	6859.02	0.10	6859.12

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
P1	80.00	3.50	6.00	6.08	21.04	12.06	8.48	18.68	10.88	7.30	348.39	
P2	448.00	3.50	6.00	6.08	18.49	10.79	7.20	16.16	9.62	6.04	1559.69	
P3	500.00	3.50	6.00	6.08	15.96	9.52	5.94	23.76	13.42	9.84	2241.44	
P4	289.00	3.50	6.00	6.08	23.55	13.32	9.74	16.04	9.56	5.98	1285.94	

P5	277.00	3.50	6.00	6.08	15.84	9.46	5.88	7.84	5.46	1.88	591.80	Sewer Too Shallow
P6	13.00	3.50	6.00	6.08	7.84	5.46	1.88	7.50	5.29	1.71	16.05	Sewer Too Shallow

Total earth volume for sewer trenches = 6043 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
    - Four inches for pipes less than 33 inches.
    - Six inches for pipes less than 60 inches.
    - Eight inches for all larger sizes.

System Input Summary 24" HDPE – 5-Year Event

Rainfall Parameters

Rainfall Return Period: 5
Rainfall Calculation Method: Formula

One Hour Depth (in): 1.00
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 4.19

Manhole Input Summary:

	Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6849.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P10	6849.00	11.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P11	6848.00	11.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	2.42	4.64	0.08	11.20	
P10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.20	
P11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.20	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)

P10	17.00	6835.41	5.2	6836.29	0.012	0.03	0.00	CIRCULAR	24.00 in	24.00 in
P11	113.00	6836.29	5.2	6842.14	0.012	0.38	0.00	CIRCULAR	24.00 in	24.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	**Flow (cfs)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Depth (in)**	**Velocity (fps)**	**Froude Number**	**Flow Condition**	**Flow (cfs)**	**Surcharged Length (ft)**	**Comment**
P10	55.91	17.80	14.41	5.69	7.29	13.90	3.70	Supercritical	11.20	0.00	
P11	55.91	17.80	14.41	5.69	7.28	13.90	3.70	Supercritical Jump	11.20	12.18	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	**Peak Flow (cfs)**	**Cross Section**	**Rise**	**Span**	**Rise**	**Span**	**Rise**	**Span**	**Area (ft^2)**	**Comment**
P10	11.20	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
P11	11.20	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.

- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 4.19

	Invert Elev.		**Downstream Manhole Losses**		**HGL**		**EGL**		
Element Name	**Downstream (ft)**	**Upstream (ft)**	**Bend Loss (ft)**	**Lateral Loss (ft)**	**Downstream (ft)**	**Upstream (ft)**	**Downstream (ft)**	**Friction Loss (ft)**	**Upstream (ft)**
P10	6835.41	6836.29	0.00	0.00	6836.02	6838.82	6839.02	0.00	6839.02
P11	6836.29	6842.14	0.07	0.00	6838.90	6843.34	6839.09	4.75	6843.84

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			**Upstream**				
Element Name	**Length (ft)**	**Wall (in)**	**Bedding (in)**	**Bottom Width (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Top Width (ft)**	**Trench Depth (ft)**	**Cover (ft)**	**Volume (cu. yd)**	**Comment**
P10	17.00	3.00	4.00	5.50	26.18	14.17	11.34	24.42	13.29	10.46	109.39	

P11	113.0 0	3.00	4.00	5.50	24.42	13.29	10.4 6	10.72	6.44	3.61	428.68	

Total earth volume for sewer trenches = 538 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
    - Four inches for pipes less than 33 inches.
    - Six inches for pipes less than 60 inches.
    - Eight inches for all larger sizes.

System Input Summary 24” HDPE – 100-Year Event

Rainfall Parameters

Rainfall Return Period: 100
Rainfall Calculation Method: Formula

One Hour Depth (in): 1.00
Rainfall Constant "A": 28.5
Rainfall Constant "B": 10
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20
Maximum Rural Overland Len. (ft): 500
Maximum Urban Overland Len. (ft): 300
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00
Maximum Depth to Rise Ratio: 0.90
Maximum Flow Velocity (fps): 18.0
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6.09

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6849.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

P10	6849.00	27.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P11	6848.00	27.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	**Overland Time (min)**	**Gutter Time (min)**	**Basin Tc (min)**	**Intensity (in/hr)**	**Local Contrib (cfs)**	**Coeff. Area**	**Intensity (in/hr)**	**Manhole Tc (min)**	**Peak Flow (cfs)**	**Comment**
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	5.82	4.65	0.03	27.10	
P10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.10	
P11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.10	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	**Sewer Length (ft)**	**Downstream Invert (ft)**	**Slope (%)**	**Upstream Invert (ft)**	**Mannings n**	**Bend Loss**	**Lateral Loss**	**Cross Section**	**Rise (ft or in)**	**Span (ft or in)**
P10	17.00	6835.41	5.2	6836.29	0.012	0.03	0.00	CIRCULAR	24.00 in	24.00 in
P11	113.00	6836.29	5.2	6842.14	0.012	0.38	0.00	CIRCULAR	24.00 in	24.00 in

Sewer Flow Summary:

	Full Flow Capacity	Critical Flow	Normal Flow	

Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
P10	56.04	17.84	21.72	9.06	11.77	17.69	3.56	Supercritical	27.10	0.00	
P11	55.91	17.80	21.72	9.06	11.78	17.66	3.55	Supercritical Jump	27.10	9.32	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
P10	27.10	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	
P11	27.10	CIRCULAR	24.00 in	24.00 in	21.00 in	21.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics where calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6.09

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
P10	6835.41	6836.29	0.00	0.00	6836.72	6838.10	6839.10	0.28	6839.38
P11	6836.29	6842.14	0.44	0.00	6838.66	6843.95	6839.81	5.41	6845.23

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K * V_fi ^ 2/(2*g)
- Lateral loss = V_fo ^ 2/(2*g)- Junction Loss K * V_fi ^ 2/(2*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

The trench side slope is 1.0 ft/ft
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
P10	17.00	3.00	4.00	5.50	26.19	14.18	11.34	24.42	13.29	10.46	109.42	
P11	113.00	3.00	4.00	5.50	24.42	13.29	10.46	10.72	6.44	3.61	428.68	

Total earth volume for sewer trenches = 538 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:

- Four inches for pipes less than 33 inches.
- Six inches for pipes less than 60 inches.
- Eight inches for all larger sizes.

8.1 Riprap Sizing

Procedures for sizing rock to be used in soil riprap, void-filled riprap, and riprap over bedding are the same.

8.1.1 Mild Slope Conditions

When subcritical flow conditions occur and/or slopes are mild (less than 2 percent), UDFCD recommends the following equation (Hughes, et al, 1983):

For $Q_{100} = 67.4$ cfs

$$d_{50} \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}} \right]^2 \qquad \text{Equation 8-11}$$

Where:

V = mean channel velocity (ft/sec) = 2.381 ft/s

S = longitudinal channel slope (ft/ft) = 0.003 ft/ft

d_{50} = mean rock size (ft) = 0.023 ft → Use D_{50} = 12"

Gs = specific gravity of stone (minimum = 2.50, typically 2.5 to 2.7), Note: In this equation (Gs -1) considers the buoyancy of the water, in that the specific gravity of water is subtracted from the specific gravity of the rock.

Note that Equation 8-11 is applicable for sizing riprap for channel lining with a longitudinal slope of no more than 2%. This equation is not intended for use in sizing riprap for steep slopes (typically in excess of 2 percent), rundowns, or protection downstream of culverts. Information on rundowns is provided in Section 7.0 of the *Hydraulic Structures* chapter of the USDCM, and protection downstream of culverts is discussed in the *Culverts and Bridges* chapter. For channel slopes greater than 2% use one of the methods presented in 8.1.2.

Rock size does not need to be increased for steeper channel side slopes, provided the side slopes are no steeper than 2.5H:1V (UDFCD 1982). Channel side slopes steeper than 2.5H:1V are not recommended because of stability, safety, and maintenance considerations. See Figure 8-34 for riprap placement specifications. At the upstream and downstream termination of a riprap lining, the thickness should be increased 50% for at least 3 feet to prevent undercutting.

8.1.2 Steep Slope Conditions

Steep slope rock sizing equations are used for applications where the slope is greater than 2 percent and/or flows are in the supercritical flow regime. The following rock sizing equations may be referred to for riprap design analysis on steep slopes:

- CSU Equation, *Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase II* (prepared by S.R. Abt, et al, Colorado State University, 1988). This method was developed for steep slopes from 2 to 20 percent.

- USDA- Agricultural Research Service Equations, *Design of Rock Chutes* (by K.M. Robinson, et al, USDA- ARS, 1998 Transactions of ASAE) and *An Excel Program to Design Rock Chutes for Grade*

Roughness of Cobble (Rock) Channels and Riprap Areas
There are multiple methods available for determining Manning's n values for cobble/rock lined channels and significant areas of riprap. Two relationships are shown below; it is the responsibility of the designer to evaluate the methods available and determine the approach most appropriate for the specific project conditions.

Determination of Roughness Coefficients for Streams in Colorado (Jarrett 1985)

$$n = 0.39S^{0.38}R^{-0.16}$$ Equation 8-8

Where:

S = channel slope (ft/ft) = 0.003 ft/ft

R = hydraulic radius (ft) = 1.313

→ n = 0.041

The Manning's roughness coefficient, n, for a void-filled or soil riprap-lined channel may be estimated using:

$$n = 0.0395D_{50}^{1/6}$$ Equation 8-9

Where:

D_{50} = mean stone size (feet)

This equation is appropriate for computing channel capacity and associated flow depth, but when soil riprap is vegetated, velocity and shear computations should be based on the roughness provided by the vegetation and not the riprap.

This equation does not apply to grouted boulders or to very shallow flow (where hydraulic radius is less than, or equal to 2.0 times the maximum rock size). In those cases the roughness coefficient will be greater than indicated by this equation. The *Hydraulic Structures* chapter covers grouted boulder applications in detail.

7.2.4 Design Storms

HEC-RAS refers to design storms as "profiles" and allows a designer to add multiple profiles. Boundary conditions are defined for each profile and options consist of known water surface elevation, critical depth, normal depth or rating curve.

It is recommended that the designer evaluate multiple return periods (profiles) when evaluating a stream reach. These may include the "bankfull" event, 2-year, 5-year, 10-year, 100-year, and perhaps larger events. The 2 through 10-year profiles are important when a shared-use path is planned adjacent to the stream to ensure proper elevation of the past. See the *Stream Access and Recreational Channels* chapter for criteria regarding trails including low-flow crossings.

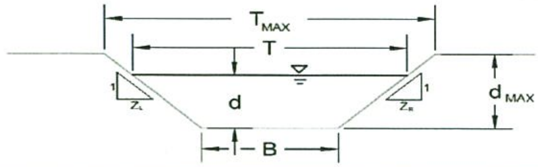
Evaluation of multiple design storms allows the designer to see variations in flow patterns for different storm events and the resulting velocities, flow depths, etc. In some cases it may be appropriate to modify Manning's n values based on the flow depth at a specific design storm to more accurately depict the flow conditions.

Version 4.05 Released March 2017

AREA INLET IN A SWALE

Enter Your Project Name Here

Inlet 1



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E	D	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0140	ft/ft
Bottom Width	B =	4.00	ft
Left Side Slope	Z1 =	10.00	ft/ft
Right Side Slope	Z2 =	10.00	ft/ft

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

Choose One:
- ◯ Non-Cohesive
- ◉ Cohesive
- ◯ Paved

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	30.00	30.00	feet
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	1.00	1.00	feet

Allowable Channel Capacity Based On Channel Geometry		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	33.0	33.0	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	1.00	1.00	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	11.2	27.1	cfs
Water Depth	d =	0.72	0.94	feet

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'

Version 4.05 Released March 2017

AREA INLET IN A SWALE

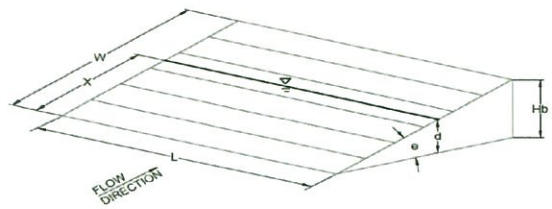
Enter Your Project Name Here

Inlet 1

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)	θ =	0.00	degrees
Width of Grate	W =	3.00	feet
Length of Grate	L =	6.00	feet
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	feet
Clogging Factor	C_f =	0.38	
Grate Discharge Coefficient	C_d =	0.78	
Orifice Coefficient	C_o =	0.52	
Weir Coefficient	C_w =	1.67	



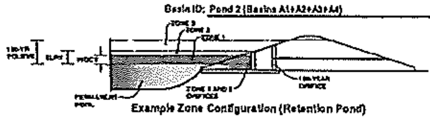
		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.72	0.94	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**18.1**	**27.1**	**cfs**
	Bypassed Flow, Q_b =	**0.0**	**0.0**	cfs
	Capture Percentage = Q_a/Q_o = C%	**100**	**100**	%

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Judge Orr Road RV Park and Storage

Basin ID: Pond 2 (Basins A1+A2+A3+A4)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB			
Watershed Area =	29.65	acres		
Watershed Length =	1,600	ft		
Watershed Slope =	0.018	ft/ft		
Watershed Imperviousness =	44.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	Denver - Capitol Building			
Water Quality Capture Volume (WQCV) =	0.470	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	1.380	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	1.009	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.517	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.109	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	3.067	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.720	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	4.676	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.01 in.) =	6.054	acre-feet	3.01	inches
Approximate 2-yr Detention Volume =	1.026	acre-feet		
Approximate 5-yr Detention Volume =	1.424	acre-feet		
Approximate 10-yr Detention Volume =	1.927	acre-feet		
Approximate 25-yr Detention Volume =	2.133	acre-feet		
Approximate 50-yr Detention Volume =	2.235	acre-feet		
Approximate 100-yr Detention Volume =	2.532	acre-feet		

Stage-Storage Calculation

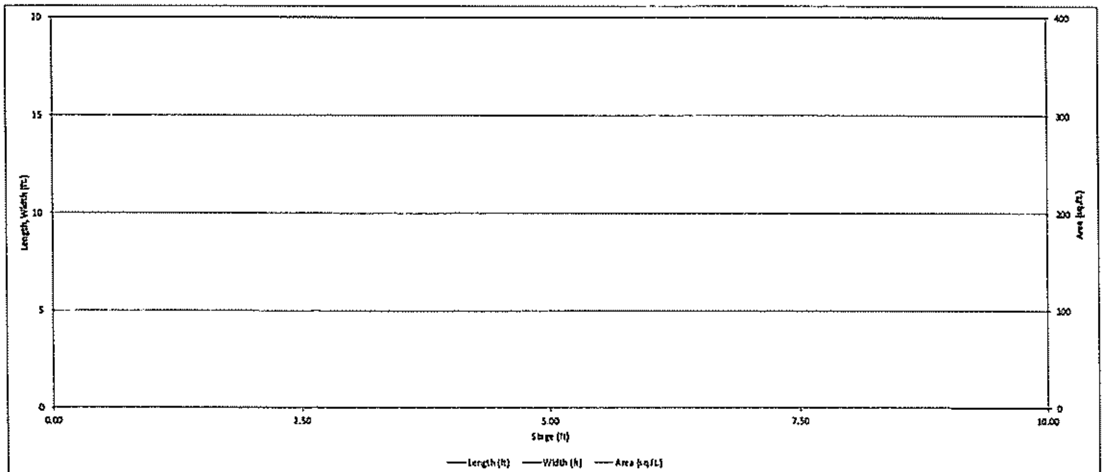
Zone 1 Volume (WQCV) =	0.470	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.910	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.152	acre-feet
Total Detention Basin Volume =	2.532	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

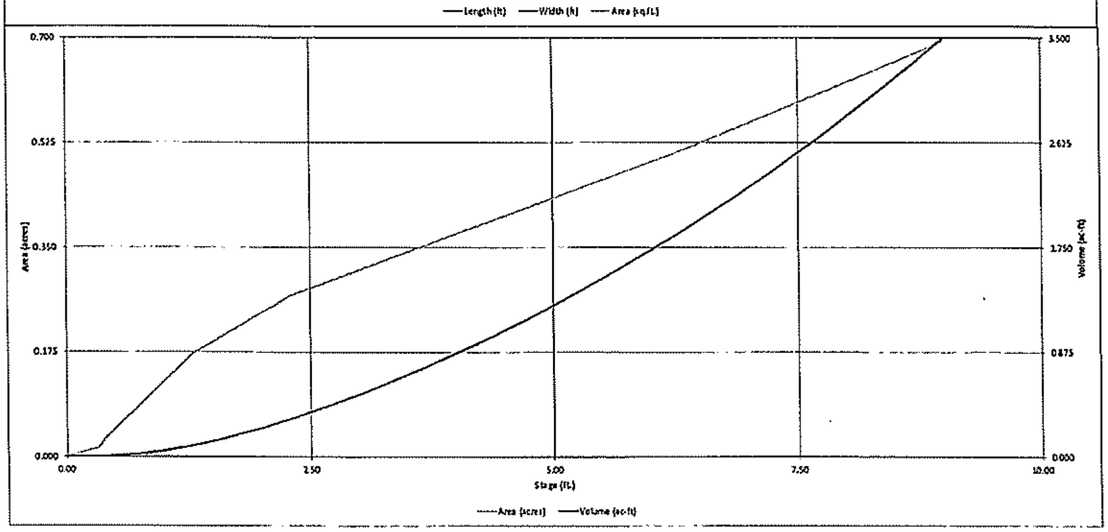
Depth Increment = 0.1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	30	0.001		
	--	0.33	--	--	--	638	0.015	104	0.002
	--	0.40	--	--	--	1,327	0.030	166	0.004
	--	0.50	--	--	--	2,016	0.046	326	0.007
	--	0.60	--	--	--	2,705	0.062	555	0.013
	--	0.70	--	--	--	3,394	0.078	853	0.020
	--	0.80	--	--	--	4,082	0.094	1,220	0.028
	--	0.90	--	--	--	4,771	0.110	1,658	0.038
	--	1.00	--	--	--	5,460	0.125	2,161	0.050
	--	1.10	--	--	--	6,149	0.141	2,734	0.063
	--	1.20	--	--	--	6,838	0.157	3,377	0.078
	--	1.30	--	--	--	7,528	0.173	4,088	0.094
	--	1.40	--	--	--	7,945	0.182	4,857	0.112
	--	1.50	--	--	--	8,364	0.192	5,669	0.130
	--	1.60	--	--	--	8,783	0.202	6,522	0.150
	--	1.70	--	--	--	9,202	0.211	7,417	0.170
	--	1.80	--	--	--	9,621	0.221	8,354	0.192
	--	1.90	--	--	--	10,040	0.230	9,333	0.214
	--	2.00	--	--	--	10,459	0.240	10,353	0.238
	--	2.10	--	--	--	10,878	0.250	11,625	0.265
	--	2.20	--	--	--	11,297	0.259	12,633	0.290
	--	2.30	--	--	--	11,716	0.269	13,784	0.316
	--	2.40	--	--	--	11,978	0.275	14,969	0.344
	--	2.50	--	--	--	12,241	0.281	16,180	0.371
	--	2.60	--	--	--	12,503	0.287	17,417	0.400
	--	2.70	--	--	--	12,766	0.293	18,680	0.429
	--	2.80	--	--	--	13,028	0.299	19,970	0.458
	--	2.90	--	--	--	13,291	0.305	21,286	0.489
	--	3.00	--	--	--	13,553	0.311	22,628	0.519
	--	3.10	--	--	--	13,816	0.317	23,997	0.551
	--	3.20	--	--	--	14,078	0.323	25,391	0.583
	--	3.30	--	--	--	14,341	0.329	26,812	0.616
	--	3.40	--	--	--	14,603	0.335	28,259	0.649
	--	3.50	--	--	--	14,866	0.341	29,733	0.683
	--	3.60	--	--	--	15,128	0.347	31,233	0.717
	--	3.70	--	--	--	15,391	0.353	32,759	0.752
	--	3.80	--	--	--	15,653	0.359	34,311	0.788
	--	3.90	--	--	--	15,916	0.365	35,889	0.824
	--	4.00	--	--	--	16,178	0.371	37,494	0.861
	--	4.10	--	--	--	16,441	0.377	39,125	0.898
	--	4.20	--	--	--	16,703	0.383	40,782	0.936
	--	4.30	--	--	--	16,966	0.389	42,466	0.975
	--	4.40	--	--	--	17,228	0.396	44,175	1.014
	--	4.50	--	--	--	17,491	0.402	45,911	1.054
	--	4.60	--	--	--	17,753	0.408	47,673	1.094
	--	4.70	--	--	--	18,016	0.414	49,462	1.135
	--	4.80	--	--	--	18,278	0.420	51,277	1.177
	--	4.90	--	--	--	18,541	0.426	53,117	1.219
	--	5.00	--	--	--	18,803	0.432	54,985	1.262
	--	5.10	--	--	--	19,066	0.438	56,878	1.306
	--	5.20	--	--	--	19,328	0.444	58,798	1.350
	--	5.30	--	--	--	19,591	0.450	60,744	1.394
	--	5.40	--	--	--	19,853	0.456	62,716	1.440
	--	5.50	--	--	--	20,116	0.462	64,714	1.486
	--	5.60	--	--	--	20,378	0.468	66,739	1.532
	--	5.70	--	--	--	20,641	0.474	68,790	1.579
	--	5.80	--	--	--	20,903	0.480	70,867	1.627
	--	5.90	--	--	--	21,166	0.486	72,971	1.675
	--	6.00	--	--	--	21,428	0.492	75,100	1.724
	--	6.10	--	--	--	21,691	0.498	77,256	1.774
	--	6.20	--	--	--	21,953	0.504	79,439	1.824
	--	6.30	--	--	--	22,216	0.510	81,647	1.874
	--	6.40	--	--	--	22,511	0.517	83,883	1.926
	--	6.50	--	--	--	22,806	0.524	86,149	1.978
	--	6.60	--	--	--	23,101	0.530	88,445	2.030
	--	6.70	--	--	--	23,396	0.537	90,769	2.084
	--	6.80	--	--	--	23,691	0.544	93,124	2.138
	--	6.90	--	--	--	23,986	0.551	95,508	2.193
	--	7.00	--	--	--	24,281	0.557	97,921	2.248
	--	7.10	--	--	--	24,576	0.564	100,364	2.304
	--	7.20	--	--	--	24,871	0.571	102,836	2.361
	--	7.30	--	--	--	25,166	0.578	105,338	2.418
	--	7.40	--	--	--	25,461	0.585	107,869	2.476
	--	7.50	--	--	--	25,757	0.591	110,430	2.535
	--	7.60	--	--	--	26,052	0.598	113,021	2.595
	--	7.70	--	--	--	26,347	0.605	115,641	2.655
	--	7.80	--	--	--	26,642	0.612	118,290	2.716
	--	7.90	--	--	--	26,937	0.618	120,969	2.777
	--	8.00	--	--	--	27,232	0.625	123,678	2.839
	--	8.10	--	--	--	27,527	0.632	126,416	2.902
	--	8.20	--	--	--	27,822	0.639	129,183	2.966
	--	8.30	--	--	--	28,117	0.645	131,980	3.030
	--	8.40	--	--	--	28,421	0.652	134,807	3.095
	--	8.50	--	--	--	28,726	0.659	137,664	3.160
	--	8.60	--	--	--	29,030	0.666	140,552	3.227
	--	8.70	--	--	--	29,335	0.673	143,470	3.294
	--	8.80	--	--	--	29,639	0.680	146,419	3.361
	--	8.90	--	--	--	29,944	0.687	149,398	3.430
	--	9.00	--	--	--	30,248	0.694	152,408	3.499
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)





Update the Basin ID to match the Detention Basin Stage-Storage Table Builder worksheet.

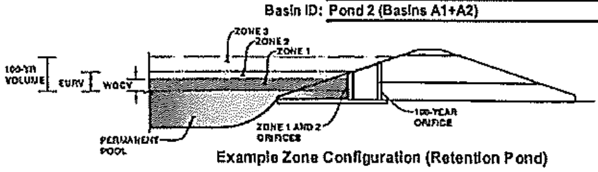
Unresolved. See title in pg 29 of 43

Detention Basin Outlet Structure

UD-Detention, Version 3.07 (February 20

Project: Judge Orr Road RV Park and Storage

Basin ID: Pond 2 (Basins A1+A2)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.84	0.470	Orifice Plate
Zone 2 (EURV)	5.27	0.910	Orifice Plate
Zone 3 (100-year)	7.50	1.152	Weir&Pipe (Restrict)
		2.532	Total

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.96	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	23.80	inches
Orifice Plate: Orifice Area per Row =	2.92	sq. inches (diameter = 1-15/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	2.028E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.99	3.97					
Orifice Area (sq. inches)	2.92	2.92	2.92					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.95	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	5.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	7.20	N/A	feet
Over Flow Weir Slope Length =	5.15	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.83	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	18.04	N/A	ft^2
Overflow Grate Open Area w/ Debris =	9.02	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	36.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	14.40		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.64	N/A	ft^2
Outlet Orifice Centroid =	0.70	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.37	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	7.70	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	40.00	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.69	feet
Stage at Top of Freeboard =	9.39	feet
Basin Area at Top of Freeboard =	0.69	acres

Routed Hydrograph Results

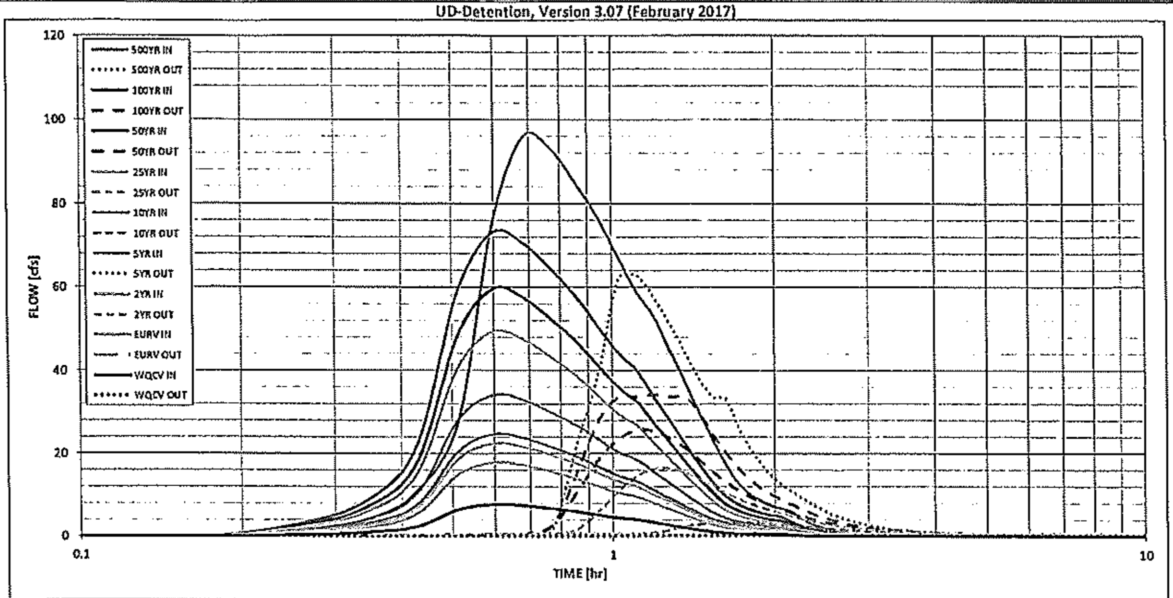
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.01
Calculated Runoff Volume (acre-ft) =	0.470	1.380	1.099	1.517	2.109	3.067	3.720	4.576	6.054
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.476	1.400	1.114	1.538	2.137	3.109	3.770	4.638	6.136
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.20	0.65	0.91	1.22	1.73
Predevelopment Peak Q (cfs) =	0.0	0.0	0.4	0.6	5.9	19.4	26.8	36.1	51.2
Peak Inflow Q (cfs) =	7.7	22.4	17.9	24.6	34.0	49.3	59.6	73.0	95.9
Peak Outflow Q (cfs) =	0.2	0.5	0.4	0.5	3.3	16.3	25.6	34.1	62.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.9	0.6	0.8	1.0	0.9	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.9	1.4	1.8	1.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	65	59	68	72	69	67	65	60
Time to Drain 99% of Inflow Volume (hours) =	40	69	62	72	78	77	76	75	73
Maximum Ponding Depth (ft) =	2.74	5.14	4.49	5.44	6.35	7.03	7.33	7.72	8.07
Area at Maximum Ponding Depth (acres) =	0.29	0.44	0.40	0.46	0.51	0.56	0.58	0.61	0.63
Maximum Volume Stored (acre-ft) =	0.438	1.323	1.050	1.453	1.900	2.259	2.430	2.667	2.883

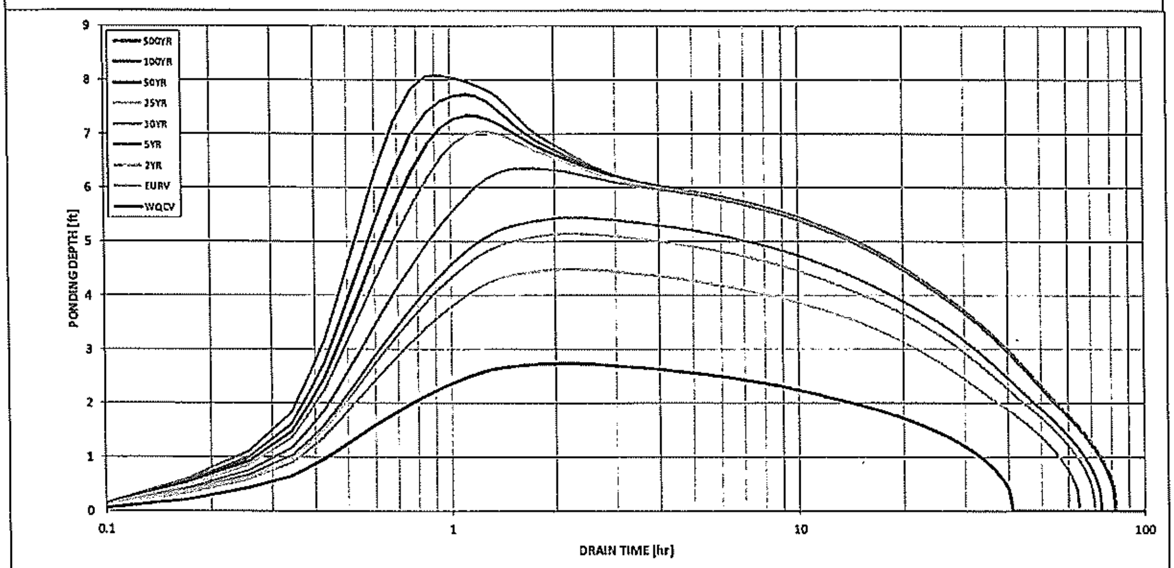
2. Revise design so the 100yr goes through the outlet pipe.

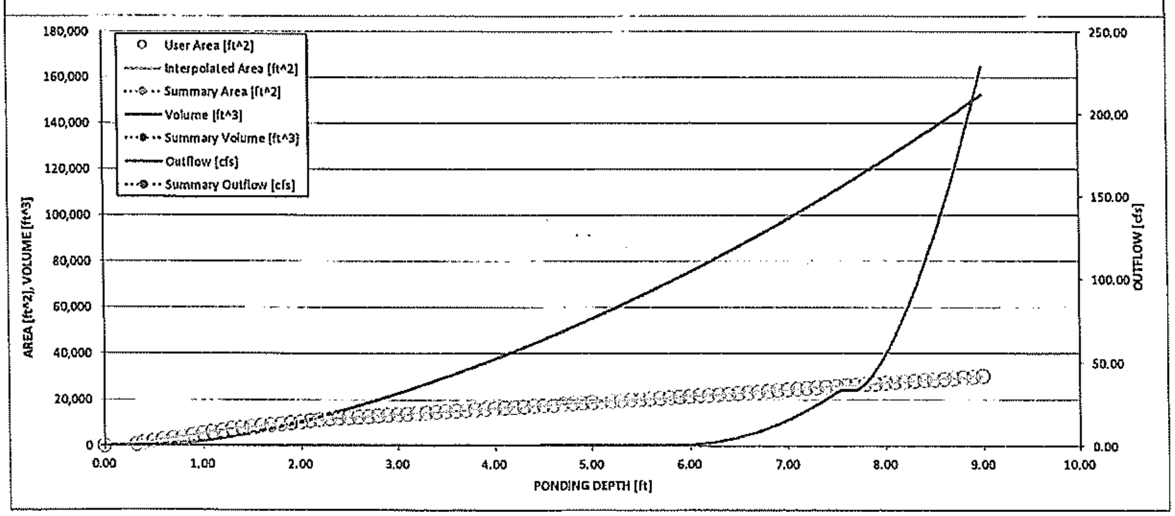
Unresolved. The 100yr is still discharging over the emergency spillway. Revise outlet structure design to provide capacity for the 100yr release rate.

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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: ______________________

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

User-Defined Time Interval	Hydrograph Constant
5.14 min	0.986

SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:05:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:10:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:15:25	0.34	0.97	0.78	1.07	1.46	2.08	2.49	3.00	3.82
0:20:34	0.93	2.65	2.12	2.90	3.99	5.74	6.90	8.38	10.83
0:25:42	2.38	6.80	5.44	7.45	10.26	14.73	17.71	21.51	27.81
0:30:50	6.53	18.67	14.96	20.45	28.15	40.42	48.57	58.95	76.18
0:35:59	7.72	22.41	17.89	24.59	34.04	49.25	59.55	72.96	95.90
0:41:07	7.36	21.43	17.10	23.52	32.60	47.25	57.22	70.31	92.93
0:46:16	6.70	19.51	15.57	21.41	29.67	43.00	52.07	64.08	84.90
0:51:24	5.98	17.49	13.94	19.20	26.65	38.69	46.90	57.74	76.54
0:56:32	5.15	15.17	12.07	16.67	23.18	33.76	40.99	50.54	67.14
1:01:41	4.49	13.19	10.50	14.48	20.15	29.42	35.77	44.14	58.70
1:06:49	4.07	11.96	9.52	13.13	18.26	26.61	32.31	39.82	52.84
1:11:58	3.35	9.94	7.90	10.93	15.23	22.25	27.06	33.41	44.49
1:17:06	2.72	8.17	6.48	8.99	12.57	18.40	22.40	27.70	36.94
1:22:14	2.09	6.37	5.03	7.02	9.86	14.52	17.72	21.98	29.44
1:27:23	1.55	4.82	3.79	5.32	7.52	11.16	13.67	17.00	22.85
1:32:31	1.12	3.51	2.75	3.89	5.54	8.28	10.19	12.72	17.18
1:37:40	0.87	2.69	2.11	2.97	4.20	6.24	7.65	9.52	12.81
1:42:48	0.72	2.20	1.73	2.42	3.42	5.04	6.16	7.65	10.24
1:47:56	0.61	1.86	1.47	2.05	2.88	4.25	5.19	6.43	8.60
1:53:05	0.54	1.63	1.28	1.79	2.52	3.70	4.52	5.59	7.46
1:58:13	0.48	1.46	1.16	1.61	2.26	3.32	4.04	5.00	6.66
2:03:22	0.45	1.34	1.06	1.48	2.07	3.04	3.70	4.58	6.09
2:08:30	0.33	0.99	0.78	1.09	1.53	2.25	2.75	3.42	4.59
2:13:38	0.24	0.72	0.57	0.80	1.11	1.64	2.00	2.47	3.32
2:18:47	0.18	0.53	0.42	0.58	0.82	1.21	1.47	1.83	2.46
2:23:55	0.13	0.39	0.31	0.43	0.61	0.90	1.10	1.36	1.83
2:29:04	0.09	0.28	0.22	0.31	0.44	0.65	0.80	1.00	1.34
2:34:12	0.07	0.20	0.16	0.22	0.31	0.47	0.58	0.72	0.97
2:39:20	0.05	0.15	0.11	0.16	0.23	0.34	0.42	0.52	0.70
2:44:29	0.03	0.10	0.08	0.11	0.16	0.24	0.29	0.36	0.49
2:49:37	0.02	0.06	0.05	0.07	0.10	0.15	0.19	0.24	0.32
2:54:46	0.01	0.03	0.02	0.04	0.05	0.08	0.11	0.14	0.19
2:59:54	0.00	0.01	0.01	0.01	0.02	0.04	0.05	0.06	0.09
3:05:02	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03
3:10:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:15:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:20:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:25:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:30:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:35:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:41:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:46:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:51:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:56:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:01:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:06:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:11:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:17:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:22:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:27:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:32:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:37:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:42:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:47:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:52:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:58:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:03:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:08:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:13:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:18:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:23:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:28:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:34:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:39:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:44:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:49:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:54:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:59:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:04:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:10:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

APPENDIX C

DETENTION POND

GEOTECHNICAL RECOMMENDATIONS

July 25, 2018

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

William Guman & Associates, Ltd.
731 North Weber Street, Suite 10
Colorado Springs, Colorado 80903

Attn: Bill Guman

Re: Detention Pond
Judge Orr RV Park and Storage
PCD File No. PPR-18-040
El Paso County, Colorado

Dear Mr. Guman:

The detention pond referenced above will be constructed within the Judge Orr RV Park and Storage property at the southeastern corner of the proposed facility, north of the intersection of Judge Orr Road and Cessna Drive. Two soil investigations have been conducted on the property in the vicinity of the detention pond; a Soil, Geology, Geologic Hazard, and Wastewater Study dated December 12, 2016, revised July 25, 2018, Job No. 160533 and a Tactile Test Pit Observation & Septic Design Letter dated August 16, 2017, Job No. 160533. The findings and development recommendations are reported under separate covers. This letter should be used in conjunction with our Soil, Geology, Geologic Hazard, and Wastewater Study and Tactile Test Pit Observation & Septic Design Letter. This document provides recommendations for constructing a detention pond based on our investigations, laboratory testing, and requirements specified in the El Paso County Engineering Criteria Manual and the El Paso County Drainage Criteria Manual.

The soils in the vicinity of the pond were recovered from test pits and a profile hole prepared nearby. The location of the test boring/pits and the test boring/pit logs are included in the Soil, Geology, Geologic Hazard, and Wastewater Study and Tactile Test Pit Observation & Septic Design Letter. The soils recovered north of the pond were described as fine to coarse grained clayey sand loam, fine to coarse grained sand loam, and sandy clay loam to depths of 8 to 10 feet. The soils south and west of the pond were described as fine to coarse grained clayey sand loam, fine to coarse grained sand loam, and sandy clay loam to depths of 5.5 to 6 feet with underlying sandy claystone. A test boring drilled west of the pond to a depth of 20-feet encountered clayey sand to a 9-foot depth overlying very clayey sandstone. Groundwater was not encountered in the test pits and encountered at a depth of 17-feet in the test boring.

Grading Plans were not finalized, however discussions pertaining to the pond indicate that the pond embankments will be less than 10-feet with significant cuts likely. Based on the existing site topography, cuts of 6 to 9 feet are likely exposing the underlying sandstone and claystone on the western and southern portions of the pond. Laboratory testing on a sample of sandstone obtained from the test boring determined the soil to contain between approximately 9 and 98 percent of the materials passing a No. 200 sieve (SC and CL) and the bedrock to contain 46.3 percent on one sample.

The detention pond design parameters and geometry shall conform to the requirements specified in the El Paso County Engineering Criteria Manual and the El Paso County Drainage Criteria Manual. Sandstone/Claystone will likely be exposed in the southern portion of the supporting the pond embankment based on the soil investigations referenced herein. The undisturbed sandstone/claystone will provide a soil bearing capacity of 3,500 psf, and soil mitigation will likely not be required. The embankment foundation shall be fully exposed and observed by personnel of Entech to determine mitigation requirements, if any, prior to constructing the embankment. Overexcavation of expansive material may be required for the outlet works which should be field determined. Groundwater is not expected at the proposed excavated depth depending on the time of year the pond is constructed. Seasonally perched groundwater is known to exist in the area and dewatering in conjunction with soil stabilization will likely be required if groundwater is encountered during construction.

The embankment soils shall be compacted to a minimum of 95 percent of the soils maximum dry density as determined by ASTM D-1557 at ±2 percent of the soils optimum moisture content. Periodic observation and density testing will be performed during construction. Based on the suggested compaction efforts for the embankment soils and the expected foundation soils, it is likely that embankment settlement will be less than 3 percent of the embankment height.

We trust this letter has provided you with the information required to construct the proposed detention pond. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

COLORADO REGISTERED
STANLEY CLARE CULP
36723
7/25/18
PROFESSIONAL ENGINEER

Stan C. Culp, P.E.
Senior Engineer

Reviewed By:

Joseph C. Goode, Jr., P.E.
President

SCC/sc
Entech Job No. 181205
F:\AA projects\2018\181205\180205 dp

APPENDIX D

DESIGN CHARTS

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

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

Figure 6-25. Estimate of Average Concentrated Shallow Flow

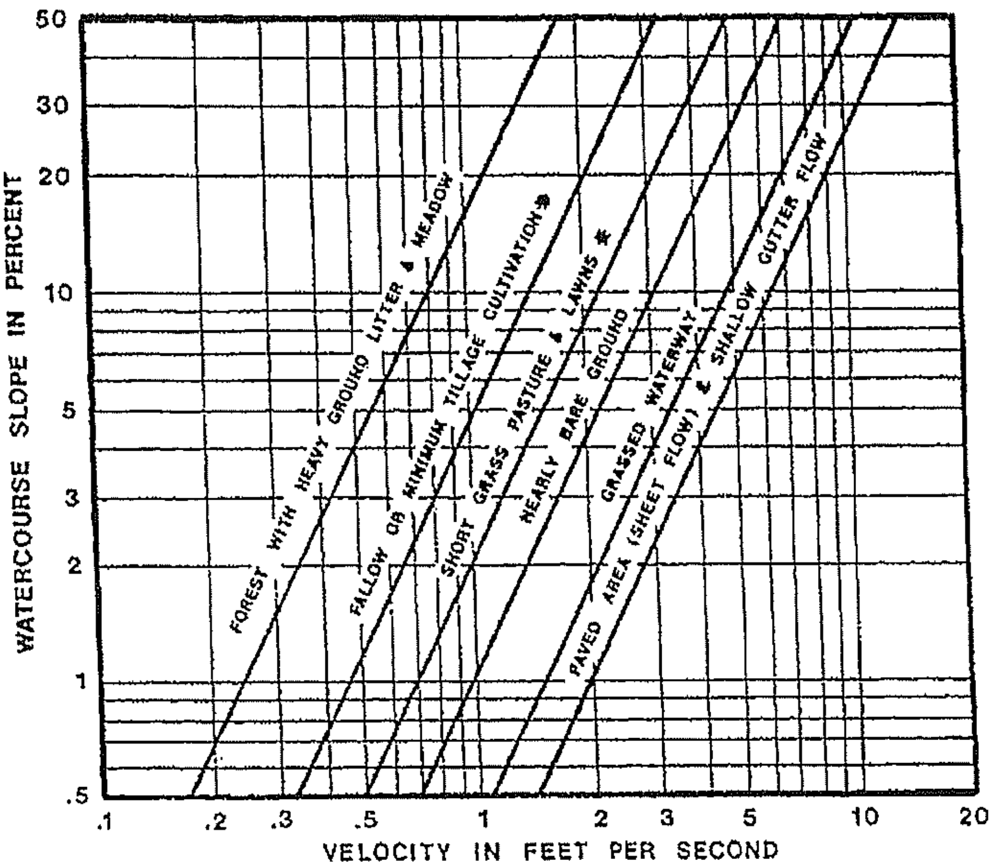
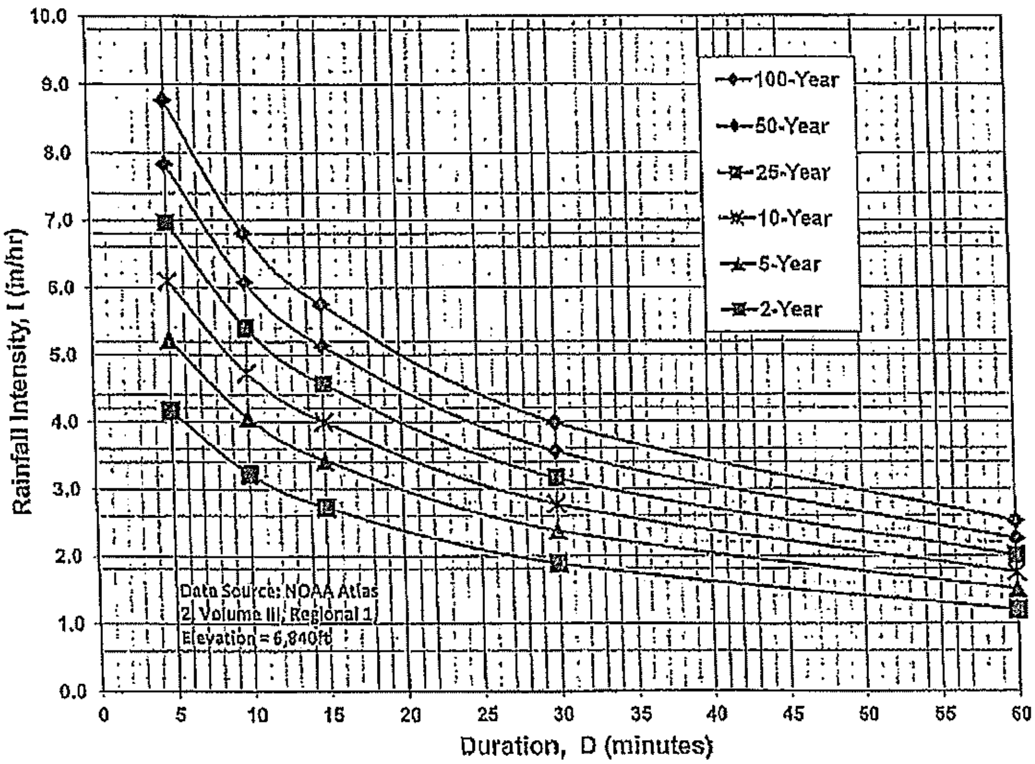


Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

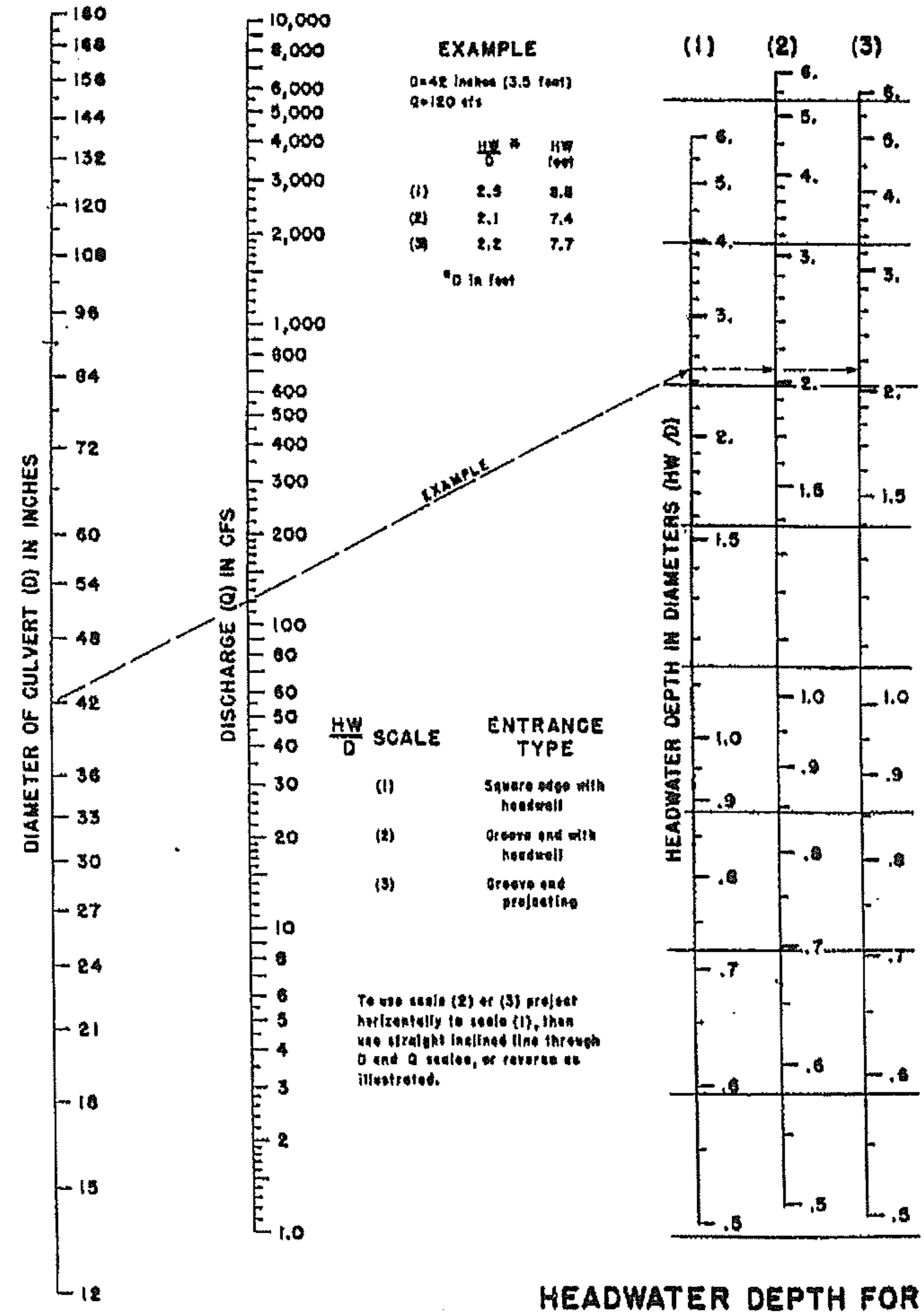
$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

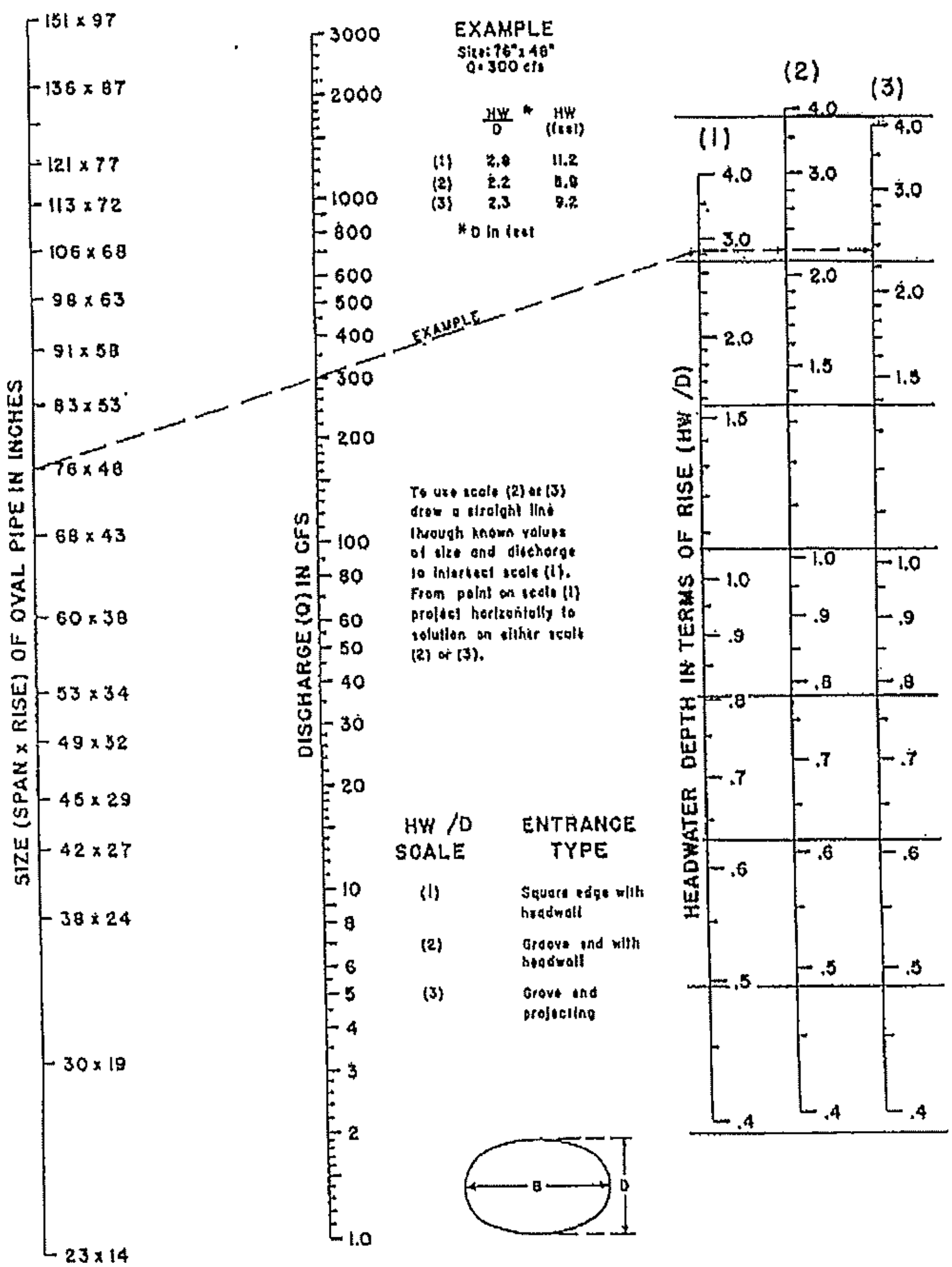
Note: Values calculated by equations may not precisely duplicate values read from figure.



BUREAU OF PUBLIC ROADS JAN. 1963

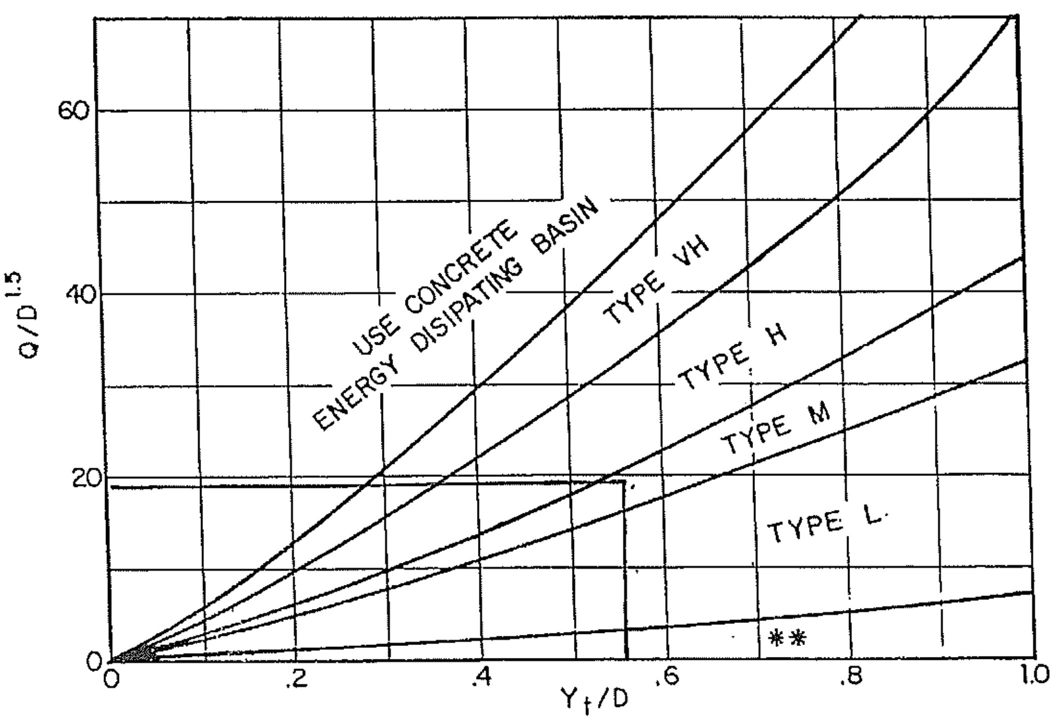
HEADWATER SCALES 2&3
REVISED MAY 1964

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL



HEADWATER DEPTH FOR OVAL CONCRETE PIPE CULVERTS LONG AXIS HORIZONTAL WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963



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

FIGURE 5-7. RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET.

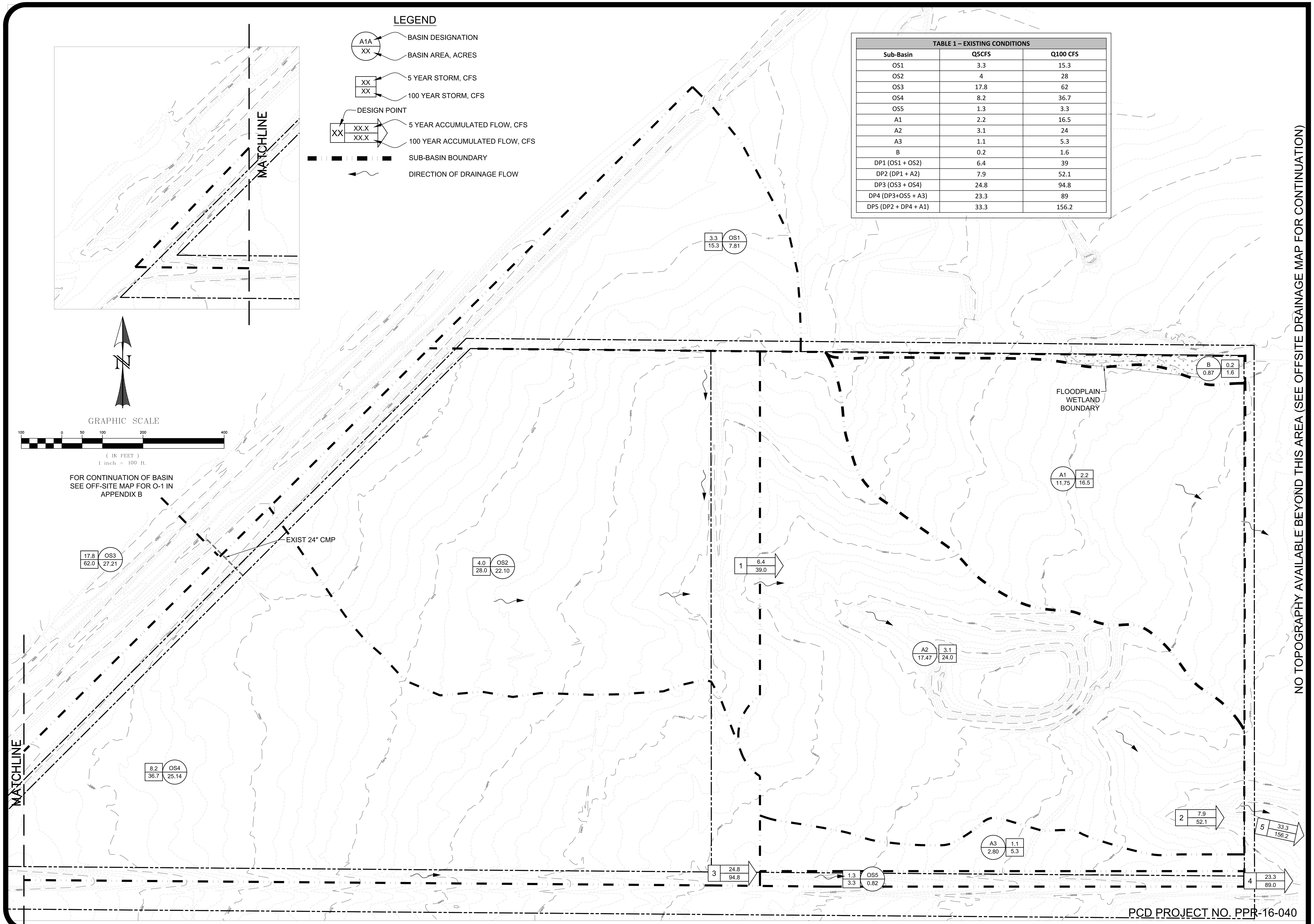


TABLE 1 – EXISTING CONDITIONS

Sub-Basin	Q5CFS	Q100 CFS
OS1	3.3	15.3
OS2	4	28
OS3	17.8	62
OS4	8.2	36.7
OS5	1.3	3.3
A1	2.2	16.5
A2	3.1	24
A3	1.1	5.3
B	0.2	1.6
DP1 (OS1 + OS2)	6.4	39
DP2 (DP1 + A2)	7.9	52.1
DP3 (OS3 + OS4)	24.8	94.8
DP4 (DP3+OS5 + A3)	23.3	89
DP5 (DP2 + DP4 + A1)	33.3	156.2

PCD PROJECT NO. PPR-16-040

M:\LAND PROJECTS\2016\160301-Judge Orr Road RV Park\DWG\160301-Existing Conditions.dwg Jim.Gill Tue, 06/18/19 2:08 PM

DATE: 8/20/18
DESIGNED BY MAB
JOB NO. 160301
PROJECT ENGINEER MAB
CAD FILE NO. 160301-Existing Conditions
PROJECT MANAGER MAB
DRAWN BY HJG
SCALE: HORZ. 1" = 100' VERT. N/A

PREPARED BY:

3520 Austin Bluffs Parkway
Suite 102
Colorado Springs, CO 80918
(719) 266-5212
fax: (719) 266-5341

NO.	DATE	REVISION	BY

JUDGE ORR ROAD RV PARK & STORAGE
COLORADO SPRINGS, COLORADO
DRAINAGE - EXIST OVERALL CONDITIONS

SHEET
1 of 3

TABLE 2 – PHASE I DEVELOPED CONDITIONS

Sub-Basin	Q5CFS	Q100 CFS
OS1	3.3	15.3
OS2	7.2	54.9
OS3	17.8	62
OS4	3.7	10.1
OS5	1	2.6
A1	12.3	26
A2A	5.7	12
A2B	2.4	4.8
A3	6.9	18
A4	11.8	30
A5	0.4	2.9
B	0.2	1.6
DP1 (OS1+OS2)	9.7	66.4
DPD1 (Existing DP1)	6.4	39
DP2 (A2A+A3)	11.2	27.1
DP3 (DP2+A1+A4)	29.6	70
DPD2 (Detained DP2)	0.5	34.1
DP4(DPD2+DPD1)	6.5	67.4
DP5 (OS3+OS4 Existing)	24.8	94.8
DP6 (A2B+A5+OS5+DP5)	22.8	87.5
DP7 (DP5+DP6)	28.9	150.6

DATE: 8/20/18
JOB NO. 160301
CAD FILE NO. 160301-Developed Conditions
DRAWN BY HJG
DESIGNED BY MAB
PROJECT ENGINEER MAB
PROJECT MANAGER
SCALE: HORZ. 1" = 100' VERT. N/A

PREPARED BY:

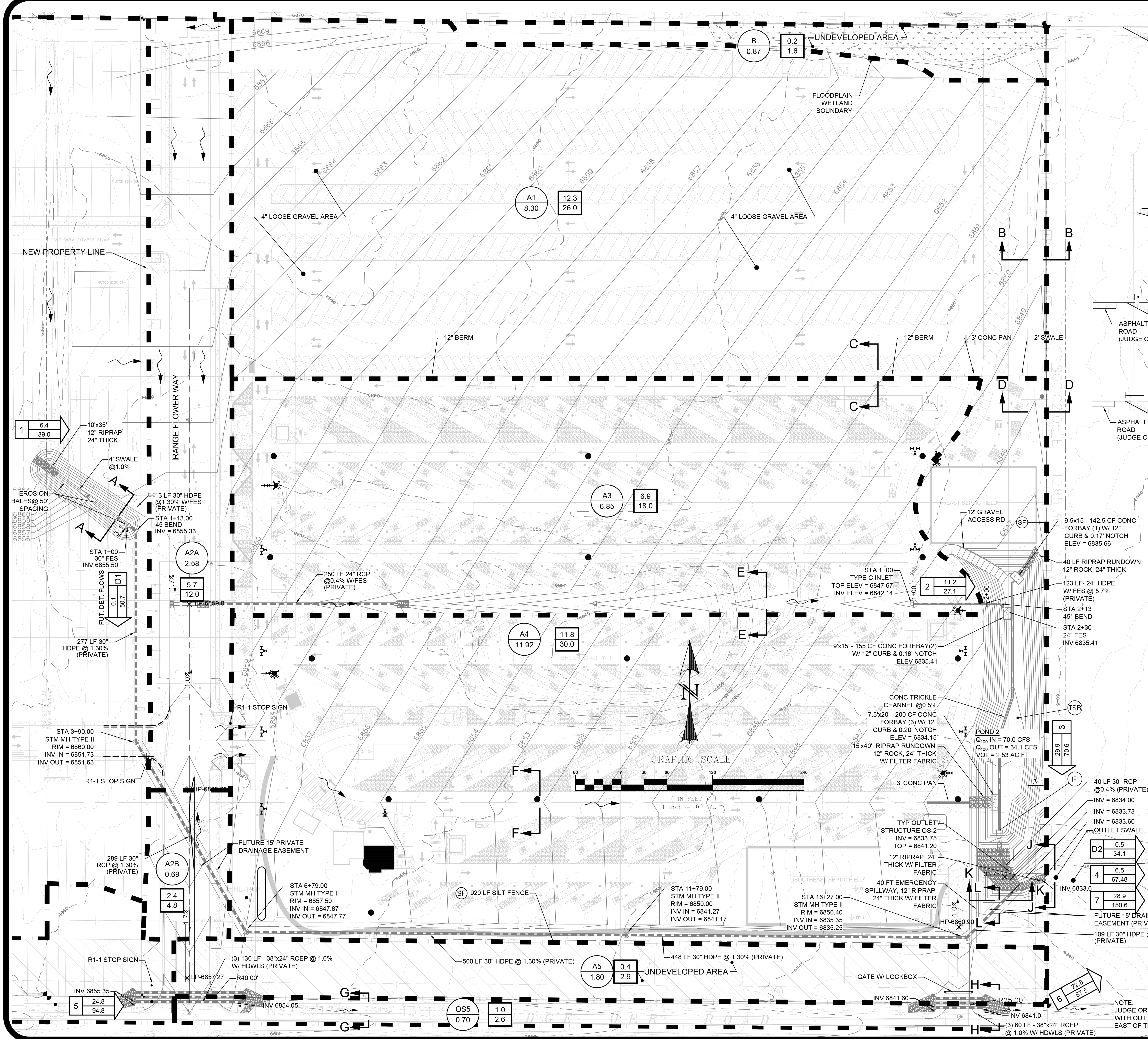
3520 Austin Bluffs Parkway
Suite 102
Colorado Springs, CO 80918
(719) 266-5212
fax: (719) 266-5341

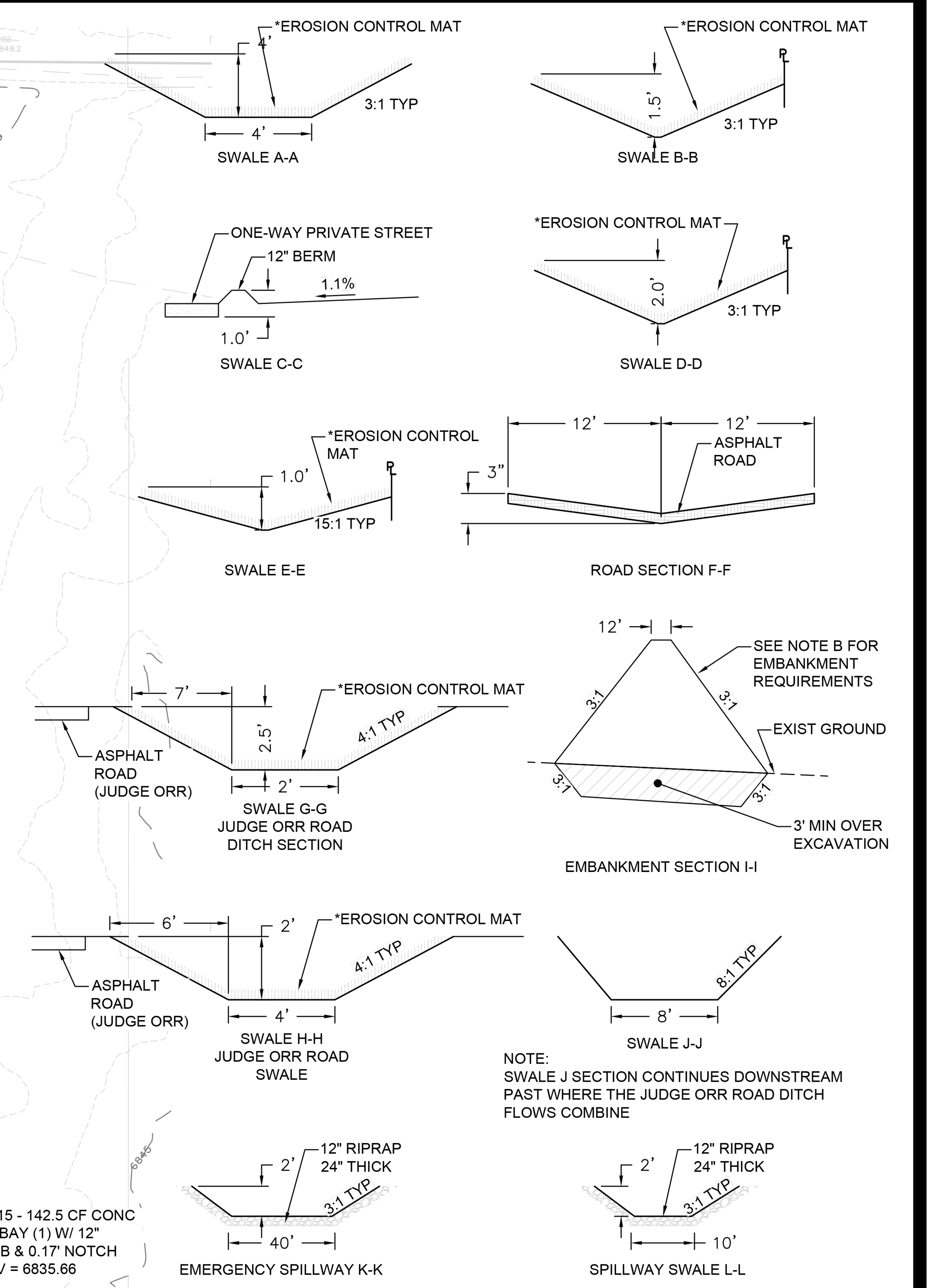
NO.	DATE	REVISION	BY

JUDGE ORR ROAD RV PARK & STORAGE

COLORADO SPRINGS, COLORADO

DRAINAGE - DEV OVERALL CONDITIONS





* EROSION CONTROL BLANKET SHALL BE 70% STRAW, 30% COCONUT BY WINTERS EXCELSIOR COMPANY OR EQUIVALENT

LEGEND

- A1A / XX — BASIN DESIGNATION; BASIN AREA, ACRES
- XX / XX — 5 YEAR STORM, CFS; 100 YEAR STORM, CFS
- DESIGN POINT XX — XX.X / XX.X — 5 YEAR ACCUMULATED FLOW, CFS; 100 YEAR ACCUMULATED FLOW, CFS
- SUB-BASIN BOUNDARY
- DIRECTION OF DRAINAGE FLOW

NOTES:

A. DETENTION POND AREA TO BE UTILIZED AS A SEDIMENTATION BASIN UNTIL EARTH MOVING IS COMPLETED AND THE GROUND STABILIZED AT WHICH TIME IT WILL BE CLEANED OUT, THE SEDIMENT BASIN OUTLET PIPE REMOVED AND THE DETENTION POND STRUCTURE OS2 ADDED. SEE SEDIMENT BASIN DETAIL SB ON SHEET 5 OF 7.

B. EMBANKMENT COMPACTION SHALL FOLLOW THE REQUIREMENTS OF THE GEOTECHNICAL LETTER FROM ENTECH ENGINEERING, INC. LOCATED IN APPENDIX C OF THE DRAINAGE REPORT.

PCD PROJECT NO. PPR-16-040

DESIGNED BY	MAB
PROJECT ENGINEER	MAB
PROJECT MANAGER	MAB
SCALE:	HORZ. 1" = 60'; VERT. N/A
DATE	02/05/19
JOB NO.	160301
CAD FILE NO.	160301-Dev Cond
DRAWN BY	HJG

PREPARED BY:

3520 Austin Bluffs Parkway
Suite 102
Colorado Springs, CO 80918
(719) 266-5212
fax: (719) 266-5341

NO.	DATE	REVISION	BY

JUDGE ORR ROAD RV PARK & STORAGE

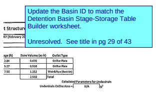
COLORADO SPRINGS, COLORADO

DRAINAGE - DEVELOPED CONDITIONS

SHEET 3 of 3

Markup Summary

dsdlaforce (5)



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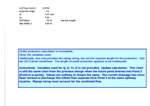
Page Index: 68
Lock: Unlocked
Author: dsdlaforce
Date: 7/10/2019 5:17:45 PM
Color:

Update the Basin ID to match the Detention Basin Stage-Storage Table Builder worksheet.

Unresolved. See title in pg 29 of 43



Subject: Text Box
Page Index: 33
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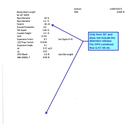
Author: dsdlaforce
Date: 7/10/2019 5:21:04 PM
Color:

Outlet protection calculation is incomplete.
Show the variables used.
Additionally, this only provides the riprap sizing, but not the required length for the protection. Use the UD-Culvert worksheet. The length of outlet protection appears to be inadequate.

Unresolved. Variables used for Q, D, Yt, D is not provided. Update calculation. This chart is still the same chart from the previous design when the future pond drained into Pond 2 (Pond-in-a-series). Values are unlikely to remain the same. The current drainage has since been revised to discharge this offsite flow separate form Pond 2 at the same spillway location. Riprap sizing must account for the combined flow.



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Page Index: 33
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Author: dsdlaforce
Date: 7/10/2019 5:24:07 PM
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Only from 30" and does not include the detention release. Per DP4 combined flow is 67.48 cfs

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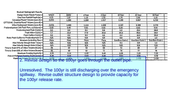
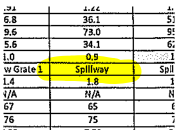


Subject: Text Box
Page Index: 68
Lock: Unlocked
Author: dsdlaforce
Date: 7/15/2019 7:42:53 AM
Color:

2. Revise design so the 100yr goes through the outlet pipe.

Unresolved. The 100yr is still discharging over the emergency spillway. Revise outlet structure design to provide capacity for the 100yr release rate.



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Date: 7/15/2019 7:43:01 AM
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