Marc Whorton

From: dane@tnesinc.com
Sent: Monday, June 18, 2018 2:25 PM
To: jmaynard@nescolorado.com
Cc: Marc Whorton; 'Luanne Ducett'
Subject: Timberridge Estates - Revised Drainage Report
Attachments: 173300 FDR.pdf

John,

Regarding the Timeberridge Estates development, attached is the revised drainage report. Since so much of the grading has already been done, I converted this to a preliminary/final drainage report with a higher level of detail.

County Comment Responses (Drainage Report Only)

- Comment 1 – R: PDR redlines have been addressed.
- Comment 2 – R: Text modified to address comment.
- Comment 3 – R: Additional text on 4 step process added.
- Comment 4 – R: Comment addressed in both text and plans.
- Comment 6 – R: Proposed drainage easement have been added to the drainage maps (north).
- Comment 7 – R: Table added to report (north).
- Comment 8 – R: Comments addressed in plans.
- Comment 10 – R: Additional drainage basin details have been added (north).

There were also some questions/comments in the comments that aren't directly answered by the report revisions. Responses to those items are shown below.

- Page 4, 2nd paragraph – Q: rural residential? X2, A: Yes to both.
- Page 7, 4th paragraph – Q: HOA or district?, A: District.
- Existing Drainage Plan – Q: What is this line?, A: It is the boundary of a surface feature in CAD, which shouldn't have been shown.
- Proposed Drainage Plan – Q: What is this line?, A: It is the boundary of a surface feature in CAD, which shouldn't have been shown.
- Proposed Drainage Plan – Q: From the contours it appears that this flow crosses Arroya Lane. Is there a culvert?..., A: Flow does cross Arroya Lane after ponding at least 2 feet. Looks like some flow may also go west along Arroya Lane after ponding (couldn't be sure since everything was dry). There is no culvert there, just a cattle guard. We aren't rerouting this flow as it's outside the development
- Proposed Drainage Plan – C: Stabilized spillway outfall needs to be entirely within the property., R: It is (shown ending at the property line).

Please contact me if you have any questions.

Thank you,

Dane Frank
Project Engineer
Terra Nova Engineering, Inc.
dane@tnesinc.com
719.635.6422

PRELIMINARY/FINAL DRAINAGE REPORT
FOR
TIMBERRIDGE ESTATES, PRELIMINARY PLAN
PART OF THE RETREAT AT TIMBERRIDGE
(NORTH OF ARROYA LANE)

June 2018

Prepared For:
TIMBERRIDGE ESTATES, LLC
2760 Brogans Bluff Dr.
Colorado Springs, CO 80919

Prepared By:

TERRA NOVA ENGINEERING, INC.
721 S. 23RD STREET
Colorado Springs, CO 80904
(719) 635-6422

Job No. 1733.00

SP-18-002

PRELIMINARY/FINAL DRAINAGE REPORT
FOR
TIMBERRIDGE ESTATES, PRELIMINARY PLAN
PART OF THE RETREAT AT TIMBERRIDGE
(NORTH OF ARROYA LANE)

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DRAINAGE PLAN

CERTIFICATION STATEMENT:

<u>Engineers Statement</u>

This 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.

____
L DUCETT, P.E. 32339 Seal

<u>Developers Statements</u>

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

<u>TIMBERRIDGE ESTATES, LLC.</u>
Business Name

By:____
Title:____
Address:____
____

El Paso County Approval:

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

____ ________________________
Jennifer Irvine, Date
County Engineer / ECM Administrator

Conditions:

PRELIMINARY/FINAL DRAINAGE REPORT
FOR
TIMBERRIDGE ESTATES, PRELIMINARY PLAN
PART OF THE RETREAT AT TIMBERRIDGE
(NORTH OF ARROYA LANE)

PURPOSE

The purpose of this Preliminary Drainage Report is to identify and analyze the proposed drainage patterns, determine proposed runoff quantities, size drainage structures for conveyance of developed runoff, and present solutions to drainage impacts on-site and off-site resulting from this development.

GENERAL DESCRIPTION

This Preliminary Drainage Report (PDR) is an analysis of approximately 35.30 acres of undeveloped land located in the northern part of El Paso County off of Volmer Road and Arroya Lane. This site is being developed by our client to include 10 single family lots consisting of 2.5 acre lots. The site is located in the south west quarter of Section 22, Township 12 South, Range 65 West of the 6th Principal Meridian currently within El Paso County, Colorado. The site is bounded to the north, and west by open space (rural residential), to the east by Vantage Point farm (rural residential) and to the south by Arroya Lane. The site is contained within the Sand Creek Basin.

Soils for this project are delineated by the map in the appendix as Kettle gravelly loamy sand (40), 3 to 8 percent slopes, Kettle gravelly loamy sand (41), 8 to 40 percent slopes and Pring Coarse sandy loam (71), 3 to 8 percent slopes. Soils in the study area are shown as mapped by S.C.S. in the "Soils Survey of El Paso County Area" and contains soils of Hydrologic Group B.

FLOODPLAIN STATEMENT

No portion of this site is within a designated F.E.M.A. floodplain, as determined by Flood Insurance Rate Map No. 08041C0535 F, dated March 17, 1997 (see appendix).

EXISTING DRAINAGE CONDITIONS

The site is currently undeveloped and is open space. The site consists mostly of natural vegetative grass and weeds, with some areas of trees. The site has been broken down into four existing basins, one onsite basin and three offsite basins tributary to the site. Below is a description of these basins.

see plan redlines

Basin OS-4B's 7.76 acres is an offsite basin located along the eastern boundary. This basin is part of a parcel currently in use as a residential property, with the basin area being largely in a natural state. Runoff (Q_5=1.8 cfs and Q_{100}=12.7 cfs) sheet flows to the southeast corner of the site, before flowing across Arroya Lane to the south (Design Point OS-3). Some of the flow at Design Point OS-3 may flow west along Arroya Lane for a short distance (less than 150 feet) before flowing across Arroya Lane to the south.

Basin OS-4A's 2.98 acres is an offsite basin located along the eastern boundary consisting of undeveloped open space. This basin is part of a parcel currently in use as a residential property, with the basin area being largely in a natural state. Runoff (Q_5=0.9 cfs and Q_{100}=6.5 cfs) sheet flows onto the southern half of the site (Design Point OS-2) and then is transported west across the site in existing channels to Design Point EX-1.

Basin OS-4's 12.99 acres is an offsite basin located along the northern boundary consisting of undeveloped open space. This basin is part of two parcels currently in use as residential properties, with the basin area being largely in a natural state. Runoff (Q_5=2.9 cfs and Q_{100}=21.3 cfs) sheet flows onto the northern half of the site (Design Point OS-1) and then is transported southwest across the site in existing channels to Design Point EX-1.

Basin EX-E1's 35.30 acres consists of undeveloped open space. Runoff (Q_5=6.5 cfs and Q_{100}=46.1 cfs) sheet flows to existing onsite drainage channels and then is routed southwest across the site in an existing channel to Design Point EX-3. At Design Point EX-3 the combined flow Q_5=17.8 cfs and Q_{100}=78.0 cfs of all four existing basins is routed south under Arroya Lane via an existing 60" CMP culvert.

EX-1 on plan

Quantify flows from each sub-basin and at each design point entering the site.

Address what type of drainage improvements might be needed at Arroya Lane and how they might affect this site. Are any drainage or construction easements needed?

PROPOSED DRAINAGE CONDITIONS

Runoff in the developed conditions consists of 15 basins, 10 onsite basins (including along Arroya Lane) and five offsite basins. Below is a description of the runoff in the developed conditions and how it will be safely routed, treated and detained. See appendix for calculations.

Provide sub-basins on north side.

As in the existing condition Runoff (Q_5=1.5 cfs and Q_{100}=11.0 cfs) from Basin OS-3's 7.76 acres sheet flows to the southeast corner of the site before flowing across Arroya Lane to the south (Design Point OS-3). No modifications to the drainage of this basin are proposed as part of this development. Modifications to this basin can be expected when Arroya Lane is upgraded to a paved road (not a part of this development).

Runoff (Q_5=1.0 cfs and Q_{100}=7.2 cfs) from Basin OS-2's 2.98 acres sheet and channel flows onto the eastern edge of the site and onto Basin A's 12.38 acres. Basin A will be comprised of large lot development. Runoff (Q_5=3.9 cfs and Q_{100}=21.4 cfs) sheet flow to existing channels. The combined flow (Q_5=4.9 cfs and Q_{100}=28.6 cfs) is routed west across the site via existing channels and proposed ditch sections to a low point (Design Point 1). Dual 24" RCP culverts will route the flow under the new Nature Refuge Way road section and onto Basin C.

Runoff (Q_5=2.0 cfs and Q_{100}=14.3 cfs) from Basin OS-1's 12.50 acres sheet flows onto the northern half of the site and onto Basin C's 15.36 acres. Basin C will also be comprised of large lot development. Runoff (Q_5=4.8 cfs and Q_{100}=24.7 cfs) sheet flow to existing channels. The combined flow (Q_5=6.8 cfs and Q_{100}=39.0 cfs) is routed southwest across the site via existing channels and proposed ditch sections to a proposed Full Spectrum Extended Detention Basin (Design Point 3).

Runoff (Q_5=0.7 cfs and Q_{100}=5.4 cfs) from Basin OS-4's 3.19 acres sheet and channel flows south onto Basin E before entering Sand Creek at Design Point 5. This basin is part of a parcel currently in use as a residential property, with the basin area being largely in a natural state.

Runoff (Q_5=1.3 cfs and Q_{100}=9.6 cfs) from Basin OS-5's 4.89 acres sheet and channel flows southeast onto Basin G before entering Sand Creek at Design Point 6. This basin is part of several parcels currently in use as a residential property or are undeveloped, with the basin area being largely in a natural state.

Basin A (12.38 acres) includes most of the eastern and southern portions of the site and is proposed for large residential lot development. Runoff (Q_5=3.9 cfs and Q_{100}=21.4 cfs) sheet and channels flows to a low point at the western side of the basin at Design Point 1. Dual 24" RCP culverts will route the flow under the new Nature Refuge Way road section and onto Basin C.

Basin A1 (1.83 acres) is an area consisting of the south and east side of the new Nature Refuge Way road and a small area off the road. Runoff (Q_5=2.7 cfs and Q_{100}=6.8 cfs) sheet and channels flows to a low point near the middle of the basin at Design Point 1. Dual 24" RCP culverts will route the flow under the new Nature Refuge Way road section and onto Basin C.

Basin B (1.66 acres) is an area consisting of the north and west side of the new Nature Refuge Way road and a small area off the road. Runoff (Q_5=2.1 cfs and Q_{100}=5.2 cfs) sheet and channels flows to a low point at the western side of the basin at Design Point 2, where it flows onto Basin C.

Basin C (15.36 acres) includes most of the western and northern portions of the site and is proposed for large residential lot development and the proposed Full Spectrum Extended Detention Basin. Runoff (Q_5=4.8 cfs and Q_{100}=24.7 cfs) sheet and channels flows to the detention basin in the southwest corner of the basin at Design Point 1. Outflow from the detention basin flows onto Basin E before flowing into Sand Creek.

Basin D (2.60 acres) is an area consisting of the north side of part of the existing Arroya Lane road and a small area north of the road. Runoff (Q_5=1.1 cfs and Q_{100}=4.7 cfs) sheet and channels flows to the west, where it crosses the new Nature Refuge Way road in a culvert and flows onto Basin E.

Basin E (1.04 acres) is an area consisting of the north side of part of the existing Arroya Lane road. Runoff (Q_5=1.8 cfs and Q_{100}=4.7 cfs) primarily channel flows to the west, where it enters Sand

Creek at Design Point 5. Flows also enter Basin E from Basin D, the detention basin outfall, Basin F, and Basin OS-4 on their path to Sand Creek.

Basin F (0.72 acres) is an area on the western edge of the site that includes some area in large residential lot development and some area around the detention basin. Runoff (Q_5=0.2 cfs and Q_{100}=1.7 cfs) sheet flows to the southwest and onto Basin E.

Basin G (1.16 acres) is an area consisting of the north side of part of the existing Arroya Lane road. Runoff (Q_5=2.0 cfs and Q_{100}=5.1 cfs) primarily channel flows to the east, where it enters Sand Creek at Design Point 6.

Basin H (1.38 acres) is an area consisting of the south side of part of the existing Arroya Lane road. Runoff (Q_5=1.8 cfs and Q_{100}=4.7 cfs) primarily channel flows to the west, where it enters Sand Creek at Design Point 8.

Basin I (1.27 acres) is an area consisting of the south side of part of the existing Arroya Lane road. Runoff (Q_5=2.2 cfs and Q_{100}=5.6 cfs) primarily channel flows to the east, where it enters Sand Creek at Design Point 7.

At Design Point 3 the combined flow (Q_5=16.6 cfs and Q_{100}=79.8 cfs) of Basins OS-1, OS-2, A, A1, B, and C will be captured in a 1.359 acre-foot Extended Detention Basin. Runoff will be routed in the natural channel into a 192 cu-ft concrete lined forbay with a 1.6 feet high concrete cutoff wall. A 6 inch notch in the wall drains the flow to a 2' concrete trickle channel then the runoff is routed to the 2.5' deep micropool which has a 0.001 ac-ft Initial Surcharge Volume. The 46.70 acres tributary to the EDB are 5.63% impervious. Based upon this we need a WQCV of 0.158 ac-ft, an ERUV volume of 0.080 ac-ft and 100-year volume of 1.100 ac-ft for a total volume needed of 1339 ac-ft. The micropool elevation is at 7247.00 while the ISV elevation is at 7247.33. The WQCV orifice starts at 7247 with 3 1-inch diameter holes spaced 7.76 inches apart. A 4'x4' outlet structure is set at 7248.94, which corresponds to the EURV elevation. The 100-year elevation tops out at 7251.96. A 30" RCP outlet will release Q_5=0.1 cfs and Q_{100}=50.1 cfs discharge southwest to a riprap pad and then be routed to Design Point 5. The combined runoff at Design Point 5 is

Q_5=21.9 cfs and Q_{100}=98.0. In "The Retreat at Timberridge Master Development Drainage Plan" it is proposed that three 6'x12' concrete box culvers will be installed to replace the existing 60' RCP.

In an effort to protect receiving water and as part of the "four-step process to minimize adverse impacts of urbanization" this site was analyzed in the following manner:

1. Reduce Runoff- Runoff at the site will be collected in natural and grass swales before being directed into Sand Creek. The low Impervious area of the site and the use of pervious swales directly reduces runoff at the site. Additionally, the new improvements and impervious areas on the site will be routed to a proposed private Extended Detention Basin. These items will reduce the volume of runoff using ponding and infiltration.
2. Stabilize Drainageways- All of the proposed drainage channels are either existing natural channels or are grass swales. Additionally, the outflow of the Extended Detention Basin will be protected by riprap in the receiving channel. All of the proposed drainage channels that discharge into Sand Creek are grass swales.
3. Provide Water Quality Capture Volume (WQCV)- The Extended Detention Basin has been sized and designed to sufficiently capture the required WQCV and slowly release it though the three hole outlet, thereby allowing solids and contaminants to settle out.
4. Consider Need for Industrial and Commercial BMPs- As this is a residential development, industrial and commercial BMPs do not apply.

HYDROLOGIC CALCULATIONS

Hydrologic calculations were performed using the El Paso County Storm Drainage Design Criteria Manual - Volumes 1 & 2, latest editions. The Rational Method was used to estimate storm water runoff anticipated from design storms with 5-year and 100-year recurrence intervals. The Urban Drainage Criteria Manual was used to calculate the detention and water quality volume.

HYDRAULIC CALCULATIONS

Hydraulic calculations were estimated using the Manning's Formula and the methods described in the El Paso County Storm Drainage Design Criteria Manual – Volumes 1 & 2, latest editions. The pertinent data sheets are included in the appendix of this report.

A number of existing drainage channels are on the site, and a number of proposed drainage channels have been added along the roads. Proposed drainage easements for the existing drainage channels and cross sections of the proposed channels are shown on the Drainage Maps (see appendix). Channel flow calculations have been included for both the existing and proposed drainage channels.

Culverts are proposed at the crossing of Sand Creek, for the detention basin outfall, at the intersection of Arroya Lane and Nature Refuge Way, and at a low point on Nature Refuge Way. Culver design calculations have been included for the proposed drainage channels.

MAINTENANCE

The Extended Detention Basin and the storm drain systems are private and therefore must be maintained by the owner (district). These should be cleaned and checked after any significant precipitation event and at least once every three months. The proposed erosion control measures will be repaired and maintained by the property owner or owner's representative as required.

Access to the Extended Detention Basin will be from Arroya Lane. Access to the proposed drainage easements will be from Nature Refuge Way and/or from Arroya Lane via the Extended Detention Basin.

CONSTRUCTION COST OPINION

Public Non Reimbursable

NOT APPLICABLE

Private Non Reimbursable

1. 24" RCP	180 LF	$ 50	$ 9,000
2. EDB	1 EA	$ 20,000	$ 20,000
		Total	**$ 20,900**

DRAINAGE FEES

The existing site is in the Sand Creek Basin. 2018 Drainage fees due prior to final plat recordation are as follows:

FEE TYPE	% IMP.	PARCEL AREA	MOD.	FEE PER IMP. AC.	SUBTOTAL
DRAINAGE FEES:	11% x	35.3 acres x	75% x	$17,197 =	$50,082
BRIDGE FEES:	11% x	35.3 acres x	100% x	$ 5,210 =	$20,230
				TOTAL	**$70,312**

SUMMARY

Development of this site will not adversely affect the surrounding development. Proposed flows, as detailed in this report, will follow the drainage patterns outlined in this report showing how runoff will be safely routed downstream. The Extended Detention Basin will control flow to historic levels and provide water quality for this site. These water features will need to be periodically maintained by the owner in order to maintain their effectiveness in cleaning the discharge form the site.

PREPARED BY:
TERRA NOVA ENGINEERING, INC.

L Ducett, P.E.
President
Jobs1733.00/drainage/drng report 1733fdr.doc

REFERENCE

"MDDP for the Retreat at TimberRidge" by Classic Consulting Engineers & Surveyors dated 2/22/18

El Paso County Drainage Criteria Manual-Volumes 1 & 2, latest edition

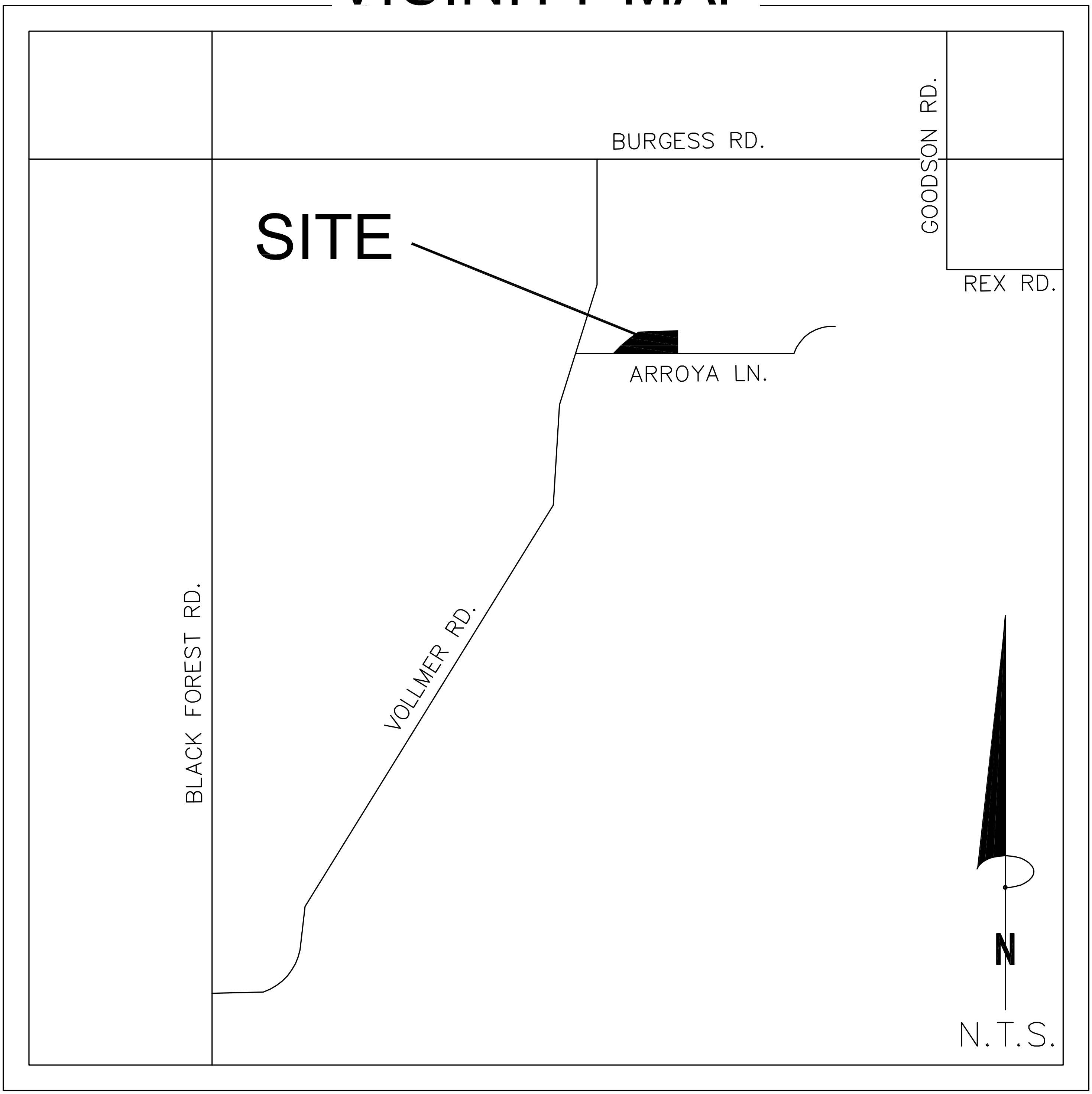
El Paso County Board Resolution No 15-042 (Adoption of Chapter 6 and Section 3.2.1 Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014, Hydrology and Full Spectrum Detention)

SCS Soils Map for El Paso County

Federal Emergency Management Agency (FEMA) flood maps

VICINITY MAP

VICINITY MAP



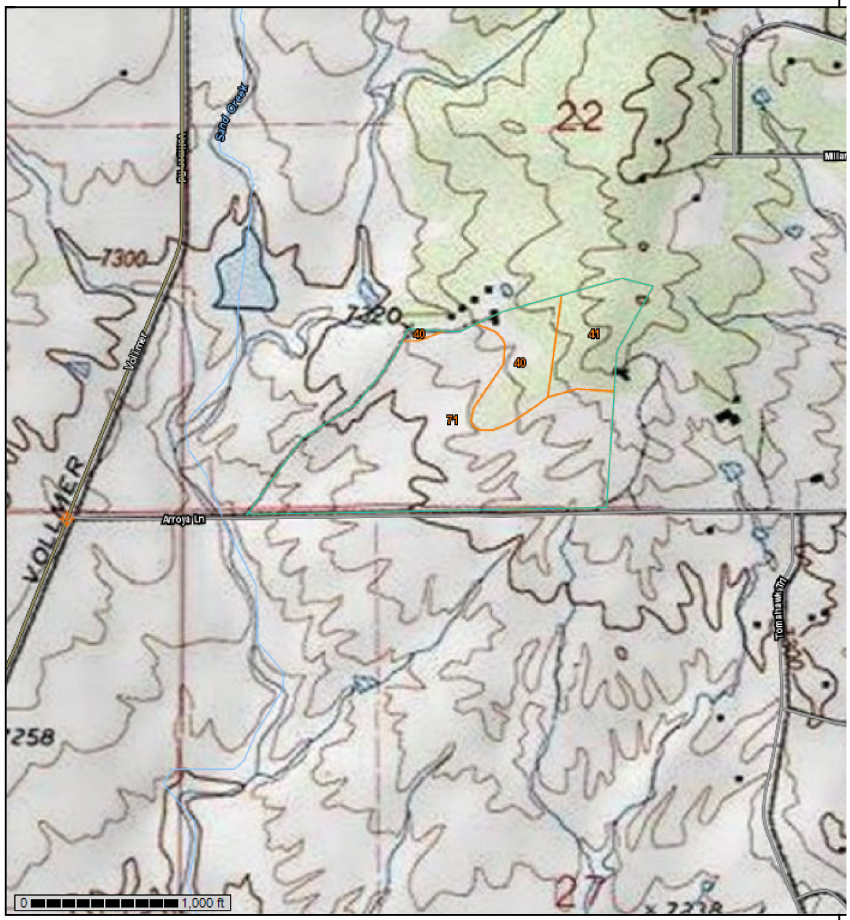
S.C.S. SOILS MAP

Map Unit Legend

El Paso County Area, Colorado (CO625)			
El Paso County Area, Colorado (CO625)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	7.9	13.1%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	8.2	13.6%
71	Pring coarse sandy loam, 3 to 8 percent slopes	44.2	73.3%
Totals for Area of Interest		**60.2**	**100.0%**

Soil Map

Scale (not to scale)



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

You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mappi
AOI were mapped at 1:24,000. The design of map units and the level of detail shown in the resulting s

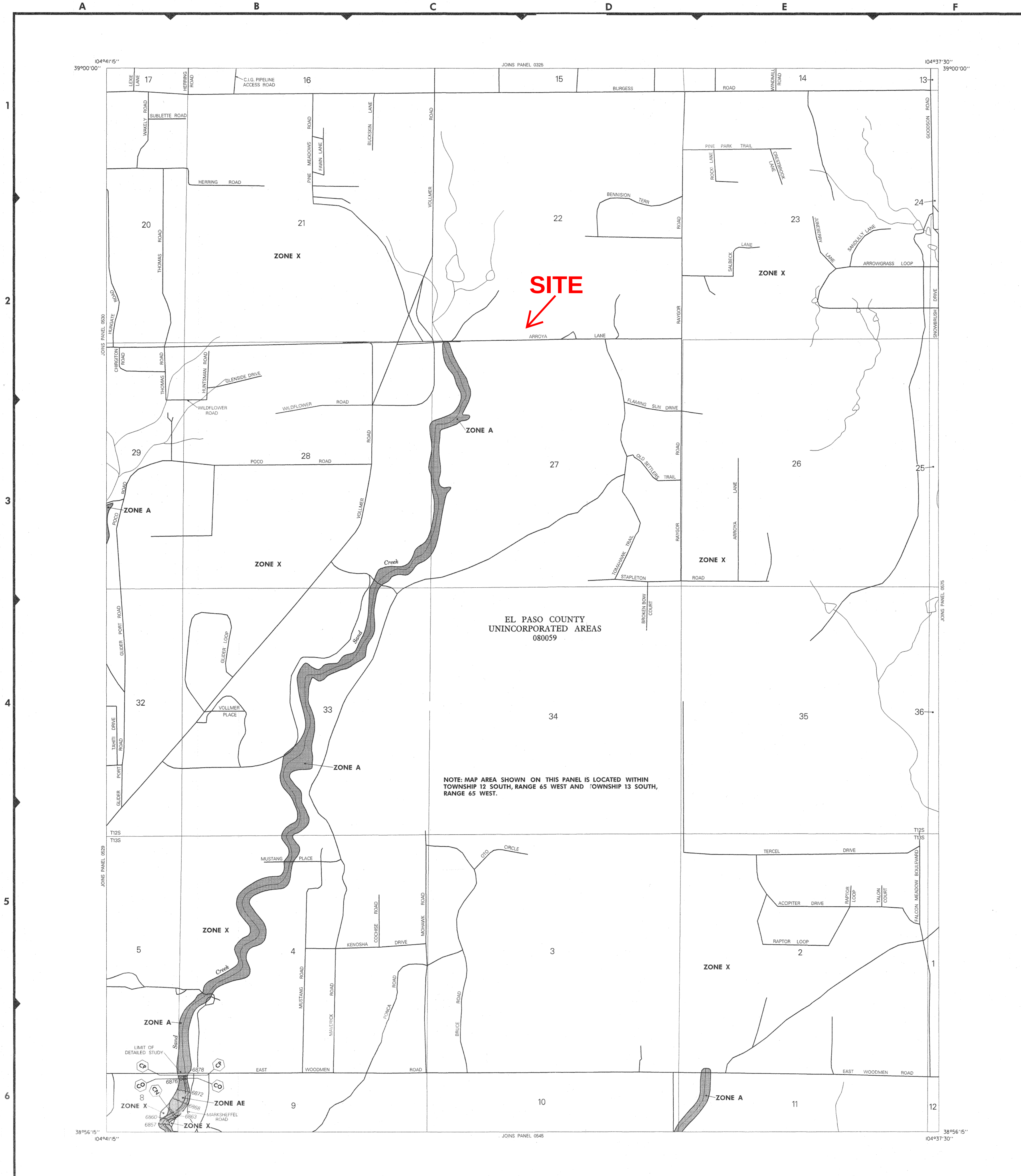
Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mappi
of contrasting soils that could have been shown at a more detailed scale.

Measure

Segment	Distance (Feet/Miles)	Distance (Meters/Kilometers)
Segment 1	1.02 miles	1.64 kilometers
Total Distance	1.02 miles	1.64 kilometers

Hydrologic Soil Group: B

FEMA FIRM MAP



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100–YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100–year flood by Federal flood protection system under construction; no base elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500–year flood; areas of 100–year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100–year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500–year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

~~~513~~~ Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

(D)——(D) Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 × Elevation Reference Mark

● M2 River Mile

97°07'30'', 32°22'30'' Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

Coastal base flood elevations apply only landward of 0.0 NGVD, and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of Special Flood Hazard (100–year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

This map may incorporate approximate boundaries of Coastal Barrier Resource System Units and /or Otherwise Protected Areas established under the Coastal Barrier Improvement Act of 1990 (PL 101–591).

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels and base map source see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Map Index

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:

MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE DATE shown on this map to determine when actuarial rates apply to structures in zones where elevations or depths have been established.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 535 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0535	F

MAP NUMBER
08041C0535 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency
~~~

HYDROLOGIC CALCULATIONS

TIMBERRIDGE ESTATES
(Area Runoff Coefficient Summary)

EXISTING CONDITIONS

		STREETS / DEVELOPED			OVERLAND / UNDEVELOPED			WEIGHTED	
BASIN	**TOTAL AREA** *(Acres)*	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	C_5	C_{100}
EX-E1	35.30	0.00	0.90	0.96	35.30	0.08	0.35	0.08	0.35
OS-4	12.99	0.00	0.90	0.96	12.99	0.08	0.35	0.08	0.35
OS-4A	2.98	0.00	0.90	0.96	2.98	0.08	0.35	0.08	0.35
OS-4B	7.76	0.00	0.90	0.96	7.76	0.08	0.35	0.08	0.35

Calculated by: DLF
Date: 6/4/2018
Checked by: ________

TIMBERRIDGE ESTATES
(Area Runoff Coefficient Summary)

DEVELOPED CONDITIONS

		STREETS / DEVELOPED			***OVERLAND / UNDEVELOPED***			***WEIGHTED***	
BASIN	**TOTAL AREA** *(Acres)*	**AREA** *(Acres)*	**C_5**	**C_{100}**	**AREA** *(Acres)*	**C_5**	**C_{100}**	**C_5**	**C_{100}**
OS-1	12.50	0.00	0.90	0.96	12.50	0.08	0.35	0.08	0.35
OS-2	2.98	0.00	0.90	0.96	2.98	0.08	0.35	0.08	0.35
OS-3	7.76	0.00	0.90	0.96	7.76	0.08	0.35	0.08	0.35
OS-4	3.19	0.00	0.90	0.96	3.19	0.08	0.35	0.08	0.35
OS-5	4.89	0.00	0.90	0.96	4.89	0.08	0.35	0.08	0.35
A	12.38	0.51	0.90	0.96	11.87	0.08	0.35	0.11	0.37
A1	1.83	0.73	0.90	0.96	1.10	0.08	0.35	0.41	0.59
B	1.66	0.66	0.90	0.96	0.99	0.08	0.35	0.41	0.59
C	15.36	0.76	0.90	0.96	14.60	0.08	0.35	0.12	0.38
D	2.60	0.26	0.90	0.96	2.34	0.08	0.35	0.16	0.41
E	1.04	0.42	0.90	0.96	0.62	0.08	0.35	0.41	0.59
F	0.72	0.00	0.90	0.96	0.72	0.08	0.35	0.08	0.35
G	1.16	0.46	0.90	0.96	0.70	0.08	0.35	0.41	0.59
H	1.38	0.55	0.90	0.96	0.83	0.08	0.35	0.41	0.59
I	1.27	0.51	0.90	0.96	0.76	0.08	0.35	0.41	0.59

Calculated by: DLF
Date: 6/4/2018
Checked by: ____________

TIMBERRIDGE ESTATES
AREA DRAINAGE SUMMARY

EXISTING CONDITIONS

		WEIGHTED		*OVERLAND*				*STREET / CHANNEL FLOW*				T_t	*INTENSITY*		*TOTAL FLOWS*	
BASIN	**AREA TOTAL** *(Acres)*	C_5	C_{100}	C_5	**Length** *(ft)*	**Height** *(ft)*	T_C *(min)*	**Length** *(ft)*	**Slope** *(%)*	**Velocity** *(fps)*	T_t *(min)*	**TOTAL** *(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
		** For Calcs See Runoff Summary*														
EX-E1	35.30	0.08	0.35	0.08	300	16.0	10.5	2148	5.0%	1.5	23.9	34.3	2.3	3.7	**6.5**	**46.1**
OS-4	12.99	0.08	0.35	0.08	300	20.0	9.7	1460	5.7%	1.8	13.5	23.2	2.8	4.7	**2.9**	**21.3**
OS-4A	2.98	0.08	0.35	0.08	300	25.0	9.0	390	5.0%	1.5	4.3	13.4	3.6	6.2	**0.9**	**6.5**
OS-4B	7.76	0.08	0.35	0.08	300	20.0	9.7	1220	5.0%	1.5	13.6	23.3	2.8	4.7	**1.8**	**12.7**

DEVELOPED CONDITIONS

		WEIGHTED		*OVERLAND*				*STREET / CHANNEL FLOW*				T_t	*INTENSITY*		*TOTAL FLOWS*	
BASIN	**AREA TOTAL** *(Acres)*	C_5	C_{100}	C_5	**Length** *(ft)*	**Height** *(ft)*	T_C *(min)*	**Length** *(ft)*	**Slope** *(%)*	**Velocity** *(fps)*	T_t *(min)*	**TOTAL** *(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
		** For Calcs See Runoff Summary*														
OS-1	12.50	0.08	0.35	0.09	300	16.0	10.4	2148	5.0%	1.1	32.0	42.4	2.0	3.3	**2.0**	**14.3**
OS-2	2.98	0.08	0.35	0.09	100	5.0	6.8	243	5.0%	1.1	3.6	10.4	4.0	6.9	**1.0**	**7.2**
OS-3	7.76	0.08	0.35	0.09	300	20.0	9.6	1460	5.7%	1.2	20.4	30.0	2.5	4.0	**1.5**	**11.0**
OS-4	3.19	0.08	0.35	0.09	300	16.0	10.4	783	4.9%	1.1	11.8	22.2	2.9	4.8	**0.7**	**5.4**
OS-5	4.89	0.08	0.35	0.09	300	15.0	10.6	416	5.1%	1.1	6.1	16.7	3.3	5.6	**1.3**	**9.6**
A	12.38	0.11	0.37	0.09	284	16.0	10.0	1226	4.4%	1.5	13.9	23.9	2.8	4.6	**3.9**	**21.4**
A1	1.83	0.41	0.59	0.09	50	4.0	4.4	844	5.2%	1.6	8.8	13.2	3.7	6.3	**2.7**	**6.8**
B	1.66	0.41	0.59	0.09	129	9.0	6.8	1098	5.1%	1.6	11.6	18.3	3.2	5.3	**2.1**	**5.2**
C	15.36	0.12	0.38	0.09	226	20.0	7.8	1780	4.5%	1.5	20.0	27.8	2.6	4.2	**4.8**	**24.7**
D	2.60	0.16	0.41	0.09	108	6.0	6.8	1448	3.1%	1.2	19.6	26.4	2.7	4.4	**1.1**	**4.7**
E	1.04	0.41	0.59	0.09	30	2.0	3.8	825	4.6%	3.2	4.3	8.1	4.4	7.7	**1.8**	**4.7**
F	0.72	0.08	0.35	0.09	150	10.0	7.3	335	6.0%	1.7	3.3	10.6	4.0	6.9	**0.2**	**1.7**
G	1.16	0.41	0.59	0.09	30	2.0	3.8	934	3.9%	3.0	5.3	9.1	4.2	7.4	**2.0**	**5.1**
H	1.38	0.41	0.59	0.09	58	2.0	6.2	904	5.3%	3.5	4.4	10.6	4.0	6.9	**2.2**	**5.7**
I	1.27	0.41	0.59	0.09	30	2.0	3.8	934	3.9%	3.0	5.3	9.1	4.2	7.4	**2.2**	**5.6**

Calculated by: DLF

Date: 6/4/2018

Checked by: ______

TIMBERRIDGE ESTATES
PROPOSED SURFACE ROUTING SUMMARY

Design Point(s)	*Contributing Basins*	*Area Ac*	*Flow*	
			Q_5	Q_{100}
1	**OS-2, A & A1**	17.18	*7.6*	*35.5*
2	**OS-2, A, A1 & B**	18.84	*9.8*	*40.7*
3	**OS-1, OS-2, A, A1, B, & C**	46.70	*16.6*	*79.8*
4	**D**	2.60	*1.1*	*4.7*
5	**OS-1, OS-2, OS-4, A, A1, B, C, D, E, & F**	54.25	*20.5*	*96.3*
6	**OS-5 & G**	8.80	*3.3*	*14.6*
7	**I**	1.27	*2.2*	*5.6*
8	**H**	1.38	*2.2*	*5.7*
OS-3	**OS-3**	7.76	*1.5*	*11.0*

Calculated by: DLF
Date: 6/4/2018
Checked by: ________

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

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

HYDRAULIC CALCULATIONS

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX1 - Min 100 Yr Channel Size (Q=1.2 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

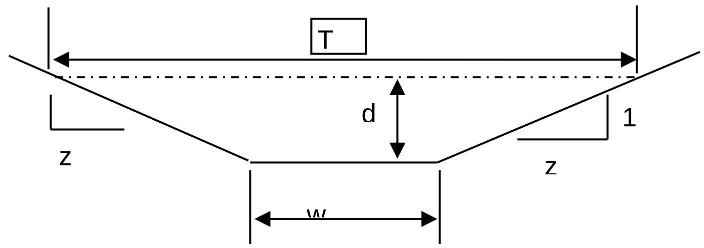
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	11.3
z (sideslope)=	17.5
b (btm width, ft)=	0
d (depth, ft)=	0.4
S (slope, ft/ft)	0.026
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.4	2.30	11.55	0.20	0.54535695	1.2565	0.545357	1.2565	T =	11.52
								Dm =	0.200
				Sc low =	0.5620	Sc high =	0.5620		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.3934	0.7307	0.3934	0.7307		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

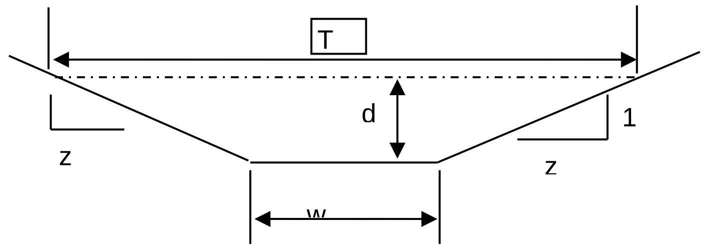
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX2 - Min 100 Yr Channel Size (Q=7.1 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

INPUT	
z (sideslope)=	11.5
z (sideslope)=	12
b (btm width, ft)=	8
d (depth, ft)=	0.47
S (slope, ft/ft)	0.056
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.47	6.36	19.08	0.33	1.12628489	7.15819	1.126285	7.15819	T =	19.045
								Dm =	0.334
				Sc low =	0.4736	Sc high =	0.4736		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.3315	0.6157	0.3315	0.6157		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX3 - Min 100 Yr Channel Size (Q=18.5 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

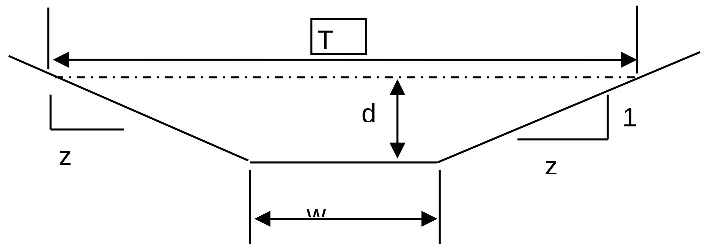
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	7.2
z (sideslope)=	7.9
b (btm width, ft)=	0
d (depth, ft)=	1.27
S (slope, ft/ft)	0.044
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.27	12.18	19.34	0.63	1.52630076	18.5864	1.526301	18.5864	T =	19.177
								Dm =	0.635
				Sc low =	0.3856	Sc high =	0.3856		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2699	0.5013	0.2699	0.5013		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX4 - Min 100 Yr Channel Size (Q=23.9 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

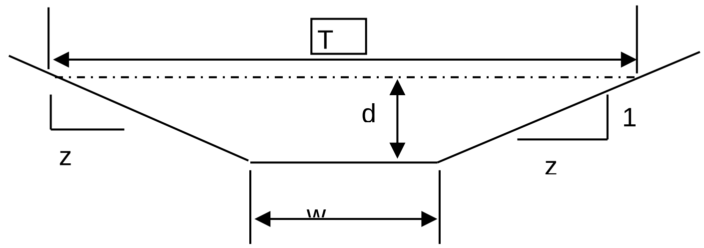
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	7.5
z (sideslope)=	6.5
b (btm width, ft)=	0
d (depth, ft)=	1.41
S (slope, ft/ft)	0.049
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.41	13.92	19.94	0.70	1.72533701	24.011	1.725337	24.011	T =	19.74
								Dm =	0.705

Sc low =	0.3731	Sc high =	0.3731
.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.2612	0.4850	0.2612	0.4850

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

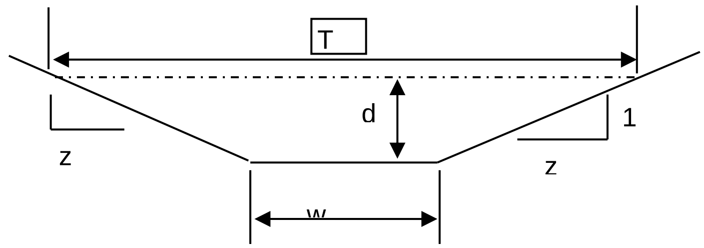
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX5 - Min 100 Yr Channel Size (Q=26.3 cfs)

By: Dane Frank Date: 6/6/2018

Chk By: Date: version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	1.99
S (slope, ft/ft)	0.03
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.99	15.84	16.41	0.97	1.6759462	26.5477	1.675946	26.5477	T =	15.92
								Dm =	0.995
				Sc low =	0.3417	Sc high =	0.3417		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2392	0.4442	0.2392	0.4442		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

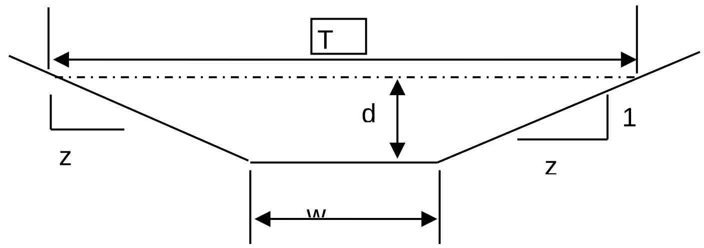
MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX6 - Min 100 Yr Channel Size (Q=35.5 cfs)

By: Dane Frank Date: 6/6/2018

Chk By: Date: version 12-2004

Mannings Formula



INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	2.21
S (slope, ft/ft)	0.031
n_{low} =	0.15
n_{high} =	0.15

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
2.21	19.54	18.22	1.07	1.82701148	35.6932	1.827011	35.6932	T =	17.68
								Dm =	1.105
				Sc low =	0.3299	Sc high =	0.3299		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2310	0.4289	0.2310	0.4289		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX7 - Min 100 Yr Channel Size (Q=7.6 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

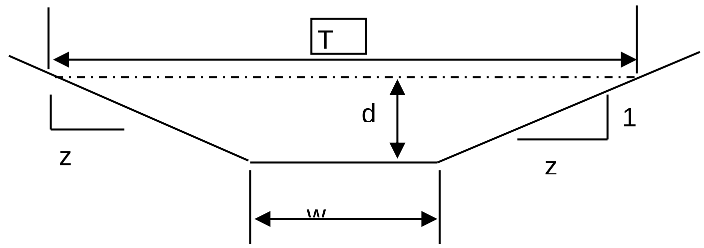
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	6.7
z (sideslope)=	16.8
b (btm width, ft)=	0
d (depth, ft)=	0.73
S (slope, ft/ft)	0.061
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.73	6.26	17.23	0.36	1.24593434	7.80151	1.245934	7.80151	T =	17.155
								Dm =	0.365
				Sc low =	0.4611	Sc high =	0.4611		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.3228	0.5994	0.3228	0.5994		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

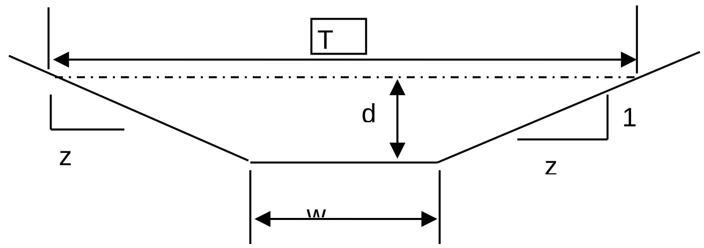
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX8 - Min 100 Yr Channel Size (Q=19.8 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004



	INPUT
z (sideslope)=	7.5
z (sideslope)=	11.5
b (btm width, ft)=	0
d (depth, ft)=	1.27
S (slope, ft/ft)	0.032
n_{low} =	0.15
n_{high} =	0.15

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.27	15.32	24.27	0.63	1.30419882	19.9837	1.304199	19.9837	T =	24.13
								Dm =	0.635
				Sc low =	0.3841	Sc high =	0.3841		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.2689	0.4993	0.2689	0.4993

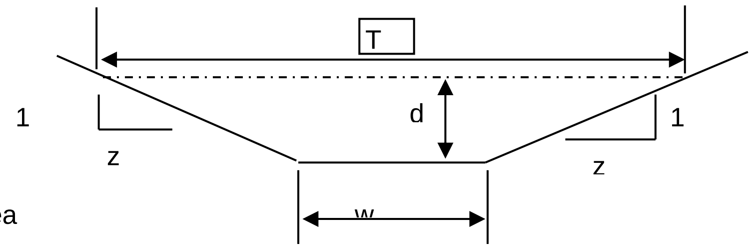
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX9 - Min 100 Yr Channel Size (Q=26.3 cfs)

By: Dane Frank Date: 6/6/2018

Chk By: Date: version 12-2004



INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	1.89
S (slope, ft/ft)	0.039
n_{low} =	0.15
n_{high} =	0.15

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.89	14.29	15.59	0.92	1.84630518	26.3807	1.846305	26.3807	T =	15.12
								Dm =	0.945
				Sc low =	0.3476	Sc high =	0.3476		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.2433	0.4519	0.2433	0.4519

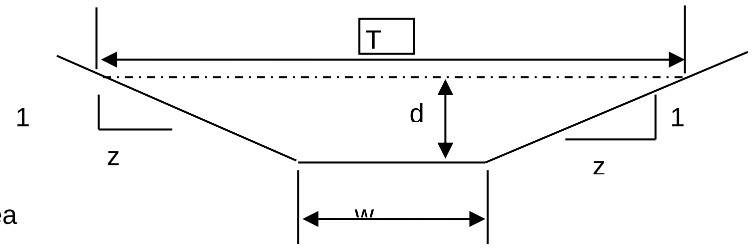
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX10 - Min 100 Yr Channel Size (Q=32.0 cfs)

By: Dane Frank Date: 6/6/2018

Chk By: Date: version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	2.09
S (slope, ft/ft)	0.034
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
2.09	17.47	17.23	1.01	1.84346581	32.2098	1.843466	32.2098	T =	16.72
								Dm =	1.045
				Sc low =	0.3361	Sc high =	0.3361		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2353	0.4370	0.2353	0.4370		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

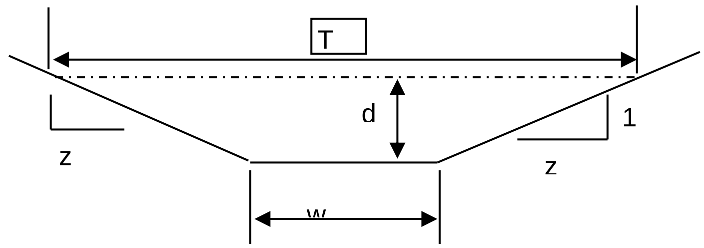
MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX11 - Min 100 Yr Channel Size (Q=76.0 cfs)

By: Dane Frank Date: 6/6/2018

Chk By: Date:

version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

	INPUT
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	2.94
S (slope, ft/ft)	0.031
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
2.94	34.57	24.24	1.43	2.20994829	76.4076	2.209948	76.4076	T =	23.52
								Dm =	1.470
				Sc low =	0.3000	Sc high =	0.3000		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2100	0.3900	0.2100	0.3900		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

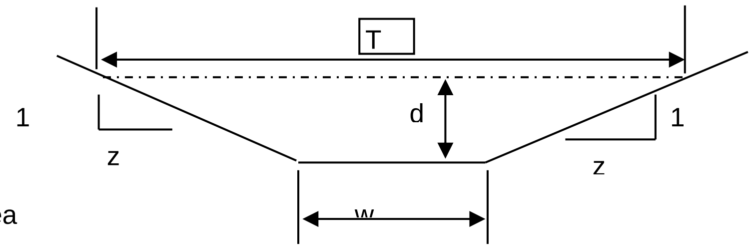
label on existing plan (all ex. channels)

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR1 - Min 100 Yr Channel Size (Q=40.7 cfs)

By: Dane Frank Date: 6/6/2018

Chk By: Date: version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

	INPUT
z (sideslope)=	5
z (sideslope)=	6
b (btm width, ft)=	20
d (depth, ft)=	1.31
S (slope, ft/ft)	0.013
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.31	35.64	34.65	1.03	1.15095872	41.0185	1.150959	41.0185	T =	34.41
								Dm =	1.036
				Sc low =	0.3268	Sc high =	0.3268		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2287	0.4248	0.2287	0.4248		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

clarify label on plan

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR2 - Min 100 Yr Channel Size (Q=79.8 cfs)

By: Dane Frank Date: 6/6/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

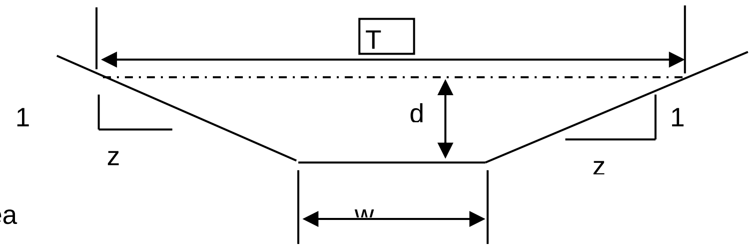
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	2.73
S (slope, ft/ft)	0.051
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
2.73	29.81	22.51	1.32	2.6979185	80.4293	2.697918	80.4293	T =	21.84
								Dm =	1.365
				Sc low =	0.3075	Sc high =	0.3075		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2153	0.3998	0.2153	0.3998		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

clarify label on plan

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR3 - Min 100 Yr Channel Size (Q=4.7 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

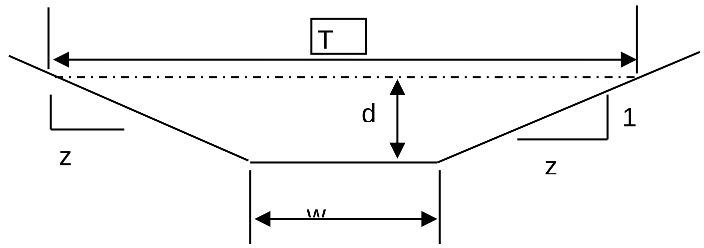
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	1
S (slope, ft/ft)	0.037
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1	4.00	8.25	0.49	1.17639986	4.7056	1.1764	4.7056	T =	8
								Dm =	0.500
				Sc low =	0.4298	Sc high =	0.4298		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.3008	0.5587	0.3008	0.5587		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** | Location: Point PR4 - Min 100 Yr Channel Size (Q=3.2 cfs)

By: Dane Frank | Date: 5/31/2018

Chk By: | Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

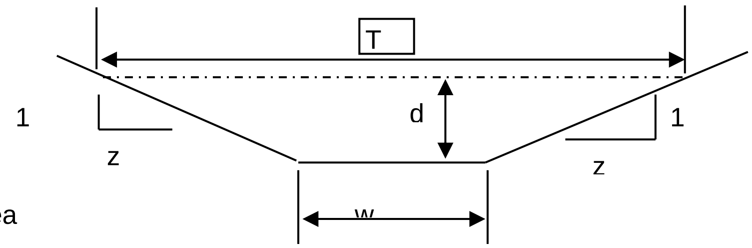
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	4.5
z (sideslope)=	3.6
b (btm width, ft)=	0
d (depth, ft)=	0.78
S (slope, ft/ft)	0.063
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.78	2.46	6.51	0.38	1.30105342	3.20582	1.301053	3.20582	T =	6.318
								Dm =	0.390
				Sc low =	0.4666	Sc high =	0.4666		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.3266	0.6066	0.3266	0.6066		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR5 - Min 100 Yr Channel Size (Q=0.9 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

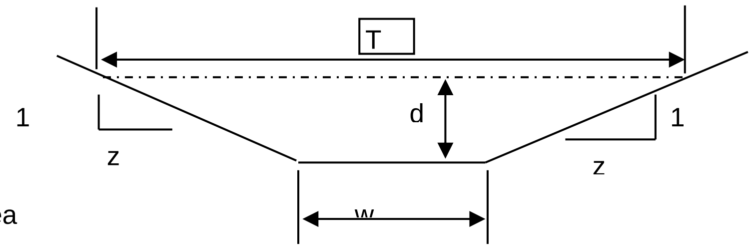
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	3.8
z (sideslope)=	3.8
b (btm width, ft)=	0
d (depth, ft)=	0.67
S (slope, ft/ft)	0.013
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.67	1.71	5.27	0.32	0.53278593	0.90884	0.532786	0.90884	T =	5.092
								Dm =	0.335
				Sc low =	0.4932	Sc high =	0.4932		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.3452	0.6412	0.3452	0.6412		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR6 - Min 100 Yr Channel Size (Q=3.6 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

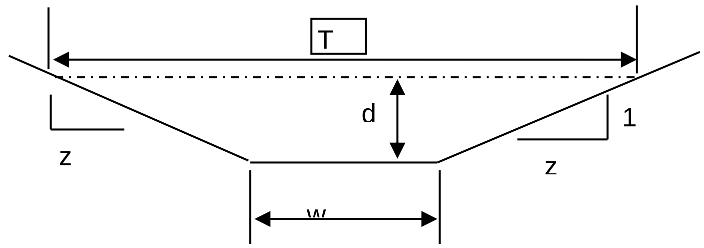
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	3.5
b (btm width, ft)=	0
d (depth, ft)=	1.13
S (slope, ft/ft)	0.013
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.13	4.79	8.77	0.55	0.754405	3.61237	0.754405	3.61237	T =	8.475
								Dm =	0.565
				Sc low =	0.4149	Sc high =	0.4149		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2904	0.5394	0.2904	0.5394		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

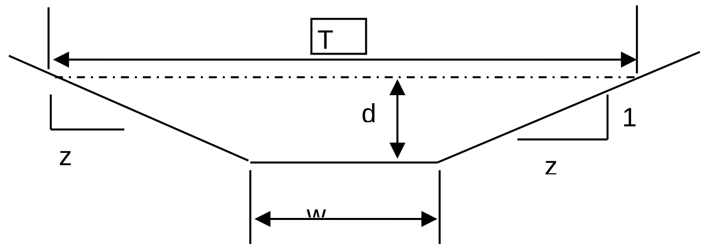
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR7 - Min 100 Yr Channel Size (Q=8.2 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004



INPUT	
z (sideslope)=	4
z (sideslope)=	3
b (btm width, ft)=	0
d (depth, ft)=	1.22
S (slope, ft/ft)	0.052
n_{low} =	0.15
n_{high} =	0.15

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.22	5.21	8.89	0.59	1.58211653	8.24188	1.582117	8.24188	T =	8.54
								Dm =	0.610
				Sc low =	0.4074	Sc high =	0.4074		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2852	0.5296	0.2852	0.5296		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR8 - Min 100 Yr Channel Size (Q=96.3 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

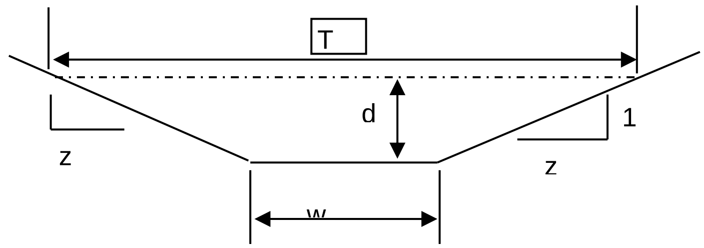
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	2.97
S (slope, ft/ft)	0.05
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
2.97	35.28	24.49	1.44	2.82569854	99.7008	2.825699	99.7008	T =	23.76
								Dm =	1.485
				Sc low =	0.2990	Sc high =	0.2990		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2093	0.3887	0.2093	0.3887		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR9 - Min 100 Yr Channel Size (Q=5.7 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

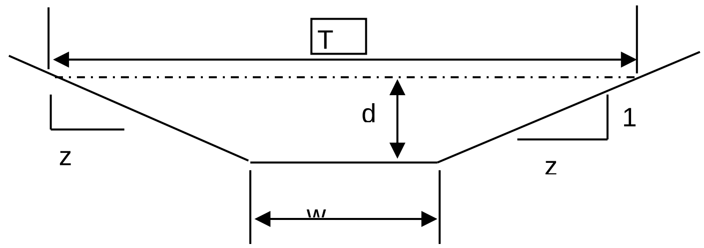
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	0.99
S (slope, ft/ft)	0.06
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
0.99	3.92	8.16	0.48	1.48805749	5.83378	1.488057	5.83378	T =	7.92
								Dm =	0.495
				Sc low =	0.4312	Sc high =	0.4312		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.3018	0.5606	0.3018	0.5606		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

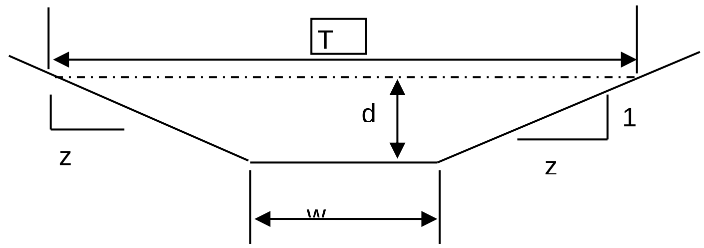
Project: **Timber Rider Estates** Location: Point PR10 - Min 100 Yr Channel Size (Q=10.5 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula



$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

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

Q = V x A

INPUT	
z (sideslope)=	3.5
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	1.27
S (slope, ft/ft)	0.059
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.27	6.05	9.86	0.61	1.73731044	10.5079	1.73731	10.5079	T =	9.525
								Dm =	0.635
				Sc low =	0.3991	Sc high =	0.3991		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.2793	0.5188	0.2793	0.5188		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**	Location:	Point PR11 - Min 100 Yr Channel Size (Q=5.6 cfs)
By:	Dane Frank	Date:	5/31/2018
Chk By:		Date:	

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

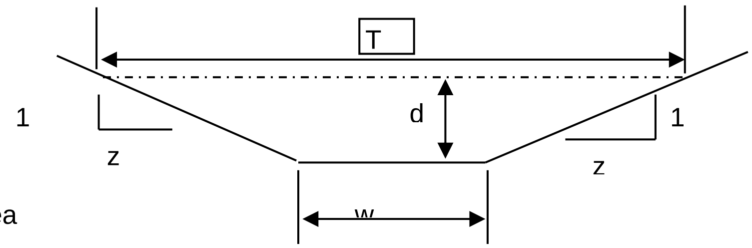
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



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

Q = V x A

	INPUT
z (sideslope)=	3.5
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	0.96
S (slope, ft/ft)	0.078
n_{low} =	0.15
n_{high} =	0.15

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.96	3.46	7.45	0.46	1.65757434	5.72858	1.657574	5.72858	T =	7.2
								Dm =	0.480
				Sc low =	0.4381	Sc high =	0.4381		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.3067	0.5695	0.3067	0.5695		

s_c = critical slope ft / ft

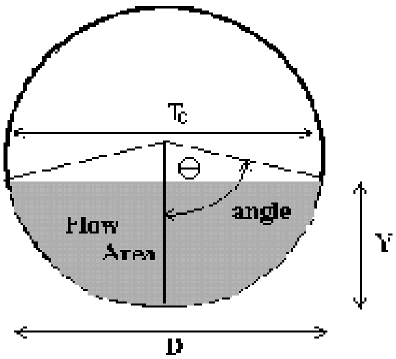
T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

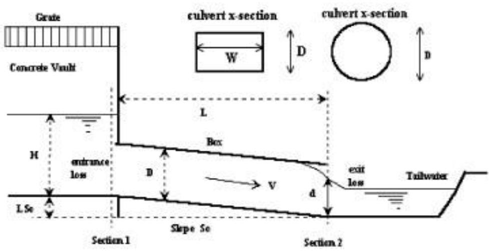
Project: **TIMBERRIDGE ESTATES**
Pipe ID: **Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts**



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	**Q =**	**17.75**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	22.68	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.91	radians
Flow area	An =	2.22	sq ft
Top width	Tn =	1.89	ft
Wetted perimeter	Pn =	3.82	ft
Flow depth	Yn =	1.33	ft
Flow velocity	Vn =	7.99	fps
Discharge	Qn =	17.75	cfs
Percent Full Flow	Flow =	78.3%	of full flow
Normal Depth Froude Number	Fr_n =	1.30	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.12	radians
Critical flow area	Ac =	2.56	sq ft
Critical top width	Tc =	1.71	ft
Critical flow depth	Yc =	1.52	ft
Critical flow velocity	Vc =	6.94	fps
Critical Depth Froude Number	Fr_c =	1.00	

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	2	
	Inlet Elevation at Culvert Invert	Inlet Elev =	7270.37	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7269.7	ft. elev.
	Culvert Length in Feet	L =	80	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.84
Sum of All Loss Coefficients	K_s =	2.04
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0342

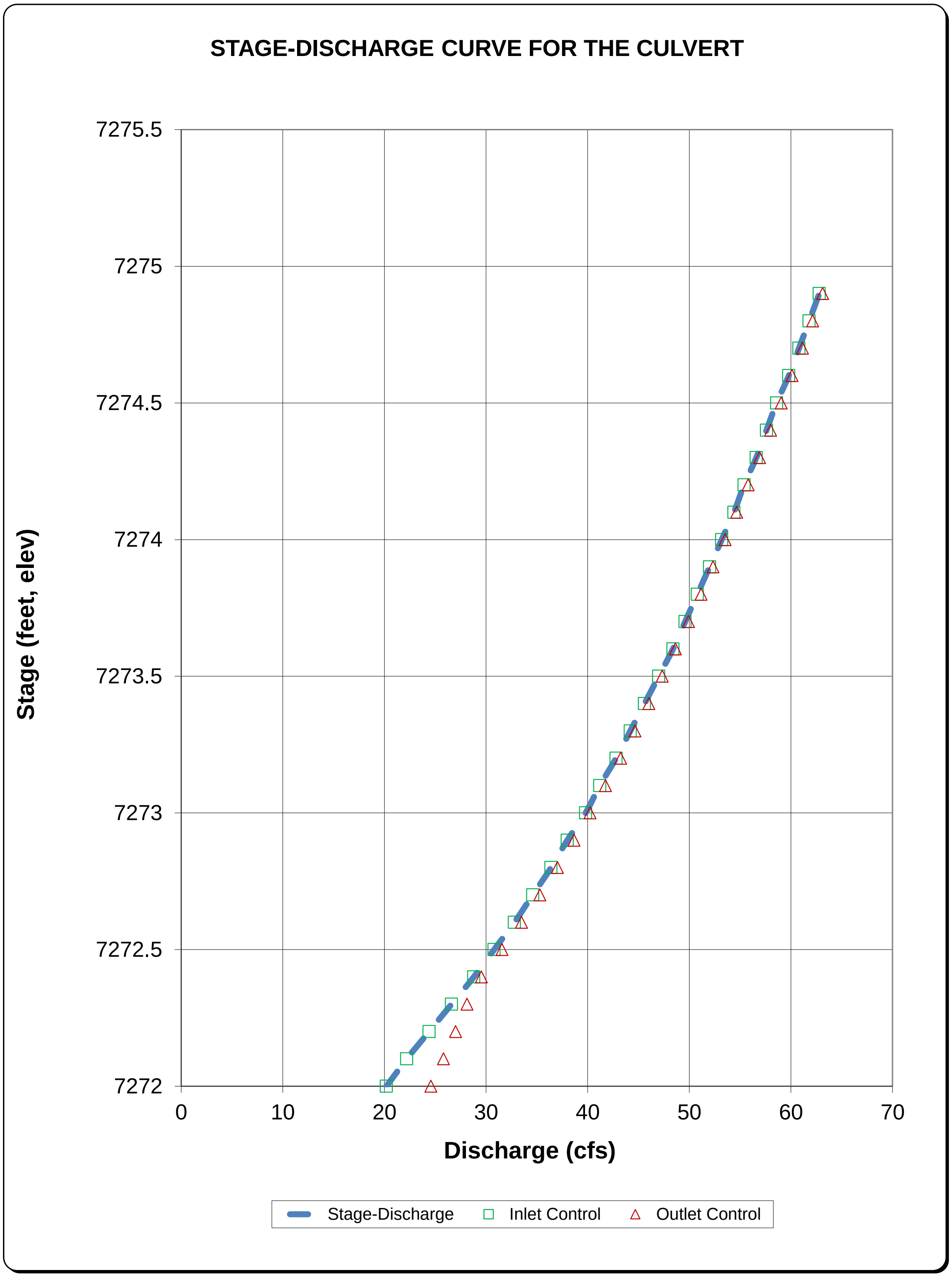
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
7272.00		20.20	24.58	**20.20**	Regression Eqn.	INLET
7272.10		22.20	25.81	**22.20**	Regression Eqn.	INLET
7272.20		24.40	27.00	**24.40**	Regression Eqn.	INLET
7272.30		26.60	28.13	**26.60**	Regression Eqn.	INLET
7272.40		28.80	29.54	**28.80**	Regression Eqn.	INLET
7272.50		30.80	31.58	**30.80**	Regression Eqn.	INLET
7272.60		32.80	33.49	**32.80**	Regression Eqn.	INLET
7272.70		34.60	35.30	**34.60**	Regression Eqn.	INLET
7272.80		36.40	37.03	**36.40**	Regression Eqn.	INLET
7272.90		38.00	38.67	**38.00**	Regression Eqn.	INLET
7273.00		39.80	40.24	**39.80**	Regression Eqn.	INLET
7273.10		41.20	41.76	**41.20**	Regression Eqn.	INLET
7273.20		42.80	43.24	**42.80**	Regression Eqn.	INLET
7273.30		44.20	44.65	**44.20**	Regression Eqn.	INLET
7273.40		45.60	46.02	**45.60**	Regression Eqn.	INLET
7273.50		47.00	47.35	**47.00**	Regression Eqn.	INLET
7273.60		48.40	48.65	**48.40**	Regression Eqn.	INLET
7273.70		49.60	49.93	**49.60**	Regression Eqn.	INLET
7273.80		50.80	51.16	**50.80**	Regression Eqn.	INLET
7273.90		52.00	52.35	**52.00**	Regression Eqn.	INLET
7274.00		53.20	53.54	**53.20**	Regression Eqn.	INLET
7274.10		54.40	54.68	**54.40**	Regression Eqn.	INLET
7274.20		55.40	55.80	**55.40**	Regression Eqn.	INLET
7274.30		56.60	56.92	**56.60**	Regression Eqn.	INLET
7274.40		57.60	58.00	**57.60**	Regression Eqn.	INLET
7274.50		58.60	59.05	**58.60**	Regression Eqn.	INLET
7274.60		59.80	60.11	**59.80**	Regression Eqn.	INLET
7274.70		60.80	61.14	**60.80**	Regression Eqn.	INLET
7274.80		61.80	62.15	**61.80**	Regression Eqn.	INLET
7274.90		62.80	63.14	**62.80**	Regression Eqn.	INLET

Processing Time: 00.87 Seconds

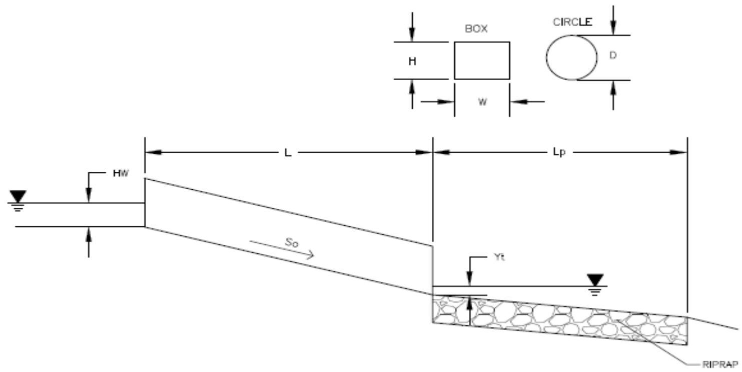
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts



Soil Type:
Choose One:
(●) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

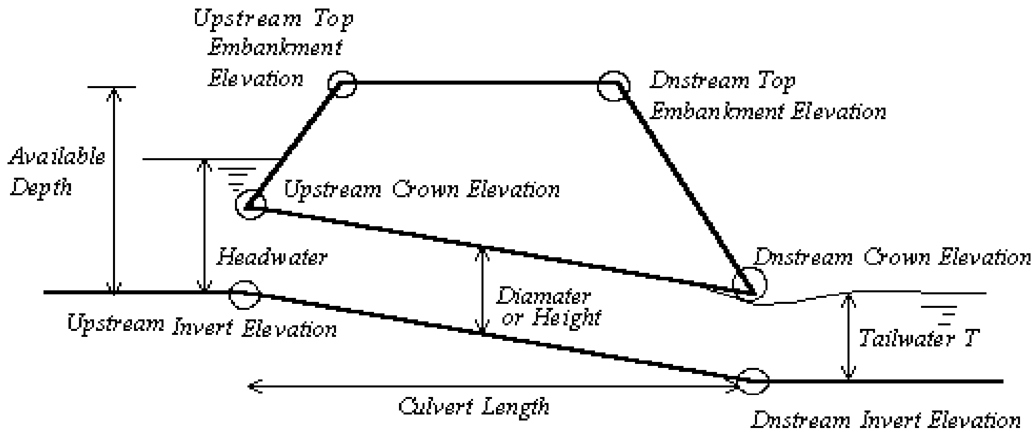
Design Discharge	Q =	17.75	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	2	
Inlet Elevation	Elev IN =	7270.37	ft
Outlet Elevation **OR** Slope	Elev OUT =	7269.7	ft
Culvert Length	L =	80	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	1.77	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.99	
Sum of All Losses Coefficients	k_s =	2.19	ft
Culvert Normal Depth	Y_n =	0.91	ft
Culvert Critical Depth	Y_c =	1.06	ft
Tailwater Depth for Design	d =	1.53	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.46	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.57	$ft^{0.5}/s$
Froude Number	Fr =	1.34	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.55	
Inlet Control Headwater	HW_I =	1.52	ft
Outlet Control Headwater	HW_O =	1.13	ft
Design Headwater Elevation	**HW =**	**7,271.89**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.76**	
Minimum Theoretical Riprap Size	d_{50} =	3	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**6**	**ft**
Width of Protection	**T =**	**3**	**ft**

Vertical Profile for the Culvert

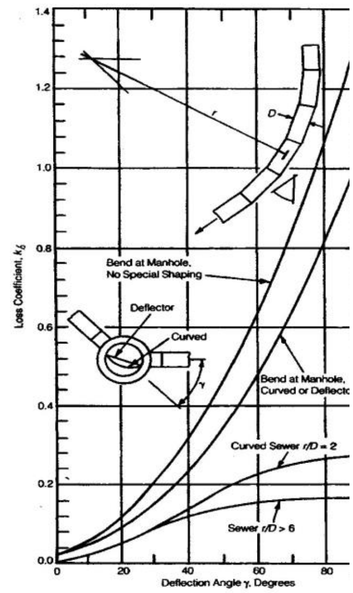
Project = Timberridge Estates
Box ID = Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	24.00	inches
Barrel Length	L =	80.00	ft
Barrel Invert Slope	So =	0.0084	ft/ft
Downstream Invert Elevation	EDI =	7269.70	ft
Downstream Top Embankment Elevation	EDT =	7272.70	ft
Upstream Top Embankment Elevation	EUT =	7273.40	ft
Design Headwater Depth (not elev.)	Hw =	1.53	ft
Tailwater Depth (not elev.)	Yt =	0.56	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	3.03	ft
Design Hw/D ratio	Hw/D =	0.77	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7270.37	ft
Upstream Crown Elevation	EUC =	7272.37	ft
Upstream Soil Cover Depth	Upsoil =	1.03	ft
Downstream Invert Elevation	EDI =	7269.70	ft
Downstream Crown Elevation	EDC =	7271.70	ft
Downstream Soil Cover Depth	Dnsoil =	1.00	ft

CIRCULAR (SHAPE = 1) SUMMARY OF SHAPES, MATERIALS, SIZES, & "n"

Matl CODE	SPANS (in.)	NO. OF CULVERTS	DEFAULT CORRUG.	DEF. "n"	ENTRANCE (ITYPE)	INLET EDGE (CI)	EQUATION NUMBER-IC	HDS 5 CHT#-SCALE
1-RCP	8-144	29,p96ac		.012	1-Conv	1-sq. proj.	8	(not used)
						3-headwall	9	1-1
						4-groove	4	1-3
						5-groove,hd	5	1-2
						6-1:1 bevel	6	3-A
						7-1.5 bev.	7	3-B
2-CSP	12-96	17,p49ai	2.7x.5	.024	1-Conv	1-thin	1	2-3
	54-144	16,p50ai	3x1	.028		2-mitered	2	2-2
	54-144	16,p50ai	5x1	.026		3-headwall	3	2-1
	60-312	43,p58ai	6x2	.035		6-1.1 bevel	6	3-A
						7-1.5 bevel	7	3-B
3-CAP	12-84	16,p39ka	2.7x.5	.024	1-Conv	(Same as CSP)		
	30-120	16,p39ka	3x1	.028				
	48-120	13,p39ka	6x1	.025				
	60-252	33,p39ka	9x2.5	.035				
ALL	See Inlet Control Procedures For Equations				2-Side (Cir)	1-thin	face, side	56-3
						2-square		56-2
						3-bevel		56-1
					3-Side	see box	face, side	58-1/2
					4-slope	see box	face, slope	59-1/2



Values of Kb

ai = AISI, Handbook of Steel Drainage & Highway Construction Products, 1983
ka = Kaiser Aluminum, Hydraulic Design Detail, DP-131, Edition 2, 1984

EQ	EDGE	KE	SR	A	BS	C	DIP	EE	F
1	thin	0.9	0.5	0.187321	0.56771	-0.156544	0.0447052	-0.00343602	8.97E-05
2	mitered	0.7	0	0.107137	0.757789	-0.361462	0.1233932	-0.01606422	7.67E-04
3	headwall	0.5	0.5	0.167433	0.538595	-0.149374	0.0391543	-0.00343974	1.16E-04
4	groove	0.2	0.5	0.108786	0.662381	-0.233801	0.0579585	-0.0055789	2.05E-04
5	grv.hdw.	0.2	0.5	0.114099	0.653562	-0.233615	0.0597723	-0.00616338	2.43E-04
6	1.1-bev.	0.2	0.5	0.063343	0.766512	-0.316097	0.0876701	-0.009836951	4.17E-04
7	1.5-bev.	0.2	0.5	0.08173	0.698353	-0.253683	0.065125	-0.0071975	3.12E-04
8	sq.-proj.	0.2	0.5	0.167287	0.558766	-0.159813	0.0420069	-0.00369252	1.25E-04
9	headwall	0.5	0.5	0.087483	0.706578	-0.253295	0.0667001	-0.00661651	2.51E-04
10	end-sect.	0.4	0.5	0.120659	0.630768	-0.218423	0.0591815	-0.00599169	2.29E-04

EQ #'s: REFERENCE
1-9 : Calculator Design Series (CDS) 3 for TI-59, FHWA, 198O, page 60
1-10: Hydraulic Computer Program (HY) 1, FHWA, 1969, page 18

BOX (SHAPE = 2) SUMMARY OF SHAPES, MATERIALS, SIZES, & "n"

Matl CODE	SPAN RANGE	RISE RANGE	DEF. "n"	ENTRANCE (ITYPE)	INLET EDGE (CI)	EQUATION NUMBER-IC	HDS 5 CHT#-SCALE
1-RCB	4'-15'	4'-20'	.012	1-Conv	1-square	1	10-1
					2-1.5 bev	2	10-3
					3-1.1 bev	3	10-2
					4-30-75sq	4	8-1
					5-90-15sq	1	8-2
					6-0 sq	5	8-3
					7-1.5 bev	6	9-2
					8-bevel	6	9-1
All	See Inlet Control Procedures For Equations			2-Side	1&2-square	face, side	58-1
					3&4-bevel		58-2
				4-Slope	1&2-square	face, slope	59-1
					3&4-bevel		59-2

ac = ACPA, Concrete Pipe Design Manual, February 1985

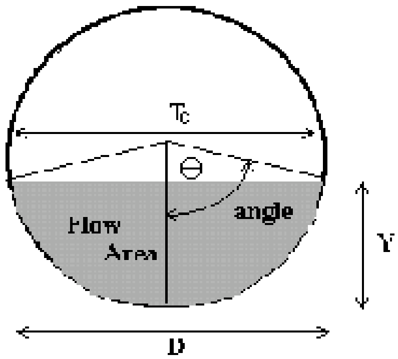
EQ	EDGE	KE	SR	A	BS	C	DIP	EE	F
1	square	0.5	0.5	0.122117	0.505435	-0.10856	0.0207809	-1.37E-03	3.46E-05
2	1.5-bev.	0.2	0.5	0.0967588	0.4551575	-0.08128951	0.01215577	-6.78E-04	0.0000148
3	1.1-bev.	0.2	0.5	0.1566086	0.3989353	-0.06403921	0.01120135	-0.0006449	1.46E-05
4	sq-30/75	0.4	0.5	0.0724927	0.507087	-0.117474	0.0221702	-1.49E-03	0.000038
5	square	0.7	0.5	0.144133	0.461363	-0.0921507	0.0200028	-1.36E-03	0.0000358
6	bevel	0.2	0.5	0.0895633	0.4412465	-0.07434981	0.01273183	-0.0007588	1.77E-05

EQ #'s: REFERENCE
1-6: Hydraulic Computer Program (HY) 6, FHWA, 1969, subroutine BEQUA
1,4,5: Hydraulic Computer Program (HY) 3, FHWA, 1969, page 16
1,3,4,6: Calculator Design Series (CDS) 3 for TI-59, FHWA, 198O, page 16

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **TIMBERRIDGE ESTATES**

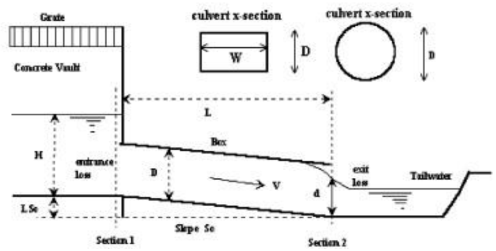
Pipe ID: **Design Point 4 (4.7 cfs) - 24" RCP**



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	**Q =**	**4.70**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	22.68	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.18	radians
Flow area	An =	0.83	sq ft
Top width	Tn =	1.85	ft
Wetted perimeter	Pn =	2.36	ft
Flow depth	Yn =	0.62	ft
Flow velocity	Vn =	5.69	fps
Discharge	Qn =	4.70	cfs
Percent Full Flow	Flow =	20.7%	of full flow
Normal Depth Froude Number	Fr_n =	1.50	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.33	radians
Critical flow area	Ac =	1.10	sq ft
Critical top width	Tc =	1.94	ft
Critical flow depth	Yc =	0.76	ft
Critical flow velocity	Vc =	4.27	fps
Critical Depth Froude Number	Fr_c =	1.00	

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Design Point 4 (4.7 cfs) - 24" RCP
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	7272	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7271.39	ft. elev.
	Culvert Length in Feet	L =	61	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.75
Sum of All Loss Coefficients	K_s =	1.95
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0342

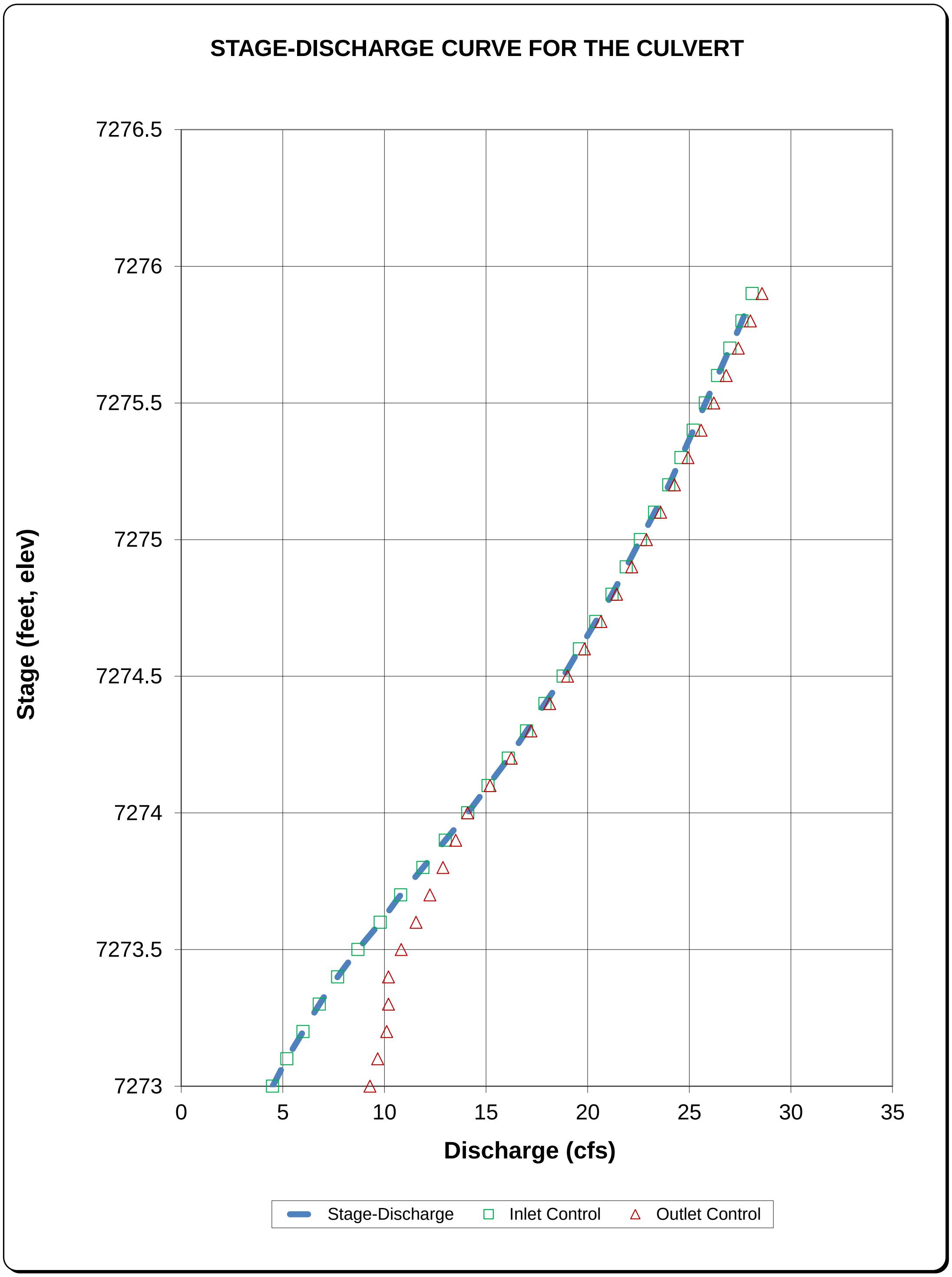
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
7273.00		4.50	9.29	**4.50**	Min. Energy. Eqn.	INLET
7273.10		5.20	9.67	**5.20**	Regression Eqn.	INLET
7273.20		6.00	10.11	**6.00**	Regression Eqn.	INLET
7273.30		6.80	10.20	**6.80**	Regression Eqn.	INLET
7273.40		7.70	10.20	**7.70**	Regression Eqn.	INLET
7273.50		8.70	10.82	**8.70**	Regression Eqn.	INLET
7273.60		9.80	11.56	**9.80**	Regression Eqn.	INLET
7273.70		10.80	12.24	**10.80**	Regression Eqn.	INLET
7273.80		11.90	12.88	**11.90**	Regression Eqn.	INLET
7273.90		13.00	13.51	**13.00**	Regression Eqn.	INLET
7274.00		14.10	14.09	**14.09**	Regression Eqn.	OUTLET
7274.10		15.10	15.20	**15.10**	Regression Eqn.	INLET
7274.20		16.10	16.24	**16.10**	Regression Eqn.	INLET
7274.30		17.00	17.22	**17.00**	Regression Eqn.	INLET
7274.40		17.90	18.13	**17.90**	Regression Eqn.	INLET
7274.50		18.80	19.01	**18.80**	Regression Eqn.	INLET
7274.60		19.60	19.85	**19.60**	Regression Eqn.	INLET
7274.70		20.40	20.65	**20.40**	Regression Eqn.	INLET
7274.80		21.20	21.42	**21.20**	Regression Eqn.	INLET
7274.90		21.90	22.17	**21.90**	Regression Eqn.	INLET
7275.00		22.60	22.89	**22.60**	Regression Eqn.	INLET
7275.10		23.30	23.60	**23.30**	Regression Eqn.	INLET
7275.20		24.00	24.27	**24.00**	Regression Eqn.	INLET
7275.30		24.60	24.94	**24.60**	Regression Eqn.	INLET
7275.40		25.20	25.59	**25.20**	Regression Eqn.	INLET
7275.50		25.80	26.21	**25.80**	Regression Eqn.	INLET
7275.60		26.40	26.82	**26.40**	Regression Eqn.	INLET
7275.70		27.00	27.42	**27.00**	Regression Eqn.	INLET
7275.80		27.60	28.01	**27.60**	Regression Eqn.	INLET
7275.90		28.10	28.58	**28.10**	Regression Eqn.	INLET

Processing Time: 00.64 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

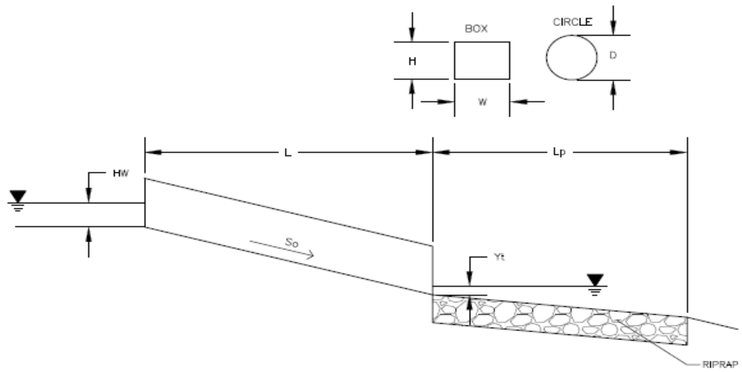
Project: Timberridge Estates
Basin ID: Design Point 4 (4.7 cfs) - 24" RCP



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates

Basin ID: Design Point 4 (4.7 cfs) - 24" RCP



Soil Type:
Choose One:
(•) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

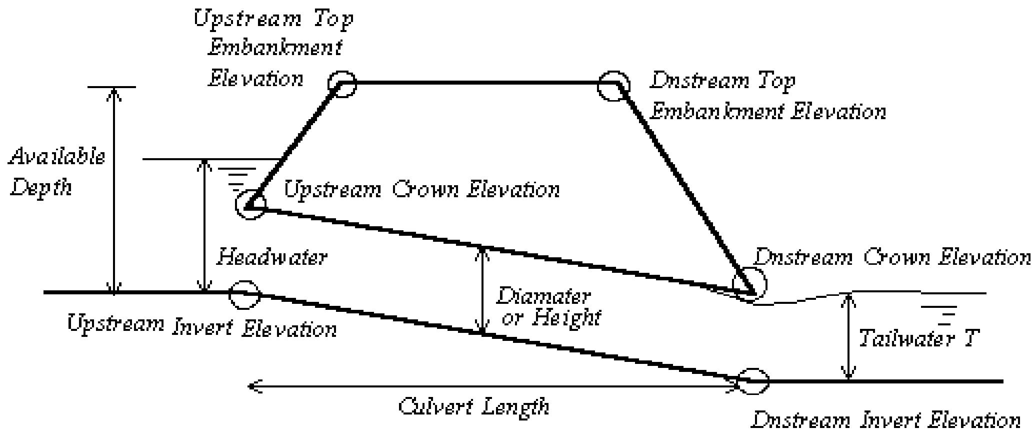
Design Discharge	Q =	4.7	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7272	ft
Outlet Elevation **OR** Slope	Elev OUT =	7271.39	ft
Culvert Length	L =	61	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	0.94	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.75	
Sum of All Losses Coefficients	k_s =	1.95	ft
Culvert Normal Depth	Y_n =	0.62	ft
Culvert Critical Depth	Y_c =	0.76	ft
Tailwater Depth for Design	d =	1.38	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.31	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	0.83	$ft^{0.5}/s$
Froude Number	Fr =	1.50	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.61	
Inlet Control Headwater	HW_I =	1.05	ft
Outlet Control Headwater	HW_O =	0.84	
Design Headwater Elevation	**HW =**	**7,273.05**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.52**	
Minimum Theoretical Riprap Size	d_{50} =	2	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	L_p =	**6**	**ft**
Width of Protection	**T =**	**3**	**ft**

Vertical Profile for the Culvert

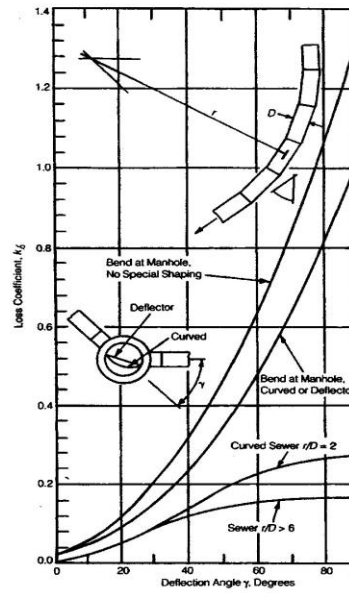
Project = **Timberridge Estates**
Box ID = **Design Point 4 (4.7 cfs) - 24" RCP**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	24.00	inches
Barrel Length	L =	61.00	ft
Barrel Invert Slope	So =	0.0100	ft/ft
Downstream Invert Elevation	EDI =	7271.39	ft
Downstream Top Embankment Elevation	EDT =	7275.00	ft
Upstream Top Embankment Elevation	EUT =	7275.00	ft
Design Headwater Depth (not elev.)	Hw =	1.05	ft
Tailwater Depth (not elev.)	Yt =	0.61	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	3.00	ft
Design Hw/D ratio	Hw/D =	0.53	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7272.00	ft
Upstream Crown Elevation	EUC =	7274.00	ft
Upstream Soil Cover Depth	Upsoil =	1.00	ft
Downstream Invert Elevation	EDI =	7271.39	ft
Downstream Crown Elevation	EDC =	7273.39	ft
Downstream Soil Cover Depth	Dnsoil =	1.61	ft

CIRCULAR (SHAPE = 1) SUMMARY OF SHAPES, MATERIALS, SIZES, & "n"

Matl CODE	SPANS (in.)	NO. OF CULVERTS	DEFAULT CORRUG.	DEF. "n"	ENTRANCE (ITYPE)	INLET EDGE (CI)	EQUATION NUMBER-IC	HDS 5 CHT#-SCALE
1-RCP	8-144	29,p96ac		.012	1-Conv	1-sq. proj.	8	(not used)
						3-headwall	9	1-1
						4-groove	4	1-3
						5-groove,hd	5	1-2
						6-1:1 bevel	6	3-A
						7-1.5 bev.	7	3-B
2-CSP	12-96	17,p49ai	2.7x.5	.024	1-Conv	1-thin	1	2-3
	54-144	16,p50ai	3x1	.028		2-mitered	2	2-2
	54-144	16,p50ai	5x1	.026		3-headwall	3	2-1
	60-312	43,p58ai	6x2	.035		6-1.1 bevel	6	3-A
						7-1.5 bevel	7	3-B
3-CAP	12-84	16,p39ka	2.7x.5	.024	1-Conv	(Same as CSP)		
	30-120	16,p39ka	3x1	.028				
	48-120	13,p39ka	6x1	.025				
	60-252	33,p39ka	9x2.5	.035				
ALL	See Inlet Control Procedures For Equations				2-Side (Cir)	1-thin	face, side	56-3
						2-square		56-2
						3-bevel		56-1
					3-Side	see box	face, side	58-1/2
					4-slope	see box	face, slope	59-1/2



Values of Kb

ai = AISI, Handbook of Steel Drainage & Highway Construction Products, 1983
ka = Kaiser Aluminum, Hydraulic Design Detail, DP-131, Edition 2, 1984

EQ	EDGE	KE	SR	A	BS	C	DIP	EE	F
1	thin	0.9	0.5	0.187321	0.56771	-0.156544	0.0447052	-0.00343602	8.97E-05
2	mitered	0.7	0	0.107137	0.757789	-0.361462	0.1233932	-0.01606422	7.67E-04
3	headwall	0.5	0.5	0.167433	0.538595	-0.149374	0.0391543	-0.00343974	1.16E-04
4	groove	0.2	0.5	0.108786	0.662381	-0.233801	0.0579585	-0.0055789	2.05E-04
5	grv.hdw.	0.2	0.5	0.114099	0.653562	-0.233615	0.0597723	-0.00616338	2.43E-04
6	1.1-bev.	0.2	0.5	0.063343	0.766512	-0.316097	0.0876701	-0.009836951	4.17E-04
7	1.5-bev.	0.2	0.5	0.08173	0.698353	-0.253683	0.065125	-0.0071975	3.12E-04
8	sq.-proj.	0.2	0.5	0.167287	0.558766	-0.159813	0.0420069	-0.00369252	1.25E-04
9	headwall	0.5	0.5	0.087483	0.706578	-0.253295	0.0667001	-0.00661651	2.51E-04
10	end-sect.	0.4	0.5	0.120659	0.630768	-0.218423	0.0591815	-0.00599169	2.29E-04

EQ #'s: REFERENCE
1-9 : Calculator Design Series (CDS) 3 for TI-59, FHWA, 198O, page 60
1-10: Hydraulic Computer Program (HY) 1, FHWA, 1969, page 18

BOX (SHAPE = 2) SUMMARY OF SHAPES, MATERIALS, SIZES, & "n"

Matl CODE	SPAN RANGE	RISE RANGE	DEF. "n"	ENTRANCE (ITYPE)	INLET EDGE (CI)	EQUATION NUMBER-IC	HDS 5 CHT#-SCALE
1-RCB	4'-15'	4'-20'	.012	1-Conv	1-square	1	10-1
					2-1.5 bev	2	10-3
					3-1.1 bev	3	10-2
					4-30-75sq	4	8-1
					5-90-15sq	1	8-2
					6-0 sq	5	8-3
					7-1.5 bev	6	9-2
					8-bevel	6	9-1
All	See Inlet Control Procedures For Equations			2-Side	1&2-square	face, side	58-1
					3&4-bevel		58-2
				4-Slope	1&2-square	face, slope	59-1
					3&4-bevel		59-2

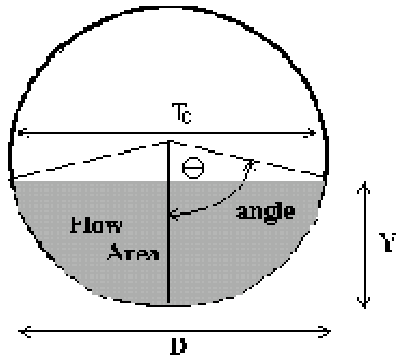
ac = ACPA, Concrete Pipe Design Manual, February 1985

EQ	EDGE	KE	SR	A	BS	C	DIP	EE	F
1	square	0.5	0.5	0.122117	0.505435	-0.10856	0.0207809	-1.37E-03	3.46E-05
2	1.5-bev.	0.2	0.5	0.0967588	0.4551575	-0.08128951	0.01215577	-6.78E-04	0.0000148
3	1.1-bev.	0.2	0.5	0.1566086	0.3989353	-0.06403921	0.01120135	-0.0006449	1.46E-05
4	sq-30/75	0.4	0.5	0.0724927	0.507087	-0.117474	0.0221702	-1.49E-03	0.000038
5	square	0.7	0.5	0.144133	0.461363	-0.0921507	0.0200028	-1.36E-03	0.0000358
6	bevel	0.2	0.5	0.0895633	0.4412465	-0.07434981	0.01273183	-0.0007588	1.77E-05

EQ #'s: REFERENCE
1-6: Hydraulic Computer Program (HY) 6, FHWA, 1969, subroutine BEQUA
1,4,5: Hydraulic Computer Program (HY) 3, FHWA, 1969, page 16
1,3,4,6: Calculator Design Series (CDS) 3 for TI-59, FHWA, 198O, page 16

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

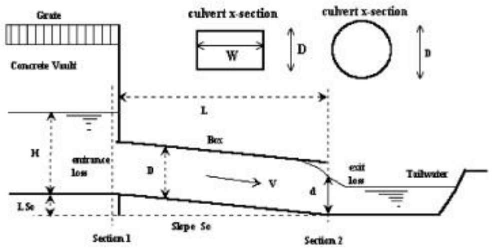
Project: **TIMBERRIDGE ESTATES**
Pipe ID: **Detention Basin Outlet (50.1 cfs) - 30" RCP**



Design Information (Input)			
Pipe Invert Slope	So =	0.0180	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	30.00	inches
Design discharge	**Q =**	**50.10**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	4.91	sq ft
Full-flow wetted perimeter	Pf =	7.85	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	55.18	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.09	radians
Flow area	An =	3.93	sq ft
Top width	Tn =	2.17	ft
Wetted perimeter	Pn =	5.22	ft
Flow depth	Yn =	1.87	ft
Flow velocity	Vn =	12.73	fps
Discharge	Qn =	50.10	cfs
Percent Full Flow	Flow =	90.8%	of full flow
Normal Depth Froude Number	Fr_n =	1.67	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.57	radians
Critical flow area	Ac =	4.73	sq ft
Critical top width	Tc =	1.35	ft
Critical flow depth	Yc =	2.30	ft
Critical flow velocity	Vc =	10.60	fps
Critical Depth Froude Number	Fr_c =	1.00	

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Detention Basin Outlet (50.1 cfs) - 30" RCP
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	30	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	7246.5	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7243.9	ft. elev.
	Culvert Length in Feet	L =	145	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	1.33
Sum of All Loss Coefficients	K_s =	2.53
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0628

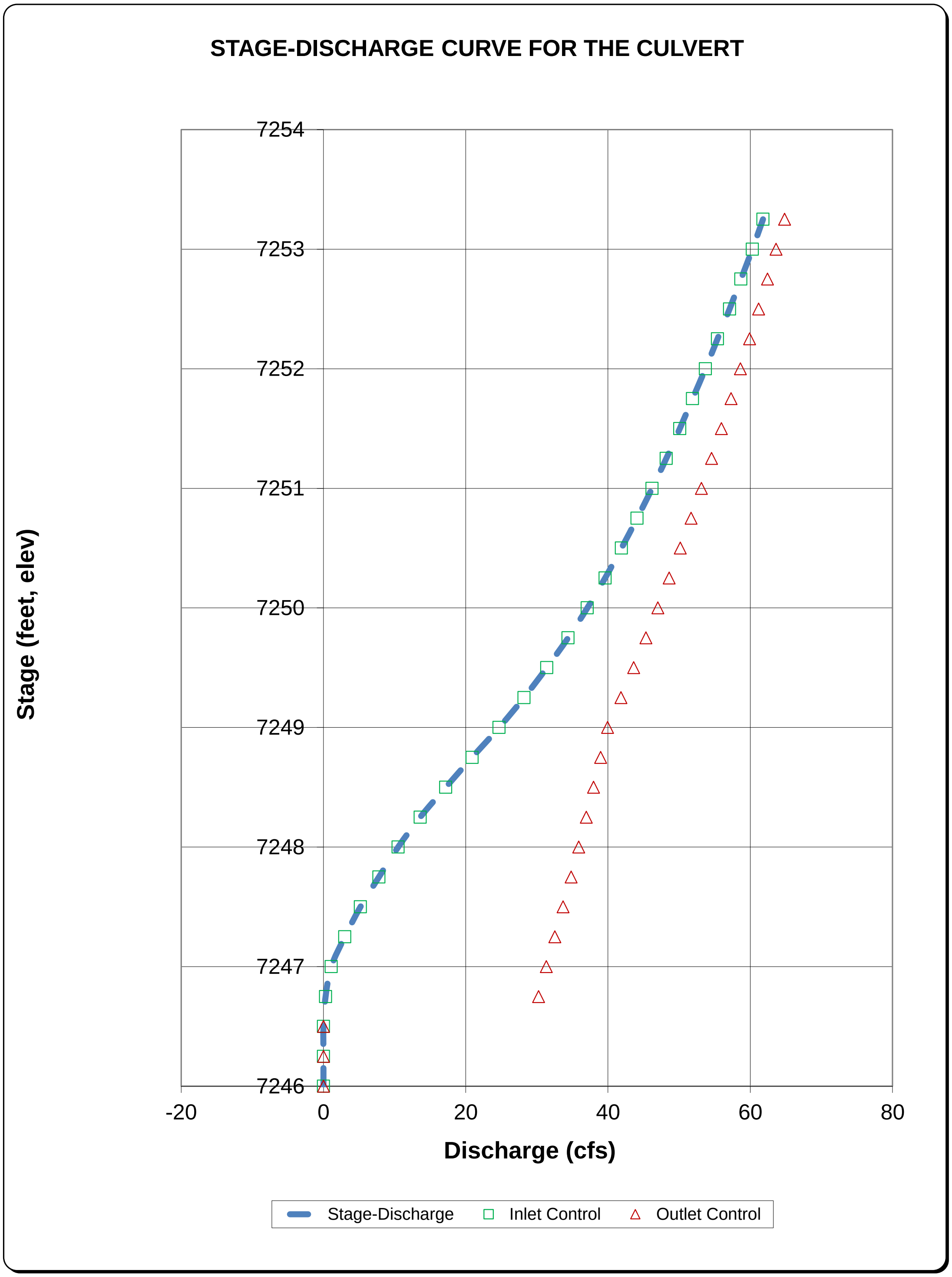
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
7246.00		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7246.25		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7246.50		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7246.75		0.30	30.24	**0.30**	Min. Energy. Eqn.	INLET
7247.00		1.10	31.33	**1.10**	Min. Energy. Eqn.	INLET
7247.25		3.00	32.54	**3.00**	Min. Energy. Eqn.	INLET
7247.50		5.20	33.70	**5.20**	Min. Energy. Eqn.	INLET
7247.75		7.80	34.82	**7.80**	Min. Energy. Eqn.	INLET
7248.00		10.50	35.89	**10.50**	Regression Eqn.	INLET
7248.25		13.60	36.96	**13.60**	Regression Eqn.	INLET
7248.50		17.20	37.98	**17.20**	Regression Eqn.	INLET
7248.75		20.90	38.97	**20.90**	Regression Eqn.	INLET
7249.00		24.70	39.96	**24.70**	Regression Eqn.	INLET
7249.25		28.20	41.83	**28.20**	Regression Eqn.	INLET
7249.50		31.40	43.61	**31.40**	Regression Eqn.	INLET
7249.75		34.40	45.34	**34.40**	Regression Eqn.	INLET
7250.00		37.10	47.02	**37.10**	Regression Eqn.	INLET
7250.25		39.60	48.61	**39.60**	Regression Eqn.	INLET
7250.50		41.90	50.17	**41.90**	Regression Eqn.	INLET
7250.75		44.10	51.68	**44.10**	Regression Eqn.	INLET
7251.00		46.20	53.14	**46.20**	Regression Eqn.	INLET
7251.25		48.20	54.57	**48.20**	Regression Eqn.	INLET
7251.50		50.10	55.94	**50.10**	Regression Eqn.	INLET
7251.75		51.90	57.31	**51.90**	Regression Eqn.	INLET
7252.00		53.70	58.63	**53.70**	Regression Eqn.	INLET
7252.25		55.40	59.92	**55.40**	Regression Eqn.	INLET
7252.50		57.10	61.19	**57.10**	Regression Eqn.	INLET
7252.75		58.70	62.42	**58.70**	Regression Eqn.	INLET
7253.00		60.30	63.63	**60.30**	Regression Eqn.	INLET
7253.25		61.80	64.84	**61.80**	Regression Eqn.	INLET

Processing Time: 00.71 Seconds

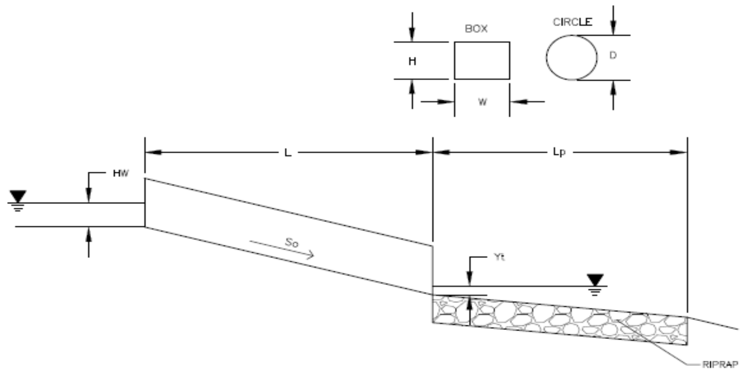
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Detention Basin Outlet (50.1 cfs) - 30" RCP



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: Detention Basin Outlet (50.1 cfs) - 30" RCP



Soil Type:
Choose One:
(●) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

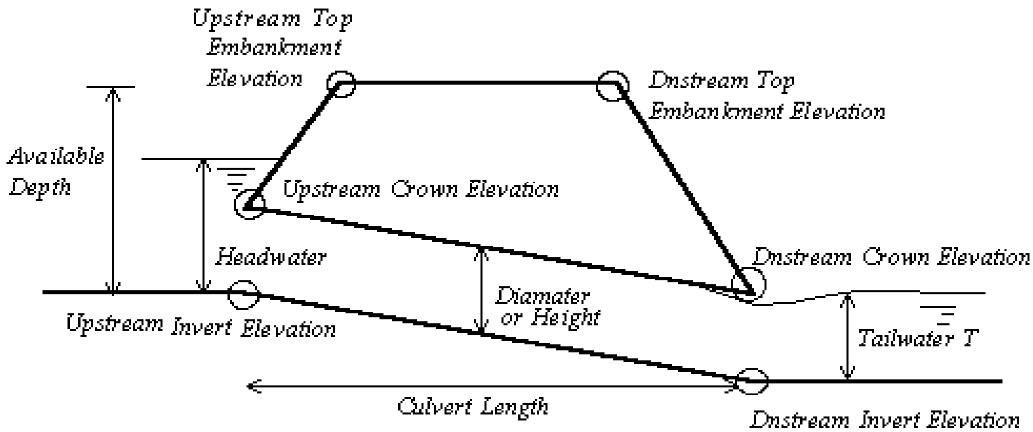
Design Discharge	Q =	50.1	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	30	inches
Inlet Edge Type (Choose from pull-down list)	Grooved End Projection		
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7246.5	ft
Outlet Elevation **OR** Slope	Elev OUT =	7243.9	ft
Culvert Length	L =	145	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	1.00	ft
Flow Area at Max Channel Velocity	A_t =	10.02	ft^2
Culvert Cross Sectional Area Available	A =	4.91	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.33	
Sum of All Losses Coefficients	k_s =	2.53	ft
Culvert Normal Depth	Y_n =	1.87	ft
Culvert Critical Depth	Y_c =	2.30	ft
Tailwater Depth for Design	d =	2.40	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	2.19	ft
Expansion Factor	1/(2*tan(Θ)) =	2.93	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	5.07	$ft^{0.5}/s$
Froude Number	Fr =	1.66	Supercritical!
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.46	
Inlet Control Headwater	HW_I =	5.01	ft
Outlet Control Headwater	HW_O =	3.89	
Design Headwater Elevation	**HW =**	**7,251.51**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**2.00**	**HW/D > 1.5!**
Minimum Theoretical Riprap Size	d_{50} =	11	in
Nominal Riprap Size	d_{50} =	12	in
UDFCD Riprap Type	**Type =**	**M**	
Length of Protection	**L_p =**	**23**	**ft**
Width of Protection	**T =**	**11**	**ft**

Vertical Profile for the Culvert

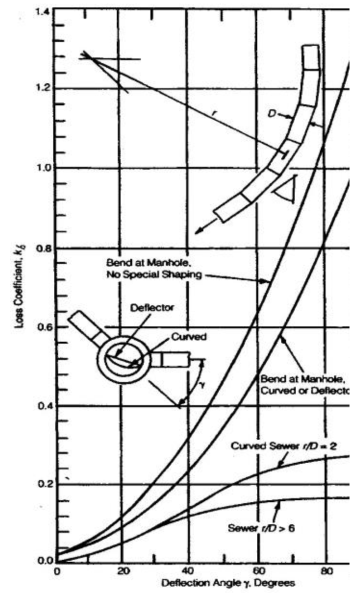
Project = **Timberridge Estates**
Box ID = **Detention Basin Outlet (50.1 cfs) - 30" RCP**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	30.00	inches
Barrel Length	L =	145.00	ft
Barrel Invert Slope	So =	0.0180	ft/ft
Downstream Invert Elevation	EDI =	7243.90	ft
Downstream Top Embankment Elevation	EDT =	7244.00	ft
Upstream Top Embankment Elevation	EUT =	7252.30	ft
Design Headwater Depth (not elev.)	Hw =	5.01	ft
Tailwater Depth (not elev.)	Yt =	0.46	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	5.79	ft
Design Hw/D ratio	Hw/D =	2.00	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7246.51	ft
Upstream Crown Elevation	EUC =	7249.01	ft
Upstream Soil Cover Depth	Upsoil =	3.29	ft
Downstream Invert Elevation	EDI =	7243.90	ft
Downstream Crown Elevation	EDC =	7246.40	ft
Downstream Soil Cover Depth	Dnsoil =	-2.40	ft

CIRCULAR (SHAPE = 1) SUMMARY OF SHAPES, MATERIALS, SIZES, & "n"

Matl CODE	SPANS (in.)	NO. OF CULVERTS	DEFAULT CORRUG.	DEF. "n"	ENTRANCE (ITYPE)	INLET EDGE (CI)	EQUATION NUMBER-IC	HDS 5 CHT#-SCALE
1-RCP	8-144	29,p96ac		.012	1-Conv	1-sq. proj.	8	(not used)
						3-headwall	9	1-1
						4-groove	4	1-3
						5-groove,hd	5	1-2
						6-1:1 bevel	6	3-A
						7-1.5 bev.	7	3-B
2-CSP	12-96	17,p49ai	2.7x.5	.024	1-Conv	1-thin	1	2-3
	54-144	16,p50ai	3x1	.028		2-mitered	2	2-2
	54-144	16,p50ai	5x1	.026		3-headwall	3	2-1
	60-312	43,p58ai	6x2	.035		6-1.1 bevel	6	3-A
						7-1.5 bevel	7	3-B
3-CAP	12-84	16,p39ka	2.7x.5	.024	1-Conv	(Same as CSP)		
	30-120	16,p39ka	3x1	.028				
	48-120	13,p39ka	6x1	.025				
	60-252	33,p39ka	9x2.5	.035				
ALL	See Inlet Control Procedures For Equations				2-Side (Cir)	1-thin	face, side	56-3
						2-square		56-2
						3-bevel		56-1
					3-Side	see box	face, side	58-1/2
					4-slope	see box	face, slope	59-1/2



Values of Kb

ai = AISI, Handbook of Steel Drainage & Highway Construction Products, 1983
ka = Kaiser Aluminum, Hydraulic Design Detail, DP-131, Edition 2, 1984

EQ	EDGE	KE	SR	A	BS	C	DIP	EE	F
1	thin	0.9	0.5	0.187321	0.56771	-0.156544	0.0447052	-0.00343602	8.97E-05
2	mitered	0.7	0	0.107137	0.757789	-0.361462	0.1233932	-0.01606422	7.67E-04
3	headwall	0.5	0.5	0.167433	0.538595	-0.149374	0.0391543	-0.00343974	1.16E-04
4	groove	0.2	0.5	0.108786	0.662381	-0.233801	0.0579585	-0.0055789	2.05E-04
5	grv.hdw.	0.2	0.5	0.114099	0.653562	-0.233615	0.0597723	-0.00616338	2.43E-04
6	1.1-bev.	0.2	0.5	0.063343	0.766512	-0.316097	0.0876701	-0.009836951	4.17E-04
7	1.5-bev.	0.2	0.5	0.08173	0.698353	-0.253683	0.065125	-0.0071975	3.12E-04
8	sq.-proj.	0.2	0.5	0.167287	0.558766	-0.159813	0.0420069	-0.00369252	1.25E-04
9	headwall	0.5	0.5	0.087483	0.706578	-0.253295	0.0667001	-0.00661651	2.51E-04
10	end-sect.	0.4	0.5	0.120659	0.630768	-0.218423	0.0591815	-0.00599169	2.29E-04

EQ #'s: REFERENCE
1-9 : Calculator Design Series (CDS) 3 for TI-59, FHWA, 198O, page 60
1-10: Hydraulic Computer Program (HY) 1, FHWA, 1969, page 18

BOX (SHAPE = 2) SUMMARY OF SHAPES, MATERIALS, SIZES, & "n"

Matl CODE	SPAN RANGE	RISE RANGE	DEF. "n"	ENTRANCE (ITYPE)	INLET EDGE (CI)	EQUATION NUMBER-IC	HDS 5 CHT#-SCALE
1-RCB	4'-15'	4'-20'	.012	1-Conv	1-square	1	10-1
					2-1.5 bev	2	10-3
					3-1.1 bev	3	10-2
					4-30-75sq	4	8-1
					5-90-15sq	1	8-2
					6-0 sq	5	8-3
					7-1.5 bev	6	9-2
					8-bevel	6	9-1
All	See Inlet Control Procedures For Equations			2-Side	1&2-square	face, side	58-1
					3&4-bevel		58-2
				4-Slope	1&2-square	face, slope	59-1
					3&4-bevel		59-2

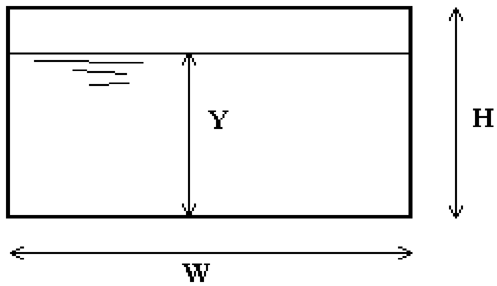
ac = ACPA, Concrete Pipe Design Manual, February 1985

EQ	EDGE	KE	SR	A	BS	C	DIP	EE	F
1	square	0.5	0.5	0.122117	0.505435	-0.10856	0.0207809	-1.37E-03	3.46E-05
2	1.5-bev.	0.2	0.5	0.0967588	0.4551575	-0.08128951	0.01215577	-6.78E-04	0.0000148
3	1.1-bev.	0.2	0.5	0.1566086	0.3989353	-0.06403921	0.01120135	-0.0006449	1.46E-05
4	sq-30/75	0.4	0.5	0.0724927	0.507087	-0.117474	0.0221702	-1.49E-03	0.000038
5	square	0.7	0.5	0.144133	0.461363	-0.0921507	0.0200028	-1.36E-03	0.0000358
6	bevel	0.2	0.5	0.0895633	0.4412465	-0.07434981	0.01273183	-0.0007588	1.77E-05

EQ #'s: REFERENCE
1-6: Hydraulic Computer Program (HY) 6, FHWA, 1969, subroutine BEQUA
1,4,5: Hydraulic Computer Program (HY) 3, FHWA, 1969, page 16
1,3,4,6: Calculator Design Series (CDS) 3 for TI-59, FHWA, 198O, page 16

BOX CONDUIT FLOW (Normal & Critical Depth Computation)

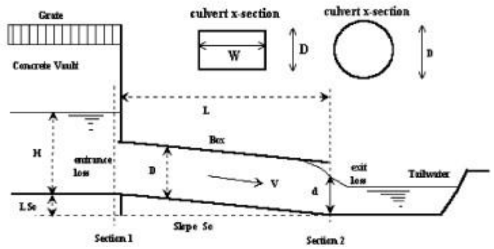
Project: **Timberridge Estates**
Box ID: **Arroya Lane Crossing Sand Creek (2,170 cfs) - 3-6'x12' Conc Box Culverts**



Design Information (Input)			
Box conduit invert slope	So =	0.0100	ft/ft
Box Manning's n-value	n =	0.0130	
Box Width	W =	12.00	ft
Box Height	H =	6.00	ft
Design discharge	**Q =**	**723.00**	**cfs**
Full-flow capacity (Calculated)			
Full-flow area	Af =	72.00	sq ft
Full-flow wetted perimeter	Pf =	36.00	ft
Full-flow capacity	Qf =	1309.97	cfs
Calculations of Normal Flow Condition			
Normal flow depth (<H)	Yn =	3.21	ft
Flow area	An =	38.56	sq ft
Wetted perimeter	Pn =	18.43	ft
Flow velocity	Vn =	18.75	fps
Discharge	Qn =	723.02	cfs
Percent Full	Flow =	55.2%	of full flow
Normal Depth Froude Number	Fr_n =	1.84	supercritical
Calculation of Critical Flow Condition			
Critical flow depth	Yc =	4.83	ft
Critical flow area	Ac =	57.97	sq ft
Critical flow velocity	Vc =	12.47	fps
Critical Depth Froude Number	Fr_c =	1.00	

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Timberridge Estates**
Basin ID: **Arroya Lane Crossing Sand Creek (2,170 cfs) - 3-6'x12' Conc Box Culverts**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =		inches
	Inlet Edge Type (choose from pull-down list)		Grooved End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =	6.00	ft.
	Barrel Width (Span) in Feet	Width (Span) =	12.00	ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	3	
	Inlet Elevation at Culvert Invert	Inlet Elev =	7233	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7232	ft. elev.
	Culvert Length in Feet	L =	100	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	0.29
Sum of All Loss Coefficients	K_s =	1.79
Orifice Inlet Condition Coefficient	C_d =	0.82
Minimum Energy Condition Coefficient	KE_{low} =	0.4004

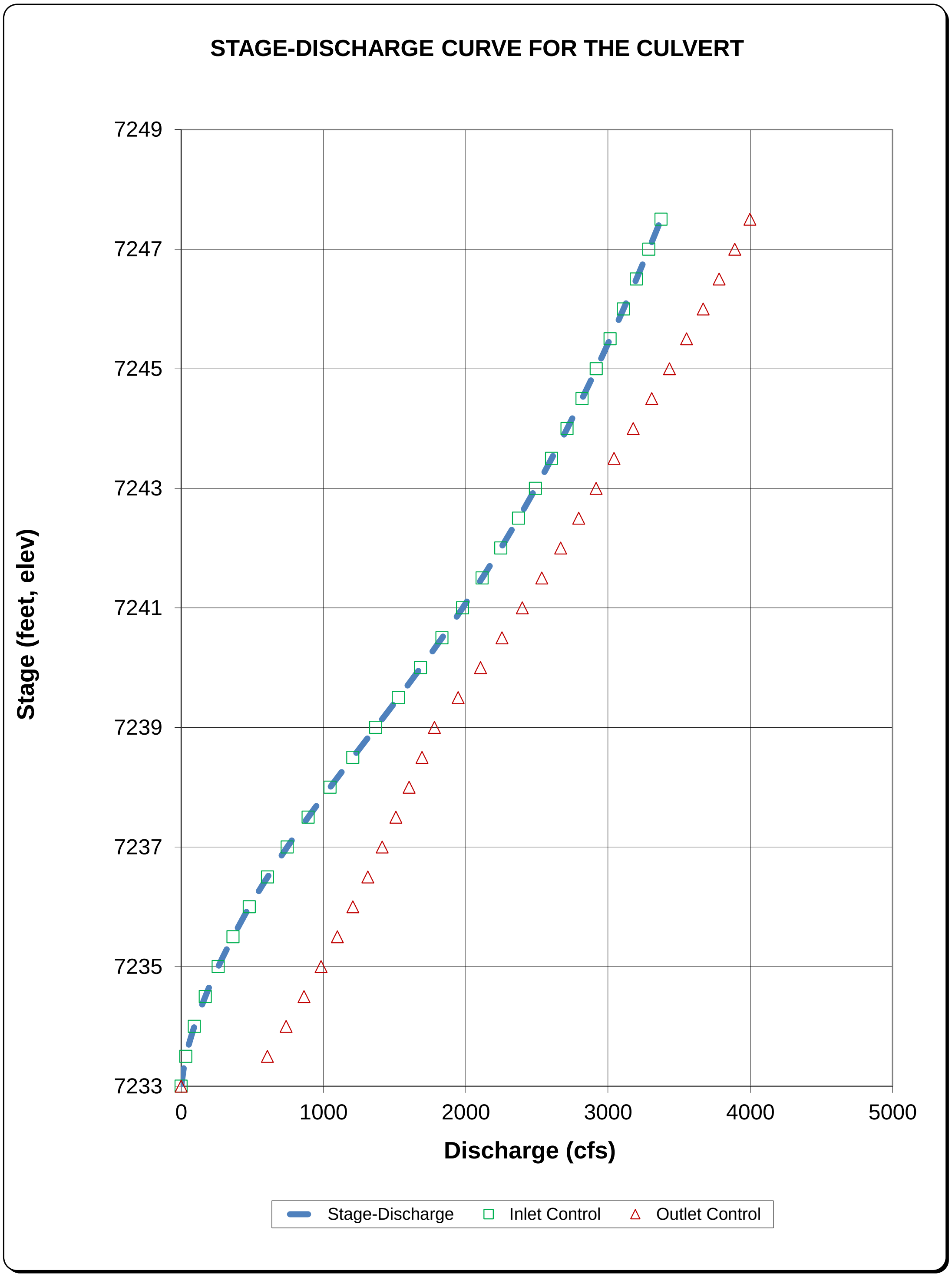
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
7233.00		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7233.50		32.70	605.74	**32.70**	Min. Energy. Eqn.	INLET
7234.00		92.40	737.63	**92.40**	Min. Energy. Eqn.	INLET
7234.50		169.50	863.44	**169.50**	Min. Energy. Eqn.	INLET
7235.00		260.70	983.37	**260.70**	Min. Energy. Eqn.	INLET
7235.50		364.50	1,097.81	**364.50**	Min. Energy. Eqn.	INLET
7236.00		479.10	1,207.17	**479.10**	Min. Energy. Eqn.	INLET
7236.50		607.50	1,312.01	**607.50**	Regression Eqn.	INLET
7237.00		745.50	1,412.54	**745.50**	Regression Eqn.	INLET
7237.50		892.80	1,509.35	**892.80**	Regression Eqn.	INLET
7238.00		1,047.30	1,602.63	**1,047.30**	Regression Eqn.	INLET
7238.50		1,206.60	1,692.77	**1,206.60**	Regression Eqn.	INLET
7239.00		1,367.70	1,780.18	**1,367.70**	Regression Eqn.	INLET
7239.50		1,527.30	1,947.14	**1,527.30**	Regression Eqn.	INLET
7240.00		1,683.30	2,104.90	**1,683.30**	Regression Eqn.	INLET
7240.50		1,833.90	2,255.01	**1,833.90**	Regression Eqn.	INLET
7241.00		1,978.20	2,398.26	**1,978.20**	Regression Eqn.	INLET
7241.50		2,115.60	2,535.44	**2,115.60**	Regression Eqn.	INLET
7242.00		2,246.70	2,667.52	**2,246.70**	Regression Eqn.	INLET
7242.50		2,371.50	2,794.51	**2,371.50**	Regression Eqn.	INLET
7243.00		2,490.60	2,917.38	**2,490.60**	Regression Eqn.	INLET
7243.50		2,604.30	3,042.41	**2,604.30**	Regression Eqn.	INLET
7244.00		2,713.20	3,177.82	**2,713.20**	Regression Eqn.	INLET
7244.50		2,817.90	3,307.55	**2,817.90**	Regression Eqn.	INLET
7245.00		2,918.40	3,432.39	**2,918.40**	Regression Eqn.	INLET
7245.50		3,015.30	3,552.91	**3,015.30**	Regression Eqn.	INLET
7246.00		3,109.20	3,669.31	**3,109.20**	Regression Eqn.	INLET
7246.50		3,199.80	3,782.19	**3,199.80**	Regression Eqn.	INLET
7247.00		3,287.70	3,891.93	**3,287.70**	Regression Eqn.	INLET
7247.50		3,373.20	3,998.54	**3,373.20**	Regression Eqn.	INLET

Processing Time: 00.70 Seconds

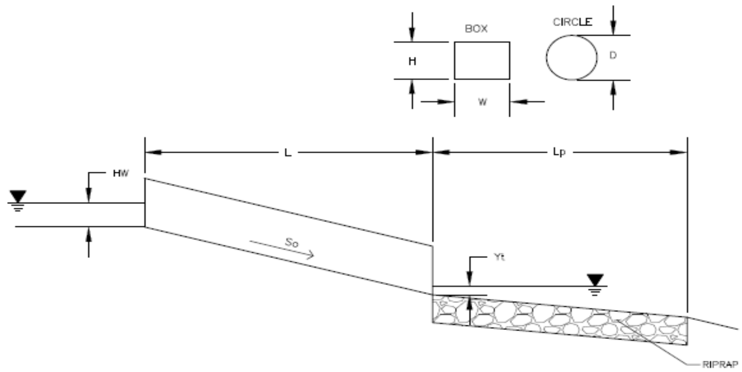
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Arroya Lane Crossing Sand Creek (2,170 cfs) - 3-6'x12' Conc Box Culverts



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: Arroya Lane Crossing Sand Creek (2,170 cfs) - 3-6'x12' Conc Box Culverts



Soil Type:
Choose One:
(●) Sandy
( ) Non-Sandy

Supercritical Flow! Using Ha to calculate protection type.

Design Information (Input):

Design Discharge	Q =	2170	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =		inches
Inlet Edge Type (Choose from pull-down list)			
Box Culvert:		OR	
Barrel Height (Rise) in Feet	Height (Rise) =	6	ft
Barrel Width (Span) in Feet	Width (Span) =	12	ft
Inlet Edge Type (Choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
Number of Barrels	No =	3	
Inlet Elevation	Elev IN =	7233	ft
Outlet Elevation **OR** Slope	Elev OUT =	7232	ft
Culvert Length	L =	100	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

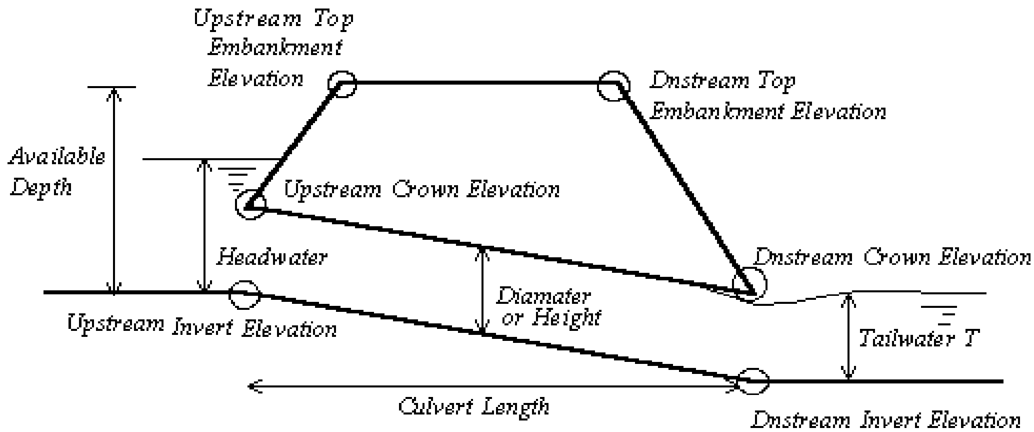
Required Protection (Output):

Tailwater Surface Height	Y_t =	2.40	ft
Flow Area at Max Channel Velocity	A_t =	144.67	ft^2
Culvert Cross Sectional Area Available	A =	72.00	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.29	
Sum of All Losses Coefficients	k_s =	1.79	ft
Culvert Normal Depth	Y_n =	3.21	ft
Culvert Critical Depth	Y_c =	4.83	ft
Tailwater Depth for Design	d =	5.42	ft
Adjusted Diameter **OR** Adjusted Rise	H_a =	4.61	ft
Expansion Factor	1/(2*tan(Θ)) =	4.34	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/WH^1.5 =	4.10	$ft^{0.5}/s$
Froude Number	Fr =	1.84	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/H =	0.52	
Inlet Control Headwater	HW_I =	8.70	ft
Outlet Control Headwater	HW_O =	7.21	ft
Design Headwater Elevation	**HW =**	**7,241.71**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/H =**	**1.45**	
Minimum Theoretical Riprap Size	d_{50} =	9	in
Nominal Riprap Size	d_{50} =	9	in
UDFCD Riprap Type	**Type =**	**M**	
Length of Protection	**L_p =**	**60**	**ft**
Width of Protection	**T =**	**26**	**ft**

Reference DCM Section 6.4.2. This is a box culvert classified as a bridge. Address freeboard requirements. Provide calcs for FEMA flows unless a LOMR with lower flows has been approved. (Also would be a FEMA floodplain to north if studied.)

Vertical Profile for the Culvert

Project = **Timberridge Estates**
Box ID = **Arroya Lane Crossing Sand Creek (2,170 cfs) - 3-6'x12' Conc Box Culverts**

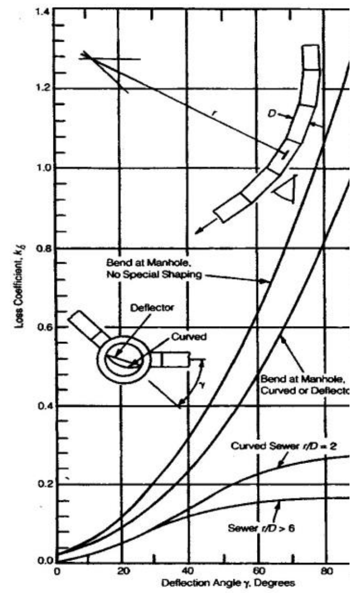


Culvert Information (Input)			
Barrel Diameter or Height	D or H =	72.00	inches
Barrel Length	L =	100.00	ft
Barrel Invert Slope	So =	0.0100	ft/ft
Downstream Invert Elevation	EDI =	7232.00	ft
Downstream Top Embankment Elevation	EDT =	7244.00	ft
Upstream Top Embankment Elevation	EUT =	7244.00	ft
Design Headwater Depth (not elev.)	Hw =	8.70	ft
Tailwater Depth (not elev.)	Yt =	0.52	ft

Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	11.00	ft
Design Hw/D ratio	Hw/D =	1.45	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7233.00	ft
Upstream Crown Elevation	EUC =	7239.00	ft
Upstream Soil Cover Depth	Upsoil =	5.00	ft
Downstream Invert Elevation	EDI =	7232.00	ft
Downstream Crown Elevation	EDC =	7238.00	ft
Downstream Soil Cover Depth	Dnsoil =	6.00	ft

CIRCULAR (SHAPE = 1) SUMMARY OF SHAPES, MATERIALS, SIZES, & "n"

Matl CODE	SPANS (in.)	NO. OF CULVERTS	DEFAULT CORRUG.	DEF. "n"	ENTRANCE (ITYPE)	INLET EDGE (CI)	EQUATION NUMBER-IC	HDS 5 CHT#-SCALE
1-RCP	8-144	29,p96ac		.012	1-Conv	1-sq. proj.	8	(not used)
						3-headwall	9	1-1
						4-groove	4	1-3
						5-groove,hd	5	1-2
						6-1:1 bevel	6	3-A
						7-1.5 bev.	7	3-B
2-CSP	12-96	17,p49ai	2.7x.5	.024	1-Conv	1-thin	1	2-3
	54-144	16,p50ai	3x1	.028		2-mitered	2	2-2
	54-144	16,p50ai	5x1	.026		3-headwall	3	2-1
	60-312	43,p58ai	6x2	.035		6-1.1 bevel	6	3-A
						7-1.5 bevel	7	3-B
3-CAP	12-84	16,p39ka	2.7x.5	.024	1-Conv	(Same as CSP)		
	30-120	16,p39ka	3x1	.028				
	48-120	13,p39ka	6x1	.025				
	60-252	33,p39ka	9x2.5	.035				
ALL	See Inlet Control Procedures For Equations				2-Side (Cir)	1-thin	face, side	56-3
						2-square		56-2
						3-bevel		56-1
					3-Side	see box	face, side	58-1/2
					4-slope	see box	face, slope	59-1/2



Values of Kb

ai = AISI, Handbook of Steel Drainage & Highway Construction Products, 1983
ka = Kaiser Aluminum, Hydraulic Design Detail, DP-131, Edition 2, 1984

EQ	EDGE	KE	SR	A	BS	C	DIP	EE	F
1	thin	0.9	0.5	0.187321	0.56771	-0.156544	0.0447052	-0.00343602	8.97E-05
2	mitered	0.7	0	0.107137	0.757789	-0.361462	0.1233932	-0.01606422	7.67E-04
3	headwall	0.5	0.5	0.167433	0.538595	-0.149374	0.0391543	-0.00343974	1.16E-04
4	groove	0.2	0.5	0.108786	0.662381	-0.233801	0.0579585	-0.0055789	2.05E-04
5	grv.hdw.	0.2	0.5	0.114099	0.653562	-0.233615	0.0597723	-0.00616338	2.43E-04
6	1.1-bev.	0.2	0.5	0.063343	0.766512	-0.316097	0.0876701	-0.009836951	4.17E-04
7	1.5-bev.	0.2	0.5	0.08173	0.698353	-0.253683	0.065125	-0.0071975	3.12E-04
8	sq.-proj.	0.2	0.5	0.167287	0.558766	-0.159813	0.0420069	-0.00369252	1.25E-04
9	headwall	0.5	0.5	0.087483	0.706578	-0.253295	0.0667001	-0.00661651	2.51E-04
10	end-sect.	0.4	0.5	0.120659	0.630768	-0.218423	0.0591815	-0.00599169	2.29E-04

EQ #'s: REFERENCE
1-9 : Calculator Design Series (CDS) 3 for TI-59, FHWA, 198O, page 60
1-10: Hydraulic Computer Program (HY) 1, FHWA, 1969, page 18

BOX (SHAPE = 2) SUMMARY OF SHAPES, MATERIALS, SIZES, & "n"

Matl CODE	SPAN RANGE	RISE RANGE	DEF. "n"	ENTRANCE (ITYPE)	INLET EDGE (CI)	EQUATION NUMBER-IC	HDS 5 CHT#-SCALE
1-RCB	4'-15'	4'-20'	.012	1-Conv	1-square	1	10-1
					2-1.5 bev	2	10-3
					3-1.1 bev	3	10-2
					4-30-75sq	4	8-1
					5-90-15sq	1	8-2
					6-0 sq	5	8-3
					7-1.5 bev	6	9-2
					8-bevel	6	9-1
All	See Inlet Control Procedures For Equations			2-Side	1&2-square	face, side	58-1
					3&4-bevel		58-2
				4-Slope	1&2-square	face, slope	59-1
					3&4-bevel		59-2

ac = ACPA, Concrete Pipe Design Manual, February 1985

EQ	EDGE	KE	SR	A	BS	C	DIP	EE	F
1	square	0.5	0.5	0.122117	0.505435	-0.10856	0.0207809	-1.37E-03	3.46E-05
2	1.5-bev.	0.2	0.5	0.0967588	0.4551575	-0.08128951	0.01215577	-6.78E-04	0.0000148
3	1.1-bev.	0.2	0.5	0.1566086	0.3989353	-0.06403921	0.01120135	-0.0006449	1.46E-05
4	sq-30/75	0.4	0.5	0.0724927	0.507087	-0.117474	0.0221702	-1.49E-03	0.000038
5	square	0.7	0.5	0.144133	0.461363	-0.0921507	0.0200028	-1.36E-03	0.0000358
6	bevel	0.2	0.5	0.0895633	0.4412465	-0.07434981	0.01273183	-0.0007588	1.77E-05

EQ #'s: REFERENCE
1-6: Hydraulic Computer Program (HY) 6, FHWA, 1969, subroutine BEQUA
1,4,5: Hydraulic Computer Program (HY) 3, FHWA, 1969, page 16
1,3,4,6: Calculator Design Series (CDS) 3 for TI-59, FHWA, 198O, page 16

TIMBERRIDGE ESTATES
NORTHEAST AND SOUTHWEST FORBAY WALL NOTCH

Wall Notch

Notch to releae 3% of the undetained 100-year peak discharge

100-y peak discharge	=	82.161	cfs
2%	=	1.64	cfs

The general form of the equation for horizontal crested weirs is Q = CLH3/2 where:

Q = Weir flow discharge (cfs)	**1.64**	
C = Weir flow coefficient	3.4	
H = Depth of flow over the weir (ft)	1.00	Opening Height
L = Length of the weir (ft)	**0.48**	Length
L = Length of the weir (in)	**6**	

Notch to releae 2% of the undetained 100-year peak discharge is 6"
wide by 12" high

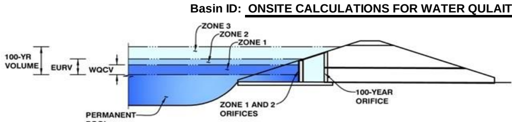
DETENTION CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: TIMBERRIDGE ESTATES

Basin ID: ONSITE CALCULATIONS FOR WATER QULAITY CAPTURE VOLUME ONLY



Example Zone Configuration (Retention Pond)

Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	**EDB**			
Watershed Area =	46.70	acres		
Watershed Length =	2,040	ft		
Watershed Slope =	0.020	ft/ft		
Watershed Imperviousness =	5.69%	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 =	User Input			
Water Quality Capture Volume (WQCV) =	0.158	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.239	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.155	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.253	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.785	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.577	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.686	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	5.134	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3 in.) =	7.573	acre-feet	3.00	inches
Approximate 2-yr Detention Volume =	0.144	acre-feet		
Approximate 5-yr Detention Volume =	0.237	acre-feet		
Approximate 10-yr Detention Volume =	0.653	acre-feet		
Approximate 25-yr Detention Volume =	0.984	acre-feet		
Approximate 50-yr Detention Volume =	1.007	acre-feet		
Approximate 100-yr Detention Volume =	1.339	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.158	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.080	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.100	acre-feet
Total Detention Basin Volume =	1.339	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 = 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	--	--	--	405	0.009		
	--	0.33	--	--	--	521	0.012	148	0.003
	--	1.00	--	--	--	6,408	0.147	2,410	0.055
	--	3.00	--	--	--	15,296	0.351	24,178	0.555
	--	5.00	--	--	--	19,725	0.453	59,199	1.359
	--	7.00	--	--	--	23,887	0.548	103,657	2.380
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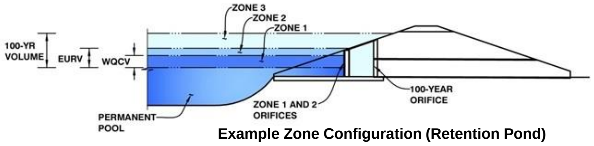
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: TIMBERRIDGE ESTATES

Basin ID: ONSITE CALCULATIONS FOR WATER QULAITY CAPTURE VOLUME ONLY



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.58	0.158	Orifice Plate
Zone 2 (EURV)	1.94	0.080	Orifice Plate
Zone 3 (100-year)	4.96	1.100	Weir&Pipe (Restrict)
		1.339	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 =	1.94	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	7.76	inches
Orifice Plate: Orifice Area per Row =	0.81	sq. inches (diameter = 1 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	5.625E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00					
Orifice Area (sq. inches)	0.81	0.81	0.81					

	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 =	1.94	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	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 =	1.94	N/A	feet
Over Flow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	2.28	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	11.20	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.60	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	30.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	4.91	N/A	ft^2
Outlet Orifice Centroid =	1.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.30	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	40.00	feet
Spillway End Slopes =	8.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.70	feet
Stage at Top of Freeboard =	7.00	feet
Basin Area at Top of Freeboard =	0.57	acres

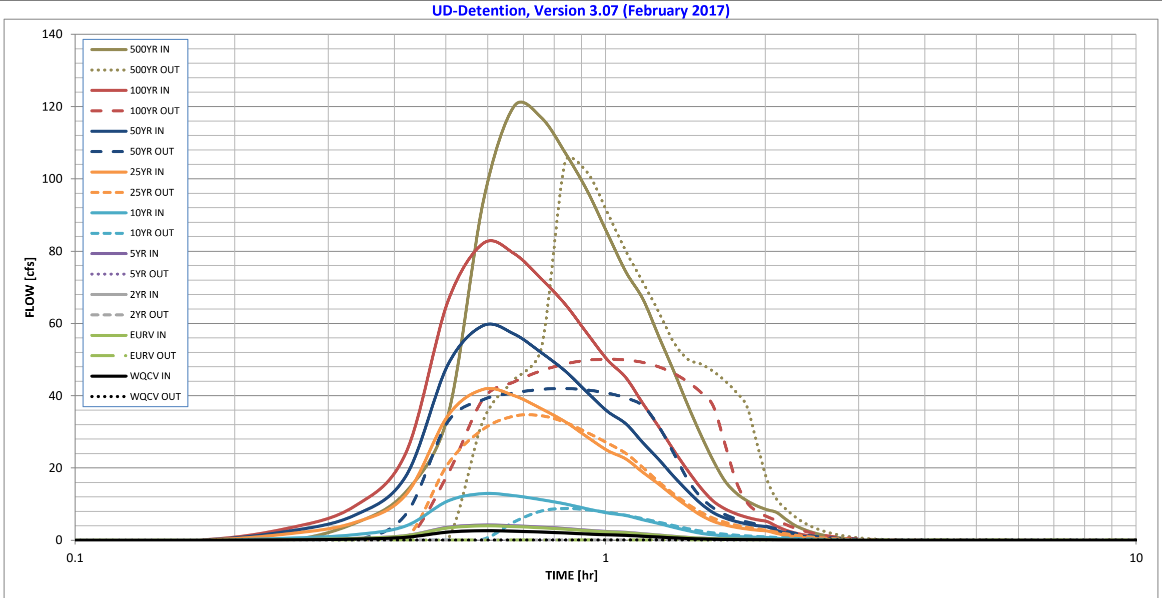
Routed Hydrograph Results

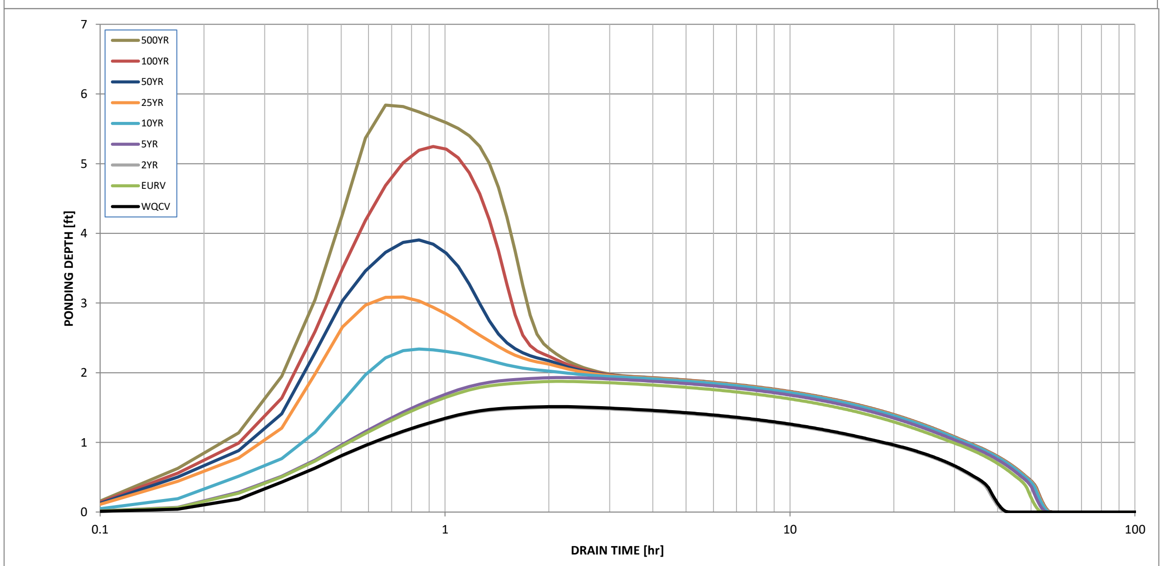
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.00
Calculated Runoff Volume (acre-ft) =	0.158	0.239	0.155	0.253	0.785	2.577	3.686	5.134	7.573
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.158	0.239	0.155	0.252	0.786	2.578	3.687	5.134	7.576
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.20	0.66	0.91	1.23	1.73
Predevelopment Peak Q (cfs) =	0.0	0.0	0.6	1.0	9.3	30.8	42.6	57.3	80.9
Peak Inflow Q (cfs) =	2.6	4.0	2.6	4.2	12.9	41.8	59.4	82.2	120.1
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	8.8	34.5	42.0	50.1	104.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.9	1.1	1.0	0.9	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.8	3.1	3.7	4.5	4.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	46	37	48	42	28	22	15	5
Time to Drain 99% of Inflow Volume (hours) =	**40**	50	39	51	49	42	38	34	29
Maximum Ponding Depth (ft) =	1.51	1.88	1.50	1.93	2.34	3.09	3.90	5.25	5.84
Area at Maximum Ponding Depth (acres) =	0.20	0.24	0.20	0.24	0.28	0.36	0.40	0.47	0.50
Maximum Volume Stored (acre-ft) =	0.145	0.223	0.143	0.238	0.343	0.583	0.892	1.469	1.755

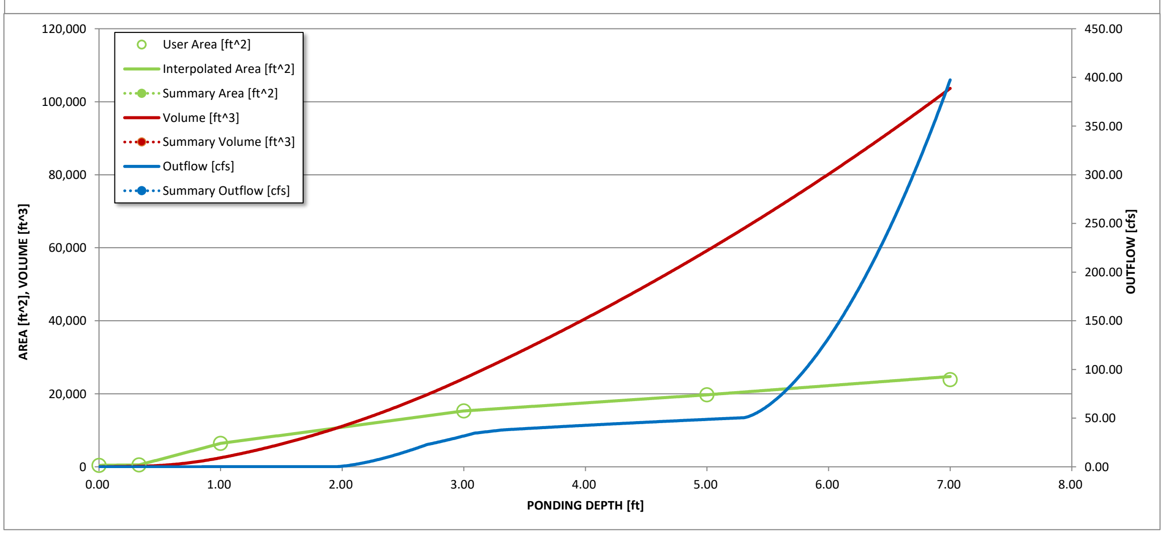
High velocity
= potential
safety issue.

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



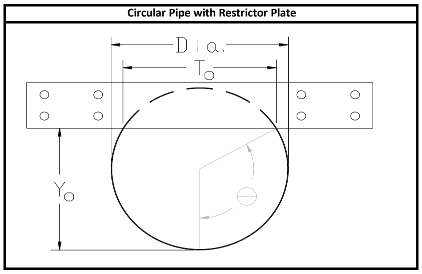




S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Reference Figures and Equations

Circular Pipe with Restrictor Plate



WQ Elliptical Slot Weir (Alternative to WQ Orifice Plate for Large Watersheds)

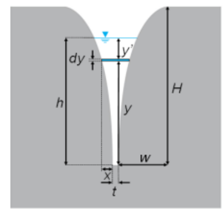
$$f(y)=\sqrt{2g(h-y)}\left[2\frac{H}{R}\left(1-1\sqrt{1-\frac{y^2}{H^2}}\right)+t\right]$$

$$Q_{app}=0.3015h\left[f(0)+f(0.603h)\right]+0.1415h\left[f(0.603h)+f(0.886h)\right]+0.0570h\left[f(0.886h)\right]$$

Orifice Equations

$$Q=C_d A_t\sqrt{2g\left(h-C_y\right)}$$

$$A_t=H(2W+t)-\frac{\pi HW}{2} \qquad C_y=\frac{\frac{H}{2}(2W+t)-\frac{2HW}{3}}{2W+t-\frac{\pi W}{2}}$$



- dy = elementary flow vertical distance [L];
- h = total flow depth [L];
- H = total weir height and semi-major ellipse axis [L];
- t = weir gap thickness [L];
- W = semi-minor ellipse axis [L];
- x = horizontal distance along the ellipse shape [L];
- y = vertical depth measured from the weir crest to the elementary flow strip [L]; and
- y' = vertical distance measured from the water surface to the elementary flow strip [L].

Watershed Runoff Volume Calculations

$$WQCV=\frac{A}{12}*a[0.91I^3-1.19I^2+0.78I]$$

$$EURV=A[0.140I^{1.28}*A\%+0.113I^{1.08}*B\%+0.100I^{1.08}]$$

$$V_{Runoff\_2yr}=P_1A[(0.084I^{1.440})A\%+(0.084I^{1.173})B\%+(0.084I^{1.094})CD\%]$$

$$V_{Runoff\_5yr}=P_1A[(0.084I^{1.350})A\%+(0.077I+0.007)B\%+(0.070I+0.014)CD\%]$$

$$V_{Runoff\_10yr}=P_1A[(0.085I^{1.220})A\%+(0.069I+0.016)B\%+(0.061I+0.024)CD\%]$$

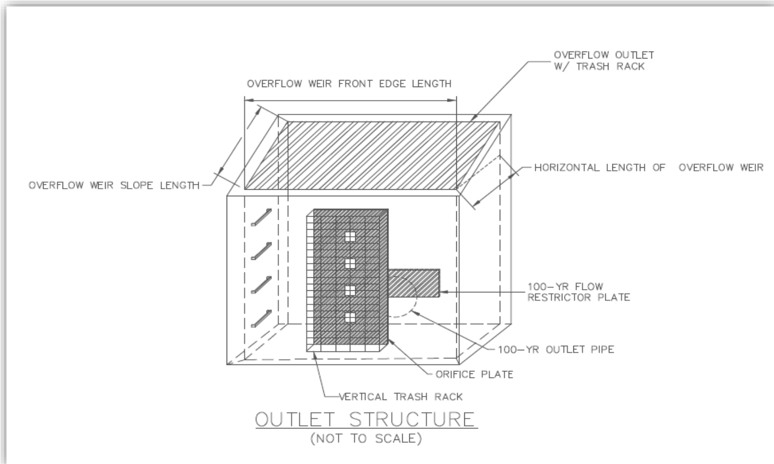
$$V\_{Runoff\_25yr}=P_1A[(0.082I+0.004)A\%+(0.055I+0.031)B\%+(0.048I+0.038)CD\%]$$

$$V_{Runoff\_50yr}=P_1A[(0.078I+0.009)A\%+(0.049I+0.038)B\%+(0.044I+0.043)CD\%]$$

$$V_{Runoff\_100yr}=P_1A[(0.073I+0.015)A\%+(0.043I+0.045)B\%+(0.038I+0.050)CD\%]$$

$$V_{Runoff\_500yr}=P_1A[(0.064I+0.025)A\%+(0.036I+0.053)B\%+(0.031I+0.058)CD\%]$$

Where *WQCV* is the water quality capture volume (acre-ft), EURV is the excess urban runoff volume (acre-ft), $V_{\#yr}$ is the volume for the given return period (acre-ft), a is a coefficient corresponding to WQCV drain time (1.0 for 40 hours, 0.9 for 24 hours, and 0.8 for 12 hours), P_1 is the one-hour rainfall depth (in), A is the contributing watershed area (acres), I is the percentage imperviousness (expressed as a decimal), *A%*, *B%*, and *CD%* are the percent of each hydraulic soil group (expressed as a decimal).



Basin Volume Calculations

Initial Surcharge Volume:

$$ISV=0.003WQCV \qquad L_{ISV}=\sqrt{A_{ISV}}$$

$$A_{ISV}=\frac{ISV}{ISD} \qquad W_{ISV}=\sqrt{A_{ISV}}$$

Where *ISV* is the initial surcharge volume (ft^3), A_{ISV} is *ISV* surface area (ft^2), *ISD* is the initial surcharge depth (ft, typically 0.33 to 0.50), and L_{ISV} and W_{ISV} are the length and width of the *ISV* (ft).

Basin Floor Volume:

$$L_{floor}=L_{ISV}+\frac{H_{floor}}{S_{TC}}+H_{floor}(S_{main}) \qquad W_{floor}=W_{ISV}+\frac{H_{floor}}{R_{L:W}(S_{TC})}$$

$$A_{floor}=L_{floor}\left(W_{floor}\right)$$

$$V_{floor}=\frac{H_{floor}}{3}\left(A_{ISV}+A_{floor}+\sqrt{A_{ISV}\left(A_{floor}\right)}\right)$$

Where L_{floor} and W_{floor} (ft) are the length and width of the basin floor section at the point where the top of the basin floor section meets the toe of the basin main section, H_{floor} is the depth of the basin floor section (ft), S_{TC} is the trickle channel slope (ft/ft), S_{main} is the side slope of the basin main section (H:V; e.g., 4 if the horizontal:vertical ratio is 4:1), $R_{L:W}$ is the basin length:width ratio (e.g., 2 if the basin length is twice the basin width), A_{floor} is top area of the basin floor section (ft^2), and V_{floor} is volume of the basin floor section (ft^3).

Main Basin Volume:

$$L_{main}=L_{floor}+2H_{main}(S_{main}) \qquad A_{main}=L_{main}(W_{main})$$

$$W_{main}=W_{floor}+2H_{main}(S_{main})$$

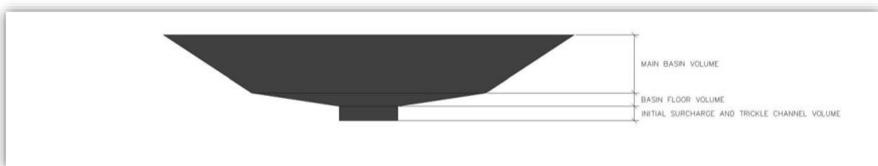
$$V_{main}=\frac{H_{main}}{3}\left(A_{main}+A_{floor}+\sqrt{A_{main}\left(A_{floor}\right)}\right)$$

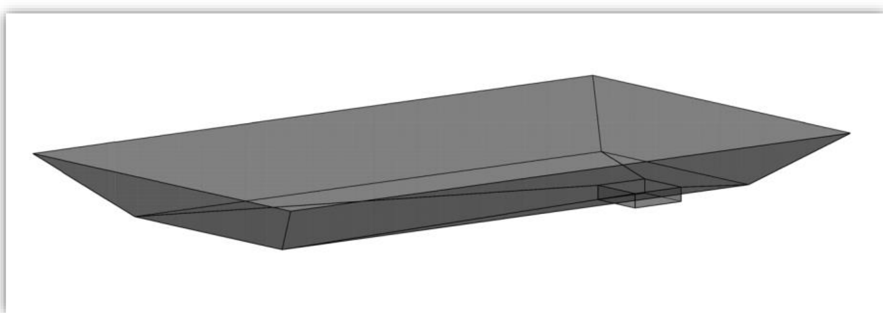
Where L_{main} and W_{main} (ft) are the length and width of the main basin section at the point at the top of the basin, H_{main} is the depth of the main basin section (ft), A_{main} is top area of the main basin section (ft^2), and V_{main} is volume of the main basin section (ft^3).

Total Basin Volume:

$$V_{total}=ISV+A_{ISV}\cdot D_{TC}+V_{floor}+V_{main}$$

Where V_{total} is the volume of the total basin (ft^3) and D_{TC} is the depth of the trickle channel (ft).





DRAINAGE MAPS

TIMBERRIDGE ESTATES

EXISTING DRAINAGE PLAN

JUNE 2018

EXISTING CONDITIONS

BASIN	ACRES	Q5 CFS	Q100 CFS
EX-E1	35.30	6.5	46.1
OS-4	12.99	2.9	21.3
OS-4A	2.98	0.9	6.5
OS-4B	7.76	1.8	12.7

DESIGN POINT SUMMARY

DP	CONTRIBUTING BASINS	AREA AC.	Q5 CFS	Q10 CFS	Q100 CFS
OS-1	OS-4	13.20	3.0	---	21.7
OS-2	OS-4A	3.00	0.9	---	6.5
OS-3	OS-4B	7.50	1.7	---	12.3
EX-1	EX-E1, OS-4, OS4A & OS4B	59.00	17.8	---	78.0
SC-1*	SAND CREEK DRAINAGE BASIN	---	---	630	2,170

*THIS POINT IS FOR THE SAND CREEK CHANNEL, FLOWS PER KIOWA DBPS

LEGEND

P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)

D — DESIGN POINT

BASIN BOUNDARY

EXISTING 2' CONTOUR

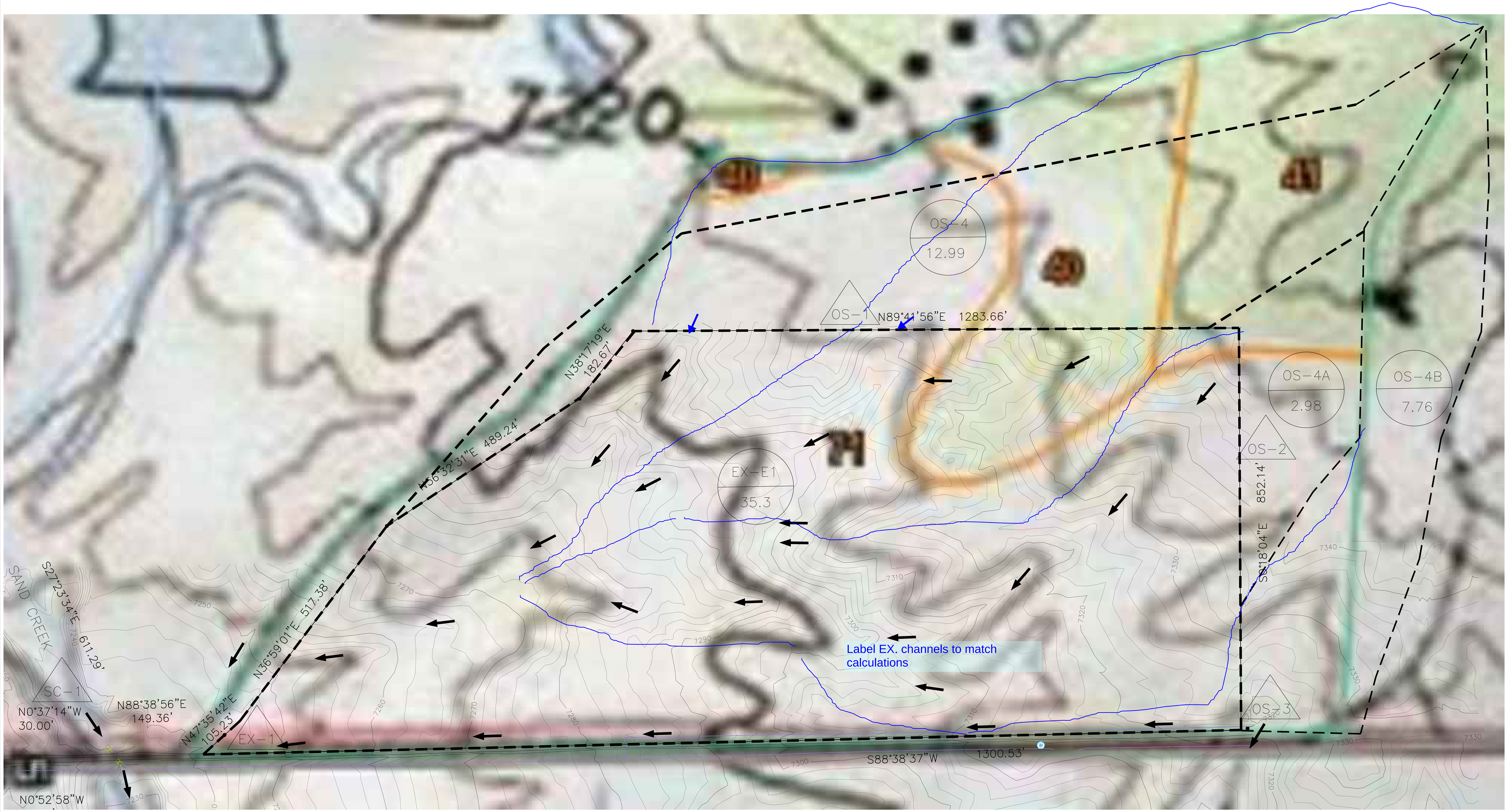
7260 — EXISTING 10' CONTOUR

FLOW DIRECTION

N

200' 0 200' 400'

SCALE: 1"=200'



REVISIONS

NO. DESCRIPTION DATE

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PREPARED FOR:
TIMBERRIDGE ESTATES, LLC
ATTN:
2760 BROGANS BLUFF
COLORADO SPRINGS, CO 80919

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Creative Civil Engineering Solutions

721 S. 23RD STREET
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OFFICE: 719-635-6422
FAX: 719-635-6426
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TIMBERRIDGE ESTATES
EXISTING DRAINAGE PLAN

DESIGNED BY	DLM
DRAWN BY	DLM
CHECKED BY	LD
H-SCALE	1"=200'
V-SCALE	N/A
JOB NO.	1733.00
DATE ISSUED	06/06/18
SHEET NO.	1 OF 3

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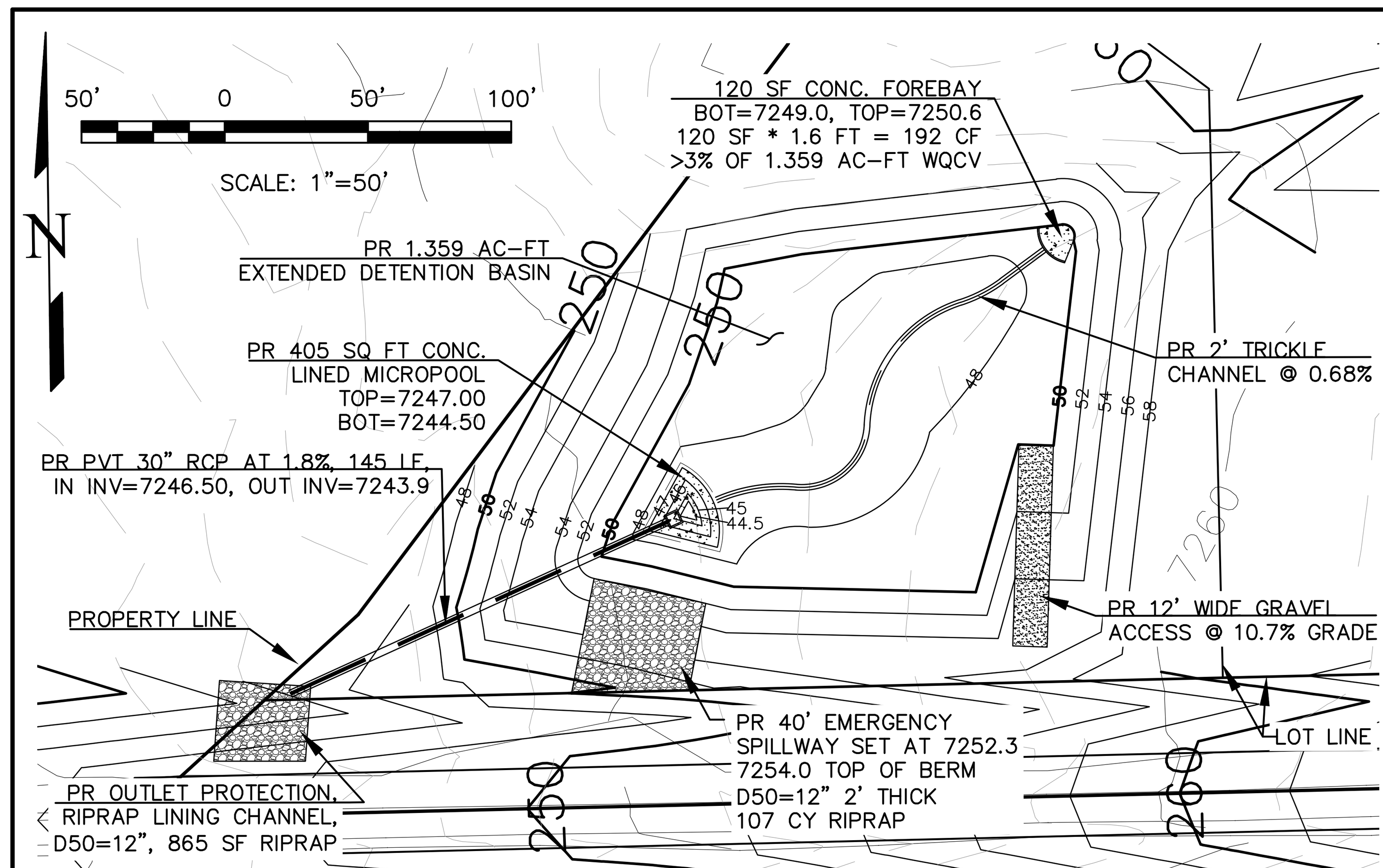
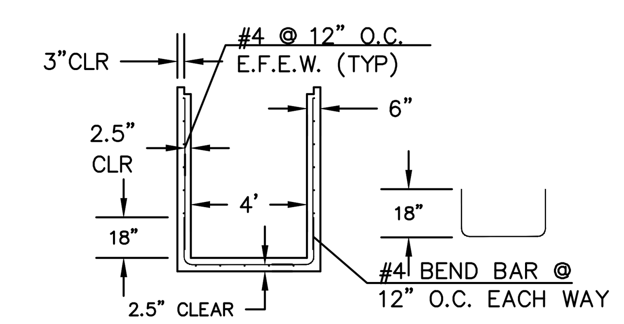
TIMBERRIDGE ESTATES
PROPOSED DRAINAGE PLAN

JUNE 2018

PRELIMINARY DRAWING
NOT FOR CONSTRUCION

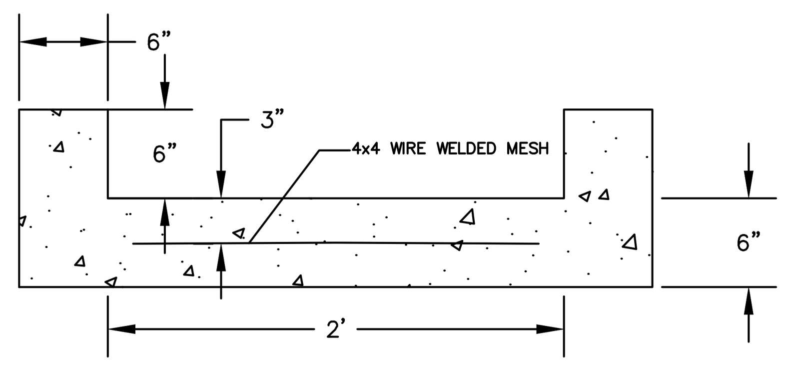


EXTENDED DETENTION BASIN DETAIL



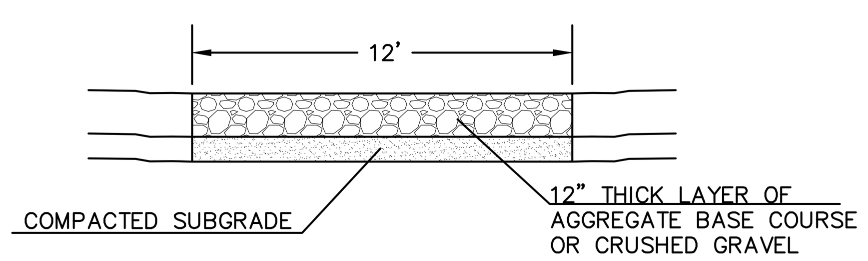
4'x4' OUTLET BOX STRUCTURAL DETAIL

NOT TO SCALE



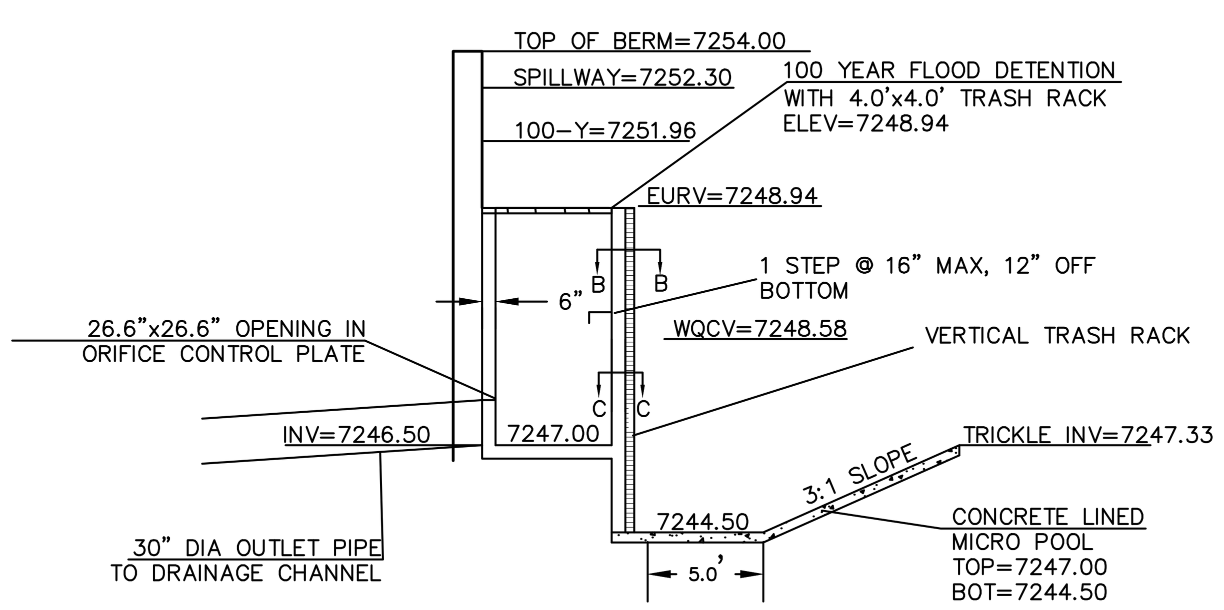
2' CONCRETE TRICKLE CHANNEL

NOT TO SCALE



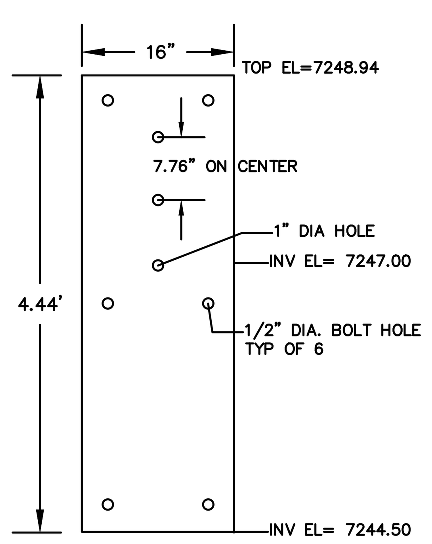
12' MAINTENANCE ACCESS ROAD SECTION

NOT TO SCALE



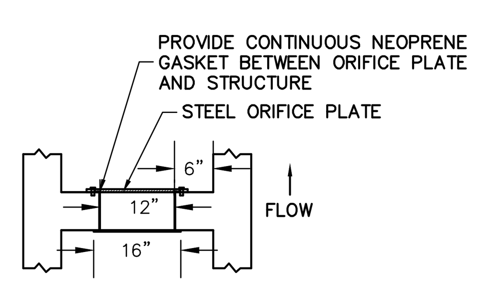
OUTLET STRUCTURE

NOT TO SCALE



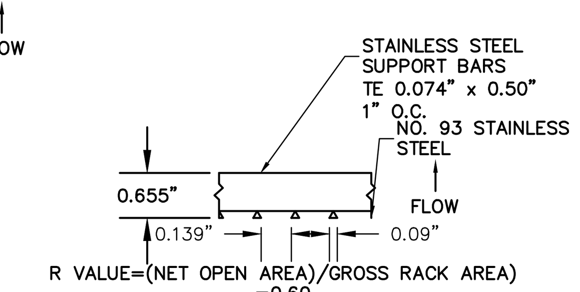
ORIFICE PLATE PERFORATED HOLE PATTERN

NOT TO SCALE



SECTION B-B

NOT TO SCALE



SECTION C-C

NOT TO SCALE

POND OUTLET OVERALL DETAIL

DRAINAGE NOTES

1. EXTENDED DETENTION BASIN ACCESS IS FROM ARROYA LANE.
2. DRAINAGE EASEMENT MAINTENANCE ACCESS IF FROM NATURE REFUGE WAY AND/OR FROM ARROYA LANE VIA THE EXTENDED DETENTION BASIN.

DESIGN POINT SUMMARY

DP	CONTRIBUTING BASINS	AREA AC.	Q5 CFS	Q10 CFS	Q100 CFS
1	OS-2, A & A1	17.18	7.6	---	35.5
2	OS-2, A, A1 & B	18.84	9.8	---	40.7
3	OS-1, OS-2, A, A1, B & C	46.70	16.6	---	79.8
4	D	2.60	1.1	---	4.7
5	OS-1, OS-2, OS-4, A, A1, B, C, D, E & F	54.25	20.5	---	96.3
6	OS-5 & G	8.80	3.3	---	14.6
7	I	1.27	2.2	---	5.6
8	H	1.38	2.2	---	5.7
OS-3	OS-3	7.76	1.5	---	11.0
SC-1*	SAND CREEK DRAINAGE BASIN	---	---	630	2,170

*THIS POINT IS FOR THE SAND CREEK CHANNEL, FLOWS PER KIOWA DBPS

PROPOSED CONDITIONS

BASIN	ACRES	Q5 CFS	Q100 CFS
OS-1	12.50	2.0	14.3
OS-2	2.98	1.0	7.2
OS-3	7.76	1.5	11.0
OS-4	3.19	0.7	5.4
OS-5	4.89	1.3	9.6
A	12.38	3.9	21.4
A1	1.83	2.7	6.8
B	1.66	2.1	5.2
C	15.36	4.8	24.7
D	2.60	1.1	4.7
E	1.04	1.8	4.7
F	0.72	0.2	1.7
G	1.16	2.0	5.1
H	1.38	2.2	5.7
I	1.27	2.2	5.6

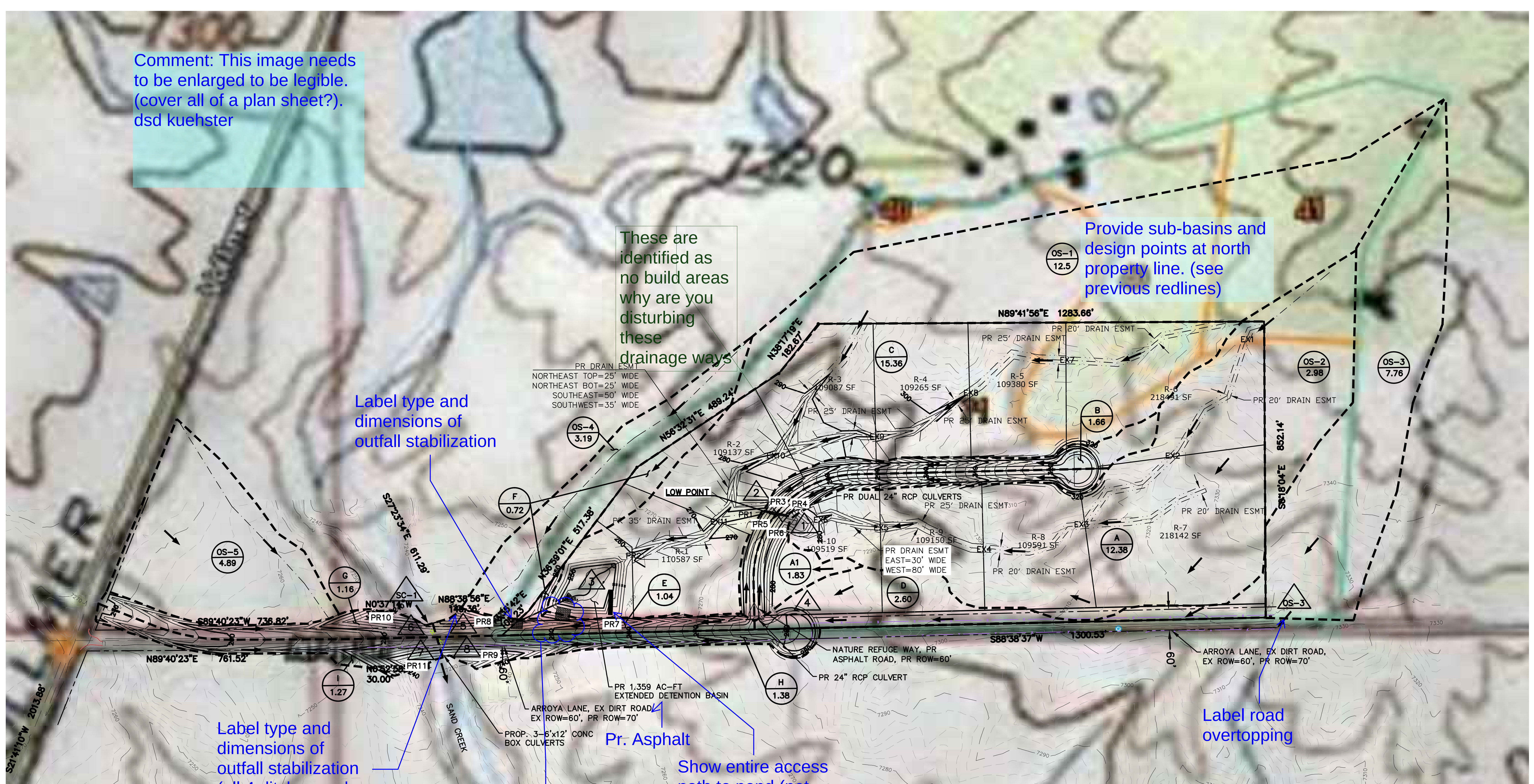
N

100' 0 100' 200'

SCALE: 1"=100'

LEGEND

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 2' CONTOUR
- 7260 — EXISTING 10' CONTOUR
- PROPOSED 2' CONTOUR
- 260 — PROPOSED 10' CONTOUR
- FLOW DIRECTION
- EXISTING SURFACE FLOW CHANNEL
- PROPOSED DRAINAGE EASEMENT
- EX# / PR# — OPEN CHANNEL FLOW CALC POINT



REVISIONS

NO.	DESCRIPTION	DATE
1	REV'D PER 6/2/16 CITY COMMENTS	8/22/16

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TIMBERRIDGE ESTATES

PROPOSED DRAINAGE PLAN

DESIGNED BY DLM
DRAWN BY DLM
CHECKED BY LD
H-SCALE 1"=200'
V-SCALE N/A
JOB NO. 1733.00
DATE ISSUED 06/06/18
SHEET NO. 2 OF 3

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TIMBERRIDGE ESTATES
PROPOSED DRAINAGE PLAN

JUNE 2018

PRELIMINARY DRAWING
NOT FOR CONSTRUCION

SWALE CROSS SECTION – EX5
24'; S 3'; N; 1:4; 1.99'
Q = 26.3 CFS
SLOPE = 3.0%
n VALUE = 0.15
DEPTH = 1.99'
VELOCITY = 1.68 FT/S

SWALE CROSS SECTION – EX9
24'; S 3'; N; 1:4; 1.89'
Q = 26.4 CFS
SLOPE = 3.9%
n VALUE = 0.15
DEPTH = 1.89'
VELOCITY = 1.85 FT/S

SWALE CROSS SECTION – EX6
26.4'; S 3.3'; N; 1:4; 2.21'
Q = 35.7 CFS
SLOPE = 3.1%
n VALUE = 0.15
DEPTH = 2.21'
VELOCITY = 1.83 FT/S

SWALE CROSS SECTION – EX10
24.8'; W 3.1'; E; 1:4; 2.09'
Q = 32.2 CFS
SLOPE = 3.4%
n VALUE = 0.15
DEPTH = 2.09'
VELOCITY = 1.84 FT/S

SWALE CROSS SECTION – EX11
32'; S 4'; N; 1:4; 2.94'
Q = 76.4 CFS
SLOPE = 3.1%
n VALUE = 0.15
DEPTH = 2.94'
VELOCITY = 2.21 FT/S

SWALE CROSS SECTION – PR11
15'; N 2'; S; 1:4; 0.96'
Q = 5.6 CFS
SLOPE = 7.8%
n VALUE = 0.15
DEPTH = 0.96'
VELOCITY = 1.66 FT/S

SWALE CROSS SECTION – PR6
17.6'; W 2.2'; E; 1:4; 1.11'
Q = 3.6 CFS
SLOPE = 1.3%
n VALUE = 0.15
DEPTH = 1.11'
VELOCITY = 0.75 FT/S

SWALE CROSS SECTION – PR1
46.4'; S 2.4'; N; 1:6; 1:5; 20'; 1.31'
Q = 41.0 CFS
SLOPE = 1.3%
n VALUE = 0.15
DEPTH = 1.31'
VELOCITY = 1.15 FT/S

SWALE CROSS SECTION – PR7
24'; S 3'; N; 1:4; 1.22'
Q = 8.2 CFS
SLOPE = 5.2%
n VALUE = 0.15
DEPTH = 1.16'
VELOCITY = 1.54 FT/S
*EXPANDED TO ALLOW FOR POSSIBLE FUTURE FLOW INCREASES

SWALE CROSS SECTION – PR2
30.4'; S 3.8'; N; 1:4; 2.73'
Q = 80.4 CFS
SLOPE = 5.1%
n VALUE = 0.15
DEPTH = 2.73'
VELOCITY = 2.70 FT/S

SWALE CROSS SECTION – PR8
40'; S 5'; N; 1:4; 2.97'
Q = 99.7 CFS
SLOPE = 5.0%
n VALUE = 0.15
DEPTH = 2.97'
VELOCITY = 2.83 FT/S
*EXPANDED TO ALLOW FOR POSSIBLE FUTURE FLOW INCREASES

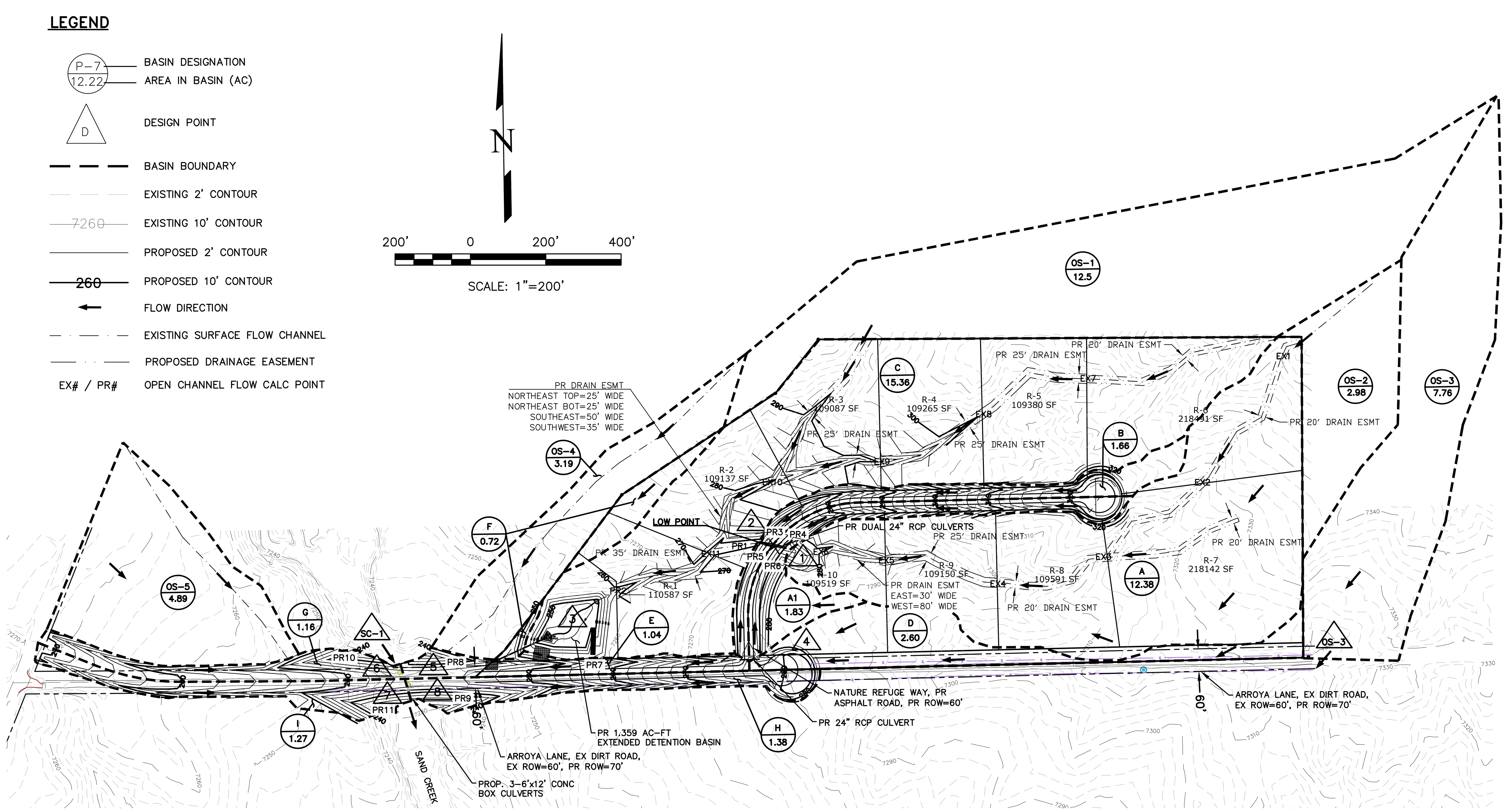
SWALE CROSS SECTION – PR3
16'; W 2'; E; 1:4; 1.00'
Q = 4.7 CFS
SLOPE = 3.7%
n VALUE = 0.15
DEPTH = 1.00'
VELOCITY = 1.18 FT/S

SWALE CROSS SECTION – PR9
16'; S 2.0'; N; 1:4; 0.99'
Q = 5.8 CFS
SLOPE = 6.0%
n VALUE = 0.15
DEPTH = 0.99'
VELOCITY = 1.49 FT/S

SWALE CROSS SECTION – PR4
16'; W 2'; E; 1:4; 0.79'
Q = 3.2 CFS
SLOPE = 6.3%
n VALUE = 0.15
DEPTH = 0.79'
VELOCITY = 1.31 FT/S

SWALE CROSS SECTION – PR10
24'; N 3'; S; 1:4; 1.27'
Q = 10.5 CFS
SLOPE = 5.9%
n VALUE = 0.15
DEPTH = 1.27'
VELOCITY = 1.74 FT/S
*EXPANDED TO ALLOW FOR POSSIBLE FUTURE FLOW INCREASES

SWALE CROSS SECTION – PR5
16'; W 2'; E; 1:4; 0.66'
Q = 0.9 CFS
SLOPE = 1.3%
n VALUE = 0.15
DEPTH = 0.66'
VELOCITY = 0.53 FT/S



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REVISIONS
NO.	DESCRIPTION	DATE

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www.tneinc.com

TIMBERRIDGE ESTATES
PROPOSED DRAINAGE DETAILS

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DRAWN BY DLM
CHECKED BY LD
H-SCALE 1"=200'
V-SCALE N/A
JOB NO. 1733.00
DATE ISSUED 06/06/18
SHEET NO. 3 OF 3

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PRELIMINARY DRAINAGE REPORT FOR

THE RETREAT AT TIMBERRIDGE PRELIMINARY PLAN

(SOUTH OF ARROYA LANE)

CCES Responses

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 Drainage Criteria Manual for the City of Colorado Springs and El Paso County. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.

____________________________________ ____________________

Marc A. Whorton Colorado P.E. #37155 Date

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

DEVELOPER'S STATEMENT:

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

Business Name: ARROYA INVESTMENTS LLC

By: ______________________________

Title: ______________________________

Address: 1271 Kelly Johnson Blvd., Suite 100

Colorado Springs, CO 80920

EL PASO COUNTY:

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

____________________________________ ____________________

Jennifer Irvine, El Paso County Engineer Date

Conditions:

CLASSIC CONSULTING ENGINEERS & SURVEYORS

PRELIMINARY DRAINAGE REPORT FOR
THE RETREAT AT TIMBERRIDGE PRELIMINARY PLAN
(SOUTH OF ARROYA LANE)

TABLE OF CONTENTS:

APPENDICES

CLASSIC CONSULTING ENGINEERS & SURVEYORS

PURPOSE

The purpose of this Preliminary Drainage Report, as part of the Retreat at TimberRidge Preliminary Plan, is to identify specific drainage features and facilities and to estimate peak rates of stormwater runoff, from on-site and off-site sources. Also the purpose is to outline the necessary improvements to safely route developed storm water runoff to adequate outfall facilities. The drainage improvements proposed in this report are preliminary in nature and final drainage reports are required upon any development within the site that detail the 'to be constructed' drainage systems and detention/SWQ ponds. This report covers the major portion of the Preliminary Plan area south of Arroya Lane. The 10 lots north of Arroya Lane can be found in "Preliminary Drainage Report for TimberRidge Estates Preliminary Plan (North of Arroya Lane)" prepared by Terra Nova Engineering, Inc., dated April 2018.

Provide acreage addressed in this report.

GENERAL DESCRIPTION

The Retreat at TimberRidge is a 234.1-acre site located in portions sections 21, 22, 27 and 28, township 12 south, range 65 west of the sixth principal meridian. The site is bounded on the north by various unplatted parcels (zoned for 5 ac. residential), to the south and east by Sterling Ranch property (zoned for future urban development) and to the west by Vollmer Road and unplatted parcels (zoned for 5 ac. residential). The site is in the upper portion of the Sand Creek Drainage Basin. Both large lot rural single family residential and urban single family residential are proposed in the Preliminary Plan for this site.

The average soil condition reflects Hydrologic Group "B" (Pring coarse sandy loam and Kettle gravelly loamy sand) as determined by the "Web Soil Survey of El Paso County Area," prepared by the Natural Resources Conservation Service (see map in Appendix).

EXISTING DRAINAGE CONDITIONS

The Retreat at TimberRidge property is located in the upper portion of the Sand Creek drainage basin on the south edge of Black Forest. The overall property was recently acquired in numerous parcels. The parcels west of Vollmer Road are on the fringe of Black Forest and contains some sparsely scattered pine trees with the majority of the parcel being native grasses. The northeast parcel, north of Arroya Lane again is on the fringe of Black Forest and contains some sparsely scattered pine trees with the majority of the parcel being native grasses. The parcel at the southeast corner of Vollmer Road and Arroya Lane also contains some sparsely scattered pine trees with native grasses and natural ravines tributary to the Sand Creek channel. The remaining larger parcels south of Arroya Lane and east of Vollmer Road are mainly covered with native grasses with few or realigned — will dedicate additional ROW as needed for development but may vacate small portion of exist. ROW w/ re-alignment.

no pine trees. The Sand Creek channel bisects this part of the property from north-south with various natural ravine tributary fingers. A wetlands delineation has been prepared for the property (See Appendix) and reflects some wetlands throughout the Sand Creek channel. Upon determination of exact channel improvements as a part of development and final platting of the site, the appropriate permitting will be prepared for and reviewed/approved by US Fish and Wildlife. Arroya Lane exists along the northern portion of the site. The westerly portion of this road is public ROW with the remainder of the road heading further east being private. A portion of this existing ROW may need to be vacated with the final plat in this area given the planned re-alignment of the Arroya Lane and Vollmer intersection. An existing 60" CMP culvert currently conveys the low flows from Sand Creek under Arroya Lane.

Portions of this site have been previously studied in the "Sand Creek Drainage Basin Planning Study" (DBPS) prepared by Kiowa Engineering Corporation, March 1996. The portion of Sand Creek that traverses the site is defined as Reach SC-9 in the DBPS. Approximately 1000+ acres north of this property is tributary to this reach of the channel. (See Off-site Drainage Map in Appendix) According to the DBPS, this reach of Sand Creek all contained within the channel has the following flow characteristics: Q_{10} = 630 cfs Q_{100} = 2170 cfs. The majority of these off-site flows enter the property at the north end of the site via various culverts under Vollmer Road conveying flows from the northwest (Black Forest area) and the off-site stock ponds to the north (both tributary to hundreds of acres of property in Black Forest). See the Pre-development Drainage Map in the Appendix.

The following descriptions represent the pre-development flows for the property:

EX DP-1 (Q_2 = 5.5 cfs Q_5 = 34.9 cfs, Q_{100} = 273.4 cfs) This does not include the major off-site channel flows but reflects only the on-site and off-site flows that travel across the property and have a direct effect on the development. This total represents the allowed developed release off-site at this location. This total pre-development flow includes the flowing basins: EX-1, EX-4, OS-1, OS-3, OS-4 and OS-5. Basin EX-1 (Q_2 = 2.6 cfs Q_5 = 17.7 cfs, Q_{100} = 140.3 cfs) consists of the majority of the site proposed for development. This basin contains areas of sheet flow that eventually travel within various natural ravines created within the site. These ravines then route the predevelopment flows

See plan redlines

? See proposed conditions for additional info.

directly into Sand Creek in the form of concentrated flows at multiple locations along the Creek. Basin EX-4 (Q_2 = 1.3 cfs Q_5 = 6.9 cfs, Q_{100} = 41.8 cfs) consists of the northeasterly portion of the property north of Arroya Lane that drains in a southwesterly direction into Sand Creek. Basin EX-5 is not used in this report. Basin OS-5 (Q_2 = 0.5 cfs Q_5 = 3.6 cfs, Q_{100} = 28.1 cfs) consists off-site property northwest of Vollmer Road that drains under Vollmer through an existing 48" CMP culvert directly on-site. Basin OS-1 (Q_2 = 0.9 cfs Q_5 = 7.0 cfs, Q_{100} = 53.9 cfs) consists of an off-site basin to the east within the Sterling Ranch property that sheet flows directly on-site. Basin OS-3 (Q_2 = 1.3 cfs Q_5 = 2.0 cfs, Q_{100} = 4.8 cfs) consists of the public ROW portion of Arroya Lane that sheet flows directly on-site. Basin OS-4 (Q_2 = 0.6 cfs Q_5 = 3.4 cfs, Q_{100} = 20.7 cfs) consists of the off-site basin directly tributary to the site through Basin EX-4 containing several existing large lot home sites located on 35+ acre property.

Provide combined flows.

EX DP-2 (Q_2 = 0.2 cfs Q_5 = 2.0 cfs, Q_{100} = 14.7 cfs) consists of combined flows from on-site Basin EX-2 (Q_2 = 0.2 cfs Q_5 = 1.7 cfs, Q_{100} = 12.2 cfs) and Basin OS-2 (Q_2 = 0.04 cfs Q_5 = 0.3 cfs, Q_{100} = 2.5 cfs). These combined pre-development flows travel off-site directly onto Sterling Ranch property prior to eventually entering the Sand Creek channel.

EX DP-3 (Q_2 = 0.4 cfs Q_5 = 3.0 cfs, Q_{100} = 23.7 cfs) consists of flows from on-site Basin EX-3 that travel off-site directly onto Sterling Ranch property prior to eventually entering the Sand Creek channel.

EX DP-4 (Q_2 = 0.1 cfs Q_5 = 0.9 cfs, Q_{100} = 7.1 cfs) consists of on-site flows from Basin EX-6 that travel in a southeasterly direction towards the existing roadside ditch along the north side of Vollmer Road. These flows will travel in a southerly direction within the roadside ditch to a release point at the corner of the property. This to flow represents the allowed developed release at this location.

PROPOSED DRAINAGE CONDITIONS

Proposed development within the Retreat at TimberRidge will consist of a variety of different residential lot sizes ranging from 1.0 – 2.5 acre large rural lots to 12,000 SF min. urban lots. The rural lots will have paved streets and roadside ditches while the urban lots paved streets with County standard curb, gutter and sidewalk. Development of the urban lots proposed will consist of overlot grading for the planned roadways and lots. Development of rural lots proposed within the site will be limited to roadways and building pads, conserving the natural feature areas. Individual home sites on these lots are to be left generally in their natural condition with minimal disturbance to existing conditions per individual lot construction. Per the El Paso County ECM, Section I.7.1.B, rural lots of 2.5 ac. and larger are not required to provide Water Quality Capture Volume (WQCV). However, based on the current County/Urban Drainage stormwater quality standards, a WQCV component is automatically built into the UD Detention spreadsheet utilized in the detention basin design. Thus, the proposed facilities within both the rural and urban portions of this development will provide WQCV along with an Excess Urban Runoff Volume (EURV) in the lower portion of the facility storage volume with an outlet control device. Frequent and infrequent inflows are released at rates approximating undeveloped conditions. This concept provides some mitigation of increased runoff volume by releasing a portion of the increased runoff at a low rate over an extended period of time, up to 72 hours. This means that frequent storms, smaller than the 2 year event, will be reduced to very low flows near or below the sediment carrying threshold value for downstream drainage ways. Also, by incorporating an outlet structure that limits the 100-year runoff to the undeveloped condition rate, the discharge hydrograph for storms between the 2 year and the 100 year event will approximate the hydrograph for the undeveloped conditions and will help effectively mitigate the effects of development. Prior to development within the Retreat at TimberRidge property, final drainage reports and construction plans will be required detailing the requirements and specifics of proposed facilities. To the greatest extent possible, WQCV will be provided for all new roads and urban lots.

The following describes how this development proposes to handle both the off-site and on-site drainage conditions:

✓ updated

Note: flow values not cross-checked against calculations.

CLASSIC CONSULTING ENGINEERS & SURVEYORS

As mentioned previously, the majority of the off-site flows are already within the Sand Creek channel prior to entering the property. However the few off-site basins that must travel through the proposed site development areas prior to entering Sand Creek have been accounted for.

The following represent the basins west of Sand Creek:

Basin OS-5 (Q_2 = 1 cfs Q_5 = 64 cfs, Q_{100} = 42 cfs) represents off-site semi-forested, undeveloped property zoned for 5 ac. residential that is currently tributary to this site via an existing 48" CMP culvert under Vollmer. If future development occurs on this property, any developed flows must be detained beyond this pre-development quantity. An extension of this culvert is planned with the improvements of Arroya Lane to route these off-site flows directly to Sand Creek and by-pass the proposed development.

Address the size and type of pipe, outfall, and impact to Sand Creek

see revised

Basin OS-3 (Q_2 = 3 cfs Q_5 = 4 cfs, Q_{100} = 8 cfs) represents the existing Arroya Lane platted ROW. These flows will continue to travel in side road ditches in an easterly direction towards Sand Creek. Proposed improvements to Arroya Lane will formalize these conveyance efforts.

Address WQCV

see revised

Basins A1 (Q_2 = 1.7 cfs Q_5 = 5 cfs, Q_{100} = 23 cfs), A2 (Q_2 = 1.0 cfs Q_5 = 3 cfs, Q_{100} = 14 cfs), A3 (Q_2 = 0.7 cfs Q_5 = 2 cfs, Q_{100} = 10 cfs) and A4 (Q_2 = 0.7 cfs Q_5 = 1 cfs, Q_{100} = 5 cfs) are all tributary to the proposed Pond B. These basins collect flows from a portion of the rural 2.5 ac. lot development on the property with various culvert crossings designed to convey the proposed ditch flows towards Pond B. Based on the UD Detention Spreadsheet for this basin, the total developed flows entering **Pond B equal (Q_2 = 3.1 cfs Q_5 = 4.7 cfs, Q_{100} = 48.1 cfs).** A proposed full-spectrum EDB is proposed at this location to release less than the pre-development flows currently seen. (See UD Detention Spreadsheet – Pond B for anticipated outlet structure and release levels) At this point, we have also shown a possible alternate location for this facility. (See Drainage Map) With the Final Plat and Drainage Report it will be determined which location works best from a lotting and development standpoint.

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Basins B1 (Q_2 = 2.7 cfs Q_5 = 8 cfs, Q_{100} = 38 cfs) and B2 (Q_2 = 1.2 cfs Q_5 = 3 cfs, Q_{100} = 16 cfs) are tributary to the proposed Pond C. These basins collect flows the rest of the portion of the rural 2.5 ac. lot development west of Sand Creek with various culvert crossings designed to convey the proposed ditch flows towards Pond C. Based on the UD Detention Spreadsheet for this basin, the total developed flows entering **Pond C equal (Q_2 = 3.1 cfs Q_5 = 4.8 cfs, Q_{100} = 48.1 cfs).** A proposed full-spectrum EDB is proposed at this location to release less than the pre-development flows currently seen. (See UD Detention Spreadsheet – Pond C for anticipated outlet structure and release levels)

urban/paved, isn't it? — Yep, see revised.

Basin B3 (Q_2 = 1.7 cfs Q_5 = 2 cfs, Q_{100} = 4 cfs) represents the south half of the proposed Poco Road extension into the site. The north half of the road has been accounted for in the basins mentioned above. At this time it is undetermined if this roadway will be rural or urban. This report assumes it will be rural and thus the south half of the roadway will continue to sheet flow off-site. Basins A5 (Q_2 = 0.9 cfs Q_5 = 3 cfs, Q_{100} = 12 cfs) and B4 (Q_2 = 1.9 cfs Q_5 = 6 cfs, Q_{100} = 27 cfs) represent portions of the rural 2.5 ac. lots west of Sand Creek that cannot reasonably be collected into the two facilities just described. With the minimal impervious areas anticipated on these large lots, these basins will continue to sheet flow towards Sand Creek. Per the ECM Section I.7.1.B, WQCV is not required for these lots given their size (2.5 Ac.). Also, the City owned regional facility downstream of this property (Sand Creek #3) is an in-line facility that provides stormwater quality. Basin H (Q_2 = 0.8 cfs Q_5 = 2 cfs, Q_{100} = 11 cfs) is proposed for two large lots averaging 3.5 ac. each west of Vollmer. Again, per the ECM Section I.7.1.B, WQCV is not required for these lots given their size (2.5 Ac. +). However, sediment control will be provided on each individual lot. After this sediment control, the minimal developed flow from these lots will be allowed to continue to sheet flow directly into the side road ditch along Vollmer Road.

see plan redlines — ✓ see revised grading and basins

no; provide WQCV — now goes to Pond C

The following represent the basins east of Sand Creek:

Basins OS-4 and EX-4 calculations are included in this report but details for these basins and Pond A are part of the Preliminary Drainage Report for north of Arroya Lane, prepared by Terra Nova Engineering.

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Address capture of existing flows. Is offsite grading and easement required? – See revised text.

Basins C1 (Q_2 = 2.5 cfs Q_5 = 6 cfs, Q_{100} = 25 cfs) and OS-1A (Q_2 = 0.4 cfs Q_5 = 1 cfs, Q_{100} = 9 cfs) are tributary to the Design Point 7. These basins represent on-site 2.5 ac. – 1.0 ac. lots and off-site future Sterling Ranch development which is planned to continue to sheet flow on-site through the proposed lots. A 30" RCP culvert will collect the flows at this location and route them further downstream within the on-site storm system. Basins C2 (Q_2 = 1.4 cfs Q_5 = 3 cfs, Q_{100} = 11 cfs) and OS-1B (Q_2 = 1.6 cfs Q_5 = 6 cfs, Q_{100} = 41 cfs) are tributary to the Design Point 8 and the on-site storm system. These basins represent on-site 1.0 ac. lots and off-site future Sterling Ranch development. A 30" RCP storm stub is proposed to collect the future off-site flows at this location. In the interim, prior to on-site development in this phase, the existing on-site stock pond will remain in place and continue to act as a sediment facility for the off-site flows. Upon development in this phase, the stock pond will be removed and storm system provided to handle these off-site flows. Future off-site Sterling Ranch development in this basin will need to meet these pre-development flows at this location. At Design Point 8, assuming an even split of flows at this time, 5' Type R sump inlets will collect the developed flows and route them further downstream in a 36" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basins D2 (Q_2 = 6.4 cfs Q_5 = 11 cfs, Q_{100} = 35 cfs) and OS-2A (Q_2 = 0.1 cfs Q_5 = 0.6 cfs, Q_{100} = 4 cfs) are tributary to the Design Point 9. These basins represent on-site 1.0 ac. – 1/3 ac. lots and off-site future Sterling Ranch development which is planned to continue to sheet flow on-site through the proposed lots. At this location, assuming an even split of flows at this time, 10' Type R sump inlets will collect the developed flows and route them further downstream in a 42" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basins D1 (Q_2 = 2.4 cfs Q_5 = 4 cfs, Q_{100} = 14 cfs) and OS-2B (Q_2 = 0.2 cfs Q_5 = 0.6 cfs, Q_{100} = 4 cfs) are tributary to the Design Point 10. These basins represent on-site 1/3 ac. lots and off-site future Sterling Ranch development which is planned to continue to sheet flow on-site through the proposed lots. At this location, assuming an even split of flows at this time, 5' Type R sump inlets will collect the developed flows and route them further downstream in a 24" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basins D3 (Q_2 = 1.8 cfs Q_5 = 3 cfs, Q_{100} = 10 cfs), OS-2C (Q_2 = 1 cfs Q_5 = 4 cfs, Q_{100} = 25 cfs) and OS-2D (Q_2 = 0.07 cfs Q_5 = 0.3 cfs, Q_{100} = 2 cfs) are tributary to the Design Point 11 and the on-site storm system. These basins represent on-site 1/3 ac. lots and off-site future Sterling Ranch development. A 30" RCP storm stub is proposed to collect the future off-site flows at this location. Future off-site Sterling Ranch development in this basin will need to meet these pre-development flows at this location. At Design Point 11, assuming an even split of flows at this time, 5' Type R sump inlets will collect the developed flows and route them further downstream in a 36" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basins D5 (Q_2 = 5.6 cfs Q_5 = 10 cfs, Q_{100} = 31 cfs) and OS-2E (Q_2 = 0.2 cfs Q_5 = 0.9 cfs, Q_{100} = 6 cfs) are tributary to the Design Point 12. These basins represent on-site 1/3 ac. – 1/4 ac. lots and off-site future Sterling Ranch development which is planned to continue to sheet flow on-site through the proposed lots. At this location, assuming an even split of flows at this time, 10' Type R sump inlets will collect the developed flows and route them along with the upstream flows directly into Pond D. The Final Drainage Report will further detail the exact inlet design.

Basin D4 (Q_2 = 3.6 cfs Q_5 = 6 cfs, Q_{100} = 18 cfs) is tributary to Design Point 13. This basin represents on-site 1/4 ac. lots. At this location, assuming an even split of flows at this time, 5' Type R sump inlets will collect the developed flows and route them further downstream in a 24" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basin D6 (Q_2 = 6.4 cfs Q_5 = 11 cfs, Q_{100} = 35 cfs) is tributary to Design Point 14. This basin represents on-site 1/4 ac. lots. At this location, assuming an even split of flows at this time, 10' Type R sump inlets will collect the developed flows and route them along with the upstream flows directly into Pond D. The Final Drainage Report will further detail the exact inlet design. Based on the UD Detention Spreadsheet for this basin, the total developed flows entering **Pond D equal (Q_2 = 33 cfs Q_5 = 48 cfs, Q_{100} = 236 cfs).** A proposed full-spectrum EDB is proposed at this location to release less than the pre-development flows currently seen. (See UD Detention Spreadsheet – Pond D for anticipated outlet structure and release levels)

Basin D10 (Q_2 = 1.1 cfs Q_5 = 2 cfs, Q_{100} = 6 cfs) represents the rear yards of proposed lots that cannot reasonably be collected by the proposed Pond D and will then continue to sheet flow off-site. Basins C3 (Q_2 = 2.1 cfs Q_5 = 5 cfs, Q_{100} = 21 cfs), D8 (Q_2 = 1.3 cfs Q_5 = 2 cfs, Q_{100} = 7 cfs) and D9 (Q_2 = 1.0 cfs Q_5 = 2 cfs, Q_{100} = 5 cfs) represent portions of the rear yards that are adjacent to Sand Creek that cannot reasonably be collected into the proposed Pond D just described. With the minimal impervious areas anticipated on the rear of these lots, these basins will continue to sheet flow towards Sand Creek. However, ss mentioned earlier, the City owned regional facility downstream of this property (Sand Creek #3) is an in-line facility that provides stormwater quality for this minimal area. Basins F1 (Q_2 = 1.0 cfs Q_5 = 4 cfs, Q_{100} = 24 cfs) and F2 (Q_2 = 0.3 cfs Q_5 = 1 cfs, Q_{100} = 8 cfs) represent the Sand Creek Channel corridor. This area will not have any development take place in it other than the required channel improvements per the DBPS and the proposed roadway crossings.

Both the Poco Road extension and Arroya Lane are proposed to cross Sand Creek. At both these locations a triple cell 6'x12' CBC is proposed to handle the 100 yr. off-site flows. (See culvert calculations in Appendix)

Address offsite easement(s) required for Poco bridge.

DETENTION FACILITIES / STORMWATER QUALITY

Final design of these recommended facilities that include planning for water quality management of storm water runoff features will be designed during final platting of this development. As required, storm water quality measures will be utilized in order to reduce the amount of sediment, debris and pollutants that are allowed to enter Sand Creek. These features include but are not limited to the multiple Full Spectrum Extended Detention Basins. Site Planning and design techniques for the large lot, rural areas should limit impervious area, minimize directly impervious area, lengthen time of travel and increase infiltration in order to decrease the rate and volume of stormwater runoff. Urban areas that require detention will provide a Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV) in the lower portion of the facility storage volume that will release the more frequent storms at a slower rate to help minimize the effects of development of the property. These measures will be taken into consideration upon final design of the individual detention facilities as well as the development of the individual land uses within the site.

Address if this velocity is adequate (slow enough) and FEMA FIS velocities (see comment letter).

MAINTENANCE

The proposed detention/SWQ facilities are to be private facilities with ownership and maintenance by the local Metropolitan District or Homeowners Association. After completion of construction and upon the Board of County Commissioners acceptance, the Sand Creek channel will be owned and maintained by the El Paso County along with all drainage facilities within the public Right of Way.

Clarify -- isn't the proposed development more urban than the DBPS assumptions?

SAND CREEK CHANNEL IMPROVEMENTS

As stated in the Sand Creek DBPS, this Reach SC-9 is recommended as a floodplain preservation design concept. Given the fact of the current requirements for detention/SWQ with these facilities planned for the property and less urbanization anticipated in this reach, the existing drainageway is expected to remain stable. However, localized improvements may be necessary in any steeply incised channel locations and to limit erosion caused by flow concentrations at culverts and storm sewers outfalls. Determination of the specific channel improvements will be made upon further channel analysis/investigation along with the future Final Drainage Report(s). However, specifically located grade control and/or drop structures were specified in the DBPS through this reach in order to slow the cannel velocity to the recommended 7 feet per second and to prevent localized and long-term stream degradation from affecting channel linings and overbanks. These facilities will help protect the native wetland vegetation from detrimental effects of stream invert head cutting. A maximum drop height of three feet is recommended with final design following the Urban Drainage Criteria Manual Vol. 2. Concept locations for these facilities are shown on the developed drainage map as recommended in the DBPS. Revegetation would occur wherever the native vegetation is disturbed by channel construction. Selectively located rip-rap bank protection such as outside bends and culvert outlets are also recommended. Also, based on the wetland delineations prepared by CORE Consultants, Inc., likely impacts to jurisdictional waters would trigger permitting under Section 404 of the Clean Water Act. This coordination and permitting would be completed along with the approval process of the final construction plans for the associated channel improvements.

proposed?

Per the approved DBPS, the anticipated developed flows just upstream of this project are $Q_{10} = 630$ cfs and $Q_{100} = 2170$ cfs as depicted within segment no. 171. The anticipated developed flows exiting this property are $Q_{10} = 670$ cfs and $Q_{100} = 2260$ cfs as depicted within segment no. 170. The northern

Preliminary analysis and recommendations need to be provided in this report.

Address FEMA flows and ultimate developed flows.

portion of Sterling Ranch is immediately downstream of this property. This portion of their development appears to be in the later phases and as such has not yet been analyzed for specific channel improvements. However, per the approved DBPS, similar grade control and check structures are shown in Sterling Ranch within Reach SC-8 as are recommended in Reach SC-9 through the TimberRidge property. Based on these anticipated flows, two proposed roadway crossings of Sand Creek are planned for this site. (Arroya Lane and the proposed east-west connector road) The current crossing of Arroya Lane is with a 60" CMP culvert. Upon development, the proposed crossing will consist of a triple cell 6'x12' CBC to facilitate the conveyance of the 100 yr. flow. This same structure is proposed at the crossing with the collector roadway as well. These facilities, along with all proposed channel improvements would be designed to continue to contain the 100 yr. flows within the current floodplain as defined by the LOMR 08-080541P. Upon final design of these culvert crossings and anticipated channel improvements, further floodplain analysis will be required to either suggest a no-rise certification or prepare an updated CLOMR/LOMR for associated improvements affecting the current 100 yr. floodplain. The Arroya Lane proposed culvert crossing is described in the DBPS as a single 6'x12' concrete box culvert (10 yr.) design. However, we would propose a triple cell 6'x12' box culvert at this location, designed to convey the 100 yr. developed flows. Based on this design we would request this facility be eligible towards this developments drainage fee obligation. (Reference the Drainage and Bridge Fees)

DRAINAGE CRITERIA

Hydrologic calculations were performed using the City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014. Detention storage and storm sewer conveyance to Sand Creek Drainage Basin was established with the Sand Creek DBPS, previously referenced. The NRCS Unit Hydrograph (Curve Number) was used to estimate stormwater runoff anticipated from design storms for the 2 year, 5 year and 100 year recurrence interval with a 24 hour NRCS Type II distribution.

Also provide Rational calculation criteria.

✓ Added

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Rainfall Depths for Colorado Springs

Return Period	24-Hour Depth
2 Year	2.10
5 Year	2.70
10 Year	3.20
25 Year	3.60
50 Year	4.20
100 Year	4.60

FLOODPLAIN STATEMENT

Portions of this site are located within a floodplain as determined by the Flood Insurance Rate Maps (F.I.R.M.) Map Number 08041C 0535F and the previously mentioned LOMR 08-08-0541P both with effective date of July 23, 2009. (See Appendix).

DRAINAGE AND BRIDGE FEES

Any applicable fees shall be provided in the Final Drainage Report(s) prior to final plat recordation of any development within this site. The following represents the anticipated overall fees for this site:

Sand Creek Drainage Basin

This site lies entirely within the Sand Creek Drainage Basin boundaries.

The fees are calculated using the following impervious acreage method approved by El Paso County. The Retreat at TimberRidge site has a total area of 234.1 acres (including the 10 lots north of Arroya Lane which are not a part of this report) with the following different land uses proposed:

22.4 Ac.	Sand Creek Drainage corridor – Basins F1 and F2)
94.8 Ac.	2.5 Ac. lots
13.4 Ac.	1.0 Ac. lots
42.8 Ac.	1/3 Ac. lots
24.4 Ac.	1/4 Ac. lots

The percent imperviousness for this subdivision is calculated as follows:

Fees for Sand Creek Drainage Corridor

(Per El Paso County Percent Impervious Chart: 2%)

22.4 Ac. x 2% = **0.45 Impervious Ac.**

Fees for 2.5 Ac. lots

(Per El Paso County Percent Impervious Chart: 11% with 25% fee reduction for 2.5 ac. lots planned)

94.8 Ac. x 11% x 75% = **7.82 Impervious Ac.**

Fees for 1.0 Ac. lots

(Per El Paso County Percent Impervious Chart: 20%)

13.4 Ac. x 20% = **2.68 Impervious Ac.**

Fees for 1/3 Ac. lots

(Per El Paso County Percent Impervious Chart: 30%)

42.8 Ac. x 30% = **12.84 Impervious Ac.**

Fees for 1/4 Ac. lots

(Per El Paso County Percent Impervious Chart: 40%)

24.4 Ac. x 40% = **9.76 Impervious Ac.**

Total Impervious Acreage: 33.55 Imp. Ac.

The following calculations are based on the 2018 drainage/bridge fees:

ESTIMATED FEE TOTALS (prior to reduction):

Bridge Fees

$ 5,210.00 x 33.55 Impervious Ac. = $ 174,795.50

Drainage Fees

$ 17,197.00 x 33.55 Impervious Ac. = $ 576,959.35

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The effect of the project's increased impervious acreage needs to be taken into account as to whether the detention facilities will be reimbursable. Compare to the situation if development were all rural lots. In either case, the drainage and bridge fees will need to be updated to account for additional costs.

Per the ECM 3.10.4a and 3.10.5.a, this development requests a reduction of drainage fees based on the on-site full spectrum detention/SWQ facilities and regional channel improvements for this stretch of Sand Creek as shown in the DBPS. The following facilities within the Sand Creek Drainage Basin seem to meet the criteria for this reduction:

Detention Pond B	5.3 ac-ft. full spectrum	$ 50,000 x 50%	=	$ 25,000.00
Detention Pond C	5.3 ac-ft. full spectrum	$ 50,000 x 50%	=	$ 25,000.00
Detention Pond D	5.3 ac-ft. full spectrum	$ 90,000 x 50%	=	$ 45,000.00
Triple Cell 6'x12' CBC Crossing Arroya Lane		$ 250,000	=	$ 250,000.00
Sand Creek Channel Improvements per DBPS		$ 175,000	=	$ 175,000.00

(Exact facility costs provided with final drainage report(s))

ESTIMATED FEE TOTALS (with reduction):

Bridge Fees

$ 5,210.00 x 33.55 Impervious Ac. = $ 174,795.50

Drainage Fees

$ 576,959.35 - 520,000.00 = $ 56,959.35

impact?

SUMMARY

The proposed Retreat at TimberRidge Preliminary Plan is within the Sand Creek Drainage Basin. Recommendations are made within this report concerning necessary improvements that may be required as a result of development of this property. The points of storm water release from the proposed site are required to be at or below the calculated historic flow quantities. The development of the proposed site does not hinder any downstream facility or property to an extent greater than that which currently exists in the 'historic' conditions. All drainage facilities within this report were sized according to the Drainage Criteria Manuals and the full-spectrum storm water quality requirements. Upon development of the individual parcels within the site, separate Final Drainage Reports will be required to be submitted and approved by El Paso County that details all storm systems, pond design and fee calculation.

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PREPARED BY:

Classic Consulting Engineers & Surveyors, LLC

Marc A. Whorton, P.E.
Project Manager

maw/252000/MDDP.doc

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					FEET (NGVD)			
Sand Creek (cont'd)								
DA	85,073	139	456	5.7	7,043.0	7,043.0	7,043.1	0.1
DB	85,483	170	328	7.9	7,053.4	7,053.4	7,053.5	0.1
DC	86,103	100	274	9.5	7,054.4	7,054.4	7,054.4	0.0
DD	86,673	197	434	6.0	7,061.7	7,061.7	7,062.0	0.3
DE	87,073	83	270	9.6	7,068.2	7,068.2	7,068.3	0.1
DF	87,573	98	325	8.0	7,077.7	7,077.7	7,077.9	0.2
DG	88,003	135	304	8.6	7,085.1	7,085.1	7,085.1	0.0
DH	88,738	89	263	9.9	7,096.9	7,096.9	7,096.9	0.0
DI	89,303	74	249	10.4	7,104.1	7,104.1	7,104.3	0.2
DJ	89,663	143	309	8.4	7,123.2	7,123.2	7,123.2	0.0
DK	90,058	140	426	6.1	7,125.1	7,125.1	7,125.2	0.1
DL	90,348	102	276	9.4	7,127.6	7,127.6	7,127.8	0.2
DM	90,698	300	398	6.5	7,141.0	7,141.0	7,141.0	0.0
DN	91,388	120	292	8.9	7,148.5	7,148.5	7,148.6	0.1
DO	91,868	105	313	8.3	7,155.2	7,155.2	7,155.9	0.7
DP	92,748	65	239	10.9	7,173.8	7,173.8	7,173.8	0.0
DQ	93,468	117	288	9.0	7,184.6	7,184.6	7,184.6	0.0
DR	94,448	81	260	10.0	7,204.5	7,204.5	7,204.6	0.1
DS	95,343	100	274	9.5	7,216.8	7,216.8	7,217.2	0.4
DT	95,723	77	252	10.3	7,224.2	7,224.2	7,224.3	0.1
DU	96,333	90	266	9.8	7,232.5	7,232.5	7,233.0	0.5

Q100 (ex) = 2,600 cfs

REVISED TO REFLECT LOMR

EFFECTIVE: July 23, 2009

[1] Feet Above Confluence With Fountain Creek

FEDERAL EMERGENCY MANAGEMENT AGENCY
EL PASO COUNTY, CO
AND INCORPORATED AREAS

FLOODWAY DATA

SAND CREEK

TABLE 5

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Tuesday, Mar 14 2017

Box Culvert (Arroya Lane & prop. collector Rd.)

Invert Elev Dn (ft)	= 7233.50
Pipe Length (ft)	= 115.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 7234.65
Rise (in)	= 72.0
Shape	= Box
Span (in)	= 144.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Flared Wingwalls
Culvert Entrance	= 30D to 75D wingwall flares
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4

Embankment

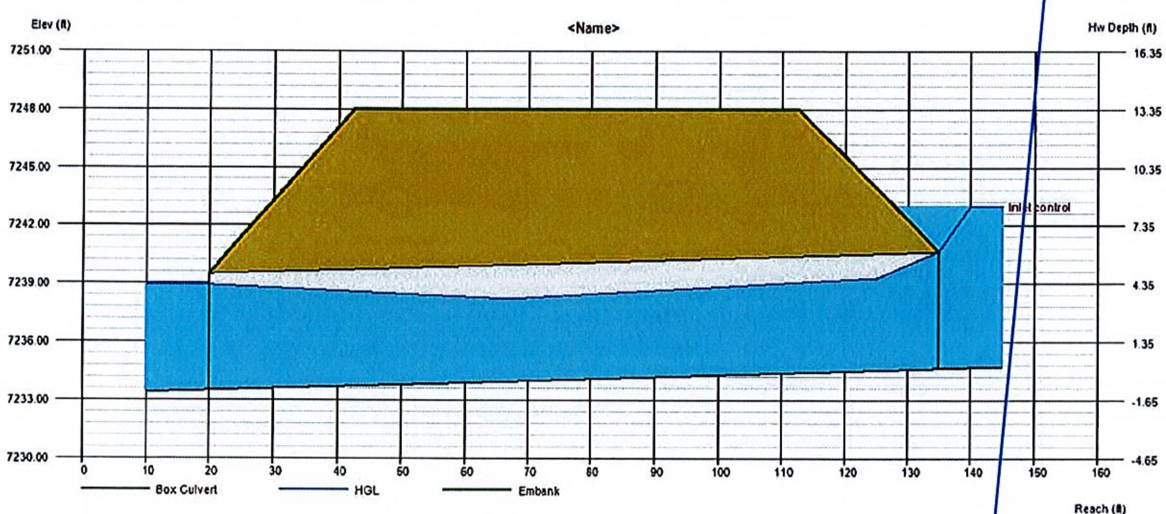
Top Elevation (ft)	= 7248.00
Top Width (ft)	= 70.00
Crest Width (ft)	= 70.00

Calculations

Qmin (cfs)	= 630.00
Qmax (cfs)	= 2170.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 2170.00
Qpipe (cfs)	= 2170.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 11.13
Veloc Up (ft/s)	= 12.49
HGL Dn (ft)	= 7238.91
HGL Up (ft)	= 7239.48
Hw Elev (ft)	= 7242.98
Hw/D (ft)	= 1.39
Flow Regime	= Inlet Control



Shouldn't this be 2,600 for FEMA flows?

– using DBPS flows

If the second 60" culvert is not in place north on Vollmer, address where flows over the single culvert's capacity will go. Provide design points. — see additional text in report

Show and label OS-4. Provide MDDP Maps.

Ensure that this is not just the floodway. — floodplain from Come

CN VALUES - EXISTING CONDITIONS

BASIN (label)	BASIN AREA (Ac)	SOIL TYPE B CN	SOIL TYPE B AREA (Ac.)	WEIGHTED C
EX-1	156.9	61	156.9	61
EX-2	9.2	61	9.2	61
EX-3	24.9	61	24.9	61
EX-4	35.2	63	35.2	63
EX-6	6.7	61	6.7	61
OS-1	49.1	61	49.1	61
OS-2	2.1	61	2.1	61
OS-3	1.0	82	1.0	82
OS-4	16.1	63	16.1	63
OS-5	27.6	61	27.6	61

TIME OF CONCENTRATION - EXISTING CONDITIONS

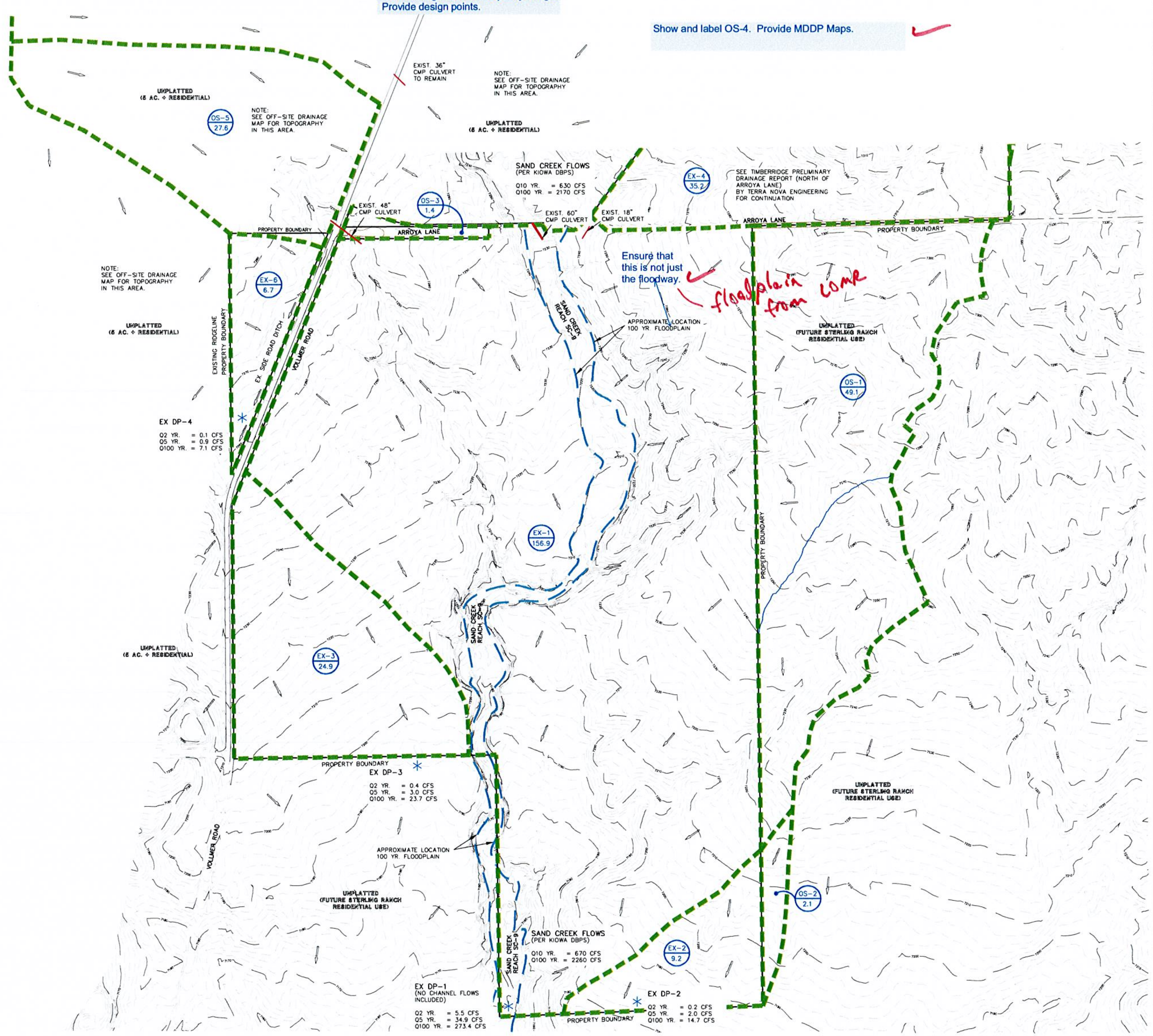
BASIN	Cn	C(5)	OVERLAND Length (ft)	OVERLAND Height (ft)	OVERLAND Tc (min)	STREET / CHANNEL FLOW Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc TOTAL (min)	Tc LAG (min)	Tc LAG (hr)
EX-1	61.0	0.08	300	8	23.1	1600	1.8%	1.3	20.5	43.6	26.2	0.44
EX-2	61.0	0.08	300	10	21.4					21.4	12.9	0.21
EX-3	61.0	0.08	300	8	23.1	1500	4.0%	1.5	16.7	39.7	23.8	0.40
EX-4	63.0	0.08	300	24	16.1	1900	6.0%	1.8	17.6	33.7	20.2	0.34
EX-6	61.0	0.08	300	14	19.2	800	1.0%	1.0	13.3	32.5	19.5	0.33
OS-1	61.0	0.08	300	22	16.5	1300	4.0%	1.5	14.4	31.0	18.6	0.31
OS-2	61.0	0.08	300	12	20.2	550	5.0%	1.7	5.4	25.6	15.3	0.26
OS-3	82.0	0.08	300	18	17.7	300	6.0%	2.2	2.3	19.9	12.0	0.20
OS-4	63.0	0.08	300	22	16.5	1100	4.0%	1.4	13.1	29.6	17.8	0.30
OS-5	61.0	0.08	300	10	21.4	1300	3.0%	1.2	18.1	39.5	23.7	0.39

BASIN SUMMARY - EXISTING CONDITIONS

BASIN (label)	TOTAL BASIN AREA (acres)	WEIGHTED CN	TOTAL LAG TIME (hours)	Q 2 Yr. (cfs)	Q 5 Yr. (cfs)	Q 100 Yr. (cfs)
EX-1	156.9	61	0.44	2.6	17.7	140.3
EX-2	9.2	61	0.21	0.2	1.7	12.2
EX-3	24.9	61	0.40	0.4	3.0	23.7
EX-4	35.2	63	0.34	1.3	6.9	41.8
EX-6	6.7	61	0.33	0.1	0.9	7.1
OS-1	49.1	61	0.31	0.9	7.0	53.9
OS-2	2.1	61	0.26	0.04	0.3	2.5
OS-3	1.0	82	0.20	1.3	2.0	4.8
OS-4	16.1	63	0.30	0.6	3.4	20.7
OS-5	27.6	61	0.39	0.5	3.6	28.1

DESIGN POINTS SURFACE ROUTING SUMMARY - EXISTING CONDITIONS

Design Point (label)	Contributing Basins	Q 2 Yr. Q (cfs)	Q 5 Yr. Q (cfs)	Q 100 Yr. Q (cfs)
EX DP-1	BASINS OS-1, OS-3, OS-4, OS-5, EX-1, EX-4, EX-5, EX-6	5.5	34.9	273.4
EX DP-2	BASINS OS-2, EX-2	0.2	2.0	14.7
EX DP-3	BASIN EX-3	0.4	3.0	23.7
EX DP-4	BASIN EX-6	0.12	0.9	7.1



LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	6910
BASIN BOUNDARY	
DESIGN POINT	*
BASIN IDENTIFIER / AREA IN ACRES	BB 10.0
EXISTING DIRECTION OF FLOW	
STORM SEWER	

N

200 100 0 200 400

SCALE: 1" = 200'

CLASSIC CONSULTING ENGINEERS & SURVEYORS

619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
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(719)785-0799 (Fax)

THE RETREAT AT TIMBERRIDGE
PRELIMINARY DRAIANGE REPORT
(SOUTH OF ARROYA LANE)
PRE-DEVELOPMENT DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE 4-5-18
DRAWN BY	MAW	(H) 1"= 200'	SHEET 1 OF 2
CHECKED BY		(V) 1"= N/A	JOB NO. 2520.00

PRELIMINARY DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

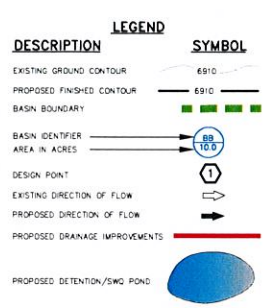
BASIN	WEIGHTED CA(2)	CA(5)	CA(100)	OVERLAND C(5)	Length (ft)	Height (ft)	Tc (min)	STREET / CHANNEL FLOW Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc TOTAL (min)	INTENSITY I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	TOTAL FLOWS Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
A1	0.72	1.68	4.80	0.14	120	2.4	15.1	740	2.5%	1.6	7.8	22.9	2.31	2.89	4.84	1.7	5	23
A2	0.41	0.97	2.76	0.14	300	12	19.0	400	4.0%	2.0	3.3	22.3	2.34	2.92	4.91	1.0	3	14
A3	0.34	0.80	2.28	0.14	300	8	21.7	400	3.0%	1.7	3.8	25.6	2.18	2.72	4.57	0.7	2	10
A4	0.25	0.42	0.92	0.20	180	8	13.3	180	4.0%	2.0	1.5	14.8	2.83	3.54	5.94	0.7	1	5
A5	0.34	0.80	2.28	0.14	280	10	19.1					19.1	2.53	3.16	5.31	0.9	3	12
B1	1.41	3.29	9.40	0.14	300	10.5	19.9	1280	3.2%	1.8	11.9	31.8	1.92	2.39	4.02	2.7	8	38
B2	0.47	1.11	3.16	0.14	300	10.5	19.9					19.9	2.48	3.10	5.20	1.2	3	16
B3	0.68	0.69	0.74	0.14			10.0				10.0	20.0	2.47	3.09	5.19	1.7	2	4
B4	0.79	1.83	5.24	0.14	300	10.5	19.9					19.9	2.48	3.10	5.20	1.9	6	27
C1	1.08	2.04	5.04	0.17	300	17	18.4	500	2.0%	2.8	3.5	21.9	2.36	2.95	4.95	2.5	6	25
C2	0.52	0.86	1.89	0.20	300	14	16.9					16.9	2.67	3.34	5.61	1.4	3	11
C3	0.77	1.45	3.61	0.17	300	17	16.4					16.4	2.71	3.39	5.68	2.1	5	21
D1	1.02	1.28	2.72	0.21	200	4	18.0	500	2.0%	2.8	3.5	21.6	2.38	2.98	5.00	2.4	4	14
D2	2.54	3.53	6.63	0.25	150	3	15.0	900	3.0%	3.5	4.3	19.3	2.51	3.14	5.28	6.4	11	35
D3	0.68	0.85	1.81	0.21	150	3	15.6	375	2.0%	2.8	2.2	17.8	2.61	3.26	5.48	1.8	3	10
D4	1.36	1.84	3.30	0.27	150	3	14.6	500	3.5%	3.7	2.7	17.3	2.64	3.31	5.56	3.6	6	18
D5	2.30	3.20	6.02	0.25	150	3	15.0	1650	2.5%	3.2	5.5	20.5	2.44	3.05	5.13	5.6	10	31
D6	2.74	3.80	7.14	0.25	150	3	15.0	1200	2.0%	2.8	7.1	22.0	2.36	2.94	4.94	6.4	11	35
D7	0.19	0.43	1.11	0.16	150	3	16.5					16.5	2.70	3.37	5.67	0.5	1	6
D8	0.38	0.53	0.99	0.25	70	2.8	6.1					6.1	3.54	4.44	7.46	1.3	2	7
D9	0.27	0.38	0.71	0.25	70	2.8	6.1					6.1	3.54	4.44	7.46	1.0	2	5
D10	0.31	0.43	0.80	0.25	80	3.2	6.7					6.7	3.46	4.34	7.29	1.1	2	6
E	1.60	1.62	1.73	0.25	30	7.5	2.9	1000	5.0%	2.2	7.5	10.4	3.25	4.06	6.84	5.2	7	12
F1	0.54	1.63	6.52	0.09	60	2	8.3	2400	2.0%	1.4	28.3	36.6	1.75	2.19	3.66	1.0	4	24
F2	0.14	0.41	1.66	0.09	60	6	6.6	1200	2.0%	1.4	14.1	20.7	2.43	3.03	5.09	0.3	1	8
H	0.40	0.94	2.68	0.14	300	11	19.6	900	2.0%	1.4	10.6	30.2	1.98	2.47	4.15	0.8	2	11
OS-1A	0.14	0.43	1.73	0.09	300	15	18.6	400	5.0%	4.5	1.5	20.1	2.47	3.08	5.18	0.4	1	9
OS-1B	0.70	2.11	8.42	0.09	300	15	18.6	1200	5.0%	4.5	4.5	23.0	2.30	2.88	4.83	1.6	6	41
OS-2A	0.06	0.18	0.72	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.1	0.6	4
OS-2B	0.07	0.21	0.83	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.2	0.6	4
OS-2C	0.45	1.34	5.36	0.09	300	12	20.0	1000	3.0%	3.5	4.8	24.8	2.21	2.77	4.64	1.0	4	25
OS-2D	0.03	0.08	0.31	0.09	250	12	17.2					17.2	2.65	3.32	5.57	0.07	0.3	2
OS-2E	0.09	0.28	1.12	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.2	0.9	6
OS-3	1.25	1.26	1.34	0.08	100	4	11.7	800	2.0%	2.6	4.7	16.4	2.71	3.39	5.68	3	4	8
OS-5	0.55	2.21	9.66	0.08	300	12	20.2	1500	3.0%	3.5	7.2	27.4	2.10	2.62	4.39	1	6	42

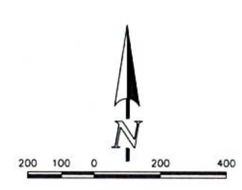
PRELIMINARY DRAINAGE REPORT ~ BASIN RUNOFF COEFFICIENT SUMMARY

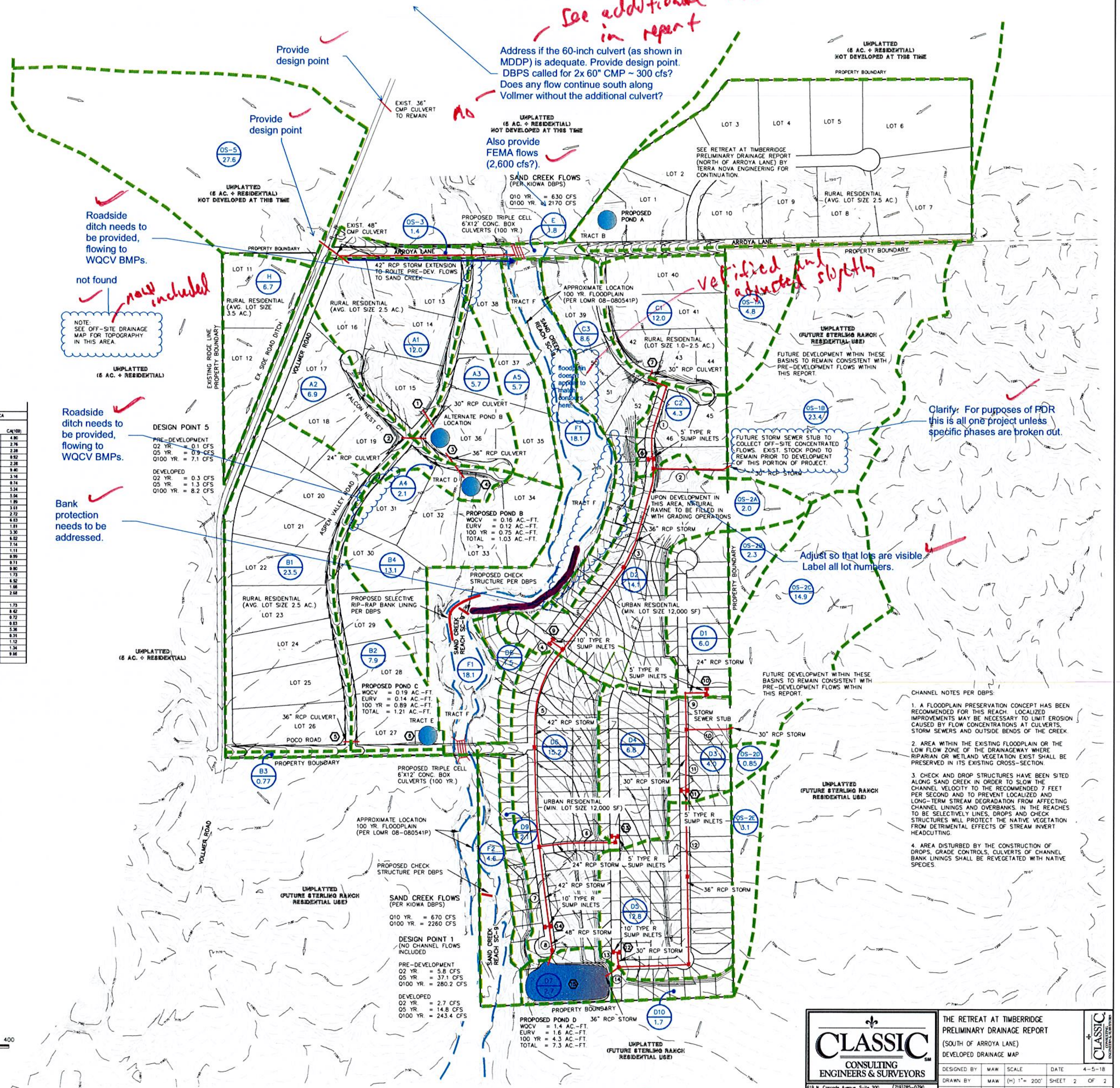
BASIN	TOTAL AREA (AC)	IMPERVIOUS AREA / STREETS AREA (AC)	C(2)	C(50)	C(100)	LANDSCAPE / DEVELOPED AREAS AREA (AC)	C(2)	C(5)	C(100)	WEIGHTED C(2)	C(5)	C(100)	WEIGHTED CA CA(2)	CA(5)	CA(100)
A1	12.0	0.00	0.89	0.95	0.96	12.00	0.06	0.14	0.40	0.06	0.14	0.40	0.72	1.68	4.80
A2	6.9	0.00	0.89	0.95	0.96	6.90	0.06	0.14	0.40	0.06	0.14	0.40	0.41	0.97	2.76
A3	5.7	0.00	0.89	0.95	0.96	5.70	0.06	0.14	0.40	0.06	0.14	0.40	0.34	0.80	2.28
A4	2.1	0.00	0.89	0.95	0.96	2.10	0.12	0.20	0.44	0.12	0.20	0.44	0.25	0.42	0.92
A5	5.7	0.00	0.89	0.95	0.96	5.70	0.06	0.14	0.40	0.06	0.14	0.40	0.34	0.80	2.28
B1	23.5	0.00	0.89	0.95	0.96	23.50	0.06	0.14	0.40	0.06	0.14	0.40	1.41	3.29	9.40
B2	7.9	0.00	0.89	0.95	0.96	7.90	0.06	0.14	0.40	0.06	0.14	0.40	0.47	1.11	3.16
B3	0.77	0.77	0.89	0.95	0.96	0.00	0.06	0.14	0.40	0.89	0.90	0.96	0.68	0.69	0.74
B4	13.1	0.00	0.89	0.95	0.96	13.10	0.06	0.14	0.40	0.06	0.14	0.40	0.79	1.83	5.24
C1	12.0	0.00	0.89	0.95	0.96	12.00	0.09	0.17	0.42	0.09	0.17	0.42	1.08	2.04	5.04
C2	4.3	0.00	0.89	0.95	0.96	4.30	0.12	0.20	0.44	0.12	0.20	0.44	0.52	0.86	1.89
C3	8.6	0.00	0.89	0.95	0.96	8.60	0.09	0.17	0.42	0.09	0.17	0.42	0.77	1.46	3.61
D1	6.0	0.00	0.89	0.95	0.96	6.00	0.17	0.21	0.45	0.17	0.21	0.45	1.02	1.28	2.72
D2	14.1	0.00	0.89	0.95	0.96	14.10	0.18	0.25	0.47	0.18	0.25	0.47	2.54	3.53	6.63
D3	4.0	0.00	0.89	0.95	0.96	4.00	0.17	0.21	0.45	0.17	0.21	0.45	0.68	0.85	1.81
D4	6.8	0.00	0.89	0.95	0.96	6.80	0.20	0.27	0.49	0.20	0.27	0.49	1.36	1.84	3.30
D5	12.8	0.00	0.89	0.95	0.96	12.80	0.18	0.25	0.47	0.18	0.25	0.47	2.30	3.20	6.02
D6	15.2	0.00	0.89	0.95	0.96	15.20	0.18	0.25	0.47	0.18	0.25	0.47	2.74	3.80	7.14
D7	2.7	0.00	0.89	0.95	0.96	2.70	0.07	0.16	0.41	0.07	0.16	0.41	0.19	0.43	1.11
D8	2.1	0.00	0.89	0.95	0.96	2.10	0.18	0.25	0.47	0.18	0.25	0.47	0.38	0.53	0.99
D9	1.5	0.00	0.89	0.95	0.96	1.50	0.18	0.25	0.47	0.18	0.25	0.47	0.27	0.38	0.71
D10	1.7	0.00	0.89	0.95	0.96	1.70	0.18	0.25	0.47	0.18	0.25	0.47	0.31	0.43	0.80
E	1.8	1.80	0.89	0.95	0.96	0.00	0.18	0.25	0.47	0.89	0.90	0.96	1.60	1.62	1.73
F1	18.1	0.00	0.89	0.95	0.96	18.10	0.03	0.09	0.36	0.03	0.09	0.36	0.54	1.63	6.52
F2	4.6	0.00	0.89	0.95	0.96	4.60	0.03	0.09	0.36	0.03	0.09	0.36	0.14	0.41	1.66
H	6.7	0.00	0.89	0.95	0.96	6.70	0.06	0.14	0.40	0.06	0.14	0.40	0.40	0.94	2.68
OS-1A	4.8	0.00	0.89	0.95	0.96	4.80	0.03	0.09	0.36	0.03	0.09	0.36	0.14	0.43	1.73
OS-1B	23.4	0.00	0.89	0.95	0.96	23.40	0.03	0.09	0.36	0.03	0.09	0.36	0.70	2.11	8.42
OS-2A	2.0	0.00	0.89	0.95	0.96	2.00	0.03	0.09	0.36	0.03	0.09	0.36	0.06	0.18	0.72
OS-2B	2.3	0.00	0.89	0.95	0.96	2.30	0.03	0.09	0.36	0.03	0.09	0.36	0.07	0.21	0.83
OS-2C	14.9	0.00	0.89	0.95	0.96	14.90	0.03	0.09	0.36	0.03	0.09	0.36	0.45	1.34	5.36
OS-2D	0.85	0.00	0.89	0.95	0.96	0.85	0.03	0.09	0.36	0.03	0.09	0.36	0.03	0.08	0.31
OS-2E	3.1	0.00	0.89	0.95	0.96	3.10	0.03	0.09	0.36	0.03	0.09	0.36	0.09	0.28	1.12
OS-3	1.4	1.40	0.89	0.95	0.96	0.00	0.02	0.08	0.35	0.89	0.90	0.96	1.25	1.26	1.34
OS-5	27.6	0.00	0.89	0.95	0.96	27.60	0.02	0.08	0.35	0.02	0.08	0.35	0.55	2.21	9.66

PRELIMINARY DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	I(100)	Flow Q(5)	Q(100)	Culvert / Inlet Size
1	A1	1.68	4.80	22.9	2.89	4.84	5	23	30" RCP
2	A2	0.97	2.76	22.3	2.92	4.91	3	14	24" RCP
3	DP-1, DP-2, A3	3.44	9.84	25.6	2.72	4.57	9	45	36" RCP
4	A1, A2, A3 and A4 (POND B INFLOW)	3.86	10.76	26.6	2.66	4.47	10	48	
5	B1	3.29	9.40	31.8	2.39	4.02	8	38	36" RCP
6	B1 and B2 (POND C INFLOW)	4.40	12.56	34.8	2.25	3.75	10	48	
7	C1, OS-1A	2.47	6.77	23.4	2.85	4.78	7	32	30" RCP
8	C2	0.86	1.89	16.9	3.34	5.61	3	11	5' Type R sump inlets
9	D2, OS-2A	3.71	7.35	20.0	3.09	5.19	11	38	10' Type R sump inlets
10	D1, OS-2B	1.49	3.55	21.6	2.98	5.00	4	18	5' Type R sump inlets
11	D3, OS-2D	0.93	2.12	17.8	3.26	5.48	3	12	5' Type R sump inlets
12	D5, OS-2E	3.48	7.13	20.5	3.05	5.13	11	37	10' Type R sump inlets
13	D4	1.84	3.30	17.3	3.31	5.56	6	18	5' Type R sump inlets
14	D6	3.80	7.14	22.0	2.94	4.94	11	35	10' Type R sump inlets
15	DP-7 Thru DP-14 and OS-1B, OS-2C, D7 (POND D INFLOW)	22.44	54.14	27.8	2.60	4.36	58	236	







Identify areas where offsite easements will be required.

PRELIMINARY DRAINAGE REPORT

FOR

THE RETREAT AT TIMBERRIDGE PRELIMINARY PLAN (SOUTH OF ARROYA LANE)

Prepared for:
ARROYA INVESTMENTS LLC
1283 KELLY JOHNSON BLVD.
COLORADO SPRINGS CO 80920
(719) 447-8773

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

Job No. 2520.20

CLASSIC CONSULTING ENGINEERS & SURVEYORS

PRELIMINARY DRAINAGE REPORT FOR
THE RETREAT AT TIMBERRIDGE PRELIMINARY PLAN
(SOUTH OF ARROYA LANE)

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

____ ____________________

Marc A. Whorton Colorado P.E. #37155 Date

DEVELOPER'S STATEMENT:
I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Business Name: ARROYA INVESTMENTS LLC

By: ____________________________________

Title: ____________________________________

Address: 1271 Kelly Johnson Blvd., Suite 100

Colorado Springs, CO 80920

EL PASO COUNTY:

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

______________________________ ____________________

Jennifer Irvine, El Paso County Engineer Date

Conditions:

PRELIMINARY DRAINAGE REPORT FOR

THE RETREAT AT TIMBERRIDGE PRELIMINARY PLAN

(SOUTH OF ARROYA LANE)

TABLE OF CONTENTS:

APPENDICES

CLASSIC CONSULTING ENGINEERS & SURVEYORS

PURPOSE

The purpose of this Preliminary Drainage Report, as part of the Retreat at TimberRidge Preliminary Plan, is to identify specific drainage features and facilities and to estimate peak rates of stormwater runoff, from on-site and off-site sources. Also the purpose is to outline the necessary improvements to safely route developed storm water runoff to adequate outfall facilities. The drainage improvements proposed in this report are preliminary in nature and final drainage reports are required upon any development within the site that detail the 'to be constructed' drainage systems and detention/SWQ ponds. This report covers the major portion of the Preliminary Plan area south of Arroya Lane. The 10 lots north of Arroya Lane can be found in "Preliminary Drainage Report for TimberRidge Estates Preliminary Plan (North of Arroya Lane)" prepared by Terra Nova Engineering, Inc., dated April 2018.

GENERAL DESCRIPTION

The Retreat at TimberRidge entire development is a 234.1-acre site located in portions sections 21, 22, 27 and 28, township 12 south, range 65 west of the sixth principal meridian. This specific report covers 196.7 acres and does not include Arroya Lane or the 10 residential lots north of Arroya Lane. The site is bounded on the north by various unplatted parcels (zoned for 5 ac. residential), to the south and east by Sterling Ranch property (zoned for future urban development) and to the west by Vollmer Road and unplatted parcels (zoned for 5 ac. residential). The site is in the upper portion of the Sand Creek Drainage Basin. Both large lot rural single family residential and urban single family residential are proposed in the Preliminary Plan for this site.

The average soil condition reflects Hydrologic Group "B" (Pring coarse sandy loam and Kettle gravelly loamy sand) as determined by the "Web Soil Survey of El Paso County Area," prepared by the Natural Resources Conservation Service (see map in Appendix).

EXISTING DRAINAGE CONDITIONS

The Retreat at TimberRidge property is located in the upper portion of the Sand Creek drainage basin on the south edge of Black Forest. The overall property was recently acquired in numerous parcels. The parcels west of Vollmer Road are on the fringe of Black Forest and contains some sparsely scattered pine trees with the majority of the parcel being native grasses. The northeast parcel, north of Arroya Lane again is on the fringe of Black Forest and contains some sparsely scattered pine trees with the majority of the parcel being native grasses. The parcel at the southeast corner of Vollmer Road and Arroya Lane also contains some sparsely scattered pine trees with native grasses and natural ravines tributary to the Sand Creek channel. The remaining larger parcels realigned

south of Arroya Lane and east of Vollmer Road are mainly covered with native grasses with few or no pine trees. The Sand Creek channel bisects this part of the property from north-south with various natural ravine tributary fingers. A wetlands delineation has been prepared for the property (See Appendix) and reflects some wetlands throughout the Sand Creek channel. Upon determination of exact channel improvements as a part of development and final platting of the site, the appropriate permitting will be prepared for and reviewed/approved by US Fish and Wildlife. Arroya Lane exists along the northern portion of the site. The westerly portion of this road is public ROW with the remainder of the road heading further east being private. A portion of this existing ROW may need to be vacated with the final plat in this area given the planned re-alignment of the Arroya Lane and Vollmer intersection. An existing 60" CMP culvert currently conveys the low flows from Sand Creek under Arroya Lane.

Portions of this site have been previously studied in the "Sand Creek Drainage Basin Planning Study" (DBPS) prepared by Kiowa Engineering Corporation, March 1996. The portion of Sand Creek that traverses the site is defined as Reach SC-9 in the DBPS. Approximately 1000+ acres north of this property is tributary to this reach of the channel. (See Off-site Drainage Map in Appendix) According to the DBPS, this reach of Sand Creek all contained within the channel has the following flow characteristics: Q_{10} = 630 cfs Q_{100} = 2170 cfs. However, the 100 yr. flow recognized by FEMA in the LOMR 08-08-0541P with effective date of July 23, 2009, equals nearly Q_{100} = 2600 cfs. The majority of these off-site flows enter the property at the north end of the site conveying flows from the northwest (Black Forest area) and the off-site stock ponds to the north (both tributary to hundreds of acres of property in Black Forest). There are multiple existing culvert crossings of Vollmer Rd. just north of Arroya Lane to facilitate these historic flow patterns. The following are the few key culverts that directly feed the Sand Creek channel north of Arroya Lane: Approximately 1,000 feet north of Arroya Lane, an existing 36" CMP crosses Vollmer Road (Basin SC-1 on Off-site Drainage Map). A small basin and natural ravine just west of Vollmer feeds this facility. From a recent field visit, this small facility seems to be in good working condition, however, not labeled in the DBPS. Another 700 feet+ north along Vollmer a much larger basin exists west of the roadway. This off-site basin is approximately 350+ acres northwest of Vollmer Road (Basin SC-2 on Off-site Drainage Map). As shown within the DBPS, this existing crossing is a 60" CMP with some very dense and tall vegetation at both the entrance and exit of this facility. But, based on a recent field visit this facility seems to be in good working condition. The DBPS depicts this facility and recommends an additional 60" CMP at this location. However, there are no signs of erosion or over topping the road at this location at this time based on the current development within the tributary area to this facility. Based on the existing surrounding topography and roadway configuration, the 100 yr. historic flows at this location would appear to spill over the roadway and continue in their historic drainage pattern downstream within the upper reach of Sand Creek.

The following descriptions represent the pre-development flow design points for the property excluding the major off-site flows within Sand Creek just described:

EX DP-1 (Q_2 = 5.6 cfs Q_5 = 36.0 cfs, Q_{100} = 281.7 cfs) This does not include the major off-site channel flows but reflects only the on-site and off-site flows that travel across the property and have a direct effect on the development. This total represents the allowed developed release off-site at this location. This total pre-development flow includes the flowing basins: EX-1, EX-4, OS-1, OS-3, OS-4 and OS-5. Basin EX-1 (Q_2 = 2.6 cfs Q_5 = 17.7 cfs, Q_{100} = 140.3 cfs) consists of the majority of the site proposed for development. This basin contains areas of sheet flow that eventually travel within various natural ravines created within the site. These ravines then route the predevelopment flows directly into Sand Creek in the form of concentrated flows at multiple locations along the Creek. Basins OS-4 (Q_2 = 0.6 cfs Q_5 = 3.4 cfs, Q_{100} = 20.7 cfs) and EX-4 (Q_2 = 1.3 cfs Q_5 = 6.9 cfs, Q_{100} = 41.8 cfs) consists of the northeasterly portion of the property north of Arroya Lane that drains in a southwesterly direction into Sand Creek. These combined flows total (Q_2 = 1.6 cfs Q_5 = 9.8 cfs, Q_{100} = 60.1 cfs) and travel directly towards the existing 60" CMP under Arroya Lane. Details for these basins and Pond A are part of the Preliminary Drainage Report for north of Arroya Lane, prepared by Terra Nova Engineering. Basin EX-5 is not used in this report. Basin OS-5 (Q_2 = 1.0 cfs Q_5 = 5.2 cfs, Q_{100} = 32.1 cfs) consists off-site property northwest of Vollmer Road that drains under Vollmer through an existing 48" CMP culvert directly on-site. Basin OS-1 (Q_2 = 0.9 cfs Q_5 = 7.0 cfs, Q_{100} = 53.9 cfs) consists of an off-site basin to the east within the Sterling Ranch property that sheet flows directly on-site. Basin OS-3 (Q_2 = 0.6 cfs Q_5 = 2.1 cfs, Q_{100} = 9.9 cfs) consists of the public ROW portion of Arroya Lane that sheet flows directly on-site.

EX DP-2 (Q_2 = 0.2 cfs Q_5 = 2.0 cfs, Q_{100} = 14.7 cfs) consists of combined flows from on-site Basin EX-2 (Q_2 = 0.2 cfs Q_5 = 1.7 cfs, Q_{100} = 12.2 cfs) and Basin OS-2 (Q_2 = 0.04 cfs Q_5 = 0.3 cfs, Q_{100} = 2.5 cfs). These combined pre-development flows travel off-site directly onto Sterling Ranch property prior to eventually entering the Sand Creek channel.

EX DP-3 (Q_2 = 0.4 cfs Q_5 = 3.0 cfs, Q_{100} = 23.7 cfs) consists of flows from on-site Basin EX-3 that travel off-site directly onto Sterling Ranch property prior to eventually entering the Sand Creek channel.

EX DP-4 (Q_2 = 0.1 cfs Q_5 = 0.9 cfs, Q_{100} = 7.1 cfs) consists of on-site flows from Basin EX-6 that travel in a southeasterly direction towards the existing roadside ditch along the north side of Vollmer Road. These flows will travel in a southerly direction within the roadside ditch to a release point at the corner of the property. This to flow represents the allowed developed release at this location.

PROPOSED DRAINAGE CONDITIONS

Proposed development within the Retreat at TimberRidge will consist of a variety of different residential lot sizes ranging from 1.0 – 2.5 acre large rural lots to 12,000 SF min. urban lots. The rural lots will have paved streets and roadside ditches while the urban lots paved streets with County standard curb, gutter and sidewalk. Development of the urban lots proposed will consist of overlot grading for the planned roadways and lots. Development of rural lots proposed within the site will be limited to roadways and building pads, conserving the natural feature areas. Individual home sites on these lots are to be left generally in their natural condition with minimal disturbance to existing conditions per individual lot construction. Per the El Paso County ECM, Section I.7.1.B, rural lots of 2.5 ac. and larger are not required to provide Water Quality Capture Volume (WQCV). However, based on the current County/Urban Drainage stormwater quality standards, a WQCV component is automatically built into the UD Detention spreadsheet utilized in the detention basin design. Thus, the proposed facilities within both the rural and urban portions of this development will provide WQCV along with an Excess Urban Runoff Volume (EURV) in the lower portion of the facility storage volume with an outlet control device. Frequent and infrequent inflows are released at rates approximating undeveloped conditions. This concept provides some mitigation of increased runoff volume by releasing a portion of the increased runoff at a low rate over an extended period of time, up to 72 hours. This means that frequent storms, smaller than the 2 year event, will be reduced to very low flows near or below the sediment carrying threshold value for downstream drainage ways. Also, by incorporating an outlet structure that limits the 100-year runoff to the undeveloped condition rate, the discharge hydrograph for storms between the 2 year and the 100 year event will approximate the hydrograph for the undeveloped conditions and will help effectively mitigate the effects of development. Prior to development within the Retreat at TimberRidge property, final drainage reports and construction plans will be required detailing the requirements and specifics of proposed facilities. To the greatest extent possible, WQCV will be provided for all new roads and urban lots.

The following describes how this development proposes to handle both the off-site and on-site drainage conditions:

As mentioned previously, the majority of the off-site flows are already within the Sand Creek channel prior to entering the property. However the few off-site basins that must travel through the proposed site development areas prior to entering Sand Creek have been accounted for.

The following represent the basins west of Sand Creek:

Basin OS-5 (Q_2 = 1 cfs Q_5 = 6 cfs, Q_{100} = 42 cfs) represents off-site semi-forested, undeveloped property zoned for 5 ac. residential that is currently tributary to this site via an existing 48" CMP culvert under Vollmer. If future development occurs on this property, any developed flows must be detained beyond this pre-development quantity. A 48" RCP extension of this culvert is planned with the improvements of Arroya Lane to route these off-site pre-development flows directly to Sand Creek and by-pass the proposed development. These flows are anticipated to tie directly into the proposed triple cell box culvert crossing of Arroya Lane. These pre-developed off-site flows historically reached Sand Creek via a natural channel through the proposed development approximately 2,000 LF south of Arroya Lane. Channel improvements are proposed within this stretch of Sand Creek and these flows are only less than 2% of the overall flow within Sand Creek at this location. Thus, moving the junction point for these flows to intercept Sand Creek further north within the property will have no significant impact to Sand Creek.

Basin OS-3 (Q_2 = 1 cfs Q_5 = 2 cfs, Q_{100} = 11 cfs) represents the north half of the proposed re-alignment and improvements to Arroya Lane along with the undeveloped property north of the roadway. These flows will continue to travel in a side road ditch to be collected by a proposed 24" RCP culvert crossing of Arroya Lane just west of Sand Creek. These flows will then enter Basin A-1 and travel towards Design Point 3. Basins A1 (Q_2 = 1.8 cfs Q_5 = 5 cfs, Q_{100} = 25 cfs), A2 (Q_2 = 1.0 cfs Q_5 = 3 cfs, Q_{100} = 14 cfs), A3 (Q_2 = 0.8 cfs Q_5 = 2 cfs, Q_{100} = 11 cfs) and A4 (Q_2 = 0.7 cfs Q_5 = 1 cfs, Q_{100} = 5 cfs) are all tributary to the proposed Pond B. These basins collect flows from a portion of the rural 2.5 ac. lot development on the property with various culvert crossings designed to convey the proposed ditch flows towards Pond B. **Design Point 6 (Q_5 = 13 cfs, Q_{100} = 60 cfs)** represents the total developed flows entering **Pond B.** A proposed full-spectrum EDB is proposed at this location to release less than the pre-development flows currently seen. (See UD Detention Spreadsheet – Pond B for anticipated outlet structure and release levels) At this point, we have also shown a possible alternate/additional location for this facility. (See Drainage Map) With the Final Plat and Drainage Report it will be determined which or both locations work best from a lotting and development standpoint. Maintenance access to this facility will be directly from the adjacent public roadway.

one?

Basins B1 (Q_2 = 2.2 cfs Q_5 = 6 cfs, Q_{100} = 30 cfs), B2 (Q_2 = 1.2 cfs Q_5 = 3 cfs, Q_{100} = 17 cfs) and B3 (Q_2 = 2.8 cfs Q_5 = 5 cfs, Q_{100} = 14 cfs) are tributary to the proposed Pond C. These basins collect flows from the rest of the portion of the rural 2.5 ac. lot development west of Sand Creek with various culvert crossings designed to convey the proposed ditch flows towards Pond C. **Design Point 9 (Q_5 = 12 cfs, Q_{100} = 52 cfs)** represents the total developed flows entering **Pond C.** A proposed full-spectrum EDB is proposed at this location to release less than the pre-development flows currently seen. (See UD Detention Spreadsheet – Pond C for anticipated outlet structure and release levels) Maintenance access to this facility will be directly from the adjacent public roadway. Basins A5 (Q_2 = 0.8 cfs Q_5 = 2 cfs, Q_{100} = 12 cfs) and B4 (Q_2 = 1.9 cfs Q_5 = 6 cfs, Q_{100} = 27 cfs) represent portions of the rural 2.5 ac. lots west of Sand Creek outside the proposed roadway improvements that cannot reasonably be collected into the two facilities just described. With the minimal impervious areas anticipated on these large lots, these basins will continue to sheet flow towards Sand Creek. Per the ECM Section I.7.1.B, WQCV is not required for these lots given their size (2.5 Ac.). Also, the City owned regional facility downstream of this property (Sand Creek #3) is an in-line facility that provides stormwater quality. Basin H (Q_2 = 0.8 cfs Q_5 = 2 cfs, Q_{100} = 11 cfs) is proposed for two large lots averaging 3.5 ac. each west of Vollmer. Again, per the ECM Section I.7.1.B, WQCV is not required for these lots given their size (2.5 Ac. +). However, sediment control will be provided on each individual lot. After this sediment control, the minimal developed flow from these lots will be allowed to continue to sheet flow directly into the side road ditch along Vollmer Road.

as appropriate

The following represent the basins east of Sand Creek:

Basins OS-4 and EX-4 calculations are included in this report but details for these basins and Pond A are part of the Preliminary Drainage Report for north of Arroya Lane, prepared by Terra Nova Engineering.

Basins C1 (Q_2 = 2.7 cfs Q_5 = 6 cfs, Q_{100} = 26 cfs) and OS-1A (Q_2 = 0.4 cfs Q_5 = 1 cfs, Q_{100} = 9 cfs) are tributary to the Design Point 10. These basins represent on-site 2.5 ac. – 1.0 ac. lots and off-site future Sterling Ranch development which is planned to continue to sheet flow on-site through the proposed lots. A 30" RCP culvert will collect the flows at this location and route them further downstream within the on-site storm system. Basins C2 (Q_2 = 1.4 cfs Q_5 = 3 cfs, Q_{100} = 11 cfs) and OS-1B (Q_2 = 1.6 cfs Q_5 = 6 cfs, Q_{100} = 41 cfs) are tributary to the Design Point 11 and the on-site storm system. These basins represent on-site 1.0 ac. lots and off-site future Sterling Ranch development. A 30" RCP storm stub is proposed to collect the future off-site flows at this location. In the interim, prior to on-site development in this phase (Phase 4 as shown on the Preliminary Plan), the existing on-site stock pond will remain in place and continue to act as a sediment facility for the off-site flows. Upon development in this phase, the stock pond will be removed and storm system provided to handle these off-site flows. Off-site grading will be required to allow for the capture of these off-site flows within the proposed storm sewer system. An off-site easement to

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allow for this grading and storm construction will be acquired prior to construction in this area. Future off-site Sterling Ranch development in this basin will need to meet these pre-development flows at this location.

At Design Point 11, assuming an even split of flows at this time, 5' Type R sump inlets will collect the developed flows and route them further downstream in a 36" RCP storm system. The Final Drainage Report will further detail the exact inlet design. Basins D2 (Q_2 = 6.4 cfs Q_5 = 11 cfs, Q_{100} = 35 cfs) and OS-2A (Q_2 = 0.1 cfs Q_5 = 0.6 cfs, Q_{100} = 4 cfs) are tributary to the Design Point 12. These basins represent on-site 1.0 ac. – 1/3 ac. lots and off-site future Sterling Ranch development which is planned to continue to sheet flow on-site through the proposed lots. At this location, assuming an even split of flows at this time, 10' Type R sump inlets will collect the developed flows and route them further downstream in a 42" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basins D1 (Q_2 = 2.4 cfs Q_5 = 4 cfs, Q_{100} = 14 cfs) and OS-2B (Q_2 = 0.2 cfs Q_5 = 0.6 cfs, Q_{100} = 4 cfs) are tributary to the Design Point 13. These basins represent on-site 1/3 ac. lots and off-site future Sterling Ranch development which is planned to continue to sheet flow on-site through the proposed lots. At this location, assuming an even split of flows at this time, 5' Type R sump inlets will collect the developed flows and route them further downstream in a 24" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basins D3 (Q_2 = 1.8 cfs Q_5 = 3 cfs, Q_{100} = 10 cfs), OS-2C (Q_2 = 1 cfs Q_5 = 4 cfs, Q_{100} = 25 cfs) and OS-2D (Q_2 = 0.07 cfs Q_5 = 0.3 cfs, Q_{100} = 2 cfs) are tributary to the Design Point 14 and the on-site storm system. These basins represent on-site 1/3 ac. lots and off-site future Sterling Ranch development. A 30" RCP storm stub is proposed to collect the future off-site flows at this location. Future off-site Sterling Ranch development in this basin will need to meet these pre-development flows at this location. At Design Point 14, assuming an even split of flows at this time, 5' Type R sump inlets will collect the developed flows and route them further downstream in a 36" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basins D5 (Q_2 = 5.6 cfs Q_5 = 10 cfs, Q_{100} = 31 cfs) and OS-2E (Q_2 = 0.2 cfs Q_5 = 0.9 cfs, Q_{100} = 6 cfs) are tributary to the Design Point 15. These basins represent on-site 1/3 ac. – 1/4 ac. lots and off-site future Sterling Ranch development which is planned to continue to sheet flow on-site through the proposed lots. At this location, assuming an even split of flows at this time, 10' Type R sump inlets will collect the developed flows and route them along with the upstream flows directly into Pond D. The Final Drainage Report will further detail the exact inlet design.

Basin D4 (Q_2 = 3.6 cfs Q_5 = 6 cfs, Q_{100} = 18 cfs) is tributary to Design Point 16. This basin represents on-site 1/4 ac. lots. At this location, assuming an even split of flows at this time, 5' Type R sump inlets will collect the developed flows and route them further downstream in a 24" RCP storm system. The Final Drainage Report will further detail the exact inlet design.

Basin D6 (Q_2 = 6.5 cfs Q_5 = 11 cfs, Q_{100} = 36 cfs) is tributary to Design Point 17. This basin represents on-site 1/4 ac. lots. At this location, assuming an even split of flows at this time, 10' Type R sump inlets will collect the developed flows and route them along with the upstream flows directly into Pond D. The Final Drainage Report will further detail the exact inlet design.

Design Point 18 (Q_5 = 59 cfs, Q_{100} = 237 cfs) represents the total developed flows entering **Pond D.** A proposed full-spectrum EDB is proposed at this location to release less than the pre-development flows currently seen. (See UD Detention Spreadsheet – Pond D for anticipated outlet structure and release levels) Maintenance access to this facility will be directly from the adjacent public roadway.

Basin D10 (Q_2 = 1.1 cfs Q_5 = 2 cfs, Q_{100} = 6 cfs) represents the rear yards of proposed lots that cannot reasonably be collected by the proposed Pond D and will then continue to sheet flow off-site. Basins C3 (Q_2 = 2.1 cfs Q_5 = 5 cfs, Q_{100} = 21 cfs), D8 (Q_2 = 1.3 cfs Q_5 = 2 cfs, Q_{100} = 7 cfs) and D9 (Q_2 = 1.0 cfs Q_5 = 2 cfs, Q_{100} = 5 cfs) represent portions of the rear yards that are adjacent to Sand Creek that cannot reasonably be collected into the proposed Pond D just described. With the minimal impervious areas anticipated on the rear of these lots, these basins will continue to sheet flow towards Sand Creek. However, ss mentioned earlier, the City owned regional facility

Address basin E including WQCV

WQCV is required prior to flows entering waters of the state.

downstream of this property (Sand Creek #3) is an in-line facility that provides stormwater quality for this minimal area. Basins F1 (Q_2 = 1.0 cfs Q_5 = 4 cfs, Q_{100} = 24 cfs) and F2 (Q_2 = 0.3 cfs Q_5 = 1 cfs, Q_{100} = 8 cfs) represent the Sand Creek Channel corridor. This area will not have any development take place in it other than the required channel improvements per the DBPS and the proposed roadway crossings.

Both the Poco Road extension and Arroya Lane are proposed to cross Sand Creek. At both these locations a triple cell 6'x12' CBC is proposed to handle the 100 yr. off-site flows. (See culvert calculations in Appendix) Both locations will require the acquisition of off-site easements for grading and construction of these facilities. These easements will be required prior to construction.

Address sizing of culverts needed to meet DCM bridge criteria for FEMA flows or LOMR to reduce flows.

DETENTION FACILITIES / STORMWATER QUALITY

Final design of these recommended facilities that include planning for water quality management of storm water runoff features will be designed during final platting of this development. As required, storm water quality measures will be utilized in order to reduce the amount of sediment, debris and pollutants that are allowed to enter Sand Creek. These features include but are not limited to the multiple Full Spectrum Extended Detention Basins. Site Planning and design techniques for the large lot, rural areas should limit impervious area, minimize directly impervious area, lengthen time of travel and increase infiltration in order to decrease the rate and volume of stormwater runoff. Urban areas that require detention will provide a Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV) in the lower portion of the facility storage volume that will release the more frequent storms at a slower rate to help minimize the effects of development of the property. These measures will be taken into consideration upon final design of the individual detention facilities as well as the development of the individual land uses within the site.

MAINTENANCE

The proposed detention/SWQ facilities are to be private facilities with ownership and maintenance by the local Metropolitan District or Homeowners Association. After completion of construction and upon the Board of County Commissioners acceptance, the Sand Creek channel will be owned and maintained by the El Paso County along with all drainage facilities within the public Right of Way.

type of drop concrete, riprap, or TBD?

SAND CREEK CHANNEL IMPROVEMENTS

As stated in the Sand Creek DBPS, this Reach SC-9 is recommended as a floodplain preservation design concept. Given the fact of the current requirements for detention/SWQ facilities planned for the property with designed release below pre-development flows, the existing Sand Creek drainageway is expected to remain stable. However, localized channel improvements are proposed in any steeply incised channel locations and to limit erosion caused by flow concentrations at culverts and storm sewers outfalls. Existing FEMA FIS channel velocities as found in the LOMR 08-080541P seem to exceed recommended allowable velocities. Although, based on the findings from the CORE Consultants, Inc. Impact Identification Report, no significant erosion or channel degradation through this property currently exists at this time. Specifically located grade control and/or drop structures (See Appendix) were specified in the DBPS through this reach in order to slow the cannel velocity to the DBPS recommended 7 feet per second and to prevent localized and long-term stream degradation from affecting channel linings and overbanks. The allowable velocity will vary depending upon the existing riparian vegetation found within the bankfull channel and floodplain terrace areas. Where channel velocities exceed the recommended allowable velocities, 36" vertical drop structures will be installed based on Urban Drainage Criteria Manual Vol. 2. (See Appendix) These facilities will incorporate and help protect the native wetland vegetation from detrimental effects of stream invert head cutting. Concept locations for these facilities are shown on the developed drainage map as recommended in the DBPS. Revegetation would occur wherever the native vegetation is disturbed by channel construction. Selectively located rip-rap bank protection will be installed in steeply incised areas, outside bends or the natural channel and detention pond/culvert outlets. (See Appendix) Also, based on the wetland delineations prepared by CORE Consultants, Inc., likely impacts to jurisdictional waters would trigger permitting under Section 404 of the Clean Water Act. This coordination and permitting would be completed along with the approval process of the final construction plans for the associated channel improvements.

Per the approved DBPS, the anticipated developed flows just upstream of this project are Q_{10} = 630 cfs and Q_{100} = 2170 cfs as depicted within segment no. 171. The anticipated developed flows exiting this property are Q_{10} = 670 cfs and Q_{100} = 2260 cfs as depicted within segment no. 170. The FEMA FIS flows appear to be slightly higher than those presented in the DBPS. However, given the anticipated land uses and overall detailed scope of the DBPS, we feel that the 100 yr. flows shown in the DBPS closer resemble the actual conditions of this stretch of Sand Creek. Therefore, the flows shown in the DBPS have been utilized in this report for preliminary channel and culvert design. The northern portion of Sterling Ranch is immediately downstream of this property. This portion of their development appears to be in the later phases and as such has not yet been analyzed for specific channel improvements. However, per the approved DBPS, similar grade control and check structures are shown in Sterling Ranch within Reach SC-8 as are recommended in Reach SC-9 through the TimberRidge property. Based on these anticipated flows, two proposed roadway crossings of Sand Creek are planned for this site. (Arroya Lane and the proposed east-west connector road) The current crossing of Arroya Lane is with a 60" CMP culvert. Upon development, the proposed crossing will consist of a triple cell 6'x12' CBC to facilitate the conveyance of the 100 yr. flow. This same structure is proposed at the crossing with the collector roadway as well. These facilities, along with all proposed channel improvements would be designed to continue to contain the 100 yr. flows within the current floodplain as defined by the LOMR 08-080541P. Upon final design of these culvert crossings and anticipated channel improvements, further floodplain analysis will be required to either suggest a no-rise certification or prepare an updated CLOMR/LOMR for associated improvements affecting the current 100 yr. floodplain. The Arroya Lane proposed culvert crossing is described in the DBPS as a single 6'x12' concrete box culvert (10 yr.) design. However, we would propose a triple cell 6'x12' box culvert at this location, designed to convey the 100 yr. developed flows. Based on this design we would request this facility be eligible towards this developments drainage fee obligation. (Reference the Drainage and Bridge Fees)

DRAINAGE CRITERIA

Hydrologic calculations were performed using the City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014. The overall pre-development design model was calculated using PondPack V8i with time of concentrations estimated using NRCS Unit Hydrograph procedures described in the DCM based upon the hydrologic soil type and runoff ARC II curve numbers (CN) chart (Table 6-10) with a 24 hour NRCS Type II distribution. Individual on-site developed basin design used for inlet sizing and storm system routing was calculated using the Rational Method. Runoff Coefficients are based on the imperviousness of the particular land use and the hydrologic soil type in accordance with Table 6-6. The average rainfall intensity, by recurrence interval found in the Intensity-Duration-Frequency (IDF) curves in Figure 6-5. (See Appendix)

FLOODPLAIN STATEMENT

Portions of this site are located within a floodplain as determined by the Flood Insurance Rate Maps (F.I.R.M.) Map Number 08041C 0535F and the previously mentioned LOMR 08-08-0541P both with effective date of July 23, 2009. (See Appendix).

DRAINAGE AND BRIDGE FEES

Any applicable fees shall be provided in the Final Drainage Report(s) prior to final plat recordation of any development within this site. The following represents the anticipated overall fees for this site:

Sand Creek Drainage Basin

This site lies entirely within the Sand Creek Drainage Basin boundaries.

The fees are calculated using the following impervious acreage method approved by El Paso County. The Retreat at TimberRidge site has a total area of 234.1 acres (including the 10 lots north of Arroya Lane which are not a part of this report) with the following different land uses proposed:

22.4 Ac.	Sand Creek Drainage corridor – Basins F1 and F2)
94.8 Ac.	2.5 Ac. lots
13.4 Ac.	1.0 Ac. lots
42.8 Ac.	1/3 Ac. lots
24.4 Ac.	1/4 Ac. lots

The percent imperviousness for this subdivision is calculated as follows:

<u>Fees for Sand Creek Drainage Corridor</u>

(Per El Paso County Percent Impervious Chart: 2%)

22.4 Ac. x 2% = **0.45 Impervious Ac.**

<u>Fees for 2.5 Ac. lots</u>

(Per El Paso County Percent Impervious Chart: 11% with 25% fee reduction for 2.5 ac. lots planned)

94.8 Ac. x 11% x 75% = **7.82 Impervious Ac.**

<u>Fees for 1.0 Ac. lots</u>

(Per El Paso County Percent Impervious Chart: 20%)

13.4 Ac. x 20% = **2.68 Impervious Ac.**

<u>Fees for 1/3 Ac. lots</u>

(Per El Paso County Percent Impervious Chart: 30%)

42.8 Ac. x 30% = **12.84 Impervious Ac.**

<u>Fees for 1/4 Ac. lots</u>

(Per El Paso County Percent Impervious Chart: 40%)

24.4 Ac. x 40% = **9.76 Impervious Ac.**

Total Impervious Acreage: 33.55 Imp. Ac.

The following calculations are based on the 2018 drainage/bridge fees:

ESTIMATED FEE TOTALS (prior to reduction):

Bridge Fees

$ 5,210.00 x 33.55 Impervious Ac. = <u>$ 174,795.50</u>

Drainage Fees

$ 17,197.00 x 33.55 Impervious Ac. = <u>$ 576,959.35</u>

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Per the ECM 3.10.4a and 3.10.5.a, this development requests a reduction of drainage fees based on the on-site full spectrum detention/SWQ facilities and regional channel improvements for this stretch of Sand Creek as shown in the DBPS. The following facilities within the Sand Creek Drainage Basin seem to meet the criteria for this reduction:

Detention Pond B	5.3 ac-ft. full spectrum	$ 50,000 x 50%	=	$ 25,000.00
Detention Pond C	5.3 ac-ft. full spectrum	$ 50,000 x 50%	=	$ 25,000.00
Detention Pond D	5.3 ac-ft. full spectrum	$ 90,000 x 50%	=	$ 45,000.00
Triple Cell 6'x12' CBC Crossing Arroya Lane		$ 250,000	=	$ 250,000.00
Sand Creek Channel Improvements per DBPS		$ 175,000	=	$ 175,000.00

(Exact facility costs provided with final drainage report(s))

ESTIMATED FEE TOTALS (with reduction):

Bridge Fees

$ 5,210.00 x 33.55 Impervious Ac. = $ 174,795.50

Drainage Fees

$ 576,959.35 - 520,000.00 = $ 56,959.35

SUMMARY

The proposed Retreat at TimberRidge Preliminary Plan is within the Sand Creek Drainage Basin. Recommendations are made within this report concerning necessary improvements that may be required as a result of development of this property. The points of storm water release from the proposed site are required to be at or below the calculated historic flow quantities. The development of the proposed site does not significantly impact any downstream facility or property to an extent greater than that which currently exists in the 'historic' conditions. All drainage facilities within this report were sized according to the Drainage Criteria Manuals and the full-spectrum storm water quality requirements. Upon development of the individual parcels within the site, separate Final Drainage Reports will be required to be submitted and approved by El Paso County that details all storm systems, pond design and fee calculation.

CLASSIC CONSULTING ENGINEERS & SURVEYORS

PREPARED BY:

Classic Consulting Engineers & Surveyors, LLC

Marc A. Whorton, P.E.
Project Manager

maw/252000/MDDP.doc

REFERENCES

1. City of Colorado Springs/County of El Paso Drainage Criteria Manual as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014.

2. "Urban Storm Drainage Criteria Manual Volume 1, 2 & 3" Urban Drainage and Flood Control District, dated January 2016.

3. "Final Drainage Report for Forest Gate Subdivision" Law & Mariotti Consultants, Inc. dated October 2004.

4. "Sand Creek Drainage Basin Planning Study," Kiowa Engineering Corporation, dated March 1996.

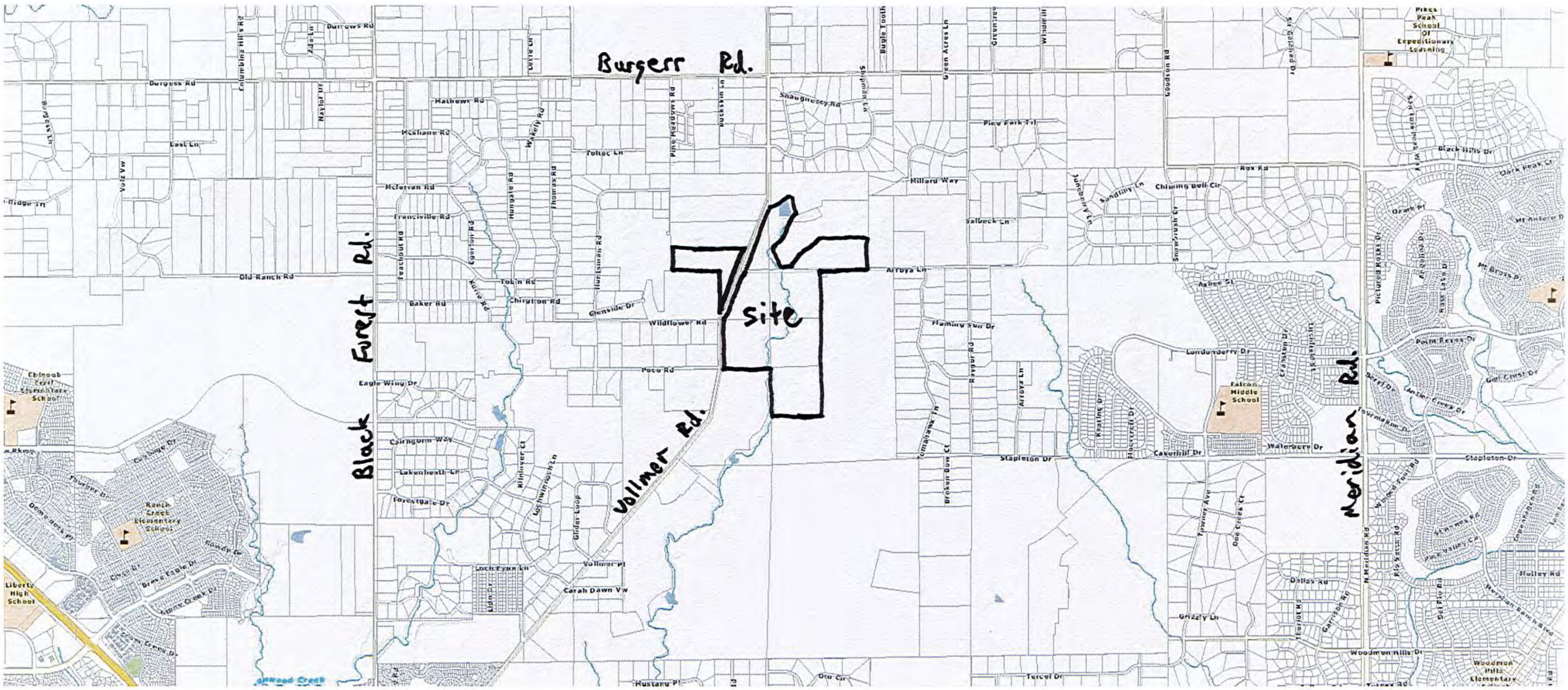
5. "Master Development Drainage Plan for The Retreat at TimberRidge", Classic Consulting, approved March 2018.

APPENDIX

VICINITY MAP

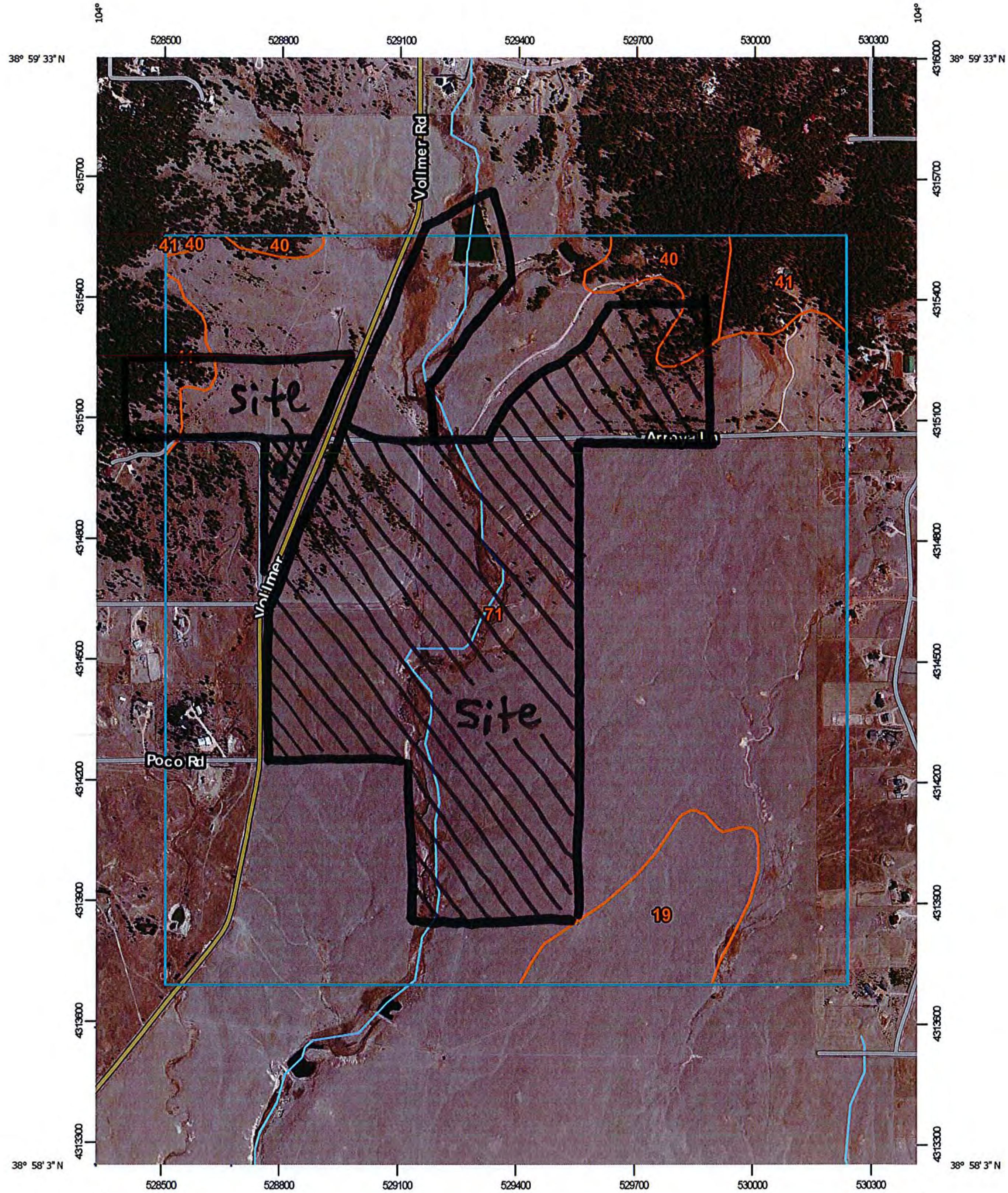
El Paso County Assessor's Office

Vicinity Map



SOILS MAP (S.C.S SURVEY)

Soil Map—El Paso County Area, Colorado



Map Scale: 1:13,400 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

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

Date(s) aerial images were photographed: Apr 15, 2011—Sep 22, 2011

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

Map Unit Legend

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	36.5	4.6%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	19.0	2.4%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	24.8	3.1%
71	Pring coarse sandy loam, 3 to 8 percent slopes	719.1	90.0%
Totals for Area of Interest		**799.4**	**100.0%**

El Paso County Area, Colorado

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

Map Unit Setting

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

Map Unit Composition

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

Description of Pring

Setting

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

Typical profile

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

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

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

Minor Components

Pleasant

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

Other soils

Percent of map unit:

Hydric soil rating: No

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

El Paso County Area, Colorado

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

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

Map Unit Composition

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

Description of Kettle

Setting

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

Typical profile

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

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

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

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

El Paso County Area, Colorado

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

Map Unit Setting

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

Map Unit Composition

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

Description of Kettle

Setting

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

Typical profile

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

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

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

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

F.E.M.A. MAP / LOMR (08-08-0541P)

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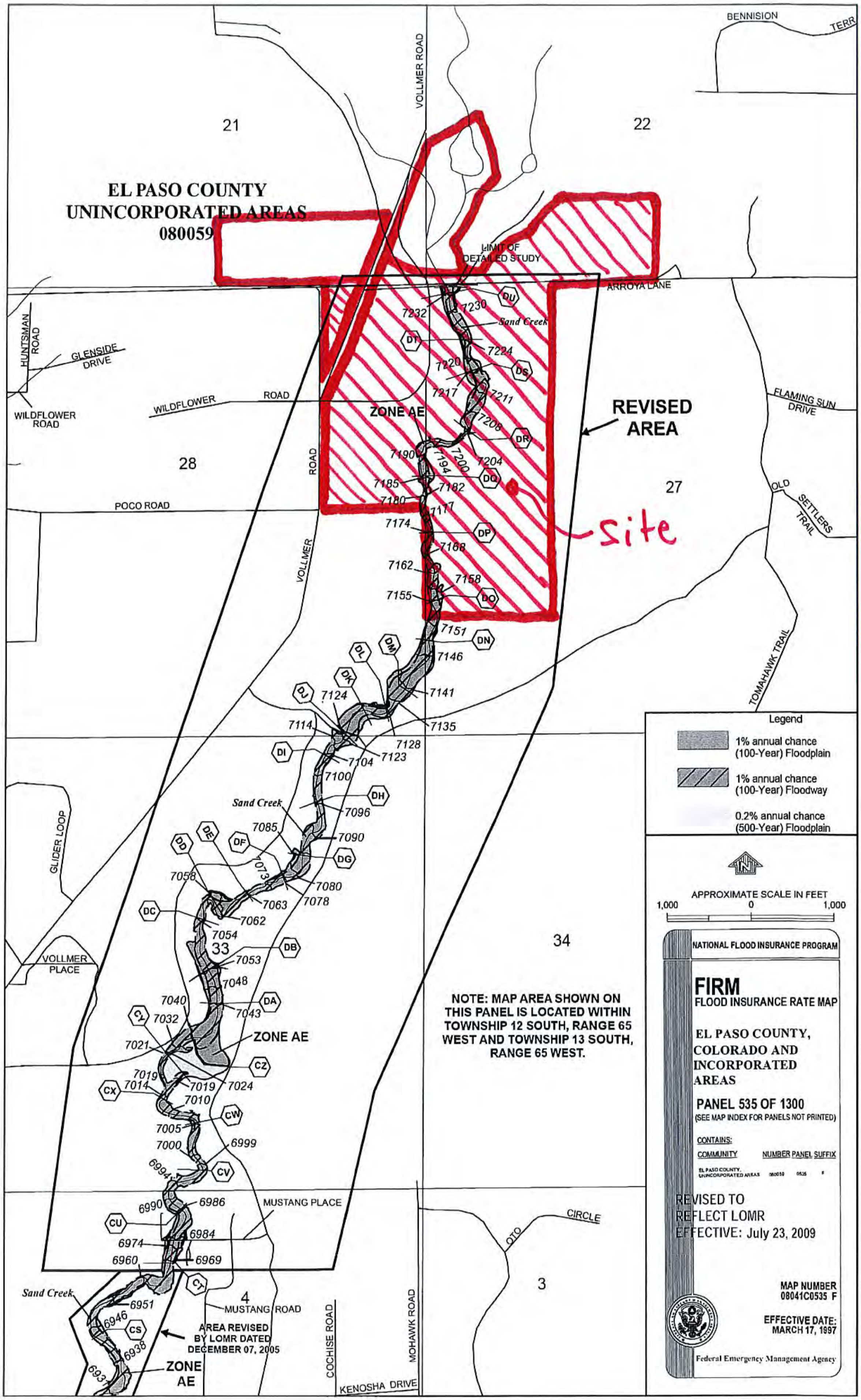

BENNISION TERR
VOLLMER ROAD
21
22
EL PASO COUNTY
UNINCORPORATED AREAS
080059
LIMIT OF DETAILED STUDY
ARROYA LANE
HUNTSMAN ROAD
GLENSIDE DRIVE
WILDFLOWER ROAD
WILDFLOWER ROAD
ZONE AE
REVISED AREA
FLAMING SUN DRIVE
28
27
POCO ROAD
OLD SETTLERS TRAIL
site
Sand Creek
VOLLMER ROAD
TOMAHAWK TRAIL
GLIDER LOOP
VOLLMER PLACE
33
34
ZONE AE
NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.
MUSTANG PLACE
OTO CIRCLE
3
4
MUSTANG ROAD
COCHISE ROAD
MOHAWK ROAD
KENOSHA DRIVE
AREA REVISED BY LOMR DATED DECEMBER 07, 2005
ZONE AE
Legend
1% annual chance (100-Year) Floodplain
1% annual chance (100-Year) Floodway
0.2% annual chance (500-Year) Floodplain
APPROXIMATE SCALE IN FEET
1,000 0 1,000
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO AND INCORPORATED AREAS
PANEL 535 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
REVISED TO REFLECT LOMR
EFFECTIVE: July 23, 2009
MAP NUMBER 08041C0535 F
EFFECTIVE DATE: MARCH 17, 1997
Federal Emergency Management Agency

Page 1 of 4	Issue Date: March 6, 2009	Effective Date: July 23, 2009	Case No.: 08-08-0541P	LOMR-APP

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT

COMMUNITY AND REVISION INFORMATION		PROJECT DESCRIPTION	BASIS OF REQUEST
COMMUNITY	El Paso County Colorado (Unincorporated Areas) COMMUNITY NO.: 080059	NO PROJECT	HYDRAULIC ANALYSIS NEW TOPOGRAPHIC DATA
IDENTIFIER	Sand Creek Letter of Map Revision, Mustang Place to Arroya Lane	APPROXIMATE LATITUDE & LONGITUDE: 38.971, -104.668 SOURCE: USGS QUADRANGLE DATUM: NAD 27	

ANNOTATED MAPPING ENCLOSURES	ANNOTATED STUDY ENCLOSURES
TYPE: FIRM* NO.: 08041C0535 F DATE: March 17, 1997	DATE OF EFFECTIVE FLOOD INSURANCE STUDY: August 23, 1999 PROFILE(S): 204P(a), 204P(b), 204P(c) AND 204P(d) FLOODWAY DATA TABLE: 5

Enclosures reflect changes to flooding sources affected by this revision.
* FIRM - Flood Insurance Rate Map; ** FBFM - Flood Boundary and Floodway Map; *** FHBM - Flood Hazard Boundary Map

FLOODING SOURCE(S) & REVISED REACH(ES)

Sand Creek - from approximately 360 feet downstream of Mustang Place to just downstream of Arroya Lane

SUMMARY OF REVISIONS

Flooding Source	Effective Flooding	Revised Flooding	Increases	Decreases
Sand Creek	Zone A	Zone AE	YES	YES
	No BFEs*	BFEs	YES	NONE
	No Floodway	Floodway	YES	NONE

* BFEs - Base Flood Elevations

DETERMINATION

This document provides the determination from the Department of Homeland Security's Federal Emergency Management Agency (FEMA) regarding a request for a Letter of Map Revision (LOMR) for the area described above. Using the information submitted, we have determined that a revision to the flood hazards depicted in the Flood Insurance Study (FIS) report and/or National Flood Insurance Program (NFIP) map is warranted. This document revises the effective NFIP map, as indicated in the attached documentation. Please use the enclosed annotated map panels revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals in your community.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

David N. Bascom

David N. Bascom, Program Specialist
Engineering Management Branch
Mitigation Directorate

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT (CONTINUED)

COMMUNITY INFORMATION

APPLICABLE NFIP REGULATIONS/COMMUNITY OBLIGATION

We have made this determination pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (P.L. 93-234) and in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, P.L. 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65. Pursuant to Section 1361 of the National Flood Insurance Act of 1968, as amended, communities participating in the NFIP are required to adopt and enforce floodplain management regulations that meet or exceed NFIP criteria. These criteria, including adoption of the FIS report and FIRM, and the modifications made by this LOMR, are the minimum requirements for continued NFIP participation and do not supersede more stringent State/Commonwealth or local requirements to which the regulations apply.

We provide the floodway designation to your community as a tool to regulate floodplain development. Therefore, the floodway revision we have described in this letter, while acceptable to us, must also be acceptable to your community and adopted by appropriate community action, as specified in Paragraph 60.3(d) of the NFIP regulations.

COMMUNITY REMINDERS

We based this determination on the 1-percent-annual-chance flood discharges computed in the FIS for your community without considering subsequent changes in watershed characteristics that could increase flood discharges. Future development of projects upstream could cause increased flood discharges, which could cause increased flood hazards. A comprehensive restudy of your community's flood hazards would consider the cumulative effects of development on flood discharges subsequent to the publication of the FIS report for your community and could, therefore, establish greater flood hazards in this area.

Your community must regulate all proposed floodplain development and ensure that permits required by Federal and/or State/Commonwealth law have been obtained. State/Commonwealth or community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction or may limit development in floodplain areas. If your State/Commonwealth or community has adopted more restrictive or comprehensive floodplain management criteria, those criteria take precedence over the minimum NFIP requirements.

We will not print and distribute this LOMR to primary users, such as local insurance agents or mortgage lenders; instead, the community will serve as a repository for the new data. We encourage you to disseminate the information in this LOMR by preparing a news release for publication in your community's newspaper that describes the revision and explains how your community will provide the data and help interpret the NFIP maps. In that way, interested persons, such as property owners, insurance agents, and mortgage lenders, can benefit from the information.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

David N. Bascom

David N. Bascom, Program Specialist
Engineering Management Branch
Mitigation Directorate

Federal Emergency Management Agency
Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Jeanine D. Petterson
Director, Mitigation Division
Federal Emergency Management Agency, Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267
(303) 235-4830

STATUS OF THE COMMUNITY NFIP MAPS

We will not physically revise and republish the FIRM and FIS report for your community to reflect the modifications made by this LOMR at this time. When changes to the previously cited FIRM panel(s) and FIS report warrant physical revision and republication in the future, we will incorporate the modifications made by this LOMR at that time.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

David N. Bascom

David N. Bascom, Program Specialist
Engineering Management Branch
Mitigation Directorate

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

PUBLIC NOTIFICATION OF REVISION

PUBLIC NOTIFICATION

FLOODING SOURCE	LOCATION OF REFERENCED ELEVATION	BFE (FEET NGVD 29)		MAP PANEL NUMBER(S)
		EFFECTIVE	REVISED	
Sand Creek	Just upstream of Mustang Place	None	6,984	08041C0535 F
	Just downstream of Arroya Lane	None	7,238	08041C0535 F

Within 90 days of the second publication in the local newspaper, a citizen may request that we reconsider this determination. Any request for reconsideration must be based on scientific or technical data. Therefore, this letter will be effective only after the 90-day appeal period has elapsed and we have resolved any appeals that we receive during this appeal period. Until this LOMR is effective, the revised BFEs presented in this LOMR may be changed.

A notice of changes will be published in the *Federal Register*. A short notice also will be published in your local newspaper on or about the dates listed below. Please refer to FEMA's website at https://www.floodmaps.fema.gov/fhm/Scripts/bfe_main.asp for a more detailed description of proposed BFE changes, which will be posted within a week of the date of this letter.

LOCAL NEWSPAPER   Name: *El Paso County News*
Dates: 03/18/09   03/25/09

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional Information about the NFIP is available on our website at http://www.fema.gov/nfip.

David N. Bascom, Program Specialist
Engineering Management Branch
Mitigation Directorate

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					FEET (NGVD)			
Sand Creek (cont'd)								
CA	65,292	164	427	6.1	6,748.7	6,748.7	6,749.4	0.7
CB	66,092	41	223	11.7	6,761.2	6,761.2	6,762.2	1.0
CC	66,247	90	270	9.6	6,773.6	6,773.6	6,773.7	0.1
CD	67,647	50	218	11.9	6,782.6	6,782.6	6,783.3	0.7
CE	68,297	65	284	8.8	6,793.9	6,793.9	6,794.4	0.5
CF	69,147	50	213	11.7	6,804.5	6,804.5	6,804.5	0.0
CG	70,157	50	213	11.7	6,815.1	6,815.1	6,815.3	0.2
CH	70,577	205	347	7.2	6,823.9	6,823.9	6,824.5	0.6
CI	70,627	180	267	9.4	6,826.7	6,826.7	6,827.7	1.0
CJ	70,727	210	340	7.3	6,831.1	6,831.1	6,831.1	0.0
CK	70,807	195	334	7.5	6,832.5	6,832.5	6,832.5	0.0
CL	71,162	90	255	9.8	6,838.0	6,838.0	6,839.0	1.0
CM	71,977	226	503	5.2	6,847.4	6,847.4	6,848.3	0.9
CN	73,052	174	328	7.9	6,861.1	6,861.1	6,861.2	0.1
CO	73,644	237	364	7.1	6,870.2	6,870.2	6,870.2	0.0
CP	75,142	172	324	8.0	6,888.5	6,888.5	6,888.7	0.2
CQ	76,161	109	283	9.2	6,903.5	6,903.5	6,903.7	0.2
CR	77,846	100	272	9.6	6,926.1	6,926.1	6,926.7	0.6
CS	79,187	117	287	9.1	6,944.1	6,944.1	6,944.1	0.0
CT	80,808	142	310	8.4	6,969.2	6,969.2	6,969.2	0.0
CU	81,501	120	342	7.6	6,986.1	6,986.1	6,986.5	0.4
CV	82,281	124	295	8.8	6,997.4	6,997.4	6,997.4	0.0
CW	82,897	64	237	11.0	7,005.3	7,005.3	7,006.1	0.8
CX	83,517	90	266	9.8	7,013.9	7,013.9	7,013.9	0.0
CY	84,087	70	244	10.7	7,024.3	7,024.3	7,024.3	0.0
CZ	84,473	160	322	8.1	7,040.2	7,040.2	7,040.2	0.0

Revised Data From LOMR Dated Dec. 7, 2005

Revised Data

[1] Feet Above Confluence With Fountain Creek

REVISED TO
REFLECT LOMR
EFFECTIVE: July 23, 2009

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY
EL PASO COUNTY, CO
AND INCORPORATED AREAS

FLOODWAY DATA

SAND CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY FEET (NGVD)	WITH FLOODWAY FEET (NGVD)	INCREASE
Sand Creek (cont'd)								
DA	85,073	139	456	5.7	7,043.0	7,043.0	7,043.1	0.1
DB	85,483	170	328	7.9	7,053.4	7,053.4	7,053.5	0.1
DC	86,103	100	274	9.5	7,054.4	7,054.4	7,054.4	0.0
DD	86,673	197	434	6.0	7,061.7	7,061.7	7,062.0	0.3
DE	87,073	83	270	9.6	7,068.2	7,068.2	7,068.3	0.1
DF	87,573	98	325	8.0	7,077.7	7,077.7	7,077.9	0.2
DG	88,003	135	304	8.6	7,085.1	7,085.1	7,085.1	0.0
DH	88,738	89	263	9.9	7,096.9	7,096.9	7,096.9	0.0
DI	89,303	74	249	10.4	7,104.1	7,104.1	7,104.3	0.2
DJ	89,663	143	309	8.4	7,123.2	7,123.2	7,123.2	0.0
DK	90,058	140	426	6.1	7,125.1	7,125.1	7,125.2	0.1
DL	90,348	102	276	9.4	7,127.6	7,127.6	7,127.8	0.2
DM	90,698	300	398	6.5	7,141.0	7,141.0	7,141.0	0.0
DN	91,388	120	292	8.9	7,148.5	7,148.5	7,148.6	0.1
DO	91,868	105	313	8.3	7,155.2	7,155.2	7,155.9	0.7
DP	92,748	65	239	10.9	7,173.8	7,173.8	7,173.8	0.0
DQ	93,468	117	288	9.0	7,184.6	7,184.6	7,184.6	0.0
DR	94,448	81	260	10.0	7,204.5	7,204.5	7,204.6	0.1
DS	95,343	100	274	9.5	7,216.8	7,216.8	7,217.2	0.4
DT	95,723	77	252	10.3	7,224.2	7,224.2	7,224.3	0.1
DU	96,333	90	266	9.8	7,232.5	7,232.5	7,233.0	0.5

[1] Feet Above Confluence With Fountain Creek

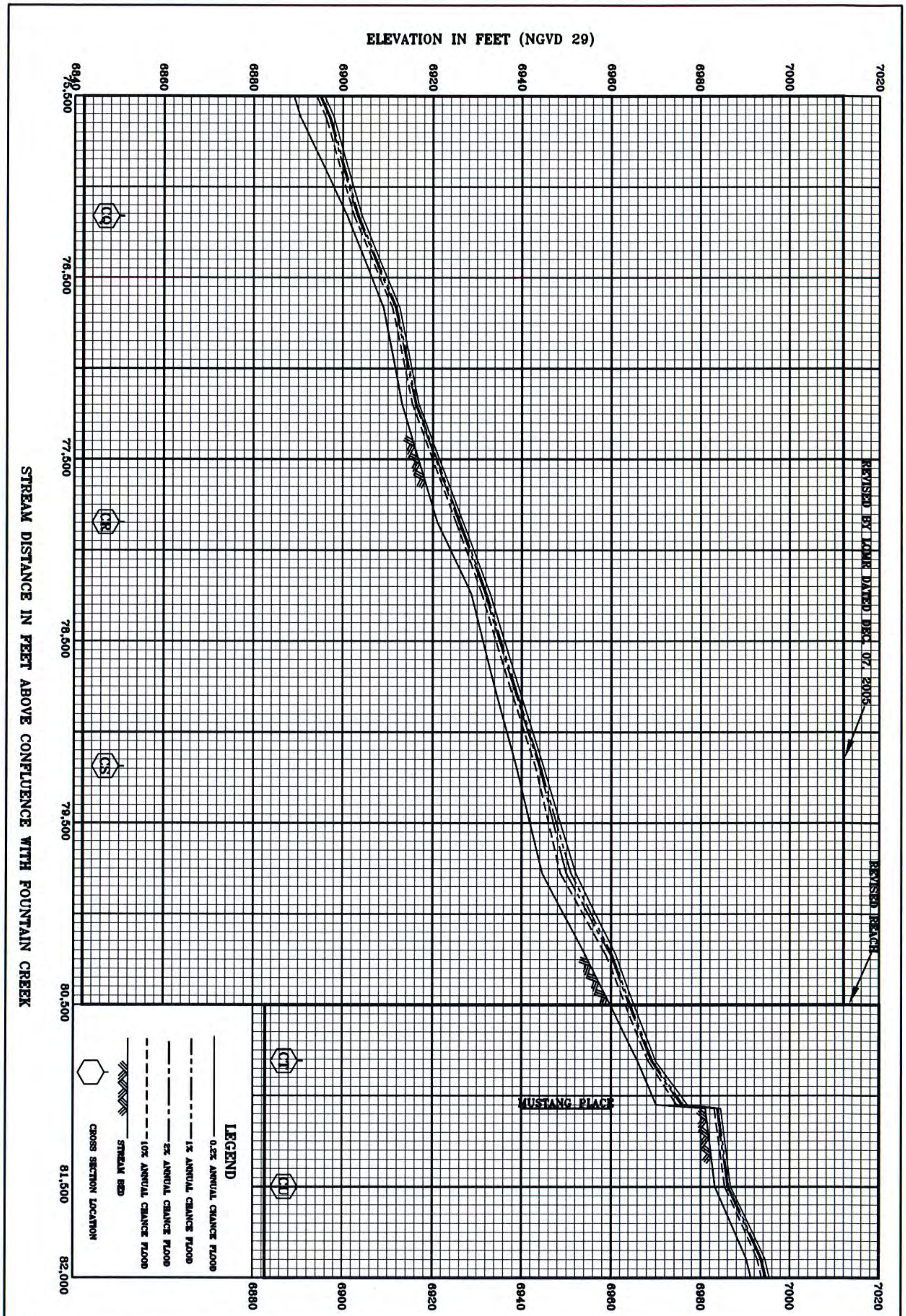
REVISED TO
REFLECT LOMR
EFFECTIVE: July 23, 2009

TABLE 5

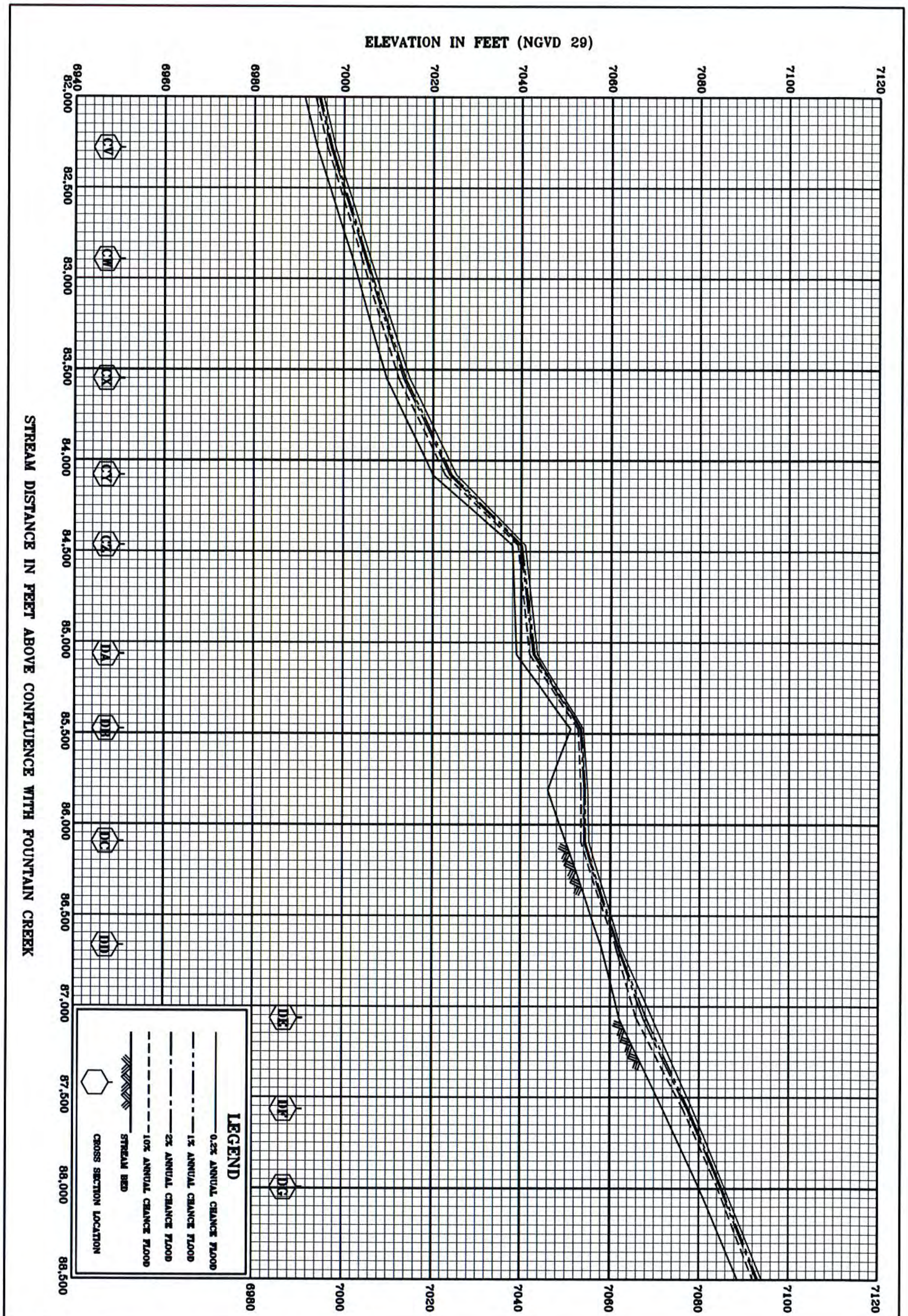
FEDERAL EMERGENCY MANAGEMENT AGENCY
EL PASO COUNTY, CO
AND INCORPORATED AREAS

FLOODWAY DATA

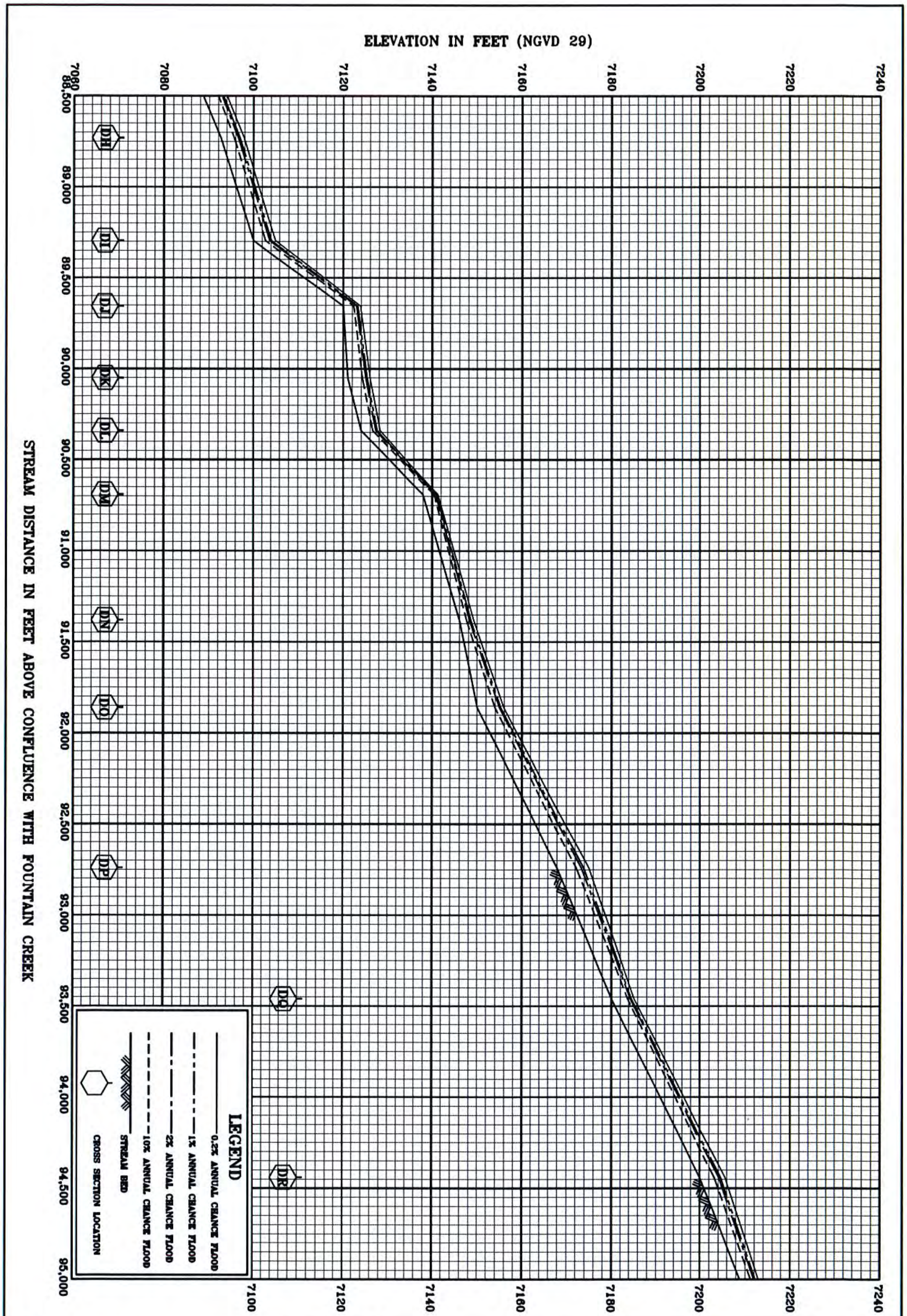
SAND CREEK



FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOOD PROFILES
EL PASO COUNTY, CO AND INCORPORATED AREAS	REVISED TO REFLECT LOMR EFFECTIVE: July 23, 2009 — SAND CREEK



FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOOD PROFILES
EL PASO COUNTY, CO AND INCORPORATED AREAS	REVISED TO REFLECT LOMR EFFECTIVE: July 23, 2009 SAND CREEK



FEDERAL EMERGENCY MANAGEMENT AGENCY

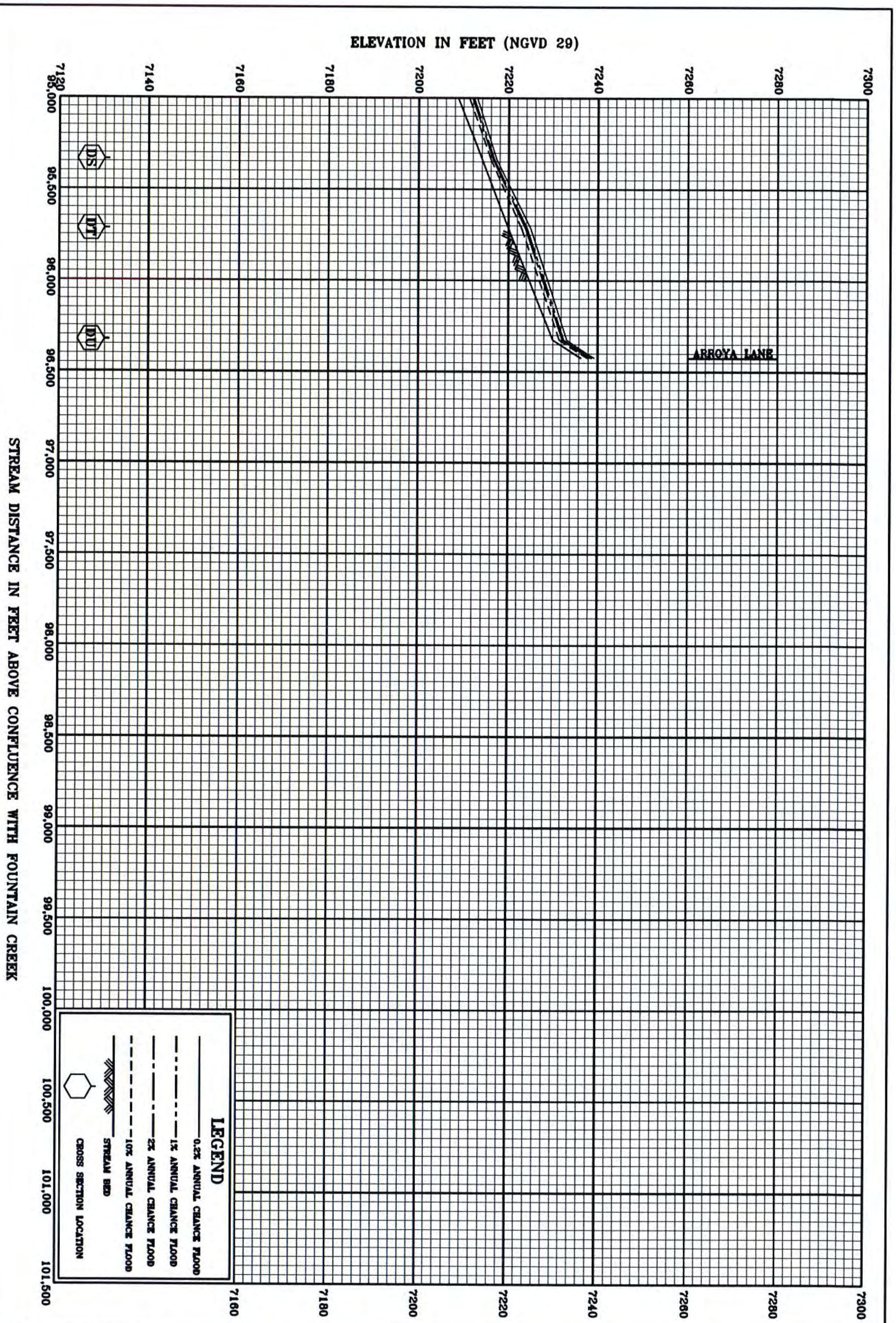
EL PASO COUNTY, CO
AND INCORPORATED AREAS

REVISED TO
REFLECT LOMR
EFFECTIVE: July 23, 2009

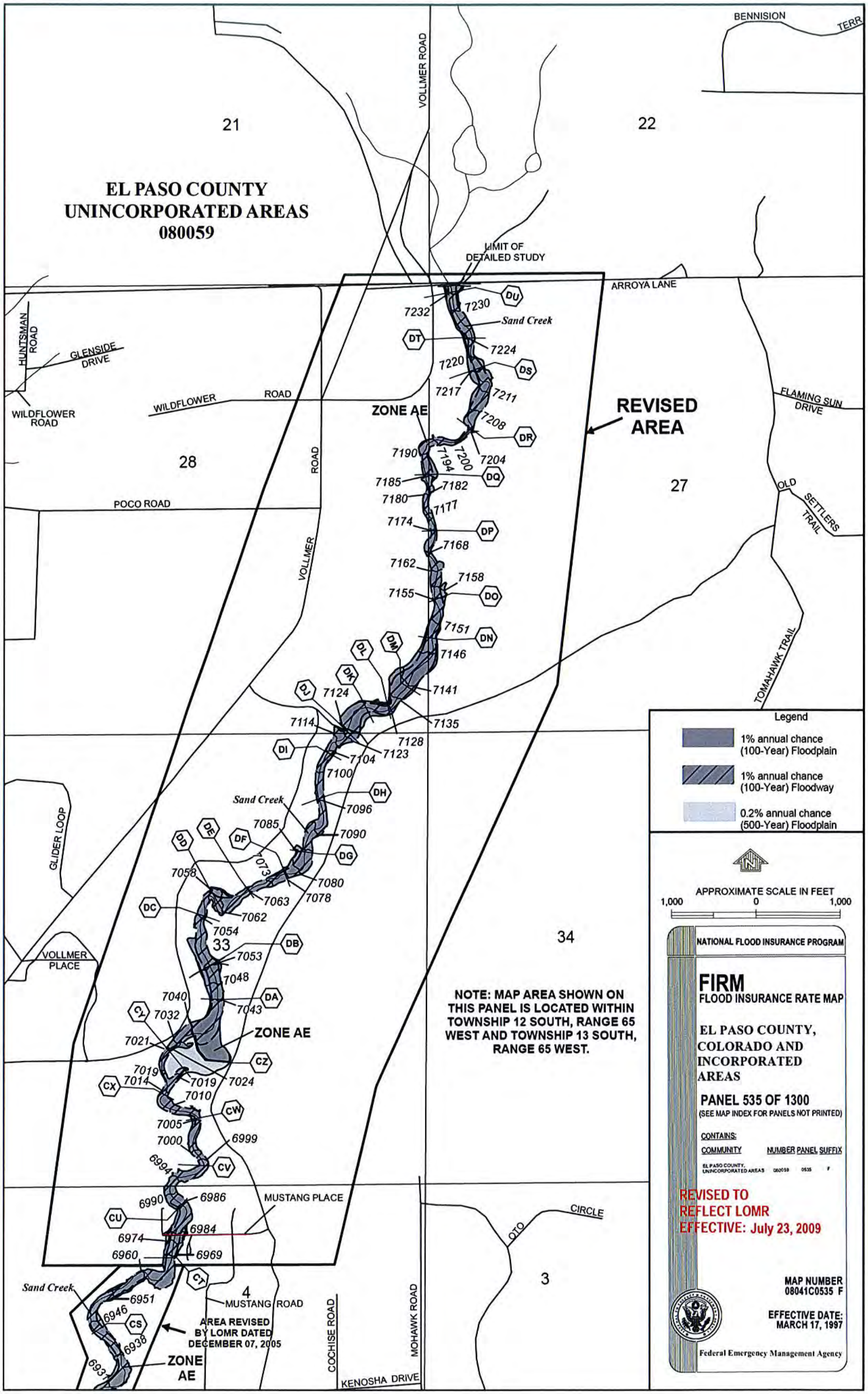
FLOOD PROFILES

SAND CREEK

204P(c)

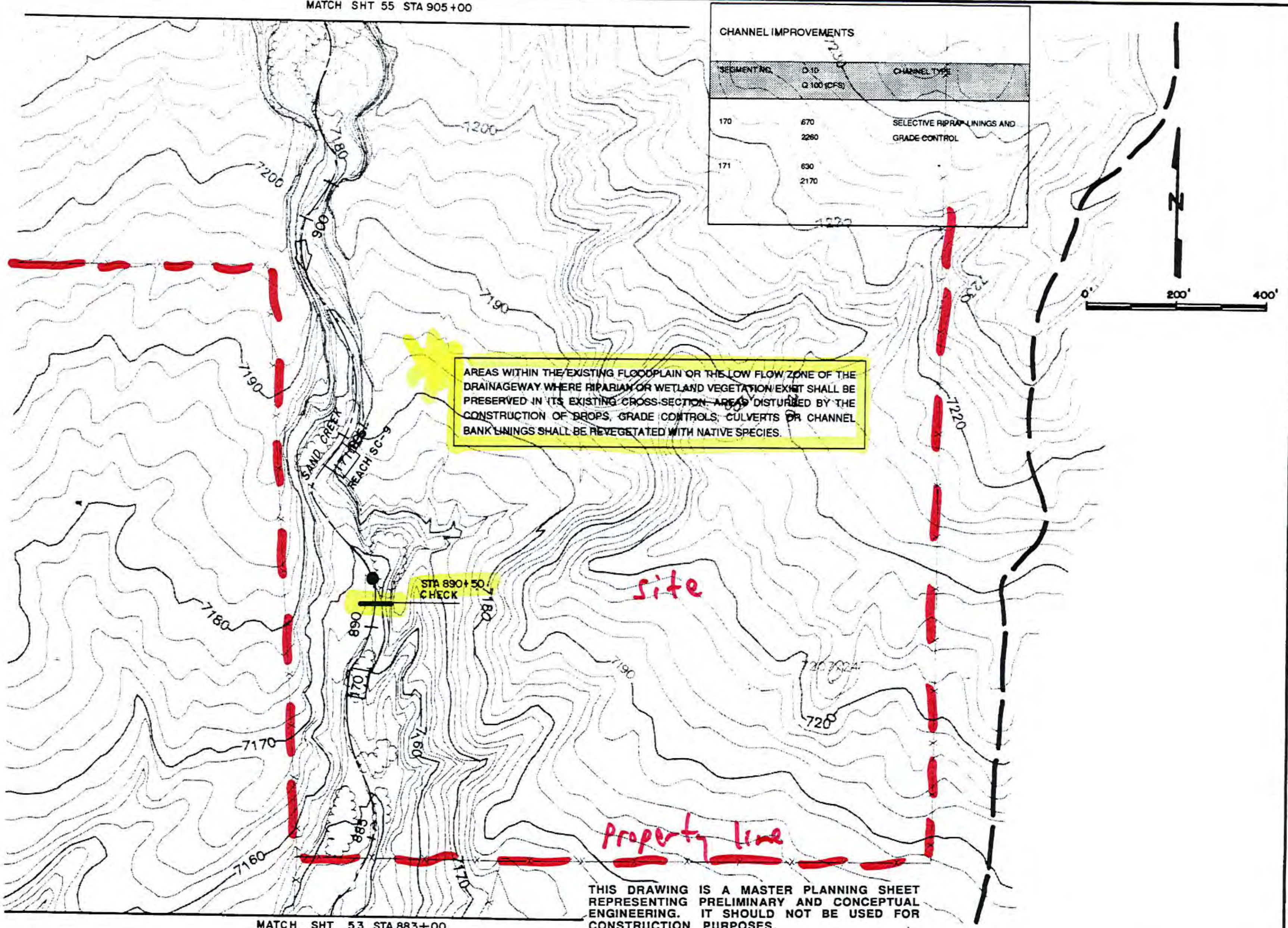


FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOOD PROFILES
EL PASO COUNTY, CO AND INCORPORATED AREAS	REVISED TO REFLECT LOMR EFFECTIVE: July 23, 2009 — SAND CREEK



EL PASO COUNTY
UNINCORPORATED AREAS
080059
21
22
27
28
33
34
3
4
VOLLMER ROAD
BENNISION
TERR
LIMIT OF DETAILED STUDY
ARROYA LANE
Sand Creek
HUNTSMAN ROAD
GLENSIDE DRIVE
WILDFLOWER ROAD
WILDFLOWER ROAD
POCO ROAD
ZONE AE
REVISED AREA
FLAMING SUN DRIVE
OLD SETTLERS TRAIL
TOMAHAWK TRAIL
GLIDER LOOP
VOLLMER PLACE
MUSTANG PLACE
MUSTANG ROAD
COCHISE ROAD
MOHAWK ROAD
KENOSHA DRIVE
OTO CIRCLE
AREA REVISED BY LOMR DATED DECEMBER 07, 2005
NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.
Legend
1% annual chance (100-Year) Floodplain
1% annual chance (100-Year) Floodway
0.2% annual chance (500-Year) Floodplain
APPROXIMATE SCALE IN FEET
1,000 0 1,000
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO AND INCORPORATED AREAS
PANEL 535 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
REVISED TO REFLECT LOMR EFFECTIVE: July 23, 2009
MAP NUMBER 08041C0535 F
EFFECTIVE DATE: MARCH 17, 1997
Federal Emergency Management Agency

RECOMMENDATIONS PER SAND CREEK DBPS



CHANNEL IMPROVEMENTS

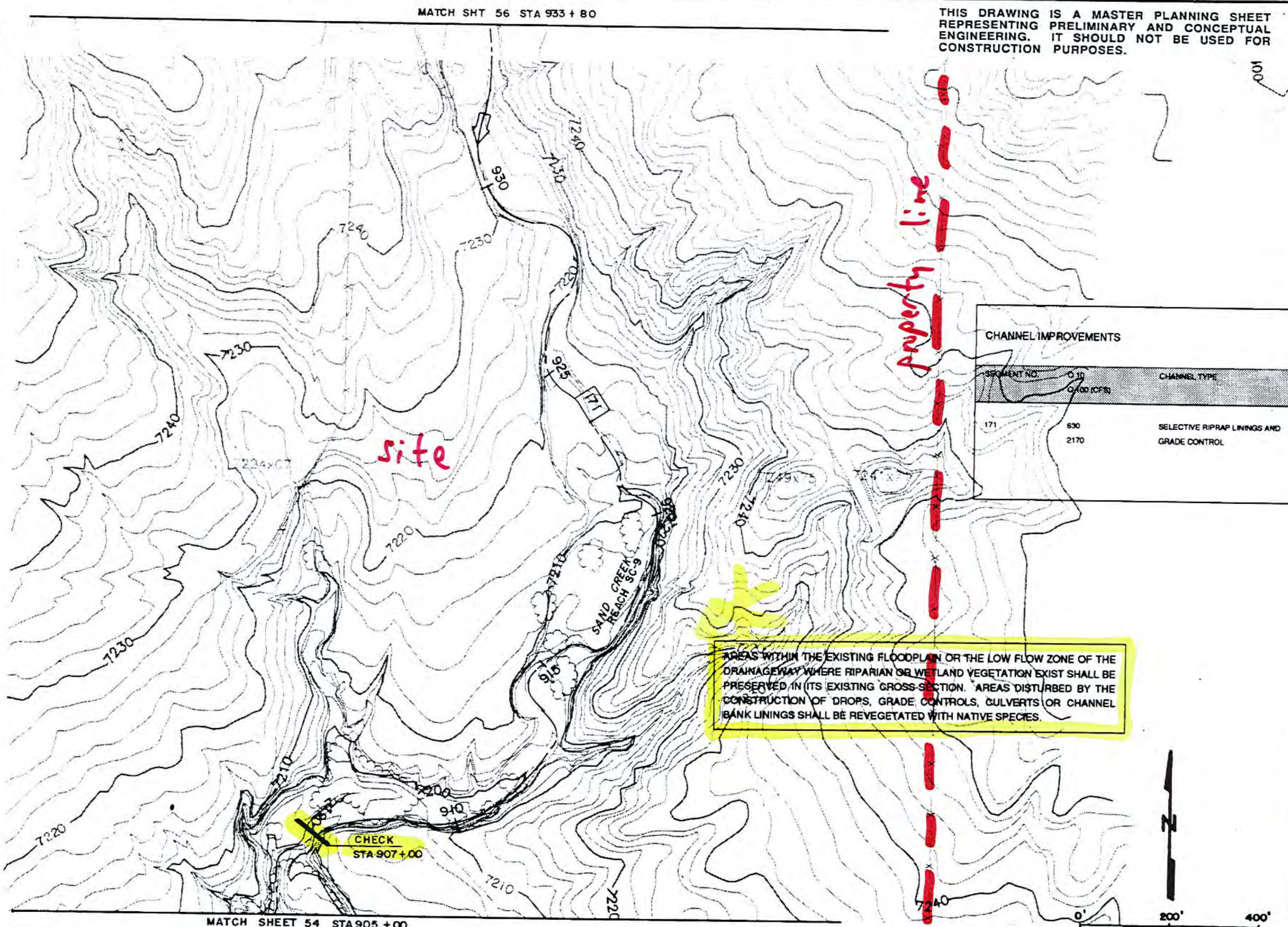
SEGMENT NO.	D 10 / Q 100 (CFS)	CHANNEL TYPE
170	670 / 2260	SELECTIVE RIPRAP LININGS AND GRADE CONTROL
171	630 / 2170	

THIS DRAWING IS A MASTER PLANNING SHEET REPRESENTING PRELIMINARY AND CONCEPTUAL ENGINEERING. IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.

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

SAND CREEK DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN PLANS

Project No.	90-04-09
Date:	9/92
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

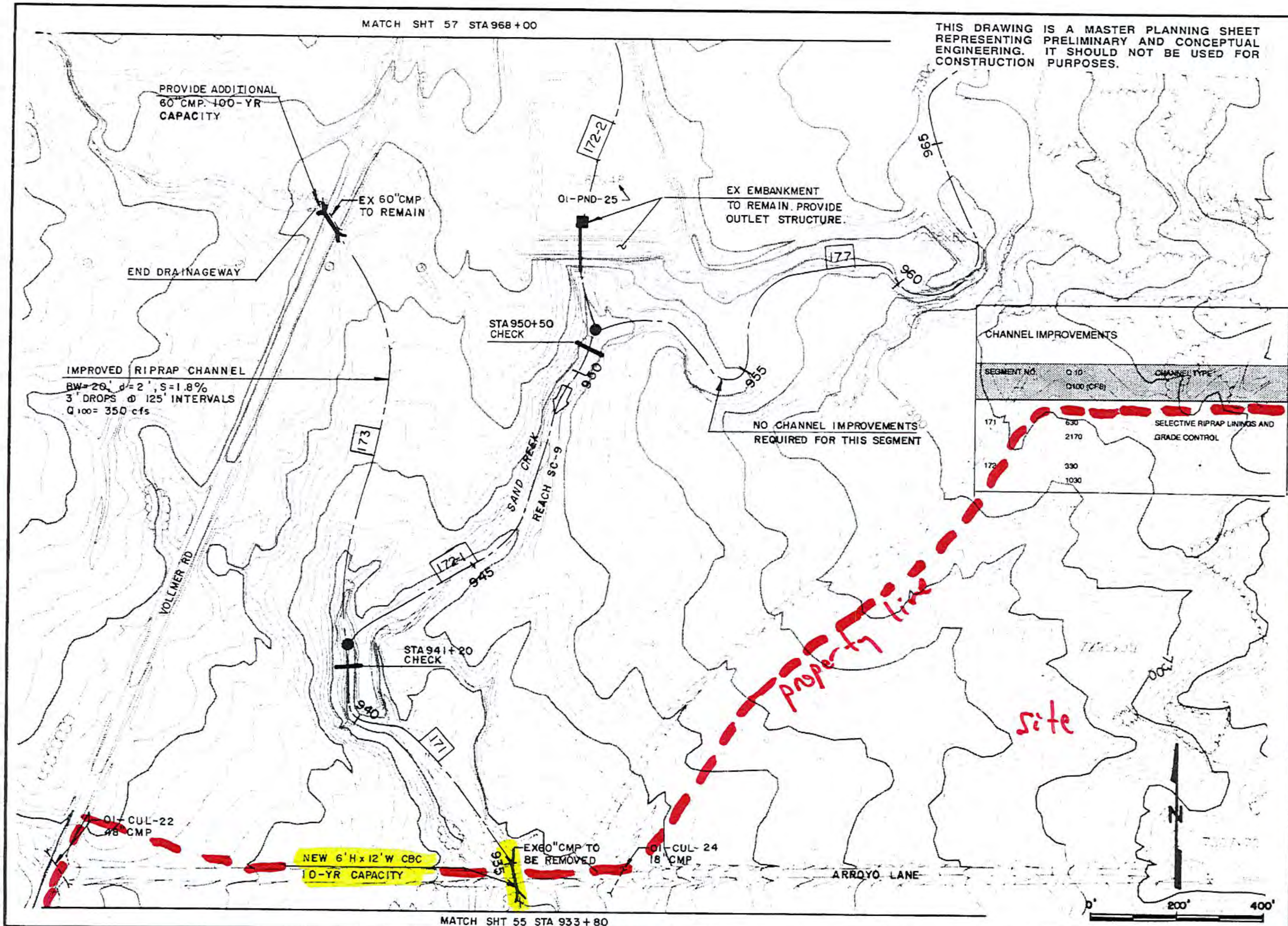


Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN PLANS

Project No.	90-04-09
Date:	9/92
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

55



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

SAND CREEK DRAINAGE
BASIN PLANNING STUDY
PRELIMINARY DESIGN PLANS

Project No	90-04-09
Date:	9/92
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

VI. DEVELOPMENT OF ALTERNATIVES AND RECOMMENDED PLAN

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

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

Channel Concepts: The channel concepts listed above have been evaluated with respect to the parameters listed in the previous chapter. A concept's feasibility depends upon its impact, positive or negative, upon the evaluation parameters. ***The floodplain preservation*** concept has been considered to be the same as the ***"do-nothing"*** alternative. The floodplain preservation concept would involve the regulation of the floodplain limits, generally as depicted on the effective City of Colorado Springs and El Paso County Flood Insurance Rate Maps. Regulation of the floodplain so that future encroachments are minimized and the floodproofing of structures which are currently within the 100-year floodplain would presumably be the methods used to address the flood hazard concerns along Sand Creek. In the upper reaches of Sand Creek, the ownership or easements associated with the 100-year floodplain (or greater limits to allow for an erosion buffer zone) would be a primary issue in regards to implementation of such a concept. Detention in the upper reaches of the basin Sand Creek basin and in the East Fork Sand Creek basin will maintain the 100-year floodplain at existing limits within the lower reaches of Sand Creek. The "do-nothing" concept is feasible wherever the existing drainageway improvements are of adequate capacity to convey flood flows. ***Channelization*** would involve the lining of the Creek into a more confined flow area, and could be done for either the ***100-year or 10-year*** flood discharges. Several typical channel concepts have been presented. The primary bank lining material would probably be riprap. Grade control and/or drop structures would be required in a channelization concept so that the flood velocities could be controlled to a level requiring medium to heavy riprap. Soil cement offers an alternative to riprap and concrete for the construction of drops or grade control structures. Revegetation would occur wherever the native vegetation was disturbed by the channel construction. Willows at the toe of the riprap banks would be a minimum replacement. ***Selective linings*** would involve the construction of grade controls, drop structures, bank linings, storm sewer outlet control structures selectively sited to resist stream erosion or to reduce potential flooding damages. Areas of future concern such as at the outside bends of the creek, or at the outlets of bridges or culverts which will cross the drainageway would be subject to selective improvements.

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

Channel Alternatives

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

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

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

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

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

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

Development of the Recommended Plan

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

Discussion of Recommended Plan

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

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

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

VII. PRELIMINARY DESIGN

The results of the preliminary design analysis are summarized in this section. The alternative improvements have been quantitatively and qualitatively evaluated, and presented to the City of Colorado Springs and other interested agencies and individuals. Field review of specific areas of concern have been conducted in order to refine the channel treatments suggested for use along Sand Creek, East Fork Sand Creek and their major tributaries. The preliminary plan for the recommended alternative is shown on the drawings contained at the rear of this report.

Criteria

The City of Colorado Springs, El Paso County Drainage Criteria Manual was used in the development of the typical sections and plans for the major drainageways within the Basin. The City/County manual was supplemented by various criteria manuals with more specific application. These were:

1. "Design Guidelines and Criteria for Channels and Hydraulic Structures on Sandy Soils," prepared by Simons, Li & Associates, Inc., 1981.

2. Urban Storm Drainage Criteria Manual, Volumes I, II, and III, prepared by the Urban Drainage and Flood Control District.

Various design plans for roadway and channel improvement projects, either proposed or already constructed were reviewed in order to prepare the preliminary design plans. Specifically, the project design plans for the Las Vegas Street and Galley Road bridge replacement projects were reviewed and the improvements incorporated in the preliminary design. The **proposed** Sand Creek Stabilization Project, AT&SF Railroad to Hancock Expressway and the **proposed** Sand Creek Stabilization Project at Fountain Boulevard design plans have been reviewed and incorporated into the preliminary design plan and profiles.

Hydrology

Presented on Table VII-1 is selected hydrologic data to be used for the sizing of major drainageway improvements within the Basin. **Peak flow rates for the 10- and 100-year frequency incorporating and the selected detention alternatives for the Sand Creek and East Fork Sand Creek Basin are summarized for key points along the major drainageways.** Contained within the The technical addenda of this report contains a complete listing of peak discharges for all the sub-basins, stream segments and design points shown on Exhibit 1.

The sizing the drainageway improvements for the tributaries will need to be verified during the final design and layout of the proposed drainageway facilities. Land development activities may alter the location of design points along the tributaries, and therefore slight alteration in a sub-basin's length, slope and area may occur. The methods outlined in the City/County Drainage Criteria Manual should be applied during final design analysis. The rational method should be used to check the peak flow rates for all tributary drainageways and storm sewers draining areas less than 100 acres in size.

Channels

The recommended channel sections for each reach of drainageway has been outlined in Section VI of this report. In general, the banks of Sand Creek channel, from the confluence with Fountain Creek to the proposed Sand Creek Detention Basin No. 2 are to be lined, or in some cases relined, with riprap to either a 10-year or 100-year flow depth, as shown on the preliminary design plans. Above the Sand Creek Detention Basin No. 2, selectively located riprap bank protection such as at outside bends, at bridge or culvert outlets, and at confluences with side tributaries have been recommended. In conjunction with the selective improvement measures, and the 10-year low flow concept, the 100-year floodplain should be preserved and regulated. Wherever existing bank linings were judged to be adequate, no improvements have been recommended at this time.

For the West Fork Sand Creek, 100-year riprap bank linings have been recommended in order to address the 100-year flooding hazard which exists at numerous locations along the West Fork. The final design improvements shown in the Palmer Park Bridge Replacement project drawings have been incorporated into the preliminary design plans. In the uppermost reaches of the West Fork, a short segment of rectangular concrete channel has been recommended because of right-of-way constraints.

For the Center Tributary of Sand Creek, 100-year riprap lined channels have been recommended from the confluence with East Fork to Platte Avenue. Above Platte Avenue, the existing concrete channels have adequate capacity except where the drainageway channel has yet to be improved. The final design plans for the US 24 Bypass Project, Phase II have been incorporated into the plans. As part of the bypass construction, it is proposed to line the Center Tributary using riprap. The location of the proposed roadway, new crossings, drops and channel as shown on the Phase II Bypass plans have been reflected on the preliminary design drawings.

For the East Fork Sand Creek drainageway, riprap lined channel banks have been recommended for the majority of the reaches. This is mainly because of the high level of development predicted for the basin in the area known as the Banning-Lewis Ranch development. Open space to accommodate the 100-year floodplains should be allowed for as the East Fork Sand Creek drainageways develop. This is consistent with the Banning-Lewis Ranch master development plan which was approved at the time of annexation of this property. Above Woodmen Road, selective channel lining improvements and grade control structures have been recommended.

For the most part the side tributaries have been recommended to be lined with riprap, however there are some locations in the upper basin which have been proposed to be grasslined. The location of the side drainageways should be considered approximate and may very likely be modified in the future because of land development.

The primary criteria used when sizing the proposed channel sections has been velocity. For all riprap lined channels, the average design velocity should be no greater than 9 feet per second. This criteria allows for the use of Type H riprap within the main flow area of the drainageway. For the case of a 10-year channel with an overall floodplain section, limiting the main channel velocity to 9 feet per second will result in overbank velocities in the five feet per second range. At this level of overbank velocity, native vegetation will be able to withstand the erosive forces which might result in a 100-year flow event. Velocities approaching 10 feet per second could occur at constrictions such as at roadway crossings and at culvert outlets.

Drop Structures and Check Structures

Drop and check structures have been sited along Sand Creek in order to slow the channel velocity to the recommended 7 feet per second, and to prevent localized and long-term stream degradation from affecting channel linings and overbanks. In the reaches to be selectively lined, drops and check structures will protect the native vegetation from the detrimental effects of stream invert headcutting. Several types of structures could be considered for the Sand Creek Basin. For channel bottom widths in excess of fifty feet, soil cement or sheet piling drops/checks are feasible. For channels narrower than this, reinforced concrete structures are probably the best alternative. **A maximum drop height of three feet is recommended. The methodology recommended for use when designing vertical structures is contained with Volume II of the Urban Storm Drainage Criteria Manual.**

Detention

The recommended plan calls for the construction of six regional detention basins within the Sand Creek basin, and six regional basins within the East Fork Sand Creek basin. The purpose of the Sand Creek detention basins is to limit peak discharges at Powers Boulevard to existing development condition levels. The detention basins in the upper portions of the Sand Creek basin will keep the majority of the existing channel sections and bridges below Powers Boulevard with adequate flow capacity in the future development condition. The detention basins within the East Fork Sand Creek basin have been sized to maintain the flow outfalling from the Banning-Lewis Ranch property at existing levels. This in turn will help to reduce flow to the mainstem of Sand Creek. The detention basins have been designed to accommodate the 100-year future condition volume without overtopping the overflow spillway. Sand Creek Basin Nos. 2 and 6, and East Fork Sand Creek Basin Nos. 1, 2, and 3 will be classified as jurisdictional structures, and their design and operation would be subject to State Engineer's office criteria. Sand Creek basins number 1 and 3 should be designed so as to take advantage of the adjacent roadway embankments, and therefore classifying as incidental storage and not subject State Engineer's regulations.

At Stetson Hills Boulevard, the roadway embankment has created a 2 acre open water wetland which was identified during the environmental review of the basin. It is recommended that this wetland be preserved. Accordingly, an outlet control structure will have to be constructed to pass the 100-year discharge to the downstream channel without overtopping the roadway. No floodwater storage or routing has been accounted for in the hydrology modelling at this roadway for the selected detention plan.

For the East Fork Sand Creek detention basin numbers 2, and 3, the existing embankment and outlet structure act to maintain a permanent pool at this time. It is recommended that the design of these detention basins be directed at maintaining the permanent pool when the flood control storage is to be added. The existence of a permanent pool may enhance the water quality aspects of these basins, and offer the opportunity of open space development conducive with open water.

Water Quality

Improvement of urban stormwater quality has become and important issue in drainage basin planning. Many pollutants are naturally associated with sediments that enter sensitive receiving waters. The pollutants are naturally occurring compounds that are carried to the drainageways in storm runoff. Other pollutants are the result of urbanization such as lawn chemicals, oil and grease, pet feces, lawn clippings and other items. Many pollutants can be limited by programs such as erosion control at construction sites, educational programs to inform the public as to the proper use of lawn chemicals, oil recycling programs and street sweeping programs. Even with these programs in place, erosion along the drainageways can generate large quantities of sediment that can settle out along the downstream channel bottoms.

Table VI-7: Matrix of Channel Alternatives
Sand Creek Drainage Basin Planning Study

Reach	Channel Alternative: Floodplain Preservation	Channelization 100-year	10-year	Selected Improvements	Comments
Sand Creek					
1			•		
2		•			
3		•			
4		•			
5				•	
6				•	
7				•	100-year channelization not feasible in this reach
8				•	"
9	•			•	"
West Fork Sand Creek					
1		•			Majority of Reach confined by narrow existing ROW
2		•			"
3		•			"
Center Tributary					
1		•			
2		•			Majority of Reach confined by narrow existing ROW
East Fork Sand Creek					
1		•			
2		•			
3			•		
4			•		
5			•		
6			•		
7		•			
8				•	
East Fork Subtributary					
1		•			
2		•			
Toy Ranches Tributary					
1				•	
2				•	
3				•	
East Bierstadt Creek					
1			•		
2		•			
West Bierstadt					
1		•			
2		•			

TABLE VIII-2: SAND CREEK DRAINAGE BASIN PLANNING STUDY
DRAINAGEWAY CONVEYANCE COST ESTIMATE
WITH SELECTED DETENTION ALTERNATIVES

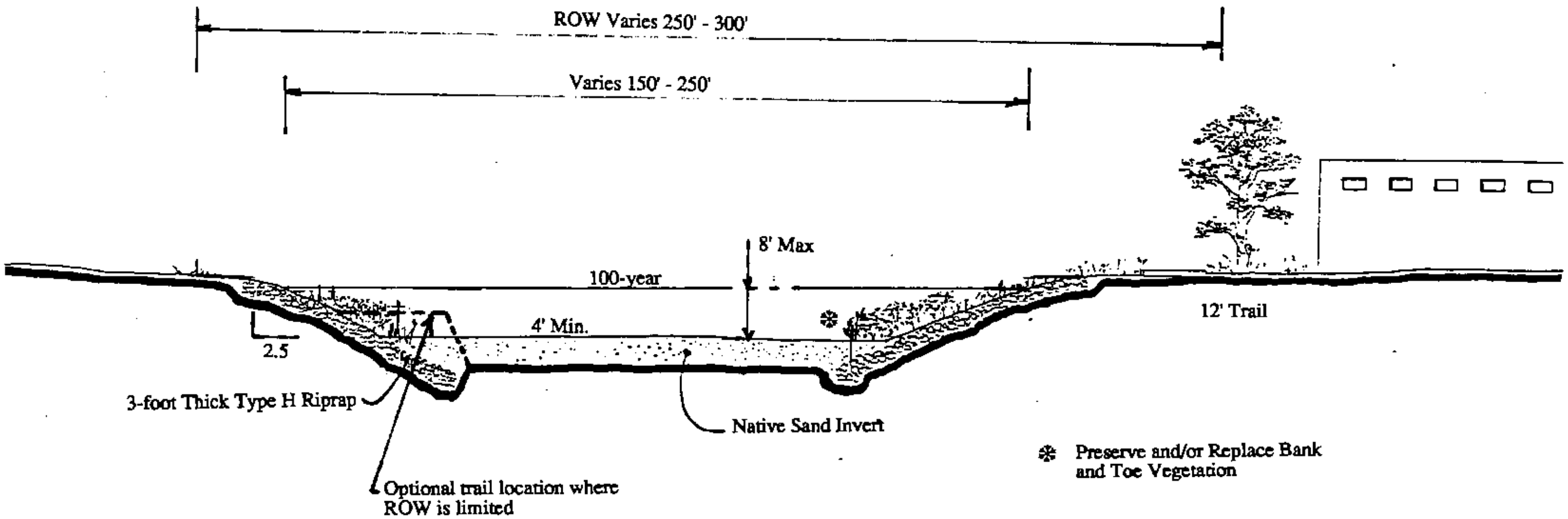
SEGMENT NUMBER	REACH NUMBER	SEGMENT LENGTH (FT)	IMPROVEMENT TYPE	IMP. LENGTH (FT)	UNIT COST ($/LF)	NUMBER OF GRADE CONTROLS	GRADE CONTROL LENGTH (FT)	TOTAL REIMBURSABL COSTS	TOTAL COST
148-2	"	2600	"	2150	127	5	620	$384,650	$384,650
151	SC-8	1700	10-YEAR RIPRAP	500	238	3	250	$164,000	$164,000
160	"	5100	SEL. LININGS (1 SIDE)	4400	127	6	720	$688,400	$688,400
			10-YR RIPRAP	600	238	0	0	$142,800	$142,800
	"								
163	"	6300	SEL. LININGS (1 SIDE)	2600	127	15	1200	$546,200	$546,200
			10-YR RIPRAP	350	238	0	0	$83,300	$83,300
187	"	1200	SEL. LININGS (1 SIDE)	0	0	2	160	$28,800	$28,800
170	SC-9	3200	"	0	0	4	320	$57,600	$57,600
171	"	5000	"	0	0	2	170	$30,600	$30,600
172	"	3650	"	0	0	2	150	$27,000	$27,000
TOTAL SAND CREEK DRAINAGEWAY								$15,560,220	$18,279,420

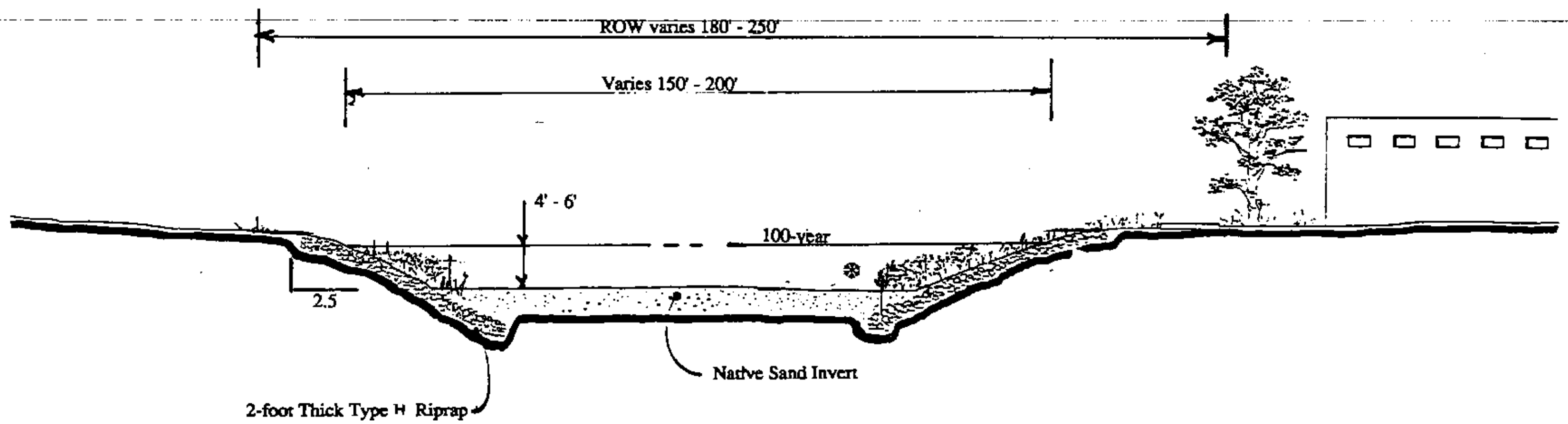
TABLE VIII-3: SAND CREEK DRAINAGE BASIN PLANNING STUDY
TRIBUTARY DRAINAGEWAY CONVEYANCE COST ESTIMATE
SAND CREEK, CENTER TRIBUTARY AND WEST FORK SAND CREEK

SEGMENT NUMBER	REACH NUMBER	IMPROVEMENT TYPE	IMP. LENGTH (FT)	UNIT COST ($/LF)	NUMBER OF GRADE CONTROLS	LENGTH OF GRADE CONTROL (FT)	TOTAL REIMBURSABLE COSTS	TOTAL COST
147-2	"	"	1150	200	1	30	$235,400	$235,400
153-1	"	"	600	150	0	0	$90,000	$90,000
153-2	"	"	450	150	0	0	$67,500	$67,500
152-1	SC-7	100-YEAR GRASSLINED	1650	150	0	0	$247,500	$247,500
152-2	"	"	800	150	2	100	$138,000	$138,000
150-1	"	100-YEAR STORM SEWER 36" RCP	800	58	0	0	$46,400	$46,400
150-2	"	100-YEAR RIPRAP	2400	200	0	0	$480,000	$480,000
161-1	"	100-YEAR GRASSLINED	550	150	0	0	$82,500	$82,500
154	SC-8	"	2100	200	10	600	$528,000	$528,000
157	"	"	2400	200	13	520	$573,600	$573,600
155-1	"	100-YEAR GRASSLINED	550	175	4	140	$121,450	$121,450
159	"	100-YEAR RIPRAP	3450	200	14	840	$841,200	$841,200
164	"	"	1350	200	5	200	$306,000	$306,000
186	"	"	2250	200	5	200	$486,000	$486,000
169	"	"	650	175	1	40	$120,950	$120,950
173	SC-9	"	950	175	8	320	$223,850	$223,850
WEST FORK SAND CREEK								
154-1	WF-1	100-YEAR RIPRAP	1550	223	2	100	$0	$363,650
161	"	"	600	223	2	80	$0	$148,200
164-2	"	100-YEAR GRASSLINED	500	150	0	0	$0	$75,000
164-4	"	100-YEAR RIPRAP	2500	175	9	280	$0	$487,900
165-1	"	"	1350	175	0	0	$0	$236,250
TOTAL SAND CREEK TRIBUTARY DRAINAGEWAYS							$7,420,650	$12,543,750

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

ROADWAY	REACH NUMBER	DRAINAGEWAY SEGMENT	CROSSING TYPE	LENGTH	UNIT	UNIT COST	TOTAL COST	TOTAL REIMBURSABLE COST
BANNING-LEWIS PRKW	SC-8	186	6'Hx10'W CBC	120	LF	$390	$46,800	$46,800
ARROYO LANE	SC-9	171	6'Hx12'W CBC	80	LF	$510	$40,800	$0
VOLLMER ROAD	SC-8	169	60-INCH CMP	80	LF	$120	$9,600	$0
"	SC-9	173	"	80	LF	$120	$9,600	$0
BURGESS ROAD	SC-9	176	42-INCH CMP	80	LF	$75	$6,000	$0
"	SC-9	178	2-42-INCH CMP	80	LF	$150	$12,000	$0
		CENTER TRIBUTARY						
TERMINAL AVENUE	CT-2	144	4-5'Hx8'W CBC	60	LF	$1,200	$72,000	$0
OMAHA BOULEVARD	CT-2	146-2	3-4'Hx9'W CBC	80	LF	$900	$72,000	$0
		WEST FORK SAND CREEK						
WOOTEN ROAD	WF-1	153	2-4'Hx6'W CBC	100	LF	$480	$48,000	$0
EDISON AVENUE	WF-1	153	2-4'Hx6'W CBC	60	LF	$240	$14,400	$0
PALMER PARK BLVD.	WF-1	154-2	2-4'Hx10'W CBC	80	LF	$540	$43,200	$0
CHICAGO RI RR	WF-1	165-1	4'Hx8'W CBC	220	LF	$270	$59,400	$0
HALF MOON DRIVE	WF-1	165-2	4'Hx6'W CBC	60	LF	$240	$14,400	$0
TOTAL CULVERT CONSTRUCTION COSTS, SAND CREEK							$1,902,600	$1,111,000





100-year Riprap Channel Concept

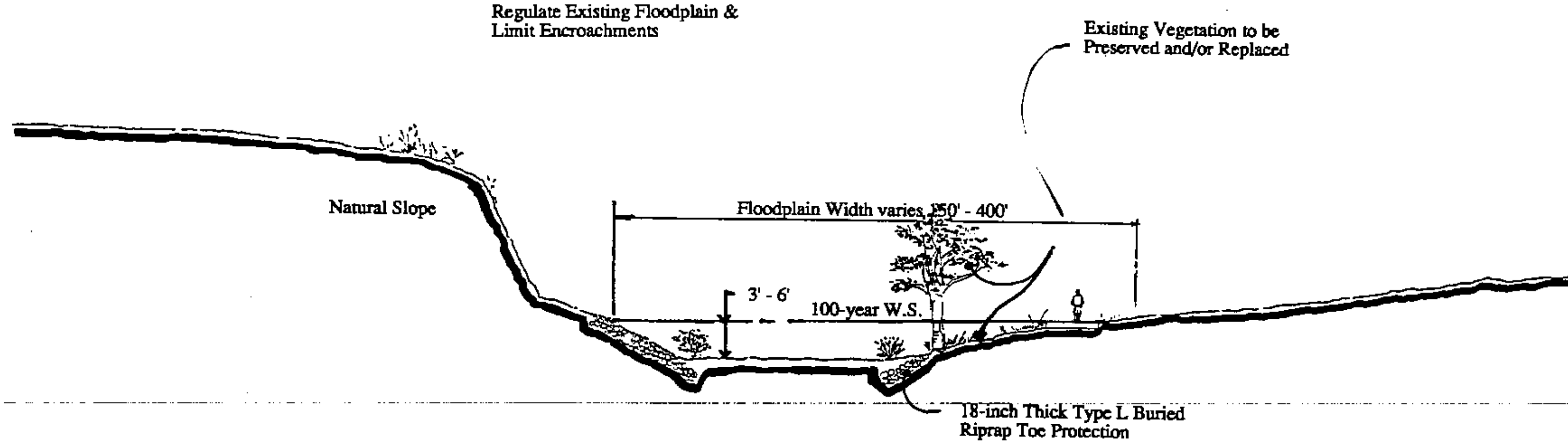
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY

Typical Channel Sections

Project No.:
Date:
Design:
Drawn:
Check:
Revisions:

CS-1



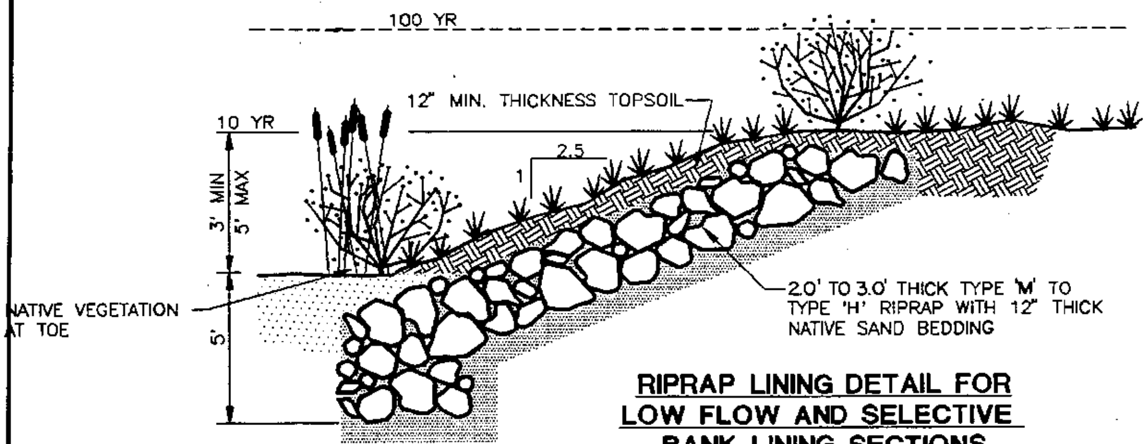
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

SAND CREEK DRAINAGE BASIN PLANNING STUDY

Typical Channel Sections

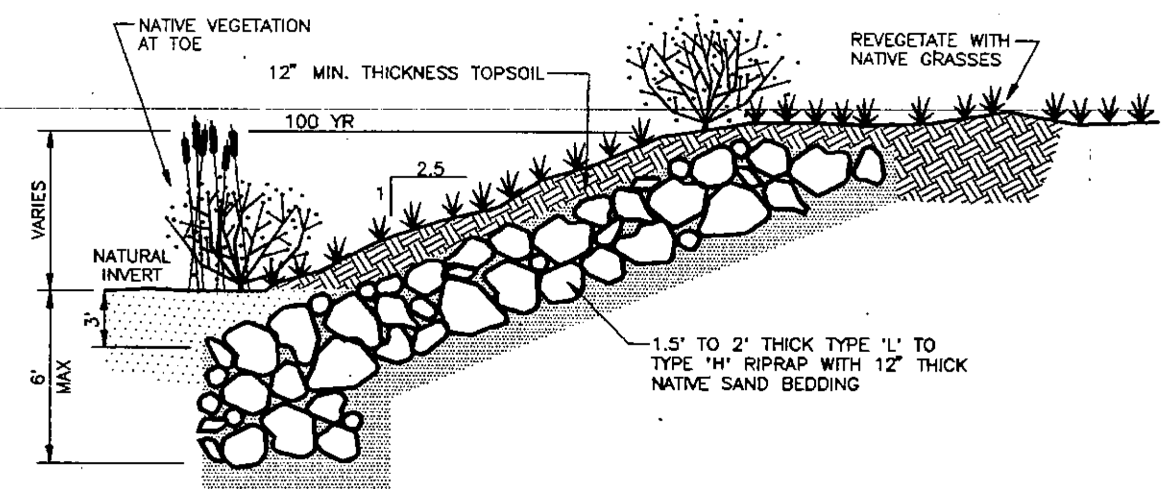
Project No.:
Date:
Design:
Drawn:
Check:
Revisions:

CS-3



RIPRAP LINING DETAIL FOR LOW FLOW AND SELECTIVE BANK LINING SECTIONS

NTS



RIPRAP LINING DETAIL FOR 100 YR CHANNEL SECTIONS

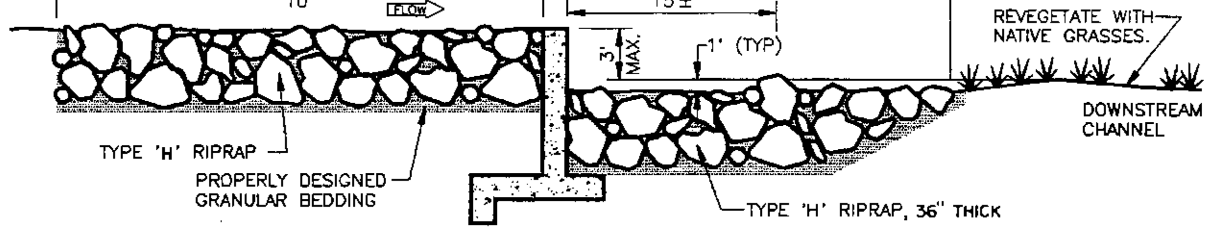
NTS

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

SAND CREEK DRAINAGE BASIN PLANNING STUDY

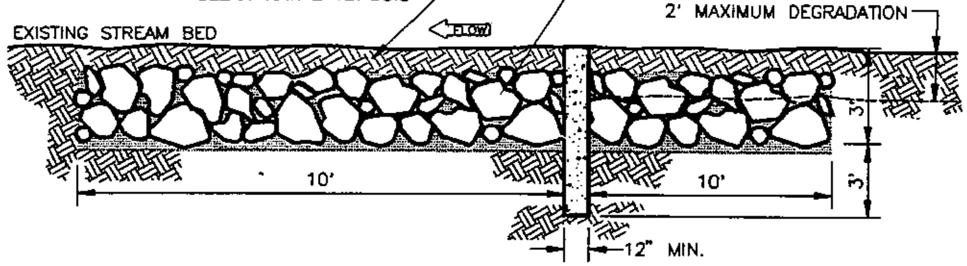
Project No. / Date: / Design: / Drawn: / Check. / Revisions:

CS-6



NOTE: DIMENSIONS OF APRON, STILLING BASIN, RIPRAP, AND CHECK STRUCTURE IS TO BE DETERMINED DURING FINAL DESIGN.

TYPICAL DROP STRUCTURE
GENERALIZED PROFILE
NTS



TYPICAL EROSION CONTROL
CHECK PROFILE
NTS

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

SAND CREEK DRAINAGE
BASIN PLANNING STUDY

Project No:
Date:
Design:
Drawn:
Check:
Revisions:

CS-7

PRELIMINARY WETLANDS MAPPING

CLASSIC
CONSULTING
ENGINEERS & SURVEYORS

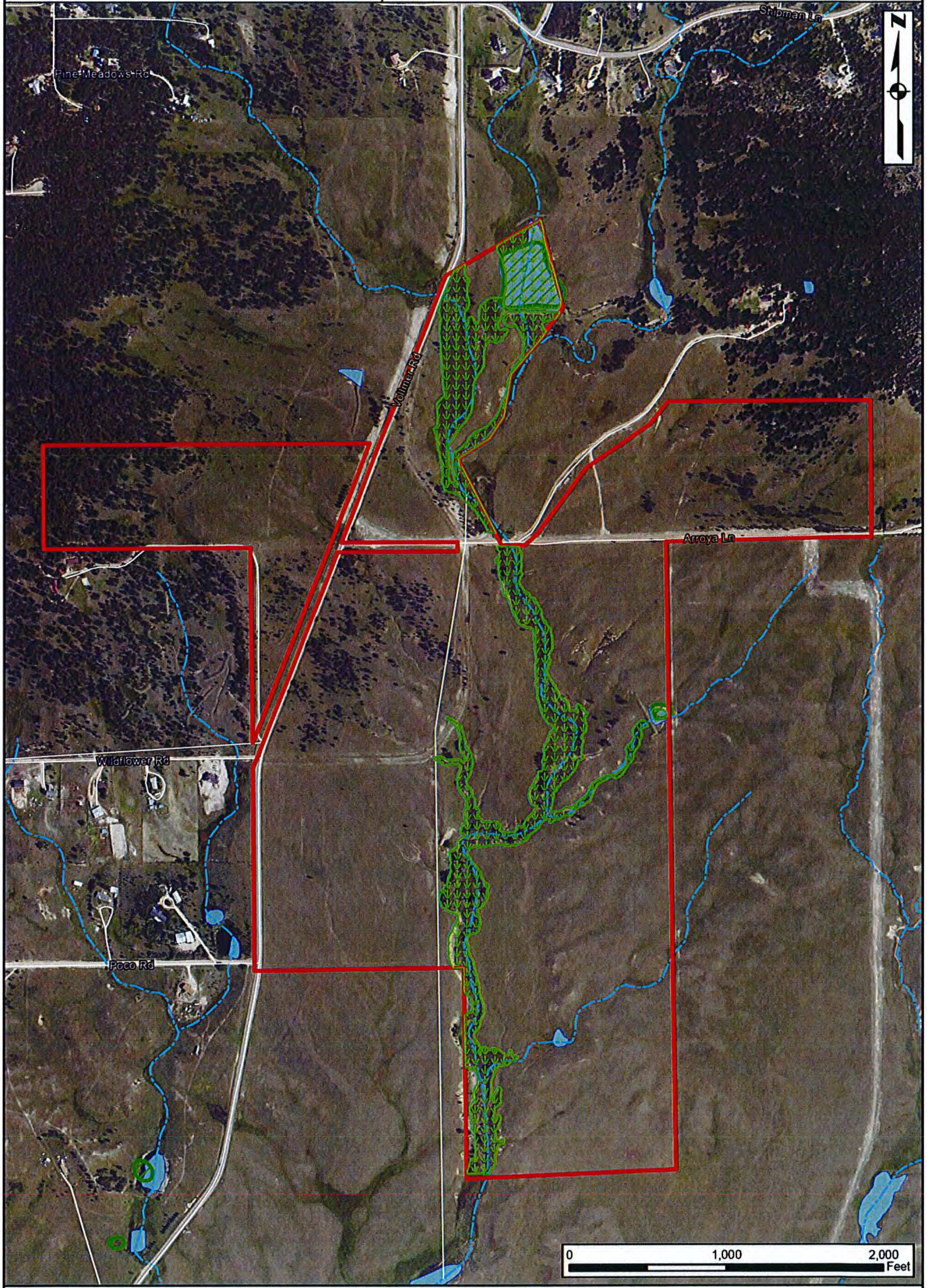
CORE CONSULTANTS

CIVIL ENGINEERING
DEVELOPMENT CONSULTING
NATURAL RESOURCES CONSULTING
LAND SURVEYING
303.703.4444
1950 W. Littleton Blvd., Ste. 109
Littleton, CO 80120

Trails at Timber Ridge

Maximum Extent of Wetlands Map

El Paso County, Colorado



- Project Boundary
- NHD Watercourse
- NHD Waterbody
- NWI Wetland
- Preliminary Wetland

Date: 4/3/2017

CORE Project #: 16-059

HYDROLOGIC CALCULATIONS

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

Table 6-2. Rainfall Depths for Colorado Springs

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

Where Z= 6,840 ft/100

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves[2] and should produce similar depth calculation results.

2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms**: Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

  To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

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

3.2 Time of Concentration

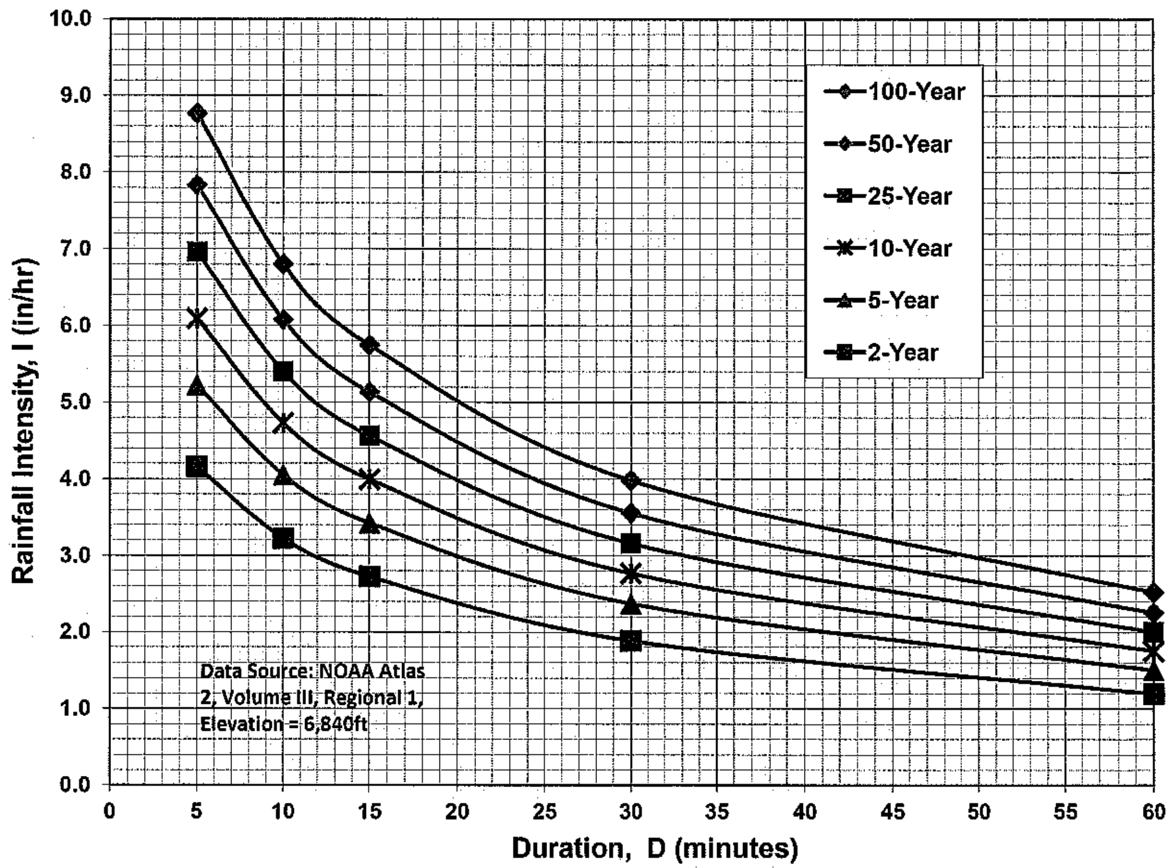
One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 6-10. NRCS Curve Numbers for Frontal Storms & Thunderstorms for Developed Conditions (ARCII)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	% I	Pre-Development CN HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)	-----	-----	---	68	79	86	89
Fair condition (grass cover 50% to 75%)	-----	-----	---	49	69	79	84
Good condition (grass cover > 75%)	-----	-----	---	39	61	74	80
Impervious areas:							
Paved parking lots, roofs, driveways, etc. (excluding right-of-way	-----	-----	---	98	98	98	98
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	-----	-----	---	98	98	98	98
Paved; open ditches (including right-of-way)	-----	-----	---	83	89	92	93
Gravel (including right-of-way)	-----	-----	---	76	85	89	91
Dirt (including right-of-way)	-----	-----	---	72	82	87	89
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	-----	-----	---	63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	-----	-----	---	96	96	96	96
Urban districts:							
Commercial and business	-----	-----	85	89	92	94	95
Industrial	-----	-----	72	81	88	91	93
Residential districts by average lot size:							
1/8 acre or less (town houses)	-----	-----	65	77	85	90	92
1/4 acre	-----	-----	38	61	75	83	87
1/3 acre	-----	-----	30	57	72	81	86
1/2 acre	-----	-----	25	54	70	80	85
1 acre	-----	-----	20	51	68	79	84
2 acres	-----	-----	12	46	65	77	82
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	77	86	91	94
Cultivated Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Fallow	Bare soil	-----	---	77	86	91	94
	Crop residue cover (CR)	Poor	---	76	85	90	93
		Good	---	74	83	88	90
Row crops	Straight row (SR)	Poor	---	72	81	88	91
		Good	---	67	78	85	89
	SR + CR	Poor	---	71	80	87	90
		Good	---	64	75	82	85
	Contoured (C)	Poor	---	70	79	84	88
		Good	---	65	75	82	86
	C + CR	Poor	---	69	78	83	87
		Good	---	64	74	81	85
	Contoured & terraced (C&T)	Poor	---	66	74	80	82
		Good	---	62	71	78	81
	C&T+ CR	Poor	---	65	73	79	81
		Good	---	61	70	77	80
Small grain	SR	Poor	---	65	76	84	88
		Good	---	63	75	83	87
	SR + CR	Poor	---	64	75	83	86
		Good	---	60	72	80	84
	C	Poor	---	63	74	82	85
		Good	---	61	73	81	84
	C + CR Poor	Poor	---	62	73	81	84
		Good	---	60	72	80	83
	C&T	Poor	---	61	72	79	82
		Good	---	59	70	78	81
	C&T+ CR	Poor	---	60	71	78	81
		Good	---	58	69	77	80

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.

UNDEVELOPED LAND ASSUMED TO BE ONE OF THE FOLLOWING: PASTURE, GRASSLAND, RANGE - POOR
HERBACEOUS MIXTURE OF GRASS WEEDS AND LOW GROWING BRUSH WITH BRUSH MINOR ELELMENT - POOR
WOODS - GRASS COMBINATION - POOR

C_N VALUES - EXISTING CONDITIONS

BASIN (label)	BASIN AREA (Ac)	**SOIL TYPE B**		**WEIGHTED** C_N
		CN	AREA (Ac.)	
EX-1	156.9	61	156.9	61
EX-2	9.2	61	9.2	61
EX-3	24.9	61	24.9	61
EX-4	35.2	63	35.2	63
EX-6	6.7	61	6.7	61
SC-1	12.5	63	12.5	63
SC-2	350.0	63	350.0	63
OS-1	49.1	61	49.1	61
OS-2	2.1	61	2.1	61
OS-3	5.7	65	5.7	65
OS-4	16.1	63	16.1	63
OS-5	27.6	63	27.6	63

TIME OF CONCENTRATION - EXISTING CONDITIONS

BASIN	Cn	C(5)	OVERLAND Length *(ft)*	Height *(ft)*	Tc *(min)*	STREET / CHANNEL FLOW Length *(ft)*	Slope *(%)*	Velocity *(fps)*	Tc *(min)*	Tc TOTAL *(min)*	Tc LAG *(min)*	Tc LAG *(hr)*
EX-1	61.0	0.08	300	8	23.1	1600	1.8%	1.3	20.5	43.6	26.2	0.44
EX-2	61.0	0.08	300	10	21.4					21.4	12.9	0.21
EX-3	61.0	0.08	300	8	23.1	1500	4.0%	1.5	16.7	39.7	23.8	0.40
EX-4	63.0	0.08	300	24	16.1	1900	6.0%	1.8	17.6	33.7	20.2	0.34
EX-6	61.0	0.08	300	14	19.2	800	1.0%	1.0	13.3	32.5	19.5	0.33
SC-1	63.0	0.08	200	6	18.1	500	2.0%	1.2	6.9	25.1	15.0	0.25
SC-2	63.0	0.08	300	12	20.2	3500	1.8%	1.3	44.9	65.1	39.0	0.65
OS-1	61.0	0.08	300	22	16.5	1300	4.0%	1.5	14.4	31.0	18.6	0.31
OS-2	61.0	0.08	300	12	20.2	550	5.0%	1.7	5.4	25.6	15.3	0.26
OS-3	65.0	0.08	300	10	21.4	250	3.0%	3.5	1.2	22.6	13.6	0.23
OS-4	63.0	0.08	300	22	16.5	1100	4.0%	1.4	13.1	29.6	17.8	0.30
OS-5	63.0	0.08	300	10	21.4	1300	3.0%	1.2	18.1	39.5	23.7	0.39

BASIN SUMMARY - EXISTING CONDITIONS

BASIN (label)	TOTAL BASIN AREA (acres)	WEIGHTED CN	TOTAL LAG TIME (hours)	Q 2 Yr. (cfs)	Q 5 Yr. (cfs)	Q 100 Yr. (cfs)
EX-1	156.9	61	0.44	2.6	17.7	140.3
EX-2	9.2	61	0.21	0.2	1.7	12.2
EX-3	24.9	61	0.40	0.4	3.0	23.7
EX-4	35.2	63	0.34	1.3	6.9	41.8
EX-6	6.7	61	0.33	0.1	0.9	7.1
SC-1	12.5	63	0.25	0.5	3.0	17.3
SC-2	350.0	63	0.65	9.9	44.2	275.3
OS-1	49.1	61	0.31	0.9	7.0	53.9
OS-2	2.1	61	0.26	0.04	0.3	2.5
OS-3	5.7	65	0.23	0.6	2.1	9.9
OS-4	16.1	63	0.30	0.6	3.4	20.7
OS-5	27.6	63	0.39	1.0	5.2	32.1

DESIGN POINTS SURFACE ROUTING SUMMARY - EXISTING CONDITIONS

Design Point (label)	Contributing Basins	Q 2 Yr. Q (cfs)	Q 5 Yr. Q (cfs)	Q 100 Yr. Q (cfs)
EX DP-1	BASINS OS-1, OS-3, OS-4, OS-5, EX-1, EX-4, EX-5, EX-6	5.6	36.0	281.7
EX DP-2	BASINS OS-2, EX-2	0.2	2.0	14.7
EX DP-3	BASIN EX-3	0.4	3.0	23.7
EX-DP-4	BASIN EX-6	0.1	1.0	7.1
Ex. 36" CMP at Vollmer	SC-1	0.5	3.0	17.3
Ex. 60" CMP at Vollmer	SC-2	9.88	44.2	275.3

JOB NAME: *The Retreat at TimberRidge (Preliminary Plan)*
JOB NUMBER: *2520.00*
DATE: *06/21/18*
CALCULATED BY: *MAW*

PRELIMINARY DRAINAGE REPORT ~ BASIN RUNOFF COEFFICIENT SUMMARY

		IMPERVIOUS AREA / STREETS				LANDSCAPE / DEVELOPED AREAS				WEIGHTED			WEIGHTED CA		
BASIN	TOTAL AREA (AC)	AREA (AC)	C(2)	C(50)	C(100)	AREA (AC)	C(2)	C(5)	C(100)	C(2)	C(5)	C(100)	**CA(2)**	**CA(5)**	**CA(100)**
A1	12.8	0.00	0.89	0.95	0.96	12.80	0.06	0.14	0.40	0.06	0.14	0.40	**0.77**	**1.79**	**5.12**
A2	6.9	0.00	0.89	0.95	0.96	6.90	0.06	0.14	0.40	0.06	0.14	0.40	**0.41**	**0.97**	**2.76**
A3	5.9	0.00	0.89	0.95	0.96	5.90	0.06	0.14	0.40	0.06	0.14	0.40	**0.35**	**0.83**	**2.36**
A4	2.1	0.00	0.89	0.95	0.96	2.10	0.12	0.20	0.44	0.12	0.20	0.44	**0.25**	**0.42**	**0.92**
A5	5.5	0.00	0.89	0.95	0.96	5.50	0.06	0.14	0.40	0.06	0.14	0.40	**0.33**	**0.77**	**2.20**
B1	18.8	0.00	0.89	0.95	0.96	18.80	0.06	0.14	0.40	0.06	0.14	0.40	**1.13**	**2.63**	**7.52**
B2	8.0	0.00	0.89	0.95	0.96	8.00	0.06	0.14	0.40	0.06	0.14	0.40	**0.48**	**1.12**	**3.20**
B3	6.10	1.10	0.89	0.95	0.96	5.00	0.06	0.14	0.40	0.21	0.28	0.50	**1.28**	**1.69**	**3.06**
B4	13.0	0.00	0.89	0.95	0.96	13.00	0.06	0.14	0.40	0.06	0.14	0.40	**0.78**	**1.82**	**5.20**
C1	12.5	0.00	0.89	0.95	0.96	12.50	0.09	0.17	0.42	0.09	0.17	0.42	**1.13**	**2.13**	**5.25**
C2	4.3	0.00	0.89	0.95	0.96	4.30	0.12	0.20	0.44	0.12	0.20	0.44	**0.52**	**0.86**	**1.89**
C3	8.6	0.00	0.89	0.95	0.96	8.60	0.09	0.17	0.42	0.09	0.17	0.42	**0.77**	**1.46**	**3.61**
D1	6.0	0.00	0.89	0.95	0.96	6.00	0.17	0.21	0.45	0.17	0.21	0.45	**1.02**	**1.28**	**2.72**
D2	14.1	0.00	0.89	0.95	0.96	14.10	0.18	0.25	0.47	0.18	0.25	0.47	**2.54**	**3.53**	**6.63**
D3	4.0	0.00	0.89	0.95	0.96	4.00	0.17	0.21	0.45	0.17	0.21	0.45	**0.68**	**0.85**	**1.81**
D4	6.8	0.00	0.89	0.95	0.96	6.80	0.20	0.27	0.49	0.20	0.27	0.49	**1.36**	**1.84**	**3.30**
D5	12.8	0.00	0.89	0.95	0.96	12.80	0.18	0.25	0.47	0.18	0.25	0.47	**2.30**	**3.20**	**6.02**
D6	15.3	0.00	0.89	0.95	0.96	15.30	0.18	0.25	0.47	0.18	0.25	0.47	**2.75**	**3.83**	**7.19**
D7	2.7	0.00	0.89	0.95	0.96	2.70	0.07	0.16	0.41	0.07	0.16	0.41	**0.19**	**0.43**	**1.11**
D8	2.1	0.00	0.89	0.95	0.96	2.10	0.18	0.25	0.47	0.18	0.25	0.47	**0.38**	**0.53**	**0.99**
D9	1.5	0.00	0.89	0.95	0.96	1.50	0.18	0.25	0.47	0.18	0.25	0.47	**0.27**	**0.38**	**0.71**
D10	1.7	0.00	0.89	0.95	0.96	1.70	0.18	0.25	0.47	0.18	0.25	0.47	**0.31**	**0.43**	**0.80**
E	1.3	1.80	0.89	0.95	0.96	-0.50	0.18	0.25	0.47	1.16	1.15	1.15	**1.51**	**1.50**	**1.49**
F1	18.1	0.00	0.89	0.95	0.96	18.10	0.03	0.09	0.36	0.03	0.09	0.36	**0.54**	**1.63**	**6.52**
F2	4.6	0.00	0.89	0.95	0.96	4.60	0.03	0.09	0.36	0.03	0.09	0.36	**0.14**	**0.41**	**1.66**
H	6.7	0.00	0.89	0.95	0.96	6.70	0.06	0.14	0.40	0.06	0.14	0.40	**0.40**	**0.94**	**2.68**
OS-1A	4.8	0.00	0.89	0.95	0.96	4.80	0.03	0.09	0.36	0.03	0.09	0.36	**0.14**	**0.43**	**1.73**
OS-1B	23.4	0.00	0.89	0.95	0.96	23.40	0.03	0.09	0.36	0.03	0.09	0.36	**0.70**	**2.11**	**8.42**
OS-2A	2.0	0.00	0.89	0.95	0.96	2.00	0.03	0.09	0.36	0.03	0.09	0.36	**0.06**	**0.18**	**0.72**
OS-2B	2.3	0.00	0.89	0.95	0.96	2.30	0.03	0.09	0.36	0.03	0.09	0.36	**0.07**	**0.21**	**0.83**
OS-2C	14.9	0.00	0.89	0.95	0.96	14.90	0.03	0.09	0.36	0.03	0.09	0.36	**0.45**	**1.34**	**5.36**
OS-2D	0.85	0.00	0.89	0.95	0.96	0.85	0.03	0.09	0.36	0.03	0.09	0.36	**0.03**	**0.08**	**0.31**
OS-2E	3.1	0.00	0.89	0.95	0.96	3.10	0.03	0.09	0.36	0.03	0.09	0.36	**0.09**	**0.28**	**1.12**
OS-3	5.7	0.35	0.89	0.95	0.96	5.35	0.02	0.08	0.35	0.07	0.13	0.39	**0.42**	**0.74**	**2.21**
OS-5	27.6	0.00	0.89	0.95	0.96	27.60	0.02	0.08	0.35	0.02	0.08	0.35	**0.55**	**2.21**	**9.66**

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CALC'D BY:	*MAW*

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

$$t_c = \frac{L}{180} + 10$$

*For buried riprap, select C_v value based on type of vegetative cover.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$

$$V = C_v S_w^{0.5}$$

Tc=L/V

PRELIMINARY DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

	WEIGHTED			OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY			TOTAL FLOWS		
BASIN	CA(2)	CA(5)	CA(100)	C(5)	Length *(ft)*	Height *(ft)*	Tc *(min)*	Length *(ft)*	Slope *(%)*	Velocity *(fps)*	Tc *(min)*	TOTAL *(min)*	I(2) *(in/hr)*	I(5) *(in/hr)*	I(100) *(in/hr)*	Q(2) *(cfs)*	Q(5) *(cfs)*	Q(100) *(cfs)*
A1	0.77	1.79	5.12	0.14	120	2.4	15.1	740	2.5%	1.6	7.8	22.9	2.31	2.89	4.84	1.8	**5**	**25**
A2	0.41	0.97	2.76	0.14	300	12	19.0	400	4.0%	2.0	3.3	22.3	2.34	2.92	4.91	1.0	**3**	**14**
A3	0.35	0.83	2.36	0.14	300	8	21.7	400	3.0%	1.7	3.8	25.6	2.18	2.72	4.57	0.8	**2**	**11**
A4	0.25	0.42	0.92	0.20	180	8	13.3	180	4.0%	2.0	1.5	14.8	2.83	3.54	5.94	0.7	**1**	**5**
A5	0.33	0.77	2.20	0.14	280	10	19.1					19.1	2.53	3.16	5.31	0.8	**2**	**12**
B1	1.13	2.63	7.52	0.14	300	10.5	19.9	1280	3.2%	1.8	11.9	31.8	1.92	2.39	4.02	2.2	**6**	**30**
B2	0.48	1.12	3.20	0.14	300	10.5	19.9					19.9	2.48	3.10	5.20	1.2	**3**	**17**
B3	1.28	1.69	3.06	0.14	300	10.5	19.9	370	1.5%	1.2	5.0	24.9	2.21	2.76	4.63	2.8	**5**	**14**
B4	0.78	1.82	5.20	0.14	300	10.5	19.9					19.9	2.48	3.10	5.20	1.9	**6**	**27**
C1	1.13	2.13	5.25	0.17	300	12	18.4	600	2.0%	2.8	3.5	21.9	2.36	2.95	4.95	2.7	**6**	**26**
C2	0.52	0.86	1.89	0.20	300	14	16.9					16.9	2.67	3.34	5.61	1.4	**3**	**11**
C3	0.77	1.46	3.61	0.17	300	17	16.4					16.4	2.71	3.39	5.68	2.1	**5**	**21**
D1	1.02	1.28	2.72	0.21	200	4	18.0	600	2.0%	2.8	3.5	21.6	2.38	2.98	5.00	2.4	**4**	**14**
D2	2.54	3.53	6.63	0.25	150	3	15.0	900	3.0%	3.5	4.3	19.3	2.51	3.14	5.28	6.4	**11**	**35**
D3	0.68	0.85	1.81	0.21	150	3	15.6	375	2.0%	2.8	2.2	17.8	2.61	3.26	5.48	1.8	**3**	**10**
D4	1.36	1.84	3.30	0.27	150	3	14.6	600	3.5%	3.7	2.7	17.3	2.64	3.31	5.56	3.6	**6**	**18**
D5	2.30	3.20	6.02	0.25	150	3	15.0	1050	2.5%	3.2	5.5	20.5	2.44	3.05	5.13	5.6	**10**	**31**
D6	2.75	3.83	7.19	0.25	150	3	15.0	1200	2.0%	2.8	7.1	22.0	2.36	2.94	4.94	6.5	**11**	**36**
D7	0.19	0.43	1.11	0.16	150	3	16.5					16.5	2.70	3.37	5.67	0.5	**1**	**6**
D8	0.38	0.53	0.99	0.25	70	2.8	8.1					8.1	3.54	4.44	7.46	1.3	**2**	**7**
D9	0.27	0.38	0.71	0.25	70	2.8	8.1					8.1	3.54	4.44	7.46	1.0	**2**	**5**
D10	0.31	0.43	0.80	0.25	80	3.2	8.7					8.7	3.46	4.34	7.29	1.1	**2**	**6**
E	1.51	1.50	1.49	0.25	30	7.5	2.9	400	5.0%	2.2	3.0	5.9	3.93	4.92	8.27	5.9	**7**	**12**
F1	0.54	1.63	6.52	0.09	60	3	8.3	2400	2.0%	1.4	28.3	36.6	1.75	2.18	3.66	1.0	**4**	**24**
F2	0.14	0.41	1.66	0.09	60	6	6.6	1200	2.0%	1.4	14.1	20.7	2.43	3.03	5.09	0.3	**1**	**8**
H	0.40	0.94	2.68	0.14	300	11	19.6	900	2.0%	1.4	10.6	30.2	1.98	2.47	4.15	0.8	**2**	**11**
OS-1A	0.14	0.43	1.73	0.09	300	15	18.6	400	5.0%	4.5	1.5	20.1	2.47	3.08	5.18	0.4	**1**	**9**
OS-1B	0.70	2.11	8.42	0.09	300	15	18.6	1200	5.0%	4.5	4.5	23.0	2.30	2.88	4.83	1.6	**6**	**41**
OS-2A	0.06	0.18	0.72	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.1	**0.6**	**4**
OS-2B	0.07	0.21	0.83	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.2	**0.6**	**4**
OS-2C	0.45	1.34	5.36	0.09	300	12	20.0	1000	3.0%	3.5	4.8	24.8	2.21	2.77	4.64	1.0	**4**	**25**
OS-2D	0.03	0.08	0.31	0.09	250	12	17.2					17.2	2.65	3.32	5.57	0.07	**0.3**	**2**
OS-2E	0.09	0.28	1.12	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.2	**0.9**	**6**
OS-3	0.42	0.74	2.21	0.08	300	10	21.4	250	3.0%	3.5	1.2	22.6	2.32	2.90	4.87	1	**2**	**11**
OS-5	0.55	2.21	9.66	0.08	300	12	20.2	1500	3.0%	3.5	7.2	27.4	2.10	2.62	4.39	1	**6**	**42**

JOB NAME: *The Retreat at TimberRidge (Preliminary Plan)*
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CALCULATED BY: *MAW*

PRELIMINARY DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Culvert / Inlet Size
					I(5)	I(100)	Q(5)	Q(100)	
1	OS-5	2.21	9.66	27.4	2.62	4.39	6	42	EX. 48" CMP
2	OS-3	0.74	2.21	22.6	2.90	4.87	2	11	24" RCP
3	DP-2, A-1	2.54	7.33	23.6	2.84	4.76	7	35	30" RCP
4	A2	0.97	2.76	22.3	2.92	4.91	3	14	24" RCP
5	DP-3, DP-4, A3	4.33	12.45	25.6	2.72	4.57	12	57	DUAL 30" RCP CULVERTS
6	**OS-3, A1, A2, A3 and A4 (POND B INFLOW)**	4.75	13.37	26.6	2.66	4.47	**13**	**60**	
7	B1	2.63	7.52	31.8	2.39	4.02	6	30	30" RCP
8	B3	1.69	3.06	24.9	2.76	4.63	5	14	5' Type R sump inlets
9	**B1, B2 and B3 (POND C INFLOW)**	5.44	13.78	34.8	2.26	3.79	**12**	**52**	
10	C1, OS-1A	2.56	6.98	23.4	2.85	4.79	7	33	30" RCP
11	C2	0.86	1.89	16.9	3.34	5.61	3	11	5' Type R sump inlets
12	D2, OS-2A	3.71	7.35	20.0	3.09	5.19	11	38	10' Type R sump inlets
13	D1, OS-2B	1.49	3.55	21.6	2.98	5.00	4	18	5' Type R sump inlets
14	D3, OS-2D	0.93	2.12	17.8	3.26	5.48	3	12	5' Type R sump inlets
15	D5, OS-2E	3.48	7.13	20.5	3.05	5.13	11	37	10' Type R sump inlets
16	D4	1.84	3.30	17.3	3.31	5.56	6	18	5' Type R sump inlets
17	D6	3.83	7.19	22.0	2.94	4.94	11	36	10' Type R sump inlets
18	**DP-10 Thru DP-17 and OS-1B, OS-2C, D7 (POND D INFLOW)**	22.55	54.40	27.8	2.60	4.36	**59**	**237**	

JOB NAME: *The Retreat at TimberRidge (Preliminary Plan)*
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CALCULATED BY: *MAW*

* PIPES ARE LISTED AT MAXIMUM SIZE REQUIRED TO ACCOMMODATE Q100 FLOWS AT MINIMUM GRADE.
REFER TO INDIVIDUAL PIPE SHEETS FOR HYDRAULIC INFORMATION.

PRELIMINARY DRAINAGE REPORT ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		
					I(5)	I(100)	Q(5)	Q(100)	Pipe Size*
1	DP-10	2.56	6.98	23.4	2.85	4.79	7	33	30" RCP
2	OS-1B	2.11	8.42	23.0	2.88	4.83	6	41	30" RCP
3	PR-1, PR-2, DP-11	5.52	17.29	25.4	2.73	4.58	15	79	36" RCP
4	DP-12	3.71	7.35	20.0	3.09	5.19	11	38	30" RCP
5	PR-3, PR-4	9.23	24.64	27.1	2.63	4.42	24	109	42" RCP
6	DP-16	1.84	3.30	17.3	3.31	5.56	6	18	24" RCP
7	PR-5, PR-6	11.06	27.94	27.1	2.63	4.42	29	123	42" RCP
8	PR-7, DP-17	14.89	35.13	27.8	2.59	4.35	39	153	48" RCP
9	DP-13	1.49	3.55	21.6	2.98	5.00	4	18	24" RCP
10	OS-2C	1.34	5.36	24.8	2.77	4.64	4	25	30" RCP
11	PR-9, PR-10	2.83	8.91	25.3	2.74	4.59	8	41	30" RCP
12	PR-11, DP-14	3.75	11.03	27.3	2.62	4.40	10	49	36" RCP
13	DP-15	3.48	7.13	20.5	3.05	5.13	11	37	30" RCP
14	PR-12, PR-13	7.23	18.16	27.6	2.61	4.37	19	79	36" RCP

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Mar 14 2017

Box Culvert (Arroya Lane & prop. collector Rd.)

Invert Elev Dn (ft)	= 7233.50
Pipe Length (ft)	= 115.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 7234.65
Rise (in)	= 72.0
Shape	= Box
Span (in)	= 144.0
No. Barrels	= 3
n-Value	= 0.013
Culvert Type	= Flared Wingwalls
Culvert Entrance	= 30D to 75D wingwall flares
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4

Embankment

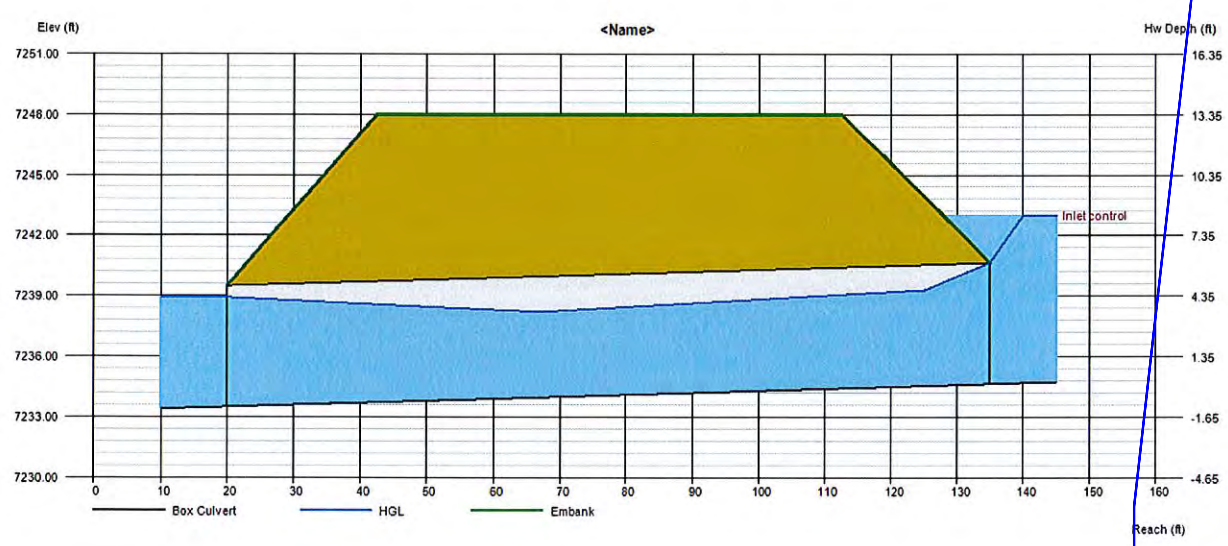
Top Elevation (ft)	= 7248.00
Top Width (ft)	= 70.00
Crest Width (ft)	= 70.00

Calculations

Qmin (cfs)	= 630.00
Qmax (cfs)	= 2170.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 2170.00
Qpipe (cfs)	= 2170.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 11.13
Veloc Up (ft/s)	= 12.49
HGL Dn (ft)	= 7238.91
HGL Up (ft)	= 7239.48
Hw Elev (ft)	= 7242.98
Hw/D (ft)	= 1.39
Flow Regime	= Inlet Control



This needs to be for FEMA flows unless there is a LOMR reducing the flows. Provide for both.

Culvert Report

Exist. Culvert Crossing at DP 1

Invert Elev Dn (ft)	= 7258.00
Pipe Length (ft)	= 130.00
Slope (%)	= 3.00
Invert Elev Up (ft)	= 7261.90
Rise (in)	= 48.0
Shape	= Circular
Span (in)	= 48.0
No. Barrels	= 1
n-Value	= 0.024
Culvert Type	= Circular Corrugate Metal Pipe
Culvert Entrance	= Headwall
Coeff. K,M,c,Y,k	= 0.0078, 2, 0.0379, 0.69, 0.5

Embankment

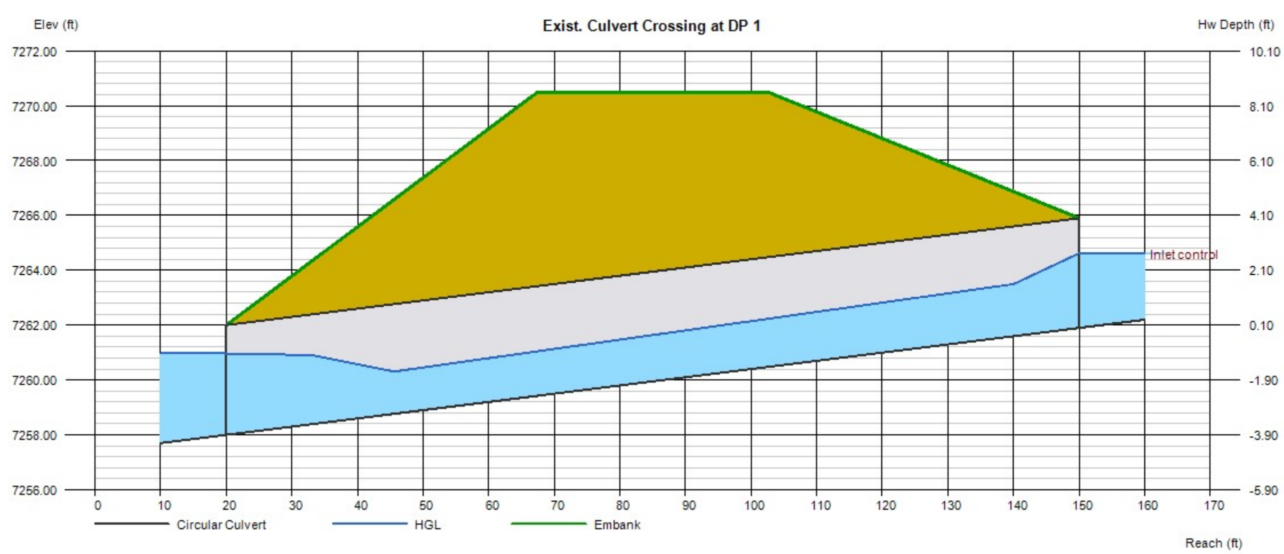
Top Elevation (ft)	= 7270.50
Top Width (ft)	= 35.00
Crest Width (ft)	= 150.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 42.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 42.00
Qpipe (cfs)	= 42.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.20
Veloc Up (ft/s)	= 6.98
HGL Dn (ft)	= 7260.97
HGL Up (ft)	= 7263.83
Hw Elev (ft)	= 7264.62
Hw/D (ft)	= 0.68
Flow Regime	= Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jun 21 2018

Culvert Crossing at DP 2

Invert Elev Dn (ft)	= 7250.00
Pipe Length (ft)	= 115.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 7251.15
Rise (in)	= 24.0
Shape	= Circular
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

Embankment

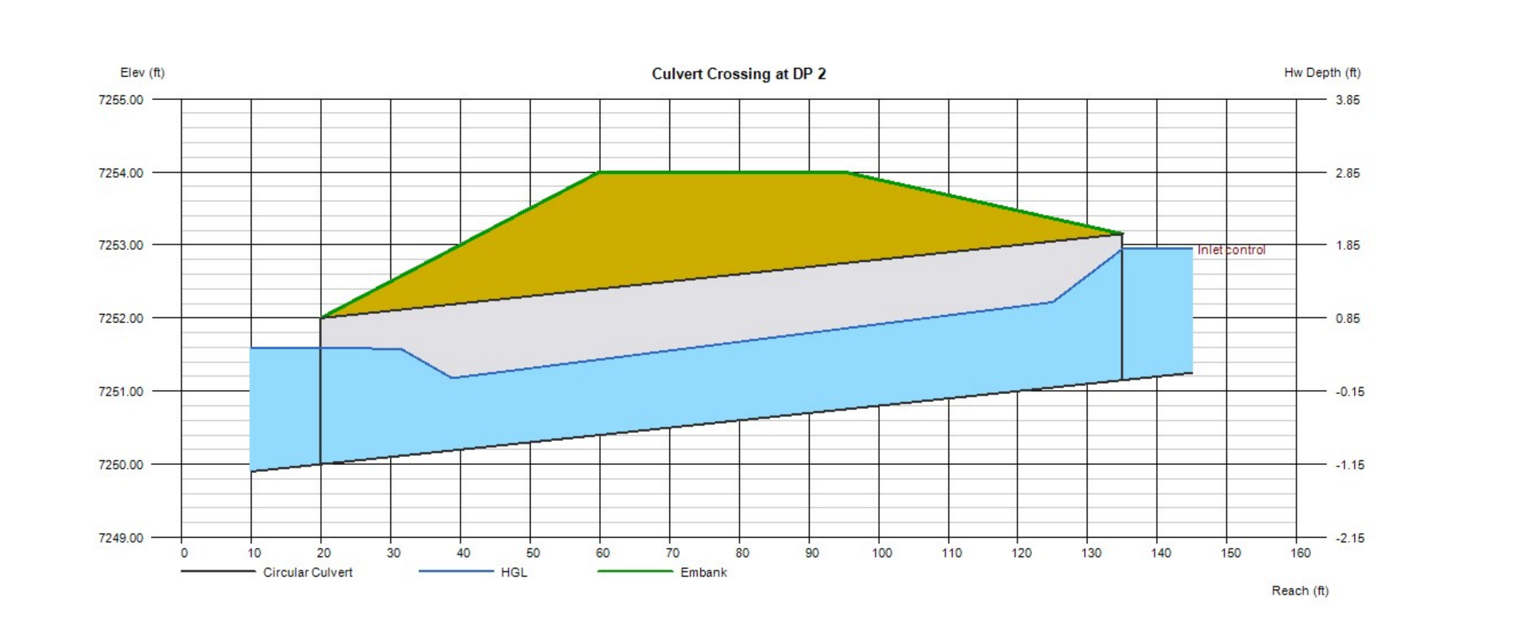
Top Elevation (ft)	= 7254.00
Top Width (ft)	= 35.00
Crest Width (ft)	= 150.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 11.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 11.00
Qpipe (cfs)	= 11.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.10
Veloc Up (ft/s)	= 5.66
HGL Dn (ft)	= 7251.59
HGL Up (ft)	= 7252.34
Hw Elev (ft)	= 7252.95
Hw/D (ft)	= 0.90
Flow Regime	= Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jun 21 2018

Culvert Crossing at DP 3

Invert Elev Dn (ft)	=	7228.00
Pipe Length (ft)	=	110.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	7229.10
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

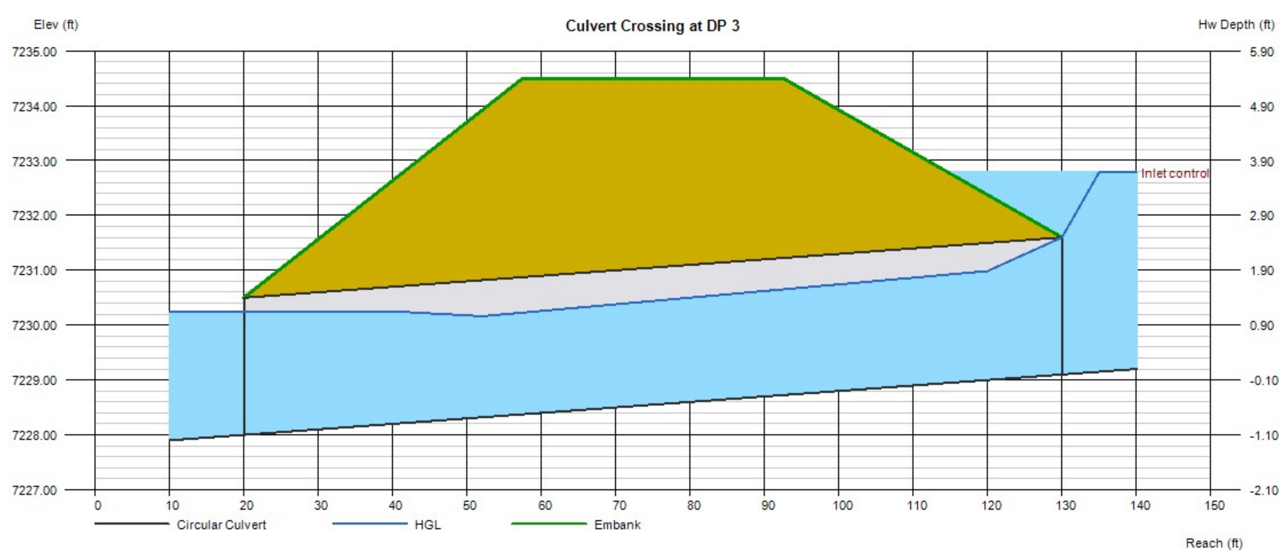
Top Elevation (ft)	=	7234.50
Top Width (ft)	=	35.00
Crest Width (ft)	=	150.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	35.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	35.00
Qpipe (cfs)	=	35.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.51
Veloc Up (ft/s)	=	8.28
HGL Dn (ft)	=	7230.25
HGL Up (ft)	=	7231.11
Hw Elev (ft)	=	7232.79
Hw/D (ft)	=	1.47
Flow Regime	=	Inlet Control



Culvert Report

Culvert Crossing at DP 4

Invert Elev Dn (ft)	=	7230.00
Pipe Length (ft)	=	140.00
Slope (%)	=	1.43
Invert Elev Up (ft)	=	7232.00
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

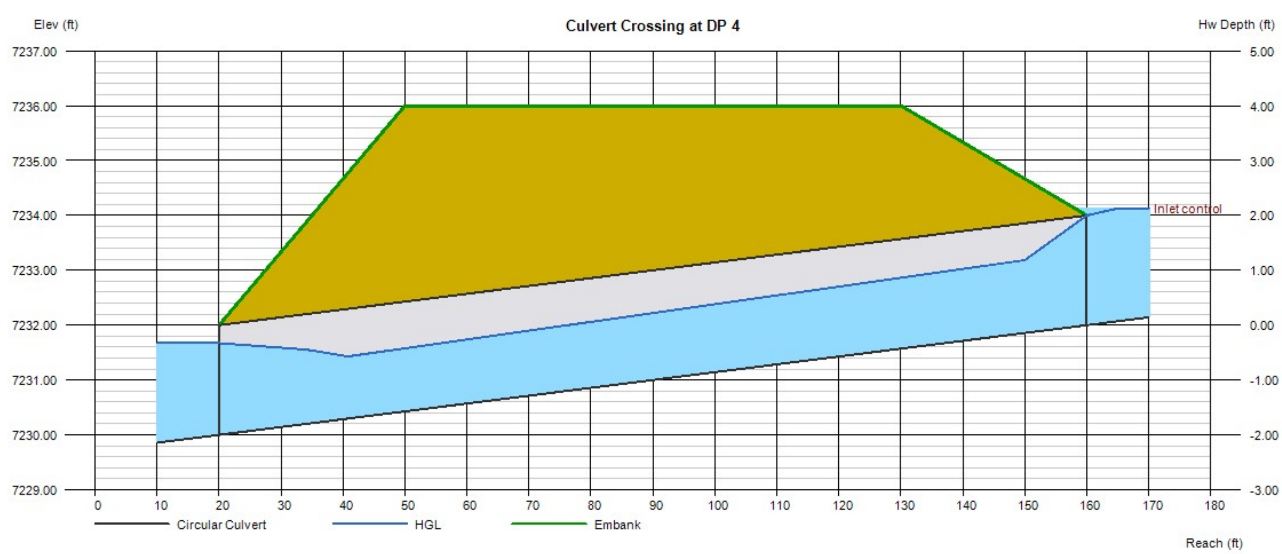
Top Elevation (ft)	=	7236.00
Top Width (ft)	=	80.00
Crest Width (ft)	=	150.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	14.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	14.00
Qpipe (cfs)	=	14.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.99
Veloc Up (ft/s)	=	6.22
HGL Dn (ft)	=	7231.67
HGL Up (ft)	=	7233.35
Hw Elev (ft)	=	7234.13
Hw/D (ft)	=	1.06
Flow Regime	=	Inlet Control



Culvert Report

Culvert Crossing at DP 5

Invert Elev Dn (ft)	=	7220.00
Pipe Length (ft)	=	160.00
Slope (%)	=	1.25
Invert Elev Up (ft)	=	7222.00
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

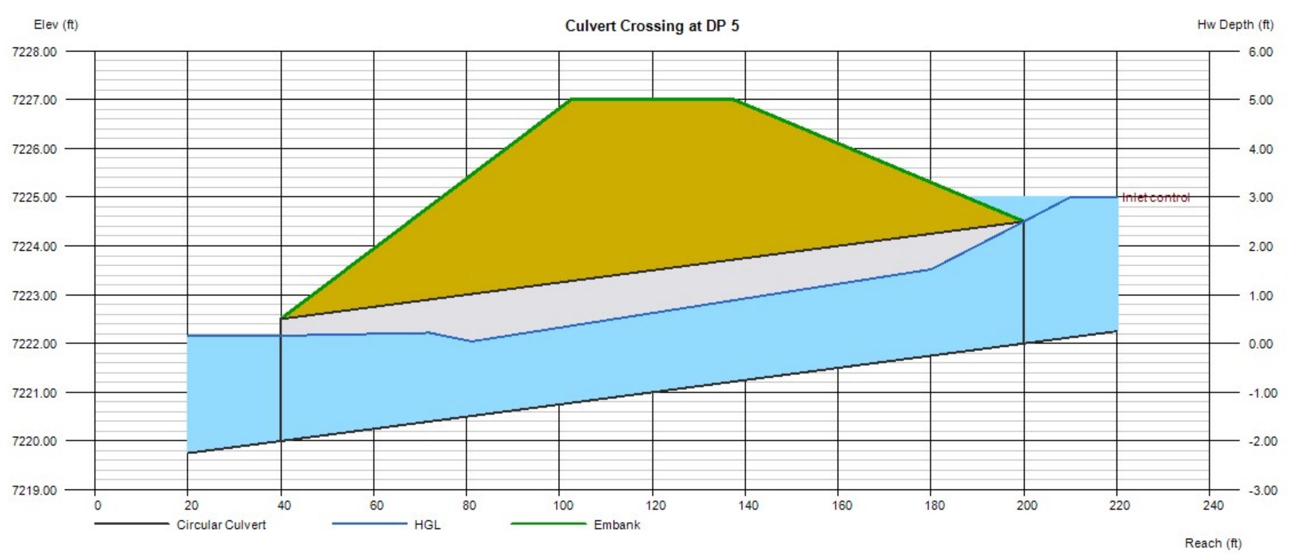
Top Elevation (ft)	=	7227.00
Top Width (ft)	=	35.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	57.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	57.00
Qpipe (cfs)	=	57.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.32
Veloc Up (ft/s)	=	7.45
HGL Dn (ft)	=	7222.16
HGL Up (ft)	=	7223.82
Hw Elev (ft)	=	7225.00
Hw/D (ft)	=	1.20
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jun 21 2018

Culvert Crossing at DP 7

Invert Elev Dn (ft)	=	7195.20
Pipe Length (ft)	=	80.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	7196.00
Rise (in)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

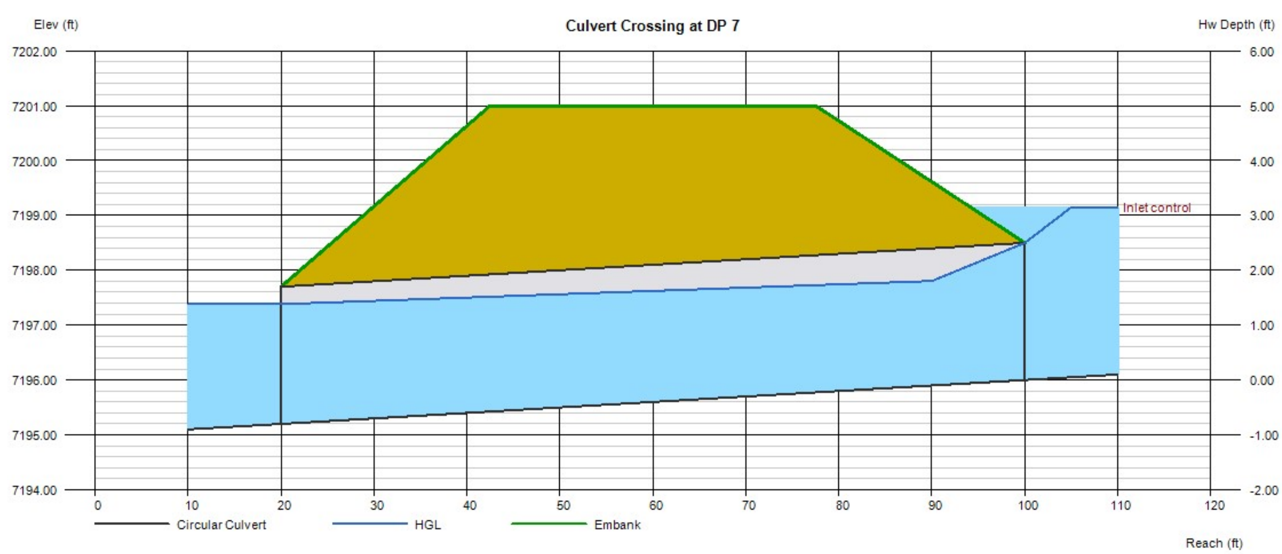
Top Elevation (ft)	=	7201.00
Top Width (ft)	=	35.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	30.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

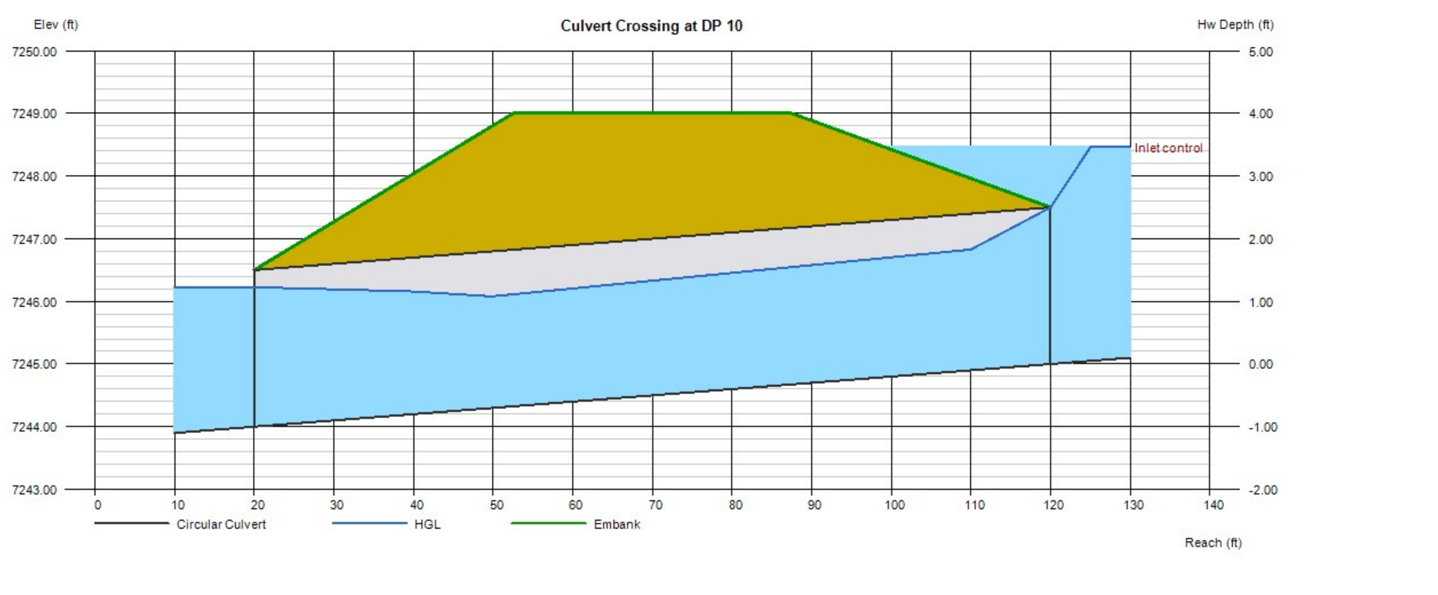
Qtotal (cfs)	=	30.00
Qpipe (cfs)	=	30.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.60
Veloc Up (ft/s)	=	7.64
HGL Dn (ft)	=	7197.38
HGL Up (ft)	=	7197.87
Hw Elev (ft)	=	7199.15
Hw/D (ft)	=	1.26
Flow Regime	=	Inlet Control



Culvert Report

Culvert Crossing at DP 10

Invert Elev Dn (ft)	= 7244.00	**Calculations**	
Pipe Length (ft)	= 100.00	Qmin (cfs)	= 0.00
Slope (%)	= 1.00	Qmax (cfs)	= 33.00
Invert Elev Up (ft)	= 7245.00	Tailwater Elev (ft)	= (dc+D)/2
Rise (in)	= 30.0		
Shape	= Circular	**Highlighted**	
Span (in)	= 30.0	Qtotal (cfs)	= 33.00
No. Barrels	= 1	Qpipe (cfs)	= 33.00
n-Value	= 0.013	Qovertop (cfs)	= 0.00
Culvert Type	= Circular Concrete	Veloc Dn (ft/s)	= 7.15
Culvert Entrance	= Square edge w/headwall (C)	Veloc Up (ft/s)	= 8.02
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5	HGL Dn (ft)	= 7246.23
		HGL Up (ft)	= 7246.95
Embankment		Hw Elev (ft)	= 7248.46
Top Elevation (ft)	= 7249.00	Hw/D (ft)	= 1.38
Top Width (ft)	= 35.00	Flow Regime	= Inlet Control
Crest Width (ft)	= 50.00		



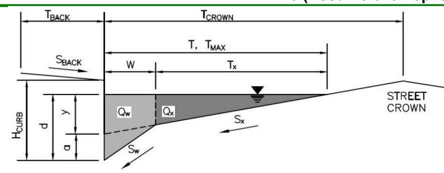
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: THE RETREAT AT TIMBERRIDGE PRELIMINARY DRAINAGE REPORT (South of Arroya Lane)

Inlet ID: DP-8 (Assume even split of flows)



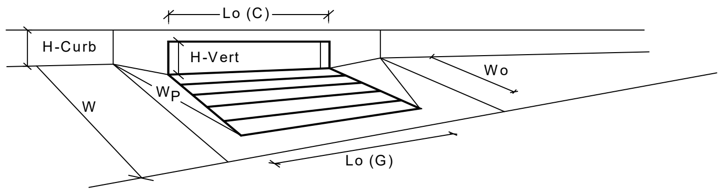
Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	20.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.010		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	14.0	14.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



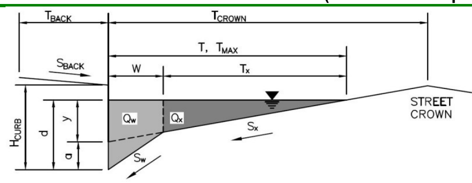
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	12.0	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	N/A	N/A	
			MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		Q_a =	**5.4**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK\ REQUIRED}$ =	3.0	7.0	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: THE RETREAT AT TIMBERRIDGE PRELIMINARY DRAINAGE REPORT (South of Arroya Lane)

Inlet ID: DP-11 (Assume even split of flows)



Gutter Geometry (Enter data in the blue cells)

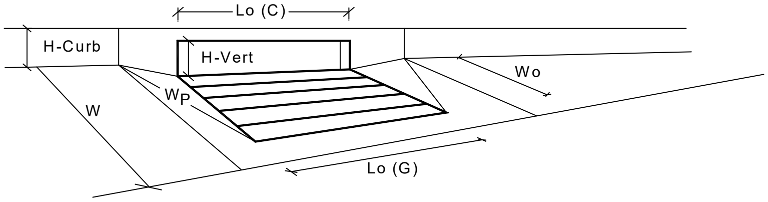
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.010	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	CDOT Type R Curb Opening	MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.4**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.0	6.0	cfs

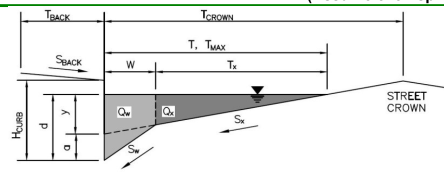
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: THE RETREAT AT TIMBERRIDGE PRELIMINARY DRAINAGE REPORT (South of Arroya Lane)

Inlet ID: DP-12 (Assume even split of flows)



Gutter Geometry (Enter data in the blue cells)

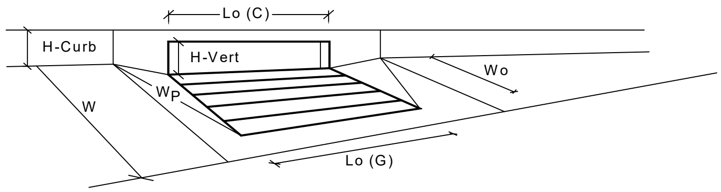
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)			MINOR	MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	12.0	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.57	1.00	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	0.93	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	N/A	N/A	
			MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		Q_a =	**8.3**	**25.5**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK\ REQUIRED}$ =	6.0	16.0	cfs

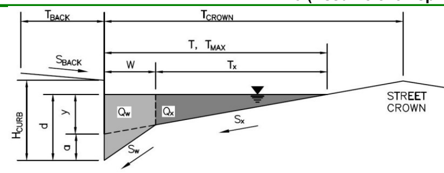
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: THE RETREAT AT TIMBERRIDGE PRELIMINARY DRAINAGE REPORT (South of Arroya Lane)

Inlet ID: DP-13 (Assume even split of flows)



Gutter Geometry (Enter data in the blue cells)

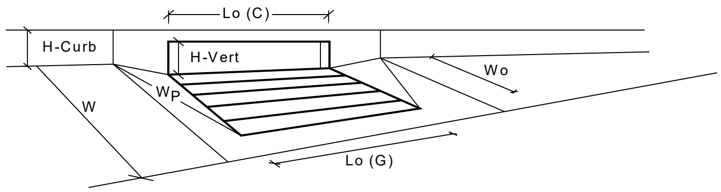
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)			MINOR	MAJOR	
Type of Inlet	CDOT Type R Curb Opening	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	12.0	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.4**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.0	9.0	cfs

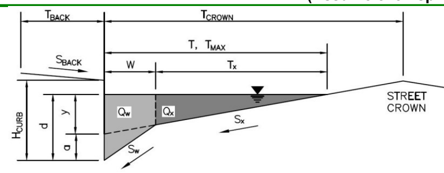
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: THE RETREAT AT TIMBERRIDGE PRELIMINARY DRAINAGE REPORT (South of Arroya Lane)

Inlet ID: DP-14 (Assume even split of flows)



Gutter Geometry (Enter data in the blue cells)

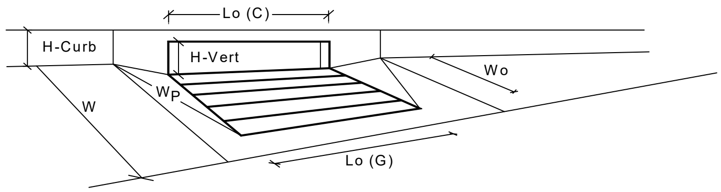
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLEET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	12.0	inches
Grate Information		MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.4**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	2.0	6.0	cfs

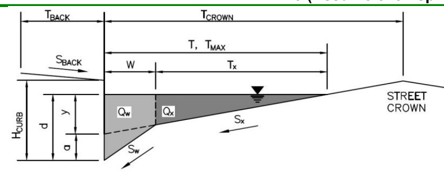
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: THE RETREAT AT TIMBERRIDGE PRELIMINARY DRAINAGE REPORT (South of Arroya Lane)

Inlet ID: DP-15 (Assume even split of flows)



Gutter Geometry (Enter data in the blue cells)

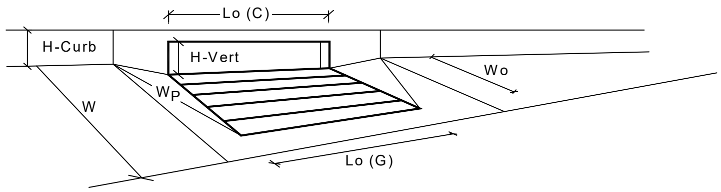
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	12.0	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.57	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.93	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

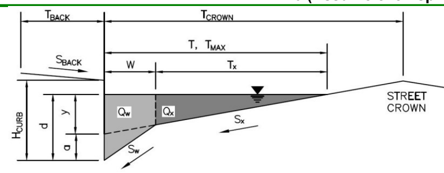
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**8.3**	**25.5**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	6.0	16.0	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: THE RETREAT AT TIMBERRIDGE PRELIMINARY DRAINAGE REPORT (South of Arroya Lane)

Inlet ID: DP-16 (Assume even split of flows)



Gutter Geometry (Enter data in the blue cells)

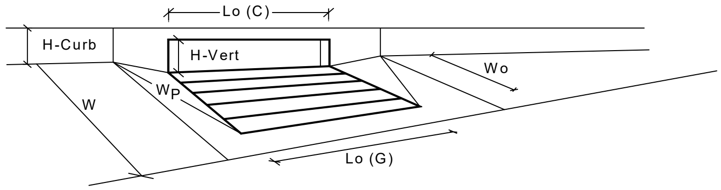
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	8.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	6.0	12.0	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	
Low Head Performance Reduction (Calculated)			MINOR	MAJOR	
Depth for Grate Midwidth		d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation		d_{Curb} =	0.33	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets		$RF_{Combination}$ =	0.77	1.00	
Curb Opening Performance Reduction Factor for Long Inlets		RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets		RF_{Grate} =	N/A	N/A	
			MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)		Q_a =	**5.4**	**12.3**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)		$Q_{PEAK\ REQUIRED}$ =	3.0	9.0	cfs

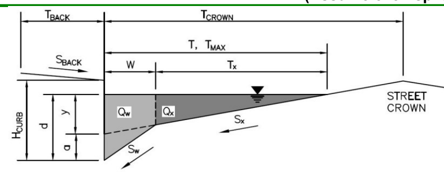
Version 4.05 Released March 2017

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: THE RETREAT AT TIMBERRIDGE PRELIMINARY DRAINAGE REPORT (South of Arroya Lane)

Inlet ID: DP17 (Assume even split of flows)



Gutter Geometry (Enter data in the blue cells)

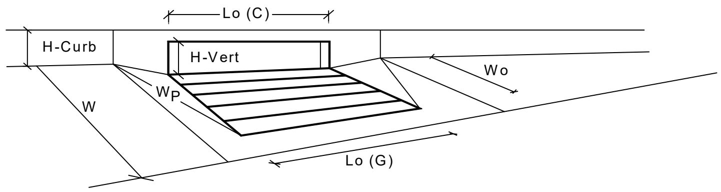
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	17.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	22.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	20.0	20.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	8.0	12.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.05 Released March 2017



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)		a_{local} =	1.00	1.00	inches
Number of Unit Inlets (Grate or Curb Opening)		No =	1	1	
Water Depth at Flowline (outside of local depression)		Ponding Depth =	8.0	12.0	inches
Grate Information			MINOR	MAJOR	☑ Override Depths
Length of a Unit Grate		L_o (G) =	N/A	N/A	feet
Width of a Unit Grate		W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)		A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)		C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)		C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)		C_o (G) =	N/A	N/A	
Curb Opening Information			MINOR	MAJOR	
Length of a Unit Curb Opening		L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches		H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches		H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)		Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)		W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)		C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)		C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)		C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.50	0.83	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.75	1.00	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**16.0**	**23.4**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	6.0	18.0	cfs

Pre-Dev 2 Year Routing

Project Summary	
Title	Retreat at TimberRidge Preliminary Drainage Report (South of Arroya Lane)
Engineer	MAW
Company	CCES
Date	6/20/2018

Notes	Pre-Dev 2 year SCS Model

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Pre-Dev 2 Year Routing

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
EX-1	Pre-Development 2 YEAR	2	1.203	12.650	2.61
EX-2	Pre-Development 2 YEAR	2	0.071	12.300	0.17
EX-3	Pre-Development 2 YEAR	2	0.191	12.600	0.42
EX-4	Pre-Development 2 YEAR	2	0.366	12.250	1.29
EX-6	Pre-Development 2 YEAR	2	0.052	12.450	0.12
OS-1	Pre-Development 2 YEAR	2	0.379	12.400	0.86
OS-2	Pre-Development 2 YEAR	2	0.016	12.350	0.04
OS-3	Pre-Development 2 YEAR	2	0.077	12.100	0.55
OS-4	Pre-Development 2 YEAR	2	0.167	12.200	0.62
OS-5	Pre-Development 2 YEAR	2	0.287	12.300	0.97
SC-1	Pre-Development 2 YEAR	2	0.130	12.150	0.53
SC-2	Pre-Development 2 YEAR	2	3.593	12.550	9.88

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
EX DP-1	Pre-Development 2 YEAR	2	2.456	12.600	5.61
EX DP-2	Pre-Development 2 YEAR	2	0.087	12.350	0.21
EX DP-3	Pre-Development 2 YEAR	2	0.191	12.600	0.42
EX DP-4	Pre-Development 2 YEAR	2	0.052	12.450	0.12
EX. 60" CMP at Arroya	Pre-Development 2 YEAR	2	0.610	12.200	2.24
Ex. 36" CMP at Vollmer	Pre-Development 2 YEAR	2	0.130	12.150	0.53
Ex. 60" CMP at Vollmer	Pre-Development 2 YEAR	2	3.593	12.550	9.88

Pre-Dev 2 Year Routing

Subsection: Time-Depth Curve | Return Event: 2 years
Label: Colo Springs 2015 | Storm Event: TYPE II 24 HOUR

Time-Depth Curve: TYPE II 24 HOUR	
Label	TYPE II 24 HOUR
Start Time	0.000 hours
Increment	0.250 hours
End Time	24.000 hours
Return Event	2 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.250 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
1.250	0.0	0.0	0.0	0.0	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.750	0.1	0.1	0.1	0.1	0.1
5.000	0.1	0.1	0.2	0.2	0.2
6.250	0.2	0.2	0.2	0.2	0.2
7.500	0.2	0.2	0.3	0.3	0.3
8.750	0.3	0.3	0.3	0.3	0.4
10.000	0.4	0.4	0.4	0.5	0.5
11.250	0.5	0.6	0.8	1.4	1.5
12.500	1.5	1.6	1.6	1.7	1.7
13.750	1.7	1.7	1.8	1.8	1.8
15.000	1.8	1.8	1.8	1.9	1.9
16.250	1.9	1.9	1.9	1.9	1.9
17.500	1.9	1.9	1.9	1.9	2.0
18.750	2.0	2.0	2.0	2.0	2.0
20.000	2.0	2.0	2.0	2.0	2.0
21.250	2.0	2.0	2.0	2.1	2.1
22.500	2.1	2.1	2.1	2.1	2.1
23.750	2.1	2.1	(N/A)	(N/A)	(N/A)

Pre-Dev 2 Year Routing

Subsection: Addition Summary — Return Event: 2 years
Label: EX DP-1 — Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-1'

Upstream Link	Upstream Node
REACH SC-9	EX. 60" CMP at Arroya
<Catchment to Outflow Node>	EX-1
<Catchment to Outflow Node>	OS-1
<Catchment to Outflow Node>	OS-5

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	REACH SC-9	0.587	12.750	1.46
Flow (From)	EX-1	1.203	12.650	2.61
Flow (From)	OS-1	0.379	12.400	0.86
Flow (From)	OS-5	0.287	12.300	0.97
Flow (In)	EX DP-1	2.456	12.600	5.61

Pre-Dev 2 Year Routing

Subsection: Addition Summary | Return Event: 2 years
Label: EX DP-2 | Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-2'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-2
<Catchment to Outflow Node>	OS-2

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-2	0.071	12.300	0.17
Flow (From)	OS-2	0.016	12.350	0.04
Flow (In)	EX DP-2	0.087	12.350	0.21

Pre-Dev 2 Year Routing

Subsection: Addition Summary — Return Event: 2 years
Label: EX DP-3 — Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-3'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-3

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-3	0.191	12.600	0.42
Flow (In)	EX DP-3	0.191	12.600	0.42

Summary for Hydrograph Addition at 'EX DP-4'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-6

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-6	0.052	12.450	0.12
Flow (In)	EX DP-4	0.052	12.450	0.12

Pre-Dev 2 Year Routing

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Pre-Dev 5 Year Routing

Project Summary	
Title	Retreat at TimberRidge Preliminary Drainage Report (South of Arroya Lane)
Engineer	MAW
Company	CCES
Date	6/20/2018

Notes	Pre-Dev 5 year SCS Model

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Pre-Dev 5 Year Routing

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
EX-1	Pre-Development 5 YEAR	5	3.342	12.250	17.71
EX-2	Pre-Development 5 YEAR	5	0.197	12.100	1.70
EX-3	Pre-Development 5 YEAR	5	0.531	12.250	2.97
EX-4	Pre-Development 5 YEAR	5	0.916	12.150	6.87
EX-6	Pre-Development 5 YEAR	5	0.143	12.150	0.91
OS-1	Pre-Development 5 YEAR	5	1.050	12.150	7.03
OS-2	Pre-Development 5 YEAR	5	0.045	12.100	0.33
OS-3	Pre-Development 5 YEAR	5	0.178	12.050	2.07
OS-4	Pre-Development 5 YEAR	5	0.419	12.150	3.41
OS-5	Pre-Development 5 YEAR	5	0.717	12.200	5.15
SC-1	Pre-Development 5 YEAR	5	0.326	12.100	3.04
SC-2	Pre-Development 5 YEAR	5	9.021	12.400	44.17

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
EX DP-1	Pre-Development 5 YEAR	5	6.589	12.250	36.03
EX DP-2	Pre-Development 5 YEAR	5	0.242	12.100	2.04
EX DP-3	Pre-Development 5 YEAR	5	0.531	12.250	2.97
EX DP-4	Pre-Development 5 YEAR	5	0.143	12.150	0.91
EX. 60" CMP at Arroya	Pre-Development 5 YEAR	5	1.513	12.150	11.81
Ex. 36" CMP at Vollmer	Pre-Development 5 YEAR	5	0.326	12.100	3.04
Ex. 60" CMP at Vollmer	Pre-Development 5 YEAR	5	9.021	12.400	44.17

Pre-Dev 5 Year Routing

Subsection: Time-Depth Curve — Return Event: 5 years
Label: Colo Springs 2015 — Storm Event: TYPE II 24 HOUR

Time-Depth Curve: TYPE II 24 HOUR	
Label	TYPE II 24 HOUR
Start Time	0.000 hours
Increment	0.250 hours
End Time	24.000 hours
Return Event	5 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.250 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
1.250	0.0	0.0	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.750	0.1	0.1	0.1	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.2
6.250	0.2	0.2	0.3	0.3	0.3
7.500	0.3	0.3	0.3	0.3	0.4
8.750	0.4	0.4	0.4	0.4	0.5
10.000	0.5	0.5	0.5	0.6	0.6
11.250	0.7	0.8	1.0	1.8	1.9
12.500	2.0	2.0	2.1	2.1	2.2
13.750	2.2	2.2	2.3	2.3	2.3
15.000	2.3	2.3	2.3	2.4	2.4
16.250	2.4	2.4	2.4	2.4	2.5
17.500	2.5	2.5	2.5	2.5	2.5
18.750	2.5	2.5	2.5	2.6	2.6
20.000	2.6	2.6	2.6	2.6	2.6
21.250	2.6	2.6	2.6	2.6	2.6
22.500	2.7	2.7	2.7	2.7	2.7
23.750	2.7	2.7	(N/A)	(N/A)	(N/A)

Pre-Dev 5 Year Routing

Subsection: Addition Summary — Return Event: 5 years
Label: EX DP-1 — Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-1'

Upstream Link	Upstream Node
REACH SC-9	EX. 60" CMP at Arroya
<Catchment to Outflow Node>	EX-1
<Catchment to Outflow Node>	OS-1
<Catchment to Outflow Node>	OS-5

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	REACH SC-9	1.479	12.300	7.91
Flow (From)	EX-1	3.342	12.250	17.71
Flow (From)	OS-1	1.050	12.150	7.03
Flow (From)	OS-5	0.717	12.200	5.15
Flow (In)	EX DP-1	6.589	12.250	36.03

Pre-Dev 5 Year Routing

Subsection: Addition Summary
Label: EX DP-2

Return Event: 5 years
Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-2'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-2
<Catchment to Outflow Node>	OS-2

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-2	0.197	12.100	1.70
Flow (From)	OS-2	0.045	12.100	0.33
Flow (In)	EX DP-2	0.242	12.100	2.04

Pre-Dev 5 Year Routing

Subsection: Addition Summary | Return Event: 5 years
Label: EX DP-3 | Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-3'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-3

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-3	0.531	12.250	2.97
Flow (In)	EX DP-3	0.531	12.250	2.97

Pre-Dev 5 Year Routing

Subsection: Addition Summary | Return Event: 5 years
Label: EX DP-4 | Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-4'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-6

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-6	0.143	12.150	0.91
Flow (In)	EX DP-4	0.143	12.150	0.91

Pre-Dev 5 Year Routing

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Pre-Dev 100 Year Routing

Project Summary	
Title	Retreat at TimberRidge Preliminary Drainage Report (South of Arroya Lane)
Engineer	MAW
Company	CCES
Date	6/20/2018

Notes	Pre-Dev 100 year SCS Model

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Pre-Dev 100 Year Routing

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
EX-1	Pre-Development 100 YEAR	100	14.733	12.200	140.28
EX-2	Pre-Development 100 YEAR	100	0.868	12.050	12.19
EX-3	Pre-Development 100 YEAR	100	2.340	12.150	23.71
EX-4	Pre-Development 100 YEAR	100	3.684	12.100	41.75
EX-6	Pre-Development 100 YEAR	100	0.631	12.100	7.12
OS-1	Pre-Development 100 YEAR	100	4.622	12.100	53.88
OS-2	Pre-Development 100 YEAR	100	0.198	12.100	2.53
OS-3	Pre-Development 100 YEAR	100	0.660	12.050	9.91
OS-4	Pre-Development 100 YEAR	100	1.685	12.100	20.68
OS-5	Pre-Development 100 YEAR	100	2.887	12.150	32.06
SC-1	Pre-Development 100 YEAR	100	1.309	12.100	17.33
SC-2	Pre-Development 100 YEAR	100	36.376	12.300	275.26

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
EX DP-1	Pre-Development 100 YEAR	100	28.208	12.150	281.74
EX DP-2	Pre-Development 100 YEAR	100	1.065	12.050	14.65
EX DP-3	Pre-Development 100 YEAR	100	2.340	12.150	23.71
EX DP-4	Pre-Development 100 YEAR	100	0.631	12.100	7.12
EX. 60" CMP at Arroya	Pre-Development 100 YEAR	100	6.029	12.100	71.16
Ex. 36" CMP at Vollmer	Pre-Development 100 YEAR	100	1.309	12.100	17.33
Ex. 60" CMP at Vollmer	Pre-Development 100 YEAR	100	36.376	12.300	275.26

Pre-Dev 100 Year Routing

Subsection: Time-Depth Curve | Return Event: 100 years
Label: Colo Springs 2015 | Storm Event: TYPE II 24 HOUR

Time-Depth Curve: TYPE II 24 HOUR	
Label	TYPE II 24 HOUR
Start Time	0.000 hours
Increment	0.250 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.250 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.1
1.250	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.2	0.2	0.2
3.750	0.2	0.2	0.2	0.3	0.3
5.000	0.3	0.3	0.3	0.3	0.4
6.250	0.4	0.4	0.4	0.5	0.5
7.500	0.5	0.5	0.6	0.6	0.6
8.750	0.6	0.7	0.7	0.7	0.8
10.000	0.8	0.9	0.9	1.0	1.1
11.250	1.2	1.3	1.8	3.0	3.3
12.500	3.4	3.5	3.6	3.6	3.7
13.750	3.7	3.8	3.8	3.9	3.9
15.000	3.9	4.0	4.0	4.0	4.1
16.250	4.1	4.1	4.1	4.2	4.2
17.500	4.2	4.2	4.2	4.3	4.3
18.750	4.3	4.3	4.3	4.4	4.4
20.000	4.4	4.4	4.4	4.4	4.4
21.250	4.5	4.5	4.5	4.5	4.5
22.500	4.5	4.5	4.5	4.6	4.6
23.750	4.6	4.6	(N/A)	(N/A)	(N/A)

Pre-Dev 100 Year Routing

Subsection: Addition Summary | Return Event: 100 years

Label: EX DP-1 | Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-1'

Upstream Link	Upstream Node
REACH SC-9	EX. 60" CMP at Arroya
<Catchment to Outflow Node>	EX-1
<Catchment to Outflow Node>	OS-1
<Catchment to Outflow Node>	OS-5

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	REACH SC-9	5.967	12.200	61.74
Flow (From)	EX-1	14.733	12.200	140.28
Flow (From)	OS-1	4.622	12.100	53.88
Flow (From)	OS-5	2.887	12.150	32.06
Flow (In)	EX DP-1	28.208	12.150	281.74

Pre-Dev 100 Year Routing

Subsection: Addition Summary — Return Event: 100 years

Label: EX DP-2 — Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-2'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-2
<Catchment to Outflow Node>	OS-2

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-2	0.868	12.050	12.19
Flow (From)	OS-2	0.198	12.100	2.53
Flow (In)	EX DP-2	1.065	12.050	14.65

Pre-Dev 100 Year Routing

Subsection: Addition Summary — Return Event: 100 years
Label: EX DP-3 — Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-3'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-3

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-3	2.340	12.150	23.71
Flow (In)	EX DP-3	2.340	12.150	23.71

Pre-Dev 100 Year Routing

Subsection: Addition Summary — Return Event: 100 years
Label: EX DP-4 — Storm Event: TYPE II 24 HOUR

Summary for Hydrograph Addition at 'EX DP-4'

Upstream Link	Upstream Node
<Catchment to Outflow Node>	EX-6

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX-6	0.631	12.100	7.12
Flow (In)	EX DP-4	0.631	12.100	7.12

Pre-Dev 100 Year Routing

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STORMWATER QUALITY CALCULATIONS

CLASSIC
CONSULTING
ENGINEERS & SURVEYORS

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer:	**Marc A. Whorton, P.E.**
Company:	**CCES**
Date:	**June 22, 2018**
Project:	**The Retreat at TimberRidge Preliminary Drainage Report - Pond B**
Location:	**El Paso County**

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 11.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.110
C) Contributing Watershed Area	Area = 33.400 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One ○ Water Quality Capture Volume (WQCV) ● Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)	V_{DESIGN}= 0.202 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= 0.197 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ______ ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One ○ A ● B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 0.349 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet	Rip-Rap Forebays
A) Describe means of providing energy dissipation at concentrated inflow locations:	

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Marc A. Whorton, P.E.**
Company:	**CCES**
Date:	**June 22, 2018**
Project:	**The Retreat at TimberRidge Preliminary Drainage Report - Pond B**
Location:	**El Paso County**

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 2% of the WQCV)	V_{FMIN} = 0.004 ac-ft
B) Actual Forebay Volume	V_F = 0.004 ac-ft
C) Forebay Depth (D_F = 18 inch maximum)	D_F = 8.0 in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = 60.00 cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = 1.20 cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe; ● Wall with Rect. Notch; ○ Wall with V-Notch Weir — **(flow too small for berm w/ pipe)**
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = ____ in
G) Rectangular Notch Width	Calculated W_N = 9.5 in
6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ● Concrete; ○ Soft Bottom
F) Slope of Trickle Channel	S = 0.0100 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One: ● Orifice Plate; ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 0.93 inches
E) Total Outlet Area	A_{ot} = 2.04 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: CCES
Date: June 22, 2018
Project: The Retreat at TimberRidge Preliminary Drainage Report - Pond B
Location: El Paso County

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = 6 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = ____ cu ft

C) Initial Surcharge Provided Above Micropool — V_s = 5.0 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = 72 square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) — *S.S. Well Screen with 60% Open Area*

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio =

D) Total Water Quality Screen Area (based on screen type) — A_{total} = 120 sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= 3.25 feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= 67 inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: CCES
Date: June 22, 2018
Project: The Retreat at TimberRidge Preliminary Drainage Report - Pond B
Location: El Paso County

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Erosion Control Blanket
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	4.00
11. Vegetation	Choose One ○ Irrigated ● Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Per IM Plan

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer: Marc A. Whorton, P.E.
Company: CCES
Date: June 22, 2018
Project: The Retreat at TimberRidge Preliminary Drainage Report - Pond C
Location: El Paso County

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 11.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.110
C) Contributing Watershed Area	Area = 32.500 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One ○ Water Quality Capture Volume (WQCV) ◉ Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)	V_{DESIGN}= 0.197 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= 0.192 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One ○ A ◉ B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 0.340 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes	
A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet	
A) Describe means of providing energy dissipation at concentrated inflow locations:	Rip-Rap Forebays

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: CCES
Date: June 22, 2018
Project: The Retreat at TimberRidge Preliminary Drainage Report - Pond C
Location: El Paso County

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.004 ac-ft

B) Actual Forebay Volume — V_F = 0.004 ac-ft

C) Forebay Depth (D_F = 18 inch maximum) — D_F = 8.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 52.00 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 1.04 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = ____ in

G) Rectangular Notch Width — Calculated W_N = 8.5 in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
- ◉ Concrete
- ○ Soft Bottom

F) Slope of Trickle Channel — S = 0.0100 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 10 sq ft

C) Outlet Type

Choose One
- ◉ Orifice Plate
- ○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = 0.92 inches

E) Total Outlet Area — A_{ot} = 2.01 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Marc A. Whorton, P.E.**
Company:	**CCES**
Date:	**June 22, 2018**
Project:	**The Retreat at TimberRidge Preliminary Drainage Report - Pond C**
Location:	**El Paso County**

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = 6 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = ____ cu ft

C) Initial Surcharge Provided Above Micropool — V_s = 5.0 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = 71 square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) — *S.S. Well Screen with 60% Open Area*

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio =

D) Total Water Quality Screen Area (based on screen type) — A_{total} = 118 sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= 3.25 feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= 67 inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: CCES
Date: June 22, 2018
Project: The Retreat at TimberRidge Preliminary Drainage Report - Pond C
Location: El Paso County

10. Overflow Embankment	
A) Describe embankment protection for 100-year and greater overtopping:	Erosion Control Blanket
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	4.00
11. Vegetation	Choose One: ○ Irrigated ● Not Irrigated
12. Access	
A) Describe Sediment Removal Procedures	Per IM Plan

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer: Marc A. Whorton, P.E.
Company: CCES
Date: April 12, 2018
Project: The Retreat at TimberRidge Preliminary Drainage Report - Pond D
Location: El Paso County

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a	I_a = 23.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i = 0.230
C) Contributing Watershed Area	Area = 129.250 ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.42 in
E) Design Concept (Select EURV when also designing for flood control)	Choose One: ○ Water Quality Capture Volume (WQCV) ◉ Excess Urban Runoff Volume (EURV)
F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$)	V_{DESIGN}= 1.374 ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$= 1.342 ac-ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{DESIGN\ USER}$= ac-ft
I) Predominant Watershed NRCS Soil Group	Choose One: ○ A ◉ B ○ C / D
J) Excess Urban Runoff Volume (EURV) Design Volume For HSG A: $EURV_A = 1.68 * i^{1.28}$ For HSG B: $EURV_B = 1.36 * i^{1.08}$ For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$	EURV = 2.995 ac-f t
2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)	L : W = 2.0 : 1
3. Basin Side Slopes A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Z = 4.00 ft / ft
4. Inlet A) Describe means of providing energy dissipation at concentrated inflow locations:	Rip-Rap Forebays

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: CCES
Date: April 12, 2018
Project: The Retreat at TimberRidge Preliminary Drainage Report - Pond D
Location: El Paso County

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV) — V_{FMIN} = 0.040 ac-ft

B) Actual Forebay Volume — V_F = 0.041 ac-ft

C) Forebay Depth (D_F = 30 inch maximum) — D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 236.00 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 4.72 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ● Wall with Rect. Notch
- ○ Wall with V-Notch Weir

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = ____ in

G) Rectangular Notch Width — Calculated W_N = 12.9 in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
- ● Concrete
- ○ Soft Bottom

F) Slope of Trickle Channel — S = 0.0100 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 100 sq ft

C) Outlet Type

Choose One
- ● Orifice Plate
- ○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = 2.31 inches

E) Total Outlet Area — A_{ot} = 12.60 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Marc A. Whorton, P.E.
Company: CCES
Date: April 12, 2018
Project: The Retreat at TimberRidge Preliminary Drainage Report - Pond D
Location: El Paso County

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 175.3 cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 50.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 390 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 549 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 5 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 88 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	**Marc A. Whorton, P.E.**
Company:	**CCES**
Date:	**April 12, 2018**
Project:	**The Retreat at TimberRidge Preliminary Drainage Report - Pond D**
Location:	**El Paso County**

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	Erosion Control Blanket
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	4.00
11. Vegetation	Choose One ○ Irrigated ● Not Irrigated
12. Access A) Describe Sediment Removal Procedures	Per IM Plan

Notes:

DETENTION POND CALCULATIONS

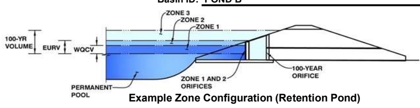
CLASSIC
CONSULTING
ENGINEERS & SURVEYORS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: **RETREAT AT TIMBER RIDGE - PRELIMINARY DRAINAGE REPORT**

Basin ID: **POND B**



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	33.40	acres		
Watershed Length =	1,650	ft		
Watershed Slope =	0.020	ft/ft		
Watershed Imperviousness =	11.00%	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 =	User Input			
Water Quality Capture Volume (WQCV) =	0.202	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.348	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.241	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.373	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.813	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.066	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.851	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.877	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.85 in.) =	7.196	acre-feet	3.85	inches
Approximate 2-yr Detention Volume =	0.224	acre-feet		
Approximate 5-yr Detention Volume =	0.349	acre-feet		
Approximate 10-yr Detention Volume =	0.696	acre-feet		
Approximate 25-yr Detention Volume =	0.957	acre-feet		
Approximate 50-yr Detention Volume =	1.003	acre-feet		
Approximate 100-yr Detention Volume =	1.289	acre-feet		

Stage-Storage Calculation

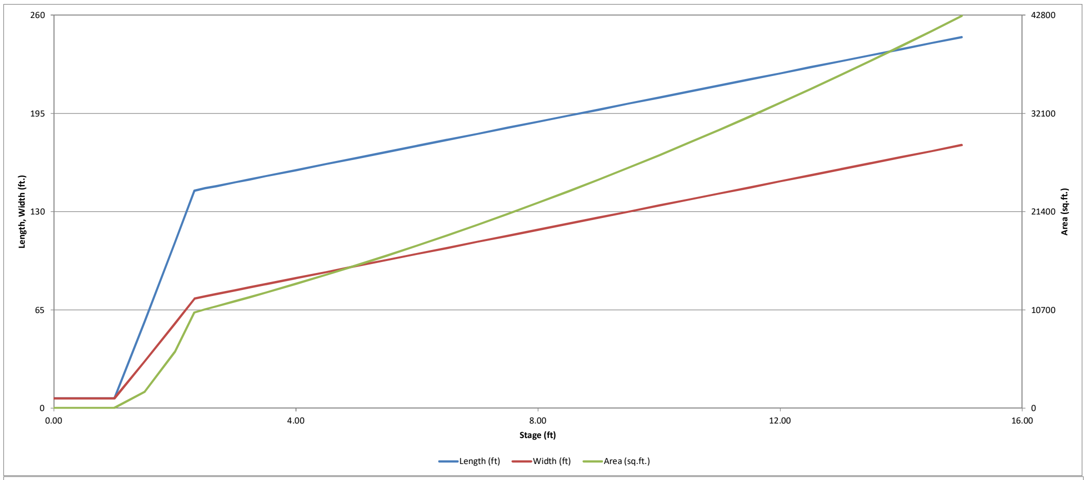
Zone 1 Volume (WQCV) =	0.202	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.146	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.941	acre-feet
Total Detention Basin Volume =	1.289	acre-feet
Initial Surcharge Volume (ISV) =	21	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	42	ft^2
Surcharge Volume Length (L_{ISV}) =	6.5	ft
Surcharge Volume Width (W_{ISV}) =	6.5	ft
Depth of Basin Floor (H_{FLOOR}) =	1.32	ft
Length of Basin Floor (L_{FLOOR}) =	144.0	ft
Width of Basin Floor (W_{FLOOR}) =	72.6	ft
Area of Basin Floor (A_{FLOOR}) =	10,459	ft^2
Volume of Basin Floor (V_{FLOOR}) =	4,922	ft^3
Depth of Main Basin (H_{MAIN}) =	3.68	ft
Length of Main Basin (L_{MAIN}) =	173.4	ft
Width of Main Basin (W_{MAIN}) =	102.0	ft
Area of Main Basin (A_{MAIN}) =	17,699	ft^2
Volume of Main Basin (V_{MAIN}) =	51,199	ft^3
Calculated Total Basin Volume (V_{total}) =	**1.289**	acre-feet

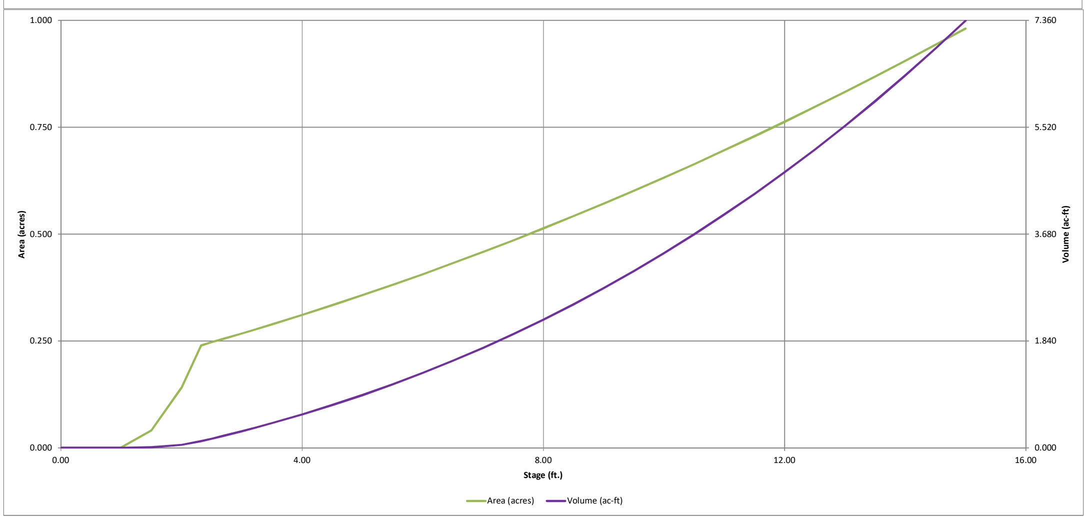
Depth Increment = 0.5 ft

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		6.5	6.5	42		0.001		
ISV	0.50		6.5	6.5	42		0.001	21	0.000
	1.00		6.5	6.5	42		0.001	42	0.001
	1.50		57.5	31.0	1,782		0.041	387	0.009
	2.00		109.5	56.0	6,132		0.141	2,258	0.052
Floor	2.32		143.8	72.5	10,427		0.239	4,959	0.114
	2.50		145.4	74.0	10,769		0.247	6,869	0.158
Zone 1 (WQCV)	2.68		146.9	75.5	11,087		0.255	8,836	0.203
	3.00		149.4	78.0	11,663		0.268	12,475	0.286
Zone 2 (EURV)	3.23		151.3	79.9	12,085		0.277	15,206	0.349
	3.50		153.4	82.0	12,589		0.289	18,537	0.426
	4.00		157.4	86.0	13,547		0.311	25,070	0.576
	4.50		161.4	90.0	14,537		0.334	32,089	0.737
	5.00		165.4	94.0	15,559		0.357	39,612	0.909
	5.50		169.4	98.0	16,613		0.381	47,654	1.094
Zone 3 (100-year)	6.00		173.4	102.0	17,699		0.406	56,230	1.291
	6.50		177.4	106.0	18,817		0.432	65,358	1.500
	7.00		181.4	110.0	19,967		0.458	75,052	1.723
	7.50		185.4	114.0	21,149		0.486	85,330	1.959
	8.00		189.4	118.0	22,363		0.513	96,206	2.209
	8.50		193.4	122.0	23,609		0.542	107,698	2.472
	9.00		197.4	126.0	24,886		0.571	119,820	2.751
	9.50		201.4	130.0	26,196		0.601	132,589	3.044
	10.00		205.4	134.0	27,538		0.632	146,022	3.352
	10.50		209.4	138.0	28,912		0.664	160,133	3.676
	11.00		213.4	142.0	30,318		0.696	174,939	4.016
	11.50		217.4	146.0	31,756		0.729	190,457	4.372
	12.00		221.4	150.0	33,226		0.763	206,701	4.745
	12.50		225.4	154.0	34,728		0.797	223,688	5.135
	13.00		229.4	158.0	36,262		0.832	241,434	5.543
	13.50		233.4	162.0	37,828		0.868	259,955	5.968
	14.00		237.4	166.0	39,426		0.905	279,268	6.411
	14.50		241.4	170.0	41,056		0.943	299,387	6.873
	15.00		245.4	174.0	42,718		0.981	320,329	7.354

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



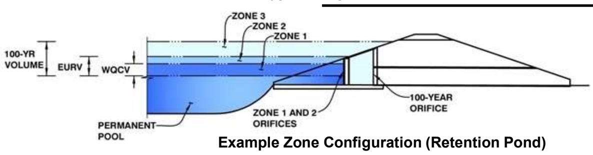


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: RETREAT AT TIMBER RIDGE - PRELIMINARY DRAINAGE REPORT

Basin ID: POND B



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.68	0.202	Orifice Plate
Zone 2 (EURV)	3.23	0.146	Orifice Plate
Zone 3 (100-year)	6.00	0.941	Weir&Pipe (Restrict)
		1.289	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 =	3.25	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.00	inches
Orifice Plate: Orifice Area per Row =	0.68	sq. inches (diameter = 15/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.722E-03	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	1.10	2.20					
Orifice Area (sq. inches)	0.68	0.68	0.68					

	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 =	3.25	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	75%	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 =	4.25	N/A	feet
Over Flow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.99	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	12.37	N/A	ft^2
Overflow Grate Open Area w/ Debris =	6.18	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 =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	15.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.07	N/A	ft^2
Outlet Orifice Centroid =	0.71	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.82	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.25	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

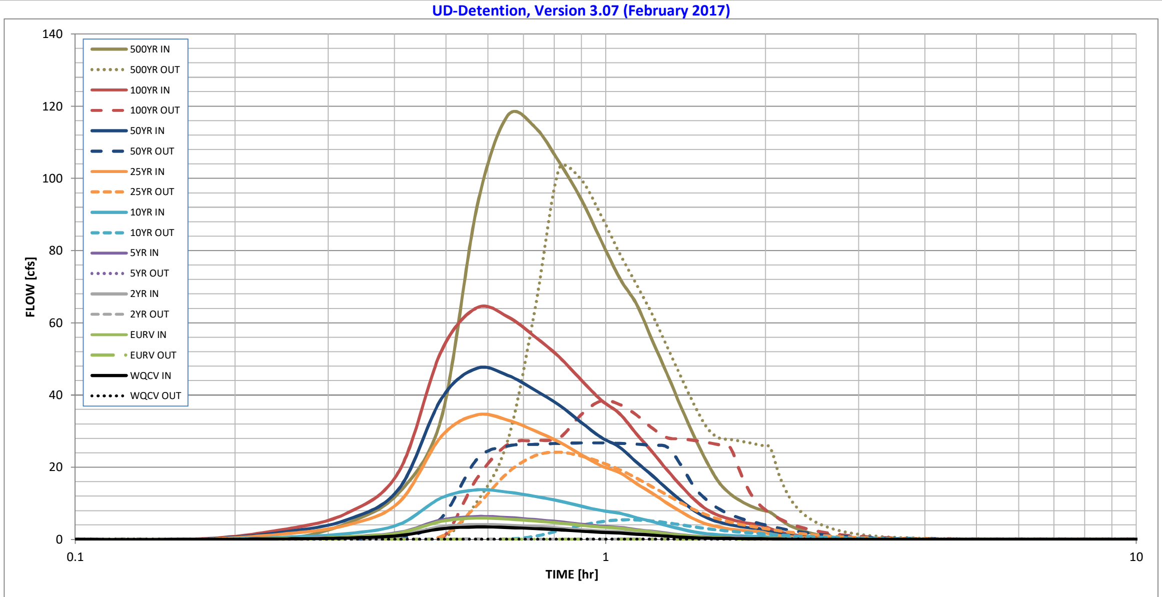
Spillway Design Flow Depth=	0.79	feet
Stage at Top of Freeboard =	8.04	feet
Basin Area at Top of Freeboard =	0.52	acres

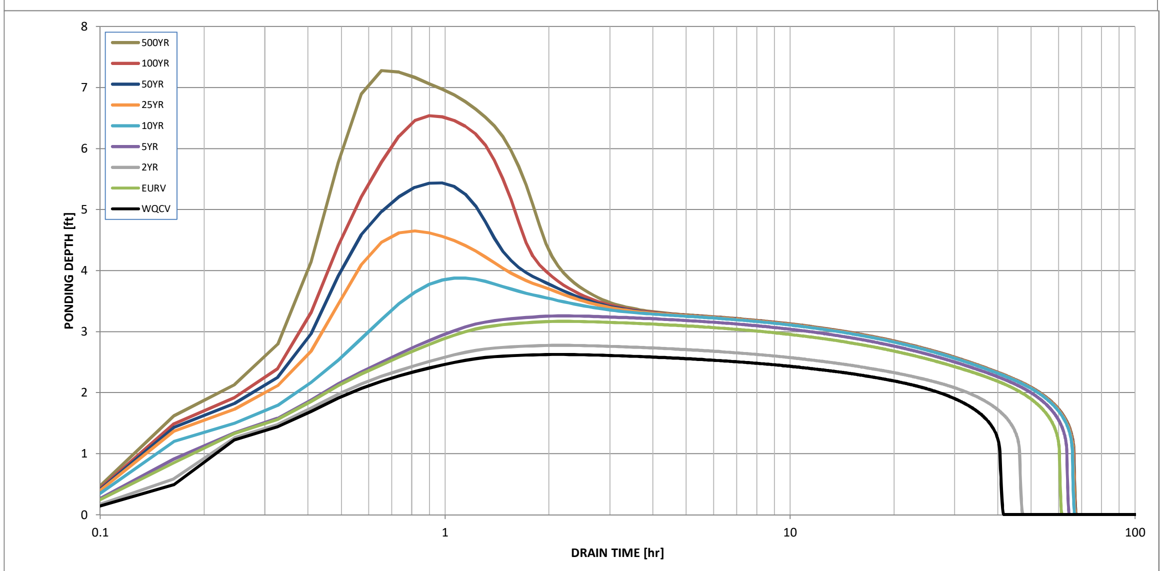
Routed Hydrograph Results

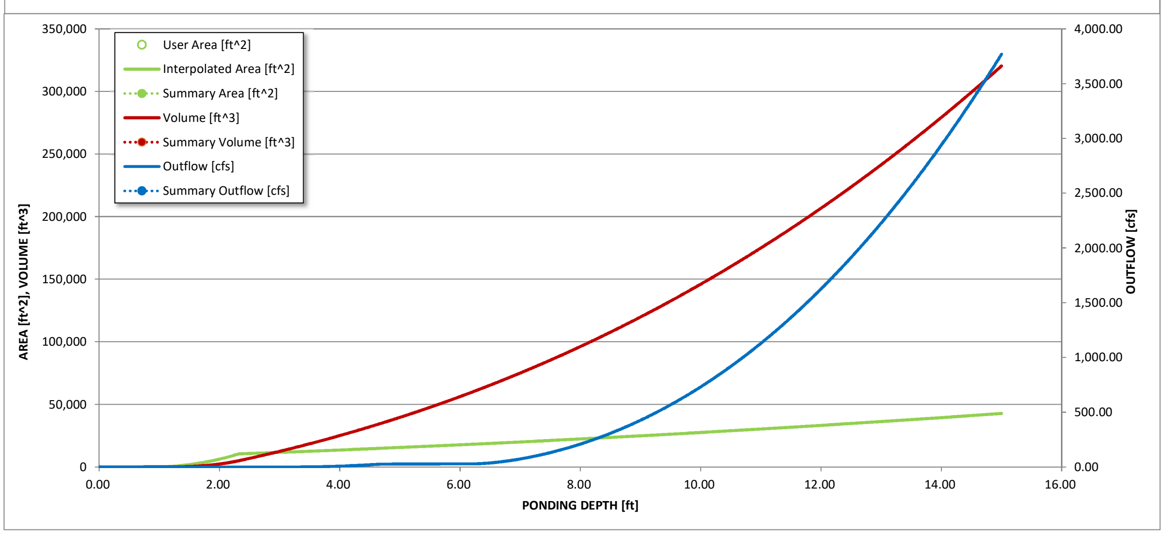
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.85
Calculated Runoff Volume (acre-ft) =	0.202	0.348	0.241	0.373	0.813	2.066	2.851	3.877	7.196
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.201	0.347	0.241	0.372	0.812	2.065	2.850	3.876	7.191
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.21	0.68	0.94	1.27	2.29
Predevelopment Peak Q (cfs) =	0.0	0.0	0.4	0.7	6.9	22.7	31.5	42.3	76.6
Peak Inflow Q (cfs) =	3.5	5.9	4.1	6.4	13.7	34.5	47.4	64.2	117.4
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	5.4	24.2	26.7	38.4	102.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.8	1.1	0.8	0.9	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.4	1.9	2.2	2.3	2.4
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	57	44	60	59	51	46	40	24
Time to Drain 99% of Inflow Volume (hours) =	**40**	60	46	63	64	60	59	56	49
Maximum Ponding Depth (ft) =	2.63	3.17	2.78	3.26	3.88	4.65	5.44	6.54	7.28
Area at Maximum Ponding Depth (acres) =	0.25	0.27	0.26	0.28	0.31	0.34	0.38	0.43	0.47
Maximum Volume Stored (acre-ft) =	0.188	0.330	0.226	0.355	0.535	0.787	1.067	1.513	1.849

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.

Time Interval	4.90 min
Hydrograph Constant	1.020

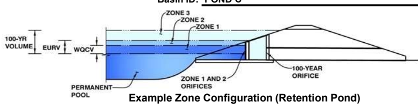
SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:04:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:09:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:14:42	0.16	0.27	0.19	0.28	0.61	1.48	2.01	2.68	4.57
0:19:36	0.42	0.71	0.50	0.76	1.63	4.05	5.53	7.42	13.09
0:24:30	1.08	1.83	1.28	1.96	4.20	10.40	14.21	19.05	33.62
0:29:24	2.96	5.04	3.52	5.39	11.53	28.55	38.98	52.25	92.02
0:34:18	3.46	5.93	4.13	6.35	13.73	34.51	47.42	64.17	117.38
0:39:12	3.29	5.65	3.93	6.05	13.11	33.05	45.47	61.68	114.23
0:44:06	3.00	5.14	3.57	5.51	11.94	30.08	41.38	56.15	104.53
0:49:00	2.66	4.58	3.18	4.90	10.67	27.02	37.22	50.57	94.27
0:53:54	2.28	3.93	2.72	4.22	9.23	23.49	32.46	44.22	82.80
0:58:48	1.99	3.43	2.38	3.68	8.04	20.42	28.28	38.59	72.44
1:03:42	1.80	3.11	2.15	3.33	7.28	18.51	25.58	34.85	65.11
1:08:36	1.47	2.55	1.76	2.74	6.02	15.44	21.38	29.19	54.96
1:13:30	1.19	2.07	1.42	2.22	4.93	12.73	17.67	24.18	45.66
1:18:24	0.89	1.58	1.08	1.70	3.81	9.99	13.93	19.14	36.49
1:23:18	0.65	1.16	0.79	1.25	2.85	7.62	10.69	14.77	28.39
1:28:12	0.48	0.85	0.58	0.91	2.06	5.61	7.92	11.02	21.41
1:33:06	0.38	0.66	0.45	0.71	1.59	4.25	5.98	8.27	15.91
1:38:00	0.31	0.54	0.37	0.59	1.31	3.46	4.84	6.66	12.68
1:42:54	0.26	0.46	0.32	0.50	1.11	2.92	4.08	5.60	10.64
1:47:48	0.23	0.41	0.28	0.44	0.97	2.55	3.56	4.88	9.23
1:52:42	0.21	0.37	0.25	0.39	0.88	2.29	3.18	4.36	8.23
1:57:36	0.20	0.34	0.23	0.37	0.81	2.10	2.92	4.00	7.52
2:02:30	0.14	0.25	0.17	0.27	0.59	1.55	2.16	2.98	5.70
2:07:24	0.10	0.18	0.13	0.20	0.43	1.13	1.57	2.16	4.11
2:12:18	0.08	0.13	0.09	0.14	0.32	0.83	1.16	1.59	3.05
2:17:12	0.06	0.10	0.07	0.11	0.23	0.62	0.86	1.19	2.27
2:22:06	0.04	0.07	0.05	0.07	0.17	0.45	0.63	0.87	1.67
2:27:00	0.03	0.05	0.03	0.05	0.12	0.32	0.45	0.62	1.21
2:31:54	0.02	0.03	0.02	0.04	0.09	0.23	0.33	0.45	0.87
2:36:48	0.01	0.02	0.01	0.02	0.06	0.16	0.23	0.31	0.62
2:41:42	0.01	0.01	0.01	0.01	0.03	0.10	0.14	0.20	0.41
2:46:36	0.00	0.01	0.00	0.01	0.02	0.05	0.08	0.12	0.24
2:51:30	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.05	0.11
2:56:24	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04
3:01:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:06:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:11:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:16:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:20:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:25:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:30:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:35:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:40:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:45:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:50:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:55:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:00:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:09:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:14:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:19:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:24:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:29:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:34:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:39:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:44:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:49:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:54:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:58:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:03:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:08:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:13:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:18:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:23:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:28:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:33:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:38:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:43:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:47:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:52:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: RETREAT AT TIMBER RIDGE - PRELIMINARY DRAINAGE REPORT

Basin ID: POND C



Example Zone Configuration (Retention Pond)

Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	EDB			
Watershed Area =	32.50	acres		
Watershed Length =	2,250	ft		
Watershed Slope =	0.018	ft/ft		
Watershed Imperviousness =	11.00%	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 =	User Input			
Water Quality Capture Volume (WQCV) =	0.197	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.339	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.235	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.363	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.791	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.010	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.774	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.772	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.85 in.) =	7.002	acre-feet	3.85	inches
Approximate 2-yr Detention Volume =	0.218	acre-feet		
Approximate 5-yr Detention Volume =	0.340	acre-feet		
Approximate 10-yr Detention Volume =	0.677	acre-feet		
Approximate 25-yr Detention Volume =	0.931	acre-feet		
Approximate 50-yr Detention Volume =	0.976	acre-feet		
Approximate 100-yr Detention Volume =	1.254	acre-feet		

Stage-Storage Calculation

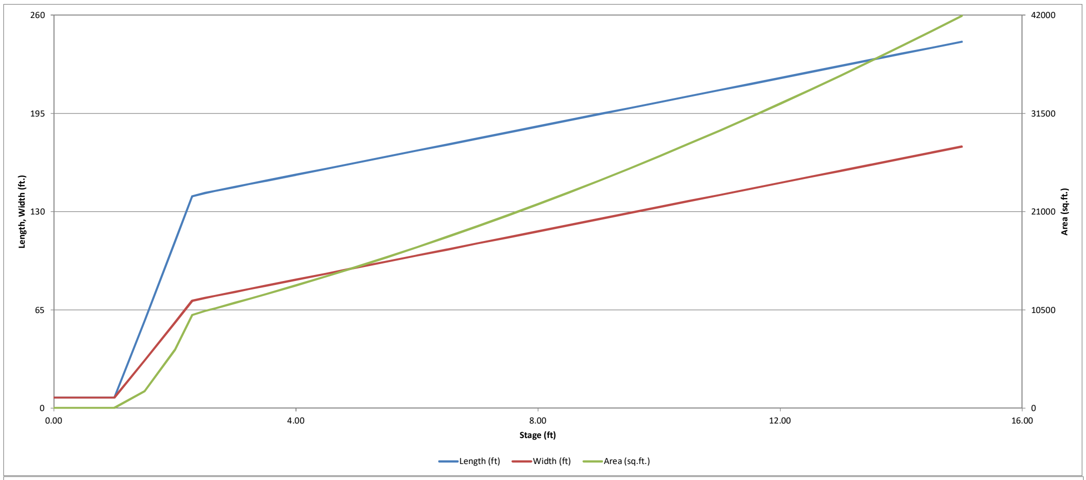
Zone 1 Volume (WQCV) =	0.197	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.142	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.916	acre-feet
Total Detention Basin Volume =	1.254	acre-feet
Initial Surcharge Volume (ISV) =	25	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	6.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.010	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	50	ft^2
Surcharge Volume Length (L_{ISV}) =	7.0	ft
Surcharge Volume Width (W_{ISV}) =	7.0	ft
Depth of Basin Floor (H_{FLOOR}) =	1.28	ft
Length of Basin Floor (L_{FLOOR}) =	140.6	ft
Width of Basin Floor (W_{FLOOR}) =	71.3	ft
Area of Basin Floor (A_{FLOOR}) =	10,022	ft^2
Volume of Basin Floor (V_{FLOOR}) =	4,614	ft^3
Depth of Main Basin (H_{MAIN}) =	3.72	ft
Length of Main Basin (L_{MAIN}) =	170.4	ft
Width of Main Basin (W_{MAIN}) =	101.0	ft
Area of Main Basin (A_{MAIN}) =	17,204	ft^2
Volume of Main Basin (V_{MAIN}) =	49,984	ft^3
Calculated Total Basin Volume (V_{total}) =	**1.255**	acre-feet

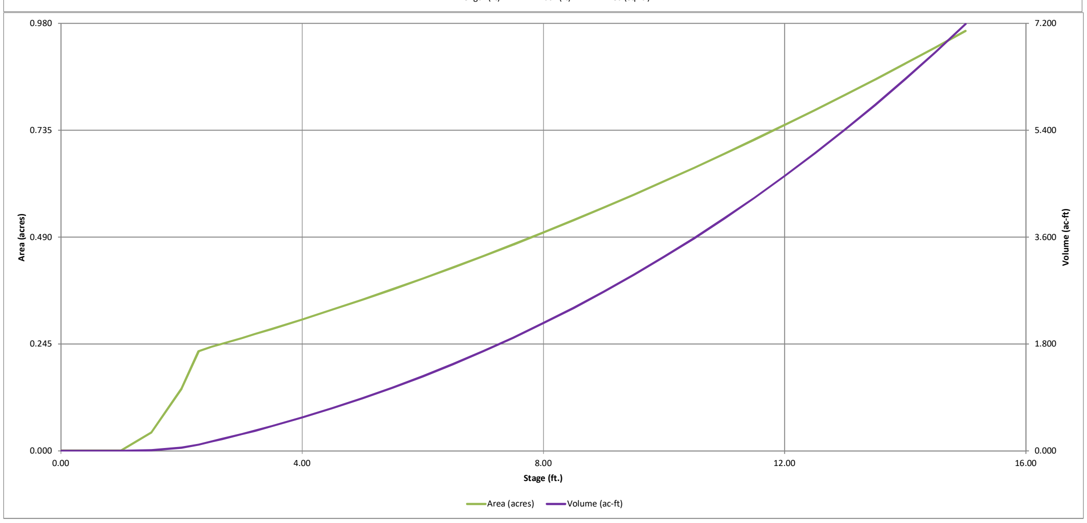
Depth Increment = 0.5 ft

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		7.0	7.0	50		0.001		
ISV	0.50		7.0	7.0	50		0.001	24	0.001
	1.00		7.0	7.0	50		0.001	49	0.001
	1.50		58.0	31.5	1,830		0.042	408	0.009
	2.00		110.0	56.5	6,220		0.143	2,312	0.053
Floor	2.28		140.2	71.0	9,958		0.229	4,637	0.106
	2.50		142.4	73.0	10,391		0.239	6,881	0.158
Zone 1 (WQCV)	2.67		143.7	74.4	10,685		0.245	8,672	0.199
	3.00		146.4	77.0	11,268		0.259	12,294	0.282
Zone 2 (EURV)	3.22		148.1	78.8	11,664		0.268	14,817	0.340
	3.50		150.4	81.0	12,177		0.280	18,154	0.417
	4.00		154.4	85.0	13,119		0.301	24,477	0.562
	4.50		158.4	89.0	14,092		0.324	31,278	0.718
	5.00		162.4	93.0	15,098		0.347	38,575	0.886
	5.50		166.4	97.0	16,135		0.370	46,381	1.065
Zone 3 (100-year)	6.00		170.4	101.0	17,204		0.395	54,715	1.256
	6.50		174.4	105.0	18,306		0.420	63,591	1.460
	7.00		178.4	109.0	19,439		0.446	73,026	1.676
	7.50		182.4	113.0	20,605		0.473	83,036	1.906
	8.00		186.4	117.0	21,802		0.501	93,636	2.150
	8.50		190.4	121.0	23,031		0.529	104,843	2.407
	9.00		194.4	125.0	24,293		0.558	116,673	2.678
	9.50		198.4	129.0	25,586		0.587	129,141	2.965
	10.00		202.4	133.0	26,912		0.618	142,264	3.266
	10.50		206.4	137.0	28,269		0.649	156,058	3.583
	11.00		210.4	141.0	29,658		0.681	170,538	3.915
	11.50		214.4	145.0	31,080		0.713	185,722	4.264
	12.00		218.4	149.0	32,533		0.747	201,623	4.629
	12.50		222.4	153.0	34,018		0.781	218,260	5.011
	13.00		226.4	157.0	35,536		0.816	235,647	5.410
	13.50		230.4	161.0	37,085		0.851	253,801	5.826
	14.00		234.4	165.0	38,667		0.888	272,738	6.261
	14.50		238.4	169.0	40,280		0.925	292,473	6.714
	15.00		242.4	173.0	41,925		0.962	313,023	7.186

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



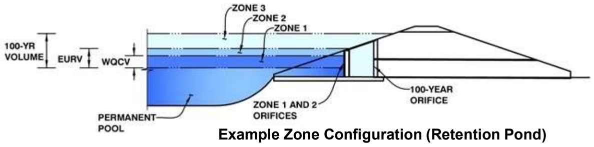


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: RETREAT AT TIMBER RIDGE - PRELIMINARY DRAINAGE REPORT

Basin ID: POND C



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.67	0.197	Orifice Plate
Zone 2 (EURV)	3.22	0.142	Orifice Plate
Zone 3 (100-year)	6.00	0.916	Weir&Pipe (Restrict)
		1.254	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 =	3.25	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.00	inches
Orifice Plate: Orifice Area per Row =	0.67	sq. inches (diameter = 15/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	4.653E-03	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	1.10	2.20					
Orifice Area (sq. inches)	0.67	0.67	0.67					

	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 =	3.25	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	75%	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 =	4.25	N/A	feet
Over Flow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.99	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	12.37	N/A	ft^2
Overflow Grate Open Area w/ Debris =	6.18	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 =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	15.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.07	N/A	ft^2
Outlet Orifice Centroid =	0.71	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.82	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.25	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

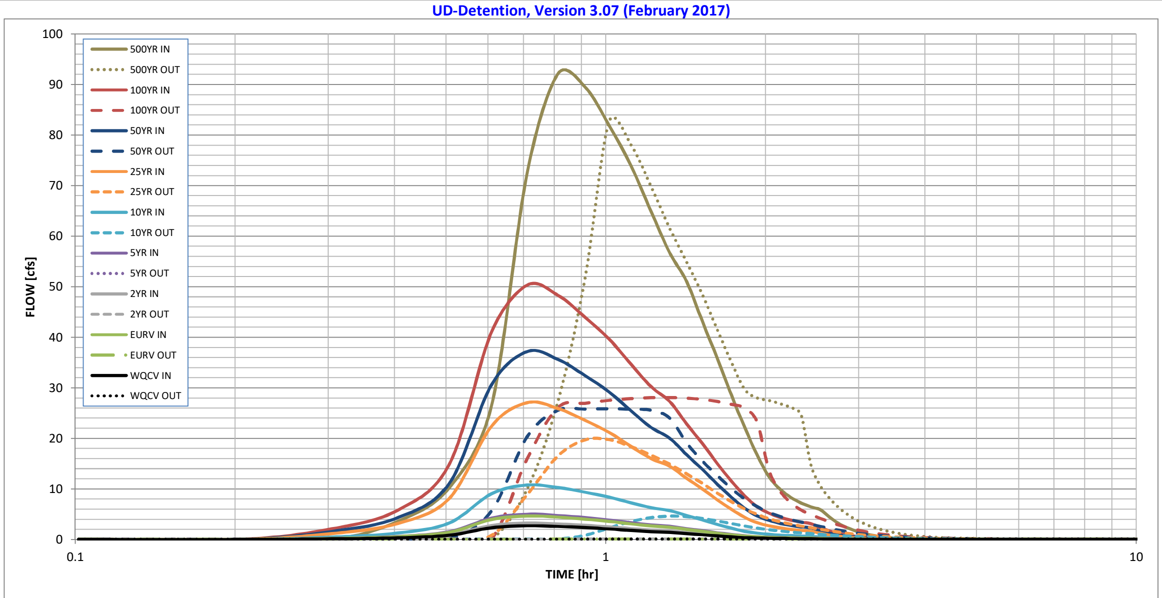
Spillway Design Flow Depth=	0.79	feet
Stage at Top of Freeboard =	8.04	feet
Basin Area at Top of Freeboard =	0.50	acres

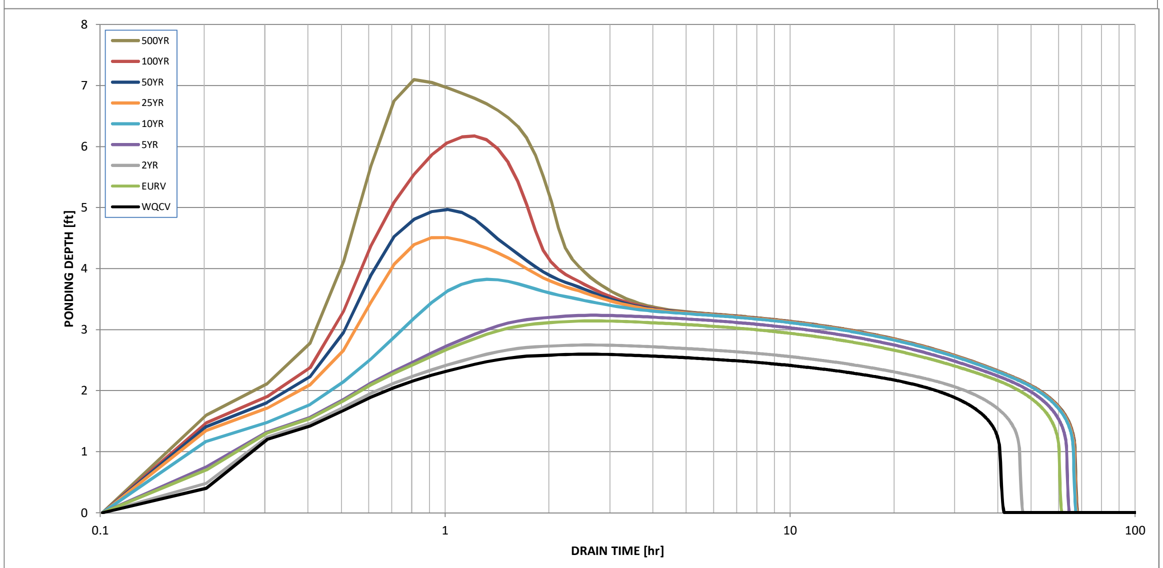
Routed Hydrograph Results

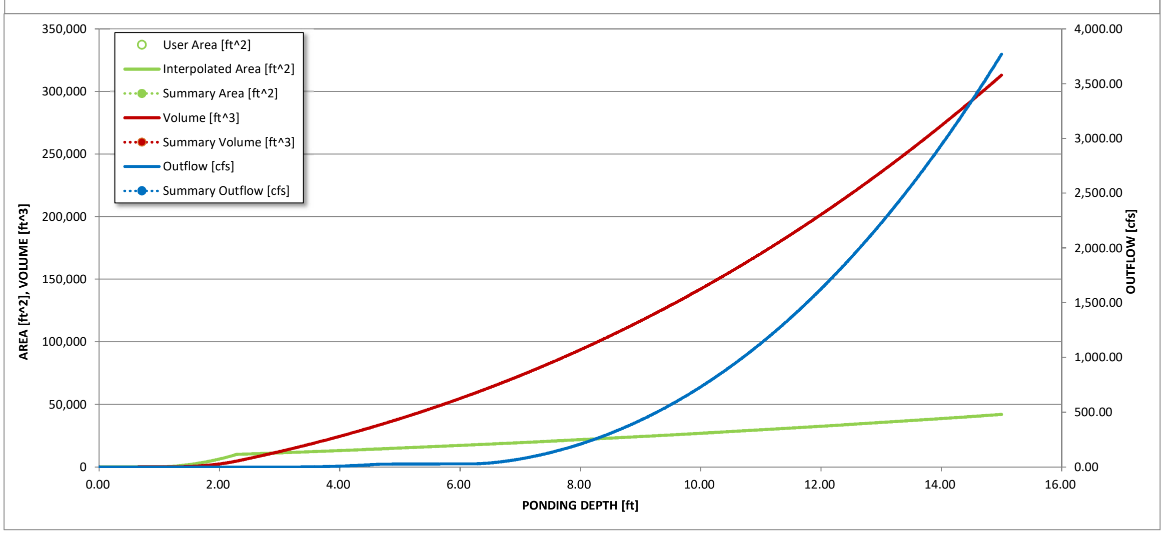
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.85
Calculated Runoff Volume (acre-ft) =	0.197	0.339	0.235	0.363	0.791	2.010	2.774	3.772	7.002
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.196	0.338	0.234	0.363	0.791	2.011	2.775	3.774	7.005
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.15	0.53	0.73	0.99	1.80
Predevelopment Peak Q (cfs) =	0.0	0.0	0.3	0.5	4.9	17.1	23.7	32.1	58.5
Peak Inflow Q (cfs) =	2.7	4.6	3.2	5.0	10.8	27.1	37.2	50.3	92.1
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	4.6	19.7	25.9	28.1	82.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.9	1.2	1.1	0.9	1.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.4	1.6	2.1	2.3	2.4
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	57	44	60	60	51	46	41	25
Time to Drain 99% of Inflow Volume (hours) =	40	59	46	62	64	61	59	57	50
Maximum Ponding Depth (ft) =	2.60	3.14	2.75	3.23	3.82	4.51	4.97	6.17	7.10
Area at Maximum Ponding Depth (acres) =	0.24	0.26	0.25	0.27	0.29	0.32	0.34	0.40	0.45
Maximum Volume Stored (acre-ft) =	0.180	0.319	0.216	0.343	0.508	0.718	0.872	1.324	1.717

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.

Time Interval: 6.09 min

Hydrograph Constant: 0.821

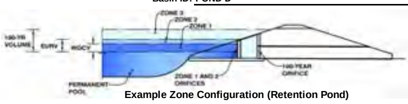
SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:06:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:12:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:18:16	0.12	0.21	0.15	0.22	0.47	1.16	1.58	2.10	3.60
0:24:22	0.33	0.56	0.39	0.60	1.28	3.18	4.34	5.82	10.29
0:30:27	0.84	1.43	1.00	1.54	3.29	8.16	11.14	14.95	26.42
0:36:32	2.32	3.94	2.76	4.23	9.04	22.39	30.57	41.00	72.33
0:42:38	2.71	4.64	3.23	4.98	10.76	27.05	37.16	50.30	92.06
0:48:43	2.58	4.42	3.08	4.75	10.28	25.91	35.63	48.33	89.53
0:54:49	2.34	4.02	2.80	4.32	9.36	23.58	32.43	43.99	81.91
1:00:54	2.08	3.58	2.49	3.85	8.37	21.17	29.16	39.62	73.86
1:06:59	1.78	3.08	2.13	3.31	7.23	18.41	25.43	34.64	64.86
1:13:05	1.56	2.69	1.86	2.89	6.30	16.00	22.15	30.22	56.74
1:19:10	1.41	2.43	1.68	2.61	5.71	14.50	20.04	27.30	51.01
1:25:16	1.15	1.99	1.38	2.14	4.72	12.09	16.74	22.86	43.04
1:31:21	0.93	1.62	1.11	1.74	3.86	9.97	13.84	18.93	35.76
1:37:26	0.70	1.23	0.84	1.33	2.98	7.82	10.90	14.98	28.56
1:43:32	0.51	0.91	0.62	0.98	2.23	5.96	8.36	11.55	22.22
1:49:37	0.37	0.66	0.45	0.71	1.61	4.39	6.20	8.61	16.74
1:55:43	0.29	0.52	0.35	0.56	1.25	3.33	4.68	6.47	12.45
2:01:48	0.24	0.43	0.29	0.46	1.02	2.71	3.78	5.21	9.93
2:07:53	0.21	0.36	0.25	0.39	0.87	2.29	3.19	4.39	8.33
2:13:59	0.18	0.32	0.22	0.34	0.76	2.00	2.78	3.82	7.22
2:20:04	0.16	0.29	0.20	0.31	0.69	1.79	2.49	3.42	6.44
2:26:10	0.15	0.27	0.18	0.29	0.63	1.64	2.29	3.13	5.89
2:32:15	0.11	0.20	0.13	0.21	0.46	1.21	1.69	2.33	4.46
2:38:20	0.08	0.14	0.10	0.15	0.34	0.88	1.23	1.69	3.22
2:44:26	0.06	0.10	0.07	0.11	0.25	0.65	0.91	1.25	2.39
2:50:31	0.04	0.08	0.05	0.08	0.18	0.48	0.67	0.93	1.77
2:56:37	0.03	0.05	0.04	0.06	0.13	0.35	0.49	0.68	1.31
3:02:42	0.02	0.04	0.03	0.04	0.09	0.25	0.35	0.49	0.94
3:08:47	0.01	0.03	0.02	0.03	0.07	0.18	0.25	0.35	0.68
3:14:53	0.01	0.02	0.01	0.02	0.04	0.12	0.18	0.25	0.48
3:20:58	0.01	0.01	0.01	0.01	0.03	0.08	0.11	0.16	0.32
3:27:04	0.00	0.00	0.00	0.01	0.01	0.04	0.06	0.09	0.19
3:33:09	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.04	0.09
3:39:14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03
3:45:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:51:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:57:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:03:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:09:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:15:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:21:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:27:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:34:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:40:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:46:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:52:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:58:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:04:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:16:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:22:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:28:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:34:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:41:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:47:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:53:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:59:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:05:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:11:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:17:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:23:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:29:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:35:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:41:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:48:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:54:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:00:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:06:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:12:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:18:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: RETREAT AT TIMBER RIDGE - PRELIMINARY DRAINAGE REPORT

Basin ID: POND D



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**	
Watershed Area =	129.25	acres
Watershed Length =	4,200	ft
Watershed Slope =	0.025	ft/ft
Watershed Imperviousness =	23.00%	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 = User Input		

			Optional User Override 1-hr Precipitation	
Water Quality Capture Volume (WQCV) =	1.374	acre-feet		
Excess Urban Runoff Volume (EURV) =	2.987	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	2.230	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	3.243	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	5.345	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	9.950	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	12.918	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	16.800	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.85 in.) =	29.996	acre-feet	3.85	inches
Approximate 2-yr Detention Volume =	2.079	acre-feet		
Approximate 5-yr Detention Volume =	3.041	acre-feet		
Approximate 10-yr Detention Volume =	4.731	acre-feet		
Approximate 25-yr Detention Volume =	5.719	acre-feet		
Approximate 50-yr Detention Volume =	6.039	acre-feet		
Approximate 100-yr Detention Volume =	7.330	acre-feet		

Stage-Storage Calculation

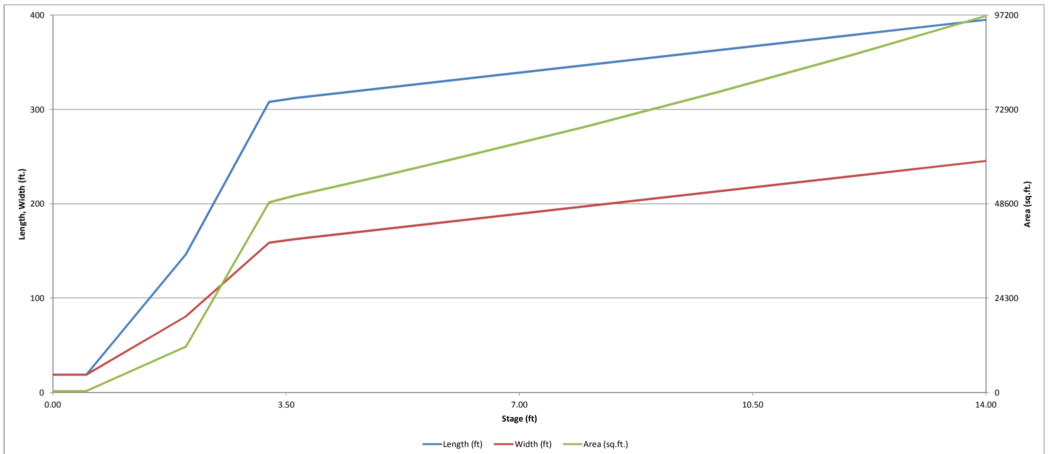
Zone 1 Volume (WQCV) =	1.374	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.613	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	4.343	acre-feet
Total Detention Basin Volume =	7.330	acre-feet
Initial Surcharge Volume (ISV) =	180	ft^3
Initial Surcharge Depth (ISD) =	0.50	ft
Total Available Detention Depth (H_{total}) =	8.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.008	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	
Initial Surcharge Area (A_{ISV}) =	359	ft^2
Surcharge Volume Length (L_{ISV}) =	19.0	ft
Surcharge Volume Width (W_{ISV}) =	19.0	ft
Depth of Basin Floor (H_{FLOOR}) =	2.25	ft
Length of Basin Floor (L_{FLOOR}) =	309.0	ft
Width of Basin Floor (W_{FLOOR}) =	159.5	ft
Area of Basin Floor (A_{FLOOR}) =	49,266	ft^2
Volume of Basin Floor (V_{FLOOR}) =	40,340	ft^3
Depth of Main Basin (H_{MAIN}) =	4.75	ft
Length of Main Basin (L_{MAIN}) =	347.0	ft
Width of Main Basin (W_{MAIN}) =	197.5	ft
Area of Main Basin (A_{MAIN}) =	68,518	ft^2
Volume of Main Basin (V_{MAIN}) =	278,595	ft^3
Calculated Total Basin Volume (V_{total}) =	**7.330**	acre-feet

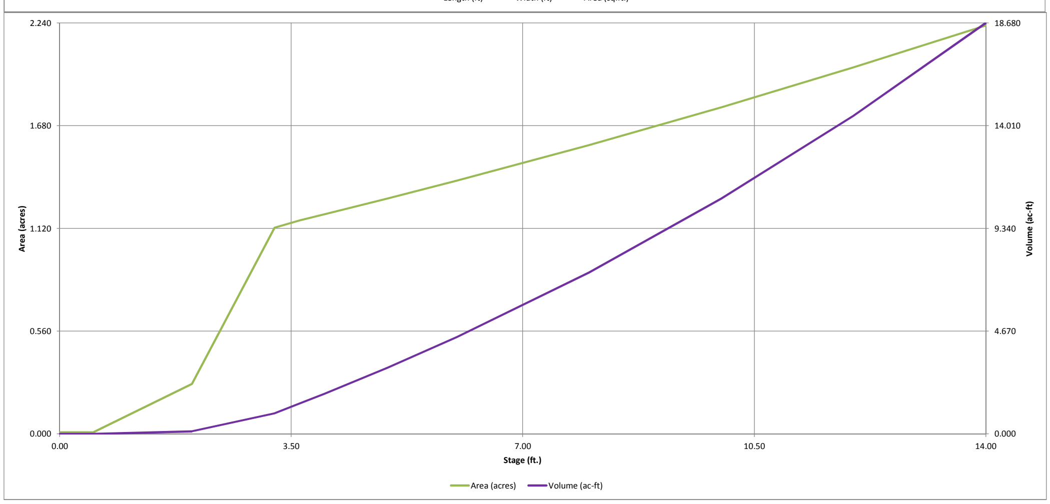
Depth Increment = 2 ft

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		19.0	19.0	359		0.008		
ISV	0.50		19.0	19.0	359		0.008	176	0.004
	2.00		146.7	80.8	11,854		0.272	5,101	0.117
Floor	3.25		307.9	159.0	48,943		1.124	40,475	0.929
Zone 1 (WQCV)	3.63		312.0	162.5	50,706		1.164	59,962	1.377
	4.00		315.0	165.5	52,120		1.197	78,984	1.813
Zone 2 (EURV)	4.95		322.6	173.1	55,829		1.282	130,251	2.990
	6.00		331.0	181.5	60,063		1.379	191,082	4.387
Zone 3 (100-year)	8.00		347.0	197.5	68,518		1.573	319,577	7.336
	10.00		363.0	213.5	77,485		1.779	465,495	10.686
	12.00		379.0	229.5	86,964		1.996	629,860	14.460
	14.00		395.0	245.5	96,956		2.226	813,694	18.680

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



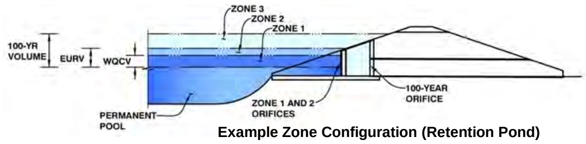


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: RETREAT AT TIMBER RIDGE - PRELIMINARY DRAINAGE REPORT

Basin ID: POND D



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.63	1.374	Orifice Plate
Zone 2 (EURV)	4.95	1.613	Orifice Plate
Zone 3 (100-year)	8.00	4.343	Weir&Pipe (Restrict)
		7.330	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 =	5.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	20.00	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.70	3.40					
Orifice Area (sq. inches)	4.20	4.20	5.50					

	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 =	5.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	10.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	75%	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 =	6.00	N/A	feet
Over Flow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	3.21	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	30.92	N/A	ft^2
Overflow Grate Open Area w/ Debris =	15.46	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 =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	42.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	42.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	9.62	N/A	ft^2
Outlet Orifice Centroid =	1.75	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	8.25	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	80.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

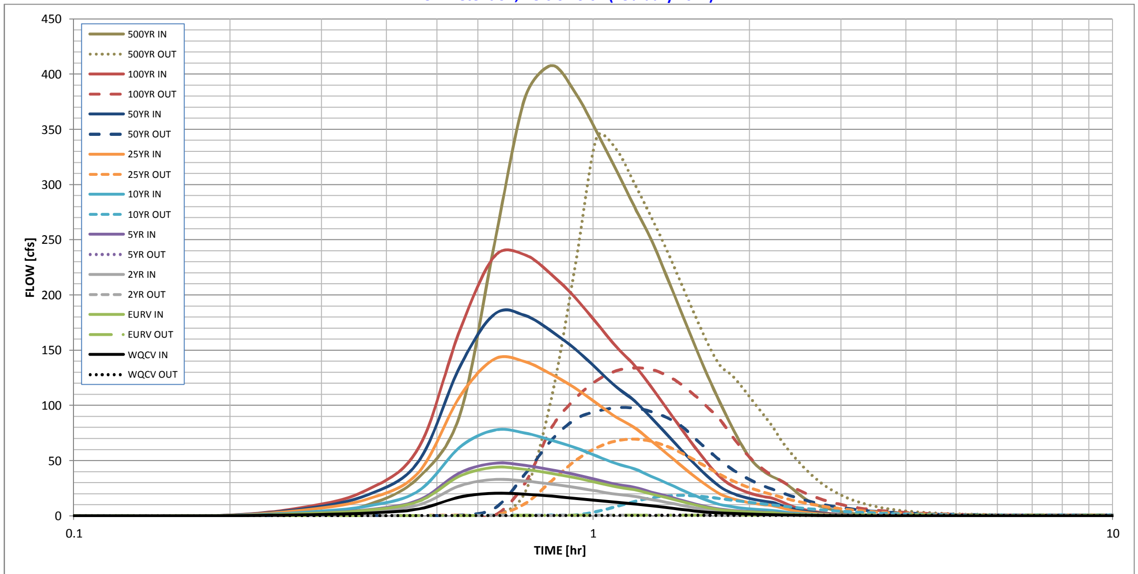
Spillway Design Flow Depth=	0.96	feet
Stage at Top of Freeboard =	10.21	feet
Basin Area at Top of Freeboard =	1.80	acres

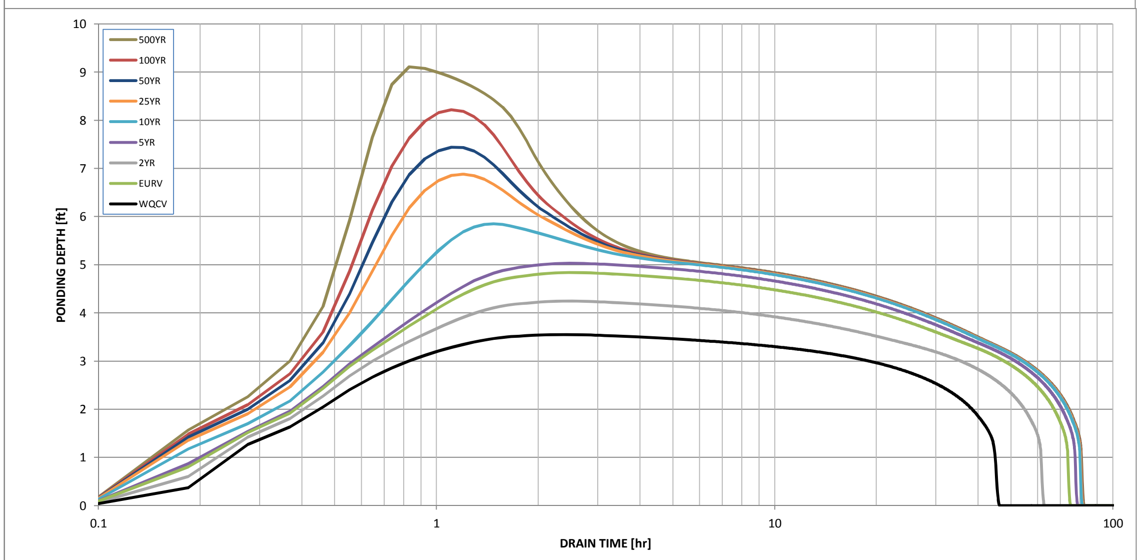
Routed Hydrograph Results

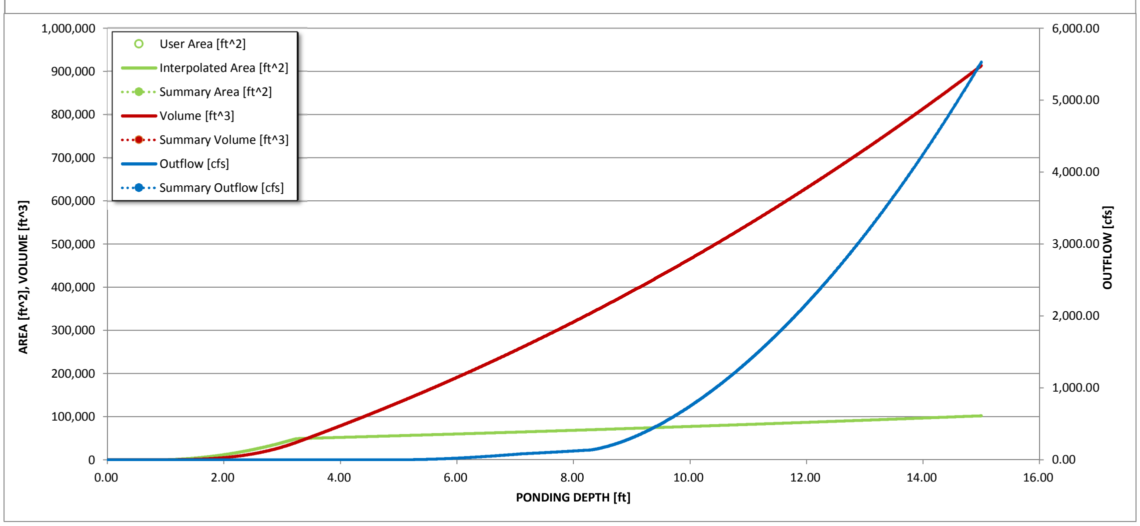
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.85
Calculated Runoff Volume (acre-ft) =	1.374	2.987	2.230	3.243	5.345	9.950	12.918	16.800	29.996
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	1.372	2.983	2.227	3.239	5.336	9.931	12.898	16.783	29.961
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.17	0.58	0.81	1.09	1.99
Predevelopment Peak Q (cfs) =	0.0	0.0	1.4	2.3	22.3	75.5	104.6	141.5	257.1
Peak Inflow Q (cfs) =	20.4	43.9	32.9	47.6	77.6	142.0	182.8	236.3	407.7
Peak Outflow Q (cfs) =	0.5	0.8	0.7	0.9	18.6	69.6	97.9	134.0	343.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.8	0.9	0.9	0.9	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.0	0.6	2.2	3.1	4.3	4.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	43	69	57	72	72	67	64	60	49
Time to Drain 99% of Inflow Volume (hours) =	**45**	72	60	76	77	75	74	72	67
Maximum Ponding Depth (ft) =	3.55	4.84	4.25	5.03	5.85	6.88	7.44	8.21	9.11
Area at Maximum Ponding Depth (acres) =	1.16	1.27	1.22	1.29	1.36	1.46	1.52	1.59	1.68
Maximum Volume Stored (acre-ft) =	1.272	2.837	2.103	3.093	4.181	5.622	6.456	7.669	9.128

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.

Time Interval	5.54 min
Hydrograph Constant	0.902

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
0:05:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:11:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:16:37	0.89	1.86	1.41	2.01	3.14	5.22	6.36	7.66	10.15
0:22:10	2.41	5.11	3.85	5.53	8.84	15.39	19.26	23.99	34.79
0:27:42	6.18	13.13	9.90	14.21	22.69	39.54	49.51	61.76	91.45
0:33:14	16.98	36.02	27.16	38.98	62.16	108.06	135.11	168.22	247.48
0:38:47	20.38	43.87	32.88	47.57	77.62	142.03	182.79	235.24	378.23
0:44:19	19.50	42.08	31.50	45.65	75.01	139.60	181.45	236.30	407.74
0:49:52	17.75	38.29	28.67	41.55	68.45	128.20	167.19	218.59	383.24
0:55:24	15.91	34.45	25.76	37.39	61.69	115.69	150.96	197.46	347.62
1:00:56	13.80	30.06	22.41	32.65	54.06	101.87	133.20	174.60	313.19
1:06:29	12.00	26.19	19.49	28.46	47.25	89.21	116.72	153.06	280.00
1:12:01	10.88	23.69	17.66	25.73	42.57	79.93	104.29	136.36	250.38
1:17:34	9.04	19.80	14.74	21.52	35.78	67.84	88.94	116.88	216.90
1:23:06	7.43	16.37	12.16	17.81	29.69	56.44	74.07	97.46	184.57
1:28:38	5.79	12.91	9.55	14.06	23.62	45.34	59.75	78.96	154.22
1:34:11	4.38	9.92	7.30	10.81	18.31	35.40	46.79	62.01	126.65
1:39:43	3.20	7.36	5.38	8.04	13.73	26.82	35.59	47.42	102.65
1:45:16	2.44	5.55	4.08	6.05	10.26	19.82	26.27	35.16	81.28
1:50:48	2.00	4.49	3.31	4.89	8.22	15.72	20.72	27.51	62.71
1:56:20	1.69	3.78	2.79	4.12	6.91	13.17	17.31	22.88	48.90
2:01:53	1.48	3.30	2.44	3.59	6.00	11.39	14.93	19.68	40.66
2:07:25	1.33	2.95	2.19	3.21	5.36	10.14	13.28	17.46	35.25
2:12:58	1.22	2.71	2.01	2.94	4.90	9.25	12.10	15.88	31.44
2:18:30	0.90	2.01	1.48	2.18	3.68	7.11	9.41	12.53	25.75
2:24:02	0.66	1.46	1.08	1.58	2.66	5.12	6.78	9.04	19.21
2:29:35	0.48	1.07	0.79	1.17	1.97	3.80	5.03	6.69	13.96
2:35:07	0.36	0.80	0.59	0.87	1.46	2.82	3.73	4.96	10.33
2:40:40	0.26	0.58	0.43	0.63	1.08	2.09	2.77	3.68	7.84
2:46:12	0.18	0.42	0.31	0.45	0.77	1.51	2.00	2.67	5.87
2:51:44	0.13	0.30	0.22	0.33	0.56	1.09	1.45	1.93	4.37
2:57:17	0.09	0.21	0.15	0.23	0.39	0.78	1.04	1.39	3.26
3:02:49	0.06	0.13	0.10	0.15	0.26	0.52	0.69	0.94	2.41
3:08:22	0.03	0.07	0.05	0.08	0.15	0.31	0.42	0.58	1.68
3:13:54	0.01	0.03	0.02	0.04	0.07	0.15	0.21	0.30	1.09
3:19:26	0.00	0.01	0.00	0.01	0.02	0.05	0.07	0.11	0.62
3:24:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.29
3:30:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
3:36:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:41:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:47:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:52:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:58:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:03:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:09:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:14:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:20:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:25:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:31:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:37:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:42:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:48:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:53:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:59:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:04:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:15:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:21:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:26:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:32:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:37:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:43:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:49:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:54:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:00:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:05:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:11:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:16:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:22:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:27:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:33:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:38:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DRAINAGE MAPS

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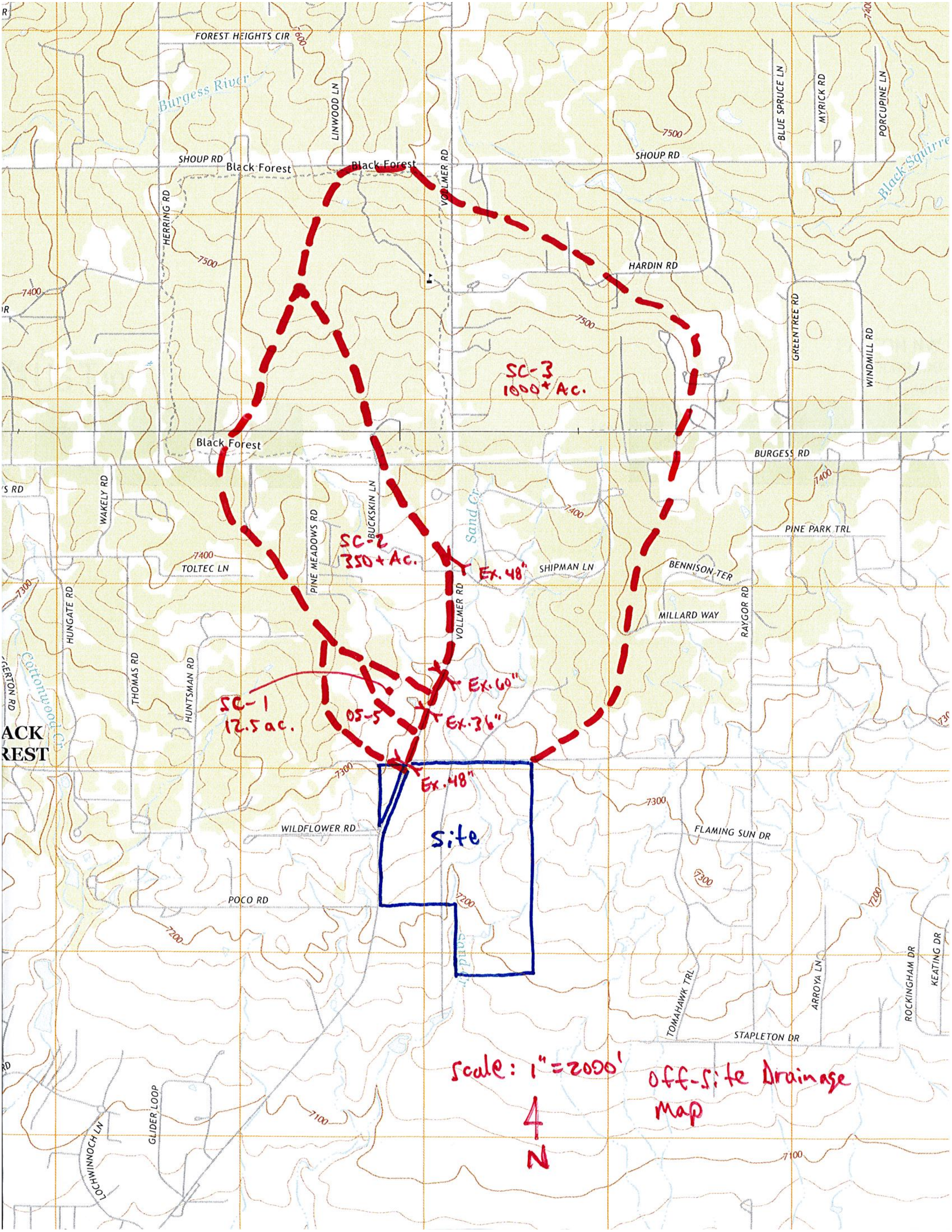

FOREST HEIGHTS CIR
Burgess River
LINWOOD LN
SHOUP RD
Black Forest
Black Forest
VOLLMER RD
HERRING RD
HARDIN RD
BLUE SPRUCE LN
MYRICK RD
PORCUPINE LN
Black Squirrel
GREENTREE RD
WINDMILL RD
SC-3
1000+ Ac.
Black Forest
BURGESS RD
WAKELY RD
BUCKSKIN LN
PINE MEADOWS RD
Sand Cr.
PINE PARK TRL
SC-2
350+ Ac.
Ex. 48"
SHIPMAN LN
BENNISON TER
TOLTEC LN
HUNGATE RD
MILLARD WAY
RAYGOR RD
THOMAS RD
HUNTSMAN RD
Cottonwood Cr.
Ex. 60"
SC-1
12.5 ac.
OS-5
Ex. 36"
Ex. 48"
Site
WILDFLOWER RD
FLAMING SUN DR
POCO RD
TOMAHAWK TRL
ARROYA LN
ROCKINGHAM DR
KEATING DR
STAPLETON DR
GLIDER LOOP
LOCHWINNOCH LN
Scale: 1" = 2000'
Off-Site Drainage Map
N

CN VALUES - EXISTING CONDITIONS

BASIN (label)	BASIN AREA (Ac)	SOIL TYPE B CN	SOIL TYPE B AREA (Ac.)	WEIGHTED CN
EX-1	156.9	61	156.9	61
EX-2	9.2	61	9.2	61
EX-3	24.9	61	24.9	61
EX-4	35.2	63	35.2	63
EX-6	6.7	61	6.7	61
SC-1	12.5	63	12.5	63
SC-2	350.0	63	350.0	63
OS-1	49.1	61	49.1	61
OS-2	2.1	61	2.1	61
OS-3	5.7	65	5.7	65
OS-4	16.1	63	16.1	63
OS-5	27.6	63	27.6	63

TIME OF CONCENTRATION - EXISTING CONDITIONS

BASIN	Cn	C(5)	OVERLAND Length (ft)	OVERLAND Height (ft)	OVERLAND Tc (min)	STREET / CHANNEL FLOW Length (ft)	STREET / CHANNEL FLOW Slope (%)	STREET / CHANNEL FLOW Velocity (fps)	STREET / CHANNEL FLOW Tc (min)	Tc TOTAL (min)	Tc LAG (min)	Tc LAG (hr)
EX-1	61.0	0.08	300	8	23.1	1600	1.8%	1.3	20.5	43.6	26.2	0.44
EX-2	61.0	0.08	300	10	21.4					21.4	12.9	0.21
EX-3	61.0	0.08	300	8	23.1	1500	4.0%	1.5	16.7	39.7	23.8	0.40
EX-4	63.0	0.08	300	24	16.1	1900	6.0%	1.8	17.6	33.7	20.2	0.34
EX-6	61.0	0.08	300	14	19.2	800	1.0%	1.0	13.3	32.5	19.5	0.33
SC-1	63.0	0.08	200	6	18.1	500	2.0%	1.2	6.9	25.1	15.0	0.25
SC-2	63.0	0.08	300	12	20.2	3500	1.8%	1.3	44.9	65.1	39.0	0.65
OS-1	61.0	0.08	300	22	16.5	1300	4.0%	1.5	14.4	31.0	18.6	0.31
OS-2	61.0	0.08	300	12	20.2	550	5.0%	1.7	5.4	25.6	15.3	0.26
OS-3	65.0	0.08	300	10	21.4	250	3.0%	3.5	1.2	22.6	13.6	0.23
OS-4	63.0	0.08	300	22	16.5	1100	4.0%	1.4	13.1	29.6	17.8	0.30
OS-5	63.0	0.08	300	10	21.4	1300	3.0%	1.2	18.1	39.5	23.7	0.39

BASIN SUMMARY - EXISTING CONDITIONS

BASIN (label)	TOTAL BASIN AREA (acres)	WEIGHTED CN	TOTAL LAG TIME (hours)	Q 2 Yr. (cfs)	Q 5 Yr. (cfs)	Q 100 Yr. (cfs)
EX-1	156.9	61	0.44	2.6	17.7	140.3
EX-2	9.2	61	0.21	0.2	1.7	12.2
EX-3	24.9	61	0.40	0.4	3.0	23.7
EX-4	35.2	63	0.34	1.3	6.9	41.8
EX-6	6.7	61	0.33	0.1	0.9	7.1
SC-1	12.5	63	0.25	0.5	3.0	17.3
SC-2	350.0	63	0.65	9.9	44.2	275.3
OS-1	49.1	61	0.31	0.9	7.0	53.9
OS-2	2.1	61	0.26	0.04	0.3	2.5
OS-3	5.7	65	0.23	0.6	2.1	9.9
OS-4	16.1	63	0.30	0.6	3.4	20.7
OS-5	27.6	63	0.39	1.0	5.2	32.1

DESIGN POINTS SURFACE ROUTING SUMMARY - EXISTING CONDITIONS

Design Point (label)	Contributing Basins	Q 2 Yr. Q (cfs)	Q 5 Yr. Q (cfs)	Q 100 Yr. Q (cfs)
EX DP-1	BASINS OS-1, OS-3, OS-4, OS-5, EX-1, EX-4, EX-5, EX-6	5.6	36.0	281.7
EX DP-2	BASINS OS-2, EX-2	0.2	2.0	14.7
EX DP-3	BASIN EX-3	0.4	3.0	23.7
EX-DP-4	BASIN EX-6	0.1	1.0	7.1
Ex. 36" CMP at Vollmer	SC-1	0.5	3.0	17.3
Ex. 60" CMP at Vollmer	SC-2	9.88	44.2	275.3

Delete?

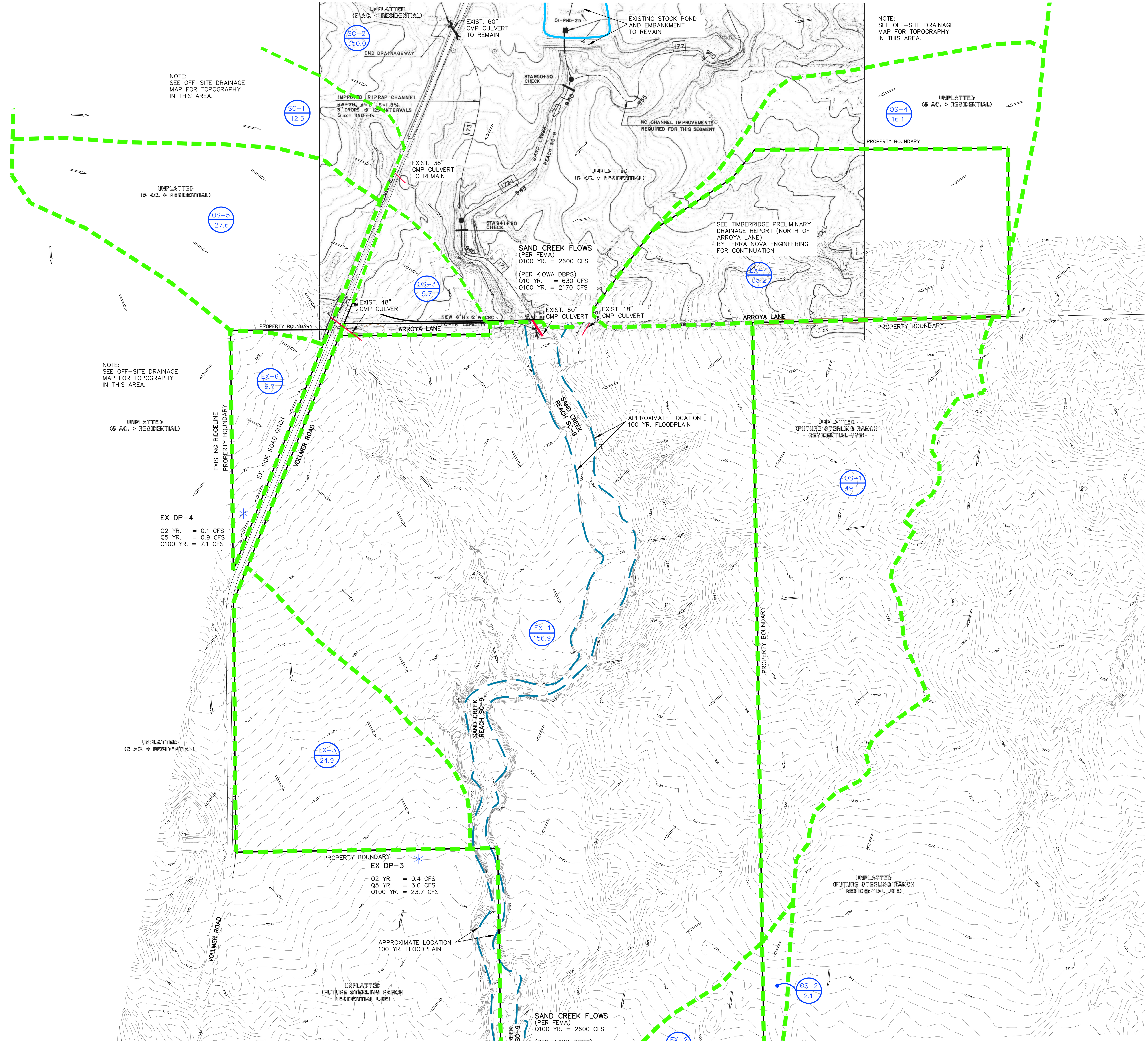
Provide column with design point contributing area

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	6910
BASIN BOUNDARY	
DESIGN POINT	
BASIN IDENTIFIER / AREA IN ACRES	BB / 10.0
EXISTING DIRECTION OF FLOW	
STORM SEWER	

200 100 0 200 400

SCALE: 1" = 200'



CLASSIC CONSULTING ENGINEERS & SURVEYORS

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Colorado Springs, Colorado 80903
(719)785-0790
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THE RETREAT AT TIMBERRIDGE
PRELIMINARY DRAIANGE REPORT
(SOUTH OF ARROYA LANE)
PRE-DEVELOPMENT DRAINAGE MAP

DESIGNED BY	MAW	SCALE	DATE 4-5-18
DRAWN BY	MAW	(H) 1"= 200'	SHEET 1 OF 2
CHECKED BY		(V) 1"= N/A	JOB NO. 2520.00

PRELIMINARY DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY																		
	WEIGHTED			OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY			TOTAL FLOWS		
BASIN	CA(2)	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	TOTAL (min)	I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
A1	0.77	1.79	5.12	0.14	120	2.4	15.1	740	2.5%	1.6	7.8	22.9	2.31	2.89	4.84	1.8	5	25
A2	0.41	0.97	2.76	0.14	300	12	19.0	400	4.0%	2.0	3.3	22.3	2.34	2.92	4.91	1.0	3	14
A3	0.35	0.83	2.36	0.14	300	8	21.7	400	3.0%	1.7	3.8	25.6	2.18	2.72	4.57	0.8	2	11
A4	0.25	0.42	0.92	0.20	180	8	13.3	180	4.0%	2.0	1.5	14.8	2.83	3.54	5.94	0.7	1	5
A5	0.33	0.77	2.20	0.14	280	10	19.1					19.1	2.53	3.16	5.31	0.8	2	12
B1	1.13	2.63	7.52	0.14	300	10.5	19.9	1280	3.2%	1.8	11.9	31.8	1.92	2.39	4.02	2.2	6	30
B2	0.48	1.12	3.20	0.14	300	10.5	19.9					19.9	2.48	3.10	5.20	1.2	3	17
B3	1.28	1.69	3.06	0.14	300	10.5	19.9	370	1.5%	1.2	5.0	24.9	2.21	2.76	4.63	2.8	5	14
B4	0.78	1.82	5.20	0.14	300	10.5	19.9					19.9	2.48	3.10	5.20	1.9	6	27
C1	1.13	2.13	5.25	0.17	300	12	18.4	600	2.0%	2.8	3.5	21.9	2.36	2.95	4.95	2.7	6	26
C2	0.52	0.86	1.89	0.20	300	14	16.9					16.9	2.67	3.34	5.61	1.4	3	11
C3	0.77	1.46	3.61	0.17	300	17	16.4					16.4	2.71	3.39	5.68	2.1	5	21
D1	1.02	1.28	2.72	0.21	200	4	18.0	600	2.0%	2.8	3.5	21.6	2.38	2.98	5.00	2.4	4	14
D2	2.54	3.53	6.63	0.25	150	3	15.0	900	3.0%	3.5	4.3	19.3	2.51	3.14	5.28	6.4	11	35
D3	0.68	0.85	1.81	0.21	150	3	15.6	375	2.0%	2.8	2.2	17.8	2.61	3.26	5.48	1.8	3	10
D4	1.36	1.84	3.30	0.27	150	3	14.6	600	3.5%	3.7	2.7	17.3	2.64	3.31	5.56	3.6	6	18
D5	2.30	3.20	6.02	0.25	150	3	15.0	1050	2.5%	3.2	5.5	20.5	2.44	3.05	5.13	5.6	10	31
D6	2.75	3.83	7.19	0.25	150	3	15.0	1200	2.0%	2.8	7.1	22.0	2.36	2.94	4.94	6.5	11	36
D7	0.19	0.43	1.11	0.16	150	3	16.5					16.5	2.70	3.37	5.67	0.5	1	6
D8	0.38	0.53	0.99	0.25	70	2.8	8.1					8.1	3.54	4.44	7.46	1.3	2	7
D9	0.27	0.38	0.71	0.25	70	2.8	8.1					8.1	3.54	4.44	7.46	1.0	2	5
D10	0.31	0.43	0.80	0.25	80	3.2	8.7					8.7	3.46	4.34	7.29	1.1	2	6
E	1.51	1.50	1.49	0.25	30	7.5	2.9	400	5.0%	2.2	3.0	5.9	3.93	4.92	8.27	5.9	7	12
F1	0.54	1.63	6.52	0.09	60	3	8.3	2400	2.0%	1.4	28.3	36.6	1.75	2.18	3.66	1.0	4	24
F2	0.14	0.41	1.66	0.09	60	6	6.6	1200	2.0%	1.4	14.1	20.7	2.43	3.03	5.09	0.3	1	8
H	0.40	0.94	2.68	0.14	300	11	19.6	900	2.0%	1.4	10.6	30.2	1.98	2.47	4.15	0.8	2	11
OS-1A	0.14	0.43	1.73	0.09	300	15	18.6	400	5.0%	4.5	1.5	20.1	2.47	3.08	5.18	0.4	1	9
OS-1B	0.70	2.11	8.42	0.09	300	15	18.6	1200	5.0%	4.5	4.5	23.0	2.30	2.88	4.83	1.6	6	41
OS-2A	0.06	0.18	0.72	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.1	0.6	4
OS-2B	0.07	0.21	0.83	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.2	0.6	4
OS-2C	0.45	1.34	5.36	0.09	300	12	20.0	1000	3.0%	3.5	4.8	24.8	2.21	2.77	4.64	1.0	4	25
OS-2D	0.03	0.08	0.31	0.09	250	12	17.2					17.2	2.65	3.32	5.57	0.07	0.3	2
OS-2E	0.09	0.28	1.12	0.09	300	12	20.0					20.0	2.47	3.09	5.19	0.2	0.9	6
OS-3	0.42	0.74	2.21	0.08	300	10	21.4	250	3.0%	3.5	1.2	22.6	2.32	2.90	4.87	1	2	11
OS-5	0.55	2.21	9.66	0.08	300	12	20.2	1500	3.0%	3.5	7.2	27.4	2.10	2.62	4.39	1	6	42

PRELIMINARY DRAINAGE REPORT ~ BASIN RUNOFF COEFFICIENT SUMMARY															
		IMPERVIOUS AREA / STREETS				LANDSCAPE / DEVELOPED AREAS				WEIGHTED			WEIGHTED CA		
BASIN	TOTAL AREA (AC)	AREA (AC)	C(2)	C(50)	C(100)	AREA (AC)	C(2)	C(5)	C(100)	C(2)	C(5)	C(100)	CA(2)	CA(5)	CA(100)
A1	12.8	0.00	0.89	0.95	0.96	12.80	0.06	0.14	0.40	0.06	0.14	0.40	0.77	1.79	5.12
A2	6.9	0.00	0.89	0.95	0.96	6.90	0.06	0.14	0.40	0.06	0.14	0.40	0.41	0.97	2.76
A3	5.9	0.00	0.89	0.95	0.96	5.90	0.06	0.14	0.40	0.06	0.14	0.40	0.35	0.83	2.36
A4	2.1	0.00	0.89	0.95	0.96	2.10	0.12	0.20	0.44	0.12	0.20	0.44	0.25	0.42	0.92
A5	5.5	0.00	0.89	0.95	0.96	5.50	0.06	0.14	0.40	0.06	0.14	0.40	0.33	0.77	2.20
B1	18.8	0.00	0.89	0.95	0.96	18.80	0.06	0.14	0.40	0.06	0.14	0.40	1.13	2.63	7.52
B2	8.0	0.00	0.89	0.95	0.96	8.00	0.06	0.14	0.40	0.06	0.14	0.40	0.48	1.12	3.20
B3	6.10	1.10	0.89	0.95	0.96	5.00	0.06	0.14	0.40	0.21	0.28	0.50	1.28	1.69	3.06
B4	13.0	0.00	0.89	0.95	0.96	13.00	0.06	0.14	0.40	0.06	0.14	0.40	0.78	1.82	5.20
C1	12.5	0.00	0.89	0.95	0.96	12.50	0.09	0.17	0.42	0.09	0.17	0.42	1.13	2.13	5.25
C2	4.3	0.00	0.89	0.95	0.96	4.30	0.12	0.20	0.44	0.12	0.20	0.44	0.52	0.86	1.89
C3	8.6	0.00	0.89	0.95	0.96	8.60	0.09	0.17	0.42	0.09	0.17	0.42	0.77	1.46	3.61
D1	6.0	0.00	0.89	0.95	0.96	6.00	0.17	0.21	0.45	0.17	0.21	0.45	1.02	1.28	2.72
D2	14.1	0.00	0.89	0.95	0.96	14.10	0.18	0.25	0.47	0.18	0.25	0.47	2.54	3.53	6.63
D3	4.0	0.00	0.89	0.95	0.96	4.00	0.17	0.21	0.45	0.17	0.21	0.45	0.68	0.85	1.81
D4	6.8	0.00	0.89	0.95	0.96	6.80	0.20	0.27	0.49	0.20	0.27	0.49	1.36	1.84	3.30
D5	12.8	0.00	0.89	0.95	0.96	12.80	0.18	0.25	0.47	0.18	0.25	0.47	2.30	3.20	6.02
D6	15.3	0.00	0.89	0.95	0.96	15.30	0.18	0.25	0.47	0.18	0.25	0.47	2.75	3.83	7.19
D7	2.7	0.00	0.89	0.95	0.96	2.70	0.07	0.16	0.41	0.07	0.16	0.41	0.19	0.43	1.11
D8	2.1	0.00	0.89	0.95	0.96	2.10	0.18	0.25	0.47	0.18	0.25	0.47	0.38	0.53	0.99
D9	1.5	0.00	0.89	0.95	0.96	1.50	0.18	0.25	0.47	0.18	0.25	0.47	0.27	0.38	0.71
D10	1.7	0.00	0.89	0.95	0.96	1.70	0.18	0.25	0.47	0.18	0.25	0.47	0.31	0.43	0.80
E	1.3	1.80	0.89	0.95	0.96	-0.50	0.18	0.25	0.47	1.16	1.15	1.15	1.51	1.50	1.49
F1	18.1	0.00	0.89	0.95	0.96	18.10	0.03	0.09	0.36	0.03	0.09	0.36	0.54	1.63	6.52
F2	4.6	0.00	0.89	0.95	0.96	4.60	0.03	0.09	0.36	0.03	0.09	0.36	0.14	0.41	1.66
H	6.7	0.00	0.89	0.95	0.96	6.70	0.06	0.14	0.40	0.06	0.14	0.40	0.40	0.94	2.68
OS-1A	4.8	0.00	0.89	0.95	0.96	4.80	0.03	0.09	0.36	0.03	0.09	0.36	0.14	0.43	1.73
OS-1B	23.4	0.00	0.89	0.95	0.96	23.40	0.03	0.09	0.36	0.03	0.09	0.36	0.70	2.11	8.42
OS-2A	2.0	0.00	0.89	0.95	0.96	2.00	0.03	0.09	0.36	0.03	0.09	0.36	0.06	0.18	0.72
OS-2B	2.3	0.00	0.89	0.95	0.96	2.30	0.03	0.09	0.36	0.03	0.09	0.36	0.07	0.21	0.83
OS-2C	14.9	0.00	0.89	0.95	0.96	14.90	0.03	0.09	0.36	0.03	0.09	0.36	0.45	1.34	5.36
OS-2D	0.85	0.00	0.89	0.95	0.96	0.85	0.03	0.09	0.36	0.03	0.09	0.36	0.03	0.08	0.31
OS-2E	3.1	0.00	0.89	0.95	0.96	3.10	0.03	0.09	0.36	0.03	0.09	0.36	0.09	0.28	1.12
OS-3	5.7	0.35	0.89	0.95	0.96	5.35	0.02	0.08	0.35	0.07	0.13	0.39	0.42	0.74	2.21
OS-5	27.6	0.00	0.89	0.95	0.96	27.60	0.02	0.08	0.35	0.02	0.08	0.35	0.55	2.21	9.66

negative?

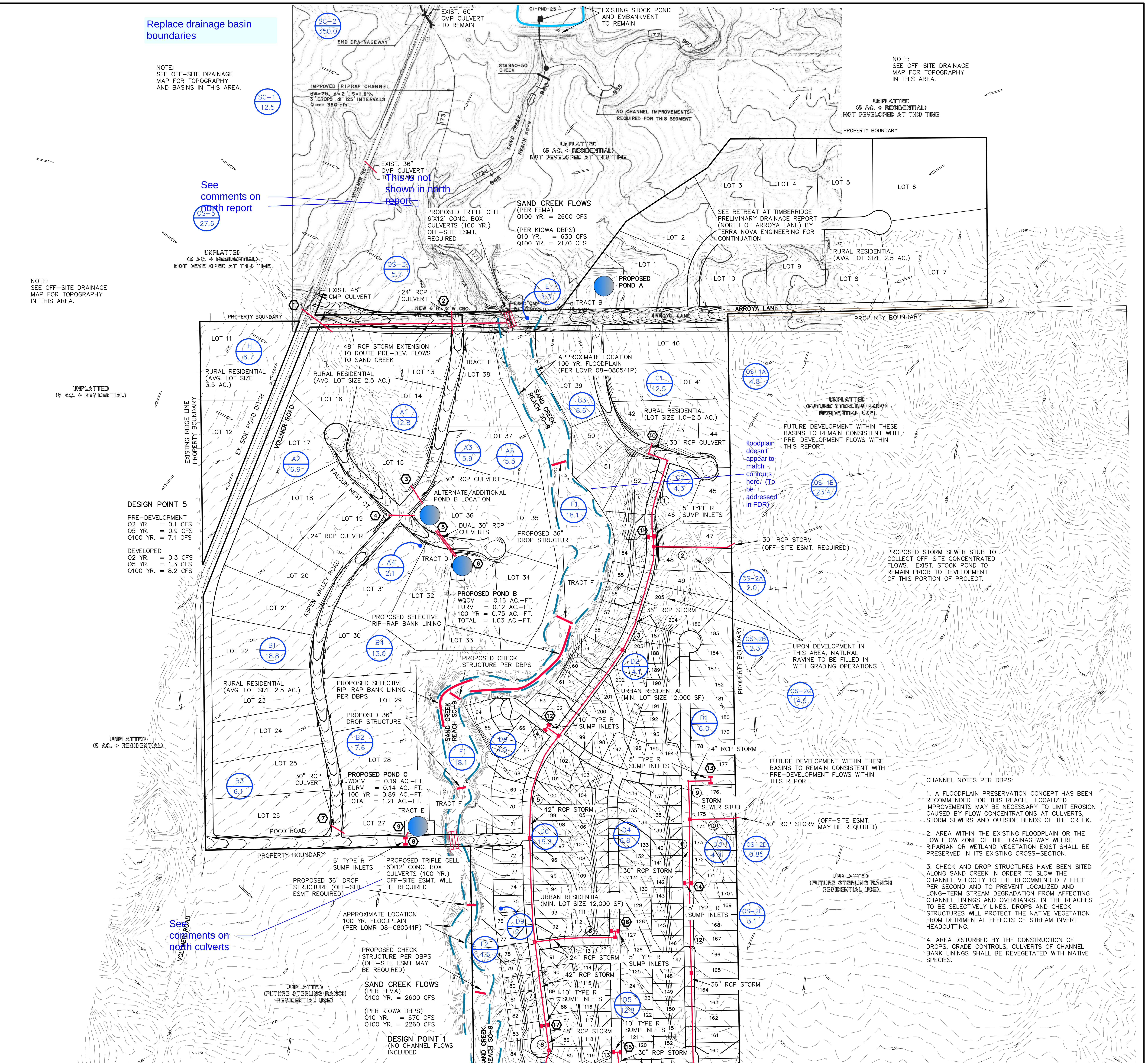
PRELIMINARY DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY									
					Intensity		Flow		
Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	I(5)	I(100)	Q(5)	Q(100)	Culvert / Inlet Size
1	OS-5	2.21	9.66	27.4	2.62	4.39	6	42	EX. 48" CMP
2	OS-3	0.74	2.21	22.6	2.90	4.87	2	11	24" RCP
3	DP-2, A-1	2.54	7.33	23.6	2.84	4.76	7	35	30" RCP
4	A2	0.97	2.76	22.3	2.92	4.91	3	14	24" RCP
5	DP-3, DP-4, A3	4.33	12.45	25.6	2.72	4.57	12	57	DUAL 30" RCP CULVERTS
6	**OS-3, A1, A2, A3 and A4 (POND B INFLOW)**	4.75	13.37	26.6	2.66	4.47	**13**	**60**	
7	B1	2.63	7.52	31.8	2.39	4.02	6	30	30" RCP
8	B3	1.69	3.06	24.9	2.76	4.63	5	14	5' Type R sump inlets
9	**B1, B2 and B3 (POND C INFLOW)**	5.44	13.78	34.8	2.26	3.79	**12**	**52**	
10	C1, OS-1A	2.56	6.98	23.4	2.85	4.79	7	33	30" RCP
11	C2	0.86	1.89	16.9	3.34	5.61	3	11	5' Type R sump inlets
12	D2, OS-2A	3.71	7.35	20.0	3.09	5.19	11	38	10' Type R sump inlets
13	D1, OS-2B	1.49	3.55	21.6	2.98	5.00	4	18	5' Type R sump inlets
14	D3, OS-2D	0.93	2.12	17.8	3.26	5.48	3	12	5' Type R sump inlets
15	D5, OS-2E	3.48	7.13	20.5	3.05	5.13	11	37	10' Type R sump inlets
16	D4	1.84	3.30	17.3	3.31	5.56	6	18	5' Type R sump inlets
17	D6	3.83	7.19	22.0	2.94	4.94	11	36	10' Type R sump inlets
18	**DP-10 Thru DP-17 and OS-1B, OS-2C, D7 (POND D INFLOW)**	22.55	54.40	27.8	2.60	4.36	**59**	**237**	

provide contributing acreage column

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	6910
BASIN BOUNDARY	
BASIN IDENTIFIER / AREA IN ACRES	B8 / 10.0
DESIGN POINT	1
EXISTING DIRECTION OF FLOW	
PROPOSED DIRECTION OF FLOW	
PROPOSED DRAINAGE IMPROVEMENTS	
PROPOSED DETENTION/SWQ POND	

SCALE: 1" = 200'



CHANNEL NOTES PER DBPS:

1. A FLOODPLAIN PRESERVATION CONCEPT HAS BEEN RECOMMENDED FOR THIS REACH. LOCALIZED IMPROVEMENTS MAY BE NECESSARY TO LIMIT EROSION CAUSED BY FLOW CONCENTRATIONS AT CULVERTS, STORM SEWERS AND OUTSIDE BENDS OF THE CREEK.
2. AREA WITHIN THE EXISTING FLOODPLAIN OR THE LOW FLOW ZONE OF THE DRAINAGEWAY WHERE RIPARIAN OR WETLAND VEGETATION EXIST SHALL BE PRESERVED IN ITS EXISTING CROSS-SECTION.
3. CHECK AND DROP STRUCTURES HAVE BEEN SITED ALONG SAND CREEK IN ORDER TO SLOW THE CHANNEL VELOCITY TO THE RECOMMENDED 7 FEET PER SECOND AND TO PREVENT LOCALIZED AND LONG-TERM STREAM DEGRADATION FROM AFFECTING CHANNEL LININGS AND OVERBANKS. IN THE REACHES TO BE SELECTIVELY LINES, DROPS AND CHECK STRUCTURES WILL PROTECT THE NATIVE VEGETATION FROM DETRIMENTAL EFFECTS OF STREAM INVERT HEADCUTTING.
4. AREA DISTURBED BY THE CONSTRUCTION OF DROPS, GRADE CONTROLS, CULVERTS OF CHANNEL BANK LININGS SHALL BE REVEGETATED WITH NATIVE SPECIES.

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THE RETREAT AT TIMBERRIDGE
PRELIMINARY DRAINAGE REPORT
(SOUTH OF ARROYA LANE)
DEVELOPED DRAINAGE MAP

DESIGNED BY	MAW	SCALE		DATE	4-5-18
DRAWN BY	MAW	(H) 1"= 200'		SHEET 2 OF 2	
CHECKED BY		(V) 1"= N/A		JOB NO.	2520.00