FINAL DRAINAGE REPORT FOR GLENEAGLE GOLF COURSE RESIDENTIAL INFILL DEVELOPMENT FILING NO. 2

PREPARED BY
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PREPARED FOR
G&S DEVELOPMENT, INC.
9800 Pyramid Court, No. 340
Englewood, CO 80112

February 12, 2019
Project Number 03524

VR-18-018

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 City/County for drainage reports, and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

_____
Michael A. Bartusek, P.E. #23329

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

By: _____
Scott Gratrix

Title: President

Address: G&S Development, Inc.
9800 Pyramid Court, Suite 340
Englewood, CO 80112

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

_____
Jennifer Irvine P.E. County Engineer/ Date
ECM Administrator

Conditions:

FINAL DRAINAGE REPORT
GLENEAGLE GOLF COURSE RESIDENTIAL INFILL DEVELOPMENT
FILING NO. 2

GENERAL

The Gleneagle Subdivision Filing No. 2 consists of a total of 7.621 acres, of which 0.83 acre will be ROW which previously comprised the Gleneagle Golf Club. The area will be developed with 12 lots and a water quality/detention basin in the western part of the proposed subdivision. The project is located in northwestern El Paso County. It is situated in Sections 6, Township 12 South, Range 67 West of the 6th Principal Meridian, El Paso County, Colorado.

The proposed development was part of the Black Forest Drainage Basin Planning Study, prepared by Wilson and Company in May 1989. The study used storm intervals of ten and 100 years. Our study follows the current City/County Drainage Criteria Manual and uses the five- and 100-year storms.

SOILS

The Soil Conservation Service (NRCS) soil survey for El Paso County has identified three soil types in this study area. They are as follows:

Map Symbol No.	Soil Name	Hydrologic Soil Group
68	Peyton-Pring Complex	B
71	Pring Coarse Sandy Loam	B

FLOODPLAIN STATEMENT

None of the site is located within a 100 year floodplain as determined by FEMA on the Flood Insurance Rate Map (FIRM) Panel 08041 CO287F, dated March 17, 1997.

METHOD OF COMPUTATION

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

$$Q = cia$$

Where

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

WETLANDS

No identified wetlands occur within the project area according to the Natural Features and Wetland Report prepared by Ecosystem Services LLC in March 2016.

EXISTING PONDS

No existing ponds are located within the project area. There is a non-jurisdictional stormwater basin located within the western area of the site which is identified on the "Existing Conditions" drainage plan.

WATER QUALITY/DETENTION CONCEPTS

In accordance with current NPDES requirements, stormwater quality BMPs will be incorporated into the development of this project. Water quality facilities will be included in all proposed detention facilities. A water quality/detention basin will be built as part of this project. The new detention basin will be equipped with a 2.5' micro-pool per the DCM Volume 2.

EXISTING DRAINAGE CONDITIONS

As stated previously, the Gleneagle Subdivision Filing No. 2 encompasses approximately 7.62 acres. This study focuses on the development of the 12 lots in the southern part of this development.

This filing of the subdivision drains the southwest area of the Gleneagle Subdivision. This basin drains the area west of the large detention pond from Filing No. 1 and Huntington Beach Dr. and north of Gleneagle Dr.

The basin flows into an existing sump area before it drains overland through existing lots along Westchester Drive. **Basin A** has further been divided into several sub-basins.

Sub-Basin A1 drains the runoff from the homes on Gleneagle Drive just west of Huntington Beach Drive. It produces flows of 1.5 cfs for the five-year storm and 5.4 cfs for the 100-year storm. The runoff then flows into Sub-Basin A2. Some flows from this Sub-Basin enters the adjacent sub-basin through a roadside swale, while most just sheet flows from the street.

Sub-Basin A2 drains the area between the existing sump detention area and Westchester Drive. The mostly undeveloped area produces flows of 3.2 cfs for the five-year storm and 22.1 cfs for the 100-year storm. When combined with the flows from Sub-Basin 1 at **DP1** the resulting flows are 4.2 cfs and 25.7 cfs for the five- and 100-year storms, respectively. This runoff currently sheet flows through the existing lots 10 and 11, located mostly on lot 10. These flows continue to the existing ditches along Westchester Drive within Sub-Basin OS1. Calculations show that these flows will split with some flows continuing to the Westchester ditch and some flowing around the back of the house and onto lot 9.

Sub-Basin A3 is a very small area along Gleneagle Drive which sheet flows off of the street and then flows through a small ditch to Westchester Drive. This area produces flows of 1.4 cfs for the five-year storm and 3.9 cfs for the 100-year storm.

Sub-Basin OS1 drains the southern developed area of Westchester Drive. It produces flows of 6.9 cfs for the five-year storm and 21.8 cfs for the 100-year storm. These flows and flows from Sub-Basin A3 combine at **DP2** to produce flows of 6.7 cfs and 20.8 cfs for the five- and 100-year storms, respectively. These flows travel north to the existing 30-inch culvert.

Sub-Basin A4 drains the undeveloped area northwest of pond B. It produces flows of 0.3 cfs for the five-year storm and 2.3 cfs for the 100-year storm. These flows then travel along Westchester Drive into Sub-Basin OS2.

Sub-Basin OS2 drains a small area along Westchester Drive, producing flows of 1.3 cfs for the five-year storm and 4.3 cfs for the 100-year storm. These flows and flows from Sub-Basin A4 combine at **DP3** to produce flows of 1.5 cfs and 6.3 cfs for the five- and 100-year storms, respectively. These combined flows then travel south along the Westchester Drive ditch, joining with flows from DP3 at **DP4**. The total combined flows at DP4 are 8.0 cfs and 26.3 cfs for the five- and 100-year storms, respectively.

The combined, total runoff at the existing 30-inch CMP located under Westchester Drive (**DP5**) is 10.7 cfs for the five-year storm and 47.2 cfs for the 100-year storm.

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

TABLE 1 – EXISTING CONDITIONS

Sub-Basin	Q_5CFS	Q_{100} CFS
A1	1.5	5.4
A2	3.2	22.1
A3	1.4	3.9
A4	0.3	2.3
OS1	6.9	21.8
OS2	1.3	4.3
DP1(A1+A2)	4.2	25.7
DP2(A3+OS1)	6.7	20.8
DP3(A4+OS2)	1.5	6.3
DP4(DP2+DP3)	8.0	26.3
DP5(DP4+DP1)	10.7	47.2

DEVELOPED DRAINAGE CONDITIONS

A total of 12 lots are proposed within this portion of the previous golf course property. With the average lot size over one-half acre, the resultant increases in flows will be slight. However, a new detention facility will be used to keep flows below historic levels. New ditches and swales will also be added to further reduce the flows that currently flow toward the homes. As a result of the proposed detention basins and other drainage improvements no adverse impacts will result due to this project.

Sub-Basin A1 will remain unchanged and will produce flows of 1.5 cfs for the five-year storm and 5.4 cfs for the 100-year storm. These combined flows will then travel into Sub-Basin A2A.

Sub-Basin A2A will drain the area just west and south of existing Pond B. It will produce flows of 1.6 cfs for the five-year storm and 9.1 cfs for the 100-year storm event. These flows will travel in proposed Swale J. Flows from Sub-Basin A1 and A2A will combine at **DP1** and produce flows of 2.8 cfs and 13.5 cfs for the five- and 100-year storms, respectively.

Sub-Basin A2B will drain the east side of Stone Eagle Place. It will produce flows of 1.9 cfs for the five-year storm and 6.6 cfs for the 100-year storm. These flows will be intercepted at the low point of the street by a modified CDOT Type 13 grated inlet situated over the 24" RCP. Flows from this sub-basin and DP1 will combine in a proposed swale at **DP2** to produce total flows of 4.4 cfs and 18.8 cfs for the five- and 100-year storms, respectively. These flows will be directed under Stone Eagle Place into Sub-Basin A2C through a 24-inch RCP culvert.

Sub-Basin A2C will drain the west side of Stone Eagle Place and be directed to a modified CDOT Type 13 grated inlet at the low point situated over the 24" RCP. It will produce flows of 2.7 cfs for the five-year storm and 7.2 cfs for the 100-year storm. Flows from this sub-basin and DP2 will combine at **DP3** to produce total flows of 6.2 cfs and 23.3 cfs for the five- and 100-year storms, respectively. These flows will then be directed into a new detention/water quality facility in Sub-Basin A2D.

Sub-Basin A2D will drain the back areas of the lots located along Stone Eagle Place and portions of the old golf course. It will produce flows of 1.7 cfs for the five-year storm and 9.7 cfs for the 100-year storm. These flows will travel through proposed Swale L with a 12" berm added where the swale makes a 90 degree bend. The combined, undetained flows at the new water quality/ detention basin C (**DP4**) will be 7.0 cfs and 28.9 cfs for the five- and 100-year storms, respectively. The outflow from this proposed detention basin will be 2.8 cfs and 18.0 cfs for the five- and 100-year storms, respectively. Flows from this detention basin will be directed to a proposed 24" private HDPE storm sewer which will be located on Lot 7 Blk 3 of the Donala Sub. No. 1. In addition the detention overflow swale will also connect to this storm sewer which will discharge into an improved ditch along Westchester Drive.

Sub-Basin A3 is a very small area along Gleneagle Drive and flows through a small ditch to Westchester Drive in Sub-Basin OS4. This area produces flows of 1.4 cfs for the five-year storm and 3.9 cfs for the 100-year storm, which is less than existing conditions.

Sub-Basin OS1 drains the southern developed area of Westchester Drive. It produces flows of 4.5 cfs for the five-year storm and 15.1 cfs for the 100-year storm. These flows and flows from Sub-Basin A3 combine at **DP5** to produce flows of 4.8 cfs and 15.6 cfs for the five- and 100-year storms, respectively. These flows combine with the flows from the detention basin to produce total flows at DP6 in the ditch of 10.9 cfs for the 5-year storm and 41.6 cfs for the 100-year storm. These flows in the riprap-lined ditch along Westchester Drive will be intercepted by a 30" public RCP storm sewer which will take the flows from Westchester Drive to the existing drainage channel located in the Paradise Villas Townhome Subdivision.

Sub-Basin A4 drains the undeveloped area northwest of Pond B. It produces flows of 0.3 cfs for the five-year storm and 2.3 cfs for the 100-year storm which flow toward the existing 30-inch CMP in Westchester Drive. These flows are less than existing conditions and travel along Westchester Drive into Sub-Basin OS2.

Sub-Basin OS2 drains the southern developed area of Westchester Drive and will remain unchanged, producing flows of 3.5 cfs for the five-year storm and 10.7 cfs for the 100-year storm. These flows and flows from Sub-Basin A4 combine at **DP7** to produce flows of 3.5 cfs and 12.0 cfs for the five- and 100-year storms, respectively. These combined flows then travel south along the Westchester Drive ditch to the existing 30" CMP in Westchester Drive.

Table 2 shows the estimated runoff produced for the project under developed conditions:

TABLE 2 – DEVELOPED CONDITIONS		
Sub-Basin	**Q_5CFS**	**Q_{100} CFS**
OS1	4.5	15.1
OS2	3.5	10.7
A1	1.5	5.4
A2A	1.6	9.1
A2B1	1.1	5.1
A2B2	1.1	2.3
A2C1	1.4	2.9
A2C2	1.3	4.2
A2D	1.7	9.7
A3	1.4	3.9
A4	0.3	2.3
DP1 (A1+A2A)	2.8	13.5
DP2 (DP1+A2B1)	3.7	17.6
DP3 (DP2+A2B2+A2C1)	5.6	21.4
DP4(DP3+A2C2)	6.6	24.5
DP5 (DP4+A4B)	6.8	28.9
DP6 (OS1+A3)	4.8	15.6
DP7 (0S2+A4)	3.5	12.0
DP8 (DP6+DP7)	7.9	26.1

The water quality basin is designed in accordance with current NPDES requirements for extended detention basins. The basin will be constructed with a 2.5-foot permanent micro-pool. Design forms for these basins can be found in *Appendix B*. The design summary is below.

TABLE 3 –WATER QUALITY DESIGN SUMMARY				
Location	**Depth**	**Size (SF)**	**Depth (FT)**	**Size (SQ IN)**
Sub-Basin A2D Detention Basin C	1.06	5,270	0,0.34,0.69	0.83,0.83,0.83

DETENTION BASIN

Developed flows from this project will be reduced to historic levels or below by using detention facilities. The *UDFCD Design for Full Spectrum Detention Basins* is used for the basin design.

TABLE 4 DETENTION BASIN DETAILS				
Location	**Size (AF)**	**Pipe Outlet**	**Outlet Structure**	**Riprap Weir Width**
A2D	0.817	24"	Typical Outlet Structure OS-2	13'

The above detention facility has been designed to reduce the total off-site flows to below historic levels.

PUBLIC DRAINAGE FACILITIES

Item	**Unit**	**Quantity**	**Unit Cost**	**Total Cost**
24" RCP FES	EA	2	$600	$ 1,200.00

24" RCP	LF	205.5	$84	$17.262.00
Mod. CDOT Type 13 Inlet	EA	2	$3400	$7,000.00
Storm MH Type II	EA	2	$3400	$29,422.00
			Sub-Total	$54,884.00
		15% Contingency & Engineering		$ 8,232.60
			TOTAL	**$48,654.60**

PRIVATE DRAINAGE FACILITIES

Item	Unit	Quantity	Unit Cost	Total Cost
24" HDPE FES	EA	2	$600	$ 1,200.00
24" HDPE	LF	486	$75	$36,450.00
Type C Inlet	EA	1	$5,000	$ 5,000.00
Detention Outlet Structure	EA	1	$8,000	$ 8,000.00
Emergency Spillway	EA	1	$1,500	$ 1,500.00
			Sub-Total	$52,150.00
		15% Contingency & Engineering		$ 7,822.50
			TOTAL	**$59,972.50**

DRAINAGE BASIN FEES

Although the Gleneagle Golf Course Residential Infill Development Filing No. 2 was previously platted under the original subdivision as Tract G, drainage fees must be paid on the impervious acreage of the subdivision.

7.62 Developed Acres x 23% impervious = 1.75 acres
2018 Drainage Fee = $17,197 per impervious acre x 1.75 = $30,094.75
2018 Bridge Fee = $468 per impervious acre x 1.75 = $795.60

Drainage basin fees for this development will be provided at the existing current fee rate when the final drainage report is submitted at the time of platting.

CONCLUSION

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

Step 1: Employ runoff reduction practices

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

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

Step 2: Stabilize drainageways

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

- Tributaries have been left in their relatively natural state where possible.
- New drainageways and swales have been stabilized with either riprap or erosion control fabric depending on the erosion potential.
- No new roadside ditches are proposed for the development.

Step 3: Provide water quality capture volume (WQCV)

The proposed development will disturb approximately 7.6 acres, a WQCV of 0.121 ac-ft will be provided.

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

The development of this project will not affect sensitive waters.

The development of this site will have little impact on downstream properties once the EDB is constructed.

The development of this site will have little impact on downstream properties once the water quality/detention basins are constructed.

REFERENCES

1. City of Colorado Springs and El Paso County (1994). ***Drainage Criteria Manual Volume 1*** (DCM).

2. City of Colorado Springs and El Paso County (1994). ***Drainage Criteria Manual Volume II*** (DCM).

3. Soil Survey of El Paso County Area, Colorado by USDA, NRCS.

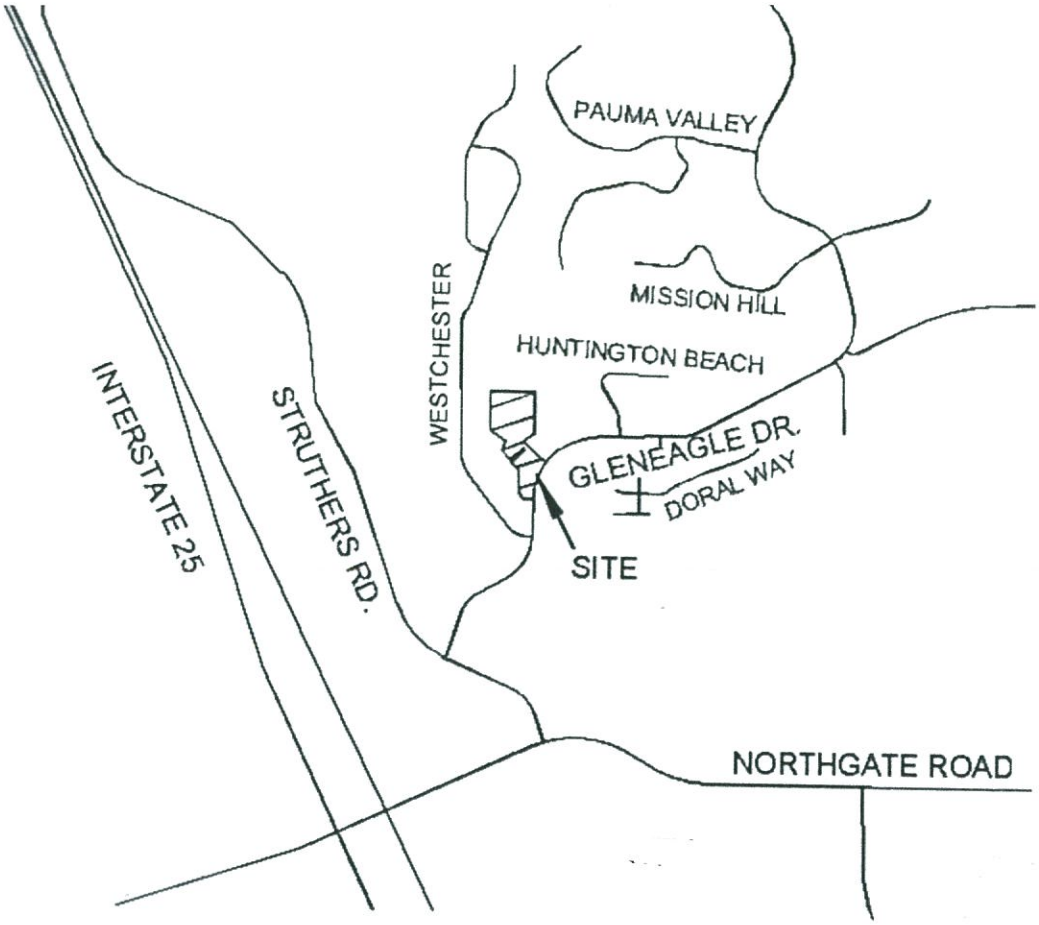
4. ***El Paso County (January 2006) Engineering Criteria Manual.***

5. Urban Drainage and Flood Control District (June 2011). ***Urban Storm Drainage Criteria Manual, Volume 1-3.***

6. Gleneagle Golf Course Residential Infill Development Preliminary/Final Drainage Report by Associated Design Professionals, Inc. dated July, 2017.

APPENDIX A

MAPS



VICINITY MAP

N.T.S.

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N

SOILS MAP

N.T.S.

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National Flood Hazard Layer FIRMette

FEMA

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/22/2019 at 9:59:02 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

APPENDIX B

DESIGN CALCULATIONS

GLENEAGLE DEVELOPMENT FILING NO 2

C FACTOR CALCULATION SHEET

EXISTING CONDITIONS

RUNOFF COEFICIENT

TYPE A/B SOILS

LAND USE	5 YR	100 YR
UNDEV	0.08	0.35
STREETS/DRIVES	0.9	0.96
ROOFS	0.73	0.81

AREA DESIG.	TOTAL AREA (acre)	SURFACE CONDITION AREAS UNDEV	PAVED STREETS & DRIVES	ROOFS	CALCULATED C 5 YR	100 YR
A1**	1.66	1.31	0.13	0.22	**0.23**	**0.46**
A2**	13.26	13.04		0.22	**0.09**	**0.36**
A3	1.07	0.75	0.32		**0.33**	**0.53**
A4	1.00	1.00			**0.08**	**0.35**
OS1*	6.35	4.76	0.84	0.75	**0.27**	**0.49**
OS2*	1.30	0.99	0.14	0.17	**0.25**	**0.48**

* Avg House = 2500 sf

** Avg House = 3200 sf

DEVELOPED CONDITIONS

RUNOFF COEFICIENT

TYPE A/B SOILS

LAND USE	5 YR	100 YR
UNDEV	0.08	0.35
STREETS/DRIVES	0.9	0.96
ROOFS	0.73	0.81

Developed Conditions

AREA DESIG.	TOTAL AREA (acre)	SURFACE CONDITION AREAS UNDEV	PAVED STREETS & DRIVES	ROOFS	CALCULATED C 5 YR	100 YR
A1**	1.66	1.31	0.13	0.22	**0.23**	**0.46**
A2A**	4.27	4.05	0.00	0.22	**0.11**	**0.37**

A2B1**	2.35	2.05	0.00	0.30	**0.16**	**0.41**
A2B2	0.43	0.15	0.28	0.00	**0.61**	**0.75**
A2C1	0.55	0.19	0.36	0.00	**0.62**	**0.75**
A2C2**	1.27	0.90	0.00	0.37	**0.27**	**0.48**
A2D**	4.39	4.17	0.00	0.22	**0.11**	**0.37**
A3	1.07	0.75	0.32	0.00	**0.33**	**0.53**
A4	1.00	1.00	0.00	0.00	**0.08**	**0.35**
OS1*	4.55	3.49	0.60	0.46	**0.25**	**0.48**
OS2*	3.10	2.26	0.38	0.46	**0.28**	**0.49**
* Avg House = 2500 sf					**13.26**	**1.75**
** Avg House = 3200 sf						
	Sub Area		Impervious Acreage			
A2A-A2D	7.62		0.64	1.11		
	Imperviousness = (0.64+1.11)/7.62 = 0.23					

GLENEAGLE DEVELOPMENT FILING NO 2

DRAINAGE CALCULATION SHEET

file: gleneagle II dr

02/14/19

AREA DESIG.	AREA (acre)	C5 (5 yr)	C100 (100 yr)	C5 X A	C100 X A	Initial Tci L (ft)	Initial Tci Slope (%)	Initial Tci ti (min)	Travel Time L (ft)	Travel Time Slope (%)	Travel Time V (fps)	Travel Time Tt (min)	TC (min)	I5 (in/hr)	I100 (in/hr)	Q5 (cfs)	Q100 (cfs)	length L (feet)	vel. V (fps)	^t (min)	AREA DESIG.
EXISTING CONDITIONS																					
A1	1.66	0.23	0.46	0.38	0.76	50	4.00	7.28	700	4.00	4.00	2.92	10.20	4.02	7.02	1.53	5.36				A1
A2	13.26	0.09	0.36	1.19	4.77	100	3.50	12.49	1350	4.00	2.00	11.25	23.74	2.65	4.63	3.17	22.12				A2
DP1	14.92			1.58	5.54								23.74	2.65	4.63	4.18	25.66				DP1
A3	1.07	0.33	0.53	0.35	0.57	30	2.00	6.27	500	4.00	2.00	4.17	10.44	3.98	6.95	1.40	3.94	600	1.70	5.88	A3
OS1	6.35	0.27	0.49	1.71	3.11	100	3.50	10.27	0	4.00	2.00	0.00	10.27	4.01	7.00	6.87	21.77				OS1
DP2	7.42			2.07	3.68								16.32	3.24	5.65	6.69	20.79				DP2
A4	1.00	0.08	0.35	0.08	0.35	50	3.50	8.92	300	3.50	1.85	2.70	11.62	3.80	6.63	0.30	2.32	100	1.85	0.90	A4
OS2	1.30	0.25	0.48	0.33	0.62	100	3.50	10.51	0	4.00	2.00	0.00	10.51	3.97	6.93	1.29	4.32				OS2
DP3	2.30			0.41	0.97								12.52	3.67	6.41	1.49	6.25				DP3
DP4	9.72			2.47	4.65								16.32	3.24	5.65	8.00	26.30				DP4
DP5	24.64			4.05	10.19								23.74	2.65	4.63	10.74	47.23				DP5
DEVELOPED CONDITIONS																					
A1	1.66	0.23	0.46	0.38	0.76	50	4.00	7.28	700	4.00	4.00	2.92	10.20	4.02	7.02	1.53	5.36				A1
A2A	4.27	0.11	0.37	0.47	1.58	50	5.00	7.70	950	4.00	2.00	7.92	15.61	3.31	5.78	1.55	9.13				A2A
DP1	5.93			0.85	2.34								15.61	3.31	5.78	2.82	13.54				DP1
A2B1	2.35	0.16	0.41	0.38	0.96	100	5.00	10.33	850	3.00	1.75	8.10	18.43	3.04	5.31	1.14	5.12				A2B1
DP2	8.28			1.23	3.31								18.43	3.04	5.31	3.73	17.57	49	10.00	0.08	DP2
A2B2	0.43	0.61	0.75	0.26	0.32	30	2.00	3.99	380	1.00	1.00	6.33	10.33	4.00	6.98	1.05	2.25				A2B2
A2C1	0.55	0.62	0.75	0.34	0.41	30	2.00	3.91	380	1.00	1.00	6.33	10.24	4.01	7.00	1.37	2.89				A2C1
DP3	9.26			1.83	4.04								18.51	3.03	5.30	5.56	21.43	100	10.00	0.17	DP3
A2C2	1.27	0.27	0.48	0.34	0.61	30	2.00	6.76	250	1.00	1.00	4.17	10.93	3.90	6.81	1.34	4.15				A2C2
DP4	10.53			2.17	4.65								18.68	3.02	5.28	6.57	24.54	220	3.00	1.22	DP4
A2D	4.39	0.11	0.37	0.48	1.62	50	3.50	8.66	350	1.00	1.00	5.83	14.49	3.43	5.99	1.66	9.73				A2D
DP5	13.65			2.31	5.67								19.90	2.92	5.10	6.76	28.91	100	1.85	0.90	DP5
	13.65			0.96	3.59	Adjusted C Factor for Detention Basin C							19.90	2.92	5.10	2.80	18.30	From Overflow Weir from UD-Det Calcs			
Overflow Pipe assuming clogged outlet structure				0.96	3.59																
A3	1.07	0.33	0.53	0.35	0.57	30	2.00	6.27	500	4.00	2.00	4.17	10.44	3.98	6.95	1.40	3.94	600	1.70	5.88	A3
OS1	4.55	0.25	0.48	1.14	2.18	100	3.50	10.51	0	4.00	2.00	0.00	10.51	3.97	6.93	4.51	15.13				OS1
DP6	5.62			1.49	2.75								16.32	3.24	5.65	4.82	15.55				DP6
A4	1.00	0.08	0.35	0.08	0.35	50	3.50	8.92	300	3.50	1.85	2.70	11.62	3.80	6.63	0.30	2.32	100	1.85	0.90	A4
OS2	3.10	0.28	0.49	0.87	1.52	100	3.50	10.14	0	4.00	2.00	0.00	10.14	4.03	7.03	3.49	10.68				OS2
DP7	4.10			0.95	1.87								12.52	3.67	6.41	3.48	11.99				DP7
DP8	9.72			2.44	4.62								16.32	3.24	5.65	7.89	26.11				DP8

FOREBAY CALCULATIONS

2% OF WQV

0.02 X 0.121 = 0.0024 AF = 105 CF

FOREBAY NOTCH CALCULATIONS

2% OF 100YR FLOW

0.02 X 28.9 = 0.58 CFS

W =Q/(D^1.5XC)

W=0.58/(1X3.0)=0.19 FT

GLENEAGLE DEVELOPMENT												
DITCH CAPACITY CALCULATION SHEET										Riprap		
Swale Location	Q5 cfs	Q100 cfs	S %	B ft	Z	D ft	d100 ft	V fps	Froude #	Size	A sf	Tw ft
J	1.7	9.7	1.0	0.0	3:1	1.5	1.0	3.2	0.79		3.2	6.1
K	4.4	18.8	0.5	2.0	4:1	2.0	1.2	2.3	0.49	ECM	6.7	10.6
L	2.8	13.5	1.5	0.0	3:1	1.5	1.1	3.5	0.81		3.5	6.9
Overflow Spillway M	6.8	28.9	6.5	6.0	3:1	3.0	0.6	5.9	1.47	0.40	4.9	9.7
			I* LEFT Z= 15:1, Right Z= 40:1				Riprap Size					
			O* LEFT Z= 5:1, Right Z= 2:1				D50=(((VS^0.17)/4.5(2.5-1)^0.66))^2					
			R* LEFT Z= 6:1, Right Z= 3:1									
Note: In ditches with low velocities & flows but higher Froude Numbers, Erosion Control Mats used in lieu of riprap												

Project Gleneagle Filing 2
By AJL
Date 2/15/2019

Description Used UDFCD UD-SEWER 2009 computer program to calculate HGL for Q100 and Q5.

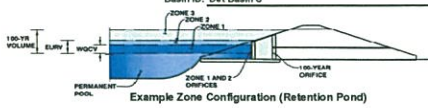
Element	Q100	DS STA	US STA	DIA (IN)	Material	Manning's n	LENGTH (FT)	DS INV	US INV	Horizontal Bend DS	Bend Loss	Lateral Loss	DS HGL	US HGL	Slope
1-1	28.9	0.00	153.50	24	HDPE	0.012	153.5	6,781.00	6,783.30	0	0.03	1.00	6,782.57	6,785.14	0.015
2-1	28.9	153.50	281.00	24	HDPE	0.012	127.5	6,783.30	6,786.74	7	0.04	0.00	6,785.21	6,788.58	0.027
3-1	28.9	281.00	337.97	24	RCP	0.013	57.0	6,786.84	6,788.38	8	0.05	0.00	6,788.65	6,790.22	0.027
4-1	28.9	337.97	443.50	24	RCP	0.013	105.5	6,788.38	6,791.21	57	0.57	0.00	6,791.07	6,793.05	0.027
5-1	28.9	443.50	463.00	24	RCP	0.013	19.5	6,791.21	6,791.74	46	0.40	0.00	6,793.68	6,794.00	0.027
6-1	28.9	463.00	610.00	24	HDPE	0.012	147	6,791.84	6,795.82	49	0.44	0.00	6,794.57	6,797.66	0.027
7-1	28.9	610.00	634.00	24	HDPE	0.012	24	6,795.92	6,797.67	0	0.03	0.32	6,798.72	6,799.51	0.073

Element	Q5	DS STA	US STA	DIA (IN)	Material	Manning's n	LENGTH (FT)	DS INV	US INV	Horizontal Bend DS	Bend Loss	Lateral Loss	DS HGL	US HGL	Slope
1-1	6.8	0.00	153.50	24	HDPE	0.012	153.5	6,781.00	6,783.30	0	0.03	1.00	6,781.64	6,784.22	0.015
2-1	6.8	153.50	281.00	24	HDPE	0.012	127.5	6,783.30	6,786.74	7	0.04	0.00	6,784.23	6,787.66	0.027
3-1	6.8	281.00	337.97	24	RCP	0.013	57.0	6,786.84	6,788.38	8	0.05	0.00	6,787.67	6,789.30	0.027
4-1	6.8	337.97	443.50	24	RCP	0.013	105.5	6,788.38	6,791.21	57	0.57	0.00	6,789.35	6,792.13	0.027
5-1	6.8	443.50	463.00	24	RCP	0.013	19.5	6,791.21	6,791.74	46	0.40	0.00	6,792.16	6,792.81	0.027
6-1	6.8	463.00	610.00	24	HDPE	0.012	147	6,791.84	6,795.82	49	0.44	0.00	6,792.85	6,796.74	0.027
7-1	6.8	610.00	634.00	24	HDPE	0.012	24	6,795.92	6,797.67	0	0.03	0.32	6,796.80	6,799.10	0.073

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Project: Gleneagle Golf Course Residential Infill Project Fil 2

Basin ID: Det Basin C



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB			
Watershed Area =	14.92	acres		
Watershed Length =	1,450	ft		
Watershed Slope =	0.025	ft/ft		
Watershed Imperviousness =	15.90%	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 =	UDFCD Default			
Water Quality Capture Volume (WQCV) =	0.121	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.231	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.173	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.431	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.704	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.186	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.537	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.949	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.01 in.) =	2.637	acre-feet	3.01	inches
Approximate 2-yr Detention Volume =	0.161	acre-feet		
Approximate 5-yr Detention Volume =	0.354	acre-feet		
Approximate 10-yr Detention Volume =	0.409	acre-feet		
Approximate 25-yr Detention Volume =	0.452	acre-feet		
Approximate 50-yr Detention Volume =	0.575	acre-feet		
Approximate 100-yr Detention Volume =	0.817	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.121	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.110	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.586	acre-feet
Total Detention Basin Volume =	0.817	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Micropool	--	0.00	--	--	--	30	0.001		
	--	0.50	--	--	--	4,765	0.109	1,151	0.026
	--	1.00	--	--	--	9,525	0.219	4,676	0.107
	--	1.50	--	--	--	19,050	0.437	11,725	0.269
	--	2.00	--	--	--	20,255	0.465	21,539	0.494
	--	2.50	--	--	--	21,460	0.493	32,170	0.739
	--	3.00	--	--	--	22,665	0.520	43,201	0.992
	--	3.50	--	--	--	23,870	0.548	54,835	1.259
	--	4.00	--	--	--	25,075	0.576	67,071	1.540
	--	4.50	--	--	--	26,280	0.603	79,910	1.834
	--	5.00	--	--	--	27,485	0.631	93,351	2.143
	--	5.50	--	--	--	28,690	0.659	107,395	2.465
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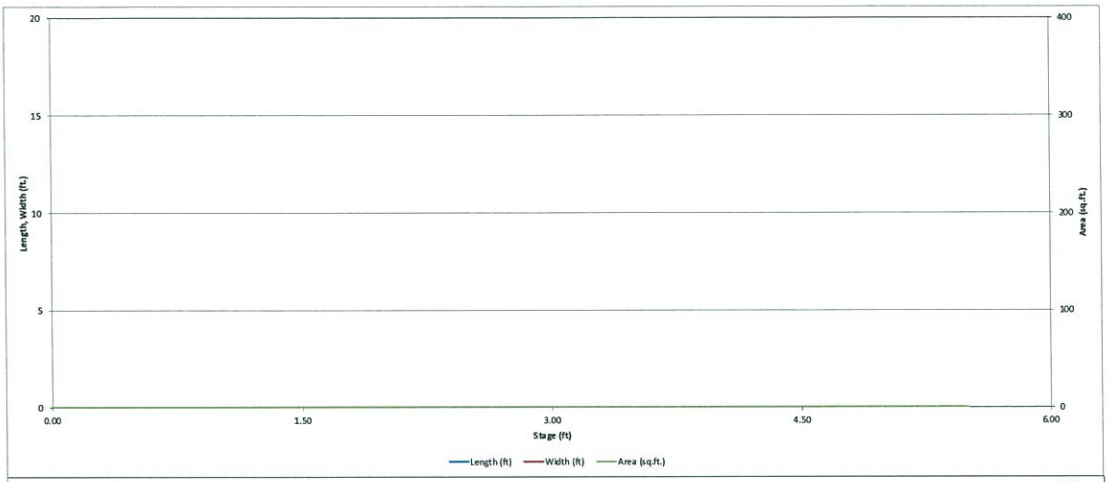
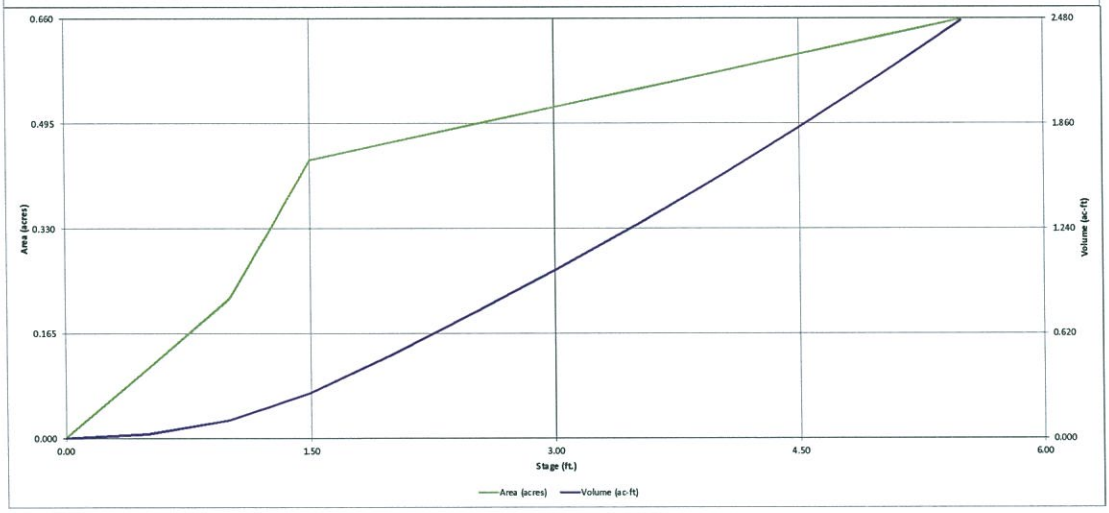
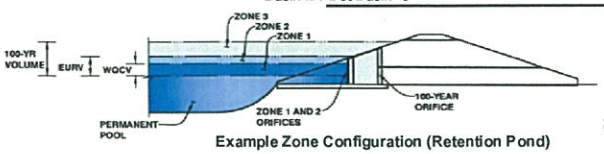
DETENTION BASIN STAGE-STORAGE TABLE BUILDER





Detention Basin Outlet Structure Design

Project: Gleneagle Golf Course Infill Project Fil 2
Basin ID: Det Basin C



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.06	0.121	Orifice Plate
Zone 2 (EURV)	1.40	0.110	Orifice Plate
Zone 3 (100-year)	2.66	0.586	Weir&Pipe (Restrict)
		0.817	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 =	1.03	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	4.10	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.34	0.69					
Orifice Area (sq. inches)	0.83	0.83	0.83					

	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 =	1.03	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 % =	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 =	2.03	N/A	feet
Over Flow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	18.80	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	11.54	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.77	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 =	0.33	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 =	6.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.61	N/A	ft^2
Outlet Orifice Centroid =	0.29	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.05	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.70	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	13.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

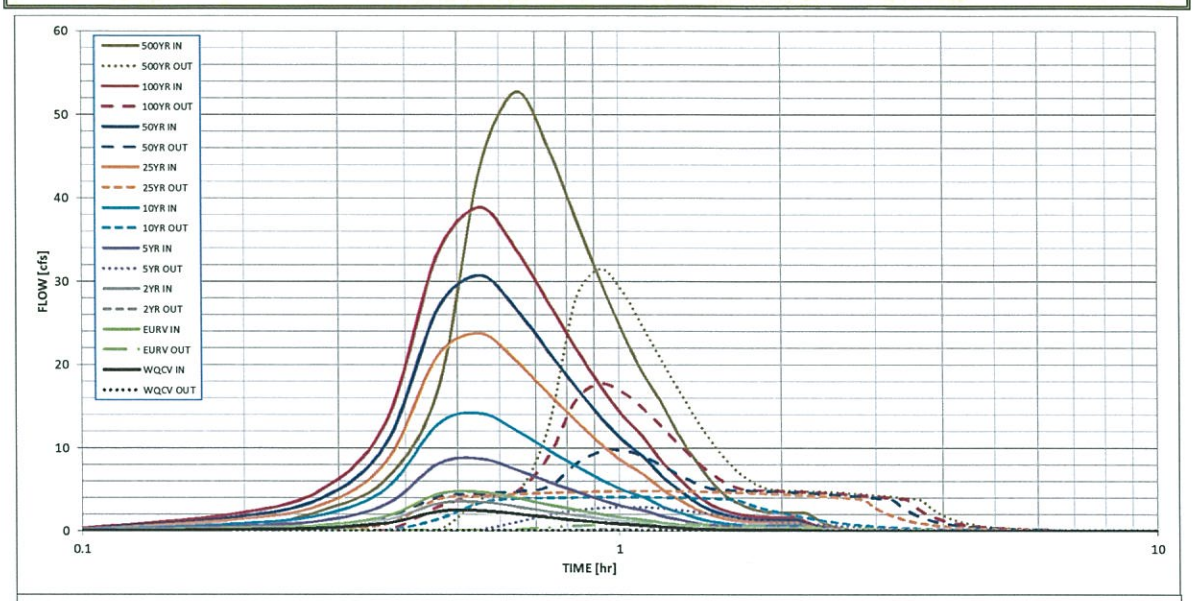
Calculated Parameters for Spillway

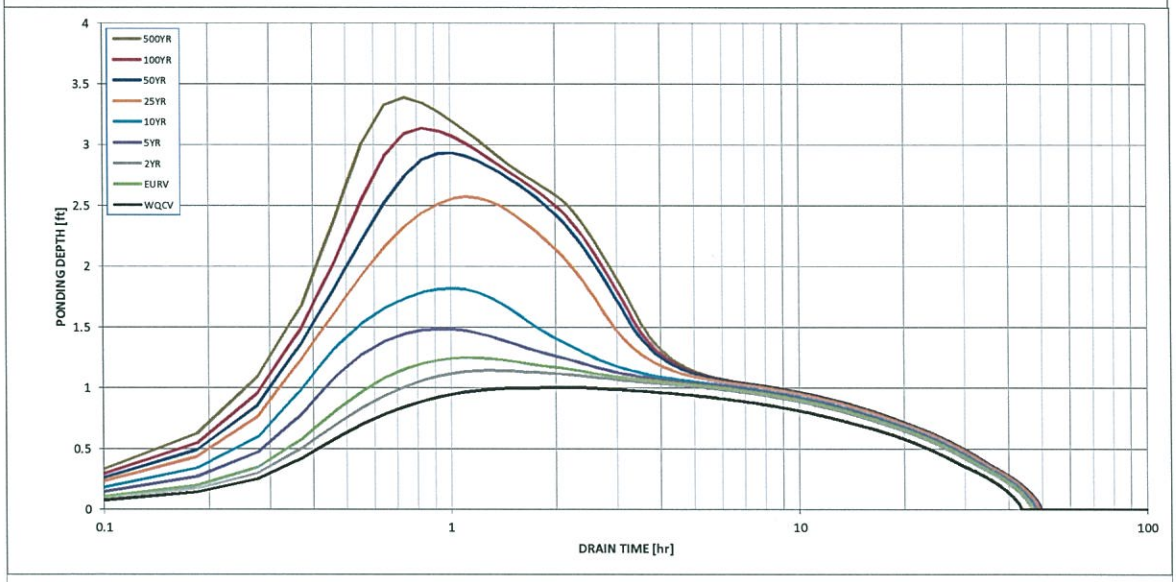
Spillway Design Flow Depth=	0.87	feet
Stage at Top of Freeboard =	4.57	feet
Basin Area at Top of Freeboard =	0.61	acres

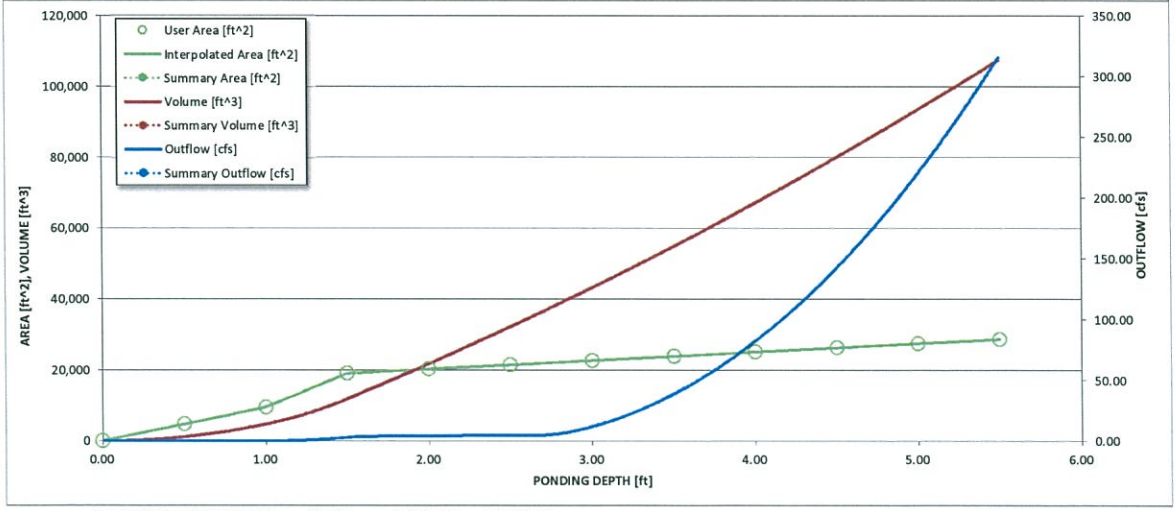
Routed Hydrograph Results

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.01
Calculated Runoff Volume (acre-ft) =	0.121	0.231	0.173	0.431	0.704	1.186	1.537	1.949	2.637
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.121	0.231	0.172	0.430	0.703	1.184	1.536	1.948	2.635
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.17	0.34	0.79	1.02	1.30	1.84
Predevelopment Peak Q (cfs) =	0.0	0.0	0.2	2.5	5.1	11.7	15.2	19.4	27.5
Peak Inflow Q (cfs) =	2.4	4.6	3.5	8.6	14.1	23.7	30.7	38.8	52.7
Peak Outflow Q (cfs) =	0.1	0.9	0.4	2.8	4.0	4.8	9.7	17.6	31.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.1	0.8	0.4	0.6	0.9	1.1
Structure Controlling Flow =	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.06	0.02	0.2	0.3	0.4	0.4	0.4	0.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	39	40	35	31	26	23	19	15
Time to Drain 99% of Inflow Volume (hours) =	41	43	44	42	40	37	35	33	30
Maximum Ponding Depth (ft) =	1.01	1.25	1.14	1.48	1.82	2.57	2.93	3.13	3.39
Area at Maximum Ponding Depth (acres) =	0.22	0.32	0.28	0.43	0.45	0.50	0.52	0.53	0.54
Maximum Volume Stored (acre-ft) =	0.110	0.175	0.144	0.265	0.412	0.768	0.955	1.060	1.193

Detention Basin Outlet Structure Design







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

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

Time Interval	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]
5.55 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:33	0.00	0.01	0.01	0.02	0.02	0.04	0.05	0.06	0.08
Hydrograph Constant	0:11:06	0.14	0.27	0.20	0.48	0.75	1.21	1.52	1.86	2.39
	0:16:39	0.34	0.64	0.48	1.16	1.85	3.03	3.86	4.81	6.35
0.900	0:22:12	0.94	1.76	1.32	3.21	5.11	8.32	10.58	13.15	17.26
	0:27:45	2.35	4.42	3.32	8.07	12.87	21.02	26.76	33.30	43.85
	0:33:18	2.44	4.65	3.46	8.65	14.09	23.69	30.68	38.85	52.71
	0:38:51	2.03	3.90	2.90	7.30	12.00	20.38	26.56	33.85	46.15
	0:44:24	1.62	3.12	2.32	5.87	9.68	16.53	21.60	27.59	37.67
	0:49:57	1.30	2.51	1.86	4.71	7.76	13.24	17.29	22.07	30.11
	0:55:30	1.01	1.96	1.45	3.69	6.10	10.43	13.64	17.44	23.82
	1:01:03	0.80	1.55	1.15	2.92	4.84	8.27	10.81	13.81	18.84
	1:06:36	0.67	1.29	0.96	2.43	3.99	6.78	8.82	11.23	15.27
	1:12:09	0.47	0.91	0.68	1.73	2.86	4.91	6.43	8.24	11.31
	1:17:42	0.36	0.69	0.51	1.30	2.15	3.67	4.80	6.14	8.38
	1:23:15	0.24	0.47	0.35	0.90	1.49	2.57	3.37	4.32	5.94
	1:28:48	0.18	0.35	0.26	0.65	1.08	1.86	2.43	3.11	4.24
	1:34:21	0.14	0.27	0.20	0.51	0.84	1.44	1.88	2.40	3.28
	1:39:54	0.12	0.22	0.17	0.42	0.69	1.18	1.53	1.95	2.66
	1:45:27	0.10	0.20	0.15	0.38	0.62	1.04	1.35	1.72	2.33
	1:51:00	0.10	0.19	0.14	0.36	0.59	0.99	1.29	1.64	2.22
	1:56:33	0.10	0.19	0.14	0.35	0.58	0.97	1.26	1.60	2.17
	2:02:06	0.10	0.19	0.14	0.35	0.58	0.97	1.26	1.60	2.17
	2:07:39	0.10	0.19	0.14	0.35	0.58	0.97	1.26	1.60	2.17
	2:13:12	0.06	0.12	0.09	0.22	0.37	0.64	0.85	1.09	1.51
	2:18:45	0.03	0.07	0.05	0.13	0.22	0.38	0.50	0.64	0.89
	2:24:18	0.02	0.04	0.03	0.07	0.12	0.21	0.28	0.37	0.51
	2:29:51	0.01	0.02	0.02	0.04	0.07	0.12	0.15	0.20	0.28
	2:35:24	0.00	0.01	0.01	0.02	0.03	0.06	0.08	0.10	0.14
	2:40:57	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04
	2:46:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:52:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:57:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:03:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:08:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:14:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:19:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:36:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:42:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:47:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:53:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:58:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:04:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:09:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:31:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:37:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:43:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:48:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:54:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:59:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:16:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:21:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:27:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:33:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:38:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:44:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:49:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:06:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:11:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:17:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:22:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:28:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:34:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:39:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

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

APPENDIX C

DESIGN CHARTS

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

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

Figure 6-25. Estimate of Average Concentrated Shallow Flow

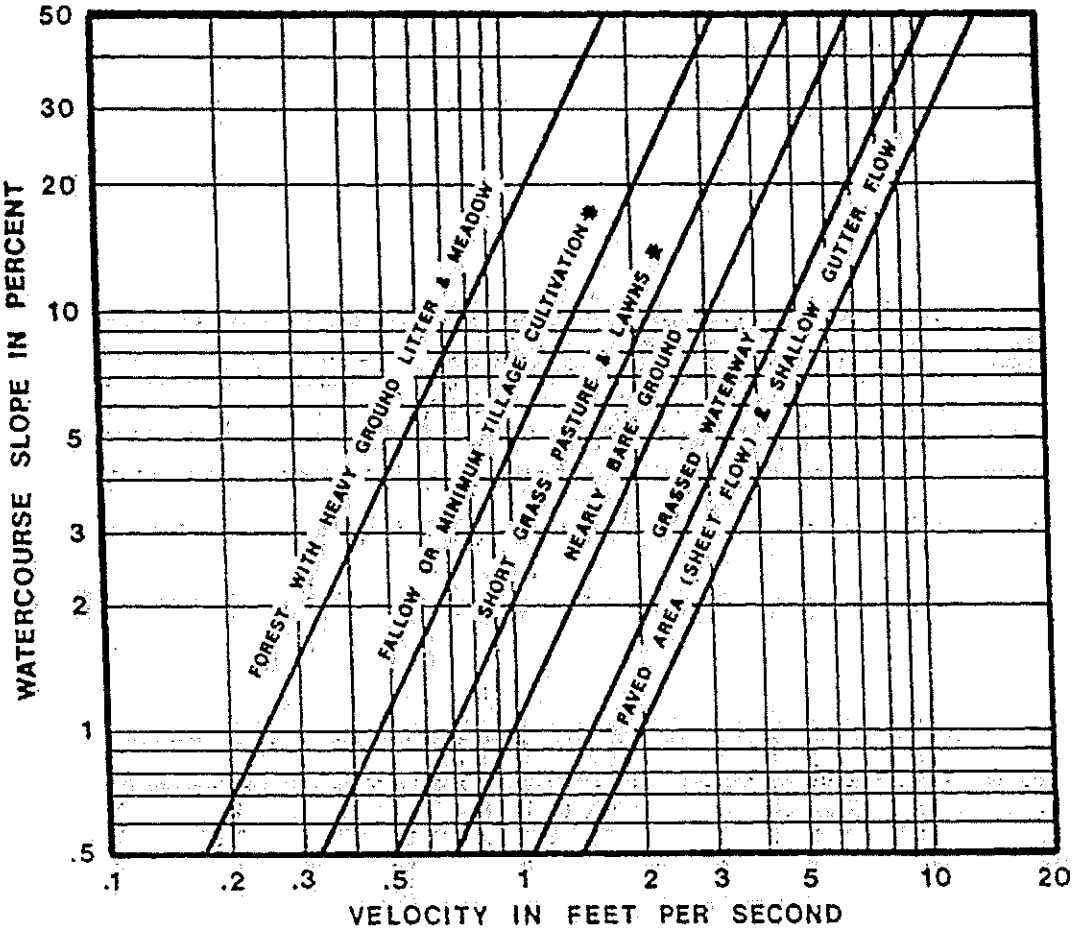
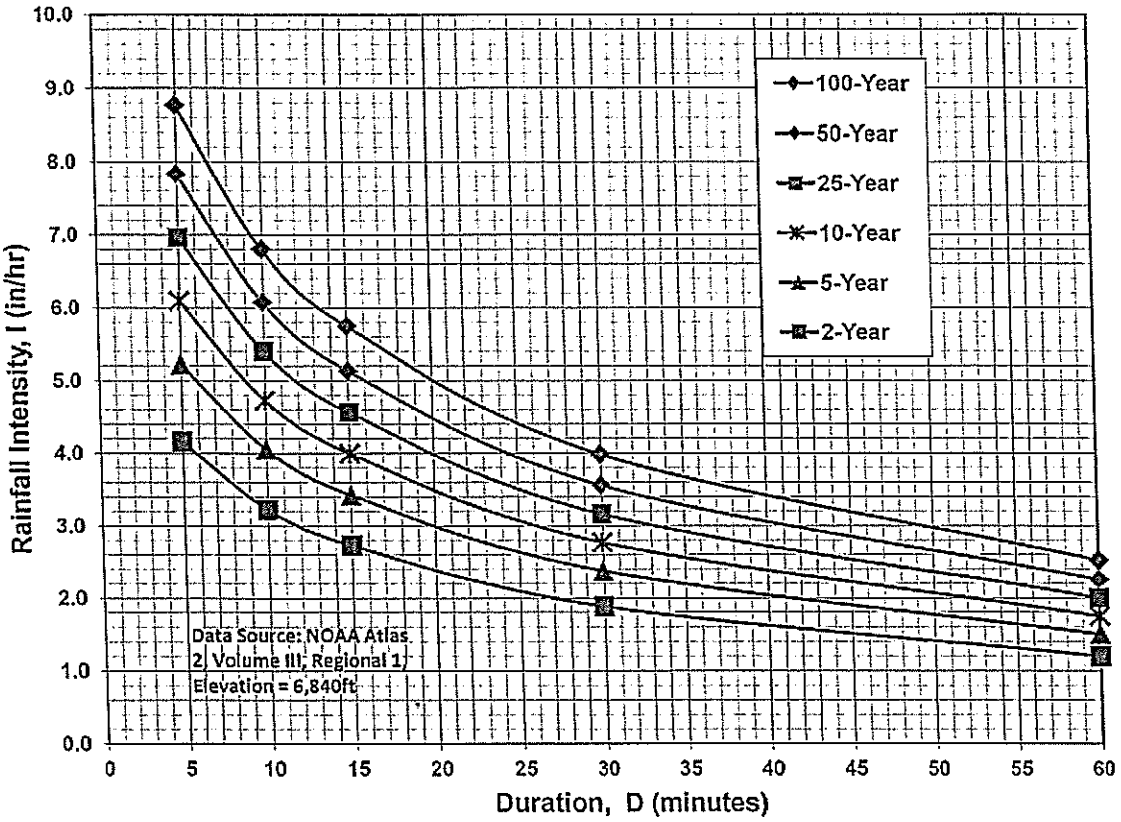


Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

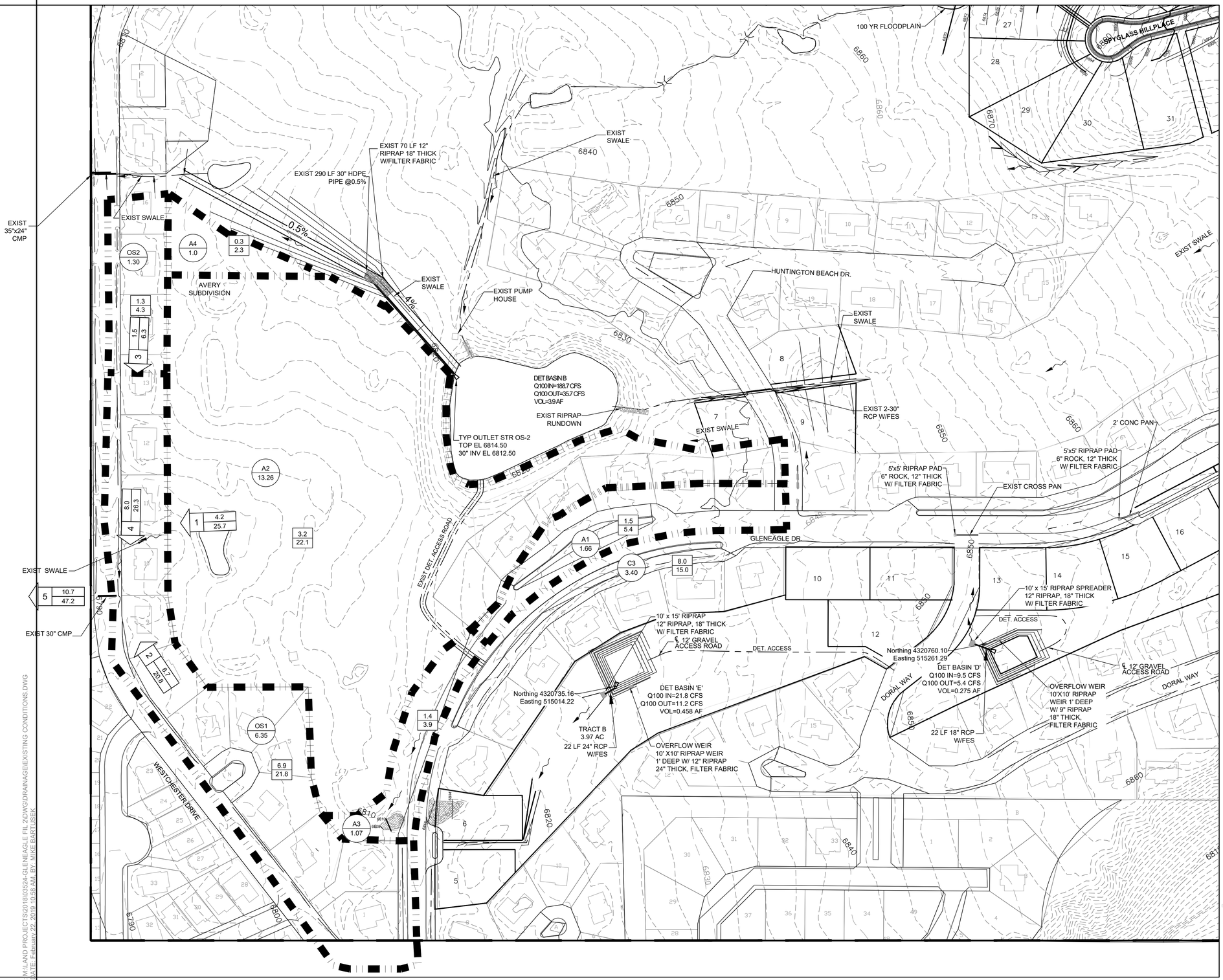


TABLE 1 – EXISTING CONDITIONS		
Sub-Basin	**Q5CFS**	**Q100 CFS**
A1	1.5	5.4
A2	3.2	22.1
A3	1.4	3.9
A4	0.3	2.3
OS1	6.9	21.8
OS2	1.3	4.3
DP1(A1+A2)	4.2	25.7
DP2(A3+OS1)	6.7	20.8
DP3(A4+OS2)	1.5	6.3
DP4(DP2+DP3)	8	26.3
DP5(DP4+DP1)	10.7	47.2

GRAPHIC SCALE

(IN FEET)
1 inch = 100 ft.

REVISION

DESIGNED	MAB
DRAWN	HJG
CHECKED	MAB
DATE	11/26/18

RESPEC
3520 AUSTIN BLUFFS PARKWAY
SUITE 102
COLORADO SPRINGS, CO 80918
PHONE (719) 266-5212

STAMP

Know what's **below.** **Call** before you dig.

PROJ NO. 03524
DWG NM. 03524-Dev-Fil2

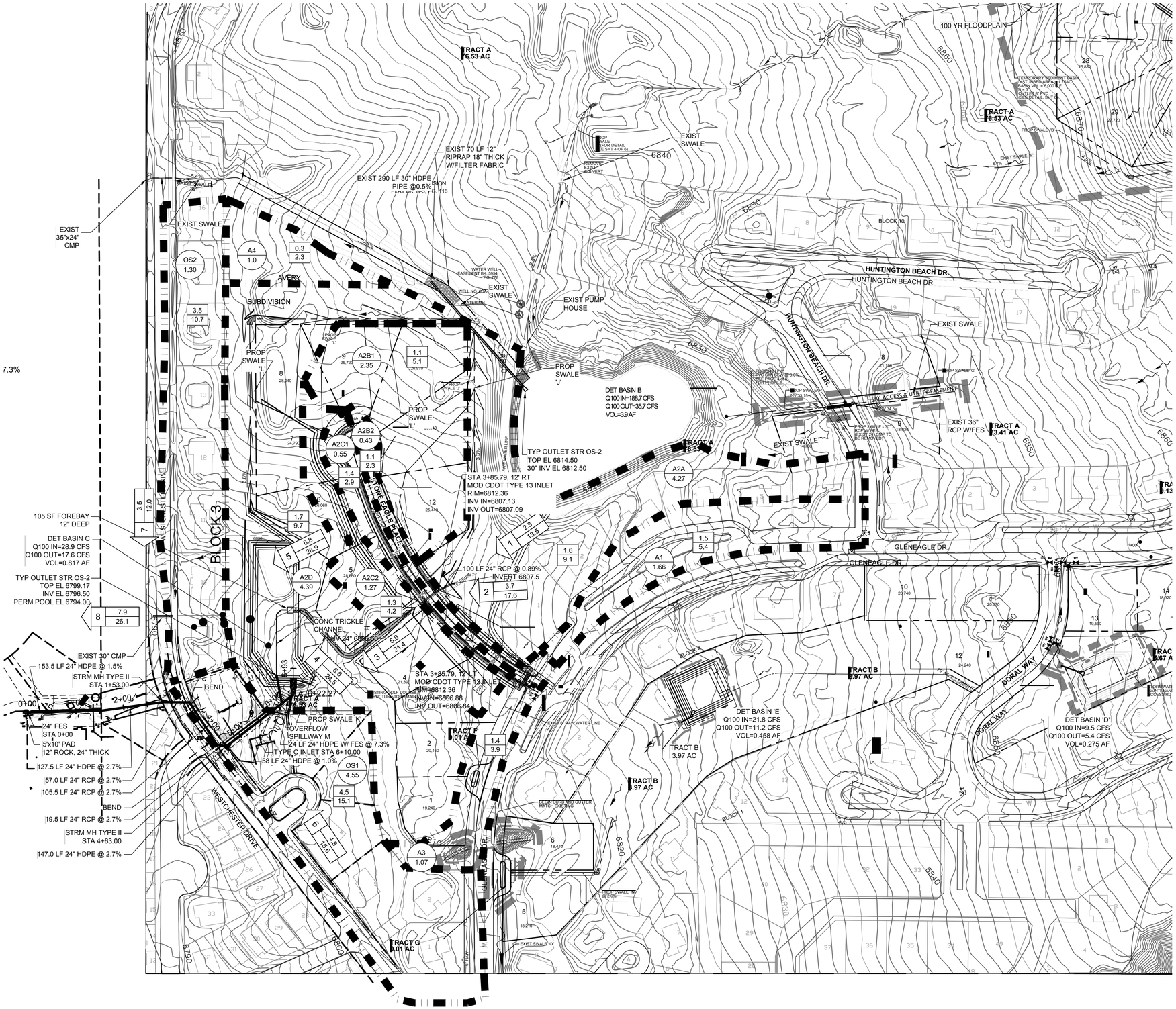
Guman & Associates, LLC
731 N Weber St, Suite 10
COLORADO SPRINGS, CO. 80903

GLENEAGLE SUBDIVISION, FIL #2

EXISTING CONDITIONS

DRAWING NUMBER:
C
SHEET 1

NAME: M:\LAND PROJECTS\2018\03524-GLENEAGLE FIL 2\DWG\DRAINAGE\EXISTING CONDITIONS.DWG
PLOT DATE: February 22, 2019 10:38 AM BY: MIKE BARTLISEK



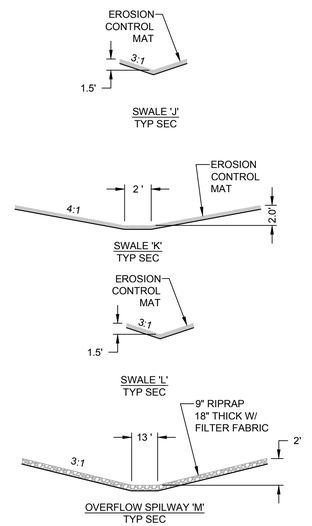


TABLE 2 – DEVELOPED CONDITIONS		
Sub-Basin	**Q5CFS**	**Q100 CFS**
OS1	4.5	15.1
OS2	3.5	10.7
A1	1.5	5.4
A2A	1.6	9.1
A2B1	1.1	5.1
A2B2	1.1	2.3
A2C1	1.4	2.9
A2C2	1.3	4.2
A2D	1.7	9.7
A3	1.4	3.9
A4	0.3	2.3
DP1 (A1+A2A)	2.8	13.5
DP2 (DP1+A2B1)	3.7	17.6
DP3 (DP2+A2B2+A2C1)	5.6	21.4
DP4(DP3+A2C2)	6.6	24.5
DP5 (DP4+A4B)	6.8	28.9
DP6 (OS1+A3)	4.8	15.6
DP7 (OS2+A4)	3.5	12
DP8 (DP6+DP7)	7.9	26.1

GRAPHIC SCALE

(IN FEET)
1 inch = 100 ft.

REVISION	
DESIGNED	MAB
DRAWN	HJG
CHECKED	MAB
DATE	11/26/18

RESPEC
3520 AUSTIN BLUFFS PARKWAY
SUITE 102
COLORADO SPRINGS, CO 80918
PHONE (719) 266-5212

STAMP

Know what's **below.** **Call** before you dig.

PROJ NO. 03524
DWG NM. 03524-Dev-Fil2

Guman & Associates, LLC
731 N Weber St, Suite 10
COLORADO SPRINGS, CO. 80903

GLENEAGLE SUBDIVISION, FIL #2

DEVELOPED CONDITIONS

DRAWING NUMBER:
C
SHEET 2

NAME: M:\LAND PROJECTS\2018\03524-GLENEAGLE FIL 2\DWG\DRAINAGE\DEVELOPED CONDITIONS.DWG
PLOT DATE: February 20, 2019 4:22 PM BY: JIM GILL