Final Drainage Report

for

Clear View Properties I, LLC
Clear View Industrial Park Filing No. 2B

Prepared for:
El Paso County Planning and
Community Development Department
2880 International Circle, Suite 110
Colorado Springs, CO 80910
(719) 520-6300

On Behalf of:
Clear View Properties I, LLC
9720 Arroya Lane
Colorado Springs, CO 80908
(719) 337-3534

Prepared by:
CTR Engineering, Inc.
16392 Timber Meadow Drive
Colorado Springs, CO 80908

PCD File No. SF2029

January 2021

Design Engineer 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.

SIGNATURE: ______________________ Date: ________________
Jonathan Moore, PE No. 34944

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

____________________ Date: ________________
Kevin Ferguson, Owner
Clear View Properties I, LLC
9720 Arroya Lane
Colorado Springs, CO 80908

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, P.E Date
County Engineer/ECM Administrator

Conditions:

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Appendix

I. General Location and Description

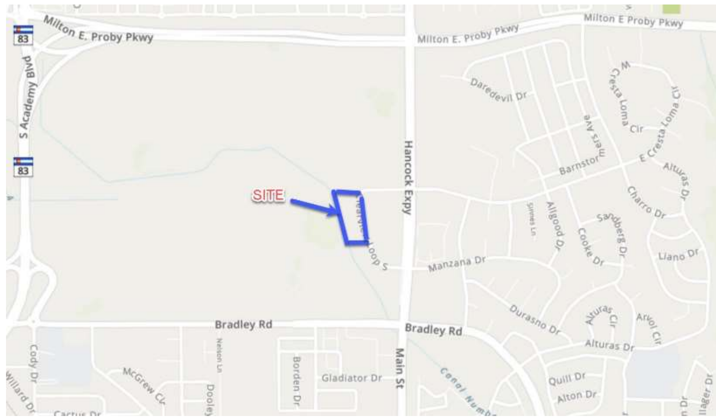
A. Location

An industrial subdivision, Clear View Industrial Park Filing No. 2B, is in Security, CO on Clear View Loop, approximately a quarter mile southwest of intersection of Milton E. Proby Parkway and Hancock Expressway.

A portion of the eastern half of the east half of the section 2, Township 15 south, range 66 west of the 6th P.M., of the City of Colorado Springs, County of El Paso, State of Colorado, shows no major drainageways or facilities existing near the site, with the exception of the Fountain Mutual Canal, which is west of the site.

<u>Names of surrounding platted developments:</u>

North – New Sunshine, LLC, a commercial/industrial building
South – Clear View Industrial Park Filing No. 1
East - Clear View Industrial Park Filing No. 1
West – Security Water and Wastewater District, agriculture ground



B. Description of property

The 2.7+/- acre site consists of 4 platted lots approved in 2008. Lot 3B contains an existing building and earthen storage yard. Lot 2B will contain the water quality pond for lots 1-3, the previous lot 4A will be converted to an easement of land within lot 2B dedicated to only a water quality pond, and will not have any structures built on it. Ground cover consists of bare ground and native grasses; and lot 3B contains some existing trees and shrubs. General topography directs all storm runoff in a westerly direction towards the Fountain Mutual Canal. General soil is Blakeland loamy sand with a Hydrologic Soil Group (HSG) of A.

No major drainageways exist on-site or adjacent to the property. No irrigation facilities exist on-site, but when lots 1B and 2B develop, they will most likely install irrigation systems for on-site landscaped areas. Lot 3B is fully developed with an existing building and gravel parking area, and contains private utility service lines, and there is an existing Security Water and Wastewater District sanitation line running along the western property boundary; however, that line has been abandoned. Normal public utilities run within the Clear View Loop right-of-way.

II. Drainage Basins and Sub-basins

A. Major basin descriptions

This site is located in the Little Johnson/Security Creek Drainage Basin Planning Study. No public improvements are called out within this property from the Study. There is no major drainage basin existing on this small site. This site lies within the County's Little Johnson drainage basin. Per the flood insurance map 08041C0763G, dated 12/7/2018, no floodplains or irrigation facilities exist on-site.

B. Sub-basin description

Existing - Historically, drainage flows have sheet flowed undetained in a westerly direction to the Fountain Mutual Canal (FMC). The entire site acting like one sub-basin. No off-site drainage patterns affect this site. Drainage runoff in Clear View Loop flow in an existing swale along Clear View Loop to the southern end of the property where they are joined with other County flows from the south and enter an existing ditch that flows to the FMC.

Proposed – Each lot has been designed as a sub-basin.

Please revise to reference ECM Appendix I.7.1.C.1.a and include a statement about how it is impractical to capture runoff from 2B-1L and direct it to the EDB.

Lot 1B flows will sheet flow to a temporary swale along the western side of the lot and then be directed to a storm pipe within lot 2B, which directs flows to the water quality pond. The temporary swale will be removed when this lot develops at some future date. It is anticipated that when lot 1B is developed, the lot owner will have to install curb and gutter to maximize their parking area.

Lot 2B flows will sheet flow to a temporary swale along the western side of the lot and then be directed to a storm pipe, which directs flows to the water quality pond. The temporary swale will be removed when this lot develops at some future date. The previous lot 4a will be converted to a drainage easement within the proposed Lot 2B. The owner of lot 2B will own and maintain the water quality pond within the drainage easement. It is anticipated that when lot 2B is developed, the lot owner will have to install curb and gutter to maximize their parking area.

Drainage Easement– This area has been divided into two basins. 1) a pond area basin (2B-1P) that will capture rainwater. 2) the landscaped area (2B-1L) around the western side of the pond. This area naturally slopes away from the pond and therefore will not be able to drain back into the water quality pond but will follow historic drainage patterns, and sheet flow to the ditch.

Lot 3B flows will be directed via a swale to an inlet and then via a storm pipe to another storm pipe in the drainage easement area, which will direct all flows to the water quality pond.

III. Drainage Design Criteria

A. Development criteria reference

The rational method was used to determine storm runoff flows, as found in the City of Colorado Springs Drainage Criteria Manual Volume 1, chapter 6. The water quality pond design is based on the Mile High Flood District spreadsheet, February 2020. No master drainage plans exist for this subdivision. No deviations are being requested. A previous drainage study by Classic Engineering, Inc., dated 2008, was submitted with the original subdivision plat. However, that drainage report designed individual water quality ponds per lot; that design is no longer being considered.

B. Hydrologic criteria

Design rainfall was calculated using the Colorado Springs Intensity Frequency Curve, found in the Appendix of this report. Runoff calculations used a weighted imperviousness for the entire site, based on percent imperviousness per lot, in order to create the overall runoff coefficient for the Rational Method. The 5-year and 100-year storm recurrence intervals were used to calculate peak runoff flows to design the storm and swale systems. Detention discharge and storage calculations were completed by the Mile High Flood District spreadsheet, with the Colorado Springs rainfall data inserted into the spreadsheet. Detention discharge will be via a concrete box with a flow limiting orifice plate. An emergency overflow weir has also been designed for any flows that exceed the 100-year storm event or pond volume capacity.

See the appendix for DCM table 6-6 for runoff coefficients, however, in some cases higher runoff coefficients were used along with higher impervious coefficients. Lot 3B imperviousness was calculated using existing field conditions.

IV. Drainage Facility Design

A. General concept

No off-site runoff flows will enter the site. All on-site storm flows will be intercepted by temporary swales and directed to proposed storm pipes that will carry the storm water to the water quality pond. Flow will be directed in a northerly direction. The drainage plan in the Appendix of this report shows all proposed topo, swales, storm pipes, and water quality pond. The extended detention basin (Full Spectrum Detention) has been designed with: 1.) a forebay, 2.) Water Quality Capture Volume (WQCV), 3.) Excess Urban Runoff Volume (EURV) and 4.) the 100-year storm event. See Appendix for all hydraulic tables and calculations. The Flowmaster program was also used to determine swale and storm pipe flow capacities.

B. Specific details

No off-site flows will affect this site or the proposed storm collection system, or water quality treatment pond. El Paso County does have street flows from Clear View Loop, which flow in a ditch along Clear View Loop to the southern edge of Lot 1B, then flow through an existing drainage swale on the southern property line to Fountain Mutual Canal. These offsite flows do not enter the site.

A hydraulic soil group of "B" was used with the sizing of the water quality pond for conservative design approach.

The following are <u>existing</u> and <u>proposed</u> composite (Comp.) hydrologic conditions for the site:

Summary of Drainage Calculations (Existing)

Basin	Design Point	Area**	Area	Impervious Area	Pervious Area	% Imper.	5 Comp.	100 Comp	Q(100) (cfs)
		(Sq. Ft.)	(Acres)	(Sq. Ft.)	(Sq. Ft.)	%	"C"	"C"	
Lot 1A		21,796	0.50	-	21,796	0%	0.08	0.35	1.6
Lot 2A		21,827	0.50	-	21,827	0%	0.08	0.35	1.6
Lot 3A		43,447	1.00	30,500	12,947	70%	0.44	0.77	6.9
Lot 4A		33,455	0.77	-	33,455	0%	0.08	0.35	2.4
Onsite Totals		120,525	2.767	30,500	90,025	25%	0.21	0.50	12.5

There will be no impacts on existing storm facilities from the construction of the water quality and storm system for this site. On the contrary, this development will help the storm runoff conditions, as current storm runoff flows directly into the Fountain Mutual Canal, without any water quality or detention.

HDPE pipe will be used in the construction of the storm system, along with multi-chamber concrete box as the outlet structure. Nyloplast inlets will also be used. Riprap

Summary of Drainage Calculations (Proposed)

Basin	Design Point	Area**	Area	Impervious Area	Pervious Area	% Imper.	5 Comp.	100 Comp	Q(100) (cfs)
		(Sq. Ft.)	(Acres)	(Sq. Ft.)	(Sq. Ft.)	%	"C"	"C"	
Lot 1B		21,796	0.50	18,526	3,270	85%	0.51	0.86	3.9
Lot 2B		21,827	0.50	18,552	3,275	85%	0.51	0.86	3.9
Lot 3B		43,447	1.00	30,500	12,947	70%	0.44	0.77	6.9
2B-1P (pond area)		23,125	0.53	-	23,125	0%	0.08	0.35	1.6
2B-1L (land area)		10,330	0.24	-	10,330	0%	0.08	0.35	0.7
Combined (Lots 1B-3B)	Forebay	87,070	2.00	67,578	19,492	78%	0.48	0.82	14.8
Onsite Totals		110,195	2.530	67,578	42,617	61%	0.39	0.72	17.1

will be used at various places around the site to minimize erosion. The storm pipe system has been aligned at the lower end of lots 1A and 2A to capture runoff and direct it to the water quality pond.
No drainage impacts on streets or utilities are found, therefore, no additional work is required for this development. All storm pipes have been designed to carry the 100-year storm event flows. No environmental features exist on-site.

Maintenance access will be off Clear View Drive, with an accessible drive lane down to the bottom of the water quality pond. Clear View Drive from Clear View Loop is a gravel road with weekly use by several different agencies. The owner of this project has a lock on the gate along with other agencies. El Paso County will have the ability to add their inspection department lock on the gate at Clear View Loop. A 12-foot wide bench has also been provided around the western edge of the water quality pond.

The full spectrum detention pond design calculations were completed, using the Mile High Flood District spreadsheet, and can be found in the Appendix of this report. No reservoir routing is required with this development. All hydrology and hydraulic calculations can also be found in the Appendix. The proposed extended detention basin (water quality pond) is being designed for the required County water quality and flood control for lots 1B through 3B.

The storm facility cost estimate can be found in the Appendix of this report. The calculated private cost estimate is $63,110. The property owner already posted approximately $60,000 back in 2008 and has installed the silt fence and the traffic pad. We propose that no other financial assurances will be required at this time.

All drainage fees and bridge fees were paid with the final plat, recorded in 2008; the County might require additional fees with this replat.

Please update statement regarding fees per email on 2/2/2021.

C. Other government agency requirements
The Fountain Mutual Ditch Company (FMDC) will need to review and approve the storm outfall for this project. They have asked for a concrete apron around the storm pipe to protect the bank, which has been provided in the construction drawings. The FMDC has indicated that they are pleased that the storm water runoff will now be contained and released at a steady state rate rather than uncontrolled rate. They have also indicated that their ditch can handle the runoff from this site with them approving this development, per their letter. The outfall pipe invert will be 4.5-foot above the ditch bottom. The ditch bottom will be protected from hydraulic erosion with the proposed concrete apron.
Security Water and Wastewater District has approved the construction drawings based on their comments. No additional outside government agencies needing to review this application.

D. Municipal Separate Storm Sewer System (MS4)
Stormwater quality protection is a very high priority within El Paso County. The following steps outline how this project is incorporating water quality features into its' design and construction:

Four Step Process

Step 1: Employ Runoff Reduction Practices
This development will utilize one entire industrial lot for water quality and will not construct any impervious surfaces within that lot. Lots 1A and 2A will be encouraged to utilize inverted landscaped islands to help reduce the runoff volumes and to reduce impervious surface connectivity. Lot 3A is utilizing a gravel parking area, instead of asphalt. Trees and vegetation along the outside of the property will remain untouched.

Step 2: Stabilize Drainageways
Currently this development drains uncontrolled storm flows to the Fountain Mutual Canal. With the construction of the Extended Detention Basin (EDB), storm flows will now be able to settle sediment particles out and control the release rate of major storm events. The outfall design will follow recommendation from the Fountain Mutual Canal company for channel protection. Riprap will be added to the outfall to protect the canal from erosion. No major drainageways are proposed or are existing.

Step 3: Provide Water Quality Capture Volume (WQCV)
This development will utilize an Extended Detention Basin (EDB) water quality pond that will slowly release storm flows. The entire site will be designed to drain to the EDB facility. Structural BMPs that will be used during this project include: 1.) concrete forebay, 2.) concrete outlet box that will release storm flows over a 40-hour period, 3.) concrete micro pool, and 4.) drainage swales to direct water to the storm pipe system (replaced by curb and gutter when lots 1B and 2B develop).
All disturbed areas will be seeded and mulched. No site watering will be used, as the seeding mix will be native grasses and plants. Erosion blankets for 3:1 slopes and erosion logs, within the swales, will be used.
Final stabilization will occur by placing erosion blankets, seeding, and mulching. Lot 3A is already developed, lot 4A will contain only the water quality pond and lots

1A and 2A will develop once they are sold. Long-term stormwater management will be achieved by the development of lots 1A and 2A and by following the IM Plan for the Extended Detention Basin Water Quality Pond.

Step 4: Consider Need for Industrial and Commercial BMP's
This development is zoned Industrial as is the majority of the surrounding area. Specific industrial and commercial BMPs were consider, however, lot 3B is already developed, and lots 1B and 2B are not proposed for development at this time. Both lots are approximately ½ acre in size and a previous development plan showed them containing small offices and parking lots. Lots 1B and 2B will have to submit site development plans and if a use is determined to contain hazardous material, then spill containment and control considerations must be considered in the design. Covering for storage or handling areas must also be considered if they pose a threat to water quality. Other specialized BMP's could be required with the development of lots 1B and 2B. Lot 3B is existing and is currently being used as a truck repair shop. All truck repairs are completed within the existing building. The owner of lot 3B is following all environmental requirements as part of his business license, no specialized consideration will be required for this lot.

V. Conclusion

There is no storm runoff water quality facilities for this development. The grading, storm, and erosion control plans will provide full spectrum detention for this site. Current storm events run directly into Fountain Mutual Canal with no water quality or detention. Construction of these improvements will help the County with their commitment to provide water quality to all projects within the region.

This development will not have any negative impacts to downstream properties and structures.

The current owner of lot 2B (Clear View Properties I, LLC) will be responsible for the maintenance of the pond.

VI. References

Little Johnson/Security Creek Drainage Basin Planning Study, by Kiowa Engineering, dated 1988

City of Colorado Springs Drainage Criteria Manual Volume 1, dated May 2014

City of Colorado Springs Drainage Criteria Manual Volume 2, dated May 2014

Mile High Flood District spreadsheets, dated February 2020

Final Drainage Report - Clear View Industrial Park Subdivision by Classic Engineering, Inc., dated 2008

El Paso County Drainage Criteria Manual Volume I, dated 10/11/94

El Paso County Engineering Criteria Manual, dated 12/13/2016

Urban Storm Drainage Criteria Manual Volume I, dated August 2018

Urban Storm Drainage Criteria Manual Volume II, dated August 2018

Urban Storm Drainage Criteria Manual Volume III, dated October 2019

Appendix

Clear View Industrial Park

Rational Method Hydologic Analysis
Developed Conditions

Composite "C" Values (Proposed)

Basin	Design Point	Area**	Area	Impervious Area	Pervious Area	% Imper.	5 Comp.	100 Comp
		(Sq. Ft.)	(Acres)	(Sq. Ft.)	(Sq. Ft.)	%	"C"	"C"
Lot 1B		21,796	0.50	18,526	3,270	85%	0.51	0.86
Lot 2B		21,827	0.50	18,552	3,275	85%	0.51	0.86
Lot 3B		43,447	1.00	30,500	12,947	70%	0.44	0.77
2B-1P (pond area)		23,125	0.53	-	23,125	0%	0.08	0.35
2B-1L (land area)		10,330	0.24		10,330	0%	0.08	0.35
Combined (Lots 1B-3B)	Forebay	87,070	2.00	67,578	19,492	78%	0.48	0.82
Onsite Totals		110,195	2.530	67,578	42,617	61%	0.39	0.72

5 Impervious "C"	0.59
5 Pervious "C"	0.08
100 Impervious "C"	0.95
100 Pervious "C"	0.35

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Clear View Industrial Park

Rational Method Hydrologic Analysis
Developed Conditions

Proposed Conditions

			Weighted Coefficients		CA		Overland Time			Swale				Asphalt/Dirt/Pipe					Intensity			Peak Runoff		
Sub-Basin Designation	Design Point	Total Area (ac.)	C(5)	C(100)	CA(5)	CA(100)	Overland Length (ft)	Overland Slope (%)	T(initial) (min.)	Travel Length (ft)	Weighted Slope (%)	Velocity (fps)	T(travel) (min.)	Travel Length (ft)	Weighted Slope (%)	Velocity (fps)	T(travel) (min.)	Final T(c)	I(2) (in/hr)	I(5) (in/hr)	I(100) (in/hr)	**Q(2) (cfs)**	**Q(5) (cfs)**	**Q(100) (cfs)**
Proposed Conditions																								
Lot 1B		0.50	0.51	0.86	0.26	0.43	10	2.0%	4.0	92	1.0%	3.1	0.5	130	1.5%	7.2	0.3	5.0	3.71	5.10	9.09	1.0	1.3	3.9
Lot 2B		0.50	0.51	0.86	0.26	0.43	10	2.0%	4.0	132	1.0%	3.1	0.7	130	1.5%	7.2	0.3	5.0	3.71	5.10	9.09	1.0	1.3	3.9
Lot 3B		1.00	0.44	0.77	0.44	0.77	10	2.0%	4.0	122	1.0%	3.1	0.6	214	1.5%	5.8	0.6	5.3	3.66	5.04	8.97	1.6	2.2	6.9
2B-1P (pond area)		0.53	0.08	0.35	0.04	0.19	20	2.0%	5.7	0	1.0%	3.1	0.0	0	1.5%	7.2	0.0	5.7	3.59	4.94	8.80	0.2	0.2	1.6
2B-1L (land area)		0.24	0.08	0.35	0.02	0.08	20	2.0%	5.7	1	101.0%	31.6	0.0	1	101.5%	59.4	0.0	5.7	3.59	4.94	8.80	0.1	0.1	0.7
Combined (Lots 1-3)	Forebay	2.00	0.48	0.82	0.95	1.63	10	2.0%	4.0	92	1.0%	3.1	0.5	240	1.5%	9.6	0.4	5.0	3.71	5.10	9.09	3.5	4.9	14.8
Total =		2.530	0.39	0.72	0.99	1.82												5.0	3.71	5.10	9.09	**3.7**	**5.0**	**17.1**

C5 = 0.08
Ti=(1.87(1.1-C5)*(L)^.5)/(s)^.33
n (street) 0.016
n (RCP) 0.013
n (HDPE) 0.012
R (street & pipe) 0.50
Tc min. of 5 min.
V=1.49/n)*(.5*^.66)*(s^.5)

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Clear View Industrial Park

Rational Method Hydologic Analysis
Developed Conditions

Summary of Drainage Calculations (Proposed)

Basin	Design Point	Area**	Area	Impervious Area	Pervious Area	% Imper.	5 Comp.	100 Comp	Q(100) (cfs)
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2B-1P (pond area)		23,125	0.53	-	23,125	0%	0.08	0.35	**1.6**
2B-1L (land area)		10,330	0.24	-	10,330	0%	0.08	0.35	**0.7**
Combined (Lots 1B-3B)	Forebay	87,070	2.00	67,578	19,492	78%	0.48	0.82	**14.8**
Onsite Totals		110,195	2.530	67,578	42,617	61%	0.39	0.72	**17.1**

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Existing Conditions

Composite "C" Values (Existing)

Basin	Design Point	Area**	Area	Impervious Area	Pervious Area	% Imper.	5 Comp.	100 Comp
		(Sq. Ft.)	(Acres)	(Sq. Ft.)	(Sq. Ft.)	%	"C"	"C"
Lot 1A		21,796	0.50	-	21,796	0%	0.08	0.35
Lot 2A		21,827	0.50	-	21,827	0%	0.08	0.35
Lot 3A		43,447	1.00	30,500	12,947	70%	0.44	0.77
Lot 4A		33,455	0.77	-	33,455	0%	0.08	0.35
Onsite Totals		120,525	2.767	30,500	90,025	25%	0.21	0.50

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Rational Method Hydrologic Analysis
Existing Conditions

Exiting Conditions

			Weighted Coefficients		CA		Overland Time			Overland				Asphalt/Dirt/Pipe					Intensity			Peak Runoff		
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Proposed Conditions																								
Lot 1A		0.50	0.08	0.35	0.04	0.18	10	2.0%	4.0	173	1.0%	3.1	0.9		1.5%	7.2	0.0	5.0	3.71	5.10	9.09	0.1	0.2	1.6
Lot 2A		0.50	0.08	0.35	0.04	0.18	10	2.0%	4.0	173	1.0%	3.1	0.9		1.5%	7.2	0.0	5.0	3.71	5.10	9.09	0.1	0.2	1.6
Lot 3A		1.00	0.44	0.77	0.44	0.77	10	2.0%	4.0	250	1.0%	3.1	1.3		1.5%	5.8	0.0	5.3	3.65	5.02	8.94	1.6	2.2	6.9
Lot 4A		0.77	0.08	0.35	0.06	0.27	10	2.0%	4.0	105	1.0%	3.1	0.6		1.5%	7.2	0.0	5.0	3.71	5.10	9.09	0.2	0.3	2.4
Total =		2.767	0.21	0.50	0.58	1.39												5.0	3.71	5.10	9.09	**2.1**	**2.9**	**12.5**

C5 = 0.08
Ti=(1.87(1.1-C5)*(L)^.5)/(s)^.33
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Lot 3A		43,447	1.00	30,500	12,947	70%	0.44	0.77	**6.9**
Lot 4A		33,455	0.77	-	33,455	0%	0.08	0.35	**2.4**
Onsite Totals		120,525	2.767	30,500	90,025	25%	0.21	0.50	**12.5**

5 Impervious "C"	0.59
5 Pervious "C"	0.08
100 Impervious "C"	0.95
100 Pervious "C"	0.35

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Clear View Industrial Park

Hydraulic Grade Line (HGL) and Energy Grade Line (EGL)

Station	Tailwater (ft)	Velocity (ft/s)	Gravity (g) ft/sec^2	V^2/2(g)	Invert of Pipe (Elev.)	Normal Depth (ft)	HGL - (Elev.)	Lenth of Pipe (ft)	Fiction Slope of Pipe (ft/ft)	Hf	Hj	Hl	EGL (E2) 100-Year
1000.00	5858.40				5857.00	1.40	5858.40						5858.40
1077.25		8.73	32.2	1.18	5857.90	1.40	5859.30	77.25	0.01476	1.14	0.41	0.44	5862.48
1089.94		8.73	32.2	1.18	5858.36	1.40	5859.76	12.69	0.01476	0.19		0.30	5861.43
1235.91		8.73	32.2	1.18	5860.50	1.40	5861.90	145.97	0.01476	2.15			5865.24

Notes:
It is assumed that the water quality pond water surface elevation equals the major storm pipe depth
Pipe flow is running like an open channel, and is not under pressure
Pipe velocity is taken from the flowmaster pipe calculations
Pipe normal depth is taken from the flowmaster pipe calculations
Hf is the fiction loss for the pipe length
Hj is the junction box loss, K=0.35
Hl is the lateral loss, see Table 7-11
Attached equations and tables are from USCDM Volume 1

$$h_E = K_E \frac{V^2}{2g}$$

Where:

h_E = entrance loss (ft)
V = pipe-full velocity in the incoming pipe (ft/s)

$$E_2 = \max\left(\frac{V_2^2}{2g} + Y_2 + Z_2, E_1\right)$$

Where:

E_2 = EGL at Section 2 (ft)
V_2 = pipe exit velocity (ft/s)
Y_2 = flow depth in feet at the pipe exit (ft)
Z_2 = invert elevation in feet at the pipe exit (ft)
E_1 = tailwater at Section 1 (ft)

$$h_f = LS_f$$

h_f = friction loss (ft)
L = length of pipe (ft)
S_f = friction slope in the pipe (ft/ft)

Friction Slope =	0.01476
Q =	14.99
n =	0.012
z =	1.486
A =	1.72
R =	0.44

Note - numbers from Flowmater pipe calc's

Table 7-11. Bend loss and lateral loss coefficients (FHWA 2009)

Angle in Degree	Bend Loss Coefficient for Curved Deflector in the Manhole	Bend Loss Coefficient for Non-shaping Manhole	Lateral Loss Coefficient on Main Line Pipe
Straight Through	0.05	0.05	Not Applicable
22.50	0.10	0.13	0.75
45.00	0.28	0.38	0.50
60.00	0.48	0.63	0.35
90.00	1.01	1.32	0.25

Lateral Junction Losses
In addition to the bend loss, the lateral junction loss is also introduced because of the added turbulence and eddies from the lateral incoming flows. The lateral junction loss is estimated as:

$$h_j = \frac{V_o^2}{2g} - K_j \frac{V_i^2}{2g} \qquad \text{Equation 7-58}$$

Where:

h_j = lateral loss (ft)

V_o = full flow velocity in the outgoing pipe (ft/s)

K_j = lateral loss coefficient

V_i = full flow velocity in the incoming pipe (ft/s)

The friction slope, S_f, is calculated by rearranging Manning's Equation to Equation 6-24.

$$S_f = \frac{Q^2 n^2}{z^2 A^2 R^{4/3}}$$

Equation 6-24.

where:

S_f = friction slope (ft./ft. or m/m)

Q = discharge (cfs or m^3/s)

n = Manning's roughness coefficient

z = 1.486 for use with English measurements only.

A = cross-sectional area of flow (sq. ft. or m^2)

R = hydraulic radius (ft. or m) = A / WP

WP = wetted perimeter of flow (the length of the channel boundary in direct contact with the water) (ft. or m).

Clear View Industrial Park

Extra Storage Capacity in the Detention Facility

Items	Min. Requirements	Provided	Excess	Comments
Total Site Imperviousness	56%	60%	4%	60% was used in the Mile High Flood District spreadsheet
Lots 1A and 2A Imperviousness	70%	85%	15%	70% imperviousness is recommended for Industrial Subdivions. Each lot site development plan will determine the overall imperviousness of that lot.
Detention Pond Min. Bottom Surface (sf)	3699	4552	853	Extra pond foot print
Total Detention Volume (cu-ft)	**12937**	**17155**	**4218**	**Extra Volume**

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Clear View Industrial Park

Orifce Equations

Q	17.1
C	0.62
A	1.408974
h	5.95

b) Orifice flow may be computed by the following equation:

$$Q = CA(2gH)^{0.5}$$

where:

C = orifice coefficient (dimensionless); for sharp-edged orifices, C = 0.6;

A = cross-sectional area of the pipe, in ft^2;

g = gravitational acceleration constant, 32.2 ft/sec^2; and

H = head above the centerline of the pipe, in ft.

Clear View Industrial Park

Top of Micropool Elev. =	5856.25
Bottom Orifice Elev. =	5856.25
Middle Orifice Elev. =	5857.31
Top Orifice Elev. =	5858.37
Front of Box Elev. =	5859.33
Back of Box Elev. =	5860.15
Emergency Spillway =	5861.15

Stage (Ft.)	Bottom Orifice	Middle Office	Top Orifice	Front Box (Weir)	2 -Side Box Weir	Back Box (Weir)	Flow (cfs)
0	0	0	0	0	0	0	0
1.06	0.0100	0	0	0	0	0	0.010
2.12	0.0141	0.0100	0	0	0	0	0.024
3.08	0.0170	0.1105	0.0762	0	0	0	0.204
3.9	0.0191	0.1038	0.1038	10.16	7.18	0	17.57
4.9	0.0215	0.1524	0.1297	33.59	23.75	13.68	71.32

Weir Coeff.	3.42	
Orifice Coeff.	0.6	
Area (Sq. Ft.)	0.00201	equals 0.29 sq in, 5/8

a) <u>Weir flow</u> may be computed by the following equation:

$Q = CLH^{1.5}$

b) <u>Orifice flow</u> may be computed by the following equation:

$Q = CA(2gH)^{0.5}$

Clear View Industrial Park

Nyloplast Inlet Calc. - Lot 3A

Weir Equation

C =	3.1	Coeff
L =	6.28	Length of weir (ft)
H =	0.66	Depth of Flow (ft)
Q =	**10.44**	**Flow (cfs)**

Note: 100-year runoff for lot 3a = 6.9cfs
inlet sufficient to handle the flow.

Circumference of pipe ©
Dia. = 24 Inches
C = 6.28 Feet

$$C = 2\pi r$$

a) Weir flow may be computed by the following equation:

$$Q = CLH^{1.5}$$

where:

C = weir coefficient (dimensionless); for riser pipes, C = 3.1 may be used;

L = length of weir, in ft. For circular riser pipes, L is the pipe circumference;

H = the depth of flow over the riser pipe crest, in ft; and

Q = discharge, in cfs.

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer:	**Jonathan Moore**
Company:	**CTR Engineering, Inc.**
Date:	**January 23, 2021**
Project:	**Clear View Industrial Park Filing No. 2B**
Location:	

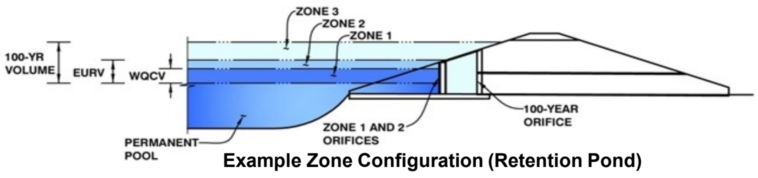
1. Basin Storage Volume			
A) Effective Imperviousness of Tributary Area, I_a	I_a =	60.0	%
B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)	i =	0.600	
C) Contributing Watershed Area	Area =	2.770	ac
D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 =		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}=	0.055	ac-ft
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$)	$V_{DESIGN\ OTHER}$=		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) NRCS Hydrologic Soil Groups of Tributary Watershed			
i) Percentage of Watershed consisting of Type A Soils	HSG_A =		%
ii) Percentage of Watershed consisting of Type B Soils	HSG_B =		%
iii) Percentage of Watershed consisting of Type C/D Soils	$HSG_{C/D}$ =		%
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: $EURV_{C/D} = 1.20 * i^{1.08}$	$EURV_{DESIGN}$ =		ac-f t
K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)	$EURV_{DESIGN\ USER}$=		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 =	2.5	: 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:			
5. Forebay			
A) Minimum Forebay Volume (V_{FMIN} = 1% of the WQCV)	V_{FMIN} =	0.001	ac-ft
B) Actual Forebay Volume	V_F =	0.002	ac-ft
C) Forebay Depth (D_F = 12 inch maximum)	D_F =	12.0	in
D) Forebay Discharge			
i) Undetained 100-year Peak Discharge	Q_{100} =	17.10	cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F =	0.34	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 =	3.6	in

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: **Clear View Industrial Park, Filing 2B**

Basin ID:



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	2.77	acres
Watershed Length =	500	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	60.00%	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
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.055	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.180	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.157	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.217	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.269	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.334	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.389	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.457	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.597	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.139	acre-feet		
Approximate 5-yr Detention Volume =	0.187	acre-feet		
Approximate 10-yr Detention Volume =	0.241	acre-feet		
Approximate 25-yr Detention Volume =	0.261	acre-feet		
Approximate 50-yr Detention Volume =	0.272	acre-feet		
Approximate 100-yr Detention Volume =	0.297	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.055	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.126	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.117	acre-feet
Total Detention Basin Volume =	0.297	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

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

Depth Increment = 0.10 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	--	--	--	10	0.000		
ISV = 5856.58	--	0.33	--	--	--	10	0.000	3	0.000
WQCV	--	1.65	--	--	--	3,884	0.089	2,573	0.059
Elev. 5858	--	1.75	--	--	--	4,541	0.104	2,995	0.069
Elev. 5859	--	2.75	--	--	--	5,198	0.119	7,864	0.181
EURV	--	2.82	--	--	--	5,916	0.136	8,253	0.189
Elev. 5860	--	3.75	--	--	--	6,634	0.152	14,089	0.323
100-Year	--	3.90	--	--	--	6,852	0.157	15,100	0.347
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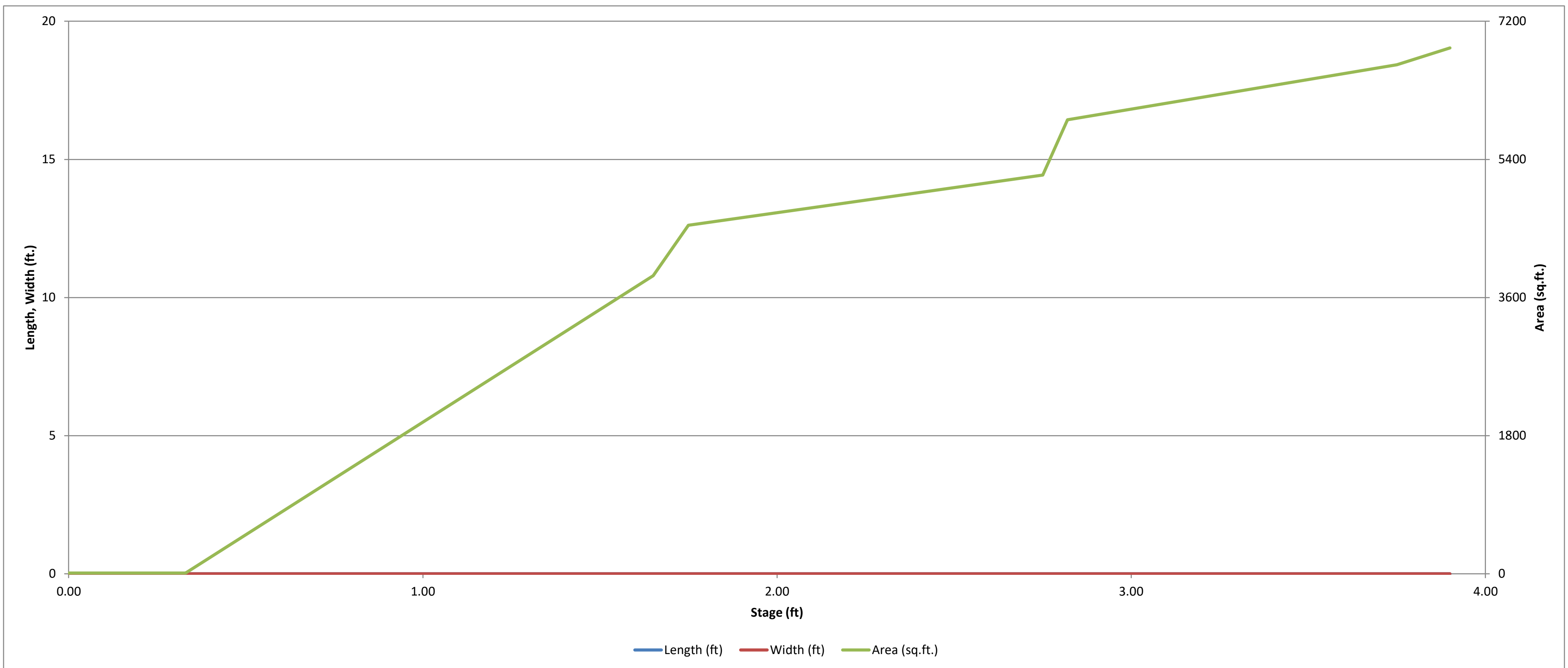
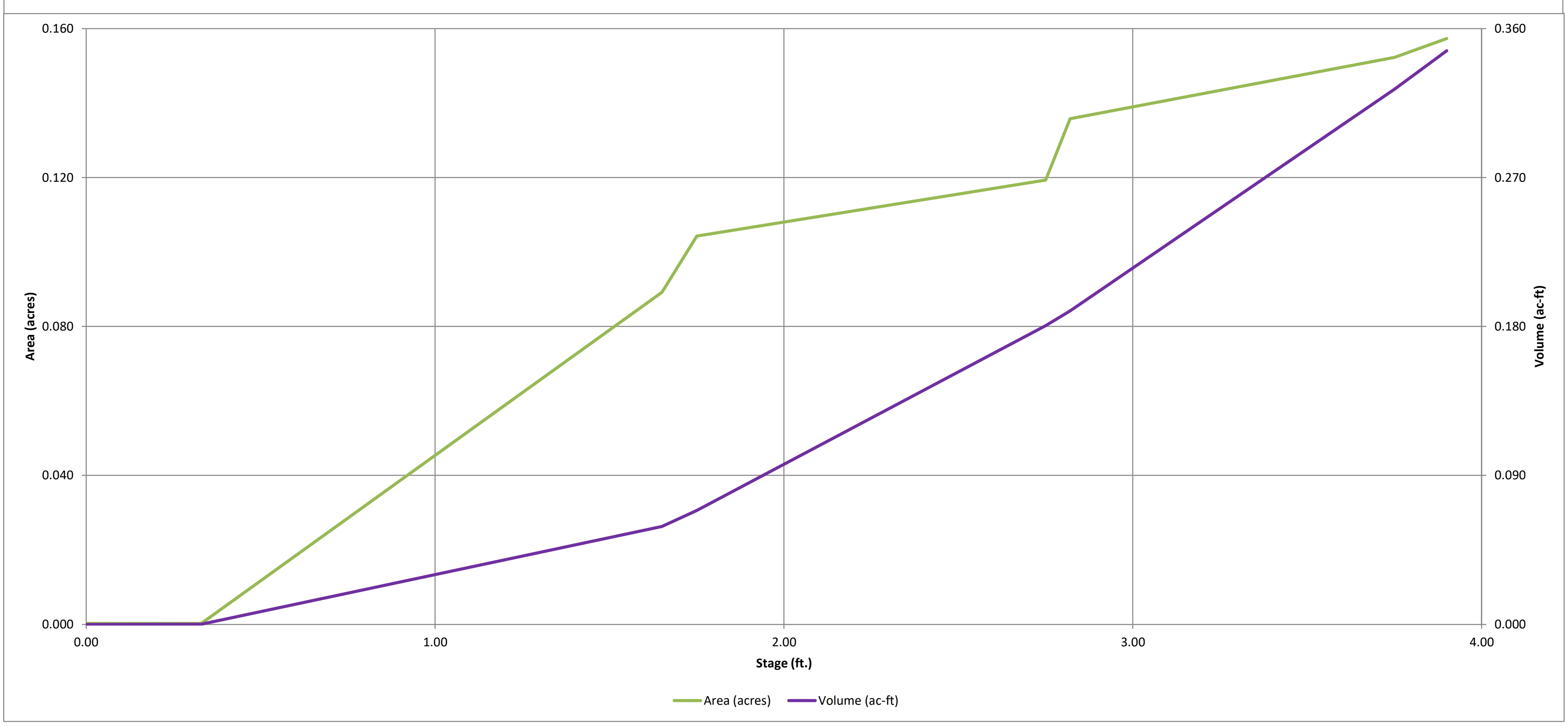
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)



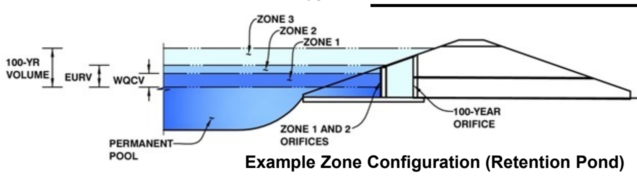


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: Clear View Industrial Park, Filing 2B

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.60	0.055	Orifice Plate
Zone 2 (EURV)	2.75	0.126	Orifice Plate
Zone 3 (100-year)	3.58	0.117	Weir&Pipe (Restrict)
Total (all zones)		0.297	

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 =	3.19	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.80	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	1.06	2.13					
Orifice Area (sq. inches)	0.29	0.70	2.00					

	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 with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.19	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	25%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	4.19	N/A	feet
Overflow Weir Slope Length =	4.12	N/A	feet
Grate Open Area / 100-yr Orifice Area =	18.16	N/A	
Overflow Grate Open Area w/o Debris =	11.54	N/A	ft^2
Overflow Grate Open Area w/ Debris =	8.66	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.70	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	7.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.64	N/A	ft^2
Outlet Orifice Centroid =	0.34	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.35	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.90	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	5.30	feet
Spillway End Slopes =	3.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.74	feet
Stage at Top of Freeboard =	5.64	feet
Basin Area at Top of Freeboard =	0.16	acres
Basin Volume at Top of Freeboard =	0.35	acre-ft

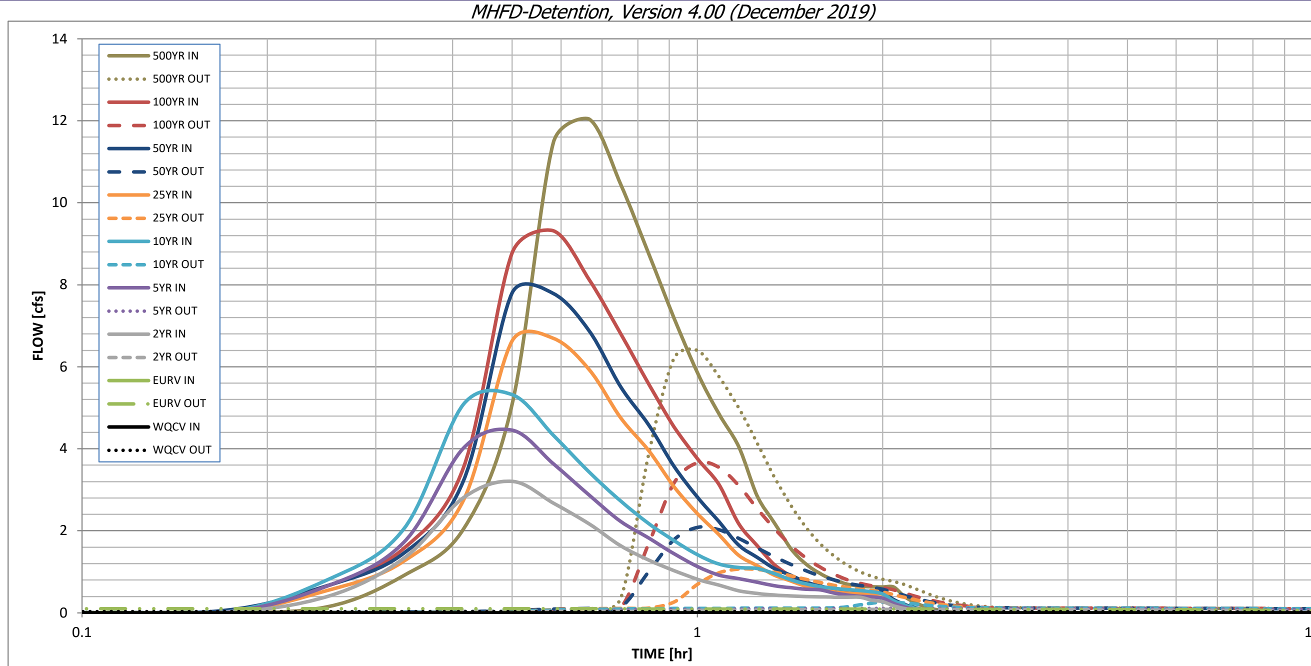
Routed Hydrograph Results

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

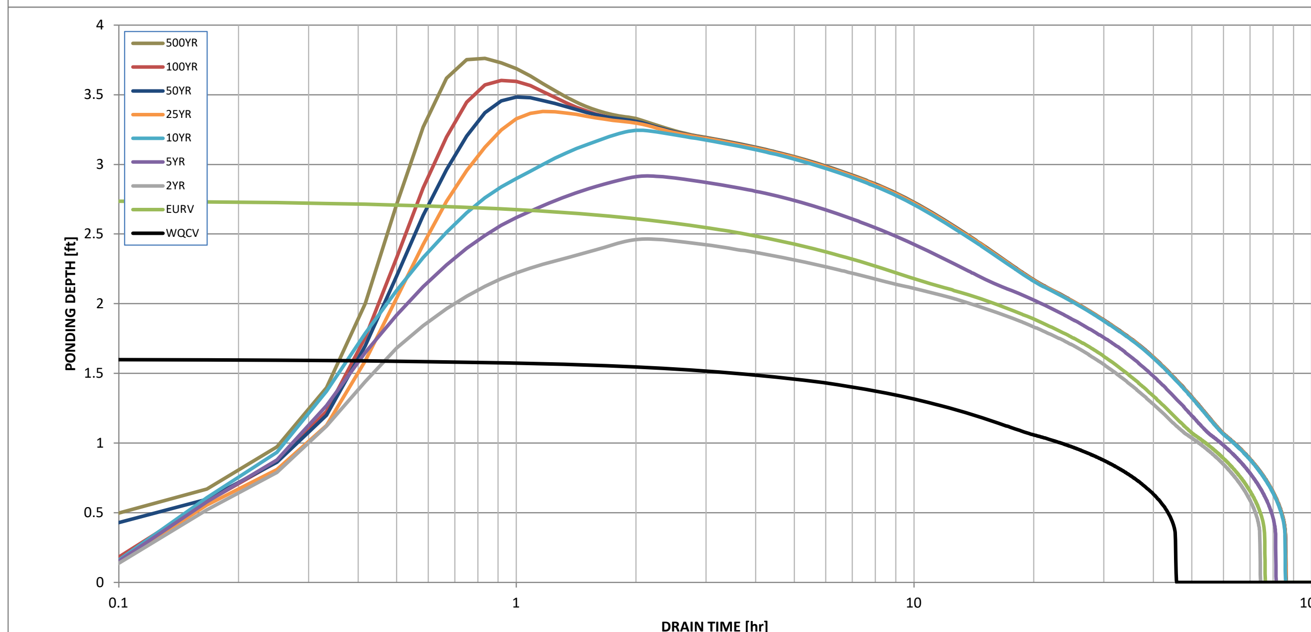
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.055	0.180	0.157	0.217	0.269	0.334	0.389	0.457	0.597
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.157	0.217	0.269	0.334	0.389	0.457	0.597
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.4	1.1	1.6	2.8	3.5	4.4	6.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.14	0.38	0.57	1.01	1.26	1.58	2.20
Peak Inflow Q (cfs) =	N/A	N/A	3.2	4.5	5.3	6.7	7.8	9.3	12.0
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.3	1.1	2.1	3.7	6.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.2	0.4	0.6	0.8	1.1
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.1	0.2	0.3	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) =	43	68	67	71	73	71	69	66	61
Time to Drain 99% of Inflow Volume (hours) =	**45**	73	71	78	81	80	80	79	77
Maximum Ponding Depth (ft) =	1.61	2.75	2.46	2.92	3.25	3.38	3.48	3.60	3.76
Area at Maximum Ponding Depth (acres) =	0.09	0.12	0.11	0.14	0.14	0.15	0.15	0.15	0.15
Maximum Volume Stored (acre-ft) =	0.056	0.181	0.147	0.202	0.248	0.267	0.283	0.301	0.325

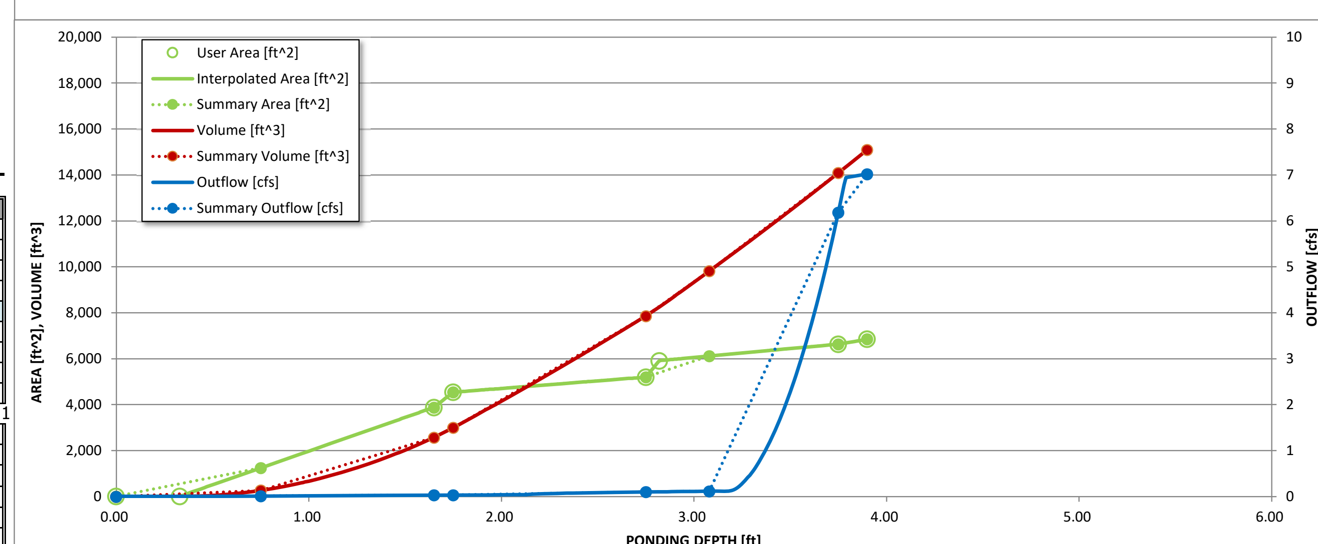
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



Time Interval
5.00 min





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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
TIME	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
0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.14
0:15:00	0.00	0.00	0.40	0.65	0.81	0.54	0.66	0.66	0.91
0:20:00	0.00	0.00	1.33	1.72	2.05	1.26	1.46	1.57	2.04
0:25:00	0.00	0.00	2.81	4.02	5.09	2.75	3.22	3.54	5.09
0:30:00	0.00	0.00	3.21	4.45	5.32	6.63	7.80	8.78	11.47
0:35:00	0.00	0.00	2.68	3.63	4.33	6.69	7.79	9.32	12.04
0:40:00	0.00	0.00	2.17	2.87	3.43	5.93	6.88	8.12	10.46
0:45:00	0.00	0.00	1.63	2.23	2.73	4.76	5.51	6.81	8.75
0:50:00	0.00	0.00	1.29	1.82	2.18	3.96	4.58	5.58	7.19
0:55:00	0.00	0.00	1.03	1.44	1.76	3.07	3.57	4.54	5.86
1:00:00	0.00	0.00	0.82	1.13	1.42	2.42	2.82	3.76	4.86
1:05:00	0.00	0.00	0.68	0.92	1.19	1.91	2.23	3.13	4.05
1:10:00	0.00	0.00	0.54	0.83	1.10	1.40	1.65	2.18	2.86
1:15:00	0.00	0.00	0.47	0.75	1.08	1.15	1.36	1.64	2.20
1:20:00	0.00	0.00	0.43	0.66	0.96	0.92	1.08	1.18	1.58
1:25:00	0.00	0.00	0.41	0.61	0.81	0.78	0.92	0.90	1.19
1:30:00	0.00	0.00	0.40	0.58	0.71	0.65	0.75	0.72	0.96
1:35:00	0.00	0.00	0.39	0.56	0.64	0.57	0.65	0.61	0.80
1:40:00	0.00	0.00	0.38	0.48	0.60	0.51	0.59	0.54	0.70
1:45:00	0.00	0.00	0.38	0.44	0.57	0.48	0.54	0.50	0.65
1:50:00	0.00	0.00	0.38	0.40	0.55	0.46	0.52	0.49	0.64
1:55:00	0.00	0.00	0.31	0.39	0.52	0.45	0.51	0.48	0.63
2:00:00	0.00	0.00	0.27	0.36	0.46	0.45	0.51	0.48	0.63
2:05:00	0.00	0.00	0.17	0.23	0.30	0.29	0.33	0.31	0.41
2:10:00	0.00	0.00	0.11	0.14	0.19	0.19	0.21	0.20	0.26
2:15:00	0.00	0.00	0.07	0.09	0.12	0.12	0.13	0.12	0.16
2:20:00	0.00	0.00	0.04	0.05	0.07	0.07	0.08	0.07	0.10
2:25:00	0.00	0.00	0.02	0.03	0.04	0.04	0.04	0.04	0.05
2:30:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2:35:00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

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]
Top of Micropool	0.00	10	0.000	0	0.000	0.00
Elev. 5857	0.75	1,243	0.029	266	0.006	0.01
WQCV	1.65	3,884	0.089	2,573	0.059	0.03
Elev. 5858	1.75	4,541	0.104	2,995	0.069	0.03
Elev. 5859	2.75	5,198	0.119	7,864	0.181	0.10
EURV	3.08	6,117	0.140	9,817	0.225	0.12
Elev. 5860	3.75	6,634	0.152	14,089	0.323	6.18
Emergency Overflow	3.90	6,852	0.157	15,100	0.347	7.02

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).

Stormwater Detention and Infiltration Design Data Sheet

SDI-Design Data v2.00, Released January 2020

Stormwater Facility Name: **Clear View Industrial Park, Filing 2B**

Facility Location & Jurisdiction: **El Paso County**

User Input: Watershed Characteristics

Extended Detention Basin (EDB)	EDB	
Watershed Area =	2.77	acres
Watershed Length =	500	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	60.0%	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
Target WQCV Drain Time =	40.0	hours

Location for 1-hr Rainfall Depths (use dropdown):

User Input

User Defined Stage [ft]	User Defined Area [ft^2]	User Defined Stage [ft]	User Defined Discharge [cfs]
0.00	10	0.00	0.00
0.75	1,243	0.75	0.01
1.65	3,884	1.65	0.03
1.75	4,541	1.75	0.04
2.75	5,198	2.75	0.10
3.08	6,117	3.08	0.12
3.75	6,634	3.75	6.18
3.90	6,852	3.90	7.02

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

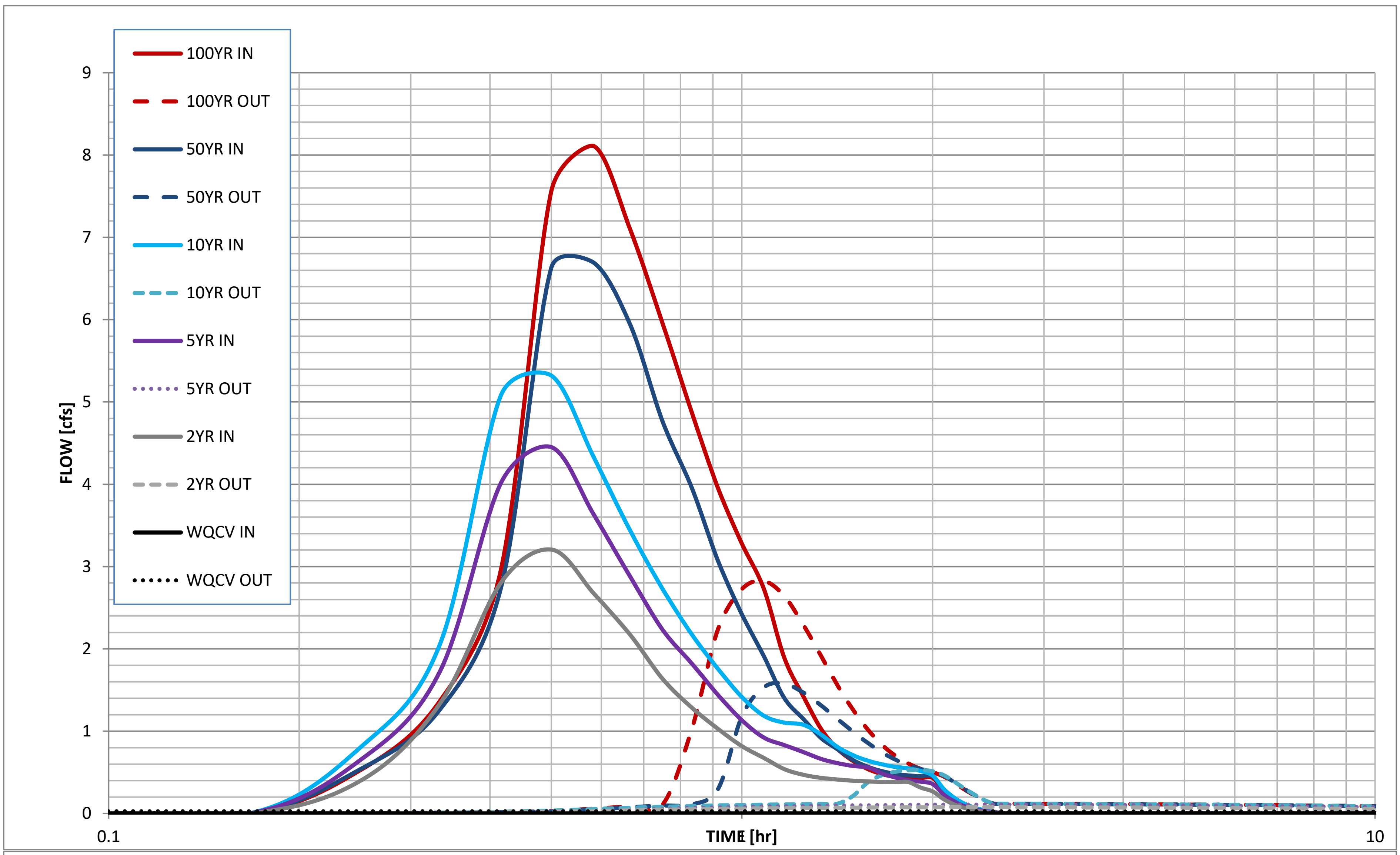
Once CUHP has been run and the Stage-Area-Discharge information has been provided, click 'Process Data' to interpolate the Stage-Area-Volume-Discharge data and generate summary results in the table below. Once this is complete, click 'Print to PDF'.

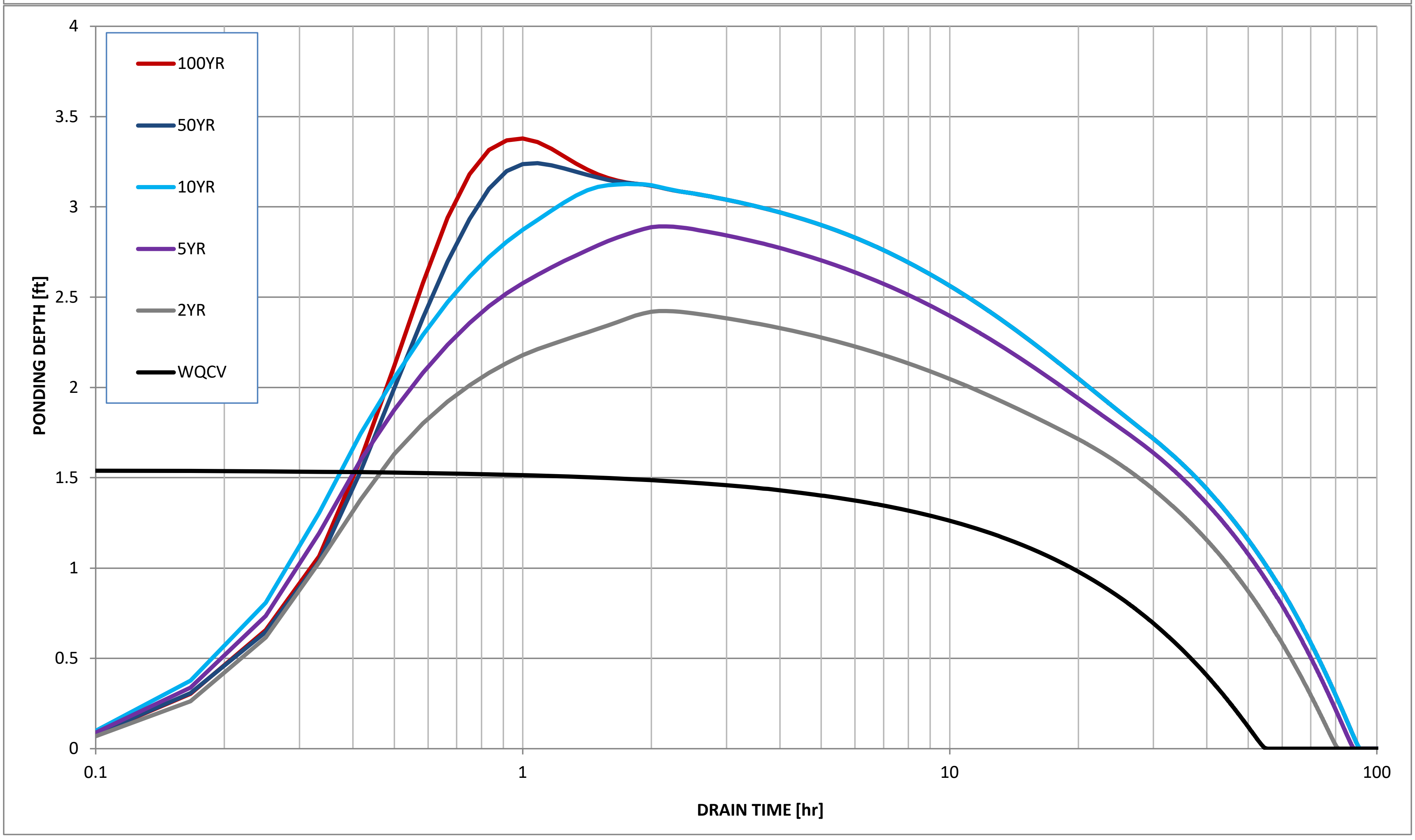
After completing and printing this worksheet to a pdf, go to:
https://maperture.digitaldataservices.com/gvh/?viewer=cswdif
Create a new stormwater facility, and attach the PDF of this worksheet to that record.

Routed Hydrograph Results

Design Storm Return Period =	WQCV	2 Year	5 Year	10 Year	50 Year	100 Year	
One-Hour Rainfall Depth =	N/A	1.19	1.50	1.75	2.00	2.25	in
CUHP Runoff Volume =	0.055	0.157	0.217	0.269	0.334	0.397	acre-ft
Inflow Hydrograph Volume =	N/A	0.157	0.217	0.269	0.334	0.397	acre-ft
Time to Drain 97% of Inflow Volume =	44.1	63.1	**67.3**	67.8	65.3	63.0	hours
Time to Drain 99% of Inflow Volume =	48.5	70.5	75.9	77.4	75.9	**74.6**	hours
Maximum Ponding Depth =	1.54	2.42	2.89	3.13	3.24	3.38	ft
Maximum Ponded Area =	0.08	0.11	0.13	0.14	0.14	**0.15**	acres
Maximum Volume Stored =	0.055	0.147	0.203	0.234	0.251	0.270	acre-ft

Stormwater Detention and Infiltration Design Data Sheet





Worksheet for Circular Pipe - Lot 3A 5Y

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01500	ft/ft
Diameter	1.50	ft
Discharge	3.50	ft³/s

Results

Normal Depth	0.51	ft
Flow Area	0.53	ft²
Wetted Perimeter	1.87	ft
Hydraulic Radius	0.28	ft
Top Width	1.42	ft
Critical Depth	0.71	ft
Percent Full	34.2	%
Critical Slope	0.00448	ft/ft
Velocity	6.56	ft/s
Velocity Head	0.67	ft
Specific Energy	1.18	ft
Froude Number	1.89	
Maximum Discharge	14.99	ft³/s
Discharge Full	13.94	ft³/s
Slope Full	0.00095	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	34.16	%
Downstream Velocity	Infinity	ft/s

Worksheet for Circular Pipe - Lot 3A 5Y

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.51	ft
Critical Depth	0.71	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.00448	ft/ft

Worksheet for Circular Pipe - 5-year total

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01500	ft/ft
Diameter	1.50	ft
Discharge	7.70	ft³/s

Results

Normal Depth	0.80	ft
Flow Area	0.95	ft²
Wetted Perimeter	2.45	ft
Hydraulic Radius	0.39	ft
Top Width	1.50	ft
Critical Depth	1.08	ft
Percent Full	53.1	%
Critical Slope	0.00615	ft/ft
Velocity	8.08	ft/s
Velocity Head	1.02	ft
Specific Energy	1.81	ft
Froude Number	1.79	
Maximum Discharge	14.99	ft³/s
Discharge Full	13.94	ft³/s
Slope Full	0.00458	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	53.07	%
Downstream Velocity	Infinity	ft/s

Worksheet for Circular Pipe - 5-year total

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.80	ft
Critical Depth	1.08	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.00615	ft/ft

Worksheet for Circular Pipe - 3.9cfs

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01500	ft/ft
Diameter	1.50	ft
Discharge	3.90	ft³/s

Results

Normal Depth	0.54	ft
Flow Area	0.58	ft²
Wetted Perimeter	1.94	ft
Hydraulic Radius	0.30	ft
Top Width	1.44	ft
Critical Depth	0.76	ft
Percent Full	36.2	%
Critical Slope	0.00458	ft/ft
Velocity	6.76	ft/s
Velocity Head	0.71	ft
Specific Energy	1.25	ft
Froude Number	1.89	
Maximum Discharge	14.99	ft³/s
Discharge Full	13.94	ft³/s
Slope Full	0.00117	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	36.18	%
Downstream Velocity	Infinity	ft/s

Worksheet for Circular Pipe - 3.9cfs

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.54	ft
Critical Depth	0.76	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.00458	ft/ft

Worksheet for Circular Pipe 18"

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01500	ft/ft
Normal Depth	1.40	ft
Diameter	1.50	ft

Results

Discharge	14.99	ft³/s
Flow Area	1.72	ft²
Wetted Perimeter	3.93	ft
Hydraulic Radius	0.44	ft
Top Width	0.75	ft
Critical Depth	1.41	ft
Percent Full	93.3	%
Critical Slope	0.01500	ft/ft
Velocity	8.73	ft/s
Velocity Head	1.18	ft
Specific Energy	2.58	ft
Froude Number	1.02	
Maximum Discharge	14.99	ft³/s
Discharge Full	13.94	ft³/s
Slope Full	0.01735	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	93.34	%
Downstream Velocity	Infinity	ft/s

Worksheet for Circular Pipe 18"

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.40	ft
Critical Depth	1.41	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.01500	ft/ft

Outlet pipe 1-24-21

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.03500	ft/ft
Normal Depth	1.40	ft
Diameter	1.50	ft

Results

Discharge	22.90	ft³/s
Flow Area	1.72	ft²
Wetted Perimeter	3.93	ft
Hydraulic Radius	0.44	ft
Top Width	0.75	ft
Critical Depth	1.48	ft
Percent Full	93.3	%
Critical Slope	0.03693	ft/ft
Velocity	13.34	ft/s
Velocity Head	2.76	ft
Specific Energy	4.16	ft
Froude Number	1.55	
Maximum Discharge	22.90	ft³/s
Discharge Full	21.29	ft³/s
Slope Full	0.04049	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	93.33	%
Downstream Velocity	Infinity	ft/s

Outlet pipe 1-24-21

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.40	ft
Critical Depth	1.48	ft
Channel Slope	0.03500	ft/ft
Critical Slope	0.03693	ft/ft

Worksheet for Circular Pipe - Outlet 5Y

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.02400	ft/ft
Diameter	1.50	ft
Discharge	8.60	ft³/s

Results

Normal Depth	0.74	ft
Flow Area	0.87	ft²
Wetted Perimeter	2.33	ft
Hydraulic Radius	0.37	ft
Top Width	1.50	ft
Critical Depth	1.14	ft
Percent Full	49.3	%
Critical Slope	0.00672	ft/ft
Velocity	9.92	ft/s
Velocity Head	1.53	ft
Specific Energy	2.27	ft
Froude Number	2.30	
Maximum Discharge	18.96	ft³/s
Discharge Full	17.63	ft³/s
Slope Full	0.00571	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	49.27	%
Downstream Velocity	Infinity	ft/s

Worksheet for Circular Pipe - Outlet 5Y

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.74	ft
Critical Depth	1.14	ft
Channel Slope	0.02400	ft/ft
Critical Slope	0.00672	ft/ft

Worksheet for Circular Pipe - 3A 100Y

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01500	ft/ft
Diameter	1.50	ft
Discharge	6.90	ft³/s

Results

Normal Depth	0.75	ft
Flow Area	0.88	ft²
Wetted Perimeter	2.35	ft
Hydraulic Radius	0.37	ft
Top Width	1.50	ft
Critical Depth	1.02	ft
Percent Full	49.7	%
Critical Slope	0.00571	ft/ft
Velocity	7.87	ft/s
Velocity Head	0.96	ft
Specific Energy	1.71	ft
Froude Number	1.81	
Maximum Discharge	14.99	ft³/s
Discharge Full	13.94	ft³/s
Slope Full	0.00368	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	49.70	%
Downstream Velocity	Infinity	ft/s

Worksheet for Circular Pipe - thru lot 2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.01500	ft/ft
Diameter	1.50	ft
Discharge	2.10	ft³/s

Results

Normal Depth	0.39	ft
Flow Area	0.37	ft²
Wetted Perimeter	1.61	ft
Hydraulic Radius	0.23	ft
Top Width	1.32	ft
Critical Depth	0.55	ft
Percent Full	26.2	%
Critical Slope	0.00422	ft/ft
Velocity	5.68	ft/s
Velocity Head	0.50	ft
Specific Energy	0.89	ft
Froude Number	1.89	
Maximum Discharge	14.99	ft³/s
Discharge Full	13.94	ft³/s
Slope Full	0.00034	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	26.23	%
Downstream Velocity	Infinity	ft/s

Worksheet for Circular Pipe - thru lot 2

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.39	ft
Critical Depth	0.55	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.00422	ft/ft

Worksheet for Circular Pipe - 3A 100Y

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	0.75	ft
Critical Depth	1.02	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.00571	ft/ft

Clear View Industrial Park

Nyloplast Inlet Calc. - Lot 3A

Weir Equation

C =	3.1	Coeff
L =	6.28	Length of weir (ft)
H =	0.66	Depth of Flow (ft)
Q =	**10.44**	**Flow (cfs)**

Note: 100-year runoff for lot 3a = 6.9cfs
inlet sufficient to handle the flow.

Circumference of pipe ©

Dia. =	24	Inches
C =	6.28	Feet

$$C = 2\pi r$$

a) <u>Weir flow</u> may be computed by the following equation:

$$Q = CLH^{1.5}$$

where:

C = weir coefficient (dimensionless); for riser pipes, C = 3.1 may be used;

L = length of weir, in ft. For circular riser pipes, L is the pipe circumference;

H = the depth of flow over the riser pipe crest, in ft; and

Q = discharge, in cfs.

Worksheet for Triangular Channel - lot 1a

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00540	ft/ft
Normal Depth	2.00	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)

Results

Discharge		27.03	ft^3/s
Flow Area		8.00	ft^2
Wetted Perimeter		8.94	ft
Hydraulic Radius		0.89	ft
Top Width		8.00	ft
Critical Depth		1.63	ft
Critical Slope		0.01631	ft/ft
Velocity		3.38	ft/s
Velocity Head		0.18	ft
Specific Energy		2.18	ft
Froude Number		0.60	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.63	ft
Channel Slope	0.00540	ft/ft
Critical Slope	0.01631	ft/ft

Worksheet for Triangular Channel - lot 3a west

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.02700	ft/ft
Normal Depth	1.00	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)

Results

Discharge	9.52	ft^3/s
Flow Area	2.00	ft^2
Wetted Perimeter	4.47	ft
Hydraulic Radius	0.45	ft
Top Width	4.00	ft
Critical Depth	1.07	ft
Critical Slope	0.01874	ft/ft
Velocity	4.76	ft/s
Velocity Head	0.35	ft
Specific Energy	1.35	ft
Froude Number	1.19	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	1.07	ft
Channel Slope	0.02700	ft/ft
Critical Slope	0.01874	ft/ft

Worksheet for Triangular Channel - 3' deep

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00840	ft/ft
Normal Depth	3.00	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)

Results

Discharge	99.40	ft³/s
Flow Area	18.00	ft²
Wetted Perimeter	13.42	ft
Hydraulic Radius	1.34	ft
Top Width	12.00	ft
Critical Depth	2.74	ft
Critical Slope	0.01371	ft/ft
Velocity	5.52	ft/s
Velocity Head	0.47	ft
Specific Energy	3.47	ft
Froude Number	0.79	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.00	ft
Critical Depth	2.74	ft
Channel Slope	0.00840	ft/ft
Critical Slope	0.01371	ft/ft

Worksheet for Triangular Channel - lot2a

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01200	ft/ft
Normal Depth	2.00	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)

Results

Discharge	40.29	ft^3/s
Flow Area	8.00	ft^2
Wetted Perimeter	8.94	ft
Hydraulic Radius	0.89	ft
Top Width	8.00	ft
Critical Depth	1.91	ft
Critical Slope	0.01546	ft/ft
Velocity	5.04	ft/s
Velocity Head	0.39	ft
Specific Energy	2.39	ft
Froude Number	0.89	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.91	ft
Channel Slope	0.01200	ft/ft
Critical Slope	0.01546	ft/ft

Worksheet for Trapezoidal Channel - Emergency Spillway

Project Description

Friction Method	Manning Formula
Solve For	Bottom Width

Input Data

Roughness Coefficient	0.078	
Channel Slope	0.02000	ft/ft
Normal Depth	1.00	ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Discharge	17.10	ft³/s

Results

Bottom Width	5.32	ft
Flow Area	7.82	ft²
Wetted Perimeter	10.71	ft
Hydraulic Radius	0.73	ft
Top Width	10.32	ft
Critical Depth	0.62	ft
Critical Slope	0.11558	ft/ft
Velocity	2.19	ft/s
Velocity Head	0.07	ft
Specific Energy	1.07	ft
Froude Number	0.44	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

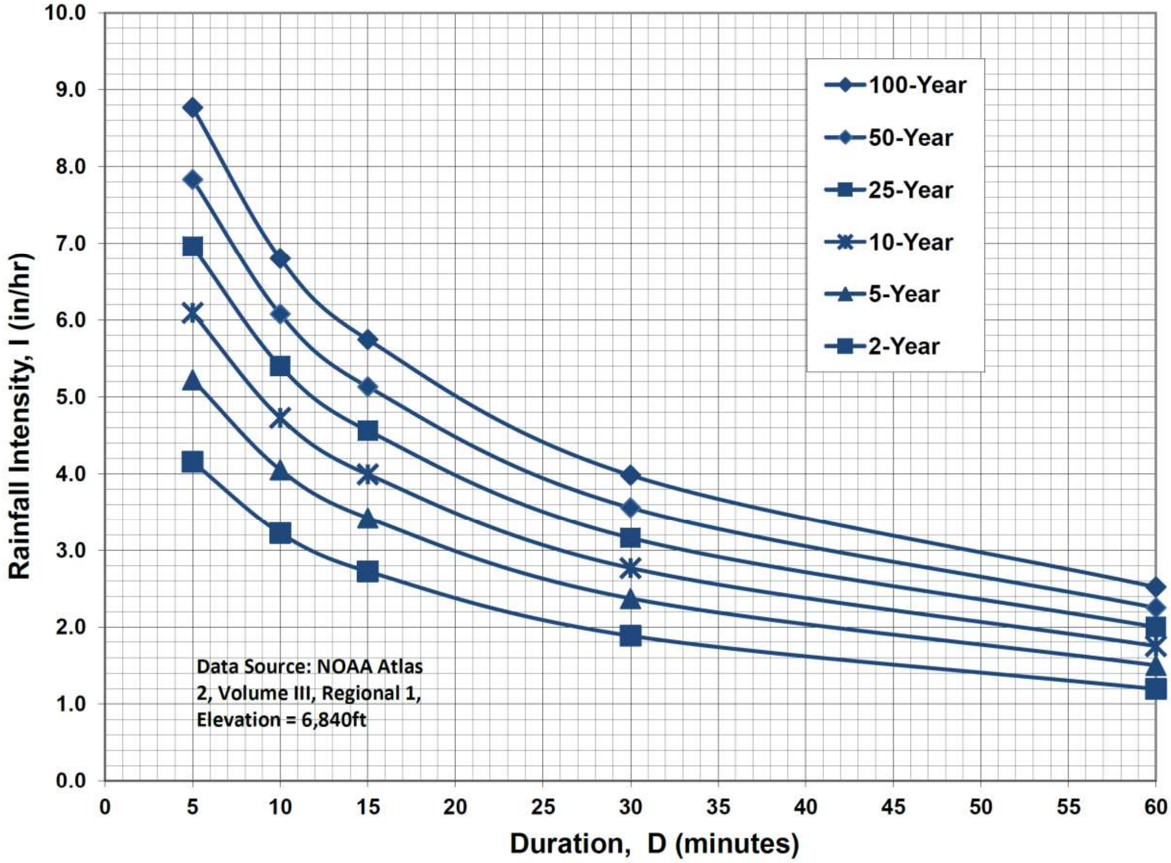
Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.62	ft
Channel Slope	0.02000	ft/ft

Worksheet for Trapezoidal Channel - Emergency Spillway

GVF Output Data

Critical Slope	0.11558	ft/ft

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 10-7

CLASSIFICATION AND GRADATION OF ORDINARY RIPRAP

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (Inches)	d_{50}* (Inches)
Type VL	70-100	12	
	50-70	9	
	35-50	6	6
	2-10	2	
Type L	70-100	15	
	50-70	12	
	35-50	9	9
	2-10	3	
Type M	70-100	21	
	50-70	18	
	35-50	12	12
	2-10	4	
Type H	100	30	
	50-70	24	
	35-50	18	18
	2-10	6	
Type VH	100	42	
	50-70	33	
	35-50	24	24
	2-10	9	

*d_{50} = Mean particle size

TABLE 10-8

RIPRAP GRADATION LIMITS FOR STEEP SLOPES

$$\frac{D_{max}}{D_{50}} = 1.25$$

$$\frac{D_{50}}{D_{10-20}} = 2\text{-}3$$

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.

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for

El Paso County Area, Colorado

May 15, 2020

Preface

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

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

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

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

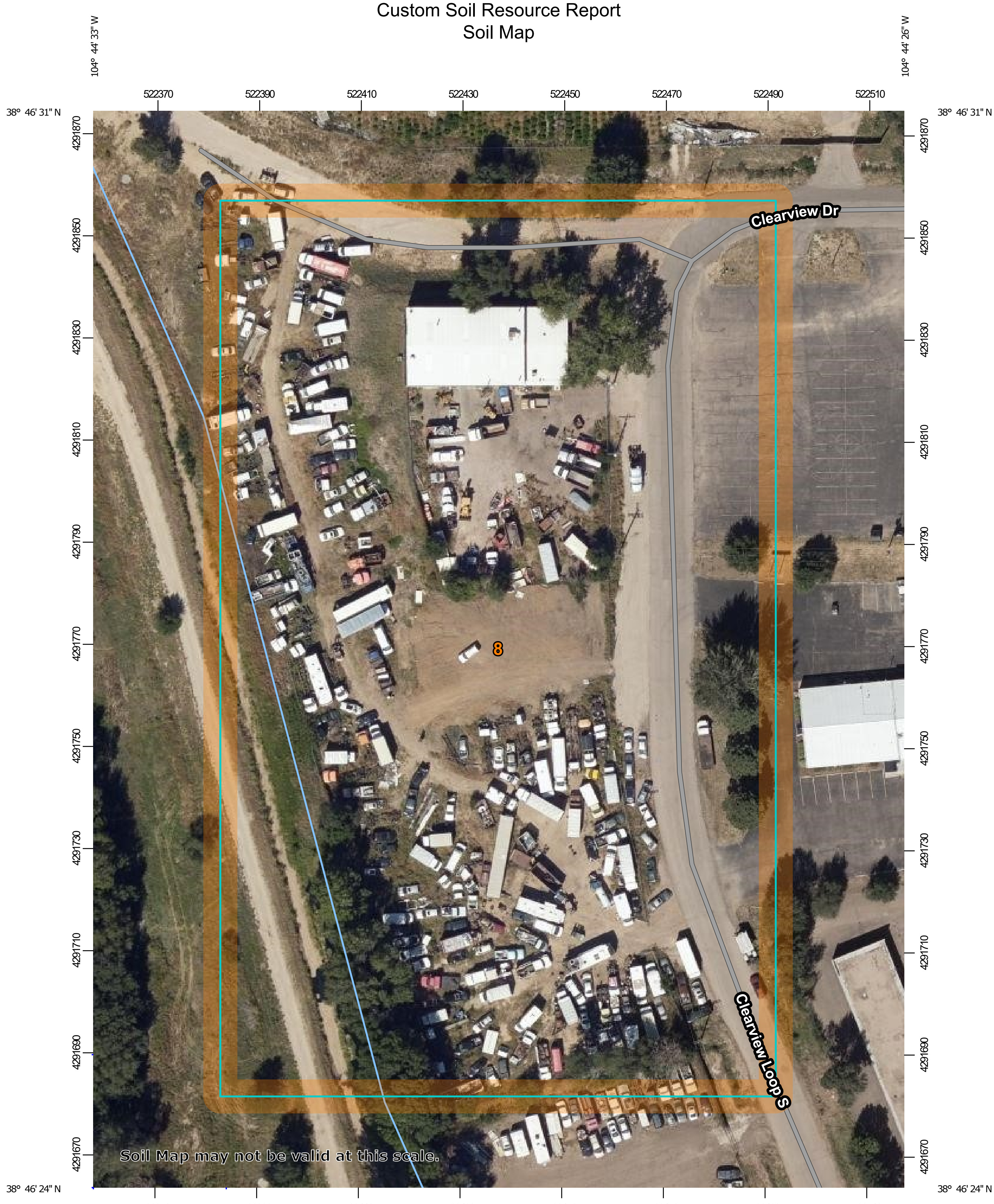
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

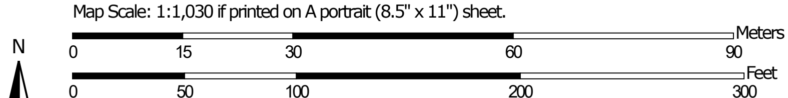
Soil Map

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

Soil Map



Map Scale: 1:1,030 if printed on A portrait (8.5" x 11") sheet.



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.

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

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

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

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

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

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

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

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

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

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	4.8	100.0%
Totals for Area of Interest		**4.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369v
Elevation: 4,600 to 5,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Hills, flats
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock and/or eolian deposits derived from sedimentary rock

Typical profile

A - 0 to 11 inches: loamy sand
AC - 11 to 27 inches: loamy sand
C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 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 to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 1 percent

Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

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National Flood Hazard Layer FIRMette

FEMA

38°46'41.97"N
104°44'49.38"W

104°44'11.92"W
38°46'13.93"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Legend

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

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

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

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

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

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

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

N

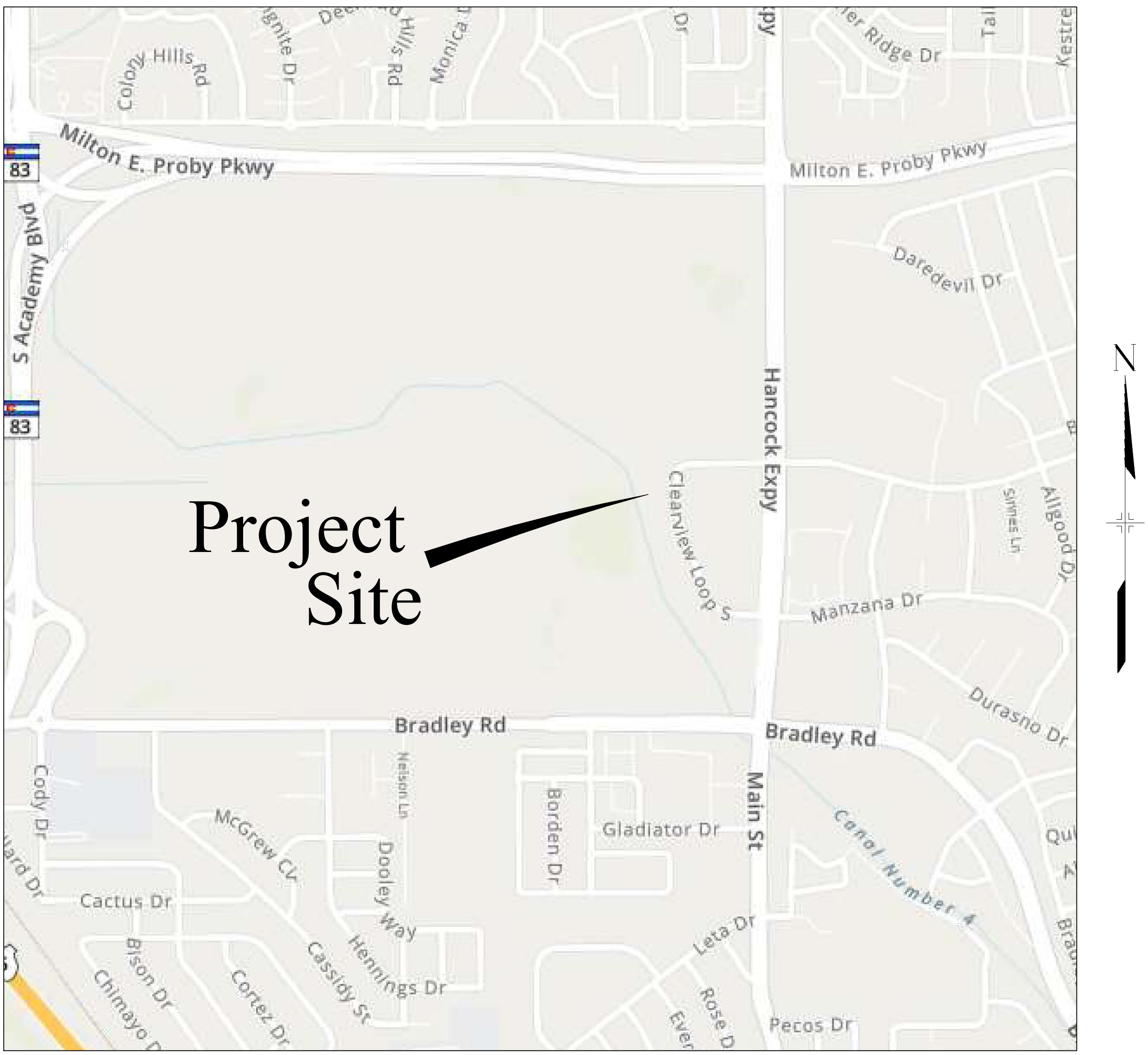
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/25/2020 at 8:04:06 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

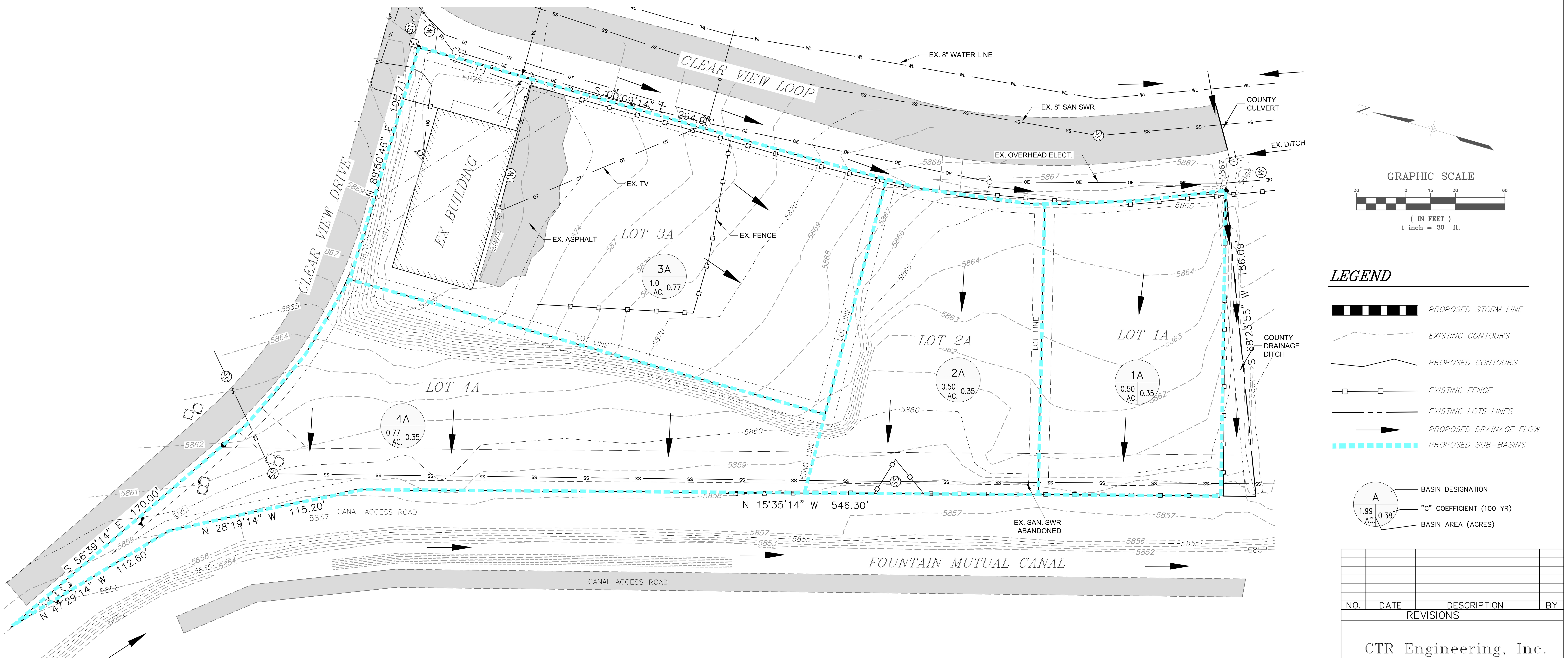
CLEAR VIEW INDUSTRIAL PARK, FILING 2A



VICINITY MAP

N.T.S.

CTR ENGINEERING, INC.



Summary of Drainage Calculations (Existing)

Basin	Design Point	Area**	Area	Impervious Area	Pervious Area	% Imper.	5 Comp.	100 Comp	Q(100) (cfs)
		(Sq. Ft.)	(Acres)	(Sq. Ft.)	(Sq. Ft.)	%	"C"	"C"	
Lot 1A		21,796	0.50	-	21,796	0%	0.08	0.35	**1.6**
Lot 2A		21,827	0.50	-	21,827	0%	0.08	0.35	**1.6**
Lot 3A		43,447	1.00	30,500	12,947	70%	0.44	0.77	**6.9**
Lot 4A		33,455	0.77	-	33,455	0%	0.08	0.35	**2.4**
Onsite Totals		120,525	2.767	30,500	90,025	25%	0.21	0.50	**12.5**

NO.	DATE	DESCRIPTION	BY

REVISIONS

CTR Engineering, Inc.

16392 TIMBER MEADOW DRIVE
COLORADO SPRINGS, CO 80908
(719) 964-6654

PROJECT:
CLEAR VIEW
INDUSTRIAL PARK FILING 2B

BENCHMARK:
Elevations are based upon FIMS monument DR02, a 2" aluminum cap, stamped "CSU FIMS CONTROL DR02", at the southeast corner of Monica Drive and Hancock Expressway (Elevation=5927.27 NGVD29)

PROJECT TITLE:
GRADING, WATER QUALITY POND AND EROSION CONTROL

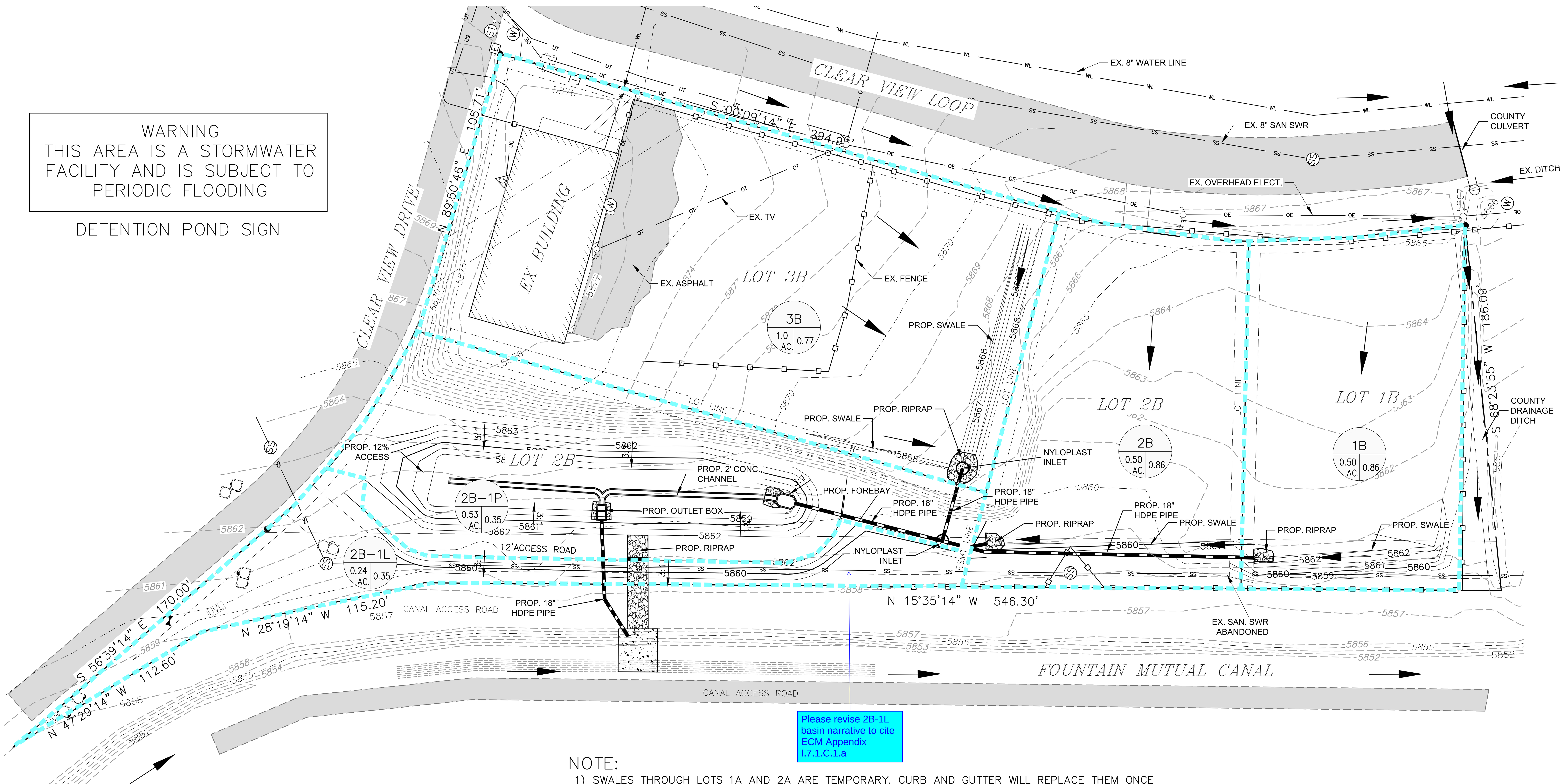
SHEET TITLE:
DRAINAGE PLAN
(EXISTING)

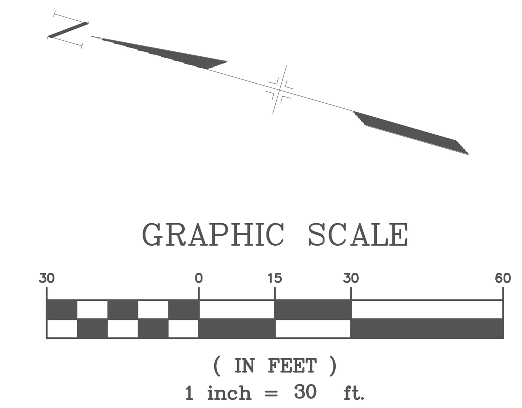
DESIGNED BY: JCM
DRAWN BY: JCM
CHECKED BY: JH
SCALE H: 1"=30' V:
DATE ISSUED: JAN. 2021
SHEET NO. 1 OF 1 SHEETS

DWG:

WARNING
THIS AREA IS A STORMWATER FACILITY AND IS SUBJECT TO PERIODIC FLOODING

DETENTION POND SIGN





LEGEND

- PROPOSED STORM LINE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- EXISTING FENCE
- EXISTING LOTS LINES
- PROPOSED DRAINAGE FLOW
- PROPOSED SUB-BASINS

BASIN DESIGNATION
"C" COEFFICIENT (100 YR)
BASIN AREA (ACRES)

NOTE:
1) SWALES THROUGH LOTS 1A AND 2A ARE TEMPORARY. CURB AND GUTTER WILL REPLACE THEM ONCE THOSE LOTS DEVELOP.
2) TIME OF CONCENTRATION WAS CHOSEN AS THE SOUTHEAST CORNER OF LOT 1A RUNNING DOWN TO THE PROPOSED SWALE, THEN ALONG THE PROPOSED STORM PIPE TO THE FOREBAY OF THE WATER QUALITY POND.
3) NO 100-YEAR FLOODPLAIN EXISTS WITHIN THIS SUBDIVISION OR ADJACENT TO IT.

Summary of Drainage Calculations (Proposed)

Basin	Design Point	Area**	Area	Impervious Area	Pervious Area	% Imper.	5 Comp.	100 Comp	Q(100) (cfs)
		(Sq. Ft.)	(Acres)	(Sq. Ft.)	(Sq. Ft.)	%	"C"	"C"	
Lot 1B		21,796	0.50	18,526	3,270	85%	0.51	0.86	**3.9**
Lot 2B		21,827	0.50	18,552	3,275	85%	0.51	0.86	**3.9**
Lot 3B		43,447	1.00	30,500	12,947	70%	0.44	0.77	**6.9**
2B-1P (pond area)		23,125	0.53	-	23,125	0%	0.08	0.35	**1.6**
2B-1L (land area)		10,330	0.24	-	10,330	0%	0.08	0.35	**0.7**
Combined (Lots 1B-3B)	Forebay	87,070	2.00	67,578	19,492	78%	0.48	0.82	**14.8**
Onsite Totals		110,195	2.530	67,578	42,617	61%	0.39	0.72	**17.1**

NO.	DATE	DESCRIPTION	BY

REVISIONS

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COLORADO SPRINGS, CO 80908
(719) 964-6654

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CLEAR VIEW INDUSTRIAL PARK FILING 2B

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