TRI-STATE GENERATION & TRANSMISSION, INC.

FOX RUN SUBSTATION
FINAL DRAINAGE REPORT

PCD FILE # PPR-22-044

March 30, 2023

Prepared by:

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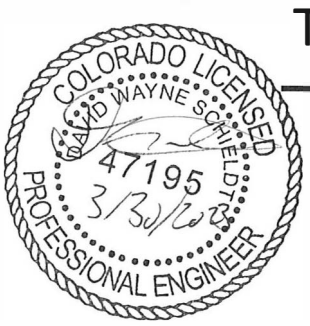

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Design Engineer's Statement:

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

Dave Schieldt — 3/30/2023

David Schieldt
Registered Professional Engineer
State of Colorado No. 47195

Date

Owner/Developer's Statement:

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

Karl W. Myers — 3/30/23

Karl Myers
Tri-State Generation and Transmission Association
1100 W. 116th Ave
Westminster, CO 80234

Date

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.

County Engineer / ECM Administrator — Date

TABLE OF CONTENTS

1.0 General Location and Description

Tri-State Generation and Transmission (TSGT) in coordination with Del-Mont Consultants, Inc. (DMC) is in the process of designing a new substation yard. The scope of work includes the construction of the substation yard & retaining walls, driveway, detention pond and swales, installation of new perimeter fence, and the addition of high voltage electrical equipment and facilities. The purpose of this report is to present the findings from the hydrologic and hydraulic analyses that were performed on the existing property as well as present the results from a detailed analysis performed on the proposed improvements to the property.

1.1 Site Location

The proposed substation yard is located on a 14.92-acre parcel owned by TSGT, situated in the NW ¼ of Section 21, Township 11 South, Range 66 West, 6th Principal Meridian in El Paso County, Colorado. The substation site is accessed from Shahara Road.

1.2 Site Description

The site naturally drains to the northeast and is currently covered in various grasses. There are currently no features on the site to provide water quality or quantity treatment for discharge from the site. Site layout details will be discussed in more detail in **Section 2**.

There are developments on the properties to the south and the west of the site. MVEA Substation located on the neighboring property to the south, and Jackson Ranch Subdivision to the west. No wetlands are present on the site and the site is not located within a floodplain per FIRM Map Number 08041C0285G.

To the knowledge of Del-Mont Consultants, no prior drainage studies have been conducted on this property.

2.0 Drainage Basins and Sub-Basins

The property functions overall as one large basin, flowing to the northeast into a drainage on the east edge of the property, ultimately flowing into West Cherry Creek. Proposed conditions produce several smaller sub-basins and will be discussed in detail in the following sections.

2.1 Existing Drainage Sub-Basins

The existing site was analyzed as one basin. A small portion of the existing site was unanalyzed as it did not affect the majority of the site. A map illustrating the delineation of the existing property can be found in **Appendix C**. There are developments on the properties to the south and the west of the site. MVEA Substation located on the neighboring property to the south, and Jackson Ranch Subdivision to the west. **Table 2-1** presents the existing basin and its corresponding acreage. The existing member substation was not analyzed as a part of this project.

Table 2-1: Existing Basin Acreages

Sub-Basin	Total Area (Acres)
Existing	14.38
Unanalyzed	0.54

2.2 Proposed Drainage Sub-Basins

The proposed conditions will produce several different sub-basins. The proposed site is divided into three different sub-basins; Yard Area, Proposed North, and Proposed South. A map illustrating the delineation of the sub-basins can be found in **Appendix C**. The Yard Area contains the entirety of the yard and the detention pond, which make up greater than 90% of the impervious or improved areas. The remainder of the impervious area consists of the access driveway, which creates negligible runoff and will continue to follow historic flow paths. The Proposed North and Proposed South areas contain swales that will route any run-on around the substation site, returning to historical discharge patterns. The run-on flows are minimal and will have negligible effects on the site. The majority of the North and South basins will not be disturbed during construction and will not require water quality treatment. The disturbed areas of the North and South basins will be reseeded, and total less the 1 acre. An offsite basin has been analyzed to verify culvert sizing for the access road. **Table 2-2** presents the proposed sub-basins and their corresponding acreages.

Table 2-2: Proposed Sub-Basin Acreages

Sub-Basin	Total Area (Acres)
Yard Area	5.23
Proposed North	6.70
Proposed South	2.44
Offsite	4.5

3.0 Drainage Design Criteria

3.1 Methodology

The hydrologic/hydraulic analysis of the site was performed using the Autodesk Storm and Sanitary analysis utilizing the Rational Method model for a 5-year and a 100-year rainfall event. Runoff Coefficients were obtained from El Paso County Drainage Criteria Manual Volume 1 Update, Chapter 6, Section 3.1, Table 6-6. Rainfall Intensity was obtained from EPC DCM Volume 1 Update, Figure 6-5. Modeling results are presented in **Appendix B**.

The Mile High Flood District *Detention Basin Design Workbook* was utilized to determine the required water quality capture volume (WQCV) and detention and to aid in the design the outlet structure. The spreadsheets/worksheets can be found in **Appendix A** and are discussed in more detail in **Section 4.0**.

Soil data was obtained from a Geotechnical Study provided by Yeh and Associates and gives a hydrologic soil group B for the site.

The described methods/tools used in the analysis, are in accordance with common engineering practices and guidelines.

3.2 Land Cover Hydrologic Properties

Runoff Coefficients and Percent Impervious numbers, for hydrologic soil group B, were assigned to the various land cover types found on the project, both existing and proposed, and are presented in **Table 3-1**.

Table 3-1: Land Cover Hydrologic Properties

Land Cover Type	Percent Impervious	Runoff Coefficient 5 Year	Runoff Coefficient 100 Year
Gravel	80	0.59	0.70
Historical Flow Analysis	2	0.09	0.36
Pond	100	0.85	0.89

3.3 Weighted Design Values

Utilizing the land cover hydrologic properties presented above, a weighted Runoff Coefficient and Percent Impervious value was calculated for each of the sub-basins, presented in **Section 2.0** to be used for analysis. **Table 3-2** presents the weighted design values for existing conditions and **Table 3-3** presents the weighted design values for proposed conditions. Detailed calculations can be found in **Appendix A**.

Table 3-2: Existing Sub-Basin Weighted Design Values

Sub-Basin	Total Area (Acres)	Weighted Percent Impervious	Weighted Runoff Coefficient 5 year	Weighted Runoff Coefficient 100 year
Existing	14.38	2%	0.09	0.36
Offsite	4.5	2%	0.09	0.36

Table 3-3: Proposed Sub-Basin Weighted Design Values

Sub-Basin	Total Area (Acres)	Weighted Percent Impervious	Weighted Runoff Coefficient 5 year	Weighted Runoff Coefficient 100 year
Yard Area	5.23	71%	0.55	0.68
Proposed North	6.70	5%	0.12	0.38
Proposed South	2.44	9%	0.14	0.40

4.0 Drainage Facility Design

4.1 Historical Drainage

Per common practice, the 100-year historical discharge value for the site shall be used to determine the allowable discharge from the site for the proposed conditions. Values presented in **Table 3-2** were used in the model to calculate a historical discharge rate for the existing property. **Table 4-1** presents the discharge rate for the existing property for both the 5-year and 100-year 1-hour storm events although the design is based on the 100-year discharge values.

Table 4-1: Existing Property Discharge Values

Sub-Basin	5-Year Discharge (CFS)	100-Year Discharge (CFS)
Existing	7.20	48.26
Offsite	2.36	15.81

4.2 Proposed Drainage

Values presented in **Table 3-3** were utilized in the model to calculate the runoff for the proposed conditions. The Mile High Flood District *Detention Basin Design Workbook* was utilized to determine the WQCV in conjunction with the model to size the detention pond. Once the pond was sized, the Mile High Flood District *Detention Basin Design Workbook* was utilized to estimate required orifice sizes in the outlet structure to provide water quality treatment. The model was then used to verify all design elements of the pond and the outlet structure to ensure the pond not only retained the correct WQCV but to also discharge at or less than the required 100-year historic discharge rate presented in **Table 4-1** as well as drain the pond in less than the allowable time per State Requirements**.** The spreadsheet showing the detailed calculations can be found in **Appendix A.** The design of the outlet structure is detailed in the grading drawings.

The west drainage swales that will receive run-on flows were not analyzed as the contributing areas are extremely small. These swales are designed as a V-bottom swale with 4:1 side slopes, a minimum depth of 1 foot, and a flow line slope of 0.5%. The swale has a max flow capacity 20cfs, which will easily convey the negligible run-on flows.

The proposed detention pond was designed to provide water quality treatment as well as detain the 100-year storm event while maintaining the required 1-foot of freeboard. The proposed detention pond stage-storage curve is presented in **Table 4-2**. The emergency spillway has been designed to convey the 100 year storm event, however the calculated 100 year water surface elevation is 1.5 feet below the emergency spillway.

Table 4-2: Detention Pond Stage-Storage Table

Elevation	Surface Area (Sq. Ft.)
7442.25	0
7443	1,640
7444	5,811
7445	11,212
7446	17,263
7447	23,884
7448	28,485

The model of the proposed site conditions was utilized to calculate discharge flow rates from the outlet structure in order to size the pond discharge culvert. **Table 4-3** presents the hydraulic capacity of the culvert and the required capacity to discharge flow from the outlet structure for the 100-year event. Hydraulic calculations for the remainder of the piping systems and corresponding capacities are found in **Appendix B.**

Table 4-3: Outlet Pipe Hydraulic Capacity (100-year event)

Drainage Feature	Pipe Diameter (in)	Total Capacity (cfs)	Required Flow Capacity (cfs)	Remaining Capacity (cfs)
Pond Outlet	18	18.59	10.1*	16.08

*Value from MHFD-Detention Spreadsheet (Appendix A)

Table 4-4 presents the discharge rates for the proposed sub-basins for both the 5-year and 100-year 1-hour storm events prior to detention. This discharge value represents the flow rate that the pond is receiving. The discharge from the pond and other basins (total discharge from site) is summarized in **Table 5-1.**

Table 4-4: Proposed Sub-Basin Discharge Values (Pre-Detention)

Sub-Basin	5-Year Discharge (CFS)	100-Year Discharge (CFS)
Yard Area	12.13	25.16
Proposed North	4.15	22.03
Proposed South	2.03	9.73

Utilizing the flow rates presented above, the model was utilized to analyze the flow path of water through the piping and pond system. With the installation of the outlet structure, the pond was designed to pass both the 5-year and 100-year events, treat the required WQCV, and slowly release the water in the required length of time after the end of an event set forth by the State. The entire substation drains to the pond and the discharge rate leaving the pond is presented in **Table 5-1.**

5.0 Conclusions

5.1 Drainage Concept

The drainage design has been prepared using sound engineering judgement and practices and will provide an effective means of controlling runoff on the project site as well as protect the site from damage. The design has been completed according to common engineering practices and will result in no downstream impacts to any people or structures. Historic flow paths, discharge rates, and water quality have been maintained or improved.

5.2 Compliance with Common Practices

Per common practices, the historical discharge rate from the 100-year storm shall be utilized to determine the allowable discharge rate for the proposed improvements. To demonstrate compliance with this requirement, both the existing and proposed conditions were combined into one overall sub-basin. **Table 5-1** presents the overall discharge rates for the overall basin as well as the individual basins.

Table 5-1: Overall Sub-Basin Discharge Values (Post Detention)

Basin	5-Year Discharge (CFS)		100-Year Discharge (CFS)	
	Existing	Proposed	Existing	Proposed
Yard Area (Pond Outlet)	3.3*	1.6*	12.4*	10.1*
North	4.58**	4.15	30.71**	22.03
South		2.03		9.73
Total	7.88	6.27	42.81	34.29

*Value from MHFD-Detention Spreadsheet (Appendix A)
**Value interpolated from SSA Model by removing Yard Area from Existing Basin Area

The pond outlet structure was sized according to common practices so that the proposed condition 100-year discharge rate is less than the required discharge rate from the 100-year storm event, resulting in compliance with common practices.

The detention pond was also sized according to UDFCD requirements to treat the WQCV, detain the 100-year event, maintain 1 foot of freeboard, and maintain historical discharge patterns resulting in no downstream impacts.

Inspections of the pond and outlet structure will be conducted by the owner on an annual basis as well as after large storm events. If deficiencies are identified or if maintenance is required, maintenance of the outlet structure will be performed by the owner of the property in an effort to return the structure to its original level of functionality. Maintenance may involve cleaning of sediment and debris from the facility, maintaining vegetation growth around the structure, and performing any additional maintenance required.

5.3 Four Step Process

The “Four Step Process” as recommended by the Urban Drainage Flood Control District has been addressed as follows:

Step 1 - Runoff Reduction

Runoff Reduction will be achieved by be maintaining all perviousness in all areas not routed through the EDB. Any disturbance in these areas, including the construction of the swales, shall be reseeded and stabilized.

Step 2 – Stabilized Drainageways

All swales proposed on the site will be stabilized with grass cover and the use of Rip-Rap armoring will be implemented in areas of higher concentration and/or velocity. Riprap sizing and pond outlet swale calculations can be found in **Appendix A**.

Step 3 – Provide Water Quality Capture Volume

The detention pond and outlet structure on site have been designed to achieve WQCV. The Mile High Flood District *Detention Basin Design Workbook* was utilized to determine the required water quality capture volume (WQCV) and to aid in the design of the outlet structure. The spreadsheets/worksheets can be found in **Appendix A** and are discussed in more detail in **Section 4.0**. The design was then analyzed with Autodesk Storm and Sanitary analysis utilizing the Rational Method model for a 5-year and a 100-year rainfall event. Modeling results are presented in **Appendix B**.

Step 4 – Consider Need for Industrial and Commercial BMPs

The site has low potential for industrial pollution upon the completion of construction. The improved areas of the site that could see vehicular traffic are all routed through the detention pond system where it receives water quality treatment. The electrical equipment found inside of the yard also utilizes local containment basins to prevent the spilling of contaminants within the yard.

6.0 References

United States Department of Agriculture Natural Resources Conservation Service. Web Soil Survey

Mile High Flood District and Flood Control District. *Detention Basin Design Workbook,* Version 4.04, February 2021.

Urban Drainage and Flood Control District. *Urban Storm Drainage Criteria Manual,* Volume *1-3*, June 2001.

El Paso County, Colorado, *Drainage Criteria Manual*, Volume 1-2, October 31, 2018

El Paso County, Colorado, *Engineering Criteria Manual,* December 13, 2016

Yeh and Associates, Inc. *Geotechnical Engineering Study, Fox Run Substation. Yeh Project Number 221-290.* November 11, 2021

Appendix A
Site Specific Physical Design Properties

Fox Run Drainage Design

Existing Conditions-5 Year

Area Name	Total Area (sf)	(acres)	Flow Length	Slope (%)	TOC (min)
Existing	626336.766	14.38	1000	6%	4.70
Offsite	196020	4.50	700	4%	4.18

Land Cover Type	Percent Impervious	Runoff Coefficient
Historical Flow Analysis	2%	0.09
Gravel	80%	0.59
Pond	100%	0.85

Roughness Coefficient and Curve Number Analysis

Existing

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Existing Site	14.38	0.09	1.29	2%	29%
		sum	1.29		29%
Total Area (ac)	**14.379**	Weighted	0.09		2%
Weighted Runoff Coefficient	**0.09**				
Weighted Percent Impervious	**2%**				

Offsite

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Existing Site	4.50	0.09	0.41	2%	9%
		sum	0.41		9%
Total Area (ac)	**4.500**	Weighted	0.09		2%
Weighted Runoff Coefficient	**0.09**				
Weighted Percent Impervious	**2%**				

Fox Run Drainage Design

Proposed Conditions-5 Year

Area Name	Total Area (sf)	(acres)	Flow Length	Slope (%)	TOC (min)
Yard	228010.3171	5.23	1000	1.00%	9.38
North Proposed	292051.9481	6.70	1000	5.00%	5.05
South Proposed	106271.1511	2.44	800	6.00%	3.96

Land Cover Type	Percent Impervious	Runoff Coefficient
Historical Flow Analysis	2%	0.09
Gravel	80%	0.59
Pond	100%	0.85

Roughness Coefficient and Curve Number Analysis

Yard

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Substation Yard	3.83	0.59	2.26	80%	306.2%
Native	0.75	0.09	0.07	2%	1.5%
Pond	0.66	0.85	0.56	100%	65.6%
		sum	2.88		373.4%
Total Area (ac)	**5.23**	Weighted	0.55		71%
Weighted Runoff Coefficient	**0.55**				
Weighted Percent Impervious	**71%**				

North Proposed

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Native	6.47	0.09	0.58	2%	12.9%
Swale	0.23	0.85	0.20	100%	23.2%
		sum	0.78		36.1%
Total Area (ac)	**6.70**	Weighted	0.12		5%
Weighted Runoff Coefficient	**0.12**				
Weighted Percent Impervious	**5%**				

South Proposed

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Native	2.24	0.09	0.20	2%	4.5%
Gravel	0.08	0.59	0.05	80%	6.2%
Swale	0.12	0.85	0.10	100%	12.0%
		sum	0.35		22.7%
Total Area (ac)	**2.44**	Weighted	0.14		9%
Weighted Runoff Coefficient	**0.14**				
Weighted Percent Impervious	**9%**				

Fox Run Drainage Design

Existing Conditions-100 Year

Area Name	Total Area (sf)	(acres)	Flow Length	Slope (%)	TOC (min)
Existing	626336.766	14.38	1000	6%	4.70
Offsite	196020	4.50	700	4%	4.18

Land Cover Type	Percent Impervious	Runoff Coefficient
Historical Flow Analysis	2%	0.36
Gravel	80%	0.7
Pond	100%	0.89

Roughness Coefficient and Curve Number Analysis

Existing

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Existing Site	14.38	0.36	5.18	2%	29%
		sum	5.18		29%
Total Area (ac)	**14.379**	Weighted	0.36		2%
Weighted Runoff Coefficient	**0.36**				
Weighted Percent Impervious	**2%**				

Offsite

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Existing Site	4.50	0.36	1.62	2%	9%
		sum	1.62		9%
Total Area (ac)	**4.500**	Weighted	0.36		2%
Weighted Runoff Coefficient	**0.36**				
Weighted Percent Impervious	**2%**				

Fox Run Drainage Design

Proposed Conditions-100 Year

Area Name	Total Area (sf)	(acres)	Flow Length	Slope (%)	TOC (min)
Yard	228010.3171	5.23	1000	1.00%	9.38
North Proposed	292051.9481	6.70	1000	5.00%	5.05
South Proposed	106271.1511	2.44	800	6.00%	3.96

Land Cover Type	Percent Impervious	Runoff Coefficient
Historical Flow Analysis	2%	0.36
Gravel	80%	0.7
Pond	100%	0.89

Roughness Coefficient and Curve Number Analysis

Yard

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Substation Yard	3.83	0.7	2.68	80%	306.2%
Native	0.75	0.36	0.27	2%	1.5%
Pond	0.66	0.89	0.58	100%	65.6%
		sum	3.53		373.4%
Total Area (ac)	**5.23**	Weighted	0.68		71%
Weighted Runoff Coefficient	**0.68**				
Weighted Percent Impervious	**71%**				

North Proposed

Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Native	6.47	0.36	2.33	2%	12.9%
Swale	0.23	0.89	0.21	100%	23.2%
		sum	2.54		36.1%
Total Area (ac)	**6.70**	Weighted	0.38		5%
Weighted Runoff Coefficient	**0.38**				
Weighted Percent Impervious	**5%**				

South Proposed

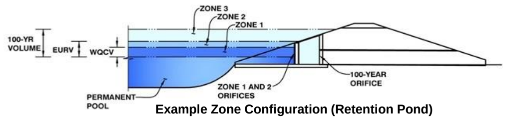
Description	Total Area (ac)	Runoff Coefficient	A*C	Percent Impervious	A*%
Native	2.24	0.36	0.81	2%	4.5%
Gravel	0.08	0.7	0.05	80%	6.2%
Swale	0.12	0.89	0.11	100%	12.0%
		sum	0.97		22.7%
Total Area (ac)	**2.44**	Weighted	0.40		9%
Weighted Runoff Coefficient	**0.40**				
Weighted Percent Impervious	**9%**				

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Fox Run Substation**

Basin ID: **Detention Pond**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	5.23	acres
Watershed Length =	500	ft
Watershed Length to Centroid =	50	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	71.00%	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) =	0.122	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.408	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.299	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.402	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.489	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.590	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.681	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.788	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.017	acre-feet		inches
Approximate 2-yr Detention Volume =	0.319	acre-feet		
Approximate 5-yr Detention Volume =	0.425	acre-feet		
Approximate 10-yr Detention Volume =	0.536	acre-feet		
Approximate 25-yr Detention Volume =	0.575	acre-feet		
Approximate 50-yr Detention Volume =	0.599	acre-feet		
Approximate 100-yr Detention Volume =	0.640	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.122	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.286	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.232	acre-feet
Total Detention Basin Volume =	0.640	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 = 0.50 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	--	--	--	0	0.000		
	--	0.25	--	--	--	222	0.005	28	0.001
	--	0.75	--	--	--	1,640	0.038	493	0.011
	--	1.25	--	--	--	3,509	0.081	1,780	0.041
	--	1.75	--	--	--	5,810	0.133	4,110	0.094
	--	2.25	--	--	--	8,441	0.194	7,673	0.176
	--	2.75	--	--	--	11,212	0.257	12,586	0.289
	--	3.25	--	--	--	14,161	0.325	18,929	0.435
	--	3.75	--	--	--	17,263	0.396	26,785	0.615
Spillway Crest	--	4.25	--	--	--	20,531	0.471	36,234	0.832
	--	4.75	--	--	--	23,884	0.548	47,338	1.087
	--	5.25	--	--	--	26,606	0.611	59,960	1.376
Top of Bank	--	5.75	--	--	--	28,486	0.654	73,733	1.693
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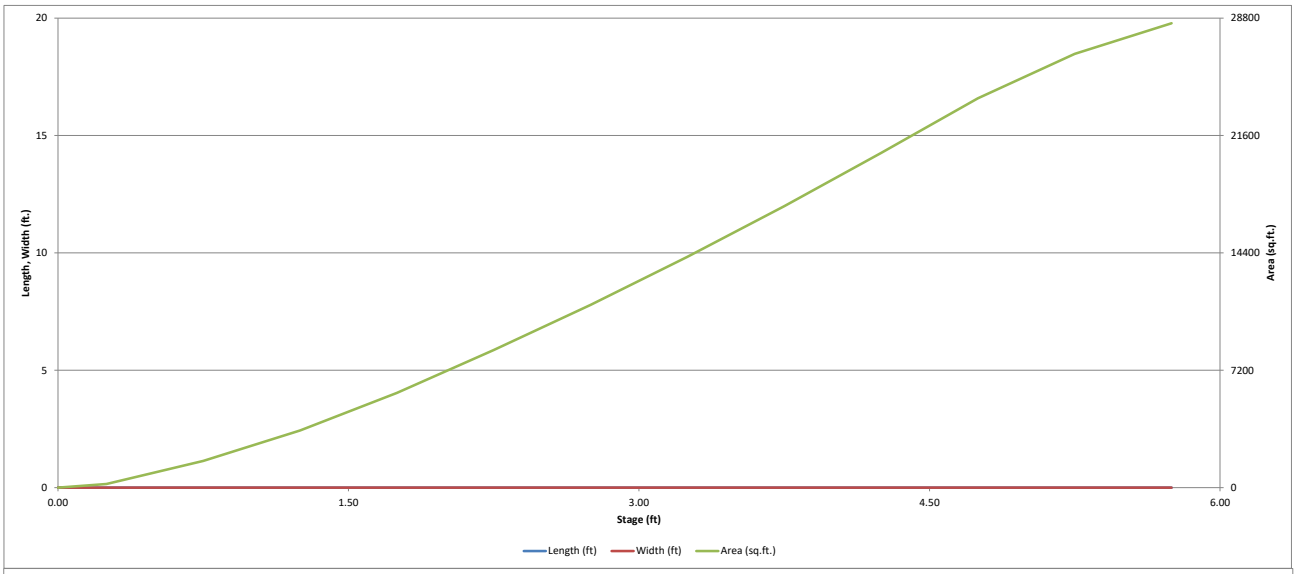
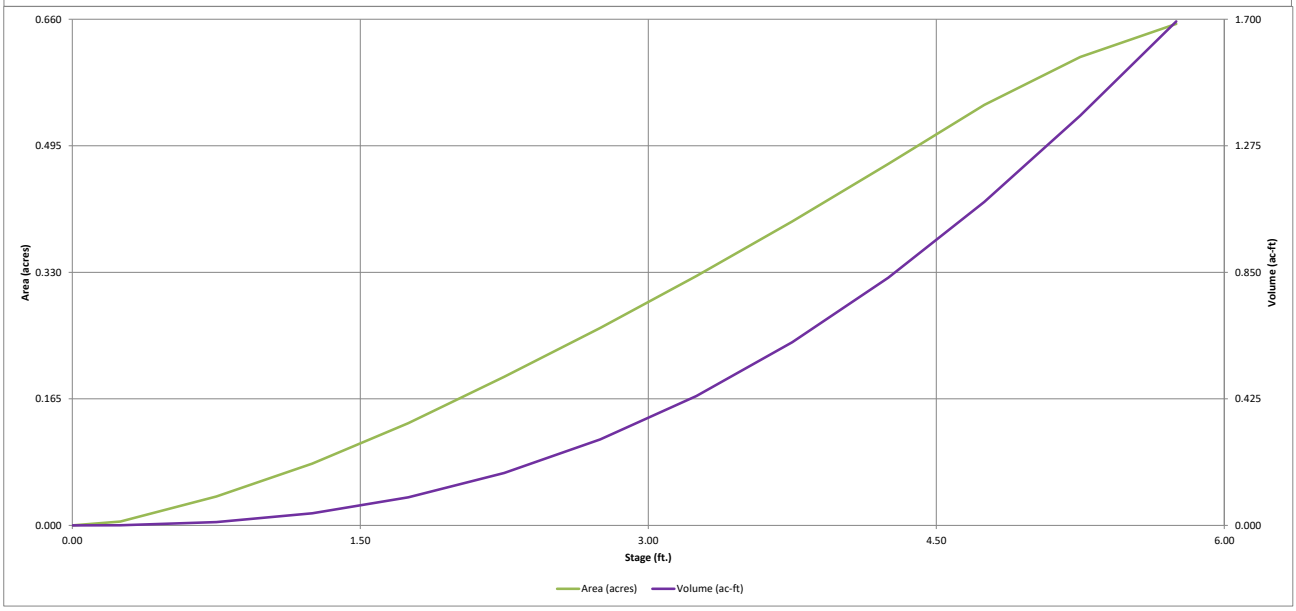
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



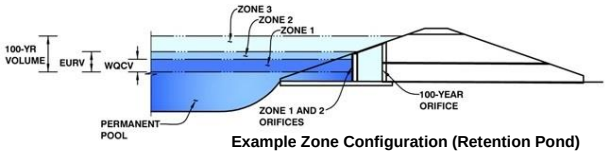


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Fox Run Substation**

Basin ID: **Detention Pond**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.94	0.122	Orifice Plate
Zone 2 (EURV)	3.17	0.286	Orifice Plate
Zone 3 (100-year)	3.82	0.232	Weir&Pipe (Restrict)
Total (all zones)		0.640	

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

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	3.056E-03	ft^2
Depth at top of Zone using Orifice Plate =	2.50	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	6.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	0.44	sq. inches (diameter = 3/4 inch)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00	1.50	2.00			
Orifice Area (sq. inches)	0.44	0.44	0.44	0.44	0.44			

	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			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

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			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.50	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.50	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	2.50	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	3.94	N/A	
Horiz. Length of Weir Sides =	2.50	N/A	feet	Overflow Grate Open Area w/o Debris =	6.96	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	3.48	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.25	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.47	feet
Spillway Crest Length =	20.00	feet	Stage at Top of Freeboard =	5.72	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.65	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	1.67	acre-ft

Calculated Parameters for Spillway

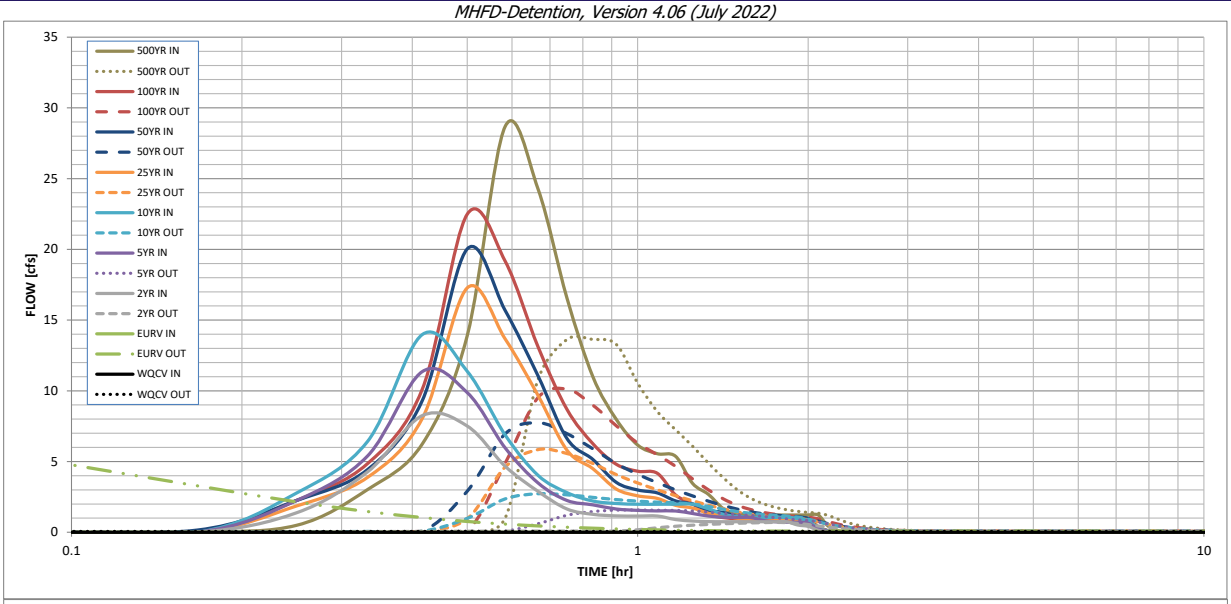
Routed Hydrograph Results

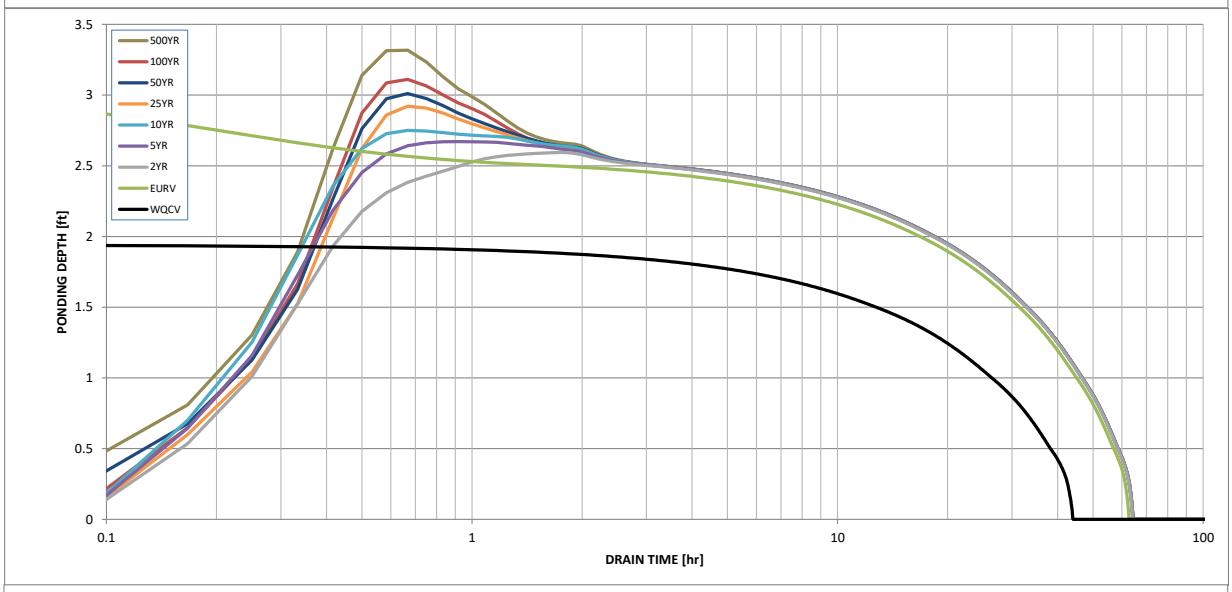
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

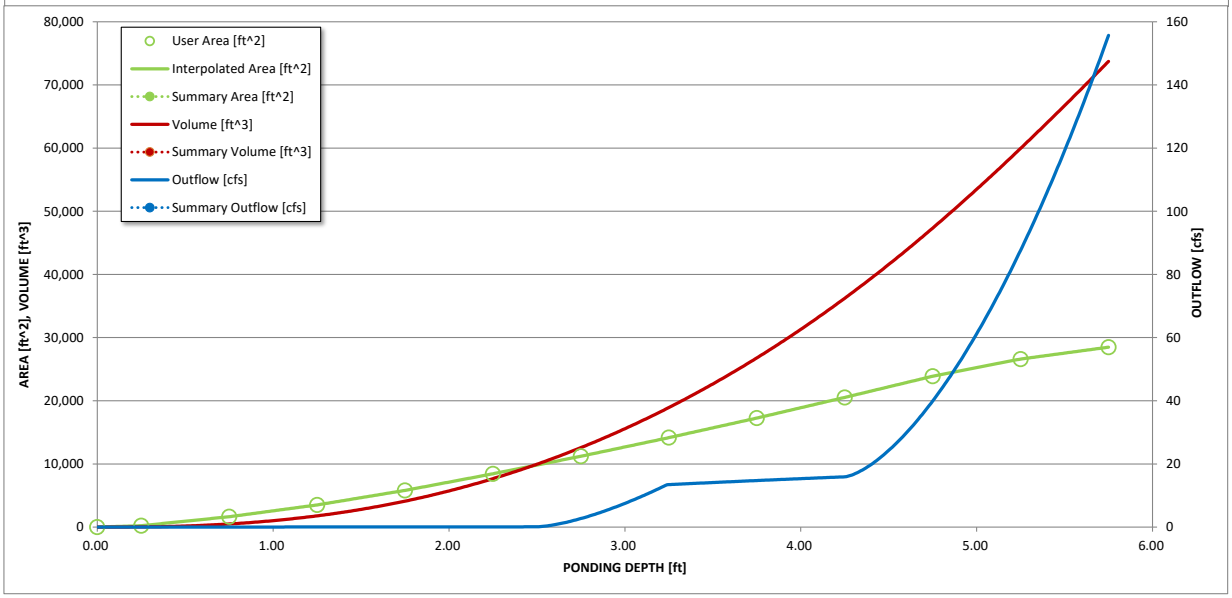
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.122	0.408	0.299	0.402	0.489	0.590	0.681	0.788	1.017
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.299	0.402	0.489	0.590	0.681	0.788	1.017
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	3.3	4.8	7.7	9.7	12.4	17.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.22	0.62	0.92	1.48	1.86	2.37	3.27
Peak Inflow Q (cfs) =	N/A	N/A	8.3	11.4	14.0	17.3	20.0	22.5	28.7
Peak Outflow Q (cfs) =	0.1	9.0	0.7	1.6	2.7	5.8	7.7	10.1	13.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.6	0.8	0.8	0.8	0.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	1.65	0.08	0.2	0.4	0.8	1.1	1.4	1.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	52	54	53	51	50	48	47	44
Time to Drain 99% of Inflow Volume (hours) =	**42**	57	60	58	58	57	56	55	54
Maximum Ponding Depth (ft) =	1.95	3.17	2.59	2.67	2.75	2.92	3.01	3.11	3.32
Area at Maximum Ponding Depth (acres) =	0.16	0.31	0.24	0.25	0.26	0.28	0.29	0.31	0.33
Maximum Volume Stored (acre-ft) =	0.123	0.409	0.249	0.269	0.289	0.335	0.360	0.390	0.454

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

Time Interval	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]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.02	0.50
	0:15:00	0.00	0.00	1.39	2.25	2.79	1.87	2.25	2.26	3.02
	0:20:00	0.00	0.00	4.27	5.39	6.42	3.88	4.43	4.85	6.25
	0:25:00	0.00	0.00	8.25	11.36	13.98	8.06	9.33	10.14	13.89
	0:30:00	0.00	0.00	7.51	9.88	11.38	17.27	20.03	22.48	28.68
	0:35:00	0.00	0.00	4.67	5.97	6.88	13.67	15.69	19.17	24.28
	0:40:00	0.00	0.00	2.90	3.49	4.03	9.68	11.07	13.12	16.56
	0:45:00	0.00	0.00	1.65	2.25	2.81	5.81	6.63	8.69	11.01
	0:50:00	0.00	0.00	1.27	1.94	2.21	4.50	5.15	6.27	7.98
	0:55:00	0.00	0.00	1.16	1.65	2.04	3.06	3.53	4.81	6.17
	1:00:00	0.00	0.00	1.15	1.55	1.98	2.58	2.99	4.32	5.56
	1:05:00	0.00	0.00	1.15	1.51	1.98	2.39	2.78	4.17	5.37
	1:10:00	0.00	0.00	0.90	1.51	1.99	1.90	2.22	2.64	3.46
	1:15:00	0.00	0.00	0.80	1.33	1.99	1.71	2.00	2.01	2.68
	1:20:00	0.00	0.00	0.75	1.15	1.66	1.35	1.56	1.27	1.67
	1:25:00	0.00	0.00	0.75	1.07	1.27	1.22	1.40	1.04	1.36
	1:30:00	0.00	0.00	0.75	1.05	1.11	0.99	1.13	0.96	1.24
	1:35:00	0.00	0.00	0.75	1.05	1.06	0.91	1.03	0.95	1.22
	1:40:00	0.00	0.00	0.75	0.84	1.06	0.88	0.99	0.95	1.22
	1:45:00	0.00	0.00	0.75	0.75	1.06	0.88	0.99	0.95	1.22
	1:50:00	0.00	0.00	0.75	0.71	1.06	0.88	0.99	0.95	1.22
	1:55:00	0.00	0.00	0.52	0.71	0.98	0.88	0.99	0.95	1.22
	2:00:00	0.00	0.00	0.42	0.65	0.81	0.88	0.99	0.95	1.22
	2:05:00	0.00	0.00	0.15	0.24	0.30	0.33	0.37	0.36	0.46
	2:10:00	0.00	0.00	0.05	0.08	0.09	0.11	0.12	0.12	0.15
	2:15:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	2:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

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

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

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

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: Thayne Clement
Company: Del-Mont Consultants
Date: March 30, 2023
Project: Fox Run Substation
Location: Monument, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 71.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.710

C) Contributing Watershed Area — Area = 5.230 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = 0.41 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} = 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) — $V_{DESIGN\ USER}$ = 0.116 ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

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: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = 0.409 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 = 1.4 : 1 **INCREASE FLOW PATH FOR 2:1 RATIO**

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} = 2% of the WQCV) — V_{FMIN} = 0.002 ac-ft

B) Actual Forebay Volume — V_F = 0.002 ac-ft

C) Forebay Depth (D_F = 18 inch maximum) — D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 25.16 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.50 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 = 4.6 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Thayne Clement
Company: Del-Mont Consultants
Date: March 30, 2023
Project: Fox Run Substation
Location: Monument, CO

6. Trickle Channel

A) Type of Trickle Channel — Choose One: (●) Concrete ( ) Soft Bottom

F) Slope of Trickle Channel — S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 11 sq ft

C) Outlet Type — Choose One: (●) Orifice Plate ( ) Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = 0.75 inches

E) Total Outlet Area — A_{ot} = 2.20 square inches

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = 4 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = cu ft

C) Initial Surcharge Provided Above Micropool — V_s = 3.7 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = 79 square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) — *S.S. Well Screen with 60% Open Area*

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio =

D) Total Water Quality Screen Area (based on screen type) — A_{total} = 131 sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= 3.17 feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= 66.04 inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = 12.0 inches **VALUE LESS THAN RECOMMENDED MIN. WIDTH. WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Designer: Thayne Clement
Company: Del-Mont Consultants
Date: March 30, 2023
Project: Fox Run Substation
Location: Monument, CO

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Ze = 4.00 ft / ft

11. Vegetation

Choose One
- ○ Irrigated
- ◉ Not Irrigated

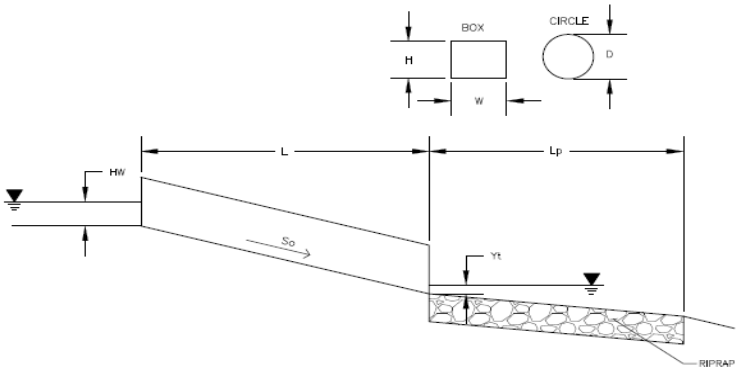
12. Access

A) Describe Sediment Removal Procedures

Notes:

Determination of Culvert Headwater and Outlet Protection

Project: Fox Run Substation
Basin ID: Driveway Culverts



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

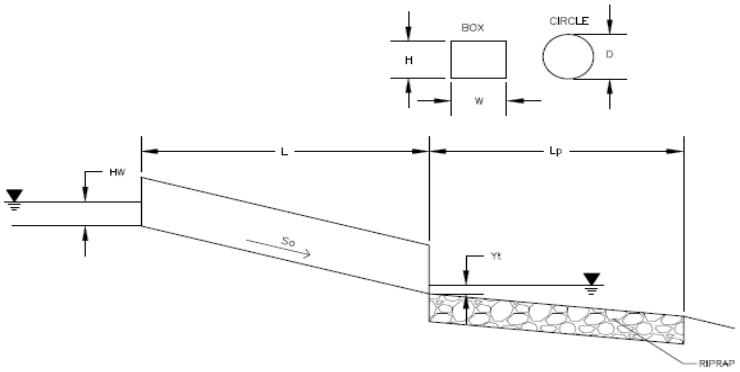
	Design Discharge	Q =	15.74	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (Choose from pull-down list)		Square End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	7462.48	ft
	Outlet Elevation **OR** Slope	Elev OUT =	7460.88	ft
	Culvert Length	L =	40	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =	7463.28	ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	2.40	ft
Flow Area at Max Channel Velocity	A_t =	3.15	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.42	
Sum of All Losses Coefficients	k_s =	1.92	ft
Culvert Normal Depth	Y_n =	0.78	ft
Culvert Critical Depth	Y_c =	1.43	ft
Tailwater Depth for Design	d =	1.72	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.39	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.78	$ft^{0.5}/s$
Froude Number	Fr =	3.22	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	1.73	
Inlet Control Headwater	HW_I =	2.34	ft
Outlet Control Headwater	HW_O =	0.86	
Design Headwater Elevation	**HW =**	**7,464.82**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.17**	
Minimum Theoretical Riprap Size	d_{50} =	1	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**6**	**ft**
Width of Protection	**T =**	**3**	**ft**

Determination of Culvert Headwater and Outlet Protection

Project: Fox Run Substation
Basin ID: Pond Outlet Pipe



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

	Design Discharge	Q =	2.53	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (Choose from pull-down list)		Square End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	7441.67	ft
	Outlet Elevation **OR** Slope	Elev OUT =	7440.47	ft
	Culvert Length	L =	60	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.60	ft
Flow Area at Max Channel Velocity	A_t =	0.51	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.93	
Sum of All Losses Coefficients	k_s =	2.43	ft
Culvert Normal Depth	Y_n =	0.40	ft
Culvert Critical Depth	Y_c =	0.60	ft
Tailwater Depth for Design	d =	1.05	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	0.95	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	0.92	$ft^{0.5}/s$
Froude Number	Fr =	2.19	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.63	
Inlet Control Headwater	HW_I =	0.85	ft
Outlet Control Headwater	HW_O =	-0.07	
Design Headwater Elevation	**HW =**	**7,442.52**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.57**	
Minimum Theoretical Riprap Size	d_{50} =	1	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**5**	**ft**
Width of Protection	**T =**	**3**	**ft**

Design Procedure Form: Grass Swale (GS)

UD-BMP (Version 3.07, March 2018) **Sheet 1 of 1**

Designer: Thayne Clement
Company: Del-Mont Consultants
Date: March 29, 2023
Project: Fox Run Substation
Location: Monument, CO

1. Design Discharge for 2-Year Return Period	Q_2 = 0.70 cfs
2. Hydraulic Residence Time	
A) : Length of Grass Swale	L_S = 60.0 ft
B) Calculated Residence Time (based on design velocity below)	T_{HR} = 1.2 minutes
3. Longitudinal Slope (vertical distance per unit horizontal)	
A) Available Slope (based on site constraints)	S_{avail} = 0.060 ft / ft
B) Design Slope	S_D = 0.020 ft / ft
4. Swale Geometry	
A) Channel Side Slopes (Z = 4 min., horiz. distance per unit vertical)	Z = 4.00 ft / ft
B) Bottom Width of Swale (enter 0 for triangular section)	W_B = 4.00 ft
5. Vegetation A) Type of Planting (seed vs. sod, affects vegetal retardance factor)	Choose One (●) Grass From Seed ( ) Grass From Sod
6. Design Velocity (0.2 ft / s maximum for desirable 5-minute residence time)	V_2 = 0.82 ft / s
7. Design Flow Depth (1 foot maximum)	D_2 = 0.18 ft
A) Flow Area	A_2 = 0.8 sq ft
B) Top Width of Swale	W_T = 5.4 ft
C) Froude Number (0.50 maximum)	F = 0.37
D) Hydraulic Radius	R_H = 0.15
E) Velocity-Hydraulic Radius Product for Vegetal Retardance	VR = 0.13
F) Manning's n (based on SCS vegetal retardance curve E for seeded grass)	n = 0.073
G) Cumulative Height of Grade Control Structures Required	H_D = 2.40 ft
8. Underdrain (Is an underdrain necessary?)	Choose One (●) YES ( ) NO
9. Soil Preparation (Describe soil amendment)	
10. Irrigation	Choose One (●) Temporary ( ) Permanent

Notes:

Emergency Spillway Calculations

RipRap Sizing		
Izbash Formula: D50 = (V^2)/(2*32.2*(0.86^2)*(2.55-1))*12		
Assume RipRap Specific Gravity 2.55		
Variable	Input	Units
100 year Discharge Rate (Q)	25.16	cfs
Disharge Velocity (V)	4.19	ft/s
Required D50 Value	**2.86**	in

Appendix B
Rational Method Modeling Results

Project Description

File Name	21036-Fox Run Drainage - RM5.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	Kirpich
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	5
Nodes	8
Junctions	4
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	11
Channels	1
Pipes	3
Pumps	0
Orifices	5
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	5 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Average Slope (%)	Flow Length (ft)	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Existing	9.15	0.0900	6.0000	1000.00	0.43	0.04	0.36	4.58	0 00:04:42
2	Offsite	4.50	0.0900	4.0000	700.00	0.40	0.04	0.16	2.36	0 00:04:10
3	Proposed-North	6.70	0.1200	5.0000	1000.00	0.43	0.05	0.35	4.14	0 00:05:03
4	Proposed-South	2.44	0.1400	6.0000	800.00	0.40	0.06	0.14	2.03	0 00:03:57
5	Yard	5.23	0.5500	1.0000	1000.00	0.66	0.36	1.89	12.13	0 00:09:22

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Culvert-In	Junction	7462.72	7464.00	0.00	0.00	0.00	2.36	7463.02	0.00	1.70	0 00:00	0.00	0.00
2	Culvert-Out	Junction	7460.63	7462.00	0.00	0.00	0.00	2.34	7460.93	0.00	1.70	0 00:00	0.00	0.00
3	Pipe-Out	Junction	7440.47	7442.00	0.00	7446.00	0.00	0.09	7440.68	0.00	1.42	0 00:00	0.00	0.00
4	Pond-Out	Junction	7441.67	7447.00	0.00	7447.00	0.00	0.09	7441.75	0.00	5.67	0 00:00	0.00	0.00
5	Existing-Out	Outfall	7435.00					4.58	7435.00					
6	Out-North	Outfall	7435.00					4.17	7435.03					
7	Out-South	Outfall	7435.00					4.27	7435.00					
8	Pond	Storage Node	7442.25	7448.00	0.00		0.00	12.13	7444.38				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Access-Culvert	Pipe	Culvert-In	Culvert-Out	52.25	7462.72	7460.63	4.0000	24.000	0.0120	2.34	49.02	0.05	9.37	0.30	0.15	0.00	Calculated
2	Link-04	Pipe	Culvert-Out	Out-South	414.64	0.00	7435.00	-1793.1200	0.000	0.0150	2.34	0.00	0.05	0.00	0.30	0.15	0.00	Calculated
3	Out-Pipe	Pipe	Pond-Out	Pipe-Out	60.00	7441.67	7440.47	2.0000	18.000	0.0120	0.09	15.20	0.01	2.30	0.08	0.05	0.00	Calculated
4	Out-Swale	Channel	Pipe-Out	Out-North	60.00	7440.47	7439.00	2.4500	12.000	0.0270	0.09	70.61	0.00	1.48	0.03	0.03	0.00	
5	Orifice-01	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.02							
6	Orifice-02	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.02							
7	Orifice-03	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.02							
8	Orifice-04	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.01							
9	Orifice-05	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.01							
10	Spillway	Weir	Pond	Pond-Out		7442.25	7441.67				0.00							
11	Weir	Weir	Pond	Pond-Out		7442.25	7441.67				0.00							

Subbasin Hydrology

Subbasin : Existing

Input Data

Area (ac) 9.15
Weighted Runoff Coefficient 0.09
Average Slope (%) 6
Flow Length (ft) 1000

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	14.38	-	0.09
Composite Area & Weighted Runoff Coeff.	14.38		0.09

Time of Concentration

TOC Method : Kirpich

Sheet Flow Equation :

Tc = (0.0078 * ((Lf^0.77) * (Sf^-0.385)))

Where :

Tc = Time of Concentration (min)
Lf = Flow Length (ft)
Sf = Slope (ft/ft)

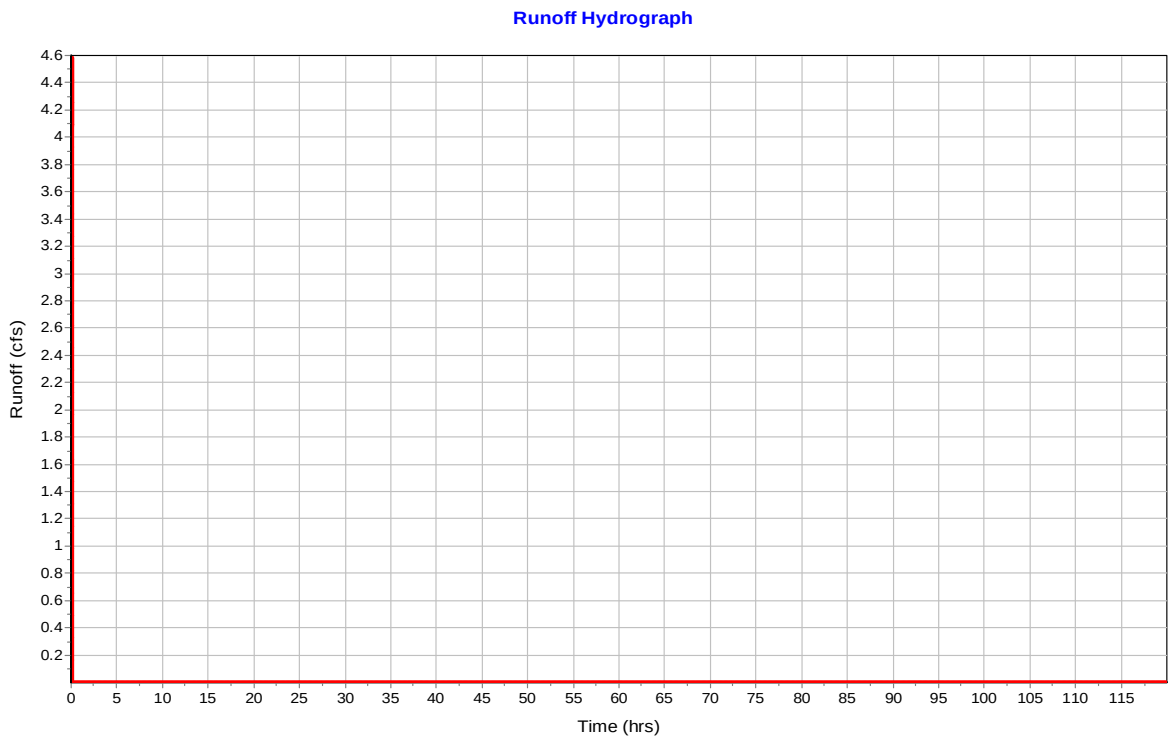
Flow Length (ft) 1000
Slope (%) 6
Computed TOC (min) 4.7

Subbasin Runoff Results

Total Rainfall (in) 0.43
Total Runoff (in) 0.04
Peak Runoff (cfs) 4.58
Rainfall Intensity 5.562
Weighted Runoff Coefficient 0.09
Time of Concentration (days hh:mm:ss) 0 00:04:42

21036 Fox Run Substation
5 Year Storm Event

Subbasin : Existing



Subbasin : Offsite

Input Data

Area (ac)	4.5
Weighted Runoff Coefficient	0.09
Average Slope (%)	4
Flow Length (ft)	700

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	4.5	-	0.09
Composite Area & Weighted Runoff Coeff.	4.5		0.09

Time of Concentration

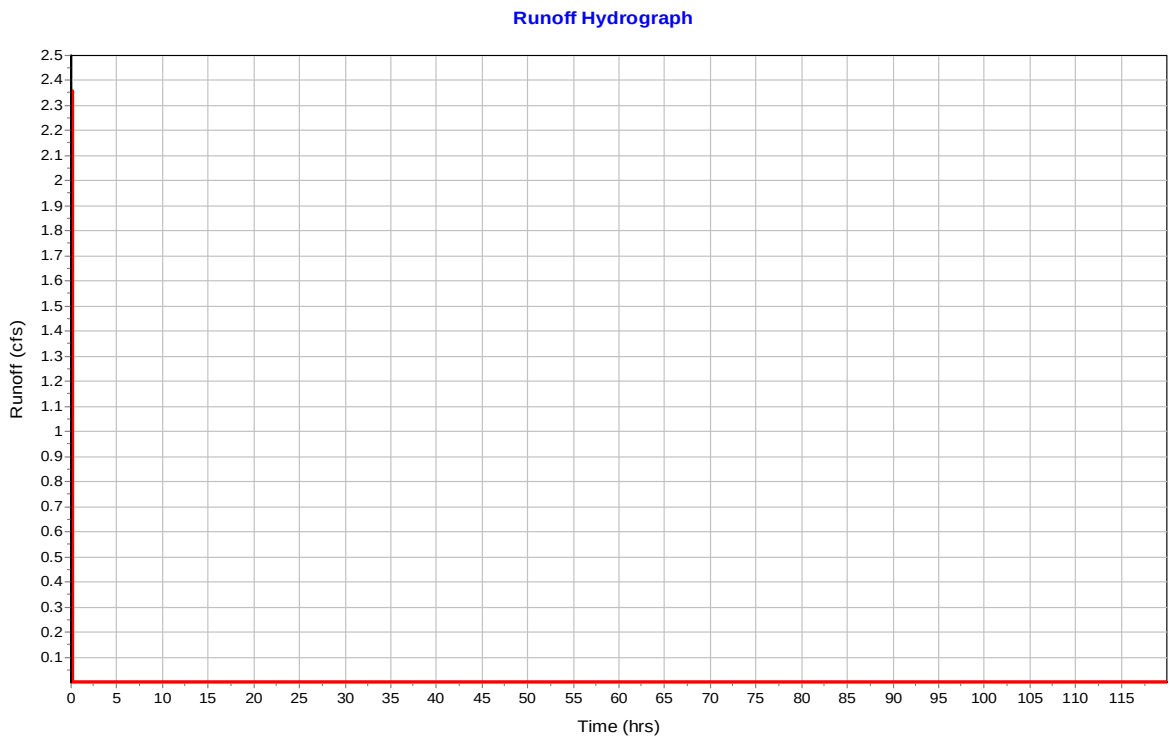
Flow Length (ft)	700
Slope (%)	4
Computed TOC (min)	4.18

Subbasin Runoff Results

Total Rainfall (in)	0.4
Total Runoff (in)	0.04
Peak Runoff (cfs)	2.36
Rainfall Intensity	5.825
Weighted Runoff Coefficient	0.09
Time of Concentration (days hh:mm:ss)	0 00:04:11

21036 Fox Run Substation
5 Year Storm Event

Subbasin : Offsite



Subbasin : Proposed-North

Input Data

Area (ac)	6.7
Weighted Runoff Coefficient	0.12
Average Slope (%)	5
Flow Length (ft)	1000

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	6.7	-	0.12
Composite Area & Weighted Runoff Coeff.	6.7		0.12

Time of Concentration

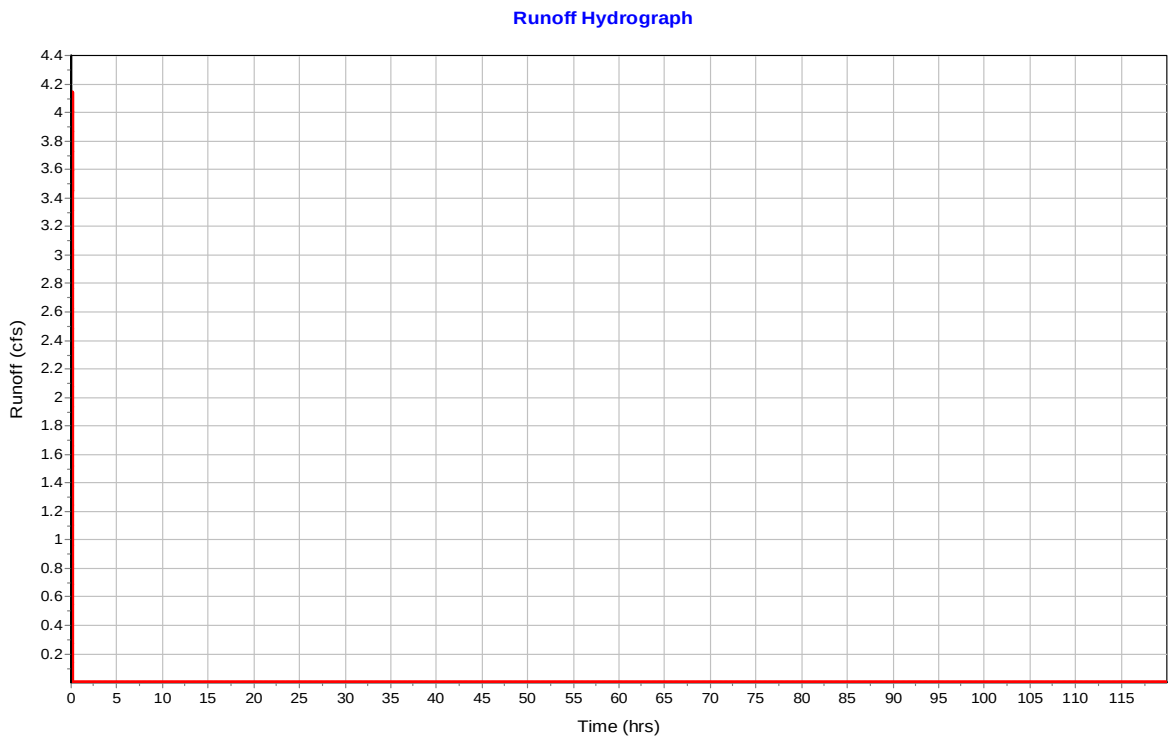
Flow Length (ft)	1000
Slope (%)	5
Computed TOC (min)	5.05

Subbasin Runoff Results

Total Rainfall (in)	0.43
Total Runoff (in)	0.05
Peak Runoff (cfs)	4.14
Rainfall Intensity	5.153
Weighted Runoff Coefficient	0.12
Time of Concentration (days hh:mm:ss)	0 00:05:03

21036 Fox Run Substation
5 Year Storm Event

Subbasin : Proposed-North



Subbasin : Proposed-South

Input Data

Area (ac)	2.44
Weighted Runoff Coefficient	0.14
Average Slope (%)	6
Flow Length (ft)	800

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	2.44	-	0.14
Composite Area & Weighted Runoff Coeff.	2.44		0.14

Time of Concentration

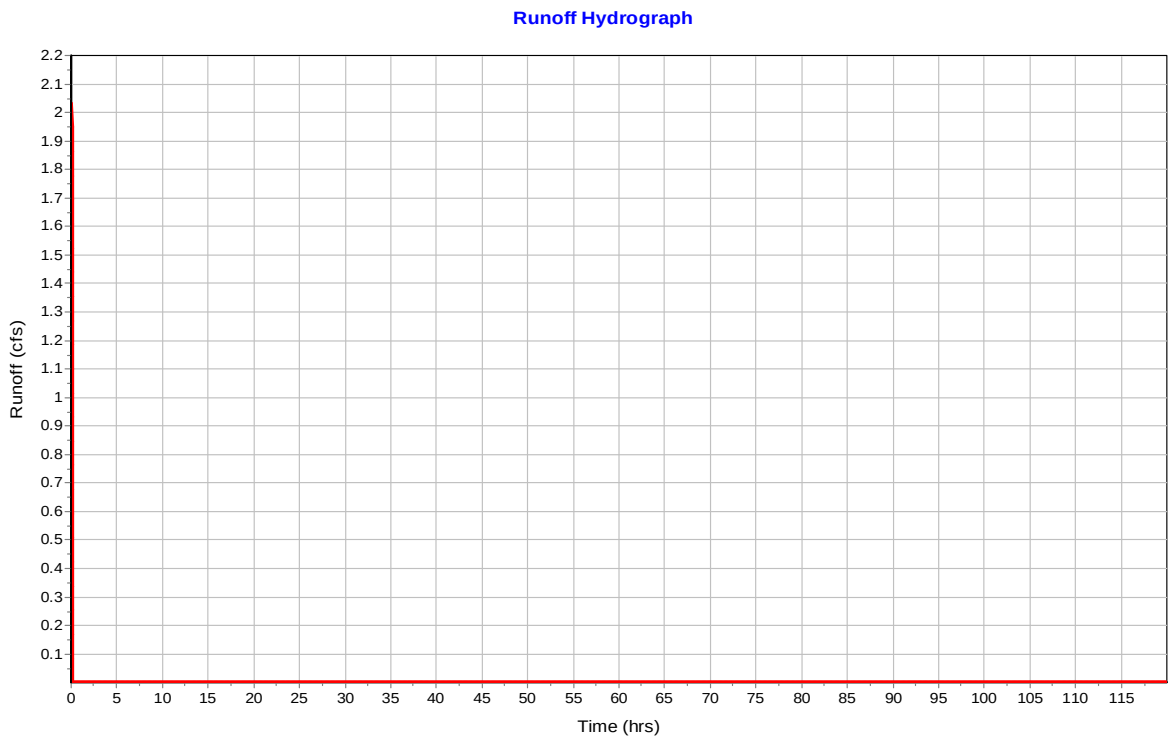
Flow Length (ft)	800
Slope (%)	6
Computed TOC (min)	3.96

Subbasin Runoff Results

Total Rainfall (in)	0.4
Total Runoff (in)	0.06
Peak Runoff (cfs)	2.03
Rainfall Intensity	5.95
Weighted Runoff Coefficient	0.14
Time of Concentration (days hh:mm:ss)	0 00:03:58

21036 Fox Run Substation
5 Year Storm Event

Subbasin : Proposed-South



Subbasin : Yard

Input Data

Area (ac)	5.23
Weighted Runoff Coefficient	0.55
Average Slope (%)	1
Flow Length (ft)	1000

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	5.23	-	0.55
Composite Area & Weighted Runoff Coeff.	5.23		0.55

Time of Concentration

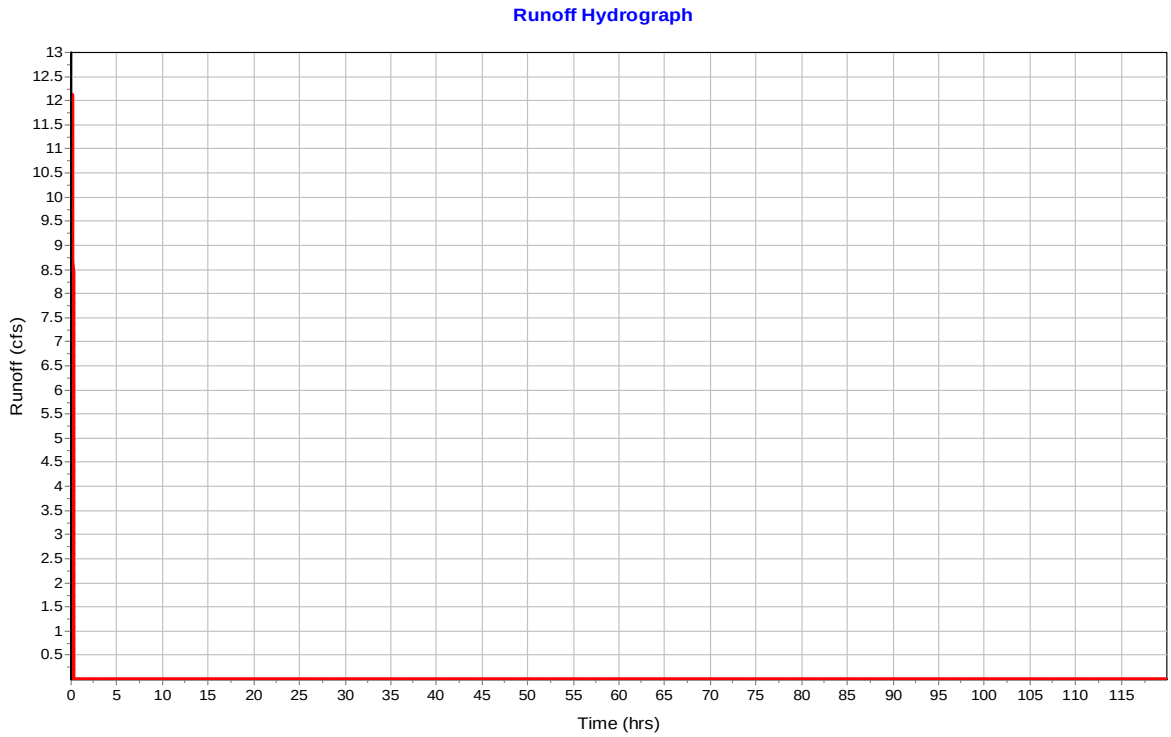
Flow Length (ft)	1000
Slope (%)	1
Computed TOC (min)	9.38

Subbasin Runoff Results

Total Rainfall (in)	0.66
Total Runoff (in)	0.36
Peak Runoff (cfs)	12.13
Rainfall Intensity	4.217
Weighted Runoff Coefficient	0.55
Time of Concentration (days hh:mm:ss)	0 00:09:23

21036 Fox Run Substation
5 Year Storm Event

Subbasin : Yard



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (in)
1	Culvert-In	7462.72	7464.00	1.28	0.00	-7462.72	0.00	-7464.00	0.00	0.00
2	Culvert-Out	7460.63	7462.00	1.37	0.00	-7460.63	0.00	-7462.00	0.00	0.00
3	Pipe-Out	7440.47	7442.00	1.53	0.00	-7440.47	7446.00	4.00	0.00	0.00
4	Pond-Out	7441.67	7447.00	5.33	0.00	-7441.67	7447.00	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Culvert-In	2.36	2.36	7463.02	0.30	0.00	1.70	7462.72	0.00	0 00:04	0 00:00	0.00	0.00
2	Culvert-Out	2.34	0.00	7460.93	0.30	0.00	1.70	7460.63	0.00	0 00:04	0 00:00	0.00	0.00
3	Pipe-Out	0.09	0.00	7440.68	0.08	0.00	1.42	7440.62	0.02	0 00:19	0 00:00	0.00	0.00
4	Pond-Out	0.09	0.00	7441.75	0.08	0.00	5.67	7441.69	0.02	0 00:18	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Out-Swale	60.00	7440.47	0.00	7439.00	4.00	1.47	2.4500	Trapezoidal	1.000	10.000	0.0270	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Out-Swale	0.09	0 00:19	70.61	0.00	1.48	0.68	0.03	0.03	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Access-Culvert	52.25	7462.72	0.00	7460.63	0.00	2.09	4.0000	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No
2	Link-04	414.64	0.00	-7460.63	7435.00	0.00	-7435.00	-1793.1200	Dummy	0.000	0.000	0.0150	0.5000	0.5000	0.0000	0.00	No
3	Out-Pipe	60.00	7441.67	0.00	7440.47	0.00	1.20	2.0000	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No

21036 Fox Run Substation
5 Year Storm Event

No. of Barrels
1
1
1

21036 Fox Run Substation
5 Year Storm Event

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Access-Culvert	2.34	0 00:04	49.02	0.05	9.37	0.09	0.30	0.15	0.00		Calculated
2	Link-04	2.34	0 00:04	0.00	0.05	0.00		0.30	0.15	0.00		Calculated
3	Out-Pipe	0.09	0 00:19	15.20	0.01	2.30	0.43	0.08	0.05	0.00		Calculated

Storage Nodes

Storage Node : Pond

Input Data

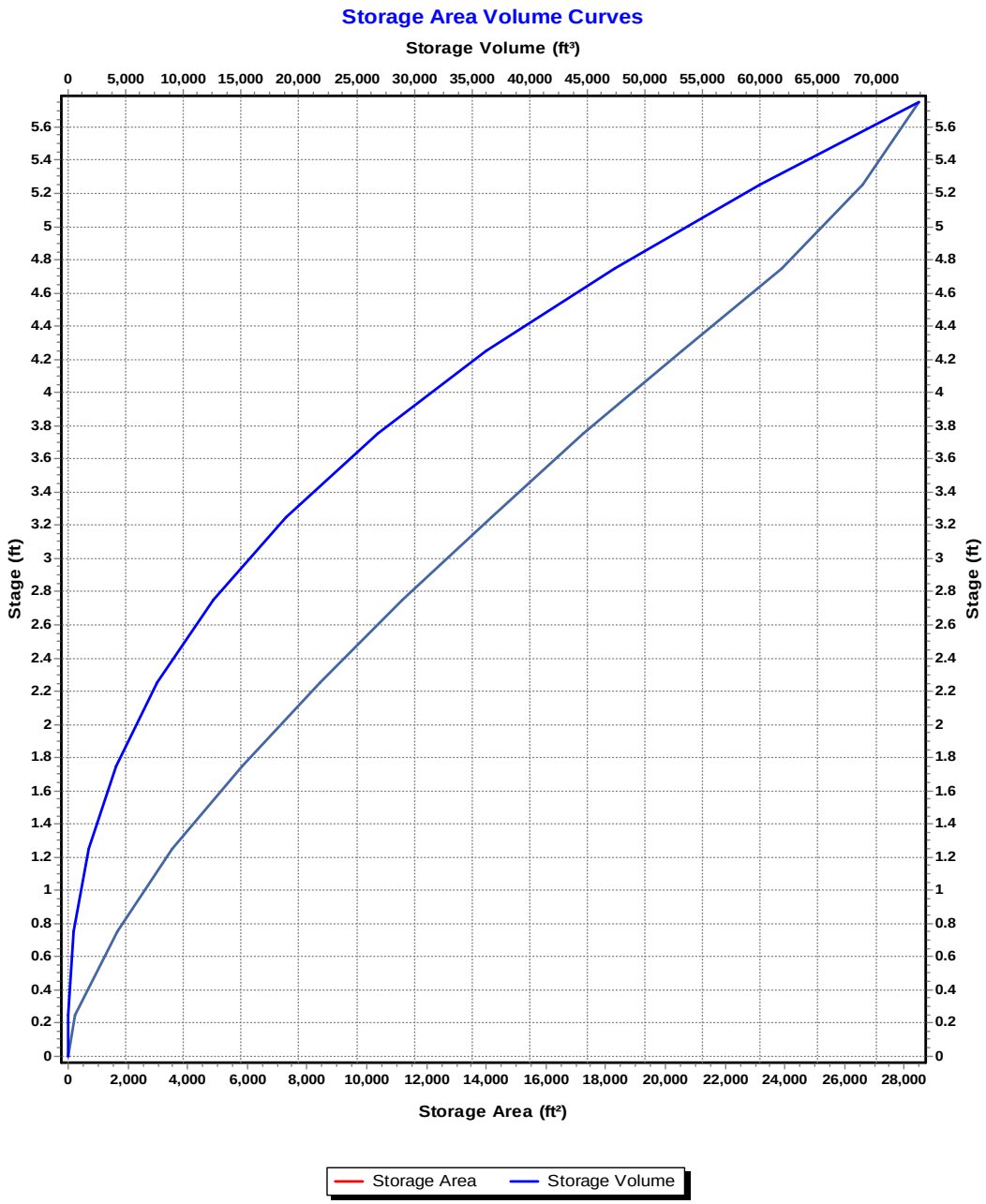
Invert Elevation (ft)	7442.25
Max (Rim) Elevation (ft)	7448
Max (Rim) Offset (ft)	5.75
Initial Water Elevation (ft)	0
Initial Water Depth (ft)	-7442.25
Ponded Area (ft²)	0
Evaporation Loss	0

Storage Area Volume Curves

Storage Curve : Detention-Pond

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
0.25	222	27.75
0.75	1640	493.25
1.25	3509	1780.5
1.75	5810	4110.25
2.25	8441	7673
2.75	11212	12586.25
3.25	14161	18929.5
3.75	17263	26785.5
4.25	20531	36234
4.75	23884	47337.75
5.25	26606	59960.25
5.75	28486	73733.25

21036 Fox Run Substation
5 Year Storm Event



Storage Node : Pond (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Spillway	Trapezoidal	No	7447.00	4.75	10.00	1.00	3.37
2	Weir	Rectangular	No	7444.75	2.50	4.00	1.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-01	Side	CIRCULAR	No	0.75			7441.92	0.61
2	Orifice-02	Side	CIRCULAR	No	0.75			7442.42	0.61
3	Orifice-03	Side	CIRCULAR	No	0.75			7442.92	0.61
4	Orifice-04	Side	CIRCULAR	No	0.75			7443.42	0.61
5	Orifice-05	Side	CIRCULAR	No	0.75			7443.92	0.61

Output Summary Results

Peak Inflow (cfs)	12.13
Peak Lateral Inflow (cfs)	12.13
Peak Outflow (cfs)	0.09
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	7444.38
Max HGL Depth Attained (ft)	2.13
Average HGL Elevation Attained (ft)	7442.66
Average HGL Depth Attained (ft)	0.41
Time of Max HGL Occurrence (days hh:mm)	0 00:18
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name	21036-Fox Run Drainage - RM100.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	Kirpich
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	5
Nodes	8
Junctions	4
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	11
Channels	1
Pipes	3
Pumps	0
Orifices	5
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Average Slope (%)	Flow Length (ft)	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Existing	9.15	0.3600	6.0000	1000.00	0.73	0.26	2.39	30.71	0 00:04:42
2	Offsite	4.50	0.3600	4.0000	700.00	0.68	0.24	1.10	15.81	0 00:04:10
3	Proposed-North	6.70	0.3800	5.0000	1000.00	0.72	0.27	1.84	22.03	0 00:05:03
4	Proposed-South	2.44	0.4000	6.0000	800.00	0.67	0.27	0.65	9.73	0 00:03:57
5	Yard	5.23	0.6800	1.0000	1000.00	1.10	0.75	3.91	25.16	0 00:09:22

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Culvert-In	Junction	7462.72	7464.00	0.00	0.00	0.00	15.81	7463.50	0.00	1.22	0 00:00	0.00	0.00
2	Culvert-Out	Junction	7460.63	7462.00	0.00	0.00	0.00	15.74	7461.41	0.00	1.22	0 00:00	0.00	0.00
3	Pipe-Out	Junction	7440.47	7442.10	0.00	7446.00	0.00	2.53	7440.87	0.00	1.23	0 00:00	0.00	0.00
4	Pond-Out	Junction	7441.67	7447.00	0.00	7447.00	0.00	2.53	7442.07	0.00	4.93	0 00:00	0.00	0.00
5	Existing-Out	Outfall	7435.00					30.71	7435.00					
6	Out-North	Outfall	7435.00					22.06	7439.17					
7	Out-South	Outfall	7435.00					25.02	7435.00					
8	Pond	Storage Node	7442.25	7448.00	0.00		0.00	25.16	7445.07				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Access-Culvert	Pipe	Culvert-In	Culvert-Out	52.25	7462.72	7460.63	4.0000	24.000	0.0120	15.74	49.02	0.32	14.33	0.78	0.39	0.00	Calculated
2	Link-04	Pipe	Culvert-Out	Out-South	414.64	0.00	7435.00	-1793.1200	0.000	0.0150	15.74	0.00	0.32	0.00	0.78	0.39	0.00	Calculated
3	Out-Pipe	Pipe	Pond-Out	Pipe-Out	60.00	7441.67	7440.47	2.0000	18.000	0.0120	2.53	16.09	0.16	6.64	0.40	0.27	0.00	Calculated
4	Out-Swale	Channel	Pipe-Out	Out-North	60.00	7440.35	7438.97	2.3000	12.000	0.0270	2.53	52.41	0.05	2.66	0.20	0.20	0.00	
5	Orifice-01	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.03							
6	Orifice-02	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.02							
7	Orifice-03	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.02							
8	Orifice-04	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.02							
9	Orifice-05	Orifice	Pond	Pond-Out		7442.25	7441.67		0.750		0.02							
10	Spillway	Weir	Pond	Out-North		7442.25	7435.00				0.00							
11	Weir	Weir	Pond	Pond-Out		7442.25	7441.67				2.42							

Subbasin Hydrology

Subbasin : Existing

Input Data

Area (ac) 9.15
Weighted Runoff Coefficient 0.36
Average Slope (%) 6
Flow Length (ft) 1000

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	14.38	-	0.36
Composite Area & Weighted Runoff Coeff.	14.38		0.36

Time of Concentration

TOC Method : Kirpich

Sheet Flow Equation :

Tc = (0.0078 * ((Lf^0.77) * (Sf^-0.385)))

Where :

Tc = Time of Concentration (min)
Lf = Flow Length (ft)
Sf = Slope (ft/ft)

Flow Length (ft) 1000
Slope (%) 6
Computed TOC (min) 4.7

Subbasin Runoff Results

Total Rainfall (in) 0.73
Total Runoff (in) 0.26
Peak Runoff (cfs) 30.71
Rainfall Intensity 9.322
Weighted Runoff Coefficient 0.36
Time of Concentration (days hh:mm:ss) 0 00:04:42

21036 Fox Run Substation
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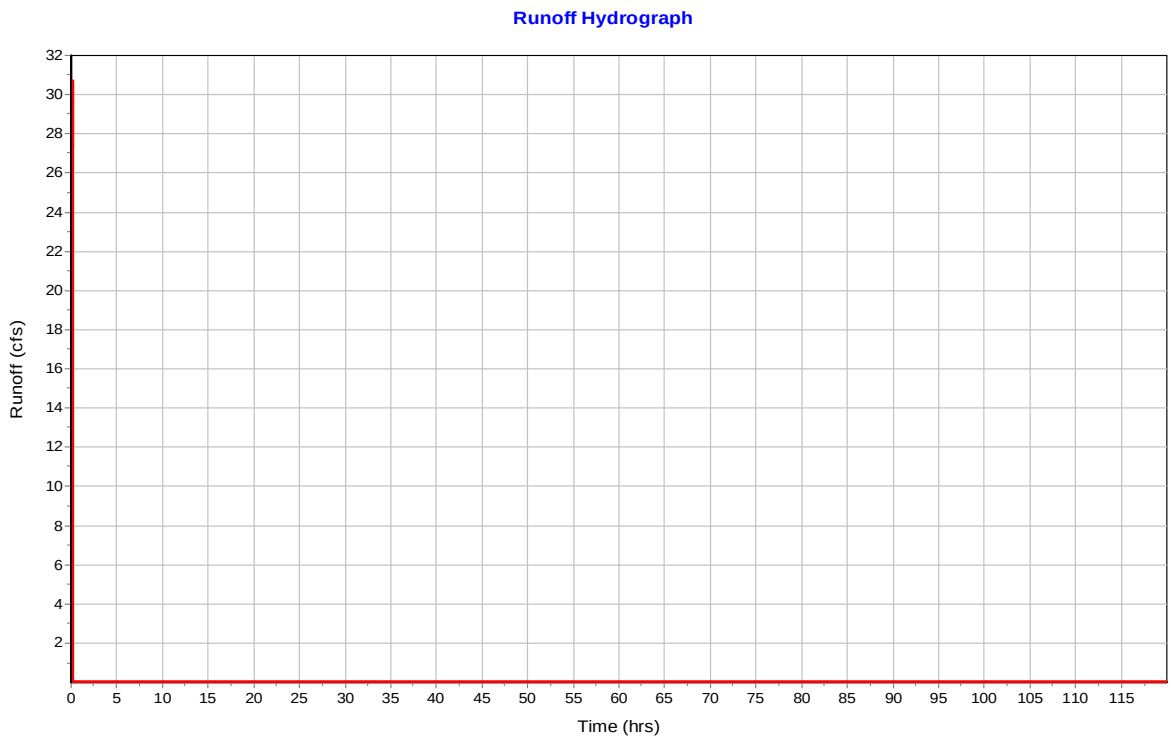
Subbasin : Existing



Subbasin : Offsite

Input Data

Area (ac)	4.5
Weighted Runoff Coefficient	0.36
Average Slope (%)	4
Flow Length (ft)	700

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	4.5	-	0.36
Composite Area & Weighted Runoff Coeff.	4.5		0.36

Time of Concentration

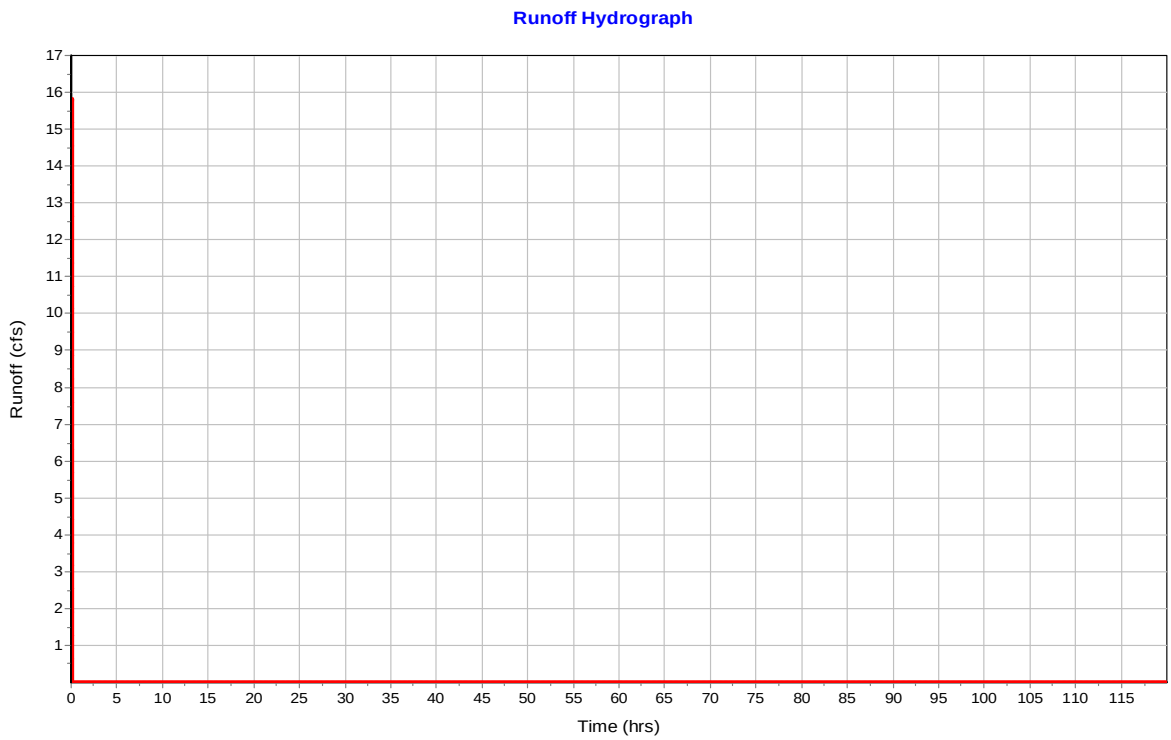
Flow Length (ft)	700
Slope (%)	4
Computed TOC (min)	4.18

Subbasin Runoff Results

Total Rainfall (in)	0.68
Total Runoff (in)	0.24
Peak Runoff (cfs)	15.81
Rainfall Intensity	9.761
Weighted Runoff Coefficient	0.36
Time of Concentration (days hh:mm:ss)	0 00:04:11

21036 Fox Run Substation
100 Year Storm Event

Subbasin : Offsite



Subbasin : Proposed-North

Input Data

Area (ac)	6.7
Weighted Runoff Coefficient	0.38
Average Slope (%)	5
Flow Length (ft)	1000

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	6.7	-	0.38
Composite Area & Weighted Runoff Coeff.	6.7		0.38

Time of Concentration

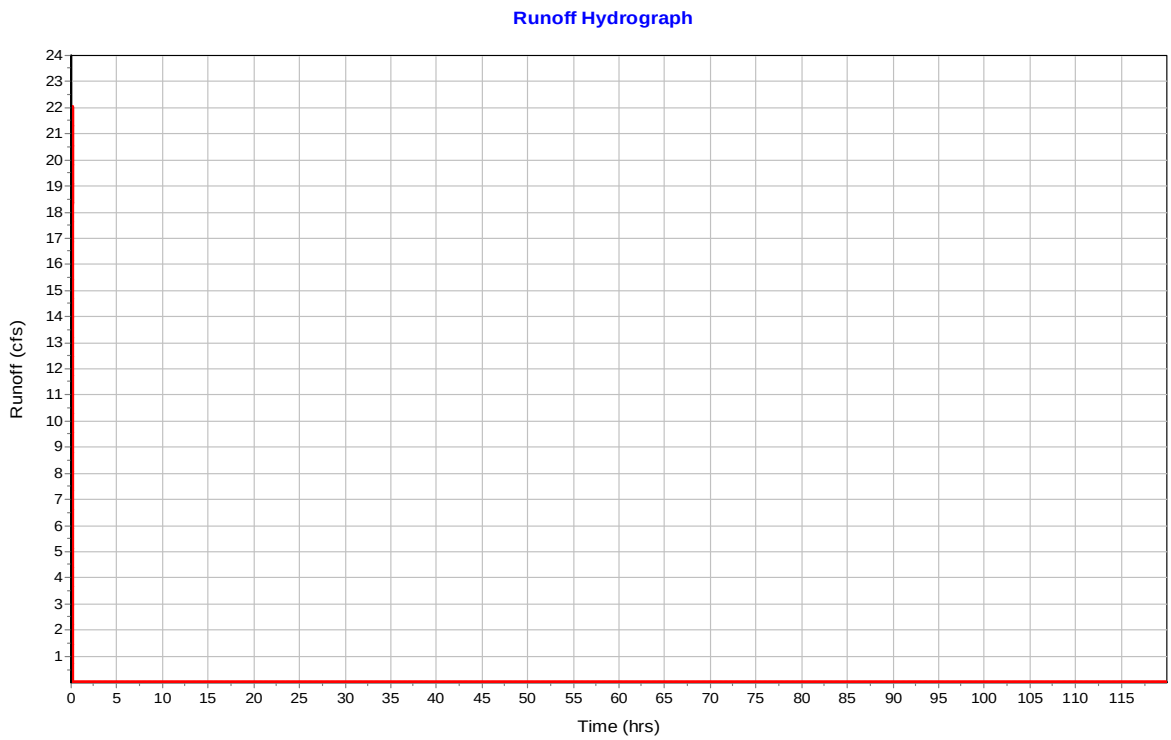
Flow Length (ft)	1000
Slope (%)	5
Computed TOC (min)	5.05

Subbasin Runoff Results

Total Rainfall (in)	0.72
Total Runoff (in)	0.27
Peak Runoff (cfs)	22.03
Rainfall Intensity	8.652
Weighted Runoff Coefficient	0.38
Time of Concentration (days hh:mm:ss)	0 00:05:03

21036 Fox Run Substation
100 Year Storm Event

Subbasin : Proposed-North



Subbasin : Proposed-South

Input Data

Area (ac)	2.44
Weighted Runoff Coefficient	0.4
Average Slope (%)	6
Flow Length (ft)	800

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	2.44	-	0.4
Composite Area & Weighted Runoff Coeff.	2.44		0.4

Time of Concentration

Flow Length (ft)	800
Slope (%)	6
Computed TOC (min)	3.96

Subbasin Runoff Results

Total Rainfall (in)	0.67
Total Runoff (in)	0.27
Peak Runoff (cfs)	9.73
Rainfall Intensity	9.97
Weighted Runoff Coefficient	0.4
Time of Concentration (days hh:mm:ss)	0 00:03:58

21036 Fox Run Substation
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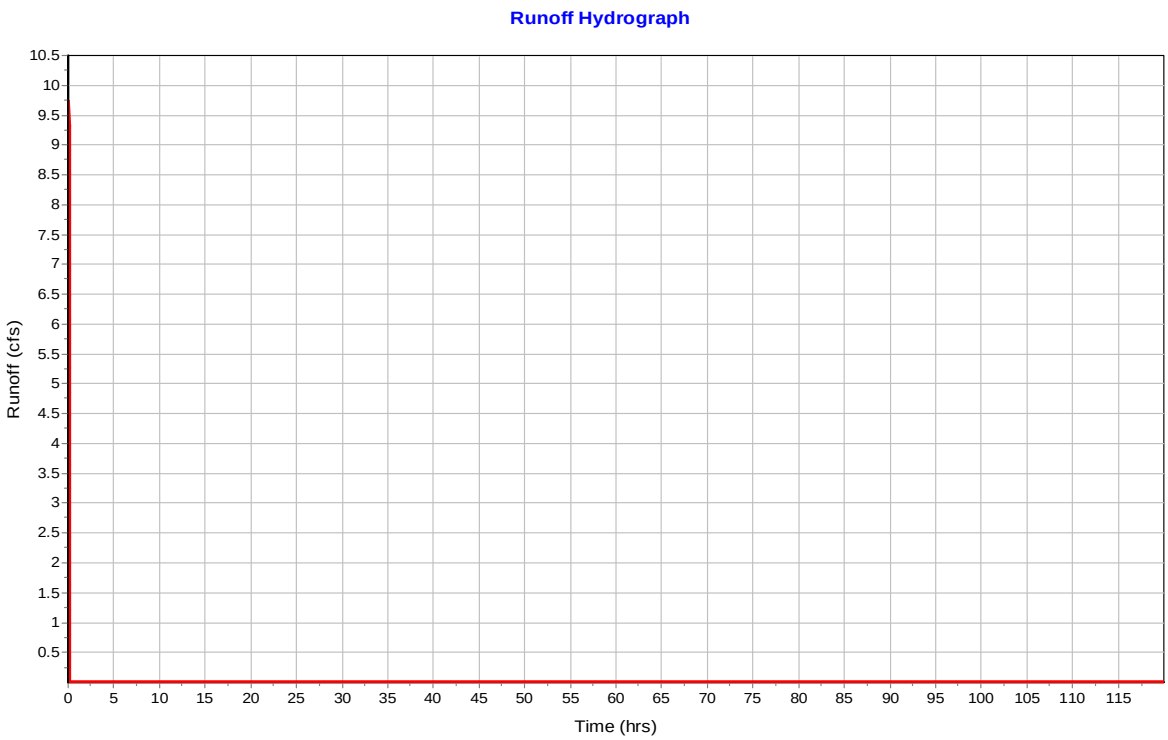
Subbasin : Proposed-South



Subbasin : Yard

Input Data

Area (ac)	5.23
Weighted Runoff Coefficient	0.68
Average Slope (%)	1
Flow Length (ft)	1000

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	5.23	-	0.68
Composite Area & Weighted Runoff Coeff.	5.23		0.68

Time of Concentration

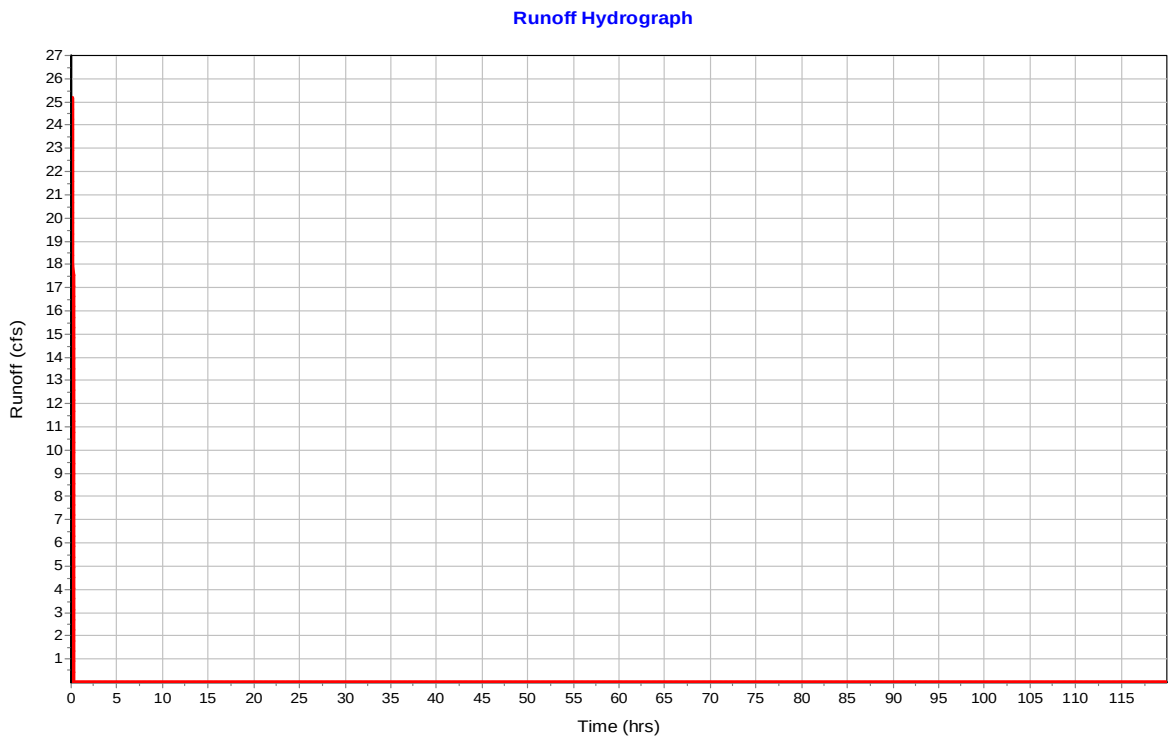
Flow Length (ft)	1000
Slope (%)	1
Computed TOC (min)	9.38

Subbasin Runoff Results

Total Rainfall (in)	1.1
Total Runoff (in)	0.75
Peak Runoff (cfs)	25.16
Rainfall Intensity	7.076
Weighted Runoff Coefficient	0.68
Time of Concentration (days hh:mm:ss)	0 00:09:23

21036 Fox Run Substation
100 Year Storm Event

Subbasin : Yard



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (in)
1	Culvert-In	7462.72	7464.00	1.28	0.00	-7462.72	0.00	-7464.00	0.00	0.00
2	Culvert-Out	7460.63	7462.00	1.37	0.00	-7460.63	0.00	-7462.00	0.00	0.00
3	Pipe-Out	7440.47	7442.10	1.63	0.00	-7440.47	7446.00	3.90	0.00	0.00
4	Pond-Out	7441.67	7447.00	5.33	0.00	-7441.67	7447.00	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Culvert-In	15.81	15.81	7463.50	0.78	0.00	1.22	7462.72	0.00	0 00:04	0 00:00	0.00	0.00
2	Culvert-Out	15.74	0.00	7461.41	0.78	0.00	1.22	7460.63	0.00	0 00:04	0 00:00	0.00	0.00
3	Pipe-Out	2.53	0.00	7440.87	0.40	0.00	1.23	7440.50	0.03	0 00:18	0 00:00	0.00	0.00
4	Pond-Out	2.53	0.00	7442.07	0.40	0.00	4.93	7441.70	0.03	0 00:17	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Out-Swale	60.00	7440.35	-0.12	7438.97	3.97	1.38	2.3000	Trapezoidal	1.000	12.000	0.0270	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Out-Swale	2.53	0 00:18	52.41	0.05	2.66	0.38	0.20	0.20	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	Access-Culvert	52.25	7462.72	0.00	7460.63	0.00	2.09	4.0000	CIRCULAR	24.000	24.000	0.0120	0.5000	0.5000	0.0000	0.00	No
2	Link-04	414.64	0.00	-7460.63	7435.00	0.00	-7435.00	-1793.1200	Dummy	0.000	0.000	0.0150	0.5000	0.5000	0.0000	0.00	No
3	Out-Pipe	60.00	7441.67	0.00	7440.47	0.00	1.20	2.0000	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No

21036 Fox Run Substation
100 Year Storm Event

No. of Barrels
1
1
1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Access-Culvert	15.74	0 00:04	49.02	0.32	14.33	0.06	0.78	0.39	0.00		Calculated
2	Link-04	15.74	0 00:04	0.00	0.32	0.00		0.78	0.39	0.00		Calculated
3	Out-Pipe	2.53	0 00:18	16.09	0.16	6.64	0.15	0.40	0.27	0.00		Calculated

Storage Nodes

Storage Node : Pond

Input Data

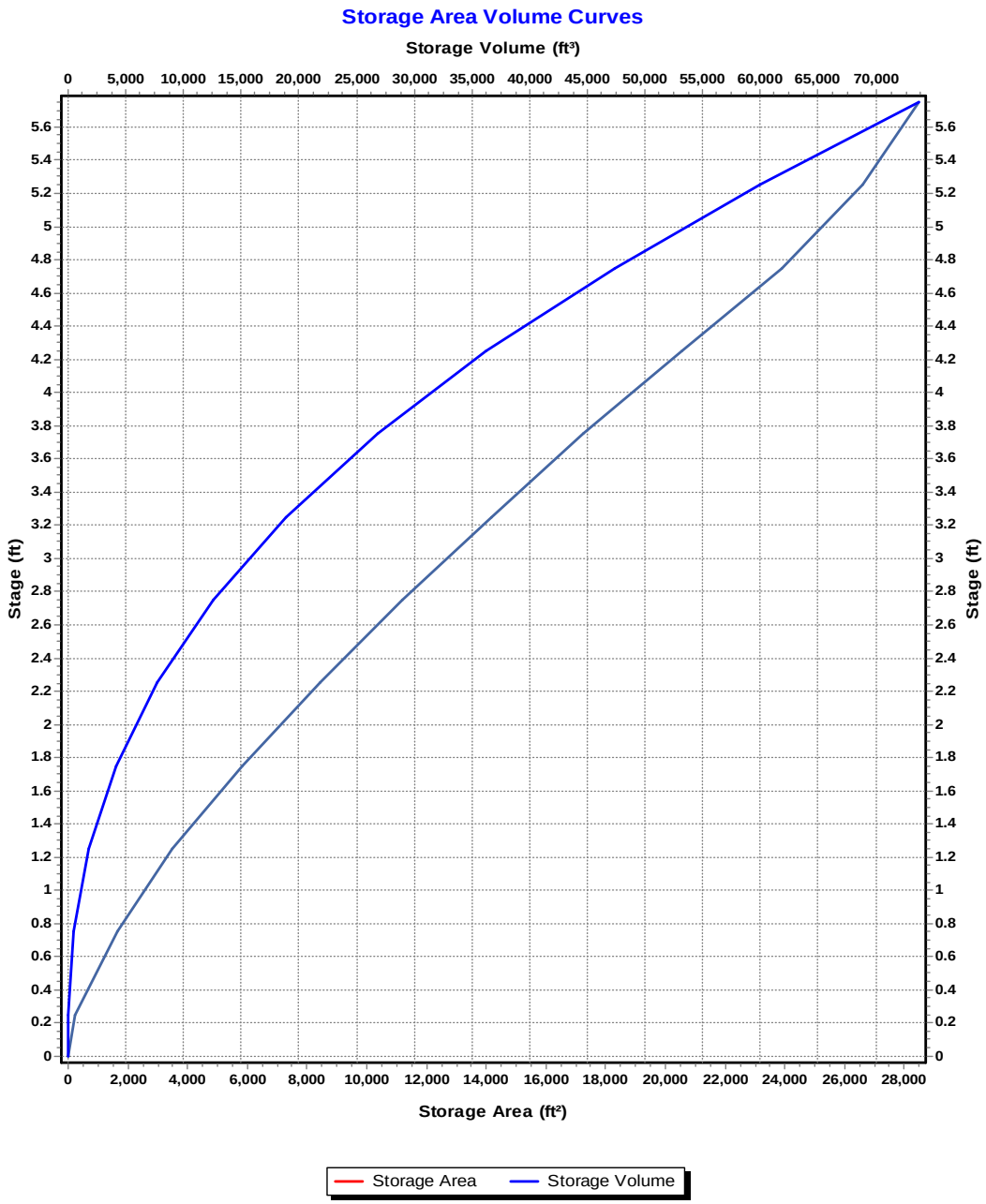
Invert Elevation (ft)	7442.25
Max (Rim) Elevation (ft)	7448
Max (Rim) Offset (ft)	5.75
Initial Water Elevation (ft)	0
Initial Water Depth (ft)	-7442.25
Ponded Area (ft²)	0
Evaporation Loss	0

Storage Area Volume Curves

Storage Curve : Detention-Pond

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
0.25	222	27.75
0.75	1640	493.25
1.25	3509	1780.5
1.75	5810	4110.25
2.25	8441	7673
2.75	11212	12586.25
3.25	14161	18929.5
3.75	17263	26785.5
4.25	20531	36234
4.75	23884	47337.75
5.25	26606	59960.25
5.75	28486	73733.25

21036 Fox Run Substation
100 Year Storm Event



Storage Node : Pond (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Spillway	Trapezoidal	No	7446.50	4.25	20.00	1.50	3.37
2	Weir	Rectangular	No	7444.75	2.50	4.00	1.00	3.33

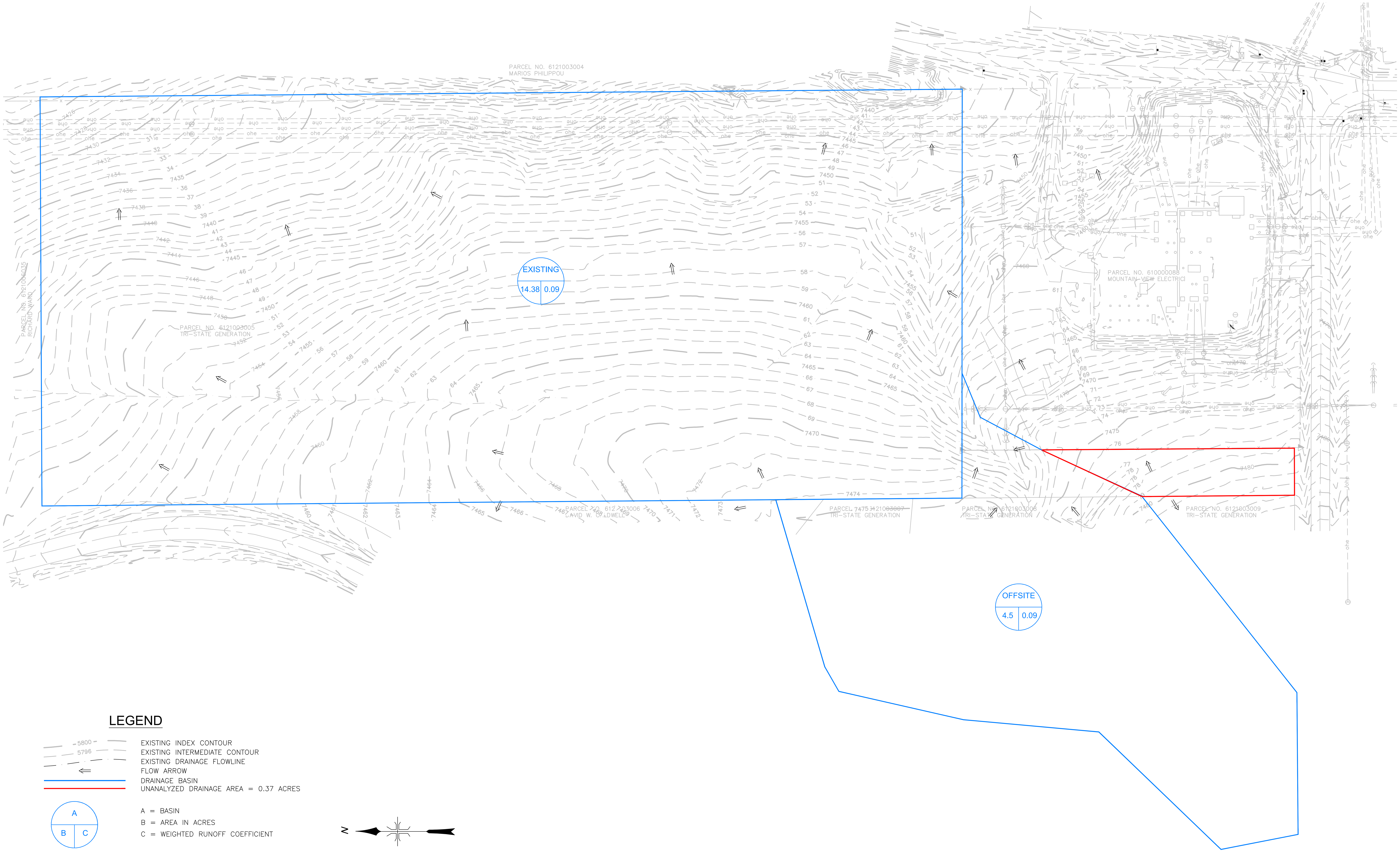
Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-01	Side	CIRCULAR	No	0.75			7441.92	0.61
2	Orifice-02	Side	CIRCULAR	No	0.75			7442.42	0.61
3	Orifice-03	Side	CIRCULAR	No	0.75			7442.92	0.61
4	Orifice-04	Side	CIRCULAR	No	0.75			7443.42	0.61
5	Orifice-05	Side	CIRCULAR	No	0.75			7443.92	0.61

Output Summary Results

Peak Inflow (cfs)	25.16
Peak Lateral Inflow (cfs)	25.16
Peak Outflow (cfs)	2.53
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	7445.07
Max HGL Depth Attained (ft)	2.82
Average HGL Elevation Attained (ft)	7442.89
Average HGL Depth Attained (ft)	0.64
Time of Max HGL Occurrence (days hh:mm)	0 00:17
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Appendix C
Site Maps & Design Drawings



LEGEND

5800 / 5796	EXISTING INDEX CONTOUR
	EXISTING INTERMEDIATE CONTOUR
	EXISTING DRAINAGE FLOWLINE
⇐	FLOW ARROW
(blue line)	DRAINAGE BASIN
(red line)	UNANALYZED DRAINAGE AREA = 0.37 ACRES

A = BASIN
B = AREA IN ACRES
C = WEIGHTED RUNOFF COEFFICIENT

N

1" = 60'

Scale in feet

60' 0 60' 120'

TRI-STATE GENERATION & TRANSMISSION
FOX RUN SUBSTATION
MONUMENT, CO

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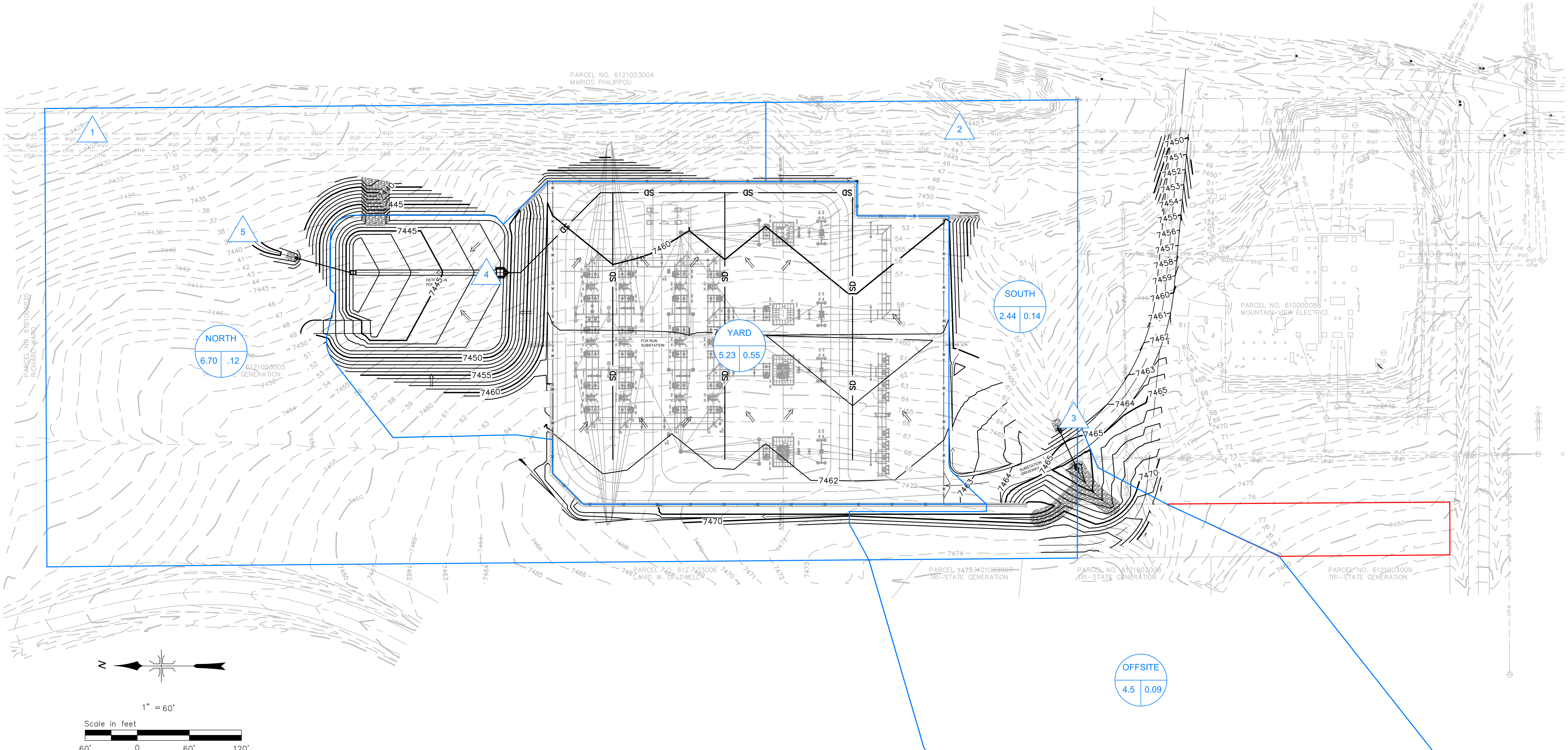
DESIGNED BY: TMC	SCALE: AS NOTED	CHECKED BY: DWS	
DRAWN BY: TMC	FILE NAME: 21036C_BASE.DWG	DATE ISSUED: 3/30/23	

NO	DATE	REVISIONS	BY

DMC JOB NO.: 21036

SHEET NO.: C-1

OF SHEETS



LEGEND

5800 / 5796 (existing)	EXISTING INDEX CONTOUR EXISTING INTERMEDIATE CONTOUR
5800 / 5796 (proposed)	PROPOSED INDEX CONTOUR PROPOSED INTERMEDIATE CONTOUR PROPOSED DRAINAGE FLOWLINE FLOW ARROW
blue line	PROPOSED DRAINAGE BASIN
red line	UNANALYZED DRAINAGE AREA = 0.37 ACRES
A / B / C	A = BASIN B = AREA IN ACRES C = WEIGHTED RUNOFF COEFFICIENT
D	D = DESIGN POINT DESIGNATION

Sumarry Runoff Tables

Design Point	Contributing Area	Runoff Peak 5-year Event	Runoff Peak 100-year Event
Existing			
	(acres)	(cfs)	(cfs)
1	14.38	7.20	48.26
Proposed			
	(acres)	(cfs)	(cfs)
1	6.7	4.15	22.03
2	2.44	2.03	9.73
3	4.5	2.36	15.81
4	5.23	12.13	25.16
5	5.23	0.09	2.53

ALL VALUES FROM SSA DRAINAGE MODEL

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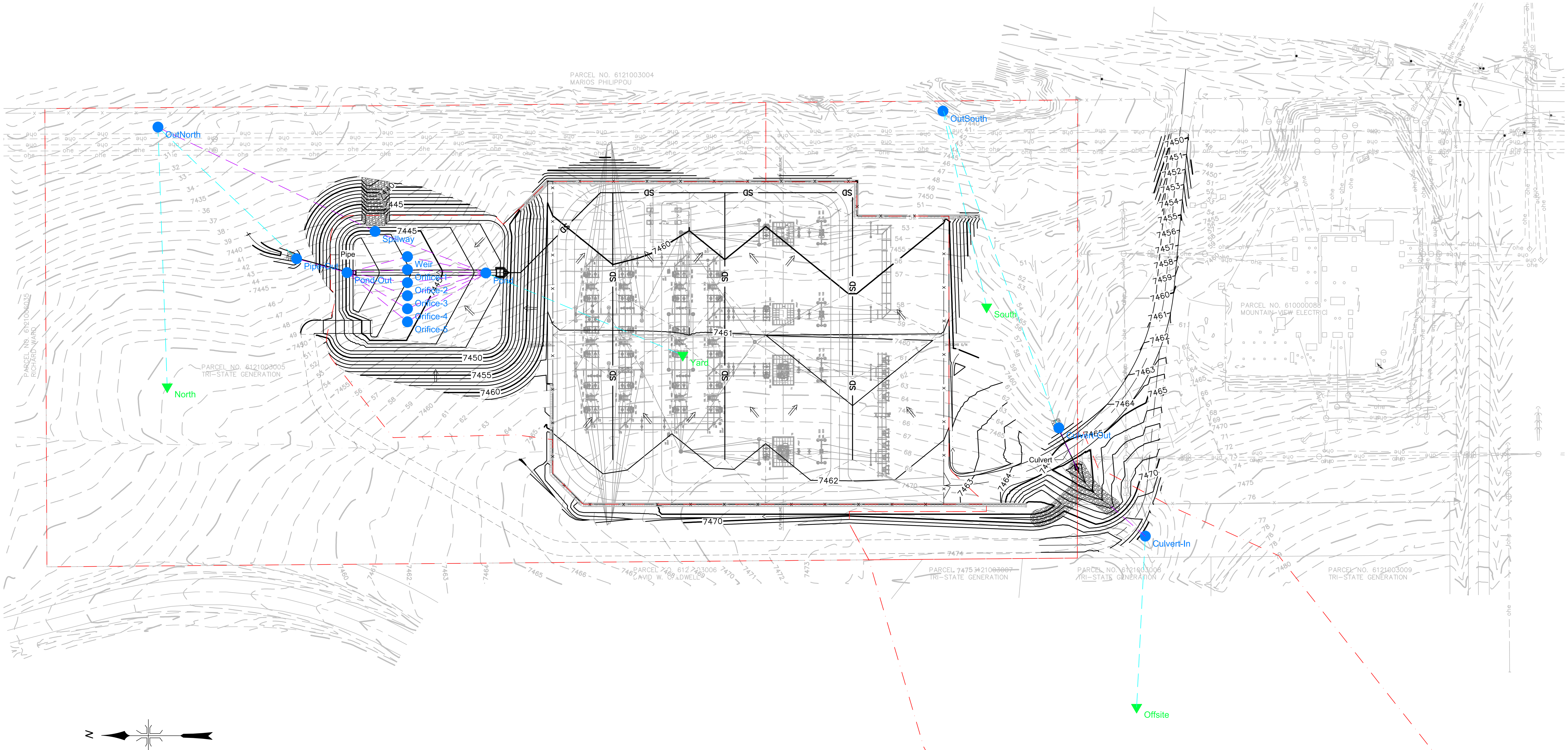
FOX RUN SUBSTATION
MONUMENT, CO

DRAINAGE BASIN DELINEATION

DMC JOB NO.: 21036

SHEET NO.: C-2



N

1" = 60'

Scale in feet

60' 0 60' 120'

LEGEND

5800 / 5796	PROPOSED INDEX CONTOUR
	PROPOSED INTERMEDIATE CONTOUR
	PROPOSED DRAINAGE FLOWLINE
STM	PROPOSED STORM PIPE
	DRAINAGE LINK
	DIRECT LINK
	DRAINAGE BASIN
Pond	DRAINAGE NODE
Yard	SUB-BASIN

NOTE: THIS DRAWING IS A SCHEMATIC REPRESENTATION OF THE AUTODESK STORM AND SANITARY ANALYSIS MODEL. FOR ALL DESIGN SPECIFIC INFORMATION SEE CIVIL PLANS.

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NO	DATE	REVISIONS	BY

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FILE NAME: 21036C_BASE.DWG	

TRI-STATE GENERATION & TRANSMISSION
FOX RUN SUBSTATION
MONUMENT, CO

DRAINAGE MODEL SCHEMATIC

DMC JOB NO.: 21036

SHEET NO.: C-3