

FINAL STORM WATER DRAINAGE REPORT

LOT 1B

DOUGLAS CORNER

LEE'S SUMMIT, MISSOURI

150 NE TUDOR ROAD

PREPARED FOR

CAPITAL BUILDERS,LLC

PREPARED BY

HG CONSULT, INC.

MAY 10th, 2023



5/10/23

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3. Project Overview

The proposed project is a speculative retail building. The building will be contained in a 7,972 square foot building footprint. This project is contained on a 1.73 acre site. The site is construction ready. The storm sewer system and detention pond will need additional improvements to allow for proper drainage from site.

The topography of the site is a gentle slope west to the east. The existing storm sewer detention system is in place on the east side of the site on the east side of NE Douglas Street and the north side of Tudor Road. The overall existing storm sewer system serves all of Douglas Corners. An additional amount of detention will be required to accommodate the entire developed area which is provided with this project.

4. Drainage Assessment of the Project Site

Due to the slope of the site and the need for a flat slab, the bench and fill grading method was used for the site along with the need to have positive drainage away from the building, drainage areas directing storm water into new storm sewer catchments that forces storm water into the detention pond. The remainder of the site grading directs pervious areas and impervious areas away from the building and drainage to the proposed detention pond. Design requirements call for a piping system with a minimum capacity for the 10 year event, with the 100 year storm event being routed overland in an above grade manner such as swales and gutters. To insure that higher frequency storms would not cause any ponding problems or inundation of parked vehicles, the structures and piping system have been designed to the 100 year event flows. With the relatively small drainage areas, these flows are low and pipe sizes are 15 inch draining to the detention pond and an existing 18" discharge pipe from the detention pond to an existing catch basin off-site.

5. Conveyance Design

As shown on the Drainage plan for the site, all areas drain to the detention pond by sheet flow over the parking and drive aisle area and by existing piping system. This system generates a 10 year flow of 34.98 cfs and a 100 year flow of 57.94 cfs pre-developed. After development and routing through the detention pond, 10 year flows have been reduced to 13.60 cfs and 100 year flows have been reduced to 16.56 cfs.

6. Temporary Erosion and Sediment Control

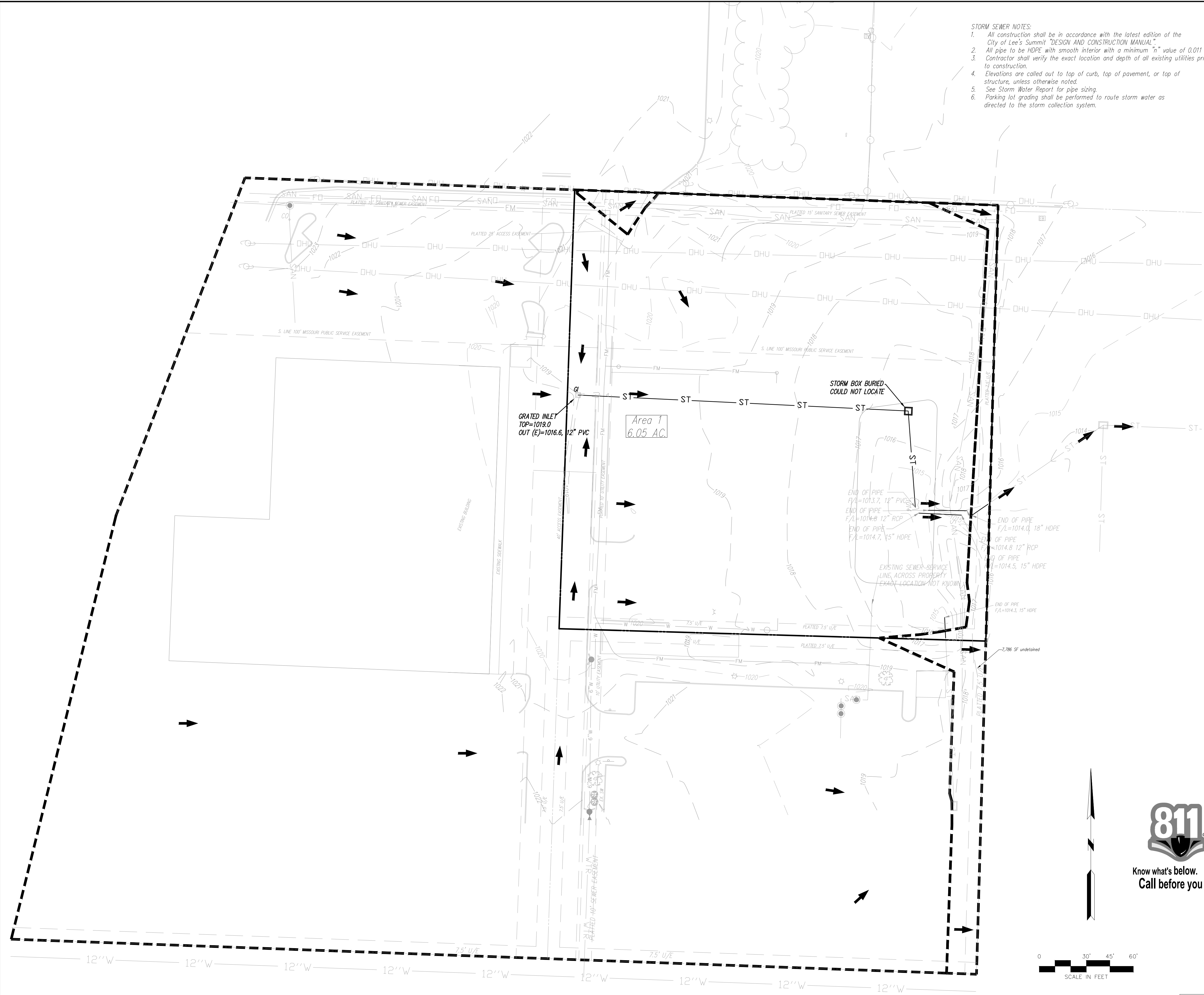
During construction and prior to paving, it will be necessary to control erosion and sediment from the site during storms with in the construction timeframe. To insure that sediment does not enter the existing storm system or runs off to the existing street, perimeter containment is controlled by silt fence installation, inlet protection and an engineered detention release structure. To keep construction traffic from tracking mud onto the adjacent city street, a stabilized rock construction entrance will need to be installed. These erosion control devices, and their maintenance throughout the construction timeframe, are required by ordinance and the details for them are referenced by the City's Design and Construction Manual and shown on Detail Sheets 10 thru 13.

Post development water quality will be addressed through the use a filtering device prior to storm water discharge into pond in lieu of the standard method of routing through the pond with extended release, due to volume considerations within the pond. The owner will need to have a routine maintenance policy for the cleaning, repair and replacement of the filters within the structures.

7.Design Calculations

See the attached for drainage area calculations, detention calculations, flows, pipe sizing, water quality calculations as requested.

8.Exhibits



- STORM SEWER NOTES:**
- All construction shall be in accordance with the latest edition of the City of Lee's Summit "DESIGN AND CONSTRUCTION MANUAL".
 - All pipe to be HDPE with smooth interior with a minimum "n" value of 0.011.
 - Contractor shall verify the exact location and depth of all existing utilities prior to construction.
 - Elevations are called out to top of curb, top of pavement, or top of structure, unless otherwise noted.
 - See Storm Water Report for pipe sizing.
 - Parking lot grading shall be performed to route storm water as directed to the storm collection system.

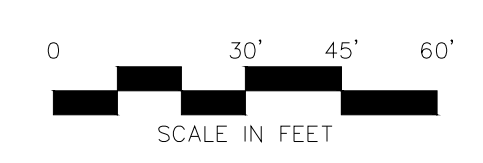
Contractor to verify all invert elevations for existing sewer connections. Contact civil engineer if conflict arises.

PROJECT BENCHMARK:

- #1 Iron bar at north west corner of property.
N: 1006947.3760
E: 2823375.6230
TOP ELEV. 1021.42
- #2 Top of curb at corner of parking lot in Schlotsky's parking.
N: 1006628.2690
E: 2823366.0320
TOP ELEV. 1019.80



Know what's below.
Call before you dig.



PROPOSED		KEY	EXISTING
— 979 —	Grades	— 960 —	
→	100 Year Overflow		
- - - - -	Drainage Area		

Contractor to verify all invert elevations for existing sewer connections. Contact civil engineer if conflict arises.

DATE	REVISION	BY	CHKAPP



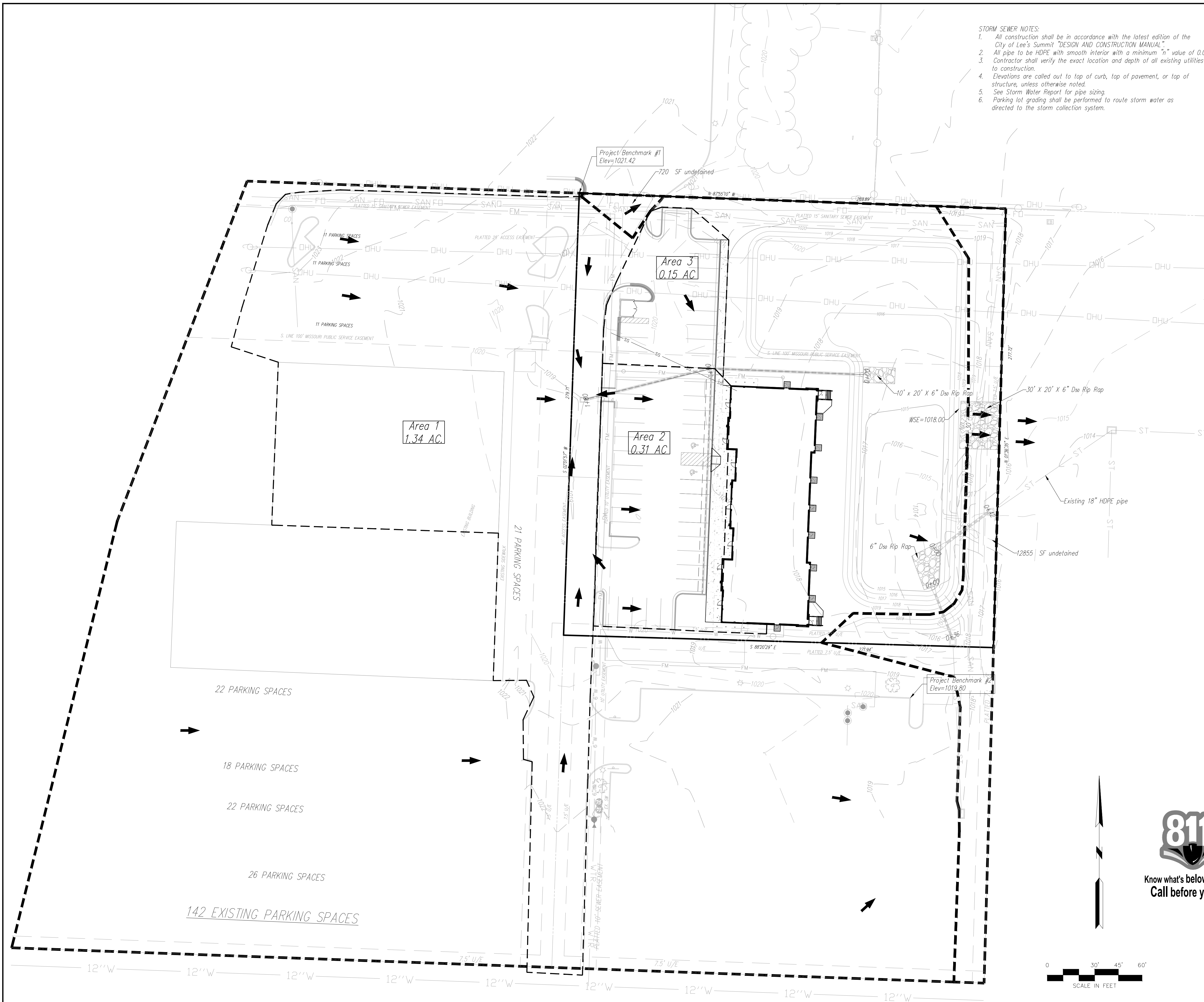
May 10, 2023

8 Consult Inc engineers
 1533 Locust Street, Kansas City, Missouri 64108
 CORPORATE LICENSE No. E201000573 (MO.) / E-1736 (KS.) / LS 2019005467

PRELIMINARY DEVELOPMENT
DRAINAGE AREA MAP

DOUGLAS CORNER BUILDING
LEE'S SUMMIT - JACKSON COUNTY - MISSOURI

X-REF NO. 18109B	6	SHEET OF 13
DRAWING NO. 23-033P09		
DATE MAY 10, 2023		
JOB NO. 23-003		



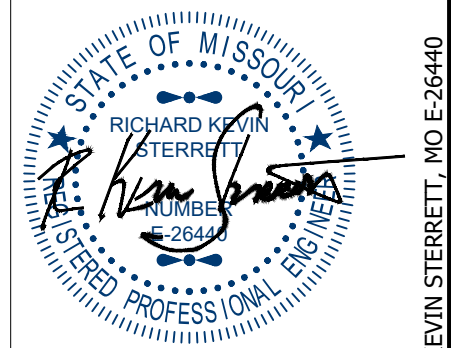
- STORM SEWER NOTES:**
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 - All pipe to be HDPE with smooth interior with a minimum "n" value of 0.011
 - Contractor shall verify the exact location and depth of all existing utilities prior to construction.
 - Elevations are called out to top of curb, top of pavement, or top of structure, unless otherwise noted.
 - See Storm Water Report for pipe sizing.
 - Parking lot grading shall be performed to route storm water as directed to the storm collection system.

Detention Pond Details:

Elevation (feet)	Surf Area (sq-ft)	Cum. Store (cubic-feet)
1014.10	52	0
1015	5,623	2,553
1016	10,269	10,499
1017	17,998	24,633
1018	20,048	43,657

Detention release was sized by Bentley PondPACK V8i and is sized to release the 100-year storm event over the proposed rip rap lined channel.

NO.	REVISION	DATE	BY	CHK/APP



May 10, 2023

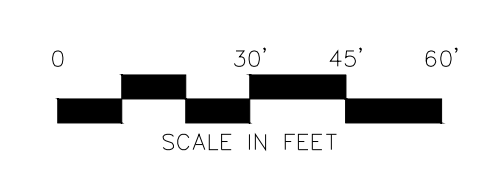
811 Consult Inc engineers planners
 1533 Locust Street, Kansas City, Missouri 64108
 CORPORATE LICENSE NO. E20100573 (MO.) / E-1736 (KS.) / LS-2019005467

*Areas shown are impervious areas to drainage structures.

Contractor to verify all invert elevations for existing sewer connections. Contact civil engineer if conflict arises.

PROJECT BENCHMARK:

- #1 Iron bar at north west corner of property.
 N: 1006947.3760
 E: 2823375.6230
 TOP ELEV. 1021.42
- #2 Top of curb at corner of parking lot in Schlotsky's parking.
 N: 1006628.2690
 E: 2823585.0320
 TOP ELEV. 1019.80



KEY

—979—	Grades	—960—
→	100 Year Overflow	
- - - - -	Drainage Area	

Contractor to verify all invert elevations for existing sewer connections. Contact civil engineer if conflict arises.

POST DEVELOPMENT DRAINAGE AREA MAP

DOUGLAS CORNER BUILDING
 LEE'S SUMMIT - JACKSON COUNTY - MISSOURI

X-REF NO. 18109B
DRAWING NO. 23-033PDP
DATE MAY 10, 2023
JOB NO. 23-003

DOUGLAS

Project Summary

Title	DOUGLAS
Engineer	Kellen Huffman
Company	Hg Consult, Inc
Date	6/18/2018

Notes

DOUGLAS

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)
Area 1	Pre-Development Water Quality	1	0.245	11.930	4.48
Area 1	Post-Development Water Quality	1	0.292	11.930	5.45
Area 1	Pre-Development 2 year	2	1.146	11.920	21.51
Area 1	Post-Development 2 year	2	1.238	11.920	23.04
Area 1	Pre-Development 10 year	10	2.022	11.920	37.16
Area 1	Post-Development 10 year	10	2.131	11.920	38.69
Area 1	Pre-Development 100 year	100	3.233	11.920	57.94
Area 1	Post-Development 100 year	100	3.356	11.920	59.35

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)
Field Inlet	Pre-Development Water Quality	1	0.245	11.930	4.48
Field Inlet	Post-Development Water Quality	1	0.292	18.630	0.10
Field Inlet	Pre-Development 2 year	2	1.146	11.920	21.51
Field Inlet	Post-Development 2 year	2	1.233	12.240	3.13
Field Inlet	Pre-Development 10 year	10	2.022	11.920	37.16
Field Inlet	Post-Development 10 year	10	2.124	12.090	11.18
Field Inlet	Pre-Development 100 year	100	3.233	11.920	57.94
Field Inlet	Post-Development 100 year	100	3.346	12.100	15.28

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
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DOUGLAS

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Detention Pond (IN)	Post-Development Water Quality	1	0.292	11.930	5.45	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development Water Quality	1	0.292	18.630	0.10	1,013.24	0.195
Detention Pond (IN)	Post-Development 2 year	2	1.238	11.920	23.04	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 2 year	2	1.233	12.240	3.13	1,014.51	0.641
Detention Pond (IN)	Post-Development 10 year	10	2.131	11.920	38.69	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 10 year	10	2.124	12.090	11.18	1,015.48	1.015
Detention Pond (IN)	Post-Development 100 year	100	3.356	11.920	59.35	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 100 year	100	3.346	12.100	15.28	1,016.74	1.545

DOUGLAS_SPILLWAY

Project Summary

Title	DOUGLAS_SPILLW AY
Engineer	Kellen Huffman
Company	Hg Consult, Inc
Date	6/18/2018

Notes

DOUGLAS_SPILLWAY

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)
Area 1	Post-Development 100 year	100	3.356	11.920	59.35

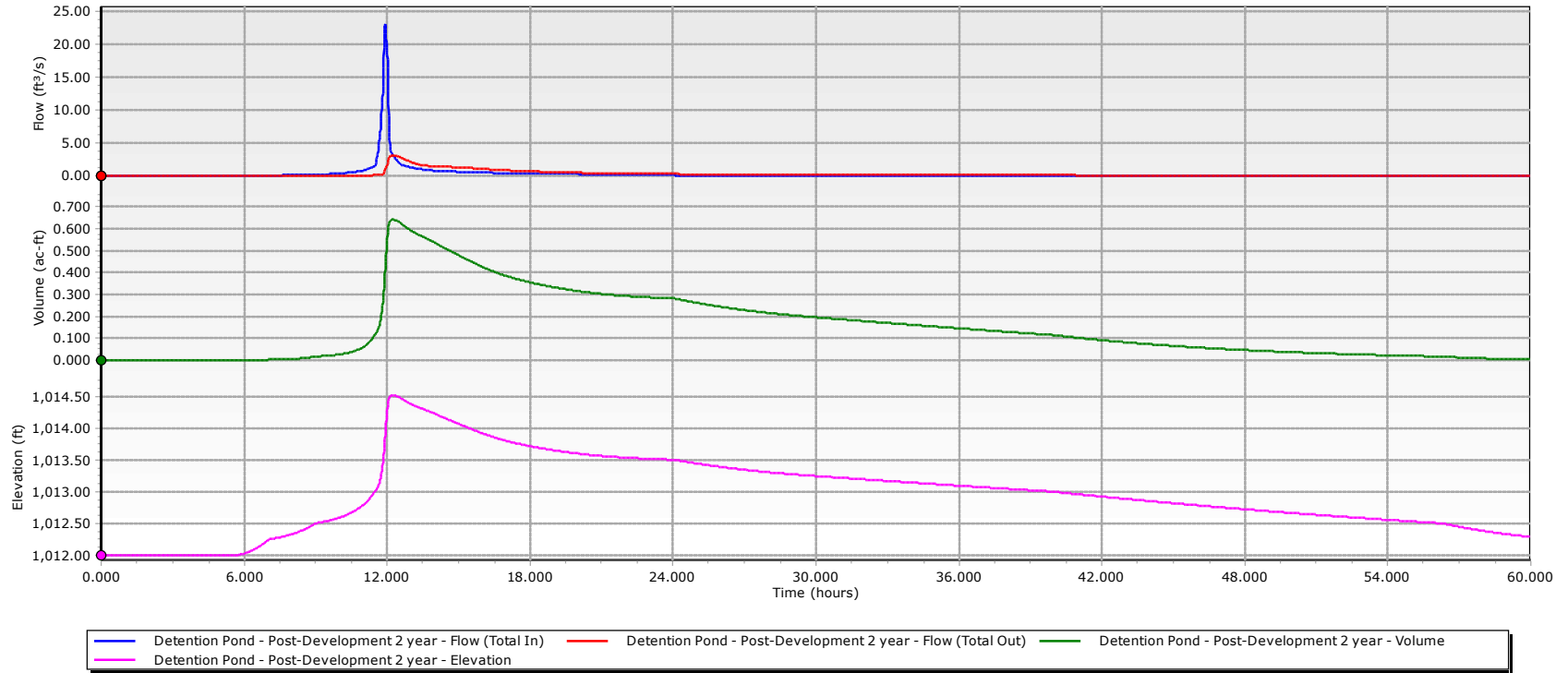
Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)
Field Inlet	Post-Development 100 year	100	3.127	11.960	51.94

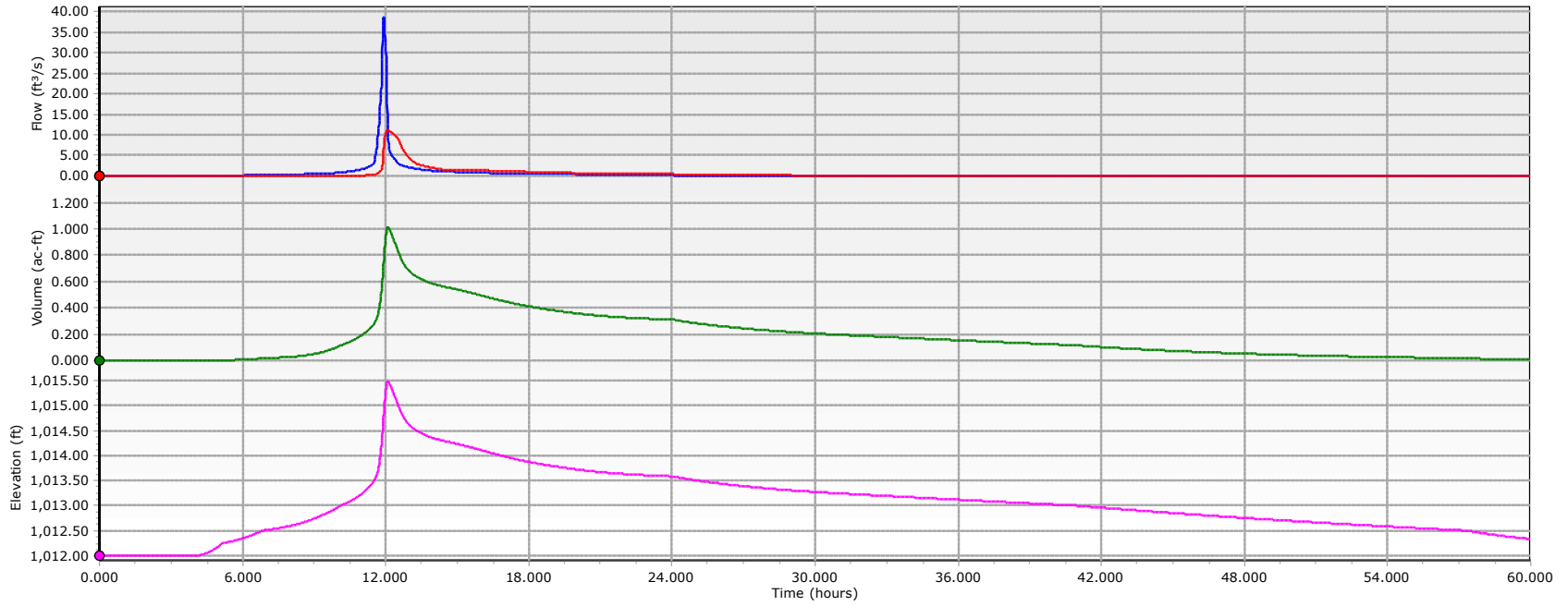
Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Detention Pond (IN)	Post-Development 100 year	100	3.356	11.920	59.35	(N/A)	(N/A)
Detention Pond (OUT)	Post-Development 100 year	100	3.127	11.960	51.94	1,017.93	2.092

New Graph

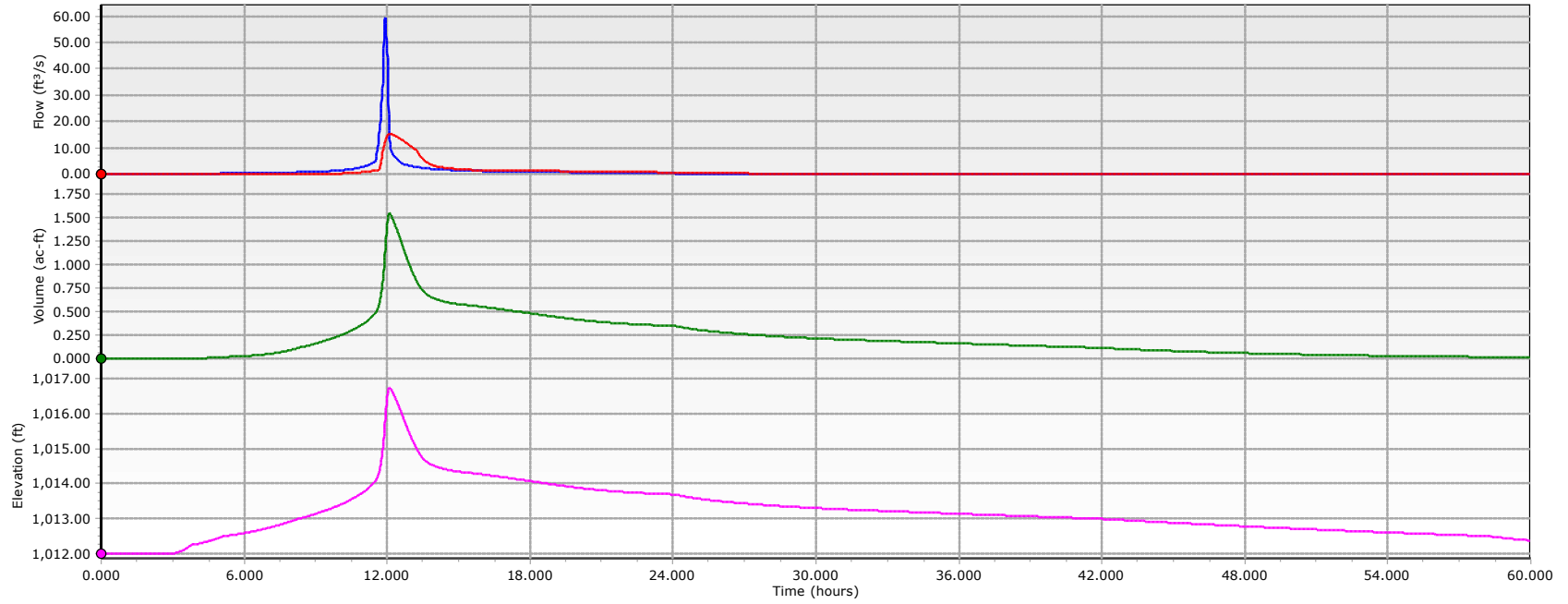


New Graph



— Detention Pond - Post-Development 10 year - Flow (Total In) — Detention Pond - Post-Development 10 year - Flow (Total Out)
— Detention Pond - Post-Development 10 year - Volume — Detention Pond - Post-Development 10 year - Elevation

New Graph



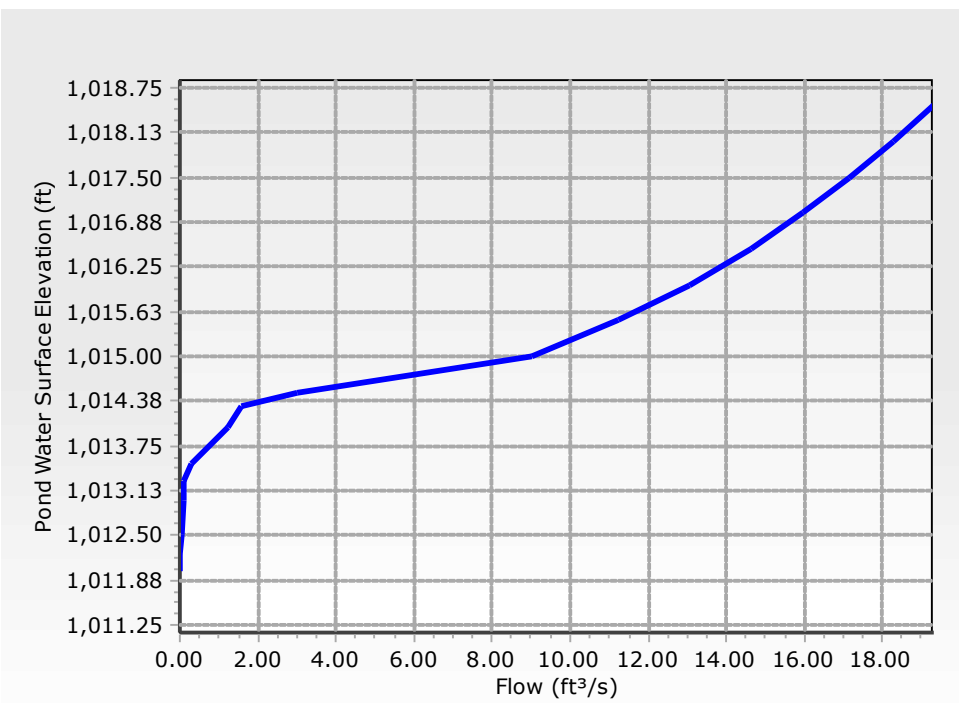
— Detention Pond - Post-Development 100 year - Flow (Total In) — Detention Pond - Post-Development 100 year - Flow (Total Out)
— Detention Pond - Post-Development 100 year - Volume — Detention Pond - Post-Development 100 year - Elevation

Composite Outlet Structure Detailed Report: Primary Outlet Structure

Element Details			
Label	Primary Outlet Structure	Notes	
Headwater Range			
Headwater Type	Use Pond for Headwater Range	Maximum (Headwater)	1,018.50 ft
Pond	Detention Pond	Increment (Headwater)	0.50 ft
Minimum (Headwater)	1,012.00 ft		
Spot Elevation (ft)			
Tailwater Setup			
Tailwater Type	Free Outfall		
Tailwater Tolerances			
Maximum Iterations	30	Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft	Flow Tolerance (Minimum)	0.001 ft ³ /s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft ³ /s
Tailwater Tolerance (Minimum)	0.01 ft		
Outlet Structure			
Outlet Structure Type	Culvert	Culvert Type	Circular
Outlet Structure (IDs and Direction)			
Outlet ID	Culvert - 1	Downstream ID	Tailwater
Flow Direction	Forward Flow Only	Notes	
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft
Culvert Data			
Number of Barrels	1	Downstream Invert	1,010.82 ft
Length	118.00 ft	Diameter	18.0 in
Upstream Invert	1,012.00 ft		
Unsubmerged->Submerged			
Specify Transitions	False	Compute Inlet Control Only	False

Composite Outlet Structure Detailed Report: Primary Outlet Structure

Culvert Coefficients			
Inlet Description	Concrete - Groove end projecting	C	0.0317
Chart	Chart 1	Y	0.6900
Nomograph	Nomograph 3	Manning's n	0.011
Equation Form	Form 1	Ke	0.200
K	0.0045	Kr	0.000
M	2.0000	Slope Correction Factor	-0.500
Culvert (Advanced)			
Convergence Tolerance	0.00 ft	Specify Number of Backwater Sections	False



RATING TABLE FOR ONE OUTLET TYPE
 Structure ID = Culvert - 1 (Culvert-Circular)

 Mannings open channel maximum capacity: 13.35 ft³/s
 Upstream ID = Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1
 Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft ³ /s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
1,012.00	0.00	0.00	0.00	Free Outfall
1,012.25	0.02	1,012.07	Free Outfall	Free Outfall

Composite Outlet Structure Detailed Report: Primary Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
 Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 13.35 ft³/s
 Upstream ID = Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1
 Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft ³ /s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
1,012.50	0.06	1,012.12	Free Outfall	Free Outfall
1,013.00	0.09	1,012.16	Free Outfall	Free Outfall
1,013.25	0.11	1,012.17	Free Outfall	Free Outfall
1,013.50	0.28	1,012.27	Free Outfall	Free Outfall
1,014.00	1.21	1,012.59	Free Outfall	Free Outfall
1,014.30	1.55	1,012.67	Free Outfall	Free Outfall
1,014.50	3.00	1,012.96	Free Outfall	Free Outfall
1,015.00	9.01	1,013.86	Free Outfall	Free Outfall
1,015.50	11.25	1,014.31	Free Outfall	Free Outfall
1,016.00	13.07	1,014.76	Free Outfall	Free Outfall
1,016.50	14.64	1,015.20	Free Outfall	Free Outfall
1,017.00	15.96	1,015.76	Free Outfall	Free Outfall
1,017.50	17.15	1,016.31	Free Outfall	Free Outfall
1,018.00	18.27	1,016.85	Free Outfall	Free Outfall
1,018.50	19.31	1,017.39	Free Outfall	Free Outfall
Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft ³ /s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.01	(N/A)	0.00	
0.00	0.01	(N/A)	0.00	
0.00	0.01	(N/A)	0.00	
0.00	0.01	(N/A)	0.00	
0.00	0.01	(N/A)	0.00	
0.00	0.01	(N/A)	0.00	
0.00	0.01	(N/A)	0.00	
0.00	0.01	(N/A)	0.00	

Message

WS below an invert; no flow.
 CRIT.DEPTH CONTROL Vh= .018ft
 Dcr= .053ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: Primary Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
 Structure ID = Culvert - 1 (Culvert-Circular)

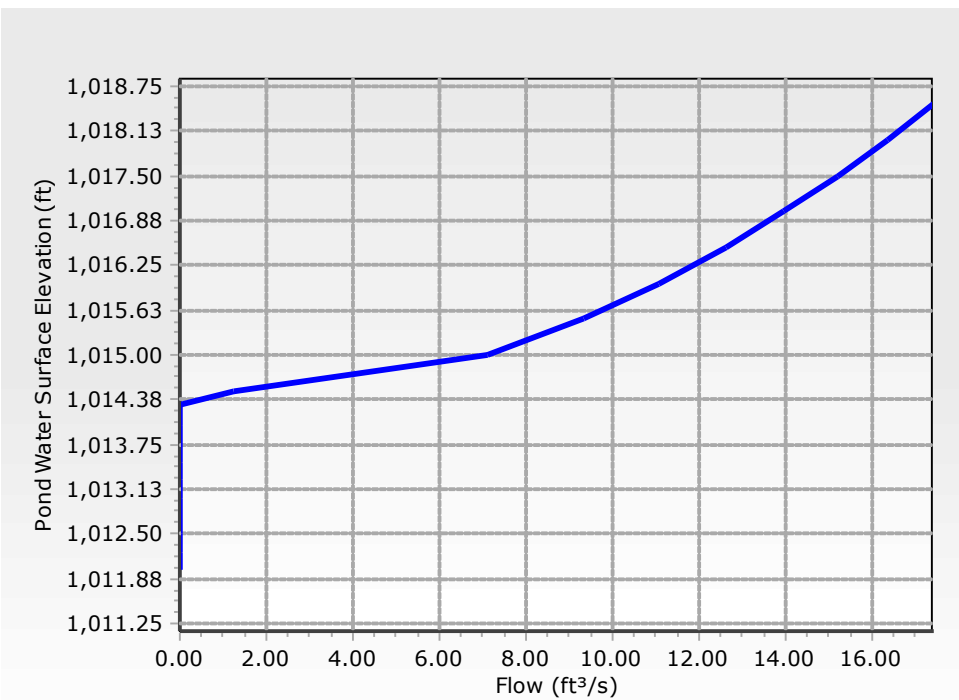
Mannings open channel maximum capacity: 13.35 ft³/s
 Upstream ID = Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1
 Downstream ID = Tailwater (Pond Outfall)

Message
CRIT.DEPTH CONTROL Vh= .029ft
Dcr= .086ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .038ft
Dcr= .111ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .040ft
Dcr= .119ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .067ft
Dcr= .194ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .147ft
Dcr= .411ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .169ft
Dcr= .468ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .251ft
Dcr= .658ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .586ft
Dcr= 1.162ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW
=2.31
INLET CONTROL... Submerged: HW
=2.76
INLET CONTROL... Submerged: HW
=3.20
FULL FLOW...Lfull=112.82ft
Vh=1.267ft HL=3.384ft Hev= .00ft
FULL FLOW...Lfull=115.54ft
Vh=1.464ft HL=3.963ft Hev= .00ft
FULL FLOW...Lfull=116.79ft
Vh=1.660ft HL=4.521ft Hev= .00ft
FULL FLOW...Lfull=117.01ft
Vh=1.855ft HL=5.057ft Hev= .00ft

Outlet Structure			
Outlet Structure Type		Riser	
Outlet Structure (IDs and Direction)			
Outlet ID	Riser - 1	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft
Outlet Structure (Riser)			

Composite Outlet Structure Detailed Report: Primary Outlet Structure

Outlet Structure (Riser)			
Riser	Stand Pipe	Transition Elevation	0.00 ft
Diameter	18.0 in	Transition Height	0.00 ft
Weir Coefficient	3.00 (ft ^{0.5})/s	K Reverse	1.000
Orifice Coefficient	0.600		
Outlet Structure (Common)			
Elevation	1,014.30 ft		
Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False



RATING TABLE FOR ONE OUTLET TYPE

Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)

Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
1,012.00	0.00	0.00	0.00	0.00
1,012.25	0.00	0.00	0.00	1,012.07
1,012.50	0.00	0.00	0.00	1,012.12

Composite Outlet Structure Detailed Report: Primary Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)

Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft ³ /s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
1,013.00	0.00	0.00	0.00	1,012.16
1,013.25	0.00	0.00	0.00	1,012.17
1,013.50	0.00	0.00	0.00	1,012.27
1,014.00	0.00	0.00	0.00	1,012.59
1,014.30	0.00	0.00	0.00	1,012.67
1,014.50	1.26	1,014.50	Free Outfall	1,012.96
1,015.00	7.12	1,015.00	Free Outfall	1,013.86
1,015.50	9.32	1,015.50	1,014.31	1,014.31
1,016.00	11.09	1,016.00	1,014.76	1,014.76
1,016.50	12.62	1,016.50	1,015.20	1,015.20
1,017.00	13.98	1,017.00	1,015.76	1,015.76
1,017.50	15.21	1,017.50	1,016.31	1,016.31
1,018.00	16.36	1,018.00	1,016.85	1,016.85
1,018.50	17.43	1,018.50	1,017.39	1,017.39
Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft ³ /s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	

Message

WS below an invert; no flow.
 WS below an invert; no flow.
 WS below an invert; no flow.
 WS below an invert; no flow.
 WS below an invert; no flow.

Composite Outlet Structure Detailed Report: Primary Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE

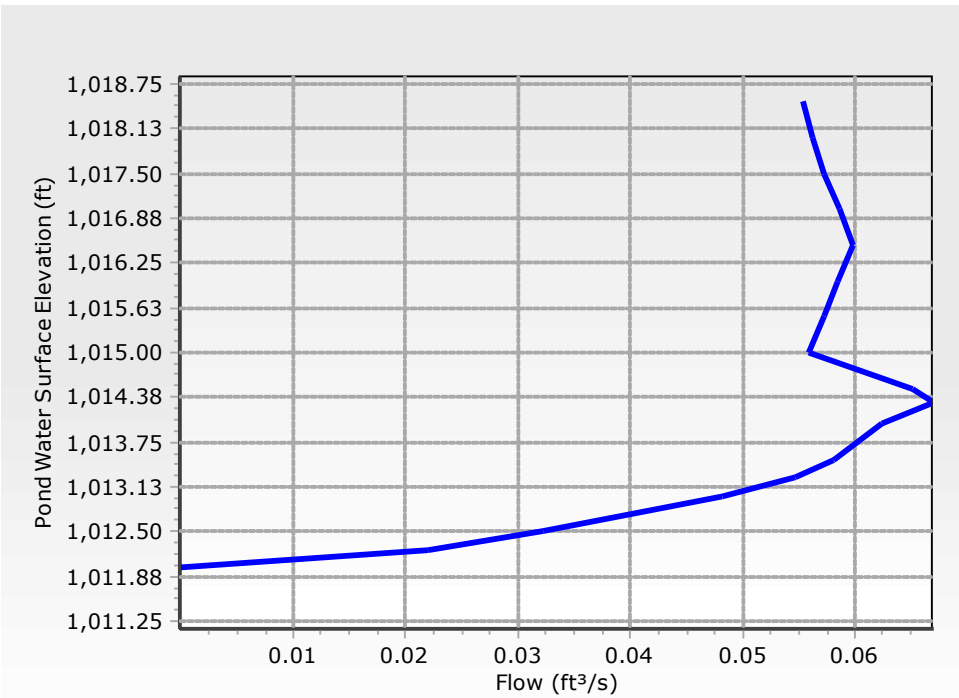
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)

Downstream ID = Culvert - 1 (Culvert-Circular)

Message			
WS below an invert; no flow.			
WS below an invert; no flow.			
WS below an invert; no flow.			
Weir: H =0.2ft			
Orifice: H =.70; Riser orifice equation controlling.			
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=1.20			
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=1.70			
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=2.20			
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=2.70			
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=3.20			
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=3.70			
FULLY CHARGED RISER: Orifice Equation Control to Crest; H=4.20			
Outlet Structure			
Outlet Structure Type		Orifice	
Outlet Structure (IDs and Direction)			
Outlet ID	Orifice - 1	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft
Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600
Number of Openings	2	Orifice Diameter	1.0 in
Outlet Structure (Common)			
Elevation	1,012.00 ft		

Composite Outlet Structure Detailed Report: Primary Outlet Structure



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
1,012.00	0.00	0.00	0.00	0.00
1,012.25	0.02	1,012.25	1,012.07	1,012.07
1,012.50	0.03	1,012.50	1,012.12	1,012.12
1,013.00	0.05	1,013.00	1,012.16	1,012.16
1,013.25	0.05	1,013.25	1,012.17	1,012.17
1,013.50	0.06	1,013.50	1,012.27	1,012.27
1,014.00	0.06	1,014.00	1,012.59	1,012.59
1,014.30	0.07	1,014.30	1,012.67	1,012.67
1,014.50	0.07	1,014.50	1,012.96	1,012.96
1,015.00	0.06	1,015.00	1,013.86	1,013.86
1,015.50	0.06	1,015.50	1,014.31	1,014.31
1,016.00	0.06	1,016.00	1,014.76	1,014.76
1,016.50	0.06	1,016.50	1,015.20	1,015.20
1,017.00	0.06	1,017.00	1,015.76	1,015.76
1,017.50	0.06	1,017.50	1,016.31	1,016.31
1,018.00	0.06	1,018.00	1,016.85	1,016.85
1,018.50	0.06	1,018.50	1,017.39	1,017.39

Composite Outlet Structure Detailed Report: Primary Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
 Structure ID = Orifice - 1 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
 Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft ³ /s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

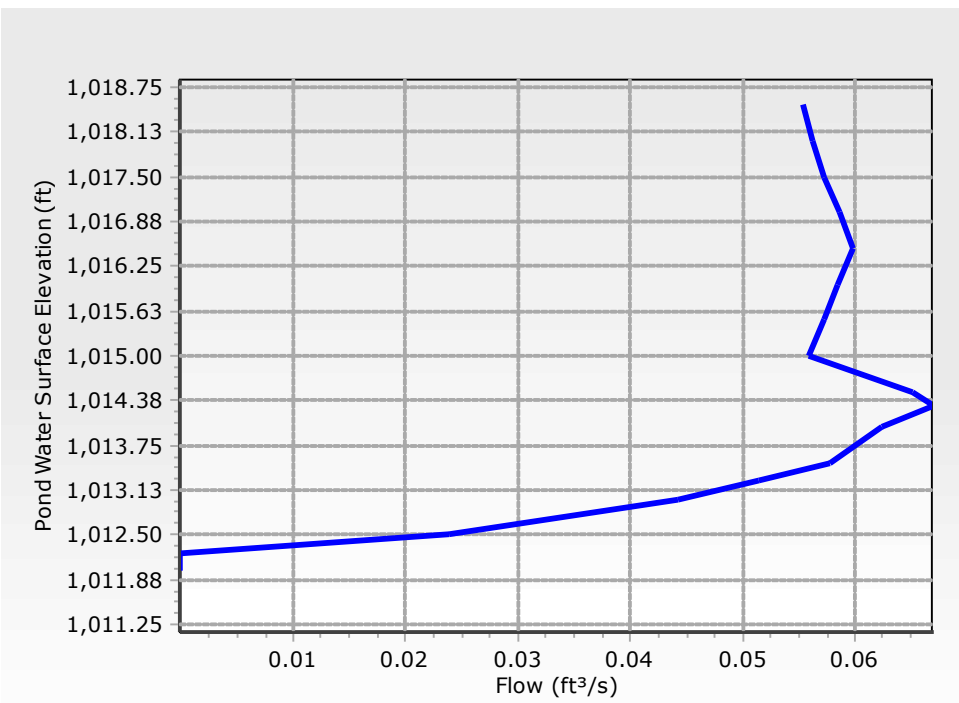
Message

WS below an invert; no flow.
 H = .18
 H = .38
 H = .84
 H = 1.08
 H = 1.23
 H = 1.41
 H = 1.63
 H = 1.54
 H = 1.14
 H = 1.19
 H = 1.24
 H = 1.30
 H = 1.24
 H = 1.19
 H = 1.15
 H = 1.11

Outlet Structure	
Outlet Structure Type	Orifice
Outlet Structure (IDs and Direction)	

Composite Outlet Structure Detailed Report: Primary Outlet Structure

Outlet Structure (IDs and Direction)			
Outlet ID	Orifice - 2	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft
Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600
Number of Openings	2	Orifice Diameter	1.0 in
Outlet Structure (Common)			
Elevation	1,012.25 ft		



RATING TABLE FOR ONE OUTLET TYPE
 Structure ID = Orifice - 2 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
 Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)

Composite Outlet Structure Detailed Report: Primary Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
 Structure ID = Orifice - 2 (Orifice-Circular)

 Upstream ID = (Pond Water Surface)
 Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft ³ /s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
1,012.00	0.00	0.00	0.00	0.00
1,012.25	0.00	0.00	0.00	1,012.07
1,012.50	0.02	1,012.50	Free Outfall	1,012.12
1,013.00	0.04	1,013.00	Free Outfall	1,012.16
1,013.25	0.05	1,013.25	Free Outfall	1,012.17
1,013.50	0.06	1,013.50	1,012.27	1,012.27
1,014.00	0.06	1,014.00	1,012.59	1,012.59
1,014.30	0.07	1,014.30	1,012.67	1,012.67
1,014.50	0.07	1,014.50	1,012.96	1,012.96
1,015.00	0.06	1,015.00	1,013.86	1,013.86
1,015.50	0.06	1,015.50	1,014.31	1,014.31
1,016.00	0.06	1,016.00	1,014.76	1,014.76
1,016.50	0.06	1,016.50	1,015.20	1,015.20
1,017.00	0.06	1,017.00	1,015.76	1,015.76
1,017.50	0.06	1,017.50	1,016.31	1,016.31
1,018.00	0.06	1,018.00	1,016.85	1,016.85
1,018.50	0.06	1,018.50	1,017.39	1,017.39
Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft ³ /s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	
0.00	0.00	(N/A)	0.00	

Message

WS below an invert; no flow.
 WS below an invert; no flow.

Composite Outlet Structure Detailed Report: Primary Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = Orifice - 2 (Orifice-Circular)

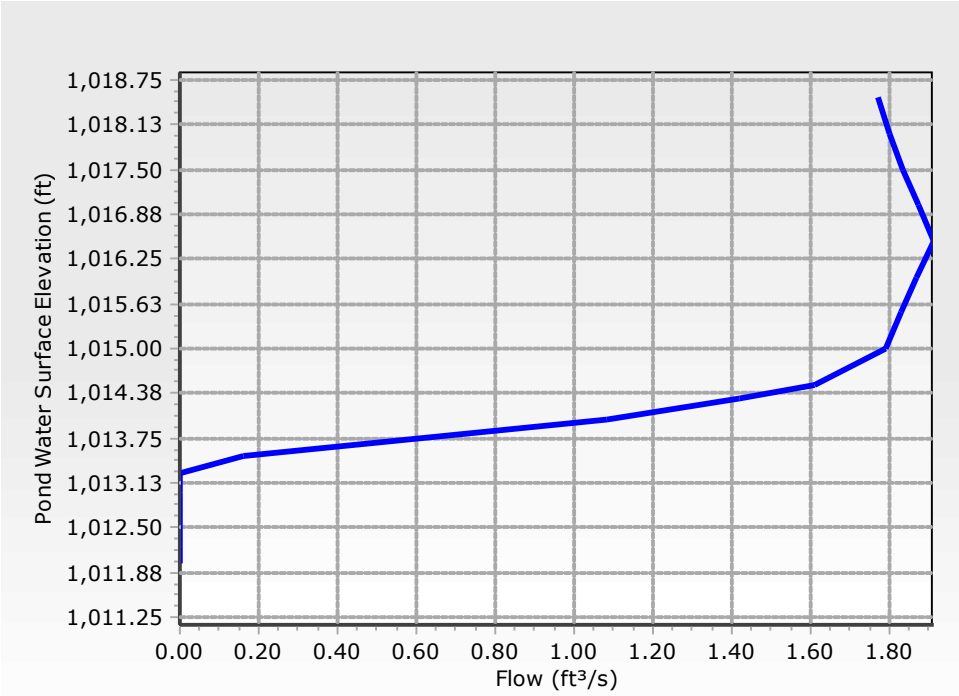
Upstream ID = (Pond Water Surface)

Downstream ID = Culvert - 1 (Culvert-Circular)

Message
H =.21
H =.71
H =.96
H =1.21
H =1.41
H =1.63
H =1.54
H =1.14
H =1.19
H =1.24
H =1.30
H =1.24
H =1.19
H =1.15
H =1.11

Outlet Structure			
Outlet Structure Type		Orifice	
Outlet Structure (IDs and Direction)			
Outlet ID	Orifice - 3	Downstream ID	Culvert - 1
Flow Direction	Forward Flow Only	Notes	
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft
Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600
Number of Openings	1	Orifice Diameter	8.0 in
Outlet Structure (Common)			
Elevation	1,013.25 ft		

Composite Outlet Structure Detailed Report: Primary Outlet Structure



RATING TABLE FOR ONE OUTLET TYPE
 Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
 Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
1,012.00	0.00	0.00	0.00	0.00
1,012.25	0.00	0.00	0.00	1,012.07
1,012.50	0.00	0.00	0.00	1,012.12
1,013.00	0.00	0.00	0.00	1,012.16
1,013.25	0.00	0.00	0.00	1,012.17
1,013.50	0.16	1,013.50	Free Outfall	1,012.27
1,014.00	1.08	1,014.00	Free Outfall	1,012.59
1,014.30	1.42	1,014.30	Free Outfall	1,012.67
1,014.50	1.61	1,014.50	Free Outfall	1,012.96
1,015.00	1.79	1,015.00	1,013.86	1,013.86
1,015.50	1.83	1,015.50	1,014.31	1,014.31
1,016.00	1.87	1,016.00	1,014.76	1,014.76
1,016.50	1.91	1,016.50	1,015.20	1,015.20
1,017.00	1.87	1,017.00	1,015.76	1,015.76
1,017.50	1.83	1,017.50	1,016.31	1,016.31
1,018.00	1.80	1,018.00	1,016.85	1,016.85
1,018.50	1.77	1,018.50	1,017.39	1,017.39

Composite Outlet Structure Detailed Report: Primary Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
 Structure ID = Orifice - 3 (Orifice-Circular)

Upstream ID = (Pond Water Surface)
 Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft ³ /s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message

WS below an invert; no flow.
 WS below an invert; no flow.
 WS below an invert; no flow.
 WS below an invert; no flow.
 WS below an invert; no flow.
 CRIT.DEPTH CONTROL Vh= .066ft
 Dcr= .184ft CRIT.DEPTH Hev= .00ft
 H =.42
 H =.72
 H =.92
 H =1.14
 H =1.19
 H =1.24
 H =1.30
 H =1.24
 H =1.19
 H =1.15
 H =1.11

Composite Outlet Structure Detailed Report: Primary Outlet Structure

Composite Rating Table

Tailwater Elevation = Free Outfall (Primary Outlet Structure)

Water Surface Elevation (ft)	Flow (ft ³ /s)	Tailwater Elevation (ft)	Convergence Error (ft)
1,012.00	0.00	(N/A)	0.00
1,012.25	0.02	(N/A)	0.00
1,012.50	0.06	(N/A)	0.00
1,013.00	0.09	(N/A)	0.00
1,013.25	0.11	(N/A)	0.00
1,013.50	0.28	(N/A)	0.00
1,014.00	1.21	(N/A)	0.00
1,014.30	1.55	(N/A)	0.00
1,014.50	3.00	(N/A)	0.00
1,015.00	9.01	(N/A)	0.00
1,015.50	11.25	(N/A)	0.00
1,016.00	13.07	(N/A)	0.00
1,016.50	14.64	(N/A)	0.00
1,017.00	15.96	(N/A)	0.00
1,017.50	17.15	(N/A)	0.00
1,018.00	18.27	(N/A)	0.00
1,018.50	19.31	(N/A)	0.00

Contributing Structures

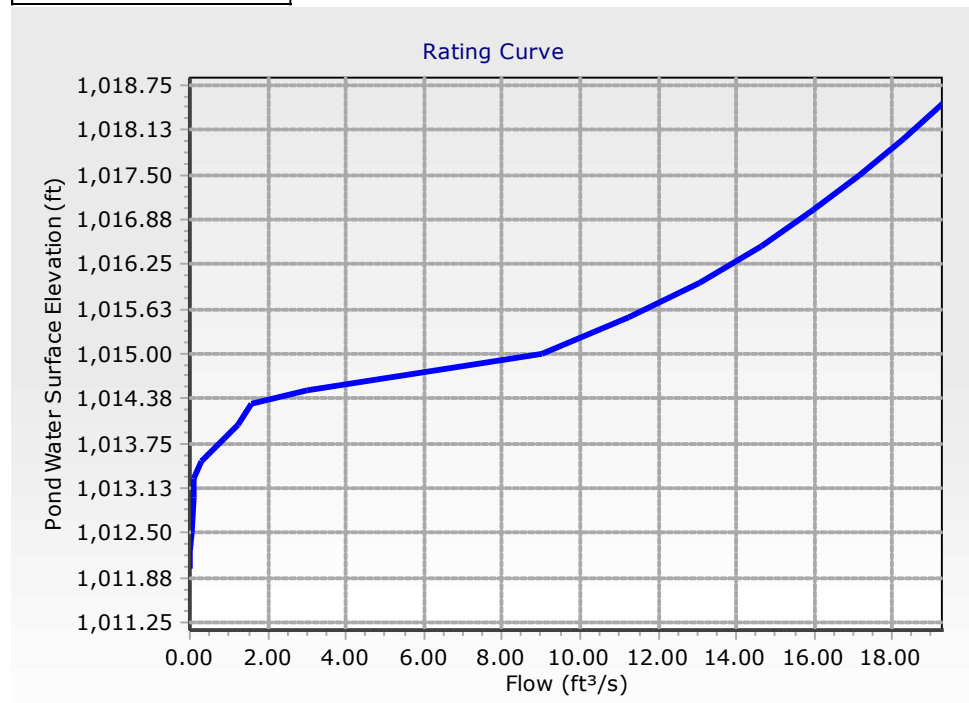
(no Q: Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1)
 Orifice - 1,Culvert - 1
 (no Q: Orifice - 2,Orifice - 3,Riser - 1)
 Orifice - 2,Orifice - 1,Culvert - 1 (no Q: Orifice - 3,Riser - 1)
 Orifice - 2,Orifice - 1,Culvert - 1 (no Q: Orifice - 3,Riser - 1)
 Orifice - 2,Orifice - 1,Culvert - 1 (no Q: Orifice - 3,Riser - 1)
 Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
 Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
 Orifice - 2,Orifice - 3,Orifice - 1,Culvert - 1 (no Q: Riser - 1)
 Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1
 Orifice - 2,Orifice - 3,Riser - 1,Orifice - 1,Culvert - 1

Composite Outlet Structure Detailed Report: Primary Outlet Structure

Composite Rating Table

Tailwater Elevation = Free Outfall (Primary Outlet Structure)

Contributing Structures
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1
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Orifice - 2, Orifice - 3, Riser - 1, Orifice - 1, Culvert - 1



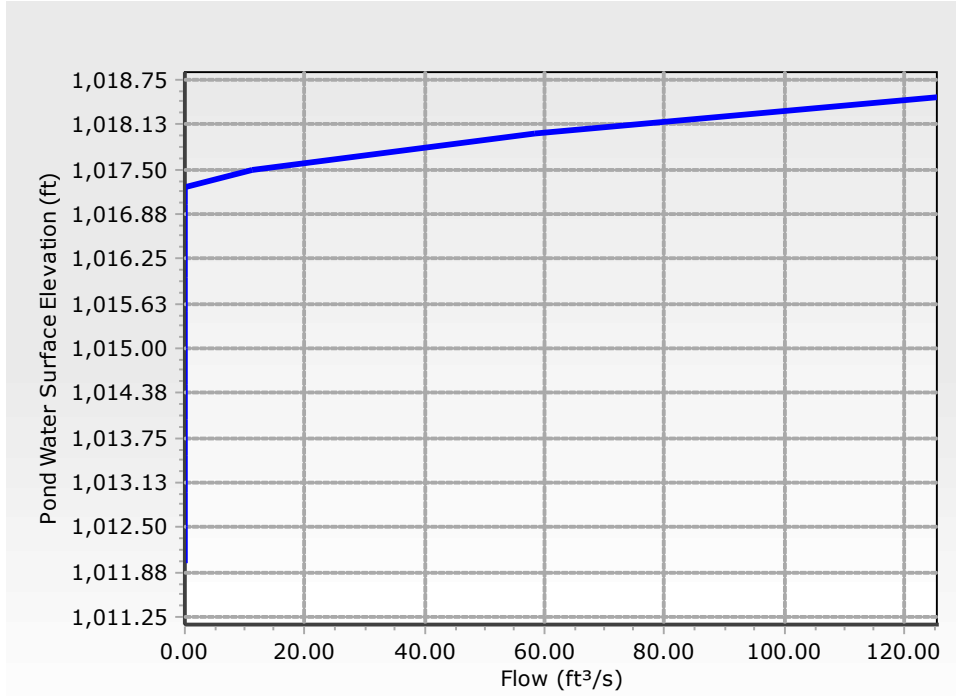
Composite Outlet Structure Detailed Report: Emergency Spillway

Element Details			
Label	Emergency Spillway	Notes	
Headwater Range			
Headwater Type	Use Pond for Headwater Range	Maximum (Headwater)	1,018.50 ft
Pond	Detention Pond	Increment (Headwater)	0.50 ft
Minimum (Headwater)	1,012.00 ft		
Spot Elevation (ft)			
Tailwater Setup			
Tailwater Type	Free Outfall		
Tailwater Tolerances			
Maximum Iterations	30	Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft	Flow Tolerance (Minimum)	0.001 ft ³ /s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft ³ /s
Tailwater Tolerance (Minimum)	0.01 ft		
Outlet Structure			
Outlet Structure Type	Weir		
Outlet Structure (IDs and Direction)			
Outlet ID	Weir	Downstream ID	Tailwater
Flow Direction	Forward Flow Only	Notes	
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft
Outlet Structure (Weir)			
Weir	Rectangular Weir	Rectangular Weir	Suppressed
Vary Coefficient with Depth	False	Weir Length	30.00 ft
Weir Coefficient	3.00 (ft ^{0.5})/s		
Outlet Structure (Common)			
Elevation	1,017.25 ft		

Composite Outlet Structure Detailed Report: Emergency Spillway

Outlet Structure (Weir, Advanced)

User Defined Table False



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Weir - 1 (Rectangular Weir)

Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
1,012.00	0.00	(N/A)	0.00
1,012.50	0.00	(N/A)	0.00
1,013.00	0.00	(N/A)	0.00
1,013.50	0.00	(N/A)	0.00
1,014.00	0.00	(N/A)	0.00
1,014.50	0.00	(N/A)	0.00
1,015.00	0.00	(N/A)	0.00
1,015.50	0.00	(N/A)	0.00
1,016.00	0.00	(N/A)	0.00
1,016.50	0.00	(N/A)	0.00
1,017.00	0.00	(N/A)	0.00
1,017.25	0.00	(N/A)	0.00
1,017.50	11.25	(N/A)	0.00
1,018.00	58.46	(N/A)	0.00

Composite Outlet Structure Detailed Report: Emergency Spillway

RATING TABLE FOR ONE OUTLET TYPE

Structure ID = Weir - 1 (Rectangular Weir)

Upstream ID = (Pond Water Surface)

Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft ³ /s)	Tailwater Elevation (ft)	Convergence Error (ft)
1,018.50	125.78	(N/A)	0.00

Computation Messages

HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 HW & TW below
 Inv.El.=1017.250
 H=.00; Htw=.00;
 Qfree=.00;
 H=.25; Htw=.00;
 Qfree=11.25;
 H=.75; Htw=.00;
 Qfree=58.46;
 H=1.25; Htw=.00;
 Qfree=125.78;

Composite Outlet Structure Detailed Report: Emergency Spillway

Composite Rating Table

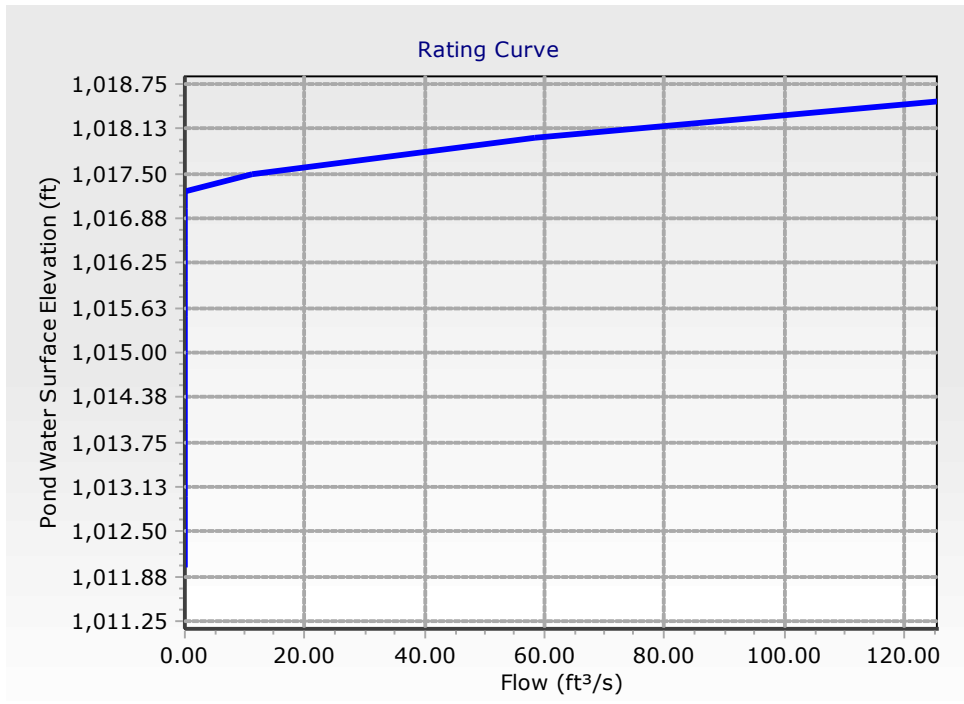
Tailwater Elevation = Free Outfall (Emergency Spillway)

Water Surface Elevation (ft)	Flow (ft ³ /s)	Tailwater Elevation (ft)	Convergence Error (ft)
1,012.00	0.00	(N/A)	0.00
1,012.50	0.00	(N/A)	0.00
1,013.00	0.00	(N/A)	0.00
1,013.50	0.00	(N/A)	0.00
1,014.00	0.00	(N/A)	0.00
1,014.50	0.00	(N/A)	0.00
1,015.00	0.00	(N/A)	0.00
1,015.50	0.00	(N/A)	0.00
1,016.00	0.00	(N/A)	0.00
1,016.50	0.00	(N/A)	0.00
1,017.00	0.00	(N/A)	0.00
1,017.25	0.00	(N/A)	0.00
1,017.50	11.25	(N/A)	0.00
1,018.00	58.46	(N/A)	0.00
1,018.50	125.78	(N/A)	0.00

Contributing Structures

None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
Weir - 1
Weir - 1
Weir - 1
Weir - 1

Composite Outlet Structure Detailed Report: Emergency Spillway



Free Online Manning Pipe Flow Calculator

>> Drop your fears at the door; love is spoken here. <<

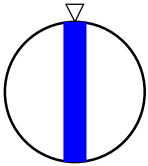
Manning Formula Uniform Pipe Flow at Given Slope and Depth

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Check out our newest spreadsheet update: [Download Spreadsheet \(spreadsheet/Manning-Pipe-Flow.xlsx\)](#) [Open Google Sheets version \(spreadsheet/Manning-Pipe-Flow.php\)](#) [View All Spreadsheets \(http://www.hawsedc.com/engcalcs/SpreadsheetLibrary.php\)](#)

--CAUTION: If you have downloaded the spreadsheet prior to September 24, you may have received incorrect results!--

Douglas Corners		Results	
Detention Pond outlet structure		Flow, Q	17.5547 cfs
Set units: <input type="checkbox"/> m <input type="checkbox"/> mm <input type="checkbox"/> ft <input type="checkbox"/> in		Velocity, v	9.9342 ft/sec
Pipe diameter, d_0	18 in	Velocity head, h_v	18.4056 in
Manning roughness, n ? (http://www.engineeringtoolbox.com/mannings-roughness-d_799.html)	0.011	Flow area	254.4695 sq. in.
Pressure slope (possibly ? (./pressureslope.php) equal to pipe slope), S_0	0.02 rise/run	Wetted perimeter	56.5487 in
Percent of (or ratio to) full depth (100% or 1 if flowing full)	1 fraction	Hydraulic radius	4.5000 in
		Top width, T	0.0000 in
		Froude number, F	0.00
		Shear stress (tractive force), τ	1.8731 psf



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14. The Time vs. Volume graph:
(See attached).

15. A discussion of all conclusions, including any waivers necessary to comply with the Design and Construction Manual.

All design is in compliance with the Design and Construction Manual. No variance requested.

16. Explanation of the accounting procedure used to calculate the allowable release rate at key points shown on the drainage maps. In essence, if off-site contributors to drainage area are present in the existing condition drainage area map, then a percentage of their existing peak flow rate can be added to the allowable peak flow rate to the various drainage points of discharge.

No off-site areas are included in this report.

17. A table showing how these drainage areas were accounted in the calculation of the allowable peak flow rate at the various drainage points of discharge.

All drainage areas discharge at the detention pond as shown and accounted for.

18. Final Report - Inflow hydrographs for the 2, 10, and 100 year storm events (please keep in mind that this information will be required to run the preliminary model, but not necessarily required in the preliminary report).

The 2, 10 and 100 year storm events are included in this report.

19. The maximum water surface elevation within the basin (normally the 100 year event).

The maximum water surface elevation within the basin are included in this report (1016.74).

20. Final Report: Stage-discharge-rating curves/data tables for each emergency spillway, primary outlet works and combined outlets and overflows.

Stage-storage rating curves included in Douglas Spillway Report.

21. Final Report: Routing curves for all design storms with time plotted as the abscissa, and the following plotted as ordinates:

- a. Cumulative inflow volume
- b. Cumulative discharge
- c. Stage elevation
- d. Cumulative storage

Routing curves to be submitted with Final Report as requested.