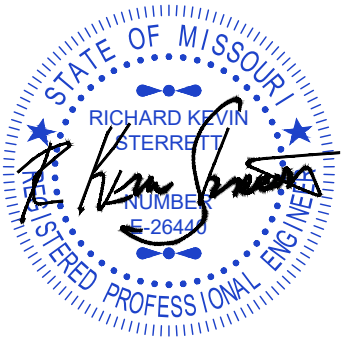
Final Stormwater Management Study

Colton's Crossing 1st Plat
Prepared for Hamblen Road Project, LLC
229 SE Douglas Street
Lee's Summit, MO 64063

HG Consult Project No. 25.018

Prepared by Richard Michael
June 11, 2025



June 11, 2025

HG Consult Inc engineers planners

I. Table of Contents

II. General Information

A. Description of Existing Site, Location, and Proposed Use

Colton's Crossing 1st Plat will consist of the development of a parcel approximately 14.68 acres. The subject property is currently zoned RP-3 (Planned Residential Mixed Use) and is located along SE Hamblen Road directly Northeast of Shamrock Hills Golf Club. The site is currently vacant and being used as farmland. The proposed land use of this phase will be single family residences. The site will also include a detention basin, road & sidewalks, and the necessary utilities to serve the development.

Figure II.A.1 – Aerial Photo of the project site

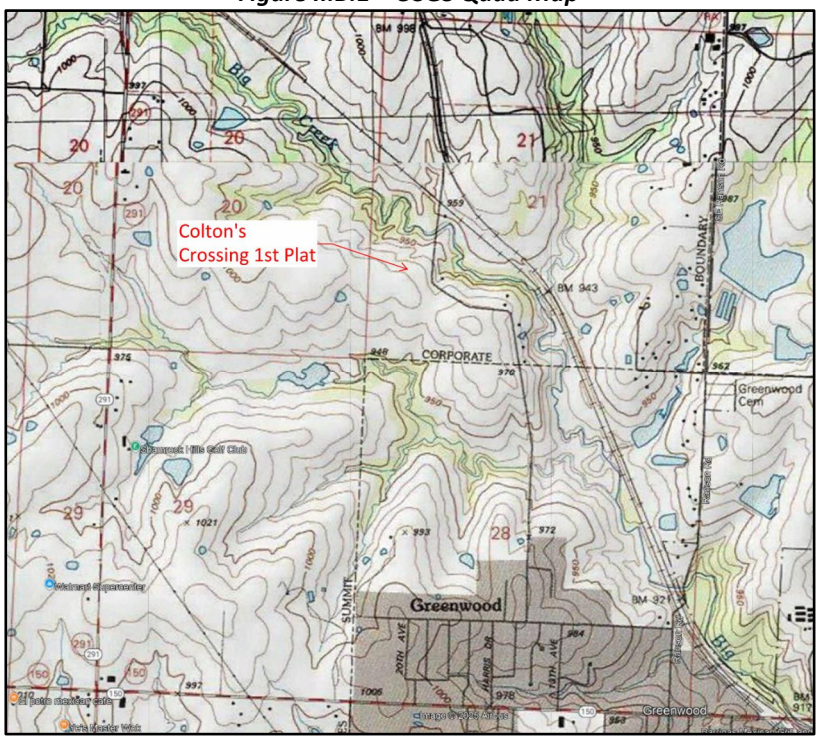
Figure II.A.2 – Aerial Photo of the project site

B. General Overview of Drainage Patterns

The project site is divided into 2 different drainage areas as shown on the Pre-Developed Drainage Area Map.

The reason for delineating the areas separately is to clearly distinguish between on-site and off-site. The subject property discharges north/northeast to Big Creek, immediately north of the property.

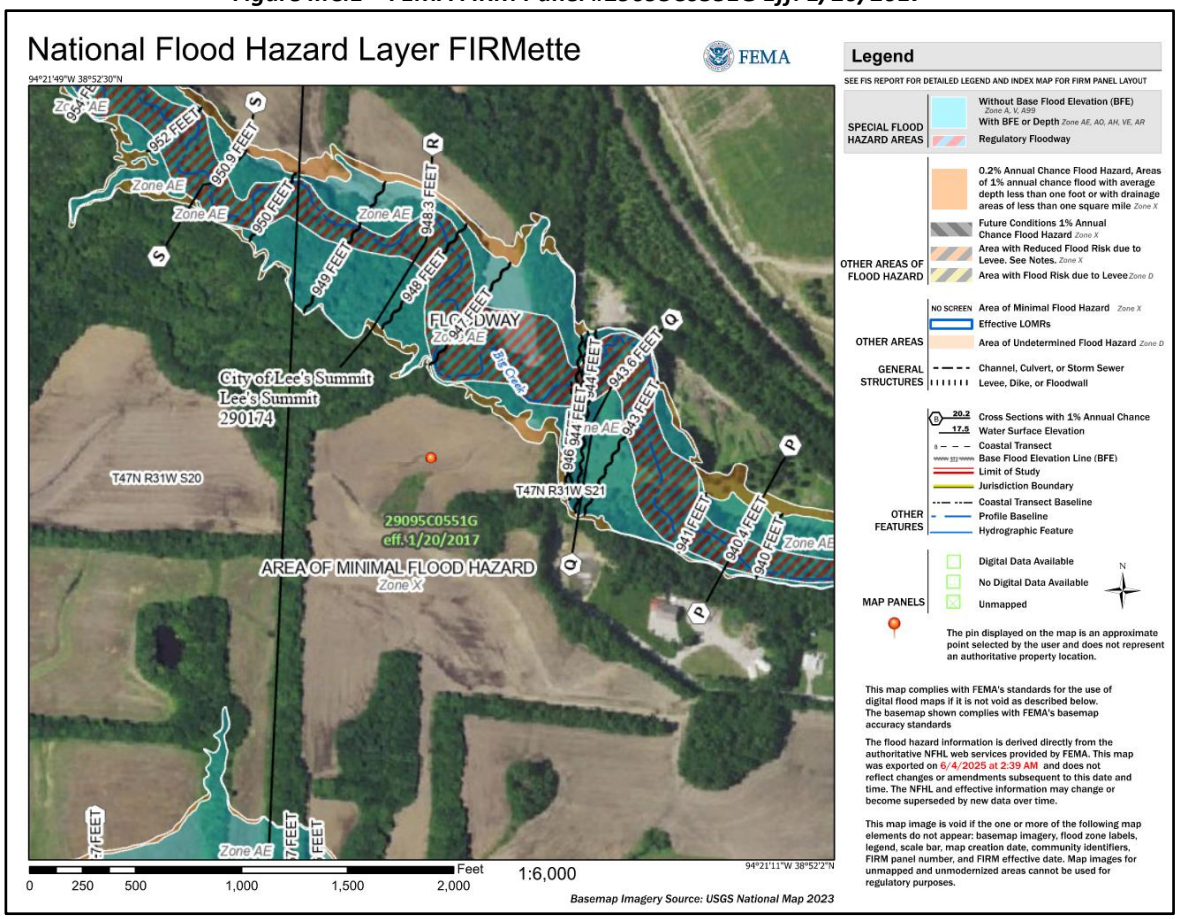
Figure II.B.1 – USGS Quad Map



C. FEMA Classification / Floodplain Issues

The project site is located primarily within Zone X (area of minimal flood hazard), with a small portion being located within Zone AE as represented in the NE. There are no floodplain boundaries being altered and therefore a Flood Study is not required. See Figure II.C.1 for Firm Panel. Included as Figure J of this report is a Stream Buffer Evaluation.

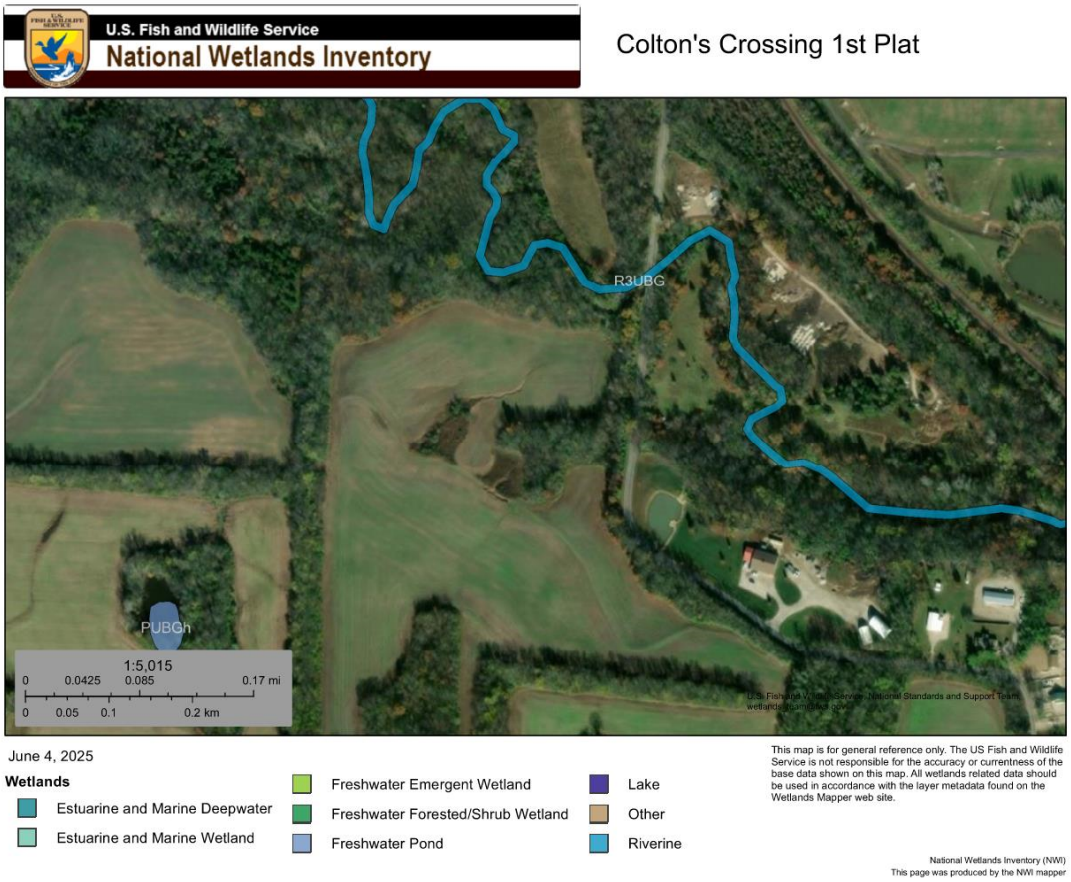
Figure II.C.1 – FEMA FIRM Panel #29095C0551G Eff. 1/20/2017



D. Wetland and USACE Issues

There are no wetlands or Waters of the US being disturbed by this project and therefore no permits are required from the Corps of Engineers for the development of this site. See figure II.D.1 for US Fish and Wildlife Wetland Inventory Map.

Figure II.D.1 – US Fish and Wildlife National Wetland Inventory



E. Soil Classification

NRCS Web Soil Survey categorizes the soils for this project below. See the appendix for additional information.

Table II.E.1 – Soil Classification

Symbol	Name	Slopes	HSG
10000	Arisburg silt loam	1-5%	C
10113	Oska silty clay loam	5-9%	D
10116	Sampsel silty clay loam	2-5%	C/D
10117	Sampsel silty clay loam	5-9%	C/D
13629	Colo silt loam	1-4%	C/D

For this analysis, Soil group C was considered for the project. Curve Numbers were used in accordance with APWA Section 5602.3.

III. Methodology

A. Unit Hydrograph Modeling Methods

The method for evaluating this project was with the use of PondPack Connect Edition. Both Pre-Development and Post-Development conditions were considered. The unit hydrograph method used was SCS TR-55.

B. Computation Methods for Runoff Determinations

The computation methods used for runoff determinations are as follows:

- AMC II Soil Moisture conditions
- 24-Hour SCS Type II Rainfall Distribution
- SCS Runoff Curve Numbers per TR-55
- Time of Concentration developed per TR-55

C. Design Storm Events Used and Source of Rainfall Data

The design storms that were considered include the 2, 10, 100, and subsequent 100-Year storms. The rainfall data was gathered from NRCS utilizing curves for a Type II 24-hour rainfall.

Table III.C.1 – Methodology and Rainfall Data

Methods and Rainfall Data	
Pond Routing	Pondpack using SCS Method
Existing CN	74, Group C soils
T_C	5 minutes
Water Quality, Type II, 24-hr	1.4 inch
2-yr rainfall, Type II, 24-hr	3.5 inch
10-yr rainfall, Type II, 24-hr	5.3 inch
100-yr rainfall, Type II, 24-hr	7.7 inch

IV. Existing Conditions Analysis

A. Summary of Comprehensive Control Requirements

As mentioned previously the soils on-site consist of primarily those with a hydrologic group of C. The site is undeveloped. The APWA default strategy was used to provide comprehensive protection. The APWA default strategy reads as follows:

> *"Under this strategy, peak runoff control is provided for the 1%, 10% and 50% chance storms and volumetric and/or extended detention control of the 90% mean annual event storm for broad protection of the receiving system, including channel erosion protection and flood peak reductions over a range of return periods. This strategy shall be the default strategy unless otherwise designated or approved by the local authority. Performance standards and sizing criteria are provided in Section 5608."*

B. Existing Drainage Area Map

See the appendix (Pre-Developed Drainage Area Map) for all drainage areas and outfall locations. See Table IV.B.1 for a summary of the drainage areas.

Table IV.B.1 – Pre-Developed Drainage Areas

Drainage Area	Total Area (acres)
E-1	14.68
E-1 OFF	3.76

C. Description of Each Drainage Area

E-1: This area represents the on-site area that discharges north into Big Creek (located off site). An SCS curve number of 74 has been applied to this area.

E-1 OFF: This area represents the off-site area that discharges to E-1. An SCS curve number of 74 has been applied to this area.

D. Table Summarizing Input Data

Table IV.D.1 – Pre-Developed Input Area Data

Sub-Area Name	Area	CN	TOC (minutes)
E-1	14.68	74	5.00
E-1 OFF	3.76	74	5.00

E. Table Summarizing Peak Runoff Rates

Table IV.E.1 – Pre-Developed Peak Runoff Rate

Sub-Area Name	2-Year (cfs)	10-Year (cfs)	100-Year (cfs)
E-1	27.95	60.13	107.22
E-1 OFF	7.16	15.40	27.46
POI E-1	35.11	75.53	134.68

V. Proposed Conditions Analysis

A. Proposed Drainage Area Map

See the appendix (Post-Developed Drainage Area Map) for all drainage areas and outfall locations. See Table V.A.1 for a summary of the drainage areas.

Table V.A.1 – Post-Developed Drainage Areas

Drainage Area	Total Area (acres)
P-1 A	11.67
P-1 B	3.01

B. Narrative Description of All Proposed Drainage Areas

P-1 A: This area represents the on-site area that discharges into the proposed basin. An SCS composite curve number of 83 has been applied to this area.

P-1 B: This area represents the on-site area that does not discharge into the proposed basin due to existing topography and vertical constraints. An SCS curve number of 76 has been applied to this area.

C. Table Summarizing Input Data

Table V.C.1 – Post-Developed Input Area Data

Sub-Area Name	Area	CN	TOC (minutes)
P-1 A	11.67	83	5.00
P-1 B	3.01	76	5.00

D. Table Summarizing Peak Runoff Rates

Table V.D.1 – Post-Developed Peak Runoff Rate

Sub-Area Name	2-Year (cfs)	10-Year (cfs)	100-Year (cfs)
P-1 A	34.14	62.68	101.36
P-1 B	6.38	13.19	22.97
POI P-1	6.87	20.73	41.91

E. Table Summarizing Pre-Developed, APWA Allowable, and Proposed Peak Runoff Rates

Table V.E.3 – Post-Developed Allowable Peak Runoff Rate based on 2011 APWA 5608.4 C

Post-Developed				Pre-Developed			Pre-Developed Rates			APWA Allowable Rates						Proposed Rates		
POI	**Area Name**	**Status**	**Area**	**POI**	**Area Name**	**Area**	**2-Yr (cfs)**	**10-Yr (cfs)**	**100-Yr (cfs)**	**2-Yr Rate (cfs/acre)**	**2-Yr (cfs)**	**10-Yr Rate (cfs/acre)**	**10-Yr (cfs)**	**100-Yr Rate (cfs/acre)**	**100-Yr (cfs)**	**2-Yr (cfs)**	**10-Yr (cfs)**	**100-Yr (cfs)**
POI P-1	P-1 A	On Site-Detained	11.67	POI E-1	E-1	14.68	27.95	60.13	107.22	0.5	7.34	2.0	29.36	3.0	44.04	34.14	62.68	101.36
POI P-1	P-1 B	On Site-Undetained	3.01													6.38	13.19	22.97
n/a	n/a	n/a	n/a	POI E-1	E-1 OFF	3.76	7.16	15.40	27.46	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
POI P-1				**POI E-1**			**35.11**	**75.53**	**134.68**	**7.34**		**29.36**		**44.04**		**6.87**	**20.73**	**41.91**

Comprehensive values utilizing 0.5 cfs (2-YR), 2 cfs (10-YR), and 3 cfs (100-YR) per site-acre applied to pre-developed on-site drainage areas only. The release rates in RED are the rates that were used as the maximums for each POI.

F. Tables Summarizing Detention/Retention Input Data and Results

Table V.F.1 –Detention Basin Input Data

	ELEV
24" Culvert (Upstream Invert)	945.90
2" Dia. Orifice (WQ)	946.00
4" Dia. Orifice (2YR)	948.10
0.5'x4' Orifice (10YR)	949.80
4'x4' Riser (100YR)	952.40
20' Overflow Weir (100YR*)	953.50
Top of Basin	956.00

**Assumes zero flow through primary outlet with subsequent 1% storm event*

Table V.F.2 – Detention Basin Results

	2-Year	10-Year	100-Year	100-Year*
Basin (IN)	34.14	62.68	101.36	101.36
Basin (OUT)	1.85	11.38	30.78	85.59
Basin WSE	949.88	950.99	952.86	954.75
Freeboard	**6.12**	**5.01**	**3.14**	**1.25**

**Assumes zero flow through primary outlet with subsequent 1% storm event*

G. Undetained Drainage Areas

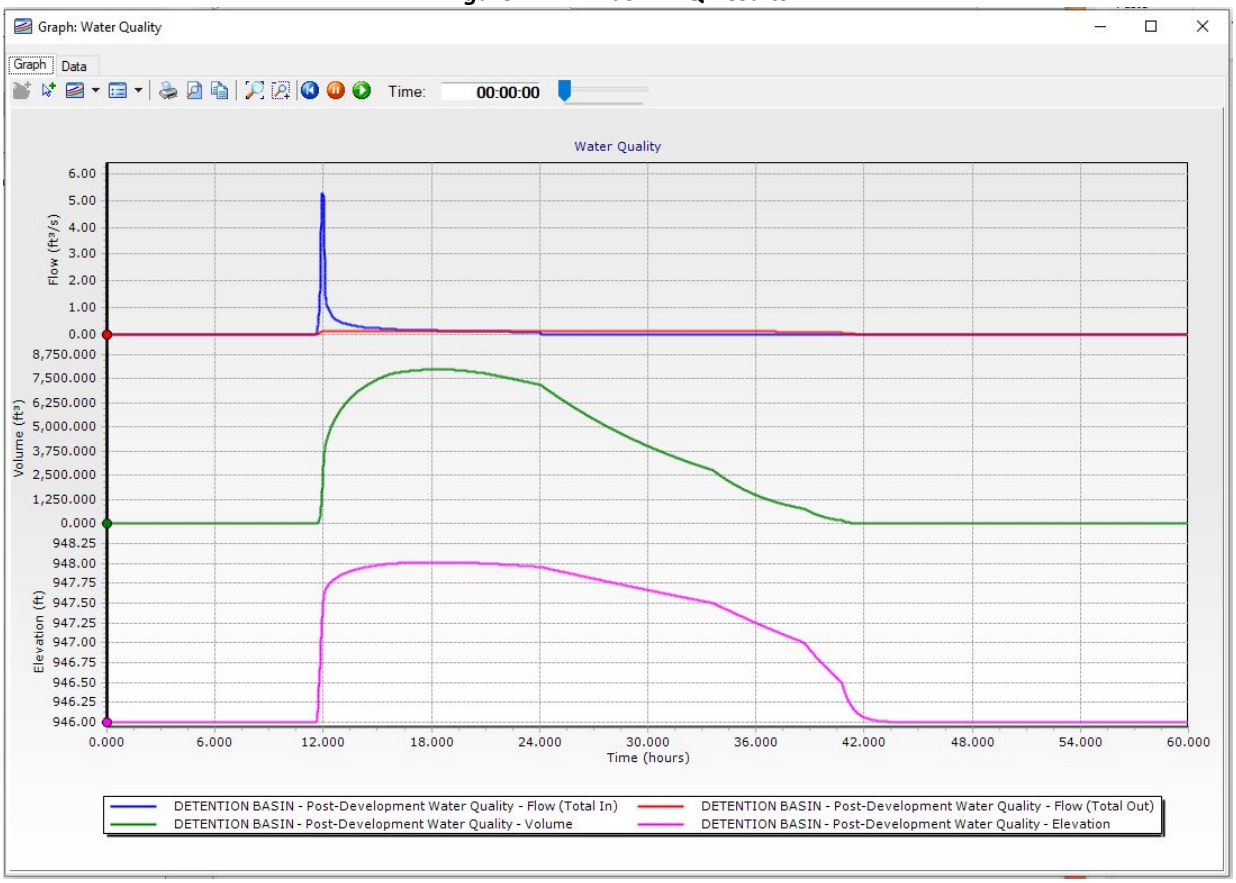
There is one area within this development which is undetained: P-1B. This fringe area is undetained due to elevation and grading constraints.

H. Water Quality Requirements

The proposed development is providing stormwater treatment per APWA 5608.4 and Chapter 6 of the MARC/APWA BMP Manual. As indicated in this study the proposed stormwater treatment is a wet detention basin with a 1.37" storm release over a 40-hour period.

I. Water Quality Summary

Figure V.I.1 – Basin WQ Results



VI. Conclusions and Recommendations

A. Overview of the Report

The proposed development will provide comprehensive control for the developed site via a dry detention basin that discharges to the north, matching the existing topography. The detention basin will treat the 2, 10, 100, and subsequent 100-year events.

The proposed detention releases the WQ event (1.37" of rainfall) over a 40-hour duration. To achieve this, an orifice size of 2" diameter was used. The 2" diameter works well with the proposed pipe guard grate because the openings are less than 1" diameter, meaning that the pipe guard grate will still screen/filter particulates before entering the 2" diameter orifice. When clogged, the pipe guard grate is easily maintained to remove debris. The subsequent 100-year storm event will flow through a 20' long weir acting as the emergency spillway. The elevation of the spillway is greater

than 0.5' above the 100-year WSE (providing 0.64'), meeting APWA criteria. There is greater than 1 foot of freeboard from the subsequent 100-year event WSE to the top of the dam (providing 1.25'), meeting APWA criteria.

Drainage area P-1B is not detained due to elevation and grading constraints.

B. List of Requested Waivers

P-1B – Waiver requested. See section V.G. Undetained Drainage Areas in this report.

VII. Appendix - Figures / Maps / Exhibits / Supporting Calculations

Figure A – Detention Basin Construction Plans
Figure B – Pre-Developed Drainage Area Map
Figure C – Post-Developed Drainage Area Map
Figure D – Detention Basin Volume Results
Figure E – Inflow Hydrographs
Figure F – Stage-Discharge Rating Curves & Input Data Per Basin Outlet
Figure G – Routing Curves for all Design Storms
Figure H – Pondpack Reports (Pre-Developed and Post-Developed)
Figure I – Web Soil Survey
Figure J – Stream Buffer Evaluation

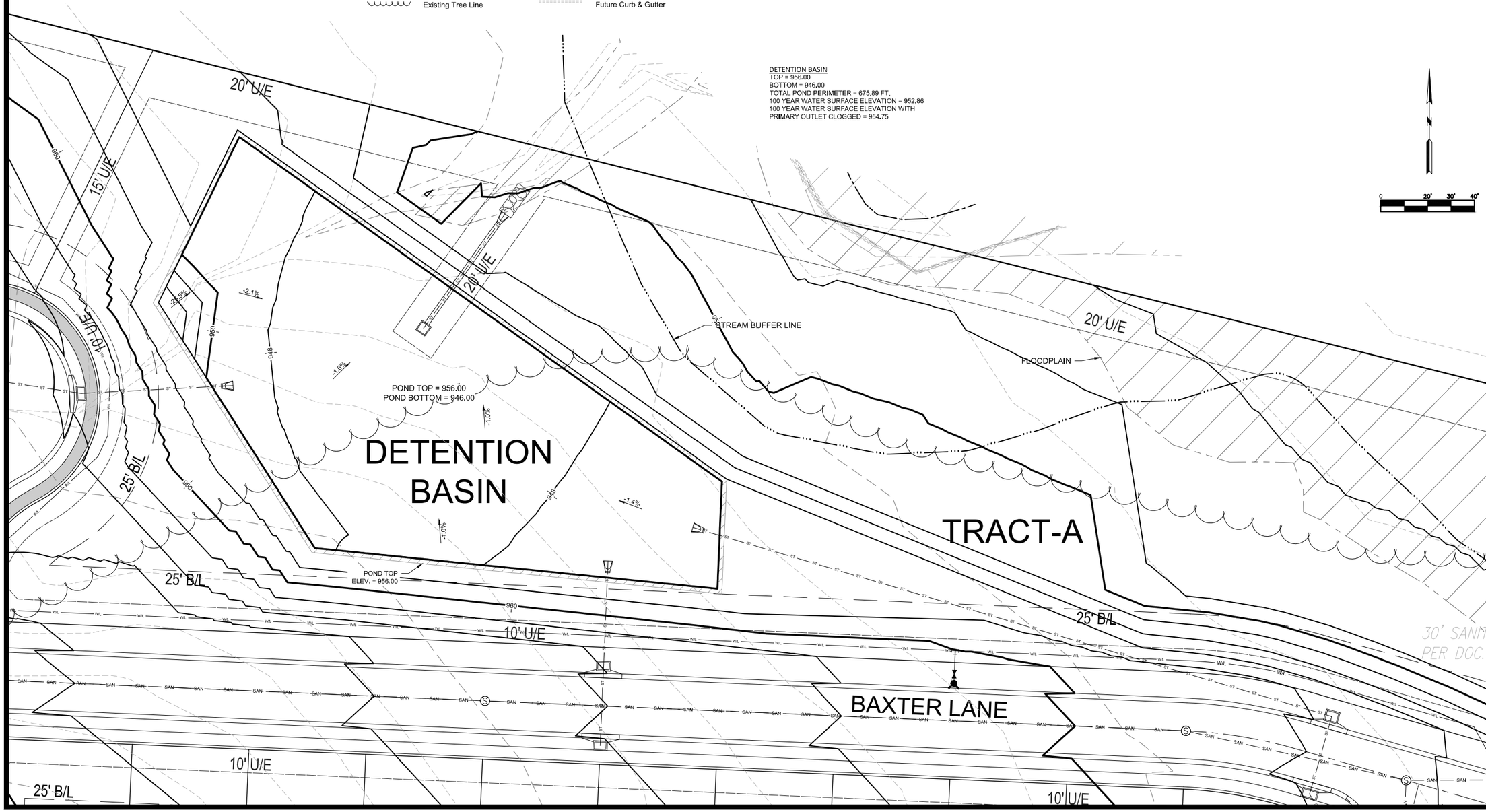
Figure A - Detention Basin Construction Plans

LEGEND

Existing Section Line	Proposed Right-of-Way
Existing Right-of-Way Line	Proposed Property Line
Existing Lot Line	Proposed Lot Line
Existing Easement Line	Proposed Easement
Existing Curb & Gutter	Proposed Curb & Gutter
Existing Sidewalk	Proposed Sidewalk
Existing Storm Sewer	Proposed Storm Sewer
Existing Storm Structure	Proposed Storm Structure
Existing Waterline	Proposed Fire Hydrant
Existing Gas Main	Proposed Waterline
Existing Sanitary Sewer	Proposed Sanitary Sewer
Existing Sanitary Manhole	Proposed Sanitary Manhole
Existing Contour Major	Proposed Contour Major
Existing Contour Minor	Proposed Contour Minor
Existing Tree Line	Future Curb & Gutter

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

DETENTION BASIN
TOP = 956.00
BOTTOM = 946.00
TOTAL POND PERIMETER = 675.89 FT.
100 YEAR WATER SURFACE ELEVATION = 952.86
100 YEAR WATER SURFACE ELEVATION WITH
PRIMARY OUTLET CLOGGED = 954.75



0 20' 30' 40'

NO.	REVISION	BY	DATE

IF THIS IS NOT A BLUE INK SEAL AND THE SIGNATURE IN BLUE INK, THE PLAN IS A COPY AND MAY CONTAIN UNAUTHORIZED ALTERATIONS. THE CERTIFICATION CONTAINED ON THIS DOCUMENT SHALL NOT APPLY TO ANY COPIES

STATE OF MISSOURI
RICHARD KEVIN STERRETT
NUMBER E-26440
REGISTERED PROFESSIONAL ENGINEER

R. KEVIN STERRETT, MO E-26440
JUNE 4, 2025

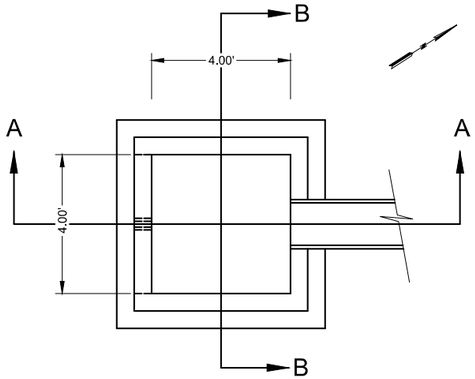
Consult Inc engineers planners
1533 Locust Street, Kansas City, Missouri 64108
CORPORATE LICENSE No. E2010005573 (MO.) / E-1736 (KS.) / LS 2019005467

STORM SEWER PLANS
DETENTION BASIN PLAN

COLTON'S CROSSING
1ST PLAT

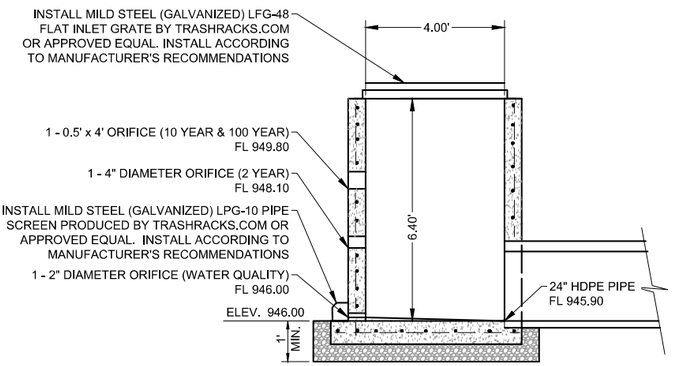
CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

X-REF NO. 25.018
DRAWING NO. 25.018
DATE JUNE 4, 2025
JOB NO. 25.018

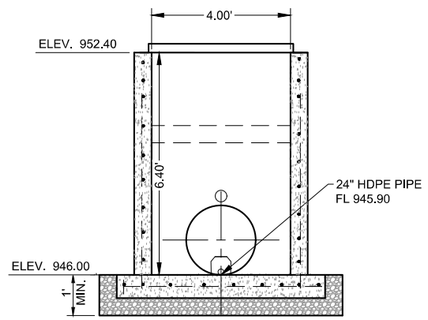


PLAN VIEW

NOTES:
1. ALL REBAR SHOWN IS #5 @ 12' MAX. SPACNG. REBAR SHALL HAVE 2" MIN. CLEAR COVER ON THE SIDE WALLS AND 3" MIN. CLEAR COVER ON THE BASE.

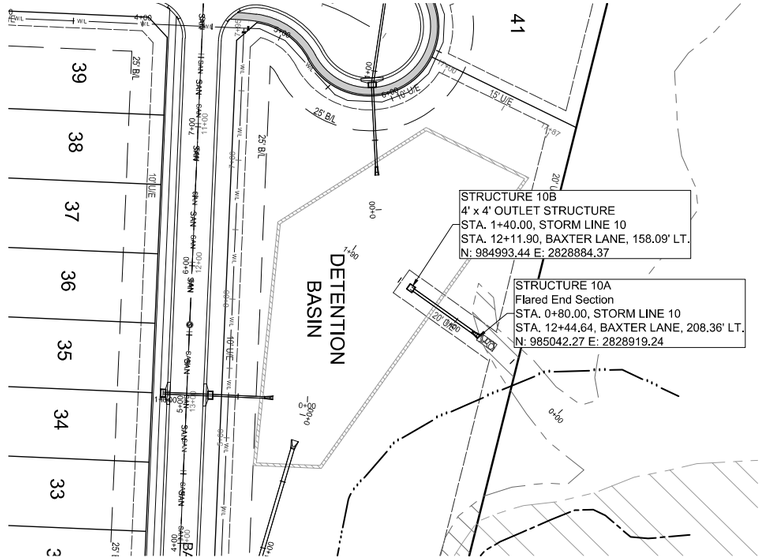


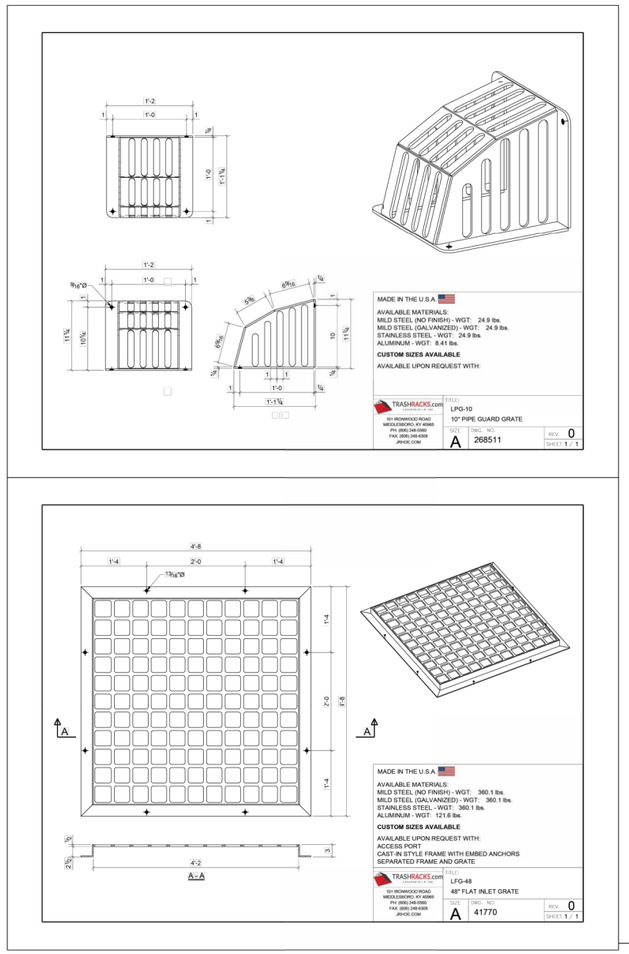
SECTION A-A

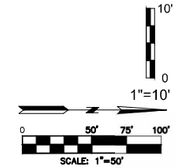


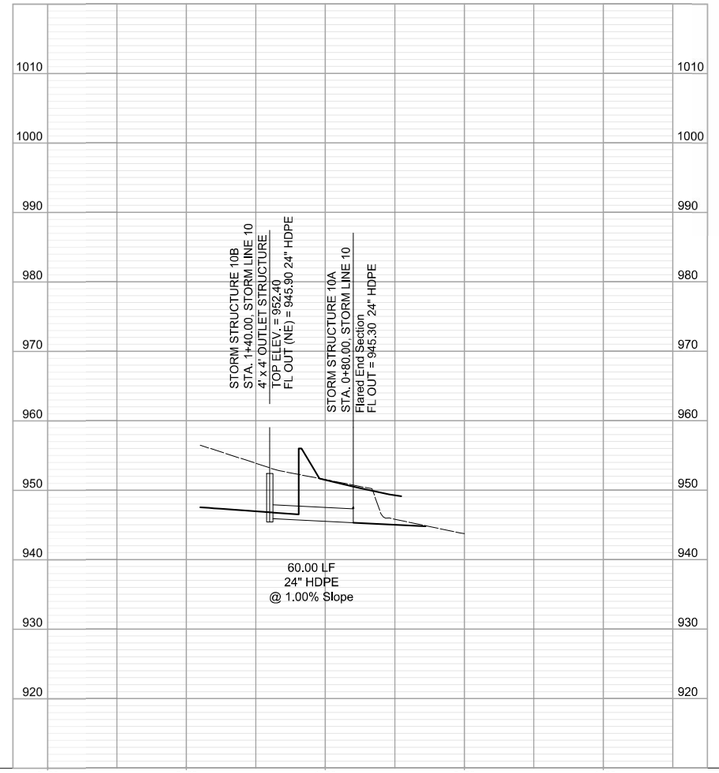
SECTION B-B

DETENTION BASIN OUTLET STRUCTURE
NOT TO SCALE









Know what's below.
Call before you dig.

NO.	REVISION	BY	CK/APP	DATE

IF THIS IS NOT A BLUE INK SEAL AND THE SIGNATURE IN BLUE INK, THE PLAN IS A COPY AND MAY CONTAIN UNAUTHORIZED ALTERATIONS. THE CERTIFICATION CONTAINED ON THIS DOCUMENT SHALL NOT APPLY TO ANY COPIES

STATE OF MISSOURI
RICHARD KEVIN STERRETT
NUMBER E-26440
ENGINEER
PROFESSIONAL ENGINEER

R. KEVIN STERRETT, MO E-26440
JUNE 4, 2025

Consult Inc engineers planners
1533 Locust Street, Kansas City, Missouri 64108
CORPORATE LICENSE No. E2010000573 (MO.) / E-1736 (KS.) / LS 2019005467

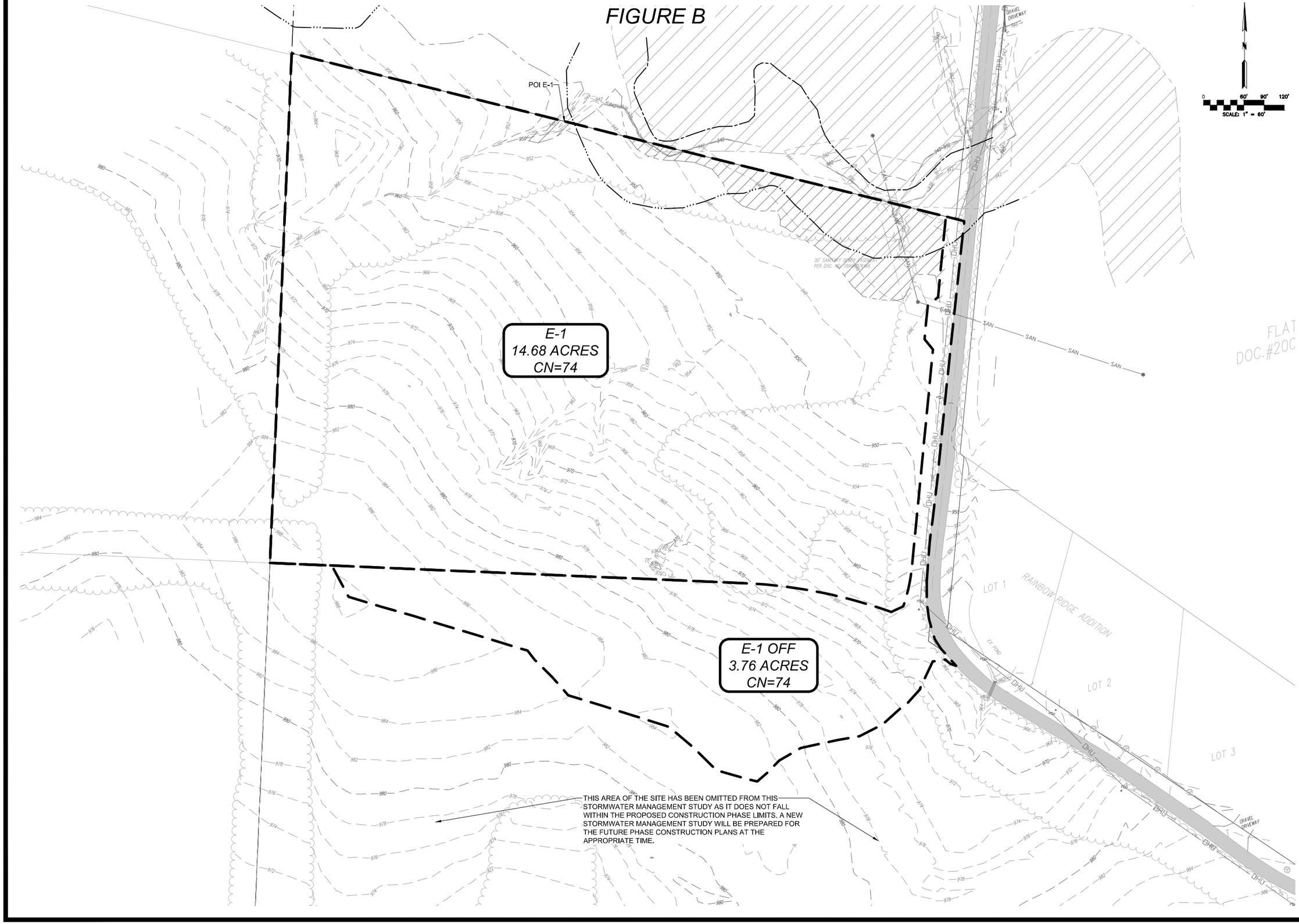
STORM SEWER PLANS
LINE 10 & OUTLET STRUCTURE

COLTON'S CROSSING
1ST PLAT
CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

X-REF NO.	25.018
DRAWING NO.	25.018
DATE	JUNE 4, 2025
JOB NO.	25.018
SHEET OF	7 OF 12

FILE: LOCATION: G:\SHARED\BENCH\PE PROJECTS\ (YR. 2025+2026)\2025.018 COLTONS CROSSING PHASE 1 (DUSTIN BAXTER)\CIVIL\SHEET_FILES\STORM PROFILES.DWG
PLOT DATE: 6/5/2025 12:58 PM by: MARK HILL

FIGURE B



FLAT
DOC.#20C

NO.	BY	CK/APP	DATE	REVISION

IF THIS IS NOT A BLUE INK SEAL AND THE SIGNATURE IN BLUE INK, THE PLAN IS A COPY AND MAY CONTAIN UNAUTHORIZED ALTERATIONS. THE CERTIFICATION CONTAINED ON THIS DOCUMENT SHALL NOT APPLY TO ANY COPIES

STATE OF MISSOURI
RICHARD KEVIN STERRETT
NUMBER E-26440
REGISTERED PROFESSIONAL ENGINEER

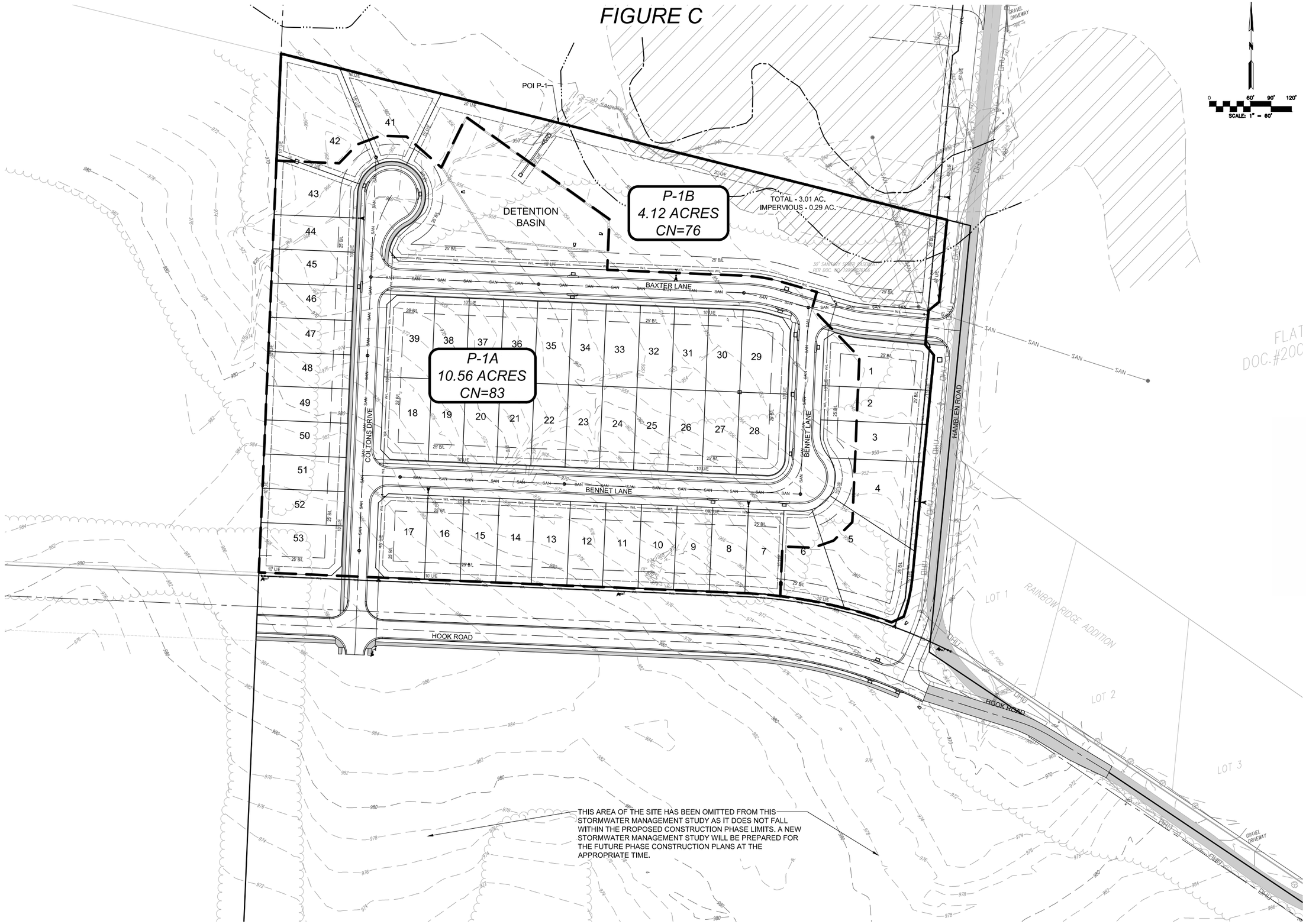
R. KEVIN STERRETT, MO E-26440
JUNE 4, 2025

Consult engineers planners Inc
1533 Locust Street, Kansas City, Missouri 64108
CORPORATE LICENSE No. E2010005573 (MO.) / E-1736 (KS.) / LS 2019005467

STORM SEWER PLANS
PRE-DEVELOPED
DRAINAGE AREA MAP
COLTON'S CROSSING
1ST PLAT
CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

X-REF NO.	25.018
DRAWING NO.	25.018
DATE	JUNE 4, 2025
JOB NO.	25.018
SHEET OF	9 OF 12

FIGURE C



FLAT
DOC.#20C

DATE	REVISION	NO.	BY	CK/APP

IF THIS IS NOT A BLUE INK SEAL AND THE SIGNATURE IN BLUE INK, THE PLAN IS A COPY AND MAY CONTAIN UNAUTHORIZED ALTERATIONS. THE CERTIFICATION CONTAINED ON THIS DOCUMENT SHALL NOT APPLY TO ANY COPIES

STATE OF MISSOURI
RICHARD KEVIN STERRETT
NUMBER E-26440
REGISTERED PROFESSIONAL ENGINEER

R. KEVIN STERRETT, MO E-26440
JUNE 4, 2025

Consult Inc engineers planners
1533 Locust Street, Kansas City, Missouri 64108
CORPORATE LICENSE No. E2010000573 (MO.) / E-1736 (KS.) / LS 2019005467

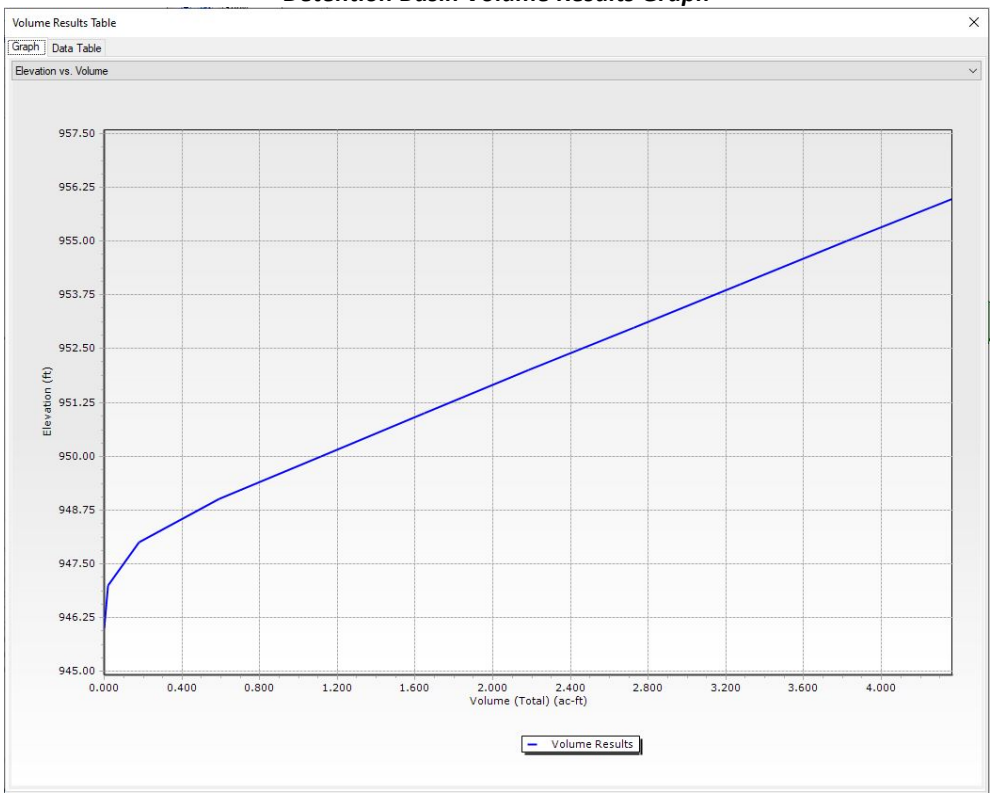
STORM SEWER PLANS
POST - DEVELOPED
DRAINAGE AREA MAP

COLTON'S CROSSING
1ST PLAT
CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

X-REF NO.	25.018
DRAWING NO.	25.018
DATE	JUNE 4, 2025
JOB NO.	25.018
SHEET OF	10 OF 12

Figure D – Detention Basin Volume Results

Detention Basin Volume Results Graph



Detention Basin Volume Results Table

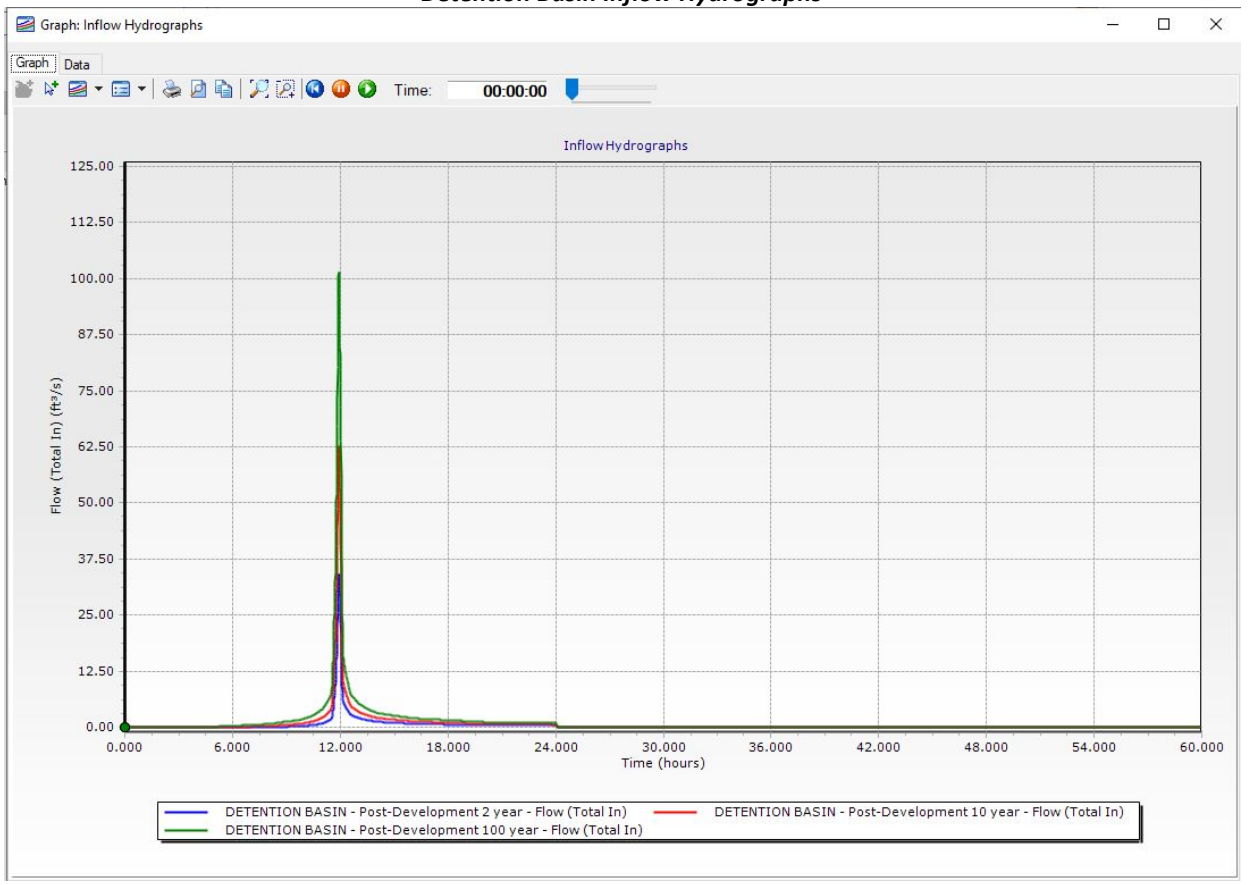
Volume Results Table

Graph | Data Table

	Elevation (ft)	Planimeter (ft²)	Area (acres)	A1+A2+sqr (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
1	946.00	0.00	0.00	0.00	0.000	0.000
2	947.00	0.00	0.04	0.05	0.017	0.017
3	948.00	0.00	0.32	0.48	0.162	0.179
4	949.00	0.00	0.51	1.24	0.412	0.591
5	950.00	0.00	0.53	1.56	0.521	1.112
6	951.00	0.00	0.54	1.61	0.535	1.647
7	952.00	0.00	0.54	1.62	0.539	2.186
8	953.00	0.00	0.54	1.63	0.542	2.728
9	954.00	0.00	0.55	1.63	0.545	3.273
10	955.00	0.00	0.55	1.64	0.547	3.820
11	956.00	0.00	0.55	1.65	0.548	4.368

Figure E – Inflow Hydrographs

Detention Basin Inflow Hydrographs



Consult Inc engineers planners

Figure F –
Stage-Discharge Rating Curves
& Input Data Per Basin Outlet

Composite Outlet Structure Detailed Report: Composite Outlet Structure

Element Details			
Label	Composite Outlet Structure	Notes	

Headwater Range			
Headwater Type	Use Pond for Headwater Range	Maximum (Headwater)	956.00 ft
Pond	DETENTION BASIN	Increment (Headwater)	0.50 ft
Minimum (Headwater)	946.00 ft		

SpotElevation (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 ft³/s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft³/s
Tailwater Tolerance (Minimum)	0.01 ft		

Outlet Structure			
Outlet Structure Type	Culvert	Culvert Type	Circular

Outlet Structure (IDs and Direction)			
Outlet ID	CULVERT	Downstream ID	Tailwater
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

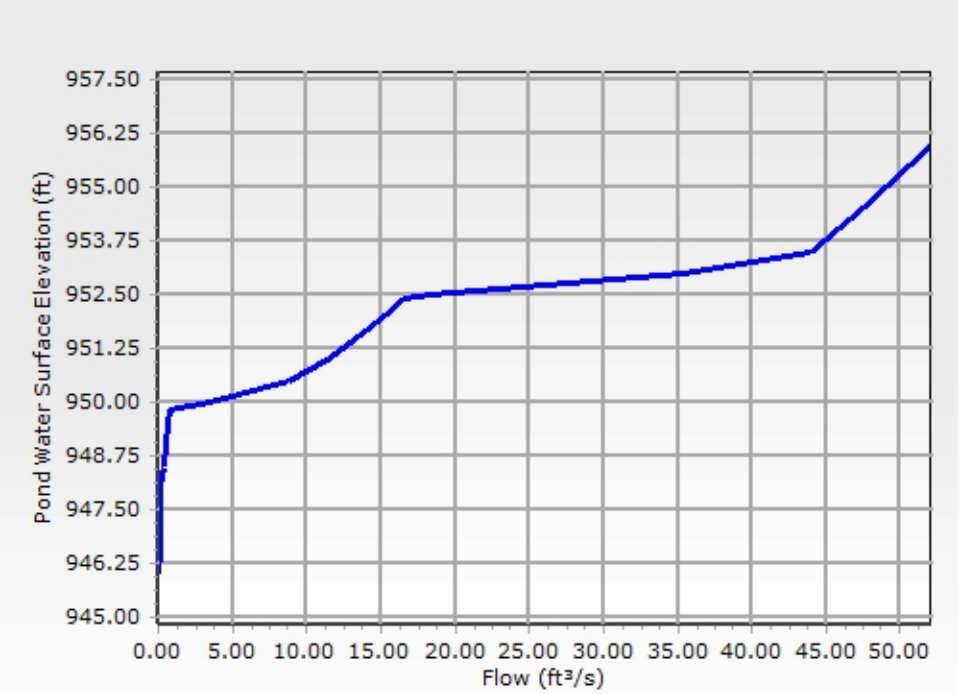
Culvert Data			
Number of Barrels	1	Downstream Invert	945.32 ft
Length	58.50 ft	Diameter	24.0 in
Upstream Invert	945.90 ft		

Unsubmerged->Submerged			
Specify Transitions	False	Compute Inlet Control Only	False

Composite Outlet Structure Detailed Report: Composite 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	0.012
Equation Form	Form 1	Ke	0.200
K	0.0045	Kr	0.200
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 (Culvert-Circular)

Mannings open channel maximum capacity: 26.25 ft³/s
Upstream ID = 2YR, 10YR, 4'X4' RISER, WQ
Downstream ID = Tailwater (Pond Outfall)

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: Composite Outlet Structure

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

Mannings open channel maximum capacity: 26.25 ft³/s
Upstream ID = 2YR, 10YR, 4'X4' RISER, WQ
Downstream ID = Tailwater (Pond Outfall)

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)
946.00	0.00	0.00	0.00	Free Outfall
946.50	0.07	946.02	Free Outfall	Free Outfall
947.00	0.10	0.00	Free Outfall	Free Outfall
947.50	0.12	0.00	Free Outfall	Free Outfall
948.00	0.15	946.08	Free Outfall	Free Outfall
948.10	0.15	0.00	Free Outfall	Free Outfall
948.50	0.36	946.19	Free Outfall	Free Outfall
949.00	0.53	946.25	Free Outfall	Free Outfall
949.50	0.66	946.29	Free Outfall	Free Outfall
949.80	0.72	946.31	Free Outfall	Free Outfall
950.00	3.46	946.83	Free Outfall	Free Outfall
950.50	8.86	947.47	Free Outfall	Free Outfall
951.00	11.43	947.73	Free Outfall	Free Outfall
951.50	13.50	947.92	Free Outfall	Free Outfall
952.00	15.29	948.09	Free Outfall	Free Outfall
952.40	16.59	948.21	Free Outfall	Free Outfall
952.50	18.39	948.37	Free Outfall	Free Outfall
953.00	35.49	951.32	Free Outfall	Free Outfall
953.50	44.04	953.50	Free Outfall	Free Outfall
954.00	45.78	954.00	Free Outfall	Free Outfall
954.50	47.45	954.50	Free Outfall	Free Outfall
955.00	49.05	955.00	Free Outfall	Free Outfall
955.50	50.62	955.50	Free Outfall	Free Outfall
956.00	52.14	956.00	Free Outfall	Free Outfall

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/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

Composite Outlet Structure Detailed Report: Composite Outlet Structure

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

Mannings open channel maximum capacity: 26.25 ft³/s
Upstream ID = 2YR, 10YR, 4'X4' RISER, WQ
Downstream ID = Tailwater (Pond Outfall)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.01	(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	0.02	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	11.34	(N/A)	0.00
0.00	51.37	(N/A)	0.00
0.00	64.15	(N/A)	0.00
0.00	75.12	(N/A)	0.00
0.00	84.97	(N/A)	0.00
0.00	93.98	(N/A)	0.00

Message
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .030ft Dcr= .088ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .036ft Dcr= .106ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .041ft Dcr= .120ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .044ft Dcr= .130ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .044ft Dcr= .130ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .086ft Dcr= .250ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .100ft Dcr= .291ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .425ft Dcr= 1.062ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure

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

Mannings open channel maximum capacity: 26.25 ft³/s
Upstream ID = 2YR, 10YR, 4'X4' RISER, WQ
Downstream ID = Tailwater (Pond Outfall)

Message
CRIT.DEPTH CONTROL Vh= .510ft Dcr= 1.214ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .582ft Dcr= 1.323ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .649ft Dcr= 1.410ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .699ft Dcr= 1.468ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .776ft Dcr= 1.544ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =5.42
INLET CONTROL... Submerged: HW =7.60
INLET CONTROL... Submerged: HW =8.10
INLET CONTROL... Submerged: HW =8.60
INLET CONTROL... Submerged: HW =9.10
INLET CONTROL... Submerged: HW =9.60
INLET CONTROL... Submerged: HW =10.10

Outlet Structure

Outlet Structure Type	Riser

Outlet Structure (IDs and Direction)

Outlet ID	4'X4' RISER	Downstream ID	CULVERT
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)

Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Riser)

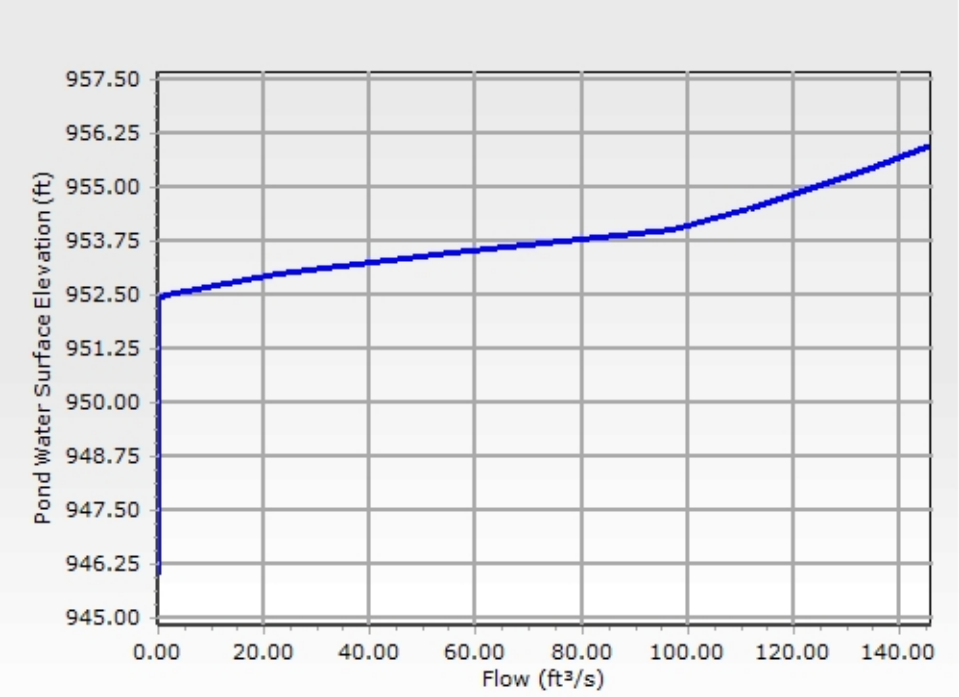
Riser	Inlet Box	Orifice Area	16.00 ft²
Weir Length	16.00 ft	Transition Elevation	0.00 ft
Weir Coefficient	3.00 (ft^0.5)/s	Transition Height	0.00 ft
Orifice Coefficient	0.600	K Reverse	1.000

Composite Outlet Structure Detailed Report: Composite Outlet Structure

Outlet Structure (Riser)			

Outlet Structure (Common)			
Elevation	952.40 ft		

Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 4'X4' RISER (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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)
946.00	0.00	0.00	0.00	0.00
946.50	0.00	0.00	0.00	946.02
947.00	0.00	0.00	0.00	0.00
947.50	0.00	0.00	0.00	0.00
948.00	0.00	0.00	0.00	946.08
948.10	0.00	0.00	0.00	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 4'X4' RISER (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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)
948.50	0.00	0.00	0.00	946.19
949.00	0.00	0.00	0.00	946.25
949.50	0.00	0.00	0.00	946.29
949.80	0.00	0.00	0.00	946.31
950.00	0.00	0.00	0.00	946.83
950.50	0.00	0.00	0.00	947.47
951.00	0.00	0.00	0.00	947.73
951.50	0.00	0.00	0.00	947.92
952.00	0.00	0.00	0.00	948.09
952.40	0.00	0.00	0.00	948.21
952.50	1.52	952.50	Free Outfall	948.37
953.00	22.31	953.00	Free Outfall	951.32
953.50	55.38	953.50	953.50	953.50
954.00	97.15	954.00	954.00	954.00
954.50	111.60	954.50	954.50	954.50
955.00	124.17	955.00	955.00	955.00
955.50	135.59	955.50	955.50	955.50
956.00	146.11	956.00	956.00	956.00

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/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

Composite Outlet Structure Detailed Report: Composite Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 4'X4' RISER (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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

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.
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.
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.
WS below an invert; no flow.
Weir: H =0.1ft
Weir: H =0.6ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =1.1ft
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

Composite Outlet Structure Detailed Report: Composite Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 4'X4' RISER (Inlet Box)

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

Message
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

Outlet Structure	
Outlet Structure Type	Orifice

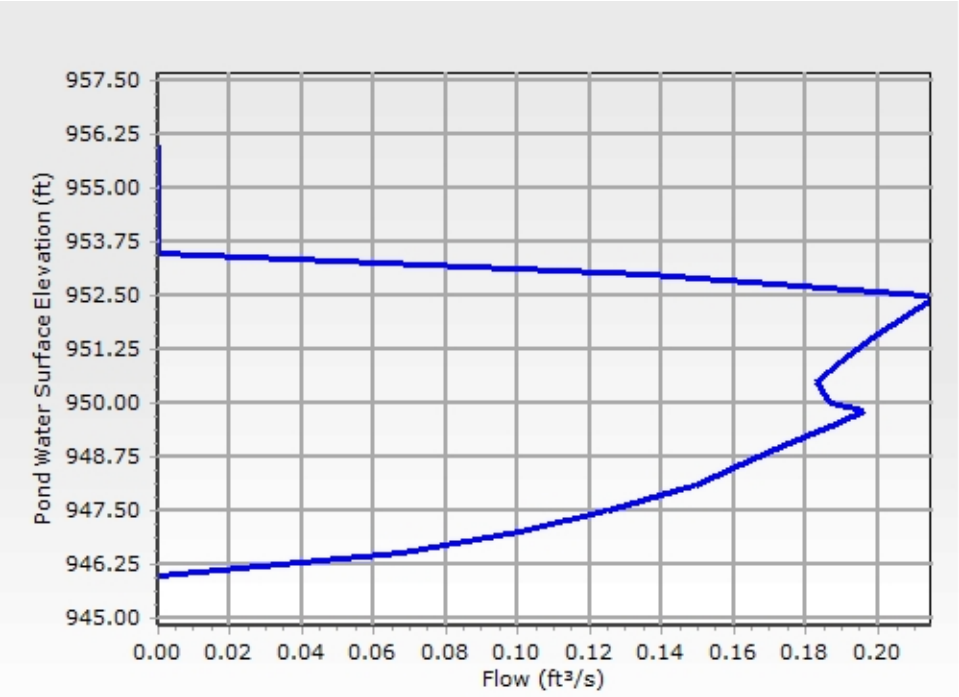
Outlet Structure (IDs and Direction)			
Outlet ID	WQ	Downstream ID	CULVERT
Flow Direction	Forward Flow Only	Notes	

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	2.0 in

Outlet Structure (Common)	
Elevation	946.00 ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure



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

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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)
946.00	0.00	0.00	0.00	0.00
946.50	0.07	946.50	946.02	946.02
947.00	0.10	947.00	946.05	0.00
947.50	0.12	947.50	946.07	0.00
948.00	0.15	948.00	946.08	946.08
948.10	0.15	948.10	Free Outfall	0.00
948.50	0.16	948.50	946.19	946.19
949.00	0.17	949.00	946.25	946.25
949.50	0.19	949.50	946.29	946.29
949.80	0.20	949.80	946.31	946.31
950.00	0.19	950.00	946.83	946.83
950.50	0.18	950.50	947.47	947.47
951.00	0.19	951.00	947.73	947.73
951.50	0.20	951.50	947.92	947.92
952.00	0.21	952.00	948.09	948.09
952.40	0.22	952.40	948.21	948.21

Composite Outlet Structure Detailed Report: Composite Outlet Structure

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

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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)
952.50	0.21	952.50	948.37	948.37
953.00	0.14	953.00	951.32	951.32
953.50	0.00	953.50	953.50	953.50
954.00	0.00	954.00	954.00	954.00
954.50	0.00	954.50	954.50	954.50
955.00	0.00	955.00	955.00	955.00
955.50	0.00	955.50	955.50	955.50
956.00	0.00	956.00	956.00	956.00

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
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 =.42
H =.92

Composite Outlet Structure Detailed Report: Composite Outlet Structure

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

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

Message
H =1.42
H =1.92
H =2.02
H =2.31
H =2.75
H =3.21
H =3.49
H =3.17
H =3.03
H =3.27
H =3.58
H =3.91
H =4.19
H =4.13
H =1.68
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Outlet Structure	
Outlet Structure Type	Orifice

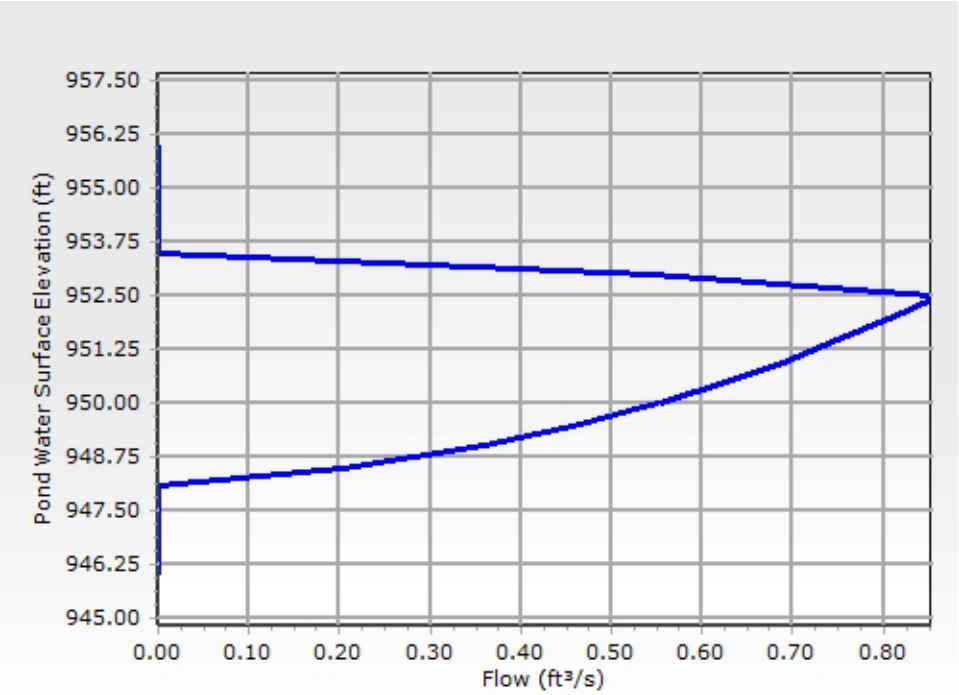
Outlet Structure (IDs and Direction)			
Outlet ID	2YR	Downstream ID	CULVERT
Flow Direction	Forward Flow Only	Notes	

Composite Outlet Structure Detailed Report: Composite Outlet Structure

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	4.0 in

Outlet Structure (Common)	
Elevation	948.10 ft



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

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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)
946.00	0.00	0.00	0.00	0.00
946.50	0.00	0.00	0.00	946.02
947.00	0.00	0.00	0.00	0.00
947.50	0.00	0.00	0.00	0.00

Composite Outlet Structure Detailed Report: Composite Outlet Structure

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

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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)
948.00	0.00	0.00	0.00	946.08
948.10	0.00	0.00	0.00	0.00
948.50	0.20	948.50	Free Outfall	946.19
949.00	0.36	949.00	Free Outfall	946.25
949.50	0.47	949.50	Free Outfall	946.29
949.80	0.52	949.80	Free Outfall	946.31
950.00	0.55	950.00	Free Outfall	946.83
950.50	0.63	950.50	Free Outfall	947.47
951.00	0.69	951.00	Free Outfall	947.73
951.50	0.76	951.50	Free Outfall	947.92
952.00	0.81	952.00	Free Outfall	948.09
952.40	0.85	952.40	948.21	948.21
952.50	0.85	952.50	948.37	948.37
953.00	0.55	953.00	951.32	951.32
953.50	0.00	953.50	953.50	953.50
954.00	0.00	954.00	954.00	954.00
954.50	0.00	954.50	954.50	954.50
955.00	0.00	955.00	955.00	955.00
955.50	0.00	955.50	955.50	955.50
956.00	0.00	956.00	956.00	956.00

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/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

Composite Outlet Structure Detailed Report: Composite Outlet Structure

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

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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

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.
WS below an invert; no flow.
H =.23
H =.73
H =1.23
H =1.53
H =1.73
H =2.23
H =2.73
H =3.23
H =3.73
H =4.13
H =4.13
H =1.68
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Composite Outlet Structure Detailed Report: Composite Outlet Structure

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

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

Message
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Outlet Structure	
Outlet Structure Type	Orifice

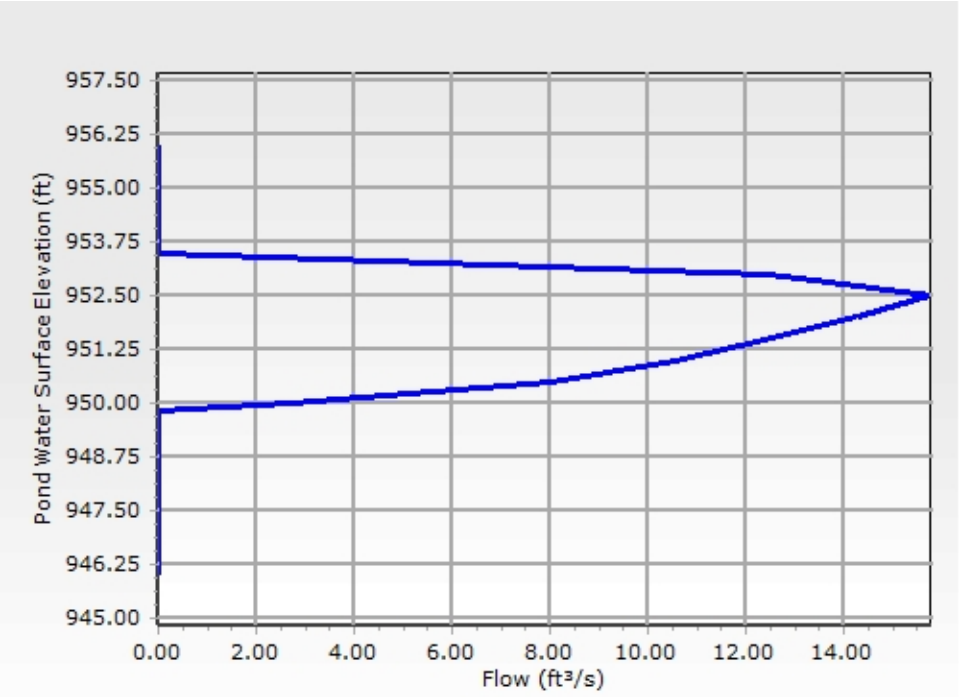
Outlet Structure (IDs and Direction)			
Outlet ID	10YR	Downstream ID	CULVERT
Flow Direction	Forward Flow Only	Notes	

Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Orifice)			
Orifice	Area Orifice	Orifice Orientation	Perpendicular Orifice
Number of Openings	1	Datum Elevation	949.80 ft
Orifice Coefficient	0.600	Top Elevation	950.30 ft
Orifice Area	2.00 ft²		

Outlet Structure (Common)	
Elevation	949.80 ft

Composite Outlet Structure Detailed Report: Composite Outlet Structure



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 10YR (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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)
946.00	0.00	0.00	0.00	0.00
946.50	0.00	0.00	0.00	946.02
947.00	0.00	0.00	0.00	0.00
947.50	0.00	0.00	0.00	0.00
948.00	0.00	0.00	0.00	946.08
948.10	0.00	0.00	0.00	0.00
948.50	0.00	0.00	0.00	946.19
949.00	0.00	0.00	0.00	946.25
949.50	0.00	0.00	0.00	946.29
949.80	0.00	0.00	0.00	946.31
950.00	2.72	950.00	Free Outfall	946.83
950.50	8.05	950.50	Free Outfall	947.47
951.00	10.54	951.00	Free Outfall	947.73
951.50	12.55	951.50	Free Outfall	947.92
952.00	14.28	952.00	Free Outfall	948.09
952.40	15.52	952.40	Free Outfall	948.21

Composite Outlet Structure Detailed Report: Composite Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 10YR (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = CULVERT (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)
952.50	15.82	952.50	Free Outfall	948.37
953.00	12.49	953.00	951.32	951.32
953.50	0.00	953.50	953.50	953.50
954.00	0.00	954.00	954.00	954.00
954.50	0.00	954.50	954.50	954.50
955.00	0.00	955.00	955.00	955.00
955.50	0.00	955.50	955.50	955.50
956.00	0.00	956.00	956.00	956.00

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/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
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.

Composite Outlet Structure Detailed Report: Composite Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 10YR (Orifice-Area)

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

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.
WS below an invert; no flow.
WS below an invert; no flow.
Hi=.20; Ht=.50; Qt=6.81
H =.70
H =1.20
H =1.70
H =2.20
H =2.60
H =2.70
H =1.68
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Composite Outlet Structure Detailed Report: Composite Outlet Structure

Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
946.00	0.00	(N/A)	0.00
946.50	0.07	(N/A)	0.00
947.00	0.10	(N/A)	0.00
947.50	0.12	(N/A)	0.00
948.00	0.15	(N/A)	0.00
948.10	0.15	(N/A)	0.00
948.50	0.36	(N/A)	0.00
949.00	0.53	(N/A)	0.00
949.50	0.65	(N/A)	0.00
949.80	0.72	(N/A)	0.00
950.00	3.46	(N/A)	0.00
950.50	8.86	(N/A)	0.00
951.00	11.43	(N/A)	0.00
951.50	13.50	(N/A)	0.00
952.00	15.29	(N/A)	0.00
952.40	16.59	(N/A)	0.00
952.50	18.39	(N/A)	0.00
953.00	35.49	(N/A)	0.00
953.50	44.04	(N/A)	0.00
954.00	45.78	(N/A)	0.00
954.50	47.45	(N/A)	0.00
955.00	49.05	(N/A)	0.00
955.50	50.62	(N/A)	0.00
956.00	52.14	(N/A)	0.00

Contributing Structures
(no Q: 2YR,10YR,4'X4' RISER,WQ,CULVERT)
WQ,CULVERT (no Q: 2YR,10YR,4'X4' RISER)
WQ,CULVERT (no Q: 2YR,10YR,4'X4' RISER)
WQ,CULVERT (no Q: 2YR,10YR,4'X4' RISER)
WQ,CULVERT (no Q: 2YR,10YR,4'X4' RISER)
WQ,CULVERT (no Q: 2YR,10YR,4'X4' RISER)
2YR,WQ,CULVERT (no Q: 10YR,4'X4' RISER)
2YR,WQ,CULVERT (no Q: 10YR,4'X4' RISER)
2YR,WQ,CULVERT (no Q: 10YR,4'X4' RISER)
2YR,WQ,CULVERT (no Q: 10YR,4'X4' RISER)

Composite Outlet Structure Detailed Report: Composite Outlet Structure

Composite Rating Table
Tailwater Elevation = Free Outfall (Composite Outlet Structure)

Contributing Structures
2YR,10YR,WQ,CULVERT (no Q: 4'X4' RISER)
2YR,10YR,WQ,CULVERT (no Q: 4'X4' RISER)
2YR,10YR,WQ,CULVERT (no Q: 4'X4' RISER)
2YR,10YR,WQ,CULVERT (no Q: 4'X4' RISER)
2YR,10YR,WQ,CULVERT (no Q: 4'X4' RISER)
2YR,10YR,WQ,CULVERT (no Q: 4'X4' RISER)
2YR,10YR,4'X4' RISER,WQ,CULVERT
2YR,10YR,4'X4' RISER,WQ,CULVERT
4'X4' RISER,CULVERT (no Q: 2YR,10YR,WQ)
4'X4' RISER,CULVERT (no Q: 2YR,10YR,WQ)
4'X4' RISER,CULVERT (no Q: 2YR,10YR,WQ)
4'X4' RISER,CULVERT (no Q: 2YR,10YR,WQ)
4'X4' RISER,CULVERT (no Q: 2YR,10YR,WQ)
4'X4' RISER,CULVERT (no Q: 2YR,10YR,WQ)

Composite Outlet Structure Detailed Report: Composite Outlet Structure

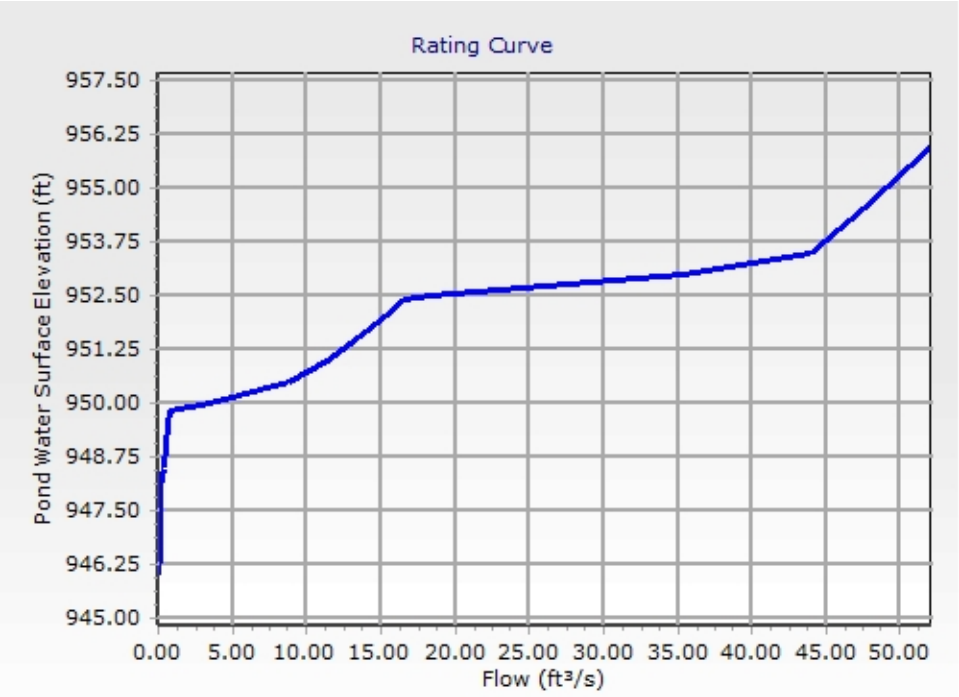
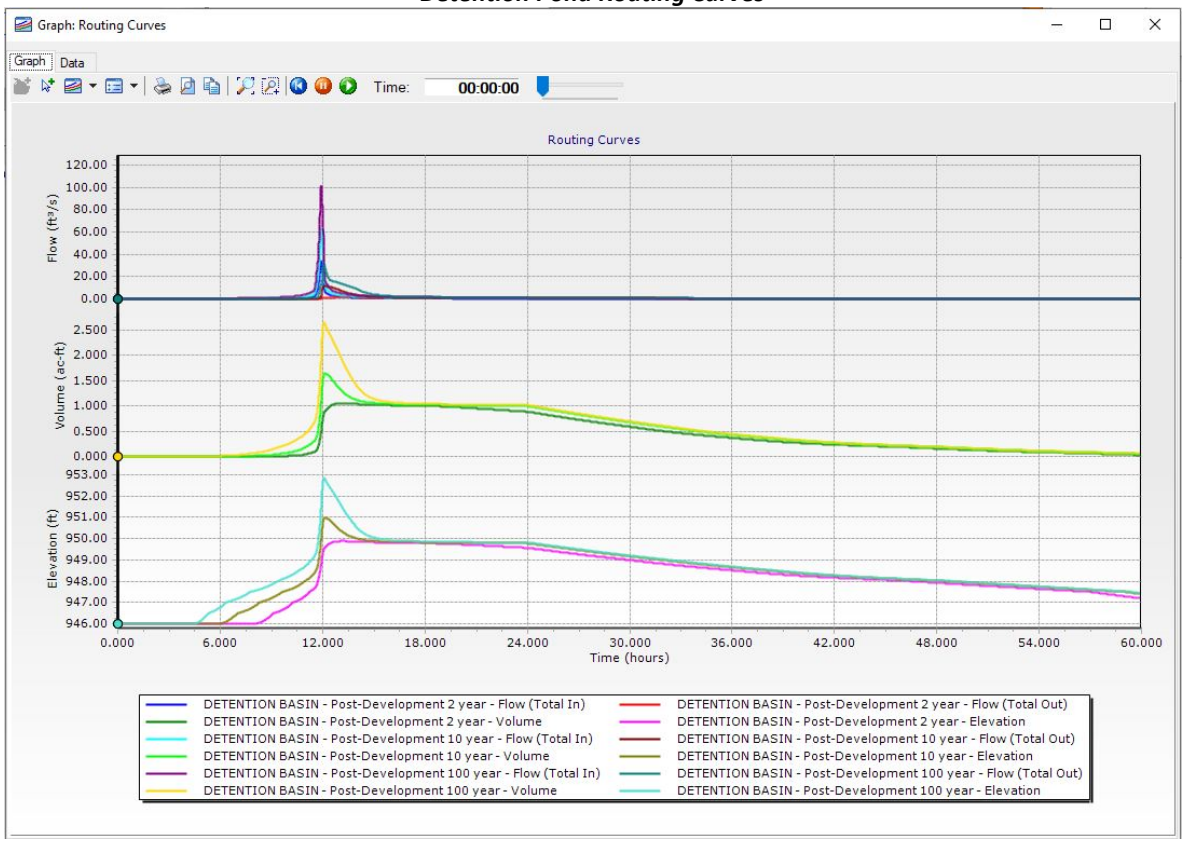


Figure G – Routing Curves for all Design Storms

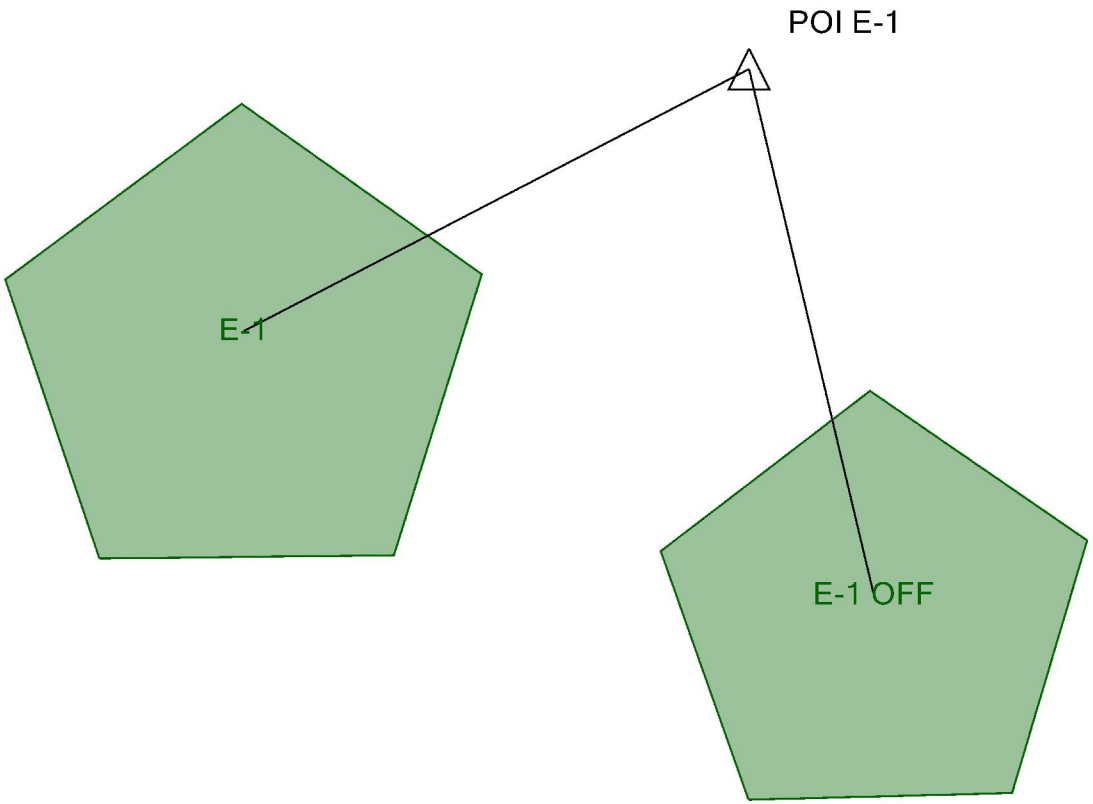
Detention Pond Routing Curves



Hg Consult Inc engineers planners

Figure H –
Pondpack Master Summary
(Pre-Developed and Post-Developed)

Scenario: Pre-Development



Colton's Crossing 1st Plat Pre-Developed

Project Summary	
Title	Colton's Crossing 1st Plat Pre-Developed
Engineer	Richard Michael
Company	Hg Consult, Inc
Date	6/4/2025

Notes

Table of Contents

Colton's Crossing 1st Plat Pre-Developed

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
E-1	Pre-Development 2 year	2	1.517	11.930	27.95
E-1	Pre-Development 10 year	10	3.188	11.920	60.13
E-1	Pre-Development 100 year	100	5.699	11.920	107.22
E-1 OFF	Pre-Development 2 year	2	0.389	11.930	7.16
E-1 OFF	Pre-Development 10 year	10	0.817	11.920	15.40
E-1 OFF	Pre-Development 100 year	100	1.460	11.920	27.46

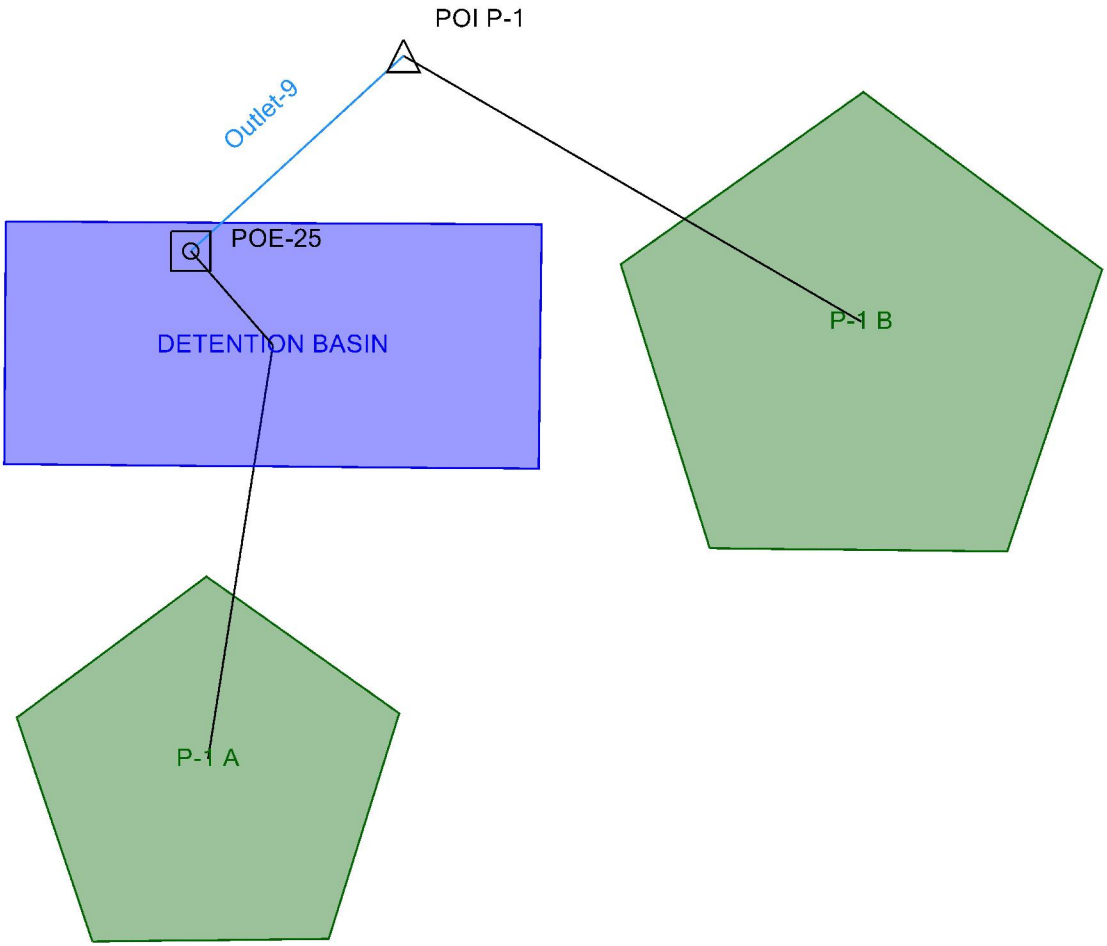
Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
POI E-1	Pre-Development 2 year	2	1.905	11.930	35.11
POI E-1	Pre-Development 10 year	10	4.004	11.920	75.53
POI E-1	Pre-Development 100 year	100	7.158	11.920	134.68

Colton's Crossing 1st Plat Pre-Developed

Index

Scenario: Post-Development



Colton's Crossing 1st Plat Post-Developed

Project Summary	
Title	Colton's Crossing 1st Plat Post-Developed
Engineer	Richard Michael
Company	Hg Consult, Inc
Date	6/4/2025

Notes

Table of Contents

Colton's Crossing 1st Plat Post-Developed

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
P-1 B	Post-Development 2 year	2	0.342	11.930	6.38
P-1 B	Post-Development 10 year	10	0.699	11.920	13.19
P-1 B	Post-Development 100 year	100	1.226	11.920	22.97
P-1 A	Post-Development 2 year	2	1.807	11.920	34.14
P-1 A	Post-Development 10 year	10	3.352	11.920	62.68
P-1 A	Post-Development 100 year	100	5.535	11.920	101.36

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
POI P-1	Post-Development 2 year	2	2.115	11.930	6.87
POI P-1	Post-Development 10 year	10	3.997	12.010	20.73
POI P-1	Post-Development 100 year	100	6.704	12.040	41.91

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
DETENTION BASIN (IN)	Post-Development 2 year	2	1.807	11.920	34.14	(N/A)	(N/A)
DETENTION BASIN (OUT)	Post-Development 2 year	2	1.773	13.180	1.85	949.88	1.049
DETENTION BASIN (IN)	Post-Development 10 year	10	3.352	11.920	62.68	(N/A)	(N/A)
DETENTION BASIN (OUT)	Post-Development 10 year	10	3.299	12.140	11.38	950.99	1.641

Colton's Crossing 1st Plat Post-Developed

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 BASIN (IN)	Post-Development 100 year	100	5.535	11.920	101.36	(N/A)	(N/A)
DETENTION BASIN (OUT)	Post-Development 100 year	100	5.478	12.090	30.78	952.86	2.653

Colton's Crossing 1st Plat Post-Developed

Index

Colton's Crossing 1st Plat Post-Developed w/ Primary Outlet Clogged

Project Summary	
Title	Colton's Crossing 1st Plat Post-Developed w/ Primary Outlet Clogged
Engineer	Richard Michael
Company	Hg Consult, Inc
Date	6/4/2025

Notes

Table of Contents

Colton's Crossing 1st Plat Post-Developed w/ Primary Outlet Clogged

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
P-1 A	Post-Development 100 year	100	241,102.000	11.920	101.36
P-1 B	Post-Development 100 year	100	53,383.000	11.920	22.97

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)
POI P-1	Post-Development 100 year	100	279,316.000	11.960	105.73

Pond Summary

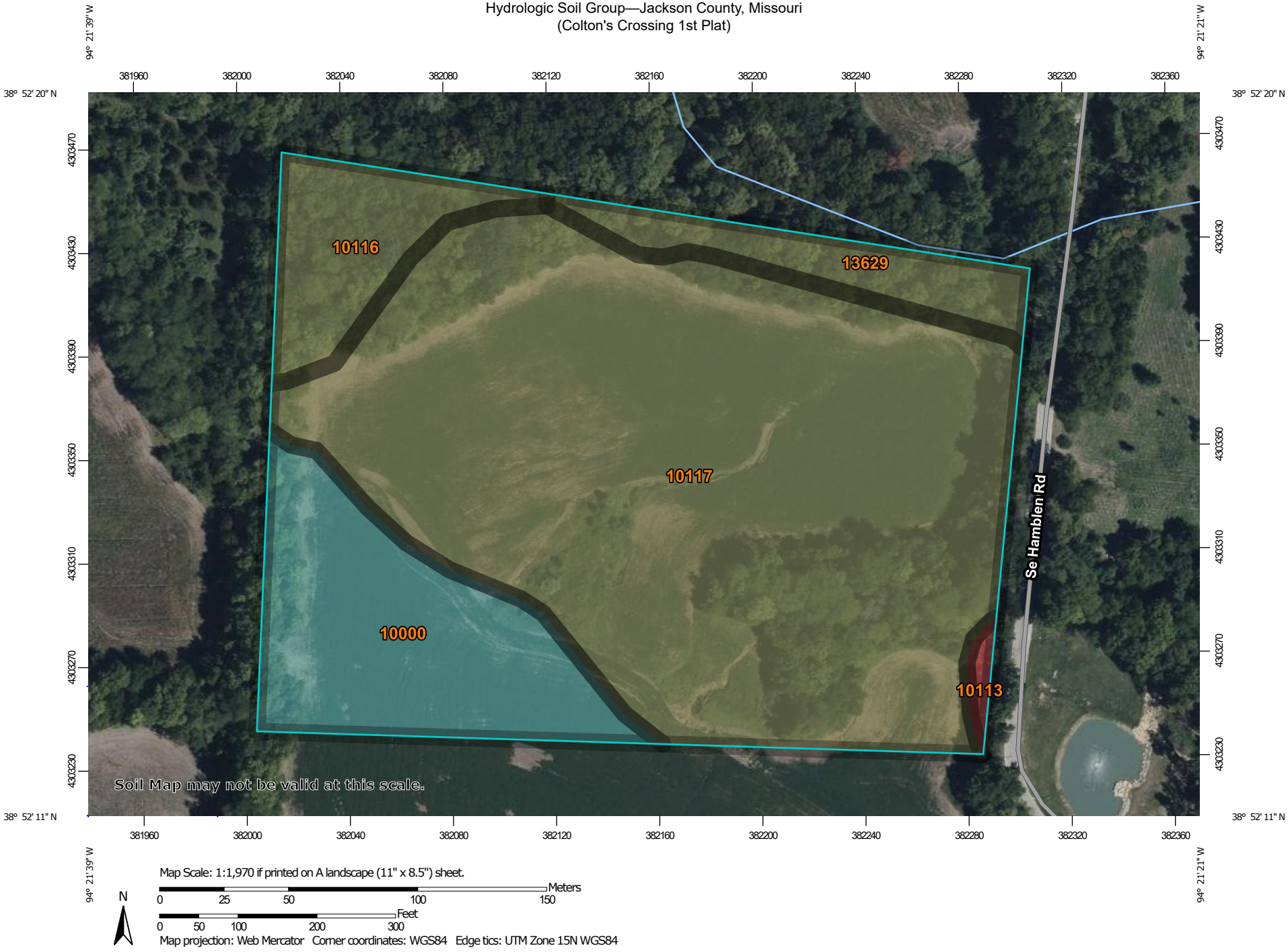
Label	Scenario	Return Event (years)	Hydrograph Volume (ft³)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ft³)
DETENTION BASIN (IN)	Post-Development 100 year	100	241,102.000	11.920	101.36	(N/A)	(N/A)
DETENTION BASIN (OUT)	Post-Development 100 year	100	225,933.000	11.980	85.59	954.75	160,549.000

Colton's Crossing 1st Plat Post-Developed w/ Primary Outlet Clogged

Index

Figure I - Web Soil Survey

Hydrologic Soil Group—Jackson County, Missouri
(Colton's Crossing 1st Plat)



Map Scale: 1:1,970 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 27, Aug 27, 2024

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

Date(s) aerial images were photographed: Aug 30, 2022—Sep 8, 2022

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10000	Arisburg silt loam, 1 to 5 percent slopes	C	2.4	16.5%
10113	Oska silty clay loam, 5 to 9 percent slopes, eroded	D	0.1	0.6%
10116	Sampsel silty clay loam, 2 to 5 percent slopes	C/D	1.1	7.2%
10117	Sampsel silty clay loam, 5 to 9 percent slopes	C/D	10.3	69.8%
13629	Colo silt loam, 1 to 4 percent slopes, occasionally flooded	C/D	0.9	5.9%
Totals for Area of Interest			**14.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Figure I –
Stream Buffer Evaluation

HABITAT ARCHITECTS

MEMORANDUM

TO: HG Consult

FROM: Jonathan Polak, P.E. – Habitat Architects

DATE: September 29, 2022

RE: Colton's Crossing Development - Stream Buffer Setback Evaluation

---

Habitat Architects (***Habitat***) was contacted by HG Consult to complete an independent evaluation of applicable stream buffer setback requirements within the limits of the proposed Colton's Crossing Development. This evaluation was completed in accordance with the American Public Works Association (APWA) Section 5600 – Storm Drainage Systems and Facilities regulations and guidelines as adopted by the City of Lee's Summit, Jackson County, Missouri. The results of this evaluation are discussed in this memorandum and depicted on the attached graphics.

Field Evaluation

Habitat completed a field reconnaissance to identify and delineate water resources on the property (07/12/22). The field reconnaissance identified the project site as having one perennial tributary, known as Big Creek, traversing along the northern property boundary, and entering the property in two short segments. There were also four drainage features that exhibited ephemeral characteristics identified within the limits of the property. These characteristics include conveyance of hydrology, non-continuous flow, dependent upon direct precipitation event, and no groundwater influence.

These four drainages were similarly compared to the common features of stream geometry and characteristics as presented in APWA Section 5600, Subsection 5605, Figures 5605–1 through 5606-3. As mapped on the attached graphics, these drainages are each located within woodland corridors adjacent to farmed agricultural activities along the southern and western limits of the property. A brief description of each of the drainages are provided below:

3904 East 185th Street
Belton, MO 64012
(816) 645-0026
www.habitatarchitects.net

Perennial Tributary

The perennial tributary found on the property, Big Creek, enters the property in two separate locations along the northern property boundary. The two locations are meanders in the tributary which only encroach on the property a few feet. There is a total of 151 linear feet (L.F.) of tributary that lie within the limits of the property. As noted during the field reconnaissance, Big Creek is approximately 25 feet wide at the ordinary high-water mark (OHM) with a bed composition made up of a mixture of silt and rock substrate. Big Creek maintains a base flow and exhibits a differentiation between a low flow channel and a bank full width. The tributary also has varying riffle/pool structures along its alignment.

Ephemeral Drainage 1 (E-1)

E-1 is an ephemeral drainage in the very northwest corner of the property where it traverses toward the northeast and eventually leaves the property and discharges into Big Creek north of the property boundary. The drainage only averages approximately 3 feet in width at the OHM and traverses approximately 511 L.F. of the northwest corner of the property. There is no base flow within the channel from a contributing groundwater or upland source. There is no channel characteristics such as riffles, pools, or sediment bars present within the narrow base width. The drainage exhibits erosive characteristic rather than traditional tributary or stream features.

Ephemeral Drainage 2 (E-2)

E-2 is an ephemeral drainage located in the southwest corner of the property where it originates in an existing wooded corridor. Similar to E-1, the drainage only averages approximately 3 feet in width at the OHM and traverses approximately 665 L.F. of the property before discharging off the property. The base of the drainage has an excessive amount of broken glass that appears to have been from previous dumping activities over several years. Below the glass the base is entirely comprised of soil with very little stone or rock present, indicative of erosive conditions likely attributable to the adjacent farming activities. There is no base flow within the channel from a contributing groundwater or upland source. There is no channel characteristics such as riffles, pools, or sediment bars present within the narrow base width.

Ephemeral Drainage 3 (E-3)

E-3 is a small ephemeral drainage, approximately 1 foot in width at the OHM. The drainage is located along the southern property boundary which originates from a visible erosive drainage within the adjacent agricultural field to the north. The drainage traverses approximately 223 L.F. of the property before existing the southern boundary.

3904 East 185th Street
Belton, MO 64012
(816) 645-0026
www.habitatarchitects.net

There is no base flow within the channel from a contributing groundwater or upland source. There is no channel characteristics such as riffles, pools, or sediment bars present within the narrow 1-foot base width. As noted, the drainage appears to be a continuation of the erosive characteristic from the adjacent field rather than a traditional tributary or stream feature.

Ephemeral Drainage 4 (E-4)

E-4 is the last ephemeral drainage identified during the field reconnaissance and is located in a wooded corridor in the southern portion of the property. The drainage originates just north of the tree line from an erosive drainage coming off the adjacent agricultural field. The drainage exhibits similar erosive characteristics and averages approximately 4 feet in width at the OHM. The drainage traverses approximately 297 L.F. before exiting the property through the southern boundary. There is no base flow within the channel from a contributing groundwater or upland source. As the widest base width of the four drainages, there are signs of sediment deposition along the alignment; however, there are no typical stream or tributary characteristics such as riffles, pools, or a traditional meander sequence within the short section of drainage located on the property.

Design Guidelines and Desktop Review

A desktop review and stream buffer evaluation of the water resources identified on the property were performed consistent with APWA Section 5600, subsection 5605 Natural Streams. The guidance addressed by this evaluation includes the following criteria.

> ***SECTION 5605 NATURAL STREAMS***
>
> ***5605.1 Scope***
>
> *This section sets forth requirements for the protection of natural streams as a conveyance for stormwater. Unless otherwise provided for by City, State, or Federal ordinance, regulation, or standards, existing natural streams shall be preserved and protected in accordance with this section. Where natural streams are not preserved, the drainage will be handled through systems designed in accordance with Sections 5606 and 5607.*
>
> ***5605.3 Stream Preservation and Buffers Zones***
>
> ***B. Default Approach:*** *Where such comprehensive strategies have not been adopted, the following requirements shall be satisfied for all development/redevelopment proposed adjacent to or ultimately discharging to an existing natural channel:*

3904 East 185th Street
Belton, MO 64012
(816) 645-0026
www.habitatarchitects.net

1. *Streams having a tributary area in excess of 40 acres shall be preserved. Preservation of smaller streams is encouraged. Preservation may be waived by the City/County Engineer where it is impractical, provided that the project has also received appropriate state and federal permits.*

2. *Buffer zones shall be established around all preserved streams. The limit of buffer zones shall be formally designated on a plat, deed, easement, or restrictive covenant, as directed by the City. Buffer widths as measured from the ordinary high-water mark (OHM) outward in each direction shall exceed the dimensions shown in Table 5605-1.*

Table 5605-1: Stream Buffer Widths

Contributing Drainage Basin Size (acres)	Buffer Width*
Less than 40 acres	40 Feet
40 acres to 160 acres	60 Feet
160 acres to 5000 acres	100 Feet
Greater than 5000 acres	120 Feet

*Measured from OHM outwards, measured separately in each direction

The perennial tributary (Big Creek) and the four ephemeral drainages on site were evaluated to determine drainage basin size. The results of the desktop evaluation are presented below.

Results

The evaluation for the contributing basin size of each tributary and drainage found on the property identified that Big Creek requires a buffer width of 100 feet due to it having a contributing water shed size of approximately 1,700 acres. The remaining drainages on the property (E-1, E-2, E-3, and E-4) all had contributing basin sizes between 8-11 acres. These basin sizes are well below the 40-acre threshold required for buffering. These drainages, although they do convey stormwater from the property, do not exhibit the general characteristics of a stream and tributary as defined in Section 5605 of the APWA guidance. Their respective size and continued erosive characteristics from adjacent agricultural practices contribute to minimal if not negative impacts to water quality due to soil loss within the drainage.

3904 East 185th Street
Belton, MO 64012
(816) 645-0026
www.habitatarchitects.net

Recommendations

Habitat recommends the placement of a 100-foot buffer along Big Creek, especially those portions that encroach on the property. The remaining four ephemeral drainages do not require a stream setback or stream buffer preservation based on the APWA guidance; however, changes in the discharge of stormwater as it relates to future development and the removal of the existing drainages should be designed in accordance with APWA Section 5606 and 5607.

Furthermore, all potential impacts to either the ephemeral drainages or elements of Big Creek would require permitting with the U.S. Army Corps of Engineers due to the presence of water resources on the site.

Please contact me at (913) 526-5085 or by email at jpolak@habitatarchitects.net if you have any questions concerning the evaluation results.

Sincerely,

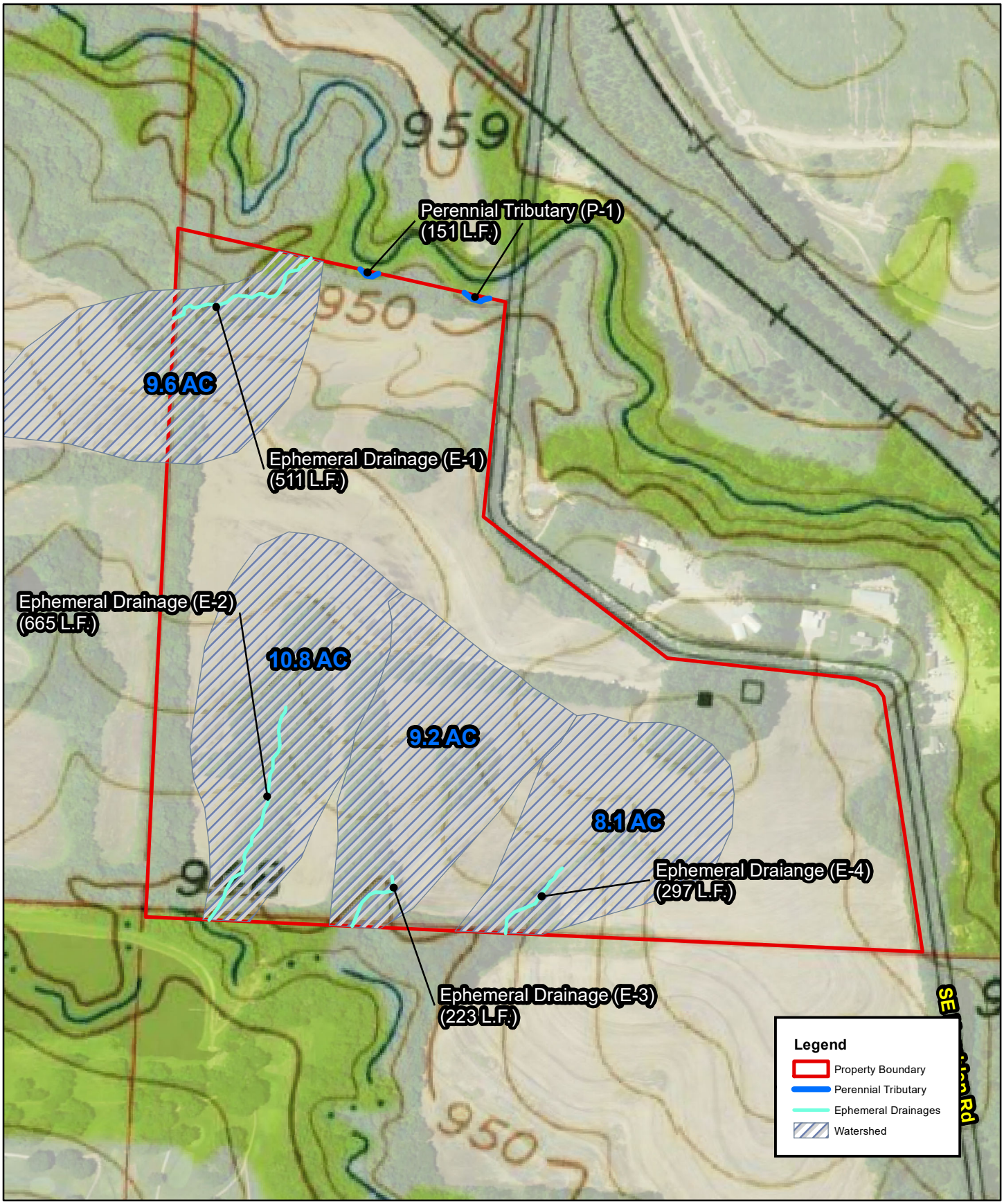
Jonathan L. Polak, P.E.
Environmental Engineer

Enclosures: Watershed Map
Stream Buffer Setback Map

References:

Kansas City Metropolitan Chapter, American Public Works Association, Standard Specifications & Design Criteria, Section 5600 -Storm Drainage Systems & Facilities, February 16, 2011.

3904 East 185th Street
Belton, MO 64012
(816) 645-0026
www.habitatarchitects.net



NORTH

0 200 400

1 in. = 400 ft.

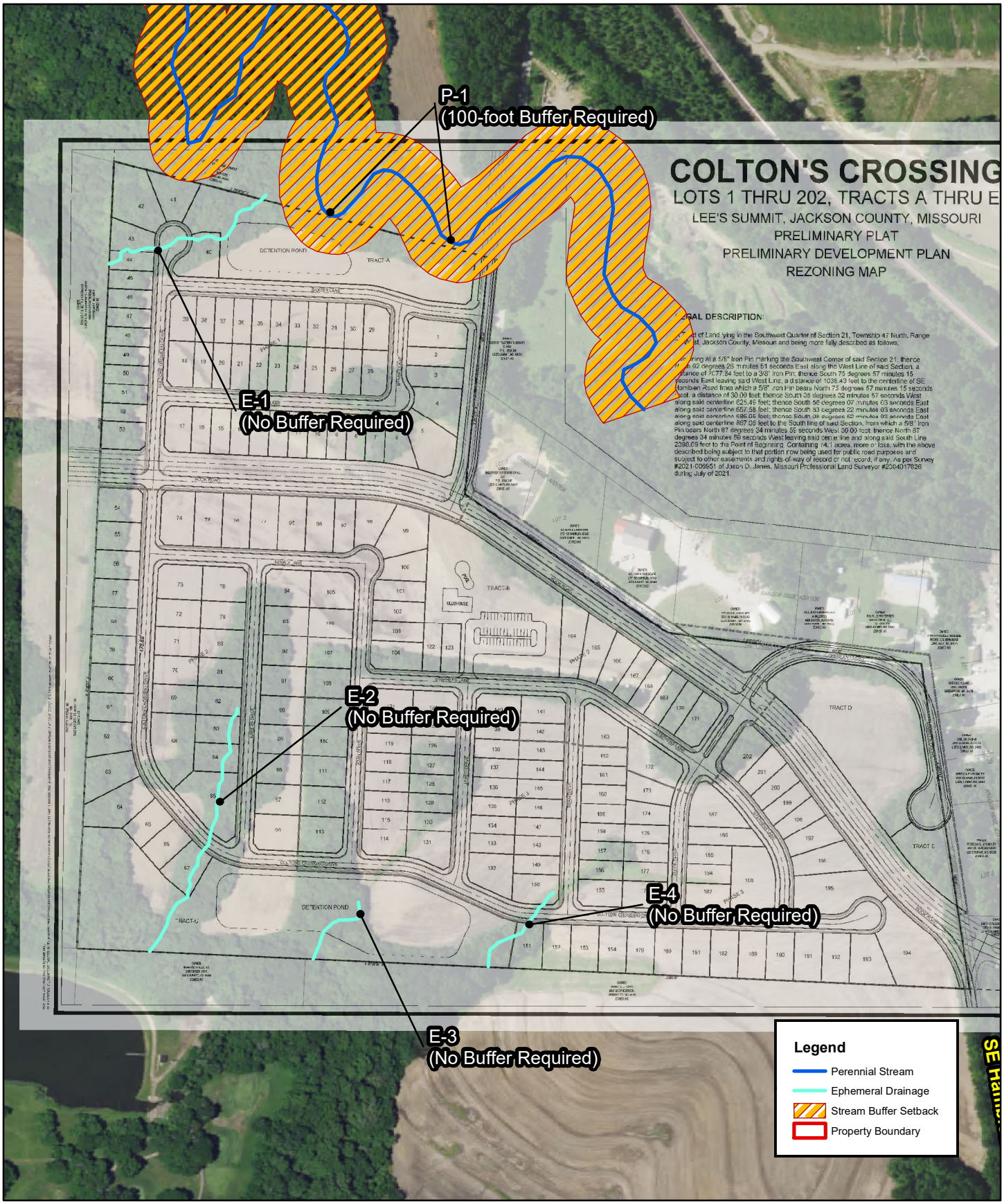
Source: NAIP 2020
Location: SW 1/4 of Sec 21 - T47N - R31W
Lee's Summit, Jackson County, MO
Pleasant Hill, MO 1:24K Quadrangle

WATERSHED MAP

COLTON'S CROSSING DEVELOPMENT
LEE'S SUMMIT, MISSOURI

HABITAT ARCHITECTS

Note: Watershed areas were based on the USGS topographic map contours. The watershed basim for Big Creek is not depicted due to scale and broader inclusion of the northern half of the project area.



NORTH

0 175 350

1 in. = 350 ft.

Source: NAIP 2020
Location: SW 1/4 of Sec 21 - T47N - R31W
Lee's Summit, Jackson County, MO
Pleasant Hill, MO 1:24K Quadrangle

STREAM BUFFER SETBACK

COLTON'S CROSSING DEVELOPMENT
LEE'S SUMMIT, MISSOURI

HABITAT ARCHITECTS