Preliminary Stormwater Management Study

Colton's Crossing
Prepared for Hamblen Road Project, LLC
705 B Melody Lane
Lee's Summit, MO 64063

City of Lee's Summit Project No. PL2022217
HG Consult Project No. 21.018

Prepared by Matthew Castor
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11/13/2022

HG Consult Inc engineers planners

I. Table of Contents

II. General Information

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

The Colton's Crossing Subdivision will consist of the development of a parcel, currently zoned AG, located along SE Hamblen Road directly Northeast of Shamrock Hills Golf Club. The site is currently vacant and being used as farmland.

The proposed use of the site will be Single Family residences and duplexes. The site will also include a clubhouse, swimming pool, and a parking lot to access these amenities.

Figure II.A.1 – 2021 Aerial Photo of the project site

Figure II.A.2 – 2021 Aerial Photo of the project site

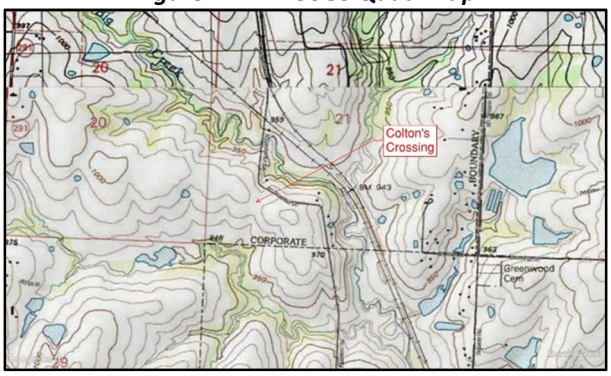
B. General Overview of Drainage Patterns

The project site is divided into several drainage areas due to an existing ridge that divides the property and the existing alignment of SE Hamblen Road.

Water that is North of the ridge is collected in several creeks/ravines and routed approximately 600 feet to a box culvert at SE Hamblen Road. The box culvert allows Big Creek to carry water under SE Hamblen Road.

Water that is South of the ridge is collected in several creeks/ravines and routed to a small tributary immediately South of the property line. From there the water is carried in the tributary South and East to Big Creek (for 1.0 mile).

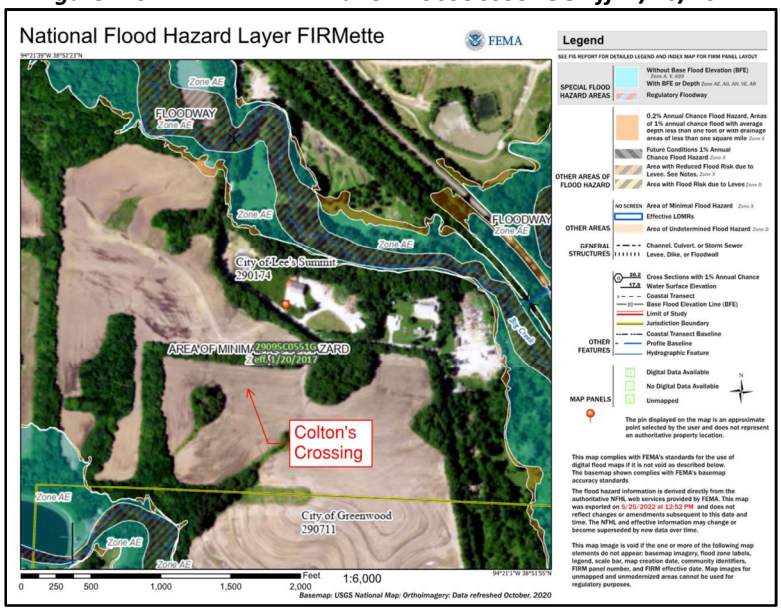
Figure II.B.1 – USGS Quad Map



C. FEMA Classification / Floodplain Issues

The Site is located primarily within a Zone X with a small portion being located within a Zone AE as represented in the NE and SW. 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 I of this report is a Stream Buffer Evaluation.

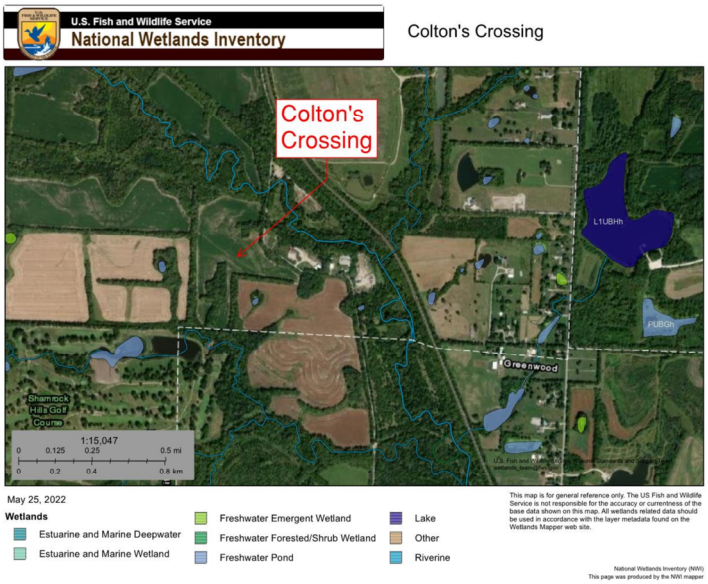
Figure II.C.1 – FEMA FIRM Panel #29095C0551GG Eff. 1/20/2017



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 by 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 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
10142	Snead-Rock outcrop	5-14%	D
13629	Colo silt loam	1-4%	C/D
30080	Greenton silty clay loam	5-9%	C/D

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

III. Methodology

A. Unit Hydrograph Modeling Methods

The method for evaluating Colton's Crossing was with the use of PondPack V8i. 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 Arisburg silt loam and Sampsel silty clay with a hydrologic group of C. The site has steep grades around the boundary, tree lines, and existing ravine areas with moderate grades everywhere else. Cover is low as its current use is farmland. The APWA default strategy was used to provide comprehensive protection. The APWA default strategy reads as follow:

> *"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 appendix (Pre-Developed Drainage Area Map) for all drainage areas and outfall location. See Table IV.B.1 for summary of On-Site/Off-Site Areas.

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

Drainage Area	Total Area (acres)
E-1A	0.74
E-1B	5.55
E-1C	12.10
E-2A	14.82
E-2B	11.78
E-2C	9.85
E-2D	0.80
E-3	1.44
E-4	5.22
E-5	3.97
E-6	4.81

C. Description of Each Drainage Area

E-1 (A-C): These areas all occur on the North side of the site with slopes ranging from 2-15%. These areas drain North in natural ravines/creeks and then routed approximately 600 feet into Big Creek.

E-2 (A-D): These areas all occur on the South side of the site with slopes ranging from 2-20%. These areas drain South in natural ravines/creeks and then routed to a small tributary immediately South of the property line. From there the water is carried in the tributary South and East to Big Creek (for 1.0 mile).

E-3: A small area located in the SE quadrant of the site with slopes ranging from 3-10%. This area drains East towards SE Hamblen Road to the POI (18" CMP). After leaving the 18" CMP the water flows East to Big Creek (for 0.09 mile).

E-4: An area located on the Eastern boundary of the site with slopes ranging from 2-15%. Most of this area drains East to a small pond (area of standing water). As the water level rises in the pond, it is then released and flows East towards SE Hamblen Road to the POI (18" RCP). After leaving the 18" RCP the water flows East to Big Creek (for 0.07 mile).

E-5: An area located on the Eastern boundary of the site with SE Hamblen Road as the Northern boundary. The slopes in this area range from 1-10%. This area drains East towards SE Hamblen Road to the POI (24" CMP). After leaving the 24" CMP the water flows East to Big Creek (for 0.11 mile).

E-6: An area located in the center of the site with slopes ranging from 2-20%. This area drains North towards SE Hamblen Road to the POI (28"x42" CMP). After leaving the 28"x42" CMP the water flows North into a small pond. The pond discharges Northeast to Big Creek (for 0.05 mile).

D. Table Summarizing Input Data

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

Sub-Area Name	Area	CN	TOC (min)
E-1A	0.74	74	5
E-1B	5.55	74	5
E-1C	12.10	74	5
E-2A	14.82	74	5
E-2B	11.78	74	5
E-2C	9.85	74	5
E-2D	0.80	74	5
E-3	1.44	74	5
E-4	5.22	74	5
E-5	3.97	74	5
E-6	4.81	74	5

E. Table Summarizing Peak Runoff Rates

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

Sub-Area Name	Q (cfs)
E-1A	5.40
E-1B	40.54
E-1C	88.37
E-2A	108.24
E-2B	86.04
E-2C	71.94
E-2D	5.84
E-3	10.52
E-4	38.13
E-5	29.00
E-6	35.13

F. Table Summarizing "Allowable Release Rate"

Table IV.F.1 – Pre-Developed Allowable Peak Runoff Rate

Sub-Area Name	2-Year (cfs)	10-Year (cfs)	100-Year (cfs)
E-1 Total (E-1A+E-1B+E-1C)	9.20	36.78	55.17
E-2 Total (E-2A+E-2B+E-2C+E-2D)	18.63	74.50	111.75
E-3	0.72	2.88	4.32
E-4	2.61	10.44	15.66
E-5	1.99	7.94	11.91
E-6	2.41	9.62	14.43

Comprehensive values utilizing 0.5 cfs (2-YR), 2 cfs (10-YR), and 3 cfs (100-YR) per site acre

V. Proposed Conditions Analysis

A. Proposed Drainage Area Map

See appendix (Post-Developed Drainage Area Map) for all on-site and off-site areas and outfall locations for each drainage area. See Table IV.A.1 for more detailed information.

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

Drainage Area	Total Area (acres)
P-1A	12.96
P-1B	1.59
P-2A	43.37
P-2B	4.86
P-3	1.22
P-4	2.63
P-5	3.66
P-6	4.01

B. Narrative Description of All Proposed Drainage Areas

P-1 (A-B): A large area containing most of the developed site North of the Hook Road re-alignment. This area decreased from the existing condition of 18.39 acres (E-1A, E-1B, and E-1C) to the proposed condition of 14.55 acres (P-1A and P-1B). This area is divided into two sub-areas. Sub-area P-1A drains into the North pond which is designed to over-detain to account for P-1B which does not get routed through the pond. The P-1 POI is reduced below the allowable rates (Table IV.F.1) using the comprehensive values of 0.5, 2, and 3 cfs per developed drainage acre (2, 10, & 100-Year values respectively). The pond also meets the freeboard requirements for APWA. The CN value increased from 74 to 83 for single family areas per APWA 5602.3.

P-2 (A-B): A large area containing most of the developed site South of the Hook Road re-alignment. This area increased from the existing condition of 37.25 acres (E-2A, E-2B, E-2C, and E-2D) to the proposed condition of 48.23 acres (P-2A and P-2B). This area is divided into two sub-areas. Sub-area P-2A drains into the South pond which is designed to over-detain to account for P-2B which does not get routed through the pond. The P-2 POI is reduced below the allowable rates (Table IV.F.1) using the comprehensive values of 0.5, 2, and 3 cfs per developed drainage acre (2, 10, & 100-Year values respectively). The pond also meets the freeboard requirements for APWA. The CN value increased from 74 to 83 for single family areas per APWA 5602.3.

P-3: A small area located in the SE quadrant of the site. This area decreased from the existing condition to the proposed condition. Although not designed yet, the anticipated design of this area would force water to flow to the same outlet as the existing condition. The CN value increased from 74 to 83 for single family areas per APWA 5602.3.

P-4: An area located on the Eastern boundary of the site where the new cul-de-sac of Hamblen Court will be constructed. This area decreased from the existing condition to the proposed condition. Although not designed yet, the anticipated design of this area would force water to flow near the same outlet as the existing condition. The CN value increased from 74 to 83 for single family areas per APWA 5602.3.

P-5: An area located on the Eastern boundary of the site where the new alignment of Hamblen Court will be constructed. This area decreased from the existing condition to the proposed condition. Although not designed yet, the antici-

pated design of this area would force water to flow near the same outlet as the existing condition. The CN value increased from 74 to 83 for single family areas per APWA 5602.3.

P-6: An area located in the center of the site that accounts for the future underground storm system for the re-aligned Hook Road. This area decreased from the existing condition to the proposed condition. Although not designed yet, the anticipated design of this area would force water to flow near the same outlet as the existing condition. The CN value increased from 74 to 83 for single family areas per APWA 5602.3.

C. Table Summarizing Input Data

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

Sub-Area Name	Area	CN	TOC (min)
P-1A	12.96	83	5
P-1B	1.59	83	5
P-2A	43.37	83	5
P-2B	4.86	83	5
P-3	1.22	83	5
P-4	2.63	83	5
P-5	3.66	83	5
P-6	4.01	83	5

D. Table Summarizing Peak Runoff Rates

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

Sub-Area Name	**Q (cfs)**
P-1A (Pond In)	112.56
P-1A (Pond Out)	37.70
P-1B	13.81
P-1 Total (P-1A+P-1B)	46.71
P-2A (Pond In)	376.68
P-2A (Pond Out)	82.93
P-2B	42.21
P-2 Total (P-2A+P-2B)	110.54
P-3	10.60
P-4	22.84
P-5	31.79
P-6	34.83

E. Table Summarizing Allowable and Proposed Release Rates

Table V.E.3 – Post-Developed Allowable Peak Runoff Rate

Sub-Area Name	2-Year (cfs)	10-Year (cfs)	100-Year (cfs)
P-1 Total Allowable	9.20	36.78	55.17
P-1 Total Proposed	9.10	29.51	46.71
P-1 Total Difference	**0.10**	**7.27**	**8.46**
P-2 Total Allowable	18.63	74.50	111.75
P-2 Total Proposed	18.63	65.47	110.54
P-2 Total Difference	**0.00**	**9.03**	**1.21**
P-3 Allowable	0.61	2.44	3.66
P-3 Proposed	3.57	6.55	10.60
P-3 Difference	**2.96**	**4.11**	**6.94**
P-4 Allowable	1.32	5.26	7.89
P-4 Proposed	7.69	14.12	22.84
P-4 Difference	**6.37**	**8.86**	**14.95**
P-5 Allowable	1.83	7.32	10.98
P-5 Proposed	10.71	19.66	31.79
P-5 Difference	**8.88**	**12.34**	**20.81**
P-6 Allowable	2.00	8.02	12.03
P-6 Proposed	11.73	21.54	34.83
P-6 Difference	**9.73**	**13.52**	**22.80**

F. Tables Summarizing Detention/Retention Input Data and Results

Table V.F.1 –North Pond Input Data

	ELEV
30" Culvert (Upstream Invert)	949.40
1.75" Orifice (WQ)	949.50
.4'x2' Orifice (2-Year)	951.60
.7'x5' Orifice (10-Year)	953.50
.4'x2' Orifice (100-Year)	954.60
5'x5' Riser (100-Year*)	956.50
Top of Pond	959.00

Table V.F.2 – North Pond Results

	2-Year	10-Year	100-Year	100-Year*
Allowable Discharge (cfs) P-1 Total	9.20	36.78	55.17	
Pond Discharge (cfs) P-1A	6.65	24.18	37.70	72.40
P-1B Discharge (cfs)	4.65	8.54	13.81	
Total Discharge (P-1)	9.10	29.51	46.71	
Difference	**0.10**	**7.27**	**8.46**	
Pond WSE	953.56	954.61	955.96	958.00
Top of Pond	959.00	959.00	959.00	959.00
Freeboard	**5.52**	**4.45**	**3.10**	**1.00**

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

Table V.F.3 –South Pond Input Data

	ELEV
48" Culvert (Upstream Invert)	948.40
3" Orifice (WQ)	948.50
0.5'x1.5' Orifice (2-Year)	951.25
1.0'x4.75' Orifice (10-Year & 100-Year)	953.50
6'x5' Riser (100-Year*)	956.75
500' Weir (100-Year*)	956.75
Top of Pond	958.25

Table V.F.4 – South Pond Results

	2-Year	10-Year	100-Year	100-Year*
Allowable Discharge (cfs) P-2 Total	18.63	74.50	111.75	
Pond Discharge (cfs) P-2A	5.86	52.94	82.93	368.56
P-2B Dishcarge (cfs)	14.22	26.10	42.21	
P-2 POI	18.63	65.47	110.54	
Difference (Allowable - P-2 POI)	**0.00**	**9.03**	**1.21**	
Pond WSE	953.48	954.53	956.25	957.11
Top of Pond	958.25	958.25	958.25	958.25
Freeboard	**4.77**	**3.72**	**2.00**	**1.14**

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

G. Undetained Drainage Areas

There are six areas within this development which are undetained. Explanations of each are below:

P-1 B: Sub-area P-1B is undetained due to elevation and grading constraints. When looking at the entirety of E-1 vs. P-1 the total acreage has been reduced. The north pond has been designed to over-detain to account for P-1B being un-detained. The P-1 POI is below the allowable for all storm events.

P-2B: Sub-area P-2B is undetained due to elevation and grading constraints. When looking at the entirety of E-2 vs. P-2 the total acreage has been increased. The south pond has been designed to over-detain to account for P-2B being un-detained. The P-2 POI is below the allowable for all storm events.

P-3: This area is undetained due to elevation and grading constraints. This area also accounts for a portion of the future Hook Road alignment storm system which will not be the responsibility of this development to detain. This area decreased from the existing condition to the proposed condition. The anticipated peak flows have increased by 0.08 cfs because of a higher CN value but there are no concerns with downstream effects. We would like to request a waiver from DCM for this fringe area.

P-4: This area is undetained due to elevation, grading, and location constraints. This area also accounts for portions of the future Hook Road & Hamblen Court alignment storm systems which will not be the responsibility of this development to detain. This area decreased from the existing condition to the proposed condition. The anticipated peak flows have decreased and there are no concerns with downstream effects.

P-5: This area is undetained due to elevation, grading, and location constraints. This area also accounts for portions of the future Hook Road & Hamblen Court alignment storm systems which will not be the responsibility of this development to detain. This area decreased from the existing condition to the proposed condition. The anticipated peak flows have increased by 2.28 cfs because of a higher CN value but there are no concerns with downstream effects.

P-6: This area is undetained because it accounts for the future Hook Road alignment storm system which will not be the responsibility of this development to detain. This area decreased from the existing condition to the proposed condition. The anticipated peak flows have decreased and there are no concerns with downstream effects.

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 extended dry detention with a 1.37" storm release over a 40-hour period.

I. Water Quality Summary

Figure V.I.1 – North Pond WQ Results

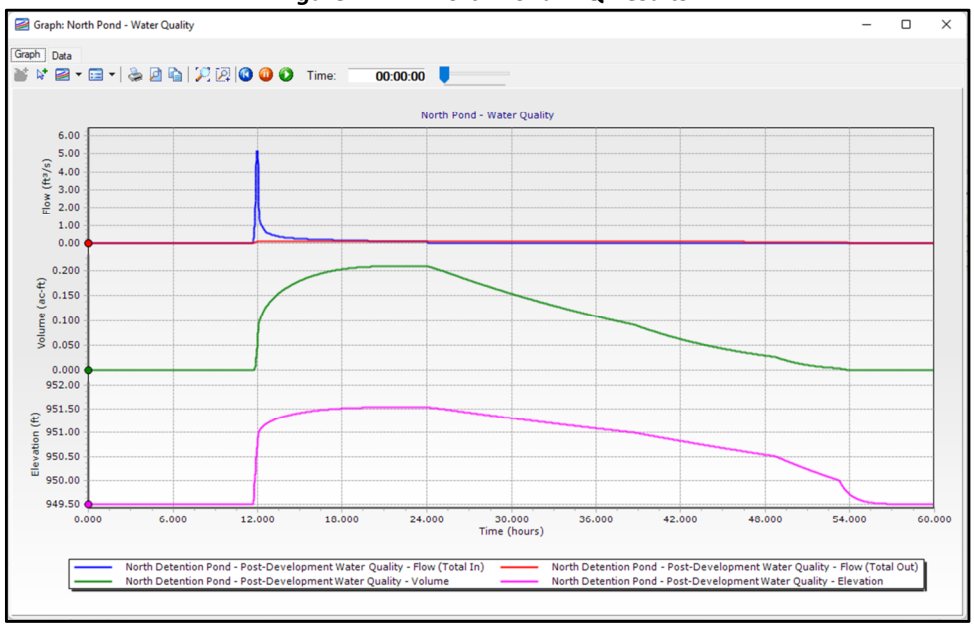
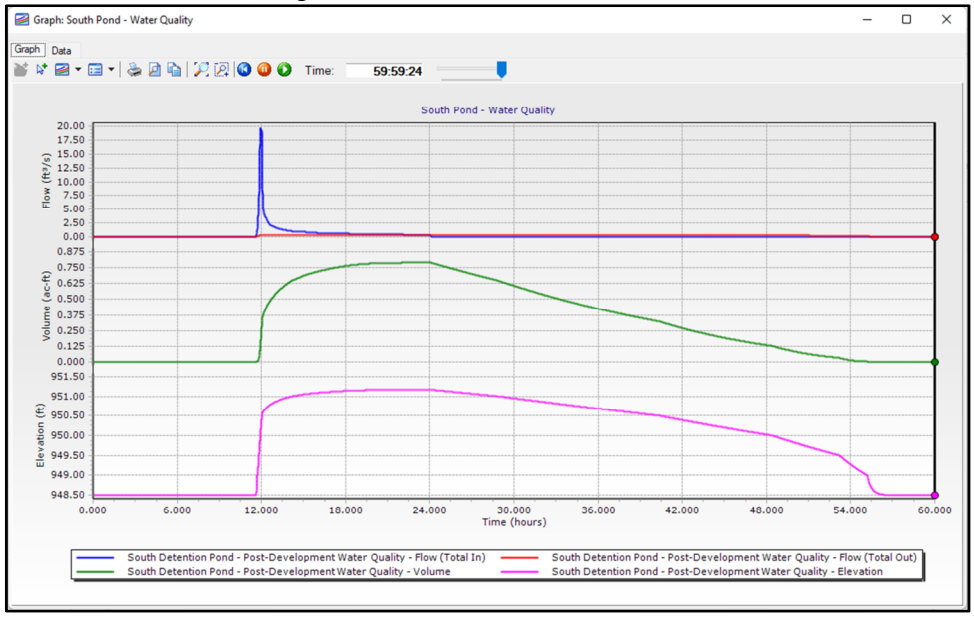


Figure V.I.2 – South Pond WQ Results



VI. Conclusions and Recommendations

A. Overview of the Report

As indicated in the report the project has 8 POI's. Within the developed area there are 2 dry ponds being proposed to provide comprehensive control on-site. These ponds will treat WQ, 2, 10, 100, and subsequent 100-Year events. There are 6 fringe areas which pose difficulty in providing comprehensive control. Three area are linear in nature (P-4, P-5, and P-6) because they encompass the new alignments of Hook Road and Hamblen Court future storm systems and do not require a waiver. P-3 is peripheral drainage and we are requesting a waiver. P-1B and P-2B are not being detained but the ponds are being overdesigned in order to account for these areas. We would like to request a waiver for the P-3 drainage area.

B. List of Requested Waivers

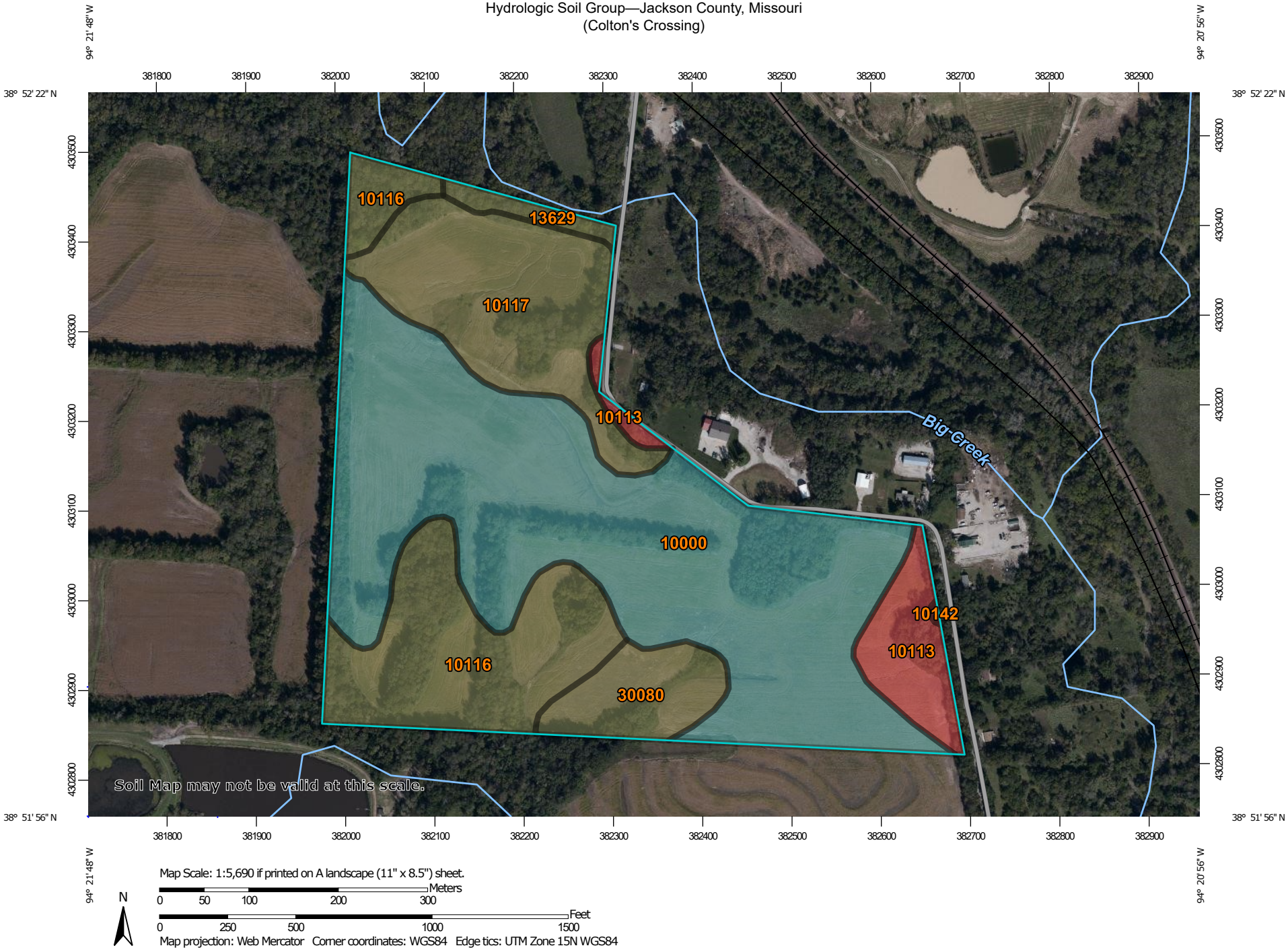
P-3 – Waiver requested. See section V.G.

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

Figure A – Web Soil Survey
Figure B – Pre-Developed Drainage Area Map
Figure C – Post-Developed Drainage Area Map
Figure D – Elevation-Area-Volume Curves
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 Master Summary
Figure I – Stream Buffer Evaluation

Figure A - Web Soil Survey

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



Map Scale: 1:5,690 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

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 23, Sep 1, 2021

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

Date(s) aerial images were photographed: Sep 6, 2019—Nov 16, 2019

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	37.9	52.2%
10113	Oska silty clay loam, 5 to 9 percent slopes, eroded	D	4.3	6.0%
10116	Sampsel silty clay loam, 2 to 5 percent slopes	C/D	13.3	18.3%
10117	Sampsel silty clay loam, 5 to 9 percent slopes	C/D	11.8	16.2%
10142	Snead-Rock outcrop complex, 5 to 14 percent slopes	D	0.0	0.1%
13629	Colo silt loam, 1 to 4 percent slopes, occasionally flooded	C/D	1.1	1.5%
30080	Greenton silty clay loam, 5 to 9 percent slopes	C/D	4.1	5.7%
Totals for Area of Interest			**72.5**	**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 B

E-1A
0.74 ACRES
CN=74

E-1B
5.55 ACRES
CN=74

E-1C
12.10 ACRES
CN=74

E-6
4.81 ACRES
CN=74

E-2A
14.82 ACRES
CN=74

E-2B
11.78 ACRES
CN=74

E-2C
9.85 ACRES
CN=74

E-2D
0.80 ACRES
CN=74

E-5
3.97 ACRES
CN=74

E-4
5.22 ACRES
CN=74

E-3
1.44 ACRES
CN=74

SE HAMBLEN RD

RAINBOW RIDGE ADDITION

FLATTERY
DOC.#200110015224

0 100' 150' 200'
SCALE: 1" = 100'

DATE	REVISION	NO.	BY	CKAPP

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STATE OF MISSOURI
MATTHEW JAMES CASTOR
NUM3ER 2015035109
REGISTERED PROFESSIONAL ENGINEER

MATT CASTOR, PE 2015035109
November 14, 2022

Consult inc engineers planners
1533 Locust Street, Kansas City, Missouri 64108
CORPORATE LICENSE No. E2010000573 (MO.) / E-1736 (NS.) / LS 2019000573 (MO.) / LS 2019055467

PRE-DEVELOPED DRAINAGE AREA MAP

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

X-REF NO.
21-018 Base
DRAWING NO.
21-018 Preliminary Plat
DATE
May 27, 2022
JOB NO.
21-018
SHEET 1 OF 2

PLOT DATE: 11/14/2022 3:29 PM by RICHARD MICHAEL
FILE LOCATION: G:\SHARED FILES\SYNC PROJECTS (YR 2021-2022)\2021\21-018 HAMBLEN ROAD MULTI-FAMILY RESIDENTIAL (HAMBLEN)\CIVIL\DWG\RETENTION DESIGN\ RAMP3+E6 RETENTION DESIGN.DWG

FIGURE C

P-1B
1.59 ACRES
CN=83

P-1A
12.96 ACRES
CN=83

P-6
4.01 ACRES
CN=83

P-2A
43.37 ACRES
CN=83

P-2B
4.86 ACRES
CN=83

P-5
3.66 ACRES
CN=83

P-4
2.63 ACRES
CN=83

P-3
1.22 ACRES
CN=83

FLATTERY
DOC.#2001I0015224

RAINBOW RIDGE ADDITION

HOOK ROAD

BAXTER LANE

BENNET LANE

COLTONS DRIVE

STEPHENS LANE

HAMBLEN COURT

SCALE: 1" = 100'

DATE	REVISION	NO.	BY	CK/APP

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MATTHEW JAMES CASTOR
NUMBER 2015035109
REGISTERED PROFESSIONAL ENGINEER

MATT CASTOR, MO 2015035109
November 14, 2022

Consult inc engineers planners
1533 Locust Street, Kansas City, Missouri 64108
CORPORATE LICENSE No. E2010000573 (MO.) / E-1736 (NS.) / LS 2019000554

POST-DEVELOPED DRAINAGE AREA MAP

COLTON'S CROSSING
FIRST PLAT

CITY OF LEE'S SUMMIT JACKSON COUNTY, MISSOURI

X-REF NO.
21-018 Base

DRAWING NO.
21-018 Preliminary Plat

DATE
May 27, 2022

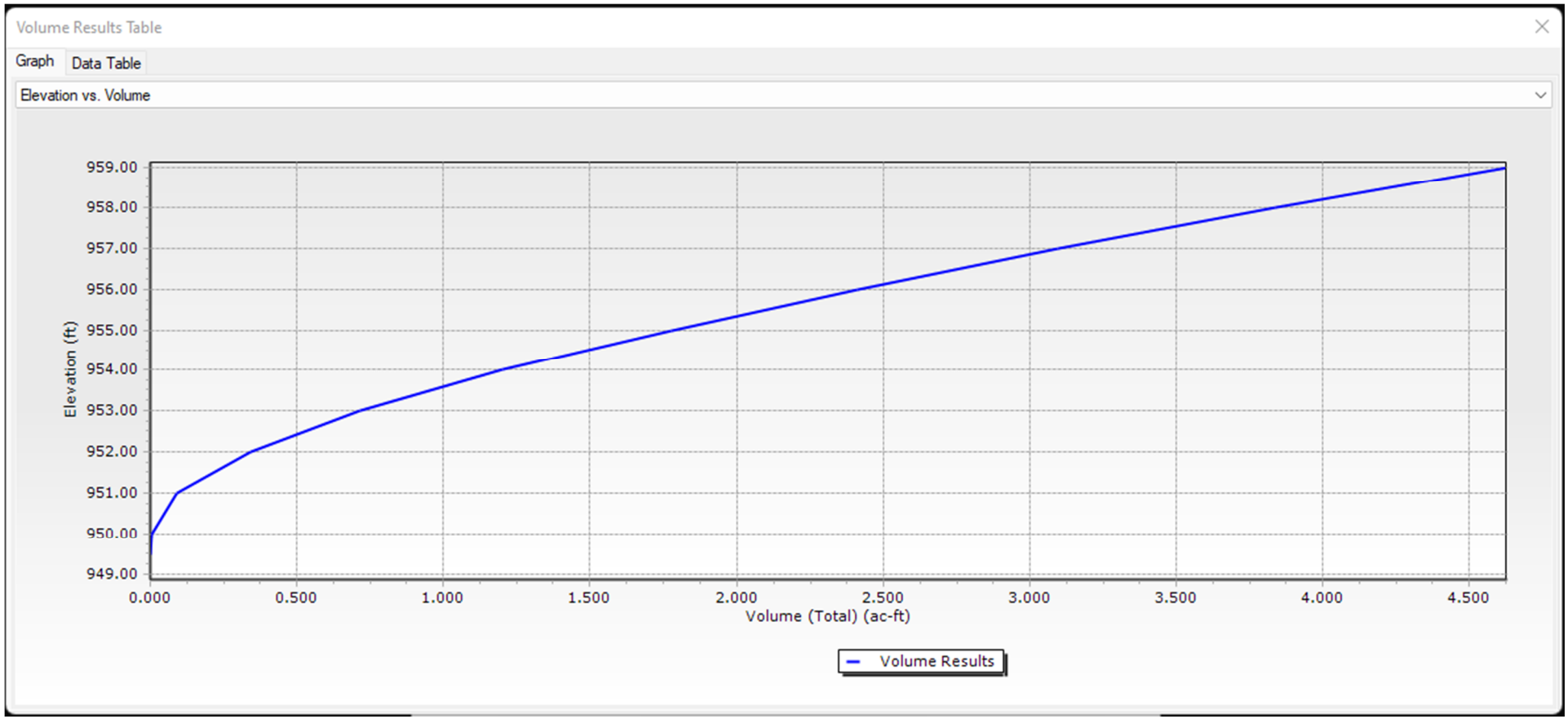
JOB NO.
21-018

SHEET 2 OF 2

PLOT DATE: 11/14/2022 3:33 PM by RICHARD MICHAEL
FILE LOCATION: G:\SHARED PROJECTS\PROJECTS (YR 2021+)\2021\21-018 HAMBLEN ROAD MULTI-FAMILY RESIDENTIAL (HAMBLEN)\CIVIL\DWG\RETENTION DESIGN\ RAWS\21-018 RETENTION DESIGN.DWG

Figure D –
Elevation-Area-Volume Curves

North Detention Pond Elevation Area Volume Curve



South Detention Pond Elevation Area Volume Curve

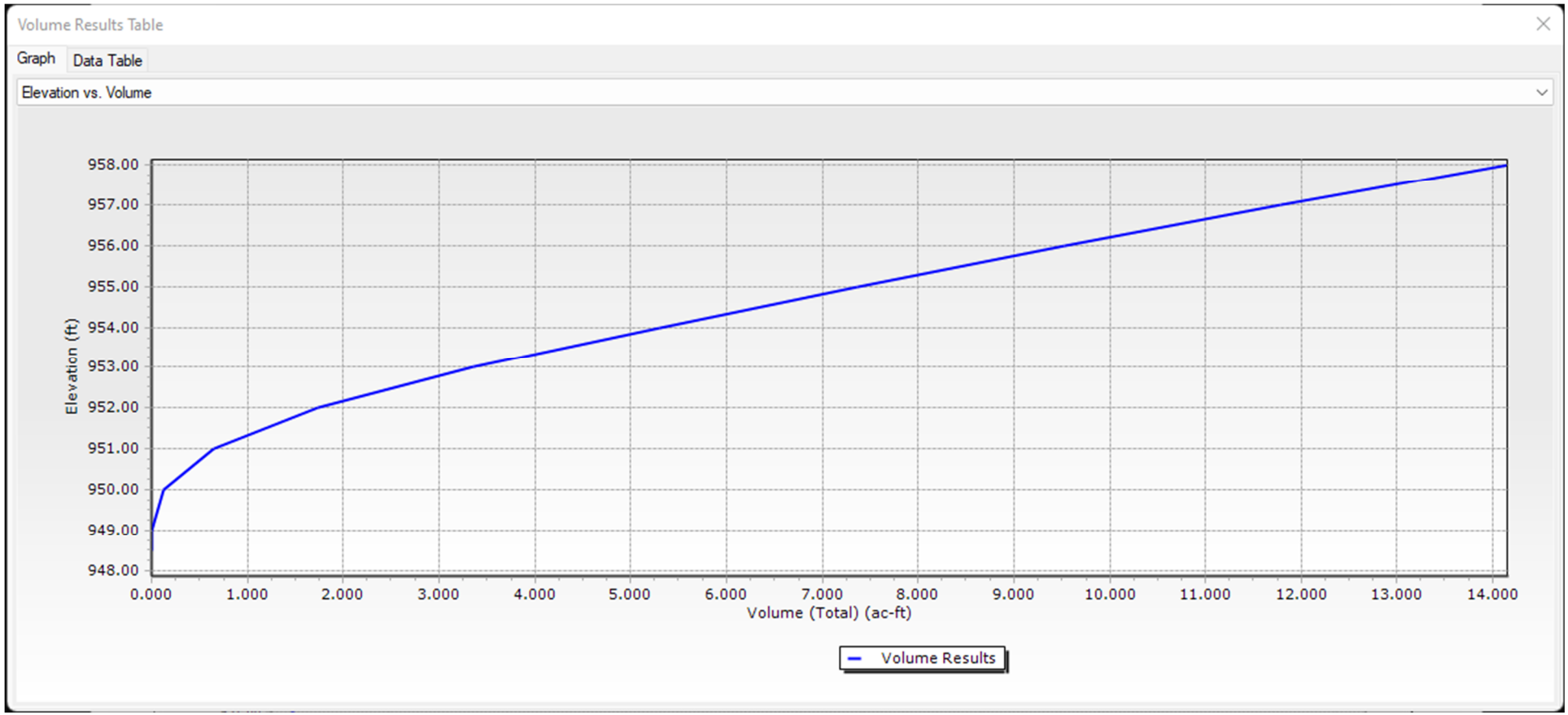
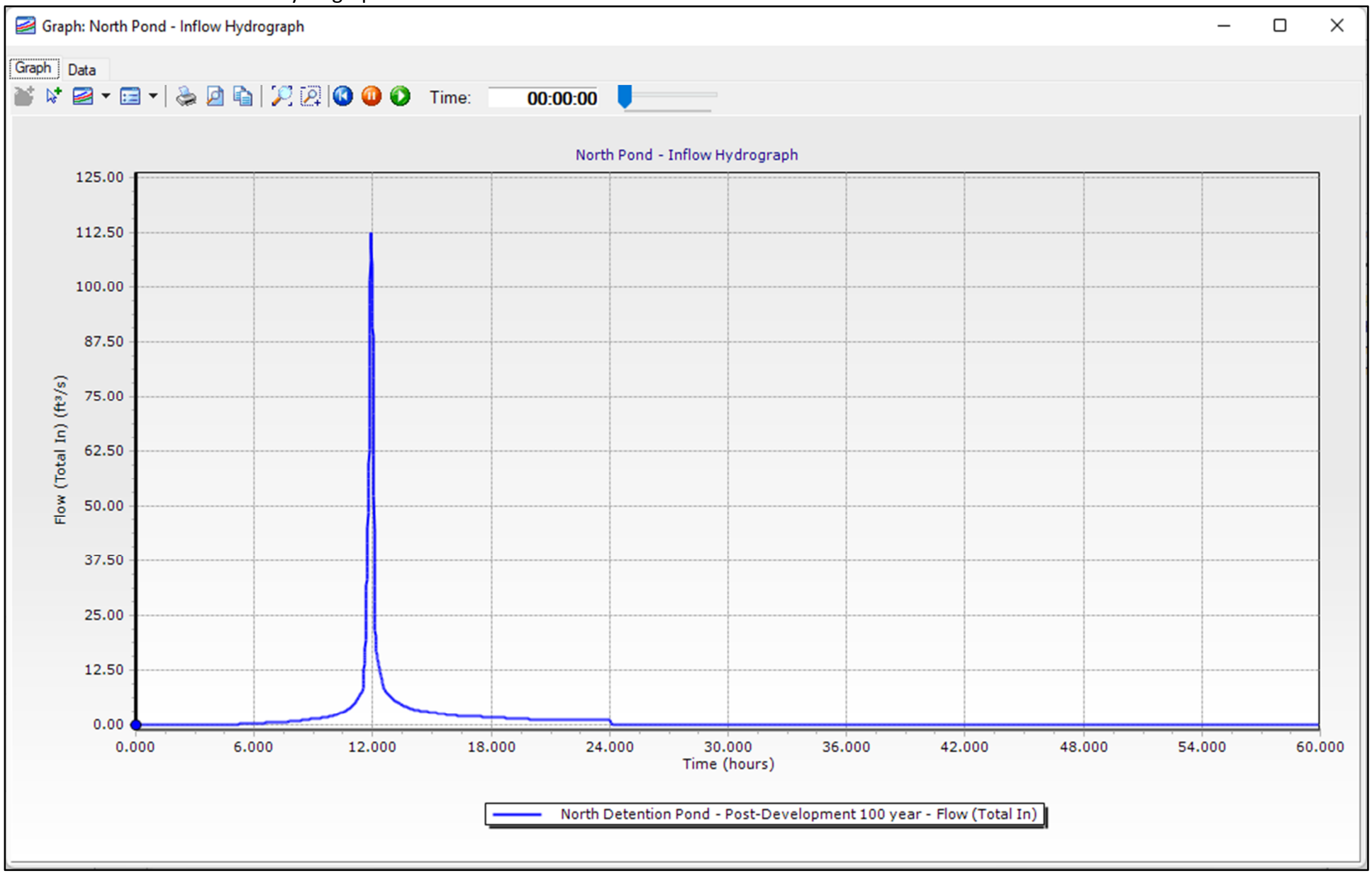


Figure E –
Inflow Hydrographs

North Detention Pond Inflow Hydrograph



South Detention Pond Inflow Hydrograph

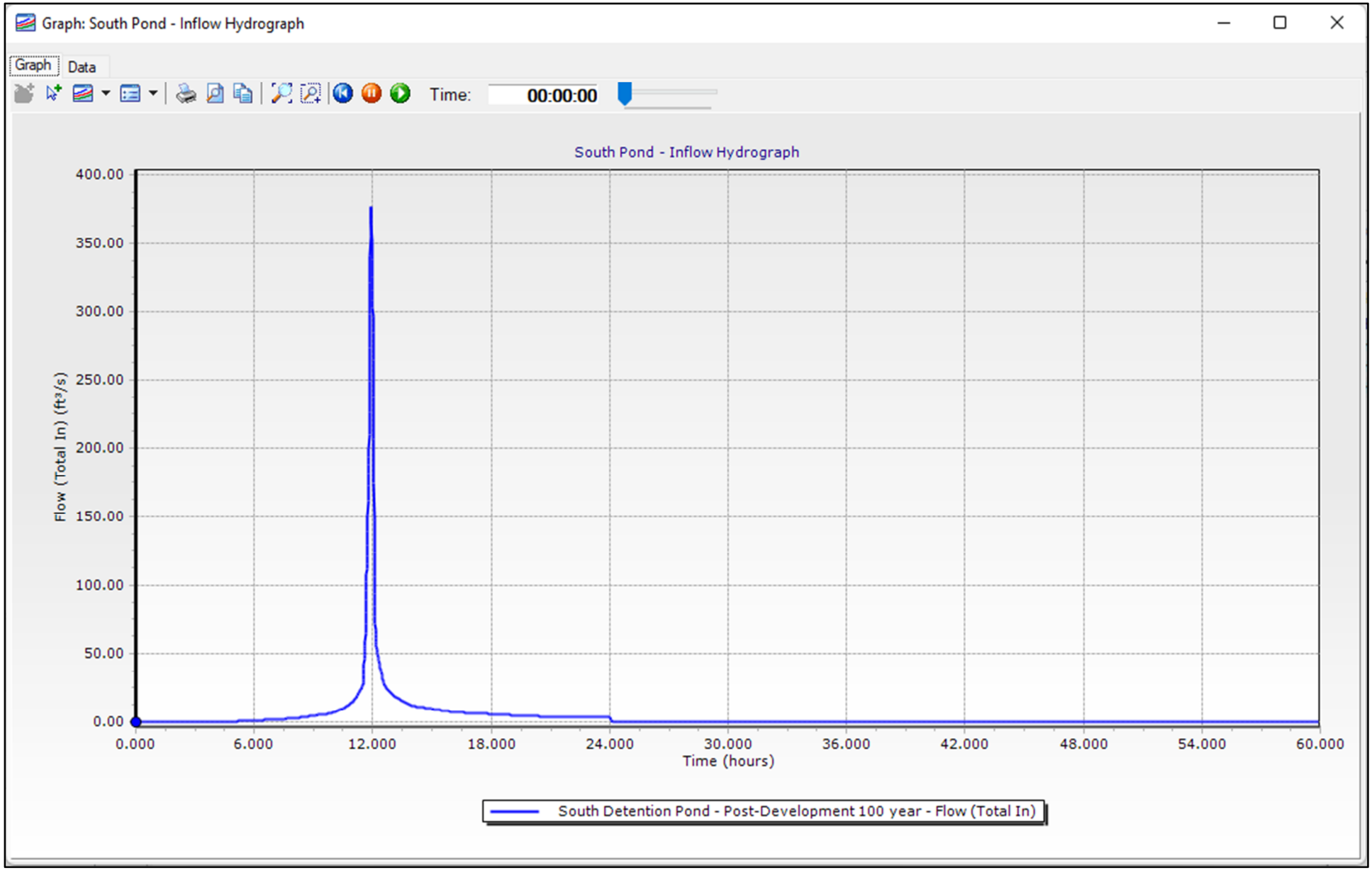


Figure F –
Stage-Discharge Rating Curves &
Input Data Per Basin Outlet

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

Element Details			
Label	North Pond Outlet Structure	Notes	

Headwater Range			
Headwater Type	Use Pond for Headwater Range	Maximum (Headwater)	959.00 ft
Pond	North Detention Pond	Increment (Headwater)	0.50 ft
Minimum (Headwater)	949.50 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	Outlet Pipe	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	948.40 ft
Length	56.09 ft	Diameter	30.0 in
Upstream Invert	949.40 ft		

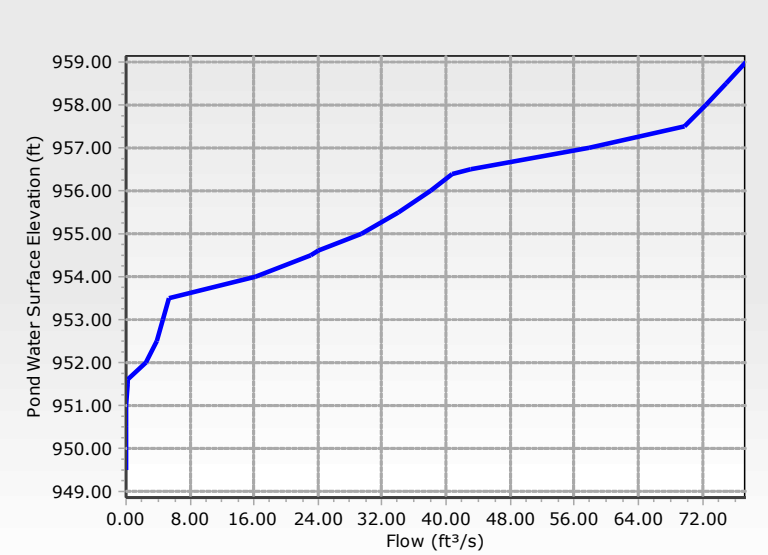
Unsubmerged->Submerged

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Culvert Coefficients			
Inlet Description	Concrete - Groove end projecting	C	0.0317
Chart	Chart 1	Y	0.6900
Nomograph	Nomograph 3	Manning's n	0.010
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 = Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 76.58 ft³/s
Upstream ID = 2-Yr Orifice, 10-Yr Orifice, 100-Yr Orifice, Inlet Box, WQ Orifice
Downstream ID = Tailwater (Pond Outfall)

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Mannings open channel maximum capacity: 76.58 ft³/s
Upstream ID = 2-Yr Orifice, 10-Yr Orifice, 100-Yr Orifice, Inlet Box, WQ Orifice
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)
949.50	0.00	0.00	0.00	Free Outfall
950.00	0.05	0.00	Free Outfall	Free Outfall
950.50	0.07	0.00	Free Outfall	Free Outfall
951.00	0.09	0.00	Free Outfall	Free Outfall
951.50	0.11	0.00	Free Outfall	Free Outfall
951.60	0.11	0.00	Free Outfall	Free Outfall
952.00	2.54	950.14	Free Outfall	Free Outfall
952.50	3.78	950.31	Free Outfall	Free Outfall
953.00	4.68	950.42	Free Outfall	Free Outfall
953.50	5.44	950.50	Free Outfall	Free Outfall
954.00	16.15	951.41	Free Outfall	Free Outfall
954.50	23.16	951.90	Free Outfall	Free Outfall
954.60	24.04	951.96	Free Outfall	Free Outfall
955.00	29.49	952.32	Free Outfall	Free Outfall
955.50	34.12	952.63	Free Outfall	Free Outfall
956.00	37.98	953.00	Free Outfall	Free Outfall
956.40	40.77	953.29	Free Outfall	Free Outfall
956.50	43.02	953.54	Free Outfall	Free Outfall
957.00	57.89	955.51	Free Outfall	Free Outfall
957.50	69.73	957.50	Free Outfall	Free Outfall
958.00	72.41	958.00	Free Outfall	Free Outfall
958.50	74.98	958.50	Free Outfall	Free Outfall
959.00	77.47	959.00	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
0.00	0.01	(N/A)	0.00
0.00	0.02	(N/A)	0.00

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Mannings open channel maximum capacity: 76.58 ft³/s
Upstream ID = 2-Yr Orifice, 10-Yr Orifice, 100-Yr Orifice, Inlet Box, WQ Orifice
Downstream ID = Tailwater (Pond Outfall)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.02	(N/A)	0.00
0.00	0.02	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	0.02	(N/A)	0.00
0.00	0.02	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.05	(N/A)	0.00
0.00	0.04	(N/A)	0.00
0.00	49.02	(N/A)	0.00
0.00	99.39	(N/A)	0.00
0.00	116.55	(N/A)	0.00

Message
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .025ft Dcr= .073ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .029ft Dcr= .085ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .032ft Dcr= .094ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .036ft Dcr= .106ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .036ft Dcr= .106ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .182ft Dcr= .521ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .227ft Dcr= .638ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .256ft Dcr= .713ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .547ft Dcr= 1.358ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .717ft Dcr= 1.638ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .740ft Dcr= 1.670ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .889ft Dcr= 1.851ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Mannings open channel maximum capacity: 76.58 ft³/s
Upstream ID = 2-Yr Orifice, 10-Yr Orifice, 100-Yr Orifice, Inlet Box, WQ Orifice
Downstream ID = Tailwater (Pond Outfall)

Message
INLET CONTROL... Submerged: HW =3.23
INLET CONTROL... Submerged: HW =3.60
INLET CONTROL... Submerged: HW =3.89
INLET CONTROL... Submerged: HW =4.14
INLET CONTROL... Submerged: HW =6.11
INLET CONTROL... Submerged: HW =8.10
INLET CONTROL... Submerged: HW =8.60
INLET CONTROL... Submerged: HW =9.10
INLET CONTROL... Submerged: HW =9.60

Outlet Structure			
Outlet Structure Type	Riser		

Outlet Structure (IDs and Direction)			
Outlet ID	Inlet Box	Downstream ID	Outlet Pipe
Flow Direction	Forward Flow Only	Notes	

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

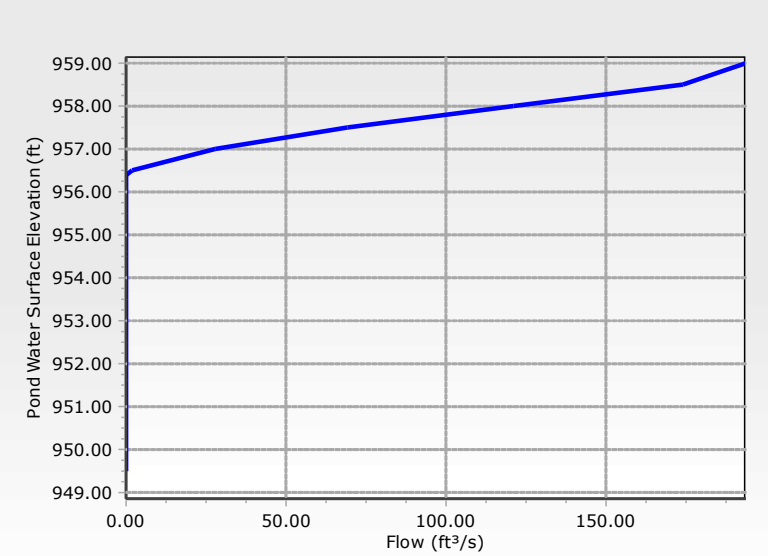
Outlet Structure (Riser)			
Riser	Inlet Box	Orifice Area	25.00 ft²
Weir Length	20.00 ft	Transition Elevation	0.00 ft
Weir Coefficient	3.00 (ft^0.5)/s	Transition Height	0.00 ft
Orifice Coefficient	0.600	K Reverse	1.000

Outlet Structure (Common)	
Elevation	956.40 ft

Outlet Structure (Riser, Advanced)

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Inlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
949.50	0.00	0.00	0.00	0.00
950.00	0.00	0.00	0.00	0.00
950.50	0.00	0.00	0.00	0.00
951.00	0.00	0.00	0.00	0.00
951.50	0.00	0.00	0.00	0.00
951.60	0.00	0.00	0.00	0.00
952.00	0.00	0.00	0.00	950.14
952.50	0.00	0.00	0.00	950.31
953.00	0.00	0.00	0.00	950.42
953.50	0.00	0.00	0.00	950.50
954.00	0.00	0.00	0.00	951.41

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Inlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
954.50	0.00	0.00	0.00	951.90
954.60	0.00	0.00	0.00	951.96
955.00	0.00	0.00	0.00	952.32
955.50	0.00	0.00	0.00	952.63
956.00	0.00	0.00	0.00	953.00
956.40	0.00	0.00	0.00	953.29
956.50	1.90	956.50	Free Outfall	953.54
957.00	27.89	957.00	Free Outfall	955.51
957.50	69.22	957.50	957.50	957.50
958.00	121.43	958.00	958.00	958.00
958.50	174.37	958.50	958.50	958.50
959.00	194.02	959.00	959.00	959.00

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

Message

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Inlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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.
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

Outlet Structure	
Outlet Structure Type	Orifice

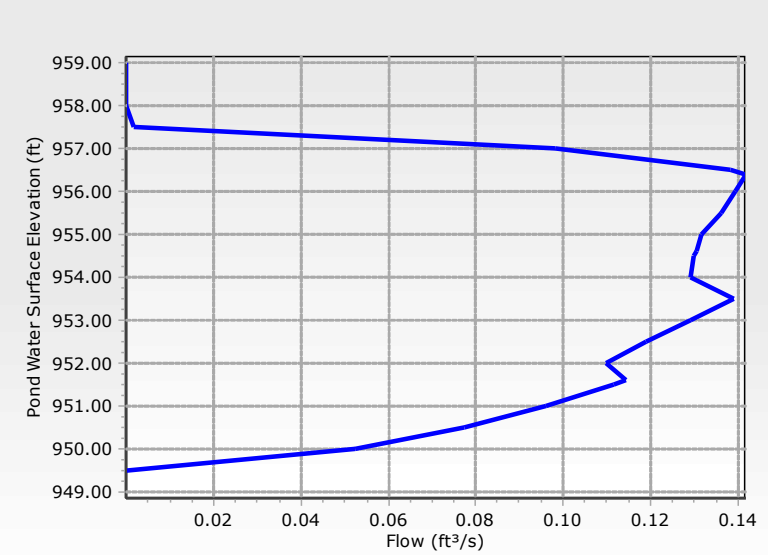
Outlet Structure (IDs and Direction)			
Outlet ID	WQ Orifice	Downstream ID	Outlet Pipe
Flow Direction	Forward Flow Only	Notes	

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

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

Outlet Structure (Orifice)			
Orifice	Circular Orifice	Orifice Coefficient	0.600
Number of Openings	1	Orifice Diameter	1.8 in

Outlet Structure (Common)	
Elevation	949.50 ft



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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
949.50	0.00	0.00	0.00	0.00
950.00	0.05	950.00	949.50	0.00
950.50	0.08	950.50	949.52	0.00
951.00	0.10	951.00	949.53	0.00
951.50	0.11	951.50	949.55	0.00
951.60	0.11	951.60	949.55	0.00
952.00	0.11	952.00	950.14	950.14

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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	0.12	952.50	950.31	950.31
953.00	0.13	953.00	950.42	950.42
953.50	0.14	953.50	950.50	950.50
954.00	0.13	954.00	951.41	951.41
954.50	0.13	954.50	951.90	951.90
954.60	0.13	954.60	951.96	951.96
955.00	0.13	955.00	952.32	952.32
955.50	0.14	955.50	952.63	952.63
956.00	0.14	956.00	953.00	953.00
956.40	0.14	956.40	953.29	953.29
956.50	0.14	956.50	953.54	953.54
957.00	0.10	957.00	955.51	955.51
957.50	0.00	957.50	957.50	957.50
958.00	0.00	958.00	958.00	958.00
958.50	0.00	958.50	958.50	958.50
959.00	0.00	959.00	959.00	959.00

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

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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

Message
WS below an invert; no flow.
H =.43
H =.93
H =1.43
H =1.93
H =2.03
H =1.86
H =2.19
H =2.58
H =3.00
H =2.59
H =2.60
H =2.64
H =2.68
H =2.87
H =3.00
H =3.11
H =2.96
H =1.49
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)

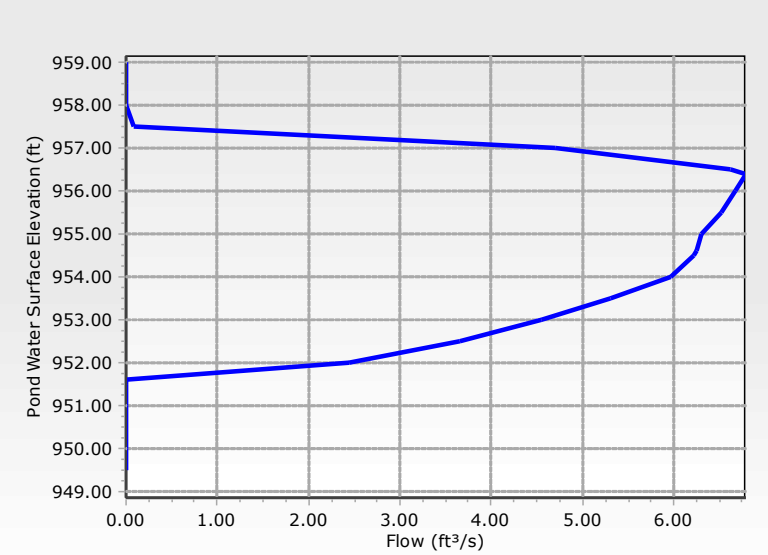
Composite Outlet Structure Detailed Report: North Pond Outlet Structure

Outlet Structure (IDs and Direction)			
Outlet ID	2-Yr Orifice	Downstream ID	Outlet Pipe
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	951.60 ft
Orifice Coefficient	0.600	Top Elevation	952.00 ft
Orifice Area	0.80 ft²		

Outlet Structure (Common)	
Elevation	951.60 ft



Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
949.50	0.00	0.00	0.00	0.00
950.00	0.00	0.00	0.00	0.00
950.50	0.00	0.00	0.00	0.00
951.00	0.00	0.00	0.00	0.00
951.50	0.00	0.00	0.00	0.00
951.60	0.00	0.00	0.00	0.00
952.00	2.44	952.00	Free Outfall	950.14
952.50	3.65	952.50	Free Outfall	950.31
953.00	4.56	953.00	Free Outfall	950.42
953.50	5.31	953.50	Free Outfall	950.50
954.00	5.97	954.00	Free Outfall	951.41
954.50	6.21	954.50	951.90	951.90
954.60	6.26	954.60	951.96	951.96
955.00	6.30	955.00	952.32	952.32
955.50	6.52	955.50	952.63	952.63
956.00	6.67	956.00	953.00	953.00
956.40	6.79	956.40	953.29	953.29
956.50	6.63	956.50	953.54	953.54
957.00	4.70	957.00	955.51	955.51
957.50	0.09	957.50	957.50	957.50
958.00	0.00	958.00	958.00	958.00
958.50	0.00	958.50	958.50	958.50
959.00	0.00	959.00	959.00	959.00

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

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

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

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
0.00	0.00	(N/A)	0.00	H =.40
0.00	0.00	(N/A)	0.00	H =.90
0.00	0.00	(N/A)	0.00	H =1.40
0.00	0.00	(N/A)	0.00	H =1.90
0.00	0.00	(N/A)	0.00	H =2.40
0.00	0.00	(N/A)	0.00	H =2.60
0.00	0.00	(N/A)	0.00	H =2.64
0.00	0.00	(N/A)	0.00	H =2.68
0.00	0.00	(N/A)	0.00	H =2.87
0.00	0.00	(N/A)	0.00	H =3.00
0.00	0.00	(N/A)	0.00	H =3.11
0.00	0.00	(N/A)	0.00	H =2.96
0.00	0.00	(N/A)	0.00	H =1.49
				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: North Pond Outlet Structure

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

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

Message
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Outlet Structure	
Outlet Structure Type	Orifice

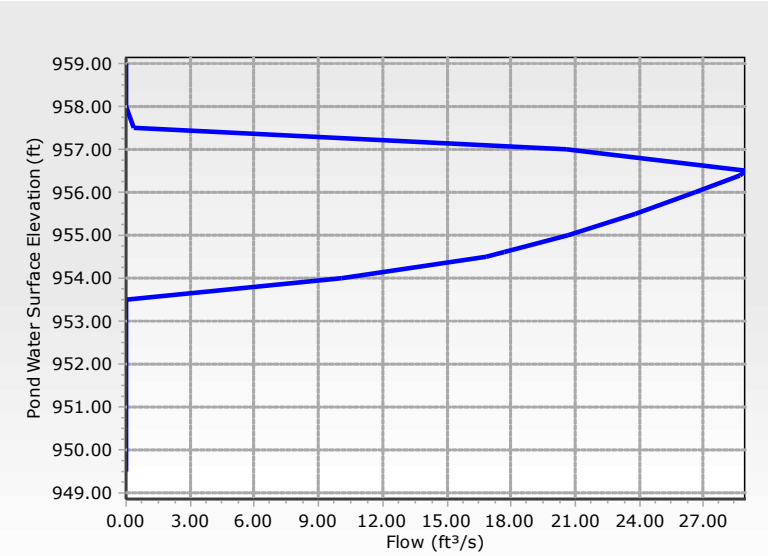
Outlet Structure (IDs and Direction)			
Outlet ID	10-Yr Orifice	Downstream ID	Outlet Pipe
Flow Direction	Forward Flow Only	Notes	

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	953.50 ft
Orifice Coefficient	0.600	Top Elevation	954.20 ft
Orifice Area	3.50 ft²		

Outlet Structure (Common)	
Elevation	953.50 ft

Composite Outlet Structure Detailed Report: North Pond Outlet Structure



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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
949.50	0.00	0.00	0.00	0.00
950.00	0.00	0.00	0.00	0.00
950.50	0.00	0.00	0.00	0.00
951.00	0.00	0.00	0.00	0.00
951.50	0.00	0.00	0.00	0.00
951.60	0.00	0.00	0.00	0.00
952.00	0.00	0.00	0.00	950.14
952.50	0.00	0.00	0.00	950.31
953.00	0.00	0.00	0.00	950.42
953.50	0.00	0.00	0.00	950.50
954.00	10.07	954.00	Free Outfall	951.41
954.50	16.85	954.50	Free Outfall	951.90
954.60	17.67	954.60	Free Outfall	951.96
955.00	20.63	955.00	Free Outfall	952.32
955.50	23.82	955.50	Free Outfall	952.63
956.00	26.64	956.00	Free Outfall	953.00

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Upstream   ID =   (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
956.40	28.69	956.40	Free Outfall	953.29
956.50	28.99	956.50	953.54	953.54
957.00	20.55	957.00	955.51	955.51
957.50	0.37	957.50	957.50	957.50
958.00	0.00	958.00	958.00	958.00
958.50	0.00	958.50	958.50	958.50
959.00	0.00	959.00	959.00	959.00

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

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: North Pond Outlet Structure

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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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.
Hi=.50; Ht=.70; Qt=14.09
H =1.00
H =1.10
H =1.50
H =2.00
H =2.50
H =2.90
H =2.96
H =1.49
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	100-Yr Orifice	Downstream ID	Outlet Pipe
Flow Direction	Forward Flow Only	Notes	

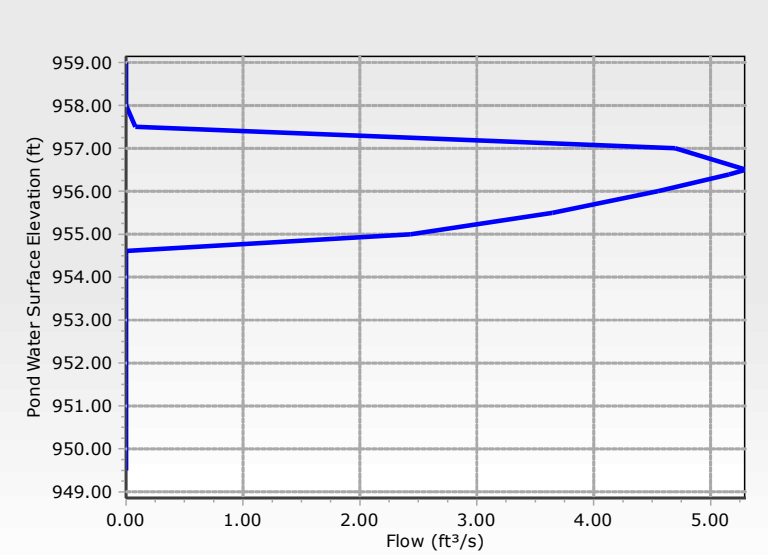
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Orifice)			
Orifice	Area Orifice	Orifice Orientation	Perpendicular Orifice

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

Outlet Structure (Orifice)			
Number of Openings	1	Datum Elevation	954.60 ft
Orifice Coefficient	0.600	Top Elevation	955.00 ft
Orifice Area	0.80 ft²		

Outlet Structure (Common)	
Elevation	954.60 ft



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 100-Yr Orifice (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
949.50	0.00	0.00	0.00	0.00
950.00	0.00	0.00	0.00	0.00
950.50	0.00	0.00	0.00	0.00
951.00	0.00	0.00	0.00	0.00
951.50	0.00	0.00	0.00	0.00
951.60	0.00	0.00	0.00	0.00
952.00	0.00	0.00	0.00	950.14

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 100-Yr Orifice (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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	0.00	0.00	0.00	950.31
953.00	0.00	0.00	0.00	950.42
953.50	0.00	0.00	0.00	950.50
954.00	0.00	0.00	0.00	951.41
954.50	0.00	0.00	0.00	951.90
954.60	0.00	0.00	0.00	951.96
955.00	2.44	955.00	Free Outfall	952.32
955.50	3.65	955.50	Free Outfall	952.63
956.00	4.56	956.00	Free Outfall	953.00
956.40	5.17	956.40	Free Outfall	953.29
956.50	5.31	956.50	Free Outfall	953.54
957.00	4.70	957.00	955.51	955.51
957.50	0.09	957.50	957.50	957.50
958.00	0.00	958.00	958.00	958.00
958.50	0.00	958.50	958.50	958.50
959.00	0.00	959.00	959.00	959.00

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

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 100-Yr Orifice (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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

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.
H =.40
H =.90
H =1.40
H =1.80
H =1.90
H =1.49
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: North Pond Outlet Structure

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

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
949.50	0.00	(N/A)	0.00
950.00	0.05	(N/A)	0.00
950.50	0.07	(N/A)	0.00
951.00	0.09	(N/A)	0.00
951.50	0.11	(N/A)	0.00
951.60	0.11	(N/A)	0.00
952.00	2.54	(N/A)	0.00
952.50	3.77	(N/A)	0.00
953.00	4.68	(N/A)	0.00
953.50	5.45	(N/A)	0.00
954.00	16.15	(N/A)	0.00
954.50	23.16	(N/A)	0.00
954.60	24.04	(N/A)	0.00
955.00	29.49	(N/A)	0.00
955.50	34.12	(N/A)	0.00
956.00	37.98	(N/A)	0.00
956.40	40.77	(N/A)	0.00
956.50	42.96	(N/A)	0.00
957.00	57.89	(N/A)	0.00
957.50	69.73	(N/A)	0.00
958.00	72.41	(N/A)	0.00
958.50	74.98	(N/A)	0.00
959.00	77.47	(N/A)	0.00

Contributing Structures
(no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box,WQ Orifice,Outlet Pipe)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box)

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

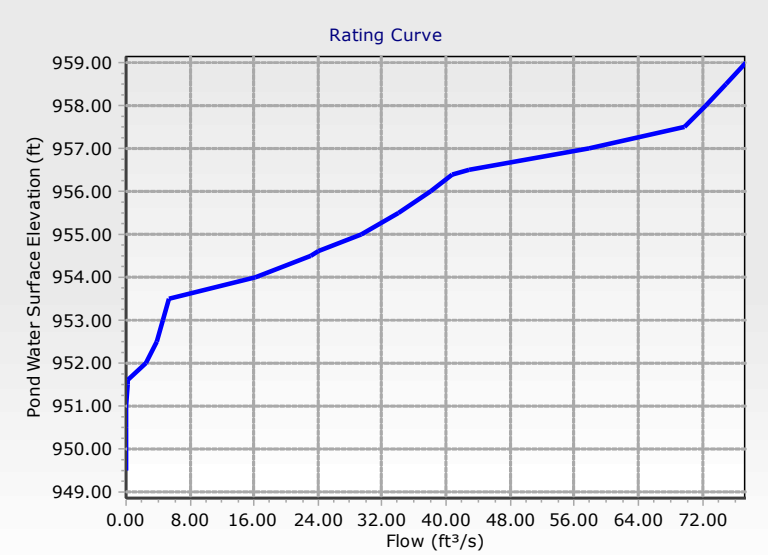
Composite Rating Table
Tailwater Elevation = Free Outfall (North Pond Outlet Structure)

Contributing Structures
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr Orifice,100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr Orifice,100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr Orifice,100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr Orifice,100-Yr Orifice,Inlet Box)
2-Yr Orifice,10-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 100-Yr Orifice,Inlet Box)
2-Yr Orifice,10-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 100-Yr Orifice,Inlet Box)
2-Yr Orifice,10-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 100-Yr Orifice,Inlet Box)
2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)

Composite Outlet Structure Detailed Report: North Pond Outlet Structure

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

Contributing Structures
2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box,WQ Orifice,Outlet Pipe
2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box,WQ Orifice,Outlet Pipe
2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,Inlet Box,WQ Orifice,Outlet Pipe
Inlet Box,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,WQ Orifice)
Inlet Box,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,WQ Orifice)
Inlet Box,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr Orifice,100-Yr Orifice,WQ Orifice)



Composite Outlet Structure Detailed Report: South Pond Outlet Structure

Element Details			
Label	South Pond Outlet Structure	Notes	

Headwater Range			
Headwater Type	Use Pond for Headwater Range	Maximum (Headwater)	958.00 ft
Pond	South Detention Pond	Increment (Headwater)	0.50 ft
Minimum (Headwater)	948.50 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	Outlet Pipe	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	948.00 ft
Length	53.50 ft	Diameter	48.0 in
Upstream Invert	948.40 ft		

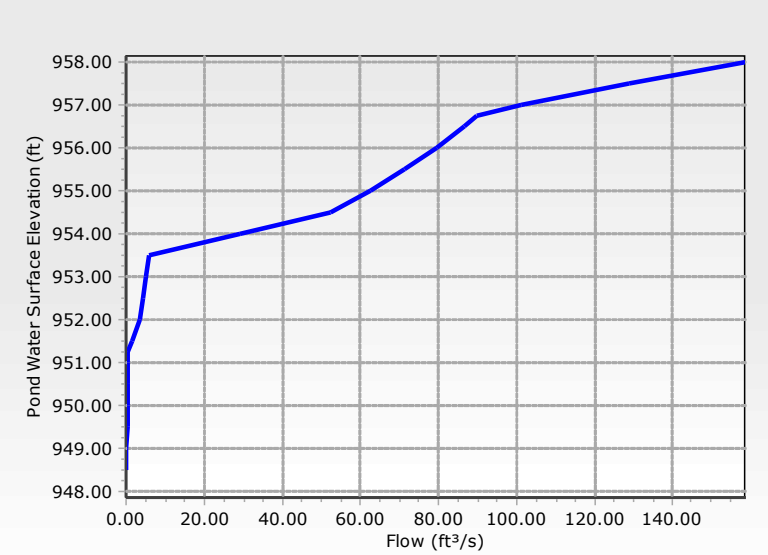
Unsubmerged->Submerged

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Culvert Coefficients			
Inlet Description	Concrete - Groove end projecting	C	0.0317
Chart	Chart 1	Y	0.6900
Nomograph	Nomograph 3	Manning's n	0.010
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 = Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 173.68 ft³/s
Upstream ID = 2-Yr Orifice, 10-Yr and 100-Yr Orifice, Inlet Box, WQ Orifice
Downstream ID = Tailwater (Pond Outfall)

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Mannings open channel maximum capacity: 173.68 ft³/s
Upstream ID = 2-Yr Orifice, 10-Yr and 100-Yr Orifice, Inlet Box, WQ Orifice
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)
948.50	0.00	0.00	0.00	Free Outfall
949.00	0.14	0.00	Free Outfall	Free Outfall
949.50	0.21	0.00	Free Outfall	Free Outfall
950.00	0.27	0.00	Free Outfall	Free Outfall
950.50	0.32	948.63	Free Outfall	Free Outfall
951.00	0.36	948.64	Free Outfall	Free Outfall
951.25	0.38	948.65	Free Outfall	Free Outfall
951.50	1.66	948.92	Free Outfall	Free Outfall
952.00	3.53	949.16	Free Outfall	Free Outfall
952.50	4.46	949.26	Free Outfall	Free Outfall
953.00	5.22	949.34	Free Outfall	Free Outfall
953.50	5.89	949.40	Free Outfall	Free Outfall
954.00	29.25	950.72	Free Outfall	Free Outfall
954.50	52.23	951.62	Free Outfall	Free Outfall
955.00	62.64	951.98	Free Outfall	Free Outfall
955.50	71.50	952.28	Free Outfall	Free Outfall
956.00	79.40	952.54	Free Outfall	Free Outfall
956.50	86.57	952.78	Free Outfall	Free Outfall
956.75	89.94	952.89	Free Outfall	Free Outfall
957.00	101.21	953.26	Free Outfall	Free Outfall
957.50	128.98	954.49	Free Outfall	Free Outfall
958.00	158.76	956.20	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
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.02	(N/A)	0.00

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Mannings open channel maximum capacity: 173.68 ft³/s
Upstream ID = 2-Yr Orifice, 10-Yr and 100-Yr Orifice, Inlet Box, WQ Orifice
Downstream ID = Tailwater (Pond Outfall)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.02	(N/A)	0.00
0.00	0.04	(N/A)	0.00
0.00	0.07	(N/A)	0.00
0.00	0.05	(N/A)	0.00
0.00	0.04	(N/A)	0.00
0.00	0.04	(N/A)	0.00
0.00	0.01	(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.
CRIT.DEPTH CONTROL Vh= .036ft Dcr= .108ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .044ft Dcr= .132ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .050ft Dcr= .147ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .055ft Dcr= .163ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .058ft Dcr= .172ft CRIT.DEPTH Hev= .00ft
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO UPSTREAM CONTROLLING STRUCTURE
CRIT.DEPTH CONTROL Vh= .244ft Dcr= .703ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .600ft Dcr= 1.603ft CRIT.DEPTH Hev= .00ft

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Mannings open channel maximum capacity: 173.68 ft³/s
Upstream ID = 2-Yr Orifice, 10-Yr and 100-Yr Orifice, Inlet Box, WQ Orifice
Downstream ID = Tailwater (Pond Outfall)

Message
CRIT.DEPTH CONTROL Vh= .874ft Dcr= 2.171ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .997ft Dcr= 2.387ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= 1.104ft Dcr= 2.557ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= 1.204ft Dcr= 2.699ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= 1.298ft Dcr= 2.821ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= 1.344ft Dcr= 2.876ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= 1.508ft Dcr= 3.048ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =6.09
INLET CONTROL... Submerged: HW =7.80

Outlet Structure

Outlet Structure Type	Riser

Outlet Structure (IDs and Direction)

Outlet ID	Inlet Box	Downstream ID	Outlet Pipe
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	30.00 ft²
Weir Length	22.00 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

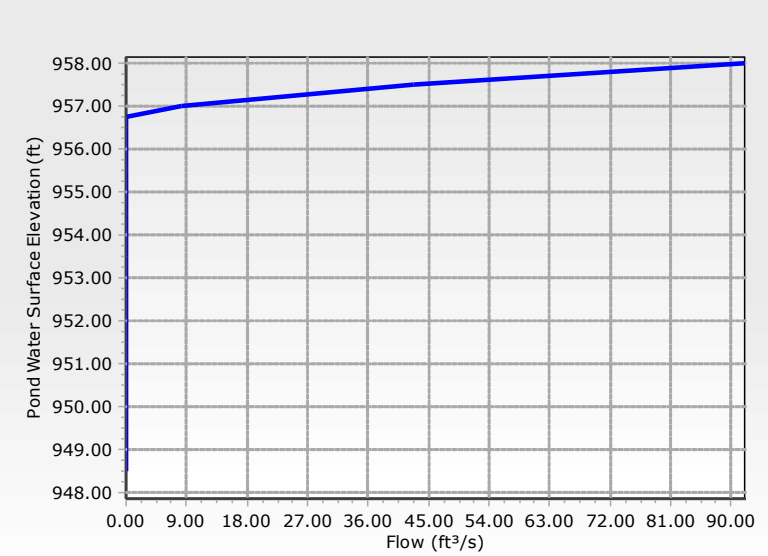
Outlet Structure (Common)

Elevation	956.75 ft

Outlet Structure (Riser, Advanced)

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Inlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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	0.00
949.00	0.00	0.00	0.00	0.00
949.50	0.00	0.00	0.00	0.00
950.00	0.00	0.00	0.00	0.00
950.50	0.00	0.00	0.00	948.63
951.00	0.00	0.00	0.00	948.64
951.25	0.00	0.00	0.00	948.65
951.50	0.00	0.00	0.00	948.92
952.00	0.00	0.00	0.00	949.16
952.50	0.00	0.00	0.00	949.26
953.00	0.00	0.00	0.00	949.34

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Inlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
953.50	0.00	0.00	0.00	949.40
954.00	0.00	0.00	0.00	950.72
954.50	0.00	0.00	0.00	951.62
955.00	0.00	0.00	0.00	951.98
955.50	0.00	0.00	0.00	952.28
956.00	0.00	0.00	0.00	952.54
956.50	0.00	0.00	0.00	952.78
956.75	0.00	0.00	0.00	952.89
957.00	8.25	957.00	Free Outfall	953.26
957.50	42.87	957.50	Free Outfall	954.49
958.00	92.24	958.00	Free Outfall	956.20

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

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

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Inlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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.
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 =0.25ft
Weir: H =0.75ft
Weir: H =1.25ft

Outlet Structure	
Outlet Structure Type	Orifice

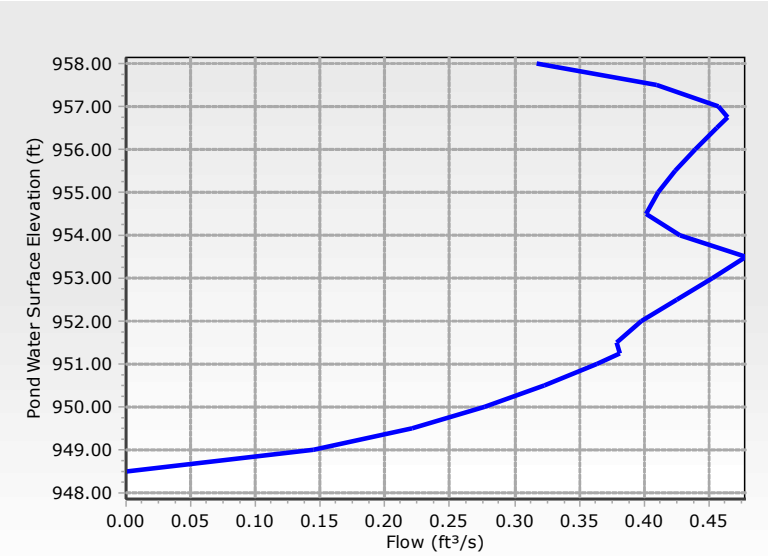
Outlet Structure (IDs and Direction)			
Outlet ID	WQ Orifice	Downstream ID	Outlet Pipe
Flow Direction	Forward Flow Only	Notes	

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	3.0 in

Outlet Structure (Common)	
Elevation	948.50 ft

Composite Outlet Structure Detailed Report: South Pond Outlet Structure



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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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	0.00
949.00	0.14	949.00	948.55	0.00
949.50	0.22	949.50	948.59	0.00
950.00	0.28	950.00	948.61	0.00
950.50	0.32	950.50	948.63	948.63
951.00	0.36	951.00	948.64	948.64
951.25	0.38	951.25	948.65	948.65
951.50	0.38	951.50	948.92	948.92
952.00	0.40	952.00	949.16	949.16
952.50	0.43	952.50	949.26	949.26
953.00	0.45	953.00	949.34	949.34
953.50	0.48	953.50	949.40	949.40
954.00	0.43	954.00	950.72	950.72
954.50	0.40	954.50	951.62	951.62
955.00	0.41	955.00	951.98	951.98
955.50	0.42	955.50	952.28	952.28

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
956.00	0.44	956.00	952.54	952.54
956.50	0.46	956.50	952.78	952.78
956.75	0.46	956.75	952.89	952.89
957.00	0.46	957.00	953.26	953.26
957.50	0.41	957.50	954.49	954.49
958.00	0.32	958.00	956.20	956.20

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

Message
WS below an invert; no flow.
H =.38
H =.88
H =1.38
H =1.87
H =2.36
H =2.60

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

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

Message
H =2.58
H =2.84
H =3.24
H =3.66
H =4.10
H =3.28
H =2.88
H =3.02
H =3.22
H =3.46
H =3.72
H =3.86
H =3.74
H =3.01
H =1.80

Outlet Structure	
Outlet Structure Type	Orifice

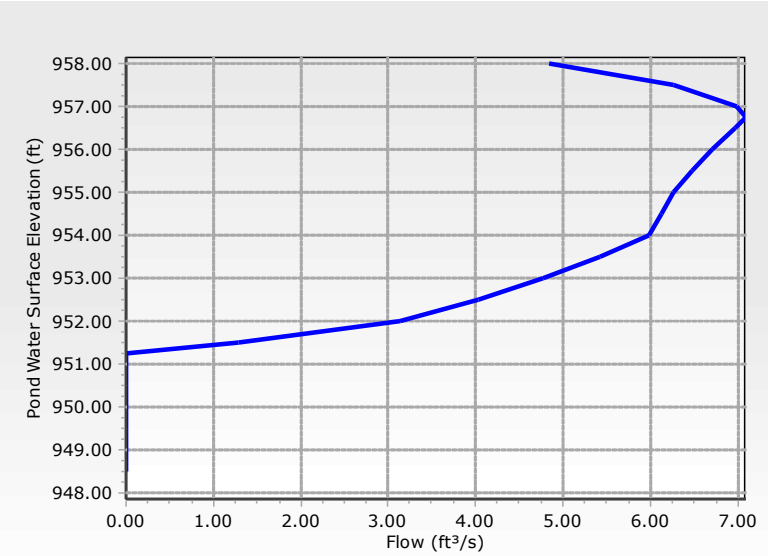
Outlet Structure (IDs and Direction)			
Outlet ID	2-Yr Orifice	Downstream ID	Outlet Pipe
Flow Direction	Forward Flow Only	Notes	

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	951.25 ft
Orifice Coefficient	0.600	Top Elevation	951.75 ft
Orifice Area	0.75 ft²		

Outlet Structure (Common)	
Elevation	951.25 ft

Composite Outlet Structure Detailed Report: South Pond Outlet Structure



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

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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	0.00
949.00	0.00	0.00	0.00	0.00
949.50	0.00	0.00	0.00	0.00
950.00	0.00	0.00	0.00	0.00
950.50	0.00	0.00	0.00	948.63
951.00	0.00	0.00	0.00	948.64
951.25	0.00	0.00	0.00	948.65
951.50	1.28	951.50	Free Outfall	948.92
952.00	3.13	952.00	Free Outfall	949.16
952.50	4.04	952.50	Free Outfall	949.26
953.00	4.78	953.00	Free Outfall	949.34
953.50	5.41	953.50	Free Outfall	949.40
954.00	5.99	954.00	Free Outfall	950.72
954.50	6.13	954.50	951.62	951.62
955.00	6.27	955.00	951.98	951.98
955.50	6.47	955.50	952.28	952.28

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Upstream   ID =   (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
956.00	6.71	956.00	952.54	952.54
956.50	6.96	956.50	952.78	952.78
956.75	7.09	956.75	952.89	952.89
957.00	6.98	957.00	953.26	953.26
957.50	6.27	957.50	954.49	954.49
958.00	4.84	958.00	956.20	956.20

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.
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.

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

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

Message
Hi=.25; Ht=.50; Qt=2.55
H =.75
H =1.25
H =1.75
H =2.25
H =2.75
H =2.88
H =3.02
H =3.22
H =3.46
H =3.72
H =3.86
H =3.74
H =3.01
H =1.80

Outlet Structure	
Outlet Structure Type	Orifice

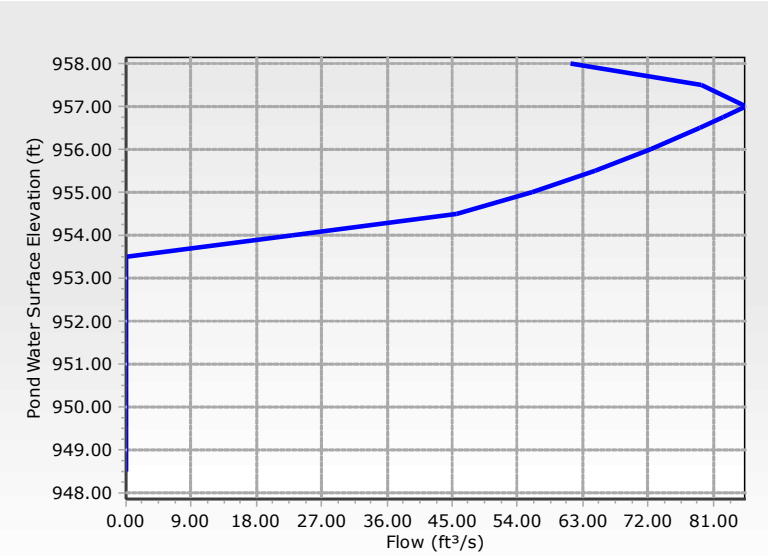
Outlet Structure (IDs and Direction)			
Outlet ID	10-Yr and 100-Yr Orifice	Downstream ID	Outlet Pipe
Flow Direction	Forward Flow Only	Notes	

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	2	Datum Elevation	953.50 ft
Orifice Coefficient	0.600	Top Elevation	954.50 ft
Orifice Area	4.75 ft²		

Outlet Structure (Common)	
Elevation	953.50 ft

Composite Outlet Structure Detailed Report: South Pond Outlet Structure



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 10-Yr and 100-Yr Orifice (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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	0.00
949.00	0.00	0.00	0.00	0.00
949.50	0.00	0.00	0.00	0.00
950.00	0.00	0.00	0.00	0.00
950.50	0.00	0.00	0.00	948.63
951.00	0.00	0.00	0.00	948.64
951.25	0.00	0.00	0.00	948.65
951.50	0.00	0.00	0.00	948.92
952.00	0.00	0.00	0.00	949.16
952.50	0.00	0.00	0.00	949.26
953.00	0.00	0.00	0.00	949.34
953.50	0.00	0.00	0.00	949.40
954.00	22.86	954.00	Free Outfall	950.72
954.50	45.72	954.50	Free Outfall	951.62
955.00	56.00	955.00	Free Outfall	951.98
955.50	64.66	955.50	Free Outfall	952.28

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 10-Yr and 100-Yr Orifice (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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)
956.00	72.30	956.00	Free Outfall	952.54
956.50	79.20	956.50	Free Outfall	952.78
956.75	82.43	956.75	Free Outfall	952.89
957.00	85.54	957.00	Free Outfall	953.26
957.50	79.39	957.50	954.49	954.49
958.00	61.26	958.00	956.20	956.20

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

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.

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = 10-Yr and 100-Yr Orifice (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = Outlet Pipe (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.
Hi=.50; Ht=1.00; Qt=22.86
H =1.00
H =1.50
H =2.00
H =2.50
H =3.00
H =3.25
H =3.50
H =3.01
H =1.80

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
948.50	0.00	(N/A)	0.00
949.00	0.14	(N/A)	0.00
949.50	0.21	(N/A)	0.00
950.00	0.27	(N/A)	0.00
950.50	0.32	(N/A)	0.00
951.00	0.36	(N/A)	0.00
951.25	0.38	(N/A)	0.00
951.50	1.66	(N/A)	0.00
952.00	3.52	(N/A)	0.00
952.50	4.46	(N/A)	0.00
953.00	5.23	(N/A)	0.00
953.50	5.89	(N/A)	0.00
954.00	29.25	(N/A)	0.00
954.50	52.23	(N/A)	0.00
955.00	62.64	(N/A)	0.00
955.50	71.50	(N/A)	0.00
956.00	79.40	(N/A)	0.00
956.50	86.57	(N/A)	0.00
956.75	89.94	(N/A)	0.00
957.00	101.22	(N/A)	0.00
957.50	128.93	(N/A)	0.00
958.00	158.65	(N/A)	0.00

Contributing Structures
(no Q: 2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box,WQ Orifice,Outlet Pipe)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box)

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Contributing Structures
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box)
WQ Orifice,Outlet Pipe (no Q: 2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr and 100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr and 100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr and 100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr and 100-Yr Orifice,Inlet Box)
2-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: 10-Yr and 100-Yr Orifice,Inlet Box)
2-Yr Orifice,10-Yr and 100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr and 100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr and 100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr and 100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr and 100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)

Composite Outlet Structure Detailed Report: South Pond Outlet Structure

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

Contributing Structures
2-Yr Orifice,10-Yr and 100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr and 100-Yr Orifice,WQ Orifice,Outlet Pipe (no Q: Inlet Box)
2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box,WQ Orifice,Outlet Pipe
2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box,WQ Orifice,Outlet Pipe
2-Yr Orifice,10-Yr and 100-Yr Orifice,Inlet Box,WQ Orifice,Outlet Pipe

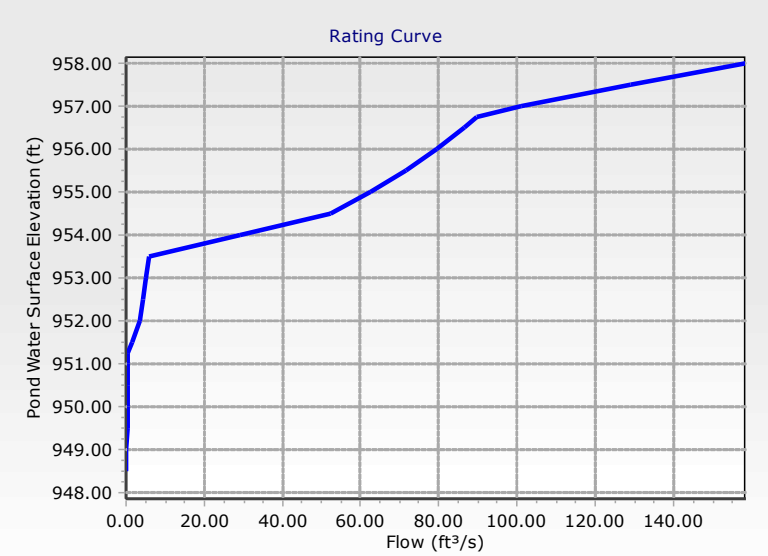
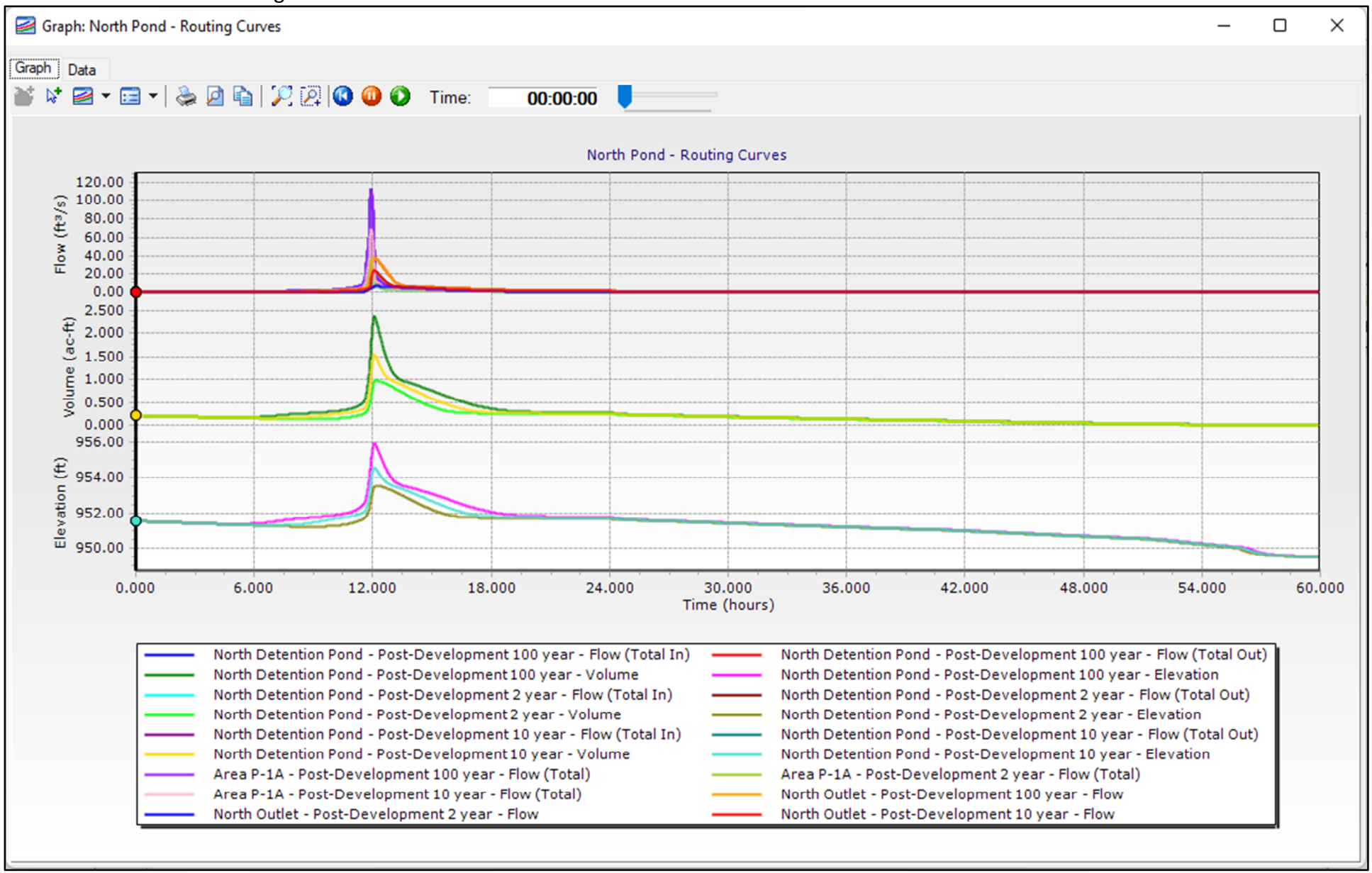


Figure G –
Routing Curves for all Design Storms

North Detention Pond Routing Curves



South Detention Pond Routing Curves

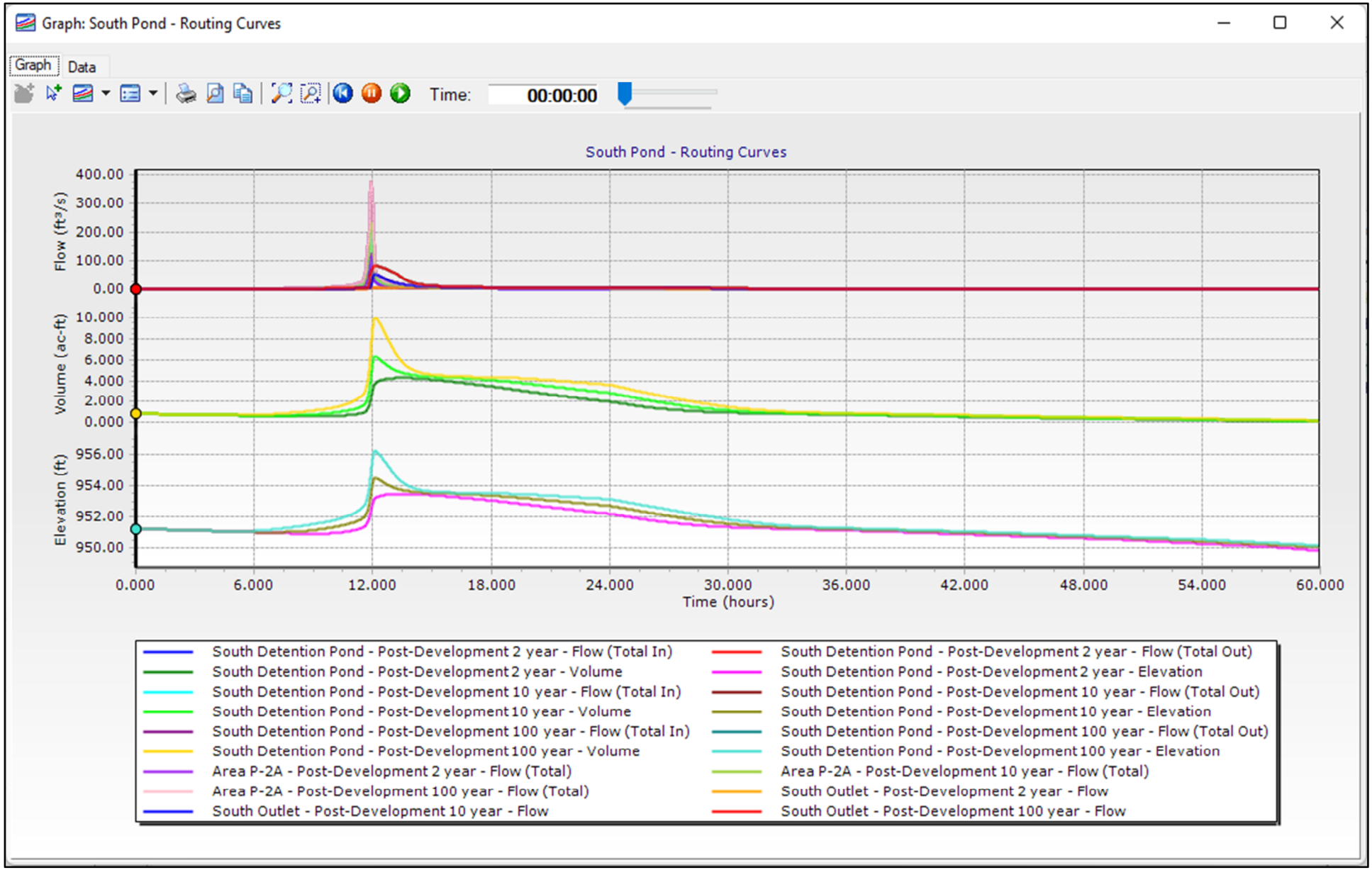


Figure H –
Pondpack Master Summary

Colton's Crossing North Pond

Project Summary	
Title	Colton's Crossing North Pond
Engineer	Matthew Castor
Company	Hg Consult, Inc
Date	11/14/2022

Notes

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Colton's Crossing North Pond

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Area P-1A	Post-Development 2 year	2	2.007	11.920	37.91
Area P-1A	Post-Development 10 year	10	3.723	11.920	69.60
Area P-1A	Post-Development 100 year	100	6.147	11.920	112.56
Area P-1B	Post-Development 2 year	2	0.246	11.920	4.65
Area P-1B	Post-Development 10 year	10	0.457	11.920	8.54
Area P-1B	Post-Development 100 year	100	0.754	11.920	13.81

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
P-1 POI	Post-Development 2 year	2	2.460	11.940	9.10
P-1 POI	Post-Development 10 year	10	4.386	12.030	29.51
P-1 POI	Post-Development 100 year	100	7.108	12.020	46.71

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)
North Detention Pond (IN)	Post-Development 2 year	2	2.007	11.920	37.91	(N/A)	(N/A)
North Detention Pond (OUT)	Post-Development 2 year	2	2.214	12.160	6.65	953.56	0.973
North Detention Pond (IN)	Post-Development 10 year	10	3.723	11.920	69.60	(N/A)	(N/A)
North Detention Pond (OUT)	Post-Development 10 year	10	3.929	12.080	24.18	954.61	1.546

Colton's Crossing North Pond

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)
North Detention Pond (IN)	Post-Development 100 year	100	6.147	11.920	112.56	(N/A)	(N/A)
North Detention Pond (OUT)	Post-Development 100 year	100	6.354	12.080	37.70	955.96	2.388

Colton's Crossing North Pond

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Colton's Crossing South Pond

Project Summary	
Title	Colton's Crossing South Pond
Engineer	Matthew Castor
Company	Hg Consult, Inc
Date	11/14/2022

Notes

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Colton's Crossing South Pond

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Area P-2A	Post-Development 2 year	2	6.717	11.920	126.87
Area P-2A	Post-Development 10 year	10	12.457	11.920	232.92
Area P-2A	Post-Development 100 year	100	20.570	11.920	376.68
Area P-2B	Post-Development 2 year	2	0.753	11.920	14.22
Area P-2B	Post-Development 10 year	10	1.396	11.920	26.10
Area P-2B	Post-Development 100 year	100	2.305	11.920	42.21

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
P-2 POI	Post-Development 2 year	2	8.202	11.930	18.63
P-2 POI	Post-Development 10 year	10	14.537	12.040	65.47
P-2 POI	Post-Development 100 year	100	23.516	12.010	110.54

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)
South Detention Pond (IN)	Post-Development 2 year	2	6.717	11.920	126.87	(N/A)	(N/A)
South Detention Pond (OUT)	Post-Development 2 year	2	7.450	13.510	5.86	953.48	4.268
South Detention Pond (IN)	Post-Development 10 year	10	12.457	11.920	232.92	(N/A)	(N/A)
South Detention Pond (OUT)	Post-Development 10 year	10	13.141	12.110	52.94	954.53	6.386

Colton's Crossing South Pond

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)
South Detention Pond (IN)	Post-Development 100 year	100	20.570	11.920	376.68	(N/A)	(N/A)
South Detention Pond (OUT)	Post-Development 100 year	100	21.211	12.110	82.93	956.25	10.068

Colton's Crossing South Pond

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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:

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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.

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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:*

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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.

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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.

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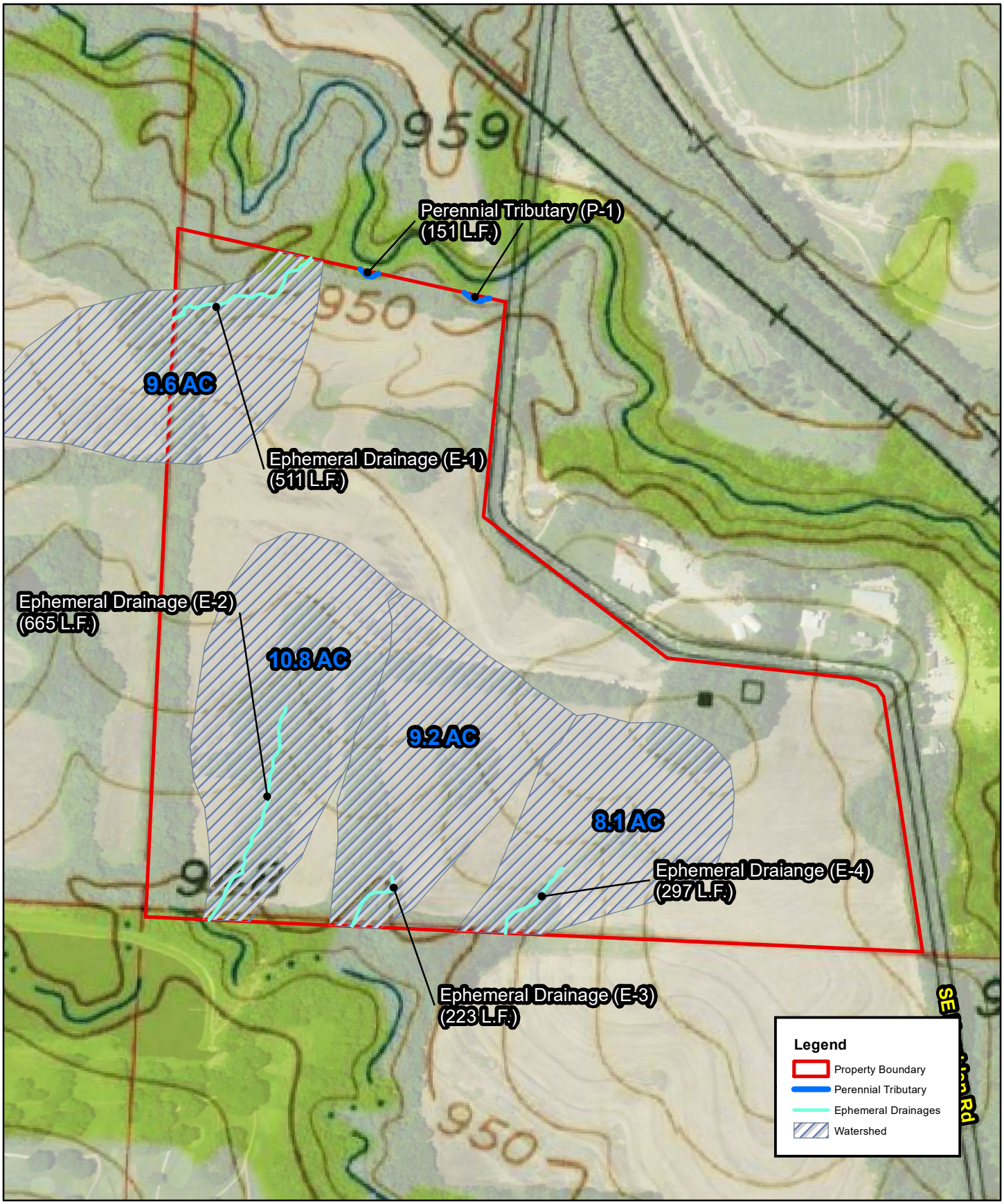


NORTH

0 200 400

1 in. = 400 ft.

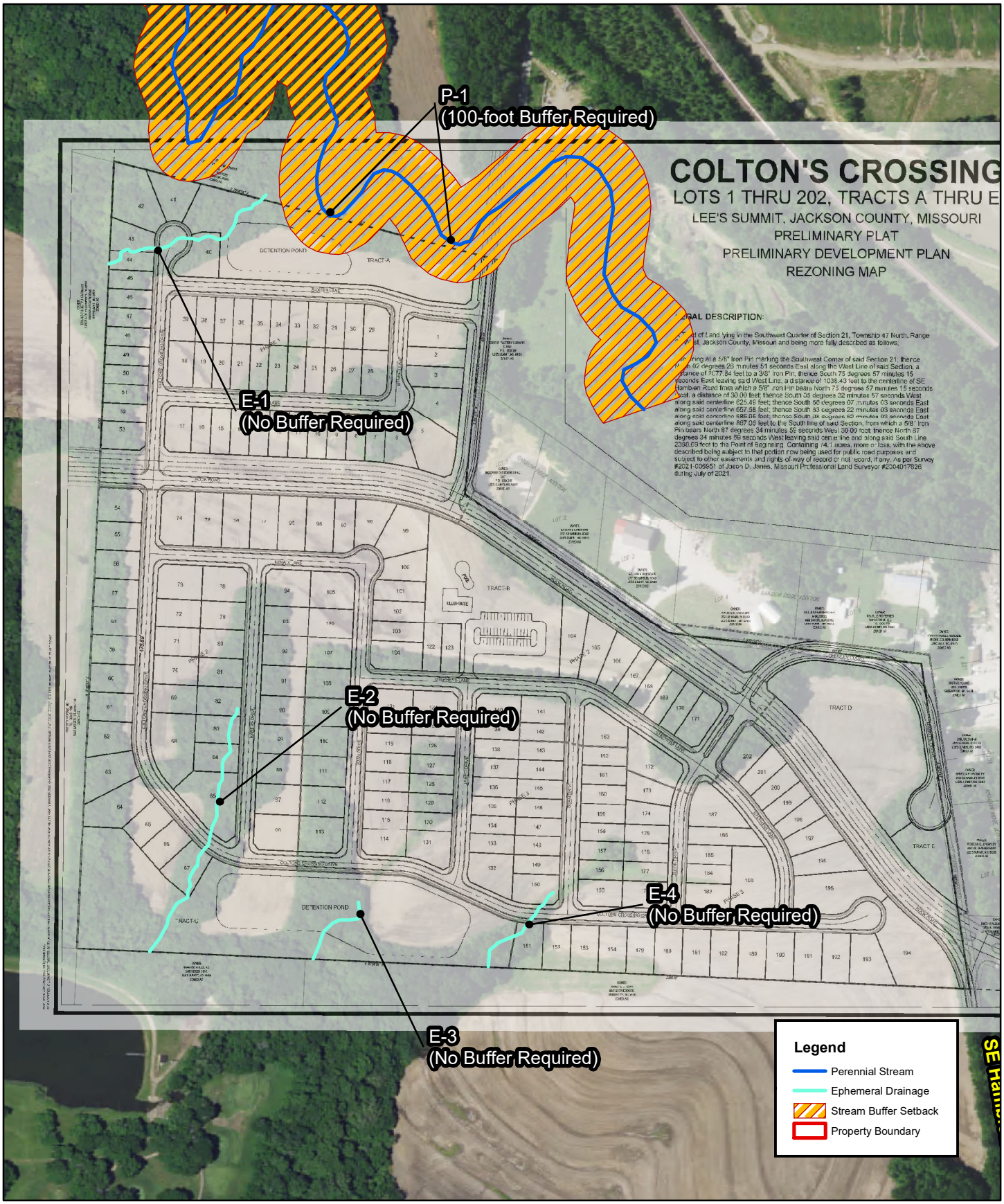
Source: NAIP 2020
Location: SW 1/4 of Sec 21 - T47N - R31W
Lee's Summit, Jackson County, MO
Pleasant Hill, MO 1:24K Quadrangle

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.



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