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DESIGN REPORT

Emm1003114B
Emmet County, Iowa
DU Project #IA-340-13



Prepared by:

Ducks Unlimited, Inc.
Great Lakes/Atlantic Region
In Cooperation with:

Iowa Department of Agriculture and Land Stewardship (IDALS)
And
United States Department of Agriculture (USDA)

January 2025

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.



Andrew Schippers, P.E.

My license number is P26317

My license renewal date is December 31, 2025

Pages of sheets covered by this seal: 1-227

1/22/25
Date



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Introduction

This constructed wetland project is located in Emmet County, Iowa just South of Iowa Lake. The constructed wetland site is situated on two different property owners: 1) Neary Family Farms and 2) Iowa Department of Natural Resources (IADNR). The constructed wetland site is currently in an existing wetland bottom area that does not consistently hold or maintain water. The existing wetland is predominately on the DNR property, however, this project requires the participation of Neary Family Farms due to a portion of the normal water level (NWL) and 100-year storm bounce extending onto the Neary Family Farm property.

Based on our on-site survey and hydrologic resources, the site exhibits a watershed of approximately 1,557.15 acres that routes into the proposed wetland area before routing to Iowa Lake. The land is currently primarily used for public recreation and conservation. A portion of the land on Neary Family Farms within the 100-year storm bounce area is currently being row cropped. The plan is to use the constructed wetland area primarily for water quality, recreation, and the intention of promoting wildlife on the site.

This wetland is planned to provide nutrient reduction benefits. Nitrates will be converted to nitrogen gas through natural processes as the water passes through the wetland. Sediment with phosphorus will also be captured but will need to be removed from the sediment basin(s) on a regular basis.

The site was initially assessed by using remote digital desktop information to see if a wetland at this location was feasible. Payment information was presented to the landowner(s) who expressed interest in participating with this project.

The wetland has been designed using the requirements outlined in NRCS Conservation Practice Standard (CPS), Constructed Wetland, Code 656 (December 2023). The project will include a constructed wetland using a sheet pile weir, berm, and two submerged berms. One tile line will be modified to divert water into the wetland. There are multiple tile that are currently out-letting into the ditch West of the wetland that already outlet at least one foot above the NWL.

The project is a Job V Classification as determined by the Iowa Engineering Job Approval Authority Form IA-ENG-6 (March 2019). Since the wetland primary design standard is CPS 656, Constructed Wetland, and the wetland falls under "Field Runoff Treatment", with a drainage area over 1,000 acres, Job Classification V applies. The Job Classification V is still satisfied with the secondary design standard, CPS 410, Grade Stabilization Structure, since the effective height is less than 35 feet.

IADNR will submit permits for this project, which will include obtaining permits from The State Historic Preservation Office (SHPO), The Army Corps of Engineers, and the Iowa Department of Natural Resources (DNR), and the local Drainage District.

The permanent easement for this project will be on one landowner – Neary Family Farms. An easement will not be provided on the IADNR land. We will be updating the abstract and will have a signed easement recorded for the area as shown on the attached site plan drawing. One 10" tile will be daylighted and allowed to surface flow to the wetland.

Proposed work includes:

- 1) Create berm to impound water within the wetland area, 2) Provide sheet pile primary weir within berm, 3) Daylighting one tile into the wetland, 4) Provide submerged berms for water retention, 5) Provide water control structure for water management, and 6) Seeding and restoration of disturbed areas.



Project Location

Site Characteristics

Pre-Development Conditions

Pre-development conditions for the work area include the uses described in the previous section, which is predominately an agricultural landscape. The surrounding areas outside the work area are mostly grain production agricultural, row crops, but also include pastures and some timber. Mild topography is predominant in the area with small waterways, drainage ditches, and culverts. The majority of ground cover is row crops during the growing season with a combination of row crop residue, tillage areas, and cover crop during non-growing season months. Soil types in the area vary with dominant hydrologic soil group D. Hydrologic soil group D is known to have a slow infiltration rate resulting in high runoff potential when wet. A NRCS Soil Map for Hydrologic Soil Groups within the Area of Interest is located in the appendix of this report. The Area of Interest (AOI) is shown on the NRCS Soil Report and NRCS Hydrologic Soil Report.



Post-Development Conditions

Post-Development conditions will remain the same as pre-development for the basin tributary to the wetland area. This project includes grading within the wetland area itself (sedimentation basin) and creating a berm at the downstream end of the wetland. None of the proposed work will change the tributary area or runoff characteristics of the basin.

It should be noted that the primary design standard for this project is the NRCS CPS, Constructed Wetland, Code 656 (December 2023). The definition of this standard is, “An artificial wetland ecosystem with hydrophytic vegetation for biological treatment of water.” Since the sheet pile weir will be a full flow open structure, NRCS CPS 410, Grade Stabilization Structure (January 2023), is the standard utilized for designing the primary weir and berm.

Embankment Design

CPS 410, Table 1 – Design Criteria for Establishing Minimum Capacity of Full-flow Open Structures was utilized in the design of the embankment and spillway. The Classification initially considered is “All Others” with Drainage Area greater than 900 acres and/or a Vertical Drop greater than 10 feet. This classification requires a minimum storm design frequency of 25 years for the principal spillway capacity, and a storm design frequency of 100-years for the Total Capacity (24-hour duration storm).

CPS 656 also requires the impoundment to have sufficient capacity to handle the peak flow and runoff volume from the 25-year frequency, 24-hour duration storm without overtopping the embankment, and provide erosion protection for the perimeter embankment. This criterion is met with the design, which is able to pass a 100-year storm through the sheet pile weir, while still providing 1-foot of freeboard.

The wetland design exhibits a water storage capacity of 116.061 acre-feet associated with the top of dam contour. The top of dam elevation is 1209.0' and the downstream toe of the dam at the lowest elevation of the outside limit of the dam is approximately 1200.0'. Accordingly, the vertical distance between these two points is 9.0'. Since the water storage capacity associated with the top of dam is greater than 50 acre-feet and the height of the dam is greater than 6 feet, this wetland is considered a jurisdictional dam by Iowa DNR dam safety criteria.

The design criteria for Iowa DNR dam safety for Low Hazard Dams is providing a principal spillway designed for a Q10 (10% probability occurrence per year) without engaging an auxiliary spillway, and then to be able to withstand a Q100 (1% probability occurrence per year) without overtopping the dam. The principal spillway (sheet pile weir) was designed to route a 100-year storm event without an auxiliary spillway. This design criteria satisfies both the NRCS guidelines and the Iowa DNR dam safety criteria.

The sheet pile weir spillway exhibits a 90 feet wide crest with sidewalls that slope up 2:1. The 25-year storm bounce in the wetland is 1206.63' and the 100-year storm bounce in the wetland is 1208.00'. The sheet pile sidewalls are designed at 1208.00', in accordance with CPS 410 design criteria (sidewalls set 0.5' higher than the water surface attained by the principal spillway design discharge and at or above the maximum water surface attained by the total capacity design discharge). The top of embankment was set 1 foot higher than the sheet pile sidewalls (1209.00'). The top of dam contour (1209.00') does extend onto the neighboring property to the Southeast but is contained within the



existing drainage ditch. A temporary water storage permit is planned to be acquired from this landowner.

Based on the Iowa Administrative Code (IAC), Chapter 73, the proposed dam is considered a low hazard dam. Specifically, Section 73.4(1) states, “*Low hazard*. A dam shall be classified as “low hazard” if failure of the dam would result in no probable loss of human life, low economic losses, and low public damages. Based on our review of aerial imagery, on-site inspections, and engineering analysis, the low hazard dam classification is satisfied due to the downstream area of the proposed wetland being approximately 1,100 acres of interconnected lakes primarily surrounded by wildlife areas. There are some houses located along certain portions of Iowa Lake northeast of 570th Avenue, however, even with an entire breach of dam (using the water storage to the top of dam), with instantaneous routing of water from the wetland into the lakes, the lake system would rise approximately 0.1 feet, which would have no adverse impact on the surrounding areas. Furthermore, in the event of an actual breach, water would be controlled by the channel between the wetland and the lake, which would cause the water rise in the lake system to be even less than 0.1 feet.

The foundation preparation of the dam includes site preparation 12 inches below the existing grade for the entire footprint of the dam. Additionally, a core trench will be excavated an additional 3 feet beyond the site preparation along the alignment of the dam for a distance and width, as shown in the construction plans and details. A clay core will be built back from the core trench and up to an elevation equal to the normal water level of the wetland (1202.2'). The clay core material will be compacted using NRCS Method 2, which includes two (2) complete passes of a tamping-type roller made over each layer. The maximum thickness of a lift of fill before compaction shall be 9 inches, unless otherwise indicated on the drawings. The roller shall be capable of exerting a minimum of two hundred (200) pounds per square inch. After the clay core has been constructed, suitable, cohesive material will then be compacted in lifts to an elevation 6 inches below the top of berm elevation. The general berm fill material will be compacted using NRCS Method 1, which includes placing earthfill so that the wheels or tracks of the loaded, hauling equipment, traveling in a direction parallel to the centerline of fill, pass over the entire surface of the layer being placed. Low ground pressure vehicles shall not be used for this purpose. Then, the final lift will be made with topsoil to the top of berm design elevation. The berm will be overbuilt in the field by 5 percent in elevation.

No structural calculations are necessary for the dam design except for the steel sheet pile spillway structure. These calculations are shown in Appendix A-6 of this report. Certain conservative assumptions were made on the soil conditions at the sheet pile structure location, in conjunction with the Iowa NRCS Standard Drawing 1411 (IA-1411) – Steel Sheet Pile Drop Structure (August 2010). This NRCS standard drawing was also utilized in sizing the stilling basin downstream of the berm and spillway.

Two submerged berms have been designed perpendicular to the flow direction in the wetland in order to maximize residence time and increase hydraulic efficiency. These submerged berms are designed with 10-foot-wide tops at elevation 1201.7' (6" below the NWL), provided with 3:1 side slopes.

An auxiliary spillway was considered and not implemented into this design due to the existing topography. The existing topography exhibits two small “hills” on each side of the natural outlet area for the wetland location to Iowa Lake. Due to these hills on each side of the outlet, significant excavation (and tree removal in a wildlife management area) would be required to construct an auxiliary spillway. Accordingly, the primary sheet pile weir was designed to be a full flow structure and accommodate a 100-year rainfall event with one foot of freeboard, without an auxiliary spillway.



Subsurface Drainage Tile Modification

DU performed a tile investigation at the subject property in order to measure location and elevation of multiple known tile, as well as to determine if other tile exist on the property. The result of our investigation is shown in the engineering plans. DU located all known tile and other unknown tile. Modifications to these tile were designed in order to outlet drainage tile inverts at least one foot above the NWL (1203.2'), or else, divert the tile around and downstream of the wetland. Existing pipe flow rate capacities were matches or exceeded with all tile modifications, which is shown in the appendices of this report.

Sedimentation Analysis

DU analyzed the sedimentation accumulation anticipated for this site, which is included in the appendix of this report. Based on our analysis, the wetland would be expected to fill in with sediment after approximately 40 years. Accordingly, a 50'x100' sedimentation basin has been designed for this site at the upstream end of the wetland at the main waterway. The sedimentation basin will allow for periodic maintenance and for removing of sediment captured prior to entering the wetland, which will extend the life of the wetland.

Usage of County Roads

There will be no planned usage of county roads except for when the contractor mobilizes to the site, as well as for hauling materials (rock, grout, etc.).

Floodways, Floodplains, and Wetlands

FEMA Map Number 19063C0250C, located in the appendix of this report, shows the existing wetland and channels within Zone A. Zone A refers to areas within the Special Flood Hazard Area (SFHA) 1% annual chance flood that do not have listed Base Flood Elevation (BFE). No portion of the project area is located within a Regulatory Floodway. The location of the berm was placed in a location of the existing basin where there is not a defined channel.

The U.S. Fish and Wildlife Service National Wetlands Inventory Map located in the appendix of this report shows "Freshwater Emergent" wetland in the basin and channels, and "freshwater" pond in the middle/bottom portion of the basin. As discussed above, the berm was placed in a location of the existing basin where there is not a defined channel.

Runoff Analysis

Watershed

Tributary area to the wetland area is determined to be 1,557.15 acres. This basin was determined with the aid of StreamStats which is a web-based Geographic Information System (GIS) application made available by the United States Geological Survey (USGS). Drainage District and topographic maps were also utilized in order to determine the watershed area. The basin area and other basin characteristics provided by the StreamStats application were reviewed prior to being referenced for this project. A watershed map and StreamStats informational report are included in the appendix of this report.



Time of Concentration

Time of Concentration was calculated using the NRCS Lag Method which is appropriate for this watershed due to its rural character and long hydraulic length. Flow length of the watershed is shown on the watershed map in the appendix of this report, which was derived from StreamStats. NRCS Lag Method considers the flow length, average watershed slope, and maximum potential retention which is a factor of the SCS curve number (CN). Flow length, average watershed slope, and CN used for runoff analysis for this watershed are listed in the HydroCAD Report in the appendix. The average slope of the entire watershed taken from LiDAR data (3.20%) was utilized in this analysis.

Precipitation Model

The rainfall events and intensities were obtained from the HydroCAD for Emmet County, Iowa, MSE, 24-hour, Storm Curve 4 (MSE4). These rainfall events were compared to the MSE 4 rainfall intensities provided by Title 210, National Engineering Handbook, 2nd Ed., Amend. 1, July 2021, Figure IA2-25, Wright County, NOAA 14 Rainfall Type MSE4. The HydroCAD Report in the appendix reflects the precipitation model and rainfall intensities for MSE4.

Runoff Model

SCS TR-20 NRCS Peak Flow method was utilized as a runoff model. SCS methods combine land use and soil type into a single parameter known as the Curve Number (CN). Based on the various land uses and the hydrologic soil groups (predominately HSG D) within the watershed discussed earlier in this report, a weighted CN of 84 was determined to be appropriate assuming straight row crops plus crop residue in good condition.

Runoff Conveyance

Hydraulic Model

HydroCAD 10.20-2g was utilized to model the watershed. Input parameters include watershed size, SCS CN (determined by land use and soil types), time of concentration calculations, precipitation input, stage-storage, discharge, and outlet details. The watershed was modeled with the proposed berm and principal spillway. The HydroCAD Hydrograph Report is included in the appendix.

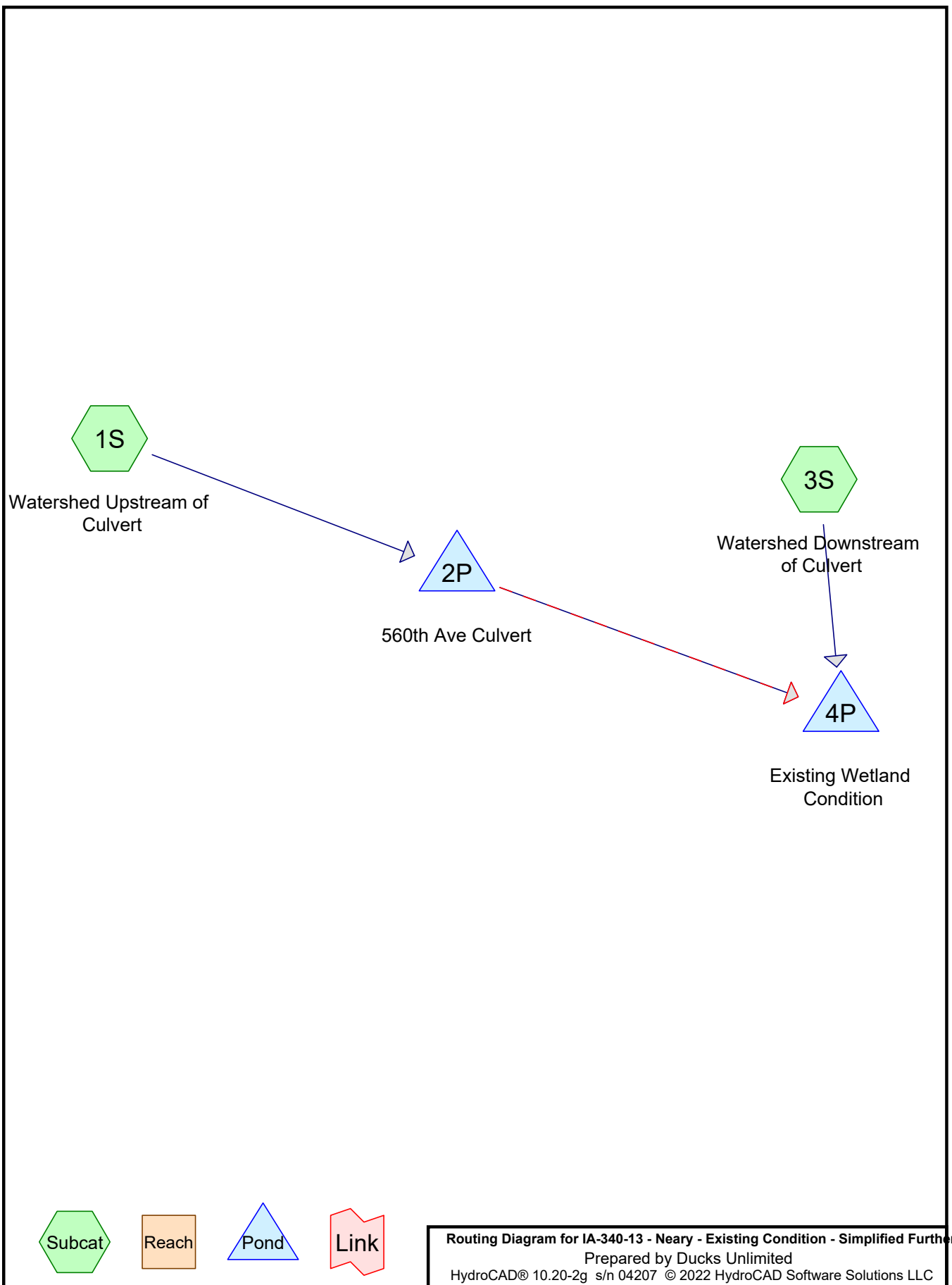
Summary & Conclusions

This project does not change the natural drainage area, drainage courses, runoff coefficients, or any other characteristics of the watershed. A berm will be constructed at the downstream end of the wetland, which will be designed to accommodate a 100-year design storm without affecting neighboring properties. Significant benefits to the wetland area and areas upstream of the wetland area include improving water quality, promotion of wildlife habitat, as well as a nutrient and sediment buffer.



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Appendix A-1
HydroCAD Report – Existing Conditions



IA-340-13 - Neary - Existing Condition - Simplified Further

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Project Notes

Copied 10 events from IOWA-SHEY 9-27-23 24-hr S1 storm
Rainfall events imported from "NRCS-Rain.txt" for 1454 IA Kossuth
Rainfall events imported from "NRCS-Rain.txt" for 1454 IA Kossuth
Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
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IA-340-13 - Neary - Existing Condition - Simplified Further

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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	10-Year	MSE 24-hr	4	Default	24.00	1	4.43	2
2	25-Year	MSE 24-hr	4	Default	24.00	1	5.57	2
3	100-Year	MSE 24-hr	4	Default	24.00	1	7.69	2

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1,557.150	84	Weighted Average (1S, 3S)
1,557.150	84	TOTAL AREA

IA-340-13 - Neary - Existing Condition - Simplified Further

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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
1,557.150	Other	1S, 3S
1,557.150		TOTAL AREA

IA-340-13 - Neary - Existing Condition - Simplified Further

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	1,557.150	1,557.150	Weighted Average	1S, 3S
0.000	0.000	0.000	0.000	1,557.150	1,557.150	TOTAL AREA	

IA-340-13 - Neary - Existing Condition - Simplified Further

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Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	2P	1,226.36	1,226.36	25.0	0.0000	0.012	72.0	60.0	0.0

IA-340-13 - Neary - Existing Condition - Simplified Further

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Notes Listing (all nodes)

Line#	Node Number	Notes
1	Project	Copied 10 events from IOWA-SHEY 9-27-23 24-hr S1 storm
2		Rainfall events imported from "NRCS-Rain.txt" for 1454 IA Kossuth
3		Rainfall events imported from "NRCS-Rain.txt" for 1454 IA Kossuth
4		Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
5		Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
6		Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
7		Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet

IA-340-13 - Neary - Existing Condition - Simplified FurtMSE 24-hr 4 10-Year Rainfall=4.43"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Watershed Upstream Runoff Area=899.170 ac 0.00% Impervious Runoff Depth=2.75"
Flow Length=11,480' Slope=0.0320 '/' Tc=109.9 min CN=84 Runoff=866.81 cfs 206.334 af

Subcatchment3S: Watershed Runoff Area=657.980 ac 0.00% Impervious Runoff Depth=2.75"
Flow Length=7,292' Slope=0.0320 '/' Tc=76.4 min CN=84 Runoff=816.20 cfs 150.988 af

Pond 2P: 560th Ave Culvert Peak Elev=1,235.54' Storage=5.743 af Inflow=866.81 cfs 206.334 af
Primary=397.66 cfs 158.433 af Secondary=457.42 cfs 47.901 af Outflow=855.07 cfs 206.334 af

Pond 4P: Existing Wetland Peak Elev=1,205.18' Storage=45.707 af Inflow=1,520.50 cfs 357.322 af
Outflow=1,411.67 cfs 357.297 af

Total Runoff Area = 1,557.150 ac Runoff Volume = 357.322 af Average Runoff Depth = 2.75"
100.00% Pervious = 1,557.150 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Watershed Upstream of Culvert

Runoff = 866.81 cfs @ 13.49 hrs, Volume= 206.334 af, Depth= 2.75"
 Routed to Pond 2P : 560th Ave Culvert

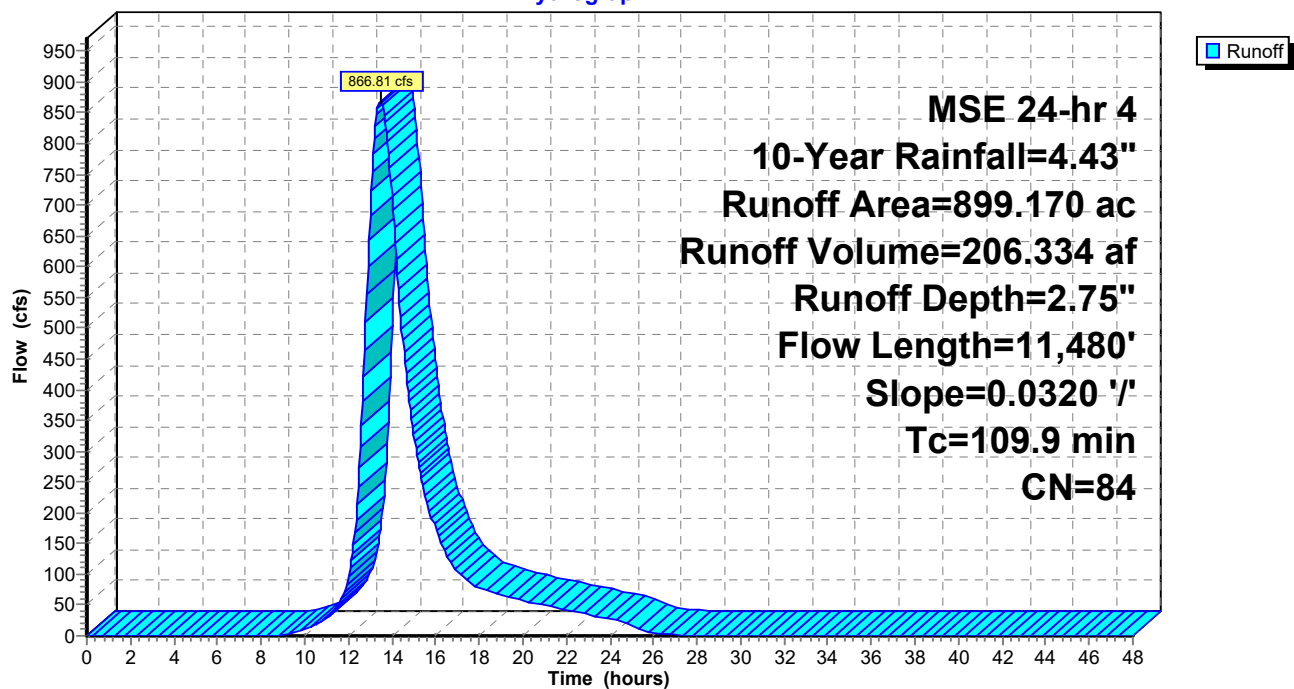
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 MSE 24-hr 4 10-Year Rainfall=4.43"

Area (ac)	CN	Description
* 899.170	84	Weighted Average
899.170		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
109.9	11,480	0.0320	1.74		Lag/CN Method, Existing Watershed Tc

Subcatchment 1S: Watershed Upstream of Culvert

Hydrograph



IA-340-13 - Neary - Existing Condition - Simplified FurtMSE 24-hr 4 10-Year Rainfall=4.43"

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Hydrograph for Subcatchment 1S: Watershed Upstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	26.00	4.43	2.75	5.43
0.50	0.01	0.00	0.00	26.50	4.43	2.75	2.75
1.00	0.02	0.00	0.00	27.00	4.43	2.75	1.39
1.50	0.04	0.00	0.00	27.50	4.43	2.75	0.69
2.00	0.05	0.00	0.00	28.00	4.43	2.75	0.34
2.50	0.07	0.00	0.00	28.50	4.43	2.75	0.16
3.00	0.09	0.00	0.00	29.00	4.43	2.75	0.07
3.50	0.12	0.00	0.00	29.50	4.43	2.75	0.02
4.00	0.14	0.00	0.00	30.00	4.43	2.75	0.00
4.50	0.17	0.00	0.00	30.50	4.43	2.75	0.00
5.00	0.20	0.00	0.00	31.00	4.43	2.75	0.00
5.50	0.24	0.00	0.00	31.50	4.43	2.75	0.00
6.00	0.27	0.00	0.00	32.00	4.43	2.75	0.00
6.50	0.31	0.00	0.00	32.50	4.43	2.75	0.00
7.00	0.35	0.00	0.00	33.00	4.43	2.75	0.00
7.50	0.39	0.00	0.00	33.50	4.43	2.75	0.00
8.00	0.44	0.00	0.05	34.00	4.43	2.75	0.00
8.50	0.49	0.01	0.55	34.50	4.43	2.75	0.00
9.00	0.54	0.01	2.10	35.00	4.43	2.75	0.00
9.50	0.62	0.03	4.93	35.50	4.43	2.75	0.00
10.00	0.70	0.05	9.98	36.00	4.43	2.75	0.00
10.50	0.79	0.07	18.03	36.50	4.43	2.75	0.00
11.00	0.96	0.13	28.65	37.00	4.43	2.75	0.00
11.50	1.20	0.25	47.80	37.50	4.43	2.75	0.00
12.00	2.08	0.80	92.52	38.00	4.43	2.75	0.00
12.50	3.23	1.71	273.52	38.50	4.43	2.75	0.00
13.00	3.47	1.91	683.98	39.00	4.43	2.75	0.00
13.50	3.64	2.05	866.80	39.50	4.43	2.75	0.00
14.00	3.73	2.13	714.92	40.00	4.43	2.75	0.00
14.50	3.81	2.21	479.79	40.50	4.43	2.75	0.00
15.00	3.89	2.28	326.72	41.00	4.43	2.75	0.00
15.50	3.94	2.32	232.44	41.50	4.43	2.75	0.00
16.00	3.99	2.36	173.87	42.00	4.43	2.75	0.00
16.50	4.04	2.40	132.63	42.50	4.43	2.75	0.00
17.00	4.08	2.44	105.01	43.00	4.43	2.75	0.00
17.50	4.12	2.48	88.76	43.50	4.43	2.75	0.00
18.00	4.16	2.51	77.93	44.00	4.43	2.75	0.00
18.50	4.19	2.54	70.47	44.50	4.43	2.75	0.00
19.00	4.23	2.57	65.47	45.00	4.43	2.75	0.00
19.50	4.26	2.60	61.19	45.50	4.43	2.75	0.00
20.00	4.29	2.62	57.24	46.00	4.43	2.75	0.00
20.50	4.31	2.65	53.39	46.50	4.43	2.75	0.00
21.00	4.34	2.67	49.59	47.00	4.43	2.75	0.00
21.50	4.36	2.69	45.83	47.50	4.43	2.75	0.00
22.00	4.38	2.71	42.06	48.00	4.43	2.75	0.00
22.50	4.39	2.72	38.28				
23.00	4.41	2.73	34.49				
23.50	4.42	2.74	30.69				
24.00	4.43	2.75	26.88				
24.50	4.43	2.75	22.80				
25.00	4.43	2.75	17.11				
25.50	4.43	2.75	10.44				

Summary for Subcatchment 3S: Watershed Downstream of Culvert

Runoff = 816.20 cfs @ 13.01 hrs, Volume= 150.988 af, Depth= 2.75"
Routed to Pond 4P : Existing Wetland Condition

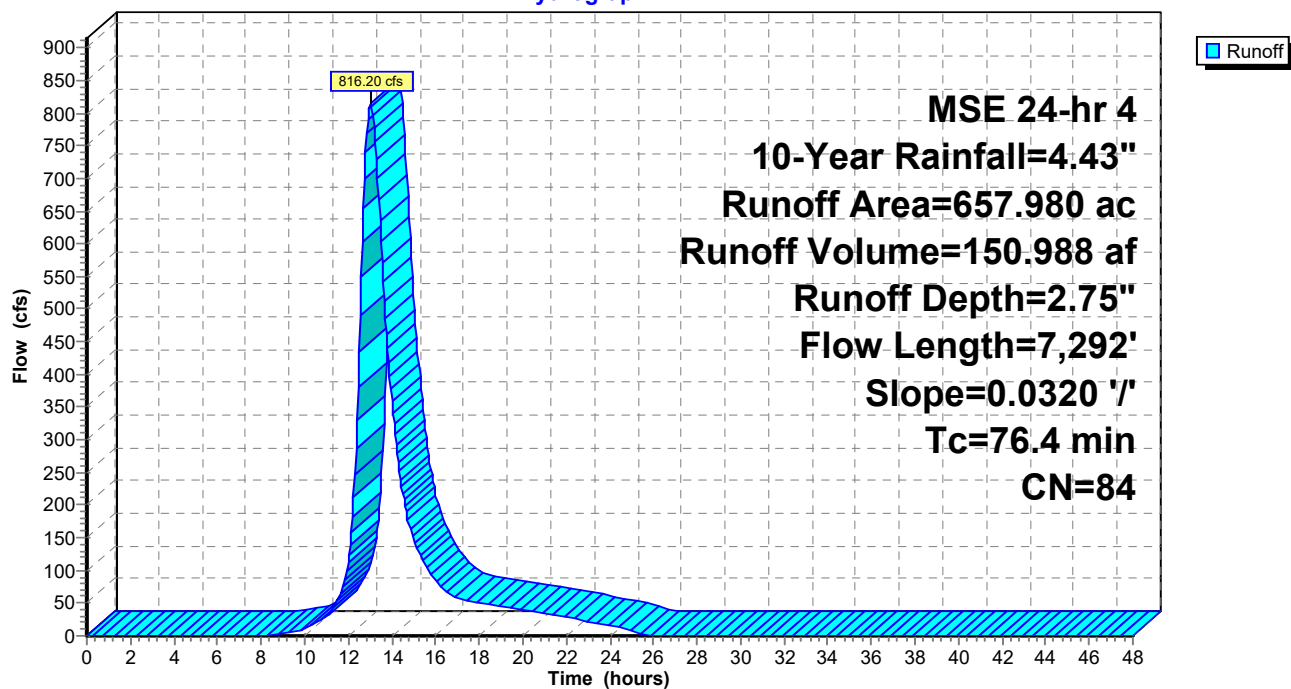
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 10-Year Rainfall=4.43"

Area (ac)	CN	Description
* 657.980	84	Weighted Average
657.980		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
76.4	7,292	0.0320	1.59		Lag/CN Method,

Subcatchment 3S: Watershed Downstream of Culvert

Hydrograph



Hydrograph for Subcatchment 3S: Watershed Downstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	26.00	4.43	2.75	1.10
0.50	0.01	0.00	0.00	26.50	4.43	2.75	0.41
1.00	0.02	0.00	0.00	27.00	4.43	2.75	0.14
1.50	0.04	0.00	0.00	27.50	4.43	2.75	0.04
2.00	0.05	0.00	0.00	28.00	4.43	2.75	0.01
2.50	0.07	0.00	0.00	28.50	4.43	2.75	0.00
3.00	0.09	0.00	0.00	29.00	4.43	2.75	0.00
3.50	0.12	0.00	0.00	29.50	4.43	2.75	0.00
4.00	0.14	0.00	0.00	30.00	4.43	2.75	0.00
4.50	0.17	0.00	0.00	30.50	4.43	2.75	0.00
5.00	0.20	0.00	0.00	31.00	4.43	2.75	0.00
5.50	0.24	0.00	0.00	31.50	4.43	2.75	0.00
6.00	0.27	0.00	0.00	32.00	4.43	2.75	0.00
6.50	0.31	0.00	0.00	32.50	4.43	2.75	0.00
7.00	0.35	0.00	0.00	33.00	4.43	2.75	0.00
7.50	0.39	0.00	0.00	33.50	4.43	2.75	0.00
8.00	0.44	0.00	0.12	34.00	4.43	2.75	0.00
8.50	0.49	0.01	1.06	34.50	4.43	2.75	0.00
9.00	0.54	0.01	3.08	35.00	4.43	2.75	0.00
9.50	0.62	0.03	6.13	35.50	4.43	2.75	0.00
10.00	0.70	0.05	12.10	36.00	4.43	2.75	0.00
10.50	0.79	0.07	20.02	36.50	4.43	2.75	0.00
11.00	0.96	0.13	29.90	37.00	4.43	2.75	0.00
11.50	1.20	0.25	54.58	37.50	4.43	2.75	0.00
12.00	2.08	0.80	113.39	38.00	4.43	2.75	0.00
12.50	3.23	1.71	434.38	38.50	4.43	2.75	0.00
13.00	3.47	1.91	815.81	39.00	4.43	2.75	0.00
13.50	3.64	2.05	603.51	39.50	4.43	2.75	0.00
14.00	3.73	2.13	358.91	40.00	4.43	2.75	0.00
14.50	3.81	2.21	217.86	40.50	4.43	2.75	0.00
15.00	3.89	2.28	145.58	41.00	4.43	2.75	0.00
15.50	3.94	2.32	112.03	41.50	4.43	2.75	0.00
16.00	3.99	2.36	85.59	42.00	4.43	2.75	0.00
16.50	4.04	2.40	66.60	42.50	4.43	2.75	0.00
17.00	4.08	2.44	58.25	43.00	4.43	2.75	0.00
17.50	4.12	2.48	53.52	43.50	4.43	2.75	0.00
18.00	4.16	2.51	50.14	44.00	4.43	2.75	0.00
18.50	4.19	2.54	47.19	44.50	4.43	2.75	0.00
19.00	4.23	2.57	44.40	45.00	4.43	2.75	0.00
19.50	4.26	2.60	41.67	45.50	4.43	2.75	0.00
20.00	4.29	2.62	38.95	46.00	4.43	2.75	0.00
20.50	4.31	2.65	36.22	46.50	4.43	2.75	0.00
21.00	4.34	2.67	33.48	47.00	4.43	2.75	0.00
21.50	4.36	2.69	30.72	47.50	4.43	2.75	0.00
22.00	4.38	2.71	27.95	48.00	4.43	2.75	0.00
22.50	4.39	2.72	25.17				
23.00	4.41	2.73	22.38				
23.50	4.42	2.74	19.58				
24.00	4.43	2.75	16.78				
24.50	4.43	2.75	13.35				
25.00	4.43	2.75	7.46				
25.50	4.43	2.75	2.93				

Summary for Pond 2P: 560th Ave Culvert

Inflow Area = 899.170 ac, 0.00% Impervious, Inflow Depth = 2.75" for 10-Year event
 Inflow = 866.81 cfs @ 13.49 hrs, Volume= 206.334 af
 Outflow = 855.07 cfs @ 13.61 hrs, Volume= 206.334 af, Atten= 1%, Lag= 7.3 min
 Primary = 397.66 cfs @ 13.61 hrs, Volume= 158.433 af
 Routed to Pond 4P : Existing Wetland Condition
 Secondary = 457.42 cfs @ 13.61 hrs, Volume= 47.901 af
 Routed to Pond 4P : Existing Wetland Condition

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 1,235.54' @ 13.61 hrs Surf.Area= 10.572 ac Storage= 5.743 af

Plug-Flow detention time= 2.7 min calculated for 206.119 af (100% of inflow)
 Center-of-Mass det. time= 2.7 min (903.5 - 900.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,226.00'	66.349 af	Custom Stage Data from Lidar (Prismatic) listed below (Recalc)

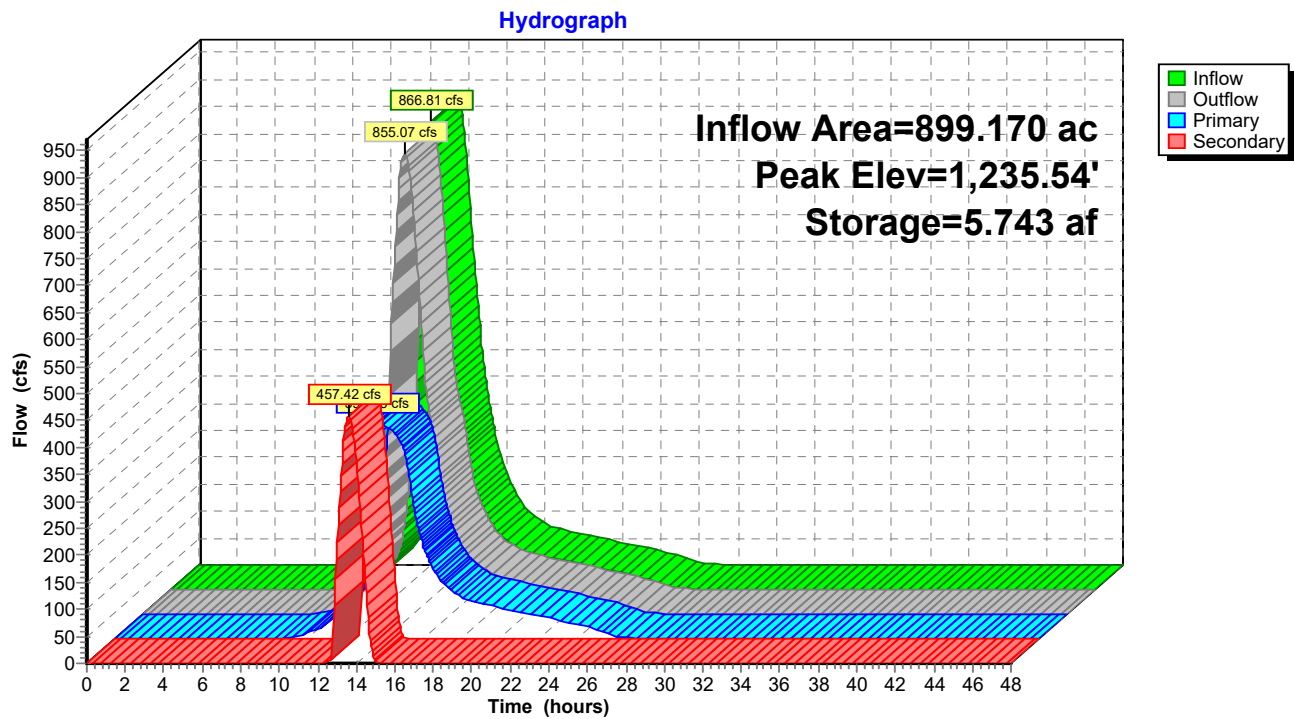
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,226.00	0.001	0.000	0.000
1,227.00	0.002	0.002	0.002
1,228.00	0.003	0.003	0.004
1,229.00	0.006	0.005	0.008
1,230.00	0.016	0.011	0.020
1,231.00	0.038	0.027	0.046
1,232.00	0.082	0.060	0.106
1,233.00	0.422	0.252	0.358
1,234.00	0.999	0.710	1.069
1,235.00	1.702	1.350	2.419
1,236.00	18.079	9.890	12.310
1,237.00	25.000	21.539	33.849
1,238.00	40.000	32.500	66.349

Device	Routing	Invert	Outlet Devices
#1	Primary	1,226.36'	72.0" W x 60.0" H Box Existing 5x6 Road Culvert L= 25.0' Box, 30-75° wingwalls, square crown, Ke= 0.400 Inlet / Outlet Invert= 1,226.36' / 1,226.36' S= 0.0000 ' / Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 30.00 sf
#2	Secondary	1,234.37'	Gravel Road - Asymmetrical Weir, C= 3.27 Offset (feet) -214.93 -167.93 -88.67 0.00 82.37 132.11 157.11 Elev. (feet) 1,237.00 1,236.27 1,235.04 1,234.37 1,235.06 1,236.20 1,237.00

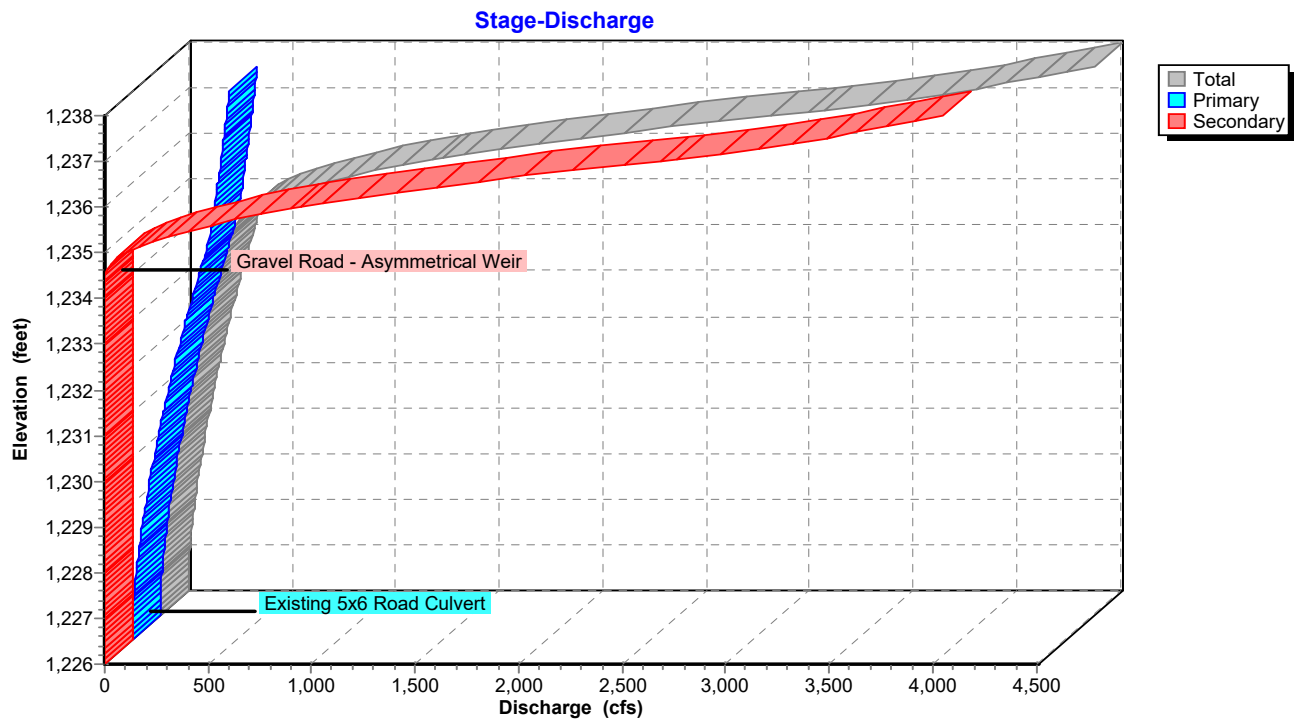
Primary OutFlow Max=397.64 cfs @ 13.61 hrs HW=1,235.54' TW=1,205.18' (Dynamic Tailwater)
 ↑1=Existing 5x6 Road Culvert (Inlet Controls 397.64 cfs @ 13.25 fps)

Secondary OutFlow Max=457.08 cfs @ 13.61 hrs HW=1,235.54' TW=1,205.18' (Dynamic Tailwater)
 ↑2=Gravel Road - Asymmetrical Weir (Weir Controls 457.08 cfs @ 2.02 fps)

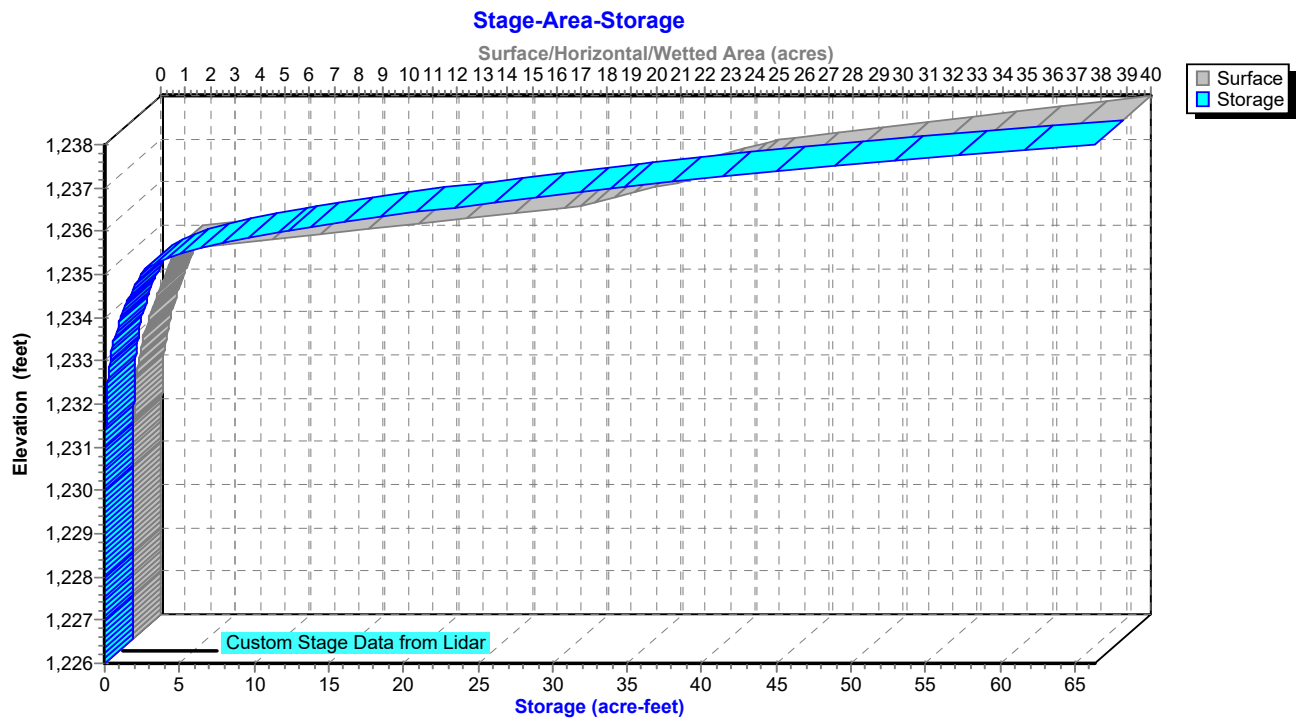
Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Hydrograph for Pond 2P: 560th Ave Culvert

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	0.000	1,226.00	0.00	0.00	0.00
1.00	0.00	0.000	1,226.00	0.00	0.00	0.00
2.00	0.00	0.000	1,226.00	0.00	0.00	0.00
3.00	0.00	0.000	1,226.00	0.00	0.00	0.00
4.00	0.00	0.000	1,226.00	0.00	0.00	0.00
5.00	0.00	0.000	1,226.00	0.00	0.00	0.00
6.00	0.00	0.000	1,226.00	0.00	0.00	0.00
7.00	0.00	0.000	1,226.00	0.00	0.00	0.00
8.00	0.05	0.000	1,226.39	0.02	0.02	0.00
9.00	2.10	0.001	1,226.67	2.10	2.10	0.00
10.00	9.98	0.002	1,227.16	9.97	9.97	0.00
11.00	28.65	0.004	1,227.93	28.62	28.62	0.00
12.00	92.52	0.015	1,229.72	91.86	91.86	0.00
13.00	683.98	3.256	1,235.23	612.64	388.10	224.55
14.00	714.92	4.770	1,235.44	768.22	394.60	373.62
15.00	326.72	1.667	1,234.51	354.68	352.35	2.33
16.00	173.87	0.072	1,231.51	175.29	175.29	0.00
17.00	105.01	0.020	1,230.04	105.21	105.21	0.00
18.00	77.93	0.011	1,229.38	77.99	77.99	0.00
19.00	65.47	0.009	1,229.05	65.50	65.50	0.00
20.00	57.24	0.007	1,228.82	57.25	57.25	0.00
21.00	49.59	0.006	1,228.60	49.61	49.61	0.00
22.00	42.06	0.005	1,228.37	42.07	42.07	0.00
23.00	34.49	0.004	1,228.13	34.50	34.50	0.00
24.00	26.88	0.004	1,227.87	26.89	26.89	0.00
25.00	17.11	0.003	1,227.49	17.12	17.12	0.00
26.00	5.43	0.001	1,226.91	5.44	5.44	0.00
27.00	1.39	0.001	1,226.61	1.40	1.40	0.00
28.00	0.34	0.001	1,226.47	0.34	0.34	0.00
29.00	0.07	0.000	1,226.41	0.07	0.07	0.00
30.00	0.00	0.000	1,226.37	0.00	0.00	0.00
31.00	0.00	0.000	1,226.36	0.00	0.00	0.00
32.00	0.00	0.000	1,226.36	0.00	0.00	0.00
33.00	0.00	0.000	1,226.36	0.00	0.00	0.00
34.00	0.00	0.000	1,226.36	0.00	0.00	0.00
35.00	0.00	0.000	1,226.36	0.00	0.00	0.00
36.00	0.00	0.000	1,226.36	0.00	0.00	0.00
37.00	0.00	0.000	1,226.36	0.00	0.00	0.00
38.00	0.00	0.000	1,226.36	0.00	0.00	0.00
39.00	0.00	0.000	1,226.36	0.00	0.00	0.00
40.00	0.00	0.000	1,226.36	0.00	0.00	0.00
41.00	0.00	0.000	1,226.36	0.00	0.00	0.00
42.00	0.00	0.000	1,226.36	0.00	0.00	0.00
43.00	0.00	0.000	1,226.36	0.00	0.00	0.00
44.00	0.00	0.000	1,226.36	0.00	0.00	0.00
45.00	0.00	0.000	1,226.36	0.00	0.00	0.00
46.00	0.00	0.000	1,226.36	0.00	0.00	0.00
47.00	0.00	0.000	1,226.36	0.00	0.00	0.00
48.00	0.00	0.000	1,226.36	0.00	0.00	0.00

Stage-Discharge for Pond 2P: 560th Ave Culvert

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
1,226.00	0.00	0.00	0.00	1,236.40	1,958.33	422.99	1,535.35
1,226.20	0.00	0.00	0.00	1,236.60	2,310.52	428.67	1,881.85
1,226.40	0.04	0.04	0.00	1,236.80	2,699.76	434.27	2,265.49
1,226.60	1.34	1.34	0.00	1,237.00	3,126.75	439.79	2,686.95
1,226.80	3.79	3.79	0.00	1,237.20	3,481.18	445.25	3,035.93
1,227.00	7.01	7.01	0.00	1,237.40	3,776.53	450.64	3,325.89
1,227.20	10.82	10.82	0.00	1,237.60	4,041.43	455.96	3,585.47
1,227.40	15.14	15.14	0.00	1,237.80	4,285.19	461.22	3,823.97
1,227.60	19.92	19.92	0.00	1,238.00	4,512.80	466.42	4,046.38
1,227.80	25.12	25.12	0.00				
1,228.00	30.69	30.69	0.00				
1,228.20	36.63	36.63	0.00				
1,228.40	42.91	42.91	0.00				
1,228.60	49.50	49.50	0.00				
1,228.80	56.40	56.40	0.00				
1,229.00	63.59	63.59	0.00				
1,229.20	71.07	71.07	0.00				
1,229.40	78.81	78.81	0.00				
1,229.60	86.82	86.82	0.00				
1,229.80	95.08	95.08	0.00				
1,230.00	103.58	103.58	0.00				
1,230.20	112.33	112.33	0.00				
1,230.40	121.30	121.30	0.00				
1,230.60	130.51	130.51	0.00				
1,230.80	139.93	139.93	0.00				
1,231.00	149.57	149.57	0.00				
1,231.20	159.42	159.42	0.00				
1,231.40	169.48	169.48	0.00				
1,231.60	179.74	179.74	0.00				
1,231.80	190.20	190.20	0.00				
1,232.00	200.86	200.86	0.00				
1,232.20	211.71	211.71	0.00				
1,232.40	222.74	222.74	0.00				
1,232.60	233.96	233.96	0.00				
1,232.80	245.36	245.36	0.00				
1,233.00	256.95	256.95	0.00				
1,233.20	269.38	269.38	0.00				
1,233.40	283.64	283.64	0.00				
1,233.60	297.22	297.22	0.00				
1,233.80	310.20	310.20	0.00				
1,234.00	322.67	322.67	0.00				
1,234.20	334.66	334.66	0.00				
1,234.40	346.30	346.25	0.05				
1,234.60	365.81	357.46	8.35				
1,234.80	408.24	368.32	39.92				
1,235.00	482.60	378.88	103.72				
1,235.20	592.10	387.09	205.01				
1,235.40	734.23	393.31	340.92				
1,235.60	909.80	399.43	510.37				
1,235.80	1,119.19	405.46	713.74				
1,236.00	1,363.16	411.39	951.77				
1,236.20	1,642.64	417.23	1,225.41				

Stage-Area-Storage for Pond 2P: 560th Ave Culvert

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,226.00	0.001	0.000	1,236.40	20.847	20.095
1,226.20	0.001	0.000	1,236.60	22.232	24.403
1,226.40	0.001	0.000	1,236.80	23.616	28.988
1,226.60	0.002	0.001	1,237.00	25.000	33.849
1,226.80	0.002	0.001	1,237.20	28.000	39.150
1,227.00	0.002	0.002	1,237.40	31.000	45.050
1,227.20	0.002	0.002	1,237.60	34.000	51.549
1,227.40	0.002	0.002	1,237.80	37.000	58.649
1,227.60	0.003	0.003	1,238.00	40.000	66.349
1,227.80	0.003	0.003			
1,228.00	0.003	0.004			
1,228.20	0.004	0.005			
1,228.40	0.004	0.005			
1,228.60	0.005	0.006			
1,228.80	0.005	0.007			
1,229.00	0.006	0.008			
1,229.20	0.008	0.010			
1,229.40	0.010	0.012			
1,229.60	0.012	0.014			
1,229.80	0.014	0.016			
1,230.00	0.016	0.020			
1,230.20	0.020	0.023			
1,230.40	0.025	0.028			
1,230.60	0.029	0.033			
1,230.80	0.034	0.039			
1,231.00	0.038	0.046			
1,231.20	0.047	0.055			
1,231.40	0.056	0.065			
1,231.60	0.064	0.077			
1,231.80	0.073	0.091			
1,232.00	0.082	0.106			
1,232.20	0.150	0.130			
1,232.40	0.218	0.167			
1,232.60	0.286	0.217			
1,232.80	0.354	0.281			
1,233.00	0.422	0.358			
1,233.20	0.537	0.454			
1,233.40	0.653	0.573			
1,233.60	0.768	0.716			
1,233.80	0.884	0.881			
1,234.00	0.999	1.069			
1,234.20	1.140	1.283			
1,234.40	1.280	1.525			
1,234.60	1.421	1.795			
1,234.80	1.561	2.093			
1,235.00	1.702	2.419			
1,235.20	4.977	3.087			
1,235.40	8.253	4.410			
1,235.60	11.528	6.389			
1,235.80	14.804	9.022			
1,236.00	18.079	12.310			
1,236.20	19.463	16.064			

Summary for Pond 4P: Existing Wetland Condition

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 2.75" for 10-Year event
 Inflow = 1,520.50 cfs @ 13.26 hrs, Volume= 357.322 af
 Outflow = 1,411.67 cfs @ 13.57 hrs, Volume= 357.297 af, Atten= 7%, Lag= 19.1 min
 Primary = 1,411.67 cfs @ 13.57 hrs, Volume= 357.297 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 1,205.18' @ 13.57 hrs Surf.Area= 14.144 ac Storage= 45.707 af

Plug-Flow detention time= 33.2 min calculated for 356.925 af (100% of inflow)
 Center-of-Mass det. time= 33.4 min (922.5 - 889.1)

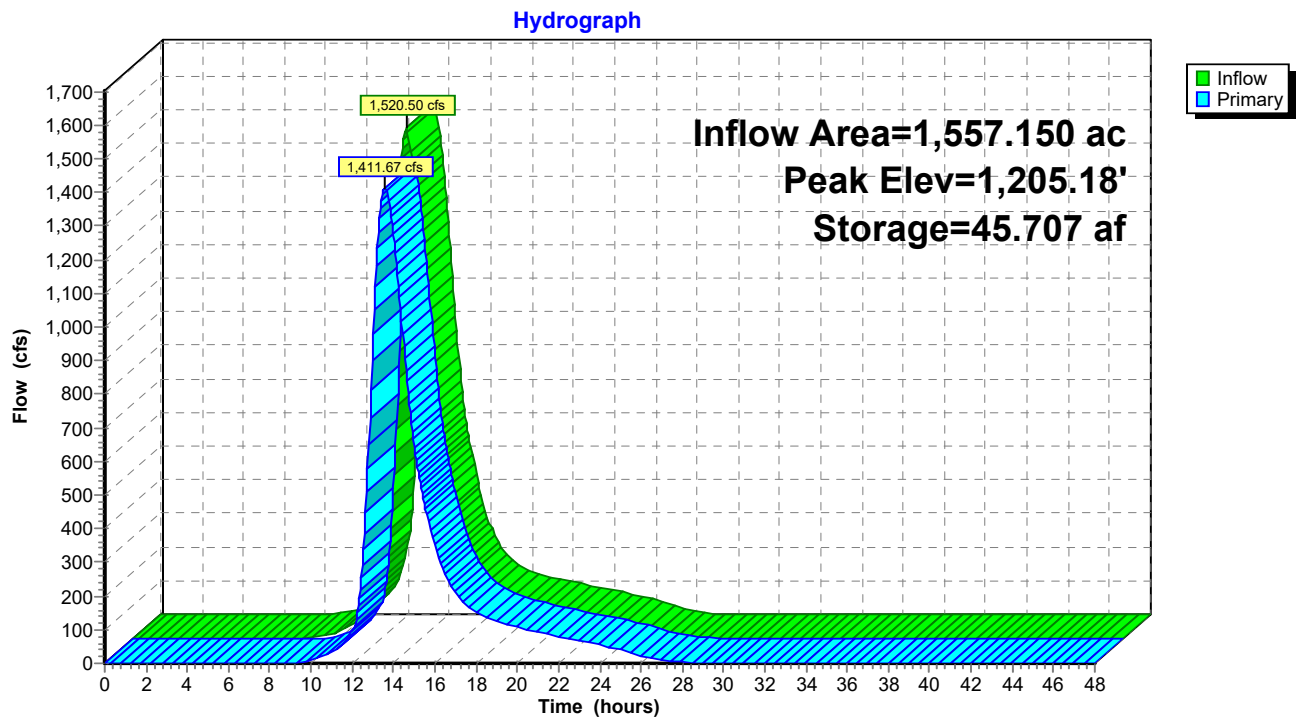
Volume	Invert	Avail.Storage	Storage Description
#1	1,199.00'	94.165 af	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,199.00	0.002	0.000	0.000
1,200.00	1.684	0.843	0.843
1,201.00	6.154	3.919	4.762
1,202.00	7.956	7.055	11.817
1,203.00	9.499	8.728	20.544
1,204.00	11.030	10.264	30.809
1,205.00	13.737	12.383	43.192
1,206.00	15.991	14.864	58.057
1,207.00	18.042	17.016	75.073
1,208.00	20.142	19.092	94.165

Device	Routing	Invert	Outlet Devices
#1	Primary	1,199.12'	Existing Outlet Channel to Lake, C= 3.27 Offset (feet) -106.52 -44.01 -15.95 0.00 10.33 70.05 Elev. (feet) 1,213.23 1,204.05 1,201.65 1,199.12 1,201.69 1,213.23

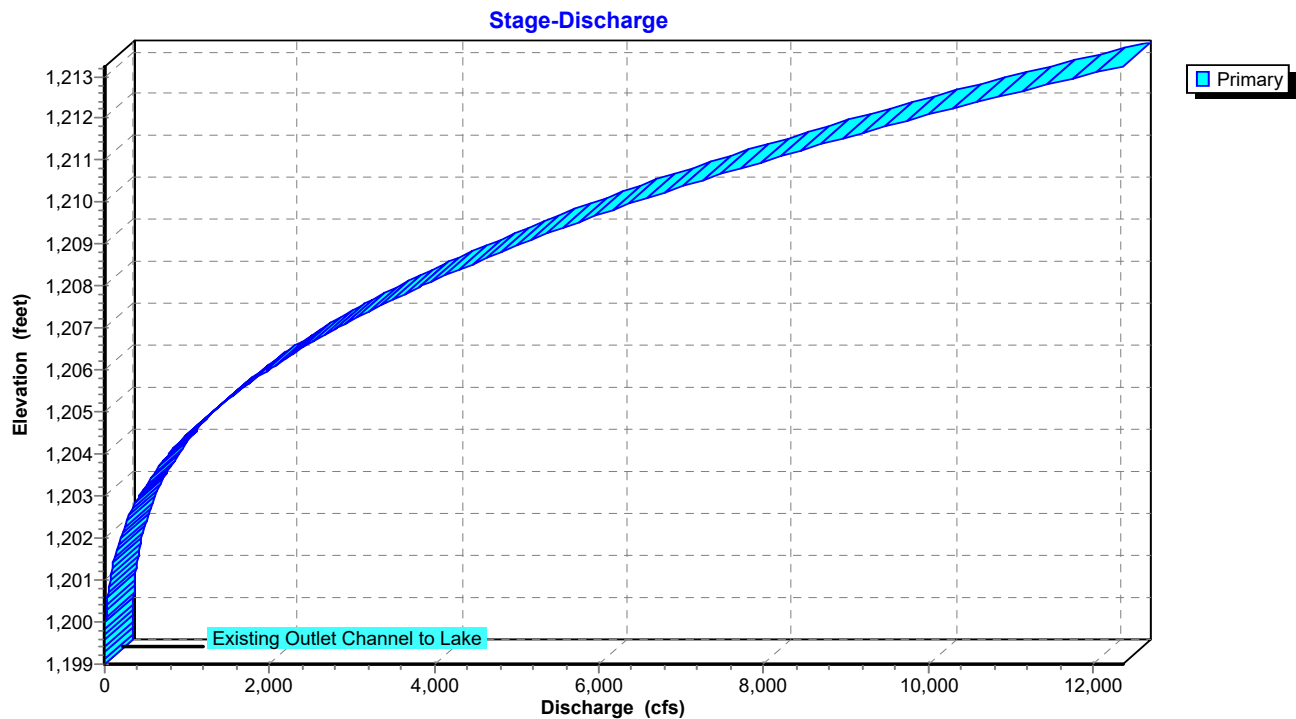
Primary OutFlow Max=1,411.01 cfs @ 13.57 hrs HW=1,205.18' (Free Discharge)

↑ **1=Existing Outlet Channel to Lake** (Weir Controls 1,411.01 cfs @ 4.28 fps)

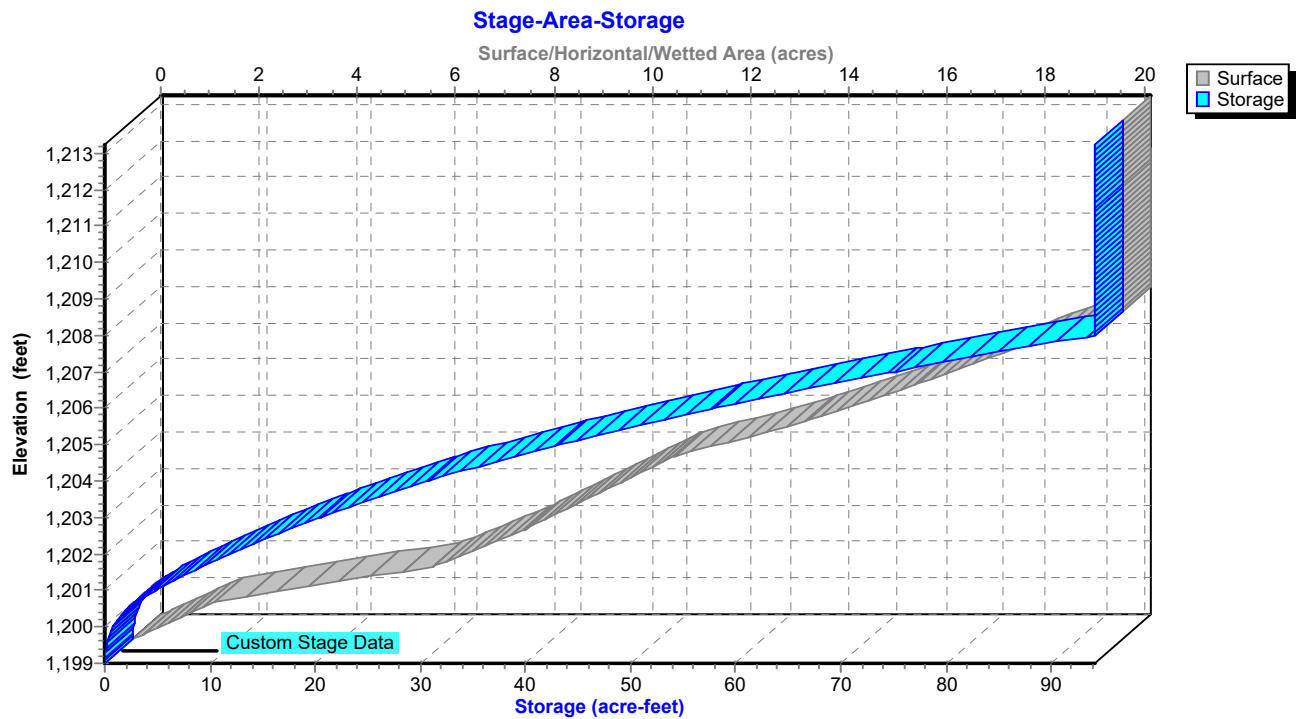
Pond 4P: Existing Wetland Condition



Pond 4P: Existing Wetland Condition



Pond 4P: Existing Wetland Condition



Hydrograph for Pond 4P: Existing Wetland Condition

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0.000	1,199.00	0.00
1.00	0.00	0.000	1,199.00	0.00
2.00	0.00	0.000	1,199.00	0.00
3.00	0.00	0.000	1,199.00	0.00
4.00	0.00	0.000	1,199.00	0.00
5.00	0.00	0.000	1,199.00	0.00
6.00	0.00	0.000	1,199.00	0.00
7.00	0.00	0.000	1,199.00	0.00
8.00	0.14	0.001	1,199.04	0.00
9.00	5.18	0.154	1,199.43	0.70
10.00	22.06	0.819	1,199.99	9.41
11.00	58.51	2.382	1,200.53	32.14
12.00	205.25	6.898	1,201.33	98.16
13.00	1,428.45	35.616	1,204.41	978.64
14.00	1,127.12	42.650	1,204.96	1,277.79
15.00	500.26	27.170	1,203.66	642.49
16.00	260.88	18.135	1,202.74	347.37
17.00	163.45	12.723	1,202.11	210.41
18.00	128.13	9.922	1,201.75	152.22
19.00	109.90	8.398	1,201.55	123.92
20.00	96.20	7.414	1,201.41	106.78
21.00	83.08	6.580	1,201.28	92.99
22.00	70.03	5.759	1,201.16	80.11
23.00	56.88	4.906	1,201.02	67.49
24.00	43.66	4.005	1,200.87	54.78
25.00	24.58	2.966	1,200.67	40.27
26.00	6.54	1.603	1,200.32	21.19
27.00	1.54	0.736	1,199.93	8.08
28.00	0.35	0.381	1,199.67	3.06
29.00	0.07	0.225	1,199.52	1.34
30.00	0.00	0.149	1,199.42	0.66
31.00	0.00	0.108	1,199.36	0.37
32.00	0.00	0.084	1,199.31	0.23
33.00	0.00	0.069	1,199.28	0.15
34.00	0.00	0.058	1,199.26	0.10
35.00	0.00	0.051	1,199.25	0.08
36.00	0.00	0.046	1,199.23	0.06
37.00	0.00	0.042	1,199.22	0.04
38.00	0.00	0.038	1,199.21	0.04
39.00	0.00	0.036	1,199.21	0.03
40.00	0.00	0.034	1,199.20	0.02
41.00	0.00	0.032	1,199.19	0.02
42.00	0.00	0.030	1,199.19	0.02
43.00	0.00	0.029	1,199.18	0.01
44.00	0.00	0.028	1,199.18	0.01
45.00	0.00	0.027	1,199.18	0.01
46.00	0.00	0.026	1,199.18	0.01
47.00	0.00	0.025	1,199.17	0.01
48.00	0.00	0.025	1,199.17	0.01

Stage-Discharge for Pond 4P: Existing Wetland Condition

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.00	0.00	1,204.20	873.63	1,209.40	5,580.36
1,199.10	0.00	1,204.30	921.64	1,209.50	5,718.95
1,199.20	0.02	1,204.40	971.21	1,209.60	5,859.52
1,199.30	0.19	1,204.50	1,022.34	1,209.70	6,002.06
1,199.40	0.56	1,204.60	1,075.02	1,209.80	6,146.60
1,199.50	1.20	1,204.70	1,129.26	1,209.90	6,293.12
1,199.60	2.16	1,204.80	1,185.06	1,210.00	6,441.66
1,199.70	3.46	1,204.90	1,242.42	1,210.10	6,592.21
1,199.80	5.15	1,205.00	1,301.37	1,210.20	6,744.77
1,199.90	7.26	1,205.10	1,361.89	1,210.30	6,899.37
1,200.00	9.81	1,205.20	1,424.01	1,210.40	7,056.01
1,200.10	12.84	1,205.30	1,487.72	1,210.50	7,214.69
1,200.20	16.37	1,205.40	1,553.03	1,210.60	7,375.43
1,200.30	20.42	1,205.50	1,619.95	1,210.70	7,538.23
1,200.40	25.03	1,205.60	1,688.50	1,210.80	7,703.10
1,200.50	30.21	1,205.70	1,758.67	1,210.90	7,870.05
1,200.60	35.98	1,205.80	1,830.48	1,211.00	8,039.08
1,200.70	42.37	1,205.90	1,903.93	1,211.10	8,210.21
1,200.80	49.40	1,206.00	1,979.04	1,211.20	8,383.45
1,200.90	57.08	1,206.10	2,055.81	1,211.30	8,558.79
1,201.00	65.44	1,206.20	2,134.25	1,211.40	8,736.25
1,201.10	74.49	1,206.30	2,214.38	1,211.50	8,915.85
1,201.20	84.26	1,206.40	2,296.19	1,211.60	9,097.57
1,201.30	94.75	1,206.50	2,379.70	1,211.70	9,281.44
1,201.40	105.99	1,206.60	2,464.92	1,211.80	9,467.46
1,201.50	118.00	1,206.70	2,551.85	1,211.90	9,655.64
1,201.60	130.79	1,206.80	2,640.51	1,212.00	9,845.98
1,201.70	144.38	1,206.90	2,730.90	1,212.10	10,038.50
1,201.80	158.84	1,207.00	2,823.03	1,212.20	10,233.20
1,201.90	174.25	1,207.10	2,916.92	1,212.30	10,430.09
1,202.00	190.67	1,207.20	3,012.57	1,212.40	10,629.18
1,202.10	208.13	1,207.30	3,109.99	1,212.50	10,830.47
1,202.20	226.68	1,207.40	3,209.18	1,212.60	11,033.98
1,202.30	246.35	1,207.50	3,310.17	1,212.70	11,239.71
1,202.40	267.18	1,207.60	3,412.95	1,212.80	11,447.66
1,202.50	289.21	1,207.70	3,517.54	1,212.90	11,657.85
1,202.60	312.46	1,207.80	3,623.94	1,213.00	11,870.29
1,202.70	336.97	1,207.90	3,732.17	1,213.10	12,084.97
1,202.80	362.76	1,208.00	3,842.22	1,213.20	12,301.92
1,202.90	389.87	1,208.10	3,954.12		
1,203.00	418.32	1,208.20	4,067.87		
1,203.10	448.14	1,208.30	4,183.48		
1,203.20	479.36	1,208.40	4,300.96		
1,203.30	511.99	1,208.50	4,420.31		
1,203.40	546.08	1,208.60	4,541.55		
1,203.50	581.63	1,208.70	4,664.68		
1,203.60	618.68	1,208.80	4,789.71		
1,203.70	657.25	1,208.90	4,916.66		
1,203.80	697.36	1,209.00	5,045.53		
1,203.90	739.04	1,209.10	5,176.32		
1,204.00	782.30	1,209.20	5,309.05		
1,204.10	827.18	1,209.30	5,443.73		

Stage-Area-Storage for Pond 4P: Existing Wetland Condition

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,199.00	0.002	0.000	1,209.40	20.142	94.165
1,199.20	0.338	0.034	1,209.60	20.142	94.165
1,199.40	0.675	0.135	1,209.80	20.142	94.165
1,199.60	1.011	0.304	1,210.00	20.142	94.165
1,199.80	1.348	0.540	1,210.20	20.142	94.165
1,200.00	1.684	0.843	1,210.40	20.142	94.165
1,200.20	2.578	1.269	1,210.60	20.142	94.165
1,200.40	3.472	1.874	1,210.80	20.142	94.165
1,200.60	4.366	2.658	1,211.00	20.142	94.165
1,200.80	5.260	3.621	1,211.20	20.142	94.165
1,201.00	6.154	4.762	1,211.40	20.142	94.165
1,201.20	6.514	6.029	1,211.60	20.142	94.165
1,201.40	6.875	7.368	1,211.80	20.142	94.165
1,201.60	7.235	8.779	1,212.00	20.142	94.165
1,201.80	7.596	10.262	1,212.20	20.142	94.165
1,202.00	7.956	11.817	1,212.40	20.142	94.165
1,202.20	8.265	13.439	1,212.60	20.142	94.165
1,202.40	8.573	15.123	1,212.80	20.142	94.165
1,202.60	8.882	16.868	1,213.00	20.142	94.165
1,202.80	9.190	18.676	1,213.20	20.142	94.165
1,203.00	9.499	20.544			
1,203.20	9.805	22.475			
1,203.40	10.111	24.467			
1,203.60	10.418	26.519			
1,203.80	10.724	28.634			
1,204.00	11.030	30.809			
1,204.20	11.571	33.069			
1,204.40	12.113	35.438			
1,204.60	12.654	37.914			
1,204.80	13.196	40.499			
1,205.00	13.737	43.192			
1,205.20	14.188	45.985			
1,205.40	14.639	48.868			
1,205.60	15.089	51.840			
1,205.80	15.540	54.903			
1,206.00	15.991	58.057			
1,206.20	16.401	61.296			
1,206.40	16.811	64.617			
1,206.60	17.222	68.020			
1,206.80	17.632	71.506			
1,207.00	18.042	75.073			
1,207.20	18.462	78.723			
1,207.40	18.882	82.458			
1,207.60	19.302	86.276			
1,207.80	19.722	90.179			
1,208.00	20.142	94.165			
1,208.20	20.142	94.165			
1,208.40	20.142	94.165			
1,208.60	20.142	94.165			
1,208.80	20.142	94.165			
1,209.00	20.142	94.165			
1,209.20	20.142	94.165			

IA-340-13 - Neary - Existing Condition - Simplified FurtMSE 24-hr 4 25-Year Rainfall=5.57"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Watershed Upstream Runoff Area=899.170 ac 0.00% Impervious Runoff Depth=3.80"
Flow Length=11,480' Slope=0.0320 '/' Tc=109.9 min CN=84 Runoff=1,192.77 cfs 284.418 af

Subcatchment3S: Watershed Runoff Area=657.980 ac 0.00% Impervious Runoff Depth=3.80"
Flow Length=7,292' Slope=0.0320 '/' Tc=76.4 min CN=84 Runoff=1,122.05 cfs 208.126 af

Pond 2P: 560th Ave Culvert Peak Elev=1,235.84' Storage=9.693 af Inflow=1,192.77 cfs 284.418 af
Primary=406.78 cfs 191.067 af Secondary=763.36 cfs 93.350 af Outflow=1,170.14 cfs 284.417 af

Pond 4P: Existing Wetland Peak Elev=1,205.96' Storage=57.348 af Inflow=2,070.29 cfs 492.544 af
Outflow=1,945.44 cfs 492.519 af

Total Runoff Area = 1,557.150 ac Runoff Volume = 492.544 af Average Runoff Depth = 3.80"
100.00% Pervious = 1,557.150 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Watershed Upstream of Culvert

Runoff = 1,192.77 cfs @ 13.46 hrs, Volume= 284.418 af, Depth= 3.80"
Routed to Pond 2P : 560th Ave Culvert

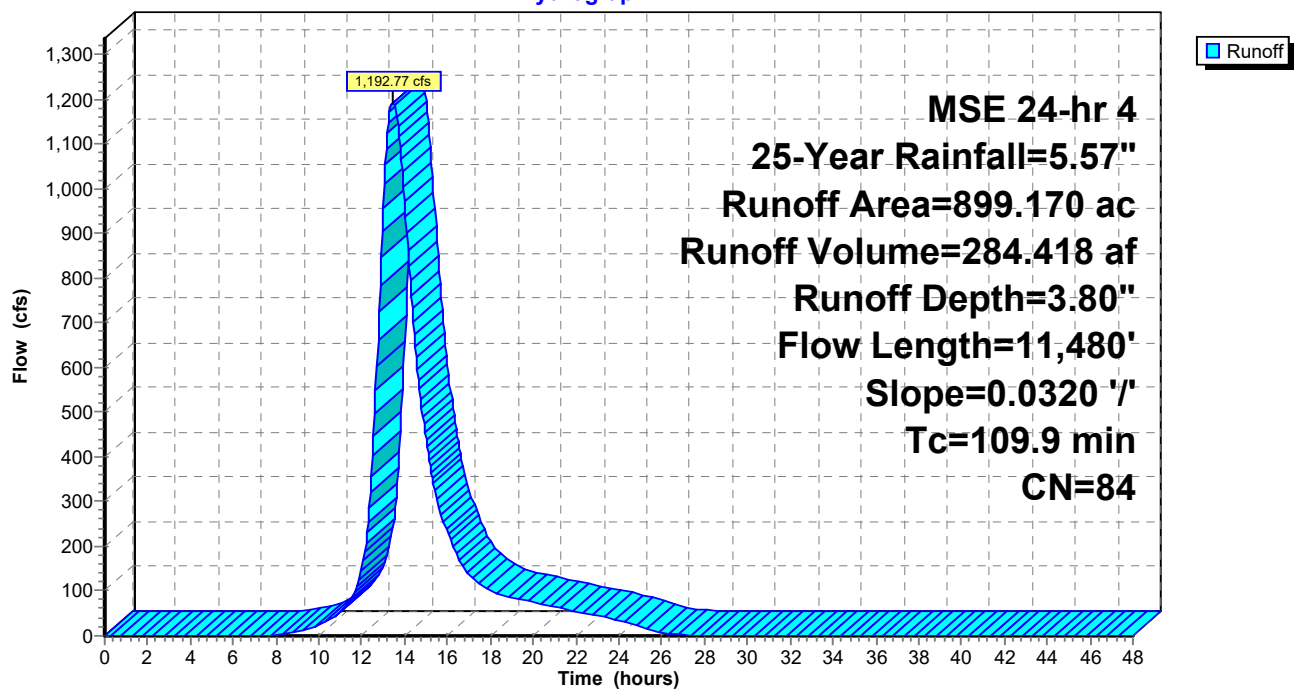
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-Year Rainfall=5.57"

Area (ac)	CN	Description
* 899.170	84	Weighted Average
899.170		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
109.9	11,480	0.0320	1.74		Lag/CN Method, Existing Watershed Tc

Subcatchment 1S: Watershed Upstream of Culvert

Hydrograph



IA-340-13 - Neary - Existing Condition - Simplified FurtMSE 24-hr 4 25-Year Rainfall=5.57"

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Hydrograph for Subcatchment 1S: Watershed Upstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	26.00	5.57	3.80	7.05
0.50	0.01	0.00	0.00	26.50	5.57	3.80	3.58
1.00	0.03	0.00	0.00	27.00	5.57	3.80	1.81
1.50	0.05	0.00	0.00	27.50	5.57	3.80	0.90
2.00	0.07	0.00	0.00	28.00	5.57	3.80	0.44
2.50	0.09	0.00	0.00	28.50	5.57	3.80	0.20
3.00	0.12	0.00	0.00	29.00	5.57	3.80	0.09
3.50	0.15	0.00	0.00	29.50	5.57	3.80	0.03
4.00	0.18	0.00	0.00	30.00	5.57	3.80	0.00
4.50	0.22	0.00	0.00	30.50	5.57	3.80	0.00
5.00	0.26	0.00	0.00	31.00	5.57	3.80	0.00
5.50	0.30	0.00	0.00	31.50	5.57	3.80	0.00
6.00	0.34	0.00	0.00	32.00	5.57	3.80	0.00
6.50	0.39	0.00	0.00	32.50	5.57	3.80	0.00
7.00	0.44	0.00	0.05	33.00	5.57	3.80	0.00
7.50	0.49	0.01	0.59	33.50	5.57	3.80	0.00
8.00	0.55	0.01	2.42	34.00	5.57	3.80	0.00
8.50	0.61	0.02	5.72	34.50	5.57	3.80	0.00
9.00	0.67	0.04	10.11	35.00	5.57	3.80	0.00
9.50	0.77	0.07	15.55	35.50	5.57	3.80	0.00
10.00	0.88	0.10	24.21	36.00	5.57	3.80	0.00
10.50	1.00	0.15	37.43	36.50	5.57	3.80	0.00
11.00	1.20	0.25	53.87	37.00	5.57	3.80	0.00
11.50	1.51	0.42	82.64	37.50	5.57	3.80	0.00
12.00	2.61	1.20	148.54	38.00	5.57	3.80	0.00
12.50	4.06	2.42	401.64	38.50	5.57	3.80	0.00
13.00	4.37	2.70	957.70	39.00	5.57	3.80	0.00
13.50	4.57	2.88	1,191.43	39.50	5.57	3.80	0.00
14.00	4.69	2.99	971.61	40.00	5.57	3.80	0.00
14.50	4.80	3.08	646.92	40.50	5.57	3.80	0.00
15.00	4.90	3.18	437.71	41.00	5.57	3.80	0.00
15.50	4.96	3.23	309.51	41.50	5.57	3.80	0.00
16.00	5.02	3.29	230.28	42.00	5.57	3.80	0.00
16.50	5.08	3.34	174.95	42.50	5.57	3.80	0.00
17.00	5.13	3.39	138.05	43.00	5.57	3.80	0.00
17.50	5.18	3.44	116.36	43.50	5.57	3.80	0.00
18.00	5.23	3.48	101.91	44.00	5.57	3.80	0.00
18.50	5.27	3.52	92.03	44.50	5.57	3.80	0.00
19.00	5.31	3.56	85.44	45.00	5.57	3.80	0.00
19.50	5.35	3.60	79.81	45.50	5.57	3.80	0.00
20.00	5.39	3.63	74.61	46.00	5.57	3.80	0.00
20.50	5.42	3.66	69.57	46.50	5.57	3.80	0.00
21.00	5.45	3.69	64.60	47.00	5.57	3.80	0.00
21.50	5.48	3.71	59.68	47.50	5.57	3.80	0.00
22.00	5.50	3.73	54.75	48.00	5.57	3.80	0.00
22.50	5.52	3.75	49.82				
23.00	5.54	3.77	44.87				
23.50	5.56	3.78	39.92				
24.00	5.57	3.80	34.96				
24.50	5.57	3.80	29.64				
25.00	5.57	3.80	22.24				
25.50	5.57	3.80	13.57				

Summary for Subcatchment 3S: Watershed Downstream of Culvert

Runoff = 1,122.05 cfs @ 13.01 hrs, Volume= 208.126 af, Depth= 3.80"
 Routed to Pond 4P : Existing Wetland Condition

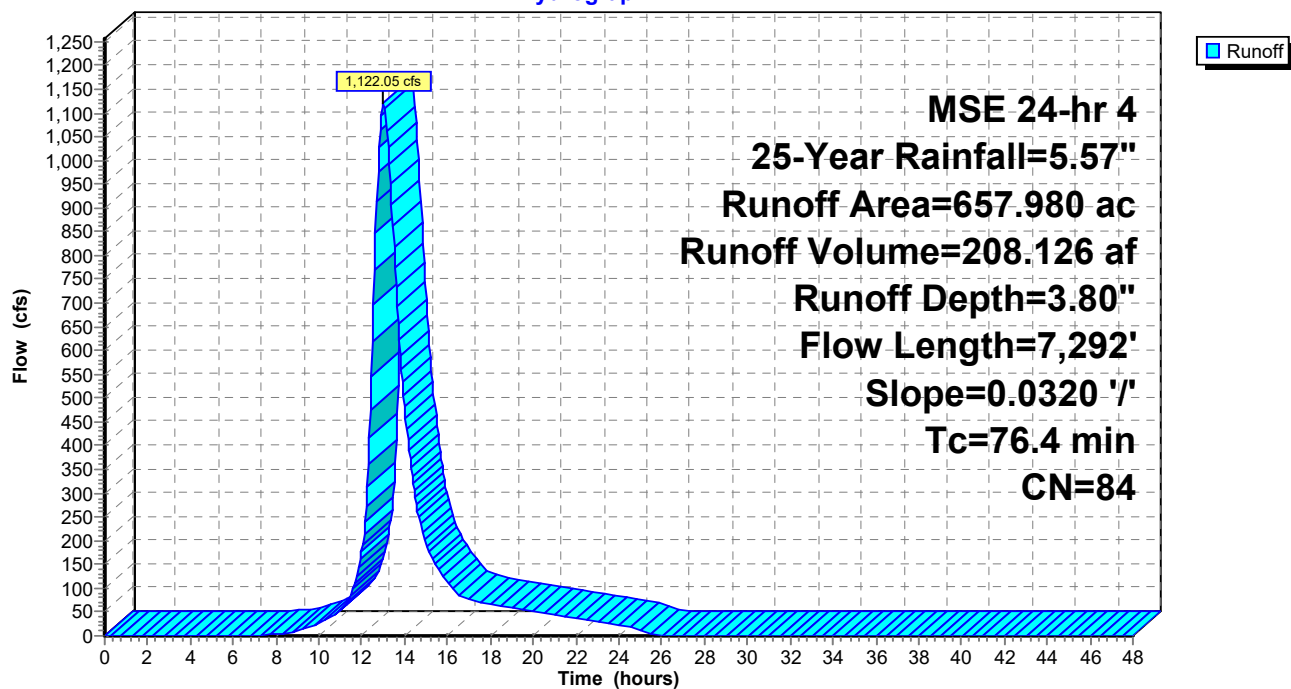
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 MSE 24-hr 4 25-Year Rainfall=5.57"

Area (ac)	CN	Description
* 657.980	84	Weighted Average
657.980		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
76.4	7,292	0.0320	1.59		Lag/CN Method,

Subcatchment 3S: Watershed Downstream of Culvert

Hydrograph



IA-340-13 - Neary - Existing Condition - Simplified FurtMSE 24-hr 4 25-Year Rainfall=5.57"

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Hydrograph for Subcatchment 3S: Watershed Downstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	26.00	5.57	3.80	1.43
0.50	0.01	0.00	0.00	26.50	5.57	3.80	0.53
1.00	0.03	0.00	0.00	27.00	5.57	3.80	0.18
1.50	0.05	0.00	0.00	27.50	5.57	3.80	0.06
2.00	0.07	0.00	0.00	28.00	5.57	3.80	0.01
2.50	0.09	0.00	0.00	28.50	5.57	3.80	0.00
3.00	0.12	0.00	0.00	29.00	5.57	3.80	0.00
3.50	0.15	0.00	0.00	29.50	5.57	3.80	0.00
4.00	0.18	0.00	0.00	30.00	5.57	3.80	0.00
4.50	0.22	0.00	0.00	30.50	5.57	3.80	0.00
5.00	0.26	0.00	0.00	31.00	5.57	3.80	0.00
5.50	0.30	0.00	0.00	31.50	5.57	3.80	0.00
6.00	0.34	0.00	0.00	32.00	5.57	3.80	0.00
6.50	0.39	0.00	0.00	32.50	5.57	3.80	0.00
7.00	0.44	0.00	0.11	33.00	5.57	3.80	0.00
7.50	0.49	0.01	1.16	33.50	5.57	3.80	0.00
8.00	0.55	0.01	3.64	34.00	5.57	3.80	0.00
8.50	0.61	0.02	7.02	34.50	5.57	3.80	0.00
9.00	0.67	0.04	10.91	35.00	5.57	3.80	0.00
9.50	0.77	0.07	15.88	35.50	5.57	3.80	0.00
10.00	0.88	0.10	25.92	36.00	5.57	3.80	0.00
10.50	1.00	0.15	38.39	36.50	5.57	3.80	0.00
11.00	1.20	0.25	52.93	37.00	5.57	3.80	0.00
11.50	1.51	0.42	89.95	37.50	5.57	3.80	0.00
12.00	2.61	1.20	175.42	38.00	5.57	3.80	0.00
12.50	4.06	2.42	617.65	38.50	5.57	3.80	0.00
13.00	4.37	2.70	1,121.92	39.00	5.57	3.80	0.00
13.50	4.57	2.88	817.61	39.50	5.57	3.80	0.00
14.00	4.69	2.99	481.39	40.00	5.57	3.80	0.00
14.50	4.80	3.08	289.98	40.50	5.57	3.80	0.00
15.00	4.90	3.18	192.53	41.00	5.57	3.80	0.00
15.50	4.96	3.23	147.42	41.50	5.57	3.80	0.00
16.00	5.02	3.29	112.26	42.00	5.57	3.80	0.00
16.50	5.08	3.34	87.15	42.50	5.57	3.80	0.00
17.00	5.13	3.39	76.14	43.00	5.57	3.80	0.00
17.50	5.18	3.44	69.91	43.50	5.57	3.80	0.00
18.00	5.23	3.48	65.45	44.00	5.57	3.80	0.00
18.50	5.27	3.52	61.58	44.50	5.57	3.80	0.00
19.00	5.31	3.56	57.90	45.00	5.57	3.80	0.00
19.50	5.35	3.60	54.32	45.50	5.57	3.80	0.00
20.00	5.39	3.63	50.75	46.00	5.57	3.80	0.00
20.50	5.42	3.66	47.18	46.50	5.57	3.80	0.00
21.00	5.45	3.69	43.59	47.00	5.57	3.80	0.00
21.50	5.48	3.71	39.99	47.50	5.57	3.80	0.00
22.00	5.50	3.73	36.37	48.00	5.57	3.80	0.00
22.50	5.52	3.75	32.74				
23.00	5.54	3.77	29.11				
23.50	5.56	3.78	25.46				
24.00	5.57	3.80	21.81				
24.50	5.57	3.80	17.36				
25.00	5.57	3.80	9.70				
25.50	5.57	3.80	3.81				

Summary for Pond 2P: 560th Ave Culvert

Inflow Area = 899.170 ac, 0.00% Impervious, Inflow Depth = 3.80" for 25-Year event
 Inflow = 1,192.77 cfs @ 13.46 hrs, Volume= 284.418 af
 Outflow = 1,170.14 cfs @ 13.62 hrs, Volume= 284.417 af, Atten= 2%, Lag= 9.3 min
 Primary = 406.78 cfs @ 13.62 hrs, Volume= 191.067 af
 Routed to Pond 4P : Existing Wetland Condition
 Secondary = 763.36 cfs @ 13.62 hrs, Volume= 93.350 af
 Routed to Pond 4P : Existing Wetland Condition

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 1,235.84' @ 13.62 hrs Surf.Area= 15.528 ac Storage= 9.693 af

Plug-Flow detention time= 4.0 min calculated for 284.417 af (100% of inflow)
 Center-of-Mass det. time= 3.5 min (896.6 - 893.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,226.00'	66.349 af	Custom Stage Data from Lidar (Prismatic) listed below (Recalc)

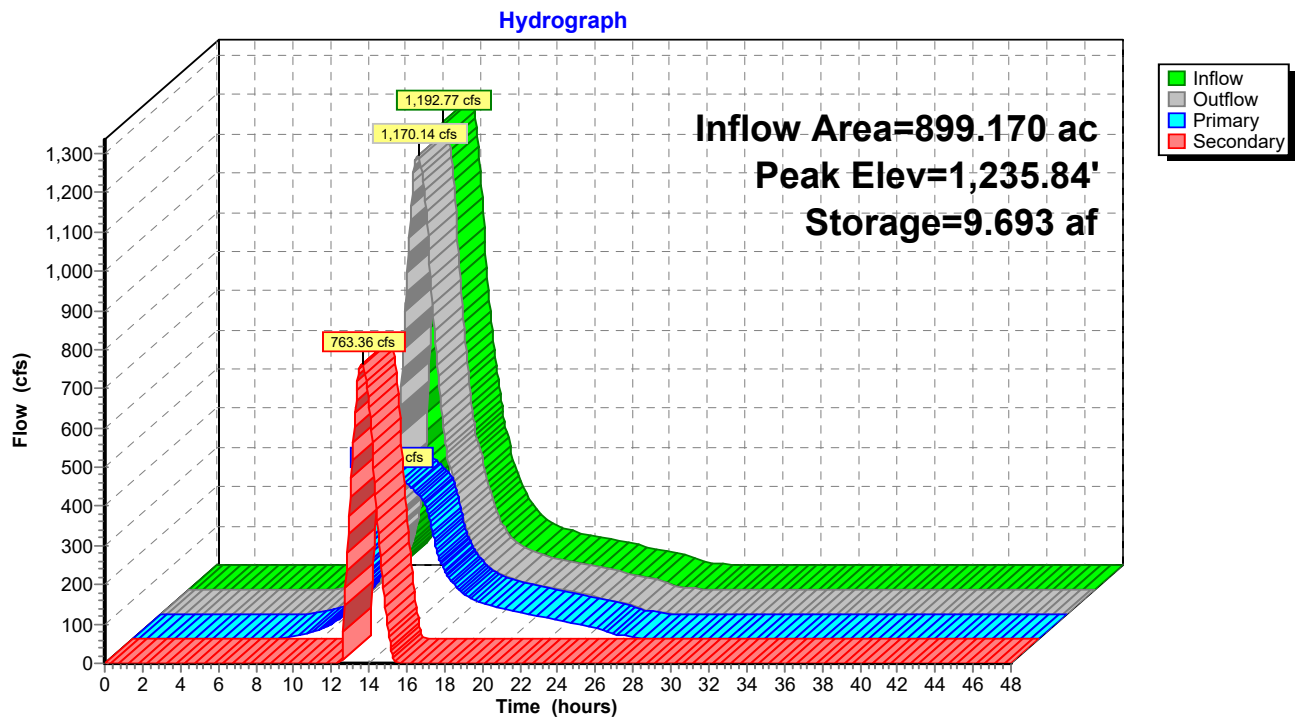
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,226.00	0.001	0.000	0.000
1,227.00	0.002	0.002	0.002
1,228.00	0.003	0.003	0.004
1,229.00	0.006	0.005	0.008
1,230.00	0.016	0.011	0.020
1,231.00	0.038	0.027	0.046
1,232.00	0.082	0.060	0.106
1,233.00	0.422	0.252	0.358
1,234.00	0.999	0.710	1.069
1,235.00	1.702	1.350	2.419
1,236.00	18.079	9.890	12.310
1,237.00	25.000	21.539	33.849
1,238.00	40.000	32.500	66.349

Device	Routing	Invert	Outlet Devices
#1	Primary	1,226.36'	72.0" W x 60.0" H Box Existing 5x6 Road Culvert L= 25.0' Box, 30-75° wingwalls, square crown, Ke= 0.400 Inlet / Outlet Invert= 1,226.36' / 1,226.36' S= 0.0000 ' / Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 30.00 sf
#2	Secondary	1,234.37'	Gravel Road - Asymmetrical Weir, C= 3.27 Offset (feet) -214.93 -167.93 -88.67 0.00 82.37 132.11 157.11 Elev. (feet) 1,237.00 1,236.27 1,235.04 1,234.37 1,235.06 1,236.20 1,237.00

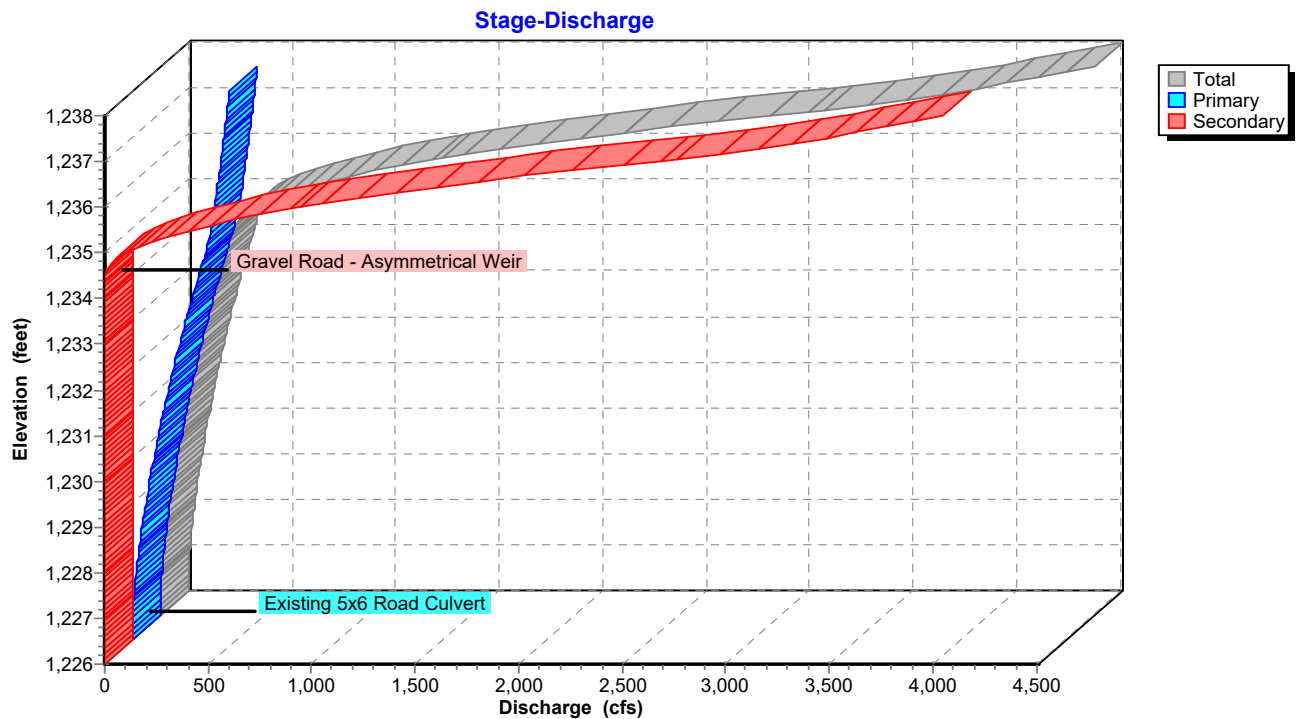
Primary OutFlow Max=406.76 cfs @ 13.62 hrs HW=1,235.84' TW=1,205.94' (Dynamic Tailwater)
 ↑1=Existing 5x6 Road Culvert (Inlet Controls 406.76 cfs @ 13.56 fps)

Secondary OutFlow Max=762.77 cfs @ 13.62 hrs HW=1,235.84' TW=1,205.94' (Dynamic Tailwater)
 ↑2=Gravel Road - Asymmetrical Weir (Weir Controls 762.77 cfs @ 2.38 fps)

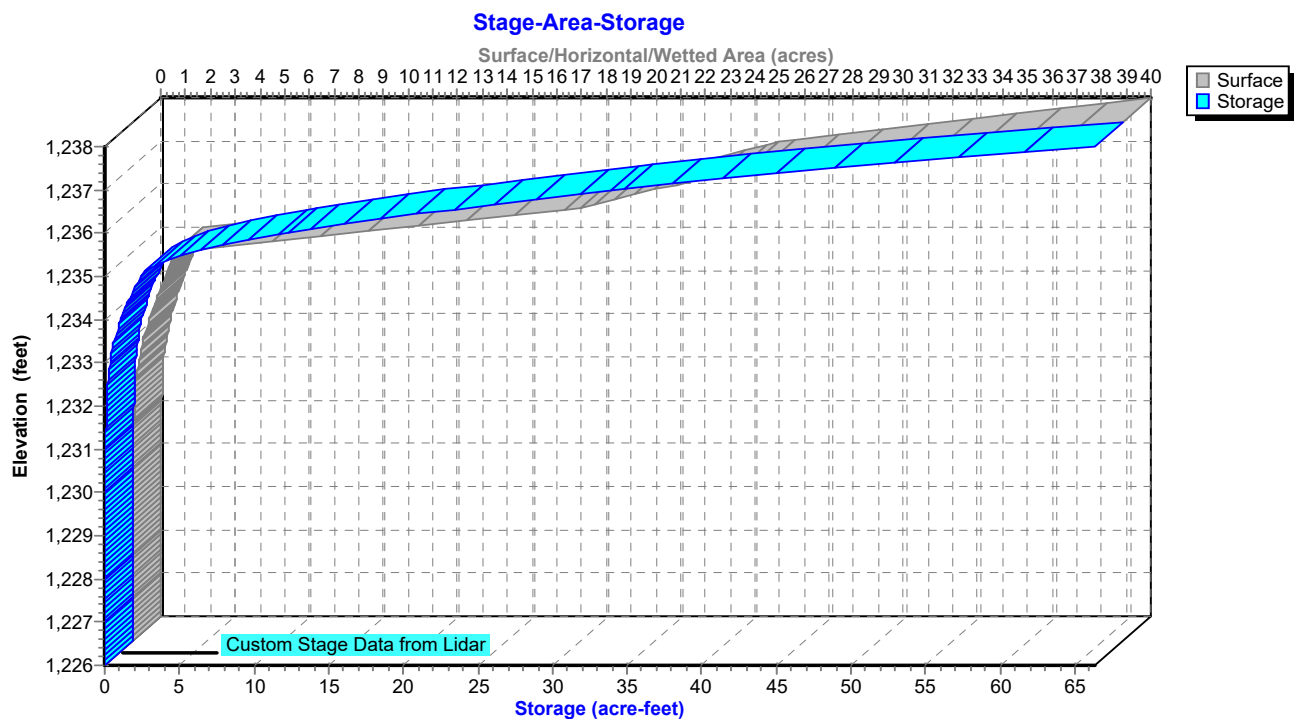
Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Hydrograph for Pond 2P: 560th Ave Culvert

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	0.000	1,226.00	0.00	0.00	0.00
1.00	0.00	0.000	1,226.00	0.00	0.00	0.00
2.00	0.00	0.000	1,226.00	0.00	0.00	0.00
3.00	0.00	0.000	1,226.00	0.00	0.00	0.00
4.00	0.00	0.000	1,226.00	0.00	0.00	0.00
5.00	0.00	0.000	1,226.00	0.00	0.00	0.00
6.00	0.00	0.000	1,226.00	0.00	0.00	0.00
7.00	0.05	0.000	1,226.37	0.00	0.00	0.00
8.00	2.42	0.001	1,226.70	2.41	2.41	0.00
9.00	10.11	0.002	1,227.16	10.10	10.10	0.00
10.00	24.21	0.003	1,227.77	24.18	24.18	0.00
11.00	53.87	0.007	1,228.73	53.80	53.80	0.00
12.00	148.54	0.044	1,230.94	146.45	146.45	0.00
13.00	957.70	5.366	1,235.50	822.14	396.54	425.61
14.00	971.61	8.201	1,235.74	1,055.72	403.74	651.98
15.00	437.71	2.315	1,234.94	455.60	375.63	79.97
16.00	230.28	0.270	1,232.77	243.62	243.62	0.00
17.00	138.05	0.038	1,230.77	138.52	138.52	0.00
18.00	101.91	0.019	1,229.96	102.03	102.03	0.00
19.00	85.44	0.014	1,229.57	85.49	85.49	0.00
20.00	74.61	0.011	1,229.29	74.64	74.64	0.00
21.00	64.60	0.009	1,229.03	64.62	64.62	0.00
22.00	54.75	0.007	1,228.75	54.77	54.77	0.00
23.00	44.87	0.006	1,228.46	44.89	44.89	0.00
24.00	34.96	0.004	1,228.15	34.97	34.97	0.00
25.00	22.24	0.003	1,227.69	22.26	22.26	0.00
26.00	7.05	0.002	1,227.00	7.07	7.07	0.00
27.00	1.81	0.001	1,226.65	1.81	1.81	0.00
28.00	0.44	0.001	1,226.49	0.44	0.44	0.00
29.00	0.09	0.001	1,226.42	0.09	0.09	0.00
30.00	0.00	0.000	1,226.37	0.00	0.00	0.00
31.00	0.00	0.000	1,226.36	0.00	0.00	0.00
32.00	0.00	0.000	1,226.36	0.00	0.00	0.00
33.00	0.00	0.000	1,226.36	0.00	0.00	0.00
34.00	0.00	0.000	1,226.36	0.00	0.00	0.00
35.00	0.00	0.000	1,226.36	0.00	0.00	0.00
36.00	0.00	0.000	1,226.36	0.00	0.00	0.00
37.00	0.00	0.000	1,226.36	0.00	0.00	0.00
38.00	0.00	0.000	1,226.36	0.00	0.00	0.00
39.00	0.00	0.000	1,226.36	0.00	0.00	0.00
40.00	0.00	0.000	1,226.36	0.00	0.00	0.00
41.00	0.00	0.000	1,226.36	0.00	0.00	0.00
42.00	0.00	0.000	1,226.36	0.00	0.00	0.00
43.00	0.00	0.000	1,226.36	0.00	0.00	0.00
44.00	0.00	0.000	1,226.36	0.00	0.00	0.00
45.00	0.00	0.000	1,226.36	0.00	0.00	0.00
46.00	0.00	0.000	1,226.36	0.00	0.00	0.00
47.00	0.00	0.000	1,226.36	0.00	0.00	0.00
48.00	0.00	0.000	1,226.36	0.00	0.00	0.00

Stage-Discharge for Pond 2P: 560th Ave Culvert

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
1,226.00	0.00	0.00	0.00	1,236.40	1,958.33	422.99	1,535.35
1,226.20	0.00	0.00	0.00	1,236.60	2,310.52	428.67	1,881.85
1,226.40	0.04	0.04	0.00	1,236.80	2,699.76	434.27	2,265.49
1,226.60	1.34	1.34	0.00	1,237.00	3,126.75	439.79	2,686.95
1,226.80	3.79	3.79	0.00	1,237.20	3,481.18	445.25	3,035.93
1,227.00	7.01	7.01	0.00	1,237.40	3,776.53	450.64	3,325.89
1,227.20	10.82	10.82	0.00	1,237.60	4,041.43	455.96	3,585.47
1,227.40	15.14	15.14	0.00	1,237.80	4,285.19	461.22	3,823.97
1,227.60	19.92	19.92	0.00	1,238.00	4,512.80	466.42	4,046.38
1,227.80	25.12	25.12	0.00				
1,228.00	30.69	30.69	0.00				
1,228.20	36.63	36.63	0.00				
1,228.40	42.91	42.91	0.00				
1,228.60	49.50	49.50	0.00				
1,228.80	56.40	56.40	0.00				
1,229.00	63.59	63.59	0.00				
1,229.20	71.07	71.07	0.00				
1,229.40	78.81	78.81	0.00				
1,229.60	86.82	86.82	0.00				
1,229.80	95.08	95.08	0.00				
1,230.00	103.58	103.58	0.00				
1,230.20	112.33	112.33	0.00				
1,230.40	121.30	121.30	0.00				
1,230.60	130.51	130.51	0.00				
1,230.80	139.93	139.93	0.00				
1,231.00	149.57	149.57	0.00				
1,231.20	159.42	159.42	0.00				
1,231.40	169.48	169.48	0.00				
1,231.60	179.74	179.74	0.00				
1,231.80	190.20	190.20	0.00				
1,232.00	200.86	200.86	0.00				
1,232.20	211.71	211.71	0.00				
1,232.40	222.74	222.74	0.00				
1,232.60	233.96	233.96	0.00				
1,232.80	245.36	245.36	0.00				
1,233.00	256.95	256.95	0.00				
1,233.20	269.38	269.38	0.00				
1,233.40	283.64	283.64	0.00				
1,233.60	297.22	297.22	0.00				
1,233.80	310.20	310.20	0.00				
1,234.00	322.67	322.67	0.00				
1,234.20	334.66	334.66	0.00				
1,234.40	346.30	346.25	0.05				
1,234.60	365.81	357.46	8.35				
1,234.80	408.24	368.32	39.92				
1,235.00	482.60	378.88	103.72				
1,235.20	592.10	387.09	205.01				
1,235.40	734.23	393.31	340.92				
1,235.60	909.80	399.43	510.37				
1,235.80	1,119.19	405.46	713.74				
1,236.00	1,363.16	411.39	951.77				
1,236.20	1,642.64	417.23	1,225.41				

Stage-Area-Storage for Pond 2P: 560th Ave Culvert

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,226.00	0.001	0.000	1,236.40	20.847	20.095
1,226.20	0.001	0.000	1,236.60	22.232	24.403
1,226.40	0.001	0.000	1,236.80	23.616	28.988
1,226.60	0.002	0.001	1,237.00	25.000	33.849
1,226.80	0.002	0.001	1,237.20	28.000	39.150
1,227.00	0.002	0.002	1,237.40	31.000	45.050
1,227.20	0.002	0.002	1,237.60	34.000	51.549
1,227.40	0.002	0.002	1,237.80	37.000	58.649
1,227.60	0.003	0.003	1,238.00	40.000	66.349
1,227.80	0.003	0.003			
1,228.00	0.003	0.004			
1,228.20	0.004	0.005			
1,228.40	0.004	0.005			
1,228.60	0.005	0.006			
1,228.80	0.005	0.007			
1,229.00	0.006	0.008			
1,229.20	0.008	0.010			
1,229.40	0.010	0.012			
1,229.60	0.012	0.014			
1,229.80	0.014	0.016			
1,230.00	0.016	0.020			
1,230.20	0.020	0.023			
1,230.40	0.025	0.028			
1,230.60	0.029	0.033			
1,230.80	0.034	0.039			
1,231.00	0.038	0.046			
1,231.20	0.047	0.055			
1,231.40	0.056	0.065			
1,231.60	0.064	0.077			
1,231.80	0.073	0.091			
1,232.00	0.082	0.106			
1,232.20	0.150	0.130			
1,232.40	0.218	0.167			
1,232.60	0.286	0.217			
1,232.80	0.354	0.281			
1,233.00	0.422	0.358			
1,233.20	0.537	0.454			
1,233.40	0.653	0.573			
1,233.60	0.768	0.716			
1,233.80	0.884	0.881			
1,234.00	0.999	1.069			
1,234.20	1.140	1.283			
1,234.40	1.280	1.525			
1,234.60	1.421	1.795			
1,234.80	1.561	2.093			
1,235.00	1.702	2.419			
1,235.20	4.977	3.087			
1,235.40	8.253	4.410			
1,235.60	11.528	6.389			
1,235.80	14.804	9.022			
1,236.00	18.079	12.310			
1,236.20	19.463	16.064			

Summary for Pond 4P: Existing Wetland Condition

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 3.80" for 25-Year event
 Inflow = 2,070.29 cfs @ 13.26 hrs, Volume= 492.544 af
 Outflow = 1,945.44 cfs @ 13.54 hrs, Volume= 492.519 af, Atten= 6%, Lag= 17.2 min
 Primary = 1,945.44 cfs @ 13.54 hrs, Volume= 492.519 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 1,205.96' @ 13.54 hrs Surf.Area= 15.891 ac Storage= 57.348 af

Plug-Flow detention time= 31.3 min calculated for 492.519 af (100% of inflow)
 Center-of-Mass det. time= 30.8 min (912.7 - 882.0)

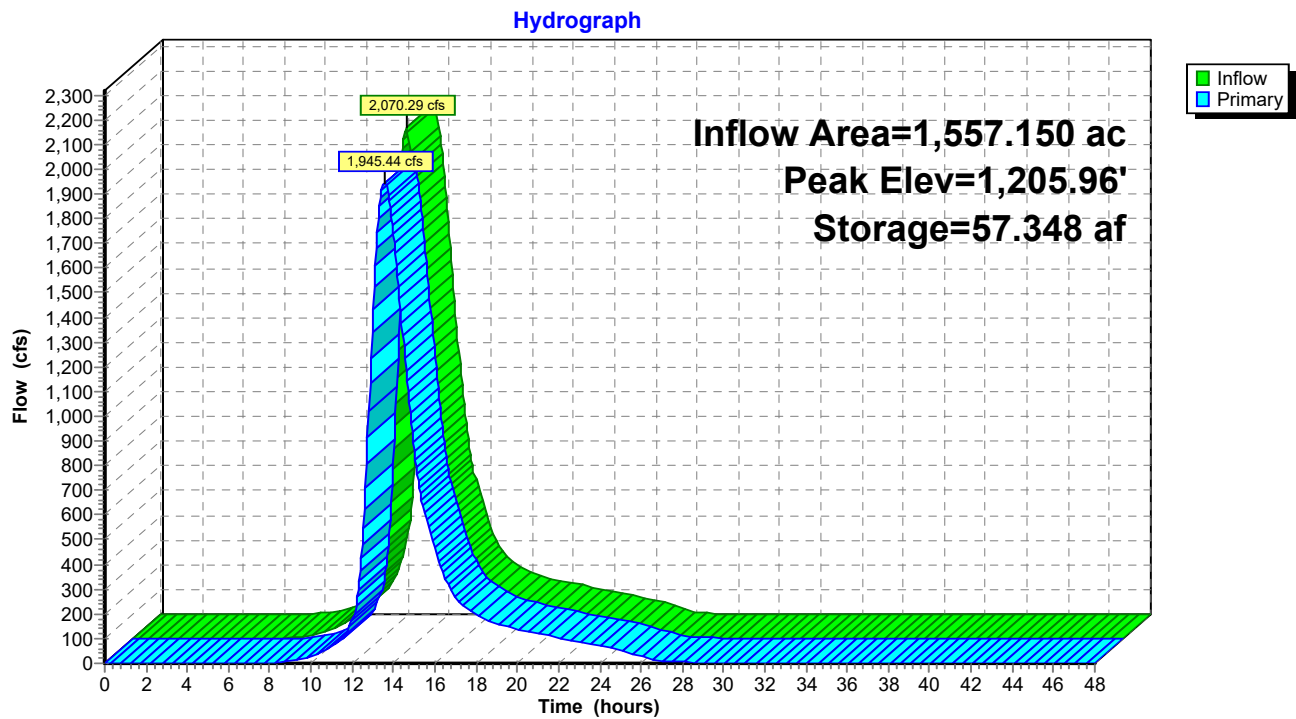
Volume	Invert	Avail.Storage	Storage Description
#1	1,199.00'	94.165 af	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,199.00	0.002	0.000	0.000
1,200.00	1.684	0.843	0.843
1,201.00	6.154	3.919	4.762
1,202.00	7.956	7.055	11.817
1,203.00	9.499	8.728	20.544
1,204.00	11.030	10.264	30.809
1,205.00	13.737	12.383	43.192
1,206.00	15.991	14.864	58.057
1,207.00	18.042	17.016	75.073
1,208.00	20.142	19.092	94.165

Device	Routing	Invert	Outlet Devices
#1	Primary	1,199.12'	Existing Outlet Channel to Lake, C= 3.27 Offset (feet) -106.52 -44.01 -15.95 0.00 10.33 70.05 Elev. (feet) 1,213.23 1,204.05 1,201.65 1,199.12 1,201.69 1,213.23

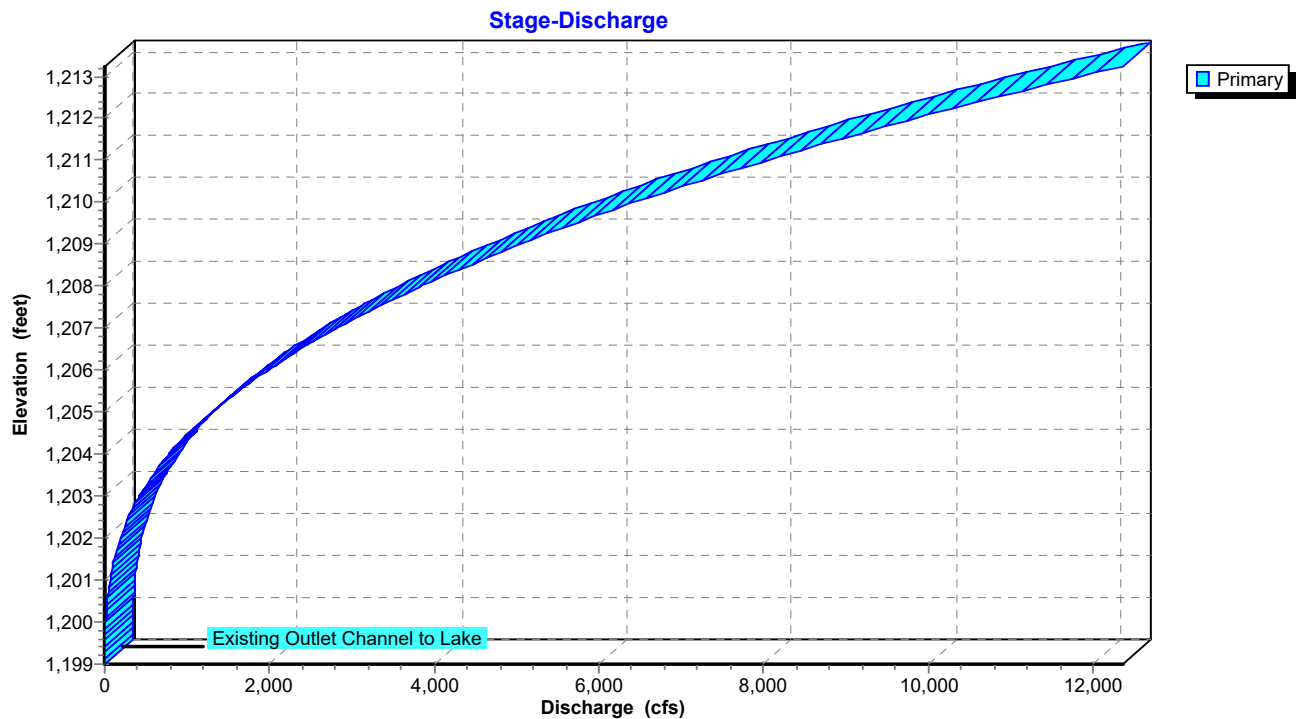
Primary OutFlow Max=1,945.01 cfs @ 13.54 hrs HW=1,205.95' (Free Discharge)

↑1=Existing Outlet Channel to Lake(Weir Controls 1,945.01 cfs @ 4.64 fps)

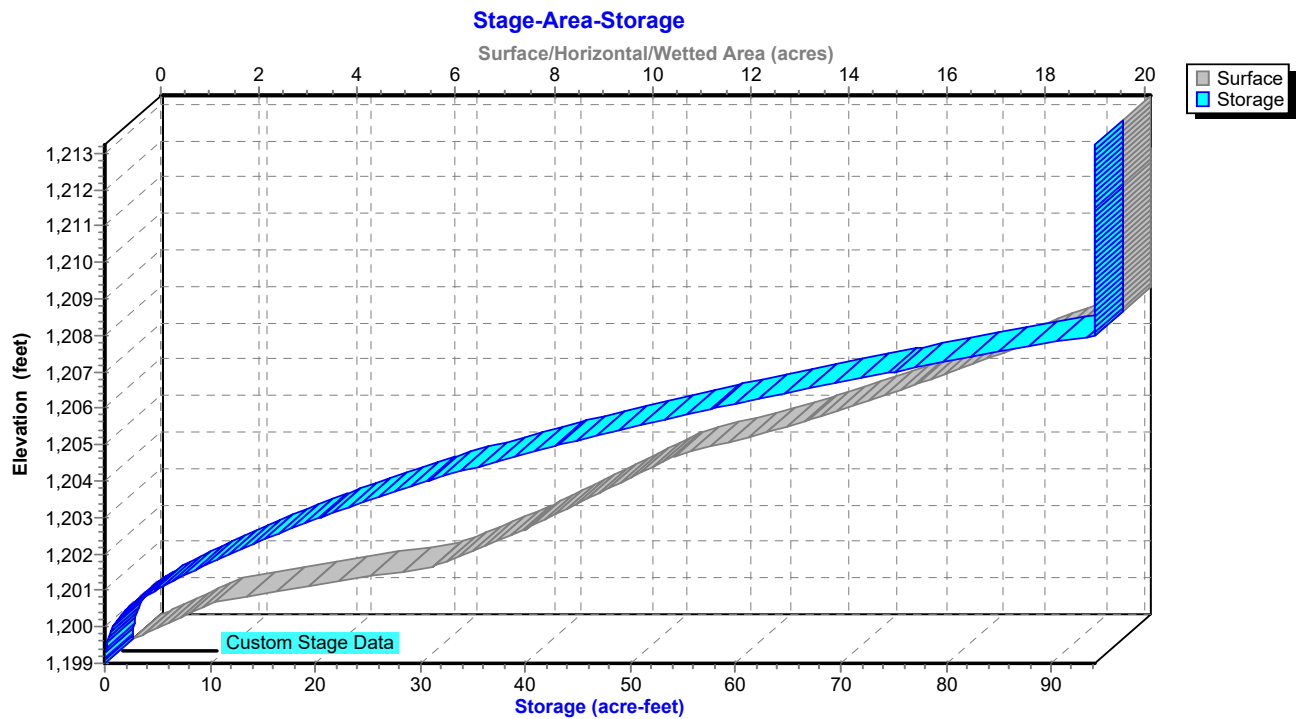
Pond 4P: Existing Wetland Condition



Pond 4P: Existing Wetland Condition



Pond 4P: Existing Wetland Condition



Hydrograph for Pond 4P: Existing Wetland Condition

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0.000	1,199.00	0.00
1.00	0.00	0.000	1,199.00	0.00
2.00	0.00	0.000	1,199.00	0.00
3.00	0.00	0.000	1,199.00	0.00
4.00	0.00	0.000	1,199.00	0.00
5.00	0.00	0.000	1,199.00	0.00
6.00	0.00	0.000	1,199.00	0.00
7.00	0.11	0.001	1,199.03	0.00
8.00	6.05	0.171	1,199.45	0.84
9.00	21.00	0.868	1,200.01	10.22
10.00	50.10	2.084	1,200.46	27.98
11.00	106.73	4.719	1,200.99	64.83
12.00	321.86	11.216	1,201.92	178.07
13.00	1,944.07	46.208	1,205.22	1,433.90
14.00	1,537.11	52.910	1,205.67	1,737.79
15.00	648.13	32.711	1,204.17	859.03
16.00	355.88	21.817	1,203.13	458.15
17.00	214.67	15.223	1,202.41	269.69
18.00	167.49	12.009	1,202.02	194.76
19.00	143.39	10.285	1,201.80	159.30
20.00	125.40	9.156	1,201.65	137.72
21.00	108.21	8.175	1,201.52	119.95
22.00	91.14	7.199	1,201.38	103.15
23.00	74.00	6.182	1,201.22	86.65
24.00	56.78	5.101	1,201.05	70.30
25.00	31.96	3.803	1,200.83	51.95
26.00	8.50	2.050	1,200.45	27.50
27.00	2.00	0.908	1,200.04	10.86
28.00	0.45	0.443	1,199.72	3.84
29.00	0.09	0.253	1,199.55	1.61
30.00	0.00	0.162	1,199.44	0.77
31.00	0.00	0.115	1,199.37	0.42
32.00	0.00	0.088	1,199.32	0.25
33.00	0.00	0.072	1,199.29	0.16
34.00	0.00	0.060	1,199.27	0.11
35.00	0.00	0.053	1,199.25	0.08
36.00	0.00	0.047	1,199.23	0.06
37.00	0.00	0.042	1,199.22	0.05
38.00	0.00	0.039	1,199.21	0.04
39.00	0.00	0.036	1,199.21	0.03
40.00	0.00	0.034	1,199.20	0.02
41.00	0.00	0.032	1,199.19	0.02
42.00	0.00	0.031	1,199.19	0.02
43.00	0.00	0.029	1,199.19	0.01
44.00	0.00	0.028	1,199.18	0.01
45.00	0.00	0.027	1,199.18	0.01
46.00	0.00	0.026	1,199.18	0.01
47.00	0.00	0.026	1,199.17	0.01
48.00	0.00	0.025	1,199.17	0.01

IA-340-13 - Neary - Existing Condition - Simplified FurtMSE 24-hr 4 25-Year Rainfall=5.57"

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Stage-Discharge for Pond 4P: Existing Wetland Condition

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.00	0.00	1,204.20	873.63	1,209.40	5,580.36
1,199.10	0.00	1,204.30	921.64	1,209.50	5,718.95
1,199.20	0.02	1,204.40	971.21	1,209.60	5,859.52
1,199.30	0.19	1,204.50	1,022.34	1,209.70	6,002.06
1,199.40	0.56	1,204.60	1,075.02	1,209.80	6,146.60
1,199.50	1.20	1,204.70	1,129.26	1,209.90	6,293.12
1,199.60	2.16	1,204.80	1,185.06	1,210.00	6,441.66
1,199.70	3.46	1,204.90	1,242.42	1,210.10	6,592.21
1,199.80	5.15	1,205.00	1,301.37	1,210.20	6,744.77
1,199.90	7.26	1,205.10	1,361.89	1,210.30	6,899.37
1,200.00	9.81	1,205.20	1,424.01	1,210.40	7,056.01
1,200.10	12.84	1,205.30	1,487.72	1,210.50	7,214.69
1,200.20	16.37	1,205.40	1,553.03	1,210.60	7,375.43
1,200.30	20.42	1,205.50	1,619.95	1,210.70	7,538.23
1,200.40	25.03	1,205.60	1,688.50	1,210.80	7,703.10
1,200.50	30.21	1,205.70	1,758.67	1,210.90	7,870.05
1,200.60	35.98	1,205.80	1,830.48	1,211.00	8,039.08
1,200.70	42.37	1,205.90	1,903.93	1,211.10	8,210.21
1,200.80	49.40	1,206.00	1,979.04	1,211.20	8,383.45
1,200.90	57.08	1,206.10	2,055.81	1,211.30	8,558.79
1,201.00	65.44	1,206.20	2,134.25	1,211.40	8,736.25
1,201.10	74.49	1,206.30	2,214.38	1,211.50	8,915.85
1,201.20	84.26	1,206.40	2,296.19	1,211.60	9,097.57
1,201.30	94.75	1,206.50	2,379.70	1,211.70	9,281.44
1,201.40	105.99	1,206.60	2,464.92	1,211.80	9,467.46
1,201.50	118.00	1,206.70	2,551.85	1,211.90	9,655.64
1,201.60	130.79	1,206.80	2,640.51	1,212.00	9,845.98
1,201.70	144.38	1,206.90	2,730.90	1,212.10	10,038.50
1,201.80	158.84	1,207.00	2,823.03	1,212.20	10,233.20
1,201.90	174.25	1,207.10	2,916.92	1,212.30	10,430.09
1,202.00	190.67	1,207.20	3,012.57	1,212.40	10,629.18
1,202.10	208.13	1,207.30	3,109.99	1,212.50	10,830.47
1,202.20	226.68	1,207.40	3,209.18	1,212.60	11,033.98
1,202.30	246.35	1,207.50	3,310.17	1,212.70	11,239.71
1,202.40	267.18	1,207.60	3,412.95	1,212.80	11,447.66
1,202.50	289.21	1,207.70	3,517.54	1,212.90	11,657.85
1,202.60	312.46	1,207.80	3,623.94	1,213.00	11,870.29
1,202.70	336.97	1,207.90	3,732.17	1,213.10	12,084.97
1,202.80	362.76	1,208.00	3,842.22	1,213.20	12,301.92
1,202.90	389.87	1,208.10	3,954.12		
1,203.00	418.32	1,208.20	4,067.87		
1,203.10	448.14	1,208.30	4,183.48		
1,203.20	479.36	1,208.40	4,300.96		
1,203.30	511.99	1,208.50	4,420.31		
1,203.40	546.08	1,208.60	4,541.55		
1,203.50	581.63	1,208.70	4,664.68		
1,203.60	618.68	1,208.80	4,789.71		
1,203.70	657.25	1,208.90	4,916.66		
1,203.80	697.36	1,209.00	5,045.53		
1,203.90	739.04	1,209.10	5,176.32		
1,204.00	782.30	1,209.20	5,309.05		
1,204.10	827.18	1,209.30	5,443.73		

Stage-Area-Storage for Pond 4P: Existing Wetland Condition

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,199.00	0.002	0.000	1,209.40	20.142	94.165
1,199.20	0.338	0.034	1,209.60	20.142	94.165
1,199.40	0.675	0.135	1,209.80	20.142	94.165
1,199.60	1.011	0.304	1,210.00	20.142	94.165
1,199.80	1.348	0.540	1,210.20	20.142	94.165
1,200.00	1.684	0.843	1,210.40	20.142	94.165
1,200.20	2.578	1.269	1,210.60	20.142	94.165
1,200.40	3.472	1.874	1,210.80	20.142	94.165
1,200.60	4.366	2.658	1,211.00	20.142	94.165
1,200.80	5.260	3.621	1,211.20	20.142	94.165
1,201.00	6.154	4.762	1,211.40	20.142	94.165
1,201.20	6.514	6.029	1,211.60	20.142	94.165
1,201.40	6.875	7.368	1,211.80	20.142	94.165
1,201.60	7.235	8.779	1,212.00	20.142	94.165
1,201.80	7.596	10.262	1,212.20	20.142	94.165
1,202.00	7.956	11.817	1,212.40	20.142	94.165
1,202.20	8.265	13.439	1,212.60	20.142	94.165
1,202.40	8.573	15.123	1,212.80	20.142	94.165
1,202.60	8.882	16.868	1,213.00	20.142	94.165
1,202.80	9.190	18.676	1,213.20	20.142	94.165
1,203.00	9.499	20.544			
1,203.20	9.805	22.475			
1,203.40	10.111	24.467			
1,203.60	10.418	26.519			
1,203.80	10.724	28.634			
1,204.00	11.030	30.809			
1,204.20	11.571	33.069			
1,204.40	12.113	35.438			
1,204.60	12.654	37.914			
1,204.80	13.196	40.499			
1,205.00	13.737	43.192			
1,205.20	14.188	45.985			
1,205.40	14.639	48.868			
1,205.60	15.089	51.840			
1,205.80	15.540	54.903			
1,206.00	15.991	58.057			
1,206.20	16.401	61.296			
1,206.40	16.811	64.617			
1,206.60	17.222	68.020			
1,206.80	17.632	71.506			
1,207.00	18.042	75.073			
1,207.20	18.462	78.723			
1,207.40	18.882	82.458			
1,207.60	19.302	86.276			
1,207.80	19.722	90.179			
1,208.00	20.142	94.165			
1,208.20	20.142	94.165			
1,208.40	20.142	94.165			
1,208.60	20.142	94.165			
1,208.80	20.142	94.165			
1,209.00	20.142	94.165			
1,209.20	20.142	94.165			

IA-340-13 - Neary - Existing Condition - Simplified Full MSE 24-hr 4 100-Year Rainfall=7.69"

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Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Watershed Upstream Runoff Area=899.170 ac 0.00% Impervious Runoff Depth=5.80"
Flow Length=11,480' Slope=0.0320 '/' Tc=109.9 min CN=84 Runoff=1,806.38 cfs 434.453 af

Subcatchment3S: Watershed Runoff Area=657.980 ac 0.00% Impervious Runoff Depth=5.80"
Flow Length=7,292' Slope=0.0320 '/' Tc=76.4 min CN=84 Runoff=1,697.07 cfs 317.917 af

Pond 2P: 560th Ave Culvert Peak Elev=1,236.28' Storage=17.719 af Inflow=1,806.38 cfs 434.453 af
Primary=419.65 cfs 244.298 af Secondary=1,350.82 cfs 190.154 af Outflow=1,770.47 cfs 434.453 af

Pond 4P: Existing Wetland Peak Elev=1,207.15' Storage=77.735 af Inflow=3,115.21 cfs 752.370 af
Outflow=2,960.99 cfs 752.345 af

Total Runoff Area = 1,557.150 ac Runoff Volume = 752.370 af Average Runoff Depth = 5.80"
100.00% Pervious = 1,557.150 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Watershed Upstream of Culvert

Runoff = 1,806.38 cfs @ 13.44 hrs, Volume= 434.453 af, Depth= 5.80"
Routed to Pond 2P : 560th Ave Culvert

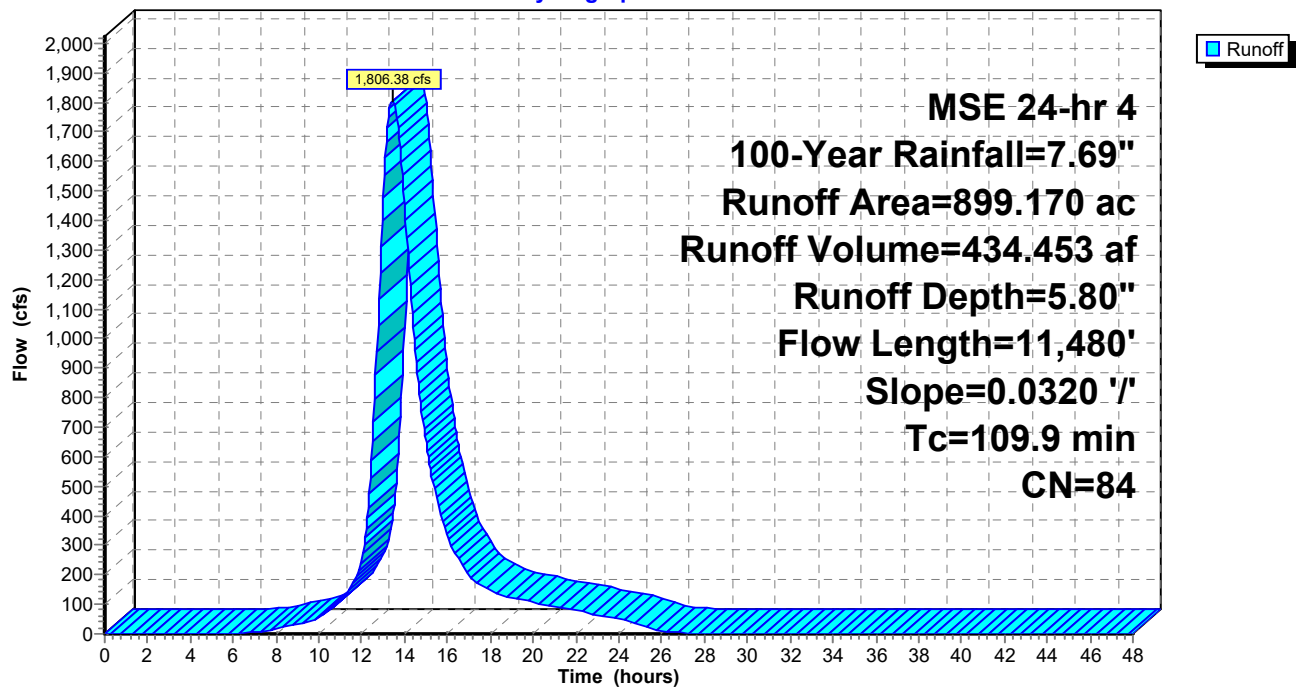
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-Year Rainfall=7.69"

Area (ac)	CN	Description
* 899.170	84	Weighted Average
899.170		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
109.9	11,480	0.0320	1.74		Lag/CN Method, Existing Watershed Tc

Subcatchment 1S: Watershed Upstream of Culvert

Hydrograph



IA-340-13 - Neary - Existing Condition - Simplified FUMSE 24-hr 4 100-Year Rainfall=7.69"

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Hydrograph for Subcatchment 1S: Watershed Upstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	26.00	7.69	5.80	10.05
0.50	0.02	0.00	0.00	26.50	7.69	5.80	5.10
1.00	0.04	0.00	0.00	27.00	7.69	5.80	2.58
1.50	0.06	0.00	0.00	27.50	7.69	5.80	1.28
2.00	0.09	0.00	0.00	28.00	7.69	5.80	0.62
2.50	0.13	0.00	0.00	28.50	7.69	5.80	0.29
3.00	0.16	0.00	0.00	29.00	7.69	5.80	0.12
3.50	0.20	0.00	0.00	29.50	7.69	5.80	0.04
4.00	0.25	0.00	0.00	30.00	7.69	5.80	0.00
4.50	0.30	0.00	0.00	30.50	7.69	5.80	0.00
5.00	0.35	0.00	0.00	31.00	7.69	5.80	0.00
5.50	0.41	0.00	0.00	31.50	7.69	5.80	0.00
6.00	0.47	0.00	0.17	32.00	7.69	5.80	0.00
6.50	0.54	0.01	1.42	32.50	7.69	5.80	0.00
7.00	0.61	0.02	4.71	33.00	7.69	5.80	0.00
7.50	0.68	0.04	9.99	33.50	7.69	5.80	0.00
8.00	0.76	0.06	16.66	34.00	7.69	5.80	0.00
8.50	0.84	0.09	24.28	34.50	7.69	5.80	0.00
9.00	0.93	0.12	32.59	35.00	7.69	5.80	0.00
9.50	1.07	0.18	42.14	35.50	7.69	5.80	0.00
10.00	1.22	0.26	57.61	36.00	7.69	5.80	0.00
10.50	1.38	0.34	81.11	36.50	7.69	5.80	0.00
11.00	1.66	0.52	108.92	37.00	7.69	5.80	0.00
11.50	2.09	0.81	156.38	37.50	7.69	5.80	0.00
12.00	3.60	2.03	263.26	38.00	7.69	5.80	0.00
12.50	5.60	3.83	652.24	38.50	7.69	5.80	0.00
13.00	6.03	4.22	1,478.06	39.00	7.69	5.80	0.00
13.50	6.31	4.49	1,801.92	39.50	7.69	5.80	0.00
14.00	6.47	4.64	1,451.57	40.00	7.69	5.80	0.00
14.50	6.62	4.78	958.37	40.50	7.69	5.80	0.00
15.00	6.76	4.91	643.98	41.00	7.69	5.80	0.00
15.50	6.85	4.99	452.39	41.50	7.69	5.80	0.00
16.00	6.93	5.07	334.64	42.00	7.69	5.80	0.00
16.50	7.01	5.15	253.11	42.50	7.69	5.80	0.00
17.00	7.08	5.22	198.98	43.00	7.69	5.80	0.00
17.50	7.15	5.28	167.22	43.50	7.69	5.80	0.00
18.00	7.22	5.35	146.07	44.00	7.69	5.80	0.00
18.50	7.28	5.41	131.70	44.50	7.69	5.80	0.00
19.00	7.34	5.46	122.19	45.00	7.69	5.80	0.00
19.50	7.39	5.51	114.07	45.50	7.69	5.80	0.00
20.00	7.44	5.56	106.59	46.00	7.69	5.80	0.00
20.50	7.49	5.60	99.35	46.50	7.69	5.80	0.00
21.00	7.53	5.64	92.21	47.00	7.69	5.80	0.00
21.50	7.56	5.68	85.15	47.50	7.69	5.80	0.00
22.00	7.60	5.71	78.11	48.00	7.69	5.80	0.00
22.50	7.63	5.74	71.05				
23.00	7.65	5.76	63.98				
23.50	7.67	5.78	56.90				
24.00	7.69	5.80	49.82				
24.50	7.69	5.80	42.24				
25.00	7.69	5.80	31.69				
25.50	7.69	5.80	19.33				

Summary for Subcatchment 3S: Watershed Downstream of Culvert

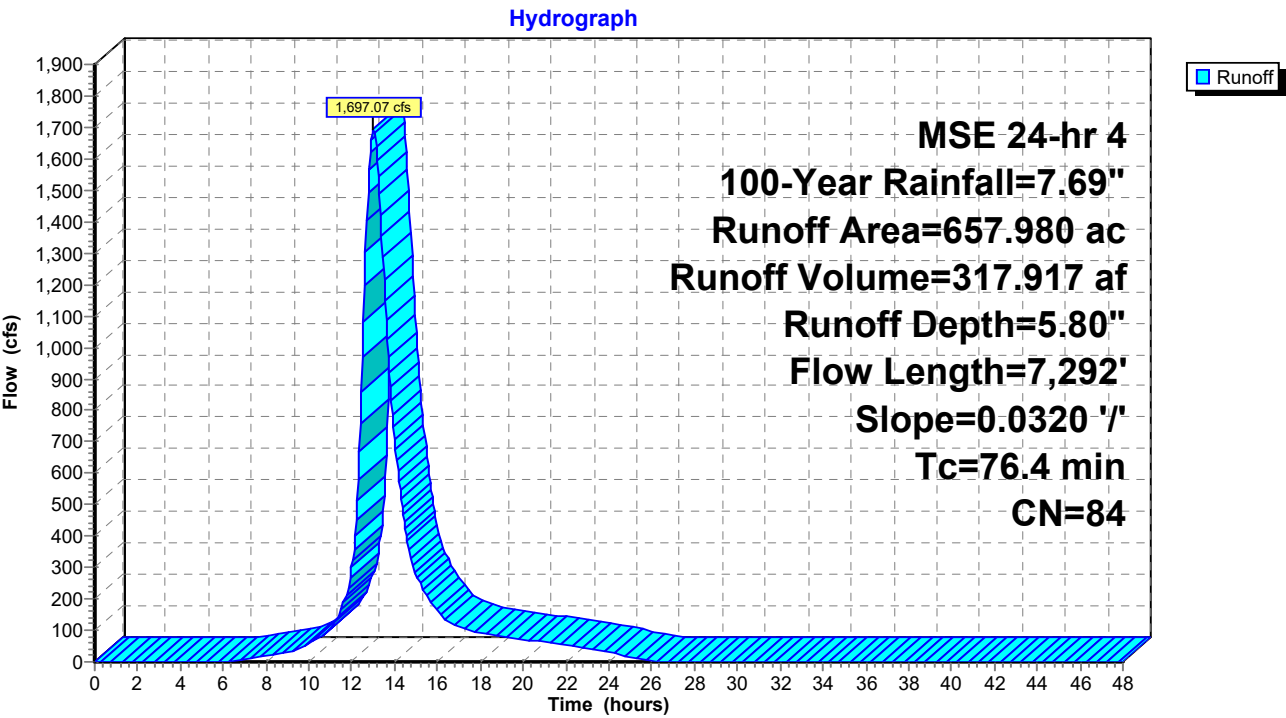
Runoff = 1,697.07 cfs @ 13.00 hrs, Volume= 317.917 af, Depth= 5.80"
Routed to Pond 4P : Existing Wetland Condition

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-Year Rainfall=7.69"

Area (ac)	CN	Description
* 657.980	84	Weighted Average
657.980		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
76.4	7,292	0.0320	1.59		Lag/CN Method,

Subcatchment 3S: Watershed Downstream of Culvert



IA-340-13 - Neary - Existing Condition - Simplified FUMSE 24-hr 4 100-Year Rainfall=7.69"

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Hydrograph for Subcatchment 3S: Watershed Downstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	26.00	7.69	5.80	2.04
0.50	0.02	0.00	0.00	26.50	7.69	5.80	0.75
1.00	0.04	0.00	0.00	27.00	7.69	5.80	0.26
1.50	0.06	0.00	0.00	27.50	7.69	5.80	0.08
2.00	0.09	0.00	0.00	28.00	7.69	5.80	0.01
2.50	0.13	0.00	0.00	28.50	7.69	5.80	0.00
3.00	0.16	0.00	0.00	29.00	7.69	5.80	0.00
3.50	0.20	0.00	0.00	29.50	7.69	5.80	0.00
4.00	0.25	0.00	0.00	30.00	7.69	5.80	0.00
4.50	0.30	0.00	0.00	30.50	7.69	5.80	0.00
5.00	0.35	0.00	0.00	31.00	7.69	5.80	0.00
5.50	0.41	0.00	0.00	31.50	7.69	5.80	0.00
6.00	0.47	0.00	0.40	32.00	7.69	5.80	0.00
6.50	0.54	0.01	2.56	32.50	7.69	5.80	0.00
7.00	0.61	0.02	6.60	33.00	7.69	5.80	0.00
7.50	0.68	0.04	11.71	33.50	7.69	5.80	0.00
8.00	0.76	0.06	17.48	34.00	7.69	5.80	0.00
8.50	0.84	0.09	23.71	34.50	7.69	5.80	0.00
9.00	0.93	0.12	30.29	35.00	7.69	5.80	0.00
9.50	1.07	0.18	38.73	35.50	7.69	5.80	0.00
10.00	1.22	0.26	57.04	36.00	7.69	5.80	0.00
10.50	1.38	0.34	78.59	36.50	7.69	5.80	0.00
11.00	1.66	0.52	102.04	37.00	7.69	5.80	0.00
11.50	2.09	0.81	163.18	37.50	7.69	5.80	0.00
12.00	3.60	2.03	299.84	38.00	7.69	5.80	0.00
12.50	5.60	3.83	968.68	38.50	7.69	5.80	0.00
13.00	6.03	4.22	1,697.07	39.00	7.69	5.80	0.00
13.50	6.31	4.49	1,216.97	39.50	7.69	5.80	0.00
14.00	6.47	4.64	708.93	40.00	7.69	5.80	0.00
14.50	6.62	4.78	423.56	40.50	7.69	5.80	0.00
15.00	6.76	4.91	279.27	41.00	7.69	5.80	0.00
15.50	6.85	4.99	212.66	41.50	7.69	5.80	0.00
16.00	6.93	5.07	161.37	42.00	7.69	5.80	0.00
16.50	7.01	5.15	124.98	42.50	7.69	5.80	0.00
17.00	7.08	5.22	109.08	43.00	7.69	5.80	0.00
17.50	7.15	5.28	100.07	43.50	7.69	5.80	0.00
18.00	7.22	5.35	93.64	44.00	7.69	5.80	0.00
18.50	7.28	5.41	88.05	44.50	7.69	5.80	0.00
19.00	7.34	5.46	82.75	45.00	7.69	5.80	0.00
19.50	7.39	5.51	77.59	45.50	7.69	5.80	0.00
20.00	7.44	5.56	72.47	46.00	7.69	5.80	0.00
20.50	7.49	5.60	67.34	46.50	7.69	5.80	0.00
21.00	7.53	5.64	62.19	47.00	7.69	5.80	0.00
21.50	7.56	5.68	57.04	47.50	7.69	5.80	0.00
22.00	7.60	5.71	51.87	48.00	7.69	5.80	0.00
22.50	7.63	5.74	46.68				
23.00	7.65	5.76	41.49				
23.50	7.67	5.78	36.29				
24.00	7.69	5.80	31.08				
24.50	7.69	5.80	24.73				
25.00	7.69	5.80	13.81				
25.50	7.69	5.80	5.42				

Summary for Pond 2P: 560th Ave Culvert

Inflow Area = 899.170 ac, 0.00% Impervious, Inflow Depth = 5.80" for 100-Year event
 Inflow = 1,806.38 cfs @ 13.44 hrs, Volume= 434.453 af
 Outflow = 1,770.47 cfs @ 13.61 hrs, Volume= 434.453 af, Atten= 2%, Lag= 9.7 min
 Primary = 419.65 cfs @ 13.61 hrs, Volume= 244.298 af
 Routed to Pond 4P : Existing Wetland Condition
 Secondary = 1,350.82 cfs @ 13.61 hrs, Volume= 190.154 af
 Routed to Pond 4P : Existing Wetland Condition

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 1,236.28' @ 13.61 hrs Surf.Area= 20.043 ac Storage= 17.719 af

Plug-Flow detention time= 4.5 min calculated for 434.001 af (100% of inflow)
 Center-of-Mass det. time= 4.5 min (887.7 - 883.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,226.00'	66.349 af	Custom Stage Data from Lidar (Prismatic) listed below (Recalc)

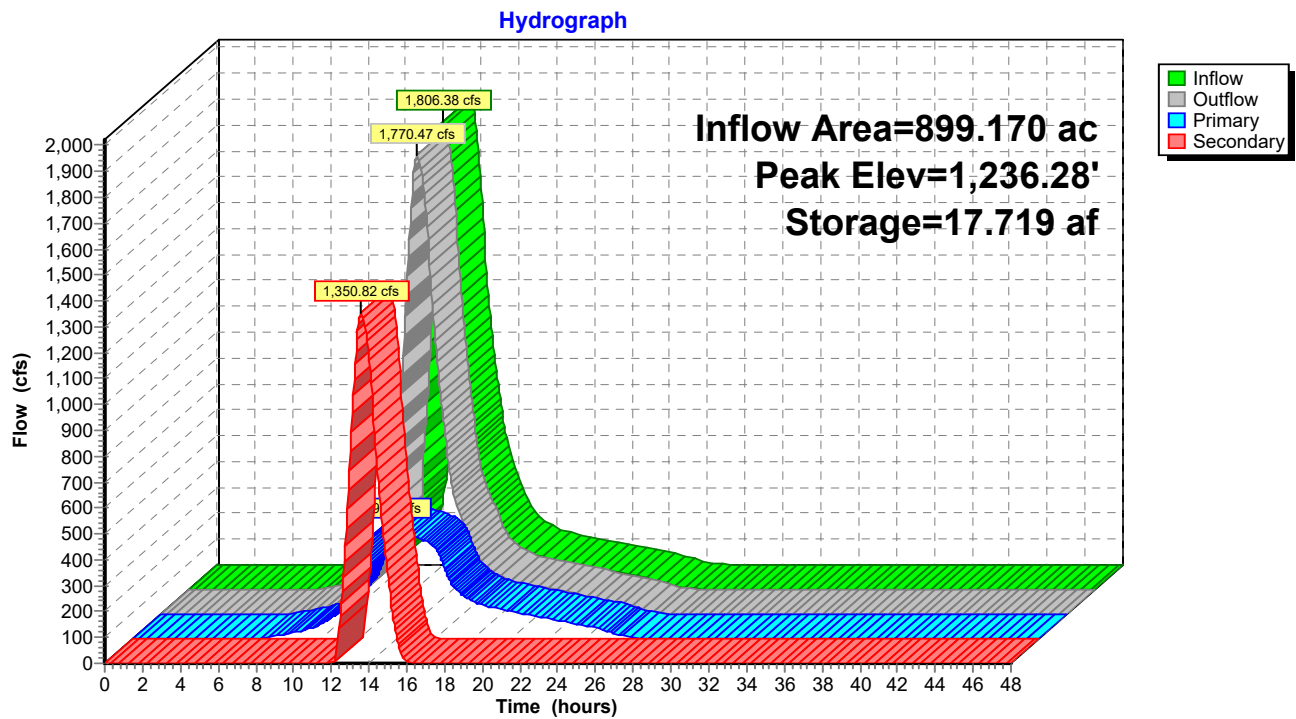
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,226.00	0.001	0.000	0.000
1,227.00	0.002	0.002	0.002
1,228.00	0.003	0.003	0.004
1,229.00	0.006	0.005	0.008
1,230.00	0.016	0.011	0.020
1,231.00	0.038	0.027	0.046
1,232.00	0.082	0.060	0.106
1,233.00	0.422	0.252	0.358
1,234.00	0.999	0.710	1.069
1,235.00	1.702	1.350	2.419
1,236.00	18.079	9.890	12.310
1,237.00	25.000	21.539	33.849
1,238.00	40.000	32.500	66.349

Device	Routing	Invert	Outlet Devices
#1	Primary	1,226.36'	72.0" W x 60.0" H Box Existing 5x6 Road Culvert L= 25.0' Box, 30-75° wingwalls, square crown, Ke= 0.400 Inlet / Outlet Invert= 1,226.36' / 1,226.36' S= 0.0000 ' / Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 30.00 sf
#2	Secondary	1,234.37'	Gravel Road - Asymmetrical Weir, C= 3.27 Offset (feet) -214.93 -167.93 -88.67 0.00 82.37 132.11 157.11 Elev. (feet) 1,237.00 1,236.27 1,235.04 1,234.37 1,235.06 1,236.20 1,237.00

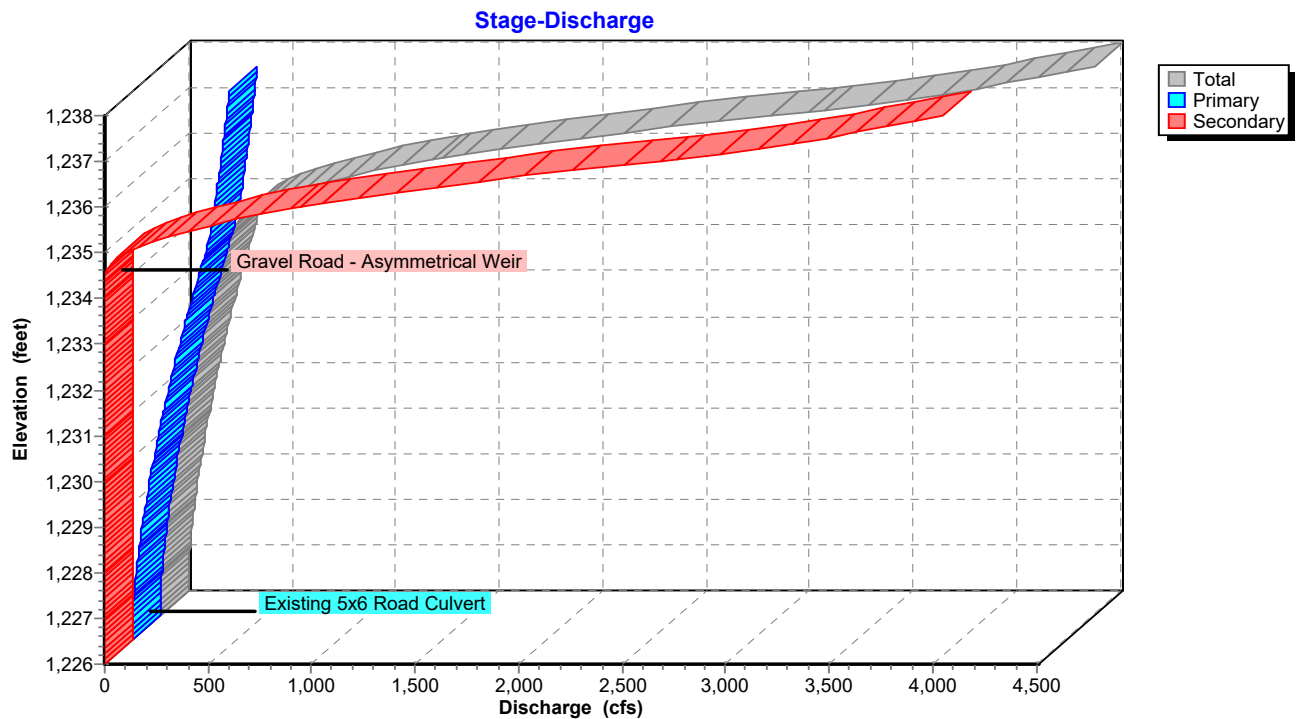
Primary OutFlow Max=419.64 cfs @ 13.61 hrs HW=1,236.28' TW=1,207.13' (Dynamic Tailwater)
 ↑1=Existing 5x6 Road Culvert (Inlet Controls 419.64 cfs @ 13.99 fps)

Secondary OutFlow Max=1,350.40 cfs @ 13.61 hrs HW=1,236.28' TW=1,207.13' (Dynamic Tailwater)
 ↑2=Gravel Road - Asymmetrical Weir (Weir Controls 1,350.40 cfs @ 2.77 fps)

Pond 2P: 560th Ave Culvert

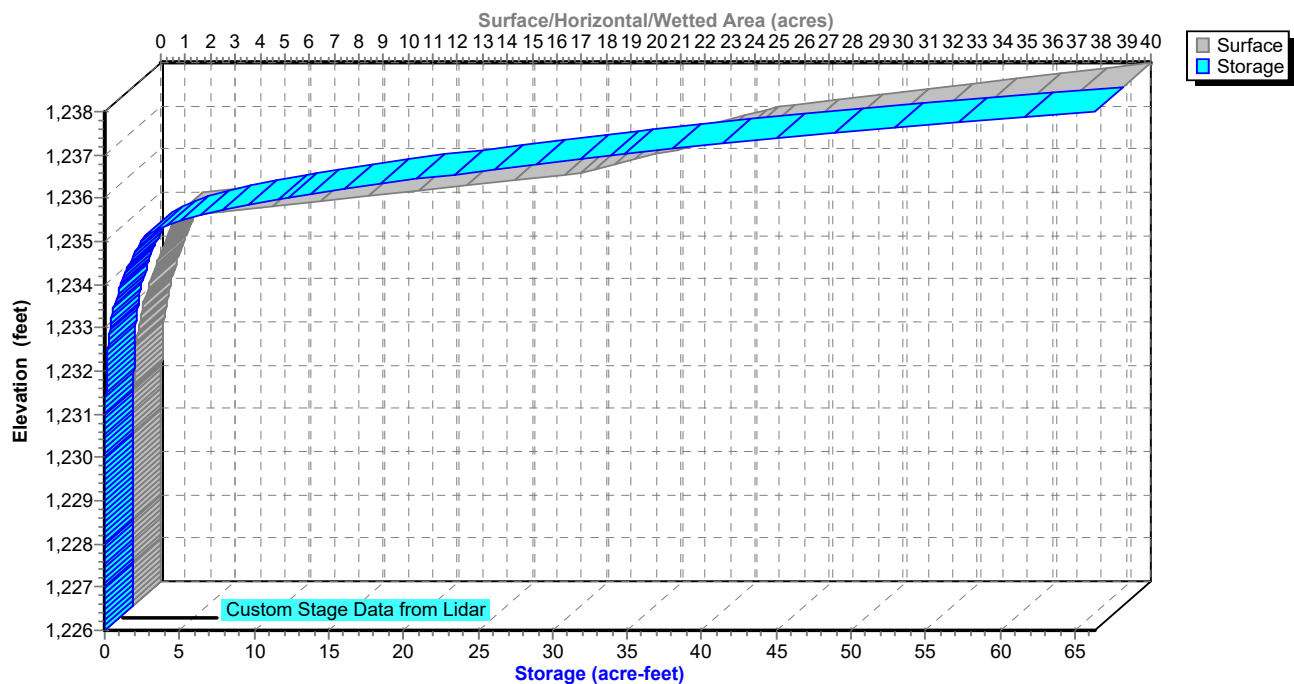


Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert

Stage-Area-Storage



Hydrograph for Pond 2P: 560th Ave Culvert

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	0.000	1,226.00	0.00	0.00	0.00
1.00	0.00	0.000	1,226.00	0.00	0.00	0.00
2.00	0.00	0.000	1,226.00	0.00	0.00	0.00
3.00	0.00	0.000	1,226.00	0.00	0.00	0.00
4.00	0.00	0.000	1,226.00	0.00	0.00	0.00
5.00	0.00	0.000	1,226.00	0.00	0.00	0.00
6.00	0.17	0.001	1,226.44	0.17	0.17	0.00
7.00	4.71	0.001	1,226.86	4.70	4.70	0.00
8.00	16.66	0.003	1,227.46	16.64	16.64	0.00
9.00	32.59	0.004	1,228.06	32.57	32.57	0.00
10.00	57.61	0.008	1,228.83	57.54	57.54	0.00
11.00	108.92	0.021	1,230.12	108.59	108.59	0.00
12.00	263.26	0.279	1,232.80	245.13	245.13	0.00
13.00	1,478.06	10.470	1,235.89	1,228.34	408.23	820.11
14.00	1,451.57	15.291	1,236.16	1,583.85	416.07	1,167.78
15.00	643.98	4.272	1,235.38	720.80	392.79	328.02
16.00	334.64	1.691	1,234.53	356.49	353.34	3.15
17.00	198.98	0.106	1,232.00	200.77	200.77	0.00
18.00	146.07	0.044	1,230.94	146.42	146.42	0.00
19.00	122.19	0.028	1,230.42	122.33	122.33	0.00
20.00	106.59	0.021	1,230.07	106.67	106.67	0.00
21.00	92.21	0.016	1,229.73	92.27	92.27	0.00
22.00	78.11	0.012	1,229.38	78.15	78.15	0.00
23.00	63.98	0.009	1,229.01	64.00	64.00	0.00
24.00	49.82	0.006	1,228.61	49.84	49.84	0.00
25.00	31.69	0.004	1,228.04	31.72	31.72	0.00
26.00	10.05	0.002	1,227.16	10.07	10.07	0.00
27.00	2.58	0.001	1,226.71	2.58	2.58	0.00
28.00	0.62	0.001	1,226.52	0.63	0.63	0.00
29.00	0.12	0.001	1,226.43	0.12	0.12	0.00
30.00	0.00	0.000	1,226.37	0.00	0.00	0.00
31.00	0.00	0.000	1,226.36	0.00	0.00	0.00
32.00	0.00	0.000	1,226.36	0.00	0.00	0.00
33.00	0.00	0.000	1,226.36	0.00	0.00	0.00
34.00	0.00	0.000	1,226.36	0.00	0.00	0.00
35.00	0.00	0.000	1,226.36	0.00	0.00	0.00
36.00	0.00	0.000	1,226.36	0.00	0.00	0.00
37.00	0.00	0.000	1,226.36	0.00	0.00	0.00
38.00	0.00	0.000	1,226.36	0.00	0.00	0.00
39.00	0.00	0.000	1,226.36	0.00	0.00	0.00
40.00	0.00	0.000	1,226.36	0.00	0.00	0.00
41.00	0.00	0.000	1,226.36	0.00	0.00	0.00
42.00	0.00	0.000	1,226.36	0.00	0.00	0.00
43.00	0.00	0.000	1,226.36	0.00	0.00	0.00
44.00	0.00	0.000	1,226.36	0.00	0.00	0.00
45.00	0.00	0.000	1,226.36	0.00	0.00	0.00
46.00	0.00	0.000	1,226.36	0.00	0.00	0.00
47.00	0.00	0.000	1,226.36	0.00	0.00	0.00
48.00	0.00	0.000	1,226.36	0.00	0.00	0.00

Stage-Discharge for Pond 2P: 560th Ave Culvert

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
1,226.00	0.00	0.00	0.00	1,236.40	1,958.33	422.99	1,535.35
1,226.20	0.00	0.00	0.00	1,236.60	2,310.52	428.67	1,881.85
1,226.40	0.04	0.04	0.00	1,236.80	2,699.76	434.27	2,265.49
1,226.60	1.34	1.34	0.00	1,237.00	3,126.75	439.79	2,686.95
1,226.80	3.79	3.79	0.00	1,237.20	3,481.18	445.25	3,035.93
1,227.00	7.01	7.01	0.00	1,237.40	3,776.53	450.64	3,325.89
1,227.20	10.82	10.82	0.00	1,237.60	4,041.43	455.96	3,585.47
1,227.40	15.14	15.14	0.00	1,237.80	4,285.19	461.22	3,823.97
1,227.60	19.92	19.92	0.00	1,238.00	4,512.80	466.42	4,046.38
1,227.80	25.12	25.12	0.00				
1,228.00	30.69	30.69	0.00				
1,228.20	36.63	36.63	0.00				
1,228.40	42.91	42.91	0.00				
1,228.60	49.50	49.50	0.00				
1,228.80	56.40	56.40	0.00				
1,229.00	63.59	63.59	0.00				
1,229.20	71.07	71.07	0.00				
1,229.40	78.81	78.81	0.00				
1,229.60	86.82	86.82	0.00				
1,229.80	95.08	95.08	0.00				
1,230.00	103.58	103.58	0.00				
1,230.20	112.33	112.33	0.00				
1,230.40	121.30	121.30	0.00				
1,230.60	130.51	130.51	0.00				
1,230.80	139.93	139.93	0.00				
1,231.00	149.57	149.57	0.00				
1,231.20	159.42	159.42	0.00				
1,231.40	169.48	169.48	0.00				
1,231.60	179.74	179.74	0.00				
1,231.80	190.20	190.20	0.00				
1,232.00	200.86	200.86	0.00				
1,232.20	211.71	211.71	0.00				
1,232.40	222.74	222.74	0.00				
1,232.60	233.96	233.96	0.00				
1,232.80	245.36	245.36	0.00				
1,233.00	256.95	256.95	0.00				
1,233.20	269.38	269.38	0.00				
1,233.40	283.64	283.64	0.00				
1,233.60	297.22	297.22	0.00				
1,233.80	310.20	310.20	0.00				
1,234.00	322.67	322.67	0.00				
1,234.20	334.66	334.66	0.00				
1,234.40	346.30	346.25	0.05				
1,234.60	365.81	357.46	8.35				
1,234.80	408.24	368.32	39.92				
1,235.00	482.60	378.88	103.72				
1,235.20	592.10	387.09	205.01				
1,235.40	734.23	393.31	340.92				
1,235.60	909.80	399.43	510.37				
1,235.80	1,119.19	405.46	713.74				
1,236.00	1,363.16	411.39	951.77				
1,236.20	1,642.64	417.23	1,225.41				

IA-340-13 - Neary - Existing Condition - Simplified Full MSE 24-hr 4 100-Year Rainfall=7.69"

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Stage-Area-Storage for Pond 2P: 560th Ave Culvert

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,226.00	0.001	0.000	1,236.40	20.847	20.095
1,226.20	0.001	0.000	1,236.60	22.232	24.403
1,226.40	0.001	0.000	1,236.80	23.616	28.988
1,226.60	0.002	0.001	1,237.00	25.000	33.849
1,226.80	0.002	0.001	1,237.20	28.000	39.150
1,227.00	0.002	0.002	1,237.40	31.000	45.050
1,227.20	0.002	0.002	1,237.60	34.000	51.549
1,227.40	0.002	0.002	1,237.80	37.000	58.649
1,227.60	0.003	0.003	1,238.00	40.000	66.349
1,227.80	0.003	0.003			
1,228.00	0.003	0.004			
1,228.20	0.004	0.005			
1,228.40	0.004	0.005			
1,228.60	0.005	0.006			
1,228.80	0.005	0.007			
1,229.00	0.006	0.008			
1,229.20	0.008	0.010			
1,229.40	0.010	0.012			
1,229.60	0.012	0.014			
1,229.80	0.014	0.016			
1,230.00	0.016	0.020			
1,230.20	0.020	0.023			
1,230.40	0.025	0.028			
1,230.60	0.029	0.033			
1,230.80	0.034	0.039			
1,231.00	0.038	0.046			
1,231.20	0.047	0.055			
1,231.40	0.056	0.065			
1,231.60	0.064	0.077			
1,231.80	0.073	0.091			
1,232.00	0.082	0.106			
1,232.20	0.150	0.130			
1,232.40	0.218	0.167			
1,232.60	0.286	0.217			
1,232.80	0.354	0.281			
1,233.00	0.422	0.358			
1,233.20	0.537	0.454			
1,233.40	0.653	0.573			
1,233.60	0.768	0.716			
1,233.80	0.884	0.881			
1,234.00	0.999	1.069			
1,234.20	1.140	1.283			
1,234.40	1.280	1.525			
1,234.60	1.421	1.795			
1,234.80	1.561	2.093			
1,235.00	1.702	2.419			
1,235.20	4.977	3.087			
1,235.40	8.253	4.410			
1,235.60	11.528	6.389			
1,235.80	14.804	9.022			
1,236.00	18.079	12.310			
1,236.20	19.463	16.064			

Summary for Pond 4P: Existing Wetland Condition

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 5.80" for 100-Year event
 Inflow = 3,115.21 cfs @ 13.26 hrs, Volume= 752.370 af
 Outflow = 2,960.99 cfs @ 13.51 hrs, Volume= 752.345 af, Atten= 5%, Lag= 15.0 min
 Primary = 2,960.99 cfs @ 13.51 hrs, Volume= 752.345 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Peak Elev= 1,207.15' @ 13.51 hrs Surf.Area= 18.349 ac Storage= 77.735 af

Plug-Flow detention time= 28.2 min calculated for 752.345 af (100% of inflow)
 Center-of-Mass det. time= 27.7 min (900.3 - 872.6)

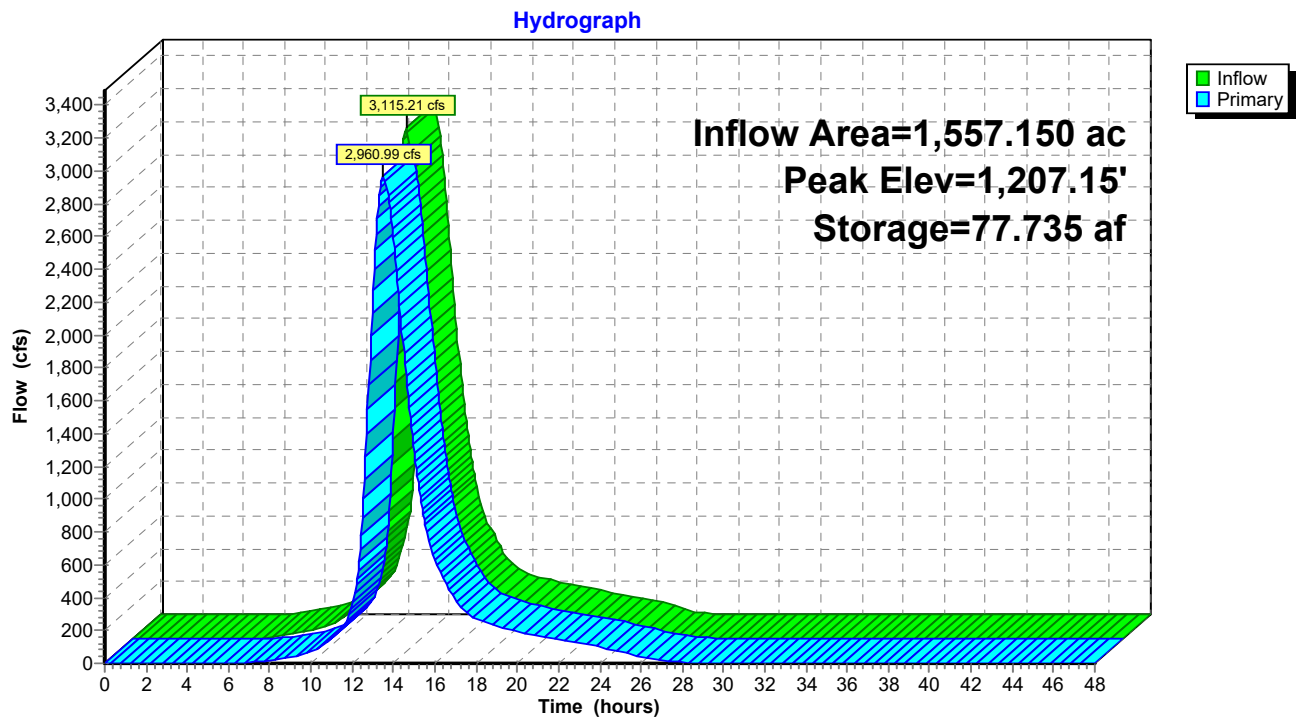
Volume	Invert	Avail.Storage	Storage Description
#1	1,199.00'	94.165 af	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,199.00	0.002	0.000	0.000
1,200.00	1.684	0.843	0.843
1,201.00	6.154	3.919	4.762
1,202.00	7.956	7.055	11.817
1,203.00	9.499	8.728	20.544
1,204.00	11.030	10.264	30.809
1,205.00	13.737	12.383	43.192
1,206.00	15.991	14.864	58.057
1,207.00	18.042	17.016	75.073
1,208.00	20.142	19.092	94.165

Device	Routing	Invert	Outlet Devices
#1	Primary	1,199.12'	Existing Outlet Channel to Lake, C= 3.27 Offset (feet) -106.52 -44.01 -15.95 0.00 10.33 70.05 Elev. (feet) 1,213.23 1,204.05 1,201.65 1,199.12 1,201.69 1,213.23

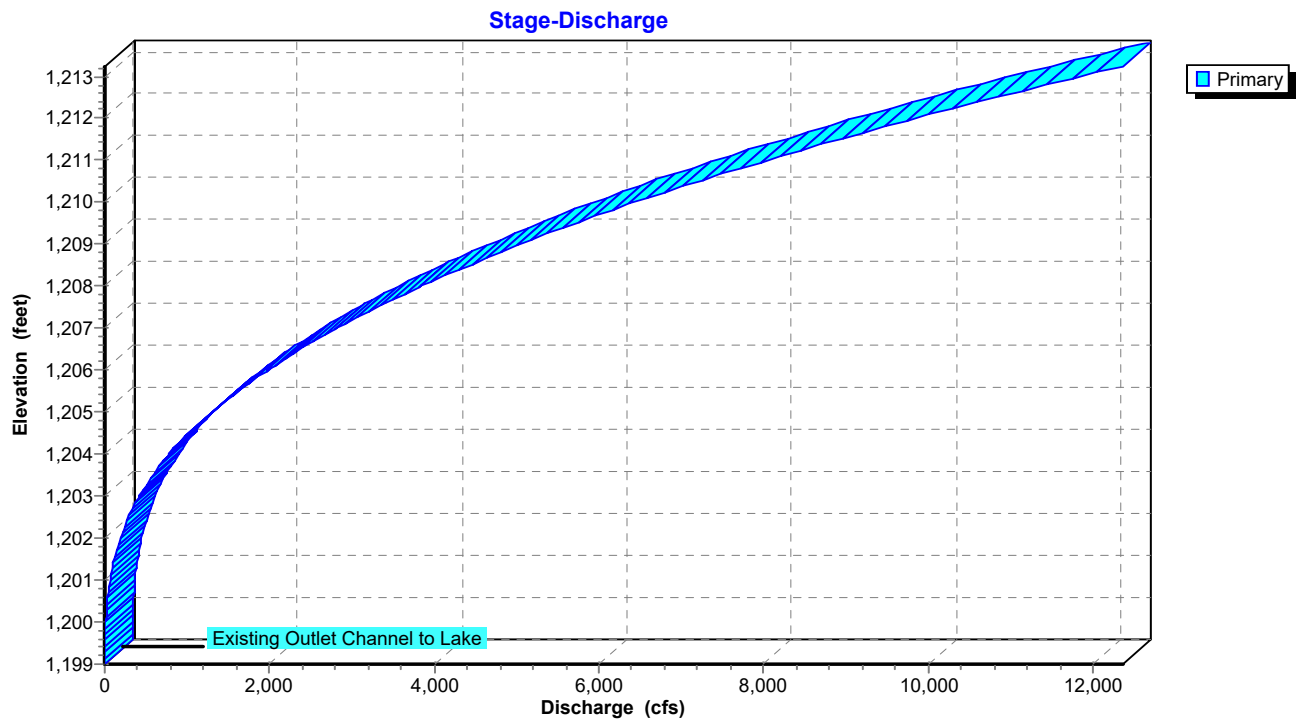
Primary OutFlow Max=2,960.10 cfs @ 13.51 hrs HW=1,207.15' (Free Discharge)

↑1=Existing Outlet Channel to Lake(Weir Controls 2,960.10 cfs @ 5.07 fps)

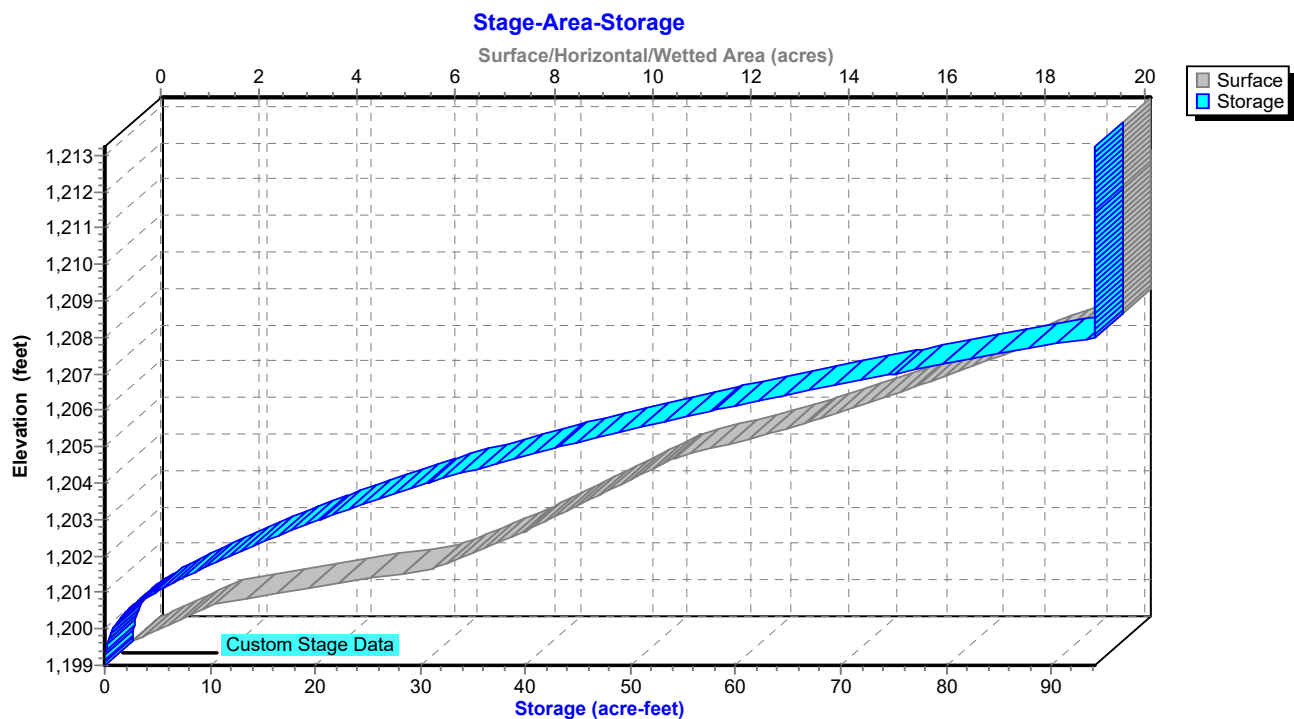
Pond 4P: Existing Wetland Condition



Pond 4P: Existing Wetland Condition



Pond 4P: Existing Wetland Condition



Hydrograph for Pond 4P: Existing Wetland Condition

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0.000	1,199.00	0.00
1.00	0.00	0.000	1,199.00	0.00
2.00	0.00	0.000	1,199.00	0.00
3.00	0.00	0.000	1,199.00	0.00
4.00	0.00	0.000	1,199.00	0.00
5.00	0.00	0.000	1,199.00	0.00
6.00	0.56	0.006	1,199.09	0.00
7.00	11.30	0.341	1,199.64	2.58
8.00	34.12	1.383	1,200.24	18.04
9.00	62.87	2.987	1,200.67	40.56
10.00	114.58	5.337	1,201.09	73.76
11.00	210.62	9.714	1,201.73	148.23
12.00	544.97	18.665	1,202.80	362.45
13.00	2,925.41	64.153	1,206.37	2,273.40
14.00	2,292.78	70.508	1,206.74	2,589.97
15.00	1,000.08	42.682	1,204.96	1,279.21
16.00	517.87	26.917	1,203.64	633.17
17.00	309.86	19.359	1,202.87	382.66
18.00	240.06	15.340	1,202.43	272.64
19.00	205.07	13.309	1,202.18	223.67
20.00	179.14	11.972	1,202.02	193.99
21.00	154.46	10.773	1,201.87	169.02
22.00	130.02	9.552	1,201.71	145.15
23.00	105.50	8.265	1,201.53	121.54
24.00	80.92	6.893	1,201.33	98.08
25.00	45.53	5.219	1,201.07	72.02
26.00	12.11	2.833	1,200.64	38.43
27.00	2.85	1.226	1,200.18	15.73
28.00	0.64	0.552	1,199.81	5.32
29.00	0.12	0.297	1,199.59	2.08
30.00	0.00	0.183	1,199.47	0.95
31.00	0.00	0.126	1,199.39	0.50
32.00	0.00	0.095	1,199.33	0.29
33.00	0.00	0.076	1,199.30	0.18
34.00	0.00	0.063	1,199.27	0.12
35.00	0.00	0.055	1,199.25	0.09
36.00	0.00	0.048	1,199.24	0.07
37.00	0.00	0.044	1,199.23	0.05
38.00	0.00	0.040	1,199.22	0.04
39.00	0.00	0.037	1,199.21	0.03
40.00	0.00	0.035	1,199.20	0.03
41.00	0.00	0.033	1,199.20	0.02
42.00	0.00	0.031	1,199.19	0.02
43.00	0.00	0.030	1,199.19	0.02
44.00	0.00	0.029	1,199.18	0.01
45.00	0.00	0.027	1,199.18	0.01
46.00	0.00	0.027	1,199.18	0.01
47.00	0.00	0.026	1,199.17	0.01
48.00	0.00	0.025	1,199.17	0.01

IA-340-13 - Neary - Existing Condition - Simplified Full MSE 24-hr 4 100-Year Rainfall=7.69"

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Stage-Discharge for Pond 4P: Existing Wetland Condition

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.00	0.00	1,204.20	873.63	1,209.40	5,580.36
1,199.10	0.00	1,204.30	921.64	1,209.50	5,718.95
1,199.20	0.02	1,204.40	971.21	1,209.60	5,859.52
1,199.30	0.19	1,204.50	1,022.34	1,209.70	6,002.06
1,199.40	0.56	1,204.60	1,075.02	1,209.80	6,146.60
1,199.50	1.20	1,204.70	1,129.26	1,209.90	6,293.12
1,199.60	2.16	1,204.80	1,185.06	1,210.00	6,441.66
1,199.70	3.46	1,204.90	1,242.42	1,210.10	6,592.21
1,199.80	5.15	1,205.00	1,301.37	1,210.20	6,744.77
1,199.90	7.26	1,205.10	1,361.89	1,210.30	6,899.37
1,200.00	9.81	1,205.20	1,424.01	1,210.40	7,056.01
1,200.10	12.84	1,205.30	1,487.72	1,210.50	7,214.69
1,200.20	16.37	1,205.40	1,553.03	1,210.60	7,375.43
1,200.30	20.42	1,205.50	1,619.95	1,210.70	7,538.23
1,200.40	25.03	1,205.60	1,688.50	1,210.80	7,703.10
1,200.50	30.21	1,205.70	1,758.67	1,210.90	7,870.05
1,200.60	35.98	1,205.80	1,830.48	1,211.00	8,039.08
1,200.70	42.37	1,205.90	1,903.93	1,211.10	8,210.21
1,200.80	49.40	1,206.00	1,979.04	1,211.20	8,383.45
1,200.90	57.08	1,206.10	2,055.81	1,211.30	8,558.79
1,201.00	65.44	1,206.20	2,134.25	1,211.40	8,736.25
1,201.10	74.49	1,206.30	2,214.38	1,211.50	8,915.85
1,201.20	84.26	1,206.40	2,296.19	1,211.60	9,097.57
1,201.30	94.75	1,206.50	2,379.70	1,211.70	9,281.44
1,201.40	105.99	1,206.60	2,464.92	1,211.80	9,467.46
1,201.50	118.00	1,206.70	2,551.85	1,211.90	9,655.64
1,201.60	130.79	1,206.80	2,640.51	1,212.00	9,845.98
1,201.70	144.38	1,206.90	2,730.90	1,212.10	10,038.50
1,201.80	158.84	1,207.00	2,823.03	1,212.20	10,233.20
1,201.90	174.25	1,207.10	2,916.92	1,212.30	10,430.09
1,202.00	190.67	1,207.20	3,012.57	1,212.40	10,629.18
1,202.10	208.13	1,207.30	3,109.99	1,212.50	10,830.47
1,202.20	226.68	1,207.40	3,209.18	1,212.60	11,033.98
1,202.30	246.35	1,207.50	3,310.17	1,212.70	11,239.71
1,202.40	267.18	1,207.60	3,412.95	1,212.80	11,447.66
1,202.50	289.21	1,207.70	3,517.54	1,212.90	11,657.85
1,202.60	312.46	1,207.80	3,623.94	1,213.00	11,870.29
1,202.70	336.97	1,207.90	3,732.17	1,213.10	12,084.97
1,202.80	362.76	1,208.00	3,842.22	1,213.20	12,301.92
1,202.90	389.87	1,208.10	3,954.12		
1,203.00	418.32	1,208.20	4,067.87		
1,203.10	448.14	1,208.30	4,183.48		
1,203.20	479.36	1,208.40	4,300.96		
1,203.30	511.99	1,208.50	4,420.31		
1,203.40	546.08	1,208.60	4,541.55		
1,203.50	581.63	1,208.70	4,664.68		
1,203.60	618.68	1,208.80	4,789.71		
1,203.70	657.25	1,208.90	4,916.66		
1,203.80	697.36	1,209.00	5,045.53		
1,203.90	739.04	1,209.10	5,176.32		
1,204.00	782.30	1,209.20	5,309.05		
1,204.10	827.18	1,209.30	5,443.73		

Stage-Area-Storage for Pond 4P: Existing Wetland Condition

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,199.00	0.002	0.000	1,209.40	20.142	94.165
1,199.20	0.338	0.034	1,209.60	20.142	94.165
1,199.40	0.675	0.135	1,209.80	20.142	94.165
1,199.60	1.011	0.304	1,210.00	20.142	94.165
1,199.80	1.348	0.540	1,210.20	20.142	94.165
1,200.00	1.684	0.843	1,210.40	20.142	94.165
1,200.20	2.578	1.269	1,210.60	20.142	94.165
1,200.40	3.472	1.874	1,210.80	20.142	94.165
1,200.60	4.366	2.658	1,211.00	20.142	94.165
1,200.80	5.260	3.621	1,211.20	20.142	94.165
1,201.00	6.154	4.762	1,211.40	20.142	94.165
1,201.20	6.514	6.029	1,211.60	20.142	94.165
1,201.40	6.875	7.368	1,211.80	20.142	94.165
1,201.60	7.235	8.779	1,212.00	20.142	94.165
1,201.80	7.596	10.262	1,212.20	20.142	94.165
1,202.00	7.956	11.817	1,212.40	20.142	94.165
1,202.20	8.265	13.439	1,212.60	20.142	94.165
1,202.40	8.573	15.123	1,212.80	20.142	94.165
1,202.60	8.882	16.868	1,213.00	20.142	94.165
1,202.80	9.190	18.676	1,213.20	20.142	94.165
1,203.00	9.499	20.544			
1,203.20	9.805	22.475			
1,203.40	10.111	24.467			
1,203.60	10.418	26.519			
1,203.80	10.724	28.634			
1,204.00	11.030	30.809			
1,204.20	11.571	33.069			
1,204.40	12.113	35.438			
1,204.60	12.654	37.914			
1,204.80	13.196	40.499			
1,205.00	13.737	43.192			
1,205.20	14.188	45.985			
1,205.40	14.639	48.868			
1,205.60	15.089	51.840			
1,205.80	15.540	54.903			
1,206.00	15.991	58.057			
1,206.20	16.401	61.296			
1,206.40	16.811	64.617			
1,206.60	17.222	68.020			
1,206.80	17.632	71.506			
1,207.00	18.042	75.073			
1,207.20	18.462	78.723			
1,207.40	18.882	82.458			
1,207.60	19.302	86.276			
1,207.80	19.722	90.179			
1,208.00	20.142	94.165			
1,208.20	20.142	94.165			
1,208.40	20.142	94.165			
1,208.60	20.142	94.165			
1,208.80	20.142	94.165			
1,209.00	20.142	94.165			
1,209.20	20.142	94.165			

Events for Subcatchment 1S: Watershed Upstream of Culvert

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
10-Year	4.43	866.81	206.334	2.75
25-Year	5.57	1,192.77	284.418	3.80
100-Year	7.69	1,806.38	434.453	5.80

Events for Subcatchment 3S: Watershed Downstream of Culvert

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
10-Year	4.43	816.20	150.988	2.75
25-Year	5.57	1,122.05	208.126	3.80
100-Year	7.69	1,697.07	317.917	5.80

Events for Pond 2P: 560th Ave Culvert

Event	Inflow (cfs)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Storage (acre-feet)
10-Year	866.81	855.07	397.66	457.42	1,235.54	5.743
25-Year	1,192.77	1,170.14	406.78	763.36	1,235.84	9.693
100-Year	1,806.38	1,770.47	419.65	1,350.82	1,236.28	17.719

Events for Pond 4P: Existing Wetland Condition

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
10-Year	1,520.50	1,411.67	1,205.18	45.707
25-Year	2,070.29	1,945.44	1,205.96	57.348
100-Year	3,115.21	2,960.99	1,207.15	77.735

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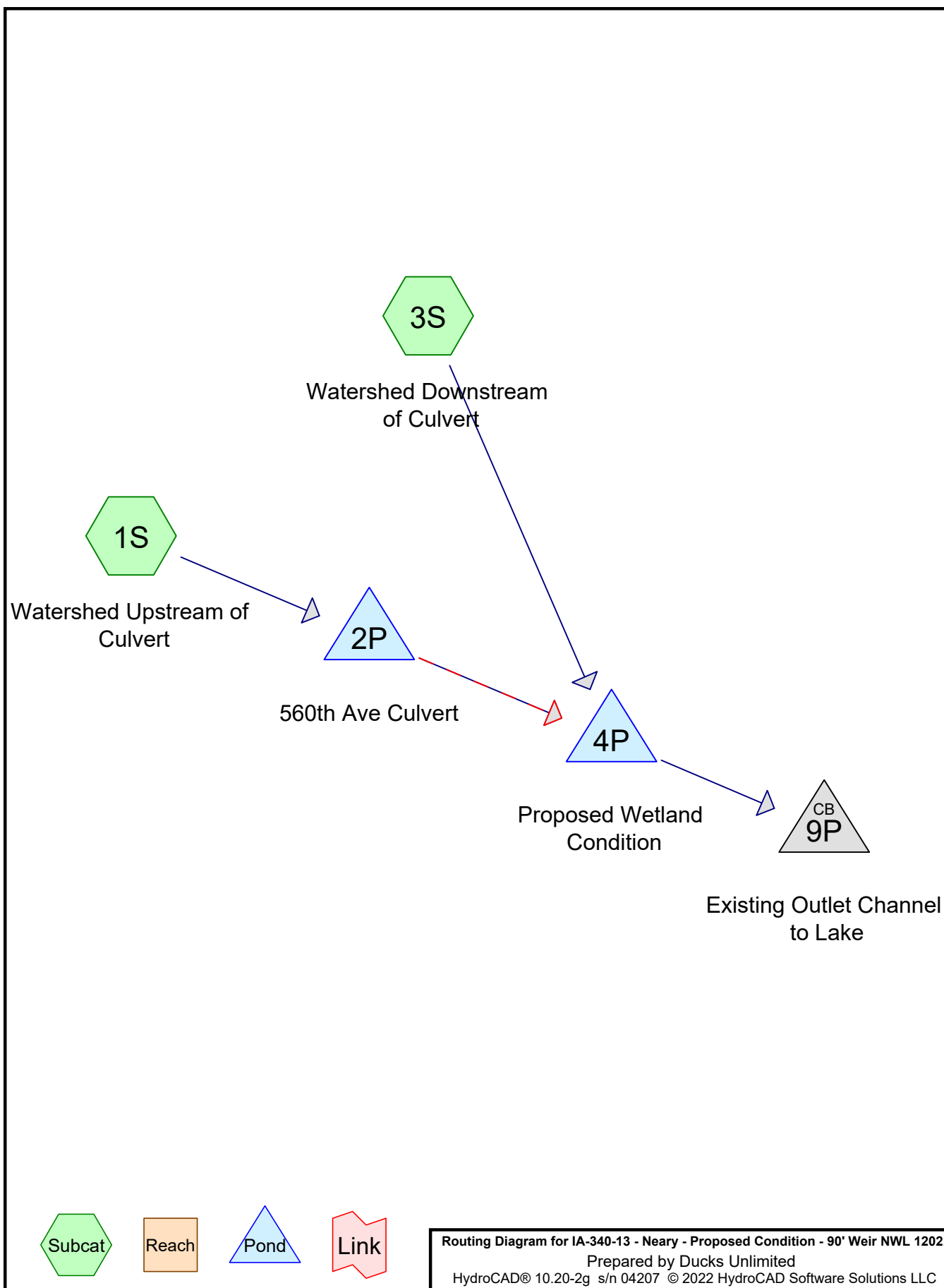
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GREAT LAKES/ATLANTIC REGION
7322 Newman Blvd., Bldg. 2
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Appendix A-2
HydroCAD Report – Proposed Conditions



IA-340-13 - Neary - Proposed Condition - 90' Weir NWL 1202.2'

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Project Notes

Copied 10 events from IOWA-SHEY 9-27-23 24-hr S1 storm
Rainfall events imported from "NRCS-Rain.txt" for 1454 IA Kossuth
Rainfall events imported from "NRCS-Rain.txt" for 1454 IA Kossuth
Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
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IA-340-13 - Neary - Proposed Condition - 90' Weir NWL 1202.2'

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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	10-Year	MSE 24-hr	4	Default	24.00	1	4.43	2
2	25-Year	MSE 24-hr	4	Default	24.00	1	5.57	2
3	100-Year	MSE 24-hr	4	Default	24.00	1	7.69	2

IA-340-13 - Neary - Proposed Condition - 90' Weir NWL 1202.2'

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1,557.150	84	Weighted Average (1S, 3S)
1,557.150	84	TOTAL AREA

IA-340-13 - Neary - Proposed Condition - 90' Weir NWL 1202.2'

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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
1,557.150	Other	1S, 3S
1,557.150		TOTAL AREA

IA-340-13 - Neary - Proposed Condition - 90' Weir NWL 1202.2'

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	1,557.150	1,557.150	Weighted Average	1S, 3S
0.000	0.000	0.000	0.000	1,557.150	1,557.150	TOTAL AREA	

IA-340-13 - Neary - Proposed Condition - 90' Weir NWL 1202.2'

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Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	2P	1,226.36	1,226.36	25.0	0.0000	0.012	72.0	60.0	0.0

IA-340-13 - Neary - Proposed Condition - 90' Weir NWL 1202.2'

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Notes Listing (all nodes)

Line#	Node Number	Notes
1	Project	Copied 10 events from IOWA-SHEY 9-27-23 24-hr S1 storm
2		Rainfall events imported from "NRCS-Rain.txt" for 1454 IA Kossuth
3		Rainfall events imported from "NRCS-Rain.txt" for 1454 IA Kossuth
4		Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
5		Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
6		Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet
7		Rainfall events imported from "NRCS-Rain.txt" for 1431 IA Emmet

IA-340-13 - Neary - Proposed Condition - 90' Weir NW *MSE 24-hr 4 10-Year Rainfall=4.43"*

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Time span=0.00-48.00 hrs, dt=0.150 hrs, 321 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Watershed Upstream Runoff Area=899.170 ac 0.00% Impervious Runoff Depth=2.75"
Flow Length=11,472' Slope=0.0320 '/' Tc=109.8 min CN=84 Runoff=867.60 cfs 206.334 af

Subcatchment3S: Watershed Runoff Area=657.980 ac 0.00% Impervious Runoff Depth=2.75"
Flow Length=7,292' Slope=0.0320 '/' Tc=76.4 min CN=84 Runoff=812.05 cfs 150.988 af

Pond 2P: 560th Ave Culvert Peak Elev=1,235.54' Storage=5.729 af Inflow=867.60 cfs 206.334 af
Primary=397.62 cfs 158.516 af Secondary=456.24 cfs 47.818 af Outflow=853.86 cfs 206.334 af

Pond 4P: Proposed Wetland Peak Elev=1,205.76' Storage=54.298 af Inflow=1,519.86 cfs 357.322 af
Outflow=1,335.18 cfs 357.315 af

Pond 9P: Existing Outlet Channel to Lake Peak Elev=1,205.06' Inflow=1,335.18 cfs 357.315 af
Outflow=1,335.18 cfs 357.315 af

Total Runoff Area = 1,557.150 ac Runoff Volume = 357.322 af Average Runoff Depth = 2.75"
100.00% Pervious = 1,557.150 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Watershed Upstream of Culvert

Runoff = 867.60 cfs @ 13.47 hrs, Volume= 206.334 af, Depth= 2.75"
 Routed to Pond 2P : 560th Ave Culvert

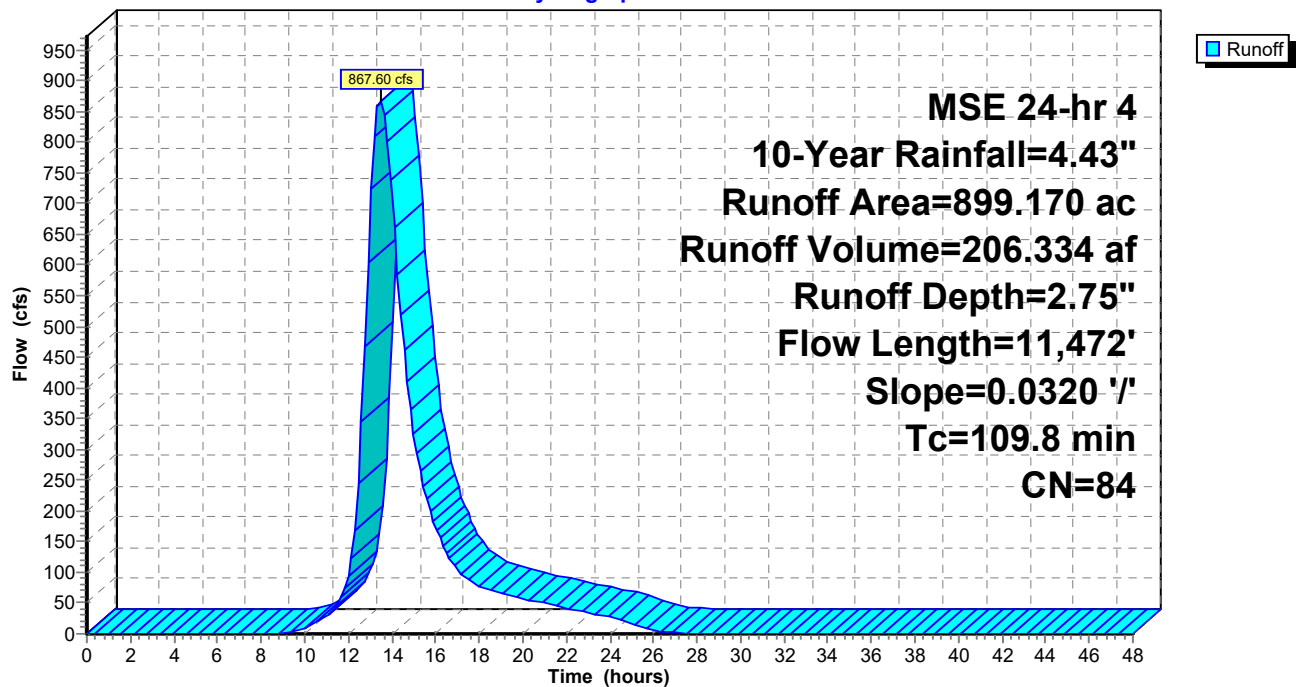
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 MSE 24-hr 4 10-Year Rainfall=4.43"

Area (ac)	CN	Description
* 899.170	84	Weighted Average
899.170		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
109.8	11,472	0.0320	1.74		Lag/CN Method, Existing Watershed Tc

Subcatchment 1S: Watershed Upstream of Culvert

Hydrograph



IA-340-13 - Neary - Proposed Condition - 90' Weir NW MSE 24-hr 4 10-Year Rainfall=4.43"

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Hydrograph for Subcatchment 1S: Watershed Upstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	39.00	4.43	2.75	0.00
0.75	0.02	0.00	0.00	39.75	4.43	2.75	0.00
1.50	0.04	0.00	0.00	40.50	4.43	2.75	0.00
2.25	0.06	0.00	0.00	41.25	4.43	2.75	0.00
3.00	0.09	0.00	0.00	42.00	4.43	2.75	0.00
3.75	0.13	0.00	0.00	42.75	4.43	2.75	0.00
4.50	0.17	0.00	0.00	43.50	4.43	2.75	0.00
5.25	0.22	0.00	0.00	44.25	4.43	2.75	0.00
6.00	0.27	0.00	0.00	45.00	4.43	2.75	0.00
6.75	0.33	0.00	0.00	45.75	4.43	2.75	0.00
7.50	0.39	0.00	0.00	46.50	4.43	2.75	0.00
8.25	0.46	0.00	0.20	47.25	4.43	2.75	0.00
9.00	0.54	0.01	2.11	48.00	4.43	2.75	0.00
9.75	0.66	0.04	7.10				
10.50	0.79	0.07	18.07				
11.25	1.07	0.18	36.46				
12.00	2.08	0.80	92.95				
12.75	3.36	1.82	467.99				
13.50	3.64	2.05	867.08				
14.25	3.77	2.17	585.02				
15.00	3.89	2.28	326.22				
15.75	3.97	2.34	200.11				
16.50	4.04	2.40	132.44				
17.25	4.10	2.46	95.65				
18.00	4.16	2.51	77.85				
18.75	4.21	2.56	67.82				
19.50	4.26	2.60	61.18				
20.25	4.30	2.64	55.30				
21.00	4.34	2.67	49.60				
21.75	4.37	2.70	43.95				
22.50	4.39	2.72	38.28				
23.25	4.41	2.74	32.59				
24.00	4.43	2.75	26.87				
24.75	4.43	2.75	20.20				
25.50	4.43	2.75	10.43				
26.25	4.43	2.75	3.86				
27.00	4.43	2.75	1.39				
27.75	4.43	2.75	0.48				
28.50	4.43	2.75	0.16				
29.25	4.43	2.75	0.04				
30.00	4.43	2.75	0.00				
30.75	4.43	2.75	0.00				
31.50	4.43	2.75	0.00				
32.25	4.43	2.75	0.00				
33.00	4.43	2.75	0.00				
33.75	4.43	2.75	0.00				
34.50	4.43	2.75	0.00				
35.25	4.43	2.75	0.00				
36.00	4.43	2.75	0.00				
36.75	4.43	2.75	0.00				
37.50	4.43	2.75	0.00				
38.25	4.43	2.75	0.00				

Summary for Subcatchment 3S: Watershed Downstream of Culvert

Runoff = 812.05 cfs @ 13.03 hrs, Volume= 150.988 af, Depth= 2.75"
 Routed to Pond 4P : Proposed Wetland Condition

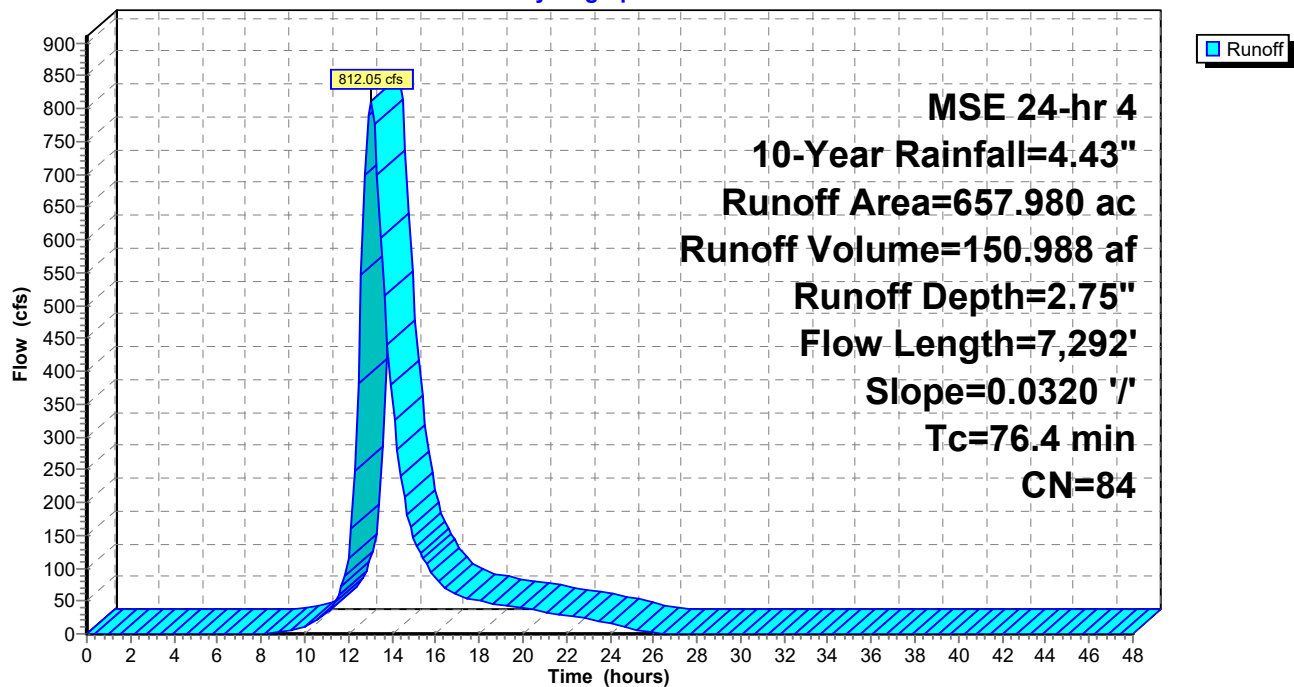
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 MSE 24-hr 4 10-Year Rainfall=4.43"

Area (ac)	CN	Description
* 657.980	84	Weighted Average
657.980		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
76.4	7,292	0.0320	1.59		Lag/CN Method,

Subcatchment 3S: Watershed Downstream of Culvert

Hydrograph



IA-340-13 - Neary - Proposed Condition - 90' Weir NW **MSE 24-hr 4 10-Year Rainfall=4.43"**

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Hydrograph for Subcatchment 3S: Watershed Downstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	39.00	4.43	2.75	0.00
0.75	0.02	0.00	0.00	39.75	4.43	2.75	0.00
1.50	0.04	0.00	0.00	40.50	4.43	2.75	0.00
2.25	0.06	0.00	0.00	41.25	4.43	2.75	0.00
3.00	0.09	0.00	0.00	42.00	4.43	2.75	0.00
3.75	0.13	0.00	0.00	42.75	4.43	2.75	0.00
4.50	0.17	0.00	0.00	43.50	4.43	2.75	0.00
5.25	0.22	0.00	0.00	44.25	4.43	2.75	0.00
6.00	0.27	0.00	0.00	45.00	4.43	2.75	0.00
6.75	0.33	0.00	0.00	45.75	4.43	2.75	0.00
7.50	0.39	0.00	0.00	46.50	4.43	2.75	0.00
8.25	0.46	0.00	0.44	47.25	4.43	2.75	0.00
9.00	0.54	0.01	3.09	48.00	4.43	2.75	0.00
9.75	0.66	0.04	8.72				
10.50	0.79	0.07	20.03				
11.25	1.07	0.18	39.41				
12.00	2.08	0.80	113.86				
12.75	3.36	1.82	698.20				
13.50	3.64	2.05	603.65				
14.25	3.77	2.17	278.96				
15.00	3.89	2.28	145.64				
15.75	3.97	2.34	98.53				
16.50	4.04	2.40	66.65				
17.25	4.10	2.46	55.67				
18.00	4.16	2.51	50.16				
18.75	4.21	2.56	45.81				
19.50	4.26	2.60	41.68				
20.25	4.30	2.64	37.59				
21.00	4.34	2.67	33.47				
21.75	4.37	2.70	29.32				
22.50	4.39	2.72	25.15				
23.25	4.41	2.74	20.97				
24.00	4.43	2.75	16.77				
24.75	4.43	2.75	10.57				
25.50	4.43	2.75	2.94				
26.25	4.43	2.75	0.68				
27.00	4.43	2.75	0.14				
27.75	4.43	2.75	0.02				
28.50	4.43	2.75	0.00				
29.25	4.43	2.75	0.00				
30.00	4.43	2.75	0.00				
30.75	4.43	2.75	0.00				
31.50	4.43	2.75	0.00				
32.25	4.43	2.75	0.00				
33.00	4.43	2.75	0.00				
33.75	4.43	2.75	0.00				
34.50	4.43	2.75	0.00				
35.25	4.43	2.75	0.00				
36.00	4.43	2.75	0.00				
36.75	4.43	2.75	0.00				
37.50	4.43	2.75	0.00				
38.25	4.43	2.75	0.00				

IA-340-13 - Neary - Proposed Condition - 90' Weir NW

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Summary for Pond 2P: 560th Ave Culvert

Inflow Area = 899.170 ac, 0.00% Impervious, Inflow Depth = 2.75" for 10-Year event
 Inflow = 867.60 cfs @ 13.47 hrs, Volume= 206.334 af
 Outflow = 853.86 cfs @ 13.61 hrs, Volume= 206.334 af, Atten= 2%, Lag= 8.3 min
 Primary = 397.62 cfs @ 13.61 hrs, Volume= 158.516 af
 Routed to Pond 4P : Proposed Wetland Condition
 Secondary = 456.24 cfs @ 13.61 hrs, Volume= 47.818 af
 Routed to Pond 4P : Proposed Wetland Condition

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 Peak Elev= 1,235.54' @ 13.61 hrs Surf.Area= 10.550 ac Storage= 5.729 af

Plug-Flow detention time= 3.3 min calculated for 206.334 af (100% of inflow)
 Center-of-Mass det. time= 2.7 min (903.4 - 900.6)

Volume	Invert	Avail.Storage	Storage Description
#1	1,226.00'	66.349 af	Custom Stage Data from Lidar (Prismatic) listed below (Recalc)

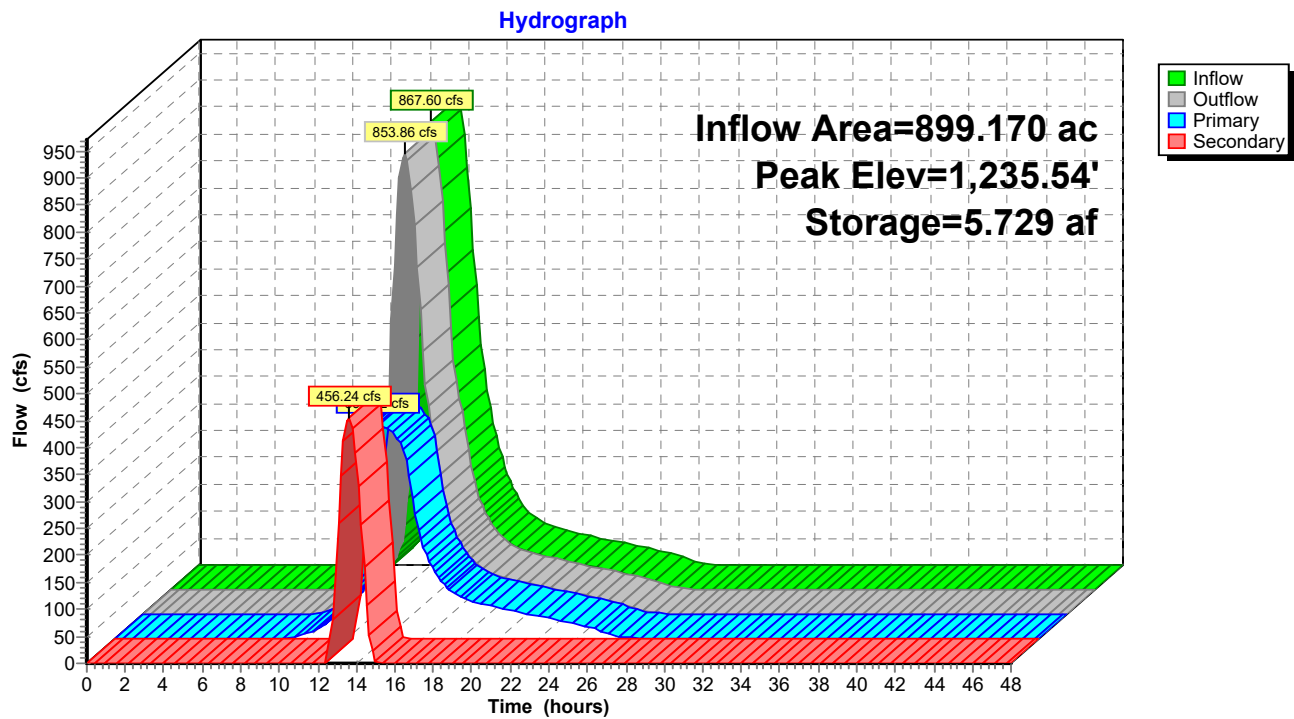
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,226.00	0.001	0.000	0.000
1,227.00	0.002	0.002	0.002
1,228.00	0.003	0.003	0.004
1,229.00	0.006	0.005	0.008
1,230.00	0.016	0.011	0.020
1,231.00	0.038	0.027	0.046
1,232.00	0.082	0.060	0.106
1,233.00	0.422	0.252	0.358
1,234.00	0.999	0.710	1.069
1,235.00	1.702	1.350	2.419
1,236.00	18.079	9.890	12.310
1,237.00	25.000	21.539	33.849
1,238.00	40.000	32.500	66.349

Device	Routing	Invert	Outlet Devices
#1	Primary	1,226.36'	72.0" W x 60.0" H Box Existing 5x6 Road Culvert L= 25.0' Box, 30-75° wingwalls, square crown, Ke= 0.400 Inlet / Outlet Invert= 1,226.36' / 1,226.36' S= 0.0000 ' / Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 30.00 sf
#2	Secondary	1,234.37'	Gravel Road - Asymmetrical Weir, C= 3.27 Offset (feet) -214.93 -167.93 -88.67 0.00 82.37 132.11 157.11 Elev. (feet) 1,237.00 1,236.27 1,235.04 1,234.37 1,235.06 1,236.20 1,237.00

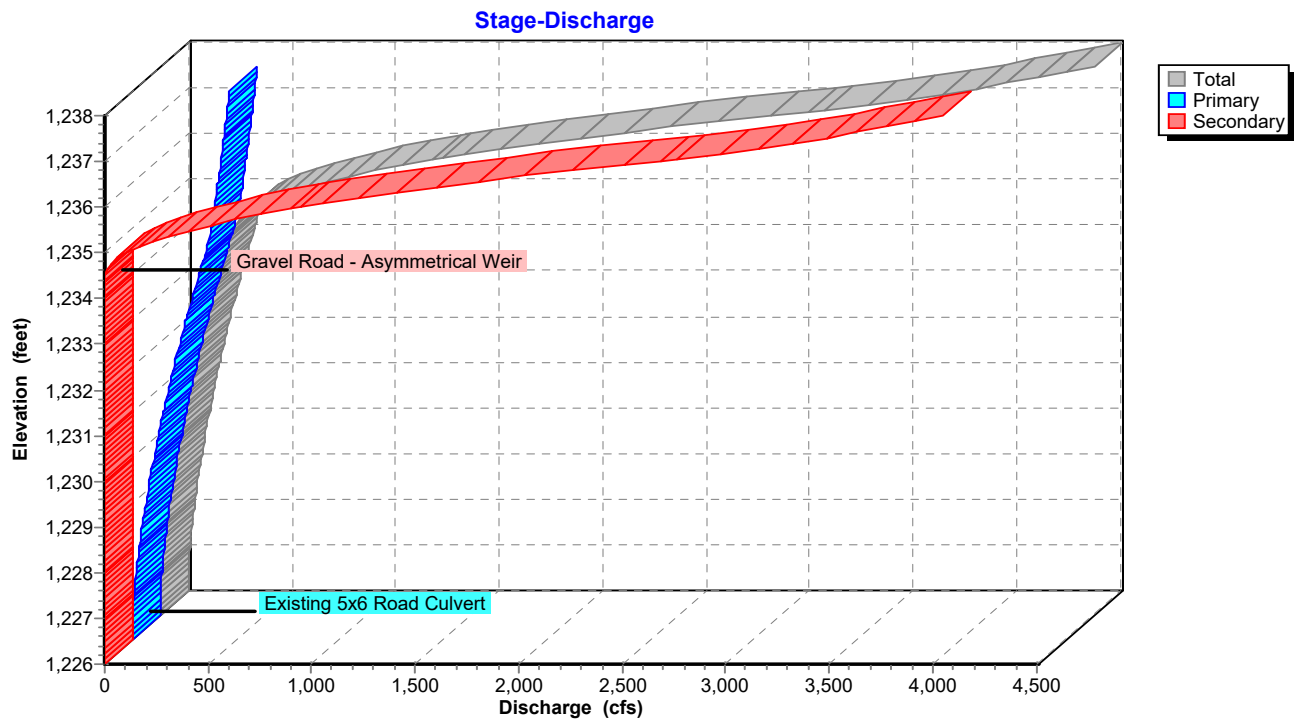
Primary OutFlow Max=397.52 cfs @ 13.61 hrs HW=1,235.54' TW=1,205.74' (Dynamic Tailwater)
 ↑1=Existing 5x6 Road Culvert (Inlet Controls 397.52 cfs @ 13.25 fps)

Secondary OutFlow Max=453.64 cfs @ 13.61 hrs HW=1,235.54' TW=1,205.74' (Dynamic Tailwater)
 ↑2=Gravel Road - Asymmetrical Weir (Weir Controls 453.64 cfs @ 2.01 fps)

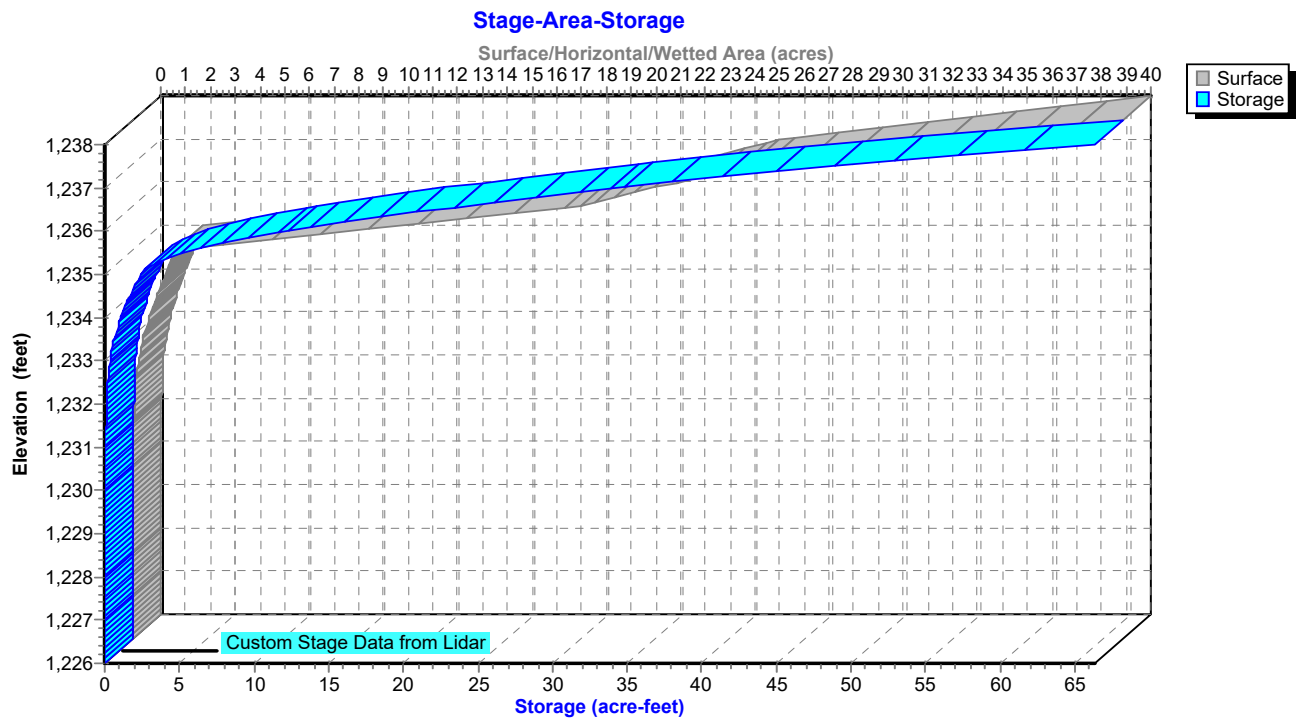
Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Hydrograph for Pond 2P: 560th Ave Culvert

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	0.000	1,226.00	0.00	0.00	0.00
1.50	0.00	0.000	1,226.00	0.00	0.00	0.00
3.00	0.00	0.000	1,226.00	0.00	0.00	0.00
4.50	0.00	0.000	1,226.00	0.00	0.00	0.00
6.00	0.00	0.000	1,226.00	0.00	0.00	0.00
7.50	0.00	0.000	1,226.00	0.00	0.00	0.00
9.00	2.11	0.001	1,226.67	2.12	2.12	0.00
10.50	18.07	0.003	1,227.52	18.06	18.06	0.00
12.00	92.95	0.016	1,229.74	92.41	92.41	0.00
13.50	867.08	5.638	1,235.53	845.94	397.35	448.59
15.00	326.22	1.658	1,234.50	353.99	351.95	2.04
16.50	132.44	0.035	1,230.65	132.92	132.92	0.00
18.00	77.85	0.011	1,229.38	77.88	77.88	0.00
19.50	61.18	0.008	1,228.93	61.18	61.18	0.00
21.00	49.60	0.006	1,228.60	49.61	49.61	0.00
22.50	38.28	0.005	1,228.25	38.29	38.29	0.00
24.00	26.87	0.004	1,227.86	26.88	26.88	0.00
25.50	10.43	0.002	1,227.18	10.45	10.45	0.00
27.00	1.39	0.001	1,226.61	1.39	1.39	0.00
28.50	0.16	0.001	1,226.44	0.16	0.16	0.00
30.00	0.00	0.000	1,226.37	0.00	0.00	0.00
31.50	0.00	0.000	1,226.36	0.00	0.00	0.00
33.00	0.00	0.000	1,226.36	0.00	0.00	0.00
34.50	0.00	0.000	1,226.36	0.00	0.00	0.00
36.00	0.00	0.000	1,226.36	0.00	0.00	0.00
37.50	0.00	0.000	1,226.36	0.00	0.00	0.00
39.00	0.00	0.000	1,226.36	0.00	0.00	0.00
40.50	0.00	0.000	1,226.36	0.00	0.00	0.00
42.00	0.00	0.000	1,226.36	0.00	0.00	0.00
43.50	0.00	0.000	1,226.36	0.00	0.00	0.00
45.00	0.00	0.000	1,226.36	0.00	0.00	0.00
46.50	0.00	0.000	1,226.36	0.00	0.00	0.00
48.00	0.00	0.000	1,226.36	0.00	0.00	0.00

Stage-Discharge for Pond 2P: 560th Ave Culvert

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
1,226.00	0.00	0.00	0.00	1,236.40	1,958.33	422.99	1,535.35
1,226.20	0.00	0.00	0.00	1,236.60	2,310.52	428.67	1,881.85
1,226.40	0.04	0.04	0.00	1,236.80	2,699.76	434.27	2,265.49
1,226.60	1.34	1.34	0.00	1,237.00	3,126.75	439.79	2,686.95
1,226.80	3.79	3.79	0.00	1,237.20	3,481.18	445.25	3,035.93
1,227.00	7.01	7.01	0.00	1,237.40	3,776.53	450.64	3,325.89
1,227.20	10.82	10.82	0.00	1,237.60	4,041.43	455.96	3,585.47
1,227.40	15.14	15.14	0.00	1,237.80	4,285.19	461.22	3,823.97
1,227.60	19.92	19.92	0.00	1,238.00	4,512.80	466.42	4,046.38
1,227.80	25.12	25.12	0.00				
1,228.00	30.69	30.69	0.00				
1,228.20	36.63	36.63	0.00				
1,228.40	42.91	42.91	0.00				
1,228.60	49.50	49.50	0.00				
1,228.80	56.40	56.40	0.00				
1,229.00	63.59	63.59	0.00				
1,229.20	71.07	71.07	0.00				
1,229.40	78.81	78.81	0.00				
1,229.60	86.82	86.82	0.00				
1,229.80	95.08	95.08	0.00				
1,230.00	103.58	103.58	0.00				
1,230.20	112.33	112.33	0.00				
1,230.40	121.30	121.30	0.00				
1,230.60	130.51	130.51	0.00				
1,230.80	139.93	139.93	0.00				
1,231.00	149.57	149.57	0.00				
1,231.20	159.42	159.42	0.00				
1,231.40	169.48	169.48	0.00				
1,231.60	179.74	179.74	0.00				
1,231.80	190.20	190.20	0.00				
1,232.00	200.86	200.86	0.00				
1,232.20	211.71	211.71	0.00				
1,232.40	222.74	222.74	0.00				
1,232.60	233.96	233.96	0.00				
1,232.80	245.36	245.36	0.00				
1,233.00	256.95	256.95	0.00				
1,233.20	269.38	269.38	0.00				
1,233.40	283.64	283.64	0.00				
1,233.60	297.22	297.22	0.00				
1,233.80	310.20	310.20	0.00				
1,234.00	322.67	322.67	0.00				
1,234.20	334.66	334.66	0.00				
1,234.40	346.30	346.25	0.05				
1,234.60	365.81	357.46	8.35				
1,234.80	408.24	368.32	39.92				
1,235.00	482.60	378.88	103.72				
1,235.20	592.10	387.09	205.01				
1,235.40	734.23	393.31	340.92				
1,235.60	909.80	399.43	510.37				
1,235.80	1,119.19	405.46	713.74				
1,236.00	1,363.16	411.39	951.77				
1,236.20	1,642.64	417.23	1,225.41				

IA-340-13 - Neary - Proposed Condition - 90' Weir NW *MSE 24-hr 4 10-Year Rainfall=4.43"*

Prepared by Ducks Unlimited

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Stage-Area-Storage for Pond 2P: 560th Ave Culvert

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,226.00	0.001	0.000	1,236.40	20.847	20.095
1,226.20	0.001	0.000	1,236.60	22.232	24.403
1,226.40	0.001	0.000	1,236.80	23.616	28.988
1,226.60	0.002	0.001	1,237.00	25.000	33.849
1,226.80	0.002	0.001	1,237.20	28.000	39.150
1,227.00	0.002	0.002	1,237.40	31.000	45.050
1,227.20	0.002	0.002	1,237.60	34.000	51.549
1,227.40	0.002	0.002	1,237.80	37.000	58.649
1,227.60	0.003	0.003	1,238.00	40.000	66.349
1,227.80	0.003	0.003			
1,228.00	0.003	0.004			
1,228.20	0.004	0.005			
1,228.40	0.004	0.005			
1,228.60	0.005	0.006			
1,228.80	0.005	0.007			
1,229.00	0.006	0.008			
1,229.20	0.008	0.010			
1,229.40	0.010	0.012			
1,229.60	0.012	0.014			
1,229.80	0.014	0.016			
1,230.00	0.016	0.020			
1,230.20	0.020	0.023			
1,230.40	0.025	0.028			
1,230.60	0.029	0.033			
1,230.80	0.034	0.039			
1,231.00	0.038	0.046			
1,231.20	0.047	0.055			
1,231.40	0.056	0.065			
1,231.60	0.064	0.077			
1,231.80	0.073	0.091			
1,232.00	0.082	0.106			
1,232.20	0.150	0.130			
1,232.40	0.218	0.167			
1,232.60	0.286	0.217			
1,232.80	0.354	0.281			
1,233.00	0.422	0.358			
1,233.20	0.537	0.454			
1,233.40	0.653	0.573			
1,233.60	0.768	0.716			
1,233.80	0.884	0.881			
1,234.00	0.999	1.069			
1,234.20	1.140	1.283			
1,234.40	1.280	1.525			
1,234.60	1.421	1.795			
1,234.80	1.561	2.093			
1,235.00	1.702	2.419			
1,235.20	4.977	3.087			
1,235.40	8.253	4.410			
1,235.60	11.528	6.389			
1,235.80	14.804	9.022			
1,236.00	18.079	12.310			
1,236.20	19.463	16.064			

IA-340-13 - Neary - Proposed Condition - 90' Weir NW MSE 24-hr 4 10-Year Rainfall=4.43"

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Summary for Pond 4P: Proposed Wetland Condition

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 2.75" for 10-Year event
 Inflow = 1,519.86 cfs @ 13.25 hrs, Volume= 357.322 af
 Outflow = 1,335.18 cfs @ 13.63 hrs, Volume= 357.315 af, Atten= 12%, Lag= 22.5 min
 Primary = 1,335.18 cfs @ 13.63 hrs, Volume= 357.315 af
 Routed to Pond 9P : Existing Outlet Channel to Lake

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 Starting Elev= 1,202.20' Surf.Area= 8.200 ac Storage= 13.433 af
 Peak Elev= 1,205.76' @ 13.72 hrs Surf.Area= 15.457 ac Storage= 54.298 af (40.865 af above start)

Plug-Flow detention time= 56.3 min calculated for 343.882 af (96% of inflow)
 Center-of-Mass det. time= 24.7 min (913.8 - 889.1)

Volume	Invert	Avail.Storage	Storage Description
#1	1,199.00'	140.919 af	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,199.00	0.002	0.000	0.000
1,200.00	1.684	0.843	0.843
1,201.00	6.154	3.919	4.762
1,202.00	7.956	7.055	11.817
1,202.20	8.200	1.616	13.433
1,203.00	9.499	7.080	20.512
1,204.00	11.030	10.264	30.777
1,205.00	13.737	12.383	43.160
1,206.00	15.991	14.864	58.024
1,207.00	18.042	17.016	75.041
1,208.00	20.142	19.092	94.133
1,209.00	23.715	21.928	116.061
1,210.00	26.000	24.857	140.919

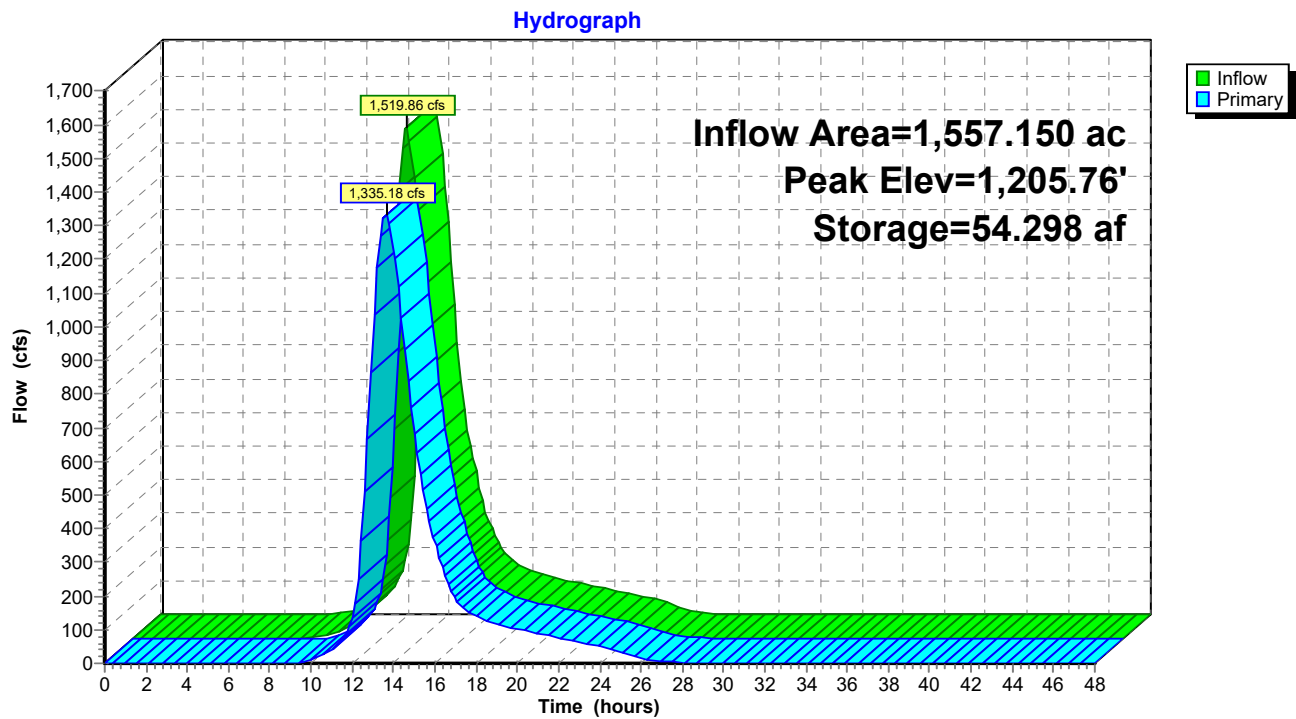
Device	Routing	Invert	Outlet Devices
#1	Primary	1,202.20'	90' Sheet Pile Weir, C= 3.27 Offset (feet) -66.60 -64.60 -56.60 -45.00 45.00 56.60 64.60 66.60 Height (feet) 6.80 5.80 5.80 0.00 0.00 5.80 5.80 6.80
#2	Primary	1,209.00'	200.0' long + 10.0 ' SideZ x 12.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64

Primary OutFlow Max=1,310.50 cfs @ 13.63 hrs HW=1,205.75' TW=1,205.05' (Dynamic Tailwater)

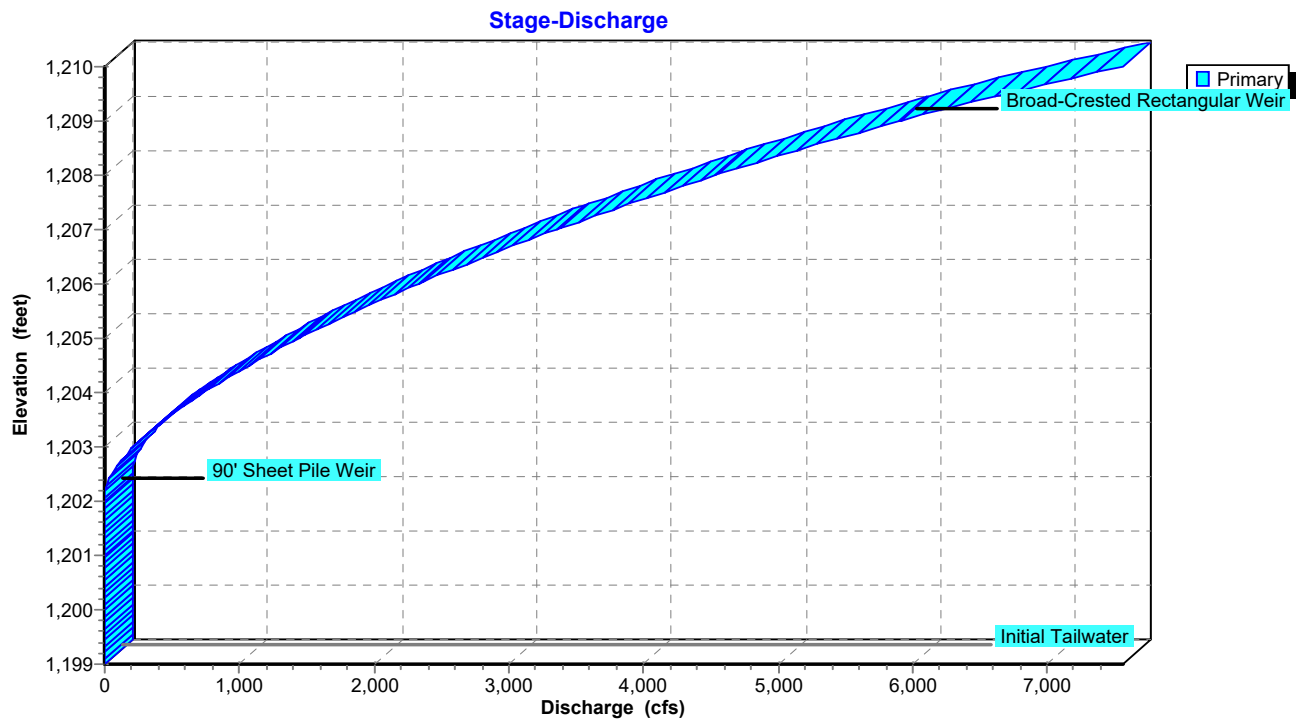
1=90' Sheet Pile Weir (Weir Controls 1,310.50 cfs @ 3.55 fps)

2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

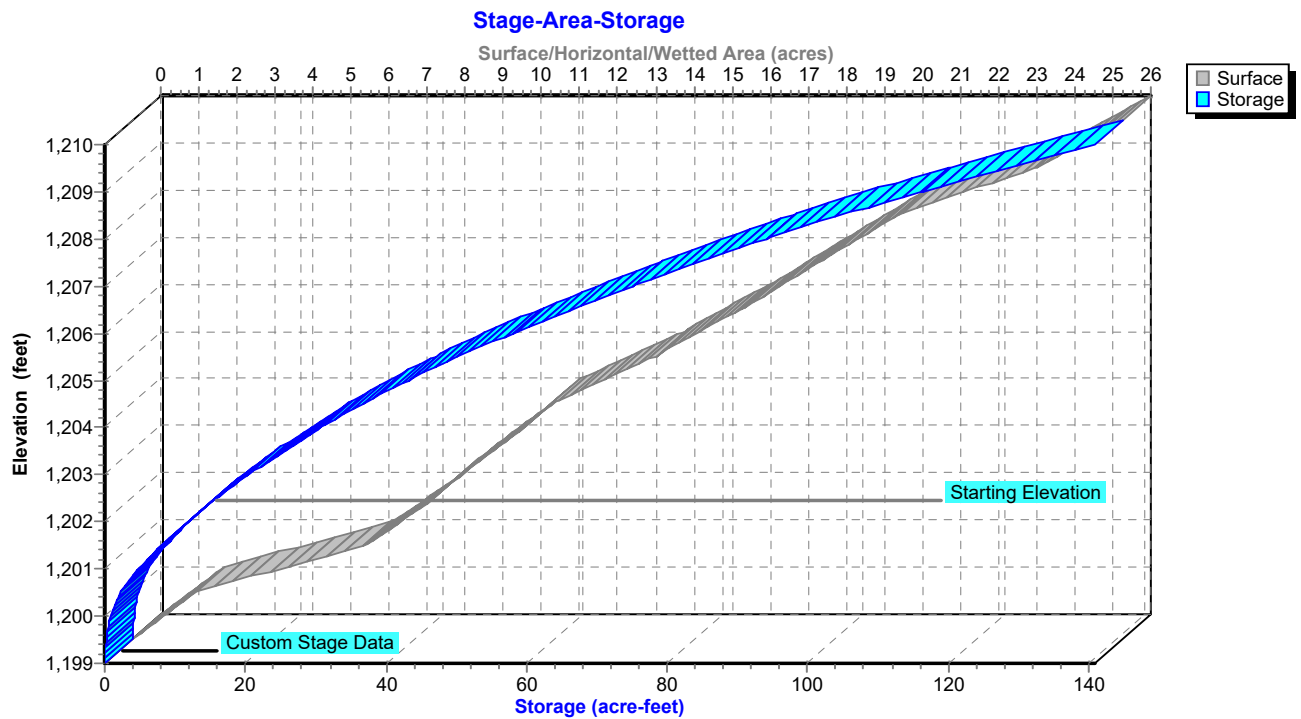
Pond 4P: Proposed Wetland Condition



Pond 4P: Proposed Wetland Condition



Pond 4P: Proposed Wetland Condition



Hydrograph for Pond 4P: Proposed Wetland Condition

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	13.433	1,202.20	0.00
1.50	0.00	13.433	1,202.20	0.00
3.00	0.00	13.433	1,202.20	0.00
4.50	0.00	13.433	1,202.20	0.00
6.00	0.00	13.433	1,202.20	0.00
7.50	0.00	13.433	1,202.20	0.00
9.00	5.20	13.585	1,202.22	0.74
10.50	38.09	14.880	1,202.37	21.33
12.00	206.27	18.635	1,202.80	137.85
13.50	1,449.59	53.216	1,205.69	1,322.87
15.00	499.63	35.957	1,204.45	679.64
16.50	199.58	21.763	1,203.13	258.06
18.00	128.05	18.638	1,202.80	137.98
19.50	102.87	17.816	1,202.71	107.80
21.00	83.08	17.234	1,202.64	87.79
22.50	63.45	16.636	1,202.58	68.47
24.00	43.65	15.985	1,202.50	49.16
25.50	13.38	14.994	1,202.39	23.88
27.00	1.54	14.053	1,202.28	6.06
28.50	0.16	13.705	1,202.23	1.77
30.00	0.00	13.574	1,202.22	0.66
31.50	0.00	13.517	1,202.21	0.31
33.00	0.00	13.489	1,202.21	0.17
34.50	0.00	13.473	1,202.20	0.10
36.00	0.00	13.463	1,202.20	0.07
37.50	0.00	13.456	1,202.20	0.04
39.00	0.00	13.451	1,202.20	0.03
40.50	0.00	13.448	1,202.20	0.02
42.00	0.00	13.445	1,202.20	0.02
43.50	0.00	13.443	1,202.20	0.01
45.00	0.00	13.442	1,202.20	0.01
46.50	0.00	13.441	1,202.20	0.01
48.00	0.00	13.439	1,202.20	0.01

Stage-Discharge for Pond 4P: Proposed Wetland Condition

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.00	0.00	1,204.20	862.00	1,209.40	6,524.18
1,199.10	0.00	1,204.30	929.05	1,209.50	6,690.99
1,199.20	0.00	1,204.40	997.90	1,209.60	6,862.68
1,199.30	0.00	1,204.50	1,068.53	1,209.70	7,032.81
1,199.40	0.00	1,204.60	1,140.91	1,209.80	7,205.23
1,199.50	0.00	1,204.70	1,215.03	1,209.90	7,381.56
1,199.60	0.00	1,204.80	1,290.85	1,210.00	7,560.57
1,199.70	0.00	1,204.90	1,368.35		
1,199.80	0.00	1,205.00	1,447.52		
1,199.90	0.00	1,205.10	1,528.34		
1,200.00	0.00	1,205.20	1,610.79		
1,200.10	0.00	1,205.30	1,694.85		
1,200.20	0.00	1,205.40	1,780.51		
1,200.30	0.00	1,205.50	1,867.76		
1,200.40	0.00	1,205.60	1,956.58		
1,200.50	0.00	1,205.70	2,046.95		
1,200.60	0.00	1,205.80	2,138.88		
1,200.70	0.00	1,205.90	2,232.34		
1,200.80	0.00	1,206.00	2,327.32		
1,200.90	0.00	1,206.10	2,423.82		
1,201.00	0.00	1,206.20	2,521.82		
1,201.10	0.00	1,206.30	2,621.32		
1,201.20	0.00	1,206.40	2,722.31		
1,201.30	0.00	1,206.50	2,824.78		
1,201.40	0.00	1,206.60	2,928.72		
1,201.50	0.00	1,206.70	3,034.12		
1,201.60	0.00	1,206.80	3,140.98		
1,201.70	0.00	1,206.90	3,249.29		
1,201.80	0.00	1,207.00	3,359.04		
1,201.90	0.00	1,207.10	3,470.23		
1,202.00	0.00	1,207.20	3,582.85		
1,202.10	0.00	1,207.30	3,696.90		
1,202.20	0.00	1,207.40	3,812.37		
1,202.30	9.32	1,207.50	3,929.25		
1,202.40	26.42	1,207.60	4,047.54		
1,202.50	48.62	1,207.70	4,167.24		
1,202.60	74.98	1,207.80	4,288.34		
1,202.70	104.98	1,207.90	4,410.84		
1,202.80	138.24	1,208.00	4,534.73		
1,202.90	174.51	1,208.10	4,661.66		
1,203.00	213.58	1,208.20	4,791.35		
1,203.10	255.30	1,208.30	4,923.32		
1,203.20	299.53	1,208.40	5,057.38		
1,203.30	346.17	1,208.50	5,193.44		
1,203.40	395.12	1,208.60	5,331.43		
1,203.50	446.30	1,208.70	5,471.30		
1,203.60	499.64	1,208.80	5,613.00		
1,203.70	555.08	1,208.90	5,756.51		
1,203.80	612.56	1,209.00	5,901.79		
1,203.90	672.04	1,209.10	6,051.34		
1,204.00	733.46	1,209.20	6,204.86		
1,204.10	796.80	1,209.30	6,362.52		

Stage-Area-Storage for Pond 4P: Proposed Wetland Condition

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,199.00	0.002	0.000	1,209.40	24.629	125.730
1,199.20	0.338	0.034	1,209.60	25.086	130.701
1,199.40	0.675	0.135	1,209.80	25.543	135.764
1,199.60	1.011	0.304	1,210.00	26.000	140.919
1,199.80	1.348	0.540			
1,200.00	1.684	0.843			
1,200.20	2.578	1.269			
1,200.40	3.472	1.874			
1,200.60	4.366	2.658			
1,200.80	5.260	3.621			
1,201.00	6.154	4.762			
1,201.20	6.514	6.029			
1,201.40	6.875	7.368			
1,201.60	7.235	8.779			
1,201.80	7.596	10.262			
1,202.00	7.956	11.817			
1,202.20	8.200	13.433			
1,202.40	8.525	15.105			
1,202.60	8.849	16.842			
1,202.80	9.174	18.645			
1,203.00	9.499	20.512			
1,203.20	9.805	22.443			
1,203.40	10.111	24.434			
1,203.60	10.418	26.487			
1,203.80	10.724	28.601			
1,204.00	11.030	30.777			
1,204.20	11.571	33.037			
1,204.40	12.113	35.405			
1,204.60	12.654	37.882			
1,204.80	13.196	40.467			
1,205.00	13.737	43.160			
1,205.20	14.188	45.953			
1,205.40	14.639	48.835			
1,205.60	15.089	51.808			
1,205.80	15.540	54.871			
1,206.00	15.991	58.024			
1,206.20	16.401	61.263			
1,206.40	16.811	64.585			
1,206.60	17.222	67.988			
1,206.80	17.632	71.473			
1,207.00	18.042	75.041			
1,207.20	18.462	78.691			
1,207.40	18.882	82.426			
1,207.60	19.302	86.244			
1,207.80	19.722	90.146			
1,208.00	20.142	94.133			
1,208.20	20.857	98.233			
1,208.40	21.571	102.475			
1,208.60	22.286	106.861			
1,208.80	23.000	111.390			
1,209.00	23.715	116.061			
1,209.20	24.172	120.850			

Summary for Pond 9P: Existing Outlet Channel to Lake

[57] Hint: Peaked at 1,205.06' (Flood elevation advised)

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 2.75" for 10-Year event
 Inflow = 1,335.18 cfs @ 13.63 hrs, Volume= 357.315 af
 Outflow = 1,335.18 cfs @ 13.63 hrs, Volume= 357.315 af, Atten= 0%, Lag= 0.0 min
 Primary = 1,335.18 cfs @ 13.63 hrs, Volume= 357.315 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs

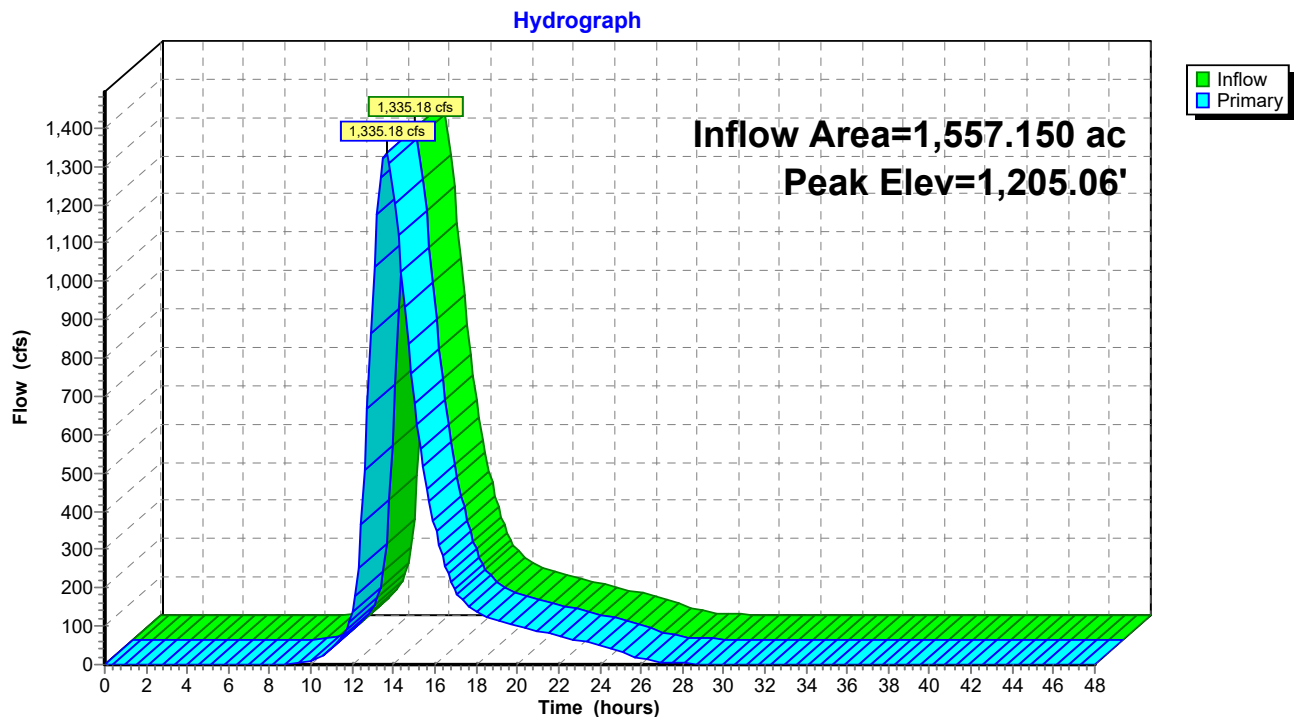
Peak Elev= 1,205.06' @ 13.63 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	1,199.12'	Existing Outlet Channel to Lake, C= 3.27 Offset (feet) -106.52 -44.01 -15.95 0.00 10.33 70.05 Elev. (feet) 1,213.23 1,204.05 1,201.65 1,199.12 1,201.69 1,213.23

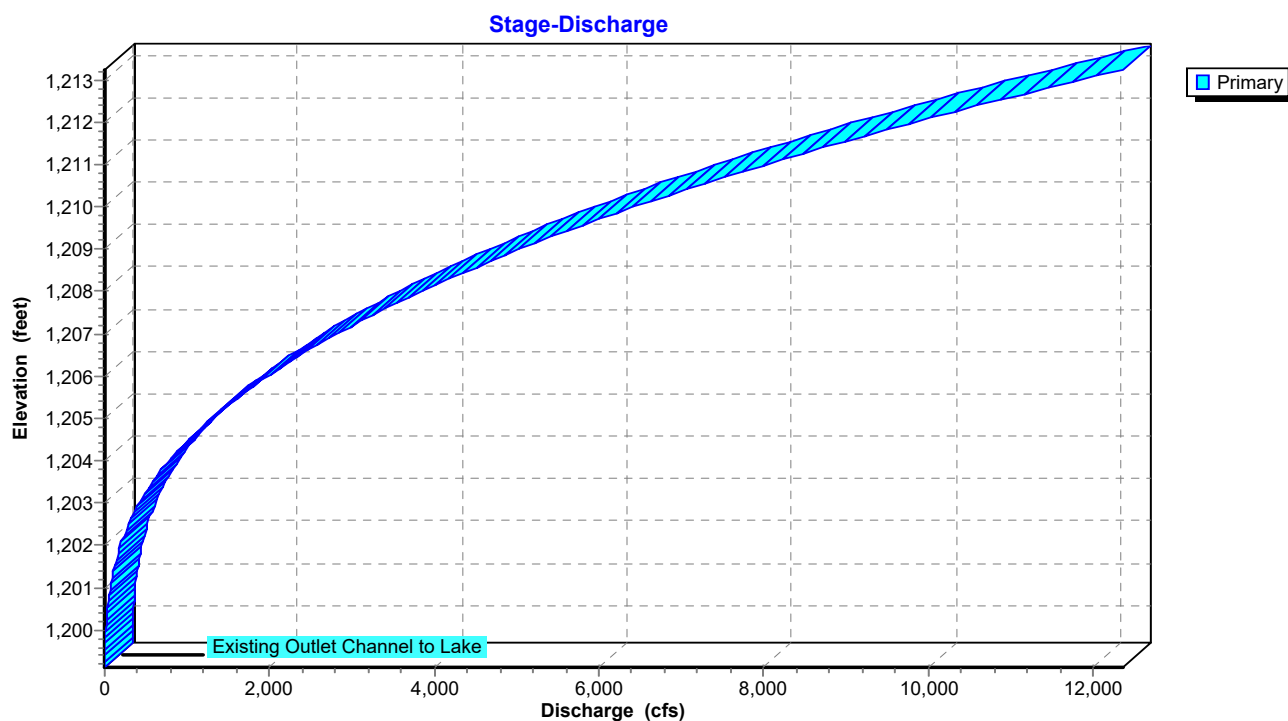
Primary OutFlow Max=1,333.19 cfs @ 13.63 hrs HW=1,205.05' (Free Discharge)

↑1=Existing Outlet Channel to Lake(Weir Controls 1,333.19 cfs @ 4.21 fps)

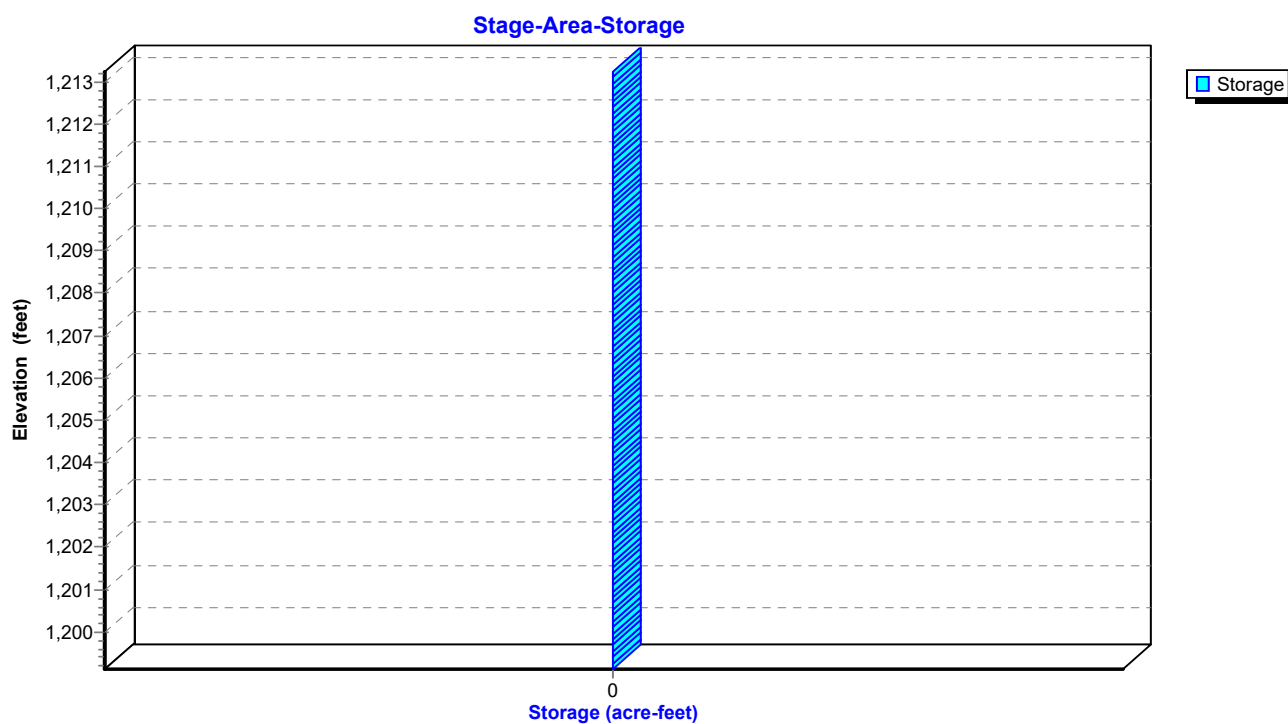
Pond 9P: Existing Outlet Channel to Lake



Pond 9P: Existing Outlet Channel to Lake



Pond 9P: Existing Outlet Channel to Lake



Hydrograph for Pond 9P: Existing Outlet Channel to Lake

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	1,199.12	0.00	39.00	0.03	1,199.21	0.03
0.75	0.00	1,199.12	0.00	39.75	0.03	1,199.20	0.03
1.50	0.00	1,199.12	0.00	40.50	0.02	1,199.20	0.02
2.25	0.00	1,199.12	0.00	41.25	0.02	1,199.19	0.02
3.00	0.00	1,199.12	0.00	42.00	0.02	1,199.19	0.02
3.75	0.00	1,199.12	0.00	42.75	0.02	1,199.19	0.02
4.50	0.00	1,199.12	0.00	43.50	0.01	1,199.18	0.01
5.25	0.00	1,199.12	0.00	44.25	0.01	1,199.18	0.01
6.00	0.00	1,199.12	0.00	45.00	0.01	1,199.18	0.01
6.75	0.00	1,199.12	0.00	45.75	0.01	1,199.18	0.01
7.50	0.00	1,199.12	0.00	46.50	0.01	1,199.17	0.01
8.25	0.01	1,199.18	0.01	47.25	0.01	1,199.17	0.01
9.00	0.74	1,199.43	0.74	48.00	0.01	1,199.17	0.01
9.75	5.63	1,199.82	5.63				
10.50	21.33	1,200.32	21.33				
11.25	51.48	1,200.83	51.48				
12.00	137.85	1,201.65	137.85				
12.75	668.61	1,203.73	668.61				
13.50	1,322.87	1,205.04	1,322.87				
14.25	1,120.39	1,204.68	1,120.39				
15.00	679.64	1,203.76	679.64				
15.75	424.08	1,203.02	424.08				
16.50	258.06	1,202.36	258.06				
17.25	171.51	1,201.88	171.51				
18.00	137.98	1,201.65	137.98				
18.75	119.82	1,201.51	119.82				
19.50	107.80	1,201.42	107.80				
20.25	97.57	1,201.33	97.57				
21.00	87.79	1,201.23	87.79				
21.75	78.12	1,201.14	78.12				
22.50	68.47	1,201.03	68.47				
23.25	58.81	1,200.92	58.81				
24.00	49.16	1,200.80	49.16				
24.75	38.63	1,200.64	38.63				
25.50	23.88	1,200.38	23.88				
26.25	12.14	1,200.08	12.14				
27.00	6.06	1,199.85	6.06				
27.75	3.18	1,199.68	3.18				
28.50	1.77	1,199.56	1.77				
29.25	1.05	1,199.48	1.05				
30.00	0.66	1,199.42	0.66				
30.75	0.44	1,199.37	0.44				
31.50	0.31	1,199.34	0.31				
32.25	0.22	1,199.31	0.22				
33.00	0.17	1,199.29	0.17				
33.75	0.13	1,199.28	0.13				
34.50	0.10	1,199.26	0.10				
35.25	0.08	1,199.25	0.08				
36.00	0.07	1,199.24	0.07				
36.75	0.05	1,199.23	0.05				
37.50	0.04	1,199.22	0.04				
38.25	0.04	1,199.22	0.04				

IA-340-13 - Neary - Proposed Condition - 90' Weir NW MSE 24-hr 4 10-Year Rainfall=4.43"

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Stage-Discharge for Pond 9P: Existing Outlet Channel to Lake

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.12	0.00	1,204.32	931.43	1,209.52	5,746.91
1,199.22	0.04	1,204.42	981.32	1,209.62	5,887.87
1,199.32	0.24	1,204.52	1,032.75	1,209.72	6,030.81
1,199.42	0.67	1,204.62	1,085.74	1,209.82	6,175.74
1,199.52	1.37	1,204.72	1,140.29	1,209.92	6,322.67
1,199.62	2.39	1,204.82	1,196.40	1,210.02	6,471.61
1,199.72	3.77	1,204.92	1,254.09	1,210.12	6,622.56
1,199.82	5.54	1,205.02	1,313.35	1,210.22	6,775.53
1,199.92	7.73	1,205.12	1,374.19	1,210.32	6,930.54
1,200.02	10.38	1,205.22	1,436.62	1,210.42	7,087.58
1,200.12	13.50	1,205.32	1,500.65	1,210.52	7,246.67
1,200.22	17.14	1,205.42	1,566.28	1,210.62	7,407.82
1,200.32	21.30	1,205.52	1,633.53	1,210.72	7,571.03
1,200.42	26.02	1,205.62	1,702.40	1,210.82	7,736.32
1,200.52	31.32	1,205.72	1,772.90	1,210.92	7,903.69
1,200.62	37.21	1,205.82	1,845.04	1,211.02	8,073.14
1,200.72	43.73	1,205.92	1,918.82	1,211.12	8,244.69
1,200.82	50.88	1,206.02	1,994.26	1,211.22	8,418.35
1,200.92	58.70	1,206.12	2,071.37	1,211.32	8,594.11
1,201.02	67.19	1,206.22	2,150.14	1,211.42	8,772.00
1,201.12	76.39	1,206.32	2,230.60	1,211.52	8,952.02
1,201.22	86.30	1,206.42	2,312.76	1,211.62	9,134.17
1,201.32	96.94	1,206.52	2,396.61	1,211.72	9,318.47
1,201.42	108.33	1,206.62	2,482.17	1,211.82	9,504.92
1,201.52	120.50	1,206.72	2,569.44	1,211.92	9,693.53
1,201.62	133.44	1,206.82	2,658.45	1,212.02	9,884.31
1,201.72	147.20	1,206.92	2,749.19	1,212.12	10,077.27
1,201.82	161.85	1,207.02	2,841.67	1,212.22	10,272.40
1,201.92	177.46	1,207.12	2,935.91	1,212.32	10,469.73
1,202.02	194.08	1,207.22	3,031.91	1,212.42	10,669.26
1,202.12	211.75	1,207.32	3,129.68	1,212.52	10,871.00
1,202.22	230.52	1,207.42	3,229.24	1,212.62	11,074.95
1,202.32	250.42	1,207.52	3,330.58	1,212.72	11,281.12
1,202.42	271.49	1,207.62	3,433.72	1,212.82	11,489.52
1,202.52	293.76	1,207.72	3,538.67	1,212.92	11,700.16
1,202.62	317.26	1,207.82	3,645.44	1,213.02	11,913.04
1,202.72	342.02	1,207.92	3,754.03	1,213.12	12,128.18
1,202.82	368.08	1,208.02	3,864.46	1,213.22	12,345.58
1,202.92	395.45	1,208.12	3,976.72		
1,203.02	424.17	1,208.22	4,090.85		
1,203.12	454.27	1,208.32	4,206.83		
1,203.22	485.77	1,208.42	4,324.68		
1,203.32	518.69	1,208.52	4,444.41		
1,203.42	553.07	1,208.62	4,566.02		
1,203.52	588.92	1,208.72	4,689.53		
1,203.62	626.27	1,208.82	4,814.95		
1,203.72	665.15	1,208.92	4,942.28		
1,203.82	705.57	1,209.02	5,071.53		
1,203.92	747.56	1,209.12	5,202.71		
1,204.02	791.15	1,209.22	5,335.83		
1,204.12	836.34	1,209.32	5,470.90		
1,204.22	883.11	1,209.42	5,607.92		

IA-340-13 - Neary - Proposed Condition - 90' Weir NW MSE 24-hr 4 10-Year Rainfall=4.43"

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Stage-Area-Storage for Pond 9P: Existing Outlet Channel to Lake

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
1,199.12	0.000	1,204.32	0.000	1,209.52	0.000
1,199.22	0.000	1,204.42	0.000	1,209.62	0.000
1,199.32	0.000	1,204.52	0.000	1,209.72	0.000
1,199.42	0.000	1,204.62	0.000	1,209.82	0.000
1,199.52	0.000	1,204.72	0.000	1,209.92	0.000
1,199.62	0.000	1,204.82	0.000	1,210.02	0.000
1,199.72	0.000	1,204.92	0.000	1,210.12	0.000
1,199.82	0.000	1,205.02	0.000	1,210.22	0.000
1,199.92	0.000	1,205.12	0.000	1,210.32	0.000
1,200.02	0.000	1,205.22	0.000	1,210.42	0.000
1,200.12	0.000	1,205.32	0.000	1,210.52	0.000
1,200.22	0.000	1,205.42	0.000	1,210.62	0.000
1,200.32	0.000	1,205.52	0.000	1,210.72	0.000
1,200.42	0.000	1,205.62	0.000	1,210.82	0.000
1,200.52	0.000	1,205.72	0.000	1,210.92	0.000
1,200.62	0.000	1,205.82	0.000	1,211.02	0.000
1,200.72	0.000	1,205.92	0.000	1,211.12	0.000
1,200.82	0.000	1,206.02	0.000	1,211.22	0.000
1,200.92	0.000	1,206.12	0.000	1,211.32	0.000
1,201.02	0.000	1,206.22	0.000	1,211.42	0.000
1,201.12	0.000	1,206.32	0.000	1,211.52	0.000
1,201.22	0.000	1,206.42	0.000	1,211.62	0.000
1,201.32	0.000	1,206.52	0.000	1,211.72	0.000
1,201.42	0.000	1,206.62	0.000	1,211.82	0.000
1,201.52	0.000	1,206.72	0.000	1,211.92	0.000
1,201.62	0.000	1,206.82	0.000	1,212.02	0.000
1,201.72	0.000	1,206.92	0.000	1,212.12	0.000
1,201.82	0.000	1,207.02	0.000	1,212.22	0.000
1,201.92	0.000	1,207.12	0.000	1,212.32	0.000
1,202.02	0.000	1,207.22	0.000	1,212.42	0.000
1,202.12	0.000	1,207.32	0.000	1,212.52	0.000
1,202.22	0.000	1,207.42	0.000	1,212.62	0.000
1,202.32	0.000	1,207.52	0.000	1,212.72	0.000
1,202.42	0.000	1,207.62	0.000	1,212.82	0.000
1,202.52	0.000	1,207.72	0.000	1,212.92	0.000
1,202.62	0.000	1,207.82	0.000	1,213.02	0.000
1,202.72	0.000	1,207.92	0.000	1,213.12	0.000
1,202.82	0.000	1,208.02	0.000	1,213.22	0.000
1,202.92	0.000	1,208.12	0.000		
1,203.02	0.000	1,208.22	0.000		
1,203.12	0.000	1,208.32	0.000		
1,203.22	0.000	1,208.42	0.000		
1,203.32	0.000	1,208.52	0.000		
1,203.42	0.000	1,208.62	0.000		
1,203.52	0.000	1,208.72	0.000		
1,203.62	0.000	1,208.82	0.000		
1,203.72	0.000	1,208.92	0.000		
1,203.82	0.000	1,209.02	0.000		
1,203.92	0.000	1,209.12	0.000		
1,204.02	0.000	1,209.22	0.000		
1,204.12	0.000	1,209.32	0.000		
1,204.22	0.000	1,209.42	0.000		

IA-340-13 - Neary - Proposed Condition - 90' Weir NW *MSE 24-hr 4 25-Year Rainfall=5.57"*

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Time span=0.00-48.00 hrs, dt=0.150 hrs, 321 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Watershed Upstream Runoff Area=899.170 ac 0.00% Impervious Runoff Depth=3.80"
Flow Length=11,472' Slope=0.0320 '/' Tc=109.8 min CN=84 Runoff=1,193.60 cfs 284.418 af

Subcatchment3S: Watershed Runoff Area=657.980 ac 0.00% Impervious Runoff Depth=3.80"
Flow Length=7,292' Slope=0.0320 '/' Tc=76.4 min CN=84 Runoff=1,115.70 cfs 208.126 af

Pond 2P: 560th Ave Culvert Peak Elev=1,235.84' Storage=9.673 af Inflow=1,193.60 cfs 284.418 af
Primary=406.74 cfs 191.141 af Secondary=761.94 cfs 93.276 af Outflow=1,168.68 cfs 284.417 af

Pond 4P: Proposed Wetland Peak Elev=1,206.63' Storage=68.467 af Inflow=2,069.53 cfs 492.544 af
Outflow=1,829.75 cfs 492.537 af

Pond 9P: Existing Outlet Channel to Lake Peak Elev=1,205.80' Inflow=1,829.75 cfs 492.537 af
Outflow=1,829.75 cfs 492.537 af

Total Runoff Area = 1,557.150 ac Runoff Volume = 492.544 af Average Runoff Depth = 3.80"
100.00% Pervious = 1,557.150 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Watershed Upstream of Culvert

Runoff = 1,193.60 cfs @ 13.46 hrs, Volume= 284.418 af, Depth= 3.80"
 Routed to Pond 2P : 560th Ave Culvert

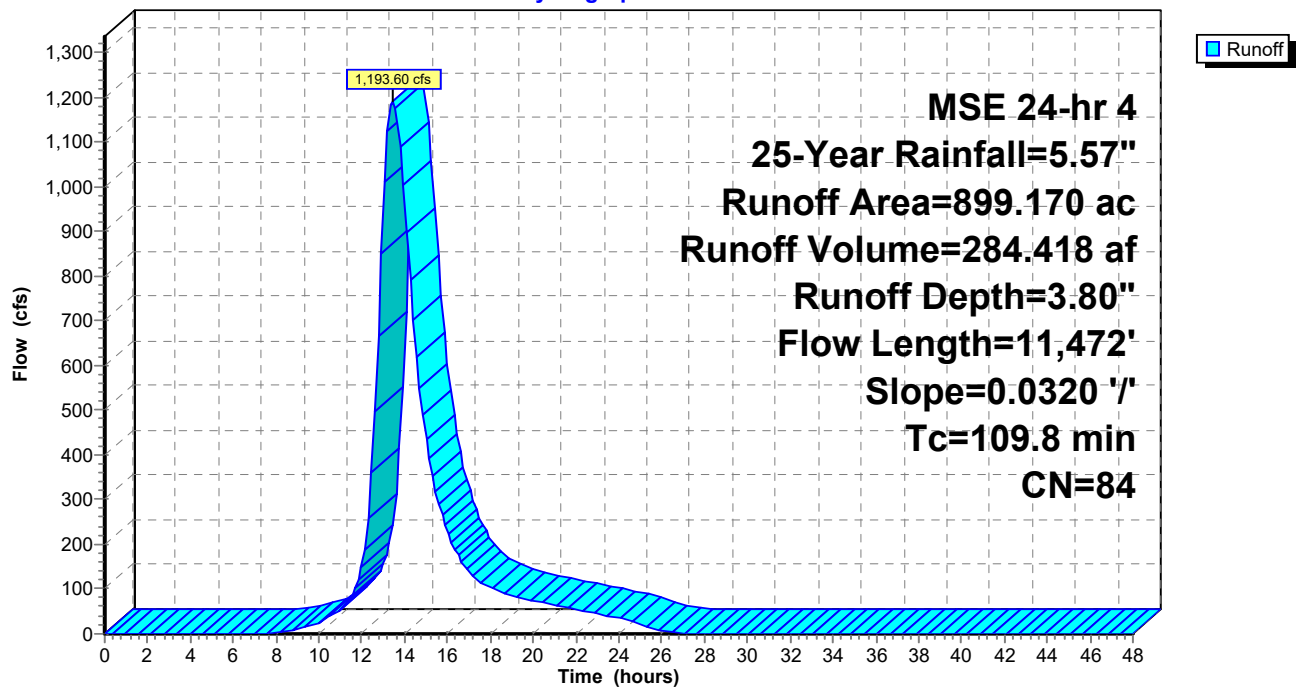
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 MSE 24-hr 4 25-Year Rainfall=5.57"

Area (ac)	CN	Description
* 899.170	84	Weighted Average
899.170		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
109.8	11,472	0.0320	1.74		Lag/CN Method, Existing Watershed Tc

Subcatchment 1S: Watershed Upstream of Culvert

Hydrograph



IA-340-13 - Neary - Proposed Condition - 90' Weir NW **MSE 24-hr 4 25-Year Rainfall=5.57"**

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Hydrograph for Subcatchment 1S: Watershed Upstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	39.00	5.57	3.80	0.00
0.75	0.02	0.00	0.00	39.75	5.57	3.80	0.00
1.50	0.05	0.00	0.00	40.50	5.57	3.80	0.00
2.25	0.08	0.00	0.00	41.25	5.57	3.80	0.00
3.00	0.12	0.00	0.00	42.00	5.57	3.80	0.00
3.75	0.16	0.00	0.00	42.75	5.57	3.80	0.00
4.50	0.22	0.00	0.00	43.50	5.57	3.80	0.00
5.25	0.28	0.00	0.00	44.25	5.57	3.80	0.00
6.00	0.34	0.00	0.00	45.00	5.57	3.80	0.00
6.75	0.42	0.00	0.01	45.75	5.57	3.80	0.00
7.50	0.49	0.01	0.59	46.50	5.57	3.80	0.00
8.25	0.58	0.02	3.91	47.25	5.57	3.80	0.00
9.00	0.67	0.04	10.12	48.00	5.57	3.80	0.00
9.75	0.83	0.08	19.30				
10.50	1.00	0.15	37.50				
11.25	1.35	0.32	65.63				
12.00	2.61	1.20	149.16				
12.75	4.22	2.57	667.19				
13.50	4.57	2.88	1,191.80				
14.25	4.74	3.04	791.65				
15.00	4.90	3.18	437.03				
15.75	4.99	3.26	265.70				
16.50	5.08	3.34	174.69				
17.25	5.15	3.41	125.55				
18.00	5.23	3.48	101.80				
18.75	5.29	3.54	88.53				
19.50	5.35	3.60	79.79				
20.25	5.41	3.64	72.08				
21.00	5.45	3.69	64.61				
21.75	5.49	3.72	57.22				
22.50	5.52	3.75	49.82				
23.25	5.55	3.78	42.40				
24.00	5.57	3.80	34.94				
24.75	5.57	3.80	26.26				
25.50	5.57	3.80	13.56				
26.25	5.57	3.80	5.02				
27.00	5.57	3.80	1.81				
27.75	5.57	3.80	0.63				
28.50	5.57	3.80	0.20				
29.25	5.57	3.80	0.05				
30.00	5.57	3.80	0.00				
30.75	5.57	3.80	0.00				
31.50	5.57	3.80	0.00				
32.25	5.57	3.80	0.00				
33.00	5.57	3.80	0.00				
33.75	5.57	3.80	0.00				
34.50	5.57	3.80	0.00				
35.25	5.57	3.80	0.00				
36.00	5.57	3.80	0.00				
36.75	5.57	3.80	0.00				
37.50	5.57	3.80	0.00				
38.25	5.57	3.80	0.00				

Summary for Subcatchment 3S: Watershed Downstream of Culvert

Runoff = 1,115.70 cfs @ 13.02 hrs, Volume= 208.126 af, Depth= 3.80"
 Routed to Pond 4P : Proposed Wetland Condition

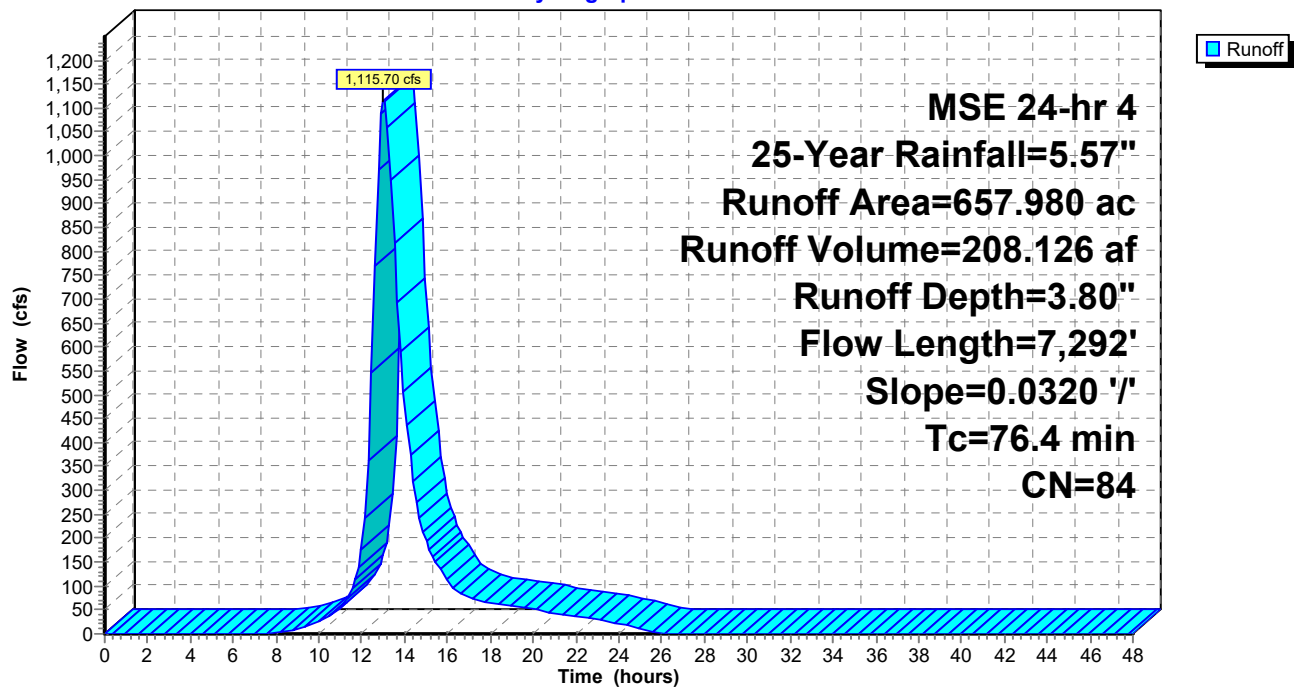
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 MSE 24-hr 4 25-Year Rainfall=5.57"

Area (ac)	CN	Description
* 657.980	84	Weighted Average
657.980		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
76.4	7,292	0.0320	1.59		Lag/CN Method,

Subcatchment 3S: Watershed Downstream of Culvert

Hydrograph



Hydrograph for Subcatchment 3S: Watershed Downstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	39.00	5.57	3.80	0.00
0.75	0.02	0.00	0.00	39.75	5.57	3.80	0.00
1.50	0.05	0.00	0.00	40.50	5.57	3.80	0.00
2.25	0.08	0.00	0.00	41.25	5.57	3.80	0.00
3.00	0.12	0.00	0.00	42.00	5.57	3.80	0.00
3.75	0.16	0.00	0.00	42.75	5.57	3.80	0.00
4.50	0.22	0.00	0.00	43.50	5.57	3.80	0.00
5.25	0.28	0.00	0.00	44.25	5.57	3.80	0.00
6.00	0.34	0.00	0.00	45.00	5.57	3.80	0.00
6.75	0.42	0.00	0.01	45.75	5.57	3.80	0.00
7.50	0.49	0.01	1.16	46.50	5.57	3.80	0.00
8.25	0.58	0.02	5.25	47.25	5.57	3.80	0.00
9.00	0.67	0.04	10.91	48.00	5.57	3.80	0.00
9.75	0.83	0.08	20.27				
10.50	1.00	0.15	38.40				
11.25	1.35	0.32	67.21				
12.00	2.61	1.20	176.06				
12.75	4.22	2.57	971.66				
13.50	4.57	2.88	817.88				
14.25	4.74	3.04	372.65				
15.00	4.90	3.18	192.61				
15.75	4.99	3.26	129.43				
16.50	5.08	3.34	87.22				
17.25	5.15	3.41	72.74				
18.00	5.23	3.48	65.49				
18.75	5.29	3.54	59.76				
19.50	5.35	3.60	54.34				
20.25	5.41	3.64	48.98				
21.00	5.45	3.69	43.58				
21.75	5.49	3.72	38.16				
22.50	5.52	3.75	32.72				
23.25	5.55	3.78	27.27				
24.00	5.57	3.80	21.80				
24.75	5.57	3.80	13.74				
25.50	5.57	3.80	3.82				
26.25	5.57	3.80	0.88				
27.00	5.57	3.80	0.19				
27.75	5.57	3.80	0.03				
28.50	5.57	3.80	0.00				
29.25	5.57	3.80	0.00				
30.00	5.57	3.80	0.00				
30.75	5.57	3.80	0.00				
31.50	5.57	3.80	0.00				
32.25	5.57	3.80	0.00				
33.00	5.57	3.80	0.00				
33.75	5.57	3.80	0.00				
34.50	5.57	3.80	0.00				
35.25	5.57	3.80	0.00				
36.00	5.57	3.80	0.00				
36.75	5.57	3.80	0.00				
37.50	5.57	3.80	0.00				
38.25	5.57	3.80	0.00				

IA-340-13 - Neary - Proposed Condition - 90' Weir NW

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Summary for Pond 2P: 560th Ave Culvert

Inflow Area = 899.170 ac, 0.00% Impervious, Inflow Depth = 3.80" for 25-Year event
 Inflow = 1,193.60 cfs @ 13.46 hrs, Volume= 284.418 af
 Outflow = 1,168.68 cfs @ 13.62 hrs, Volume= 284.417 af, Atten= 2%, Lag= 9.7 min
 Primary = 406.74 cfs @ 13.62 hrs, Volume= 191.141 af
 Routed to Pond 4P : Proposed Wetland Condition
 Secondary = 761.94 cfs @ 13.62 hrs, Volume= 93.276 af
 Routed to Pond 4P : Proposed Wetland Condition

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 Peak Elev= 1,235.84' @ 13.62 hrs Surf.Area= 15.508 ac Storage= 9.673 af

Plug-Flow detention time= 4.1 min calculated for 284.417 af (100% of inflow)
 Center-of-Mass det. time= 3.5 min (896.5 - 893.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,226.00'	66.349 af	Custom Stage Data from Lidar (Prismatic) listed below (Recalc)

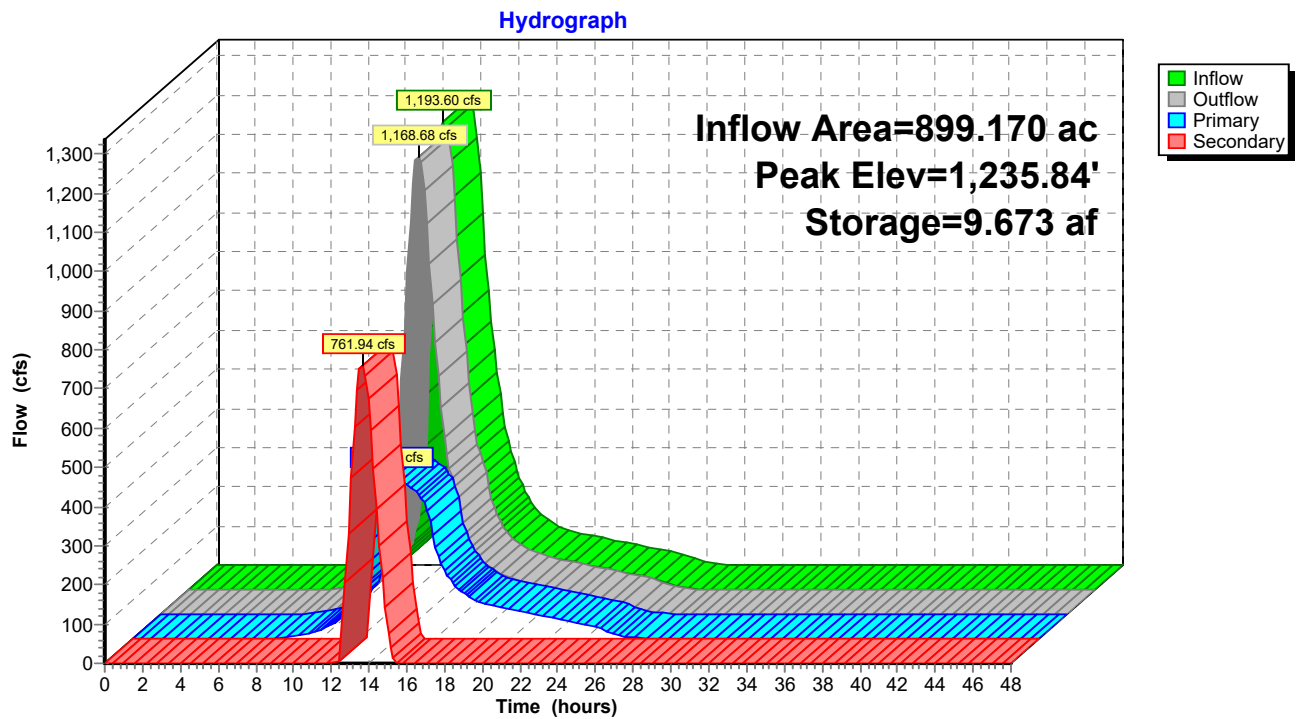
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,226.00	0.001	0.000	0.000
1,227.00	0.002	0.002	0.002
1,228.00	0.003	0.003	0.004
1,229.00	0.006	0.005	0.008
1,230.00	0.016	0.011	0.020
1,231.00	0.038	0.027	0.046
1,232.00	0.082	0.060	0.106
1,233.00	0.422	0.252	0.358
1,234.00	0.999	0.710	1.069
1,235.00	1.702	1.350	2.419
1,236.00	18.079	9.890	12.310
1,237.00	25.000	21.539	33.849
1,238.00	40.000	32.500	66.349

Device	Routing	Invert	Outlet Devices
#1	Primary	1,226.36'	72.0" W x 60.0" H Box Existing 5x6 Road Culvert L= 25.0' Box, 30-75° wingwalls, square crown, Ke= 0.400 Inlet / Outlet Invert= 1,226.36' / 1,226.36' S= 0.0000 ' / Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 30.00 sf
#2	Secondary	1,234.37'	Gravel Road - Asymmetrical Weir, C= 3.27 Offset (feet) -214.93 -167.93 -88.67 0.00 82.37 132.11 157.11 Elev. (feet) 1,237.00 1,236.27 1,235.04 1,234.37 1,235.06 1,236.20 1,237.00

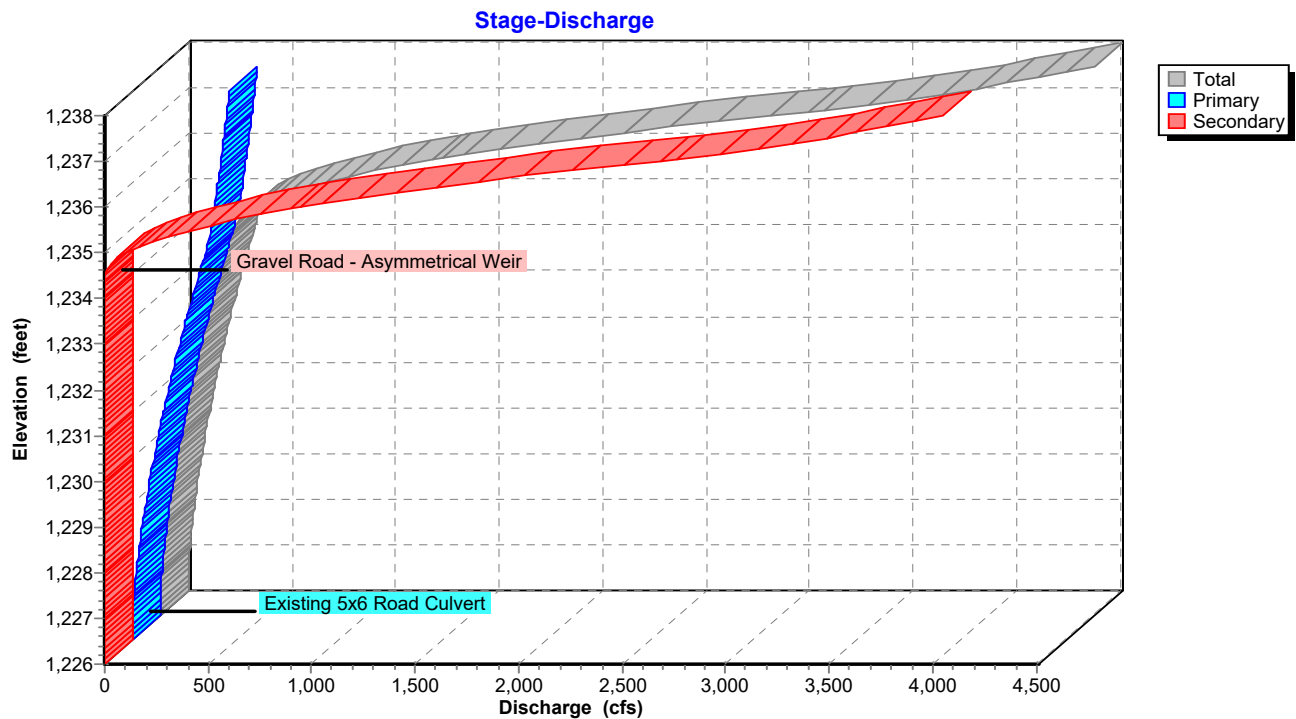
Primary OutFlow Max=406.66 cfs @ 13.62 hrs HW=1,235.84' TW=1,206.61' (Dynamic Tailwater)
 ↳ **1=Existing 5x6 Road Culvert** (Inlet Controls 406.66 cfs @ 13.56 fps)

Secondary OutFlow Max=758.80 cfs @ 13.62 hrs HW=1,235.84' TW=1,206.61' (Dynamic Tailwater)
 ↳ **2=Gravel Road - Asymmetrical Weir** (Weir Controls 758.80 cfs @ 2.38 fps)

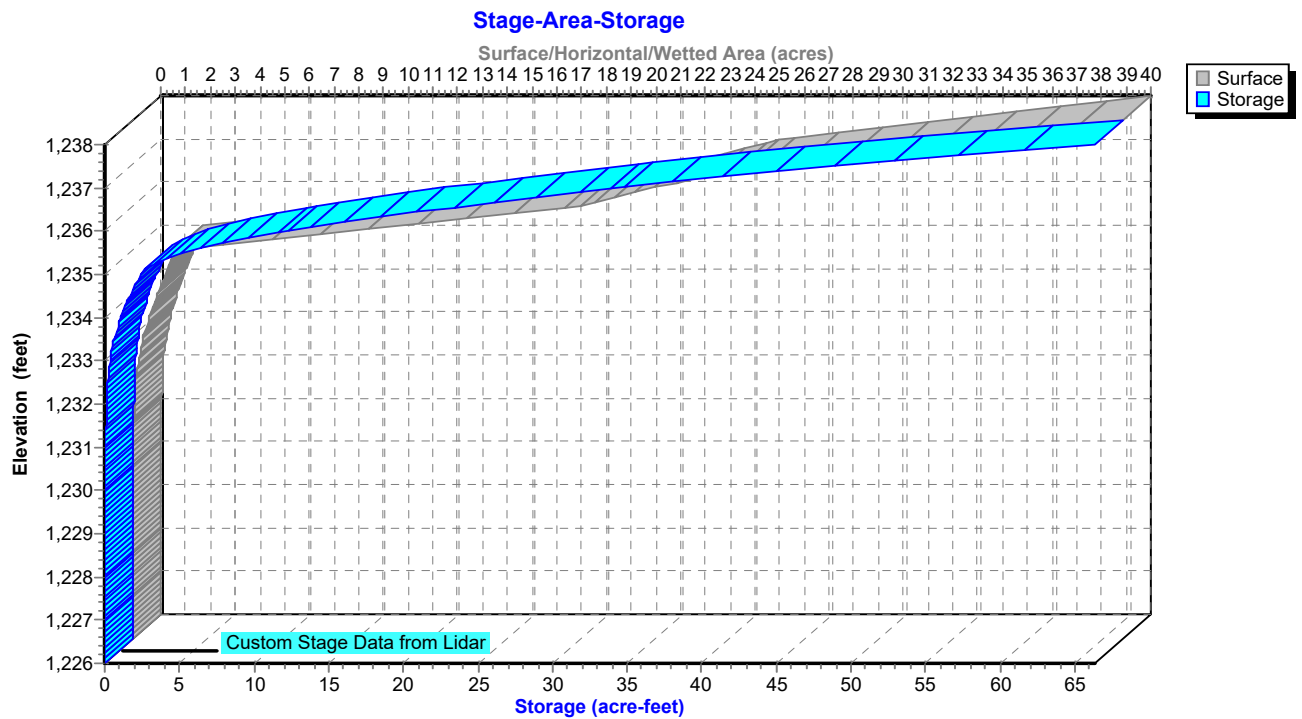
Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Hydrograph for Pond 2P: 560th Ave Culvert

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	0.000	1,226.00	0.00	0.00	0.00
1.50	0.00	0.000	1,226.00	0.00	0.00	0.00
3.00	0.00	0.000	1,226.00	0.00	0.00	0.00
4.50	0.00	0.000	1,226.00	0.00	0.00	0.00
6.00	0.00	0.000	1,226.00	0.00	0.00	0.00
7.50	0.59	0.001	1,226.51	0.60	0.60	0.00
9.00	10.12	0.002	1,227.17	10.12	10.12	0.00
10.50	37.50	0.005	1,228.23	37.46	37.46	0.00
12.00	149.16	0.045	1,230.95	147.33	147.33	0.00
13.50	1,191.80	9.509	1,235.83	1,156.29	406.42	749.87
15.00	437.03	2.305	1,234.93	453.14	375.31	77.84
16.50	174.69	0.073	1,231.54	176.42	176.42	0.00
18.00	101.80	0.019	1,229.96	101.95	101.95	0.00
19.50	79.79	0.012	1,229.43	79.85	79.85	0.00
21.00	64.61	0.009	1,229.03	64.64	64.64	0.00
22.50	49.82	0.006	1,228.61	49.85	49.85	0.00
24.00	34.94	0.004	1,228.14	34.96	34.96	0.00
25.50	13.56	0.002	1,227.33	13.58	13.58	0.00
27.00	1.81	0.001	1,226.65	1.81	1.81	0.00
28.50	0.20	0.001	1,226.45	0.20	0.20	0.00
30.00	0.00	0.000	1,226.37	0.00	0.00	0.00
31.50	0.00	0.000	1,226.36	0.00	0.00	0.00
33.00	0.00	0.000	1,226.36	0.00	0.00	0.00
34.50	0.00	0.000	1,226.36	0.00	0.00	0.00
36.00	0.00	0.000	1,226.36	0.00	0.00	0.00
37.50	0.00	0.000	1,226.36	0.00	0.00	0.00
39.00	0.00	0.000	1,226.36	0.00	0.00	0.00
40.50	0.00	0.000	1,226.36	0.00	0.00	0.00
42.00	0.00	0.000	1,226.36	0.00	0.00	0.00
43.50	0.00	0.000	1,226.36	0.00	0.00	0.00
45.00	0.00	0.000	1,226.36	0.00	0.00	0.00
46.50	0.00	0.000	1,226.36	0.00	0.00	0.00
48.00	0.00	0.000	1,226.36	0.00	0.00	0.00

Stage-Discharge for Pond 2P: 560th Ave Culvert

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
1,226.00	0.00	0.00	0.00	1,236.40	1,958.33	422.99	1,535.35
1,226.20	0.00	0.00	0.00	1,236.60	2,310.52	428.67	1,881.85
1,226.40	0.04	0.04	0.00	1,236.80	2,699.76	434.27	2,265.49
1,226.60	1.34	1.34	0.00	1,237.00	3,126.75	439.79	2,686.95
1,226.80	3.79	3.79	0.00	1,237.20	3,481.18	445.25	3,035.93
1,227.00	7.01	7.01	0.00	1,237.40	3,776.53	450.64	3,325.89
1,227.20	10.82	10.82	0.00	1,237.60	4,041.43	455.96	3,585.47
1,227.40	15.14	15.14	0.00	1,237.80	4,285.19	461.22	3,823.97
1,227.60	19.92	19.92	0.00	1,238.00	4,512.80	466.42	4,046.38
1,227.80	25.12	25.12	0.00				
1,228.00	30.69	30.69	0.00				
1,228.20	36.63	36.63	0.00				
1,228.40	42.91	42.91	0.00				
1,228.60	49.50	49.50	0.00				
1,228.80	56.40	56.40	0.00				
1,229.00	63.59	63.59	0.00				
1,229.20	71.07	71.07	0.00				
1,229.40	78.81	78.81	0.00				
1,229.60	86.82	86.82	0.00				
1,229.80	95.08	95.08	0.00				
1,230.00	103.58	103.58	0.00				
1,230.20	112.33	112.33	0.00				
1,230.40	121.30	121.30	0.00				
1,230.60	130.51	130.51	0.00				
1,230.80	139.93	139.93	0.00				
1,231.00	149.57	149.57	0.00				
1,231.20	159.42	159.42	0.00				
1,231.40	169.48	169.48	0.00				
1,231.60	179.74	179.74	0.00				
1,231.80	190.20	190.20	0.00				
1,232.00	200.86	200.86	0.00				
1,232.20	211.71	211.71	0.00				
1,232.40	222.74	222.74	0.00				
1,232.60	233.96	233.96	0.00				
1,232.80	245.36	245.36	0.00				
1,233.00	256.95	256.95	0.00				
1,233.20	269.38	269.38	0.00				
1,233.40	283.64	283.64	0.00				
1,233.60	297.22	297.22	0.00				
1,233.80	310.20	310.20	0.00				
1,234.00	322.67	322.67	0.00				
1,234.20	334.66	334.66	0.00				
1,234.40	346.30	346.25	0.05				
1,234.60	365.81	357.46	8.35				
1,234.80	408.24	368.32	39.92				
1,235.00	482.60	378.88	103.72				
1,235.20	592.10	387.09	205.01				
1,235.40	734.23	393.31	340.92				
1,235.60	909.80	399.43	510.37				
1,235.80	1,119.19	405.46	713.74				
1,236.00	1,363.16	411.39	951.77				
1,236.20	1,642.64	417.23	1,225.41				

IA-340-13 - Neary - Proposed Condition - 90' Weir NW *MSE 24-hr 4 25-Year Rainfall=5.57"*

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Stage-Area-Storage for Pond 2P: 560th Ave Culvert

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,226.00	0.001	0.000	1,236.40	20.847	20.095
1,226.20	0.001	0.000	1,236.60	22.232	24.403
1,226.40	0.001	0.000	1,236.80	23.616	28.988
1,226.60	0.002	0.001	1,237.00	25.000	33.849
1,226.80	0.002	0.001	1,237.20	28.000	39.150
1,227.00	0.002	0.002	1,237.40	31.000	45.050
1,227.20	0.002	0.002	1,237.60	34.000	51.549
1,227.40	0.002	0.002	1,237.80	37.000	58.649
1,227.60	0.003	0.003	1,238.00	40.000	66.349
1,227.80	0.003	0.003			
1,228.00	0.003	0.004			
1,228.20	0.004	0.005			
1,228.40	0.004	0.005			
1,228.60	0.005	0.006			
1,228.80	0.005	0.007			
1,229.00	0.006	0.008			
1,229.20	0.008	0.010			
1,229.40	0.010	0.012			
1,229.60	0.012	0.014			
1,229.80	0.014	0.016			
1,230.00	0.016	0.020			
1,230.20	0.020	0.023			
1,230.40	0.025	0.028			
1,230.60	0.029	0.033			
1,230.80	0.034	0.039			
1,231.00	0.038	0.046			
1,231.20	0.047	0.055			
1,231.40	0.056	0.065			
1,231.60	0.064	0.077			
1,231.80	0.073	0.091			
1,232.00	0.082	0.106			
1,232.20	0.150	0.130			
1,232.40	0.218	0.167			
1,232.60	0.286	0.217			
1,232.80	0.354	0.281			
1,233.00	0.422	0.358			
1,233.20	0.537	0.454			
1,233.40	0.653	0.573			
1,233.60	0.768	0.716			
1,233.80	0.884	0.881			
1,234.00	0.999	1.069			
1,234.20	1.140	1.283			
1,234.40	1.280	1.525			
1,234.60	1.421	1.795			
1,234.80	1.561	2.093			
1,235.00	1.702	2.419			
1,235.20	4.977	3.087			
1,235.40	8.253	4.410			
1,235.60	11.528	6.389			
1,235.80	14.804	9.022			
1,236.00	18.079	12.310			
1,236.20	19.463	16.064			

Summary for Pond 4P: Proposed Wetland Condition

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=3)

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 3.80" for 25-Year event
 Inflow = 2,069.53 cfs @ 13.26 hrs, Volume= 492.544 af
 Outflow = 1,829.75 cfs @ 13.61 hrs, Volume= 492.537 af, Atten= 12%, Lag= 21.1 min
 Primary = 1,829.75 cfs @ 13.61 hrs, Volume= 492.537 af
 Routed to Pond 9P : Existing Outlet Channel to Lake

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 Starting Elev= 1,202.20' Surf.Area= 8.200 ac Storage= 13.433 af
 Peak Elev= 1,206.63' @ 13.70 hrs Surf.Area= 17.279 ac Storage= 68.467 af (55.035 af above start)

Plug-Flow detention time= 49.3 min calculated for 479.104 af (97% of inflow)
 Center-of-Mass det. time= 23.9 min (905.8 - 881.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,199.00'	140.919 af	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,199.00	0.002	0.000	0.000
1,200.00	1.684	0.843	0.843
1,201.00	6.154	3.919	4.762
1,202.00	7.956	7.055	11.817
1,202.20	8.200	1.616	13.433
1,203.00	9.499	7.080	20.512
1,204.00	11.030	10.264	30.777
1,205.00	13.737	12.383	43.160
1,206.00	15.991	14.864	58.024
1,207.00	18.042	17.016	75.041
1,208.00	20.142	19.092	94.133
1,209.00	23.715	21.928	116.061
1,210.00	26.000	24.857	140.919

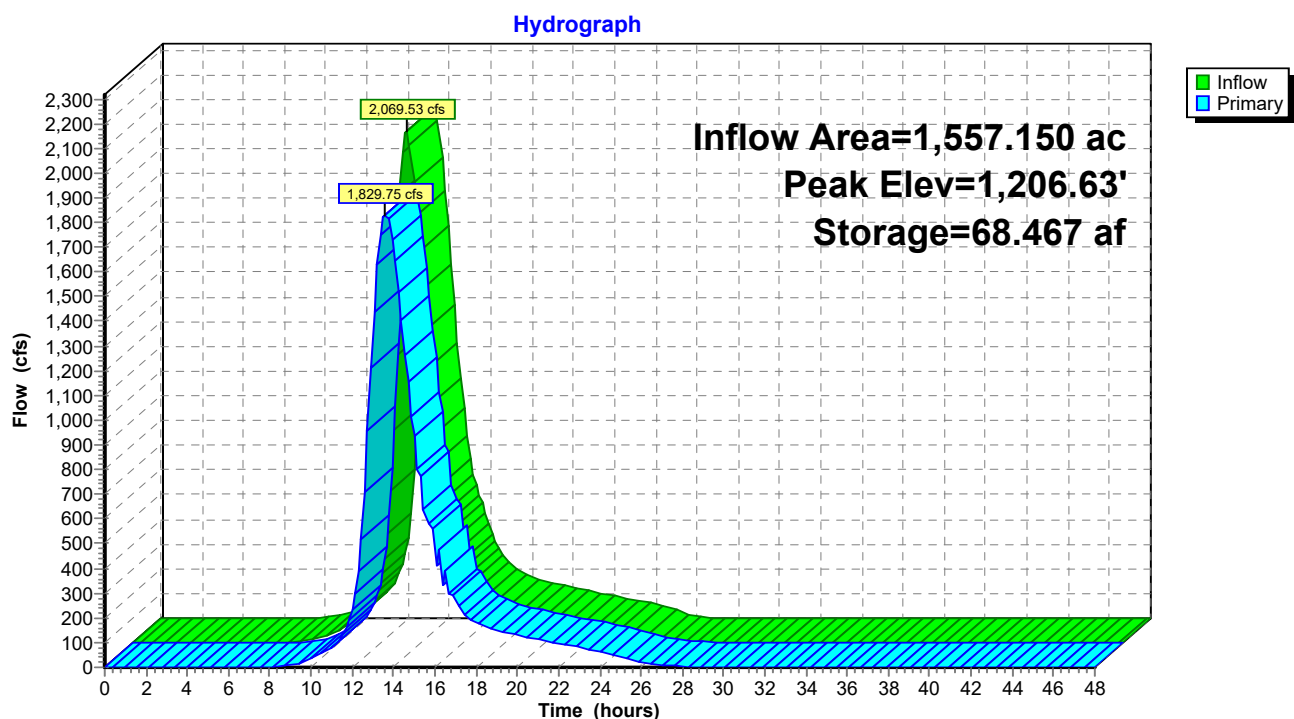
Device	Routing	Invert	Outlet Devices
#1	Primary	1,202.20'	90' Sheet Pile Weir, C= 3.27 Offset (feet) -66.60 -64.60 -56.60 -45.00 45.00 56.60 64.60 66.60 Height (feet) 6.80 5.80 5.80 0.00 0.00 5.80 5.80 6.80
#2	Primary	1,209.00'	200.0' long + 10.0 ' SideZ x 12.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64

Primary OutFlow Max=1,794.00 cfs @ 13.61 hrs HW=1,206.60' TW=1,205.79' (Dynamic Tailwater)

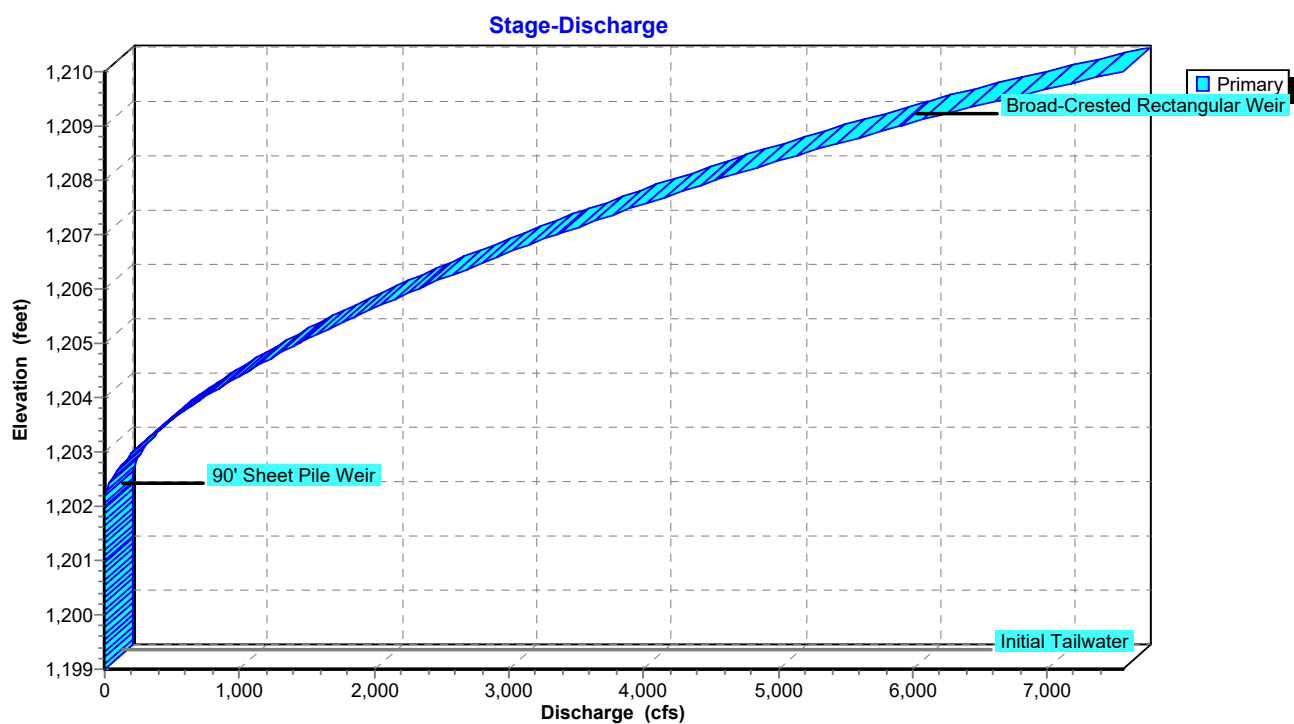
1=90' Sheet Pile Weir (Weir Controls 1,794.00 cfs @ 3.79 fps)

2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

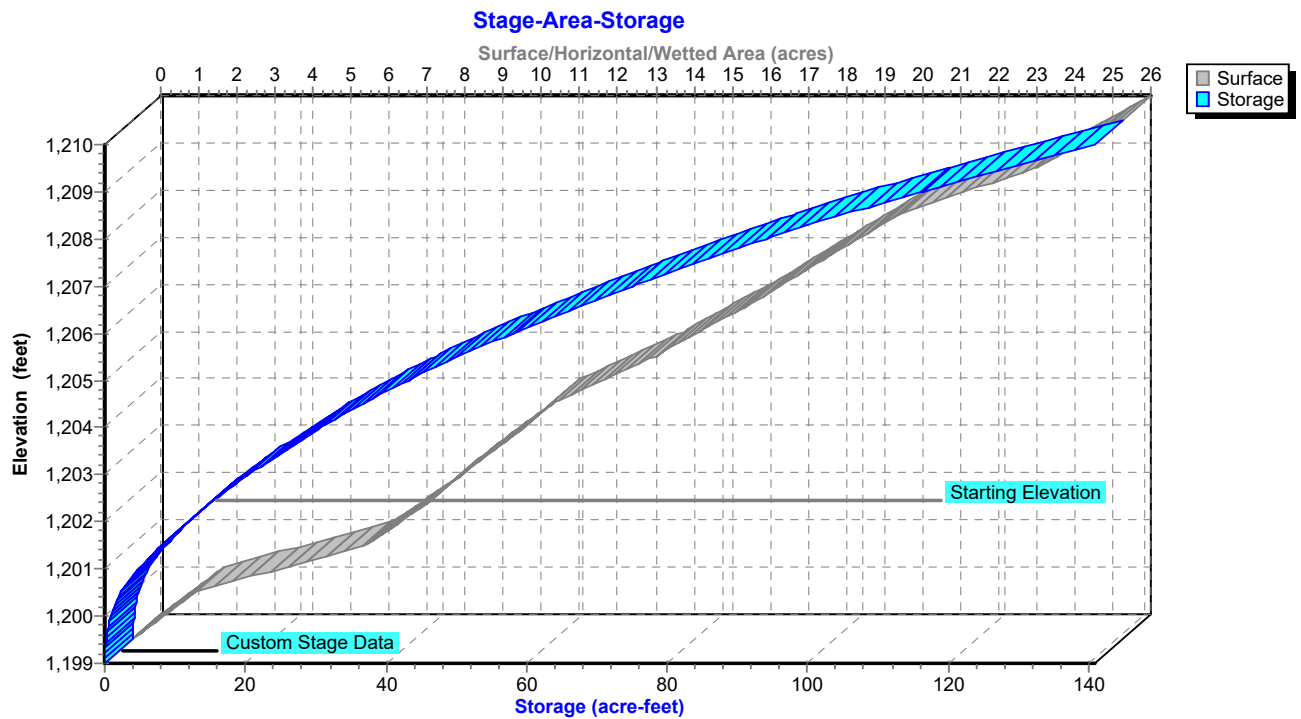
Pond 4P: Proposed Wetland Condition



Pond 4P: Proposed Wetland Condition



Pond 4P: Proposed Wetland Condition



Hydrograph for Pond 4P: Proposed Wetland Condition

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	13.433	1,202.20	0.00
1.50	0.00	13.433	1,202.20	0.00
3.00	0.00	13.433	1,202.20	0.00
4.50	0.00	13.433	1,202.20	0.00
6.00	0.00	13.433	1,202.20	0.00
7.50	1.76	13.465	1,202.20	0.07
9.00	21.03	14.309	1,202.31	10.14
10.50	75.86	16.182	1,202.52	54.79
12.00	323.39	20.989	1,203.05	234.13
13.50	1,974.16	67.229	1,206.56	1,820.51
15.00	645.76	43.857	1,205.05	935.45
16.50	263.64	24.844	1,203.44	386.97
18.00	167.44	19.717	1,202.92	180.45
19.50	134.18	18.695	1,202.81	140.15
21.00	108.22	17.987	1,202.73	113.93
22.50	82.57	17.260	1,202.65	88.65
24.00	56.77	16.472	1,202.56	63.43
25.50	17.40	15.263	1,202.42	30.17
27.00	2.00	14.135	1,202.28	7.30
28.50	0.20	13.732	1,202.24	2.05
30.00	0.00	13.584	1,202.22	0.74
31.50	0.00	13.522	1,202.21	0.34
33.00	0.00	13.492	1,202.21	0.18
34.50	0.00	13.474	1,202.21	0.11
36.00	0.00	13.464	1,202.20	0.07
37.50	0.00	13.457	1,202.20	0.05
39.00	0.00	13.452	1,202.20	0.03
40.50	0.00	13.448	1,202.20	0.02
42.00	0.00	13.446	1,202.20	0.02
43.50	0.00	13.444	1,202.20	0.01
45.00	0.00	13.442	1,202.20	0.01
46.50	0.00	13.441	1,202.20	0.01
48.00	0.00	13.440	1,202.20	0.01

Stage-Discharge for Pond 4P: Proposed Wetland Condition

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.00	0.00	1,204.20	862.00	1,209.40	6,524.18
1,199.10	0.00	1,204.30	929.05	1,209.50	6,690.99
1,199.20	0.00	1,204.40	997.90	1,209.60	6,862.68
1,199.30	0.00	1,204.50	1,068.53	1,209.70	7,032.81
1,199.40	0.00	1,204.60	1,140.91	1,209.80	7,205.23
1,199.50	0.00	1,204.70	1,215.03	1,209.90	7,381.56
1,199.60	0.00	1,204.80	1,290.85	1,210.00	7,560.57
1,199.70	0.00	1,204.90	1,368.35		
1,199.80	0.00	1,205.00	1,447.52		
1,199.90	0.00	1,205.10	1,528.34		
1,200.00	0.00	1,205.20	1,610.79		
1,200.10	0.00	1,205.30	1,694.85		
1,200.20	0.00	1,205.40	1,780.51		
1,200.30	0.00	1,205.50	1,867.76		
1,200.40	0.00	1,205.60	1,956.58		
1,200.50	0.00	1,205.70	2,046.95		
1,200.60	0.00	1,205.80	2,138.88		
1,200.70	0.00	1,205.90	2,232.34		
1,200.80	0.00	1,206.00	2,327.32		
1,200.90	0.00	1,206.10	2,423.82		
1,201.00	0.00	1,206.20	2,521.82		
1,201.10	0.00	1,206.30	2,621.32		
1,201.20	0.00	1,206.40	2,722.31		
1,201.30	0.00	1,206.50	2,824.78		
1,201.40	0.00	1,206.60	2,928.72		
1,201.50	0.00	1,206.70	3,034.12		
1,201.60	0.00	1,206.80	3,140.98		
1,201.70	0.00	1,206.90	3,249.29		
1,201.80	0.00	1,207.00	3,359.04		
1,201.90	0.00	1,207.10	3,470.23		
1,202.00	0.00	1,207.20	3,582.85		
1,202.10	0.00	1,207.30	3,696.90		
1,202.20	0.00	1,207.40	3,812.37		
1,202.30	9.32	1,207.50	3,929.25		
1,202.40	26.42	1,207.60	4,047.54		
1,202.50	48.62	1,207.70	4,167.24		
1,202.60	74.98	1,207.80	4,288.34		
1,202.70	104.98	1,207.90	4,410.84		
1,202.80	138.24	1,208.00	4,534.73		
1,202.90	174.51	1,208.10	4,661.66		
1,203.00	213.58	1,208.20	4,791.35		
1,203.10	255.30	1,208.30	4,923.32		
1,203.20	299.53	1,208.40	5,057.38		
1,203.30	346.17	1,208.50	5,193.44		
1,203.40	395.12	1,208.60	5,331.43		
1,203.50	446.30	1,208.70	5,471.30		
1,203.60	499.64	1,208.80	5,613.00		
1,203.70	555.08	1,208.90	5,756.51		
1,203.80	612.56	1,209.00	5,901.79		
1,203.90	672.04	1,209.10	6,051.34		
1,204.00	733.46	1,209.20	6,204.86		
1,204.10	796.80	1,209.30	6,362.52		

Stage-Area-Storage for Pond 4P: Proposed Wetland Condition

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,199.00	0.002	0.000	1,209.40	24.629	125.730
1,199.20	0.338	0.034	1,209.60	25.086	130.701
1,199.40	0.675	0.135	1,209.80	25.543	135.764
1,199.60	1.011	0.304	1,210.00	26.000	140.919
1,199.80	1.348	0.540			
1,200.00	1.684	0.843			
1,200.20	2.578	1.269			
1,200.40	3.472	1.874			
1,200.60	4.366	2.658			
1,200.80	5.260	3.621			
1,201.00	6.154	4.762			
1,201.20	6.514	6.029			
1,201.40	6.875	7.368			
1,201.60	7.235	8.779			
1,201.80	7.596	10.262			
1,202.00	7.956	11.817			
1,202.20	8.200	13.433			
1,202.40	8.525	15.105			
1,202.60	8.849	16.842			
1,202.80	9.174	18.645			
1,203.00	9.499	20.512			
1,203.20	9.805	22.443			
1,203.40	10.111	24.434			
1,203.60	10.418	26.487			
1,203.80	10.724	28.601			
1,204.00	11.030	30.777			
1,204.20	11.571	33.037			
1,204.40	12.113	35.405			
1,204.60	12.654	37.882			
1,204.80	13.196	40.467			
1,205.00	13.737	43.160			
1,205.20	14.188	45.953			
1,205.40	14.639	48.835			
1,205.60	15.089	51.808			
1,205.80	15.540	54.871			
1,206.00	15.991	58.024			
1,206.20	16.401	61.263			
1,206.40	16.811	64.585			
1,206.60	17.222	67.988			
1,206.80	17.632	71.473			
1,207.00	18.042	75.041			
1,207.20	18.462	78.691			
1,207.40	18.882	82.426			
1,207.60	19.302	86.244			
1,207.80	19.722	90.146			
1,208.00	20.142	94.133			
1,208.20	20.857	98.233			
1,208.40	21.571	102.475			
1,208.60	22.286	106.861			
1,208.80	23.000	111.390			
1,209.00	23.715	116.061			
1,209.20	24.172	120.850			

Summary for Pond 9P: Existing Outlet Channel to Lake

[57] Hint: Peaked at 1,205.80' (Flood elevation advised)

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 3.80" for 25-Year event
 Inflow = 1,829.75 cfs @ 13.61 hrs, Volume= 492.537 af
 Outflow = 1,829.75 cfs @ 13.61 hrs, Volume= 492.537 af, Atten= 0%, Lag= 0.0 min
 Primary = 1,829.75 cfs @ 13.61 hrs, Volume= 492.537 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs

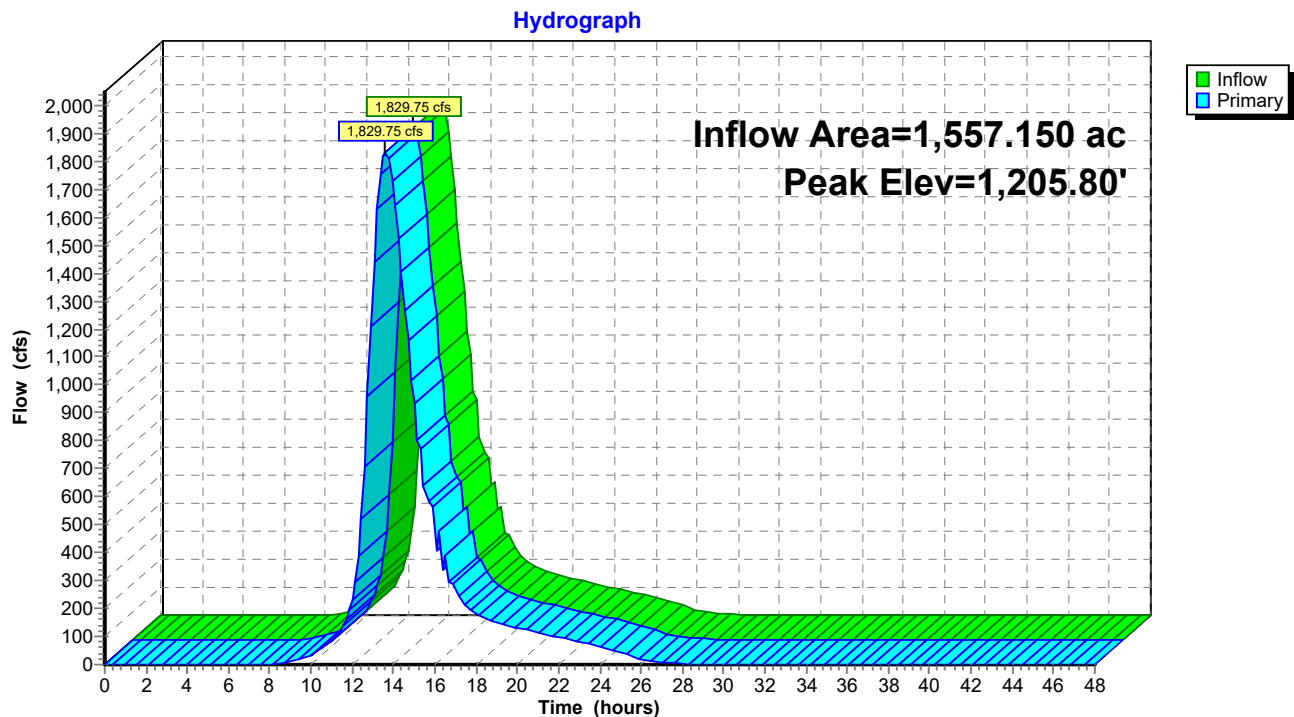
Peak Elev= 1,205.80' @ 13.61 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	1,199.12'	Existing Outlet Channel to Lake, C= 3.27 Offset (feet) -106.52 -44.01 -15.95 0.00 10.33 70.05 Elev. (feet) 1,213.23 1,204.05 1,201.65 1,199.12 1,201.69 1,213.23

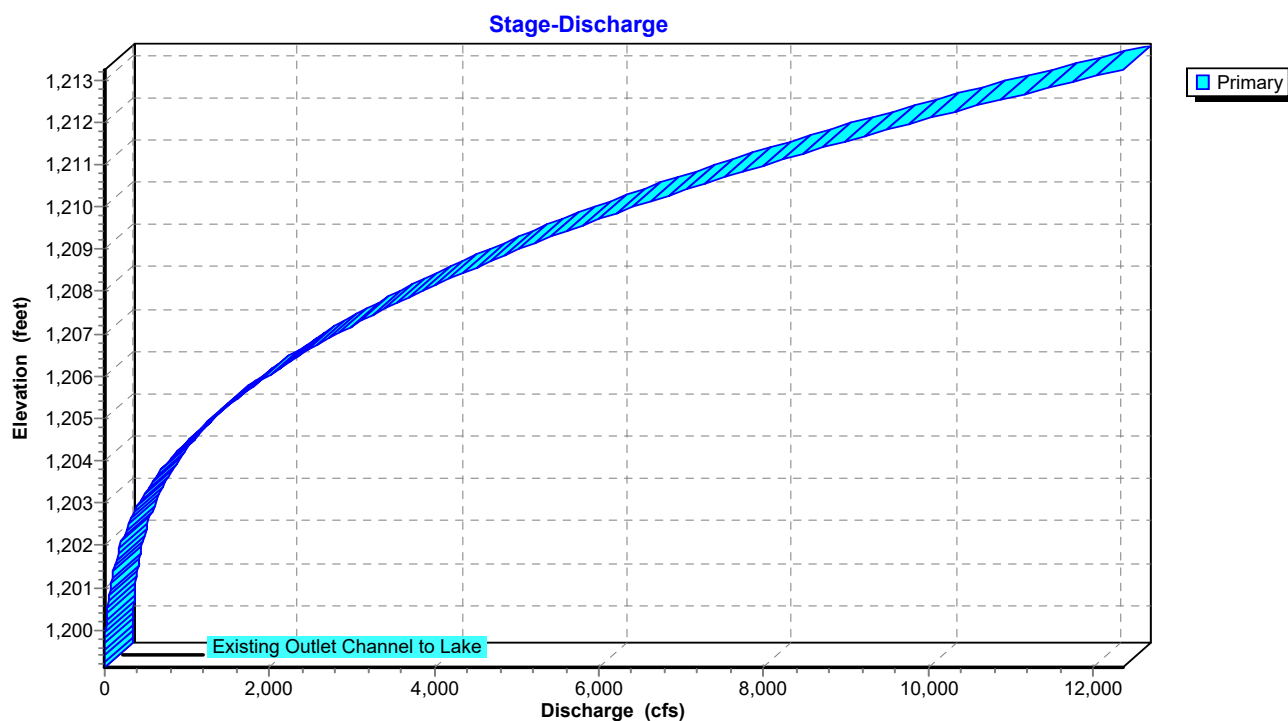
Primary OutFlow Max=1,826.09 cfs @ 13.61 hrs HW=1,205.79' (Free Discharge)

↑1=Existing Outlet Channel to Lake(Weir Controls 1,826.09 cfs @ 4.57 fps)

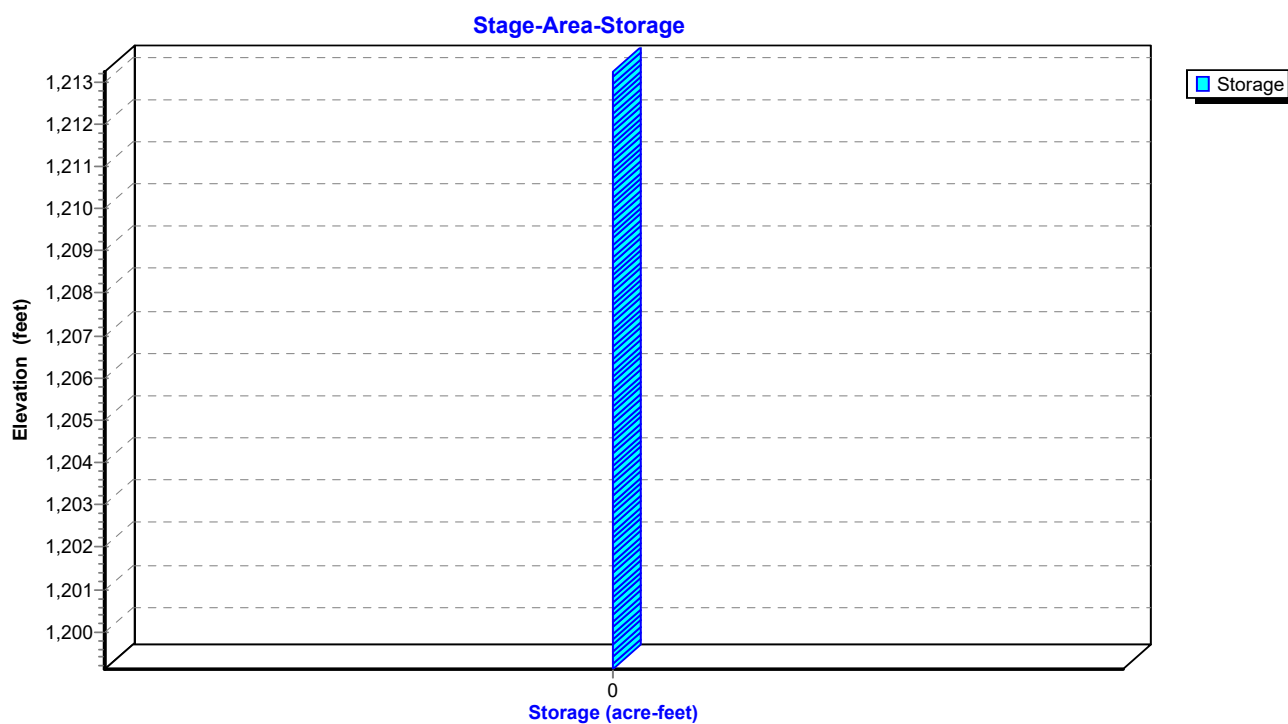
Pond 9P: Existing Outlet Channel to Lake



Pond 9P: Existing Outlet Channel to Lake



Pond 9P: Existing Outlet Channel to Lake



Hydrograph for Pond 9P: Existing Outlet Channel to Lake

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	1,199.12	0.00	39.00	0.03	1,199.21	0.03
0.75	0.00	1,199.12	0.00	39.75	0.03	1,199.20	0.03
1.50	0.00	1,199.12	0.00	40.50	0.02	1,199.20	0.02
2.25	0.00	1,199.12	0.00	41.25	0.02	1,199.20	0.02
3.00	0.00	1,199.12	0.00	42.00	0.02	1,199.19	0.02
3.75	0.00	1,199.12	0.00	42.75	0.02	1,199.19	0.02
4.50	0.00	1,199.12	0.00	43.50	0.01	1,199.18	0.01
5.25	0.00	1,199.12	0.00	44.25	0.01	1,199.18	0.01
6.00	0.00	1,199.12	0.00	45.00	0.01	1,199.18	0.01
6.75	0.00	1,199.12	0.00	45.75	0.01	1,199.18	0.01
7.50	0.07	1,199.24	0.07	46.50	0.01	1,199.17	0.01
8.25	2.02	1,199.59	2.02	47.25	0.01	1,199.17	0.01
9.00	10.14	1,200.01	10.14	48.00	0.01	1,199.17	0.01
9.75	25.25	1,200.40	25.25				
10.50	54.79	1,200.87	54.79				
11.25	101.98	1,201.37	101.98				
12.00	234.13	1,202.24	234.13				
12.75	956.13	1,204.37	956.13				
13.50	1,820.51	1,205.79	1,820.51				
14.25	1,520.42	1,205.35	1,520.42				
15.00	935.45	1,204.33	935.45				
15.75	513.62	1,203.30	513.62				
16.50	386.97	1,202.89	386.97				
17.25	234.50	1,202.24	234.50				
18.00	180.45	1,201.94	180.45				
18.75	155.87	1,201.78	155.87				
19.50	140.15	1,201.67	140.15				
20.25	126.75	1,201.57	126.75				
21.00	113.93	1,201.47	113.93				
21.75	101.27	1,201.36	101.27				
22.50	88.65	1,201.24	88.65				
23.25	76.03	1,201.12	76.03				
24.00	63.43	1,200.98	63.43				
24.75	49.63	1,200.80	49.63				
25.50	30.17	1,200.50	30.17				
26.25	14.98	1,200.16	14.98				
27.00	7.30	1,199.90	7.30				
27.75	3.74	1,199.72	3.74				
28.50	2.05	1,199.59	2.05				
29.25	1.19	1,199.50	1.19				
30.00	0.74	1,199.43	0.74				
30.75	0.49	1,199.38	0.49				
31.50	0.34	1,199.35	0.34				
32.25	0.24	1,199.32	0.24				
33.00	0.18	1,199.30	0.18				
33.75	0.14	1,199.28	0.14				
34.50	0.11	1,199.26	0.11				
35.25	0.08	1,199.25	0.08				
36.00	0.07	1,199.24	0.07				
36.75	0.06	1,199.23	0.06				
37.50	0.05	1,199.22	0.05				
38.25	0.04	1,199.22	0.04				

IA-340-13 - Neary - Proposed Condition - 90' Weir NW MSE 24-hr 4 25-Year Rainfall=5.57"

Prepared by Ducks Unlimited

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Stage-Discharge for Pond 9P: Existing Outlet Channel to Lake

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.12	0.00	1,204.32	931.43	1,209.52	5,746.91
1,199.22	0.04	1,204.42	981.32	1,209.62	5,887.87
1,199.32	0.24	1,204.52	1,032.75	1,209.72	6,030.81
1,199.42	0.67	1,204.62	1,085.74	1,209.82	6,175.74
1,199.52	1.37	1,204.72	1,140.29	1,209.92	6,322.67
1,199.62	2.39	1,204.82	1,196.40	1,210.02	6,471.61
1,199.72	3.77	1,204.92	1,254.09	1,210.12	6,622.56
1,199.82	5.54	1,205.02	1,313.35	1,210.22	6,775.53
1,199.92	7.73	1,205.12	1,374.19	1,210.32	6,930.54
1,200.02	10.38	1,205.22	1,436.62	1,210.42	7,087.58
1,200.12	13.50	1,205.32	1,500.65	1,210.52	7,246.67
1,200.22	17.14	1,205.42	1,566.28	1,210.62	7,407.82
1,200.32	21.30	1,205.52	1,633.53	1,210.72	7,571.03
1,200.42	26.02	1,205.62	1,702.40	1,210.82	7,736.32
1,200.52	31.32	1,205.72	1,772.90	1,210.92	7,903.69
1,200.62	37.21	1,205.82	1,845.04	1,211.02	8,073.14
1,200.72	43.73	1,205.92	1,918.82	1,211.12	8,244.69
1,200.82	50.88	1,206.02	1,994.26	1,211.22	8,418.35
1,200.92	58.70	1,206.12	2,071.37	1,211.32	8,594.11
1,201.02	67.19	1,206.22	2,150.14	1,211.42	8,772.00
1,201.12	76.39	1,206.32	2,230.60	1,211.52	8,952.02
1,201.22	86.30	1,206.42	2,312.76	1,211.62	9,134.17
1,201.32	96.94	1,206.52	2,396.61	1,211.72	9,318.47
1,201.42	108.33	1,206.62	2,482.17	1,211.82	9,504.92
1,201.52	120.50	1,206.72	2,569.44	1,211.92	9,693.53
1,201.62	133.44	1,206.82	2,658.45	1,212.02	9,884.31
1,201.72	147.20	1,206.92	2,749.19	1,212.12	10,077.27
1,201.82	161.85	1,207.02	2,841.67	1,212.22	10,272.40
1,201.92	177.46	1,207.12	2,935.91	1,212.32	10,469.73
1,202.02	194.08	1,207.22	3,031.91	1,212.42	10,669.26
1,202.12	211.75	1,207.32	3,129.68	1,212.52	10,871.00
1,202.22	230.52	1,207.42	3,229.24	1,212.62	11,074.95
1,202.32	250.42	1,207.52	3,330.58	1,212.72	11,281.12
1,202.42	271.49	1,207.62	3,433.72	1,212.82	11,489.52
1,202.52	293.76	1,207.72	3,538.67	1,212.92	11,700.16
1,202.62	317.26	1,207.82	3,645.44	1,213.02	11,913.04
1,202.72	342.02	1,207.92	3,754.03	1,213.12	12,128.18
1,202.82	368.08	1,208.02	3,864.46	1,213.22	12,345.58
1,202.92	395.45	1,208.12	3,976.72		
1,203.02	424.17	1,208.22	4,090.85		
1,203.12	454.27	1,208.32	4,206.83		
1,203.22	485.77	1,208.42	4,324.68		
1,203.32	518.69	1,208.52	4,444.41		
1,203.42	553.07	1,208.62	4,566.02		
1,203.52	588.92	1,208.72	4,689.53		
1,203.62	626.27	1,208.82	4,814.95		
1,203.72	665.15	1,208.92	4,942.28		
1,203.82	705.57	1,209.02	5,071.53		
1,203.92	747.56	1,209.12	5,202.71		
1,204.02	791.15	1,209.22	5,335.83		
1,204.12	836.34	1,209.32	5,470.90		
1,204.22	883.11	1,209.42	5,607.92		

Stage-Area-Storage for Pond 9P: Existing Outlet Channel to Lake

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
1,199.12	0.000	1,204.32	0.000	1,209.52	0.000
1,199.22	0.000	1,204.42	0.000	1,209.62	0.000
1,199.32	0.000	1,204.52	0.000	1,209.72	0.000
1,199.42	0.000	1,204.62	0.000	1,209.82	0.000
1,199.52	0.000	1,204.72	0.000	1,209.92	0.000
1,199.62	0.000	1,204.82	0.000	1,210.02	0.000
1,199.72	0.000	1,204.92	0.000	1,210.12	0.000
1,199.82	0.000	1,205.02	0.000	1,210.22	0.000
1,199.92	0.000	1,205.12	0.000	1,210.32	0.000
1,200.02	0.000	1,205.22	0.000	1,210.42	0.000
1,200.12	0.000	1,205.32	0.000	1,210.52	0.000
1,200.22	0.000	1,205.42	0.000	1,210.62	0.000
1,200.32	0.000	1,205.52	0.000	1,210.72	0.000
1,200.42	0.000	1,205.62	0.000	1,210.82	0.000
1,200.52	0.000	1,205.72	0.000	1,210.92	0.000
1,200.62	0.000	1,205.82	0.000	1,211.02	0.000
1,200.72	0.000	1,205.92	0.000	1,211.12	0.000
1,200.82	0.000	1,206.02	0.000	1,211.22	0.000
1,200.92	0.000	1,206.12	0.000	1,211.32	0.000
1,201.02	0.000	1,206.22	0.000	1,211.42	0.000
1,201.12	0.000	1,206.32	0.000	1,211.52	0.000
1,201.22	0.000	1,206.42	0.000	1,211.62	0.000
1,201.32	0.000	1,206.52	0.000	1,211.72	0.000
1,201.42	0.000	1,206.62	0.000	1,211.82	0.000
1,201.52	0.000	1,206.72	0.000	1,211.92	0.000
1,201.62	0.000	1,206.82	0.000	1,212.02	0.000
1,201.72	0.000	1,206.92	0.000	1,212.12	0.000
1,201.82	0.000	1,207.02	0.000	1,212.22	0.000
1,201.92	0.000	1,207.12	0.000	1,212.32	0.000
1,202.02	0.000	1,207.22	0.000	1,212.42	0.000
1,202.12	0.000	1,207.32	0.000	1,212.52	0.000
1,202.22	0.000	1,207.42	0.000	1,212.62	0.000
1,202.32	0.000	1,207.52	0.000	1,212.72	0.000
1,202.42	0.000	1,207.62	0.000	1,212.82	0.000
1,202.52	0.000	1,207.72	0.000	1,212.92	0.000
1,202.62	0.000	1,207.82	0.000	1,213.02	0.000
1,202.72	0.000	1,207.92	0.000	1,213.12	0.000
1,202.82	0.000	1,208.02	0.000	1,213.22	0.000
1,202.92	0.000	1,208.12	0.000		
1,203.02	0.000	1,208.22	0.000		
1,203.12	0.000	1,208.32	0.000		
1,203.22	0.000	1,208.42	0.000		
1,203.32	0.000	1,208.52	0.000		
1,203.42	0.000	1,208.62	0.000		
1,203.52	0.000	1,208.72	0.000		
1,203.62	0.000	1,208.82	0.000		
1,203.72	0.000	1,208.92	0.000		
1,203.82	0.000	1,209.02	0.000		
1,203.92	0.000	1,209.12	0.000		
1,204.02	0.000	1,209.22	0.000		
1,204.12	0.000	1,209.32	0.000		
1,204.22	0.000	1,209.42	0.000		

IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Time span=0.00-48.00 hrs, dt=0.150 hrs, 321 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: Watershed Upstream Runoff Area=899.170 ac 0.00% Impervious Runoff Depth=5.80"
Flow Length=11,472' Slope=0.0320 '/' Tc=109.8 min CN=84 Runoff=1,807.88 cfs 434.453 af

Subcatchment3S: Watershed Runoff Area=657.980 ac 0.00% Impervious Runoff Depth=5.80"
Flow Length=7,292' Slope=0.0320 '/' Tc=76.4 min CN=84 Runoff=1,686.72 cfs 317.917 af

Pond 2P: 560th Ave Culvert Peak Elev=1,236.28' Storage=17.694 af Inflow=1,807.88 cfs 434.453 af
Primary=419.61 cfs 244.354 af Secondary=1,348.84 cfs 190.099 af Outflow=1,768.46 cfs 434.453 af

Pond 4P: Proposed Wetland Peak Elev=1,208.00' Storage=94.188 af Inflow=3,113.12 cfs 752.370 af
Outflow=2,781.19 cfs 752.363 af

Pond 9P: Existing Outlet Channel to Lake Peak Elev=1,206.95' Inflow=2,781.19 cfs 752.363 af
Outflow=2,781.19 cfs 752.363 af

Total Runoff Area = 1,557.150 ac Runoff Volume = 752.370 af Average Runoff Depth = 5.80"
100.00% Pervious = 1,557.150 ac 0.00% Impervious = 0.000 ac

IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Summary for Subcatchment 1S: Watershed Upstream of Culvert

Runoff = 1,807.88 cfs @ 13.44 hrs, Volume= 434.453 af, Depth= 5.80"
Routed to Pond 2P : 560th Ave Culvert

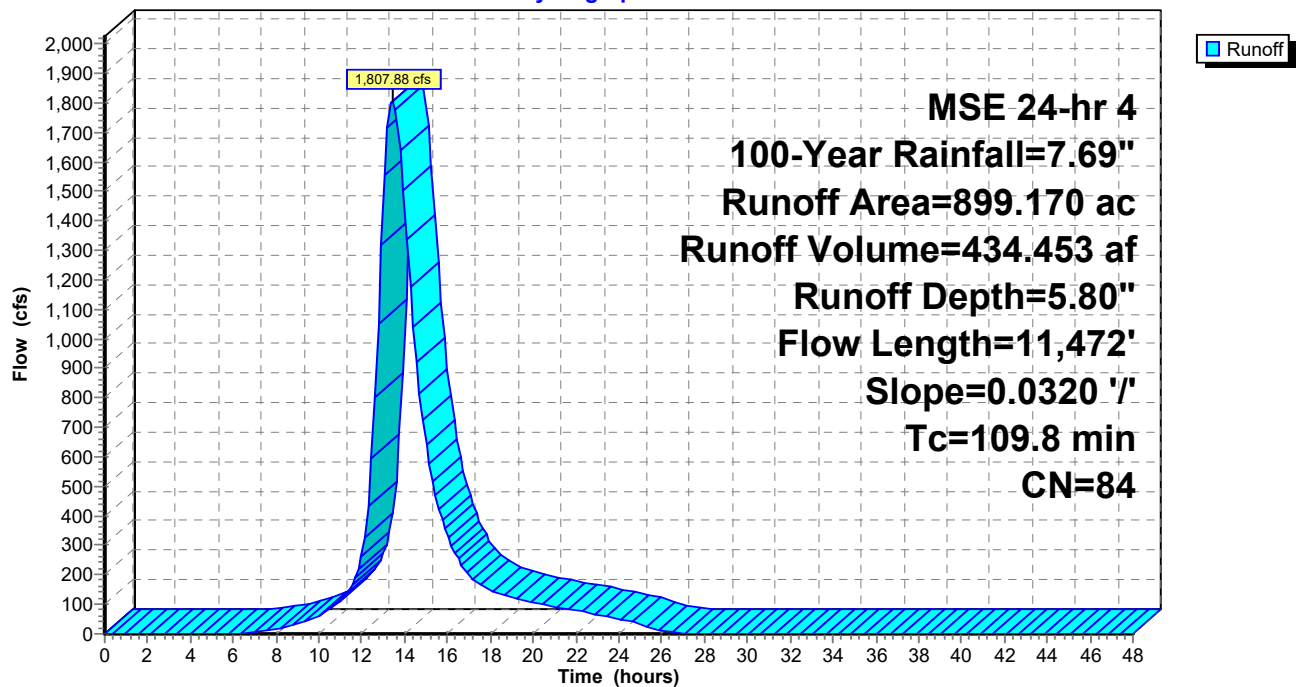
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
MSE 24-hr 4 100-Year Rainfall=7.69"

Area (ac)	CN	Description
* 899.170	84	Weighted Average
899.170		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
109.8	11,472	0.0320	1.74		Lag/CN Method, Existing Watershed Tc

Subcatchment 1S: Watershed Upstream of Culvert

Hydrograph



IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Hydrograph for Subcatchment 1S: Watershed Upstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	39.00	7.69	5.80	0.00
0.75	0.03	0.00	0.00	39.75	7.69	5.80	0.00
1.50	0.06	0.00	0.00	40.50	7.69	5.80	0.00
2.25	0.11	0.00	0.00	41.25	7.69	5.80	0.00
3.00	0.16	0.00	0.00	42.00	7.69	5.80	0.00
3.75	0.23	0.00	0.00	42.75	7.69	5.80	0.00
4.50	0.30	0.00	0.00	43.50	7.69	5.80	0.00
5.25	0.38	0.00	0.00	44.25	7.69	5.80	0.00
6.00	0.47	0.00	0.18	45.00	7.69	5.80	0.00
6.75	0.57	0.02	2.80	45.75	7.69	5.80	0.00
7.50	0.68	0.04	10.01	46.50	7.69	5.80	0.00
8.25	0.80	0.08	20.39	47.25	7.69	5.80	0.00
9.00	0.93	0.12	32.62	48.00	7.69	5.80	0.00
9.75	1.14	0.22	48.79				
10.50	1.38	0.34	81.22				
11.25	1.86	0.65	128.34				
12.00	3.60	2.03	264.23				
12.75	5.83	4.04	1,050.06				
13.50	6.31	4.49	1,802.43				
14.25	6.55	4.71	1,177.30				
15.00	6.76	4.91	642.99				
15.75	6.89	5.03	387.16				
16.50	7.01	5.15	252.72				
17.25	7.12	5.25	180.68				
18.00	7.22	5.35	145.90				
18.75	7.31	5.43	126.64				
19.50	7.39	5.51	114.05				
20.25	7.46	5.58	102.95				
21.00	7.53	5.64	92.23				
21.75	7.58	5.69	81.64				
22.50	7.63	5.74	71.05				
23.25	7.66	5.77	60.44				
24.00	7.69	5.80	49.80				
24.75	7.69	5.80	37.41				
25.50	7.69	5.80	19.32				
26.25	7.69	5.80	7.14				
27.00	7.69	5.80	2.57				
27.75	7.69	5.80	0.90				
28.50	7.69	5.80	0.29				
29.25	7.69	5.80	0.07				
30.00	7.69	5.80	0.00				
30.75	7.69	5.80	0.00				
31.50	7.69	5.80	0.00				
32.25	7.69	5.80	0.00				
33.00	7.69	5.80	0.00				
33.75	7.69	5.80	0.00				
34.50	7.69	5.80	0.00				
35.25	7.69	5.80	0.00				
36.00	7.69	5.80	0.00				
36.75	7.69	5.80	0.00				
37.50	7.69	5.80	0.00				
38.25	7.69	5.80	0.00				

IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Summary for Subcatchment 3S: Watershed Downstream of Culvert

Runoff = 1,686.72 cfs @ 13.01 hrs, Volume= 317.917 af, Depth= 5.80"

Routed to Pond 4P : Proposed Wetland Condition

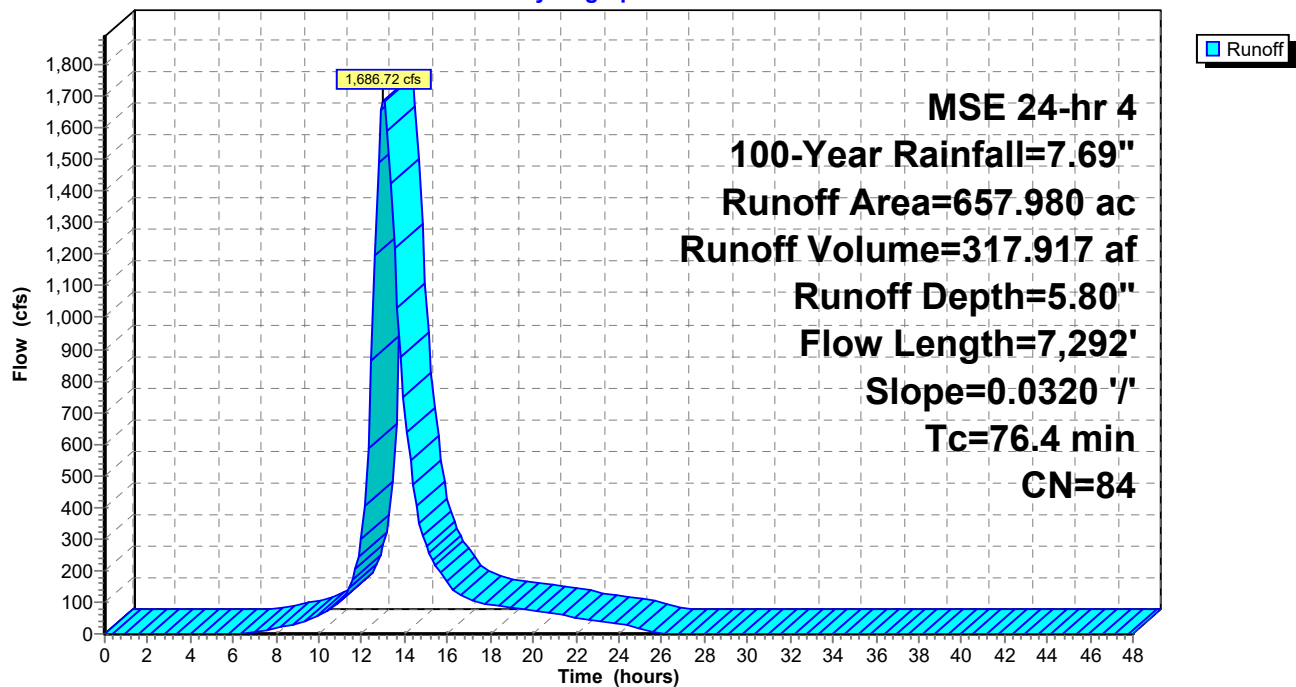
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
MSE 24-hr 4 100-Year Rainfall=7.69"

Area (ac)	CN	Description
* 657.980	84	Weighted Average
657.980		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
76.4	7,292	0.0320	1.59		Lag/CN Method,

Subcatchment 3S: Watershed Downstream of Culvert

Hydrograph



IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Hydrograph for Subcatchment 3S: Watershed Downstream of Culvert

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	39.00	7.69	5.80	0.00
0.75	0.03	0.00	0.00	39.75	7.69	5.80	0.00
1.50	0.06	0.00	0.00	40.50	7.69	5.80	0.00
2.25	0.11	0.00	0.00	41.25	7.69	5.80	0.00
3.00	0.16	0.00	0.00	42.00	7.69	5.80	0.00
3.75	0.23	0.00	0.00	42.75	7.69	5.80	0.00
4.50	0.30	0.00	0.00	43.50	7.69	5.80	0.00
5.25	0.38	0.00	0.00	44.25	7.69	5.80	0.00
6.00	0.47	0.00	0.41	45.00	7.69	5.80	0.00
6.75	0.57	0.02	4.40	45.75	7.69	5.80	0.00
7.50	0.68	0.04	11.71	46.50	7.69	5.80	0.00
8.25	0.80	0.08	20.56	47.25	7.69	5.80	0.00
9.00	0.93	0.12	30.31	48.00	7.69	5.80	0.00
9.75	1.14	0.22	46.74				
10.50	1.38	0.34	78.60				
11.25	1.86	0.65	125.62				
12.00	3.60	2.03	300.81				
12.75	5.83	4.04	1,488.87				
13.50	6.31	4.49	1,217.50				
14.25	6.55	4.71	546.42				
15.00	6.76	4.91	279.39				
15.75	6.89	5.03	186.37				
16.50	7.01	5.15	125.08				
17.25	7.12	5.25	104.17				
18.00	7.22	5.35	93.69				
18.75	7.31	5.43	85.43				
19.50	7.39	5.51	77.62				
20.25	7.46	5.58	69.92				
21.00	7.53	5.64	62.18				
21.75	7.58	5.69	54.43				
22.50	7.63	5.74	46.65				
23.25	7.66	5.77	38.87				
24.00	7.69	5.80	31.07				
24.75	7.69	5.80	19.57				
25.50	7.69	5.80	5.44				
26.25	7.69	5.80	1.25				
27.00	7.69	5.80	0.26				
27.75	7.69	5.80	0.04				
28.50	7.69	5.80	0.00				
29.25	7.69	5.80	0.00				
30.00	7.69	5.80	0.00				
30.75	7.69	5.80	0.00				
31.50	7.69	5.80	0.00				
32.25	7.69	5.80	0.00				
33.00	7.69	5.80	0.00				
33.75	7.69	5.80	0.00				
34.50	7.69	5.80	0.00				
35.25	7.69	5.80	0.00				
36.00	7.69	5.80	0.00				
36.75	7.69	5.80	0.00				
37.50	7.69	5.80	0.00				
38.25	7.69	5.80	0.00				

IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Summary for Pond 2P: 560th Ave Culvert

Inflow Area = 899.170 ac, 0.00% Impervious, Inflow Depth = 5.80" for 100-Year event
 Inflow = 1,807.88 cfs @ 13.44 hrs, Volume= 434.453 af
 Outflow = 1,768.46 cfs @ 13.61 hrs, Volume= 434.453 af, Atten= 2%, Lag= 10.0 min
 Primary = 419.61 cfs @ 13.61 hrs, Volume= 244.354 af
 Routed to Pond 4P : Proposed Wetland Condition
 Secondary = 1,348.84 cfs @ 13.61 hrs, Volume= 190.099 af
 Routed to Pond 4P : Proposed Wetland Condition

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 Peak Elev= 1,236.28' @ 13.61 hrs Surf.Area= 20.034 ac Storage= 17.694 af

Plug-Flow detention time= 4.5 min calculated for 433.099 af (100% of inflow)
 Center-of-Mass det. time= 4.5 min (887.5 - 883.1)

Volume	Invert	Avail.Storage	Storage Description
#1	1,226.00'	66.349 af	Custom Stage Data from Lidar (Prismatic) , listed below (Recalc)

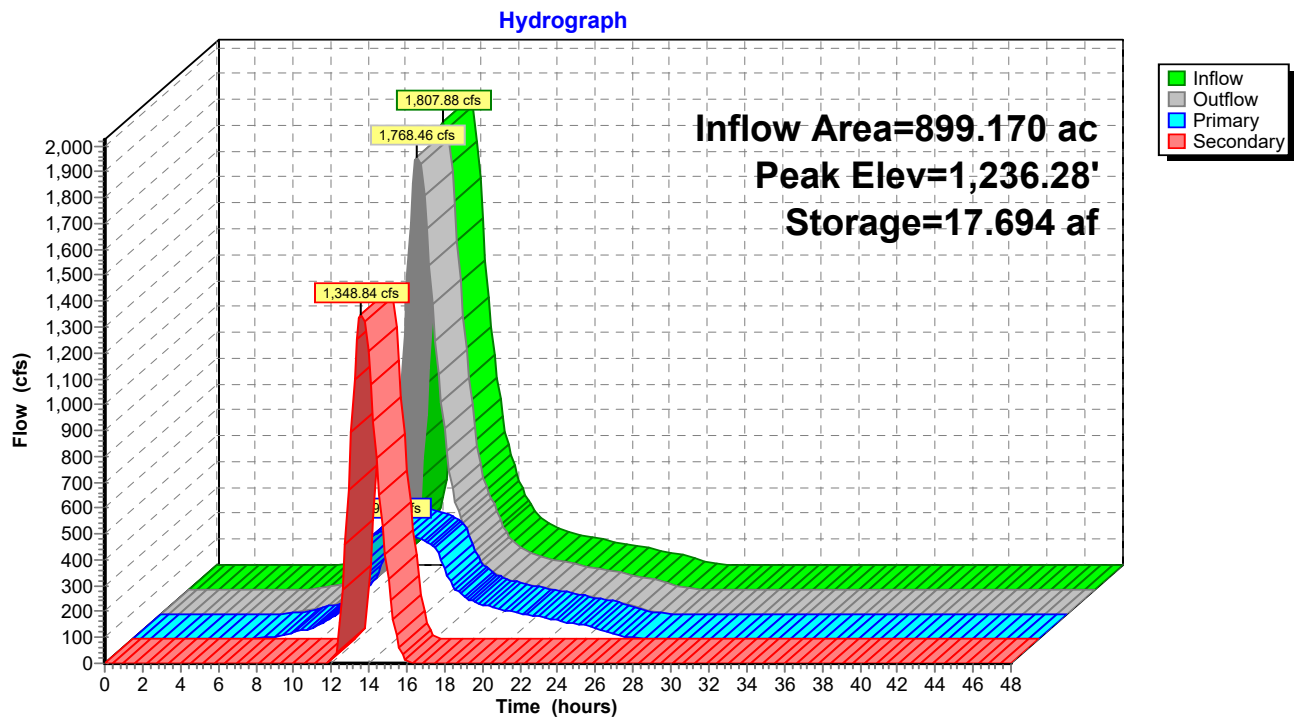
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,226.00	0.001	0.000	0.000
1,227.00	0.002	0.002	0.002
1,228.00	0.003	0.003	0.004
1,229.00	0.006	0.005	0.008
1,230.00	0.016	0.011	0.020
1,231.00	0.038	0.027	0.046
1,232.00	0.082	0.060	0.106
1,233.00	0.422	0.252	0.358
1,234.00	0.999	0.710	1.069
1,235.00	1.702	1.350	2.419
1,236.00	18.079	9.890	12.310
1,237.00	25.000	21.539	33.849
1,238.00	40.000	32.500	66.349

Device	Routing	Invert	Outlet Devices
#1	Primary	1,226.36'	72.0" W x 60.0" H Box Existing 5x6 Road Culvert L= 25.0' Box, 30-75° wingwalls, square crown, Ke= 0.400 Inlet / Outlet Invert= 1,226.36' / 1,226.36' S= 0.0000 ' / Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 30.00 sf
#2	Secondary	1,234.37'	Gravel Road - Asymmetrical Weir, C= 3.27 Offset (feet) -214.93 -167.93 -88.67 0.00 82.37 132.11 157.11 Elev. (feet) 1,237.00 1,236.27 1,235.04 1,234.37 1,235.06 1,236.20 1,237.00

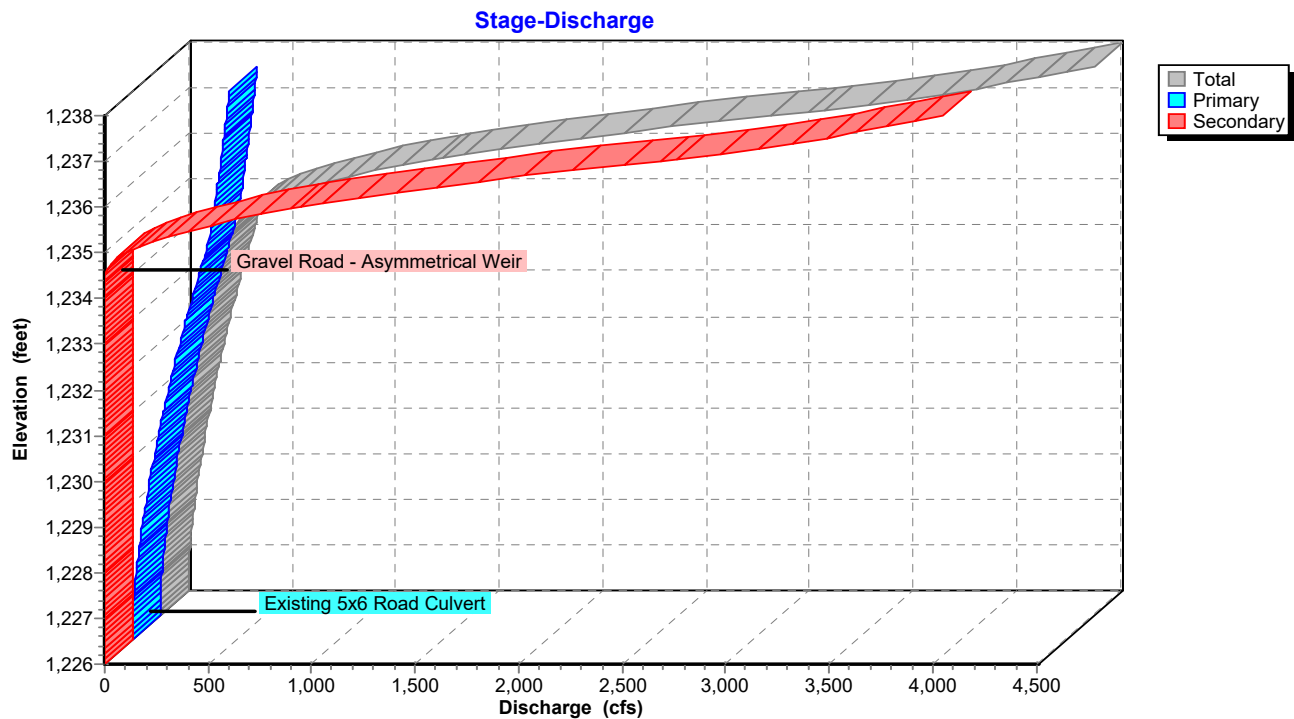
Primary OutFlow Max=419.50 cfs @ 13.61 hrs HW=1,236.28' TW=1,207.98' (Dynamic Tailwater)
 ↳ **1=Existing 5x6 Road Culvert** (Inlet Controls 419.50 cfs @ 13.98 fps)

Secondary OutFlow Max=1,342.57 cfs @ 13.61 hrs HW=1,236.28' TW=1,207.98' (Dynamic Tailwater)
 ↳ **2=Gravel Road - Asymmetrical Weir** (Weir Controls 1,342.57 cfs @ 2.77 fps)

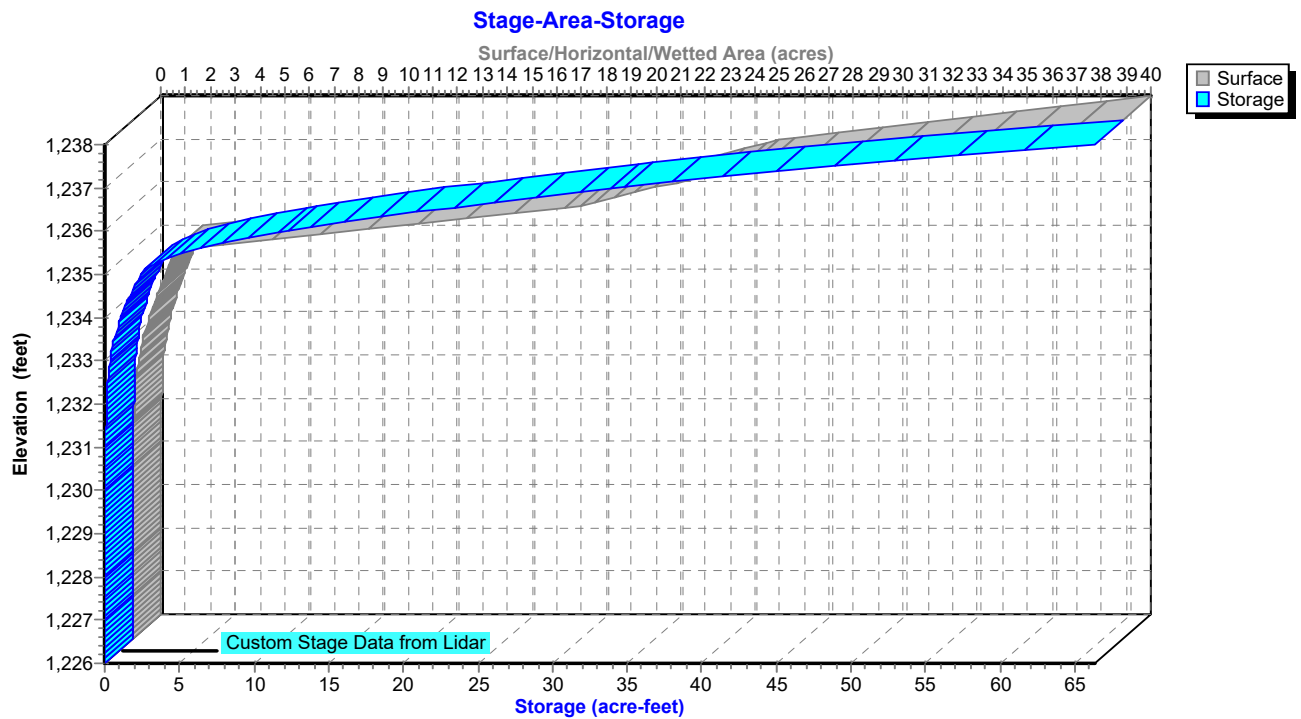
Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



Pond 2P: 560th Ave Culvert



IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Hydrograph for Pond 2P: 560th Ave Culvert

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)
0.00	0.00	0.000	1,226.00	0.00	0.00	0.00
1.50	0.00	0.000	1,226.00	0.00	0.00	0.00
3.00	0.00	0.000	1,226.00	0.00	0.00	0.00
4.50	0.00	0.000	1,226.00	0.00	0.00	0.00
6.00	0.18	0.001	1,226.45	0.19	0.19	0.00
7.50	10.01	0.002	1,227.16	10.00	10.00	0.00
9.00	32.62	0.004	1,228.07	32.61	32.61	0.00
10.50	81.22	0.012	1,229.46	81.06	81.06	0.00
12.00	264.23	0.287	1,232.82	246.40	246.40	0.00
13.50	1,802.43	17.496	1,236.27	1,753.08	419.33	1,333.75
15.00	642.99	4.257	1,235.38	719.32	392.73	326.59
16.50	252.72	0.489	1,233.26	273.94	273.94	0.00
18.00	145.90	0.044	1,230.93	146.17	146.17	0.00
19.50	114.05	0.024	1,230.24	114.13	114.13	0.00
21.00	92.23	0.016	1,229.73	92.28	92.28	0.00
22.50	71.05	0.010	1,229.20	71.09	71.09	0.00
24.00	49.80	0.006	1,228.61	49.82	49.82	0.00
25.50	19.32	0.003	1,227.58	19.35	19.35	0.00
27.00	2.57	0.001	1,226.71	2.58	2.58	0.00
28.50	0.29	0.001	1,226.47	0.29	0.29	0.00
30.00	0.00	0.000	1,226.37	0.00	0.00	0.00
31.50	0.00	0.000	1,226.36	0.00	0.00	0.00
33.00	0.00	0.000	1,226.36	0.00	0.00	0.00
34.50	0.00	0.000	1,226.36	0.00	0.00	0.00
36.00	0.00	0.000	1,226.36	0.00	0.00	0.00
37.50	0.00	0.000	1,226.36	0.00	0.00	0.00
39.00	0.00	0.000	1,226.36	0.00	0.00	0.00
40.50	0.00	0.000	1,226.36	0.00	0.00	0.00
42.00	0.00	0.000	1,226.36	0.00	0.00	0.00
43.50	0.00	0.000	1,226.36	0.00	0.00	0.00
45.00	0.00	0.000	1,226.36	0.00	0.00	0.00
46.50	0.00	0.000	1,226.36	0.00	0.00	0.00
48.00	0.00	0.000	1,226.36	0.00	0.00	0.00

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Stage-Discharge for Pond 2P: 560th Ave Culvert

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
1,226.00	0.00	0.00	0.00	1,236.40	1,958.33	422.99	1,535.35
1,226.20	0.00	0.00	0.00	1,236.60	2,310.52	428.67	1,881.85
1,226.40	0.04	0.04	0.00	1,236.80	2,699.76	434.27	2,265.49
1,226.60	1.34	1.34	0.00	1,237.00	3,126.75	439.79	2,686.95
1,226.80	3.79	3.79	0.00	1,237.20	3,481.18	445.25	3,035.93
1,227.00	7.01	7.01	0.00	1,237.40	3,776.53	450.64	3,325.89
1,227.20	10.82	10.82	0.00	1,237.60	4,041.43	455.96	3,585.47
1,227.40	15.14	15.14	0.00	1,237.80	4,285.19	461.22	3,823.97
1,227.60	19.92	19.92	0.00	1,238.00	4,512.80	466.42	4,046.38
1,227.80	25.12	25.12	0.00				
1,228.00	30.69	30.69	0.00				
1,228.20	36.63	36.63	0.00				
1,228.40	42.91	42.91	0.00				
1,228.60	49.50	49.50	0.00				
1,228.80	56.40	56.40	0.00				
1,229.00	63.59	63.59	0.00				
1,229.20	71.07	71.07	0.00				
1,229.40	78.81	78.81	0.00				
1,229.60	86.82	86.82	0.00				
1,229.80	95.08	95.08	0.00				
1,230.00	103.58	103.58	0.00				
1,230.20	112.33	112.33	0.00				
1,230.40	121.30	121.30	0.00				
1,230.60	130.51	130.51	0.00				
1,230.80	139.93	139.93	0.00				
1,231.00	149.57	149.57	0.00				
1,231.20	159.42	159.42	0.00				
1,231.40	169.48	169.48	0.00				
1,231.60	179.74	179.74	0.00				
1,231.80	190.20	190.20	0.00				
1,232.00	200.86	200.86	0.00				
1,232.20	211.71	211.71	0.00				
1,232.40	222.74	222.74	0.00				
1,232.60	233.96	233.96	0.00				
1,232.80	245.36	245.36	0.00				
1,233.00	256.95	256.95	0.00				
1,233.20	269.38	269.38	0.00				
1,233.40	283.64	283.64	0.00				
1,233.60	297.22	297.22	0.00				
1,233.80	310.20	310.20	0.00				
1,234.00	322.67	322.67	0.00				
1,234.20	334.66	334.66	0.00				
1,234.40	346.30	346.25	0.05				
1,234.60	365.81	357.46	8.35				
1,234.80	408.24	368.32	39.92				
1,235.00	482.60	378.88	103.72				
1,235.20	592.10	387.09	205.01				
1,235.40	734.23	393.31	340.92				
1,235.60	909.80	399.43	510.37				
1,235.80	1,119.19	405.46	713.74				
1,236.00	1,363.16	411.39	951.77				
1,236.20	1,642.64	417.23	1,225.41				

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Stage-Area-Storage for Pond 2P: 560th Ave Culvert

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,226.00	0.001	0.000	1,236.40	20.847	20.095
1,226.20	0.001	0.000	1,236.60	22.232	24.403
1,226.40	0.001	0.000	1,236.80	23.616	28.988
1,226.60	0.002	0.001	1,237.00	25.000	33.849
1,226.80	0.002	0.001	1,237.20	28.000	39.150
1,227.00	0.002	0.002	1,237.40	31.000	45.050
1,227.20	0.002	0.002	1,237.60	34.000	51.549
1,227.40	0.002	0.002	1,237.80	37.000	58.649
1,227.60	0.003	0.003	1,238.00	40.000	66.349
1,227.80	0.003	0.003			
1,228.00	0.003	0.004			
1,228.20	0.004	0.005			
1,228.40	0.004	0.005			
1,228.60	0.005	0.006			
1,228.80	0.005	0.007			
1,229.00	0.006	0.008			
1,229.20	0.008	0.010			
1,229.40	0.010	0.012			
1,229.60	0.012	0.014			
1,229.80	0.014	0.016			
1,230.00	0.016	0.020			
1,230.20	0.020	0.023			
1,230.40	0.025	0.028			
1,230.60	0.029	0.033			
1,230.80	0.034	0.039			
1,231.00	0.038	0.046			
1,231.20	0.047	0.055			
1,231.40	0.056	0.065			
1,231.60	0.064	0.077			
1,231.80	0.073	0.091			
1,232.00	0.082	0.106			
1,232.20	0.150	0.130			
1,232.40	0.218	0.167			
1,232.60	0.286	0.217			
1,232.80	0.354	0.281			
1,233.00	0.422	0.358			
1,233.20	0.537	0.454			
1,233.40	0.653	0.573			
1,233.60	0.768	0.716			
1,233.80	0.884	0.881			
1,234.00	0.999	1.069			
1,234.20	1.140	1.283			
1,234.40	1.280	1.525			
1,234.60	1.421	1.795			
1,234.80	1.561	2.093			
1,235.00	1.702	2.419			
1,235.20	4.977	3.087			
1,235.40	8.253	4.410			
1,235.60	11.528	6.389			
1,235.80	14.804	9.022			
1,236.00	18.079	12.310			
1,236.20	19.463	16.064			

IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Summary for Pond 4P: Proposed Wetland Condition

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 5.80" for 100-Year event
 Inflow = 3,113.12 cfs @ 13.26 hrs, Volume= 752.370 af
 Outflow = 2,781.19 cfs @ 13.59 hrs, Volume= 752.363 af, Atten= 11%, Lag= 19.7 min
 Primary = 2,781.19 cfs @ 13.59 hrs, Volume= 752.363 af
 Routed to Pond 9P : Existing Outlet Channel to Lake

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs
 Starting Elev= 1,202.20' Surf.Area= 8.200 ac Storage= 13.433 af
 Peak Elev= 1,208.00' @ 13.68 hrs Surf.Area= 20.152 ac Storage= 94.188 af (80.756 af above start)

Plug-Flow detention time= 39.7 min calculated for 736.628 af (98% of inflow)
 Center-of-Mass det. time= 22.9 min (895.5 - 872.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,199.00'	140.919 af	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
1,199.00	0.002	0.000	0.000
1,200.00	1.684	0.843	0.843
1,201.00	6.154	3.919	4.762
1,202.00	7.956	7.055	11.817
1,202.20	8.200	1.616	13.433
1,203.00	9.499	7.080	20.512
1,204.00	11.030	10.264	30.777
1,205.00	13.737	12.383	43.160
1,206.00	15.991	14.864	58.024
1,207.00	18.042	17.016	75.041
1,208.00	20.142	19.092	94.133
1,209.00	23.715	21.928	116.061
1,210.00	26.000	24.857	140.919

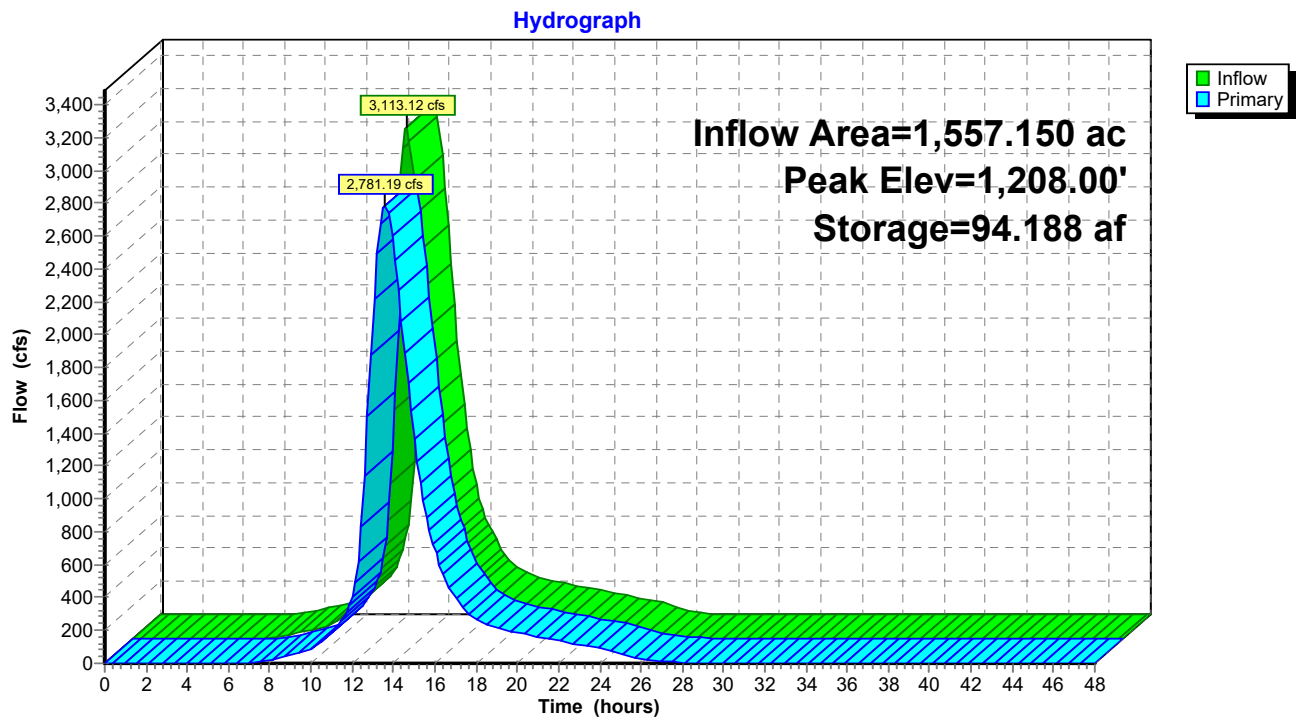
Device	Routing	Invert	Outlet Devices
#1	Primary	1,202.20'	90' Sheet Pile Weir, C= 3.27 Offset (feet) -66.60 -64.60 -56.60 -45.00 45.00 56.60 64.60 66.60 Height (feet) 6.80 5.80 5.80 0.00 0.00 5.80 5.80 6.80
#2	Primary	1,209.00'	200.0' long + 10.0 ' SideZ x 12.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.57 2.62 2.70 2.67 2.66 2.67 2.66 2.64

Primary OutFlow Max=2,723.65 cfs @ 13.59 hrs HW=1,207.97' TW=1,206.95' (Dynamic Tailwater)

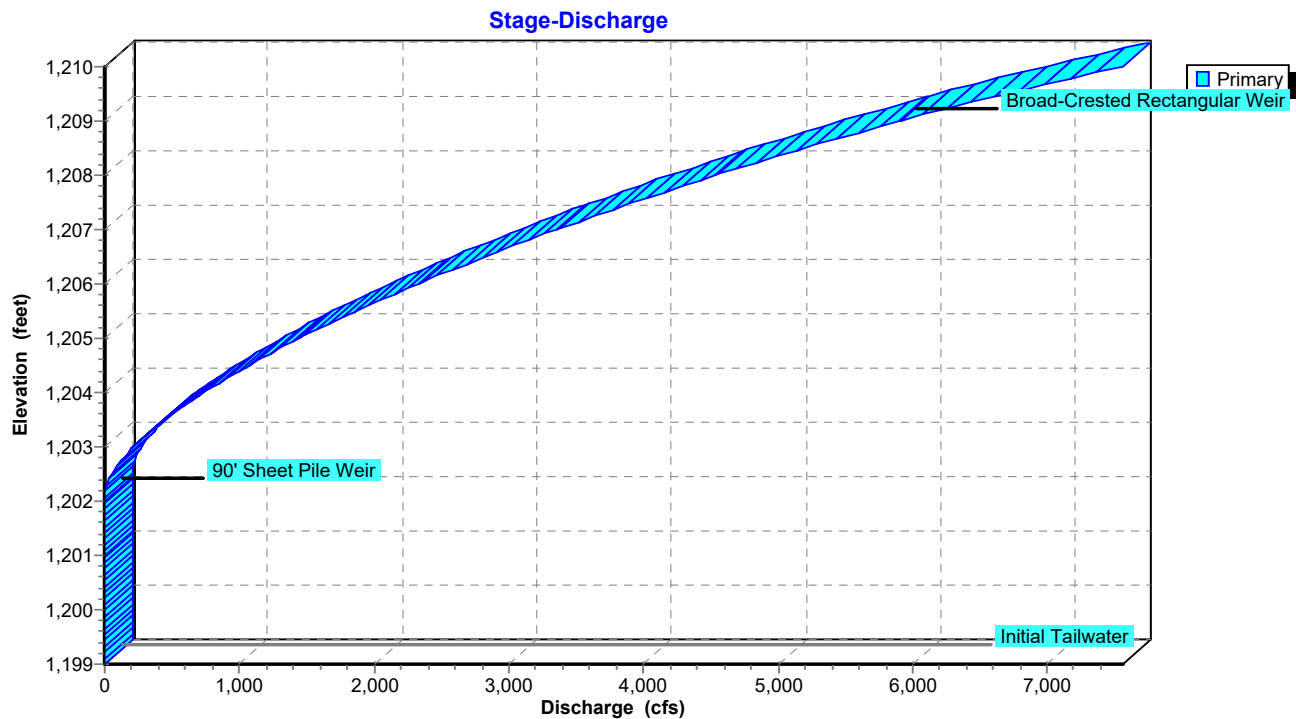
1=90' Sheet Pile Weir (Weir Controls 2,723.65 cfs @ 4.17 fps)

2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

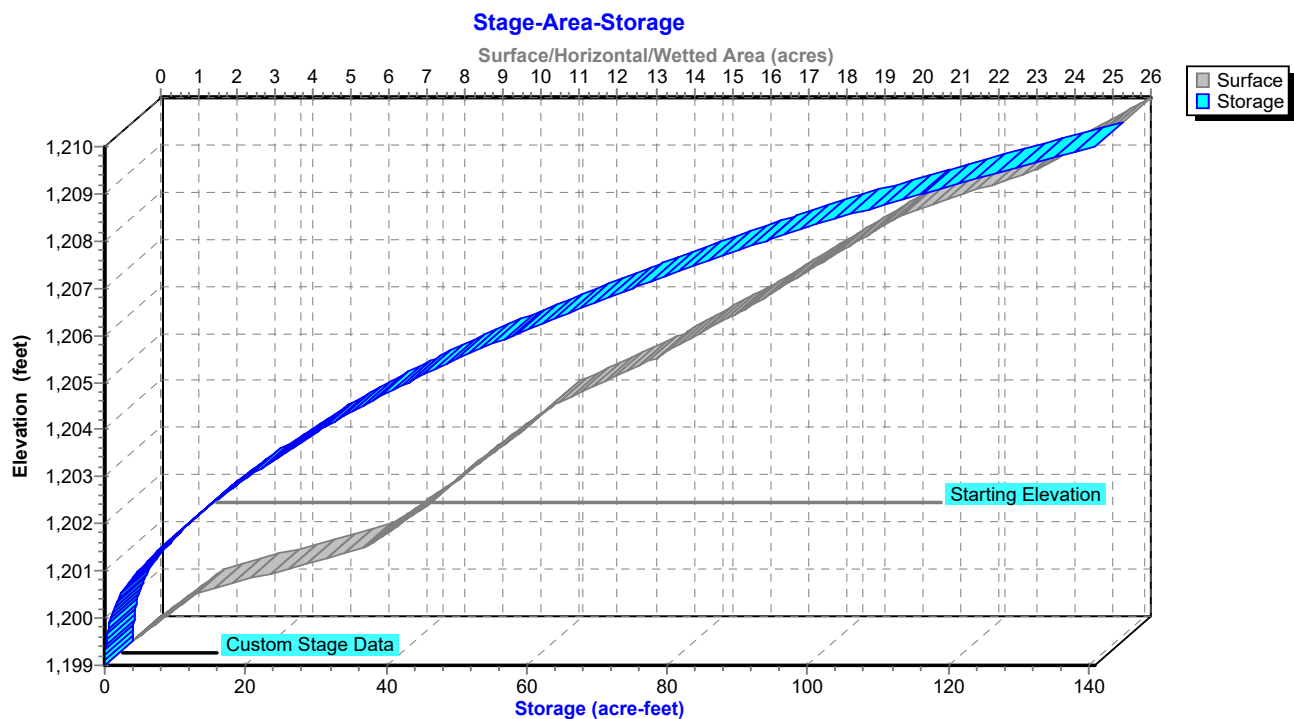
Pond 4P: Proposed Wetland Condition



Pond 4P: Proposed Wetland Condition



Pond 4P: Proposed Wetland Condition



IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Hydrograph for Pond 4P: Proposed Wetland Condition

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	13.433	1,202.20	0.00
1.50	0.00	13.433	1,202.20	0.00
3.00	0.00	13.433	1,202.20	0.00
4.50	0.00	13.433	1,202.20	0.00
6.00	0.60	13.440	1,202.20	0.01
7.50	21.72	14.230	1,202.30	8.82
9.00	62.92	15.985	1,202.50	49.15
10.50	159.67	18.446	1,202.78	130.76
12.00	547.21	25.419	1,203.50	408.25
13.50	2,970.58	92.791	1,207.93	2,769.68
15.00	998.71	58.117	1,206.01	1,369.42
16.50	399.01	30.302	1,203.96	500.87
18.00	239.86	21.923	1,203.15	267.06
19.50	191.75	20.183	1,202.97	199.71
21.00	154.46	19.256	1,202.87	161.93
22.50	117.74	18.309	1,202.76	125.65
24.00	80.89	17.286	1,202.65	89.53
25.50	24.79	15.704	1,202.47	41.44
27.00	2.84	14.266	1,202.30	9.41
28.50	0.29	13.774	1,202.24	2.49
30.00	0.00	13.600	1,202.22	0.86
31.50	0.00	13.529	1,202.21	0.38
33.00	0.00	13.495	1,202.21	0.20
34.50	0.00	13.477	1,202.21	0.12
36.00	0.00	13.465	1,202.20	0.07
37.50	0.00	13.458	1,202.20	0.05
39.00	0.00	13.452	1,202.20	0.04
40.50	0.00	13.449	1,202.20	0.03
42.00	0.00	13.446	1,202.20	0.02
43.50	0.00	13.444	1,202.20	0.01
45.00	0.00	13.442	1,202.20	0.01
46.50	0.00	13.441	1,202.20	0.01
48.00	0.00	13.440	1,202.20	0.01

IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Stage-Discharge for Pond 4P: Proposed Wetland Condition

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.00	0.00	1,204.20	862.00	1,209.40	6,524.18
1,199.10	0.00	1,204.30	929.05	1,209.50	6,690.99
1,199.20	0.00	1,204.40	997.90	1,209.60	6,862.68
1,199.30	0.00	1,204.50	1,068.53	1,209.70	7,032.81
1,199.40	0.00	1,204.60	1,140.91	1,209.80	7,205.23
1,199.50	0.00	1,204.70	1,215.03	1,209.90	7,381.56
1,199.60	0.00	1,204.80	1,290.85	1,210.00	7,560.57
1,199.70	0.00	1,204.90	1,368.35		
1,199.80	0.00	1,205.00	1,447.52		
1,199.90	0.00	1,205.10	1,528.34		
1,200.00	0.00	1,205.20	1,610.79		
1,200.10	0.00	1,205.30	1,694.85		
1,200.20	0.00	1,205.40	1,780.51		
1,200.30	0.00	1,205.50	1,867.76		
1,200.40	0.00	1,205.60	1,956.58		
1,200.50	0.00	1,205.70	2,046.95		
1,200.60	0.00	1,205.80	2,138.88		
1,200.70	0.00	1,205.90	2,232.34		
1,200.80	0.00	1,206.00	2,327.32		
1,200.90	0.00	1,206.10	2,423.82		
1,201.00	0.00	1,206.20	2,521.82		
1,201.10	0.00	1,206.30	2,621.32		
1,201.20	0.00	1,206.40	2,722.31		
1,201.30	0.00	1,206.50	2,824.78		
1,201.40	0.00	1,206.60	2,928.72		
1,201.50	0.00	1,206.70	3,034.12		
1,201.60	0.00	1,206.80	3,140.98		
1,201.70	0.00	1,206.90	3,249.29		
1,201.80	0.00	1,207.00	3,359.04		
1,201.90	0.00	1,207.10	3,470.23		
1,202.00	0.00	1,207.20	3,582.85		
1,202.10	0.00	1,207.30	3,696.90		
1,202.20	0.00	1,207.40	3,812.37		
1,202.30	9.32	1,207.50	3,929.25		
1,202.40	26.42	1,207.60	4,047.54		
1,202.50	48.62	1,207.70	4,167.24		
1,202.60	74.98	1,207.80	4,288.34		
1,202.70	104.98	1,207.90	4,410.84		
1,202.80	138.24	1,208.00	4,534.73		
1,202.90	174.51	1,208.10	4,661.66		
1,203.00	213.58	1,208.20	4,791.35		
1,203.10	255.30	1,208.30	4,923.32		
1,203.20	299.53	1,208.40	5,057.38		
1,203.30	346.17	1,208.50	5,193.44		
1,203.40	395.12	1,208.60	5,331.43		
1,203.50	446.30	1,208.70	5,471.30		
1,203.60	499.64	1,208.80	5,613.00		
1,203.70	555.08	1,208.90	5,756.51		
1,203.80	612.56	1,209.00	5,901.79		
1,203.90	672.04	1,209.10	6,051.34		
1,204.00	733.46	1,209.20	6,204.86		
1,204.10	796.80	1,209.30	6,362.52		

IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Stage-Area-Storage for Pond 4P: Proposed Wetland Condition

Elevation (feet)	Surface (acres)	Storage (acre-feet)	Elevation (feet)	Surface (acres)	Storage (acre-feet)
1,199.00	0.002	0.000	1,209.40	24.629	125.730
1,199.20	0.338	0.034	1,209.60	25.086	130.701
1,199.40	0.675	0.135	1,209.80	25.543	135.764
1,199.60	1.011	0.304	1,210.00	26.000	140.919
1,199.80	1.348	0.540			
1,200.00	1.684	0.843			
1,200.20	2.578	1.269			
1,200.40	3.472	1.874			
1,200.60	4.366	2.658			
1,200.80	5.260	3.621			
1,201.00	6.154	4.762			
1,201.20	6.514	6.029			
1,201.40	6.875	7.368			
1,201.60	7.235	8.779			
1,201.80	7.596	10.262			
1,202.00	7.956	11.817			
1,202.20	8.200	13.433			
1,202.40	8.525	15.105			
1,202.60	8.849	16.842			
1,202.80	9.174	18.645			
1,203.00	9.499	20.512			
1,203.20	9.805	22.443			
1,203.40	10.111	24.434			
1,203.60	10.418	26.487			
1,203.80	10.724	28.601			
1,204.00	11.030	30.777			
1,204.20	11.571	33.037			
1,204.40	12.113	35.405			
1,204.60	12.654	37.882			
1,204.80	13.196	40.467			
1,205.00	13.737	43.160			
1,205.20	14.188	45.953			
1,205.40	14.639	48.835			
1,205.60	15.089	51.808			
1,205.80	15.540	54.871			
1,206.00	15.991	58.024			
1,206.20	16.401	61.263			
1,206.40	16.811	64.585			
1,206.60	17.222	67.988			
1,206.80	17.632	71.473			
1,207.00	18.042	75.041			
1,207.20	18.462	78.691			
1,207.40	18.882	82.426			
1,207.60	19.302	86.244			
1,207.80	19.722	90.146			
1,208.00	20.142	94.133			
1,208.20	20.857	98.233			
1,208.40	21.571	102.475			
1,208.60	22.286	106.861			
1,208.80	23.000	111.390			
1,209.00	23.715	116.061			
1,209.20	24.172	120.850			

Summary for Pond 9P: Existing Outlet Channel to Lake

[57] Hint: Peaked at 1,206.95' (Flood elevation advised)

Inflow Area = 1,557.150 ac, 0.00% Impervious, Inflow Depth = 5.80" for 100-Year event
 Inflow = 2,781.19 cfs @ 13.59 hrs, Volume= 752.363 af
 Outflow = 2,781.19 cfs @ 13.59 hrs, Volume= 752.363 af, Atten= 0%, Lag= 0.0 min
 Primary = 2,781.19 cfs @ 13.59 hrs, Volume= 752.363 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.150 hrs

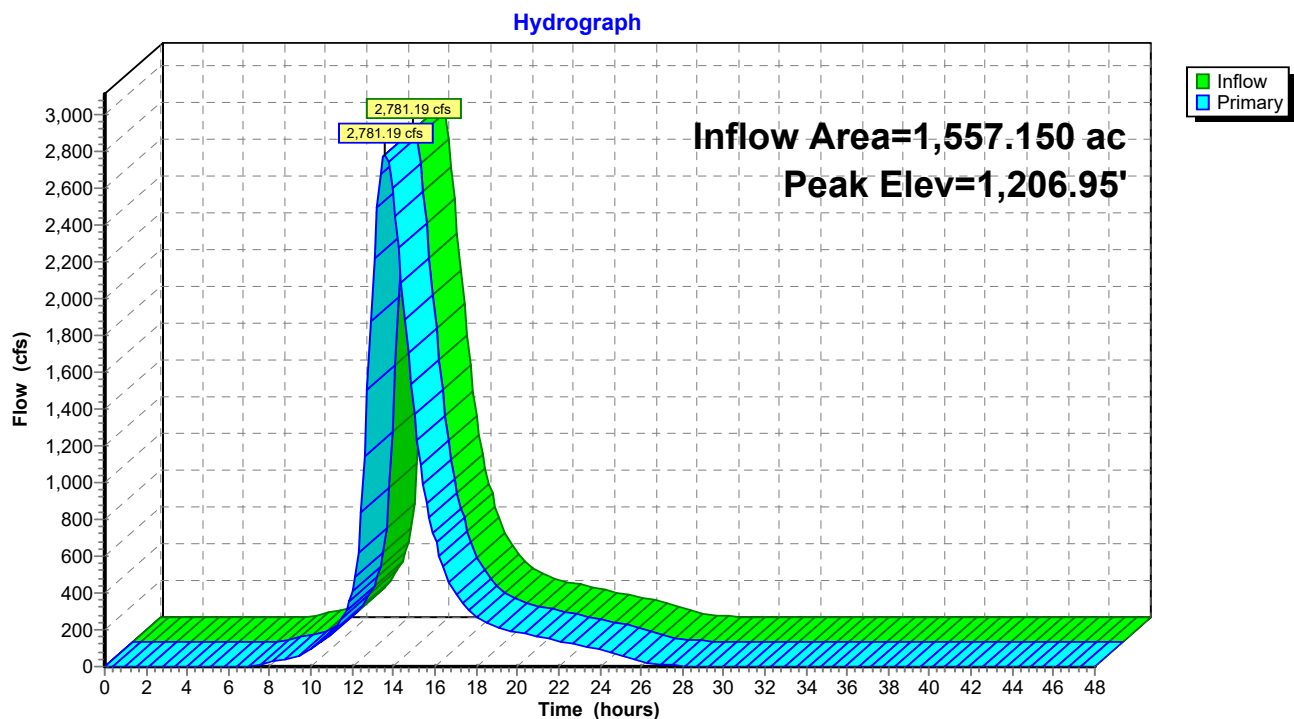
Peak Elev= 1,206.95' @ 13.59 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	1,199.12'	Existing Outlet Channel to Lake, C= 3.27 Offset (feet) -106.52 -44.01 -15.95 0.00 10.33 70.05 Elev. (feet) 1,213.23 1,204.05 1,201.65 1,199.12 1,201.69 1,213.23

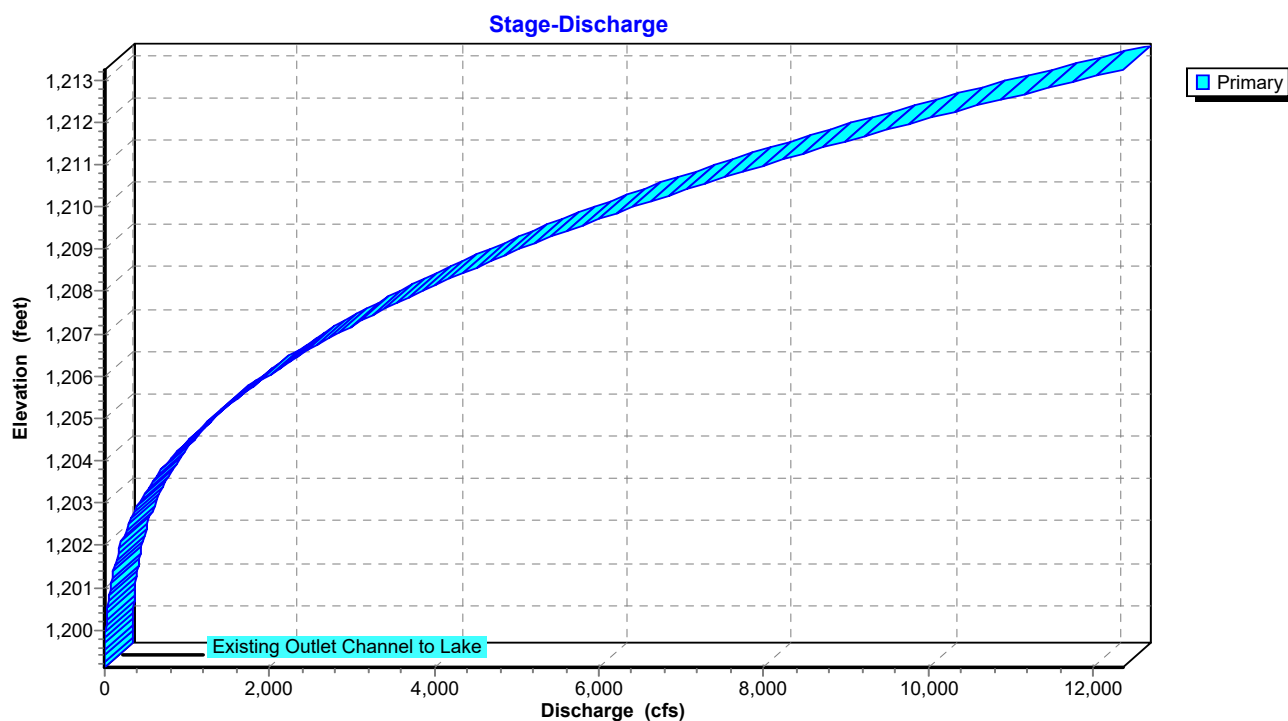
Primary OutFlow Max=2,773.06 cfs @ 13.59 hrs HW=1,206.95' (Free Discharge)

↑1=Existing Outlet Channel to Lake(Weir Controls 2,773.06 cfs @ 5.00 fps)

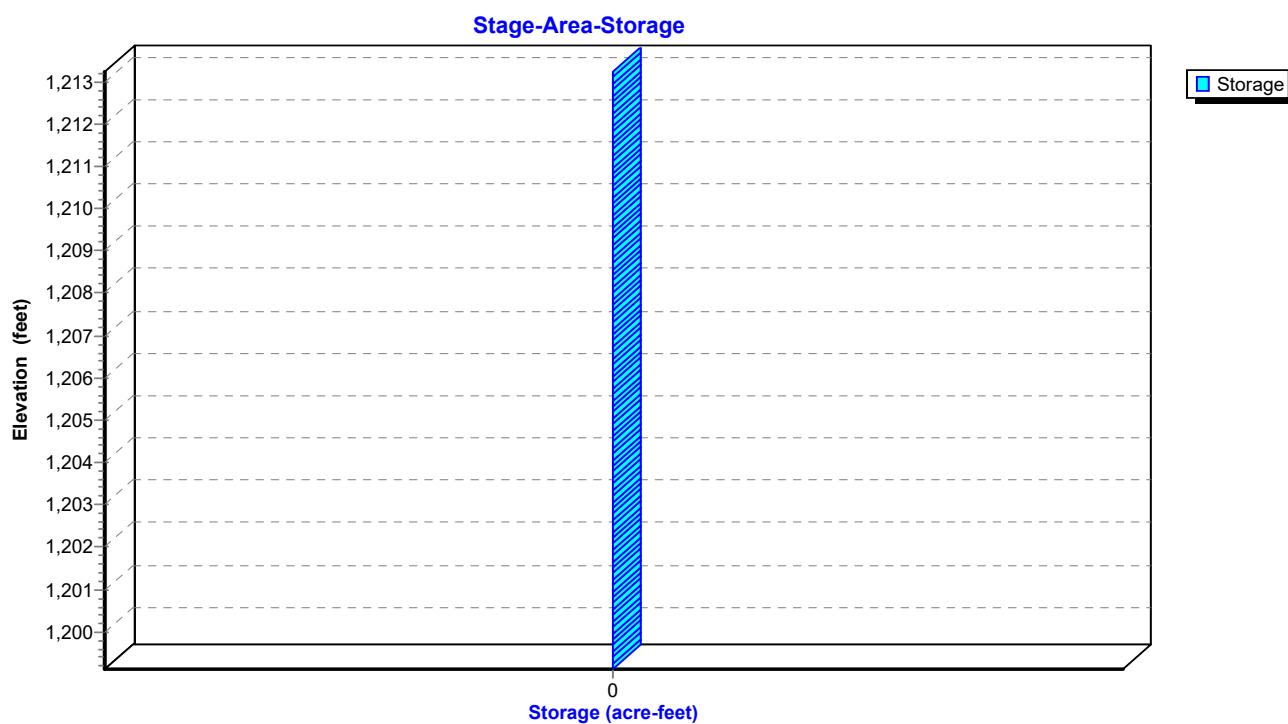
Pond 9P: Existing Outlet Channel to Lake



Pond 9P: Existing Outlet Channel to Lake



Pond 9P: Existing Outlet Channel to Lake



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Hydrograph for Pond 9P: Existing Outlet Channel to Lake

Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)	Time (hours)	Inflow (cfs)	Elevation (feet)	Primary (cfs)
0.00	0.00	1,199.12	0.00	39.00	0.04	1,199.21	0.04
0.75	0.00	1,199.12	0.00	39.75	0.03	1,199.21	0.03
1.50	0.00	1,199.12	0.00	40.50	0.03	1,199.20	0.03
2.25	0.00	1,199.12	0.00	41.25	0.02	1,199.20	0.02
3.00	0.00	1,199.12	0.00	42.00	0.02	1,199.19	0.02
3.75	0.00	1,199.12	0.00	42.75	0.02	1,199.19	0.02
4.50	0.00	1,199.12	0.00	43.50	0.01	1,199.19	0.01
5.25	0.00	1,199.12	0.00	44.25	0.01	1,199.18	0.01
6.00	0.01	1,199.17	0.01	45.00	0.01	1,199.18	0.01
6.75	1.01	1,199.47	1.01	45.75	0.01	1,199.18	0.01
7.50	8.82	1,199.96	8.82	46.50	0.01	1,199.18	0.01
8.25	26.37	1,200.43	26.37	47.25	0.01	1,199.17	0.01
9.00	49.15	1,200.80	49.15	48.00	0.01	1,199.17	0.01
9.75	76.89	1,201.13	76.89				
10.50	130.76	1,201.60	130.76				
11.25	210.55	1,202.11	210.55				
12.00	408.25	1,202.97	408.25				
12.75	1,502.05	1,205.32	1,502.05				
13.50	2,769.68	1,206.94	2,769.68				
14.25	2,275.13	1,206.37	2,275.13				
15.00	1,369.42	1,205.11	1,369.42				
15.75	808.84	1,204.06	808.84				
16.50	500.87	1,203.27	500.87				
17.25	358.55	1,202.78	358.55				
18.00	267.06	1,202.40	267.06				
18.75	224.20	1,202.19	224.20				
19.50	199.71	1,202.05	199.71				
20.25	180.36	1,201.94	180.36				
21.00	161.93	1,201.82	161.93				
21.75	143.76	1,201.70	143.76				
22.50	125.65	1,201.56	125.65				
23.25	107.56	1,201.41	107.56				
24.00	89.53	1,201.25	89.53				
24.75	69.65	1,201.05	69.65				
25.50	41.44	1,200.69	41.44				
26.25	19.92	1,200.29	19.92				
27.00	9.41	1,199.99	9.41				
27.75	4.69	1,199.77	4.69				
28.50	2.49	1,199.63	2.49				
29.25	1.42	1,199.53	1.42				
30.00	0.86	1,199.45	0.86				
30.75	0.55	1,199.40	0.55				
31.50	0.38	1,199.36	0.38				
32.25	0.27	1,199.33	0.27				
33.00	0.20	1,199.30	0.20				
33.75	0.15	1,199.28	0.15				
34.50	0.12	1,199.27	0.12				
35.25	0.09	1,199.26	0.09				
36.00	0.07	1,199.24	0.07				
36.75	0.06	1,199.23	0.06				
37.50	0.05	1,199.23	0.05				
38.25	0.04	1,199.22	0.04				

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Stage-Discharge for Pond 9P: Existing Outlet Channel to Lake

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
1,199.12	0.00	1,204.32	931.43	1,209.52	5,746.91
1,199.22	0.04	1,204.42	981.32	1,209.62	5,887.87
1,199.32	0.24	1,204.52	1,032.75	1,209.72	6,030.81
1,199.42	0.67	1,204.62	1,085.74	1,209.82	6,175.74
1,199.52	1.37	1,204.72	1,140.29	1,209.92	6,322.67
1,199.62	2.39	1,204.82	1,196.40	1,210.02	6,471.61
1,199.72	3.77	1,204.92	1,254.09	1,210.12	6,622.56
1,199.82	5.54	1,205.02	1,313.35	1,210.22	6,775.53
1,199.92	7.73	1,205.12	1,374.19	1,210.32	6,930.54
1,200.02	10.38	1,205.22	1,436.62	1,210.42	7,087.58
1,200.12	13.50	1,205.32	1,500.65	1,210.52	7,246.67
1,200.22	17.14	1,205.42	1,566.28	1,210.62	7,407.82
1,200.32	21.30	1,205.52	1,633.53	1,210.72	7,571.03
1,200.42	26.02	1,205.62	1,702.40	1,210.82	7,736.32
1,200.52	31.32	1,205.72	1,772.90	1,210.92	7,903.69
1,200.62	37.21	1,205.82	1,845.04	1,211.02	8,073.14
1,200.72	43.73	1,205.92	1,918.82	1,211.12	8,244.69
1,200.82	50.88	1,206.02	1,994.26	1,211.22	8,418.35
1,200.92	58.70	1,206.12	2,071.37	1,211.32	8,594.11
1,201.02	67.19	1,206.22	2,150.14	1,211.42	8,772.00
1,201.12	76.39	1,206.32	2,230.60	1,211.52	8,952.02
1,201.22	86.30	1,206.42	2,312.76	1,211.62	9,134.17
1,201.32	96.94	1,206.52	2,396.61	1,211.72	9,318.47
1,201.42	108.33	1,206.62	2,482.17	1,211.82	9,504.92
1,201.52	120.50	1,206.72	2,569.44	1,211.92	9,693.53
1,201.62	133.44	1,206.82	2,658.45	1,212.02	9,884.31
1,201.72	147.20	1,206.92	2,749.19	1,212.12	10,077.27
1,201.82	161.85	1,207.02	2,841.67	1,212.22	10,272.40
1,201.92	177.46	1,207.12	2,935.91	1,212.32	10,469.73
1,202.02	194.08	1,207.22	3,031.91	1,212.42	10,669.26
1,202.12	211.75	1,207.32	3,129.68	1,212.52	10,871.00
1,202.22	230.52	1,207.42	3,229.24	1,212.62	11,074.95
1,202.32	250.42	1,207.52	3,330.58	1,212.72	11,281.12
1,202.42	271.49	1,207.62	3,433.72	1,212.82	11,489.52
1,202.52	293.76	1,207.72	3,538.67	1,212.92	11,700.16
1,202.62	317.26	1,207.82	3,645.44	1,213.02	11,913.04
1,202.72	342.02	1,207.92	3,754.03	1,213.12	12,128.18
1,202.82	368.08	1,208.02	3,864.46	1,213.22	12,345.58
1,202.92	395.45	1,208.12	3,976.72		
1,203.02	424.17	1,208.22	4,090.85		
1,203.12	454.27	1,208.32	4,206.83		
1,203.22	485.77	1,208.42	4,324.68		
1,203.32	518.69	1,208.52	4,444.41		
1,203.42	553.07	1,208.62	4,566.02		
1,203.52	588.92	1,208.72	4,689.53		
1,203.62	626.27	1,208.82	4,814.95		
1,203.72	665.15	1,208.92	4,942.28		
1,203.82	705.57	1,209.02	5,071.53		
1,203.92	747.56	1,209.12	5,202.71		
1,204.02	791.15	1,209.22	5,335.83		
1,204.12	836.34	1,209.32	5,470.90		
1,204.22	883.11	1,209.42	5,607.92		

IA-340-13 - Neary - Proposed Condition - 90' Weir NWMSE 24-hr 4 100-Year Rainfall=7.69"

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Stage-Area-Storage for Pond 9P: Existing Outlet Channel to Lake

Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
1,199.12	0.000	1,204.32	0.000	1,209.52	0.000
1,199.22	0.000	1,204.42	0.000	1,209.62	0.000
1,199.32	0.000	1,204.52	0.000	1,209.72	0.000
1,199.42	0.000	1,204.62	0.000	1,209.82	0.000
1,199.52	0.000	1,204.72	0.000	1,209.92	0.000
1,199.62	0.000	1,204.82	0.000	1,210.02	0.000
1,199.72	0.000	1,204.92	0.000	1,210.12	0.000
1,199.82	0.000	1,205.02	0.000	1,210.22	0.000
1,199.92	0.000	1,205.12	0.000	1,210.32	0.000
1,200.02	0.000	1,205.22	0.000	1,210.42	0.000
1,200.12	0.000	1,205.32	0.000	1,210.52	0.000
1,200.22	0.000	1,205.42	0.000	1,210.62	0.000
1,200.32	0.000	1,205.52	0.000	1,210.72	0.000
1,200.42	0.000	1,205.62	0.000	1,210.82	0.000
1,200.52	0.000	1,205.72	0.000	1,210.92	0.000
1,200.62	0.000	1,205.82	0.000	1,211.02	0.000
1,200.72	0.000	1,205.92	0.000	1,211.12	0.000
1,200.82	0.000	1,206.02	0.000	1,211.22	0.000
1,200.92	0.000	1,206.12	0.000	1,211.32	0.000
1,201.02	0.000	1,206.22	0.000	1,211.42	0.000
1,201.12	0.000	1,206.32	0.000	1,211.52	0.000
1,201.22	0.000	1,206.42	0.000	1,211.62	0.000
1,201.32	0.000	1,206.52	0.000	1,211.72	0.000
1,201.42	0.000	1,206.62	0.000	1,211.82	0.000
1,201.52	0.000	1,206.72	0.000	1,211.92	0.000
1,201.62	0.000	1,206.82	0.000	1,212.02	0.000
1,201.72	0.000	1,206.92	0.000	1,212.12	0.000
1,201.82	0.000	1,207.02	0.000	1,212.22	0.000
1,201.92	0.000	1,207.12	0.000	1,212.32	0.000
1,202.02	0.000	1,207.22	0.000	1,212.42	0.000
1,202.12	0.000	1,207.32	0.000	1,212.52	0.000
1,202.22	0.000	1,207.42	0.000	1,212.62	0.000
1,202.32	0.000	1,207.52	0.000	1,212.72	0.000
1,202.42	0.000	1,207.62	0.000	1,212.82	0.000
1,202.52	0.000	1,207.72	0.000	1,212.92	0.000
1,202.62	0.000	1,207.82	0.000	1,213.02	0.000
1,202.72	0.000	1,207.92	0.000	1,213.12	0.000
1,202.82	0.000	1,208.02	0.000	1,213.22	0.000
1,202.92	0.000	1,208.12	0.000		
1,203.02	0.000	1,208.22	0.000		
1,203.12	0.000	1,208.32	0.000		
1,203.22	0.000	1,208.42	0.000		
1,203.32	0.000	1,208.52	0.000		
1,203.42	0.000	1,208.62	0.000		
1,203.52	0.000	1,208.72	0.000		
1,203.62	0.000	1,208.82	0.000		
1,203.72	0.000	1,208.92	0.000		
1,203.82	0.000	1,209.02	0.000		
1,203.92	0.000	1,209.12	0.000		
1,204.02	0.000	1,209.22	0.000		
1,204.12	0.000	1,209.32	0.000		
1,204.22	0.000	1,209.42	0.000		

Events for Subcatchment 1S: Watershed Upstream of Culvert

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
10-Year	4.43	867.60	206.334	2.75
25-Year	5.57	1,193.60	284.418	3.80
100-Year	7.69	1,807.88	434.453	5.80

Events for Subcatchment 3S: Watershed Downstream of Culvert

Event	Rainfall (inches)	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
10-Year	4.43	812.05	150.988	2.75
25-Year	5.57	1,115.70	208.126	3.80
100-Year	7.69	1,686.72	317.917	5.80

Events for Pond 2P: 560th Ave Culvert

Event	Inflow (cfs)	Outflow (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Storage (acre-feet)
10-Year	867.60	853.86	397.62	456.24	1,235.54	5.729
25-Year	1,193.60	1,168.68	406.74	761.94	1,235.84	9.673
100-Year	1,807.88	1,768.46	419.61	1,348.84	1,236.28	17.694

Events for Pond 4P: Proposed Wetland Condition

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
10-Year	1,519.86	1,335.18	1,205.76	54.298
25-Year	2,069.53	1,829.75	1,206.63	68.467
100-Year	3,113.12	2,781.19	1,208.00	94.188

Events for Pond 9P: Existing Outlet Channel to Lake

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (acre-feet)
10-Year	1,335.18	1,335.18	1,205.06	0.000
25-Year	1,829.75	1,829.75	1,205.80	0.000
100-Year	2,781.19	2,781.19	1,206.95	0.000

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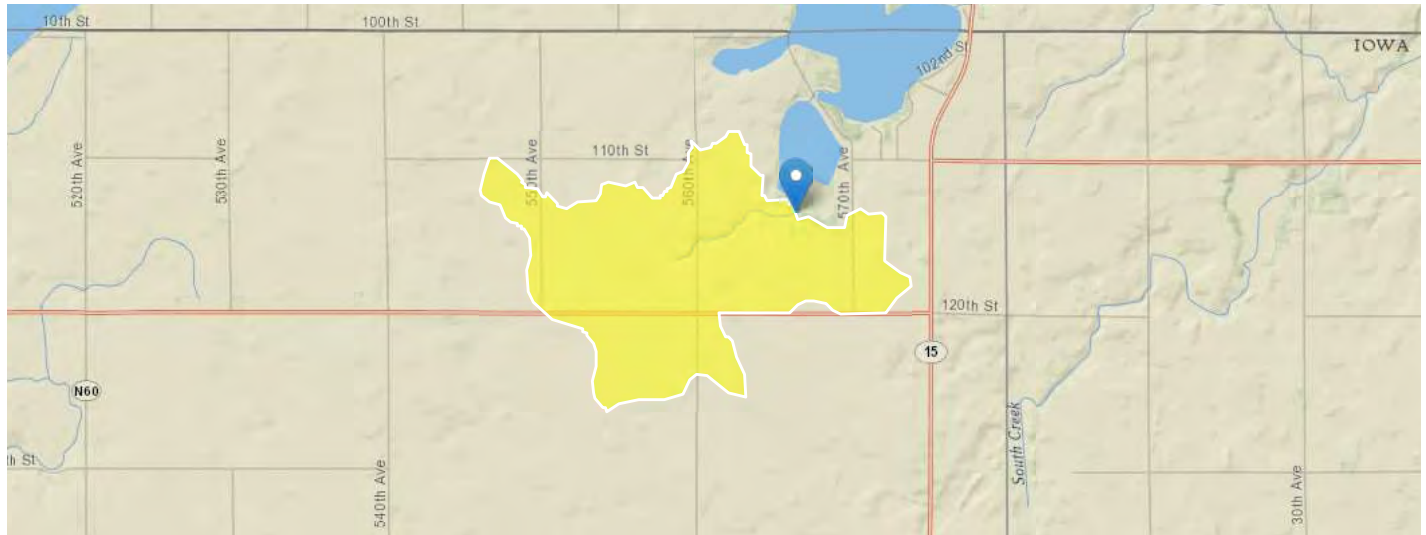
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GREAT LAKES/ATLANTIC REGION
7322 Newman Blvd., Bldg. 2
Dexter, MI 48130
(734) 623-2000
www.ducks.org

Appendix A-3
StreamStats Report

Region ID: IA
Workspace ID: IA20230125150555837000
Clicked Point (Latitude, Longitude): 43.48337, -94.46947
Time: 2023-01-25 09:06:17 -0600



➤ Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BASLENAH	Basin length from outlet to basin divide determined using the method in the ArcHydro Toolset	2.4	miles
BFI	Proportion of mean annual flow that is from ground water (base flow)	0.56355	dimensionless
BSLDEM10M	Mean basin slope computed from 10 m DEM	1.38	percent
CCM	Constant of channel maintenance computed as drainage area divided by total stream length	2.4	square mile per mile
CSL100	Longest flow path slope in feet per miles, using DEM	16.6	feet per mi
DRNAREA	Area that drains to a point on a stream	2.43	square miles
HYSEP	Median percentage of baseflow to annual streamflow	58.41	percent
I24H10Y	Maximum 24-hour precipitation that occurs on average once in 10 years	4.12	inches
LC11CRPHAY	Percentage of cultivated crops and hay, classes 81 and 82, from NLCD 2011	92.1	percent
PRECIP	Mean Annual Precipitation	30.73	inches
PRJULDEC10	Basin average mean precipitation for July to December from PRISM 1981-2010	2.72	inches
RSD	Relative stream density first defined in SIR 2012_5171	2.37	dimensionless
SSURGOA	Percentage of area of Hydrologic Soil Type A from SSURGO	4.89	percent
SSURGOB	Percentage of area of Hydrologic Soil Type B from SSURGO	95.1	percent
SSURGOC	Percentage of area of Hydrologic Soil Type C from SSURGO	0	percent
SSURGOD	Percentage of area of Hydrologic Soil Type D from SSURGO	0	percent
STREAM_VARG	Streamflow variability index as defined in WRIR 02-4068, computed from regional grid	0.66	dimensionless
STRMTOT	total length of all mapped streams (1:24,000-scale) in the basin	1.013	miles
TAU_ANN_G	Tau, Average annual base-flow recession time constant as defined in SIR 2008-5065	23.34	days

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Region 1 DA only 2015 5055]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	0.06	5464
STRMTOT	Stream Length Total	1.013	miles		

Peak-Flow Statistics Flow Report [Peak Region 1 DA only 2015 5055]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	ASEp
Drainage Area Only 50-percent AEP flood	80.4	ft ³ /s	35.4	183	51.9
Drainage Area Only 20-percent AEP flood	196	ft ³ /s	98.2	391	42.9
Drainage Area Only 10-percent AEP flood	300	ft ³ /s	151	595	42.4
Drainage Area Only 4-percent AEP flood	459	ft ³ /s	225	938	44.4
Drainage Area Only 2-percent AEP flood	593	ft ³ /s	281	1250	46.6
Drainage Area Only 1-percent AEP flood	736	ft ³ /s	337	1610	48.9
Drainage Area Only 0.5-percent AEP flood	892	ft ³ /s	392	2030	51.8
Drainage Area Only 0.2-percent AEP flood	1110	ft ³ /s	461	2670	55.8

Peak-Flow Statistics Citations

Eash, D.A., 2015, Comparisons of estimates of annual exceedance-probability discharges for small drainage basins in Iowa, based on data through water year 2013: U.S. Geological Survey Scientific Investigations Report 2015-5055, 37 p. (<http://dx.doi.org/10.3133/sir20155055>.)

➤ Low-Flow Statistics

Low-Flow Statistics Parameters [Low Flow Northwest annual 2012 5171]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	23.4	5464
BFI	Base Flow Index	0.56355	dimensionless	0.358	0.623
SSURGOA	SSURGO Percent Hydrologic Soil Type A	4.89	percent	0	7.87

Low-Flow Statistics Disclaimers [Low Flow Northwest annual 2012 5171]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Low-Flow Statistics Flow Report [Low Flow Northwest annual 2012 5171]

Statistic	Value	Unit
1 Day 10 Year Low Flow	0.00432	ft ³ /s
7 Day 10 Year Low Flow	0.00611	ft ³ /s
30 Day 10 Year Low Flow	0.0207	ft ³ /s
30 Day 5 Year Low Flow	0.0576	ft ³ /s

Low-Flow Statistics Citations

Eash, D.A., and Barnes, K.K., 2012, Methods for estimating selected low-flow frequency statistics and harmonic mean flows for streams in Iowa: U.S. Geological Survey Scientific Investigations Report 2012-5171, 99 p. (<http://pubs.usgs.gov/sir/2012/5171/>)

➤ Flow-Duration Statistics

Flow-Duration Statistics Parameters [Statewide Flow Duration 2012 5232]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	15.5	7782
SSURGO C	SSURGO Percent Hydrologic Soil Type C	0	percent	0.09	83.5
PRECIP	Mean Annual Precipitation	30.73	inches	27.7	38
RSD	Relative Stream Density	2.37	dimensionless	0.22	0.49
HYSEP	Hydrograph separation percent	58.41	percent	20.3	78
STREAM_VARG	Streamflow Variability Index from Grid	0.66	dimensionless	0.21	0.76
SSURGO B	SSURGO Percent Hydrologic Soil Type B	95.1	percent	5.7	99.4
SSURGO D	SSURGO Percent Hydrologic Soil Type D	0	percent	0	57

Flow-Duration Statistics Disclaimers [Statewide Flow Duration 2012 5232]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Flow-Duration Statistics Flow Report [Statewide Flow Duration 2012 5232]

Statistic	Value	Unit
1 Percent Duration	11	ft ³ /s
5 Percent Duration	460	ft ³ /s
10 Percent Duration	717	ft ³ /s
15 Percent Duration	1.1	ft ³ /s
20 Percent Duration	0.934	ft ³ /s
30 Percent Duration	0.745	ft ³ /s
40 Percent Duration	0.571	ft ³ /s
50 Percent Duration	0.464	ft ³ /s
60 Percent Duration	0.354	ft ³ /s
70 Percent Duration	0.226	ft ³ /s
80 Percent Duration	0.0616	ft ³ /s
85 Percent Duration	0.0386	ft ³ /s
90 Percent Duration	0.0241	ft ³ /s
95 Percent Duration	0.00894	ft ³ /s
99 Percent Duration	0.00204	ft ³ /s

Flow-Duration Statistics Citations

Linhart, S.M., Nania, J.F., Sanders, C.L., Jr., and Archfield, S.A., 2012, Computing daily mean streamflow at ungaged locations in Iowa by using the Flow Anywhere and Flow Duration Curve Transfer statistical methods: U.S. Geological Survey Scientific Investigations Report 2012–5232, 50 p. (<http://pubs.usgs.gov/sir/2012/5232/>)

➤ Seasonal Flow Statistics

Seasonal Flow Statistics Parameters [Low Flow Northwest Apr Jun 2016 5111]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	7.42	5460
SSURGO A	SSURGO Percent Hydrologic Soil Type A	4.89	percent	0.014	7.89
SSURGO D	SSURGO Percent Hydrologic Soil Type D	0	percent	0	11.4

Seasonal Flow Statistics Parameters [Low Flow Northwest Oct Dec 2016 5111]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	7.42	5460
SSURGOA	SSURGO Percent Hydrologic Soil Type A	4.89	percent	0.014	7.89
SSURGOD	SSURGO Percent Hydrologic Soil Type D	0	percent	0	11.4

Seasonal Flow Statistics Disclaimers [Low Flow Northwest Apr Jun 2016 5111]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Seasonal Flow Statistics Flow Report [Low Flow Northwest Apr Jun 2016 5111]

Statistic	Value	Unit
Apr to Jun 1 Day 10 Year Low Flow	0.0113	ft ³ /s
Apr to Jun 7 Day 10 Year Low Flow	0.0152	ft ³ /s
Apr to Jun 30 Day 10 Year Low Flow	0.0371	ft ³ /s

Seasonal Flow Statistics Disclaimers [Low Flow Northwest Oct Dec 2016 5111]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Seasonal Flow Statistics Flow Report [Low Flow Northwest Oct Dec 2016 5111]

Statistic	Value	Unit
1 Day 10 Year lowflow Oct to Dec	0.000556	ft ³ /s
7 Day 10 Year lowflow Oct to Dec	0.000782	ft ³ /s
Oct_to_Dec_30_Day_10_Year_Low_Flow	0.00223	ft ³ /s

Seasonal Flow Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Apr to Jun 1 Day 10 Year Low Flow	0.0113	ft ³ /s
Apr to Jun 7 Day 10 Year Low Flow	0.0152	ft ³ /s
Apr to Jun 30 Day 10 Year Low Flow	0.0371	ft ³ /s
1 Day 10 Year lowflow Oct to Dec	0.000556	ft ³ /s
7 Day 10 Year lowflow Oct to Dec	0.000782	ft ³ /s
Oct_to_Dec_30_Day_10_Year_Low_Flow	0.00223	ft ³ /s

Seasonal Flow Statistics Citations

Eash, D.A., Barnes, K.K., and O'Shea, P.S., 2016, Methods for estimating selected spring and fall low-flow frequency statistics for ungaged stream sites in Iowa, based on data through June 2014: U.S. Geological Survey Scientific Investigations Report 2016–5111, 32 p. (<http://dx.doi.org/10.3133/sir20165111>)

➤ General Flow Statistics

General Flow Statistics Parameters [Low Flow Northwest annual 2012 5171]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	23.4	5464
TAU_ANN_G	Tau Annual from Grid	23.34	days	21.2	35.8
RSD	Relative Stream Density	2.37	dimensionless	0.189	0.511

General Flow Statistics Disclaimers [Low Flow Northwest annual 2012 5171]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

General Flow Statistics Flow Report [Low Flow Northwest annual 2012 5171]

Statistic	Value	Unit
Harmonic Mean Streamflow	9900	ft ³ /s

General Flow Statistics Citations

Eash, D.A., and Barnes, K.K., 2012, Methods for estimating selected low-flow frequency statistics and harmonic mean flows for streams in Iowa: U.S. Geological Survey Scientific Investigations Report 2012-5171, 99 p. (<http://pubs.usgs.gov/sir/2012/5171/>)

➤ Bankfull Statistics

Bankfull Statistics Parameters [Interior Plains D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	0.19305	59927.7393

Bankfull Statistics Parameters [Central Lowland P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	0.200772	59927.66594

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.43	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Interior Plains D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	16	ft
Bieger_D_channel_depth	1.77	ft
Bieger_D_channel_cross_sectional_area	32.8	ft ²

Bankfull Statistics Flow Report [Central Lowland P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	18.3	ft
Bieger_P_channel_depth	2.15	ft
Bieger_P_channel_cross_sectional_area	31.3	ft ²

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	16.9	ft
Bieger_USA_channel_depth	1.46	ft
Bieger_USA_channel_cross_sectional_area	27.6	ft ²

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	16	ft
Bieger_D_channel_depth	1.77	ft

Statistic	Value	Unit
Bieger_D_channel_cross_sectional_area	32.8	ft^2
Bieger_P_channel_width	18.3	ft
Bieger_P_channel_depth	2.15	ft
Bieger_P_channel_cross_sectional_area	31.3	ft^2
Bieger_USA_channel_width	16.9	ft
Bieger_USA_channel_depth	1.46	ft
Bieger_USA_channel_cross_sectional_area	27.6	ft^2
<i>Bankfull Statistics Citations</i>		
Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515? utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPages)		

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Application Version: 4.12.0
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

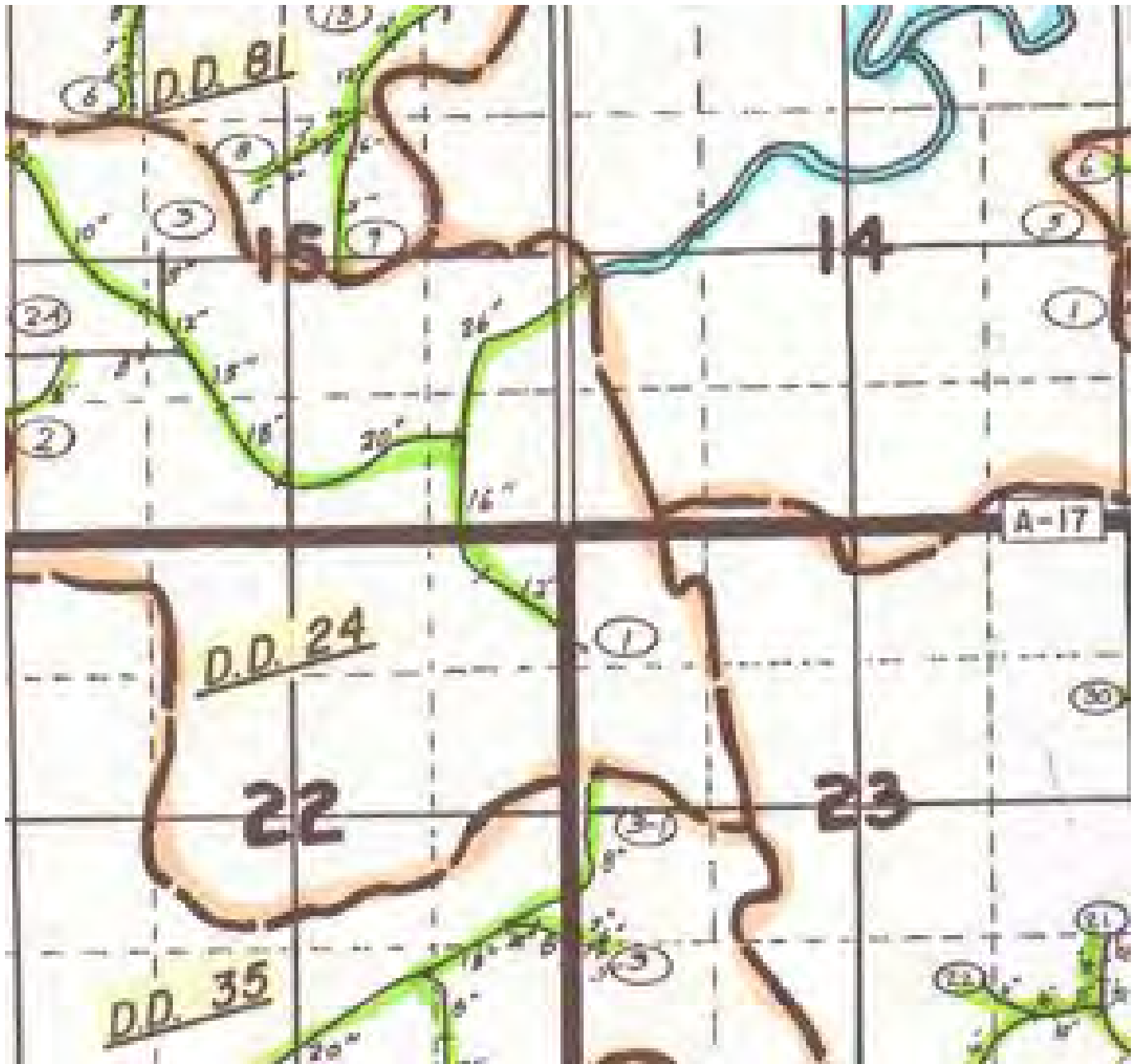


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Appendix A-4
Drainage District Map

DRAINAGE DISTRICT 22 MAP

26" TILE OUTLETS AT END OF GREEN-COLORED LINE; DRAINAGE DISTRICT 24 ENDS AT OPEN DITCH; OPEN DITCH BEGINS AT BLUE-COLORED LINE AND ROUTES TO IOWA LAKE.

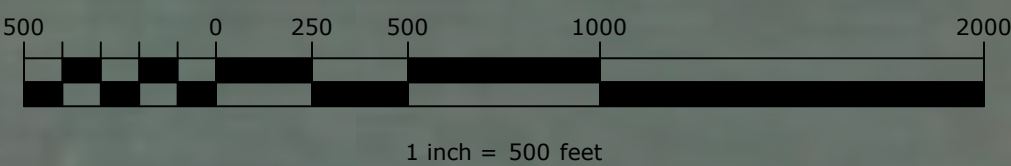




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Appendix A-5
Watershed Characteristics

- WATERSHED AREA TOTAL: 1,557.15 ACRES
- WEST SUB-WATERSHED AREA: 899.17 ACRES
- WEST SUB-WATERSHED FLOW PATH: 11,480 FT.
- EAST SUB-WATERSHED AREA: 657.98 ACRES
- EAST SUB-WATERSHED FLOW PATH: 7,292 FT.
- AVERAGE LAND SLOPE: 3.20%



AFFIX SEAL: DUCKS UNLIMITED, INC.

[illegible]

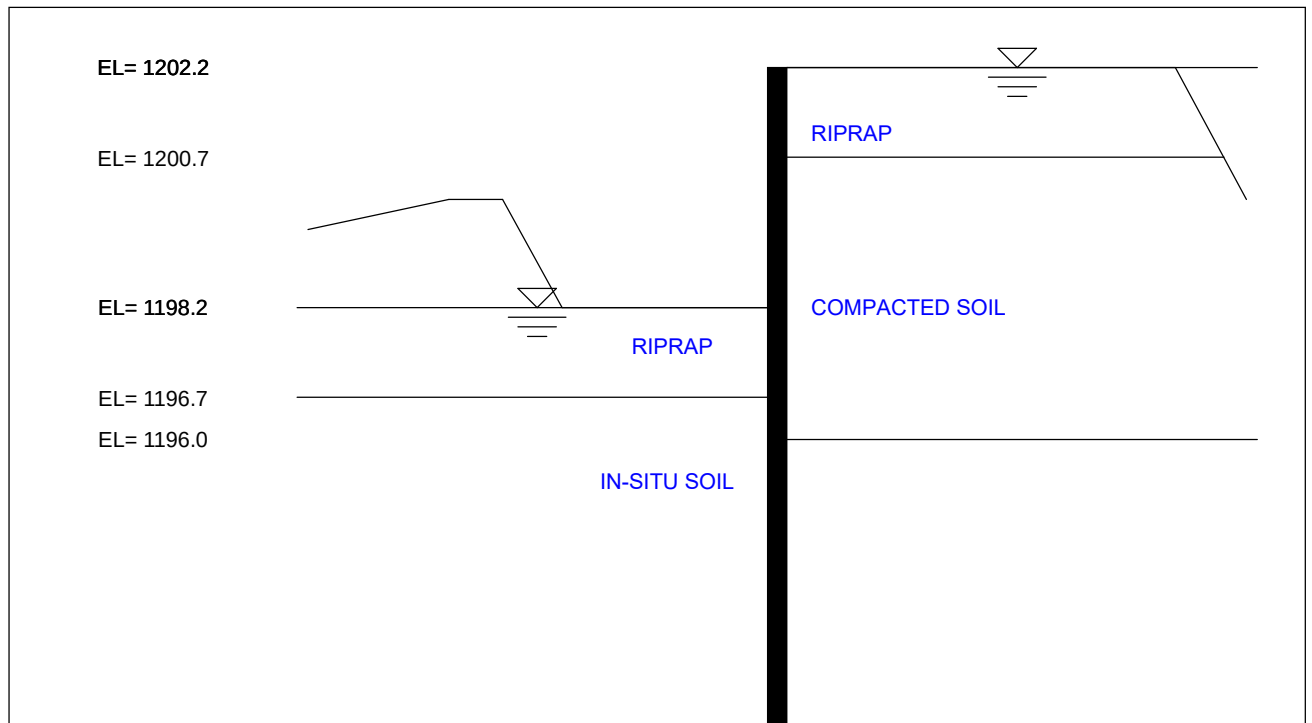
NOT FOR CONSTRUCTION



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Appendix A-6
Sheet Pile Calculations

'IA-340-13 - SHEET PILE



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 14-NOVEMBER-2024

TIME: 10:23:01

* INPUT DATA *

I.--HEADING
'IA-340-13 - SHEET PILE

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.00
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

FOR EMBEDMENT CALCULATION

III.--WALL DATA
ELEVATION AT TOP OF WALL = 1202.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE
DIST. FROM ELEVATION
WALL (FT) (FT)
0.00 1202.20
37.00 1202.20
43.60 1200.00

IV.B.--LEFTSIDE
DIST. FROM ELEVATION
WALL (FT) (FT)
0.00 1198.20
20.00 1198.20
25.50 1200.00
30.50 1200.00
43.60 1199.50

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT.	MOIST	ANGLE OF	COH-	ANGLE OF	ADH-	<--BOTTOM-->		<-SAFETY->	
WGHT.	WGHT.	INTERNAL	ESION	WALL	ESION	ELEV.	SLOPE	<-FACTOR->	
(PCF)	(PCF)	FRICTION	(PSF)	FRICTION	(PSF)	(FT)	(FT/FT)	ACT.	PASS.
140.00	140.00	10.00	0.00	0.00	0.00	1200.70	0.00	DEF	DEF
120.00	120.00	14.00	500.00	14.00	0.00	1196.00	0.00	DEF	DEF
90.00	87.00	14.00	100.00	14.00	0.00			DEF	DEF

LAYERS (TOP TO BOTTOM):
-RIPRAP
-COMPACTED SOIL
-IN-SITU SOIL

V.B.--LEFTSIDE

LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT

LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH- ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH- ESION (PSF)	<--BOTTOM--> ELEV. (FT)	<--FACTOR--> SLOPE (FT/FT)	ACT.	PASS.
140.00	140.00	10.00	0.00	0.00	0.00	1196.70	0.00	DEF	DEF
90.00	87.00	14.00	100.00	14.00	0.00			DEF	DEF

VI.--WATER DATA

UNIT WEIGHT = 62.40 (PCF)

RIGHTSIDE ELEVATION = 1202.20 (FT) ASSUMED AT FSL

LEFTSIDE ELEVATION = 1198.20 (FT) ASSUMED AT BOTTOM OF STILLING BASIN

NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS

NONE

VIII.--HORIZONTAL LOADS

NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 14-NOVEMBER-2024

TIME: 10:23:04

* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *

I.--HEADING

'IA-340-13 - SHEET PILE

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY SWEEP SEARCH WEDGE METHOD.

LEFTSIDE SOIL PRESSURES DETERMINED BY SWEEP SEARCH WEDGE METHOD.

<-----NET----->

ELEV.	NET	<---LEFTSIDE--->		(SOIL + WATER)		<---RIGHTSIDE--->	
(FT)	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
1202.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1201.2	62.4	0.0	0.0	117.0	160.5	54.6	98.1
1200.9+	83.2	0.0	0.0	83.2	658.5	0.0	575.3
1200.9-	83.2	0.0	0.0	83.2	499.4	0.0	416.2
1200.7	93.6	0.0	0.0	93.6	668.9	0.0	575.3
1200.2	124.8	0.0	0.0	124.8	1198.4	0.0	1073.6
1199.2	187.2	0.0	0.0	187.2	1417.6	0.0	1230.4
1198.2	249.6	0.0	0.0	249.6	1601.7	0.0	1352.1
1197.2	249.6	98.1	54.6	151.5	1656.5	0.0	1461.5
1196.8+	249.6	239.5	0.0	18.5	1755.6	0.0	1506.0
1196.8-	249.6	222.7	0.0	18.5	1755.6	0.0	1506.0
1196.7	249.6	239.5	0.0	10.1	1761.5	0.0	1511.9
1196.7	249.6	249.6	0.0	0.0	1765.1	0.0	1515.5
1196.2	249.6	374.9	0.0	-125.3	1809.7	0.0	1560.1
1196.0	249.6	388.6	0.0	-139.0	1678.4	0.0	1428.8
1195.2	249.6	435.3	0.0	-185.7	1131.1	0.0	881.5
1194.2	249.6	487.0	0.0	-237.4	1174.6	0.0	925.0
1193.2	249.6	536.0	0.0	-286.4	1218.9	0.0	969.3
1192.2	249.6	583.7	0.0	-334.1	1263.7	0.0	1014.1
1191.2	249.6	630.5	0.0	-380.9	1308.8	0.0	1059.2
1190.2	249.6	676.2	0.0	-426.6	1353.5	0.0	1103.9
1189.2	249.6	722.0	0.0	-472.4	1396.1	0.0	1146.5
1188.2	249.6	768.1	4.8	-518.5	1434.5	0.0	1189.7
1187.2	249.6	814.2	40.5	-564.6	1444.3	0.0	1235.2
1186.2	249.6	860.2	78.5	-610.6	1451.8	0.0	1280.7
1185.2	249.6	915.7	92.7	-666.1	1483.1	0.0	1326.2
1184.2	249.6	994.2	107.0	-744.6	1514.5	0.0	1371.9
1183.2	249.6	1072.1	121.2	-822.5	1545.9	0.0	1417.5
1182.2	249.6	1143.2	135.4	-835.5	1577.4	58.2	1463.2
1181.2	249.6	1247.1	149.6	-795.6	1608.9	201.8	1508.9
1180.2	249.6	1332.9	163.8	-788.9	1640.4	294.4	1554.6
1179.2	249.6	1425.2	177.9	-867.2	1209.4	308.4	1137.7
1178.2	249.6	1525.7	249.8	-953.6	1064.5	322.5	1064.6
1177.2	249.6	1636.5	321.2	-1050.3	1382.5	336.6	1454.1
1176.2	249.6	1732.8	333.2	-1132.5	1416.2	350.7	1499.7
1175.2	249.6	1829.9	344.4	-1215.5	1444.1	364.8	1538.9
1174.2	249.6	1954.6	356.4	-1326.1	1470.5	378.9	1577.3
1173.2	249.6	2026.8	375.2	-1384.2	1496.5	393.0	1622.1
1172.2	249.6	2080.0	393.2	-1423.2	1524.0	407.2	1667.5
1171.2	249.6	2096.5	403.8	-1425.6	1558.8	421.3	1713.0
1170.2	249.6	2071.2	414.7	-1386.2	1593.4	435.4	1758.5
1169.2	249.6	2040.3	427.3	-1341.1	1626.3	449.6	1804.0
1168.2	249.6	2028.2	445.5	-1314.8	1653.6	463.8	1849.5
1167.2	249.6	2049.1	462.3	-1319.9	1682.3	479.6	1895.0

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 14-NOVEMBER-2024

TIME: 10:23:05

* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *

I.--HEADING

'IA-340-13 - SHEET PILE

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY SWEEP SEARCH WEDGE METHOD.

LEFTSIDE SOIL PRESSURES DETERMINED BY SWEEP SEARCH WEDGE METHOD.

WALL BOTTOM ELEV. (FT)	:	1187.57	10.63' OF EMBEDMENT + 4' ABOVE GROUND
PENETRATION (FT)	:	10.63	FOR FULL PILE DEPTH = 14.63' MINIMUM
MAX. BEND. MOMENT (LB-FT)	:	3.6249E+03	
AT ELEVATION (FT)	:	1192.81	
MAX. SCALED DEFL. (LB-IN^3)	:	3.8814E+08	
AT ELEVATION (FT)	:	1202.20	

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 14-NOVEMBER-2024

TIME: 10:23:05

* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *

I.--HEADING
'IA-340-13 - SHEET PILE

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
1202.20	0.0000E+00	0.	3.8814E+08	0.00
1201.20	1.9504E+01	59.	3.4410E+08	117.03
1200.87	4.4883E+01	92.	3.2943E+08	83.20
1200.70	6.1401E+01	107.	3.2209E+08	93.60
1200.20	1.2771E+02	161.	3.0011E+08	124.80
1199.20	3.6173E+02	317.	2.5636E+08	187.20
1198.20	7.8294E+02	536.	2.1326E+08	249.60
1197.20	1.4270E+03	736.	1.7154E+08	151.48
1196.76	1.7620E+03	774.	1.5386E+08	18.50
1196.70	1.8077E+03	774.	1.5154E+08	10.14
1196.66	1.8368E+03	775.	1.5007E+08	0.00
1196.20	2.1906E+03	746.	1.3231E+08	-125.29
1196.00	2.3371E+03	719.	1.2488E+08	-139.01
1195.20	2.8631E+03	589.	9.6852E+07	-185.66
1194.20	3.3510E+03	378.	6.6313E+07	-237.44
1193.20	3.6020E+03	116.	4.1531E+07	-286.35
1192.20	3.5668E+03	-194.	2.2932E+07	-334.14
1191.20	3.1976E+03	-552.	1.0448E+07	-380.85
1190.20	2.4477E+03	-956.	3.4341E+06	-426.61
1189.82	2.0541E+03	-1121.	1.9573E+06	-443.99
1189.20	1.3065E+03	-1235.	5.9018E+05	76.08
1188.20	2.4934E+02	-740.	1.4855E+04	914.13
1187.57	0.0000E+00	0.	0.0000E+00	1440.67

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELLASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

III.--WATER AND SOIL PRESSURES

ELEVATION (FT)	WATER PRESSURE (PSF)	<-----SOIL PRESSURES----->			
		<----LEFTSIDE----->		<---RIGHTSIDE----->	
		PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
1202.20	0.	0.	0.	0.	0.
1201.20	62.	0.	0.	55.	98.
1200.87+	83.	0.	0.	0.	575.
1200.87-	83.	0.	0.	0.	416.
1200.70	94.	0.	0.	0.	575.
1200.20	125.	0.	0.	0.	1074.
1199.20	187.	0.	0.	0.	1230.
1198.20	250.	0.	0.	0.	1352.

1197.20	250.	98.	55.	0.	1462.
1196.76+	250.	239.	0.	0.	1506.
1196.76-	250.	223.	0.	0.	1506.
1196.70	250.	239.	0.	0.	1512.
1196.66	250.	250.	0.	0.	1516.
1196.20	250.	375.	0.	0.	1560.
1196.00	250.	389.	0.	0.	1429.
1195.20	250.	435.	0.	0.	882.
1194.20	250.	487.	0.	0.	925.
1193.20	250.	536.	0.	0.	969.
1192.20	250.	584.	0.	0.	1014.
1191.20	250.	630.	0.	0.	1059.
1190.20	250.	676.	0.	0.	1104.
1189.82	250.	694.	0.	0.	1120.
1189.20	250.	722.	0.	0.	1146.
1188.20	250.	768.	5.	0.	1190.
1187.57	250.	814.	40.	0.	1235.
1186.20	250.	860.	79.	0.	1281.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 14-NOVEMBER-2024

TIME: 10:45:19

* INPUT DATA *

I.--HEADING
'IA-340-13 - SHEET PILE

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.00 FOR SHEET PILE SECTION
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.00 CALCULATIONS)

III.--WALL DATA
ELEVATION AT TOP OF WALL = 1202.20 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE
DIST. FROM ELEVATION
WALL (FT) (FT)
0.00 1202.20
37.00 1202.20
43.60 1200.00

IV.B.--LEFTSIDE
DIST. FROM ELEVATION
WALL (FT) (FT)
0.00 1198.20
20.00 1198.20
25.50 1200.00
30.50 1200.00
43.60 1199.50

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF		ANGLE OF		<--BOTTOM-->		<-SAFETY->	
		INTERNAL FRICTION (DEG)	COH- ESION (PSF)	WALL FRICTION (DEG)	ADH- ESION (PSF)	ELEV. (FT)	SLOPE (FT/FT)	ACT.	PASS.
140.00	140.00	10.00	0.00	0.00	0.00	1200.70	0.00	DEF	DEF
120.00	120.00	14.00	500.00	14.00	0.00	1196.00	0.00	DEF	DEF
90.00	87.00	14.00	100.00	14.00	0.00			DEF	DEF

V.B.--LEFTSIDE

LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT

LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH- ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH- ESION (PSF)	<--BOTTOM--> ELEV. (FT)	<--FACTOR--> SLOPE (FT/FT)	ACT.	PASS.
140.00	140.00	10.00	0.00	0.00	0.00	1196.70	0.00	DEF	DEF
90.00	87.00	14.00	100.00	14.00	0.00			DEF	DEF

VI.--WATER DATA

UNIT WEIGHT = 62.40 (PCF)

RIGHTSIDE ELEVATION = 1202.20 (FT)

LEFTSIDE ELEVATION = 1198.20 (FT)

NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS

NONE

VIII.--HORIZONTAL LOADS

NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 14-NOVEMBER-2024

TIME: 10:45:21

* SOIL PRESSURES FOR *
* CANTILEVER WALL DESIGN *

I.--HEADING

'IA-340-13 - SHEET PILE

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY SWEEP SEARCH WEDGE METHOD.

LEFTSIDE SOIL PRESSURES DETERMINED BY SWEEP SEARCH WEDGE METHOD.

<-----NET----->

ELEV.	NET	<---LEFTSIDE--->		(SOIL + WATER)		<---RIGHTSIDE--->	
(FT)	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
1202.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1201.2	62.4	0.0	0.0	117.0	172.6	54.6	110.2
1200.9+	83.2	0.0	0.0	83.2	971.2	0.0	888.0
1200.9-	83.2	0.0	0.0	83.2	711.9	0.0	628.7
1200.7	93.6	0.0	0.0	93.6	981.6	0.0	888.0
1200.2	124.8	0.0	0.0	124.8	1854.3	0.0	1729.5
1199.2	187.2	0.0	0.0	187.2	2211.9	0.0	2024.7
1198.2	249.6	0.0	0.0	249.6	2474.6	0.0	2225.0
1197.2	249.6	110.2	54.6	139.4	2586.5	0.0	2391.5
1196.9	249.6	258.4	17.2	0.0	2670.1	0.0	2437.7
1196.8+	249.6	326.6	0.0	-64.2	2708.6	0.0	2459.0
1196.8-	249.6	301.0	0.0	-64.2	2708.6	0.0	2459.0
1196.7	249.6	326.6	0.0	-77.0	2717.7	0.0	2468.1
1196.2	249.6	549.8	0.0	-300.2	2787.6	0.0	2538.0
1196.0	249.6	573.9	0.0	-324.3	2543.5	0.0	2293.9
1195.2	249.6	649.3	0.0	-399.7	1535.0	0.0	1285.4
1194.2	249.6	726.4	0.0	-476.8	1587.6	0.0	1338.0
1193.2	249.6	794.6	0.0	-545.0	1642.7	0.0	1393.1
1192.2	249.6	860.5	0.0	-610.9	1699.4	0.0	1449.8
1191.2	249.6	924.7	0.0	-675.1	1757.3	0.0	1507.7
1190.2	249.6	987.7	0.0	-738.1	1815.9	0.0	1566.3
1189.2	249.6	1047.9	0.0	-798.3	1871.5	0.0	1621.9
1188.2	249.6	1107.5	4.8	-857.9	1919.9	0.0	1675.1
1187.2	249.6	1177.2	40.5	-927.6	1940.9	0.0	1731.8
1186.2	249.6	1287.8	78.5	-1038.2	1962.3	0.0	1791.2
1185.2	249.6	1420.6	92.7	-1171.0	2007.8	0.0	1850.9
1184.2	249.6	1540.9	107.0	-1291.3	2053.3	0.0	1910.7
1183.2	249.6	1708.5	121.2	-1458.9	2099.0	0.0	1970.6
1182.2	249.6	1861.6	135.4	-1553.8	1559.2	58.2	1444.9
1181.2	249.6	2031.3	149.6	-1579.9	1447.8	201.8	1347.7
1180.2	249.6	2202.1	163.8	-1658.2	1892.4	294.4	1806.6
1179.2	249.6	2315.8	184.6	-1757.8	1921.3	308.4	1856.3
1178.2	249.6	2411.5	249.8	-1839.4	1935.2	322.5	1935.4
1177.2	249.6	2454.0	314.5	-1867.8	1930.0	336.6	1994.9
1176.2	249.6	2461.3	333.2	-1861.0	1971.0	350.7	2054.5
1175.2	249.6	2447.6	344.4	-1833.2	2019.4	364.8	2114.2
1174.2	249.6	2436.7	356.4	-1808.2	2067.1	378.9	2173.9
1173.2	249.6	2451.3	375.2	-1808.7	2108.0	393.0	2233.6
1172.2	249.6	2500.2	393.2	-1843.5	2149.8	407.2	2293.3
1171.2	249.6	2559.2	403.8	-1888.3	2198.9	421.3	2353.1
1170.2	249.6	2619.1	414.7	-1934.1	2247.9	435.4	2412.9
1169.2	249.6	2671.9	427.3	-1972.7	2295.1	449.6	2472.7
1168.2	249.6	2721.3	445.5	-2007.9	2336.7	463.8	2532.6
1167.2	249.6	2778.7	462.3	-2049.5	2379.7	479.6	2592.5

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 14-NOVEMBER-2024

TIME: 10:45:22

* SUMMARY OF RESULTS FOR *
* CANTILEVER WALL DESIGN *

I.--HEADING

'IA-340-13 - SHEET PILE

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY SWEEP SEARCH WEDGE METHOD.

LEFTSIDE SOIL PRESSURES DETERMINED BY SWEEP SEARCH WEDGE METHOD.

~~WALL BOTTOM ELEV. (FT) : 1190.61~~
~~PENETRATION (FT) : 7.50~~

MAX. BEND. MOMENT (LB-FT) : 2.7354E+03 MAXIMUM BENDING MOMENT = 2,735.4 FT-LBS.
AT ELEVATION (FT) : 1194.51

MAX. SCALED DEFL. (LB-IN^3): 1.7671E+08
AT ELEVATION (FT) : 1202.20

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS

DATE: 14-NOVEMBER-2024

TIME: 10:45:22

* COMPLETE OF RESULTS FOR *
* CANTILEVER WALL DESIGN *

I.--HEADING
'IA-340-13 - SHEET PILE

II.--RESULTS

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
1202.20	0.0000E+00	0.	1.7671E+08	0.00
1201.20	1.9504E+01	59.	1.5221E+08	117.03
1200.87	4.4883E+01	92.	1.4405E+08	83.20
1200.70	6.1401E+01	107.	1.3997E+08	93.60
1200.20	1.2771E+02	161.	1.2775E+08	124.80
1199.20	3.6173E+02	317.	1.0354E+08	187.20
1198.20	7.8294E+02	536.	7.9972E+07	249.60
1197.20	1.4250E+03	730.	5.7793E+07	139.36
1196.90	1.6495E+03	751.	5.1530E+07	0.00
1196.76	1.7538E+03	747.	4.8728E+07	-64.23
1196.70	1.7978E+03	742.	4.7555E+07	-77.03
1196.20	2.1502E+03	648.	3.8092E+07	-300.21
1196.00	2.2736E+03	586.	3.4558E+07	-324.30
1195.20	2.6304E+03	296.	2.2067E+07	-399.66
1194.20	2.7138E+03	-142.	1.0531E+07	-476.83
1193.20	2.3219E+03	-653.	3.6152E+06	-545.05
1192.43	1.6556E+03	-1091.	1.0457E+06	-595.59
1192.20	1.3883E+03	-1194.	6.3359E+05	-290.74
1191.20	2.6741E+02	-830.	1.4325E+04	1018.76
1190.61	0.0000E+00	0.	0.0000E+00	1791.93

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

MAXIMUM SHEAR = 1,194 LBS.

III.--WATER AND SOIL PRESSURES

<-----SOIL PRESSURES----->					
		<----LEFTSIDE----->		<---RIGHTSIDE----->	
ELEVATION (FT)	WATER PRESSURE (PSF)	PASSIVE (PSF)	ACTIVE (PSF)	ACTIVE (PSF)	PASSIVE (PSF)
1202.20	0.	0.	0.	0.	0.
1201.20	62.	0.	0.	55.	110.
1200.87+	83.	0.	0.	0.	888.
1200.87-	83.	0.	0.	0.	629.
1200.70	94.	0.	0.	0.	888.
1200.20	125.	0.	0.	0.	1729.
1199.20	187.	0.	0.	0.	2025.
1198.20	250.	0.	0.	0.	2225.
1197.20	250.	110.	55.	0.	2391.
1196.90	250.	258.	17.	0.	2438.
1196.76+	250.	327.	0.	0.	2459.

1196.76-	250.	301.	0.	0.	2459.
1196.70	250.	327.	0.	0.	2468.
1196.20	250.	550.	0.	0.	2538.
1196.00	250.	574.	0.	0.	2294.
1195.20	250.	649.	0.	0.	1285.
1194.20	250.	726.	0.	0.	1338.
1193.20	250.	795.	0.	0.	1393.
1192.43	250.	845.	0.	0.	1437.
1192.20	250.	861.	0.	0.	1450.
1191.20	250.	925.	0.	0.	1508.
1190.61	250.	988.	0.	0.	1566.
1189.20	250.	1048.	0.	0.	1622.

SHEET PILE DESIGN

A.S.

Maximum Bending Moment, $M_{max} = 2,735.4 \text{ ft-lbs.}$

MIN. GRADE STEEL:

Maximum Shear, $V_{max} = 1,194 \text{ lbs.}$

- STEEL GRADE: 50 KSI

- PILING TYPE: SCZ

$$S_{allow} = \frac{M_{max}}{f_b} \quad (\text{EM 1110-2-2504, 6-3})$$

↓

$$f_b = 0.5 f_y = 0.5 \times 50,000 \text{ lb/in}^2 = 25,000 \text{ lbs/in}^2$$

$$S_{allow} = \frac{2,735.4 \text{ ft-lbs./ft. wall} \times 12 \text{ in./ft.}}{25,000 \text{ lbs./in}^2} = 1.3130 \text{ in}^3/\text{ft. of wall}$$

$$A_{allow} = \frac{V_{max}}{f_v} \quad (\text{EM 1110-2-2504, 6-4})$$

SZ-22

3/8"

$$f_v = 0.33 f_y = 0.33 \times 50,000 \text{ lb/in}^2 = 16,500 \text{ lb/in}^2$$

19.3 in.³/ft.

$$A_{allow} = \frac{1,194 \text{ lbs.}}{16,500 \text{ lbs./in}^2} = 0.0724 \text{ in}^2/\text{ft. of wall}$$

$$\text{Shear Area for Z-shaped Piling, } A_v = \frac{t_w \cdot h}{w} \quad (\text{EM-1110-2-2504, 6-5})$$

USE SCZ 2IN

$$A_v = \frac{(0.375 \text{ in}) \cdot (10 \text{ in})}{\frac{28.5 \text{ in}}{12 \text{ in./ft.}}} = 1.58 \text{ in}^2/\text{ft. of wall} > 0.07 \text{ in}^2/\text{ft. of wall}$$

O.K.

$$\text{SCZ 2IN Section Modulus} = 21.43 \text{ in}^3/\text{ft} > 1.31 \text{ in}^3/\text{ft.} \quad \text{O.K.} \quad S = \frac{I}{c}$$

$$I = S \cdot c$$

SCZ 2IN OK

DESIGN GRADE: 50 KSI

MIN. MOMENT OF INERTIA:

PILING TYPE: SCZ 2IN, 0.375" THICK

$$I = 6.913 \times 5 = 34.6 \text{ in}^4$$

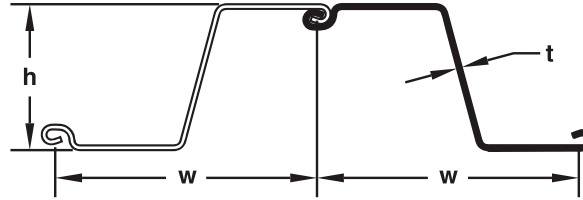
NRCs, SECTION MODULUS MIN. = 4.4 in.³/ft.

MIN. THICKNESS = 0.25 in.

NRCs, M.O.I. MIN. = 8.1 in.⁴/ft.

SCZ/SKZ

SCZ/SKZ Cold Formed Steel Sheet Pile



SECTION	Width (w) in (mm)	Height (h) in (mm)	Thickness (t) in (mm)	Cross Sectional Area in ² /ft (cm ² /m)	WEIGHT		SECTION MODULUS		Moment of Inertia in ⁴ /ft (cm ⁴ /m)	COATING AREA	
					Pile lb/ft (kg/m)	Wall lb/ft ² (kg/m ²)	Elastic in ³ /ft (cm ³ /m)	Plastic in ³ /ft (cm ³ /m)		Both Sides ft ² /ft (m ² /m)	Coating Area ft ² /ft ² (m ² /m ²)
SCZ 12	28.50 723.9	10.00 254.0	0.200 5.1	3.32 70.3	27.01 40.20	11.37 55.51	11.52 619	13.10 704	57.6 7866	6.10 1.86	1.28 1.28
SCZ 14	28.50 723.9	10.00 254.0	0.250 6.4	4.18 88.48	33.81 50.31	14.23 69.50	14.36 772	16.32 877.4	71.82 9808	6.10 1.86	1.28 1.28
SCZ 16	28.50 723.9	10.00 254.0	0.276 7.0	4.62 97.79	37.37 55.61	15.73 76.82	15.75 847	17.97 965.9	78.73 10751	6.10 1.86	1.28 1.28
SCZ 17N	28.50 723.9	10.00 254.0	0.295 7.5	4.95 104.78	40.03 59.58	16.86 82.32	16.87 907	19.21 1033	84.35 11519	6.10 1.86	1.28 1.28
SCZ 18N	28.50 723.9	10.00 254.0	0.317 8.1	5.31 112.39	42.94 63.91	18.08 88.28	18.10 973	20.61 1108	90.48 12356	6.10 1.86	1.28 1.28
SCZ 21N	28.50 723.9	10.00 254.0	0.375 9.5	6.29 133.06	50.84 75.66	21.41 104.54	21.43 1152	24.40 1312	107.13 14629	6.10 1.86	1.28 1.28
SKZ 20	28.50 723.9	16.00 406.4	0.315 8.0	6.00 127.00	48.24 71.79	20.31 99.17	31.69 1704	36.66 1970.97	253.51 34618	7.60 2.32	1.60 1.60
SKZ 22	28.50 723.9	16.00 406.4	0.335 8.5	6.30 133.35	51.30 76.34	21.60 105.46	33.43 1797	38.94 2093.55	267.40 36515	7.60 2.32	1.60 1.60
SKZ 23	28.50 723.9	16.00 406.4	0.354 9.0	6.70 141.82	54.20 80.66	22.82 111.42	35.61 1915	41.12 2210.75	284.90 38905	7.60 2.32	1.60 1.60
SKZ 24	28.50 723.9	16.00 406.4	0.375 9.5	7.10 150.28	57.43 85.47	24.18 118.06	37.73 2028	43.52 2339.78	301.80 41213	7.60 2.32	1.60 1.60
SKZ 25	28.50 723.9	16.00 406.4	0.399 10.1	7.60 160.87	61.10 90.93	25.73 125.61	40.14 2158	46.24 2486.02	321.12 43851	7.60 2.32	1.60 1.60
SKZ 31	28.50 723.9	18.00 457.2	0.450 11.4	9.07 192.04	73.82 109.85	31.08 151.75	51.56 2772	60.51 3253.29	464.05 63369	8.06 2.46	1.70 1.70
SKZ 33	28.50 723.9	18.00 457.2	0.475 12.1	9.40 198.97	77.64 115.54	32.69 159.61	54.89 2951	63.57 3417.68	494.03 67462	8.06 2.46	1.70 1.70
SKZ 34	28.50 723.9	18.00 457.2	0.500 12.7	9.89 209.25	81.42 121.17	34.28 167.38	57.62 3098	66.86 3594.60	518.62 70821	8.06 2.46	1.70 1.70
SKZ 36	28.50 723.9	18.00 457.2	0.535 13.6	10.78 228.10	86.81 129.19	36.55 178.46	60.71 3264	71.58 3848.17	546.43 74619	8.06 2.46	1.70 1.70
SKZ 38	28.50 723.9	18.00 457.2	0.550 14.0	11.07 234.42	88.95 132.37	37.45 182.85	62.32 3350	73.52 3952.44	560.85 76588	8.06 2.46	1.70 1.70

Interlock Compatibility

	SCZ 14	SCZ 16	SCZ 17N	SCZ 18N	SCZ 21N	SKZ 20	SKZ 22	SKZ 23	SKZ 24	SKZ 25	SKZ 31	SKZ 33	SKZ 34	SKZ 36	SKZ 38
SCZ 14	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SCZ 16	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SCZ 17N	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SCZ 18N	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SCZ 21N	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SKZ 20	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SKZ 22	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SKZ 23	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SKZ 24	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SKZ 25	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○
SKZ 31	○	○	○	○	○	○	○	○	○	○	●	●	●	●	●
SKZ 33	○	○	○	○	○	○	○	○	○	○	●	●	●	●	●
SKZ 34	○	○	○	○	○	○	○	○	○	○	●	●	●	●	●
SKZ 36	○	○	○	○	○	○	○	○	○	○	●	●	●	●	●
SKZ 38	○	○	○	○	○	○	○	○	○	○	●	●	●	●	●

SCZ/SKZ

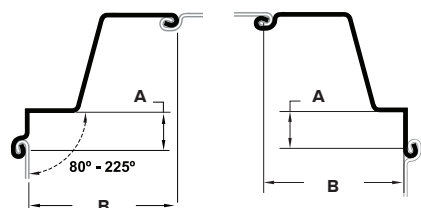
SCZ/SKZ Cold Formed Steel Sheet Pile

Available Steel Grades

ASTM	YIELD STRENGTH		ASTM	YIELD STRENGTH	
	ksi	MPa		ksi	MPa
A 572 Grade 50	50	345	A 588	50	345
A 572 Grade 55	55	380	A 690 Grade 50	50	345
A 572 Grade 60	60	415	A 690 Grade 60	60	415
A 572 Grade 65	65	450			

Highlighted fields represent the most commonly used and readily available steel grades.

Corner Piles



B2 Corner Pile

A: 5.0"
127 mm
B: 23.5"
596.9 mm

B3 Corner Pile

A: 5.0"
127 mm
B: 23.5"
596.9 mm



SKLC 90*

Gr: S 355 GP / Gr. 60
Wt: 8.50 lb/ft (12.6 kg/m)
A: 4.09" (103.9 mm)
B: 1.10" (27.9 mm)
C: 2.05" (52.1 mm)

* SKLC 90 only compatible with
SCZ 14-21N / SKZ 20-25.

Delivery Conditions & Tolerances

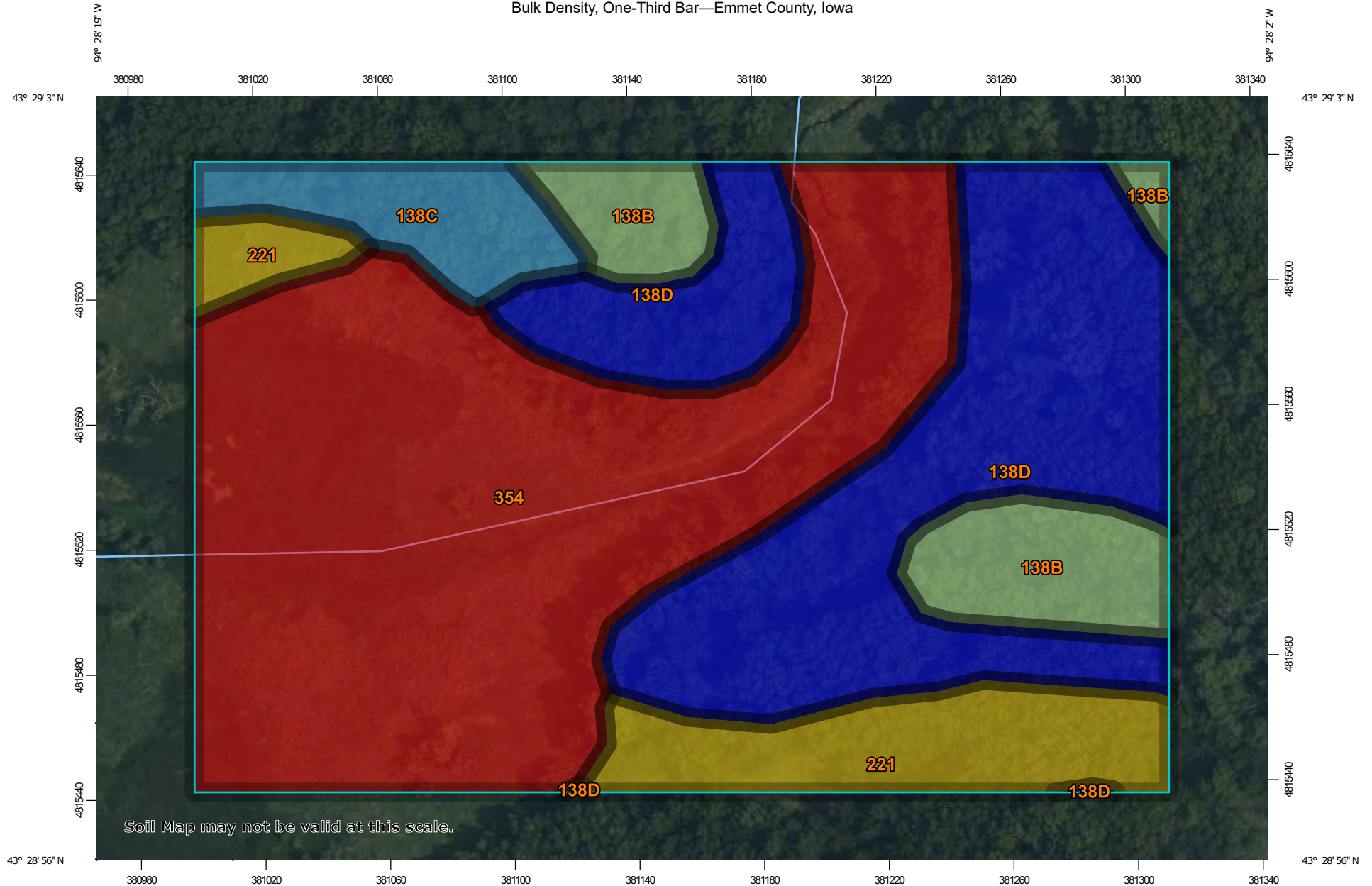
	ASTM A6		EN 10249-2	
Mass	± 2.5%		± 7%	
Length	+ 5 inches	- 0 inches	± 50 mm	
Straightness				
Bending (S)			0.25% of the length	
Curving (C)			0.25% of the length	
Twisting (V)			2% of the length	

Maximum Rolled Lengths*

SCZ/SKZ 90 ft. 27.4 m

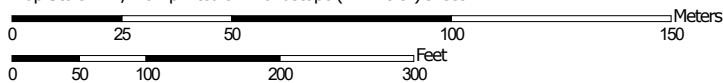
* Longer lengths may be possible upon request.

Bulk Density, One-Third Bar—Emmet County, Iowa



Soil Map may not be valid at this scale.

Map Scale: 1:1,720 if printed on A landscape (11" x 8.5") sheet.



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



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

11/14/2024
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MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

-  ≤ 0.51
-  > 0.51 and ≤ 1.00
-  > 1.00 and ≤ 1.50
-  > 1.50 and ≤ 1.51
-  > 1.51 and ≤ 1.55
-  Not rated or not available

Soil Rating Lines

-  ≤ 0.51
-  > 0.51 and ≤ 1.00
-  > 1.00 and ≤ 1.50
-  > 1.50 and ≤ 1.51
-  > 1.51 and ≤ 1.55
-  Not rated or not available

Soil Rating Points

-  ≤ 0.51
-  > 0.51 and ≤ 1.00
-  > 1.00 and ≤ 1.50
-  > 1.50 and ≤ 1.51
-  > 1.51 and ≤ 1.55
-  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 1:15,800.

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: Emmet County, Iowa
Survey Area Data: Version 34, Aug 29, 2024

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

Date(s) aerial images were photographed: Jul 2, 2023—Aug 8, 2023

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.

Bulk Density, One-Third Bar

Map unit symbol	Map unit name	Rating (grams per cubic centimeter)	Acres in AOI	Percent of AOI
138B	Clarion loam, 2 to 6 percent slopes	1.50	1.3	8.6%
138C	Clarion loam, 6 to 10 percent slopes	1.51	0.8	5.3%
138D	Clarion loam, 9 to 14 percent slopes	1.55	4.7	29.8%
221	Klossner muck, 0 to 1 percent slopes	1.00	1.6	10.4%
354	Aquolls, ponded	0.51 31.8 pcf	7.2	46.0%
Totals for Area of Interest			15.6	100.0%

Description

ISU Document, states Mollisols can have a dry density of 0.9 -1.3 g/cm³.
Aquolls is a suborder of Mollisols.

Bulk density, one-third bar, is the oven-dry weight of the soil material less than 2 millimeters in size per unit volume of soil at water tension of 1/3 bar, expressed in grams per cubic centimeter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: grams per cubic centimeter

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

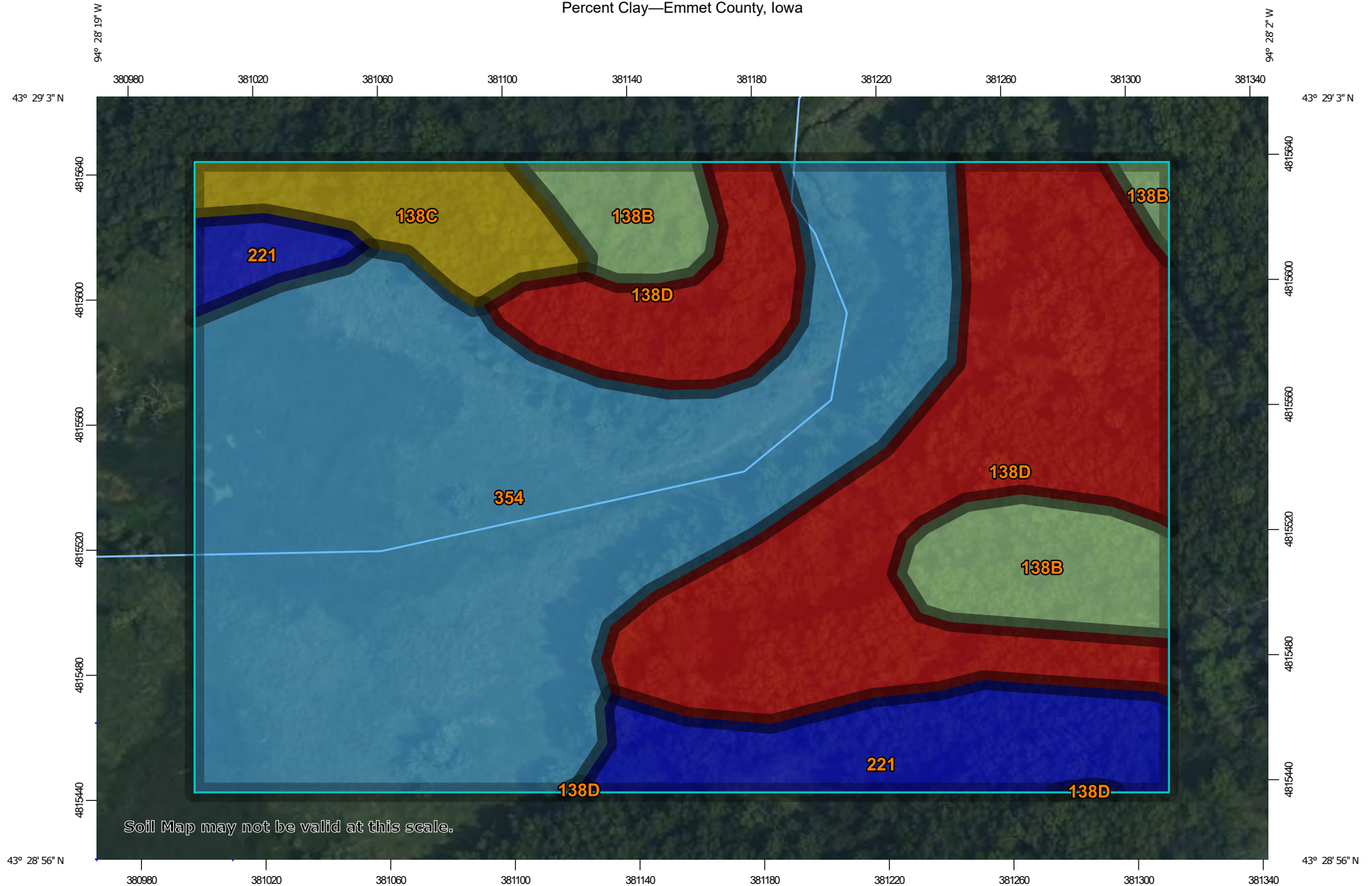
Top Depth: 0

Bottom Depth: 360

*AN AVERAGE WAS TAKEN FOR ALL ATTACHED SOURCES BEST DESCRIBING THE SOIL AT THE LOCATION OF THE SHEET PILE STRUCTURE, WHICH WOULD BE CONSIDERED A CLAYEY-SILT MATERIAL, BASED ON NRCS WEB SOIL SURVEY. THIS IS ALSO IN THE DES MOINES LOBE WHERE GLACIAL TILL IS THE DOMINANT SOIL FORMATION. AVERAGE DRY WEIGHT = 65.3 PCF
AVERAGE WET WEIGHT = 99 PCF
A FACTOR OF 1.45 WAS USED TO CONVERT THE DRY WEIGHT TO MOIST WEIGHT.
THE ADJUSTED VALUES USING A CONSERVATIVE APPROACH ARE:
AVERAGE MOIST WEIGHT = 87 PCF
AVERAGE SATURATED WEIGHT = 90 PCF

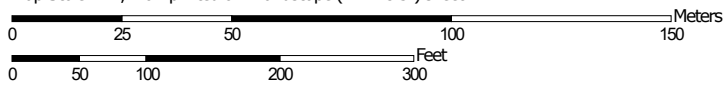
Units of Measure: Inches

Percent Clay—Emmet County, Iowa



Soil Map may not be valid at this scale.

Map Scale: 1:1,720 if printed on A landscape (11" x 8.5") sheet.



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



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

11/14/2024
Page 1 of 4

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

-  ≤ 20.9
-  > 20.9 and ≤ 22.1
-  > 22.1 and ≤ 22.3
-  > 22.3 and ≤ 28.0
-  > 28.0 and ≤ 29.2
-  Not rated or not available

Soil Rating Lines

-  ≤ 20.9
-  > 20.9 and ≤ 22.1
-  > 22.1 and ≤ 22.3
-  > 22.3 and ≤ 28.0
-  > 28.0 and ≤ 29.2
-  Not rated or not available

Soil Rating Points

-  ≤ 20.9
-  > 20.9 and ≤ 22.1
-  > 22.1 and ≤ 22.3
-  > 22.3 and ≤ 28.0
-  > 28.0 and ≤ 29.2
-  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 1:15,800.

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: Emmet County, Iowa
Survey Area Data: Version 34, Aug 29, 2024

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

Date(s) aerial images were photographed: Jul 2, 2023—Aug 8, 2023

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.

Percent Clay

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
138B	Clarion loam, 2 to 6 percent slopes	22.3	1.3	8.6%
138C	Clarion loam, 6 to 10 percent slopes	22.1	0.8	5.3%
138D	Clarion loam, 9 to 14 percent slopes	20.9	4.7	29.8%
221	Klossner muck, 0 to 1 percent slopes	29.2	1.6	10.4%
354	Aquolls, ponded	28.0	7.2	46.0%
Totals for Area of Interest			15.6	100.0%

Description

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Most of the material is in one of three groups of clay minerals or a mixture of these clay minerals. The groups are kaolinite, smectite, and hydrous mica, the best known member of which is illite.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

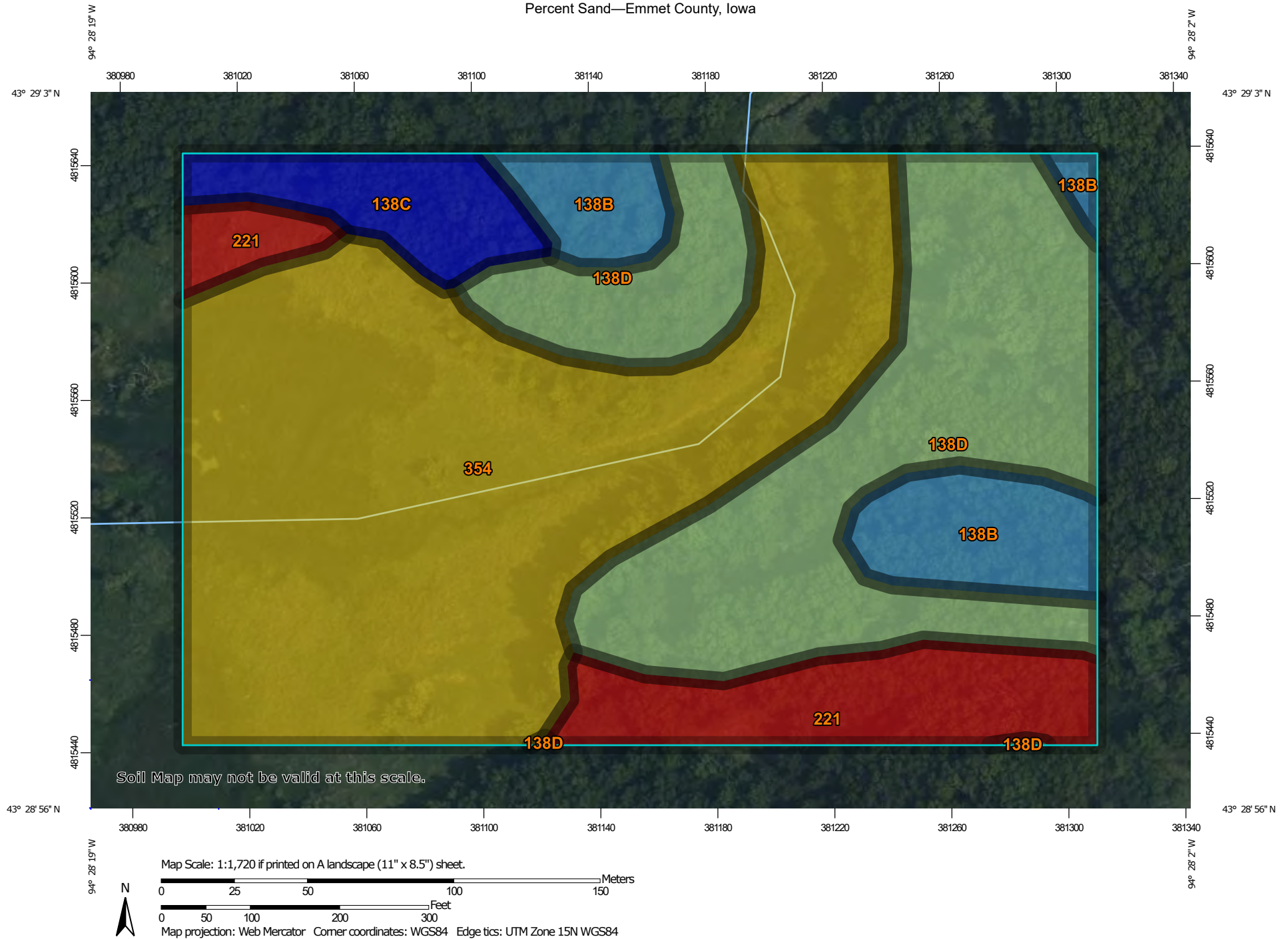
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 360

Units of Measure: Inches

Percent Sand—Emmet County, Iowa



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

-  ≤ 17.1
-  > 17.1 and ≤ 19.1
-  > 19.1 and ≤ 41.0
-  > 41.0 and ≤ 43.2
-  > 43.2 and ≤ 43.3
-  Not rated or not available

Soil Rating Lines

-  ≤ 17.1
-  > 17.1 and ≤ 19.1
-  > 19.1 and ≤ 41.0
-  > 41.0 and ≤ 43.2
-  > 43.2 and ≤ 43.3
-  Not rated or not available

Soil Rating Points

-  ≤ 17.1
-  > 17.1 and ≤ 19.1
-  > 19.1 and ≤ 41.0
-  > 41.0 and ≤ 43.2
-  > 43.2 and ≤ 43.3
-  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

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Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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Survey Area Data: Version 34, Aug 29, 2024

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

Date(s) aerial images were photographed: Jul 2, 2023—Aug 8, 2023

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Percent Sand

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
138B	Clarion loam, 2 to 6 percent slopes	43.2	1.3	8.6%
138C	Clarion loam, 6 to 10 percent slopes	43.3	0.8	5.3%
138D	Clarion loam, 9 to 14 percent slopes	41.0	4.7	29.8%
221	Klossner muck, 0 to 1 percent slopes	17.1	1.6	10.4%
354	Aquolls, ponded	19.1	7.2	46.0%
Totals for Area of Interest			15.6	100.0%

Description

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In the database, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

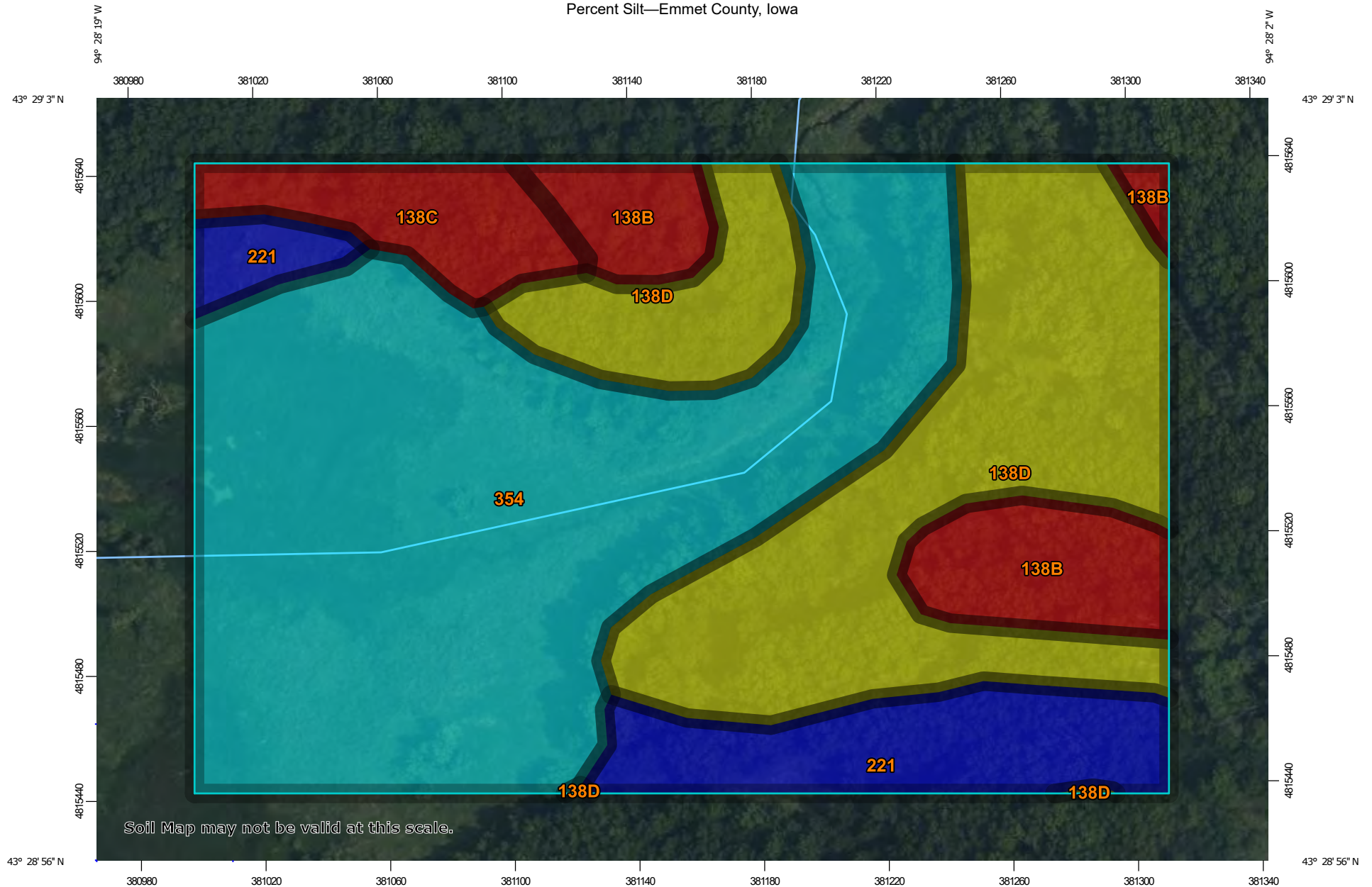
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 360

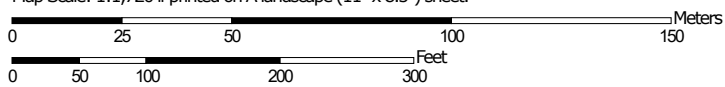
Units of Measure: Centimeters

Percent Silt—Emmet County, Iowa



Soil Map may not be valid at this scale.

Map Scale: 1:1,720 if printed on A landscape (11" x 8.5") sheet.



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



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

11/14/2024
Page 1 of 3

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 ≤ 34.6
 > 34.6 and ≤ 38.1
 > 38.1 and ≤ 52.9
 > 52.9 and ≤ 53.6
 Not rated or not available

Soil Rating Lines

 ≤ 34.6
 > 34.6 and ≤ 38.1
 > 38.1 and ≤ 52.9
 > 52.9 and ≤ 53.6
 Not rated or not available

Soil Rating Points

 ≤ 34.6
 > 34.6 and ≤ 38.1
 > 38.1 and ≤ 52.9
 > 52.9 and ≤ 53.6
 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

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Percent Silt

Map unit symbol	Map unit name	Rating (percent)	Acres in AOI	Percent of AOI
138B	Clarion loam, 2 to 6 percent slopes	34.6	1.3	8.6%
138C	Clarion loam, 6 to 10 percent slopes	34.6	0.8	5.3%
138D	Clarion loam, 9 to 14 percent slopes	38.1	4.7	29.8%
221	Klossner muck, 0 to 1 percent slopes	53.6	1.6	10.4%
354	Aquolls, ponded	52.9	7.2	46.0%
Totals for Area of Interest			15.6	100.0%

Description

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In the database, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 360

Units of Measure: Inches

Table 1: Typical unit weight values for soils in their natural state (after Peck, Hanson, and Thornburn, 1974).

soil description	dry unit weight (pcf)	wet unit weight (pcf)
uniform sand (loose)	90	118
uniform sand (dense)	109	130
well-graded sand (loose)	99	124
well-graded sand (dense)	116	135
windblown silt (loose)	85	116
glacial till	132	145
soft glacial clay	76	110
stiff glacial clay	106	129
soft slightly organic clay	58	98
soft very organic clay	43	89

Shear Strength

The shear strength of a soil can be evaluated by one of the following methods:

- Geotechnical laboratory testing.
- Correlations with in-situ field testing results.
- Correlations based on index parameters.

The laboratory test that is selected and used to evaluate the shear strength of a soil should be the method that is best suited to model the loading condition (undrained total stress or drained effective stress) and the soil response. Shear strength laboratory testing methods are described in Section [200D-1](#). The selection of peak, fully softened, or residual shear strength for design analyses should be based on review of the expected or tolerable displacements of the soil.

Undrained Cohesive: The short term, end of construction design of the project should be based on undrained (total) shear strength parameters. The undrained shear strength (S_u) of cohesive soils (clay and highly plastic silts) can be measured using unconfined compression (UC) tests, unconsolidated undrained (UU) triaxial tests, or consolidated undrained (CU) triaxial tests of undisturbed samples. Typically, the total internal friction angle (ϕ) is negligible and assumed to be zero ($\phi = 0$) in cohesive materials. However, if required for the analyses, the undrained (total) friction angle (ϕ) and cohesion components of the shear strength can be determined using appropriate laboratory testing methods.

The undrained shear strength (S_u) of cohesive soils may also be correlated to results of in-situ testing such as Standard Penetration Test (SPT), Cone Penetrometer Test (CPT), Flat Plate Penetrometer Test (CPT), Flat Plate Dilatometer Test (DMT), or Vane Shear Test (VST). For example, undrained shear strength (S_u) can be correlated to the N_{60} value obtained from the Standard Penetration Test (SPT). The undrained shear strength (S_u) can be estimated for low plasticity clays ($PI \leq 10$) and medium to high plasticity clays ($11 \leq PI \leq 40$) using the relationship developed by McGregor and Duncan, 1986, see Figure 1.

BASED ON THE INFORMATION BELOW, A CONSERVATIVE
VALUE OF 100 PSF WAS USED FOR THE COHESION OF THE
IN-SITU MATERIAL.

TABLE 6
Typical Values of Soil Index Properties

Particle Size and Gradation					Voids ⁽¹⁾					Unit Weight ⁽²⁾ (lb./cu.ft.)						
	Approximate Size Range (mm)		Approx. D ₁₀ (mm)	Approx. Range Uniform Coefficient C _u	Void Ratio			Porosity (%)		Dry Weight		Wet Weight		Submerged Weight		
	D _{max}	D _{min}			e _{max} loose	e _{cr}	e _{min} dense	D _{max} loose	D _{min} dense	Min loose	100% Mod. AASHTO	Max dense	Min loose	Max dense	Min loose	Max dense
GRANULAR MATERIALS																
Uniform Materials																
a. Equal spheres (theoretical values)	-	-	-	1.0	0.92	-	0.35	47.6	26	-	-	-	-	-	-	-
b. Standard Ottawa SAND	0.84	0.59	0.67	1.1	0.80	0.75	0.50	44	33	92	-	110	93	131	57	69
c. Clean, uniform SAND (fine or medium)	-	-	-	1.2 to 2.0	1.0	0.80	0.40	50	29	83	115	118	84	136	52	73
d. Uniform, inorganic SILT	0.05	0.005	0.012	1.2 to 2.0	1.1	-	0.40	52	29	80	-	118	81	136	51	73
Well-graded Materials																
a. Silty SAND	2.0	0.005	0.02	5 to 10	0.90	-	0.30	47	23	87	122	127	88	142	54	79
b. Clean, fine to coarse SAND	2.0	0.05	0.09	4 to 6	0.95	0.70	0.20	49	17	85	132	138	86	148	53	86
c. Micaceous SAND	-	-	-	-	1.2	-	0.40	55	29	76	-	120	77	138	48	76
d. Silty SAND & GRAVEL	100	0.005	0.02	15 to 300	0.85	-	0.14	46	12	89	-	146 ⁽³⁾	90	155 ⁽³⁾	56	92
MIXED SOILS																
Sandy or Silty CLAY	2.0	0.001	0.003	10 to 30	1.8	-	0.25	64	20	60	130	135	100	147	38	85
Skip-graded Silty CLAY with stones or rk frags	250	0.001	-	-	1.0	-	0.20	50	17	84	-	140	115	151	53	89
Well-graded GRAVEL, SAND, SILT & CLAY mixture	250	0.001	0.002	25 to 1000	0.70	-	0.13	41	11	100	140	148 ⁽⁴⁾	125	156 ⁽⁴⁾	62	94
CLAY SOILS																
CLAY (30%-50% clay sizes)	0.05	0.5μ	0.001	-	2.4	-	0.50	71	33	50	105	112	94	133	31	71
Colloidal CLAY (-0.002 mm: 50%)	0.01	10Å	-	-	12	-	0.60	92	37	13	90	106	71	128	8	66
ORGANIC SOILS																
Organic SILT	-	-	-	-	3.0	-	0.55	75	35	40	-	110	87	131	25	69
Organic CLAY (30% - 50% clay sizes)	-	-	-	-	4.4	-	0.70	81	41	30	-	100	81	125	18	62

TABLE
Typical Properties of Compacted Soils

Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression		Typical Strength Characteristics				Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
				At 1.4 tsf (20 psi)	At 3.6 tsf (50 psi)	Cohesion (as compacted) psf	Cohesion (saturated) psf	ϕ (Effective Stress Envelope Degrees)	Tan δ			
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix.	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-6}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	$5 \times >10^{-5}$	10 - 40	100 - 300
-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	$2 \times >10^{-6}$	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	$5 \times >10^{-7}$	5 - 20	100 - 300
CL	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$>10^{-5}$	15 or less	100 - 200
-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	$5 \times >10^{-7}$	.....	
CL	Inorganic clays of low to medium plasticity.	95 - 120 AVG. 90	24 - 12	1.3	2.5	1800	270	28	0.54	$>10^{-7}$	15 or less	50 - 200
OL	Organic silts and silty clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	$5 \times >10^{-7}$	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105 AVG. 83	36 - 19	2.6	3.9	2150	230	19	0.35	$>10^{-7}$	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

Notes:

- All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
- Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.
- Compression values are for vertical loading with complete lateral confinement.
- (>) indicates that typical property is greater than the value shown.
(..) indicates insufficient data available for an estimate.

Table 5: Typical engineering properties of glacial deposits.

material	soil type (USCS classification)	undrained		drained		dry unit weight (pcf)
		angle of internal friction (degrees)	cohesion (psf)	angle of internal friction (degrees)	cohesion (psf)	
Glacial Till	CL, CH, CL-ML A-4, A-5 , A-6 and A-7	10 to 15	100 to 1500	20 to 30	50 to 500	110 to 120
Gumbotil	CL, CH A-4, A-5 , A-6 and A-7	8 to 11	100 to 1000	16 to 22	50 to 500	90 to 115
Glacial Outwash	GW, GP, GW-GM, GP-GM, SW, SW-SM, SP, SC, SM A-1, A-3, A-3	25 to 34	0 to 50	28 to 38	0	90 to 110

Alluvium: Alluvium is all material deposited by streams. Alluvial soils are typically composed of clayey over-bank deposits underlain by silts, sandy silts, clayey silts, and silty sands. These soils generally have no continuity in their layering at shallow depths across a given site due to the complex process of erosion and deposition by flowing water and the varying depositional processes. However, continuity of soil layering does usually increase with depth in larger streams and rivers. Near surface soils normally consist of a combination of deposits deposited by slack water during flooding and tend to be finer-grained cohesive and moderately cohesive materials. Below the more cohesive blanket of surface and near surface alluvial soils, the deeper alluvial soils generally become less cohesive and grade from sandy silts and silty sands to medium to coarse sands, which become coarser grained and more dense with depth. Locally, clay filled abandoned channels and other features are often present and may contain isolated zones of clay and other cohesive soils.

The engineering properties of alluvial soils can vary significantly, so characterization of these materials through laboratory testing is preferred. Preliminary engineering properties for the cohesive and non-cohesive materials can be estimated using the correlations presented earlier in this section.

Bedrock

The bedrock in Iowa generally consists of sedimentary limestone, dolomite, shale, and sandstone. Thin layers of coal and gypsum are also found. With the exception of Sioux Quartzite exposed in far northwestern Iowa and the Manson Impact Structure in Calhoun and Pocahontas County, metamorphic and igneous rocks are found deeply buried beneath sedimentary rock and unconsolidated surficial deposits. The bedrock generally dips to the southwest at 2 degrees. The engineering properties of rock vary, so characterization of these materials through laboratory testing is preferred. Preliminary engineering properties for the bedrock can be estimated using the referenced publications presented earlier in this section.

Properties of Engineered Materials

Compacted soils are used to construct roadway embankments and bridge approaches. Selection of soil parameters for compacted soils should be based on laboratory testing or conservatively estimated from past test data and field correlations. Table 6 provides a guideline for engineering property selection on engineered fills based on the Soils Design Section's experience with soil materials typically found in Iowa.

TABLE 1
Estimated Friction Factors and Adhesion for Dissimilar Materials

Interface Materials	Friction factor, $\tan \delta$	Friction angle, δ degrees
Mass concrete on the following foundation materials:		
Clean sound rock.....	0.70	35
Clean gravel, gravel-sand mixtures, coarse sand...	0.55 to 0.60	29 to 31
Clean fine to medium sand, silty medium to coarse sand, silty or clayey gravel.....	0.45 to 0.55	24 to 29
Clean fine sand, silty or clayey fine to medium sand.....	0.35 to 0.45	19 to 24
Fine sandy silt, nonplastic silt.....	0.30 to 0.35	17 to 19
Very stiff and hard residual or preconsolidated clay.....	0.40 to 0.50	22 to 26
Medium stiff and stiff clay and silty clay.....	0.30 to 0.35	17 to 19
(Masonry on foundation materials has same friction factors.)		
Steel sheet piles against the following soils:		δ
Clean gravel, gravel-sand mixtures, well-graded rock fill with spalls.....	0.40	22
Clean sand, silty sand-gravel mixture, single size hard rock fill.....	0.30	17
Silty sand, gravel or sand mixed with silt or clay	0.25	14
Fine sandy silt, nonplastic silt.....	0.20	11
Formed concrete or concrete sheet piling against the following soils:		
Clean gravel, gravel-sand mixture, well-graded rock fill with spalls.....	0.40 to 0.50	22 to 26
Clean sand, silty sand-gravel mixture, single size hard rock fill.....	0.30 to 0.40	17 to 22
Silty sand, gravel or sand mixed with silt or clay	0.30	17
Fine sandy silt, nonplastic silt.....	0.25	14
Various structural materials:		
Masonry on masonry, igneous and metamorphic rocks:		
Dressed soft rock on dressed soft rock.....	0.70	35
Dressed hard rock on dressed soft rock.....	0.65	33
Dressed hard rock on dressed hard rock.....	0.55	29
Masonry on wood (cross grain).....	0.50	26
Steel on steel at sheet pile interlocks.....	0.30	17

The engineering properties are based primarily on classification, gradation, and compaction requirements, with consideration of the geologic source of the fill material. For suitable materials, where the material types vary, additional laboratory testing will be required to evaluate the range of engineering properties to be considered. For existing and new cohesive highway embankments, the Soils Design Section's standard of practice has been to assume a cohesion of 600 psf and a 12 degree friction angle for shear strength parameters; however, engineering judgment and project specific considerations must also be used in all instances.

Table 6: Typical engineering properties of engineered materials.

material	Iowa DOT standard specification	soil type (AASHTO/USCS classification)	friction angle (degrees)	cohesion (psf)	total unit weight (pcf)
suitable materials	2102.02.A	AASHTO T-99 Proctor Density of 95 pcf or greater, and AASHTO M 145 Group index less than 30 Liquid Limit (LL) < 50	Perform lab testing	Perform lab testing	Perform lab testing
select soils (cohesive)	2102.02.D.1.a	A-6 or A-7-6 soils of glacial origin (excluding Gumbotil and Palesols) Must have a AASHTO T-99 proctor density of 110 pcf or greater. Must have 45% or less silt content. Must have a plasticity index (PI) > 10	20 to 30	50 to 600	120 to 135
select soils (granular)	2102.02.D.1.b	A-1, A-2, or A-3 (0) / GW, GP, GW-GM, GP-GM, SW, SW-SM, SP Must have a AASHTO T-99 proctor density of 110 pcf or greater. Must have a combined silt and clay content of 15% or less (finer than 0.074 mm or #200 sieve). Must have a plasticity index (PI) of 3 or less	30 to 45	0	125 to 135

Final Property Selection

Engineering judgment and project specific considerations, combined with parametric analyses as needed, should always be used in selection of engineering properties. Previous experience with geologic units and other laboratory and field data should also be considered in the evaluation. The geotechnical engineer must recognize the variability of materials, and the influence of the uncertainty on the design level of safety. If the impact of this uncertainty is likely to be significant, parametric analyses should be conducted, or more data could be obtained to help reduce the uncertainty. The selection of engineering properties to be used for design is outlined in Sabatini, et al. (2002).

References

1. AASHTO, 2012. LRFD Bridge Design Specifications, Sixth Edition.
2. Goodman, R. E., 1989. Introduction to Rock Mechanics, 2nd Edition, John Wiley & Sons, New York, NY.
3. Hoek, E., Carranza-Torres, C., and Corkum, B., 2002, "Hoek-Brown Criterion – 2002 Edition," Proceedings NARMS-TAC Conference, Toronto, 2002, 1, pp. 267-273.
4. Ladd, C. C., 1973, Estimating Settlement of Structures on Cohesive Soils. Presentation prepared for the Foundations and Soil Mechanics Division of the ASCE, April 9-10, 1973.



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Appendix A-7
NRCS Soils Report

[illegible]

Map scale: 1:5000000

 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 Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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: Emmet County, Iowa

Survey Area Data: Version 33, Sep 12, 2023

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

Date(s) aerial images were photographed: Sep 5, 2021—Aug 8, 2023

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
6	Okoboji silty clay loam, 0 to 1 percent slopes	67.4	4.3%
28B	Dickman sandy loam, 2 to 6 percent slopes	1.6	0.1%
55	Nicollet clay loam, 1 to 3 percent slopes	402.0	25.8%
62C2	Storden loam, 6 to 10 percent slopes, moderately eroded	5.9	0.4%
62D2	Storden loam, 10 to 16 percent slopes, moderately eroded	7.0	0.5%
90	Okoboji mucky silt loam, 0 to 1 percent slopes	20.4	1.3%
95	Harps clay loam, 0 to 2 percent slopes	58.7	3.8%
107	Webster clay loam, 0 to 2 percent slopes	75.0	4.8%
138B	Clarion loam, 2 to 6 percent slopes	242.8	15.6%
138C	Clarion loam, 6 to 10 percent slopes	9.2	0.6%
138C2	Clarion loam, 6 to 10 percent slopes, moderately eroded	17.1	1.1%
138D	Clarion loam, 9 to 14 percent slopes	11.3	0.7%
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	6.4	0.4%
221	Klossner muck, 0 to 1 percent slopes	65.3	4.2%
354	Aquolls, ponded	9.4	0.6%
485B	Spillville loam, 2 to 5 percent slopes	5.3	0.3%
507	Canisteo clay loam, 0 to 2 percent slopes	441.3	28.3%
638B	Clarion-Swanlake complex, 2 to 6 percent slopes	8.7	0.6%
638C2	Clarion-Storden complex, 6 to 10 percent slopes, moderately eroded	32.1	2.1%
638D2	Omsrud-Storden complex, 10 to 16 percent slopes, moderately eroded	8.4	0.5%
639D2	Storden-Salida complex, 5 to 14 percent slopes, moderately eroded	2.4	0.2%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
655	Crippin loam, 1 to 3 percent slopes	47.4	3.0%
828B	Zenor sandy loam, 2 to 5 percent slopes	1.1	0.1%
1707B	Delft-Terril complex, 2 to 5 percent slopes	10.7	0.7%
Totals for Area of Interest		1,557.0	100.0%



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Appendix A-8
NRCS Hydrologic Soils Report

M 95.92 °46



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



Hydrologic Soil Group—Emmet County, Iowa (globalwatershed)

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 1:15,800.

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: Emmet County, Iowa
 Survey Area Data: Version 33, Sep 12, 2023

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

Date(s) aerial images were photographed: Sep 5, 2021—Aug 8, 2023

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
6	Okoboji silty clay loam, 0 to 1 percent slopes	C/D	67.4	4.3%
28B	Dickman sandy loam, 2 to 6 percent slopes	A	1.6	0.1%
55	Nicollet clay loam, 1 to 3 percent slopes	C/D	402.0	25.8%
62C2	Storden loam, 6 to 10 percent slopes, moderately eroded	B	5.9	0.4%
62D2	Storden loam, 10 to 16 percent slopes, moderately eroded	B	7.0	0.5%
90	Okoboji mucky silt loam, 0 to 1 percent slopes	C/D	20.4	1.3%
95	Harpis clay loam, 0 to 2 percent slopes	C/D	58.7	3.8%
107	Webster clay loam, 0 to 2 percent slopes	C/D	75.0	4.8%
138B	Clarion loam, 2 to 6 percent slopes	C	242.8	15.6%
138C	Clarion loam, 6 to 10 percent slopes	B	9.2	0.6%
138C2	Clarion loam, 6 to 10 percent slopes, moderately eroded	B	17.1	1.1%
138D	Clarion loam, 9 to 14 percent slopes	B	11.3	0.7%
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	B	6.4	0.4%
221	Klossner muck, 0 to 1 percent slopes	C/D	65.3	4.2%
254	Aquatics, ponded	A/D	9.4	0.6%
485B	Spillville loam, 2 to 5 percent slopes	C	5.3	0.3%
507	Canisteo clay loam, 0 to 2 percent slopes	C/D	441.3	28.3%
638B	Clarion-Swanlake complex, 2 to 6 percent slopes	C	8.7	0.6%
638C2	Clarion-Storden complex, 6 to 10 percent slopes, moderately eroded	B	32.1	2.1%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
639D2	Dresden-Storden complex, 10 to 16 percent slopes, moderately eroded	B	98.4	6.5%
639D2	Storden-Salida complex, 5 to 14 percent slopes, moderately eroded	B	2.4	0.2%
655a	Cropman loam, 1 to 3 percent slopes	B	47.4	3.0%
828B	Zenon sandy loam, 2 to 5 percent slopes	A	1.1	0.1%
1707B	Delft-Terril complex, 2 to 5 percent slopes	C	10.7	0.7%
Totals for Area of Interest			1,557.0	100.0%

(SR + crop residue ; GOOD CONDITION)

$$\begin{aligned}
 A - 2.7 / 1556.9 &= .0017 \times 64 = 0.1088 \\
 B - 99.8 / 1556.9 &= .0641 \times 75 = 4.8075 \\
 C - 256.8 / 1556.9 &= .1649 \times 82 = 13.5218 \\
 D - 1,197.4 / 1556.9 &= .7693 \times 85 = 65.3905
 \end{aligned}$$

TOTAL 1,556.9

TOTAL = 83.8

WEIGHTED CN = 84

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



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Appendix A-9
Tile #1 Calculations



Partially Full Pipe Flow Calculations
Pipes > 1/2 Full

Landowner: *****	Project: *****	Field: *****
County: *****	State: *****	Tract ID: *****
By: *****	Date: *****	Checked: *****
Subject: *****		Date: *****

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V

for pipes more than half full

Instructions: Enter values in blue boxes. Spreadsheet calculates values in yellow boxes

Inputs

Pipe Diameter, **D** = 12 in

Depth of flow, **y** = 11.16 in
(must have $y \geq D/2$)

Full Pipe Manning
roughness, **n_{full}** = 0.012

Channel bottom
slope, **S** = 0.007 ft/ft

Calculations

n/n_{full} = 1.035

Calculations

Pipe Diameter, **D** = 1 ft

Pipe Radius, **r** = 0.5 ft

Circ. Segment Height, **h** = 0.070 ft

Central Angle, **θ** = 1.07 radians

Cross-Sect. Area, **A** = 0.76 ft²

Wetted Perimeter, **P** = 2.6 ft

Hydraulic Radius, **R** = 0.29 ft

Discharge, **Q** = 3.36 cfs

Equations used for calculations:

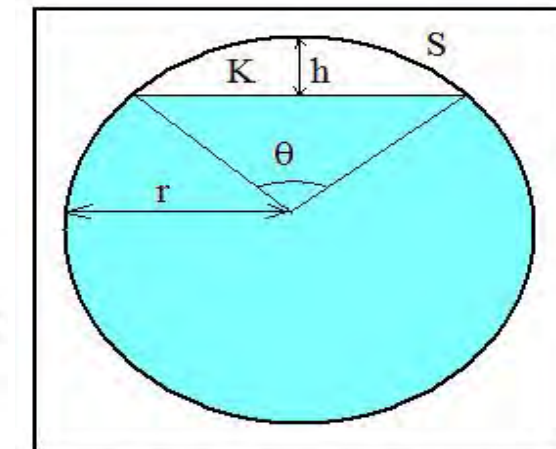
$$r = D/2$$

$$h = 2r - y$$

$$\theta = 2 \arccos \left(\frac{r - h}{r} \right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$R = A/P \quad (\text{hydraulic radius})$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2}) \quad (\text{Manning Equation})$$

$$V = Q/A$$



United States
Department of
Agriculture

Natural Resources Conservation Service

Partially Full Pipe Flow Calculations Pipes > 1/2 Full

MDNRCS-ENG
Ver 1.0
04/2020

Sheet 2 of 2

Partially Full Manning

roughness, $n =$

0.012

Ave. Velocity, $V =$

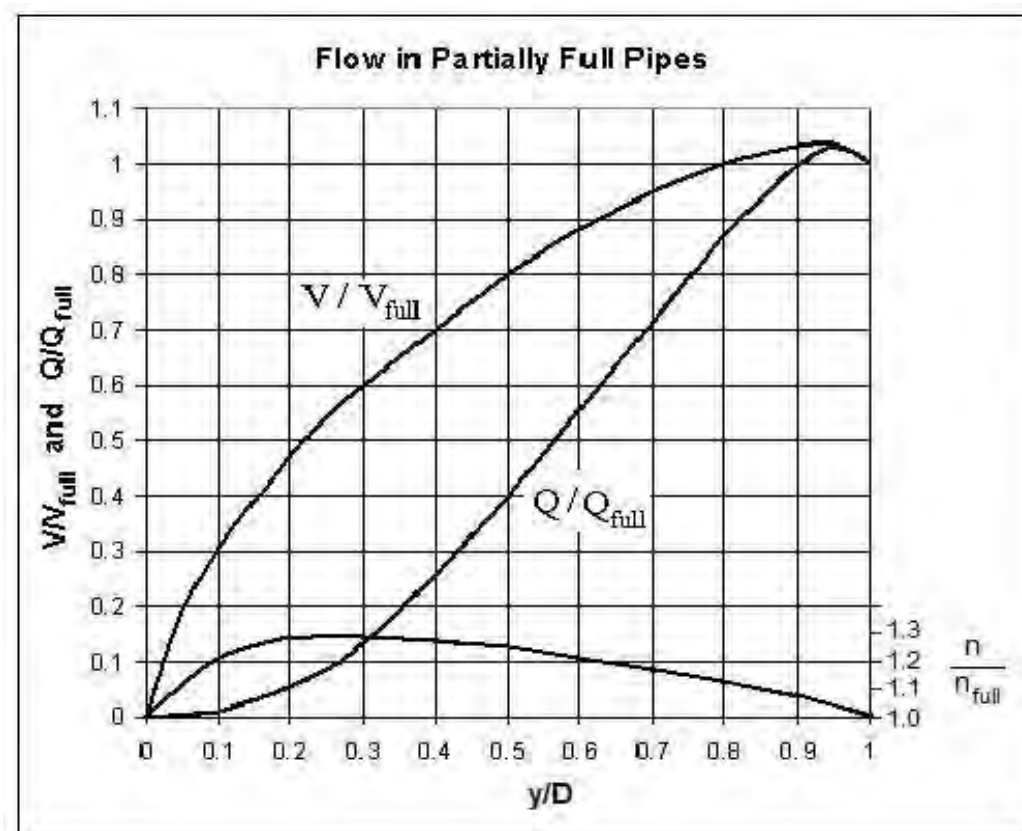
4.42

ft/sec

pipe % full $[(A/A_{full}) * 100\%] =$

96.9%

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)



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Partially Full Pipe Flow Calculations
Pipes > 1/2 Full

Landowner: *****	Project: *****	Field: *****
County: *****	State: *****	Tract ID: *****
By: *****	Date: *****	Checked: *****
Subject: *****		Date: *****

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V

for pipes more than half full

Instructions: Enter values in blue boxes. Spreadsheet calculates values in yellow boxes

Inputs

Pipe Diameter, **D** = 10 in

Depth of flow, **y** = 9.3 in
(must have $y \geq D/2$)

Full Pipe Manning
roughness, **n_{full}** = 0.013

Channel bottom
slope, **S** = 0.0175 ft/ft

Calculations

n/n_{full} = 1.035

Calculations

Pipe Diameter, **D** = 0.833333 ft

Pipe Radius, **r** = 0.416667 ft

Circ. Segment Height, **h** = 0.058 ft

Central Angle, **θ** = 1.07 radians

Cross-Sect. Area, **A** = 0.53 ft²

Wetted Perimeter, **P** = 2.2 ft

Hydraulic Radius, **R** = 0.24 ft

Discharge, **Q** = 3.02 cfs

Equations used for calculations:

$$r = D/2$$

$$h = 2r - y$$

$$\theta = 2 \arccos \left(\frac{r - h}{r} \right)$$

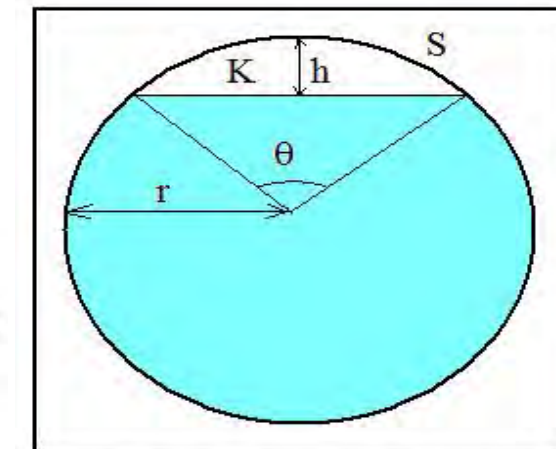
$$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$R = A/P \quad (\text{hydraulic radius})$$

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2}) \quad (\text{Manning Equation})$$

$$V = Q/A$$



Partially Full Pipe Flow Parameters
(More Than Half Full)



United States
Department of
Agriculture

Natural Resources Conservation Service

Partially Full Pipe Flow Calculations Pipes > 1/2 Full

MDNRCS-ENG
Ver 1.0
04/2020

Sheet 2 of 2

Partially Full Manning

roughness, $n =$

0.013

Ave. Velocity, $V =$

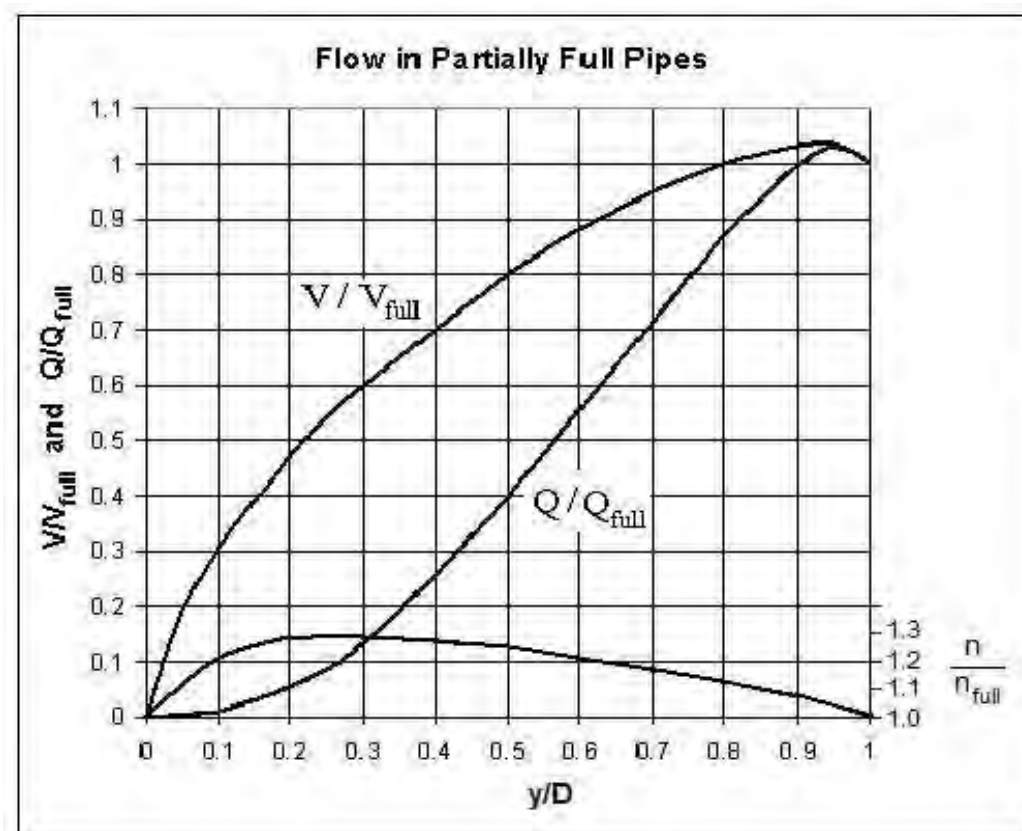
5.71

ft/sec

pipe % full $[(A/A_{full}) * 100\%] =$

96.9%

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)



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Appendix A-10
Sediment Accumulation Calculations

DU PROJECT NO.: IA-340-13
IDALS PROJECT NO.: Emm1003114B
DESIGNED BY: A.S.
DATE: 11/13/2024

SEDIMENT ACCUMULATION

CONTRIBUTING DRAINAGE AREA ¹ :	1557.15 ACRES	2.433	SQMI
STORAGE VOLUME AT NWL ¹ :		13.43	AC-FT
TRAP EFFICIENCY ² :		90	PERCENT
AVG. ANNUAL SHEET AND RILL EROSION ³ :		5.0	TONS/AC/YR
AREA OF DEPRESSIONS NOT SUBJECT TO SEDIMENT DELIVERY ¹ :		0	ACRES
AREA SUBJECT TO SHEET AND RILL EROSION ¹ :		1,557	ACRES
AVG. ANNUAL SHEET AND RILL EROSION:		7,786	TONS/YR
DELIVERY RATIO ² :		5.6	PERCENT
SHEET AND RILL EROSION DELIVERED TO SITE:		436	TONS/YR
ADJUSTMENT FOR LRA 103 ⁴ :		1.3	FACTOR
ADJUSTED SHEET AND RILL EROSION DELIVERED:		567	TONS/YR
LENGTH OF GULLY EROSION ¹ :		3,520	FT
AVG. ANNUAL GULLY EROSION RATE ² :		0.25	FT ³ /FT
IN-PLACE DENSITY OF GULLY MATERIAL ² :		90	LB/FT ³
AVG. ANNUAL GULLY EROSION (100% DELIVERED):		40	TON/YR
TOTAL SEDIMENT DELIVERED:		606	TON/YR
WEIGHT OF SEDIMENT RETAINED IN WETLAND AT 90 PERCENT TRAPPED:		546	TON/YR
SEDIMENT ACCUMULATION DURING 150 YEAR PERIOD:		81,864	TONS
ESTIMATE 80 PERCENT OF DELIVERED SEDIMENT WILL BE SUBMERGED ⁵ :		65,491	TONS
VOLUME OF SUBMERGED SEDIMENT ⁵ AT 1,307 TON/AC-FT ² :		50.11	AC-FT
NORMAL POOL VOLUME 13.433 AC-FT	WETLAND STORAGE EXCEEDED		
ESTIMATE 20 PRECENT OF DELIVERED SEDIMENT WILL BE AERATED ⁵ :		16,373	TONS
VOLUME OF AERATED SEDIMENT ⁵ AT 1,742 TON/AC-FT ² :		9.40	AC-FT
WETLAND SEDIMENTATION ACCUMULATION DESIGN STORAGE LIFE:		40	YEARS

REFERENCES:

- ¹ DETERMINED BY ENGINEER.
- ² NRCS, FIELD OFFICE TECHNICAL GUIDE, IOWA, "EROSION AND SEDIMENT DELIVERY", MARCH 1998.
- ³ NATIONAL ACADEMICS PRESS, "SOIL CONSERVATION", CHAPTER 1, PG. 8.
- ⁴ NATIONAL ACADEMICS PRESS, "SOIL CONSERVATION", CHAPTER 3, PG. 51.
- ⁵ NATIONAL ENGINEERING HANDBOOK, CHAPTER 8, SEDIMENT-STORAGE DESIGN CRITERIA.



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Appendix A-11
FEMA Flood Map

National Flood Hazard Layer FIRMMette



94°28'36"W 43°29'12"N



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

1:6,000

94°27'58"W 43°28'45"N

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped
		The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.



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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **12/1/2022 at 5:41 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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



Table

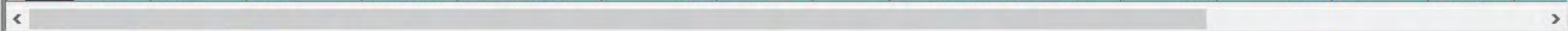


Table



S_XS

	FID	Shape	DFIRM_ID	VERSION_ID	XS_LN_ID	WTR_NM	STREAM_STN	START_ID	XS_LTR	XS_LN_TYP	WSEL_REG	STRMBED_EL	LEN_UNIT	V_DATUM	PROF
▶	14	Polyline	19063C	2.4.3.0	19063C_15	07020009002912	3161	19063C_4		NOT LETTERED, NOT MAPPED	1203.1	1199.9	Feet	NAVD88	



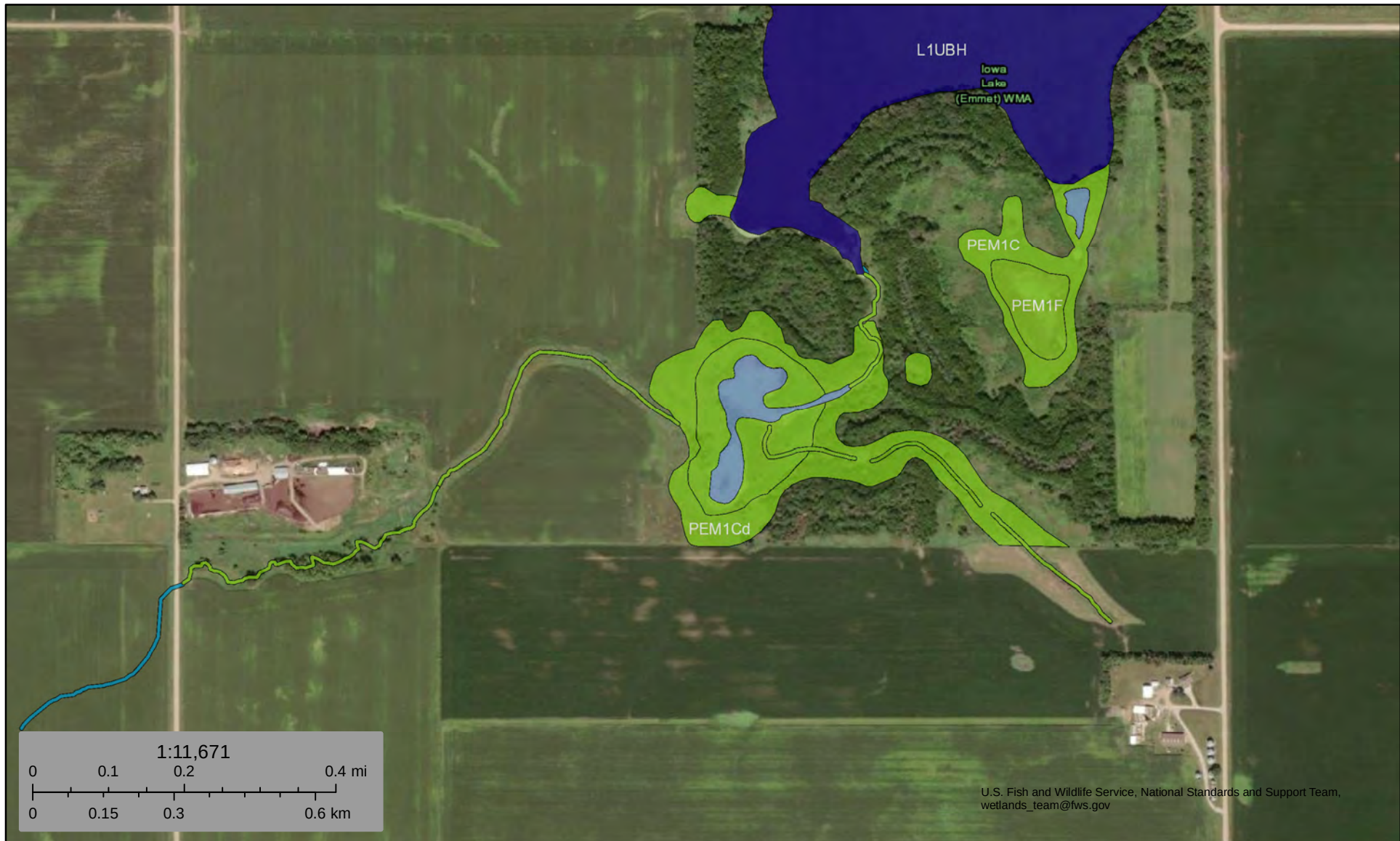
1 (1 out of 1939 Selected)

S_XS



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Appendix A-12
FWS Wetland Inventory Map



December 1, 2022

Wetlands

- | | | | | | |
|---|--------------------------------|---|-----------------------------------|---|----------|
|  | Estuarine and Marine Deepwater |  | Freshwater Emergent Wetland |  | Lake |
|  | Estuarine and Marine Wetland |  | Freshwater Forested/Shrub Wetland |  | Other |
| | |  | Freshwater Pond |  | Riverine |

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.