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INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN
SOUTH ASH POND 2S AND SOUTH ASH POND 3S
WILL COUNTY STATION
OCTOBER 2016

Pursuant to Code of Federal Regulations Title 40, Part 257, Subpart D (40 CFR), herein referred to as the coal combustion residual (CCR) Rule, Section 257.82(c), Geosyntec Consultants (Geosyntec) prepared this Inflow Design Flood Control System Plan for South Ash Ponds 2S and 3S (Ponds 2S and 3S) at the Will County Station (Site) in Romeoville, Illinois. The Basins are owned and operated by Midwest Generation, LLC (Midwest Generation).

Section 257.82(c) of the CCR Rule requires that operators of every existing or new CCR surface impoundment design, construct, operate, and maintain an inflow design flood control system that adequately manages flow into the CCR unit during and following the peak discharge of the inflow design flood. The Preamble to the CCR Rule provides guidance on the documentation that should be provided for the inflow design flood control system plan.

This Inflow Design Flood Control System Plan for Ponds 2S and 3S meets the requirements of §257.82(c). The inflow design flood control systems consist of maintaining operational levels within the Ponds and emergency overflow structures. Justification and documentation of the adequacy of the inflow design flood control systems are presented in the sections below.

The work presented in this report was performed under the direction of Ms. Jane Soule, P.E., of Geosyntec Consultants, Inc. (Geosyntec) in accordance with §257.82(c). Mr. Robert White reviewed this plan in accordance with Geosyntec's senior review policy.

1. Pond Design

The Ponds are approximately 2 acres each and are located in the southwestern portion of the Site, west of the switchyard, and east of the Des Plaines River (Figure 1). Ponds 2S and 3S are currently operated to intermittently receive approximately 3,400 gallons per minute (gpm) of sluiced CCR and other process water from plant operations. Inflow from plant operations is discharged into Ponds 2S and 3S through supported pipes. Plant flows are generally directed to one pond (the receiving pond) while dewatering and CCR removal is conducted in the other pond.

Ponds 2S and 3S include outlet systems that consist of a weir and trough located along their western boundary. Outflow from Pond 3S flows from the trough to a 36-inch reinforced concrete pipe to a junction box that connects to a 48-inch reinforced concrete pipe (48-inch Collector Pipe) that drains north to the Recycle Pump Station wet well (Figure 2). Outflow from Pond 2S flows from the trough to a 36-inch reinforced concrete pipe that tees into the 48-inch Collector Pipe that drains to the Recycle Pump Station wet well. The junction box includes a metal grate at approximately elevation 588.5 feet MSL[1] that serves as an emergency overflow structure for both ponds.

Ponds 1S and 1N are located north of Ponds 2S and 3S and are no longer in service. Ponds 1S and 1N also drain stormwater into the 48-inch Collector Pipe. Ponds 1S and 1N have been retrofitted with dewatering systems that drain water from the bottom of the ponds as well as stormwater runoff from the remaining weir and trough systems similar to those in Ponds 2S and 3S. A retention basin, approximately 0.37 acres in plan area and located northeast of the Recycle Pump Station, also drains to the Recycle Pump Station. An additional emergency overflow structure, with a grate elevation of approximately 590 feet MSL is located west of the Recycle Pump Station. Discharge from Ponds 1N, 1S and the retention basin are evaluated in this plan because they discharge to the 48-inch Collector Pipe that also carries flow from Ponds 2S and 3S and the emergency overflow structures are common to these five ponds.

There are four operational low-pressure recycle pumps in the Recycle Pump Station. Each pump has a rated capacity of 5,000 gpm (at a total head of 80 feet). These pumps operate in parallel and discharge into a 36 inch (in) pressure main. The pressure main tees at a 16-inch blowdown line to the wastewater treatment system and a 30–inch return line back to the plant. From the wastewater treatment system, treated blowdown is discharged at a permitted National Pollutant Discharge Elimination System (NPDES) outfall at a maximum rate of 3.71 million gallons per day (MGD).

2. Inflow Design Flood Control System Plan Documentation

Due to the relatively small size and design of the Ponds, some of the references and drawings recommended for inclusion in the Inflow Design Flood Control System Plan by the Preamble to the CCR Rule (page 21392) are not applicable. Table 1 below provides a summary of this documentation.

[1] Mean Sea Level – vertical datum unknown.

Table 1: Recommended Documentation

Documentation	Assessment
Identification of the design storm event for the catchment area and CCR unit	Identification of the design storm event is provided in Section 4. Figure 2 presents a drawing of the ponds and catchment areas.
Characterization of the rainfall abstractions, including but not limited to depression storage and infiltration in the upstream catchment area	Full capture of the design precipitation event was assumed, so rainfall abstractions were assumed to be zero, i.e., 100% of the volume falling within the catchment area for each pond was routed to the appropriate pond. Typical abstractions include mechanisms such as evaporation and infiltration.
Selection and basis of the appropriate run-off model and run-on or run-off routing model	A run-on model was not required because full capture within the limited catchment areas is demonstrated. A simplified analysis is used to demonstrate full capture of the inflow design event within each ash pond. Therefore, a run-off model was not necessary.
Identification and characterization of any intake or decant structures	The outflow structures associated with Ponds 2S and 3S are described in Section 1 and evaluated in Appendix A.
Characterization and capacity of spillways	The capacity of the emergency overflow structures is presented in Appendix A.
Characterization of downstream hydraulic structures	The capacity of the inflow design system, including overflow structures and Ponds 1N, 1S, 2S and 3S is presented in Appendix A.

3. Catchment Areas

Based on site topography, Ponds 1N, 1S, 2S, 3S and the retention basin do not receive water from a natural stream and do not receive stormwater flows except for direct precipitation that falls within the limit of each embankment crest. The catchment areas for the ponds are shown on Figure 2.

In the past, runoff from the South Area Runoff Basins, located south of the Pond 3S, was managed in the same 48-inch Collector Pipe that receives outflow from Ponds 2S and 3S. However, this connection has been terminated by filling the 48-inch pipe with concrete on the southern end.

4. Design Event

As Ponds 2S and 3S are classified as significant hazard potential surface impoundments (Geosyntec, 2016), the inflow design flood is defined as the 1,000-year flood. Because direct precipitation is collected within the ponds and run-on is limited to the embankment crest areas, the inflow design is based on the 1,000-year precipitation event. The 1,000-year, 24-hour and 1,000-year, 6-hour storm depths were used to determine inflows to the ponds in this analysis. The 24-hour storm duration was selected to maximize the volume entering the pond during a 1000-year event, while the 6-hour duration was used maximize peak flow entering the pond due to a shorter duration. Table 2 presents the storm depths for each frequency and duration.

Table 2: Design Precipitation Events

Return Interval	Duration	Depth
1,000-year	6-hour	8.73 inches
1,000-year	24-hour	13.3 inches

Source: NOAA, 2016

Total inflow from the design events is calculated as the depth of precipitation multiplied by the catchment area[2].

5. Analysis of Inflow Design Flow

Evaluation of the inflow design flood control system included routing of stormwater inflows from the design event to the ponds (Ponds 1N, 1S, 2S, 3S, and the retention basin). The EPA's Storm Water Management Model (SWMM) Version 5.1.011 was used to route the inflow design flows through the ponds and pipe network (EPA, 2015). A description of the analysis is presented in Appendix A.

Table 3: Routing Analysis Results

Pond[3]	Minimum Freeboard (feet)	
	6-hour, 1000-year Design Event	24-hour, 1000-year Design Event
Pond 1N	0.4	0.4
Pond 1S	0.5	0.5
Pond 2S	0.5	0.5
Pond 3S	0.5	0.5

[2] Depression storage or infiltration of stormwater into the embankment crest and other rainfall abstractions are assumed to be negligible and are not included in inflow volume calculations. Similarly, this calculation does not require the use of a run-on model for the precipitation falling on the embankment crest.

[3] The model assumes that all overflow from the retention basin is discharged to the 48-inch Collector Pipe and no evaluation of potential storage and variation in freeboard was performed.

Table 3 summarizes the analysis results for the design storm events and indicates that a minimum of approximately 0.4 to 0.5 feet of freeboard is maintained throughout the design event in Ponds 2S and 3S, as well as in Ponds 1N and 1S. Discharge from the emergency overflow structure west of Pond 3S is anticipated during the design event. Riprap is located downstream of this structure to limit erosion from discharge during the design event. The inflow design system, as designed and constructed, meets the requirements of 40 CFR §257.82.

6. Plan Amendments and Revisions

In accordance with §257.82(c)(2) and (4), this Inflow Design Flood Control System Plan will be amended or revised whenever there is a change in conditions that would substantially affect the plan or every five years.

7. Limitations and Certification

This inflow design flood control system plan meets the requirements of §257.82(c) of the Code of Federal Regulations Title 40, Part 257, Subpart D, and was prepared in accordance with current practices and the standard of care exercised by scientists and engineers performing similar tasks in the field of civil engineering. The contents of this report are based solely on the observations of the conditions observed by Geosyntec personnel and information provided to Geosyntec by Midwest Generation. Consistent with applicable professional standards of care, our opinions and recommendations were based in part on data furnished by others, which was consistent with other information that we developed in the course of our performance of the scope of services. The information contained in this report is intended for use solely by Midwest Generation and their subconsultants.

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Illinois Professional Engineer No. 062-067766
License Expires: 11/30/17

8. References

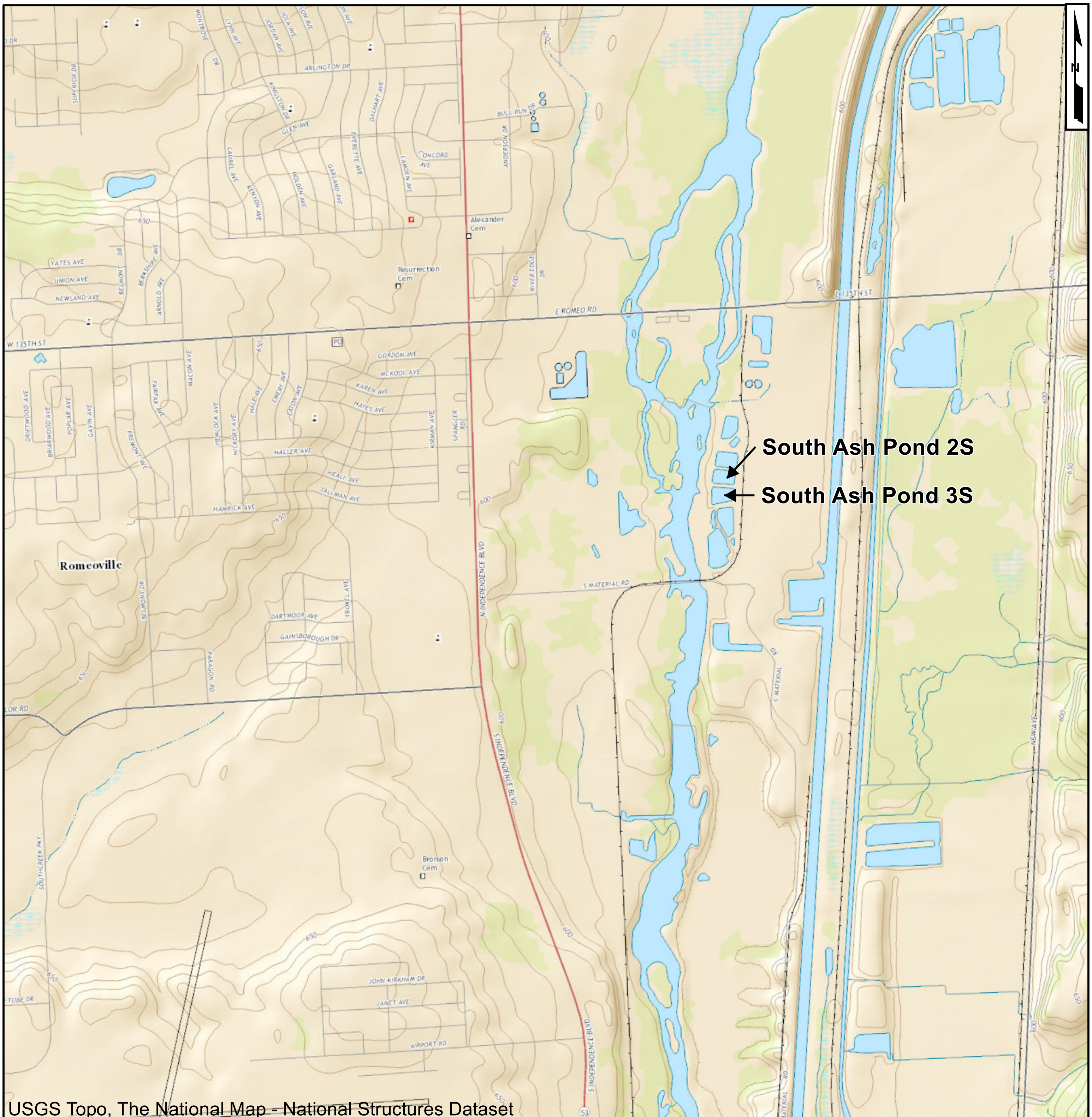
Geosyntec Consultants, 2016, Hazard Potential Classification Assessment, East and West Ash Basins, Waukegan Station, October 2016.

NOAA, 2016, NOAA Atlas 14 Point Precipitation Frequency Estimates: Illinois, available at: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

United States Environmental Protection Agency, 2015. Storm Water Management Model User's Manual Version 5.1. EPA/600/R-14/413b, Revised September 2015.

Attachments

Figure 1: Site Location
Figure 2: Basin Topography and Catchment Area
Appendix A: Inflow Routing Calculations



2,000 1,000 0 2,000 Feet

Site Location

South Ash Ponds 2S and 3S
Will County Station
Romeoville, Illinois

Geosyntec consultants

San Diego | October 2016

Figure

1

W:\GIS\WillCounty.mxd.Name

USGS (2011). National Elevation Dataset (NED) 1/9 arc-second resolution, Will County, Illinois - LiDAR Data, 2004. U.S. Geological Survey (USGS), Reston, Virginia, 2011.

Catchment Areas and Topography
Will County Station

Romeoville, Illinois

Geosyntec consultants

San Diego | October, 2016

Figure 2

Legend

- Pond Catchment
- 1' Elevation Contour
- Pipe
- Emergency Overflow Structure

Appendix A

Inflow Routing Calculations

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Midwest Generation **Project:** Will County **Project #:** SW0251 **Task #:** 09/06

TITLE OF COMPUTATIONS INFLOW ROUTING CALCULATIONS

COMPUTATIONS BY:	Signature	[signature]	13 October 2016 DATE
	Printed Name and Title	Maxwell Dugan Engineer	
ASSUMPTIONS AND PROCEDURES CHECKED BY: (Peer Reviewer)	Signature	[signature]	13 October 2016 DATE
	Printed Name and Title	Venkat Gummadi Senior Engineer	
COMPUTATIONS CHECKED BY:	Signature	[signature]	13 October 2016 DATE
	Printed Name and Title	Venkat Gummadi Senior Engineer	
COMPUTATIONS BACKCHECKED BY: (Originator)	Signature	[signature]	13 October 2016 DATE
	Printed Name and Title	Maxwell Dugan Engineer	
APPROVED BY: (PM or Designate)	Signature	[signature]	13 October 2016 DATE
	Printed Name and Title	Jane Soule P.E. Senior Engineer	

APPROVAL NOTES:

INFLOW ROUTING CALCULATIONS
Ash Ponds 2S and 3S
Will County Station, Romeoville, Illinois

1. BACKGROUND AND PURPOSE

Pursuant to Code of Federal Regulations Title 40, Part 257, Subpart D, (40 CFR) Section 257.82(c), Geosyntec Consultants (Geosyntec) prepared this calculation package to support development of the Inflow Design Flood Control System Plan for Ash Ponds 2S and 3S at the Will County Station (Site) in Will County near Romeoville, Illinois. 40 CFR Section 257.82(c) requires that operators of every existing or new CCR (coal combustion residuals) surface impoundment design, construct, operate, and maintain an inflow design flood control system that adequately manages flow into the CCR units during and following the peak discharge of the inflow design flood. This calculation evaluates the inflow design flood and evaluates the capacity of the ponds and downstream outflow systems to handle inflow from this event.

2. SITE DESCRIPTION AND POND CHARACTERISTICS

CCR generated at the site is sluiced into two lined surface impoundments identified as South Ash Pond 2S and South Ash Pond 3S (Pond 2S and 3S), (see Figure 1). Two additional ponds which are no longer in service, South Pond 1S (Pond 1S) and North Ash Pond (Pond 1N), are located north of Ponds 2S and 3S. A retention basin is also located northeast of the Recycle Pump House. Additional stormwater detention ponds are located south of Ponds 2S and 3S but are hydraulically separated from Ponds 2S and 3S and associated drainage/operation systems. The Site is bounded by the Des Plaines River on the west and the Chicago Sanitary and Ship Canal on the east.

Water from Ponds 2S and 3S is routed to a Recycle Pump Station north of the ponds via overflow weirs (approximate crest elevation 589.5 feet) in each pond. Water that overflows the weirs is collected by a pipe network and routed to the Recycle Pump Station via a 48" diameter reinforced concrete pipe (RCP) (referred to herein as the 48-inch Collector Pipe). There are four operational low-pressure recycle pumps in the Recycle Pump Station. Each pump has a rated capacity of 5,000 gpm (at a total head of 80 feet) to pump the collected water to either the wastewater treatment plant, or back to the station. In addition to water from Ponds 2S and 3S, the 48–inch Collector Pipe collects runoff from Ponds 1S and 1N. Both Ponds 1S and 1N are out of service and have been retrofitted with dewatering systems that drain water from the bottom of the ponds (with a check value to control backflow) as well as stormwater runoff from the remaining weir and trough systems similar to those in Ponds 2S and 3S. Water from the retention basin also drains to the 48-inch Collector Pipe via the Recycle Pump Station.

Two concrete box structures with metal grate outlets in the vicinity of Pond 3S and the recycle pump station provide emergency overflow for the system. The elevation of these emergency overflow structures is approximately 588.5 feet and 590.0 feet for the overflows near Pond 3S and the Recycle Pump Station, respectively. In the event of pump outage or large storm event, water may collect in the pipe network downstream of the ponds until a water surface elevation (WSE) of 588.5 feet is reached, at which point water will either exit the system via the emergency overflow structure or flow over the pond weir structures back into the ponds. Figure 2 shows the general site layout and location of ponds, pipe network features, and emergency overflow structures.

3. INFLOW DESIGN ANALYSIS

3.1 Design Event

Flood flows are typically established by performing statistical analysis on historical stream gauge records. In instances where measured stream flow records are not available, deterministic methods such as a design storm method (ASCE, 1996) is used to establish flood flows. In the design storm method, a rainfall to runoff analysis is used to establish the flood flows. The underlying assumptions in the design storm method are: 1) rainfall will occur uniformly across the entire contributing watershed; and 2) a specified return period storm event produces the same return period flood flow. The design storm method was used to estimate the inflows to the ponds for the 1,000-year precipitation event based on the Hazard Potential Classification Assessment (Geosyntec, 2016).

3.2 Precipitation

Precipitation data was obtained from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Estimates: IL, see Attachment B (NOAA, 2016). The 1,000-year, 24-hour and 1,000-year, 6-hour storm depths were used to determine inflows to the ponds in this analysis. The 24-hour storm duration was selected to model a high total storm volume entering the ponds during a 1000-year event, while the 6-hour duration was used model a higher peak flow entering the ponds due to a shorter duration. Table 1 presents the storm depths for each frequency and duration.

Table 1: Precipitation Data

Return Interval (years)	Duration (hours)	Depth (inches)
1,000	6	8.73
1,000	24	13.3

3.2 Hydrology and Sub-basin Characteristics

Ponds 2S, 3S, 1S, and 1N are surrounded by embankments on all sides. Inflow into these ponds is limited to run-on from the ponds' embankments and direct precipitation into the ponds. Sub-basins for each pond were delineated in ArcGIS and are based on available topography (USGS, 2011).

Due to the limited size of the catchment areas, no losses associated with infiltration or other abstractions (e.g. evaporation) were considered and 100% of rainfall in each catchment area is considered to enter the associated pond. Inflow hydrographs were developed by applying the precipitation depth for the design event (6-hr or 24-hr duration) to the SCS Type II distribution (NRCS, 1993). The catchment areas and resulting peak inflows are summarized in Table 2.

Table 2: Catchment Areas and Peak Inflows

Pond	Catchment Area (acres)	Peak Inflow 24-hr (cfs)	Peak Inflow 6-hr (cfs)
1S	2.0	26	34
2S	2.2	29	38
3S	2.4	31	41
1N	2.2	28	37

3.3 Process Flow

Pond 2S and 3S are currently operated to receive CCR process water from plant operations. Plant flows are generally directed to one pond at a time. Inflow to Pond 2S (or Pond 3S) is on the order of 3,400 gallons per minute (gpm) intermittently, typically over a period of approximately 12 hours per day. Inflow is discharged into the pond via an elevated pipe network that discharges within the footprint of the pond. Analysis of the 1,000 year stormwater routing assumes that process flow, as well as pumping from the Recycle Pump Station, is discontinued during the design storm event.

3.4 Basin Outlet Structures and Culverts

As discussed in Section 2, Ponds 1S, 2S, 3S, and 1N each have overflow weirs (length varies) at elevations of 589.5 ft located along their western boundary. The weirs flow into troughs and then into 36-inch (Ponds 2S and 3S) and 48-inch (Ponds 1S and 1N) RCP pipes which gravity flow to the 48-inch Collector Pipe approximately 40 feet west of the ponds. Additionally, Ponds 1S and 1N have an additional low flow outlet pipe (invert ~582.5 ft), with backflow preventer, that outlets to the same trough as the weir in each respective basin. The outlets for the system include water pumped through the Recycle Pump Station (variable) and outflow through one of two overflow structures with grates at approximately 588.5 ft. and 590.0 ft. The retention basin discharges to the Recycle Pump Station and, for the purpose of this analysis, direct rainfall captured by the basin is assumed to discharge directly to the 48-inch Collector Pipe. Tables 3 and 4 present the properties of the outlet structures and pipe network for the ponds based on available design drawings, provided in Attachment A.

Table 3: Outlet Structures

Outlet Structure	Invert Elevation
Pond 1S Weir	589.5 ft
Pond 2S Weir	589.5 ft
Pond 3S Weir	589.5 ft
Pond 1N Weir	589.5 ft
Pond 1S Low Flow	582.5 ft
Pond 1N Low Flow	582.5 ft
Emergency Outflow (3S)	588.5 ft
Emergency Outflow (West of Pump Station)	590.0 ft
Recycle Pump Sump (Flooding)	592.0 ft

Table 4: Pipe Network Characteristics

Culvert	Estimated Length (feet)	Inlet Invert Elevation (feet)	Outlet Invert Elevation (feet)	Size and Type
2S36	40	580.5	580	36-inch RCP
3S36	44	580.5	580	36-inch RCP
1S48	40	580	580	48-inch RCP
1N48	40	580	580	48-inch RCP
1SLow	>10	582.5	582.5	NA[1]
1NLow	>10	582.5	582.5	NA[1]
48-Inch Collector	680	580	580	48-inch RCP

1. The size and length of low flow dewatering pipes within Ponds 1S and 1N is not available. Capacity of these pipes is not anticipated to limit flow during the design event based on available head (7-feet) before weir overtopping.

3.5 Elevation-Storage Curves

Elevation-storage curves were approximated based on the available topographic data, design drawings, and input from site operations staff. Table 5 summarizes the estimated available storage above the weir crest (assumed starting WSE).

Table 5: Elevation Storage Curves

Pond	Available Depth (ft)	Average Area (ac)
1S	2.0	1.0
2S	1.0	1.25
3S	1.0	1.25
1N	1.0	1.0

3.6 Inflow Design Routing

The EPA's Storm Water Management Model (SWMM) Version 5.1.011 was used to route the inflow design flows through the Ponds and pipe network. SWMM is a dynamic rainfall-runoff simulation model that also has hydraulic routing capabilities including dynamic wave analysis. The dynamic wave equations allow the model to account for effects such as backwater, pressurized flow, pipe storage, and flow reversal by solving the full set of continuity and momentum equations (St. Venant equations). Using the model's dynamic wave routing option, the inflow design hydrographs were routed through the pond and pipe network. Model input and output files are provided in Attachment E. Key simulation parameters are summarized in Table 6 below.

Table 6: SWMM Model Parameters

Parameter	Input
Routing Method	Dynamic Wave
Time Steps	0.1 Seconds
Simulation Length	24 Hours

3.7 Initial Conditions and Assumptions

The model assumes that the water level in both Pond 2S and 3S is at the top of the weir, 589.5 feet. Ponds 1S and 1N are assumed to contain no free water, and the 48-inch Collector Pipe) was assumed to be full. Pipe roughness n-values of 0.014 were assumed for all pipes (SWMM User's

Manual Table A.7 for smooth concrete, EPA, 2015). Minor loss coefficients for pipe entrances, exits, and junctions were assumed to be 0.5 (HEC-22, USDOT, 2009).

4. RESULTS AND CONCLUSIONS

Based on the analysis of both the 1,000-year, 24-hour storm and the 1,000-year, 6-hour storm, the ponds and associated downstream hydraulic structures convey the flow and maintain a minimum of 0.46-ft and 0.51-ft of freeboard in Ponds 2S and 3S. Tables 7 and 8 summarize the results of the maximum water surface elevation reached in the ponds and the maximum inflows and outflows. Full inflow and outflow hydrographs are provided in Attachment D.

Table 7: Results 1,000-year, 24-hour Storm

Pond	Maximum Water Surface Elevation (ft)	Freeboard (ft)	Maximum Inflow (cfs)	Maximum Outflow (cfs)
1S	590.00	0.50	26.3	25.3
2S	590.04	0.46	29.1	13.8
3S*	589.99	0.51	31.2	17.5
1N*	590.10	0.40	28.4	17.5
Retention Basin	-	-	4.82	4.82

Table 8: Results 1,000-year, 6-hour Storm

Pond	Maximum Water Surface Elevation (ft)	Freeboard (ft)	Maximum Inflow (cfs)	Maximum Outflow (cfs)
1S	589.98	0.52	34.5	11.73
2S	590.03	0.47	38.1	13.52
3S*	589.99	0.51	40.8	17.60
1N*	590.09	0.41	37.2	7.86
Retention Basin	-	-	6.31	6.31

*Maximum outflow values for Ponds 3S and 1N represent net flow values (i.e. the sum of inflows or outflows through both 1S48 and 1N48 and the respective weir in each pond).

6. REFERENCES

ASCE, 1996. American Society of Civil Engineers Task Committee on Hydrology Handbook. Hydrology Handbook. ASCE Publications.

Geosyntec Consultants, 2016, Hazard Potential Classification Assessment, East and West Ash Basins, Waukegan Station, October 2016.

NOAA, 2016, NOAA Atlas 14 Point Precipitation Frequency Estimates: Illinois, available at: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

United States Department of Agriculture and Natural Resource Conservation Service, 1993 "Chapter 4: Storm Rainfall Depth and Distribution." National Engineering Handbook Part 630 Hydrology. March 1993.

United States Department of Transportation, Federal Highway Administration, 2009. Hydraulic Engineering Circular No. 22 (HEC-22), Third Edition. Urban Drainage Design Manual. Publication No. FHWA-NHI-10-009. September 2009, Revised August 2013.

USGS (2011). National Elevation Dataset (NED) 1/9 arc-second resolution, Will County, Illinois - LiDAR Data, 2004. U.S. Geological Survey (USGS), Reston, Virginia, 2011

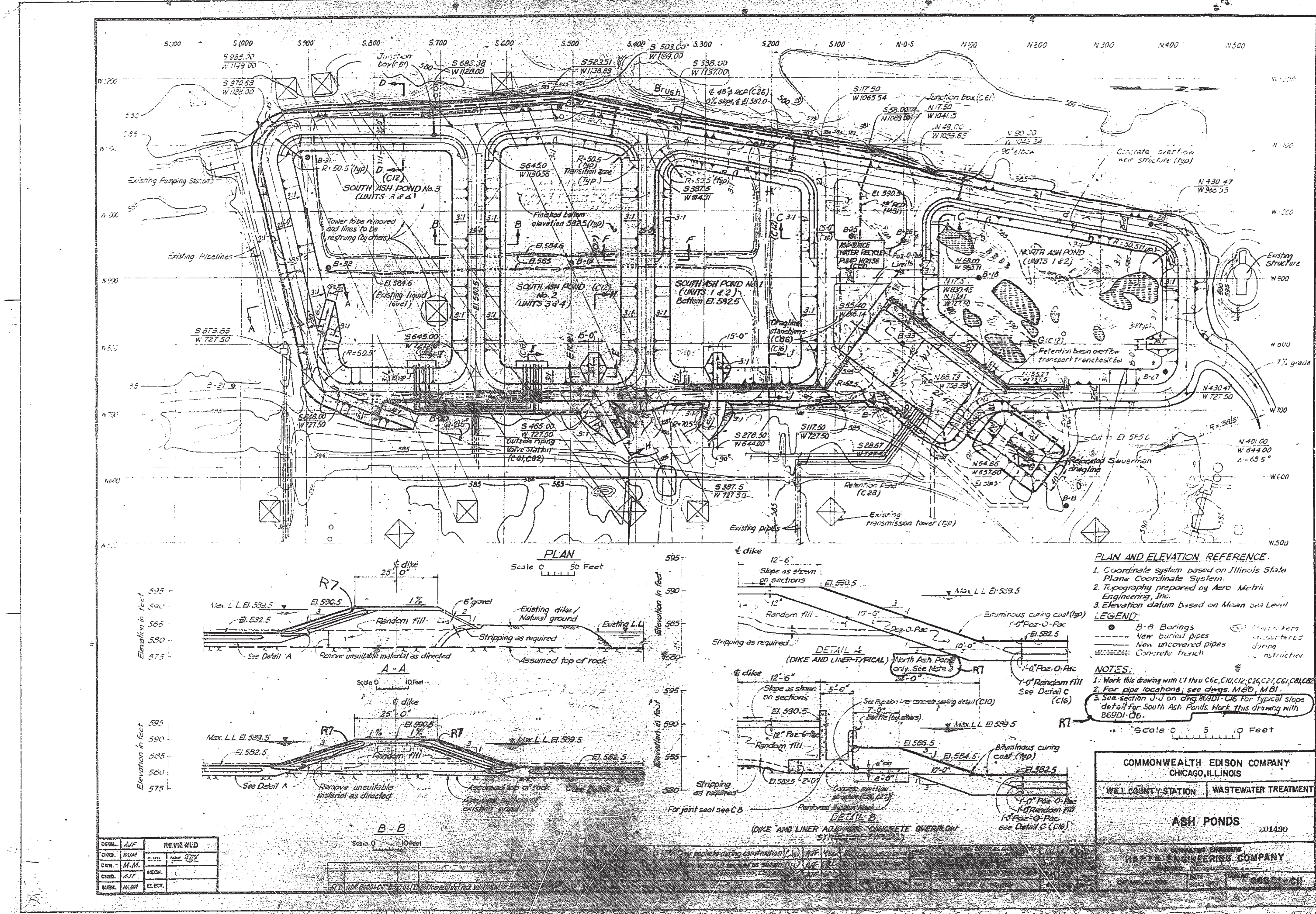
United States Environmental Protection Agency, 2015. Storm Water Management Model User's Manual Version 5.1. EPA/600/R-14/413b, Revised September, 2015.

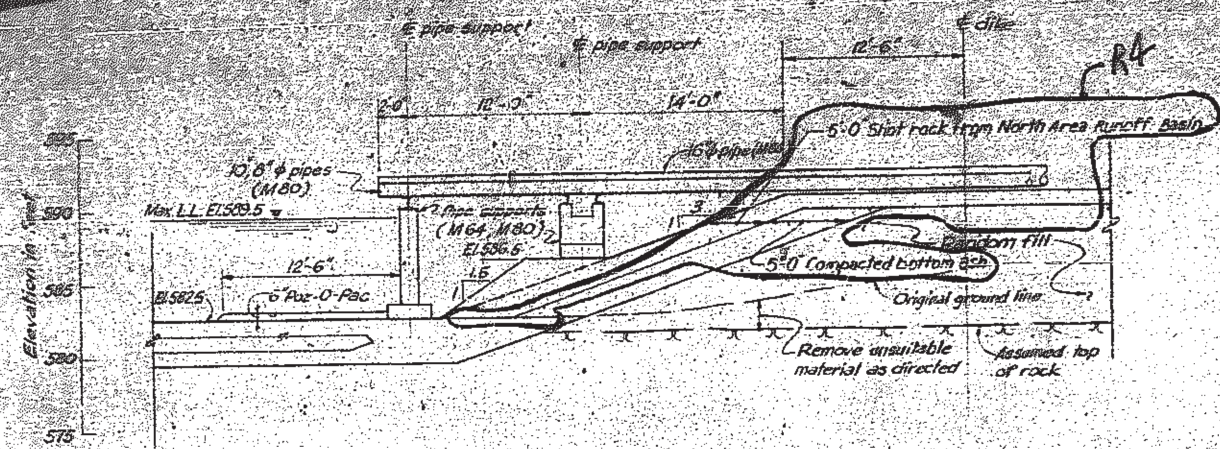
Attachments

Attachment A: Design Drawings
Attachment B: NOAA Atlas 14
Attachment C: 3S Emergency Overflow Structure Curve
Attachment D: Hydrographs
Attachment E: SWMM Files

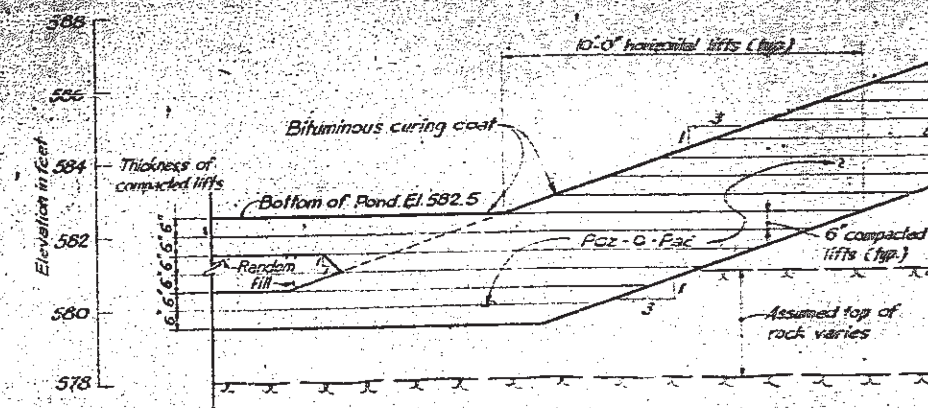
ATTACHMENT A

DESIGN DRAWINGS

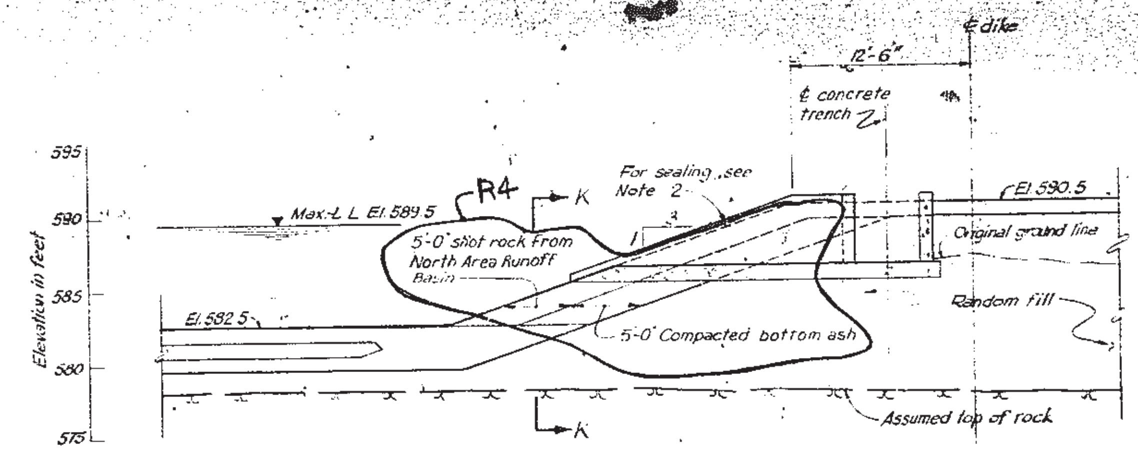

SOUTH ASH POND No. 3 (UNITS 1&2 & 1)
SOUTH ASH POND No. 2 (UNITS 3 & 4)
SOUTH ASH POND No. 1 (UNITS 1 & 2) Bottom El. 582.5
NORTH ASH POND (UNITS 1 & 2)
Existing Pumping Station
Existing Pipelines
Existing Structure
Retention Pond (C28)
Existing transmission tower (typ)
Existing pipes
Relocated Sauerman dragline
Concrete overflow weir structure (typ)
Finished bottom elevation 582.5 (typ)
Tower to be removed and lines to be restrung (by others)
PLAN
Scale 0 50 Feet
A-A
Scale 0 10 Feet
B-B
Scale 0 10 Feet
DETAIL A (DIKE AND LINER-TYPICAL)
DETAIL B (DIKE AND LINER ADJOINING CONCRETE OVERFLOW STRUCTURE-TYPICAL)
Random fill
Stripping as required
Remove unsuitable material as directed
Assumed top of rock
See Detail A
Elevation in feet
PLAN AND ELEVATION REFERENCE:
1. Coordinate system based on Illinois State Plane Coordinate System.
2. Topography prepared by Aero-Metric Engineering, Inc.
3. Elevation datum based on Mean Sea Level
LEGEND:
B-8 Borings
New buried pipes
New uncovered pipes
Concrete trench
NOTES:
1. Work this drawing with C1 thru C6c, C10, C12, C26, C27, C61, C81, C82.
2. For pipe locations, see dwgs. M80, M81.
3. See section J-J on dwg. 869D1-C16 for typical slope detail for South Ash Ponds. Work this drawing with 869D1-C6.
Scale 0 5 10 Feet
COMMONWEALTH EDISON COMPANY
CHICAGO, ILLINOIS
WILL COUNTY STATION
WASTEWATER TREATMENT
ASH PONDS
201490
HARZA ENGINEERING COMPANY
869D1-C11
REVIEWED



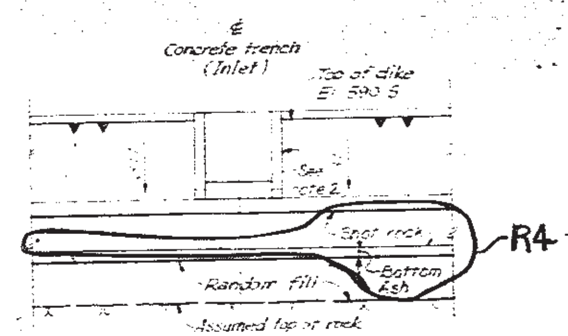
I - I (C11)
Scale 0 5 Feet



DETAIL C
(POZ-O-PAC PLACEMENT IN ASH POND)
Scale 0 2 Feet



J - J (C11)
Scale 0 5 Feet



K - K
Scale 0 5 Feet

NOTES:

1. Work this drawing with C1 thru C6c, C11 and C12.
2. Apply joint sealant as directed by the Owner's Representative, at concrete/Poz-O-Pac joints.

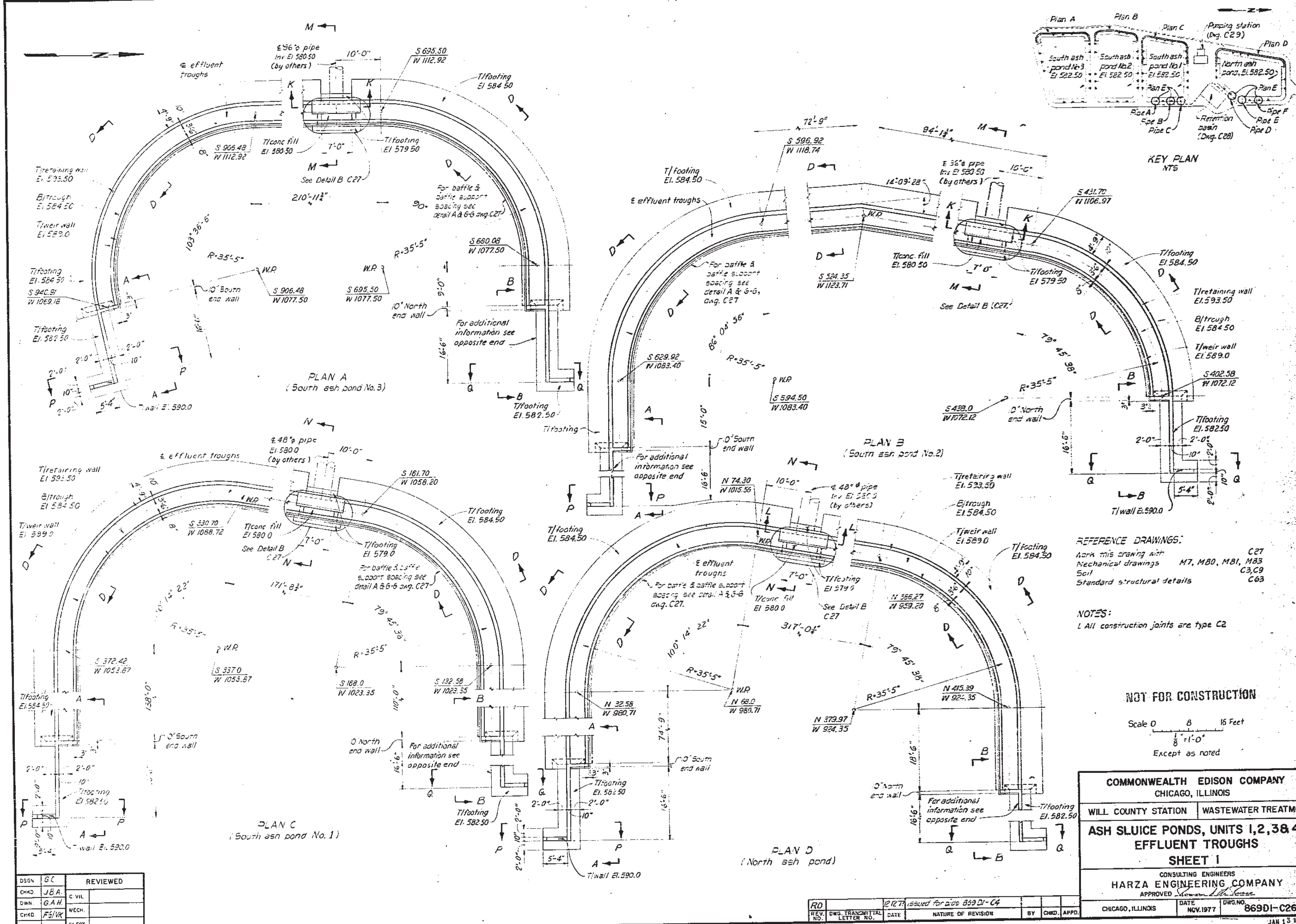
COMMONWEALTH EDISON COMPANY
CHICAGO, ILLINOIS

WILL COUNTY STATION	WASTEWATER TREATMENT

ASH POND SECTIONS & DETAILS

HARZA ENGINEERING COMPANY

DSGN.	AJF	REVIEWED	
CHKD.	WJM	CIVIL	
DWN.	MM	MECH.	
CHKD.	AJF	ELECT.	
SUBM.	AJF		



COMMONWEALTH EDISON COMPANY
CHICAGO, ILLINOIS

WILL COUNTY STATION	WASTEWATER TREATMENT

ASH SLUICE PONDS, UNITS 1,2,3 & 4
EFFLUENT TROUGHS
SHEET 1

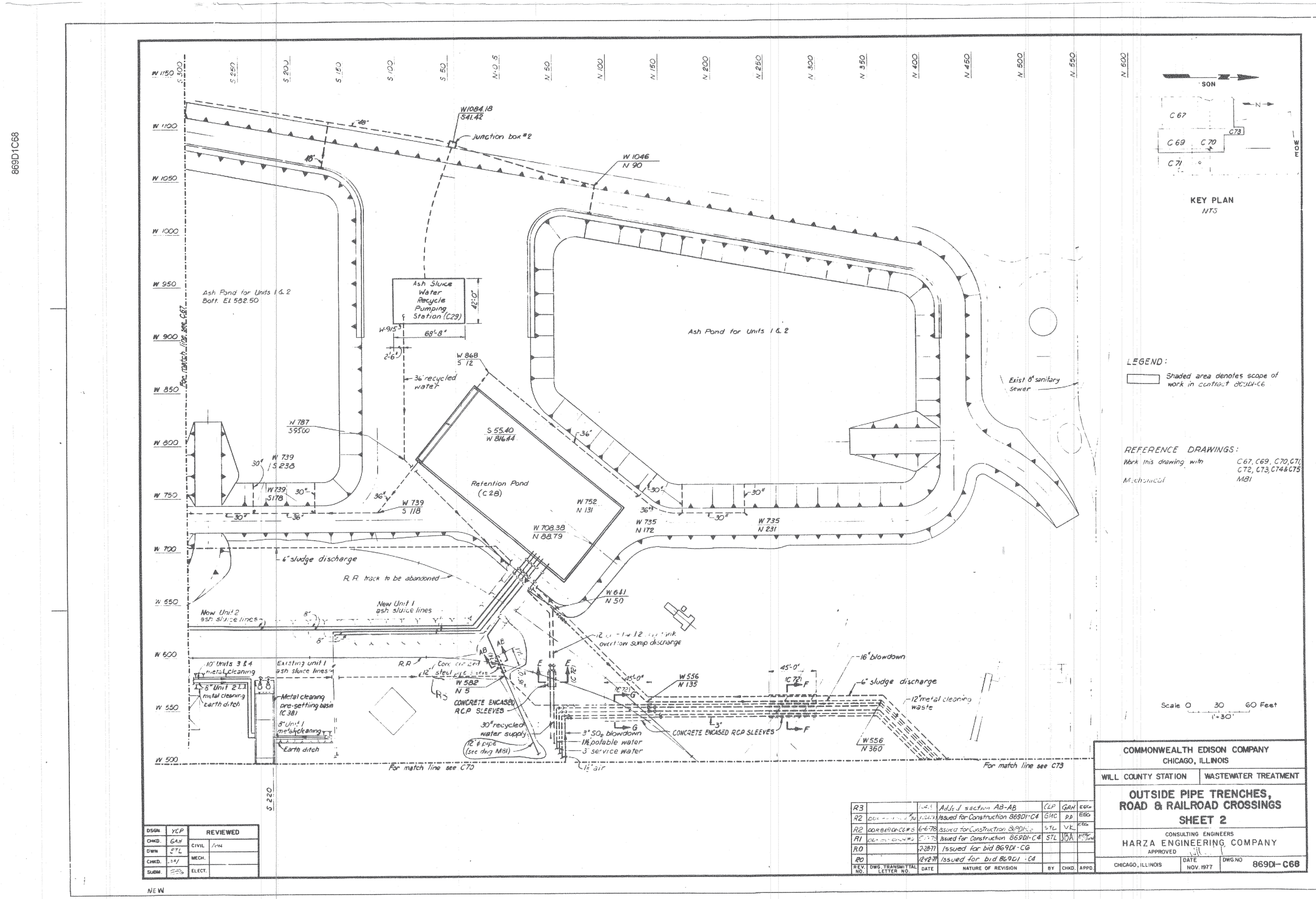
CONSULTING ENGINEERS
HARZA ENGINEERING COMPANY
APPROVED

CHICAGO, ILLINOIS	DATE NOV. 1977	DWG. NO. 869DI-C26

JAN 13 1978 C4

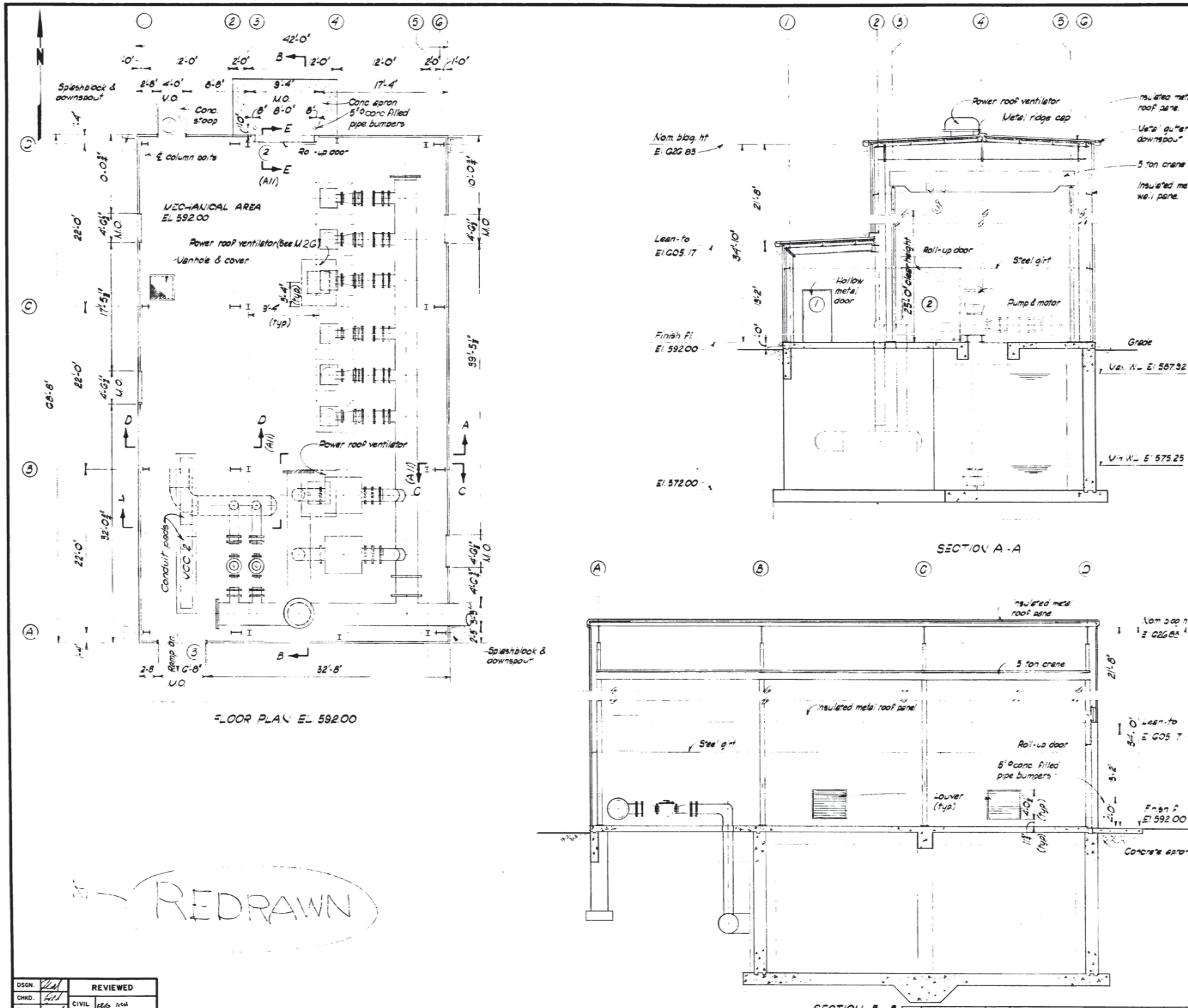
REV. NO.	DWG. TRANSMITTAL LETTER NO.	DATE	NATURE OF REVISION	BY	CHKD.	APPD.
RO		12/2/77	Issued for bids 869DI-C4			

		REVIEWED	
DSGN.	GC		
CHKD.	JBA	C. VIL.	
DWN.	GAH	MECH.	
CHKD.	FS/VK		
SUBM.		ELECT.	



869D1C68
KEY PLAN
NTS
LEGEND:
Shaded area denotes scope of work in contract 869D1-C6
REFERENCE DRAWINGS:
Work this drawing with C67, C69, C70, C71, C72, C73, C74 & C75
Mechanical M81
Ash Pond for Units 1 & 2
Bott. El. 582.50
Ash Sluice Water Recycle Pumping Station (C29)
Retention Pond (C28)
Junction box #2
36" recycled water
6" sludge discharge
R.R. track to be abandoned
New Unit 1 ash sluice lines
New Unit 2 ash sluice lines
12" overflow sump discharge
16" blowdown
6" sludge discharge
12" metal cleaning waste
Exist 8" sanitary sewer
10" Units 3 & 4 metal cleaning
Existing unit 1 ash sluice lines
5" Unit 2 & 1 metal cleaning earth ditch
Metal cleaning ore-settling basin (C38)
8" Unit 1 metal cleaning
Earth ditch
CONCRETE ENCASED RCP SLEEVES
30" recycled water supply
12" pipe (see dwg M81)
3" SO_2 blowdown
1½" potable water
3" service water
1½" air
For match line see C70
For match line see C73
Scale 0 30 60 Feet
1" = 30'
COMMONWEALTH EDISON COMPANY
CHICAGO, ILLINOIS
WILL COUNTY STATION
WASTEWATER TREATMENT
OUTSIDE PIPE TRENCHES, ROAD & RAILROAD CROSSINGS
SHEET 2
CONSULTING ENGINEERS
HARZA ENGINEERING COMPANY
APPROVED
CHICAGO, ILLINOIS
DATE NOV. 1977
DWG. NO 869D1-C68
R3 Added section AB-AB CLP GAH EEG
R2 Issued for Construction 869D1-C4 GMC DD EEG
R2 DDR869D1-C6#3 6-6-78 Issued for Construction 869D1-C6 STL VK EEG
R1 Issued for Construction 869D1-C4 STL JBA
R0 2-28-77 Issued for bid 869D1-C6
R0 12-12-77 Issued for bid 869D1-C4
REV. NO. DWG. TRANSMITTAL LETTER NO. DATE NATURE OF REVISION BY CHKD. APPD.
DSGN. YCP
CHKD. GAH
DWN STL
REVIEWED
CIVIL
MECH.
ELECT.
NEW

869D1A9



DOOR SCHEDULE

Door type (1): 1 Required (Exterior)

- Door size - 3'-0" x 7'-0"
- Door type - Hollow metal
- Frame type - Pressed steel
- Mfr's opng - 4'-0" x 7'-2½"
- Hardware - 1½ pair butts
  - 1 Lockset type Exterior door
  - 1 Closer
  - 1 Threshold

Door type (2): 1 Required (Exterior)

- Door size 8'-0" x 10'-0"
- Door type Roll-up
- Frame type Steel
- Mfr's opng 8'-4" x 10'-0"
- Hardware See Specification

Door type (3): 1 Required (Exterior)

- Door size - (2) 3'-0" x 7'-0"
- Door type - Hollow metal
- Frame type - Pressed steel
- Mfr's opng - 6'-8" x 7'-2½"
- Hardware - 3 pair butts
  - 1 Lockset type Exterior door
  - 1 Closer on active leaf
  - 1 Threshold
  - 2 Flush bolts
  - 2 Strikes

NOTES

1. Exterior swinging doors are part of the metal building work. See specifications for hardware description.
2. Framing members shall be designed by metal building manufacturer to work within these overall dimensions.
3. Metal building manufacturer shall supply anchor bolts, setting plates and their layout to concrete contractor before concrete is placed. Anchor bolt layout shall be verified and accepted by metal building contractor before starting erection. No cutting of bearing plates will be allowed.
4. Metal building maufacturer shall design, furnish and install the necessary beam and supporting members for a 5-ton crane.
5. Openings through metal wall and roof for pipes, ducts etc. shall be provided with sleeves, flashing, sealants and necessary reinforcement as required. See Mechanical drawings for size and location.

REFERENCE DRAWINGS:

Work this drawing with 869D

Architecture A'0 & A

Civil: C29

Electrical: 8E-3545

Mechanical: M2G

Scale 0 1 2 Feet

¼" = 1'-0"

DSGN.		REVIEWED	
CHKD.		CIVIL	
DWN.		MECH.	
CHKD.		ELECT.	
SUBM.			

REV. NO.	DWG. TRANSMITTAL LETTER NO.	DATE	NATURE OF REVISION	BY	CHKD.	APPD.
R1			Issued for Construction 869D1-26			
R1			Issued for Construction 869D1-09			

COMMONWEALTH EDISON COMPANY
CHICAGO, ILLINOIS

WILL COUNTY STATION | WATER TREATMENT

ASH SLUICE WATER RECYCLE PUMP HOUSE PLAN & SECTION

CONSULTING ENGINEERS
HARZA ENGINEERING COMPANY
APPROVED
CHICAGO, ILLINOIS

DATE June 1975

DWG. NO. 869D1-A9

ATTACHMENT B

NOAA ATLAS 14

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: IL

Data description

Data type: Precipitation depth ▼ **Units:** English ▼ **Time series type:** Partial duration ▼

Select location

1) Manually:

a) By location

◉ Decimal degrees ○ Degrees, decimal minutes ○ Degrees, minutes, seconds

Latitude: ____.____° N Longitude: ____.____° E Submit

b) By station

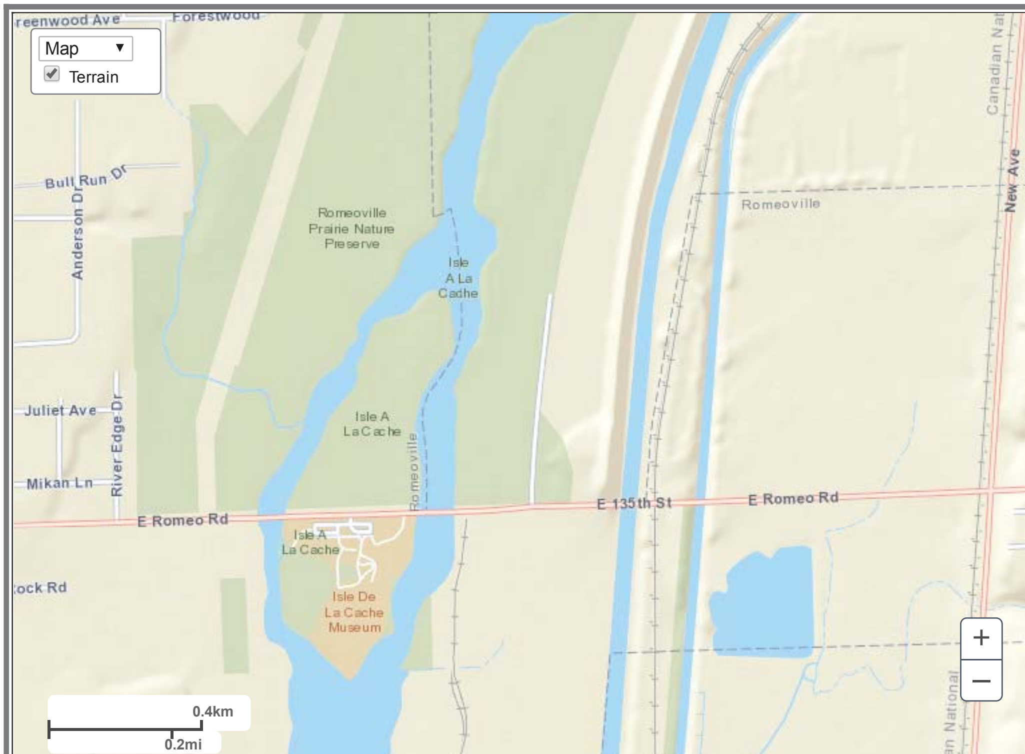
Click here for a list of stations used in frequency analysis for IL:

Select station ▼

c) By address

Search

2) Use map:



a) Select location

Move crosshair or double click

b) Click on station icon

☐ Show stations on map

Location information:
Name: Lockport, Illinois, USA*
Latitude: 41.5638° N
Longitude: -88.0754° E
Elevation: 562.95 ft **

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 2, Version 3

PF tabular PF graphical Supplementary information Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.387** (0.348-0.431)	**0.435** (0.395-0.480)	**0.484** (0.439-0.534)	**0.578** (0.523-0.637)	**0.661** (0.595-0.730)	**0.756** (0.674-0.838)	**0.840** (0.742-0.936)	**0.932** (0.812-1.05)	**1.05** (0.896-1.19)	**1.18** (0.993-1.37)
10-min	**0.601** (0.541-0.670)	**0.679** (0.616-0.749)	**0.752** (0.683-0.830)	**0.891** (0.807-0.983)	**1.01** (0.910-1.12)	**1.15** (1.02-1.27)	**1.26** (1.12-1.41)	**1.39** (1.21-1.56)	**1.54** (1.32-1.75)	**1.72** (1.45-1.99)
15-min	**0.737** (0.664-0.821)	**0.830** (0.753-0.917)	**0.923** (0.838-1.02)	**1.10** (0.993-1.21)	**1.25** (1.12-1.38)	**1.42** (1.26-1.57)	**1.57** (1.39-1.75)	**1.73** (1.51-1.95)	**1.92** (1.64-2.18)	**2.16** (1.81-2.49)

30-min	**0.975** (0.878-1.09)	**1.11** (1.01-1.23)	**1.26** (1.15-1.40)	**1.52** (1.38-1.68)	**1.76** (1.59-1.95)	**2.03** (1.81-2.25)	**2.27** (2.00-2.53)	**2.53** (2.20-2.84)	**2.84** (2.44-3.23)	**3.23** (2.71-3.73)
60-min	**1.19** (1.07-1.33)	**1.36** (1.24-1.50)	**1.59** (1.44-1.75)	**1.94** (1.75-2.14)	**2.29** (2.06-2.52)	**2.67** (2.38-2.96)	**3.03** (2.68-3.38)	**3.43** (2.98-3.85)	**3.93** (3.37-4.47)	**4.54** (3.80-5.24)
2-hr	**1.38** (1.24-1.54)	**1.59** (1.44-1.76)	**1.86** (1.69-2.06)	**2.29** (2.07-2.53)	**2.72** (2.44-3.02)	**3.21** (2.85-3.56)	**3.67** (3.23-4.09)	**4.17** (3.62-4.68)	**4.81** (4.11-5.46)	**5.58** (4.66-6.42)
3-hr	**1.49** (1.33-1.67)	**1.71** (1.55-1.91)	**2.02** (1.82-2.25)	**2.49** (2.24-2.78)	**2.97** (2.66-3.32)	**3.52** (3.11-3.93)	**4.03** (3.53-4.53)	**4.59** (3.97-5.20)	**5.32** (4.51-6.08)	**6.19** (5.14-7.17)
6-hr	**1.77** (1.58-2.01)	**2.04** (1.83-2.30)	**2.42** (2.16-2.73)	**3.04** (2.70-3.43)	**3.70** (3.27-4.18)	**4.48** (3.90-5.06)	**5.24** (4.50-5.95)	**6.12** (5.16-6.98)	**7.29** (6.01-8.40)	**8.73** (7.00-10.2)
12-hr	**2.06** (1.82-2.36)	**2.36** (2.10-2.69)	**2.78** (2.47-3.17)	**3.47** (3.06-3.95)	**4.21** (3.69-4.79)	**5.06** (4.39-5.77)	**5.91** (5.05-6.76)	**6.87** (5.78-7.91)	**8.15** (6.70-9.47)	**9.73** (7.77-11.5)
24-hr	**2.40** (2.15-2.70)	**2.90** (2.61-3.28)	**3.70** (3.30-4.18)	**4.40** (3.90-4.97)	**5.49** (4.79-6.21)	**6.49** (5.58-7.40)	**7.65** (6.46-8.78)	**9.03** (7.45-10.5)	**11.2** (8.98-13.3)	**13.3** (10.3-16.0)
2-day	**2.78** (2.48-3.14)	**3.35** (3.00-3.79)	**4.23** (3.76-4.79)	**4.98** (4.41-5.65)	**6.16** (5.36-7.02)	**7.22** (6.19-8.29)	**8.44** (7.13-9.79)	**9.88** (8.15-11.6)	**12.2** (9.72-14.6)	**14.2** (11.1-17.4)
3-day	**2.95** (2.68-3.29)	**3.54** (3.22-3.95)	**4.43** (4.00-4.94)	**5.21** (4.67-5.83)	**6.43** (5.68-7.26)	**7.56** (6.56-8.61)	**8.88** (7.56-10.2)	**10.4** (8.68-12.2)	**13.0** (10.4-15.6)	**15.4** (12.0-18.9)
4-day	**3.12** (2.88-3.43)	**3.73** (3.44-4.11)	**4.63** (4.25-5.09)	**5.43** (4.94-6.01)	**6.71** (6.00-7.50)	**7.90** (6.94-8.94)	**9.31** (8.00-10.7)	**11.0** (9.21-12.9)	**13.8** (11.1-16.6)	**16.5** (12.9-20.4)
7-day	**3.65** (3.39-3.97)	**4.33** (4.03-4.72)	**5.26** (4.88-5.73)	**6.09** (5.61-6.66)	**7.42** (6.72-8.20)	**8.63** (7.69-9.65)	**10.1** (8.78-11.4)	**11.8** (10.0-13.6)	**14.6** (11.9-17.4)	**17.2** (13.7-21.0)
10-day	**4.13** (3.87-4.45)	**4.89** (4.58-5.27)	**5.87** (5.49-6.34)	**6.75** (6.27-7.31)	**8.12** (7.43-8.87)	**9.37** (8.44-10.3)	**10.8** (9.56-12.1)	**12.5** (10.8-14.3)	**15.2** (12.7-17.9)	**17.9** (14.5-21.5)
20-day	**5.62** (5.28-6.00)	**6.63** (6.23-7.09)	**7.83** (7.35-8.37)	**8.87** (8.29-9.50)	**10.4** (9.65-11.3)	**11.8** (10.8-12.9)	**13.4** (12.0-14.8)	**15.2** (13.4-17.0)	**18.0** (15.4-20.7)	**20.5** (17.1-24.0)
30-day	**6.98** (6.60-7.42)	**8.21** (7.76-8.72)	**9.55** (9.01-10.1)	**10.7** (10.0-11.4)	**12.3** (11.5-13.2)	**13.7** (12.7-14.8)	**15.3** (13.9-16.7)	**17.0** (15.3-18.8)	**19.6** (17.2-22.2)	**21.8** (18.8-25.2)
45-day	**8.78** (8.31-9.28)	**10.3** (9.76-10.9)	**11.8** (11.2-12.5)	**13.1** (12.3-13.9)	**14.9** (13.9-15.9)	**16.4** (15.2-17.6)	**18.0** (16.5-19.4)	**19.7** (17.9-21.6)	**22.2** (19.9-24.8)	**24.3** (21.4-27.6)
60-day	**10.6** (10.1-11.2)	**12.4** (11.8-13.1)	**14.2** (13.5-15.0)	**15.7** (14.8-16.5)	**17.7** (16.6-18.8)	**19.3** (18.0-20.6)	**21.0** (19.5-22.7)	**22.9** (20.9-24.9)	**25.5** (23.0-28.2)	**27.6** (24.6-31.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates ▼ Submit

Main Link Categories:
Home | OWP(OHD)

ATTACHMENT C

3S EMERGENCY OVERFLOW STRUCTURE CURVE

The outlet from the emergency overflow spillway in the vicinity of Pond 3S is controlled in the model by a stage-discharge table that was constructed by combining the flow from a 30-in rectangular weir at elevation 588.5 ft. and a 80-in by 40-in grated outlet at an elevation of 589.5 ft. Curves for both outlets were created based on the weir and orifice equation respectively and combined to generate a composite curve.

Weir Equation:

$Q \text{ (cfs)} = Cd*L*H^{3/2}$

Where,

Cd is the coefficient of discharge, assumed to be 3.33 (SWMM Users Manual),

L is the length of the weir (ft), and

H is the head above the weir (ft)

Orifice Equation:

Q (cfs)= Cd*A* sqrt(2*g*H)

Where,

Cd is the coefficient of discharge for a submerged orifice, assumed to be 0.6 (SWMM Users Manual),

A is the area of the orifice,

g is the gravitational constant (32.2 ft/s^2), and

H is the head above the weir (ft)

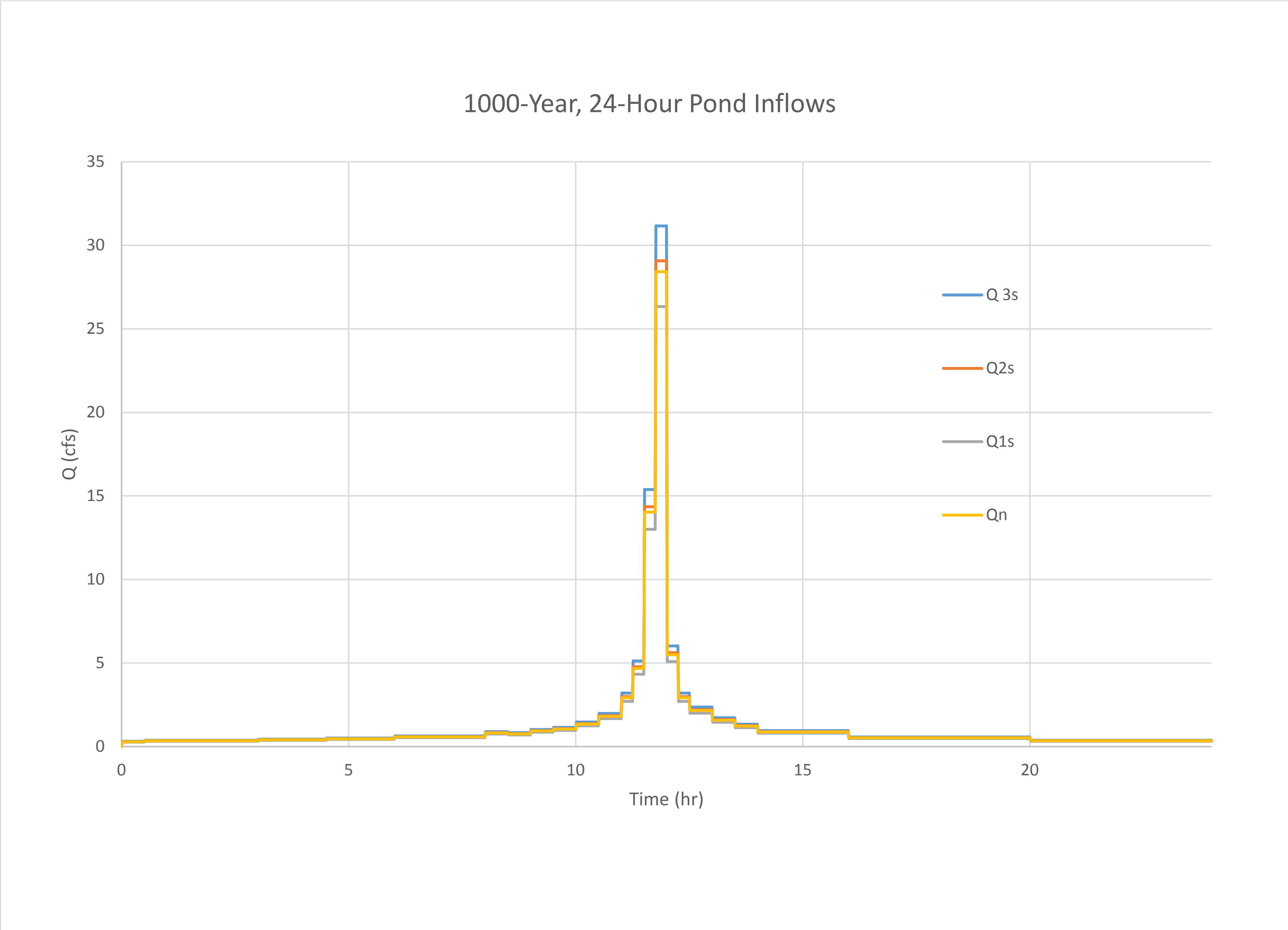
A clogging factor of 0.5 was applied to the resulting orifice flow to account for reduced flow area due to the grate and potential trapping of debris.

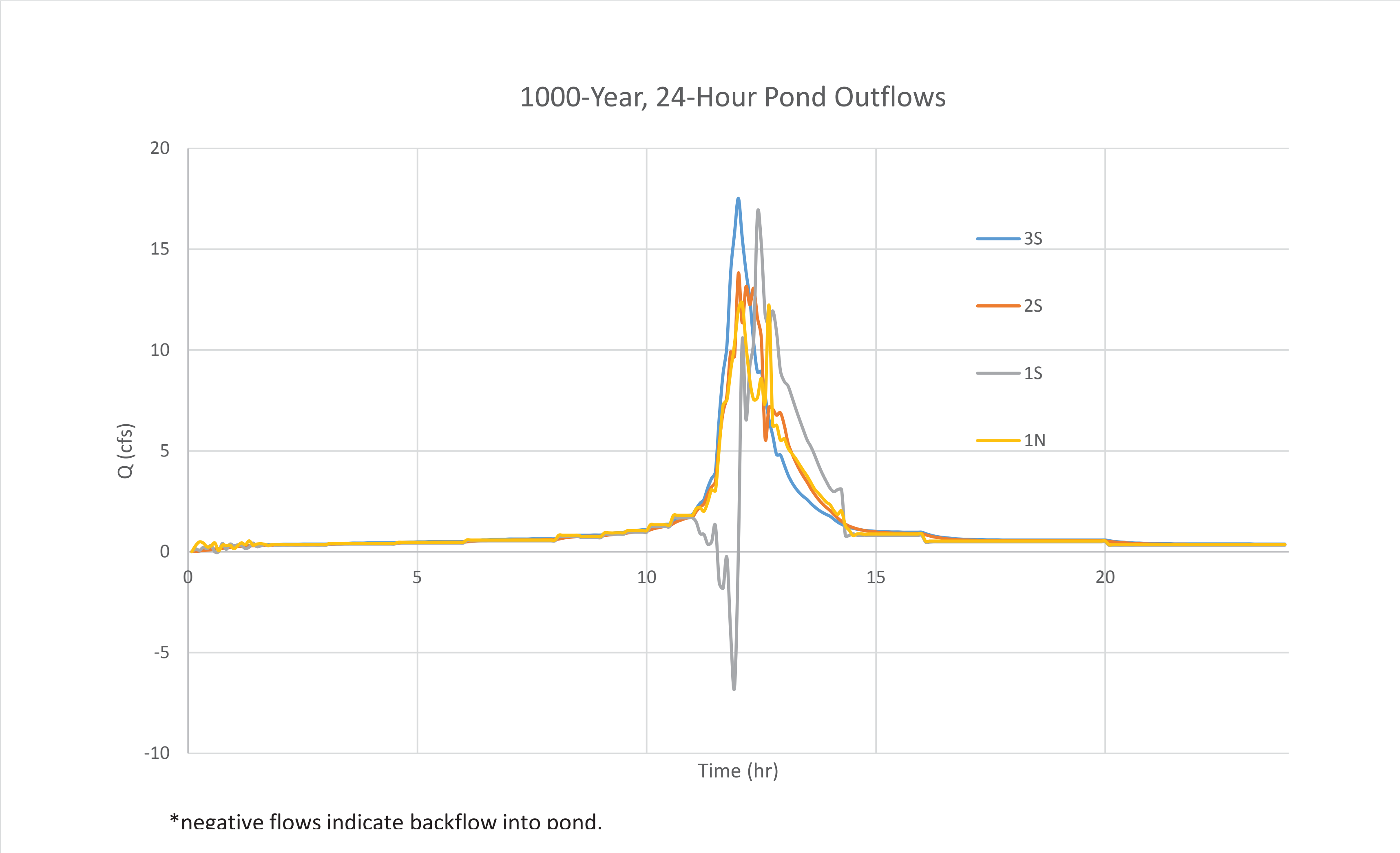
The combined outflow curve is provided below.

H (ft)	Q (cfs)	H (ft)	Q (cfs)
0	0.00	1.1	9.6
0.1	0.26	1.2	11
0.2	0.74	1.3	12
0.3	1.4	1.4	14
0.4	2.1	1.5	15
0.5	2.9	1.6	17
0.6	3.9	1.7	18
0.7	4.9	1.8	20
0.8	6.0	1.9	22
0.9	7.1	2	24
1	8.3		

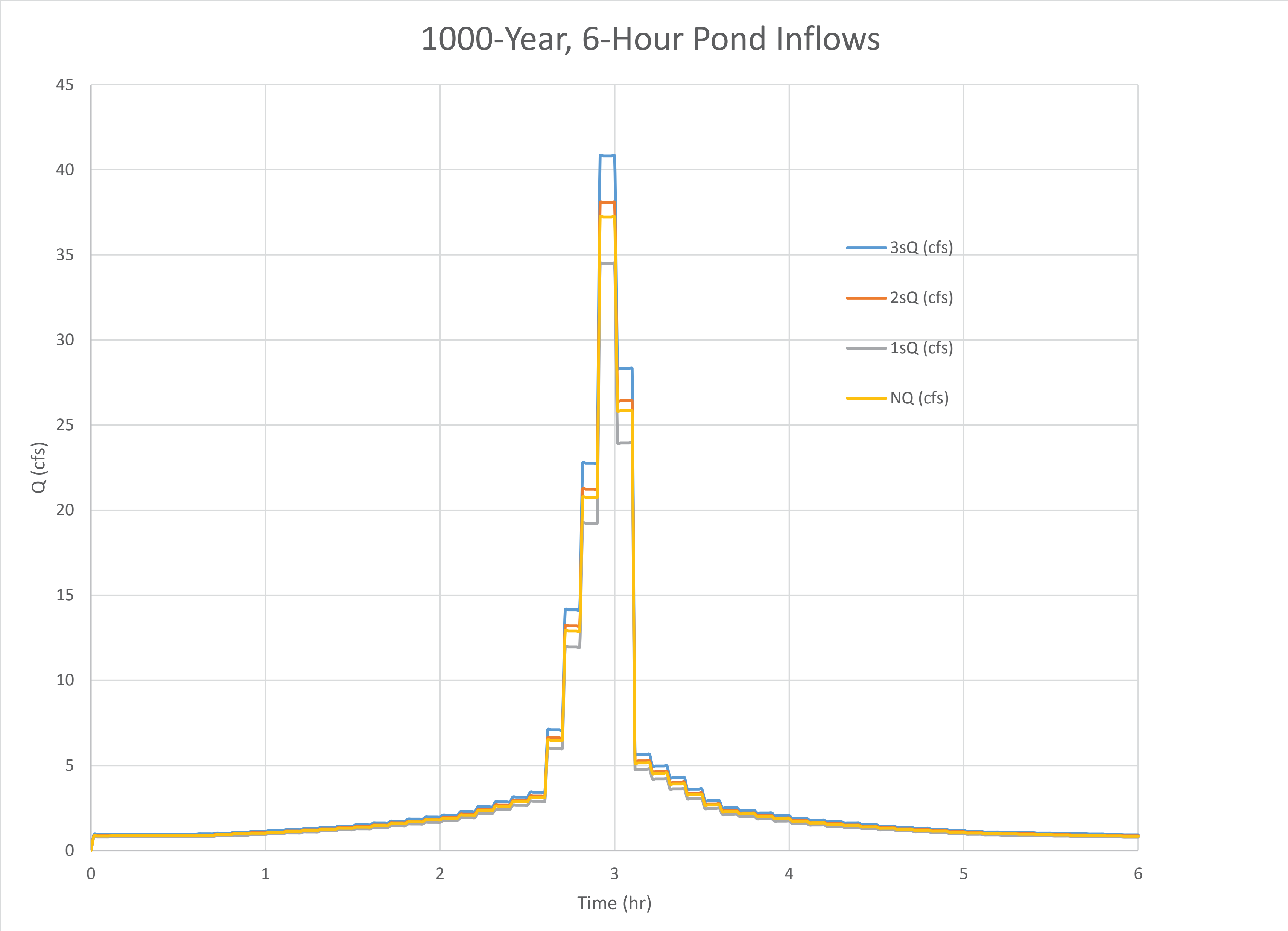
ATTACHMENT D

HYDROGRAPHS

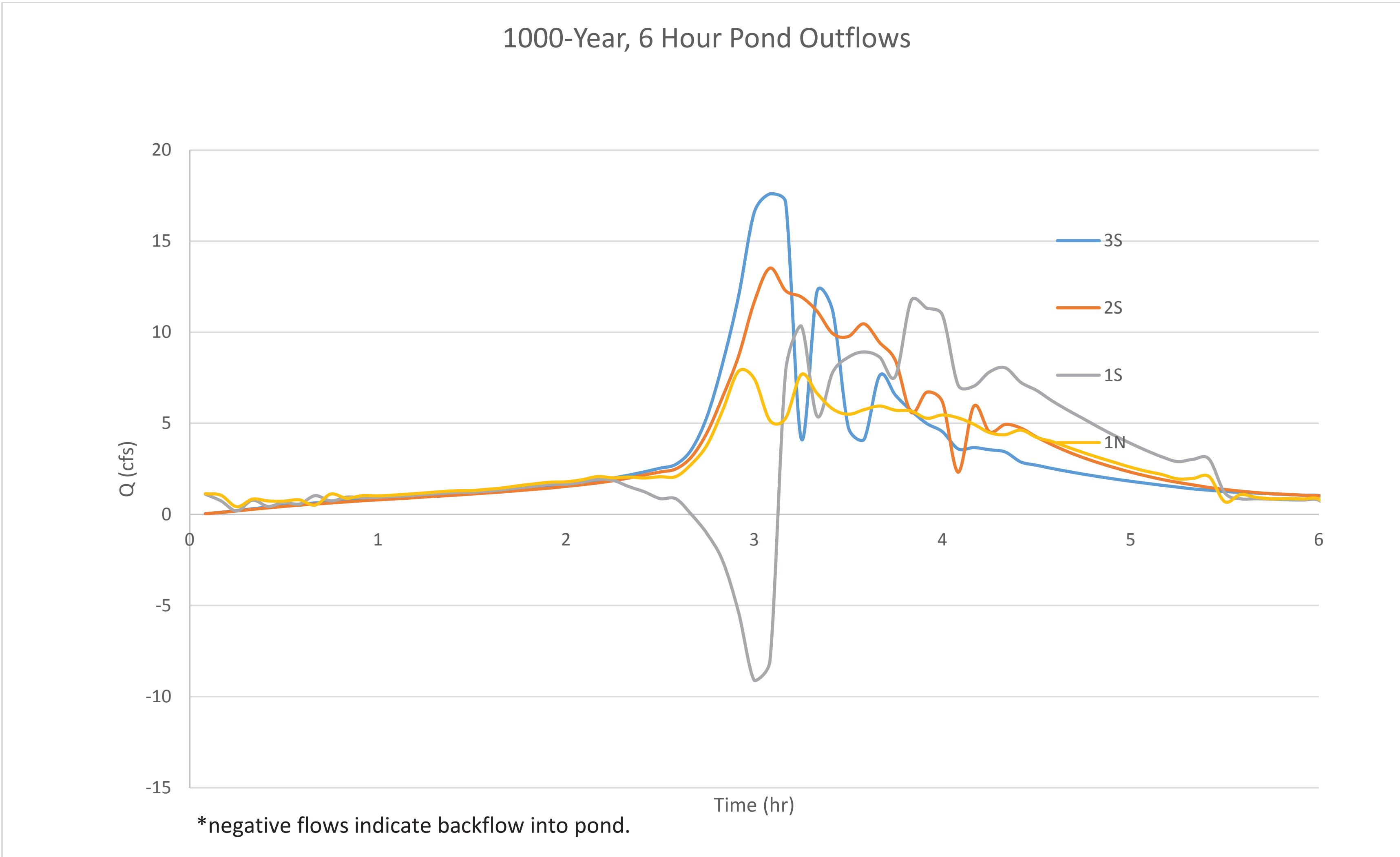

1000-Year, 24-Hour Pond Inflows
35
30
25
20
15
10
5
0
Q (cfs)
0
5
10
15
20
Time (hr)
Q 3s
Q2s
Q1s
Qn



Note on hydrograph results: The observed multi-peak nature of the outflow hydrographs depicts the attenuated peak flows (from each of the ponds) as they are routed past the respective pond/collector junction. The temporal distribution of the peaks is characterized by the travel time within the system and the dynamic storage characteristics of the ponds and system.



1000-Year, 6-Hour Pond Inflows
Q (cfs)
Time (hr)
3sQ (cfs)
2sQ (cfs)
1sQ (cfs)
NQ (cfs)
0
5
10
15
20
25
30
35
40
45
0
1
2
3
4
5
6



Note on hydrograph results: The observed multi-peak nature of the outflow hydrographs depicts the attenuated peak flows (from each of the ponds) as they are routed past the respective pond/collector junction. The temporal distribution of the peaks is characterized by the travel time within the system and the dynamic storage characteristics of the ponds and system..

ATTACHMENT E

SWMM Files

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.011)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 2
WARNING 04: minimum elevation drop used for Conduit 3
WARNING 04: minimum elevation drop used for Conduit 4
WARNING 04: minimum elevation drop used for Conduit 13
WARNING 02: maximum depth increased for Node 1

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Starting Date ............ 09/28/2016 00:00:00
Ending Date .............. 09/28/2016 23:59:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 0.10 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


**************************        Volume         Volume
Flow Routing Continuity        acre-feet       10^6 gal
**************************     ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......         0.000          0.000
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
```

```
External Inflow ..........         6.683         2.178
External Outflow .........         6.681         2.177
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.228         0.074
Final Stored Volume ......         0.237         0.077
Continuity Error (%) .....        -0.091


*************************
Highest Continuity Errors
*************************
Node Pond-11 (8.01%)
Node 3 (4.63%)
Node Pond-10 (-1.66%)
Node 4 (1.07%)


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
Link 8 (7)
Link 12 (6)
Link 7 (6)
Link 2 (6)
Link 14 (6)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.10 sec
Average Time Step           :     0.10 sec
Maximum Time Step           :     0.10 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.35
Percent Not Converging      :     5.81


******************
Node Depth Summary
```

****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
1	JUNCTION	8.66	9.82	589.82	0 03:06	9.81
2	JUNCTION	8.67	20.37	600.37	0 00:14	9.96
3	JUNCTION	8.67	10.08	590.08	0 03:18	10.02
4	JUNCTION	8.67	10.03	590.03	0 03:06	10.02
5	JUNCTION	8.67	10.06	590.06	0 03:09	10.00
Pond-10	JUNCTION	8.16	9.50	590.00	0 03:06	9.45
Pond-11	JUNCTION	8.17	9.53	590.03	0 03:06	9.51
9	JUNCTION	0.00	0.00	580.00	0 00:00	0.00
6	OUTFALL	0.00	0.00	588.50	0 00:00	0.00
7	OUTFALL	0.00	0.00	590.00	0 00:00	0.00
8	OUTFALL	0.00	0.00	589.50	0 00:00	0.00
Pond3s	STORAGE	0.03	0.49	589.99	0 03:06	0.47
Pond2s	STORAGE	0.03	0.53	590.03	0 03:06	0.50
Pond1s	STORAGE	6.17	7.48	589.98	0 03:08	7.48
Pond1N	STORAGE	6.17	7.59	590.09	0 03:06	7.56

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
1	JUNCTION	0.00	42.85	0 03:06	0	2.19	0.404
2	JUNCTION	0.00	26.74	0 03:30	0	1.62	0.100
3	JUNCTION	0.00	26.63	0 03:28	0	1.23	4.850

4	JUNCTION	0.00	19.62	0	03:06	0	0.692	1.083
5	JUNCTION	0.00	23.28	0	03:09	0	0.483	0.000
Pond-10	JUNCTION	0.00	21.21	0	03:02	0	0.56	-1.629
Pond-11	JUNCTION	0.00	17.04	0	03:03	0	0.546	8.708
9	JUNCTION	6.32	6.32	0	02:55	0.0877	0.0877	0.000
6	OUTFALL	0.00	42.84	0	03:06	0	2.18	0.000
7	OUTFALL	0.00	0.45	0	03:06	0	0.000787	0.000
8	OUTFALL	0.00	0.00	0	00:00	0	0	0.000 gal
Pond3s	STORAGE	40.81	40.81	0	02:55	0.566	0.566	1.043
Pond2s	STORAGE	38.08	38.08	0	02:55	0.528	0.528	-3.251
Pond1s	STORAGE	34.49	44.49	0	02:59	0.479	0.529	-2.517
Pond1N	STORAGE	37.22	37.22	0	02:55	0.517	0.522	8.421

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
1	JUNCTION	23.39	1.320	0.000
2	JUNCTION	23.98	16.374	0.000
3	JUNCTION	23.42	2.084	0.916
5	JUNCTION	23.43	2.064	0.936
Pond-10	JUNCTION	23.98	6.496	1.504
Pond-11	JUNCTION	23.98	6.535	1.465
9	JUNCTION	23.98	0.000	0.000

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
Pond3s	1.494	3	0	0	26.563	49	0 03:06	21.21
Pond2s	1.813	3	0	0	28.622	53	0 03:06	17.04
Pond1s	2.178	2	0	0	42.591	49	0 03:08	16.14
Pond1N	1.200	3	0	0	25.887	59	0 03:06	23.28

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
6	78.91	4.27	42.84	2.176
7	0.67	0.18	0.45	0.001
8	0.00	0.00	0.00	0.000
System	26.53	4.45	43.17	2.177

****
Link Flow Summary

****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	CONDUIT	26.74	0	03:30	2.13	10.06	1.00
2	CONDUIT	20.30	0	03:28	1.62	5.26	1.00
3	CONDUIT	19.15	0	03:06	1.52	4.57	1.00
4	CONDUIT	17.51	0	03:07	1.39	4.61	1.00
12	CONDUIT	11.66	0	03:00	1.65	0.18	1.00
11	CONDUIT	18.12	0	03:06	2.56	0.26	1.00
9	CONDUIT	8.96	0	03:25	0.71	0.03	1.00
10	CONDUIT	9.87	0	03:07	0.79	0.03	1.00
13	DUMMY	6.32	0	02:55			
5	PUMP	0.00	0	00:00			
6	ORIFICE	0.45	0	03:06			
7	WEIR	21.21	0	03:02			0.50
8	WEIR	17.04	0	03:03			0.53
14	WEIR	14.49	0	03:10			0.56
15	WEIR	13.90	0	03:09			0.59
16	DUMMY	42.84	0	03:06			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
		---------- Fraction of Time in Flow Class ----------								
1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
4	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	

0.00

12	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
11	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
9	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
10	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

	--------- Hours Full --------			Hours Above Full Normal Flow	Hours Capacity Limited
Conduit	Both Ends	Upstream	Dnstream		
1	23.98	23.98	23.98	5.19	0.49
2	23.98	23.98	23.98	3.15	0.62
3	23.98	23.98	23.98	1.90	0.77
4	23.98	23.98	23.98	1.88	2.11
12	23.98	23.98	23.98	0.01	0.01
11	23.98	23.98	23.98	0.01	0.01
9	23.58	23.58	23.98	0.01	0.01
10	23.57	23.57	23.98	0.01	0.01

****
Pumping Summary
****

Pump	Percent Utilized	Number of Start-Ups	Min Flow CFS	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal	Power Usage Kw-hr	% Time Off Pump Curve Low	High
5	0.00	0	0.00	0.00	0.00	0.000	0.00	0.0	0.0

```
Analysis begun on:  Mon Oct 10 17:27:38 2016
Analysis ended on:  Mon Oct 10 17:27:50 2016
Total elapsed time: 00:00:12
```

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.011)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 1
WARNING 04: minimum elevation drop used for Conduit 2
WARNING 04: minimum elevation drop used for Conduit 3
WARNING 04: minimum elevation drop used for Conduit 4
WARNING 04: minimum elevation drop used for Conduit 13
WARNING 02: maximum depth increased for Node 1

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Starting Date ............ 09/28/2016 00:00:00
Ending Date .............. 09/28/2016 23:59:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 0.10 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


**************************        Volume         Volume
Flow Routing Continuity        acre-feet       10^6 gal
**************************      ---------      ---------
Dry Weather Inflow .......          0.000          0.000
Wet Weather Inflow .......          0.000          0.000
Groundwater Inflow .......          0.000          0.000
RDII Inflow ..............          0.000          0.000
```

```
External Inflow ..........       10.182         3.318
External Outflow .........        9.838         3.206
Flooding Loss ............        0.000         0.000
Evaporation Loss .........        0.000         0.000
Exfiltration Loss ........        0.000         0.000
Initial Stored Volume ....        0.228         0.074
Final Stored Volume ......        0.286         0.093
Continuity Error (%) .....        2.753


*************************
Highest Continuity Errors
*************************
Node Pond-11 (5.72%)
Node 3 (4.06%)
Node Pond-10 (-1.46%)


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
Link 15 (14)
Link 14 (7)
Link 8 (7)
Link 10 (6)
Link 12 (6)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.10 sec
Average Time Step           :     0.10 sec
Maximum Time Step           :     0.10 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.27
Percent Not Converging      :     4.01


******************
Node Depth Summary
******************
```

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
1	JUNCTION	8.84	9.83	589.83	0 12:00	9.82
2	JUNCTION	8.85	22.37	602.37	0 00:35	9.99
3	JUNCTION	8.85	10.10	590.10	0 12:14	10.02
4	JUNCTION	8.85	10.05	590.05	0 12:00	10.05
5	JUNCTION	8.85	10.09	590.09	0 12:07	10.03
Pond-10	JUNCTION	8.34	9.51	590.01	0 12:00	9.46
Pond-11	JUNCTION	8.35	9.55	590.05	0 12:00	9.51
9	JUNCTION	0.00	0.00	580.00	0 00:00	0.00
6	OUTFALL	0.00	0.00	588.50	0 00:00	0.00
7	OUTFALL	0.00	0.00	590.00	0 00:00	0.00
8	OUTFALL	0.00	0.00	589.50	0 00:00	0.00
Pond3s	STORAGE	0.05	0.49	589.99	0 12:00	0.49
Pond2s	STORAGE	0.05	0.54	590.04	0 12:00	0.53
Pond1s	STORAGE	6.35	7.50	590.00	0 12:01	7.50
PondN	STORAGE	6.35	7.60	590.10	0 12:00	7.59

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
1	JUNCTION	0.00	43.42	0 12:00	0	3.22	0.280
2	JUNCTION	0.00	26.71	0 12:13	0	2.36	0.055
3	JUNCTION	0.00	26.07	0 12:21	0	1.69	4.233
4	JUNCTION	0.00	18.29	0 11:58	0		

							0.923	0.862
5	JUNCTION	0.00	21.65	0	11:55	0	0.792	0.000
Pond-10	JUNCTION	0.00	20.02	0	11:56	0	0.849	-1.436
Pond-11	JUNCTION	0.00	17.02	0	11:58	0	0.817	6.067
9	JUNCTION	4.82	4.82	0	11:46	0.134	0.134	0.000
6	OUTFALL	0.00	43.41	0	12:00	0	3.2	0.000
7	OUTFALL	0.00	0.84	0	12:00	0	0.00137	0.000
8	OUTFALL	0.00	0.00	0	00:00	0	0	0.000 gal
Pond3s	STORAGE	31.15	31.15	0	11:46	0.863	0.863	0.686
Pond2s	STORAGE	29.07	29.07	0	11:46	0.805	0.805	-2.350
Pond1s	STORAGE	26.33	38.19	0	11:59	0.729	0.761	-2.198
PondN	STORAGE	28.42	38.59	0	11:59	0.787	0.789	-0.170

****

Node Surcharge Summary

****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
1	JUNCTION	22.63	1.330	0.000
2	JUNCTION	23.98	18.368	0.000
3	JUNCTION	22.70	2.098	0.902
5	JUNCTION	22.70	2.093	0.907
Pond-10	JUNCTION	23.98	6.505	1.495
Pond-11	JUNCTION	23.98	6.552	1.448
9	JUNCTION	23.98	0.000	0.000

****

Node Flooding Summary

****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
Pond3s	2.488	5	0	0	26.808	49	0 12:00	20.02
Pond2s	2.741	5	0	0	29.447	54	0 12:00	17.02
Pond1s	2.214	3	0	0	43.841	50	0 12:01	18.28
PondN	1.203	3	0	0	26.450	60	0 12:00	21.65

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
6	94.34	5.26	43.41	3.204
7	0.80	0.26	0.84	0.001
8	0.00	0.00	0.00	0.000
System	31.72	5.52	43.96	3.205

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
1	CONDUIT	26.71	0 12:14	2.13	10.05	1.00
2	CONDUIT	19.55	0 12:22	1.56	5.07	1.00
3	CONDUIT	18.02	0 11:58	1.43	4.30	1.00
4	CONDUIT	15.73	0 12:01	1.25	4.14	1.00
12	CONDUIT	10.90	0 11:53	1.54	0.17	1.00
11	CONDUIT	17.94	0 12:00	2.54	0.26	1.00
9	CONDUIT	10.58	0 12:20	0.84	0.03	1.00
10	CONDUIT	13.62	0 12:01	1.08	0.04	1.00
13	DUMMY	4.82	0 11:46			
5	PUMP	0.00	0 00:00			
6	ORIFICE	0.84	0 12:00			
7	WEIR	20.02	0 11:56			0.50
8	WEIR	17.02	0 11:58			0.54
14	WEIR	11.86	0 11:59			0.57
15	WEIR	14.44	0 12:27			0.62
16	DUMMY	43.41	0 12:00			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
		---------- Fraction of Time in Flow Class ----------								
1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
4	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00

12	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
11	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
9	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
10	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	--------- Hours Full -------- Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
1	23.98	23.98	23.98	6.98	0.86
2	23.98	23.98	23.98	3.06	0.82
3	23.98	23.98	23.98	1.93	1.35
4	23.98	23.98	23.98	1.92	2.18
12	23.98	23.98	23.98	0.01	0.01
11	23.98	23.98	23.98	0.01	0.01
9	23.02	23.02	23.98	0.01	0.01
10	23.01	23.01	23.98	0.01	0.01

****
Pumping Summary
****

Pump	Percent Utilized	Number of Start-Ups	Min Flow CFS	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal	Power Usage Kw-hr	% Time Off Pump Curve Low	High
5	0.00	0	0.00	0.00	0.00	0.000	0.00	0.0	0.0

```
Analysis begun on:  Fri Oct 07 16:33:13 2016
Analysis ended on:  Fri Oct 07 16:33:21 2016
Total elapsed time: 00:00:08
```