ALLIANT ENERGY
Interstate Power and Light Company
Ottumwa Generating Station

CCR SURFACE IMPOUNDMENT

INFLOW DESIGN FLOOD CONTROL PLAN

Report Issued: September 29, 2016
Revision 0

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EXECUTIVE SUMMARY

This Inflow Flood Control Plan (Report) is prepared in accordance with the requirements of the United States Environmental Protection Agency (USEPA) published Final Rule for Hazardous and Solid Waste Management System – Disposal of Coal Combustion Residual from Electric Utilities (40 CFR Parts 257 and 261, also known as the CCR Rule) published on April 17, 2015 and effective October 19, 2015.

This Report assesses the hydrologic and hydraulic capacity requirements for each CCR unit at Ottumwa Generating Station in Ottumwa, Iowa in accordance with §257.82 of the CCR Rule. For purposes of this Report, a CCR unit is defined as an existing or inactive CCR surface impoundment. Primarily, the Report documents how the inflow design flood control system has been designed and constructed to meet the CCR Rule section §257.82.

Table of Contents

Figures

Appendices

1 Introduction

The owner or operator of the Coal Combustion Residual (CCR) unit must conduct an initial and periodic inflow design flood control system plan to determine if each CCR unit adequately manages flow into and from each CCR unit during and following the peak discharge of the inflow design flood. The inflow design flood is selected based on the hazard potential classification (§257.73(a)(2)) for each CCR unit.

This Report is prepared in accordance with the requirements of §257.82 of the CCR Rule.

1.1 CCR Rule Applicability

The CCR Rule requires an initial and periodic inflow design flood control system plan certified by a qualified professional engineer (PE) for all existing CCR surface impoundments. This report is the initial inflow design flood control system plan.

On August 5th, 2016, USEPA published revisions to the CCR Rule (the "Extension Rule") that extend the above requirements to inactive CCR surface impoundments with different deadlines. The effective date of the Extension Rule is October 4th, 2016.

1.2 Hydrologic and Hydraulic Capacity Applicability

The Ottumwa Generating Station (OGS) in Ottumwa, Iowa (Figure 1) has one existing and one inactive CCR surface impoundment, identified as follows:

- OGS Ash Pond (existing)
- OGS Zero Liquid Discharge Pond (inactive)

2 FACILITY DESCRIPTION

OGS is located approximately ten miles northwest of Ottumwa, Iowa on the western shore of the Des Moines River in Wapello County, at 20775 Power Plant Road, Ottumwa, Iowa (Figure 1). The McNeese Wildlife Area is located to the southeast of OGS. Middle Avery Creek, which flows to the northeast into the Des Moines River, is located to the south and east of OGS.

OGS is a fossil-fueled electric generating station consisting of one steam electric generating unit. Sub-bituminous coal is the primary fuel for producing steam. The burning of coal produces a by-product of CCR. The CCR at OGS is categorized into three types; bottom ash, fly ash, and flue gas desulfurization (scrubber) byproducts. The fly ash also can be subdivided into two types, economizer fly ash and precipitator fly ash.

The majority of precipitator fly ash is collected by the electrostatic precipitators and sent to the on-site storage silo located on the west side of the generating plant. Historically, the precipitator fly ash has then either been transported off-site for beneficial reuse or was placed in the fly ash reclamation processing area adjacent to the coal pile storage area for the purposes of producing hydrated fly ash. In the fly ash reclamation processing area, the fly ash was rolled out, compacted, hydrated, and allowed to dry into a very hard, cement-like material that was stored in this area until transported off-site. Although this fly ash hydrating process has occurred in the past, this process ceased prior to October 19, 2015.

The precipitator fly ash that is not collected by the electrostatic precipitators becomes part of the flue gas desulfurization pollution control process at OGS. Activated carbon is injected into the flue gas stream and binds with mercury. This flue gas stream travels to the spray dry desulfurization towers. From there, a water based slurry of hydrated (slaked) lime is injected into the spray dry desulfurization towers. The hydrated lime reacts with the sulfur compounds in the flue gas and the water evaporates. A precipitate is left that consists of activated carbon bound to mercury, calcium sulfate, calcium sulfite, unreacted slaked lime, and some unreacted fly ash. This flue gas stream is directed to the bag house where the particulate matter is removed. A portion of the solids are recycled back to the process and the rest of the scrubber byproducts are sent to the air quality control system byproduct silo. The material from the byproduct silo is mixed with water in a pin mixer to reduce dust, loaded into trucks, and transported to the off-site Ottumwa-Midland CCR landfill for disposal.

The bottom ash and economizer fly ash at OGS are sluiced to a surface impoundment identified as the OGS Ash Pond (Figure 2). The OGS Ash Pond is located east of the generating plant and is presently the only existing CCR surface impoundment at OGS.

In addition to the OGS Ash Pond, OGS has one inactive CCR surface impoundment identified as the OGS Zero Liquid Discharge (ZLD) Pond. The OGS ZLD Pond is located northeast of the generating plant and north of the OGS Ash Pond. The OGS ZLD Pond, presently, only receives surface water runoff from the surrounding area.

General Facility Information:

- Date of Initial Facility Operations: 1981
- NPDES Permit Number: IA90-001-01
- Latitude / Longitude: 41°5′53″N 92°33′17″W
- Nameplate Ratings: Unit 1 (1981) 725 MW

2.1 OGS Ash Pond

The OGS Ash Pond is located east of the generating plant on the eastern portion of the site. The OGS Ash Pond receives influent flows from the generating plant floor drains, oil/water separator, boiler blow down water, solid contact unit sludge, sluiced CCR (bottom ash and economizer fly ash), recirculating media sanitary treatment plant, and surface water runoff from the generating site proper.

The sluiced CCR is discharged into the west end of the OGS Ash Pond. The sluiced CCR is discharged into a collection pad area where the majority of CCR is recovered. A dozer is used to scrape the collection pad and push the CCR into a stockpile for dewatering. Once dewatered, the CCR is then loaded into over-the-road haul trucks for transporting off-site. The sluiced water from the CCR drains into a narrow channel that flows into the southwest portion of the OGS Ash Pond. Routine maintenance dredging of the narrow channel occurs as the CCR settles out in the channel. Approximately 4 million gallons per day (MGD) of process water is recirculated back into OGS for reuse.

The water in the OGS Ash Pond from other sources flows to the east and discharges through the facility's National Pollution Discharge Elimination System (NPDES) Outfall 001, located in the northeast corner of the OGS Ash Pond. NPDES Outfall 001 consists of a concrete discharge structure with a six foot wide overflow weir and includes a Parshall flume and instrumentation to measure the flow of the discharged water. The water flows through the NPDES Outfall 001 and discharges into an unnamed creek at an average rate of 1.54 MGD. The water flows through the NPDES Outfall 001 and discharges into an unnamed creek. The unnamed creek flows into the Des Moines River downstream of the water intake structure and before the confluence of Middle Avery Creek.

The surface area of the OGS Ash Pond is approximately 18 acres and has an embankment height of approximately 25 feet from the crest to the toe of the downstream slope. The interior storage depth of the OGS Ash Pond is approximately 20 feet. Currently, the total volume of impounded CCR and water within the OGS Ash Pond is approximately 556,000 cubic yards.

2.2 OGS Zero Liquid Discharge Pond

The OGS Zero Liquid Discharge (ZLD) Pond is located northeast of the generating plant on the eastern portion of the site and north of the OGS Ash Pond. The OGS ZLD Pond historically received influent flows from the generating plant that consisted of boiler wash water, air heater wash, turbine chemical cleaning water, and boiler chemical cleaning water. Presently, the OGS ZLD Pond only receives storm water runoff from the surrounding area, which includes the inactive hydrated fly ash area located west of the surface impoundment, as well as occasional excess storm water runoff from the coal pile storage area. One 24-inch diameter high-density polyethylene culvert connects the coal pile runoff pond to the OGS ZLD Pond. The culvert is used as an emergency overflow to route storm water from the coal pile runoff pond into the OGS ZLD Pond.

The OGS ZLD Pond does not currently discharge. Two 48-inch diameter concrete culverts, located along the south embankment, previously connected the OGS ZLD Pond to the OGS Ash Pond prior to being permanently sealed off with concrete.

The OGS ZLD Pond covers a surface area of approximately 19 acres and has an embankment height of approximately 29 feet from crest to toe of the downstream slope. The interior storage depth of the OGS ZLD Pond is approximately 25 feet. Based on readily available information, the OGS ZLD Pond has a total storage capacity of approximately 515,000 cubic yards.

3 HYDROLOGIC AND HYDRAULIC CAPACITY- §257.82(a)

This Report provides hydrologic and hydraulic capacity information for inflow design flood control systems which is intended to:

1. Adequately manage flow into each CCR unit during and following the peak discharge inflow of the specified design flood,
2. Adequately manage flow from each CCR unit during and following the peak discharge inflow of the specified design flood; and,
3. Handle discharge from the CCR unit in accordance with National Pollutant Discharge Elimination System (NPDES) regulations §257.3-3.

3.1 Hazard Classification and Design Storm

Both the OGS Ash Pond and the OGS ZLD Pond are classified as low hazard potential because a release would principally be limited to the facility property and there would likely be low economic losses and environmental damages.

The design storm for the surface impoundments is the 100 year return event SCS Type II 24 hour storm as defined in 40 CFR 257.82 (3) (ii). The total rainfall for the event selected from the National Oceanographic and Atmospheric Administration's probabilistic map for the OGS site coordinates is 7.15 inches for the 100 year event, Appendix B.

3.2 Hydrologic and Hydraulic Capacity Methods

The 100 year SCS Type II storm was routed through the OGS Ash Pond through its discharge weir and outlet pipe, Appendix C. The routing was completed using the program Hydraflow by Intelisolve[1]. Hydraflow uses the unit hydrograph method to generate a Type II distribution rainfall for the drainage area of the OGS Ash Pond. Hydraflow routes the rainfall hydrograph through the outlet structure storing water within the impoundment in accordance with the reservoir capacity of the impoundment. The proportion of runoff to rainfall for the drainage watershed is input based on characteristics of the watershed area. The drainage areas of the watershed include 18

[1] Intelisolve, Pond Routing Software Hydraflow, 2002

acres of level power plant, 18 acres of water surface and embankment, and 40 acres of open low ground for a total of 72 acres draining to the OGS Ash Pond.

The OGS ZLD Pond receives storm water from 36 acres of flat plant site that was previously used for the production and storing of hydrated fly ash and excess storm water from the coal pile runoff pond.

Since the OGS ZLD Pond does not have an outlet, the capacity of the impoundment is calculated to contain the full volume of the design storm from both the former hydrated fly ash area and from the coal storage area, which is approximately 44 acres. The volume of water stored in the coal pile runoff control pond between its normal water elevation of 670 feet and the overflow to the OGS ZLD Pond at 676.5 feet is taken away from the volume requiring storage in the OGS ZLD Pond. The analysis ignores the discharge from the coal pile runoff pond, because of its limited discharge capacity and provides a conservative assessment of the volume that will flow into the OGS ZLD during the design event.

3.3 Hydrologic and Hydraulic Capacity Input and Assumptions

This section identifies the input and assumptions for the hydrologic and hydraulic capacity calculations. The input for each sub-drainage area of the OGS Ash Pond are:

Sub-Area	Acreage	Curve Number (CN)	Slope (%)	Hydraulic Length (ft)
Plant Facilities	18	93	0.5	1,700
Low Flat Areas	40	89	0.5	800
OGS Ash Pond	18	100	N/A	N/A
Weighted Average	76	93	0.5	1,700

The slope and hydraulic length for the flat areas control the arrival of the peak water from rainfall.

The outlet from the OGS Ash Pond is through a six foot wide overflow weir, Appendix C. This overflow weir is adjustable and is normally operated with the weir set at elevation 675.5 feet, Appendix C. The outlet pipes from the weir box are two 66 inch diameter pipes and the capacity of the outlet pipes does not restrict the flow from the impoundment as shown on the combined outlet characteristics analysis, Appendix C

During normal operation, the process water flow to the OGS Ash Pond is 1.54 MGD or 2.4 cubic feet per second, Appendix A. Based on the overflow weir equation[2] with a weir coefficient of 3.3 the normal operating elevation of the water in the OGS Ash Pond is 675.75 feet. The operating water elevation in the OGS Ash Pond rounded to elevation 676 feet is the starting elevation for storage of the 100 year rainfall event.

Since the two discharge pipes do not restrict the outlet flow for either inlet control or submerged outlet flow, the flood stage of the Des Moines River will have no impact on the outlet capacity.

The storage capacity of the OGS Ash Pond is generated by digitizing the area of the impoundment at elevation 676 and elevation 680 and assigning a linear increase with storage depth. No exfiltration of water from OGS Ash Pond is allowed during the storm routing.

The storm routing for the OGS ZLD Pond is by full containment of the storm water volume. The following simplifying assumptions are made in analysis of the impoundment capacity to contain the storm.

1. The full volume of rainfall accumulates into the impoundment without consideration of the infiltration that occurs into the closed hydrated fly ash area or the Coal Storage Pile area.

2. Surface water that comes to the OGS ZLD Pond from the Coal Storage Area is reduced by the volume of storage in the coal pile runoff pond.

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[2] Q (flow in cfs) = weir coefficient * length of weir * (head (ft))$^{1.5}$

3. No discharge of storm water occurs from the coal pile runoff pond to the Des Moines River during the 24 hour storm event.

4. The available impoundment volume is calculated as the area of the impoundment at normal water operating elevation projected vertically without considering the increase in area with depth of water in the impoundment.

5. No exfiltration is considered during the storm event.

4 Inflow Design Flood Control System Plan

The normal operating water elevation for the OGS Ash Pond is elevation of 676 feet and elevation 673 feet for the OGS ZLD Pond, Figure 2.

During the design storm, the OGS Ash Pond accumulates 26.3 acre feet of water and the OGS ZLD Pond accumulates 41.1 acre feet of water. At the end of the storm the water elevation in the OGS Ash Pond will be 677.2 feet with 4.8 feet of freeboard remaining on the exterior embankment. At the end of the storm the water elevation in the OGS ZLD Pond will be 675.2 feet with 6.8 feet of freeboard remaining on the exterior embankment. The calculation of volumes and storage elevation are included in Appendix D.

5 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

To meet the requirements of 40 CFR 257.82(c)(5), I Mark W. Loerop hereby certify that I am a licensed professional engineer in the State of Iowa; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in 40 CFR 257.82.

LICENSED PROFESSIONAL ENGINEER
MARK W. LOEROP
22197
IOWA

By: [signature]

Name: Mark Loerop

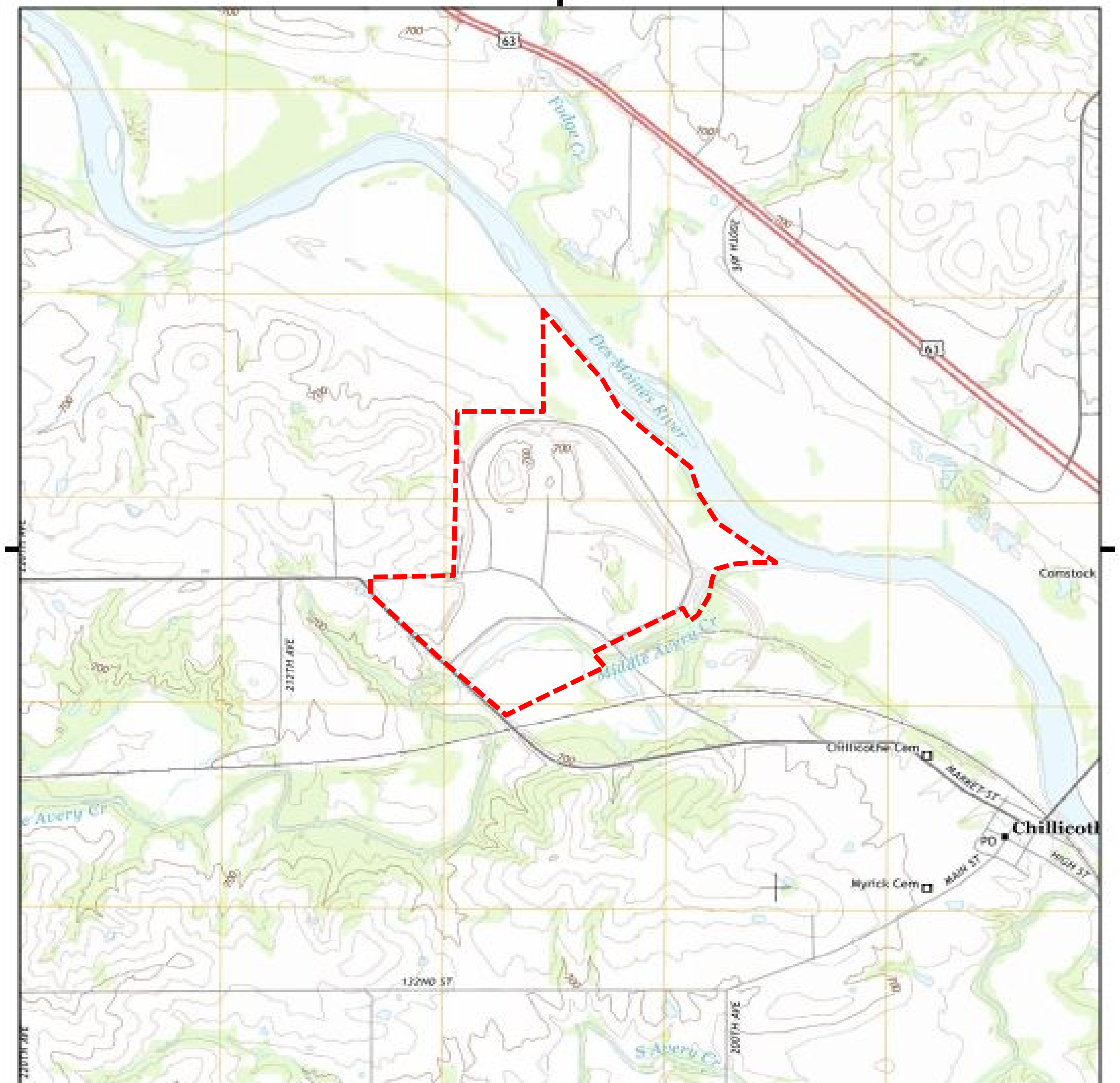
Date: 9/30/2016

FIGURES

Alliant Energy
Interstate Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

Inflow Design Flood Control System Plan

Historical Topo Map 2013



This report includes information from the following map sheet(s).

TP, Chillicothe, 2013, 7.5-minute

Miles 0.25 0.5 1 1.5

SITE NAME: Ottumwa Generating Station
ADDRESS: 20775 Power Plant Road
Ottumwa, IA 52501
CLIENT: Environmental Site Assessors

4555570 - 5 page 4

Historical Aerial Photo 4/13/2016

Approximate Property Boundary

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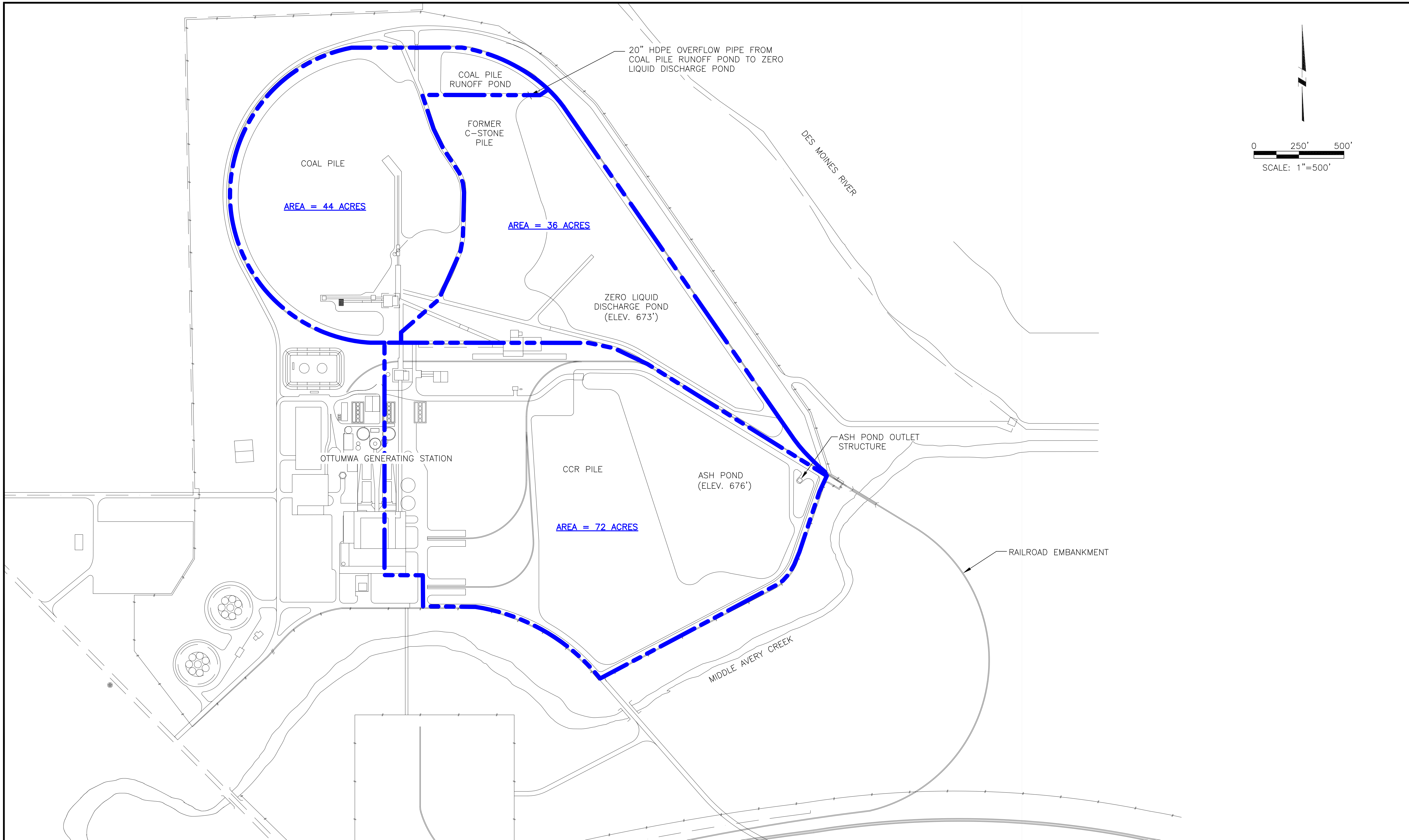
Site Location
Ottumwa Generating Station
Intersate Power and Light Company

Drawing: Figure 1

Date: 7/12/2016



REV	DATE	BY	DESCRIPTION
5			
4			
3			
2			
1			

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SCALE:	AS SHOWN
DATE:	8-29-16
DRAWN BY:	JFD
CHKD BY:	THJ
APRVD BY:	MWL

CLIENT / LOCATION
INTERSTATE POWER AND LIGHT (IPL)
OTTUMWA GENERATING STATION
OTTUMWA, IA

DRAWING DESCRIPTION
INFLOW DESIGN FLOOD CONTROL PLAN

JOB 154.018.002.003
SHT. FIGURE 2
DWG. 154.018.002.003-D2

APPENDIX A – Water Balance Chart

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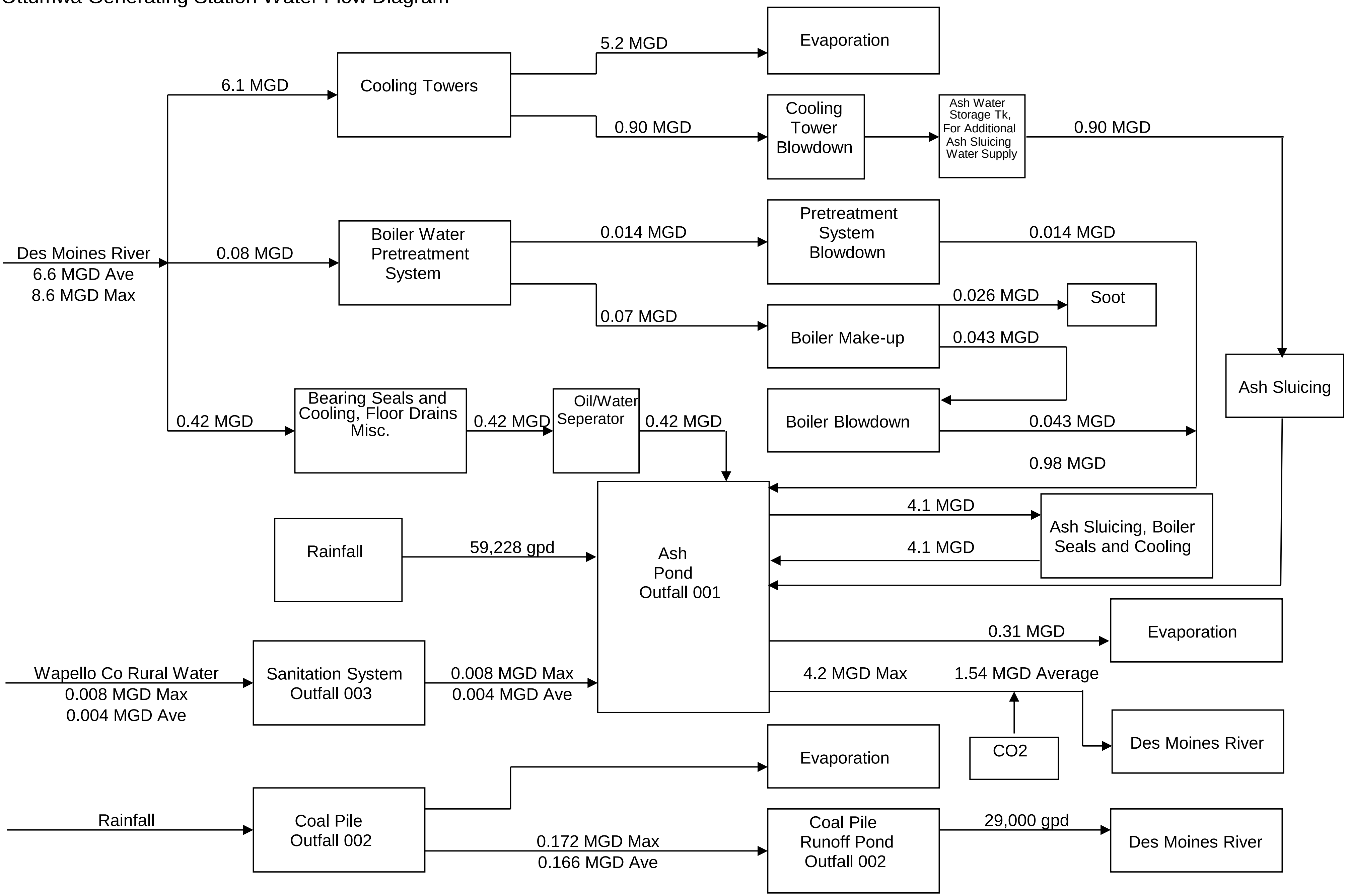
Ottumwa Generating Station
Ottumwa, Iowa

Inflow Design Flood Control System Plan

Ottumwa Generating Station Water Flow Diagram



NOTES: Coal Pile Runoff Discharge is a controlled discharge, so these values are not a constant discharge
Cooling Tower Blowdown can be used to sluice ash

Updated: August 2007
By: Bill Skalitzky

APPENDIX B – NOAA Storm Frequency

Alliant Energy
Interstate Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

Inflow Design Flood Control System Plan

NOAA Atlas 14, Volume 8, Version 2
Location name: Ottumwa, Iowa, US*
Latitude: 41.1000°, Longitude: -92.5500°
Elevation: 668 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point 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	0.384 (0.308–0.481)	0.444 (0.357–0.557)	0.550 (0.440–0.691)	0.644 (0.512–0.811)	0.783 (0.604–1.02)	0.897 (0.674–1.17)	1.02 (0.736–1.35)	1.15 (0.793–1.54)	1.33 (0.880–1.81)	1.47 (0.946–2.02)
10-min	0.562 (0.452–0.704)	0.651 (0.522–0.816)	0.806 (0.645–1.01)	0.943 (0.750–1.19)	1.15 (0.885–1.49)	1.31 (0.987–1.71)	1.49 (1.08–1.97)	1.68 (1.16–2.26)	1.94 (1.29–2.65)	2.15 (1.39–2.95)
15-min	0.685 (0.551–0.859)	0.794 (0.637–0.995)	0.983 (0.786–1.23)	1.15 (0.915–1.45)	1.40 (1.08–1.81)	1.60 (1.20–2.09)	1.82 (1.32–2.40)	2.05 (1.42–2.75)	2.37 (1.57–3.23)	2.62 (1.69–3.60)
30-min	0.959 (0.771–1.20)	1.11 (0.893–1.40)	1.38 (1.10–1.73)	1.62 (1.29–2.04)	1.97 (1.52–2.55)	2.25 (1.69–2.94)	2.56 (1.85–3.38)	2.88 (2.00–3.87)	3.33 (2.21–4.55)	3.69 (2.38–5.07)
60-min	1.23 (0.987–1.54)	1.44 (1.16–1.81)	1.81 (1.44–2.27)	2.13 (1.69–2.68)	2.61 (2.01–3.38)	3.00 (2.25–3.91)	3.41 (2.47–4.51)	3.85 (2.66–5.17)	4.46 (2.96–6.10)	4.95 (3.19–6.79)
2-hr	1.50 (1.22–1.86)	1.77 (1.43–2.19)	2.23 (1.80–2.77)	2.64 (2.12–3.29)	3.25 (2.53–4.17)	3.74 (2.84–4.83)	4.26 (3.12–5.58)	4.82 (3.38–6.41)	5.59 (3.77–7.56)	6.21 (4.06–8.43)
3-hr	1.66 (1.35–2.05)	1.97 (1.60–2.43)	2.50 (2.03–3.09)	2.97 (2.40–3.68)	3.67 (2.87–4.68)	4.23 (3.23–5.43)	4.83 (3.56–6.29)	5.47 (3.86–7.23)	6.35 (4.32–8.54)	7.06 (4.66–9.53)
6-hr	1.96 (1.62–2.39)	2.33 (1.91–2.84)	2.96 (2.42–3.62)	3.52 (2.87–4.31)	4.34 (3.44–5.49)	5.02 (3.88–6.38)	5.73 (4.28–7.39)	6.49 (4.65–8.50)	7.56 (5.21–10.1)	8.41 (5.63–11.2)
12-hr	2.31 (1.91–2.78)	2.70 (2.24–3.26)	3.40 (2.81–4.11)	4.02 (3.30–4.87)	4.93 (3.95–6.17)	5.69 (4.45–7.15)	6.49 (4.90–8.27)	7.34 (5.33–9.51)	8.53 (5.97–11.2)	9.49 (6.45–12.5)
24-hr	2.68 (2.24–3.19)	3.11 (2.60–3.71)	3.86 (3.22–4.61)	4.52 (3.75–5.42)	5.50 (4.45–6.79)	6.31 (4.98–7.83)	7.15 (5.48–9.02)	8.06 (5.93–10.3)	9.32 (6.62–12.1)	10.3 (7.14–13.5)
2-day	3.08 (2.60–3.63)	3.55 (3.00–4.20)	4.37 (3.68–5.17)	5.08 (4.26–6.03)	6.12 (5.00–7.45)	6.96 (5.56–8.53)	7.83 (6.06–9.75)	8.76 (6.53–11.1)	10.0 (7.23–12.9)	11.0 (7.75–14.3)
3-day	3.36 (2.86–3.94)	3.86 (3.28–4.53)	4.71 (3.99–5.54)	5.45 (4.59–6.42)	6.52 (5.35–7.88)	7.38 (5.93–8.97)	8.27 (6.45–10.2)	9.20 (6.92–11.6)	10.5 (7.62–13.4)	11.5 (8.15–14.8)
4-day	3.62	4.13	5.00	5.75	6.84	7.70	8.60	9.55	10.8	11.9

	(3.09–4.22)	(3.52–4.82)	(4.25–5.85)	(4.87–6.75)	(5.64–8.21)	(6.22–9.33)	(6.74–10.6)	(7.22–11.9)	(7.93–13.8)	(8.46–15.2)
7-day	**4.31** (3.71–4.99)	**4.85** (4.17–5.62)	**5.77** (4.94–6.68)	**6.55** (5.58–7.61)	**7.67** (6.38–9.12)	**8.56** (6.98–10.3)	**9.49** (7.51–11.5)	**10.4** (7.99–12.9)	**11.8** (8.71–14.8)	**12.8** (9.25–16.2)
10-day	**4.95** (4.28–5.70)	**5.54** (4.78–6.37)	**6.52** (5.61–7.51)	**7.36** (6.30–8.50)	**8.54** (7.13–10.1)	**9.48** (7.76–11.3)	**10.4** (8.32–12.6)	**11.4** (8.80–14.1)	**12.8** (9.53–16.0)	**13.8** (10.1–17.5)
20-day	**6.81** (5.94–7.74)	**7.61** (6.63–8.65)	**8.90** (7.74–10.1)	**9.98** (8.63–11.4)	**11.4** (9.64–13.3)	**12.6** (10.4–14.7)	**13.7** (11.0–16.3)	**14.8** (11.6–18.0)	**16.3** (12.3–20.1)	**17.4** (12.9–21.8)
30-day	**8.37** (7.34–9.45)	**9.36** (8.21–10.6)	**11.0** (9.57–12.4)	**12.2** (10.7–13.9)	**14.0** (11.8–16.1)	**15.2** (12.7–17.7)	**16.5** (13.4–19.5)	**17.7** (13.9–21.3)	**19.3** (14.7–23.6)	**20.5** (15.3–25.4)
45-day	**10.3** (9.13–11.6)	**11.6** (10.2–13.0)	**13.5** (11.9–15.2)	**15.1** (13.2–17.0)	**17.1** (14.5–19.5)	**18.6** (15.5–21.4)	**19.9** (16.3–23.3)	**21.3** (16.8–25.3)	**22.9** (17.6–27.7)	**24.0** (18.2–29.6)
60-day	**12.0** (10.7–13.4)	**13.5** (11.9–15.1)	**15.7** (13.9–17.6)	**17.5** (15.4–19.6)	**19.7** (16.8–22.3)	**21.3** (17.9–24.4)	**22.8** (18.7–26.5)	**24.2** (19.2–28.6)	**25.8** (19.9–31.0)	**26.9** (20.5–32.9)

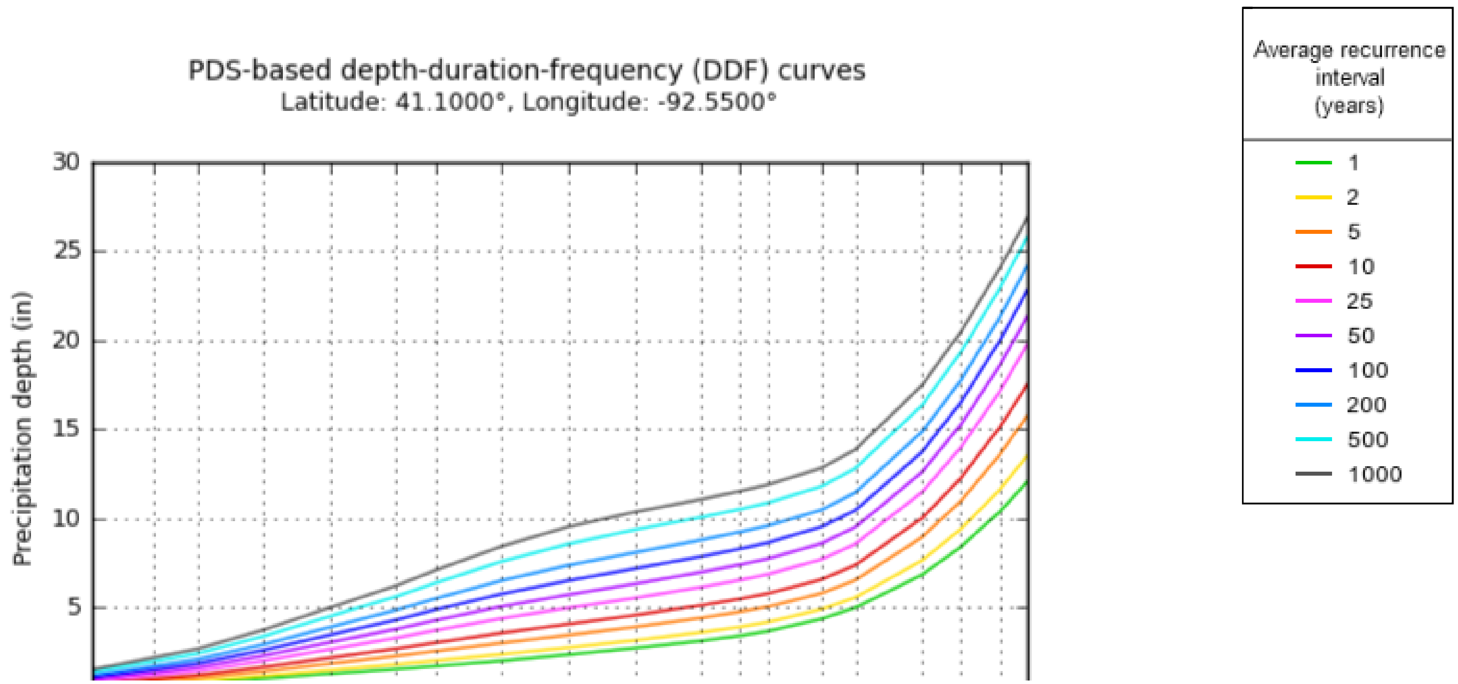
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

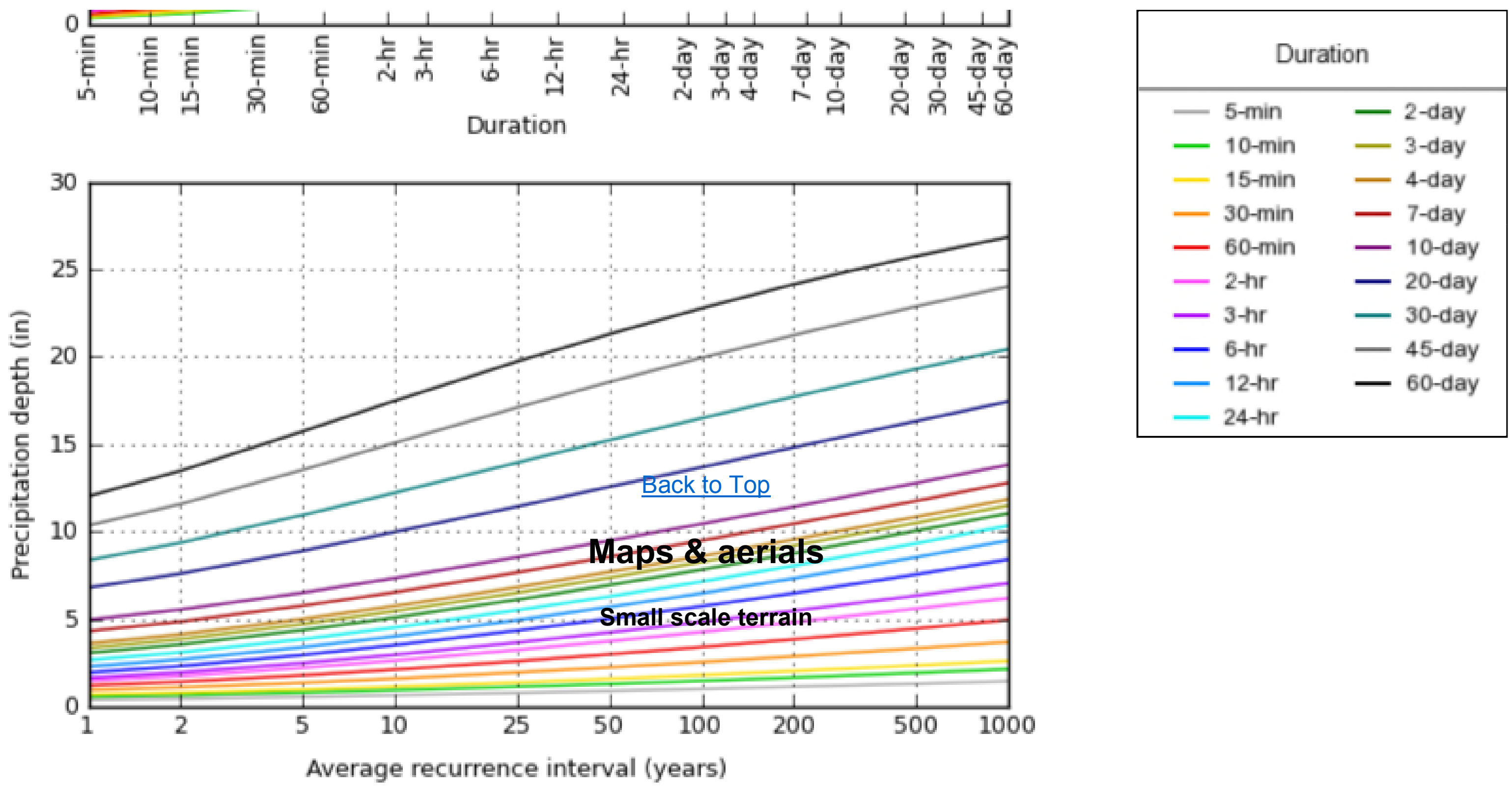
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper 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.

Back to Top

PF graphical





NOAA Atlas 14, Volume 8, Version 2

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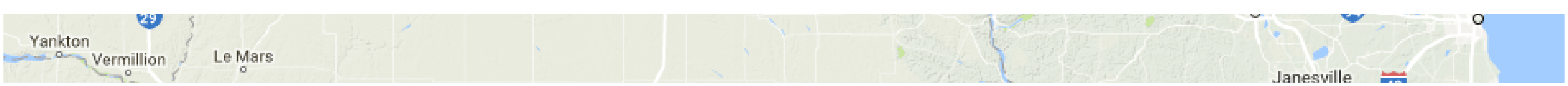
Back to Top

Maps & aerials

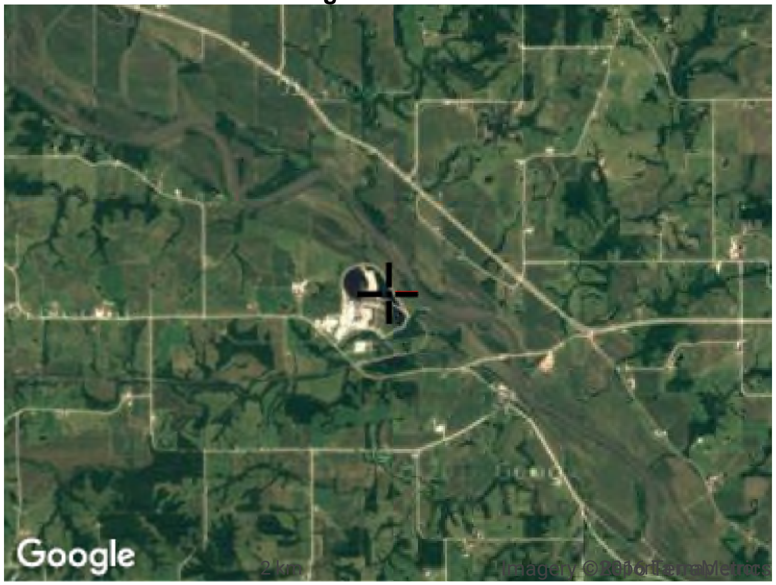
Small scale terrain




Sioux City
Fort Dodge
Waterloo
Dubuque
Kenosha
Rockford
Norfolk
Chicago
Naperville
Columbus
Omaha
Papillion
Bellevue
Des Moines River
Kirkville Rd
Dudley
Chillicothe
Eddyville Rd
H21
Peoria
ILLINO
Springfield
Google
2 km
Map data ©2016 Google


Des Moines River
Kirkville Rd
Dudley
H21
Chillicothe
Eddyville Rd
Google
2 km
Map data ©2016 Google

Large scale aerial



Back to Top

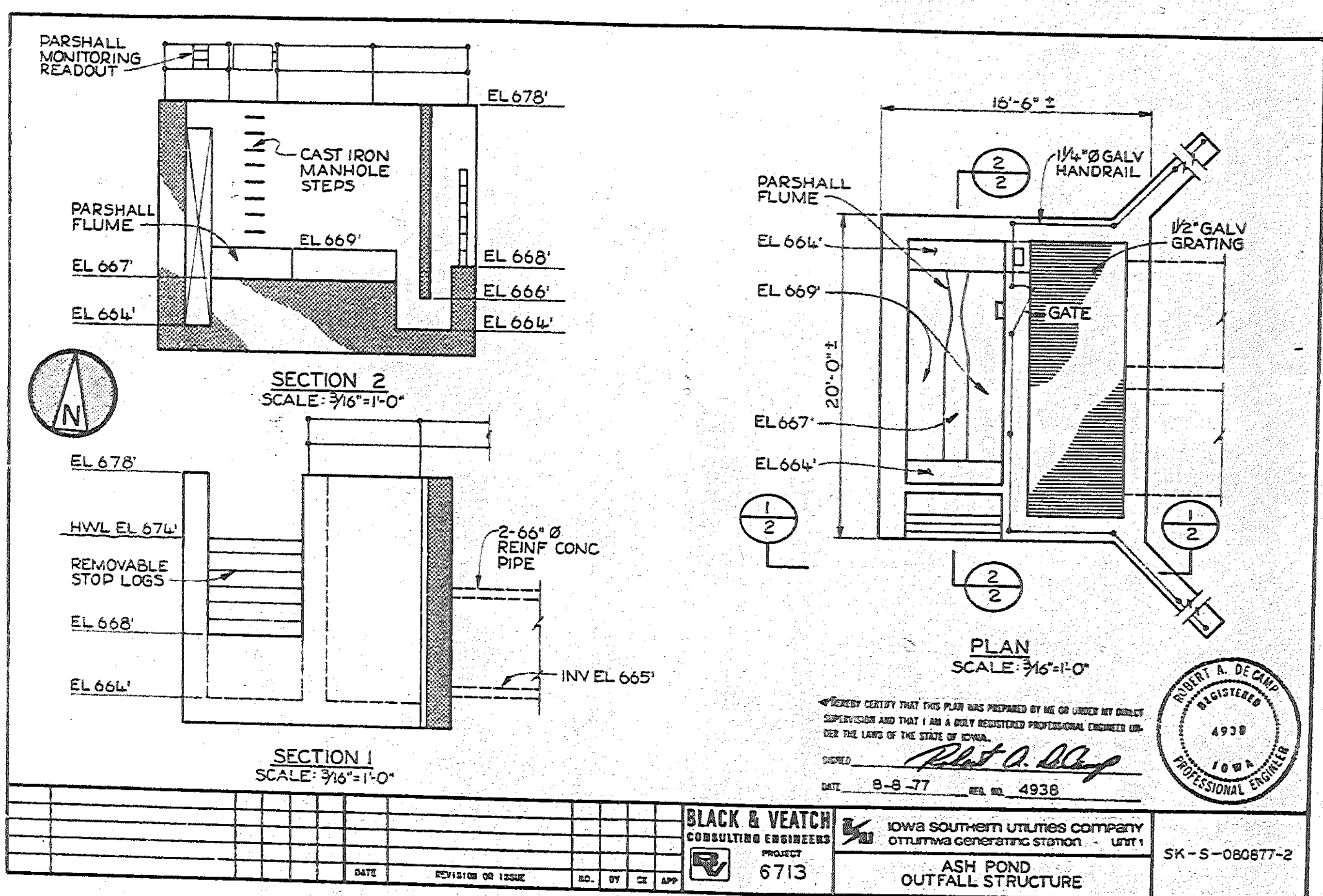
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

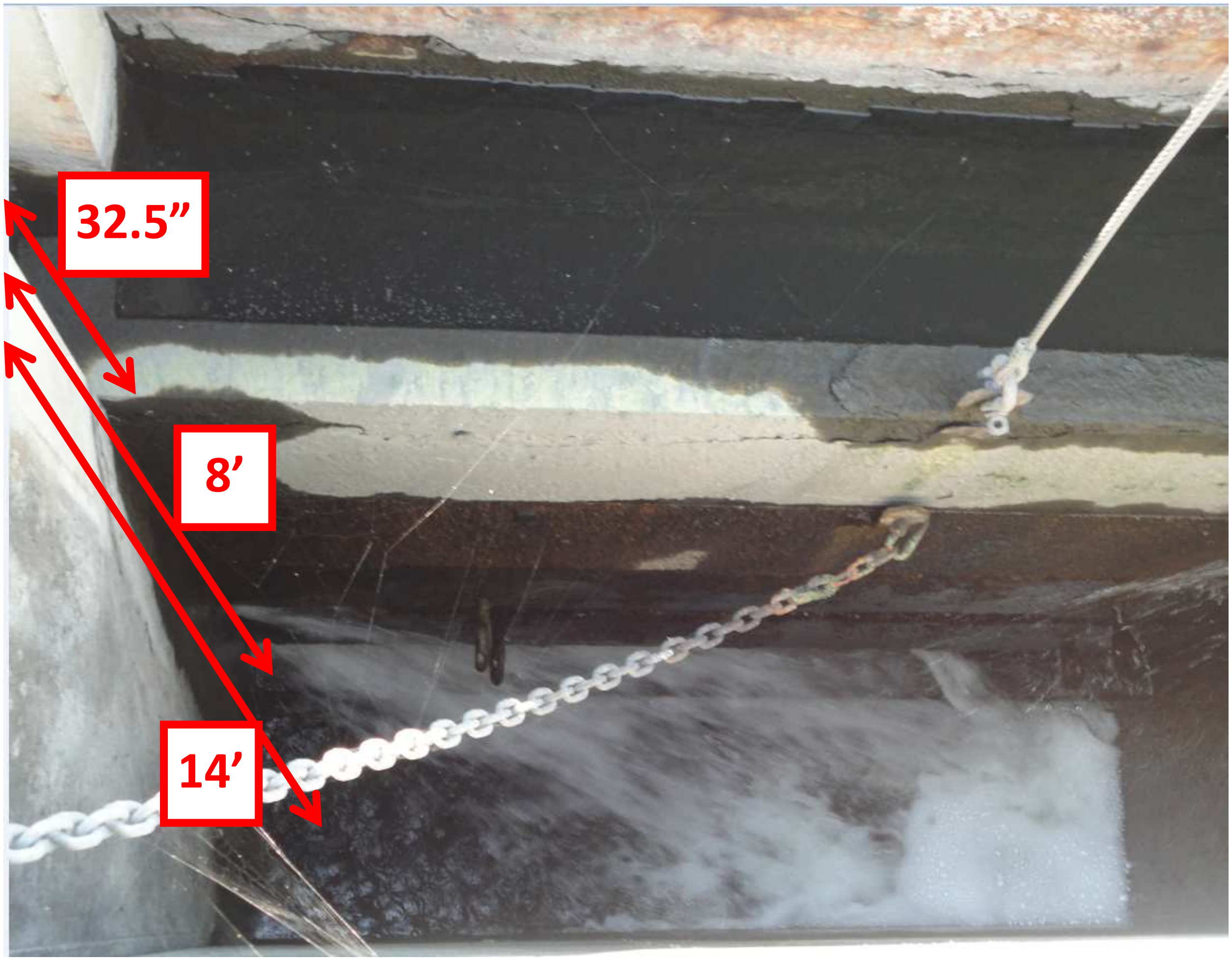
Disclaimer

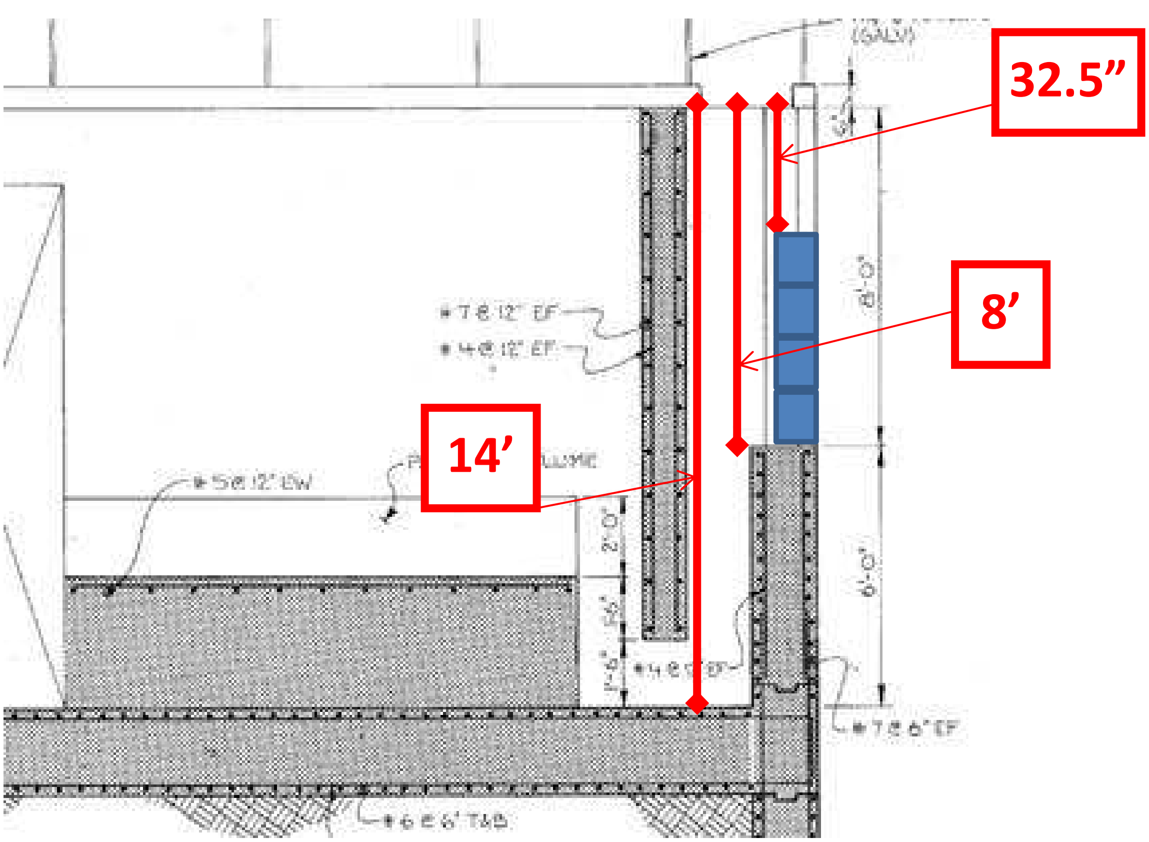
APPENDIX C – Outfall Drawings

Alliant Energy
Interstate Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

Inflow Design Flood Control System Plan


PARSHALL MONITORING READOUT
EL 678'
CAST IRON MANHOLE STEPS
PARSHALL FLUME
EL 669'
EL 668'
EL 667'
EL 666'
EL 664'
EL 664'
SECTION 2
SCALE: 3/16"=1'-0"
N
EL 678'
HWL EL 674'
REMOVABLE STOP LOGS
EL 668'
EL 664'
2-66" Ø REINF CONC PIPE
INV EL 665'
SECTION 1
SCALE: 3/16"=1'-0"
16'-6" ±
1 1/4" Ø GALV HANDRAIL
PARSHALL FLUME
1/2" GALV GRATING
EL 664'
EL 669'
GATE
20'-0" ±
EL 667'
EL 664'
PLAN
SCALE: 3/16"=1'-0"
I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF IOWA.
SIGNED
DATE 8-8-77 REG. NO. 4938
ROBERT A. DE CAMP REGISTERED 4938 IOWA PROFESSIONAL ENGINEER
DATE
REVISION OR ISSUE
NO.
BY
CK
APP
BLACK & VEATCH
CONSULTING ENGINEERS
PROJECT
6713
Iowa Southern Utilities Company
Ottumwa Generating Station - Unit 1
ASH POND
OUTFALL STRUCTURE
SK-S-080877-2

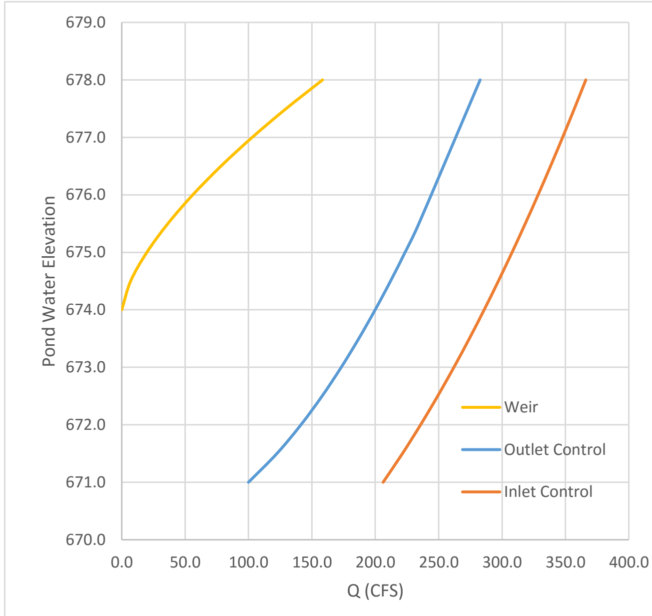

32.5”
8’
14’


(GALV)
32.5”
8’
14’
8'-0"
6'-0"
2'-0"
#7 @ 12" EF
#4 @ 12" EF
#5 @ 12" EW
#7 @ 6" EF
#6 @ 6" T&B

OSG - Slag Pond Outlet Discharge Curve

SINGLE OUTLET PIPE !!!!!
SUMMERGED OUTLET

5.5	FT = Pipe Diameter Steel
1.375	FT = Hydraulic Radius
3.636	k in Q outlet control equation
665	FT = Pipe Inlet Invert Elevation
180	FT = Length
0.025	= n for RCP
0.6	= Co for Inlet Control
670	FT = Tail Water Elevation
6	FT = Weir Width
3.3	= Weir Coefficient



OUTLET CONTROL / BARROW CONTROL

Q CFS	Elevation	Head Ft
99.947	671.0	1.0
122.41	671.5	1.5
141.35	672.0	2.0
158.03	672.5	2.5
173.11	673.0	3.0
186.98	673.5	3.5
199.89	674.0	4.0
212.02	674.5	4.5
223.49	675.0	5.0
234.4	675.5	5.5
282.69	678.0	8.0

Weir Equation
Q = Cw * L * H^1.5

H Ft	Q CFS
674.0	0.0
674.5	7.0
675.0	19.8
675.5	36.4
676.0	56.0
676.5	78.3
677.0	102.9
677.5	129.6
678.0	158.4

INLET CONTROL

Q CFS	Elevation	Head (to pipe middle) Ft
206.15	671.0	3.25
221.44	671.5	3.75
235.74	672.0	4.25
249.22	672.5	4.75
262.01	673.0	5.25
274.2	673.5	5.75
285.87	674.0	6.25
297.09	674.5	6.75
307.9	675.0	7.25
318.34	675.5	7.75
328.44	676.0	8.25
338.25	676.5	8.75
347.78	677.0	9.25
357.06	677.5	9.75
366.1	678.0	10.25

The two Wier outlet pipes can easily handle high flows even if one pipe is plugged and the outlet submerged (15' + above the flood plain).

APPENDIX D – Hydraulic Analysis

Alliant Energy
Interstate Power and Light Company
Ottumwa Generating Station
Ottumwa, Iowa

Inflow Design Flood Control System Plan

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	290.16	6	738	39.282	----	------	------	Watershed
2	Reservoir	24.68	6	846	39.212	1	677.15	26.317	Settling Impoundment

Proj. file: Ottumwa.gpw	Return Period: 100 yr	Run date: 08-22-2016

Hydrograph Report

Hydraflow Hydrographs by Intelisolve

Hyd. No. 1

Watershed

Hydrograph type	= SCS Runoff	Peak discharge	= 290.16 cfs
Storm frequency	= 100 yrs	Time interval	= 6 min
Drainage area	= 76.50 ac	Curve number	= 93
Basin Slope	= 0.5 %	Hydraulic length	= 1700 ft
Tc method	= LAG	Time of conc. (Tc)	= 42.4 min
Total precip.	= 7.15 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 39.282 acft

Hydrograph Discharge Table

Time -- (hrs	Outflow cfs)	Time -- (hrs	Outflow cfs)	Time -- (hrs	Outflow cfs)	Time -- (hrs	Outflow cfs)
4.70	2.98	8.10	8.03	11.50	35.13	14.90	18.43
4.80	3.12	8.20	8.19	11.60	40.65	15.00	18.00
4.90	3.26	8.30	8.39	11.70	51.88	15.10	17.60
5.00	3.40	8.40	8.61	11.80	73.23	15.20	17.22
5.10	3.55	8.50	8.89	11.90	114.43	15.30	16.85
5.20	3.69	8.60	9.21	12.00	168.71	15.40	16.48
5.30	3.84	8.70	9.57	12.10	220.46	15.50	16.11
5.40	3.98	8.80	9.98	12.20	263.58	15.60	15.74
5.50	4.13	8.90	10.41	12.30	290.16 <<	15.70	15.37
5.60	4.28	9.00	10.88	12.40	283.68	15.80	15.00
5.70	4.43	9.10	11.35	12.50	254.59	15.90	14.63
5.80	4.58	9.20	11.82	12.60	222.77	16.00	14.26
5.90	4.73	9.30	12.27	12.70	188.84	16.10	13.89
6.00	4.88	9.40	12.68	12.80	153.40	16.20	13.54
6.10	5.03	9.50	13.03	12.90	118.24	16.30	13.20
6.20	5.18	9.60	13.33	13.00	86.12	16.40	12.89
6.30	5.33	9.70	13.61	13.10	60.24	16.50	12.61
6.40	5.48	9.80	13.90	13.20	46.91	16.60	12.36
6.50	5.63	9.90	14.23	13.30	42.11	16.70	12.15
6.60	5.78	10.00	14.62	13.40	38.25	16.80	11.96
6.70	5.93	10.10	15.11	13.50	35.20	16.90	11.79
6.80	6.08	10.20	15.70	13.60	32.77	17.00	11.64
6.90	6.23	10.30	16.39	13.70	30.79	17.10	11.50
7.00	6.38	10.40	17.18	13.80	29.07	17.20	11.36
7.10	6.53	10.50	18.08	13.90	27.50	17.30	11.23
7.20	6.68	10.60	19.09	14.00	26.07	17.40	11.10
7.30	6.83	10.70	20.21	14.10	24.78	17.50	10.96
7.40	6.98	10.80	21.45	14.20	23.61	17.60	10.83
7.50	7.13	10.90	22.81	14.30	22.54	17.70	10.70
7.60	7.28	11.00	24.31	14.40	21.59	17.80	10.57
7.70	7.43	11.10	25.85	14.50	20.76	17.90	10.43
7.80	7.58	11.20	27.63	14.60	20.05	18.00	10.30
7.90	7.73	11.30	29.73	14.70	19.44	18.10	10.17
8.00	7.87	11.40	32.20	14.80	18.90	18.20	10.04

Continues on next page...

Hydrograph Discharge Table

Time -- (hrs	Outflow cfs)	Time -- (hrs	Outflow cfs)
18.30	9.90	23.40	6.16
18.40	9.77	23.50	6.14
18.50	9.64	23.60	6.11
18.60	9.51	23.70	6.08
18.70	9.37	23.80	6.06
18.80	9.24	23.90	6.03
18.90	9.11	24.00	6.01
19.00	8.98	24.10	5.80
19.10	8.84	24.20	5.41
19.20	8.71	24.30	4.85
19.30	8.58	24.40	4.11
19.40	8.45	24.50	3.19
19.50	8.31		
19.60	8.18		
19.70	8.05		
19.80	7.91		
19.90	7.78		
20.00	7.65		
20.10	7.52		
20.20	7.39		
20.30	7.27		
20.40	7.17		
20.50	7.08		
20.60	7.00		
20.70	6.94		
20.80	6.88		
20.90	6.84		
21.00	6.80		
21.10	6.77		
21.20	6.75		
21.30	6.72		
21.40	6.69		
21.50	6.67		
21.60	6.64		
21.70	6.61		
21.80	6.59		
21.90	6.56		
22.00	6.54		
22.10	6.51		
22.20	6.48		
22.30	6.46		
22.40	6.43		
22.50	6.40		
22.60	6.38		
22.70	6.35		
22.80	6.32		
22.90	6.30		
23.00	6.27		
23.10	6.24		
23.20	6.22		
23.30	6.19		

...End

Hyd. No. 2

Settling Impoundment

Hydrograph type	= Reservoir	Peak discharge	= 24.68 cfs
Storm frequency	= 100 yrs	Time interval	= 6 min
Inflow hyd. No.	= 1	Reservoir name	= Settling Impoundm
Max. Elevation	= 677.15 ft	Max. Storage	= 26.317 acft

Storage Indication method used. Outflow hydrograph volume = 39.212 acft

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
11.10	25.85	676.21	-----	-----	-----	-----	2.63	-----	-----	-----	-----	2.63
11.40	32.20	676.24	-----	-----	-----	-----	2.98	-----	-----	-----	-----	2.98
11.70	51.88	676.27	-----	-----	-----	-----	3.47	-----	-----	-----	-----	3.47
12.00	168.71	676.38	-----	-----	-----	-----	4.78	-----	-----	-----	-----	4.77
12.30	290.16 <<	676.63	-----	-----	-----	-----	10.30	-----	-----	-----	-----	10.30
12.60	222.77	676.90	-----	-----	-----	-----	17.24	-----	-----	-----	-----	17.24
12.90	118.24	677.06	-----	-----	-----	-----	22.12	-----	-----	-----	-----	22.12
13.20	46.91	677.12	-----	-----	-----	-----	23.84	-----	-----	-----	-----	23.84
13.50	35.20	677.14	-----	-----	-----	-----	24.37	-----	-----	-----	-----	24.37
13.80	29.07	677.14	-----	-----	-----	-----	24.61	-----	-----	-----	-----	24.61
14.10	24.78	677.15 <<	-----	-----	-----	-----	24.68	-----	-----	-----	-----	24.68 <<
14.40	21.59	677.15	-----	-----	-----	-----	24.63	-----	-----	-----	-----	24.63
14.70	19.44	677.14	-----	-----	-----	-----	24.50	-----	-----	-----	-----	24.50
15.00	18.00	677.13	-----	-----	-----	-----	24.31	-----	-----	-----	-----	24.31
15.30	16.85	677.13	-----	-----	-----	-----	24.09	-----	-----	-----	-----	24.09
15.60	15.74	677.12	-----	-----	-----	-----	23.84	-----	-----	-----	-----	23.84
15.90	14.63	677.11	-----	-----	-----	-----	23.57	-----	-----	-----	-----	23.57
16.20	13.54	677.10	-----	-----	-----	-----	23.26	-----	-----	-----	-----	23.27
16.50	12.61	677.09	-----	-----	-----	-----	22.94	-----	-----	-----	-----	22.94
16.80	11.96	677.08	-----	-----	-----	-----	22.60	-----	-----	-----	-----	22.60
17.10	11.50	677.07	-----	-----	-----	-----	22.26	-----	-----	-----	-----	22.25
17.40	11.10	677.05	-----	-----	-----	-----	21.91	-----	-----	-----	-----	21.91
17.70	10.70	677.04	-----	-----	-----	-----	21.56	-----	-----	-----	-----	21.56
18.00	10.30	677.03	-----	-----	-----	-----	21.20	-----	-----	-----	-----	21.20
18.30	9.90	677.02	-----	-----	-----	-----	20.85	-----	-----	-----	-----	20.85
18.60	9.51	677.01	-----	-----	-----	-----	20.50	-----	-----	-----	-----	20.50
18.90	9.11	677.00	-----	-----	-----	-----	20.14	-----	-----	-----	-----	20.14
19.20	8.71	676.98	-----	-----	-----	-----	19.78	-----	-----	-----	-----	19.78
19.50	8.31	676.97	-----	-----	-----	-----	19.43	-----	-----	-----	-----	19.42
19.80	7.91	676.96	-----	-----	-----	-----	19.06	-----	-----	-----	-----	19.06
20.10	7.52	676.95	-----	-----	-----	-----	18.70	-----	-----	-----	-----	18.70
20.40	7.17	676.94	-----	-----	-----	-----	18.34	-----	-----	-----	-----	18.34
20.70	6.94	676.92	-----	-----	-----	-----	17.98	-----	-----	-----	-----	17.98
21.00	6.80	676.91	-----	-----	-----	-----	17.63	-----	-----	-----	-----	17.63
21.30	6.72	676.90	-----	-----	-----	-----	17.28	-----	-----	-----	-----	17.28
21.60	6.64	676.89	-----	-----	-----	-----	16.95	-----	-----	-----	-----	16.95
21.90	6.56	676.88	-----	-----	-----	-----	16.62	-----	-----	-----	-----	16.62
22.20	6.48	676.87	-----	-----	-----	-----	16.30	-----	-----	-----	-----	16.30

Continues on next page...

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
22.50	6.40	676.86	-----	-----	-----	-----	15.98	-----	-----	-----	-----	15.98
22.80	6.32	676.85	-----	-----	-----	-----	15.68	-----	-----	-----	-----	15.68
23.10	6.24	676.84	-----	-----	-----	-----	15.38	-----	-----	-----	-----	15.38
23.40	6.16	676.83	-----	-----	-----	-----	15.08	-----	-----	-----	-----	15.08
23.70	6.08	676.82	-----	-----	-----	-----	14.80	-----	-----	-----	-----	14.80
24.00	6.01	676.81	-----	-----	-----	-----	14.52	-----	-----	-----	-----	14.52
24.30	4.85	676.80	-----	-----	-----	-----	14.25	-----	-----	-----	-----	14.25
24.60	2.39	676.79	-----	-----	-----	-----	13.99	-----	-----	-----	-----	13.99
24.90	0.68	676.77	-----	-----	-----	-----	13.68	-----	-----	-----	-----	13.68
25.20	0.00	676.76	-----	-----	-----	-----	13.35	-----	-----	-----	-----	13.35
25.50	0.00	676.74	-----	-----	-----	-----	13.02	-----	-----	-----	-----	13.02
25.80	0.00	676.73	-----	-----	-----	-----	12.70	-----	-----	-----	-----	12.70
26.10	0.00	676.72	-----	-----	-----	-----	12.39	-----	-----	-----	-----	12.38
26.40	0.00	676.70	-----	-----	-----	-----	12.08	-----	-----	-----	-----	12.08
26.70	0.00	676.69	-----	-----	-----	-----	11.78	-----	-----	-----	-----	11.78
27.00	0.00	676.68	-----	-----	-----	-----	11.49	-----	-----	-----	-----	11.49
27.30	0.00	676.67	-----	-----	-----	-----	11.21	-----	-----	-----	-----	11.21
27.60	0.00	676.65	-----	-----	-----	-----	10.93	-----	-----	-----	-----	10.93
27.90	0.00	676.64	-----	-----	-----	-----	10.66	-----	-----	-----	-----	10.66
28.20	0.00	676.63	-----	-----	-----	-----	10.40	-----	-----	-----	-----	10.40
28.50	0.00	676.62	-----	-----	-----	-----	10.14	-----	-----	-----	-----	10.14
28.80	0.00	676.61	-----	-----	-----	-----	9.89	-----	-----	-----	-----	9.89
29.10	0.00	676.60	-----	-----	-----	-----	9.65	-----	-----	-----	-----	9.65
29.40	0.00	676.59	-----	-----	-----	-----	9.41	-----	-----	-----	-----	9.41
29.70	0.00	676.58	-----	-----	-----	-----	9.18	-----	-----	-----	-----	9.18
30.00	0.00	676.57	-----	-----	-----	-----	8.95	-----	-----	-----	-----	8.95
30.30	0.00	676.56	-----	-----	-----	-----	8.73	-----	-----	-----	-----	8.73
30.60	0.00	676.55	-----	-----	-----	-----	8.52	-----	-----	-----	-----	8.52
30.90	0.00	676.54	-----	-----	-----	-----	8.31	-----	-----	-----	-----	8.31
31.20	0.00	676.53	-----	-----	-----	-----	8.10	-----	-----	-----	-----	8.10
31.50	0.00	676.52	-----	-----	-----	-----	7.90	-----	-----	-----	-----	7.90
31.80	0.00	676.51	-----	-----	-----	-----	7.71	-----	-----	-----	-----	7.71
32.10	0.00	676.51	-----	-----	-----	-----	7.52	-----	-----	-----	-----	7.52
32.40	0.00	676.50	-----	-----	-----	-----	7.33	-----	-----	-----	-----	7.33
32.70	0.00	676.49	-----	-----	-----	-----	7.15	-----	-----	-----	-----	7.15
33.00	0.00	676.48	-----	-----	-----	-----	6.97	-----	-----	-----	-----	6.97
33.30	0.00	676.48	-----	-----	-----	-----	6.80	-----	-----	-----	-----	6.80
33.60	0.00	676.47	-----	-----	-----	-----	6.63	-----	-----	-----	-----	6.63
33.90	0.00	676.46	-----	-----	-----	-----	6.47	-----	-----	-----	-----	6.47
34.20	0.00	676.45	-----	-----	-----	-----	6.31	-----	-----	-----	-----	6.31
34.50	0.00	676.45	-----	-----	-----	-----	6.16	-----	-----	-----	-----	6.16
34.80	0.00	676.44	-----	-----	-----	-----	6.00	-----	-----	-----	-----	6.00
35.10	0.00	676.43	-----	-----	-----	-----	5.86	-----	-----	-----	-----	5.86
35.40	0.00	676.43	-----	-----	-----	-----	5.71	-----	-----	-----	-----	5.71
35.70	0.00	676.42	-----	-----	-----	-----	5.57	-----	-----	-----	-----	5.57
36.00	0.00	676.42	-----	-----	-----	-----	5.43	-----	-----	-----	-----	5.43
36.30	0.00	676.41	-----	-----	-----	-----	5.30	-----	-----	-----	-----	5.30
36.60	0.00	676.40	-----	-----	-----	-----	5.17	-----	-----	-----	-----	5.17
36.90	0.00	676.40	-----	-----	-----	-----	5.05	-----	-----	-----	-----	5.05
37.20	0.00	676.39	-----	-----	-----	-----	4.98	-----	-----	-----	-----	4.98
37.50	0.00	676.39	-----	-----	-----	-----	4.91	-----	-----	-----	-----	4.91

Continues on next page...

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
37.80	0.00	676.38	-----	-----	-----	-----	4.84	-----	-----	-----	-----	4.84
38.10	0.00	676.38	-----	-----	-----	-----	4.78	-----	-----	-----	-----	4.78
38.40	0.00	676.37	-----	-----	-----	-----	4.71	-----	-----	-----	-----	4.71
38.70	0.00	676.37	-----	-----	-----	-----	4.65	-----	-----	-----	-----	4.65
39.00	0.00	676.36	-----	-----	-----	-----	4.59	-----	-----	-----	-----	4.59
39.30	0.00	676.36	-----	-----	-----	-----	4.53	-----	-----	-----	-----	4.53
39.60	0.00	676.35	-----	-----	-----	-----	4.46	-----	-----	-----	-----	4.46
39.90	0.00	676.35	-----	-----	-----	-----	4.40	-----	-----	-----	-----	4.40
40.20	0.00	676.34	-----	-----	-----	-----	4.34	-----	-----	-----	-----	4.34
40.50	0.00	676.34	-----	-----	-----	-----	4.28	-----	-----	-----	-----	4.28
40.80	0.00	676.33	-----	-----	-----	-----	4.23	-----	-----	-----	-----	4.23
41.10	0.00	676.33	-----	-----	-----	-----	4.17	-----	-----	-----	-----	4.17
41.40	0.00	676.33	-----	-----	-----	-----	4.11	-----	-----	-----	-----	4.11
41.70	0.00	676.32	-----	-----	-----	-----	4.06	-----	-----	-----	-----	4.06
42.00	0.00	676.32	-----	-----	-----	-----	4.00	-----	-----	-----	-----	4.00
42.30	0.00	676.31	-----	-----	-----	-----	3.95	-----	-----	-----	-----	3.95
42.60	0.00	676.31	-----	-----	-----	-----	3.89	-----	-----	-----	-----	3.89
42.90	0.00	676.30	-----	-----	-----	-----	3.84	-----	-----	-----	-----	3.84
43.20	0.00	676.30	-----	-----	-----	-----	3.79	-----	-----	-----	-----	3.79
43.50	0.00	676.30	-----	-----	-----	-----	3.74	-----	-----	-----	-----	3.74
43.80	0.00	676.29	-----	-----	-----	-----	3.69	-----	-----	-----	-----	3.69
44.10	0.00	676.29	-----	-----	-----	-----	3.64	-----	-----	-----	-----	3.64
44.40	0.00	676.28	-----	-----	-----	-----	3.59	-----	-----	-----	-----	3.59
44.70	0.00	676.28	-----	-----	-----	-----	3.54	-----	-----	-----	-----	3.54
45.00	0.00	676.28	-----	-----	-----	-----	3.49	-----	-----	-----	-----	3.49
45.30	0.00	676.27	-----	-----	-----	-----	3.44	-----	-----	-----	-----	3.44
45.60	0.00	676.27	-----	-----	-----	-----	3.40	-----	-----	-----	-----	3.40
45.90	0.00	676.27	-----	-----	-----	-----	3.35	-----	-----	-----	-----	3.35
46.20	0.00	676.26	-----	-----	-----	-----	3.31	-----	-----	-----	-----	3.31
46.50	0.00	676.26	-----	-----	-----	-----	3.26	-----	-----	-----	-----	3.26
46.80	0.00	676.25	-----	-----	-----	-----	3.22	-----	-----	-----	-----	3.22
47.10	0.00	676.25	-----	-----	-----	-----	3.17	-----	-----	-----	-----	3.17
47.40	0.00	676.25	-----	-----	-----	-----	3.13	-----	-----	-----	-----	3.13
47.70	0.00	676.24	-----	-----	-----	-----	3.09	-----	-----	-----	-----	3.09
48.00	0.00	676.24	-----	-----	-----	-----	3.05	-----	-----	-----	-----	3.05
48.30	0.00	676.24	-----	-----	-----	-----	3.00	-----	-----	-----	-----	3.00
48.60	0.00	676.23	-----	-----	-----	-----	2.96	-----	-----	-----	-----	2.96
48.90	0.00	676.23	-----	-----	-----	-----	2.92	-----	-----	-----	-----	2.92
49.20	0.00	676.23	-----	-----	-----	-----	2.88	-----	-----	-----	-----	2.88
49.50	0.00	676.23	-----	-----	-----	-----	2.84	-----	-----	-----	-----	2.84
49.80	0.00	676.22	-----	-----	-----	-----	2.81	-----	-----	-----	-----	2.81
50.10	0.00	676.22	-----	-----	-----	-----	2.77	-----	-----	-----	-----	2.77
50.40	0.00	676.22	-----	-----	-----	-----	2.73	-----	-----	-----	-----	2.73
50.70	0.00	676.21	-----	-----	-----	-----	2.69	-----	-----	-----	-----	2.69
51.00	0.00	676.21	-----	-----	-----	-----	2.66	-----	-----	-----	-----	2.66
51.30	0.00	676.21	-----	-----	-----	-----	2.62	-----	-----	-----	-----	2.62
51.60	0.00	676.20	-----	-----	-----	-----	2.59	-----	-----	-----	-----	2.59
51.90	0.00	676.20	-----	-----	-----	-----	2.55	-----	-----	-----	-----	2.55
52.20	0.00	676.20	-----	-----	-----	-----	2.52	-----	-----	-----	-----	2.52
52.50	0.00	676.20	-----	-----	-----	-----	2.48	-----	-----	-----	-----	2.48

...End

Reservoir Report

Hydraflow Hydrographs by Intelisolve

Reservoir No. 1 - Settling Impoundment

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	676.00	779,000	0.000	0.000
4.00	680.00	1,220,000	91.781	91.781

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise in	= 0.0	0.0	0.0	0.0
Span in	= 0.0	0.0	0.0	0.0
No. Barrels	= 0	0	0	0
Invert El. ft	= 0.00	0.00	0.00	0.00
Length ft	= 0.0	0.0	0.0	0.0
Slope %	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

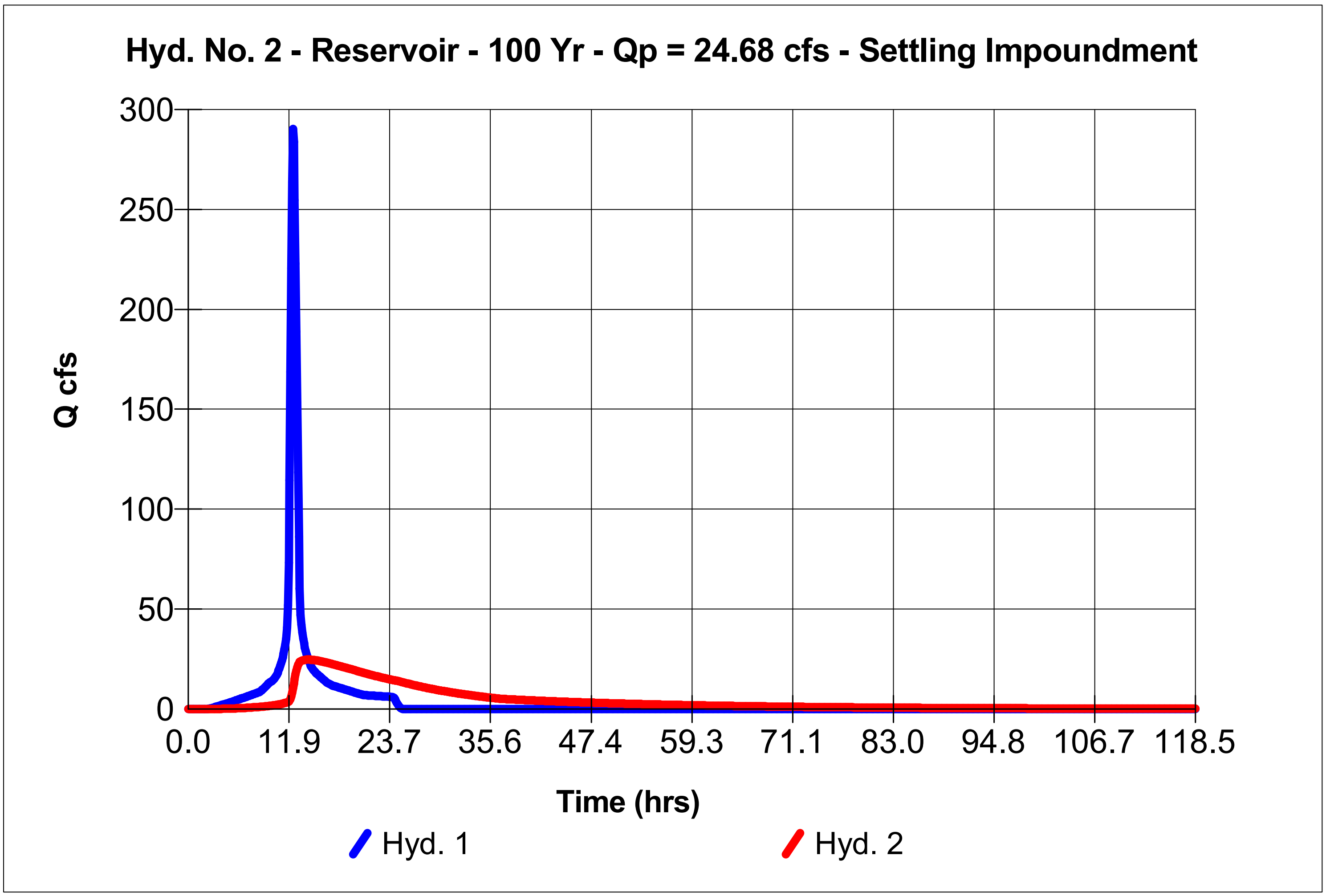
	[A]	[B]	[C]	[D]
Crest Len ft	= 6.00	0.00	0.00	0.00
Crest El. ft	= 676.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration Rate = 0.00 in/hr/sqft Tailwater Elev. = 0.00 ft

Note: All outflows have been analyzed under inlet and outlet control.

Stage / Storage / Discharge Table

Stage ft	Storage acft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0.000	676.00	---	---	---	---	0.00	---	---	---	---	0.00
4.00	91.781	680.00	---	---	---	---	159.84	---	---	---	---	159.84



Hyd. No. 2 - Reservoir - 100 Yr - Qp = 24.68 cfs - Settling Impoundment
Q cfs
300
250
200
150
100
50
0
0.0
11.9
23.7
35.6
47.4
59.3
71.1
83.0
94.8
106.7
118.5
Time (hrs)
Hyd. 1
Hyd. 2

HE&C

Harrington Engineering & Construction, Inc.

By TJH Date 8/24/16 Subject ZERO LIQUID DISCHARGE POND (ZLD) Sheet No. 1 of 2

Chk: ______ Date ______ 100-YEAR STORM ANALYSIS Proj. # 154.018.012.003

1/4" x 1/4"

1.) 100 YEAR 24-HOUR TYPE II STORM 7.15 INCHES

2.) STARTING ELEVATION ZLD POND 673 FEET

3.) ZLD DIRECT RUNOFF AREA 36 ACRES OF WHICH 19 ACRES IS POND WATER SURFACE

4.) ZLD INDIRECT RUNOFF AREA (COAL PILE) 44 ACRES WHICH FLOWS THROUGH COAL PILE RUNOFF SETTLING POND

5.) COAL PILE RUNOFF SETTLING POND

NORMAL WATER ELEVATION	670 FT	1.22 ACRES
OVERFLOW TO ZLD	676.5 FT	1.73 ACRES

CALCULATE VOLUME OF WATER

a.) DIRECT RUNOFF 36 ACRES × 7.15 IN / 12 IN/FT = 21.5 ACRE-FT

b.) INDIRECT RUNOFF 44 ACRES × 7.15 IN / 12 IN/FT = 26.2 ACRE-FT

c.) REMOVE COAL POND $4.5^{FT} \left(\frac{1.22+1.73}{2}\right)$ ACRE = − 6.6 ACRE-FT

TOTAL = 41.1 ACRE/FT

HE&C

Harrington Engineering & Construction, Inc.

By TJH Date 8/24/16 Subject ZERO LIQUID DISCHARGE POND Sheet No. 2 of 2

Chk: ______ Date ______ 100-YEAR STORM ANALYSIS Proj. # 154.018.012.00

1/4" x 1/4"

DEPTH OF WATER IN ZLD = 41.1 ACRE-FT / 19 ACRE = 2.2 FEET

FINAL ELEVATION = 673 FT + 2.2 FT = 675.2 FT

FREEBOARD = 682 FT − 675.2 FT = 6.8 FT