HISTORY OF CONSTRUCTION

EXISTING CCR IMPOUNDMENTS

CCR Rule Section 257.73(c)

ASBURY POWER PLANT

21133 Uphill Lane
Asbury, Missouri 64832

October 17, 2016

EMPIRE DISTRICT ELECTRIC COMPANY

Prepared by:

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October 17, 2016

Empire District Electric Company
Asbury Power Plant
21133 Uphill Lane
Asbury, Missouri 64832

RE: **History of Construction** – CCR Rule Section 257.73(c)
Empire District Electric Company – Asbury Power Plant
Asbury, Missouri
PPI Project Number 231518

To Whom It May Concern:

The attached Report summarizes the **History of Construction** of the Empire District Electric Company's CCR Impoundment at the Asbury Power Plant (Asbury CCR Impoundment). In accordance with Section 257.73(b), the Asbury CCR Impoundment has a height of five feet or more and a storage volume of 20 acre-feet or more, and is therefore subject to the requirements of Section 257.73(c) through (e). This document has been prepared to meet the requirements of Section 257.73(c) of the CCR Rule.

In accordance with Section 257.105(f)(5) of the CCR Rule, a copy of this document should be maintained in Empire's operating records. In accordance with Section 257.107(f)(4), a copy of this document should also be posted to Empire's CCR Compliance website. Notification of the availability of this document should be provided to the State Director, as required in Section 257.106(f)(8).

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PALMERTON & PARRISH, INC.

HISTORY OF CONSTRUCTION – EXISTING CCR IMPOUNDMENTS

CCR RULE SECTION 257.73(C)

EMPIRE DISTRICT ELECTRIC COMPANY – ASBURY POWER PLANT

ASBURY, MISSOURI

1.0 INTRODUCTION

"CCR Rule Section 257.73(c)(1) No later than October 17, 2016, the owner or operator of the CCR unit must compile a history of construction, which shall contain, to the extent feasible, the information specified in paragraphs(c)(1)(i) through (xi) of this section…"

Section 257.73(c) of the CCR Rule requires compilation of a History of Construction. This Report summarizes the required information, to the extent feasible. As indicated in the Preamble of the CCR Rule, this Report only incorporates information where factual documentations exists and was available for review. This Report does not include anecdotal or speculative information regarding the Asbury CCR Impoundment's design and construction history.

2.0 OWNER / OPERATOR / IDENTIFICATION

CCR Rule Section 257.73(c)(i): The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identified number of the CCR unit if one has been assigned by the State.

Table 2.0-1: Impoundment Identification and Owner	
Impoundment Name	Asbury CCR Impoundment
Owner	Empire District Electric Company
Address	21133 Uphill Lane Asbury, Missouri 64832
Identification Number	None

3.0 SITE PLAN

CCR Rule Section 257.73(c)(ii): The location of the CCR unit identified on the most recent U.S. Geological Survey (USGS) 7 ½ minute or 15 minute topographic quadrangle map, or a topographic map of equivlanet scale if a USGS map is not available.

The location of the Asbury CCR Impoundment is shown on the United States Geological Survey (USGS) topographic quadrangle map on Figure 1, included in Appendix I.

4.0 STATEMENT OF PURPOSE

CCR Rule Section 257.73(c)(iii): A statement of the purpose for which the CCR unit is being used.

The primary purpose of the Asbury CCR Impoundment is for storage of coal combustion residuals. The secondary purpose of the Asbury CCR Impoundment is for retention of make-up water for Plant operations and temporary retention of storm water.

5.0 WATERSHED DATA

CCR Rule Section 257.73(c)(iv): The name and size in acres of the watershed within which the CCR unit is located.

The Asbury CCR Impoundment is located in the Blackberry Creek watershed (USGS ID# 11070207-0507) within the larger Spring River Watershed (USGS ID# 11070207). The Blackberry Creek watershed drains approximately 13,888 acres.

6.0 FOUNDATION AND ABUTMENT

CCR Rule Section 257.73(c)(v): A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

Little to no as-built documentation is available for the Asbury CCR Impoundment. However, several studies have been completed at the Asbury CCR Impoundment to characterize the levee embankments for the purposes of slope stability analysis, and to estimate the volume of CCR stored in the Asbury CCR Impoundment.

The Asbury CCR Impoundment is constructed of a perimeter earthen levee embankment. The Asbury CCR Impoundment is subdivided into three (3) operational Ponds, identified as the Lower Pond, Upper Pond, and South Pond. The Lower Pond, Upper Pond, and South Pond are separated by interior earthen embankments. The Asbury CCR Impoundment does not have ñabutmentsò in the context of the CCR Rule. The table below summarizes subsurface conditions within the Asbury CCR Impoundment levee embankments, and underlying foundation conditions, based on the results of previous subsurface investigations.

Table 6.0-1: Levee Embankment and Foundation Physical and Engineering Properties

Zone	Physical and Engineering Properties
Perimeter Levee Embankments	Earth fill typically consisting of stiff to very stiff lean clay. Field and laboratory test data indicates moderate to high in situ shear strength.
Interior Earthen Levee Embankments	Earth fill typically consisting of stiff to very stiff lean clay. Field and laboratory test data indicates moderate to high in situ shear strength.
Foundation Conditions	Natural lean clay soils, medium stiff to very stiff, often logged as shaley and/or with shale layers. Natural lean clay soils transition to weathered shale bedrock at depth.

7.0 CONSTRUCTION HISTORY

CCR Rule Section 257.73(c)(vi): A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

Little to no as-built documentation is available for the Asbury CCR Impoundment. The Asbury CCR Impoundment is constructed of a perimeter earthen levee embankment. The Asbury CCR Impoundment is subdivided into three (3) operational Ponds, identified as the Lower Pond, Upper Pond, and South Pond. The Lower Pond, Upper Pond, and South Pond are separated by interior earthen embankments.

There are no as-built records pertaining to construction of the Asbury CCR Impoundment. No records are available pertaining to original geotechnical investigation, soil borrow data, or compaction during construction. As discussed in Section 6.0 of this Report, several studies have been completed to characterize the levee embankments for the purposes of slope stability analysis and to estimate the volume of CCR stored in the Asbury CCR Impoundment. Table 6.0-1 presents a general summary of the physical and engineering properties of the Asbury CCR Impoundment levee embankments and underlying foundation conditions.

Table 7.0-1 below summarizes the embankment levee geometry of the Upper Pond, South Pound, and Lower Pond.

Table 7.0-1: Levee Embankment Geometry

Parameter	Upper Pond	Lower Pond	South Pond
Maximum Height (ft.)	20	20	11.5
Perimeter Length (ft.)[1]	6,060	7,690	3,300
Crest Width (ft.)	10 to 20	10 to 20	15 to 20
Crest Elevation (ft.)[2]	953.8	931.5	954.2
Approximate Surface Area (ac.)	22.5	80	14

[1]Perimeter Length refers to the entire perimeter of each Pond. It should be noted that the Upper Pond and Lower Pond have approximately 1,700 feet of levee perimeter length in common, and that the Upper Pond and South Pond have approximately 1,300 feet of levee perimeter length in common.
[2]Crest Elevation refers to the lowest elevation of the top of the earthen perimeter embankment.

The total volume of coal combustion residuals (CCR) stored at the Asbury CCR Impoundment is conservatively estimated to be approximately 2,461,000 cubic yards. This volume has been computed based upon the past operating history of the Asbury Power Plant, a Volume Study completed in 2012 that included subsurface borings to quantify the depth of CCR at various locations, and volume study updates completed since 2012. This volume is considered conservative in part due to the fact that CCR has been sold to contractors for beneficial use applications throughout the operating life of the Asbury Power Plant.

Table 7.0-2 below presents a general construction history timeline, to the extent factual documentation was available for review.

Table 7.0-2: Construction History Timeline	
Approximate Date	Construction Activity and/or Operating Modification
1970	Original commissioning of Asbury Power Plant Unit 1, 213 MW.
1970	The Upper Pond was constructed as part of the original Asbury Power Plant construction.
1974	The Lower Pond was constructed.
1978	The South Pond was constructed.
1986	Commissioning of Asbury Power Plant Unit 2, 19 MW.
1987 / 1988	Design and construction, respectively, of the seepage cutoff trench around the Lower Pond.
2014	Commissioning of the Asbury Environmental Retrofit Project, which resulted in the termination of fly ash sluicing, and dry hauling of flue gas desulfurization (FGD) byproduct to the Asbury CCR Impoundment.
2016	Operating water level of the South Pond lowered to approximate pond bottom elevation.

8.0 ENGINEERING DRAWINGS

CCR Rule Section 257.73(c)(vii): At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural and manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

As-built engineering drawings for the Asbury CCR Impoundment do not exist. For the purposes of this Report, the site plan included as Figure 2 in Appendix I shows the current topographic survey for the Asbury CCR Impoundment; the location of piping, valves, and spillways; nomenclature used to identify the sections within the Asbury CCR Impoundment; and the typical operating water levels with the Asbury CCR Impoundment.

A site plan showing the location of existing instrumentation is presented in Section 9.0 of this Report. The approximate maximum depth of CCR at selected locations throughout the Asbury CCR Impoundment is shown on Figure 3 included in Appendix I.

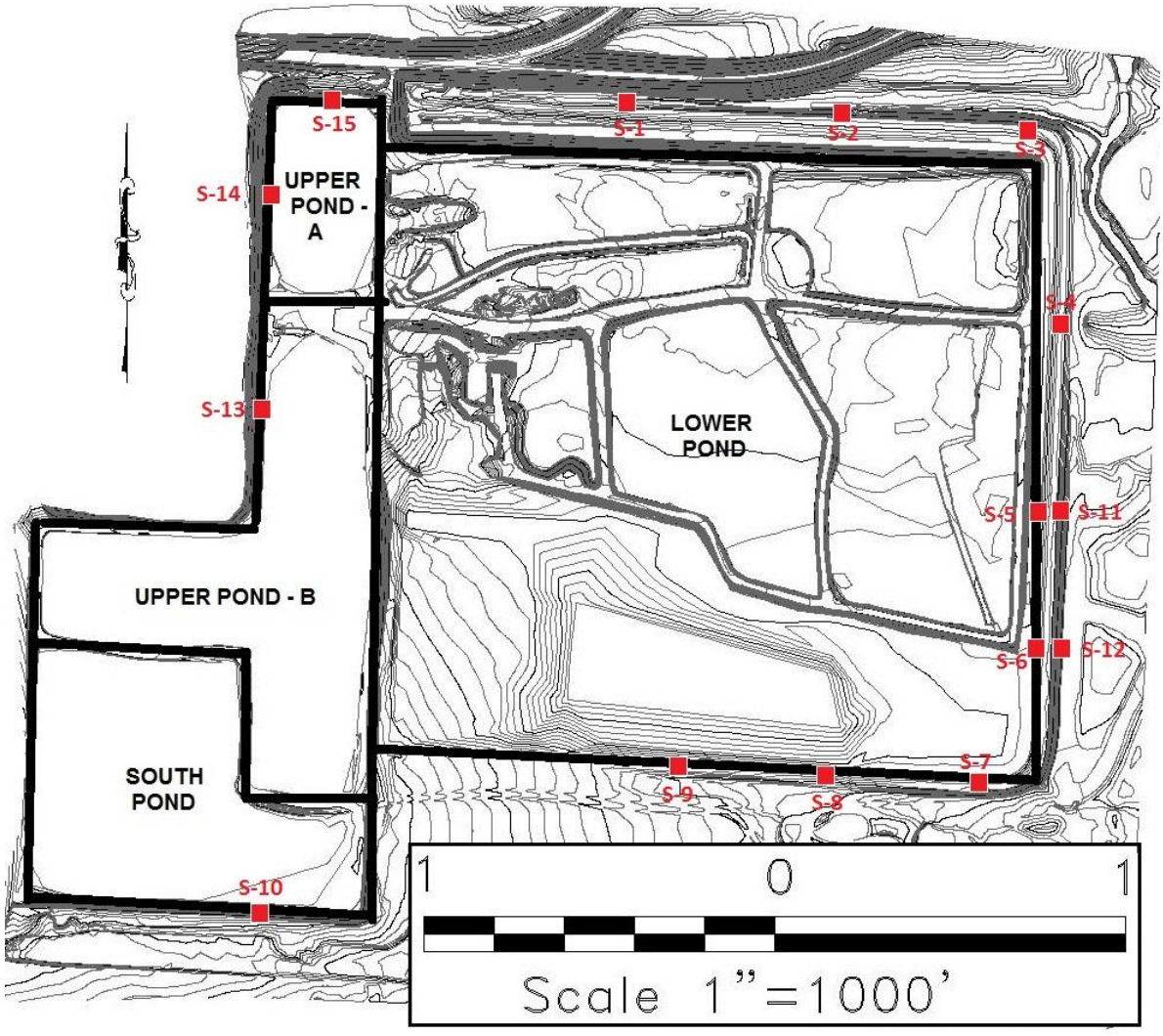
9.0 INSTRUMENTATION

CCR Rule Section 257.73(c)(viii): A description of the type, purpose, and location of existing instrumentation.

There are twelve (12) existing settlement monuments and fifteen (15) existing vertical deflection monuments in place around the perimeter of the Asbury CCR Impoundment embankment. The settlement monuments were installed in 2012 for the purpose of monitoring the stability of the Asbury CCR Impoundment levee embankments. The settlement monuments were surveyed regularly from 2012 to 2016 using level loop survey methods, and have shown no signs of embankment instability.

To reduce the level of effort associated with the monthly monitoring, vertical deflection monuments were installed in 2016. Vertical deflection monuments were installed adjacent to the existing settlement monuments, and an additional three (3) monuments were installed at new locations. In accordance with CCR Rule Section 257.83, the vertical deflection monuments are monitored monthly.

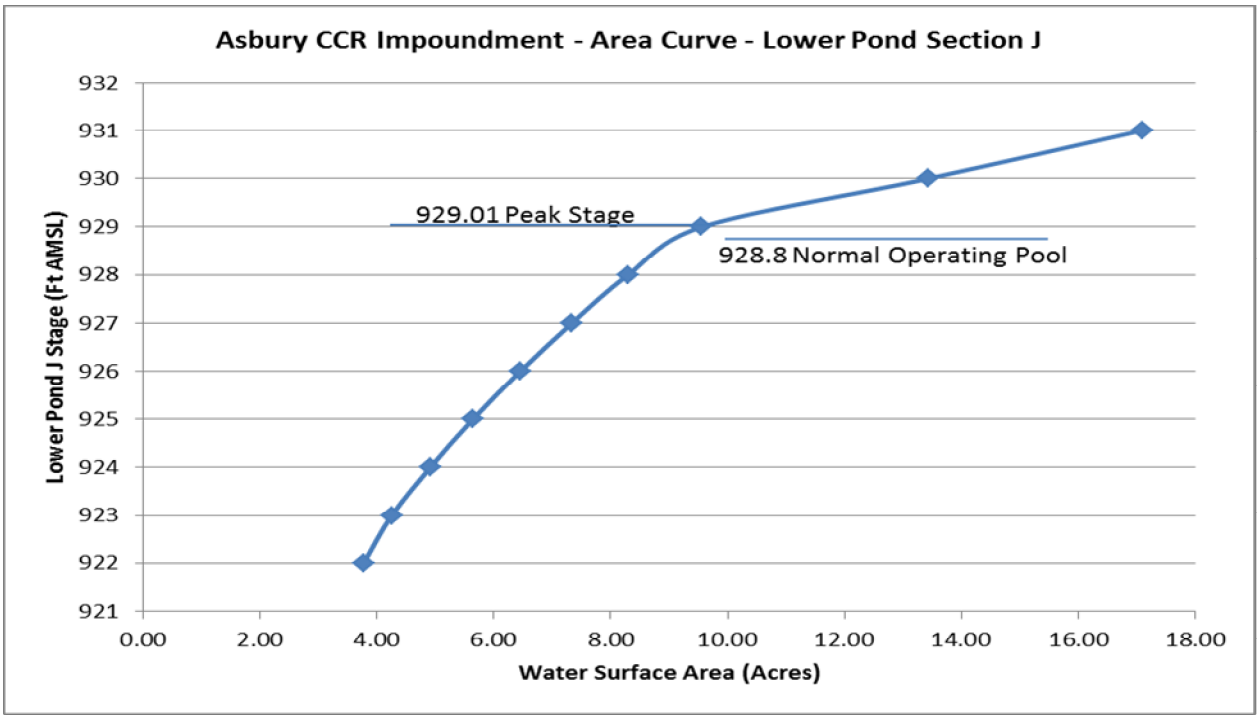
The approximate locations of the settlement monuments and vertical deflection monuments are shown on the Site Plan below.

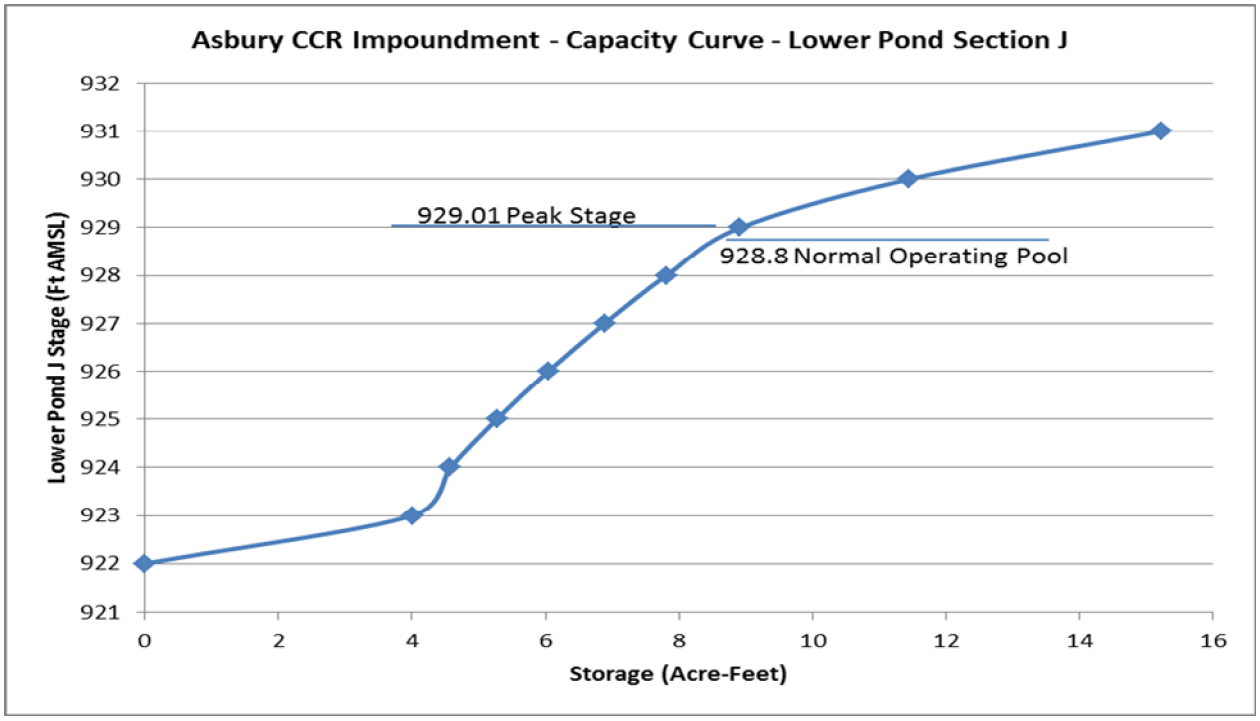


10.0 AREA CAPACITY CURVE

CCR Rule Section 257.73(c)(ix): Area capacity curves for the CCR unit

Area and capacity curves were developed for the Lower Pond Section J. The outlet structure in Lower Pond Section J is where water leaves the Asbury CCR Impoundment. The normal operating pool and peak stage from the design flood are labeled on the curves.





11.0 SPILLWAY STRUCTURES

Section 257.73(c)(x): A description of each spillway and diversion design features and capacities and calculations used in their determination.

The Asbury CCR Impoundment has a single discharge point, identified as Outfall #002. The primary spillway at Outfall #002 consists of two (2) 12-inch diameter PVC pipes with butterfly valves. The intake for these two (2) pipes is set at approximately 928.8 feet. Flow through these pipes was estimated using Manningôs equation.

Outfall #002 also has an auxiliary spillway consisting of a trapezoidal shaped concrete lined channel that is 24 feet wide and 1.2 feet from the bottom of spillway to the top of the berm. The flowline of the auxiliary spillway is at elevation 930.35 feet. Flow over the auxiliary spillway was estimated using the equation for flow over an Ogee spillway.

Water discharges from Upper Pond A into Lower Pond Section D from three (3) 10-inch pipes. The intake of two of these pipes is set at 952.16 feet and the intake of the third pipe is set at 953.0 feet. Flow through these three pipes was estimated using Manningôs equation. Water in Lower Pond Section D discharges to Lower Pond Section E from two (2) 10-inch pipes passing through the interior separating dike. Flow through these two pipes was estimated using Manningôs equation until the pipe inlets became submerged with 2.5 feet of water. With water 2.5 feet or higher over the pipe inlets, flow was estimated using the Hazen Williams equation for flow under pressure. There are no spillways on Upper Pond A, Lower Pond Section D, or Lower Pond Section E.

There are overflow pipes from Lower Pond Section G to Lower Pond Section J, but the ponding level in Section G does not reach the pipe inverts under the design flood.

Water discharges from Upper Pond B into Lower Pond Section J from one (1) 10-inch pipe. The intake of this pipe is set at approximately 953.0 feet. Flow through this pipe was estimated using Manningôs equation.

Pipe flow computations are included in Appendix II of this Report.

12.0 OPERATION AND MONITORING

Section 257.73(c)(xi): The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

Empireôs staff completes daily surveillance of the Asbury CCR Impoundment. Water level readings are collected regularly.

Empireôs staff completes a weekly inspection and required form in accordance with CCR Rule Section 257.83. Empireôs staff reports items of note to the Maintenance Manager, who arranges for additional field review and/or repair on a case-by-case basis. The most typical action item resulting from Empireôs surveillance activities is repair of animal burrow holes.

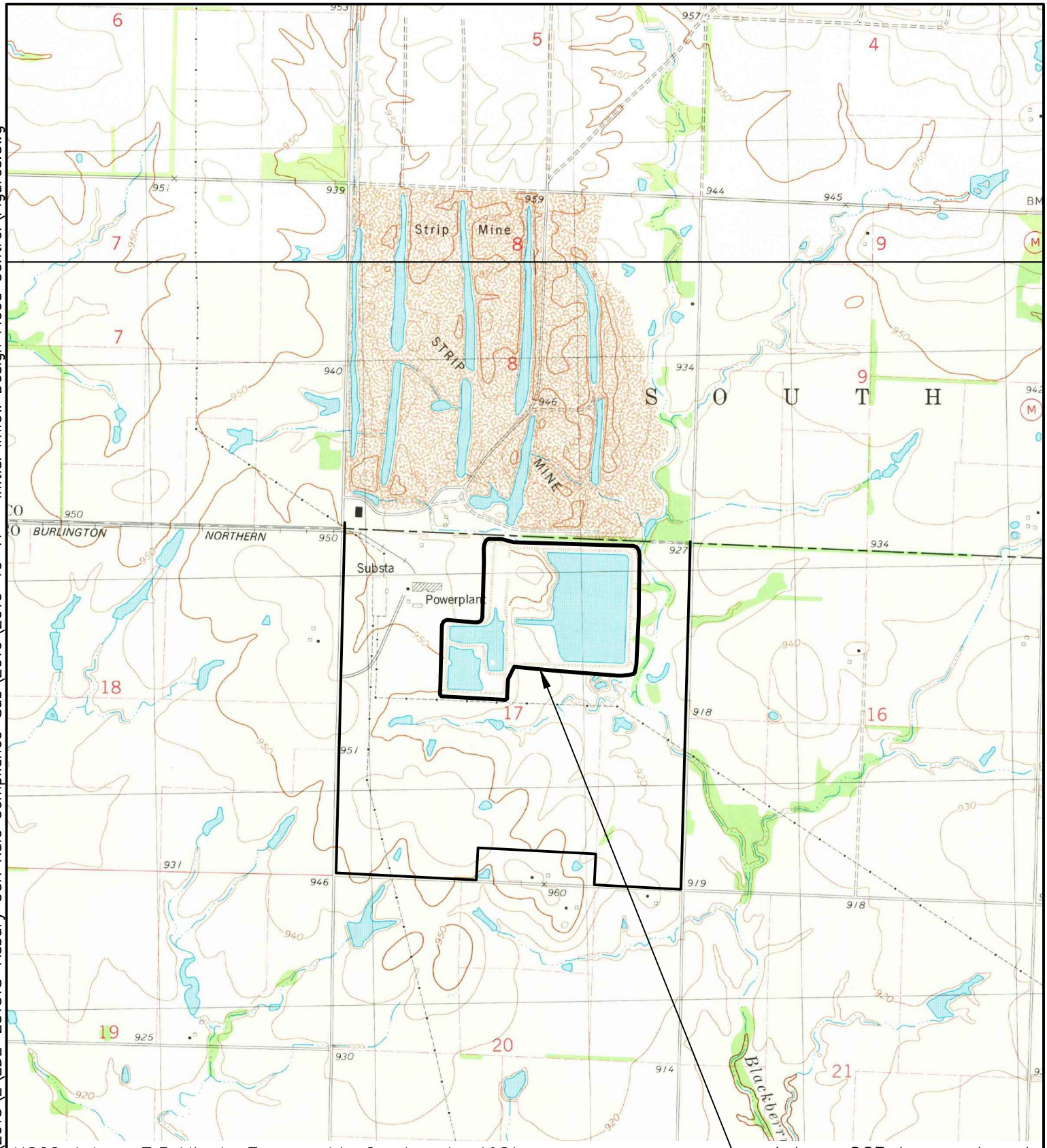
13.0 STRUCTURAL INSTABILITY

Section 257.73(c)(xii): Any record or knowledge of structural instability of the CCR unit.

There is no documentation of structural instability at the Asbury CCR Impoundment.

APPENDIX I

FIGURES



USGS Asbury 7.5 Minute Topographic Quadrangle, 1981
USGS Mindenmines 7.5 Minute Topographic Quadrangle, 1981

SCALE
1"=2000'

Project: Asbury Power Plant, 21133 Uphill Lane, Asbury, MO
Client: Empire District Electric Company

Site Location on Topographic Map

DATE: October 17, 2016

Project Number: 231518

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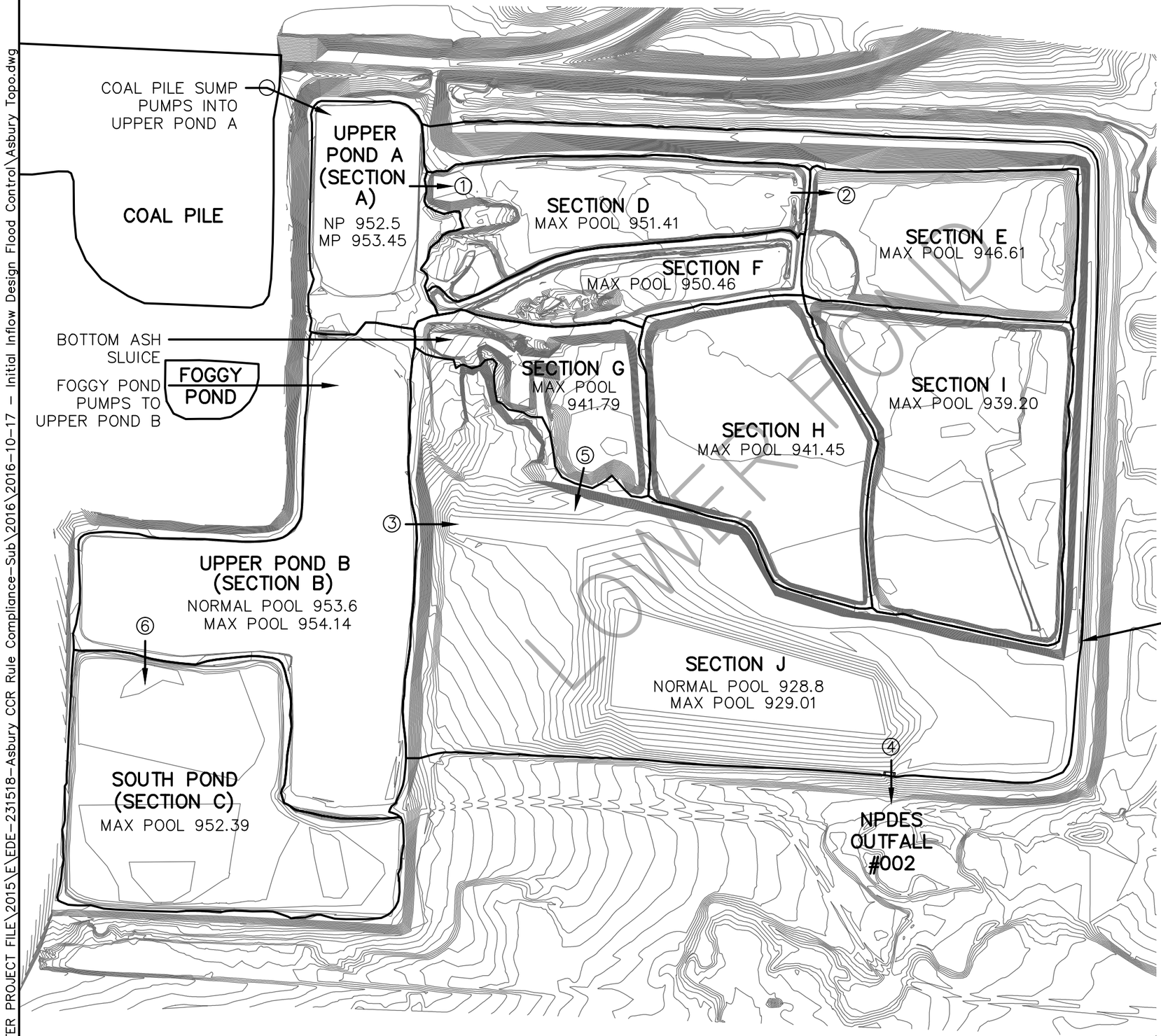
FIGURE 1

S:_MASTER PROJECT FILE\2015\E\EDE-231518-Asbury CCR Rule Compliance-Sub\2016\2016-10-17 - Initial Inflow Design Flood Control\Figures.dwg



① 3–10" PIPES THROUGH DIKE

② 2–10" PIPES THROUGH DIKE

③ 1–10" PIPE THROUGH DIKE

④ NPDES OUTFALL #002
PRIMARY SPILLWAY: 2–12" PIPES WITH VALVES THROUGH DIKE
AUXILIARY SPILLWAY: 24' WIDE CONCRETE SPILLWAY ON TOP OF DIKE

⑤ 3–12" PIPES THROUGH DIKE

⑥ 2–12" PIPES WITH VALVES THROUGH DIKE

Project: Asbury Power Plant, 21133 Uphill Lane, Asbury, Missouri
Client: Empire District Electric Company

Asbury CCR Impoundment

DATE: October 17, 2016 Project Number: 231518

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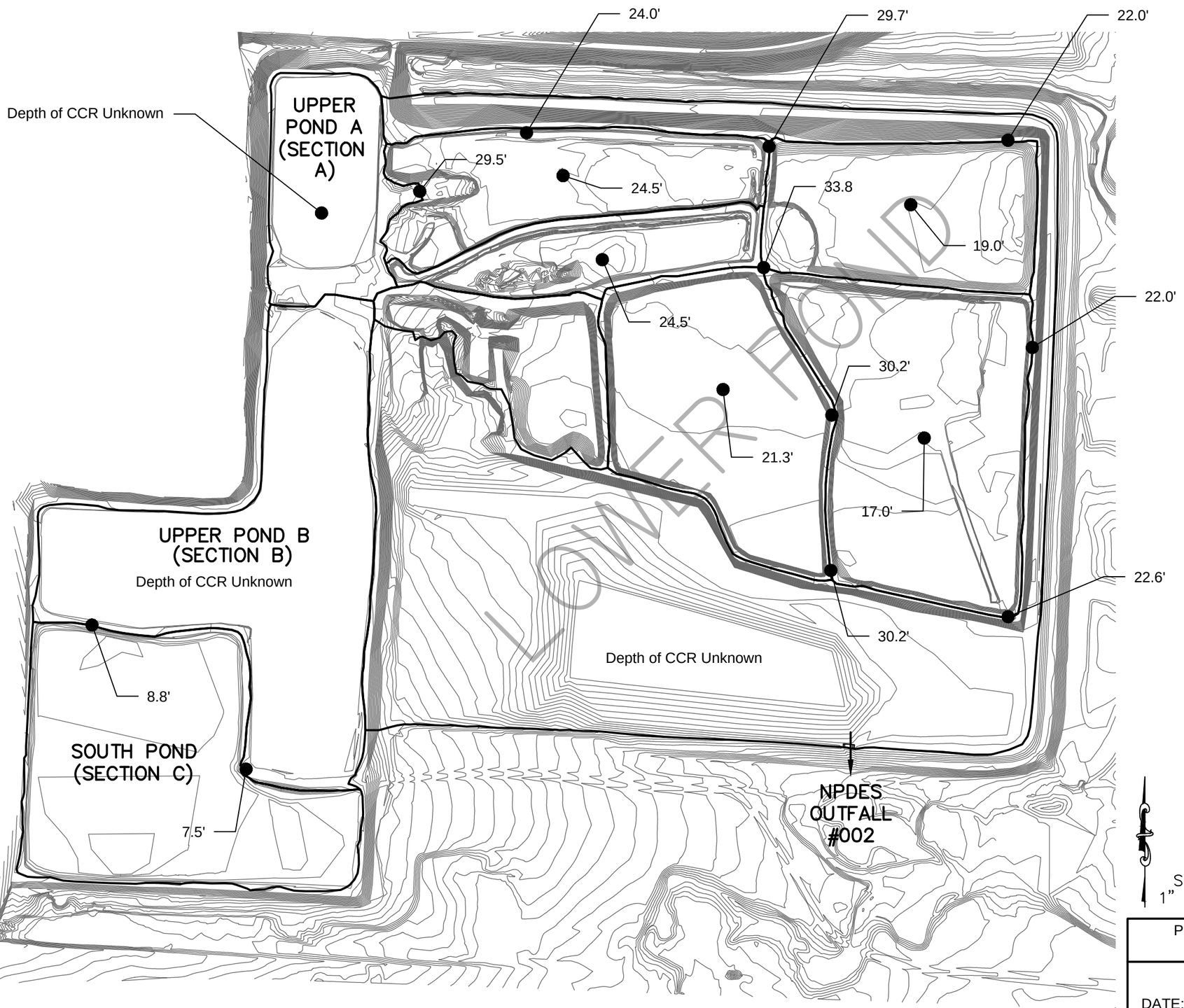
FIGURE 2

S:_MASTER PROJECT FILE\2015\E\EDE-231518-Asbury CCR Rule Compliance-Sub\2016-10-17 - Initial Inflow Design Flood Control\Asbury Topo.dwg



Project: Asbury Power Plant, 21133 Uphill Lane, Asbury, Missouri
Client: Empire District Electric Company

Approximate Depth of Stored CCR

DATE: October 17, 2016 Project Number: 231518

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FIGURE 3

S:_MASTER PROJECT FILE\2015\E\EDE-231518-Asbury CCR Rule Compliance-Sub\2016\2016-10-17 - Initial Inflow Design Flood Control\Draf\Asbury Topo.dwg

APPENDIX II

PIPE FLOW COMPUTATIONS

Manning's Equation $V = (Cf/n)\ R^{0.67}\ S^{0.5}$

$Q = VA$

V = Velocity (ft/sec) **Cf** = Conversion factor **S** = Slope

Q = Flow (cu ft/sec) **n** = Pipe roughness cooefficient

R = Hydraulic Radius (ft) = Area (A) / Wetted Perimeter (P)

Upper Pond A to Section D

Q	5.82	cfs
V	10.68	fps
Pipe Dia	10	in
	0.83	ft
n	0.012	PVC
Cf	1.49	
A	0.55	sq ft
P	2.62	ft
S	0.06	
R	0.21	ft

Section D to Section E

Q	4.76	cfs
V	8.72	fps
Pipe Dia	10	in
	0.83	ft
n	0.012	PVC
Cf	1.49	
A	0.55	sq ft
P	2.62	ft
S	0.04	
R	0.21	ft

Section G to Lower Pond J

Q	11.21	cfs
V	14.27	fps
Pipe Dia	12	in
	1	ft
n	0.012	PVC
Cf	1.49	
A	0.79	sq ft
P	3.14	ft
S	0.084	
R	0.25	ft

Upper Pond B to Lower Pond J

Q	3.36	cfs
V	6.17	fps
Pipe Dia	10	in
	0.83	ft
n	0.012	PVC
Cf	1.49	
A	0.55	sq ft
P	2.62	ft
S	0.02	
R	0.21	ft

Outlet - Outfall 002

Q	5.47	cfs
V	6.97	fps
Pipe Dia	12	in
	1	ft
n	0.012	PVC
Cf	1.49	
A	0.79	sq ft
P	3.14	ft
S	0.02	
R	0.25	ft

Hazen Williams Equation for Flow $Q = 0.285\ C\ (D^{2.63})(S^{0.54})$

Q = Flow (cu ft/sec)
C = Hazen Williams Friction Coefficient (140 for PVC)
D = Pipe Diameter (ft)
S = Hydraulic Grade Line Slope = Water Height/Pipe Length (50')

Pressure flow from 10" pipe between Section D and Section E.

Water Height	S	Q	Water Elev
2.5	0.05	4.895	951
3.5	0.07	5.870	952