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Coal Combustion Waste Impoundment
Round 6 - Dam Assessment Report

Vermilion Power Station (Site 015)

Fly Ash Dikes
Dynegy Midwest Generation, Inc.
Oakwood, Illinois

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

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INTRODUCTION, SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The release of over five million cubic yards from the Tennessee Valley Authority's Kingston, Tennessee facility in December 2008, which flooded more than 300 acres of land, damaging homes and property, is a wake-up call for diligence on coal combustion waste disposal units. We must marshal our best efforts to prevent such catastrophic failure and damage. A first step toward this goal is to assess the stability and functionality of the ash impoundments and other units, then quickly take any needed corrective measures.

This assessment of the stability and functionality of the Vermilion Power Station Fly Ash Dam management units is based on a review of available documents and on the site assessment conducted by Dewberry personnel on Tuesday, August 10, 2010, as well as data submitted subsequent to the site visit. We found the supporting technical documentation adequate for the East Ash Pond System (Section 1.1.3).

In summary:

- The East Ash Pond System is FAIR for continued safe and reliable operation, with no recognized existing or potential management unity safety deficiencies.
- The North Ash Pond System is not rated.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is embarking on an initiative to investigate the potential for catastrophic failure of Coal Combustion Surface Impoundments (i.e., management unit) from occurring at electric utilities in an effort to protect lives and property from the consequences of a dam failure or the improper release of impounded slurry. The EPA initiative is intended to identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures (if present); to note the extent of deterioration (if present), status of maintenance and/or a need for immediate repair; to evaluate conformity with current design and construction practices; and to determine the hazard potential classification for units not currently classified by the management unit owner or by a state or federal agency. The initiative will address management units that are classified as having a Less-than-Low, Low, Significant or High Hazard Potential ranking. (For Classification, see pp. 3-8 of the 2004 Federal Guidelines for Dam Safety)

In February 2009, the EPA sent letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion waste. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such

management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units. The EPA used the information received from the utilities to determine preliminarily which management units had or potentially could have High Hazard Potential ranking.

The purpose of this report is to evaluate the condition and potential of waste release from the selected Coal Combustion Waste (CCW) management units. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner.

Factors considered in determining the hazard potential classification of the management units(s) included the age and size of the impoundment, the quantity of coal combustion residuals or by-products that were stored or disposed of in these impoundments, its past operating history, and its geographic location relative to down gradient population centers and/or sensitive environmental systems.

This report presents the opinion of the assessment team as to the potential of catastrophic failure and reports on the condition of the management unit(s).

LIMITATIONS

The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion waste management unit(s). Qualified Dewberry engineering personnel performed the field observations and review and made the assessment in conformance with the required scope of work and in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is made with regard to our assessment of dam safety.

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit on August 10, 2010, and review of technical documentation provided by Dynegy.

1.1.1 Conclusions Regarding the Structural Soundness of the Management Unit(s)

The New East Ash Pond system did not indicate any areas of significant concern during the one-day site visit. The impoundment dam is under the regulatory authority of the State of Illinois Dam Safety program and has had no significant adverse findings in prior State inspections.

Review of the structural stability analysis indicated some potential issues related to stability in the event of short term loading conditions including rapid draw down, rapid increase in ash loading in the pond, and selection of the seismic event.

- The analyses evaluated only long term stability using long term, drained soil strength data. A short term, post-construction event can produce short term increases in soil pore pressure and a corresponding decrease in shear strength. This phenomenon can cause failure of embankments that have otherwise been stable for decades.
- The ground acceleration used in the seismic loading analysis does not meet the current recommended design criteria and should be re-analyzed using current design criteria.
- The embankment geometry used in the slope stability analysis does not appear to be consistent with the geometry indicated on the design drawings.

1.1.2 Conclusions Regarding the Hydrologic/Hydraulic Safety of the Management Unit(s)

The New East Ash Pond System design report includes critical rainfall analyses, freeboard design, outfall design calculations, and impact on flood elevations of the Middle Fork Vermilion River. Appropriate safety considerations were applied.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

The supporting technical documentation is adequate. Engineering documentation reviewed is referenced in Appendix A.

1.1.4 Conclusions Regarding the Description of the Management Unit(s)

The description of the management unit provided by Dynegy was an accurate representation of what Dewberry observed in the field.

1.1.5 Conclusions Regarding the Field Observations

For the New East Ash Pond System, Dewberry staff was provided access to all areas in the vicinity of the management unites required to conduct a thorough field observation. The visible parts of the dike embankments and outlet structure were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability. Embankments visually appear structurally sound. There are no indications of unsafe conditions or conditions needing remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

For the New East Ash Pond System, the current maintenance and methods of operation appear to be adequate for the fly ash management unit. There was no evidence of repaired embankments or prior releases observed during the field inspection.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

For the New East Ash Pond System, the surveillance program appears to be adequate. The management unit dikes are not instrumented. Based on the size of the dikes, the history of satisfactory performance and the current inspection program, installation of a dike monitoring system is not needed at this time.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

The New East Ash Pond System is FAIR for continued safe and reliable operation. Acceptable performance is expected under all

applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable criteria.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Structural Stability

The documentation is adequate to demonstrate structural stability of the embankment under long term loading conditions. However, the soil strength parameters, seismic loading criteria, and embankment cross section geometry used in the analyses do not demonstrate embankment stability under adverse short term loading conditions. Additional structural analysis is recommended

- Re-analyze structural stability using a cross section configuration that more closely matches to the design configuration.
- Re-analyze structural stability using undrained soil shear strength values for short term loading conditions, including rapid draw down and rapid increase in ash loading to the pond
- Reanalyze seismic loading using current design criteria published by the U.S Geologic Society.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

No recommendations appear warranted at this time.

1.2.3 Recommendations Regarding the Supporting Technical Documentation

No recommendations appear warranted at this time.

1.2.4 Recommendations Regarding the Description of the Management Unit(s)

No recommendations appear warranted at this time.

1.2.5 Recommendations Regarding the Field Observations

No recommendations appear warranted at this time.

1.2.6 Recommendations Regarding the Maintenance and Methods of Operation

No recommendations appear warranted at this time.

1.2.7 Recommendations Regarding the Surveillance and Monitoring Program

No recommendations appear warranted at this time.

1.2.8 Recommendations Regarding Continued Safe and Reliable Operation

No recommendations appear warranted at this time.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

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Thomas L. Davis, Dynegy Midwest Generation, Inc.
Charles P. Nerone, Dynegy Midwest Generation, Inc.
Ken Berry, P.E., URS
Cleighton Smith, P.E., Dewberry
Julia Moline, E.I.T., Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on August 10, 2010.

Cleighton Smith, P.E.	Julia Moline, E.I.T

2.0 DESCRIPTION OF THE COAL COMBUSTION WASTE MANAGEMENT UNIT(S)

2.1 LOCATION AND GENERAL DESCRIPTION

The Vermilion Power Station is located near the Middle Fork Vermilion River near Oakwood, Illinois. A map of the site is provided in Appendix A – Doc 01. The plant is operated by Dynegy Midwest Generation, Inc. The Vermilion Power Station includes three ash pond systems: The Old East Ash Pond System, the North Ash Pond System, and the New East Ash Pond System. A labeled aerial photograph is provided in Appendix A – Doc 02.

- The Old East Ash Pond System was built as part of the original plant construction in the mid-1950's, and was taken out of service in the mid-1970's. Because the Old East Ash Pond System has not been operational since the 1970's, it was not assessed and is not discussed in this report.

- The North Ash Pond System was constructed in the mid-1970's. It is a two-cell system. Since construction of the New East Ash Pond System in 1988, the North Ash Pond System has been used primarily for stormwater storage. The North Ash Pond System is surrounded by a continuous earthen embankment, and an internal earthen dike separates the primary cell from the secondary cell. The North Ash Pond System embankment is described in design drawings (Appendix A – Docs 03, 04, 05, and 06) as being constructed with ―controlled compacted fill"; other information about the embankment material is unavailable. The North Ash Pond System is not regulated by a state agency and is not discussed in this report beyond Section 2.

- The New East Ash Pond System (referred to as the East Ash Pond System for the remainder of the report) was constructed in 1988 and expanded in 2002. It is a two-cell system. The East Ash Pond System is surrounded by a continuous earthen embankment, and an internal earthen dike separates the primary cell from the secondary cell. The East Ash Pond System embankment is constructed with a minimum 8 foot clay core surrounded by compacted earth (Appendix A – Docs 07-09/Original Construction Drawings and Docs 10-15/Expansion Drawings). The East Ash Pond System is regulated by the Illinois Department of Natural Resources (DNR).

Both the North Ash Pond System and the East Ash Pond System were observed by Dewberry, and both units are described in the field observations section. However,

because the North Ash Pond System is no longer permitted or regulated and has not been used for coal combustion waste storage since 1989, little documentation is available for that unit. Note that failure of the dike would not result in any offsite environmental release. Therefore, the North Ash Pond system is not discussed in Sections 3, 7, 8, 9, or 10 of this report.

Table 2.1a summarizes the dimensions of the embankments surrounding the East Ash Pond System[1].

Table 2.1a: Embankment Dimensions East Ash Pond	
Dam Height (ft)	48
Crest Width (ft)	15
Length (ft)	3,660
Side Slopes (upstream) H:V	3:1
Side Slopes (downstream) H:V	3:1

[1]Appendix A—Docs 10-15 and 16

2.2 SIZE AND HAZARD CLASSIFICATION

The East Ash Pond System is an intermediate size impoundment, based on Table 2.2a. It is approximately 48 feet high and has a design storage of 566 acre-feet (Appendix A—Doc 16). The North Ash Pond System was an intermediate size impoundment, based on Table 2.2a.

Table 2.2a: USACE ER 1110-2-106, Size Classification		
	Impoundment	
Category	**Storage (Ac-ft)**	**Height (ft)**
Small (East Ash Pond System)	50 and < 1,000	25 and < 40
Intermediate	***1,000 and < 50,000***	***40 and < 100***
Large	> 50,000	> 100

The East Ash Pond System is classified as having S***ignificant*** hazard, based on Table 2.2b below. While loss of human life would not be expected if a failure would occur, there would be environmental losses due to the presence of the Middle Fork of the Vermilion River and the Kickapoo State Park in the immediate downstream vicinity.

Table 2.2b: FEMA Federal Guidelines for Dam Safety Hazard Classification		
	Loss of Human Life	**Economic, Environmental, Lifeline Losses**
Low	None Expected	Low and generally limited to owner
Significant	***None Expected***	***Yes***
High	Probable. One or more expected	Yes (but not necessary for classification)

The East Ash Pond System is an intermediate, significant hazard impoundment. For the purposes of this report, the North Ash Pond System is not classified.

2.3 AMOUNT AND TYPE OF RESIDUALS CURRENTLY CONTAINED IN THE UNIT(S) AND MAXIMUM CAPACITY

The East Ash Pond System is designed and permitted to contain fly ash, bottom ash, boiler slag, and other materials. Key information is presented in Table 2.3b.

Table 2.3b: Maximum Capacity of Unit, East Ash Pond System	
Surface Area (acre)[1]	20
Current Storage Capacity (cubic yards)	534,013
Current Storage Capacity (acre-feet) [1]	331
Total Storage Capacity (cubic yards)	897,013
Total Storage Capacity (acre-feet) [1]	566
Crest Elevation (feet)[2]	620
Normal Pond Level (feet)[2]	582

[1]Appendix A—Doc 16

[2]Appendix A—Doc 10-15

2.4 PRINCIPAL PROJECT STRUCTURES

2.4.1 Earth Embankment

The East Ash Pond System consists of an earthen embankment ring dike. Design drawings indicate design of an impervious clay core surrounded by compacted fill (Appendix A—Doc 10-15).

2.4.2 Outlet Structures

The East Ash Pond System outlet structure is a 36-inch diameter concrete pipe (Appendix A—Doc 11) which discharges to a rock-lined channel, which in turn discharges to the Middle Fork Vermilion River. There is

also an emergency spillway, which consists of a concrete pipe drop structure.

2.5 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

There is no critical infrastructure within five miles down gradient. There is a road bridge within Kickapoo State Park about six miles downstream and an instate highway bridge about eight miles downstream.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

3.1 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS.

The East Ash Pond System was built under the Illinois Department of Transportation Division of Water Resources Permit Number 19333, dated August 23, 1988 (Appendix A – Doc 17). The East Ash Pond System is currently regulated by the Illinois Department of Natural Resources Permit #DS2002056 (Appendix A – Doc 18). The dam is inspected annually by a P.E. and was most recently inspected in March of 2010.

The East Ash Pond System was issued National Pollutant Discharge Elimination System Permit #IL0004057. The permit was issued on March 3, 2003 and expired on February 28, 2008. A renewal has been filed, but the permit had not been re-issued at the time of the inspection (Appendix C – Checklist).

3.2 SUMMARY OF SPILL/RELEASE INCIDENTS

Data reviewed by Dewberry did not indicate any spills, unpermitted release, or other performance related problems with the North or East Ash Pond System embankments over the last 10 years.

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4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The Vermilion Power Station was originally constructed in the 1950's. The North Ash Pond System was designed and constructed in the late 1970's to replace the original ash pond system (the Old East Ash Pond System). The Old East Ash Pond was not used after the North Ash Pond System began operation.

In 1988 and 1989, the (New) East Ash Pond System was designed and constructed to replace the North Ash Pond System. In 2002, the East Ash Pond System was expanded.

4.1.2 Significant Changes/Modifications in Design since Original Construction

As noted above, the East Ash Pond System, the current operational ash pond system, is the third ash pond system to serve the Vermilion Power Station since its construction in the 1950's.

The East Ash Pond System was expanded to the current layout in 2002. The embankment height was increased and the surface area of the ring dike was expanded (Appendix A-Doc 10-15).

4.1.3 Significant Repairs/Rehabilitation since Original Construction

The North Ash Pond System embankment underwent repairs for erosion in 1988 (Appendix A-Doc 19). No significant repairs have taken place along the East Ash Pond System embankment since original construction.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

The North Ash Pond System does not have a written operation and maintenance plan. The North Ash Pond System was originally designed and operated for fly ash sedimentation and control. The pond received plant process waste water, coal combustion waste slurry, and stormwater runoff from the pond embankments. Treated process water was discharged through an overflow outlet structure.

The East Ash Pond System has an Operation and Maintenance Plan approved by the State of Illinois under the dam safety permit. It is included in Appendix A—Doc20. The East Ash Pond System, which replaced the North Ash Pond System as the operational fly ash sedimentation and control unit, receives plant process waste water, coal combustion waste slurry, and stormwater runoff from the pond embankments. Treated process water is discharged through an overflow outlet structure.

4.2.2 Significant Changes in Operational Procedures and Original Startup

The North Ash Pond System has been used primarily for stormwater collection since the construction of the East Ash Pond System in 1989. Plant process waste water and coal combustion waste slurry are no longer received by or collected in the North Ash Pond System. The North Ash Pond System is no longer permitted by the state. Stormwater flows from the primary cell of the North Ash Pond System to the secondary cell via a portable pump. Pumping is periodic, as needed, typically after significant rainfall events.

No significant changes in the Operations Procedures were reported since original startup for the East Ash Pond System.

4.2.3 Current Operational Procedures

The North Ash Pond System continues to capture stormwater runoff from the Vermilion power station. Stormwater is pumped from the primary cell into the secondary cell as needed. Stormwater is discharged manually, as needed, into the Middle Fork Vermilion River.

Discharge from the primary cell of the East Ash Pond System to the secondary cell is via gravity overflow. Flow from the secondary cell to the Middle Fork Vermilion River is also via gravity overflow.

4.2.4 Other Notable Events since Original Startup

No additional information was provided to Dewberry concerning notable events impacting the operation of the impoundment.

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5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Cleighton Smith, P.E. and Julia Moline, E.I.T. performed a site visit on August 10, 2010 in company with the participants.

The site visit began at 8:00 AM. The weather was cool and overcast, with occasional rain showers. Photographs were taken of conditions observed. Please refer to photographs in Appendix B and the Dam Inspection Checklist in Appendix C. Selected photographs are included herein for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit.

The overall assessment of the embankments was that they were in satisfactory condition and no significant findings were noted.

5.2 NORTH ASH POND SYSTEM

5.2.1 Crest

The crest of the embankment had no signs of significant depressions, tension cracks or other indications of settlement or shear failure. A gravel service road covered the majority of the embankment. Figure 5.2.1-1 shows the typical crest conditions.

Figure 5.2.1-1: Photograph of Crest of North Ash Pond System Embankment

5.2.2 Upstream/Inside Slope

The inside slope of the North Ash Pond System embankment is vegetated with various species of tall grass and weeds. Heavy overgrowth in the primary cell of the North Ash Pond System made close observation of embankment conditions difficult. There were no observed scarps, sloughs, bulging, cracks, depressions or other indications of slope instability. Figure 5.2.2-1 shows a representative section of the inside slope of the primary cell embankment. Figure 5.2.2-2 shows a representative section of the inside slope of the secondary cell embankment.

Figure 5.2.2-1: Photograph of the Inside Slope of the North Ash Pond System Primary Cell Embankment

Figure 5.2.2-2: Photograph of the Inside Slope of the North Ash Pond System Secondary Cell Embankment

5.2.3 Downstream/Outside Slope and Toe

The outside slope of the embankment is vegetated with various species of tall grass and weeds. No major scarps, sloughs, bulging, cracks, depressions or other indications of slope instability, or signs of uncontrolled seepage were observed. Figure 5.2.3-1 shows a representative section of the outside slope of the embankment.

Figure 5.2.3-1: Photograph of the Outside Slope of the North Ash Pond System Embankment.

One large tree was observed near the emergency spillway of the North Ash Pond System. Figure 5.2.3-2 shows the tree.

Figure 5.2.3-2: Photograph of Large Tree Near Emergency Spillway on North Ash Pond System Embankment.

Most of the toe of the embankment is densely vegetated with various species of trees, grass, and weeds. In some sections, the toe is also armored with riprap. Figure 5.2.3-3 shows a portion of the toe that is armored with riprap and also covered in dense vegetation.

Figure 5.2.3-3: Photograph of Riprap and Dense Vegetation at the Toe of the North Ash Pond System Embankment.

5.2.4 Abutments and Groin Areas

The dike is continuous therefore there are no abutments. Descriptions of groin areas are included in the description of the dike crest and slopes.

5.3 NEW EAST ASH POND SYSTEM

5.3.1 Crest

The crest of the embankment had no signs of significant depressions, tension cracks or other indications of settlement or shear failure. Figure 5.3.1-1 shows the typical crest conditions.

Figure 5.3.1-1: Photograph of the Crest of the East Ash Pond System Embankment.

5.3.2 Upstream/Inside Slope

The inside slope of the East Ash Pond System embankment is vegetated with various species of tall grass and weeds. There were no observed scarps, sloughs, bulging, cracks, depressions or other indications of slope instability. Figure 5.3.2-1 shows a representative section of the inside slope of the primary cell embankment. Figure 5.3.2-2 shows a representative section of the inside slope of the secondary cell embankment.

Figure 5.3.2-1: Photograph of the Inside Slope of the East Ash Pond System Primary Cell Embankment.

Figure 5.3.2-2: Photograph of the Inside Slop of the East Ash Pond System Secondary Cell Embankment.

5.3.3 Downstream/Outside Slope and Toe

The outside slope of the embankment is vegetated with various species of tall grass and weeds. No major scarps, sloughs, bulging, cracks, depressions or other indications of slope instability, or signs of

uncontrolled seepage were observed. Figure 5.3.3-1 shows a representative section of the outside slope of the embankment.

Figure 5.3.3-1: Photograph of the Outside Slope of the East Ash Pond System Embankment.

Most of the toe of the embankment is densely vegetated with various species of trees, grass, and weeds. In some sections, the toe is also armored with riprap. Figure 5.3.3-2 shows a portion of the toe that is armored with riprap and also covered in dense vegetation.

Figure 5.3.3-2: Photograph of Riprap and Vegetation at the Toe of the East Ash Pond System Embankment.

5.3.4 Abutments and Groin Areas

The dike is continuous therefore there are no abutments. Descriptions of groin areas are included in the description of the dike crest and slopes.

5.4 OUTLET STRUCTURES

5.4.1 Overflow Structure

The North Ash Pond System overflow structure discharges through a spillway into the Middle Fork Vermilon River, with a metal grate walkway for access. Adjacent to the riser is a depth gauge to show the water level

The North Ash Pond System overflow structure was observed to be working properly, discharging flow from the pond, and visually appeared to be in satisfactory condition. There was no sign of clogging of the spillway and the water exiting the outlet was flowing clear. Figure 5.4.1-1 shows the main outlet structure.

Figure 5.4.1-1: Photograph of the North Ash Pond System Overflow Structure.

The East Ash Pond System overflow structure also discharges through a spillway into the Middle Fork Vermilon River. There is a metal grate walkway over the concrete pipe for access.

The East Ash Pond System overflow structure was observed to be working properly, discharging flow from the pond, and visually appeared to be in satisfactory condition. There was no sign of clogging of the spillway and the water exiting the outlet was flowing clear. Figure 5.4.1-2 shows the main outlet structure.

Figure 5.4.1-2: Photograph of the East Ash Pond System Primary Outfall Structure.

An emergency outfall pipe is present in the East Ash Pond System, directly below the primary outfall structure. Figure 5.4.1-3 shows the emergency outfall pipe.

Figure 5.4.1-3: Photograph of the East Ash Pond System Emergency Outfall Pipe.

5.4.2 Outlet Conduit

The outlet conduit appeared to be in good shape and operating normally with no sign of clogging and the water exiting the outlet was flowing clear. Figure 5.4.2-1 shows the spillway outfall pipe discharge.

The design of the spillway outfall pipe includes a vertical bend upward at the discharge end. The upward bend provides energy dissipation that reduces potential erosion along the receiving drainageway.

5.4.3 Emergency Spillway

A corrugated metal pipe serves as the emergency spillway for the North Ash Pond System. The spillway has not been used in recent memory. Figure 5.4.3-1 shows the North Ash Pond System emergency spillway.

Figure 5.4.3-1: Photograph of the North Ash Pond System Emergency Spillway.

No emergency overflow spillway is present for the East Ash Pond System.

5.4.4 Low Level Outlet

No low level outlet is present.

DRAFT

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation has been provided about the flood of record.

6.1.2 Inflow Design Flood

URS, the design firm for the East Ash Pond System expansion, conducted a hydrologic and hydraulic analysis of the capacity of the East Ash Pond System to store water from the design storm event (See Appendix A – Doc. 16). Per State requirements, the design storm is a 100-year (1 percent probability in a given year) event. The report estimates that the 1 percent probability storm will raise the level of the pond 0.8 tenths of a foot, leaving a freeboard of 2 feet.

6.1.3 Spillway Rating

The URS hydrologic/hydraulic analysis for the East Ash Pond System (Appendix A – Doc 16) reports that the combined discharge from building and coal pile runoff is 4.5 cfs. The spillway was designed with a 400 cfs capacity to allow for future expansion.

6.1.4 Downstream Flood Analysis

The hydrologic/hydraulic analysis for the East Ash Pond System notes that the expansion raised the 100-year event water surface level of the Middle Fork Vermilion River by 3 inches. The report notes that IDNR deemed this increase in water surface level minimal (Appendix A—Doc 16).

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Supporting documentation for the East Ash Pond System is adequate.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

Based on the calculations provided in the hydrologic and hydraulic study (Appendix A – Doc 16) the East Ash Pond System can retain the 1 percent design storm event with a freeboard safety of 2 feet. Hence dike failure by overtopping seems improbable.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

East Ash Pond System

The Dynegy Calculation Book (Appendix A – Doc 16) includes two sets of slope stability analyses: ―East Ash Pond Expansion Slope Stability Analyses by URS" dated April 30, 2002, and ―East Ash Pond Expansion – Final Report – Slope Stability Analysis by URS" dated July 9, 2002.

Both reports analyzed the same five load conditions.

- Downstream slope with pond full – gravity loads only
- Upstream slope with pond full – gravity loads only
- Downstream slope with pond full – seismic and gravity loads
- Upstream slope with pond full – seismic and gravity loads
- Upstream slope after 20 ft. rapid drawdown – gravity loads only.

Based on the results of the analyses it was concluded that the embankment has stability safety factors at or above the minimum recommended values.

7.1.2 Design Parameters and Dam Materials

East Ash Pond System

The Dynegy Calculation Book (Appendix A – Doc 16) includes the results of two sets of slope stability analyses preformed by URS Corp. The first set, dated April 30, 2002 used soil properties based on data provided by others and adjusted based on published literature. The report, dated July 9, 2002 presents the results of soil shear strength tests and discusses minor changes in dike design. The report indicates the changes were analyzed and the previously calculated safety factors were not significantly affected. The July 2002 report concludes that the preliminary slope stability analyses should be considered final.

The documentation provided indicates the preliminary stability analyses assumed nine geologic strata: existing dike – sandy gravelly clay; new

dike sandy- gravelly clay; native glacial till; upper 5 feet of alluvium; bottom 5 feet of alluvium; sand and gravel fill; weak shale, shale and bottom ash. The material properties used for the stability analyses are shown in Table 7.2.1

Table 7.2.1 Summary of Soil Properties Used in Stability Analyses

Soil Strata	Unit Weight (pounds/cubic foot)	Drained Shear Strength Properties	
		Cohesive Strength (pounds/square foot)	Angle of Internal Friction
Existing Dike	137	1,480	25.1
New	137	1,480	25.1
Native Glacial Till	137	0	30
Alluvium - Top 5 ft.	120	0	28
Alluvium - Bottom 5 ft.	120	0	30
Sand & Gravel Fill	130	0	36
Weak Shale	140	400	18
Shale	140	1,000	35
Bottom Ash	97	0	30

The April 2002 report, which is the basis for the reported slope safety factors states that the slope stability analyses were conducted using long-term, drained soil strength parameters as a more realistic approach to ensuring the long term stability of the slope. The report also indicates that short-term stability was not analyzed because it will not control stability (see Section 7.3).

Slope stability analysis data sheets indicate the embankment was modeled as consisting of clayey fill in the upstream half of the cross section and sand and gravel fill in the downstream half of the cross section. Construction drawings (Appendix A Doc 07 – 09) indicate the embankment consists of a clay core surrounded by compacted clayey and gravelly sands.

7.1.3 Uplift and/or Phreatic Surface Assumptions

East Ash Pond System

The URS Slope Stability reports included in the Calculation Book (Appendix A – Doc 16) indicate that two separate piezometric surfaces were used in the analyses. The first piezometric surface was used for all soils except the bottom ash. It assumes an upstream phreatic surface equal to the normal pool elevation, with the elevation decreasing as it passes through the upstream half of the embankment cross section. At the center of the embankment cross section an internal drain lowers the phreatic surface to an elevation equal to the top of the original dike.

The piezometric surface in the bottom ash was modeled based on full hydrostatic pressure with the pond at normal pool elevation. The model was selected to account for hydrostatic uplift forces at the base of the embankment.

7.1.4 Factors of Safety and Base Stresses

East Ash Pond System

The URS slope stability reports (Appendix A – Doc 16) indicate stability analyses were conducted for two cross-sections shown in prior calculations by others to be the critical locations. The two locations, designated Critical Section 1 and Critical Section 2 are located in the southeast portion of the pond, and the north section of the pond between the primary and secondary ponds, respectively. The safety factors reported in the slope stability report are listed in Table 7.1.4

Table 7.1.4 Slope Stability Factor of Safety Vermilion East Ash Pond

Loading Condition	Required Safety Factor (US Army Corps of Engineers)	Critical Section 1	Critical Section 2
Downstream slope – Pond Full – Gravity Only	1.5	1.9	1.5
Upstream slope – Pond Full – Gravity Only	1.5	2.1	1.5
Downstream slope – Pond Full – Seismic and Gravity	>1.0	1.8	1.4
Upstream slope – Pond Full – Seismic and Gravity	>1.0	1.8	1.2
Upstream Slope after 20 ft. rapid Drawdown – Gravity Only	1.3	1.3	1.3

Based on the results summarized in Table 7.1.4 the embankments were found to have stability safety factors at or above the recommended minimum values.

7.1.5 Liquefaction Potential

East Ash Pond System

The URS Stability Analysis reports reviewed by Dewberry (Appendix A – Doc 16) indicated that an evaluation of the liquefaction potential of subsurface materials was not conducted. The documentation indicates that based on the clay and medium dense sands present at the site, a liquefaction analysis was not required.

7.1.6 Critical Geological Conditions

East Ash Pond System

Unconsolidated geologic deposits at the site consist of alluvial and colluvial deposits underlain by glacial till. Beneath the glacial till is weathered shale and shale bedrock.

The stability analyses (Appendix A – Doc 16) used a peak ground acceleration of 0.025g for seismic loading. The basis for the selection was not provided.

The current Seismic Risk Map of the United States was reviewed using the U. S. Geologic Survey web site. The 2% probability of exceedance in 50 years ground acceleration at the site is 0.19g to 0.26g. The seismic design criteria used in the analysis are not in conformance with current design recommendations.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

East Ash Pond

Structural stability documentation is adequate.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Overall, the structural stability of the East Ash Pond System embankment appears to be fair based on the following observations:

- No obvious signs of erosion damage, cracks, sloughs or release of materials;
- Outlet works are in good working condition;
- Embankment is regulated by the State of Illinois and therefore is subject to periodic inspections by State dam safety officials;
- Existence of a State-approved Operations and Maintenance manual;
- Existence of recent inspection reports;
- Structural stability documentation indicates issues that merit further analyses:
    - The report used drained soil shear strength for long term slope stability analysis; however undrained shear strength is more

appropriate for short term loading conditions including rapid drawdown, seismic loading and rapid filling on top of existing ash. The use of undrained soil strength can reduce calculated safety factors 10 percent to 20 percent, which may create concern for the drawdown analysis, since the current data has a calculated safety factor equal to the recommended minimum value.

- The ground acceleration used in the seismic loading analysis does not meet the current recommended design criteria and should be reanalyzed using current design criteria
- The embankment geometry used in the slope stability analysis does not appear to be consistent with the geometry indicated on the design drawings. The embankment cross section used for an updated stability analysis should more closely match the design cross section.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

The East Ash Pond System is operated for storage of fly ash deposits. Treated coal combustion process waste water is discharged through an overflow outlet structure.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

The East Ash Pond System Operations and Maintenance Plan (Appendix A – Doc 20) establishes inspection and maintenance requirements for the embankment. The required procedures include:

- Quarterly inspections by plant personnel
- Annual inspections by a licensed professional engineer in accordance with IDNR requirements
- Maintenance of low-growth vegetation cover, including tree and shrub removal
- Semiannual inspections of the effluent discharge canal
- Repair of animal burrows
- Reporting requirements

The Operations and Maintenance Plan also includes the quarterly inspection form.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operating Procedures

Based on the assessments of this report, operation procedures seem to be adequate.

8.3.2 Adequacy of Maintenance

Various dam inspection reports, including P.E. inspection reports dated February 13, 2009 and March 30, 2010 (Appendix A – Docs 21 and 22) and the Dam Inspection Checklist of August 10, 2010 by Dewberry (Appendix C), reported no major maintenance issues. The 2009 and 2010 P.E. Inspection Reports include some maintenance recommendations, but none that are considered critical or imminent. This indicates that the current maintenance plan is most likely followed in practice, and that

adequate maintenance is provided for the embankments and project facilities.

Although maintenance appears to be adequate, the following recommendations were made in the 2009 and 2010 inspection reports:

- Monitor and eliminate saplings along embankment
- Limit traffic on embankments to decrease cracking along slope face

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Weekly Inspections

Weekly inspections are conducted by plant personnel.

Quarterly Inspections

Quarterly Inspections are conducted by qualified plant personnel. Inspection reports are submitted to a third party P.E. (employed by URS) responsible for annual inspections for review and appropriate corrective actions.

Annual Inspections

Annual inspections are conducted by a licensed professional engineer (employed by URS) in accordance with IDNR regulations. The 2010 Inspection Report was submitted in March of 2010.

Special Inspections

No special inspections have been conducted at the Vermilion Power Station fly ash ponds.

9.2 INSTRUMENTATION MONITORING

The Vermilion Power Station embankments do not have an instrumentation monitoring system.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Based on the data reviewed by Dewberry, including observations during the site visit, the inspection program is adequate.

9.3.2 Adequacy of Instrumentation Monitoring Program

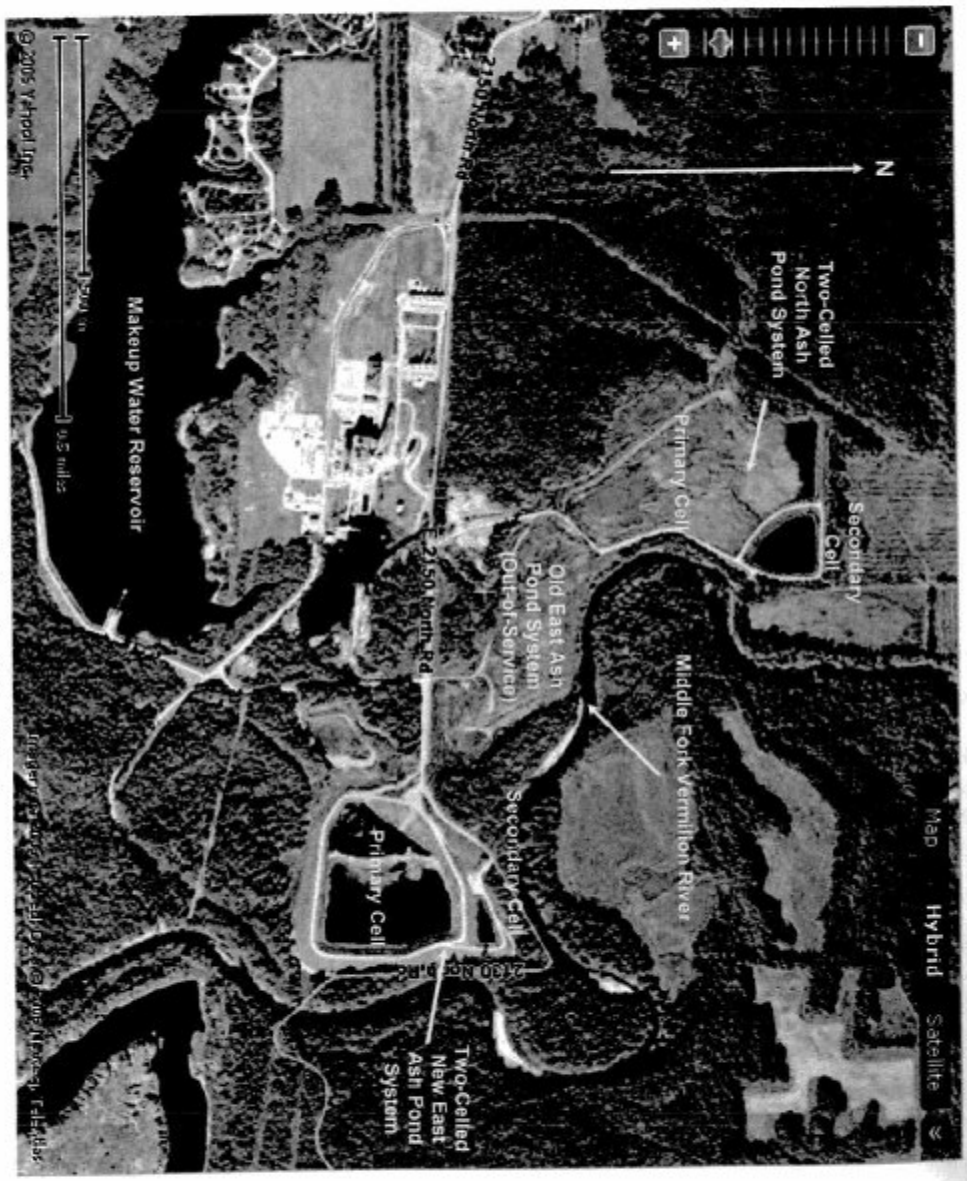
The Vermilion Power Station embankments are not instrumented. Based on the size of the embankments, the portion of the impoundment currently used to store wet fly ash and stormwater, the history of satisfactory impoundment performance, and the current inspection program, installation of a dike monitoring system is not needed at this time.

APPENDIX A

Documents

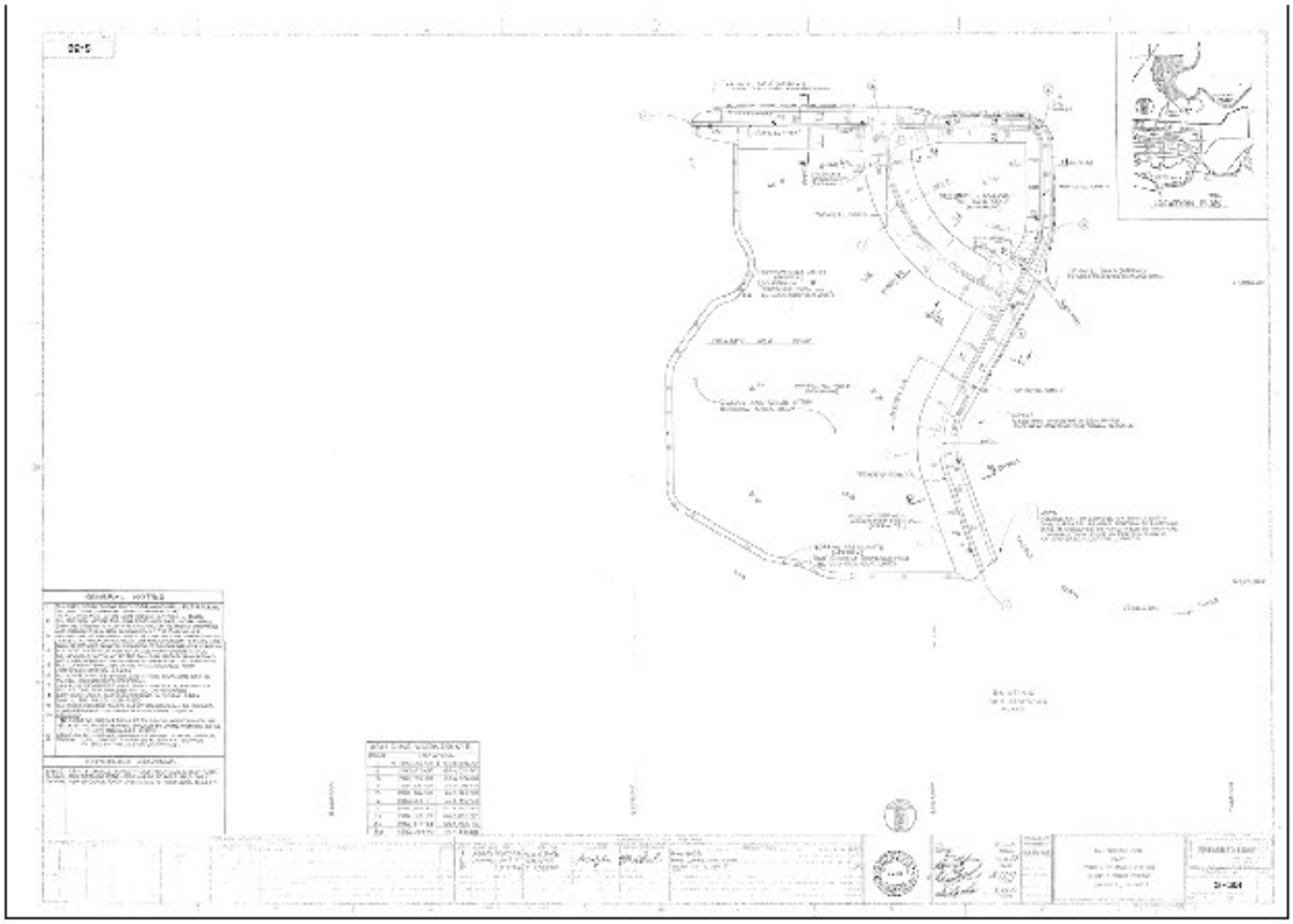
Document 1: Map of site

Document 2: Labeled Aerial Photo

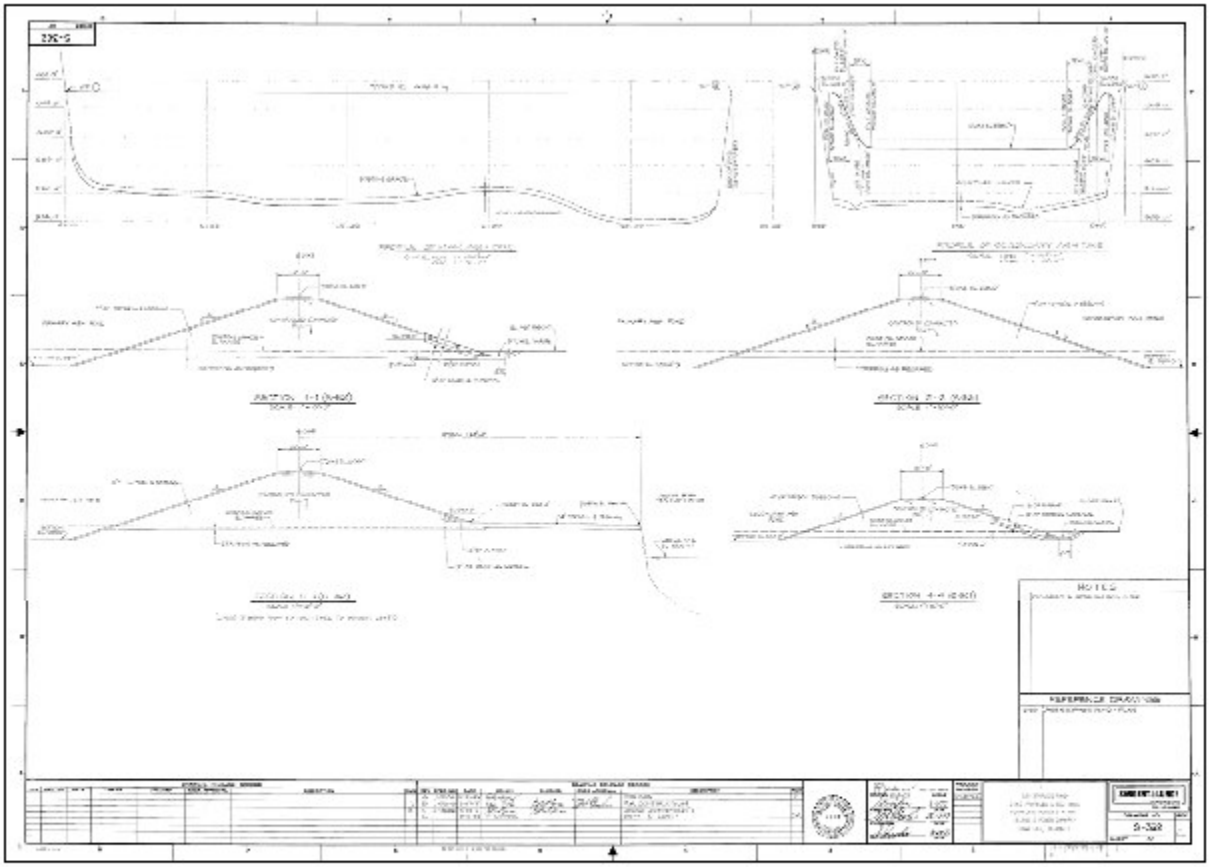


Vermilion Power Station Ash Pond Systems

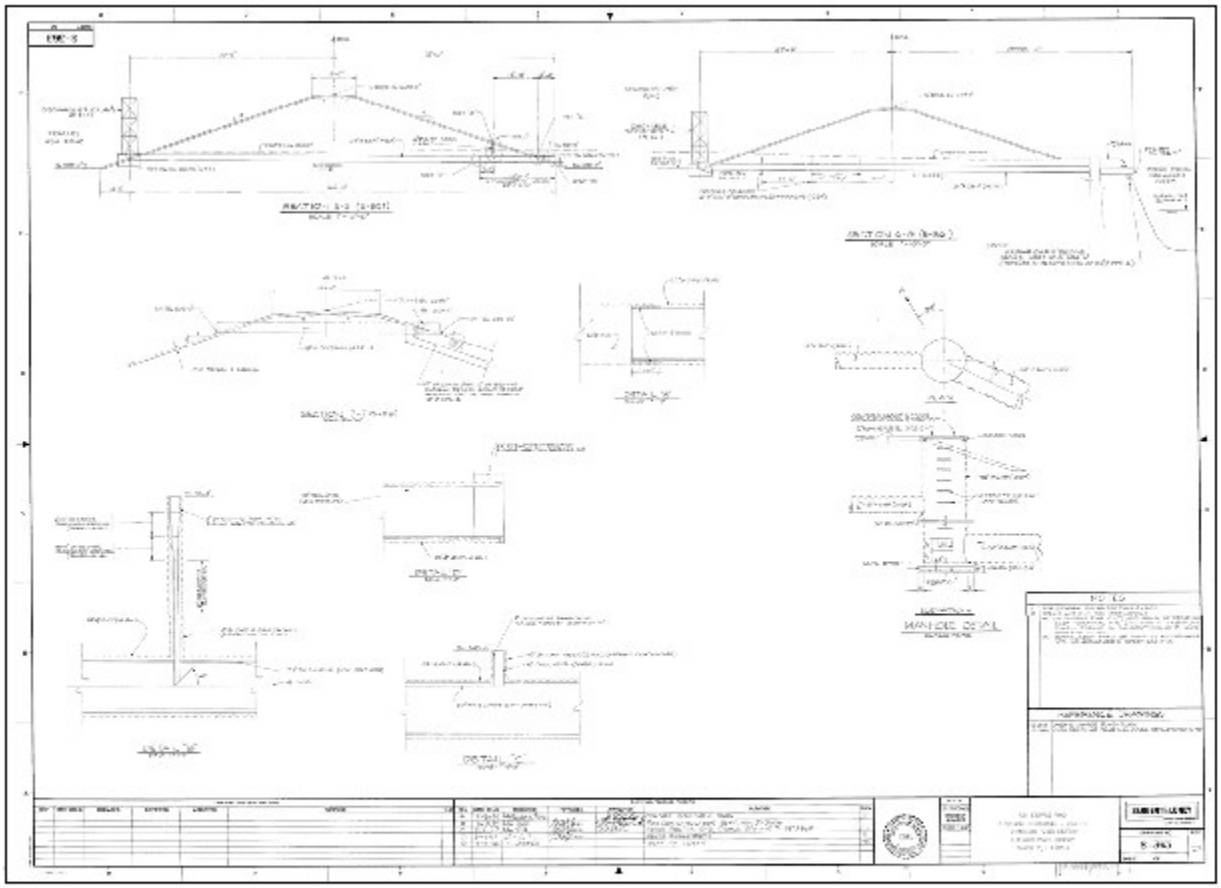
Document 3: North Ash Pond System Plan Drawing



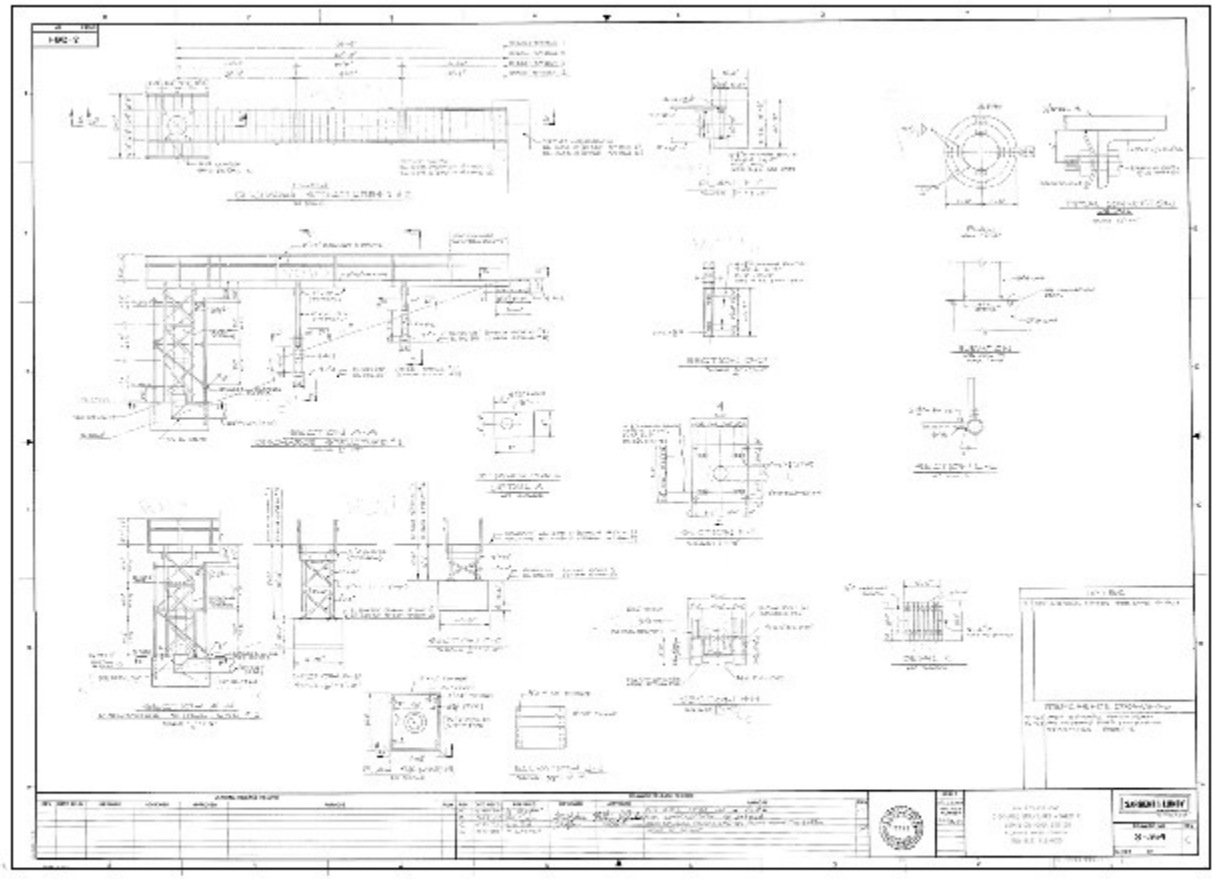
Document 4: North Ash Pond System Typical Sections



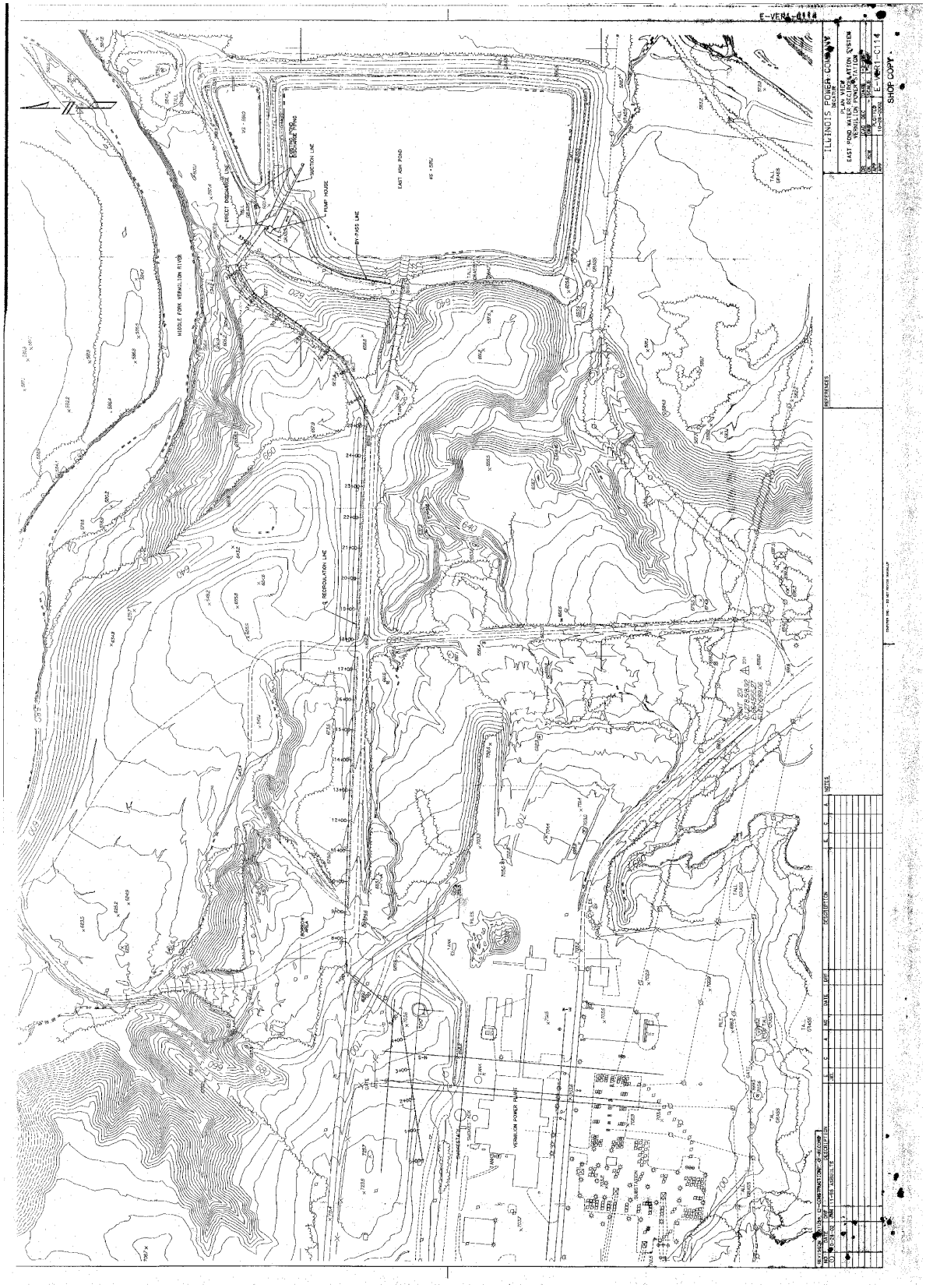
Document 5: North Ash Pond System Discharge Structure Details



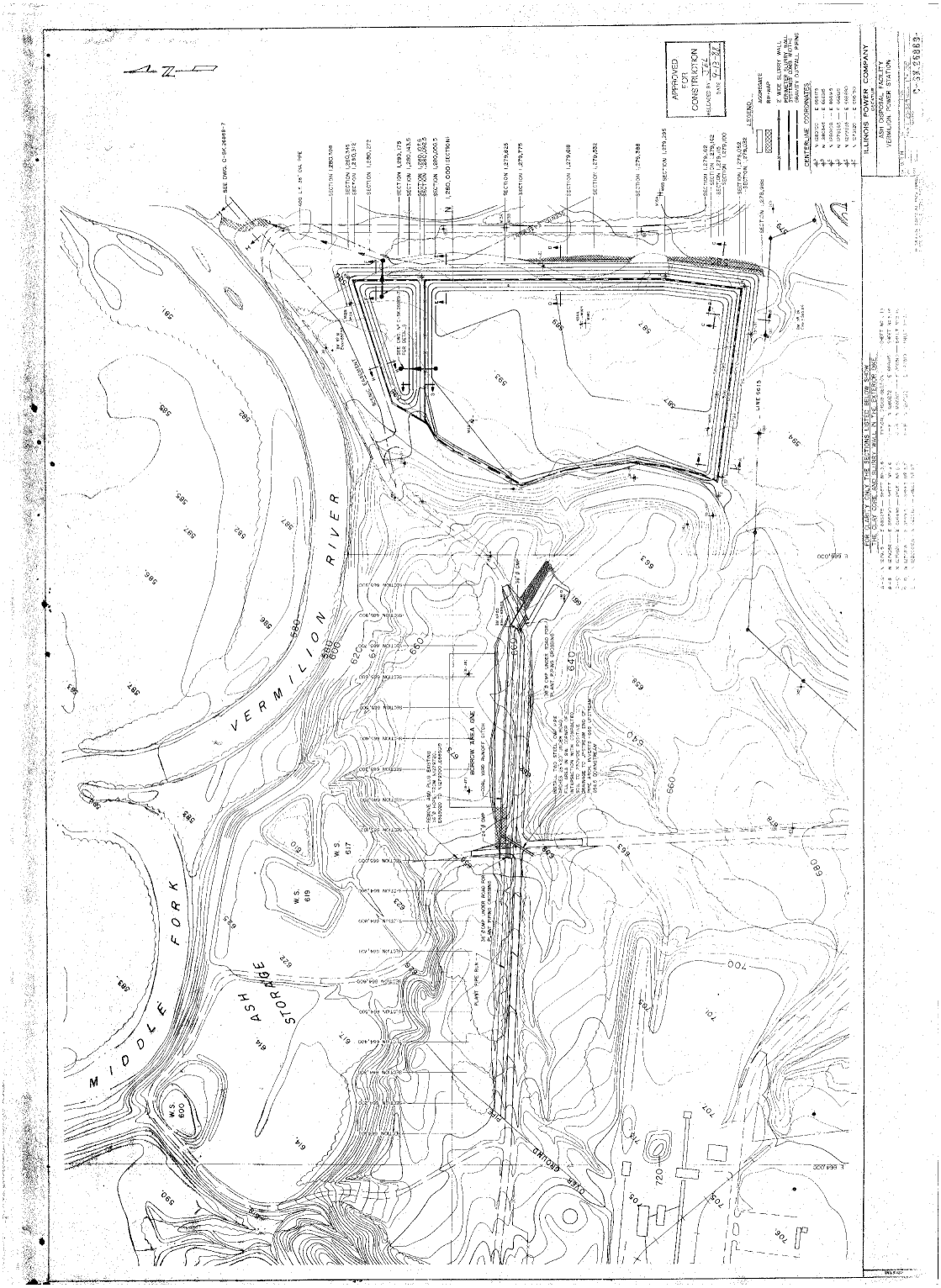
Document 6: North Ash Pond System Discharge Structure Additional Details



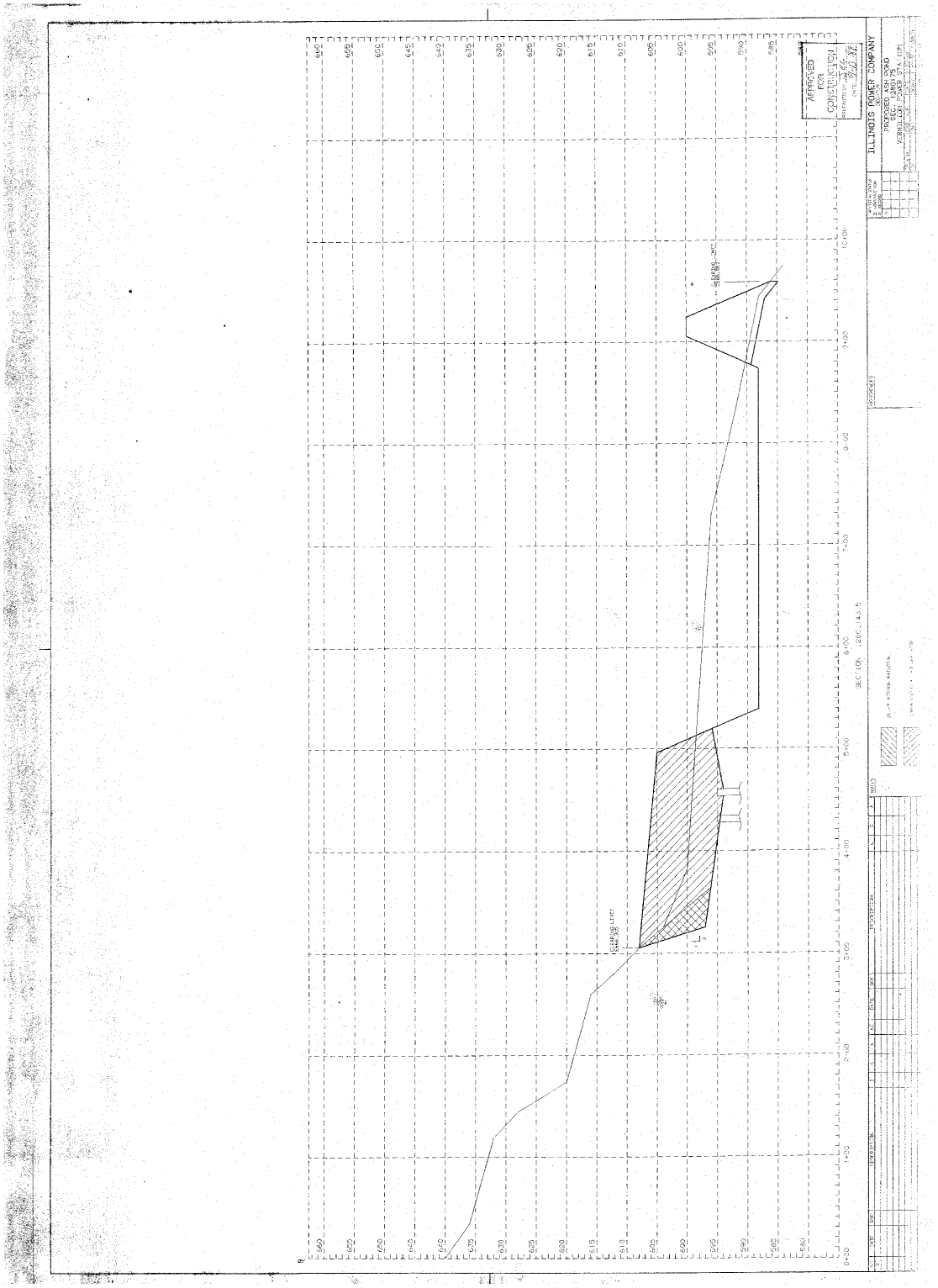
Document 7: East Ash Pond System Plan View



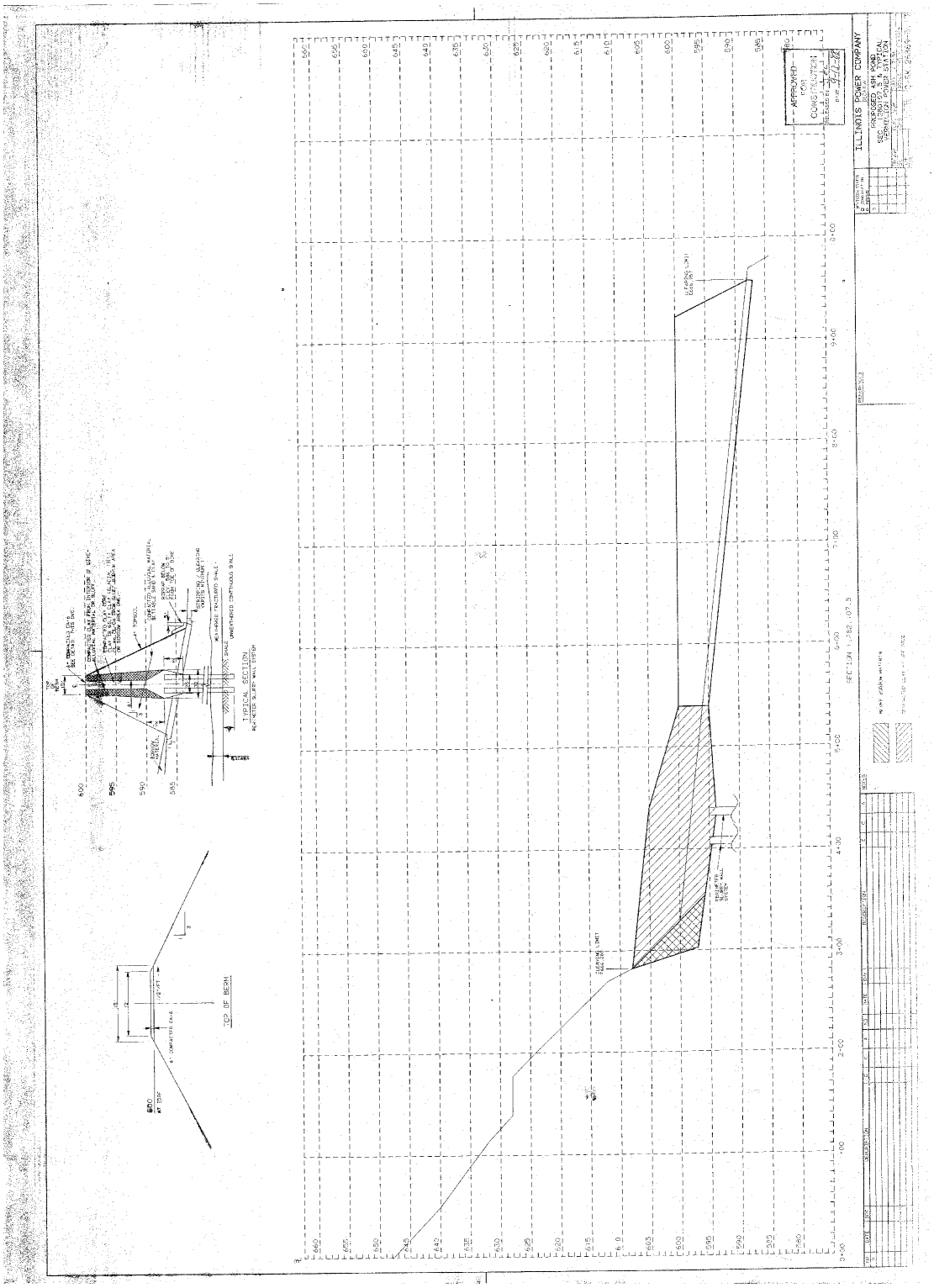
Document 8: East Ash Pond System Plan Layout with Cross-Section Locations



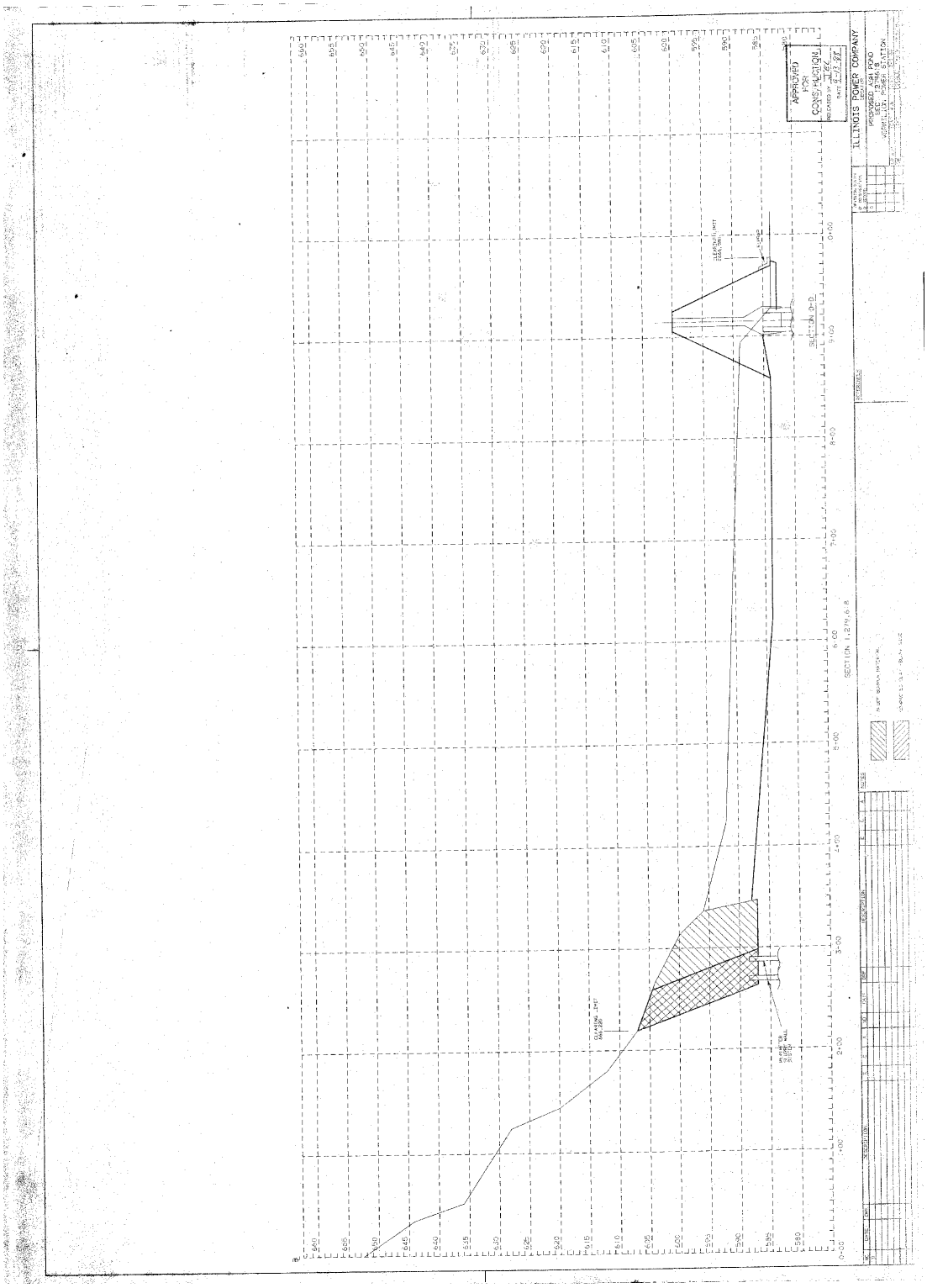
Document 9: East Ash Pond System Typical Sections 1 of 3



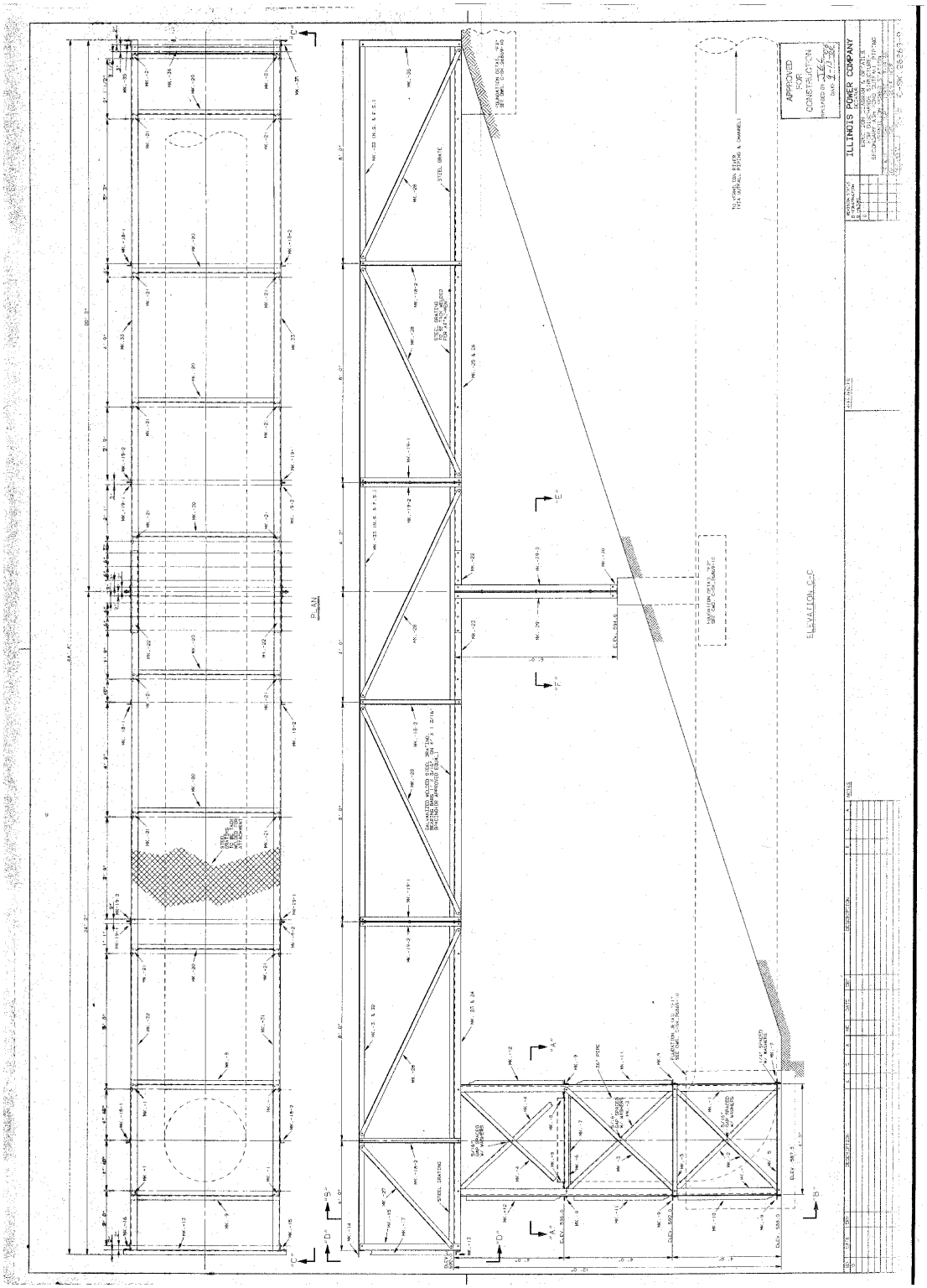
Document 10: East Ash Pond System Typical Sections 2 of 3



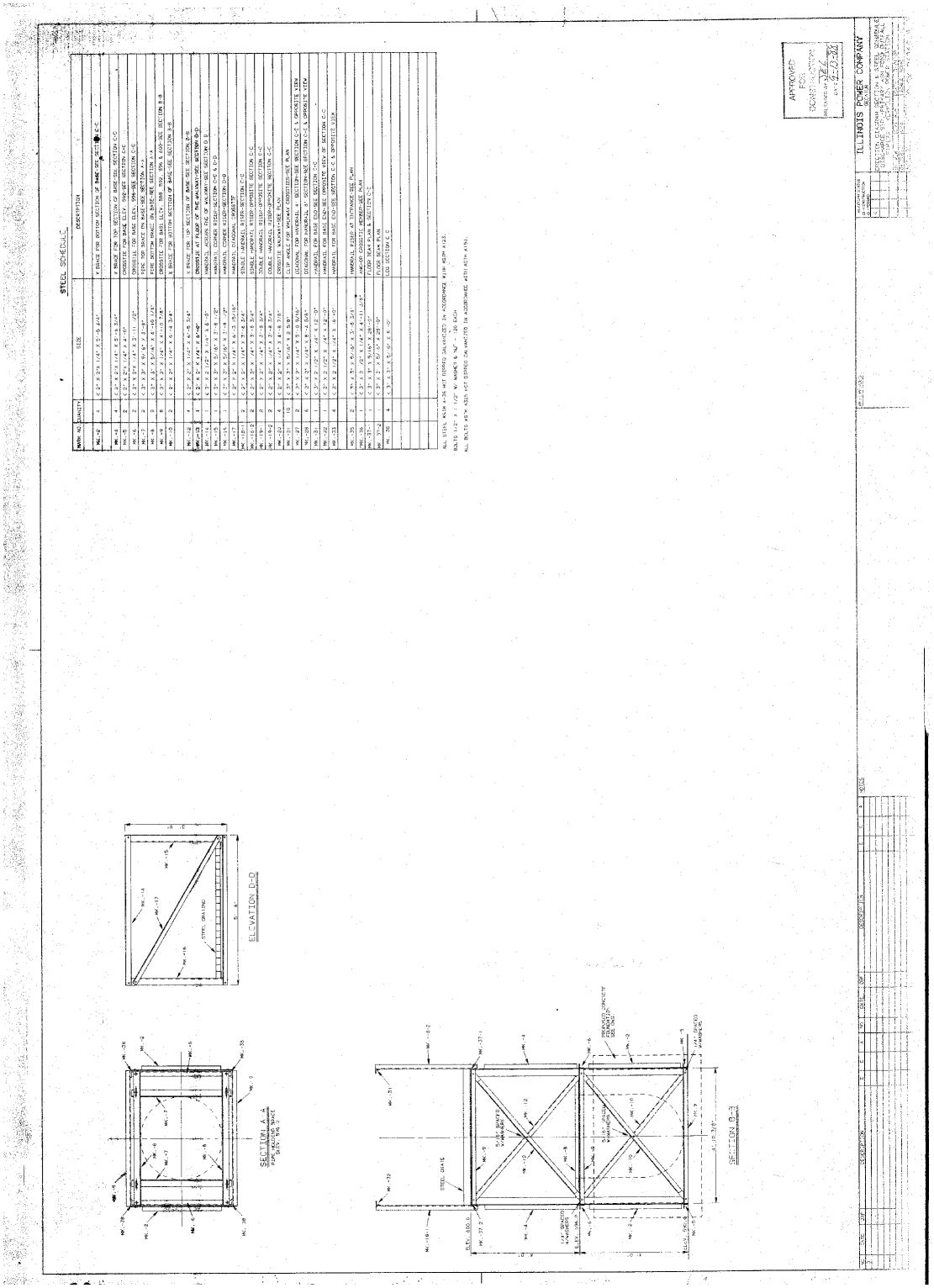
Document 11: East Ash Pond System Typical Sections 3 of 3



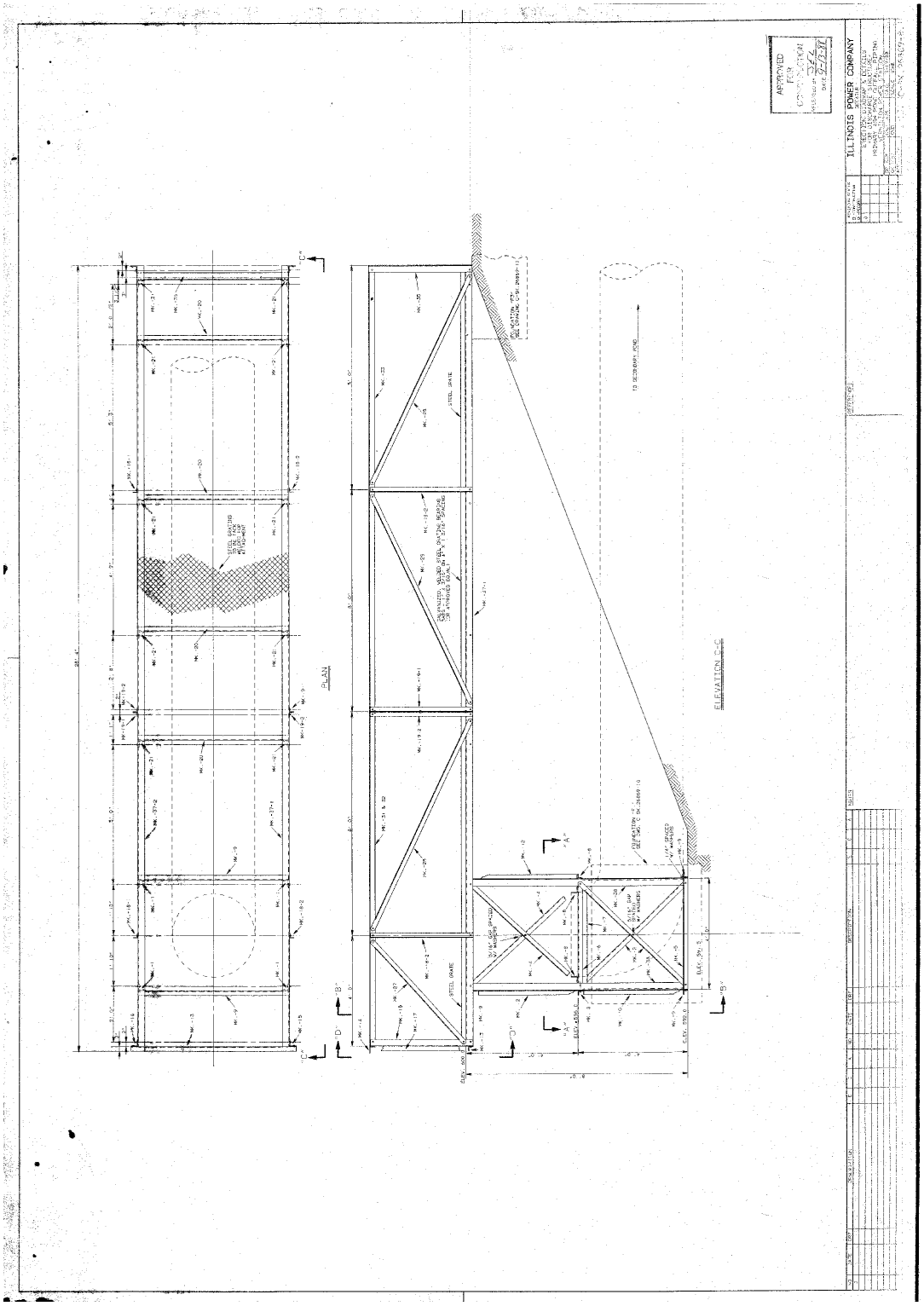
Document 12: East Ash Pond System Discharge Structure Details 1 of 3



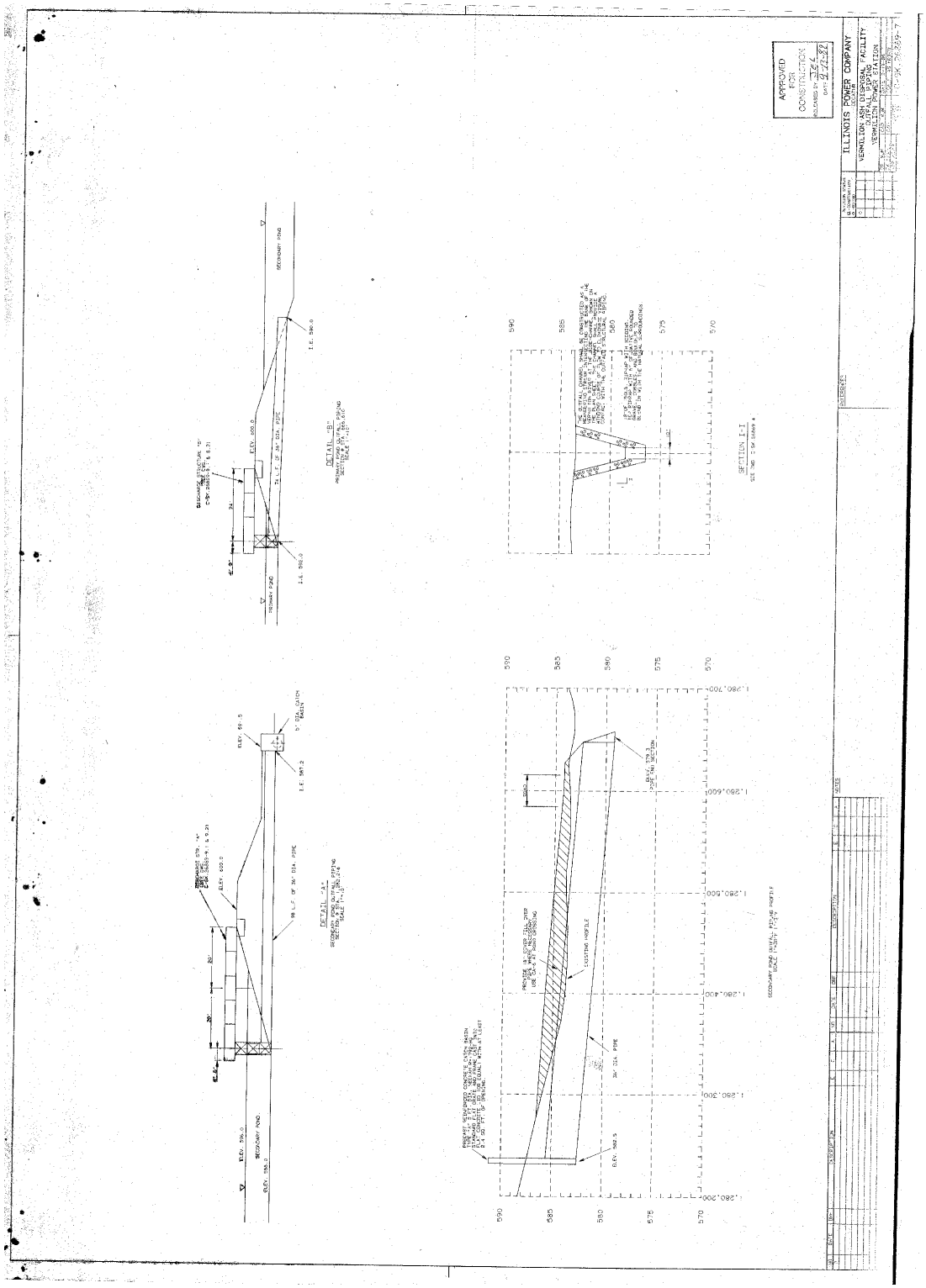
Document 13: East Ash Pond System Discharge Structure Details 2 of 3



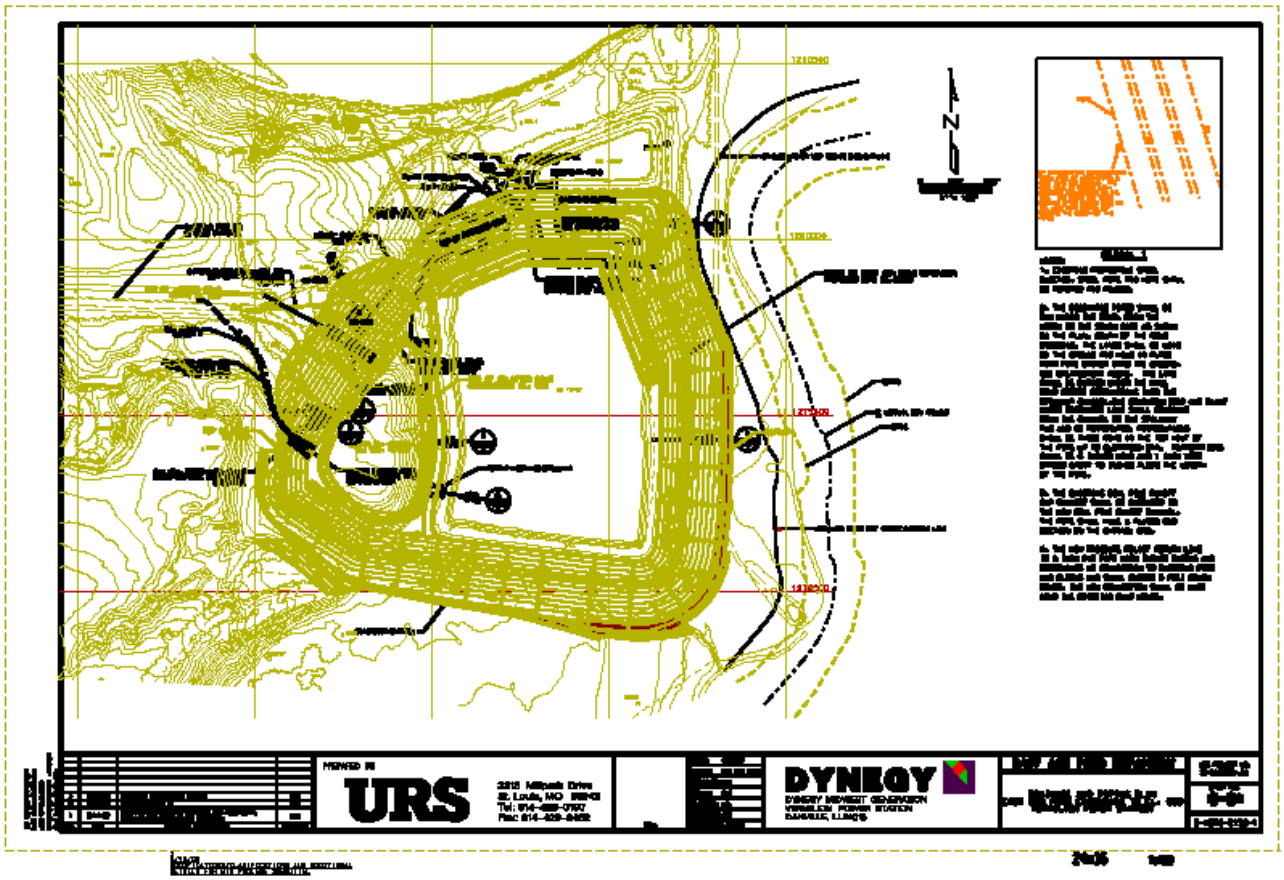
Document 14: East Ash Pond System Discharge Structure Details 3 of 3



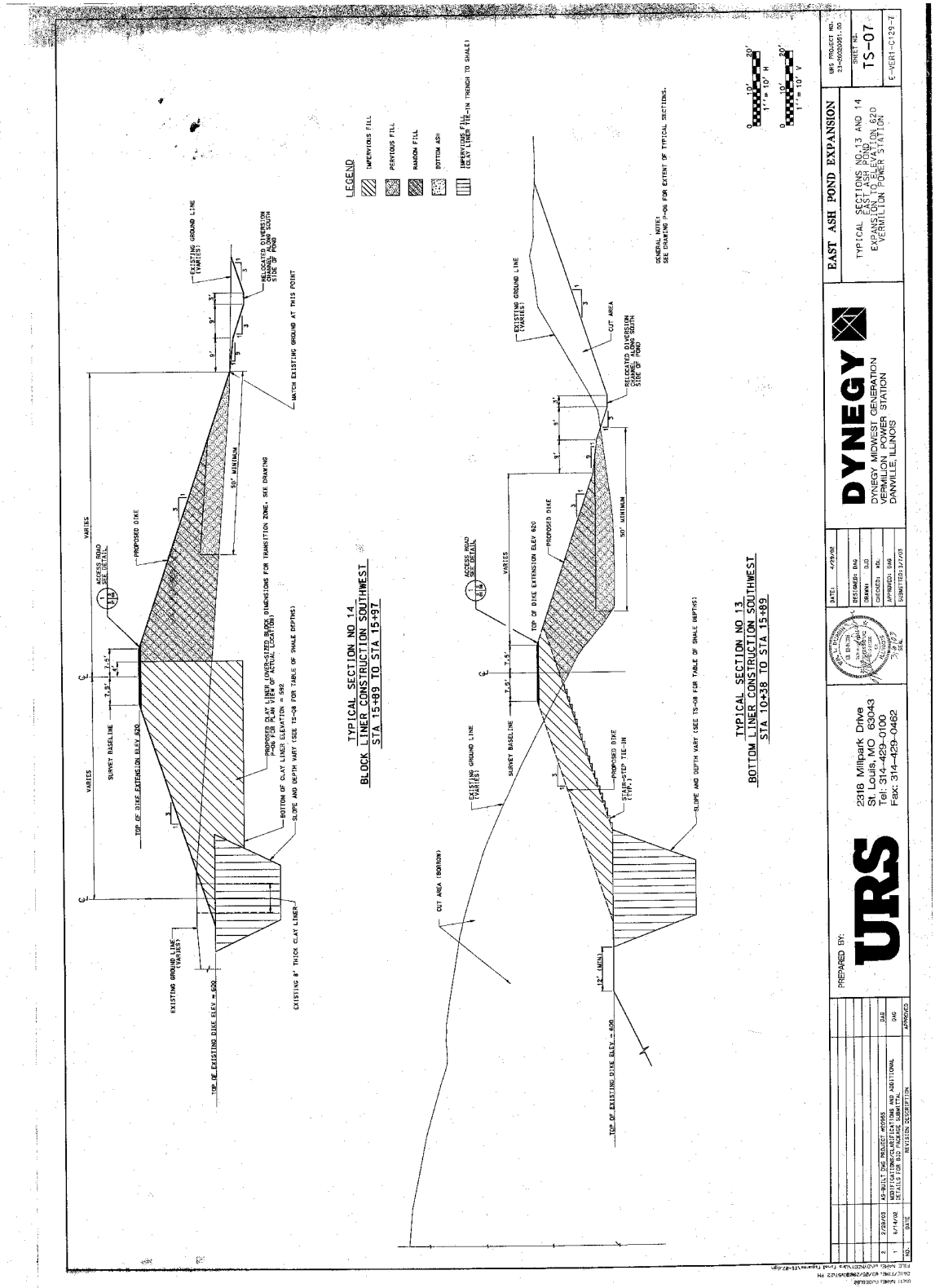
Document 15: East Ash Pond System Outfall Piping



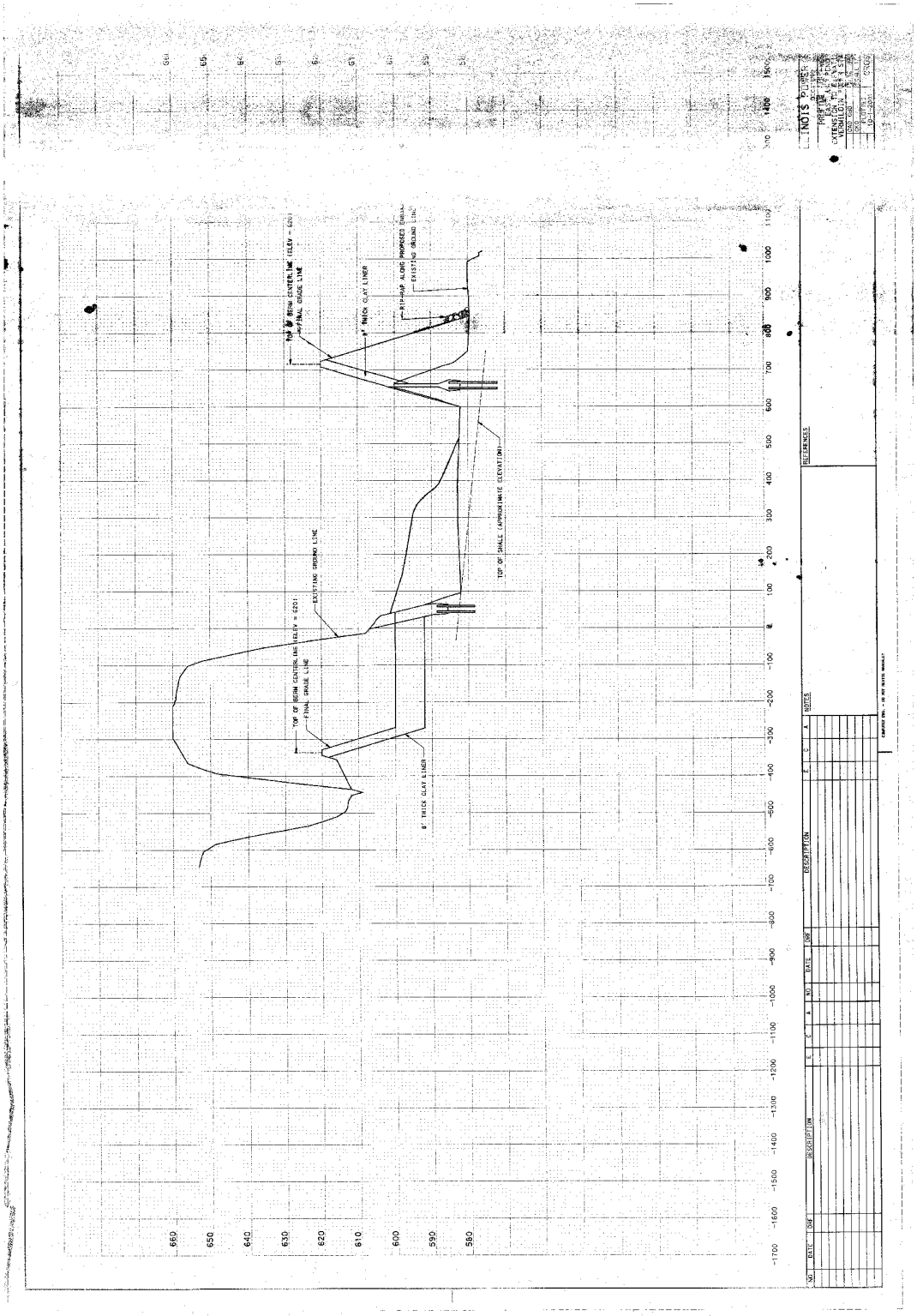
Document 16: East Ash Pond System Expansion Plan Drawing



Document 17: East Ash Pond System Expansion Typical Sections 1 of 2



Document 18: East Ash Pond System Expansion Typical Sections 2 of 2



APPENDIX B PHOTOGRAPHS

East Ash Pond System

Inlet Pipes

Primary Pond Emergency Spillway

Primary Pond Principal Spillway

Primary Pond Principal Spillway

Primary Pond Typical Downstream Slope

Primary Pond Rip Rap on Downstream Toe

Primary Pond Rip Rap on Downstream Toe

Primary Pond Typical Downstream Slope

Primary Pond Typical Downstream Slope

Primary Pond Typical Downstream Slope

Primary Pond Typical Upstream Slope

Primary Pond Typical Downstream Slope

Primary Pond Typical Upstream Slope

Primary Pond Typical Upstream Slope

Primary Pond Typical Upstream Slope

Primary Pond

Primary Pond

Primary Pond Typical Upstream Slope

Primary Pond Typical Upstream Slope

Primary Pond Typical Crest

Primary Pond Settlement Marker

Secondary Pond

Secondary Pond Upstream Slope

Secondary Pond Outlet Structure – Four V-notched morning glory type looking down

Secondary Pond Outfall Structure

Secondary Pond Outfall Structure and downstream channel

North Ash Pond System

Secondary Pond

Secondary Pond Typical Upstream Section

Secondary Pond Typical Downstream Section

Secondary Pond Outlet Structure

Site Name:	**Vermillion Power Station**	Date:	**8/10/2010**
Unit Name:	**New East Ash Pond System**	Operator's Name:	**Dynegy Midwest Generation, Inc.**
Unit I.D.:		Hazard Potential Classification:	**High** ☐ **Significant** ☐ **Low** ☒ **Class 3-Intermediate (size)**
Inspector's Name:		Cleighton Smith, PE and Julia Moline, EIT	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	X		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	600' primary/ 591' secondary		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	600'/591'		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?		NA	Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	620'		Is water exiting outlet, but not entering inlet?		X
6. If instrumentation is present, are readings recorded (operator records)?		X	Is water exiting outlet flowing clear?	X	
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below)[2]:		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	X		From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	X		From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?		NA	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Issue #	Comments
1	PE inspections annually. Plant staff inspections monthly and quarterly, with weekly site visits.
12	Skimmers, not trash racks
21	Difficult to monitor seepage in downstream areas because of vegetation at the toe; portions of the toe we saw showed no signs of seepage

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit	IL0004057; issued 3/7/2003; expired 2/28/2008 (renewal has been filed; hasn't been reissued)	**INSPECTOR**	Cleighton Smith, PE

Date 8/10/2010
Impoundment Name New East Ash Pond Unit

Impoundment Company Dynegy
EPA Region 5

State Agency (Field Office) Address Illinois DNR
Name of Impoundment New East Ash Pond Unit

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☒ **Update** ☐

	Yes	No
Is impoundment currently under construction?	☐	☒
Is water or ccw currently being pumped into the impoundment?	☒	☐

IMPOUNDMENT FUNCTION: Handling of coal combustion waste

Nearest Downstream Town Name: Danville

Distance from the impoundment: 10 miles

Location:

Latitude	40	Degrees	10	Minutes	47.2938	Seconds	**N**
Longitude	87	Degrees	45	Minutes	7.8474	Seconds	**W**

State Illinois **County** Vermilion

	Yes	No
Does a state agency regulate this impoundment?	☒	☐

If So Which State Agency? Illinois DNR

HAZARD POTENTIAL *(In the event the impoundment should fail, the following would occur):*

☐ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

☒ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

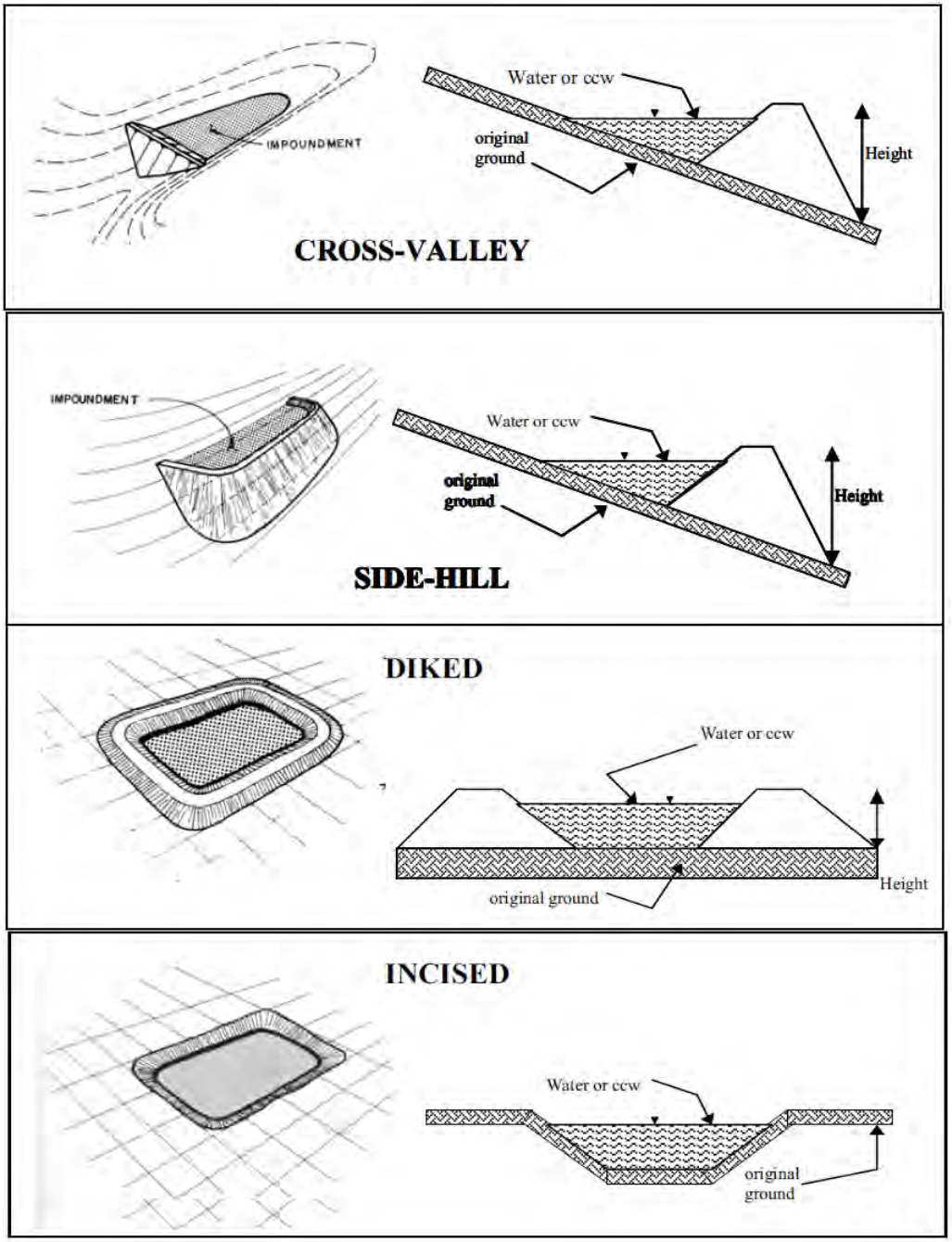
☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

No residences or other development anywhere near dam. Failure could result in release of hazardous substances and therefore cause some environmental losses.

CONFIGURATION:



☐ Cross-Valley ☐ Side-Hill ☒ Diked (ring)

☐ Incised (form completion optional) ☐ Combination Incised/Diked

Embankment Height (ft)	40’	**Embankment Material**	Minimum 8’ clay core surrounded by compacted earth
Pool Area (ac)	Unknown—requested information	**Liner**	NA
Current Freeboard (ft)	29’ (crest is 620’, water is 591’→29’)	**Liner Permeability**	NA

TYPE OF OUTLET (Mark all that apply)

☒ **Open Channel Spillway**

☒ Trapezoidal

☐ Triangular

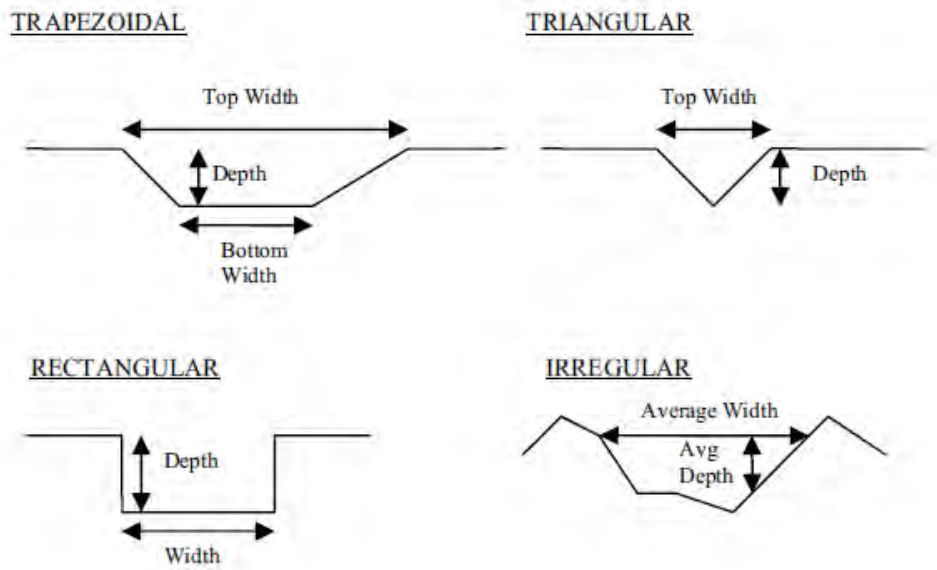
☐ Rectangular

☐ Irregular

depth (ft)

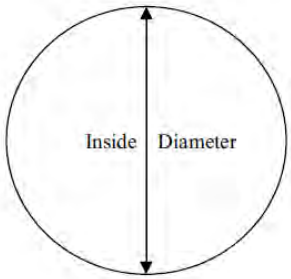
average bottom width (ft)

top width (ft)



☒ **Outlet**

36" inside diameter
concrete pipe that leads to the spillway channel



Material

☐ corrugated metal

☐ welded steel

☒ Concrete

☐ plastic (hdpe, pvc, etc.)

☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☐	☒

☐ **No Outlet**

☐ **Other Type of Outlet**
(specify):

The Impoundment was Designed By	**Illinois Power Company, 1988; expanded designed by URS in 2002**

	Yes	No
Has there ever been a failure at this site?	☐	☒

If So When?

If So Please Describe :

	Yes	No
Have there ever been significant seepages at this site?	☐	☒

If So When?

If So Please Describe :

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒

If so, which method (e.g., piezometers, gw pumping,...)?

If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? If there is no information just note that.

No, not built over unsuitable materials (applies to original construction and expansion).

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?

No, not of original design. Yes—representative of Engineer of Record for expansion present at time of assessment.

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?

No.