REPORT
2020012463

AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
40 CFR PART 257
FRANKLIN COUNTY, MISSOURI

Prepared for

Ameren
MISSOURI

Prepared by

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October 2021

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AMEREN MISSOURI LABADIE ENERGY CENTER
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1.0 INTRODUCTION

The Labadie Energy Center (LEC) is located in northeastern Franklin County, Missouri along the Missouri River. The plant is approximately 3 miles north of the Town of Labadie on the south bank of the Missouri River at river mile 57.5. The LEC is located within the floodplain of the Missouri River. The LEC has two active surface impoundments that are designated as LCPA (Bottom Ash Pond) and LCPB (Fly Ash Pond). The single stage industrial embankment dams impound an area of approximately 243-acres. The surface impoundments have been dewatered, no longer receive CCRs and are currently being closed. A map showing the location of the surface impoundments is attached as Figure 1.

1.1 Purpose

The purpose of this report is to document evaluations and assessments completed for the Ameren Missouri Labadie Energy Center CCR Units as required by select sections within 40 CFR Part 257, the final rule to regulate the disposal of CCR as solid waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA). Specifically Reitz & Jens completed assessments and evaluations as required by :

A. §257.73(c)(1), History of Construction
B. §257.73(a)(2), Periodic Hazard Potential Classification
C. §257.73(d)(1), Periodic Structural Stability Assessment
D. §257.73(e)(1), Periodic Safety Factor Assessment
E. §257.82, Hydrologic and Hydraulic Capacity Requirements, and
F. §257.83(b), Inspection Requirements for CCR Surface Impoundments

The evaluations and assessments required by §257.73(c)(1) are discussed in the body of this report. The evaluations and assessments required by the remaining applicable sections of 40 CFR Part 257 are contained in the Appendices.

2.0 LABADIE ENERGY CENTER CCR UNIT

2.1 Owner and Operator

The CCR Units at the LEC are owned and operated by Ameren Missouri. LEC plant personnel have the primary responsibility of CCR unit operation. The LEC is located at 226 Labadie Power Plant Road in Labadie, Missouri 63055. The Ameren Missouri Dam Safety Group performs CCR unit inspections, and reviews all updates to the Operations and Maintenance (O&M) Manual. A copy of the 2012 Labadie Bottom Ash and Fly Ash Pond Embankment O&M manual is included in Appendix A. The Ameren Missouri Dam Safety Group is located at 3700 South Lindbergh Boulevard in St. Louis, Missouri 63127.

2.2 CCR Unit Location

The CCR Units are located as identified on the most recent 7.5 minute topographic quadrangle map in Sections 18 and 19, Township 44 North, Range 2 East of the 5th Principal Meridian. A plot of the USGS topographic quadrangle map showing the location of the LEC is attached as Figure 2.

2.3 CCR Unit Identification and Purpose

There are two active surface impoundment at the LEC used to store CCR. The surface impoundments are called the LCPA (Bottom Ash Pond) and LCPB (Fly Ash Pond). LCPA and LCPB have been dewatered and are currently being closed. Prior to closure construction, decant water from the LCPB was pumped into the LCPA by two 6-inch submersible pumps. LCPA decant water was discharged by gravity into a man-made channel through Outfall #002. The NPDES permit number for the LCPA outfall is MO-0004812. The outfall on the man-made channel is approximately 0.5 miles upstream of its confluence with the Missouri River. The LCPA outfall was converted into a new gravity outfall for surface water runoff from the closed impoundment. The embankments for the surface impoundments are not regulated as dams by the Missouri Department of Natural Resources (MDNR) because the heights of the perimeter dams are less than 35 feet.

Table 1 - Labadie Energy Center CCR Units

CCR Unit	CCR Type	Operational Status
Bottom Ash Pond (LCPA)	Bottom Ash	Active
Fly Ash Pond (LCPB)	Fly Ash	Active

2.4 CCR Unit Watershed

The LEC is located adjacent to the Missouri River within 100-year floodplain at approximate river mile 57.5 above the confluence with the Mississippi River. According to the current Flood Insurance Rate Map (FIRM), the regulatory 100-year flood elevation at the site is el. 483 to 485 feet. The LEC facility is built on hydraulic fill that has a minimum elevation of about 490 feet. The Missouri River is to the north of the CCR units. Labadie Creek, which flows to the Missouri River, is located immediately to the west of the LCPA. Outfall #002 discharges into man-made channel extending approximately 0.5 miles to the Missouri River. The Missouri River has a watershed area of approximately 520,000 square miles at the site. The Labadie Energy Center does not receive stormwater run-on from areas outside the facility. The LCPB has an area of approximately 79 acres and does not receive stormwater run-on from areas outside of the impoundment. The LCPA has an area of approximately 164 acres and has a tributary area of approximately 397 acres.

2.5 Geomorphology and Foundation Geology

The geology at the LEC consists of natural alluvium, approximately 100 feet thick, deposited by the Missouri River which is underlain by Paleozoic Era sedimentary rocks of the Ordovician System.

The natural alluvium generally consists of 7 to 10 feet of silts and clays at the ground surface. The upper stratum of clays and silts is underlain by complex fluvial depositional sequences of predominately sands followed by gravels, silts and lesser amounts of clay to about 105 feet. In general, the fluvial sequences of coarse-grained sand are overlain by very fine- to fine-grained sand, which in turn, are overlain by very fine-grained sand interbedded with silt and clay, followed by interbedded silt, silty clay, and clay. Some gravel, cobbles and boulders are present in the lower part of the sand stratum. Limestone rock exists beneath the alluvium.

Groundwater levels at the LEC closely follow the stage of the adjacent Missouri River. The direction of groundwater flow is intrinsically related to the Missouri River elevation. When river elevations are relatively high, groundwater movement is generally east to southeast away from the river. When river elevations are relatively low, groundwater movement is generally north to northwest towards the river.

2.6 Surveillance, Maintenance and Repair of the CCR Units

The Labadie Bottom Ash & Fly Ash Pond Embankments O&M manual outlines objectives, responsibilities, and procedures for Ameren personnel who are responsible for the management of the CCR units. The embankments of the CCR units are visually inspected weekly by Ameren plant operations staff. Ameren Missouri Dam Safety Group personnel perform annual inspections and periodic inspections or assessments with plant operations staff. In addition, the Ameren Missouri Dam Safety Group may conduct unannounced safety inspections. Descriptions of each type of inspection or assessment are included in the following sections. Checklists used during inspection of the CCR Units are included in the attached O&M manual.

2.6.1 Surveillance

2.6.1.1 Weekly Inspections

Weekly inspections are conducted by plant staff or support staff familiar with the pond/dam. The weekly inspections consist of visually inspecting the crest and slopes of each ash pond embankment to identify new or changed conditions. Checklists are completed and are made available to the Dam Safety Group for review.

2.6.1.2 Annual Inspection

These inspections are conducted annually by the plant staff and the Ameren Missouri Dam Safety Group staff. The annual inspection is a detailed visual inspection of the ash pond embankment crest, interior and exterior slopes, downstream toe area, inlet/outlet works, and appurtenant structures.

An annual inspection report is to be prepared by the Ameren Missouri Dam Safety Group staff that includes a description of the observations of the visual inspection, photographs of the facilities taken during the inspection, and a written evaluation of the results. A record of maintenance activities for the ash pond embankments is also kept current by the Ameren Missouri Dam Safety Group.

2.6.1.3 Periodic Structural Stability Assessments

The Periodic Structural Stability Assessments are conducted every 5 years by the Ameren Missouri Dam Safety Group staff to document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein in general accordance with 40 CFR Part §257.73(d)(1).

Ameren Missouri Dam Safety Group staff will prepare a periodic structural stability assessment report which at a minimum will document whether the CCR unit has been designed, constructed, operated, and maintained with:

i. Stable foundations and abutments;
ii. Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;
iii. Dikes (embankments) mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;
iv. Vegetated slopes of dikes and surrounding areas not to exceed a height of 6 inches above the slope of the dike, except for slopes which have an alternate form of slope protection;
v. A single spillway or a combination of spillways designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the design flood event. The spillways must be either of non-erodible construction and designed to carry sustained flows; or earth or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected;
vi. Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure;
vii. For CCR units with downstream slopes which can be inundated by the pool level of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

If a deficiency or a release is identified during the periodic assessment, Ameren Missouri will remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

2.6.1.4 Periodic Hazard Potential Classification

Ameren Missouri Dam Safety Group staff will update the hazard potential classification every 5 years in general accordance with 40 CFR Part §257.73(a)(2). Ameren Missouri Dam Safety Group staff will prepare documentation of the hazard potential classification of each CCR unit as either high hazard potential CCR surface impoundment, a significant hazard potential CCR surface impoundment, or a low hazard potential CCR surface impoundment, and the basis for each hazard potential classification. Ameren Missouri Dam Safety Group staff will prepare and maintain a written Emergency Action Plan if it is determined that a CCR unit is either a high hazard potential surface impoundment or a significant hazard surface impoundment.

2.6.1.5 Periodic Safety Factor Assessment

Ameren Missouri Dam Safety Group staff will conduct periodic safety factor assessments every 5 years in general accordance with 40 CFR Part §257.73(e)(1). The periodic safety factor assessments will be conducted for each CCR unit and will document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in §257.73(e)(1) for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments will be supported by appropriate engineering calculations.

2.6.1.6 Periodic Inflow Design Flood Control System Plan

Ameren Missouri Dam Safety Group staff will prepare an inflow design flood control system plan every 5 years in general accordance with 40 CFR Part §257.82. The plan will document how the inflow design flood control system has been designed, constructed, operated and maintained to adequately manage flow by definition or regulation into the CCR surface impoundment during and following the peak discharge of the inflow design flood. The inflow design flood is the probable maximum flood for a high hazard potential CCR surface impoundment, the 1000-year flood for a significant hazard potential CCR surface impoundment, the 100-year flood for a low hazard potential CCR surface impoundment, and the 25-year flood for an incised surface impoundment.

2.6.1.7 Special Inspections

Special inspections are conducted when extreme events which may impact stability (seismic activity, severe flooding, etc.) occur. Special inspections are similar to the annual inspection, but may be focused on a particular area. If conditions are discovered during a weekly or annual inspection which create concern for the LEC plant, personnel, or surrounding properties, a special inspection will be conducted. Responsibility for performance of special inspections will be evaluated based on the severity of the event and potential damage.

2.6.1.8 Unannounced Inspections

The Ameren Missouri Chief Dam Safety Engineer (CDSE) may conduct unannounced inspections at the site as deemed appropriate. The inspection may include a visual inspection of the facility, a review of the inspection documentation, and interviews with plant personnel to review their understanding of the required inspection procedures.

2.6.1.9 Inspection Findings

Observations made during the inspections are rated with a condition code as shown in the following Table 2. The timeliness of response to deficiencies observed depends on the severity of the condition.

Table 2 - Ameren Missouri dam safety inspection condition codes

Condition Code	Description
EC	Emergency Condition. A serious dam safety condition exists that need immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, emergency repairs, work stoppage, plant stoppage.
IM	Item needing immediate maintenance to restore or ensure its safety and integrity. Remediation should be complete within 1 month or as required.
MM	Minor Maintenance. Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.
OB	Condition requires regular observation and potential future minor maintenance.
GC	Good Condition.
NO	No observation possible.
NI	Not Inspected. State reason in comment column.

2.6.2 Maintenance and Repair of the CCR Units

The O&M requires that timely repairs must be made after problem areas are identified. The plant engineer is to specify the work to be completed using Ameren's Work Control Process and provide direction to correct items noted in the operation and maintenance, and engineering inspections. The work request by the plant engineer will be reviewed with the Dam Safety Group to ensure proper emphasis has been placed on the request. The O&M specifies the minimum maintenance activities and requires that maintenance activities be documented. The O&M further specifies that no alterations or repairs to structural elements should be made without the approval of the Chief Dam Safety Engineer and the concurrence of the MDNR Water Resources Center.

3.0 LCPA (BOTTOM ASH POND)

3.1 History of Construction

The design plans for the LCPA were issued for construction in 1969 and construction was completed shortly after. The LCPA is located south of the plant and has an approximate area of 164 acres. The location of the LCPA and the pond's significant features are shown in Figure 1. The embankment forms a ring dam which ties into plant fill on the north side of the impoundment. The embankment height is the greatest on the south and west sides of the pond, the maximum dam height is 26.3 feet. The north side of the impoundment is adjacent to plant fill, the embankment height is generally less than 5 feet. The embankment on the east side of the impoundment is shared by both the LCPA and LCPB. The embankment dam was constructed of compacted fill with upstream slopes of 2 horizontal (H) to 1 vertical (V) and downstream slopes of 3H to 1V. The minimum crown width is approximately 20 feet. The width of the embankment section is increased considerably on the west side of the impoundment because of fill placed for the plant access road and over a distance of 2000 lineal feet along the south side of the impoundment because of a beneficial fill. Drawings for the LCPA are presented in the O&M manual in Appendix A.

The LCPA has been dewatered, no longer receives CCRs and is being closed. Previously, LCPA received process water used to sluice bottom ash, flow from the plant combined drain sump (CDS), and discharge from the LCPB. The impoundment received both bottom and fly ash prior to completion of the LCPB. Discharge from the LCPB was near the southeast corner of the impoundment, and the water generally flowed east to west through ditches in the CCR. The CDS discharged near the northeast corner of the impoundment and collected stormwater from an area of approximately 154 acres.

The LCPA contained a principal and emergency spillway; however, these have been repurposed or removed. The principal spillway for the LCPA consisted of an 8-foot diameter galvanized corrugated metal pipe (CMP) skimmer and 36-inch diameter carbon steel pipe. On the upstream end the carbon steel pipe was upturned to el. 478.5 feet, and the invert on the downstream end was el. 472.0 feet. Flow through this pipe and the pool elevation was regulated by two motor operated butterfly valves. The LCPA also had a 75-foot-long broad crested emergency spillway that is located on the southwest side of the pond.

A summary of pertinent data for the LCPA is summarized in Table 3.

Table 3 – Bottom Ash Pond (LCPA)

CCR Unit	Maximum Pond Area (acres)	Maximum Dam Height (feet)	Minimum Crest Width (feet)	Crest Length (feet)	Upstream Slope Steepness (H:V)	Downstream Slope Steepness (H:V)
Bottom Ash Pond (LCPA)	164	26.3	20	10,500	2:1	3:1

3.2 Modifications to Embankment Geometry and Operation

3.2.1 1990s Embankment Raise

In the early 1990's, the LCPA embankment was raised 8.5 feet to increase its storage capacity. The new embankment fill consisted of a mixture of bottom and fly ash that was blended and compacted to achieve a hydraulic conductivity of 1x10^{-6} cm/sec. The compacted ash was covered with a minimum of 1 foot of earthen cover, except for the access road at the crest of the embankment. A plan for the embankment raise is attached as Figure 3.

At the same time, the original spillway was replaced with the principal spillway in its current configuration. The original spillway consisted of two pumps and discharge piping which ran over the embankment dam and discharged just south of the current outlet works. A plan showing the original spillway is presented in the O&M manual.

3.2.2 2006 and 2008 Beneficial Fill

A beneficial fill was constructed in 2006 and 2008 parallel to the southern embankment section for a new concrete packaging facility. Over a distance of approximately 2000 lineal feet, the fill increased the embankment section width from 70 to 225 feet. The fill was constructed of compacted bottom and fly ash. The approximate extents of the beneficial fill are shown in Figure 1.

3.2.3 2011 Slurry Wall and Anti Seepage Collar Construction

In 2011 Ameren constructed a 500 foot long slurry wall near the southwest corner of the pond. The wall was constructed to help mitigate seepage that was occurring at this location. The wall was constructed through the crest of the embankment with a width of 2.5 feet. The wall was terminated in fine grain foundation soil, or at a minimum depth of 30 feet. The wall had a minimum hydraulic conductivity of 1x10^{-6} cm/sec. A plan showing the slurry wall is presented in Figure 4.

At the same time an anti-seepage collar was constructed around the spillway conduit to help prevent a small amount of seepage that was occurring. The seepage collar consisted of a compacted soil and bentonite mixture to the extents shown in Figure 5.

3.2.4 2012 Emergency Spillway

In 2012 an emergency spillway was constructed near the southwest corner of the pond. The emergency spillway is a 75-foot long broad crested weir with an elevation of 490.0. The spillway was constructed of MoDOT Type 4 riprap on the upstream and downstream slopes, and the crest is constructed of aggregate sufficient to withstand design flows. Design computations for the spillway are presented in the O&M manual presented in Appendix A.

3.2.5 2013 Slurry Wall

Seepage was identified below the emergency spillway that was constructed in 2012. To cut-off the seepage, a soil-bentonite slurry wall was constructed through the crest of the embankment. The extent of the slurry wall was approximately from the southern extent of the slurry wall constructed in 2011 and continued 600 feet east.

3.2.6 2015 Seepage Collar and Valve Replacement

In 2015 slight seepage was still occurring at the outlet works and a concrete collar was constructed around the outfall pipe to help reduce seepage. At the same time, the area surrounding the downstream outlet works was graded to drain and armored with riprap. The upstream outlet works butterfly valve was also replaced in 2015.

3.2.7 West Detention Basin

The West Detention Basin was constructed over an approximate 8-acre area on the north side of the LCPA. The area was filled and graded to form the basin. The area was then capped with HDPE geomembrane inside the basin, and HDPE geomembrane and closure turf outside the basin. The West Detention Basin is used for plant stormwater management and water quality treatment.

3.2.8 Closure Construction (2019 to 2021)

Closure of LCPA was initiated in 2019 and is planned to be complete in 2021. Closure includes grading the remaining exposed CCR to facilitate drainage and capping the CCR with HDPE geomembrane overlain by 2 feet of soil. The principal spillway has been converted to a stormwater inlet and gravity outfall for stormwater runoff from a closed section of the pond. The emergency spillway has been removed. Stormwater is routed to 5 stormwater outlets through the perimeter embankment.

3.3 Foundation and Abutment Geology

The typical soil profile for the LCPA foundation consists of an upper most stratum of stiff to very stiff clay that is 5 feet thick. The clay is intermittently silty, and low to high plastic. The clay is underlain by silt and silty sand with a thickness of 5 to 15 feet. This silt is generally medium dense, and triaxial shear strength tests show the friction angle ranges from 30 to 33°. Sand is encountered beneath the silt, and is fine to coarse, medium dense and with some silty layers and gravel. Typically at a depth of about 40 to 50 feet beneath the original ground surface the sands become gravelly sand or sandy gravel. Limestone bedrock exists beneath the alluvium at a depth of 100 to 120 feet. Geotechnical investigations which document the foundation geology at the LCPA are presented in Appendix A.

3.4 Embankment Material

There are no construction documents or records for the original construction of the LCPA Dam. The embankment was raised 8.5 feet in the early 1990's using a mixture of bottom and fly ash. Fill placed to raise the embankments was blended and compacted to achieve permeability no greater than $1x10^{-6}$ cm/sec. Based on borings conducted in 2010, the top 9 to 10 feet of the embankment is medium dense to very dense and consists of bottom and fly ash. Beneath the ash fill are 1 to 3 foot thick layers of clay, silt and sand. The coarse grain layers have an estimated friction angle of 30 to 33°. The fine grain soils have an undrained strength that ranges from 1400 to 1500 psf, based on UU tests and correlations for N-values, and CPT tip resistance and skin friction.

3.5 Operating Pool Surface Elevations

The LCPA has been dewatered and is currently being closed.

3.6 CCR Unit Outlet Works

The principal spillway has been converted to a stormwater inlet and gravity outfall for stormwater runoff from a closed section of the pond. The emergency spillway has been removed. Stormwater is routed to 5 stormwater outlets through the perimeter embankment.

3.7 Impounded CCR

The LCPA impounds bottom and fly ash. Table 4 summarizes the approximate volume and depth of the CCR stored in the unit.

Table 4 – Bottom Ash Pond (LCPA) estimated volume and depth of impounded CCR

CCR Unit	Est. Volume of CCR (CY)	Approximate Bottom Elev. of CCR Unit (feet)	Est. Maximum CCR Elev. (feet)	Est. Average Depth of CCR (feet)	Est. Maximum Depth of CCR (feet)
LCPA	16,208,668	407.6	507	68	97

Up until the 1990's the LCPA received both bottom and fly ash. In the early 1990's the LCPB was constructed and put in service, and only bottom ash was sluiced to the LCPA. Borings through the LCPA show that the fly ash and bottom ash are deposited in layers of varying thickness and density. The fly ash and bottom ash are interbedded in some zones. The measured N_{60}-values would be classified as "very loose" to "medium-dense". Borings conducted in the interior of the pond are presented in Appendix A.

A sample of bottom ash was obtained from the LEC and the particle-size distribution showed that the material is poorly-graded with particle-sizes ranging from fine gravel to fine sand, with only about 1% fines. The specific gravity of the bottom ash sample was 2.80. The minimum and maximum density determined by laboratory tests (ASTM D4253 and D4254) was 83.6 pcf and 109.6 pcf, in that order.

3.8 Instrumentation

The LCPA has been dewatered and is currently being closed. Currently there are no instruments monitored to check impoundment operation.

3.9 Structural Instability

There are no records of structural instability for the LCPA.

4.0 LCPB (FLY ASH POND)

4.1 History of Construction

The LCPB was built in the 1990's and has an area of approximately 79 acres. The location of the LCPB and the pond's significant features are shown in Figure 1. The LCPB is located east of the LCPA and south of the plant. The embankment forms a ring dam which ties into plant fill near the northwest corner of the impoundment. The embankment height is greatest on the east and south sides of the pond, the maximum dam height is 29.5 feet. The western embankment section separates the pond from the LCPA. The embankment dam was constructed of earth fill with upstream slopes of 2H to 1V and 3H to 1V, and downstream slopes of 3H to 1V. Earth fill was obtained from the incised portion of the pond, the lowest elevation at the bottom of the pond is at 460.0 feet. The crown width is 10 feet near the northwest corner of the pond where the embankment height is generally less than 10 feet. The crown width for the remainder of the pond has a minimum width of 20 feet. Excluding the length of the western embankment section that was originally constructed for the LCPA, the crest length of the dam is approximately 6,100 feet. The interior of the LCPB is lined with 60 MIL HDPE on the interior slopes, and 40 MIL HDPE on the pond bottom. Drawings for the LCPB are presented in the O&M manual in Appendix A.

The LCPB has been dewatered, no longer receives CCRs and is being closed. Historically, the LCPB received process water used to sluice fly ash. The LCPB did not receive run-on from areas outside of the perimeter embankment. Water was sluiced to ditches excavated in the ash. Fly ash settled in the ditches, and the decant water flowed to the outlet works on the south side of the pond. The ditches were periodically excavated to remove the settled ash, and the excavated material was placed in large stockpiles built within the pond.

The LCPB outlet works were removed during closure construction. The outlet works were located near the southwest corner of the pond. The principal spillway consisted of two manually operated 6-inch diameter submersible pumps that discharged into 6-inch diameter PVC pipes. The LCPB also contained a 50-foot-long broad crested weir emergency spillway which is also located near the southwest corner of the pond. Both the principal and emergency spillways discharged into the LCPA.

A summary of pertinent data for the LCPB is summarized in Table 5.

Table 5 – Fly Ash Pond (LCPB)

CCR Unit	Maximum Pond Area (acres)	Maximum Dam Height (feet)	Minimum Crest Width (feet)	Crest Length (feet)	Upstream Slope Steepness (H:V)	Downstream Slope Steepness (H:V)
Fly Ash Pond (LCPB)	79	29.5	10	6,100	2:1 & 3:1	3:1

4.2 Modifications to Embankment Geometry and Operation

4.2.1 2012 Emergency Spillway

In 2012 an emergency spillway was constructed near the southwest corner of the pond. The emergency spillway is a 50-foot long broad crested weir with an elevation of 491.7. The spillway was constructed of MoDOT Type 4 riprap on the upstream and downstream slopes, and the crest is constructed of aggregate sufficient to withstand design flows. Design computations for the spillway are presented in the O&M manual presented in Appendix A.

4.2.2 Planned Haul Road (2016-2017)

Construction of a haul road on the crest of the north embankment is began in late 2016 and was completed in 2017. The construction lowered the crest of the embankment to el. 491, and the HDPE liner to el. 490. The haul road was paved with 12 inches of non-reinforced concrete that is underlain by 12 inches of compacted MoDOT Type 1 Aggregate Base Course.

4.2.3 Closure Construction (2019 – 2021)

Closure of LCPB was initiated in 2019 and is planned to be complete in 2021. Closure includes grading the remaining exposed CCR to facilitate drainage and capping the CCR with HDPE geomembrane overlain by 2 feet of soil. Stormwater is routed to 5 stormwater outlets through the perimeter embankment.

4.3 Foundation and Abutment Geology

The typical soil profile for the LCPB foundation consists of a thin upper most stratum of firm to stiff clay that is 2 to 5 feet thick. The foundation soil then becomes clayey or sandy silt and loose to medium-dense. The thickness of the silty soil is typically 4 to 10 feet. Underlying the silt is poorly graded, fine to coarse sand which is medium dense to dense. Typically at a depth of about 40 to 50 feet beneath the original ground surface the sands become gravelly sand or sandy gravel. Limestone bedrock exists beneath the alluvium at a depth of 100 to 120 feet. Geotechnical investigations which document the foundation geology at the LCPB are presented in Appendix A.

4.4 Embankment Material

The embankment was constructed of earth fill borrowed from the interior of the pond. The design plans note that the top 6 feet of the foundation soil inside the perimeter berm should be used as fill. CPT soundings conducted in 2010 showed that the embankment fill is heterogeneous and consists of sand, silt and clay that were generally placed in 8 to 12 inch thick lifts. The coarse grain lifts are generally medium dense and the fine grain lifts are firm to stiff.

4.5 Operating Pool Surface Elevations

The LCPB has been dewatered and is currently being closed.

4.6 CCR Unit Outlet Works

During closure construction the principal and emergency spillways have been removed. Rainfall falling within the footprint of the LCPB is routed to 5 stormwater outlets around the perimeter embankment.

4.7 Impounded CCR

The LCPB impounds fly ash. Table 6 summarizes the approximate volume and depth of the CCR stored in the unit.

Table 6 – Fly Ash Pond (LCPB) estimated volume and depth of impounded CCR

CCR Unit	Est. Volume of CCR (CY)	Approximate Bottom Elev. of CCR Unit (feet)	Est. Maximum CCR Elev. (feet)	Est. Average Depth of CCR (feet)	Est. Maximum Depth of CCR (feet)
LCPB	3,861,136	460.0	501.0	31.0	41

Fly ash impounded in the LCPB consists of uniform silt-size and clay-size particles, with some fine sand-size particles. The specific gravity of the ash is approximately 2.87. The fly ash is very pozzalanic and hardens in a few minutes after it is mixed with water. The undrained shear strength of the ash when mixed with water and tested at 1 day cure time varies from about 81 psi at a moisture content of 15% to 6.3 psi at a moisture content of 40%.

4.8 Instrumentation

The LCPB has been dewatered and is currently being closed. Currently there are no instruments monitored to check impoundment operation.

4.9 Structural Instability

There are no records of structural instability for the LCPB.

5.0 PERIODIC HAZARD POTENTIAL CLASSIFICATION

40 CFR Part 257
Periodic Hazard Potential Classification Assessments for CCR Surface Impoundments §257.83(a)(2)

The 2020 Periodic Hazard Potential Classification Assessment was conducted for active CCR surface impoundments LCPA and LCPB at the Labadie Energy Center. These CCR surface impoundments are low hazard potential because failure of the impoundment is not expected to cause a loss of human life, and the economic, environmental and lifeline losses are expected to be low and generally limited to the owner. The hazard potential classification was completed in general accordance with Federal Guidelines for Dam Safety: Hazard Potential Classification for Dams by the Federal Emergency Management Agency (January 2004).

CCR Unit	Hazard Potential Classification
LCPA	Low
LCPB	Low

The basis for the hazard potential classification is documented in Appendix B: Labadie Energy Center Hazard Potential Classification. The subsequent assessment of the hazard potential must be conducted within 5 years of this initial assessment.

Engineer's Seal

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License: PE-2010025265
Date: October 15, 2021

6.0 PERIODIC STRUCTURAL STABILITY ASSESSMENT

40 CFR Part 257
Periodic Structural Stability Assessment for CCR Surface Impoundments §257.73(d)(1)

The 2020 Periodic Structural Stability Assessment was conducted for the active CCR surface impoundments LCPA and LCPB at the Labadie Energy Center. The structural stability assessment was completed in general accordance with 40 CFR Part §257.73(d)(1). Assessment of both CCR Units found no structural stability deficiencies, no significant issues with the current operations and maintenance, and that the design and construction are adequate, however some corrective measures were recommended.

Requirement	LCPA (Bottom Ash Pond)	LCPB (Fly Ash Pond)
Periodic assessment was completed in general accordance with the requirements of 40 CFR Part §257.73(d)(1)	Yes	Yes

Refer to Appendix C for the 2020 Periodic Structural Stability Assessment report. The first subsequent Periodic Structural Stability Assessment must be conducted within 5 years of this initial assessment.

Engineer's Seal

STATE OF MISSOURI
JEFF
BERTEL
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PROFESSIONAL ENGINEER

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Date: October 15, 2021

7.0 PERIODIC SAFETY FACTOR ASSESSMENT

40 CFR Part 257
Periodic Safety Factor Assessment for CCR Surface Impoundments §257.73(e)(1)

The initial periodic safety factor assessments for LCPA and LCPB were completed in October 2016. The initial assessment found that the calculated factors of safety for the critical cross-sections of each CCR unit exceed the minimum factors of safety for each loading condition required by 40 CFR §257.73(e). LCPA and LCPB no longer receive CCRs, have been dewatered and are currently being closed. The current conditions are no longer representative of those used in the 2016 assessment. A separate safety factor assessment for the closed condition has been performed by Reitz & Jens. This assessment found that the static and seismic stability factors of safety meet or exceed the minimum requirements.

Requirement	LCPA	LCPB
The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.	≥1.50	≥1.50
The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.	≥1.40	≥1.40
The calculated seismic factor of safety must equal or exceed 1.00.	≥1.00	≥1.00
The calculated liquefaction factor of safety must equal or exceed 1.20.	≥1.20	≥1.20

Reitz & Jens's initial periodic safety factor assessment and closure stability report is included in Appendix D.

Engineer's Seal

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NUMBER
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Jeff Bertel, P.E.
License: PE-2010025265
Date: October 15, 2021

8.0 HYDROLOGIC AND HYDRAULIC CAPACITY REQUIREMENTS

40 CFR Part 257
Initial Hydrologic and Hydraulic Capacity Requirements for CCR Surface Impoundment §257.82

The initial inflow design flood control system plan was completed in 2016 for LCPA and LCPB in general accordance with 40 CFR Part §257(e)(1) using the 100-year design flood for low hazard potential CCR surface impoundments. LCPA and LCPB have been dewatered and are currently being closed. Closure of LCPA and LCPB was designed so that water is not permanently impounded within the perimeter embankments.

Requirement	LCPA	LCPB
The periodic inflow design flood control system plan meets the requirements of 40 CFR Part §257.82	Yes	Yes

Refer to Appendix E for the Initial Inflow Design Control System Plan.

Engineer's Seal

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Date: October 15, 2021

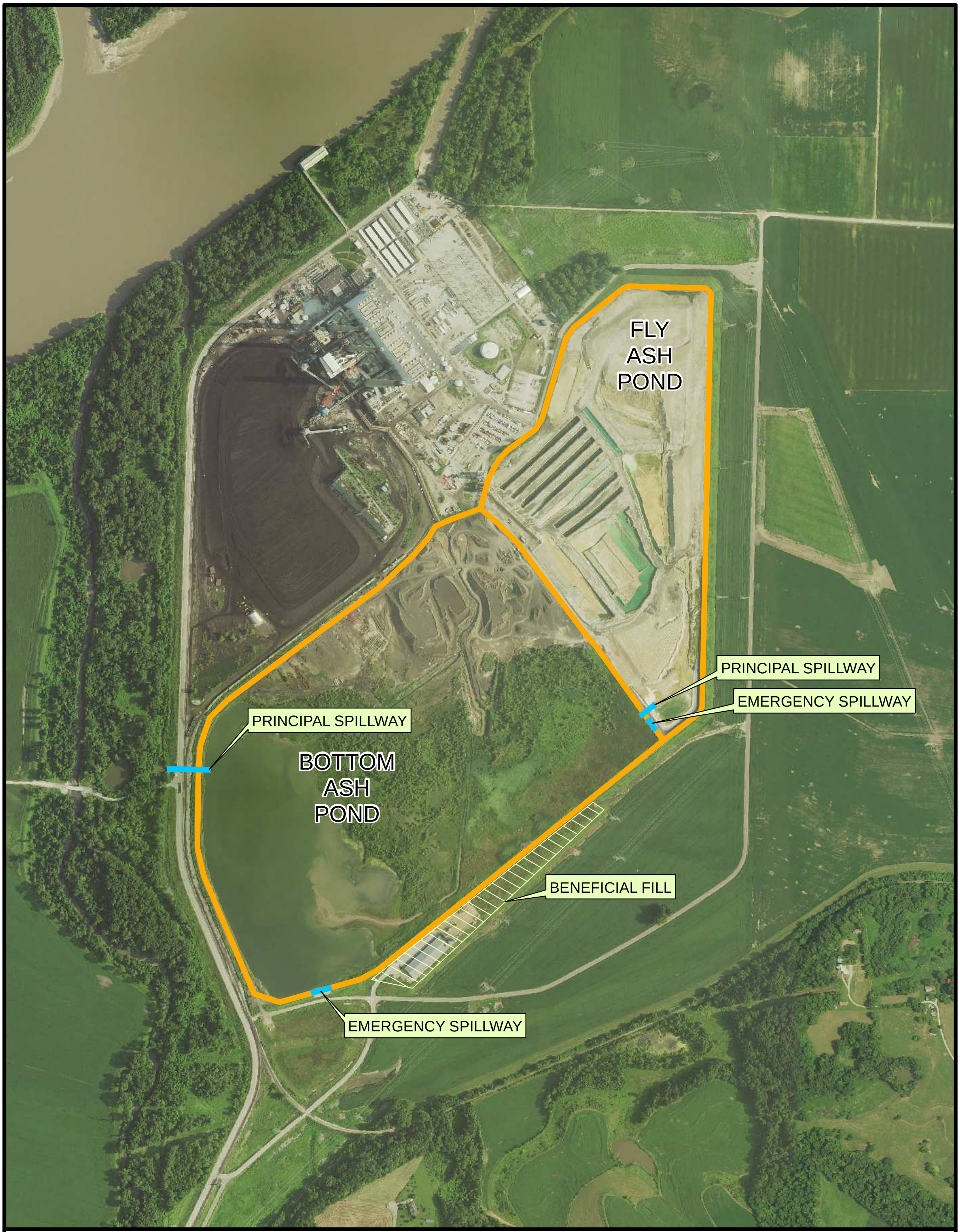
9.0 CLOSURE

The preceding history of construction is regarded as a living document. If there is a significant change to any information or there are periodic updates, Ameren must update the relevant information and place it in the facility’s operating record.

10.0 REFERENCES

Ameren Missouri. (2012). “Operation and Maintenance Manual; Labadie Bottom Ash & Fly Ash Pond Embankments, Labadie, Missouri, Franklin County.” Dam Safety and Hydro Engineering, St. Louis, Missouri.

Environmental Protection Agency. (2015). “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule.” 40 CFR Parts 257 and 261., Vol. 80, No. 74.



Legend

🟧 Embankment

🟦 Spillway

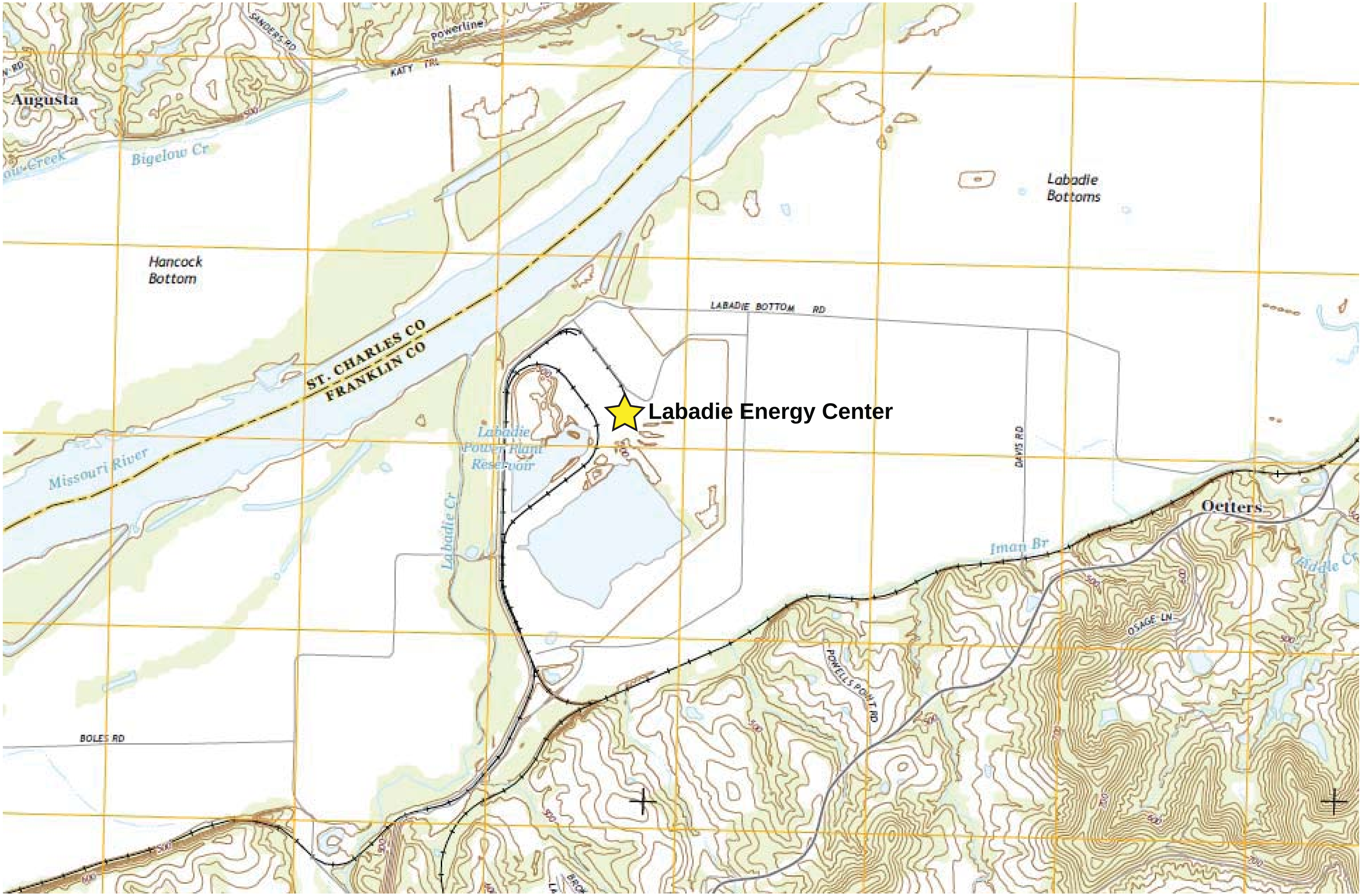
N

0 500 1,000 Feet

AMEREN MISSOURI
LABADIE ENERGY CENTER
ACTIVE CCR SURFACE IMPOUNDMENTS
FIGURE 1

Ameren MISSOURI

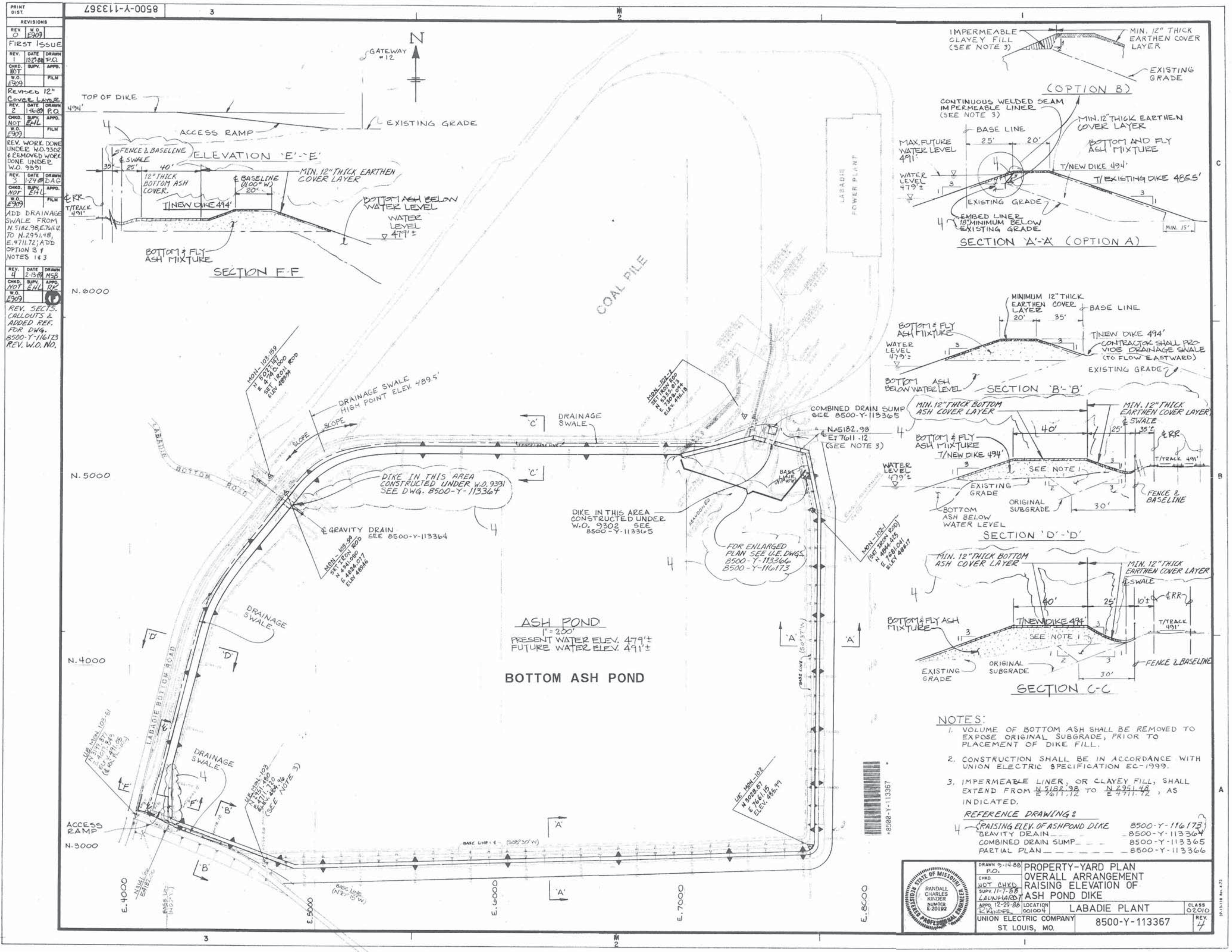
REITZ & JENS, INC.
CONSULTING ENGINEERS



Ameren Missouri
Labadie Energy Center
CCR Unit Evaluation
USGS 7.5 minute quadrangle map

REITZ & JENS, INC.

Figure 2



PRINT DIST.		
REVISIONS		
REV 0	W.O. E909	
FIRST ISSUE		
REV. 1	DATE 12-29-88	DRAWN P.O.
CHKD. NOT	SUPV.	APPD.
W.O. E909		FILM
REVISED 12" COVER LAYER		
REV. 2	DATE 1-16-89	DRAWN P.O.
CHKD. NOT	SUPV. EHL	APPD.
W.O. E909		FILM
REV. WORK DONE UNDER W.O. 9302 & REMOVED WORK DONE UNDER W.O. 9391		
REV. 3	DATE 1-24-89	DRAWN DAG
CHKD. NOT	SUPV. EHL	APPD.
W.O. E909		FILM
ADD DRAINAGE SWALE FROM N.5182.98, E.7611.12 TO N.2951.48, E.4711.72; ADD OPTION B & NOTES 1 & 3		
REV. 4	DATE 2-13-89	DRAWN MSB
CHKD. NOT	SUPV. EHL	APPD. RK
W.O. E909		
REV. SECTS. CALLOUTS & ADDED REF. FOR DWG. 8500-Y-116173 REV. W.O. NO.		

NOTES:

1. VOLUME OF BOTTOM ASH SHALL BE REMOVED TO EXPOSE ORIGINAL SUBGRADE, PRIOR TO PLACEMENT OF DIKE FILL.
2. CONSTRUCTION SHALL BE IN ACCORDANCE WITH UNION ELECTRIC SPECIFICATION EC-1999.
3. IMPERMEABLE LINER, OR CLAYEY FILL, SHALL EXTEND FROM N 5182.98 / E 7611.12 TO N 2951.48 / E 4711.72, AS INDICATED.

REFERENCE DRAWING:

RAISING ELEV. OF ASHPOND DIKE	8500-Y-116173
GRAVITY DRAIN	8500-Y-113364
COMBINED DRAIN SUMP	8500-Y-113365
PARTIAL PLAN	8500-Y-113366

RANDALL CHARLES KINDER NUMBER E-20192

DRAWN 9-14-88 P.O.	PROPERTY-YARD PLAN OVERALL ARRANGEMENT RAISING ELEVATION OF ASH POND DIKE		
CHKD. NOT CHKD			
SUPV. 11-7-88 LAUNHARDT			
APPD. 12-29-88 R KINDER	LOCATION 001004	LABADIE PLANT	CLASS 02010
UNION ELECTRIC COMPANY ST. LOUIS, MO.	8500-Y-113367		REV. 4

8500-Y-113367

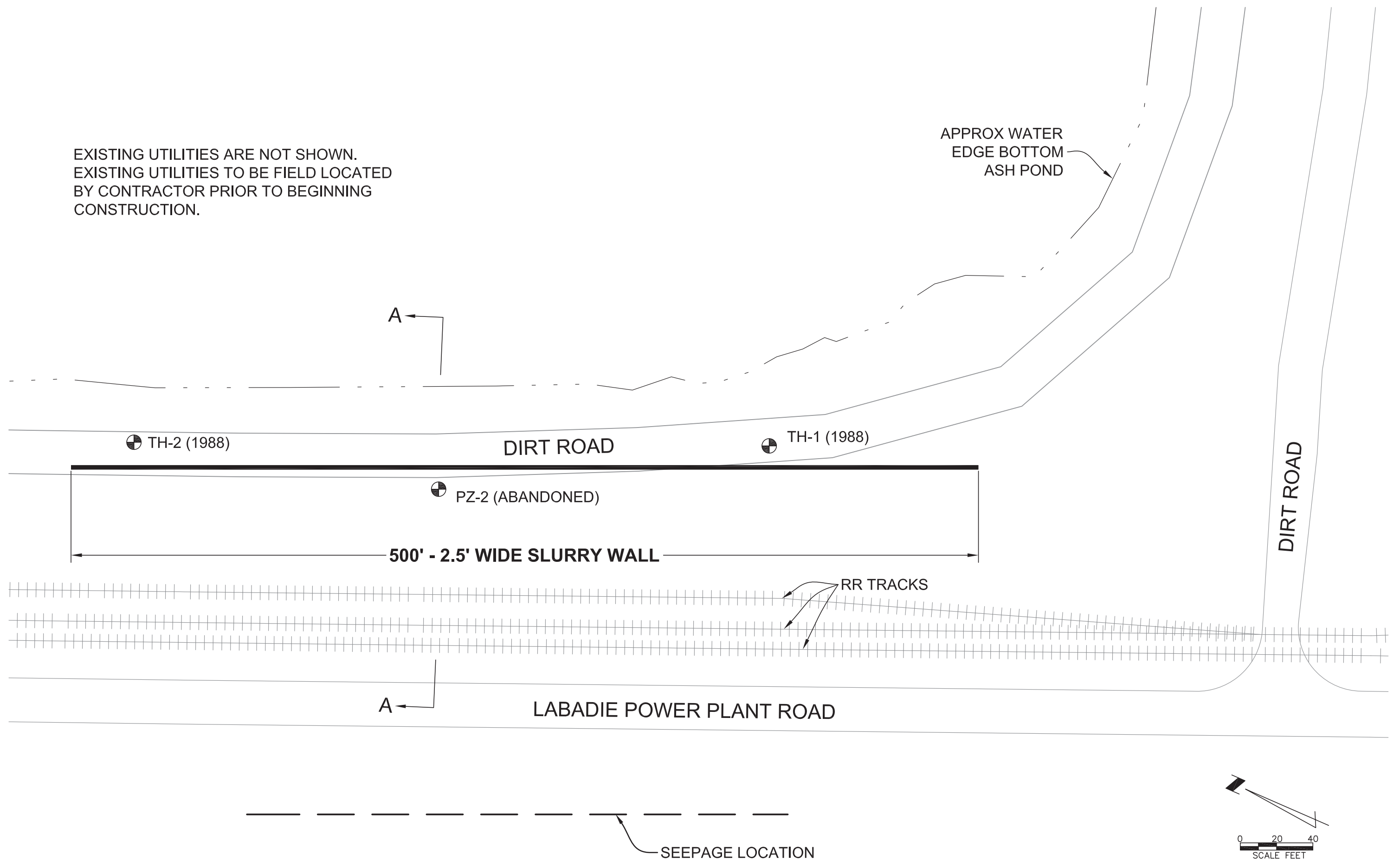
Figure 3

PRINT DIST.

REVISIONS

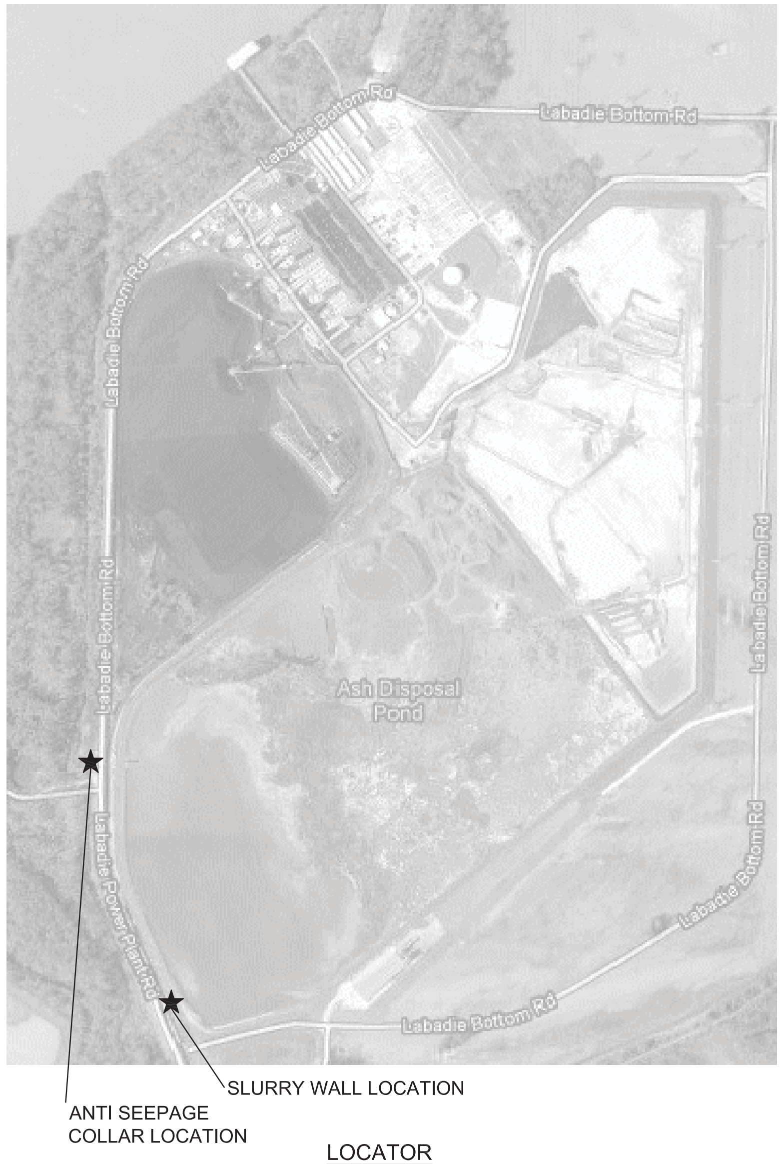
REV.	W.O.

EXISTING UTILITIES ARE NOT SHOWN. EXISTING UTILITIES TO BE FIELD LOCATED BY CONTRACTOR PRIOR TO BEGINNING CONSTRUCTION.



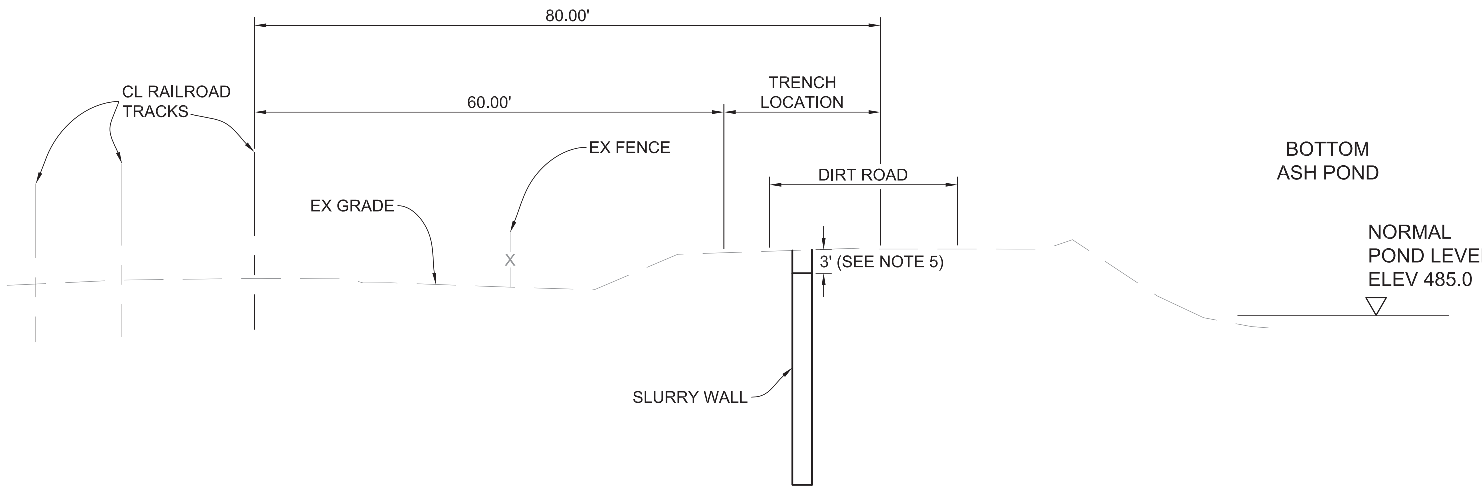
ALL LOCATIONS ARE APPROXIMATE, AMEREN TO STAKE THE SLURRY WALL LOCATION.

PLAN



LOCATOR

NO SCALE



SECTION A-A

SLURRY WALL NOTES

1) SLURRY WALL IN-PLACE/PERMAMENT HYDRAULIC CONDUCTIVITY 1X10^{-6} cm/sec OR LESS

2) TRENCH WIDTH MINIMUM 30 INCHES

3) TRENCH DEPTH FROM SURFACE MINIMUM 30 FEET, VERIFY THAT BOTTOM OF WALL TERMINATES IN NATURAL FINE GRAINED SOIL

4) TRENCH LENGTH MINIMUM 500 FEET, LENGTH MAY BE INCREASED BASED ON FIELD OBSERVATIONS

5) TOP OF SLURRY WALL SHALL BE WITHIN 3 FEET OF EXISTING GROUND SURFACE

6) BACKFILL ABOVE SLURRY WALL TO BE COMPLETED BY OTHERS

BEFORE YOU DIG - DRILL - BLAST
1-800-344-7483
(TOLL FREE)
MISSOURI ONE CALL SYSTEM, INC.

THE ENGINEER WHOSE SIGNATURE AND PERSONAL SEAL APPEAR HEREON ASSUMES RESPONSIBILITY ONLY FOR WHAT APPEARS ON THIS PAGE AND DISCLAIMS PURSUANT TO SECTION 327.411 RSMO) ANY RESPONSIBILITY FOR ALL OTHER PLANS, SPECIFICATIONS, ESTIMATES, REPORTS OR OTHER DOCUMENTS OR INSTRUMENTS NOT SEALED BY THE UNDERSIGNED ENGINEER RELATING TO OR INTENDED TO BE USED FOR ANY PART OR PARTS OF THE PROJECT TO WHICH THIS PAGE REFERS.

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LABADIE POWER PLANT
BOTTOM ASH POND
SLURRY WALL SCHEMATIC
SHEET 1 OF 2

LOCATION 001004
LABADIE PLANT
CLASS 02010

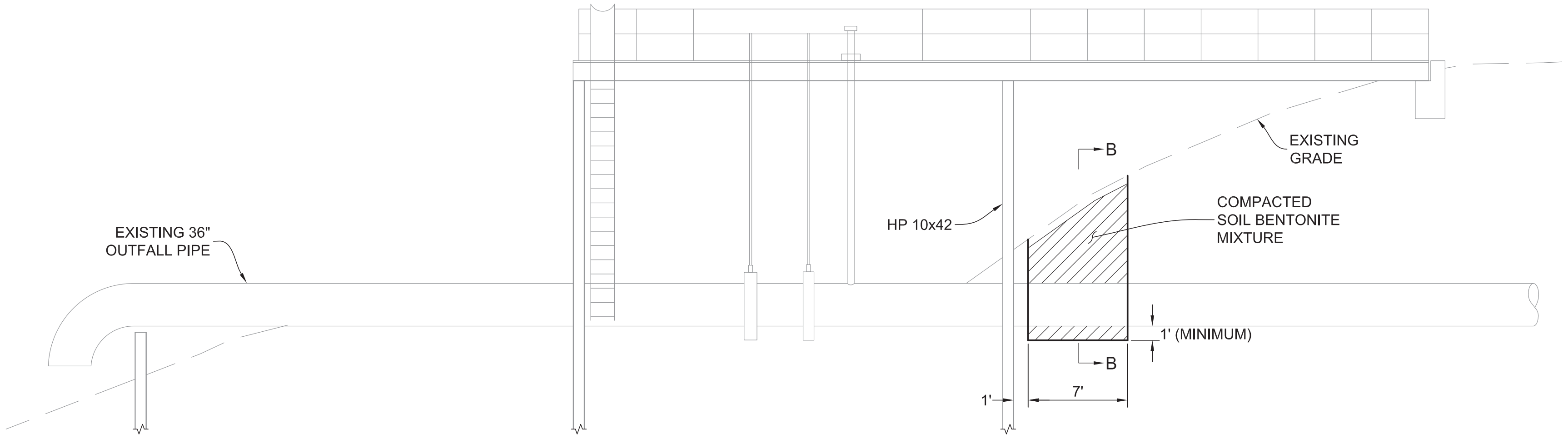
Ameren MISSOURI ST. LOUIS, MISSOURI
LB-DWG-PROP-000002
REV.

Figure 4

PRINT DIST.

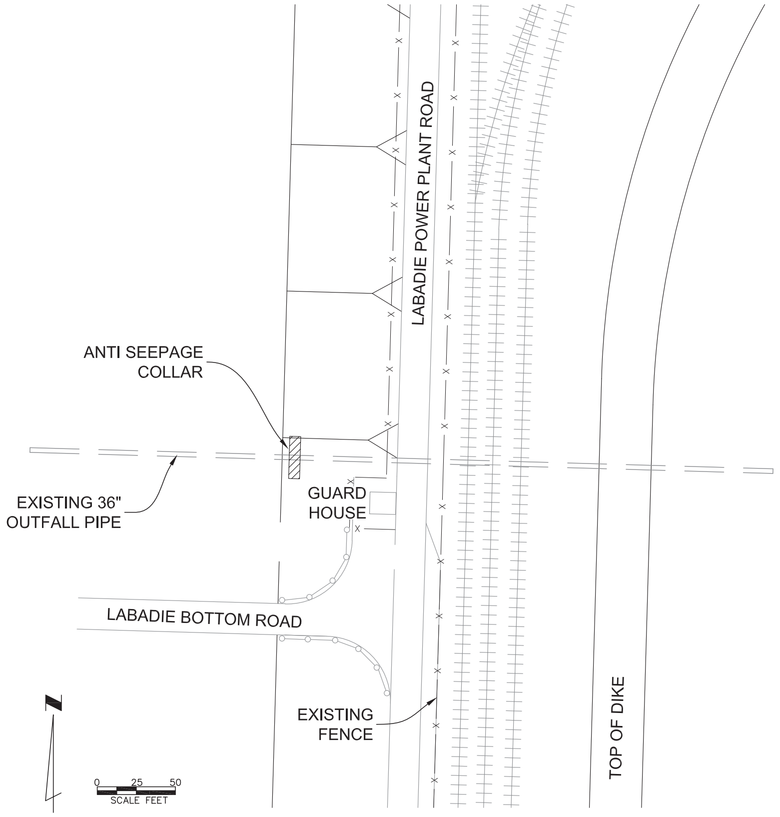
REVISIONS

REV.	W.O.	

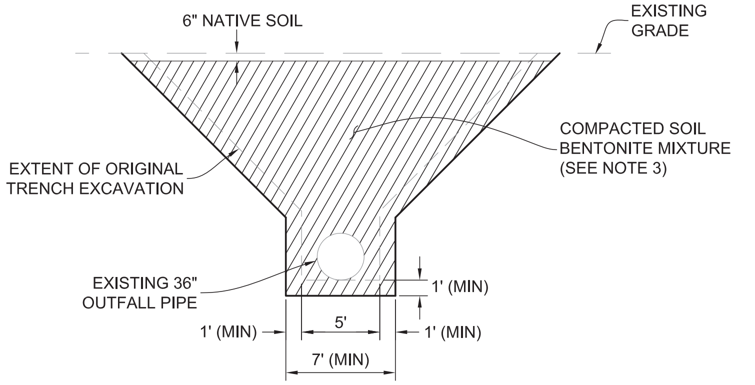


PROFILE

SCALE: 1"=5' H&V



PLAN



SECTION B-B

SCALE: 1"=5' H&V

ANTI SEEPAGE COLLAR NOTES

1) ANTI SEEPAGE COLLAR SHALL BE EXCAVATED 1 FOOT INTO THE UNDISTURBED TRENCH WALL AND FLOOR.

2) ANTI SEEPAGE COLLAR SHALL BE A MINIMUM OF 7 FEET LONG.

3) THE BENTONITE SOIL MIXTURE SHALL CONSIST OF THREE PARTS SOIL AND ONE PART GRANULAR BENTONITE BY VOLUME. THE MIXTURE SHALL BE THOROUGHLY MIXED BY MECHANICAL MEANS AND COMPACTED INTO THE WIDENED TRENCH ALL AROUND THE CONDUIT. THE MIXTURE SHOULD BE PREPARED AS IT IS USED, MIXED STOCK MORE THAN 6 HOURS OLD WILL NOT BE ALLOWED

4) THE MIXTURE SHALL BE COMPACTED TO AT LEAST 85% OF THE MODIFIED PROCTOR DENSITY (ASTM D-1557).

5) FENCE AND/OR GUARDRAIL REMOVAL TO ACCESS SITE SHALL BE PERFORMED BY CONTRACTOR. THE CONTRACTOR SHALL REPLACE ANY FENCE AND GUARDRAIL AFTER COMPLETING WORK.

THE ENGINEER WHOSE SIGNATURE AND PERSONAL SEAL APPEAR HEREON ASSUMES RESPONSIBILITY ONLY FOR WHAT APPEARS ON THIS PAGE AND DISCLAIMS PURSUANT TO SECTION 327.411 RSMO) ANY RESPONSIBILITY FOR ALL OTHER PLANS, SPECIFICATIONS, ESTIMATES, REPORTS OR OTHER DOCUMENTS OR INSTRUMENTS NOT SEALED BY THE UNDERSIGNED ENGINEER RELATING TO OR INTENDED TO BE USED FOR ANY PART OR PARTS OF THE PROJECT TO WHICH THIS PAGE REFERS.

PREPARED FOR Ameren MISSOURI

DRAWN
CHKD.
SUPV.
APPD.

LABADIE POWER PLANT
BOTTOM ASH POND
ANTI SEEPAGE COLLAR
SHEET 2 OF 2

LOCATION 001004
LABADIE PLANT
CLASS 02010

Ameren MISSOURI ST. LOUIS, MISSOURI
LB-DWG-PROP-000003
REV.

Figure 5

APPENDIX A

2012 LABADIE BOTTOM ASH AND FLY ASH POND EMBANKMENT O&M MANUAL

1966 TEST BORING REPORT RAYMOND CONCRETE PILE DIVISION

2010 LABADIE DAM SAFETY REPORT BORINGS AND SOIL LABORATORY TESTS

2015 LABADIE PLANT BOTTOM ASH POND CLOSURE BORING LOGS

OPERATION AND MAINTENANCE MANUAL

LABADIE BOTTOM ASH & FLY ASH POND EMBANKMENTS
LABADIE, MISSOURI
FRANKLIN COUNTY

SEPTEMBER 19, 2012

DAM SAFETY & HYDRO ENGINEERING
3700 S. LINDBERGH BLVD
ST. LOUIS, MO 63127

OPERATION AND MAINTENANCE PLAN
LABADIE BOTTOM ASH & FLY ASH POND EMBANKMENTS
FRANKLIN CO., MO

TABLE OF CONTENTS

SECTION 1

GENERAL

This operation and maintenance plan, (hereafter referred to as the O&M Manual), outlines objectives, proposed policies, responsibilities, and procedures for Ameren personnel who are responsible for the management of the Labadie Bottom Ash and Fly Ash Ponds.

REASONS FOR DEVELOPMENT AND DISSEMINATION OF THE O&M MANUAL

As an ash pond embankment owner, Ameren is responsible for the safety of the public and for maintaining the structures within the Ameren's jurisdiction for both safety and economy. The overall public interest is served by providing a document to serve as a basis for the safe and economical operation and maintenance of the ash pond embankment during both emergency and day-to-day conditions.

GENERAL RESPONSIBILITIES CONCERNING ASH POND EMBANKMENTS

Shift Supervisor

Contacts local agencies when emergency conditions exist at the Labadie Bottom Ash or Fly Ash Ponds.

Plant Engineer

Ensures operation and maintenance program is being implemented as outlined in this document. Ensures performance of weekly inspections. Performs annual assessment of the Operation and Maintenance Manual.

Chief Dam Safety Engineer

Reviews all updates to the Operation and Maintenance Manual.

Dam Safety Group

Performs annual bottom ash and fly ash pond embankment inspection with the Plant Engineer. Reviews weekly dam safety inspection reports.

SECTION 2

DEFINITIONS

Abutment - That part of the valley side or concrete walls against which the dam is constructed. Right and left abutments are those on respective sides of an observer when viewed looking downstream.

Appurtenant Works - The structures or machinery auxiliary to dams that are built to operate and maintain dams; such as outlet works, spillways, gates, valves, channels, etc.

Auxiliary Spillway - A spillway that works in conjunction with the principal spillway to control flood flows and is constructed of non-erodible materials.

Boil - A stream of water discharging from the ground surface downstream of the dam carrying with it a volume of soil that is distributed around the hole formed by the discharging water.

Berm - A horizontal step or bench in the sloping profile of an embankment dam.

Breach - A break, gap, or opening (failure) in a dam that releases impoundment water.

Concrete Block - An erosion protection method using interlocking concrete blocks, usually with openings that are filled with soil and grass.

Core - A zone of material of low permeability in an earthen dam.

Dam - A barrier built for impounding or diverting the flow of water.

Dike (Levee) - An embankment or structure built alongside a river to prevent high water from flooding bordering land.

Drain, Layer or Blanket - A layer of pervious material in a dam to facilitate the drainage of the embankment, including such items as a toe drain, a weep hole, and a chimney drain.

Drawdown - The resultant lowering of water surface level due to the controlled release of water from the impoundment.

Embankment - Fill material, usually earth or rock, placed with sloping sides.

Emergency Spillway - A spillway designed to operate very infrequently, only during exceptionally large floods, usually constructed of materials expected to erode slowly.

Earthen Dam - Any dam constructed of excavated natural materials.

Failure - An incident resulting in the uncontrolled release of water from a dam.

Freeboard - The vertical distance between a stated water level and the top of a dam.

Gate or Valve - In general, a device in which a leaf or member is moved across the waterway to control or stop the flow.

Groin - The junction of the upstream or downstream face of the dam with the valley wall.

Maintenance - The upkeep, involving labor and materials, necessary for efficient operation of dams and their appurtenant works.

Operation - The administration, management, and performance needed to operate the dam and appurtenant works.

Operation and Maintenance Inspection - Inspections conducted by the Plant Engineer. These inspections are frequent visual inspections of the dam surface and appurtenant works.

Outlet - An opening through which water can freely discharge for a particular purpose from an impoundment.

Phreatic Surface - The upper surface of saturation in an embankment.

Piping - The progressive development of internal erosion by seepage, appearing downstream as a hole or seam, discharging water that contains soil particles.

Principal Spillway - The main spillway that controls both normal and flood flows and is constructed of non-erodible materials.

Riprap - A layer of large stones, broken rock or precast blocks placed in a random fashion, usually on the upstream slope of an embankment dam, on a reservoir shore, or on the sides of a channel as a protection against current, wave and ice action.

Silt/Sediment - Soil particles and debris in an impoundment.

Slump/Slide Area - A portion of earth embankment that moves downslope, sometimes suddenly, often with cracks developing.

Spillway System - A structure or structures over or through which flows are discharged. If the flow is controlled by gates, it is considered a controlled spillway. If the elevation of the spillway crest is the only control of the flows, it is considered an uncontrolled spillway.

Stilling Basin - A basin constructed to dissipate the energy of fast flowing water, such as from a spillway, and to protect the stream bed from erosion.

Toe of Embankment - The junction of the face of the dam with the ground surface in the floodplain upstream or downstream of the dam.

Trash Rack - A structure of metal or concrete bars located in the waterway at an intake to prevent the entry of floating or submerged debris.

SECTION 3

INFORMATION ABOUT THE ASH POND EMBANKMENT

LOCATION

The Labadie Power Station is located in northeastern Franklin County, Missouri in the flood plain of the Missouri River. The plant is located north of the Town of Labadie on the south bank of the Missouri River at river mile marker 57.5. The plant is located in Sections 18 and 19, Township 44 North, Range 2 East of the 5th Principal Meridian.

DESCRIPTION OF ASH POND EMBANKMENT AND APPURTENANCES

The Labadie Ash Ponds are a single stage industrial ash pond embankment. The embankment impounds an area of approximately 233-acres for coal combustion ash sedimentation purposes. The perimeter of the ash pond embankment has a length of approximately 11,700-lineal-feet (lf) and a maximum height of 29.5-ft. The ash pond embankment forms the perimeter of two impoundments which are separated by an interior levee. The two impoundments are the Bottom Ash Pond and Fly Ash Pond.

Bottom Ash Pond

The Bottom Ash pond is located south of the plant and forms the southwest portion of the ash impoundment area. The Bottom Ash Pond is approximately 154-acres. Design plans for the Bottom Ash Pond were issued for construction in 1969 and construction was completed shortly after. The dam was constructed of compacted earth fill with design slopes of 2 horizontal (H) to 1 vertical (V) upstream slopes and 3H:1V downstream slopes. The pond embankment was raised from its original design approximately 8.5 feet to create additional storage due to the amount of bottom ash deposited in the pond. The material used for the levee raise consisted of bottom and fly ash and was blended to achieve a permeability of 1×10^{-6} centimeters per second or less.

A 75-ft wide broad crested weir emergency spillway is located on the southwest side of the bottom ash pond. The emergency spillway is constructed of MODOT Type 4 Rip-Rap on the upstream and downstream slopes. The crest of the emergency spillway is constructed of aggregate sufficient to withstand design flows.

Fly Ash Pond

The Fly Ash Pond is located to the east of the plant and is in the northeast portion of the ash impoundment area. The Fly Ash Pond was built in the 1990's and has an area of approximately 79 acres. The upstream slopes of the Fly Ash Pond range from 2H:1V to 3H:1V. The downstream slopes are primarily 3H:1V with a short section of 2H:1V in the northwest corner. The Fly Ash Pond is also lined with a 60 mil high-density polyethylene

(HDPE) liner from the bottom to an elevation of 491-ft. No data was provided regarding the initial geotechnical design assumptions or construction criteria.

A 50-ft wide broad crested weir emergency spillway is located on the southwest side of the fly ash pond. The emergency spillway is constructed of MODOT Type 4 Rip-Rap on the upstream and downstream slopes. The crest of the emergency spillway is constructed of aggregate sufficient to withstand design flows.

HAZARD CLASSIFICATION

The Labadie Dam Impoundment is not currently subject to MDNR dam safety regulations. If regulations did apply, the Labadie Dam would be classified as a Class III, LOW HAZARD POTENTIAL, as defined by Missouri Department of Natural Resources (MDNR), because there are no dwellings downstream. In addition, there are no dams currently registered with MDNR directly influencing the Labadie Ash Ponds.

PURPOSE OF ASH POND EMBANKMENT

The dam forms the perimeter of two impoundments which are separated by an interior levee. The two impoundments are the Bottom Ash and Fly Ash Ponds. The active reservoirs are used for coal combustion (Bottom Ash and Fly Ash) sedimentation storage.

PERTINENT DATA

Pertinent data about the ash pond embankment, appurtenant works, and reservoir is presented in Table 1.

TABLE 1
PROJECT DATA

Drainage Area	387-Acres
Ash Pond Embankment:	
Type	Earth Embankment
Elevation, Top of Embankment	Varies from 491 to 494 feet
Height Above Streambed	Approximately 29.5 feet
Length	11,700 feet
Top Width	Varies
Minimum Freeboard Requirements	2.5 Feet
Bottom Ash Pond:	
Upstream Slope	2 (H) on 1 (V)
Downstream Slope	3 (H) on 1 (V)
Elevation, Top of Embankment	492.7 to 494.6 feet (490.0 – Flow Line of Emergency Spillway)
Elevation, Normal Pool	484 feet
Area	154 acres
Freeboard, Normal Pool	8.3 feet
Liner	Not Lined
Outlet Works:	
Structure Type	8 ft CMP Skimmer, 36" dia. metal discharge pipe, Two 36' dia, motor operated butterfly valves
Inlet Invert Elevation	478.5 feet
Outlet Invert Elevation	472 feet
Emergency Spillway	75' Broad Crested Weir (Elevation 490.0 feet)
Fly Ash Pond:	
Upstream Slope	3 (H) on 1 (V)
Downstream Slope	3 (H) on 1 (V)
Elevation, Top of Embankment	492.7 to 494 feet (491.7 – Flow Line of Emergency Spillway)
Elevation, Normal Pool	485 feet
Area	79 acres
Freeboard, Normal Pool	7.7 feet
Liner	60 MIL HDPE from bottom to El. 491'
Outlet Works:	
Structure Type	Two submersible pumps discharge into 6" PVC pipes, original construction included a 10 ft CMP Skimmer that is currently not used
Inlet Invert Elevation	Pumps at El. 460 feet
Outlet Invert Elevation	Discharge into BA Pond at El. 491.3 feet
Emergency Spillway	50' Broad Crested Weir (Elevation 491.7 feet)

SECTION 4

OPERATION ACTIVITIES

NORMAL OPERATION

The Fly Ash Pond receives flow from sluice water used to transport coal combustion fly ash. The water is carried through a series of open ditches and eventually flows into a pond where the ash is settled out. The Fly Ash Pond level is regulated by two submersible pumps that discharge through two, six-inch diameter PVC pipes. The discharge from the Fly Ash Pond flows into the Bottom Ash Pond.

The Bottom Ash Pond receives discharge from the Fly Ash Pond and flow from sluice water used to transport coal combustion bottom ash. The Bottom Ash Pond also receives flow from the Combined Drain Sump (CDS) which collects drainage from approximately 154 acres of the plant facility. The Bottom Ash Pond outfall structure consists of an 8-ft diameter galvanized CMP skimmer and a 36-in diameter carbon steel pipe. Upstream, the 36-in diameter pipe is upturned to an elevation of 478.5-ft and the invert elevation on the downstream end is 472-ft. Two 36-in diameter motor operated butterfly valves are installed within the pipe. The outfall discharges to a canal running along the west boundary of the plant. A National Pollutant Discharge Elimination System (NPDES) permit is required at the discharge of the Bottom Ash Pond.

INSTRUMENTATION MONITORING DATA

There is a staff gage mounted at the skimmer in the Bottom Ash Pond. The staff gage is checked weekly to ensure that the reservoir level is at or below the standard operating level of 485-feet. The Fly Ash Pond does not have a staff gage.

TYPES OF ASH POND EMBANKMENT INSPECTIONS

Weekly visual inspections are conducted at the ash pond embankment by plant operations staff. The Ameren Missouri Dam Safety Group performs annual inspections with plant operations. In addition, the Ameren Missouri Dam Safety Group may conduct unannounced safety inspections. The following sections describe each type of inspection.

Pond water level elevations should be maintained in accordance with Table 1. At no time should the water levels be above the minimum required 2.5 foot freeboard.

Weekly Inspection:

Weekly inspections are conducted by plant staff or support staff familiar with the ash pond embankments. The weekly inspection consists of visually inspecting the crest and slopes of the ash pond embankment to identify any new or changed conditions. Checklists are completed and are made available to the Dam Safety Group for review. A recommended inspection checklist for the weekly inspection is included in ***Appendix A.***

Annual Inspection:

These inspections are conducted annually by the plant staff and the Ameren Missouri Dam Safety Group staff. The annual inspection is a detailed visual inspection of the Bottom Ash Pond and Fly Ash Pond. Items inspected include the embankment crest, interior and exterior slopes, downstream toe area, inlet/outlet works, and appurtenant structures. A recommended inspection checklist for the annual inspection is included in ***Appendix A.***

An inspection report is prepared by the Ameren Missouri Dam Safety Group staff that includes a description of the observations of the visual inspection, photographs of the facilities taken during the inspection, and a written evaluation of the results. A record of activities occurring at the ash pond embankment is to be kept current by the Ameren Missouri Dam Safety Group.

Special Inspection:

These inspections are conducted when extreme events which may impact stability (seismic activity, severe flooding, etc.). Special inspections are similar to the annual inspection, but may be focused on a particular area. If conditions are discovered during a weekly or annual inspection which create concern for the plant or dam safety staff, a special inspection will be conducted. Responsibility for performance of special inspections will be evaluated based on severity of the event. An annual inspection checklist (included in ***Appendix A***) can be utilized when conducting a special inspection**.**

Unannounced Inspections:

The Ameren Missouri Chief Dam Safety Engineer (CDSE) may conduct unannounced inspections at the site as deemed appropriate. The inspection may include a visual inspection of the facility, a review of the inspection documentation, and interviews with plant personnel to review their understanding of the required inspection procedure.

The inspection checklists are to be completed and filed for each inspection. Checklists for inspections are located in ***Appendix A.*** Condition codes are given to each item listed on the inspection checklist. The condition codes are defined below.

EC - Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.

Examples: Whirlpools, piping situation, embankment slough extending through half crest width, sinkhole in crest

IM - Item needing immediate maintenance to restore or ensure its safety or integrity. Remediation should be completed within 1 month.

Examples: Sinkhole on downstream slopes, gate of valve failure

MM - Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.

Examples: Crest rutting, rodent holes and animal burrows, tree growth on embankment slope, minor downstream embankment slough

OB - Condition requires regular observation to ensure that the condition does not become worse.

Examples: Minor seepage – No evidence of material movement

GC - Good Condition.

NE - No evidence of a problem.

NI - Not Inspected. Reason should be stated in comment.

SECTION 5

MAINTENANCE ACTIVITIES

Timely repairs are a must after problem areas have been identified. The Plant Engineer is to specify the work by generating a Job Request (JR) and provide direction to correct items noted in the operation and maintenance and engineering inspections. Prioritization of maintenance JR's should be reviewed with the Dam Safety Group to ensure proper emphasis has been placed on the JR. Such items include mowing, seeding, tree and brush removal, painting, replacing riprap, repairing fences and locks, clearing debris, etc. The maintenance activities specified in the following sections are minimum requirements. Maintenance activities should be documented. NOTE: NO alterations or repairs to structural elements should be made without the approval of the Chief Dam Safety Engineer.

Ash Pond Stacking: Ash may be temporarily stacked up to an elevation of 15 feet above the top levee elevation with the toe of the slope of the stacked ash a minimum of 125 feet from the existing ash containment levee. The ash stack slope shall be a minimum 3 horizontal to 1 vertical. No perched water level above the crest of the perimeter embankment is permissible.

Debris: Remove all trash, logs and other debris that may obstruct flow from the outlet works.

Concrete Block and Rip Rap: Replace or level blocks and rip rap as needed to provide adequate protection against erosion.

Vegetation Control:

(1) A good grass cover on the embankment should be maintained by seeding, fertilizing and mulching areas that are refilled, barren, or thinly vegetated. Seeding mixtures used for maintenance reseeding shall result in cover compatible with adjacent cover.

(2) Grassed areas such as the embankment and areas beyond the embankment toe for a distance of approximately 20 feet should be mowed at least twice annually, where physically accessible.

(3) All eroded areas should be filled and compacted, reseeded, fertilized and mulched to establish a thick erosion resistant cover.

(4) All trees and brush on the ash pond embankment should be removed to prevent development of a root system that could provide seepage paths. Herbicides utilized for tree and brush control are discussed in ***Appendix B***.

(5) All brush and trees should be removed to a distance of approximately 20 feet beyond the toe of the ash pond embankment, where physically accessible.

Animal Damage: Rodent holes should be filled with compacted clay dirt and reseeded. If rodents become a nuisance, an effective rodent control program as approved by the Missouri Department of Natural Resources District Wildlife Biologist should be implemented.

Concrete: Spalled and cracked areas on concrete structures should be patched to guard against any further deterioration of the structure. Concrete construction joints should be filled with a suitable joint filler, such as a bituminous sealant, to protect against weathering.

Drains: All drains and weep holes should be kept open and functional by cleaning them of silt and debris.

Painting: All metal work, fencing, railing, etc. should be properly prepared and repainted as necessary to protect against rusting.

Signs: All warning signs and staff gages should be maintained (repaired, painted, or replaced) as needed.

SECTION 6

EMERGENCY CONDITIONS

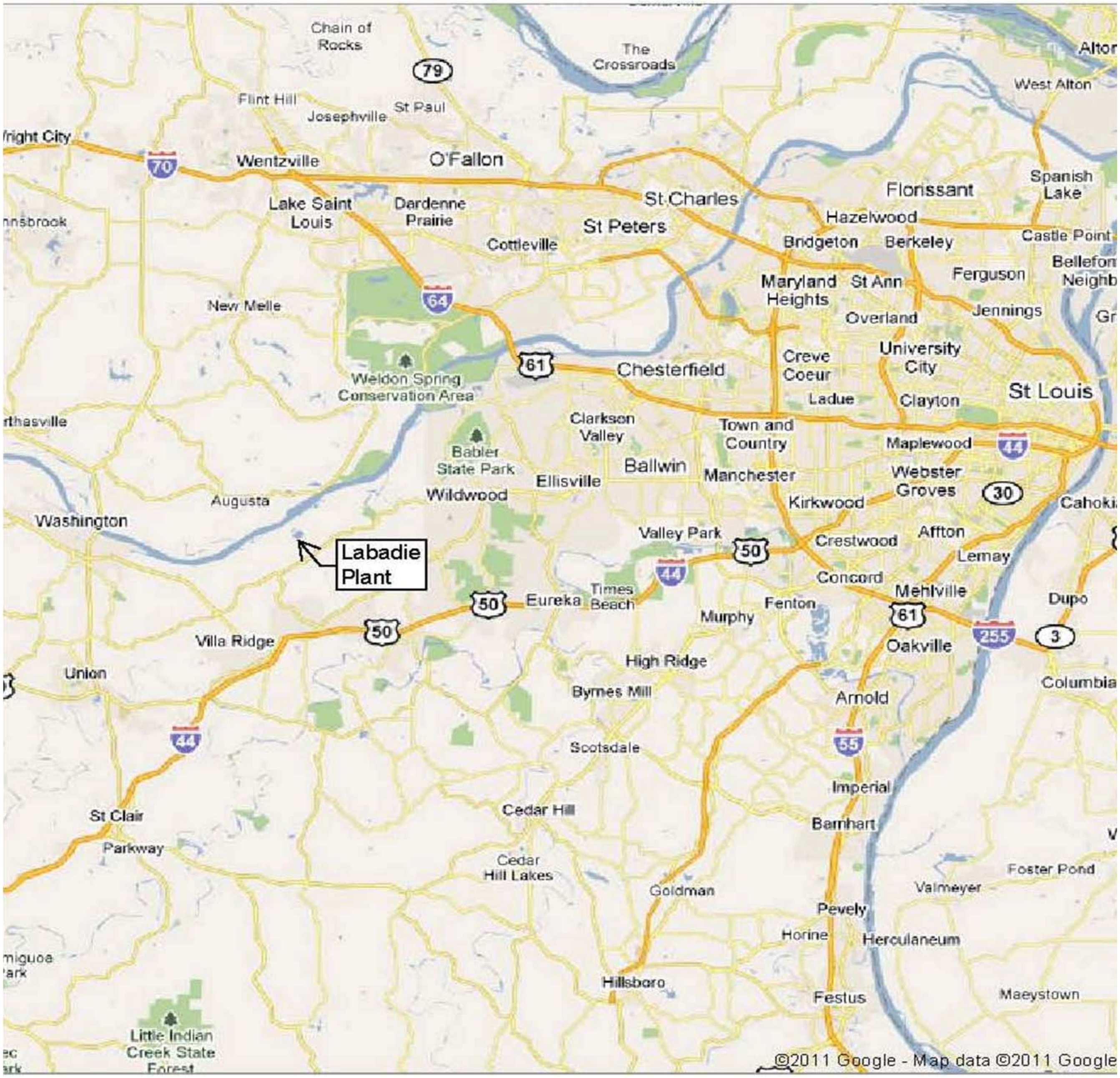
If a condition arises where there is a possibility of ash pond embankment failure, the following plan will be put into effect (Refs. Labadie Emergency Implementing Procedure LB -EIP-DAMINT-16 and LB-EIP-NOTIFY-17).

(1) The pond level will be lowered by the outlet structure, and the area will be closely monitored for changes in conditions. If the outlet structure should become inoperable, supplemental pumps will be used to lower the level of the pond.

(2) The following agencies would be notified by Ameren concerning the status of the ash pond embankment. These agencies will inform the public as to what action would be taken. Ameren will do whatever possible to minimize damage at downstream locations.

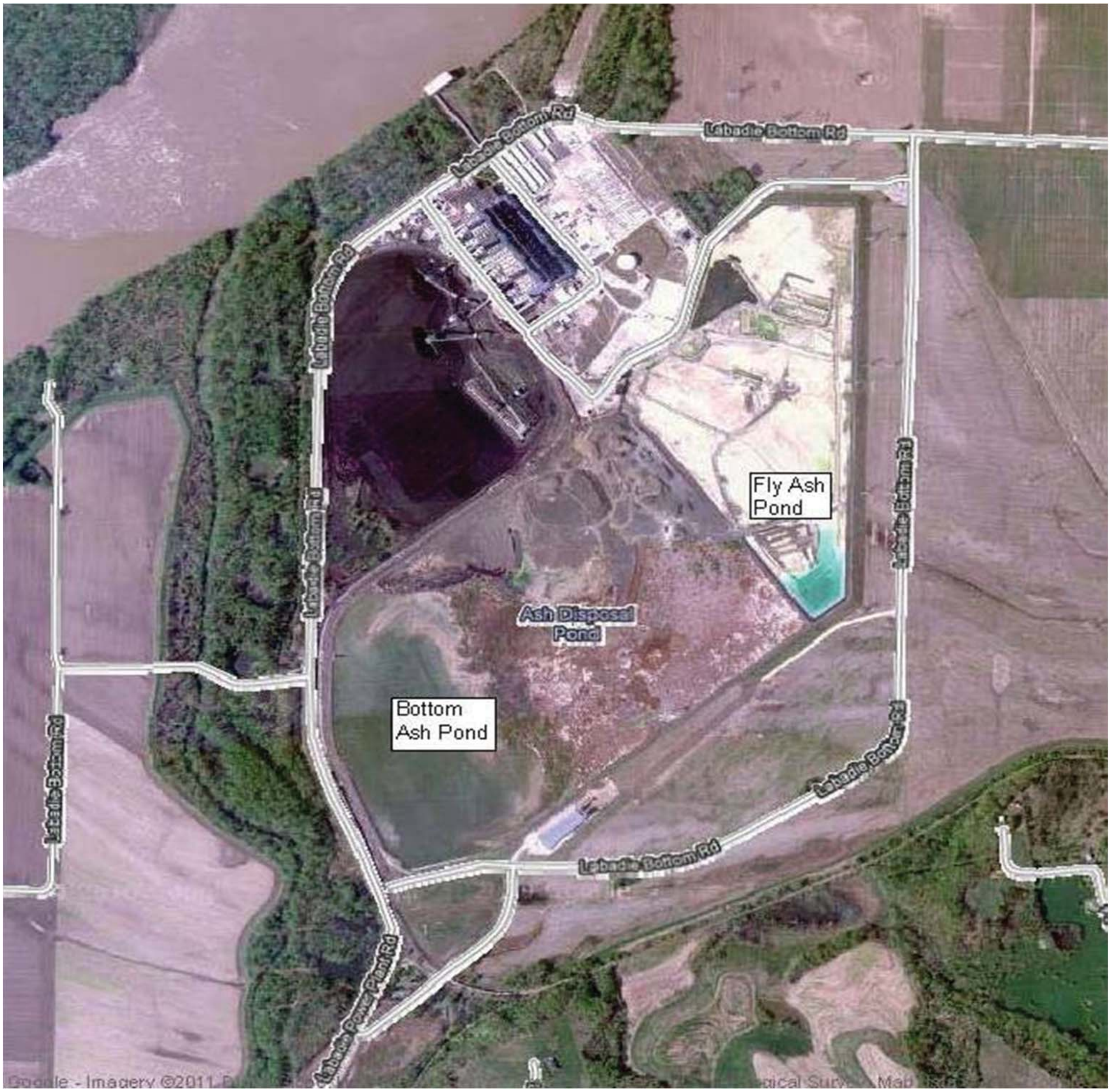
A. Franklin County Sheriff	636-583-2560
B. Franklin County Emergency Management	636-583-1679
C. MDNR –Dam Safety	573-368-2175
D. Army Corps of Engineers (St. Louis District)	314-331-8567
E. Ameren Chief Dam Safety Engineer	314-210-4356

FIGURES



©2011 Google - Map data ©2011 Google

Location Map
Labadie Power Plant
Labadie, MO



Aerial View
Labadie Power Plant
Labadie, MO

APPENDIX A

INSPECTION CHECKLISTS

Fly Ash Pond

Annual Inspection Checksheet

Date	
Inspector	
Lake Level	
Temperature	
Weather	

	Item	Condition Code *	Comments
Inlet and Outlet	Obstruction		
	Inlet Piping Supports		
	Leakage		
	Outfall Condition		
	Outfall Gate		
	Other		
Earth Embankment	Vertical & Horizontal Alignment of Crest		
	Liner		
	Seepage		
	Erosion		
	Fencing		
	Vegetation		
	Unusual Movement or Cracking At or Beyond Toe		
	Other		

Condition Codes

EC = Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work
IM = Item needing immediate maintenance to restore or ensure its safety or integrity. Remediation should be completed within 1 month.
MM = Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.
OB = Condition requires regular observation to ensure that the condition does not become worse.
GC = Good Codition.
NE = No evidence of a problem.
NI = Not Inspected. Reason should be stated in comment

Bottom Ash Pond

Annual Inspection Checksheet

Date	
Inspector	
Lake Level	
Temperature	
Weather	

	Item	Condition Code *	Comments
Inlet and Outlet	Obstruction		
	Inlet Piping Supports		
	Leakage		
	Outfall Concrete Condition		
	Outfall Valve		
	Other		
Earth Embankment	Vertical & Horizontal Alignment of Crest		
	Liner		
	Seepage		
	Erosion		
	Fencing		
	Vegetation		
	Unusual Movement or Cracking At or Beyond Toe		
	Other		

Condition Codes

EC = Emergency Condition. A serious dam safety condition exists that needs immediate action.
IM = Item needing immediate maintenance to restore or ensure its safety or integrity. Remediation should
MM = Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is
OB = Condition requires regular observation to ensure that the condition does not become worse.
GC = Good Codition.
NE = No evidence of a problem.
NI = Not Inspected. Reason should be stated in comment

Labadie Fly Ash Pond

Weekly Inspection Checksheet

Date	
Inspector	
Lake Level	
Temperature	
Weather	

	Item	Condition Code *	Comments
Inlet / Outlet	Structure / Supports		
	Outfall Condition		
	Other		
Earth Embankment	Vertical & Horizontal Alignment of Crest		
	Pond Liner		
	Seepage		
	Erosion		
	Vegetation		
	Unusual Movement or Cracking		
	Other		

Condition Codes

EC = Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.

IM = Item needing immediate maintenance to restore or ensure its safety or integrity. Remediation should be completed within 1 month.

MM = Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.

OB = Condition requires regular observation to ensure that the condition does not become worse.

GC = Good Codition.

NE = No evidence of a problem.

NI = Not Inspected. Reason should be stated in comment

Labadie Bottom Ash Pond

Weekly Inspection Checksheet

Date	
Inspector	
Lake Level	
Temperature	
Weather	

	Item	Condition Code *	Comments
Inlet and Outlet	Obstruction		
	Structure / Supports		
	Leakage		
	Outfall Condition		
	Other		
Earth Embankment	Vertical & Horizontal Alignment of Crest		
	Seepage (known seepage at SWC)		
	Erosion		
	Vegetation		
	Unusual Movement or Cracking		
	Other		

Condition Codes

EC = Emergency Condition. A serious dam safety condition exists that needs immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.

IM = Item needing immediate maintenance to restore or ensure its safety or integrity. Remediation should be completed within 1 month.

MM = Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.

OB = Condition requires regular observation to ensure that the condition does not become worse.

GC = Good Codition.

NE = No evidence of a problem.

NI = Not Inspected. Reason should be stated in comment

APPENDIX B

HERBICIDES

HERBICIDES

Site personnel should check with the Missouri Department of Natural Resources, Regional Fisheries Biologist and the Regional Wildlife Biologist before using any herbicide. Read the product label prior to use and follow the use directions and precautions accordingly.

On March 1, 1979 the U.S. Environmental Protection Agency (U.S.E.P.A.) halted the use of the herbicide 2, 4, 5-T in parks and recreation areas. The use of silvex (2, 4, 5-TP) around water has also been banned.

Some examples of approved herbicides are:

1)	Tordon RTU by DOW Chemical. (Can be obtained with blue dye.)
2)	WEEDONE 170 by Union Carbide
3)	WEEDONE, 2, 4-DP by Union Carbide
4)	A 1% to 2% solution of ROUNDUP
5)	Garlon by DOW Chemical
6)	Banvel by Sandoz

Your distributor may carry brand name herbicides other than those listed above. Be certain that the product does not contain the ingredients 2, 4, 5-T or 2, 4, 5-TP. An example of an unacceptable product is ESTERON 2, 4, 5 by DOW Chemical.

APPENDIX C

SUPPLEMENTAL CALCULATIONS

Engineering Design Calculations Form – GEN-FRM-ADM-3205-01

(Calculations Performed By Ameren)

Section 1

Calculation Number: LB-CALC-000068

Plant / Station: Labadie Energy Center

Project Title & ID: Labadie Fly Ash and Bottom Ash Pond Emergency Spillway

Description: Calculate Peak Discharge and Size Emergency Spillway for Fly Ash and Bottom Ash Pond

Date: May 5, 2012	**Rev.:** 0
Calculation Performed by: Gene Campbell	**Company:** *Ameren Missouri*
Independent Reviewer: Matt Balven	**Company:** *Ameren Missouri*

Section 2

Index:

Design Control Number (DCN) (If Applicable): LB-2012-DC-0005

Design Assumptions: See Calculation

List Formula(s): See Calculation

Define Symbols: See Calculation

Define Units: See Calculation

Reference Material: See Calculation

Computer Generated Information: See Calculation

Section 3

Calculation Performed By: Gene Q. Campbell
Signature
Date: 5/7/2012

Independent Reviewer: Matthew B. Balven
Signature
Date: 5/7/2012

Supervisor:
Signature
Date: 5/7/2012

Engineering Design Calculations Form Instructions (Calculations Performed By Ameren)

(GEN-FRM-ADM3205-01)
Page 1 of 2

Section 1

Calculation No: *Enter the unique calculation number as assigned by the Electronic Document Management System (EDMS).*

Plant: *Identify name of power plant / station.*

Project Title & ID: *Enter the project title or study title and Project ID (WO) number that calculation is associated with.*

Description: *Define the scope of the calculation, including the reason for the calculation, description of constraints, and the design objectives.*

Date: *Provide the date the calculation was initiated.*

Rev.: *Provide current revision for the calculation.*

Calculation Performed By / Company: *Identify who performed the calculation and the name of the company for which they work.*

Independent Reviewer / Company: *Identify who was assigned to perform the independent review of the calculation and associated documentation and the name of the company for which they work.*

Section 2

Index: *Provide an index on the first page.*

Design Assumptions: *List design assumptions on the first page.*

List Formulas: *List any formulas that were used in the performance of the calculation(s).*

Define Symbols: *List and define symbols used.*

Define Units: *List and define units used.*

Design Basis Review: *Perform a review of the existing design basis documentation. If the design basis documentation does not exist or is inadequate, then address this per* GEN-ADM-3203, *Design Basis. Ensure that the new design basis documentation is filed and/or submitted to the Document Control Administrator per* GEN-ADM-2100, *Document Control. The Document Control Number (DCN) shall be recorded on the Engineering Design Calculations Form – GEN-FRM-ADM3205-01.*

Perform Calculations: *Perform calculation; ensuring calculation is neat and legible.*

Number Pages: *Ensure that the pages are numbered in the proper order to align with the above Index*

Engineering Design Calculations Form Instructions (Calculations Performed By Ameren)

(GEN-FRM-ADM3205-01)
Page 2 of 2

Reference Material: *If applicable, include copies of reference material (codes, standards, catalogs, other handwritten or computer calculations, other inputs to the calculation, etc.).*

Computer-Generated Information: *If applicable, document the computer software used, version number and any applicable certification for computer generated calculations. Label copies of computer-generated information such as tables, graphs, input and output data, etc., and include them at the end of the calculation.*

Self-Check: *When the calculation package is complete, the engineer performs a self-check of the package. When the self-check is complete, submit the calculation package to an Independent Reviewer.*

Independent Review: *Independent Reviewer checks the calculation package for completeness, technical accuracy and compliance with applicable codes, laws and regulations; industry standards; specific project requirements (including acceptable margins of safety); Ameren standards and policies; and stated assumptions. Special, intricate or unusual designs shall be checked in detail.*

Reconcile and Review: *If necessary, the engineer reconciles the Independent Reviewer's comments, revises the calculation package, and initials and dates the revisions.*

P.E. Seal: *If required, the engineer provides or obtains a Professional Engineer's Seal on the package.*

Section 3

Calculation Performed By / Date: *Signature and date of the engineer who performed the calculation.*

Independent Reviewer / Date: *Signature and date of the Independent Reviewer.*

Supervisor / Date: *Signature and date of the Supervisor. Supervisor Reviews to ensure calculation has been prepared and processed in accordance with this procedure.*

Calculation Review Form – GEN-FRM-ADM3205-03

Date: May 5, 2012

Calculation Number: LB-CALC-000068 **Revision:** 0

Calculation Performed by: Gene Campbell **Company:** Ameren Missouri

Independent Reviewer: Matt Balven **Company:** Ameren Missouri

Comment Number	Page Number	Comment (Independent Reviewer)	Comment Resolution (Original Preparer)
1	2 & 17	Include stone sizing chart	

Independent Reviewer: Matthew E. Balven **Date:** 5/7/12

Signature

Ameren Dam Safety & Hydro Engineering

PROJECT Fly Ash and Bottom Ash Pond Emergency Spillway			
NAME Gene Campbell		**DATE**	
CHK'D. Matt Balven		**DATE**	
SUBJECT Labadie Fly Ash and Bottom Ash Pond Emergency Spillway Design		**W.O. #** 0A263	
LOCATION Labadie Energy Center		**SHEET** 1 **OF** 30	

Fly Ash Pond

Install an Emergency Overflow Spillway on the South West Corner of the Fly Ash Pond.

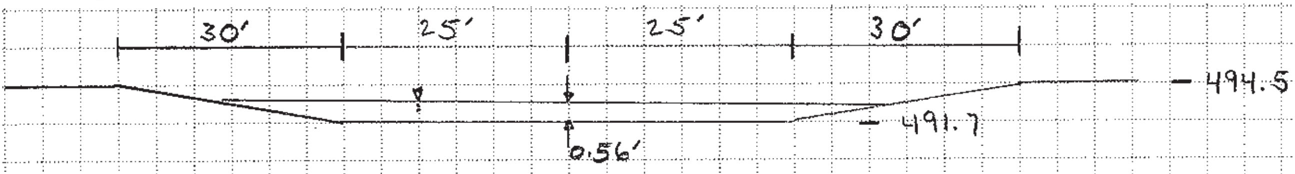
Watershed Area = 79 Acres
Low Elevation = 492.70 ft.
Area of Pond at Overtopping = 62.4 Acres
Design Flood = 100 yr. 24 hr. Storm
CN = 98 (WinTR-55 Limitation)
tc = 0.1 hr (WinTR-55 Limitation)
Assume no Discharge from Outfall
Assume 14-cfs Sluice Water from Plant

-Try 50 Foot Long Broad Crested Emergency Spillway @ 491.70 ft. which is 12" below the lowest spot of the existing levee.

-Peak Outflow = 44.68 cfs (WinTR-55) + 14 cfs (Plant Sluice) = 58.68 cfs

- A 50' Broad Crested Emergency Spillway will peak at 492.26 ft.

-Recommend using a 50' Long Emergency Spillway with trafficable side slopes.



FOR MAX FLOW OF $Q = 58.68$ cfs AND DEPTH $D = 0.56$

FLOW AREA $= (50ft)(0.56ft) + (2)(0.5)(0.56ft)(6ft) = 31.4 ft^2$

Dam Safety & Hydro Engineering

PROJECT Fly Ash and Bottom Ash Pond Emergency Spillway

NAME Gene Campbell **DATE**

CHK'D. Matt Balven **DATE**

SUBJECT Labadie Fly Ash and Bottom Ash Pond Emergency Spillway Design

W.O. # 0A263

LOCATION Labadie Energy Center

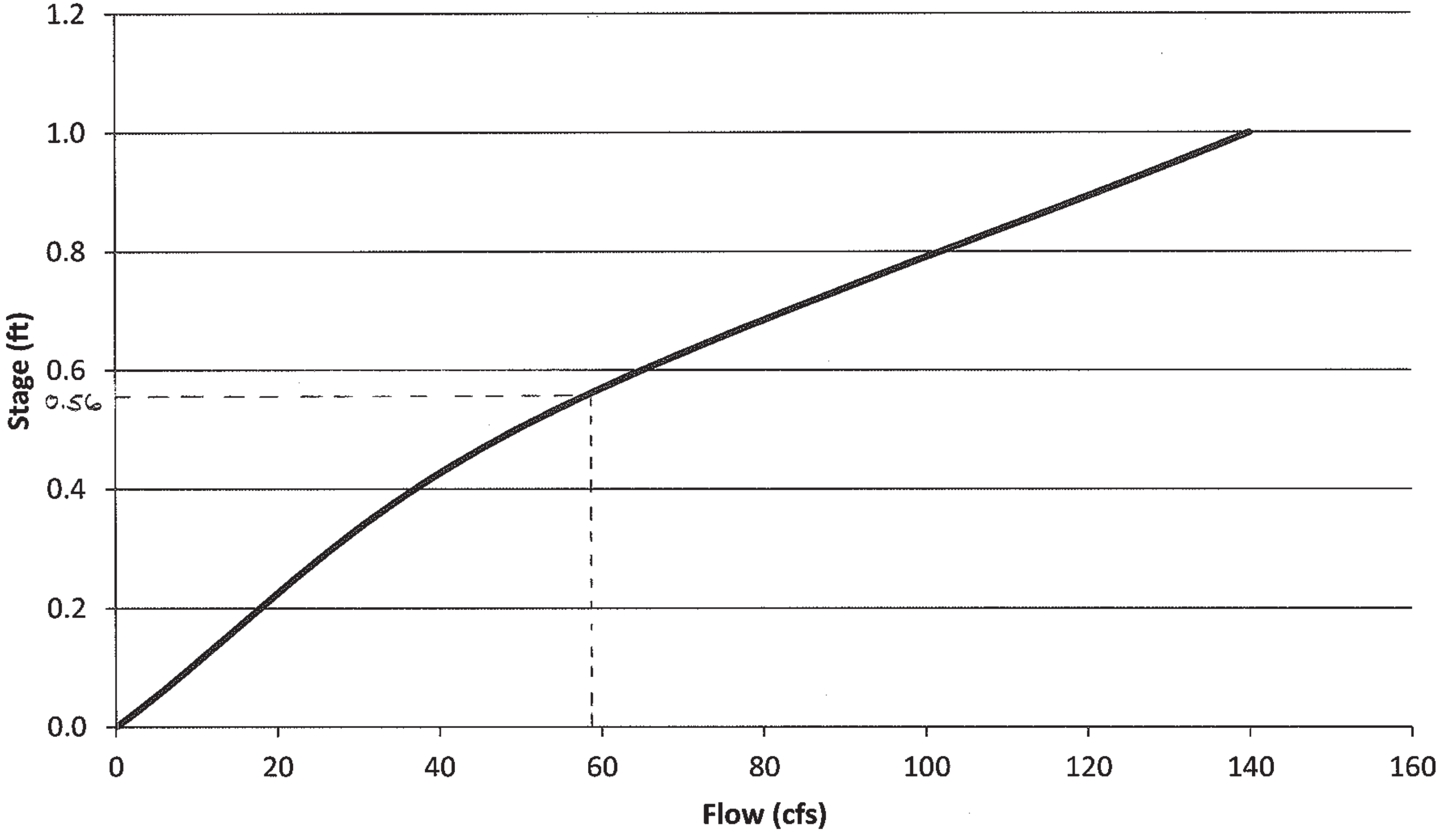
SHEET 2 **OF** 30

APPROACH VELOCITY $V = Q/A$

$V = \frac{58.68\ ft^3/s}{31.4\ ft^2} = \underline{\underline{1.87\ ft/s}}$ ∴ USE 4" STONE PROPERLY BEDDED + NESTED W/ FILLER

3/30

Fly Ash Pond Weir Rating Curve



```
                     WinTR-55 Current Data Description

                         --- Identification Data ---


User:     G Campbell                              Date:         05/03/2012
Project:  Labadie Spillway                        Units:        English
SubTitle: Fly Ash Pond                            Areal Units: Acres
State:    Missouri
County:   Franklin
Filename: G:\Hydro_DamSafety\Dam Safety & Hydro Engineering\Labadie\Projects\0A263_Labadie Spillway\


                           --- Sub-Area Data ---

Name          Description           Reach        Area(ac)      RCN     Tc
--------------------------------------------------------------------------
Fly Ash       Pond                  ES              79          98    0.100

Total area: 79 (ac)


                           --- Storm Data  --

                 Rainfall Depth by Rainfall Return Period

  2-Yr       5-Yr       10-Yr      25-Yr      50-Yr      100-Yr      1-Yr
  (in)       (in)       (in)       (in)       (in)       (in)        (in)
----------------------------------------------------------------------------
   3.5        4.5        5.1        5.8        6.5        7.2         3.0


Storm Data Source:               Franklin County, MO  (NRCS)
Rainfall Distribution Type:      Type II
Dimensionless Unit Hydrograph:   <standard>
```

5/30

G Campbell

Labadie Spillway
Fly Ash Pond
Franklin County, Missouri

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.5	4.5	5.1	5.8	6.5	7.2	3.0

Storm Data Source: Franklin County, MO (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

```
G Campbell                       Labadie Spillway
                                   Fly Ash Pond
                              Franklin County, Missouri

                                Watershed Peak Table


 Sub-Area              Peak Flow by Rainfall Return Period
 or Reach  ANALYSIS:
Identifier     (cfs)
---------------------------------------------------------------------------------
SUBAREAS
Fly Ash       728.55


REACHES
ES            728.55
    Down       44.68


OUTLET         44.68
```

```
G Campbell                     Labadie Spillway
                                 Fly Ash Pond
                           Franklin County, Missouri

                       Hydrograph Peak/Peak Time Table

 Sub-Area       Peak Flow and Peak Time (hr) by Rainfall Return Period
 or Reach  ANALYSIS:
Identifier     (cfs)
             (hr)
-----------------------------------------------------------------------------------
SUBAREAS
Fly Ash       728.55
           11.93


REACHES
ES            728.55
           11.93
    Down       44.68
           12.75


OUTLET         44.68
```

```
G Campbell                       Labadie Spillway
                                   Fly Ash Pond
                                Franklin County, Missouri

                                 Structure Output Table

Reach             Peak Flow (PF), Storage Volume (SV), Stage (STG)
 Identifier                by Rainfall Return Period
Structure
 Identifier ANALYSIS:
--------------------------------------------------------------------------------
Reach: ES
Weir : ES
 50(ft)
  PF   (cfs)     44.68
  SV (ac ft)     26.88
  STG   (ft)       .45
```

9/30

```
G Campbell                        Labadie Spillway
                                    Fly Ash Pond
                               Franklin County, Missouri

                                Sub-Area Summary Table

 Sub-Area   Drainage    Time of     Curve  Receiving     Sub-Area
Identifier    Area   Concentration Number    Reach      Description
              (ac)       (hr)
--------------------------------------------------------------------------------
Fly Ash        79.00     0.100       98     ES         Pond

Total Area:   79 (ac)
```

10/30

```
G Campbell                    Labadie Spillway
                                Fly Ash Pond
                           Franklin County, Missouri

                             Reach Summary Table


               Receiving     Reach         Routing
  Reach          Reach       Length        Method
Identifier    Identifier      (ft)
----------------------------------------------------------------------

  ES            Outlet                     STRUCTURE(ES)
```

```
G Campbell                        Labadie Spillway
                                    Fly Ash Pond
                                Franklin County, Missouri

                         Sub-Area Time of Concentration Details

 Sub-Area     Flow                Mannings's    End     Wetted                Travel
Identifier/  Length     Slope        n         Area    Perimeter   Velocity    Time
              (ft)     (ft/ft)               (sq ft)     (ft)      (ft/sec)    (hr)
--------------------------------------------------------------------------------------
Fly Ash
  User-provided                                                                0.100

                                                      Time of Concentration    0.100
                                                                              ========
```

12/30

```
G Campbell                           Labadie Spillway
                                       Fly Ash Pond
                                 Franklin County, Missouri

                        Sub-Area Land Use and Curve Number Details

 Sub-Area                                          Hydrologic  Sub-Area   Curve
Identifier          Land Use                          Soil       Area     Number
                                                      Group      (ac)
--------------------------------------------------------------------------------
Fly Ash   CN directly entered by user                  -          79        98

          Total Area / Weighted Curve Number                       79        98
                                                                   ==        ==
```

```
G Campbell                    Labadie Spillway
                                Fly Ash Pond
                            Franklin County, Missouri

                           Reach Channel Rating Details

  Reach        Reach        Reach         Friction       Bottom       Side
 Identifier    Length      Manning's       Slope         Width        Slope
                (ft)          n           (ft/ft)         (ft)
------------------------------------------------------------------------------

  ES           (This reach is a structure: ES)

  Reach                                     End           Top       Friction
 Identifier    Stage         Flow          Area          Width       Slope
                (ft)         (cfs)        (sq ft)         (ft)      (ft/ft)
------------------------------------------------------------------------------
  ES           (This reach is a structure: ES)
```

```
G Campbell                      Labadie Spillway
                                  Fly Ash Pond
                             Franklin County, Missouri

                         Structure Description - User Entered

               Surface      Height     Surface
  Reach        Area @       Above      Area @        Pipe      Head on    Weir
 Identifier     Crest       Crest      Ht Above     Diameter    Pipe      Length
                (ac)         (ft)       (ac)         (in)       (ft)       (ft)
-------------------------------------------------------------------------------

  ES
                58.6          1         62.4                               50
```

```
G Campbell                      Labadie Spillway
                                  Fly Ash Pond
                            Franklin County, Missouri

                        Structure Rating Details - Computed

   Reach                       Pool                  Flows (cfs) @ Weir Length
 Idendifier    Stage          Storage      Length #1     Length #2     Length #3
               (ft)           (ac ft)        50ft          ft            ft
-------------------------------------------------------------------------------
ES               0              0.00         0.000
               0.5             29.78        49.497
                 1             60.50       140.000
                 2            124.80       395.980
                 5            340.50      1565.248
                10            776.00      4427.189
                20           1932.00     12521.981
```

Ameren Dam Safety & Hydro Engineering

PROJECT Fly Ash and Bottom Ash Pond Emergency Spillway

NAME Gene Campbell **DATE**

CHK'D. Matt Balven **DATE**

SUBJECT Labadie Fly Ash and Bottom Ash Pond Emergency Spillway Design **W.O. #** 0A263

LOCATION Labadie Energy Center **SHEET** 16 OF 30

Bottom Ash Pond

Install an Emergency Overflow Spillway on the South Side of the Bottom Ash Pond.

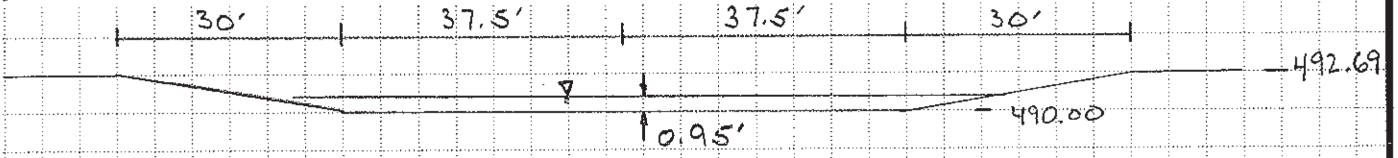
Watershed Area = 308 Acres
Low Elevation = 492.69 ft.
Area of Pond at Overtopping = 123.5 Acres
Design Flood = 100 yr. 24 hr. Storm
CN = 98 (WinTR-55 Limitation)
tc = 0.1 hr (WinTR-55 Limitation)
Peak Discharge from Fly Ash Pond = 58.68 cfs
Assume no Discharge from Outfall
Assume 14-cfs Sluice Water from Plant
Assume 50-cfs from Plant CDS

-Try 75 foot Long Broad Crested Emergency Spillway @ 490.00 ft.

-Peak Outflow = 72.55 cfs (WinTR-55) + 14 cfs (Plant Sluice) + 50 cfs (Plant CDS)+ 58.68 cfs (Fly Ash Pond) = 195.23 cfs

- A 75' Broad Crested Emergency Spillway will peak at 490.95 ft.

-Recommend using a 75' Long Emergency Spillway with trafficable side slopes.



Ameren **Dam Safety & Hydro Engineering**

PROJECT Fly Ash and Bottom Ash Pond Emergency Spillway

NAME Gene Campbell **DATE**

CHK'D. Matt Balven **DATE**

SUBJECT Labadie Fly Ash and Bottom Ash Pond Emergency Spillway Design **W.O. #** 0A263

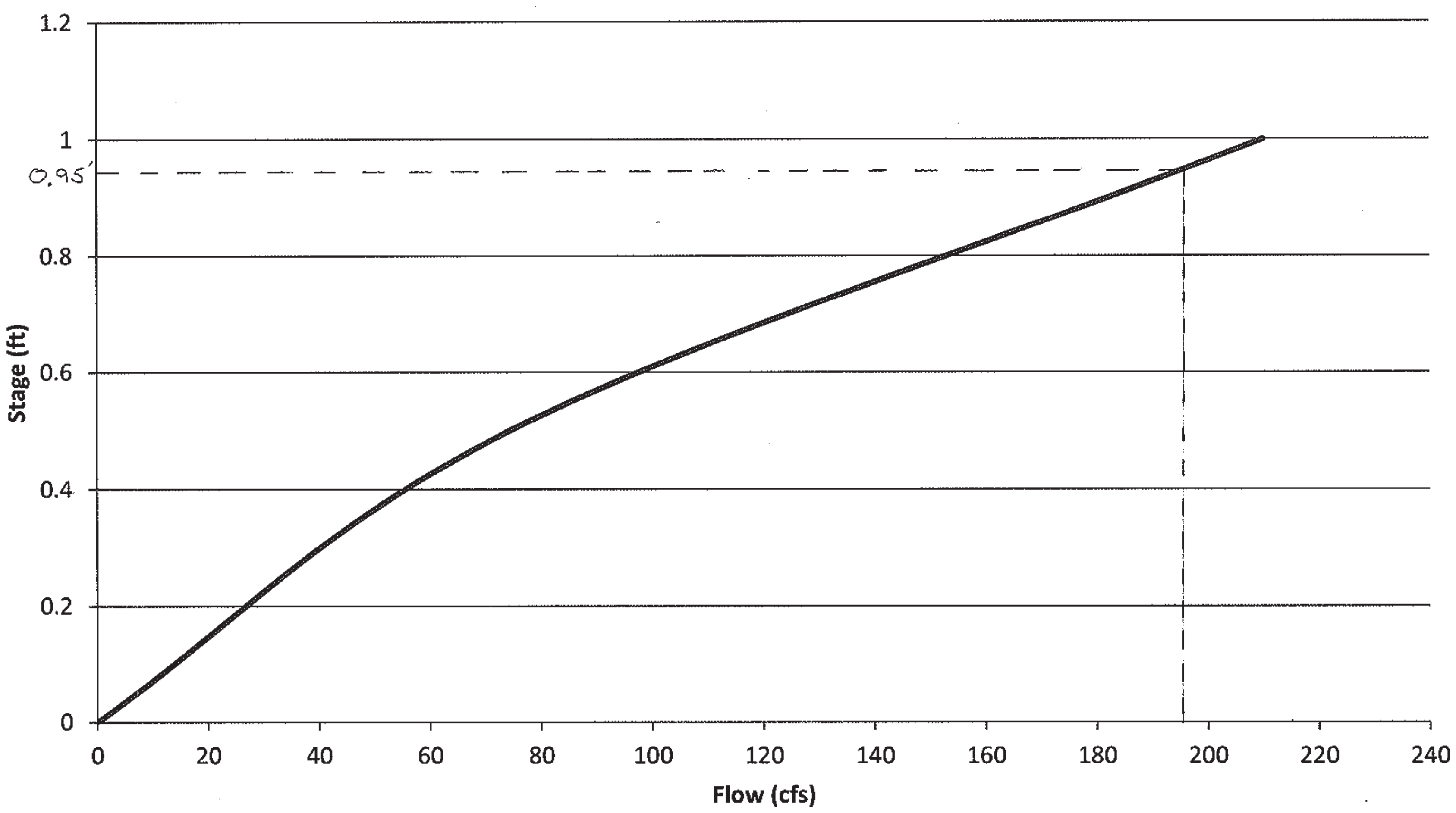
LOCATION Labadie Energy Center **SHEET** $\overset{17}{2}$ **OF** 30

FOR MAX FLOW $Q = 195.23$ cfs AND DEPTH $D = 0.95$

FLOW AREA $= (75ft)(0.95) + (2)(0.5)(0.95')(10.6ft) = 81.3ft^2$

APPROACH VELOCITY $V = \frac{195.23\ cfs}{81.3ft^2} = 2.4$ ft/s ∴ USE 4" STONE PROPERLY BEDDED AND NESTED W/ FILLER.

Bottom Ash Pond Weir Rating Curve



19/30

```
                         WinTR-55 Current Data Description

                             --- Identification Data ---


User:      G Campbell                                Date:         05/03/2012
Project:   Labadie Spillway                          Units:        English
SubTitle:  Bottom Ash Pond                           Areal Units: Acres
State:     Missouri
County:    Franklin
Filename:  G:\Hydro_DamSafety\Dam Safety & Hydro Engineering\Labadie\Projects\0A263_Labadie Spillway\


                               --- Sub-Area Data ---

Name           Description              Reach       Area(ac)     RCN     Tc
-------------------------------------------------------------------------------
Bottom Ash    Pond                     ES             154          98    0.100

Total area: 154 (ac)


                               --- Storm Data  --

                   Rainfall Depth by Rainfall Return Period

   2-Yr        5-Yr        10-Yr       25-Yr       50-Yr       100-Yr      1-Yr
   (in)        (in)        (in)        (in)        (in)        (in)        (in)
---------------------------------------------------------------------------------
   3.5         4.5         5.1         5.8         6.5         7.2         3.0


Storm Data Source:               Franklin County, MO  (NRCS)
Rainfall Distribution Type:      Type II
Dimensionless Unit Hydrograph:   <standard>
```

G Campbell

Labadie Spillway
Bottom Ash Pond
Franklin County, Missouri

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.5	4.5	5.1	5.8	6.5	7.2	3.0

Storm Data Source:	Franklin County, MO (NRCS)
Rainfall Distribution Type:	Type II
Dimensionless Unit Hydrograph:	<standard>

```
G Campbell                      Labadie Spillway
                                 Bottom Ash Pond
                             Franklin County, Missouri

                               Watershed Peak Table


 Sub-Area           Peak Flow by Rainfall Return Period
 or Reach  ANALYSIS:
Identifier     (cfs)
-----------------------------------------------------------------------------------
SUBAREAS
Bottom Ash   1420.22


REACHES
ES           1420.22
    Down       72.55


OUTLET         72.55
```

22/30

```
G Campbell                      Labadie Spillway
                                Bottom Ash Pond
                            Franklin County, Missouri

                        Hydrograph Peak/Peak Time Table

 Sub-Area       Peak Flow and Peak Time (hr) by Rainfall Return Period
 or Reach  ANALYSIS:
Identifier     (cfs)
            (hr)
-----------------------------------------------------------------------------------
SUBAREAS
Bottom Ash   1420.22
           11.93


REACHES
ES           1420.22
           11.93
    Down       72.55
           13.00


OUTLET         72.55
```

23/30

```
G Campbell                       Labadie Spillway
                                 Bottom Ash Pond
                             Franklin County, Missouri

                              Structure Output Table

Reach            Peak Flow (PF), Storage Volume (SV), Stage (STG)
 Identifier               by Rainfall Return Period
Structure
 Identifier ANALYSIS:
--------------------------------------------------------------------------------
Reach: ES
Weir : ES
 75(ft)
  PF   (cfs)      72.55
  SV (ac ft)      54.80
  STG   (ft)        .49
```

24/30

```
G Campbell                     Labadie Spillway
                               Bottom Ash Pond
                           Franklin County, Missouri

                            Sub-Area Summary Table

 Sub-Area  Drainage     Time of     Curve  Receiving     Sub-Area
Identifier   Area    Concentration Number    Reach      Description
             (ac)        (hr)
------------------------------------------------------------------------------
Bottom Ash    154.00      0.100        98     ES          Pond

Total Area:   154 (ac)
```

```
G Campbell                    Labadie Spillway
                              Bottom Ash Pond
                            Franklin County, Missouri

                              Reach Summary Table

              Receiving    Reach        Routing
  Reach        Reach       Length       Method
Identifier   Identifier     (ft)
----------------------------------------------------------------------

  ES            Outlet                  STRUCTURE(ES)
```

```
G Campbell                     Labadie Spillway
                               Bottom Ash Pond
                            Franklin County, Missouri

                     Sub-Area Time of Concentration Details

 Sub-Area      Flow              Mannings's    End     Wetted                 Travel
Identifier/   Length    Slope        n         Area   Perimeter   Velocity   Time
               (ft)    (ft/ft)               (sq ft)    (ft)      (ft/sec)    (hr)
--------------------------------------------------------------------------------

Bottom Ash
  User-provided                                                               0.100

                                                Time of Concentration         0.100
                                                                           ========
```

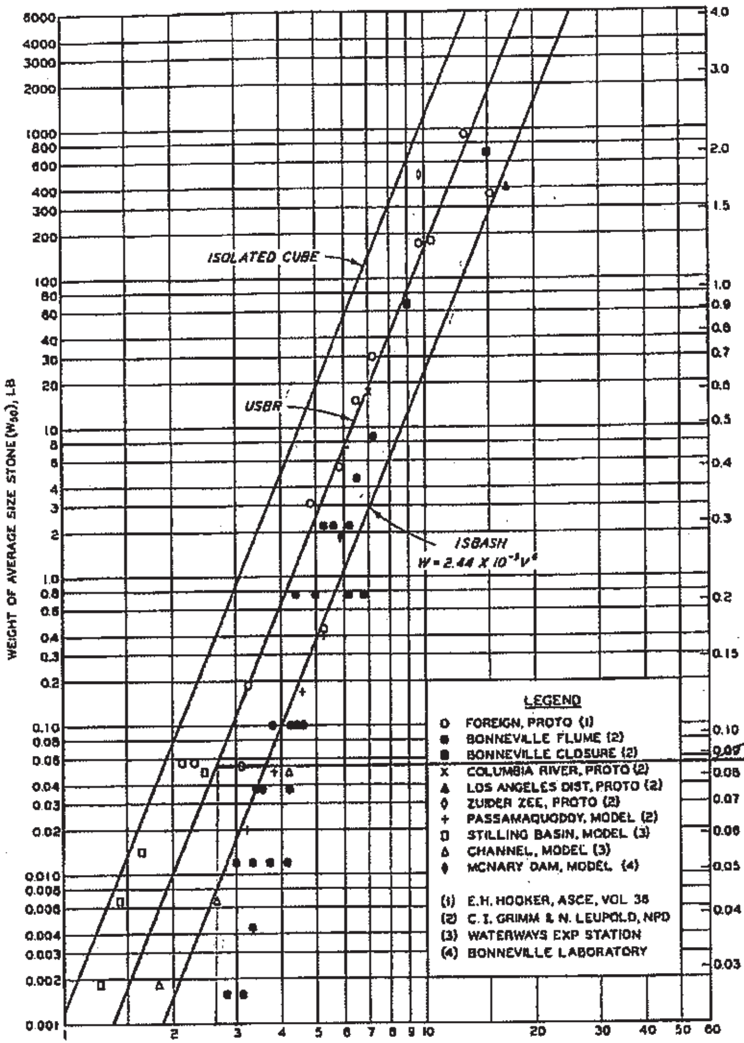
```
G Campbell                    Labadie Spillway
                              Bottom Ash Pond
                          Franklin County, Missouri

                  Sub-Area Land Use and Curve Number Details

 Sub-Area                                           Hydrologic   Sub-Area   Curve
Identifier           Land Use                          Soil        Area     Number
                                                       Group       (ac)
--------------------------------------------------------------------------------
Bottom AshCN directly entered by user                   -          154        98

          Total Area / Weighted Curve Number                        154        98
                                                                    ===        ==
```

```
G Campbell                        Labadie Spillway
                                  Bottom Ash Pond
                              Franklin County, Missouri

                            Reach Channel Rating Details

  Reach        Reach        Reach        Friction      Bottom     Side
 Identifier    Length      Manning's      Slope        Width      Slope
                (ft)          n          (ft/ft)        (ft)
--------------------------------------------------------------------------------

  ES          (This reach is a structure: ES)

  Reach                                    End         Top      Friction
 Identifier    Stage        Flow          Area        Width      Slope
                (ft)        (cfs)        (sq ft)       (ft)      (ft/ft)
--------------------------------------------------------------------------------
  ES          (This reach is a structure: ES)
```

```
G Campbell                    Labadie Spillway
                              Bottom Ash Pond
                          Franklin County, Missouri

                    Structure Description - User Entered

              Surface     Height     Surface
  Reach       Area @      Above      Area @       Pipe      Head on    Weir
 Identifier    Crest      Crest      Ht Above    Diameter    Pipe      Length
               (ac)        (ft)       (ac)        (in)       (ft)       (ft)
--------------------------------------------------------------------------------

  ES
                111        2.69       123.5                               75
```

```
G Campbell                        Labadie Spillway
                                  Bottom Ash Pond
                              Franklin County, Missouri

                        Structure Rating Details - Computed


   Reach                      Pool                 Flows (cfs) @ Weir Length
 Idendifier   Stage         Storage      Length #1      Length #2      Length #3
              (ft)          (ac ft)        75ft            ft             ft
--------------------------------------------------------------------------------
ES                0           0.00          0.000
                0.5          56.08         74.246
                  1         113.32        210.000
                  2         231.29        593.970
                  5         613.09       2347.871
                 10        1342.34       6640.783
                 20        3149.37      18782.971
```

~~Sheet 8 of~~



=1"+

2.5 fps.

NOTE: SPECIFIC WEIGHT OF ROCK = 165 LB/CU FT.
*FOR STONE PROTECTION BELOW ENERGY DISSIPATORS USE AS AVERAGE VELOCITY ACROSS END SILL.

VELOCITY VS STONE WEIGHT

SEE TEXT PAGE 35

Plate 29

APPENDIX D

PROJECT DRAWINGS

PRINT DIST.

REVISIONS

REV.	W.O.	
0	E107	

FIRST ISSUE

REV.	DATE	DRAFT
1	040992	MSB
CHKD.	**SUPV.**	**APPD.**
NOT	SKO	CWR
W.O.		**FILM.**
E107		

ADD. NOTE-1 AND MONITORING WELLS NOTE

REV.	DATE	DRAFT
2	042292	MSB
CHKD.	**SUPV.**	**APPD.**
NOT	SKO	CWR
W.O.		**FILM.**
E107		

ADD. LINER ANCHORING DETAILS

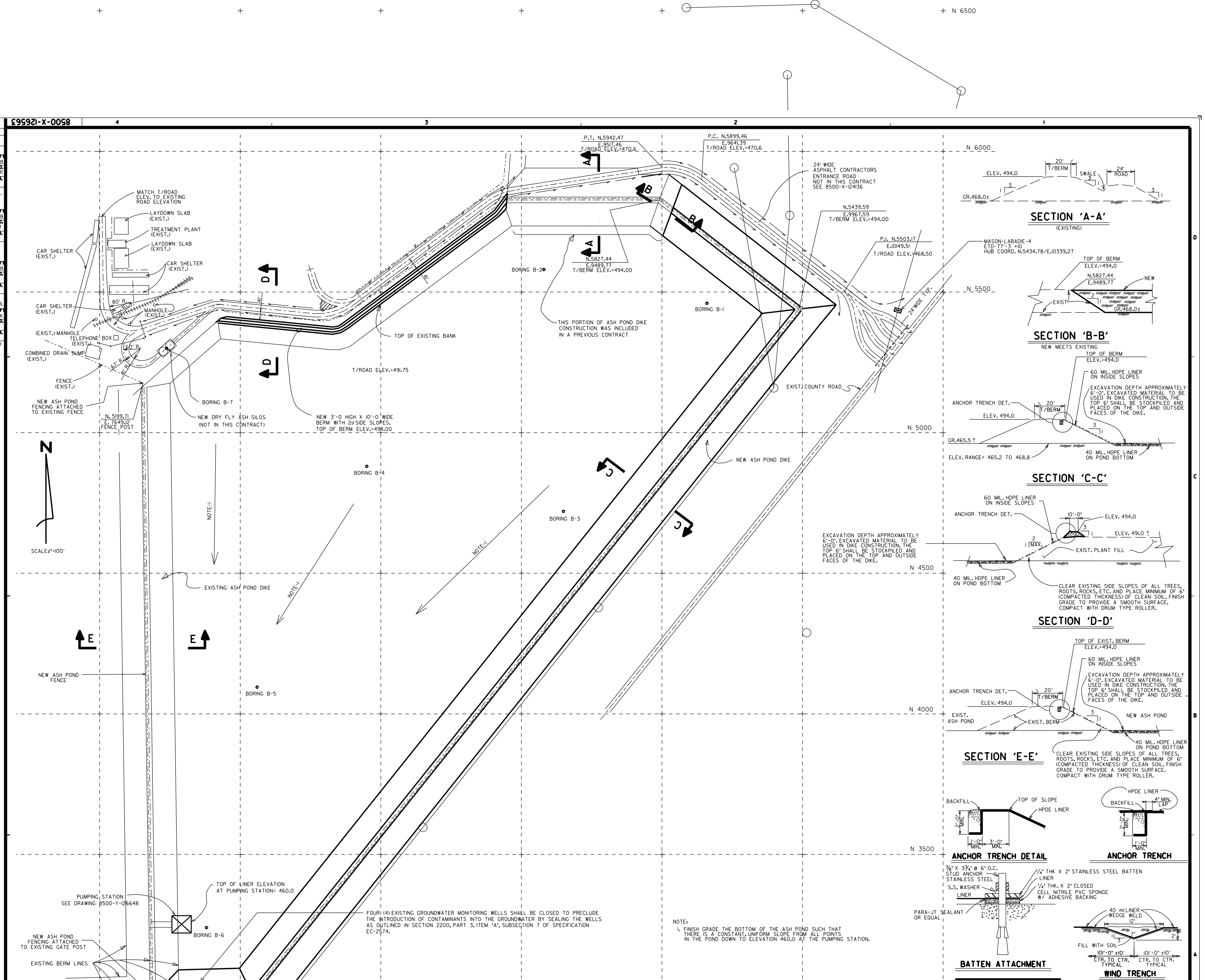
REV.	DATE	DRAFT
3	060492	MSB
CHKD.	**SUPV.**	**APPD.**
NOT		
W.O.		**FILM.**
E107		

ADD WIND TRENCH DETAIL

REV.	DATE	DRAFT
4	010995	JSK
CHKD.	**SUPV.**	**APPD.**
NOT		
W.O.		**FILM.**

ADD NEW ASH POND FENCE

8500-X-126563



FOUR (4) EXISTING GROUNDWATER MONITORING WELLS SHALL BE CLOSED TO PRECLUDE THE INTRODUCTION OF CONTAMINANTS INTO THE GROUNDWATER BY SEALING THE WELLS AS OUTLINED IN SECTION 2200, PART 3, ITEM "A", SUBSECTION 7 OF SPECIFICATION EC-2574.

NOTE:

1. FINISH GRADE THE BOTTOM OF THE ASH POND SUCH THAT THERE IS A CONSTANT, UNIFORM SLOPE FROM ALL POINTS IN THE POND DOWN TO ELEVATION 460.0 AT THE PUMPING STATION.

NOTICE OF LIMITED RESPONSIBILITY

THE RESPONSIBILITY OF THE UNDERSIGNED ENGINEER IS LIMITED TO THE DESIGN WORK SHOWN ON PROJECT DRAWINGS AND DOCUMENTS BEARING HIS/HER SEAL, SIGNATURE OR INITIALS. HE/SHE DOES NOT HAVE AUTHORITY OVER THE PROJECT AS A WHOLE. THE UNDERSIGNED DISCLAIMS ANY RESPONSIBILITY FOR WORK DONE UNDER SUBSEQUENT REVISIONS AND ANY OTHER DOCUMENTS ASSOCIATED WITH THE PROJECT WHICH DO NOT BEAR HIS/HER SEAL, SIGNATURE OR INITIALS.

REV. 0 SEALED BY
NAME
C.W. REZONYA
NUMBER
E-18282
STATE OF MISSOURI

DRAWN 3-31-92 M. BRUNS
CHKD. NOT CHK'D.
SUPV. 4-09-92 SKO
APPD. 4-09-92 C.W. REZONYA

PROPERTY-PLAN
NEW ASH POND

LOCATION 001004

LABADIE PLANT

CLASS 02010

UNION ELECTRIC COMPANY
ST. LOUIS, MO.

8500-X-126563

REV. 4

37-13-070 Rev. 9-85

Printed on: 07-13-2011 12:26:28

SCALE RATIO =
THIS DRAWING HAS BEEN REFERENCED TO FILE(S):

PRINT DIST.

REVISIONS

REV.	W.O.	
0	9302	

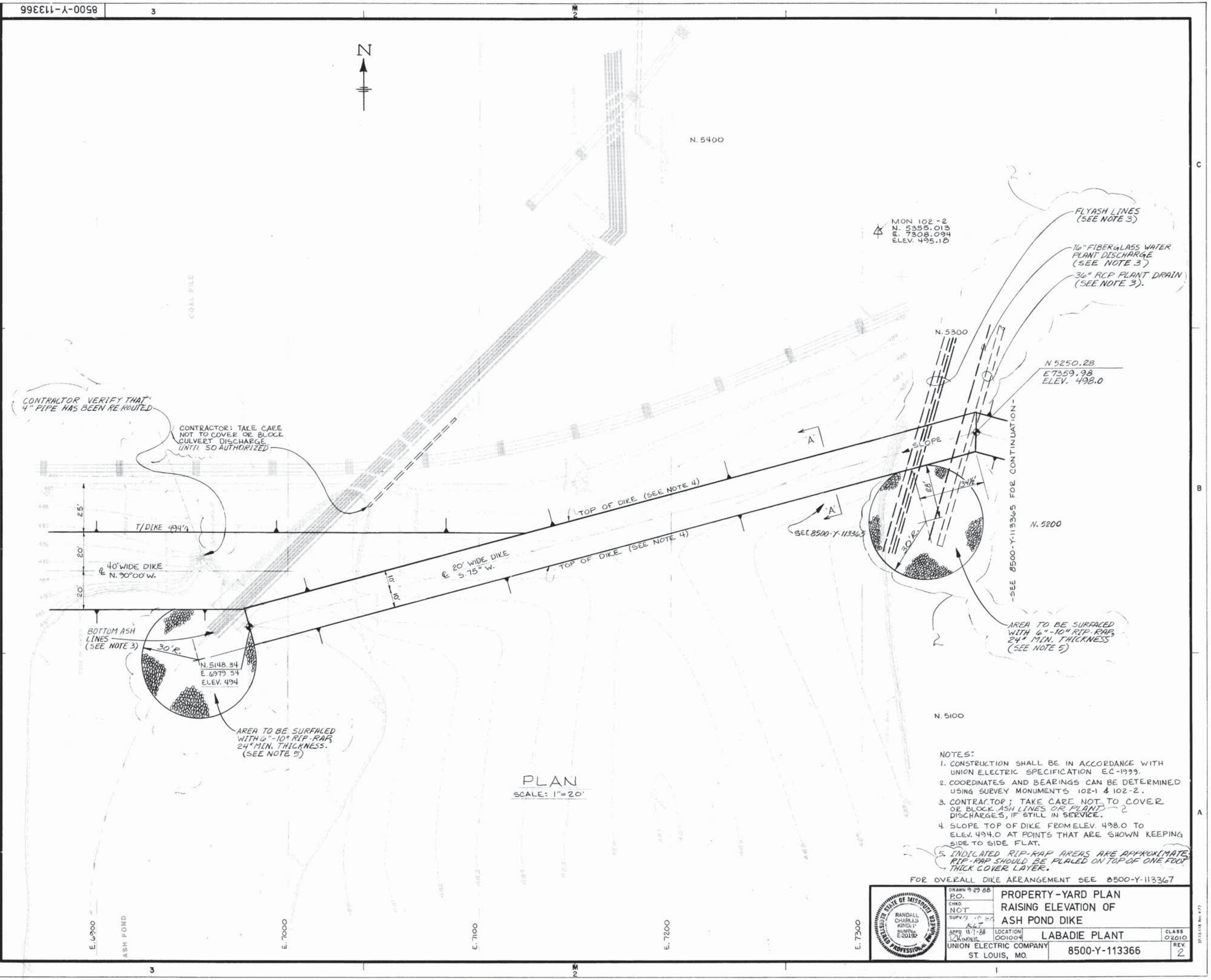
FIRST ISSUE

REV.	DATE	DRAWN
1	1-16-89	P.O.
CHKD.	SUPV.	APPD.
NOT	EHL	
W.O.		FILM
9302		

REV. DRAWING TO SHOW ALL WORK TO BE DONE UNDER U.E. SPEC. 1999

REV.	DATE	DRAWN
2	2-13-89	MSB
CHKD.	SUPV.	APPD.
NOT	EHL	DK
W.O.		
9302		

ADDED RIP-RAP AREAS & NOTES, PIPING AT EAST END OF DIKE. REV. NOTE 3 & ADDED NOTE 5.



PLAN
SCALE: 1"=20'

NOTES:
1. CONSTRUCTION SHALL BE IN ACCORDANCE WITH UNION ELECTRIC SPECIFICATION EC-1999.
2. COORDINATES AND BEARINGS CAN BE DETERMINED USING SURVEY MONUMENTS 102-1 & 102-2.
3. CONTRACTOR; TAKE CARE NOT TO COVER OR BLOCK ASH LINES OR PLANT DISCHARGES, IF STILL IN SERVICE.
4. SLOPE TOP OF DIKE FROM ELEV. 498.0 TO ELEV. 494.0 AT POINTS THAT ARE SHOWN KEEPING SIDE TO SIDE FLAT.
5. INDICATED RIP-RAP AREAS ARE APPROXIMATE; RIP-RAP SHOULD BE PLACED ON TOP OF ONE FOOT THICK COVER LAYER.

FOR OVERALL DIKE ARRANGEMENT SEE 8500-Y-113367

STATE OF MISSOURI
RANDALL CHARLES KIND
NUMBER E-20192
REGISTERED PROFESSIONAL ENGINEER

DRAWN 9-29-88 P.O.
CHKD NOT
SUPV. 9-10-88 KLT
APPD 11-7-88 RKinder

PROPERTY-YARD PLAN
RAISING ELEVATION OF
ASH POND DIKE

LOCATION 001004

LABADIE PLANT

CLASS 02010

UNION ELECTRIC COMPANY
ST. LOUIS, MO.

8500-Y-113366

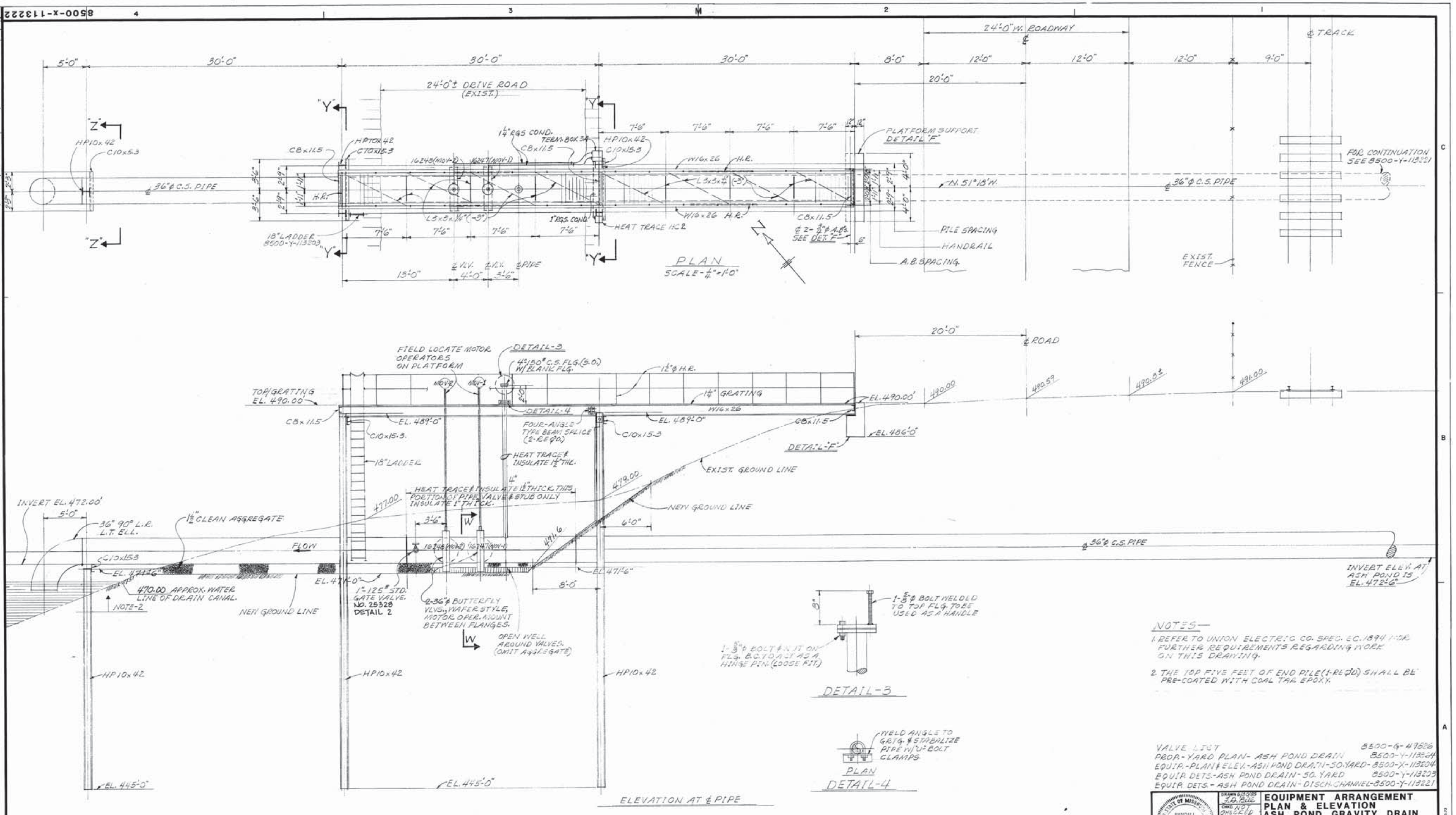
REV. 2

PRINT DIST.

REVISIONS

REV.	W.O.	
0	E010	Ⓕ

FIRST ISSUE.
1 11/16/88 Bell
— EHL
9391 Ⓕ
ADD VALVE NOS. 16247 & 16248
2 11/14/89 Bell
R.C. RLT JMS
9391 Ⓕ
ADD. COND. & J.B.'s FOR HEAT TRACING.
3 4-19-89 MGL
ABB EHL
9391 Ⓕ
ADD VALVE NO. 25328 ON ELEV.



NOTES—

1. REFER TO UNION ELECTRIC CO. SPEC. EC.1894 FOR FURTHER REQUIREMENTS REGARDING WORK ON THIS DRAWING.
2. THE TOP FIVE FEET OF END PILE (1-REQ'D) SHALL BE PRE-COATED WITH COAL TAR EPOXY.

VALVE LIST	8500-G-49526
PROP.-YARD PLAN- ASH POND DRAIN	8500-Y-113264
EQUIP.-PLAN & ELEV.-ASH POND DRAIN-SO. YARD-	8500-X-113204
EQUIP. DETS.-ASH POND DRAIN-SO. YARD	8500-Y-113203
EQUIP. DETS.- ASH POND DRAIN- DISCH. CHANNEL-	8500-Y-113221

STATE OF MISSOURI
RANDALL CHARLES KINDER
NUMBER E-20192
REGISTERED PROFESSIONAL ENGINEER

DRAWN 6/13/88 J.D. Bell
CHKD. NOT CHECKED
SUPV. 9-1-88 LAUNHARDT
APPD. KINDER / JJV

EQUIPMENT ARRANGEMENT
PLAN & ELEVATION
ASH POND GRAVITY DRAIN
DISCHARGE CHANNEL

LOCATION 001004
LABADIE PLANT
CLASS 07020
UNION ELECTRIC COMPANY
ST. LOUIS, MO.
8500-x-113222
REV. 3

Printed on: 07-13-2011 12:40:53

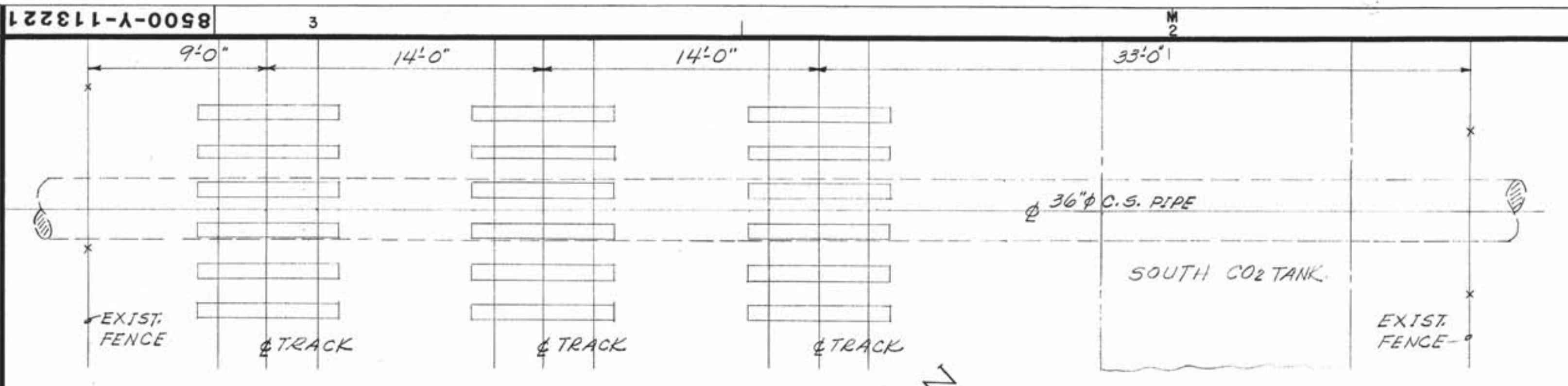
PRINT DIST.-

REVISIONS

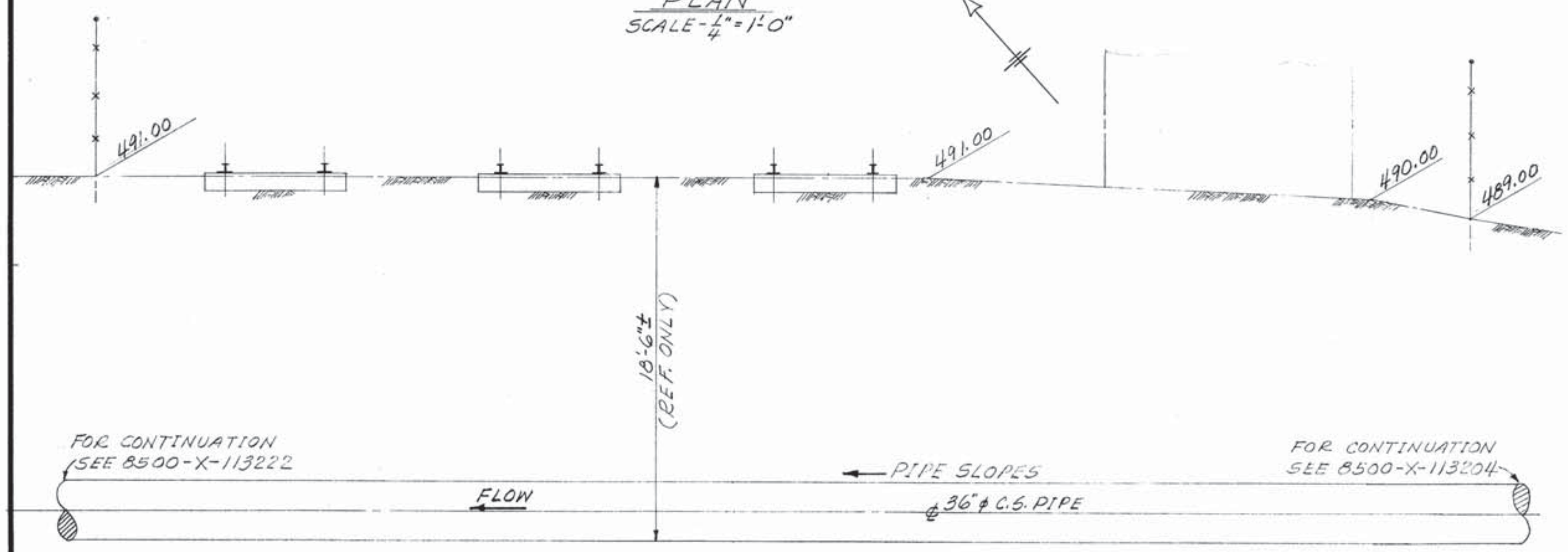
REV.	W.O.	
0	E010	Ⓕ

FIRST ISSUE.

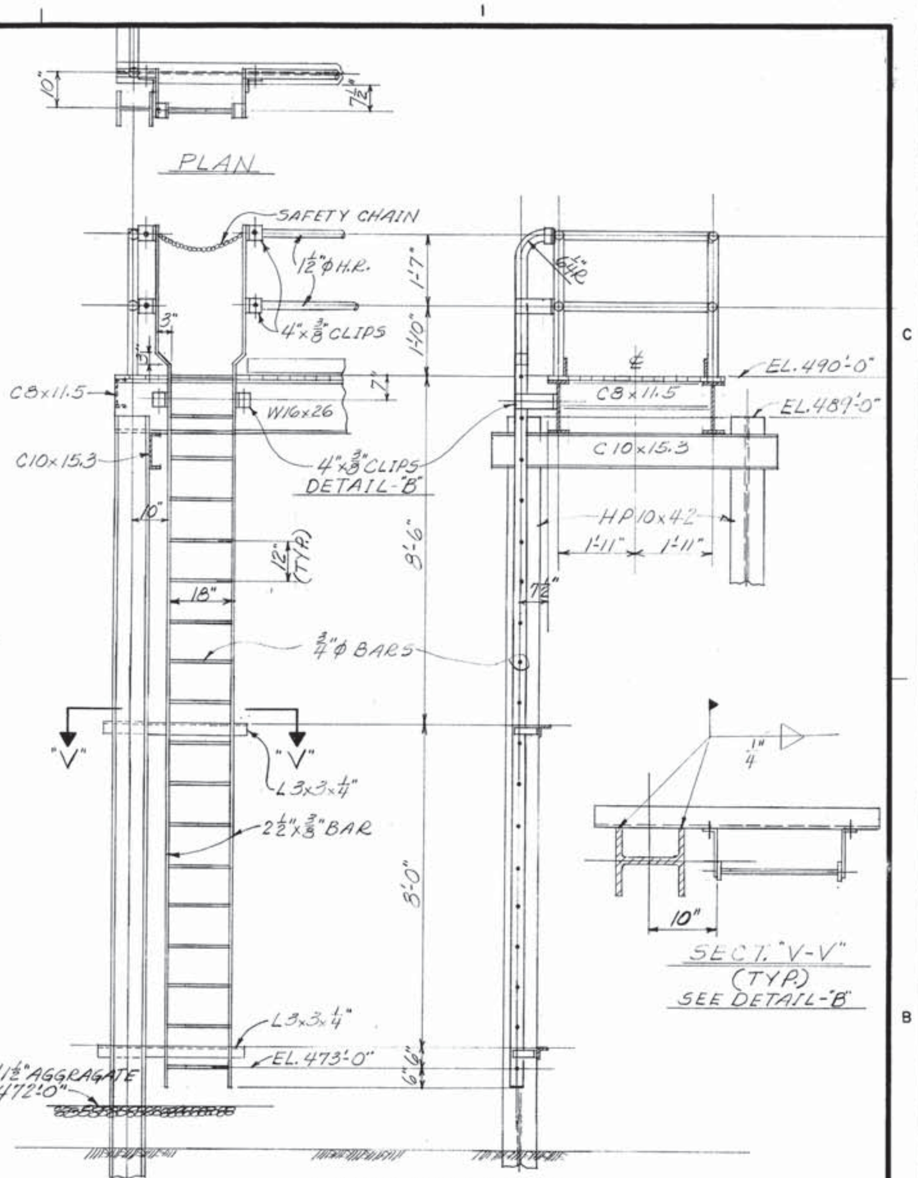
8500-Y-113221



PLAN
SCALE-1/4"=1'-0"

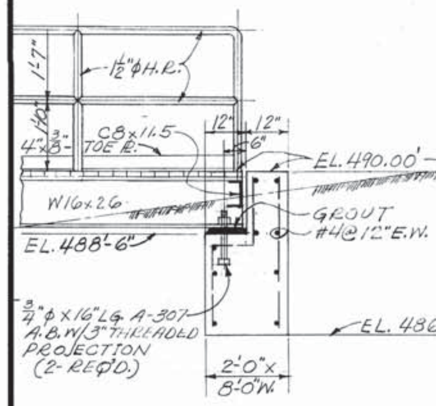


ELEVATION @ PIPE



LADDER DETAILS
8500-X-113222

SECT. "V-V"
(TYP.)
SEE DETAIL-"B"



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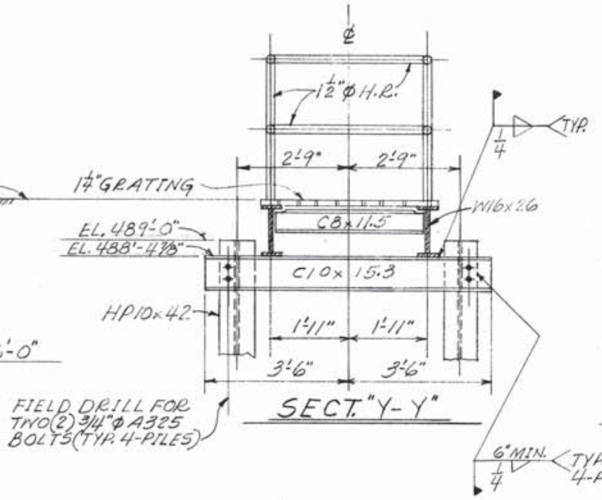
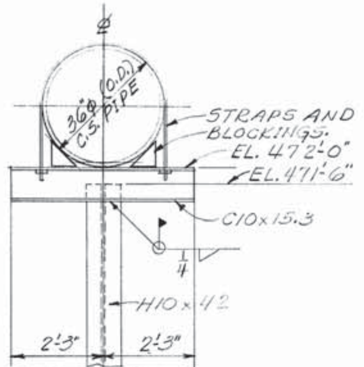
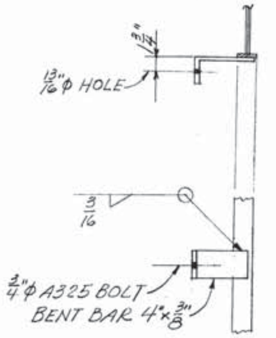


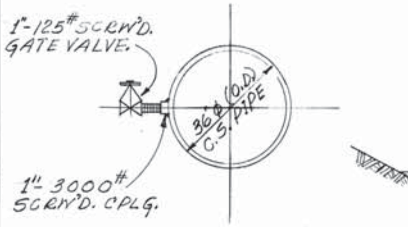
SECT. "Y-Y"



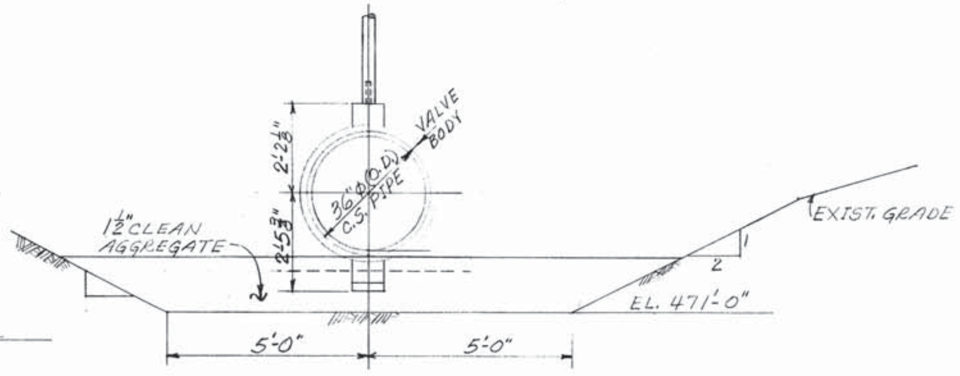
SECT. "Z-Z"



DETAIL-"B"



DETAIL-2



SECT. "W-W"

NOTES—

1. REFER TO UNION ELECTRIC CO. SPEC. EC.-1894 FOR FURTHURE REQUIREMENTS REGARDING WORK ON THIS DWG.

PROP.- YARD PLAN-ASH POND DRAIN	8500-Y-113364
EQUIP.-DETS.-ASH POND DRAIN SO. YARD.	8500-Y-113203
EQUIP.-PLAN & ELEV.-ASH POND DRAIN-SO. YARD	8500-X-113204
EQUIP.-PLAN & ELEV.-ASH POND DRAIN-DISCH. CHNL.	8500-X-113222

RANDALL CHARLES KINDER NUMBER E-20192

DRAWN 6/30/88 J.D. Bell
CHKD. NOT CHECKED
SUPV. 9-1-88 LAUNHARDT
APPD. KINDER/JJV

EQUIPMENT DETAILS
ASH POND GRAVITY DRAIN
DISCHARGE CHANNEL

LOCATION 001004

LABADIE PLANT

CLASS 07030

UNION ELECTRIC COMPANY
ST. LOUIS, MO.

8500-Y-113221

REV. 0

8500-X-113204

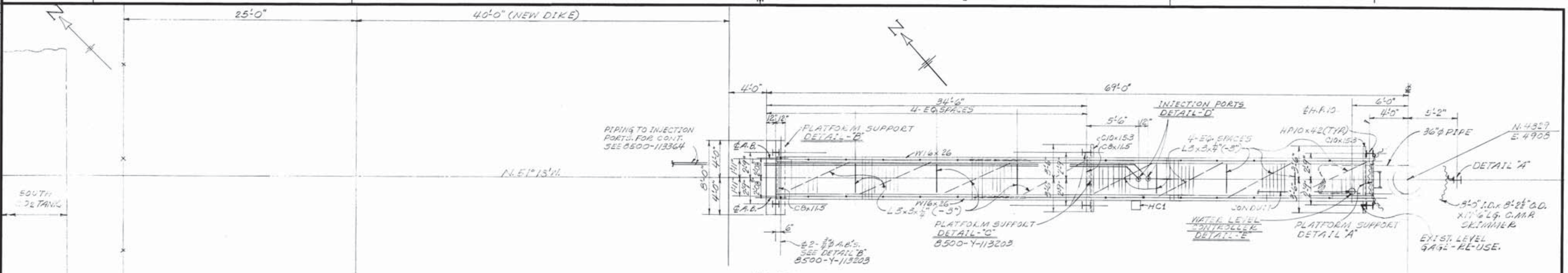
PRINT DIST.

REVISIONS

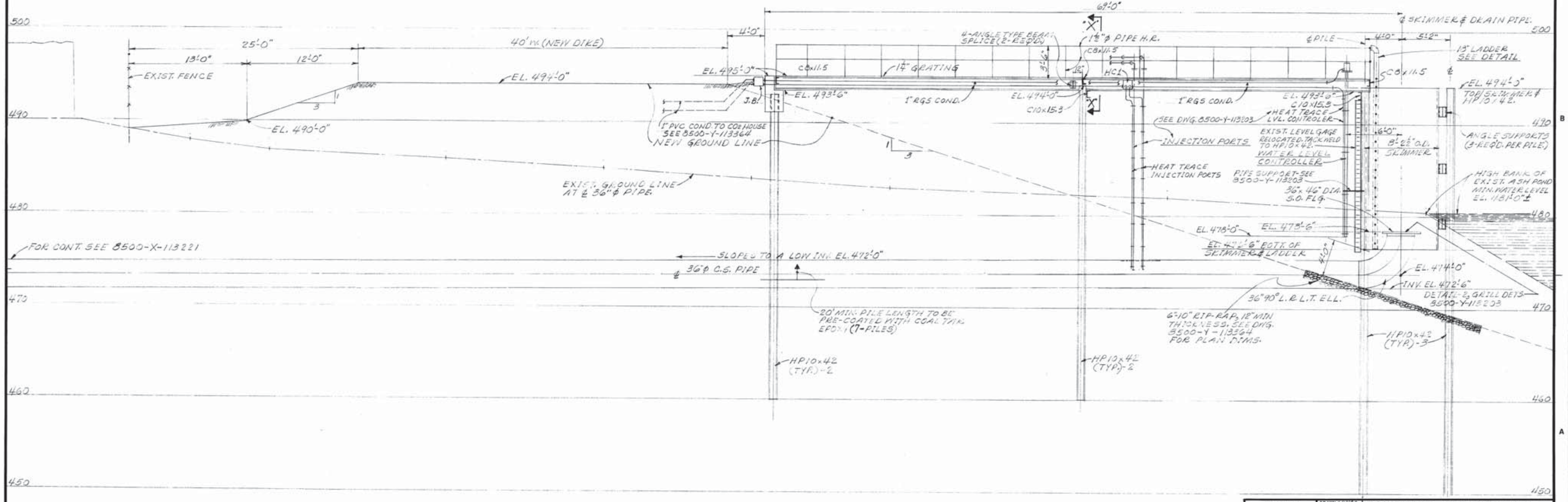
REV.	W.O.	
0	E010	Ⓕ

FIRST ISSUE

1 4/8/09 Beer
N.C. RLT JMS
9891 Ⓕ
ADD. HEAT TRACING, J.B.'S & CONDUIT.



PLAN
SCALE-1/4"=1'-0"



ELEVATION AT ℄ 36"φ PIPE

PROP.-YARD PLAN-ASH POND DRAIN	8500-Y-113364
EQUIP. DETS.- ASH POND DRAIN. SO. YARD	8500-Y-113203
EQUIP. DETS.-ASH POND DRAIN DISCH. CHNL.	8500-Y-113221
EQUIP.-PLAN & ELEV.-ASH POND DRAIN-DISCH. CHNL.	8500-X-113222

RANDALL CHARLES KINDER
NUMBER E-20192

DRAWN 6/13/88 F.O. Bell
CHKD. NOT CHECKED
SUPV. 9-1-88 LAURHARDT
APPD. KINDER / JJV

EQUIPMENT ARRANGEMENT
PLAN & ELEVATION
ASH POND GRAVITY DRAIN
SOUTH YARD

LOCATION 001004
LABADIE PLANT
CLASS 07020
UNION ELECTRIC COMPANY
ST. LOUIS, MO.
8500-X-113204
REV. 1

PRINT DIST.

8500 -Y- 113203

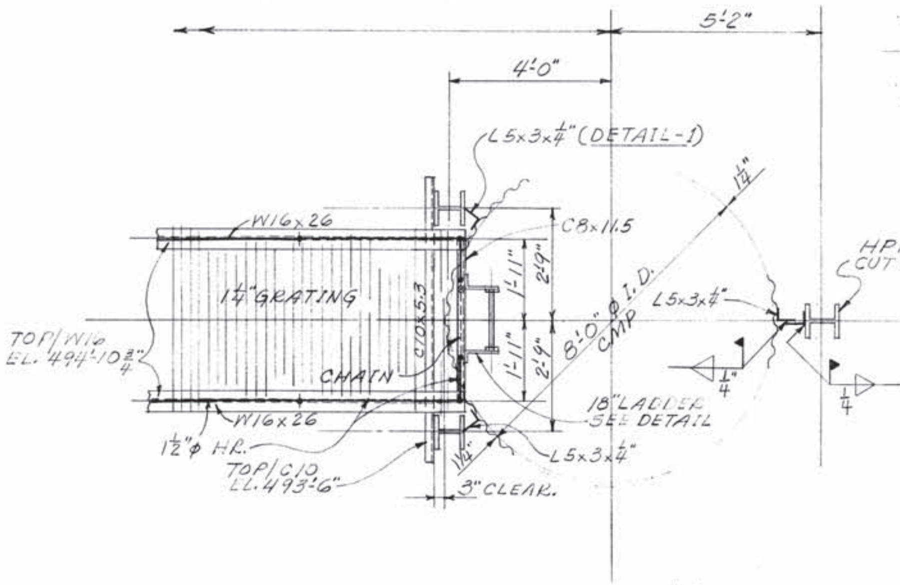
REVISIONS

REV.	W.O.	
0	E010	Ⓕ

FIRST ISSUE

1	4/21/89	Bell
N.C.	RLT	JMS
9391		Ⓕ

ADD. HEAT TRACE NOTES & SIZED COND.



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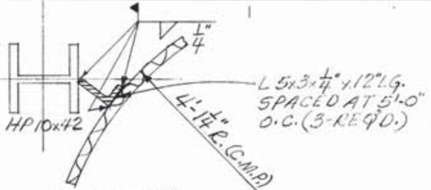
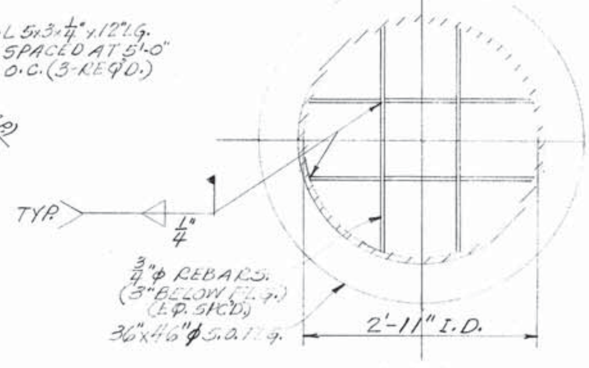
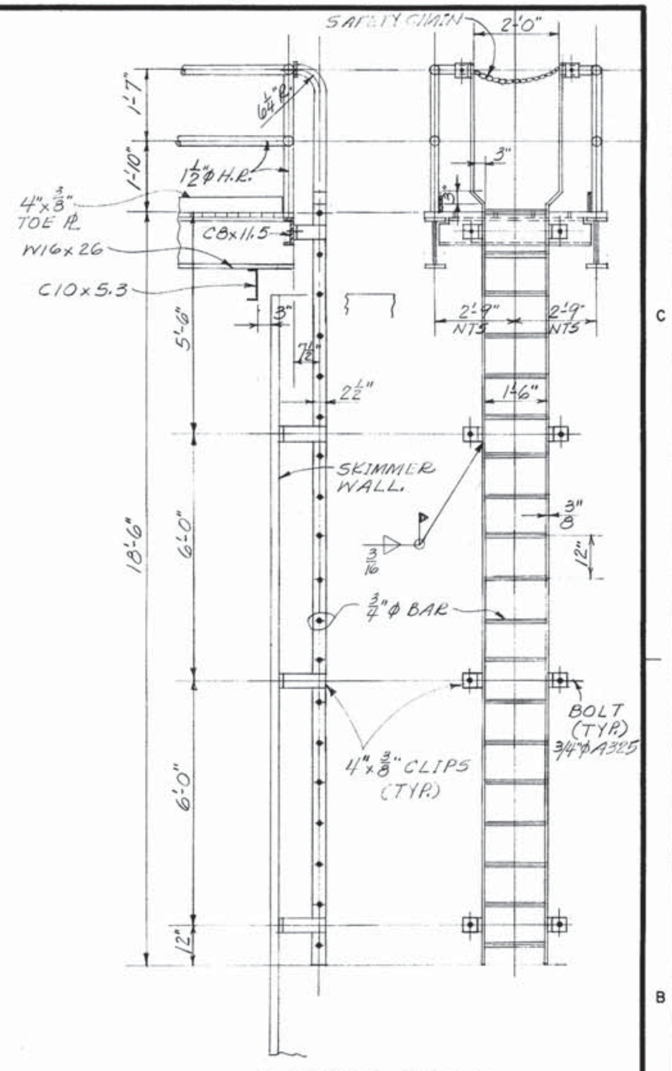


DETAIL-"1"

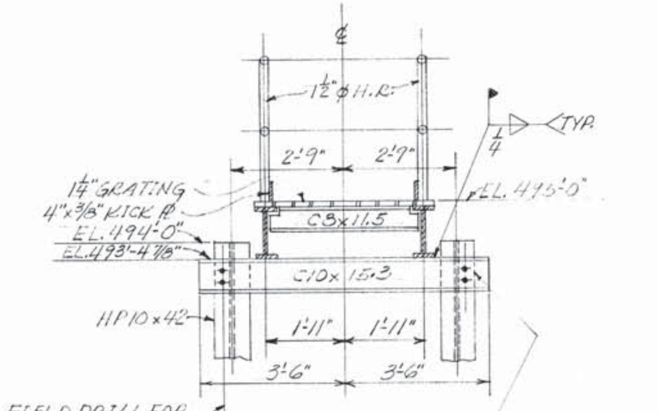
HP10x42 (TYP.) CUT OFF EL. 494'-0"



DETAIL-2



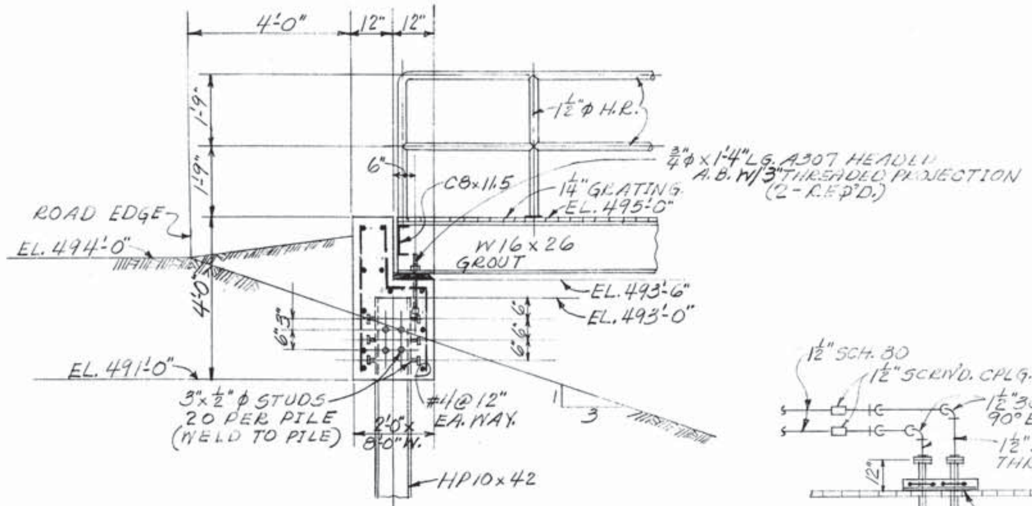
LADDER DETAIL
FOR SKIMMER



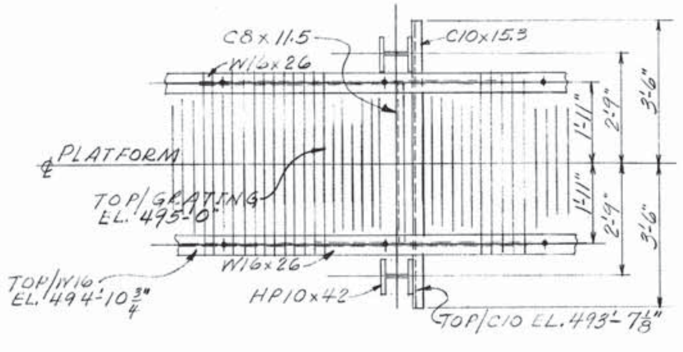
FIELD DRILL FOR TWO (2) ¾"φ A325 BOLTS (TYP. 4-PILES)

SECT. "X-X"
(8500-X-113204)

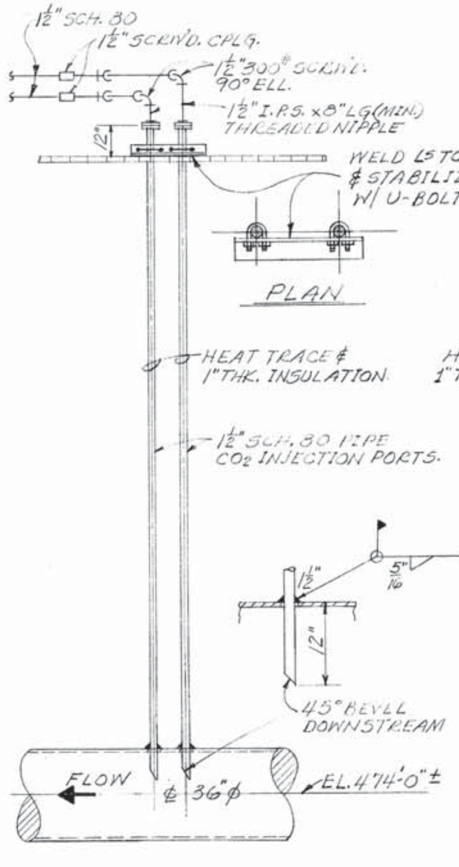
6" MIN. ¼ TYP. 4-PILES



DETAIL-"B"



DETAIL-"C"



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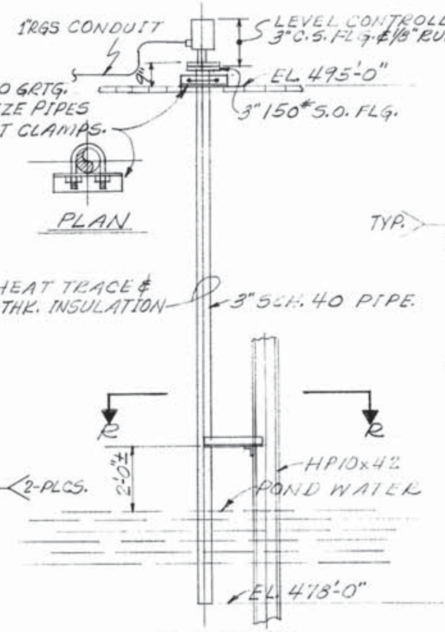
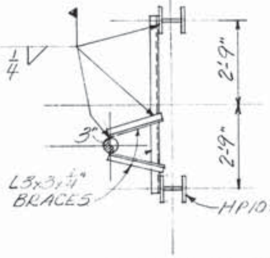


DETAIL-"E"



PLAN "R-R"

PROP.-YARD PLAN-ASH POND DRAIN 8500-Y-113364
EQUIP.-DETS.-ASH POND DRAIN-DISCH. CHNL. 8500-Y-113221
EQUIP.-PLAN & ELEV.-ASH POND DRAIN-DISCH. CHNL. 8500-X-113222
EQUIP.-PLAN & ELEV.-ASH POND DRAIN-SO. YARD-8500-X-113204

STATE OF MISSOURI
RANDALL CHARLES KINDER
NUMBER E-20192
REGISTERED PROFESSIONAL ENGINEER

DRAWN 6/13/88 F.D. Bell
CHKD. NOT CHECKED
SUPV. 9-1-88 LAUNHARDT
APPD. Kinder / JJV
LOCATION 001004

EQUIPMENT DETAILS
ASH POND GRAVITY DRAIN
SOUTH YARD

LABADIE PLANT

CLASS 07030

UNION ELECTRIC COMPANY
ST. LOUIS, MO.

8500-Y-113203

REV. 1

27-13-118 Rev. 4-73

PRINT DIST.

8500-Y-85887

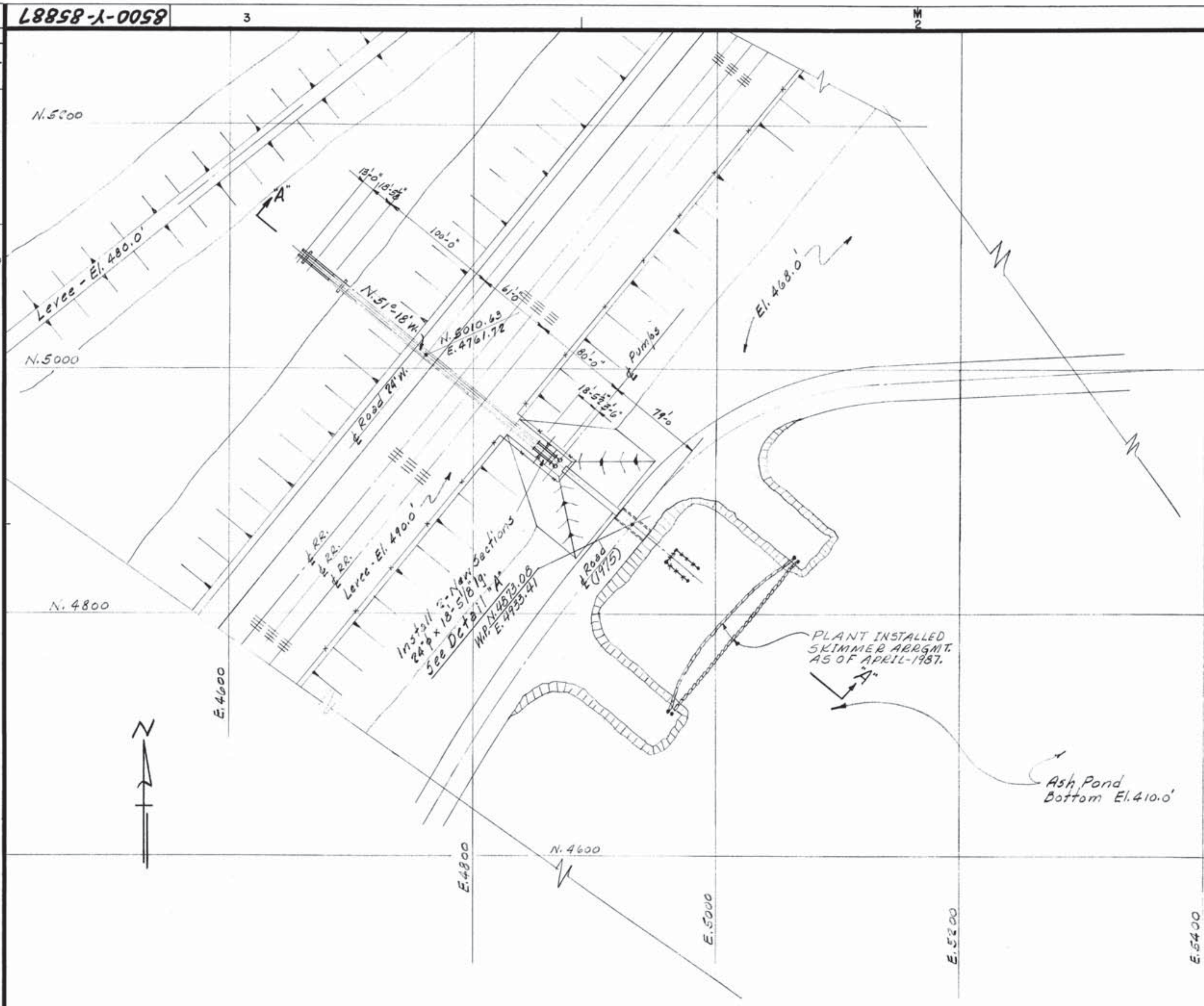
REVISIONS

REV.	W.O.
0	1722 Ⓕ

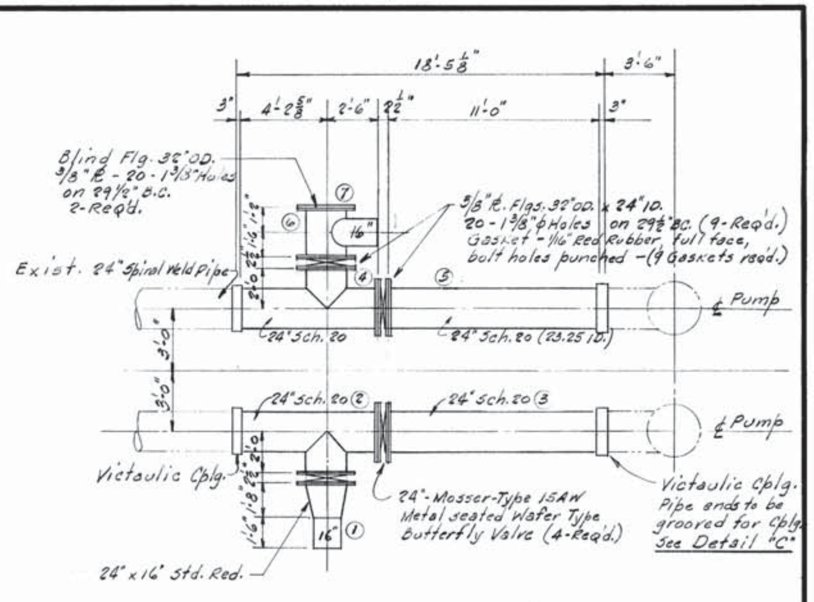
FIRST ISSUE

1 11-4-82 Ewk
Ⓕ M.O.L. 1722
ADDED REF. DRWG.
8500-X-91915

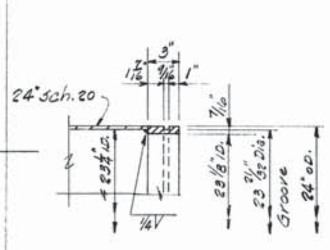
2 4/7/87 Bell
NOT
E0/0
ADD. SKIMMER
ARRGMT. AT
N.4800, E.5000
"AS BUILT.



PLAN



DETAIL "A"



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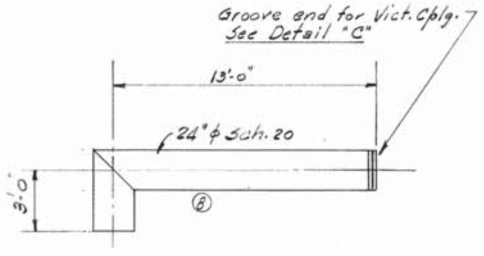
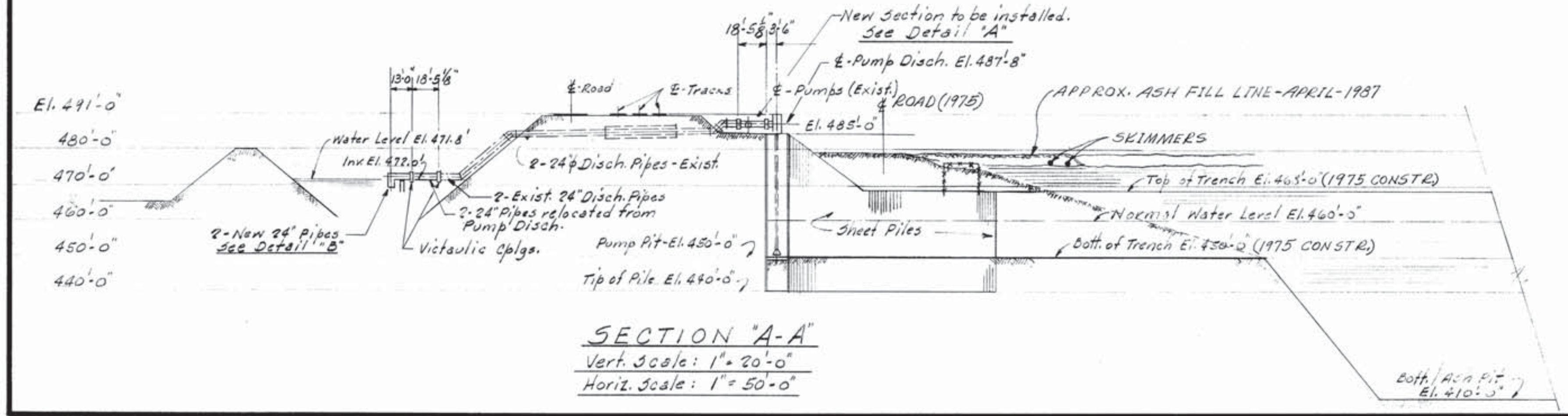


DETAIL "B"
2-Req'd.

NOTES

1.) Fabricated piping pieces No. 1, 2, 3, 4, 5, 6, 7 & 8 furnished by Piping Fabricator under U.E. Purchase Order No. 16371
2.) Gaskets furnished by Piping Fabricator under U.E. Purch. Order #16371.
3.) Bolting: Sq. Hd. Mach. Bolts with heavy Hex. Nuts, furnished by Piping Fabricator under U.E. Purchase Order #16371.
4.) Butterfly Valves furnished by Union Electric under Purchase Order No. 16072
5.) Victaulic Cplgs. furnished by Union Electric under Purchase Order No. 16073

Ash Pond Pumping Plant	8500-X-49286
P.&I.D. CO2 Injection Piping	8500-X-91915

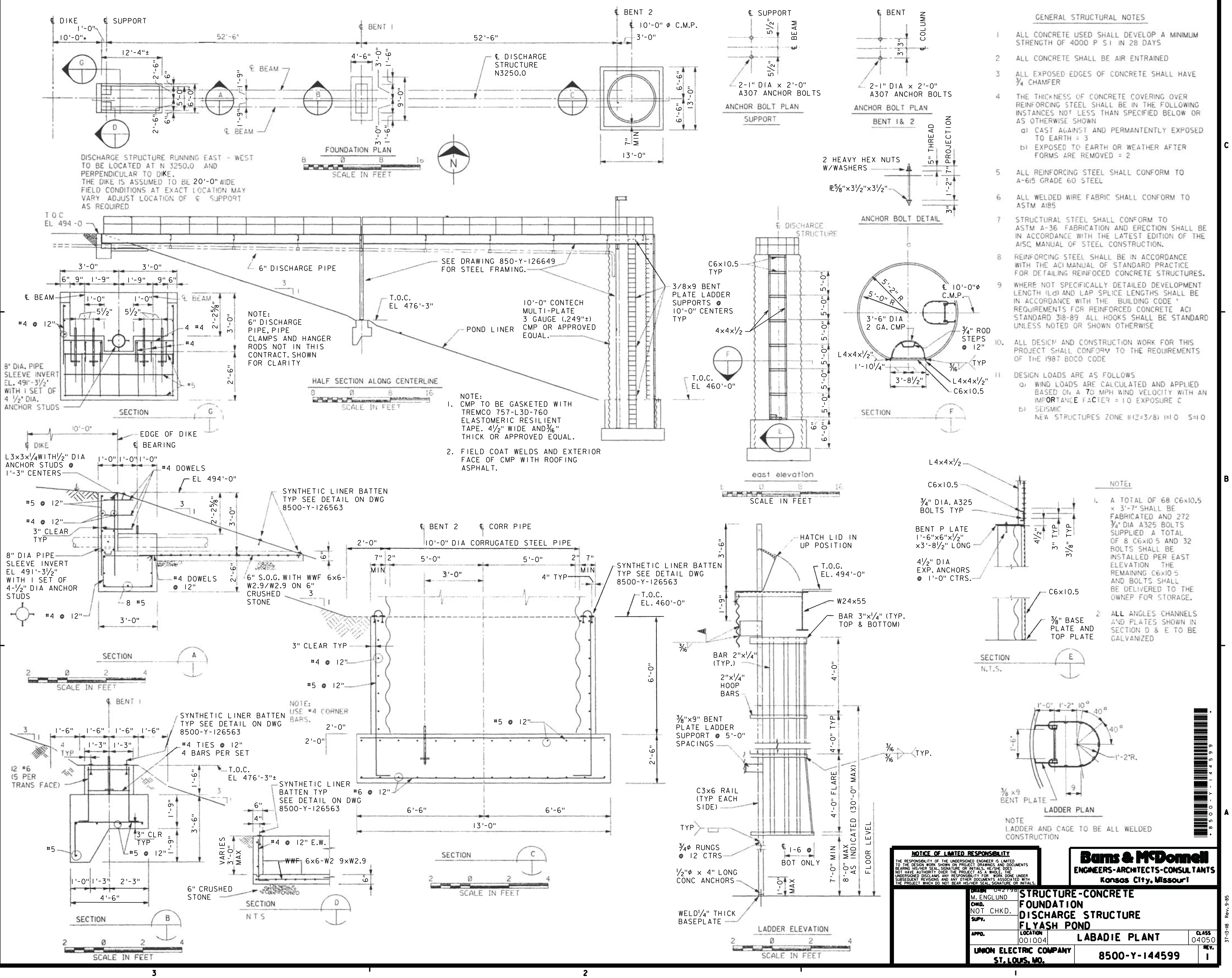


SECTION "A-A"
Vert. Scale: 1" = 20'-0"
Horiz. Scale: 1" = 50'-0"

DRAWN 2-24-75 C. KENNEDY	PIPING INSTALL. - WATER PUMP DISCHARGE ASH POND PUMPING PLANT
CHKD. 3-4-75 Allgeyer	
SUPV. 3-4-75 Launhardt	
APPD. 3/4/75 Stehly	LOCATION 001004 — LABADIE PLANT — CLASS 06032
UNION ELECTRIC COMPANY ST. LOUIS, MO.	8500-Y-85887 — REV. 2

37-13-118 Rev. 4-73

PRINT DIST.	
REVISIONS	
REV. 0	W.O. —
SCANNED FROM ORIGINAL 8500-Y-126648	
REV 1	DATE 062298 DRAWN RWV
CHKD	SUPV APPD
W.O.	FILM
CHANGED TITLE	



DISCHARGE STRUCTURE RUNNING EAST - WEST TO BE LOCATED AT N 3250.0 AND PERPENDICULAR TO DIKE. THE DIKE IS ASSUMED TO BE 20'-0" WIDE FIELD CONDITIONS AT EXACT LOCATION MAY VARY. ADJUST LOCATION OF ℄ SUPPORT AS REQUIRED

NOTE:
1. CMP TO BE GASKETED WITH TREMCO 757-L3D-760 ELASTOMERIC RESILIENT TAPE. 4½" WIDE AND 3/16" THICK OR APPROVED EQUAL.
2. FIELD COAT WELDS AND EXTERIOR FACE OF CMP WITH ROOFING ASPHALT.

NOTE:
1. A TOTAL OF 68 C6x10.5 x 3'-7' SHALL BE FABRICATED AND 272 ¾" DIA A325 BOLTS SUPPLIED A TOTAL OF 8 C6x10 5 AND 32 BOLTS SHALL BE INSTALLED PER EAST ELEVATION THE REMAINING C6x10 5 AND BOLTS SHALL BE DELIVERED TO THE OWNER FOR STORAGE.
2. ALL ANGLES CHANNELS AND PLATES SHOWN IN SECTION D & E TO BE GALVANIZED

GENERAL STRUCTURAL NOTES

1 ALL CONCRETE USED SHALL DEVELOP A MINIMUM STRENGTH OF 4000 P S I IN 28 DAYS

2 ALL CONCRETE SHALL BE AIR ENTRAINED

3 ALL EXPOSED EDGES OF CONCRETE SHALL HAVE ¾ CHAMFER

4 THE THICKNESS OF CONCRETE COVERING OVER REINFORCING STEEL SHALL BE IN THE FOLLOWING INSTANCES NOT LESS THAN SPECIFIED BELOW OR AS OTHERWISE SHOWN
   a) CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH = 3
   b) EXPOSED TO EARTH OR WEATHER AFTER FORMS ARE REMOVED = 2

5 ALL REINFORCING STEEL SHALL CONFORM TO A-615 GRADE 60 STEEL

6 ALL WELDED WIRE FABRIC SHALL CONFORM TO ASTM A185

7 STRUCTURAL STEEL SHALL CONFORM TO ASTM A-36 FABRICATION AND ERECTION SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE AISC MANUAL OF STEEL CONSTRUCTION.

8 REINFORCING STEEL SHALL BE IN ACCORDANCE WITH THE ACI MANUAL OF STANDARD PRACTICE FOR DETAILING REINFOCED CONCRETE STRUCTURES.

9 WHERE NOT SPECIFICALLY DETAILED DEVELOPMENT LENGTH (Ld) AND LAP SPLICE LENGTHS SHALL BE IN ACCORDANCE WITH THE BUILDING CODE " REQUIREMENTS FOR REINFORCED CONCRETE ACI STANDARD 318-89 ALL HOOKS SHALL BE STANDARD UNLESS NOTED OR SHOWN OTHERWISE

10. ALL DESIGN AND CONSTRUCTION WORK FOR THIS PROJECT SHALL CONFORM TO THE REQUIREMENTS OF THE 1987 BOCO CODE

11 DESIGN LOADS ARE AS FOLLOWS
   a) WIND LOADS ARE CALCULATED AND APPLIED BASED ON A 70 MPH WIND VELOCITY WITH AN IMPORTANCE FACTER = 1 0 EXPOSURE C
   b) SEISMIC
      NEW STRUCTURES ZONE II(Z=3/8) I=1 0 S=1 0

NOTICE OF LIMITED RESPONSIBILITY

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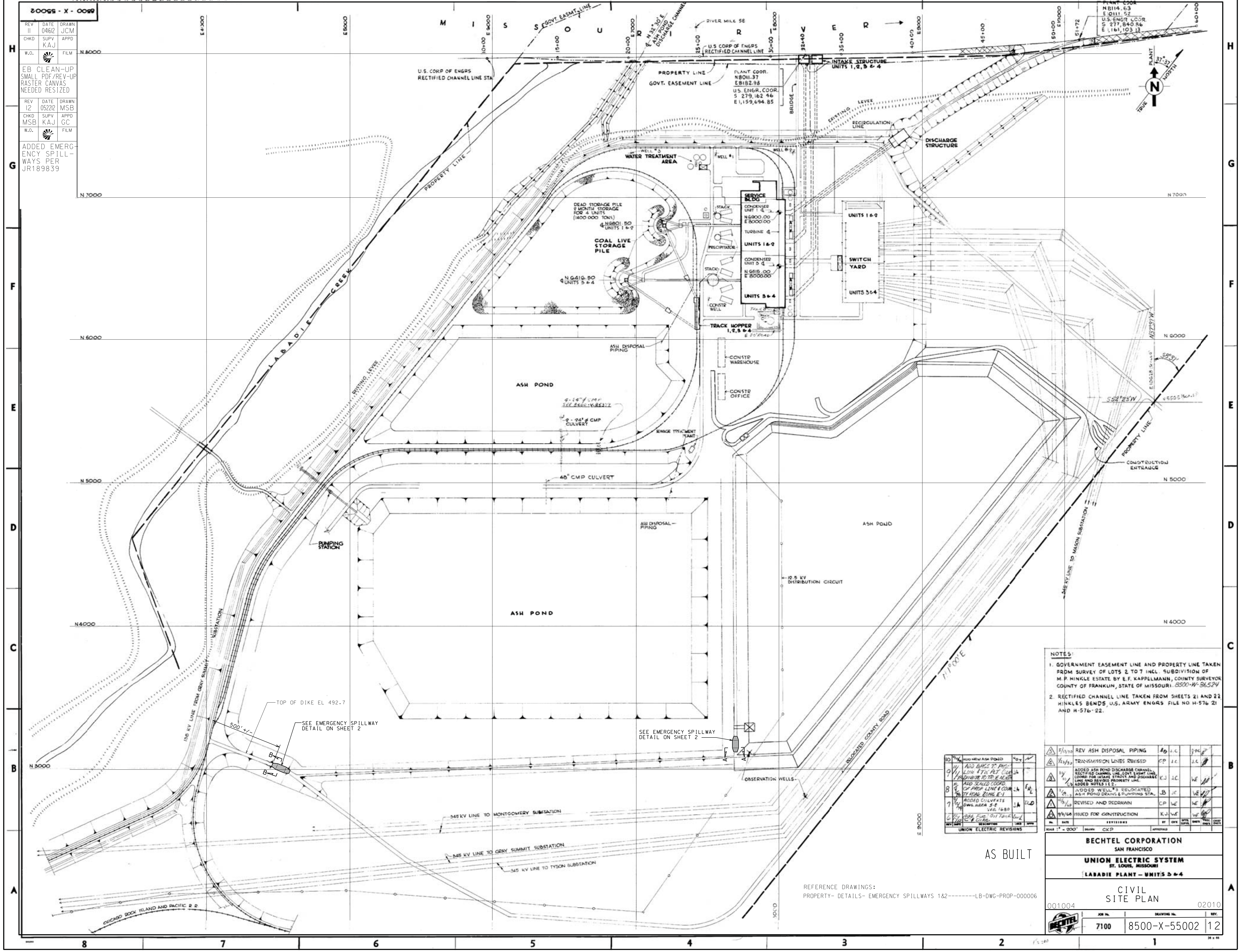
Burns & McDonnell
ENGINEERS-ARCHITECTS-CONSULTANTS
Kansas City, Missouri

DRAWN 042798 M. ENGLUND	STRUCTURE-CONCRETE FOUNDATION DISCHARGE STRUCTURE FLYASH POND	
CHKD. NOT CHKD.		
SUPV.		
APPD.	LOCATION 001004 LABADIE PLANT	CLASS 04050
UNION ELECTRIC COMPANY ST. LOUIS, MO.	8500-Y-144599	REV. 1

37-13-118 Rev. 9-85

SCALE RATIO = 1
THIS DRAWING HAS BEEN REFERENCED TO FILE(S):



8500 - X - 55002

REV	DATE	DRAWN
11	041612	JCM
CHKD	SUPV	APPD
	KAJ	
W.O.		FILM

EB CLEAN-UP
SMALL PDF/REV-UP
RASTER CANVAS
NEEDED RESIZED

REV	DATE	DRAWN
12	052212	MSB
CHKD	SUPV	APPD
MSB	KAJ	GC
W.O.		FILM

ADDED EMERG-
ENCY SPILL-
WAYS PER
JR189839

NOTES:

1. GOVERNMENT EASEMENT LINE AND PROPERTY LINE TAKEN FROM SURVEY OF LOTS 2 TO 7 INCL. SUBDIVISION OF M. P. HINKLE ESTATE BY E. F. KAPPELMANN, COUNTY SURVEYOR COUNTY OF FRANKLIN, STATE OF MISSOURI. 8500-W-86524
2. RECTIFIED CHANNEL LINE TAKEN FROM SHEETS 21 AND 22 HINKLES BENDS, U.S. ARMY ENGRS FILE NO. H-576 21 AND H-576-22.

REV	DATE	DESCRIPTION		
10	[illegible]	ADD NEW ASH POND	HOT	
9	11/1/78	ADD BRGS TO PROP. LINE & TIE PLT. COORDINATE TO TRUE NORTH	JA	
8	10/4/78	ADD SCALED COORD. OF PROP LINE & COUNTY ROAD ZONE E-1	JA	ENL
7	[illegible]	ADDED CULVERTS DWG. AREA 5-E W.O. 1680	JA	DLD
6	[illegible]	Add. Fuel Oil Tank "C" & Dike.	[illegible]	

UNION ELECTRIC REVISIONS

No.	DATE	REVISIONS	BY	CHK	DPTE. SUPVR.	ENG'R	PROJ. ENG'R	CHIEF ENG'R
5	5/13/70	REV ASH DISPOSAL PIPING	[illegible]	J.C.		J.C.		
4	1/23/70	TRANSMISSION LINES REVISED	C.P.	J.C.		J.C.		
3	10/10/69	ADDED ASH POND DISCHARGE CHANNEL, RECTIFIED CHANNEL LINE, GOVT. EASMT. LINE, COORD. FOR INTAKE STRUCT. AND DISCHARGE LINE AND REVISED PROPERTY LINE. ADDED NOTES 1 & 2.	K.J.	J.C.		WE		
2	3/24/69	ADDED WELL #3 RELOCATED ASH POND DRAINS & PUMPING STA.	JB	JC		WE		
1	10/31/68	REVISED AND REDRAWN	CP	WE		WE		
0	9/9/68	ISSUED FOR CONSTRUCTION	K.J.	WE		WE		

SCALE 1" = 200' DRAWN CKP APPROVALS

AS BUILT

REFERENCE DRAWINGS:
PROPERTY- DETAILS- EMERGENCY SPILLWAYS 1&2--------LB-DWG-PROP-000006

BECHTEL CORPORATION
SAN FRANCISCO

UNION ELECTRIC SYSTEM
ST. LOUIS, MISSOURI
LABADIE PLANT – UNITS 3 & 4

CIVIL
SITE PLAN

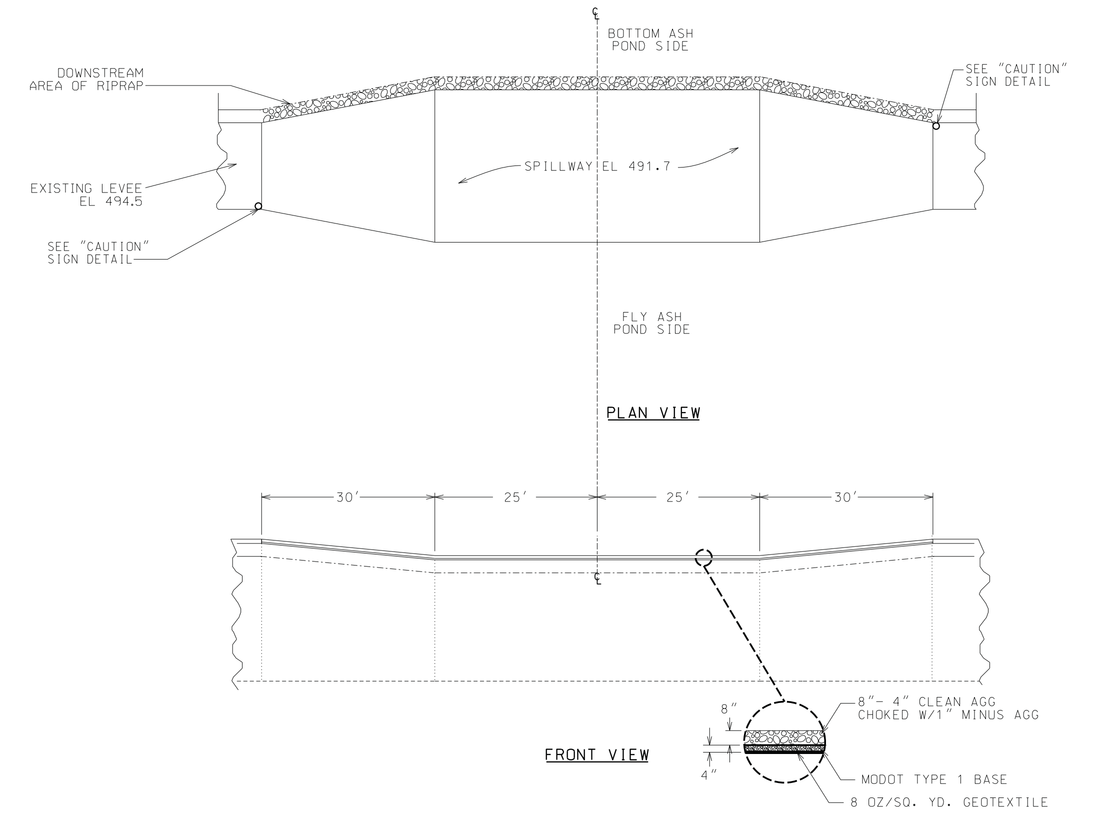
001004 02010

JOB No.	DRAWING No.	REV.
7100	8500-X-55002	12

1" = 200

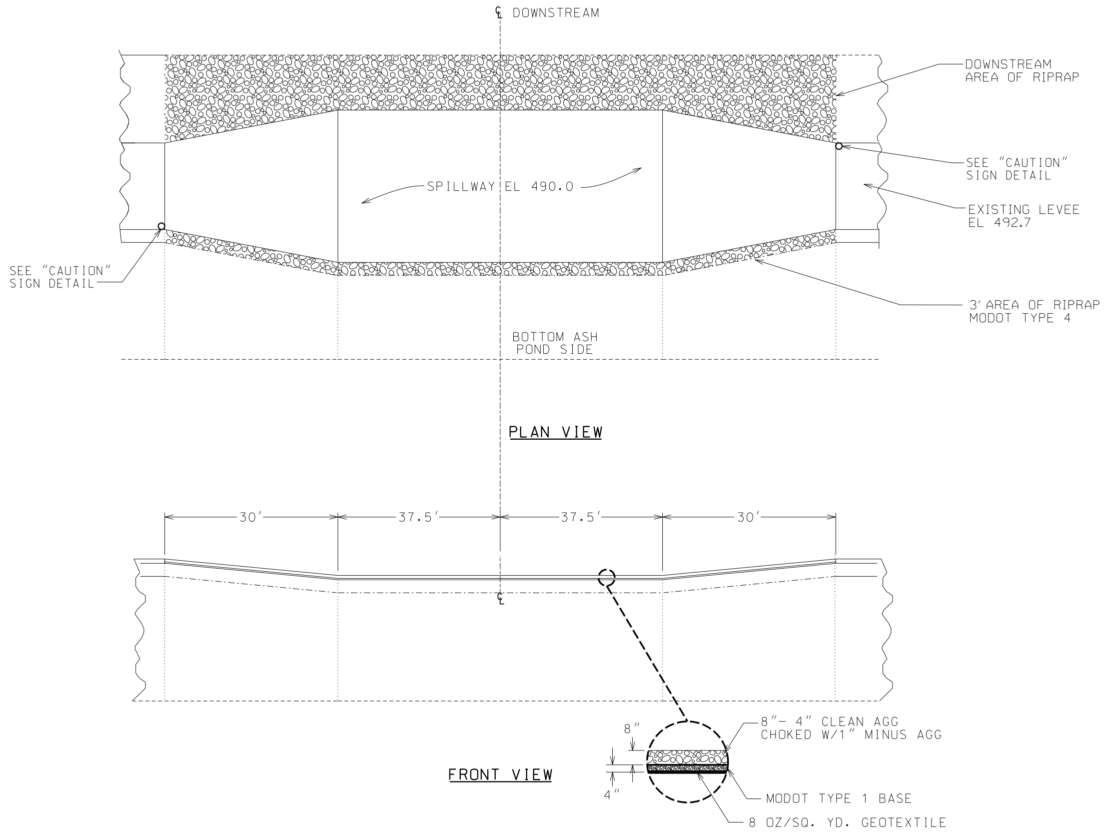
34 x 44

SHEET NO. 001	
LG-DWG-PROP-000006	000
DRAWING NO.	REV.



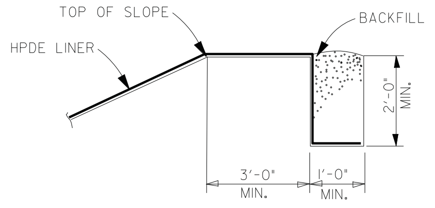
FLY ASH POND EMERGENCY SPILLWAY DETAIL

N.T.S.

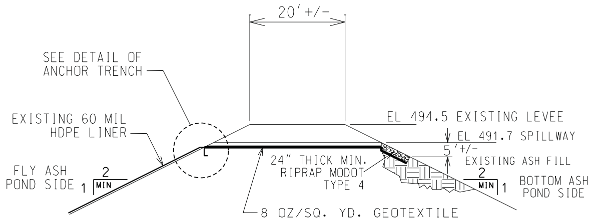


BOTTOM ASH POND EMERGENCY SPILLWAY DETAIL

N.T.S.

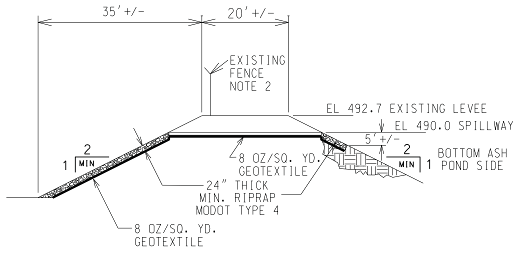


DETAIL OF ANCHOR TRENCH



SECTION 'A-A'

N.T.S.



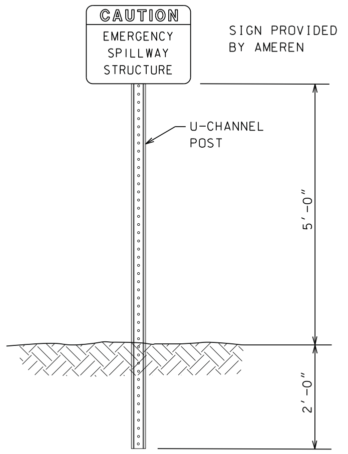
SECTION 'B-B'

N.T.S.

NOTES:

1). EXISTING HDPE LINER ANCHOR TRENCH WILL REQUIRE RELOCATION TO ALLOW INSTALLATION OF THE "EMERGENCY SPILLWAY". CARE SHALL BE TAKEN TO PROTECT THE EXISTING LINER FROM BEING DAMAGED DURING EXCAVATION AND ANCHOR TRENCH RELOCATION.

2). CONTRACTOR IS RESPONSIBLE FOR FENCE REMOVAL AS REQUIRED FOR CONSTRUCTION, AND LIKE KIND REPLACEMENT FOR FENCE UPON COMPLETION OF "EMERGENCY SPILLWAY" INSTALLATION.



DETAIL-"CAUTION" SIGN

REFERENCE DRAWINGS:
PROPERTY-CIVIL SITE PLAN------------------------8500-X-55002

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AS BUILT

MARK UP DRAWING NO.	REV.
------------------	---

SHEET NO. ---

DRAWING RECORD									
REV.	DATE	PROJECT NO.	AMEREN SUPV ENGR	DRAFTING DRFTR	DRAFTING CHK'D	DRAFTING SUPV	ENGR APPROVAL AMEREN	ENGR APPROVAL OTHER	DESCRIPTION
0	052312	-	-	MSB	MSB	KAJ	GC	-	FIRST ISSUE JR189839/ AS BUILT 9/ 13 /12

SCALE
NONE

UNIT NO.
A&2

DWG. SIZE
34X44

SUB CLASS
-

PROPERTY-CIVIL PLOT PLAN
FLY ASH & BOTTOM ASH POND
EMERGENCY SPILLWAYS-DETAILS &
SECTIONS

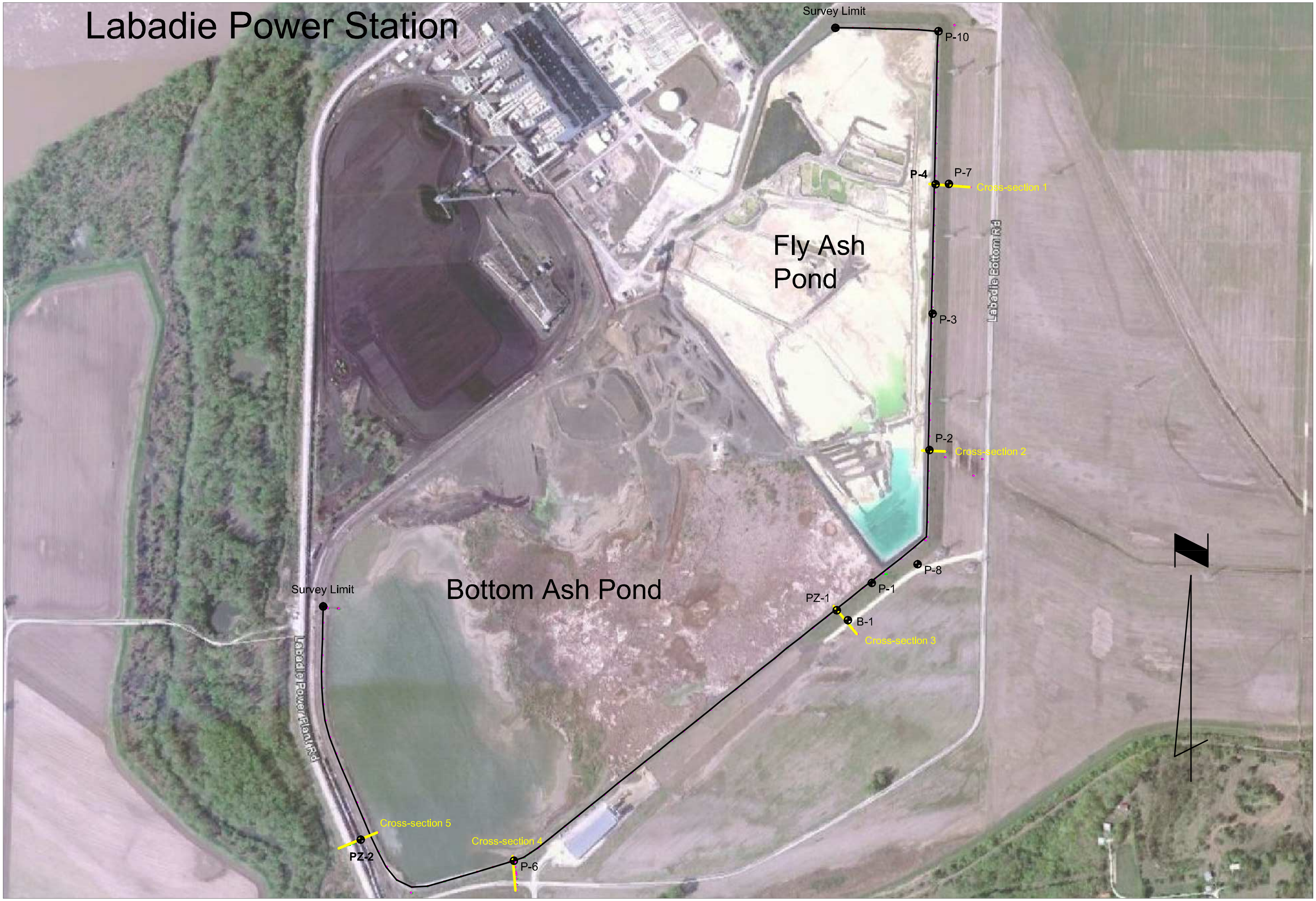
SITE:

TEXT HEIGHT

Ameren
MISSOURI

DRAWING NO.	REV.
LB-DWG-PROP-000006	000

SHEET NO. 001



Elevation Profile Survey Limits
Locations of Cross-section and Borings

REITZ & JENS, INC.
CONSULTING ENGINEERS

Figure 1

KEY TO BORING LOGS

Symbol	Description
KEY TO SOIL SYMBOLS	
▦	Crushed Limestone
▩	Miscellaneous FILL
▥	Low plastic Clayey SILT (ML)
▥	Inorganic, non-plastic SILT (ML)
▥	Silty SAND or Sandy SILT (SM)
░	Poorly-graded SAND (SP)
▨	High plastic CLAY (CH)
MISCELLANEOUS SYMBOLS	
▽	Water table during drilling
⌁	Boring continues
●	Moisture content (%)
▲	N-value from Standard Penetration Test, ASTM D-1586 (blows/ft)
SOIL SAMPLERS	
◩	2-in. O.D. Split-Spoon
▯	3-in. O.D. Shelby Tube

Notes:

1. Details of the drilling and sampling program are presented in the general introduction of the report

2. Stratification lines shown on the log represent approximate soil boundaries; actual changes in strata may be gradual or occur between samples.

Figure 2-0

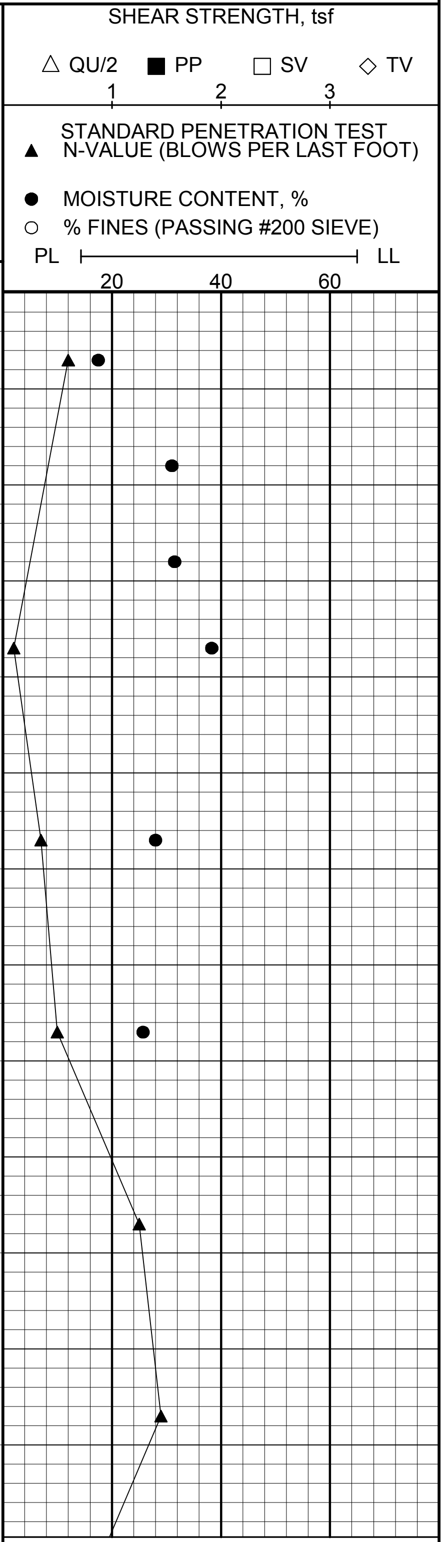
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-1

Ash Pond Stability
Labadie Power Plant
CLIENT: **Ameren Missouri**

LOCATION: N 990518.668 E 725765.215
ELEVATION: 467.7 DATUM: NAVD88
DATE DRILLED: 6-21-10

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0				8" CRUSHED LIMESTONE, 1-1/2" clean rock		
			78	Fill, gray-brown, very stiff, silty clay, dry, with trace ash	2-4-8	17.5
	465	▽				
5			58	Clayey SILT (ML), brown, moist, with very fine sand, fine roots and trace limonite	84.4	31.0
			92	SILT (ML), brownish gray, medium dense, trace clay and very fine sand, soft, very moist	90.2	31.5
	460					
			83	Becoming clayey, stiff	0-1-1	38.3
10				Began mud rotary drilling at 10'		
	455					
			89	Sandy SILT (SM), brown, fine grain, with fine sand lenses, loose	2-4-3	28.0
15						
	450					
			89	Becoming gray, and medium dense	4-4-6	25.7
20						
	445					
			94	SAND (SP), gray, fine grain, trace silt and lignite, dense	6-12-13	
25						
	440					
			89	Without silt	6-10-19	
30						



DRILLER: Terra Drill
METHOD: HSA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 88.6
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 3 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT ___ FEET

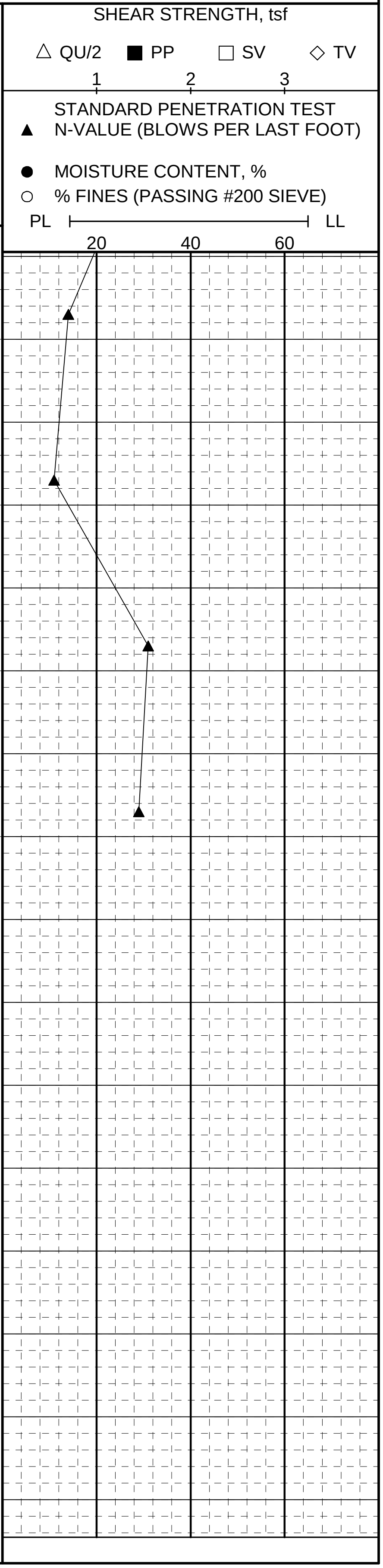
File: 2010012488

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG B-1

Ash Pond Stability

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	435				78	Becoming medium dense	2-5-9	
35	430				67	Becoming fine to medium grain sand, and trace coarse sand	6-5-6	
40	425				89	Becoming dense	9-12-19	
45	420				89	Becoming medium grain sand with fine and coarse grain sand, trace fine gravel	9-12-17	
50						Boring terminated at 50'-0"		
	415							
55	410							
60	405							
65	400							
70								



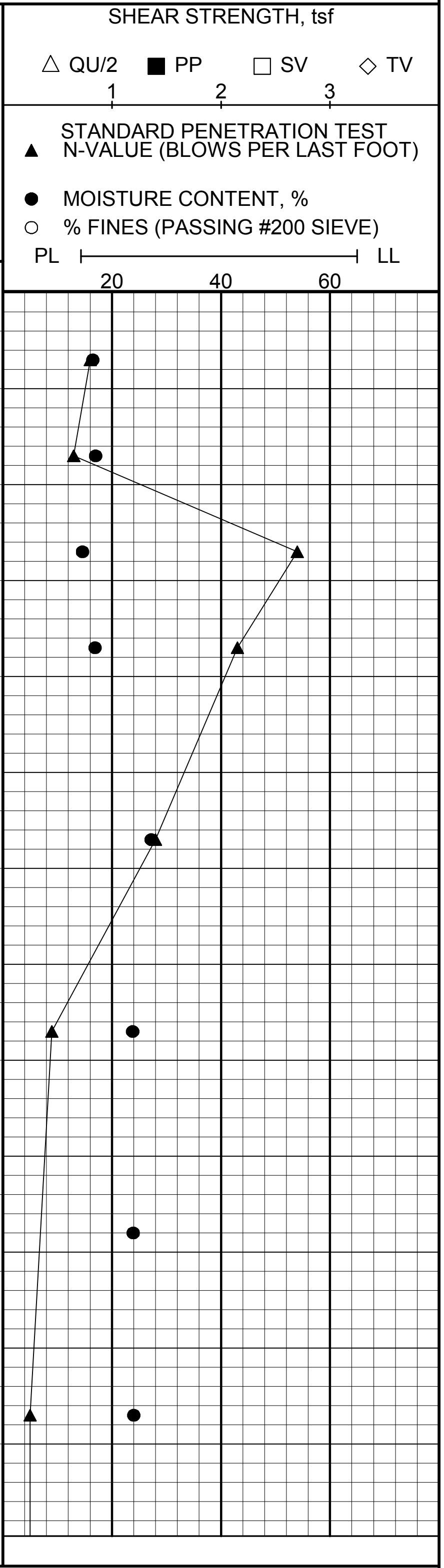
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG PZ-1

Ash Pond Stability
Labadie Power Plant
CLIENT: **Ameren Missouri**

LOCATION: N 990578.486 E 725699.099
ELEVATION: 493.6 DATUM: NAVD88
DATE DRILLED: 06-25-10

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0								
					67	FILL, consisting mostly of bottom ash, layered with sand, high plastic clay, silty clay and fly ash, medium dense, dry	2-7-9	16.5
	490							
					89		4-6-7	17.0
5								
					100	Becoming very dense	6-22-32	14.6
	485							
					89		12-22-21	16.9
10								
	480				100	Becoming dense, moist	7-11-17	27.2
15								
	475				100	CLAY (CH), gray, high plastic, with silt and fine sand, stiff	2-3-6	23.8
20								
						PZ-1, screened interval from 22'6" to 27'6"		
	470				96	Becoming gray-brown and dark grayish tan, with silty clay, clayey silt and very fine sand	98.4	23.9
25								
	465				100	CLAY (CH), gray-brown, high plastic, with variable silt content, stiff	2-3-6	24.0
30								



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 88.6
LOGGED BY: JJP

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 33 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

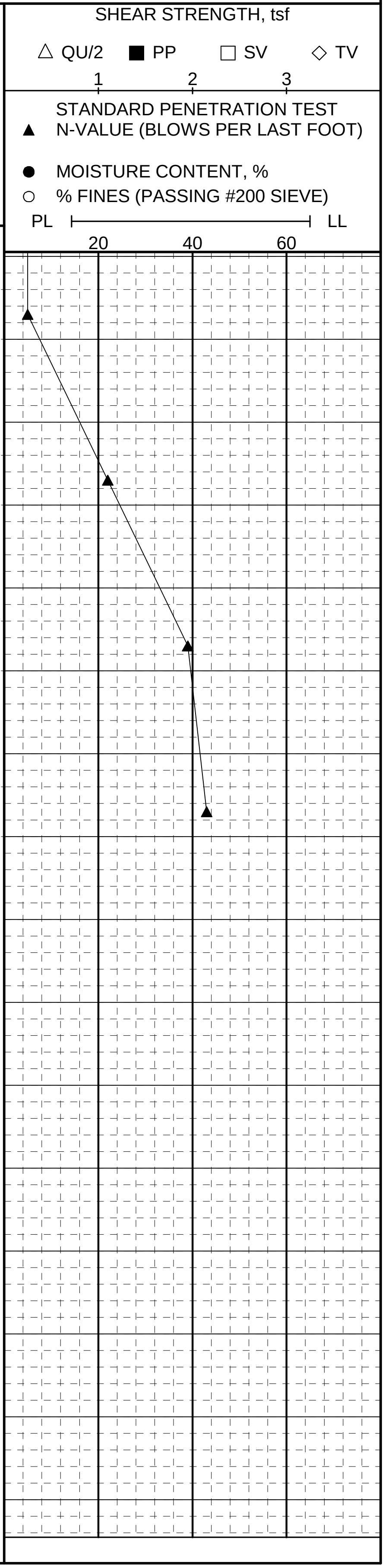
File: 2010012488

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG PZ-1

Ash Pond Stability

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	460	▽			100	SAND (SP), tan, fine grain, loose	2-3-2	
35						Began mud rotary drilling at 35'		
	455				100	Becoming medium dense	7-10-12	
40								
	450				72	Becoming dense, fine to medium grain with some clay laminations, trace fine gravel	8-16-23	
45								
	445				100	Becoming fine to coarse grain with fine gravel	11-20-23	
50						Boring terminated at 50'-0"		
	440							
55								
	435							
60								
	430							
65								
	425							
70								



File: 2010012488

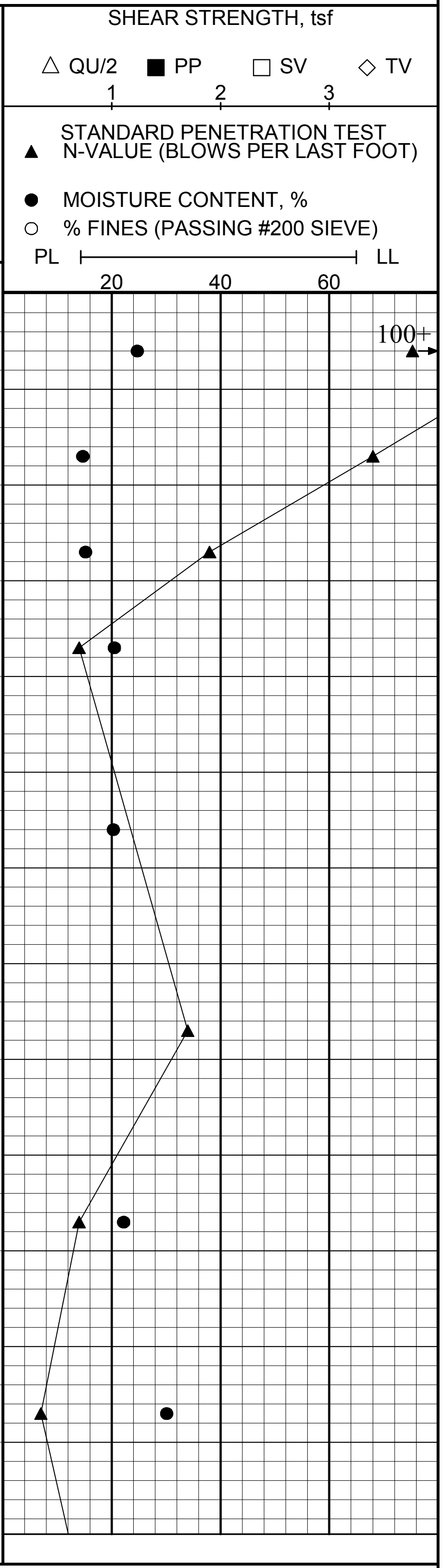
REITZ & JENS, INC.
CONSULTING ENGINEERS

B O R I N G L O G PZ-2

Ash Pond Stability
Labadie Power Plant
CLIENT: **Ameren Missouri**

LOCATION: N 989158.946 E 722726.691
ELEVATION: 489.2 DATUM: NAVD88
DATE DRILLED: 06-23-10

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0				FILL, consisting of bottom ash, fly ash and trace coal, very dense, dry		
			92		18-50/5	24.7
	485		94		12-28-40	14.7
5						
			100	Trace crushed limestone	10-18-20	15.2
	480		100	FILL, brown, clayey silt, very stiff, moist	4-6-8	20.5
10						
				PZ-2, screened interval from 11'4" to 21'4"		
	475	▽	92	Becoming sandy silt, and gray and brown	109.5	20.3
15						
				SAND (SP), tan, fine grain, very dense Began mud rotary drilling at 15.5'		
	470		94		10-18-16	
20						
	465		100	Silty SAND (SM), gray, fine grain, medium dense	2-6-8	22.2
25						
	460		100	Becoming tan-brown, loose, very moist	1-2-5	30.1
30						



DRILLER: Terra Drill
METHOD: HSA/Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): 88.6
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 14.5 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2010012488

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG PZ-2

Ash Pond Stability

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	455				78	Becoming medium dense	5-7-8	
35								
	450				89	Sandy SILT (SM), medium-gray, medium dense, fine sand, with trace carbon and clay	1-3-7	52.9
40						Boring terminated at 40'-0" in silty sand		
	445							
45								
	440							
50								
	435							
55								
	430							
60								
	425							
65								
	420							
70								

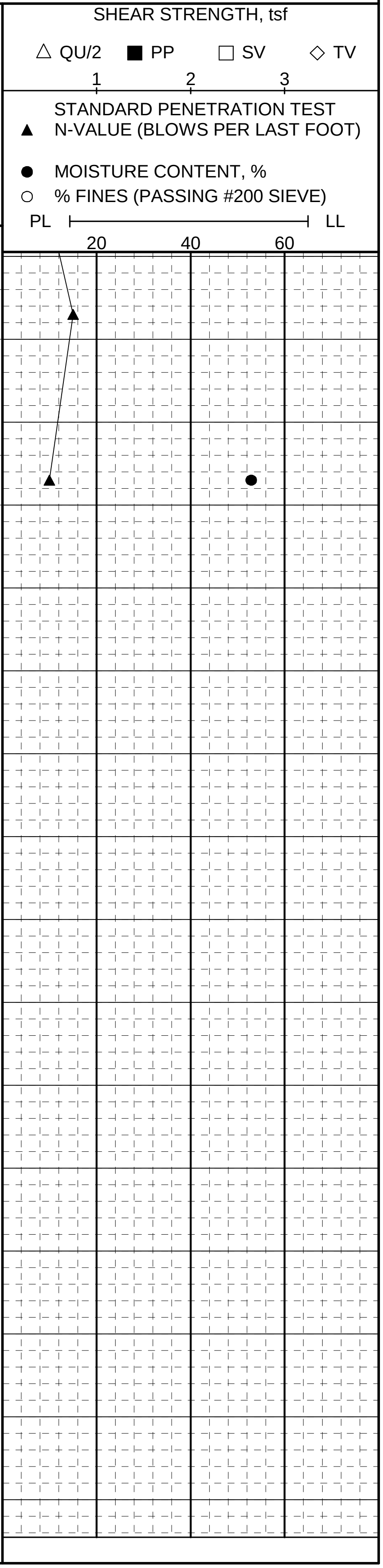
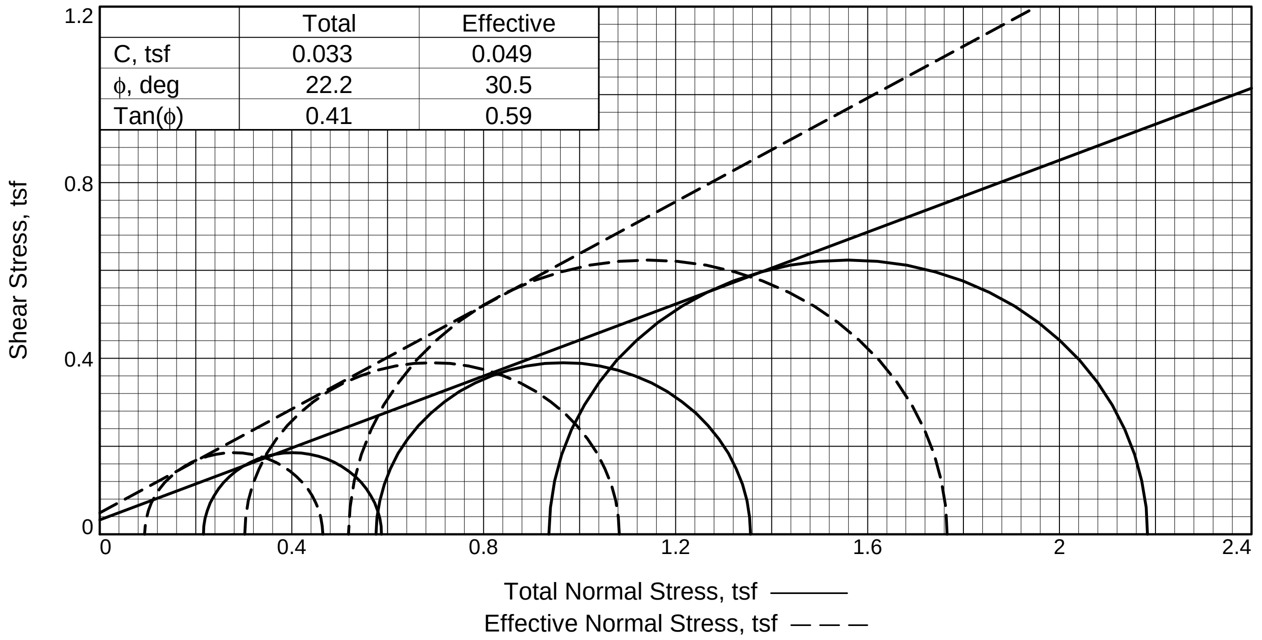
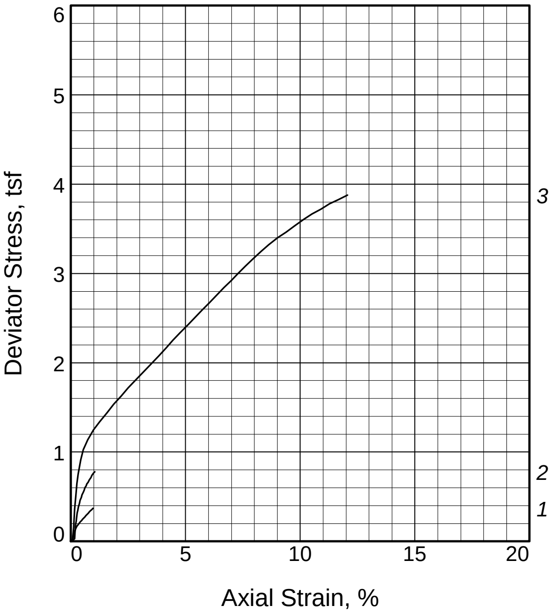


Figure 2-3



	Total	Effective
C, tsf	0.033	0.049
ϕ, deg	22.2	30.5
Tan(ϕ)	0.41	0.59



	Sample No.	1	2	3
Initial	Water Content,	31.4	31.4	31.4
	Dry Density, pcf	89.3	89.3	89.3
	Saturation,	96.5	96.5	96.5
	Void Ratio	0.8733	0.8733	0.8733
	Diameter, in.	2.85	2.85	2.85
	Height, in.	5.82	5.82	5.82
At Test	Water Content,	32.2	31.9	31.7
	Dry Density, pcf	89.8	90.2	90.5
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.8637	0.8549	0.8491
	Diameter, in.	2.85	2.86	2.87
	Height, in.	5.81	5.75	5.68
	Strain rate, %/min.	0.05	0.05	0.05
	Back Pressure, tsf	3.96	4.32	5.04
	Cell Pressure, tsf	4.18	4.90	5.98
	Fail. Stress, tsf	0.37	0.78	1.25
	Total Pore Pr., tsf	4.08	4.59	5.46
	Ult. Stress, tsf			3.88
	Total Pore Pr., tsf			4.51
	$\bar{\sigma}_1$ Failure, tsf	0.46	1.08	1.77
	$\bar{\sigma}_3$ Failure, tsf	0.09	0.30	0.52

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tube

Description: SILT (ML), brownish grey, slightly clayey, traces of fine sand, highly laminated near bottom of sample

Assumed Specific Gravity= 2.68

Remarks:

Figure 2-4

Client: Ameren Missouri

Project: Ash Pond Stability

Source of Sample: B-1 **Depth:** 6

Sample Number: ST-3

Proj. No.: 2010012488 **Date:** 6/25/2010

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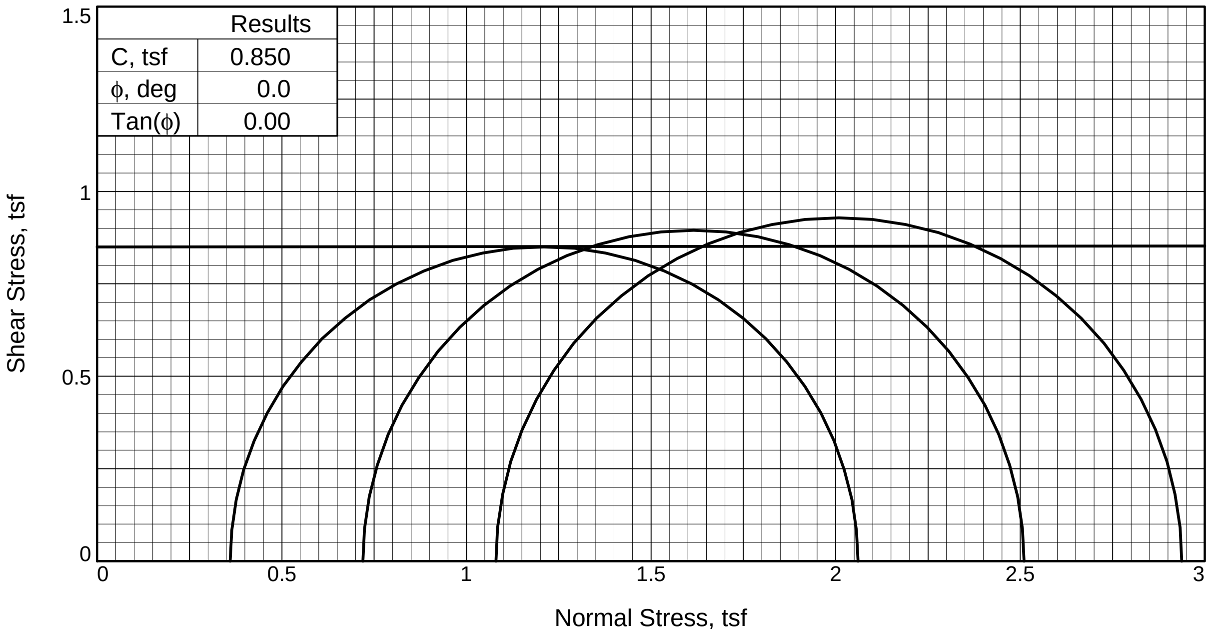
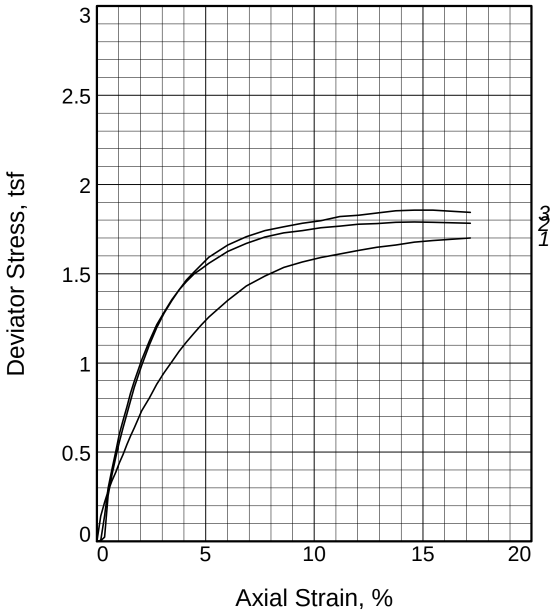
CONSULTING ENGINEERS

Tested By: K. Kocher **Checked By:** J. Bertel



Results	
C, tsf	0.850
ϕ, deg	0.0
Tan(ϕ)	0.00



	Sample No.	1	2	3
Initial	Water Content,	23.1	24.7	24.0
	Dry Density, pcf	98.8	97.8	98.7
	Saturation,	89.2	93.2	92.4
	Void Ratio	0.6940	0.7109	0.6959
	Diameter, in.	2.85	2.85	2.85
	Height, in.	5.82	5.82	5.82
At Test	Water Content,	23.1	24.7	24.0
	Dry Density, pcf	98.8	97.8	98.7
	Saturation,	89.2	93.2	92.4
	Void Ratio	0.6940	0.7109	0.6959
	Diameter, in.	2.85	2.85	2.85
	Height, in.	5.82	5.82	5.82
	Strain rate, %/min.	0.83	0.83	0.83
	Back Pressure, tsf	0.00	0.00	0.00
	Cell Pressure, tsf	0.36	0.72	1.08
	Fail. Stress, tsf	1.70	1.79	1.86
	Ult. Stress, tsf			
	σ_1 Failure, tsf	2.06	2.51	2.94
	σ_3 Failure, tsf	0.36	0.72	1.08

Type of Test:
Unconsolidated Undrained

Sample Type: Shelby Tube

Description: Clay FILL (CH), dark gray and grayish tan, silty clay, clayey silt and high plasticity clay, with very fine sand and trace

Assumed Specific Gravity= 2.68

Remarks:

Client: Ameren Missouri

Project: Ash Pond Stability

Source of Sample: PZ-1 **Depth:** 23.5

Sample Number: 7

Proj. No.: 2010012488 **Date:** 07-28-10

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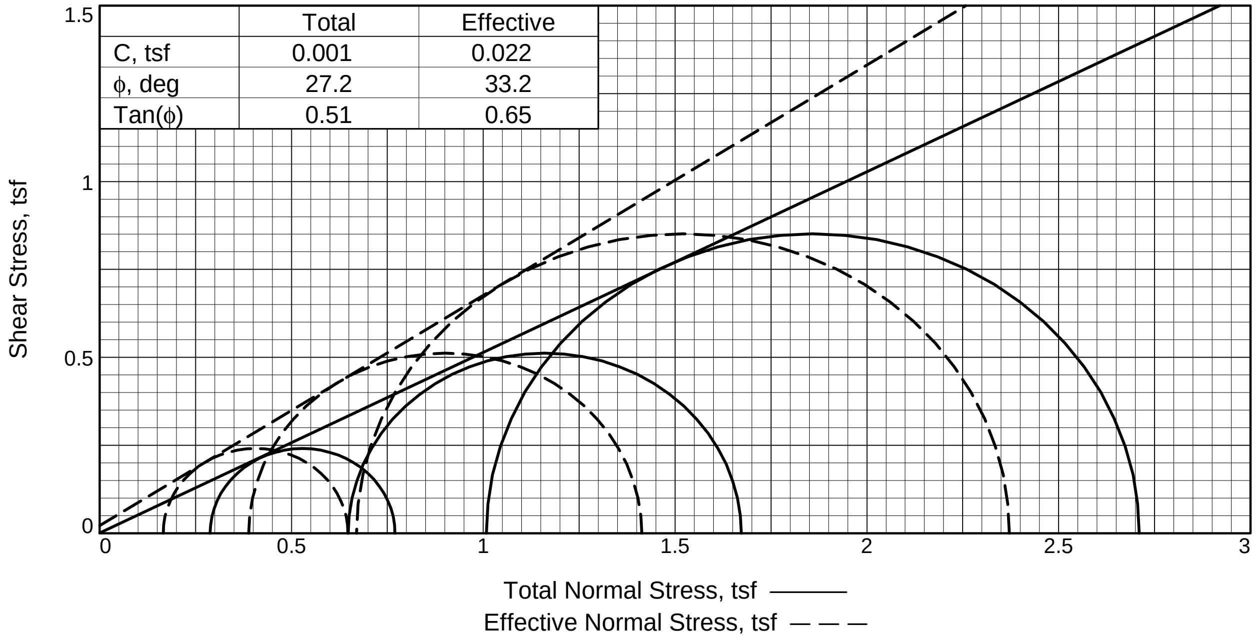
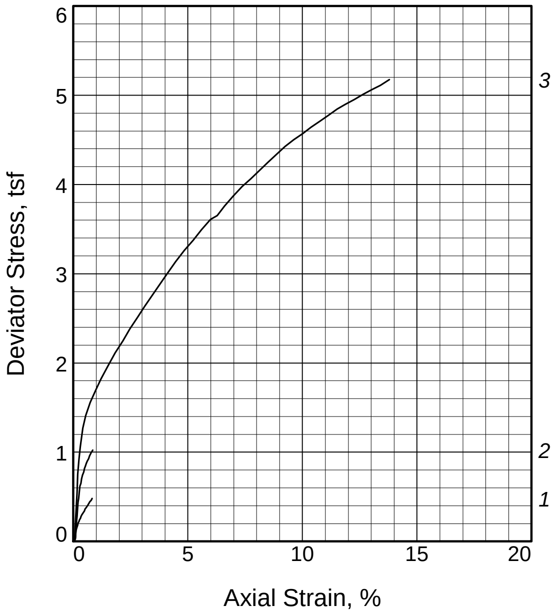
Figure 2-5

Tested By: J. David/J. Pruett

	Total	Effective
C, tsf	0.001	0.022
ϕ, deg	27.2	33.2
Tan(ϕ)	0.51	0.65





Sample No.		1	2	3
Initial	Water Content,	20.3	20.3	20.3
	Dry Density, pcf	109.5	109.5	109.5
	Saturation,	103.0	103.0	103.0
	Void Ratio	0.5274	0.5274	0.5274
	Diameter, in.	2.85	2.85	2.85
	Height, in.	5.82	5.82	5.82
At Test	Water Content,	19.6	19.6	19.4
	Dry Density, pcf	109.7	109.7	110.1
	Saturation,	100.0	100.0	100.0
	Void Ratio	0.5251	0.5251	0.5203
	Diameter, in.	2.85	2.86	2.87
	Height, in.	5.82	5.77	5.71
Strain rate, %/min.		0.05	0.05	0.05
Back Pressure, tsf		3.96	4.32	5.04
Cell Pressure, tsf		4.25	4.97	6.05
Fail. Stress, tsf		0.48	1.02	1.70
Total Pore Pr., tsf		4.08	4.58	5.38
Ult. Stress, tsf				5.18
Total Pore Pr., tsf				4.12
$\bar{\sigma}_1$ Failure, tsf		0.65	1.41	2.37
$\bar{\sigma}_3$ Failure, tsf		0.17	0.39	0.67

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tube

Description: Sandy silt FILL (SM), brown and grey, with clay

Assumed Specific Gravity= 2.68

Remarks:

Client: Ameren Missouri

Project: Ash Pond Stability

Source of Sample: PZ-2 **Depth:** 13.5

Sample Number: ST-5

Proj. No.: 2010012488 **Date:** 6/25/2010

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Figure 2-6

Tested By: K. Kocher **Checked By:** J. Fouse

LEGEND

KEY TO SOIL SYMBOLS

Symbol	Description
≋	Organic Material
▨	Clay
▨	Silty Clay to Clay
▥	Clayey Silt to Silty Clay
▥	Sandy Silt to Clayey Silt
▥	Silty Sand to Sandy Silt
░	Sand to Silty Sand
░	Sand
▓	Gravelly Sand to Sand

│ qc = Cone Tip Pressure, tons/sq. ft.

│ fs = Skin Friction, tons/sq. ft.

│ Rf = Friction ratio (fs/qc) in %

│ u2 = Porewater Pressure, psi

│ N60 = Calculated Equivalent N-value, blows/foot, (Standard Penetration Test)

│ Su = Calculated Undrained Shear Strength, ksf

│ Phi = Friction Angle, degrees

Notes:

1. Details of the drilling and sampling program are presented in the general introduction of the report.
2. Stratification lines shown on the log represent approximate soil boundaries; actual changes in strata may be gradual.

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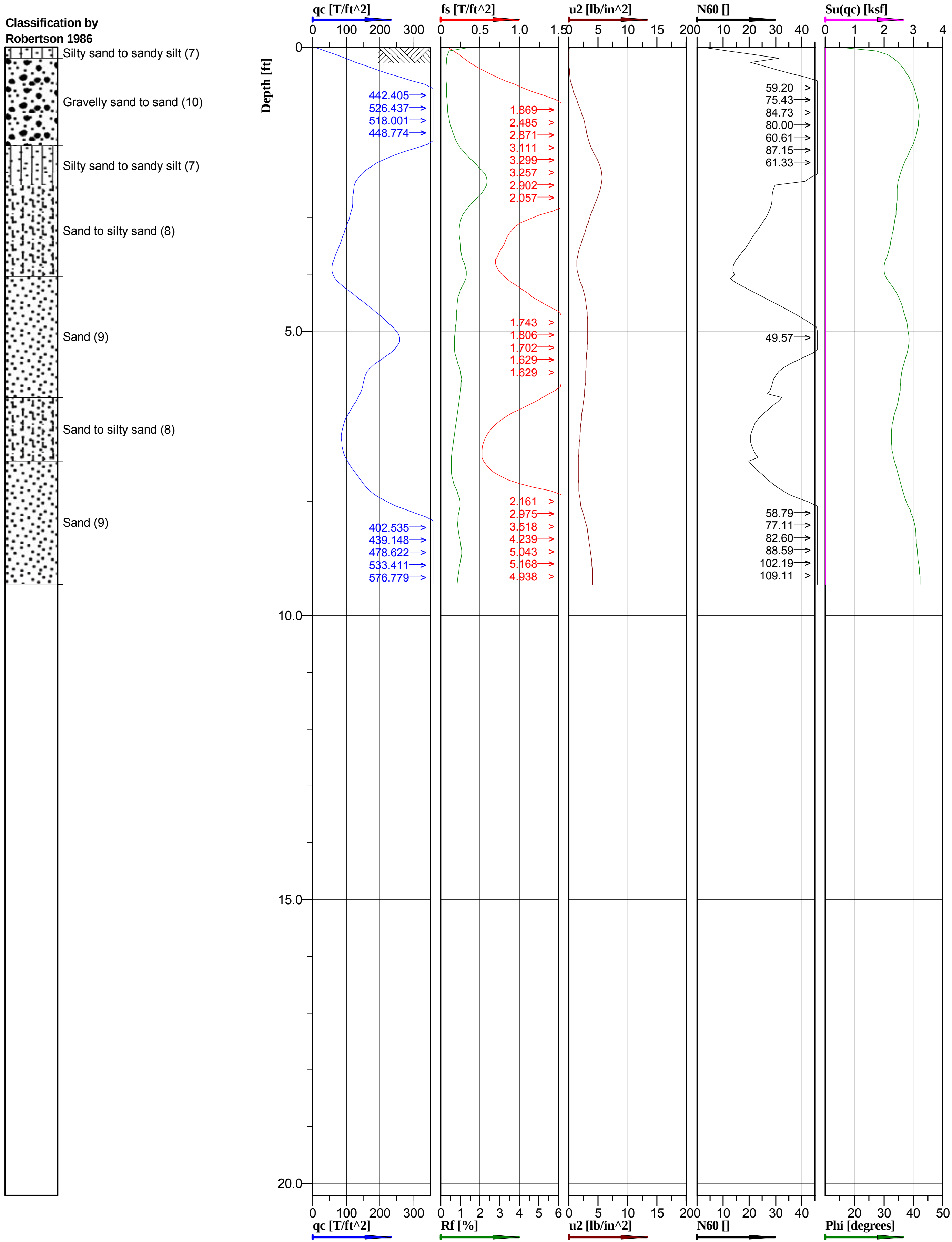
[1] Robertson et al. (1986) *Use of piezometer cone data.* Proceedings of the ASCE Specialty Conference: In Situ 86: Use of In Situ Tests in Geotechnical Engineering. ASCE 1986

[2] Lunne, T. Robertson, P.K. and Powell, J.J.M. (1997) Cone Penetration Testing in Geotechnical Practice, Published by Blackie Academic & Professional.

[3] Bowles, Joseph E. (1996) Foundation Analysis and Design. McGraw-Hill. 5th ed. Page 180.

Figure 3-0



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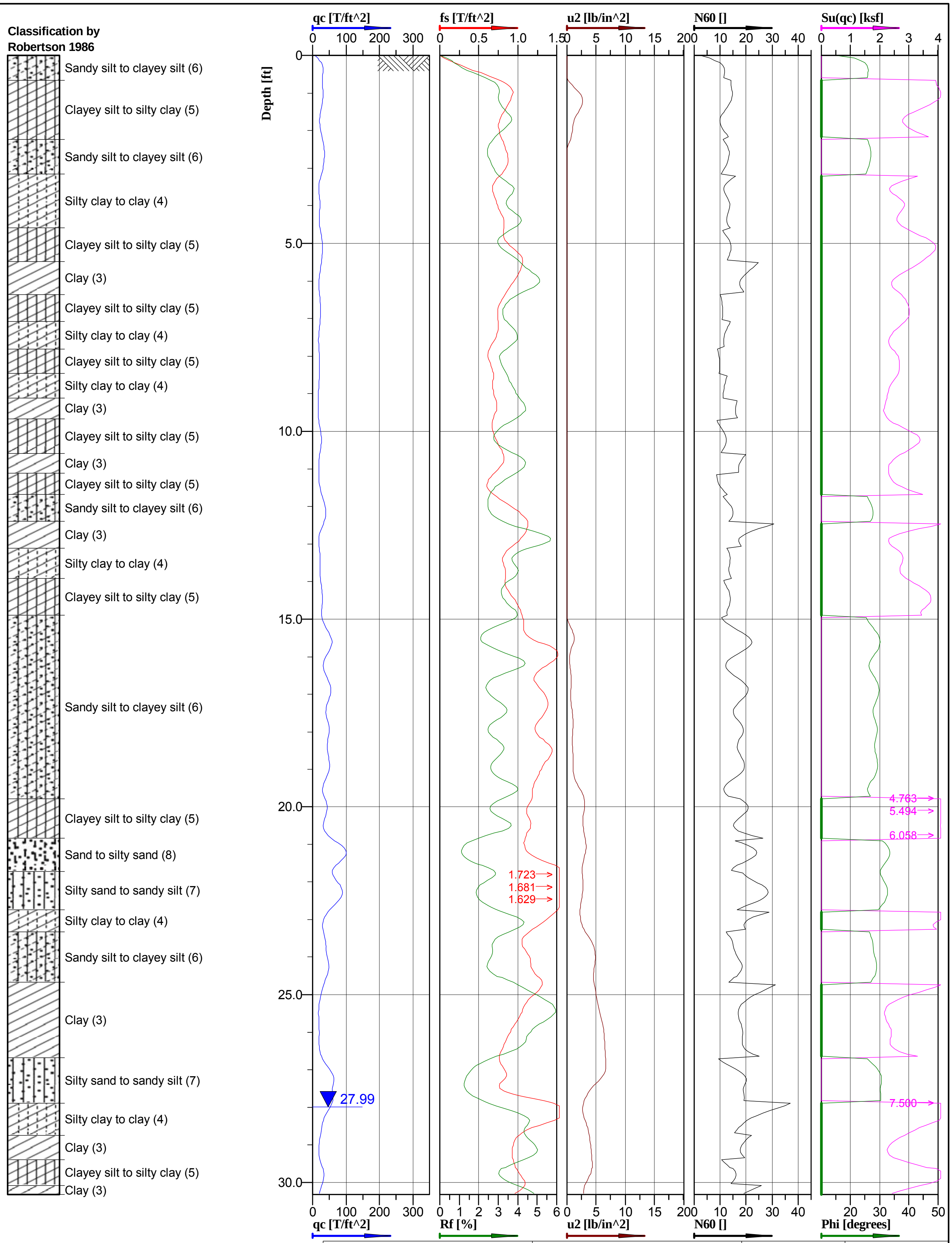
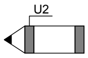
CONSULTING ENGINEERS

U2

Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant	Position: X: 725910.99 ft, Y: 990746.00 ft	Ground level: 493.50	Test no: P-1
Project ID: 2010012488	Client: Ameren Missouri	Date: 6/23/2010	Scale: 1 : 28
Project: Ash Pond Stability Analysis		Page: 1/1	Fig: 3-1
Boring terminated at 9.5' due to augers pulling out.		File: P-1.cpd	

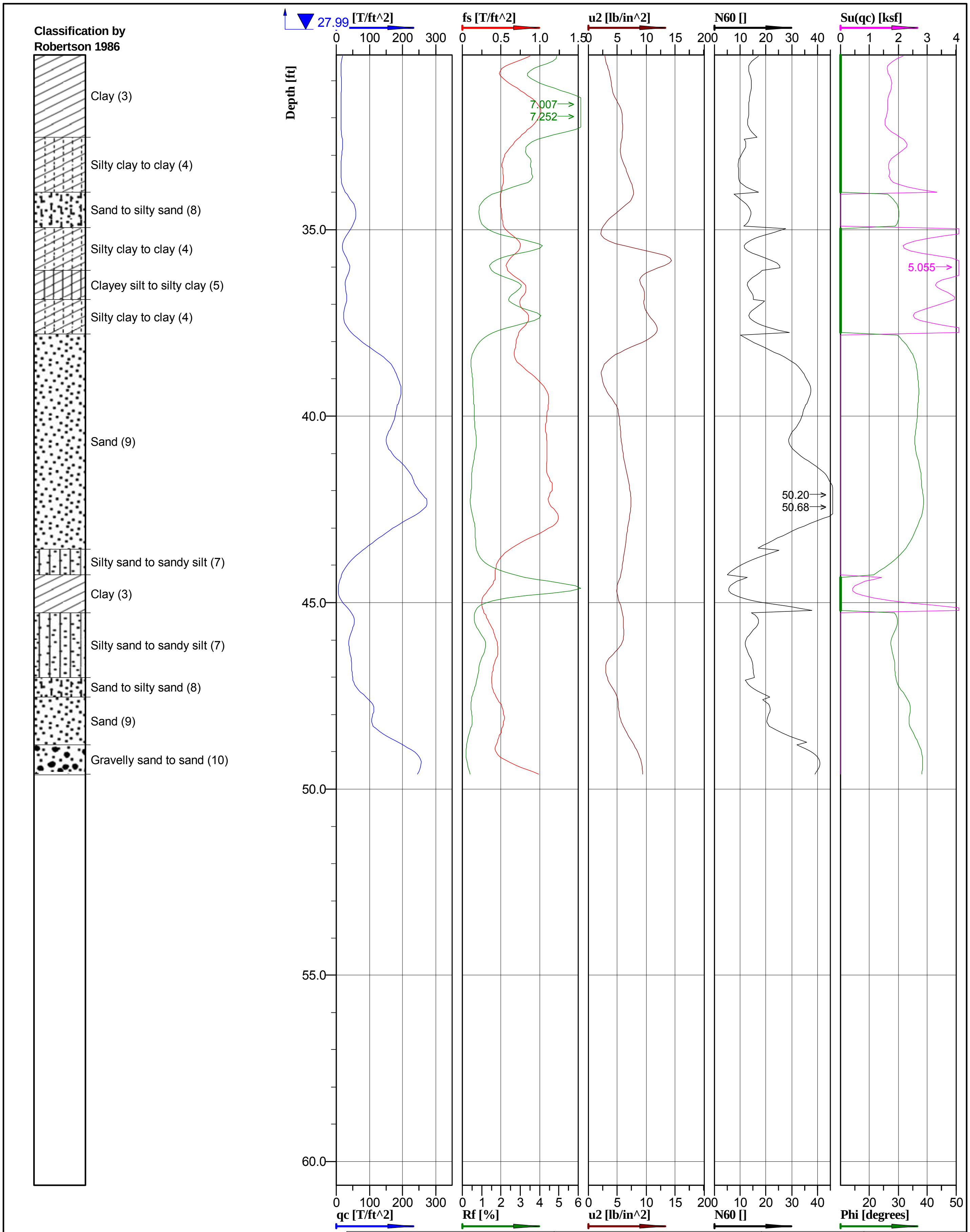


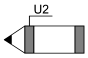


Location: Labadie Power Plant
Position: X: 726264.53 ft, Y: 991560.33 ft
Ground level: 492.78
Test no: P-2
Project ID: 2010012488
Client: Ameren Missouri
Date: 6/23/2010
Scale: 1 : 42
Project: Ash Pond Stability Analysis
Page: 1/2
Fig: 3-2
File: P-2.cpd

Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

REITZ & JENS, INC.
CONSULTING ENGINEERS

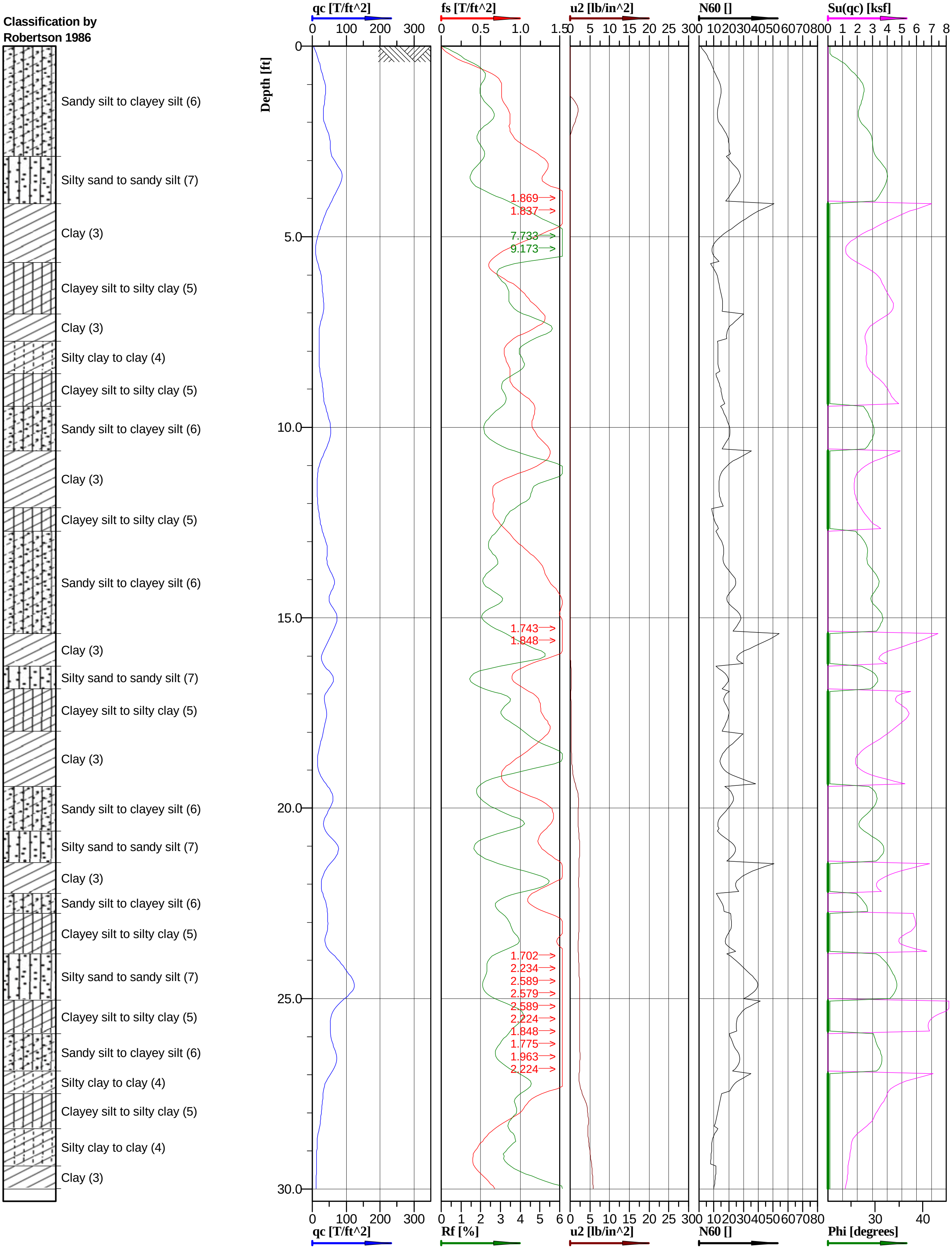




Reitz & Jens, Inc.
CONSULTING ENGINEERS

Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant	Position: X: 726264.53 ft, Y: 991560.33 ft	Ground level: 492.78	Test no: P-2
Project ID: 2010012488	Client: Ameren Missouri	Date: 6/23/2010	Scale: 1 : 42
Project: Ash Pond Stability Analysis		Page: 2/2	Fig: 3-2
		File: P-2.cpd	



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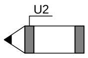
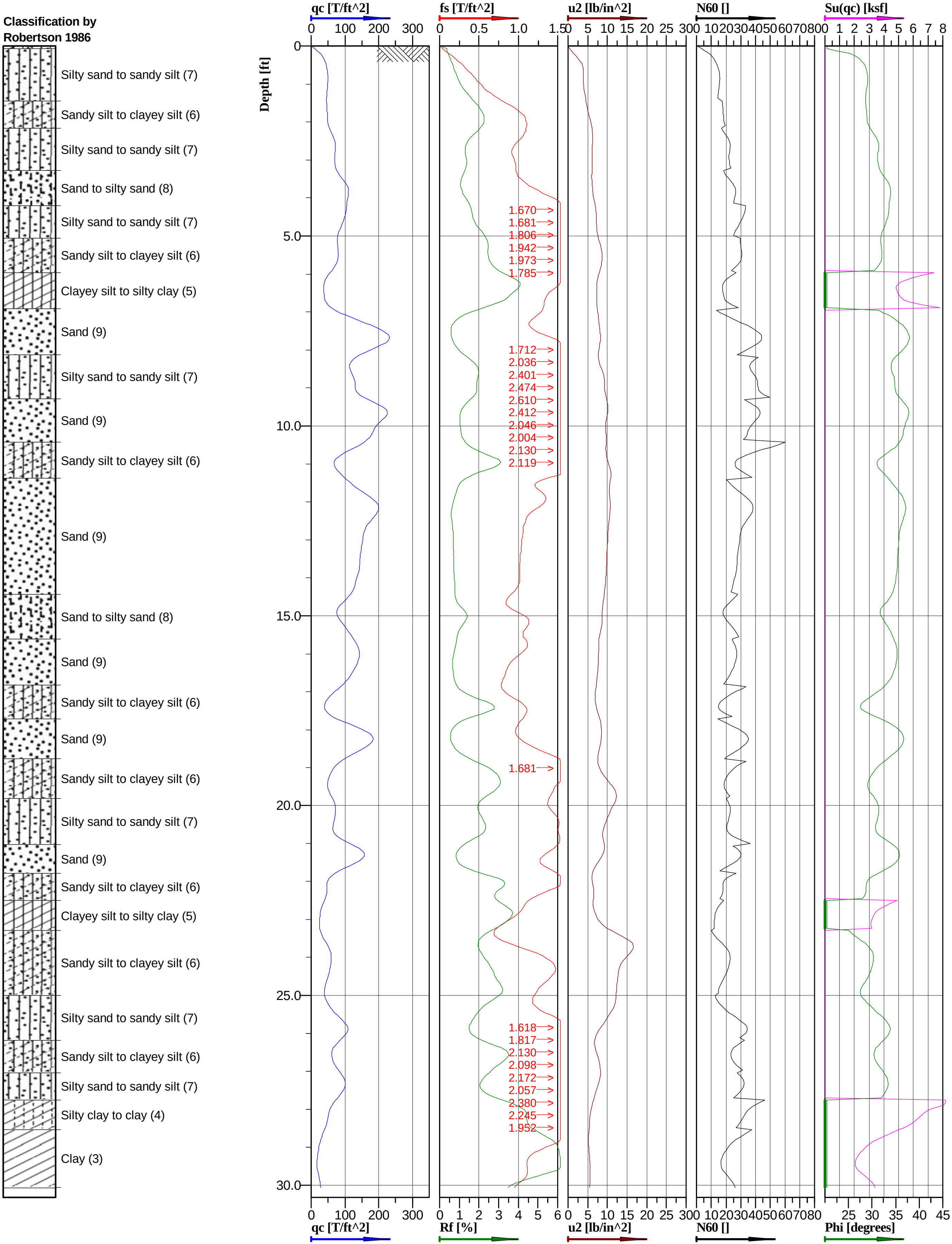
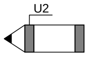


Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant	Position: X: 726283.89 ft, Y: 992395.37 ft	Ground level: 492.49	Test no: P-3
Project ID: 2010012488	Client: AmerenUE	Date: 6/23/2010	Scale: 1 : 42
Project: Ash Pond Stability Analysis		Page: 1/1	Fig: 3-3
Revised 8/2/2011		File:	P-3.cpd





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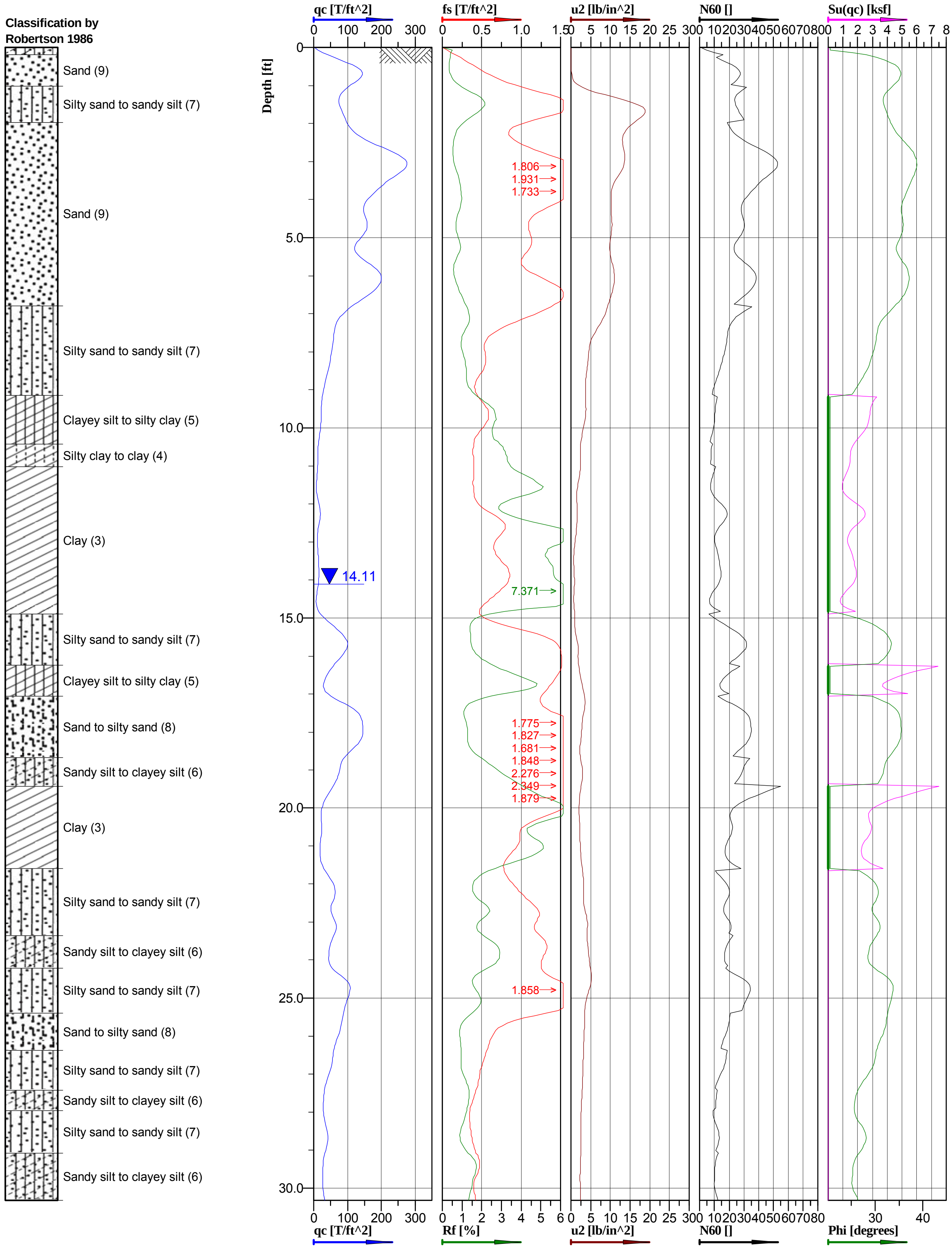
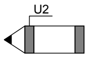
CONSULTING ENGINEERS

Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

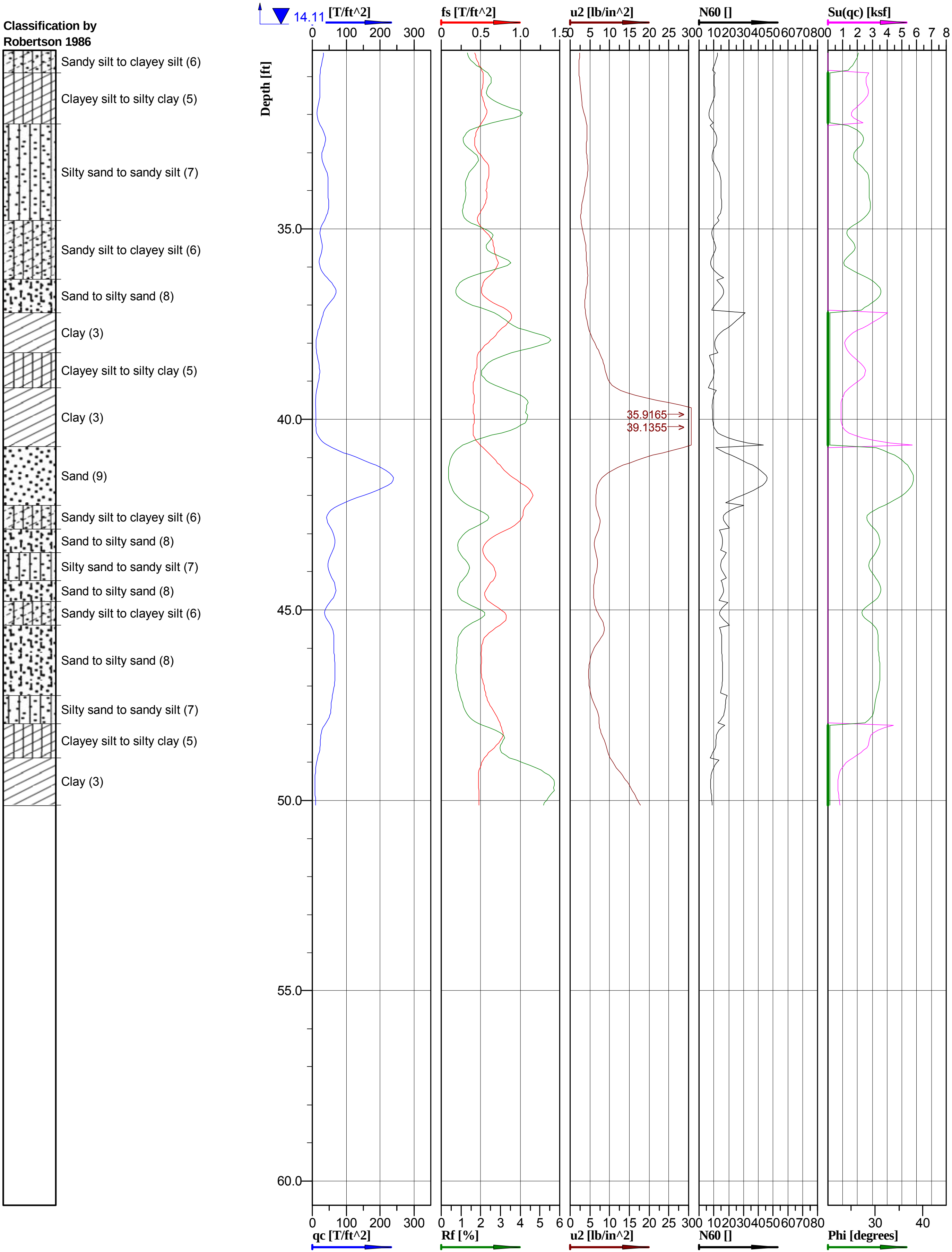
Location: Labadie Power Plant
Position: X: 726302.49 ft, Y: 993187.86 ft
Ground level: 493.64
Test no: P-4
Project ID: 2010012488
Client: AmerenUE
Date: 6/24/2010
Scale: 1 : 42
Project: Ash Pond Stability Analysis
Page: 1/1
Fig: 3-4
Revised 8/2/2011
File: P-4.cpd





Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant
Position:
Ground level: 493.50
Test no: P-6
Project ID: 2010012488
Client: Ameren Missouri
Date: 6/23/10
Scale: 1 : 42
Project: Ash Pond Stability Analysis
Page: 1/2
Fig: 3-5
File: P-6.cpd



Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant	Position:	Ground level: 493.50	Test no: P-6
Project ID: 2010012488	Client: Ameren Missouri	Date: 6/23/10	Scale: 1 : 42
Project: Ash Pond Stability Analysis		Page: 2/2	Fig: 3-5
		File:	P-6.cpd

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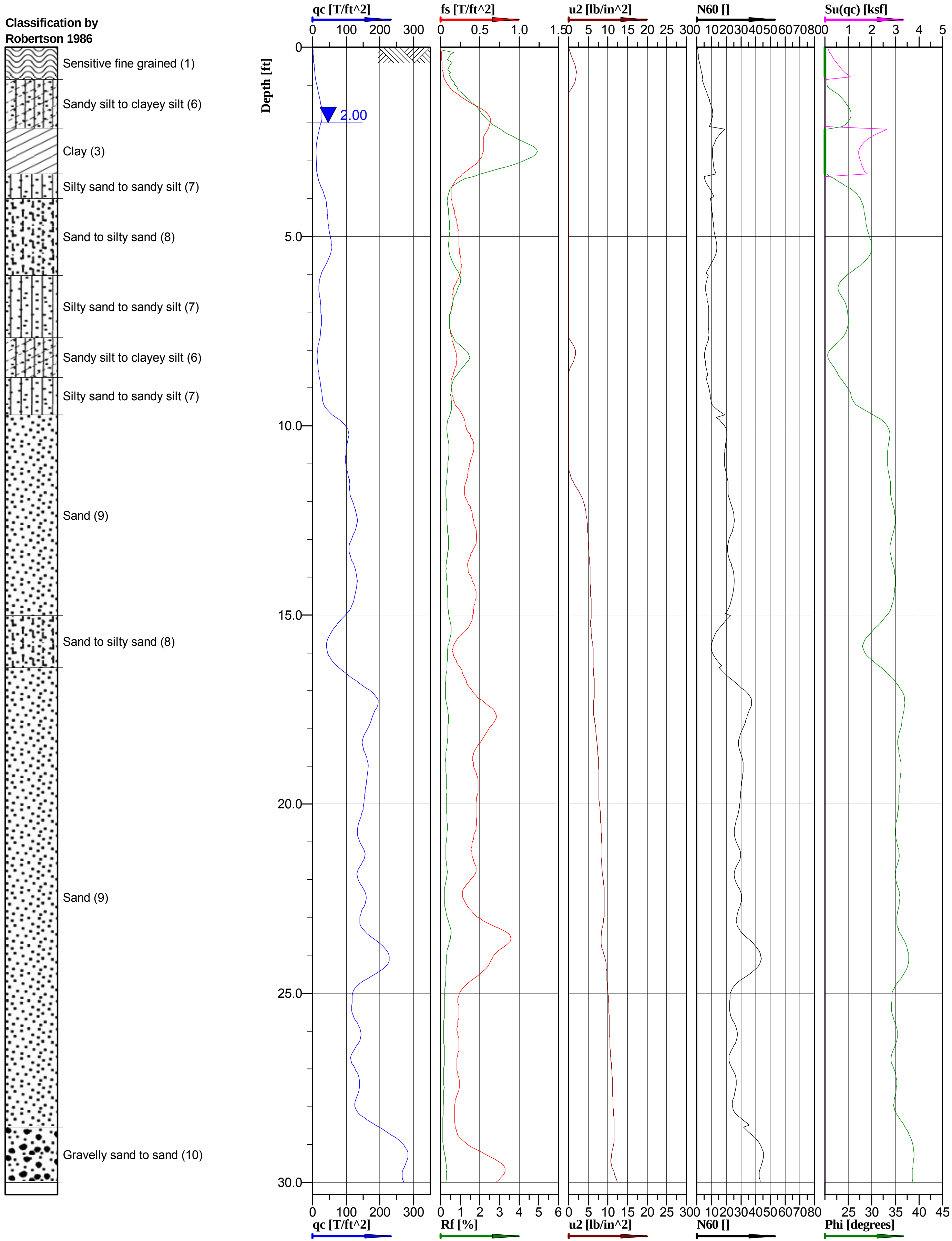

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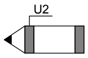
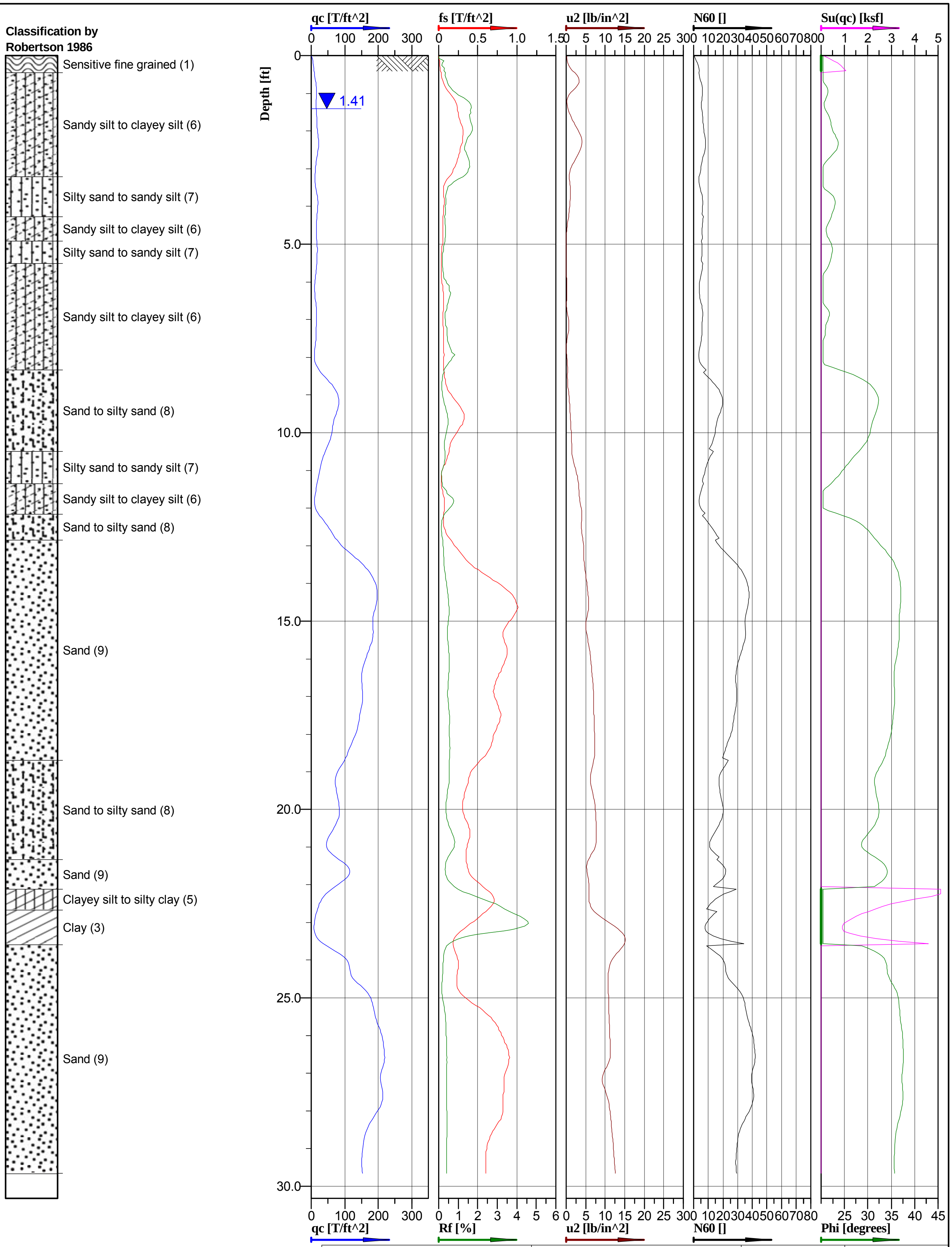


Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant	Position: X: 726383.37 ft, Y: 993189.86 ft	Ground level: 467.19	Test no: P-7
Project ID: 2010012488	Client: Ameren Missouri	Date: 6/24/2010	Scale: 1 : 42
Project: Ash Pond Stability Analysis		Page: 1/1	Fig: 3-6
		File: P-7b.cpd	



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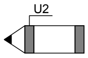
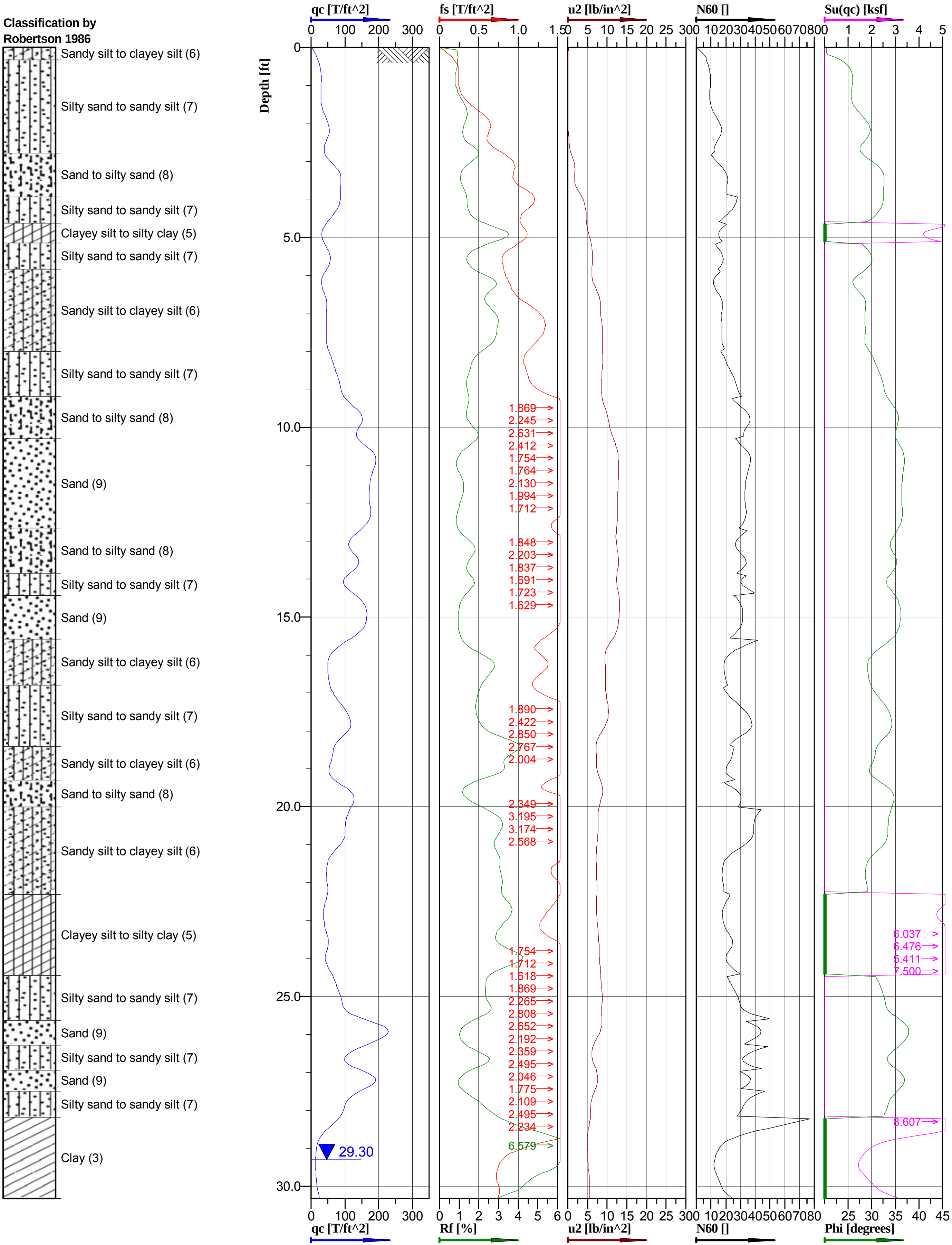
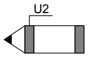


Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant	Position: X: 726192.03 ft, Y: 990861.09 ft	Ground level: 466.67	Test no: P-8
Project ID: 2010012488	Client: Ameren Missouri	Date: 6/24/10	Scale: 1 : 42
Project: Ash Pond Stability Analysis		Page: 1/1	Fig: 3-7
		File: P-8.cpd	

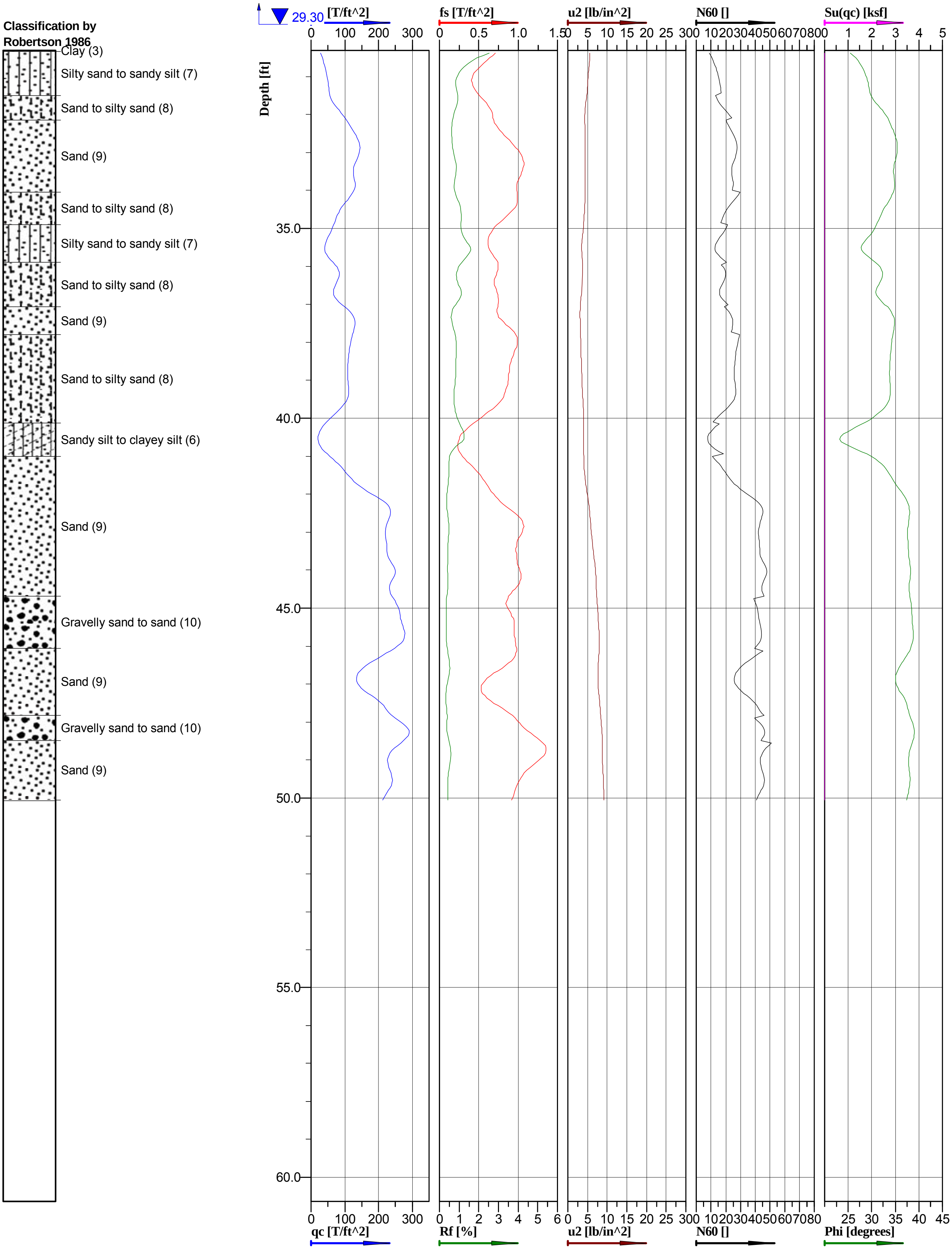




Reitz & Jens, Inc.
Consulting Engineers

Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant	Position: X: 726319.59 ft, Y: 994124.90 ft	Ground level: 493.37	Test no: P-10
Project ID: 2010012488	Client: Ameren Missouri	Date: 6/24/2010	Scale: 1 : 42
Project: Ash Pond Stability Analysis		Page: 1/2	Fig: 3-8
		File: P-10.cpd	



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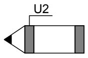
Consulting Engineers



Cone No: 4274
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Labadie Power Plant	Position: X: 726319.59 ft, Y: 994124.90 ft	Ground level: 493.37	Test no: P-10
Project ID: 2010012488	Client: Ameren Missouri	Date: 6/24/2010	Scale: 1 : 42
Project: Ash Pond Stability Analysis		Page: 2/2	Fig: 3-8
		File: P-10.cpd	

F-348-C-50 PADS 9-63

TEST BORING REPORT
RAYMOND
CONCRETE PILE DIVISION
RAYMOND INTERNATIONAL INC.
140 CEDAR STREET - NEW YORK 6, N.Y.

To SVERDRUP AND PARCEL AND ASSOCIATES, INC.,   Date NOVEMBER 15, 19 66

Address 915 OLIVE ST. ST. LOUIS, MISSOURI

We have completed the following borings for you at LABADIE, MISSOURI PROPOSED POWER PLANT with results shown below. In accordance with your instructions, we have sent labelled samples of the strata encountered

To SAME AS ABOVE Address

Via under date of Raymond Concrete Pile Division Raymond International Inc.

LOCATION PLAN   SCALE 1" =

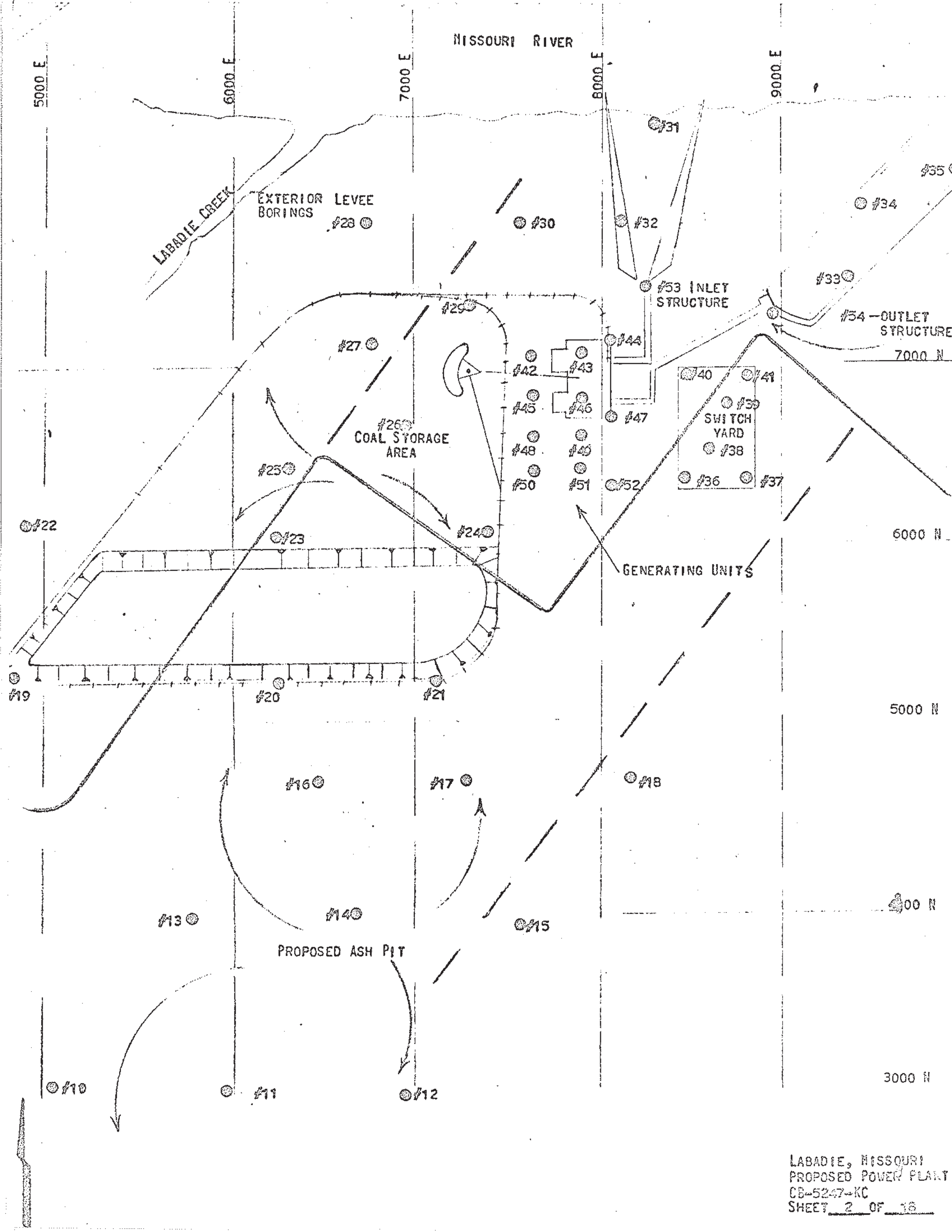
TEST BORING REPORT
FOR
PROPOSED POWER PLANT
LABADIE, MISSOURI

INDEX

Compass Points

This boring report prepared in the
ST. LOUIS OFFICE of the
Raymond Concrete Pile Division
RAYMOND INTERNATIONAL INC.

By S. E. & S. S.
Job No. B CR-5247
Sheet 1 of 18



LABADIE, MISSOURI
PROPOSED POWER PLANT
CB-5247-KC
SHEET 2 OF 16

F 30058 30 PADS 2-62

TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES, INC., Date OCTOBER 25, 1966 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

470 465 460 455 450 445 440 435 430 425 420 415 410 405

No. 42

GROUND SURFACE		CASING BLOWS	
ELEV. 469.3'			0.0'
DARK BROWN DRY SILTY TOPSOIL			2.0'
LT.BROWN DRY CLAYEY SILT	2-2-1		4.0'
BR.MO.STY.CLAY TR. V.F.SAND LENSES	2-3-3		6.5'
LT.BROWN DRY CLY. SILT TR.V.F.SAND	2-2-3		8.5'
	24 1	0	10.5'
BROWN MOIST CLAY AND SILT	1-2-2		12.0'
	24 2	24	14.0'
BROWN DAMP SILTY FINE SAND	4-4-5		18.0'
BROWN FINE TO MEDIUM SAND TRACE CO.SAND & SM.GVL.	2-2-2		22.0'
BROWN AND GRAY FINE TO MEDIUM SAND TR.COARSE SAND AND SMALL GRAVEL	2-1-1		30.0'
BR.FINE TO COARSE SAND TR.SM.GVL.	6-5-3		33.0'
BROWN AND GRAY FINE TO COARSE SAND,TR.SM.GRAVEL AND ORG.MATTER	5-8-8 *		37.0'
GRAY MED.TO CO. SAND TR.SM.GRAVEL AND ORGANIC MATTER	4-8-9		43.0'
GRAY MEDIUM TO COARSE SAND TRACE SMALL TO MEDIUM GRAVEL	2-2-3 2-3-3		52.0'
GRAY MEDIUM TO COARSE SAND TRACE FINE SAND,SMALL TO MEDIUM GRAVEL AND LIMESTONE FRAGS.	5-4-6 3-3-3	26 35 36	64.0'
GRAY FINE TO COARSE SAND TRACE	4-6-5	34	

No. 43

GROUND SURFACE		CASING BLOWS	
ELEV. 469.3'			0.0'
DK.BR.DRY STY.TOP.			1.0'
LT.BR.DRY ST.TR.CY.			2.5'
	1-2-2		3.0'
DARK BROWN MOIST SILTY CLAY	24 1	19	5.0' 5.5'
LIGHT BROWN DRY CLAYEY SILT TRACE VERY FINE SAND	2-3-4 2-3-3		12.0'
BROWN MOIST SILTY VERY FINE SAND	3-5-5		17.0'
BROWN WET FINE SAND TRACE MEDIUM TO COARSE SAND, AND SILT	2-2-5		22.0'
GRAY WET SILTY VERY FINE SAND	2-3-5 5-8-8		31.0'
BROWN AND GRAY WET FINE TO COARSE SAND, TRACE SMALL GRAVEL	6-9-12		38.0'
BROWN AND GRAY WET SMALL TO MEDIUM GRAVEL TR. COARSE SAND	9-9-9		43.0'
GRAY WET SMALL TO MED. GRAVEL TR.CO. SAND & MED. SAND	9-7-5		46.0'
GRAY FINE TO COARSE SAND,SMALL TO MEDIUM GRAVEL TR. LIMESTONE FRAGMENTS	3-3-3 * 8-5-4 * 4-4-4 *	28 29	62.0'
GRAY WET FINE TO MEDIUM SAND TRACE	9-12-8	63 35	

No. 44

GROUND SURFACE		CASING BLOWS	
ELEV. 469.2'			0.0' 0.5'
BROWN DAMP SILTY TOPSOIL			2.5'
DK.BR.MO.CLY.SILT	2-2-2		3.0'
DK.BR.MO.STY.CLAY	24 1	15	5.0'
LT.BROWN DRY V. FINE SAND & SILT			6.0'
DK. BROWN DRY CLAYEY SILT	1-2-9		9.0'
LIGHT BROWN DRY CLAYEY SILT	1-3-3		10.5'
	24 2	22	12.5'
LIGHT BROWN DRY VERY FINE SAND TRACE MEDIUM SAND AND SILT	4-5-6 2-2-2		23.0'
GRAY WET FINE TO MEDIUM SAND	2-2-3		28.5'
SAME MORE DENSE	2-8-12		32.5'
GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL	3-2-4		38.0'
GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL,SMALL GRAY CLAY SEAMS & LIMESTONE FRAGS.	5-11-9		43.0'
GRAY WET SM.TO MED. GVL.& LIMESTONE FRAGS.,TR.MED.TO CO.SAND & SMALL GRAY CLAY SEAMS	5-2-2		46.0' 48.0'
GRAY WET F.TO MED. SAND TR.CO.SAND & SM.GRAVELS.	2-6-7 *		51.0'
GRAY WET SM.TO MED. GRAVEL TR.LIMESTONE FRAGS.,MED.TO CO. SAND TR.SM.GR. CLAY SEAMS	7-8-10 *		57.5'
GRAY WET F.TO CO. SAND TR.SM.GRAVEL			
GRAY WET FINE TO CO. SAND TR.SM. GRAVEL & LIMEST. FRAGS.	5-5-6 *		63.5'
GRAY WET SMALL TO MEDIUM GRAVEL TR. FINE TO CO. SAND	13-12-8		

410
405
400
395
390
385
380
375
370
365
360
355
350
345

FINE SAND, SMALL TO MEDIUM GRAVEL AND LIMESTONE FRAGS.	3-3-3	35 36	64.0'
GRAY FINE TO COARSE SAND TRACE SMALL TO MED. GVL.	4-6-5	34	69.5'
GRAY AND BROWN COARSE SAND TR. MEDIUM TO FINE SAND AND SMALL GRAVEL	6-7-6 4-5-6 5-7-9	40 50 45 90 69	91.0'
BR. CO. SANDTR. MED. TO FINE SAND & SMALL GRAVEL		59 74	92.0'
GRAY AND BROWN COARSE SAND TRACE MEDIUM TO FINE SAND, SMALL GRAVEL, & LIMESTONE FRAGS.	5-8-16* 5-8-12	84 80 87	103.0'
GRAY ADN BROWN CO. SAND TR. MEDIUM TO FINE SAND AND SMALL GRAVEL	5-8-6	85 63 73	110.2'
LIMESTONE AND DOLOMITE (SOME SANDY) WITH SHALE PARTINGS, SOME SANDSTONE	60/24		115.2'
	60/56		120.2'
	60/58		125.2'

	4-4-4 *	29	62.0'
GRAY WET FINE TO MEDIUM SAND TRACE SMALL GRAVEL AND LIMESTONE FRAGMENTS	9-12-8 3-2-3 2-2-3	63 35 25 36	79.0'
GRAY WET FINE TO CO. SAND TR. SM. GVL.	3-3-3		81.0'
BROWN MEDIUM TO COARSE SAND TRACE FINE SAND, LIMESTONE FRAGMENTS AND SMALL GRAVEL	14-6-5 3-4-5 * 2-2-5* 5-8-8*	49 37 35 69	103.5'
BR. & GRAY COMP. F. TO MED. SD. TR. CO.	63/4	63	104.7'
LIMESTONE & DOLOMITE (SOME SANDY) W/SDST. SLIGHTLY POROUS	[illegible]		109.7'
LIMESTONE & DOLOMITE W/SHALE PARTINGS SOME SANDSTONE	60/55		114.7'
	60/50		119.7'

CASING BLOWS - INDICATE NUMBER OF BLOWS REQ UIRED TO DRIVE CASING ONE FOOT, USING 350 LB. WEIGHT FALLING 24 INCHES.

GRAY WET F. TO CO. SAND TR. SM. GRAVEL			
GRAY WET FINE TO CO. SAND TR. SM. GRAVEL & LIMEST. FRAGS.	5-5-6 *		63.[illegible]
GRAY WET SMALL TO MEDIUM GRAVEL TR. FINE TO CO. SAND AND LIMESTONE FRAGS.	13-12-8		70.0'
GRAY WET SMALL TO MEDIUM GRAVEL, TR. FINE TO COARSE SAND, LIMESTONE FRAGMENTS, GRAY CLAY SEAMS AND ORGANIC MATTER	11-5-6 6-8-8 3-3-4* 4-5-5	65	87.0'
BROWN AND GRAY WET MEDIUM TO COARSE SAND TRACE SMALL GRAVEL AND LIMESTONE FRAGS.	3-2-3 2-3-3 10-20-15 3-3-5*	50 71 71	108.3'
			108.5'
LIMESTONE AND DOLOMITE WITH SHALB PARTINGS TRACE SANDSTONE	60/53		113.5'
	[illegible]		118.5'
	60/50		123.5'

BORING ADVANCED BY AUGER TO 15.0'
USED 110' OF N X CASING.
WATER ENCOUNTERED AT 15.0'
WATER LEVEL 15.0' ON COMPLETION.

BORING ADVANCED BY AUGER TO 14.0'.
USED 104.5' OF NX CASING.
WATER LEVEL ENCOUNTERED AT 14.0'.
WATER LEVEL 17.0' BEFORE PULLING CAS.
WATER LEVEL 14.0' AFTER PULLING CAS.

BORING ADVANCED BY AUGER TO 16.0'
USED 108.3' OF NX CASING.
WATER ENCOUNTERED AT 16.0'
WATER LEVEL 13.0' ON COMPLETION.

* - INDICATES NO RECOVERY.
WASH SAMPLE OBTAINED.

FIGURES IN SECOND HAND COLUMN SHOWN AS FRACTIONS - NUMERATOR - NO. OF BLOWS (IN INS.)
DENOMINATOR - PENETRATION (IN INS.)

INDICATES SHELBY TUBE
A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

INDICATES ROCK CORE
A - AMOUNT CORED (IN INCHES)
B - AMOUNT OF CORE RECOVERED (IN INCHES)

9/22-23-24/66
9/16-17-18-19/66
9/14-15-16/66

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in ~~XXXXXXXXX~~ SECOND column indicate number of blows required to drive 2" O.D. sampling pipe ~~XXXXXXXX~~ SIX INCHES using 140-lb. weight falling 30 inches.

Total Footage 368.4'
Foreman A. J. HOUSE
Classification by FOREMAN
Sheet 3 of 18

F 344-4 30 PADS 2-622

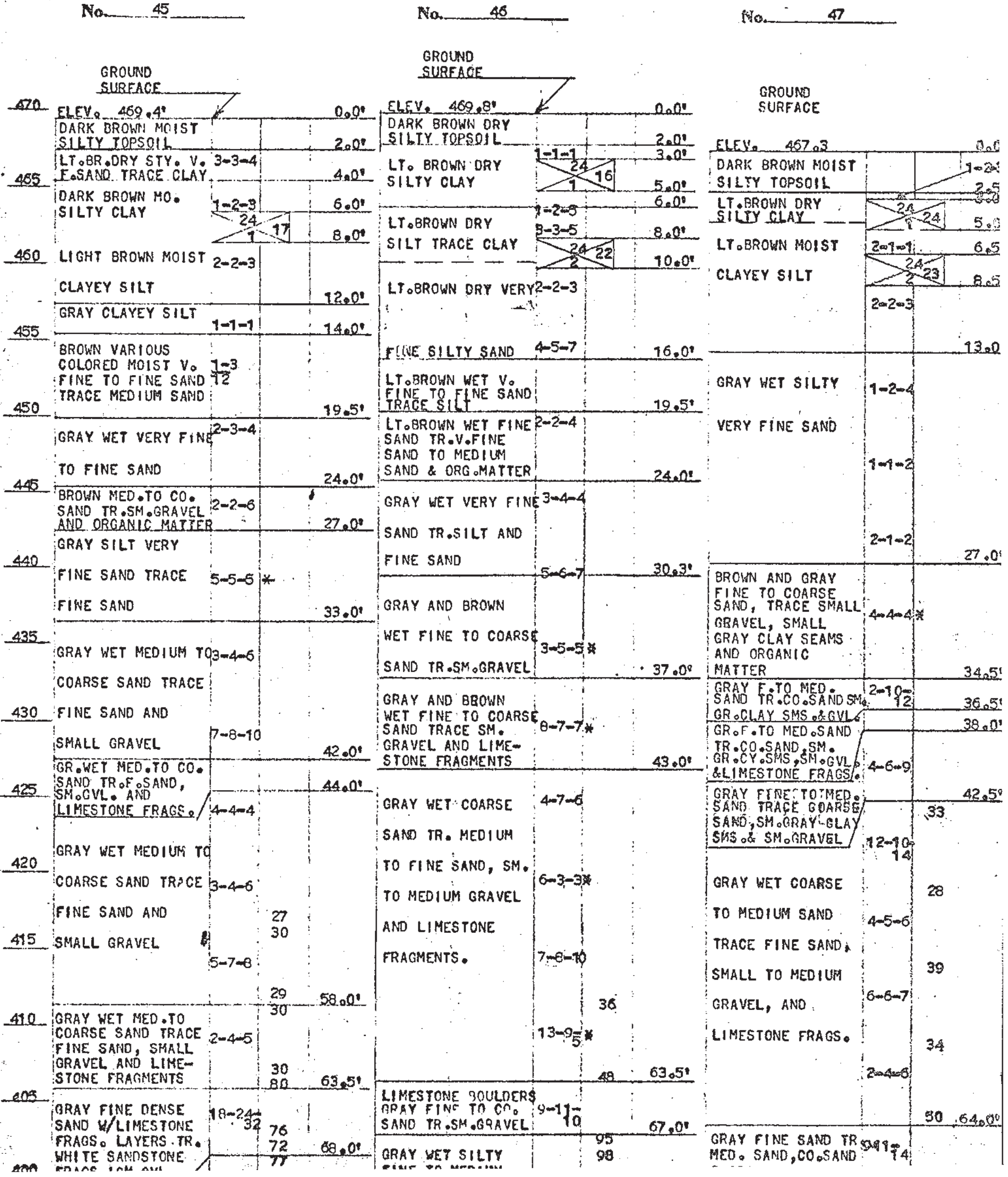
TEST BORING REPORT

RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES INC., Date OCTOBER 26, 1966 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.



No. 45

ELEV. 469.4'		0.0'
DARK BROWN MOIST SILTY TOPSOIL		2.0'
LT.BR.DRY STY. V. F.SAND TRACE CLAY	3-3-4	4.0'
DARK BROWN MO. SILTY CLAY	1-2-3	6.0'
	24 1 17	8.0'
LIGHT BROWN MOIST CLAYEY SILT	2-2-3	12.0'
GRAY CLAYEY SILT	1-1-1	14.0'
BROWN VARIOUS COLORED MOIST V. FINE TO FINE SAND TRACE MEDIUM SAND	1-3 12	19.5'
GRAY WET VERY FINE TO FINE SAND	2-3-4	24.0'
BROWN MED.TO CO. SAND TR.SM.GRAVEL AND ORGANIC MATTER	2-2-6	27.0'
GRAY SILT VERY FINE SAND TRACE FINE SAND	5-5-6 *	33.0'
GRAY WET MEDIUM TO COARSE SAND TRACE FINE SAND AND SMALL GRAVEL	3-4-6 7-8-10	42.0'
GR.WET MED.TO CO. SAND TR.F.SAND, SM.GVL. AND LIMESTONE FRAGS.		44.0'
GRAY WET MEDIUM TO COARSE SAND TRACE FINE SAND AND SMALL GRAVEL	4-4-4 3-4-6 27 30 5-7-8 29 30	58.0'
GRAY WET MED.TO COARSE SAND TRACE FINE SAND, SMALL GRAVEL AND LIME-STONE FRAGMENTS	2-4-5 30 80	63.5'
GRAY FINE DENSE SAND W/LIMESTONE FRAGS. LAYERS TR. WHITE SANDSTONE	18-24-32 76 72 77	68.0'

No. 46

ELEV. 469.8'		0.0'
DARK BROWN DRY SILTY TOPSOIL		2.0'
LT. BROWN DRY SILTY CLAY	1-1-1	3.0'
	24 1 16	5.0'
		6.0'
LT.BROWN DRY SILT TRACE CLAY	1-2-3 3-3-5	8.0'
	24 2 22	10.0'
LT.BROWN DRY VERY FINE SILTY SAND	2-2-3 4-5-7	16.0'
LT.BROWN WET V. FINE TO FINE SAND TRACE SILT		19.5'
LT.BROWN WET FINE SAND TR.V.FINE SAND TO MEDIUM SAND & ORG.MATTER	2-2-4	24.0'
GRAY WET VERY FINE SAND TR.SILT AND FINE SAND	3-4-4	30.3'
GRAY AND BROWN WET FINE TO COARSE SAND TR.SM.GRAVEL	5-6-7 3-5-5 *	37.0'
GRAY AND BROWN WET FINE TO COARSE SAND TRACE SM. GRAVEL AND LIME-STONE FRAGMENTS	8-7-7 *	43.0'
GRAY WET COARSE SAND TR. MEDIUM TO FINE SAND, SM. TO MEDIUM GRAVEL AND LIMESTONE FRAGMENTS.	4-7-6 6-3-3 * 7-8-10 36 13-9 5 * 48	63.5'
LIMESTONE BOULDERS GRAY FINE TO CO. SAND TR.SM.GRAVEL	9-11- 10	67.0'
GRAY WET SILTY	95 98	

No. 47

ELEV. 467.3		0.0
DARK BROWN MOIST SILTY TOPSOIL	1-2-	2.5
LT.BROWN DRY SILTY CLAY	24 1 24	5.0
LT.BROWN MOIST CLAYEY SILT	2-1-1	6.5
	24 2 23	8.5
	2-2-3	13.0
GRAY WET SILTY VERY FINE SAND	1-2-4 1-1-2 2-1-2	27.0'
BROWN AND GRAY FINE TO COARSE SAND, TRACE SMALL GRAVEL, SMALL GRAY CLAY SEAMS AND ORGANIC MATTER	4-4-4 *	34.5'
GRAY F.TO MED. SAND TR.CO.SAND SM. GR.CLAY SMS.&GVL.	2-10- 12	36.5'
		38.0'
GR.F.TO MED.SAND TR.CO.SAND,SM. GR.CY.SMS,SM.GVL. &LIMESTONE FRAGS.	4-6-9	42.5'
GRAY FINE TO MED. SAND TRACE COARSE SAND,SM.GRAY CLAY SMS.& SM.GRAVEL	33 12-10- 14	
GRAY WET COARSE TO MEDIUM SAND TRACE FINE SAND, SMALL TO MEDIUM GRAVEL, AND LIMESTONE FRAGS.	28 4-5-6 39 6-6-7 34 2-4-6 50	64.0'
GRAY FINE SAND TR MED. SAND,CO.SAND	9-11- 14	

410	GRAY WET MED.TO COARSE SAND TRACE FINE SAND, SMALL GRAVEL AND LIMESTONE FRAGMENTS	2-4-5	30 30 80	63.5'
405 400	GRAY FINE DENSE SAND W/LIMESTONE FRAGS. LAYERS TR. WHITE SANDSTONE FRAGS.&SM.GVL.	18-24-32	76 72 77	68.0'
395 390 385 380	GRAY COARSE AND MEDIUM SAND TRACE FINE SAND, SMALL GRAVEL AND LIMESTONE FRAGS.	8-16-7 7-5-6 6-5-7	44 36 46 47 40 50 51 52 56 54 49 62	93.5'
375 370 365 360	BROWN AND GRAY FINE TO COARSE SAND TR. SMALL GRAVEL AND LIMESTONE FRAGMENTS	9-5-6 5-7-8*	50 53 50 80 86 108 119 112	110.7' 111.0'
355	LIMESTONE AND DOLOMITE (SOME SANDY) SANDSTONE AND SHALE PARTINGS	(60/51)		116.0'
350		(60/49)		121.0'
345		(36/36)		124.0'

9/27-28-29/66
BORING ADVANCED BY AUGER TO 14.0'
USED 110'9" OF NX CASING.
WATER ENCOUNTERED AT 14.0'.
WATER LEVEL 15.0' ON COMPLETION.

	13-9-5*	48	63.5'
LIMESTONE BOULDERS GRAY FINE TO CO. SAND TR.SM.GRAVEL	9-11-10		67.0'
GRAY WET SILTY FINE TO MEDIUM SAND TR.CO. SAND	8-6-9	95 98	71.0'
GRAY WET COARSE SAND TR.FINE TO MEDIUM SAND, CO. SAND, SMALL GRAVEL AND LIMESTONE FRAGS.	6-13-5* 9-7-6*	42 45 45 46 54	82.5'
BROWN AND GRAY WET COARSE SAND, TRACE FINE TO MEDIUM SAND, SMALL GRAVEL AND LIMESTONE FRAGMENT	3-5-7 8-6-5	52 51 56 50	93.0'
BROWN WET FINB TO COARSE SAND TR.SM. GVL.& LIMESTONE FR.	9-5-5	55	97.0'
BROWN AND GRAY DENSE FINE TO MEDIUM SAND	8-9-7	97 151 70 87	103.5'
GRAY DENSE FINE TO MEDIUM SAND (SOME BOULDERS)	7-14-21 WS WS WS	80 85	114.2'
LIMESTONE			116.0'

NOTE - BENT CASING, ASSUMED TO BE A RESULT OF BOULDER OR BOULDERS PREVENTED CORE BARREL FROM PASSING THROUGH TO THE BOTTOM FOR THE PURPOSE OF CORING THE ROCK.

9/24-26-27/66
BORING ADVANCED BY AUGER TO 16.0'
USED 114'2" OF NX CASING.
WATER ENCOUNTERED AT 16.0'.
WATER LEVEL 15.5' ON COMPLETION

GRAVEL, AND LIMESTONE FRAGS.	2-4-6	34 50	64.0'
GRAY FINE SAND TR MED. SAND,CO.SAND & ORGANIC MATTER	9-11-14		67.5'
GRAY FINE TO CO. SAND TR. SMALL GRAVEL AND LIMESTONE FRAGS.	5-4-7	54	73.0'
BROWN AND GRAY FINE TO MEDIUM TR. CO. SAND	8-14-20	71	77.0'
BROWN AND GRAY COARSE TO MEDIUM SAND TRACE FINE SAND	3-3-4	54	82.5'
BROWN AND GRAY COARSE TO MEDIUM SAND TR.F.SD., SM. GVL.& LIMESTONE FR.	4-5-6	57	87.0'
BROWN MEDIUM TO COARSE SAND TR. F. SAND, SMALL TO MEDIUM GRAVEL AND LIMESTONE FRAGMENTS.	4-5-6*	49 75	94.0'
GRAY AND BROWN MEDIUM TO COARSE SAND TRACE FINE SAND,SMALL TO MEDIUM GRAVEL TR. LIMESTONE FRAGS.	5-14-18 2-3-6	97 72	107.1'
CHERT			107.5'
SAND & SM.GVL. LIMESTONE, POROUS WITH SAND LIMEST. & DOLOMITE	(60/52)		112.5'
RECOVERED 6" SAND & GRAVEL, 18"LIMESTONE & DOLOMITE, (SOME SANDY). SAND & GRAVEL MAY HAVE ENTERED HOLE AT 107.9 &CAUSED ROCK TO GRIND AWAY	(60/18)		117.5'

9/19-20-22/66
BORING ADVANCED BY AUGER TO 13.0'
USED 107'2" OF NX CASING.
WATER ENCOUNTERED AT 13.0'
WATER LEVEL

CASING BLOWS - INDICATE NUMBER OF BLOWS REQUIRED TO DRIVE CASING ONE FOOT, USING 350 LB. WEIGHT FALLING 24 INCHES.

* - INDICATES NO RECOVERY WASH SAMPLE OBTAINED.

WS - INDICATES DEPTHS WASH SAMPLE OBTAINED

INDICATE SHELBY TUBE	A / B / C	A - AMOUNT PENETRATED (IN INCHES) B - AMOUNT RECOVERED (IN INCHES) C - SHELBY TUBE NUMBER
INDICATE ROCK CORE	(A/B)	A- AMOUNT CORED (IN INCHES) B -AMOUNT OF CORE RECOVERED (IN INCHES)

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site ography, etc., may cause changes in these levels.

ures in SECOND column indicate number of blows required to drive sampling pipe SIX INCHES using 140-lb. weight falling 30 inches.

Total Footage 357.5'
Foreman A.J.HOUSE
Classification by FOREMAN
Sheet 4 of 18

F. 348-4-30 PADS 2-62

TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES, INC. Date NOVEMBER 1, 19XX66 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

470 465 460 455 450 445 440 435 430 425 420 415 410 405

No. 48

GROUND SURFACE

CASING BLOWS

ELEV. 468.4'			0.0'
LT. BR. MO. STY. TOPS. TR. V.F. SDY. CY			2.0'
LT. BR. DRY SILTY VERY FINE SAND	2-2-3		3.0'
DARK BROWN & GRAY MOIST SILTY CLAY	1-2-2 24 22 1		6.0' 8.0'
LIGHT BROWN DRY SILT TRACE VERY FINE SAND & CLAY	2-2-2		12.0'
BR. VARI COLORED V.F. SAND TR. SILT	2-2-1		13.0' 14.0'
GRAY WET SOFT SILTY CLAY	9-10-8		
BROWN VARICOLORED VERY FINE TO FINE SAND TRACE MEDIUM SAND	2-4-4 6-7-8		27.0'
BROWN & GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL, & ORGANIC MATTER	4-4-5		33.0'
GRAY FINE MEDIUM TO COARSE SAND TRACE SMALL GRAVEL	4-3-6		38.0'
GR. FINE TO COARSE SAND TR. SMALL TO MED. GRAVEL, LIMESTONE FRAGS. CHERT GRAVEL	4-7-10		42.5'
GRAY FINE TO MEDIUM COARSE SAND TRACE SMALL TO MEDIUM GRAVEL, LIMESTONE FRAGS., CHERT GRAVEL, & ORGANIC MATTER	4-5-5 4-5-8 4-5-6 7-5-7 6-8-12	22 22 36 47 28 33	67.0'
		50	

No. 49

GROUND SURFACE

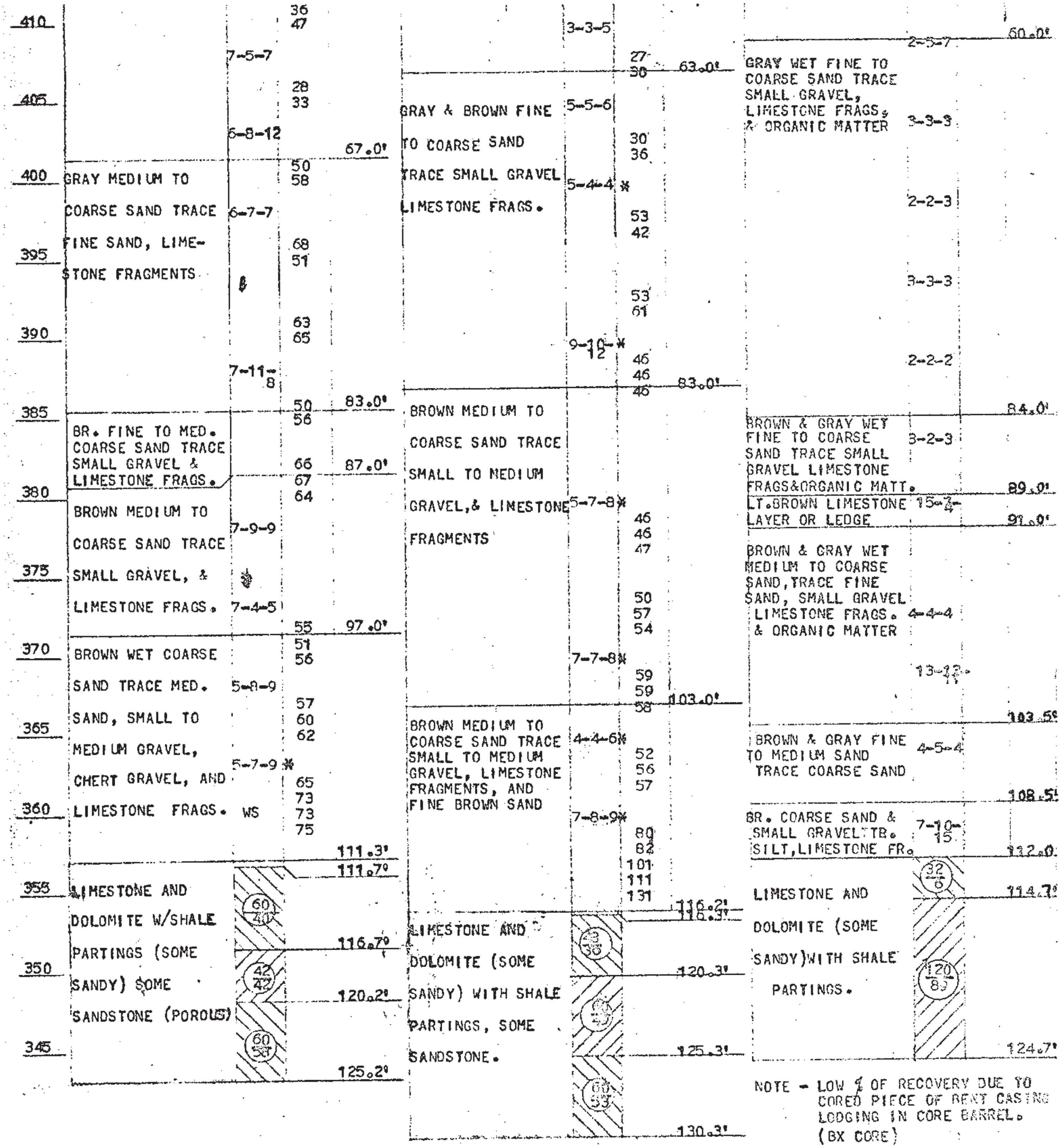
CASING BLOWS

ELEV. 469.8'			0.0'
DK. BR. MOIST STY. V.F. SANDY TOPS.			0.5'
LT. BR. DAMP STY. VERY FINE SAND	2-2-2		3.5'
BROWN MOIST CLAYEY SILT	24 17 1 3-6-6		4.5' 6.5' 8.5'
LIGHT BROWN DRY SILTY VERY FINE SAND	5-6-7 4-5-6		16.0'
LT. BR. WET FINE TO MEDIUM SAND TR. COARSE SAND & SMALL GRAVEL.	5-10-12		18.5'
GR. WET FINE TO MEDIUM SAND, TR. COARSE SAND W/V.F. SAND LAYERS, & BROWN FINE SAND LAYERS.	5-4-5 4-3-3		22.0'
GRAY WET V.F. SAND TRACE ORGANIC MATTER.	3-4-4		30.3'
GRAY FINE TO COARSE SAND, TRACE SMALL GRAVEL			33.0'
GRAY FINE TO MEDIUM SAND TRACE COARSE SAND	8-6-8		40.0'
GRAY FINE TO COARSE SAND TRACE SMALL GRAVEL, LIMESTONE FRAGS.	15-15-8 9-9-11 5-6-9 4-5-5 3-3-5	25 26 24 25 27 30	63.0'
GRAY & BROWN FINE TO COARSE SAND	5-5-6	30 36	

No. 50

GROUND SURFACE

ELEV. 468.3'			0.0'
DK. BR. MO. STY. V.F. SANDY TOPS.			1.0'
LT. BR. DRY SILTY VERY FINE SAND	2-2-3		3.5'
DK. BR. W/ TRACE GRAY MO. CLAYEY SILT & FINE SAND	1-2-3 24 24 1		5.5' 7.5'
LIGHT BROWN MOIST VERY FINE SAND & SILT	1-2-2 1-3-2		11.0'
LT. BROWN DRY V.F. SAND TR. SILT & MEDIUM SAND			14.0'
BROWN MOIST FINE SAND WITH TRACE FINE SAND & COARSE SAND	7-7-7 2-3-3 2-3-4		27.0'
GRAY & BROWN WET MEDIUM TO COARSE SAND TRACE FINE SAND & SMALL GRAVEL	1-4-5 2-3-4		37.0'
GRAY WET VERY FINE TO FINE SAND	6-9-12		42.0'
GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL, LIMESTONE FRAGS.	5-10-11		48.0'
SAME MORE DENSE	14-18-13		53.0'
SAME LESS DENSE	4-7-7		60.0'
GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL, LIMESTONE FRAGS, & ORGANIC MATTER	2-5-7 3-3-3		



GRAY MEDIUM TO COARSE SAND TRACE FINE SAND, LIMESTONE FRAGMENTS

BR. FINE TO MED. COARSE SAND TRACE SMALL GRAVEL & LIMESTONE FRAGS.

BROWN MEDIUM TO COARSE SAND TRACE SMALL GRAVEL, & LIMESTONE FRAGS.

BROWN WET COARSE SAND TRACE MED. SAND, SMALL TO MEDIUM GRAVEL, CHERT GRAVEL, AND LIMESTONE FRAGS.

LIMESTONE AND DOLOMITE W/SHALE PARTINGS (SOME SANDY) SOME SANDSTONE (POROUS)

USED 111'4" OF NX CASING.
WATER ENCOUNTERED AT 16.0'.
WATER LEVEL 18.0' ON COMPLETION.

GRAY & BROWN FINE TO COARSE SAND TRACE SMALL GRAVEL LIMESTONE FRAGS.

BROWN MEDIUM TO COARSE SAND TRACE SMALL TO MEDIUM GRAVEL,& LIMESTONE FRAGMENTS

BROWN MEDIUM TO COARSE SAND TRACE SMALL TO MEDIUM GRAVEL, LIMESTONE FRAGMENTS, AND FINE BROWN SAND

LIMESTONE AND DOLOMITE (SOME SANDY) WITH SHALE PARTINGS, SOME SANDSTONE.

USED 116'3" OF NX CASING.
WATER ENCOUNTERED AT 16.0'.
WATER LEVEL 16.0' ON COMPLETION.

GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL, LIMESTONE FRAGS, & ORGANIC MATTER

BROWN & GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL LIMESTONE FRAGS&ORGANIC MATT.

LT.BROWN LIMESTONE LAYER OR LEDGE

BROWN & GRAY WET MEDIUM TO COARSE SAND,TRACE FINE SAND, SMALL GRAVEL LIMESTONE FRAGS. & ORGANIC MATTER

BROWN & GRAY FINE TO MEDIUM SAND TRACE COARSE SAND

BR. COARSE SAND & SMALL GRAVEL TR. SILT,LIMESTONE FR.

LIMESTONE AND DOLOMITE (SOME SANDY)WITH SHALE PARTINGS.

NOTE - LOW % OF RECOVERY DUE TO CORED PIECE OF BENT CASING LODGING IN CORE BARREL. (BX CORE)

USED 112' OF NX CASING.
WATER ENCOUNTERED AT 15.0'.
WATER LEVEL 18.0' ON COMPLETION.

* - INDICATES NO RECOVERY. WASH SAMPLE OBTAINED

INDICATE SHELBY TUBE A B C
A - AMOUNT PENETRATED (IN INS.)
B - AMOUNT RECOVERED (IN INS.)
C - SHELBY TUBE NUMBER

INDICATES ROCK CORE
A - AMOUNT CORED
B - AMOUNT OF CORE RECOVERED (IN IN.)

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH figures in SECOND hand column indicate number of blows required to drive 2" O.D. sampling pipe ~~xxxxxxxxx~~ SIX INCHES using 140-lb. weight falling 30 inches.

Total Footage 380.2'
Foreman A.J.HOUSE
Classification by FOREMAN
Sheet [illegible] of 18

TEST BORING REPORT

RAYMOND

CONCRETE PILE COMPANY

GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES INC. Date NOVEMBER 2, 19~~5~~66 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

No. 51

GROUND SURFACE

		CASING BLOWS	
470	ELEV. 469.9'		0.0'
	DK. BR. MO. SILTY V.F. SANDY TOPS.	1-2-3	2.5'
465	DK. BROWN MOIST SILT V.F. SAND TRACE CLAY	2-1-2 2-2-3	5.5'
460	LIGHT BROWN SILTY VERY FINE SAND	2-3-4	
455		3-2-4	15.0'
	BR. WET V.F. TO FINE SAND.		16.5'
450	LT. BR. WET FINE TO MEDIUM SAND TR. COARSE SAND ORGANIC MATTER	2-3-5	21.0'
445	GRAY WET VERY FINE TO FINE SAND	3-6-7	28.0'
440	GRAY WET FINE TO MEDIUM SAND	10-13 5	33.0'
435	GRAY WET VERY FINE SAND TRACE SILT	10-16- 13	36.0'
430	GRAY FINE TO MEDIUM SAND TRACE COARSE SAND TRACE SMALL GRAVEL	11-11 15	
425			44.5'
	BR.LIMESTONE LEDGE OR LAYERS OF LIMESTONE FRAG	10-8- 8	46.0'
420	GR.FINE TO COARSE SAND TR.SMALL TO MED.GRAVEL,& LIMESTONE FRAGS.	8-11- 10	52.0'
415	GRAY MEDIUM TO COARSE SAND TR. FINE SAND, & SMALL GRAVEL	4-3-5	58.0'
410	GRAY MEDIUM TO COARSE SAND TR. FINE SAND,SMALL	4-3-4	

No.

No. 52

GROUND SURFACE

	CASING BLOWS		
ELEV. 466.6'			0.0'
DK.BR.MO.CLY.TOPS.			1.0'
DK.BR.MO.CLY.TOPS.			2.5'
LT. BR. SILTY VERY FINE SAND	2-2-4		4.5'
DK. BROWN MOIST SILT	2-3-4		7.5'
LT. BROWN VERY FINE SAND TRACE SILT	3-8- 10		11.0'
GRAY WET SILTY VERY FINE SAND TRACE ORGANIC MATTER	2-2-3 2-2-2 2-2-2		23.0'
GRAY WET VERY FINE TO FINE SAND	2-2-1		27.5'
GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL	2-3-4 3-4-6		39.0'
GRAY MEDIUM TO COARSE SAND TRACE FINE SAND, CHERT ROCK W/ SMALL LAYERS LIMESTONE FRAGMENTS	24-15 14 7-7-7 6-4-6 6-8-9	27	

410	GRAY MEDIUM TO COARSE SAND TR. FINE SAND, SMALL TO MEDIUM GRAVEL, & LIMESTONE FRAGMENTS	4-3-4		
405		3-3-3*		67.5'
395	GRAY MEDIUM TO COARSE SAND TR. SMALL GRAVEL W/ SMALL LAYERS GRAY CLAY	6-4-4	29 31	73.0'
390	GRAY COARSE SAND TR., MEDIUM SAND SMALL GRAVEL, & LIMESTONE FRAGS.	2-4-4	43 35	
385		3-4-4	29 31	
380		7-5-2*	40	87.0'
375	BROWN & GRAY COARSE SAND TR. FINE SAND, SMALL GRAVEL, LIMESTONE FRAGMENTS, & CHERT ROCK	10-10-10	43 41 43	
370		7-5-6*	39 39	97.0'
365	BROWN MEDIUM TO COARSE SAND TR. FINE SAND, SMALL TO MEDIUM GRAVEL, AND LIMESTONE FRAGMENTS	9-12-6*	42 43 48 57	
360		7-8-9*	68 73 73	
355		10-6-13	49 49 49	
350			63 69 73 82	118.0' 118.3'
345	LIMESTONE AND DOLOMITE (SOME SANDY) SOME SANDSTONE SOME SHALE PARTINGS	60/32		123.3'
340		59/33		126.6'
335		60/55		131.6'

NOTE - LOW % OF RECOVERY FROM 118.3' TO 123.3' DUE TO CORE RETAINEB LODGED IN BARREL.

USED 118.0' OF NX CASING.
WATER ENCOUNTERED AT 16.0'
WATER LEVEL 17.8' ON COMPLETION WITH CASING IN PLACE.
WATER LEVEL 16.8' ON COMPLETION WITH CASING REMOVED.

	6-8-9	27 26	
	4-2-4	28 31	
	4-5-4*	38 42	
	6-4-4*	32 39	
		44 41	
	2-3-3	32 32	85.0'
GRAY FINE MEDIUM TO COARSE SAND TR, SMALL TO MED. GRAV.	2-3-8	46	88.0'
BROWN COARSE SAND TRACE FINE TO MEDIUM SAND, SMALL TO MEDIUM GRAVEL, AND LIMESTONE FRAGMENTS	22-22ⓧ-7	47 43 39	
	2-3-3	43 45 43	
	2-5-8	47 47 53	
	7-10-12		106.7'
LIMESTONE AND DOLOMITE (SANDY- SLIGHTLY POROUS), WHITE FINE GRAINED SANDSTONE	60/24		111.7'
	40/40		115.7'
(SANDY & POROUS TO 117.5' ±)	56/48		120.4'

INDICATES ROCK CORE

A - AMT. CORED
B - AMT. RECD.
(ALL IN INCHES)

* - INDICATES NO RECOVERY WASH SAMPLE OBTAINED.

ⓧ LIMESTONE FRAGMENT INCREASED BLOWS

CASING BLOWS - INDICATE NUMBER OF BLOWS REQUIRED TO DRIVE CASING, ONE FOOT, USING 350LB. WEIGHT FALLING 24 INCHES.

USED 106.7' OF NX CASING.
WATER ENCOUNTERED AT 11.0'.
WATER LEVEL 12.0' ON COMPLETION.

Classifications are made by Visual Inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in SECOND hand column indicate number of blows required to drive 2" O.D. sampling pipe ~~one foot~~, using 140-lb. weight falling 30 inches.

Total Footage 252.0'
Foreman A.J. HOUSE
Classification by FOREMAN
Sheet 6 of 18

206-1-30 PADS 7-57

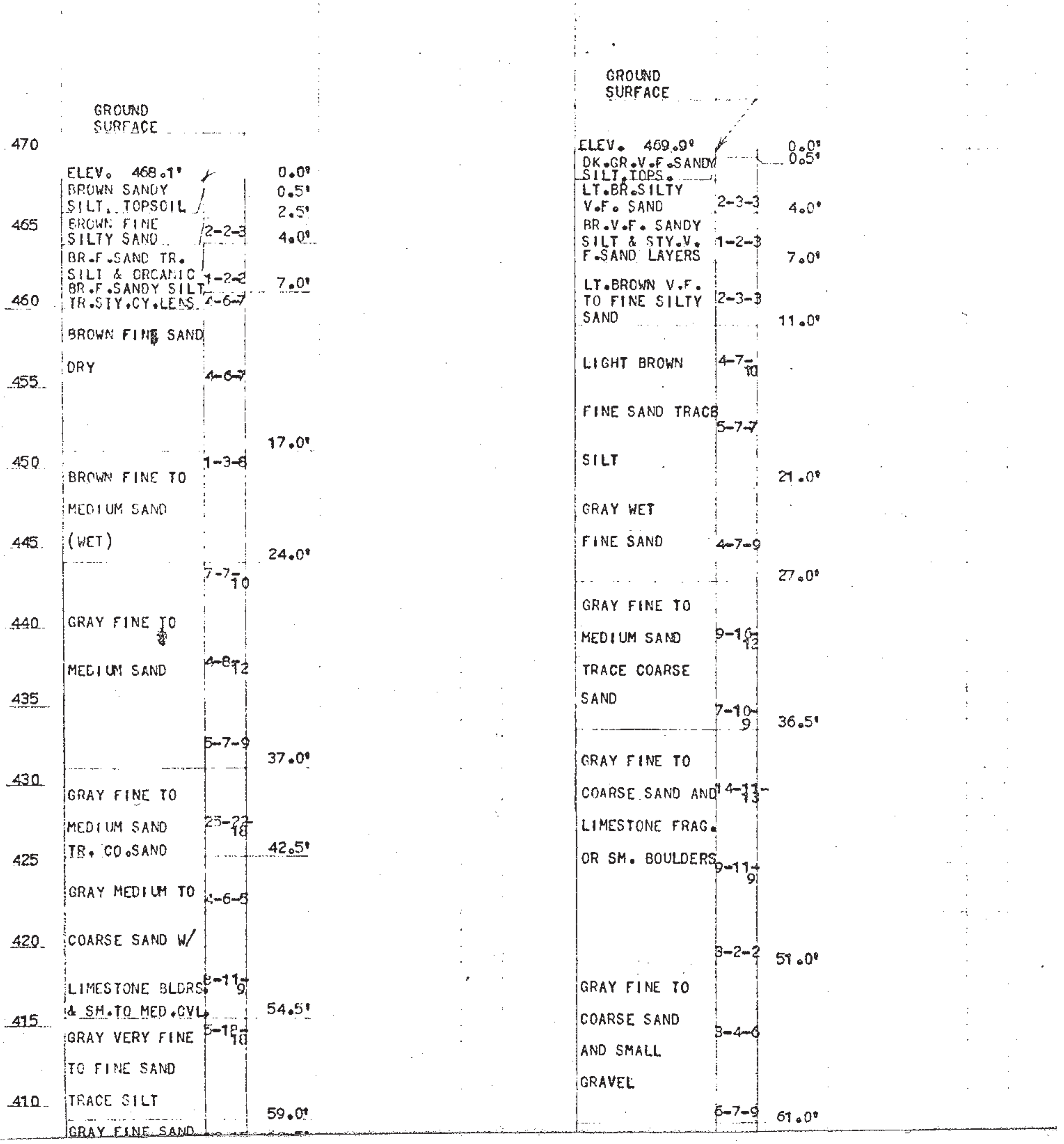
TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
A DIVISION OF RAYMOND INTERNATIONAL INC.

To SVERDRUP AND PARCEL AND ASSOCIATES, INC., Date NOVEMBER 9, 1966

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

Boring No. 53 Boring No. ______ Boring No. 54 Boring No. ______



	TO FINE SAND		
410	TRACE SILT		59.0'
	GRAY FINE SAND W/CO.SAND AND SM.GRAVEL LENS	10-15-17	60.5'
405			

	GRAVEL		
		6-7-9	61.0'
	GRAY FINE TO		
405	MED. SAND LENS	19-23-21	
	OF MEDIUM TO CO. SAND TRACE SMALL GRAVEL		69.0'
400	GRAY FINE TO	10-9-10	
	COARSE SAND TR.		
395	SMALL GRAVEL		
			76.0'
390	BROWNFINE TO MED. SAND SOME COARSE SAND TR. LIMESTONE GRAVEL	14-19-16	
			83.0'
385	GRAY FINE TO	15-13-16	
	COARSE SAND TR.		
380	SMALL GRAVEL		
		10-12-14	
375			
		11-5-7	96.0'
	BROWN AND GRAY		
370	FINE TO MED.	12-15-20/2	
	& CO. SAND W/ SANDSTONE AND LIMESTONE AND SMALL BOULDERS		
365			105.1'
	LIMESTONE W/SO. SOME SOFT PARTS.	60/26	
360	LIMESTONE AND DOLOMITE WITH SAND (MOSTLY POROUS)		110.1' 110.5'
		60/53	
355			115.5'
350			

USED 59.0' OF NX CASING.

WATER ENCOUNTERED AT 16.5'.
WATER LEVEL 15.3' ON COMPLETION.

10/6/66

USED 105.0' OF NX CASING.

WATER LEVEL 16.0'- 16 HOURS AFTER COMPLETION.

10/10-12/66

INDICATES
ROCK CORE

A/B

A - AMOUNT CORED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)

FIGURES IN RIGHT HAND COLUMN SHOWN AS
FRACTIONS - NUMERATOR - NO. OF BLOWS (IN INCHES)
DENOMINATOR- PENETRATION (IN INCHES)

Classifications are made by visual inspection.
Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.
Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe XXXXXXXX using 140 lb. weight falling 30 inches.
SIX INCHES

Total Footage 176.0'
Foreman JAMES TURNER
Job No. CB-5247-KC
Classification by FOREMAN
Sheet 7 of 18

TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES **Date** NOVEMBER 4, 19~~XX~~66 **Job No.** CB-5247-KC

Location of Borings LABADIE, MISSOURI

All borings are plotted to a scale of 1" = 8' **ft. using** ELEVATIONS AS FURNISHED **as a fixed datum.**

Elevation scale: 470, 465, 460, 455, 450, 445, 440, 435, 430, 425, 420, 415, 410

No. 36

GROUND SURFACE

ELEV. 469.5'		0.0'
LT.BR.MO.STY.TOPS.		1.0'
LT. BR. MOIST STY W/ CLAY LENS	2-2-9	3.0'
LIGHT BROWN MO. LOOSE V.F. SAND	2-2-2	6.0'
DARK BROWN MOIST CLAY	2-2-3	6.5' 7.5'
LIGHT BROWN MOIST CLAYEY SILT TRACE VERY FINE SAND	24 18 1 5-7-8	9.5'
LIGHT BROWN DRY SILT VERY FINE SAND	4-7-7	13.0'
BROWN WET FINE SILTY SAND	2-3-4	22.0'
GRAY FINE SAND SOME MEDIUM	10-11-14 8-12-11 10-11-15	36.0'
GRAY FINE TO COARSE SAND FEW SCATTERED SMALL GRAVEL	5-6-10	43.0'
GRAY FINE TO COARSE SAND WITH LIMESTONE FRAGS.	9-11-14 7-8-12	52.0'
GRAY MEDIUM TO COARSE SAND TRACE SMALL GRAVEL	7-8-10 8-7-11	60.5'

No. 37

GROUND SURFACE

ELEV. 468.9'		0.0'
DARK BROWN MOIST STY.TOPS.TR.STY. FINE SAND& CLAY		1.5' 2.5'
LT.BR.MO. V.F. SAND TR. SILT	1-2-3	6.0'
MOTTLED BR.&GR.MO. CLAYEY SILT	1-1-1 24 14 1	8.0'
LIGHT BROWN MOIST LOOSE SLIGHTLY CLAYEY SILT	1-1-1 2-2-3	10.5'
LT. BR. LOOSE V.F. SAND TR. SILT		13.0'
BROWN & GRAY FINE SAND TRACE SILT	4-5-5	17.0'
GRAY VERY FINE TO FINE SAND TRACE MEDIUM	3-4-6 6-8-12	28.0'
GRAY FINE TO MEDIUM SAND	4-7-8 7-9-8	39.0'
GRAY FINE SAND & LIMESTONE LEDGE OR BOULDERS	8-18-42	42.0'
GRAY FINE SAND TRACE COURSE SAND	12-9-6	47.0'
GRAY FINE TO COARSE SAND TRACE SMALL GRAVEL	5-4-5 12-12-14 5-6-5	60.5'

No. 38

GROUND SURFACE

ELEV. 470.4'		0.0'
LT. BROWN MOIST SILTY TOPSOIL		1.0'
LT.BR. MOIST SILT TRACE CLAY & V.F. SAND	2-2-3	6.0'
MOTTLED BROWN & GRAY MOIST CLAYEY SILT	1-2-2 24 24 1 5-7-9	6.5' 8.5' 11.5'
BR. & TR. GR. FINE TO MED. SAND TR. STY	5-7-9	13.0'
GRAY & BROWN SILTY FINE TO MEDIUM SAND	4-5-7 4-5-8	22.0'
GRAY FINE SAND TRACE MEDIUM SAND AND ORGANIC SEAMS	3-4-5	27.0'
LIGHT GRAY FINE TO MEDIUM SAND TRACE SILT W/ SCATTERED SMALL GRAVEL	7-8-12	32.0'
LIGHT GRAY VERY FINE TO FINE SAND TRACE SILT	22-35-41	37.0'
GRAY FINE TO MED. TRACE COARSE SAND		39.0'
GRAY FINE TO COARSE SAND & AND LIMESTONE FRAGMENTS OR SMALL BOULDERS	29-41-27 ← WOOD NOTED 22-23-14 12-10-8	53.5'

	COARSE SAND	7-8-10		12-12-14	
	TRACE SMALL				
410	GRAVEL	8-7-11	60.5'	5-6-5	60.5'

USED 59.0' OF NX CASING.

WATER ENCOUNTERED AT 17.0'.
WATER LEVEL 14.5' ON COMPLETION.

USED 59.0' OF NX CASING.

WATER ENCOUNTERED AT 17.6'.
WATER LEVEL

USED 29.0' OF 3 1/2" CASING.

WATER ENCOUNTERED AT 17.0'.
WATER LEVEL 14.0' ON COMPLETION.

9/27/66

9/29-30/66
10/1/66

9/26/66

INDICATES
SHELBY TUBE
A B
C

A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe ~~xxxxxxx~~ using 140-lb. weight falling 30 inches.
SIX INCHES

Total Footage 174.5'
Foreman JAMES TURNER
Classification by FOREMAN
Sheet 8 of 18

208-1-30 PADS 7-57

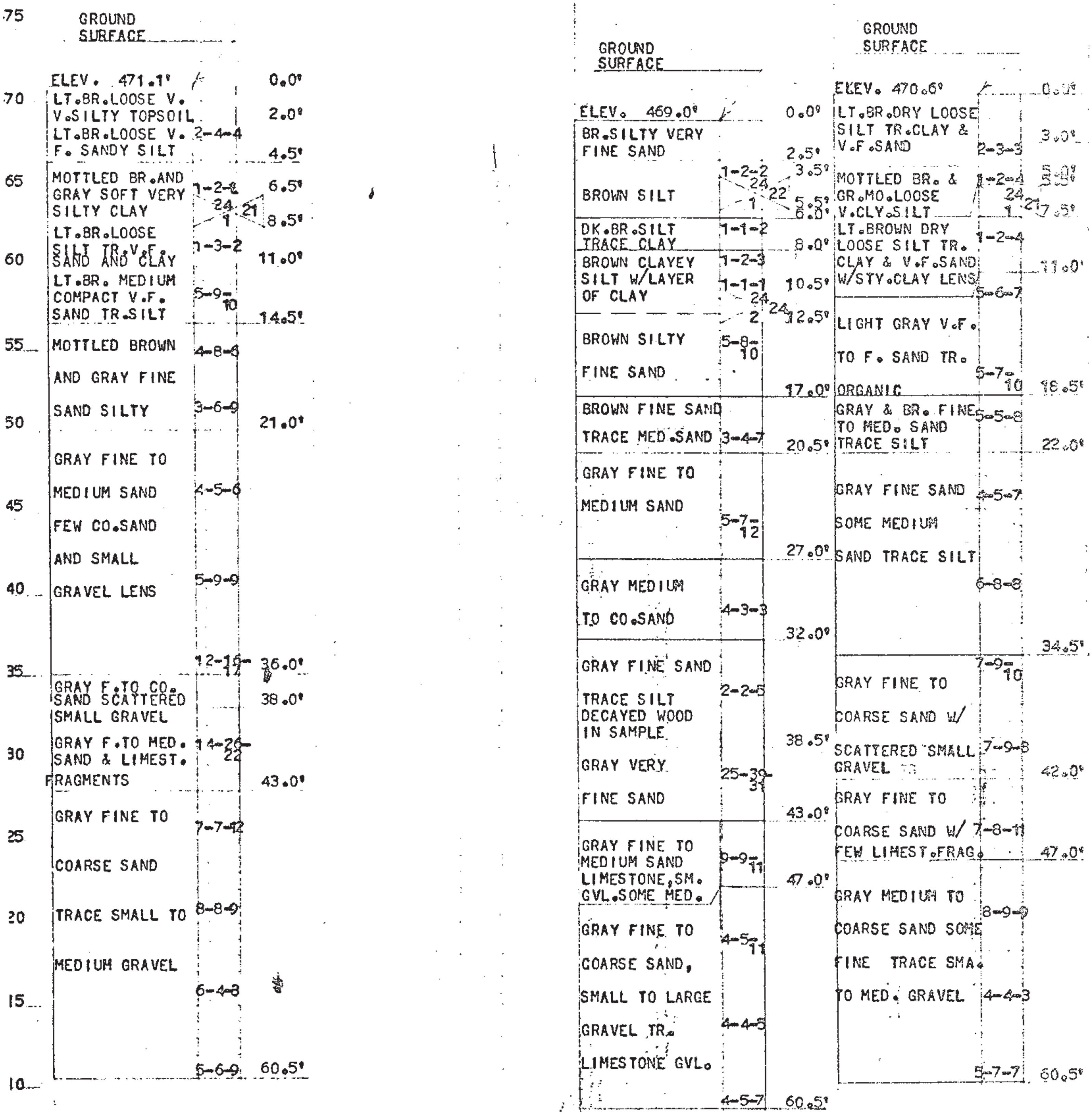
TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
A DIVISION OF RAYMOND INTERNATIONAL INC.

To SVERDRUP AND PARCEL AND ASSOCIATES, INC., Date NOVEMBER 15, 1966

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

Boring No. 39 Boring No. Boring No. 40 Boring No. 41



410 5-6-9 60.5'

USED 59.0' OF NX CASING.
WATER ENCOUNTERED AT 17.0'.

9/28/66

LIMESTONE GVL.
4-5-7 60.5'

USED 54.0' OF 3 1/2" CASING.
WATER ENCOUNTERED AT 18.0'
WATER LEVEL 14.0' ON COMPLETION.

9/20-21/66

5-7-7 60.5'

USED 59.0' OF NX CASING.
WATER ENCOUNTERED AT 17.0'
BORING CAVED AT 17.5'.

9/28/66

INDICATES
SHELBY TUBE

A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe~~xxxxxxxx~~ SIX INCHES, using 140 lb. weight falling 30 inches.

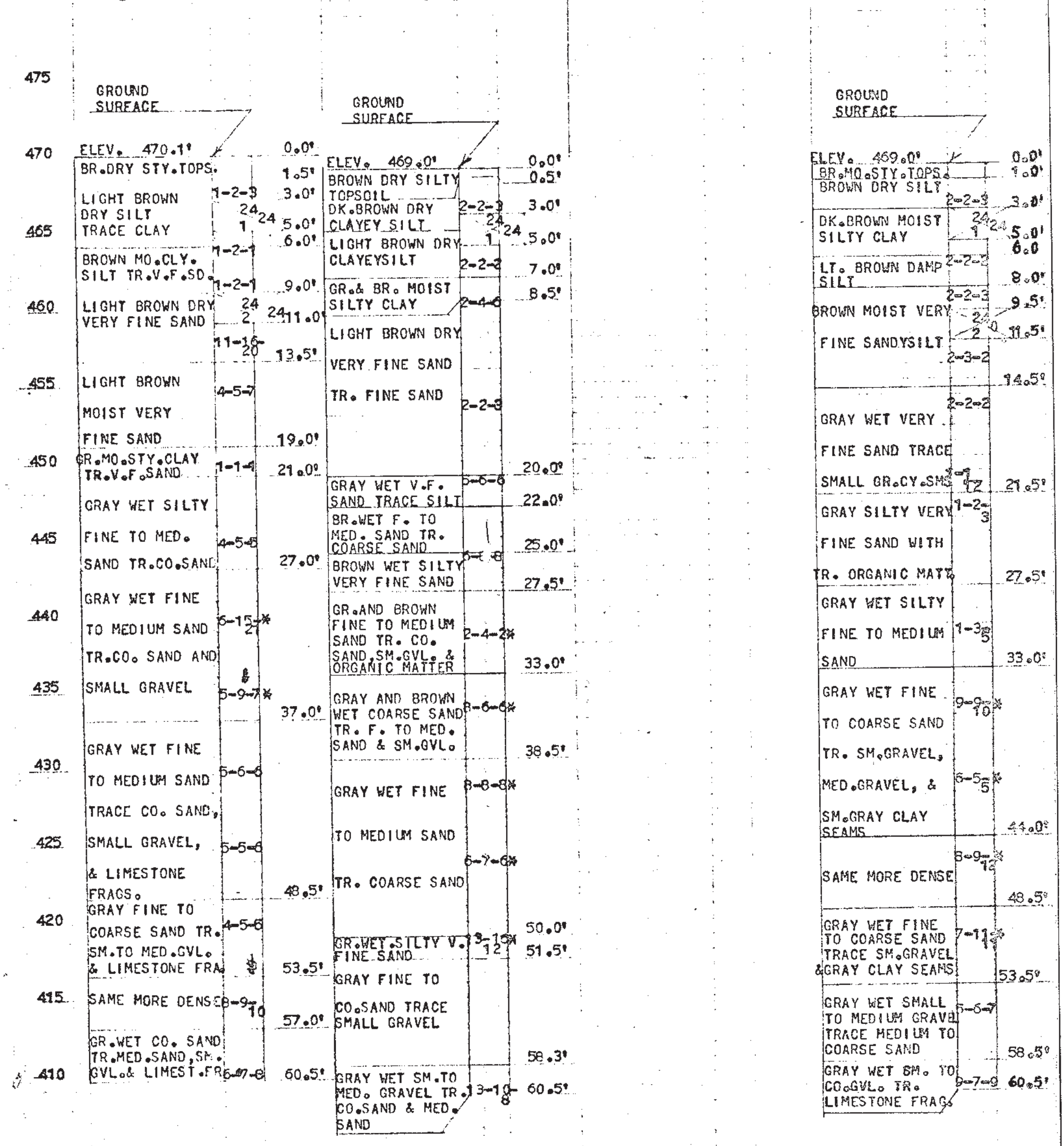
Total Footage 181.5'
Foreman JAMES TURNER
Job No. CB-5247-KC
Classification by FOREMAN
Sheet 9 of 18

TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
A DIVISION OF RAYMOND INTERNATIONAL INC.

To SVERDRUP AND PARCEL AND ASSOCIATES INC.,
Date NOVEMBER 9, 1966
Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

Boring No. 19 Boring No. 20 Boring No. Boring No. 21



410 GR.WET CO. SAND
TR.MED.SAND,SM.
GVL.& LIMEST.FR 6-7-8 60.5'

USED 59.0' OF NX CASING.
WATER ENCOUNTERED AT 14.0'.
WATER LEVEL 13.0' ON
COMPLETION.

9/7-8/66

58.3'
GRAY WET SM.TO
MED. GRAVEL TR.
CO.SAND & MED.
SAND 13-10-8 60.5'

USED 59.0' OF NX CASING.
WATER ENCOUNTERED AT 14.0'.
WATER LEVEL 12.0' ON COMPLETION.

9/8-9/66

TRACE MEDIUM TO
COARSE SAND 58.5'
GRAY WET SM. TO
CO.GVL. TR.
LIMESTONE FRAG. 9-7-9 60.5'

USED 59.0' OF NX CASING.
WATER ENCOUNTERED AT 14.0'
WATER LEVEL 12.0' ON
COMPLETION.

9/6-7/66

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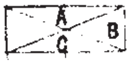
* - INDICATES NO RECOVERY
WASH SAMPLE OBTAINED.

FIGURES IN RIGHT HAND COLUMN SHOWN AS
FRACTION - NUMERATOR - NO. OF BLOWS (IN INCHES)
DENOMINATOR-PENETRATION (IN INCHES)

INDICATES
SHELBY TUBE



A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe xxxxxxx, using 140 lb. weight falling 30 inches.
SIX INCHES

Total Footage 181.5'
Foreman A.J.HOUSE
Job No. CB-5247-KC
Classification by FOREMAN
Sheet 10 of 18

TEST BORING REPORT

RAYMOND

CONCRETE PILE COMPANY

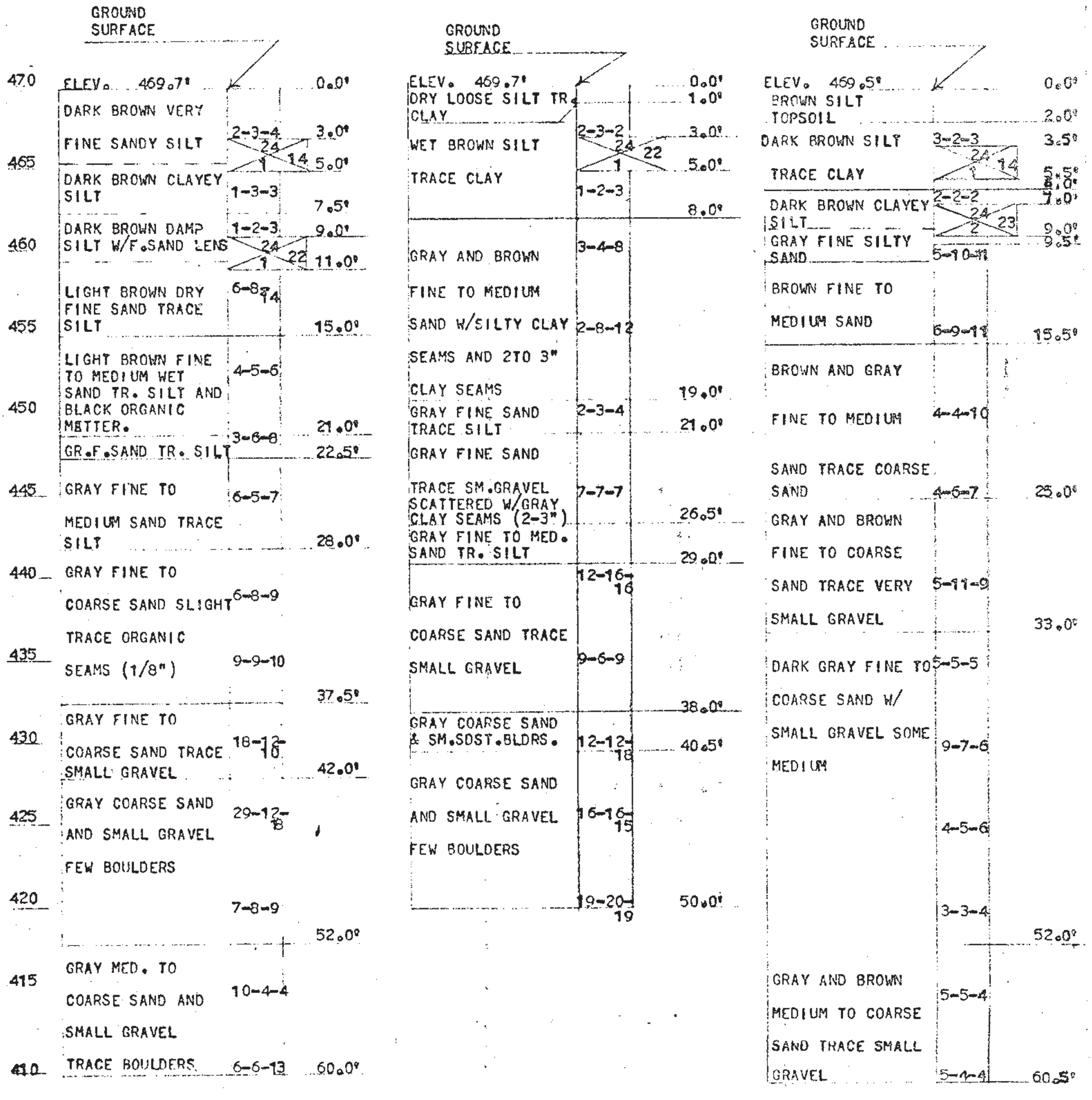
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES INC., Date NOVEMBER 9, 19~~5~~66 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

No. 26 No. 27 No. 29



BORING ADVANCED BY AUGER TO 25.0'.
USED 50.0' OF DRILLING MUD.

BORING ADVANCED BY AUGER TO 18.5'.
USED 26.0' OF 3 1/2" CASING.

BORING ADVANCED BY AUGER TO 13.5'.
USED 50.0' OF 3 1/2" CASING.

COARSE SAND AND

SMALL GRAVEL

410 TRACE BOULDERS 6-6-13 60.0'

BORING ADVANCED BY AUGER TO 25.0'.
USED 50.0' OF DRILLING MUD.
USED 54.0' OF 3 1/2" CASING.
USED DRILLING MUD FROM 55.0' TO 60.0'.

WATER ENCOUNTERED AT 16.5'.

9/15-16/66

BORING ADVANCED BY AUGER TO 18.5'.
USED 26.0' OF 3 1/2" CASING.

WATER ENCOUNTERED AT 17.0'.
WATER LEVEL 16.0' - 12 HOURS AFTER COMPLETION.

9/13-14/66

MEDIUM TO COARSE 5-5-4

SAND TRACE SMALL

GRAVEL 5-4-4 60.5'

BORING ADVANCED BY AUGER TO 13.5'.
USED 59.0' OF 3 1/2" CASING.

WATER ENCOUNTERED AT 15.5'.

9/19/66

INDICATES SHELBY TUBE A B C

A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe XXXXXXXX, using 140-lb. weight falling 30 inches.
SIX INCHES

Total Footage 170.5'
Foreman JAMES TURNER
Classification by FOREMEN
Sheet 12 of 18

TEST BORING REPORT

RAYMOND

CONCRETE PILE COMPANY

A DIVISION OF RAYMOND INTERNATIONAL INC.

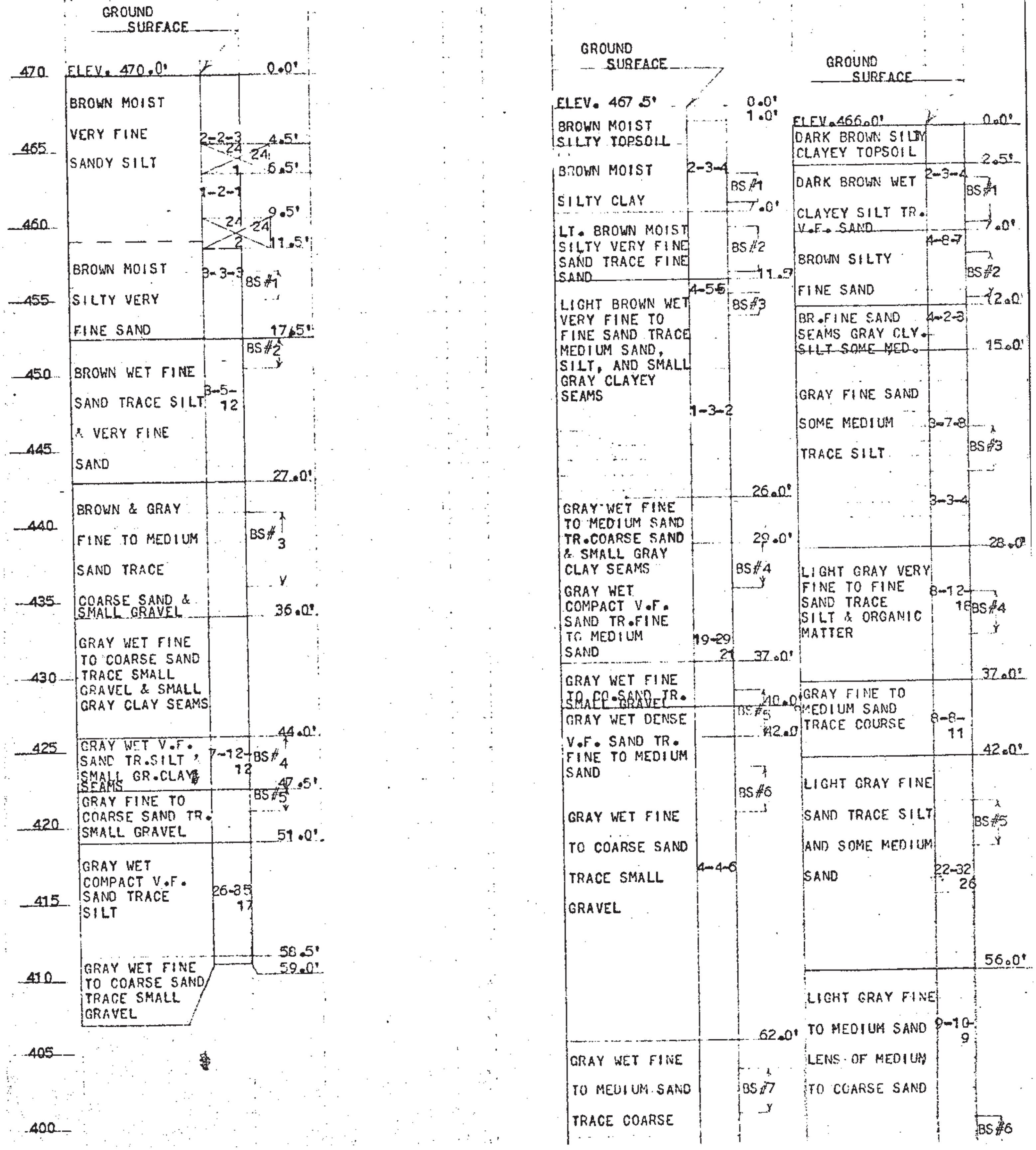
To SVERDRUP AND PARCEL AND ASSOCIATES

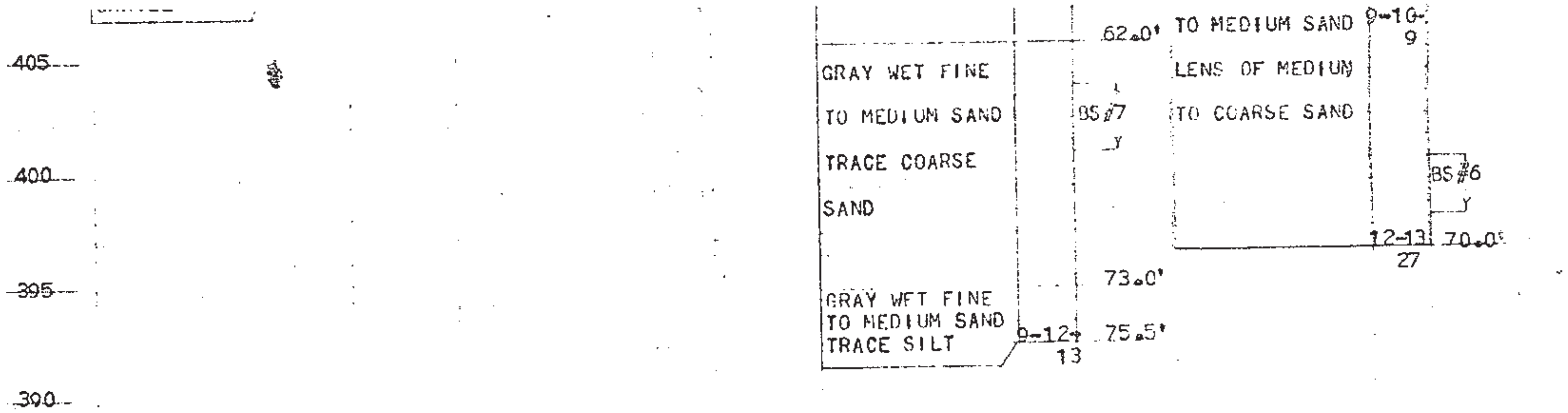
Date NOVEMBER 11, 1966

Location of Borings LABADIE, MISSOURI

All borings are plotted to a scale of 1″= 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

Boring No. 10   Boring No. ____   Boring No. 11   Boring No. 12





385 USED 59.0' NX CASING.

WATER ENCOUNTERED AT 14.0'.

USED 74.0' NX CASING.

WATER ENCOUNTERED AT 11.5'.
WATER LEVEL 12.0' ON COMPLETION.

USED 29.0' OF 31/2 INCH
CASING AND DRILLING MUD.

WATER ENCOUNTERED AT 15.0
WATER LEVEL 13.0' ON
COMPLETION.

8/30/66

9/2/66

9/24/66

BS- INDICATES BAG SAMPLE OBTAINED

INDICATES SHELBY TUBE $\boxed{\frac{A}{C}\; B}$

A- AMOUNT PENETRATED IN INCHES
B- AMOUNT RECOVERED IN INCHES
C- SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe EACH ~~foot~~ SIX INCHES, using 140 lb. weight falling 30 inches.

Total Footage 204.5'
Foreman A.J. HOUSE & JAMES TURNER
Job No. CB-5247-KC
Classification by FOREMAN
Sheet 13 of 18

TEST BORING REPORT

RAYMOND

CONCRETE PILE COMPANY

GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES, INC., Date NOVEMBER 8, 1966 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

No. 23

475	GROUND SURFACE		
470	ELEV. 470.7'		0.0'
	LT.BROWN DRY CLAYEY SILT		1.5'
	LT.BROWN DRY SILT TRACE VERY FINE SAND	3-3-3	
465	DK.BR.DRY SILTY CY.	1-2-2 24 1	5.0' 5.5' 23 7.5'
	LT.BROWN DRY V.F. SAND TRACE SILT	2-4-6	9.0'
460	LT.BROWN DRY V.F. SAND TRACE SILT AND THIN CLAYEY SILT SEAMS		14.0'
455	LT.BROWN DRY VERY FINE SAND TRACE SILT AND F. SAND	2-3-4	18.0'
450	SAME MORE DENSE	9-19-23	24.5'
445	GRAY VERY FINE SAND TRACE SILT	8-11-12	27.5'
440 435 430	GRAY WET FINE TO COARSE SAND TRACE SMALL GRAVEL	2-4-4 7-9-11 9-10-12	42.5'
425	GRAY WET FINE TO MEDIUM SAND TR.CO. SAND & SM.CLAY SMS.	11-12-13	48.5'
420	GRAY FINE TO MEDIUM SAND TRACE SMALL CLAY SEAMS, SM.GVL. &ORG. MATT.	7-10-18	54.0'
415	GRAY FINE TO MED. SAND TR.CO.SAND, SM.CY.SMS. TR. LIMESTONE FRAGS.		57.0'
410	GRAY WET CO.SAND TR.F.TO MED. SAND, SM. GRAVEL AND LIMESTONE FRAGS.	6-6-6	60.5'

No. 24

GROUND SURFACE		
ELEV. 469.0'		0.0'
DRY LOOSE BROWN SILT		2.5'
BROWN V.F. SANDY SILT	2-2-4 24 22 1	3.0'
BROWN AND GRAY SILT & V.F. SAND	2-2-3	5.0' 6.5'
BR.&GR.SILT TR.CY.	1-3-3	8.0'
BROWN SILTY FINE SAND	2-3-4	13.0'
BR.& GR.F.SDY.SILT		14.5'
BROWN FINE SAND TRACE SILT	1-2-6	19.0'
GRAY FINE TO MED. SAND TR. SILT AND ORGANIC MATERIAL	3-4-6	24.0'
GRAY FINE SAND TRACE SILT AND ORGANIC MATERIAL	4-7-8 8-13-15	34.0'
GRAY FINE TO COARSE SAND	10-10-10	37.0'
GRAY MEDIUM TO COARSE SAND TRACE SMALL GRAVEL	7-4-5	43.0'
GRAY FINE TO COARSE SAND SOME LIMESTONE FRAGS.	20-14-15	46.0'
GRAY FINE TO COARSE SAND TR. SMALL GRAVEL	8-7-8 8-9-11	55.0'

No. 25

GROUND SURFACE		
ELEV. 469.5'		0.0'
BROWN DRY SILTY TOPSOIL		0.5'
LT.BR.DRY V.F. SAND &SILT TR.CY.	2-2-3	3.5'
DK.BR.DRY CLY.SILT	1-2-2	5.5'
LIGHT BROWN DRY CLAYEY SILT	24 1, 24	7.5' 8.5'
LT.BR.DRY SILTY VERY FINE SAND	4-4-5	9.5'
LT. BROWN DRY CLY. SILT TR. F. SAND		13.0'
LIGHT BROWN DRY CLAYEY SILT TRACE FINE SAND AND ORGANIC MATTER	2-2-2	17.5'
GRAY WET CLAYEY SILT	1-2-2 24 1 24	19.0' 21.0' 22.0'
GRAY WET SILTY VERY FINE SAND	3-5-6 2-3-3	28.0'
GRAY WET FINE TO MEDIUM SAND TR. CO. SAND, SMALL GVL.& ORGANIC MATT.	6-8-4	33.0'
GRAY WET FINE TO MEDIUM SAND TR. CO. SAND, SMALL GRAY CLAY SEAMS	8-10-6 * 6-10-9	44.0'
GRAY SMALL TO MED. GRAVEL AND CO.SAND TR. MED. SAND AND LIMESTONE FRAGS.	4-5-6 *	48.5'
SAME MORE DENSE	5-10-11	56.0'
GRAY FINE TO CO. SAND TR. SMALL GRAVEL AND LIMESTONE FRAGMENTS		60.5'

415 SAND TR.CO.SAND, SM.CY.SMS. TR. LIMESTONE FRAGS. 57.0'

410 GRAY WET CO.SAND TR.F.TO MED. SAND, SM. GRAVEL AND LIMESTONE FRAGS. 6-6-6 60.5'

8-9-11 55.0'

56.0'

GRAY FINE TO CO. SAND TR. SMALL GRAVEL AND LIMESTONE FRAGMENTS 60.5'

USED 59.0' OF NX CASING.

WATER ENCOUNTERED AT 16.0'
WATER LEVEL 14.0' ON COMPLETION WITH CASING IN PLACE.
WATER LEVEL 15.0' ON COMPLETION WITH CASING REMOVED.

BORING ADVANCED BY AUGERTO 25.0'

USED 26.0' OF 3 1/2" CASING & DRILLING MUD.
WATER ENCOUNTERED AT 16.5'.

USED 59.0' OF NX CASING.

WATER ENCOUNTERED AT 13.5'.
WATER LEVEL 13.0' ON COMPLETION.

* - INDICATES NO RECOVERY.
WASH SAMPLE OBTAINED.

9/12-14/66

9/12-13/66

9/9/66

INDICATES SHELBY TUBE ☒ A B C

A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe ~~XXXXXXX~~ SIX INCHES, using 140-lb. weight falling 30 inches.

Total Footage 176.0'
Foreman JAMES TURNER AND A.J.HOUSE
Classification by FOREMEN
Sheet 11 of 18

F 383 4 70 PADS 5-4

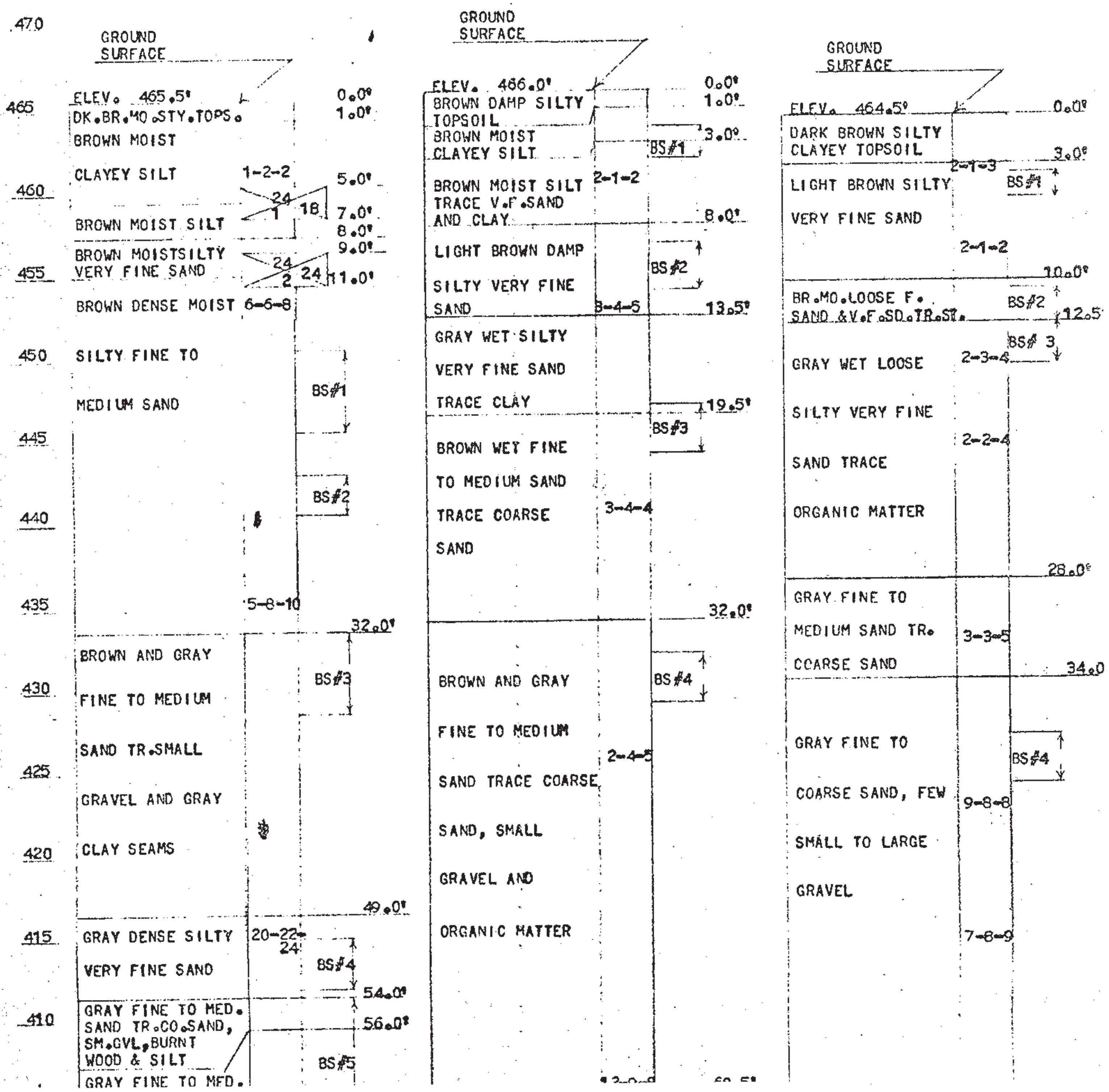
TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES, INC., Date NOVEMBER 8, 1966 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

No. 13 No. 14 No. 15



415 GRAY DENSE SILTY VERY FINE SAND 20-22-24 BS#4 54.0'

410 GRAY FINE TO MED. SAND TR.CO.SAND, SM.GVL, BURNT WOOD & SILT 56.0' BS#5

405 GRAY FINE TO MED. SAND TR.CO.SAND, SMALL GRAVEL, SILT AND LIME-STONE FRAGS. 12-13-14 60.5'

ORGANIC MATTER 12-9-8 60.5'

7-8-9

12-12-14 60.0'

USED 59.0' OF NX CASING.

WATER ENCOUNTERED AT 14.0'
WATER LEVEL 13.5' ON COMPLETION.

USED 59.0' OF NX CASING.

WATER ENCOUNTERED AT 11.5'.
WATER LEVEL 11.5' ON COMPLETION.

USED 20.0' OF DRILLING MUD AND 3 1/2" CASING.
WATER ENCOUNTERED AT 15.0'.
WATER LEVEL 14.0' ON COMPLETION.

8/29-30/66

9/1-2/66

9/23/66

BS - INDICATES BAG SAMPLE OBTAINED.

INDICATE SHELBY TUBE

A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (W.L.). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe ~~XXXXXXXX~~ EACH SIX INCHES, using 140-lb. weight falling 30 inches.

Total Footage 181.0'
Foreman A.J.HOUSE AND JAMES TURNER
Classification by FOREMEN
Sheet 14 of 18

F 344 R 30 [illegible]

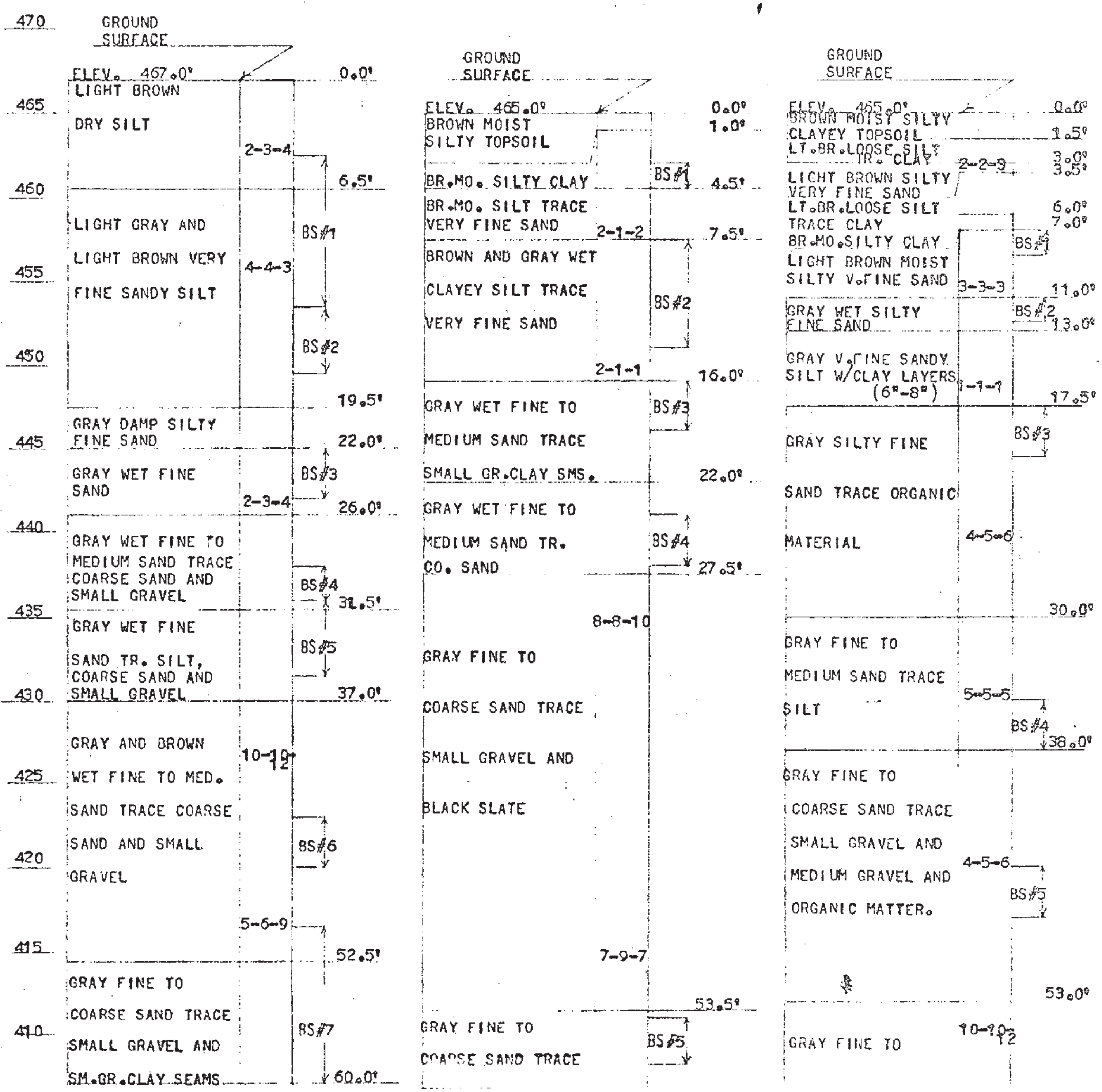
TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES, INC., Date NOVEMBER 8, 19~~5~~66 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

No. 16 No. 17 No. 18



410
405
400
395
390

GRAY FINE TO
COARSE SAND TRACE
SMALL GRAVEL AND
SM.GR.CLAY SEAMS
BS#7
60.0'

USED 57.0' OF NX CASING.

WATER ENCOUNTERED AT 14.5'.
WATER LEVEL 14.0' ON COMPLETION.

8/26-29/66

53.5'

GRAY FINE TO
COARSE SAND TRACE
SMALL GRAY CLAY
SEAMS AND SMALL
TO MEDIUM GRAVEL
BS#5
63.0'

GRAY FINE TO
COARSE SAND TRACE
SMALL GRAVEL AND
LIMESTONE FRAGS.
BS#6
68.0'

GRAY COARSE SAND
TRACE FINE TO
MEDIUM SAND
4-27-21
74.0'

USED 74.0' OF NX CASING.

WATER LEVEL 12.0' ON COMPLETION.

8/31/66
9/1/66

53.0'

GRAY FINE TO
COARSE SAND AND
SMALL GRAVEL SOME
MEDIUM TO COAPSE
GRAVEL
10-10-12
8-7-7
7-6-7
75.0'

USED 29.0' OF 3 1/2" CASING WITH
DRILLING MUD.

WATER ENCOUNTERED AT 15.0'
WATER LEVEL 14.0' ON COMPLETION.

9/21-22/66

BS - INDICATES BAG SAMPLE OBTAINED.

Classifications are made by visual Inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels

ACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe ~~xxxxxxxx~~, using 140-lb. weight falling 30 inches.
SIX INCHES

Total Footage 209.0'
Foreman A.J.HOUSE AND JAMES TURNER
Classification by FOREMEN
Sheet 15 of 18

TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES, INC., Date NOVEMBER 7, 19~~5~~66 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

Elevations: 470, 465, 460, 455, 450, 445, 440, 435, 430, 425, 420, 415, 410

No. 22

GROUND SURFACE

ELEV. 465.3'		0.0'
BR.SILT TR.CLAY		1.0'
LIGHT BROWN SILTY FINE SAND	4-6-7 5-5-6 3-6-9	14.0'
BROWN FINE TO MEDIUM SAND	1-2-4 5-8-6	22.0'
BROWN AND GRAY F. TO MED. SAND TRACE COARSE SAND	5-9-10	26.0'
GRAY TRACE BROWN FINE TO COARSE SAND AND SCATTERED SMALL GRAVEL	5-8-9 5-7-6 9-17-7	43.0'
GRAY SOME BROWN FINE TO COARSE SD FRAGS.OF LIMEST. & SOME GRAVEL	6-7-9	47.0'
GRAY FINE TO COARSE SAND TRACE SMALL GRAVEL	6-8-11	

No. 28

GROUND SURFACE

ELEV. 466.0'		0.0'
DARK GRAY CLAY AND SILTY CLAY		3.0'
GRAY SILT TRACE CLAY	2-3-3 1-2-2 24 1 13	5.0' 7.0' 8.0'
LIGHT BROWN FINE TO MEDIUM SAND	2-2-7	12.0'
WET BROWN FINE TO MEDIUM SAND TRACE SILT	3-5-7	16.0'
GRAY WET FINE TO MEDIUM SAND TRACE SCATTERED COARSE SAND	5-7-9 6-7-7	28.0'
GRAY FINE SAND	16-26-39	34.0'
GRAY F. TO MED.SD. TR.LIMESTONE FRAG.	19-10-8	36.0'
GRAY FINE TO COARSE SAND TRACE LIMESTONE BOULDERS AND FRAGMENTS	8-9-12 7-9-8 6-7-10	

No. 30

GROUND SURFACE

ELEV. 468.5'		0.0'
BLACK SILTY CLAY		0.7'
LIGHT BROWN DRY SILT	4-6-7 3-5-6	6.5'
	24 1 22	8.5'
LIGHT BROWN FINE TO MED. SAND AND TR.CO.SAND LENS	5-9-9	13.0'
LIGHT BROWN FINE TO MEDIUM SAND TRACE SILT	6-9-8	18.0'
LT.GRAY FINE TO V.F. SAND	9-15-17	21.0'
GRAY FINE SAND	2-2-3	28.0'
GRAY FINE TO MEDIUM SAND	3-5-10	34.0'
GRAY FINE TO COARSE SAND WITH LIMESTONE LEDGES OR BOULDERS	9-17-10 10-13-16 7-10-11	47.0'
GRAY FINE TO COARSE SAND TRACE SMALL GRAVEL	7-5-5 4-6-7 7-5-4	60.5'

COARSE SAND TRACE 410 SMALL GRAVEL 405 5-6-5 60.5'	9-13-18 60.5'	SMALL GRAVEL 4-6-7 7-5-4 60.5'
USED 59.0' OF NX CASING WATER ENCOUNTERED AT 9.0' WATER LEVEL 12.0' ON COMPLETION.	USED 59.0' OF NX CASING. WATER ENCOUNTERED AT 16.0'. WATER LEVEL 14.5' ON COMPLETION.	USED 59.0' OF NX CASING. WATER ENCOUNTERED AT 16.0'. WATER LEVEL 14.5' ON COMPLETION WITH CASING IN PLACE.
10/6-7/66	10/3-4/66	10/4-5/66

INDICATES SHELBY TUBE ⊠ A B C

A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe ~~XXXXXXX~~, using 140-lb. weight falling 30 inches.
SIX INCHES

Total Footage 181.5'
Foreman JAMES TURNER
Classification by FOREMAN
Sheet 16 of 18

TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES INC., Date NOVEMBER 7, 1966 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

Elevations: 470, 465, 460, 455, 450, 445, 440, 435, 430, 425, 420, 415, 410

No. 31

GROUND SURFACE

ELEV. 468.7'		0.0'
LIGHT BROWN SILTY VERY FINE SAND	2-2-4 2-3-4	8.0'
LT.BROWN FINE SAND		9.0'
LT. BROWN SILTY VERY FINE SAND	2-4-3	12.5'
BROWN FINE SAND TRACE SILT	4-5-7	18.0'
GRAY AND BROWN FINE SAND TR. MED. SAND	2-5-5	23.0'
GRAY FINE SAND TRACE MED. SAND	4-6-5 6-5-5	31.0'
GRAY FINE TO MEDIUM SAND	7-9-11	37.0'
GRAY FINE TO COARSE SAND AND SMALL GRAVEL, TR. LIMESTONE FRAGS. (SMALL . BOULDERS)	6-7-9 6-10-11 17-8-4 5-14-9 17-27-9	

No. 32

GROUND SURFACE

ELEV. 467.2'		0.0'
LIGHT BROWN VERY FINE SANDY SILT	5-5-6	4.0'
LT.BROWN SILT & V.F. TO F. SAND	5-5-5	6.5'
LIGHT BROWN FINE SAND TRACE SILT	5-7-10	10.0'
BROWN FINE SAND TRACE SILT LENS & ORGANIC MATERIAL	3-3-4	14.0'
BROWN VERY FINE TO FINE SAND TR. SILT	3-4-5	17.0'
GRAY VERY FINE SAND	4-5-6	23.0'
GRAY FINE SAND SOME MEDIUM SAND	3-4-4 12-10-14	31.0'
GRAY FINE TO MED. SAND TRACE COARSE SAND	9-11-13 11-8-10	43.0'
GRAY FINE TO CO. SAND TRACE SMALL GVL. & LIMESTONE BOULDERS	8-13-14	47.0'
GRAY MEDIUM TO COARSE SAND SOME FINE SAND WITH SMALL GRAVEL	4-6-7 9-8-	60.5'

No. 33

GROUND SURFACE

ELEV. 468.1'		0.0'
DARK BROWN CLAYEY SILT	1-2-3	3.0'
BROWN SILT TRACE VERY FINE SAND	1-2-3	8.0'
LIGHT BROWN SILTY VERY FINE SAND TRACE ORGANIC MATT.	1-3-5	13.0'
BROWN FINE TO MED. SAND TRACE COARSE SAND	5-9-8 3-2-4	21.0'
BROWN AND GRAY FINE TO MEDIUM SAND TR.CO.SAND	7-7-10	27.0'
GRAY FINE TO CO. SAND TRACE LIMESTONE FRAGMENTS	7-7-9	32.0'
GRAY MED. TO CO. SAND AND LIMESTONE LEDGES OR BOULDERS TR. FINE SAND	15-21-31 9-11-14 8-12-13	47.0'
GRAY FINE TO COARSE SAND TRACE PEA GRAVEL	13-13-10	59.5'
GRAY FINE ORGANIC SAND AND SM. TO	12-18-16	60.5'

415		5-14-9	
410		17-27-9	
			63.0'
405	LIGHT BROWN SANDSTONE LEDGES OR BOULDERS WITH GRAY F.TO CO.SAND	12-12-10	
400		10-6-6	
			72.0'
395	GRAY AND SOME BROWN FINE TO CO. SAND & SMALL GRAVEL TR. LIME-STONE GRAVEL	9-8-9	
390		9-11-10	82.0'
385	(TR. RED CLAY) →	9-10-5	
380	GRAY AND BROWN FINE TO COARSE SAND AND SMALL GRAVEL	9-11-13	
375		9-6-7	
370		4-5-6	
			103.0'
365	WHITE FINE GRAINED SANDSTONE WITH MANY PARTINGS (SOME DECOMPOSED)	60/20	108.0'
360	LIMESTONE AND DOLOMITE W/SAND &SANDSTONE,SOME POROUS TR.CLAY PARTINGS.	48/41	112.0'
355			

USED 103.0' OF NX CASING.
WATER ENCOUNTERED AT 16.0'.
WATER LEVEL 17.0' ON COMPLETION.

10/7-8-9/66

FINE SAND WITH SMALL GRAVEL	9-8-10	60.5'

USED 59.0' OF NX CASING.
WATER ENCOUNTERED AT 15.0'.
WATER LEVEL 15.0' ON COMPLETION.

10/5/66

		59.5'
GRAY FINE ORGANIC SAND AND SM.TO MED.GRAVEL AND MED. TO CO. SAND	12-18-16	60.5'

USED 59.0' OF NX CASING.
WATER ENCOUNTERED AT 17.0'.
WATER LEVEL 14.0' ON COMPLETION.

10/1/66

INDICATES ROCK CORE ▨ A/B

A - AMOUNT CORED (IN INCHES)
B - AMOUNT OF CORE RECOVERED (IN INCHES)
C -

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe ~~XXXXXXXX~~ SIX INCHES, using 140-lb. weight falling 30 inches.

Total Footage 133.0'
Foreman JAMES TURNER
Classification by FOREMAN
Sheet 17 of 18

TEST BORING REPORT
RAYMOND
CONCRETE PILE COMPANY
GOW DIVISION

To SVERDRUP AND PARCEL AND ASSOCIATES INC., Date NOVEMBER 7, 19~~5~~66 Job No. CB-5247-KC

Location of Borings LABADIE, MISSOURI PROPOSED POWER PLANT

All borings are plotted to a scale of 1" = 8' ft. using ELEVATIONS AS FURNISHED as a fixed datum.

No. 34

475			
	GROUND SURFACE		
470	ELEV. 470.4'		0.0'
	LIGHT BROWN DRY		
	FINE TO MEDIUM	4-7-9	
465	SAND TRACE SILT		
		3-3-3	7.5'
	BROWN DRY LOOSE		
460	SILT VERY FINE	4-3-3	11.5'
	SAND TRACE VERY	24 1 22	13.5'
455	SM.GRAVEL & CLAY	2-1-2	16.0'
	BROWN WET FINE		
	AND MEDIUM SAND	5-7-11	
450	TR.CO.SAND & SILT		22.0'
	BROWN AND GRAY FINE TO COARSE		
445	SAND TR. SILT	4-4-6	26.0'
	GRAY AND BROWN		
440	FINE TO MEDIUM	5-7-8	
	SAND TRACE COARSE		
	SAND		
435		4-6-6	36.5'
	COMPACT LIMESTONE BOULDER OR LEDGES		
430	WITH FINE TO MEDIUM SAND	18-10-11	42.0'
425	GRAY FINE TO	10-12-16	
	COARSE SAND TRACE		
420	LIMESTONE FRAGS.	8-8-12	
415		6-9-9	
410		5-7-8	60.5'

No.

No. 35

GROUND SURFACE		
ELEV. 469.9'		0.0'
DARK BROWN SILTY FINE SAND		1.0'
BROWN FINE TO MEDIUM SAND TRACE COARSE SAND	4-4-5	
		6.0'
	3-3-5	6.5'
GRAY SILT	24 1 21	8.5'
		9.5'
	1-3-5	
LIGHT GRAY SILTY VERY FINE SAND		13.0'
BROWN FINE SAND TRACE SILT	7-10-11	16.0'
BROWN FINE TO MEDIUM SAND TRACE COARSE SAND	6-9-10	21.0'
GRAY AND BROWN		
FINE TO MEDIUM	3-4-5	
SAND TR.CO.SAND		26.5'
GRAY FINE SAND		30.0'
	8-7-8	
GRAY FINE TO		
COARSE SAND TR.		
SMALL GRAVEL	8-4-3	37.0'
SANDSTONE BOULDERS SOME LIMESTONE W/ F.TO CO. SAND	24-16-9	42.0'
GRAY FINE TO	9-14-12	
COARSE SAND TRACE		
SMALL GRAVEL		
	8-9-11	
		59.5'
GRAY FINE SAND	20-41-43	60.5'

412 6-9-9

410 5-7-8 60.5'

USED 59.0' OF NX CASING.
WATER ENCOUNTERED AT 18.0'.

10/2/66

		59.5'
GRAY FINE SAND	20-41-43	60.5'

USED 59.5' OF NX CASING.
WATER ENCOUNTERED AT 18.0'.
WATER LEVEL 17.0' ON COMPLETION.

10/3/66

INDICATES SHELBY TUBE 

A - AMOUNT PENETRATED (IN INCHES)
B - AMOUNT RECOVERED (IN INCHES)
C - SHELBY TUBE NUMBER

Classifications are made by visual inspection.

Water levels (WL). Figure indicates time of reading (hours) after completion of boring. Water levels indicated are those observed when borings were made, or as noted. Porosity of the soil strata, variations of rainfall, site topography, etc., may cause changes in these levels.

EACH Figures in right hand column indicate number of blows required to drive 2" O.D. sampling pipe XXXXXXX SIX INCHES using 140-lb. weight falling 30 inches.

Total Footage 121.0'
Foreman JAMES TURNER
Classification by FOREMAN
Sheet 18 of 18

KEY TO BORING LOGS

Symbol	Description
	KEY TO SOIL SYMBOLS
▩	Fly Ash and/or Bottom ASH (FILL)
░	Poorly-graded SAND (SP)
▥	Silty SAND (SM)
▒	Crushed Limestone
▥	Low plastic Clayey SILT (ML)
▥	Inorganic, non-plastic SILT (ML)
	MISCELLANEOUS SYMBOLS
▽	Water table during drilling
⌁	Boring continues
▲	N-value from Standard Penetration Test, ASTM D-1586 (blows/ft)
■	Shear strength from Pocket Penetrometer (tsf)

Symbol	Description
	SOIL SAMPLERS
◩	2-in. O.D. Split-Spoon

Notes:

1. Borings were drilled on October 28 through November 3, 2015, by Midwest Drilling, Inc., Florissant, Missouri, under subcontract with Reitz & Jens. Borings were made using a CME 550X ATV-mounted drill rig. Borings were advanced with 3.75-inch I.D. hollow-stem, continuous-flight augers (HSA) or 4.25-inch O.D. solid continuous-flight augers (CFA). When ground water was encountered, the augers were flooded with water or mud and rotary driling was begun. Borings were backfilled with cement grout and topped with cuttings.

2. Boring locations were staked before drilling using a hand held GPS. Stakes were left at the drilled locations for later identification. The coordinates and elevations of the borings were surveyed by Kuhlmann Design Group (KdG) for Ameren.

3. The borings were logged in the field by a Reitz & Jens' NICET-Certified Soils Technician based upon the recovered samples, cuttings and drilling characteristics. Samples were transported to Reitz & Jens' lab for testing. Field logs were revised, if needed, based upon laboratory classification. The field work was done under the supervision of Chris Cook, P.E.

4. Stratification lines shown on the logs represent approximate soil boundaries; actual changes in soil strata may be gradual or occur between samples.

Figure A-0

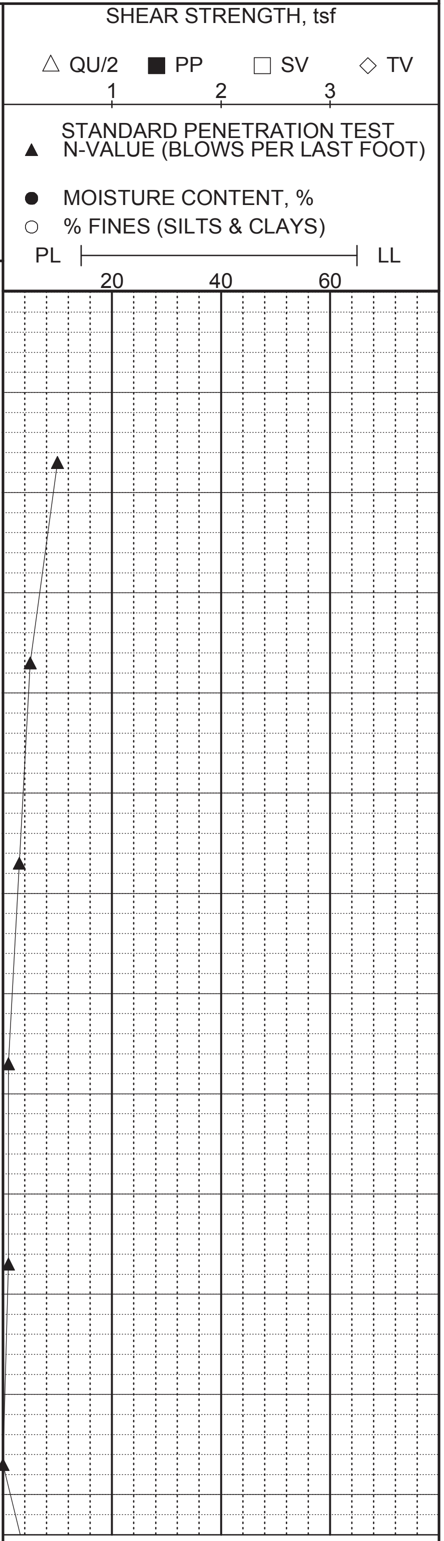
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG TH-2

Ameren: Labadie Plant Bottom Ash Pond Closure
CLIENT: **Gredell Engineering Resources**

LOCATION: N 991237.6, E 723549.1
ELEVATION: 497.6 DATUM: NAVD 1988
DATE DRILLED: 11-02-15

DEPTH (FEET)	ELEVATION	WATER TABLE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0				BOTTOM ASH, dark brown, fine sand-size grain, with gravel-sized cinders (<3/8"), medium-dense		
	495					
			50		4-5-5	
5						
	490					
			72	Becoming loose, with cinders <1/2"	1-3-2	
10						
	485					
			89	FLY ASH, gray, silt- to fine sand-size grain, very loose, with trace fine sand	1-2-1	
15						
	480					
			100	Becoming moist	1-0-1	
20						
	475	▽				
			44	Becoming saturated	1-0-1	
25						
	470					
			100		0-0-0	
30						



DRILLER: Midwest Drilling
METHOD: HSA / Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 23 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2015120902

BORING LOG TH-2

Ameren: Labadie Plant Bottom Ash Pond Closure

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	465							
					100	Becoming medium-dense	6-5-4	
35								
	460							
					56	BOTTOM ASH, dark gray, fine to coarse sand-size grain, medium-dense	6-9-13	
40								
	455							
					56	Becoming dark brown, fine sand-size grain Note: 3 feet fall in after SS-9; filled HSA, switched to mud rotary drilling.	9-10-7	
45								
	450							
					100	Becoming silt to coarse sand grain, loose	5-5-0	
50								
	445							
55								
						SAND (SP), tan medium gray, medium-dense, fine		
	440							
					33		2-4-5	
60						Boring terminated at 60'-0" in sand		
	435							
65								
	430							

SHEAR STRENGTH, tsf

△ QU/2 ■ PP ☐ SV ◇ TV

1 2 3

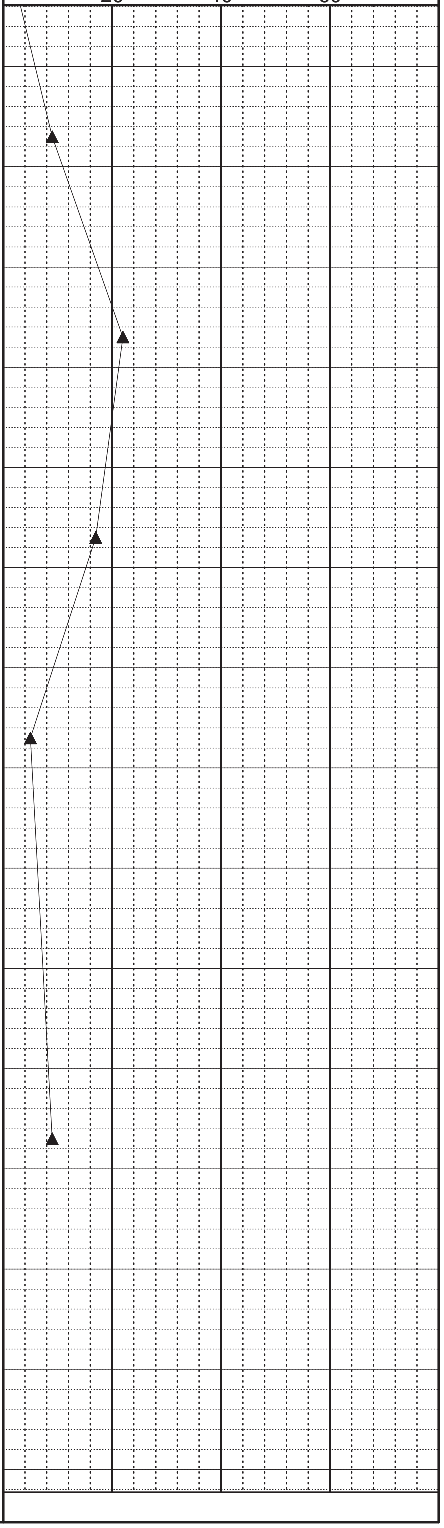
▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %

○ % FINES (SILTS & CLAYS)

PL ├──┤ LL

20 40 60



File: 2015120902

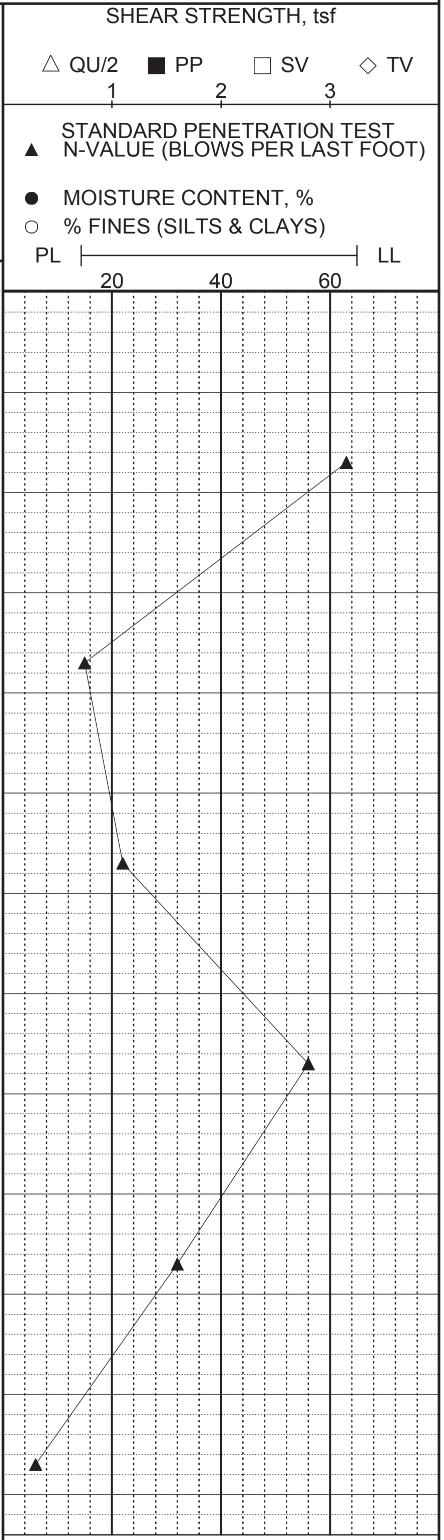
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG TH-3

Ameren: Labadie Plant Bottom Ash Pond Closure
CLIENT: **Gredell Engineering Resources**

LOCATION: N 991801.5, E 723758.8
ELEVATION: 497.3 DATUM: NAVD 1988
DATE DRILLED: 10-30-15

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						FLY ASH, gray-brown, fine sand-size grain, with bottom ash, cinders and unburnt coal, very dense, dry		
	495							
					89		12-28-35	
5								
	490							
					78	Becoming medium-dense	7-8-7	
10								
	485							
					78	Becoming dark brown, with trace cinders (<1/2")	5-8-14	
15								
	480							
					89	Becoming very dense, with silt- to fine sand-size grains, trace cinders (<1/2")	15-22-34	
20								
	475							
					67	BOTTOM ASH, dark gray to black, silt- to fine sand-size, trace up to <1/4", dense	11-19-13	
25								
	470							
					89	Sandy SILT (SM), gray, trace clay, with clay lenses, loose, dry	1-3-3	
30						Boring terminated at 30'-0" in sandy silt		



DRILLER: Midwest Drilling
METHOD: HSA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING Dry FEET
Y BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2015120902

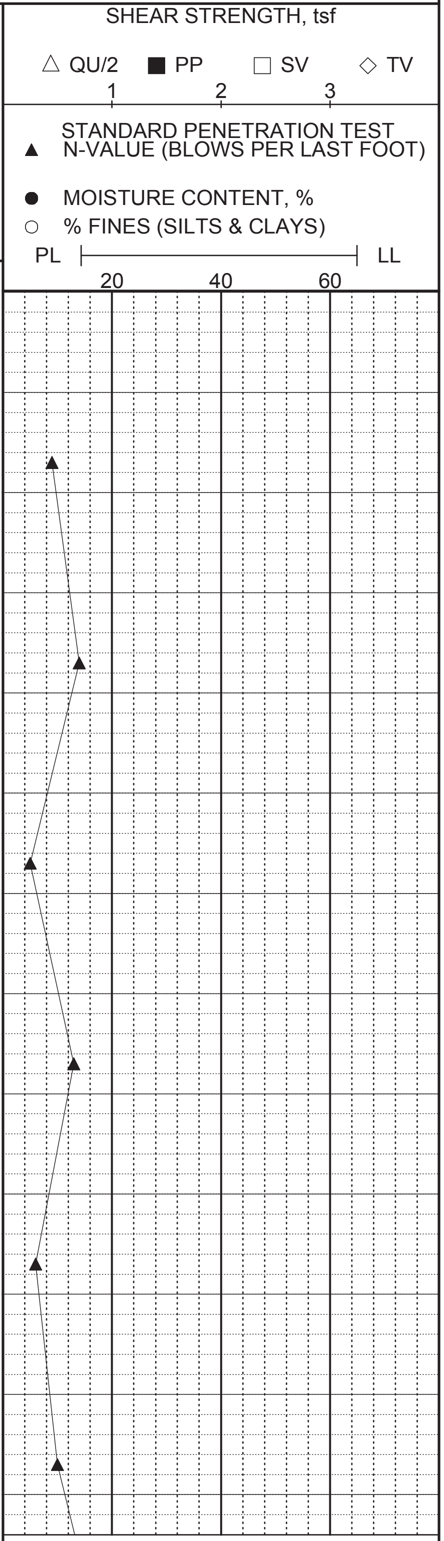
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG TH-4

Ameren: Labadie Plant Bottom Ash Pond Closure
CLIENT: **Gredell Engineering Resources**

LOCATION: N 991723.6, E 724216.7
ELEVATION: 528.9 DATUM: NAVD 1988
DATE DRILLED: 10-28&29-2015

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						BOTTOM ASH, dark brown, fine to coarse sand-size grains, medium-dense, with trace up to 1/2"		
5	525				67		6-5-4	
10	520				56	With trace silt-size particles (fly ash)	2-1-13	
15	515				33	Becoming loose, dark golden brown and fine sand-size grains	1-3-2	
20	510				78	Becoming medium-dense	4-6-7	
25	505				78	BOTTOM ASH/FLY ASH MIX, with silt to fine sand size grains, loose	3-3-3	
30	500				89	Becoming medium-dense, with particles up to 3/4"	5-5-5	



DRILLER: Midwest Drilling
METHOD: CFA / Mud Rotary
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%): ______
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 58 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT ___ FEET

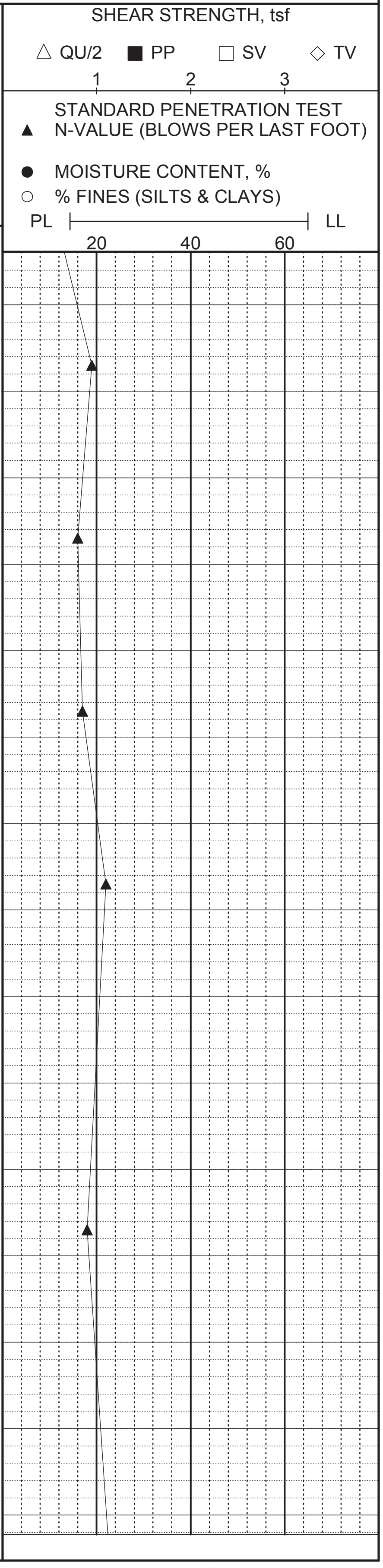
File: 2015120902

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG TH-4

Ameren: Labadie Plant Bottom Ash Pond Closure

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	495			◣	89	BOTTOM ASH, fine sand-size to fine gravel-size grains and coal (<3/4"), medium-dense	3-7-12	
35								
	490			◣	67		5-3-13	
40								
	485			◣	83		8-8-9	
45								
	480			◣	89	Becoming dark brown to black, trace gravel-size grains (<3/8")	3-11-11	
50								
	475							
55								
		▽						
	470			◣	94	Becoming black to dark gray, with traces of gravel-size grains and coal	3-8-10	
60								
	465							
65								



REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG TH-4

Ameren: Labadie Plant Bottom Ash Pond Closure

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
70	460				100	Becoming medium to coarse sand-size grains with fine gravel-size grains	3-6-17	
75	455							
80	450				100	FLY ASH, dark gray, silt to fine sand-size grains, very loose Note: no drilling mud return, 80' to 86'.	2-2-2	
85	445							
90	440				100	Becoming black, silt-size particles Note: hole collapsed to 77' while mixing mud; rods clogging.	0-2-2	
	435					Silty SAND (SM), gray, fine, medium-dense, with some gray silty clay		
95					83		6-12-12	
						Boring terminated at 96'-6" in silty sand		
100	430							
105	425							

SHEAR STRENGTH, tsf

△ QU/2 ■ PP □ SV ◇ TV

1 2 3

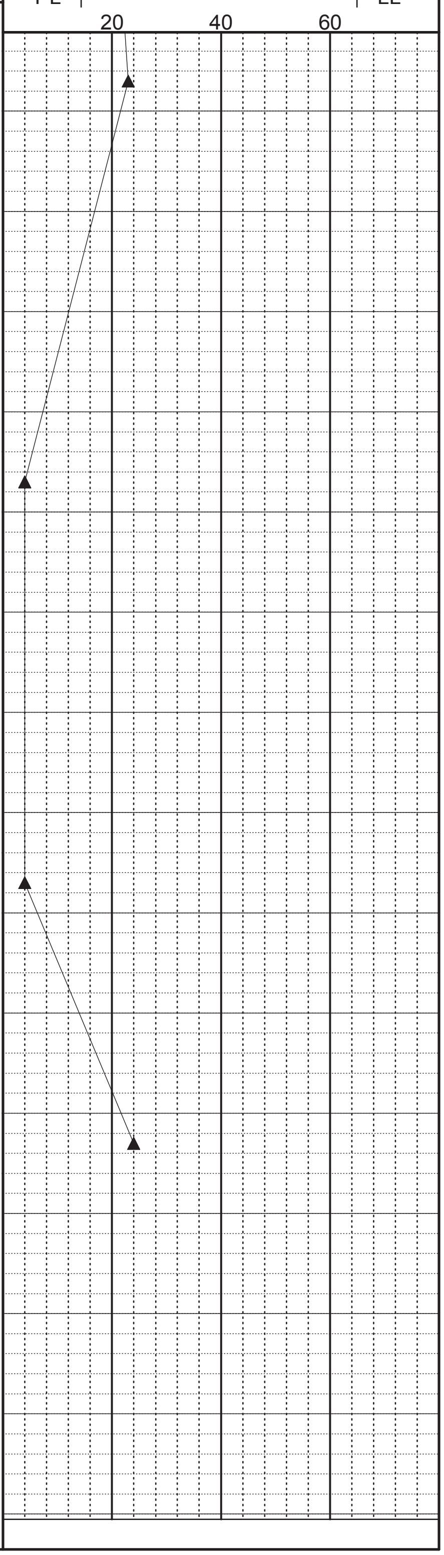
▲ STANDARD PENETRATION TEST N-VALUE (BLOWS PER LAST FOOT)

● MOISTURE CONTENT, %

○ % FINES (SILTS & CLAYS)

PL ├──┤ LL

20 40 60

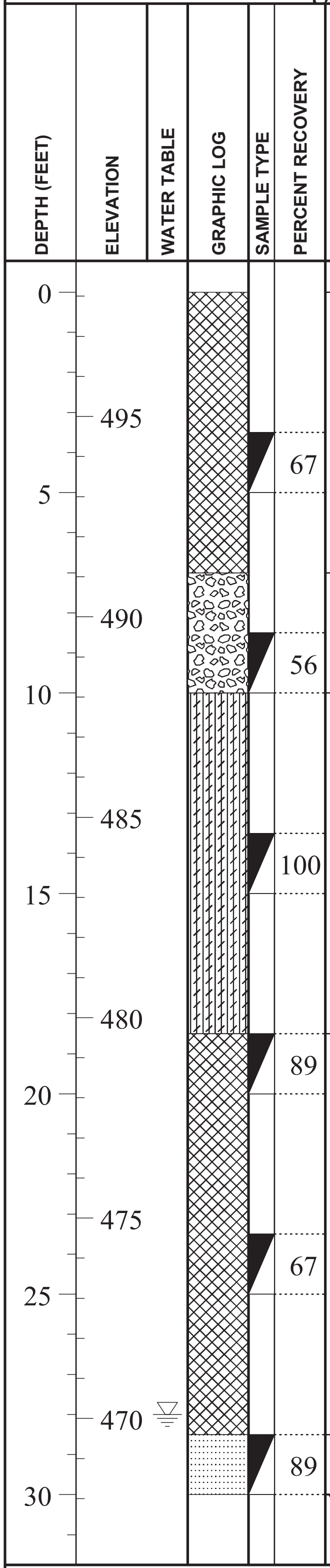


REITZ & JENS, INC.
CONSULTING ENGINEERS

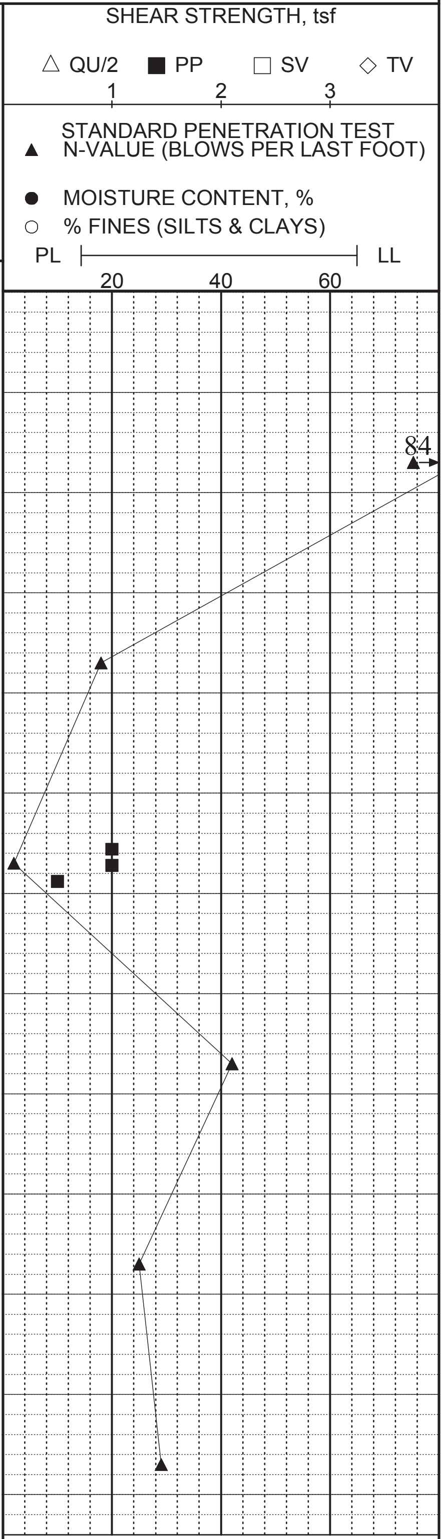
BORING LOG TH-26

Ameren: Labadie Plant Bottom Ash Pond Closure
CLIENT: **Gredell Engineering Resources**

LOCATION: N 992027.8, E 724055.9
ELEVATION: 498.1 DATUM: NAVD 1988
DATE DRILLED: 10-30-2015



PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	FLY ASH, tan and gray-brown, silt to very fine sand-size grains, very dense, with traces bottom ash (<3/8")		
67		22-40-44	
	CRUSHED LIMESTONE, with black bottom ash, medium-dense		
56		14-10-8	
	Clayey SILT FILL (ML), greenish gray, trace bottom ash, very loose		
100		1-1-1	
89	BOTTOM ASH, dark brown, fine sand-size grains, with fly ash and cinders, trace silty clay, dense	12-21-21	
67	Becoming medium dense, with unburnt coal, moist	15-15-10	
89	SAND (SP), gray, fine, slightly silty, dense, with trace fine gravel, saturated	6-14-15	
	Boring terminated at 30'-0" in sand		



DRILLER: Midwest Drilling
METHOD: HSA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 28 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS
PIEZOMETER: INSTALLED AT ___ FEET

File: 2015120902

Figure A-4

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG TH-27

Ameren: Labadie Plant Bottom Ash Pond Closure

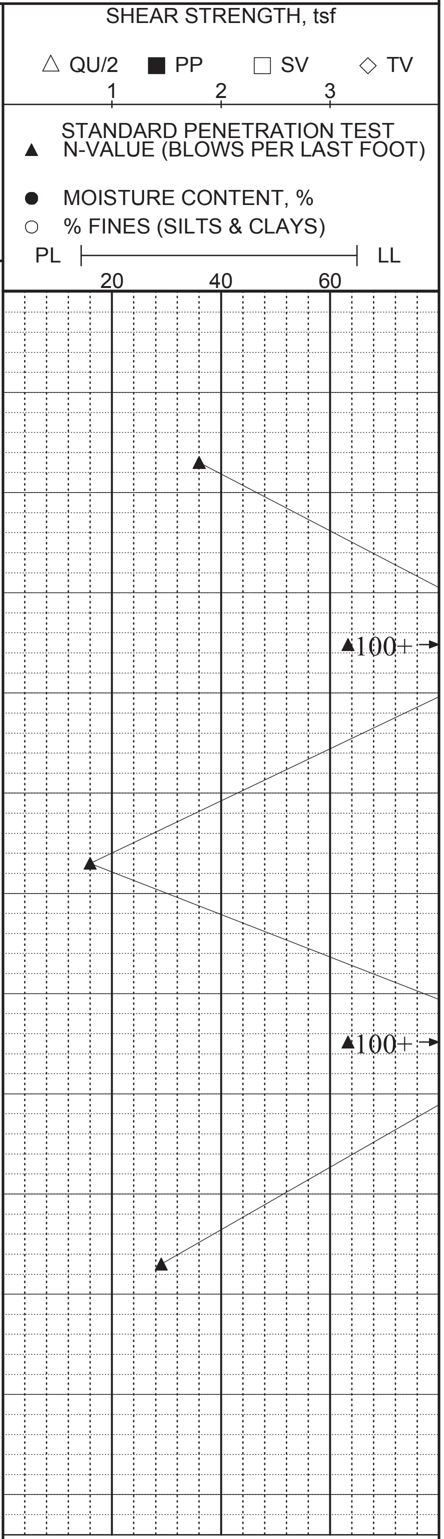
CLIENT: **Gredell Engineering Resources**

LOCATION: N 992223.7, E 724329.1

ELEVATION: 492.6 DATUM: NAVD 1988

DATE DRILLED: 10-29-2015

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						FLY ASH, grayish greenish brown, silt- to fine sand-size grains, dense		
	490							
					56		9-22-14	
5								
						Perched water at 6.5'		
	485							
					86	Becoming very dense, dry	23-50/1"	
10								
	480							
					89	BOTTOM ASH, dark gray-brown, medium to coarse sand-size grains, some fine gravel-size (<1/2"), medium-dense	5-7-9	
15								
	475	∇						
					100	Becoming gray, fine to coarse sand-size grains, very dense	50/5"	
20								
	470							
					89	SAND (SP), gray-tan, fine, dense	2-7-22	
25						Boring terminated at 25'-0" in sand		
	465							
30								



DRILLER: Midwest Drilling
METHOD: HSA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 18 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT ___ FEET

File: 2015120902

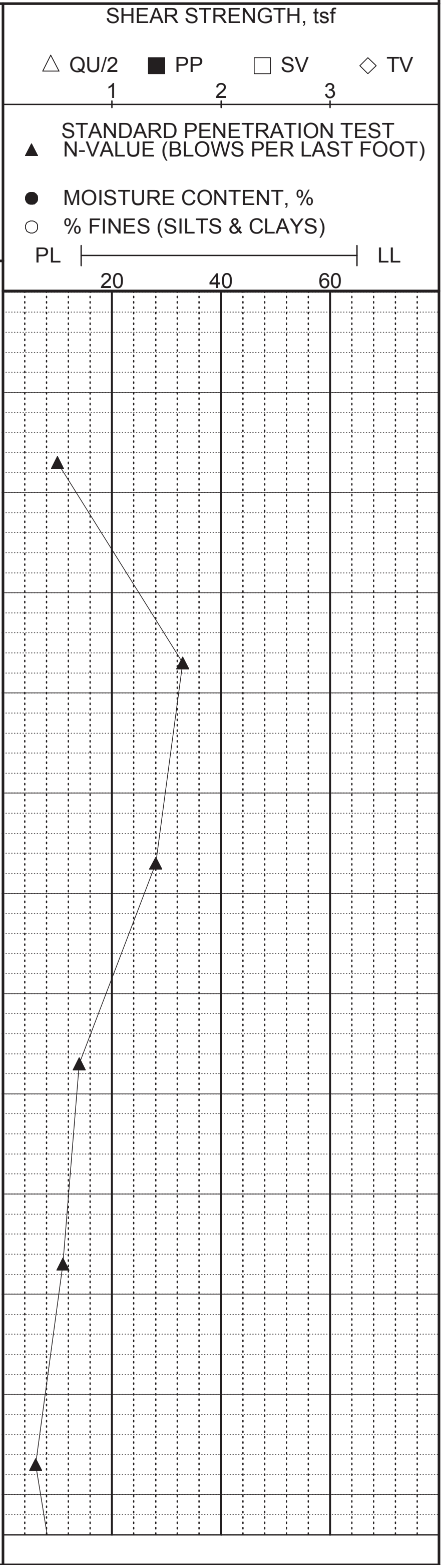
REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG TH-30

Ameren: Labadie Plant Bottom Ash Pond Closure
CLIENT: **Gredell Engineering Resources**

LOCATION: N 991479.9, E 723339.6
ELEVATION: 492.8 DATUM: NAVD 1988
DATE DRILLED: 11-03-2015

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
0						BOTTOM ASH, dark brown, fine sand-size grains, trace tan fly ash, medium-dense		
	490							
					89		3-4-6	
5								
	485							
					94	Becoming dense, fine sand-size to gravel-size grains, with unburnt coal and cinders	15-14-19	
10								
	480							
					83		9-14-14	
15								
	475							
					67	Becoming medium-dense, fine to medium sand-size grains	5-6-8	
20								
	470	▽						
					100	Becoming fine to coarse sand-size grains, with cinders (<1/2"), moist	5-7-4	
25								
						SILT (ML), tannish gray, trace clay, loose		
	465							
					100		2-2-4	
30								



DRILLER: Midwest Drilling
METHOD: HSA
TYPE OF SPT HAMMER: Automatic
HAMMER EFFICIENCY (%):
LOGGED BY: J. Pruett

STRATIFICATION LINES ARE APPROXIMATE SOIL BOUNDARIES ONLY; ACTUAL CHANGES MAY BE GRADUAL OR MAY OCCUR BETWEEN SAMPLES.

WATER LEVELS: DURING DRILLING 22.75 FEET
N BORING DRY AT COMPLETION OF DRILLING
AT ______ FEET AFTER ____ HOURS
AT ______ FEET AFTER ____ HOURS

PIEZOMETER: INSTALLED AT ___ FEET

File: 2015120902

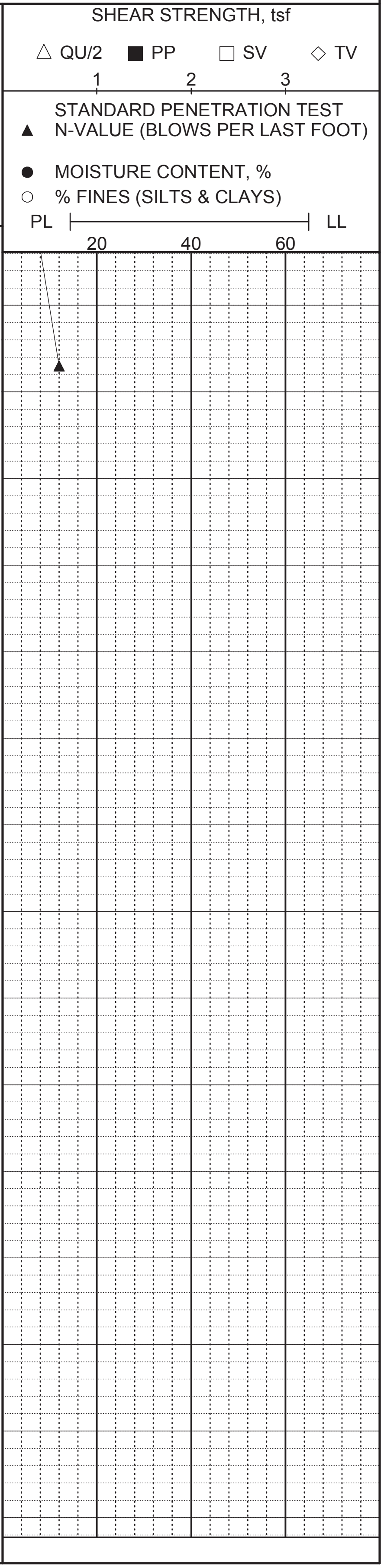
Figure A-6

REITZ & JENS, INC.
CONSULTING ENGINEERS

BORING LOG TH-30

Ameren: Labadie Plant Bottom Ash Pond Closure

DEPTH (FEET)	ELEVATION	WATER TABLE	GRAPHIC LOG	SAMPLE TYPE	PERCENT RECOVERY	MATERIAL DESCRIPTION	DRY UNIT WEIGHT (PCF) BLOWS PER 6 INCHES RQD= ROCK QUALITY DES.	MOISTURE CONTENT PERCENT BY WEIGHT
	460					Silty SAND (SM), tan, fine, medium-dense		
					17		3-5-7	
35						Boring terminated at 35'-0" in silty sand		
	455							
40								
	450							
45								
	445							
50								
	440							
55								
	435							
60								
	430							
65								
	425							



File: 2015120902

APPENDIX B

PERIODIC HAZARD CLASSIFICATION

AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
40 CFR PART 257
FRANKLIN COUNTY, MISSOURI

APPENDIX B: PERIODIC HAZARD POTENTIAL CLASSIFICATION
257.73(a)(2)

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AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
FRANKLIN COUNTY, MISSOURI

APPENDIX B: PERIODIC HAZARD POTENTIAL CLASSIFICATION §257.73(a)(2)

1.0 INTRODUCTION

The Labadie Energy Center (LEC) is located in northeastern Franklin County, Missouri along the Missouri River. The plant is approximately 3 miles north of the Town of Labadie on the south bank of the Missouri River at river mile 57.5. The LEC is located within the floodplain of the Missouri River. The LEC has two active surface impoundments that are designated as LCPA (Bottom Ash Pond) and LCPB (Fly Ash Pond). The single stage industrial embankment dams impound an area of approximately 243-acres. The surface impoundments have been dewatered, no longer receive CCRs and are currently being closed. A map showing the location of the surface impoundments is attached as Figure 1.

1.1 Purpose

40 CFR Part §257.73(a)(2) requires the owner or operator of an existing surface impoundment to conduct an initial and periodic hazard potential classification assessment of the CCR unit. The owner or operator must document the hazard classification of each CCR unit as either a high hazard potential CCR surface impoundment, a significant hazard potential CCR surface impoundment, or a low hazard potential CCR surface impoundment. The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and each subsequent periodic classification was conducted in accordance with the requirements of §257.73(a)(2). The following documents Reitz & Jens, Inc.'s periodic hazard potential classification evaluation for LCPA and LCPB at the Ameren Missouri Labadie Energy Center.

2.0 LABADIE ENERGY CENTER CCR UNITS

The Labadie Energy Center has two active surface impoundments; LCPA (Bottom Ash Pond) and LCPB (Fly Ash Pond). The surface impoundments have been dewatered, no longer receive CCRs and are currently being closed. Historically, the surface impoundments were used to store CCR, water retention, water clarification and alkalinity adjustment prior to discharge through Outfall #002 of NPDES permit number MO-0004812. The surface impoundment location and the centerline of the embankments are shown in Figure 1.

The hazard potential classifications were determined for the active surface impoundments at the Labadie Energy Center based on the Federal Emergency Management Agency (FEMA) hazard potential classification criteria. Pertinent data regarding each surface impoundment are shown in Table 1.

Table 1 – Active surface impoundments at the Labadie Energy Center

CCR Unit	Maximum Surface Area (acres)	Dam Height (feet)	Crest Length (feet)	Normal Pool Elevation (feet)
LCPA (Bottom Ash Pond)	164	26.3	10,500	NA
LCPB (Fly Ash Pond)	79	29.5	6,100	NA

The FEMA classification system has three levels of Hazard Potential Classification: Low, Significant, and High. The hazard potential classification system categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests should the dam fail. The classification system relies heavily on judgement and common sense, because all possibilities cannot be defined. Allowances for evacuation or emergency actions by the population were not considered because emergency procedures should not be a substitute for appropriate design, construction, and maintenance of dam structures. A summary for the FEMA hazard classification system of dams is shown in Table 2.

Table 2 - FEMA hazard classification system of dams

Hazard Potential 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 no necessary for this classification)

2.1 LCPA (Bottom Ash Pond)

The design plans for the LCPA were issued for construction in 1969 and construction was completed shortly after. The LCPA is located south of the plant and has an approximate area of 164 acres. The location of the LCPA and the pond's significant features are shown in Figure 1. The embankment forms a ring dam which ties into plant fill on the north side of the impoundment. The embankment height is the greatest on the south and west sides of the pond, and the maximum dam height is 26.3 feet. The LCPA has been dewatered, no longer receives CCRs and is being closed. Previously, LCPA received process water used to sluice bottom ash, flow from the plant combined drain sump (CDS), and discharge from the LCPB. The impoundment received both bottom and fly ash prior to completion of the LCPB. Discharge from the LCPB was near the southeast corner of the impoundment, and the water generally flowed east to west through ditches in the CCR. The LCPA contained a principal and emergency spillway; however, these have been repurposed or removed. Drawings for the LCPA are presented in the O&M manual in Appendix A of the *Ameren Missouri Labadie Energy Center: Evaluation of CCR Units* report.

Failure of the LCPA would result in the release of water and CCR into a man-made channel, Labadie Creek and/or the surrounding terrain. The failure should not cause loss of life or significant environmental impacts. Economic and lifeline losses of the impoundment would generally be limited to the owner. Therefore, according to the FEMA Hazard Potential Classification of Dams, the LCPA should have a Low Hazard Potential Classification.

2.2 LCPB (Fly Ash Pond)

The LCPB was built in the 1990's and has an area of approximately 79 acres. The location of the LCPB and the pond's significant features are shown in Figure 1. The LCPB is located east of the LCPA and south of the plant. The embankment forms a ring dam which ties into plant fill near the northwest corner of the impoundment. The embankment height is greatest on the east and south sides of the pond, and the maximum dam height is 29.5 feet. The western embankment section separates the pond from the LCPA. The LCPB has been dewatered, no longer receives CCRs and is being closed. Historically, the LCPB received process water used to sluice fly ash. The LCPB did not receive run-on from areas outside of the perimeter embankment. The LCPB outlet works were removed during closure construction. Drawings for the LCPB are presented in the O&M manual in Appendix A of the *Ameren Missouri Labadie Energy Center: Evaluation of CCR Units* report.

Failure of the LCPB would result in the release of water and CCR into the surrounding terrain. The failure should not cause loss of life or significant environmental impacts. Economic and lifeline losses of the impoundment would generally be limited to the owner. Therefore, according to the FEMA Hazard Potential Classification of Dams, the LCPB should have a Low Hazard Potential Classification.

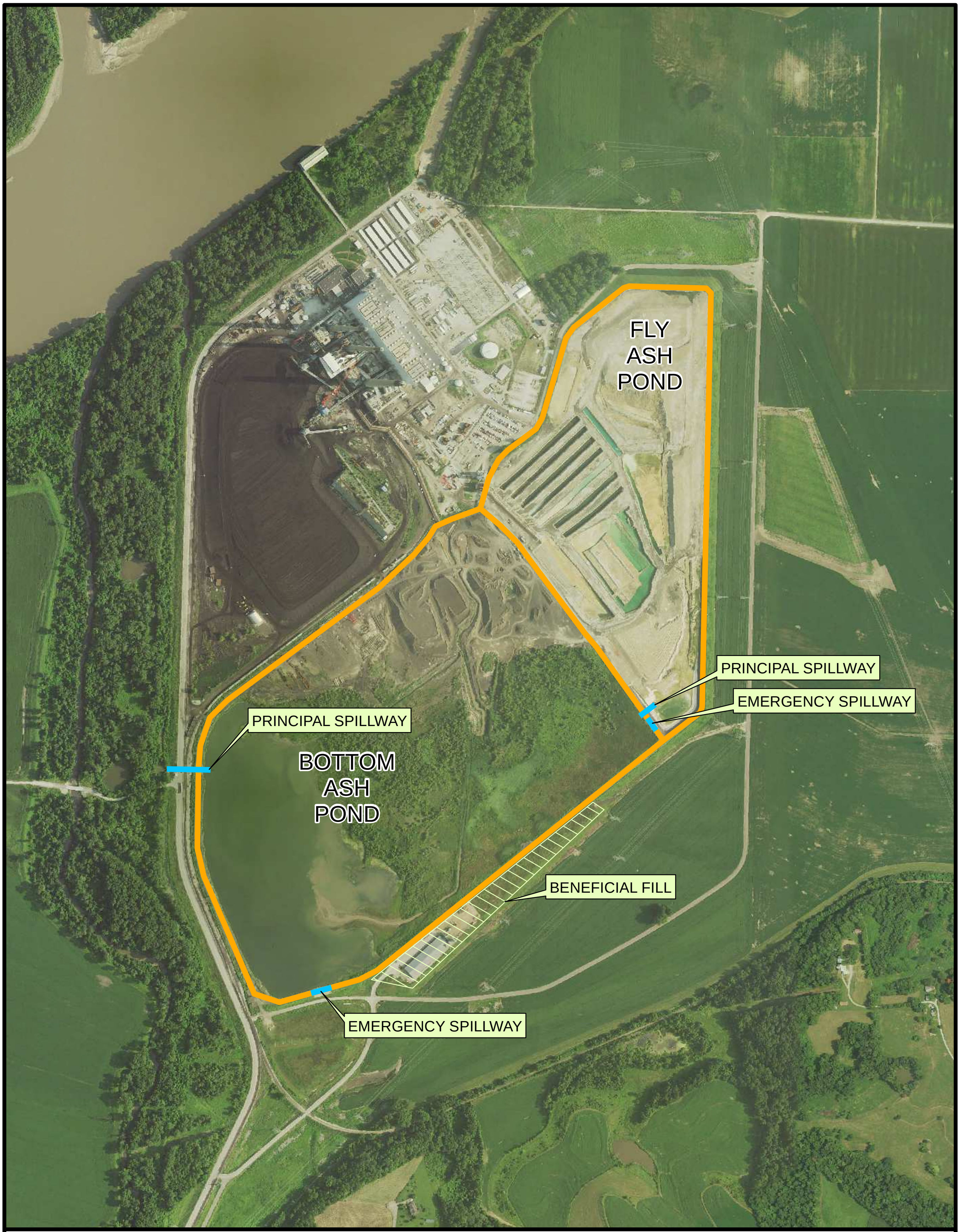
3.0 CONCLUSION

The initial hazard potential classifications for the active CCR surface impoundments at the Labadie Energy Center is Low Hazard Potential for the LCPA and LCPB. The hazard potential classification should be re-evaluated within 5 years of the initial hazard potential classification.

4.0 REFERENCES

Environmental Protection Agency. (2015). “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule.” 40 CFR Parts 257 and 261., Vol. 80, No. 74.

Federal Emergency Management Agency. (2004). “Federal Guidelines for Dam Safety, Hazard Potential Classification System for Dams.” Interagency Committee on Dam Safety.



Legend

- 🟧 Embankment
- 🟦 Spillway

AMEREN MISSOURI
LABADIE ENERGY CENTER
ACTIVE CCR SURFACE IMPOUNDMENTS
FIGURE 1

Ameren MISSOURI

REITZ & JENS, INC.
CONSULTING ENGINEERS

APPENDIX C

PERIODIC STRUCTURAL STABILITY ASSESSMENT

AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
40 CFR PART 257
FRANKLIN COUNTY, MISSOURI

APPENDIX C: PERIODIC STRUCTURAL STABILITY ASSESSMENT
257.73(d)(1)

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APPENDIX C: PERIODIC STRUCTURAL STABILITY ASSESSMENT 257.73(d)(1)

1.0 INTRODUCTION

The Labadie Energy Center (LEC) is located in northeastern Franklin County, Missouri along the Missouri River. The plant is approximately 3 miles north of the Town of Labadie on the south bank of the Missouri River at river mile 57.5. The LEC is located within the floodplain of the Missouri River. The LEC has two active surface impoundments that are designated as LCPA (Bottom Ash Pond) and LCPB (Fly Ash Pond). The single stage industrial embankment dams impound an area of approximately 243-acres. The surface impoundments have been dewatered, no longer receive CCRs and are currently being closed. A map showing the location of the surface impoundments is attached as Figure 1.

1.1 Purpose

40 CFR Part 257.73(d)(1) specifies that the owner or operator of all existing CCR surface impoundments, except for incised CCR units, shall conduct periodic structural stability assessments and document whether the design, construction, operation and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein.

The purpose of this periodic structural stability assessment for LCPA and LCPB at the Labadie Energy Center is to provide the information required by 40 CFR Part 257.73(d)(1). The periodic structural stability assessment consisted of field inspections, design and construction document review, and review of operation and maintenance records. Additional information for the LCPA and LCPB are included in the History of Construction Report.

2.0 FIELD INSPECTION

A field inspection of the existing surface impoundment at the Labadie Energy Center was conducted on October 28, 2020 by Reitz & Jens, Inc. personnel Jeff Bertel, P.E., Laura Sutton, P.E. and Ashley Martinez, E.I.; who were accompanied by Ameren Missouri personnel Marc Lueckenhoff, P.E. The weather was cloudy with temperatures around 45 degrees (F). The Missouri River stage at the LEC was elevation 452.0. The field inspection consisted of walking the crest and toe of the LCPA and LCPB perimeter berms, and visually reviewing the hydraulic outlet structures.

Observations made during the inspection were recorded on the Ameren Annual Inspection Check Sheet for each surface impoundment and is included in Appendix I. A photograph log of the main inspection findings is also included in Appendix I. Photographs taken during the inspection are included on a DVD contained in Appendix II. Observations from the field inspection are summarized below for each CCR unit.

2.1 LCPA (Bottom Ash Pond)

2.1.1 Embankment and Foundation Stability

Field inspection of the LCPA perimeter berm found no signs of instability. There was no visible vertical or horizontal misalignment of the crest. No slides, sloughs, tension cracking, slope depressions or bulges were observed in the crest or downstream slope. The downstream slope had recently been mowed and the vegetation was in good condition. No animal burrow activity was observed.

The downstream slopes have been inundated due to high water levels in the Missouri River and there were no signs of instability due to sudden drawdown.

Active closure construction was observed during the inspection. Some areas of the crest and upstream slopes have been disturbed due to the construction. The closure plans indicate that these areas will be repaired in latter stages of construction.

The weekly inspection reports from January 2019 to May 2020 describe minor erosion along Crest Rd. No deficiency was noted during the current inspection in this area and we assume it has been repaired.

2.1.2 Slope Protection

The downstream slopes for the LCPA are vegetated on the south and west sides of the pond. The southern embankment section width over a distance of approximately 2000 feet is considerable because of an adjacent beneficial fill. On the north side of the pond the downstream slope in this area is poorly defined given the thick section width, and low embankment height that tapers at a shallow slope angle into the adjacent plant fill. The downstream slope on the north side of the pond is vegetated or consists of bottom ash. The east embankment downstream slope was nearly indistinguishable during the current inspection. The vegetated downstream embankment slopes had recently been mowed and were in good condition.

The upstream slopes have been disturbed by closure construction. The upstream slopes are planned to be capped with an HDPE geomembrane liner overlain by 2 feet of soil that is vegetated.

2.1.3 Hydraulic Structures

The principal spillway has been converted to a stormwater inlet and gravity outfall for stormwater runoff from a closed section of the pond. The emergency spillway has been removed. Stormwater is routed to 5 stormwater outlets through the perimeter embankment.

Some minor deficiencies were observed at the locations of the new stormwater outlets. Specifically, the duckbill valve at Station 8+00 was no longer fixed to the outfall, the duckbill valve at Station 16+00 was partially buried in sediment and there is ponding above the invert of the duckbill at Station 21+00. We recommend reinspecting these outfalls after completion of closure construction to verify that they have been adequately addressed.

2.1.4 LCPA Investigation Conclusions

There were no significant deficiencies or signs of instability observed during the field inspection of LCPA, however there are maintenance items and additional monitoring that should occur. The following remedial items should be addressed as soon as feasible. Ameren should prepare documentation detailing the corrective measures taken as these items are addressed.

- Inspect areas disturbed by closure construction to verify that these areas have been restored and adequately armored for erosion protection. Inspect the stormwater outlets to verify that they have been installed in accordance with closure plans.

2.2 LCPB (Fly Ash Pond)

2.2.1 Embankment and Foundation Stability

Field inspection of the LCPB perimeter berm found no signs of instability. There was no visible vertical or horizontal misalignment of the crest. No slides, sloughs, tension cracking, slope depressions or bulges were observed in the crest or downstream slope.

The downstream slopes have been inundated by the Missouri River and there were no signs of instability due to sudden drawdown.

Ruts due to closure construction were observed on the embankment crest on the east and south sides of the impoundment. Verify that these ruts are repaired at the completion of closure construction.

There is good access to the embankment for surveillance of the crest and slopes. No operational activities or adjacent developments were observed that might threaten the integrity of the embankment.

The weekly inspection reports from January 2019 to May 2020 describe only minor deficiencies related to disturbance from closure construction.

2.2.2 Slope Protection

The downstream slopes of the LCPB are vegetated, and the upstream slopes are currently being capped with an HDPE geomembrane overlain by 2 feet of soil.

The vegetation on the downstream slopes has been highly disturbed by closure construction. A portion of the slopes has been seeded but vegetation has not been established. We recommend inspecting the downstream slopes after construction has been completed to verify that they are adequately vegetated.

2.2.3 Hydraulic Structures

During closure construction the principal and emergency spillways have been removed. Rainfall falling within the footprint of the LCPB is routed to 5 stormwater outlets around the perimeter embankment.

2.2.4 LCPB Investigation Conclusions

There were no significant deficiencies or signs of instability observed during the field inspection of LCPB, however there are maintenance items and additional monitoring that should occur. The following remedial items should be addressed as soon as feasible. Ameren should prepare documentation detailing the corrective measures taken as these items are addressed.

- Verify that rutting on the embankment crest has been repaired at the completion of closure construction.
- We recommend inspecting the downstream slopes after construction has been completed to verify that they are adequately vegetated.

3.0 OPERATIONS AND MAINTENANCE REVIEW

The available operations and maintenance records were reviewed as part of the periodic structural stability assessment. The review included the Labadie Bottom Ash & Fly Ash Pond Embankments O&M Manual, the preceding weekly and annual inspections for a period of 1 year, on-site meetings to discuss ongoing maintenance, and the most recent survey data provided by Ameren Missouri.

The O&M Manual specifies minimum requirements for maintenance and establishes operational requirements for CCR placement. The manual states that no alterations or repairs to structural elements should be made without the approval of the Chief Dam Safety Engineer. The O&M Manual is attached in Appendix A of the *Ameren Missouri Labadie Energy Center: Evaluation of CCR Units* report.

3.1 LCPA (Bottom Ash Pond)

3.1.1 Operations

The LCPA has been dewatered and is currently being closed. The LCPA historically received bottom ash sluice flow, discharge from the LCPB, and flow from the Combined Drain Sump (CDS) which collects stormwater from the plant facility and coal pile, and wastewater treatment plant effluent.

Table 1 includes pertinent data regarding the volume and depth of impounded CCR in the LCPA.

Table 1 – Volume and depth of impounded CCR in LCPA

CCR Unit	Est. Volume of Water and CCR (CY)	Est. Bottom Elev. of CCR Unit (feet)	Est. Minimum CCR Elev. (feet)	Est. Minimum Depth of CCR (feet)	Est. Maximum CCR Elev. (feet)	Est. Maximum Depth of CCR (feet)
LCPA	16,208,668	407.6	478	68	507	97

3.1.2 Maintenance

Weekly inspection check sheets from January 2019 to May 2020, and the 2019 annual inspection check sheet were reviewed. The following is a summary of observations from these inspections and their condition during the current inspection. The 2019 Labadie Annual Levee Inspection is included in Appendix I.

Weekly inspection reports describe erosion along Crest Rd at the discharge. During the current inspection no erosion was observed in this location.

In general, the inspection reports indicate the level of maintenance within the last year is adequate, and nearly all deficiencies recorded during the weekly and annual inspection reports within the last year have been addressed or are related to closure construction . During the current inspection the vegetated embankment slopes had recently been mowed. The current frequency of mowing and spraying should be adjusted as necessary to prevent excess vegetation growth and to promote dense vegetative cover.

3.2 LCPB (Fly Ash Pond)

3.2.1 Operations

The LCPB has been dewatered, no longer receives CCRs and is being closed. Historically, the LCPB received process water used to sluice fly ash. There is no contributing watershed to this pond outside of the perimeter dike.

Table 2 includes pertinent data regarding the volume and depth of impounded CCR in the LCPB.

Table 2 – Volume and depth of impounded CCR in LCPB

CCR Unit	Est. Volume of Water and CCR (CY)	Est. Bottom Elev. of CCR Unit (feet)	Est. Minimum CCR Elev. (feet)	Est. Minimum Depth of CCR (feet)	Est. Maximum CCR Elev. (feet)	Est. Maximum Depth of CCR (feet)
LCPB	3,861,136	460	481	21	501	41

3.2.2 Maintenance

Weekly inspection check sheets from January 2019 to May 2020, and the 2019 annual inspection check sheet were reviewed. The following is a summary of observations from these inspections and their condition during the current inspection. The 2019 Labadie Annual Levee Inspection is included in Appendix I.

Weekly inspection reports minor deficiencies such as erosion or HDPE liner disturbance that are generally related to closure construction.

The 2019 annual inspection noted small holes in the liner on the east side of the impoundment but further describes that they will be repaired as part of closure construction. Ponding was noted at the downstream toe on the east side of the impoundment from a recent flood. No flowing water was observed. The report recommended that the area be monitored during routine inspections. The report also describes ruts on the embankment crown, probably related to closure construction.

In general, the inspection reports indicate the level of maintenance within the last year is adequate, and nearly all deficiencies recorded during the weekly and annual inspection reports within the last year have been addressed or are related to closure construction. During the current inspection the downstream slopes were highly disturbed and should be reinspected at the completion of closure to verify they are adequately vegetated.

4.0 DESIGN AND CONSTRUCTION DOCUMENT REVIEW

4.1 LCPA (Bottom Ash Pond)

4.1.1 Embankment and Foundation Stability

There are no construction documents or records for the original construction of the LCPA Dam. The embankment was raised 8.5 feet in the early 1990's using a mixture of bottom and fly ash. Fill placed to raise the embankments was blended and compacted to achieve permeability no greater than 1x10-6 cm/sec. Based on borings conducted in 2010, the top 9 to 10 feet of the embankment is medium dense to very dense and consists of bottom and fly ash. Beneath the ash fill are 1 to 3 foot thick layers of clay, silt and sand. The coarse grain layers have an estimated friction angle of 30 to 33°. The fine grain soils have an undrained strength that ranges from 1400 to 1500 psf, based on UU tests and correlations for N-values, and CPT tip resistance and skin friction.

The embankment dam was constructed of compacted fill with upstream slopes of 2 horizontal (H) to 1 vertical (V) and downstream slopes of 3H to 1V. The minimum crown width is approximately 20 feet. The width of the embankment section is increased considerably on the west side of the impoundment because of fill placed for the plant access road and over a distance of 2000 lineal feet along the south side of the impoundment because of a beneficial fill.

The initial periodic safety factor assessment for LCPA were completed in October 2016. LCPA has been dewatered and is currently being closed. Reitz & Jens completed analyses of LCPA for the closed condition. Reitz & Jens's report is included in Appendix D. The initial periodic safety factor assessment was completed by Reitz & Jens, and is also included in Appendix D.

4.1.2 Slope Protection

The perimeter berm of the LCPA was originally designed with vegetated downstream and upstream slopes. Presently, the downstream slopes are vegetated. The upstream slopes are being capped with HDPE geomembrane overlain by 2 feet of soil. There are no design documents for the slope protection. No significant erosion concerns were observed during the inspection.

4.1.3 Spillways

The principal spillway has been converted to a stormwater inlet and gravity outfall for stormwater runoff from a closed section of the pond. The emergency spillway has been removed. Stormwater is routed to 5 stormwater outlets through the perimeter embankment.

4.2 LCPB (Fly Ash Pond)

4.2.1 Embankment and Foundation Stability

The original construction plans for the LCPB are presented in the O&M Manual. The embankment dam was constructed of earth fill with upstream slopes of 2H to 1V and 3H to 1V, and downstream slopes of 3H to 1V. Earth fill was obtained from the incised portion of the pond, and the lowest elevation at the bottom of the pond is at 460.0 feet. The crown width is 10 feet near the northwest corner of the pond where the embankment height is generally less than 10 feet. The crown width for the remainder of the pond has a minimum width of 20 feet. The interior of the LCPB is lined with 60 MIL HDPE on the interior slopes, and 40 MIL HDPE on the pond bottom.

The embankment was constructed of earth fill burrowed from the interior of the pond. The design plans note that the top 6 feet of the foundation soil inside the perimeter berm should be used as fill. CPT soundings conducted in 2010 showed that the embankment fill is heterogeneous and consists of sand, silt and clay that were generally placed in 8 to 12 inch thick lifts. The coarse grain lifts are generally medium dense and the fine grain lifts are firm to stiff.

The initial periodic safety factor assessment for LCPB were completed in October 2016. LCPB has been dewatered and is currently being closed. Reitz & Jens completed analyses of LCPB for the closed condition. Reitz & Jens's report is included in Appendix D. The initial periodic safety factor assessment was completed by Reitz & Jens, and is also included in Appendix D.

4.2.2 Slope Protection

The LCPB was originally designed with vegetated downstream slopes and upstream slopes lined with 60-mil HDPE. The vegetation on the downstream slopes has been highly disturbed by closure construction. A portion of the slopes has been seeded but vegetation has not been established. We recommend inspecting the downstream slopes after construction has been completed to verify that they are adequately vegetated. The upstream slopes are being capped with HDPE geomembrane overlain by 2 feet of soil. There are no design documents for the slope protection. No significant erosion concerns were observed during the inspection.

4.2.3 Spillways

During closure construction the principal and emergency spillways have been removed. Rainfall falling within the footprint of the LCPB is routed to 5 stormwater outlets around the perimeter embankment.

5.0 PERIODIC STRUCTURAL STABILITY ASSESSMENT SUMMARY

The initial periodic structural stability assessment found no structural stability deficiencies, no significant issues with the current operations and maintenance, and that the design and construction of the embankments and spillways were adequate for the range of loading conditions under which the CCR unit should be subjected. However, the deficiencies listed below do need to be addressed.

5.1 LCPA (Bottom Ash Pond)

- Inspect areas disturbed by closure construction to verify that these areas have been restored and adequately armored for erosion protection. Inspect the stormwater outlets to verify that they have been installed in accordance with closure plans.

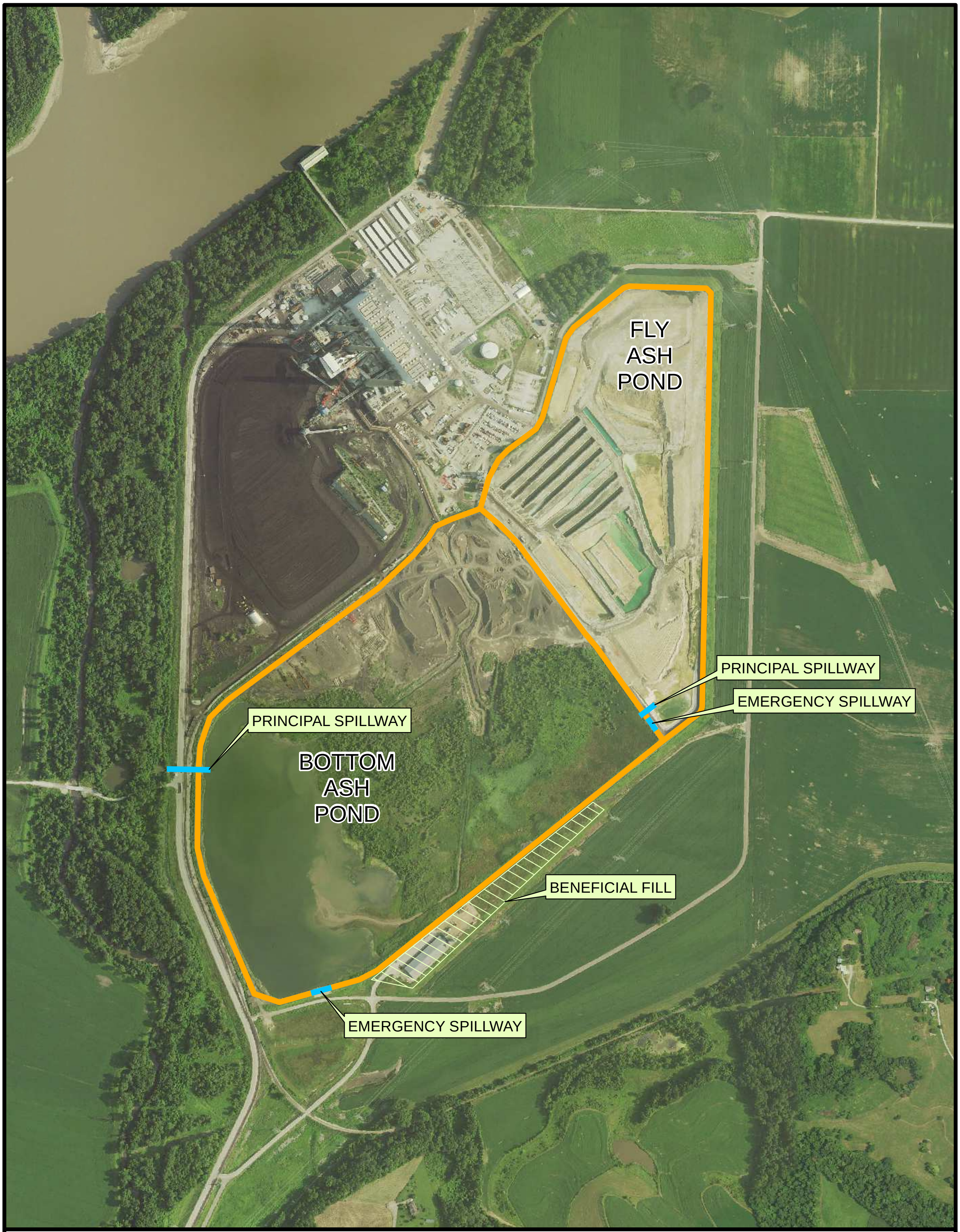
5.2 LCPB (Fly Ash Pond)

- Verify that rutting on the embankment crest has been repaired at the completion of closure construction.
- We recommend inspecting the downstream slopes after construction has been completed to verify that they are adequately vegetated.

6.0 REFERENCES

Ameren Missouri. (2012). “Operation and Maintenance Manual; Labadie Bottom Ash & Fly Ash Pond Embankments, Labadie, Missouri, Franklin County.” Dam Safety and Hydro Engineering, St. Louis, Missouri.

Environmental Protection Agency. (2015). “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule.” 40 CFR Parts 257 and 261., Vol. 80, No. 74.



AMEREN MISSOURI
LABADIE ENERGY CENTER
ACTIVE CCR SURFACE IMPOUNDMENTS
FIGURE 1

Ameren
MISSOURI

REITZ & JENS, INC.
CONSULTING ENGINEERS

APPENDIX I

2020 PERIODIC INSPECTION CHECK SHEETS

2020 PERIODIC INSPECTION PHOTOGRAPH LOG

2019 LABADIE ENERGY CENTER ANNUAL INSPECTION CHECK SHEET

REITZ & JENS, INC.
CONSULTING ENGINEERS

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December 14, 2020

Jeffrey Greer, P.E.
Manager of Dam Safety & Hydro Licensing
Ameren Missouri
11149 Lindbergh Business Ct.
St. Louis, MO 63123

RE: Ameren Missouri – Labadie Energy Center
2020 Annual Inspection
Landfill Cell 1 (LCL1), Fly Ash Pond (LCPB) and Bottom Ash Pond (LCPA)

Dear Matt,

Enclosed herewith are Annual Inspection Check Sheets for the 2020 Annual Inspection of the active surface impoundments Fly Ash Pond (LCPB) and Bottom Ash Pond (LCPA), and active landfill Cell 1 (LCL1) at Ameren Missouri's Labadie Energy Center conducted on October 28, 2020 by Reitz & Jens and Ameren Personnel. The Annual Inspection was in general accordance with 40 CFR Part 257.83(b), and included a review of available information regarding the status and condition of the CCR unit, including files available in the operating record.

No signs of structural weakness which would impact the operation and safety of the unit were observed. Minor maintenance items observed in the 2020 Annual Inspection associated with routine upkeep, presently do not impact the structural integrity of the embankment. Nonetheless, Ameren should address these minor maintenance items in a timely manner.

The following documents were reviewed as part of the Inspection:

1. *Ameren Missouri. (2012). "Operation and Maintenance Manual; Labadie Bottom Ash & Fly Ash Pond Embankments, Labadie, Missouri, Franklin County." Dam Safety and Hydro Engineering, St. Louis, Missouri.*
2. *Ameren Missouri. (2016). Operation and Maintenance Manual for Cell 1 and Pond 1, Labadie Energy Center Utility Waste Landfill, Franklin County, Missouri." Power Operations Services, St. Louis, Missouri.*
3. *Ameren Missouri. (2016). "Ameren Missouri Labadie Energy Center Construction Permit Modifications for Permitted Utility Waste Landfill, Permit Number 0907101, Franklin County, Missouri."*
4. *Ameren Missouri. (2016). "2016 Labadie Annual Inspection Checklist." September 23, 2016*

5. *Ameren Missouri. (2017). "2017 Labadie Annual Inspection Checklist." September 21, 2017*
6. *Ameren Missouri. (2018). "2018 Labadie Annual Inspection Checklist." September 19, 2018*
7. *Ameren Missouri. (2018). "Labadie Energy Center Ash Pond Closures 95% Construction Drawings Franklin County, Missouri Revised February 2020."*
8. *Ameren Missouri. (2019). "2019 Labadie Annual Inspection Checklist." September 17, 2019*
9. *Ameren Missouri. (2019). "Cell 1, Labadie Fly Ash Pond, and Labadie Bottom Ash Pond, Weekly Inspection Checksheet." January 4 to December 31, 2019*
10. *Ameren Missouri. (2020). "Cell 1, Labadie Fly Ash Pond, and Labadie Bottom Ash Pond, Weekly Inspection Checksheet." January 8 to May 19, 2020*
11. *Ameren Ash Volumes Inventory, Excel Spreadsheet*
12. *Ameren CCR Unit Inventory, Excel Spreadsheet*
13. *Environmental Protection Agency (EPA). (2015). "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities." 40 CFR Parts 257 to 261. Vol. 80. No. 74. Federal Register*
14. *O'Brien & Gere. (2011). "Dam Safety Assessment of CCW Impoundments, Labadie Power Station." USEPA Contract Number; EP-10W000673*

The subsequent annual inspection must be conducted no later than October 28, 2021.

Sincerely,

Jeff Bertel

Jeff Bertel, P.E.
Project Manager
Reitz & Jens, Inc.

LABADIE ENERGY CENTER
Bottom Ash Pond (LCPA)
Annual Inspection Check Sheet

Date	10/28/2020
Inspector	J. Bertel, L. Sutton, A. Martinez, M. Lueckenhoff
Pool Level	NA
River Level	El. 452
Temperature	45°F
Weather	Cloudy

Date of Previous Annual Inspection: 09/17/2019

Date of Previous Periodic Inspection: 09/23/2015

Description of Emergency (EC) or Immediate Maintenance (IM) conditions observed since the last annual inspection:
None

Describe any action taken to restore or improve safety and integrity of impounding structure:
The impoundment is currently being closed and no longer contains impounded water.

Describe any modifications to the geometry of the impounding structure since the previous annual inspection:
The interior of the impoundment is being capped with 2 feet of soil and an HDPE geomembrane. The interior has been graded to drain surface water to conduits through the perimeter embankment, the HDPE geomembrane has been installed, and soil is being placed on top of the geomembrane.

Describe any modifications to the operation of the impounding structure since the previous annual inspection:
Impoundment no longer used for ash handling and disposal, and is being closed.

List the approximate remaining storage capacity of the impounding structure:
NA

List the approximate maximum, minimum and present depth and elevation of the impounded water since the previous annual inspection:
Max – el. 484.99 ft, depth 75.09 ft; Min – el. 477.85 ft, depth 68.04 ft; Present – None

List the approximate maximum, minimum and present depth and elevation of the impounded CCR since the previous annual inspection:
Max – el. 507 ft, depth 97 ft; Min – el. 478 ft, depth 68 ft; Present – el. 507, depth 97 feet

Approximate volume of impounded water and CCR at the time of the inspection:
16,208,668 CY of CCR, no impounded free water

Describe any changes to the downstream watershed:
None

Inlet and Outlet Works

Item	Condition Code	Comments
Outlet Condition	NI	The outlet has been retrofitted to serve as a pipe for stormwater only surface drainage from the closed impoundment.
Valve Condition/ Operability	NI	The existing gate valves no longer serve any purpose.
Discharge Piping Condition	NI	
Leakage	NI	
Outfall Condition	NI	
Outlet Channel	GC	The outlet channel appeared in good condition. (IMG_3866)
Discharge (color and/or sediment)	NI	Discharge was from stormwater runoff from a portion of closed impoundment.
Obstructions	GC	No obstructions were observed in outlet channel.
Instrumentation	NI	
Inlet Piping and Supports Condition	NI	Inlet piping has been removed.
Emergency Spillway Condition	NI	Emergency spillway has been filled as part of closure. (IMG_3848)
Other		

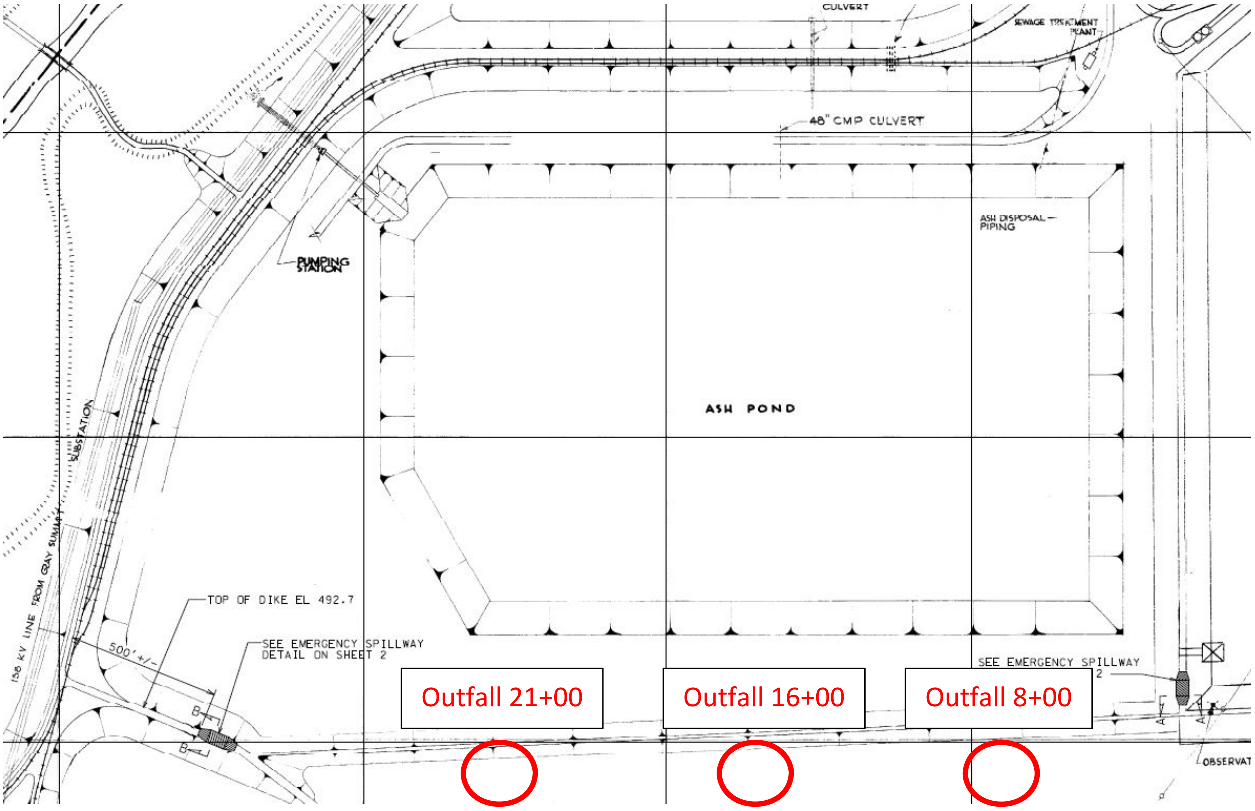
Earth Embankment

Item	Condition Code	Comments
Vertical & Horizontal Alignment of Crest	GC	There was no visible vertical or horizontal misalignment of the crest. (IMG_3851 and IMG_3853).
Seepage/Wetness/	GC	No seepage, wetness or ponding areas were observed.

Earth Embankment

Item	Condition Code	Comments
Ponding Areas		
Erosion	GC	No erosion was observed.
Fencing	GC	The perimeter fence is in good condition. (IMG_20201028_091024)
Vegetation	GC	Vegetation on the downstream embankment had recently been mowed and was in an adequate condition. (IMG_20201028_091654)
Sloughs/Slides/ Cracks	GC	No sloughs, slides or cracks were observed.
Animal Control	GC	
Other	MM	The duckbill valve at Station 8+00 is no longer fixed to the outfall. Reattach duckbill valve. (IMG_20201028_091336) The duckbill valve at Station 16+00 is partially buried in sediment. Remove sediment and create positive drainage away from the valve. (IMG_20201028_091901) There is ponding above the invert of the duckbill valve at Station 21+00. Create positive drainage away from the outfall. (IMG_20201028_092702)

Note location of observation on attached plan sheet.



Condition Code

EC = Emergency Condition. A serious dam safety condition exists that need immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.

IM = Item needing immediate maintenance to restore or ensure its safety and integrity. Remediation should be complete within 1 month or as required.

MM = Minor Maintenance. Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.

OB = Condition requires regular observation and potential future minor maintenance.

GC = Good Condition

NO = No observation possible.

NI = Not Inspected. State reason in comment column.

Figure 1 –LCPA outlet channel in good condition.

Figure 2 – LCPA emergency spillway has been removed as part of closure.

Figure 3 – Embankment crest on southwest side of LCPA.

Figure 4 – Embankment crest on the west side of the impoundment.

Figure 5 – The perimeter fence is in good condition.

Figure 6 – Vegetation on downstream slope..

Figure 7 – Duckbill valve at Station 8+00 is no longer attached.

Figure 8 – The duckbill valve at Station 16+00 is partially buried in sediment.

Figure 9 – There is ponding above the invert of the duckbill valve at Station 21+00.

LABADIE ENERGY CENTER
Fly Ash Pond (LCPB)
Annual Inspection Check Sheet

Date	10/28/2020
Inspector	J. Bertel, L. Sutton, A. Martinez, M. Leuckenhoff
Pool Level	NA
River Level	El. 452
Temperature	45°
Weather	Cloudy

Date of Previous Annual Inspection: 09/17/2019

Date of Previous Periodic Inspection: 09/23/2015

Description of Emergency (EC) or Immediate Maintenance (IM) conditions observed since the last annual inspection:
None

Describe any action taken to restore or improve safety and integrity of impounding structure:
The impoundment is currently being closed and no longer contains impounded water.

Describe any modifications to the geometry of the impounding structure since the previous annual inspection:
The perimeter embankment on the east and south sides has been lowered to el. 488 feet. The interior of the impoundment is being capped with 2 feet of soil and an HDPE geomembrane. The interior has been graded to drain surface water to conduits through the perimeter embankment, the HDPE geomembrane has been installed, and soil is being placed on top of the geomembrane.

Describe any modifications to the operation of the impounding structure since the previous annual inspection:
Impoundment no longer used for ash handling and disposal, and is being closed.

List the approximate remaining storage capacity of the impounding structure:
NA

List the approximate maximum, minimum and present depth and elevation of the impounded water since the previous annual inspection:
Max. – el. 481.5 feet, depth 21.5 feet, Min. – el. 467.75 feet, depth 7.75 feet, Present - None

List the approximate maximum, minimum and present depth and elevation of the impounded CCR since the previous annual inspection:
Max. – el. 501 feet, depth 41 feet, Min. – el. 481 feet, depth 21 feet, Present – el. 501 feet, depth 41 feet.

Approximate volume of impounded water and CCR at the time of the inspection:
3,861,136 CY of CCR, no impounded free water

Describe any changes to the downstream watershed:
None.

Inlet and Outlet Works

Item	Condition Code	Comments
Outlet Condition	NO	Outlet has been removed as part of closure.
Pump Condition/ Operability	NO	
Outfall Condition	NO	
Leakage	NO	
Discharge (color and/or sediment)	NO	
Obstructions	NO	
Instrumentation	NO	
Inlet Piping and Supports	NO	Inlet piping has been removed as part of closure.
Emergency Spillway Condition	NO	Emergency spillway has been removed as part of closure.
Other		

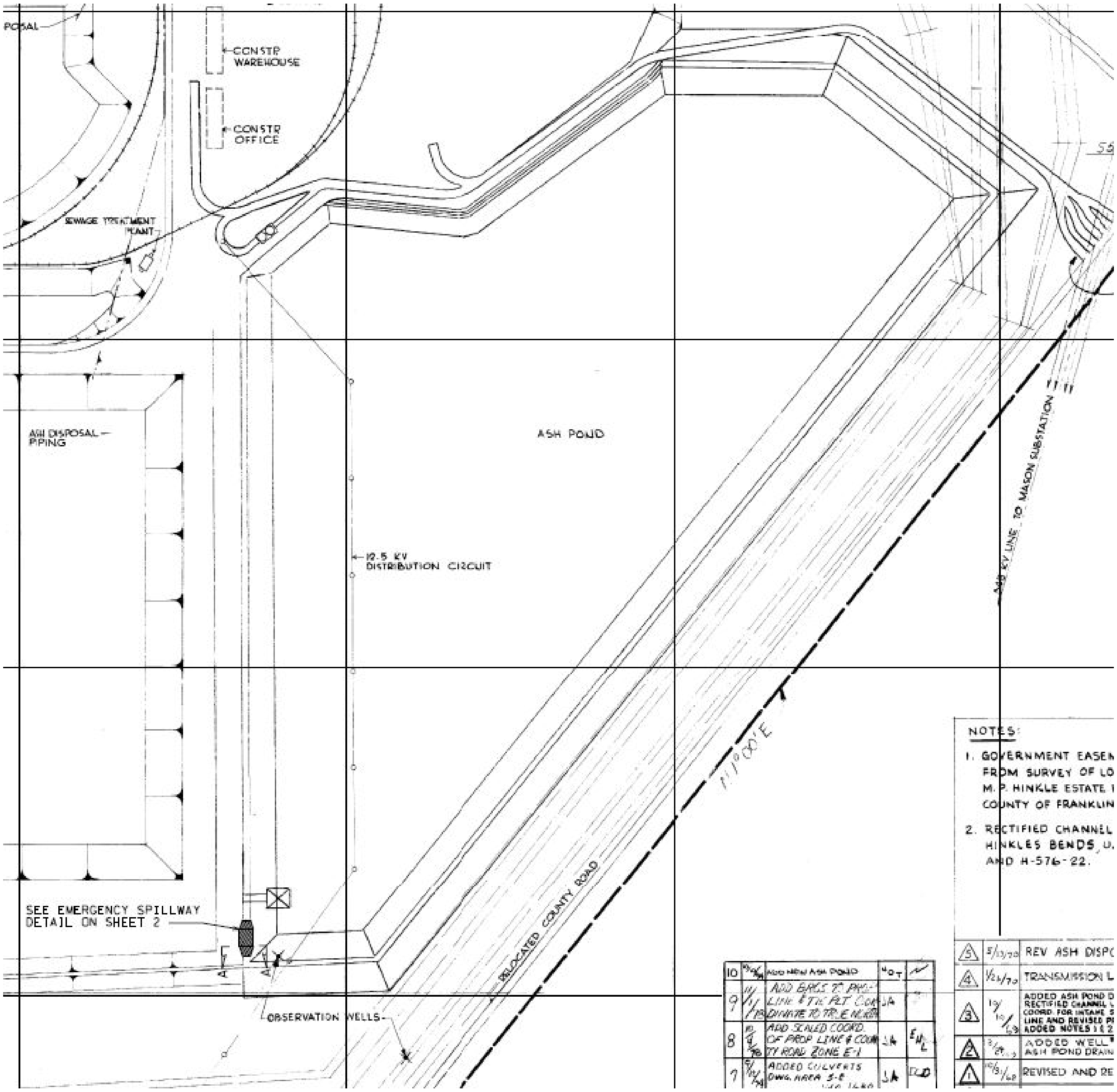
Earth Embankment

Item	Condition Code	Comments
Vertical & Horizontal Alignment of Crest	GC	There was no visible vertical or horizontal misalignment of the crest. (IMG_3807 and IMG_3812).
HDPE Liner	NI	The bottom HDPE liner is covered with soil used for closure.
Seepage/Wetness/ Ponding Areas	GC	No seepage/wetness or ponding areas observed.
Erosion/Rutting	OB	Rutting was observed on the embankment crest on the east and south sides. (IMG_3802) It is likely the ruts will be addressed during closure construction.
Fencing	GC	The perimeter fence is in good condition.

Earth Embankment

Item	Condition Code	Comments
Vegetation	MM	The vegetation on the downstream slopes has been highly disturbed by closure construction (IMG_1339). A portion of the slopes has been reseeded but vegetation has not been established. We recommend inspecting the downstream slopes after construction has been completed.
Animal Control	GC	
Sloughs/Slides/ Cracks	GC	No sloughs, slides or cracks were observed.
Other		

Note location of observation on attached plan sheet.



Condition Code

EC = Emergency Condition. A serious dam safety condition exists that need immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.

IM = Item needing immediate maintenance to restore or ensure its safety and integrity. Remediation should be complete within 1 month or as required.

MM = Minor Maintenance. Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.

OB = Condition requires regular observation and potential future minor maintenance.

GC = Good Condition

NO = No observation possible.

NI = Not Inspected. State reason in comment column.

Figure 1 –LCPB embankment crest with ruts on east side of the impoundment.

Figure 2 – LCPB embankment crest with ruts on east side of the impoundment.

Figure 3 – LCPB embankment crest with ruts on east side of the impoundment.

Figure 4 – The downstream slopes have been highly disturbed by closure construction.

Figure 5 – LCPB outlet works have been removed.

LABADIE ENERGY CENTER
Cell 1 (LCL1) and Pond 1

Date	10/28/2020
Inspector	J. Bertel, M. Lueckenhoff
Weather	45°
Temperature	Cloudy

Date of Previous Annual Inspection: 09/17/2019

Date of Previous Periodic Inspection: 12/14/2016

Description of Emergency (EC) or Immediate Maintenance (IM) conditions observed since the last annual inspection:
None

Describe any action taken to restore or improve safety and integrity of impounding structure:
None

Describe any modifications to the geometry of the impounding structure since the previous annual inspection:
None.

Describe any modifications to the operation of the impounding structure since the previous annual inspection:
Currently installing the UWL return water line to help manage water levels in Pond 1.

List the approximate remaining storage capacity of the impounding structure:
2,293,608 CY

List the approximate maximum, minimum and present depth and elevation of the impounded CCR in Cell 1 since the previous annual inspection:

	Maximum		**Minimum**		**Present**	
	Elevation (ft)	Depth (ft)	Elevation (ft)	Depth (ft)	Elevation (ft)	Depth (ft)
Cell 1	484	6	479	2	484	6

Approximate volume of CCR at the time of the inspection:
121,353 CY

Describe any changes to the downstream watershed:
None.

Is water ponded in Cell 1? (Y or N)	No
Water Level in Pond 1 (Meter at Pump Wet Well)	127.1
Elapsed Hours on Cell 1 North Leachate Pump (#1)	9,646.5
Elapsed Hours on Cell 1 South Leachate Pump (#2)	10,165.5

Cell 1

Item	Condition Code	Comments
Erosion, sloughing, sliding, boils, seepage	GC	None observed. (IMG_3931, IMG_3934 and IMG_3935)
Settlement, depression or crack in embankment	GC	The FCM revetment has a small crack near the downstream toe where it curves downward into the anchor trench. This condition does not seem indicate a larger issue related to embankment stability. Monitor during future inspections. (IMG_3948)
Erosion or rutting gravel top & perimeter roads and external ramps	GC	No erosion or rutting observed. (IMG_3936)
Storm Water Inlet to Pond 1 – settlement, cracking, depression	OB	Small cracks have developed in the center slabs. Monitor the cracks during future inspections. (IMG_3933)
FCM revetment below Storm Water Inlet in Pond 1	GC	
HDPE Liner – damage, folds, etc.	NI	HDPE liner is not exposed.
HDPE Rain Flap – damage, folds, out of position	GC	The rain flap appeared to be adequately secured. (IMG_3937)
Leachate Pump No. 1 (North) – note alarm, damage, slide erosion	GC	☒ Check if pump test passed.

Cell 1

Item	Condition Code	Comments
Leachate Pump No. 1 (North) – record both leachate level meters	GC	Pump Level – 13.4” Secondary Level – 10.9”
Leachate Pump No. 2 (South) – note alarm, damage, slide, erosion	GC	☒ Check if pump test passed.
Leachate Pump No. 2 (South) – record both leachate level meters	GC	Pump Level – 16.4” Secondary Level – 17.2”
Storm Water Sump Pump – running, alarm, power on, discharge to Pond	GC	Stormwater pump was not actively running but appeared functional.

Leachate Tank

Item	Condition Code	Comments
Leachate Tank – record leachate level, note alarm, leakage, damage	OB	Level in Tank – -144.2” Verify that level sensor is calibrated and the reading is meaningful.
Leachate Tank Heat Trace – note alarm, any damage	MM	Alarm indication lights were on for the heat trace. Repair heat trace electrical system. (IMG_3925)
Main Electric Panel – note any alarms, damage, any problems	GC	

Evaporator No. 1 (West)

Item	Condition Code	Comments
Evaporator – note if running, any alarm, leaking, hose, any problems	GC	Evaporator was running. (IMG_3930)
Booster Pump – note if running, any alarms, leaks, hoses, any problems	GC	Booster pump was running. (IMG_3933)
Electric Panel – note any alarm, any problems, check cables	NO	

Evaporator No. 2 (East)

Item	Condition Code	Comments
Evaporator – note if running, any alarm, leaking, hose, any problems	GC	Evaporator was running. (IMG_3930)
Booster Pump – note if running, any alarms, leaks, hoses, any problems	GC	Booster pump was running. (IMG_3932)
Electric Panel – note any alarm, any problems, check cables	NO	

Pond 1

Item	Condition Code	Comments
Perimeter erosion, sloughing, slides, boils, seepage	GC	None observed. (IMG_3927 and IMG_3929)
Settlement, depression or crack in embankment	GC	No settlement, depressions or cracks observed.
Erosion or rutting gravel top & perimeter roads and external ramps	GC	No erosion or rutting observed.
Emergency Spillway – settlement, cracking, depression	GC	The emergency spillway was in good condition. (IMG_3920 and IMG_3921)
Imminent discharge through emergency spillway	GC	The water level was several feet below the spillway invert. (IMG_3920)
HDPE Liner – damage, folds, etc.	GC	The HDPE liner appeared in good condition.
Pipes from Leachate Tank and Evaporator Booster Pumps	GC	

Storm Water Wet Well

Item	Condition Code	Comments
Gate Valve to Pond 1 – normally should be fully open	GC	
Gate Valve to Exterior Flood Water Inlet – should be fully closed	OB	Some corrosion on handwheel, gate stem, valve housing and stem brackets. Some corrosion on handrail adjacent to metal grating. Remove corrosion and paint. (IMG_3913 to IMG_3916)

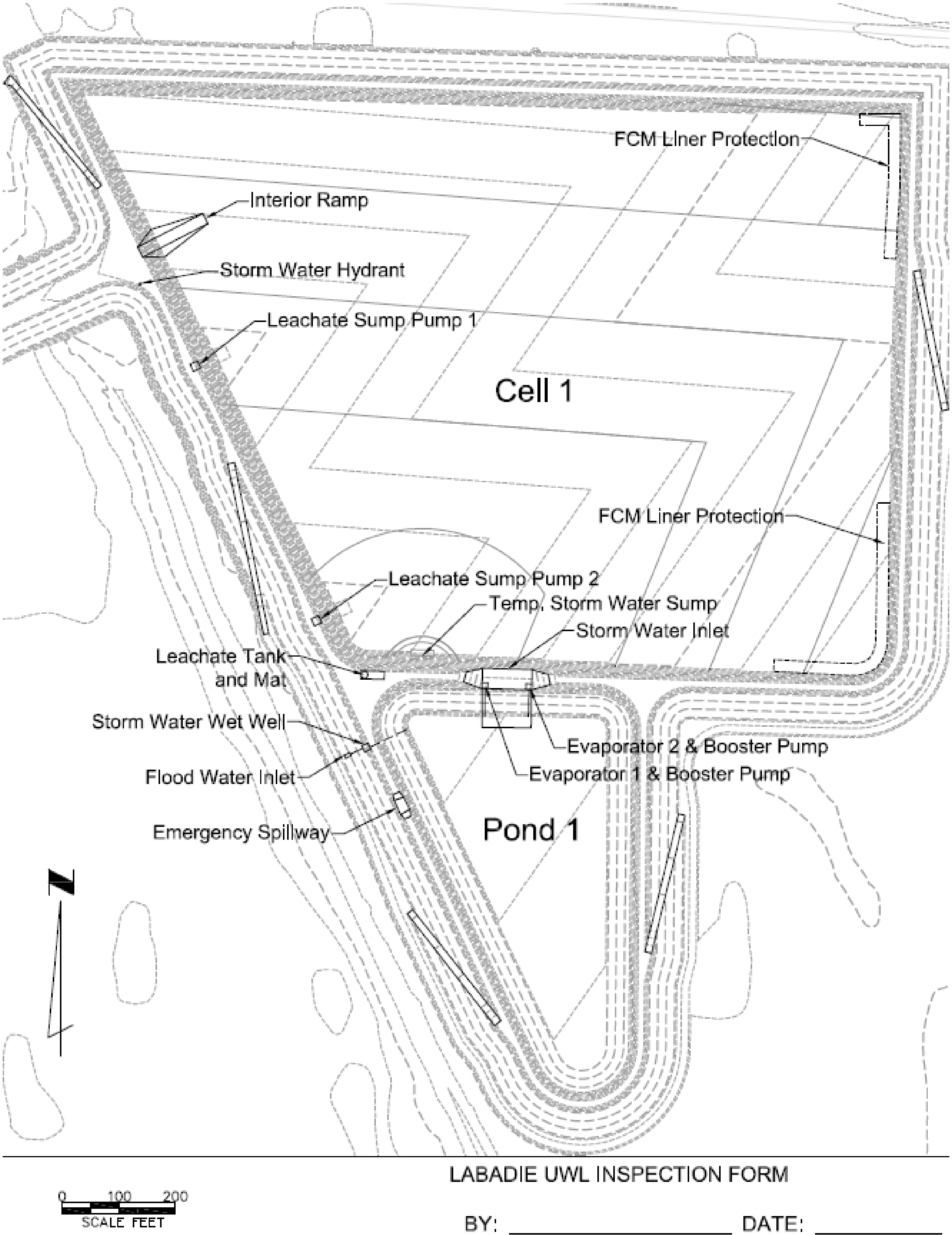
Storm Water Wet Well

Item	Condition Code	Comments
Storm Water Pump No. 1 – note if running, any alarms, valve position	NI	Storm water pump was not running during the inspection.
Storm Water Pump No. 2 – note if running, any alarms, valve position	NI	Stormwater pump was not running during the inspection.
Storm Water Pumps Electrical Panel – note any alarms, problems	GC	
Flood Water Inlet – note any discharge, accumulation of debris	GC	

Other

Item	Condition Code	Comments
Hydrant	NI	
Overpass	NI	
Overpass Abutments & Wing Walls – seepage, settlement, problems	NI	
Lights, Security Cameras	NI	
Perimeter Fence & Gate – holes, breaks, vandalism, gates unlocked	GC	

LABADIE ENERGY CENTER
Cell 1 (LCL1) & Pond 1
Annual Inspection Check Sheet



LABADIE UWL INSPECTION FORM

BY: ____________________ DATE: ___________

Condition Code

EC = Emergency Condition. A serious dam safety condition exists that need immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.
IM = Item needing immediate maintenance to restore or ensure its safety and integrity. Remediation should be complete within 1 month or as required.
MM = Minor Maintenance. Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.
OB = Condition requires regular observation and potential future minor maintenance.
GC = Good Condition
NO = No observation possible.
NI = Not Inspected. State reason in comment column.

Drive slowly around tops of embankments looking for visible signs of present or developing major problems. Indicate location(s) of problems or anomalies on inspection plan - sign, date and attach sheet to report.

If a problem is noted, email or FAX report to appropriate persons. If emergency condition is noted, immediately contact the Shift Operations Supervisor and Chief Dam Safety Engineer.

Campbell, Gene A

From:	Campbell, Gene A
Sent:	Friday, November 22, 2019 11:58 AM
To:	Becker, Albert W; Morrell, Patrick G
Cc:	Frerking, Matthew K; Greer, Jeff W
Subject:	Labadie 2019 Annual Dam Safety Levee Inspection
Attachments:	BAP.pdf; FAP.pdf; Landfill.pdf

All,

The 2019 Labadie Pond LCPA (Bottom Ash Pond), Pond LCPB (Fly Ash Pond), and Landfill LCL1 (Labadie Landfill) inspection checklists are attached. The inspection was performed by Gene Campbell and Albert Becker on September 17, 2019.

Inspection photos are located at P:\Labadie\Dam Safety\Annual Inspections\2019 Inspection\09-17-19 Final Inspection Photos

Overall the ponds and landfill are in good condition with minor maintenance items identified. The following are recommended action items from the annual inspection. Please review the action items and give me a call if you have any questions. Dam Safety will coordinate with our vegetation contractor to continue maintaining the vegetation on the levee.

Dam Safety and Maintenance Items from the Annual Inspection

Pond LCPA (Bottom Ash Pond)

1. Known leak through the discharge on valve 2.
2. Standing water was noted at the toe of the levee on the south side due to tire ruts. This rutting should be repaired to create positive drainage.
3. Standing water was noted at the toe of the levee on the west side of the pond. This area should continue to be inspected during the plant weekly inspections.
4. Continue to clear vegetation on the slopes of the embankment
5. Repair the erosion on the upstream side of the levee near the emergency spillway.
6. Clean the staff gage.

Pond LCPB (Fly Ash Pond)

1. Continue to clear the vegetation on the embankments and on the crest.

Landfill (Cell 1 and Pond 1)

1. Minor erosion area noted on the upstream side at the northeast corner of the landfill. This area should continue to be inspected during the plant weekly inspections.
2. There is a tear in the HDPE rain flap on the upstream southwest corner of the Landfill. This should be repaired.
3. There is a faulty level sensor for Leachate Pump 1 and 2. Parts are on order.
4. There is a faulty level sensor on the leachate tank. Parts are on order.
5. Erosion was noted on the perimeter ramps. The ramps should be repaired.

Completed actions since the last inspection

1. Vegetation management completed Dam Safety's Vegetation Contractor.

Please let me know if you have any questions or comments.

Thank you,

::::::::::::::::::::::::

GENE CAMPBELL, P.E., PMP
Career Engineer
Dam Safety & Hydro Engineering
T 314.957.3432
C 618.444.0823
E gcampbell2@ameren.com
....

Ameren Missouri
11149 Lindbergh Business Ct.
St. Louis, Missouri 63123
AmerenMissouri.com

40 CFR Parts 257

Checklist for Inspection Requirements for CCR Surface Impoundments
257.83 (b)

Labadie Power Station – LCPA (Bottom Ash Pond)

1. Annual Inspection

Requirements	Signs of actual or potential structural weakness	Disruptions or potential disruption to the operation and safety of the unit
CCR Unit and appurtenant structures 257.83(b)(ii)	None Observed	None Observed
Hydraulic structures underlying the base of the CCR unit 257.83(b)(iii)	None Observed	None Observed

The 2019 Annual Inspection included a review of available information regarding the status and condition of the CCR unit, including, but not limited to, files available in the operating record in general accordance with 257.83(b)(i).

Minor maintenance items (e.g. animal burrows, ruts, etc.) associated with routine upkeep observed during the 2019 Annual Inspection, presently do not impact the structural integrity of the embankment. Ameren plans to address these items in a timely manner through Ameren's work control process.

Engineer's Seal

STATE OF MISSOURI
GENE A.
CAMPBELL JR.
Gene A. Campbell
NUMBER
PE-2011020071
11/22/19
PROFESSIONAL ENGINEER

Gene Campbell, P.E.
License: PE- 2011020071
Date: November 22, 2019

LABADIE ENERGY CENTER
Bottom Ash Pond (LCPA)
Annual Inspection Check Sheet

Date	9/17/2019
Inspector	G. Campbell A. Becker
Pool Level	478.78
River Level	464.1
Temperature	85°F
Weather	Partly Cloudy

Date of Previous Annual Inspection: 09/19/2018

Date of Previous Periodic Inspection: Not Applicable

Description of Emergency (EC) or Immediate Maintenance (IM) conditions observed since the last annual inspection:
None

Describe any action taken to restore or improve safety and integrity of impounding structure:
None

Describe any modifications to the geometry of the impounding structure since the previous annual inspection:
Pond LCPA is currently being closed.

Describe any modifications to the operation of the impounding structure since the previous annual inspection:
Pond LCPA is currently being closed.

List the approximate remaining storage capacity of the impounding structure:
Approx. 2,414,961 CY

List the approximate maximum, minimum and present depth and elevation of the impounded water since the previous annual inspection:
Max: el. 486.1, depth – 76.2 ft.; Min: el. 474.7 depth – 64.8 ft.
Present: el. 478.8, depth – 68.9 ft.

List the approximate maximum, minimum and present depth and elevation of the impounded CCR since the previous annual inspection:
Max. – el. 515 & depth = 105 feet, Min – el. 410 & depth=0ft, Avg depth = 60ft

Approximate volume of impounded water and CCR at the time of the inspection:
Approx. 16,325,039 CY

Describe any changes to the downstream watershed:
None

LABADIE ENERGY CENTER
Bottom Ash Pond (LCPA)
Annual Inspection Check Sheet

Inlet and Outlet Works

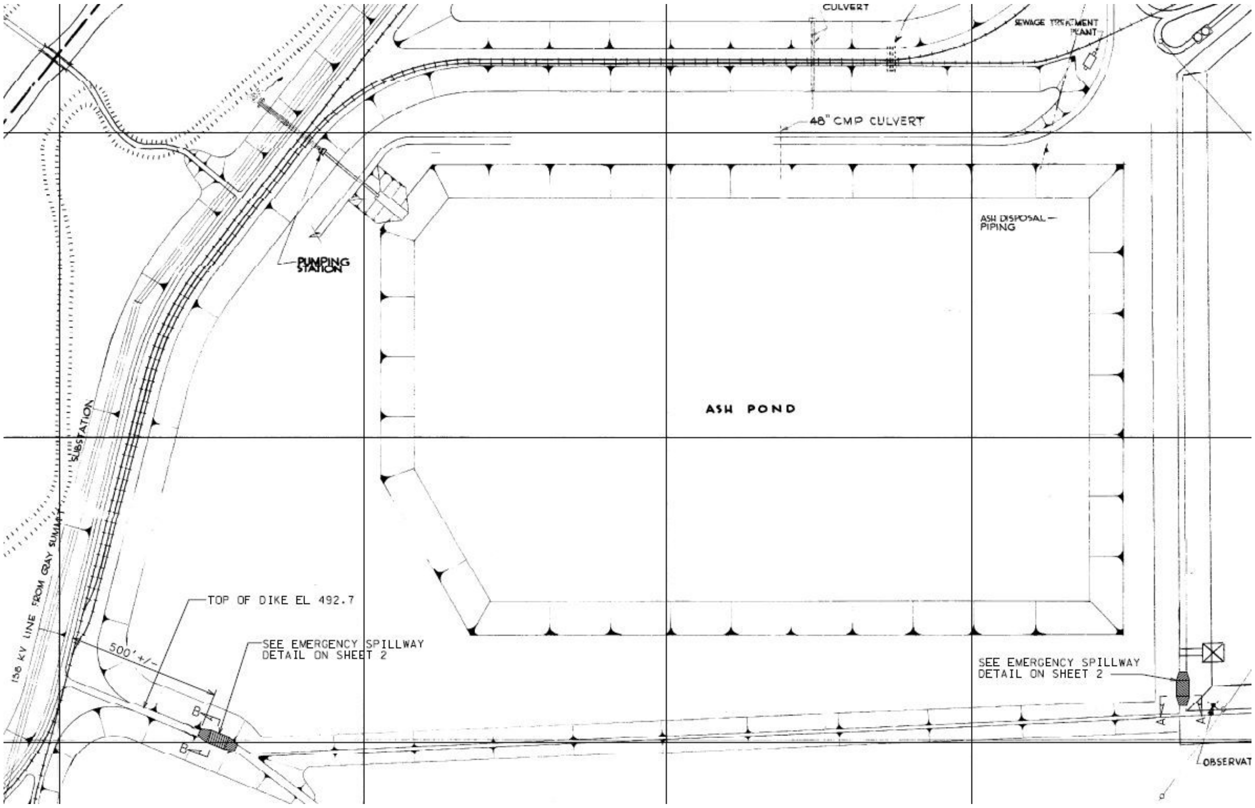
Item	Condition Code	Comments
Outlet Condition	OB	The outlet structure is generally in good condition, with some corrosion on metal parts. The crane mast is bent and may be repaired as necessary.
Valve Condition/ Operability	MM	Valve 1 is stuck in the open position. Minor leak past valve 2.
Discharge Piping Condition	GC	The discharge piping appears to be in good condition.
Leakage	GC/MM	No leakage was observed around the discharge pipe. Minor leak through valve 2 in the discharge pipe (see valve condition/operability). Valve 1 is stuck in the open position (see valve condition/operability).
Outfall Condition	GC	The outfall is in good condition.
Outlet Channel	GC	
Discharge (color and/or sediment)	GC	Discharge water was clear.
Obstructions	GC	No obstructions observed.
Instrumentation	MM	Clean staff gage.
Inlet Piping and Supports Condition	GC	
Emergency Spillway Condition	GC	The emergency spillway is in good condition.
Other		

LABADIE ENERGY CENTER
Bottom Ash Pond (LCPA)
Annual Inspection Check Sheet

Earth Embankment

Item	Condition Code	Comments
Vertical & Horizontal Alignment of Crest	GC	No visual displacement observed.
Seepage/Wetness/ Ponding Areas	MM	There is ponding water at the south and west downstream toe of the levee from the recent 2019 flood. There is no flowing water. This area should continue to be observed during routine inspections.
Erosion	MM	Erosion noted on the upstream slope of the bottom ash pond near the emergency spillway. The erosion should be repaired.
Fencing	GC	
Vegetation	MM	Unable to mow vegetation at the west and south downstream toe of the levee due to standing water. Clear additional vegetation on the south downstream slope. Continue to clear vegetation on the crest and downstream side of the levee.
Sloughs/Slides/ Cracks	GC	None observed.
Animal Control	GC	No presence of burrowing activity.
Other	GC	Repaired upstream erosion on the west slope.

Note location of observation on attached plan sheet.



Condition Code

EC = Emergency Condition. A serious dam safety condition exists that need immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.

IM = Item needing immediate maintenance to restore or ensure its safety and integrity. Remediation should be complete within 1 month or as required.

MM = Minor Maintenance. Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.

OB = Condition requires regular observation and potential future minor maintenance.

GC = Good Condition

NO = No observation possible.

NI = Not Inspected. State reason in comment column.

40 CFR Parts 257

Checklist for Inspection Requirements for CCR Surface Impoundments

257.83 (b)

Labadie Power Station – LCPB (Fly Ash Pond)

1. Annual Inspection

Requirements	Signs of actual or potential structural weakness	Disruptions or potential disruption to the operation and safety of the unit
CCR Unit and appurtenant structures 257.83(b)(ii)	None Observed	None Observed
Hydraulic structures underlying the base of the CCR unit 257.83(b)(iii)	None Observed	None Observed

The 2019 Annual Inspection included a review of available information regarding the status and condition of the CCR unit, including, but not limited to, files available in the operating record in general accordance with 257.83(b)(i).

Minor maintenance items (e.g. animal burrows, ruts, etc.) associated with routine upkeep observed during the 2019 Annual Inspection, presently do not impact the structural integrity of the embankment. Ameren plans to address these items in a timely manner through Ameren's work control process.

Engineer's Seal

STATE OF MISSOURI
GENE A.
CAMPBELL JR.
Gene A. Campbell
NUMBER
PE-2011020071
11/22/19
PROFESSIONAL ENGINEER

Gene Campbell, P.E.
License: PE- 2011020071
Date: November 22, 2019

LABADIE ENERGY CENTER
Fly Ash Pond (LCPB)
Annual Inspection Check Sheet

Date	9/17/2019
Inspector	G. Campbell A. Becker
Pool Level	NA - Drained
River Level	464.1
Temperature	85°F
Weather	Partly Cloudy

Date of Previous Annual Inspection: 09/19/2018

Date of Previous Periodic Inspection: Not Applicable

Description of Emergency (EC) or Immediate Maintenance (IM) conditions observed since the last annual inspection:
None

Describe any action taken to restore or improve safety and integrity of impounding structure:
None

Describe any modifications to the geometry of the impounding structure since the previous annual inspection:
Pond LCPB is currently being closed. The pond is drained. The pond is no longer receiving processed water or CCR material.

Describe any modifications to the operation of the impounding structure since the previous annual inspection:
Pond LCPB is currently being closed. The pond is drained.

List the approximate remaining storage capacity of the impounding structure:
Approx. 337,488 CY

List the approximate maximum, minimum and present depth and elevation of the impounded water since the previous annual inspection:
Max: el. 481.8, depth – 21.8 ft.; Min: Pond is being closed, no impounded water.; Present: Pond is being closed, no impounded water.

List the approximate maximum, minimum and present depth and elevation of the impounded CCR since the previous annual inspection:
Max. el. 504 & depth = 29ft; Min. el 460 & depth = 0ft; Present avg. depth = 20 ft,

Approximate volume of impounded water and CCR at the time of the inspection:
Approx. 3,662,512 CY

Describe any changes to the downstream watershed:
None

Inlet and Outlet Works

Item	Condition Code	Comments
Outlet Condition	NI	The pond is drained. The outlet has been removed for pond closure.
Pump Condition/ Operability	NI	The pond is drained. Pumps have been removed for pond closure.
Outfall Condition	NI	The pond is drained. There is no outfall.
Leakage	NI	The pond is drained.
Discharge (color and/or sediment)	NI	The pond is drained and no longer discharging.
Obstructions	NI	The pond is drained. The outlet has been removed for pond closure.
Instrumentation	NI	The pond is drained. There is no instrumentation.
Inlet Piping and Supports	NI	No longer sluicing to the pond.
Emergency Spillway Condition	NI	The pond is drained. The emergency spillway has been removed for pond closure.
Other		

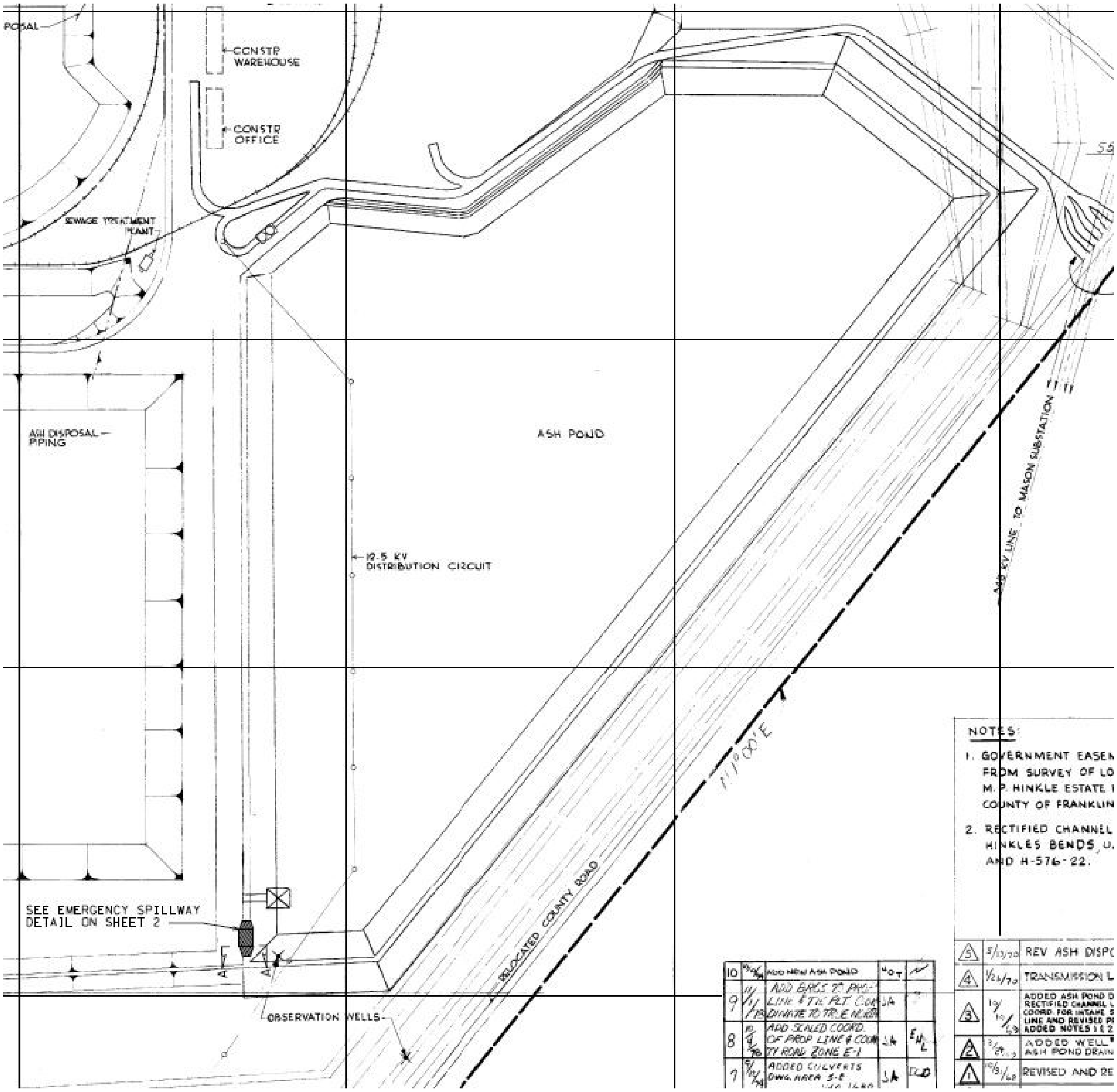
LABADIE ENERGY CENTER
Fly Ash Pond (LCPB)
Annual Inspection Check Sheet

Earth Embankment

Item	Condition Code	Comments
Vertical & Horizontal Alignment of Crest	GC/MM	There was no visible vertical or horizontal misalignment of the crest. Clear additional minor vegetation on the crest road
HDPE Liner	OB	There were small holes noted in the liner on the east side of the pond. This will be addressed as part of the ongoing pond closure. No action required.
Seepage/Wetness/ Ponding Areas	OB	There is ponding water at the east downstream toe of the levee from the recent 2019 flood. There is no flowing water. This area should continue to be observed during routine inspections.
Erosion/Rutting	OB	Minor rutting observed on the crest of the levee.
Fencing	GC	
Vegetation	MM	Unable to mow vegetation at the east downstream toe of the levee due to standing water. Clear vegetation at the northwest corner of the pond, downstream of the landfill haul road. Clear small area of vegetation at the north downstream side of the levee. Spray vegetation on the upstream side of the levee. Continue to clear vegetation on the crest and downstream side of the levee.
Animal Control	GC	No animal burrows were observed.
Sloughs/Slides/ Cracks	GC	None observed.
Other	GC	Repaired erosion area on the south downstream side of the levee.

Note location of observation on attached plan sheet.

LABADIE ENERGY CENTER
Fly Ash Pond (LCPB)
Annual Inspection Check Sheet



Condition Code

EC = Emergency Condition. A serious dam safety condition exists that need immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.
IM = Item needing immediate maintenance to restore or ensure its safety and integrity. Remediation should be complete within 1 month or as required.
MM = Minor Maintenance. Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.
OB = Condition requires regular observation and potential future minor maintenance.
GC = Good Condition
NO = No observation possible.
NI = Not Inspected. State reason in comment column.

40 CFR Parts 257

Checklist for Inspection Requirements for CCR Landfills
257.84 (b)

Labadie Power Station – LCL1 (Landfill Cell 1)

1. Annual Inspection

Requirements	Signs of actual or potential structural weakness	Disruptions or potential disruption to the operation and safety of the unit
CCR Unit and appurtenant structures 257.84(b)(ii)	None Observed	None Observed

The 2019 Annual Inspection included a review of available information regarding the status and condition of the CCR unit, including, but not limited to, files available in the operating record in general accordance with 257.84(b)(i).

Engineer's Seal

STATE OF MISSOURI
GENE A.
CAMPBELL JR.
Gene A. Campbell
NUMBER
PE-2011020071
11/22/19
PROFESSIONAL ENGINEER

Gene Campbell, P.E.
License: PE- 2011020071
Date: November 22, 2019

LABADIE ENERGY CENTER
Cell 1 (LCL1) and Pond 1

Date	9/17/2019
Inspector	G. Campbell A. Becker
Weather	Partly Cloudy
Temperature	85°F

Date of Previous Annual Inspection: 09/19/2018

Date of Previous Periodic Inspection: Not Applicable

Description of Emergency (EC) or Immediate Maintenance (IM) conditions observed since the last annual inspection:
None

Describe any action taken to restore or improve safety and integrity of impounding structure:
None

Describe any modifications to the geometry of the impounding structure since the previous annual inspection:
None

Describe any modifications to the operation of the impounding structure since the previous annual inspection:
None

List the approximate remaining storage capacity of the impounding structure:
2,209,772 CY

List the approximate maximum, minimum and present depth and elevation of the impounded CCR in Cell 1 since the previous annual inspection:

	Maximum		Minimum		Present	
	Elevation (ft)	Depth (ft)	Elevation (ft)	Depth (ft)	Elevation (ft)	Depth (ft)
Cell 1	484	6	479	2	481.5	4

Approximate volume of CCR at the time of the inspection:
90,228 CY

Describe any changes to the downstream watershed:
None

LABADIE ENERGY CENTER
Cell 1 (LCL1) & Pond 1
Annual Inspection Check Sheet

Is water ponded in Cell 1? (Y or N)	No
Water Level in Pond 1 (Meter at Pump Wet Well)	211 inches
Elapsed Hours on Cell 1 North Leachate Pump (#1)	5959.9
Elapsed Hours on Cell 1 South Leachate Pump (#2)	6263.3

Cell 1

Item	Condition Code	Comments
Erosion, sloughing, sliding, boils, seepage	OB	Minor erosion at the upstream northeast and northwest corners of the landfill.
Settlement, depression or crack in embankment	GC	
Erosion or rutting gravel top & perimeter roads and external ramps	GC	
Storm Water Inlet to Pond 1 – settlement, cracking, depression	GC	
FCM revetment below Storm Water Inlet in Pond 1	OB	There is a tear in the FMC blanket near the toe where the FMC is anchored into the ground. The tear is along the entire length of the FCM.
HDPE Liner – damage, folds, etc.	NI	Liner is not exposed to inspect.
HDPE Rain Flap – damage, folds, out of position	MM	There is a tear in the HDPE rain flap on the upstream southwest corner of the Landfill.
Leachate Pump No. 1 (North) – note alarm, damage, slide erosion	GC	☑Check if pump test passed.

LABADIE ENERGY CENTER
Cell 1 (LCL1) & Pond 1
Annual Inspection Check Sheet

Cell 1

Item	Condition Code	Comments
Leachate Pump No. 1 (North) – record both leachate level meters	MM	Pump Level – 55.0” – High level alarm is on Secondary Level – 51.4” The high level alarm is due to a faulty level sensor. Parts are on order to replace. Pump is running.
Leachate Pump No. 2 (South) – note alarm, damage, slide, erosion	GC	☑Check if pump test passed.
Leachate Pump No. 2 (South) – record both leachate level meters	MM	Pump Level – 56.5” – High level alarm is on Secondary Level – 57.1” The high level alarm is due to a faulty level sensor. Parts are on order to replace. Pump is running.
Storm Water Sump Pump – running, alarm, power on, discharge to Pond	GC	Pump was bumped and ran without issue.

Leachate Tank

Item	Condition Code	Comments
Leachate Tank – record leachate level, note alarm, leakage, damage	MM	Level in Tank – 7.1”. Faulty level sensor. Parts are on order to replace.
Leachate Tank Heat Trace – note alarm, any damage	GC	
Main Electric Panel – note any alarms, damage, any problems	GC	

Evaporator No. 1 (West)

Item	Condition Code	Comments
Evaporator – note if running, any alarm, leaking, hose, any problems	GC	Evaporator was running during the inspection.
Booster Pump – note if running, any alarms, leaks, hoses, any problems	GC	Booster Pump was running during the inspection.
Electric Panel – note any alarm, any problems, check cables	GC	

Evaporator No. 2 (East)

Item	Condition Code	Comments
Evaporator – note if running, any alarm, leaking, hose, any problems	GC	Evaporator was running during the inspection.
Booster Pump – note if running, any alarms, leaks, hoses, any problems	GC	Booster Pump was running during the inspection.
Electric Panel – note any alarm, any problems, check cables	GC	

Pond 1

Item	Condition Code	Comments
Perimeter erosion, sloughing, slides, boils, seepage	GC	
Settlement, depression or crack in embankment	GC	
Erosion or rutting gravel top & perimeter roads and external ramps	MM	Erosion noted on the perimeter ramps. This is an ongoing maintenance item. These ramps will be regraded.
Emergency Spillway – settlement, cracking, depression	GC	
Imminent discharge through emergency spillway	GC	See water level reading.
HDPE Liner – damage, folds, etc.	GC	
Pipes from Leachate Tank and Evaporator Booster Pumps	GC	

Storm Water Wet Well

Item	Condition Code	Comments
Gate Valve to Pond 1 – normally should be fully open	GC	
Gate Valve to Exterior Flood Water Inlet – should be fully closed	GC	

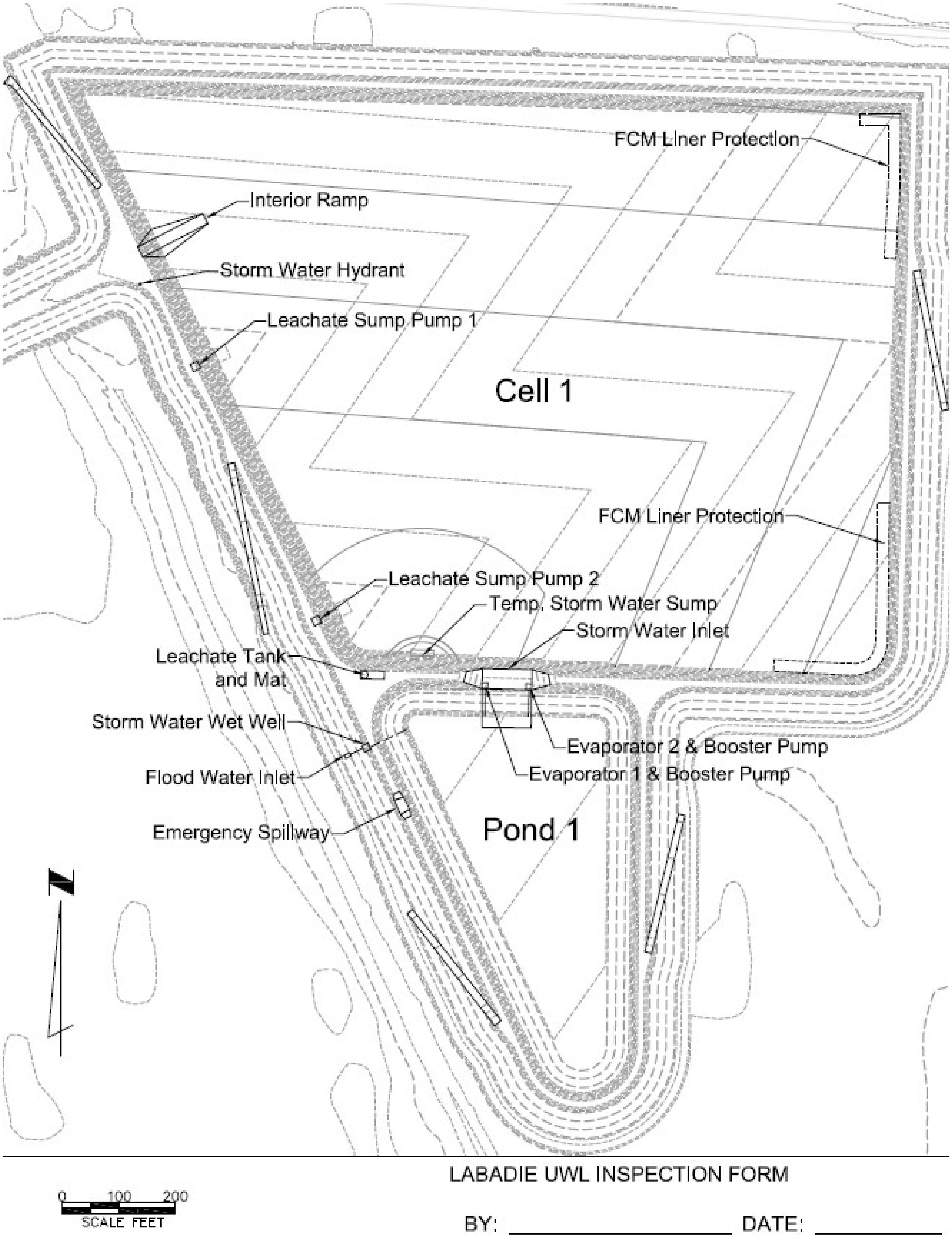
Storm Water Wet Well

Item	Condition Code	Comments
Storm Water Pump No. 1 – note if running, any alarms, valve position	NI	Storm water pump was not running during the inspection.
Storm Water Pump No. 2 – note if running, any alarms, valve position	NI	Storm water pump was not running during the inspection.
Storm Water Pumps Electrical Panel – note any alarms, problems	GC	
Flood Water Inlet – note any discharge, accumulation of debris	GC	

Other

Item	Condition Code	Comments
Hydrant	GC	
Overpass	GC	
Overpass Abutments & Wing Walls – seepage, settlement, problems	GC	
Lights, Security Cameras	GC	
Perimeter Fence & Gate – holes, breaks, vandalism, gates unlocked	GC	

LABADIE ENERGY CENTER
Cell 1 (LCL1) & Pond 1
Annual Inspection Check Sheet



LABADIE UWL INSPECTION FORM

BY: ____________________ DATE: ___________

Condition Code

EC = Emergency Condition. A serious dam safety condition exists that need immediate action. Emergency measures implemented as instructed by Chief Dam Safety Engineer; pool draw down, work stoppage, plant stoppage.

IM = Item needing immediate maintenance to restore or ensure its safety and integrity. Remediation should be complete within 1 month or as required.

MM = Minor Maintenance. Item needing minor maintenance and/or repairs within the year. The safety or integrity of the item is not yet imperiled.

OB = Condition requires regular observation and potential future minor maintenance.

GC = Good Condition

NO = No observation possible.

NI = Not Inspected. State reason in comment column.

Drive slowly around tops of embankments looking for visible signs of present or developing major problems. Indicate location(s) of problems or anomalies on inspection plan - sign, date and attach sheet to report.

If a problem is noted, email or FAX report to appropriate persons. If emergency condition is noted, immediately contact the Shift Operations Supervisor and Chief Dam Safety Engineer.

APPENDIX II

DVD CONTAINING 2020 PERIODIC INSPECTION PHOTOGRAPHS

APPENDIX D

PERIODIC SAFETY FACTOR ASSESSMENT

AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
40 CFR PART 257
FRANKLIN COUNTY, MISSOURI

APPENDIX D: SAFETY FACTOR ASSESSMENT §257.73(e)

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AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
FRANKLIN COUNTY, MISSOURI

APPENDIX D: SAFETY FACTOR ASSESSMENT §257.73(e)

1.0 INTRODUCTION

The Labadie Energy Center (LEC) is located in northeastern Franklin County, Missouri along the Missouri River. The plant is approximately 3 miles north of the Town of Labadie on the south bank of the Missouri River at river mile 57.5. The LEC is located within the floodplain of the Missouri River. The LEC has two active surface impoundments that are designated as LCPA (Bottom Ash Pond) and LCPB (Fly Ash Pond). The single stage industrial embankment dams impound an area of approximately 243-acres. The surface impoundments have been dewatered, no longer receive CCRs and are currently being closed. A map showing the location of the surface impoundments is attached as Figure 1.

1.1 Purpose

40 CFR §257.73(e) requires that the owner or operator of an existing CCR surface impoundment to conduct initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum factors of safety for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments should be supported by appropriate engineering calculations. The specified minimum safety factors are shown in Table 1.

Table 1 - Minimum Safety Factors

Loading Condition	Minimum Factor of Safety
Static, long-term, maximum storage pool	1.50
Static, maximum surcharge pool	1.40
Seismic	1.00
Liquefaction	1.20

2.0 REVIEW OF PREVIOUS SAFETY FACTOR ASSESSMENT

The initial periodic safety factor assessment for LCPA and LCPB was completed in October 2016. The Initial Periodic Safety Factor Assessment report documents the analyses performed and includes graphical outputs of the results of the stability analyses is included in Appendix I. The LCPA and LCPB no longer receives CCRs, have been dewatered and are currently being closed. The current conditions are no longer representative of those used in the 2016 assessment. Reitz & Jens completed analyses of LCPA and LCPB for the closed condition. Reitz & Jens's geotechnical analyses reports for closure of LCPA and LCPB are included in Appendix II.

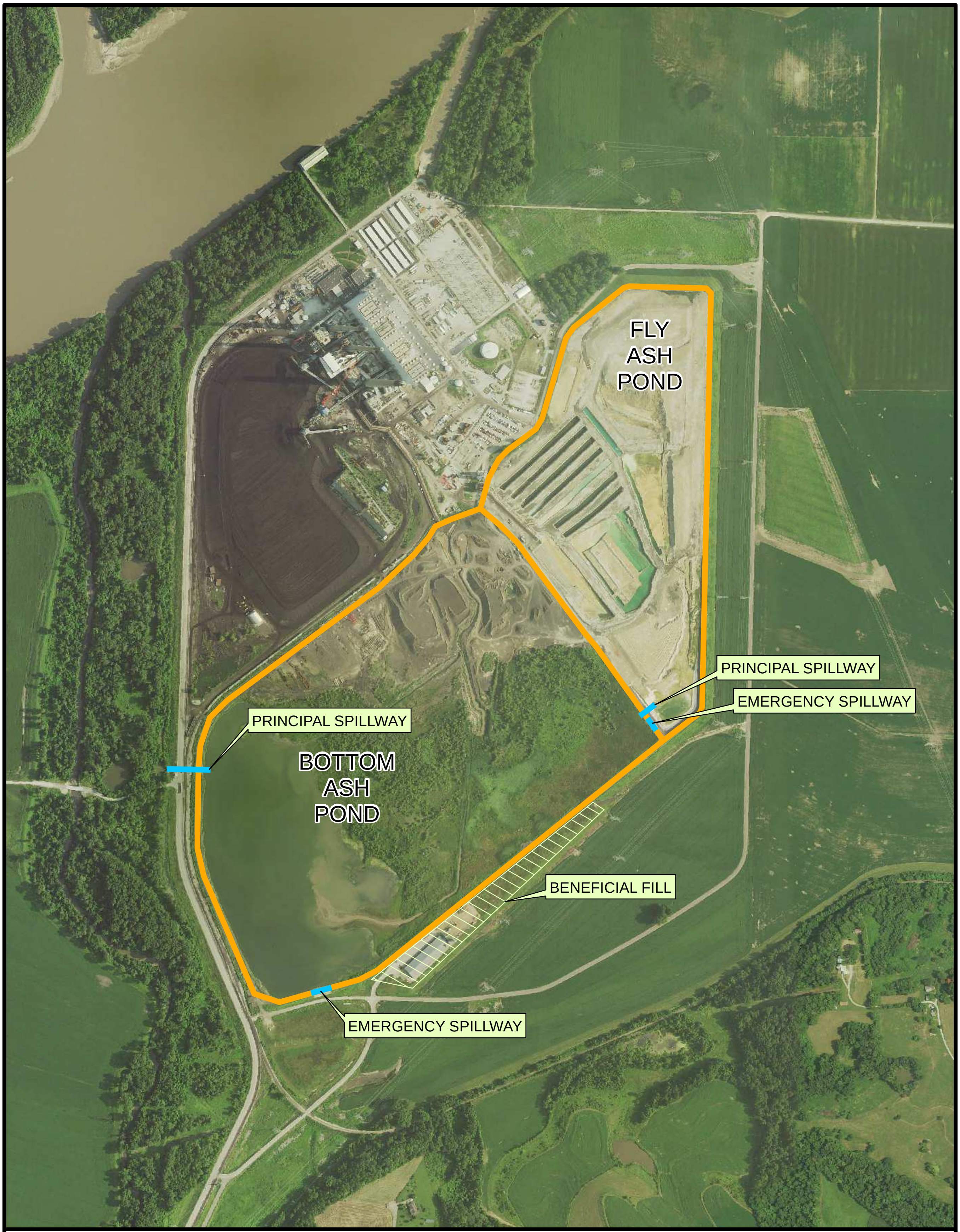
3.0 CONCLUSIONS

The initial periodic safety factor assessment for the LCPA and LCPB found that the calculated factors of safety for the critical cross-sections for the CCR units exceed the minimum factors of safety for each loading condition required by 40 CFR §257.73(e). The LCPA and LCPB have been dewatered and are currently being closed. A safety factor assessment for the closed condition has been performed by Reitz & Jens. They found that the static and seismic analyses meet or exceed the minimum requirements.

4.0 REFERENCES

Reitz & Jens (2017), "Geotechnical Analyses for Ameren Missouri Labadie Energy Center Bottom Ash Pond Closure." Ameren Missouri, St. Louis, Missouri.

Reitz & Jens (2017), "Geotechnical Analyses for Ameren Missouri Labadie Energy Center Fly Ash Pond Closure." Ameren Missouri, St. Louis, Missouri.



Legend

- 🟧 Embankment
- 🟦 Spillway

AMEREN MISSOURI
LABADIE ENERGY CENTER
ACTIVE CCR SURFACE IMPOUNDMENTS
FIGURE 1

Ameren
MISSOURI

REITZ & JENS, INC.
CONSULTING ENGINEERS

APPENDIX I

INITIAL SAFETY FACTOR ASSESSMENT FOR LCPA AND LCPB

AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
40 CFR PART 257
FRANKLIN COUNTY, MISSOURI

APPENDIX D: SAFETY FACTOR ASSESSMENT §257.73(e)

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EVALUATION OF CCR UNITS
FRANKLIN COUNTY, MISSOURI

APPENDIX D: SAFETY FACTOR ASSESSMENT §257.73(e)

1.0 INTRODUCTION

The Labadie Energy Center (LEC) is located in northeastern Franklin County, Missouri along the Missouri River. The plant is approximately 3 miles north of the Town of Labadie on the south bank of the Missouri River at river mile 57.5. The LEC is located within the floodplain of the Missouri River. The LEC has two active surface impoundments that are designated as LCPA (Bottom Ash Pond) and LCPB (Fly Ash Pond). The single stage industrial embankment dams impound an area of approximately 243-acres. The surface impoundments are used for managing coal combustion residuals (CCR). Decant water in the LCPB is pumped into LCPA, and a NPDES permitted outfall from LCPA discharges into Labadie Creek. A map showing the location of the surface impoundments is attached as Figure 1.

1.1 Purpose

40 CFR §257.73(e) requires that the owner or operator of an existing CCR surface impoundment to conduct initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum factors of safety for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments should be supported by appropriate engineering calculations. The specified minimum safety factors are shown in Table 1.

Table 1 - Minimum Safety Factors

Loading Condition	Minimum Factor of Safety
Static, long-term, maximum storage pool	1.50
Static, maximum surcharge pool	1.40
Seismic	1.00
Liquefaction	1.20

A periodic safety factor assessment has been conducted for the active surface impoundments at the Labadie Energy Center, which includes the Bottom Ash Pond and Fly Ash Pond.

2.0 PERIODIC SAFETY FACTOR ASSESSMENT

2.1 Static Stability Analyses

Slope stability analyses were performed in general accordance with United States Army Corps of Engineers (USACE) EM1110-2-1902 *Slope Stability* and MSHA's 2009 *Engineering and Design Manual for Coal Refuse Disposal Facilities*, and using the computer program SLIDE 6.0. This program uses the Spencer method in a limit-equilibrium analysis, which resolves the static forces on each vertical slice of soil profile along a given circular or irregular assumed failure surface. The program searches for the minimum Factor of Safety (FS) against slope failure for each center point in the grid by incrementally varying the radius of the failure surface. The plotted results from the program show the minimum FS, and the center and radius of the failure surface with the minimum FS. The output of the program also plots contours of equal FS within the grid of possible center points.

2.2 Seismic Stability Analyses

The critical cross-section was analyzed using a pseudo-static acceleration as a horizontal body force on the soil mass to calculate the minimum factor of safety for a seismic event. The seismic acceleration was based upon the USGS 2014 seismic hazard maps for a Peak Horizontal Ground Acceleration (PHGA) for seismic loading event with a 2% probability of exceedance in 50 years. The PHGA was factored for the seismic site class in accordance with ASCE 7 *Minimum Design Loads for Buildings and Other Structures, International Building Code*. A seismic coefficient of 0.5 was applied to the PHGA, which is consistent with MSHA's 2009 *Engineering and Design Manual for Coal Refuse Disposal Facilities*, in particular Chapter 7, "Seismic Design: Stability and Deformation Analyses." The manual cites research by Hynes-Griffen and Franklin (1984) which found that for seismic coefficient of 0.5 would result in deformations of less than 3 feet for a safety factor of 1.0.

The published 2014 USGS hazard map for the Labadie Energy Center is reproduced in Figure 2. This is the latest map available from the USGS website. The probabilistic PHGA for the design earthquake at the Labadie site is 0.180g (that is, 18.0% of standard gravity acceleration of 32.2 feet/sec^2). This value takes into account attenuation of bedrock shaking with distance from the probable sources and general soil interactions such as damping for a hypothetical soil profile. This value is meant to be a conservative estimate. Based upon the data, the most probable earthquake magnitudes (M_w) for these accelerations are between 7.0 and 8.0. We applied a multiplier of 1.440 to the base PHGA to account for the soil profile at the LEC to obtain a site specific PHGA of 0.259g. Therefore, the pseudo-static seismic load was 0.130g.

2.3 Liquefaction Stability Analyses

The liquefaction slope stability analysis is a post-earthquake, static analysis which includes the effects of potential liquefaction or softening of the soils. Liquefaction occurs when ground shaking is sufficient to produce cyclic particle movements that cause excess pore water pressures to build to the point that most of the shear strength of the soil is lost. Liquefaction occurs in loose sandy soils with less than about 35% fines (soils which are finer than standard U.S. #200 or 0.075mm). Liquefaction can occur in very loose soils with up to 50 percent fines, and soils up to the size of fine gravel. Liquefaction only occurs below the ground water table (phreatic surface). The presence of soil susceptible to liquefaction in the top 50 feet of the soil profile at the LEC typically included the foundation clays, silts and sands. Conservative estimates of post-earthquake or residual shear strengths in the liquefied strata were assumed using a correlation between the normalized residual shear strength ratio for liquefied soils and overburden-correction CPT penetration resistance recommended by Idriss and Boulanger (2008).

3.0 LCPA (BOTTOM ASH POND)

3.1 Critical Section and Assumptions

The critical section for the Bottom Ash Pond is located at the southeast corner of the perimeter berm. The location of the section is shown as Cross-section 4 in Figure 3, and a cross section at the location is presented in Figure 4. The height of the section at this location is about 21 feet.

For stability analysis, the groundwater table was assumed to be at the ground surface at the downstream toe or el. 471.6. The groundwater level for the post-earthquake load case was conservatively assumed at el. 464; however lower than the static analysis because the probability of high river levels and a seismic event occurring simultaneously are remote. The line of seepage through the section was conservatively assumed based on nearby boring logs. A 30 foot deep slurry wall was constructed in this location in 2013, and the line of seepage is likely lower than that assumed. For the static, long-term, maximum storage pool load case the water level in the Bottom Ash Pond was assumed to be at the normal pool of el. 484.5. The water surface elevation was increased to el. 491.3 for the maximum surcharge pool load case.

Soil parameters used for stability analyses of the Bottom Ash Pond critical section were derived from borings and CPT soundings completed in 2010 for the Ash Pond Stability Analyses Project and original plant borings drilled in 1966. The boring and CPT sounding logs are included in Appendix A of the *Ameren Missouri Labadie Energy Center: Evaluation of CCR Units* report.

The perimeter berm was constructed of primarily fine-grained soil excavated from the incised portion of the pond. A CPT sounding and a geotechnical boring through the crest of the embankment were used to develop conservative assumptions for the undrained and effective stress parameters. The CPT sounding located through the section showed primarily silts and clays with some sand in the embankment fill. The top of the berm at this section was about el. 493.5 feet with the natural ground surface at about el. 472.5 feet. For stability analysis the embankment fill was assumed to consist of an upper fill. The upper fill consists of a mixture of fly and bottom ash and has a thickness of about 9 feet. The upper fill was followed by clayey fill to about el. 478.5 feet, and a lower fill consisting of a mixture of sands, silts and clays from el. 478.5 feet to the natural ground surface. Results from CU triaxial tests on similar fill material sampled along the Bottom Ash Pond southwest embankment were referenced for effective and total stress parameters in the lower fill.

The CPT sounding through the section showed the foundation material to be primarily silty sand, sandy silt or clayey silt, with intermittent clay lenses to the sounding termination depth at el. 443.5 feet. The silty soils are primarily medium dense, but occasionally loose and dense. The original plant borings in the vicinity of the ash pond show that fine to coarse sand underlie the silt layers to a depth of 100 to 110 feet when bedrock is encountered. The sand is intermittently gravelly and generally medium-dense to dense.

Liquefaction analysis (Idriss and Boulanger, 2008) determined that layers within the foundation silts and sands would liquefy during post-earthquake conditions. Undrained residual strengths for the liquefied layers were chosen based on correlations for normalized residual shear strength ratio of liquefied sand versus equivalent clean-sand SPT corrected blow count or normalized residual shear strength ratio for liquefied soil versus overburden-corrected CPT penetration resistance (Idriss and Boulanger, 2008).

The soil parameters assumed in the stability analyses are summarized in Table 2.

Table 2 – Soil Properties Assumed in the Bottom Ash Pond Critical Section Stability Analyses

Material	**Unit Weight**		**Normal/Max Pool**		**Seismic**		**Liquefaction**	
	γ (pcf)	**γ′ (pcf)**	**c′ (psf)**	**ϕ‘ (°)**	**c (psf)**	**ϕ (°)**	**c (psf)**	**ϕ (°)**
Upper Fill	120	58	1	30	1	30	1	30
Clay Fill	120	58	100	25	100	25	1200	0
Lower Fill	120	58	40	33	40	33	40	33
Sand & Silt	120	58	1	28	1	28	1	28
Liq 1	120	58	-	-	-	-	230	0
Liq 2	120	58	-	-	-	-	370	0

3.2 Stability Analysis Results

The Bottom Ash Pond stability analysis results for each load case are presented in Table 3. The search for critical failure surfaces was limited to those that significantly impact the dike. The analyses show that the calculated factors of safety exceeds the minimum presented in §257.73(e) for each loading condition. Graphical outputs of the results of the stability analyses are shown in Appendix I.

Table 3 – Bottom Ash Pond Stability Analyses Results

Loading Condition	**Minimum Factor of Safety**	**Calculated Factor of Safety**
Static, long-term, maximum storage pool	1.50	1.81
Static, maximum surcharge pool	1.40	1.52
Seismic	1.00	1.16
Liquefaction	1.20	1.30

4.0 LCPB (FLY ASH POND)

4.1 Critical Section and Assumptions

The critical section for the Fly Ash Pond is at along the southern half of the east berm. The location of the section is shown as Cross-section 2 in Figure 3, and a cross section at the location is presented in Figure 5. The height of the section at this location is about 28.8 feet.

For stability analysis, the groundwater table was assumed to be at the ground surface at the downstream toe or el. 464.0. The Fly Ash Pond has a 60-mil HDPE liner which hydraulically separates the ponded water from the natural groundwater. This analysis assumes the groundwater table was not influenced by the pond level, and there was no seepage from the pond. The normal storage and maximum surcharge pools were assumed to be at el. 485 and 491.3, respectively.

Soil parameters used for stability analyses of the Bottom Ash Pond critical section were derived from borings and CPT soundings completed in 2010 for the Ash Pond Stability Analyses Project and original plant borings drilled in 1966. The boring and CPT sounding logs are included in Appendix A of the *Ameren Missouri Labadie Energy Center: Evaluation of CCR Units* report.

The embankment was constructed of earth fill borrowed from the interior of the pond. The design plans note that the top 6 feet of the foundation soil inside the perimeter berm should be used as fill. CPT soundings conducted in 2010 showed that the embankment fill is heterogeneous and consists of sand, silt and clay that were generally placed in 8 to 12 inch thick lifts. A CPT sounding near the section showed primarily silts and clays with some sand in the embankment fill. The top of the berm at this section was about el. 493 feet with the natural ground surface at about el. 464 feet. For stability purposes the fill assumed to consist of an upper, middle and lower layer. The upper fill was assumed from the top of the berm to about el. 489 feet, followed by the middle fill to about el. 472 feet, and the lower fill to the natural ground surface. The clayey embankment fill is stiff, and the sandy and silty fill is medium dense to dense.

A CPT sounding at the critical section shows the foundation material is clay to about el. 459 feet, followed by silty clay and clayey silt to about el. 455 feet. The silt and clay was underlain by sand that was intermittently silty and with clay lenses, from about el. 455 feet to the sounding termination depth at el. 443 feet. The foundation clays are generally firm to stiff, and the sand and silt stratum are medium dense to dense. The original plant borings in the vicinity of the ash pond show that fine to coarse sand underlie the silt layers to a depth of 100 to 110 feet when bedrock is encountered. The sand is intermittently gravelly and generally medium-dense to dense.

Liquefaction analysis (Idriss and Boulanger, 2008) determined layers within the foundation clays, silts and sands would liquefy during post-earthquake conditions. Undrained residual strengths for the liquefied layers were chosen based on correlations for normalized residual shear strength ratio of liquefied sand versus equivalent clean-sand SPT corrected blow count or normalized residual shear strength ratio for liquefied soil versus overburden-corrected CPT penetration resistance (Idriss and Boulanger, 2007). The undrained residual strengths were assumed to be a ratio of the confining pressure, so liquefied strata outside the footprint of the embankment typically have lower strengths.

The soil parameters used in the stability analyses were conservatively assumed and are summarized in Table 4.

Table 4 – Soil Properties Assumed in the Fly Ash Pond Critical Section Stability Analyses

Material	Unit Weight		Normal/Max Pool		Seismic		Liquefaction	
	γ (pcf)	γ' (pcf)	c' (psf)	ϕ' (°)	c (psf)	ϕ (°)	c (psf)	ϕ (°)
Upper Fill	115	53	1	25	1	25	1	25
Middle Fill	118	56	5	28	5	28	5	28
Lower Fill	120	58	1	29	1	29	1	29
Clay	120	58	0	25	0	25	0	25

Material	Unit Weight		Normal/Max Pool		Seismic		Liquefaction	
	γ (pcf)	γ' (pcf)	c' (psf)	ϕ' (°)	c (psf)	ϕ (°)	c (psf)	ϕ (°)
Silt & Clay	120	58	1	25	1	25	1	25
Sand	120	58	1	31	1	31	1	31
Liq 1	112	50	-	-	-	-	180	0
Liq 2	120	58	-	-	-	-	275	0
Liq 3	120	58	-	-	-	-	30	0
Liq 4	120	58	-	-	-	-	85	0
Liq 5	120	58	-	-	-	-	150	0

4.2 Stability Analysis Results

The Fly Ash Pond stability analysis results for each load case are presented in Table 5. The search for critical failure surfaces was limited to those that significantly impact the dike. The analyses show that the calculated factors of safety exceeds the minimum presented in §257.73(e) for each loading condition. Graphical outputs of the results of the stability analyses are shown in Appendix I.

Table 5 – Fly Ash Pond Stability Analyses Results

Loading Condition	Minimum Factor of Safety	Calculated Factor of Safety
Static, long-term, maximum storage pool	1.50	1.64
Static, maximum surcharge pool	1.40	1.64
Seismic	1.00	1.08
Liquefaction	1.20	1.27

5.0 CONCLUSIONS

The initial periodic safety factor assessment for the Labadie Energy Center Ash Pond found that the calculated factors of safety for the critical cross-sections at each CCR unit exceed the minimum factors of safety for each loading condition required by 40 CFR §257.73(e). The subsequent periodic safety factor assessment should be conducted within 5 years of the date of this report.

6.0 REFERENCES

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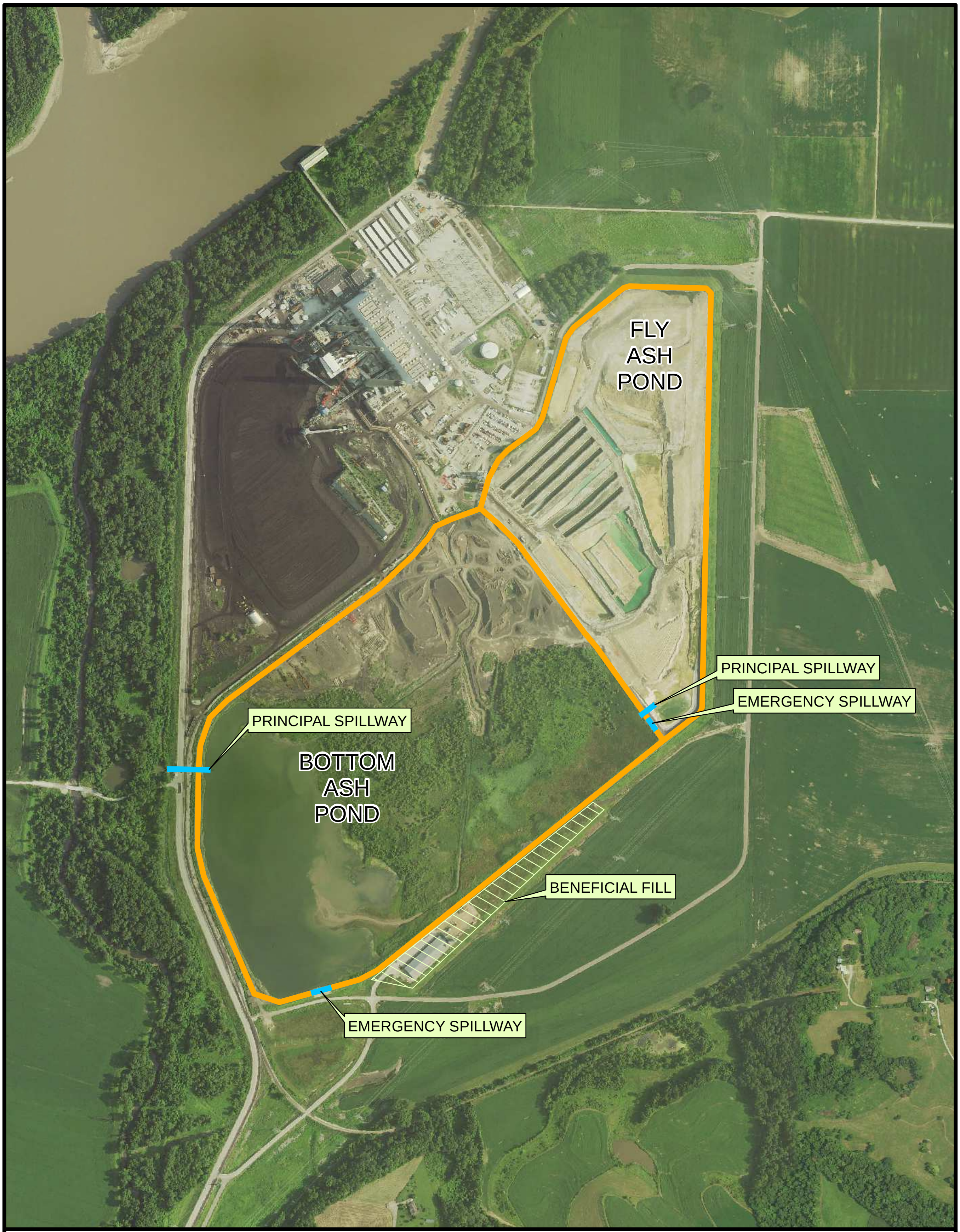

AMEREN MISSOURI
LABADIE ENERGY CENTER
ACTIVE CCR SURFACE IMPOUNDMENTS
FIGURE 1

Ameren
MISSOURI

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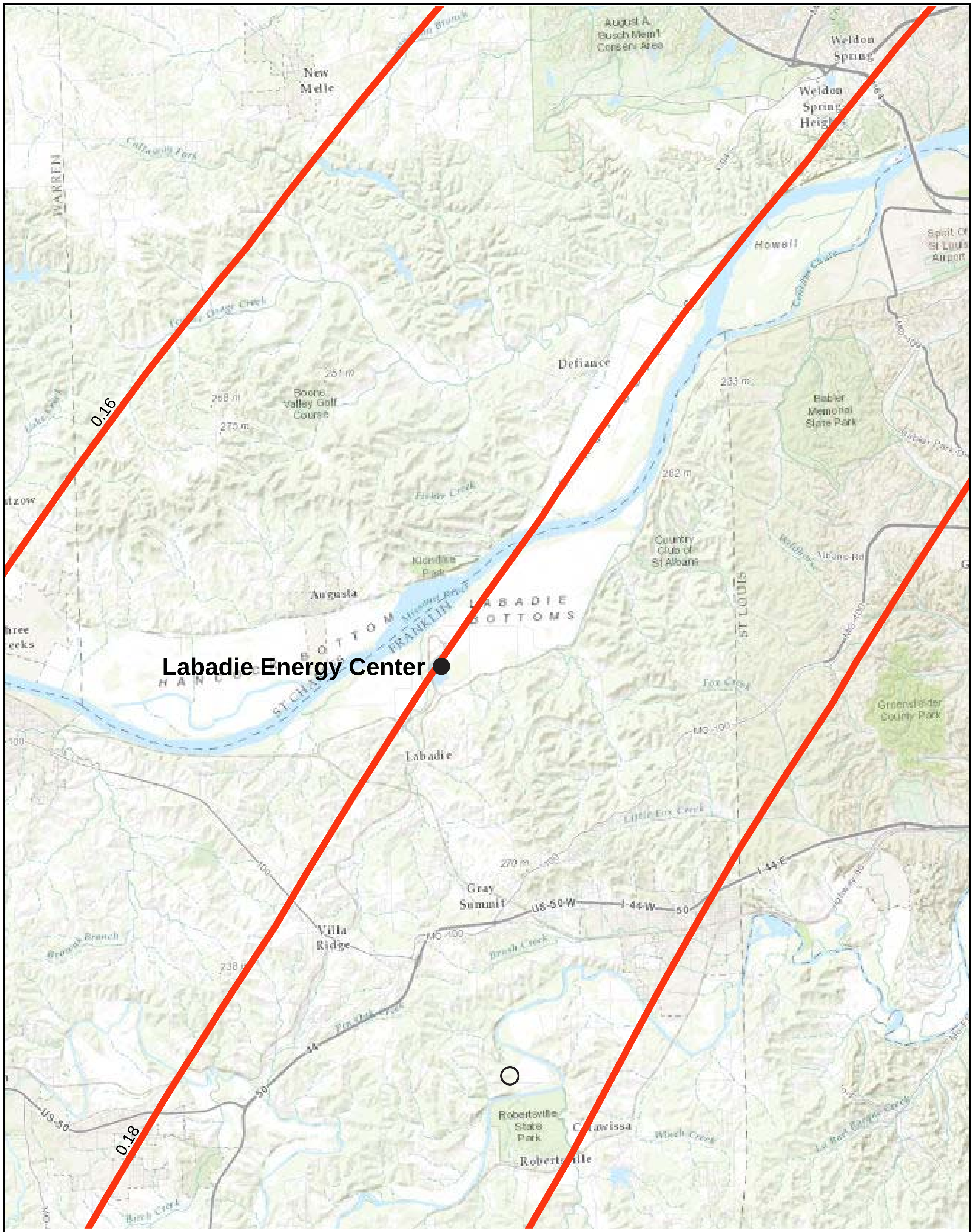
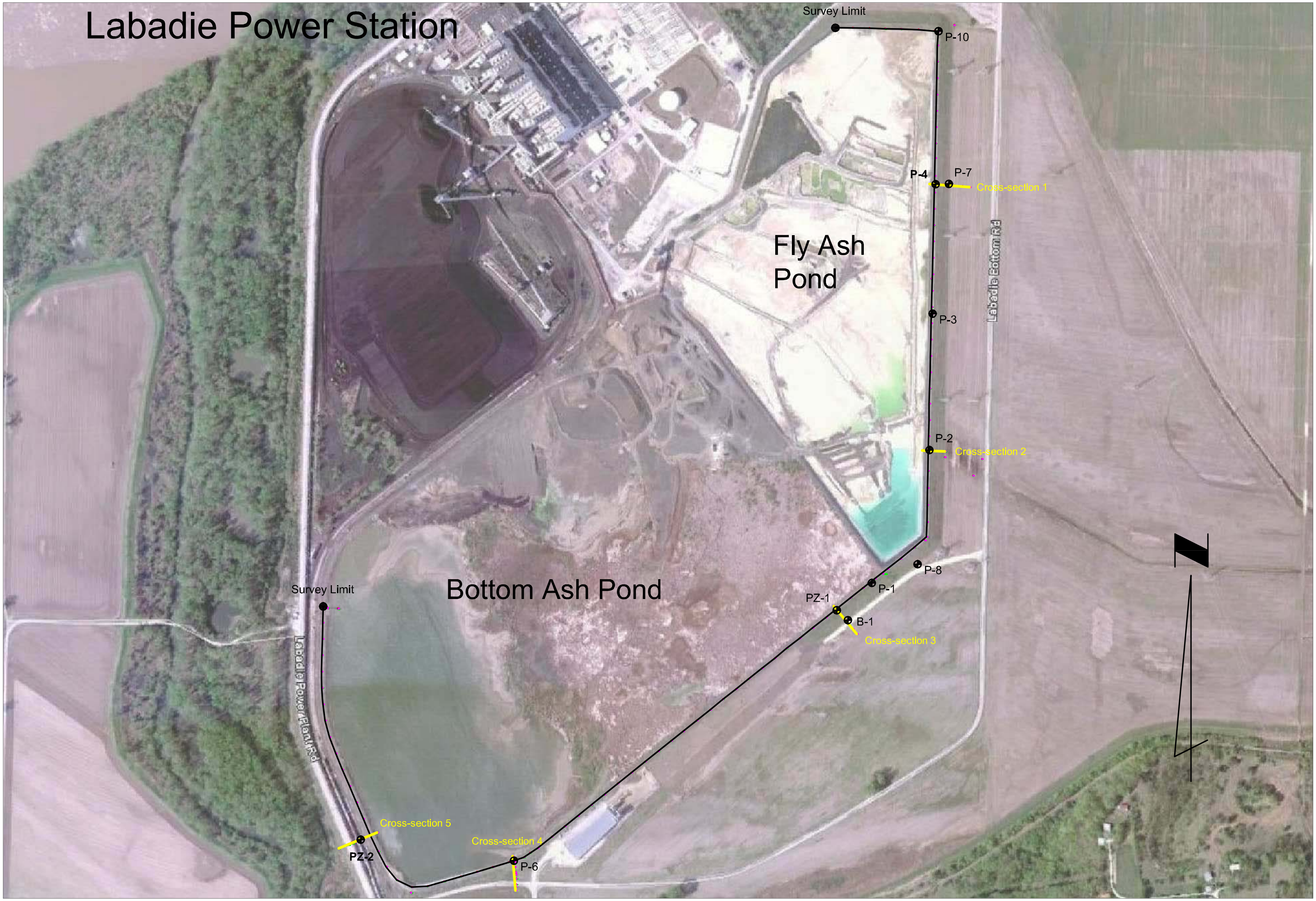
CONSULTING ENGINEERS



2% Probability of Exceedance in 50 Years Map of Peak Ground Acceleration

Ameren Missouri: Labadie Energy Center
2014 USGS Seismic Hazard Map

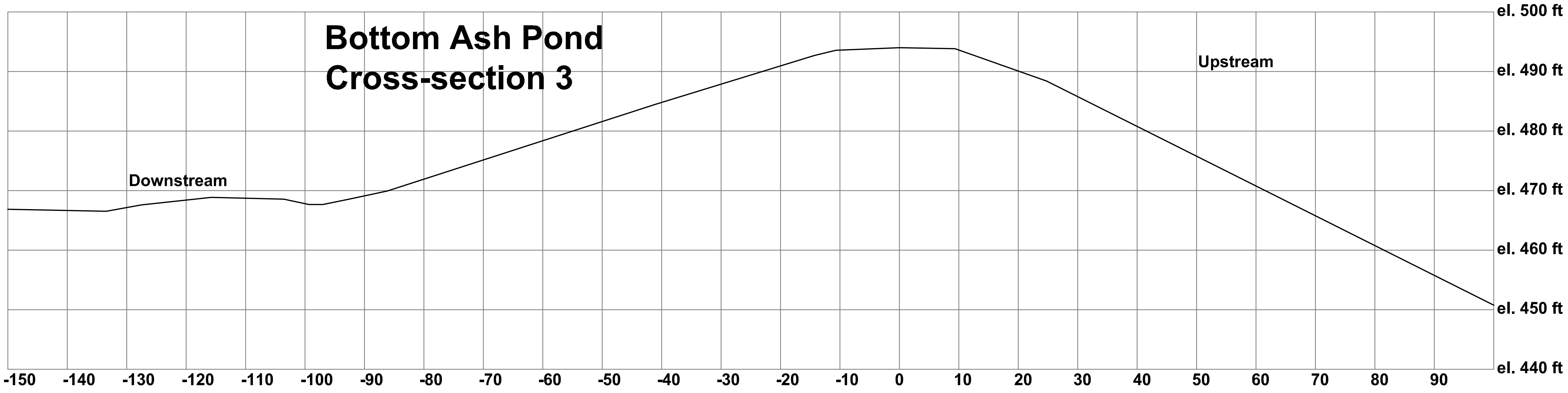


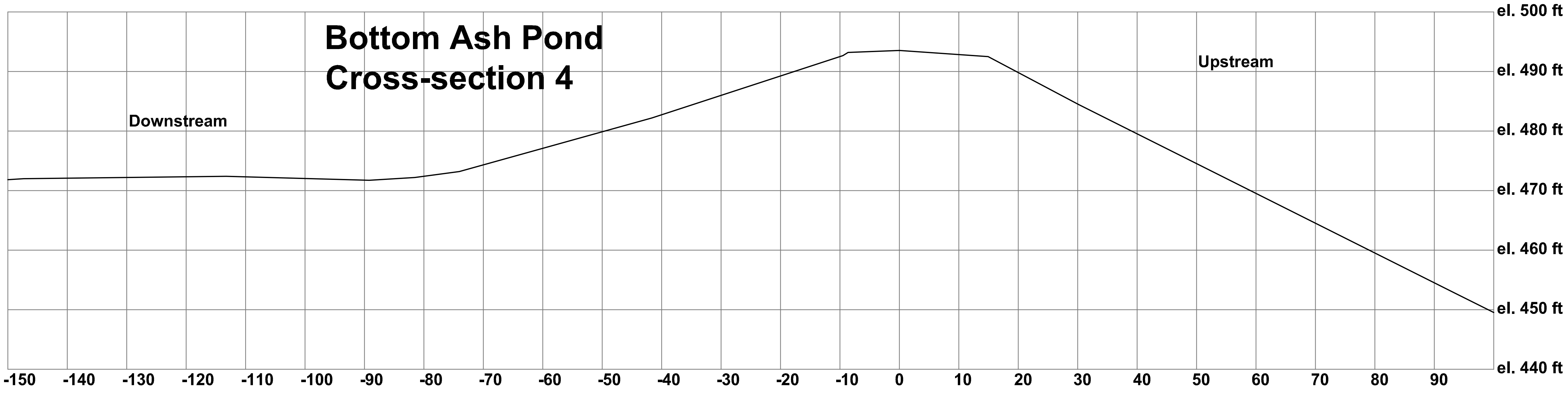
Elevation Profile Survey Limits
Locations of Cross-section and Borings

REITZ & JENS, INC.
CONSULTING ENGINEERS

Figure 3

Labadie Power Station





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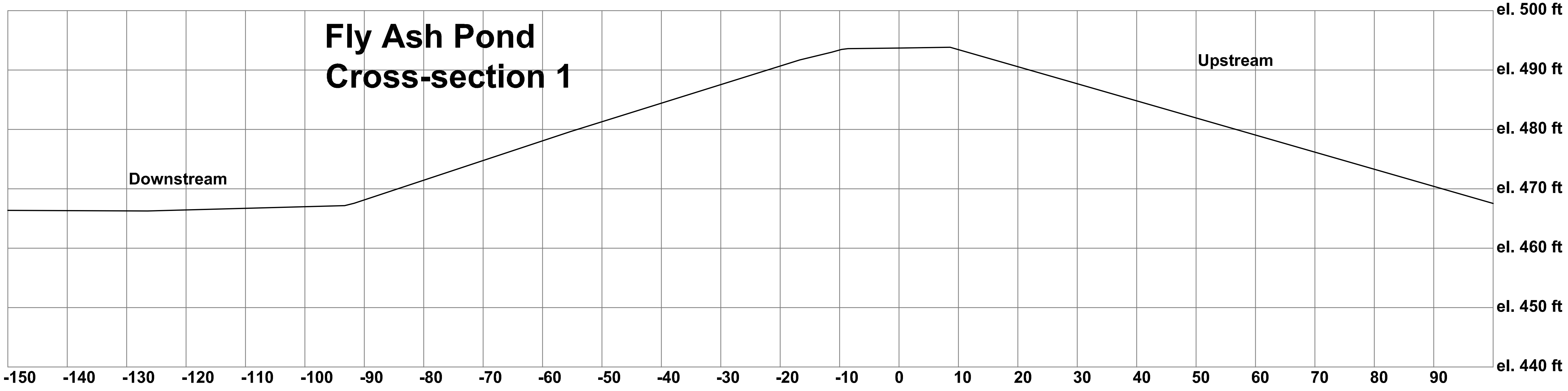
CONSULTING ENGINEERS
1055 Corporate Square Drive
St. Louis, Missouri 63132

Figure A-2

Figure 4

Labadie Power Station


Fly Ash Pond Cross-section 1

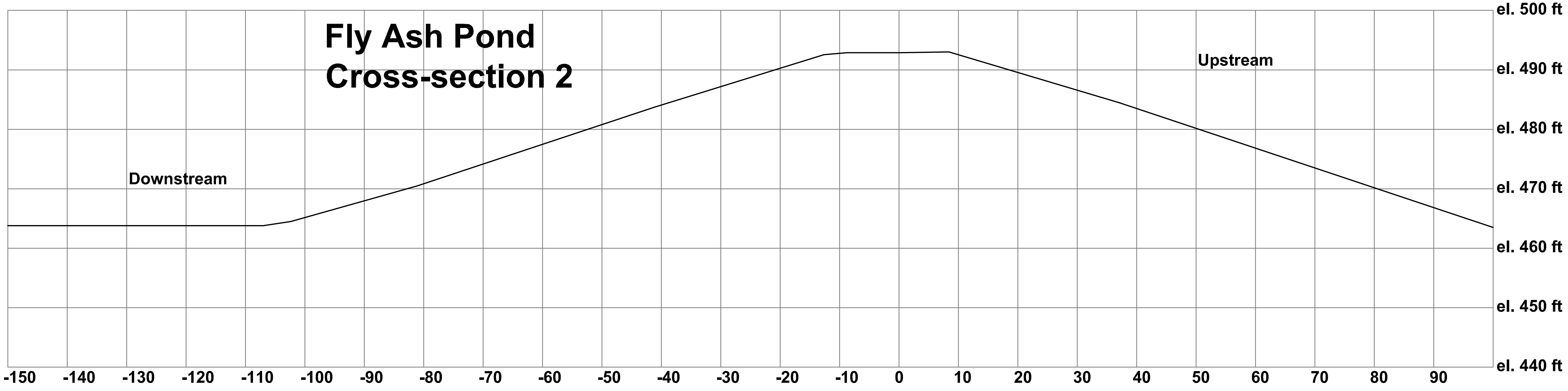

Fly Ash Pond Cross-section 2

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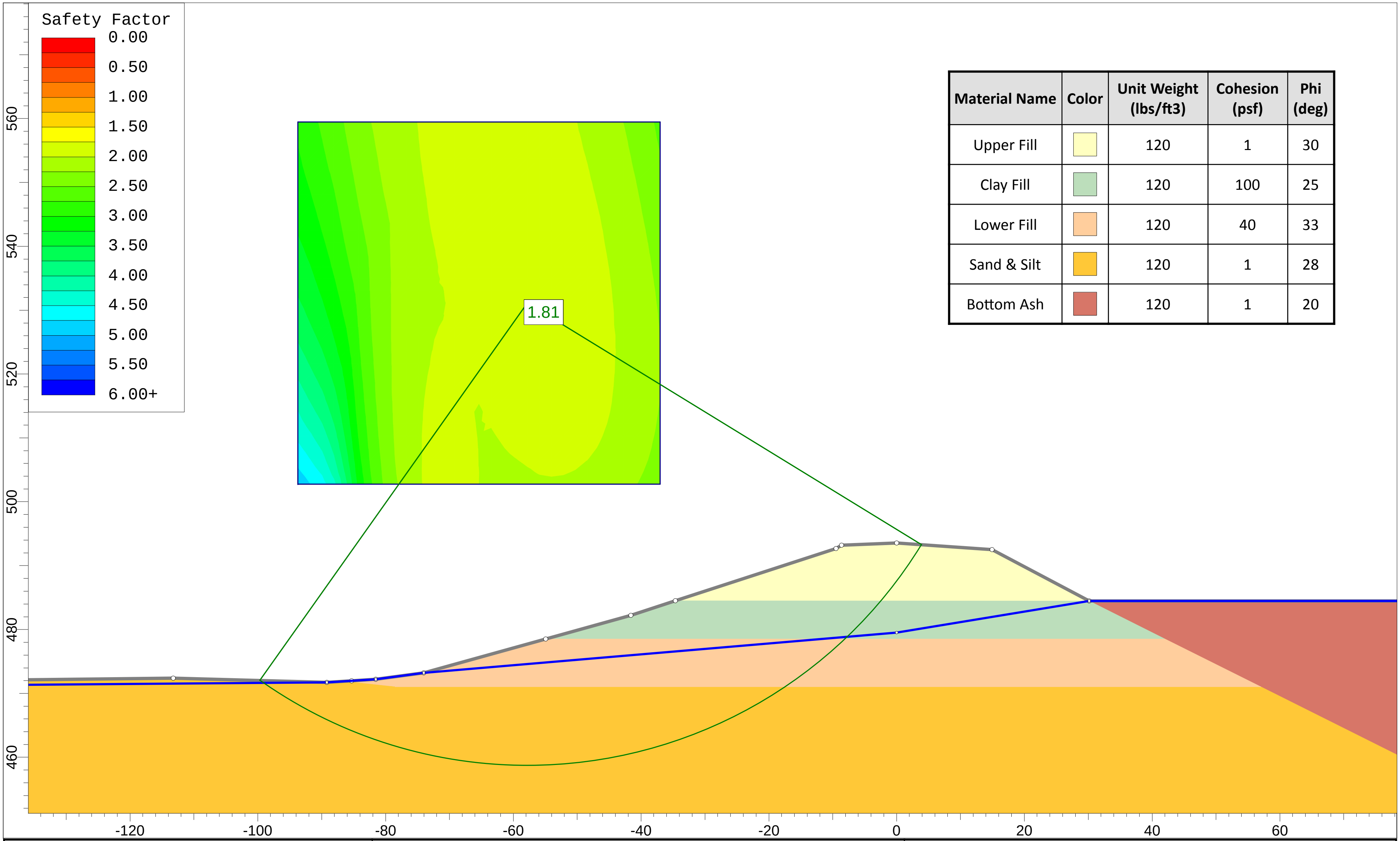
Figure A-1

APPENDIX I

GRAPHICAL RESULTS OF SLOPE STABILITY ANALYSES



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	120	1	30
Clay Fill	🟩	120	100	25
Lower Fill	🟧	120	40	33
Sand & Silt	🟨	120	1	28
Bottom Ash	🟥	120	1	20

REITZ & JENS, INC.
CONSULTING ENGINEERS

Project Name: Periodic Safety Factor Assessment

Client: Ameren - Labadie Energy Center

Section Location: Section 4 - Bottom Ash Pond

Load Case: Static, Maxium Storage Pool

File Path/Name: P:\Amerenue\2015012432\Labadie\calc\xsect_4\xsect_4.sli

Project Number: 2015012432

Analysis By: J. Bertel

Checked By: J. Gilliam

Figure:

Slide Analysis Information

Periodic Safety Factor Assessment

Project Summary

File Name:	xsect_4
Slide Modeler Version:	6.035
Project Title:	Periodic Safety Factor Assessment
Analysis:	Static, Maxium Storage Pool
Author:	J. Bertel
Company:	Ameren - Labadie Energy Center

Comments

2015012432
Section 4 - Bottom Ash Pond
J. Gilliam

General Settings

Units of Measurement:	Imperial Units
Time Units:	seconds
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type: Vertical

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function:	Half Sine
	Spencer

Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]: 62.4
Use negative pore pressure cutoff: Yes
Maximum negative pore pressure [psf]: 0
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Material Properties

Property	Upper Fill	Clay Fill	Lower Fill	Sand & Silt	Bottom Ash
Color	🟨	🟩	🟧	🟨	🟥
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	120	120	120	120	120
Cohesion [psf]	1	100	40	1	1
Friction Angle [deg]	30	25	33	28	20
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1

Global Minimums

Method: spencer

FS	1.810180
Center:	-57.825, 531.106
Radius:	72.427
Left Slip Surface Endpoint:	-99.695, 472.008
Right Slip Surface Endpoint:	3.923, 493.252
Resisting Moment:	5.03595e+006 lb-ft
Driving Moment:	2.78202e+006 lb-ft
Resisting Horizontal Force:	62424 lb
Driving Horizontal Force:	34485 lb
Total Slice Area:	1542.04 ft2

Method: gle/morgenstern-price

FS	1.814170
Center:	-57.825, 532.997
Radius:	74.074
Left Slip Surface Endpoint:	-99.870, 472.013
Right Slip Surface Endpoint:	4.652, 493.202
Resisting Moment:	5.17225e+006 lb-ft
Driving Moment:	2.85103e+006 lb-ft
Resisting Horizontal Force:	62720.6 lb
Driving Horizontal Force:	34572.6 lb
Total Slice Area:	1540.89 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	5924
Number of Invalid Surfaces:	4647

Error Codes:

Error Code -103 reported for 4635 surfaces
Error Code -108 reported for 12 surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces:	5924
Number of Invalid Surfaces:	4647

Error Codes:

Error Code -103 reported for 4635 surfaces
Error Code -108 reported for 12 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.81018

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.11429	641.015	-33.3683	Sand & Silt	1	28	47.5648	86.1009	222.292	62.2414	160.051
2	4.11429	1829.91	-29.5483	Sand & Silt	1	28	107.41	194.431	585.451	221.66	363.791
3	4.11429	2860.33	-25.8684	Sand & Silt	1	28	151.715	274.632	873.41	358.782	514.628
4	4.11429	3864.38	-22.3003	Sand & Silt	1	28	191.183	346.075	1137.41	488.413	648.992
5	4.11429	4775.23	-18.8216	Sand & Silt	1	28	223.924	405.343	1362.36	601.905	760.458
6	4.11429	5662.07	-15.4137	Sand & Silt	1	28	251.61	455.46	1570.34	715.622	854.715
7	4.11429	6517.61	-12.061	Sand & Silt	1	28	280.904	508.486	1764.1	809.658	954.441
8	4.11429	7447.23	-8.74995	Sand & Silt	1	28	322.227	583.288	1973.85	878.723	1095.12
9	4.11429	8265.12	-5.46817	Sand & Silt	1	28	356.831	645.928	2145.58	932.648	1212.93
10	4.11429	8965.8	-2.20435	Sand & Silt	1	28	384.887	696.714	2280.2	971.757	1308.45
11	4.11429	9550.58	1.0523	Sand & Silt	1	28	407.044	736.823	2380.1	996.22	1383.88
12	4.11429	10019.7	4.31237	Sand & Silt	1	28	423.804	767.161	2447.01	1006.06	1440.95
13	4.11429	10372.2	7.58654	Sand & Silt	1	28	435.554	788.431	2482.11	1001.17	1480.94
14	4.11429	10605.9	10.8859	Sand & Silt	1	28	442.595	801.176	2486.18	981.261	1504.92
15	4.11429	10755.3	14.2224	Sand & Silt	1	28	447.678	810.378	2468.13	945.92	1522.21
16	4.11429	10836.1	17.6091	Sand & Silt	1	28	452.12	818.418	2431.87	894.522	1537.35
17	4.11429	10783.9	21.0608	Sand & Silt	1	28	452.058	818.306	2363.36	826.228	1537.14
18	4.11429	10589.2	24.595	Sand & Silt	1	28	447.52	810.092	2261.59	739.919	1521.68
19	4.11429	10240.3	28.2325	Sand & Silt	1	28	438.533	793.824	2125.2	634.119	1491.08
20	4.11429	9721.64	31.9992	Sand & Silt	1	28	425.079	769.469	1952.15	506.867	1445.28
21	4.68367	10185.6	36.2153	Lower Fill	40	33	500.146	905.354	1675.57	343.04	1332.53
22	4.68367	8960.77	40.9663	Lower Fill	40	33	467.182	845.684	1374.7	134.058	1240.65
23	5.62573	7992.22	46.6647	Clay Fill	100	25	304.215	550.684	966.494	0	966.494
24	3.16966	2659.4	51.9431	Upper Fill	1	30	169.504	306.832	529.717	0	529.717
25	3.16966	942.783	56.2336	Upper Fill	1	30	56.7932	102.806	176.333	0	176.333

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.81417

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.12944	628.428	-32.6867	Sand & Silt	1	28	35.5551	64.503	179.417	59.9858	119.432
2	4.12944	1795.05	-28.9631	Sand & Silt	1	28	86.1242	156.244	508.053	216.081	291.972
3	4.12944	2805.82	-25.3696	Sand & Silt	1	28	132.501	240.379	800.807	350.6	450.207
4	4.12944	3794.22	-21.8806	Sand & Silt	1	28	179.255	325.199	1087.52	477.788	609.73
5	4.12944	4693.88	-18.4752	Sand & Silt	1	28	221.693	402.188	1343.75	589.225	754.525
6	4.12944	5573.34	-15.1364	Sand & Silt	1	28	258.545	469.045	1582.09	701.823	880.266
7	4.12944	6421.59	-11.8497	Sand & Silt	1	28	294.697	534.631	1798.9	795.288	1003.61
8	4.12944	7350.01	-8.60219	Sand & Silt	1	28	340.463	617.657	2023.53	863.771	1159.76
9	4.12944	8169.7	-5.38242	Sand & Silt	1	28	376.54	683.107	2200.21	917.36	1282.85
10	4.12944	8873.55	-2.17966	Sand & Silt	1	28	402.809	730.764	2328.85	956.363	1372.49
11	4.12944	9462.86	1.01628	Sand & Silt	1	28	420.327	762.545	2413.2	980.941	1432.26
12	4.12944	9937.81	4.21539	Sand & Silt	1	28	430.391	780.803	2457.71	991.12	1466.59
13	4.12944	10297.5	7.42777	Sand & Silt	1	28	434.399	788.073	2467.06	986.788	1480.28
14	4.12944	10540	10.6639	Sand & Silt	1	28	433.718	786.839	2445.64	967.691	1477.95
15	4.12944	10700.8	13.9349	Sand & Silt	1	28	432.177	784.042	2406.12	933.423	1472.69
16	4.12944	10794.8	17.2532	Sand & Silt	1	28	431.832	783.417	2354.92	883.403	1471.52
17	4.12944	10758	20.6325	Sand & Silt	1	28	429.502	779.189	2280.41	816.839	1463.57
18	4.12944	10581.5	24.0889	Sand & Silt	1	28	425.65	772.202	2183.11	732.686	1450.42
19	4.12944	10254.4	27.6417	Sand & Silt	1	28	420.452	762.772	2062.25	629.57	1432.68
20	4.12944	9762.26	31.3146	Sand & Silt	1	28	413.711	750.542	1915.36	505.675	1409.68
21	4.81335	10503.9	35.4706	Lower Fill	40	33	496.186	900.166	1668.61	344.071	1324.54
22	4.81335	9270.17	40.1948	Lower Fill	40	33	474.463	860.757	1399.63	135.778	1263.86
23	5.78834	8235.75	45.8481	Clay Fill	100	25	316.627	574.416	1017.39	0	1017.39
24	3.25914	2737.51	51.07	Upper Fill	1	30	185.402	336.35	580.844	0	580.844
25	3.25914	963.623	55.2905	Upper Fill	1	30	63.763	115.677	198.626	0	198.626

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.81018

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-99.695	472.008	0	0	0
2	-95.5807	469.298	798.236	145.482	10.329
3	-91.4664	466.966	2606.1	474.973	10.329
4	-87.3521	464.971	4973.44	906.428	10.329
5	-83.2378	463.284	7680.16	1399.74	10.329
6	-79.1236	461.881	10513	1916.03	10.329
7	-75.0093	460.747	13330.6	2429.55	10.329
8	-70.895	459.868	16038.4	2923.06	10.329
9	-66.7807	459.235	18615.5	3392.75	10.329
10	-62.6664	458.841	20930.3	3814.62	10.329
11	-58.5521	458.682	22876.6	4169.36	10.329
12	-54.4378	458.758	24373.3	4442.13	10.329
13	-50.3235	459.068	25359.7	4621.9	10.329
14	-46.2092	459.616	25793.5	4700.96	10.329
15	-42.0949	460.407	25649.3	4674.68	10.329
16	-37.9806	461.45	24919.5	4541.67	10.329
17	-33.8663	462.756	23606	4302.28	10.329
18	-29.7521	464.34	21723.6	3959.2	10.329
19	-25.6378	466.224	19307.7	3518.9	10.329
20	-21.5235	468.433	16419.2	2992.46	10.329
21	-17.4092	471.004	13151.4	2396.9	10.329
22	-12.7255	474.433	9749.56	1776.89	10.329
23	-8.04185	478.5	6349.69	1157.26	10.329
24	-2.41612	484.463	2300.27	419.233	10.329
25	0.753537	488.511	693.474	126.388	10.329
26	3.92319	493.252	0	0	0

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.81417

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-99.8704	472.013	0	0	0
2	-95.7409	469.363	622.313	18.2044	1.67558
3	-91.6115	467.078	2139.33	124.2	3.32261
4	-87.4821	465.119	4254.89	365.771	4.91334
5	-83.3526	463.461	6799.1	765.25	6.42171
6	-79.2232	462.081	9569.09	1314.86	7.82385
7	-75.0937	460.964	12404.6	1986.58	9.09858
8	-70.9643	460.098	15180.9	2739.02	10.2276
9	-66.8349	459.473	17851.7	3533.33	11.1957
10	-62.7054	459.084	20263.6	4303.64	11.9905
11	-58.576	458.927	22294	4984.3	12.6024
12	-54.4465	459	23854	5517.91	13.0246
13	-50.3171	459.305	24884.3	5860.5	13.2522
14	-46.1877	459.843	25351	5984.78	13.283
15	-42.0582	460.621	25241.5	5881.54	13.1165
16	-37.9288	461.645	24561.9	5559.83	12.7545
17	-33.7993	462.928	23326	5043.72	12.2011
18	-29.6699	464.482	21555.1	4370.66	11.4623
19	-25.5405	466.329	19283.3	3590.31	10.547
20	-21.411	468.491	16560.7	2761.38	9.46657
21	-17.2816	471.004	13458.4	1947.88	8.23543
22	-12.4682	474.433	10125.4	1177.53	6.6334
23	-7.65488	478.5	6718.48	573.921	4.88259
24	-1.86654	484.462	2486.37	114.369	2.63366
25	1.3926	488.497	747.413	17.2727	1.32387
26	4.65175	493.202	0	0	0

List Of Coordinates

Water Table

X	Y
-250	471.47
-162.22	471.12
-89.2	471.72
-81.54	472.18
-74.04	473.19
0	479.5
30.13	484.45
250	484.45

External Boundary

X	Y
-8.63	493.19
-9.48	492.66
-34.6222	484.475
-41.61	482.2
-54.9275	478.5
-74.04	473.19
-81.54	472.18
-85.3128	471.953
-89.2	471.72
-113.25	472.38
-147.31	472
-162.22	471.12
-183.37	471.47
-250	471.47
-250	400
250	400
250	410
250	411.16
250	484.45
30.13	484.45
14.93	492.5
0	493.52

Material Boundary

X	Y
30.13	484.45
42.0276	478.5
57.0175	471.004
179	410
250	410

Material Boundary

X	Y
-34.6222	484.475
30.13	484.45

Material Boundary

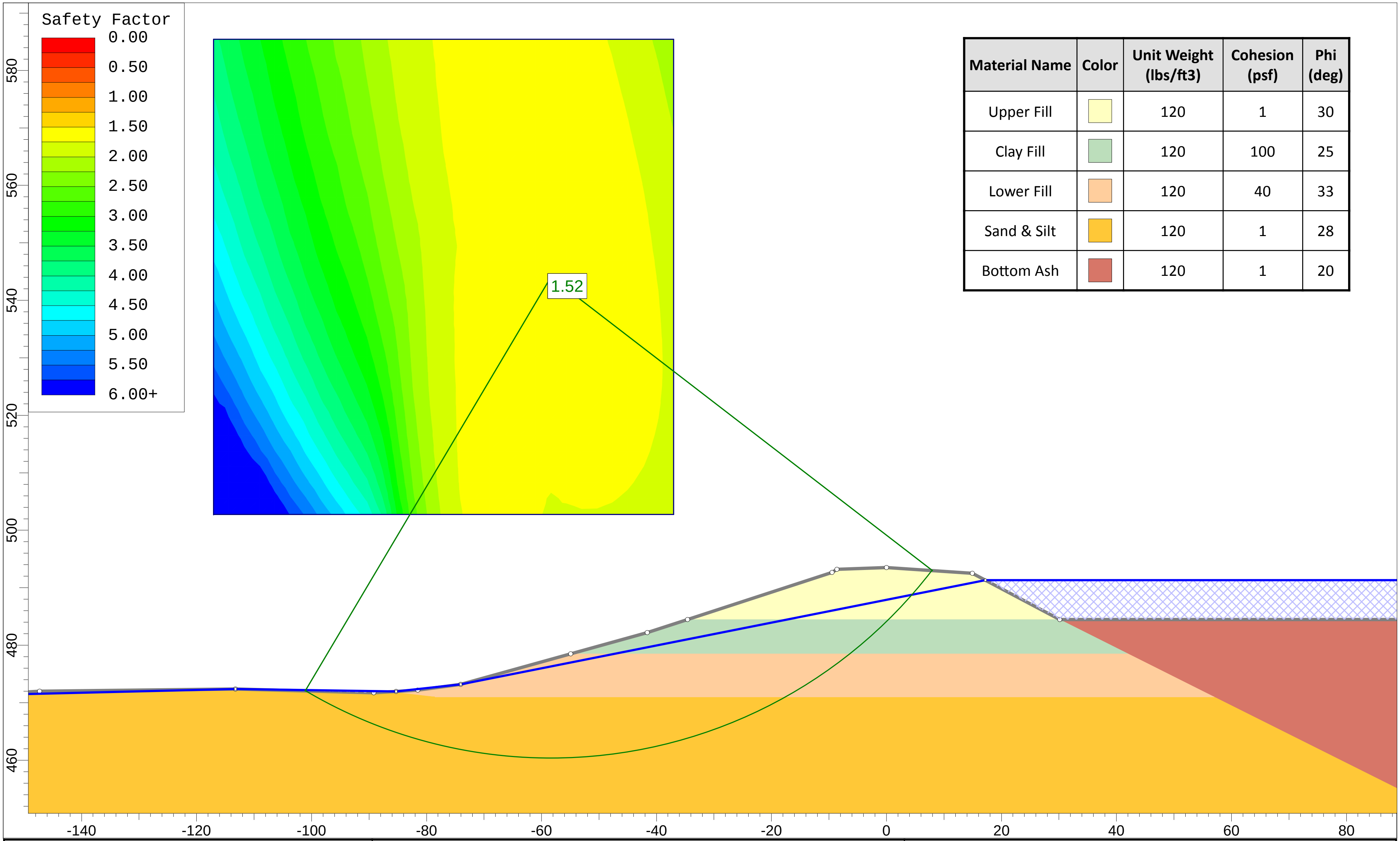
X	Y
-54.9275	478.5
42.0276	478.5

Material Boundary

X	Y
-84.9558	471.72
-78.55	471.004
57.0175	471.004

Material Boundary

X	Y
-85.3128	471.953
-84.9558	471.72



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	120	1	30
Clay Fill	🟩	120	100	25
Lower Fill	🟧	120	40	33
Sand & Silt	🟧	120	1	28
Bottom Ash	🟥	120	1	20

REITZ & JENS, INC.
CONSULTING ENGINEERS

Project Name: Periodic Safety Factor Assessment

Client: Ameren - Labadie Energy Center

Section Location: Section 4 - Bottom Ash Pond

Load Case: Static, Maxium Surcharge Pool

File Path/Name: P:\Amerenue\2015012432\Labadie\calc\xsect_4\xsect_4 MAX.sli

Project Number: 2015012432

Analysis By: J. Bertel

Checked By: J. Gilliam

Figure:

Slide Analysis Information

Periodic Safety Factor Assessment

Project Summary

File Name:	xsect_4 MAX
Slide Modeler Version:	6.035
Project Title:	Periodic Safety Factor Assessment
Analysis:	Static, Maxium Surcharge Pool
Author:	J. Bertel
Company:	Ameren - Labadie Energy Center
Comments	
	2015012432
	Section 4 - Bottom Ash Pond
	J. Gilliam

General Settings

Units of Measurement:	Imperial Units
Time Units:	seconds
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
GLE/Morgenstern-Price with interslice force function:	Half Sine
	Spencer
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]: 62.4
Use negative pore pressure cutoff: Yes
Maximum negative pore pressure [psf]: 0
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Material Properties

Property	Upper Fill	Clay Fill	Lower Fill	Sand & Silt	Bottom Ash
Color	🟨	🟩	🟧	🟨	🟥
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	120	120	120	120	120
Cohesion [psf]	1	100	40	1	1
Friction Angle [deg]	30	25	33	28	20
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1

Global Minimums

Method: spencer

FS	1.524790
Center:	-58.368, 544.090
Radius:	83.763
Left Slip Surface Endpoint:	-101.099, 472.047
Right Slip Surface Endpoint:	7.990, 492.974
Left Slope Intercept:	-101.099 472.194
Right Slope Intercept:	7.990 492.974
Resisting Moment:	4.85555e+006 lb-ft
Driving Moment:	3.1844e+006 lb-ft
Resisting Horizontal Force:	53368.2 lb
Driving Horizontal Force:	35000.3 lb
Total Slice Area:	1513.82 ft2

Method: gle/morgenstern-price

FS	1.528040
Center:	-55.700, 544.090
Radius:	83.402
Left Slip Surface Endpoint:	-97.552, 471.949
Right Slip Surface Endpoint:	10.090, 492.831
Left Slope Intercept:	-97.552 472.140
Right Slope Intercept:	10.090 492.831
Resisting Moment:	4.90159e+006 lb-ft
Driving Moment:	3.20777e+006 lb-ft
Resisting Horizontal Force:	54090.7 lb
Driving Horizontal Force:	35398.8 lb
Total Slice Area:	1525.76 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	6798
Number of Invalid Surfaces:	3773

Error Codes:

Error Code -103 reported for 3557 surfaces
Error Code -107 reported for 192 surfaces
Error Code -108 reported for 23 surfaces
Error Code -111 reported for 1 surface

Method: gle/morgenstern-price

Number of Valid Surfaces:	6801
Number of Invalid Surfaces:	3770

Error Codes:

Error Code -103 reported for 3557 surfaces
Error Code -107 reported for 192 surfaces
Error Code -108 reported for 21 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.52479

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.40272	659.495	-28.9519	Sand & Silt	1	28	41.2175	62.8481	199.444	83.1257	116.319
2	4.40272	1810.07	-25.5614	Sand & Silt	1	28	107.17	163.412	526.076	220.624	305.452
3	4.40272	2797.71	-22.2647	Sand & Silt	1	28	156.145	238.088	784.265	338.368	445.897
4	4.40272	3712.8	-19.0442	Sand & Silt	1	28	200.221	305.295	1010.12	437.829	572.294
5	4.40272	4632.02	-15.8853	Sand & Silt	1	28	234.652	357.795	1222.57	551.54	671.034
6	4.40272	5501.6	-12.7753	Sand & Silt	1	28	266.647	406.58	1414.7	651.914	762.785
7	4.40272	6379.7	-9.70333	Sand & Silt	1	28	299.542	456.738	1602.44	745.324	857.119
8	4.40272	7356.75	-6.65932	Sand & Silt	1	28	338.578	516.26	1808.45	839.383	969.063
9	4.40272	8212.66	-3.63414	Sand & Silt	1	28	369.745	563.783	1977.12	918.679	1058.44
10	4.40272	8945.34	-0.619105	Sand & Silt	1	28	393.591	600.143	2110.24	983.42	1126.82
11	4.40272	9555.54	2.39421	Sand & Silt	1	28	410.826	626.424	2209.94	1033.69	1176.25
12	4.40272	10042.9	5.41419	Sand & Silt	1	28	422.017	643.487	2277.81	1069.46	1208.35
13	4.40272	10406.2	8.44938	Sand & Silt	1	28	427.614	652.021	2314.97	1090.57	1224.4
14	4.40272	10656.1	11.5087	Sand & Silt	1	28	428.984	654.11	2325.05	1096.73	1228.32
15	4.40272	10859	14.6018	Sand & Silt	1	28	431.494	657.938	2323.02	1087.51	1235.51
16	4.40272	10941.2	17.7392	Sand & Silt	1	28	429.946	655.578	2293.39	1062.32	1231.07
17	4.40272	10881.6	20.9328	Sand & Silt	1	28	423.437	645.652	2232.77	1020.36	1212.41
18	4.40272	10671.3	24.1962	Sand & Silt	1	28	412.12	628.396	2140.58	960.626	1179.96
19	4.40272	10299.4	27.5458	Sand & Silt	1	28	396.114	603.991	2015.84	881.788	1134.05
20	5.58808	12245.4	31.4861	Lower Fill	40	33	464.297	707.956	1793.79	765.233	1028.56
21	5.58808	10940.5	36.0937	Lower Fill	40	33	420.959	641.874	1527.36	600.558	926.801
22	3.36483	5424.69	39.9611	Clay Fill	100	25	305.961	466.527	1226.95	440.928	786.02
23	3.36483	4271.75	43.0374	Clay Fill	100	25	256.816	391.59	921.925	296.609	625.316
24	3.76542	3124.93	46.4827	Upper Fill	1	30	172.121	262.449	571.859	119.017	452.842
25	3.76542	1085.45	50.3729	Upper Fill	1	30	68.6908	104.739	179.681	0	179.681

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.52804

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.5572	700.133	-28.3409	Sand & Silt	1	28	31.2574	47.7625	174.391	86.4437	87.9474
2	4.5572	1897.82	-24.8369	Sand & Silt	1	28	89.9407	137.433	481.194	224.601	256.593
3	4.5572	2987.41	-21.4299	Sand & Silt	1	28	148.92	227.556	767.966	341.876	426.09
4	4.5572	4070.28	-18.101	Sand & Silt	1	28	202.552	309.508	1048.97	468.753	580.219
5	4.5572	5099.09	-14.8343	Sand & Silt	1	28	253.131	386.794	1309.65	584.08	725.574
6	4.5572	6126.03	-11.6165	Sand & Silt	1	28	302.442	462.144	1558.05	690.763	867.287
7	4.5572	7254.44	-8.43552	Sand & Silt	1	28	354.883	542.275	1815.51	797.524	1017.99
8	4.5572	8246.8	-5.28061	Sand & Silt	1	28	394.718	603.145	2020.67	888.198	1132.47
9	4.5572	9100.97	-2.14174	Sand & Silt	1	28	421.985	644.81	2173.93	963.104	1210.83
10	4.5572	9818.42	0.990689	Sand & Silt	1	28	437.83	669.021	2278.78	1022.41	1256.37
11	4.5572	10399.4	4.1261	Sand & Silt	1	28	443.856	678.23	2339.83	1066.14	1273.69
12	4.5572	10842.8	7.27397	Sand & Silt	1	28	441.909	675.255	2362.27	1094.18	1268.09
13	4.5572	11177.7	10.4442	Sand & Silt	1	28	436.19	666.516	2357.93	1106.27	1251.66
14	4.5572	11452.3	13.6471	Sand & Silt	1	28	431.951	660.038	2341.46	1101.98	1239.48
15	4.5572	11582.6	16.8944	Sand & Silt	1	28	424.601	648.807	2299.07	1080.72	1218.35
16	4.5572	11557	20.1987	Sand & Silt	1	28	414.966	634.085	2232.33	1041.68	1190.65
17	4.5572	11366.2	23.5751	Sand & Silt	1	28	403.811	617.04	2142.37	983.768	1158.61
18	4.5572	10997.7	27.041	Sand & Silt	1	28	391.457	598.162	2028.7	905.594	1123.1
19	3.77923	8707.41	30.3024	Lower Fill	40	33	472.209	721.554	1865.24	815.739	1049.5
20	3.77923	8225.86	33.3606	Lower Fill	40	33	455.633	696.226	1726.51	716.008	1010.5
21	3.77923	7341.17	36.5307	Lower Fill	40	33	413.947	632.527	1510.25	597.837	912.413
22	3.398	5511.4	39.6628	Clay Fill	100	25	309.462	472.87	1266.66	467.037	799.622
23	3.398	4305.55	42.7694	Clay Fill	100	25	261.074	398.931	964.216	323.155	641.061
24	3.73949	3052.52	46.2162	Upper Fill	1	30	174.318	266.365	607.182	147.556	459.626
25	3.73949	1059.89	50.0747	Upper Fill	1	30	73.2127	111.872	192.036	0	192.036

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.52479

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-101.099	472.047	0.682783	0	0
2	-96.6959	469.611	666.777	118.779	10.1007
3	-92.2932	467.505	2245.96	400.091	10.1006
4	-87.8905	465.703	4348.37	774.612	10.1006
5	-83.4877	464.183	6766.53	1205.38	10.1006
6	-79.085	462.93	9331.85	1662.36	10.1006
7	-74.6823	461.932	11919.3	2123.29	10.1006
8	-70.2796	461.179	14445.3	2573.27	10.1007
9	-65.8769	460.665	16866.6	3004.58	10.1006
10	-61.4741	460.385	19048.3	3393.24	10.1006
11	-57.0714	460.338	20882.7	3720.01	10.1006
12	-52.6687	460.522	22285.8	3969.96	10.1006
13	-48.266	460.939	23194.5	4131.83	10.1006
14	-43.8632	461.593	23564.3	4197.72	10.1007
15	-39.4605	462.489	23370	4163.09	10.1006
16	-35.0578	463.636	22606.5	4027.08	10.1006
17	-30.6551	465.045	21270.6	3789.11	10.1006
18	-26.2524	466.729	19375.8	3451.57	10.1006
19	-21.8496	468.707	16956.6	3020.63	10.1007
20	-17.4469	471.004	14072.5	2506.86	10.1007
21	-11.8588	474.426	10529.4	1875.7	10.1007
22	-6.27075	478.5	6660.88	1186.56	10.1006
23	-2.90592	481.32	4231.62	753.814	10.1006
24	0.458909	484.461	2199.74	391.859	10.1006
25	4.22433	488.427	580.543	103.417	10.1006
26	7.98975	492.974	0	0	0

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.52804

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-97.5522	471.949	1.13949	0	0
2	-92.995	469.491	570.402	17.7409	1.78146
3	-88.4378	467.382	1995.6	123.04	3.52814
4	-83.8806	465.593	4049.78	369.014	5.20639
5	-79.3234	464.104	6535.42	777.544	6.78481
6	-74.7662	462.897	9270.75	1341.73	8.23508
7	-70.209	461.96	12109.3	2033.43	9.53235
8	-65.6518	461.284	14954.2	2813.69	10.6558
9	-61.0946	460.863	17604.9	3610.06	11.5884
10	-56.5374	460.692	19899.3	4344.91	12.3169
11	-51.9802	460.771	21715.9	4946.27	12.8315
12	-47.423	461.1	22970.3	5356.12	13.1255
13	-42.8658	461.682	23610.9	5535.86	13.1953
14	-38.3086	462.522	23618.8	5470.26	13.0401
15	-33.7514	463.628	22997.4	5166.56	12.6618
16	-29.1942	465.012	21751.1	4649.14	12.065
17	-24.637	466.689	19900.3	3961.18	11.2577
18	-20.0798	468.677	17480.9	3161.33	10.2509
19	-15.5226	471.004	14546.7	2319.36	9.05912
20	-11.7434	473.212	12212.4	1704.13	7.94381
21	-7.96414	475.7	9639.18	1136.87	6.72654
22	-4.18491	478.5	6976.13	662.11	5.42175
23	-0.786902	481.317	4459.5	326.477	4.18712
24	2.6111	484.461	2316.27	117.64	2.90747
25	6.35059	488.362	599.366	15.3115	1.46337
26	10.0901	492.831	0	0	0

List Of Coordinates

Water Table

X	Y
-250	471.47
-163.957	471.149
-113.25	472.38
-85.3128	471.953
-74.04	473.19
17.1958	491.3
250	491.3

External Boundary

X	Y
-8.63	493.19
-9.48	492.66
-34.6222	484.475
-41.61	482.2
-54.9275	478.5
-74.04	473.19
-81.54	472.18
-85.3128	471.953
-89.2	471.72
-113.25	472.38
-147.31	472
-162.22	471.12
-183.37	471.47
-250	471.47
-250	400
250	400
250	410
250	411.16
250	484.45
30.13	484.45
14.93	492.5
0	493.52

Material Boundary

X	Y
30.13	484.45
42.0276	478.5
57.0175	471.004
179	410
250	410

Material Boundary

X	Y
-34.6222	484.475
30.13	484.45

Material Boundary

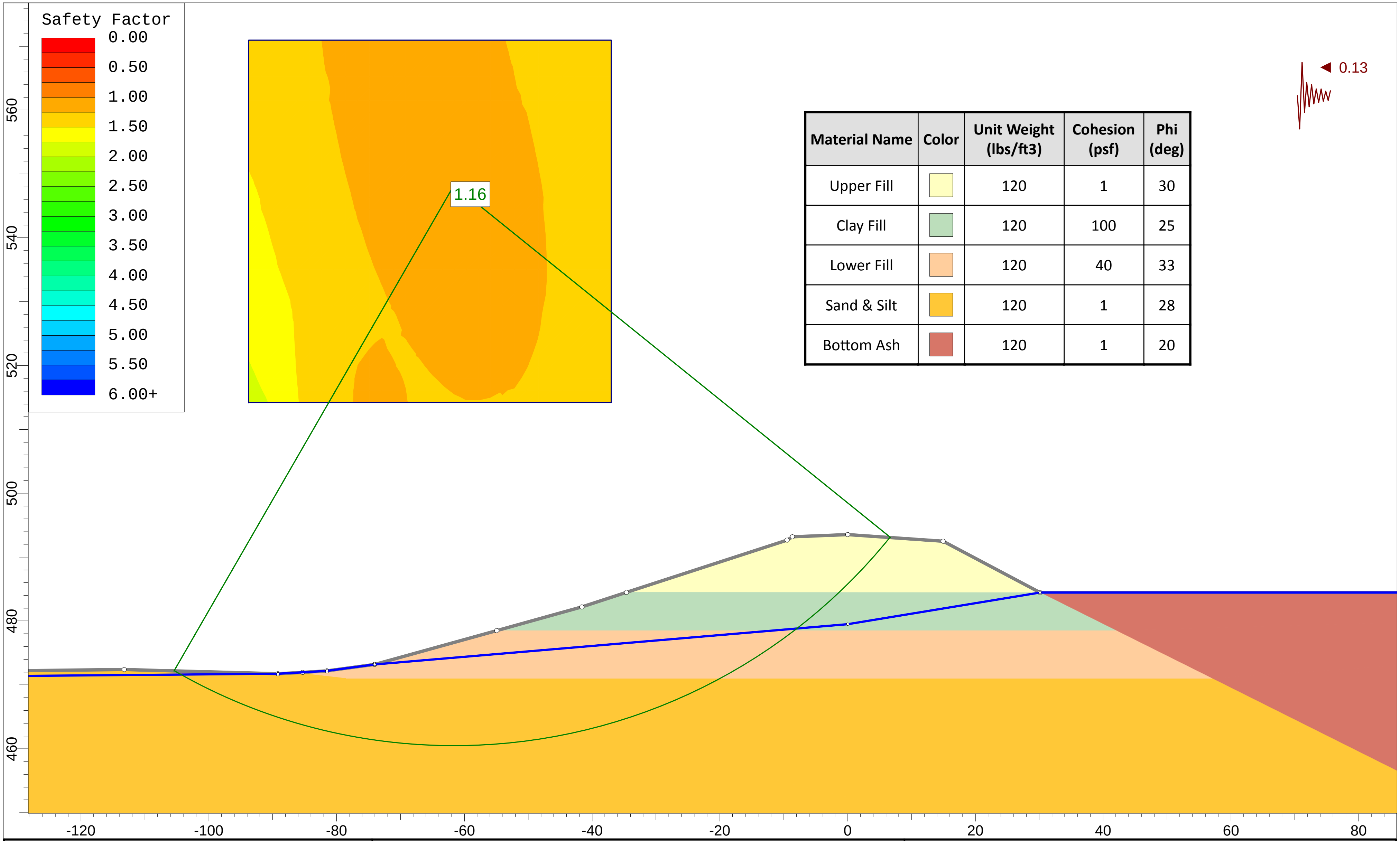
X	Y
-54.9275	478.5
42.0276	478.5

Material Boundary

X	Y
-84.9558	471.72
-78.55	471.004
57.0175	471.004

Material Boundary

X	Y
-85.3128	471.953
-84.9558	471.72



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	120	1	30
Clay Fill	🟩	120	100	25
Lower Fill	🟧	120	40	33
Sand & Silt	🟨	120	1	28
Bottom Ash	🟥	120	1	20

REITZ & JENS, INC.
CONSULTING ENGINEERS

Project Name: Periodic Safety Factor Assessment

Client: Ameren - Labadie Energy Center

Section Location: Section 4 - Bottom Ash Pond

Load Case: Seismic

File Path/Name: P:\Amerenue\2015012432\Labadie\calc\xsect_4\xsect_4 PS LT.sli

Project Number: 2015012432

Analysis By: J. Bertel

Checked By: J. Gilliam

Figure:

Slide Analysis Information

Periodic Safety Factor Assessment

Project Summary

File Name:	xsect_4 PS LT
Slide Modeler Version:	6.035
Project Title:	Periodic Safety Factor Assessment
Analysis:	Seismic
Author:	J. Bertel
Company:	Ameren - Labadie Energy Center

Comments

2015012432
Section 4 - Bottom Ash Pond
J. Gilliam

General Settings

Units of Measurement:	Imperial Units
Time Units:	seconds
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type: Vertical

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function:	Half Sine
	Spencer

Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]: 62.4
Use negative pore pressure cutoff: Yes
Maximum negative pore pressure [psf]: 0
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Loading

Seismic Load Coefficient (Horizontal): 0.13

Material Properties

Property	Upper Fill	Clay Fill	Lower Fill	Sand & Silt	Bottom Ash
Color	🟨	🟩	🟧	🟨	🟥
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	120	120	120	120	120
Cohesion [psf]	1	100	40	1	1
Friction Angle [deg]	30	25	33	28	20
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1	1

Global Minimums

Method: spencer

FS	1.160710
Center:	-61.606, 548.253
Radius:	87.817
Left Slip Surface Endpoint:	-105.454, 472.166
Right Slip Surface Endpoint:	6.701, 493.062
Resisting Moment:	5.75538e+006 lb-ft
Driving Moment:	4.95849e+006 lb-ft
Resisting Horizontal Force:	60114.5 lb
Driving Horizontal Force:	51791.1 lb
Total Slice Area:	1479.37 ft2

Method: gle/morgenstern-price

FS	1.157350
Center:	-63.497, 546.362
Radius:	86.341
Left Slip Surface Endpoint:	-107.759, 472.229
Right Slip Surface Endpoint:	4.544, 493.210
Resisting Moment:	5.55026e+006 lb-ft
Driving Moment:	4.79566e+006 lb-ft
Resisting Horizontal Force:	58854.9 lb
Driving Horizontal Force:	50853.2 lb
Total Slice Area:	1467.99 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	6272
Number of Invalid Surfaces:	4299

Error Codes:

Error Code -103 reported for 4267 surfaces
Error Code -112 reported for 32 surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces:	6272
Number of Invalid Surfaces:	4299

Error Codes:

Error Code -103 reported for 4267 surfaces
Error Code -112 reported for 32 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.16071

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.75637	690.387	-28.1939	Sand & Silt	1	28	100.965	117.191	263.123	44.6008	218.523
2	4.75637	1968.56	-24.7246	Sand & Silt	1	28	201.912	234.361	633.811	194.923	438.888
3	4.75637	3049.68	-21.3499	Sand & Silt	1	28	264.546	307.061	899.32	323.702	575.618
4	4.75637	3988.46	-18.0516	Sand & Silt	1	28	306.377	355.615	1100.72	433.784	666.935
5	4.75637	4932.19	-14.8142	Sand & Silt	1	28	344.523	399.891	1289.43	539.221	750.205
6	4.75637	5829.16	-11.6247	Sand & Silt	1	28	374.955	435.214	1453.92	637.276	816.64
7	4.75637	6706.45	-8.47138	Sand & Silt	1	28	401.481	466.003	1604.42	729.876	874.542
8	4.75637	7718.77	-5.34384	Sand & Silt	1	28	456.492	529.855	1787.32	792.69	994.632
9	4.75637	8652.89	-2.23224	Sand & Silt	1	28	506.35	587.726	1941.12	837.65	1103.47
10	4.75637	9439.36	0.872765	Sand & Silt	1	28	543.821	631.218	2051.73	866.469	1185.27
11	4.75637	10078.5	3.98034	Sand & Silt	1	28	570.711	662.43	2123.15	879.176	1243.97
12	4.75637	10569.2	7.09974	Sand & Silt	1	28	588.418	682.983	2158.28	875.662	1282.62
13	4.75637	10909.2	10.2405	Sand & Silt	1	28	598.041	694.152	2159.3	855.663	1303.64
14	4.75637	11116.1	13.4128	Sand & Silt	1	28	602.373	699.18	2131.85	818.759	1313.09
15	4.75637	11259.2	16.6277	Sand & Silt	1	28	608.255	706.008	2090.27	764.347	1325.93
16	4.75637	11246.3	19.8976	Sand & Silt	1	28	608.368	706.139	2017.79	691.611	1326.18
17	4.75637	11056	23.2369	Sand & Silt	1	28	602.239	699.025	1912.27	599.476	1312.8
18	4.75637	10675.4	26.6622	Sand & Silt	1	28	590.358	685.234	1773.4	486.539	1286.86
19	3.86184	8250.88	29.8515	Lower Fill	40	33	717.028	832.262	1585.77	365.791	1219.98
20	3.86184	7743.21	32.8032	Lower Fill	40	33	692.814	804.156	1416.22	239.52	1176.7
21	3.86184	7124.28	35.8567	Lower Fill	40	33	667.317	774.561	1226.44	95.3168	1131.13
22	3.50111	5612.92	38.8786	Clay Fill	100	25	502.865	583.681	1037.26	0	1037.26
23	3.50111	4416.74	41.8801	Clay Fill	100	25	395.737	459.336	770.598	0	770.598
24	3.97654	3330.95	45.2575	Upper Fill	1	30	242.973	282.021	486.742	0	486.742
25	3.97654	1159.41	49.0817	Upper Fill	1	30	80.7587	93.7374	160.626	0	160.626

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.15735

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.54755	656.938	-29.1127	Sand & Silt	1	28	70.7846	81.9226	191.075	38.8817	152.193
2	4.54755	1877.27	-25.7105	Sand & Silt	1	28	156.377	180.983	527.04	188.542	338.498
3	4.54755	2918.12	-22.4033	Sand & Silt	1	28	233.918	270.725	824.958	317.679	507.279
4	4.54755	3792.97	-19.1733	Sand & Silt	1	28	298.611	345.597	1075.93	427.836	648.092
5	4.54755	4603.93	-16.0057	Sand & Silt	1	28	355.663	411.627	1298.64	526.364	772.277
6	4.54755	5397.17	-12.8877	Sand & Silt	1	28	406.18	470.093	1498.8	616.569	882.235
7	4.54755	6175.52	-9.80823	Sand & Silt	1	28	443.909	513.758	1670.51	706.153	964.357
8	4.54755	6932.08	-6.75719	Sand & Silt	1	28	473.364	547.848	1812.98	784.511	1028.47
9	4.54755	7818.8	-3.72534	Sand & Silt	1	28	522.749	605.004	1970.71	834.744	1135.97
10	4.54755	8604.31	-0.70393	Sand & Silt	1	28	556.648	644.236	2079.66	869.909	1209.75
11	4.54755	9258.85	2.31551	Sand & Silt	1	28	574.416	664.8	2138.53	890.099	1248.43
12	4.54755	9782.14	5.34143	Sand & Silt	1	28	579.734	670.955	2155.28	895.28	1260
13	4.54755	10172.8	8.38241	Sand & Silt	1	28	576.317	667.001	2137.86	885.291	1252.57
14	4.54755	10428.1	11.4474	Sand & Silt	1	28	567.508	656.805	2093.23	859.837	1233.39
15	4.54755	10556.6	14.5462	Sand & Silt	1	28	557.125	644.789	2029.27	818.474	1210.79
16	4.54755	10629.1	17.6891	Sand & Silt	1	28	553.654	640.772	1963.83	760.591	1203.24
17	4.54755	10567.8	20.8883	Sand & Silt	1	28	551.276	638.019	1883.43	685.377	1198.06
18	4.54755	10345.6	24.1575	Sand & Silt	1	28	548.816	635.172	1784.48	591.775	1192.7
19	4.54755	9950.66	27.5129	Sand & Silt	1	28	545.97	631.878	1664.93	478.42	1186.51
20	5.61986	11457.8	31.3996	Lower Fill	40	33	667.026	771.982	1451.68	324.528	1127.15
21	5.61986	10163.8	35.8869	Lower Fill	40	33	642.809	743.955	1204.52	120.525	1084
22	3.40632	5360.67	39.6573	Clay Fill	100	25	505.311	584.822	1039.7	0	1039.7
23	3.40632	4265.52	42.6626	Clay Fill	100	25	408.938	473.284	800.511	0	800.511
24	3.92373	3278.8	46.0768	Upper Fill	1	30	263.22	304.638	525.916	0	525.916
25	3.92373	1163.16	49.9789	Upper Fill	1	30	91.4365	105.824	181.56	0	181.56

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.16071

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-105.454	472.166	0	0	0
2	-100.698	469.616	1062.7	312.552	16.3892
3	-95.9417	467.426	3157.99	928.799	16.3892
4	-91.1854	465.567	5695.36	1675.07	16.3892
5	-86.429	464.017	8344.48	2454.2	16.3892
6	-81.6726	462.759	10968.6	3225.98	16.3892
7	-76.9162	461.78	13421.8	3947.51	16.3892
8	-72.1599	461.072	15601.5	4588.58	16.3892
9	-67.4035	460.627	17570.6	5167.7	16.3892
10	-62.6471	460.442	19220.7	5653.03	16.3892
11	-57.8907	460.514	20438.8	6011.27	16.3892
12	-53.1344	460.845	21148	6219.86	16.3892
13	-48.378	461.438	21302	6265.15	16.3892
14	-43.6216	462.297	20880.8	6141.28	16.3892
15	-38.8652	463.431	19890.8	5850.11	16.3892
16	-34.1089	464.851	18359.2	5399.64	16.3892
17	-29.3525	466.573	16325.2	4801.4	16.3891
18	-24.5961	468.615	13855.1	4074.94	16.3892
19	-19.8397	471.004	11047.8	3249.26	16.3891
20	-15.9779	473.22	9237.39	2716.81	16.3891
21	-12.1161	475.709	7388.7	2173.1	16.3892
22	-8.25422	478.5	5623.75	1654	16.3891
23	-4.75311	481.323	3731.52	1097.48	16.3892
24	-1.25201	484.462	2127.69	625.778	16.3892
25	2.72454	488.475	710.535	208.976	16.3892
26	6.70108	493.062	0	0	0

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.15735

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-107.759	472.229	0	0	0
2	-103.211	469.697	720.995	32.3931	2.57247
3	-98.6639	467.507	2343.45	208.873	5.09335
4	-94.1163	465.633	4576.39	603.591	7.51351
5	-89.5688	464.051	7145.15	1232.7	9.78846
6	-85.0212	462.747	9861.15	2074.44	11.8798
7	-80.4737	461.706	12569.7	3077.14	13.7558
8	-75.9261	460.92	15102.7	4157.65	15.3918
9	-71.3785	460.381	17335.1	5223.57	16.7691
10	-66.831	460.085	19283.9	6218.97	17.8743
11	-62.2834	460.029	20817.8	7045.76	18.6983
12	-57.7359	460.213	21838	7620.03	19.2356
13	-53.1883	460.638	22291.3	7886.21	19.4827
14	-48.6408	461.309	22162.1	7821.16	19.4383
15	-44.0932	462.229	21464.5	7433.84	19.1026
16	-39.5457	463.409	20236	6762.03	18.4775
17	-34.9981	464.86	18528.5	5865.85	17.567
18	-30.4506	466.595	16397.8	4819.21	16.3777
19	-25.903	468.635	13913.6	3707.33	14.92
20	-21.3554	471.004	11163.9	2620.26	13.2087
21	-15.7356	474.434	8450.4	1608.08	10.7744
22	-10.1157	478.5	5850.71	826.071	8.03656
23	-6.7094	481.324	3942.53	432.306	6.25759
24	-3.30308	484.463	2270.71	175.11	4.40974
25	0.620652	488.537	736.613	28.5746	2.2215
26	4.54439	493.21	0	0	0

List Of Coordinates

Water Table

X	Y
-250	471.47
-162.22	471.12
-89.2	471.72
-81.54	472.18
-74.04	473.19
0	479.5
30.13	484.45
250	484.45

External Boundary

X	Y
-8.63	493.19
-9.48	492.66
-34.6222	484.475
-41.61	482.2
-54.9275	478.5
-74.04	473.19
-81.54	472.18
-85.3128	471.953
-89.2	471.72
-113.25	472.38
-147.31	472
-162.22	471.12
-183.37	471.47
-250	471.47
-250	400
250	400
250	410
250	411.16
250	484.45
30.13	484.45
14.93	492.5
0	493.52

Material Boundary

X	Y
30.13	484.45
42.0276	478.5
57.0175	471.004
179	410
250	410

Material Boundary

X	Y
-34.6222	484.475
30.13	484.45

Material Boundary

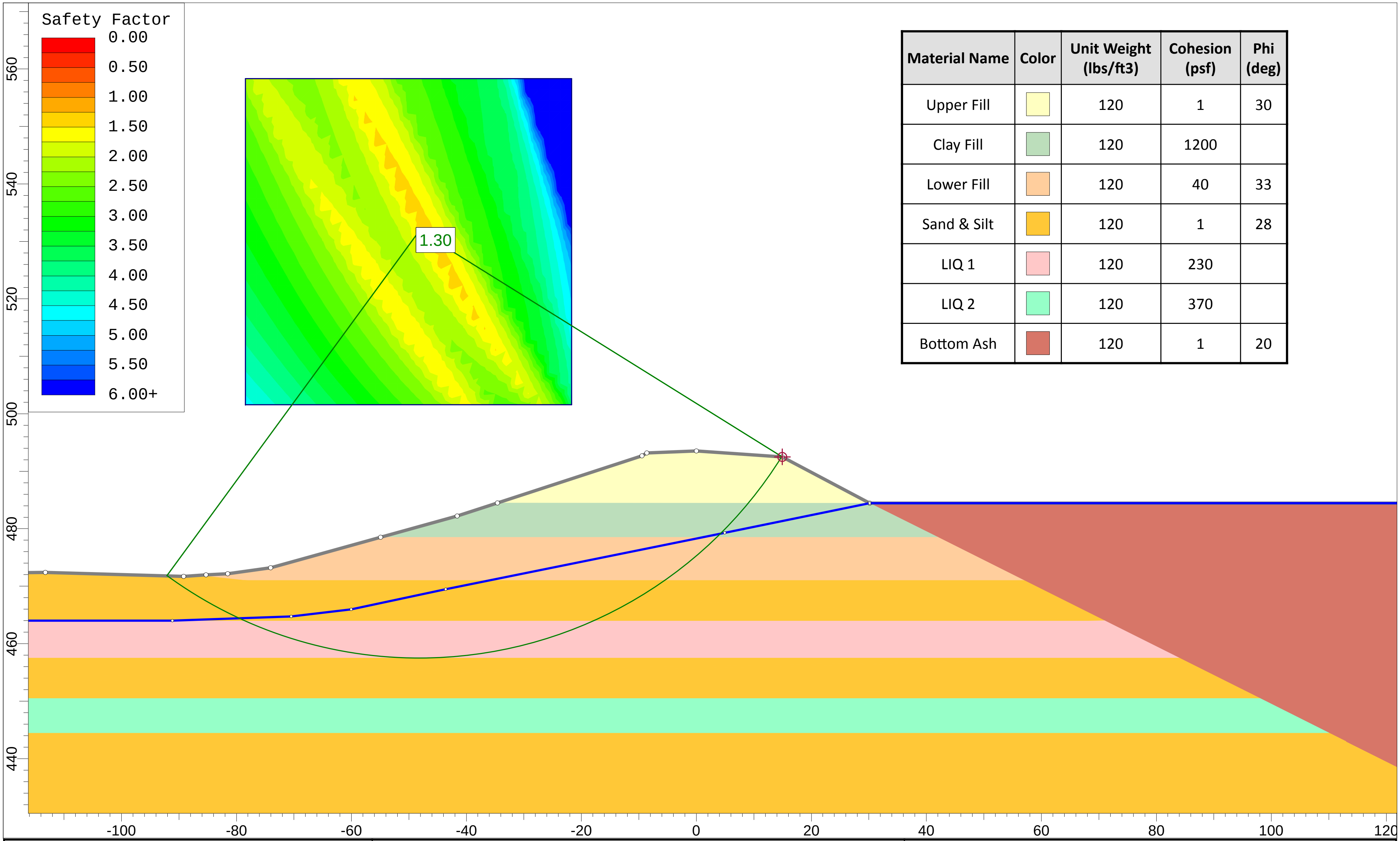
X	Y
-54.9275	478.5
42.0276	478.5

Material Boundary

X	Y
-84.9558	471.72
-78.55	471.004
57.0175	471.004

Material Boundary

X	Y
-85.3128	471.953
-84.9558	471.72



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	120	1	30
Clay Fill	🟩	120	1200	
Lower Fill	🟧	120	40	33
Sand & Silt	🟧	120	1	28
LIQ 1	🟥	120	230	
LIQ 2	🟩	120	370	
Bottom Ash	🟥	120	1	20

REITZ & JENS, INC.
CONSULTING ENGINEERS

Project Name: Periodic Safety Factor Assessment

Client: Ameren - Labadie Energy Center

Section Location: Section 4 - Bottom Ash Pond

Load Case: Liquefaction

File Path/Name: P:\Amerenue\2015012432\Labadie\calc\xsect_4\xsect_4 POST EQ.sli

Project Number: 2015012432

Analysis By: J. Bertel

Checked By: J. Gilliam

Figure:

Slide Analysis Information

Periodic Safety Factor Assessment

Project Summary

File Name:	xsect_4 POST EQ
Slide Modeler Version:	6.035
Project Title:	Periodic Safety Factor Assessment
Analysis:	Liquefaction
Author:	J. Bertel
Company:	Ameren - Labadie Energy Center

Comments

2015012432
Section 4 - Bottom Ash Pond
J. Gilliam

General Settings

Units of Measurement:	Imperial Units
Time Units:	seconds
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type: Vertical

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function:	Half Sine
	Spencer

Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Grid Search
Radius Increment:	10
Composite Surfaces:	Disabled
Reverse Curvature:	Create Tension Crack
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Material Properties

Property	Upper Fill	Clay Fill	Lower Fill	Sand & Silt	LIQ 1	LIQ 2	Bottom Ash
Color	🟨	🟩	🟧	🟨	🟥	🟩	🟥
Strength Type	Mohr-Coulomb	Undrained	Mohr-Coulomb	Mohr-Coulomb	Undrained	Undrained	Mohr-Coulomb
Unit Weight [lbs/ft3]	120	120	120	120	120	120	120
Cohesion [psf]	1		40	1			1
Friction Angle [deg]	30		33	28			20
Cohesion Type		1200			230	370	
Water Surface	Water Table	None	Water Table	Water Table	None	None	Water Table
Hu Value	1		1	1			1
Ru Value		0			0	0	

Global Minimums

Method: spencer

FS	1.295320
Center:	-48.199, 531.825
Radius:	74.376
Left Slip Surface Endpoint:	-92.116, 471.800
Right Slip Surface Endpoint:	14.930, 492.500
Resisting Moment:	4.27055e+006 lb-ft
Driving Moment:	3.29692e+006 lb-ft
Resisting Horizontal Force:	48058.8 lb
Driving Horizontal Force:	37101.9 lb
Total Slice Area:	1902.08 ft2

Method: gle/morgenstern-price

FS	1.292080
Center:	-48.199, 531.825
Radius:	74.376
Left Slip Surface Endpoint:	-92.116, 471.800
Right Slip Surface Endpoint:	14.930, 492.500
Resisting Moment:	4.25988e+006 lb-ft
Driving Moment:	3.29692e+006 lb-ft
Resisting Horizontal Force:	47910.4 lb
Driving Horizontal Force:	37080.1 lb
Total Slice Area:	1902.08 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	961
Number of Invalid Surfaces:	0

Method: gle/morgenstern-price

Number of Valid Surfaces:	961
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.29532

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.46572	790.292	-34.1126	Sand & Silt	1	28	110.259	142.821	266.727	0	266.727
2	4.46572	2392.03	-30.047	Sand & Silt	1	28	310.176	401.777	753.753	0	753.753
3	4.46572	3850.83	-26.143	Sand & Silt	1	28	471.844	611.189	1147.6	0	1147.6
4	3.9695	4597.74	-22.5705	LIQ 1	230	0	177.562	230	1268.59	0	1268.59
5	3.9695	5667.63	-19.2943	LIQ 1	230	0	177.562	230	1526.83	0	1526.83
6	3.9695	6792.19	-16.0827	LIQ 1	230	0	177.562	230	1798.32	0	1798.32
7	3.9695	7807.01	-12.9224	LIQ 1	230	0	177.562	230	2040.92	0	2040.92
8	3.9695	8712.58	-9.80166	LIQ 1	230	0	177.562	230	2254.91	0	2254.91
9	3.9695	9512.47	-6.71015	LIQ 1	230	0	177.562	230	2441.33	0	2441.33
10	3.9695	10209.1	-3.63822	LIQ 1	230	0	177.562	230	2600.94	0	2600.94
11	5.46631	15001.4	0	LIQ 1	230	0	177.562	230	2753.52	0	2753.52
12	3.9695	11457.9	3.63822	LIQ 1	230	0	177.562	230	2874.93	0	2874.93
13	3.9695	11859.6	6.71015	LIQ 1	230	0	177.562	230	2957.96	0	2957.96
14	3.9695	12200.6	9.80166	LIQ 1	230	0	177.562	230	3025.05	0	3025.05
15	3.9695	12435.9	12.9224	LIQ 1	230	0	177.562	230	3064.91	0	3064.91
16	3.9695	12562	16.0827	LIQ 1	230	0	177.562	230	3076.72	0	3076.72
17	3.9695	12574	19.2943	LIQ 1	230	0	177.562	230	3059.26	0	3059.26
18	3.9695	12465.6	22.5705	LIQ 1	230	0	177.562	230	3010.99	0	3010.99
19	4.09576	12611.4	25.9818	Sand & Silt	1	28	829.324	1074.24	2650.6	632.128	2018.47
20	4.09576	12205.6	29.5508	Sand & Silt	1	28	799.308	1035.36	2494.55	549.213	1945.34
21	4.09576	11560.9	33.2514	Sand & Silt	1	28	757.086	980.668	2287.28	444.789	1842.49
22	4.52014	11213.5	37.3283	Lower Fill	40	33	798.801	1034.7	1839.66	307.952	1531.71
23	4.52014	9189.05	41.8566	Lower Fill	40	33	668.432	865.833	1402.91	131.241	1271.67
24	5.49445	7650.93	47.3181	Clay Fill	1200	0	926.412	1200	411.219	0	411.219
25	5.78712	2929.66	54.2606	Upper Fill	1	30	135.711	175.789	302.743	0	302.743

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.29208

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.46572	790.292	-34.1126	Sand & Silt	1	28	103.357	133.545	249.281	0	249.281
2	4.46572	2392.03	-30.047	Sand & Silt	1	28	297.953	384.979	722.159	0	722.159
3	4.46572	3850.83	-26.143	Sand & Silt	1	28	462.528	597.623	1122.08	0	1122.08
4	3.9695	4597.74	-22.5705	LIQ 1	230	0	178.008	230	1269.4	0	1269.4
5	3.9695	5667.63	-19.2943	LIQ 1	230	0	178.008	230	1535.54	0	1535.54
6	3.9695	6792.19	-16.0827	LIQ 1	230	0	178.008	230	1813.97	0	1813.97
7	3.9695	7807.01	-12.9224	LIQ 1	230	0	178.008	230	2061.84	0	2061.84
8	3.9695	8712.58	-9.80166	LIQ 1	230	0	178.008	230	2278.7	0	2278.7
9	3.9695	9512.47	-6.71015	LIQ 1	230	0	178.008	230	2465.26	0	2465.26
10	3.9695	10209.1	-3.63822	LIQ 1	230	0	178.008	230	2622.29	0	2622.29
11	5.46631	15001.4	0	LIQ 1	230	0	178.008	230	2768.78	0	2768.78
12	3.9695	11457.9	3.63822	LIQ 1	230	0	178.008	230	2881.92	0	2881.92
13	3.9695	11859.6	6.71015	LIQ 1	230	0	178.008	230	2957.18	0	2957.18
14	3.9695	12200.6	9.80166	LIQ 1	230	0	178.008	230	3016.78	0	3016.78
15	3.9695	12435.9	12.9224	LIQ 1	230	0	178.008	230	3050.43	0	3050.43
16	3.9695	12562	16.0827	LIQ 1	230	0	178.008	230	3058.23	0	3058.23
17	3.9695	12574	19.2943	LIQ 1	230	0	178.008	230	3039.93	0	3039.93
18	3.9695	12465.6	22.5705	LIQ 1	230	0	178.008	230	2994.73	0	2994.73
19	4.09576	12611.4	25.9818	Sand & Silt	1	28	827.162	1068.76	2640.31	632.128	2008.18
20	4.09576	12205.6	29.5508	Sand & Silt	1	28	798.681	1031.96	2488.16	549.213	1938.95
21	4.09576	11560.9	33.2514	Sand & Silt	1	28	758.988	980.673	2287.28	444.789	1842.49
22	4.52014	11213.5	37.3283	Lower Fill	40	33	802.977	1037.51	1843.99	307.952	1536.04
23	4.52014	9189.05	41.8566	Lower Fill	40	33	675.102	872.286	1412.85	131.241	1281.61
24	5.49445	7650.93	47.3181	Clay Fill	1200	0	928.735	1200	392.43	0	392.43
25	5.78712	2929.66	54.2606	Upper Fill	1	30	139.145	179.786	309.667	0	309.667

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.29532

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-92.1156	471.8	0	0	0
2	-87.6499	468.775	1299.88	67.1612	2.95768
3	-83.1842	466.192	4633.96	239.424	2.95769
4	-78.7185	464	9259.3	478.402	2.95768
5	-74.749	462.35	12058.2	623.012	2.95768
6	-70.7795	460.96	14885.7	769.103	2.95768
7	-66.81	459.816	17649.6	911.903	2.95767
8	-62.8405	458.905	20214.2	1044.41	2.95768
9	-58.871	458.219	22466.3	1160.77	2.95768
10	-54.9015	457.752	24312.2	1256.14	2.95767
11	-50.932	457.5	25674.5	1326.53	2.95768
12	-45.4656	457.5	26646.4	1376.74	2.95767
13	-41.4961	457.752	26626.5	1375.72	2.95769
14	-37.5266	458.219	25950.8	1340.81	2.95769
15	-33.5571	458.905	24582.1	1270.09	2.95769
16	-29.5876	459.816	22496.5	1162.33	2.95768
17	-25.6181	460.96	19681.1	1016.87	2.95769
18	-21.6486	462.35	16135.6	833.678	2.95767
19	-17.6791	464	11873.4	613.463	2.95767
20	-13.5834	465.996	9983.96	515.842	2.95768
21	-9.48761	468.318	7469.56	385.931	2.95768
22	-5.39184	471.004	4432.18	228.998	2.95768
23	-0.871707	474.45	1706.47	88.1682	2.95767
24	3.64843	478.5	-949.204	-49.0427	2.95768
25	9.14288	484.458	1697.65	87.7126	2.95768
26	14.93	492.5	0	0	0

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.29208

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-92.1156	471.8	0	0	0
2	-87.6499	468.775	1215.78	10.1694	0.47924
3	-83.1842	466.192	4412.28	73.1797	0.95019
4	-78.7185	464	8938	219.177	1.40472
5	-74.749	462.35	11739.3	366.59	1.78863
6	-70.7795	460.96	14580	546.895	2.14815
7	-66.81	459.816	17362.8	751.527	2.47843
8	-62.8405	458.905	19947.5	966.87	2.775
9	-58.871	458.219	22217	1177.52	3.03389
10	-54.9015	457.752	24075.2	1367.76	3.25159
11	-50.932	457.5	25443.9	1522.9	3.42525
12	-45.4656	457.5	26417.3	1656.54	3.58813
13	-41.4961	457.752	26396.8	1683.38	3.64893
14	-37.5266	458.219	25722.5	1645.55	3.6604
15	-33.5571	458.905	24360.6	1542.19	3.62237
16	-29.5876	459.816	22289.2	1377.07	3.53535
17	-25.6181	460.96	19496.1	1158.46	3.40052
18	-21.6486	462.35	15978.5	898.827	3.21962
19	-17.6791	464	11744.2	614.481	2.9951
20	-13.5834	465.996	9863.11	468.736	2.72089
21	-9.48761	468.318	7357.76	309.322	2.40731
22	-5.39184	471.004	4325.09	155.485	2.05887
23	-0.871707	474.45	1599.79	45.8013	1.63991
24	3.64843	478.5	-1068.94	-22.2408	1.19195
25	9.14288	484.458	1697.59	18.3652	0.619824
26	14.93	492.5	0	0	0

List Of Coordinates

Water Table

X	Y
-250	464
-146.396	464
-91.1625	464
-70.49	464.736
-60.057	465.983
-43.627	469.453
4.923	479.295
30.13	484.45
250	484.45

External Boundary

X	Y
-8.63	493.19
-9.48	492.66
-34.6222	484.475
-41.61	482.2
-54.9275	478.5
-74.04	473.19
-81.54	472.18
-85.3128	471.953
-89.2	471.72
-113.25	472.38
-147.31	472
-162.22	471.12
-183.37	471.47
-250	471.47
-250	464
-250	458
-250	457.5
-250	452
-250	450.5
-250	450
-250	445
-250	444.5
-250	443
-250	400
250	400
250	410
250	411.16
250	484.45
30.13	484.45
14.93	492.5
0	493.52

Material Boundary

X	Y
30.13	484.45
42.0276	478.5
57.0175	471.004
71.0218	464
83.0193	458
84.0191	457.5
95.0169	452
98.0163	450.5
99.0161	450
109.014	445
110.014	444.5
113.013	443
179	410
250	410

Material Boundary

X	Y
-34.6222	484.475
30.13	484.45

Material Boundary

X	Y
-54.9275	478.5
42.0276	478.5

Material Boundary

X	Y
-84.9558	471.72
-78.55	471.004
57.0175	471.004

Material Boundary

X	Y
-85.3128	471.953
-84.9558	471.72

Material Boundary

X	Y
-250	464
71.0218	464

Material Boundary

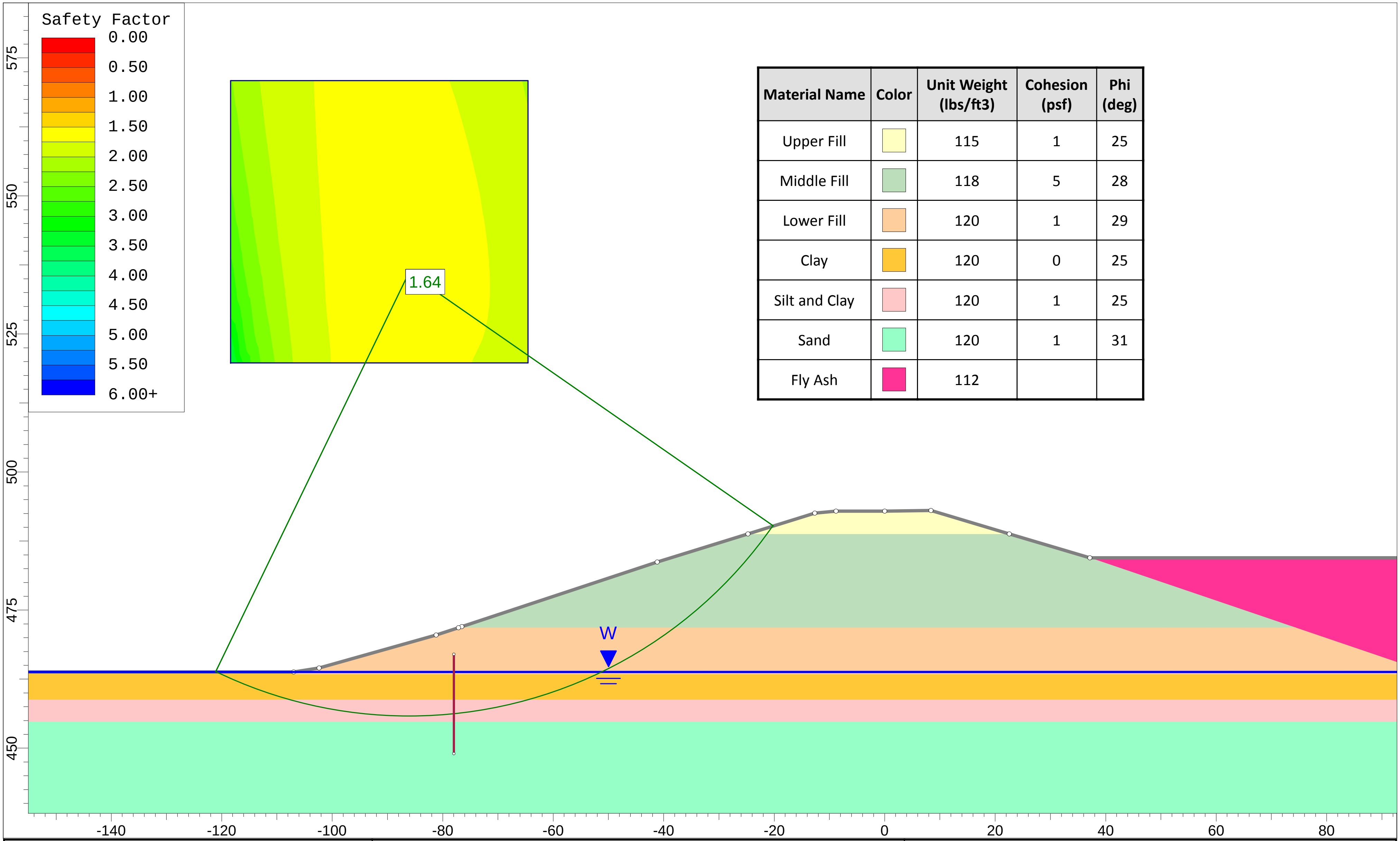
X	Y
-250	457.5
84.0191	457.5

Material Boundary

X	Y
-250	450.5
98.0163	450.5

Material Boundary

X	Y
-250	444.5
110.014	444.5



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	115	1	25
Middle Fill	🟩	118	5	28
Lower Fill	🟧	120	1	29
Clay	🟧	120	0	25
Silt and Clay	🟥	120	1	25
Sand	🟩	120	1	31
Fly Ash	🟪	112		

REITZ & JENS, INC.
CONSULTING ENGINEERS

Project Name: Periodic Safety Factor Assessment

Client: Ameren - Labadie Energy Center

Section Location: Section 2 - Fly Ash Pond

Load Case: Static, Maxium Storage Pool

File Path/Name: P:\Amerenue\2015012432\Labadie\calc\xsect_2\xsect_2.sli

Project Number: 2015012432

Analysis By: J. Bertel

Checked By: J. Gilliam

Figure:

Slide Analysis Information

Periodic Safety Factor Assessment

Project Summary

File Name:	xsect_2
Slide Modeler Version:	6.035
Project Title:	Periodic Safety Factor Assessment
Analysis:	Static, Maxium Storage Pool
Author:	J. Bertel
Company:	Ameren - Labadie Energy Center
	Comments
	2015012432
	Section 2 - Fly Ash Pond
	J. Gilliam

General Settings

Units of Measurement:	Imperial Units
Time Units:	seconds
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
GLE/Morgenstern-Price with interslice force function:	Half Sine
	Spencer
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]: 62.4
Use negative pore pressure cutoff: Yes
Maximum negative pore pressure [psf]: 0
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Material Properties

Property	Upper Fill	Middle Fill	Lower Fill	Clay	Silt and Clay	Sand	Fly Ash
Color	🟨	🟩	🟧	🟨	🟥	🟩	🟪
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	No strength
Unit Weight [lbs/ft3]	115	118	120	120	120	120	112
Cohesion [psf]	1	5	1	0	1	1	
Friction Angle [deg]	25	28	29	25	25	31	
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	None
Hu Value	1	1	1	1	1	1	
Ru Value							0

Global Minimums

Method: spencer

FS	**1.637960**
Center:	-86.107, 536.093
Radius:	80.329
Left Slip Surface Endpoint:	-121.127, 463.800
Right Slip Surface Endpoint:	-20.165, 490.218
Resisting Moment:	4.43418e+006 lb-ft
Driving Moment:	2.70714e+006 lb-ft
Resisting Horizontal Force:	50291.7 lb
Driving Horizontal Force:	30703.9 lb
Total Slice Area:	1136.85 ft2

Method: gle/morgenstern-price

FS	**1.637650**
Center:	-86.107, 546.319
Radius:	90.487
Left Slip Surface Endpoint:	-123.234, 463.800
Right Slip Surface Endpoint:	-13.533, 492.273
Resisting Moment:	5.57784e+006 lb-ft
Driving Moment:	3.40601e+006 lb-ft
Resisting Horizontal Force:	56380.3 lb
Driving Horizontal Force:	34427.6 lb
Total Slice Area:	1258.43 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 7436
Number of Invalid Surfaces: 0

Method: gle/morgenstern-price

Number of Valid Surfaces: 7436
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.63796

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.3819	516.165	-24.134	Clay	0	25	25.9356	42.4814	152.355	61.2532	91.1017
2	4.3819	1468.81	-20.75	Clay	0	25	69.1201	113.216	417.096	174.303	242.793
3	4.3819	2267.21	-17.4404	Clay	0	25	100.468	164.563	621.957	269.05	352.907
4	3.97726	2710.54	-14.338	Silt and Clay	1	25	129.759	212.54	797.366	343.718	453.648
5	3.97726	3466.88	-11.4265	Silt and Clay	1	25	171.012	280.111	999.072	400.517	598.555
6	3.97726	4314.45	-8.54481	Silt and Clay	1	25	221.182	362.288	1219.03	444.242	774.785
7	3.97726	5085.19	-5.68475	Silt and Clay	1	25	265.796	435.364	1406.74	475.239	931.497
8	3.97726	5760.39	-2.83887	Silt and Clay	1	25	303.943	497.846	1559.23	493.745	1065.49
9	3.97726	6341.11	0	Silt and Clay	1	25	336.318	550.876	1679.11	499.899	1179.21
10	3.97726	6830.94	2.83887	Silt and Clay	1	25	363.726	595.768	1769.23	493.745	1275.49
11	3.97726	7291.81	5.68475	Silt and Clay	1	25	391.141	640.674	1847.03	475.239	1371.79
12	3.97726	7675.87	8.54481	Silt and Clay	1	25	415.232	680.134	1900.65	444.242	1456.41
13	3.97726	7959.59	11.4265	Silt and Clay	1	25	434.71	712.037	1925.34	400.517	1524.82
14	3.97726	8143.31	14.338	Silt and Clay	1	25	450.056	737.174	1922.45	343.718	1578.73
15	4.0314	8335.22	17.3082	Clay	0	25	460.942	755.004	1891.92	272.804	1619.11
16	4.0314	8304.81	20.3479	Clay	0	25	468.703	767.717	1833.34	186.961	1646.37
17	4.0314	8155.3	23.4489	Clay	0	25	472.781	774.396	1746.46	85.7571	1660.7
18	4.72943	9199.65	26.908	Lower Fill	1	29	542.74	888.987	1601.97	0	1601.97
19	4.72943	8593.78	30.763	Lower Fill	1	29	486.317	796.567	1435.24	0	1435.24
20	4.72943	7723.89	34.7802	Lower Fill	1	29	417.875	684.463	1233	0	1233
21	4.19354	5876.04	38.7523	Middle Fill	5	28	332.248	544.209	1014.1	0	1014.1
22	4.19354	4728.58	42.706	Middle Fill	5	28	255.269	418.121	776.969	0	776.969
23	4.19354	3303.91	46.9322	Middle Fill	5	28	169.483	277.607	512.699	0	512.699
24	4.19354	1525.28	51.5275	Middle Fill	5	28	74.5342	122.084	220.203	0	220.203
25	1.00967	64.1768	54.553	Upper Fill	1	25	10.6796	17.4927	35.3686	0	35.3686

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.63765

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.7146	555.334	-22.6069	Clay	0	25	19.274	31.5641	128.94	61.2509	67.6896
2	4.7146	1580.51	-19.4071	Clay	0	25	56.9609	93.282	374.367	174.323	200.044
3	4.7146	2439.55	-16.2692	Clay	0	25	90.5596	148.305	587.113	269.072	318.041
4	4.17878	2795.66	-13.3543	Silt and Clay	1	25	120.947	198.069	765.566	342.95	422.616
5	4.17878	3540.27	-10.6481	Silt and Clay	1	25	163.868	268.359	971.769	398.414	573.355
6	4.17878	4423.15	-7.96577	Silt and Clay	1	25	219.408	359.313	1209.58	441.171	768.404
7	4.17878	5256.08	-5.30096	Silt and Clay	1	25	271.584	444.759	1423.16	471.512	951.645
8	4.17878	5990.84	-2.64764	Silt and Clay	1	25	315.958	517.428	1597.12	489.638	1107.48
9	4.17878	6628.4	0	Silt and Clay	1	25	352.456	577.199	1731.33	495.667	1235.66
10	4.17878	7174.45	2.64764	Silt and Clay	1	25	381.81	625.271	1828.39	489.638	1338.75
11	4.17878	7697.85	5.30096	Silt and Clay	1	25	409.54	670.683	1907.65	471.512	1436.14
12	4.17878	8138.84	7.96577	Silt and Clay	1	25	432.08	707.596	1956.47	441.171	1515.3
13	4.17878	8477.62	10.6481	Silt and Clay	1	25	449.126	735.511	1973.58	398.414	1575.17
14	4.17878	8714.3	13.3543	Silt and Clay	1	25	461.873	756.386	1962.88	342.95	1619.93
15	4.3373	9181.67	16.1439	Clay	0	25	470.789	770.988	1926.22	272.829	1653.39
16	4.3373	9200.85	19.0262	Clay	0	25	477.854	782.558	1865.19	186.992	1678.2
17	4.3373	9091.64	21.9597	Clay	0	25	482.862	790.759	1781.55	85.7636	1695.79
18	5.11147	10383.1	25.2297	Lower Fill	1	29	558.861	915.219	1649.3	0	1649.3
19	5.11147	9799.15	28.8671	Lower Fill	1	29	507.463	831.046	1497.44	0	1497.44
20	5.11147	8904.68	32.6374	Lower Fill	1	29	445.708	729.913	1314.99	0	1314.99
21	4.63073	7050.24	36.3808	Middle Fill	5	28	367.817	602.355	1123.46	0	1123.46
22	4.63073	5836.03	40.1197	Middle Fill	5	28	298.712	489.186	910.621	0	910.621
23	4.63073	4321.89	44.0785	Middle Fill	5	28	218.175	357.295	662.569	0	662.569
24	4.63073	2439.88	48.3252	Middle Fill	5	28	122.383	200.42	367.532	0	367.532
25	2.7206	411.452	51.9277	Upper Fill	1	25	31.4809	51.5547	108.415	0	108.415

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.63796

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-121.127	463.8	0	0	0
2	-116.745	461.837	412.722	103.756	14.1114
3	-112.363	460.177	1407.95	353.951	14.1114
4	-107.982	458.8	2704.24	679.831	14.1114
5	-104.004	457.783	4030.77	1013.31	14.1114
6	-100.027	456.98	5513.85	1386.15	14.1114
7	-96.0498	456.382	7121.76	1790.37	14.1114
8	-92.0725	455.986	8735.52	2196.06	14.1114
9	-88.0952	455.789	10251.5	2577.17	14.1114
10	-84.118	455.789	11588.7	2913.34	14.1114
11	-80.1407	455.986	12686	3189.19	14.1114
12	-76.1634	456.382	13509.9	3396.32	14.1114
13	-72.1862	456.98	14025.1	3525.83	14.1114
14	-68.2089	457.783	14205.8	3571.26	14.1114
15	-64.2317	458.8	14040.9	3529.8	14.1114
16	-60.2003	460.056	13521.8	3399.3	14.1114
17	-56.1689	461.551	12669.7	3185.09	14.1114
18	-52.1375	463.3	11521.2	2896.37	14.1114
19	-47.408	465.7	10242.2	2574.83	14.1114
20	-42.6786	468.515	8501.06	2137.12	14.1114
21	-37.9492	471.8	6426.83	1615.67	14.1114
22	-33.7556	475.166	4406.28	1107.71	14.1114
23	-29.5621	479.036	2469.18	620.739	14.1114
24	-25.3686	483.523	879.547	221.113	14.1114
25	-21.175	488.8	29.96	7.53178	14.1114
26	-20.1654	490.218	0	0	0

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.63765

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-123.234	463.8	0	0	0
2	-118.519	461.837	343.975	14.7302	2.45211
3	-113.805	460.176	1234.24	104.747	4.85093
4	-109.09	458.8	2468.88	309.516	7.14572
5	-104.911	457.808	3733.59	595.053	9.05554
6	-100.732	457.022	5181.64	990.264	10.8193
7	-96.5536	456.438	6805.53	1497.95	12.4133
8	-92.3748	456.05	8491.88	2088.64	13.818
9	-88.196	455.857	10120.4	2715.2	15.0182
10	-84.0172	455.857	11592.8	3324.62	16.002
11	-79.8384	456.05	12834.6	3865.43	16.7609
12	-75.6596	456.438	13805.8	4297.14	17.2891
13	-71.4809	457.022	14466.8	4584.35	17.5828
14	-67.3021	457.808	14792.5	4703.79	17.6399
15	-63.1233	458.8	14774.8	4647.19	17.4602
16	-58.786	460.055	14397.8	4408.56	17.0244
17	-54.4487	461.551	13680.1	4010.18	16.338
18	-50.1114	463.3	12658.1	3488.16	15.4065
19	-44.9999	465.709	11541.6	2878.82	14.0055
20	-39.8885	468.526	9915.1	2161.09	12.2959
21	-34.777	471.8	7887.85	1434.22	10.3053
22	-30.1463	475.212	5757.72	838.963	8.29028
23	-25.5155	479.114	3587.18	383.961	6.10951
24	-20.8848	483.598	1626.15	108.112	3.80362
25	-16.2541	488.8	280.8	6.95312	1.41846
26	-13.5335	492.273	0	0	0

List Of Coordinates

Water Table

X	Y
-250	463.8
150	463.8

Focus Search Line

X	Y
-78	449
-78	467

External Boundary

X	Y
-8.81	492.89
-12.64	492.55
-24.7427	488.8
-41.17	483.71
-76.5298	472
-77.1337	471.8
-81.18	470.46
-102.38	464.5
-107	463.8
-250	463.8
-250	458.8
-250	454.8
-250	400
150	400
150	454.8
150	458.8
150	460
150	484.45
37.12	484.45
22.5371	488.8
8.39	493.02
0	492.9

Material Boundary

X	Y
37.12	484.45
73.7826	472
74.3715	471.8
97.9298	463.8
99.4022	463.3
109.12	460
150	460

Material Boundary

X	Y
-24.7427	488.8
22.5371	488.8

Material Boundary

X	Y
-77.1337	471.8
74.3715	471.8

Material Boundary

X	Y
-107	463.3
-107	463.8

Material Boundary

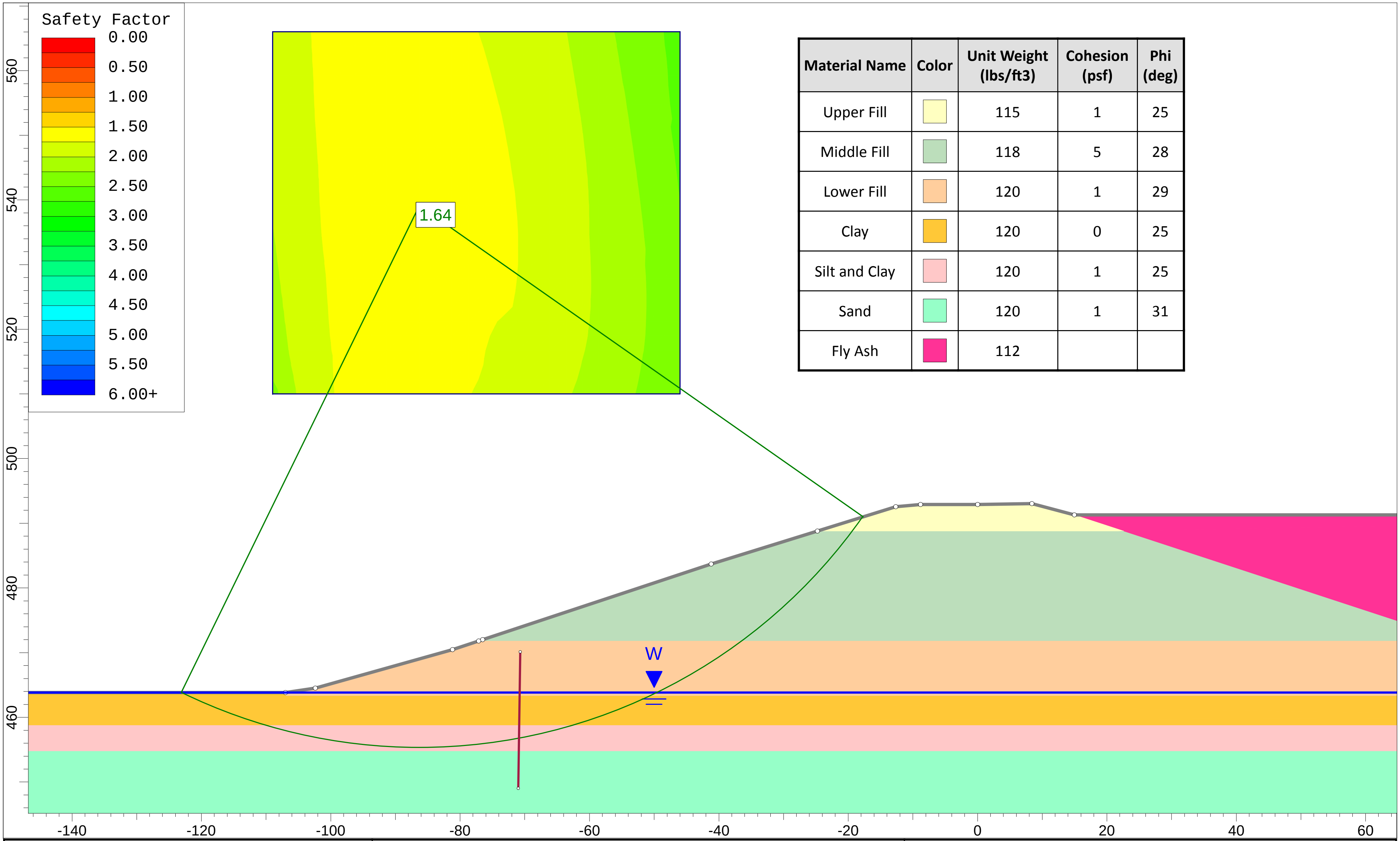
X	Y
-107	463.3
99.4022	463.3

Material Boundary

X	Y
-250	458.8
150	458.8

Material Boundary

X	Y
-250	454.8
150	454.8



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	115	1	25
Middle Fill	🟩	118	5	28
Lower Fill	🟧	120	1	29
Clay	🟧	120	0	25
Silt and Clay	🟥	120	1	25
Sand	🟩	120	1	31
Fly Ash	🟪	112		

REITZ & JENS, INC.
CONSULTING ENGINEERS

Project Name: Periodic Safety Factor Assessment	Client: Ameren - Labadie Energy Center
Section Location: Section 2 - Fly Ash Pond	Load Case: Static, Maxium Surcharge Pool

File Path/Name: P:\Amerenue\2015012432\Labadie\calc\xsect_2\max. xsect_2.sli

Project Number: 2015012432	Analysis By: J. Bertel	Checked By: J. Gilliam	Figure:

Slide Analysis Information

Periodic Safety Factor Assessment

Project Summary

File Name:	max. xsect_2
Slide Modeler Version:	6.035
Project Title:	Periodic Safety Factor Assessment
Analysis:	Static, Maxium Surcharge Pool
Author:	J. Bertel
Company:	Ameren - Labadie Energy Center

Comments

2015012432
Section 2 - Fly Ash Pond
J. Gilliam

General Settings

Units of Measurement:	Imperial Units
Time Units:	seconds
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function:	Half Sine
	Spencer

Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]: 62.4
Use negative pore pressure cutoff: Yes
Maximum negative pore pressure [psf]: 0
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Material Properties

Property	Upper Fill	Middle Fill	Lower Fill	Clay	Silt and Clay	Sand	Fly Ash
Color	🟨	🟩	🟧	🟨	🟥	🟩	🟪
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	No strength
Unit Weight [lbs/ft3]	115	118	120	120	120	120	112
Cohesion [psf]	1	5	1	0	1	1	
Friction Angle [deg]	25	28	29	25	25	31	
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	None
Hu Value	1	1	1	1	1	1	
Ru Value							0

Global Minimums

Method: spencer

FS	1.637240
Center:	-86.320, 539.120
Radius:	83.833
Left Slip Surface Endpoint:	-123.129, 463.800
Right Slip Surface Endpoint:	-17.681, 490.988
Resisting Moment:	4.94721e+006 lb-ft
Driving Moment:	3.02169e+006 lb-ft
Resisting Horizontal Force:	53775.6 lb
Driving Horizontal Force:	32845.3 lb
Total Slice Area:	1225.33 ft2

Method: gle/morgenstern-price

FS	1.637730
Center:	-86.320, 543.600
Radius:	88.139
Left Slip Surface Endpoint:	-123.744, 463.800
Right Slip Surface Endpoint:	-14.993, 491.821
Resisting Moment:	5.39866e+006 lb-ft
Driving Moment:	3.29642e+006 lb-ft
Resisting Horizontal Force:	55893.9 lb
Driving Horizontal Force:	34128.8 lb
Total Slice Area:	1262.8 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	7436
Number of Invalid Surfaces:	0

Method: gle/morgenstern-price

Number of Valid Surfaces:	7436
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.63724

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.26475	496.038	-24.4439	Clay	0	25	25.6364	41.9729	150.493	60.4818	90.0112
2	4.26475	1417.08	-21.2786	Clay	0	25	68.8897	112.789	414.66	172.784	241.876
3	4.26475	2200.47	-18.1803	Clay	0	25	101.115	165.549	623.324	268.303	355.021
4	4.36636	2938.15	-15.1006	Silt and Clay	1	25	126.165	206.563	789.59	348.759	440.831
5	4.36636	3740.79	-12.0291	Silt and Clay	1	25	162.294	265.715	982.23	414.548	567.682
6	4.36636	4708.6	-8.99254	Silt and Clay	1	25	213.206	349.07	1211.57	465.135	746.439
7	4.36636	5652.65	-5.98127	Silt and Clay	1	25	263.47	431.364	1423.89	500.967	922.919
8	4.36636	6475.36	-2.98655	Silt and Clay	1	25	306.184	501.296	1595.24	522.348	1072.89
9	4.36636	7178.22	0	Silt and Clay	1	25	342.203	560.268	1728.81	529.456	1199.35
10	4.36636	7767.68	2.98655	Silt and Clay	1	25	372.612	610.056	1828.47	522.348	1306.13
11	4.36636	8318.56	5.98127	Silt and Clay	1	25	402.909	659.659	1913.47	500.967	1412.5
12	4.36636	8765	8.99254	Silt and Clay	1	25	428.941	702.279	1969.03	465.135	1503.9
13	4.36636	9085.25	12.0291	Silt and Clay	1	25	449.789	736.412	1991.64	414.548	1577.1
14	4.36636	9277.85	15.1006	Silt and Clay	1	25	465.912	762.81	1982.47	348.759	1633.71
15	3.91767	8381.45	18.0544	Clay	0	25	476.563	780.248	1945.4	272.156	1673.25
16	3.91767	8329.46	20.8958	Clay	0	25	483.576	791.73	1883.52	185.647	1697.87
17	3.91767	8171.64	23.7923	Clay	0	25	487.263	797.767	1795.91	85.0907	1710.82
18	4.73079	9490.51	27.0714	Lower Fill	1	29	559.31	915.725	1650.21	0	1650.21
19	4.73079	8879.27	30.769	Lower Fill	1	29	502.907	823.38	1483.61	0	1483.61
20	4.73079	7998.36	34.6156	Lower Fill	1	29	434.051	710.646	1280.24	0	1280.24
21	4.27281	6235.05	38.4449	Middle Fill	5	28	347.773	569.388	1061.46	0	1061.46
22	4.27281	5067.87	42.2836	Middle Fill	5	28	270.348	442.624	823.051	0	823.051
23	4.27281	3625.03	46.3743	Middle Fill	5	28	184.114	301.438	557.518	0	557.518
24	4.27281	1829.02	50.8021	Middle Fill	5	28	88.4586	144.828	262.979	0	262.979
25	1.58761	154.842	54.0369	Upper Fill	1	25	16.8777	27.6328	57.1143	0	57.1143

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.63773

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.46393	520.911	-23.5422	Clay	0	25	19.1876	31.4241	128.07	60.6805	67.3893
2	4.46393	1486.73	-20.4111	Clay	0	25	56.8217	93.0586	372.752	173.188	199.564
3	4.46393	2304.99	-17.3426	Clay	0	25	90.7897	148.689	587.371	268.507	318.864
4	4.36943	2924.26	-14.3563	Silt and Clay	1	25	120.666	197.618	768.541	346.892	421.649
5	4.36943	3698.84	-11.441	Silt and Clay	1	25	161.654	264.746	974.979	409.374	565.605
6	4.36943	4646.16	-8.55559	Silt and Clay	1	25	217.707	356.545	1219.94	457.473	762.468
7	4.36943	5576.75	-5.69189	Silt and Clay	1	25	273.055	447.191	1448.43	491.57	956.86
8	4.36943	6391.88	-2.84242	Silt and Clay	1	25	319.479	523.22	1631.83	511.926	1119.9
9	4.36943	7092.84	0	Silt and Clay	1	25	356.953	584.592	1770.21	518.695	1251.52
10	4.36943	7686.05	2.84242	Silt and Clay	1	25	386.399	632.817	1866.86	511.926	1354.94
11	4.36943	8246.5	5.69189	Silt and Clay	1	25	413.748	677.608	1942.56	491.57	1450.99
12	4.36943	8708.35	8.55559	Silt and Clay	1	25	435.466	713.176	1984.74	457.473	1527.27
13	4.36943	9050.26	11.441	Silt and Clay	1	25	451.462	739.373	1992.82	409.374	1583.45
14	4.36943	9271.31	14.3563	Silt and Clay	1	25	463.082	758.403	1971.15	346.892	1624.26
15	4.10218	8795.11	17.2185	Clay	0	25	470.605	770.724	1925.16	272.336	1652.82
16	4.10218	8771.63	20.0338	Clay	0	25	476.191	779.873	1858.44	186.002	1672.44
17	4.10218	8634.54	22.9008	Clay	0	25	480.042	786.18	1771.24	85.2663	1685.97
18	4.92744	10013.9	26.1325	Lower Fill	1	29	553.607	906.658	1633.85	0	1633.85
19	4.92744	9413.63	29.762	Lower Fill	1	29	501.454	821.247	1479.76	0	1479.76
20	4.92744	8522.02	33.5288	Lower Fill	1	29	439.298	719.452	1296.12	0	1296.12
21	4.47802	6736.84	37.2799	Middle Fill	5	28	361.254	591.636	1103.3	0	1103.3
22	4.47802	5539.48	41.0395	Middle Fill	5	28	291.558	477.494	888.633	0	888.633
23	4.47802	4054.32	45.0295	Middle Fill	5	28	210.476	344.703	638.889	0	638.889
24	4.47802	2208.96	49.323	Middle Fill	5	28	113.944	186.609	341.556	0	341.556
25	2.29379	304.682	52.7895	Upper Fill	1	25	27.5533	45.1249	94.6263	0	94.6263

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.63724

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-123.129	463.8	0	0	0
2	-118.864	461.861	401.032	99.1398	13.8858
3	-114.6	460.201	1383.46	342.007	13.8858
4	-110.335	458.8	2687.55	664.394	13.8858
5	-105.969	457.622	4168.54	1030.51	13.8858
6	-101.602	456.691	5790.85	1431.56	13.8857
7	-97.2359	456	7558.67	1868.59	13.8858
8	-92.8695	455.543	9360.11	2313.93	13.8858
9	-88.5032	455.315	11060	2734.16	13.8858
10	-84.1368	455.315	12553.7	3103.42	13.8858
11	-79.7705	455.543	13763.6	3402.53	13.8858
12	-75.4041	456	14647	3620.9	13.8857
13	-71.0377	456.691	15158.7	3747.41	13.8858
14	-66.6714	457.622	15269	3774.67	13.8858
15	-62.305	458.8	14967	3700.01	13.8858
16	-58.3873	460.077	14349	3547.25	13.8858
17	-54.4697	461.573	13425.8	3319.01	13.8858
18	-50.552	463.3	12232.1	3023.92	13.8858
19	-45.8212	465.718	10887.3	2691.46	13.8857
20	-41.0904	468.535	9086.84	2246.37	13.8858
21	-36.3596	471.8	6959.06	1720.36	13.8858
22	-32.0868	475.192	4844.04	1197.5	13.8857
23	-27.814	479.078	2800.68	692.361	13.8858
24	-23.5412	483.561	1087.83	268.925	13.8858
25	-19.2684	488.8	87.839	21.7148	13.8858
26	-17.6808	490.988	0	0	0

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.63773

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-123.744	463.8	0	0	0
2	-119.28	461.855	334.766	13.4531	2.30128
3	-114.816	460.194	1207.69	96.2603	4.55719
4	-110.352	458.8	2431.93	286.728	6.72421
5	-105.982	457.682	3818.85	585.799	8.721
6	-101.613	456.797	5387.62	1004.53	10.5616
7	-97.2436	456.14	7141.16	1546.34	12.2181
8	-92.8741	455.705	8965.5	2180.24	13.6679
9	-88.5047	455.488	10716	2849.96	14.8933
10	-84.1353	455.488	12276.3	3492.53	15.8807
11	-79.7659	455.705	13560.2	4047.85	16.6209
12	-75.3964	456.14	14522.8	4469.73	17.107
13	-71.027	456.797	15121.6	4720.06	17.3352
14	-66.6576	457.682	15332.7	4776.78	17.304
15	-62.2881	458.8	15152.5	4636.45	17.0134
16	-58.186	460.071	14636.3	4337.26	16.5064
17	-54.0838	461.567	13810.6	3901.88	15.7765
18	-49.9816	463.3	12711.2	3365.4	14.8293
19	-45.0541	465.717	11490.4	2740.81	13.4161
20	-40.1267	468.535	9792.85	2031.78	11.7212
21	-35.1993	471.8	7726.49	1330.7	9.77194
22	-30.7212	475.209	5583.81	765.812	7.80932
23	-26.2432	479.107	3425.92	341.838	5.69811
24	-21.7652	483.59	1504.89	91.4124	3.47608
25	-17.2872	488.8	235.683	4.87676	1.1854
26	-14.9934	491.821	0	0	0

List Of Coordinates

Water Table

X	Y
-250	463.8
150	463.8

Focus Search Line

X	Y
-71	449
-70.7033	470.104

External Boundary

X	Y
-8.81	492.89
-12.64	492.55
-24.7427	488.8
-41.17	483.71
-76.5298	472
-77.1337	471.8
-81.18	470.46
-102.38	464.5
-107	463.8
-250	463.8
-250	458.8
-250	454.8
-250	400
150	400
150	454.8
150	458.8
150	460
150	491.3
14.969	491.3
8.39	493.02
0	492.9

Material Boundary

X	Y
14.969	491.3
22.5873	488.8
73.7826	472
74.3715	471.8
97.9298	463.8
99.4022	463.3
109.12	460
150	460

Material Boundary

X	Y
-77.1337	471.8
74.3715	471.8

Material Boundary

X	Y
-107	463.3
-107	463.8

Material Boundary

X	Y
-107	463.3
99.4022	463.3

Material Boundary

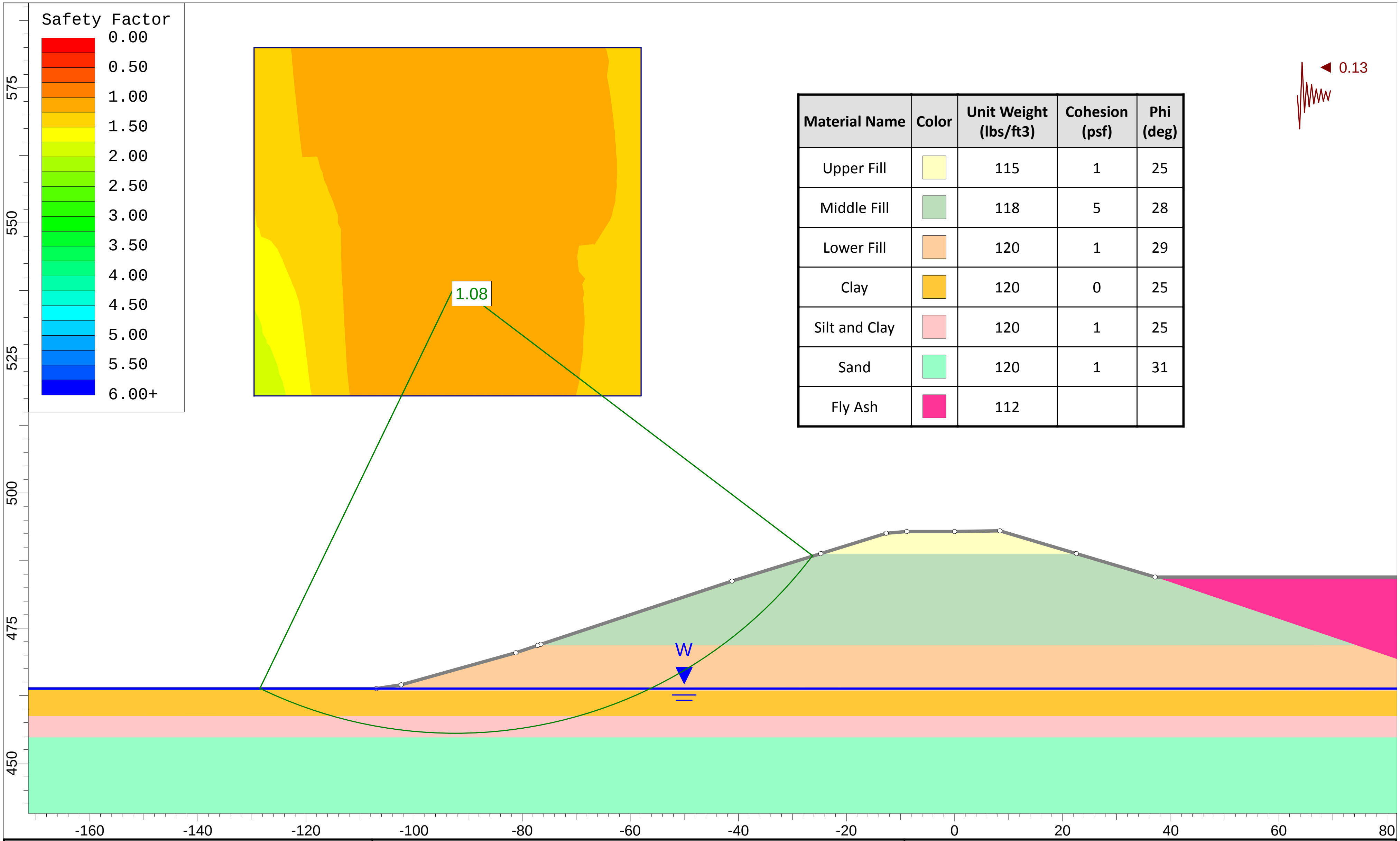
X	Y
-250	458.8
150	458.8

Material Boundary

X	Y
-250	454.8
150	454.8

Material Boundary

X	Y
-24.7427	488.8
22.5873	488.8



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	115	1	25
Middle Fill	🟩	118	5	28
Lower Fill	🟧	120	1	29
Clay	🟧	120	0	25
Silt and Clay	🟥	120	1	25
Sand	🟩	120	1	31
Fly Ash	🟪	112		

REITZ & JENS, INC.
CONSULTING ENGINEERS

Project Name: Periodic Safety Factor Assessment	Client: Ameren - Labadie Energy Center
Section Location: Section 2 - Fly Ash Pond	Load Case: Seismic

File Path/Name: P:\Amerenue\2015012432\Labadie\calc\xsect_2\seismic xsect_2.sli

Project Number: 2015012432	Analysis By: J. Bertel	Checked By: J. Gilliam	Figure:

Slide Analysis Information

Periodic Safety Factor Assessment

Project Summary

File Name:	seismic xsect_2
Slide Modeler Version:	6.035
Project Title:	Periodic Safety Factor Assessment
Analysis:	Seismic
Author:	J. Bertel
Company:	Ameren - Labadie Energy Center
Comments	
	2015012432
	Section 2 - Fly Ash Pond
	J. Gilliam

General Settings

Units of Measurement:	Imperial Units
Time Units:	seconds
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
GLE/Morgenstern-Price with interslice force function:	Half Sine
	Spencer
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Grid Search
Radius Increment:	10
Composite Surfaces:	Disabled
Reverse Curvature:	Create Tension Crack
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

Seismic Load Coefficient (Horizontal):	0.13

Material Properties

Property	Upper Fill	Middle Fill	Lower Fill	Clay	Silt and Clay	Sand	Fly Ash
Color	🟨	🟩	🟧	🟨	🟥	🟩	🟪
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	No strength
Unit Weight [lbs/ft3]	115	118	120	120	120	120	112
Cohesion [psf]	1	5	1	0	1	1	
Friction Angle [deg]	25	28	29	25	25	31	
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	None
Hu Value	1	1	1	1	1	1	
Ru Value							0

Global Minimums

Method: spencer

FS	1.076260
Center:	-92.367, 538.620
Radius:	83.099
Left Slip Surface Endpoint:	-128.524, 463.800
Right Slip Surface Endpoint:	-26.199, 488.349
Resisting Moment:	3.85203e+006 lb-ft
Driving Moment:	3.57909e+006 lb-ft
Resisting Horizontal Force:	42703.3 lb
Driving Horizontal Force:	39677.5 lb
Total Slice Area:	1035.76 ft2

Method: gle/morgenstern-price

FS	1.076980
Center:	-92.367, 536.043
Radius:	80.842
Left Slip Surface Endpoint:	-128.649, 463.800
Right Slip Surface Endpoint:	-27.357, 487.990
Resisting Moment:	3.73912e+006 lb-ft
Driving Moment:	3.47184e+006 lb-ft
Resisting Horizontal Force:	42499.9 lb
Driving Horizontal Force:	39462 lb
Total Slice Area:	1041.86 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	5511
Number of Invalid Surfaces:	1925

Error Codes:

Error Code -103 reported for 1925 surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces:	5511
Number of Invalid Surfaces:	1925

Error Codes:

Error Code -103 reported for 1925 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.07626

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.34859	508.706	-24.1491	Clay	0	25	50.2375	54.0686	176.781	60.8305	115.95
2	4.34859	1450.7	-20.901	Clay	0	25	128.207	137.984	469.379	173.473	295.906
3	4.34859	2246.57	-17.722	Clay	0	25	179.764	193.473	683.548	268.643	414.905
4	4.20205	2798.19	-14.6505	Silt and Clay	1	25	213.288	229.553	836.408	346.273	490.135
5	4.20205	3294.04	-11.6736	Silt and Clay	1	25	231.423	249.071	939.624	407.634	531.99
6	4.20205	3830.48	-8.72839	Silt and Clay	1	25	260.026	279.856	1052.86	454.849	598.009
7	4.20205	4528.89	-5.80636	Silt and Clay	1	25	313.091	336.967	1208.79	488.309	720.483
8	4.20205	5284.08	-2.89944	Silt and Clay	1	25	374.58	403.145	1370.68	508.281	862.404
9	4.20205	5933.42	0	Silt and Clay	1	25	424.782	457.176	1493.19	514.921	978.274
10	4.20205	6475.44	2.89944	Silt and Clay	1	25	465.175	500.649	1579.78	508.281	1071.5
11	4.20205	6909.73	5.80636	Silt and Clay	1	25	497.095	535.004	1633.49	488.309	1145.18
12	4.20205	7272.23	8.72839	Silt and Clay	1	25	525.376	565.441	1665.3	454.849	1210.45
13	4.20205	7586.52	11.6736	Silt and Clay	1	25	552.919	595.085	1681.65	407.634	1274.02
14	4.20205	7780.77	14.6505	Silt and Clay	1	25	573.298	617.018	1667.33	346.273	1321.06
15	3.99744	7474.82	17.5938	Clay	0	25	586.553	631.283	1626.24	272.451	1353.79
16	3.99744	7436.55	20.5112	Clay	0	25	595.369	640.772	1560.38	186.244	1374.14
17	3.99744	7285.72	23.4855	Clay	0	25	599.665	645.395	1469.45	85.3924	1384.05
18	3.57434	6290.96	26.3637	Lower Fill	1	29	695.01	748.011	1347.64	0	1347.64
19	3.57434	5982.76	29.1502	Lower Fill	1	29	634.158	682.519	1229.49	0	1229.49
20	3.57434	5575.21	32.0147	Lower Fill	1	29	566.049	609.216	1097.25	0	1097.25
21	3.57434	5059	34.972	Lower Fill	1	29	490.9	528.336	951.34	0	951.34
22	4.19168	5113.57	38.3181	Middle Fill	5	28	390.728	420.525	781.488	0	781.488
23	4.19168	4003.85	42.1085	Middle Fill	5	28	288.631	310.642	574.828	0	574.828
24	4.19168	2630.46	46.1428	Middle Fill	5	28	178.263	191.857	351.427	0	351.427
25	4.19168	936.408	50.5014	Middle Fill	5	28	60.8036	65.4405	113.672	0	113.672

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.07698

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.14301	481.251	-25.0463	Clay	0	25	32.6513	35.1648	135.814	60.4031	75.4111
2	4.14301	1375.33	-21.8437	Clay	0	25	97.7623	105.288	398.412	172.622	225.79
3	4.14301	2136.98	-18.7115	Clay	0	25	157.743	169.886	632.538	268.218	364.32
4	3.97555	2651.84	-15.6976	Silt and Clay	1	25	208.958	225.044	827.324	346.86	480.464
5	3.97555	3133.62	-12.7893	Silt and Clay	1	25	246.501	265.477	977.048	409.876	567.172
6	3.97555	3581.21	-9.91416	Silt and Clay	1	25	280.313	301.891	1104.97	459.711	645.263
7	3.97555	4170.25	-7.06411	Silt and Clay	1	25	332.902	358.529	1263.49	496.762	766.724
8	3.97555	4862.64	-4.23157	Silt and Clay	1	25	396.874	427.425	1435.78	521.31	914.471
9	3.97555	5489.33	-1.40938	Silt and Clay	1	25	448.775	483.322	1567.88	533.539	1034.34
10	3.97555	6022.52	1.40938	Silt and Clay	1	25	486	523.412	1653.86	533.539	1120.32
11	3.97555	6462.22	4.23157	Silt and Clay	1	25	510.647	549.957	1698.55	521.31	1177.24
12	3.97555	6809.38	7.06411	Silt and Clay	1	25	525.491	565.943	1708.28	496.762	1211.52
13	3.97555	7122.63	9.91416	Silt and Clay	1	25	539.581	581.118	1703.78	459.711	1244.07
14	3.97555	7362.86	12.7893	Silt and Clay	1	25	550.736	593.132	1679.71	409.876	1269.83
15	3.97555	7498.71	15.6976	Silt and Clay	1	25	557.916	600.864	1633.27	346.86	1286.41
16	3.80529	7208.86	18.584	Clay	0	25	562.018	605.282	1570.11	272.082	1298.03
17	3.80529	7141.14	21.4559	Clay	0	25	565.871	609.432	1492.43	185.502	1306.93
18	3.80529	6971.68	24.3856	Clay	0	25	568.943	612.74	1399.05	85.0201	1314.03
19	4.60172	8043.14	27.7086	Lower Fill	1	29	648.859	698.808	1258.88	0	1258.88
20	4.60172	7425.89	31.463	Lower Fill	1	29	570.677	614.608	1106.98	0	1106.98
21	4.60172	6573.81	35.3755	Lower Fill	1	29	484.617	521.923	939.77	0	939.77
22	3.98403	4810.65	39.1979	Middle Fill	5	28	386.883	416.665	774.229	0	774.229
23	3.98403	3761.21	42.9492	Middle Fill	5	28	296.072	318.864	590.293	0	590.293
24	3.98403	2467.43	46.9469	Middle Fill	5	28	191.25	205.972	377.974	0	377.974
25	3.98403	877.606	51.2727	Middle Fill	5	28	68.2783	73.5344	128.894	0	128.894

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.07626

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-128.524	463.8	0	0	0
2	-124.176	461.85	497.597	166.634	18.5145
3	-119.827	460.19	1647.52	551.717	18.5145
4	-115.478	458.8	3089.22	1034.51	18.5145
5	-111.276	457.701	4542.95	1521.33	18.5145
6	-107.074	456.833	5905.59	1977.65	18.5145
7	-102.872	456.188	7182.5	2405.25	18.5145
8	-98.6701	455.761	8429.47	2822.83	18.5145
9	-94.4681	455.548	9612.57	3219.02	18.5145
10	-90.266	455.548	10631.1	3560.09	18.5144
11	-86.064	455.761	11413.1	3821.97	18.5144
12	-81.8619	456.188	11911.3	3988.83	18.5146
13	-77.6599	456.833	12105.3	4053.78	18.5145
14	-73.4578	457.701	11988.8	4014.77	18.5145
15	-69.2558	458.8	11561.3	3871.62	18.5145
16	-65.2583	460.068	10879.3	3643.23	18.5145
17	-61.2609	461.563	9965.51	3337.22	18.5145
18	-57.2634	463.3	8869.7	2970.26	18.5145
19	-53.6891	465.071	8155.52	2731.09	18.5145
20	-50.1148	467.065	7199.59	2410.97	18.5145
21	-46.5404	469.3	6051.49	2026.5	18.5145
22	-42.9661	471.8	4774.74	1598.95	18.5145
23	-38.7744	475.113	3163.54	1059.4	18.5146
24	-34.5827	478.901	1678.4	562.055	18.5144
25	-30.391	483.263	552.661	185.073	18.5145
26	-26.1993	488.349	0	0	0

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.07698

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-128.649	463.8	0	0	0
2	-124.506	461.864	335.942	18.0802	3.08065
3	-120.363	460.203	1224.72	130.741	6.09335
4	-116.22	458.8	2489.48	393.148	8.97425
5	-112.245	457.683	3901.64	798.234	11.5625
6	-108.269	456.78	5358.12	1329.61	13.9364
7	-104.294	456.085	6777.19	1951.42	16.0632
8	-100.318	455.593	8183.87	2646.33	17.9191
9	-96.3426	455.299	9555.29	3381.31	19.4872
10	-92.367	455.201	10783	4086.82	20.757
11	-88.3915	455.299	11774.7	4690.87	21.7216
12	-84.4159	455.593	12469.5	5133.92	22.3779
13	-80.4404	456.085	12836.3	5375.85	22.724
14	-76.4649	456.78	12876.3	5401.89	22.7591
15	-72.4893	457.683	12597.6	5213.79	22.4833
16	-68.5138	458.8	12020.7	4831.62	21.8972
17	-64.7085	460.079	11218	4316.68	21.0467
18	-60.9032	461.575	10215.7	3701.17	19.9156
19	-57.0979	463.3	9065.69	3034.9	18.5089
20	-52.4962	465.717	7969.95	2353.43	16.4512
21	-47.8945	468.533	6519.31	1628.54	14.0256
22	-43.2927	471.8	4829.13	962.149	11.268
23	-39.3087	475.049	3232.95	491.892	8.65118
24	-35.3247	478.758	1736.98	178.458	5.86601
25	-31.3406	483.022	567.98	29.4015	2.96327
26	-27.3566	487.99	0	0	0

List Of Coordinates

Water Table

X	Y
-250	463.8
150	463.8

External Boundary

X	Y
-8.81	492.89
-12.64	492.55
-24.7427	488.8
-41.17	483.71
-76.5298	472
-77.1337	471.8
-81.18	470.46
-102.38	464.5
-107	463.8
-250	463.8
-250	458.8
-250	454.8
-250	400
150	400
150	454.8
150	458.8
150	460
150	484.45
37.12	484.45
22.5371	488.8
8.39	493.02
0	492.9

Material Boundary

X	Y
37.12	484.45
73.7826	472
74.3715	471.8
97.9298	463.8
99.4022	463.3
109.12	460
150	460

Material Boundary

X	Y
-24.7427	488.8
22.5371	488.8

Material Boundary

X	Y
-77.1337	471.8
74.3715	471.8

Material Boundary

X	Y
-107	463.3
-107	463.8

Material Boundary

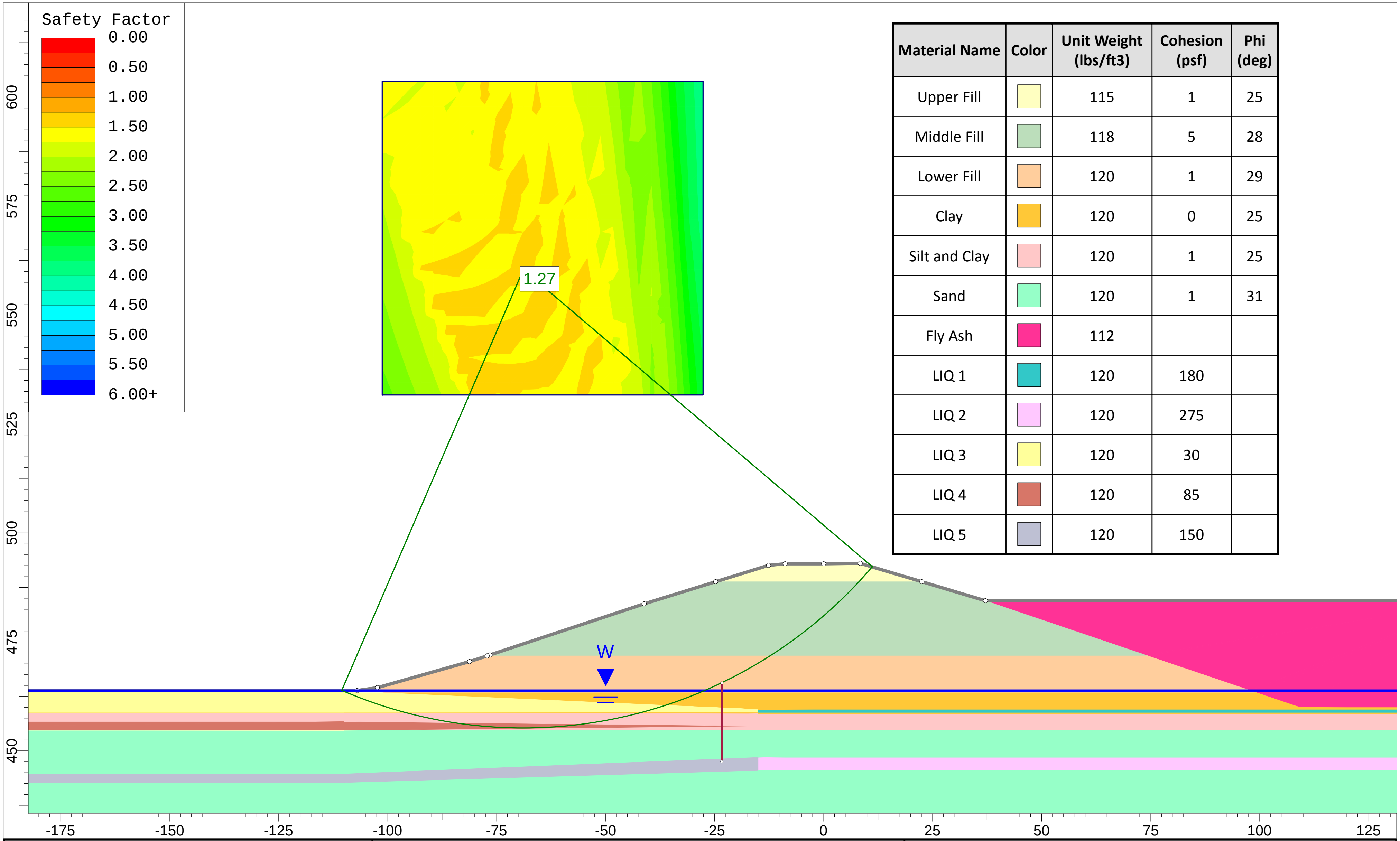
X	Y
-107	463.3
99.4022	463.3

Material Boundary

X	Y
-250	458.8
150	458.8

Material Boundary

X	Y
-250	454.8
150	454.8



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	115	1	25
Middle Fill	🟩	118	5	28
Lower Fill	🟧	120	1	29
Clay	🟧	120	0	25
Silt and Clay	🟥	120	1	25
Sand	🟩	120	1	31
Fly Ash	🟪	112		
LIQ 1	🟦	120	180	
LIQ 2	🟪	120	275	
LIQ 3	🟨	120	30	
LIQ 4	🟥	120	85	
LIQ 5	⬜	120	150	

Reitz & Jens, Inc.
CONSULTING ENGINEERS

Project Name: Periodic Safety Factor Assessment
Client: Ameren - Labadie Energy Center
Section Location: Section 2 - Fly Ash Pond
Load Case: Liquefaction
File Path/Name: P:\Amerenue\2015012432\Labadie\calc\xsect_2\xsect_2 POST EQ.sli
Project Number: 2015012432
Analysis By: J. Bertel
Checked By: J. Gilliam
Figure:

Slide Analysis Information

Periodic Safety Factor Assessment

Project Summary

File Name:	xsect_2 POST EQ
Slide Modeler Version:	6.035
Project Title:	Periodic Safety Factor Assessment
Analysis:	Liquefaction
Author:	J. Bertel
Company:	Ameren - Labadie Energy Center
Comments	
	2015012432
	Section 2 - Fly Ash Pond
	J. Gilliam

General Settings

Units of Measurement:	Imperial Units
Time Units:	seconds
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
GLE/Morgenstern-Price with interslice force function:	Half Sine
	Spencer
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Grid Search
Radius Increment:	10
Composite Surfaces:	Disabled
Reverse Curvature:	Create Tension Crack
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Material Properties

Property	Upper Fill	Middle Fill	Lower Fill	Clay	Silt and Clay	Sand	Fly Ash	LIQ 1
Color	🟨	🟩	🟧	🟨	🟥	🟩	🟪	🟦
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	No strength	Undrained
Unit Weight [lbs/ft3]	115	118	120	120	120	120	112	120
Cohesion [psf]	1	5	1	0	1	1		
Friction Angle [deg]	25	28	29	25	25	31		
Cohesion Type								180
Water Surface	Water Table	Water Table	Water Table	Water Table	Water Table	Water Table	None	None
Hu Value	1	1	1	1	1	1		
Ru Value							0	0

Property	LIQ 2	LIQ 3	LIQ 4	LIQ 5
Color	🟪	🟨	🟥	⬜
Strength Type	Undrained	Undrained	Undrained	Undrained
Unit Weight [lbs/ft3]	120	120	120	120
Cohesion Type	275	30	85	150
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS	1.274630
Center:	-68.868, 560.386
Radius:	105.202
Left Slip Surface Endpoint:	-110.564, 463.800
Right Slip Surface Endpoint:	11.223, 492.175
Resisting Moment:	7.4873e+006 lb-ft
Driving Moment:	5.87408e+006 lb-ft
Resisting Horizontal Force:	64081.8 lb
Driving Horizontal Force:	50274.7 lb
Total Slice Area:	2020.54 ft2

Method: gle/morgenstern-price

FS	1.262510
Center:	-57.100, 545.997
Radius:	87.248
Left Slip Surface Endpoint:	-93.893, 466.886
Right Slip Surface Endpoint:	11.503, 492.091
Resisting Moment:	5.03766e+006 lb-ft
Driving Moment:	3.9902e+006 lb-ft
Resisting Horizontal Force:	51191.1 lb
Driving Horizontal Force:	40547.1 lb
Total Slice Area:	1728.11 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	7436
Number of Invalid Surfaces:	0

Method: gle/morgenstern-price

Number of Valid Surfaces:	7436
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.27463

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	0.232412	1.33637	-23.2808	Upper Fill	1	25	2.65272	3.38124	8.22658	3.12	5.10658
2	4.70655	601.815	-21.8311	LIQ 3	30	0	23.5362	30	156.365	0	156.365
3	4.70655	1914.68	-19.0938	LIQ 3	30	0	23.5362	30	455.057	0	455.057
4	4.70655	3433.8	-16.4013	LIQ 3	30	0	23.5362	30	793.51	0	793.51
5	0.487834	443.012	-14.9277	Clay	0	25	292.258	372.521	1114.93	316.058	798.875
6	5.33331	5811.95	-13.2977	Silt and Clay	1	25	351.502	448.035	1318.11	359.443	958.67
7	5.33331	7485.93	-10.3287	Silt and Clay	1	25	447.288	570.127	1649.59	429.097	1220.5
8	6.03736	10274.3	-7.19496	LIQ 4	85	0	66.686	85	1774.88	0	1774.88
9	6.03736	12096.7	-3.88955	LIQ 4	85	0	66.686	85	2054.09	0	2054.09
10	6.03736	13693.8	-0.597097	LIQ 4	85	0	66.686	85	2289.01	0	2289.01
11	6.03736	15038.1	2.69338	LIQ 4	85	0	66.686	85	2476.58	0	2476.58
12	6.03736	16130	5.9928	LIQ 4	85	0	66.686	85	2618.34	0	2618.34
13	6.21492	17473.8	9.36163	Silt and Clay	1	25	846.473	1078.94	2758.93	447.284	2311.65
14	6.21492	18074	12.813	Silt and Clay	1	25	876.027	1116.61	2763.64	371.216	2392.42
15	0.916348	2701.54	14.807	Clay	0	25	888.728	1132.8	2748.85	319.558	2429.29
16	5.46486	16145.6	16.6184	LIQ 3	30	0	23.5362	30	2769.51	0	2769.51
17	7.70935	22552.2	20.4122	Clay	0	25	898.488	1145.24	2576.69	120.711	2455.98
18	5.40879	15395.5	24.2686	Lower Fill	1	29	1032.17	1315.64	2371.68	0	2371.68
19	5.40879	14737	27.546	Lower Fill	1	29	951.123	1212.33	2185.3	0	2185.3
20	5.40879	13809	30.9246	Lower Fill	1	29	856.217	1091.36	1967.06	0	1967.06
21	5.08638	11497.8	34.3191	Middle Fill	5	28	704.666	898.188	1679.84	0	1679.84
22	5.08638	9332.74	37.7484	Middle Fill	5	28	548.749	699.452	1306.07	0	1306.07
23	5.08638	6818.63	41.3457	Middle Fill	5	28	383.42	488.719	909.743	0	909.743
24	5.08638	3980.45	45.1555	Middle Fill	5	28	213.606	272.268	502.658	0	502.658
25	3.00159	736.493	48.3501	Upper Fill	1	25	60.2406	76.7845	162.52	0	162.52

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.26251

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.49093	862.255	-23.3359	Lower Fill	1	29	109.053	137.681	246.58	0	246.58
2	4.49093	2508.95	-20.1587	Lower Fill	1	29	318.275	401.826	723.109	0	723.109
3	2.57989	2131.66	-17.6985	Clay	0	25	358.457	452.555	1027.39	56.8861	970.507
4	4.44888	4780.55	-15.2946	LIQ 3	30	0	23.7622	30	1159.87	0	1159.87
5	4.44888	6141.95	-12.2848	LIQ 3	30	0	23.7622	30	1483.03	0	1483.03
6	4.44888	7368.85	-9.30921	LIQ 3	30	0	23.7622	30	1766.29	0	1766.29
7	4.44888	8469.3	-6.35877	LIQ 3	30	0	23.7622	30	2008.38	0	2008.38
8	4.44888	9446.16	-3.42522	LIQ 3	30	0	23.7622	30	2208.9	0	2208.9
9	5.97313	13994.3	0	LIQ 3	30	0	23.7622	30	2389.69	0	2389.69
10	3.69385	9306.51	3.17649	LIQ 3	30	0	23.7622	30	2518.49	0	2518.49
11	3.69385	9713.86	5.61012	LIQ 3	30	0	23.7622	30	2587.2	0	2587.2
12	3.69385	10050.8	8.05398	LIQ 3	30	0	23.7622	30	2635.49	0	2635.49
13	3.69385	10312	10.5127	LIQ 3	30	0	23.7622	30	2664.69	0	2664.69
14	5.02444	14264.6	13.4429	Clay	0	25	930.401	1174.64	2682.73	163.708	2519.02
15	5.02444	14366.4	16.8635	Clay	0	25	928.713	1172.51	2593.18	78.7191	2514.46
16	4.52292	12857.7	20.17	Lower Fill	1	29	1079.13	1362.41	2456.03	0	2456.03
17	4.52292	12614.9	23.3704	Lower Fill	1	29	1015.27	1281.79	2310.61	0	2310.61
18	4.52292	12197.5	26.6503	Lower Fill	1	29	942.868	1190.38	2145.72	0	2145.72
19	4.52292	11574.5	30.0277	Lower Fill	1	29	861.308	1087.41	1959.94	0	1959.94
20	3.99635	9248.16	33.3137	Middle Fill	5	28	729.916	921.526	1723.73	0	1723.73
21	3.99635	7961.99	36.5171	Middle Fill	5	28	610.977	771.365	1441.32	0	1441.32
22	3.99635	6480.12	39.8598	Middle Fill	5	28	484.55	611.749	1141.13	0	1141.13
23	3.99635	4821.58	43.3751	Middle Fill	5	28	352.163	444.609	826.784	0	826.784
24	3.99635	2940.42	47.109	Middle Fill	5	28	210.533	265.8	490.494	0	490.494
25	2.71898	641.363	50.4392	Upper Fill	1	25	60.2339	76.0459	160.936	0	160.936

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.27463

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-110.564	463.8	0	0	0
2	-110.331	463.7	1.44021	0.3205	12.546
3	-105.625	461.815	407.216	90.6207	12.546
4	-100.918	460.185	1259.56	280.3	12.546
5	-96.2118	458.8	2469.8	549.621	12.546
6	-95.724	458.67	2757.61	613.67	12.546
7	-90.3907	457.409	6296.88	1401.29	12.546
8	-85.0574	456.437	10289.8	2289.85	12.5459
9	-79.02	455.675	12045.8	2680.63	12.546
10	-72.9827	455.265	13292.2	2958.01	12.546
11	-66.9453	455.202	13839.5	3079.8	12.546
12	-60.908	455.486	13539.4	3013.02	12.546
13	-54.8706	456.12	12283.2	2733.47	12.546
14	-48.6557	457.144	14725.9	3277.06	12.546
15	-42.4408	458.558	16273	3621.35	12.546
16	-41.5244	458.8	16422.9	3654.7	12.546
17	-36.0595	460.431	12034.5	2678.13	12.546
18	-28.3502	463.3	11580.4	2577.07	12.546
19	-22.9414	465.739	11389	2534.47	12.546
20	-17.5326	468.56	10376.9	2309.24	12.546
21	-12.1238	471.8	8641.88	1923.14	12.546
22	-7.03745	475.272	6399.32	1424.09	12.546
23	-1.95107	479.21	4051.69	901.652	12.546
24	3.13531	483.686	1933.43	430.26	12.546
25	8.22169	488.8	451.085	100.383	12.546
26	11.2233	492.175	0	0	0

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.26251

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-93.8925	466.886	0	0	0
2	-89.4016	464.949	967.855	33.756	1.9975
3	-84.9106	463.3	3590.46	248.209	3.95457
4	-82.3307	462.477	5361.76	473.372	5.04537
5	-77.8819	461.26	6878.69	825.664	6.84459
6	-73.433	460.291	8421.21	1260.4	8.51226
7	-68.9841	459.562	9815.1	1734.13	10.0196
8	-64.5352	459.066	10916.6	2189.73	11.3423
9	-60.0864	458.8	11610.6	2565.62	12.4605
10	-54.1132	458.8	11752.6	2846.32	13.6141
11	-50.4194	459.005	11324.2	2848.09	14.1174
12	-46.7255	459.368	10473.3	2699.79	14.4549
13	-43.0317	459.891	9183.58	2396.27	14.6241
14	-39.3378	460.576	7444.88	1942.53	14.6237
15	-34.3134	461.777	8901.29	2277.34	14.3509
16	-29.289	463.3	9621.55	2357.66	13.7684
17	-24.766	464.961	10425.5	2404.24	12.986
18	-20.2431	466.916	10505	2227.03	11.9693
19	-15.7202	469.186	9902.25	1876.84	10.7323
20	-11.1973	471.8	8677.11	1419.89	9.2933
21	-7.20092	474.426	7068.95	977.38	7.87202
22	-3.20457	477.385	5247.62	582.125	6.33001
23	0.791782	480.722	3377.9	277.078	4.68929
24	4.78814	484.498	1664.5	86.4867	2.97439
25	8.78449	488.8	396.426	8.38677	1.21197
26	11.5035	492.091	0	0	0

List Of Coordinates

Water Table

X	Y
-250	463.8
150	463.8

Focus Search Line

X	Y
-23.3589	447.537
-23.3589	465.537

External Boundary

X	Y
-8.81	492.89
-12.64	492.55
-24.7427	488.8
-41.17	483.71
-76.5298	472
-77.1337	471.8
-81.18	470.46
-102.38	464.5
-107	463.8
-250	463.8
-250	463.7
-250	458.8
-250	458.7
-250	456.7
-250	454.8
-250	454.7
-250	444.7
-250	442.7
-250	400
150	400
150	445.5
150	448.5
150	454.8
150	458.5
150	458.8
150	459.5
150	460
150	484.45
37.12	484.45
22.5371	488.8
8.39	493.02
0	492.9

Material Boundary

X	Y
37.12	484.45
73.7826	472
74.3715	471.8
97.9298	463.8
99.4022	463.3
109.12	460
150	460

Material Boundary

X	Y
-24.7427	488.8
22.5371	488.8

Material Boundary

X	Y
-77.1337	471.8
74.3715	471.8

Material Boundary

X	Y
-107	463.3
-107	463.567
-107	463.8

Material Boundary

X	Y
-107	463.3
-100.952	463.3
99.4022	463.3

Material Boundary

X	Y
-250	458.8
-15	458.8
150	458.8

Material Boundary

X	Y
-250	454.8
-100.5	454.8
150	454.8

Material Boundary

X	Y
-250	463.7
-110	463.7
-107	463.567
-100.952	463.3
-15	459.5
150	459.5

Material Boundary

X	Y
-250	458.7
-110	458.7
-15	458.5
150	458.5

Material Boundary

X	Y
-15	458.8
-15	459.5

Material Boundary

X	Y
-250	444.7
-110	444.7
-15	448.5
150	448.5

Material Boundary

X	Y
-250	442.7
-110	442.7
-15	445.5
150	445.5

Material Boundary

X	Y
-250	456.7
-110	456.7
-15	455.7

Material Boundary

X	Y
-250	454.7
-110	454.7
-100.5	454.8
-15	455.7

Material Boundary

X	Y
-15	445.5
-15	448.5

APPENDIX II

GEOTECHNICAL ANALYSES FOR AMEREN MISSOURI ENERGY CENTER BOTTOM ASH POND CLOSURE

GEOTECHNICAL ANALYSES FOR AMEREN MISSOURI ENERGY CENTER FLY ASH POND CLOSURE

FINAL REPORT
2015120902

GEOTECHNICAL ANALYSES FOR AMEREN MISSOURI LABADIE ENERGY CENTER BOTTOM ASH POND CLOSURE

Prepared for

Ameren
MISSOURI

and

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING LAND - AIR – WATER

Prepared by

REITZ & JENS, INC.
CONSULTING ENGINEERS

STATE OF MISSOURI
JEFFREY LYNN FOUSE
NUMBER E-21043
REGISTERED PROFESSIONAL ENGINEER

September 27, 2017

9/27/2017

The Professional whose signature and personal seal appear hereon assumes responsibility only for what appears in the attached report and disclaims (pursuant to Section 327.411 RSMo) any responsibility for all other plans, estimates, specifications, reports, or other documents or instruments not sealed by the undersigned Professional relating to or intended to be used for any part or parts of the project to which this report refers.

GEOTECHNICAL ANALYSES FOR
AMEREN MISSOURI LABADIE ENERGY CENTER
BOTTOM ASH POND CLOSURE

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GEOTECHNICAL ANALYSES FOR
AMEREN MISSOURI LABADIE ENERGY CENTER
BOTTOM ASH POND CLOSURE

INTRODUCTION

The geotechnical analyses and recommendations presented in this report are for the design of the permanent closure of the Bottom Ash Pond (BAP) at the Ameren Missouri Labadie Energy Center (LEC). This work was done for GREDELL Engineering Resources (GER), the designer of the closure. Reitz & Jens, Inc. (R&J) was a subconsultant to GER.

The findings from the geotechnical investigation for the permanent closure are presented in the Data Report for the Bottom Ash and Fly Ash Ponds Closure, dated August 15, 2017. A summary of the history of the site is included in the Data Report.

MISSOURI RIVER FLOOD LEVELS

According to panel 29071C0190D of the Flood Insurance Rate Map (FIRM) for Franklin County, effective October 18, 2011, the existing ponds are within Zone AE of the 100-year floodplain with a Base (100-year) Flood Elevation (BFE) of 484 NGVD. The FIRM also shows the areas outside of the perimeter berms to be within the Zone AE and the regulatory floodway with a BFE of 483 NGVD. However, the BFEs in this area are created entirely by backwater flooding from the Missouri River. As a result, proposed improvements will not decrease the conveyance of the Missouri River or create a rise in the BFE. GER used this information to set the elevation of the top of the perimeter berm.

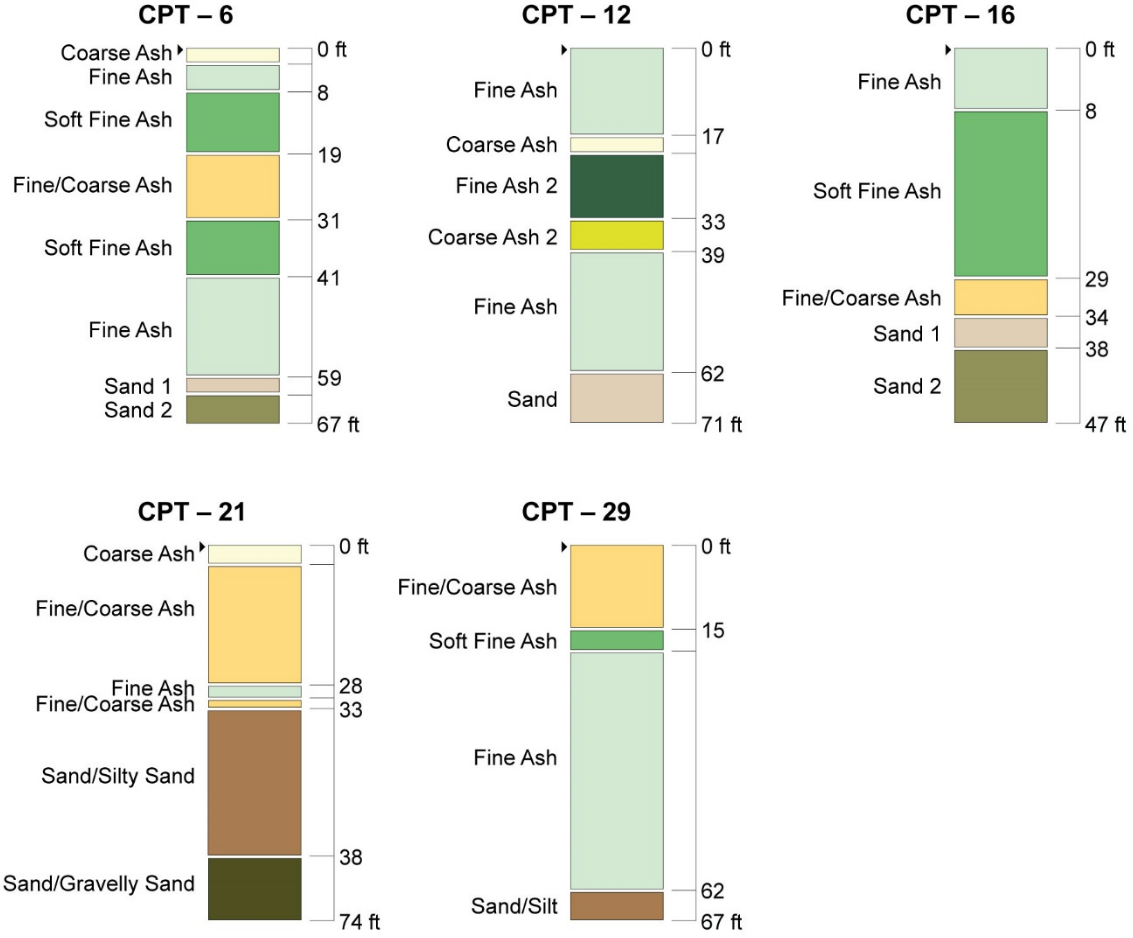
CDG Engineers completed a detailed Missouri River Floodplain Analysis for the Labadie Energy Center in June 2012. According to this analysis, the BFE along the perimeter berms (River Mile Sections 57.52 to 58.15) increases from 484.34 to 485.52 NGVD.

SETTLEMENT

Settlement analyses were completed using the computer program SETTLE3D 3.013. The program calculates the effective vertical stress at depths for a uniform surface load on an assumed elastic half-space using the Boussinesq stress distribution. Settlement of the BAP was estimated for loading due to added CCR fill, in accordance with the preliminary grading plan developed by GER, dated July 6, 2017, as well as lowering of the water level in the pond. The water in the BAP is maintained at about el. 484. We anticipated that the water level initially would be lowered to about el. 480 to complete the grading over most of the BAP, outside of the existing detention pond on the west end of the BAP. We assumed that over time the water level within the BAP would be lowered by natural drainage to about el. 465, that is slightly above the prevailing high groundwater table surrounding the BAP.

R&J performed a geotechnical investigation for the West Detention Basin (WDB) which is being constructed along the northern portion of the BAP (see Figure 1). Our findings were presented in a report to Ameren Missouri and GER dated May 3, 2016. We completed a settlement analysis of the WDB in May 2017. We estimated that the construction of the perimeter berms would produce settlements of 3 to 8 inches. We estimated that the initial filling of the WDB would produce additional settlements of 6.5 to 9 inches. Because the estimated differential settlements could affect the liner and the buried pipes, we recommended placing a preload fill over the area of the WDB using bottom ash. We also recommended monitoring the settlements produced by the preload fill, to verify the magnitude of the estimated settlement and time required for the settlement to occur, which we estimated would primarily occur during the construction of the preload fill. Settlement plates were installed after the area had been prepared and prior to the placement of fill. The preload fill was completed on May 2, 2017. We monitored the settlement through May 25, at which point it appears that the primary settlement was 90% or more completed. The settlements ranged from 0.6 inches to 5.0 inches. The distribution of settlements was in general agreement with the anticipated settlements.

The BAP stratigraphy was estimated using field data obtained from the fall of 2015, which included CPT soundings and borings. The site consists of varying thicknesses of coarse and fine ash underlain by silty sand and sand. The ash thickness varied from 24 to 82 feet throughout the BAP. The stratigraphy at those five locations are shown below:



The CPT measurements of side friction and cone resistance reflect the material's engineering behavior rather than the composition and was used to estimate Equivalent Standard Penetration Test (SPT) N_{60} values, with empirical corrections developed by R&J. A correlation for the stress-strain elastic soil modulus (E_s) was used which accounted for the percent fines in a non-cohesive material and the N_{60} corrected value (Source: Das, *Principles of Foundation Engineering* 2007) as follows:

$$E_s = p_a \alpha N_{60}$$

where
p_a = atmospheric pressure of approximately 2 ksf
α = 5 for sands with fines, 10 for clean normally consolidated sand
N_{60} = the corrected SPT blow count

The values of E_S were estimated as described above. These values were then modified by multiple analyses to approximate the settlements which were measured for the WDB preload fill. The following tables presents the estimated E_S and the adjusted E_S for the various materials in the BAP.

Table of Estimated and Adjusted E_S for the BAP and Thicknesses (feet) in CPT's

	E (tsf)	E adjusted (tsf)	CPT 29	CPT 21	CPT 6	CPT 12	CPT 16
Fine Ash 1	50	100	0	0	0	17	8
Coarse Ash 1	60	180	0	0	3	0	0
Coarse Ash 2	300	900	0	4	0	3	0
Mixed Ash	80	240	15	24	0	0	0
Fine Ash 1	50	100	0	0	5	13	0
Soft Fine Ash	20	40	4	0	11	0	21
Mixed Ash	80	240	0	0	12	0	5
Fine Ash 2	100	300	43	3	0	0	0
Mixed Ash	80	240	0	2	0	0	0
Soft Fine Ash	20	40	0	0	10	0	0
Coarse Ash 2	300	900	0	0	0	6	0
Fine Ash 1	50	100	0	0	18	23	0
Sand 1	100	300	0	0	3	0	4
Sand 2	250	750	5	29	0	9	9
Gravelly Sand	400	1200	0	12	5	0	0

Settlement will have two components: elastic deformation based upon the E_S, and one-dimensional consolidation. The elastic deformation component would occur quickly due to changes in stress conditions. Settlement will also occur from dissipation of excess pore pressures which result in consolidation of the materials. We calculated the settlement based upon the adjusted E_S in the above table for the full depth of the CCR. As a check, we also calculated the strain due to consolidation in the fine-grain materials. Materials, such as fine fly ash, which exhibited increases in pore pressures during the CPT sounding were modeled as consolidating layers. One-dimensional consolidation test laboratory results on ponded and recompacted fly ash from May 2016 were used to estimate the field properties of sluiced fly ash. Layers, which did not exhibit excessive pore pressures from the CPT soundings, such as coarse ash, interbedded fine and coarse ash or sand, were only modeled as elastic materials.

The applied load was assumed to have a moist unit weight of 120 pcf, which is an estimate of the compacted ash fill. The model of the applied surface loads in the SETTLE3D analyses is shown in Figure 2. The plan of the resulting settlement due to the CCR fills is shown in Figure 3. As shown in Figures 2 and 3, "imaginary" boreholes had to be incorporated in the model to replicate the boundaries of the initial excavation of the BAP, that is where the thickness of the CCR are much greater than around the perimeter of the BAP. The parameters for these "imaginary" boreholes were inferred based upon the closest actual borings and CPT soundings. These results are plotted along the profiles of the proposed drainage channels, BAP2, BAP4, BAP6 and BAP8, in Figures 5 through 12, and are termed "Initial Settlement" because we judge that most of this settlement will occur during placement and grading of the CCR fills, as it did for the WDB. To check the impact of this assumption, we also substituted estimated consolidation properties for the fine-grain ash layers. This resulted in settlements that are approximately 10% greater than those shown in Figures 3 and 5 through 12. This is within the accuracy of the data used in our settlement analyses, so we judge that the settlements shown in Figures 3 and 5 through 12 are the most reasonable estimates.

Similarly, increases in the stress condition will occur in the materials as the water level in the BA Pond is lowered. Lowering the water level increases the effective stresses in the materials by decreasing the pore water pressure. This will result in settlement due to the consolidation of the materials, in particular the fine-grain materials. This consolidation is time-dependent. SETTLE3D provides a means to model the lowering of the water level. The plan of the resulting total settlement due to both the placement of the CCR fills and the subsequent lowering of the water level is shown in Figure 4. These results are also plotted in the profiles in Figures 5 through 12. Again, substituting estimated consolidation properties for the fine-grain ash layers resulted in total settlements that are approximately 10% greater than those shown in Figures 4 and 5 through 12.

Significant amounts of estimation and judgement were required to build the model in SETTLE3D for these settlement analyses, as described briefly in the foregoing paragraphs. Even in the best conditions with homogeneous soils, and extensive field investigation and laboratory testing, research has shown that these methods of settlement analysis are usually conservative, overestimating settlement by up to 40%. We have tried to be conservative in our analyses; however, it must be recognized that our estimates of settlement are approximate. Our distinction of “initial” and “total” settlement is also based upon judgement. At least a portion of the “initial” settlement will take time to occur and may not be complete at the end of construction.

If all of the “initial” settlement does occur during construction, then this will result in an apparent “shrinkage” for the contractor, that is more CCR will have to be moved and placed to achieve the specified surface grades than would be calculated based upon the initial topographic survey and the specified surface grades. We estimated the volume of the “initial” settlement using the end-area method. The calculated volume of the “initial” settlement was about 67,000 cubic yards.

The net final grades along the proposed drainage channels are plotted in Figures 6, 8, 10 and 12. Based upon our estimate of the total settlement, that is the long-term settlement primarily due to the lowering of the water level in the BA Pond, it appears that the proposed profiles along these channels will have a positive slope toward the south perimeter embankment as intended as the total estimated settlement had occurred. We estimate that there may be a settlement of the CCR of 3 to 6 inches at the proposed storm water inlets (at el. 480). Therefore, some maintenance of grade should be anticipated at each of these inlets.

Settlement Due to Liquefaction

We reviewed published papers on recent research of the liquefaction potential of ponded fly ash. Some research indicates that ponded fly ash is less likely to liquefy than natural soils of the same consistency and grain-size distribution due to diagenesis of ponded fly ash (i.e. changes in chemistry, density and cementation), and because fly ash tends to be more dilatant under shear stress than natural soil. Other research indicates that ponded fly ash may liquefy at lower cyclic stress ratios than natural soils because fly ash has a lower specific gravity. Although, we measured the specific gravity of fly ash and bottom ash samples from Labadie and found that the specific gravities are similar to natural soils (see Data Report). It is possible that some irregular, differential settlements may occur due to liquefaction after a large earthquake, which may require repairing and re-grading the cap.

SLOPE STABILITY

Reitz & Jens completed a geotechnical investigation of the BAP and the FAP at the Labadie EC in 2010. The purpose of that investigation was to evaluate the stability of the ash pond perimeter embankments. Slope stability analyses were conducted for the load cases required by the Missouri Department of Natural Resources (MDNR) Dam Safety Program (DSP). These findings were submitted in a report to Ameren Missouri, dated November 16, 2010. The investigation included four borings and 8 CPT soundings, the approximate locations of which are shown in Figure 1. These borings and CPT soundings were made through the perimeter embankments and at the exterior toe of the embankments of the BAP and the FAP. Two temporary piezometers were installed to help define the line of seepage through the embankment. The piezometers were located as close to the downstream crest as possible, with the tips located in the lower most embankment fill above the native soils. The locations of the piezometers are shown in Figure 1 (PZ-1 and PZ-2). These were removed at the end of the investigation. The logs of the 2010 borings and CPT soundings are included in the Data Report, as well as the results of the laboratory testing of samples obtained from the borings.

Reitz & Jens evaluated the periodic safety factor assessments for the Labadie ash ponds in accordance with the 2015 EPA CCR Rule - 40 CFR §257.73(e). The findings were submitted to Ameren Missouri in June 2016. The model of the geometry of the BAP perimeter berm and the properties of the berm and foundation soil strata were developed for slope stability analyses of two critical sections. The basis for the models is presented in the 2016 report. Only Section 3 in the 2016 report was re-analyzed for this study because Section 3 would be modified by the proposed grading plan for the BAP closure. The location of Section 3 is shown in Figure 1. These results of this re-evaluation are presented in this section.

Seismicity

The critical cross-section was analyzed using a pseudo-static acceleration as a horizontal body force on the soil mass to calculate the minimum factor of safety for a seismic event. The seismic acceleration was based upon the USGS 2014 seismic hazard maps for a Peak Horizontal Ground Acceleration (PHGA) for seismic loading event with a 2% probability of exceedance in 50 years. The PHGA was factored for the seismic site class in accordance with ASCE 7 *Minimum Design Loads for Buildings and Other Structures, International Building Code*. A seismic coefficient of 0.5 was applied to the PHGA, which is consistent with MSHA's 2009 *Engineering and Design Manual for Coal Refuse Disposal Facilities*, in particular Chapter 7, "Seismic Design: Stability and Deformation Analyses." The manual cites research by Hynes-Griffen and Franklin (1984) which found that for seismic coefficient of 0.5 would result in deformations of less than 3 feet for a safety factor of 1.0.

The probabilistic PHGA for the design earthquake at the Labadie site is 0.180g (that is, 18.0% of standard gravity acceleration of 32.2 feet/sec^2). This value takes into account attenuation of bedrock shaking with distance from the probable sources and general soil interactions such as damping for a hypothetical soil profile. This value is meant to be a conservative estimate. Based upon the data, the most probable earthquake magnitudes (M_w) for these accelerations are between 7.0 and 8.0. We applied a multiplier of 1.440 to the base PHGA to account for the soil profile at the LEC to obtain a site specific PHGA of 0.259g. Therefore, the pseudo-static seismic load was 0.130g, which was used in the re-evaluation of the critical cross-section presented herein.

Liquefaction

The liquefaction slope stability analysis is a post-earthquake, static analysis which includes the effects of potential liquefaction or softening of the soils. Liquefaction occurs when ground shaking is sufficient to produce cyclic particle movements that cause excess pore water pressures to build to the point that most of the shear strength of the soil is lost. Liquefaction occurs in loose sandy soils with less than about 35% fines (soils which are finer than standard U.S. #200 or 0.075mm). Liquefaction can occur in very loose soils with up to 50 percent fines, and soils up to the size of fine gravel. Liquefaction only occurs below the ground water table (phreatic surface). The presence of soil susceptible to liquefaction in the top 50 feet of the soil profile at the LEC typically included the foundation silts and sands. Conservative estimates of post-earthquake or residual shear strengths in the liquefied strata were assumed using a correlation between the normalized residual shear strength ratio for liquefied soils and overburden-correction CPT penetration resistance recommended by Idriss and Boulanger (2008).

Results of Stability Analyses

The slope stability of Section 3 was evaluated for four load cases using the computer program SLIDE 6.0. This program uses the Spencer method, which resolves the static forces on each vertical slice of soil profile along a given circular or irregular assumed failure surface. The program searches for the minimum factor of safety (FS) against slope failure for each center point in the grid by incrementally varying the radius of the failure surface. The plotted results from the program show the minimum FS, the center and radius of the failure surface with the minimum FS. The output of the program also plots contours of equal FS within the grid of possible center points. The input to the slope stability analyses and graphical representations of the results are included in Figures 13 through 16.

The first analysis was the “static” case, using the drained strength properties of the embankment and subsurface soil strata, as shown in Figure 13. The bottom ash was assumed to have no shear strength, which is very conservative but had no effect on the critical failure surfaces through the exterior slope of the embankment. The minimum FS was 2.69, much greater that the minimum acceptable FS of 1.5.

The seismic load was analyzed for both undrained shear strength properties for the embankment and subsurface soil strata (Figure 14) and using the drained shear strength properties (Figure 15). The minimum FS for the seismic-undrained case was 1.99, and 1.85 for the seismic-drained case. The minimum acceptable FS for the seismic load case is 1.0.

The fourth analysis was the post-earthquake condition in which reduced shear strength properties are used in the subsurface soil strata that have been identified as having a high liquefaction potential, as shown in Figure 16. The identification of the liquefiable strata and the post-liquefaction shear strength properties are discussed in the 2016 CCR periodic safety factor assessment. The minimum FS for this condition was 1.69. The minimum FS in the CCR Rule is 1.20.

Therefore, the re-analyses of the slope stability for the critical Section 3 with the proposed modifications demonstrated that the slope stability is acceptable.

SHRINKAGE

R&J excavated test pits at various locations in the BAP and the FAP to measure the *in-situ* densities of the bottom ash and the fly ash. The approximate locations of the test pits are shown in Appendix H in the Data Report. The field densities were measured with a nuclear density gage. Because of the problems associated with measuring the moisture content of CCR with a nuclear density gauge, a bag sample or a drive tube was collected for each field density test. The corrected field dry densities are listed in the Table 1. Test Pits BA-1, BA-2 and BA-3 were made along the southern berm of the BAP. BA-1 and BA-2 were made in temporary roads constructed by Charah for the field investigation using bottom ash. The bottom ash in these 3 test pits were well compacted, with an average dry unit weight (γ_d) or dry density (DD) of 99.9 PCF. Test Pits BA-5 and BA-6 were made in the stockpiled bottom ash. These test pits were excavated in 1-foot increments and the dry density was measured at each increment. Test Pits BA-7 and BA-8 were also made in the stockpiled bottom ash. The DD of the stockpiled bottom ash ranged from 86.3 to 102.9 PCF, and averaged 94.1 PCF. Test Pits BA-9 and BA-10 were made in the bottom ash outside the area of stockpiled bottom ash, and are thought to represent the general bottom ash that has been moved and graded but not compacted. The DD from these 2 test pits averaged 81.8 PCF. The overall average DD of the (corrected) field tests on the bottom ash was 93.7 PCF (see Table 2).

The standard calculation for Shrinkage = $\left(1 - \frac{In\ Situ\ \text{Dry Density}}{\text{Target Dry Density}}\right) x\ 100\%$

For the *in-situ* Dry Density, we recommend using the average *in-situ* Dry Density minus one Standard Deviation. We recommend using a Target Dry Density of 94 PCF for the bottom ash. This was the average DD measured for the stockpiled bottom ash, which represents the level of compaction effort for the placement and grading of the bottom ash in the BAP. It is also the required DD for the construction of the berms of the West Detention Basin (Relative Density, D_r = 75%) for the gray and tan bottom ash from the stockpile. The computed Shrinkage for the bottom ash field density tests are listed in Table 2. The overall Shrinkage for the bottom ash is about 8% if the Standard Deviation of the field density tests is included.

The standard calculation of Shrinkage Factor (SF) = 1 – Shrinkage/100% = $\left(\frac{In\ Situ\ \text{Dry Density}}{\text{Target Dry Density}} \right)$

The overall SF for the bottom ash is 0.92. We recommend using a non-weighted average of 0.9.

SUITABILITY OF SOIL FOR VEGETATIVE COVER

The outside of the east end of the southern embankment of the BAP is to be excavated to a depth of about 5 feet. The construction plans show that the southern embankment was raised in 1989-1990 by placing a mixture of bottom ash and fly ash on the exterior (southern) face of the embankment as well as the top, with a 1-foot soil cap. Therefore, most of the excavated material from the southern embankment of the BAP will be CCR and will have to be disposed of in the BAP; it will not be suitable for the vegetative cap. In addition, 2 feet of the CCR fill will have to be removed to construct the closure cap on the exposed CCR in the outside face of the embankment.

Approximately 15 feet of the outside portion of the existing perimeter embankment of the FAP is to be excavated. The fill used to construct the perimeter embankment of the FAP was excavated from the top few feet of the soil in the interior of the FAP. It appears that this will be suitable material for the vegetative cap. The fill is probably heterogeneous and was placed in thin lifts. Some of the fill material may be unsuitable for the vegetative cover, for example sand or non-plastic silt which is highly erodible. Up to one-half of the excavated fill material may not be suitable for the clay cap for the BAP. The unsuitable excavated soil may need to be segregated, or mixed with the clayey soil to make a suitable mix for the vegetative cover.

CONSTRUCTABILITY

Most of the major difficulties in closing of CCR ponds is the constructability of the CCR, in particular drying of the CCR so that it may be placed and compacted, and trafficability. The bottom ash is similar to a fine sand in that it dries fairly quickly. The fly ash does not tend to lose moisture unless it is disced and spread out. A pile of fly ash does not lose moisture content by gravity.

Charah was able to build roads across the BAP for the exploration borings and CPT sounding using 2 to 3 feet of dried bottom ash from the stockpile after the ground water level in the BAP had been lowered 3 feet or more below the working surface. It should not be necessary to use a woven geotextile or geo-grid to reinforce the base of temporary roads within the BAP if the ground water level is lowered and construction equipment with low ground pressure is used. The contractor will be responsible for planning of haul roads, selection of equipment, and means and methods.

RECOMMENDATIONS FOR EARTHWORK

Clearing and Grubbing

The majority of the BAP is overgrown with various grasses, small shrubs and some large trees. The grasses and fine vegetation may be plowed into the CCR. The woody vegetation and trees are a problem because surface settlement may occur where the woody vegetation is concentrated and as it rots. Also, it would be difficult to get compaction of the CCR around the fallen trees. The thick woody vegetation and trees should be removed.

Compaction of CCR

The compaction of the CCR fill is needed to control settlement due to consolidation within the fill. If the CCR fill is compacted sufficiently for trafficability then it should be adequate for compaction of the clay cap and vegetative cover. As stated above, the target DD for the bottom ash is 94 PCF, and 83 PCF for the fly ash. The contractor should cooperate with the CQA Engineer to establish a compaction procedure at the start of the fill. The contractor should propose the compaction equipment and procedures, such as a minimum of two uniform complete coverages with a tracked bulldozer or loader with a minimum applied ground pressure of 1350 PSF. The contractor should construct a test pad of sufficient size to test the operation of the proposed compaction equipment. The CQA Engineer will test the density obtained and make recommendations of equipment, moisture content conditioning, or procedures necessary to achieve the minimum desired dry unit weight. Field density testing of the CCR should not be required. The CQA

Engineer may perform periodic field density tests to monitor whether the target DD are being achieved or if the CCR fill is being over-compacted, resulting in greater "Shrinkage."

Compaction of Clay Cap

The clay should be placed in 6- to 8-inch lifts, and compacted using a pad-foot or similar kneading type of compactor – not by a vibratory compactor. The minimum compaction should be 95% of the maximum dry unit weight as determined by the Standard Proctor Moisture-Density Test (ASTM D698). We recommend a minimum of one field density test for every 1 acre if the placement and compaction is under full-time observation by an experienced and qualified soils technician.

We recommend a full set of laboratory tests on the clay cap material a minimum of every 25,000 C.Y. or when there is a change in the borrow source or the material classification. A full set of laboratory tests should include a standard Proctor moisture-density test, percent passing U.S. #200 sieve, a hydraulic conductivity test and Atterberg liquid and plastic limits tests.

Compaction of Vegetative Cover

Compaction of the vegetative cover should be accomplished by a minimum of two uniform complete coverages with a tracked bulldozer or loaded with a minimum applied ground pressure of 1000 PSF. The CQA Engineer or his representative should observe to verify the compaction effort.

Excavations

Construction of the perimeter storm water pipes will require excavations up to about 20 feet deep, unless the pipes are installed by directional boring. If installed by excavation, the contractor will have to use temporary slopes or shoring, or a combination. Temporary slopes through the CCR mix used to raise the southern embankment of the BAP will have to be cut to 3(H)-to-1(V) or flatter if there is seepage out of the cut slope. Temporary slopes in the soil fill may be cut to 2(H)-to-1(V) or flatter. The excavations will have to be designed by a registered Professional Engineer in accordance with OSHA Section 1926, Subpart P – Excavations.

Ameren Labadie Ash Pond Closures

TABLE 1 - RESULTS OF FIELD DENSITY TESTS ON CCP

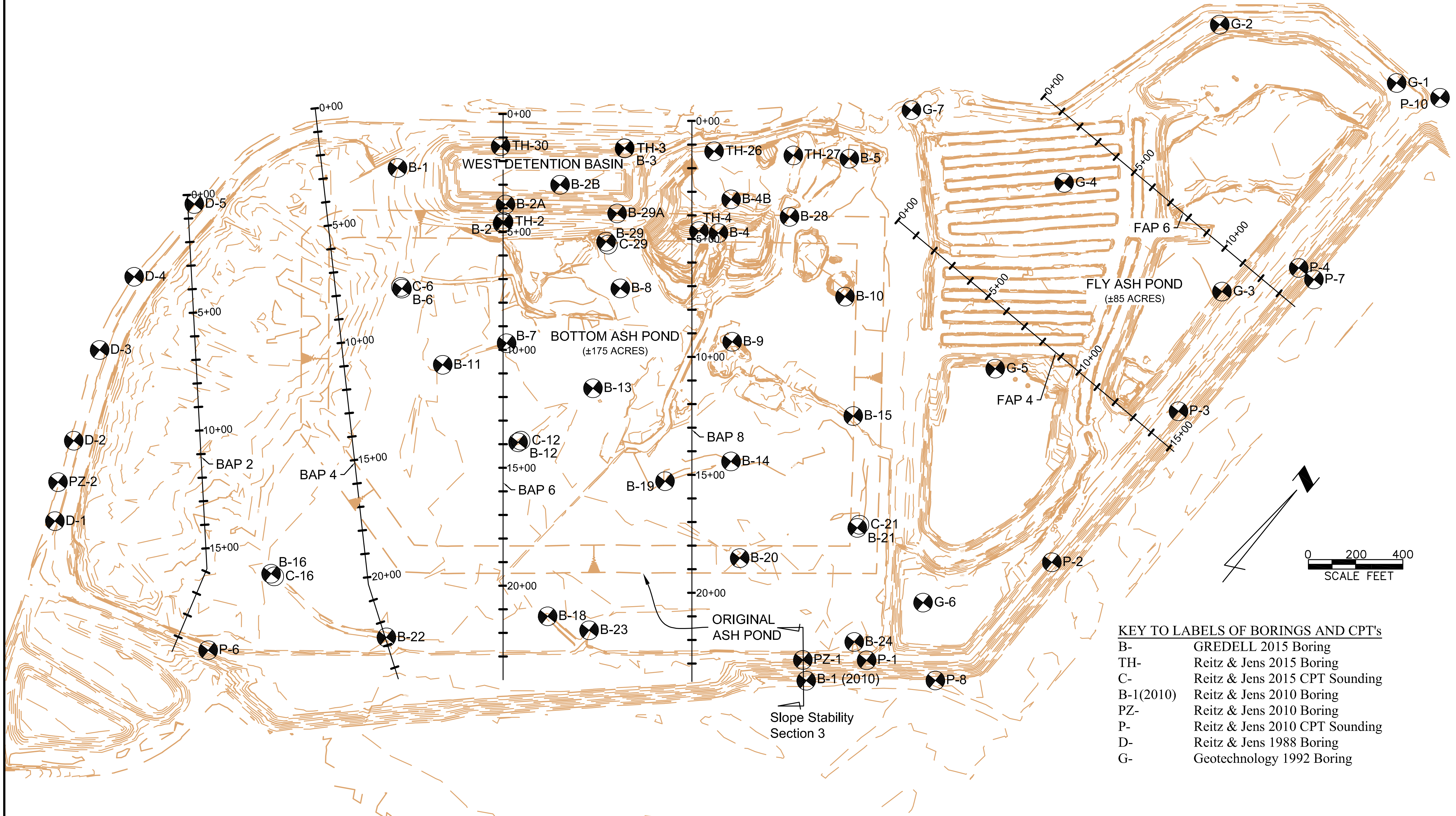
			Nuclear Density Gauge			Laboratory Results		Corrected Nuclear Field Dry Density pcf	Corrected Field Dry Density		Ratio Oven MC to Nuke MC	Ratio of Oven MC to Nuke MC		Oven MC at Lower Temp. %	Ratio High Oven MC to Low Oven MC
	Test No.	Depth feet	Moist Density pcf	Dry Density pcf	Moisture Content %	Tube Dry Density pcf	Moisture Content %		Average pcf	S.D. pcf		Average	Stand. Dev.		
South Berm	BA-1	0	114.0	110.7	3.0	No Tube Densities - Bottom Ash Sample not retained in tubes.	7.1	106.4	99.9	4.6	2.37	2.22	0.75		
	BA-2	0	101.5	98.6	2.9		5.6	96.1			1.94				
	BA-3	0	103.9	100.2	3.7		6.8	97.3			1.84				
Bottom Ash Stockpile	BA-5 Test Pit	0	105.3	103.3	1.9		4.5	100.8	94.1	5.0	2.36				
		1	109.8	107.3	2.3		6.7	102.9			2.91				
		2	101.1	98.6	2.5		7.1	94.4			2.82				
		3	98.1	94.3	4.0		13.6	86.3			3.41				
		4	100.7	97.7	3.1		10.3	91.3			3.34				
	BA-6 Test Pit	0	99.4	96.7	2.8		6.1	93.7			2.17				
		1	101.2	97.7	3.6		9.7	92.3			2.68				
		2	105.0	99.1	6.0		14.4	91.8			2.41				
		3	100.2	95.7	4.7		12.1	89.4			2.57				
		4	96.8	92.5	4.6		9.0	88.8			1.96				
	BA-7	0	104.9	102.3	2.5		5.1	99.8			2.04				
	BA-8	0	102.2	99.7	2.5		4.5	97.8			1.82			0.46	9.87
BA Pond	BA-9	0	87.4	72.7	20.2		10.8	78.9	81.8	2.9	0.53			5.6	1.93
	BA-10	0	92.6	81.1	14.2		9.3	84.7			0.65			4.1	2.27
Older Stockpile	FA-1 Test Pit	0	92.2	76.6	20.3	78.6	24.4	74.1	83.1	6.7	1.20	1.60	-0.41	32.35	0.75
		1	112.7	97.6	15.5	78.6	30.0	86.7			1.94			38.63	0.78
		2	102.1	91.6	11.5		13.2	90.2			1.15			16.14	0.82
		3	101.8	92.9	9.6	86.2	15.8	87.9			1.65			14.86	1.06
		4	98.1	82.8	18.4	71.7	32.2	74.2			1.75			41.95	0.77
Older Stockpile	FA-2 Test Pit	0	89.7	76.3	17.5	75.7	23.3	72.7			1.33			33.31	0.70
		1	103.9	85.7	21.2		17.0	88.8			0.80			23.27	0.73
		2	112.7	99.8	12.9		23.6	91.2			1.83			27.14	0.87
		3	99.2	86.3	14.9	84.9	19.4	83.1			1.30			25.44	0.76
		4	104.0	89.3	16.4	81.5	27.4	81.6			1.67			29.56	0.93
Newer Stockpile	FA-3 Test Pit	0	106.4	103.5	2.8	92.4	6.0	100.4	72.3	14.5	2.14			14.8	0.41
		1	96.0	82.2	16.8	67.2	33.0	72.2			1.96			39.95	0.83
		2	95.5	79.1	20.7	77.4	27.7	74.8			1.34			28.2	0.98
		3	89.0	73.1	21.7	69.0	29.0	69.0			1.34			32.03	0.91
		4	84.5	59.8	41.2	53.0	67.6	50.4			1.64			74.32	0.91
Newer Stockpile	FA-4 Test Pit	0	103.8	93.6	10.9		20.1	86.4			1.84			16.8	1.20
		1	104.1	86.6	20.2	70.2	31.9	78.9			1.58			32.2	0.99
		2	100.7	85.2	18.3		26.9	79.4			1.47			28.46	0.95
		3	91.5	67.2	36.2	58.4	66.4	55.0			1.83			62.21	1.07
		4	95.7	70.0	36.8	56.2	67.9	57.0			1.85			63.65	1.07
	FA-5	0	118.2	116.8	1.2		3.2	114.5	103.0	11.6	2.67				
	FA-6	0	97.6	91.0	7.2		6.8	91.4			0.94				
	FA-7	Trench	Drive Tube Only			69.4	49.5		70.5	1.0				47.6	1.04
	FA-8	Trench	Drive Tube Only			71.5	40.8							55.5	0.74
														Max.	1.20
								All Fly Ash	82.2	5.1				Min.	0.41
														Average	0.87

Ameren Labadie Ash Pond Closures

TABLE 2 - SHRINKAGE AND SHRINKAGE FACTORS

		Average *In-Situ* Dry Density PCF	Standard Deviation *In-Situ* DD PCF	Ratio Target DD *(In-Situ DD - Stand. Dev.)*	Standard Shrinkage %	Standard Shrinkage Factor
Bottom Ash	Stockpiled	94.1	5.0	1.05	5.2	0.95
	South Berm	99.9	4.6	0.99	-1.4	1.01
	Non-Stockpiled	81.8	2.9	1.19	16.1	0.84
	All Bottom Ash Tests	93.7	6.8	1.08	7.5	0.92
Fly Ash	Older Stockpiled	83.1	6.7	1.09	8.0	0.92
	Recent Stockpiled	72.3	14.5	1.44	30.3	0.70
	All Stockpiled	77.7	12.5	1.27	21.5	0.79
	Trenches	70.5	1.0	1.20	16.3	0.84
	All Fly Ash Tests	82.2	5.1	1.08	7.1	0.93

Notes: Target Dry Density (DD) for bottom ash is 94.0 PCF. Target DD for fly ash is 83.0 PCF.
Standard Shrinkage = [1 - (Avg. DD - Stand. Dev. DD)/Target DD] x 100%
Shrinkage Factor = 1 - (Stand. Shrinkage)/100



KEY TO LABELS OF BORINGS AND CPT's

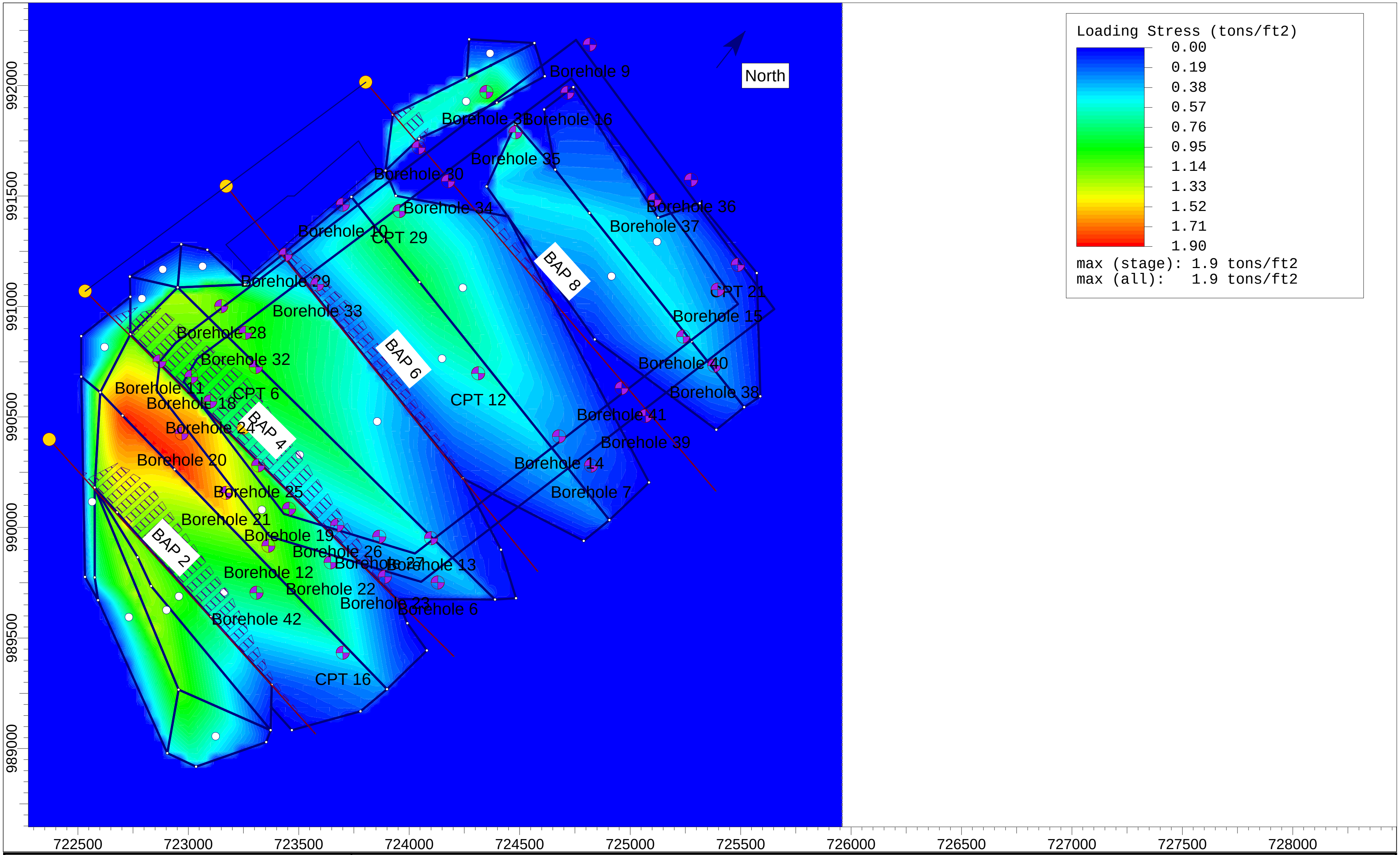
B-	GREDELL 2015 Boring
TH-	Reitz & Jens 2015 Boring
C-	Reitz & Jens 2015 CPT Sounding
B-1(2010)	Reitz & Jens 2010 Boring
PZ-	Reitz & Jens 2010 Boring
P-	Reitz & Jens 2010 CPT Sounding
D-	Reitz & Jens 1988 Boring
G-	Geotechnology 1992 Boring

Note: Existing contours & features provided by Kuhlmann Design Group, Inc. on October 26, 2015, and June 16, 2017. Actual conditions may vary.

Ameren Missouri Labadie
Bottom Ash and Fly Ash Ponds Closure
APPROXIMATE LOCATIONS OF BORINGS,
CPT SOUNDINGS, PROFILES AND SECTION

Reitz & Jens, Inc.

Figure 1

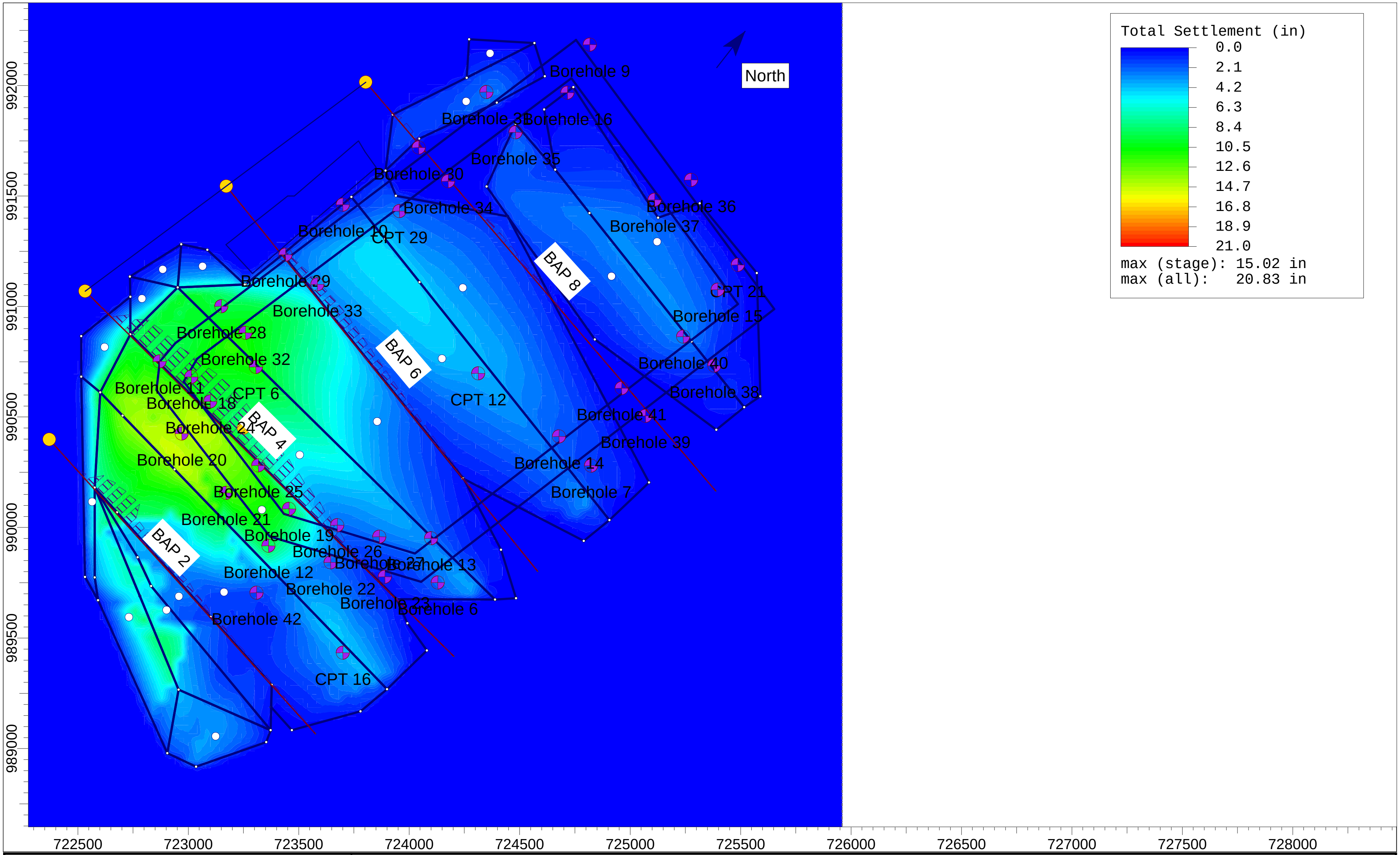


SETTLE3D 3.020

Project	Gredell: Labadie Bottom Ash Pond
Analysis Description	Plan of Surface Loads for New Grading Plan

Drawn By	LAS	*Company*	Reitz & Jens, Inc.
Date	8/2/2017	*File Name*	Settlement Estimate Shelf New Grading 3.s3z

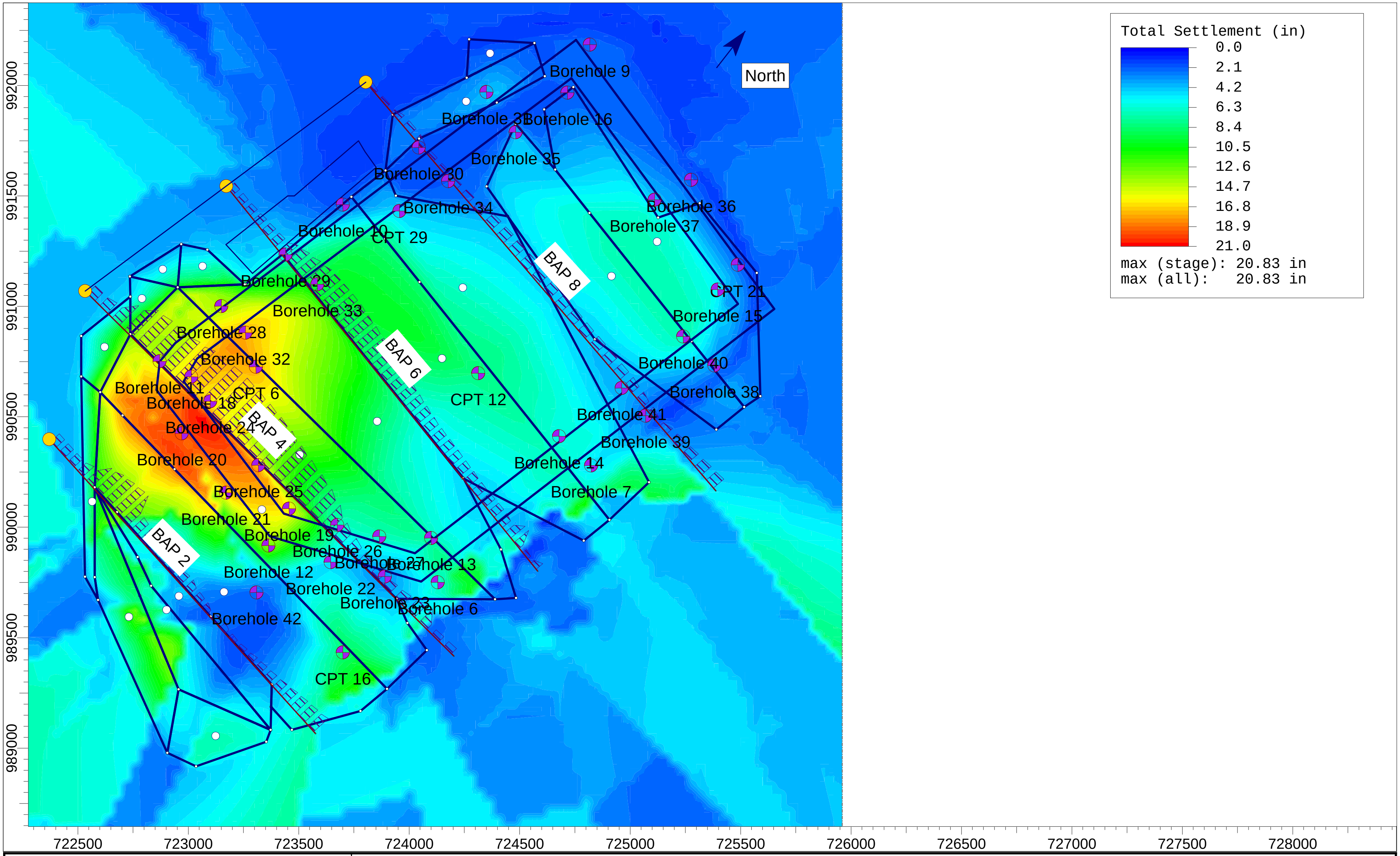
Figure 2



SETTLE3D 3.020

Project	Gredell: Labadie Bottom Ash Pond
Analysis Description	Settlement Due to New CCR Fill in New Grading Plan
Drawn By	LAS
Company	Reitz & Jens, Inc.
Date	8/2/2017
File Name	Settlement Estimate Shelf New Grading 3.s3z

Figure 3



SETTLE3D 3.020

Project
Gredell: Labadie Bottom Ash Pond

Analysis Description
Total Settlement Due to CCR Fills and Dewatering

Drawn By
LAS

Company
Reitz & Jens, Inc.

Date
8/2/2017

File Name
Settlement Estimate Shelf New Grading 3.s3z

Figure 4

Ameren Missouri Labadie Bottom Ash Pond Closure
INITIAL AND TOTAL SETTLEMENT
ALONG PROFILE BAP2

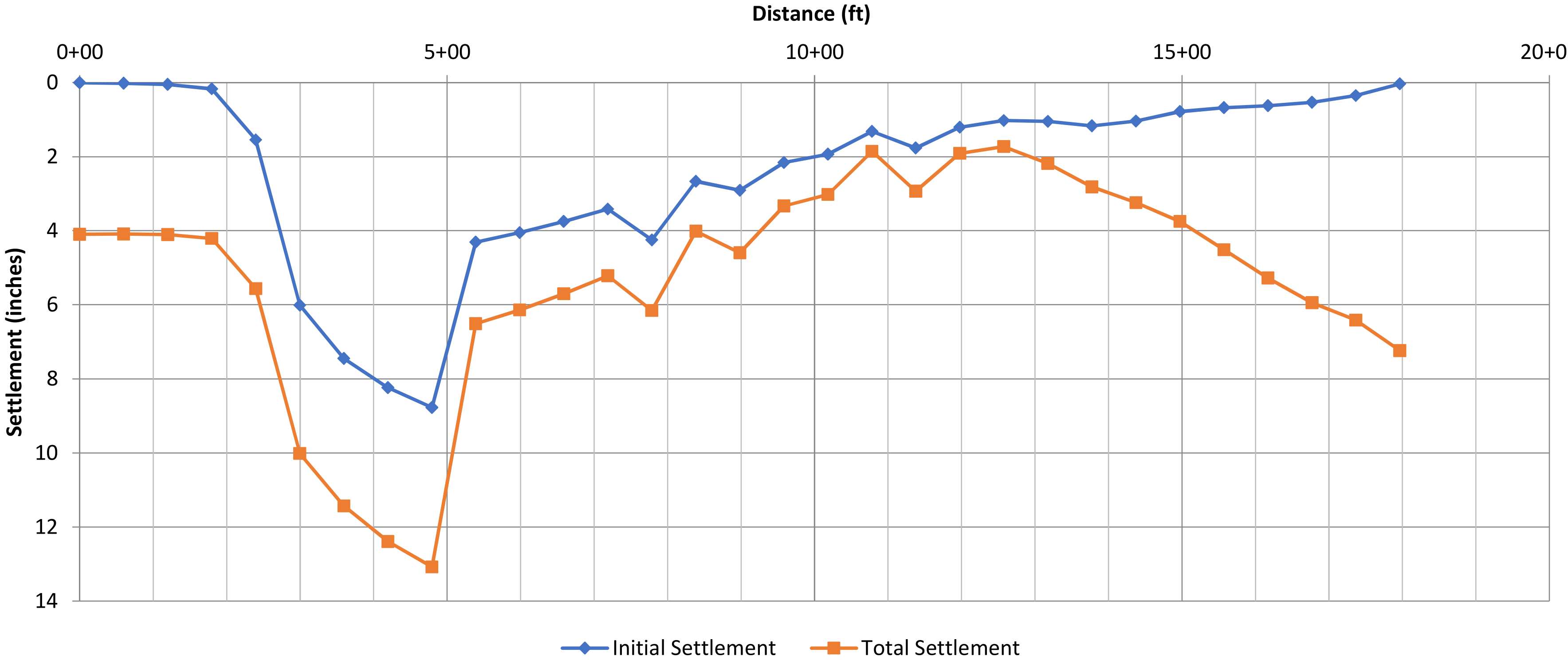


Figure 5

Ameren Missouri Labadie Bottom Ash Pond Closure
DESIGN & NET FINAL GRADE
ALONG PROFILE BAP2

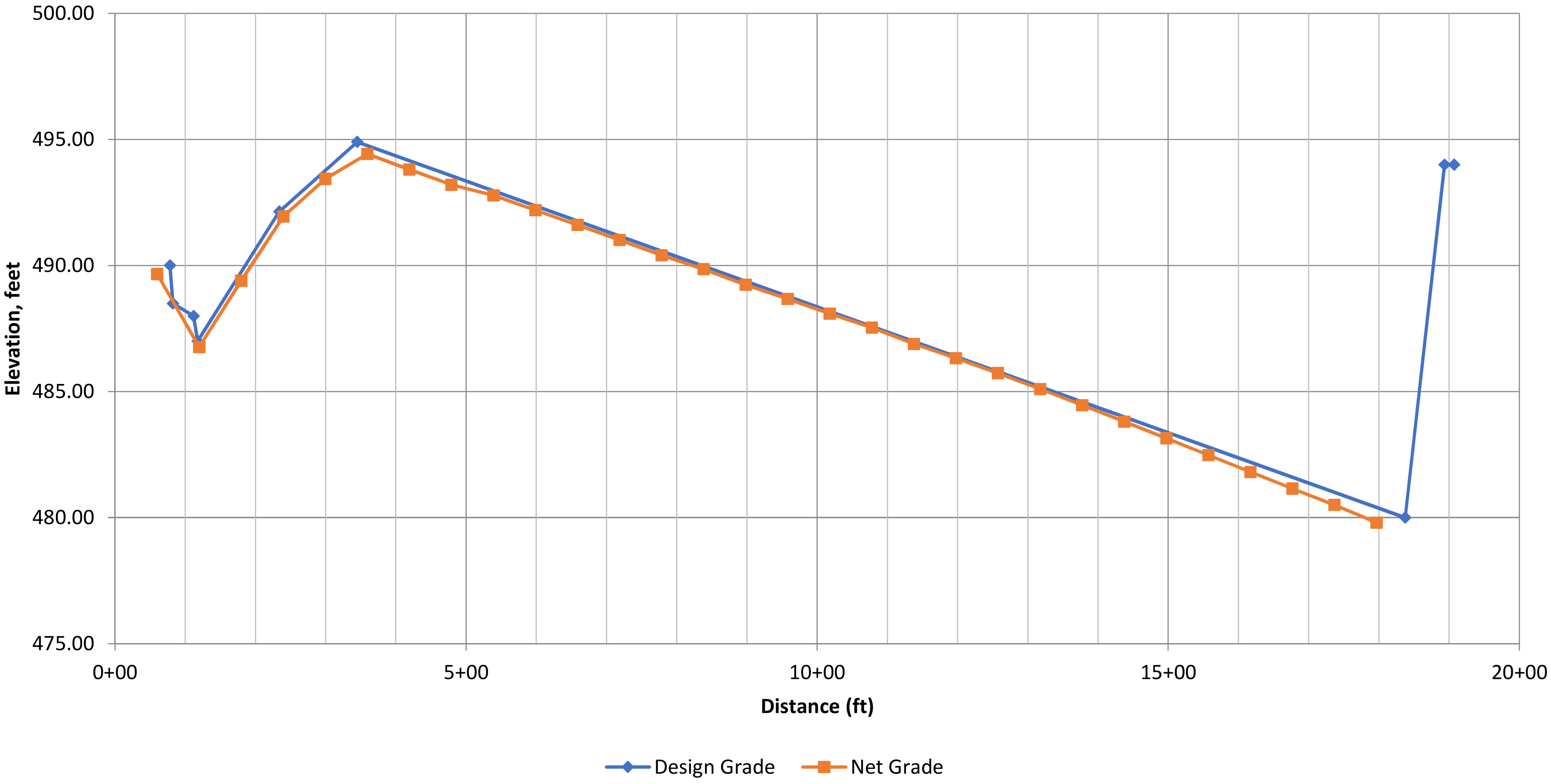


Figure 6

Ameren Missouri Labadie Bottom Ash Pond Closure
INITIAL AND TOTAL SETTLEMENT
ALONG PROFILE BAP4

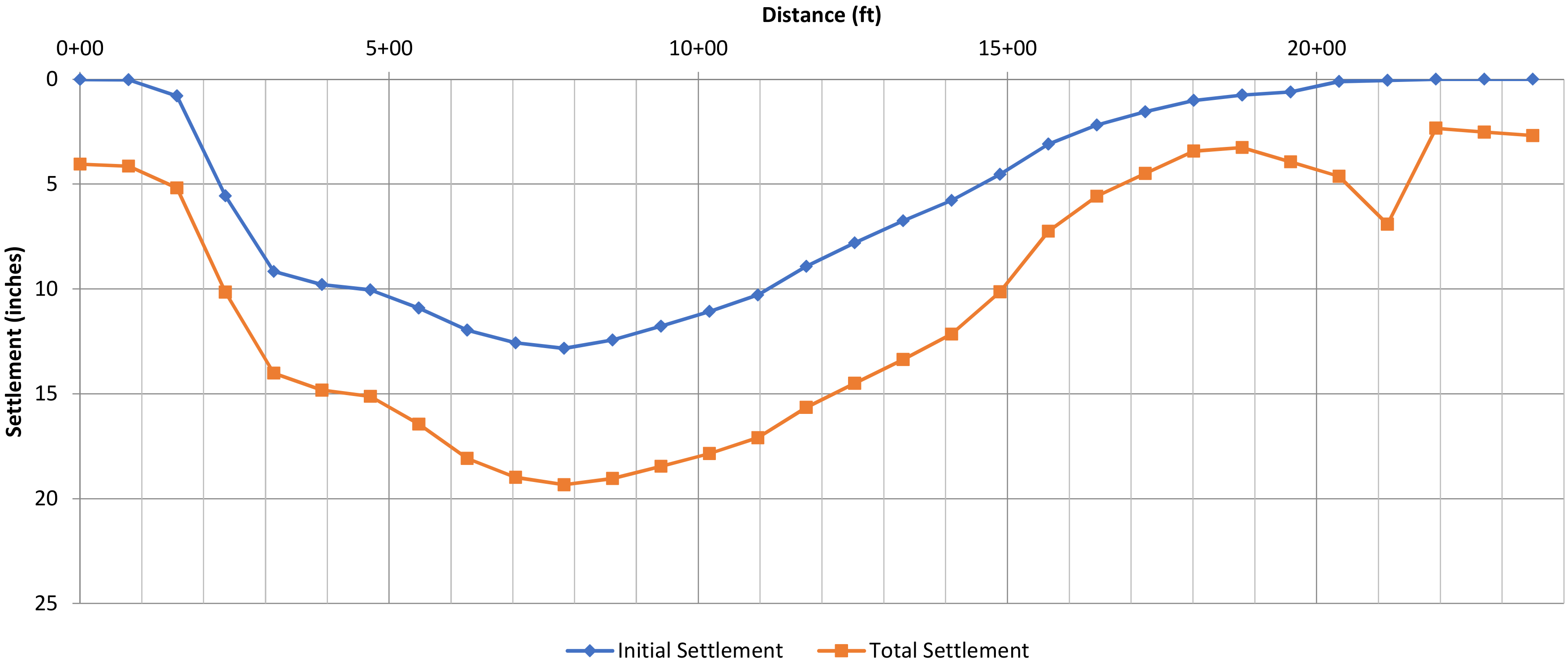
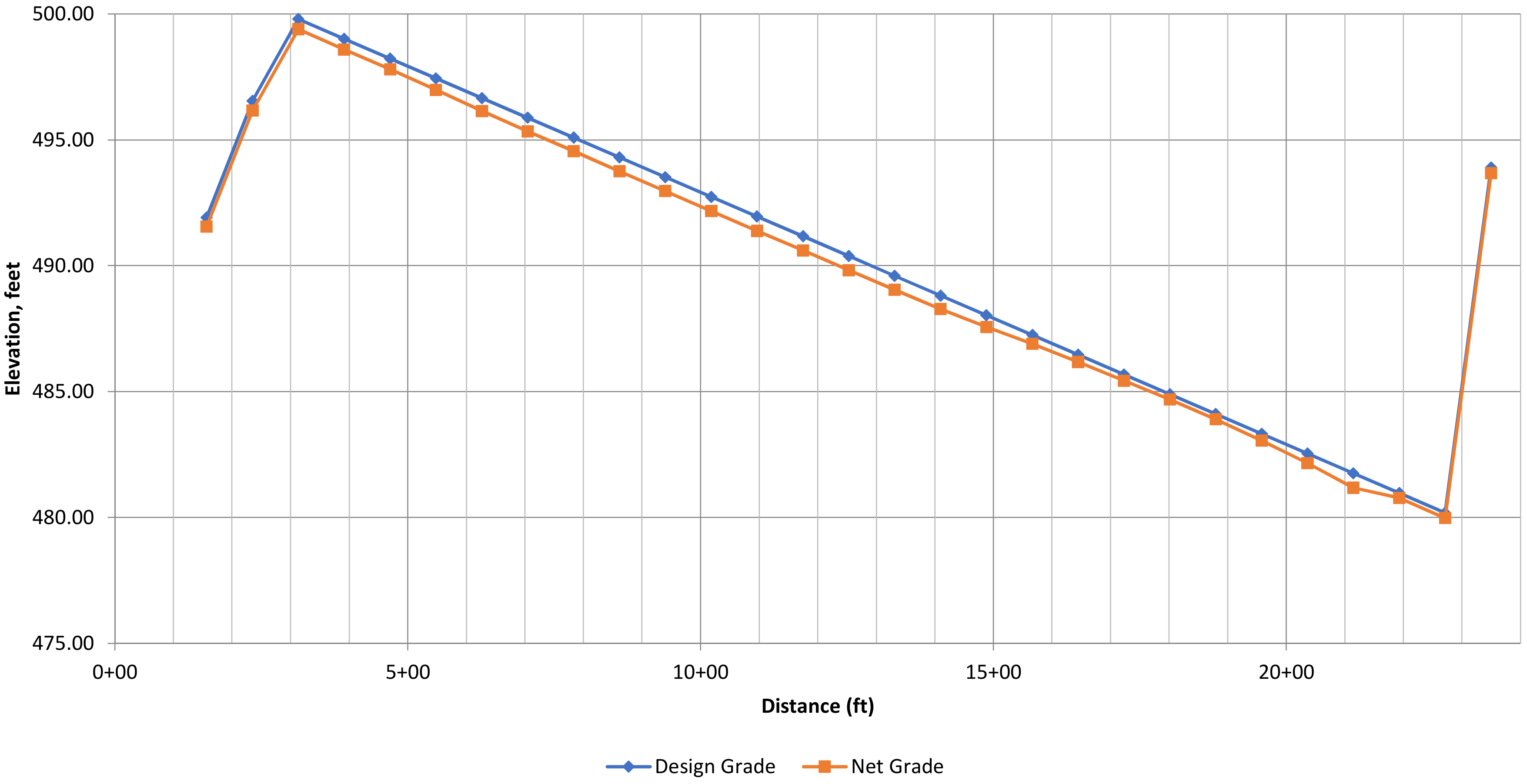


Figure 7

Ameren Missouri Labadie Bottom Ash Pond Closure
DESIGN & NET FINAL GRADE
ALONG PROFILE BAP4



Ameren Missouri Labadie Bottom Ash Pond Closure
INITIAL AND TOTAL SETTLEMENT
ALONG PROFILE BAP6

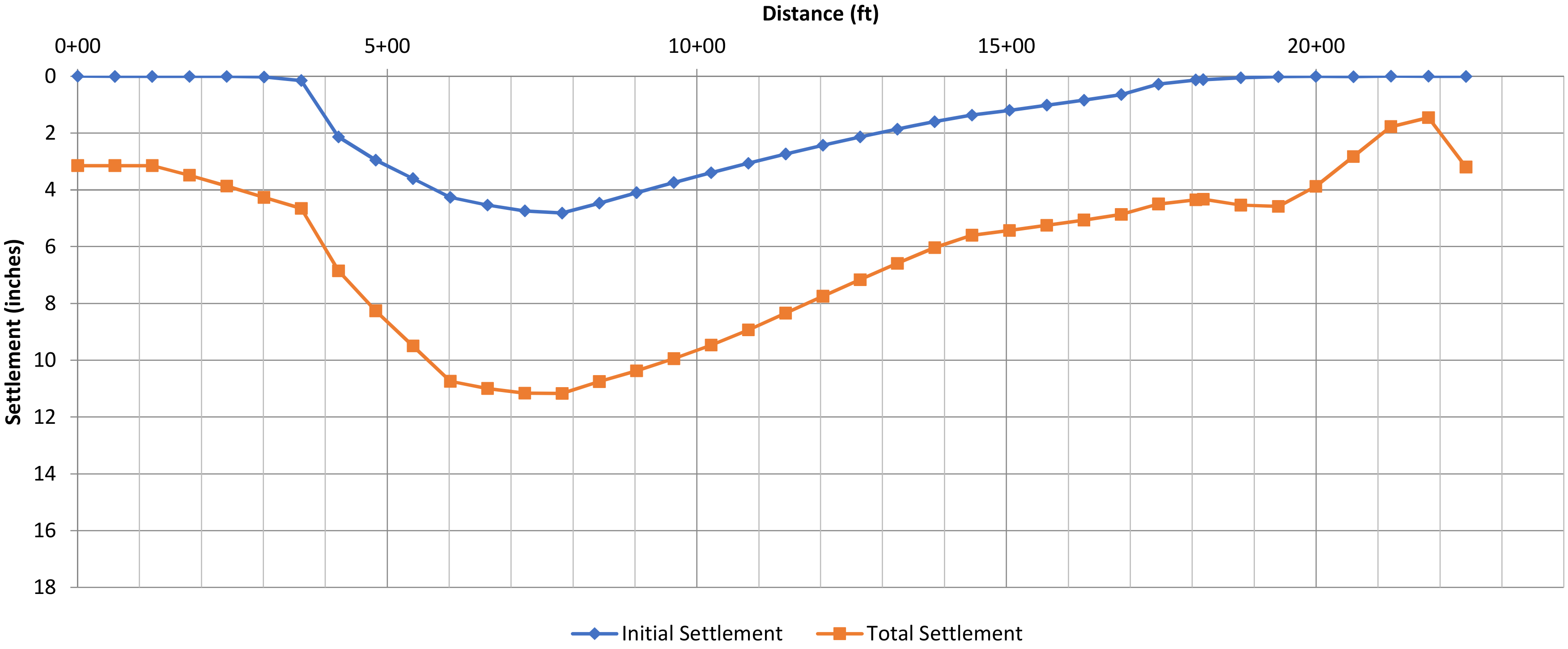


Figure 9

Ameren Missouri Labadie Bottom Ash Pond Closure
DESIGN & NET FINAL GRADE
ALONG PROFILE BAP6

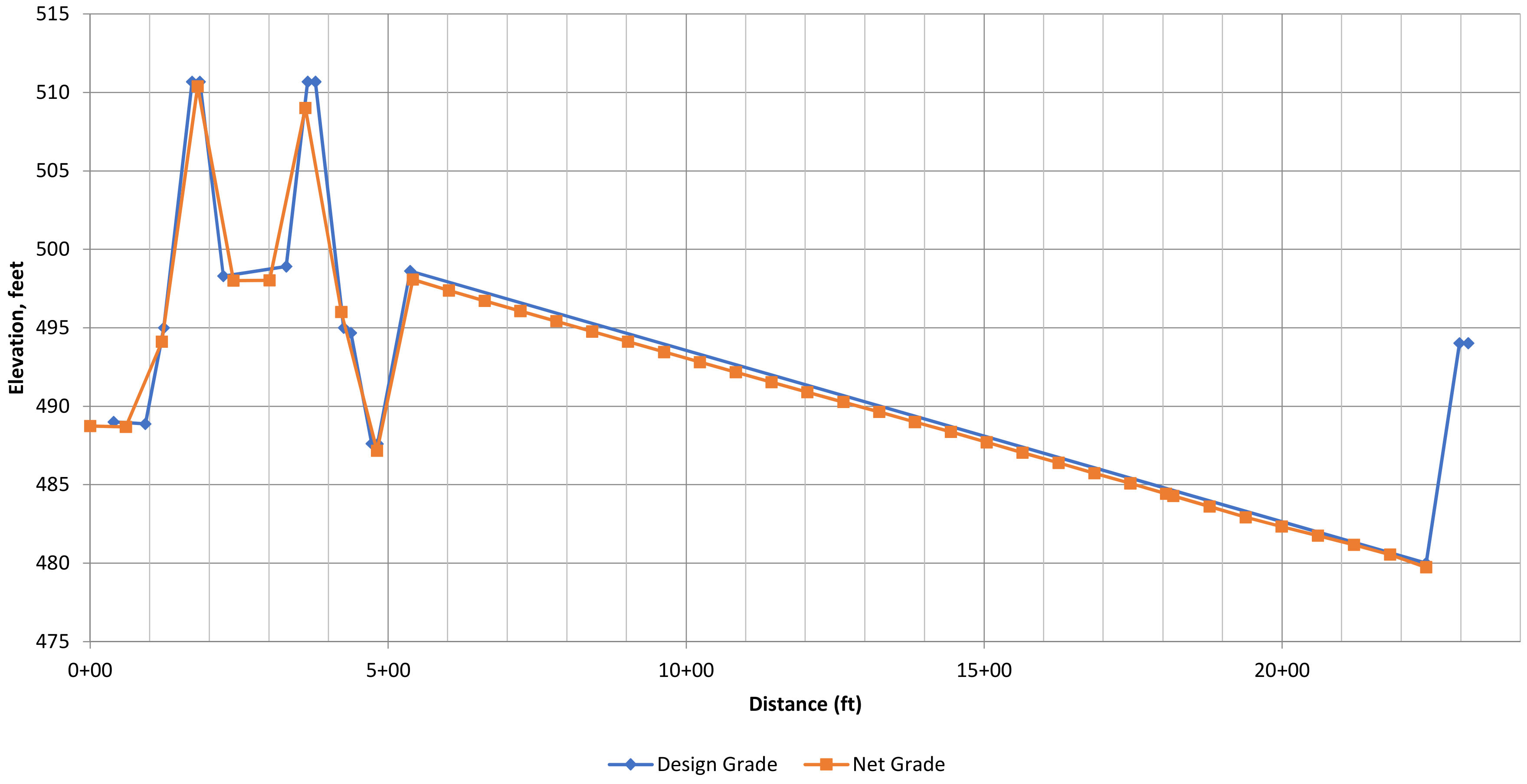


Figure 10

Ameren Missouri Labadie Bottom Ash Pond Closure
INITIAL AND TOTAL SETTLEMENT
ALONG PROFILE BAP8

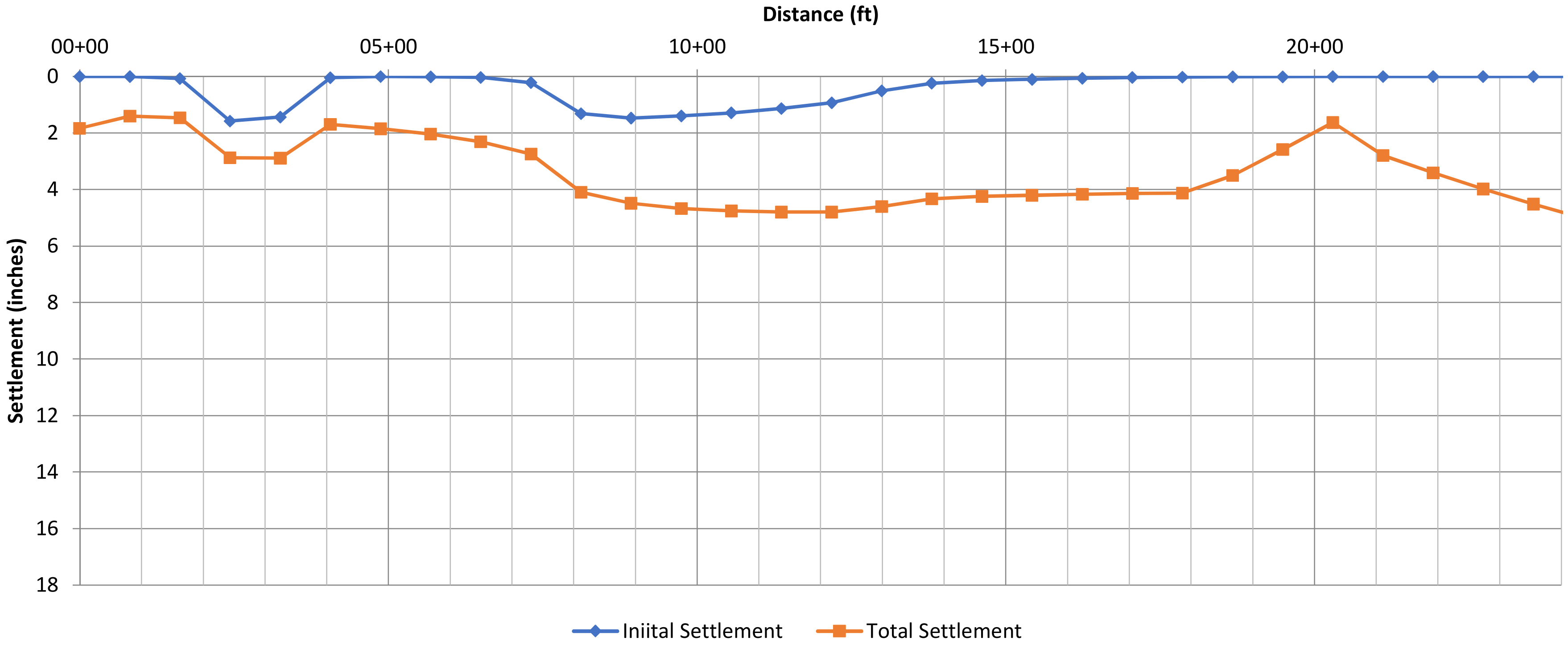
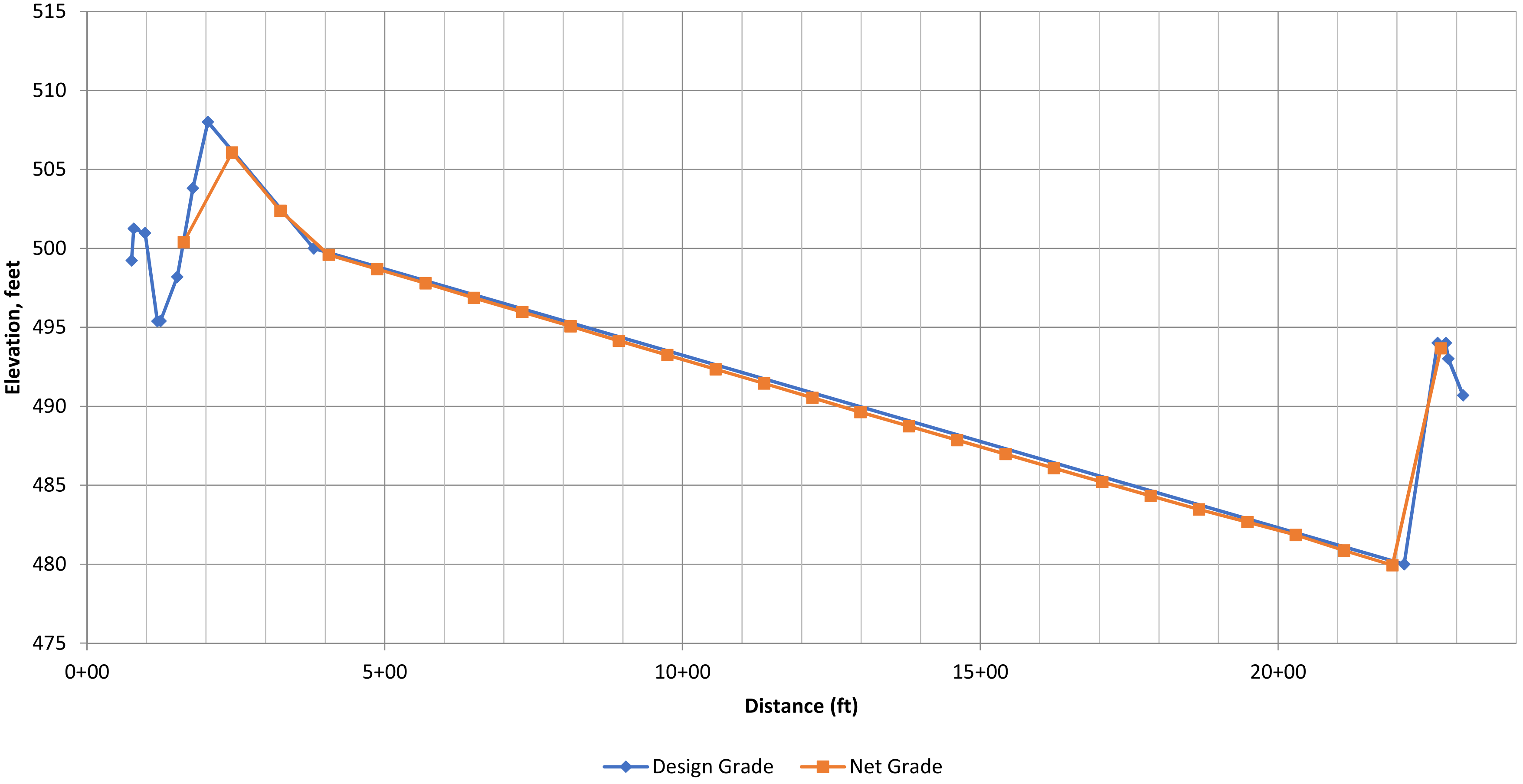


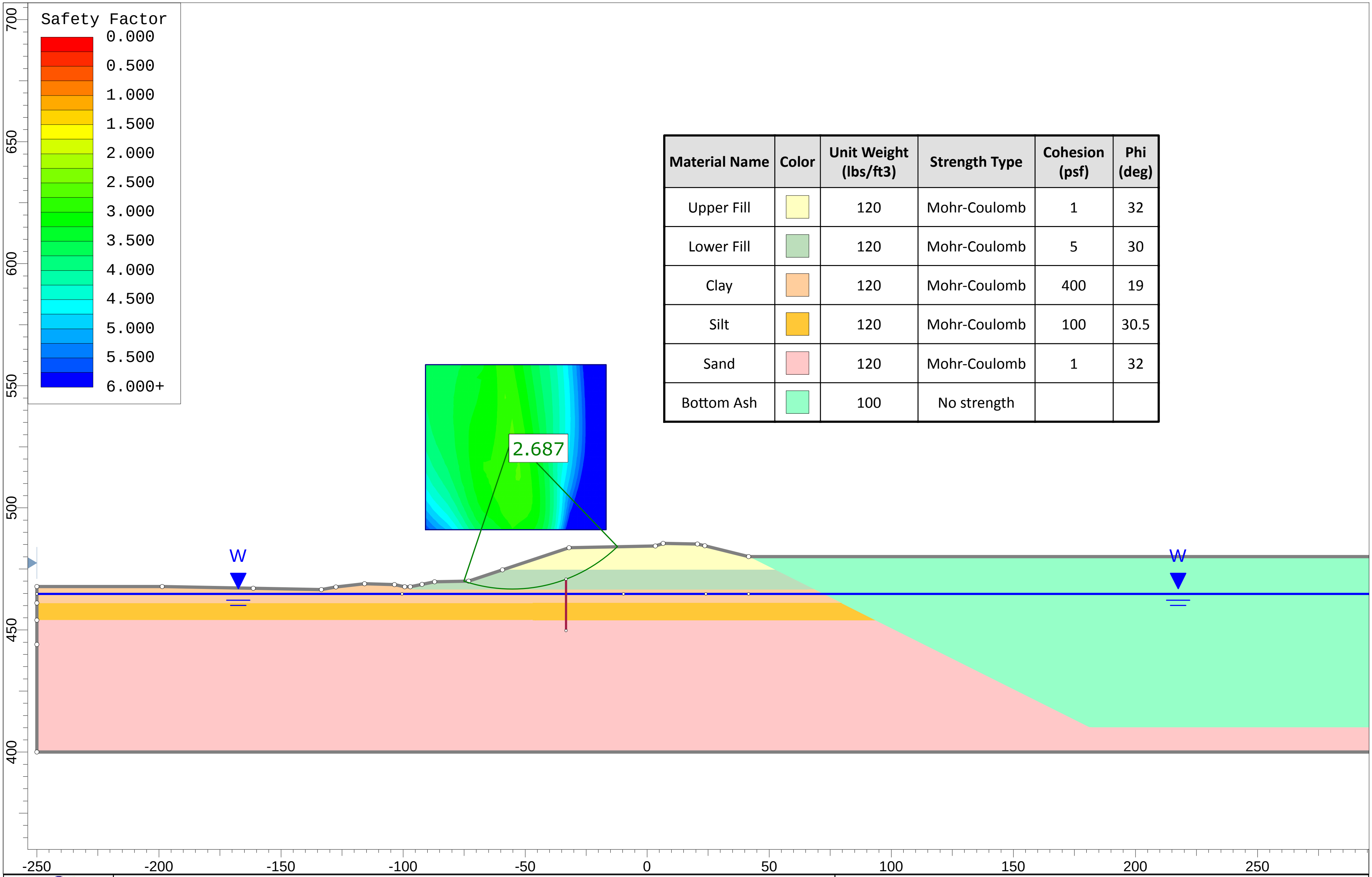
Figure 11

Ameren Missouri Labadie Bottom Ash Pond Closure
DESIGN & NET FINAL GRADE
ALONG PROFILE BAP8



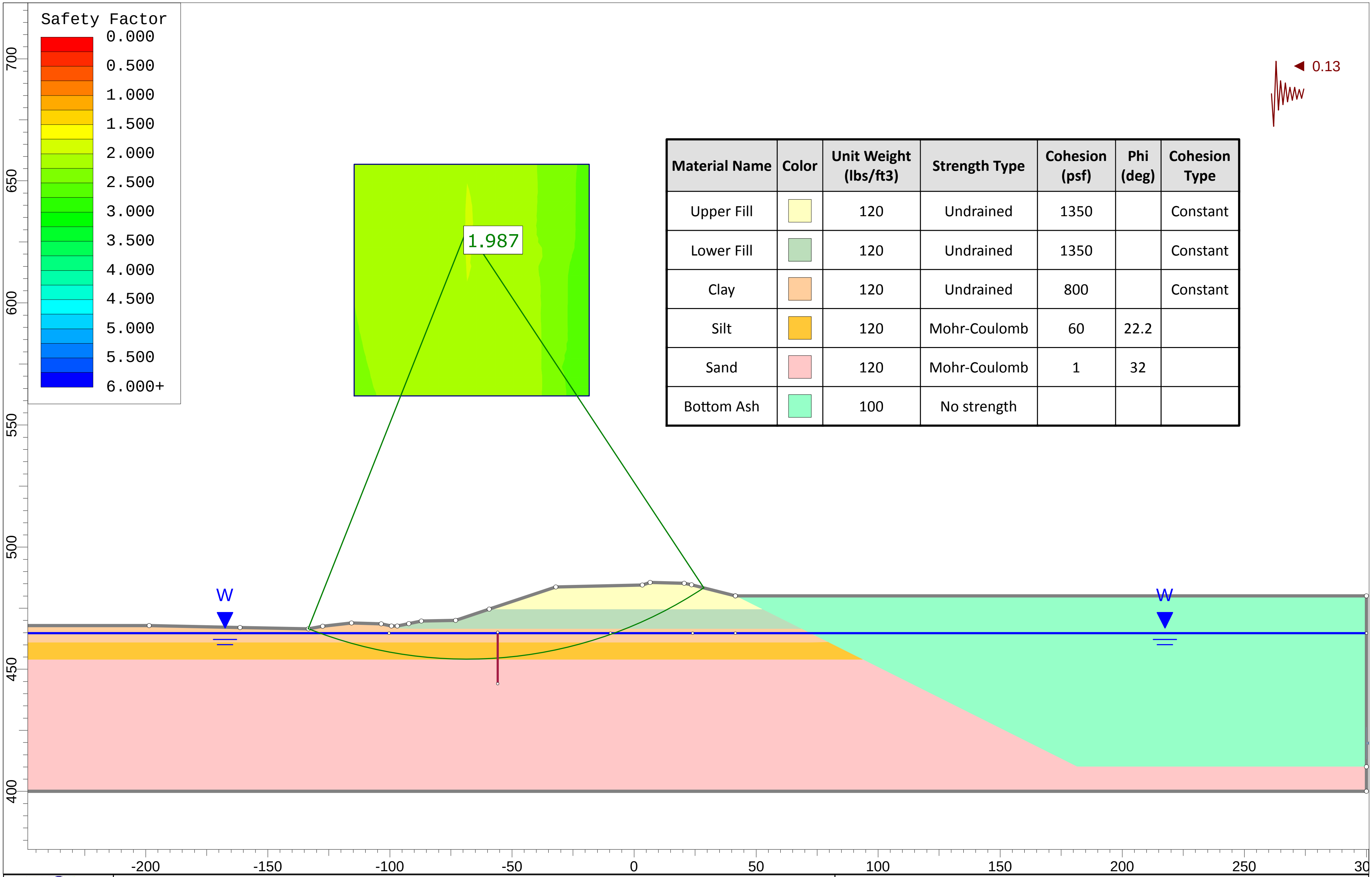
REITZ & JENS, INC.

Figure 12



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	120	Mohr-Coulomb	1	32
Lower Fill	🟩	120	Mohr-Coulomb	5	30
Clay	🟧	120	Mohr-Coulomb	400	19
Silt	🟧	120	Mohr-Coulomb	100	30.5
Sand	🟥	120	Mohr-Coulomb	1	32
Bottom Ash	🟩	100	No strength		

Project Name: Labadie Bottom Ash Pond Closure
Client: Gredell
Section Location: Section 3 - Bottom Ash Pond
Load Case: Static
Project Number: 2015120902
Analysis By: J. Bertel
Checked By: L. Sutton
Figure: 13



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type
Upper Fill	🟨	120	Undrained	1350		Constant
Lower Fill	🟩	120	Undrained	1350		Constant
Clay	🟧	120	Undrained	800		Constant
Silt	🟧	120	Mohr-Coulomb	60	22.2	
Sand	🟥	120	Mohr-Coulomb	1	32	
Bottom Ash	🟩	100	No strength			

Project Name: Labadie Bottom Ash Pond Closure

Client: Gredell

Section Location: Section 3 - Bottom Ash Pond

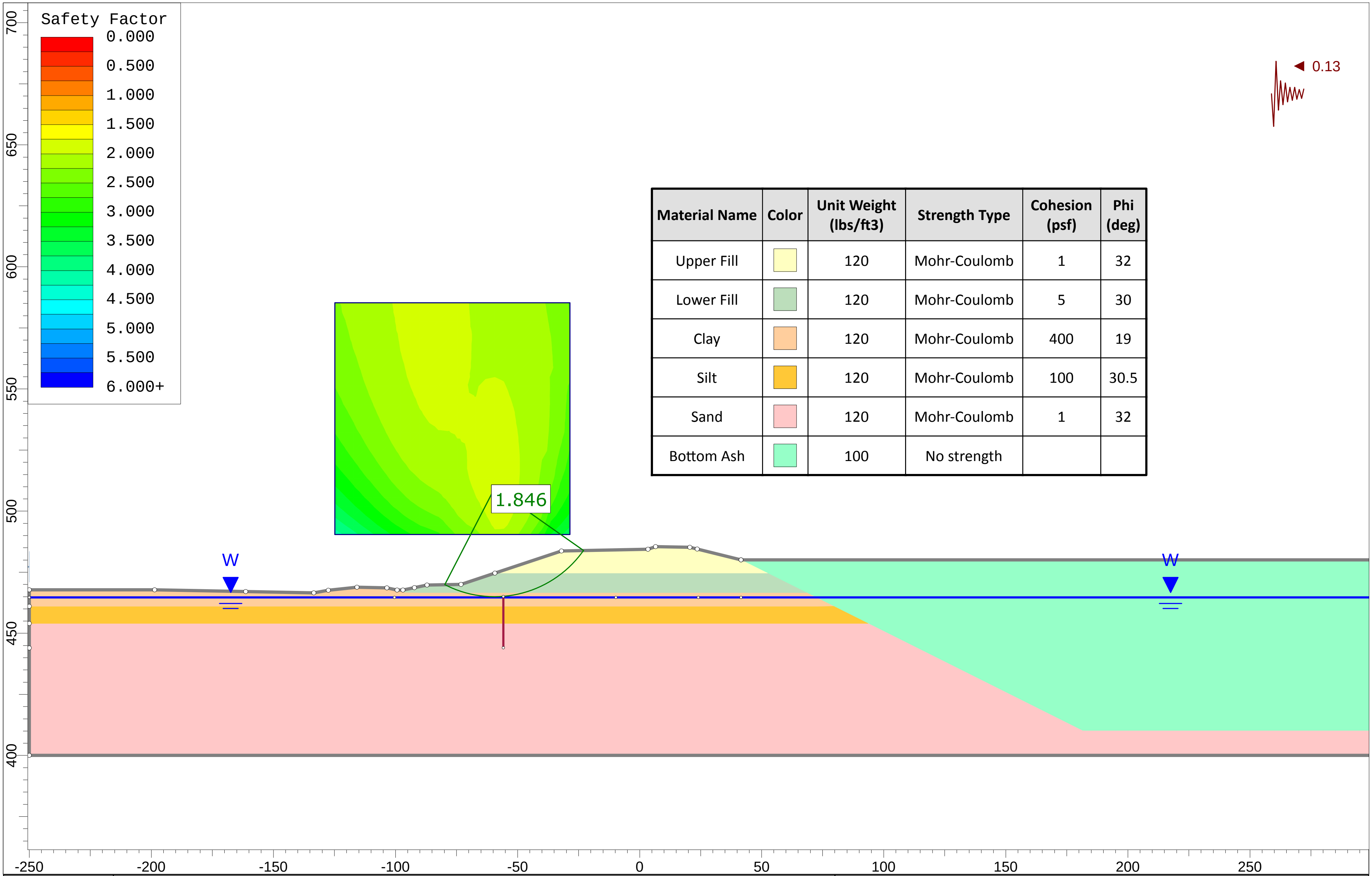
Load Case: Seismic Undrained

Project Number: 2015120902

Analysis By: J. Bertel

Checked By: L. Sutton

Figure: 14



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Upper Fill	■	120	Mohr-Coulomb	1	32
Lower Fill	■	120	Mohr-Coulomb	5	30
Clay	■	120	Mohr-Coulomb	400	19
Silt	■	120	Mohr-Coulomb	100	30.5
Sand	■	120	Mohr-Coulomb	1	32
Bottom Ash	■	100	No strength		

Project Name: Labadie Bottom Ash Pond Closure

Client: Gredell

Section Location: Section 3 - Bottom Ash Pond

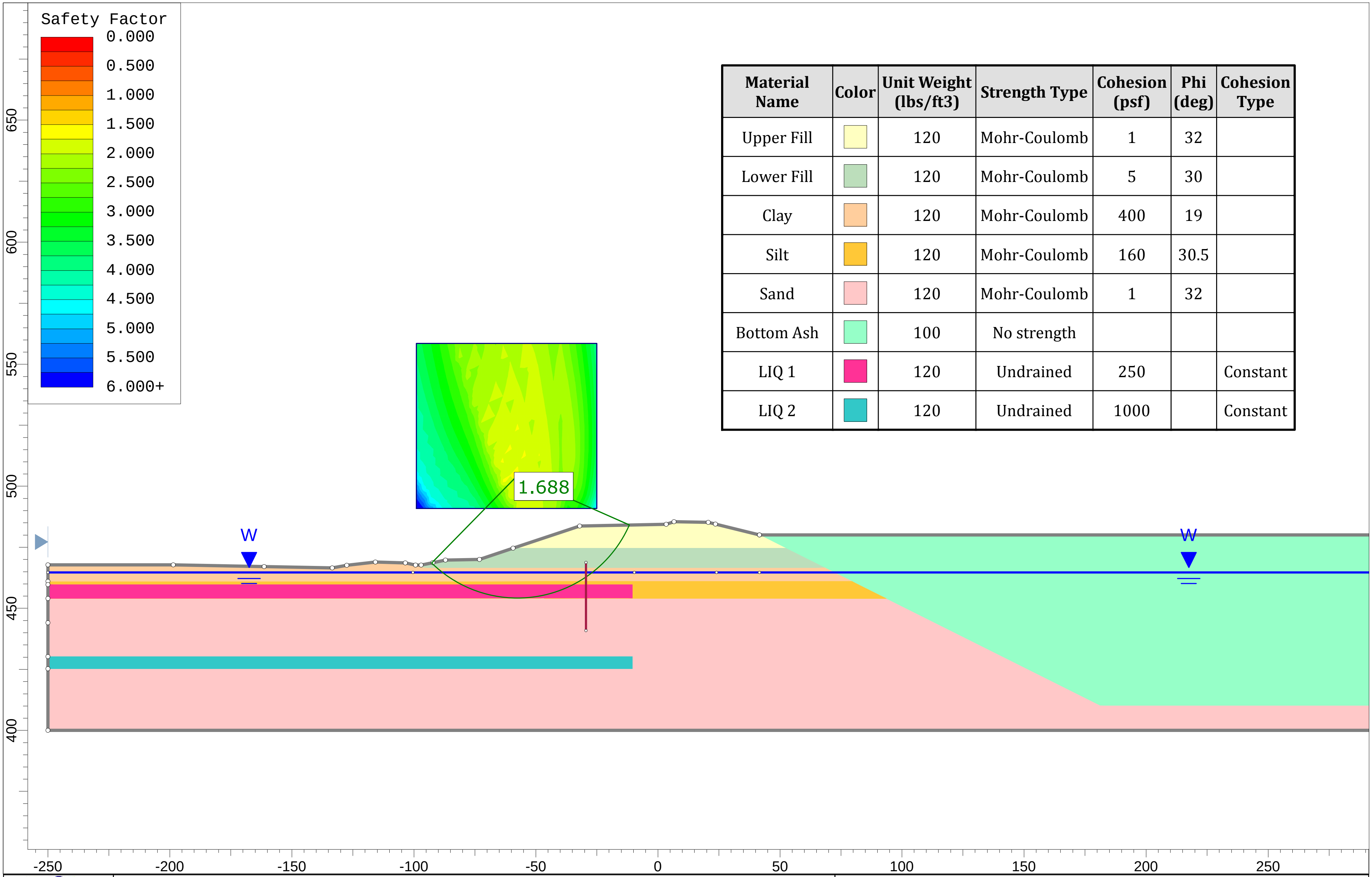
Load Case: Seismic, Drained

Project Number: 2015120902

Analysis By: J. Bertel

Checked By: L. Sutton

Figure: 15



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type
Upper Fill	■	120	Mohr-Coulomb	1	32	
Lower Fill	■	120	Mohr-Coulomb	5	30	
Clay	■	120	Mohr-Coulomb	400	19	
Silt	■	120	Mohr-Coulomb	160	30.5	
Sand	■	120	Mohr-Coulomb	1	32	
Bottom Ash	■	100	No strength			
LIQ 1	■	120	Undrained	250		Constant
LIQ 2	■	120	Undrained	1000		Constant

Project Name: Labadie Bottom Ash Pond Closure	Client: Gredell
Section Location: Section 3 - Bottom Ash Pond	Load Case: Liquefaction (Post Earthquake)

Project Number: 2015120902	Analysis By: J. Bertel	Checked By: L. Sutton	Figure: 16

FINAL REPORT
2015120905

GEOTECHNICAL ANALYSES FOR AMEREN MISSOURI LABADIE ENERGY CENTER FLY ASH POND CLOSURE

Prepared for

Ameren
MISSOURI

and

GREDELL Engineering Resources, Inc.

ENVIRONMENTAL ENGINEERING LAND-AIR-WATER

Prepared by

REITZ & JENS, INC.
CONSULTING ENGINEERS

STATE OF MISSOURI
JEFFREY LYNN FOUSE
NUMBER E-21043
REGISTERED PROFESSIONAL ENGINEER
Jeffrey Fouse
9/27/2017

September 27, 2017

The Professional whose signature and personal seal appear hereon assumes responsibility only for what appears in the attached report and disclaims (pursuant to Section 327.411 RSMo) any responsibility for all other plans, estimates, specifications, reports, or other documents or instruments not sealed by the undersigned Professional relating to or intended to be used for any part or parts of the project to which this report refers.

GEOTECHNICAL ANALYSES FOR
AMEREN MISSOURI LABADIE ENERGY CENTER
FLY ASH POND CLOSURE

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GEOTECHNICAL ANALYSES FOR
AMEREN MISSOURI LABADIE ENERGY CENTER
FLY ASH POND CLOSURE

INTRODUCTION

The geotechnical analyses and recommendations presented in this report are for the design of the permanent closure of the Fly Ash Pond (FAP) at the Ameren Missouri Labadie Energy Center (LEC). This work was done for GREDELL Engineering Resources (GER), the designer of the closure. Reitz & Jens, Inc. (R&J) was a subconsultant to GER.

The findings from the geotechnical investigation for the permanent closure are presented in the Data Report for the Bottom Ash and Fly Ash Ponds Closure, dated August 15, 2017. A summary of the history of the site is included in the Data Report.

MISSOURI RIVER FLOOD LEVELS

According to panel 29071C0190D of the Flood Insurance Rate Map (FIRM) for Franklin County, effective October 18, 2011, the existing ponds are within Zone AE of the 100-year floodplain with a Base (100-year) Flood Elevation (BFE) of 484 NGVD. The FIRM also shows the areas outside of the perimeter berms to be within the Zone AE and the regulatory floodway with a BFE of 483 NGVD. However, the BFEs in this area are created entirely by backwater flooding from the Missouri River. As a result, proposed improvements will not decrease the conveyance of the Missouri River or create a rise in the BFE. GER used this information to establish the top of the perimeter berm.

CDG Engineers completed a detailed Missouri River Floodplain Analysis for the Labadie Energy Center in June 2012. According to this analysis, the BFE along the perimeter berms (River Mile Sections 57.52 to 58.15) increases from 484.34 to 485.52 NGVD.

SETTLEMENT

Settlement analyses were completed using the computer program SETTLE3D 3.013. The program calculates the effective vertical stress at depths for a uniform surface load on an assumed elastic half-space using the Boussinesq stress distribution. Settlement of the BAP was estimated for loading due to added CCR fill, in accordance with the preliminary grading plan developed by GER, dated July 6, 2017. The proposed cut and fill thicknesses in feet are reproduced in Figure 2. We assumed a moist unit weight of 127 PCF, to be conservative. The majority of the FAP will be unloaded, that is the fly ash will be excavated and used to close the BAP. The rebound of the fly ash due to unloading will not be significant.

The basin at the south end of the FAP will be dewatered and filled with fly ash. The dewatering of the basin will increase the effective stress on the fly ash, which would also cause some consolidation and settlement. However, the fly ash does not drain readily. Therefore, only the fly ash in the vicinity of the basin will probably be affected by the dewatering for the short period of time until the basin is filled with fly ash. Since the FAP is lined, the existing water level in the FAP probably will not change very much over time. Therefore, the potential settlement due to lowering of the ground water level in the FAP was not included in our analysis.

No borings or CPT soundings have been made in the FAP since it was constructed. The geotechnical borings shown in Figure 1 – G-1 through G-7 – were made by Geotechnology, Inc. for the design of the

FAP in 1992. These borings were only 20 feet deep. All of the CCR in the FAP is fly ash. The consolidation properties of the fly ash used in our analysis were based upon a consolidation test performed on a compacted sample of the Labadie EC fly ash (see Data Report). The consolidation properties of the underlying natural soils were estimated based upon the borings by Geotechnology. The consolidation properties of the clays were based upon consolidation tests on the natural clays performed for the Detailed Site Investigation for the Labadie EC Utility Waste Landfill (UWL). The compressibility (elastic modulus) of the natural sand strata were estimated based upon the N-values from the Standard Penetration Tests in the same borings.

The plan of the resulting settlement due to the fly ash fills is shown in Figure 3. These results are plotted along the profiles of the proposed drainage channels, FAP2, FAP4, FAP6 and FAP8, in Figures 4 through 11. Most of this settlement should occur over a long time, due to the fine-grain nature of the fly ash and the fact that the FAP is lined. There is significant settlement in the area of the filled basin because Boring G-6 revealed 20 feet of silts and clays, and this area has only been loaded by the ponded water in the basin. The other areas of maximum settlement (up to 21 inches) is where the new fly ash fills are the thickest. We estimated the volume of the settlement using the end-area method. The calculated volume was about 43,000 cubic yards.

Significant amounts of estimation and judgement were required to build the model in SETTLE3D for these settlement analyses, as described briefly in the foregoing paragraphs. Even in the best conditions with homogeneous soils, and extensive field investigation and laboratory testing, research has shown that these methods of settlement analysis are usually conservative, overestimating settlement by up to 40%. We have tried to be conservative in our analyses; however, it must be recognized that our estimates of settlement are approximate.

The net final grades along the proposed drainage channels are plotted in Figures 5, 7, 9 and 11. There is very little estimated settlement along Profile FAP2 since this is mostly across areas of cut. There is some estimated settlement near the southeast embankment, where the fill in the basin extends to Profile FAP2. The estimated settlement below the thickest areas of fill along Profiles FAP4 (Figure 7) and FAP6 (Figure 9) would result in ponding along these drainage swales. If the FAP is to have a GCL cover, then it may be problematic to correct the grades in the future. So, an additional 18 inches of fill may be placed along Profile FAP4 to compensate for the estimated settlement. The problem is less extensive along FAP6. An additional 8 inches of fill may be placed at the west end of FAP6 to compensate for future settlement. There is also potential for ponding at the west end of FAP8 (Figure 11) if the intention is for drainage to be toward the east along the entire length of FAP8.

Settlement Due to Liquefaction

We reviewed published papers on recent research of the liquefaction potential of ponded fly ash. Some research indicates that ponded fly ash is less likely to liquefy than natural soils of the same consistency and grain-size distribution due to diagenesis of ponded fly ash (i.e. changes in chemistry, density and cementation), and because fly ash tends to be more dilatant under shear stress than natural soil. Other research indicates that ponded fly ash may liquefy at lower cyclic stress ratios than natural soils because fly ash has a lower specific gravity. Although, we measured the specific gravity of fly ash and bottom ash samples from LEC and found that the specific gravities are similar to natural soils (see Data Report). It is possible that some irregular, differential settlements may occur due to liquefaction after a large earthquake, which may require repairing and re-grading the cap.

SLOPE STABILITY

Reitz & Jens completed a geotechnical investigation of the BAP and the FAP at the Labadie EC in 2010. The purpose of this investigation was to evaluate the stability of the ash pond perimeter embankments. Slope stability analyses were conducted for the load cases required by the Missouri Department of Natural Resources (MDNR) Dam Safety Program (DSP). These findings were submitted in a report to Ameren Missouri, dated November 16, 2010. The investigation included four borings and 8 CPT soundings, the approximate locations of which are shown in Figure 1. These borings and CPT soundings were made through the perimeter embankments and at the exterior toe of the embankments of the BAP and the FAP. The logs of the 2010 borings and CPT soundings are included in the Data Report, as well as the results of the laboratory testing of samples obtained from the borings.

Reitz & Jens evaluated the periodic safety factor assessments for the Labadie ash ponds in accordance with the 2015 EPA CCR Rule - 40 CFR §257.73(e). The findings were submitted to Ameren Missouri in June 2016. The model of the geometry of the FAP perimeter berm and the properties of the berm and foundation soil strata were developed for slope stability analyses of two critical sections. The basis for the models is presented in the 2016 report. Sections 1 and 2 in the 2016 report were re-analyzed for this study because these sections would be modified by the proposed grading plan for the FAP closure. The locations of Sections 1 and 2 are shown in Figure 1.

Seismicity

The critical cross-section was analyzed using a pseudo-static acceleration as a horizontal body force on the soil mass to calculate the minimum factor of safety for a seismic event. The seismic acceleration was based upon the USGS 2014 seismic hazard maps for a Peak Horizontal Ground Acceleration (PHGA) for seismic loading event with a 2% probability of exceedance in 50 years. The PHGA was factored for the seismic site class in accordance with ASCE 7 *Minimum Design Loads for Buildings and Other Structures*, *International Building Code*. A seismic coefficient of 0.5 was applied to the PHGA, which is consistent with MSHA's 2009 *Engineering and Design Manual for Coal Refuse Disposal Facilities,* in particular Chapter 7, "Seismic Design: Stability and Deformation Analyses." The manual cites research by Hynes-Griffen and Franklin (1984) which found that for seismic coefficient of 0.5 would result in deformations of less than 3 feet for a safety factor of 1.0.

The probabilistic PHGA for the design earthquake at the Labadie site is 0.180g (that is, 18.0% of standard gravity acceleration of 32.2 feet/sec^2). This value takes into account attenuation of bedrock shaking with distance from the probable sources and general soil interactions such as damping for a hypothetical soil profile. This value is meant to be a conservative estimate. Based upon the data, the most probable earthquake magnitudes (M_w) for these accelerations are between 7.0 and 8.0. We applied a multiplier of 1.440 to the base PHGA to account for the soil profile at the LEC to obtain a site specific PHGA of 0.259g. Therefore, the pseudo-static seismic load was 0.130g, which was used in the slope stability analyses presented herein.

Liquefaction

The liquefaction slope stability analysis is a post-earthquake, static analysis which includes the effects of potential liquefaction or softening of the soils. Liquefaction occurs when ground shaking is sufficient to produce cyclic particle movements that cause excess pore water pressures to build to the point that most of the shear strength of the soil is lost. Liquefaction occurs in loose sandy soils with less than about 35% fines (soils which are finer than standard U.S. #200 or 0.075mm). Liquefaction can occur in very loose soils with up to 50 percent fines, and soils up to the size of fine gravel. Liquefaction only occurs below the ground water table (phreatic surface). The presence of soil susceptible to liquefaction in the top 50 feet of the soil profile at the LEC typically included the foundation silts and sands. Conservative estimates of post-earthquake or residual shear strengths in the liquefied strata were assumed using a correlation between the normalized residual shear strength ratio for liquefied soils and overburden-correction CPT penetration resistance recommended by Idriss and Boulanger (2008).

Results of Stability Analyses

The slope stability of Sections 1 and 2 were evaluated for four conditions using the computer program SLIDE 6.0. This program uses the Spencer method, which resolves the static forces on each vertical slice of soil profile along a given circular or irregular assumed failure surface. The program searches for the minimum factor of safety (FS) against slope failure for each center point in the grid by incrementally varying the radius of the failure surface. The plotted results from the program show the minimum FS, the center and radius of the failure surface with the minimum FS. The output of the program also plots contours of equal FS within the grid of possible center points. The input to the slope stability analyses and graphical representations of the results are included in Figures 12 through 19. The resulting minimum FS are summarized in the following table:

Minimum FS from Slope Stability Analyses

Condition	Section 1	Section 2	Minimum Acceptable
Static (Long-term)	2.70	2.18	1.5
Seismic (Drained Strength)	1.58	1.30	1.0
Seismic (Undrained Strength)	1.86	2.28	1.0
Liquefaction	1.54	1.56	1.2

The first condition that was analyzed was the “static” case, using the drained strength properties of the embankment and subsurface soil strata as shown in Figures 12 and 16. The bottom ash was assumed to have no shear strength, which is very conservative but had no effect on the critical failure surfaces through the exterior slope of the embankment. The minimum FS were much greater than the minimum acceptable FS of 1.5.

The seismic load case was analyzed using both undrained shear strength properties for the embankment and subsurface soil strata and using the drained shear strength properties. The minimum FS were much greater than the minimum acceptable FS of 1.0.

The fourth analysis was the post-earthquake condition in which reduced shear strength properties are used in the subsurface soil strata that have been identified as having a high liquefaction potential, as shown in Figures 15 and 19. The identification of the liquefiable strata and the post-liquefaction shear strength properties are discussed in the 2016 CCR periodic safety factor assessment. The minimum FS for this condition were greater than the minimum FS in the CCR Rule (1.2).

Therefore, the re-analyses of the slope stability for the critical Sections 1 and 2 with the proposed modifications demonstrated that the slope stability is acceptable.

SHRINKAGE

R&J excavated test pits at various locations in the BAP and the FAP to measure the *in-situ* densities of the bottom ash and the fly ash. The approximate locations of the test pits are shown in Appendix H in the Data Report. The field densities were measured with a nuclear density gage. Because of the problems associated with measuring the moisture content of CCR with a nuclear density gauge, a bag sample or a drive tube was collected for each field density test. The corrected field dry densities (DD) are listed in the Table 1. Test Pits FA-1 through FA-4 were made in the stockpiled fly ash. These test pits were excavated in 1-foot increments and the dry density was measured at each increment. FA-1 and FA-2 were excavated in the "older" stockpile of fly ash at the northern end of the FAP. FA-3 and FA-4 were excavated in the more recently stockpiled fly ash. FA-5 and FA-6 were excavated in the fly ash that appears to have been in place for some time; the DD were much greater (average 103 PCF) and the moisture contents were much less (3.2% and 6.8%) than any of the other fly ash field tests. Test Pits FA-7 and FA-8 were excavated from two of the sedimentation trenches that were dry at the surface. Drive tube samples were obtained from the bucket of the trackhoe (see photos in Appendix H of the Data Report). The DD of the stockpiled fly ash ranged from 72.3 PCF to 103.0 PCF, and averaged 77.7 PCF. The average DD of all of the fly ash field tests was 82.2 PCF.

The standard calculation for Shrinkage = $\left(1 - \frac{In\ Situ\ \text{Dry Density}}{\text{Target Dry Density}}\right) x\ 100\%$

For the *in-situ* Dry Density, we recommend using the average *in-situ* Dry Density minus one Standard Deviation. We recommend using a Target Dry Density of 83 PCF for the fly ash. This was the average DD measured for the older stockpiled fly ash, which represents the level of compaction effort for the placement and grading of the fly ash. The computed Shrinkage for the fly ash field density tests are listed in Table 2. The Shrinkage varied from 8% for the older stockpiled fly ash to 30% for the recently stockpiled fly ash. The high values of Shrinkage are due in part to the high Standard Deviations. The overall simple average Shrinkage for the fly ash is about 7% if the Standard Deviation of the field density tests is included.

The standard calculation of Shrinkage Factor (SF) = 1 – Shrinkage/100% = $\left(\frac{In\ Situ\ \text{Dry Density}}{\text{Target Dry Density}} \right)$

The overall SF for the fly ash is 0.93. However, we recommend using a non-weighted average of 0.85 because of the variability of the field DD.

SUITABILITY OF SOIL FOR VEGETATIVE COVER

Approximately 15 feet of the outside portion of the existing perimeter embankment of the FAP is to be excavated. The fill used to construct the perimeter embankment of the FAP was excavated from the top few feet of the soil in the interior of the FAP. It appears that this will be suitable material for the vegetative cap. The fill is probably heterogeneous and was placed in thin lifts. Some of the fill material may be unsuitable for the vegetative cover, for example sand or non-plastic silt which are highly erodible. Up to one-half of the excavated fill material may not be suitable for the clay cap for the BAP. The unsuitable excavated soil may need to be segregated, or mixed with the clayey soil to make a suitable mix for the vegetative cover.

CONSTRUCTABILITY

Most of the major difficulties in closing of CCR ponds is the constructability of the CCR, in particular drying of the CCR so that it may be placed and compacted, and trafficability. Charah has been running earth moving equipment across the FAP during normal operations. The top several feet of the fly ash dries to form a shale-like structure (see photos in Appendix H of the Data Report). However, if the top several feet of non-stockpile fly ash is removed, the subgrade fly ash will probably be very wet and not able to support construction traffic. The fly ash does not tend to lose moisture unless it is disced and spread out. A pile of fly ash does not lose moisture content by gravity. The contractor will have to dry some of the fly ash that is to be excavated for the BAP closure. It should not be necessary to use a woven geotextile or geo-grid to reinforce the base of temporary roads within the FAP if construction equipment with low ground pressure is used. The contractor will be responsible for planning of haul roads, selection of equipment, and means and methods.

RECOMMENDATIONS FOR EARTHWORK

Clearing and Grubbing

The grasses and fine vegetation may be plowed into the CCR. The thick woody vegetation and trees should be removed.

Compaction of CCR

The compaction of the CCR fill is needed to control settlement due to consolidation within the fill. If the CCR fill is compacted sufficiently for trafficability then it should be adequate for compaction of the clay cap and vegetative cover. As stated above, the target DD is 83 PCF for the fly ash. The contractor should cooperate with the CQA Engineer to establish a compaction procedure at the start of the fill. The contractor should propose the compaction equipment and procedures, such as a minimum of two uniform complete coverages with a tracked bulldozer with a minimum applied ground pressure of 1350 PSF. The contractor should construct a test pad of sufficient size to test the operation of the proposed compaction equipment. The CQA Engineer will test the density obtained and make recommendations of equipment, moisture content conditioning, or procedures necessary to achieve the minimum desired dry unit weight. Field density testing of the CCR should not be required. The CQA Engineer may perform periodic field density tests to monitor whether the target DD are being achieved or if the CCR fill is being over-compacted, resulting in greater “Shrinkage.”

Compaction of Vegetative Cover

Compaction of the vegetative cover should be accomplished by a minimum of two uniform complete coverages with a tracked bulldozer with a minimum applied ground pressure of 1000 PSF. The CQA Engineer or his representative should observe to verify the compaction effort.

Excavations

Construction of the perimeter storm water pipes will require excavations up to about 20 feet deep, unless the pipes are installed by directional boring. If installed by excavation, the contractor will have to use temporary slopes or shoring, or a combination. Temporary slopes through the CCR mix used to raise the southern embankment of the BAP will have to be cut to 3(H)-to-1(V) or flatter if there is seepage out of the cut slope. Temporary slopes in the soil fill may be cut to 2(H)-to-1(V) or flatter. The excavations will have to be designed by a registered Professional Engineer in accordance with OSHA Section 1926, Subpart P – Excavations.

Ameren Labadie Ash Pond Closures

TABLE 1 - RESULTS OF FIELD DENSITY TESTS ON CCP

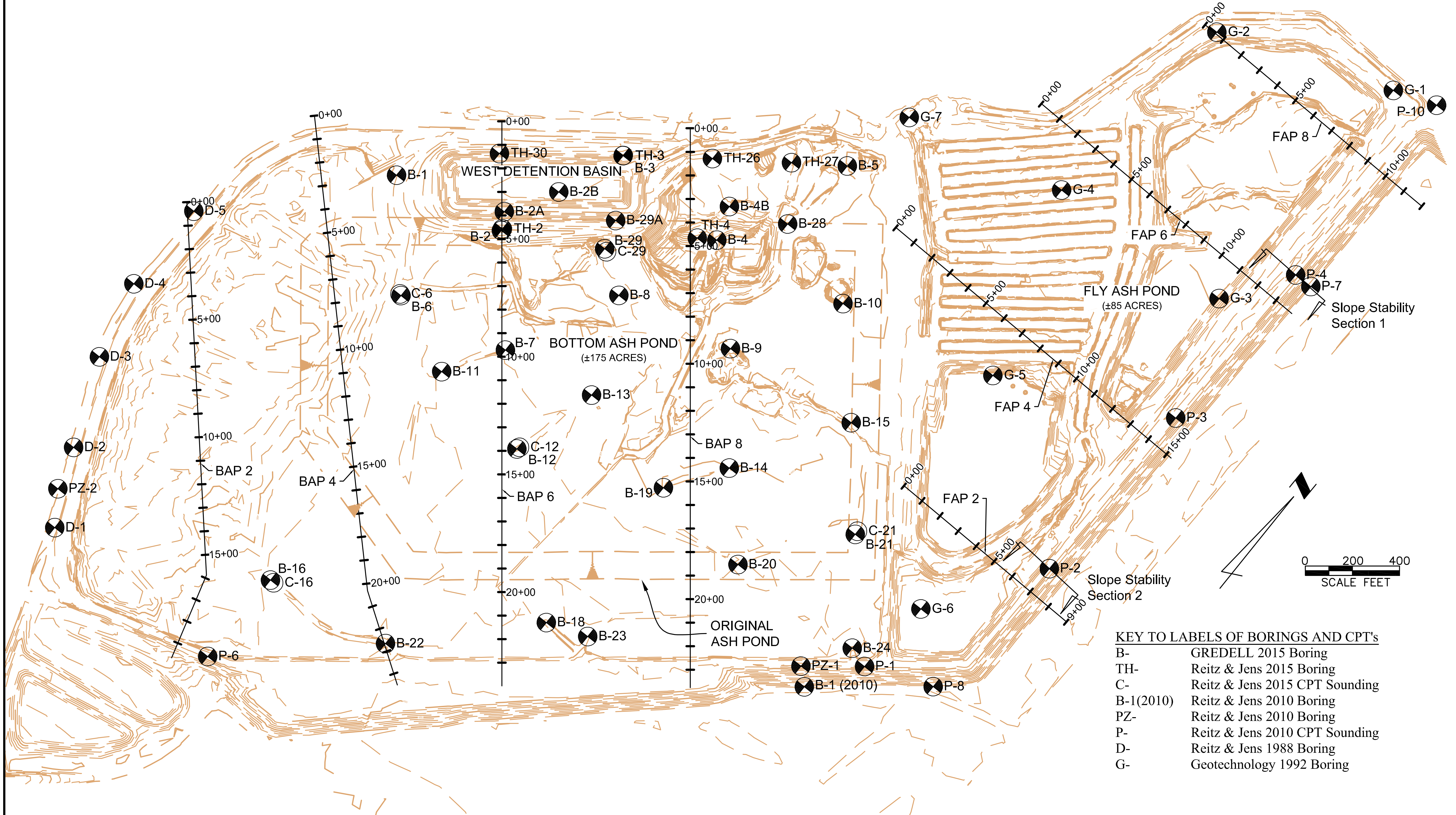
			Nuclear Density Gauge			Laboratory Results		Corrected Nuclear Field Dry Density pcf	Corrected Field Dry Density		Ratio Oven MC to Nuke MC	Ratio of Oven MC to Nuke MC		Oven MC at Lower Temp. %	Ratio High Oven MC to Low Oven MC
	Test No.	Depth feet	Moist Density pcf	Dry Density pcf	Moisture Content %	Tube Dry Density pcf	Moisture Content %		Average pcf	S.D. pcf		Average	Stand. Dev.		
South Berm	BA-1	0	114.0	110.7	3.0	No Tube Densities - Bottom Ash Sample not retained in tubes.	7.1	106.4	99.9	4.6	2.37	2.22	0.75		
	BA-2	0	101.5	98.6	2.9		5.6	96.1			1.94				
	BA-3	0	103.9	100.2	3.7		6.8	97.3			1.84				
Bottom Ash Stockpile	BA-5 Test Pit	0	105.3	103.3	1.9		4.5	100.8	94.1	5.0	2.36				
		1	109.8	107.3	2.3		6.7	102.9			2.91				
		2	101.1	98.6	2.5		7.1	94.4			2.82				
		3	98.1	94.3	4.0		13.6	86.3			3.41				
		4	100.7	97.7	3.1		10.3	91.3			3.34				
	BA-6 Test Pit	0	99.4	96.7	2.8		6.1	93.7			2.17				
		1	101.2	97.7	3.6		9.7	92.3			2.68				
		2	105.0	99.1	6.0		14.4	91.8			2.41				
		3	100.2	95.7	4.7		12.1	89.4			2.57				
		4	96.8	92.5	4.6		9.0	88.8			1.96				
	BA-7	0	104.9	102.3	2.5		5.1	99.8			2.04				
	BA-8	0	102.2	99.7	2.5		4.5	97.8			1.82			0.46	9.87
BA Pond	BA-9	0	87.4	72.7	20.2		10.8	78.9	81.8	2.9	0.53			5.6	1.93
	BA-10	0	92.6	81.1	14.2		9.3	84.7			0.65			4.1	2.27
Older Stockpile	FA-1 Test Pit	0	92.2	76.6	20.3	78.6	24.4	74.1	83.1	6.7	1.20	1.60	-0.41	32.35	0.75
		1	112.7	97.6	15.5	78.6	30.0	86.7			1.94			38.63	0.78
		2	102.1	91.6	11.5		13.2	90.2			1.15			16.14	0.82
		3	101.8	92.9	9.6	86.2	15.8	87.9			1.65			14.86	1.06
		4	98.1	82.8	18.4	71.7	32.2	74.2			1.75			41.95	0.77
Older Stockpile	FA-2 Test Pit	0	89.7	76.3	17.5	75.7	23.3	72.7			1.33			33.31	0.70
		1	103.9	85.7	21.2		17.0	88.8			0.80			23.27	0.73
		2	112.7	99.8	12.9		23.6	91.2			1.83			27.14	0.87
		3	99.2	86.3	14.9	84.9	19.4	83.1			1.30			25.44	0.76
		4	104.0	89.3	16.4	81.5	27.4	81.6			1.67			29.56	0.93
Newer Stockpile	FA-3 Test Pit	0	106.4	103.5	2.8	92.4	6.0	100.4	72.3	14.5	2.14			14.8	0.41
		1	96.0	82.2	16.8	67.2	33.0	72.2			1.96			39.95	0.83
		2	95.5	79.1	20.7	77.4	27.7	74.8			1.34			28.2	0.98
		3	89.0	73.1	21.7	69.0	29.0	69.0			1.34			32.03	0.91
		4	84.5	59.8	41.2	53.0	67.6	50.4			1.64			74.32	0.91
Newer Stockpile	FA-4 Test Pit	0	103.8	93.6	10.9		20.1	86.4			1.84			16.8	1.20
		1	104.1	86.6	20.2	70.2	31.9	78.9			1.58			32.2	0.99
		2	100.7	85.2	18.3		26.9	79.4			1.47			28.46	0.95
		3	91.5	67.2	36.2	58.4	66.4	55.0			1.83			62.21	1.07
		4	95.7	70.0	36.8	56.2	67.9	57.0			1.85			63.65	1.07
	FA-5	0	118.2	116.8	1.2		3.2	114.5	103.0	11.6	2.67				
	FA-6	0	97.6	91.0	7.2		6.8	91.4			0.94				
	FA-7	Trench	Drive Tube Only			69.4	49.5		70.5	1.0				47.6	1.04
	FA-8	Trench	Drive Tube Only			71.5	40.8							55.5	0.74
								All Fly Ash	82.2	5.1				Max. Min. Average	1.20 0.41 0.87

REITZ & JENS, INC.

Ameren Labadie Ash Pond Closures
TABLE 2 - SHRINKAGE AND SHRINKAGE FACTORS

		Average *In-Situ* Dry Density PCF	Standard Deviation *In-Situ* DD PCF	Ratio Target DD (*In-Situ DD* - Stand. Dev.)	Standard Shrinkage %	Standard Shrinkage Factor
Bottom Ash	Stockpiled	94.1	5.0	1.05	5.2	0.95
	South Berm	99.9	4.6	0.99	-1.4	1.01
	Non-Stockpiled	81.8	2.9	1.19	16.1	0.84
	All Bottom Ash Tests	93.7	6.8	1.08	7.5	0.92
Fly Ash	Older Stockpiled	83.1	6.7	1.09	8.0	0.92
	Recent Stockpiled	72.3	14.5	1.44	30.3	0.70
	All Stockpiled	77.7	12.5	1.27	21.5	0.79
	Trenches	70.5	1.0	1.20	16.3	0.84
	All Fly Ash Tests	82.2	5.1	1.08	7.1	0.93

Notes: Target Dry Density (DD) for bottom ash is 94.0 PCF. Target DD for fly ash is 83.0 PCF.
Standard Shrinkage = [1 - (Avg. DD - Stand. Dev. DD)/Target DD] x 100%
Shrinkage Factor = 1 - (Stand. Shrinkage)/100



KEY TO LABELS OF BORINGS AND CPT's

B-	GREDELL 2015 Boring
TH-	Reitz & Jens 2015 Boring
C-	Reitz & Jens 2015 CPT Sounding
B-1(2010)	Reitz & Jens 2010 Boring
PZ-	Reitz & Jens 2010 Boring
P-	Reitz & Jens 2010 CPT Sounding
D-	Reitz & Jens 1988 Boring
G-	Geotechnology 1992 Boring

Note: Existing contours & features provided by Kuhlmann Design Group, Inc. on October 26, 2015, and June 16, 2017. Actual conditions may vary.

Ameren Missouri Labadie
Bottom Ash and Fly Ash Ponds Closure
APPROXIMATE LOCATIONS OF BORINGS,
CPT SOUNDINGS, PROFILES AND SECTIONS

Reitz & Jens, Inc.

Figure 1

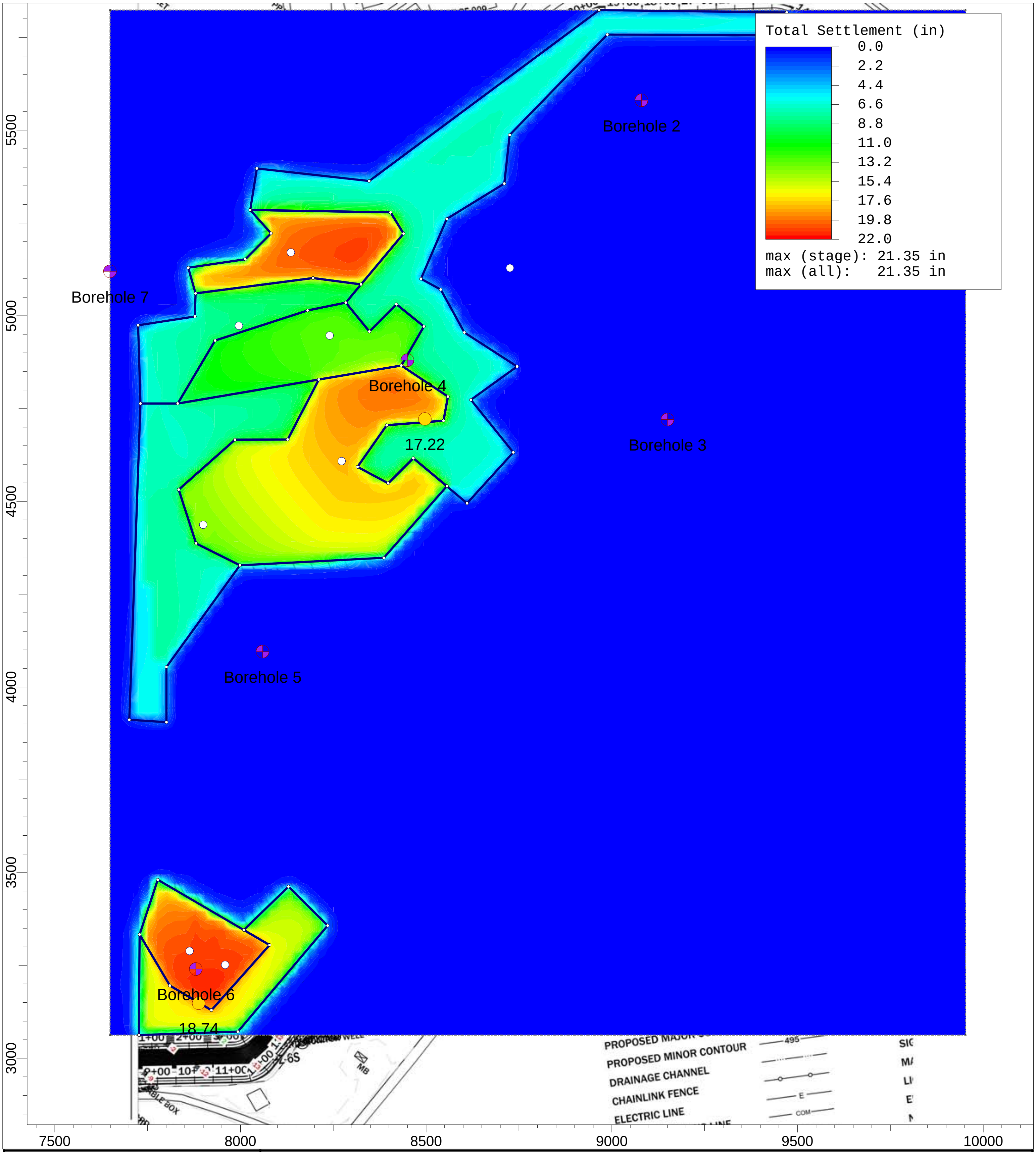
0 25 50
SCALE FEET

N

Ameren Missouri Labadie Fly Ash Pond
PROPOSED GRADING PLAN

REITZ & JENS, INC.

Figure 2



Project

Ameren Missouri Labadie Fly Ash Pond Closure

Analysis Description Estimated Settlement Due to Grading Plan

Drawn By C. Cook

Company Reitz & Jens, Inc

Date 7/10/2017

Figure 3

SETTLE3D 3.020

Ameren Missouri Fly Ash Pond Closure
ESTIMATED SETTLEMENT ALONG PROFILE FA2

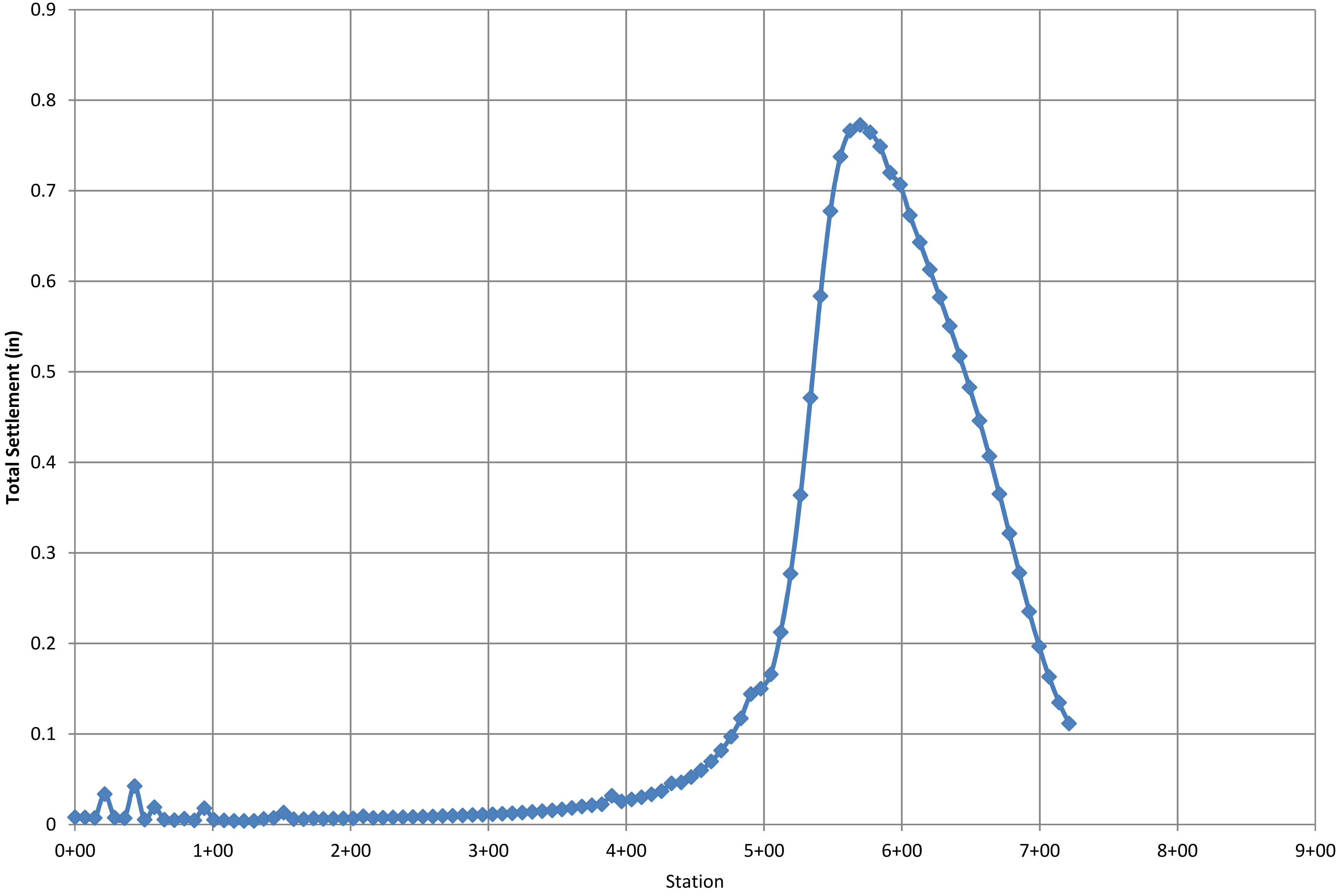


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Figure 4

Ameren Missouri Labadie Fly Ash Pond Closure
DESIGN & NET FINAL GRADE
ALONG PROFILE FAP2

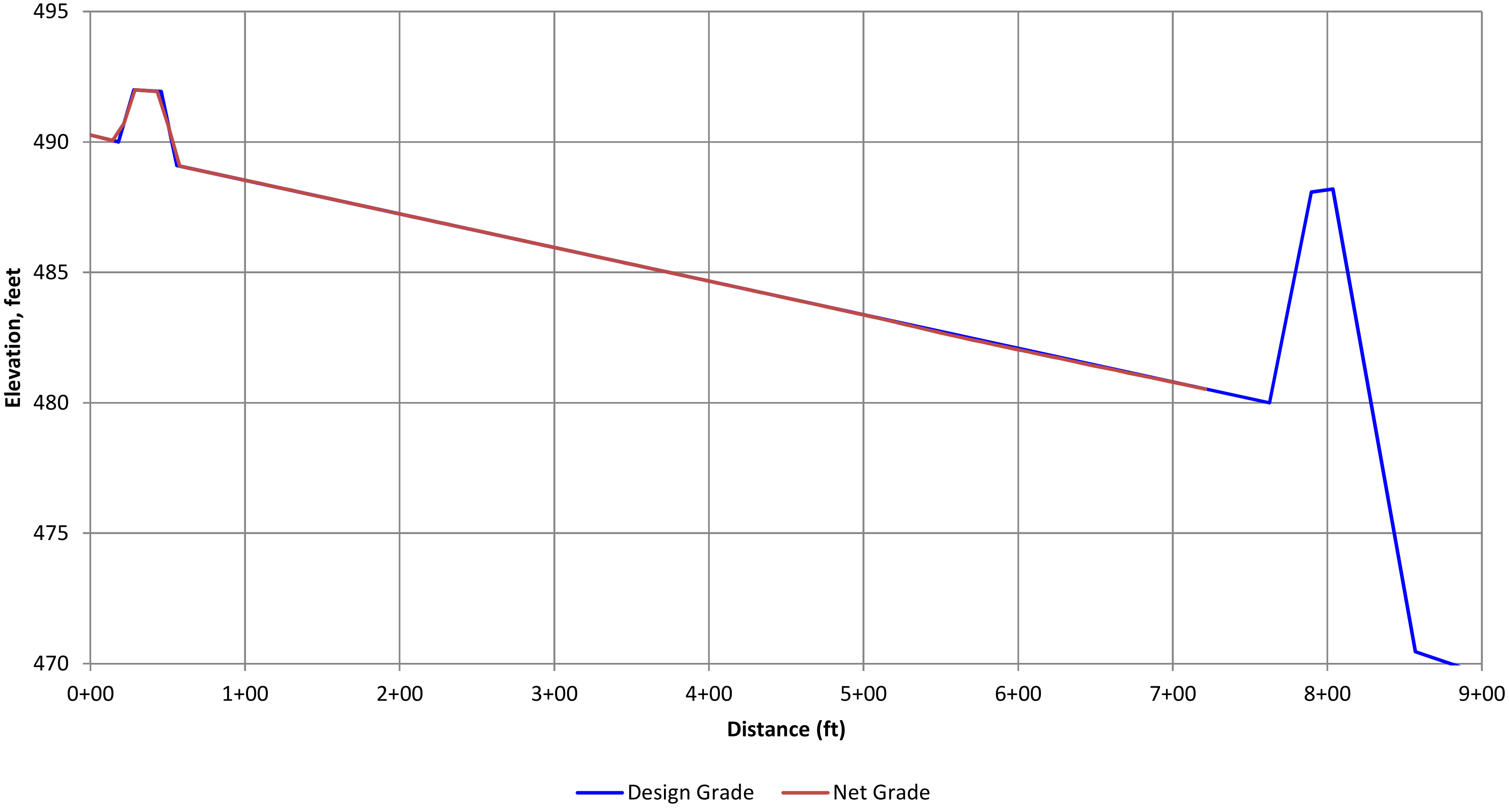

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Figure 5

Ameren Missouri Labadie Fly Ash Pond Closure
ESTIMATED SETTLEMENT ALONG PROFILE FA4

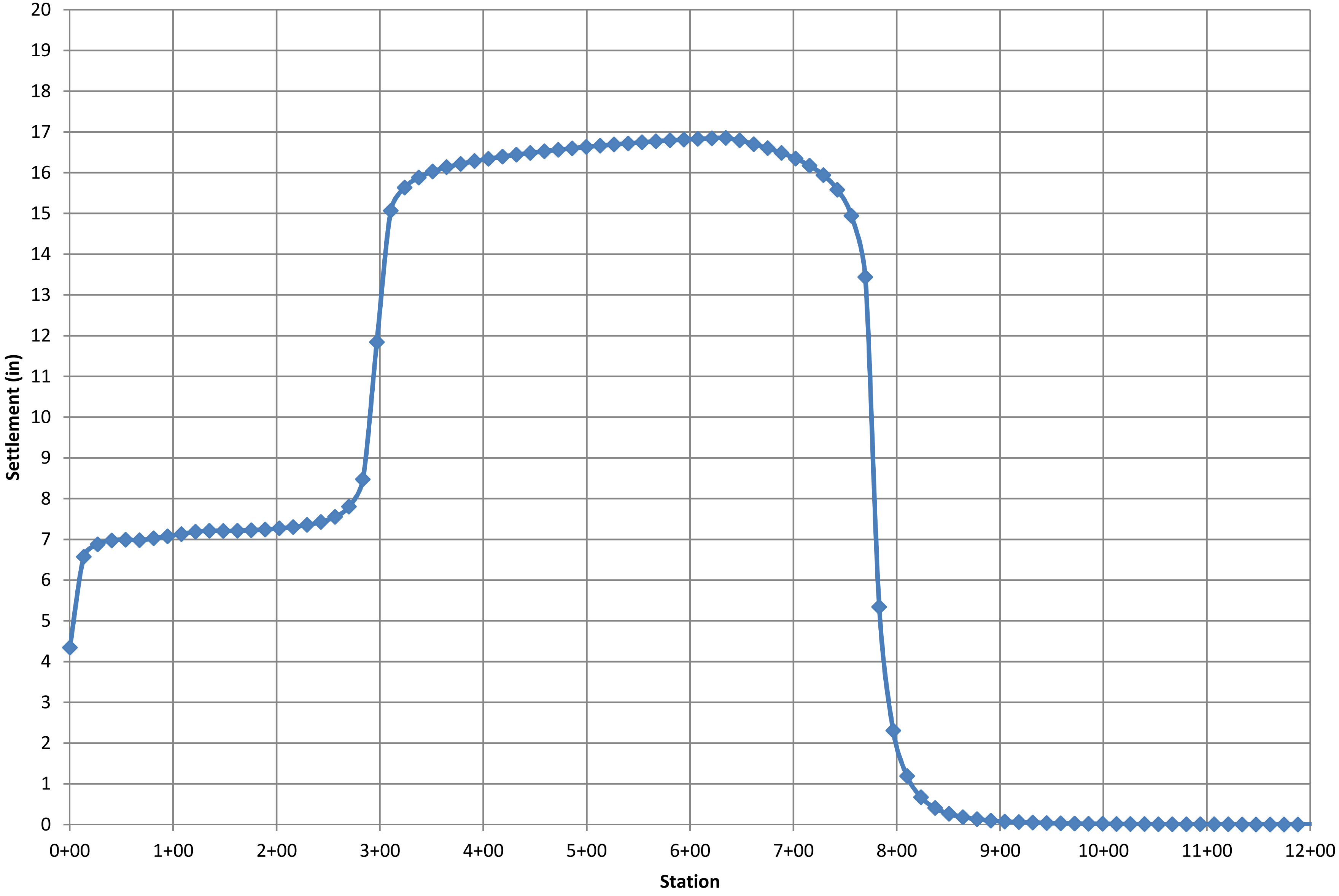

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Figure 6

Ameren Missouri Labadie Fly Ash Pond Closure
DESIGN & NET FINAL GRADE
ALONG PROFILE FAP4

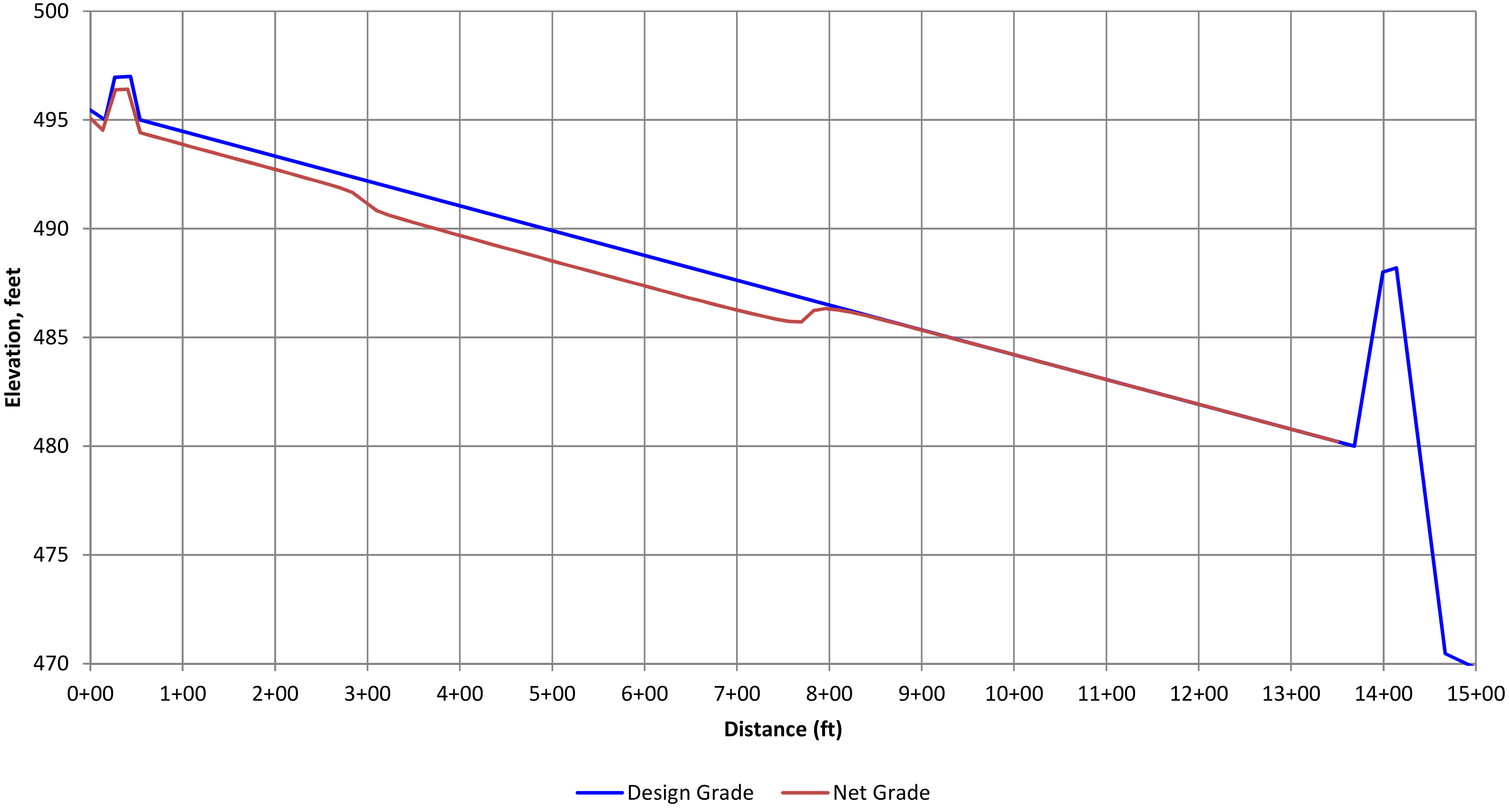

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Figure 7

Ameren Missouri Labadie Fly Ash Pond Closure
ESTIMATED SETTLEMENT ALONG PROFILE FAP6

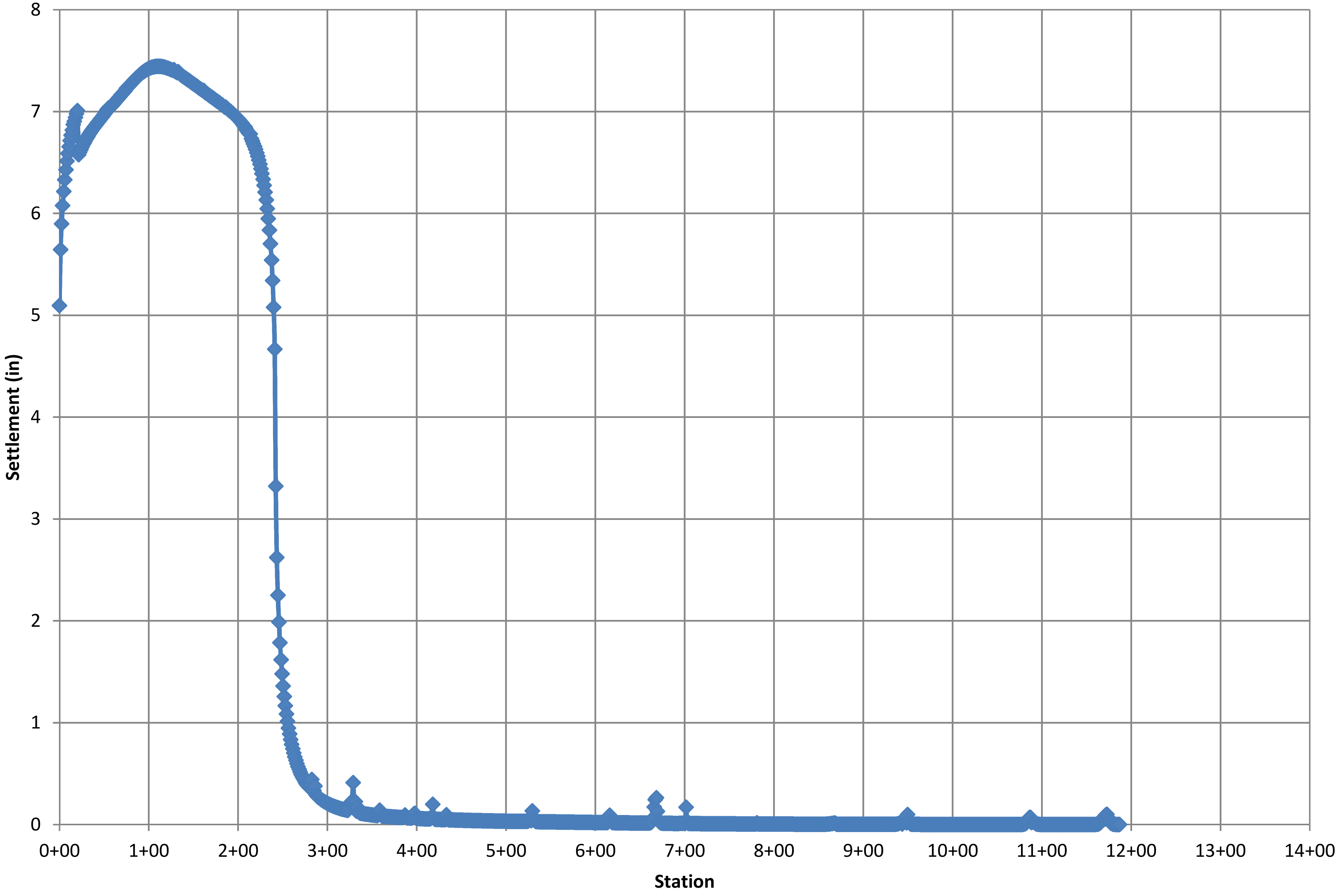

Figure 8

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Ameren Missouri Labadie Fly Ash Pond Closure
DESIGN & NET FINAL GRADE
ALONG PROFILE FAP6

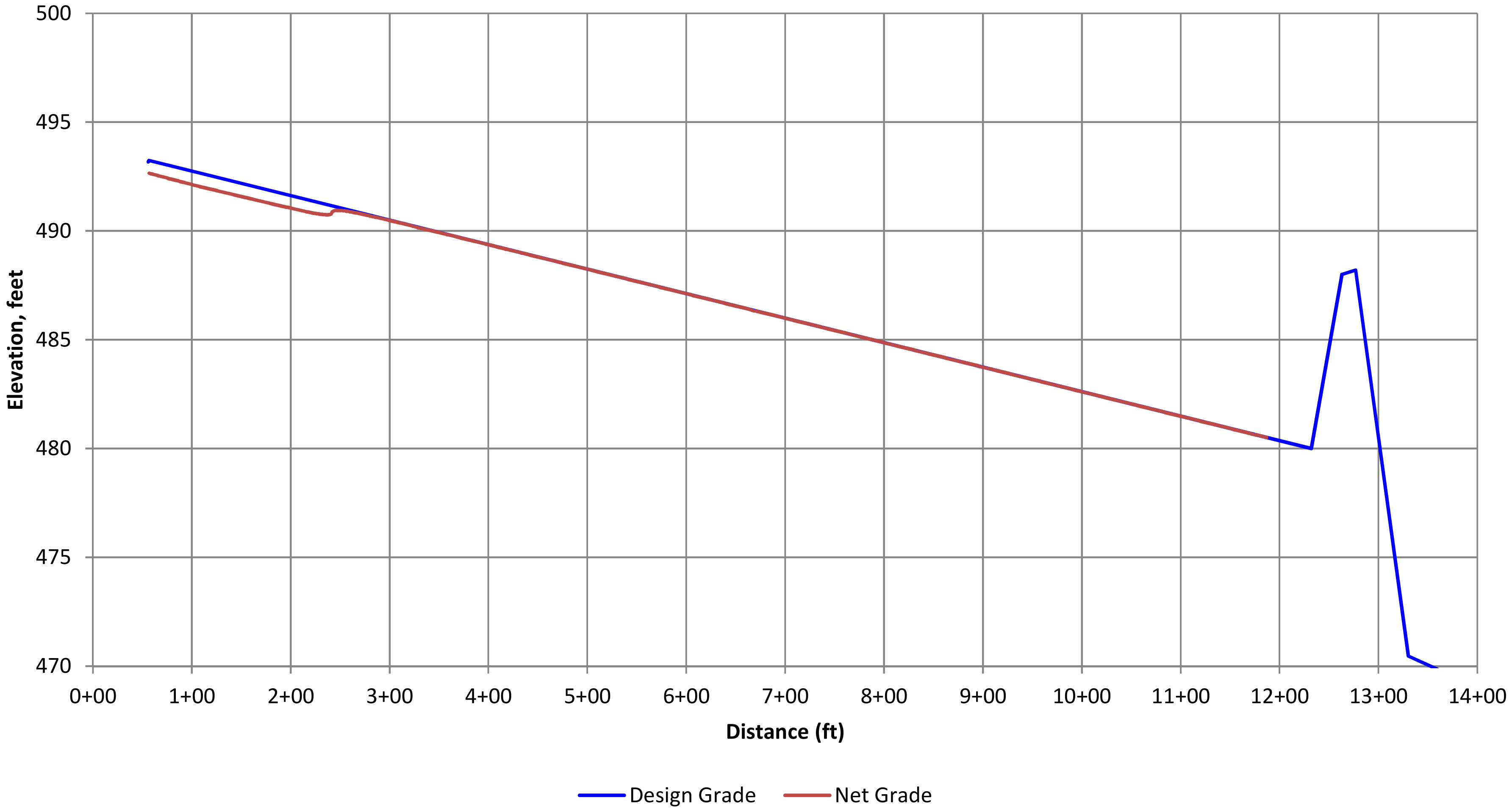

Figure 9

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Ameren Missouri Labadie Fly Ash Pond Closure

ESTIMATED SETTLEMENT ALONG PROFILE FAP8

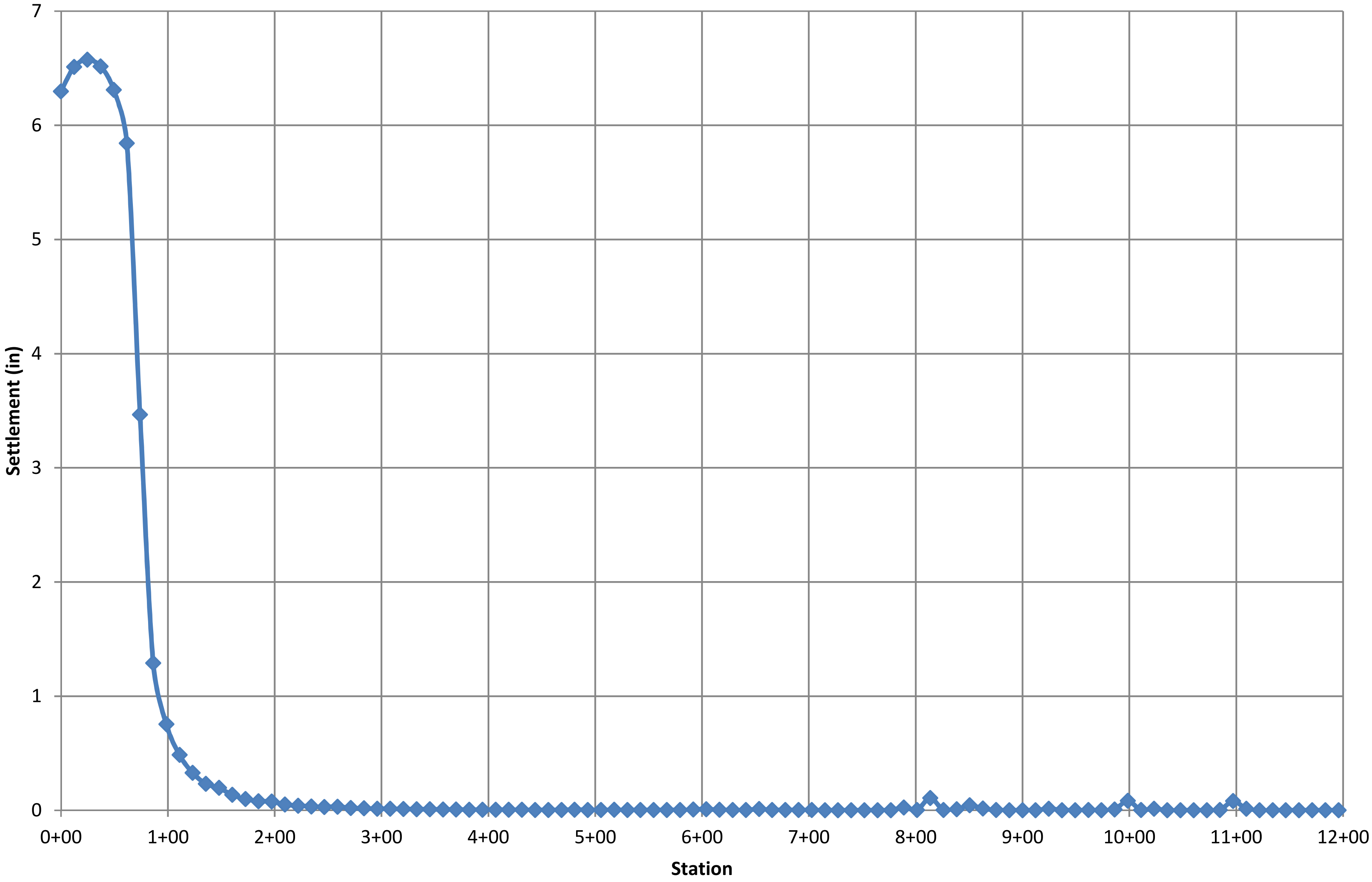

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Figure 10

Ameren Missouri Labadie Fly Ash Pond Closure
DESIGN & NET FINAL GRADE
ALONG PROFILE FAP8

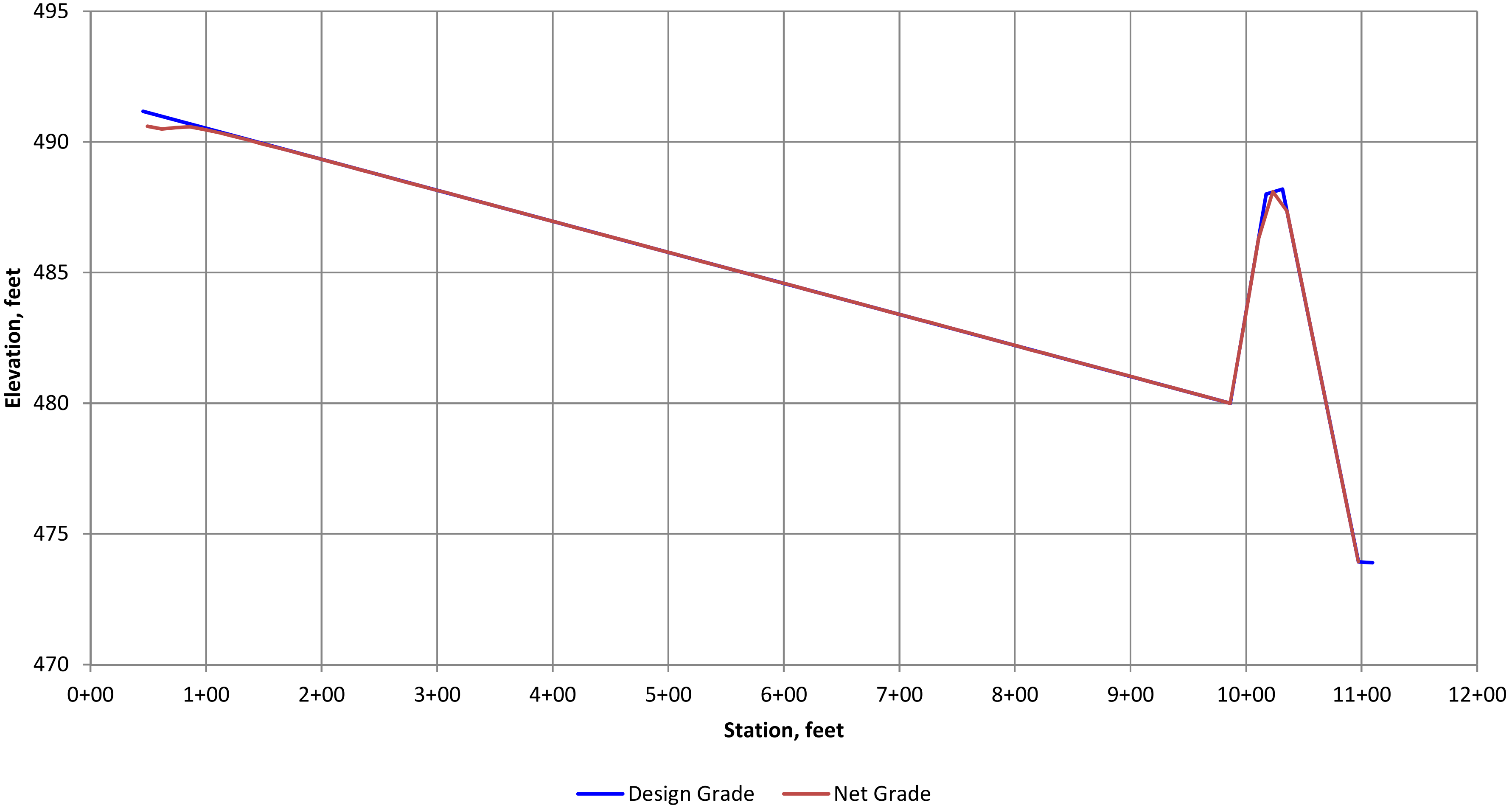

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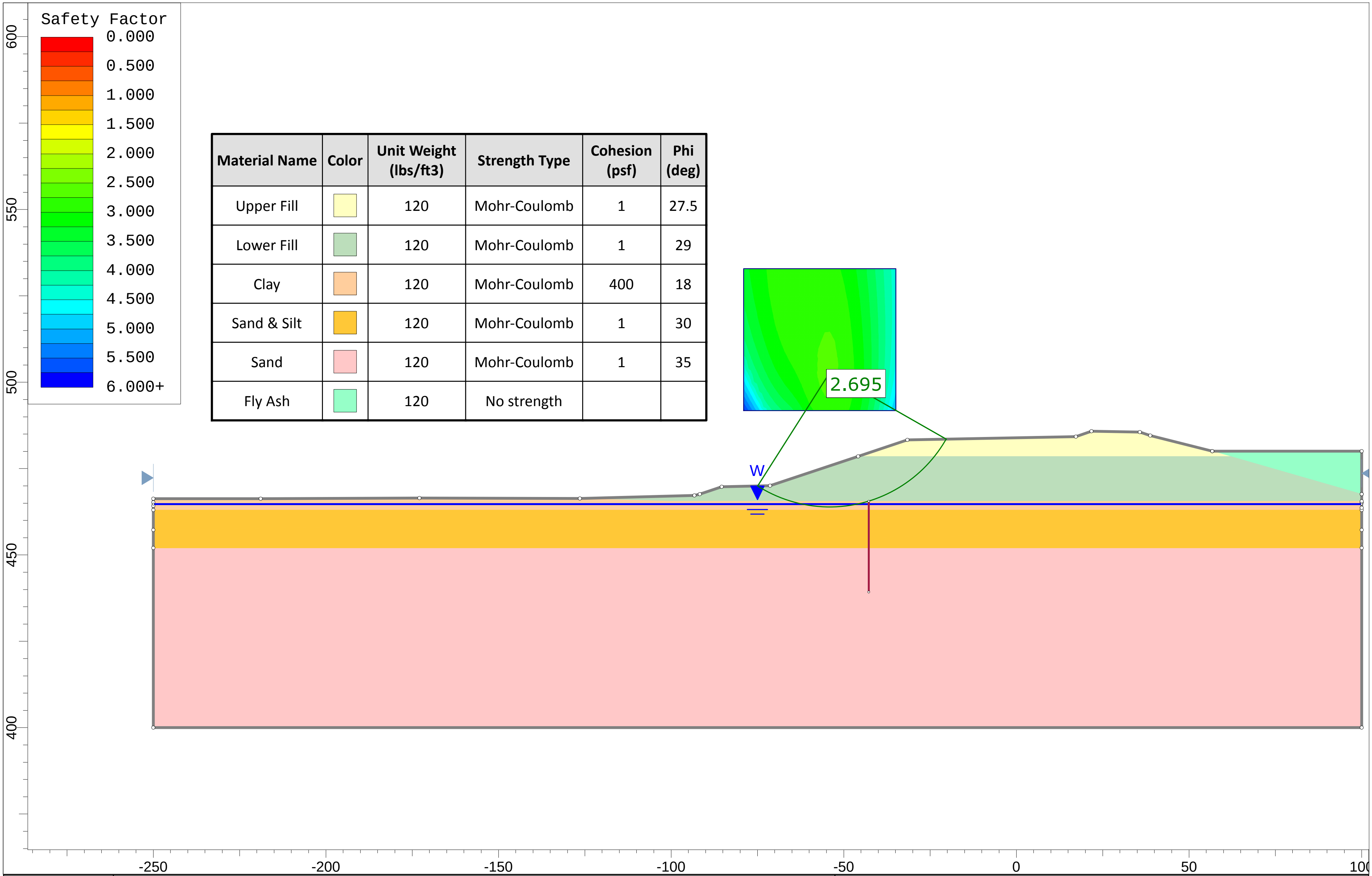
Figure 11



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	120	Mohr-Coulomb	1	27.5
Lower Fill	🟩	120	Mohr-Coulomb	1	29
Clay	🟧	120	Mohr-Coulomb	400	18
Sand & Silt	🟧	120	Mohr-Coulomb	1	30
Sand	🟥	120	Mohr-Coulomb	1	35
Fly Ash	🟩	120	No strength		

Project Name: Labadie Fly Ash Pond Closure

Client: Gredell

Section Location: Section 1 - Fly Ash Pond

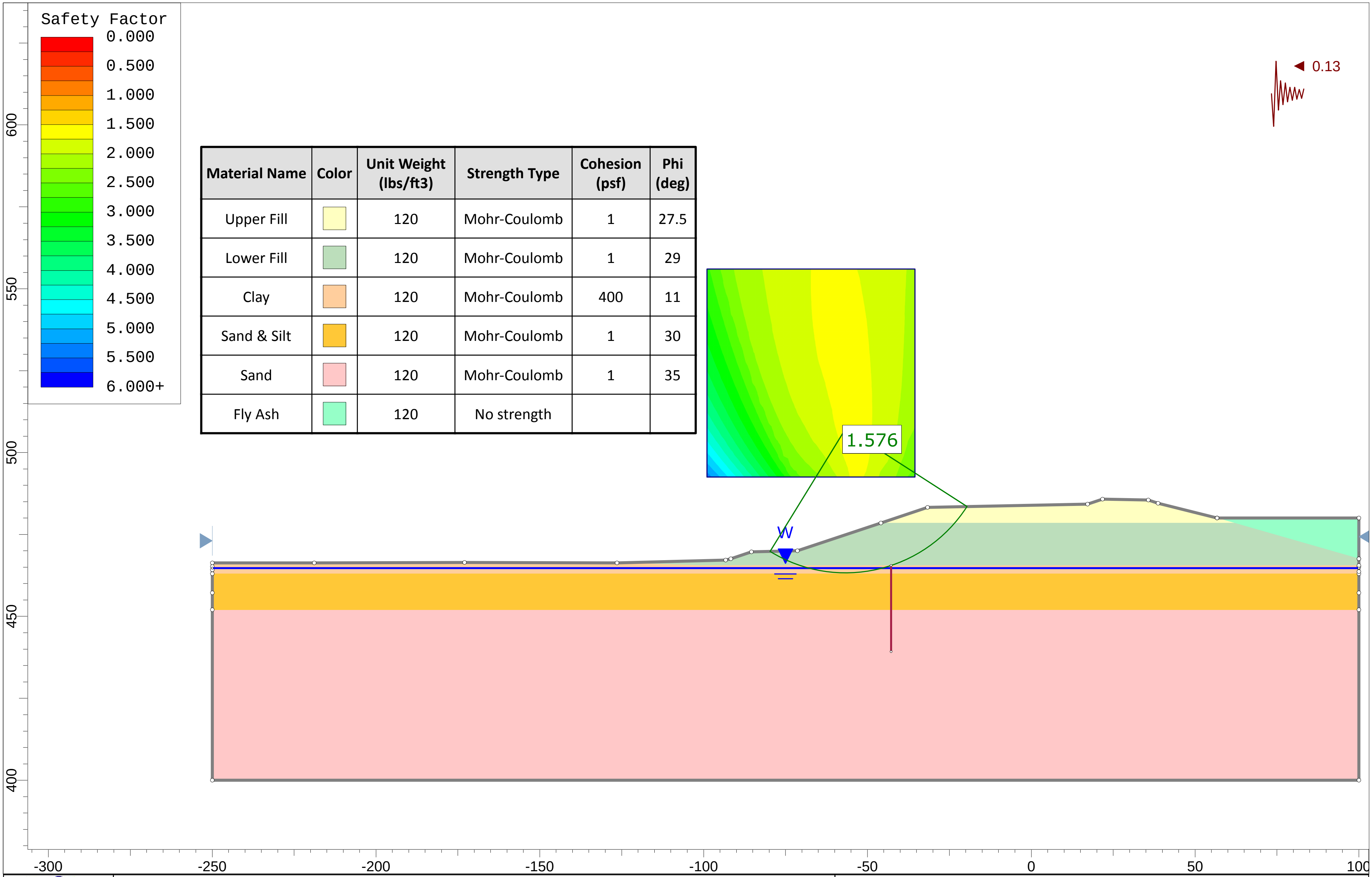
Load Case: Static

Project Number: 2015120905

Analysis By: J. Bertel

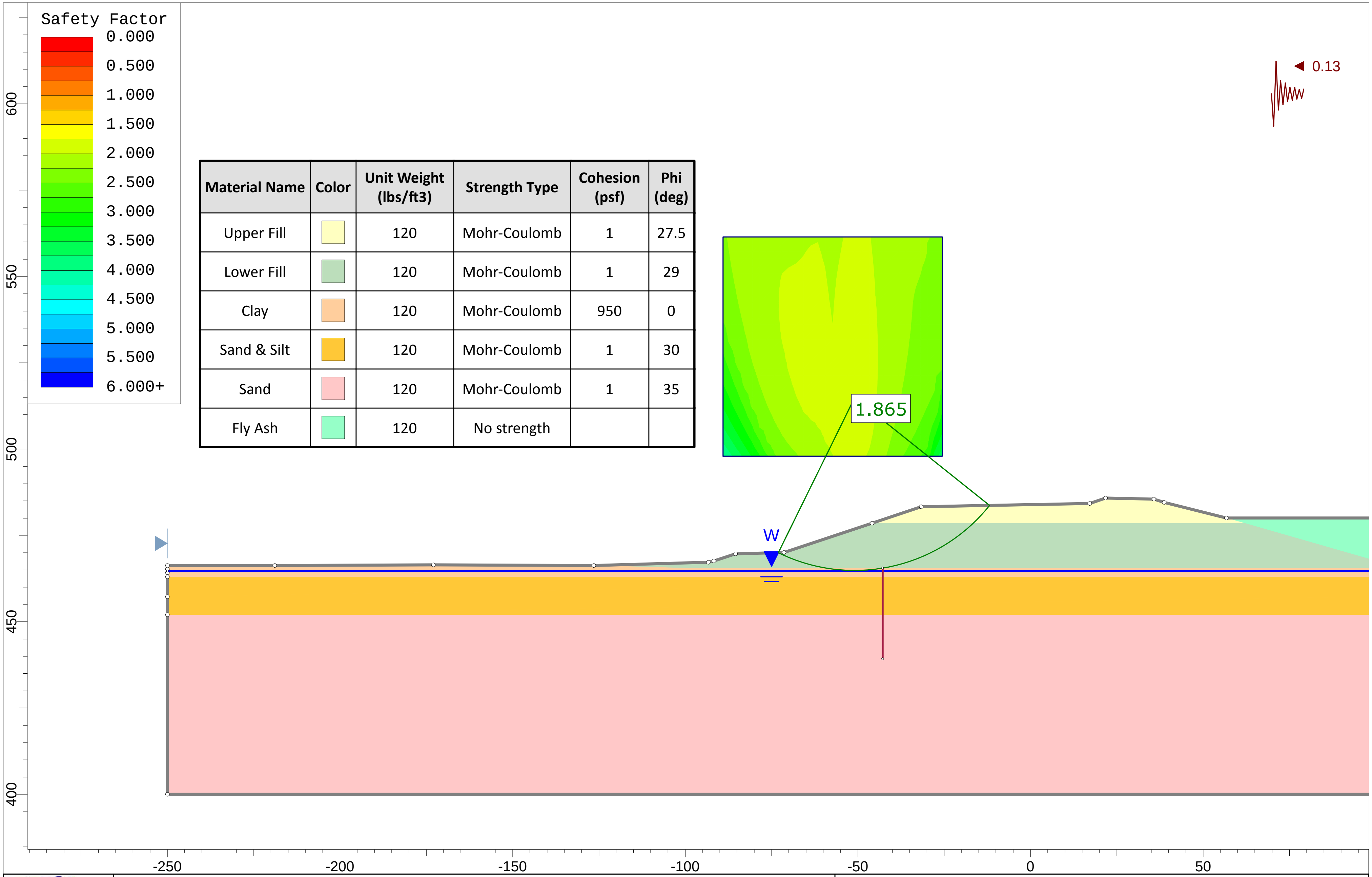
Checked By: L. Sutton

Figure: 12



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	120	Mohr-Coulomb	1	27.5
Lower Fill	🟩	120	Mohr-Coulomb	1	29
Clay	🟧	120	Mohr-Coulomb	400	11
Sand & Silt	🟧	120	Mohr-Coulomb	1	30
Sand	🟥	120	Mohr-Coulomb	1	35
Fly Ash	🟩	120	No strength		

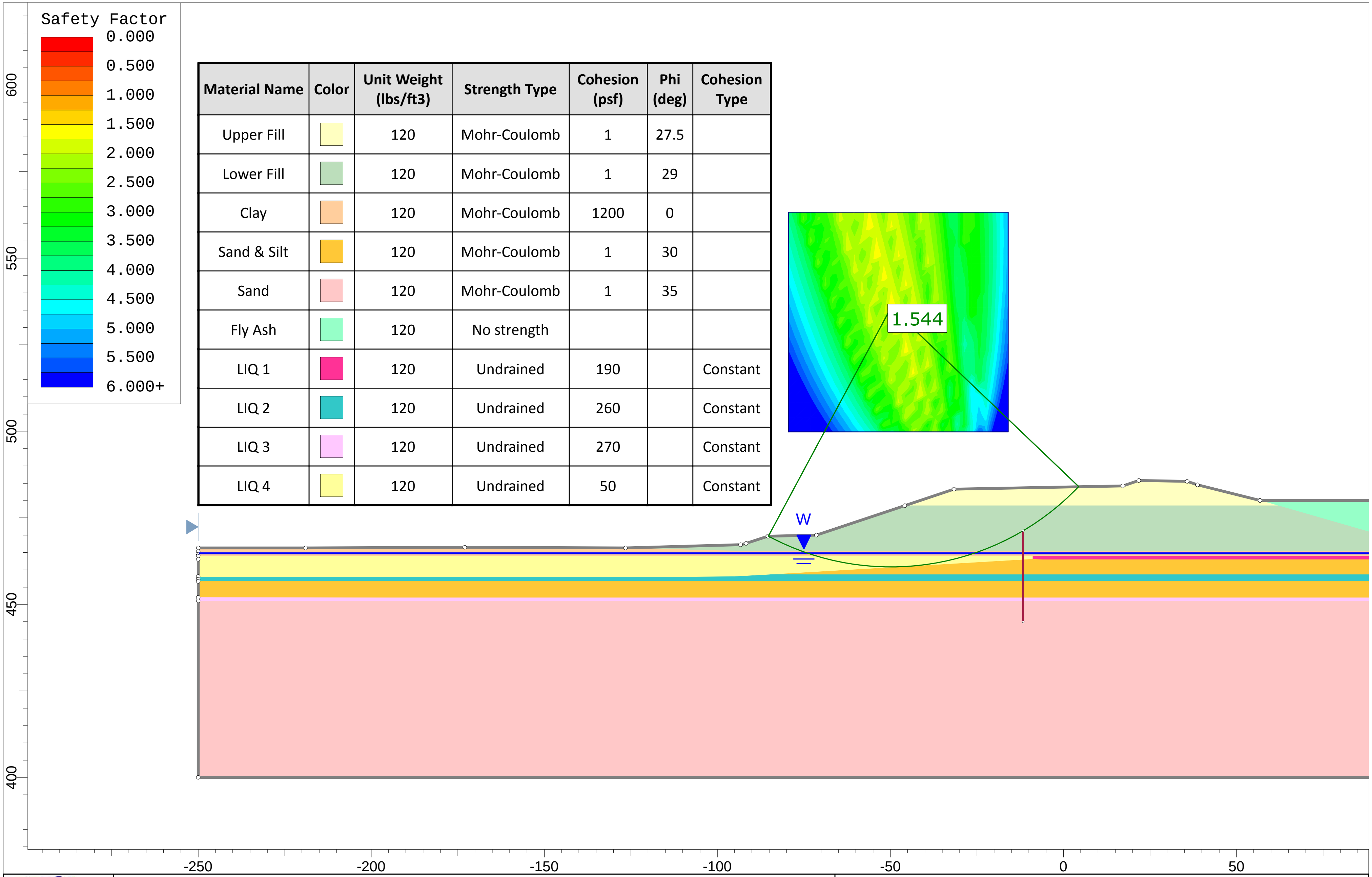
Project Name: Labadie Fly Ash Pond Closure
Client: Gredell
Section Location: Section 1 - Fly Ash Pond
Load Case: Seismic - Drained Strength Properties
Project Number: 20125120905
Analysis By: J. Bertel
Checked By: L. Sutton
Figure: 13



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Upper Fill	🟨	120	Mohr-Coulomb	1	27.5
Lower Fill	🟩	120	Mohr-Coulomb	1	29
Clay	🟧	120	Mohr-Coulomb	950	0
Sand & Silt	🟧	120	Mohr-Coulomb	1	30
Sand	🟥	120	Mohr-Coulomb	1	35
Fly Ash	🟩	120	No strength		

Project Name: Labadie Fly Ash Pond Closure	Client: Gredell
Section Location: Section 1 - Fly Ash Pond	Load Case: Seismic - Undrained Strength Properties

Project Number: 2015120905
Analysis By: J. Bertel
Checked By: L. Sutton
Figure: 14



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type
Upper Fill	🟨	120	Mohr-Coulomb	1	27.5	
Lower Fill	🟩	120	Mohr-Coulomb	1	29	
Clay	🟧	120	Mohr-Coulomb	1200	0	
Sand & Silt	🟧	120	Mohr-Coulomb	1	30	
Sand	🟥	120	Mohr-Coulomb	1	35	
Fly Ash	🟩	120	No strength			
LIQ 1	🟪	120	Undrained	190		Constant
LIQ 2	🟦	120	Undrained	260		Constant
LIQ 3	🟪	120	Undrained	270		Constant
LIQ 4	🟨	120	Undrained	50		Constant

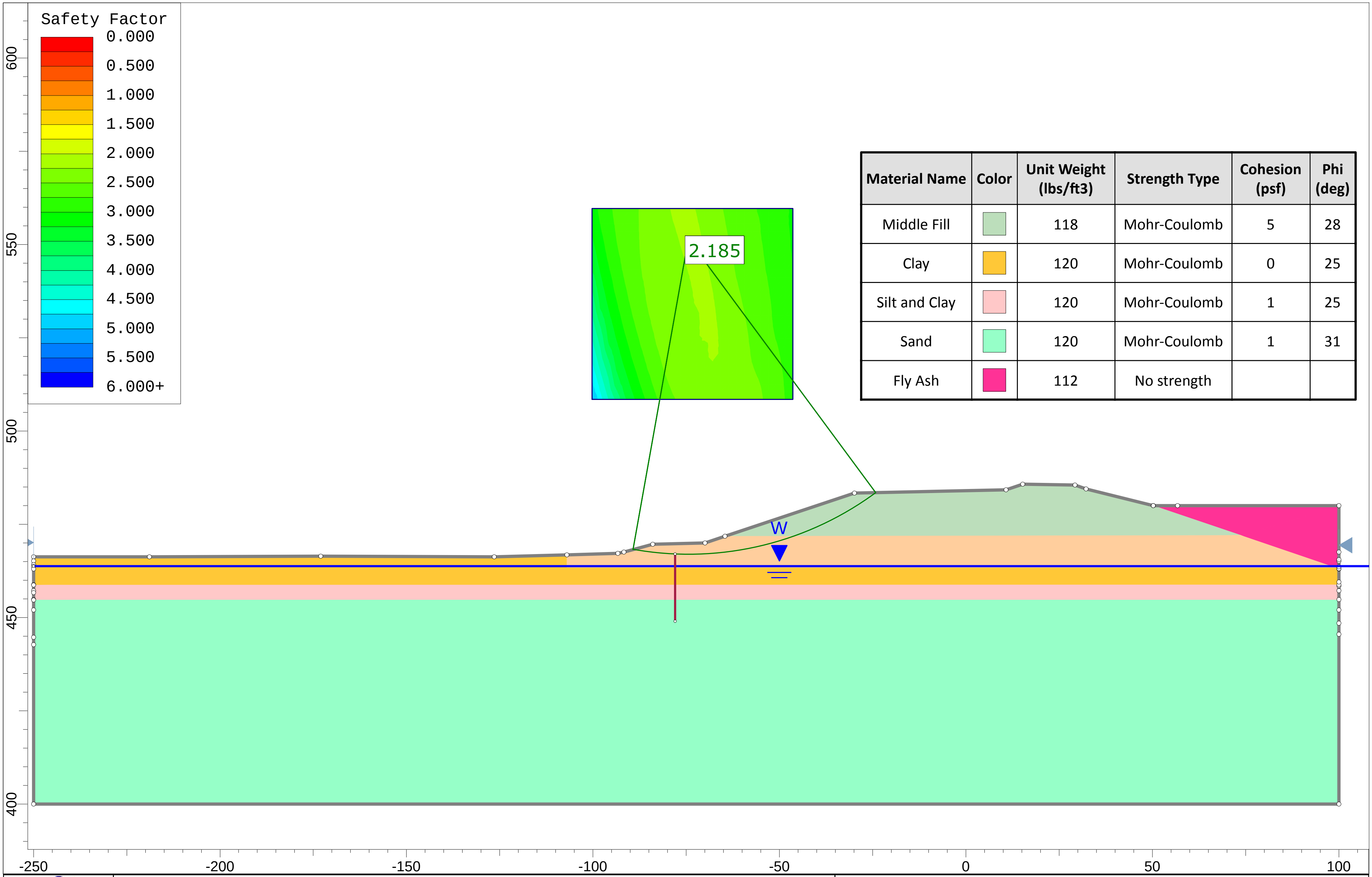
Project Name: Labadie Fly Ash Pond Closure	Client: Gredell
Section Location: Section 1 - Fly Ash Pond	Load Case: Liquefaction (Post Earthquake)

Project Number: 2015120905

Analysis By: J. Bertel

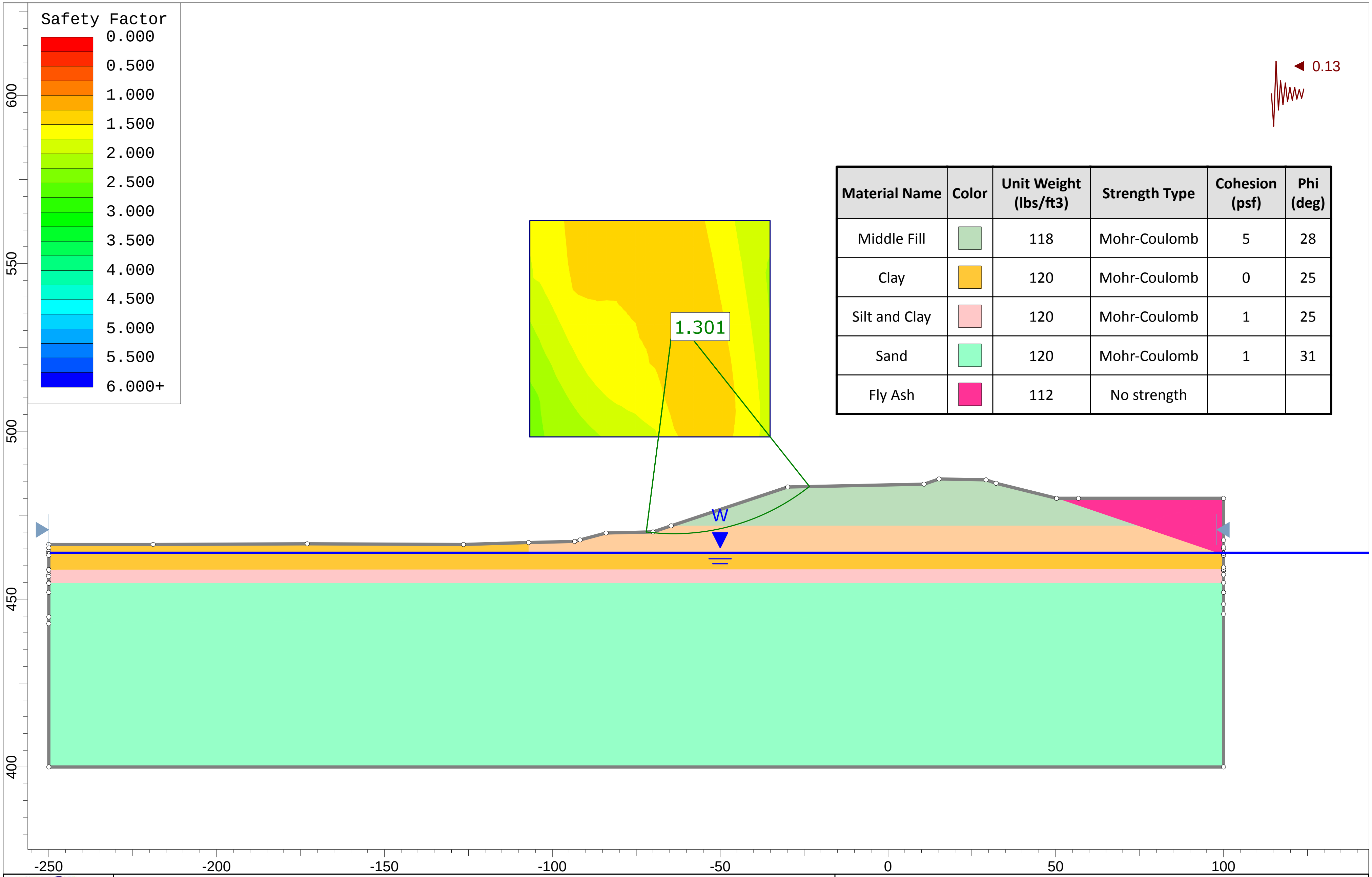
Checked By: L. Sutton

Figure: 15



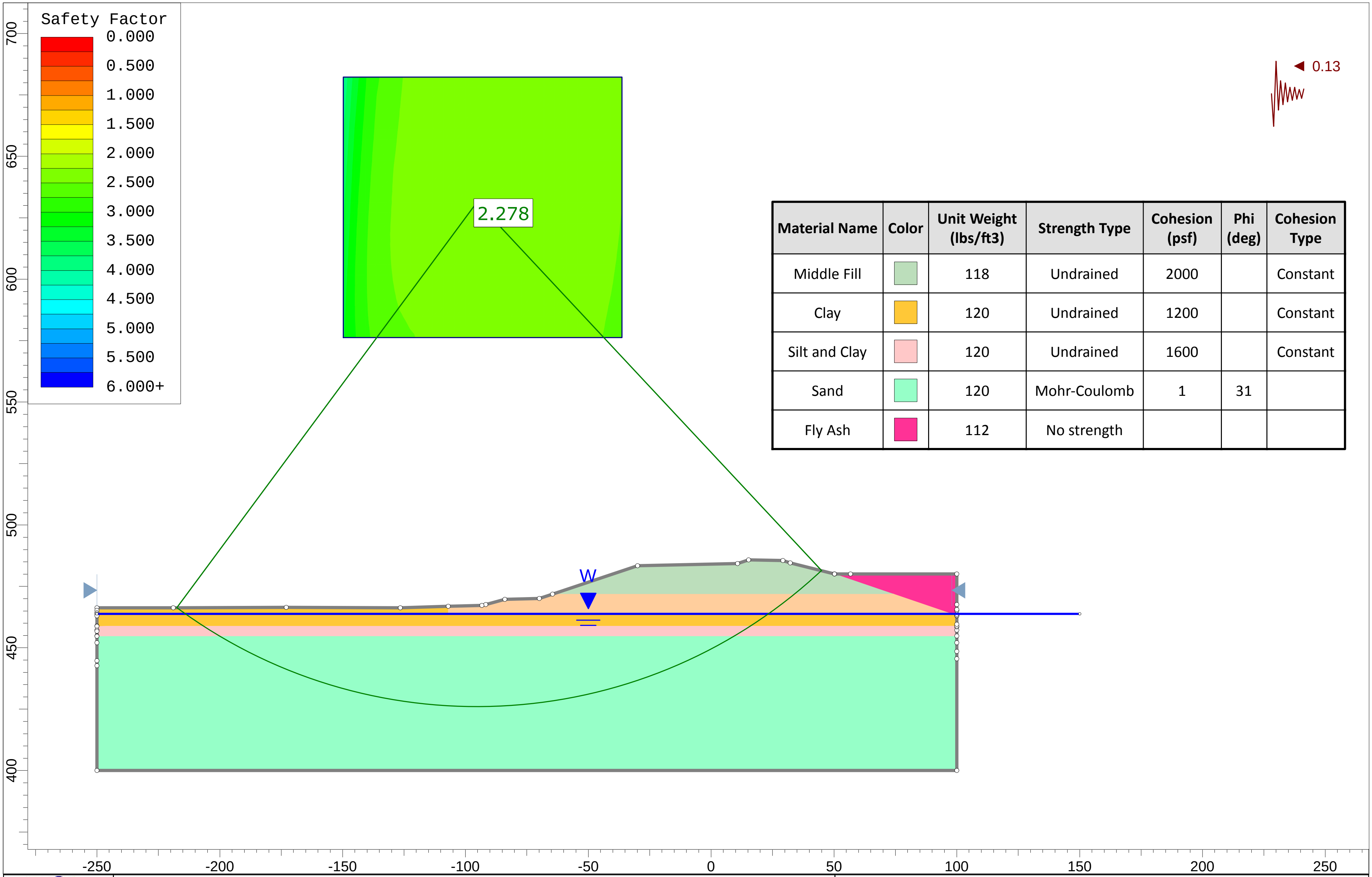
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Middle Fill	🟩	118	Mohr-Coulomb	5	28
Clay	🟨	120	Mohr-Coulomb	0	25
Silt and Clay	🟥	120	Mohr-Coulomb	1	25
Sand	🟩	120	Mohr-Coulomb	1	31
Fly Ash	🟪	112	No strength		

Project Name: Labadie Fly Ash Pond Closure
Client: Gredell
Section Location: Section 2 - Fly Ash Pond
Load Case: Static
Project Number: 2015120905
Analysis By: J. Bertel
Checked By: L. Sutton
Figure: 16



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Middle Fill	🟩	118	Mohr-Coulomb	5	28
Clay	🟧	120	Mohr-Coulomb	0	25
Silt and Clay	🟥	120	Mohr-Coulomb	1	25
Sand	🟩	120	Mohr-Coulomb	1	31
Fly Ash	🟪	112	No strength		

Project Name: Labadie Fly Ash Pond Closure		Client: Gredell	
Section Location: Section 2 - Fly Ash Pond		Load Case: Seismic - Drained Strength Properties	
Project Number: 2015120905	Analysis By: J. Bertel	Checked By: L. Sutton	Figure: 17



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type
Middle Fill	🟩	118	Undrained	2000		Constant
Clay	🟨	120	Undrained	1200		Constant
Silt and Clay	🟥	120	Undrained	1600		Constant
Sand	🟩	120	Mohr-Coulomb	1	31	
Fly Ash	🟪	112	No strength			

Project Name: Labadie Fly Ash Pond Closure

Client: Gredell

Section Location: Section 2 - Fly Ash Pond

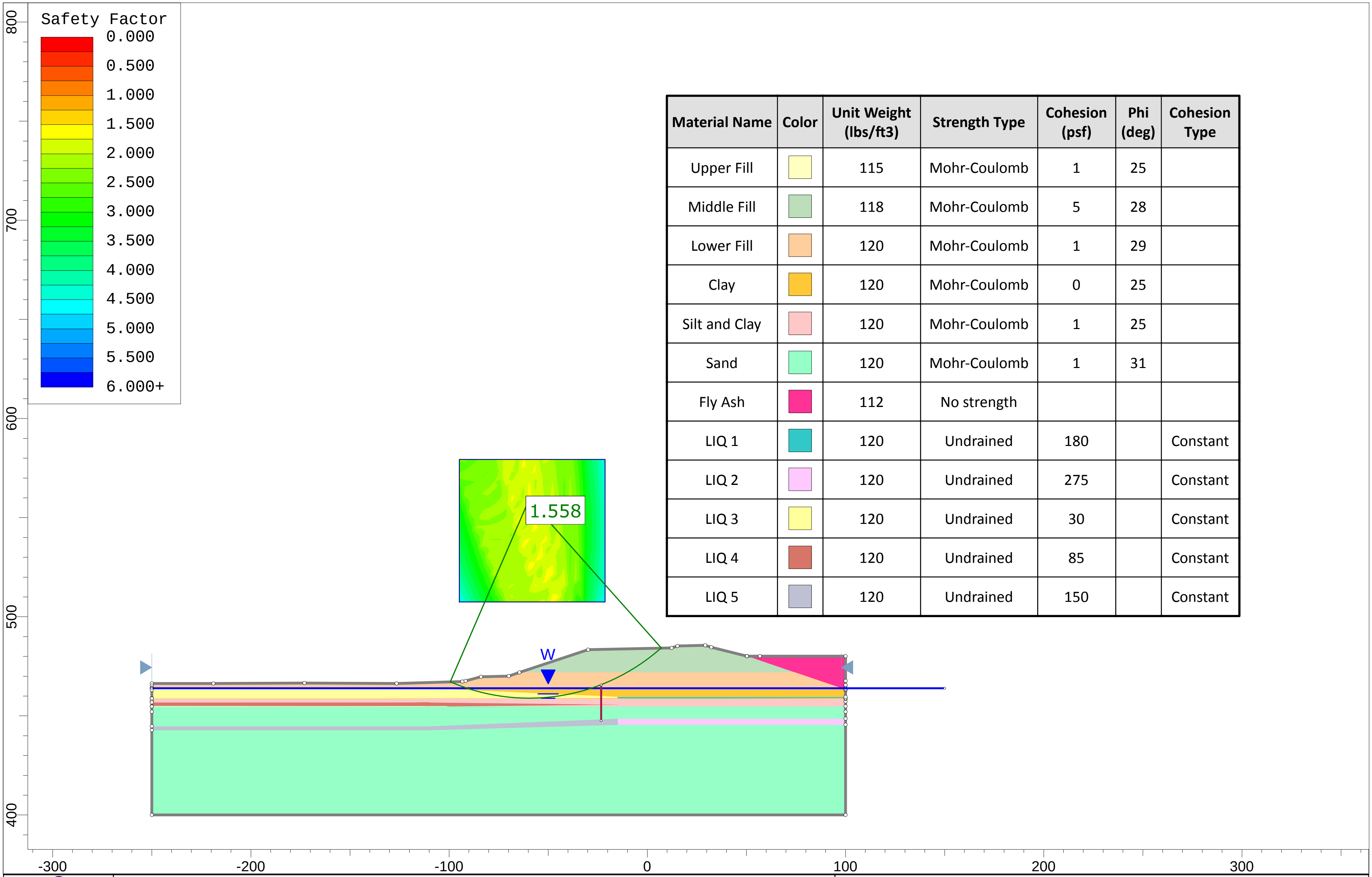
Load Case: Seismic - Undrained Strength Properties

Project Number: 2015120905

Analysis By: J. Bertel

Checked By: L. Sutton

Figure: 18



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type
Upper Fill	🟨	115	Mohr-Coulomb	1	25	
Middle Fill	🟩	118	Mohr-Coulomb	5	28	
Lower Fill	🟧	120	Mohr-Coulomb	1	29	
Clay	🟧	120	Mohr-Coulomb	0	25	
Silt and Clay	🟥	120	Mohr-Coulomb	1	25	
Sand	🟩	120	Mohr-Coulomb	1	31	
Fly Ash	🟪	112	No strength			
LIQ 1	🟦	120	Undrained	180		Constant
LIQ 2	🟪	120	Undrained	275		Constant
LIQ 3	🟨	120	Undrained	30		Constant
LIQ 4	🟥	120	Undrained	85		Constant
LIQ 5	⬜	120	Undrained	150		Constant

Project Name: Labadie Fly Ash Pond Closure

Client: Gredell

Section Location: Section 2 - Fly Ash Pond

Load Case: Liquefaction (Post Earthquake)

Project Number: 2015120905

Analysis By: J. Bertel

Checked By: L. Sutton

Figure: 19

APPENDIX E

HDYROLOGY AND HYDRAULICS

AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
40 CFR PART 257
FRANKLIN COUNTY, MISSOURI

APPENDIX E: INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN §257.82

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AMEREN MISSOURI LABADIE ENERGY CENTER
EVALUATION OF CCR UNITS
FRANKLIN COUNTY, MISSOURI

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1.0 INTRODUCTION

The Labadie Energy Center (LEC) is located in northeastern Franklin County, Missouri along the Missouri River. The plant is approximately 3 miles north of the Town of Labadie on the south bank of the Missouri River at river mile 57.5. The LEC is located within the floodplain of the Missouri River. The LEC has two active surface impoundments that are designated as LCPA (Bottom Ash Pond) and LCPB (Fly Ash Pond). The single stage industrial embankment dams impound an area of approximately 243-acres. The surface impoundments have been dewatered, no longer receive CCRs and are currently being closed. A map showing the location of the surface impoundments is attached as Figure 1.

1.1 Purpose

40 CFR §257.82 requires the owner or operator of an existing CCR surface impoundment to prepare periodic inflow design flood control system plans for the CCR unit. The plan should document how the inflow design flood control system has been designed, constructed, operated and maintained to meet the requirements of §257.82. The section specifies that the inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood and must manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood. Because the existing CCR surface impoundments at the Labadie Energy Center are classified as Low Hazard Potential dams, 40 CFR §257.82 requires that the 100-Year flood is used as the design flood in this analysis.

2.0 REVIEW OF INITIAL INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

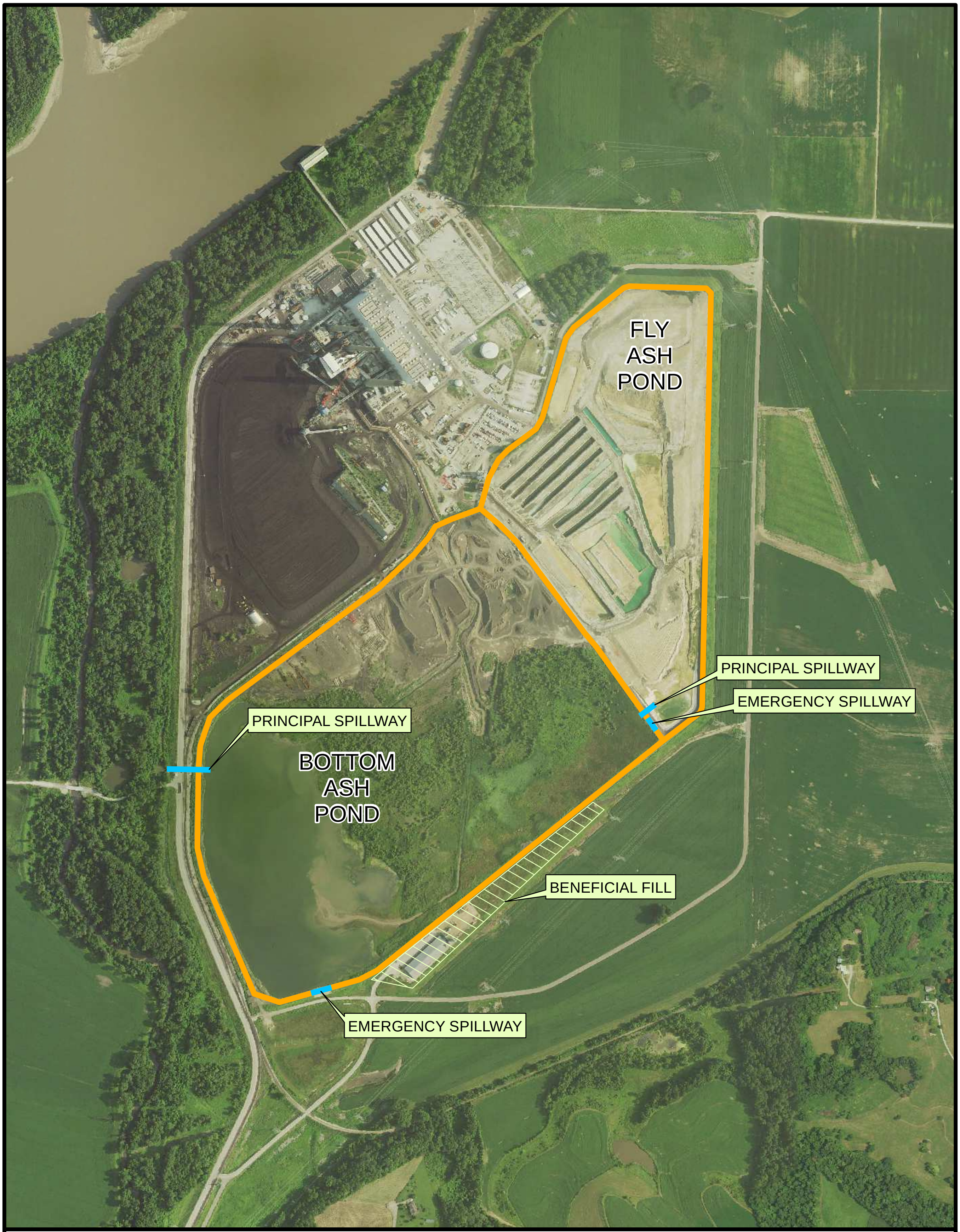
The initial inflow design flood control system plan was completed for the active CCR surface impoundments LCPA and LCPB at the Labadie Energy Center in 2016. These CCR units have been dewatered and are currently being closed. Stormwater falling within the footprint of these impoundments is actively managed by the closure contractor to prevent overtopping of the perimeter embankment. During closure construction the principal and emergency spillways for both impoundments were removed or reused as a stormwater inlet. Rainfall falling within the footprint of the LCPA and LCPB is routed over closed portions of the impoundments to ten stormwater outlets located around the perimeter embankment.

3.0 CONCLUSIONS

LCPA and LCPB have been dewatered and are currently being closed. Closure of LCPA and LCPB was designed so that water is not permanently impounded within the perimeter embankments. The interior of the LCPA and LCPB have been graded and capped to route stormwater to 10 locations around the perimeter embankment. Stormwater is discharged through gravity outlet pipes with stormwater management features to prevent erosion. An inflow design flood control system plan is no longer applicable or necessary for the LCPA and LCPB.

4.0 REFERENCES

Environmental Protection Agency. (2015). “Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule.” 40 CFR Parts 257 and 261., Vol. 80, No. 74.



AMEREN MISSOURI
LABADIE ENERGY CENTER
ACTIVE CCR SURFACE IMPOUNDMENTS
FIGURE 1

Ameren
MISSOURI

REITZ & JENS, INC.
CONSULTING ENGINEERS