

US EPA ARCHIVE DOCUMENT

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**Coal Combustion Waste Impoundment
Round 7- Dike Assessment Report (Site #007)**

Lawrence Energy Center

Ash Impoundment Dike

Westar Energy

Lawrence, Kansas

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

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INTRODUCTION, SUMMARY CONCLUSIONS AND RECOMMENDATIONS

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

This assessment of the stability and functionality of the Lawrence Energy Center Ash Dike management unit is based on a review of available documents and on the site assessment conducted by Dewberry personnel on Thursday, September 24, 2010. We found the supporting technical documentation adequate (Section 1.1.3). As detailed in Section 1.2.5 and 1.2.7, there are two recommendations based on field observations that may help to maintain a safe and trouble-free operation,

In summary, the Lawrence Energy Center Ash Impoundment is **SATISFACTORY** for continued safe and reliable operation, with no recognized existing or potential management unit safety deficiencies.

PURPOSE AND SCOPE

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

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

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

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

The purpose of this report is to evaluate the condition and potential of waste release from **management units that have not been rated for hazard potential classification**. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner.

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

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

LIMITATIONS

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

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- Doc 01: Aerial Map
- Doc 02: Westar Response to EPA Request for Information
- Doc 03: Golder Associates Stability Study of Internal Dikes
- Doc 04: Golder Associates Evaluation of Berms
- Doc 05: Black & Veatch Construction Drawings – Outlet Structures
- Doc 06: Black & Veatch Construction Drawings – Finish Grading

APPENDIX B – PHOTOGRAPHS

1. Exterior of north dike - Taken from east end of Area, looking west.
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23. Storm water pond at south end of ash pond area/Area 3 – Taken from western dike looking east.
24. Storm water pond discharge pipe on interior of south side of dike.
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29. Area2/middle cell – Taken from west end looking east.
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APPENDIX C – DAM INSPECTION CHECKLIST FORM

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit and review of technical documentation provided by Westar Energy.

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

The dike embankments appear to be structurally sound based on a review of the engineering data provided by the owner's technical staff and Dewberry engineers' observations during the site visit.

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

Hydrologic and hydraulic data provided to Dewberry for review indicate adequate impoundment capacity to contain the 1 percent probability design storm without overtopping the dikes.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

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

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

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

1.1.5 Conclusions Regarding the Field Observations

Dewberry staff was provided access to all areas in the vicinity of the management units required to conduct a thorough field observation. The visible parts of the dike embankments were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability, although visual observations were hampered by the presence of thick vegetation in some areas. A recommendation is included in Section 1.2.5 that could improve the ability to inspect and possibly prevent future seepage problems associated with large tree and vegetation growth on the embankments. Currently the embankments visually appear structurally

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sound. There are no indications of unsafe conditions or conditions needing remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The current maintenance and methods of operation appear to be adequate for the ash management unit. There was no evidence of repaired embankments or prior releases observed during the field inspection.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The surveillance program appears to be adequate. A recommendation is included in Section 1.2.7 that could assist in ensuring the adequacy of the surveillance program. The management unit dikes are not instrumented. Based on the size of the dikes, the history of satisfactory performance and the current inspection program, installation of a dike monitoring system is not needed at this time.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

The facility is SATISFACTORY for continued safe and reliable operation. No existing or potential management unit safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable criteria.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Structural Stability

No recommendations appear warranted at this time.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

No recommendations appear warranted at this time

1.2.3 Recommendations Regarding the Supporting Technical Documentation

No recommendations appear warranted at this time.

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

No recommendations appear warranted at this time.

1.2.5 Recommendations Regarding the Field Observations

The large trees along the lower section of the western embankment should be removed. A vegetation control program should be instituted to control the type, amount, and height of vegetation on the outer embankment slopes. Implementation of this recommendation will prevent the creation of potential seepage paths in the embankment and allow for easier inspection of the outer slopes and toes of the embankment.

1.2.6 Recommendations Regarding the Maintenance and Methods of Operation

These recommendations should improve the safety and operation of the dike system:

- Continually repair animal burrows
- Implement the recommendation included in Section 1.2.5

1.2.7 Recommendations Regarding the Surveillance and Monitoring Program

A written program detailing a regular scheduled inspection of the dike should be developed.

1.2.8 Recommendations Regarding Continued Safe and Reliable Operation

No recommendations appear warranted at this time.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

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Dave Claussen, Westar Energy
David Walter, P.E., Westar Energy
Andy Rietcheck, P.E., Westar Energy
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Tom Morey, Kansas Dept. of Agriculture
Edward Byrd, Kansas Dept. of Agriculture—DWR
Gary Christensen, KDHE
Gib Jones, P.E., Dewberry
Frank Lockridge, P.E., Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on Sept.24, 2010.

Gilbert Jones, P.E. (KS#18547)

Frank Lockridge, P.E.

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

2.1 LOCATION AND GENERAL DESCRIPTION

The Lawrence Energy Center is located in Douglas County, Kansas in the City of Lawrence. It is bounded on the North by the Kansas River and the other three sides by developed farmland. The plant is operated by Westar Energy.

The Center utilizes four staging areas for drying the Coal Combustion Wastes (CCW). These four areas are adjacent to the plant and shown on the project location aerial photograph provided in Figure 2.1-1. Since all four of the pond areas are encompassed by a perimeter dike, the Dewberry engineers consider them all part of one large impoundment containing several cells separated by internal dikes. The internal dikes are occasionally shifted to accept varying amounts of wash from the plant. An investigation was obtained from Golder Associates to assist in the safe reconstruction of the internal dikes and is included in Appendix A – Doc 03.



Figure 2.1-1: Configuration of Ash Ponds at Lawrence Energy Center, Lawrence, KS.

The Lawrence Energy Center Ash Dike is constructed of silty clay. This material was obtained by excavation of existing grades in the area. The first two units or cells were constructed in 1969 and areas 3 and 4 added in 1976. The crest elevation of the perimeter dike is 839. A review of the design drawings indicates a maximum berm height of 15 feet along the northwestern section of the berm.

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The impoundment area is approximately 47.4 acres and has a storage capacity of 683.5 acre-ft (See Appendix A – Doc 2). The storage in each of the cells is also listed in this document and it is noted that the actual amount of storage varies from zero to total capacity depending on plant operation.

2.2 SIZE AND HAZARD CLASSIFICATION

The classification for size, based on the height and storage capacity of the dam is “Small” in accordance with the USACE Recommended Guidelines for Safety Inspection of Dams ER 1110-2-106 criteria summarized in Table 2.2a.

Category	Impoundment	
	Storage (Ac-ft)	Height (ft)
Small	50 and < 1,000	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

Dams in the state are regulated by the Kansas Department of Agriculture. This dike is not in the National Inventory of Dams, therefore the dike does not have an established hazard classification. Dewberry conducted a qualitative hazard classification based on the 2004 Federal Guidelines for Dam Safety classification system (shown in Table 2.2b).

	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable. One or more expected	Yes (but not necessary for classification)

Loss of human life is not probable in the event of a catastrophic failure of the dikes. However, a failure of the dikes could have an economic and environmental impact. Therefore, Dewberry evaluated the western and north dikes as “**significant hazard potential**”.

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

The Westar response attached as Doc 02 in Appendix A indicates that there is no permanent storage or disposal in the units. The amount stored in each cell varies from minimal to full capacity. Materials staged in the ponds include fly ash, bottom ash, boiler slag and flue gas emission residues.

2.4 PRINCIPAL PROJECT STRUCTURES

2.4.1 Earth Embankment

The dike section of the impoundment is an earthen embankment that merges into natural grade on the south and east sides. The crest width is approximately 30 feet. The perimeter of the impoundment is approximately 2000 feet, with the actual built-up or diked section being approximately 1100 feet along the north and western perimeters. The inside and outside slopes of the dike embankment were designed to be 3:1, however some areas of the northern slope were steeper. The Golder Report, Appendix A, Doc 04, indicates that some of the inner slopes are steeper than 1H to 1V.

The southern and eastern areas of the impoundment are formed by excavation of the original grade and merging the embankment into the natural grade.

2.4.2 Outlet Structures

Water is discharged from the clear pond (Area 1) via an underground pipe to the Kansas River, located approximately 0.1-mile to the northeast.

In addition, there is an emergency overflow structure in the clear pond that discharges into a ditch at the northern toe of the north dike. Details of the structure are shown in Appendix A – Doc 05. The plant personnel believe the emergency overflow structure has never been used.

The impoundment has no emergency spillway.

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2.5 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

Critical infrastructure inventory data were not provided to Dewberry for review.

Based on available area topographic maps, surface drainage in the area of the Ash Pond is to the northwest. Baldwin Creek intercepts surface runoff and carries it to the Kansas River. (Appendix A – Doc 01) Releases from the west side of the impoundment will discharge into Baldwin Creek and/or agriculture fields.

Discharges from the north dike will flow into Baldwin creek and/or the Kansas River. Based on available area aerial photographs and a brief driving tour of the area, Dewberry did not identify any critical infrastructure assets down gradient of the Ash Pond.

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3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

Westar Lawrence Energy Center staff provided both hard copies and digital copies of the documents listed in Appendix A.

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

The State of Kansas Department of Agriculture regulates dams; however, the dikes at this location are not currently regulated. Discharge from the impoundment outlet is regulated by the Kansas Department of Health & Environment under a National Pollutant Discharge Elimination System Permit (Permit No. KS0079821). Summary of Spill/Release Incidents

Data reviewed by Dewberry did not indicate any spills, unpermitted release, or other performance related problems with the dam over the last 10 years.

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4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The first cells (Areas 1 and 2) of the impoundment were constructed beginning in 1969 and the last two (Areas 3 and 4) were completed in 1976. The original design crest elevation was 839 feet (See Appendix A – Doc 06).

4.1.2 Significant Changes/Modifications in Design since Original Construction

Since the addition of Areas 3 and 4, the plant effluent wash moves through Area 2 to parts of Area 3, then through Area 4 to the Clear Water Pond (Area 1). The cells within Areas 3 and 4 are routinely undergoing clean-out and occasionally reconfigured depending on plant demand. As clean-out and reconstruction take place of Area 3, an 18” clay liner is currently placed over the bottom and inner slopes.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

No information was provided regarding major repairs or rehabilitation. No evidence of prior releases, failures, or patchwork was observed on the earthen embankment during the visual site assessment and no documents or statements were provided to the dam assessor that indicate that prior releases or failures have occurred.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

The impoundment was designed and operated for CCW sedimentation and control. The pond receives plant coal combustion waste slurry, and stormwater runoff from the pond embankments. Treated (via sedimentation) process water is discharged through the NDPES discharge point. An overflow outlet structure in the clear water pond is present, but there is generally no overflow.

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4.2.2 Significant Changes in Operational Procedures and Original Startup

No documents were provided to indicate any operational procedures have changed.

4.2.3 Current Operational Procedures

Operations are conducted the same as stated above with the exception that the plant coal combustion waste may be placed in a different cell depending on availability.

4.2.4 Other Notable Events Since Original Startup

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

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5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Gilbert Jones, P.E. and Frank Lockridge, P.E. performed a site visit on Thursday, September 24, 2010 in company with the participants.

The site visit began at 9:00 AM. The weather was warm and sunny. Photographs were taken of conditions observed. Please refer to photographs in Appendix B and the Dam Inspection Checklist in Appendix C. Selected photographs are included here for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit.

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

5.2 NORTH DIKE (AREAS 1 AND 4)

5.2.1 Crest

The crest of the north dike had no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory conditions. Figure 5.2.1-1 shows the conditions of the crest of the north dike.



Figure 5.2.1-1: Crest of North Dike.

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5.2.2 Inside Slope

The inside dike embankments are basically unprotected. Much of the interior embankment was substantially vegetated. Figure 5.2.2-1 shows the general condition of the inside slope of the north dike (Area 1).



Figure 5.2.2-1: Inside Slope of the North Dike.

There were no observed scarps, sloughs or other indications of slope instability.

5.2.3 Outside Slope and Toe

The outside slope of the north dike embankment is bordered by a small ditch that drains to Baldwin Creek and the coal supply railroad, see Figure 5.2.3-1. The outside slope is covered with various species of tall grass and other vegetation. The steepness of the slope makes access difficult. Dewberry inspectors were not able to access parts of the toe of the embankment.

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Figure 5.2.3-1: Outside Slope of North Dike. (Area 1).

The emergency overflow outlet discharges at the base of the northern slope. The heavy vegetation made access to this area impossible, see Figure 5.2.3-2.



Figure 5.2.3-2: Vegetative Growth in the Area of the Overflow Outlet.

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5.2.4 Abutments and Groin Areas

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

5.3 NORTHWEST AND WEST DIKE (AREAS 4 AND 3)

5.3.1 Crest

The crest of the northwest and west dike had no signs of any depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition.

5.3.2 Upstream/Inside Slope

The inside slope of the west dike reveals varying amounts of exposed earth embankment depending on the amount of sediment or plant wash contained in them. Similar to most areas, substantial vegetation was observed on the interior of the dike in Area 4, see Figure 5.3.2-1.



Figure 5.3.2-1: Inside Slope of Northwest Dike (Area 4).

At the time of the site visit, Area 3 was drained and the ash was being removed. A clay liner was being installed and the slope was being restored to 3:1, see Figure 5.3.2-2.

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Figure 5.3.2-2: Inside Slope of West Dike (Area 3).

5.3.3 Outside Slope and Toe

The outside slope is heavily vegetated, including some large trees in the lower portion and toe areas, see Figure 5.3.3-2. The northwestern half of the dike is bordered by Baldwin Creek and a dirt road, which appeared to be seldom used based upon the vegetation growing in the roadway, see Figure 5.3.3-3. There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instability or signs of erosion. Figure 5.3.3-1 shows the general condition of the outside slope.

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Figure 5.3.3-1: Typical Condition of Outside Slope of West Dike.



Figure 5.3.3-2: Trees on Outside of West Dike.

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Figure 5.3.3-2: Agricultural Land West of the Ash Ponds.

5.3.4 Abutments and Groin Areas

The dike is continuous therefore there are no abutments on the west side.

5.4 SOUTH DIKE (AREA 3 AND 2)

5.4.1 Crest

The crest of the south dike had no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition. This is the section of the impoundment that merges into natural terrain. It currently is bordered by a laydown yard, storm water pond, and solid waste disposal area to the south.



Figure 5.4.1-1: Looking East Across Storm Water Pond on South Side of Ash Pond Area (Adjacent to Area 3). Closed landfill is seen in background.

5.4.2 Inside Slope

There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instability or signs of erosion. Figure 5.4.1-1 above shows the general condition of the inside slope of the south dike.

5.4.3 Outside Slope and Toe

The south side of Area 3 is bordered by a storm water pond, which also has a small embankment along the south side, see Figure 5.4.3-1.

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Figure 5.4.3-1: Outside of the Stormwater Pond Embankment on South Side.

A shallow ditch connecting Areas 2 and 3 is immediately adjacent to the southern portion of Area 2 of the ash pond area, see Figure 5.4.3-2.



Figure 5.4.3-2: Ditch Connecting Areas 2 and 3.

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5.4.4 Abutments and Groin Areas

The east end of the south storm water pond dike ties into a road embankment, see Figure 5.4.4-1.



Figure 5.4.4-1: Tie-in of south dike to road embankment.

5.5 OUTLET STRUCTURES

5.5.1 Overflow Structure

The plant personnel believe the overflow structure has never been used. It visibly appears to be in working condition; however, we were not able to access the discharge outlet, see Figure 5.5.1-1



Figure 5.5.1-1: Overflow Outlet Structure.

5.5.2 Outlet Conduit

Water from the clear water pond is discharged via a pipe in the northeast corner of Area 1 to the Kansas River (Figure 5.5.2-1).



Figure 5.5.2-1: Inlet end of the Clear Water Pond Outlet Structure that leads to the Kansas River.

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5.5.3 Emergency Spillway

No emergency spillway is present.

5.5.4 Low Level Outlet

No low level outlet is present.

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6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation has been provided about the flood of record.

6.1.2 Inflow Design Flood

No documentation has been provided about the inflow design. Note that the stormwater flow into the ash pond system is minimal; nearly all stormwater on the plant is directed to a separate storm water pond and/or drains.

6.1.3 Downstream Flood Analysis

No downstream flood analysis data were provided for review

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Supporting documentation reviewed by Dewberry is adequate.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

Based upon a review of available topographic information, site plans, and field observations, stormwater flow into the ash pond system is minimal; nearly all stormwater on the plant is directed to a separate storm water pond and/or drains. Hence dike failure by overtopping seems improbable.

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7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

After responding to the 2009 EPA Request for Information in preparation for this site visit, Westar Energy commissioned an evaluation of the ash pond berm stability. This study was performed by Golder Associates in December 2009 and is attached in Appendix A – Doc 04. Field sampling and laboratory testing were performed on samples obtained from 4 soil test borings performed on the berms along the north and western boundaries of the impoundment. Ground water was not encountered in any of the borings.

The stability analyses were run on two cross sections of the berm believed to represent the typical construction of the berm. An analysis was performed for two conditions:

- Static conditions based on assumed CCW and water levels shown in the report.
- Seismic loading applied to the steady state loading. A horizontal acceleration of 0.05 g used for seismic loading

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

7.1.2 Design Parameters and Parameters of Materials

The documentation indicated the stability analyses assumed three material strata. The stratigraphy of the berms consisted of 1-5 feet of asphalt and bottom ash road base underlain by layers of low plastic clay and with higher plastic clay in the lower parts of the berm. The material properties used for the primary stability analyses are shown in Table 7.1.2.

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Material	Unit Weight	Friction Angle	Cohesion
CCW	85 pcf	No strength	
Clay (PI=39)	116 pcf	26	260 psf
Clay (PI=50)	116 pcf	28	410 psf

7.1.3 Uplift and/or Phreatic Surface Assumptions

The phreatic surface assumed a straight line between the upstream edge of the berm crest and the static groundwater level at the borehole location.

7.1.4 Factors of Safety and Base Stresses

The safety factors computed in the Slope Stability Analysis report (See Appendix A - Doc 04) are listed in Table 7.1.4.

Cross Section	Computed Factor of Safety	Minimum Factor of Safety
Sect.1-Static	3.0	1.5
Sect.1-Seismic	2.7	1.1
Sect.2-Static	3.1	1.5
Sect.2-Seismic	2.5	1.1

The slope stability analyses indicate that the calculated safety factors against slope failures are equal to, or greater than the recommended minimum values.

7.1.5 Liquefaction Potential

The documentation reviewed by Dewberry did not include an evaluation of liquefaction potential. Foundation soil conditions do not appear to be susceptible to liquefaction.

7.1.6 Critical Geological Conditions

Surficial geologic deposits are sedimentary alluvial and low terrace deposits consisting of firm to stiff silty clays and/or clayey silts.

In the stability analyses (See Appendix A-Doc 04) a peak ground acceleration of 0.05g was used for seismic loading. This corresponds to a 2% probability of exceedance in 50 years in accordance with the current

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USGS Seismic Risk Map of the United States. The seismic design criteria used in the analyses are appropriate for the Lawrence Energy Center Ash Pond.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Structural stability documentation is adequate.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Overall, the structural stability of the dikes appears to be satisfactory based on the observations during the Sept. 24, 2010 field visit by Dewberry and the 2010 Slope Stability Analysis report (See Appendix A - Doc 04):

- The crest appeared free of depressions and no significant vertical or horizontal alignment variations were observed,
- There were no indication of major scarps, sloughs or bulging along the dikes,
- Boils, sinks or uncontrolled seepage was not observed along the slopes, groins or toe of the dikes,
- The computed factors of safety comply with accepted criteria.

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8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATIONAL PROCEDURES

The facility is operated for temporary storage of fly ash, bottom ash, boiler ash, and flue gas emission control residual deposits. Treated coal combustion process waste water is discharged through an NPDES monitored outlet structure.

8.2 MAINTENANCE OF THE IMPOUNDMENT DIKE AND PROJECT FACILITIES

Plant management has established the following maintenance procedures:

- Daily inspection by plant personnel.
- Review of the status of each cell and planning for reconstruction by senior plant personnel on a weekly basis.
- Maintaining a uniform cover of suitable species of grass on embankment slopes which shall be mowed at least twice a year.
- Dam crests shall be protected by a suitable thin asphalt or granular surface.
- Trees and woody brush should not be allowed on the outside slopes, crest and along the water line of the dikes.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operational Procedures

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

8.3.2 Adequacy of Maintenance

Although maintenance appears to be adequate, several recommendations have been made. These include:

- Immediately implementing a program to remove the large trees along the outside slope of the west dike
- Develop and implement a vegetation control program for all the dikes
- Develop a written periodic inspection program of the dike condition
- Check the serviceability of the overflow structure

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9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Weekly Inspections

Weekly inspections are conducted by plant personnel.

Special Inspections

No special inspections have been conducted at the Lawrence Energy Center ash pond by regulatory or plant personnel.

9.2 INSTRUMENTATION MONITORING

The Lawrence Energy Center ash impoundment dikes do not have an instrumentation monitoring system.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

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

9.3.2 Adequacy of Instrumentation Monitoring Program

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

**APPENDIX A
ADDITIONAL INFORMATION**

Doc 01: Aerial Map



May 11, 2009
12:52pm

E 1200 RD

4

1

3

2

© 2009 Tele Atlas
Image © 2009 DigitalGlobe

© 2008 Google

39°00'29.40" N 95°16'19.86" W

Apr 28, 2006

Eye alt 1.10 km

Doc 02: Westar Response to EPA Request for Information



May 18, 2009

Mr. Richard Kinch
US Environmental Protection Agency (5306P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Westar Energy, Lawrence Energy Center
Reply to Request for Information Under Section 104 (e) of the Comprehensive
Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9604(e)

Dear Mr. Kinch,

Enclosed is Westar Energy's Lawrence Energy Center response to the recently received information collection request. The response details the applicable coal combustion waste management units and provides Westar's response to each question in the request.

I certify that the information contained in this response to EPA's request for information and the accompanying documents is true, accurate, and complete. As to the identified portions of this response for which I cannot personally verify their accuracy, I certify under penalty of law that this response and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Sincerely,

John Bridson
Plant Manager

Cc w/o enclosure: C. Swartzendruber, Topeka GO

Based on the recently received information collection request (ICR) concerning coal combustion waste (CCW) surface impoundments and similar diked or bermed management units, Westar Energy's Lawrence Energy Center (Westar) is providing this response with respect to the applicable areas at the facility. Based on the past and current operational scheme of the plant, the areas deemed applicable to this request are the NPDES Ash Ponds and Clear Pond. The aerial photograph attached as Figure 1 provides an overview of the site CCW waste management areas.

In general, the facility sluices CCW from the boilers and air pollution control equipment to the NPDES Ash Ponds where waste is temporarily staged prior to de-watering and transport to the dry ash landfill on-site. The site has two active dry landfills permitted with the Kansas Bureau of Waste Management. No CCW is permanently stored in wet surface impoundments at the Lawrence Energy Center. Water removed from the waste travels through the series of NPDES Ash Ponds before arrival at the Clear Pond and discharge at a permitted NPDES outfall.

The ten questions from EPA's ICR appear below followed by Westar's response. Attachments in support of the responses are included according to the following table.

Attachment	Management Unit	Attachment Description
1	Overall Site	Aerial Photograph
2	Area 1	Lawrence Energy Center Construction Drawing G-2
3	Area 1 and Area 2	Lawrence Energy Center Construction Drawing G-3
4	Area 3 and Area 4	Lawrence Energy Center Ash Drawing

1. Relative to the National Inventory of Dams criteria for High, Significant, Low, or Less than Low Hazard Potential, please provide the rating for each management unit and indicate which State or federal regulatory agency assigned that rating. If the unit does not have a rating, please note that fact.

The CCW temporary staging ponds at Lawrence Energy Center do not have traditionally defined dams. At construction, the ponds were excavated from grade and a minimal height berm was constructed around the perimeter. Do to the nature of the ponds, the berm has not been evaluated by any state or federal regulatory agency and no rating has been established.

2. What year was each management unit commissioned and expanded?

The staging ponds at Lawrence were constructed at different times. Referencing the areas identified in Attachment 1, construction estimates are as follows:

Area	Year of Construction	Year of Modification
1	1969	NA
2	1969	NA
3	1976	NA
4	1976	NA

3. What materials are temporarily or permanently contained in the unit? Use the following categories to respond to this question: (1) fly ash; (2) bottom ash; (3) boiler slag; (4) flue gas emission control residuals; (5) other. If the management unit contains more than one type of material, please identify all that apply. Also, if you identify "other," please specify the other types of materials that are temporarily or permanently contained in the unit(s).

The NPDES Ash Ponds are used for staging only. There is no permanent disposal of material in these ponds. Materials that may be staged in the NPDES Ash Ponds include fly ash, bottom ash, boiler slag, and flue gas emission control residues. In addition, the plant uses the ponds to stage and dry sediment from incoming river water that collects in the settlement basins and the cooling tower. Following drying, all materials are permanently contained in the on-site dry landfills.

The Clear Pond is not used for temporary or permanent disposal of CCW. It contains only water removed from the NPDES Ash Ponds. There is a residual amount of surface water scum collected on the pond. Water is discharged from this pond out the permitted NPDES outfall.

4. Do you have a Professional Engineer's certification for the safety (structural integrity) of the management unit(s)? Please provide a copy if you have one. If you do not have such a certification, do you have other documentation attesting to the safety (structural integrity) of the management unit(s)? If so, please provide a copy of such documentation.

Each CCW temporary storage area at the Lawrence facility was constructed to an engineered design. Attachments 2, 3, and 4 provide the designs for each area. Areas 1 and 2 were part of the initial plant design by the professional engineering firm Black and Veatch. However, Westar is not currently in possession of the PE stamped designs for any of the temporary storage areas.

5. When did the company last assess or evaluate the safety (i.e., structural integrity) of the management unit(s)? Briefly describe the credentials of those conducting the structural integrity assessments/evaluations. Identify actions taken or planned by facility personnel as a result of these assessments or evaluations. If corrective actions were taken, briefly describe the credentials of those performing the corrective actions, whether they were company employees or contractors. If the company plans an assessment or evaluation in the future, when is it expected to occur?

As previously described, the NPDES Ash Ponds and Clear Pond were constructed by excavation from grade. The site has not assessed the structural integrity of the perimeter berm as risk of any failure is extremely low. In response to this request, Westar plans to complete an engineering evaluation of pond/berm integrity in 2010.

6. When did a State or a Federal regulatory official last inspect or evaluate the safety (structural integrity) of the management unit(s)? If you are aware of a planned state or federal inspection or evaluation in the future, when is it expected to occur? Please identify the Federal or State regulatory agency or department which conducted or is planning the inspection or evaluation. Please provide a copy of the most recent official inspection report or evaluation.

Westar has no knowledge of site inspections relating to berm structural integrity.

Westar isn't aware of any planned state or federal site inspections.

7. Have assessments or evaluations, or inspections conducted by State or Federal regulatory officials conducted within the past year uncovered a safety issue(s) with the management unit(s), and, if so, describe the actions that have been or are being taken to deal with the issue or issues. Please provide any documentation that you have for these actions.

To Westar's knowledge, there have been no on-site inspections or evaluations relating to berm structural integrity conducted by State or Federal officials in the past year.

8. What is the surface area (acres) and total storage capacity of each of the management units? What is the volume of material currently stored in each of the management unit(s)? Please provide the date that the volume measurement was taken

Approximate surface area, capacity, and the most recently calculated volume for each unit is included in the following table.

Management Unit	Surface Area (acres)	Total Capacity (acre-ft)	Current Volume CCW Stored	
			(acre-ft)	(Date of Measurement)
Area 1	4.7	70.5	*	*
Area 2	10.3	155	*	*
Area 3	18.2	273	*	*
Area 4	14.2	185	*	*

*Storage in these areas is temporary in nature and varies from no storage to total capacity dependent on current plant operations.

47,4

683.5

9. Please provide a brief history of known spills or unpermitted releases from the unit within the last ten years, whether or not these were reported to State or federal regulatory agencies. For purposes of this question, please include only releases to surface water or to the land (do not include releases to groundwater).

There are no known spills or unpermitted releases from any of the units in the last ten years. The Clear Pond is permitted to discharge water through an NPDES permitted outfall. Westar interprets any releases under this permit allowance to be outside the scope of this request.

10. Please identify all current legal owner(s) and operator(s) at the facility.

The current owner and operator of the Lawrence Energy Center is Westar Energy, Inc.

Baldwin Creek

N



by stormwater runoff pond

Jared S Morrison /WRI

07/08/2009 02:49 PM

To dufficy.craig@epa.gov

cc Craig Swartzendruber/WRI@WRI, Andrew L
Evans/WRI@WRI, John Bridson/WRI, Jeff Culp/WRI@WRI,
David Walter/WRI@WRI

bcc

Subject Lawrence Energy Center Response to Question

History:  This message has been forwarded.

Mr. Dufficy,

In response to your question concerning the dam (berm) height at the Lawrence Energy Center coal combustion waste ponds, I gathered the following information from the design drawings.

As noted in the original ICR response, the Lawrence Energy center coal combustion waste ponds were incised from original grade with a minimal berm constructed around four distinct areas. While the interior of the ponds are incised, the outer edge as depicted in the ICR attachments descends as it approaches river elevation. This outer edge berm height is reported as a maximum of 13 ft in the design drawings included as Attachment 4 of the ICR.

If you have additional questions or need further clarification, please feel free to contact me.

Thanks,

Jared Morrison
Environmental Services
Westar Energy
818 South Kansas Avenue
Topeka, KS 66612
Phone: (785) 575-8273 Fax: (785) 575-8039
Cell: (785) 217-5700
jared.s.morrison@westarenergy.com

Doc 03: Golder Associates Stability Study of Internal Dikes



TECHNICAL MEMORANDUM

Date: January 15, 2010

Project No.: 093-81765.2

To: Andy Evans, PE

Company: Westar Energy

From: Jason Obermeyer, PE

cc: Ron Jorgenson

Email: jobermeyer@golder.com

RE: RESULTS OF STABILITY ANALYSES TO SUPPORT REMOVAL OF ASH FROM EXISTING ASH PONDS AT WESTAR ENERGY'S LAWRENCE ENERGY CENTER

Golder Associates Inc. (Golder) has prepared this technical memorandum to provide Westar Energy (Westar) with the results of stability analyses to support ash removal from existing ash ponds at Lawrence Energy Center in Lawrence, Kansas. Recommendations are provided herein for embankment geometries to be left in place, both temporarily and permanently.

1.0 GEOTECHNICAL INVESTIGATION

Eight soil borings, LEC-1 to LEC-8, were completed on October 26, 2009, at the locations shown in Figure 1 to support Golder's stability evaluation. The borehole locations were designated by Golder and Westar. Boreholes were advanced with a truck-mounted CME drill rig using 6-inch-diameter hollow stem continuous flight augers. Relatively undisturbed samples were collected from several boreholes using 2-inch-diameter thin-walled tube samplers (Shelby tubes). Soil samples were visually classified by Golder's geotechnical engineer in accordance with the Unified Soil Classification System (USCS). Borehole depths ranged from 13 to 24 feet. Borehole logs based on field and laboratory soil classification are provided in Attachment A.

The embankments consist primarily of silty clay and bottom ash. Golder also found soft saturated clay in LEC-7 and LEC-8. Photographs from the geotechnical investigation are presented in Attachment B.

2.0 STABILITY EVALUATION

Golder performed the stability analyses using SLIDE, a two-dimensional slope stability computer program developed by Rocscience Inc. (2009). Factors of safety for static conditions were computed for circular failure surfaces using Spencer's method for force and moment equilibrium.

2.1 Cross Sections

Golder developed cross sections for the stability analyses at locations where ash removal will result in an excavated slope approximately 20 feet in height, typically with impounded ash or water on the upstream side, based on Westar's phased ash removal sequence as provided in the Request for Proposal dated October 21, 2009 (Sketches #2 to #5). Golder performed stability analyses for the following cross sections, the locations of which are depicted in Figures 2 to 5:

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44 Union Blvd., Suite 300
Lakewood, CO 80228 USA

Tel: (303) 980-0540 Fax: (303) 985-2080 www.golder.com

Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

- 1A, 1B, 1C, and 1D – These four cross sections are associated with the first phase of ash removal, as shown on Sketch #2
- 2A, 2B, 2C, and 2D – These four cross sections are associated with the second phase of ash removal, as shown on Sketch #3
- 3A, 3B, and 3C – These three cross sections are associated with the third phase of ash removal, as shown on Sketch #4.
- 4A, 4B, and 4C – These three cross sections represent the conditions to be left in place following completion of ash removal, as shown on Sketch #5

Golder assumed the depth of ash removal to be 20 feet, based on borehole logs provided by Westar (Terracon Consultants, Inc. 2009a). Golder conservatively assumed the upstream slopes of existing ash pond embankments to be sloped at 0.5 horizontal (H) to 1 vertical (V).

2.2 Engineering Parameters

Golder collected relatively undisturbed soil samples from several boreholes for geotechnical testing to determine engineering parameters for use in the slope stability analyses. Geotechnical test results are presented in Attachment C. For purposes of the stability analyses, Golder represented distinct material layers based primarily on the stratigraphy observed in nearby boreholes, as summarized in Table 1.

TABLE 1
BASIS FOR STRATIGRAPHY USED IN STABILITY ANALYSES

Cross Section	Basis for Assumed Stratigraphy
1A	Borehole LEC-6
1B	Borehole LEC-5
1C	Embankment material (temporary berm)
1D	Borehole LEC-7
2A	Borehole LEC-5
2B	Embankment material (temporary berm)
2C	Borehole LEC-8
2D	Embankment material (temporary berm)
3A	Borehole LEC-7
3B	Borehole LEC-7
3C	Borehole LEC-7
4A	Borehole LEC-6
4B	Borehole LEC-5
4C	Borehole LEC-7

Golder assigned engineering parameters to stratigraphic layers based on field soil classification and laboratory test data. Golder assigned unit weights and strength parameters to silty clay layers based on density testing and consolidated-undrained triaxial testing of an undisturbed soil sample collected at LEC. Golder assigned unit weights and strength parameters to clayey sand layers based on previous experience with similar materials. Golder assigned unit weights and strength parameters to layers consisting primarily of bottom ash based on the results of direct shear testing of recompacted bottom ash collected at LEC by others (Terracon Consultants, Inc. 2009b). Golder reinterpreted these results as

appropriate for the relatively low normal stresses in the ash pond embankments, as shown in Attachment D. Golder assigned unit weights and strength parameters to competent ash layers based on previous experience with similar materials that have been placed using appropriate embankment construction techniques, including moisture conditioning and compaction to achieve at least 95 percent of the standard Proctor maximum dry unit weight. Strength characteristics of these materials can vary significantly, and project-specific strength testing should be performed to confirm the assumptions made in these analyses if a combination of bottom ash, fly ash, and/or soil will be used in embankment construction. Golder assigned a unit weight to soft saturated clay layers based on previous experience with similar materials and assigned an undrained strength based on published data for soft clays (e.g. Terzaghi and Peck 1967). Golder assigned a unit weight to impounded ash based on previous experience with similar materials and assumed that ash within the ash ponds is saturated and contributes no strength. Engineering parameters used in the slope stability analyses are summarized in Table 2.

TABLE 2
SUMMARY OF ENGINEERING PARAMETERS USED IN STABILITY ANALYSES

Material	Unit Weight	Strength Parameters			
		Total Stress (Undrained)		Effective Stress (Drained)	
		Friction Angle	Cohesion	Friction Angle	Cohesion
Silty clay	116 pcf	17 degrees	260 psf	26 degrees	260 psf
Clayey sand ¹	125 psf	--	--	35 degrees	0 psf
Bottom ash ¹	92 psf	--	--	37 degrees	0 psf
Competent ash ²	92 psf	20 degrees	200 psf	30 degrees	200 psf
Saturated soft clay ³	90 pcf	0 degrees	250 psf	--	--
Impounded ash	85 pcf	No strength			

2.3 Piezometric Line

Based on historic (Geotechnical Services Inc. 1999) and observed piezometric levels in and around the ash pond embankments, dewatering will likely be necessary to facilitate removal of ash to a depth of approximately 20 feet. Accordingly, Golder assumed the piezometric line during ash removal to be a straight line between the upstream edge of the berm crest and the downstream toe of the berm. Golder assumed ash ponds in operation to be filled with saturated ash to within 2 feet of the berm crest. Golder assumed areas containing water to be filled to within 2 feet of the berm crest.

¹ Based on visual observation, clayey sand and bottom ash layers are assumed to consist of free-draining materials that will exhibit drained strength during and after ash removal.

² Competent ash may consist of a mixture of bottom ash, fly ash, and/or clay that will achieve the strength parameters indicated in Table 1 when compacted. Golder is not aware of and has not performed strength testing to confirm the strength parameters used in the stability analyses. If ash will be used to construct temporary embankments, Golder recommends performing a consolidated-undrained triaxial test with pore pressure measurement on a reconstituted sample of the proposed ash mixture to confirm that the required strength parameters will be achieved.

³ Saturated soft clay layers are assumed to consist of a material that drains slowly and will exhibit undrained strength during ash removal and throughout the relevant period of time following ash removal.

2.4 Results

Golder performed short-term⁴ and long-term⁵ stability analyses for each temporary cross section, beginning with a 1H to 1V slope and a 12-foot-wide crest. For cross sections that did not exhibit acceptable factors of safety under this configuration, Golder adjusted the slope angle and/or crest width incrementally until slope stability analyses indicated an acceptable factor of safety under short-term and long-term conditions. A factor of safety of 1.3 is generally considered the minimum acceptable value for temporary earthen structures. The factors of safety resulting from the slope stability analyses are summarized in Tables 3 to 13, with the recommended embankment configurations shown in bold text. The results of slope stability analyses for the recommended embankment configurations are shown graphically in Figures 6 to 16.

TABLE 3
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 1A

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	1.2	1.1
12'	1.5:1	1.3	1.3
20'	1:1	1.2	1.3

TABLE 4
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 1B

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	1.2	1.3
12'	1.5:1	1.4	1.5
20'	1:1	1.2	1.4

⁴ Short-term analyses are applicable for the condition where construction-induced pore pressures have not dissipated. Specific time periods are not inferred. For short-term analyses, Golder used undrained strength parameters and total stresses for materials that were not assumed to be free-draining and drained strength parameters and effective stresses for materials that were assumed to be free-draining.

⁵ Long-term analyses are applicable for the condition where construction-induced pore pressures have dissipated. Specific time periods are not inferred. For long-term analyses, Golder used drained strength parameters and effective stresses for all materials except saturated soft clay.

TABLE 5
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 1C

Crest Width	Material	Slope (H:V)	Factor of Safety	
			Short-Term	Long-Term
12'	Silty Clay	1:1	1.2	1.4
12'	Silty Clay	1.5:1	1.5	1.6
12'	Bottom Ash	1:1	0.8	0.8
12'	Bottom Ash	1.5:1	1.0	1.0
12'	Bottom Ash	2:1	1.1	1.1
12'	Bottom Ash	3:1	1.4	1.4
12'	Competent Ash	1:1	1.3	1.4

TABLE 6
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 1D

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.6	0.6
12'	1.5:1	0.8	0.8
12'	2:1	0.9	0.9
12'	3:1	1.2	1.2
20'	3:1	1.3	1.3

TABLE 7
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 2A⁶

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	1.2	1.3
12'	1.5:1	1.4	1.5
20'	1:1	1.2	1.4

TABLE 8
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 2B

Crest Width	Material	Slope (H:V)	Factor of Safety	
			Short-Term	Long-Term
12'	Silty Clay	1:1	1.2	1.4
12'	Silty Clay	1.5:1	1.5	1.6
12'	Bottom Ash	1:1	0.8	0.8
12'	Bottom Ash	1.5:1	1.0	1.0
12'	Bottom Ash	2:1	1.1	1.1
12'	Bottom Ash	3:1	1.4	1.4
12'	Competent Ash	1:1	1.3	1.4

⁶ Depending on the embankment geometry resulting from the first phase of ash removal (Section 1B), compacted fill material may need to be added to the south side of the embankment to achieve the embankment geometry recommended for the second phase of ash removal.

TABLE 9
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 2C

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.7	0.7
12'	1.5:1	0.9	0.9
12'	2:1	1.0	1.0
12'	3:1	1.3	1.3

TABLE 10
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 2D

Crest Width	Material	Slope (H:V)	Factor of Safety	
			Short-Term	Long-Term
12'	Silty Clay	1:1	1.2	1.4
12'	Silty Clay	1.5:1	1.5	1.6
12'	Bottom Ash	1:1	0.8	0.8
12'	Bottom Ash	1.5:1	1.0	1.0
12'	Bottom Ash	2:1	1.1	1.1
12'	Bottom Ash	3:1	1.4	1.4
12'	Competent Ash	1:1	1.3	1.4

TABLE 11
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 3A

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.7	0.7
12'	1.5:1	0.9	0.9
12'	2:1	1.1	1.1
12'	3:1	1.4	1.4

TABLE 12
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 3B

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.7	0.7
12'	1.5:1	0.9	0.9
12'	2:1	1.0	1.0
12'	3:1	1.4	1.4

TABLE 13
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 3C

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.7	0.7
12'	1.5:1	0.9	0.9
12'	2:1	1.0	1.0
12'	3:1	1.4	1.4

Golder performed long-term stability analyses for Cross Sections 4A and 4B using a 2H to 1V slope (steepest recommended slope for permanent embankments) and a 12-foot-wide crest and for Cross Section 4C using a 3H to 1V slope and a 12-foot-wide crest to confirm that permanent embankment slopes will remain stable. Consistent with direction from Westar, Golder assumed the excavated areas to be filled with water to within 2 feet of the berm crest. A factor of safety of 1.5 is the minimum acceptable value for permanent earthen structures. The factors of safety resulting from the slope stability analyses are summarized in Tables 14 to 16 and meet or exceed the required factor of safety in each case. The results of slope stability analyses for the recommended embankment configurations are shown graphically in Figures 17 to 19.

TABLE 14
RESULTS OF STABILITY ANALYSIS FOR CROSS SECTION 4A

Crest Width	Slope (H:V)	Factor of Safety
12'	2:1	2.0

TABLE 15
RESULTS OF STABILITY ANALYSIS FOR CROSS SECTION 4B

Crest Width	Slope (H:V)	Factor of Safety
12'	2:1	2.8

TABLE 16
RESULTS OF STABILITY ANALYSIS FOR CROSS SECTION 4C

Crest Width	Slope (H:V)	Factor of Safety
12'	3:1	2.2

3.0 CONCLUSIONS AND RECOMMENDATIONS

Recommended embankment configurations for the analyzed cross sections are summarized in Table 17.

TABLE 17
SUMMARY OF RECOMMENDED EMBANKMENT CONFIGURATIONS

Cross Section	Crest Width (minimum)	Slope (H:V) (maximum)
1A	12'	1.5:1
1B/2A	12'	1.5:1
1C/2D	12'	1.5:1 (Silty Clay)
1D	20'	3:1
2B	12'	1.5:1 (Silty Clay)
2C	12'	3:1
3A/3B/4C	12'	3:1
3C	12'	3:1
4A	12'	2:1
4B	12'	2:1

The stability analyses indicate that some excavation slopes must be 3H to 1V or flatter to meet slope stability requirements. In most cases, this is due to the potential presence and weak nature of soft saturated clay material within the embankment (refer to Photographs 6 and 7 in Attachment B). Prior to ash removal, the excavation contractor should excavate test slots in the embankments in which soft saturated clay was found to delineate the extent of this material and determine whether the material exists in pockets or in continuous layers. If soft saturated clay is not present throughout the embankments, steeper excavation slopes may be feasible in areas where it is not found. If a thicker layer of soft saturated ash is found, flatter excavation slopes may be required. During ash removal, the designated competent person⁷, the excavation contractor, and other site personnel should be vigilant in identifying the presence of soft saturated clay and modifying excavation slopes and protocols to account for the weak nature of this material. Additionally, the designated competent person, the excavation contractor, and other site personnel should closely monitor seepage conditions, and Westar should notify Golder in the event that seepage is observed in the embankment slope

Temporary embankments intended to facilitate ash removal should be constructed using generally accepted techniques, including moisture conditioning and compaction to achieve at least 95 percent of the standard Proctor maximum dry unit weight. Silty clay derived from LEC should be used to construct the temporary embankments in the absence of consolidated-drained triaxial testing with pore pressure measurement to confirm the suitability of another material for this purpose. Bottom ash is not well suited for this purpose because it lacks appreciable cohesive strength.

⁷ Refer to 29 CFR Part 1926.650-.652 Subpart P.

For safety and stability under traffic loads and unforeseen loading scenarios, Golder recommends that permanent embankment slopes be left no steeper than 2H:1V. Permanent slopes may need to be left flatter than 2H:1V if indicated by stability analyses.

The stability analyses presented in this technical memorandum are applicable only for the locations and materials described herein. If actual conditions during ash removal differ from the conditions described in this technical memorandum, additional analyses should be performed to confirm the stability of proposed excavation slopes.

4.0 REFERENCES

Geotechnical Services Inc., 1999. Groundwater Flow Maps. January 15, 1999. Provided by Westar Energy.

Rocscience Inc., 2009. SLIDE Version 5.043. Build date: September 29, 2009.

Terracon Consultants, Inc., 2009a. Surface Impoundment Boring Logs and Geotechnical Test Data. September-October 2009. Provided by Westar Energy.

Terracon Consultants, Inc., 2009b. Results of Direct Shear Test of Soils Under Consolidated Drained Conditions. October 21, 2009. Provided by Westar Energy.

Terzaghi, K. and Peck, R. B., 1967. *Soil Mechanics in Engineering Practice*. John Wiley, New York.

FIGURES



LEGEND

LEC-2 BOREHOLE LOCATION

REFERENCES

1. AERIAL IMAGE FROM GOOGLE EARTH.

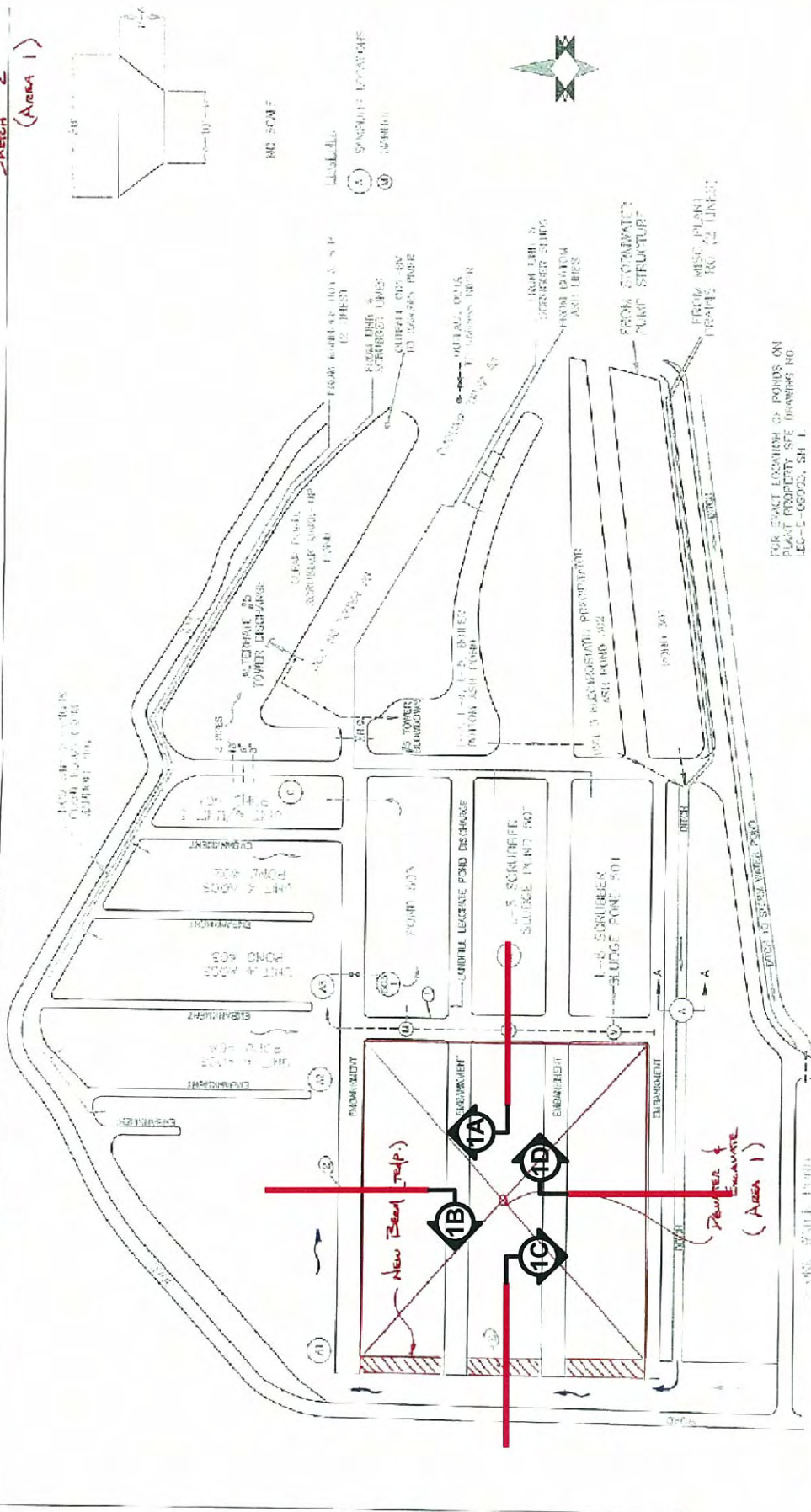
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**SITE LAYOUT AND
BOREHOLE LOCATIONS**

FIGURE 1



Sheet #2
(Area 1)



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FOR EXACT LOCATION OF PONDS ON
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 LEC-L-06023, SH 1

DATE	BY	APP'D	REV
06/24/02	J.L.		

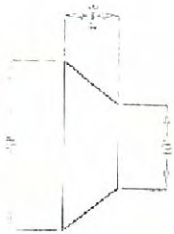
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2	05/29/07	LG	
3	05-07-07	LG	

CROSS SECTION LOCATIONS FIRST PHASE OF ASH REMOVAL

FIGURE 2

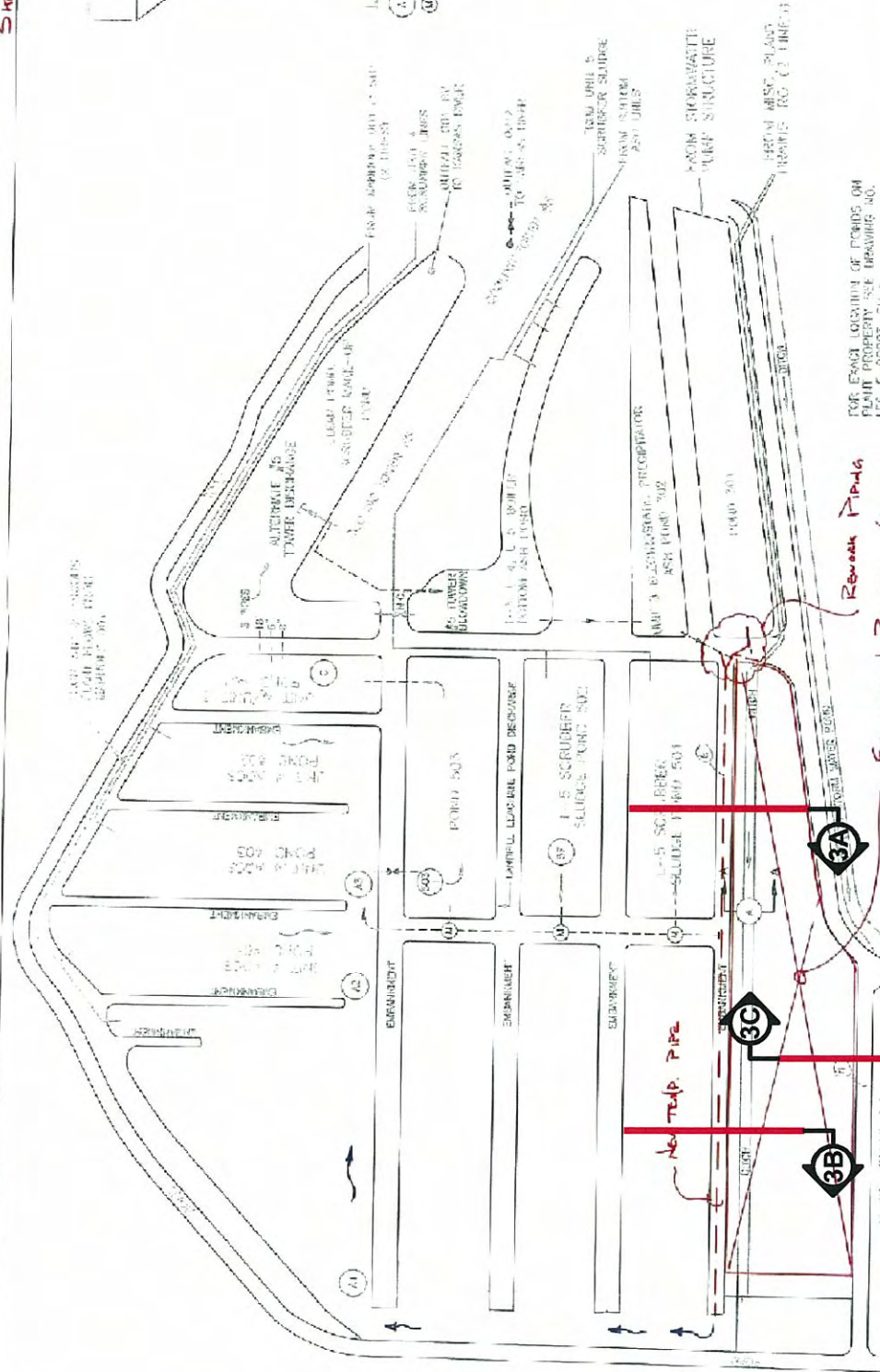


Sketch # 4
(Asect 3)



B/C SCALE

- ① SCHEDULE 40 GALVANIZED STEEL
- ② SCHEDULE 40 BLACK PIPE



FOR EXACT LOCATION OF POND NO. ON PLANT PROPERTY SEE DRAWING NO. LEC-6-02005, 5H

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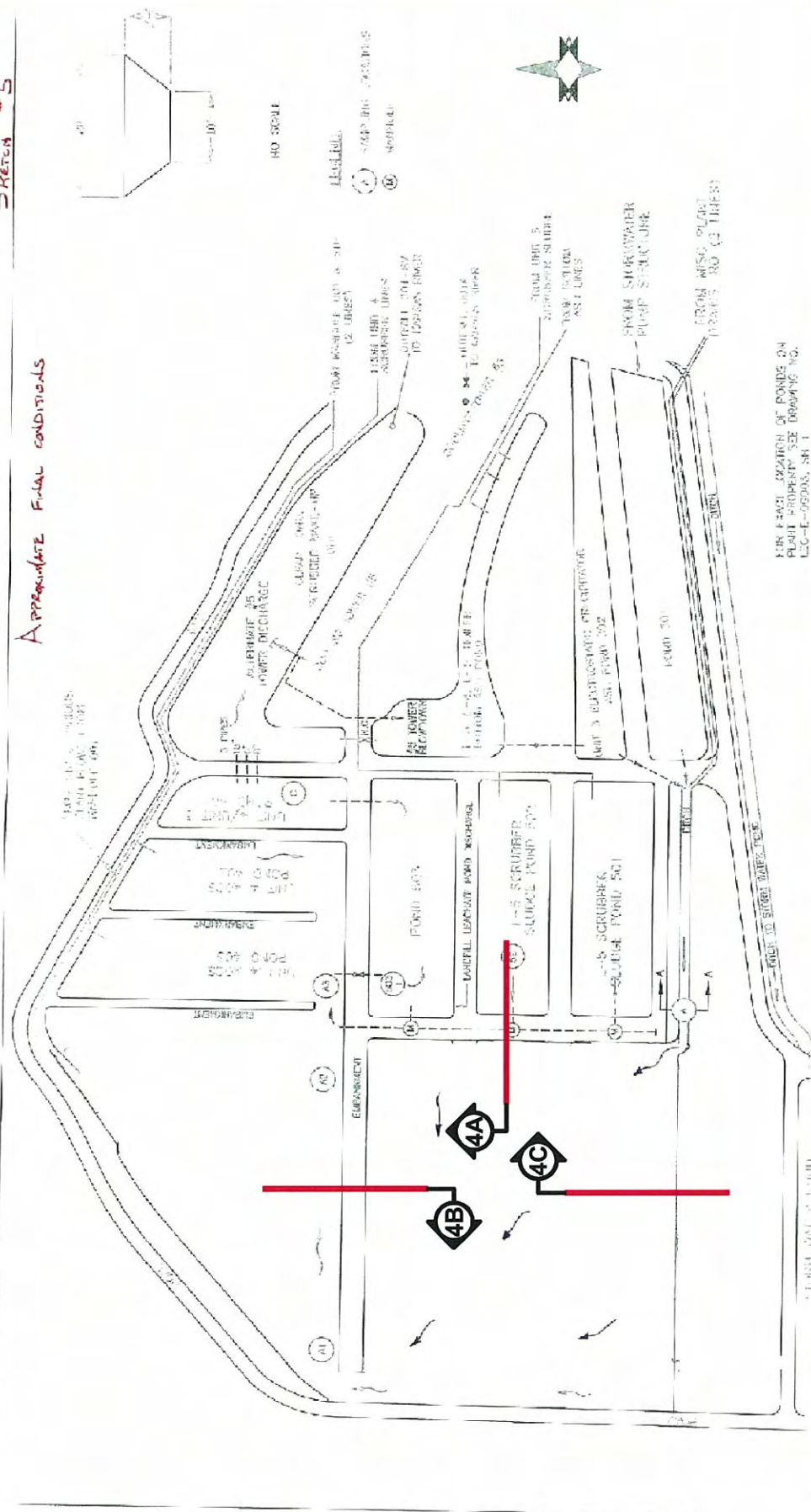
CROSS SECTION LOCATIONS THIRD PHASE OF ASH REMOVAL

FIGURE 4



SKETCH # 5

APPROXIMATE FINAL CONDITIONS



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 LC-E-0500A, SH 1

FOR FINAL LOCATION OF PONDS ON
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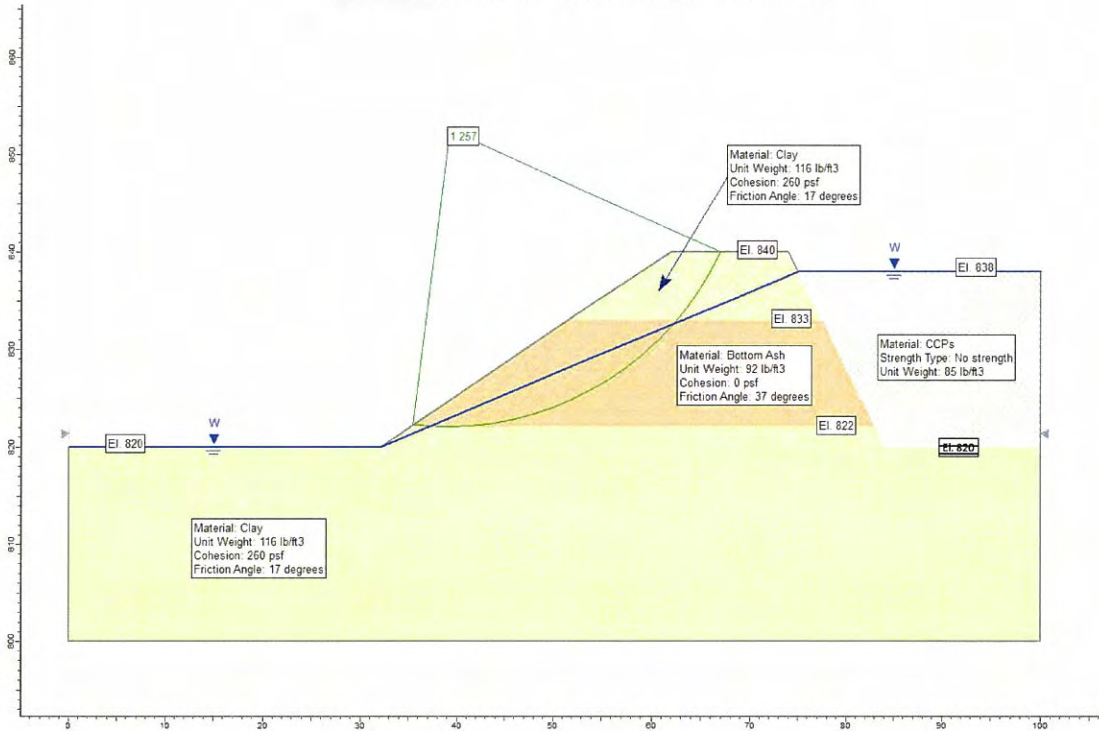
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CROSS SECTION LOCATIONS FINAL CONDITIONS

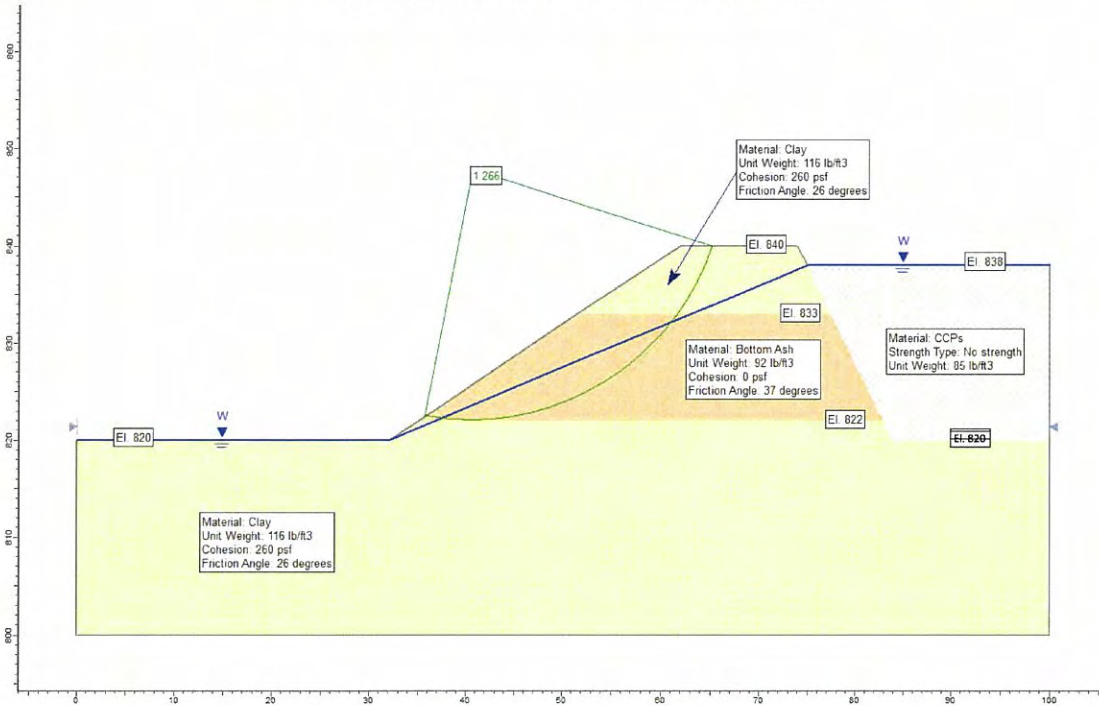
FIGURE 5



CROSS SECTION 1A - SHORT-TERM ANALYSIS



CROSS SECTION 1A - LONG-TERM ANALYSIS



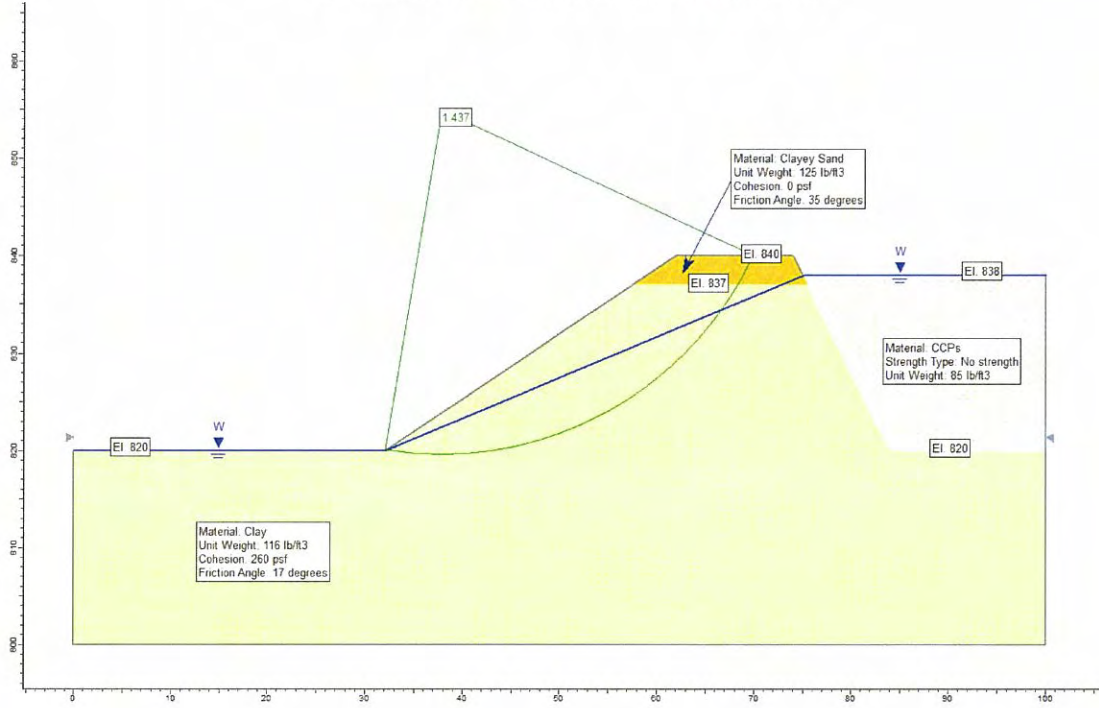
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STABILITY ANALYSES RESULTS CROSS SECTION 1A

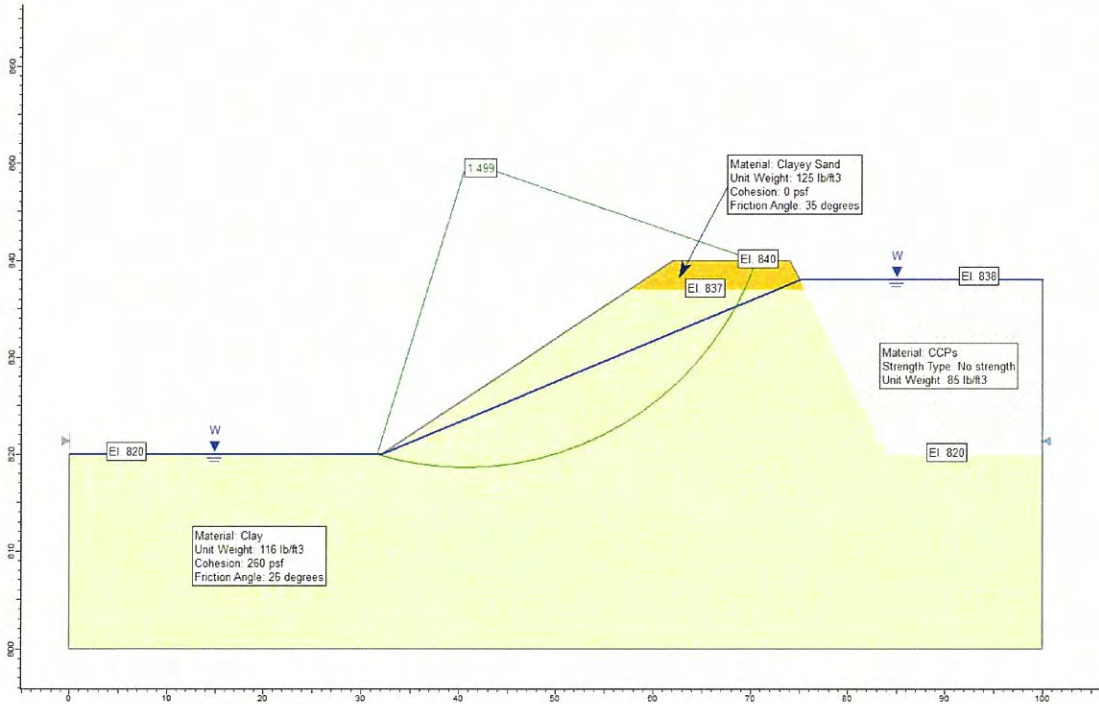
FIGURE 6



CROSS SECTION 1B - SHORT-TERM ANALYSIS



CROSS SECTION 1B - LONG-TERM ANALYSIS



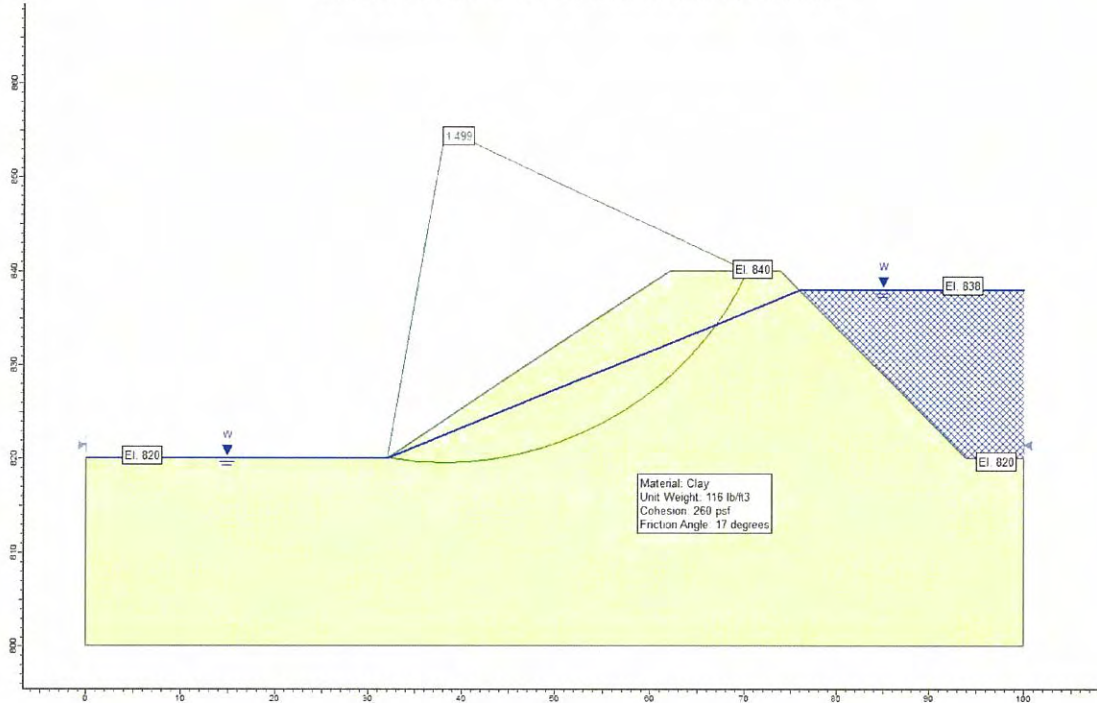
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**STABILITY ANALYSES RESULTS
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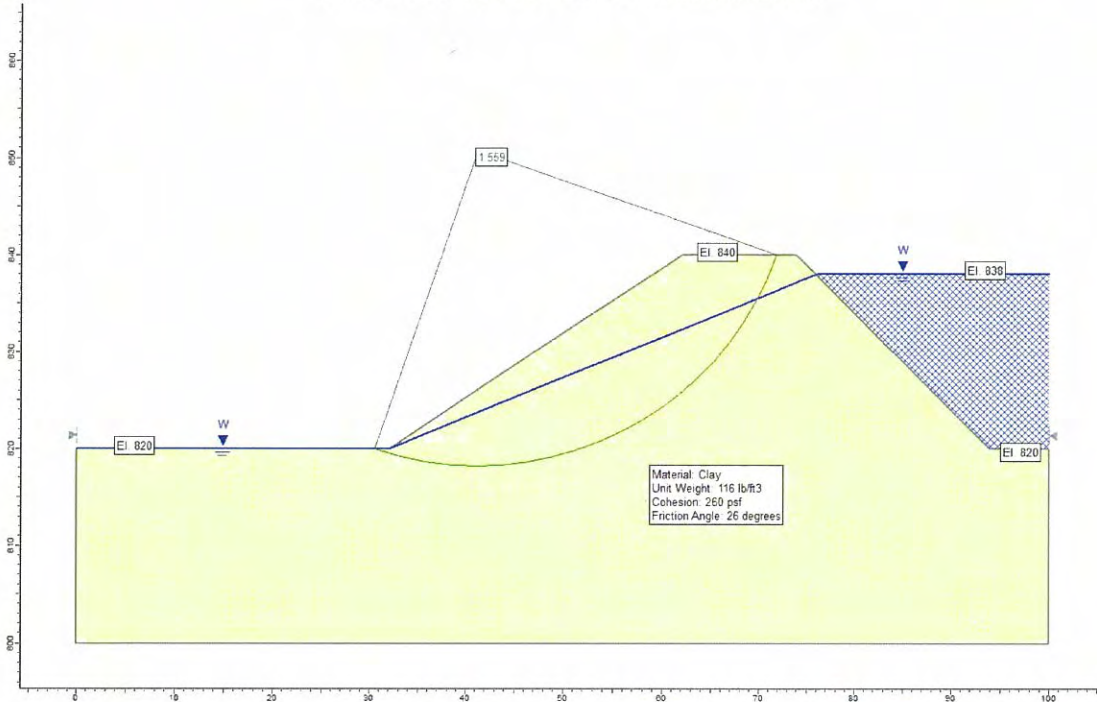
FIGURE 7



CROSS SECTION 1C - SHORT-TERM ANALYSIS



CROSS SECTION 1C - LONG-TERM ANALYSIS



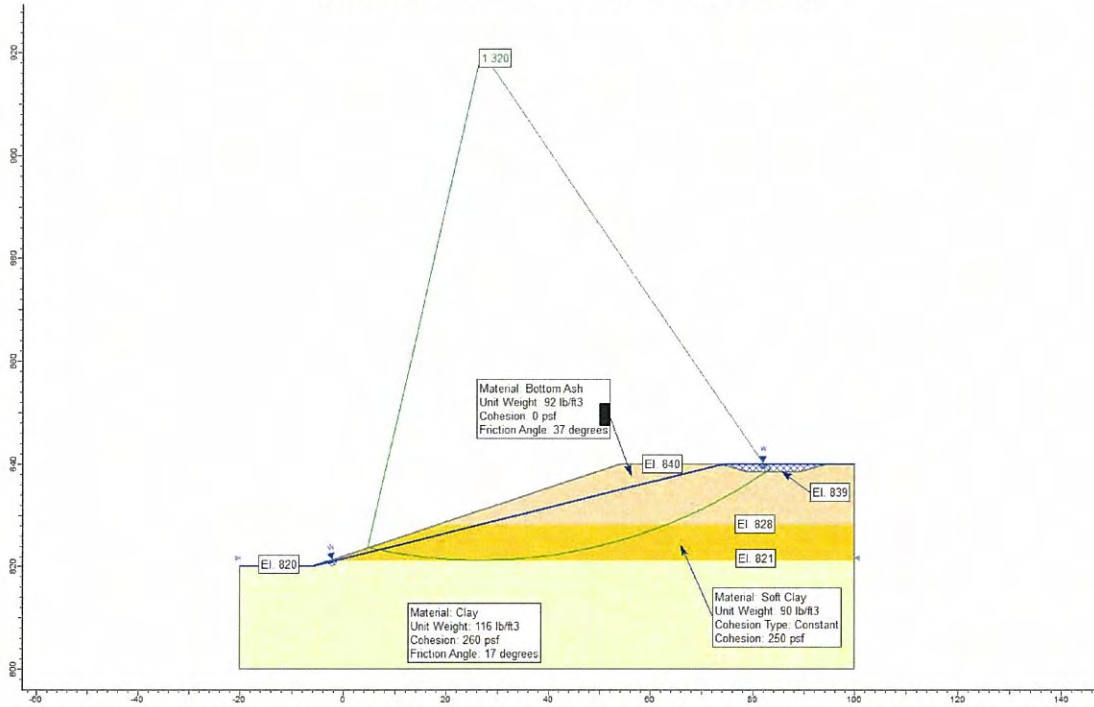
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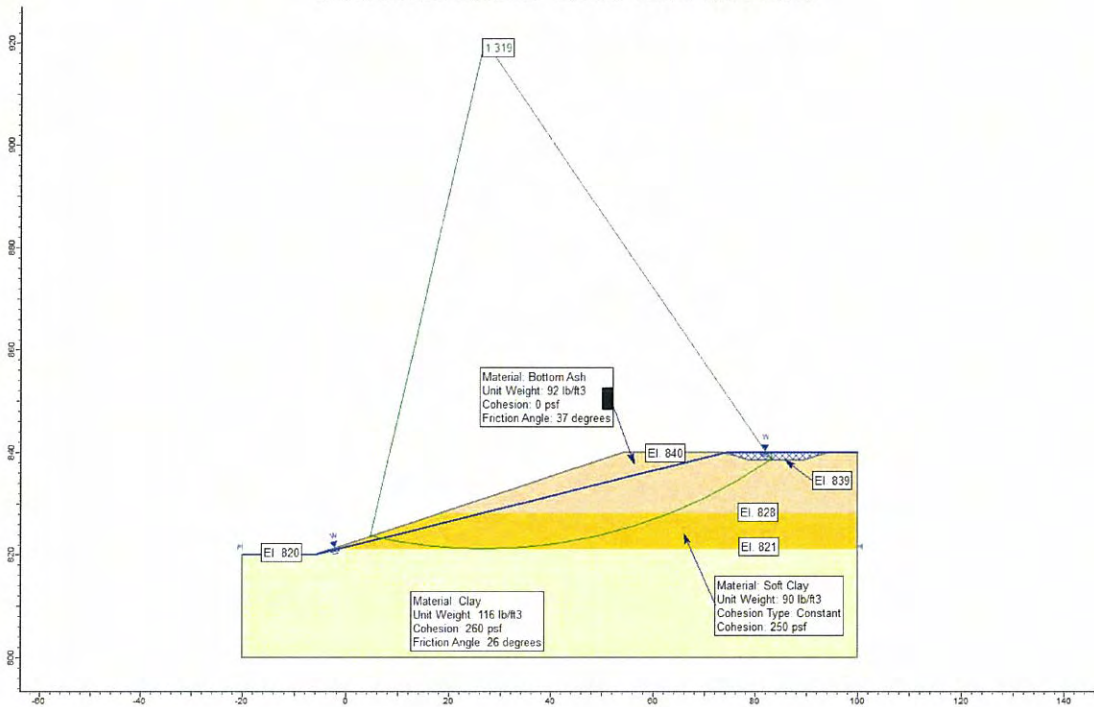
FIGURE 8



CROSS SECTION 1D - SHORT-TERM ANALYSIS



CROSS SECTION 1D - LONG-TERM ANALYSIS



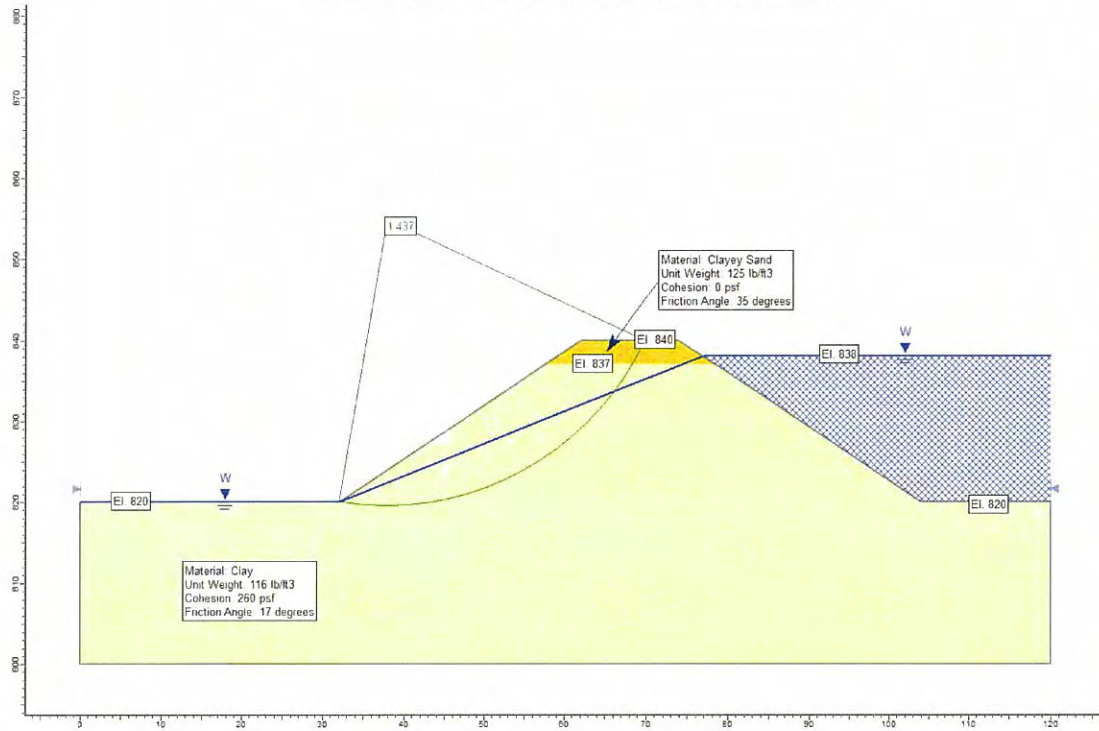
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**STABILITY ANALYSES RESULTS
CROSS SECTION 1D**

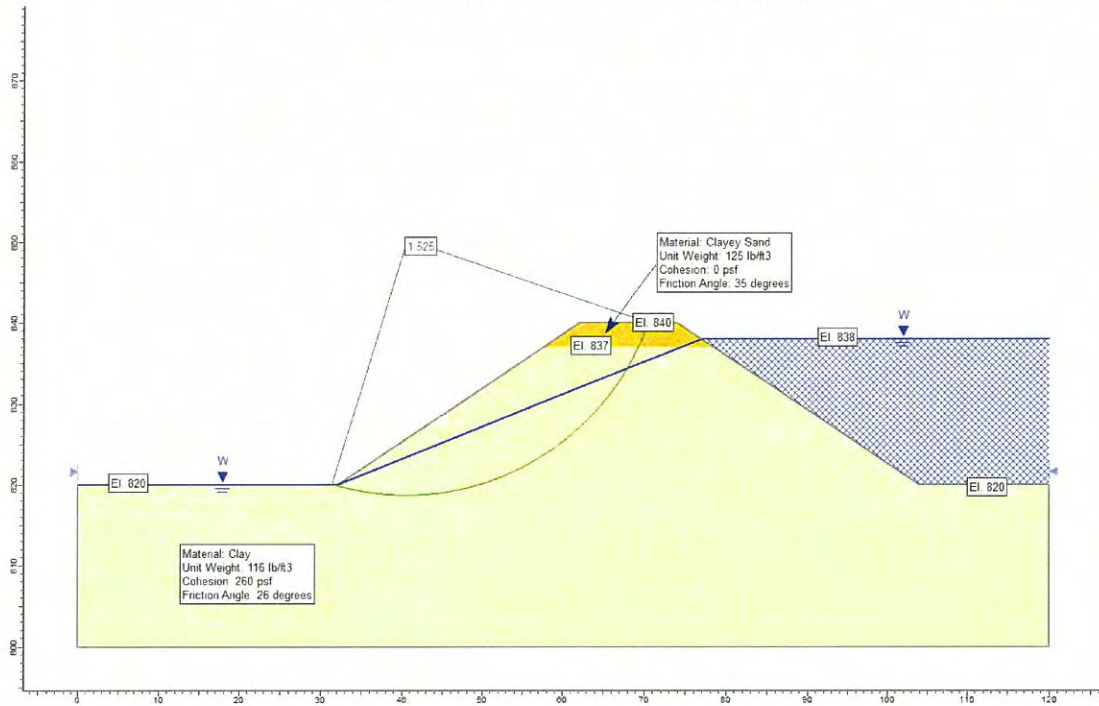
FIGURE 9



CROSS SECTION 2A - SHORT-TERM ANALYSIS



CROSS SECTION 2A - LONG-TERM ANALYSIS



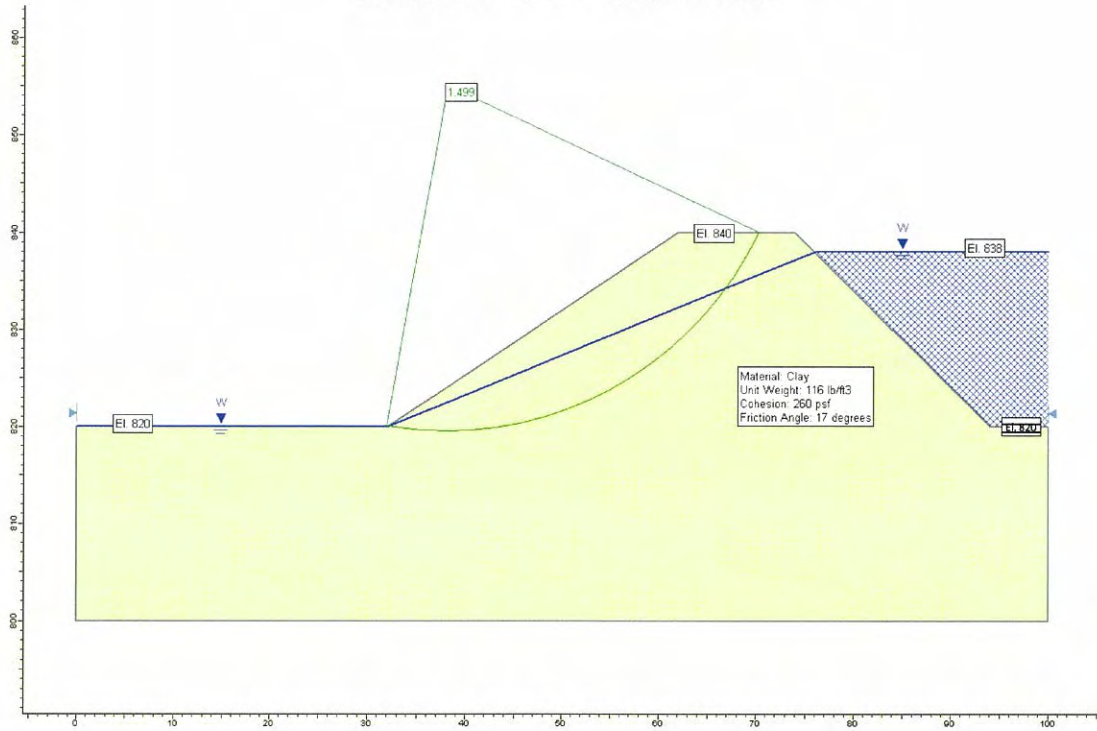
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STABILITY ANALYSES RESULTS CROSS SECTION 2A

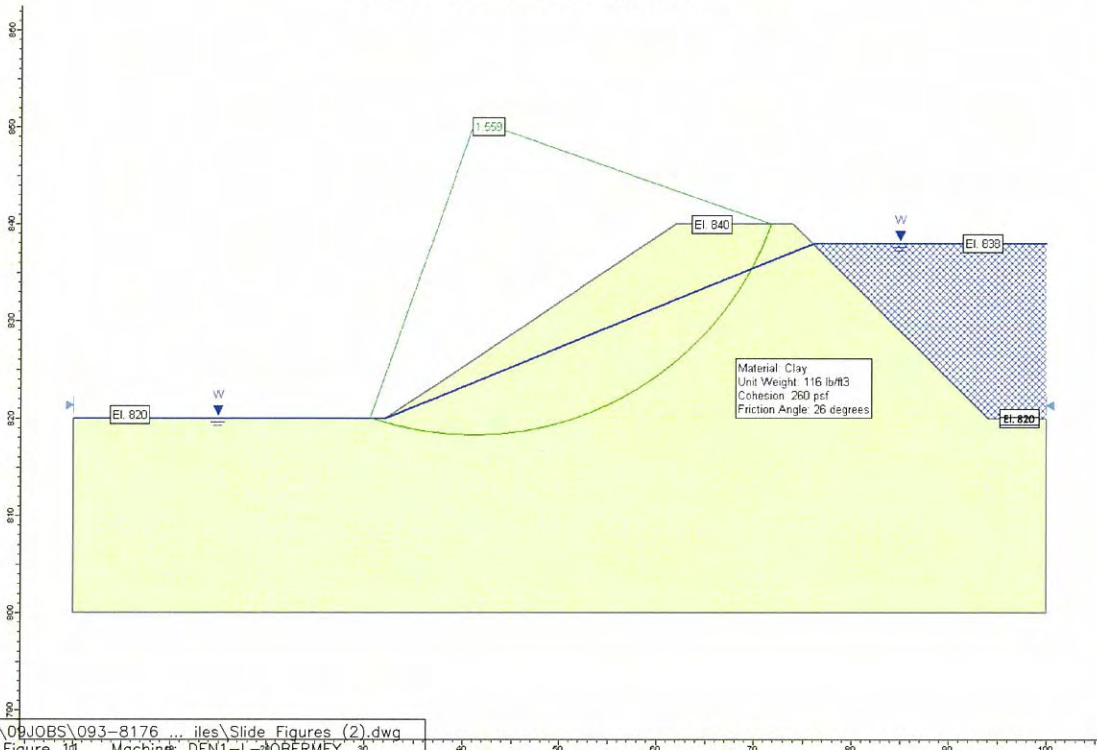


FIGURE 10

SECTION 2B - SHORT-TERM ANALYSIS



SECTION 2B - LONG-TERM ANALYSIS



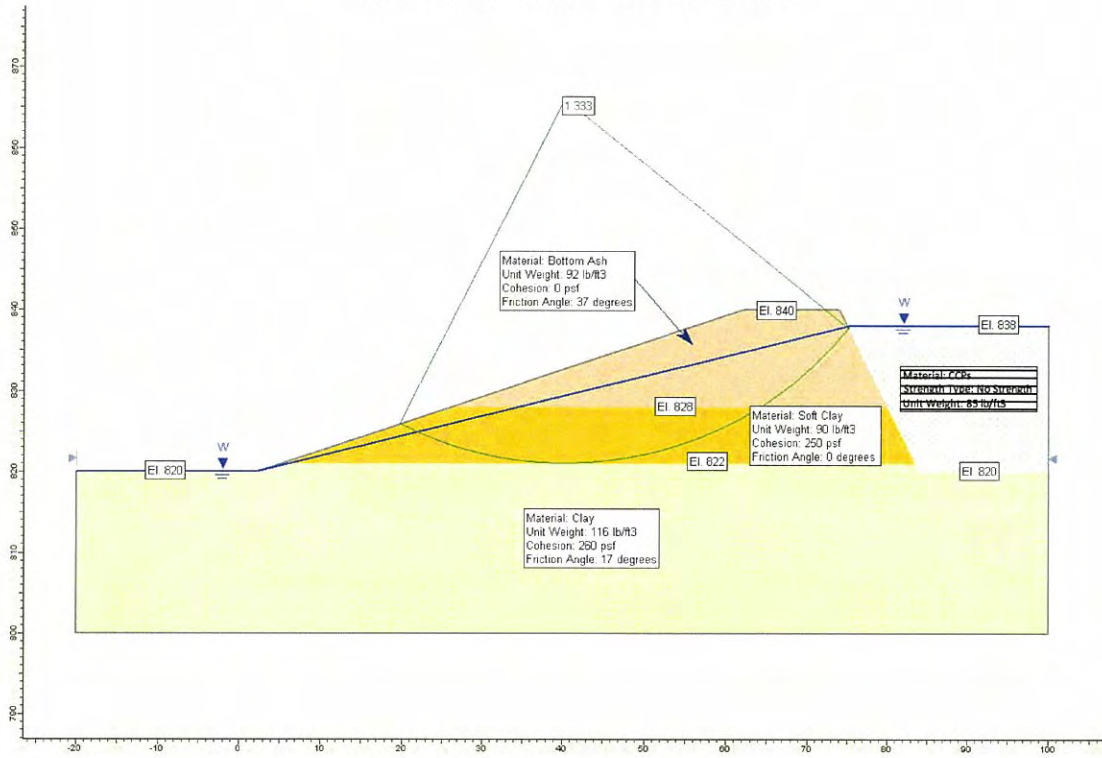
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STABILITY ANALYSES RESULTS
 CROSS SECTION 2B

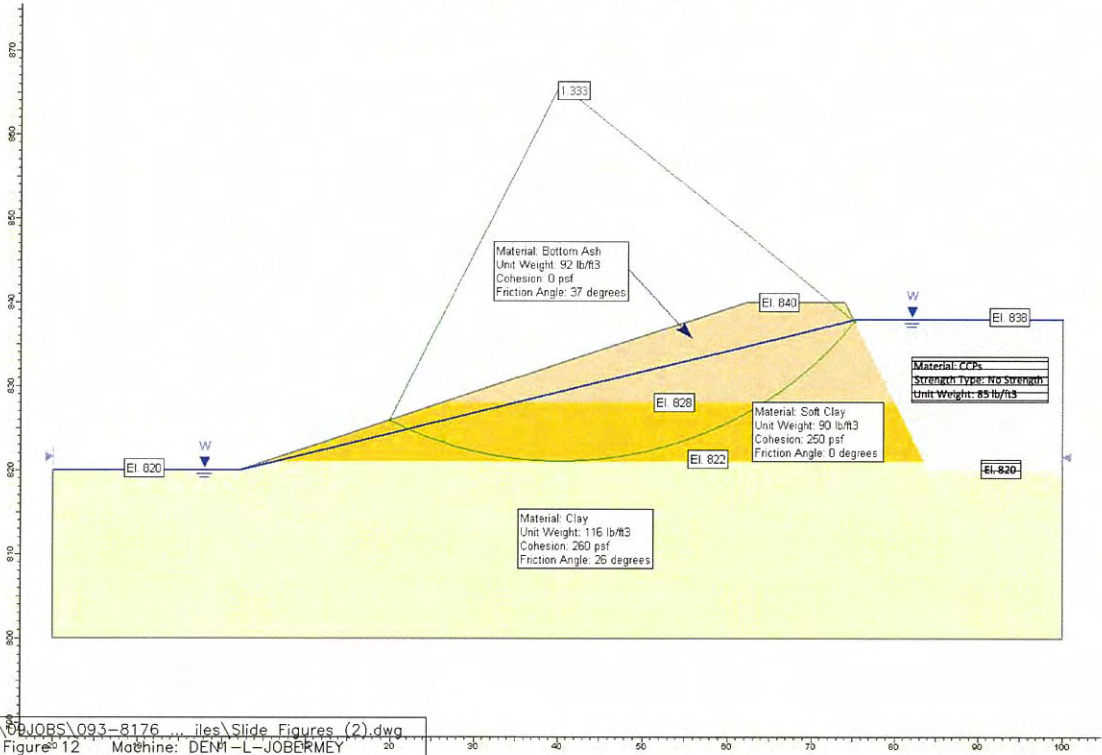
FIGURE 11



SECTION 2C - SHORT-TERM ANALYSIS



SECTION 2C - LONG-TERM ANALYSIS



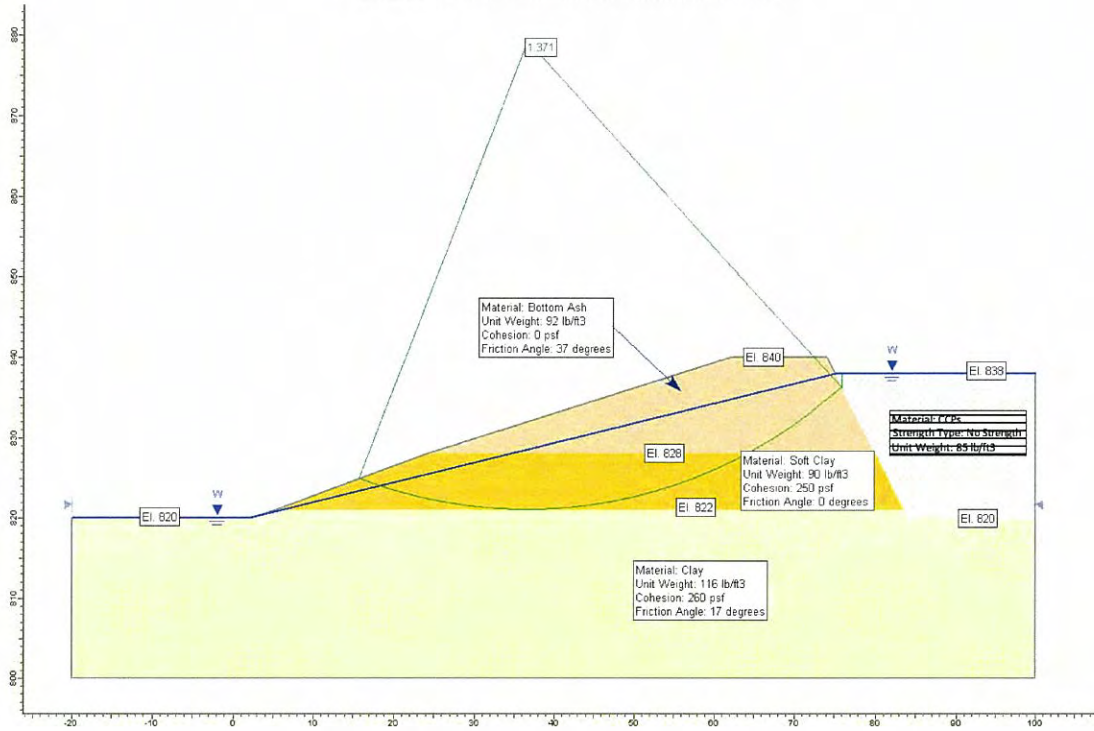
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STABILITY ANALYSES RESULTS
CROSS SECTION 2C

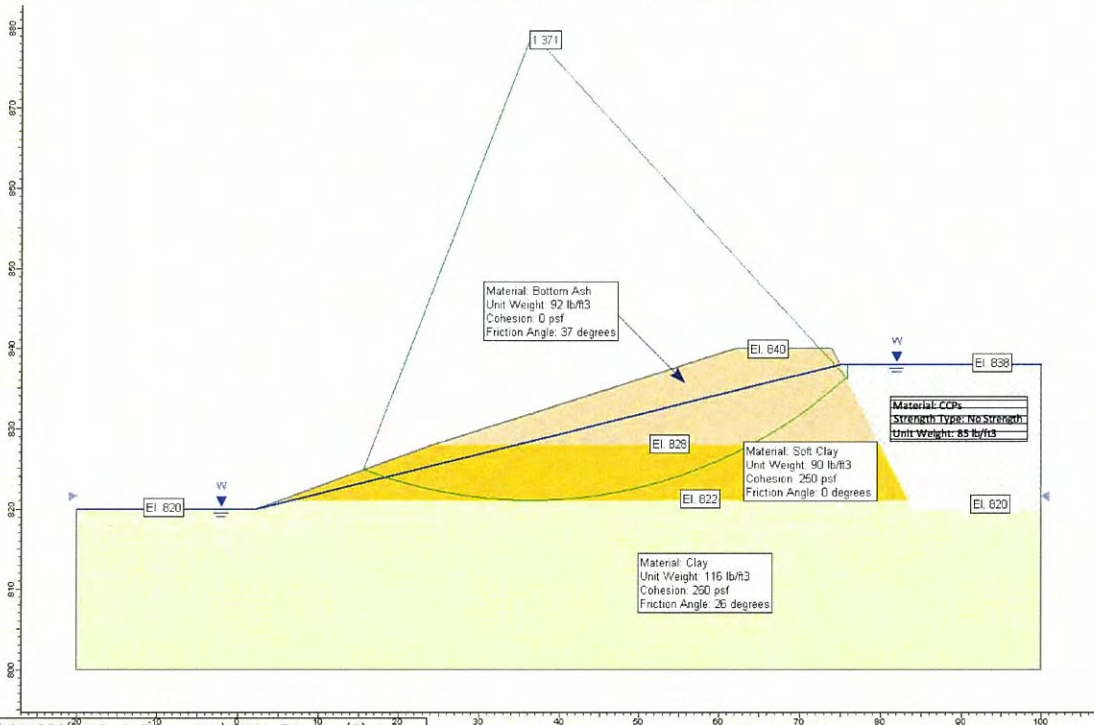
FIGURE 12



SECTION 3A - SHORT-TERM ANALYSIS



SECTION 3A - LONG-TERM ANALYSIS



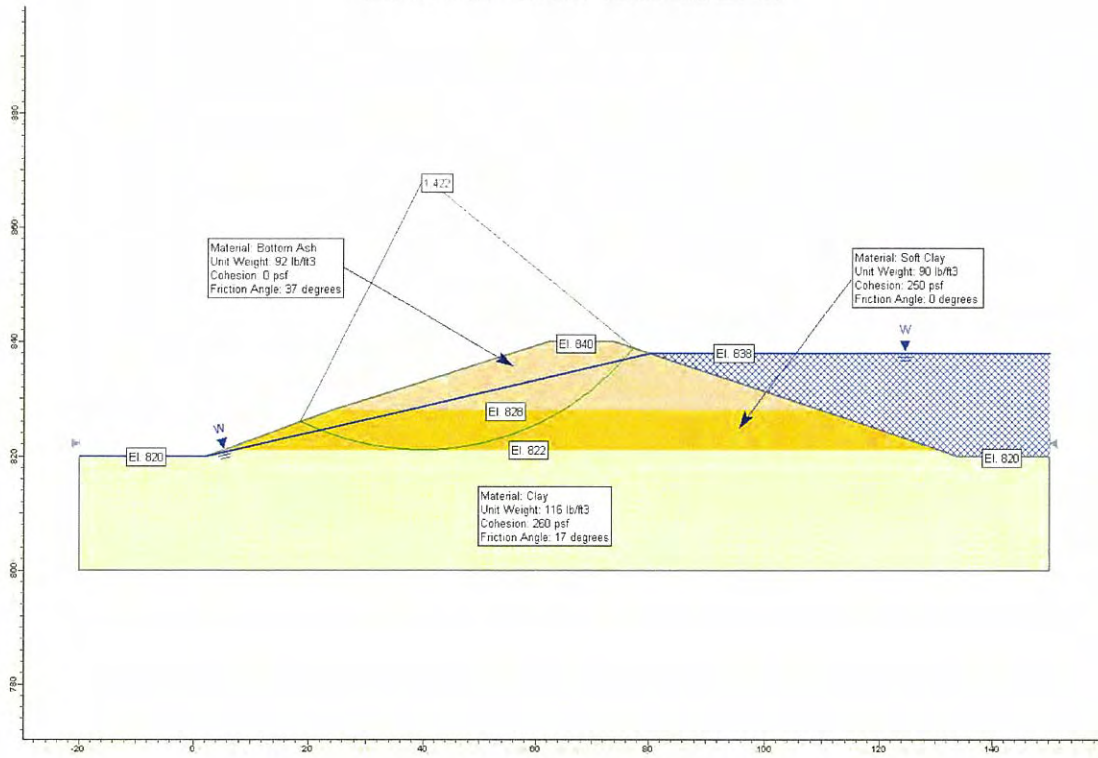
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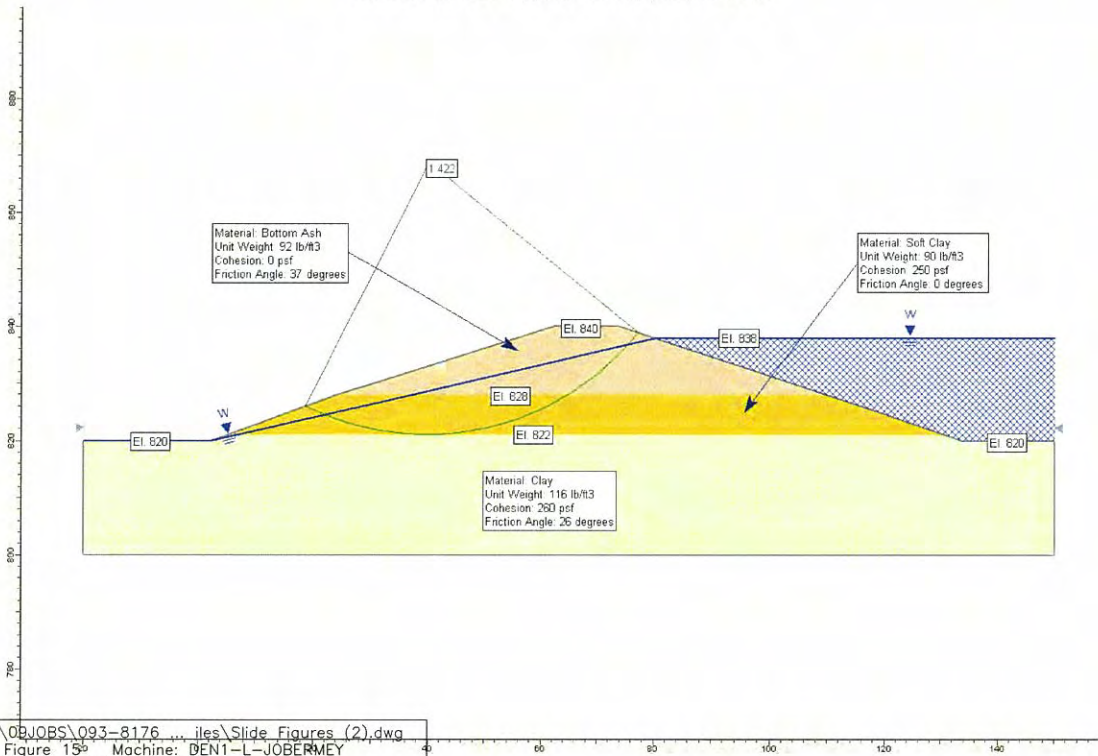
FIGURE 14



SECTION 3B - SHORT-TERM ANALYSIS



SECTION 3B - LONG-TERM ANALYSIS



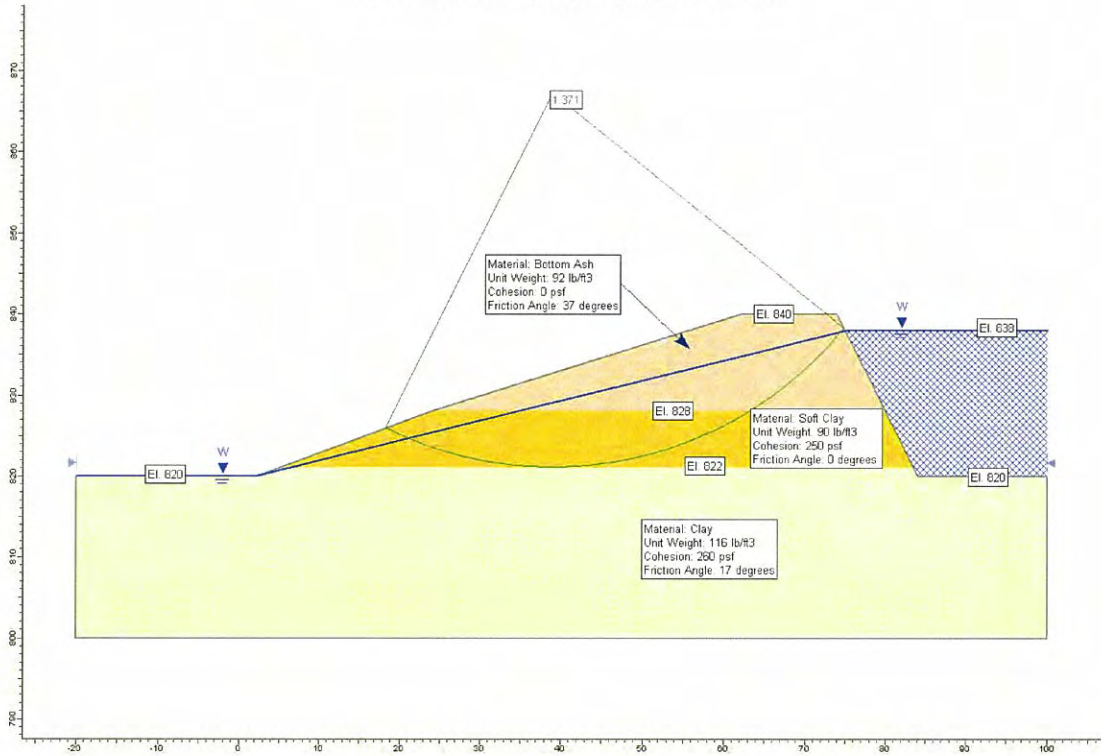
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STABILITY ANALYSES RESULTS
 CROSS SECTION 3B

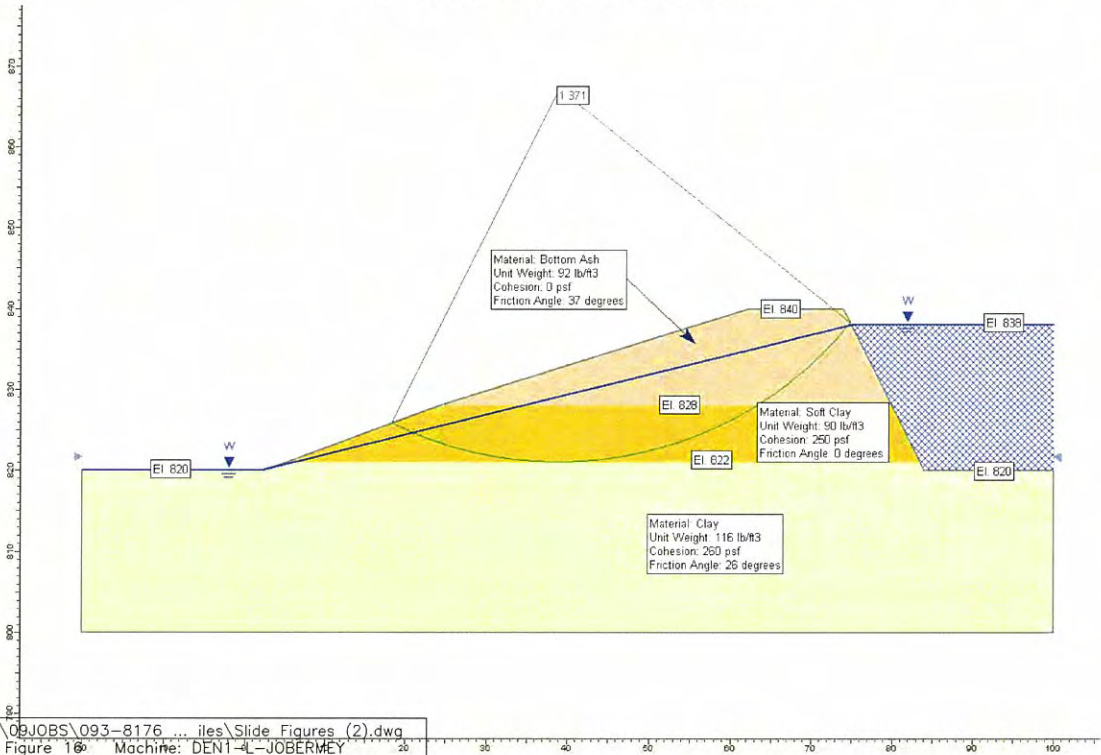
FIGURE 15



SECTION 3C - SHORT-TERM ANALYSIS



SECTION 3C - LONG-TERM ANALYSIS



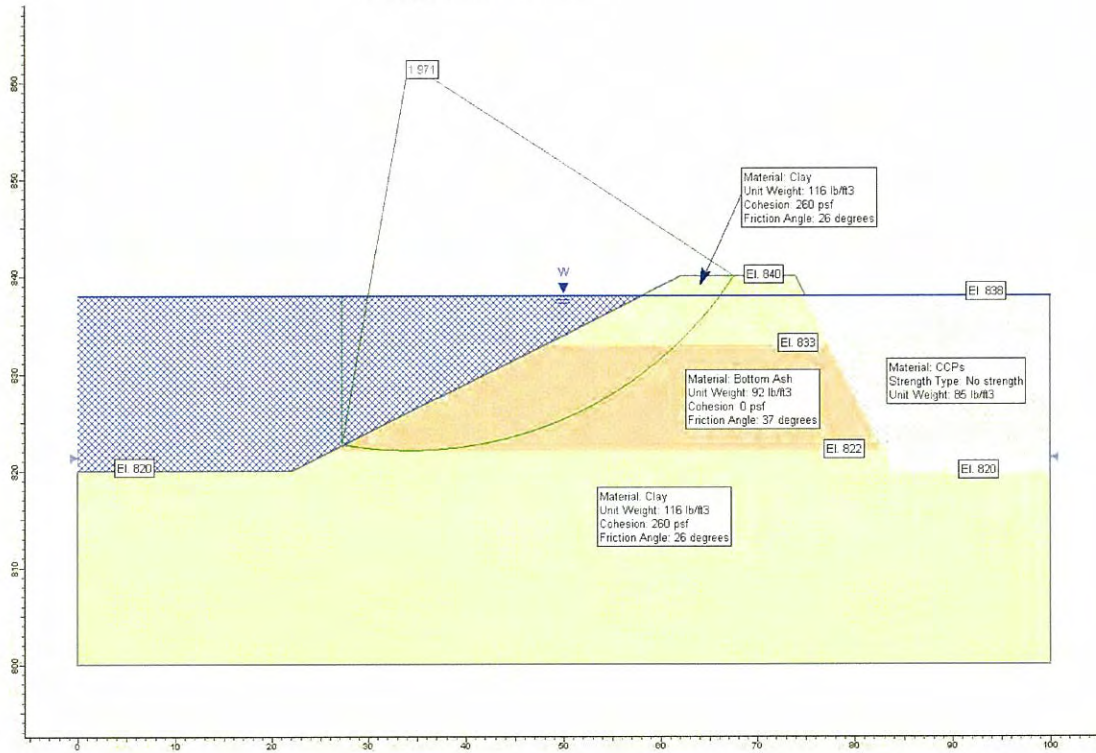
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**STABILITY ANALYSES RESULTS
 CROSS SECTION 3C**

FIGURE 16



SECTION 4A - LONG-TERM ANALYSIS



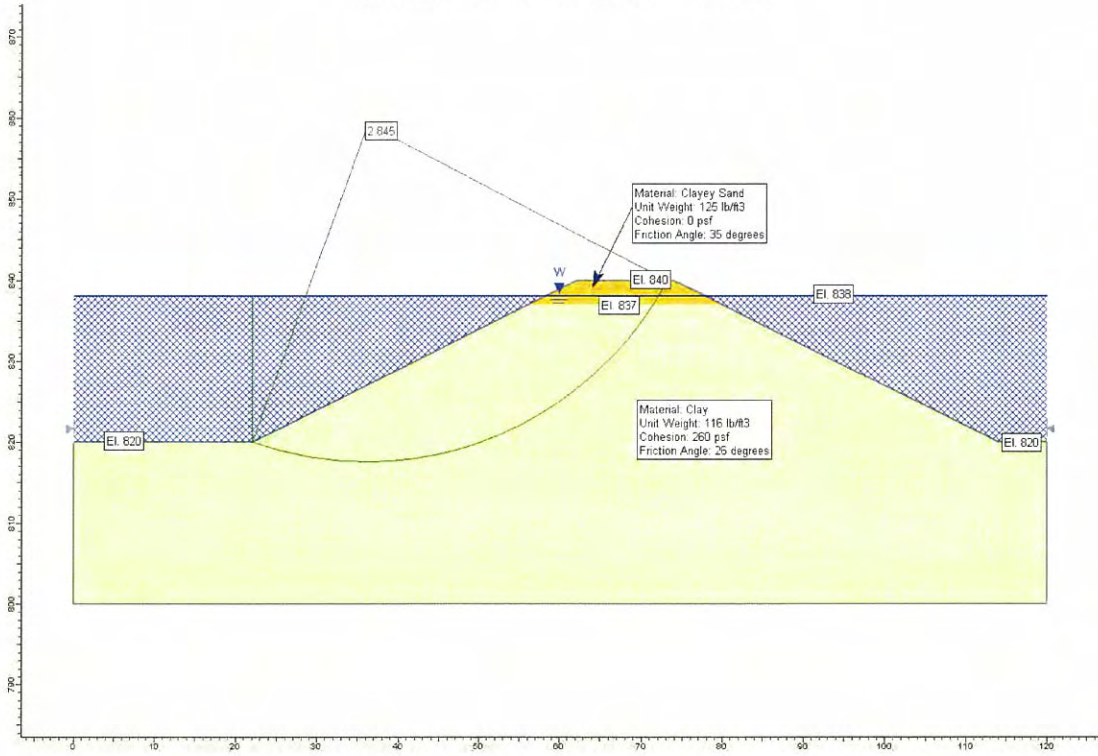
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STABILITY ANALYSIS RESULT
 CROSS SECTION 4A

FIGURE 17



SECTION 4B - LONG-TERM ANALYSIS



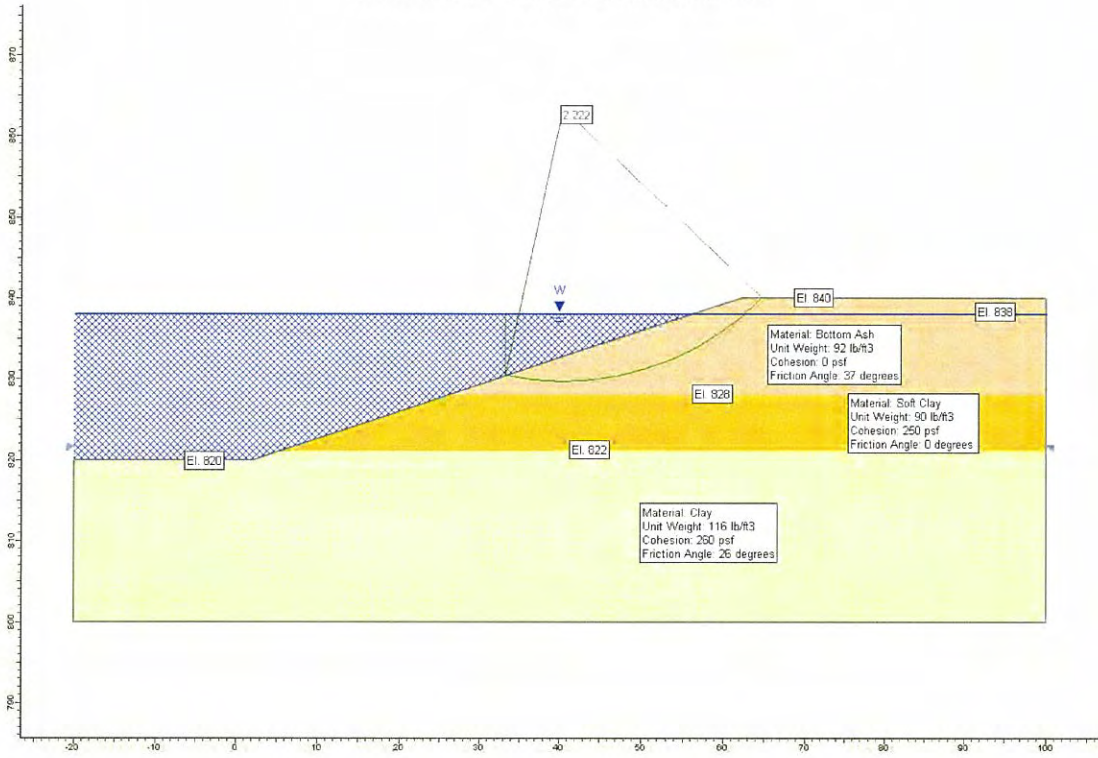
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STABILITY ANALYSIS RESULT
 CROSS SECTION 4B

FIGURE 18



SECTION 4C - LONG-TERM ANALYSIS



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**STABILITY ANALYSIS RESULT
 CROSS SECTION 4C**

FIGURE 19



ATTACHMENTS

**ATTACHMENT A
BOREHOLE LOGS**



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-1
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 258,450 Easting 2,086,625 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-1' ASPHALT and loose, black, BOTTOM ASH, (ML) 1-5' Firm, brown, SILTY CLAY, trace sand, (CL)	Berm road and road base
5	5-18' Stiff to very stiff, dark brown, SILTY CLAY, trace sand, (CL to CH)	Encountered and penetrated an unidentified 6" PVC pipe at depth of approximately 7' near the centerline of the berm.
10		
15		2" Shelby tube sample (Sample 1) from 13-15' Pocket penetrometer result: 3.25 tsf (15')
20		End of boring at 18'
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Water entered the borehole after Westar personnel initiated flow through the 6" PVC pipe to determine its purpose. Westar personnel directed the water into the ash pond. The 6" PVC pipe was promptly repaired by Schmidlein Excavating, Inc., personnel. Northing and easting are approximate (±25'). Borehole location was approximately 25' northwest of the discharge location and approximately 10' from the upstream berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-2
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 258,450 Easting 2,086,210 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-1' ASPHALT 1-5' Loose, black, BOTTOM ASH, (ML)	Berm road Road base and fill
5	5-16' Very stiff, light gray, SILTY CLAY, trace gravel, trace sand, (CL to CH)	
10		2" Shelby tube sample (Sample 1) from 8-10' (18" recovered) Pocket penetrometer result: 4.5 tsf (10')
15		2" Shelby tube sample (Sample 2) from 13-15' (16" recovered) Pocket penetrometer result: 4.25 tsf (15')
20	16-20' Very stiff, dark brown, SILTY CLAY, trace sand, (CL to CH)	
25		2" Shelby tube sample (Sample 3) from 18-20' (17" recovered) Pocket penetrometer result: 3.75 tsf (20')
30		End of boring at 20'

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately 21' from the upstream berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-3
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 258,115 Easting 2,085,825 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-1' ASPHALT 1-3' Loose, black, BOTTOM ASH, (ML)	Berm road Road base and fill
5	3-7' Stiff, gray to brown, SILTY CLAY, trace sand, (CL)	
10	7-13' Stiff, to very stiff, dark brown, SILTY CLAY, little sand, (CL to CH)	2" Shelby tube sample (Sample 1) from 8-10' (26" recovered) Pocket penetrometer result: 2.75 tsf (10')
15	13-24' Stiff to very stiff, dark brown, CLAY, little sand, (CH)	2" Shelby tube sample (Sample 2) from 13-15' (10" recovered) Pocket penetrometer result: 4.75 tsf (15')
20		2" Shelby tube sample (Sample 3) from 18-20' (24" recovered) Pocket penetrometer result: 1.75 tsf (20')
25		End of boring at 24'
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately 21' from the upstream berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-5
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 257,850 Easting 2,086,250 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-3' Loose, dark brown, CLAYEY SAND, (SC)	
5	3-5' Stiff, dark brown, CLAY, (CH)	
5	5-18' Very stiff, gray, SILTY CLAY, little sand, (CL)	
10		2" Shelby tube sample (Sample 1) from 8-10' (14" recovered) Pocket penetrometer result: 4.25 tsf (10')
15		
20		End of boring at 18'
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately in the center of the berm. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-6
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 257,525 Easting 2,086,350 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-3' Loose, black, BOTTOM ASH, some gravel, little clay, (ML)	
5	3-5' Stiff, red to brown, SILTY CLAY, little sand (CL)	
5	5-14' Dense, black, BOTTOM ASH, (ML)	
10		
15	14-18' Stiff, red, SILTY CLAY, some sand, (CL)	Bottom ash mixed in; likely a transition zone from the bottom ash layer to an underlying clay layer
15		End of boring at 18'
20		
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately 10' from the west berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-7
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 257,200 Easting 2,086,550 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-12' Compact, black, BOTTOM ASH, some clay, (ML)	
5		
10	12-17' Very soft, brown, SLUDGE, (ML)	
15	17-19' Soft, gray, SLUDGE, some sand, (ML) 19-23' Stiff, brown, SILTY CLAY, some sand, (CL)	
20		End of boring at 23'
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was encountered at a depth of 6'. Northing and easting are approximate (±25'). Borehole location was approximately 30' from the north berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



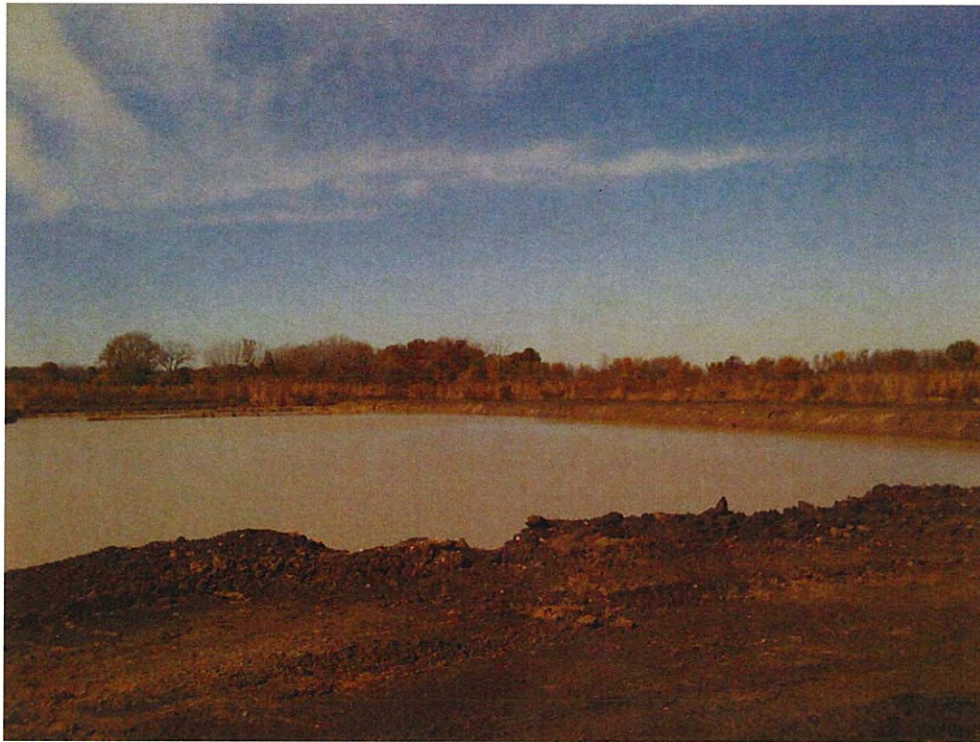
BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring: LEC-8
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date: 10/26/09
 Location: Lawrence Energy Center Northing: 258,250 Easting: 2,086,375 Job No.: 093-81765.2

Depth (ft)	Material	Notes
0	0-12' Compact, black, BOTTOM ASH, some clay, (ML)	
5		
10	12-18' Very soft, brown, SLUDGE, some sand, (ML)	Driller was able to penetrate stratum without rotating the auger
15		End of boring at 18'
20		
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was encountered at a depth of 4'. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately 10' from the west berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			

**ATTACHMENT B
PHOTOGRAPHS**



Photograph 1 – CCP storage facility (looking northwest)



Photograph 2 – CCP storage facility (looking east)



Photograph 3 – CCP storage facility (looking east)



Photograph 4 – Berm crest near Borehole LEC-1 (looking northwest)



Photograph 5 – Drilling Borehole LEC-5 (looking west)



Photograph 6 – Soft saturated clay found in Borehole LEC-7 (looking northeast)



Photograph 7 – Soft saturated clay found in Borehole LEC-7 (looking northeast)

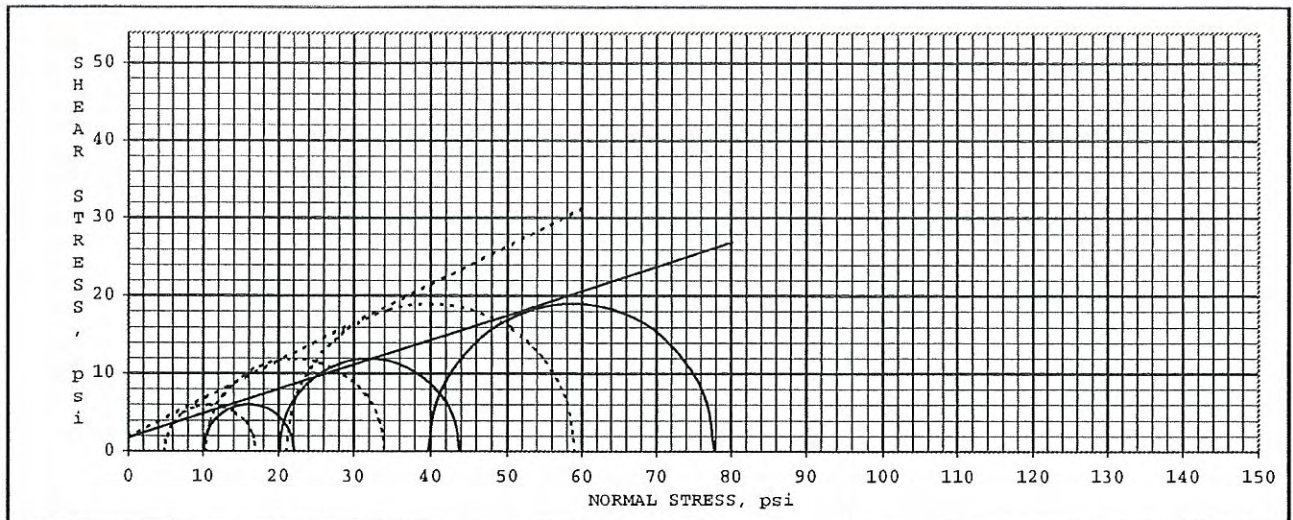


Photograph 8 – Drilling Borehole LEC-8 (looking north)

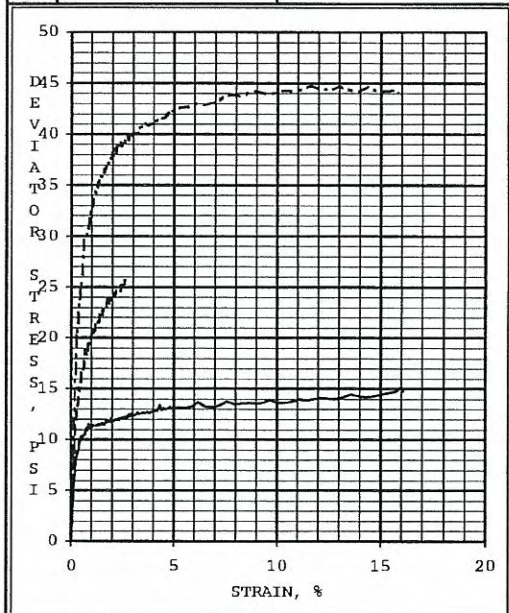
ATTACHMENT C
GEOTECHNICAL TEST RESULTS

**EVALUATION OF ASH POND BERMS AT WESTAR ENERGY'S LAWRENCE ENERGY CENTER
SUMMARY OF LABORATORY GEOTECHNICAL TEST DATA**

Borehole	Sample	Depth	USCS	Dry Unit Weight	Moisture Content	Liquid Limit	Plasticity Limit	Plasticity Index	Friction Angle	Cohesion
LEC-1	1	13-15'	CL	94 pcf	28%	46	20	26		
LEC-2	1	8-10'	CH	93 pcf	25%	61	22	39	26 deg	250 psf
LEC-3	3	18-20'	CH	91 pcf	27%	74	24	50	28 deg	410 psf
LEC-4	1	8-10'	CL	106 pcf	21%	41	18	23		
LEC-4	2	13-15'			26%					
LEC-4	3	18-20'			27%					



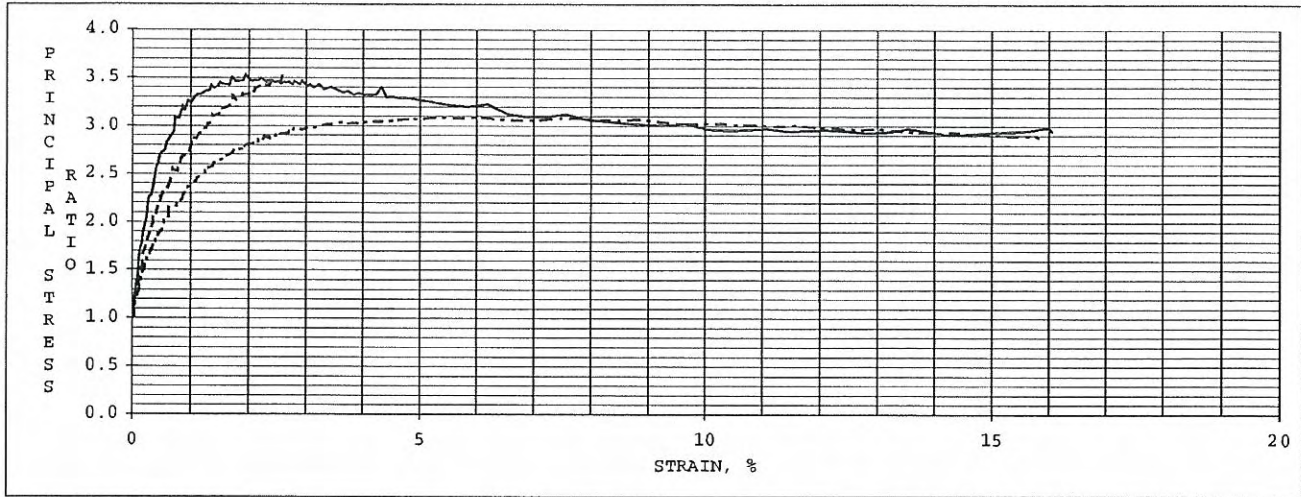
EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	26.1	COHESION, psi	1.8
TOTAL STRESS ———	ANGLE OF INTERNAL FRICTION, deg	17.4	COHESION, psi	1.8



SPECIMEN ID:		A	B	C
INITIAL	WATER CONTENT, %	26.6	22.8	24.8
	DRY DENSITY, pcf	87.8	97.8	101.0
	SATURATION, %	78	85	100
	VOID RATIO	0.92	0.72	0.67
BEFORE SHEAR	WATER CONTENT, %	33.1	24.8	23.5
	DRY DENSITY, pcf	89.0	100.9	103.2
	SATURATION (B PARAMETER)	0.96	0.99	NA
	VOID RATIO	0.89	0.67	0.63
	FINAL BACK PRESSURE, psi	100.3	94.9	94.8
MINOR PRINCIPAL STRESS, psi		10.0	20.0	39.8
EFFECTIVE STRESS PEAK AT % STRAIN		2.0	2.0	2.0
EFF. DEVIATOR STRESS AT PEAK STRAIN, psi		12.1	23.8	38.1
TOTAL STRESS PEAK AT % STRAIN		2.0	2.0	2.0
TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi		12.1	23.8	38.1
ULTIMATE DEVIATOR STRESS (15% STR), psi		14.5	NA	44.3
TIME TO 50% PRIMARY CONSOLIDATION, min		2.20	31.00	NA
STRAIN RATE, % / hour		4.09	0.57	0.56
INITIAL DIAMETER, inch		1.864	1.841	1.828
INITIAL HEIGHT, inch		3.793	3.731	3.664
AREA AFTER CONSOLIDATION, inch ²		2.707	2.601	2.574
PROJECT NO. 14095047		PROJECT: LEC / TEC LAB		
CIRCLE B & C SAMPLE WAS STAGE LOADED				
BORING #: LEC-2				
LABORATORY: TERRACON - LENEXA		SAMPLE #: 1		
DATE: 11/18/2009		DEPTH, feet: 8.0 - 10.0 feet		

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS (TERRACON MODIFIED FOR STAGE LOADING)



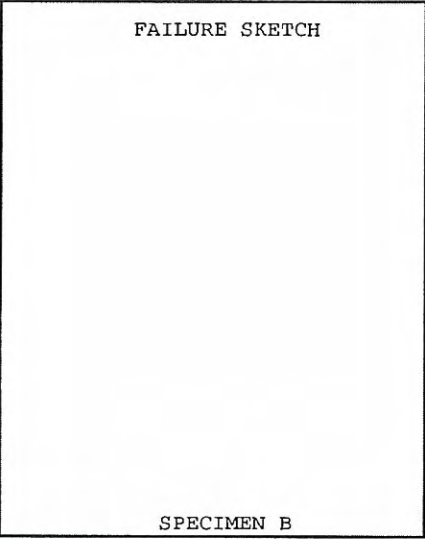


FAILURE SKETCH



SPECIMEN A

FAILURE SKETCH



SPECIMEN B

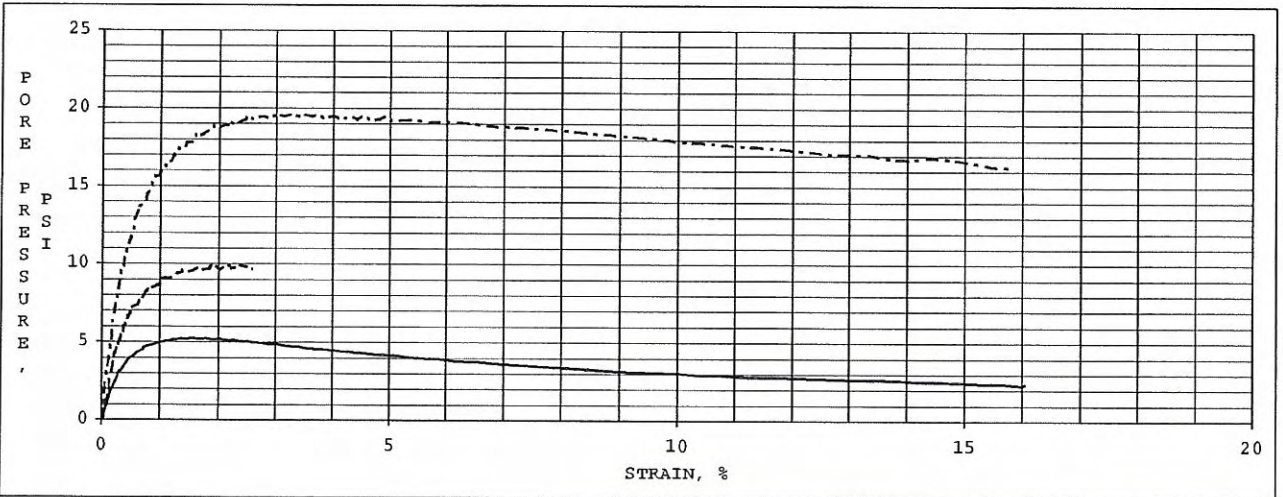
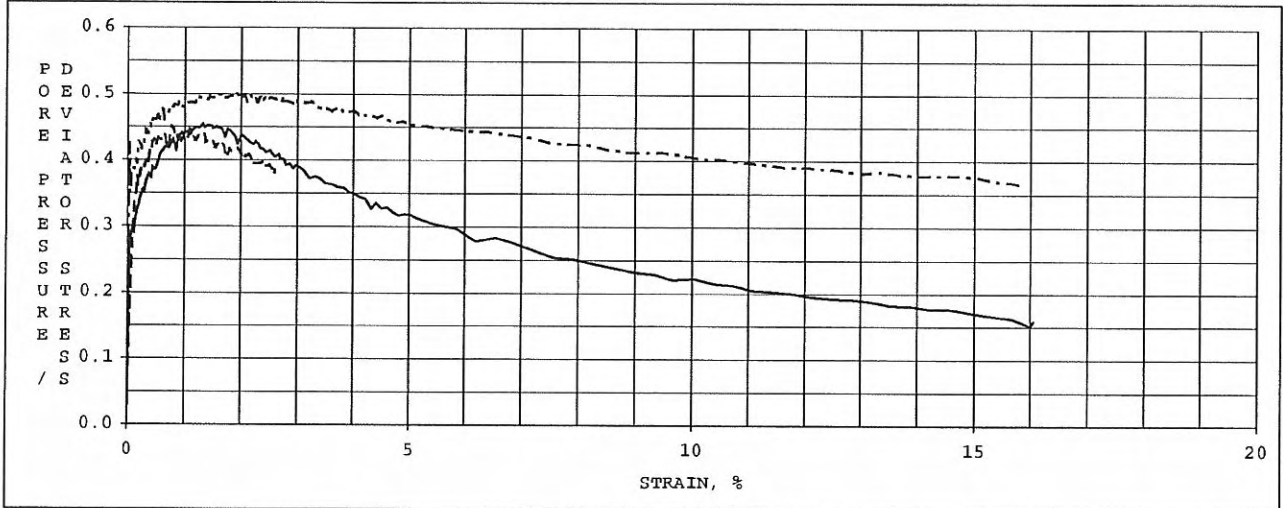
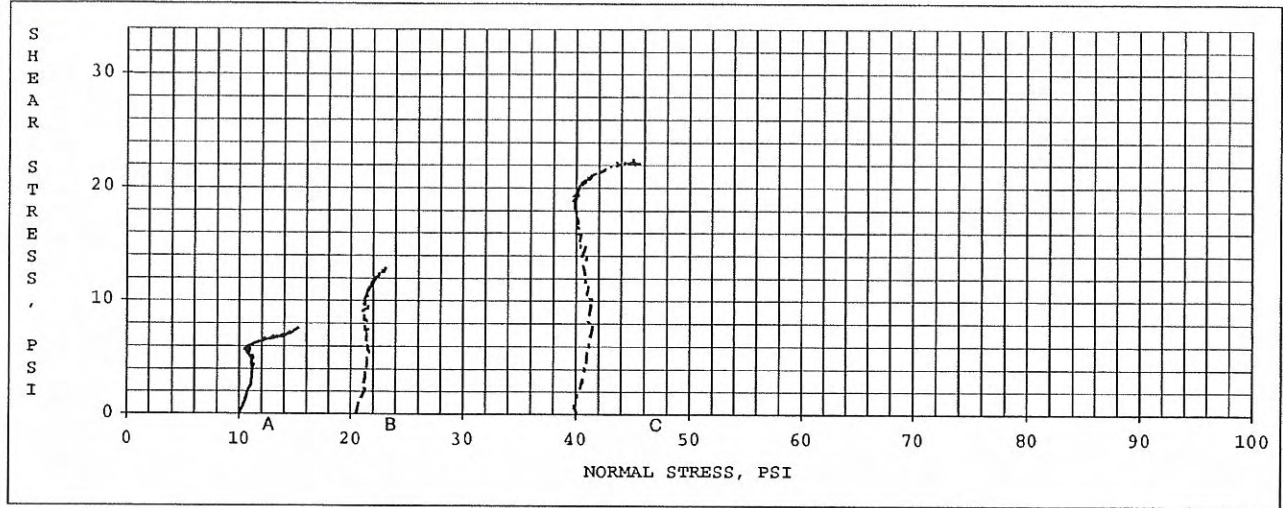
FAILURE SKETCH



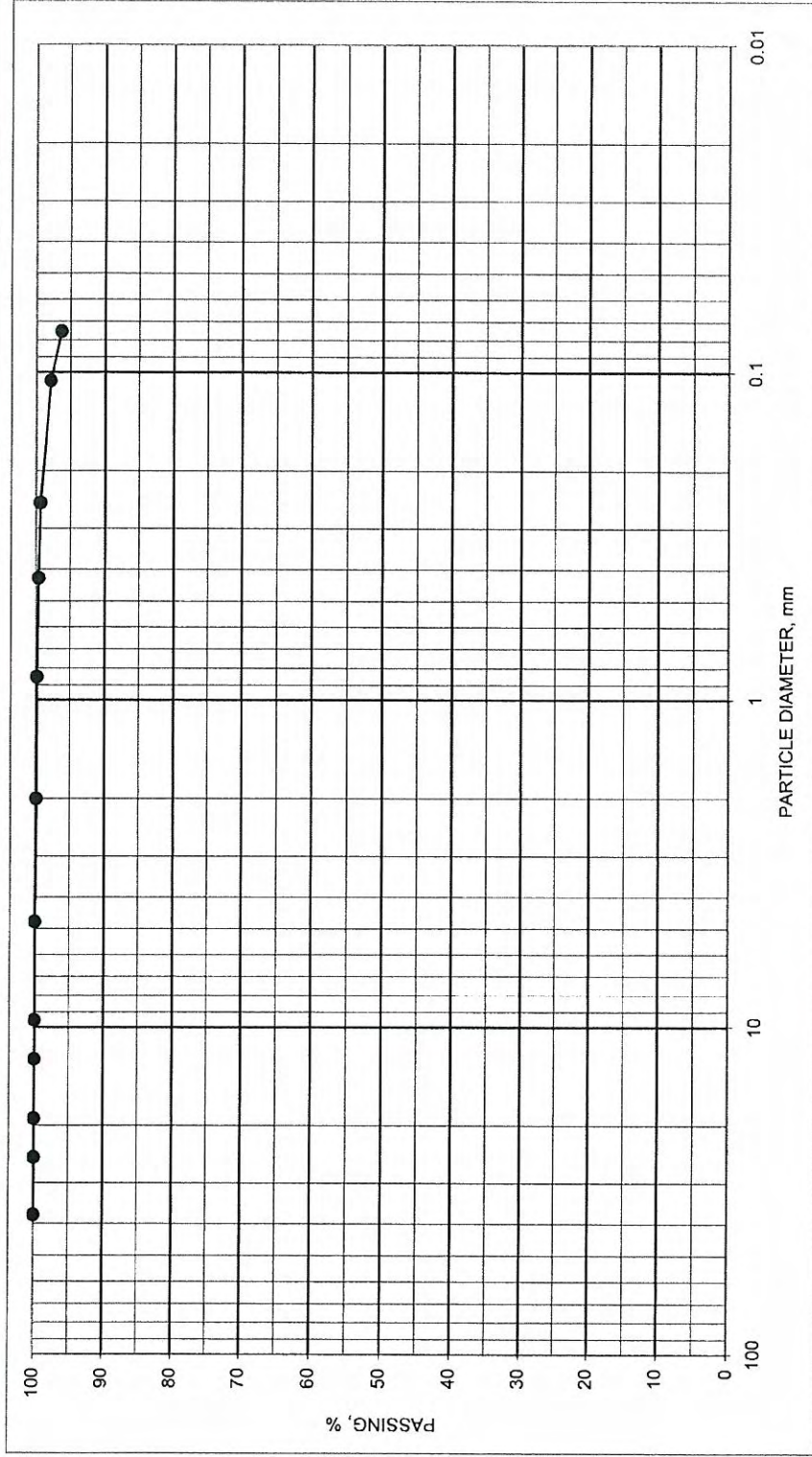
SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.
 EFFECTIVE STRESS FAILURE DATA BASED ON 2 % STRAIN.
 EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.
 TOTAL STRESS FAILURE DATA BASED ON 2 % STRAIN.
 TOTAL STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.
 DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.
 AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A



SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	99
#140	0.106	98
#200	0.075	96.3



GRAIN SIZE DISTRIBUTION CURVE

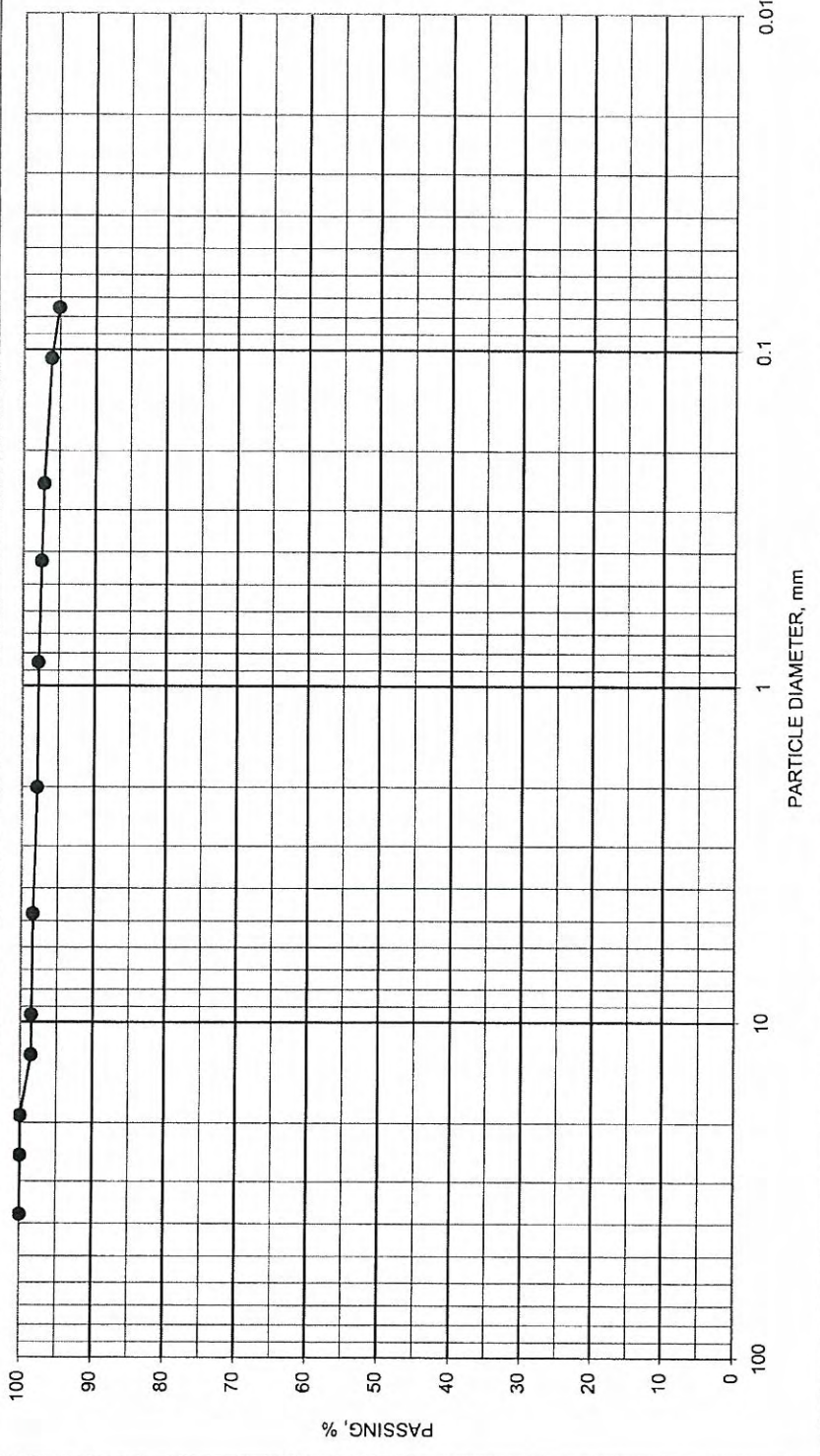
BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
						LL	PL	PI
LEC-1	1	13 TO 15	LEAN CLAY DARK GRAY	CL	28.4	46	20	26

PROJECT LEC / TEC LAB

JOB NO. 14095047 DATE 11/13/2009



SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	99
3/8"	9.50	99
#4	4.75	98
#10	2.00	98
#20	0.850	98
#40	0.425	97
#60	0.250	97
#140	0.106	96
#200	0.075	95.1



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
						LL	PL	PI
LEC-2	1	8 TO 10	FAT CLAY DARK GRAY	CH		61	22	39

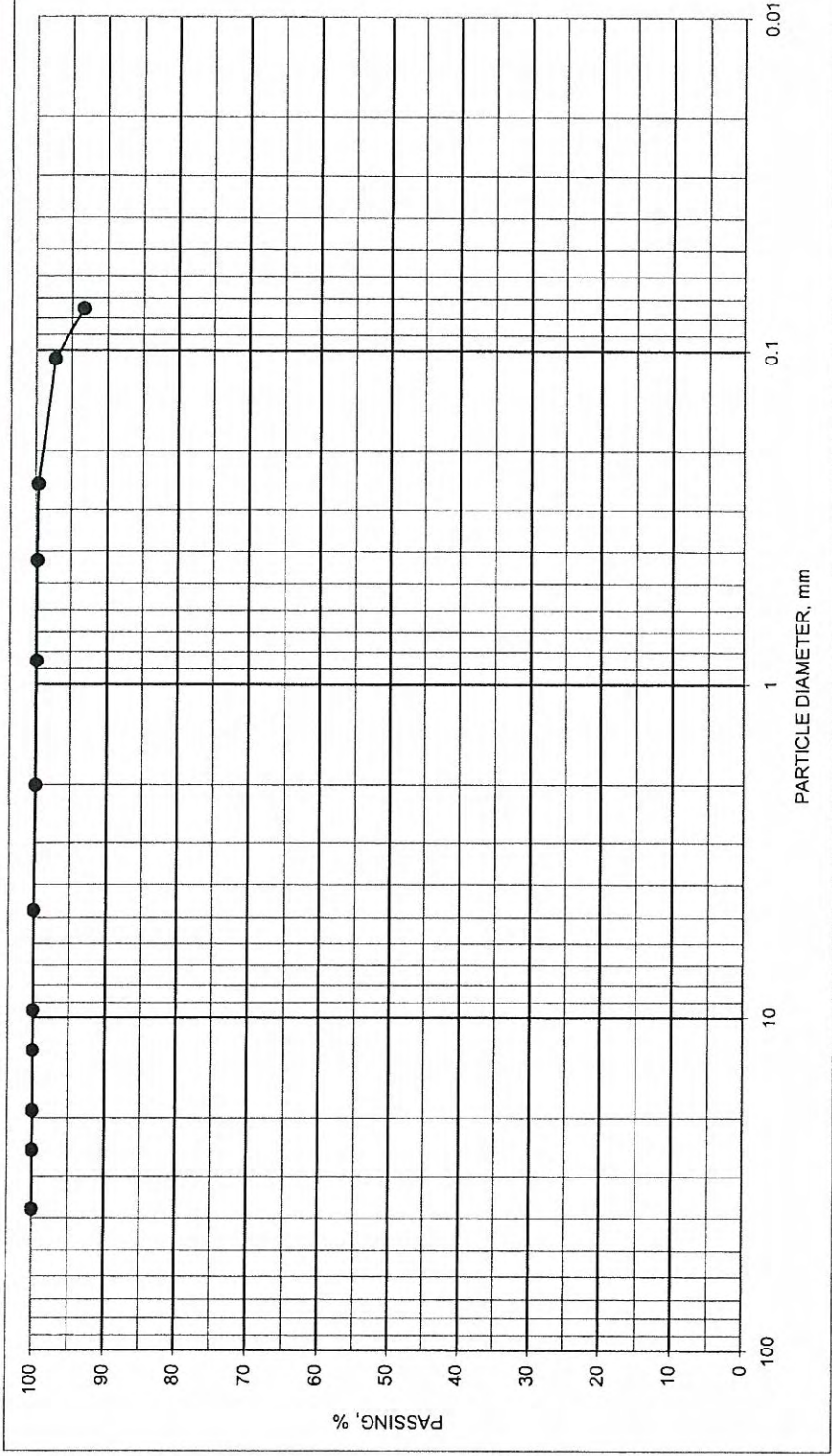
PROJECT LEC / TEC LAB

JOB NO. 14095047 DATE 11/13/2009

N:\CMLAB_DATA\00 Projects in Progress\2009 Projects in Progress\14095047\14095047 GradALPlot LEC2-1-8.0.xls\ATTERBERG M%



SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	100
#140	0.106	97
#200	0.075	93.3



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
						LL	PL	PI
LEC-3	3	18 TO 20	FAT CLAY DARK GRAYISH BROWN & LIGHT GRAY	CH		74	24	50

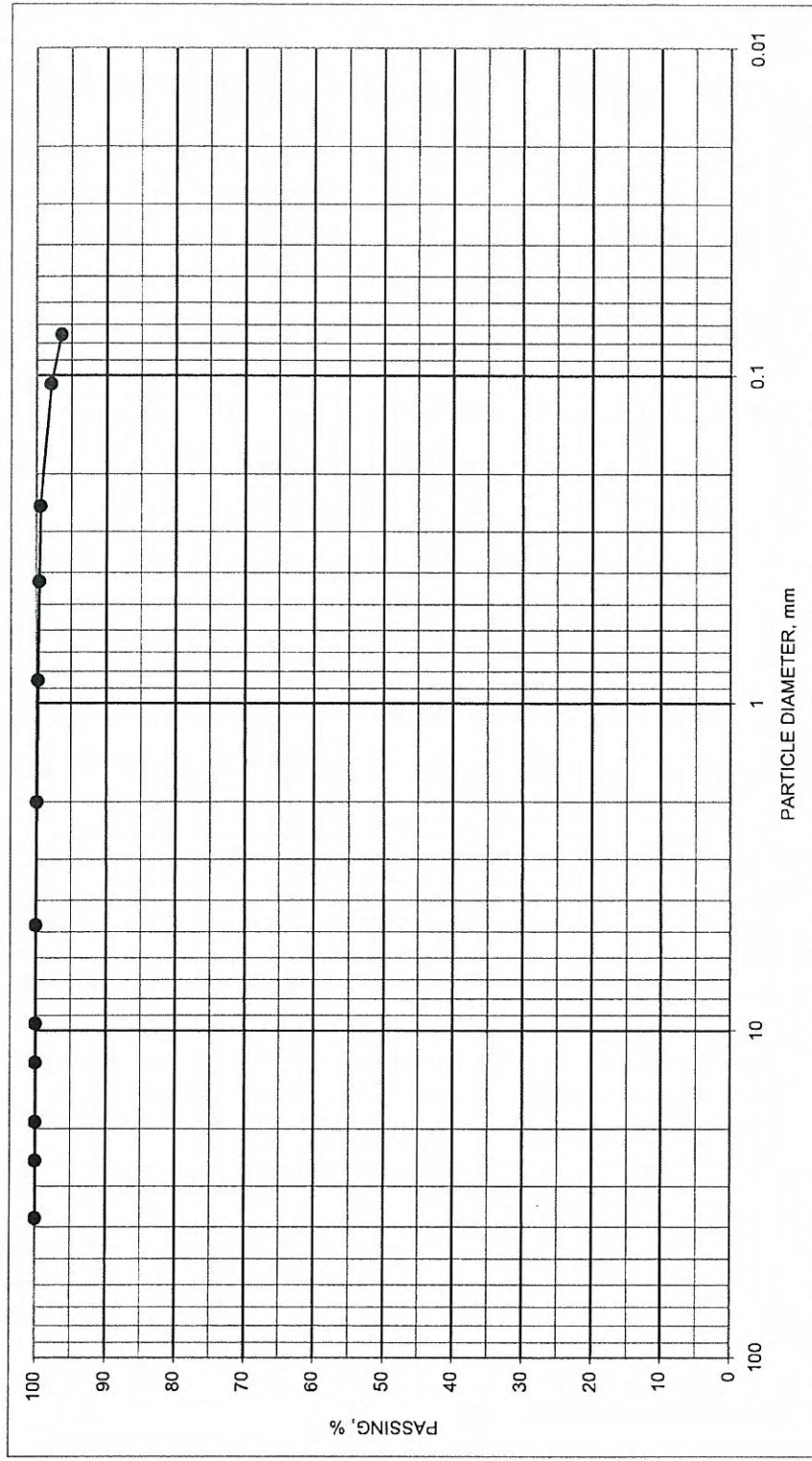
PROJECT LEC/TECLAB

JOB NO. 14095047 DATE 11/19/2009

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SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	99
#140	0.106	98
#200	0.075	96.4



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
						LL	PL	PI
LEC-4	1	8 TO 10	LEAN CLAY DARK GRAY	CL	21.0	41	18	23

PROJECT LEC / TEC LAB

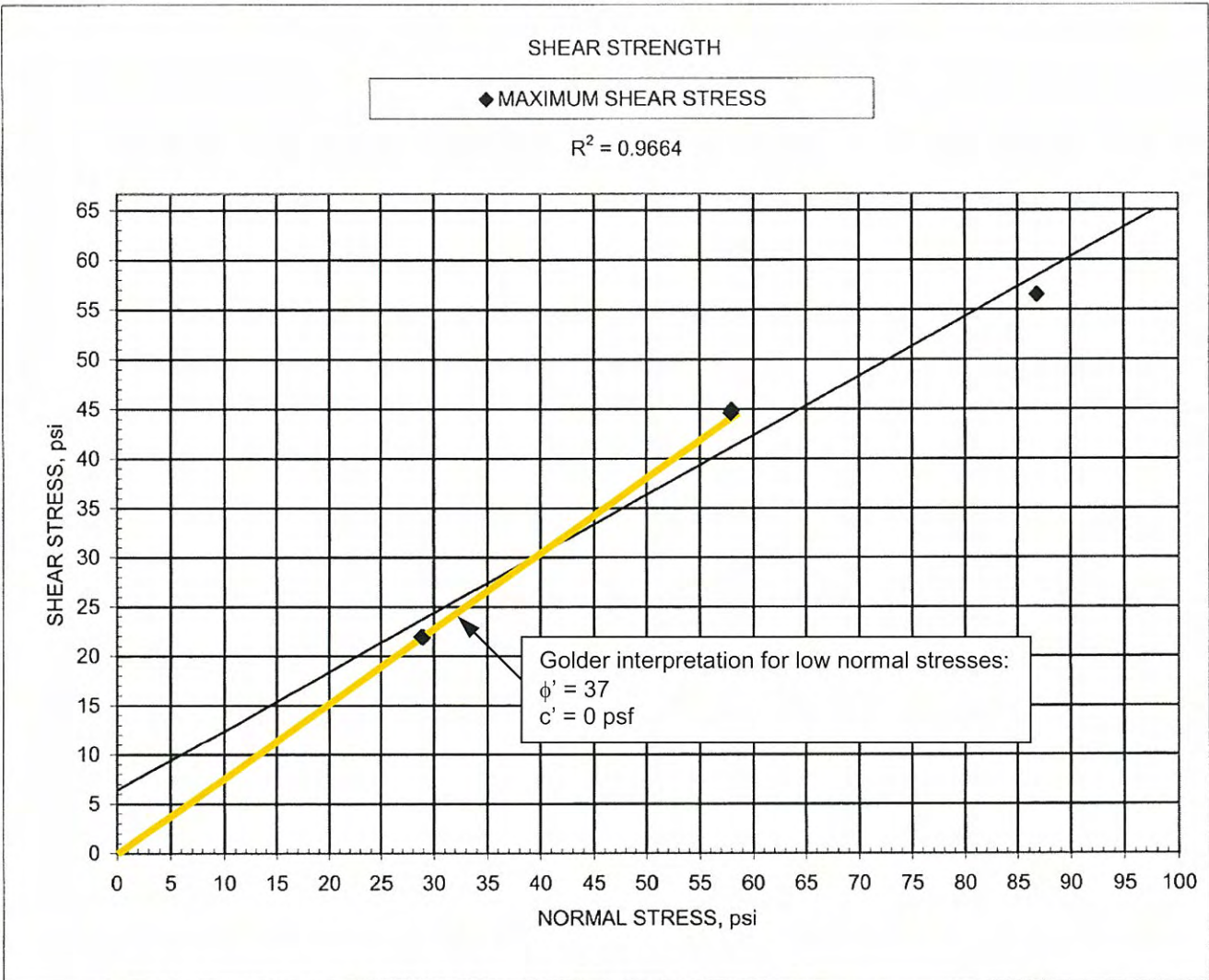
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ATTACHMENT D
BOTTOM ASH STRENGTH ADJUSTMENT

**DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080**



		FRICITION ANGLE	COHESION (apparent)	NORMAL STRESS, psi	NORMAL STRESS, psi	NORMAL STRESS, psi
AT MAXIMUM SHEAR STRESS		30.9 deg	6.4 psi	28.98	58.00	86.79
INITIAL AREA, mm ²	3172.0	INITIAL MOISTURE, %		25.5	25.6	25.4
INITIAL LENGTH, mm	26.16	INITIAL DRY DENSITY, pcf		74.1	75.9	69.7
SPECIFIC GRAVITY	2.70	INITIAL SATURATION, %		54	57	48
SG TESTED	X	INITIAL VOID RATIO		1.27	1.22	1.42
SG ASSUMED		FINAL MOISTURE, %		38.7	35.5	37.5
LIQUID LIMIT		FINAL SATURATION, %		85	84	87
PLASTIC LIMIT		FINAL VOID RATIO		1.23	1.14	1.17
PLASTICITY INDEX		MAXIMUM SHEAR STRESS, psi		21.92	44.89	56.53
SAMPLE TYPE	RECOMPACTED	RATE OF LOADING, in/min		0.0022	0.0022	0.0022
DESCRIPTION	BOTTOM ASH					

PROJECT NAME: LEC - WESTAR

BORING NO. B-2

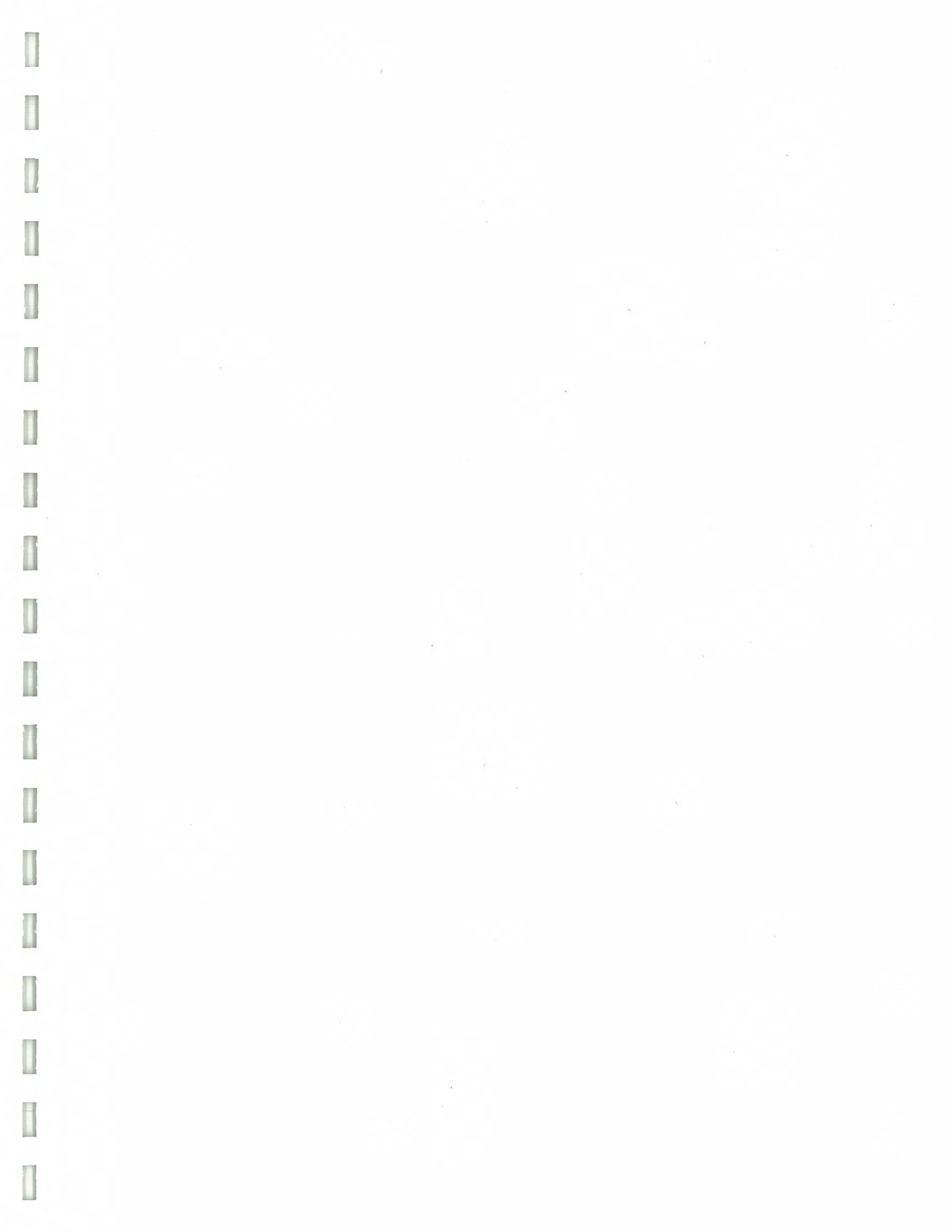
LOCATION: ASH LAGOONS

SAMPLE NO. BULK

JOB NO.: 14097035

DEPTH, feet 5 TO 11

DATE: 10/21/2009



Doc 04: Golder Associates Evaluation of Berms



EVALUATION OF ASH POND BERM STABILITY

Westar Energy – Lawrence Energy Center



REPORT

Submitted to: Westar Energy
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Distribution: 2 Copies – Westar Energy
2 Copies – Golder Associates Inc.

December 23, 2009

093-81765.2

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1.0 INTRODUCTION

1.1 Background

Golder Associates Inc. (Golder) has prepared this report to provide Westar Energy (Westar) with the results of Golder's site observations and stability evaluation of coal combustion product (CCP) storage facilities at Westar's Lawrence Energy Center (LEC) in Lawrence, Kansas. This report is in response to the United States Environmental Protection Agency's (EPA's) request for information under Section 104(e) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regarding impoundments storing liquid-borne CCPs. The report presents a general history of the CCP storage facilities at LEC and a description of Golder's geotechnical investigation (Section 1), the basis and results for Golder's stability analysis (Section 2), a summary of observations made by Golder while visually assessing the CCP storage facilities at LEC (Section 3), and a summary of Golder's conclusions and recommendations (Section 4).

1.2 Site History

Lawrence Energy Center is located in Douglas County, on the north edge of Lawrence, Kansas. Coal combustion products generated at LEC are temporarily staged in impoundments to facilitate dewatering. After the CCPs are dewatered, they are transported to on-site landfills for permanent disposal. Lawrence Energy Center has four staging areas that are separated by earthen embankments, as shown in Figure 1. Areas 1 and 2 were constructed in 1969, concurrent with construction of the energy generation facility, and Areas 3 and 4 were added in 1976. It is Golder's understanding that the staging areas were constructed to an engineered design. However, Westar is not in possession of the design drawings bearing a professional engineer's stamp or the construction records. The staging areas were constructed by excavation from existing grades and have not undergone engineered modifications since initial construction. Agricultural land surrounds the northwest, west, and south sides of the CCP storage facilities, and the energy generation facility and the Kansas River lie to the east and northeast.

1.3 Geotechnical Investigation

Four soil borings, LEC-1, LEC-2, LEC-3, and LEC-4, were completed on October 26, 2009, at the locations shown in Figure 1 to support Golder's stability evaluation. The borehole locations were designated by Golder and Westar in areas where site topography indicated a downstream berm slope height of 12 feet or more, generally around the north and west sides of the CCP storage facilities. Boreholes were drilled near the downstream edge of the berm crest and were advanced with a truck-mounted CME drill rig using 6-inch-diameter hollow stem continuous flight augers. Relatively undisturbed samples were collected from each borehole using 2-inch-diameter thin-walled tube samplers (Shelby tubes). Soil samples were visually classified by Golder's geotechnical engineer in accordance with the Unified Soil Classification System (USCS). Berm stratigraphy was fairly consistent between boreholes and generally consisted of asphalt and bottom ash road base in the top 1 to 5 feet, underlain by low-plasticity clay (CL) and high-plasticity clay (CH) layers to the completed borehole depth. Borehole depths

ranged from 18 to 24 feet. Groundwater was not observed in boreholes drilled around the perimeter of the staging areas at LEC. The berm crest is at an elevation of 840 feet above mean sea level. Borehole logs based on field and laboratory soil classification are provided in Appendix A.

2.0 STABILITY EVALUATION

2.1 Slope Geometries

Golder developed two cross sections to evaluate the stability of the embankments surrounding the staging areas at LEC using site topography provided by Westar. The locations of the cross sections are shown in Figure 2. Based on site topography and visual assessment, Golder selected cross section locations to represent the critical slopes for stability analysis of the CCP storage facilities at LEC. Golder conservatively assumed that the staging areas were filled with CCPs to an elevation two feet below the berm crest and that ponded water reached the same elevation as the berm crest. The depth of CCP storage facilities was assumed to be 20 feet based on information provided by Westar (Terracon Consultants, Inc. 2009). Golder conservatively used a 0.5 (horizontal) to 1 (vertical) slope ratio for the upstream berm slopes.

2.2 Engineering Parameters

Golder collected relatively undisturbed soil samples from each borehole for geotechnical testing to determine engineering parameters for use in the slope stability analysis. Geotechnical test results are presented in Appendix B. For purposes of the stability analysis, Golder represented distinct soil layers and assigned engineering parameters based on field soil classification and laboratory test data, primarily plasticity index (PI), as shown in Figure 3. Golder assigned unit weights to each soil layer based on density testing of undisturbed soil samples collected at LEC. Golder assigned effective stress strength parameters to each soil layer based on the results of consolidated-undrained triaxial testing of undisturbed samples collected at LEC. Golder assigned a unit weight to CCPs based on previous experience and assumed that CCPs within the staging areas contribute no strength. Engineering parameters assigned to soil layers are summarized in Table 1.

TABLE 1
SUMMARY OF STABILITY ANALYSIS ENGINEERING PARAMETERS

Material	Unit Weight	Strength Parameters	
		Friction Angle	Cohesion
LEC-2 Sample 1 (PI=39)	116 pcf	26 degrees	260 psf
LEC-3 Sample 3 (PI=50)	116 pcf	28 degrees	410 psf
Coal combustion products	85 pcf	No strength	

2.3 Groundwater Information

Groundwater was not observed in any of the four boreholes drilled around the perimeter of the staging areas at LEC. Therefore, to develop phreatic surfaces within each cross section for stability analysis based on effective stresses, Golder used a straight line between the upstream edge of the berm crest and the static groundwater level at the approximate borehole location, as shown in Figure 3. The static

groundwater level is based on information provided by Westar (Geotechnical Services, Inc. 1999) and included in Appendix C.

2.4 Stability Analysis

Golder performed the stability analysis using SLIDE, a two-dimensional slope stability computer program developed by Rocscience Inc. (2009). Factors of safety for static conditions were computed for circular failure surfaces using Spencer's method for force and moment equilibrium, as shown in Figure 4. For seismic analyses, Golder used a seismic coefficient of 0.05 based on the United States Geological Survey (USGS) seismic hazard map corresponding to a two-percent chance of exceedance in 50 years, as shown in Appendix D (USGS 2008). Factors of safety for seismic loading conditions were computed for circular failure surfaces using Spencer's method for force and moment equilibrium, as shown in Figure 5. The computed factors of safety for static and seismic slope stability analyses are summarized and compared with typical minimum acceptable factors of safety for permanent civil engineering structures in Table 2.

TABLE 2
SUMMARY OF STABILITY ANALYSIS RESULTS

Cross Section	Computed Factor of Safety	Minimum Factor of Safety
Section 1 – Static	3.0	1.5
Section 1 – Seismic	2.7	1.1
Section 2 – Static	3.1	1.5
Section 2 – Seismic	2.5	1.1

Based on the factors of safety computed using SLIDE, the CCP storage facilities at LEC should remain stable under maximum anticipated loading conditions.

3.0 VISUAL EVALUATION

3.1 Visual Evaluation Terminology

Visual evaluation terms used in the following discussions are defined as follows:

Condition of Impoundment

- Good: A condition that is generally better than what is minimally expected based on the design criteria and maintenance performed at the facility.
- Fair: A condition that generally meets what is expected based on the design criteria and maintenance performed at the facility.
- Poor: A condition that is generally below what is minimally expected based on the design criteria and maintenance performed at the facility.

Severity of Deficiency

- Minor: An observed deficiency where current maintenance is below what is desired but does not currently pose a threat to the structural safety or stability.
- Significant: An observed deficiency where current maintenance has neglected to improve a condition. Typically, these conditions are identified, but no remedial action has been implemented.
- Excessive: An observed deficiency where current maintenance is worse than what is desired and hinders the ability of the observer to evaluate the structure or poses a significant threat to structural safety and stability.

3.2 Visual Observations

Golder performed a visual observation of the CCP storage facilities at LEC on October 26, 2009. Golder observed the condition of inflow and outflow structures, upstream berm slopes, the berm crest, downstream berm slopes, and the berm toe. Photographs taken during the visual observation are included in Appendix E.

3.2.1 Inflow and Outflow Structures

Inflow piping and structures appeared to be in working order and fair condition at the time of observation. The outflow structure appeared to be in good condition at the time of observation.

3.2.2 Upstream Berm Slopes

The condition of upstream berm slopes was difficult to assess given the high water levels in the CCP storage areas. Freeboard typically ranged from 2 to 6 feet in the various impoundments at the time of observation. Some upstream berm slopes appear to be steeper than 1 (horizontal) to 1 (vertical) in active areas, and riprap is not being used to protect upstream berm slopes against erosion. Wave action did not appear to be occurring at the time of observation. The condition of upstream berm slopes is generally fair.

3.2.3 Berm Crest

The berm crest around the perimeter of the CCP storage facilities is paved to provide an asphalt road with bottom ash road base for normal vehicular traffic. The width of the berm crest is approximately 30 feet, on average. Golder did not observe cracking or excessive settlement in any portion of the berm crest. The berm crest is well-compacted and appears to be in good condition.

3.2.4 Downstream Berm Slope

The downstream berm slope ranges from 0 to 23 feet in height and is heavily vegetated in most areas. The vegetation consists of trees, grasses, and reeds and is not unexpected given that the embankment is a natural slope rather than an engineered structure. Golder did not observe indications of seepage, sloughing, cracking, excessive settlement, or vegetation that seemed to be thriving abnormally. Ground conditions were firm, with the exception of small areas of animal burrowing near the top of the downstream berm slope northeast of the CCP storage facilities. The downstream berm slope is generally in good condition.

3.2.5 Berm Toe

The berm toe is heavily vegetated by grass and mature trees, particularly on the northeast and northwest sides of the CCP storage areas. The creek on the northwest side of the staging areas was approximately 1 foot deep on average and exhibited a relatively low flow rate at the time of observation. Ditches along the road on the west side of the CCP storage areas were dry at the time of observation. The berm toe is generally in good condition.

4.0 CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the results of Golder's stability analysis and visual observations to confirm the stability of CCP storage facilities at LEC. The information provided herein is based on observations made and information gathered by Golder during a site assessment on October 26, 2009.

The CCP storage facilities, portions of which have been in use since 1969, were constructed by excavation from original grade. Therefore, the downstream berm slope consists primarily of natural topography and is heavily vegetated in most locations. The factors of safety resulting from Golder's stability analysis, which range from 3.0 to 3.1 for static conditions and 2.5 to 2.7 for seismic conditions, are well above typical minimum acceptable factors of safety for permanent civil engineering structures (1.5 for static conditions and 1.1 for seismic conditions). Therefore, the CCP storage areas should remain stable under maximum anticipated loading conditions. Golder observed good vegetation and did not identify significant deficiencies such as seepage, excessive erosion or settlement, or cracking during the visual observation of the CCP storage areas at LEC. The overall condition of the CCP storage facilities is good.

Golder recommends that Westar personnel perform quarterly observations of the CCP storage facilities, particularly the berm crest and downstream berm slope, to identify undesirable or changing conditions. Such conditions may include, but are not limited to: seepage, sloughing, cracking, excessive settlement, extensive animal burrowing, excessive erosion, and abnormal thriving of vegetation. Inflow and outflow structures should be observed to confirm that water can continue to be managed in accordance with the design. Westar should regularly monitor groundwater levels in wells adjacent to the CCP storage facilities to identify changing conditions.

GOLDER ASSOCIATES INC.

David L. O'Sadnick, P.E.
Principal Geotechnical Engineer

Jason E. Obermeyer, P.E.
Senior Project Engineer



5.0 REFERENCES

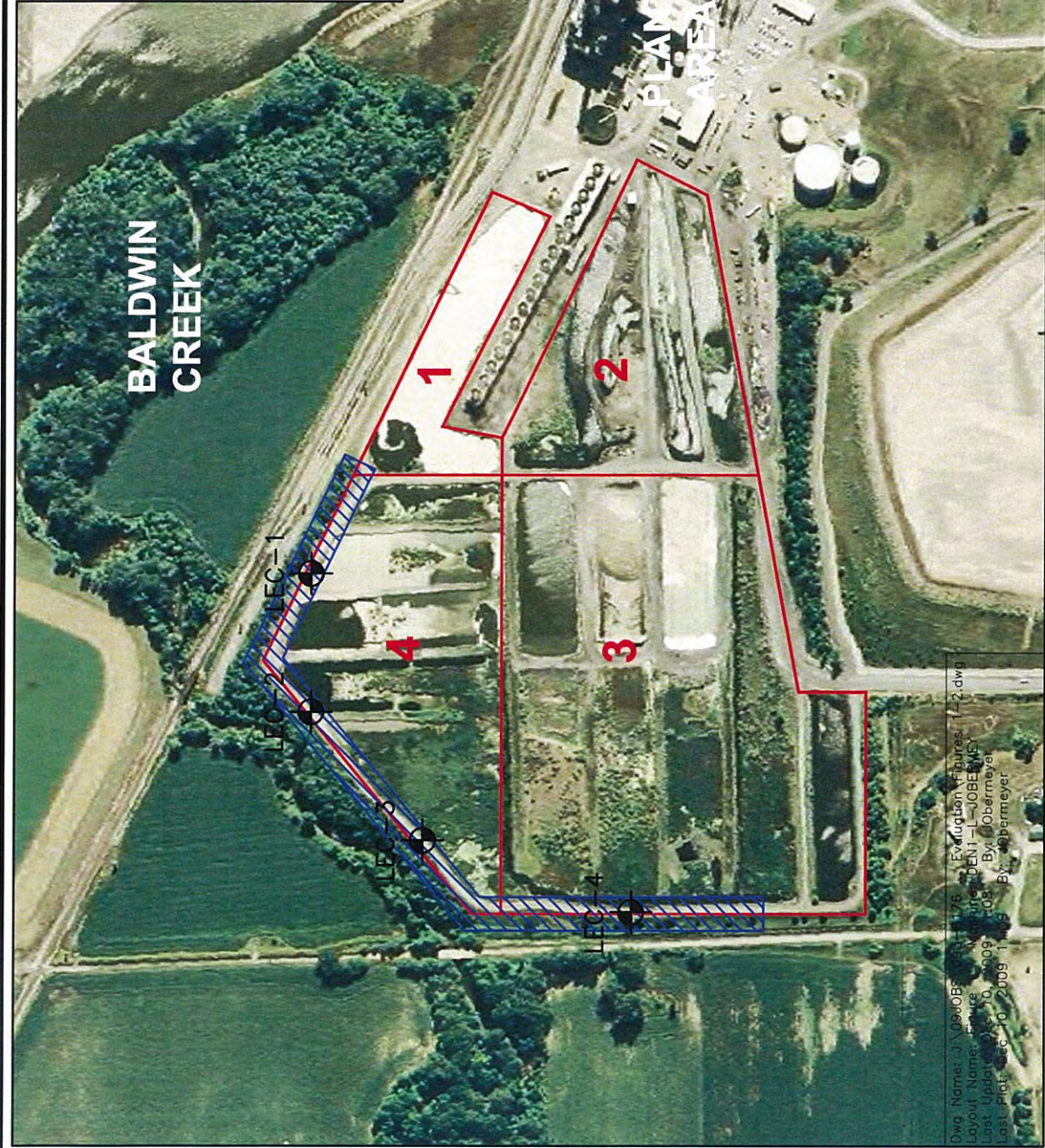
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Terracon Consultants, Inc. 2009. Letter Summary Surface Impoundment Sampling, Lawrence Energy Center, Coal Combustion Waste Surface Impoundments, Lawrence, Douglas County, Kansas, Terracon Project No: 14097035. October 21, 2009.

United States Geological Survey. 2008. National Seismic Hazard Map, Coterminous U.S., 2% in 50 Years, Peak Ground Acceleration. <http://earthquake.usgs.gov/hazards/products/coterminous/2008/maps/us/PGA.usa.jpg>. Accessed December 9, 2009.

FIGURES



LEGEND

- STAGING AREA BOUNDARY
- LEC-2  BOREHOLE LOCATION
-  BERM (>12' HIGH)

REFERENCES

1. AERIAL IMAGE FROM GOOGLE EARTH.



SITE LAYOUT
FIGURE 1

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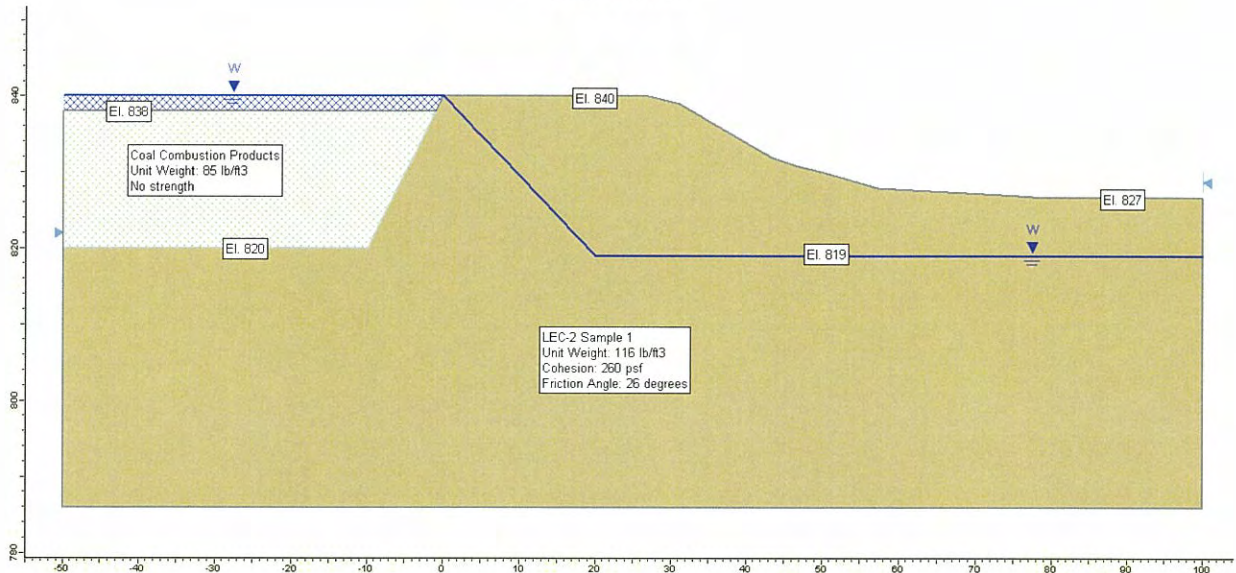
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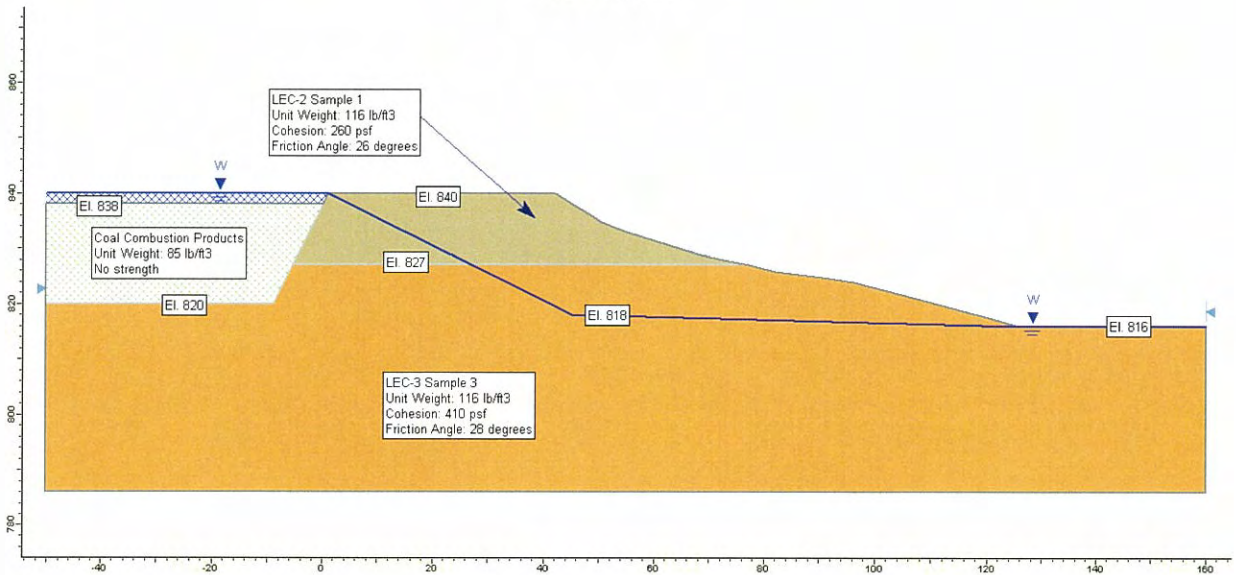
CROSS SECTION LOCATIONS

FIGURE 2

SECTION 1



SECTION 2



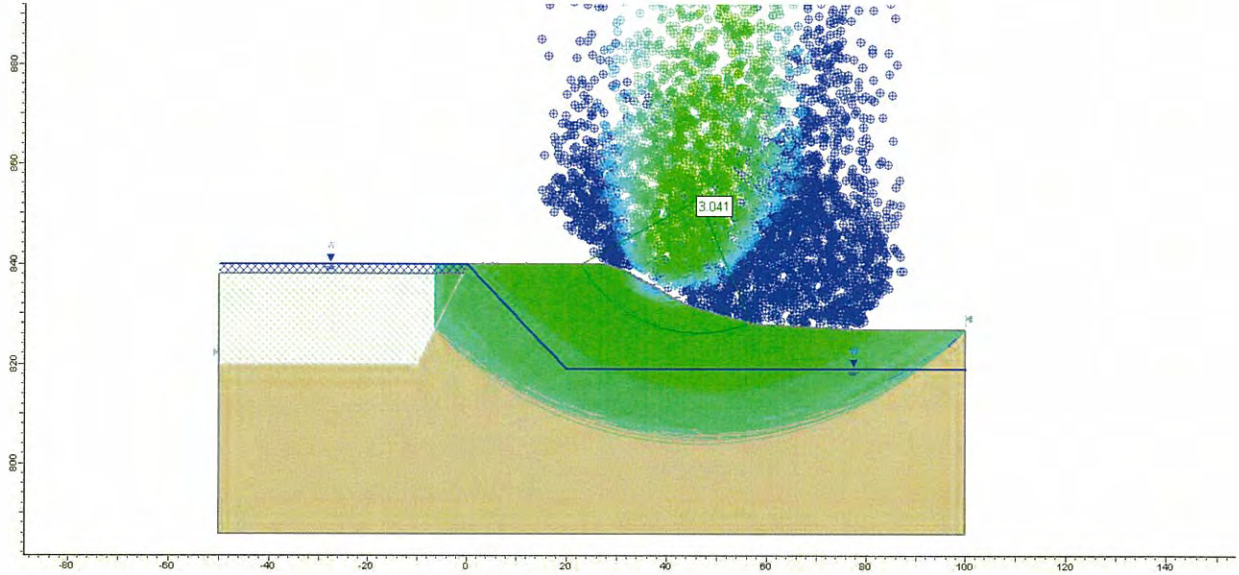
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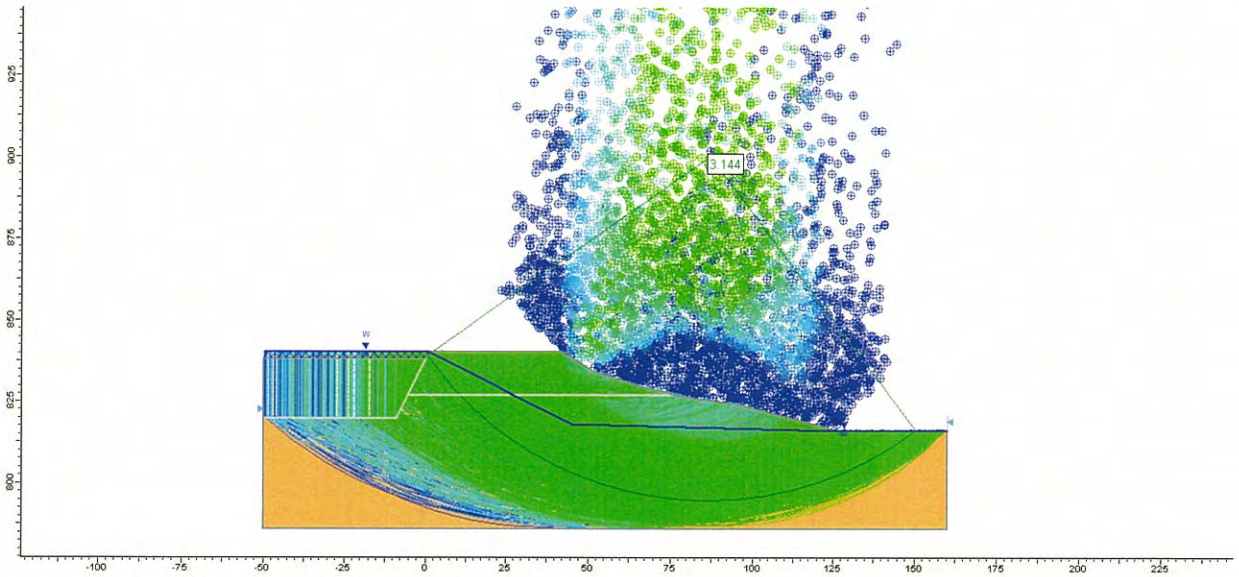
CROSS SECTIONS

FIGURE 3

SECTION 1



SECTION 2



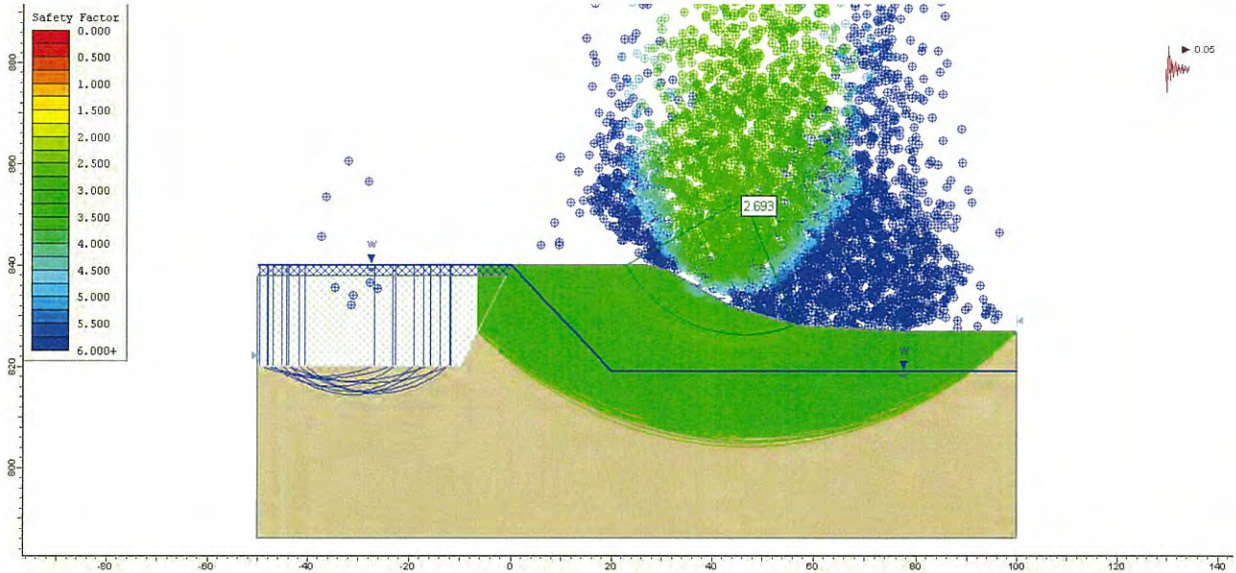
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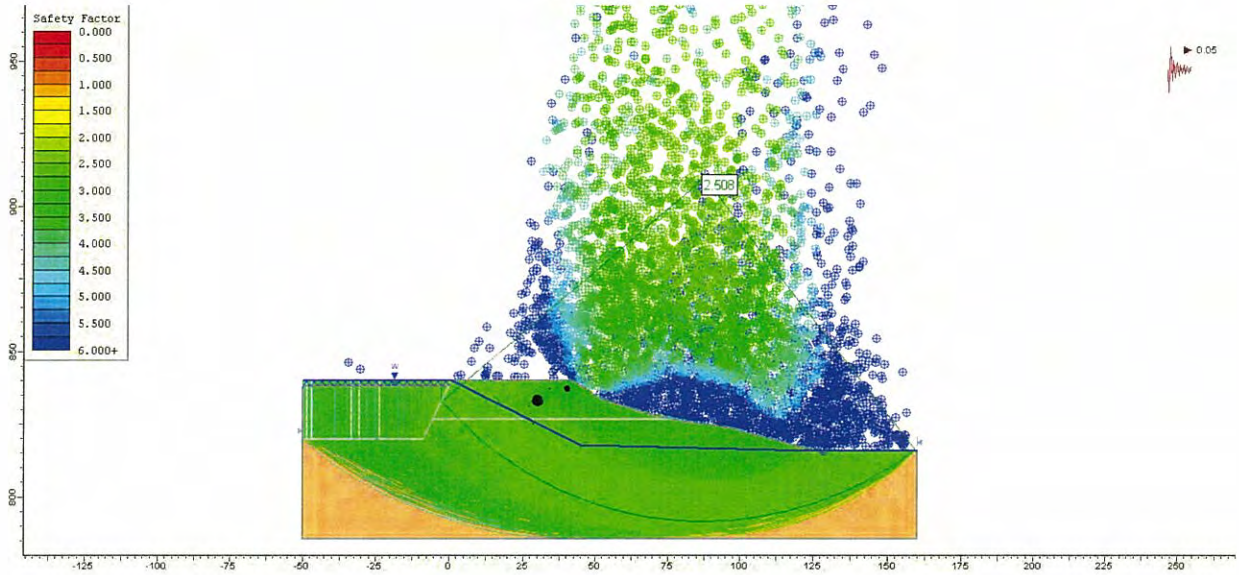
STABILITY ANALYSIS RESULTS - STATIC

FIGURE 4

SECTION 1



SECTION 2



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 Last Plot: Dec 23, 2009 09:51 By: JObermeyer



STABILITY ANALYSIS RESULTS - SEISMIC

FIGURE 5

**APPENDIX A
BOREHOLE LOGS**



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-1
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 258,450 Easting 2,086,625 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-1' ASPHALT and loose, black, BOTTOM ASH, (ML) 1-5' Firm, brown, SILTY CLAY, trace sand, (CL)	Berm road and road base
5	5-18' Stiff to very stiff, dark brown, SILTY CLAY, trace sand, (CL to CH)	Encountered and penetrated an unidentified 6" PVC pipe at depth of approximately 7' near the centerline of the berm.
10		
15		2" Shelby tube sample (Sample 1) from 13-15' Pocket penetrometer result: 3.25 tsf (15')
20		End of boring at 18'
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Water entered the borehole after Westar personnel initiated flow through the 6" PVC pipe to determine its purpose. Westar personnel directed the water into the ash pond. The 6" PVC pipe was promptly repaired by Schmidlein Excavating, Inc., personnel. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately 25' northwest of the discharge location and approximately 10' from the upstream berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring: LEC-2
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date: 10/26/09
 Location: Lawrence Energy Center Northing: 258,450 Easting: 2,086,210 Job No.: 093-81765.2

Depth (ft)	Material	Notes
0 1 2 3 4 5	0-1' ASPHALT 1-5' Loose, black, BOTTOM ASH, (ML)	Berm road Road base and fill
5 6 7 8 9 10	5-16' Very stiff, light gray, SILTY CLAY, trace gravel, trace sand, (CL to CH)	2" Shelby tube sample (Sample 1) from 8-10' (18" recovered) Pocket penetrometer result: 4.5 tsf (10')
10 11 12 13 14 15		2" Shelby tube sample (Sample 2) from 13-15' (16" recovered) Pocket penetrometer result: 4.25 tsf (15')
15 16 17 18 19 20	16-20' Very stiff, dark brown, SILTY CLAY, trace sand, (CL to CH)	2" Shelby tube sample (Sample 3) from 18-20' (17" recovered) Pocket penetrometer result: 3.75 tsf (20')
20 21 22 23 24 25		End of boring at 20'
25 26 27 28 29 30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately 21' from the upstream berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-3
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 258,115 Easting 2,085,825 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-1' ASPHALT 1-3' Loose, black, BOTTOM ASH, (ML)	Berm road Road base and fill
5	3-7' Stiff, gray to brown, SILTY CLAY, trace sand, (CL)	
10	7-13' Stiff, to very stiff, dark brown, SILTY CLAY, little sand, (CL to CH)	2" Shelby tube sample (Sample 1) from 8-10' (26" recovered) Pocket penetrometer result: 2.75 tsf (10')
15	13-24' Stiff to very stiff, dark brown, CLAY, little sand, (CH)	2" Shelby tube sample (Sample 2) from 13-15' (10" recovered) Pocket penetrometer result: 4.75 tsf (15')
20		2" Shelby tube sample (Sample 3) from 18-20' (24" recovered) Pocket penetrometer result: 1.75 tsf (20')
25		End of boring at 24'
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately 21' from the upstream berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			



BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-4
 Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
 Location Lawrence Energy Center Northing 257,490 Easting 2,085,610 Job No. 093-81765.2

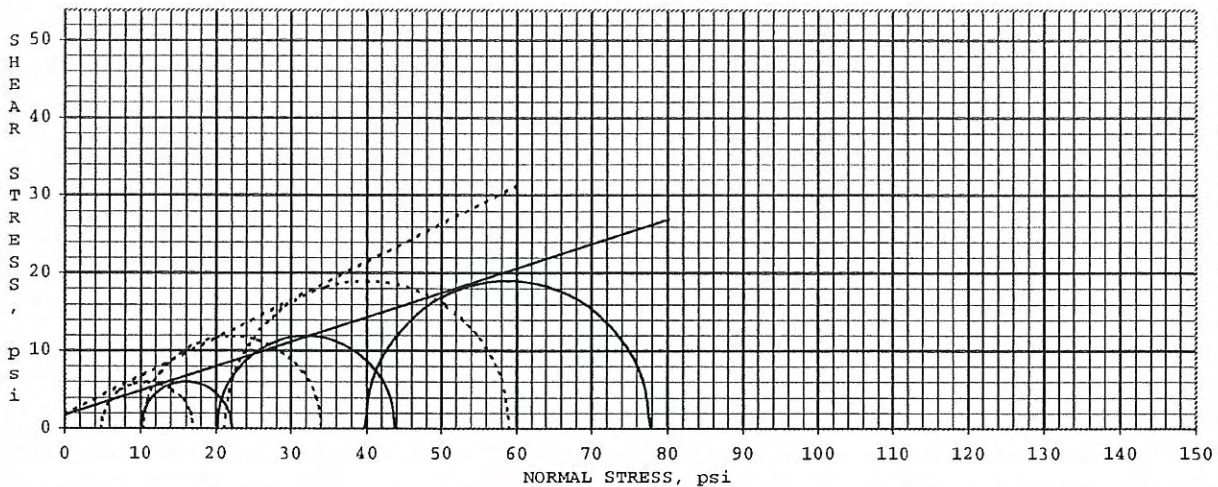
Depth (ft)	Material	Notes
0 1 2 3 4 5	0-1' ASPHALT 1-5' Loose, black, BOTTOM ASH, (ML)	Berm road Road base and fill
5 6 7 8 9 10	5-17' Very stiff, dark brown, SILTY CLAY, little sand, (CL)	2" Shelby tube sample (Sample 1) from 8-10' (11" recovered) Pocket penetrometer result: 4.25 tsf (10')
10 11 12 13 14 15		2" Shelby tube sample (Sample 2) from 13-15' (26" recovered) Pocket penetrometer result: 4.0 tsf (15')
15 16 17 18 19 20	17-20' Soft, light gray, CLAYEY SILT, some sand, (ML)	2" Shelby tube sample (Sample 3) from 18-20' (11" recovered) Pocket penetrometer result: 0.5 tsf (20')
20 21 22 23 24 25		End of boring at 20'
25 26 27 28 29 30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
<ul style="list-style-type: none"> Groundwater was not encountered. Northing and easting are approximate ($\pm 25'$). Borehole location was approximately 18' from the upstream berm crest. 			
Special Notes:			
Terracon personnel: John Johnson, Brandon Hall			

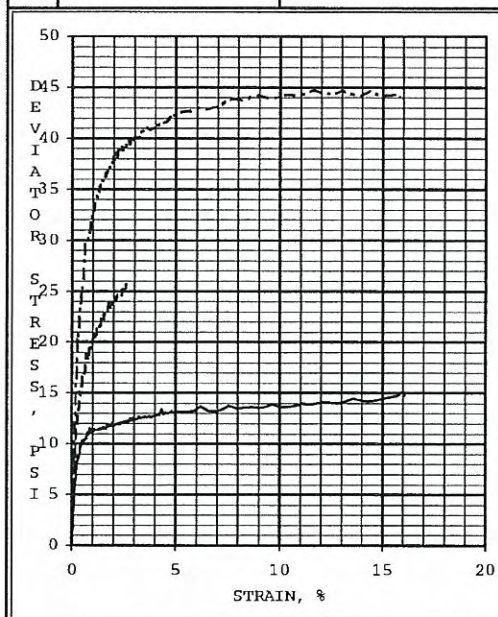
APPENDIX B
GEOTECHNICAL DATA

**EVALUATION OF ASH POND BERMS AT WESTAR ENERGY'S LAWRENCE ENERGY CENTER
SUMMARY OF LABORATORY GEOTECHNICAL TEST DATA**

Borehole	Sample	Depth	USCS	Dry Unit Weight	Moisture Content	Liquid Limit	Plasticity Limit	Plasticity Index	Friction Angle	Cohesion
LEC-1	1	13-15'	CL	94 pcf	28%	46	20	26		
LEC-2	1	8-10'	CH	93 pcf	25%	61	22	39	26 deg	250 psf
LEC-3	3	18-20'	CH	91 pcf	27%	74	24	50	28 deg	410 psf
LEC-4	1	8-10'	CL	106 pcf	21%	41	18	23		
LEC-4	2	13-15'			26%					
LEC-4	3	18-20'			27%					



EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	26.1	COHESION, psi	1.8
TOTAL STRESS ———	ANGLE OF INTERNAL FRICTION, deg	17.4	COHESION, psi	1.8



SPECIMEN ID:		A	B	C
INITIAL	WATER CONTENT, %	26.6	22.8	24.8
	DRY DENSITY, pcf	87.8	97.8	101.0
	SATURATION, %	78	85	100
	VOID RATIO	0.92	0.72	0.67
BEFORE SHEAR	WATER CONTENT, %	33.1	24.8	23.5
	DRY DENSITY, pcf	89.0	100.9	103.2
	SATURATION (B PARAMETER)	0.96	0.99	NA
	VOID RATIO	0.89	0.67	0.63
	FINAL BACK PRESSURE, psi	100.3	94.9	94.8
MINOR PRINCIPAL STRESS, psi		10.0	20.0	39.8
EFFECTIVE STRESS PEAK AT % STRAIN		2.0	2.0	2.0
EFF. DEVIATOR STRESS AT PEAK STRAIN, psi		12.1	23.8	38.1
TOTAL STRESS PEAK AT % STRAIN		2.0	2.0	2.0
TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi		12.1	23.8	38.1
ULTIMATE DEVIATOR STRESS (15% STR), psi		14.5	NA	44.3
TIME TO 50% PRIMARY CONSOLIDATION, min		2.20	31.00	NA
STRAIN RATE, % / hour		4.09	0.57	0.56
INITIAL DIAMETER, inch		1.864	1.841	1.828
INITIAL HEIGHT, inch		3.793	3.731	3.664
AREA AFTER CONSOLIDATION, inch ²		2.707	2.601	2.574
PROJECT NO. 14095047		PROJECT: LEC / TEC LAB		
CIRCLE B & C SAMPLE WAS STAGE LOADED		BORING #: LEC-2		
LABORATORY: TERRACON - LENEXA		SAMPLE #: 1		
DATE: 11/18/2009		DEPTH, feet: 8.0 - 10.0 feet		

CONTROLLED - STRAIN TEST

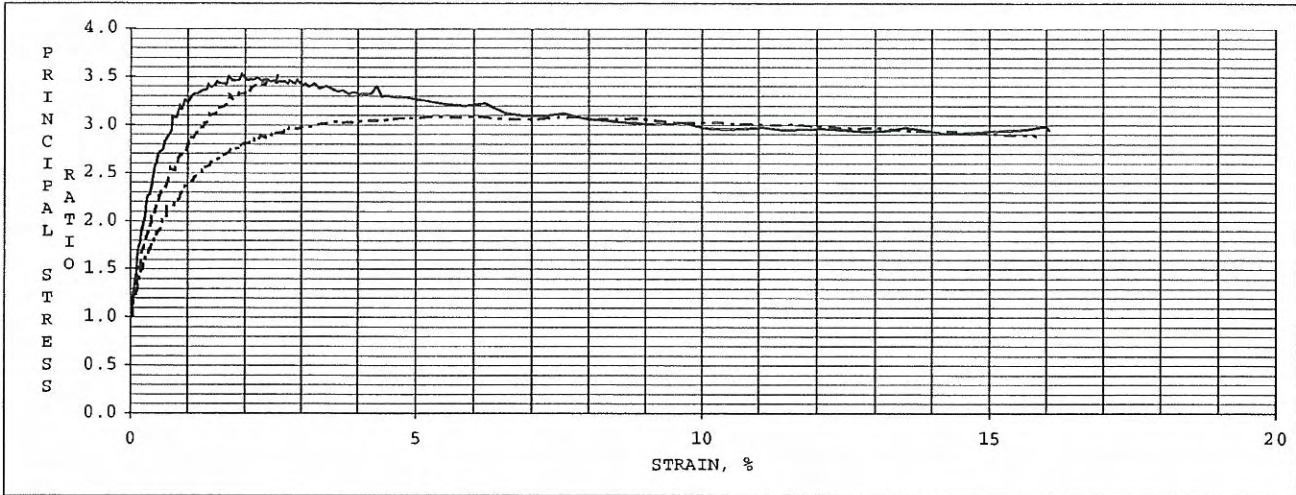
SAMPLE TYPE: 2" SHELBY TUBE

DESCRIPTION OF SPECIMENS:
FAT CLAY, DARK GRAY

LL 61 | PL 22 | PI 39 | Gs 2.7 EST.

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS (TERRACON MODIFIED FOR STAGE LOADING)



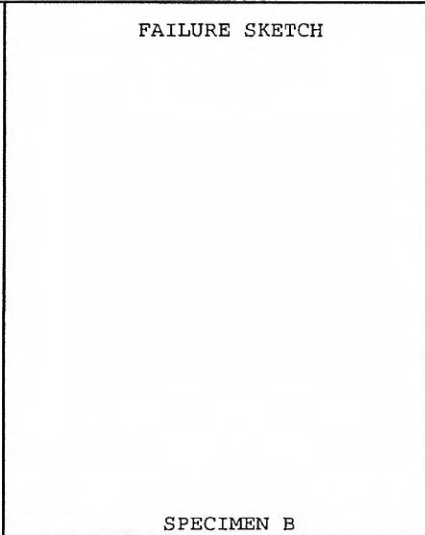


FAILURE SKETCH



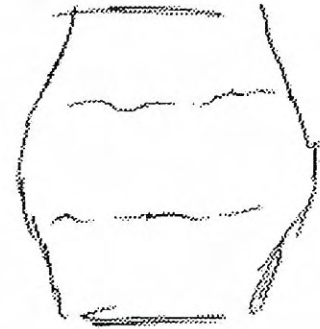
SPECIMEN A

FAILURE SKETCH



SPECIMEN B

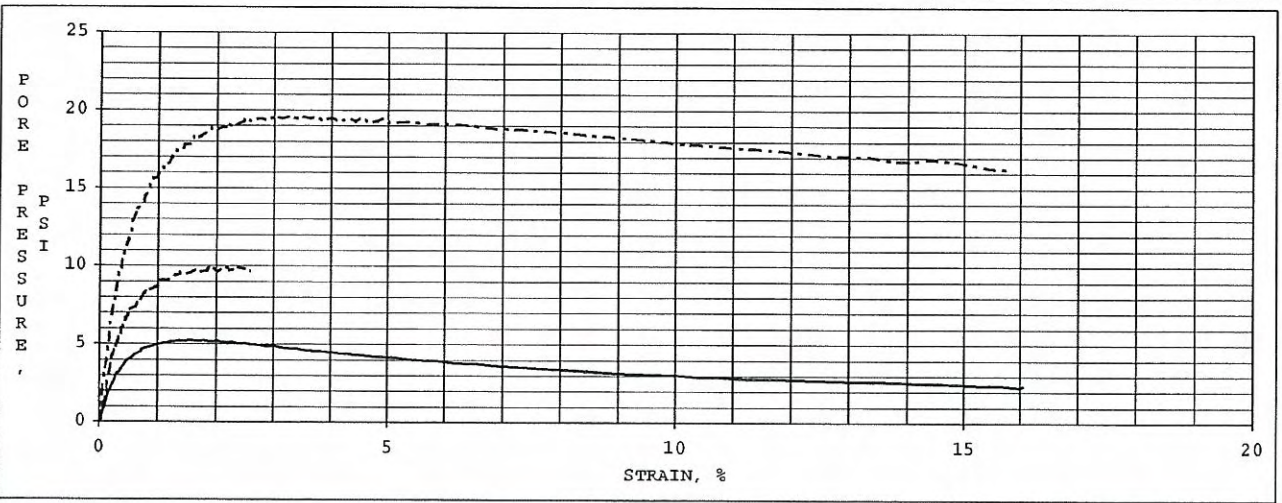
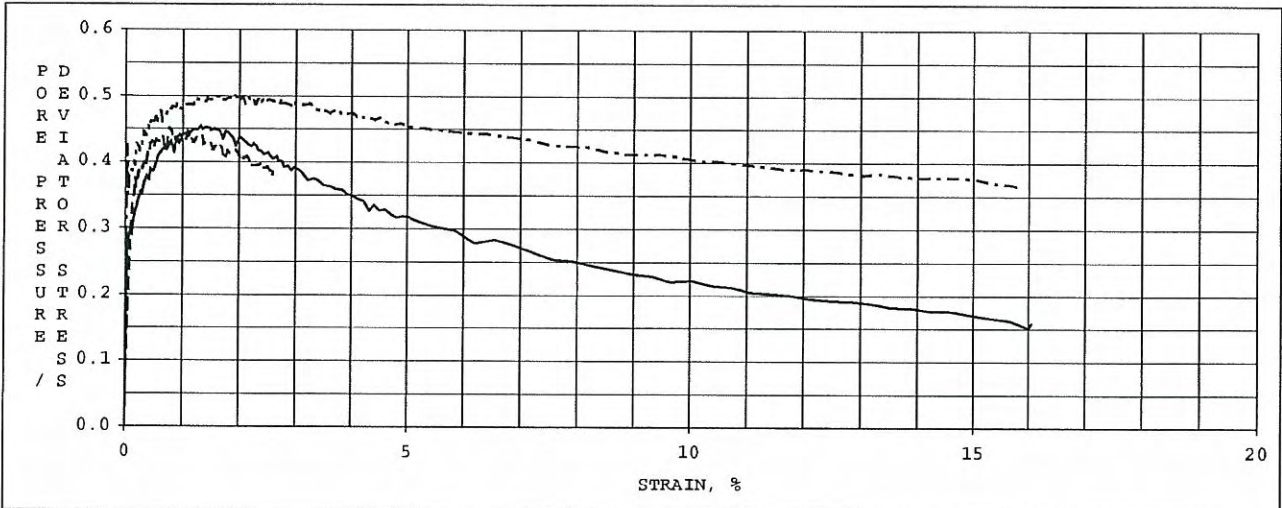
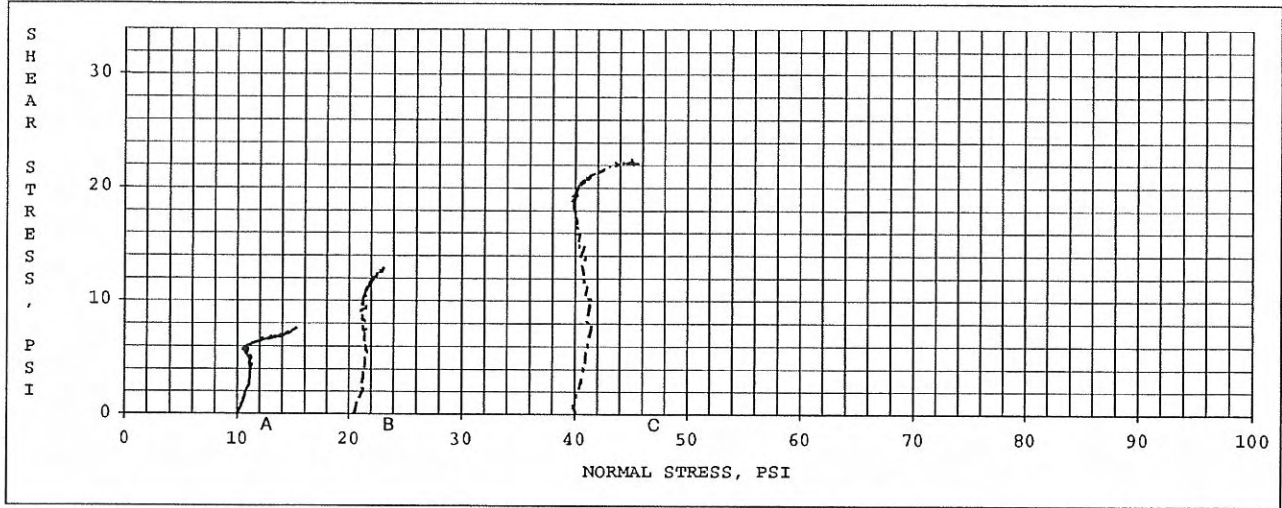
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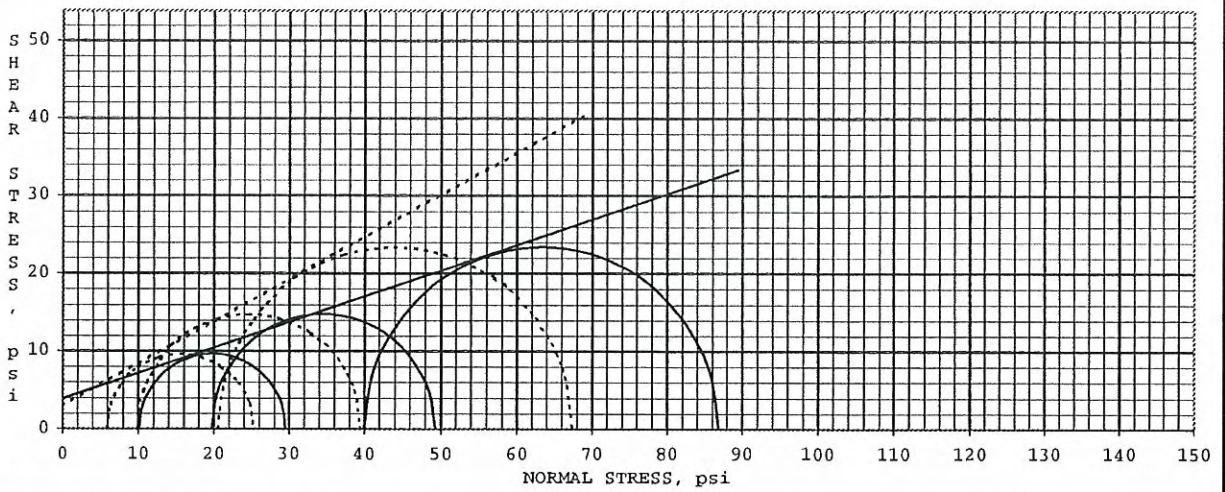


SPECIMEN C

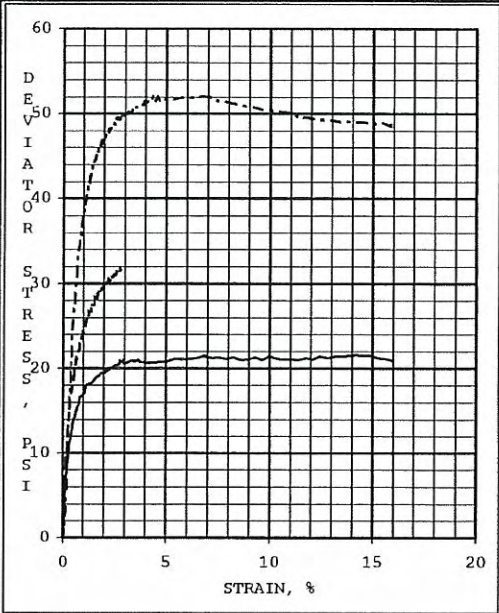
REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.
 EFFECTIVE STRESS FAILURE DATA BASED ON 2 % STRAIN.
 EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.
 TOTAL STRESS FAILURE DATA BASED ON 2 % STRAIN.
 TOTAL STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.
 DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.
 AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A





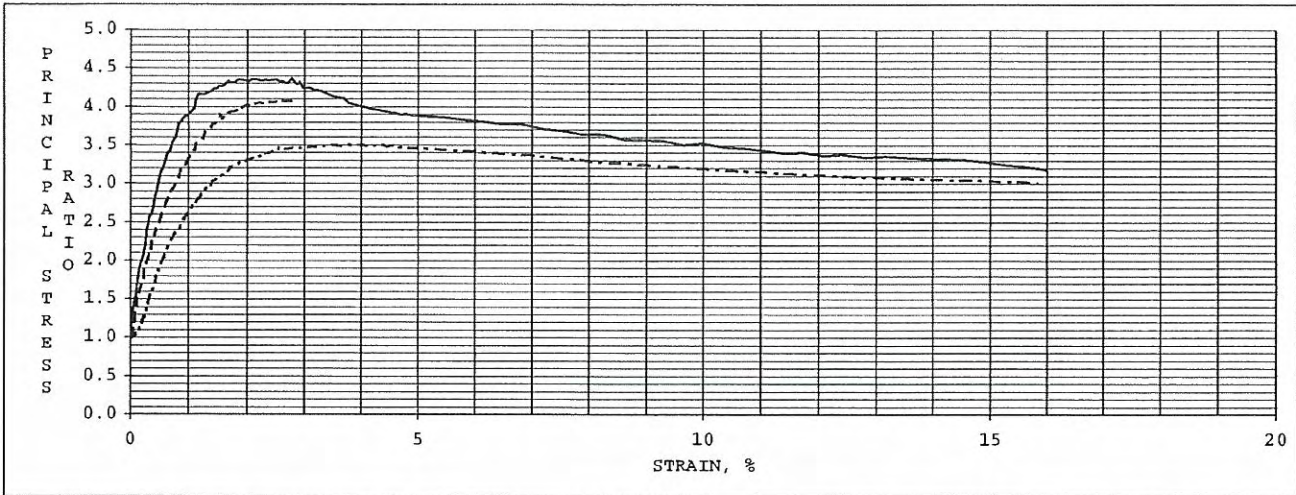
EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	28.6	COHESION, psi	2.9
TOTAL STRESS ———	ANGLE OF INTERNAL FRICTION, deg	18.2	COHESION, psi	3.9



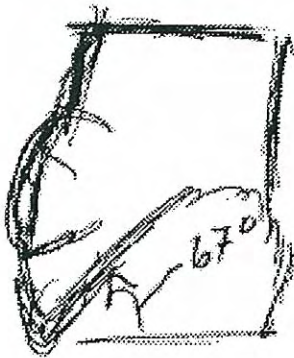
SPECIMEN ID:		A	B	C
INITIAL	WATER CONTENT, %	28.2	26.1	28.1
	DRY DENSITY, pcf	89.2	93.0	95.9
	SATURATION, %	86	87	100
	VOID RATIO	0.89	0.81	0.76
BEFORE SHEAR	WATER CONTENT, %	31.7	28.1	26.9
	DRY DENSITY, pcf	90.7	95.9	97.5
	SATURATION (B PARAMETER)	0.95	0.98	NA
	VOID RATIO	0.86	0.76	0.73
FINAL BACK PRESSURE, psi		100.0	99.7	99.4
MINOR PRINCIPAL STRESS, psi		10.1	19.7	40.0
EFFECTIVE STRESS PEAK AT % STRAIN		2.0	2.0	2.0
EFF. DEVIATOR STRESS AT PEAK STRAIN, psi		19.4	29.6	46.9
TOTAL STRESS PEAK AT % STRAIN		2.0	2.0	2.0
TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi		19.4	29.6	46.9
ULTIMATE DEVIATOR STRESS (15% STR), psi		21.4	NA	49.0
TIME TO 50% PRIMARY CONSOLIDATION, min		1.80	4.00	NA
STRAIN RATE, % / hour		3.19	3.19	3.19
INITIAL DIAMETER, inch		1.802	1.860	1.849
INITIAL HEIGHT, inch		3.712	3.685	3.614
AREA AFTER CONSOLIDATION, inch ²		2.519	2.650	2.642
PROJECT NO. 14095047		PROJECT: LEC / TEC LAB		
CIRCLE B & C SAMPLE WAS STAGE LOADED		BORING #: LEC-3		
LABORATORY: TERRACON - LENEXA		SAMPLE #: 3		
DATE: 11/18/2009		DEPTH, feet: 18.0 - 20.0 feet		

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS (TERRACON MODIFIED FOR STAGE LOADING)



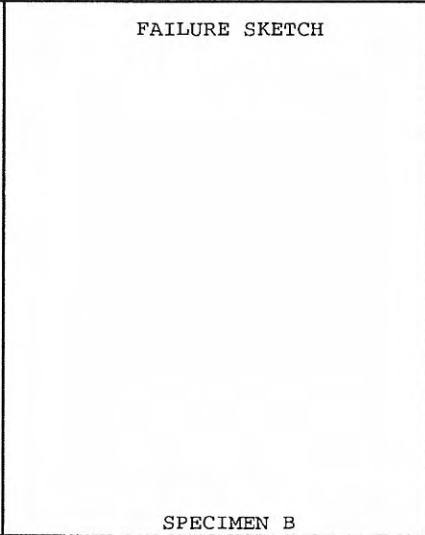


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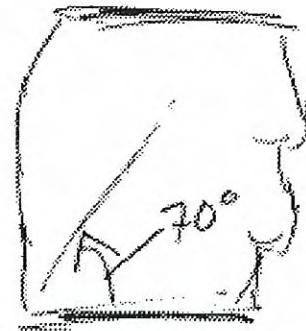
SPECIMEN A

FAILURE SKETCH



SPECIMEN B

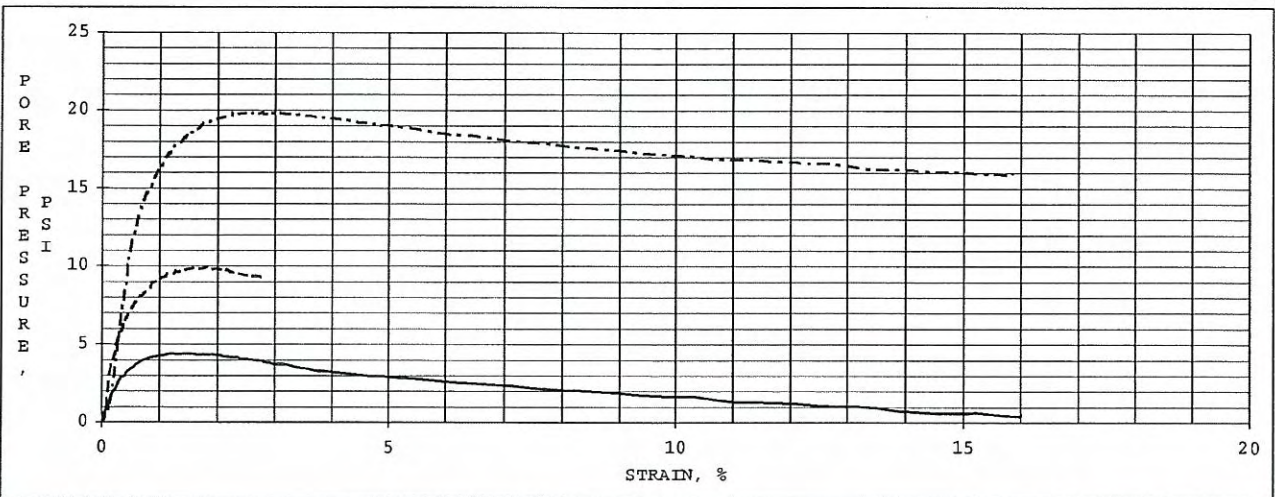
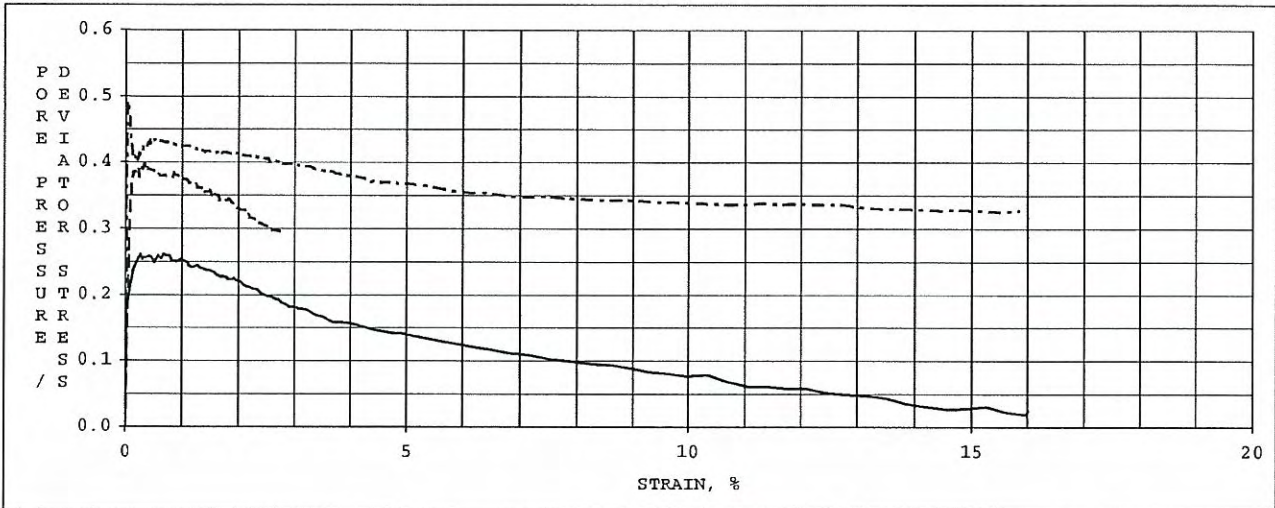
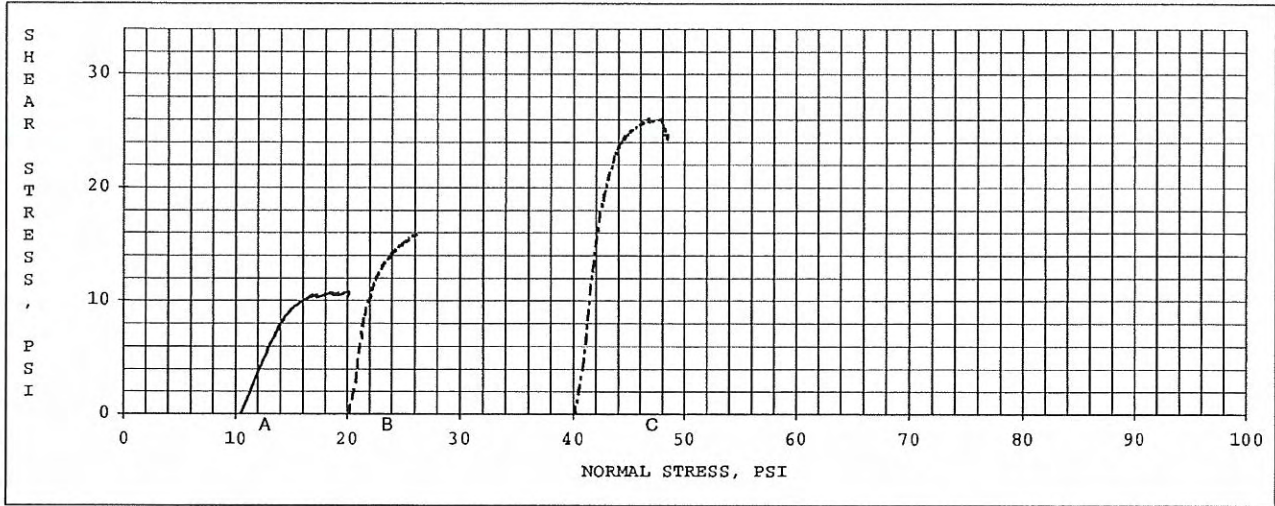
FAILURE SKETCH



SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.
 EFFECTIVE STRESS FAILURE DATA BASED ON 2 % STRAIN.
 EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.
 TOTAL STRESS FAILURE DATA BASED ON 2 % STRAIN.
 TOTAL STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.
 DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.
 AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A



LEC / TEC Berm Analysis

14095047

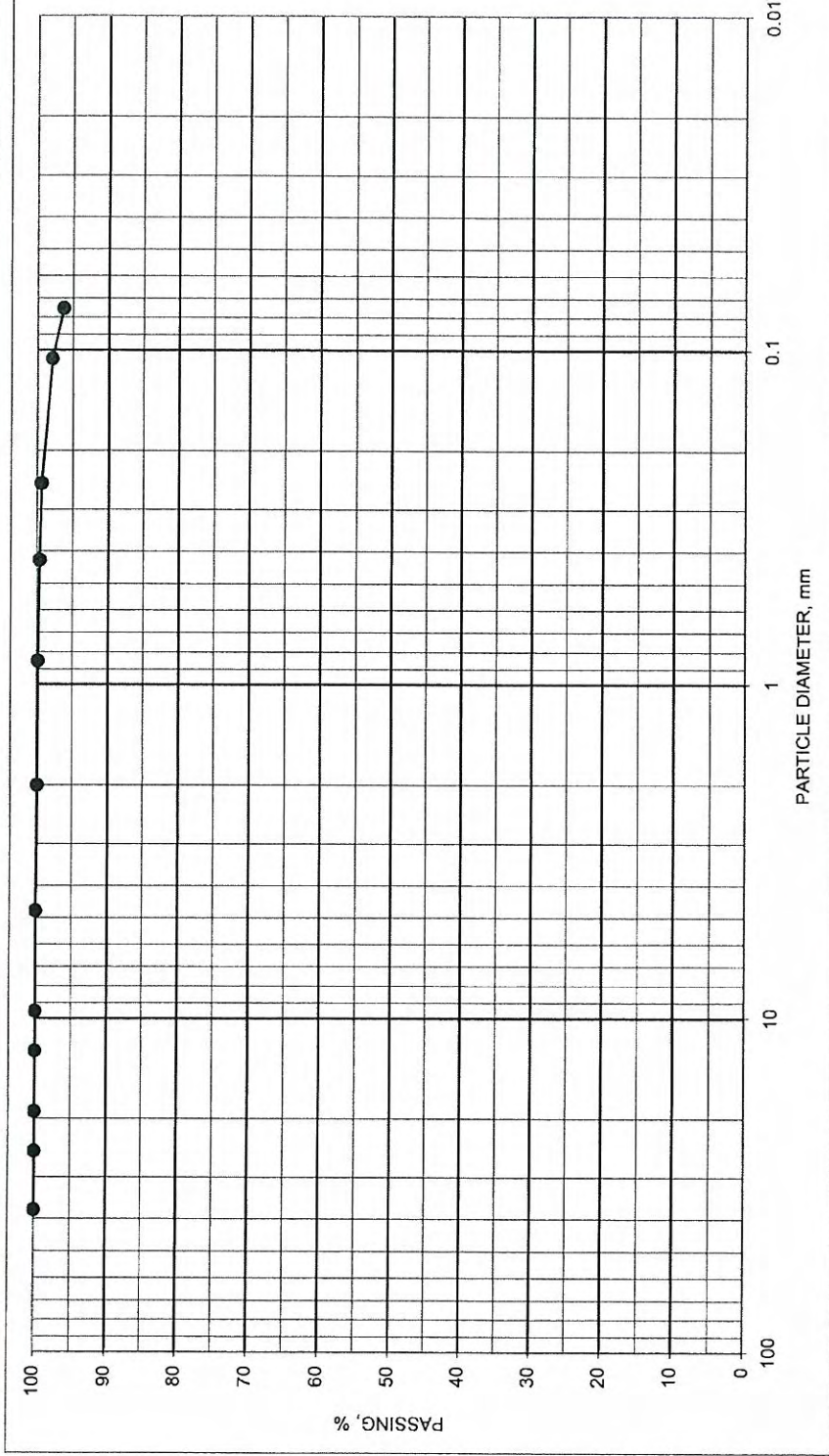
11/16/2009

MOISTURE DENSITY RESULTS

<u>BORING NO.</u>	<u>SAMPLE NO.</u>	<u>DEPTH, feet</u>	<u>DRY DENSITY, pcf</u>	<u>MOISTURE CONTENT, %</u>
LEC-1	1	13.0 - 15.0	94.1	28.4
LEC-4	1	8.0 - 10.0	105.5	21.0
LEC-4	2	13.0 - 15.0	NA	26.0
LEC-4	3	18.0 - 20.0	NA	26.9

Terracon

SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	99
#140	0.106	98
#200	0.075	96.3



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
						LL	PL	PI
LEC-1	1	13 TO 15	LEAN CLAY DARK GRAY	CL	28.4	46	20	26

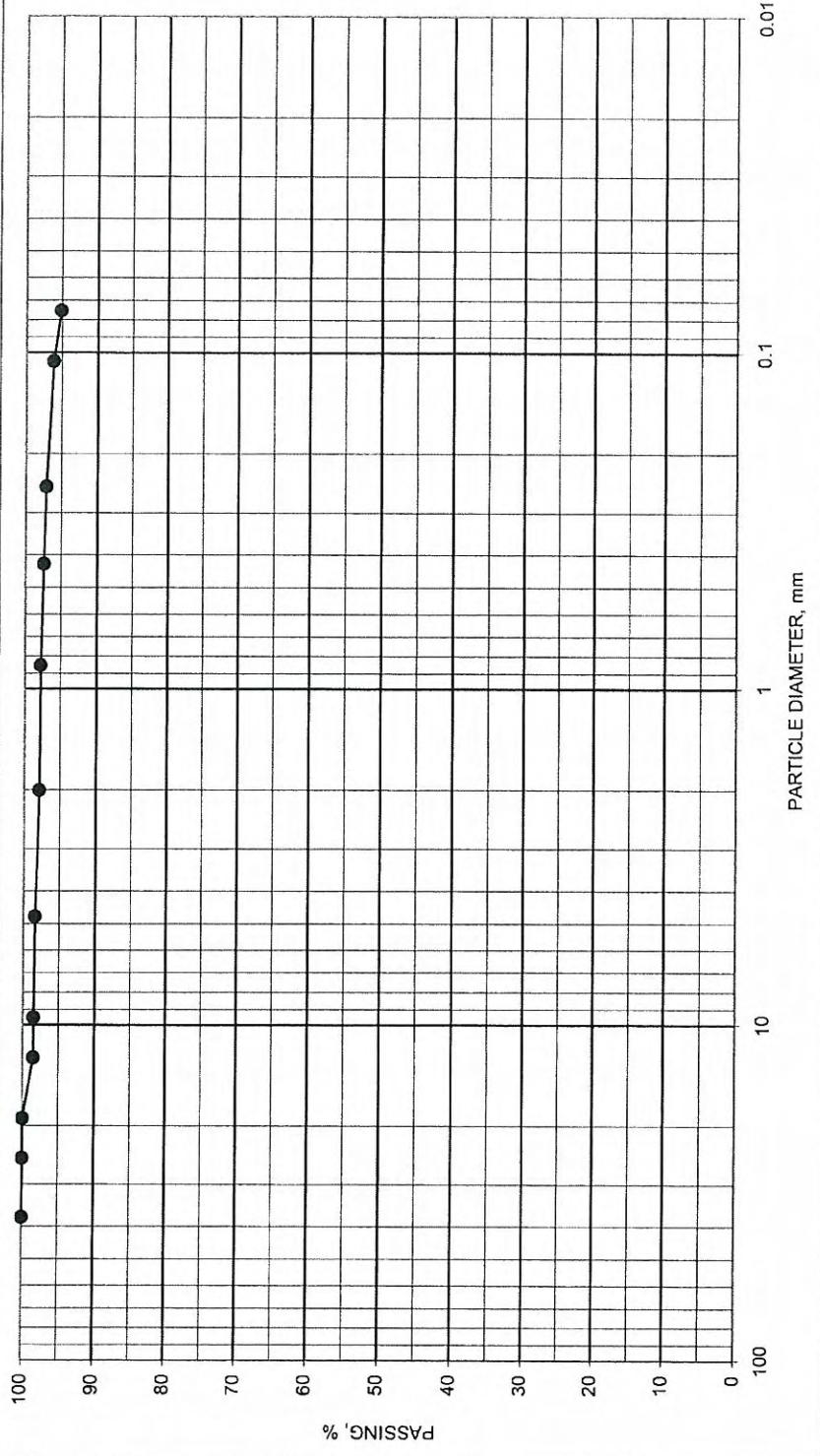
PROJECT LEC / TEC LAB

JOB NO. 14095047 DATE 11/13/2009

N:\CMLAB_DATA\00 Projects in Progress\2009 Projects in Progress\14095047\14095047 GradAL Plot LEC1-1-13.0.xls\GRADATION



SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	99
3/8"	9.50	99
#4	4.75	98
#10	2.00	98
#20	0.850	98
#40	0.425	97
#60	0.250	97
#140	0.106	96
#200	0.075	95.1



GRAIN SIZE DISTRIBUTION CURVE

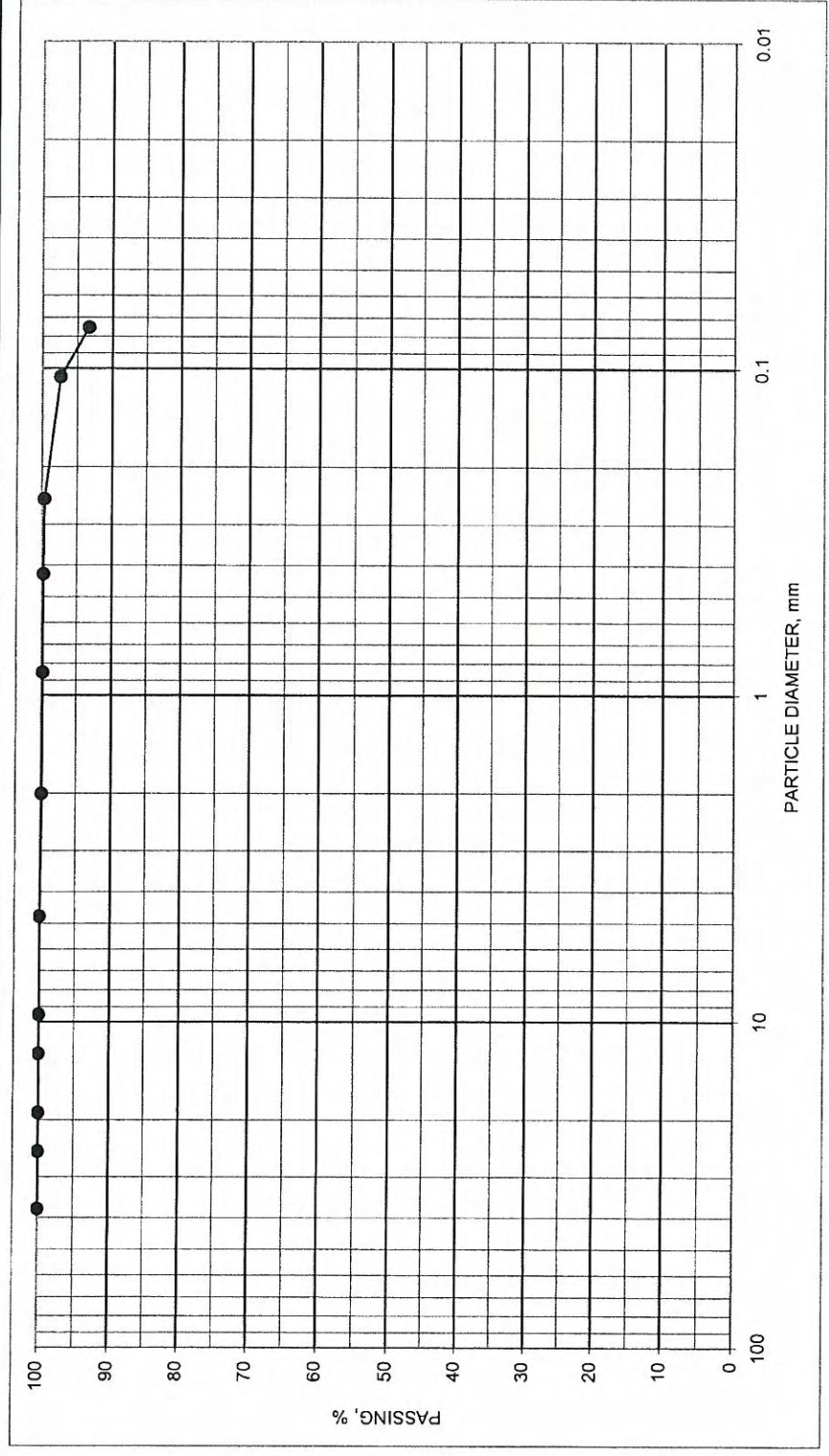
BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
						LL	PL	PI
LEC-2	1	8 TO 10	FAT CLAY DARK GRAY	CH		61	22	39

PROJECT LEC / TEC LAB

JOB NO. 14095047 DATE 11/13/2009



SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"		100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	100
#140	0.106	97
#200	0.075	93.3



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
LEC-3	3	18 TO 20	FAT CLAY DARK GRAYISH BROWN & LIGHT GRAY	CH		LL	PL	PI
						74	24	50

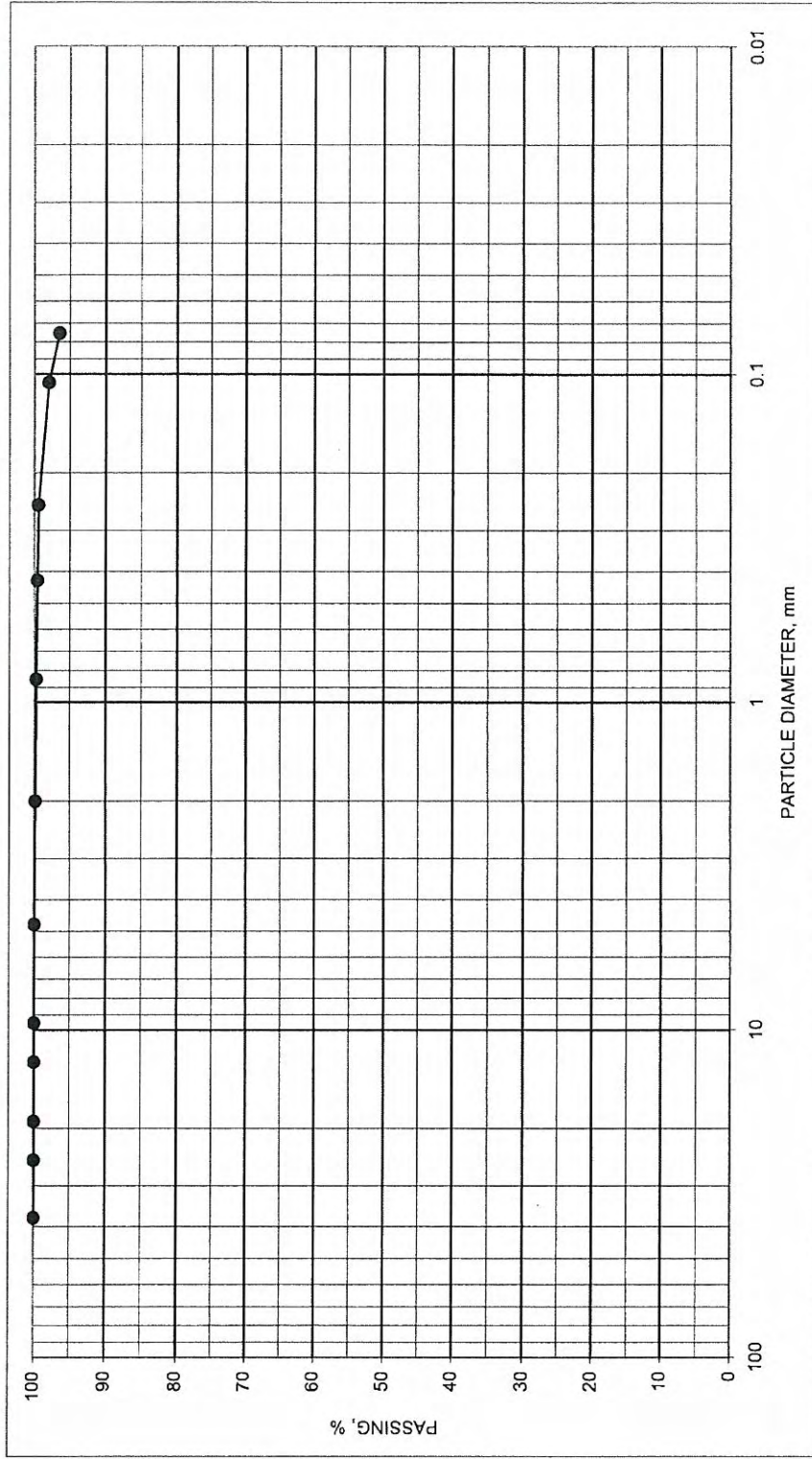
PROJECT LEC/TECLAB

JOB NO. 14095047 DATE 11/19/2009

N:\CMLAB_DATA\100 Projects in Progress\2009 Projects in Progress\14095047\14095047 GradALPlot.LEC3-3-18.0.xls\ATTERBERG M%



SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	99
#140	0.106	98
#200	0.075	96.4



GRAIN SIZE DISTRIBUTION CURVE

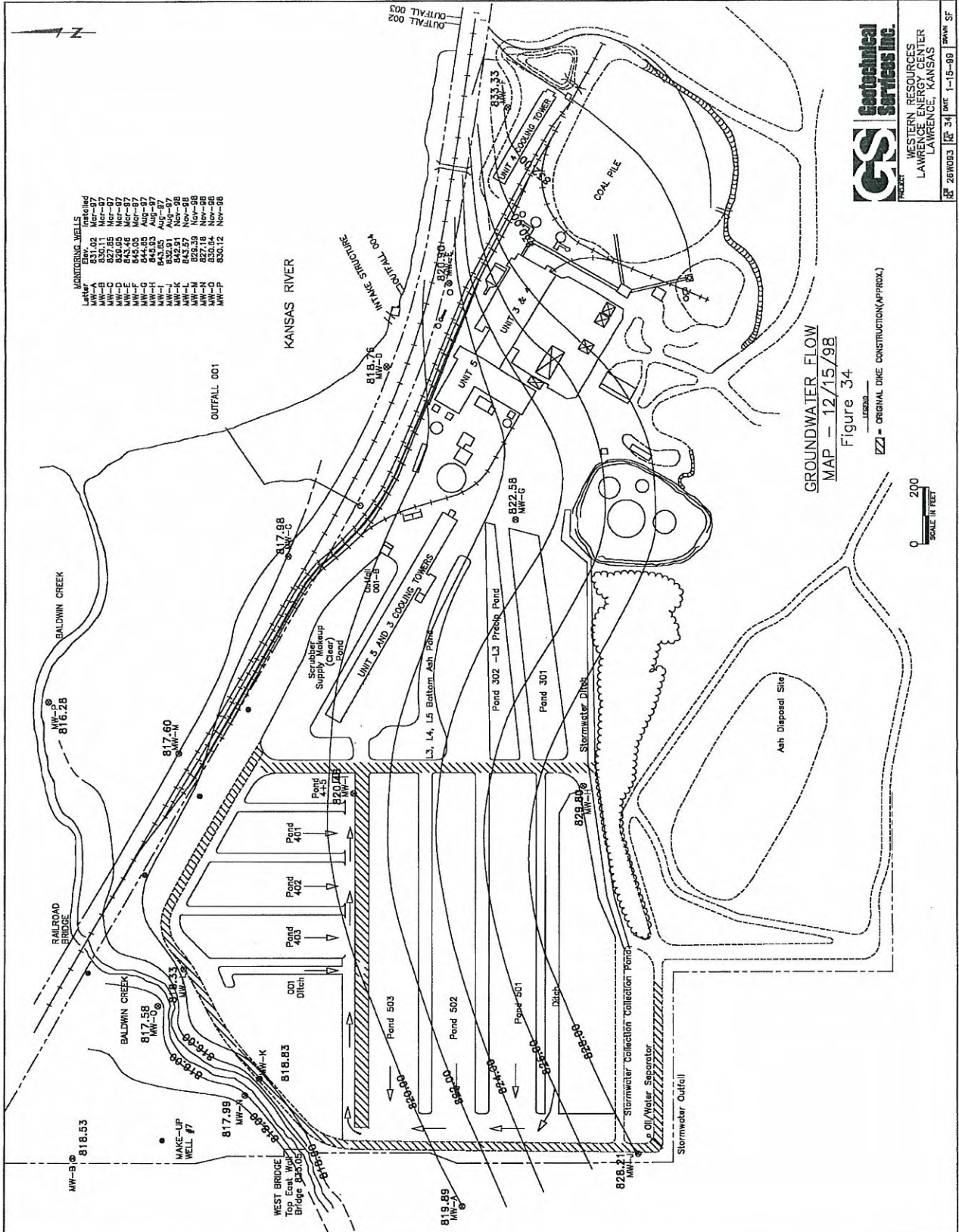
BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
						LL	PL	PI
LEC-4	1	8 TO 10	LEAN CLAY DARK GRAY	CL	21.0	41	18	23

PROJECT LEC/TEC LAB

JOB NO. 14095047 DATE 11/13/2009



APPENDIX C
POTENTIOMETRIC SURFACE MAP



MONITORING WELLS

Well	Depth	Installed
MW-A	831.02	Mar-97
MW-B	830.11	Mar-97
MW-C	827.85	Mar-97
MW-D	843.46	Mar-97
MW-E	843.05	Mar-97
MW-F	843.05	Mar-97
MW-G	843.93	Aug-97
MW-H	843.85	Aug-97
MW-I	843.91	Nov-98
MW-J	842.91	Nov-98
MW-K	843.57	Nov-98
MW-L	827.33	Nov-98
MW-M	827.33	Nov-98
MW-N	830.54	Nov-98
MW-O	830.54	Nov-98
MW-P	830.12	Nov-98

GROUNDWATER FLOW
 MAP - 12/15/98
 Figure 34

Geotechnical Services Inc.
 WESTERN RESOURCES
 LAWRENCE ENERGY CENTER
 LAWRENCE, KANSAS
 PROJECT NO. 261003 | SHEET 34 | DATE 1-15-99 | DRAWN SF

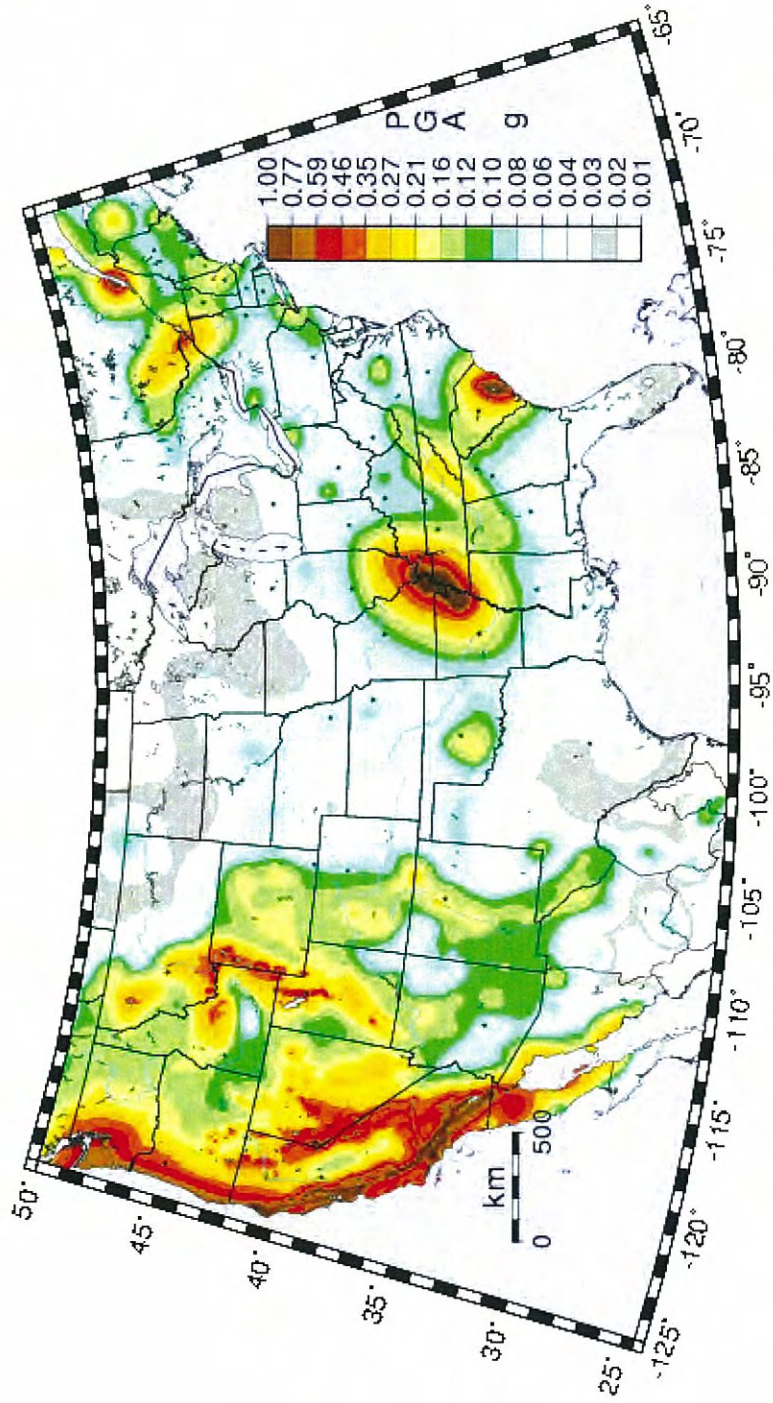
ZZZ - ORIGINAL DIKE CONSTRUCTION (APPROX.)



APPENDIX D
SEISMIC HAZARD MAP

Peak ground acceleration with a 2% probability of exceedance in 50 years

Reference: United States Geological Survey (2008)



APPENDIX E
PHOTOGRAPHS



Photograph 1 – CCP storage facility (looking northwest)



Photograph 2 – CCP storage facility (looking east)



Photograph 3 – CCP storage facility (looking east)



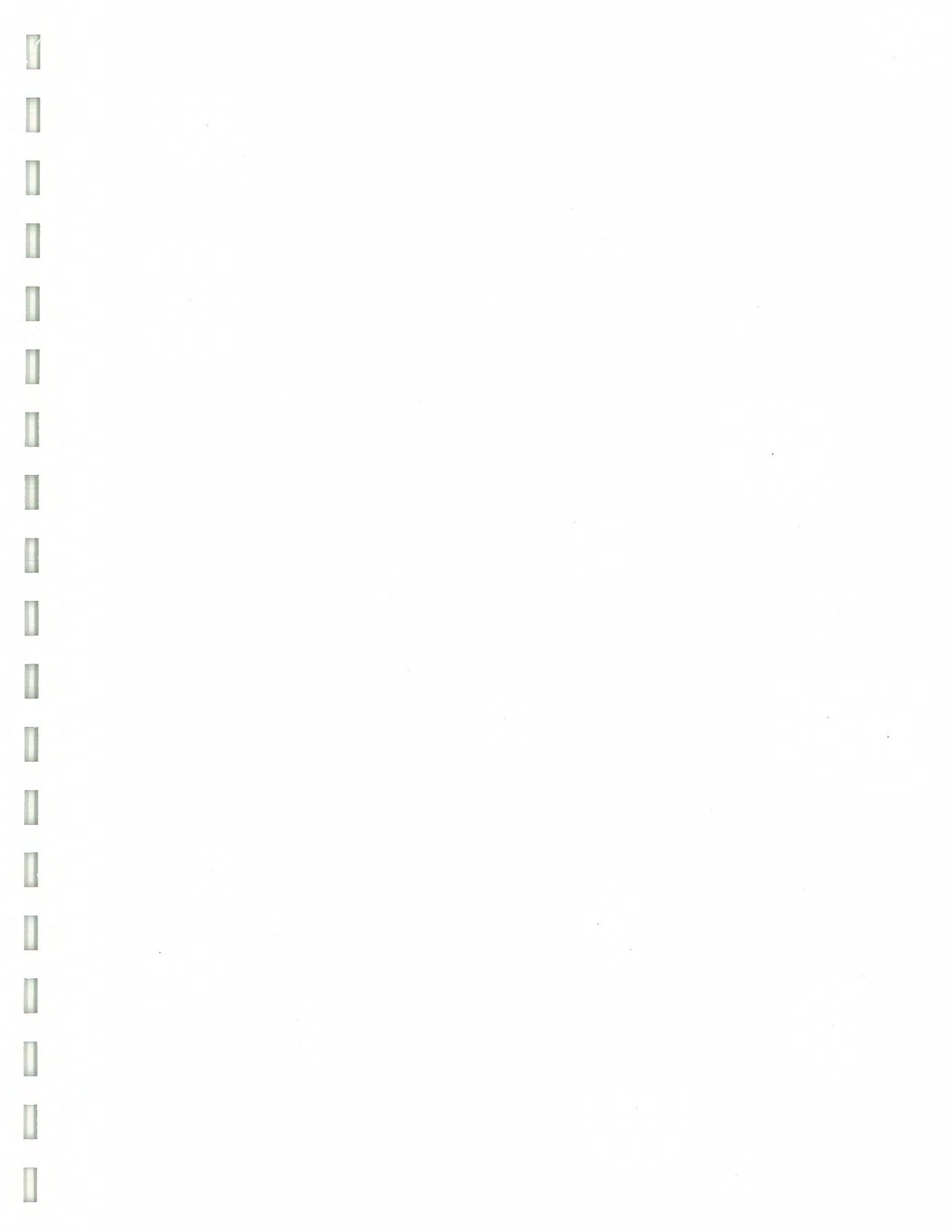
Photograph 4 – CME drill rig used to complete boreholes (looking north)



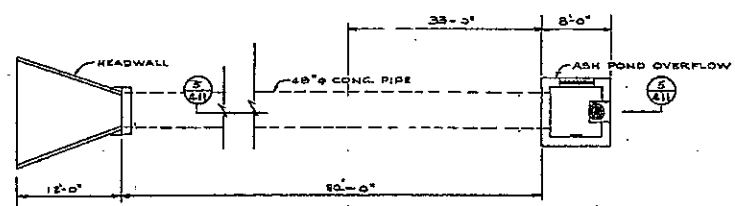
Photograph 5 – Berm crest (looking northwest)



Photograph 6 – Downstream berm slope northwest of CCP storage facilities (looking east)

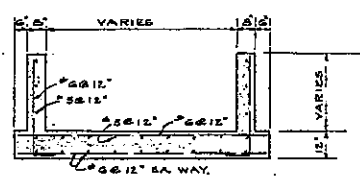


Doc 05: Black & Veatch Construction Drawings – Outlet Structures

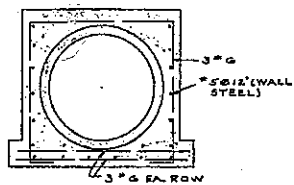


PLOT PLAN
ASH POND OVERFLOW
SCALE: 1/8"=1'-0"

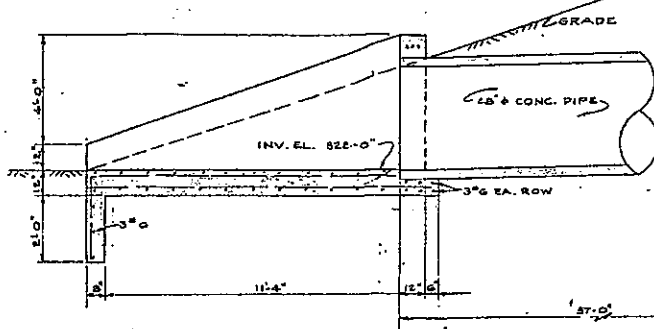
NOTE: FOR LOCATION
SEE SH. G-2



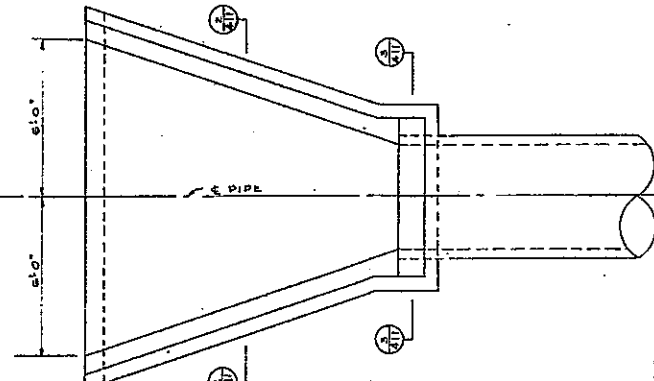
SECTION 2
SCALE: 1/8"=1'-0"



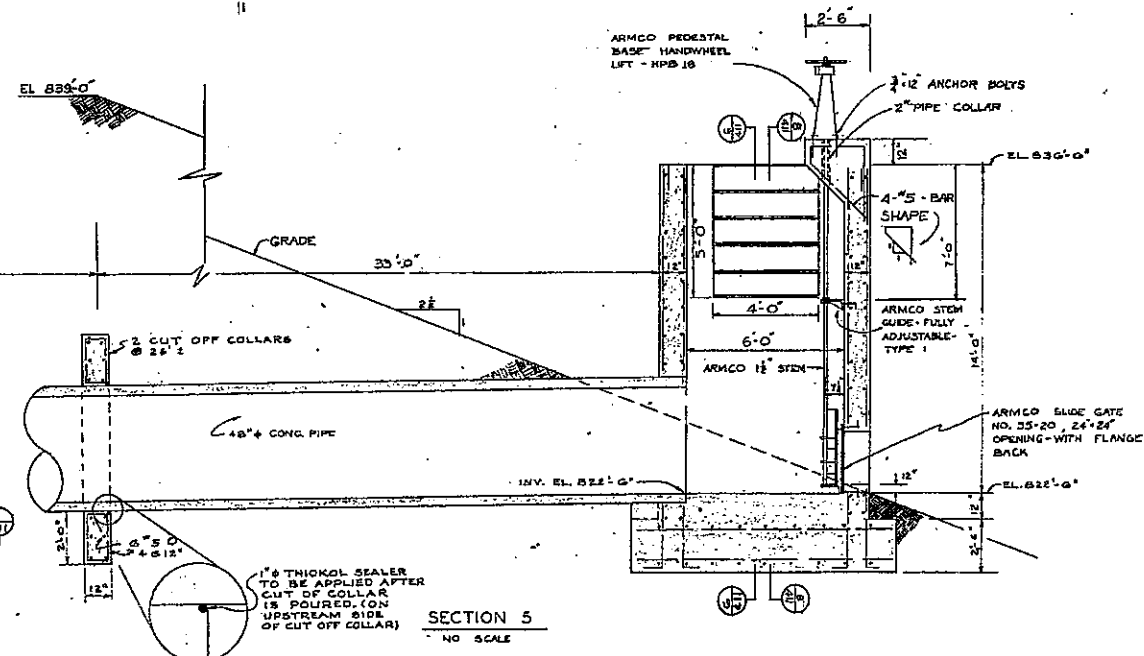
SECTION 3
SCALE: 1/8"=1'-0"



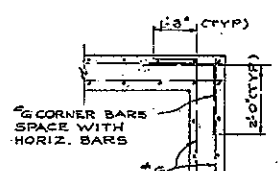
SECTION 1
SCALE: 1/8"=1'-0"



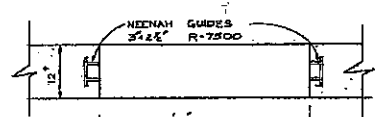
PLAN
HEADWALL
SCALE: 1/8"=1'-0"



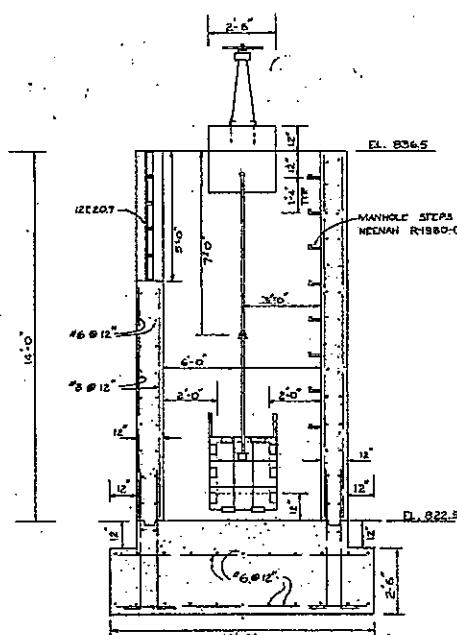
SECTION 5
NO SCALE



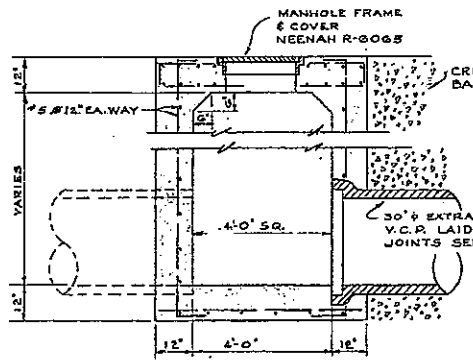
TYP WALL CORNER BARS
NO SCALE



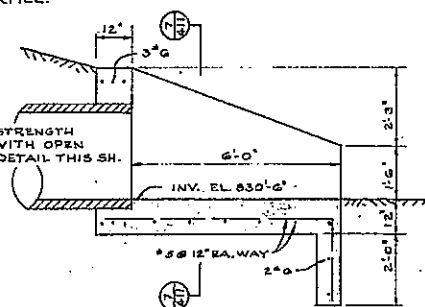
PLAN
STOP LOG GUIDE
SCALE: 1/8"=1'-0"



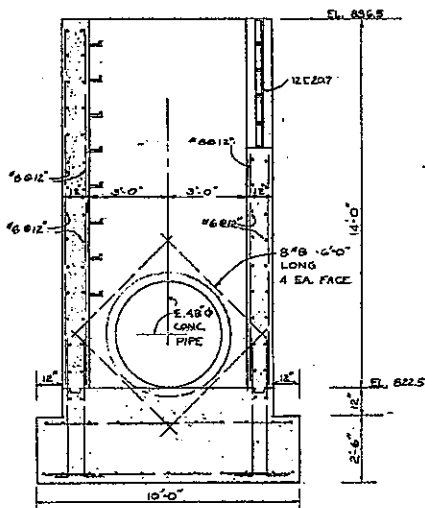
SECTION 8
SCALE: 1/8"=1'-0"



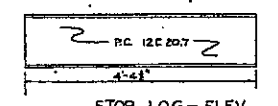
MANHOLE
SCALE: 1/8"=1'-0"



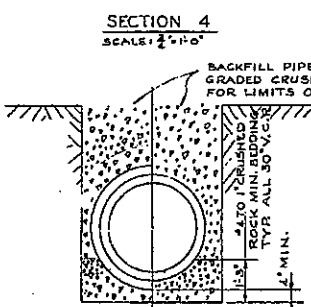
ELEVATION
SCALE: 1/8"=1'-0"



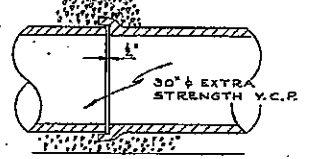
SECTION 6
SCALE: 1/8"=1'-0"



STOP LOG - ELEV
SCALE: 1/8"=1'-0"

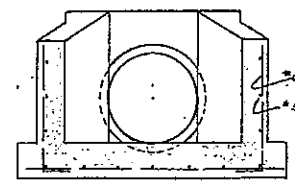


BEDDING & BACKFILL DETAIL
NO SCALE

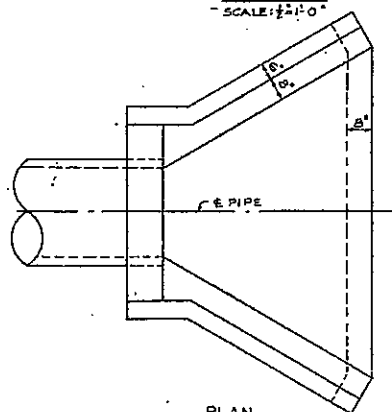


OPEN JOINT DETAIL
NO SCALE

NOTE: CENTER BARREL IN SOCKET AND PROVIDE 1/2" CLEAR BETWEEN END OF BARREL AND END OF SOCKET AS SHOWN.



SECTION 7
SCALE: 1/8"=1'-0"



PLAN
HEADWALL DETAILS
SCALE: 1/8"=1'-0"

COAL PILE AREA DRAIN DETAILS

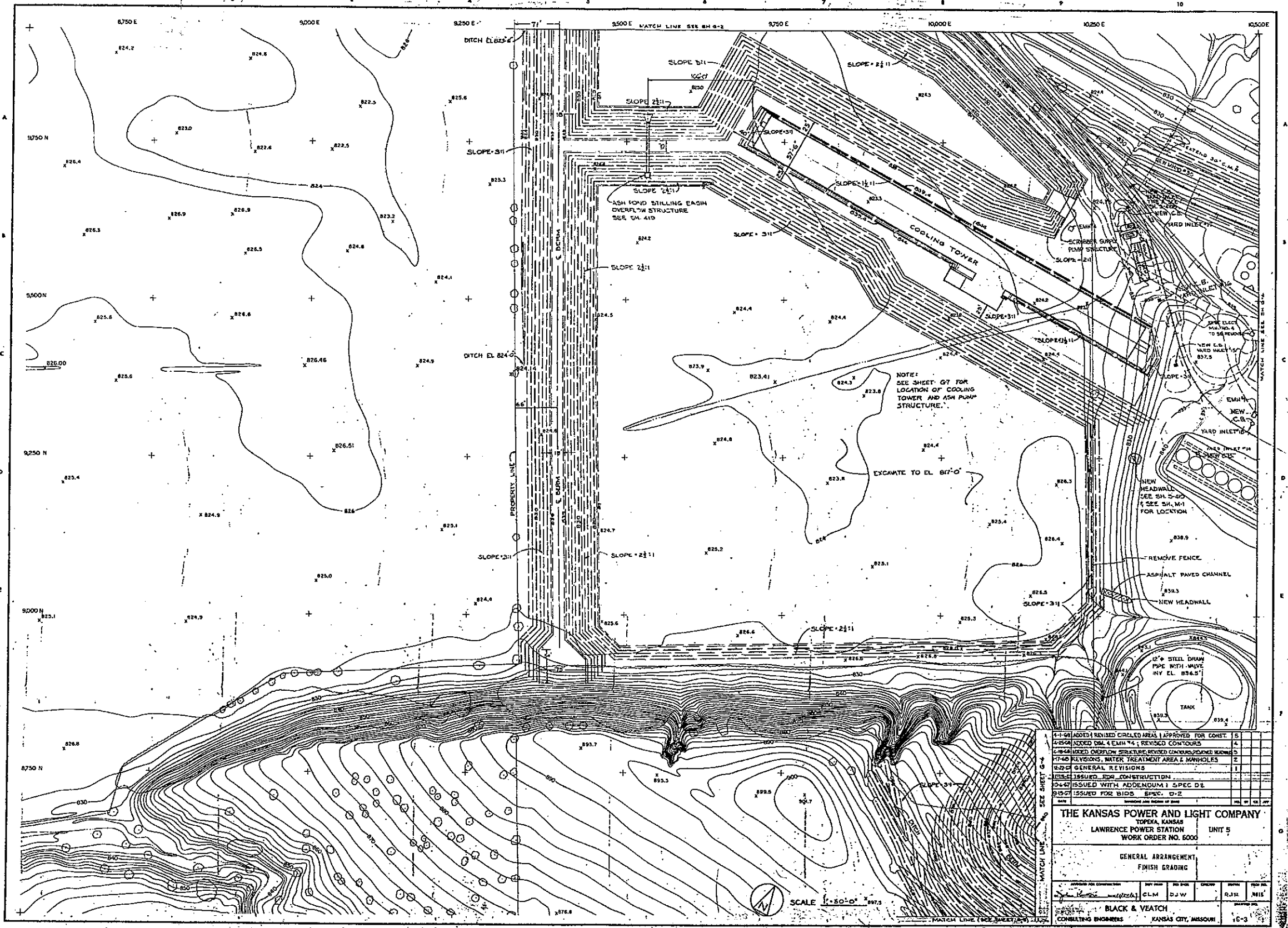


SCALE AS NOTED

30" X 42" = 875 SQ. FT.

0-14-71	CONFORMED TO CONSTRUCTION RECORDS				
0-15-69	APPROVED FOR CONSTRUCTION - PHASE II				
0-15-67	ISSUED FOR CONSTRUCTION				
0-13-62	ISSUED FOR BID 5 SPEC. D-GA				
0-6-67	ISSUED WITH ADDENDUM 1 SPEC. D-2				
0-15-67	ISSUED FOR BIDS - SPEC. D-2				
DATE	REVISION AND NUMBER OF ISSUE	REV. NO.	BY	CHK.	APP.
THE KANSAS POWER AND LIGHT COMPANY TOPEKA, KANSAS LAWRENCE POWER STATION UNIT 5 WORK ORDER NO. 6000					
STRUCTURAL MISCELLANEOUS YARD STRUCTURES					
APPROVED FOR CONSTRUCTION	CHK. BY	DES. BY	CHECKED	DATE	SCALE
	CLM	DJW	RJR	0815	
BLACK & VEATCH CONSULTING ENGINEERS					DRAWING NO. S-411

Doc 06: Black & Veatch Construction Drawings – Finish Grading



NOTE:
SEE SHEET 07 FOR
LOCATION OF COOLING
TOWER AND ASH PUMP
STRUCTURE.

EXCAVATE TO EL. 817'-0"

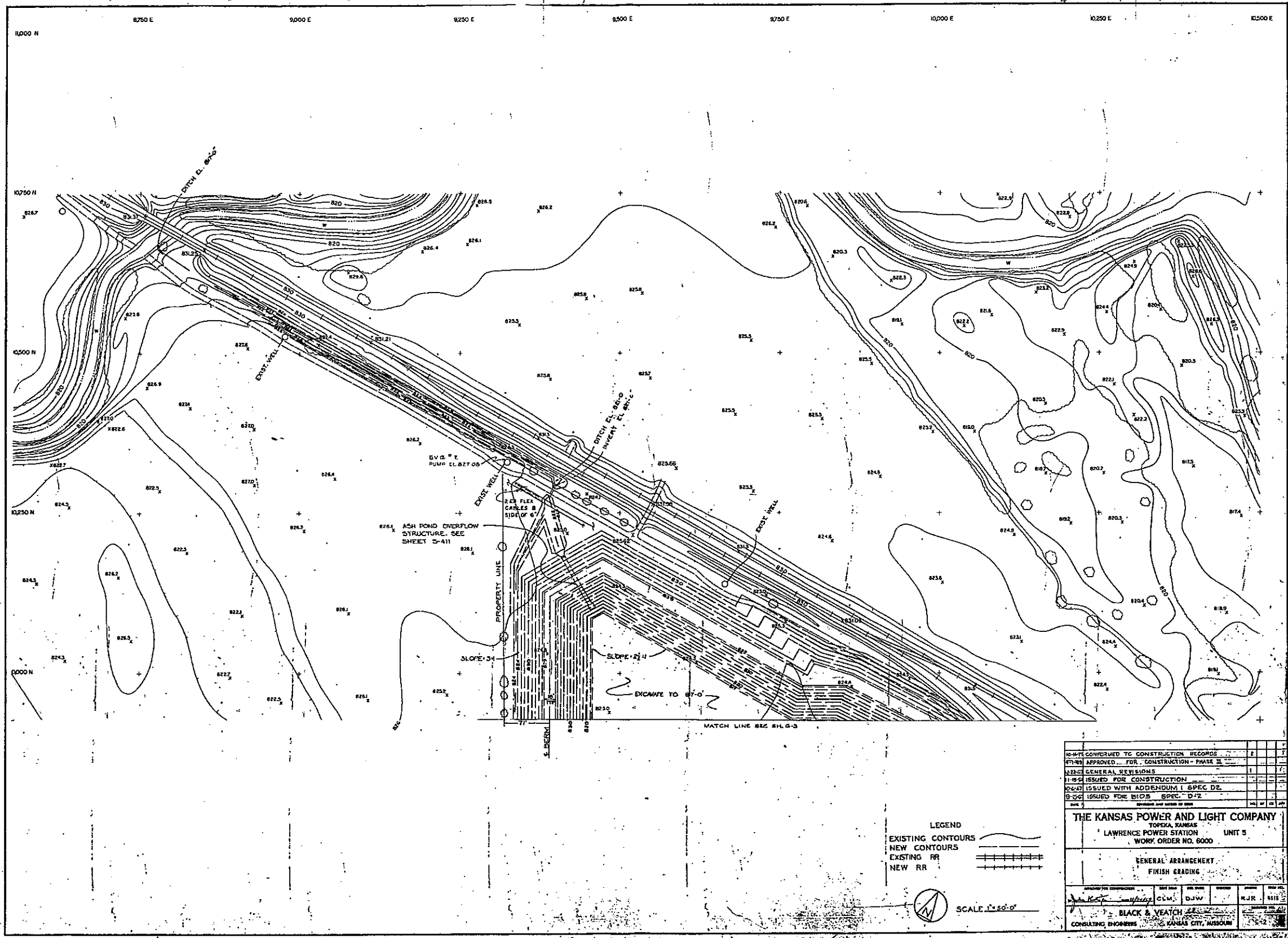
11-54	SHADED REVISION CIRCLED AREA APPROVED FOR CONST.	15
11-54	ADDED DIM. 4 EACH "4"; REVISED CONTOURS	4
11-54	ADDED OVERFLOW STRUCTURE BODIED CONDUIT/POURED HEADWALL	2
11-54	REVISIONS, WATER TREATMENT AREA & MANHOLES	2
11-54	GENERAL REVISIONS	1
11-54	ISSUED FOR CONSTRUCTION	
10-67	ISSUED WITH ADDENDUM 1 SPEC D-2	
9-57	ISSUED FOR BIDS SPEC. D-2	

THE KANSAS POWER AND LIGHT COMPANY
TOPEKA, KANSAS
LAWRENCE POWER STATION UNIT 5
WORK ORDER NO. 5000

GENERAL ARRANGEMENT
FINISH GRADING

CLM	DJW	RJR	MB
BLACK & VEATCH		KANSAS CITY, MISSOURI	

SCALE 1" = 50'-0"



LEGEND

- EXISTING CONTOURS
- NEW CONTOURS
- EXISTING RR
- NEW RR

SCALE 1" = 50.0'

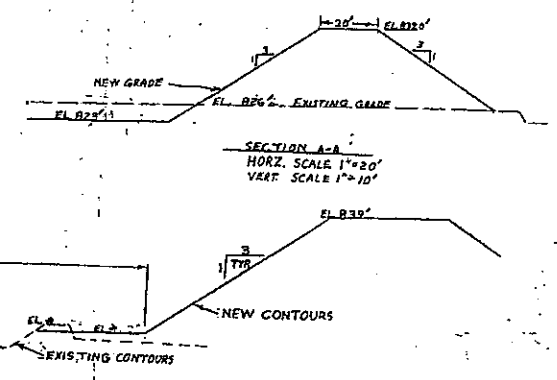
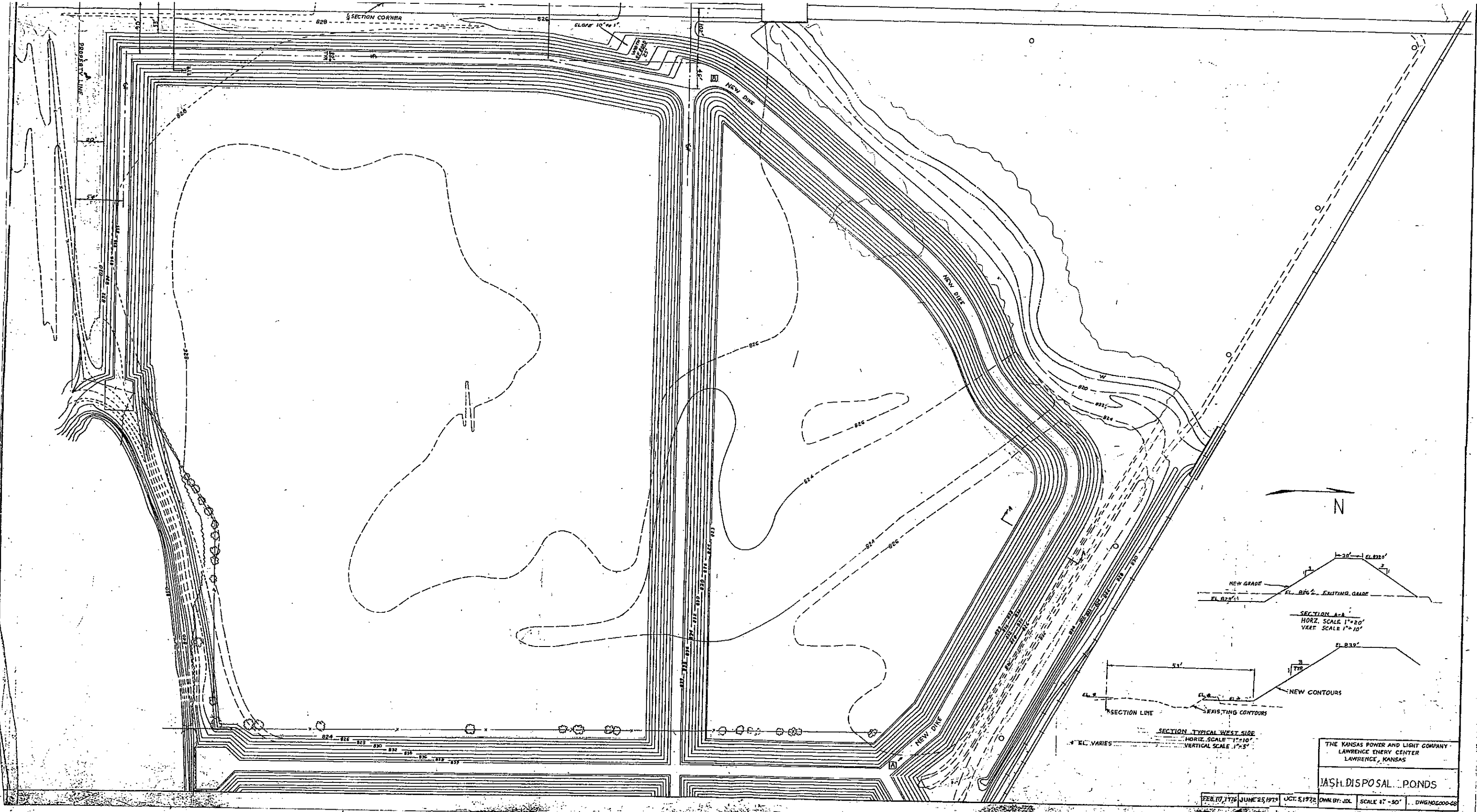
10-411 COVERED TO CONSTRUCTION RECORDS	2		
47-411 APPROVED FOR CONSTRUCTION - PHASE II	1		
11-522 GENERAL REVISIONS	1		
11-522 ISSUED FOR CONSTRUCTION	1		
05-527 ISSUED WITH ADDENDUM I SPEC. D2			
9-528 ISSUED FOR BIDS SPEC. D-2			
DATE	BY	CHKD.	APP'D.

THE KANSAS POWER AND LIGHT COMPANY
 TOPEKA, KANSAS
 LAWRENCE POWER STATION UNIT 5
 WORK ORDER NO. 6000

GENERAL ARRANGEMENT
 FINISH GRADING

DESIGNED BY	CHKD.	APP'D.	DATE

BLACK & VEATCH
 CONSULTING ENGINEERS
 KANSAS CITY, MISSOURI



THE KANSAS POWER AND LIGHT COMPANY
 LAWRENCE ENERGY CENTER
 LAWRENCE, KANSAS

IASH DISPOSAL PONDS

FEB. 10, 1976 JUNE 25, 1976 OCT. 5, 1976 OWN. BY: JKL SCALE 1" = 50' DWG. NO. 6000-28

**APPENDIX B
PHOTOGRAPHS**

Photo Log
Site Visit - Lawrence Energy Center Coal Ash Ponds, Lawrence, KS
September 23, 2010



1. Exterior of north dike – Taken from east end of Area 1, looking west



2. Discharge pipe at east end of Area 1



3. Interior of north dike – Taken from east end of Area 1, looking west



4. Exterior of north dike – Taken from east end of Area 1, looking west



5. Emergency overflow structure – west end of Area 1



6. Outfall of emergency overflow structure – exterior of north side of Area 1 dike. Heavy vegetation made access to the outfall impractical.



7. Exterior of dike – Taken from north side of Area 2 looking south, up side of dike.



8. Interior separation dike, separating Area 1 from Area 2 - Taken from north end, looking south.



9. Top of northern dike – Taken from midpoint looking west.



10. Interior of northern dike in Area 2 – Some minor washout/erosion observed.



11. Close-up of 10.



12. Exterior of northern dike (Area 4) – heavy vegetation observed.



13. Exterior of northwestern dike (Area 4) – heavy vegetation and trees observed.



14. Interior of northwestern dike (Area 4)



15. Exterior of northwestern dike (Area 4) – 10” tree observed at toe of embankment.



16. Exterior of northwestern dike (Area 4) – multiple trees observed on embankment.



17. Baldwin Creek flowing near toe of northwestern dike (Area 4)



18. Exterior of northwestern dike (Area 4) – 10" tree observed at toe of embankment.



19. Interior of western dike – Taken from midpoint (between Area 3 and 4) looking north



20. Interior of western dike (Area 3) – Taken from western dike looking south along interior of dike. Clay liner being installed



21. Interior separation dike (Area 3) – Taken from western dike looking east along interior separation dike. Clay liner being installed



22. Looking west towards agricultural fields – Taken from top of western dike.



23. Storm water pond at south end of ash pond area/Area 3 – Taken from western dike looking east.



24. Storm water pond discharge pipe on interior of south side of dike.



25. Storm water pond outfall pipes on exterior of south side of dike.



26. South dike – south side of storm water pond (Area 3).



27. Exterior tie-in of south dike to existing grade/road embankment.



28. Interior tie-in of south dike to existing grade/road embankment.



29. Area 2/middle cell – Taken from west end looking east.



30. Channel connecting Area 2 and Area 3 – Taken from east end looking west.



31. Area 2/south cell – Taken from southwest corner looking northeast.

**APPENDIX C
DAM INSPECTION CHECK LIST**



Site Name:	WESTAR ENERGY LAWRENCE ENERGY CTR.	Date:	Sept. 23, 2010
Unit Name:	AREA 1	Operator's Name:	
Unit I.D.:	Combined	Hazard Potential Classification:	High <input type="checkbox"/> Significant <input type="checkbox"/> Low <input type="checkbox"/>
Inspector's Name:		F. LOCKRIDGE AND G. JONES	

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

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Nonroutine - bi-shift		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	Varies		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	836		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	840		Is water exiting outlet, but not entering inlet?		X
6. If instrumentation is present, are readings recorded (operator records)?		X	Is water exiting outlet flowing clear?	X	
7. Is the embankment currently under construction?	Internal Dikes	External Perimeter-No	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	Per Spans Not Visible now		From underdrain?		N/A
9. Trees growing on embankment? (If so, indicate largest diameter below)	X - 30"		At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	N/A		From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?			23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

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

Issue #	Comments
	Since internal (separator) dikes are continuously under const. and relocation, it was decided to evaluate the perimeter embankments and consider the 4 cells as comprising one large impoundment.



Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit *KS0079821* INSPECTOR

Date *4/01/2009*

Impoundment Name *Lawrence Energy Center*

Impoundment Company *Westar Energy*

EPA Region *7*

State Agency *Kansas Dept. of Health & Environment - (KDHE)*
(Field Office) Address *1000 SW Jackson, Suite 320, Topeka, KS 66612-1366*

Name of Impoundment *Lawrence Energy Center*

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

New

Update

Is impoundment currently under construction?	Yes <input checked="" type="checkbox"/> <i>Note 1.</i>	No <input type="checkbox"/>
Is water or ccw currently being pumped into the impoundment?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>

IMPOUNDMENT FUNCTION:

Nearest Downstream Town Name: *Lawrence, KS.*

Distance from the impoundment: *Actually in the city limits*

Location:

Latitude *39* Degrees Minutes *29.40* Seconds *N*

Longitude *95* Degrees Minutes *16* Seconds *19.86* *W*

State *KANSAS* County *DOUGLAS*

Does a state agency regulate this impoundment?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
--	---	-----------------------------

If So Which State Agency? *KDHE*

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

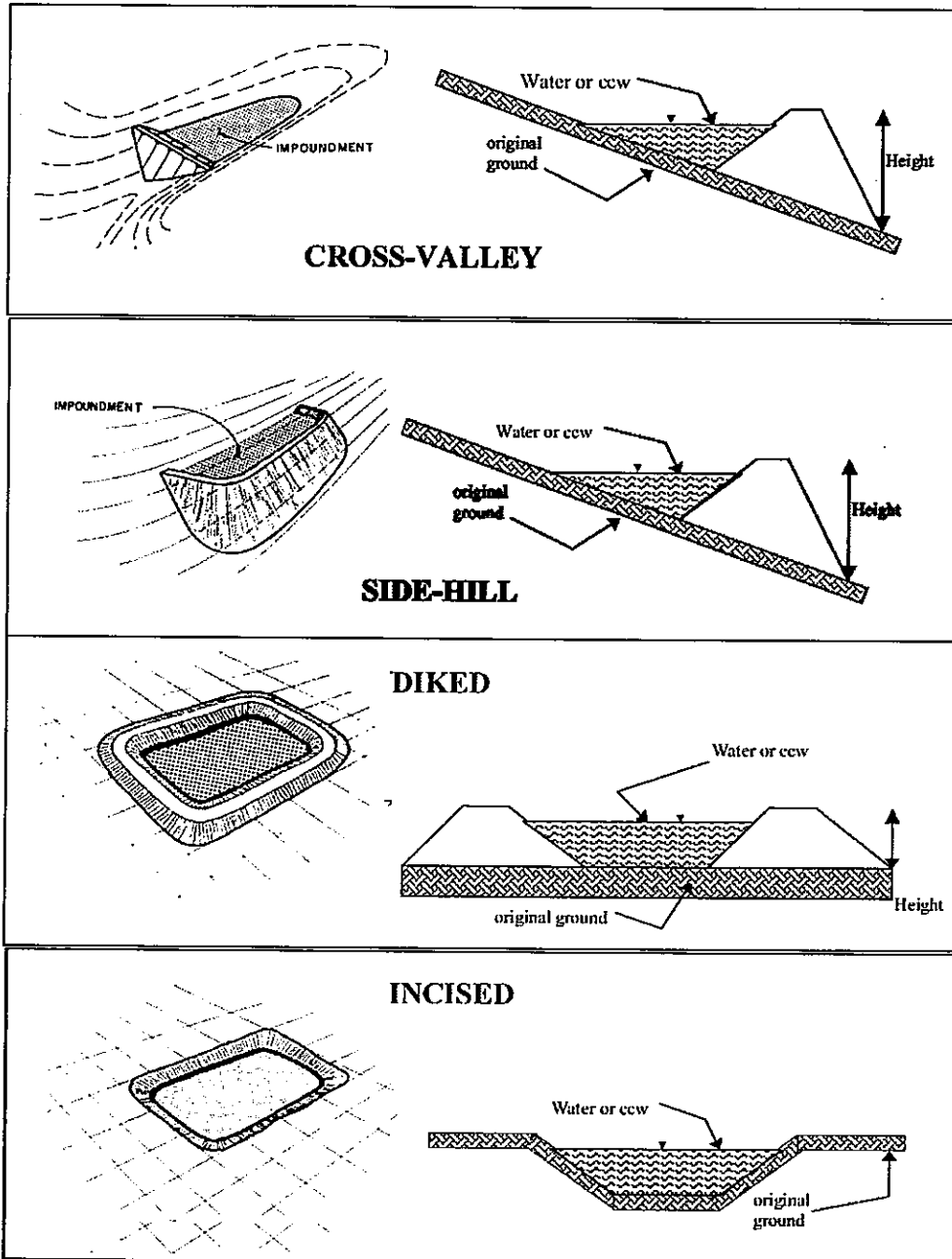
- LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.
- LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
- SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

Dike failure at this location would probably not result in loss of human life, but could result in economic ^{loss} and environmental damage by contaminating down gradient agriculture fields and the Kansas River.



CONFIGURATION:



- | | | | | | |
|-------------------------------------|------------------------------------|-------------------------------------|---------------------------|--------------------------|-------|
| <input type="checkbox"/> | Cross-Valley | <input checked="" type="checkbox"/> | Side-Hill | <input type="checkbox"/> | Diked |
| <input checked="" type="checkbox"/> | Incised (form completion optional) | <input checked="" type="checkbox"/> | Combination Incised/Diked | | |

Embankment Height (ft)

Embankment Material *Silty Clay*

Pool Area (ac)

Liner

Current Freeboard (ft)

Liner Permeability



TYPE OF OUTLET (Mark all that apply)

Open Channel Spillway *N/A*

Trapezoidal

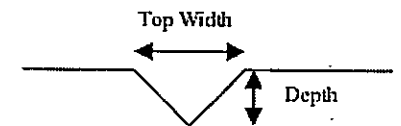
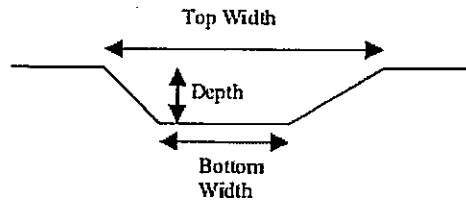
TRAPEZOIDAL

Triangular

TRIANGULAR

Rectangular

Irregular

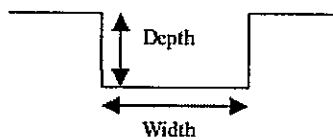


depth (ft)

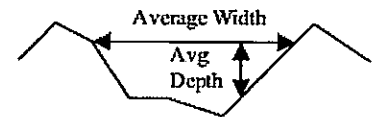
average bottom width (ft)

RECTANGULAR

top width (ft)



IRREGULAR



Outlet

~~48" 18" inside diameter~~
~~(SDR 17 = smooth lined → 19.5" OD)~~

Material

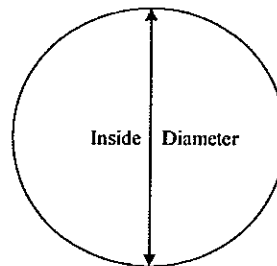
corrugated metal

welded steel

concrete

plastic (hdpe, pvc, etc.)

other (specify):



Yes

No

Is water flowing through the outlet?

No Outlet

Other Type of Outlet
 (specify):

~~The Impoundment was Designed By: AEP in-house personnel~~

Black and VEATCH



Yes No

Has there ever been a failure at this site?

If So When?

If So Please Describe :

No cracking during '93 flood.



Has there ever been significant seepages
at this site?

Yes

No

If So When?

If So Please Describe :



Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?

Yes

No

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

If So Please Describe :



ADDITIONAL INSPECTION QUESTIONS

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

No information

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

No

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

No