MidAmerican Energy
OBSESSIVELY, RELENTLESSLY AT YOUR SERVICE

4299 NW Urbandale Drive
Urbandale, Iowa 50322

August 23, 2011

Delivered via E-Mail to
hoffman.stephen@epa.gov

Mr. Stephen Hoffman
U.S. Environmental Protection Agency
Two Potomac Yard
2733 South Crystal Drive
5th Floor, N-5838
Arlington, Virginia 22202-2733

Re: Responses to Recommendations in Final Coal Combustion Waste Impoundment Round 7 - Dam Assessment Report for George Neal North Energy Center

Dear Mr. Hoffman:

MidAmerican Energy Company ("MidAmerican") appreciates the opportunity to provide responses to the recommendations outlined in the Final Coal Combustion Waste Impoundment Round 7 - Dam Assessment Report for George Neal North Energy Center. The specific recommendations were summarized in EPA's June 26, 2011 letter, Enclosure 2, submitted to MidAmerican's Ms. Cathy Woollums.

MidAmerican takes its environmental responsibilities very seriously. I therefore hope you find the responses complete and consistent with your expectations. However, if you have any questions or require any additional information, please don't hesitate to contact me.

Sincerely,

Kevin D. Dodson
Director – Environmental Programs,
Compliance and Permitting
Phone: 515-281-2692
kddodson@midamerican.com

Attachments

cc: Reg Soepnel
Dave Ulozas
Cathy Woollums
Dave Maystrick

# George Neal North Energy Center Recommendations

## 1.2.1 Recommendations Regarding the Supporting Technical Documentation

**EPA Comment:** Maintain current documentation of all relevant appropriate stability analyses and hydrologic analyses in MidAmerican files, including copies of the current stability analyses conducted by HWS. Perform hydrologic calculations to provide formal documentation of internal hydrologic safety of the ash, taking into consideration changes in internal drainage patterns and reduction in available surcharge storage for storm water as the basins fill with ash (see Subsection 1.1.3 of the final report).

**MEC Response:** All documents with any relevance to the stability analyses and hydrologic analyses will be maintained in the plant files for a minimum of five years. Additional analyses will currently be of limited value as the hydrologic safety and internal drainage patterns remain relatively consistent throughout the ash impoundment system. The reason the hydrologic safety and internal drainage patterns remain relatively consistent is due to continuous dredging and removal of ash from the impoundments to the lined ash monofill on site. The contract with the current vendor (contract runs through 2021) states that the vendor is responsible to remove any ash produced by the facility. However, if internal drainage patterns change, and/or the available storage for storm water is reduced, the facility will conduct the requisite hydrologic calculations as necessary.

## 1.2.2 Recommendations Regarding the Field Observations

**EPA Comment:** Two field observations relate to repair issues that MidAmerican already has plans to address. One concerns reconstruction of the embankment where apparent seepage erosion has occurred in the outside face of the perimeter dike on the northeast side near east corner of Pond 3B North. It is recommended that Pond 3B North not be filled with water or contain water to an elevation that exceeds about elevation 1076 feet until the embankment is reconstructed to replace erodible soils in that section of the dike (see Subsection 1.1.5 of the final report).

**MEC Response:** HGM Associates has been engaged to provide an engineering study for reconstruction of the outer face of Pond 3B North. MidAmerican is meeting with the engineering firm on August 23, 2011, to discuss the scope of the work. An engineering study will be completed by December 31, 2011. The study will include site reconstruction specifications. By December 31, 2012, the outer face of Pond 3B north will be reconstructed as per engineering specifications if determined feasible. A reconstruction of the slope will allow the water level to be maintained up to an elevation of 1082 feet based upon the hydrologic study completed by HWS. Until that project is completed, water will not be placed into this area.

**EPA Comment:** The other repair issue concerns raising the low dike section around much of Pond 3B South. It is recommended that the need for raising the low dike be reconsidered with HWS' assistance, to review and evaluate: the cause of the dike being low in this section, whether settlement or subsidence is currently taking place, whether adding fill to the embankment section will rejuvenate or initiate additional settlement or subsidence, whether the outlet pipe would be impacted by additional settlement or subsidence in the deeper part of the embankment section, and whether the additional freeboard gained by raising the low dike is actually needed for hydrologic safety (see Subsection 1.1.5 of the final report).

**MEC Response:** HGM Associates has been engaged to provide an engineering study to reconstruct the low dike area around the south berm of Pond 3B South. The engineering study will be completed by December 31, 2011. The study will include site reconstruction specifications. There are two potential options identified to address the issue.

- Option 1: The study completed by HWS (provided in Exhibit A) recommended the water level for Pond 3B South be maintained at an elevation of 1079.5 feet. MEC may opt to continue operating the ash pond below this recommended level without pursuing raising the elevation of the berm.
- Option 2: Complete the raising the elevation of the berm according to specifications in the engineering study completed in 2011. Construction of the berm would be completed by December 31, 2012. If this option is pursued, the water level for Pond 3B South will be maintained at an elevation of 1082 feet or below.

**EPA Comment:** One field observation relates to a maintenance issue. Recommendations regarding maintenance issues are included in the following Subsection 1.2.3.

**MEC Response:** Please refer to MidAmerican's response provided in Subsection 1.2.3.

### 1.2.3 Recommendations Regarding the Maintenance and Methods of Operation

**EPA Comment:** No recommendations appear to be warranted at this time with respect to methods of operation, other than to work within the ash pond operating conditions (constraints) recommended by HWS for maximum operating pool elevations and minimum pond floor elevations (see Table 7.5 of the final report).

One maintenance recommendation is as follows:

- Establish a grass cover or other erosion protection on the bare outside slope of the perimeter dike at the offset near the south corner of Pond 3A (see Subsection 1.1.6 of the final report).

**MEC Response:** HGM Associates will provide specifications on methods to mitigate the erosion along the slope of Pond 3A. Specifications will be completed by December 31, 2011. Contractor will complete the work by September 30, 2012.

### 1.2.4 Recommendations Regarding the Surveillance and Monitoring Program

**EPA Comment:** With regard to record keeping in the recently developed inspection program, it is recommended that the retention time for inspection records, etc. be 5 years (rather than 3), or as needed to be available for review during the 5-year engineering inspections.

**MEC Response:** All inspections records will be maintained on site for a minimum of five years.

**EPA Comment:** No recommendations for permanent performance monitoring instruments appear to be warranted at this time. However, after raising the low dike section at Pond 3B South, install at least two temporary elevation monuments, one on the crest and one at the outside toe of the section where the lowest crest elevation occurred (near outlet structure), and take elevations on the monuments monthly for 6 months after the initial elevation measurements; the monument at the toe will serve to check for heave in the unlikely event of rotational shear failure. After 6 months, review and evaluate the monitoring data to determine if monitoring should continue for further evaluation or be terminated.

**MEC Response:** MEC will install temporary monument markers on the low dike section of Pond 3B south once the decision is made to either maintain the existing berm elevation, or after berm modifications have been completed. Elevation readings will be taken monthly for 6 months and the data maintained in the plant files. After 6 months, the data will be reviewed to determine if monitoring should continue for further evaluation or be terminated.

# GEOTECHNICAL ENGINEERING REPORT

## Fly Ash Disposal Pond Containment Assessment

MidAmerican Energy - Port Neal North

West of Salix, Iowa

PREPARED FOR

## MidAmerican Energy Company

Neal Energy Center

401 Douglas, P.O. Box 778

Sioux City, Iowa 51102

June 15, 2009

PREPARED BY

HWS

Solutions Through Service

HWS
Solutions Through Service

HWS Consulting Group
825 J Street, Box 80358
Lincoln, NE 68501-0358
402.479.2200 • Fax: 402.479.2276
www.hws.com

June 15, 2009

Mr. DeWayne L. Keegel-Supervising Engineer
MidAmerican Energy Company
Neal Energy Center
401 Douglas, P.O. Box 778
Sioux City, IA 51102

REFERENCE: Geotechnical Investigation and Analysis
Fly Ash Disposal Pond Containment Assessment
MidAmerican Energy-Port Neal North
West of Salix, Iowa

Dear Mr. Keegel:

HWS Consulting Group Inc. (HWS) is pleased to submit the enclosed report that summarizes the findings of a soil and geotechnical engineering investigation, analysis, and assessment. It also provides recommendations related to the geotechnical assessment for the fly ash disposal containment ponds at the referenced location.

If any questions arise concerning this report or if additional information is needed, please contact HWS for assistance.

Sincerely,

HWS CONSULTING GROUP INC.

Prepared By:

LICENSED PROFESSIONAL ENGINEER
BRANDON L. DESH
19195
6-15-09
IOWA

Brandon L. Desh, P.E.

Reviewed By:

Gary E. Proskovec, P.E.

BLD/bld
Enclosures
52-89-3756 (52-69-5092)
H:\Geodata\Projects\52-69-5092..\Mid American Energy Port Neal Fly Ash Pond Containment Report.doc
Orig. & 2 cc: MidAmerican Energy Company; Attn. Mr. DeWayne L. Keegel, Supervising Eng
1 cc.: MidAmerican Energy Company; Attn. Mr. Shad Sweeney, Engineer II
1 cc.: HWS Consulting Group; Attn. Mr. Frank Doland

# GEOTECHNICAL ENGINEERING REPORT

## Fly Ash Disposal Pond Containment Assessment
**MidAmerican Energy - Port Neal North**
**West of Salix, Iowa**

**Prepared**
**for**

## MidAmerican Energy Company
**North Neal Center**
**401 Douglas, P.O. Box 778**
**Sioux City, IA 51102**

**June 15, 2009**

**Prepared**
**by**


## HWS CONSULTING GROUP INC.
**825 "J" Street**
**Lincoln, Nebraska 68508**

## CONTENTS

## I. INTRODUCTION

MidAmerican Energy currently operates three fly ash disposal ponds (Units I, II, IIIa and IIIb) to the south of their Port Neal North Power Plant just off the Missouri River west of Salix, Iowa. The intent of this project is to assess the stability of the existing perimeter dikes (berms) located around the three fly ash disposal ponds. It is not the intent of this assessment to address containment or seepage losses from the fly ash disposal ponds. The geotechnical field exploration, laboratory soils testing, analysis, and assessment included: (1) a review of original design plans and project specifications that were developed between 1960 and 1975 and made available to HWS, (2) performing field survey to establish the current configuration of dikes at potential assessment locations, (3) geotechnical exploration and laboratory soils testing, (4) presenting slope stability, seepage failure, and liquefaction analyses findings, (5) consultation with MidAmerican Energy engineering personnel to assess the operating conditions such as maximum pool elevations and fly ash containment heights for all three units (6) discussion on the condition of the existing dikes with recommended berm remedial measures, and (7) recommendations for satisfactory future operation of the dike system.

Field and laboratory work consisted of: (a) making auger borings and Dutch friction-cone soundings to determine the depth, thickness, and composition of each soil formation encountered to the depths of the borings, (b) performing field tests to determine the approximate strength of the foundation and dike soils, (c) performing a geologic study to determine the origin of the deposits underlying the site, and (d) performing standard tests to determine the engineering properties of both the soil strata and fly-ash that would affect the stability of the dikes.

## II. SUBSURFACE EXPLORATION

A program of Dutch friction-cone soundings, test borings, and soil sampling was performed at the project site from July 24 through 27, 2006. Seven (7) Dutch friction-cone soundings were made at the site. The results of the soundings were used to determine the depths for obtaining undisturbed soil samples from an exploratory boring made immediately adjacent to each sounding. Twenty-five (25) exploratory borings were taken to depths of 4.8 to 35 feet below the existing grade to establish the general subsurface conditions of the area under consideration. Originally twelve locations were proposed for exploration to determine the general subsurface, soil dike, fly-ash dike and dike material conditions. Seven (7) exploratory locations needed to be added to the field exploration program due to dikes not being located at the anticipated locations, and due to seepage noted (at the time subsurface exploration operations were being performed) through a dike near the pump house on the south side of ash disposal unit (pond) #3B.

The Dutch friction-cone soundings were performed with a mechanical penetrometer in accordance with ASTM D 3441-98, Standard Method for Deep, Quasi-Static, Cone, and Friction Cone Penetration Tests of Soil. The mechanical penetrometer operates incrementally, using a set of inner rods to operate a telescoping penetrometer tip and to transmit the components of penetration resistance (cone bearing and friction sleeve resistance) to the surface for measurement. The plot of the test data identifies the relative positions and thicknesses of hard and soft layers. The borings were made in accordance with ASTM D 1452, Standard Practice for Soil Investigation and Sampling by Auger Borings. A machine-driven, hollow-stem, continuous-flight auger having an outside diameter of 6 inches was used to advance the holes for split-barrel and thin-walled tube sampling. The bore holes were stable and casing was not required. Locations that were not accessible with the truck mounted drill rig due to terrain or existent overhead power lines required the use of manually operated field exploration equipment to log and sample subsurface soils.

Penetration tests were performed with a CME Automatic Free-Fall SPT Hammer in accordance with ASTM D 1586, Standard Method for Penetration Test and Split-Barrel Sampling of Soils. Representative samples of soil were obtained for identification purposes. The resistance of the soil to penetration of the sampler, measured in blows per foot (N), is an indication of the relative density of cohesionless soil and of the consistency of cohesive soil.

Twenty-six (26) relatively undisturbed soil samples were recovered for visual observation and laboratory testing. This sampling was performed in accordance with ASTM D 1587, Standard Method for Thin-Walled Tube Sampling of Soil, utilizing an open-tube sampler having an outside diameter of 3.0 inches.

Rock core drilling was performed at boring C-4 (section B-B located on the north side of ash pond #3A) to a depth to a depth of 17.3 feet to try and sample the solidified fly ash material at the boring location. This drilling and sampling was performed in accordance with ASTM D 2113, Standard Practice for Rock Core Drilling and Sampling.

The vicinity map and the boring location plan are presented in Appendix A. The penetration diagrams (see Appendix C) present the results of the Dutch friction-cone soundings. The boring logs (refer to Appendix C) present the data obtained in the subsurface exploration. The logs include the surface elevations, the approximate depths and elevations of major changes in the character of the subsurface materials, visual descriptions of the materials in accordance with the criteria presented in Appendix D, groundwater data, the penetration resistance recorded in blows per 0.5-ft increments of depth, and the locations of undisturbed samples of soil. The locations and elevations (NAVD88) of the soundings and borings were determined by an HWS survey crew. Water level readings were made in the auger borings at times and under conditions stated on the boring logs.

## III. LABORATORY ANALYSES

The split-barrel, undisturbed soil samples, and fly ash core samples obtained during the subsurface exploration were examined in the laboratory by a member of HWS' professional engineering staff to supplement the field identification. Standard tests were performed on selected samples to determine the engineering properties of the foundation, dike, natural seepage blanket, and fly-ash materials.

The moisture contents and dry unit weights of selected undisturbed soil samples were determined in the laboratory. These test results are presented in the boring logs opposite the respective sample locations. The moisture contents were determined in accordance with either ASTM D 4643, Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method, or ASTM D 2216, Standard Test Method for Determination of Water (Moisture) Content of Soil and Rock by Mass. The dry unit weights were determined in accordance with the Displacement Method of the Corps of Engineers, EM1110-2-1906, Appendix II, Unit Weights, Void Ratio, Porosity, and Degree of Saturation. These data correlate with the strength and compressibility of the soil. High moisture content and low density usually indicate low strength and high compressibility.

The unconfined compressive strengths of several undisturbed samples were estimated in the laboratory with a calibrated hand penetrometer. These strengths are presented on the boring logs and are estimates only. Actual values are generally lower than the estimated values indicated on the boring logs.

Washed sieve analyses were performed on four (4) samples of the subsurface materials. The results of these tests, performed in accordance with ASTM C 136, Standard Methods for Sieve Analysis of Fine and Coarse Aggregates, are presented in Table 1.

**TABLE 1**
**Particle Size Distribution of Mineral Aggregates**

| Boring No. | Depth ft. | Total Percentage Finer by Weight | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1" | 3/4" | ½" | 3/8" | #4 | #10 | #20 | #40 | #50 | #100 | #200 |
| B-9a | 20.0-23.5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 99.9 | 95.8 | 11.0 | 2.8 |
| B-14 | 6.0-8.05 | 100 | 100 | 100 | 100 | 100 | 100 | 99.5 | 95.7 | 75.9 | 32.5 | 25.7 |
| B-15 | 20.0-23.5 | 100 | 100 | 100 | 100 | 100 | 100 | 99.8 | 94.3 | 65.1 | 11.4 | 5.2 |
| B-15x | 9.5-10.5 | 100 | 100 | 100 | 100 | 99.7 | 99.6 | 98.5 | 93.5 | 69.6 | 31.9 | 26.3 |

The unconfined compressive strengths of four (4) undisturbed samples were determined in accordance with ASTM D 2166, Standard Test Method for Unconfined Compressive Strength of Cohesive Soil. These data are summarized in Table 2, and the complete test reports are presented in Appendix E.

**TABLE 2**
**Unconfined Compression Test Data**

| Boring No. | Depth, ft | Moisture, % | Dry Density, lbf/ft³ | Unconfined Compressive Strength, tons/ft² |
|---|---|---|---|---|
| B-1 | 4.7-5.3 | 18.1 | 98.1 | 0.5 |
| B-9a | 3.0-3.5 | 19.5 | 101.8 | 1.0 |
| B-12 | 6.1-6.7 | 31.8 | 82.9 | 0.7 |
| B-12 | 12.2-12.9 | 31.1 | 85.6 | 0.8 |

Unconsolidated, undrained triaxial compression tests were performed on three (3) samples of the subsurface materials to provide data on the shearing strength of these materials. The triaxial compression tests were performed in accordance with ASTM D 2850, Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils. Specimens were backpressure saturated prior to shearing. A summary of the test data is shown in Table 3, and the complete test reports are presented in Appendix F.

**TABLE 3**
**Triaxial Compression Test Data**

| Boring No. | Depth ft. | Cohesion (c) lbf/ft$^2$ |
|---|---|---|
| B-9a | 17.2-17.8 | 588 |
| B-14c | 0.9-1.7 | 1872 |
| B-15 | 5.5-6.1 | 1728 |

Five (5) crumb tests were performed on the subsurface materials. The crumb test is an indicator test used in the identification of dispersive soils. A summary of the test results is presented in Table 4.

**TABLE 4**
**Dispersion Test Data**

| Boring No. | Depth ft | Moisture Content | Crumb-Test Grade[a] | | | |
|---|---|---|---|---|---|---|
| | | | 2 min. | 10 min | 1 hr. | 6 hrs. |
| B-9 | 0.8-1.9 | Wet | 1 | 1 | 1 | 1 |
| B-9 | 2.5-3.5 | Wet | 1 | 1 | 1 | 1 |
| B-9b | 2.0-3.5 | Saturated | 1 | 1 | 1 | 1 |
| B-12b | 2.5-3.5 | Wet | 1 | 1 | 1 | 1 |
| B-14 | 2.5-3.5 | Wet | 1 | 1 | 1 | 1 |

[a]Crumb-Test Grades:
1 - Nondispersive; 2 - Intermediate; 3 - Dispersive; 4 – Highly Dispersive

A constant-head permeability test was performed on one (1) remolded specimen of cohesionless soils. The test result is shown in Table 5.

**TABLE 5**
**Permeability Test Data**

| Boring No. | Material Type | Depth ft | Coefficient of Permeability cm/sec |
|---|---|---|---|
| B-1 | SM | 3.5-5.0 | 2.0E-03 |

Seven (7) falling head permeability tests were performed on relatively undisturbed specimens of alluvial clay and silt and fly ash in accordance with Corp of Engineers, EM1110-2-1906, Appendix VII, Permeability Test Procedures. The test results are shown in Table 6.

**TABLE 6**
**Falling Head Permeability Test Data**

| Boring No. | Depth ft | Material Type | Dry Density lbf/ft³ | Moisture Content, % | Coefficient of Permeability cm/sec |
|---|---|---|---|---|---|
| B-1 | 4.1-4.7 | ML | 98.3 | 19.0 | 8.0E-6 |
| B-2 | 7.0-7.7 | ML | 95.1 | 24.0 | 1.6E-5 |
| B-5b | 1.4-1.9 | ML | 89.7 | 21.7 | 1.7E-4 |
| B-9a | 16.6-17.2 | CH | 75.3 | 43.7 | 1.1E-7 |
| B-12b | 1.4-1.8 | CL | 89.2 | 31.0 | 2.2E-7 |
| B-14c | 4.2-4.5 | CH | 94.0 | 27.1 | 3.5E-8 |
| B-15 | 5.0-5.5 | Fly Ash | 81.2 | 54.9 | 1.2E-5 |

## IV. GEOLOGY AND SITE CONDITIONS

The project site lies in the Dissected Till Plains section of Iowa, a part of the Central Lowland province of the Interior Plains physiographic division[1]. The project site is located on alluvial bottomlands adjacent to the Missouri River. It is HWS' understanding that a subsurface exploration was completed in 1960 for the site. Plan sheets from 1960 and 1961 indicate a general layout of the property but do not detail the ash disposal pond system. The materials encountered during this original investigation generally consisted of an upper cohesive layer of soil that ranged from approximately 2 to 8 feet in thickness/depth that is underlain with sandy materials to significant depth. The upper cohesive layer was comprised of relatively thin seams and beds of clays, lean clays, silty clays, and clayey silts materials. A 1961 plan sheet indicates a 100 year flood level of 1076.0 feet for the Missouri river adjacent the site.

A 1970 plan sheet provided HWS by Mid-American Energy (MAE) shows the approximate current configuration of Ash Disposal Units (Ponds) #1 and #2. The plan sheet indicates that Units #1 was to be excavated down to an elevation of 1074.0 feet. Unit #2 was to be excavated down to an elevation of 1069.0 feet or to the elevation required to obtain sufficient fill materials for the construction of access roads, railroad subgrades, and the Unit #2 ash disposal dikes. The plans do not indicate which soils may or may not be utilized for the construction of the dikes. A 1975 plan shows the approximate current configuration of Units #3A and #3B and indicates the unit bottoms were to be excavated to an elevation of 1072.5 feet or to such a lower elevation as may be necessary to obtain sufficient fill material for construction of access roads and ash dikes. The 1970 and 1975 plans show a dike cross section with a 10-foot-wide top of berm width having a finished surface elevation of 1085.0. The dikes were to be constructed having a 2[H]:1[V] slope on the inside of the dike and a 3[H]:1[V] slope on the outside of the dike. The plans also stated that the topsoil onsite was to be stripped

[1] Physiographic Provinces of North America, Map by A. K. Lobeck, 1948; The Geographical Press; Columbia University, New York

(approximately 6-inches), the elevation on the outside toe of the dikes was to be assumed at a natural grade of 1075.0 feet, and excavation and placing of compacted fill for the dikes was to be completed in accordance with Ebasco Specification IOWA N2-CH-1. MAE was not able to find Specifications for the construction of Ash Disposal Units #1, #2 or #3. Additional information provided on the Ash Pond Unit plan sheets indicate that the maximum water level within the ponds is to equal 1078.5 feet for all four units. Additional discussion regarding operating maximum pool elevation is presented in the "General Discussions" section of the Discussion and Recommendations section below.

HWS made a field reconnaissance to select exploratory locations. The field reconnaissance indicated that the dikes and fly-ash surfaces within the units was drastically different from those shown on the design plans. Field survey information obtained at fifteen (15) potential exploratory assessment locations provided information concerning the current configuration of the dikes and confirmed differences existent between the construction plans and existing conditions. The cross sections provided in Appendix B present the original dike cross section as described in the 1970 and 1975 plans in red. The actual existent ground surface at each cross-section is presented in green. As indicated in the cross sections, some locations (such as at cross-section locations H2-H2, K-K, and K2-K2) have cross sections similar to the original proposed construction plans. At a number of locations the existing cross-sections are significantly different from the original proposed cross-sections. Generally, additional fly ash has been constructed above and, in some cases, on both side of the original dike section at those locations where the current cross-section deviates significantly from the proposed construction plans. It should be noted, that subsurface exploratory borings performed at section G-G (located within the south berm of Ash Disposal Unit #2) indicate that only a portion of the original dike is existent. The upper portion of the dike at this exploratory location appears to have been removed, possibly by previous ash pond cleanout operations. In addition, for the depth that dike materials were encountered if would indicate that the original dike is not located within or below the current approximately 45-foot-wide drive perceived to be the berm location but in fact is located within what surficially appears to be the sound end of the actual pond. Boring performed the day this report was being authored confirms the assumptions discussed immediately above.

The subsurface materials encountered to the depths investigated generally consisted of various thicknesses of fly ash (solidified and unsolidified), cohesive and granular fill overlying alluvium (lean and fat clays with varying sand contents; poorly graded, clayey, and silty sands; and silts)—in descending order of occurrence. Detailed descriptions are provided in the boring logs, which are presented in Appendix B.

Groundwater was encountered at borings 3, 9a, 9b, 12, and 12b at depths of 15.8, 20.7, 1.5, 6.0, and 1.0 feet below existing grade, respectively. Groundwater was not encountered to the depths of exploration at the other boring locations.

# V. DISCUSSION AND RECOMMENDATIONS

## General Discussion

### A. Field Exploration:

HWS completed seven (7) soundings and eighteen (18) borings at six of the cross sections that HWS surveyed, (i.e., @ cross-section locations A-A, B-B, E-E, G-G, H2-H2, and K2-K2). The locations were selected to represent what visually appeared to be the most critical sections for each of the four units (#1, #2, #3A, and #3B) as well as to provide representative samples for lab testing and in situ testing information for the dike slope stability, underseepage, and liquefaction analyses completed for each of the units. Generally, at each of the locations selected for exploration, one or more borings were completed on top of the existing dike to confirm the presence, location, and physical soil characteristics of the original dike. In addition, the boring exploration, field testing and soil sampling were performed to delineate the extent that additional fly ash material had been used to construct existing grades above and around the original dike structure at each location. One or more borings were also performed at each of the selected exploratory locations to define the characteristics of the blanket materials located beyond the outside toe of dike --- outside of the Ash Disposal Unit. A boring (B-9) was performed approximately in the middle of the east dike of Unit #3B to establish whether dispersive soils were contributing to dike slope deterioration on the outside slope of the dike at this location (i.e., at approximately section L-L). A boring (B-5b) was completed adjacent the outside toe of dike at section M-M to represent the existing natural conditions onsite along the east and north sides of Unit 3B. Lastly the fly-ash within the north end of Unit #3A was cored (@ location C-4) to sample the solidified fly ash.

From the in situ testing completed in the field and laboratory testing described above, soil properties for the fly ash materials, dike fill materials, and the natural alluvium materials encountered onsite were determined and used to prepare models for slope stability, underseepage, and liquefaction analyses performed at the locations selected for assessment as discussed immediately above. The following paragraphs provide discussion concerning the procedures used for each of the analyses performed and the findings of these analyses at each location assessed. In addition, recommendations are provided concerning operation requirements for satisfactory dike performance in the future, and dike rehabilitation.

## B. <u>Engineering Analyses Performed</u>:

**1. <u>Embankment and Foundation Stability.</u>** The satisfactory performance of the dikes embankments and underlying foundation materials and their ability to avoid slope stability, underseepage, and/or liquefaction failure depend on 1) the strength of subsurface soils under maximum operating pool elevation within each unit, 2) the slopes of the original dikes constructed as well as those as they presently existing now and after the performance of clean-out operations within each of the units, 3) the permeability or transmissivity of water through the soils located under the dike at maximum operating pool elevations, and 4) the foundation soils ability to resist earthquake induced forces. The 100-year flood elevation of 1076.0 feet was also a consideration when performing the analyses performed at those locations adjacent to the river, drainage ditch, or adjacent fresh water ponds.

Specific discussion concerning each of the stability analyses that were performed (and discussed immediately above are as follows:

### a. <u>Embankment Slope Stability Analysis:</u>

To establish the stability of both existing and proposed dike embankments, a computer-assisted slope stability analysis was performed at the six critical sections using the simplified Bishop method of slices with effective and total stress soil parameters. The U.S. Army Corps of Engineers recommends that the minimum factor of safety for dikes under long-term (drained) conditions be 1.4 and under short-term (undrained) conditions be 1.3.

A safety factor of 1.0 indicates that the driving forces are equal to the resisting forces and that failure is imminent. The slope stability analyses results for each unit are discussed below and reference should be made to the enclosed figures in Appendix G, which present the failure arcs having the lowest safety factors associated with the stability analyses performed at each critical section.

### b. Seepage (Uplift) Stability Analysis:

The most common cause of dike failure, other than overtopping, is uplift at the land-side toe resulting from a high exit gradient in the water seeping under the dike. The occurrence of this form of dike failure is being assessed by the performance of a seepage analysis. Failure is defined as occurring when the pressure in the water at any point below the dike toe equals the buoyant weight of the soil above that point. This ratio of pressure to buoyant weight is called the critical exit gradient. During failure, the water lifts the soil and moves it out of the way. This shortens the distance the water must travel under the dike and causes more soil to be removed/eroded in the same manner. The Gradient Safety Factor is computed to define the potential for a seepage failure.

The Gradient Safety Factor (GSF) is calculated at the base of the natural --- most impervious --- soil blanket (if it exists) at the land-side toe of dike, where

$$GSF = \frac{\text{actual exit gradient}}{\text{critical exit gradient}}$$

The U.S. Army Corps of Engineers recommends that the minimum GSF at the land-side toe of the dike must be at 1.5 or greater.

For this dike, the GSF was calculated at the six critical sections, using the methodology of Turnbull and Mansur (1961), for the dike sections as they exist and for the proposed sections following "cleanout" operations with the units. The under seepage analysis for each unit is discussed below and the calculations are summarized for the existing and anticipated sections in Appendix G.

### c. Liquefaction Potential Analysis:

Dikes need to be evaluated for the potential of liquefaction during earthquake events. Liquefaction occurs when rapid vibrations in saturated sands cause a cyclical increase in pore water pressure at a point in the sand until the pore water pressure equals the total weight of the soil and water above that point. At that time, the sand and water at the point in question become a dense liquid, offering little resistance to flow resulting in an inability to support loads on the surface. This results in sand boils - where sand flows out of the ground, which on this project would result in spreading failures under and beyond the dikes.

The state-of-the-practice for evaluating liquefaction is consolidated in a paper called "Liquefaction Resistance of Soils: Summary Report from 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils" chaired by T.L. Youd, that presents a consensus among many prominent experts in the field. In simple terms, the current methodology for predicting liquefaction potential is as follows:

1. Determine the largest probable earthquake for the site, with respect to intensity, magnitude, and maximum horizontal acceleration at the ground surface.
2. Calculate the liquefaction resistance of the layer in terms of the Cyclic Resistance Ratio (CRR) for the magnitude of the design earthquake.
3. Calculate the seismic demand on a soil layer, expressed in terms of the Cyclic Stress Ratio (CSR).
4. Determine the factor of safety as CRR/CSR, with corrections for sloping ground and for overburden pressure. A minimum safety factor of 1.5 was selected for the Recent deposits found onsite.

The United States Geologic Survey (USGS) Probable Seismic Hazard Deaggregation was used for the determination of the design earthquake intensity for the site. The USGS provided a mean return time of 4975 years, the mean magnitude was 5.87 with a peak horizontal ground acceleration of 0.069 times gravity, or 69 cm/sec/sec.

### CRR Considerations

The above referenced paper suggests that the prediction of liquefaction from standard penetration test (SPT) results is more accurate than predictions based on the results of the cone penetration test (CPT). For this reason and because SPT data for the site were much more plentiful, the SPT data were used exclusively. For use in the predictions, the SPT blow counts, N, had to be converted to $(N_1)_{60}$. $(N_1)_{60}$ are the SPT blow count normalized to an overburden of one atmosphere and a hammer energy efficiency of 60 percent. CRR is first calculated for clean sand and an earthquake magnitude of 7.5. Adjustments are then made for fines content and for the design magnitude.

### CSR Considerations

The CSR is based on the maximum horizontal acceleration, the ratio of total vertical stress to effective vertical stress at the point of each SPT and a coefficient to account for the flexibility of the soil profile.

Factor of safety calculations for each SPT in sand are included in Appendix H

## Specific Discussion and Recommendations

As stated in the Geology and Site Conditions section above, the current operating maximum pool elevation for all four units is 1078.5 feet. MidAmerican has requested that HWS provide recommendations for consideration of a maximum operating pool elevation of greater than the 1078.5 feet elevation. The analyses findings discussed below were performed assuming a maximum operating pool elevation of 1082 feet, which allows for 3 feet of freeboard from the original design top of dike elevation of 1085 feet. In addition HWS analyzed the original minimum unit floor elevations and provided recommendations for any changes to these elevations for satisfactory ash disposal unit dike performance. The slope stability, seepage, and liquefaction analysis results and operating requirements for each unit are discussed below.

## I. Ash Disposal Unit #1 Stability Analysis Findings and Operating Recommendations.

Unit #1 currently has a top of dike elevation on the north, south, and west sides ranging from approximately 1085 feet to 1089 feet and a unit floor elevation ranging from approximately 1066.5 feet to 1084 feet based on HWS survey data. At the time of our survey of the sections performed across the dikes in Unit #1 there was no measurable water within the unit at the four cross section locations. The Missouri River Water Surface elevation was 1055.7 feet.

Section E-E, located through/across the west dike of Unit #1 was the location selected for the performance of the slope stability, under seepage, and liquefaction analyses. Ash removal operations performed within Unit #1 have removed materials located within the Unit to a level upto 8 feet or lower than the original unit floor elevation.

A computer-assisted slope stability analysis was performed though the Unit #1 dike at this location assuming the base of the unit is excavated to this level (depth) and assuming a maximum operating pool elevation of 1082 feet. The calculated safety factor for drained (i.e., representing long term design conditions) and undrained (i.e., representing short term conditions) soil conditions was 1.8 and 2.2, respectively. These safety factors are both greater than the U.S. Army Corps of Engineers recommended minimum factor of safety for dikes under long-term (drained) conditions being 1.4 and under short-term (undrained) conditions being 1.3.

The minimum calculated gradient safety factor (GSF) computed as part of the seepage analysis was 0.6, which is significantly less than the U.S. Army Corps of Engineers recommendation that the minimum GSF at the land-side toe of the dike must be at 1.5 or greater. Mid-American Energy has informed HWS that water will never be allowed to fill Unit

#1 in the future. Given this condition seepage stability will not be an issue. However, if the decision is made to store waters in Unit #1 in the future it would be necessary to reconstruct the floor within this unit to its original plan elevation of 1074.0 feet, ideally using cohesive fill materials. In addition, it is recommended that the maximum water surface elevation within the cell be 1078.5 feet --- all to provide a GSF value of 1.5 or greater.

The "Liquefaction Resistance of Soils: Summary Report from 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils" discussed above would recommend that the minimum safety factor required to avoid liquefaction is 1.5. The computed factor of safety for liquefaction was 2.9 which is greater than this Summary Report's recommended 1.5 value.

## II. Ash Disposal Unit #2 Stability Analysis Findings and Operating Recommendations.

Unit #2 is currently nearly full of fly ash and scheduled for cleanout and landfilling this summer of 2009. HWS survey data indicates that the current top of dike elevation is approximately equal to 1088 feet. and top of fly ash elevation is approximately 1084.5 feet along the south side of the Unit #2.

Section G-G, located through/across the south dike of Unit #2 was the location selected for the performance of the slope stability, under seepage, and liquefaction analyses for this unit. At the time of our survey at the location of section G-G there was no measurable water in Unit #2 and the elevation of the outlet channel water surface, to the south of Unit #2, was 1069.9 feet. The survey data indicates that the unit is currently "filled" to within approximately 0.5 feet of the top of dike elevation (1085.0 feet). Fly ash has been placed atop and to the south of the south dike. The surface elevation of the fly ash is 3 or more feet above the original proposed top of dike elevation of 1085.0 feet.

A computer-assisted slope stability analysis was performed though the Unit #2 dike at this Section G-G location. As previously stated, the fly ash in Unit #2 is scheduled for removal and landfilling during the Summer of 2009. HWS recommends that the fly ash removal operations be limited to removing those fly ash materials located above an elevation of 1072.5 feet to avoid creating under seepage stability issues. Assuming that the excavation operations are limited to those fly ash materials located above an elevation of 1072.5 and a maximum water surface elevation within Unit #2 of 1082 feet, the calculated safety factor for drained (i.e., representing long term design conditions) and undrained (i.e., representing short term conditions) soil conditions was 1.5 and 2.7, respectively. These safety factors are both greater than the U.S. Army Corps of Engineers recommended minimum factor of safety for dikes under long-term (drained) conditions being 1.4 and under short-term (undrained) conditions being 1.3.

Assuming that the fly ash excavation operations do not extend below an elevation of 1072.5 feet and that the maximum pool level in Unit #2 is 1082.0 feet the minimum calculated gradient safety factor (GSF) computed as part of the seepage analysis was 1.9 which is greater than the U.S. Army Corps of Engineers recommendation that the minimum GSF at the land-side toe of the dike must be at 1.5 or greater.

The "Liquefaction Resistance of Soils: Summary Report from 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils" discussed above would recommend that the minimum safety factor required to avoid liquefaction is 1.5. The computed factor of safety for liquefaction was 4.1 which is greater than the Summary Report's recommended 1.5 value.

## III. Ash Disposal Unit #3A Stability Analysis Findings and Operating Recommendations.

The north dike of Ash Disposal Unit #3A was selected for the performance of the slope stability, under seepage, and liquefaction analyses for this unit. The cross-section is representative of dike conditions at this location are shown as Section B-B. The original dike constructed at this location has top of dike elevation of approximately 1087.0 feet. A second dike constructed of fly ash materials was constructed immediately adjacent to the original dike. The elevation of the top of the fly ash dike is approximately 1097.5 feet as shown on Section B-B.

A computer-assisted slope stability analysis was performed though the Unit #3A dike at this Section B-B location. For the sake of performing the stability analyses it was assumed that the two tiered dike system discussed above would remain. In addition it was assumed that fly ash removal operations within this unit would be limited to those materials located "above" an elevation of 1072.5 feet and the maximum water level in Unit #3A would be 1082.0 feet. Given these excavation and maximum water level elevations, the calculated safety factor for drained (i.e., representing long term design conditions) and undrained (i.e., representing short term conditions) soil conditions was 1.8 and 4.5, respectively. These safety factors are both greater than the U.S. Army Corps of Engineers recommended minimum factor of safety for dikes under long-term (drained) conditions being 1.4 and under short-term (undrained) conditions being 1.3.

Assuming that the fly ash excavation operations do not extend below an elevation of 1072.5 feet and that the maximum pool level in Unit #2 is 1082.0 feet the minimum calculated gradient safety factor (GSF) computed as part of the seepage analysis was 9.2 which is greater than the U.S. Army Corps of Engineers recommendation that the minimum GSF at the land-side toe of the dike must be at 1.5 or greater.

The "Liquefaction Resistance of Soils: Summary Report from 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils" discussed above would recommend that the minimum safety factor required to avoid liquefaction is 1.5. The computed factor of safety for liquefaction was 4.1 which is greater than the Summary Report's recommended 1.5 value.

## IV. Ash Disposal Unit #3B-North Stability Analysis Findings and Operating Recommendations.

The north dike of Ash Disposal Unit #3B was selected as one of the locations for the performance of the slope stability, under seepage, and liquefaction analyses for this unit. The cross-section is representative of dike conditions at this location are shown as Section A-A. The original dike constructed at this location has top of dike elevation of approximately 1086 feet. A second dike constructed of fly ash materials was constructed immediately adjacent to the original dike. The elevation of the top of the fly ash dike is approximately 1091.5 feet as shown on Section A-A. Top of fly ash surface to the south of the fly ash dike is located at an elevation of approximately 1086.3 feet. No water was encountered in the unit to the limits of the cross-section performed at Section A-A.

A computer-assisted slope stability analysis was performed though the Unit #3B-North dike at the Section A-A location. For the sake of performing the stability analyses it was assumed that the two tiered dike system discussed above would remain. In addition it was assumed that fly ash removal operations within this unit would not limited to those materials located "above" an elevation of 1072.5 feet and the maximum water level in Unit #3A would be 1082.0 feet. Given these excavation and maximum water level elevations, the calculated safety factor for drained (i.e., representing long term design conditions) and undrained (i.e., representing short term conditions) soil conditions was 2.9 and 5.0, respectively. These safety factors are both greater than the U.S. Army Corps of Engineers recommended minimum factor of safety for dikes under long-term (drained) conditions being 1.4 and under short-term (undrained) conditions being 1.3.

Assuming that the fly ash excavation operations do not extend below an elevation of 1072.5 feet and that the maximum pool level in Unit #2 is 1082.0 feet the minimum calculated gradient safety factor (GSF) computed as part of the seepage analysis was 2.9 which is greater than the U.S. Army Corps of Engineers recommendation that the minimum GSF at the land-side toe of the dike must be at 1.5 or greater.

The "Liquefaction Resistance of Soils: Summary Report from 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils" discussed above would recommend that the minimum safety factor required to avoid liquefaction is 1.5. The computed factor of safety for liquefaction was 4.1 which is greater than the Summary Report's recommended 1.5 value.

## V. Ash Disposal Unit #3B-South Stability Analysis Findings and Operating Recommendations.

Portions of the east and south dikes of Ash Disposal Unit #3B-South are similar in that the existing dikes at these location are very near to the design dike cross-section. Fly ash excavation operations adjacent to the inside of the dikes have extended down to elevations varying between approximately 1074 and 1076 feet. Water level within the south portion of Unit #3B was located at approximately 1079 feet. The elevation of the water surface within New Lake located immediately adjacent outside edge of the east and south dikes of Unit #3B-South at these locations was approximately 1070 feet. The top of dike elevation at section K2-K2 is approximately 1085.5 feet which is approximately 0.5 feet above the design top of dike elevation. The top of dike elevation at section H2-H2 is approximately 1083 which is approximately 2 feet "below" the design top of dike elevation. Given the lower top of dike elevation, Section H2-H2 was selected for the performance of the slope stability, under seepage, and liquefaction analyses for Unit #3B-South.

A computer-assisted slope stability analysis was performed though the Unit #3B-South dike at the Section H2-H2 location. It was assumed that fly ash removal operations within this unit would be limited to those materials located "above" an elevation of 1072.5 feet and the maximum water level in Unit #3A would 1082.0 feet. Given these excavation and maximum water level elevations, the calculated safety factor for drained (i.e., representing long term design conditions) and undrained (i.e., representing short term conditions) soil conditions was 2.0 and 4.7, respectively. These safety factors are both greater than the U.S. Army Corps of Engineers recommended minimum factor of safety for dikes under long-term (drained) conditions being 1.4 and under short-term (undrained) conditions being 1.3.

Assuming that the fly ash excavation operations do not extend below an elevation of 1072.5 feet and that the maximum pool level in Unit #2 is 1082.0 feet the minimum calculated gradient safety factor (GSF) computed as part of the seepage analysis was 1.0 which is less than the U.S. Army Corps of Engineers recommendation that the minimum GSF at the land-side toe of the dike must be at 1.5 or greater. In order to increase the gradient factor of safety to a value above 1.5 in Unit #3B-South, HWS recommends that the maximum operating pool elevation should "not" be allowed to rise above an elevation of 1079.0 feet and that fly ash excavation operations performed within 50 feet of the "inside" faces of the Unit #3B-South dikes (i.e., within the inside of the ash disposal unit) "not" extend below an elevation of 1074.0feet.

The "Liquefaction Resistance of Soils: Summary Report from 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils" discussed above would recommend that the minimum safety factor required to avoid liquefaction is 1.5. The computed factor of safety for liquefaction was 1.6 which is greater than the Summary Report's recommended 1.5 value.

**A. <u>Top of Dike Reconstruction Recommendation</u>:** It is recommended that compacted fill be installed to raise the top of dike elevation along all portions of the Unit #3B-

South to 1085.0 feet. These fill materials should consist of cohesive fill soils placed in accordance with the compaction recommendations presented for dike reconstruction below.

**B. Rip-Rap Dike Protection:** The inside faces of the east and south dikes of Unit #3B-South currently have existing slopes steeper than the 2(H):1(V) original design slope. It is anticipated that wave action is causing these inside dike foreslopes to become eroded. The dikes have adequate cross-section at the locations surveyed. However, these inside dike slopes should be monitored for further erosion and loss of dike cross-section. It is recommended that rip-rap facing be installed on the inside face of the east and south dikes to avoid loss of dike cross-section resulting from wave action within Ash Disposal Unit #3B-South.

## VI. Dike Erosion Caused by Potentially Dispersive Soils & Dike Rehabilitative Recommendations:

The results of the laboratory performed crumb testing performed on soil samples collected in the field in the areas where apparent erosion is occurring near section L-L (i.e., along a portion of the east dike of Unit #3B-North) indicate that the soils are not due to dispersive soil conditions. This does not preclude the possibility that dispersive soils might be present in areas not sampled as part of this investigation. Given the results of the soil testing performed on soil samples obtained from this portion of the east dike of Ash Disposal Unit #3B-North it is anticipated that the observed slope instability is the result of having constructed a significant portion of this section of dike using silty and/or sandy materials. These soils would be pervious which would facilitate seepage through the dike that would result in erosion of the soils on the landside of the dike. HWS recommends that the outer slope of the dike at this location be reconstructed to original plan dimension. The Soil Engineer should inspect these rehabilitative grading operations to further assess the nature and types of soils that were utilized to construct this portion of the dike at this location. The Soils Engineer should determine the extent of dike reconstruction required to remove and replace those portions of the dike that are constructed of these highly permeable and erodible silty and/or sandy materials. The Soils Engineer should further inspect the dike rehabilitation operations in this area to further confirm that dispersive soils are not present. Field crumb tests could be performed to quickly determine if soils located outside of those sampled are dispersive in nature. Dispersive soil conditions can be stabilized using the following procedures. In areas were dispersive soils are present, HWS suggests that the outer 2 feet of existing dike soil materials located on the inside face (pond side) of the dike be stabilized by either A) mixing the dispersive soils with 6% fly ash (by dry weight of compacted soil), or B) replacing with non-dispersive *"cohesive"* lean clay soils derived from an off-site borrow location. The outside face of the dike should be reconstructed having the original 3(H):1(V) or flatter slope using cohesive non-dispersive soils. The fill materials used during reconstruction of this section of the dike should be compacted in accordance with the compaction recommendations presented in the general recommendations section below.

## VII. Dike Erosion Caused by Sluice Water Discharged Into Unit #1 and Dike Rehabilitative Recommendations:

It was noted, during the field reconnaissance performed to determine field exploration locations, that sluice waters discharged into Unit #1 were eroding a portion of the inside face of the west dike. The direction that the sluice water was being discharged into the unit was adjusted to avoid further erosion of the west dike. It is recommended that the inside portion of the west dike of Unit #1 be reconstructed using compacted cohesive fill material. Recommendations concerning both the types of fill materials that should be used for the performance of this dike rehabilitative operations and their compactions are presented under VIII. General Findings and Rehabilitative Construction Recommendations, presented below. The Soils Engineer should observe the dike rehabilitative operations.

## VIII. General Findings and Rehabilitative Construction Recommendations:

**A. Types of Soils to be used as Fill and Backfill.** Controlled earth fill used to reconstruct dike embankments should be constructed of cohesive, inorganic, nondispersive lean clay materials having a maximum liquid limit of 50 and a maximum plasticity index of 30. Borrow materials proposed for use as controlled earth fill should be tested to verify their material characteristics and to verify that they are "nondispersive".

Proposed fill and backfill materials should be subject to approval by the Geotechnical Engineer. Representative samples of the proposed fill and backfill materials should be submitted to the Geotechnical Engineer at least three days prior to placement so the necessary laboratory tests can be performed.

**B. Placement of Fill and Backfill.** The suggested basis for controlling the placement of fill and backfill on the site, excluding free-draining granular materials, are the "optimum moisture content" and "maximum dry density" as determined by ASTM D 698, Procedure A, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$) (600 kN-m/m$^3$). The recommended acceptable values of moisture content and degree of compaction are given in Table 7.

**TABLE 7**
**Compaction Recommendations of Controlled Earth Fill and Backfill**

| Location | Soil Type | Minimum Moisture Content | Minimum Compaction* |
|---|---|---|---|
| | Glacial Till | Optimum | 95% |
| Dike Embankment Reconstruction And General Fill Placement Outside Of the Ash Pond Units | Silty and Lean Clays | 1% Below Optimum | 95% |

* Percent of Maximum Dry Density (ASTM D 698-00a, Procedure A)
** Moisture as necessary to obtain density (near Optimum)

**C. Grading Observation.** Observation and frequent testing by the Geotechnical Engineering Firm during compaction of fill and backfill are necessary to verify proper moisture content and degree of compaction. A professional opinion should be obtained from the Geotechnical Engineer that the site has been properly prepared, and that all fill, backfill, and subgrade materials conform to the moisture content and compaction recommendations presented above. As the Geotechnical Engineer for this project, HWS has interpreted the results of the subsurface exploration and laboratory tests to arrive at the recommendations presented in this report. Consequently, HWS is in the best position to relate actual observed conditions to those assumed for this report and to provide revised recommendations if differences are found during grading operations for the referenced project.

**D. Ash Disposal Units Fly Ash Excavation Removal Operation Limits**: As discussed earlier in this report, fly ash materials are periodically excavated from the Ash Disposal Units and placed within a landfill located to the south of the units. It is recommended that fly ash excavation operations be limited to those fly ash materials located 25 "or more" feet inside the interior faces of the original constructed dikes. The original constructed dike locations should be established prior to the performance of the fly ash excavation operations. Their locations may not be as perceived by visual site observation. The center of the south dike of Unit #2 was believed to be located approximately 15 to 25 feet north of the south shoulder point along the south side of this ash disposal unit. Field exploration was required to verify its actual location, which was found to be approximately 50 to 60 feet north of the existing south shoulder point along the south side of Ash Disposal Unit #2.

**E. Applicability of Recommendations.** The recommendations presented in this report are based in part upon HWS' analyses of the data from the Dutch friction-cone soundings and soil borings. The penetration diagrams, boring logs, and related information depict subsurface conditions only at the specific sounding and boring locations and at the time of the subsurface exploration. Soil conditions may differ between the soundings and exploratory

## VI. CONCLUSIONS

HWS concludes, on the basis of the findings of the subsurface exploration at the project site and the evaluation of the engineering properties of samples of the subsurface materials, that the stability of existing dikes, both under current and future conditions will be adequate if the recommended operating conditions summarized in Table 8 below are utilized.

**TABLE 8**
**Recommended Fly Ash Containment Unit Operating Conditions**

| Ash Disposal Unit No. | Maximum Operating Pool Elevation (ft)* | Minimum Unit Floor Elevation After Excavattion (ft) |
|---|---|---|
| 1 | 1078.5** | 1074.0 |
| 2 | 1082.0 | 1072.5 |
| 3A | 1082.0 | 1072.5 |
| 3B-North | 1082.0 | 1072.5 |
| 3B-South | 1079.0** | 1074.0 |

*Assumes a minimum original top of dike elevation of 1085.0 feet is maintained or re-established.
**Maximum Operating Pool Elevation is lower than 1082.0 feet to satisfy minimum Gradient Safety Factor.

Dispersive soils were not encountered in our investigation, but could be present and should be dealt with as recommended, if encountered.

The existing dikes in the vicinity of Sections D2-D2 and L-L should be reconstructed utilizing cohesive compacted fill materials constructed of soils placed in accordance with the compaction recommendations presented in this report.

Fly ash excavation operations periodically performed within the Ash Disposal Ponds should be maintained a minimum of 25 feet away from the inside face of the original dikes. The original dike locations should be established prior to commencement of these excavation operations.

Rip-rap materials should be installed on the inside face of both the east and south dikes of Unit #3B-South if wave action causes additional erosion of the inside faces of these dikes.

This report has been prepared in accordance with generally accepted soil engineering practices for exclusive use by the MidAmerican Energy Company for specific application to the fly ash containment dike assessment study. The recommendations of this report are not valid for any other purpose.

HWS should be contacted if any questions arise concerning this report or if changes in the nature, design, or location of the dikes operations are planned. If any such changes are made, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed by HWS and the conclusions of this report are modified or verified in writing. This report shall not be reproduced, except in full, without the written approval of HWS Consulting Group Inc.

Submitted By

HWS CONSULTING GROUP INC.

Prepared By:

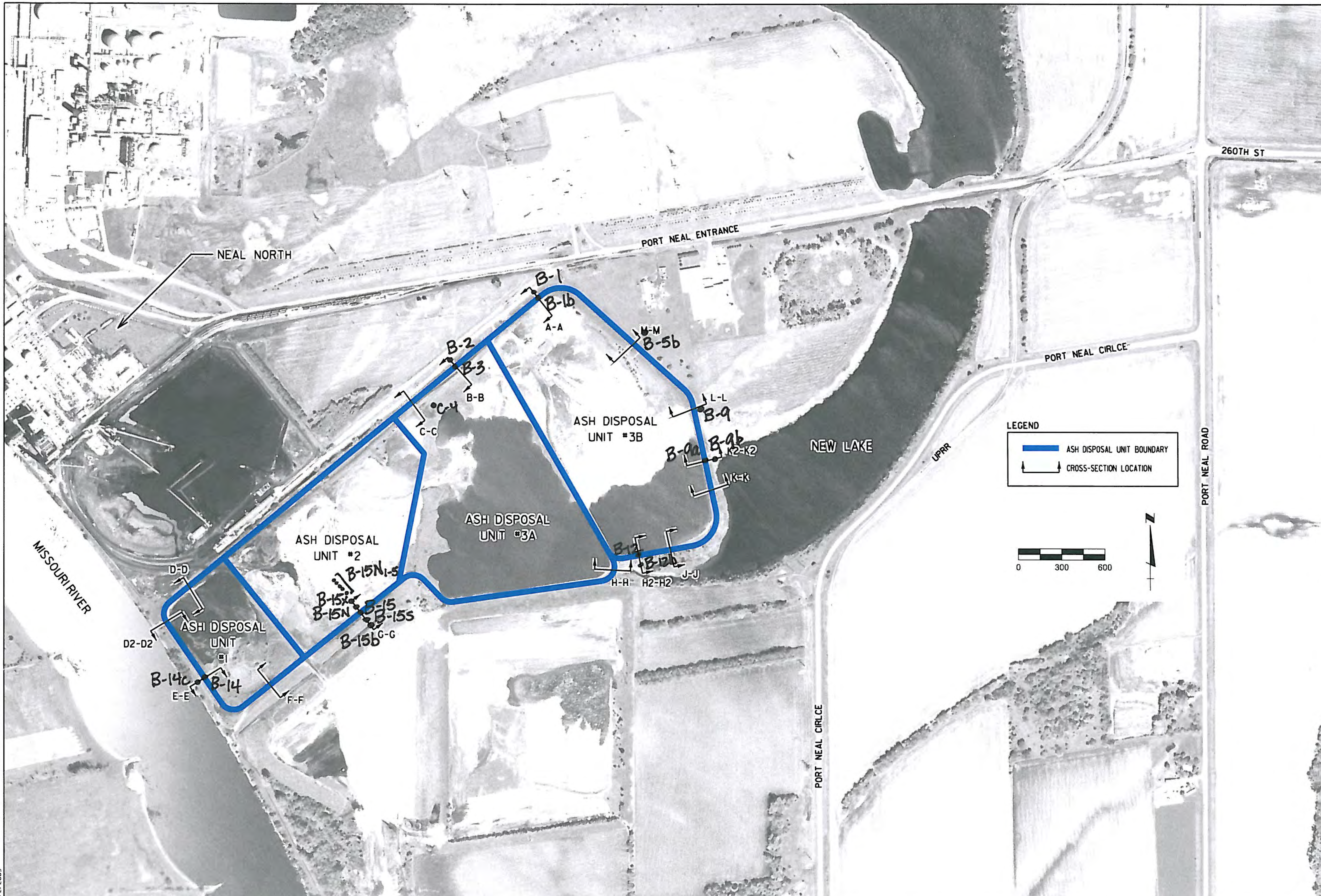
Brandon L. Desh, P.E.

LICENSED PROFESSIONAL ENGINEER
BRANDON L. DESH
19195
6-15-09
IOWA

Reviewed By:

Gary E. Proskovec, P.E.

# APPENDIX A. BORING LOCATION PLAN




F:\Transportation\695092\Design\Sheets\CROSS SECTION REFERENCE PLAN.dgn
6/2/2009

# CROSS SECTION REFERENCE PLAN

MidAmerican ENERGY

LINCOLN OFFICE

HWS

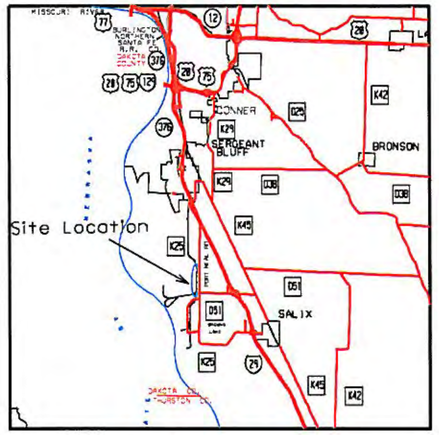
SCALE: AS NOTED

DATE: JUNE 2009

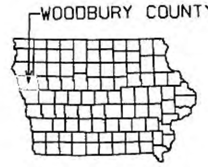
JOB NO.: 52-69-5092

SHEET NO.: 2

# APPENDIX B. VICINITY MAP AND DIKE CROSS SECTIONS



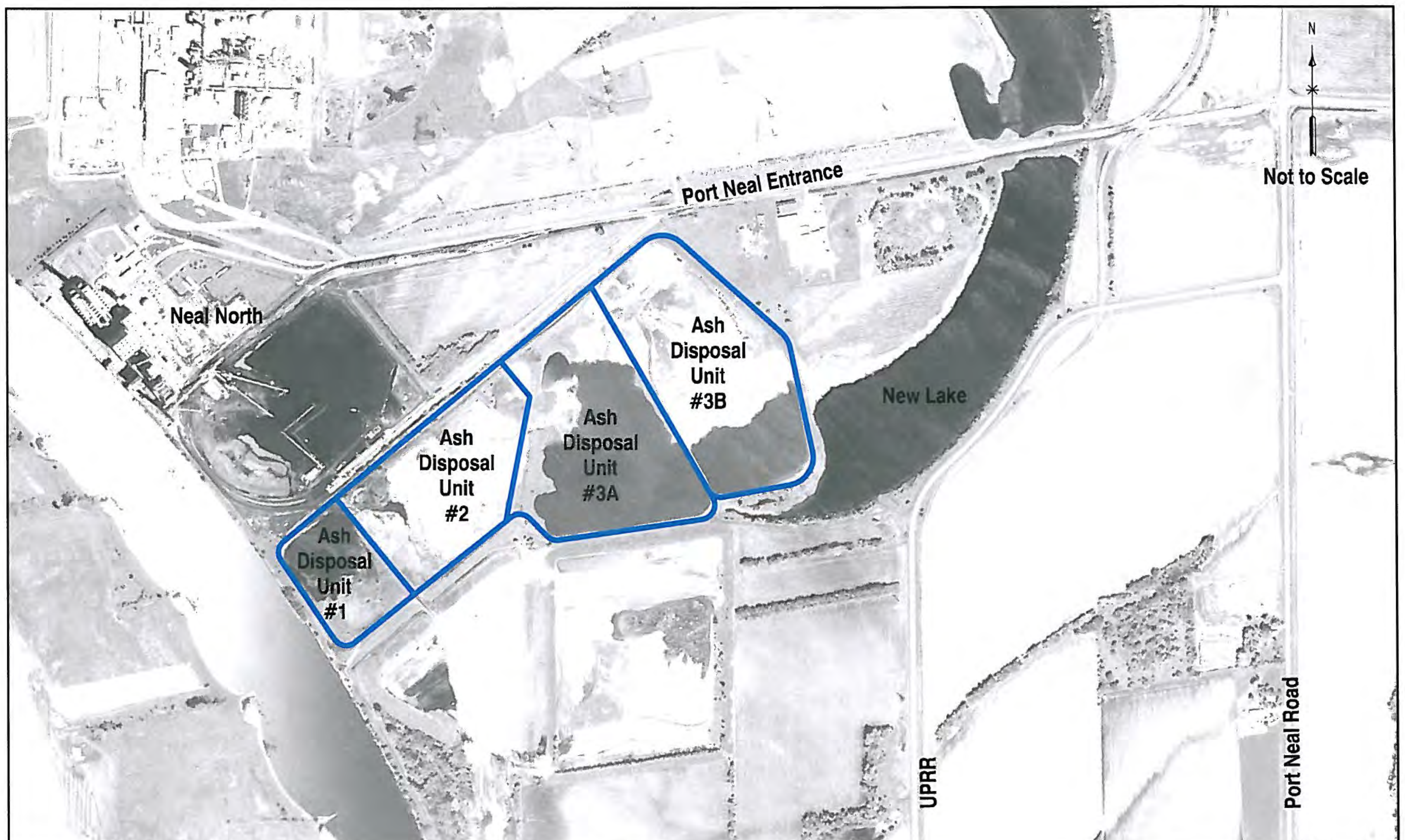

**Vicinty Map**




# PORT NEAL POWER PLANT
# ASH DISPOSAL DIKE
# STABILITY ASSESSMENT
# JUNE 2009

## SHEET INDEX

1 - COVER SHEET
2 - CROSS SECTION REFERENCE PLAN
3 - CROSS SECTION SHEETS




COVER SHEET

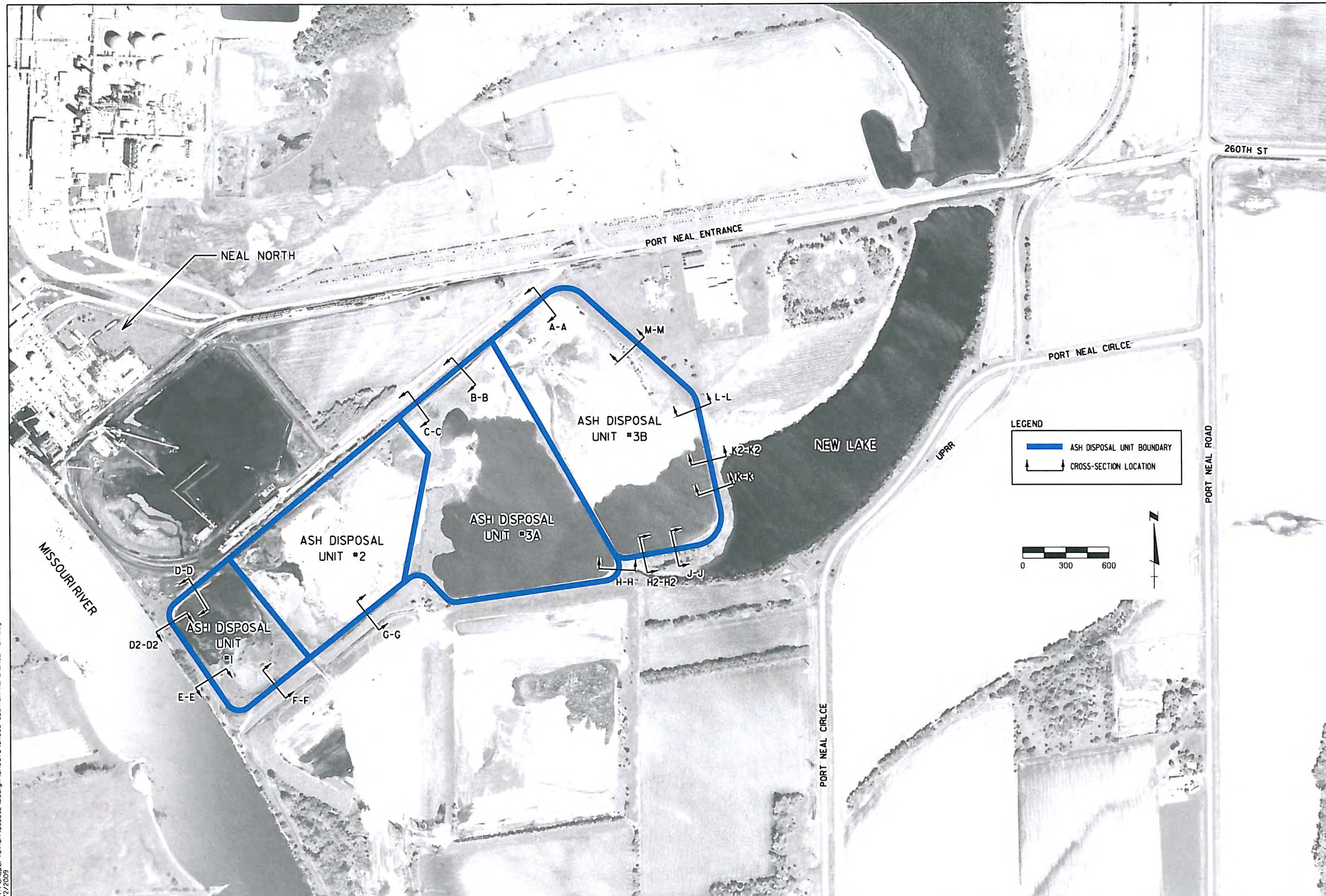
MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

SCALE: NOT TO SCALE
DATE: JUNE 2009
JOB NO.: 52-69-5092
SHEET NO.: 1

F:\Transportation\695092\Design\Sheets\COVER SHEET.dgn
6/12/2009




# CROSS SECTION REFERENCE PLAN

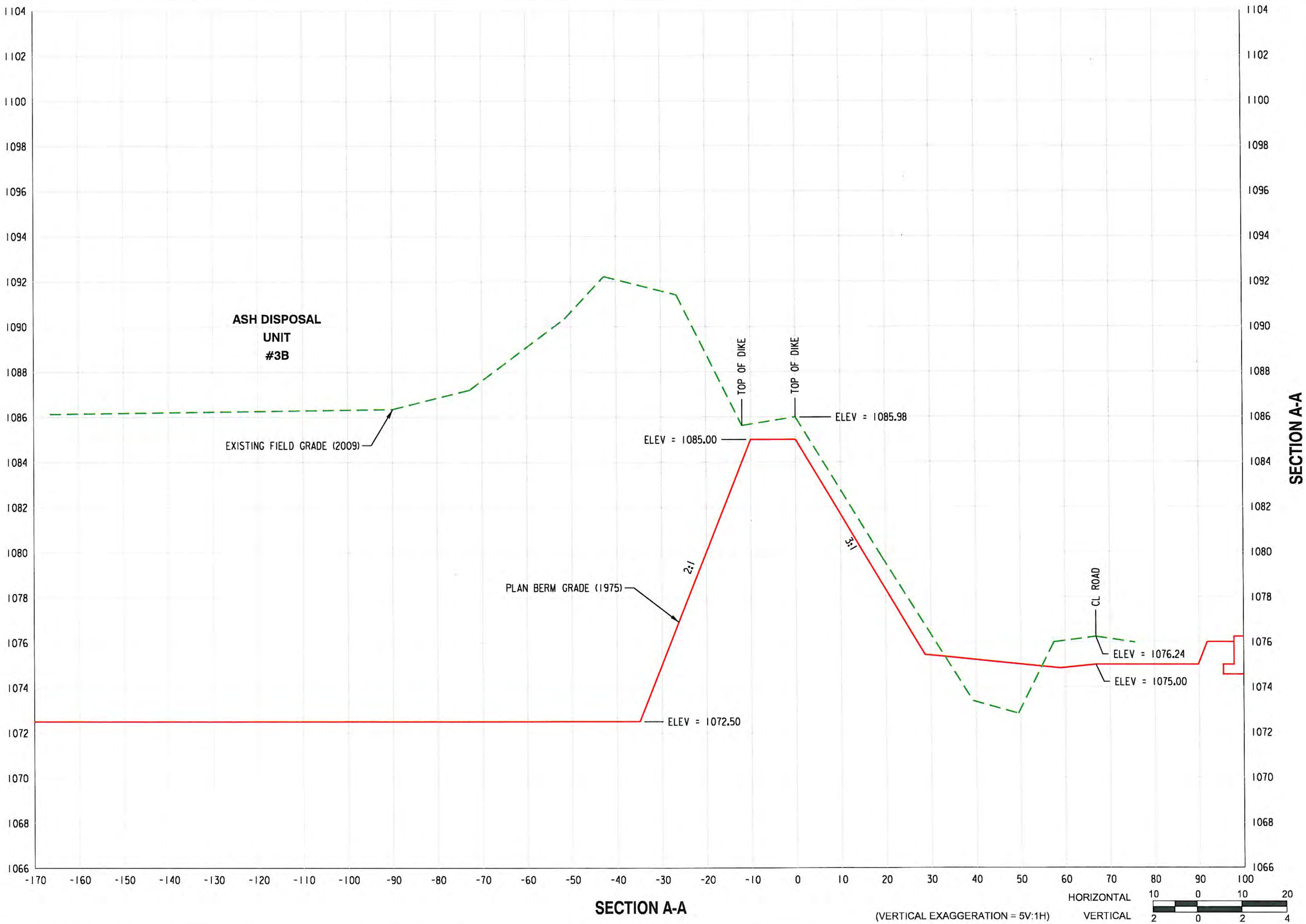
MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

SCALE: AS NOTED
DATE: JUNE 2009
JOB NO.: 52-69-5092
SHEET NO.: 2

F:\Transportation\695092\Design\Sheets\CROSS SECTION REFERENCE PLAN.dgn
6/2/2009




# SECTION A-A

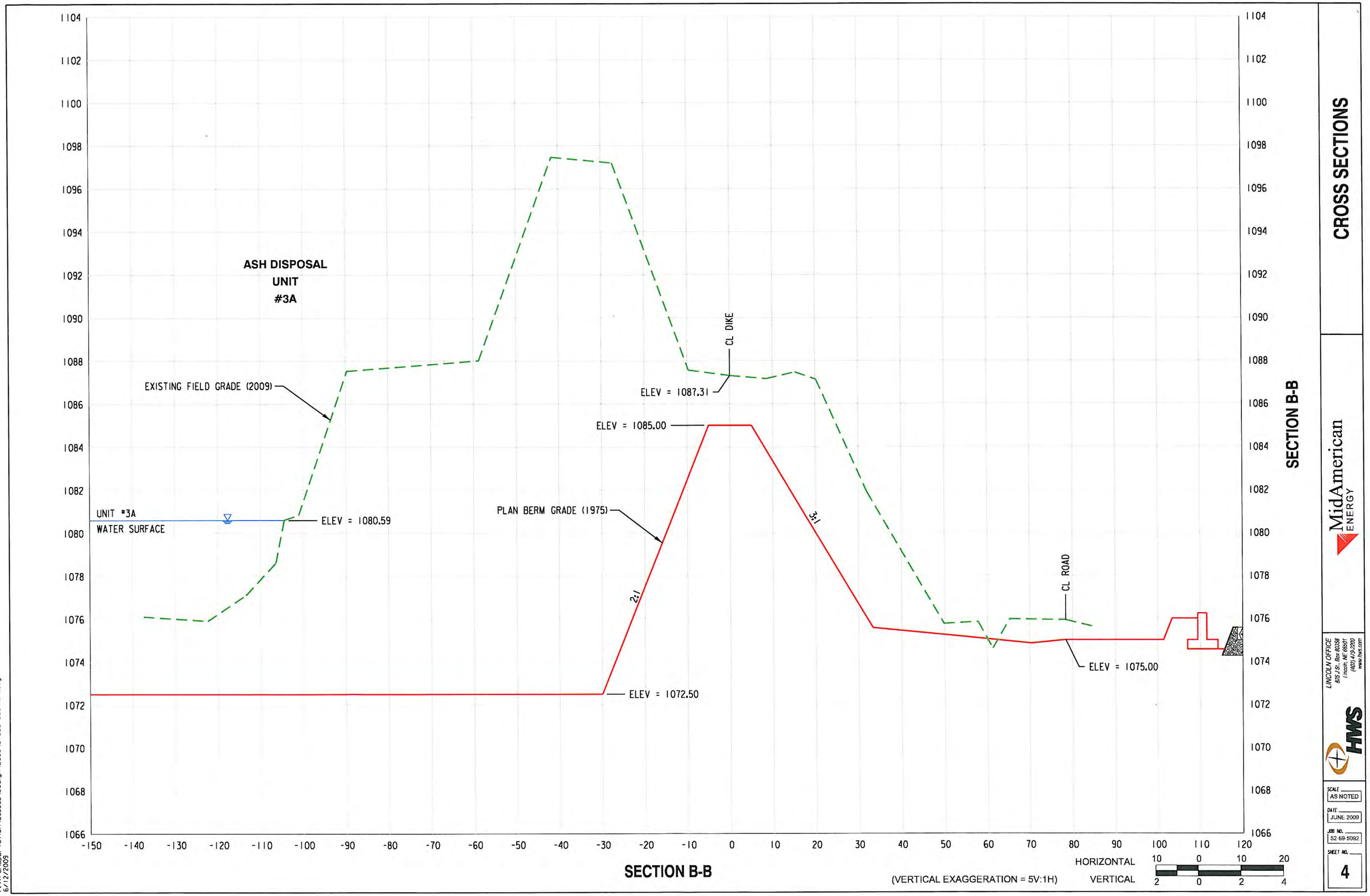
# CROSS SECTIONS

MidAmerican ENERGY

HWS
LINCOLN OFFICE

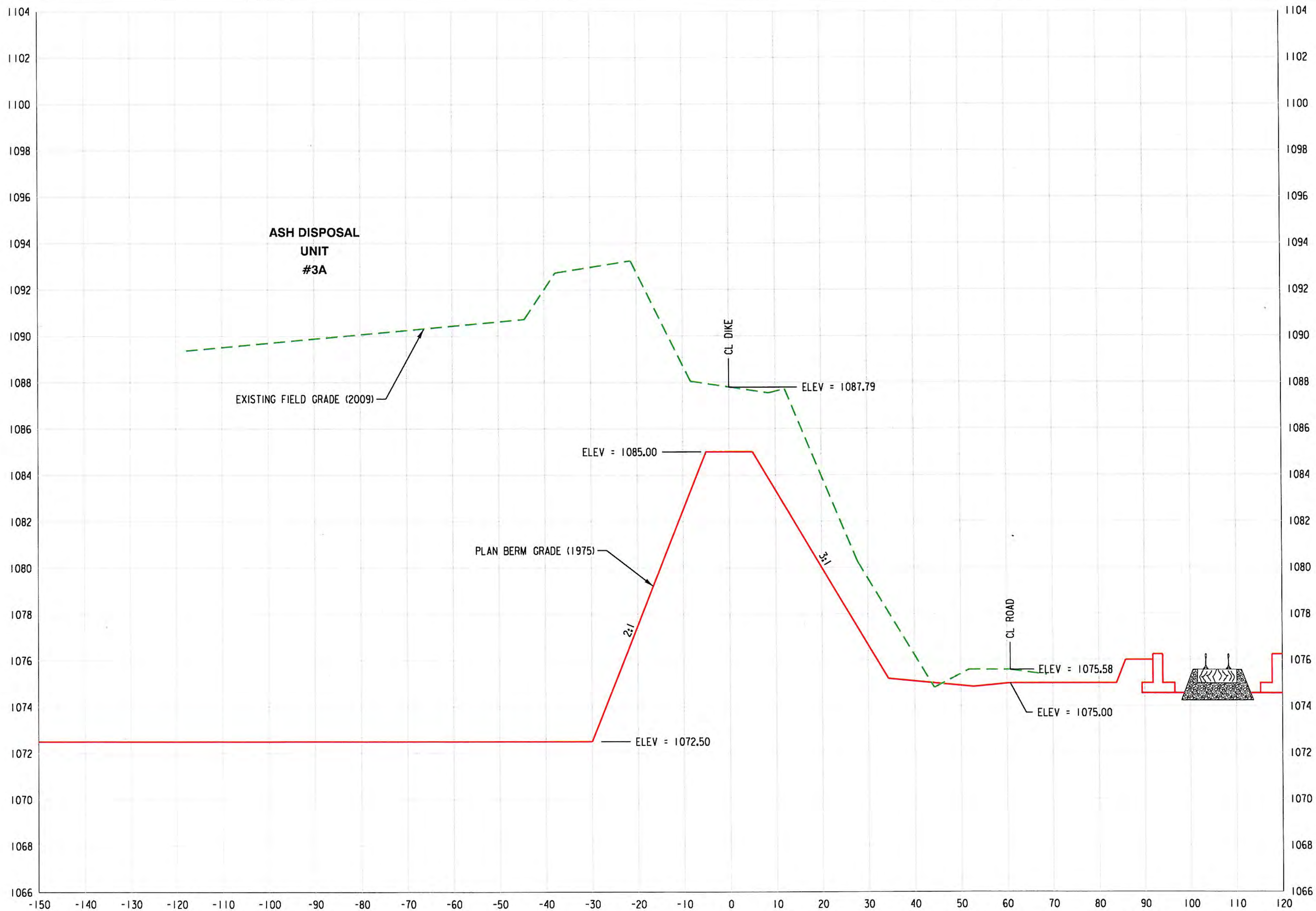
SCALE AS NOTED
DATE JUNE 2009
JOB NO. 52 68 5082
SHEET NO. 3

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




SECTION B-B

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




# SECTION C-C

(VERTICAL EXAGGERATION = 5V:1H)

HORIZONTAL 10 0 10 20

VERTICAL 2 0 2 4

SECTION C-C

# CROSS SECTIONS

MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

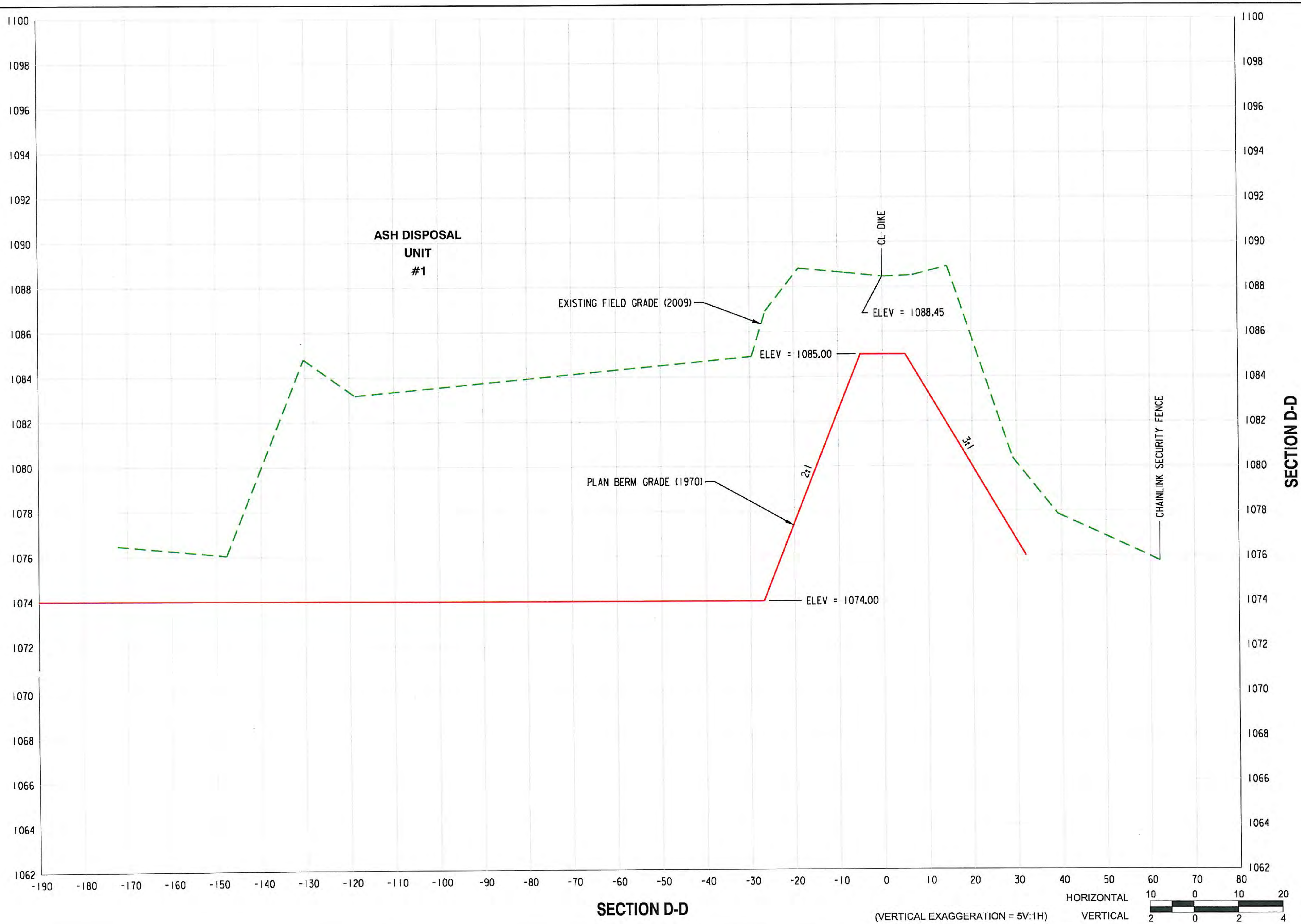
SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52-69-5092

SHEET NO. 5

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




# SECTION D-D

CROSS SECTIONS

SECTION D-D

MidAmerican ENERGY

HWS

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

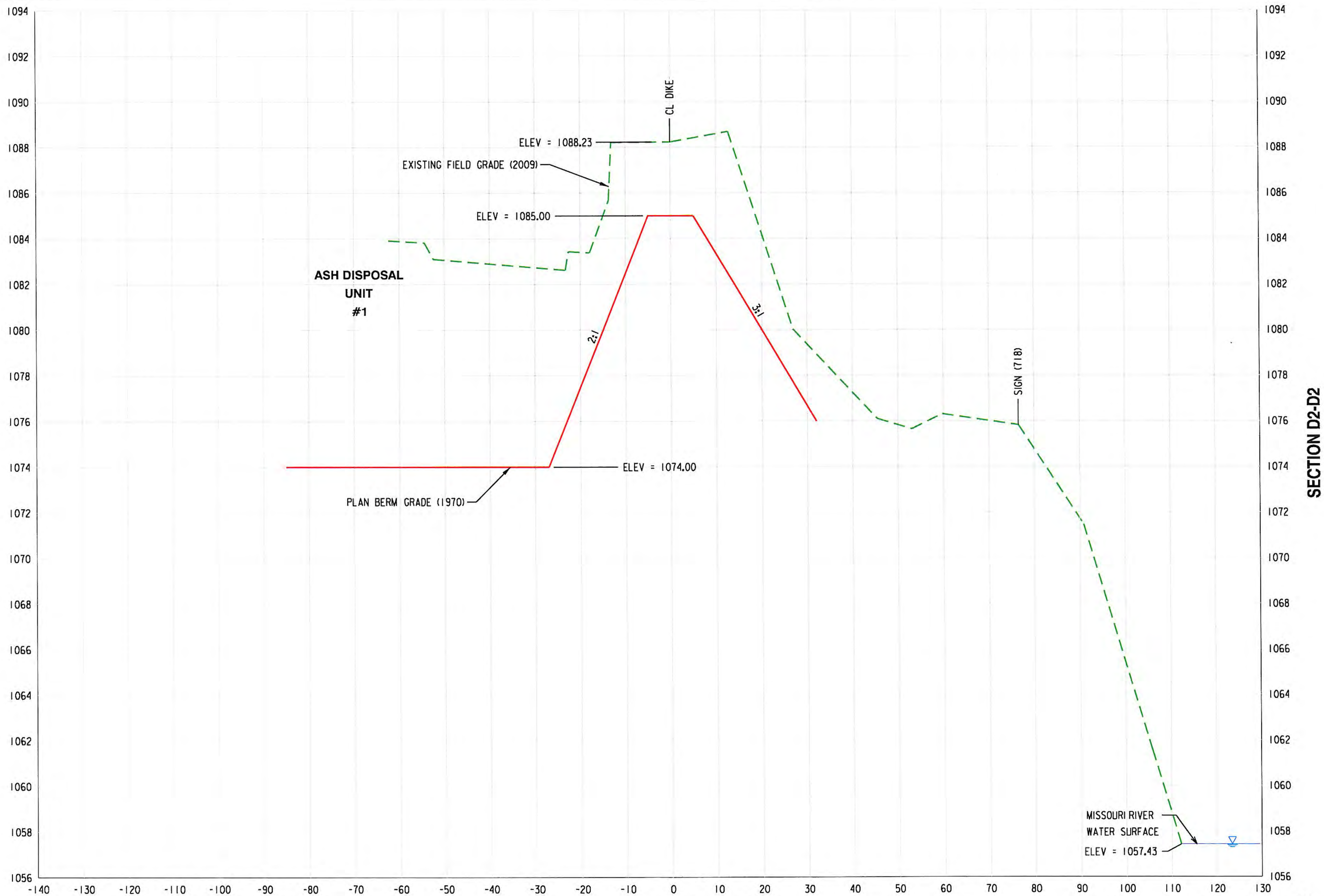
SCALE: AS NOTED

DATE: JUNE 2009

JOB NO.: 52 59-5092

SHEET NO.: 6

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




**SECTION D2-D2**

(VERTICAL EXAGGERATION = 5V:1H)

HORIZONTAL 10 0 10 20

VERTICAL 2 0 2 4

**SECTION D2-D2**

**CROSS SECTIONS**

MidAmerican ENERGY

LINCOLN OFFICE

HWS

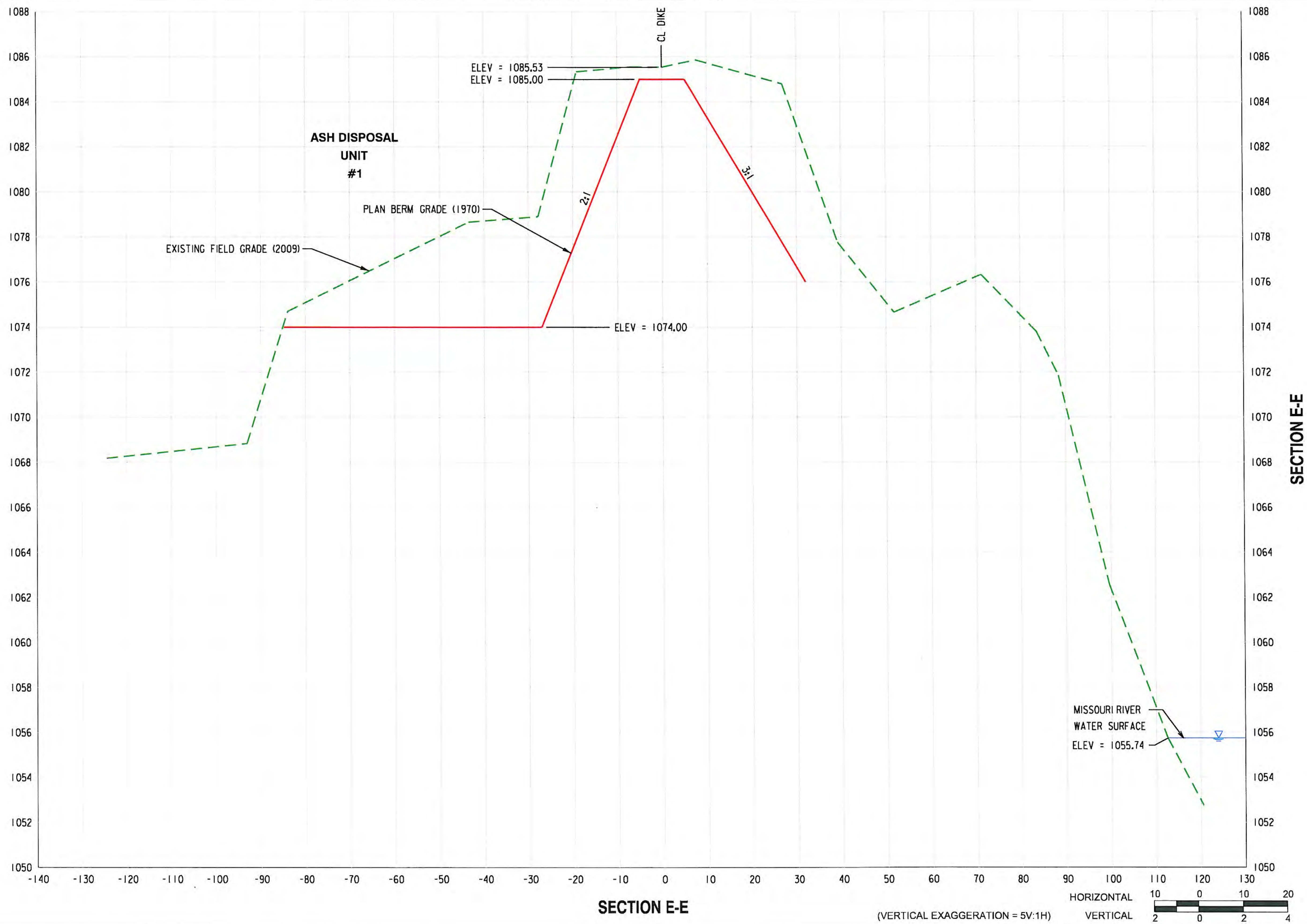
SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52 69 5092

SHEET NO. 7

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




## SECTION E-E

(VERTICAL EXAGGERATION = 5V:1H)

# CROSS SECTIONS

SECTION E-E

MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

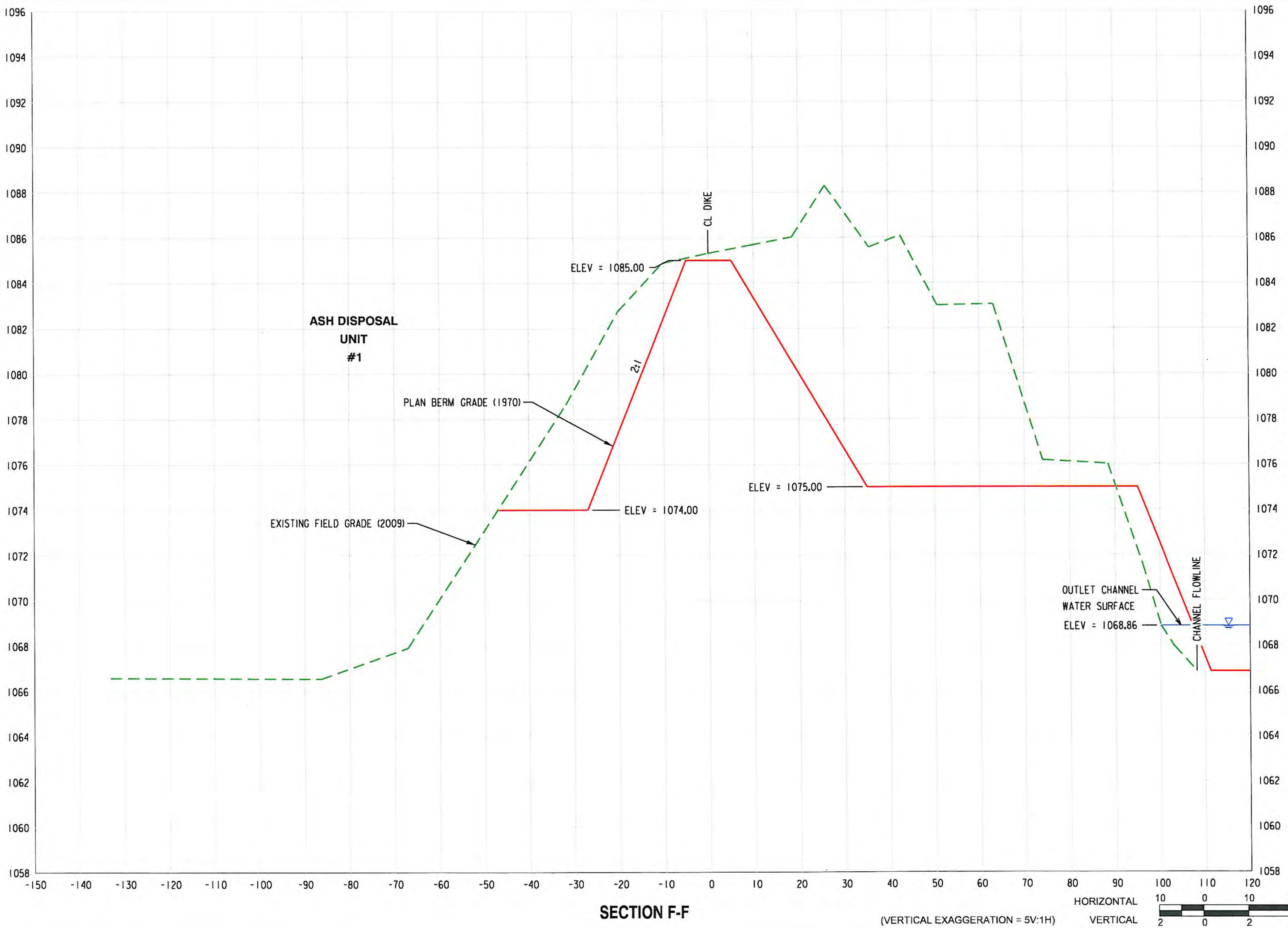
SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52-69-5092

SHEET NO. 8

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




SECTION F-F

CROSS SECTIONS

MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

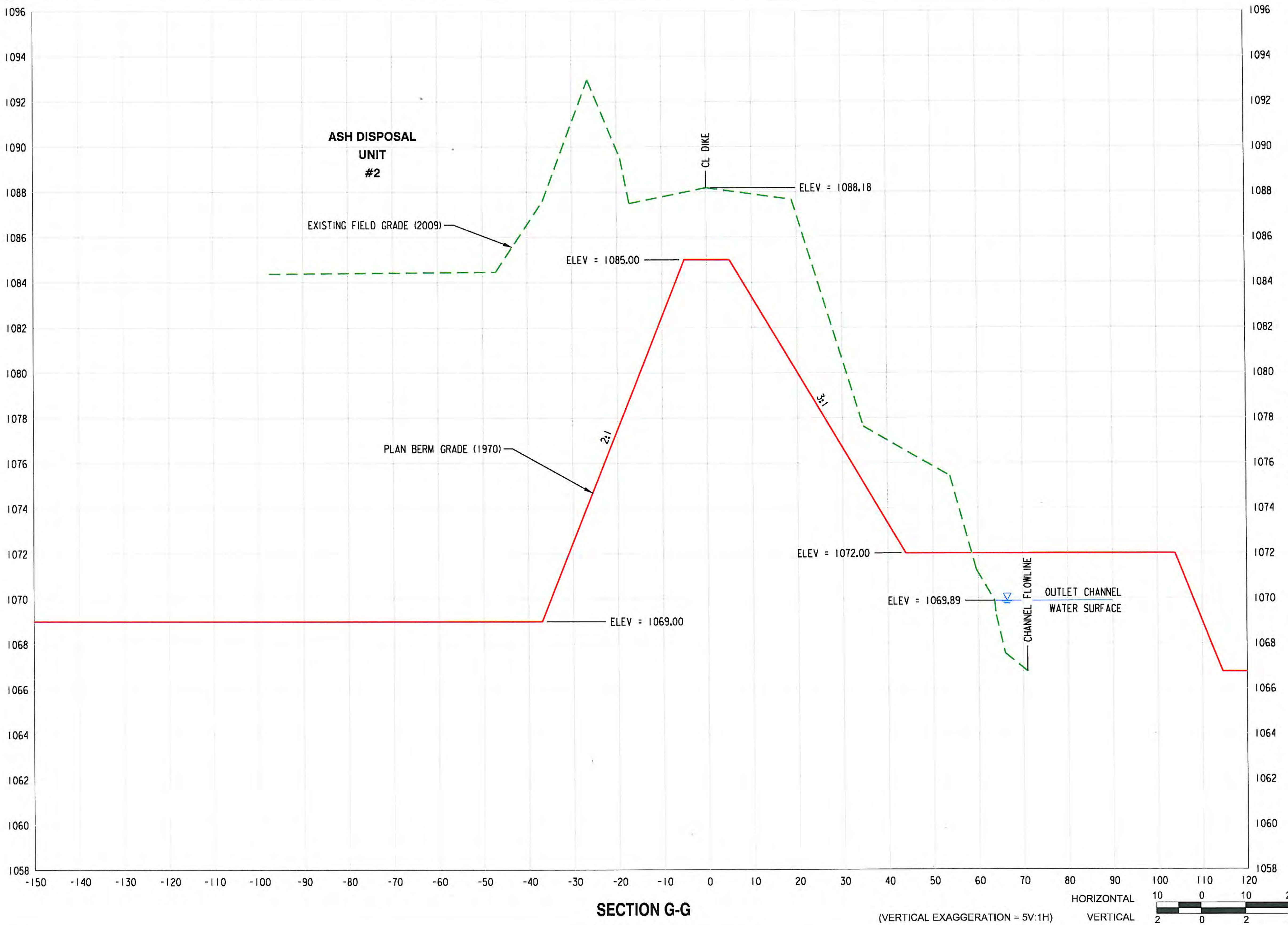
SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52 69 5082

SHEET NO. 9

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




# SECTION G-G

(VERTICAL EXAGGERATION = 5V:1H)

## CROSS SECTIONS

SECTION G-G

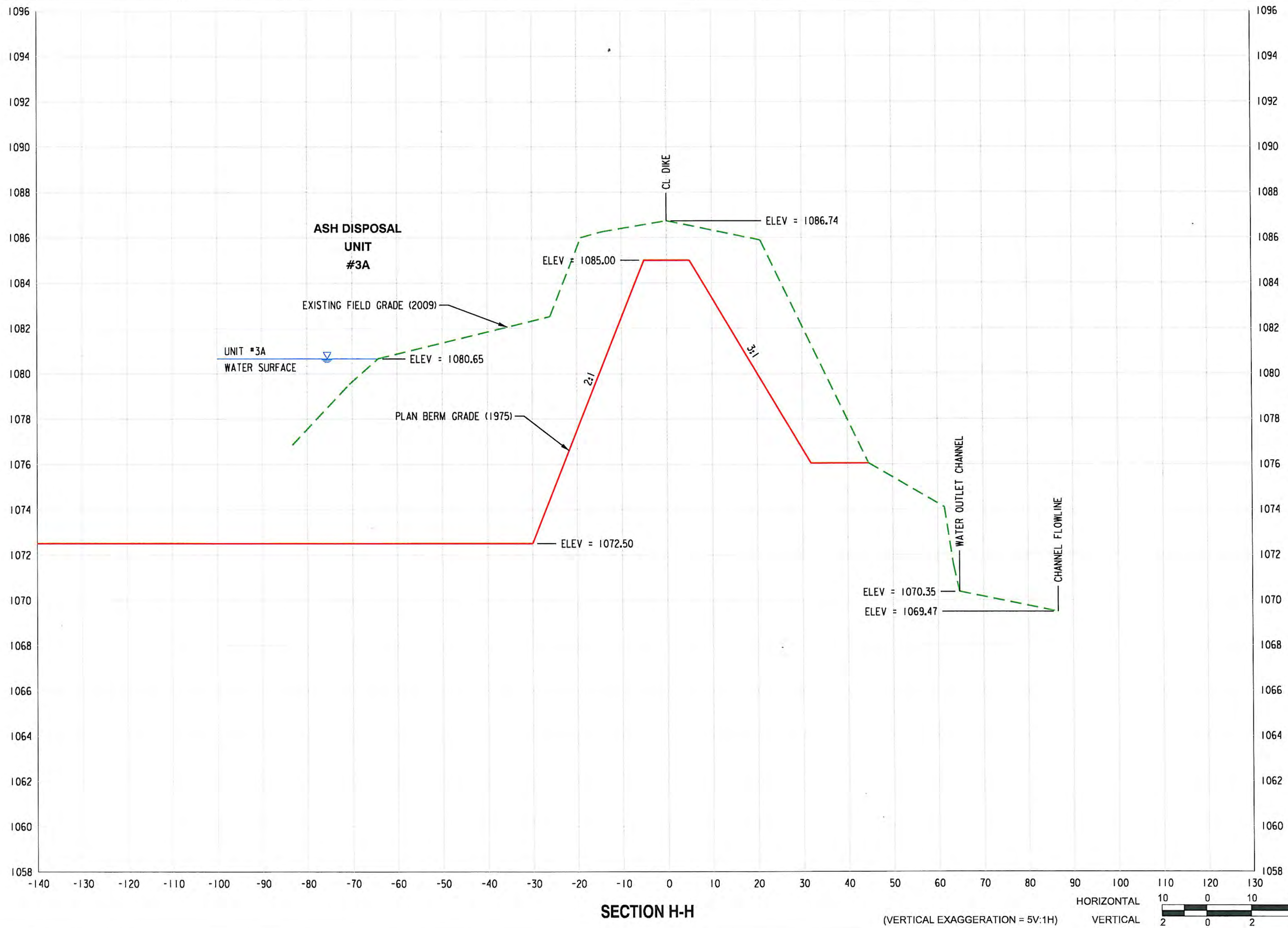
MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 474-6311
www.hws.com

HWS

SCALE AS NOTED
DATE JUNE 2009
JOB NO. 52 69 5092
SHEET NO. 10

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




SECTION H-H

(VERTICAL EXAGGERATION = 5V:1H)

CROSS SECTIONS

SECTION H-H

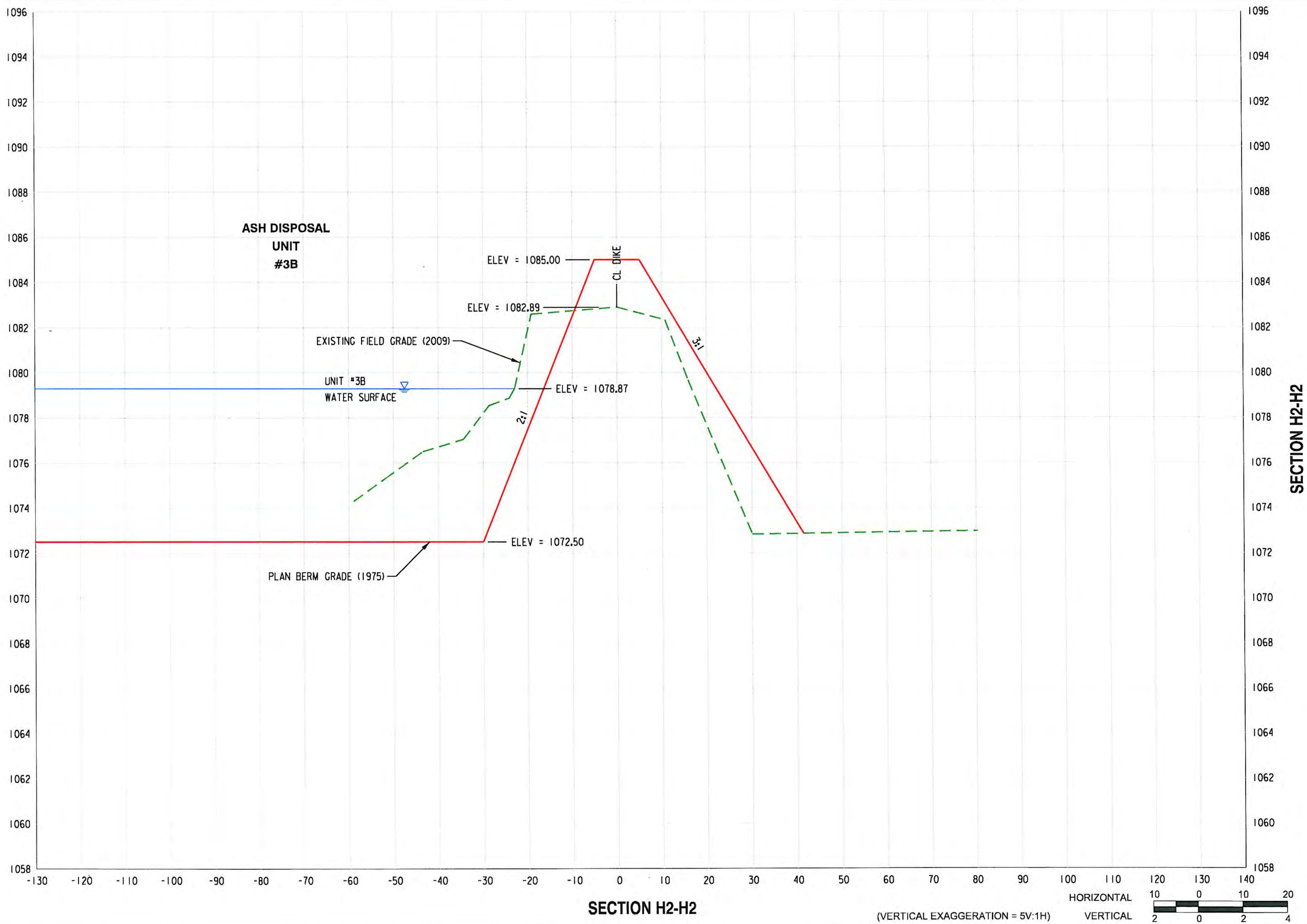
MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

SCALE AS NOTED
DATE JUNE 2009
JOB NO. 52 69-5092
SHEET NO. 11

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




CROSS SECTIONS

MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

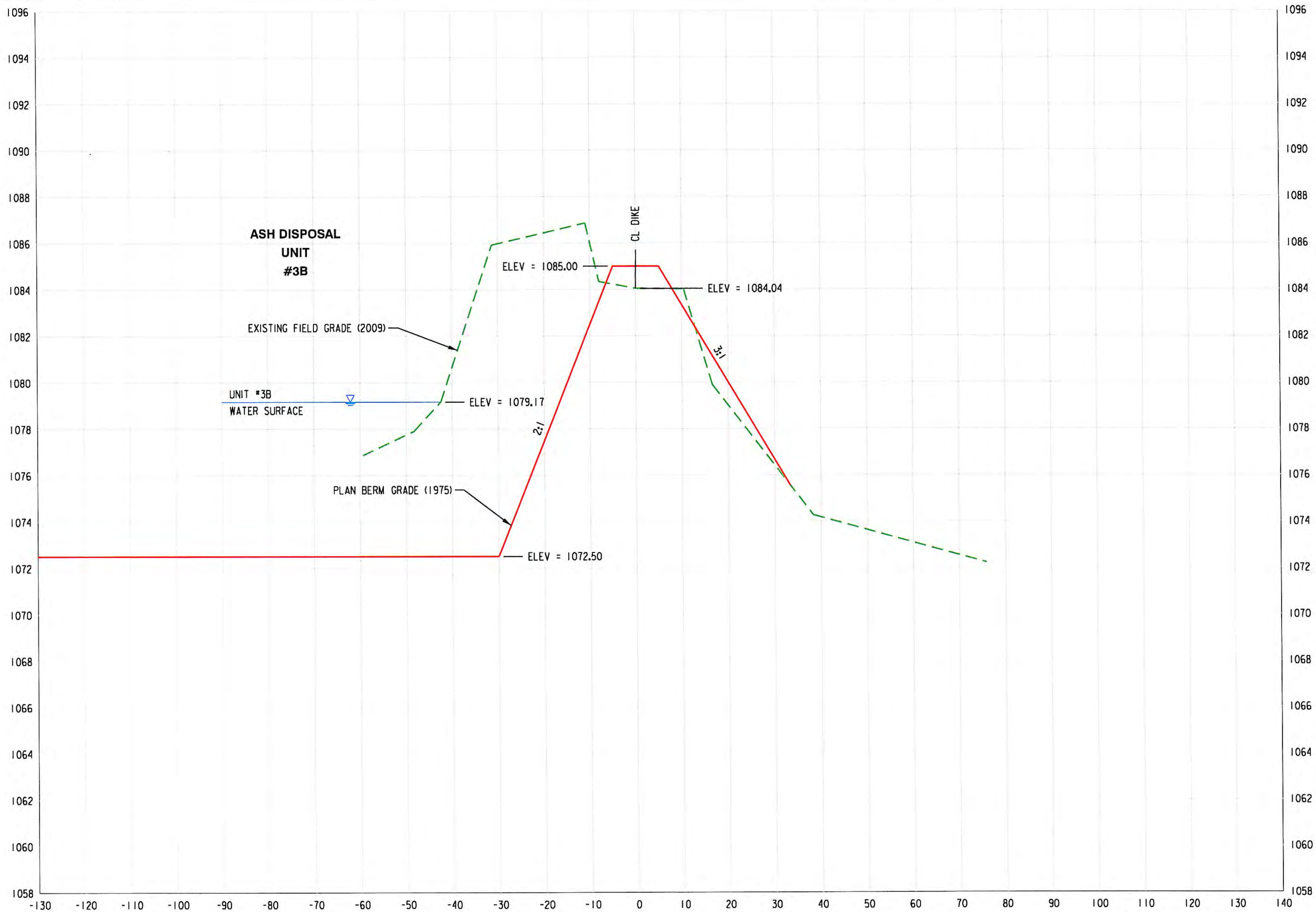
SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52 69 5092

SHEET NO. 12

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




## SECTION J-J

(VERTICAL EXAGGERATION = 5V:1H)

HORIZONTAL 10 0 10 20

VERTICAL 2 0 2 4

SECTION J-J

CROSS SECTIONS

MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

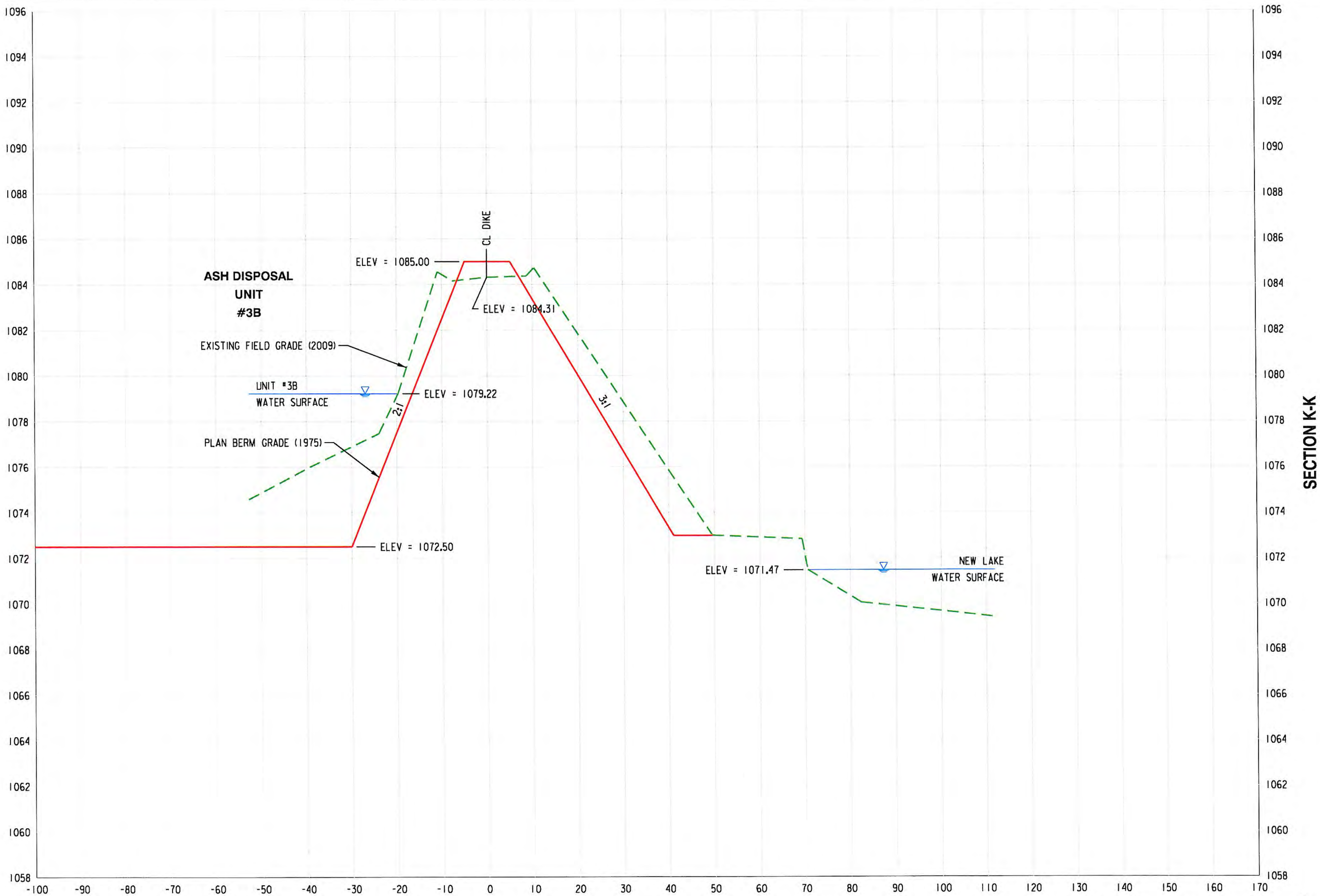
SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52 69 5092

SHEET NO. 13

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




# SECTION K-K

HORIZONTAL 10 0 10 20

VERTICAL 2 0 2 4

(VERTICAL EXAGGERATION = 5V:1H)

## CROSS SECTIONS

SECTION K-K

MidAmerican ENERGY

LINCOLN OFFICE

HWS

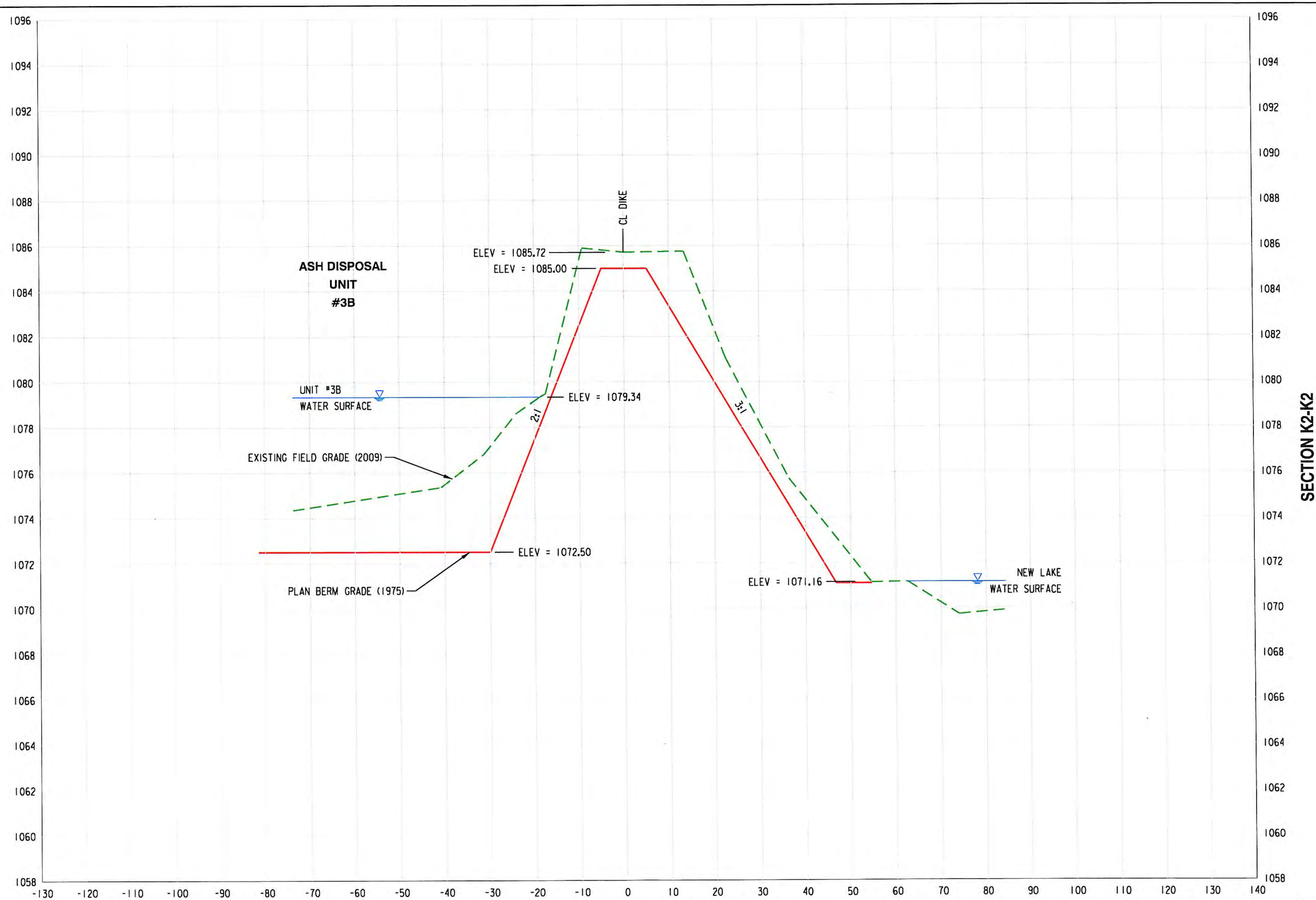
SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52-69-5082

SHEET NO. 14

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




## SECTION K2-K2

(VERTICAL EXAGGERATION = 5V:1H)

HORIZONTAL 10 0 10 20

VERTICAL 2 0 2 4

# CROSS SECTIONS

## SECTION K2-K2

MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

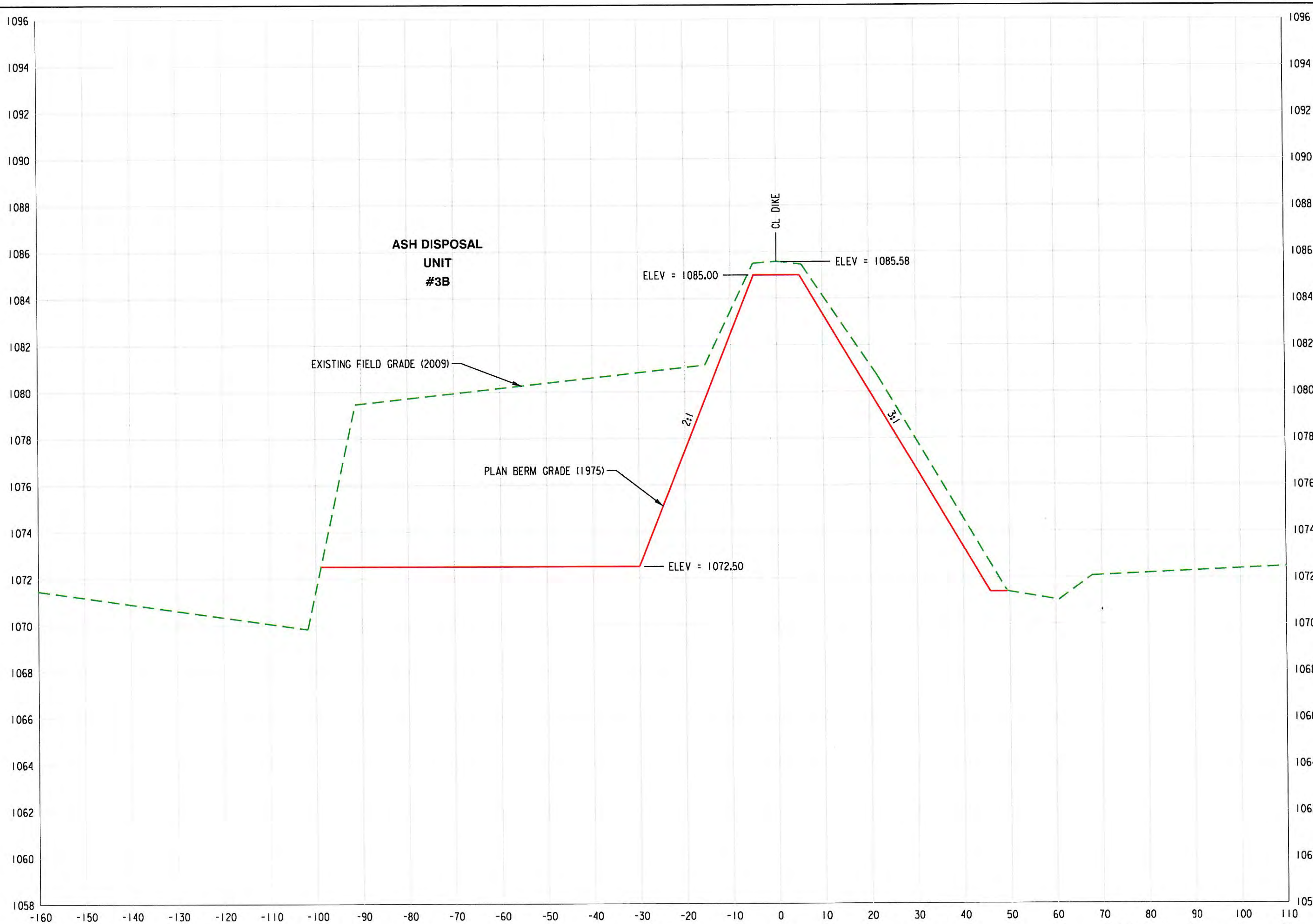
SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52 69-5092

SHEET NO. 15

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




# SECTION L-L

(VERTICAL EXAGGERATION = 5V:1H)

HORIZONTAL 10 0 10 20

VERTICAL 2 0 2 4

## CROSS SECTIONS

## SECTION L-L

MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

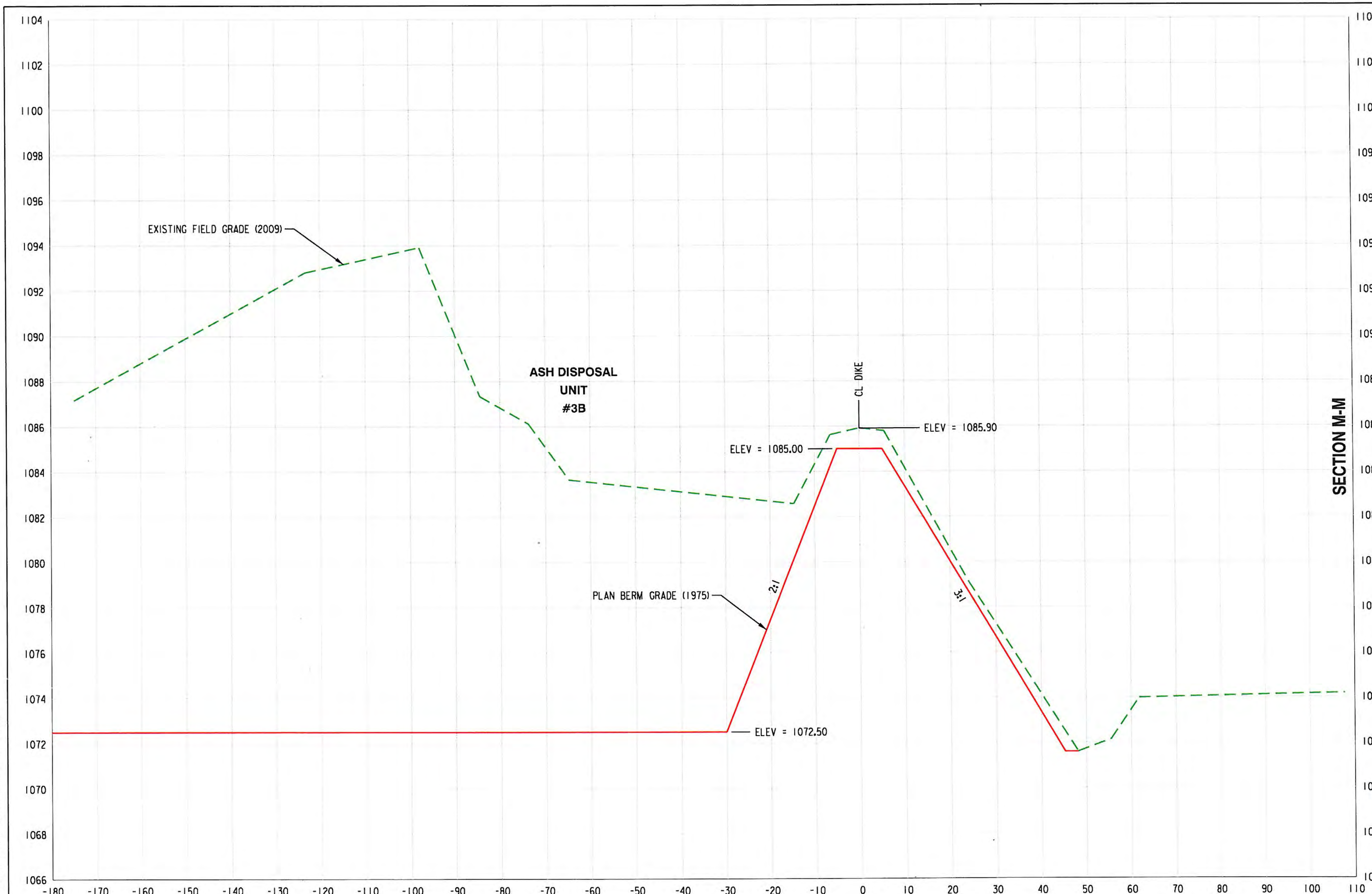
SCALE: AS NOTED

DATE: JUNE 2009

JOB NO.: 52-69-5092

SHEET NO.: 16

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009




## SECTION M-M

(VERTICAL EXAGGERATION = 5V:1H)

HORIZONTAL 10 0 10 20

VERTICAL 2 0 2 4

# CROSS SECTIONS

MidAmerican ENERGY

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
(402) 479-2200
www.hws.com

HWS

SCALE AS NOTED

DATE JUNE 2009

JOB NO. 52-69-5092

SHEET NO. 17

F:\Transportation\695092\Design\Base\Cross Sections.dgn
6/12/2009

# APPENDIX C.
# BORING LOGS & DUTCH FRICTION-CONE PENETRATION DIAGRAMS

Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section A-A, N 3595289.4, E 4146237.4
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 1



JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

DATE: 4-22-2009

WATER LEVELS ∇ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | SAND CONTENT (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1086.3 | 0.0 | | ML - SILT with Sand; 10-20% fine sand; low plasticity; black; moist; loose. (Fill) | | | | | | | 0.0 |
| 1085.3 | 1.0 | | CL - LEAN CLAY; 10-15% fine sand; medium plasticity; brown; wet; stiff. (Fill) | | 1 3 6 (9) | | | | | |
| 1084.3 | 2.0 | | ML - SILT with Sand; 15-25% fine sand; low plasticity; dark brown; wet; medium dense. (Fill) | | | | | | | 2.5 |
| 1082.3 | 4.0 | | ML - SANDY SILT; 35-45% fine sand; low plasticity; dark brown; moist to wet; loose to medium dense. (Fill) | 1 | | | 99.0 | 20 | | |
| | | | | | | 0.5 | 97.6 | 21.4 | | 5.0 |
| 1080.6 | 5.7 | | ML - SANDY SILT; 35-45% fine sand; low plasticity; brown; wet; medium dense. (Fill) | | | | | | 45 | 7.5 |
| 1076.3 | 10.0 | | ML - SANDY SILT; 35-45% fine sand; low plasticity; brown; wet; medium dense. (Fill) | | 6 7 9 (16) | | | | | 10.0 |
| 1074.8 | 11.5 | | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; grayish brown; wet; stiff. (Alluvium) | | | | | | | 12.5 |
| 1073.3 | 13.0 | | ML - SILT with Sand; 20-30% fine sand; low plasticity; grayish brown; wet; loose. (Alluvium) | 2 | | | | | | |
| 1073.1 | 13.2 | | SP - POORLY GRADED SAND; 95-100% fine to medium sand; nonplastic; light brown; moist; loose to medium dense. (Alluvium) | | | | | | | |
| 1071.3 | 15.0 | | SP - POORLY GRADED SAND; 95-100% fine to medium sand; nonplastic; light grayish brown; wet; medium dense. (Alluvium) | | 4 6 7 (13) | | | | | 15.0 17.5 |
| 1066.3 | 20.0 | | | | | | | | | 20.0 |

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/9/09

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section A-A, N 3595289.4, E 4146237.4
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 1

JOB NO.: 52-69-5092



RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

DATE: 4-22-2009

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | SAND CONTENT (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | SP - POORLY GRADED SAND; 95-100% fine to medium sand; nonplastic; light grayish brown; wet to saturated; medium dense. (Alluvium) | | | | | | | 20.0 |
| | | | | | | | | | | 22.5 |
| | | | | | 4 4 6 (10) | | | | | |
| 1061.3 | 25.0 | | Boring Terminated at: 25.0ft | | | | | | | 25.0 |
| | | | | | | | | | | 27.5 |
| | | | | | | | | | | 30.0 |
| | | | | | | | | | | 32.5 |
| | | | | | | | | | | 35.0 |
| | | | | | | | | | | 37.5 |
| | | | | | | | | | | 40.0 |

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section A-A, N 3595275.8, E 4146253.5
Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Hollow-Stem
CREW: CL&SG

BORING No.: 1b
SHEET 1 of 2
DATE: 4-22-2009

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | DEPTH (feet) |
|---|---|---|---|---|---|---|
| 1091.7 | 0.0 | | FLY ASH; gray; moist; medium dense. (Fill) | | | 0.0 |
| | | | | | | 2.5 |
| | | | | | 3<br>6<br>6<br>(12) | |
| 1086.7 | 5.0 | | FLY ASH; gray; wet to saturated; loose. (Fill) | | | 5.0 |
| | | | | | | 7.5 |
| | | | | | 1<br>2<br>4<br>(6) | |
| 1081.7 | 10.0 | | FLY ASH; gray; wet to saturated; loose; with thin layers of solidified fly ash. (Fill) | | | 10.0 |
| | | | | | | 12.5 |
| | | | | | 4<br>2<br>2<br>(4) | 15.0 |
| | | | | | | 17.5 |
| 1073.2 | 18.5 | | CL - LEAN CLAY; medium plasticity; brown mottled with grayish brown; wet; stiff. (Alluvium) | | 4<br>6<br>11<br>(17) | |
| 1072.2 | 19.5 | | SP-SM - POORLY GRADED SAND with Silt; 90-95% fine to medium sand; low plasticity; light yellowish brown; | | | 20.0 |



Figure C - 2a

| | | |
|---|---|---|
| HWS Solutions Through Service<br>825 J Street<br>Lincoln, NE 68501<br>402-479-2200 * Fax: 402-479-2276<br>www.hws.com | PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment<br>LOCATION: Section A-A, N 3595275.8, E 4146253.5<br>Port Neal North Powerplant, West of Salix, Iowa<br>JOB NO.: 52-69-5092<br>RIG / METHOD: CME 75HT / Hollow-Stem<br>CREW: CL&SG | **BORING LOG**<br>BORING No.: 1b<br>SHEET 2 of 2<br>DATE: 4-22-2009 |
| | WATER LEVELS ⊻ No Groundwater Encountered | |

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | DEPTH (feet) |
|---|---|---|---|---|---|---|
| | | | wet; medium dense. (Alluvium) | | | 20.0 |
| | | | | | | 22.5 |
| 1068.2 | 23.5 | | SP - POORLY GRADED SAND; 95-100% fine to medium sand; nonplastic; light grayish brown; wet; dense. (Alluvium) | | 11<br>13<br>17<br>(30) | |
| 1066.7 | 25.0 | | Boring Terminated at: 25.0ft | | | 25.0 |
| | | | | | | 27.5 |
| | | | | | | 30.0 |
| | | | | | | 32.5 |
| | | | | | | 35.0 |
| | | | | | | 37.5 |
| | | | | | | 40.0 |

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/9/09

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section B-B, N 3594846.6, E 4145705.3 Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

BORING No.: 2

DATE: 4-22-2009

WATER LEVELS ∇ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | DRY DENSITY (pcf) | MOISTURE (%) |
|---|---|---|---|---|---|---|---|
| 1087.3 | 0.0 | | FLY ASH; 5-10% fine to coarse hardended fly ash nodulues; grayish brown; moist; medium dense. (Fill) | | | | |
| 1083.9 | 3.4 | | CL - LEAN CLAY; 5-15% fine sand; medium plasticity; dark grayish brown mottled with grayish brown; wet; medium stiff. (Fill) | 3 | | 72.2<br>89.2 | 35.8<br>27.1 |
| 1083.1 | 4.2 | | ML - SANDY SILT; 30-40% fine to medium sand; low plasticity; dark yellowish brown; wet; medium dense. (Fill) | | | | |
| 1080.3 | 7.0 | | ML - SILT with Sand; 10-20% fine sand; low plasticity; dark grayish brown; wet; loose to medium dense. (Fill) | 4 | | 93.5<br>101.1 | 26<br>19.8 |
| 1078.9 | 8.4 | | CL - LEAN CLAY; 10-15% fine to medium sand; medium plasticity; brown; wet; medium stiff. (Fill) | | | | |
| 1077.8 | 9.5 | | CL - LEAN CLAY with Sand; 15-25% fine to medium sand; medium plasticity; brown mottled with gray; wet; stiff. (Fill) | | 3<br>3<br>4<br>(7) | | |
| 1076.3 | 11.0 | | CL - LEAN CLAY; 5-15% fine to medium sand; medium plasticity; dark gray; wet; stiff. (Fill) | | | | |
| 1075.3 | 12.0 | | CL - LEAN CLAY; 10-15% fine sand; medium plasticity; yellowish brown; wet; medium stiff. (Fill) | | | | |
| 1073.8 | 13.5 | | ML - SILT with Sand; 15-25% fine sand; low plasticity; dark yellowish brown; wet; loose to medium dense. (Alluvium) | | 2<br>3<br>4<br>(7) | | |
| 1072.3 | 15.0 | | ML - SANDY SILT; 30-40% fine sand; low plasticity; dark grayish brown; wet to saturated; loose. (Alluvium) | 5 | | 93.7 | 25.9 |
| 1071.9 | 15.4 | | SM - SILTY SAND; 55-65% fine sand; low plasticity; dark brown mottled with grayish brown; wet to saturated; loose. (Alluvium) | | | | |
| 1071.0 | 16.3 | | ML - SILT; 5-15% fine sand; low plasticity; olive brown mottled with yellowish red; wet to saturated; medium dense. (Alluvium) | | | | |
| 1068.8 | 18.5 | | SP - POORLY GRADED SAND; 95-100% fine to medium sand; nonplastic; light grayish brown; wet; medium dense. (Alluvium) | | 4<br>6<br>8<br>(14) | | |

DEPTH (feet) scale: 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0



Figure C - 3a

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

| | |
|---|---|
| PROJECT: | Mid American Energy Fly Ash Ponds Containment Assessment |
| LOCATION: | Section B-B, N 3594846.6, E 4145705.3 Port Neal North Powerplant, West of Salix, Iowa |
| JOB NO.: | 52-69-5092 |
| RIG / METHOD: | CME 75HT / Straight Auger |
| CREW: | CL&SG |
| WATER LEVELS | ⊻ No Groundwater Encountered |

# BORING LOG

BORING No.: 2



DATE: 4-22-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | DRY DENSITY (pcf) | MOISTURE (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 20.0 |
| | | | | | | | | 22.5 |
| | | | | | 6<br>5<br>4<br>(9) | | | |
| 1062.3 | 25.0 | | Boring Terminated at: 25.0ft | | | | | 25.0 |
| | | | | | | | | 27.5 |
| | | | | | | | | 30.0 |
| | | | | | | | | 32.5 |
| | | | | | | | | 35.0 |
| | | | | | | | | 37.5 |
| | | | | | | | | 40.0 |



Figure C - 3b

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

BORING No.: 3



DATE: 4-22-2009

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

LOCATION: Section B-B, N 3594817.8, E 4145730.0
Port Neal North Powerplant, West of Salix, Iowa

JOB NO.: 52-69-5092

RIG / METHOD: CME 75HT / Hollow-Stem

CREW: CL&SG

WATER LEVELS ▼ 17.0 IAD ▼ 15.8 on 4-23-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | DEPTH (feet) |
|---|---|---|---|---|---|---|
| 1097.1 | 0.0 | | FLY ASH; 10-15% fine to coarse hardened fly ash nodulues; dark gray; moist; loose. (Fill) | | | 0.0 |
| | | | | | | 2.5 |
| | | | | | 2<br>2<br>2<br>(4) | |
| 1092.1 | 5.0 | | FLY ASH; 10-15% fine to coarse hardened fly ash nodulues; dark gray; wet; medium dense. (Fill) | | | 5.0 |
| | | | | | | 7.5 |
| | | | | | 1<br>2<br>15<br>(17) | |
| 1087.1 | 10.0 | | FLY ASH; 10-15% fine to coarse hardened fly ash nodulues; dark gray; wet; medium dense. (Fill) | | | 10.0 |
| | | | | | | 12.5 |
| | | | | | 12<br>10<br>6<br>(16) | |
| 1082.1 | 15.0 | | FLY ASH; 5-10% fine to coarse hardened fly ash nodulues; dark gray; wet to saturated; loose. (Fill) | | | 15.0 |
| | | | | | | 17.5 |
| | | | | | 5<br>3<br>2<br>(5) | 20.0 |



Figure C - 4a

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section B-B, N 3594817.8, E 4145730.0
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 3



JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Hollow-Stem
CREW: CL&SG

DATE: 4-22-2009

WATER LEVELS ▼ 17.0 IAD ▼ 15.8 on 4-23-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | DEPTH (feet) |
|---|---|---|---|---|---|---|
| | | | | | | 20.0 |
| | | | | | | 22.5 |
| 1073.6 | 23.5 | | ML - SILT with Sand; 15-25% fine sand; low plasticity; dark brown; saturated; very dense. (Alluvium ) | | 6<br>19<br>35<br>(54) | 25.0 |
| | | | | | | 27.5 |
| 1068.6 | 28.5 | | SM - SILTY SAND; 80-90% fine sand; low plasticity; yellowish brown; saturated; medium dense. (Alluvium) | | 4<br>6<br>8<br>(14) | 30.0 |
| | | | | | | 32.5 |
| 1063.6 | 33.5 | | SP-SM - POORLY GRADED SAND with Silt; 85-95% fine to coarse sand; nonplastic; light grayish brown; saturated; medium dense. (Alluvium) | | 4<br>9<br>17<br>(26) | |
| 1062.1 | 35.0 | | Boring Terminated at: 35.0ft | | | 35.0 |
| | | | | | | 37.5 |
| | | | | | | 40.0 |



Figure C - 4b

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section B-B, N 3594752.8, E 4145711.9
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 4

JOB NO.: 52-69-5092

SHEET 1 of 1

RIG / METHOD: CME 75HT / Hollow-Stem & Rock Coring

CREW: CL&SG

DATE: 4-21-2009

WATER LEVELS ∇ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LITHOLOGY DESCRIPTION | SAMPLE | DRY DENSITY (pcf) | MOISTURE (%) |
|---|---|---|---|---|---|
| 1086.9 | 0.0 | FLY ASH (SOLIDIFIED); dark gray; moderately soft; slightly porous | | | |
| 1086.8 | 0.1 | FLY ASH (SOLIDIFIED); dark gray with 1/2" to 1" thick seams of light live brown; very soft; fine-grained | | 59.6 | 55.9 |
| 1086.0 | 0.9 | FLY ASH (SOLIDIFIED); light grayish brown with 1 1/2" thick layers of brown; very soft; fine-grained | | | |
| 1085.5 | 1.4 | FLY ASH (SOLIDIFIED); light gray; moderately soft; fine-grained | | | |
| 1085.4 | 1.5 | FLY ASH (SOLIDIFIED); with 30-40% black cinders; light brownish gray; soft; layered with fine to coarse gravel | | | |
| 1085.2 | 1.7 | FLY ASH (UNSOLIDIFIED); fine-grained | | | |
| 1083.6 | 3.3 | FLY ASH (SOLIDIFIED); gray; very soft | | | |
| 1083.3 | 3.6 | FLY ASH (SOLIDIFIED); light brownish gray with few light olive brown layers; very soft | | 44.7 | 88.1 |
| 1082.0 | 4.9 | FLY ASH (UNSOLIDIFIED); grayish brown with abundant fine to coarse sand-sized to fine to coarse gravel-sized black cinders | | | |
| 1074.6 | 12.3 | FLY ASH (SOLIDIFIED); grayish brown with few layers of light brownish gray; very soft; fine-grained | | 45.1 | 88 |
| | | | | 38.2 | 115.8 |
| 1070.9 | 16.0 | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; very dark grayish brown; wet; stiff. (Alluvial Clay) | | | |
| 1069.6 | 17.3 | Boring Terminated at: 17.3ft | | | |

Depth scale (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

| | |
|---|---|
| PROJECT: | Mid American Energy Fly Ash Ponds Containment Assessment |
| LOCATION: | Section M-M, N 3595126.7, E 4146829.1 Port Neal North Powerplant, West of Salix, Iowa |
| JOB NO.: | 52-69-5092 |
| RIG / METHOD: | Hand Auger / Hand Auger |
| CREW: | CL&SG |
| WATER LEVELS | ⊻ No Groundwater Encountered |

# BORING LOG

BORING No.: 5b



DATE: 4-23-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | DRY DENSITY (pcf) | MOISTURE (%) |
|---|---|---|---|---|---|---|
| 1075.1 | 0.0 | | CL - LEAN CLAY; 5-15% fine sand; medium plasticity; very dark brown; wet; stiff. (Topsoil) | | | |
| 1074.6 | 0.5 | | ML - SILT; 10-15% fine sand; low plasticity; grayish brown mottled with yellowish brown; moist to wet; loose to medium dense. (Alluvium) | 6 | 89.7 | 17.9 |
| 1072.9 | 2.2 | | SM - SILTY SAND; 60-70% fine sand; low plasticity; light olive brown; wet; medium dense. (Alluvium) | | | |
| 1071.6 | 3.5 | | SM - SILTY SAND; 70-80% fine sand; low plasticity; light olive brown; wet; medium dense. (Alluvium) | | | |
| 1070.1 | 5.0 | | Boring Terminated at: 5.0ft | | | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/9/09

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section L-L, N 3594548.5, E 4147351.3 Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: Hand Auger / Hand Auger
CREW: CL&SG

BORING No.: 9
SHEET 1 of 1
DATE: 4-23-2009

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LITHOLOGY DESCRIPTION | SAMPLE | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) |
|---|---|---|---|---|---|---|
| 1080.8 | 0.0 | CL - LEAN CLAY; 10-15% fine to medium sand; medium plasticity; brown; wet; medium stiff. (Fill) | | | | |
| 1080.3 | 0.5 | CL - LEAN CLAY; 5-15% fine sand; medium plasticity; dark grayish brown; wet; medium stiff. (Fill) | 7 | 0.75* | 84.6 | 29.2 |
| 1080.0 | 0.8 | CH - FAT CLAY; 0-5% fine sand; high plasticity; grayish brown; wet; stiff. (Fill) | | 1.0* | 94.6 | 26.6 |
| 1079.5 | 1.3 | ML - SILT; 10-20% fine sand; low plasticity; dark grayish brown mottled with yellowish red; wet; medium dense. (Fill) | | | | |
| 1079.0 | 1.8 | CH - FAT CLAY; high plasticity; grayish brown; wet; very stiff. (Fill) | | | | |
| 1078.7 | 2.1 | CL/CH - LEAN TO FAT CLAY; medium to high plasticity; dark olive brown; wet; stiff. (Fill) | | | | |
| 1077.3 | 3.5 | CH - FAT CLAY; high plasticity; dark grayish brown; wet; stiff. (Alluvium) | | | | |
| 1077.0 | 3.8 | SM - SILTY SAND; 75-85% fine to medium sand; low plasticity; dark grayish brown; moist; medium dense. (Alluvium) | 8 | 1.0* | 93.4 | 28.9 |
| 1076.8 | 4.0 | CH - FAT CLAY; high plasticity; grayish brown slightly mottled with yellowish red; wet; medium dense; stiff. (Alluvium) | | | | |
| 1075.6 | 5.2 | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; brown; wet; stiff. (Alluvium) | | | | |
| 1073.8 | 7.0 | Boring Terminated at: 7.0ft | | | | |

DEPTH (feet) scale: 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0



* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

LOCATION: Section K2-K2, N 3594186.1, E 4147431.2
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 9a



JOB NO.: 52-69-5092

RIG / METHOD: CME 75HT / Straight Auger

CREW: CL&SG

DATE: 4-22-2009

WATER LEVELS: ▽ 22.4 IAD ▽ 20.7 on 4-23-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | SAND CONTENT (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1085.7 | 0.0 | | FLY ASH; gray; moist; loose. (Fill) | | | | | | | 0.0 |
| 1085.3 | 0.4 | | CL - LEAN CLAY; 5-15% fine to medium sand; medium plasticity; brown; wet; stiff. (Fill) | | | | | | | 2.5 |
| 1082.7 | 3.0 | | CL - LEAN CLAY; 5-15% fine sand; medium plasticity; dark grayish brown slightly mottled with dark reddish brown; wet; very stiff. (Fill) | 9 | | 1.0 | 100.3 | 21.4 | | |
| 1081.6 | 4.1 | | CH - FAT CLAY; 0-5% fine sand; high plasticity; dark grayish brown; wet; very stiff. (Fill) | | | 2.0* | 103.3 | 19.3 | | |
| 1081.1 | 4.6 | | CL - LEAN CLAY; 5-10% fine to medium sand; medium plasticity; brown mottled with pale brown; wet; stiff. (Fill) | | | | | | | 5.0 |
| 1079.7 | 6.0 | | CH - SANDY FAT CLAY; 40-45% fine to coarse sand; high plasticity; dark grayish brown slightly mottled with reddish brown; wet; very stiff; with silt seams. (Fill) | 10 | | | 109.1 | 19.2 | 42 | |
| 1078.9 | 6.8 | | SC - CLAYEY SAND; 50-55% fine sand; medium plasticity; dark gray mottled with dark grayish brown; wet; loose to medium dense. (Fill) | | | | | | 50 | |
| 1078.5 | 7.2 | | CL - LEAN CLAY; 5-15% fine sand; medium plasticity; brown mottled with pale brown; wet; medium stiff to stiff. (Fill) | | | | | | | 7.5 |
| 1077.2 | 8.5 | | CL - LEAN CLAY; 10-15% fine to coarse sand; medium plasticity; grayish brown mottled with very dark grayish brown; wet; stiff. (Fill) | | 4<br>5<br>6<br>(11) | | | | | |
| 1075.7 | 10.0 | | CH - FAT CLAY; high plasticity; dark brown; wet; very stiff. (Fill) | | | | | | | 10.0<br>12.5 |
| 1072.2 | 13.5 | | CH - FAT CLAY; high plasticity; dark brown mottled with gray; wet; very stiff. (Fill) | | 4<br>4<br>6<br>(10) | | | | | |
| 1070.7 | 15.0 | | CH - FAT CLAY; high plasticity; olive; wet; medium stiff. (Alluvium) | | | | | | | 15.0 |
| 1069.7 | 16.0 | | CH - FAT CLAY; high plasticity; grayish brown mottled with gray and dark gray; wet; stiff. (Alluvium) | 11 | | | | | | |
| 1069.1 | 16.6 | | CH - FAT CLAY; high plasticity; dark grayish brown slightly mottled with grayish brown; wet; stiff. (Alluvium) | | | 0.25*<br>1.0* | 78.9<br>76.6 | 40.3<br>44 | | 17.5 |
| 1067.9 | 17.8 | | CH - FAT CLAY; high plasticity; gray; wet; medium stiff. (Alluvium) | | 5<br>9<br>10<br>(19) | | | | | |
| 1066.2 | 19.5 | | SP - POORLY GRADED SAND; 95-100% fine sand; low plasticity; dark | | | | | | | |
| 1065.7 | 20.0 | | | | | | | | | 20.0 |

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.



Figure C - 8a

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

| | |
|---|---|
| PROJECT: | Mid American Energy Fly Ash Ponds Containment Assessment |
| LOCATION: | Section K2-K2, N 3594186.1, E 4147431.2 Port Neal North Powerplant, West of Salix, Iowa |
| JOB NO.: | 52-69-5092 |
| RIG / METHOD: | CME 75HT / Straight Auger |
| CREW: | CL&SG |

# BORING LOG

BORING No.: 9a

SHEET 2 of 2

DATE: 4-22-2009

WATER LEVELS ▼ 22.4 IAD ▼ 20.7 on 4-23-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|
| | | | brown; wet; medium dense. (Alluvium) | | | | | | 20.0 |
| | | | SP - POORLY GRADED SAND; 95-100% fine to coarse sand; low plasticity; grayish brown; saturated; medium dense. (Alluvium) | | | | | | 22.5 |
| | | | | | 3 4 6 (10) | | | | |
| 1060.7 | 25.0 | | Boring Terminated at: 25.0ft | | | | | | 25.0 |
| | | | | | | | | | 27.5 |
| | | | | | | | | | 30.0 |
| | | | | | | | | | 32.5 |
| | | | | | | | | | 35.0 |
| | | | | | | | | | 37.5 |
| | | | | | | | | | 40.0 |

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/9/09

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section K2-K2, N 3594210.6, E 4147477.9
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 9b



JOB NO.: 52-69-5092
RIG / METHOD: Hand Auger / Hand Auger
CREW: CL&SG

DATE: 4-23-2009

WATER LEVELS ▼ 1.5 IAD

| ELEV (NAVD88) | DEPTH (feet) | LITHOLOGY DESCRIPTION | SAMPLE | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) |
|---|---|---|---|---|---|---|
| 1071.6 | 0.0 | OL - ORGANIC CLAY; medium plasticity; black; wet; medium stiff. (Topsoil) | | | | |
| 1071.1 | 0.5 | CL - LEAN CLAY; medium plasticity; grayish brown; wet to saturated; medium stiff. (Alluvium) | 12 | 2.75* | 91.3 | 29.5 |
| 1070.7 | 0.9 | CL - LEAN CLAY; medium plasticity; grayish brown; wet to saturated; stiff. (Alluvium) | | | 104.9 | 24.8 |
| 1070.1 | 1.5 | CL - LEAN CLAY; medium plasticity; dark gray slightly mottled with brown; saturated; medium stiff to stiff. (Alluvium) | | | | |
| 1068.1 | 3.5 | CH - FAT CLAY; high plasticity; olive brown mottled with olive gray; saturated; stiff. (Alluvium) | 13 | 0.75* | 74.1 | 46.1 |
| 1067.1 | 4.5 | CH - FAT CLAY; high plasticity; gray mottled with brown; saturated; medium stiff. (Alluvium) | | | | |
| 1065.1 | 6.5 | SP-SM - POORLY GRADED SAND with Silt; 90-95% fine sand; nonplastic; light olive brown; saturated; medium dense. (Alluvium) | | | | |
| 1062.6 | 9.0 | Boring Terminated at: 9.0ft | | | | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0



* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section H2-H2, N 3593557.2, E 4146975.6
Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

BORING No.: 12

DATE: 4-21-2009

WATER LEVELS ▼ 9.5 IAD ▼ 6.0 on 4-22-2009

| ELEV (NAVD88) | DEPTH (feet) | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | SAND CONTENT (%) |
|---|---|---|---|---|---|---|---|---|
| 1082.8 | 0.0 | FLY ASH; 10-15% fine to coarse gravel; light yellow mottled with dark brown; moist; very dense. (Fill) | | | | | | |
| 1081.6 | 1.2 | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; dark grayish brown slightly mottled with yellowish red; wet; stiff. (Fill) | | | | | | |
| 1079.3 | 3.5 | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; dark grayish brown slightly mottled with yellowish red; wet; medium stiff. (Fill) | | 2 2 3 (5) | 2.0* | 85.9 | 29.7 | |
| 1076.8 | 6.0 | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; dark grayish brown slightly mottled with yellowish red; saturated; medium stiff. (Fill) | 14 | | 0.5* 0.7 | 84.3 | 32.7 | |
| 1074.3 | 8.5 | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; dark brown; saturated; medium stiff. (Fill) | | 2 2 2 (4) | | | | |
| 1071.8 | 11.0 | CL - LEAN CLAY; medium plasticity; dark gray mottled with gray; saturated; medium stiff. (Fill) | 15 | | 0.75* | 86.3 | 32.2 | |
| | | | | | 0.5* 0.8 | 84.3 | 33.4 | |
| 1069.9 | 12.9 | CL - LEAN CLAY; medium plasticity; dark gray mottled with gray; saturated; medium stiff. (Fill) | | | | | | |
| 1069.3 | 13.5 | CL - LEAN CLAY; 5-10% fine to coarse sand; medium plasticity; dark gray mottled with gray; saturated; medium stiff. (Fill) | | 1 1 2 (3) | | | | |
| 1067.8 | 15.0 | CL - LEAN CLAY with Sand; 20-30% fine to coarse sand; medium plasticity; olive brown mottled with grayish brown; saturated; medium stiff. (Alluvium) | | | | | | |
| 1064.8 | 18.0 | CH - FAT CLAY; 10-15% fine sand; high plasticity; brown; saturated; stiff. (Alluvium) | | | | | | |
| 1062.8 | 20.0 | | | | | | | |

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

Figure C - 10a

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section H2-H2, N 3593557.2, E 4146975.6 Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

BORING No.: 12

DATE: 4-21-2009

WATER LEVELS: 9.5 IAD; 6.0 on 4-22-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | SAND CONTENT (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 20.0 |
| 1062.3 | 20.5 | | CH - FAT CLAY; 10-15% fine sand; high plasticity; brown; saturated; stiff. (Alluvium) | | | | | | | |
| 1060.8 | 22.0 | | SC - CLAYEY SAND; 65-75% fine sand; medium plasticity; brown; saturated; loose. (Alluvium) | | 0 1 3 (4) | | | | 71.0 | |
| | | | | | | | | | | 22.5 |
| 1059.3 | 23.5 | | CH - FAT CLAY; high plasticity; brown; saturated; stiff. (Alluvium) | | | | | | | |
| 1057.8 | 25.0 | | CH - FAT CLAY; high plasticity; brown; saturated; stiff; with sand seams. (Alluvium) | | 2 3 5 (8) | | | | | 25.0 |
| | | | Boring Terminated at: 25.0ft | | | | | | | |
| | | | | | | | | | | 27.5 |
| | | | | | | | | | | 30.0 |
| | | | | | | | | | | 32.5 |
| | | | | | | | | | | 35.0 |
| | | | | | | | | | | 37.5 |
| | | | | | | | | | | 40.0 |

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/9/09

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section H2-H2, N 3593534.2, E 4146979.3, Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: Hand Auger / Hand Auger
CREW: CL&SG

BORING No.: 12b
SHEET 1 of 1
DATE: 4-23-2009

WATER LEVELS ▽ 1.0 IAD

| ELEV (NAVD88) | DEPTH (feet) | LITHOLOGY DESCRIPTION | SAMPLE | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) |
|---|---|---|---|---|---|---|
| 1075.6 | 0.0 | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; brown; wet; soft to medium stiff. (Fill) | | | | |
| 1075.1 | 0.5 | CL - LEAN CLAY; medium plasticity; dark grayish brown mottled with reddish brown; wet; soft. (Fill) | 16 | 0.25* | 80.1 | 39.2 |
| 1074.6 | 1.0 ▽ | | | | | |
| 1074.2 | 1.4 | CL - LEAN CLAY; medium plasticity; dark grayish brown mottled with reddish brown; saturated; soft. (Fill) | | 0.5* | 87.4 | 33.9 |
| 1073.8 | 1.8 | CL - LEAN CLAY; medium plasticity; dark grayish brown mottled with olive brown; saturated; medium stiff. (Fill) | | | | |
| | | CL - LEAN CLAY; medium plasticity; very dark grayish brown; saturated; soft to medium stiff. (Fill) | | | | |
| 1072.1 | 3.5 | CL - LEAN CLAY; medium plasticity; dark gray; saturated; very soft. (Fill) | 17 | 0.0* | 81.9 | 36.6 |
| 1071.2 | 4.4 | CH - FAT CLAY; high plasticity; dark grayish brown mottled with grayish brown; saturated; stiff. (Fill) | | 1.5* | 84.1 | 37.6 |
| 1070.7 | 4.9 | CL - LEAN CLAY; medium plasticity; very dark grayish brown; saturated; stiff. (Alluvium) | | | | |
| 1069.6 | 6.0 | CL - LEAN CLAY; medium plasticity; brown; saturated; stiff. (Alluvium) | | | | |
| 1067.6 | 8.0 | Boring Terminated at: 8.0ft | | | | |

Depth scale (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section E-E, N 3592699.3, E 4143971.6
Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

BORING No.: 14

DATE: 4-22-2009

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | SAND CONTENT (%) |
|---|---|---|---|---|---|---|---|---|
| 1085.8 | 0.0 | BOTTOM ASH WITH FLY ASH; 10-15% fine to coarse sand; black; moist; loose. (Fill) | | | | | | |
| 1081.8 | 4.0 | CL - LEAN CLAY with Sand; 20-30% fine to medium sand; medium plasticity; grayish brown with dark gray; wet; very stiff. (Fill) | 18 | | 3.5* | 104.5 | 17.6 | 25.0 |
| 1081.3 | 4.5 | SC - CLAYEY SAND; 55-65% fine to medium sand; medium plasticity; dark grayish brown with dark gray; wet; medium dense. (Fill) | | | | | | |
| 1080.9 | 4.9 | SM - SILTY SAND; 65-75% fine to medium sand; low plasticity; dark grayish brown with reddish brown; wet; loose to medium dense; with zones of fat clay and clayey sand. (Fill) | | | | | | 71.0 |
| 1079.9 | 5.9 | SM - SILTY SAND; 65-75% fine to coarse sand; low plasticity; yellowish brown; wet; medium dense. (Fill) | | | | | | 74.0 |
| 1077.3 | 8.5 | CL - SANDY LEAN CLAY; 30-40% fine to coarse sand; medium plasticity; gray; wet; stiff. (Fill) | | | | | | |
| 1076.3 | 9.5 | SM - SILTY SAND; 80-90% fine to medium sand; low plasticity; gray with dark gray and strong brown; moist; loose to medium dense; zones of fat clay. (Fill) | 19 | | 1.75* | | | |
| 1075.9 | 9.9 | SC - CLAYEY SAND; 60-70% fine to medium sand; medium plasticity; dark grayish brown with black; wet; medium dense; zones of fat clay. (Fill) | | | 3.75* | 116.0 | 13.5 | 68.0 |
| 1075.3 | 10.5 | CH - FAT CLAY; high plasticity; gray slightly mottled with black; wet; stiff. (Alluvium) | | | | | | |
| 1072.8 | 13.0 | CH - FAT CLAY; 0-5% fine sand; high plasticity; dark gray with grayish brown and reddish brown; wet; very stiff. (Alluvium) | 20 | | 3.75*<br>2.5* | 92.5 | 25.2 | |
| 1071.4 | 14.4 | ML - SANDY SILT; 30-40% fine to medium sand; low plasticity; dark brown with yellowish brown; moist; medium dense. (Alluvium) | | | 3.5* | | | |
| 1071.0 | 14.8 | SM - SILTY SAND; 65-75% fine sand; low plasticity; light yellowish brown mottled with yellowish red; wet; medium dense. (Alluvium) | | | | | | |
| 1067.3 | 18.5 | SP - POORLY GRADED SAND; 95-100% fine sand; nonplastic; light yellowish brown; moist; medium dense. (Alluvium) | | 3<br>3<br>5<br>(8) | | | | |
| 1065.8 | 20.0 | | | | | | | |

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

| | | | |
|---|---|---|---|
| PROJECT: | Mid American Energy Fly Ash Ponds Containment Assessment | | **BORING LOG** |
| LOCATION: | Section E-E, N 3592699.3, E 4143971.6 Port Neal North Powerplant, West of Salix, Iowa | | BORING No.: 14 |
| JOB NO.: | 52-69-5092 | | SHEET 2 of 2 |
| RIG / METHOD: | CME 75HT / Straight Auger | | DATE: 4-22-2009 |
| CREW: | CL&SG | | |
| WATER LEVELS | ⊻ No Groundwater Encountered | | |

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | SAND CONTENT (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | SP-SM - POORLY GRADED SAND with Silt; 90-95% fine sand; nonplastic; light yellowish brown; moist; loose to medium dense. (Alluvium) | | | | | | | 20.0 |
| | | | | | | | | | | 22.5 |
| 1060.8 | 25.0 | | | | 2 2 3 (5) | | | | | 25.0 |
| | | | Boring Terminated at: 25.0ft | | | | | | | |
| | | | | | | | | | | 27.5 |
| | | | | | | | | | | 30.0 |
| | | | | | | | | | | 32.5 |
| | | | | | | | | | | 35.0 |
| | | | | | | | | | | 37.5 |
| | | | | | | | | | | 40.0 |

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS GDT 6/9/09

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

# BORING LOG

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

| | |
|---|---|
| PROJECT: | Mid American Energy Fly Ash Ponds Containment Assessment |
| LOCATION: | Section E-E<br>Port Neal North Powerplant, West of Salix, Iowa |
| JOB NO.: | 52-69-5092 |
| RIG / METHOD: | CME 75HT / Straight Auger |
| CREW: | CL&SG |
| WATER LEVELS | ⊻ No Groundwater Encountered |

BORING No.: 14E
SHEET 1 of 1
DATE: 4-22-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE |
|---|---|---|---|---|
| 1085.8 | 0.0 | | BOTTOM ASH WITH FLY ASH; 10-15% fine to coarse sand; black; moist; loose. (Fill) | |
| 1081.3 | 4.5 | | SC - CLAYEY SAND; 60-70% fine to coarse sand; medium plasticity; yellowish brown; wet; medium dense. (Fill) | |
| 1079.8 | 6.0 | | SC - CLAYEY SAND; 60-70% fine to coarse sand; medium plasticity; yellowish brown; wet; medium dense; with lean clay and poorly graded sand seams. (Fill) | |
| 1075.8 | 10.0 | | Boring Terminated at: 10.0ft | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/9/09

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section E-E
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 14W

JOB NO.: 52-69-5092



RIG / METHOD: CME 75HT / Straight Auger

DATE: 4-22-2009

CREW: CL&SG

WATER LEVELS ∇ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | DEPTH (feet) |
|---|---|---|---|---|---|
| 1085.8 | 0.0 | | BOTTOM ASH WITH FLY ASH; 10-15% fine to coarse sand; black; moist; loose. (Fill) | | 0.0 |
| 1084.3 | 1.5 | | FLY ASH; 10-15% fine to coarse sand; moist; loose. (Fill) | | 2.5 |
| 1080.3 | 5.5 | | CL - LEAN CLAY; medium plasticity; brown; wet; medium stiff. (Fill) | | 5.0 |
| 1078.3 | 7.5 | | SP-SM - POORLY GRADED SAND with Silt; 90-95% fine to medium sand; nonplastic; light yellowish brown; wet; medium dense. (Fill) | | 7.5 |
| 1075.8 | 10.0 | | Boring Terminated at: 10.0ft | | 10.0 |
| | | | | | 12.5 |
| | | | | | 15.0 |
| | | | | | 17.5 |
| | | | | | 20.0 |

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS GDT 6/9/09

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section E-E
Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: Hand Auger / Hand Auger
CREW: CL&SG

# BORING LOG

BORING No.: 14c

DATE: 4-23-2009

WATER LEVELS ▽ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 1075.6 | 0.0 | | CL - LEAN CLAY; medium plasticity; very dark grayish brown; wet; medium stiff. (Fill) | | | | | 0.0 |
| 1075.1 | 0.5 | | CL - LEAN CLAY; 0-5% fine sand; medium plasticity; dark grayish brown; wet; stiff; friable. (Alluvium) | 21 | 3.25* | | | |
| 1074.7 | 0.9 | | CH - FAT CLAY; 0-5% fine sand; high plasticity; dark grayish brown; wet; very stiff. (Alluvium) | | | 99.5 | 24.2 | |
| 1073.9 | 1.7 | | SM - SILTY SAND; 65-75% fine sand; low plasticity; yellowish brown; wet; loose to medium dense; interbedded with lean clay seams. (Alluvium) | | 2.0* | | | |
| 1073.7 | 1.9 | | CH - FAT CLAY; high plasticity; dark olive brown; wet; stiff. (Alluvium) | | | | | 2.5 |
| 1072.1 | 3.5 | | CH - FAT CLAY; high plasticity; dark grayish brown slightly mottled with yellowish red; wet; stiff. (Alluvium) | 22 | | 81.8 | 30.9 | |
| 1071.3 | 4.3 | | CH - FAT CLAY; high plasticity; dark grayish brown slightly mottled with yellowish red; wet; very stiff. (Alluvium) | | | 94.6 | 26.3 | |
| 1070.8 | 4.8 | | Boring Terminated at: 4.8ft | | | | | 5.0 |
| | | | | | | | | 7.5 |
| | | | | | | | | 10.0 |
| | | | | | | | | 12.5 |
| | | | | | | | | 15.0 |
| | | | | | | | | 17.5 |
| | | | | | | | | 20.0 |



* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

BORING No.: 15



DATE: 4-23-2009

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section G-G, N 3593138.5, E 4145056.6
Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) |
|---|---|---|---|---|---|---|---|---|
| 1087.7 | 0.0 | | FLY ASH; 10-15% fine to coarse sand; 5-10% fine to coarse gravel; yellowish brown; moist; loose. (Fill) | | | | | |
| 1087.2 | 0.5 | | FLY ASH; 10-15% fine to coarse sand; 5-10% fine to coarse gravel; yellowish brown; moist; medium dense. (Fill) | | 14 7 3 (10) | | | |
| 1086.3 | 1.4 | | FLY ASH; gray; wet; medium dense. (Fill) | | | | | |
| 1085.7 | 2.0 | | FLY ASH; gray; wet to saturated; medium dense. (Fill) | | | | | |
| 1084.2 | 3.5 | | FLY ASH with seams of bottom ash; gray with black; wet to saturated; loose. (Fill) | | 1 1 1 (2) | | | |
| 1082.7 | 5.0 | | FLY ASH with seams of bottom ash; gray with black; wet; loose. (Fill) | 23 | | | 59.5 | 58.1 |
| 1081.0 | 6.7 | | FLY ASH with seams of bottom ash; gray with black; wet; loose to medium dense. (Fill) | | 1 0 1 (1)<br>1 10 14 (24) | | | |
| 1074.9 | 12.8 | | CL/CH - LEAN TO FAT CLAY; medium to high plasticity; dark gray; wet; medium stiff. (Alluvium) | | 9 4 4 (8) | | | |
| 1073.7 | 14.0 | | CH - FAT CLAY; high plasticity; dark gray mottled with black and greenish gray; wet; stiff. (Alluvium) | 24 | | 1.5*<br>1.75* | 84.2 | 34.7 |
| 1072.4 | 15.3 | | CH - FAT CLAY; 5-15% fine sand; high plasticity; dark gray slightly mottled with black and yellowish red; wet; stiff. (Alluvium) | 25 | | 1.5* | 97.9 | 26.2 |
| 1069.2 | 18.5 | | SP-SM - POORLY GRADED SAND with Silt; 90-95% fine to medium sand; nonplastic; yellowish brown; wet; medium dense. (Alluvium) | | 3 4 7 (11) | | | |
| 1067.7 | 20.0 | | | | | | | |

* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/9/09

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section G-G, N 3593138.5, E 4145056.6
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 15



JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

DATE: 4-23-2009

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | SPT | qu (tsf) | DRY DENSITY (pcf) | MOISTURE (%) | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|---|
| | | | SP - POORLY GRADED SAND; 95-100% fine sand; nonplastic; light grayish brown; wet; medium dense. (Alluvium) | | | | | | 20.0 |
| | | | | | | | | | 22.5 |
| | | | | | 7 8 10 (18) | | | | |
| 1062.7 | 25.0 | | SP-SM - POORLY GRADED SAND with Silt; 90-95% fine to medium sand; nonplastic; yellowish brown; wet; medium dense. (Alluvium) | | | | | | 25.0 |
| | | | | | | | | | 27.5 |
| | | | | | 2 3 6 (9) | | | | |
| 1057.7 | 30.0 | | Boring Terminated at: 30.0ft | | | | | | 30.0 |
| | | | | | | | | | 32.5 |
| | | | | | | | | | 35.0 |
| | | | | | | | | | 37.5 |
| | | | | | | | | | 40.0 |



* Unconfined compressive strength was estimated using a calibrated hand penetrometer.

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section G-G, N 3593120.4, E 4145071.8
Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

BORING No.: 15b

DATE: 4-23-2009

WATER LEVELS ▽ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LITHOLOGY DESCRIPTION | SPT |
|---|---|---|---|
| 1087.8 | 0.0 | FLY ASH; 10-15% fine to coarse sand; 5-10% fine to coarse gravel; dark yellowish brown; moist; loose. (Fill) | |
| 1086.8 | 1.0 | FLY ASH; light gray; wet to saturated; loose. (Fill) | |
| 1084.3 | 3.5 | FLY ASH; light gray; wet; loose. (Fill) | 1 1 1 (2) |
| 1082.8 | 5.0 | FLY ASH with bottomash; light gray with black; wet to saturated; loose. (Fill) | |
| 1079.3 | 8.5 | FLY ASH with bottomash; light gray with black; wet; loose. (Fill) | 1 0 1 (1) |
| 1074.0 | 13.8 | CL/CH - LEAN TO FAT CLAY; 0-5% fine sand; medium to high plasticity; dark gray; wet; stiff. (Alluvium) | 3 4 7 (11) |
| 1072.8 | 15.0 | MH - SILT; low plasticity; dark olive brown mottled with yellowish red; wet; medium dense. (Alluvium) | |
| 1070.3 | 17.5 | SP - POORLY GRADED SAND; 95-100% fine to medium sand; nonplastic; light grayish brown; wet; medium dense. (Alluvium) | 3 4 6 (10) |
| 1067.8 | 20.0 | Boring Terminated at: 20.0ft | |

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/11/09

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section G-G, 7' N of B-15
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 15N

JOB NO.: 52-69-5092

SHEET 1 of 1

RIG / METHOD: CME 75HT / Straight Auger

DATE: 4-23-2009

CREW: CL&SG

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE |
|---|---|---|---|---|
| 1087.7 | 0.0 | | FLY ASH; 10-15% fine to coarse sand; 5-10% fine to coarse gravel; yellowish brown; moist; loose. (Fill) | |
| 1086.2 | 1.5 | | FLY ASH; gray; wet to saturated; loose. (Fill) | |
| 1082.7 | 5.0 | | FLY ASH with 5-10% bottomash; trace of gravel; gray; wet to saturated; loose. (Fill) | |
| 1075.7 | 12.0 | | CL - LEAN CLAY; medium plasticity; dark gray; wet; stiff. (Fill) | |
| 1074.2 | 13.5 | | SM - SILTY SAND; 75-85% fine to coarse sand; low plasticity; yellowish brown; wet; loose to medium dense. (Alluvium) | |
| 1073.2 | 14.5 | | CL - LEAN CLAY; medium plasticity; gray mottled with olive brown; wet; stiff. (Alluvium) | |
| 1072.7 | 15.0 | | Boring Terminated at: 15.0ft | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section G-G, 9' S of B-15, Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 15S



JOB NO.: 52-69-5092

RIG / METHOD: CME 75HT / Straight Auger

CREW: CL&SG

DATE: 4-23-2009

WATER LEVELS: No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE |
|---|---|---|---|---|
| 1087.7 | 0.0 | | FLY ASH; 10-15% fine to coarse sand; 5-10% fine to coarse gravel; yellowish brown; moist; loose. (Fill) | |
| 1086.7 | 1.0 | | FLY ASH; gray; wet; loose. (Fill) | |
| 1084.7 | 3.0 | | FLY ASH; 10-15% fine to coarse sand; 5-10% fine to coarse gravel; yellowish brown; wet to saturated; loose. (Fill) | |
| 1081.7 | 6.0 | | FLY ASH with 5-10% bottom ash; gray with balck; wet to saturated; loose. (Fill) | |
| 1077.7 | 10.0 | | FLY ASH; gray; wet; loose. (Fill) | |
| 1073.7 | 14.0 | | CL/CH - LEAN TO FAT CLAY; 0-5% fine sand; medium to high plasticity; dark gray mottled with black; wet; stiff. (Alluvium) | |
| 1072.7 | 15.0 | | Boring Terminated at: 15.0ft | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section G-G, 14' N of B-15, Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: CME 75HT / Straight Auger
CREW: CL&SG

BORING No.: 15X
SHEET 1 of 1
DATE: 4-23-2009

WATER LEVELS ∇ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LITHOLOGY DESCRIPTION | SAMPLE | SPT | DRY DENSITY (pcf) | MOISTURE (%) | SAND CONTENT (%) |
|---|---|---|---|---|---|---|---|
| 1087.7 | 0.0 | FLY ASH; 0-5% fine to coarse sand; gray; wet; loose. (Fill) | | | | | |
| 1082.7 | 5.0 | FLY ASH with 10-20% bottom ash; grayish brown with yellowish brown and black; wet; medium dense. (Fill) | 26 | | 57.6 | 55.9 | |
| 1081.9 | 5.8 | BOTTOM ASH; black; moist; loose. (Fill) | | | | | |
| 1081.4 | 6.3 | FLY ASH with 10-20% bottom ash; gray with black; wet; loose. (Fill) | | | | | |
| 1079.7 | 8.0 | CL - LEAN CLAY; medium plasticity; brown mottled with black and dark brown; wet; stiff. (Fill) | | | | | |
| 1078.2 | 9.5 | SM - SILTY SAND; 70-80% fine to coarse sand; nonplastic; light yellowish brown; wet; medium dense. (Fill) | | | | | 74.0 |
| 1077.2 | 10.5 | SM - SILTY SAND; 70-80% fine to coarse sand; nonplastic; light yellowish brown; wet; medium dense; with lean clay seams. (Fill) | | | | | |
| 1075.7 | 12.0 | CL/CH - LEAN TO FAT CLAY; medium to high plasticity; gray; wet; stiff. (Alluvium) | | | | | |
| 1074.2 | 13.5 | CL/CH - LEAN TO FAT CLAY; medium to high plasticity; gray; wet; stiff. (Alluvium) | | 2<br>4<br>5<br>(9) | | | |
| 1072.7 | 15.0 | Boring Terminated at: 15.0ft | | | | | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section G-G, 46' N of B-15b
Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: Hand Auger / Hand Auger
CREW: CL&GW

BORING No.: 15N-1
SHEET 1 of 1
DATE: 6-11-2009

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | DEPTH (feet) |
|---|---|---|---|---|---|
| 1087.6 | 0.0 | | ML - SANDY SILT; 35-45% fine sand; low plasticity; dark grayish brown; wet; loose; with fly ash chuncks. (Fill) | | 0.0 |
| | | | | | 2.5 |
| 1084.1 | 3.5 | | ML - SANDY SILT; 35-45% fine sand; low plasticity; dark grayish brown; wet to saturated; loose; with fly ash chunks. (Fill) | | |
| | | | | | 5.0 |
| 1081.0 | 6.6 | | CL - LEAN CLAY; medium plasticity; very dark grayish brown; wet; very stiff; with clayey sand seams. (Fill) | | |
| 1080.4 | 7.2 | | SP-SM - POORLY GRADED SAND with Silt; dark brown; moist to wet; loose. (Fill) | | |
| 1079.9 | 7.7 | | CL - LEAN CLAY with Sand; 15-25% fine sand; medium plasticity; very dark grayish brown; wet; stiff to very stiff. (Fill) | | 7.5 |
| 1078.5 | 9.1 | | SP-SM - POORLY GRADED SAND with Silt; 85-95% fine sand; nonplastic; dark yellowish brown; moist to wet; medium dense. (Fill) | | |
| 1077.6 | 10.0 | | Boring Terminated at: 10.0ft | | 10.0 |
| | | | | | 12.5 |
| | | | | | 15.0 |
| | | | | | 17.5 |
| | | | | | 20.0 |

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/15/09

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

# BORING LOG

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment
LOCATION: Section G-G, 52.5' N of B-15b
Port Neal North Powerplant, West of Salix, Iowa
JOB NO.: 52-69-5092
RIG / METHOD: Hand Auger / Hand Auger
CREW: CL&GW

BORING No.: 15N-2
SHEET 1 of 1
DATE: 6-11-2009

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE |
|---|---|---|---|---|
| 1087.1 | 0.0 | | FLY ASH - Unconsolidated. (Fill) | |
| 1085.1 | 2.0 | | SM - SILTY SAND; 70-80% fine sand; low plasticity; dark grayish brown; moist to wet; loose to medium dense; with clayey sand and fly ash seams. (Fill) | |
| 1084.1 | 3.0 | | SM - SILTY SAND; 70-80% fine sand; low plasticity; dark grayish brown; moist to wet; loose to medium dense. (Fill) | |
| 1083.6 | 3.5 | | CL - LEAN CLAY; medium plasticity; dark gray mottled with yellowish red; wet; stiff. (Fill) | |
| 1082.6 | 4.5 | | SP-SM - POORLY GRADED SAND with Silt; 85-95% fine sand; low plasticity; dark grayish brown; moist to wet; loose. (Fill) | |
| 1082.1 | 5.0 | | CL - LEAN CLAY; medium plasticity; very dark grayish brown; wet; very stiff; with clayey sand seams. (Fill) | |
| 1080.6 | 6.5 | | Boring Terminated at: 6.5ft | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

| | |
|---|---|
| PROJECT: | Mid American Energy Fly Ash Ponds Containment Assessment |
| LOCATION: | Section G-G, 56' N of B-15b<br>Port Neal North Powerplant, West of Salix, Iowa |
| JOB NO.: | 52-69-5092 |
| RIG / METHOD: | Hand Auger / Hand Auger |
| CREW: | CL&GW |
| WATER LEVELS | ⊻ No Groundwater Encountered |

# BORING LOG

BORING No.: 15N-3

SHEET 1 of 1

DATE: 6-11-2009

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE |
|---|---|---|---|---|
| 1087.1 | 0.0 | | Fly Ash - Unconsolidated. (Fill) | |
| 1084.1 | 3.0 | | SM - SILTY SAND; 70-80% fine sand; low plasticity; grayish brown; moist; loose. (Fill) | |
| 1083.6 | 3.5 | | SP-SM - POORLY GRADED SAND with Silt; 85-95% fine sand; nonplastic; grayish brown; moist; loose. (Fill) | |
| 1081.7 | 5.4 | | CL - LEAN CLAY; 20-30% fine sand; medium plasticity; very dark grayish brown; wet; very stiff. (Fill) | |
| 1080.1 | 7.0 | | Boring Terminated at: 7.0ft | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

BORING LOG MID AMERICA ENERGY LOGS.GPJ HWS.GDT 6/15/09

HWS
Solutions Through Service
825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

PROJECT: Mid American Energy Fly Ash Ponds Containment Assessment

# BORING LOG

LOCATION: Section G-G, 61' N of B-15b
Port Neal North Powerplant, West of Salix, Iowa

BORING No.: 15N-4

JOB NO.: 52-69-5092

SHEET 1 of 1

RIG / METHOD: Hand Auger / Hand Auger

DATE: 6-11-2009

CREW: CL&GW

WATER LEVELS ∇ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE |
|---|---|---|---|---|
| 1086.7 | 0.0 | | FLY ASH - Unconsolidated, brown, moist. (Fill) | |
| 1084.7 | 2.0 | | FLY ASH - Consolidated mixed with unconsolidated, white & brown, wet. (Fill) | |
| 1082.9 | 3.8 | | SC-SM - SILTY, CLAYEY SAND; 50-60% fine sand; low to medium plasticity; very dark grayish brown with gray and very dark gray; wet; loose to medium dense. (Fill) | |
| 1081.4 | 5.3 | | SM - SILTY SAND; 70-80% fine sand; nonplastic; light gray; wet; loose. (Fill) | |
| 1080.1 | 6.6 | | CL - LEAN CLAY; medium plasticity; very dark gray mottled with yellowish red; wet; stiff. (Fill) | |
| 1079.7 | 7.0 | | CH - FAT CLAY; high plasticity; very dark gray mottled with yellowish red; wet; very stiff; Refusal on medium dense sand. (Fill) | |
| 1078.7 | 8.0 | | Boring Terminated at: 8.0ft | |

DEPTH (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

HWS
Solutions Through Service

825 J Street
Lincoln, NE 68501
402-479-2200 * Fax: 402-479-2276
www.hws.com

| | |
|---|---|
| PROJECT: | Mid American Energy Fly Ash Ponds Containment Assessment |
| LOCATION: | Section G-G, 66' N of B-15b<br>Port Neal North Powerplant, West of Salix, Iowa |
| JOB NO.: | 52-69-5092 |
| RIG / METHOD: | Hand Auger / Hand Auger |
| CREW: | CL&GW |

# BORING LOG

BORING No.: 15N-5

SHEET 1 of 1

DATE: 6-11-2009

WATER LEVELS ⊻ No Groundwater Encountered

| ELEV (NAVD88) | DEPTH (feet) | LOG | LITHOLOGY DESCRIPTION | SAMPLE | DEPTH (feet) |
|---|---|---|---|---|---|
| 1086.7 | 0.0 | | FLY ASH - Unconsolidated. (Fill) | | 0.0 |
| 1084.7 | 2.0 | | FLY ASH - Consolidated, hand auger refusal on solid fly ash. (Fill) | | |
| 1084.2 | 2.5 | | Boring Terminated at: 2.5ft | | 2.5 |
| | | | | | 5.0 |
| | | | | | 7.5 |
| | | | | | 10.0 |
| | | | | | 12.5 |
| | | | | | 15.0 |
| | | | | | 17.5 |
| | | | | | 20.0 |

**LINCOLN OFFICE**
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

SOUNDING NO.: **S-1**
LOCATION: **B-1**
SURFACE ELEVATION: **1086.3 feet**

DATE: **April 20, 2009**
TESTED BY: **CL**
RECORDED BY: **SG**

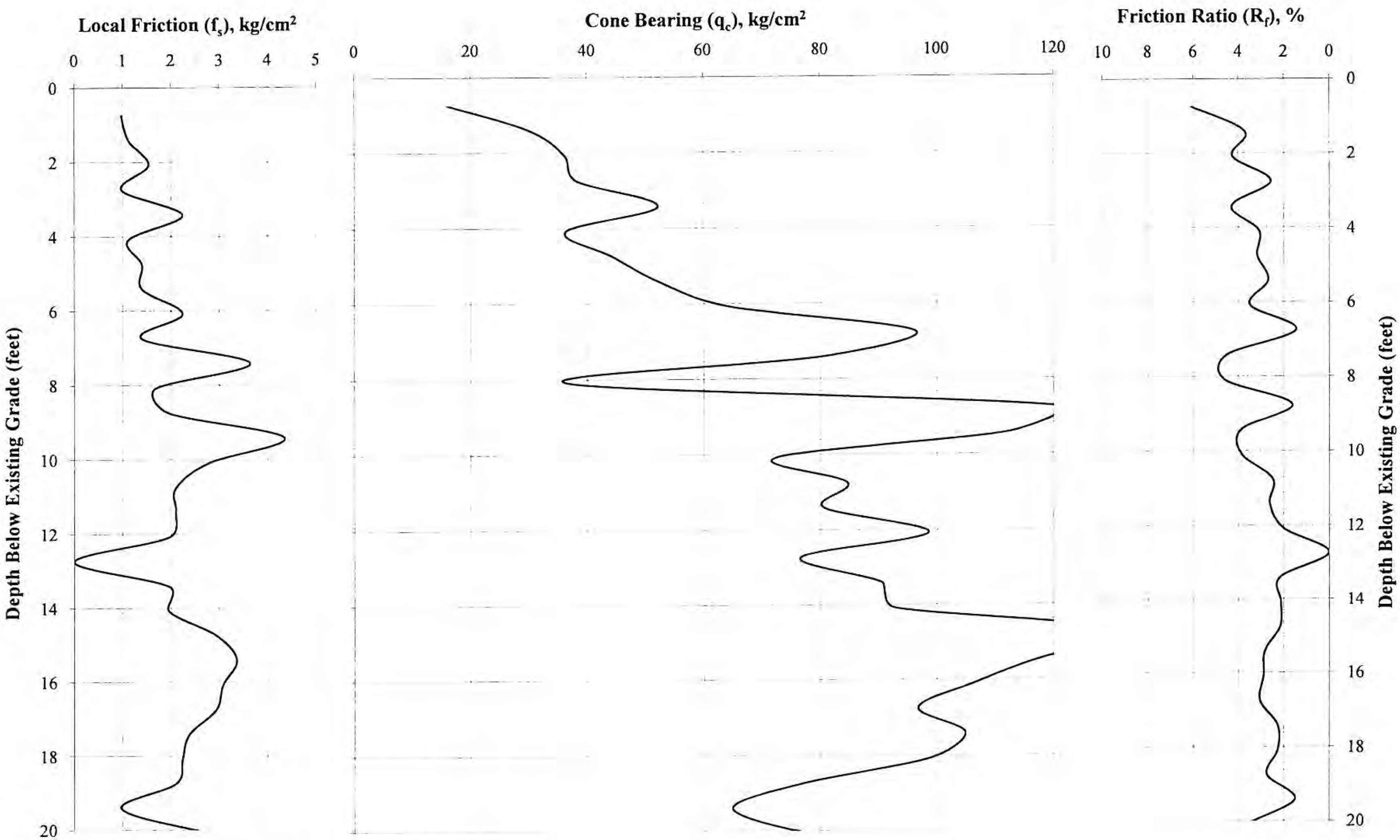



**Figure C-26a**

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

| | | | |
|---|---|---|---|
| SOUNDING NO.: | **S-1** | DATE: | **April 20, 2009** |
| LOCATION: | **B-1** | TESTED BY: | **CL** |
| SURFACE ELEVATION: | **1086.3 feet** | RECORDED BY: | **SG** |

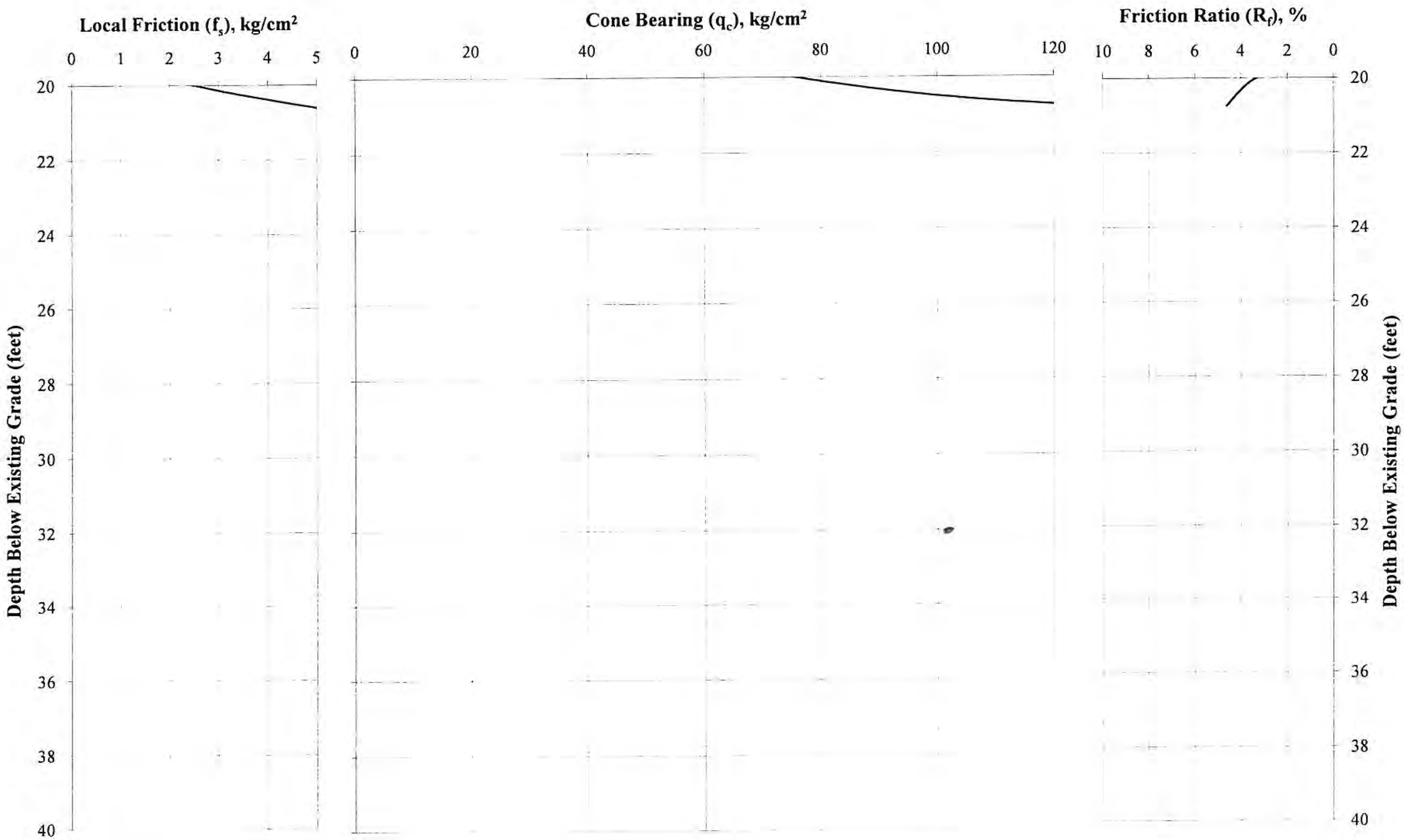



Figure C-26b

HWS Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

| | | | |
|---|---|---|---|
| SOUNDING NO.: | **S-2** | DATE: | **April 20, 2009** |
| LOCATION: | **B-2** | TESTED BY: | **CL** |
| SURFACE ELEVATION: | **1087.3 feet** | RECORDED BY: | **SG** |

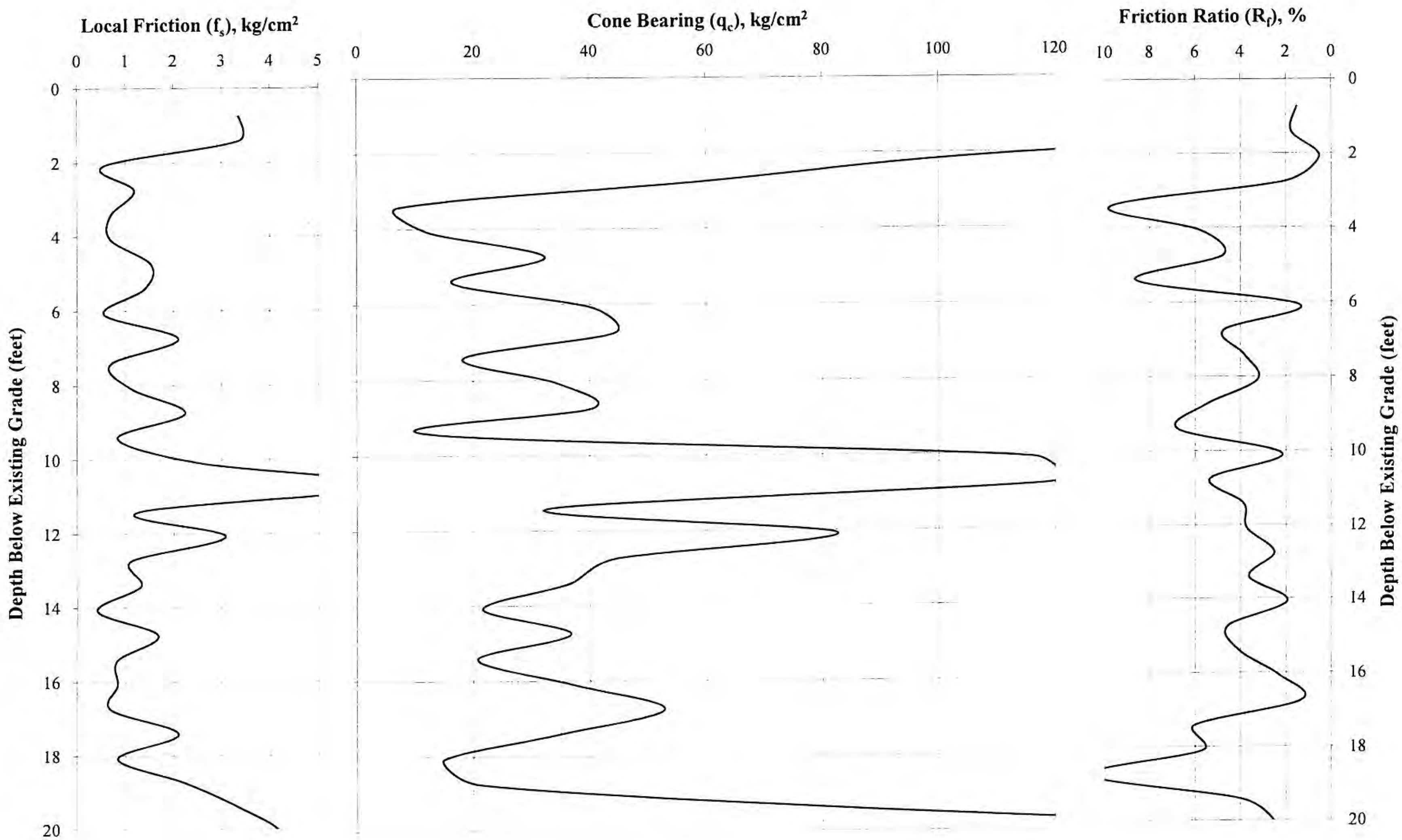



Figure C-27a

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

| | | | | |
|---|---|---|---|---|
| SOUNDING NO.: | S-2 | | DATE: | April 20, 2009 |
| LOCATION: | B-2 | | TESTED BY: | CL |
| SURFACE ELEVATION: | 1087.3 | feet | RECORDED BY: | SG |

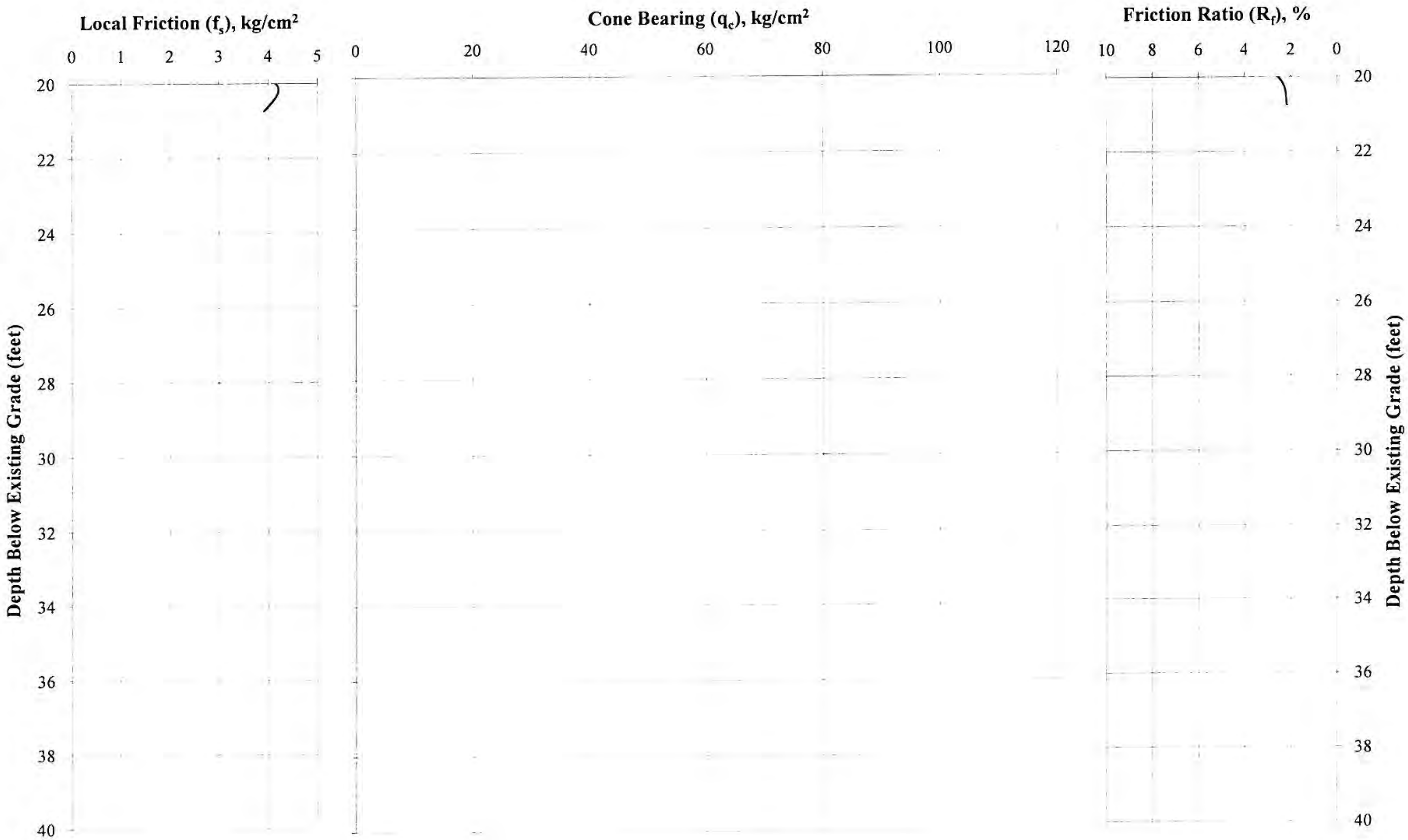



Figure C-27b

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

SOUNDING NO.: **S-9a**
LOCATION: **B-9a**
SURFACE ELEVATION: **1085.6 feet**

DATE: **April 20, 2009**
TESTED BY: **CL**
RECORDED BY: **SG**

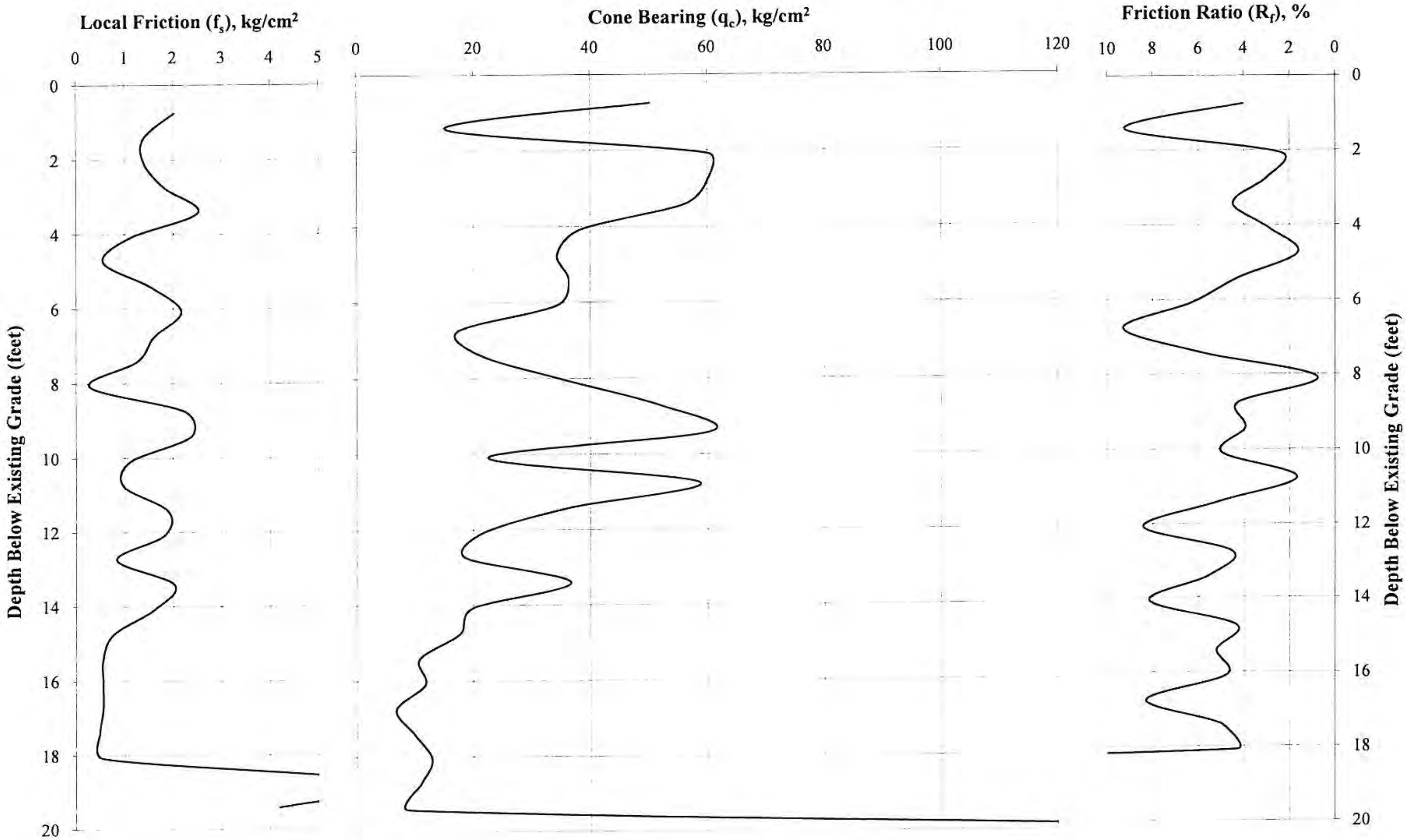



Figure C-28a

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: Mid-America Energy
52-69-5092

| | | | |
|---|---|---|---|
| SOUNDING NO.: | S-12 | DATE: | April 20, 2009 |
| LOCATION: | B-12 | TESTED BY: | CL |
| SURFACE ELEVATION: | 1082.8 feet | RECORDED BY: | SG |

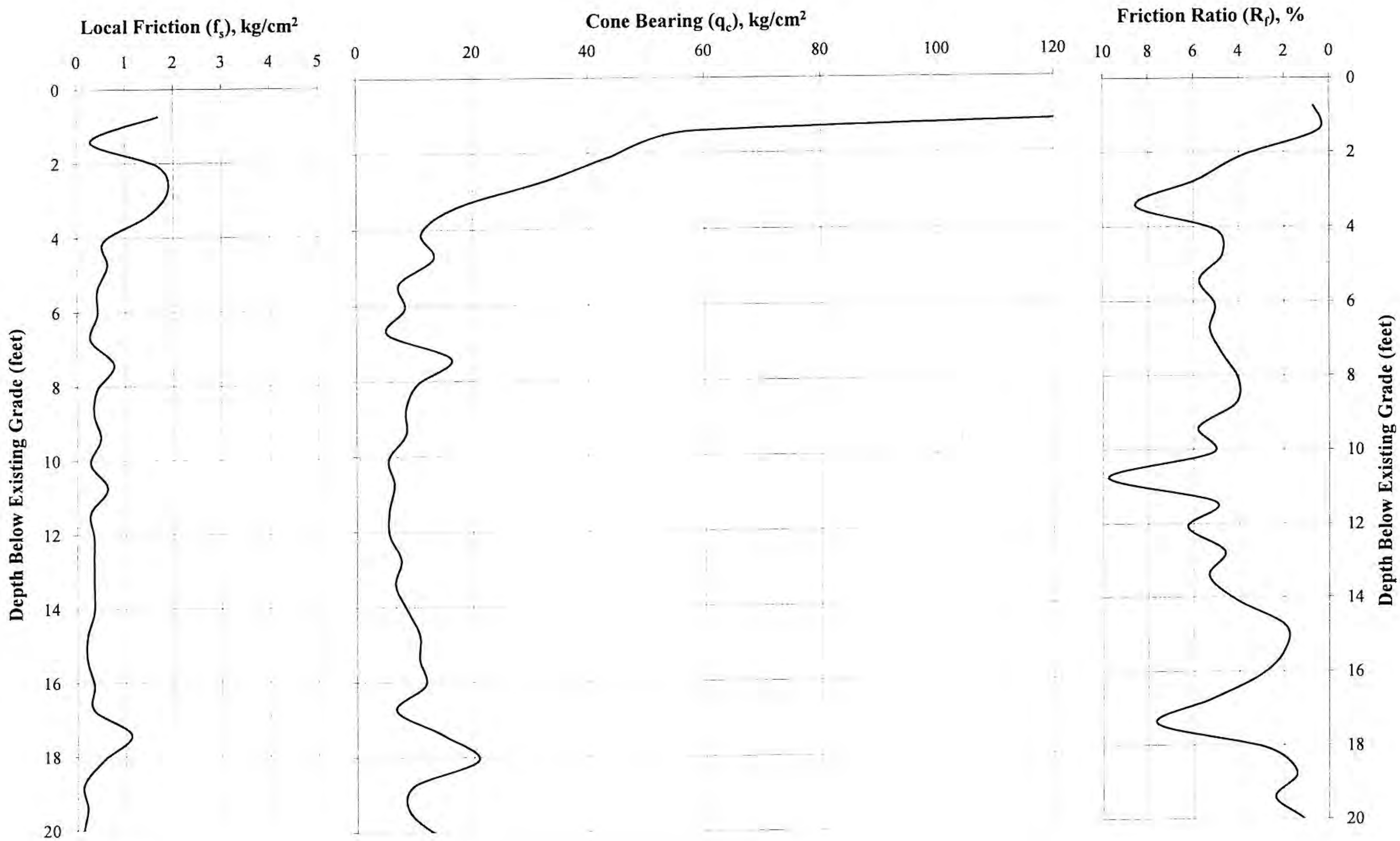



Figure C-29a

**LINCOLN OFFICE**
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

| | | | | |
|---|---|---|---|---|
| SOUNDING NO.: | **S-12** | | DATE: | **April 20, 2009** |
| LOCATION: | **B-12** | | TESTED BY: | **CL** |
| SURFACE ELEVATION: | **1082.8** | **feet** | RECORDED BY: | **SG** |

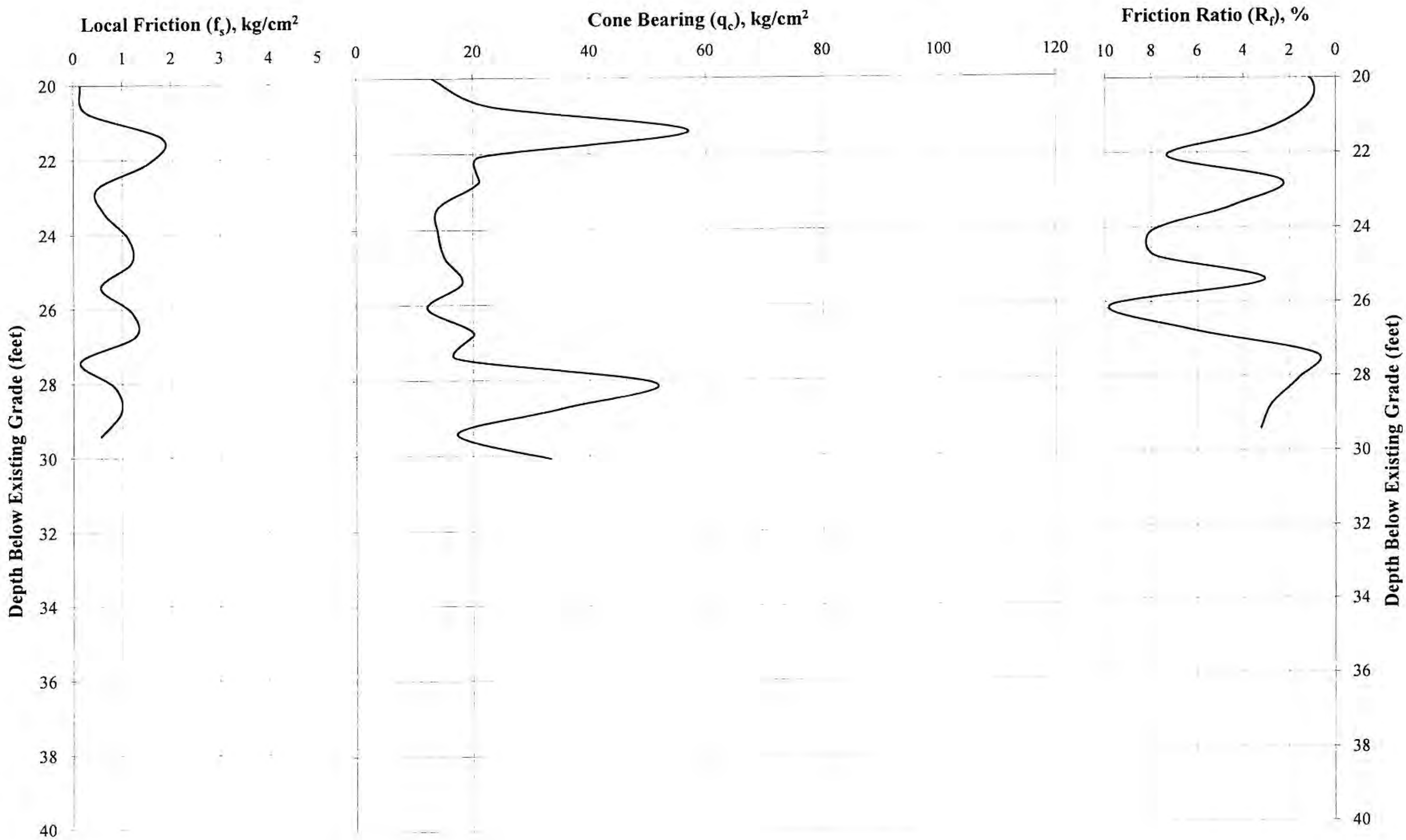



**Figure C-29b**

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

| | | | |
|---|---|---|---|
| SOUNDING NO.: | **S-14** | DATE: | **April 20, 2009** |
| LOCATION: | **B-14** | TESTED BY: | **CL** |
| SURFACE ELEVATION: | **1085.8 feet** | RECORDED BY: | **SG** |

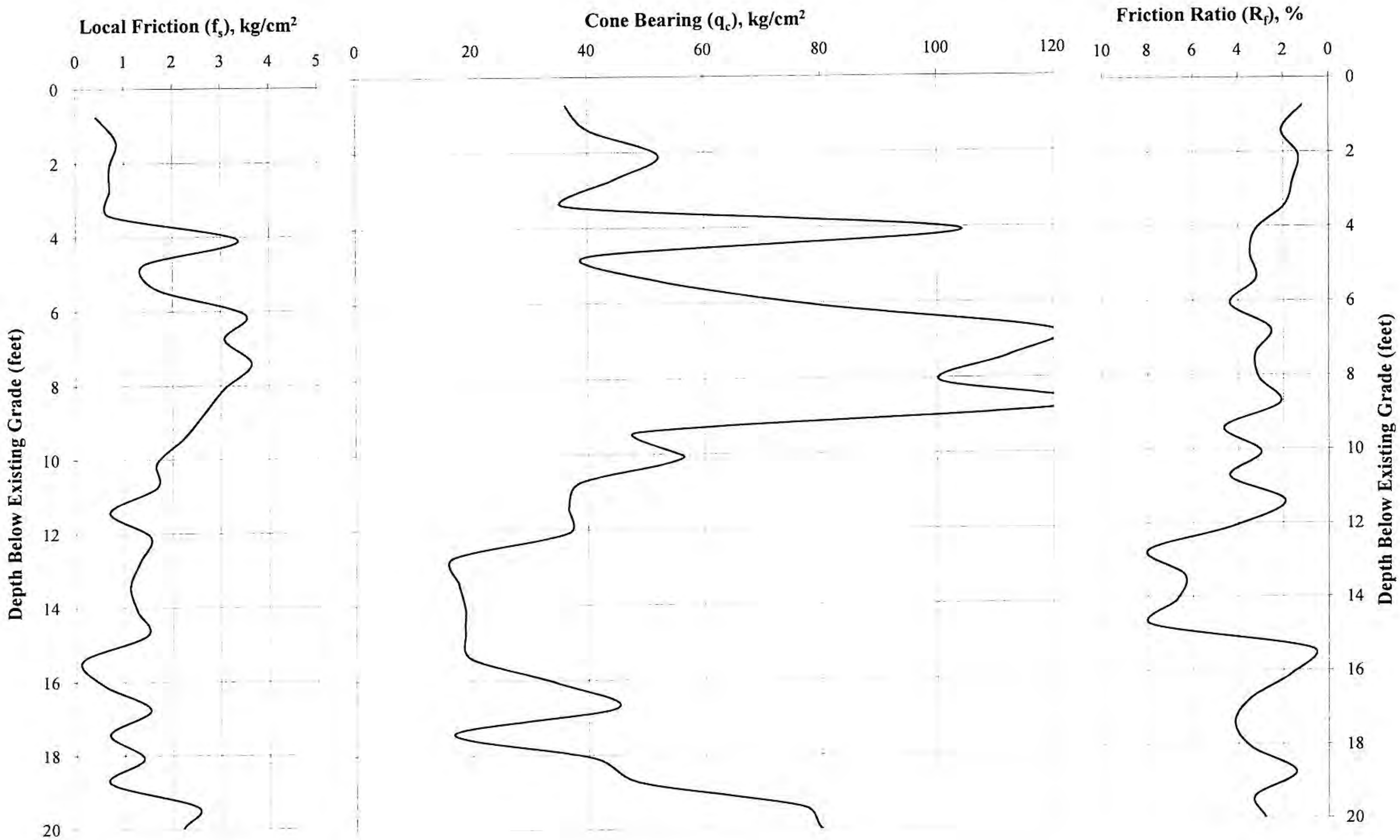



Figure C-30a

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

SOUNDING NO.: **S-14**
LOCATION: **B-14**
SURFACE ELEVATION: **1085.8 feet**

DATE: **April 20, 2009**
TESTED BY: **CL**
RECORDED BY: **SG**

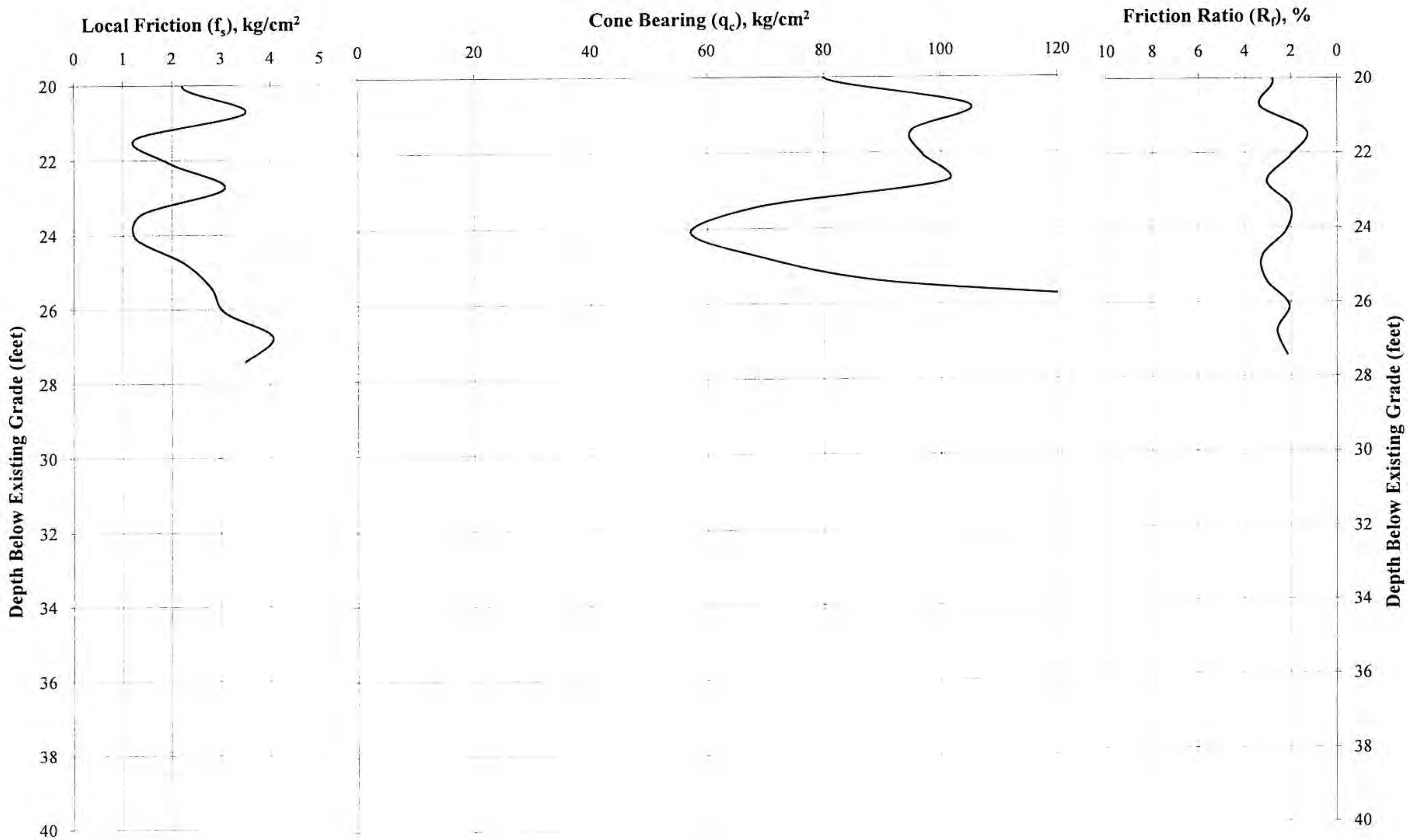



**Figure C-30b**

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

SOUNDING NO.: **S-15**
LOCATION: **B-15**
SURFACE ELEVATION: **1087.7 feet**

DATE: **April 20, 2009**
TESTED BY: **CL**
RECORDED BY: **SG**

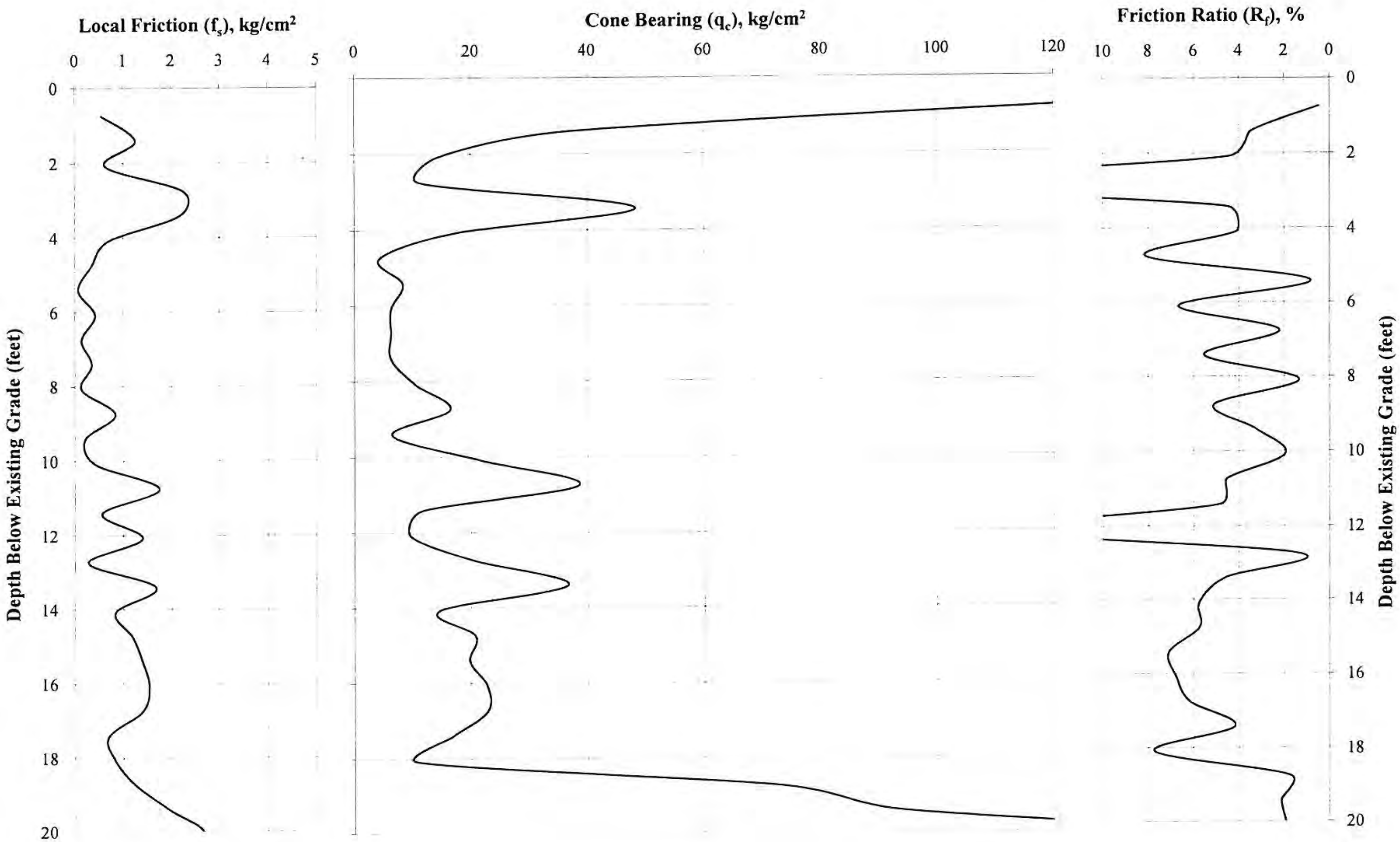



**Figure C-31a**

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

| | | | | |
|---|---|---|---|---|
| SOUNDING NO.: | **S-15** | | DATE: | **April 20, 2009** |
| LOCATION: | **B-15** | | TESTED BY: | **CL** |
| SURFACE ELEVATION: | **1087.7** | **feet** | RECORDED BY: | **SG** |

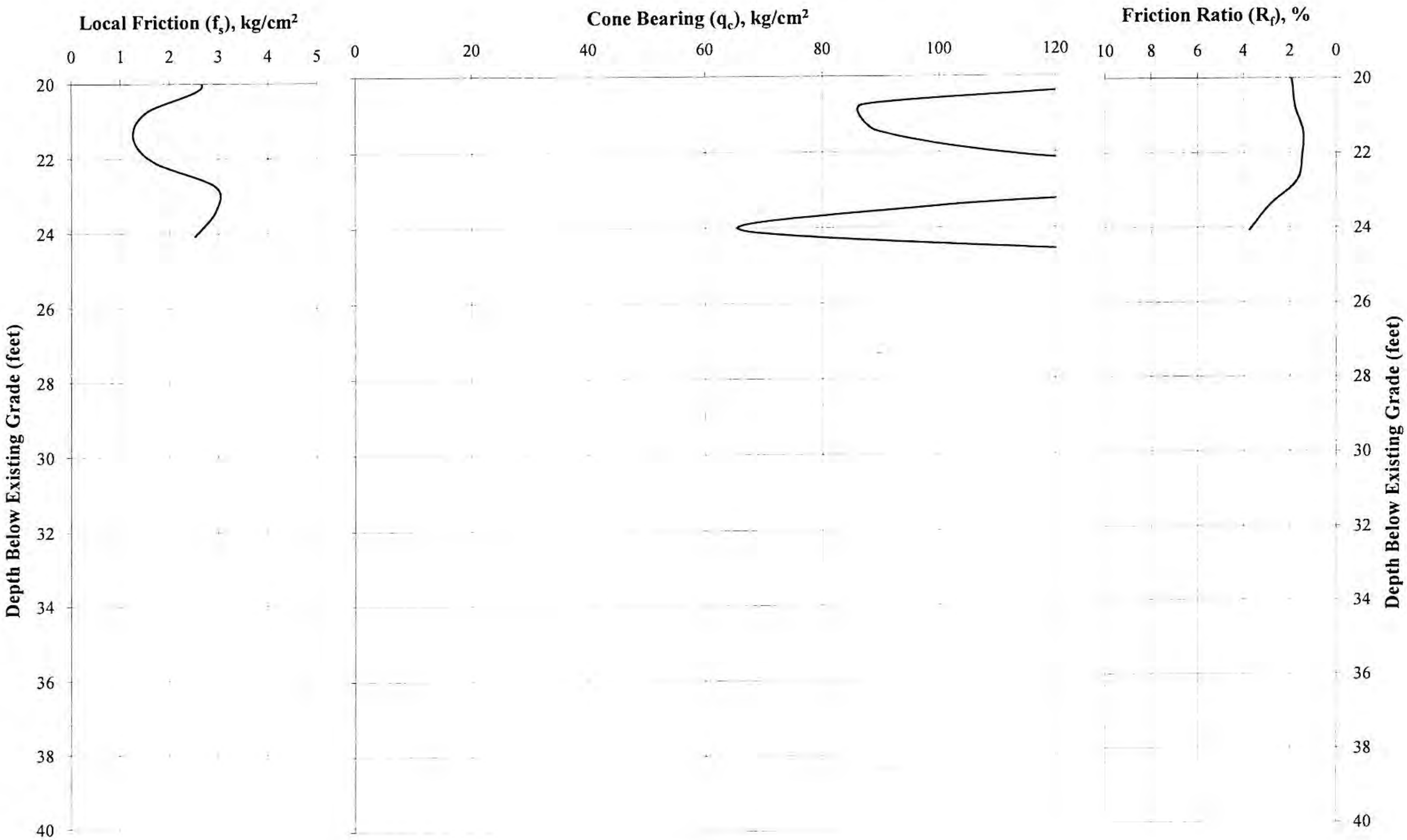



Figure C-31b

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 · FAX (402) 479-2276

# PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Mid-America Energy**
**52-69-5092**

SOUNDING NO.: **S-15b**
LOCATION: **B-15b**
SURFACE ELEVATION: **1087.8 feet**

DATE: **April 21, 2009**
TESTED BY: **CL**
RECORDED BY: **SG**

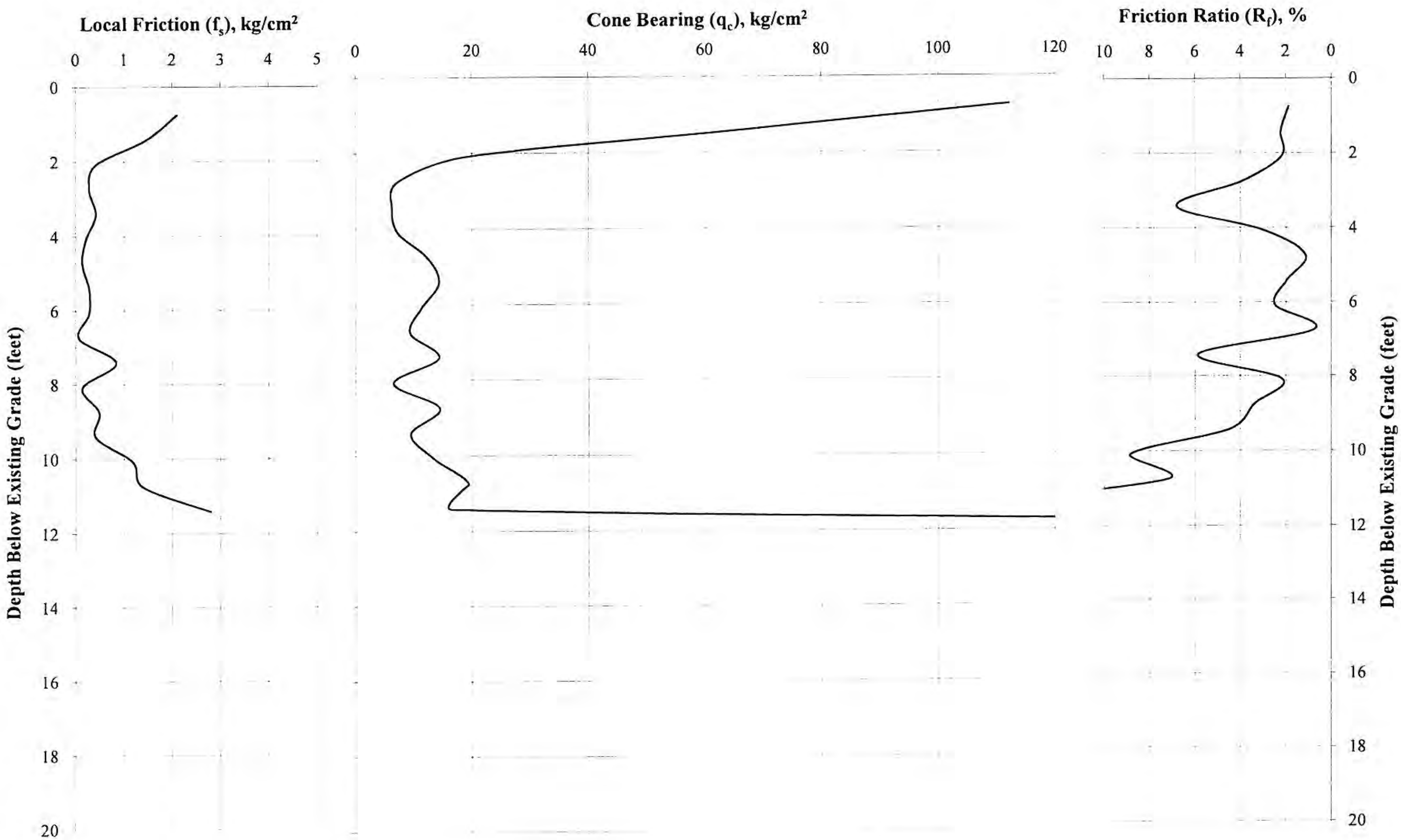



**Figure C-32a**

# APPENDIX D.
# CRITERIA USED FOR VISUAL SOIL CLASSIFICATION

TABLE D-1

**Soil Classification Chart**

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A] | | | Group | Soil Classification: Group Symbol | Soil Classification: Group Name[B] |
|---|---|---|---|---|---|
| Coarse-Grained Soils More than 50% retained on No. 200 sieve | Gravels More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels Less than 5% fines[C] | $Cu \geq 4$ and $1 \leq Cc \leq 3$[E] | GW | Well-graded gravel[F] |
| | | | $Cu < 4$ and/or $1 > Cc > 3$[E] | GP | Poorly graded gravel[F] |
| | | Gravels with Fines More than 12% fines[C] | Fines classify as ML or MH | GM | Silty gravel[F,G,H] |
| | | | Fines classify as CL or CH | GC | Clayey gravel[F,G,H] |
| | Sands 50% or more of coarse fraction passes No. 4 sieve | Clean Sands Less than 5% fines[D] | $Cu \geq 6$ and $1 \leq Cc \leq 3$[E] | SW | Well-graded sand[1] |
| | | | $Cu < 6$ and/or $1 \geq Cc \geq 3$[E] | SP | Poorly graded sand[1] |
| | | Sands with Fines More than 12% fines[D] | Fines classify as ML or MH | SM | Silty sand[G,H,I] |
| | | | Fines classify as CL or CH | SC | Clayey sand[G,H,I] |
| Fine-Grained Soils 50% or more passes the No. 200 sieve | Silts and Clays Liquid limit less than 50 | inorganic | PI>7 and plots on or above "A" line[J] | CL | Lean clay[K,L,M] |
| | | | PI<4 or plots below "A" line[J] | ML | Silt[K,L,M] |
| | | organic | $\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$ | OL | Organic clay[K,L,M] / Organic silt[K,L,M,O] |
| | Silts and Clays Liquid limit 50 or more | inorganic | PI plots on or above "A" line | CH | Fat clay[K,L,M] |
| | | | PI plots below "A" line | MH | Elastic silt[K,L,M] |
| | | organic | $\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$ | OH | Organic clay[K,L,M,P] / Organic silt[K,L,M,Q] |
| Highly organic soils | Primarily organic matter, dark in color, and organic odor | | | PT | Peat |

[A] Based on the material passing the 3-in. (77-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded with silt
GP-GC poorly graded gravel with clay
[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
[H] If fines are organic, add "with organic fines' to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
[L] If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
[M] If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥4 and plots on or above "A" line.
[O] PI <4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

## TABLE D-2

| CRITERIA FOR DESCRIBING MOISTURE CONDITION OF CLAY SOIL | |
|---|---|
| **Description** | **Criteria** |
| Dry | Absence of moisture, dusty, dry to the touch. |
| Moist | Damp, slightly wet, moisture content below plastic limit. |
| Wet | Moisture content above the plastic limit. |
| Saturated | Very wet. Usually soil is below water table. |

## TABLE D-3

| CRITERIA FOR DESCRIBING MOISTURE CONDITION OF GRANULAR SOIL | |
|---|---|
| **Description** | **Criteria** |
| Dry | Absence of moisture, dry to the touch. |
| Moist | Damp but no visible free water. |
| Wet | Visible free water. |
| Saturated | Usually soil is below water table. |

## TABLE D-4

| CRITERIA FOR DESCRIBING CONSISTENCY OF CLAY SOIL | |
|---|---|
| **Density** | **Penetration Resistance, N Blows per 12 in.** |
| Very Soft | Less Than 2 |
| Soft | 2-4 |
| Medium | 4-8 |
| Stiff | 8-15 |
| Very Stiff | 15-30 |
| Hard | Greater Than 30 |

TABLE D-5

| CRITERIA FOR DESCRIBING DENSITY OF COARSE-GRAINED SOIL | |
|---|---|
| **Density** | **Penetration Resistance, N Blows per 12 in.** |
| Loose | Less Than 10 |
| Medium | 10-30 |
| Dense | 30-50 |
| Very Dense | Greater Than 50 |

TABLE D-6

| CRITERIA FOR DESCRIBING STRENGTH OF ROCK | |
|---|---|
| **Description** | **Criteria** |
| Very soft | Permits denting by moderate pressure of the fingers. |
| Soft | Resists denting by the fingers, but can be abraded and pierced to a shallow depth by a pencil point. |
| Moderately soft | Resists a pencil point, but can be scratched and cut with a knife blade. |
| Moderately hard | Resistant to abrasion or cutting by a knife blade, but can be easily dented or broken by light blows of a hammer. |
| Hard | Can be deformed or broken by repeated moderate hammer blows. |
| Very hard | Can be broken only by heavy, and in some rocks, repeated hammer blows. |

**TABLE D-7**

## ROCK QUALITY DESIGNATION (RQD)

This is a general method by which the quality of the rock at a site is obtained based on the relative amount of fracturing and alteration.

The Rock Quality Designation (RQD) is based on a modified core recovery procedure that, in turn, is based indirectly on the number of fractures (except those due directly to drilling operations) and the amount of softening or alteration in the rock mass as observed in the rock cores from a drill hole. Instead of counting the fractures, an indirect measure is obtained by summing the total length of core recovered by counting only those pieces of hard and sound core which are 4 inches or greater in length. The ratio of this modified core recovery length to the total core run length is known as the RQD.

An example is given below from a core run of 60 inches. For this particular case, the total core recovery is 50 inches yielding a core recovery of 83 percent. On the modified basis, only 38 inches are counted the RQD is 63 percent.

| CORE RECOVERY, in. | MODIFIED CORE RECOVERY, in. |
|---|---|
| 10 | 10 |
| 2 | |
| 2 | |
| 3 | |
| 4 | 4 |
| 5 | 5 |
| 3 | |
| 4 | 4 |
| 6 | 6 |
| 4 | 4 |
| 2 | |
| 5 | 5 |
| --- | --- |
| 50 | 38 |

% Core Recovery = 50/60 = 83%; RQD = 38/60 = 63%

A general description of the rock quality can be made for the RQD Value.

| RQD (ROCK QUALITY DESIGNATION) | DESCRIPTION OF ROCK QUALITY |
|---|---|
| 0 – 25 | very poor |
| 25 – 50 | poor |
| 50 – 75 | fair |
| 75 – 90 | good |
| 90 – 100 | excellent |

# APPENDIX E. UNCONFINED COMPRESSION TEST REPORTS

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street
P.O. Box 80358
Lincoln, Nebraska
(402) 479-2200

# UNCONFINED - COMPRESSION TEST

**ASTM Designation: D 2166**

Project: **MidAmerican Energy Flyash Containment Assessment**

Job No. **52-69-5092** Boring No. **B-1** Depth **4.7'-5.3'**

Sample No. **T-1** Lab No. **26049** Classification **ML**

Type of Specimen **3" Tube** Humidity During Trimming **50%**

Remarks

| MOISTURE | |
|---|---|
| Container Number | 1167 |
| Total Wet Wt. (g) | 204.0 |
| Total Dry Wt. (g) | 178.6 |
| Container Wt. (g) | 38.3 |
| Water Content (%) | 18.1 |
| Saturation (%) | 68.1 |

| | |
|---|---|
| Specimen Diameter (in) | 2.870 |
| Initial Length (in) | 5.969 |
| Wet Wt. of Specimen (g) | 1174.7 |
| End Area ($in^2$) | 6.47 |
| Volume ($in^3$) | 38.61 |
| Wet Unit Wt. ($lbs/ft^3$) | 115.9 |
| Dry Unit Wt. ($lbs/ft^3$) | 98.1 |
| Length/Diameter | 2.1 |

| | ($lbs/in^2$) | ($tons/ft^2$) |
|---|---|---|
| **Uncon. Compressive Strength =** | **7.6** | **0.5** |
| **Shear Strength =** | **3.8** | **0.3** |

**Strain at failure =** **1.8%**

**Avg. Strain Rate (%/min) =** **1.0%**

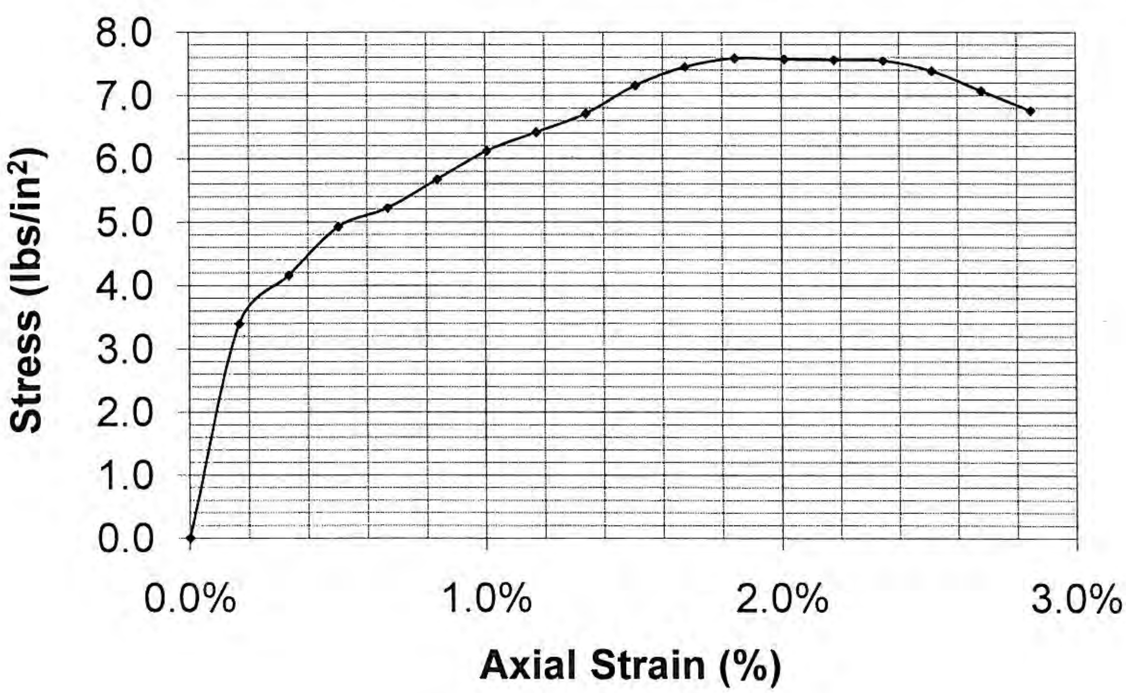



**Figure E-1**

LINCOLN OFFICE
825 "J" Street
P.O. Box 80358
Lincoln, Nebraska
(402) 479-2200

HWS
Solutions Through Service

# UNCONFINED - COMPRESSION TEST

**ASTM Designation: D 2166-98a**

| | | | | | |
|---|---|---|---|---|---|
| Project | **MidAmerican Energy Fly Ash Containment Assessment** | | | | |
| Job No. | **52-69-5092** | Boring No. | **B-9a** | Depth | **3.0'-3.5'** |
| Sample No. | **T-1** | Lab No. | **26086** | Classification | **CL** |
| Type of Specimen | **1.4" Remolded** | | | Humidity During Trimming | **50%** |
| Remarks | | | | | |

| MOISTURE | |
|---|---|
| Container Number | 1175 |
| Total Wet Wt. (g) | 180.8 |
| Total Dry Wt. (g) | 157.6 |
| Container Wt. (g) | 38.6 |
| Water Content (%) | 19.5 |
| Saturation (%) | 80.4 |

| | |
|---|---|
| Specimen Diameter (in) | 1.409 |
| Initial Length (in) | 2.927 |
| Wet Wt. of Specimen (g) | 145.8 |
| End Area ($in^2$) | 1.56 |
| Volume ($in^3$) | 4.56 |
| Wet Unit Wt. ($lbs/ft^3$) | 121.7 |
| Dry Unit Wt. ($lbs/ft^3$) | 101.8 |
| Length/Diameter | 2.1 |

| | ($lbs/in^2$) | ($tons/ft^2$) | | |
|---|---|---|---|---|
| **Uncon. Compressive Strength =** | **14.4** | **1.0** | **Strain at failure =** | **1.9%** |
| **Shear Strength =** | **7.2** | **0.5** | **Avg. Strain Rate (%/min) =** | **1.0%** |

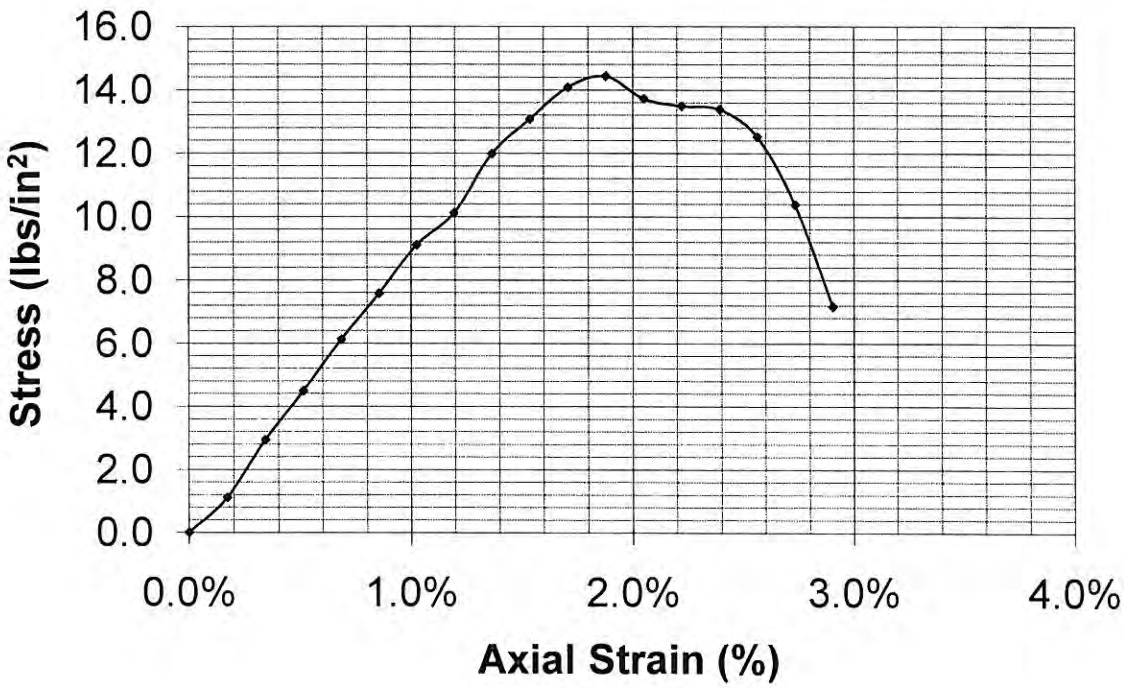



**Figure E-2**

LINCOLN OFFICE
825 "J" Street
P.O. Box 80358
Lincoln, Nebraska
(402) 479-2200

HWS Solutions Through Service

# UNCONFINED - COMPRESSION TEST

**ASTM Designation: D 2166**

| | | | | | |
|---|---|---|---|---|---|
| Project | **MidAmerican Energy Flyash Containment Assessment** | | | | |
| Job No. | **52-69-5092** | Boring No. | **B-12** | Depth | **6.1'-6.7'** |
| Sample No. | **T-1** | Lab No. | **26096** | Classification | **CL** |
| Type of Specimen | **3" Tube** | | | Humidity During Trimming | **50%** |
| Remarks | | | | | |

| MOISTURE | |
|---|---|
| Container Number | 1181 |
| Total Wet Wt. (g) | 169.6 |
| Total Dry Wt. (g) | 138.1 |
| Container Wt. (g) | 39.1 |
| Water Content (%) | 31.8 |
| Saturation (%) | 83.2 |

| | |
|---|---|
| Specimen Diameter (in) | 2.844 |
| Initial Length (in) | 5.400 |
| Wet Wt. of Specimen (g) | 983.5 |
| End Area ($in^2$) | 6.35 |
| Volume ($in^3$) | 34.30 |
| Wet Unit Wt. ($lbs/ft^3$) | 109.2 |
| Dry Unit Wt. ($lbs/ft^3$) | 82.9 |
| Length/Diameter | 1.9 |

| | ($lbs/in^2$) | ($tons/ft^2$) |
|---|---|---|
| **Uncon. Compressive Strength =** | **9.4** | **0.7** |
| **Shear Strength =** | **4.7** | **0.3** |

**Strain at failure =** **6.7%**
**Avg. Strain Rate (%/min) =** **1.1%**

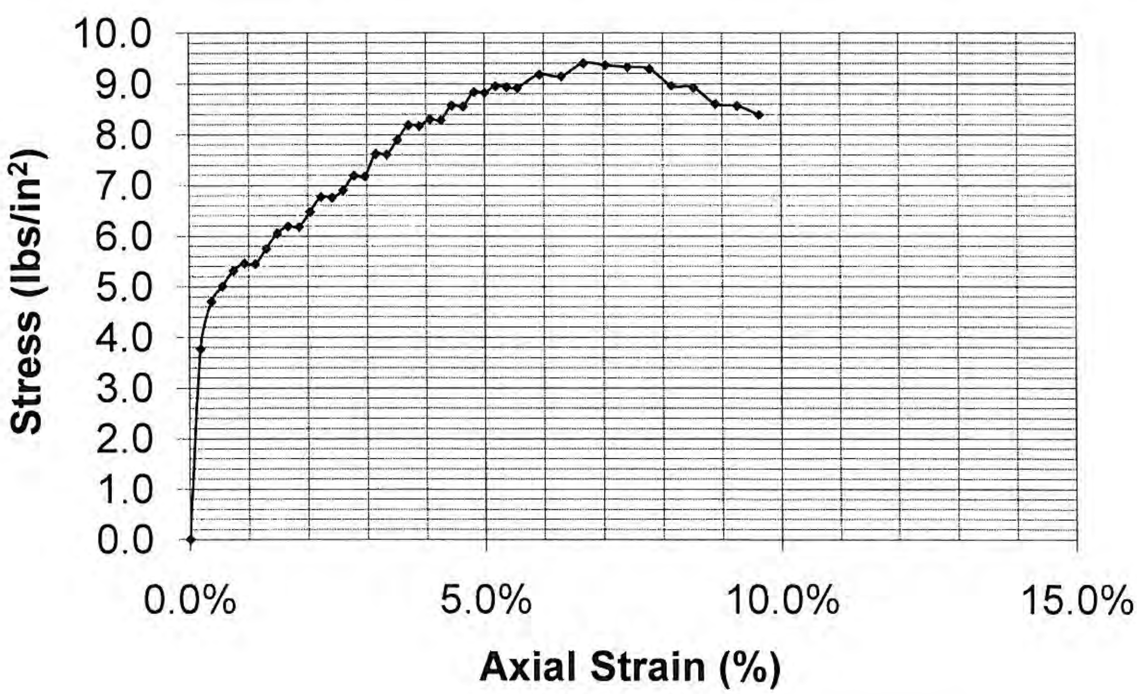



**Figure E-3**

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street
P.O. Box 80358
Lincoln, Nebraska
(402) 479-2200

# UNCONFINED - COMPRESSION TEST

**ASTM Designation: D 2166**

Project **MidAmerican Energy Flyash Containment Assessment**

| | | | | | |
|---|---|---|---|---|---|
| Job No. | **52-69-5092** | Boring No. | **B-12** | Depth | **12.2'-12.9'** |
| Sample No. | **T-2** | Lab No. | **26098** | Classification | **CL** |
| Type of Specimen | **3" Tube** | | | Humidity During Trimming | **50%** |
| Remarks | | | | | |

| MOISTURE | |
|---|---|
| Container Number | 1205 |
| Total Wet Wt. (g) | 176.0 |
| Total Dry Wt. (g) | 143.6 |
| Container Wt. (g) | 39.4 |
| Water Content (%) | 31.1 |
| Saturation (%) | 86.7 |

| | |
|---|---|
| Specimen Diameter (in) | 2.839 |
| Initial Length (in) | 5.066 |
| Wet Wt. of Specimen (g) | 944.4 |
| End Area ($in^2$) | 6.33 |
| Volume ($in^3$) | 32.07 |
| Wet Unit Wt. ($lbs/ft^3$) | 112.2 |
| Dry Unit Wt. ($lbs/ft^3$) | 85.6 |
| Length/Diameter | 1.8 |

| | ($lbs/in^2$) | ($tons/ft^2$) | | |
|---|---|---|---|---|
| **Uncon. Compressive Strength =** | **11.1** | **0.8** | **Strain at failure =** | **6.3%** |
| **Shear Strength =** | **5.5** | **0.4** | **Avg. Strain Rate (%/min) =** | **1.1%** |

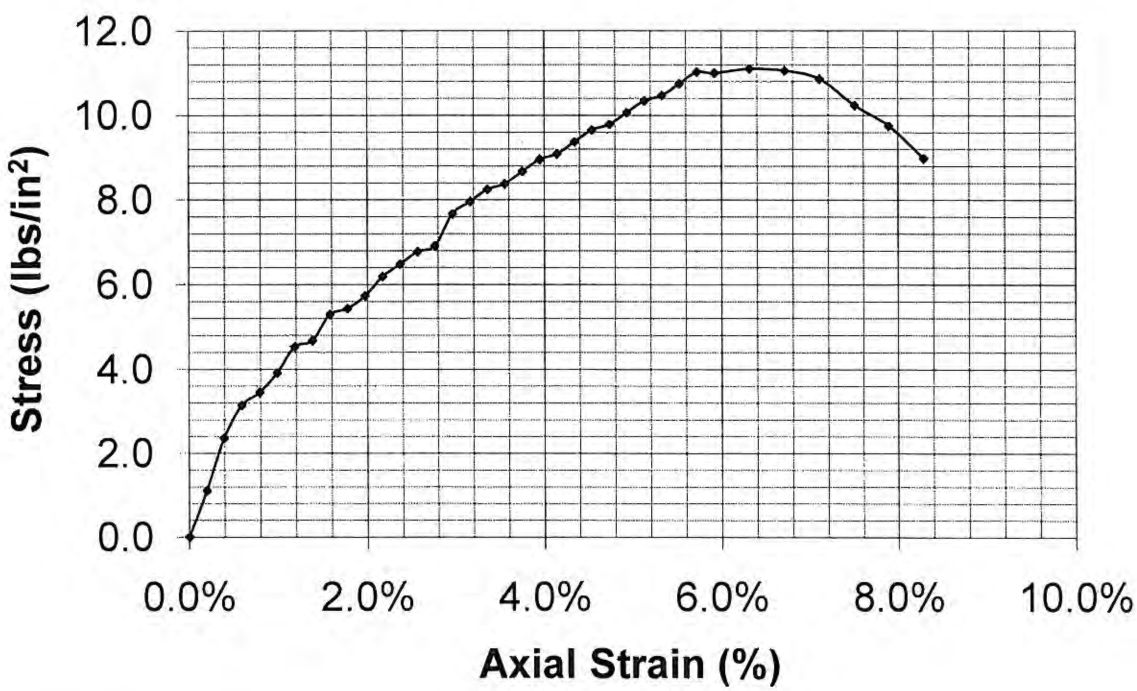



**Figure E-4**

# APPENDIX F. TRIAXIAL COMPRESSION TEST REPORTS

HWS Solutions Through Service

# TRIAXIAL SHEAR TEST

| PROJECT and STATE | | | SAMPLE LOCATION |
|---|---|---|---|
| MID AMERICAN ENERGY -- FLY ASH CONTAINMENT | | | B-9a |
| FIELD SAMPLE NO: 26091 | DEPTH: 17.2'-17.8' | GEOLOGIC ORIGIN: FAT CLAY | |
| TYPE OF SAMPLE: 5" Shelby Tube | TESTED AT: HWS, Lincoln, NE | APPROVED BY: B. Desh | DATE: 6-2-2009 |

**INDEX TEST DATA**

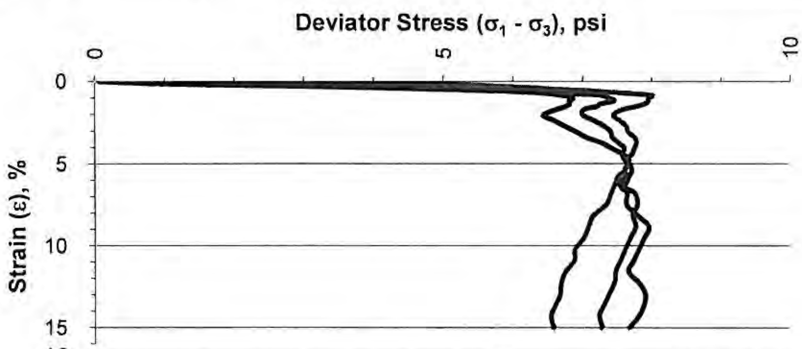
USCS CH ; LL ; PI
%FINER(mm): 0.002 ; 0.005 ;
0.074(#200)
$G_s$ (-#4) ; $G_s$ (+#4)
STANDARD: $\gamma_d$ MAX. pcf ; $W_{opt}$ %
MODIFIED: $\gamma_d$ MAX. pcf ; $W_{opt}$ %

**SPECIMEN DATA**

HEIGHT 2.94 "; DIAMETER 1.40 "
MATERIALS TESTED PASSED SIEVE
METHOD OF PREPARATION TRIMMED FROM 5" SHELBY TUBE SAMPLE
MOLDING MOISTURE %
MOLDED AT % OF $\gamma_d$ MAXIMUM

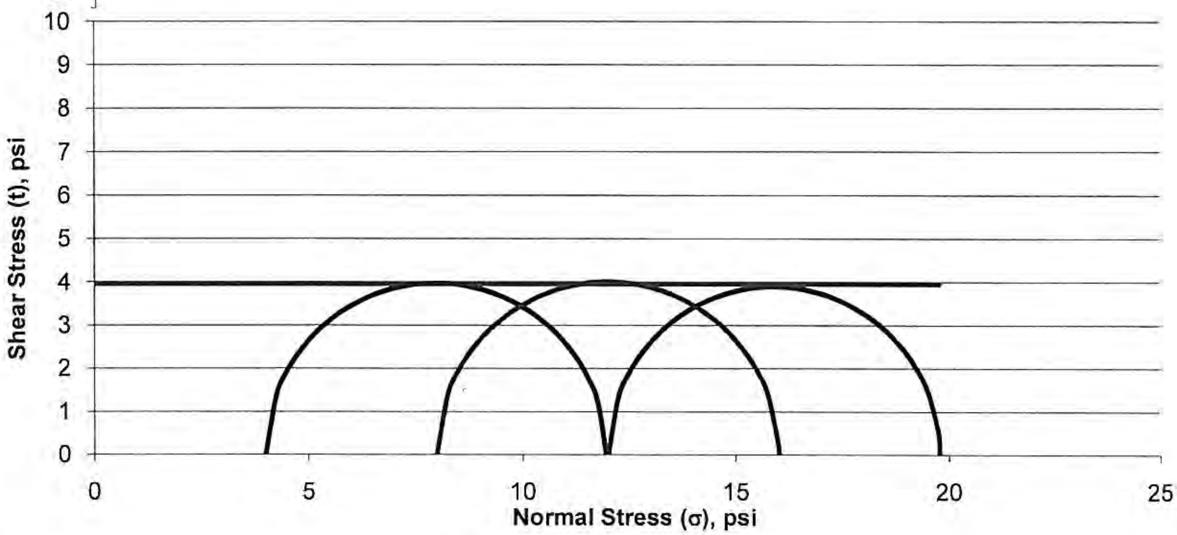
TYPE OF TEST: UU [XXX]; CU [ ]; CU' [ ]; CD [ ]

| DRY DENSITY INITIAL (pcf [XX] / g/cc [ ]) | DRY DENSITY CONSOLIDATED (pcf [XX] / g/cc [ ]) | B PARAMETER | MOISTURE CONTENT, % START OF TEST | DEG. OF SAT. AT START OF TEST | END OF TEST | TIME OF CONSOLIDATION (hrs.) | MINOR PRINCIPAL STRESS $\sigma_3$ (psi.) | DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi.) | AXIAL STRAIN AT FAILURE, $\varepsilon$ (%) |
|---|---|---|---|---|---|---|---|---|---|
| 75.3 | 71.9 | 97 | 45.5 | 99.4 | 49.8 | - | 4.0 | 8.0 | 8.9 |
| 75.4 | 72.4 | 96 | 46.2 | 101.0 | 49.3 | - | 8.0 | 8.0 | 0.9 |
| 76.0 | 72.3 | 98 | 44.7 | 99.0 | 49.7 | - | 12.0 | 7.8 | 7.5 |
| | | | | | | | | | |
| | | | | | | | | | |




SHEAR PARAMETERS

| | | |
|---|---|---|
| $\phi$ | 0 | deg. |
| tan $\phi$ | 0 | |
| c | 570 | psf |




REMARKS

# TRIAXIAL SHEAR TEST

HWS Solutions Through Service

| PROJECT and STATE | SAMPLE LOCATION |
|---|---|
| MID AMERICAN ENERGY -- FLY ASH CONTAINMENT | B-14c |

| FIELD SAMPLE NO. | DEPTH | GEOLOGIC ORIGIN |
|---|---|---|
| 26113 | 0.9'-1.7' | FAT CLAY |

| TYPE OF SAMPLE | TESTED AT | APPROVED BY | DATE |
|---|---|---|---|
| 5" Shelby Tube | HWS, Lincoln, NE | B. Desh | 6-3-2009 |

**INDEX TEST DATA**

USCS CH ; LL ____ ; PI ____
%FINER(mm): 0.002 ____ ; 0.005 ____ ;
0.074(#200) ____
$G_s$ (-#4) ____ ; $G_s$ (+#4) ____
STANDARD: $\gamma_d$ MAX. ____ pcf ; $W_{opt}$ ____ %
MODIFIED: $\gamma_d$ MAX. ____ pcf ; $W_{opt}$ ____ %

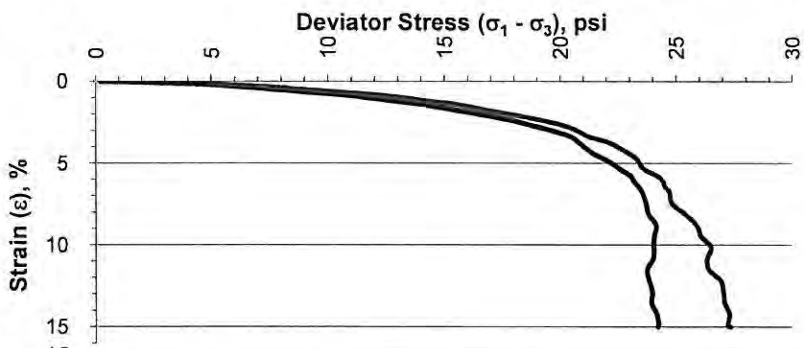
**SPECIMEN DATA**

HEIGHT 2.94 "; DIAMETER 1.40 "
MATERIALS TESTED PASSED ____ SIEVE
METHOD OF PREPARATION TRIMMED FROM 5" SHELBY TUBE SAMPLE
MOLDING MOISTURE ____ %
MOLDED AT ____ % OF $\gamma_d$ MAXIMUM

**TYPE OF TEST**

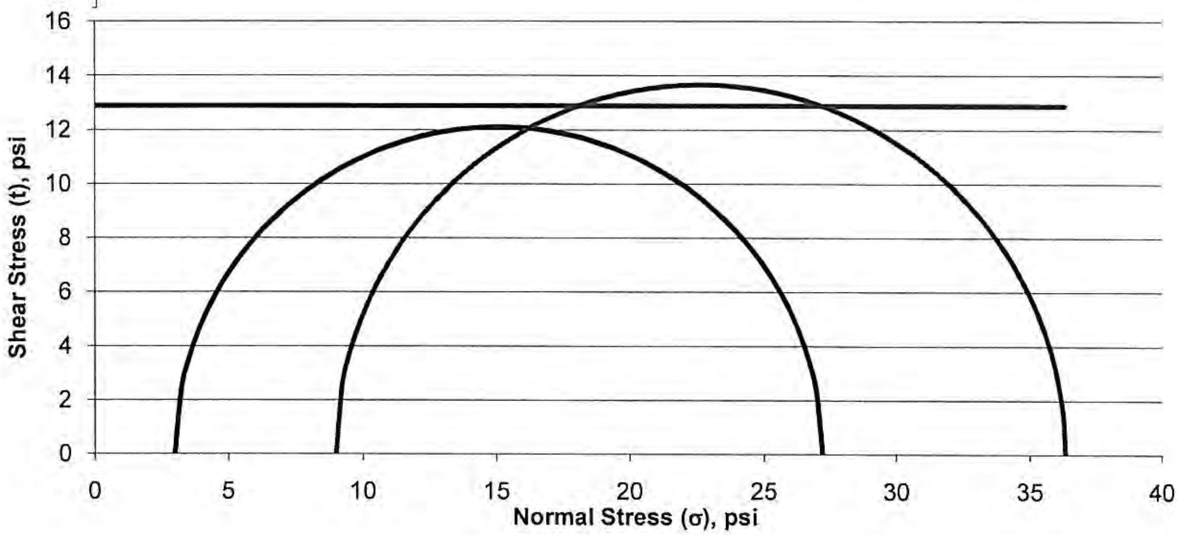
UU [XXX]
CU [ ]
CU' [ ]
CD [ ]

| DRY DENSITY INITIAL pcf [XX] g/cc [ ] | DRY DENSITY CONSOLIDATED pcf [XX] g/cc [ ] | B PARAMETER | MOISTURE CONTENT, % START OF TEST | DEG. OF SAT. AT START OF TEST | END OF TEST | TIME OF CONSOLIDATION (hrs.) | MINOR PRINCIPAL STRESS $\sigma_3$ (psi.) | DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi.) | AXIAL STRAIN AT FAILURE, $\varepsilon$ (%) |
|---|---|---|---|---|---|---|---|---|---|
| 98.5 | 97.2 | 97 | 26.3 | 99.8 | 27.4 | - | 3.0 | 24.2 | 14.9 |
| 101.9 | 99.7 | 97 | 23.0 | 95.0 | 25.8 | - | 9.0 | 27.3 | 15.0 |
| ##### | ##### | | #### | ##### | #### | - | 0.0 | 0.0 | 0.0 |
| | | | | | | | | | |
| | | | | | | | | | |




SHEAR PARAMETERS

| | | |
|---|---|---|
| $\phi$ | 0 | deg. |
| tan $\phi$ | 0 | |
| c | 1856 | psf |




REMARKS

# TRIAXIAL SHEAR TEST

HWS Solutions Through Service

| PROJECT and STATE | | | | SAMPLE LOCATION |
|---|---|---|---|---|
| MID AMERICAN ENERGY -- FLY ASH CONTAINMENT | | | | B-15 |
| FIELD SAMPLE NO. 26200 | DEPTH 5.5'-6.1' | GEOLOGIC ORIGIN FLY ASH | | |
| TYPE OF SAMPLE 5" Shelby Tube | TESTED AT HWS, Lincoln, NE | APPROVED BY B. Desh | | DATE 5-31-2009 |

**INDEX TEST DATA**

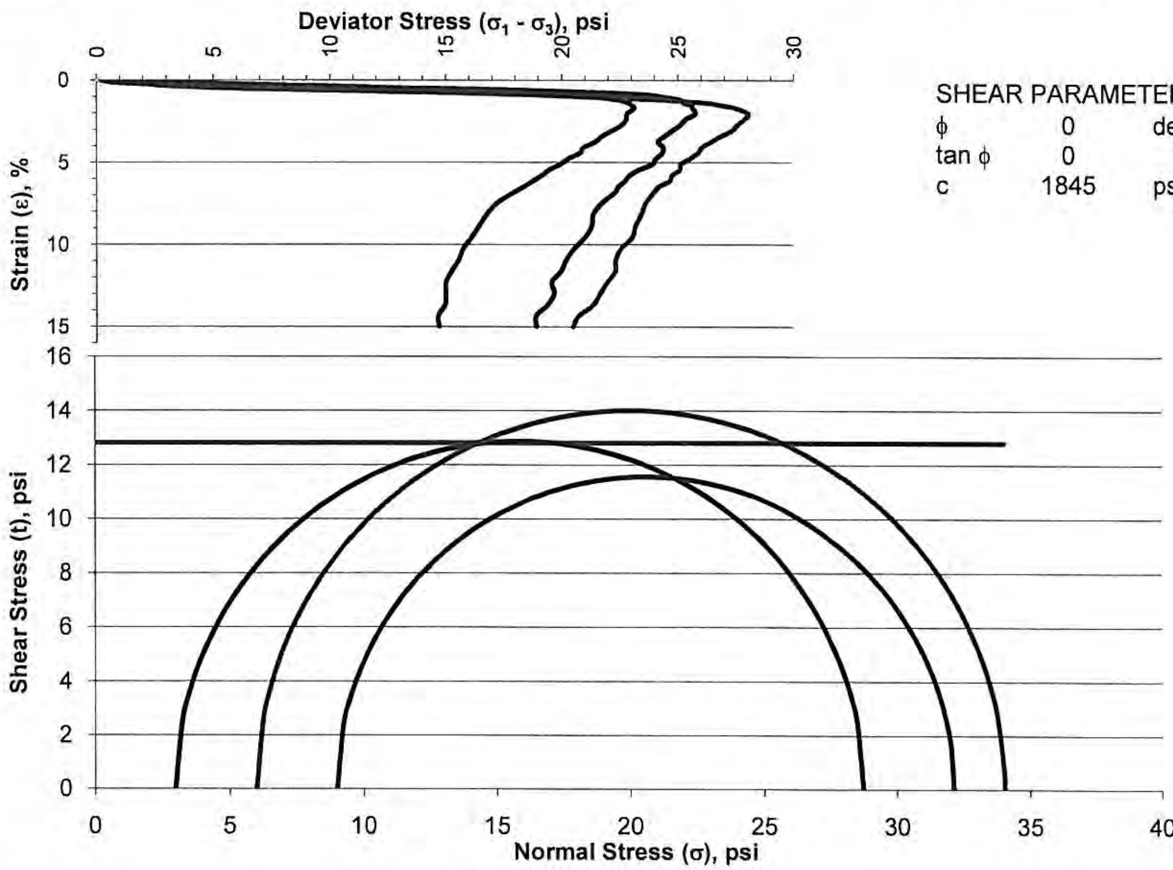
USCS ______ ; LL ______ ; PI ______
%FINER(mm): 0.002 ______ ; 0.005 ______ ;
0.074(#200) ______
$G_s$ (-#4) ______ ; $G_s$ (+#4) ______
STANDARD: $\gamma_d$ MAX. ______ pcf ; $W_{opt}$ ______ %
MODIFIED: $\gamma_d$ MAX. ______ pcf ; $W_{opt}$ ______ %

**SPECIMEN DATA**

HEIGHT 2.94 "; DIAMETER 1.40 "
MATERIALS TESTED PASSED ______ SIEVE
METHOD OF PREPARATION **TRIMMED FROM 5" SHELBY TUBE SAMPLE**
MOLDING MOISTURE ______ %
MOLDED AT ______ % OF $\gamma_d$ MAXIMUM

TYPE OF TEST: UU [XXX] CU [ ] CU' [ ] CD [ ]

| DRY DENSITY INITIAL pcf [XX] g/cc [ ] | DRY DENSITY CONSOLIDATED pcf [XX] g/cc [ ] | B PARAMETER | MOISTURE CONTENT, % START OF TEST | DEG. OF SAT. AT START OF TEST | END OF TEST | TIME OF CONSOLIDATION (hrs.) | MINOR PRINCIPAL STRESS $\sigma_3$ (psi.) | DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi.) | AXIAL STRAIN AT FAILURE, $\varepsilon$ (%) |
|---|---|---|---|---|---|---|---|---|---|
| 52.9 | 56.1 | 96 | 72.2 | 89.1 | 74.3 | - | 3.0 | 25.7 | 2.0 |
| 53.0 | 53.1 | 97 | 71.3 | 88.3 | 80.5 | - | 6.0 | 28.0 | 2.1 |
| 51.8 | 50.1 | 96 | 70.8 | 84.8 | 87.7 | - | 9.0 | 23.1 | 1.7 |
| | | | | | | | | | |
| | | | | | | | | | |




SHEAR PARAMETERS

| | | |
|---|---|---|
| ϕ | 0 | deg. |
| tan ϕ | 0 | |
| c | 1845 | psf |

REMARKS

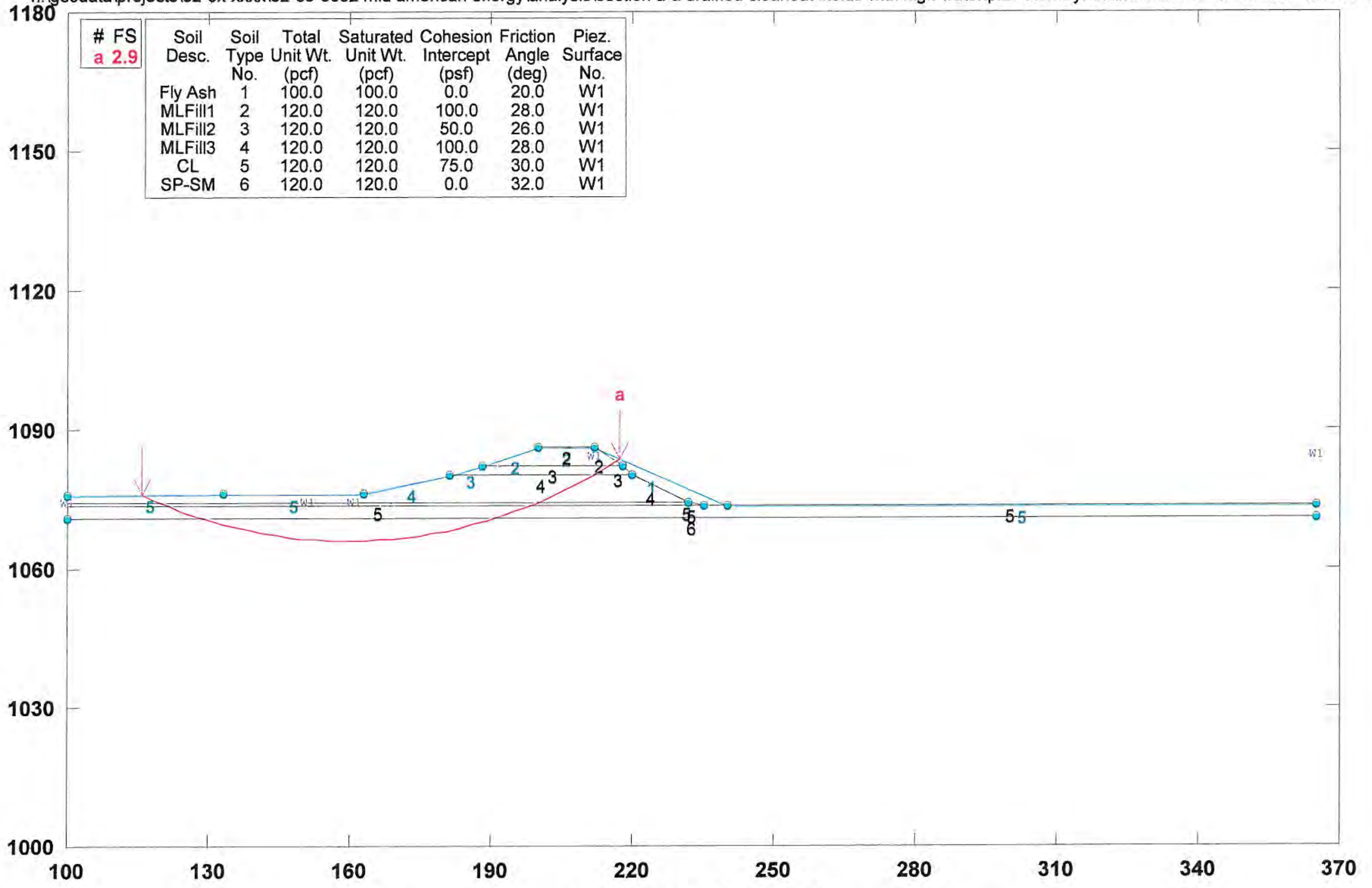
# APPENDIX G. EMBANKMENT STABILITY FAILURE ANALYSES

# Mid American Energy Fly Ash Containment Section A-A Drained

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section a-a drained cleanout inside with high water.pl2 Run By: Brandon Desh 6/10/2009 01:42PM

| # | FS |
|---|---|
| a | 2.9 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 0.0 | 20.0 | W1 |
| MLFill1 | 2 | 120.0 | 120.0 | 100.0 | 28.0 | W1 |
| MLFill2 | 3 | 120.0 | 120.0 | 50.0 | 26.0 | W1 |
| MLFill3 | 4 | 120.0 | 120.0 | 100.0 | 28.0 | W1 |
| CL | 5 | 120.0 | 120.0 | 75.0 | 30.0 | W1 |
| SP-SM | 6 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |

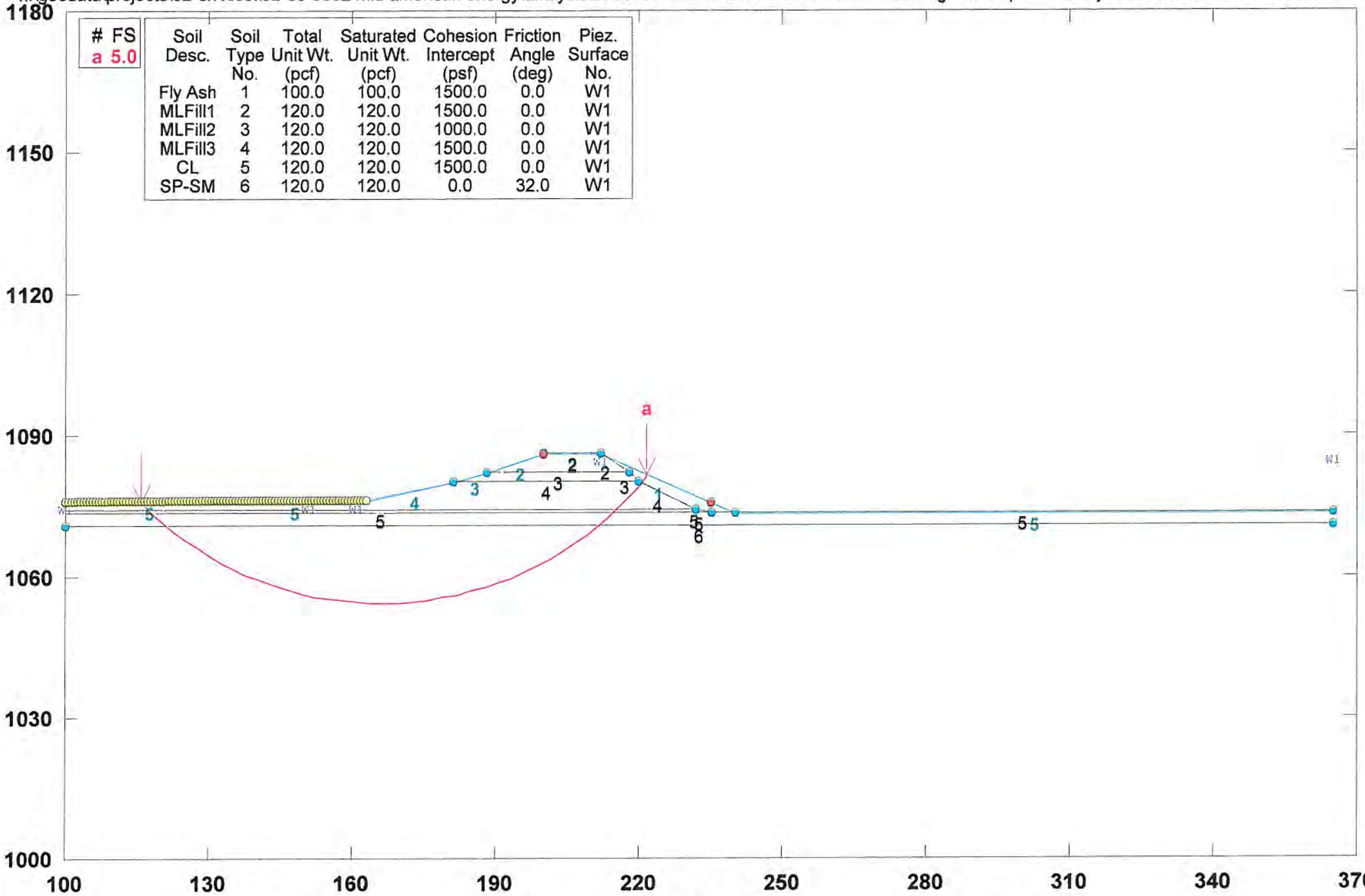



GSTABL7 v.2 FSmin=2.9
Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

# Mid American Energy Fly Ash Containment Section A-A Undrained

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section a-a undrained cleanout inside with high water.pl2 Run By: Brandon Desh 6/12/2009 07:34AM




| # | FS |
|---|---|
| a | 5.0 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 1500.0 | 0.0 | W1 |
| MLFill1 | 2 | 120.0 | 120.0 | 1500.0 | 0.0 | W1 |
| MLFill2 | 3 | 120.0 | 120.0 | 1000.0 | 0.0 | W1 |
| MLFill3 | 4 | 120.0 | 120.0 | 1500.0 | 0.0 | W1 |
| CL | 5 | 120.0 | 120.0 | 1500.0 | 0.0 | W1 |
| SP-SM | 6 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |

**GSTABL7 v.2 FSmin=5.0**

**Safety Factors Are Calculated By The Modified Bishop Method**

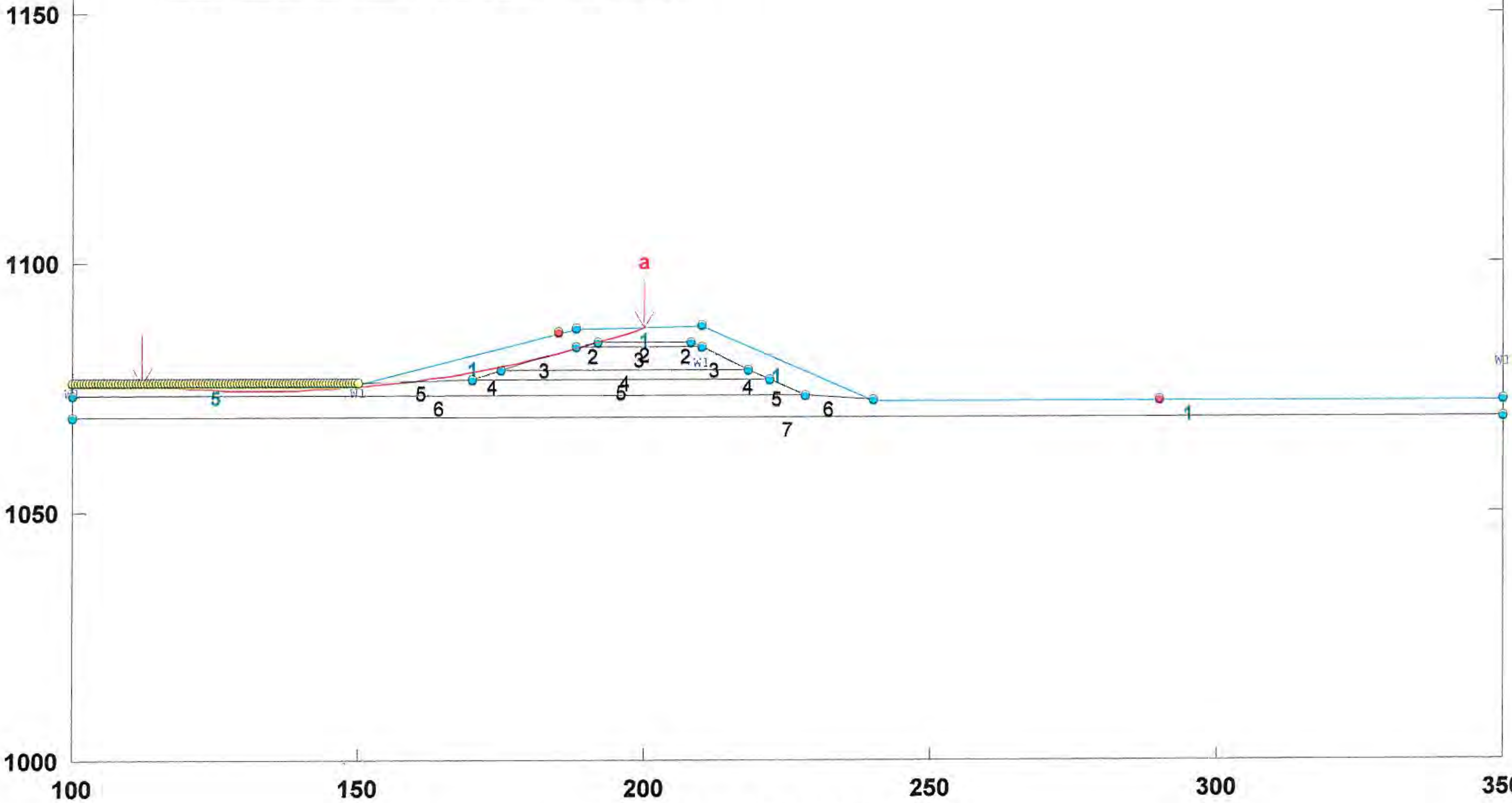
GSTABL7

# Mid American Energy Fly Ash Containment Section B-B Drained

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section b-b drained clean out inside with water el 1082.pl2 Run By: Brandon Desh 6/10/2009 08:42AM

| # | FS |
|---|---|
| a | 1.8 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 0.0 | 20.0 | W1 |
| CLFill | 2 | 115.0 | 115.0 | 75.0 | 30.0 | W1 |
| MLFill2 | 3 | 120.0 | 120.0 | 50.0 | 26.0 | W1 |
| CLFill2 | 4 | 120.0 | 120.0 | 75.0 | 30.0 | W1 |
| CLFill3 | 5 | 120.0 | 120.0 | 0.0 | 25.0 | W1 |
| MLAll | 6 | 120.0 | 120.0 | 100.0 | 28.0 | W1 |
| SP | 7 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |



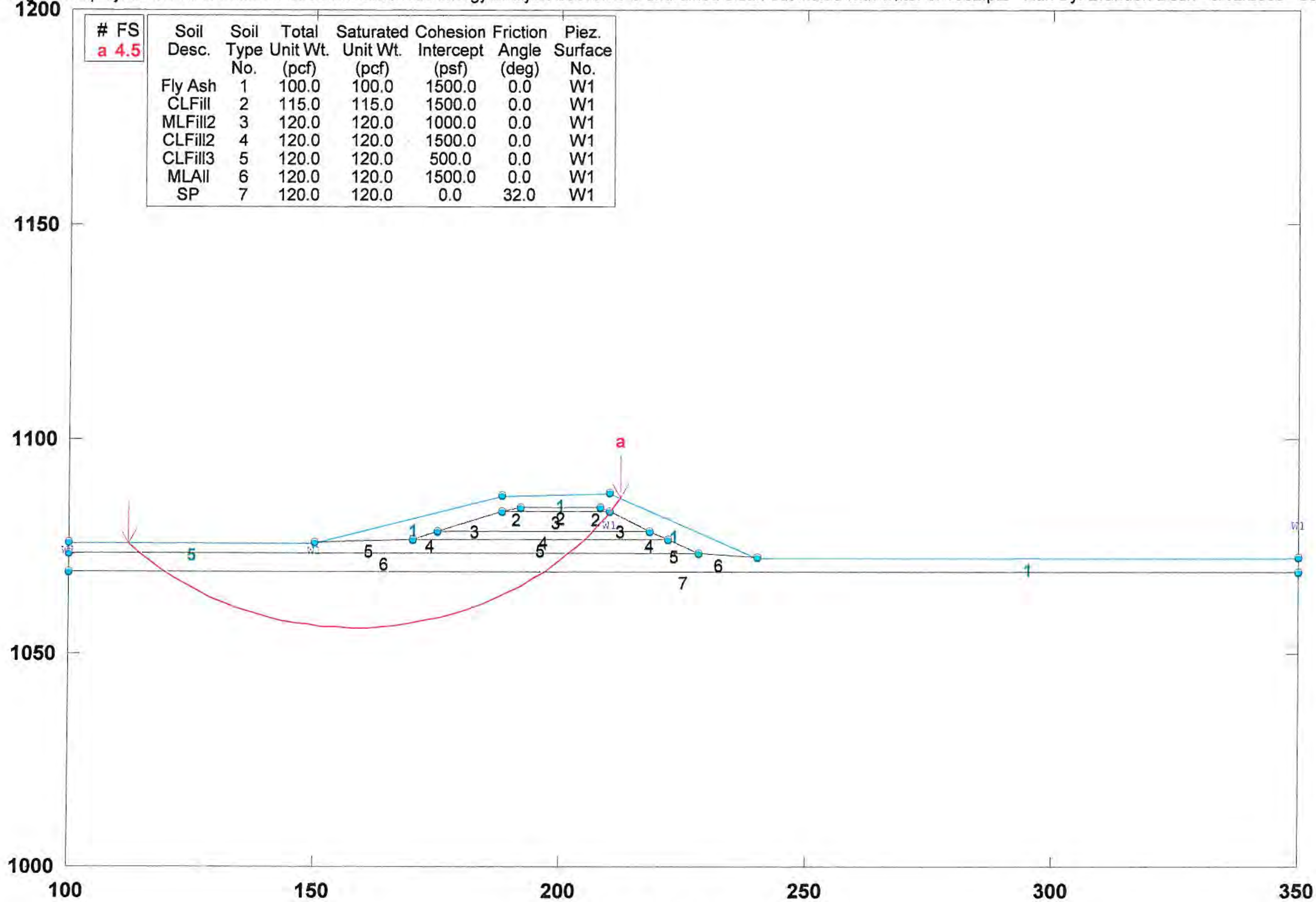

GSTABL7 v.2 FSmin=1.8

Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

# Mid American Energy Fly Ash Containment Section B-B Undrained

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section b-b undrained clean out inside with water el 1082.pl2 Run By: Brandon Desh 6/12/2009 03:53PM




| # | FS |
|---|---|
| a | 4.5 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 1500.0 | 0.0 | W1 |
| CLFill | 2 | 115.0 | 115.0 | 1500.0 | 0.0 | W1 |
| MLFill2 | 3 | 120.0 | 120.0 | 1000.0 | 0.0 | W1 |
| CLFill2 | 4 | 120.0 | 120.0 | 1500.0 | 0.0 | W1 |
| CLFill3 | 5 | 120.0 | 120.0 | 500.0 | 0.0 | W1 |
| MLAll | 6 | 120.0 | 120.0 | 1500.0 | 0.0 | W1 |
| SP | 7 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |

**GSTABL7 v.2 FSmin=4.5**

**Safety Factors Are Calculated By The Modified Bishop Method**

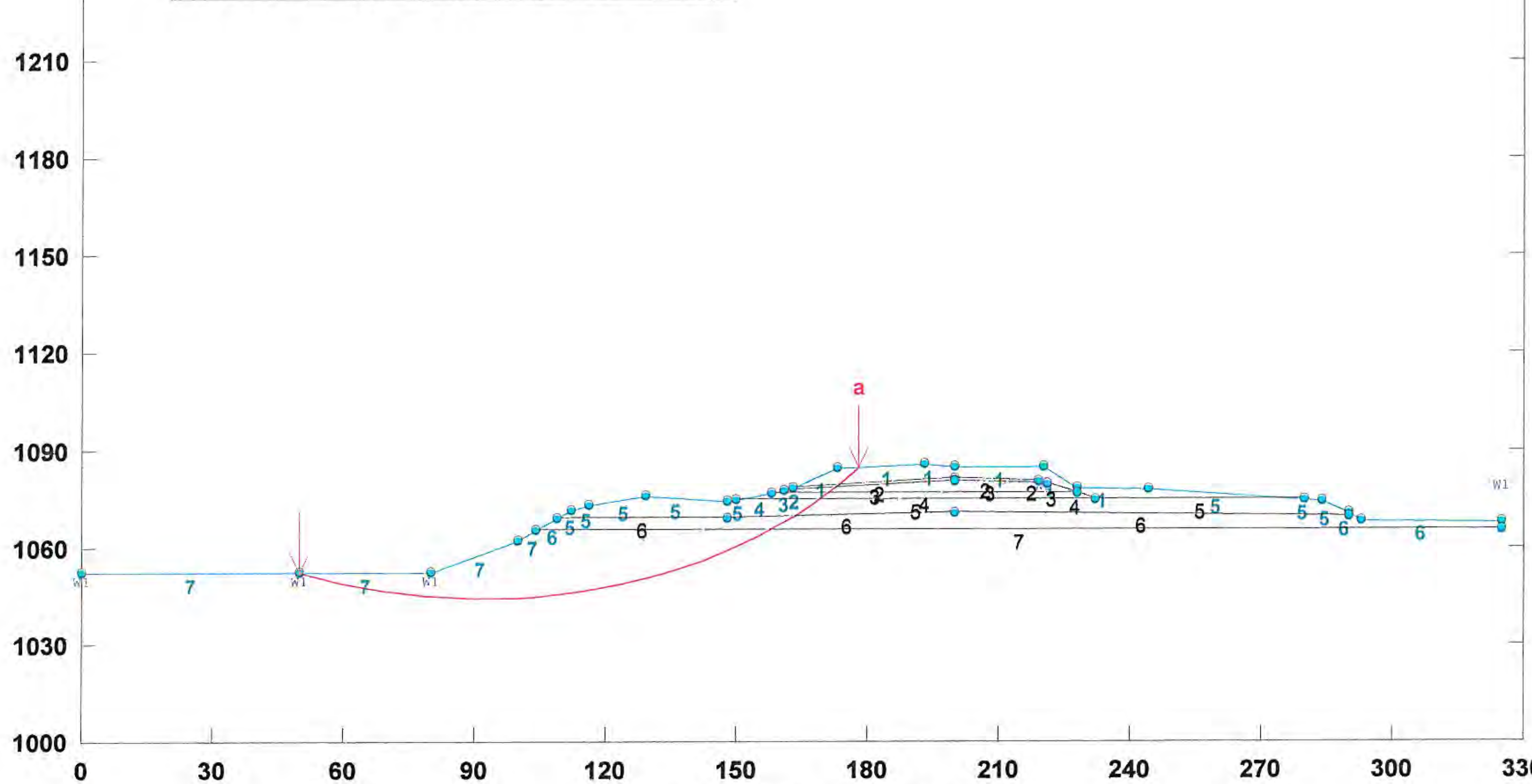
GSTABL7

# Mid American Energy Fly Ash Containment Section E-E Drained Analysis

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section e-e drained water elevation 1082.pl2 Run By: Brandon Desh 6/5/2009 04:05PM

| # | FS |
|---|---|
| a | 1.8 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 0.0 | 20.0 | W1 |
| CL Fill1 | 2 | 123.0 | 123.0 | 100.0 | 32.0 | W1 |
| SM Fill | 3 | 120.0 | 120.0 | 0.0 | 30.0 | W1 |
| CL Fill2 | 4 | 132.0 | 132.0 | 75.0 | 30.0 | W1 |
| CH Alluv | 5 | 116.0 | 116.0 | 75.0 | 30.0 | W1 |
| SM Alluv | 6 | 110.0 | 110.0 | 0.0 | 30.0 | W1 |
| SP Alluv | 7 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |




GSTABL7 v.2 FSmin=1.8

Safety Factors Are Calculated By The Modified Bishop Method

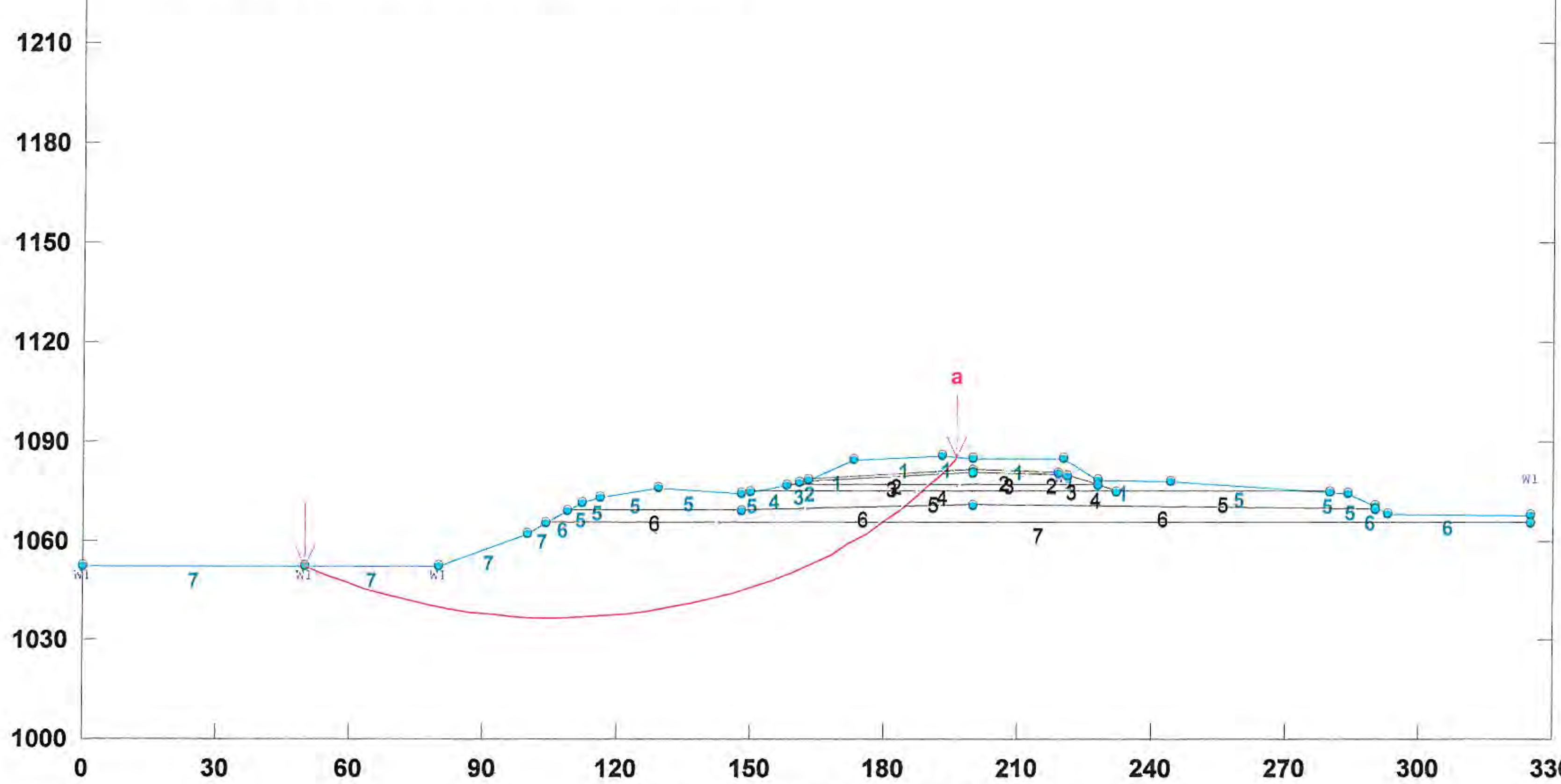
GSTABL7

# Mid American Energy Fly Ash Containment Section E-E Undrained Analysis

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section e-e undrained water elevation 1082.pl2 Run By: Brandon Desh 6/5/2009 04:19PM

| # | FS |
|---|---|
| a | 2.2 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 1800.0 | 0.0 | W1 |
| CL Fill1 | 2 | 123.0 | 123.0 | 2000.0 | 0.0 | W1 |
| SM Fill | 3 | 120.0 | 120.0 | 0.0 | 30.0 | W1 |
| CL Fill2 | 4 | 132.0 | 132.0 | 1500.0 | 0.0 | W1 |
| CH Alluv | 5 | 116.0 | 116.0 | 1500.0 | 0.0 | W1 |
| SM Alluv | 6 | 110.0 | 110.0 | 0.0 | 30.0 | W1 |
| SP Alluv | 7 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |

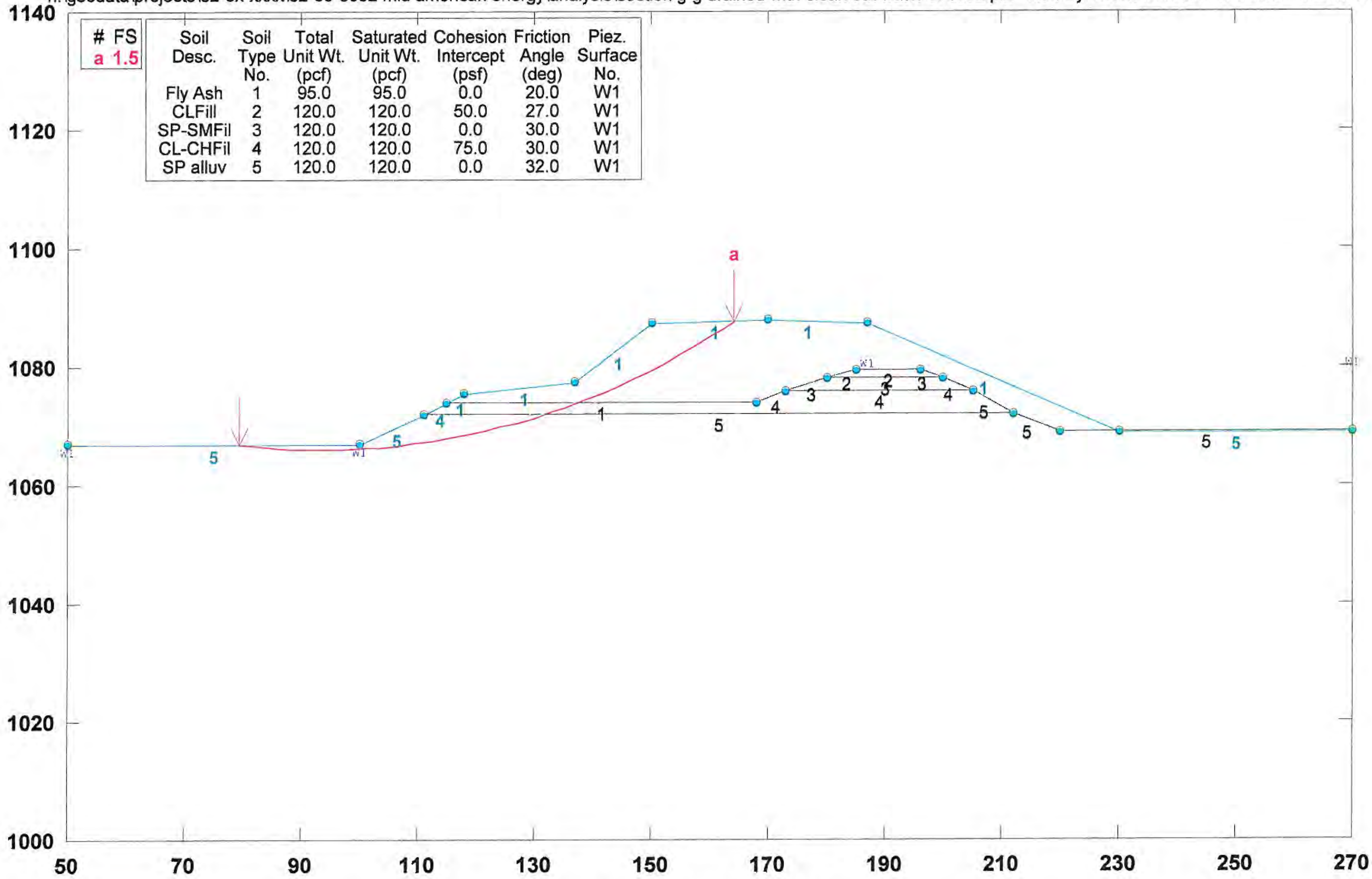



GSTABL7 v.2 FSmin=2.2
Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

## Mid American Energy Fly Ash Containment Section G-G Drained Analysis

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section g-g drained with clean out water el 1082.pl2 Run By: Brandon Desh 6/5/2009 01:42PM




| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 95.0 | 95.0 | 0.0 | 20.0 | W1 |
| CLFill | 2 | 120.0 | 120.0 | 50.0 | 27.0 | W1 |
| SP-SMFil | 3 | 120.0 | 120.0 | 0.0 | 30.0 | W1 |
| CL-CHFil | 4 | 120.0 | 120.0 | 75.0 | 30.0 | W1 |
| SP alluv | 5 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |

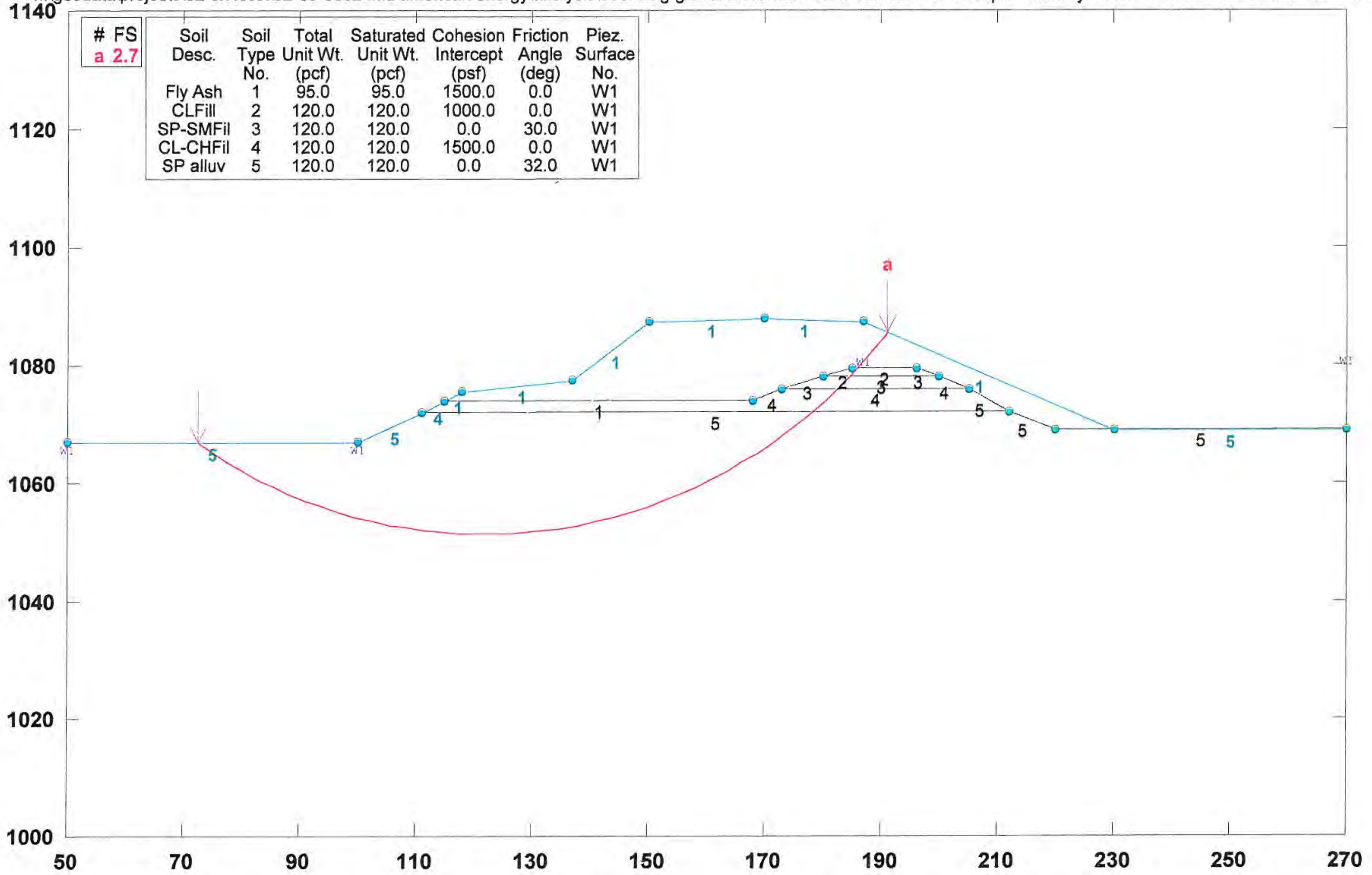
**GSTABL7 v.2 FSmin=1.5**

**Safety Factors Are Calculated By The Modified Bishop Method**

GSTABL7

# Mid American Energy Fly Ash Containment Section G-G Undrained Analysis

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section g-g undrained with clean out water el 1082.pl2 Run By: Brandon Desh 6/11/2009 08:41PM

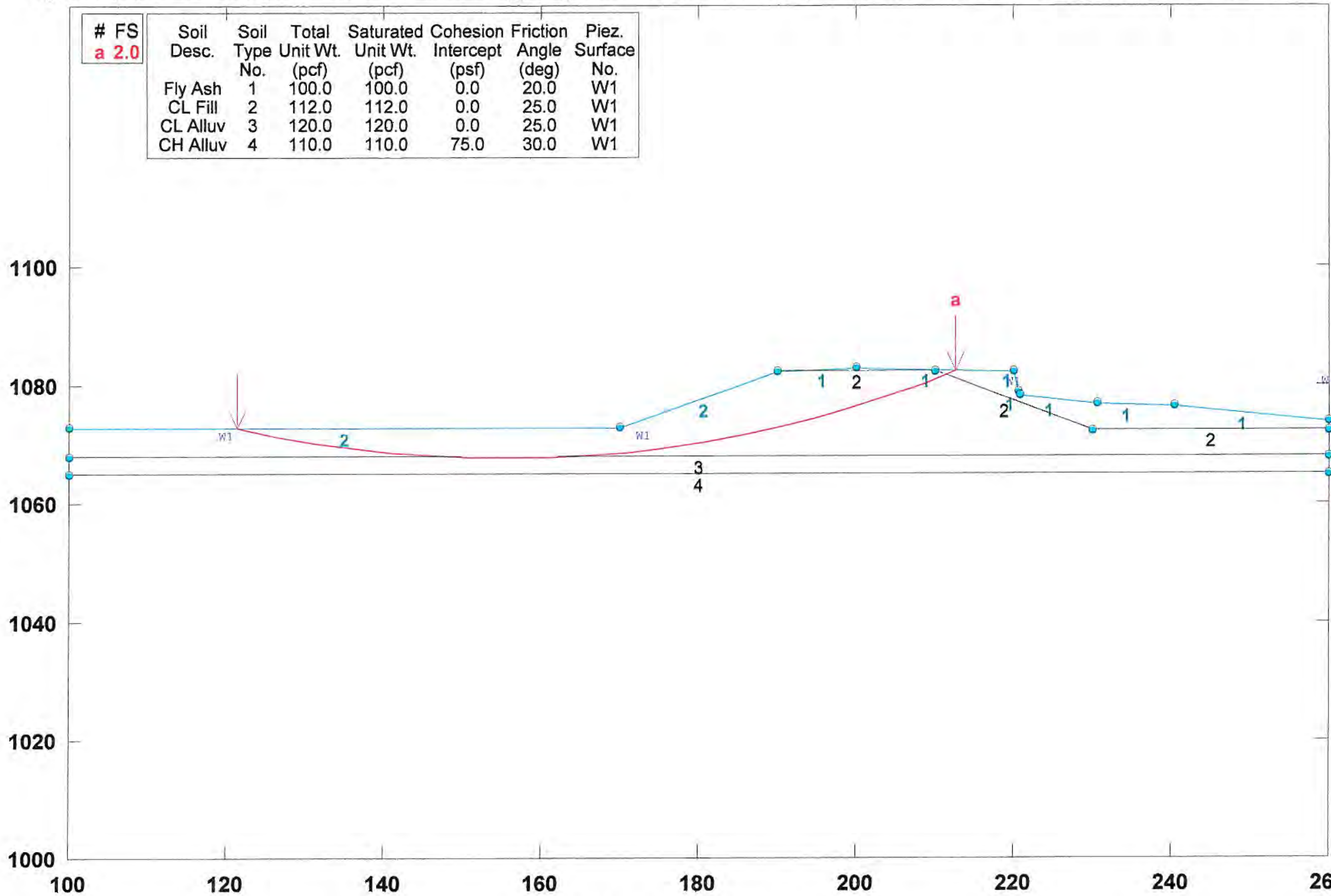



GSTABL7 v.2 FSmin=2.7

Safety Factors Are Calculated By The Modified Bishop Method

# Mid American Energy Fly Ash Containment Section H2-H2 Drained Analysis

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section h2-h2 drained analysis with water el 1082.pl2 Run By: Brandon Desh 6/5/2009 03:21PM



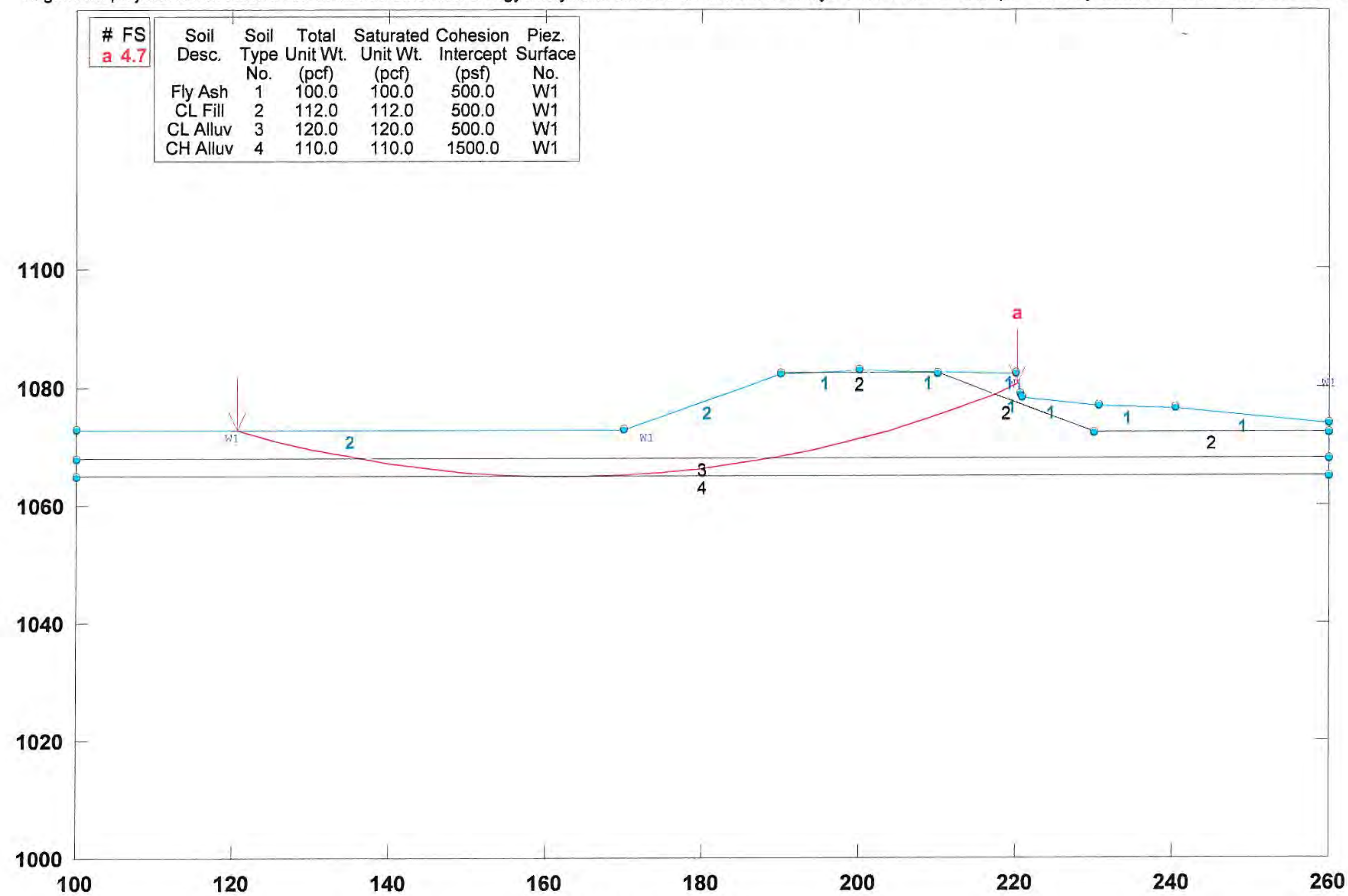

GSTABL7 v.2 FSmin=2.0

Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

## Mid American Energy Fly Ash Containment Section H2-H2 Undrained Analysis

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section h2-h2 undrained analysis with water el 1082.pl2 Run By: Brandon Desh 6/5/2009 03:38PM




| # | FS |
|---|---|
| a | 4.7 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Piez. Surface No. |
|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 500.0 | W1 |
| CL Fill | 2 | 112.0 | 112.0 | 500.0 | W1 |
| CL Alluv | 3 | 120.0 | 120.0 | 500.0 | W1 |
| CH Alluv | 4 | 110.0 | 110.0 | 1500.0 | W1 |

**GSTABL7 v.2 FSmin=4.7**

**Safety Factors Are Calculated By The Modified Bishop Method**

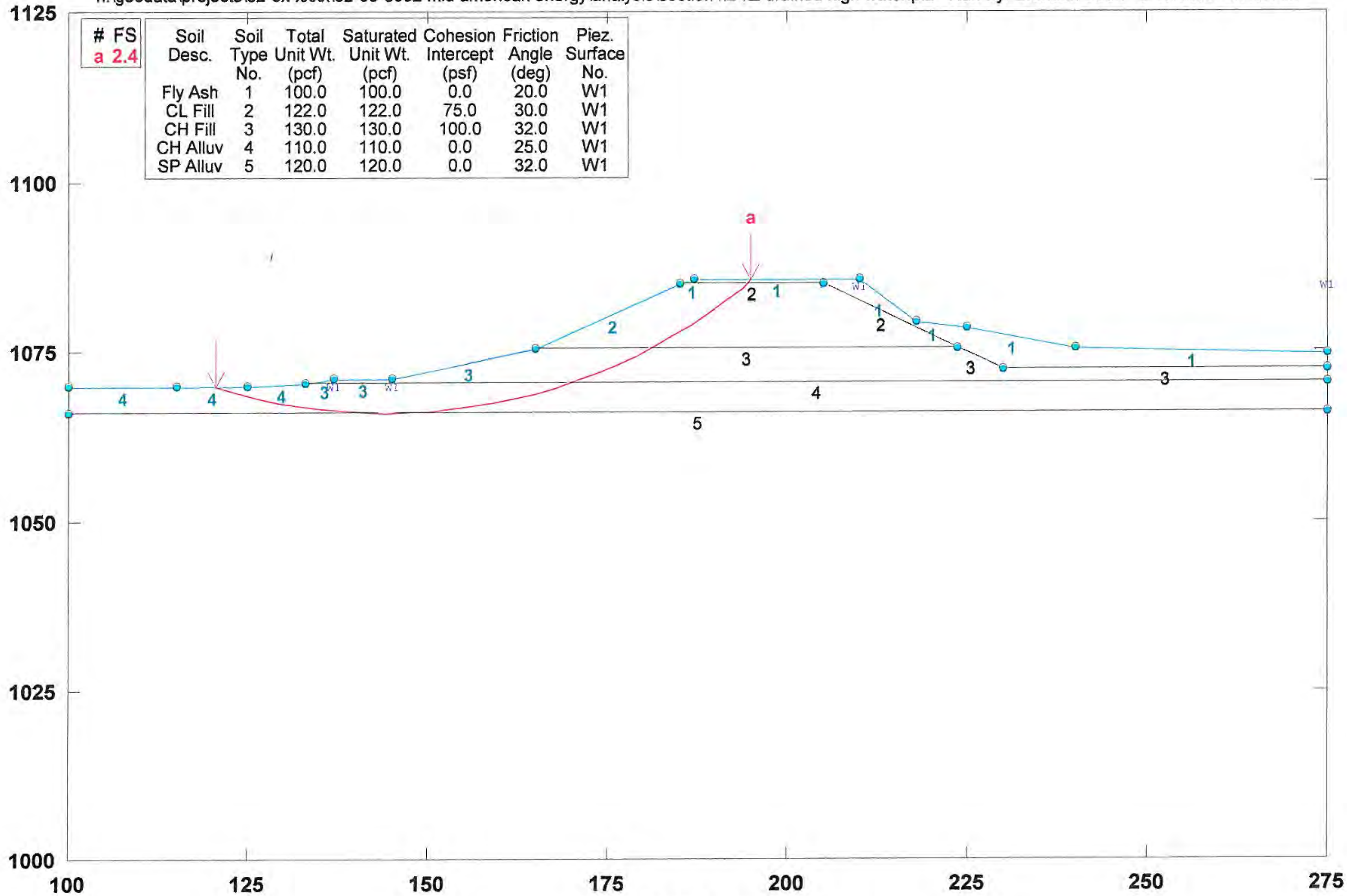
GSTABL7

# Mid American Energy Fly Ash Containment Section K2-K2 Drained Analysis

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section k2-k2 drained high water.pl2 Run By: Brandon Desh 6/10/2009 07:37AM

| # | FS |
|---|---|
| a | 2.4 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 0.0 | 20.0 | W1 |
| CL Fill | 2 | 122.0 | 122.0 | 75.0 | 30.0 | W1 |
| CH Fill | 3 | 130.0 | 130.0 | 100.0 | 32.0 | W1 |
| CH Alluv | 4 | 110.0 | 110.0 | 0.0 | 25.0 | W1 |
| SP Alluv | 5 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |




GSTABL7 v.2 FSmin=2.4
Safety Factors Are Calculated By The Modified Bishop Method

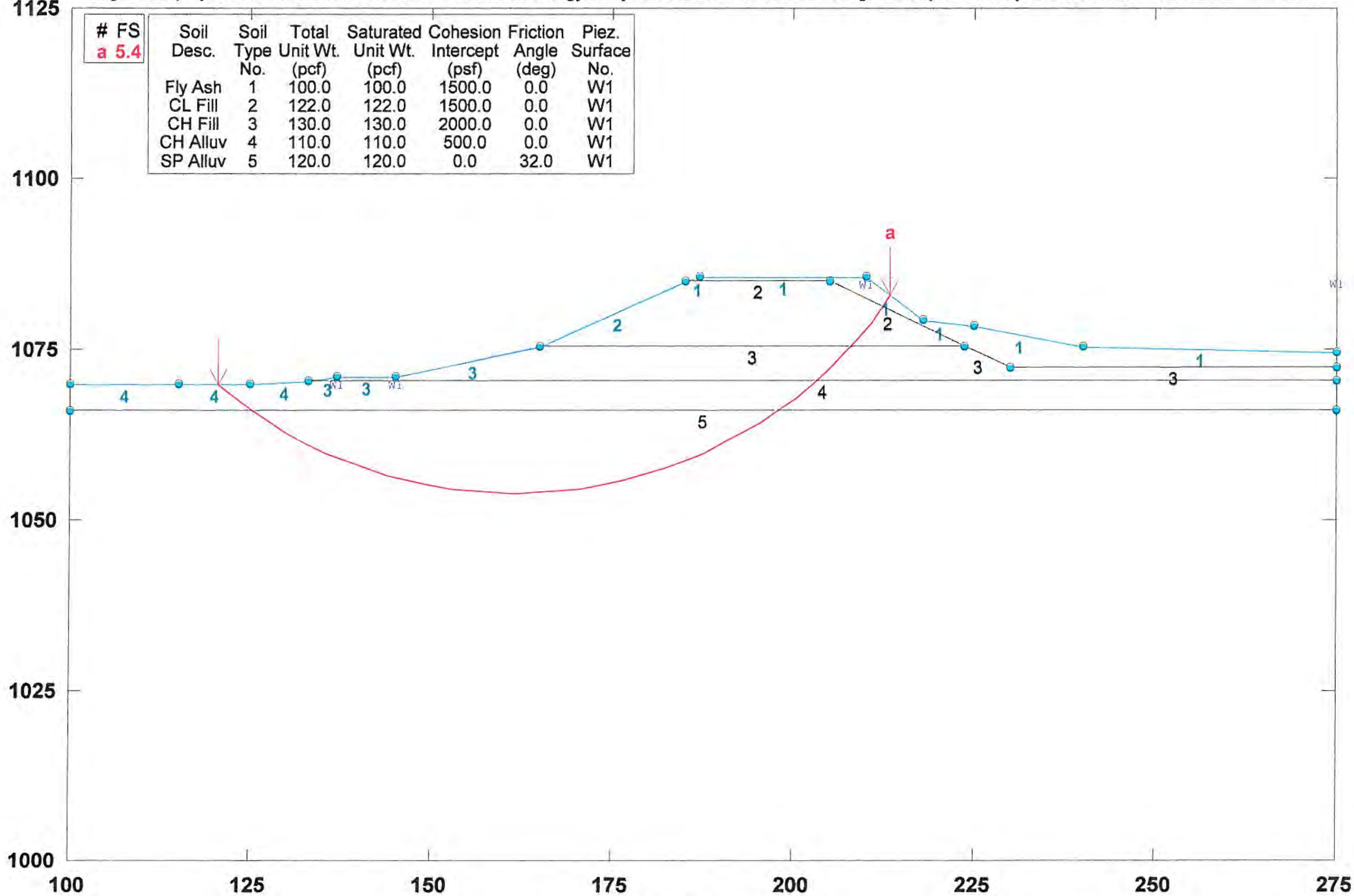
GSTABL7

# Mid American Energy Fly Ash Containment Section K2-K2 Undrained Analysis

h:\geodata\projects\52-6x-xxxx\52-69-5092 mid american energy\analysis\section k2-k2 undrained high water.pl2 Run By: Brandon Desh 6/10/2009 07:40AM

| # | FS |
|---|---|
| a | 5.4 |

| Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No. |
|---|---|---|---|---|---|---|
| Fly Ash | 1 | 100.0 | 100.0 | 1500.0 | 0.0 | W1 |
| CL Fill | 2 | 122.0 | 122.0 | 1500.0 | 0.0 | W1 |
| CH Fill | 3 | 130.0 | 130.0 | 2000.0 | 0.0 | W1 |
| CH Alluv | 4 | 110.0 | 110.0 | 500.0 | 0.0 | W1 |
| SP Alluv | 5 | 120.0 | 120.0 | 0.0 | 32.0 | W1 |




GSTABL7 v.2 FSmin=5.4
Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

# APPENDIX H. UNDERSEEPAGE ANALYSES

Mid American Energy Port Neal North Fly Ash Berm Underseepage Calculations
Underseepage Analysis with Current Profile-June 9, 2009
Unit Side ("River") Analysis, Max Pool Elevation Shown

ic = 0.92

| | Max Pool | Floor | | Natural Blanket | | | | | | | | | | | w/o | Berm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Elevation[1] | Elevation | H | Dbr | Dbl | kf/kbr | kf/kbl | Df | Lr | L2 | Le | Cbr | L1 | Ls | ho | G.S.F |
| A-A | 1089 | 1086 | 3 | 14 | 4 | 3.60E+01 | 2.50E+00 | 70 | 1000 | 36 | 26.458 | 187.83 | 187.82 | 223.82 | 0.3171 | 11.6 |
| B-B | 1089 | 1076 | 13 | 2 | 7 | 1.96E+03 | 2.50E+00 | 70 | 1000 | 116 | 35 | 523.16 | 500.78 | 616.78 | 0.6981 | 9.2 |
| E-E | 1082 | 1069 | 13 | 2 | 7.5 | 3.60E+01 | 1.26E+04 | 70 | 600 | 116 | 2576.8 | 70.993 | 70.993 | 186.99 | 12.12 | 0.6 |
| G-G | 1086 | 1084.5 | 1.5 | 15.5 | 8 | 3.60E+01 | 2.70E+01 | 70 | 750 | 24 | 122.96 | 197.64 | 197.44 | 221.44 | 0.5356 | 13.7 |
| H2-H2 | 1082 | 1074 | 8 | 16 | 8 | 1.96E+03 | 1.96E+03 | 70 | 1500 | 76 | 1046.3 | 1479.7 | 1135.4 | 1211.4 | 3.7076 | 2.0 |
| K2-K2 | 1082 | 1074 | 8 | 6.5 | 4 | 3.91E+03 | 1.95E+03 | 70 | 1000 | 76 | 739.68 | 1333.6 | 846.92 | 922.92 | 3.5591 | 1.0 |

Mid American Energy Port Neal North Fly Ash Berm Underseepage Calculations
Underseepage Analysis for Proposed Profile-June 9, 2009
Unit Side ("River") Analysis, Max Pool Elevation Shown

ic = 0.92

| | Max Pool | Floor | | Natural Blanket | | | | | | | | | | | w/o | Berm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Elevation[1] | Elevation | H | Dbr | Dbl | kf/kbr | kf/kbl | Df | Lr | L2 | Le | Cbr | L1 | Ls | ho | G.S.F |
| A-A | 1082 | 1074 | 8 | 1.5 | 4 | 3.60E+01 | 2.50E+00 | 70 | 1000 | 76 | 26.458 | 61.482 | 61.482 | 137.48 | 1.2911 | 2.9 |
| B-B | 1082 | 1072.5 | 9.5 | 2 | 7 | 1.96E+03 | 2.50E+00 | 70 | 1000 | 88 | 35 | 523.16 | 500.78 | 588.78 | 0.533 | 12.1 |
| E-E | 1078.5 | 1074 | 4.5 | 4 | 7.5 | 3.60E+01 | 1.26E+04 | 70 | 500 | 48 | 2576.8 | 100.4 | 100.39 | 148.39 | 4.255 | 1.6 |
| G-G | 1082 | 1072.5 | 9.5 | 3.5 | 8 | 3.60E+01 | 2.70E+01 | 70 | 750 | 88 | 122.96 | 93.915 | 93.915 | 181.91 | 3.8315 | 1.9 |
| H2-H2 | 1082 | 1072.5 | 9.5 | 14.5 | 8 | 1.96E+03 | 1.96E+03 | 70 | 1500 | 88 | 1046.3 | 1408.7 | 1109.3 | 1197.3 | 4.4303 | 1.7 |
| K2-K2 | 1078.5 | 1074 | 5 | 8 | 4 | 3.91E+03 | 1.95E+03 | 70 | 1000 | 52 | 739.68 | 1479.7 | 871.24 | 923.24 | 2.224 | 1.7 |

Mid American Energy Port Neal North Fly Ash Berm Underseepage Calculations
Underseepage Analysis with Current Profile-June 9, 2009
River or Pond Side Analysis, 100 year Flood Elevation =1076.0 feet
ic = 0.92

| Station | 100 yr Elevation[1] | Blanket Top Elevation | H | Natural Blanket Dbr | Natural Blanket Dbl | kf/kbr | kf/kbl | Df | Lr | L2 | Le | Cbr | L1 | Ls | w/o ho | Berm G.S.F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-A | No river at this location | | | | | | | | | | | | | | | |
| B-B | No river at this Location | | | | | | | | | | | | | | | |
| E-E | 1076 | 1075 | 1 | 5 | 5 | 1.26E+04 | 3.60E+01 | 70 | 40 | 20 | 112.25 | 2103.9 | 39.995 | 59.995 | 0.6517 | 7.1 |
| G-G | 1076 | 1074 | 2 | 4 | 15.5 | 2.69E+02 | 3.58E+02 | 70 | 30 | 28 | 623.24 | 274.44 | 29.881 | 57.881 | 1.83 | 7.8 |
| H2-H2 | 1076 | 1073 | 3 | 8 | 16 | 1.96E+03 | 1.96E+03 | 70 | 50 | 36 | 1479.7 | 1046.3 | 49.962 | 85.962 | 2.8353 | 5.2 |
| K2-K2 | 1076 | 1074 | 2 | 4 | 6.5 | 1.96E+03 | 3.91E+03 | 70 | 50 | 28 | 1333.8 | 739.86 | 49.924 | 77.924 | 1.8896 | 3.2 |

Mid American Energy Port Neal North Fly Ash Berm Underseepage Calculations
Underseepage Analysis with Proposed Profile-June 9, 2009
River or Pond Side Analysis, 100 year Flood Elevation =1076.0 feet

ic = 0.92

| | 100 yr | Blanket Top | | Natural Blanket | | | | | | | | | | | w/o | Berm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Elevation[1] | Elevation | H | Dbr | Dbl | kf/kbr | kf/kbl | Df | Lr | L2 | Le | Cbr | L1 | Ls | ho | G.S.F |
| A-A | No river or pond at this location | | | | | | | | | | | | | | | |
| B-B | No river or pond at this Location | | | | | | | | | | | | | | | |
| E-E | 1076 | 1075 | 1 | 5 | 1 | 1.26E+04 | 3.60E+01 | 70 | 40 | 20 | 50.2 | 2103.9 | 39.995 | 59.995 | 0.4556 | 2.0 |
| G-G | 1076 | 1074 | 2 | 4 | 3.5 | 2.69E+02 | 3.58E+02 | 70 | 30 | 28 | 296.16 | 274.44 | 29.881 | 57.881 | 1.673 | 1.9 |
| H2-H2 | 1076 | 1073 | 3 | 8 | 16 | 1.96E+03 | 1.96E+03 | 70 | 50 | 36 | 1479.7 | 1046.3 | 49.962 | 85.962 | 2.8353 | 5.2 |
| K2-K2 | 1076 | 1074 | 2 | 4 | 6.5 | 1.96E+03 | 3.91E+03 | 70 | 50 | 28 | 1333.8 | 739.86 | 49.924 | 77.924 | 1.8896 | 3.2 |