FINAL

Coal Combustion Residue Impoundment
Round 12 - Dam Assessment Report

Keystone Generating Station
Ash Filter Ponds & Thermal Pond
GenOn Energy
Shelocta, PA

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

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INTRODUCTION, SUMMARY CONCLUSIONS AND RECOMMENDATIONS

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

This assessment of the stability and functionality of the CCR management units, Ash Filter Ponds and Thermal Pond (aka Cooling Pond "A") at the Keystone Generating Station is based on a review of available documents and on the site assessment conducted by Dewberry personnel on September 13, 2012. We found the supporting documentation, supplemented with new studies of slope stability, piezometric measurements, and hydrologic analyses performed in November 2013, to be adequate. The maintenance and operating procedures appear to be adequate. As detailed in Subsection 1.2.4, there are a few minor maintenance recommendations based on field observations that may help to maintain safe and trouble-free operations. The surveillance program was found to be adequate now that inspections at the Ash Filter Ponds have been formalized (Subsection 1.1.7).

In summary, both of the CCR management units at the Keystone Generating Station are SATISFACTORY for continued safe and reliable operation, with no recognized existing or potential management unit safety deficiencies.

PURPOSE AND SCOPE

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

In February 2009, the EPA sent letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion residue. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

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

The purpose of this report is **to evaluate the condition and potential of residue release from management units and to determine the hazard potential classification**. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner. Also, after the field visit, additional information was received by Dewberry Consultants LLC about the facility that was reviewed and used in preparation of this report.

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

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

FINAL

LIMITATIONS

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

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit on September 13, 2012, and review of technical documentation provided by GenOn Energy.

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

The Ash Filter Ponds dike, Thermal Pond dam, and the associated outlet structures appear to be structurally sound, based on a November 2013 seismic analysis performed by Geosyntec for the utility (see Appendix A – Doc 11). The report shows that under both static and seismic conditions the Ash Filter Pond dikes and the Thermal Pond dam have factors of safety that exceed minimum requirements. These findings are consistent with the review of the engineering data provided by GenOn's technical staff and Dewberry engineers' observations during the site visit, as well as conservative simple calculations to check stability of the Ash Filter Ponds dike provided in the Draft report.

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

The Ash Filter Ponds and the Thermal Pond, which do not receive off-site runoff, have adequate hydrologic/hydraulic safety against design rainfall events as calculated by Geosyntec and presented in the November 2013 report (see Appendix A – Doc 11). This conclusion confirms conclusions made by Dewberry in the Draft report based on a review of furnished technical information.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

The furnished supporting technical documentation for the Thermal Pond is adequate. The furnished project documentation for the Ash Filter Ponds is adequate

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

Overall, the descriptions of the subject management units provided by GenOn are generally accurate representations of what Dewberry observed in the field. We note there is a discrepancy in the downstream slope geometry both observed during the site visit and used in the Geosyntec slope stability analyses versus furnished design documents. This discrepancy does not affect the conclusions that the units have adequate factors of safety since the steeper slope values were used in the analysis.

1.1.5 Conclusions Regarding the Field Observations

Dewberry staff was provided access to all areas in the vicinity of the subject management units required to conduct a thorough field observation. The visible parts of the impounding embankments and outlet structures were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability although visual observations were hampered by the presence of thick vegetation in some areas, particularly on the outside slope of the highest dike embankment at the Ash Filter Ponds. The embankments appeared structurally sound. There were no apparent indications of unsafe conditions or conditions needing emergency remedial action. Based on the field observations, minor maintenance items are recommended (see Subsection 1.2.4).

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The current maintenance and methods of operation for both the Ash Filter Ponds and the Thermal Pond appear to be adequate. There was no evidence of significant embankment repairs or prior releases observed during the field inspection. (See Subsection 1.2.4 for minor maintenance recommendations.)

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The surveillance program for the Ash Filter Ponds was formalized in 2013 and is adequate. The Thermal Pond surveillance program was in place at the time of the site visit and is adequate. The Geosyntec study (see Appendix A – Doc 11) found that the seeps near the Thermal Pond are not due to liner failure and do not require further monitoring.

There is no dam performance monitoring instrumentation in place at either the Ash Filter Ponds or the Thermal Pond. No problem or suspect condition, such as excessive settlement, significant flowing seepage, shear failure, or displacement was observed in the field that might be reason for installation of instrumentation for long-term performance monitoring. Therefore, there is no need for performance monitoring instrumentation at this time.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

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

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Structural Stability

No recommendations for remedial work to ensure structural stability appear warranted at this time.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

No recommendations for remedial work to ensure hydrologic/hydraulic safety appear warranted at this time.

1.2.3 Recommendations Regarding the Supporting Technical Documentation

No recommendations for additional supporting technical documentation are warranted at this time.

1.2.4 Recommendations Regarding the Field Observations

Ash Filter Ponds and Thermal Pond

Based on the field observations, some minor maintenance recommendations are provided as follows:

1) Control burrowing animals (e.g. ground hogs) and appropriately fill-in burrows in the embankments around the ponds.

2) Schedule and complete mowing of the embankments just before the quarterly inspections that are conducted during the growing season. According to a November 2013 e-mail from GenOn an adequate inspection and mowing program recently has been established (see Appendix A – Docs 12 and 13).

1.2.5 Recommendations Regarding the Maintenance and Methods of Operation

No recommendations appear warranted at this time for maintenance procedures and methods of operation (see Subsection 1.2.4 above for minor maintenance recommendations).

1.2.6 Recommendations Regarding the Surveillance and Monitoring Program

Ash Filter Ponds

There are no recommendations regarding surveillance of the Ash Filter Ponds now that they are included in the plant's formal surveillance program.

Thermal Pond

There are no recommendations for additional monitoring of the Thermal Pond since the seeps were adequately investigated in 2013 (see Appendix A – Doc 11) and the source was not due to liner failure.

1.2.7 Recommendations Regarding Continued Safe and Reliable Operation

No additional recommendations appear warranted at this time. Implementation of the above recommendations in Section 1.2.4 will help ensure continued safe and reliable operation of the Keystone CCR management units and upgraded rating.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

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1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on September 13, 2012.

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

2.1 LOCATION AND PROJECT DESCRIPTION

The Keystone Generating Station is located in the southeast section of Armstrong County at 313 Keystone Drive, Shelocta, PA on 1,459-acres. The town of Shelocta is located approximately 2.5 miles east of the Keystone facility. Crooked Creek borders the facility to the south. See Figure 2.1-1 for the location of the Keystone Generating Station on a USGS topographic map. Keystone is a coal-fired electric generating station featuring two pulverized coal, supercritical boilers (1,700 MW) and four diesel units (12 MW) with total generating capacity of 1,712 megawatts.

Keystone Generating Station is jointly owned by a group of seven co-owners. NRG REMA LLC, a subsidiary of NRG, has a 16.7 percent interest in Keystone, NRG itself has a 3.7 percent interest in Keystone. GenOn Northeast Management Company (GenOn) operates the facility for the owners group. The two units were originally commissioned in the summers of 1967 and 1968.

The generating facility maintains a relatively small complex of Ash Filter Ponds that consist of three contiguous clay-lined cells (Ponds A, B and C) that receive water produced from dewatering of bottom ash. See Figure 2.1-2 for an aerial view of the Ash Filter Ponds. The water originates at the Bottom Ash Dewatering Bins located southeast of the Ash Filter Ponds; it consists of decant water from dewatering of the bottom ash and dewatering bin overflow of the water used to sluice bottom ash from the Ash Hoppers to the Dewatering Bins. The water is piped from the Dewatering Bins to a distribution box that controls flow to the individual cells. The water contains some fine suspended ash particles, which are removed by sedimentation in the Ash Filter Ponds. The multiple cells allow two cells to remain in operation while a third cell is dewatered and cleaned out, when needed, by excavation and removal of settled ash to an on-site landfill. The individual cells receive the water at the southeast end of the cells. Each individual cell is nominally 82 ft wide by 386 ft long at the normal water surface elevation of 1,018.5 ft. The clarified water exits each cell on the northwest end via saw tooth weirs on each side of metal weir troughs that discharge into a concrete riser structure that has bottom discharge to a pump station via an 18-inch diameter vitrified clay pipe (VTC). The pump station pumps the water collected from the cells via a 24-inch diameter polyethylene pipe (PE) to the Thermal Pond located 2,000 ft northwest of the Ash Filter Ponds.

The pumped water is received at a distribution box located at the west end of the Thermal Pond. The distribution box evenly divides the flow among a series of small pipes, which are spaced at intervals of approximately 20 feet and discharge into the geomembrane-lined Thermal Pond. The Thermal Pond has a storage volume of approximately 5.6 million cubic feet at normal operating level. See Figure 2.1-3 for an aerial view of the Thermal Pond. The available surface area for cooling is approximately 310,000 square feet. Cooled water leaves the pond through a concrete overflow structure at the east end, which has bottom discharge through an 18-inch diameter HDPE pipe that passes though the embankment dam and ultimately discharges into a stream channel at the toe of the dam. The original discharge pipe was a 21-inch diameter corrugated metal pipe (CMP), but it had been retrofitted with the HDPE pipe sleeved through it. Water discharged into the stream channel follows the channel to a 13 ft by 7 ft precast concrete culvert that passes through a high embankment that supports railroad tracks and a road; the water continues to a long lagoon on the other (south) side of the railroad embankment and ultimately discharges through a permitted outfall at Crooked Creek farther south. Upgradient (north) of the discharge location in the stream channel below the Thermal Pond dam, a small dam across the channel diverts natural stream flow into an 18-inch diameter spiral polyethylene (SPE) pipe that carries the natural stream flow all the way to Crooked Creek, separating it from the flow of water discharging from the Thermal Pond.

A number of emission control systems have either been upgraded or installed since the plant was first commissioned. The flue gas desulfurization (FGD) system, upgraded in 2009, uses state-of-the-art technology designed to remove 98 percent of the sulfur dioxide (SO2) emitted at Keystone, lowering SO2 emissions by 173,000 tons per year, in addition to approximately 80 percent of the mercury and other emissions. A gypsum material is generated that is managed separately from other coal combustion wastes; the gypsum is not managed in impoundments. Other upgrades include modifications to the electrostatic precipitators, the addition of a flue-gas conditioning system to improve precipitator performance, a low-nitrogen oxide burner system to reduce NOx emissions and installation of a selective catalytic reduction system to further reduce NOx emissions.

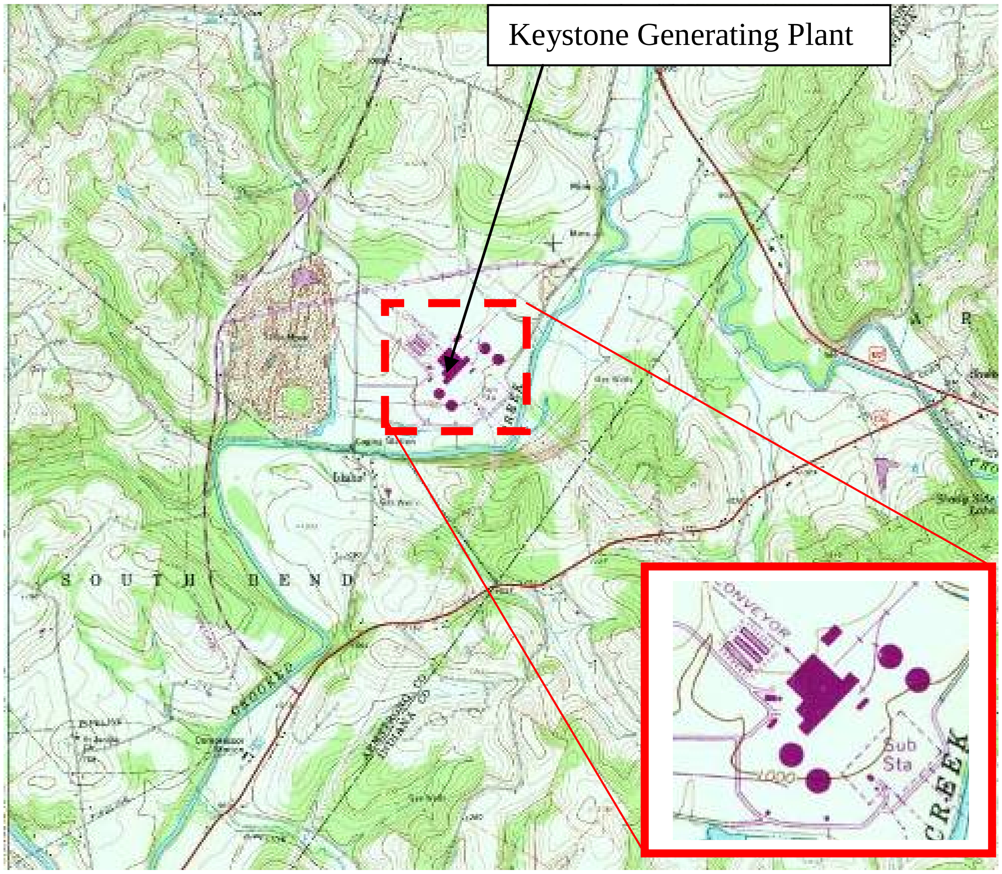

Figure 2.1-1: Keystone Generating Plant Location Plan

Table 2.1 shows a summary of the size and dimensions of the Ash Filter Ponds perimeter dike and Thermal Pond dam.

Table 2.1: Summary of Dam Dimensions and Size		
	Ash Filter Ponds	**Thermal Pond**
Dam Height (ft)	Varies 0 to 10.5 ft	48 ft
Crest Width (ft)	25 ft	20 ft
Length (ft)	1,420 ft	2,700 ft
Side Slopes (upstream) H:V	2:1	2.5:1
Side Slopes (downstream) H:V	2:1 to 2.5:1 (Typ.) 1.5:1 (Locally)	2:1 Above Berm 1.75:1 Below Berm


Imagery ©2012 DigitalGlobe, GeoEye, U.S. Geological Survey, USDA Farm Service Agency, Map data ©2012 Google - Edit in Google Map Maker

Figure 2.1-2: CCR Impoundment (Ash Filter Ponds) at Keystone Generating Plant

Figure 2.1-3 Thermal Pond location at Keystone Generating Station

2.2 COAL COMBUSTION RESIDUE HANDLING

2.2.1 Fly Ash

Fly ash generated through the coal combustion process is collected at the precipitator hoppers and pneumatically conveyed in the dry to storage/load-out bins. After conditioning with some moisture to control dust and to facilitate handling, the fly ash is loaded onto trucks and taken to a landfill on site.

2.2.2 Bottom Ash

The bottom ash is sluiced from the four ash hoppers in each of Units 1 and 2 to one of four dewatering bins using 2,600 gpm ash sluice pumps. The dewatering bin overflow and periodic decant water then flows by gravity to the bottom ash filter ponds. The three cells comprising the Ash Filter Ponds are each sized for 50 percent of the bottom ash transport water design flow. Normal operation is two ponds in service at all times, with the third pond being drained, cleaned, and prepared for return to service.

2.2.3 Boiler Slag

Boiler slag is not handled separately but included in the bottom ash and therefore treated as bottom ash, which is dewatered in the dewatering bins, loaded onto trucks, and hauled to the on-site landfill for disposal.

2.2.4 Flue Gas Desulfurization Sludge

Gypsum produced from the flue gas desulfurization system, which uses wet scrubbers, is dewatered and transported through an enclosed tubular gallery conveyor to a dome covered storage pad. The filtrate from dewatering is sent to the waste water treatment plant. Depending on market conditions and quality, the gypsum is sold to an off-site third party for beneficial reuse or transported and disposed in the on-site landfill. The FGD gypsum is not sluiced or managed in the Ash Filter Ponds or Thermal Pond, or any embanked impoundments.

2.3 SIZE AND HAZARD CLASSIFICATION

Size classification per U.S. Army Corps of Engineers (USACE) criteria (ER 1110-2-106) is based on maximum potential storage capacity (of water) or maximum dam height, as shown in Table 2.2a. Either dam height or storage capacity may determine the size classification, whichever gives the larger size. See Tables 2.1 and 2.3 for embankment height and estimated pond storage capacity.

Table 2.2a: Size Classification (USACE ER 1110-2-106)

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

According to the information GenOn provided and the field inspection, the Ash Filter Ponds complex has a maximum storage capacity of 7.3 acre-ft total for the three cells with a maximum dike height of 10.5 ft. In accordance with the USACE ER 1110-2-106 criteria (Table 2.2a), the Ash Filter Ponds complex actually has less than Small size classification considering either dam height or storage capacity, but Small is assumed for purposes of this assessment. The Ash Filter Ponds embankments are not regulated for dam safety by a federal or state agency. Therefore, the Ash Filter Ponds complex does not have federal or state hazard classifications.

The Thermal Pond is regulated for dam safety and permitted with the PA Department of Environmental Resources Bureau of Dams, Waterways and Wetlands Division of Dam Safety (Permit No. D03-044). The Thermal Pond has a maximum storage capacity of 137 acre-ft with a maximum height of 48 ft. In accordance with USACE ER 1110-2-106, the Thermal Pond has an Intermediate size classification on the basis of dam height, and category B size, in accordance with PA dam safety criteria. The impoundment was assigned a hazard potential classification of 3 (equivalent to Low hazard potential) in accordance with PA dam safety criteria in the April 1993 Dam Permit Application for the Thermal Pond (see Appendix A – Doc 2). (Note: It appears that the PA classification of B-3, which was made in 1993, would today be B-4 in accordance with current PA dam safety criteria, which were amended in 2011.)

Hazard potential classification per the FEMA Federal Guidelines for Dam Safety is based on the criteria shown in Table 2.2b.

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

For both the Ash Filter Ponds and the Thermal Pond, loss of human life is not expected, and economic and environmental losses are expected to be minimal or low. If failure occurred, ash residuals would remain on GenOn property. Therefore, in accordance with the Federal Guidelines (Table 2.2b), a **Low** hazard potential classification is given for both the Ash Filter Ponds and the Thermal Pond.

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

Each cell of the Ash Filter Ponds is cleaned out when the ash residuals (sediment) accumulates to a thickness of 4 ft, which is the design allowance. The clean out is done once or twice a year on a rotating basis, with two cells remaining in operation while the third is cleaned out. Thus, the maximum amount of residuals in the Ash Filter Ponds never reaches the value shown for current storage capacity (12.9 acre-ft or 20,796 cubic yards) in Table 2.3 below, or the value shown for maximum storage capacity (the total volume of all three cells from original bottoms to the top of the perimeter dike embankment).

The Thermal Pond receives practically no ash residuals, but it is still checked and cleaned periodically by divers using a suction hose. It is understood that during the last cleaning the divers reported an ash sediment layer on the bottom only 1/16 inch thick.

Table 2.3: Estimated Capacity and Other Data for the Unit(s)		
	Ash Filter Ponds	**Thermal Pond**
Surface Area (acre)[1, 2, 3]	2.2	7.12
Current Storage Capacity (cubic yards)[1, 2, 3]	20,796	207,407
Current Storage Capacity (acre-feet)	12.9	128.6
Max. Storage Capacity (cubic yards)[1, 2, 4]	27,907	221,027
Max. Storage Capacity (acre-feet)	17.3 (Est.)	137
Crest Elevation (feet) [1]	1020.5	1020
Normal Pond Level (feet) [1]	1018.5	1017

[1] See Appendix A - Doc 1: Part D-Pond/Impoundment Systems and other wastewater treatment operations
[2] See Appendix A – Doc 2: Thermal Pond Dam Permit Application
[3] Water surface area and storage capacity at normal pond level, including volume in incised part of filter ponds
[4] Storage capacity at top of dam level, including volume in incised part of filter ponds

2.5 PRINCIPAL PROJECT STRUCTURES

2.5.1 Earth Embankments/Ponds

Ash Filter Ponds

The Ash Filter Ponds consist of three contiguous cells surrounded by a perimeter dike and separated by two interior divider dikes. The cells are not hydraulically connected and are managed independently. Each cell is approximately 90 ft by 410 ft at top of dike embankment elevation, with the long dimension of the cells oriented generally northwest-southeast. The top of embankment elevation (inside edge) varies from 1020.5 ft on the northwest side to 1022.5 ft on the southeast side. The normal water elevation in the cells is 1018.5 ft. The interior side slopes of the cells are 2 horizontal (H) to 1 vertical (V). The perimeter dike embankment is highest at 10.5 ft above the outside toe on the southwest side and has an exterior slope that typically varies from 2H: 1V to 2.5H: 1V but locally is as steep as 1.5H: 1V. The northeast side is fully incised so that there is practically no dike on that side. The height of the perimeter dike embankment on the northwest and southeast sides varies from about 1 ft (northeast end) to 10.5 ft (southwest end). The perimeter dike crest width around the pond is approximately 25 ft, and the typical crest width of the divider dikes is 23 ft.

As previously mentioned, the Ash Filter Pond cells are clay lined. The permeability of the liner is indicated to be 1 x 10^{-7} cm/sec. They also include an underdrain system. On the bottom the liner is indicated to consist of the following, in descending order:

1. 18-inch thick on-site clay fill;
2. 8-inch thick bentonite treated (2.4 lb/ft^2) clay (compacted); and
3. 16-inch thick on-site clay fill.

On the side slopes the liner is indicated to consist of:

1. 24-inch thick (perpendicular to slope) bentonite treated (1.8 lb/ft^2) clay (compacted in 6-inch thick horizontal lifts).

The liner on the side slopes is protected with an 18-inch thick blanket of small riprap ("R-3 rock").

The underdrain system is indicated to consist of two runs of perforated Schedule 80 PVC pipes, 8-inch diameter increasing to 12-inch in each run, laid just above the 8-inch thick bentonite-treated clay layer along the length of each cell and connecting to 12-inch diameter solid wall Schedule 80 PVC header pipes on the northwest side that drain to the discharge structure in each cell. The perforated pipes are indicated to be encased within No. 57 stone in 2 ft wide trenches extending most of the way through the upper clay fill layer of the liner system, with the stone a minimum of 4 inches thick under the pipe and mounded 6 inches over the pipe. Above the No. 57 stone encased pipes, the bottom is indicated to be covered with 18-inch thick blanket of No. 8 coarse aggregate, in turn covered with a 30-inch thick layer of bottom ash incorporated as the primary filter media.

Thermal Pond

The Thermal Pond is approximately 328.5 ft wide by 1060 ft long at the top of dam embankment (rim) elevation, with the long dimension oriented generally east-west. The top of embankment (crest) elevation is 1020 ft, and the typical crest width is 20 ft. The normal water surface elevation is 1017 ft. The main embankment section is on the east side of the pond, with a maximum height of 48 feet above the outside toe. The west side is incised and there is essentially no dam embankment height above the outside toe, although the rim is 16 feet above the inside toe. The wide embankment supporting the plant railroad and coal truck road lies immediately along the south side of the Thermal Pond and has surface elevations near that of the pond dam embankment crest. The pond embankment crest typically is only 3 to 4 feet above the outside toe ditch between the crest and the adjacent railroad siding but is 16 to 38 ft above the inside toe, due to the sloping bottom of the pond that ranges from elevation 1004 ft at the west end to 982 ft at the east end. Approximately 1/3 of the north side of the pond is much like the west side of the pond. The dam along the remaining part of the north side ranges in height up to a maximum of 38 ft above both the inside and outside toes. This section of dam embankment actually divides a former ash basin into two areas. The south area now comprises the Thermal Pond. The north area was originally planned to be another cooling pond, but the basin was never completely developed for use as a cooling pond and was retired. The retired basin does not now contain CCR.

The interior side slopes of the Thermal Pond are 2.5H: 1V. The main embankment section on the east side has a 12 ft wide berm (access road) on the outside slope between elevation 998 ft and 999 ft. The slope below the berm is 1.75H: 1V. The slope above the berm is shown at 1.75: 1V above the berm on a furnished drawing (D-739-5019) dated January 28, 1993. However, slope stability analysis in the dam permit application dated April 1993 shows the slope above the berm to be at 2H: 1V on the lower part and 3.5H: 1V on the upper part of the section analyzed. The low outside slope above the ditch along the south side is generally 2H: 1V but locally steeper. The outside slope of the embankment on the north side (i.e., inside slope of retired basin) is 2.5H: 1V.

The Thermal Pond has a 50-mil thick high density polyethylene (HDPE) synthetic liner. To protect the liner, a 3-inch thick concrete erosion control revetment is installed on top of the liner on the side slopes and a minimum of two feet of bottom ash is placed on top of the liner on the pond bottom. A nonwoven geotextile and 2-inch thick layer of sand is installed below the liner.

2.5.2 Outlet Structures

Ash Filter Ponds

The outlet for each cell at the Ash Filter Pond complex consists of a 6 ft by 8 ft (plan inside dimensions) by 17.5 ft high concrete riser (discharge structure) and two approximately 38 ft long coated metal weir troughs that discharge into the riser from the northeast and southwest sides of the riser. The troughs are fitted with "saw tooth" weirs on each side with notches set at elevation 1018.5 ft. Turbidity curtains are arranged along the upstream (southeast) side of the weir troughs. Water discharges from the bottom of the riser through an 18-inch diameter VTC pipe to a pump station that pumps the water to the Thermal Pond. The discharge structure also receives flow from the underdrain, which is controlled through two 12-inch knife gates mounted to the discharge structure. An adjustable weir gate at the discharge structure allows removal of the pond water when the cell is dewatered for excavation and removal of settled ash.

Thermal Pond

The outlet for the Thermal Pond consists of a dual chamber riser structure with bottom discharge through an 18-inch diameter HDPE pipe with inlet invert elevation 978.25 ft, which passes through the embankment to a manhole near the toe of the dam. As previously mentioned, the HDPE is sleeved through the original 21-inch diameter CMP. From the manhole the flow passes through a Parshall flume with invert elevation 974 ft before discharging into a creek channel.

The riser structure is 46 ft high from top to foundation level. The original (larger) chamber has plan inside dimensions of 6 ft by 8 ft. The west side of the structure was originally designed for use of stop logs. When the pond was retrofitted for use as a thermal pond, the stop log opening on the west side was filled with concrete to elevation 1016.5 ft, and a smaller chamber with inside dimensions of 3 ft by 4 ft (according to drawings) and an emergency overflow elevation of 1017 ft was constructed on the west side, along with a submerged "launder" that connects to the smaller chamber and draws water from near the bottom of the pond. (Note: In the field the long dimension of the smaller chamber appeared to match that of the larger chamber, so that its inside dimensions appeared to be more on the order of 3 ft by 8 ft.) The launder consists of a 42-inch diameter pipe approximately 60 feet long located 3 feet above the bottom of the pond. On the underside of the launder are a series of orifices that draw the coldest water off the pond bottom into the submerged launder. Water from the launder fills the smaller chamber and overflows into the larger chamber and out the bottom discharge pipe.

The larger chamber also receives water through the north wall from the 12-inch diameter pipe from the underdrain system, which is controlled with a valve that is operated with a hand wheel on the top of the riser. In addition, there are three drawdown ports at elevations 1006 ft, 995.5 ft, and 985 ft through the south wall of the larger chamber controlled with 8-inch valves operated by hand wheels on the top of the riser. The essential features of the Thermal Pond outlet are shown in the following Figure 2.5.2-1.

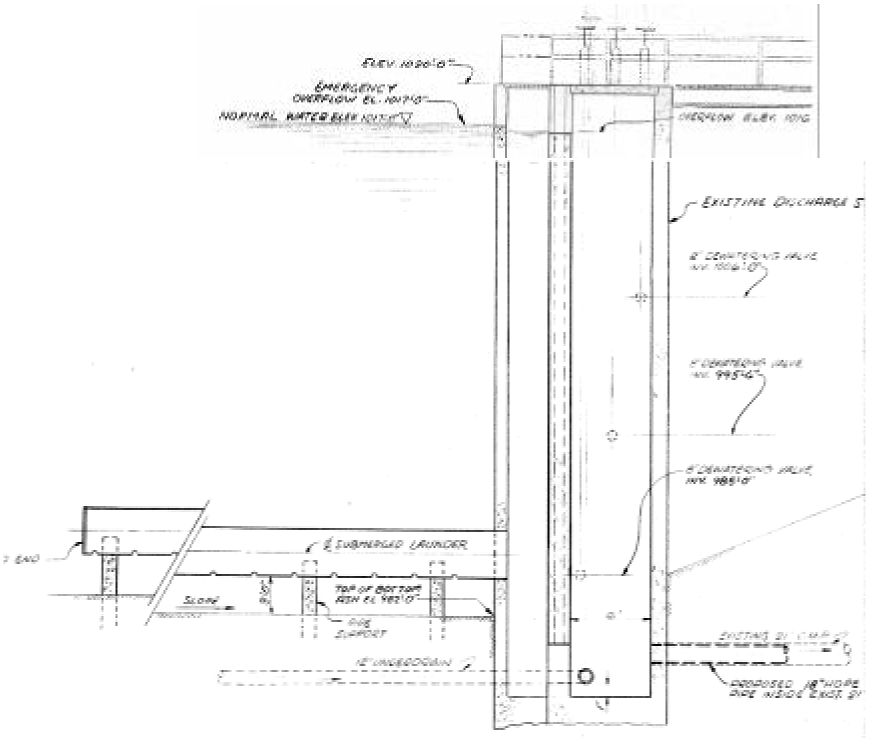

Figure 2.5.2-1 Section view of Thermal Pond outlet.

2.6 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

"Critical" infrastructure includes facilities such as schools, hospitals, fire stations, police stations, etc. There appears that one such facility (Pump Station) may be considered critical or potentially critical infrastructure located within a 5-mile radius of the plant (down gradient). The facility is noted on the 5-mile radius map (see Figure 2.6-1). It does not appear that the facility would be threatened or directly impacted by failure of the dikes at the Keystone plant. In general the land use around Keystone is rural. Flood waters and CCR released from a postulated failure of the Ash Ponds perimeter dike and the Thermal Pond would primarily impact GenOn property and not impact the Crooked Creek or the surrounding area.

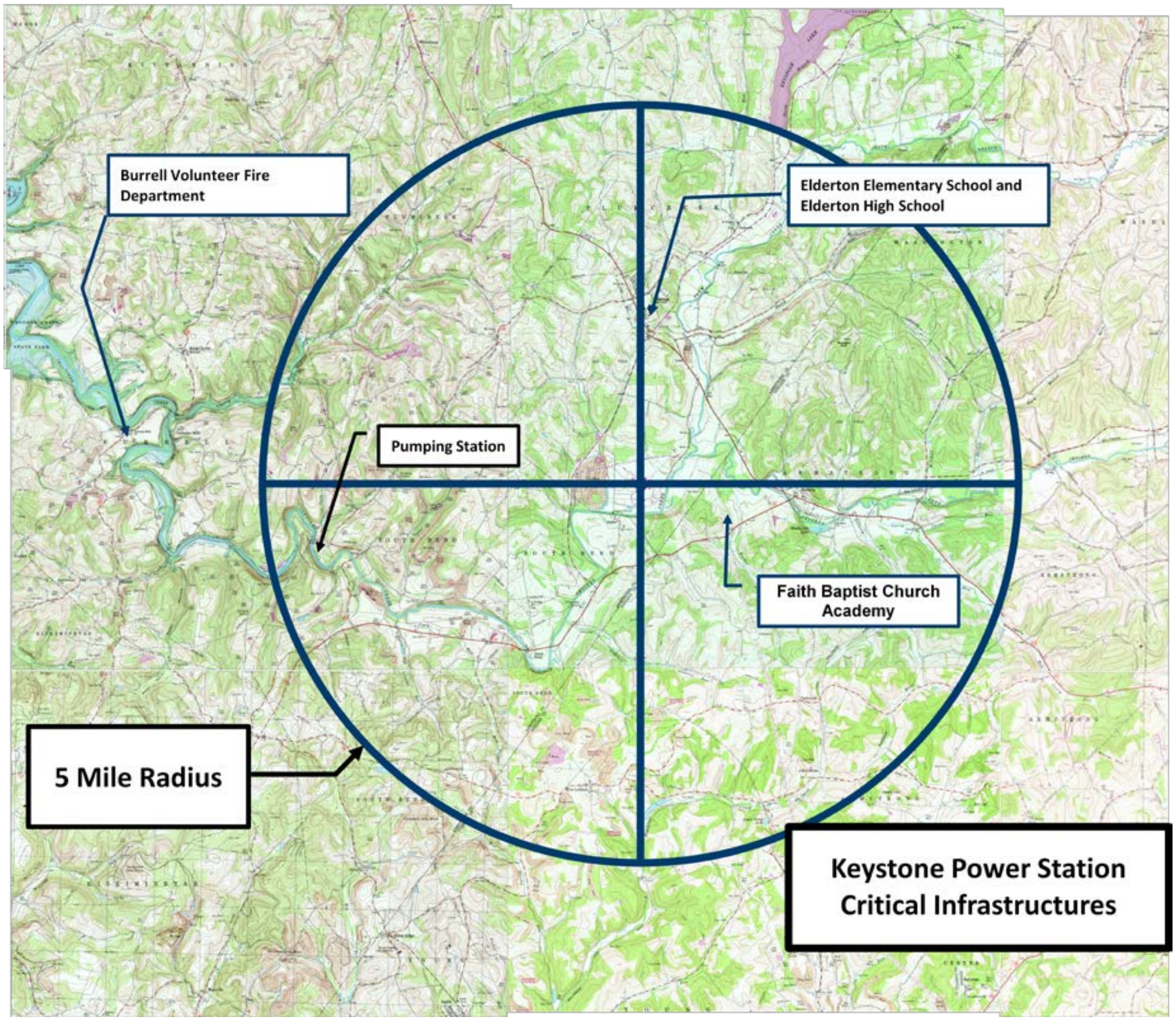

Figure 2.6-1: Critical Infrastructures within a 5 mile radius of the facility.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

3.1 SUMMARY OF REPORTS ON THE SAFETY OF THE MANAGEMENT UNIT

No field reports on the safety performance of the Ash Filter Ponds are available, although inspection reports will be generated beginning in 2014 (see Appendix A – Docs 12 and 13). For the Thermal Pond, GenOn provided four Quarterly Dam Inspection Checklist reports that provide documentation of recent inspections performed by station personnel (see Appendix A – Docs 03, 04, 05 and 06).

The reports for the Thermal Pond (aka Cooling Pond “A”) indicate that the dam and associated works appeared overall to be in good condition with only visual monitoring required. Items requiring monitoring are: minor deterioration of concrete revetment; revetment geotextile deterioration; and flowing water observed on the access road bench at right (south) groin area. It was noted that the flow originates along the railroad embankment on the south side.

3.2 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS

The Thermal Pond dam is permitted by the PA Department of Environmental Protection [known as Department of Environmental Resources (DER) before July 1, 1995], Bureau of Dams, Waterways and Wetlands, Division of Dam Safety, and the dam has been issued a permit. Dam Permit No. D03-044 was issued May 6, 1994 for construction of modifications, and the as-built drawings were accepted by the DER in a letter dated May 3, 1995 (see Appendix A—Doc 07).

Discharge from the impoundment is regulated by the Pennsylvania Department of Environmental Protection (DEP), Bureau of Waste Management, and the impoundment has been issued a National Pollutant Discharge Elimination System Permit. Permit No. PA0002062 was issued February 2008 (see Appendix A – Doc 08).

3.3 SUMMARY OF SPILL/RELEASE INCIDENTS

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

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The Keystone Generating Station began commercial operation in 1967 and 1968. Bottom ash was originally sluiced to a large ash disposal basin located northwest of the main plant structures. This basin is now occupied by the Thermal Pond (Cooling Pond A) in the south part and the retired basin (uncompleted Cooling Pond B that was never put into service) in the north part.

4.1.2 Significant Changes/Modifications in Design since Original Construction

The Ash Filter Ponds went into service in 1989 and presumably eliminated the need for sluicing bottom ash to the former ash disposal basin. The overflow from the three cells originally went to an 18-inch diameter header pipe that discharged by gravity flow to the Keystone lagoon.

In 1992 the owner of the power plant entered into a Consent Order and Agreement (COA) with the PA Department of Environmental Resources to establish a schedule for design and construction of facilities necessary to meet effluent thermal limitations. This required re-routing the bottom ash filter pond discharge from the Keystone lagoon by pumping the discharge from the Ash Filter Ponds to a new Thermal Pond constructed in the south part of the former bottom ash disposal basin. The Thermal Pond retrofit construction was completed in December 1994, and the pond went into service shortly thereafter (see Appendix A - Doc 02 Dam Permit Application). Prior to retrofit construction, ash in the old ash disposal basin had been excavated and removed. The new design allows the Thermal Pond to normally discharge the coldest water from near the bottom of the pond through a new submerged launder that is integrated into the existing discharge structure as previously described (see Subsection 2.5.2).

4.1.3 Significant Repairs/Rehabilitation since Original Construction

No documentation was provided to indicate any significant repair/rehabilitation has taken place since the original construction.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

Furnished documents do not include the original operational procedures related to wet disposal or storage of CCR when the plant was first commissioned. However, the original bottom ash disposal basin presumably was designed and operated for bottom ash sedimentation and control. The basin received coal combustion waste slurry and plant process waste water. The water was treated via sedimentation and discharged through overflow outlet structures (decant towers) fitted with stop logs to control the water level as the basin filled with bottom ash (and boiler slag) sediment. Fly ash has been handled in a dry state since original startup (see Subsection 2.2.1).

4.2.2 Significant Changes in Operational Procedures since Original Startup

Operational procedures have changed in that bottom ash is no longer sluiced to a large ash disposal basin for sedimentation. Since 1989 the bottom ash has been dewatered in dewatering bins and landfilled. Filtrate from the dewatering operation is sent to the Ash Filter Ponds for treatment by sedimentation. Since 1994 the discharge from the Ash Filter Ponds has received thermal treatment by pumping it to the Thermal Pond and allowing the water to cool to an acceptable temperature before discharging it to the Keystone lagoon. Another change is the relatively recent addition of the FGD system, which became operational in 2009. However, no wet ponds are associated the handling or disposition of CCR (Gypsum) from this system (see Subsection 2.2.4).

4.2.3 Current Operational Procedures

Current operations related to handling of CCR at the Keystone plant are briefly described in Section 2.2, and current general operations related to the ponds are inherent in the changes in operations described above (Subsection 4.2.2). Additional information on current operations is included in the project description in Section 2.1.

4.2.4 Other Notable Events since Original Startup

No additional information was provided to Dewberry concerning notable events impacting the operation of ash disposal activities.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Fred Tucker, P.E. and Edward Farquhar performed a site visit on September 13, 2012 in company with the participants listed in Section 1.3.

The site visit began at 9:00 AM. The weather was sunny with temperatures in the high 70's. Photographs were taken of conditions observed. Selected photographs are included here for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit. Please refer to the Dam Inspection Checklists in Appendix B.

The overall visual assessment of the Ash Filter Pond dikes and the Thermal Pond dam is that they were in satisfactory condition and no significant findings were noted.

5.2 EARTH EMBANKMENT 1 (ASH FILTER POND)

5.2.1 Crest

The gravel-surfaced crest of the embankment was observed to have no significant depressions, tension cracks or other indications of settlement or shear failure. Figure 5.2.1-1 and Figure 5.2.1-2 shows the typical crest conditions along the most significant section of the perimeter dike embankment.

Figure 5.2.1-1 Crest and outside slope of Ash Filter Ponds – southwest side viewed northwest (highest embankment, next to Pond A).

Figure 5.2.1-2 Crest and inside slope of Ash Filter Ponds – southwest side viewed southeast (highest embankment, next to Pond A).

5.2.2 Upstream/Inside Slope

The visible parts of the inside slopes of all the cells within the Ash Filter Pond complex above the waterline appeared stable with no signs of significant erosion. The R-3 rock covering the clay liner on the slopes was observed to have some grass and weed growth and grass was observed to cover the upper slope near the crest. There were no observed scarps, sloughs, bulges, cracks, depressions or other indications of slope instability. Typical views of the inside slopes are shown in the following Figure 5.2.2-1 and Figure 5.2.1-2 above.

Figure 5.2.2-1 Typical inside slope – northwest side of Ash Filter Ponds viewed northeast (next to Pond A).

5.2.3 Downstream/Outside Slope and Toe

The outside slope of the dike embankment was observed to have a well-established cover of grasses/weeds, which were quite tall on the most significant section of the perimeter dike embankment. No obvious scarps, sloughs, bulges, cracks, depressions or other indications of slope instability were observed along the slope, although the tall growth on the main slope obscured observations for these conditions. There were no signs of significant erosion and no signs of seepage. Figures 5.2.3-1 and 5.2.3-2, as well as Figure 5.2.1-1, show representative views of the outside slope of the most significant embankment sections of the dike embankment.

Figure 5.2.3-1 Outside slope and toe of highest embankment – southwest side of Ash Filter Ponds viewed southeast (next to Pond A).

Two animal holes were observed in the outside slope. One hole was observed on the lower part of the main dike embankment slope (southwest side), as shown in Figure 5.2.3-3. The other was observed near the top of the outside slope on the southeast side of the ash Filter Ponds, approximately in line with the divider dike between Ponds A and B.

Figure 5.2.3-2 Outside slope and paved ditch below the toe of the perimeter dike embankment – southeast side viewed northeast (next to Pond A).

Figure 5.2.3-3 Animal hole in lower part of outside slope of perimeter dike embankment on southwest side of Ash Filter Ponds (next to Pond A).

5.2.4 Abutments and Groin Areas

Because the ponds are contained within a perimeter dike system, there are no real groins on the exterior sides, although there is a slight groin at the west corner, where the exterior grade drops down from the northwest side to the southwest side, as shown in Figure 5.2.4-1. There were no signs of instability, erosion, or seepage in this groin area.

Figure 5.2.4-1 Groin area at the west corner of the Ash Filter Ponds

5.3 EARTH EMBANKMENT 2 (THERMAL POND)

5.3.1 Crest

The gravel-surfaced crest of the main dam embankment that occurs on the east side of the Thermal Pond was observed to have no significant depressions, tension cracks or other indications of settlement or shear failure. Figure 5.3.1-1 shows the typical crest conditions along the main dike embankment.

Figure 5.3.1-1 Crest of the Thermal Pond – viewed north.

5.3.2 Upstream/Inside Slope

The visible parts of the inside slopes of the Thermal Pond appeared stable and well maintained. The three-inch thick concrete erosion control revetment that protects the underlying HDPE liner system appeared to be in overall satisfactory condition with only minor deterioration and minor growth of vegetation in the revetment. The pool was at the normal operating elevation 1017 ft, consequently only 3 ft (vertically) of the inside was visible during the site visit. There were no observed scarps, sloughs, bulging, cracks, depressions or other indications of slope instability. Figure 5.3.2-1 shows a typical view of the Thermal Pond inside slope. Black pipes observed sticking up through the revetment at regular intervals appeared to be pressure relief vents.

Figure 5.3.2-1 Typical upstream (inside) slope of Thermal Pond – north side viewed east.

5.3.3 Downstream/Outside Slope and Toe

The outside slope of the Thermal Pond main dam embankment appeared to have a satisfactory cover of grasses/weeds. Figure 5.3.3-1 shows an overall view of this slope. No significant erosion was observed. A gravel-surfaced access road extends along a berm at approximately mid-height of the slope. The cover of grasses/weeds on the slope above the access road is relatively well maintained, as shown in Figure 5.3.3-2. The cover of grasses/weeds on the slope below the access road was observed to be higher, suggesting less maintenance. A minor apparent seep area was noted along the edge of the access road and in the ditch at the base of the slope above the south part of the access road (see Figure 5.3.3-1). Dam inspection reports have reported the seep. No scarps, sloughs, significant bulges, cracks, depressions or other indications of slope instability were observed along the slope. The outside slope of the dam embankment on the north side of the Thermal Pond was observed to have a tall thick growth of grasses/weeds, as shown in Figure 5.3.3-3. Although the grasses/weeds did not appear to be as well maintained as on the main embankment section on the east side, this slope also appeared stable and free of significant erosion. It is noted that this slope forms the south inside slope of the retired basin on the north side of the Thermal Pond. Several animal holes were noted all along the upper part of the outside slope of the low embankment on the south side of the Thermal Pond. A view of one animal hole shown in Figure 5.3.3-4 is typical.

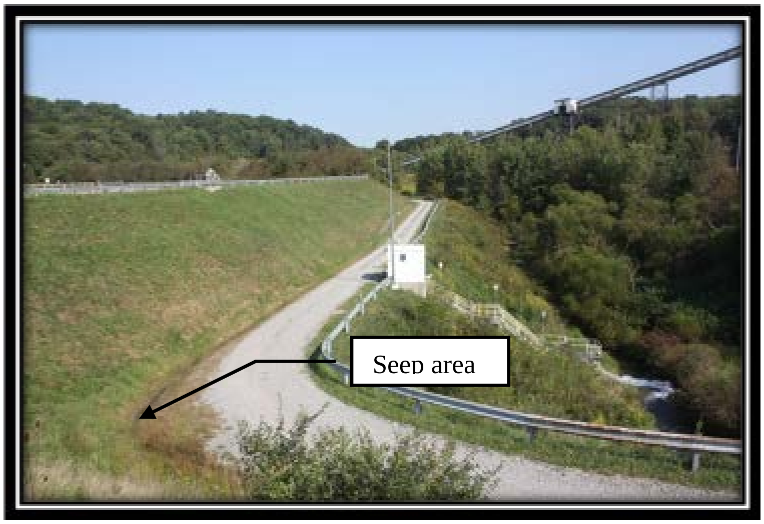

Figure 5.3.3-1 Outside slope and seep area of main embankment dam impounding the Thermal Pond – east side viewed north.

Figure 5.3.3-2 Outside slope above access road berm – viewed north.

Figure 5.3.3-3 Outside slope of embankment dam on north side of Thermal Pond, which forms south inside slope of retired basin on the north side of the Thermal Pond– viewed east.

Figure 5.3.3-4 One of several animal holes observed at top of outside slope of low embankment on south side of Thermal Pond – viewed north.

5.3.4 Abutments and Groin Areas

There were no obvious scarps, sloughs, bulges, cracks, depressions or other indications of slope instability at the principal dam abutment and groin areas located at the south end of the main (east) dam embankment of the Thermal Pond, although tall vegetation obscured observation for these conditions just beyond the abutment contact. No erosion was observed. The previously noted seep area extends to the abutment contact and base of the groin above the access road.

Figure 5.3.4-1 Groin area at south end of the east side main embankment dam above access road berm – viewed west.

5.4 OUTLET STRUCTURES

5.4.1 Outlet Structures (Ash Filter Ponds)

The visible parts of the outlet structures for the Ash Filter Ponds (all three Cells) above waterline were observed to be in generally satisfactory condition. A view of the Pond B outlet structure shown in Figure 5.4.1-1 is typical. The metal skimmers located in front of the weir troughs appeared to be functioning properly in keeping floating matter from entering the weirs and discharge structures. It was observed that grass and weeds tend to encroach into the weir troughs, most significantly at the Pond C outlet.

Figure 5.4.1-1 Typical outlet structure for Ash Filter Ponds – Pond B outlet viewed southwest.

5.4.2 Outlet Structure (Thermal Pond)

The visible part of the outlet structure above the waterline at the Thermal Pond was observed to be in generally satisfactory condition, although the gate operator stands and handwheels for the 8-inch drawdown valves and the 12-inch valve for the underdrain discharge pipe appeared to be in need of maintenance. An overall view of the top of the outlet structure and the access footbridge is shown in Figure 5.4.2-1. The footbridge appeared to be in satisfactory condition. The corroded operators for the drawdown valves are shown in Figure 5.4.2-2. The operator for the underdrain discharge pipe valve has a similar appearance. The utility indicated in an e-mail to EPA dated November 25, 2013 (see Appendix A – Doc 12) that "work is scheduled to paint corroded metal parts and hardware at the discharge structures."

The discharge from the Thermal Pond appeared to be clear flowing, as shown in Figure 5.4.2-3. The water in the stream channel below the discharge point was observed to flow into a large concrete culvert under the high fill embankment that supports the plant railroad tracks and haul road, as shown in Figure 5.4.2-4. A view of the old decant tower in the adjacent retired basin is shown in Figure 5.4.2-5; this is the type of outlet structure that was modified into the dual chamber outlet structure for the Thermal Pond.

Figure 5.4.2-1 Thermal Pond outlet structure – viewed southwest from main embankment dam on east side of Thermal Pond.

Figure 5.4.2-2 Surface corrosion on gate operators for the three drawdown valves on the south side of the Thermal Pond outlet structure.

Figure 5.4.2-3 Thermal Pond discharge from Parshall flume at end of outlet pipe.

Figure 5.4.2-4 Stream channel flow between discharge point and large culvert through high railroad/roadway embankment a short distance downstream (south).

Figure 5.4.2-5 View of decant tower (outlet structure) in retired basin adjacent to the north side of the Thermal Pond.

5.4.3 Emergency Spillway

Not applicable; no emergency spillway exists at this facility.

5.4.4 Low Level Outlet

As previously noted, the Thermal Pond water surface can be drawn down to three different levels, the lowest being elevation 985 ft (3 ft above the bottom at the outlet structure), by means of 8-inch valves actuated by rising stems controlled by handwheels at the operator stands on the top deck of the outlet structure. The valves, stems, stem guides, etc. are located on the inside of the structure but could not be easily accessed for observation. As previously described, the operator stands and handwheels were observed to be corroded (see Figure 5.4.2-2), but the utility is taking steps to address the corrosion.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation has been provided about the flood of record. However, neither the Ash Filter Ponds nor the Thermal Pond receives off-site drainage. The water levels in the ponds are controlled more by plant process than by flood events. Thus, a flood of record for the ponds is not applicable.

In addition, there are no reported instances of plant operational problems that would have caused the pond water levels to significantly exceed the normal water levels.

6.1.2 Inflow Design Flood

The Ash Filter Ponds and the Thermal Pond at the Keystone Generating Station do not receive uncontrolled inflows from off-site. For such ponds that are totally contained within a perimeter dike system, safe containment of water within the ponds is provided by maintaining sufficient freeboard to contain 100 percent of design precipitation over the pond areas. The design precipitation amounts may be determined as discussed below for each pond facility.

Ash Filter Ponds – For the “small” size and “low” hazard potential classification assigned to the Ash Filter Pond dike, the USACE hydrologic evaluation guidelines (ER-1110-2-106 26 Sept 1979 “Recommended Guidelines for the Safety Inspection of Dams”) recommend a spillway design flood (SDF) of 50-year to 100-year frequency, where the magnitude selected most closely relates to the involved risk. For comparison, the Pennsylvania Dam Safety Regulations (amended 2011) require the same SDF (50-year to 100-year frequency) for dams classified C-4, which is equivalent to the small size, low hazard potential classification. The precipitation depths for 24-hour duration at the Ash Filter Ponds coordinates are 4.64 inches and 5.19 inches for 50-year frequency and 100-year frequency, respectively, from the National Weather Service’s on-line Precipitation Frequency Data Server, which gives point precipitation frequency estimates from “Precipitation-Frequency Atlas of the United States” NOAA Atlas 14, Volume 2, Version 3.

Thermal Pond – For the “intermediate” size and “low” hazard potential classification assigned to the Thermal Pond dam, the USACE hydrologic evaluation guidelines recommend a SDF of 100-year frequency to 1/2 probable maximum flood (1/2 PMF). For comparison, the Pennsylvania Dam Safety Regulations require the same SDF (100-year frequency to 1/2 PMF) for dams classified B-4, which is equivalent to the intermediate size, low hazard potential classification. The precipitation depth for 24-hour duration at the Thermal Pond coordinates is 5.17 inches for the 100-year frequency from the National Weather Service’s on-line Precipitation Frequency Data Server; the 24-hour duration probable maximum precipitation (PMP) from Hydrometeorological Report No. 51 (HMR-51) is 32 inches, and 1/2 PMP is 16 inches.

6.1.3 Spillway Rating

No spillway rating was provided for the outlet structures at the Ash Filter Ponds and the Thermal Pond. However, no outfall is assumed in the assessment in Section 6.3

6.1.4 Downstream Flood Analysis

Ash Filter Ponds – No downstream flood analysis has been provided for the Ash Filter Ponds. A qualitative analysis based on field observations and review of available data is as follows:

Failure of the low perimeter dike impounding the 2.2-acre Ash Filter Ponds would discharge coal combustion residue onto surrounding plant property. A failure would most likely be of only one cell, which contains only a third of the total volume of the Ash Filter Pond complex or less than 4.3 acre-ft. The failure would not be expected to cause loss of life but would cause minor onsite environmental damage. Due to the low head above outside grade and low volume of water and coal combustion residue, the water and material released would most likely be entirely contained within the plant boundaries and likely would not reach Crooked Creek located 0.4 mile away. Any ash sediment that is carried with the water would mostly be deposited in immediately adjacent areas, especially a low area on the southeast side. The preferential direction of flow of water leaving the vicinity of the Ash Filter Ponds would be toward lowest ground to the southwest. If the water flows far enough before being diminished by the increasing overland flow distance, entrapment in local surface depressions, and infiltration, it would be intercepted by drainage ditches that lead to the Keystone Lagoon, which is the final holding area for all plant site drainage before water is discharged to Crooked Creek.

Thermal Pond – In the April 1993 Dam Permit Application prepared by Gilbert/Commonwealth, Inc. for the Thermal Pond dam, a conservative dam break analysis was provided (see Appendix A – Doc 2). In that analysis it was assumed that 5.6 million cubic feet of water stored at normal operating level in the Thermal Pond (Cooling Pond "A") would be released due to instantaneous dam failure, causing water to pond behind the culvert through the high railroad/roadway embankment (see photograph in Figure 5.4.2-4). Using the average end area method the elevation to which the water would rise along the confined reach of the stream channel was determined to be approximately elevation 1012 ft, which is below the top of the railroad/roadway embankment (by some 7 ft) and below the elevation of State Route 210 located upgradient along the stream channel. A map showing the inundation area was provided, and it was noted that there are "no inhabitants residing in the proposed area of inundation." Presumably this conservative analysis assumed no flow through the culvert. Actually, water would flow through the 13 ft wide by 7 ft high culvert and the extent of inundation would not reach even the relatively small limits shown on the inundation map. Also, the culvert would serve to attenuate flow downstream, so that there would be no flood wave. Since there essentially is only trace amounts of CCR in the Thermal Pond, no significant environmental damage would be expected, other than perhaps bank erosion along the on-site stream channel to the Keystone Lagoon on the other side of the railroad/roadway embankment.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Simple hydrologic/hydraulic analyses have been provided for the Ash Filter Ponds and Thermal Pond (see Appendix A – Doc 11, Section 7). For ponds that are totally contained within perimeter dike systems and do not receive uncontrolled off-site drainage, rigorous analyses of natural flooding events are not warranted. In the April 1993 Dam Permit Application for the Thermal Pond dam a simple hydrologic/hydraulic analysis, which examined the ability of the pond to safely contain 100 percent of the design precipitation depth over the pond area, was provided. The Geosyntec report provides a simple analysis based on the fact that the ponds are totally contained with no outside in-flow. Therefore the supporting technical documentation is considered adequate for both the ash Filter Ponds and the Thermal Pond.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

Ash Filter Ponds – The Geosyntec Report (see Appendix A – Doc 11) calculates that the 2-foot freeboard is more than adequate to handle the design maximum precipitation depth of 0.48 ft. Also, by inspection, the Ash Filter Ponds appear to have adequate hydrologic safety for the design precipitation depths given in Subsection 6.1.2, since there currently is more than sufficient flood storage volume available between the normal operating water level and the crest elevation of the impounding perimeter dike. That is, the normal freeboard is maintained at 2 ft in the ponds and the design precipitation depth at the high end of the design range (100-year frequency) is 5.76 inches or 0.48 ft, which is much less than the available freeboard, indicating there is ample available surcharge storage for safe containment of the design precipitation over the pond area, including runoff from the crest areas (which are graded to drain into the ponds) and conservatively assuming no outflow. The Ash Filter Ponds should continue to have adequate hydrologic safety unless the average surface elevation of ash sediment is allowed to build up to approximately the design precipitation depth below the crest elevation; however, because of the periodic maintenance cleaning of the ash sediment in the ponds, the sediment level should never reach such a high level and most likely would never be allowed to build up above the normal operating level.

Thermal Pond – The hydrologic/hydraulic analysis given in the April 1993 Dam Permit Application for the Thermal Pond dam (see Appendix A – Doc 2) is similar to the analysis described above and demonstrates that the Thermal Pond has adequate hydrologic safety for the design precipitation depth, taken as the upper limit of the design range (1/2 PMP), i.e., 16 inches. It was noted, “The only stormwater that enters the cooling ponds is the precipitation that falls directly on the ponds’ surface area.” (Note: At the time it was anticipated that the adjacent basin, now retired, would be developed as a second cooling pond.) It was further noted, “The ponds are designed for three feet of freeboard and therefore, easily accommodate the recommended design flood.”

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

Ash Filter Ponds – Slope stability analyses for the Ash Filter Ponds were provided by the utility in a November 2013 report (Geosyntec Report, see Appendix A – Doc 11). Stability was analyzed by both the sliding block method and slip circle method.

Thermal Pond – Slope stability analyses of the Thermal Pond dam are briefly discussed in the April 1993 Dam Permit Application prepared by Gilbert/Commonwealth, Inc. (see Appendix A – Doc 2) as well as included in the Geosyntec Report. The maximum height section, represented by the east side dam, was analyzed by both the sliding block method and the slip circle method. It was indicated that the critical circle was determined by computer using the Modified Bishop method of analysis.

Only the downstream slope was analyzed, apparently because it is higher and steeper than the upstream slope and because the rapid drawdown case is not applicable, since the pond is lined and there should be no drawdown effects on the upstream slope if the liner functions properly. No flood case was analyzed because the ponds are lined and the elevated water level would have no potential impact on the phreatic surface in the dam embankment. The cases analyzed were:

1. Static loading with normal pond water surface
2. Seismic loading with maximum horizontal acceleration (a_{max} = 0.5g).

The parameters used in the SLIDE program for calculating the stability values are provided in Appendix A – Document 11, Appendix D.

7.1.2 Design Parameters and Dam Materials

The design properties and parameters used in the slope stability analyses for the Ash Filter Ponds and Thermal Pond dam are shown in Table 7.1-1. The embankment fill is indicated to consist of predominantly clayey sand with rock fragments (Unified Soil Classification of SC). It appears that the strength parameters used for the embankment fill were taken between tested values of the drained and undrained strength parameters, whereas the strength parameters for the foundation materials were taken as the estimated undrained strength parameters. The upper, relatively thin foundation layer was indicated to be sandy clay (CL), and the lower foundation layer was indicated to be weathered rock.

Table 7.1-1: Design Properties and Parameters of Materials used in the Slope Stability Analyses

Material	Effective Unit Wt. (pcf)	Shear Strength Parameters	
		C (psf)	Ø (deg)
AFP Embankment	120	0	32
TP Embankment (SC)	120	240	28
Foundation Soil both ponds (CL)	135	1,250 (undrained)	32
Foundation (Weath. Rock)	145	8,000	0

See Appendix A - Doc 11, Appendix C for source of information in this table.

For the soils information used in the stability analysis performed by Geosyntec there were 3 borings drilled at the top of the Ash Filter Pond embankments and one boring in the Thermal Pond dam (see Appendix A – Doc 11). These borings supplement the 12 borings and 9 test pits that previously had been made in the area of the then proposed cooling ponds. These included four borings drilled in or near the dam embankment on the east side of the Thermal Pond (Cooling Pond A). The results of the 16 borings were used to develop the model profile for the slope stability analyses. The borings indicate that the embankments consist of typically firm clayey sand with rock fragments and stiff to very stiff sandy silt and clay with rock fragments. The top of rock was encountered at elevations ranging from 971.5 ft to 962 ft. The rock is indicated to slope at a 20H: 1V grade toward the stream at the toe of the dam.

The structural stability analysis assumed additional loads of 250 psf on the tops of the embankments to simulate traffic loads that sporadically occur on the embankments. Based on piezometric readings taken as part of the soil boring studies, no seepage was assumed through the thermal pond embankments.

7.1.3 Uplift and/or Phreatic Surface Assumptions

Since the Thermal Pond is lined, no phreatic surface was assumed to develop in the dam embankment. However, the design groundwater level was assumed to occur along the top of the upper foundation soil layer that consists of sandy clay.

7.1.4 Factors of Safety and Base Stresses

The documentation did not indicate what factor of safety (FS) criteria were adopted for design of the ponds. Conventional minimum FS criteria are 1.5 for static long-term stability and 1.0 for earthquake (seismic) stability (by pseudo-static method).

7.1.5 Liquefaction Potential

The Geosyntec Report analyzed liquefaction potential for the ponds based on the four borings. The soils in the Ash Filter Pond borings may be characterized as silty (CL) or clayey (ML) soils with blow counts ranges of 10-45 blows/ft. The Thermal Pond embankment contains silty sand or silty gravel with underlain clay. The Thermal Pond soils strengths are 2-31 blows/ft and the underlain clay has soil strength of 6-20 blows/ft. The Report stated that the cohesiveness of the soils below the groundwater table in conjunction with the low seismic activity in the area of the plant led to a determination that the potential for liquefaction at the site is negligible.

7.1.6 Critical Geological Conditions

Geology and Soil Survey information are briefly discussed in the 1993 Dam Permit Application for the Thermal Pond dam (see Appendix A – Doc 2). The permit application references the “Geologic Map of Pennsylvania,” prepared by the Pennsylvania Topographic and Geologic Survey (1980), which indicates that the formation underlying the area of the Thermal Pond site is the Glenshaw Formation of Pennsylvanian Age. “The Glenshaw Formation is described as cyclic sequences of shale, sandstone, red beds, and then limestone and coal. It also includes four marine limestone or shale horizons. The red beds are involved in landslides and the base is at the top of Upper Freeport Coal.”

The permit application also references the “Soil Survey of Armstrong County, Pennsylvania,” Sheet Numbers 68 and 73, which maps the area with the symbol Sm, denoting strip mines. “Strip mines consist of sandstone, boulders, fractured shale, and some soil material that has been disturbed by mining operations. Slopes range from nearly level to very steep.”

As previously mentioned, borings drilled at the main dam on the east side of the Thermal Pond encountered silty clay foundation soils over weathered shale. The weathered shale could be penetrated only approximately 3 to 5 feet before encountering auger refusal. Some of the weathered shale was indicated to be wet or saturated.

Hazards associated with the geology of the region include the potential presence of old mine tunnels in former coal seams or possibly solution voids in the limestone layers and risk of landslides in redbeds exposed in natural slopes or in manmade cut slopes.

Seismicity – The Keystone Generation Station is located in a region of relatively low seismic hazard, based on internet review of published information concerning seismicity in this part of Pennsylvania. From the USGS Interactive Deaggregation website, based on the USGS Seismic-Hazard Maps for Central and Eastern United States, dated 2008, the Ash Filter Ponds and the Thermal Pond are at locations anticipated to experience 0.0503g peak (horizontal) ground acceleration (PGA) with a 2-percent probability of exceedance in 50 years (2,475-year exceedance return time), assuming uniform firm-rock site conditions, i.e., a site with average shear wave velocity of 2,500 feet per second (fps) in the upper 100 feet below the ground surface (Appendix A – Doc 11, Appendix D).

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Ash Filter Ponds – The Geosyntec Report provides adequate technical support for the slope stability analysis.

Thermal Pond - The provided structural stability documentation for the Thermal Pond dam is adequate. It is noted that the slope geometry used for the Thermal Pond analysis is based upon aerial photometry from photos taken by the utility in October 2013. The geometry shows steeper slopes than design documentation. The Geosyntec slope stability analysis used the steeper slope configuration.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Ash Filter Ponds – Structural stability of the Ash Filter Ponds containment dike is **Satisfactory** based on the Geosyntec Report results (see Table 7.3-1 below).

The outflow structures at the Ash Filter Ponds appeared to be in satisfactory condition and stable.

Thermal Pond – Structural stability of the Thermal Pond dam appears **Satisfactory**, based on the Geosyntec Report, shown in Table 7.3-1 below.

The outflow structure at the Thermal Pond appeared to be in satisfactory condition and stable.

Table 7.3-1: Calculated Slope Stability Factors of Safety vs. Required Value

Cross Section	Condition	Failure Mode	Calculated Safety Factor	Required Safety Factor
Ash Filter Pond A-A	Undrained	Block	6.73	--
	Drained	Block	1.74	1.5
	Seismic	Circular	5.78	1.0
Thermal Pond B-B	Undrained	Circular	1.64	--
	Drained	Block	1.67	1.5
	Seismic	Circular	1.53	1.0

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

The Ash Filter Ponds and the Thermal Pond are the only CCR surface impoundments at the Keystone Generating Station. Both are related to the bottom ash operations. Boiler slag is not distinguished from the bottom ash. As previously described in this report, fly ash is dry handled and disposed in an on-site landfill. FGD sludge (gypsum) is dewatered, temporarily stored on a dome-covered pad, and either sold for beneficial reuse or trucked to the on-site landfill. The water removed from the FGD sludge is sent to the wastewater treatment plant and reused after treatment.

Operation of the Ash Filter Ponds and the Thermal Pond has been previously described in this report (see Sections 2.1, 2.2, and 4.2). The primary source of operating information for the Ash Filter Ponds is its Operation and Maintenance Manual (see Appendix A – Doc 09); for the Thermal Pond the primary sources of operating information are the Design Engineer’s Report (see Appendix A – Doc 10) and the Dam Permit Application (see Appendix A – Doc 07).

The Ash Filter Pond complex is operated for treating water removed from the bottom ash at the dewatering bins by settling residual suspended ash particles in the water and temporarily storing the ash sediment until the sediment has built up to the allowed level; then the cell is dewatered and the ash sediment drained, so that the ash can be removed dry and disposed in the on-site landfill. When a cell is dewatered for removal of the ash sediment, valves for the two (per cell) underdrain pipes are opened to allow drainage of the ash sediment; the water in the sediment drains into the discharge structure, where the valves are located. The valves are closed before placing the cell back into service after removal of the ash sediment.

The Thermal Pond is operated for cooling treated water from the Ash Filter Ponds. Originally, there were to be two cooling ponds, so that one could remain in operation while the other was drained and cleaned out, at expected time intervals of five years. As at the Ash Filter Ponds, the valve that controls underdrain flow into the discharge structure was to be opened during the cleaning operation to allow drainage of the ash sediment accumulation, so ash could be excavated and removed in the dry. However, it was found that very little ash sediment accumulates in the Thermal Pond. What little accumulates is now removed by divers using suction hoses, still at 5-year intervals. Apparently it was determined that the second cooling pond was not needed, and the adjacent basin, which had not yet been lined, was retired. Discharge from the Thermal Pond is monitored at Monitoring Station Point 503.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

Station personnel are present daily at both the Ash Filter Ponds and the Thermal Pond to check proper functioning of structures, piping, and equipment. Maintenance is performed as required.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operating Procedures

Based on field observations and review of operations pertaining to CCR containment at the Ash Filter Ponds and the Thermal Pond, operating procedures appear to be adequate.

8.3.2 Adequacy of Maintenance

Maintenance of the impounding embankments and outlet works of the Ash Filter Ponds and the Thermal Pond appears to be generally adequate. No major maintenance issues were noted from review of the inspection reports for the Thermal Pond dam. Based on the field observations, some minor maintenance is recommended (see Subsection 1.2.5).

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Ash Filter Ponds –Within the past year the utility has initiated a formal quarterly inspection program for the Ash Filter Ponds in addition to the daily observations made by station personnel. The new program includes quarterly mowing of the embankments to facilitate surveillance activities. A Quarterly Inspection checklist is provided in Appendix A – Doc 13. Appropriate maintenance and any needed corrective actions are performed as required.

Thermal Pond – The Thermal Pond dam is regulated by the state, but based on its size and hazard potential classification, the state does not require annual inspections performed by a registered professional engineer. However, according to the 1993 Dam Permit Application (see Appendix A – Doc 2), "an annual inspection will be performed by Penelec (now GenOn) Design Engineering." In addition, "A walkdown of the cooling ponds (Thermal Pond) and appurtenant works will be conducted at least once every three months by station personnel." As previously mentioned, these inspections are documented in Quarterly Dam Inspection Checklist reports (see Appendix A – Docs 03, 04, 05 and 06 for the most recent inspections). Any observations requiring monitoring, investigation, or repair are noted in the reports as requiring action.

9.2 INSTRUMENTATION MONITORING

There is no dam performance monitoring instrumentation in place in the impounding embankments of the Ash Filter Ponds or the Thermal Pond.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

The newly initiated quarterly inspection and monitoring program for the Ash Filter Ponds is adequate. The inspection program for the Thermal Pond is appropriate and adequate as described. Quarterly inspection checklist reports were provided for review, but no reports documenting annual inspections by design engineers were included. No major safety issues were noted in any of the quarterly inspection checklist reports reviewed.

9.3.2 Adequacy of Instrumentation Monitoring Program

There is no dam performance monitoring instrumentation in place at either the Ash Filter Ponds or the Thermal Pond. No problem or suspect condition, such as excessive settlement, significant flowing seepage, shear failure, or displacement was observed in the field that might be reason for installation of instrumentation for long-term performance monitoring. In the absence of stability problems or significant seepage issues, there is no need for performance monitoring instrumentation at this time.

In response to the EPA draft report, the utility installed two piezometers at the Thermal Pond area to assess groundwater flows where a seep was observed. There was concern that the seep represented a leak in the pond liner system. Two weeks after installation of the piezometers, field measurements showed the monitoring wells were dry. It was concluded that if the seep resulted from a leak from the pond liner system there would be water in the wells. The dry condition is more representative of a perched water condition at a nearby localized, more-permeable soil or a leak from a nearby piping system within the embankment.

APPENDIX A

Document 1

April 1993 Dam Permit Application for the Thermal Pond

DAM PERMIT APPLICATIONS

PENNSYLVANIA ELECTRIC COMPANY
KEYSTONE STATION

INDUSTRIAL WASTE TREATMENT MODIFICATIONS: THERMAL DISCHARGE ABATEMENT PROJECT COOLING PONDS

APRIL 1993

F. GREGORY NADEAU
No. 032198-E

Gilbert/Commonwealth, Inc.
P. O. Box 1498
Reading, PA 19603

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

APPLICATION FOR DAM PERMIT

April 2, 1993

In compliance with the provisions of the Act of November 26, 1978, P.L. 1375, *as amended* (32 P.S. §693.1 *et seq.*) known as the "Dam Safety and Encroachments Act"; Act of October 4, 1978, P.L. 851 (32 P.S. §679.101 *et seq.*), known as the "Flood Plain Management Act"; and the Administrative Code, Act of April 9, 1929, P.L. 177, *as amended,* which empowers the Department of Environmental Resources to exercise certain powers and perform certain duties by law vested in and imposed upon the Water Supply Commission of Pennsylvania, and the Water and Power Resources Board.

Pennsylvania Electric Company, 1001 Broad Street, Johnstown, PA 15907
(Applicant)

hereby makes application for the consent or permit of the Department of Environmental Resources to ☐ construct, ☒ modify, ☐ enlarge, ☐ operate and maintain, ☐ breach and abandon

existing old bottom ash disposal pond (proposed cooling pond "A")
(State the name of the dam or reservoir if known)

adjacent to ~~in, along, or across~~ an unnamed tributary of Crooked Creek
(State name of stream or other body of water.)

at a point located approximately 3,100 feet north of the confluence of the
(Give location, by distance from mouth of stream, county, township, or municipal boundary; also give city, town or township and county in which located)

station lagoon and Crooked Creek in Plumcreek Township, Armstrong County

for the purpose of
(State fully the purpose, necessity, and description of the dam.)

cooling effluent from bottom ash filter ponds to improve thermal discharge characteristics.

in accordance with the complete maps, plans, profiles, and specifications filed with this application and made a part

MUST BE COMPLETED BY APPLICANT

Drainage Area 7.4 acres or square miles

Maximum Depth to Top of Dam 49 feet

Crest Length 325 feet

Surface Area: at normal pool 7.1 acres

at top of dam 7.5 acres

Storage Volume: at normal pool 129 acre-feet

at top of dam 137 acre-feet

Size and Hazard Classification B-3

Justification for Hazard Classification No loss of life is expected in the event of an embankment failure. There are no permanent structures for human habitation downstream of the dam to the station lagoons confluence with Crooked Creek. Minimal economic loss is expected in the event of dam failure.

FOR DEPARTMENT USE ONLY

Application Fee

Check No.

Amount

Check Date

Application No.

Date Received

Municipal Notification

County Notification

(Continued on other side)

TYPE OF OWNERSHIP (Check one)

☐ Privately Owned ☐ Partnership ☒ Corporation ☐ Government Agency/Political Subdivision

privately owned, the individual owner(s) must sign. One or more members authorized to sign on behalf of an entire rtnership must sign. For a corporation, the president, vice president or other responsible official is required to sign. For a Government Agency/Political Subdivision, we require signatures of the chief officer or other responsible official empowered to sign with the seal affixed and attested by the clerk.

J. G. Herbein, Vice President, Generation
(Print Name)

(Signature and Title)

SEAL

1001 Broad Street
(Address)
Johnstown, PA 15907

(814) 533-8600
(Telephone Number)

Attest:
Assistant Secretary

If a fictitious name entity, are you registered with the Pennsylvania Department of State? ☒ Yes ☐ No

All applications for permits, except those submitted by federal, state, county or municipal agencies, must be accompanied by a check payable to "Commonwealth of Pennsylvania" in accordance with the following schedule:
*Class A dams — $3000, Class B dams — $2500, Class C dams — $1500.

A single application may be submitted or a single permit may be issued for multiple structures and activities which are part of a single project or facility or part of related projects and facilities, located in a single county, constructed, operated, or maintained by the same persons. When a single application covers multiple structures or activities other than a single structure and related maintenance dredging, the application fee shall be the sum of fees set forth above r the applicable structures and activities.

Each application for a permit shall be accompanied by a completed Application checklist and Environmental Assessment Form and such information, maps, plans, specifications, design analyses, test reports, and other data as may be specifically required by the provisions of Chapter 105 and such additional information as may be required by the Department to determine compliance with the provisions of Chapter 105.

All applications for permits pursuant to Chapter 105 shall be accompanied by proof of an application for an Earth Disturbance Permit or an erosion and sedimentation control plan for all activities in the stream and all earthmoving activities. which plan shall conform to the requirements contained in Chapter 102 of this title (relating to erosion control) and shall include a copy of a letter from the conservation district in the county where the project is located indicating that the district has reviewed the applicant's erosion and sedimentation control plan and considers it to be satisfactory

All plans, specifications and reports accompanying applications for dams shall be affixed with the seal of a registered professional engineer and a certification signed by the registered professional engineer, which shall read as follows

"I (name) do hereby certify pursuant to the penalties of 18 Pa. C.S.A. Sec. 4904 to the best of my knowledge, information and belief, that the information contained in the accompanying plans, specifications, and reports has been prepared in accordance with accepted engineering practice, is true and correct, and is in conformance with Chapter 105 of the rules and regulations of the Department of Environmental Resources."

Duplicate applications with duplicate set of plans shall be submitted to Department of Environmental Resources, Bureau of Dams and Waterway Management, P. O. Box 8554, Harrisburg, PA 17105-8554.

This application, together with all maps, plans, profiles and specifications, and all papers, information and data filed n connection therewith, will remain on file in the Department.

*Based on size classification as defined in § 105.91 of Chapter 105, Rules and Regulations.

ER–DWM–12: Rev. 10/91

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

APPLICATION FOR DAM PERMIT

April 2, 19 93.

In compliance with the provisions of the Act of November 26, 1978, P.L. 1375, *as amended* (32 P.S. §693.1 *et seq.*) known as the "Dam Safety and Encroachments Act"; Act of October 4, 1978, P.L. 851 (32 P.S. §679.101 *et seq.*), known as the "Flood Plain Management Act"; and the Administrative Code, Act of April 9, 1929, P.L. 177, *as amended,* which empowers the Department of Environmental Resources to exercise certain powers and perform certain duties by law vested in and imposed upon the Water Supply Commission of Pennsylvania, and the Water and Power Resources Board.

Pennsylvania Electric Company, 1001 Broad Street, Johnstown, PA 15907
(Applicant)

hereby makes application for the consent or permit of the Department of Environmental Resources to ☐construct, ☒modify, ☐enlarge, ☐operate and maintain, ☐breach and abandon

existing bottom ash disposal pond (proposed cooling pond "B")
(State the name of the dam or reservoir if known)

adjacent to ~~in, along or across~~ an unnamed tributary of Crooked Creek
(State name of stream or other body of water.)

at a point located approximately 3,500 feet north of the confluence of the
(Give location, by distance from mouth of stream, county, township, or municipal boundary; also give city, town or township and county in which

station lagoon and Crooked Creek in Plumcreek Township, Armstrong County.

for the purpose of cooling effluent from bottom ash filter ponds to
(State fully the purpose, necessity, and description of the dam.)

improve thermal discharge characteristics.

in accordance with the complete maps, plans, profiles, and specifications filed with this application and made a part

MUST BE COMPLETED BY APPLICANT

Drainage Area 6.0 acres or square miles

Maximum Depth to Top of Dam 47 feet

Crest Length 625 feet

Surface Area: at normal pool 5.7 acres

at top of dam 6.0 acres

Storage Volume: at normal pool 110 acre feet

at top of dam 118 acre feet

Size and Hazard Classification B-3

Justification for Hazard Classification No loss of life is expected in the event of an embankement failure. There are no permanent structures for human habitation downstream of the dam to the station lagoon's confluence with Crooked Creek. Minimal economic loss is expected in the event of dam failure.

FOR DEPARTMENT USE ONLY

Application Fee

Check No.

Amount

Check Date

Application No.

Date Received

Municipal Notification

County Notification

(Continued on other side)

TYPE OF OWNERSHIP (Check one)

☐ Privately Owned ☐ Partnership ☒ Corporation ☐ Government Agency/Political Subdivision

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J. G. Herbein, Vice President, Generation
(Print Name)

JG Herbein
(Signature and Title)

1001 Broad Street
(Address)

Johnstown, PA 15907

(814) 533-8600
(Telephone Number)

SEAL

Attest: J M Bruno
Assistant Secretary

If a fictitious name entity, are you registered with the Pennsylvania Department of State? ☑ Yes ☐ No

All applications for permits, except those submitted by federal, state, county or municipal agencies, must be accompanied by a check payable to "Commonwealth of Pennsylvania" in accordance with the following schedule:
*Class A dams — $3000, Class B dams — $2500, Class C dams — $1500.

A single application may be submitted or a single permit may be issued for multiple structures and activities which are part of a single project or facility or part of related projects and facilities, located in a single county, constructed, operated, or maintained by the same persons. When a single application covers multiple structures or activities other han a single structure and related maintenance dredging, the application fee shall be the sum of fees set forth above r the applicable structures and activities.

Each application for a permit shall be accompanied by a completed Application checklist and Environmental Assessment Form and such information, maps, plans, specifications, design analyses, test reports, and other data as may be specifically required by the provisions of Chapter 105 and such additional information as may be required by the Department to determine compliance with the provisions of Chapter 105.

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"I (name) do hereby certify pursuant to the penalties of 18 Pa. C.S.A. Sec. 4904 to the best of my knowledge, information and belief, that the information contained in the accompanying plans, specifications, and reports has been prepared in accordance with accepted engineering practice, is true and correct, and is in conformance with Chapter 105 of the rules and regulations of the Department of Environmental Resources."

Duplicate applications with duplicate set of plans shall be submitted to Department of Environmental Resources, Bureau of Dams and Waterway Management, P. O. Box 8554, Harrisburg, PA 17105-8554.

This application, together with all maps, plans, profiles and specifications, and all papers, information and data filed in connection therewith, will remain on file in the Department.

*Based on size classification as defined in § 105.91 of Chapter 105, Rules and Regulations.

ER-DWM: 06/25/92

APPLICATION CHECKLIST FOR DAM PERMIT

DER USE ONLY
FILE NO. ____
DATE SENT ____
DATE REC'D ____

structions: Applicant or engineer should place a check in the left column for all items provided, sign on the reverse side and return with the Dam Permit Application. Section references are to Chapter 105 of the Department's Rules and Regulations as revised October 12, 1991.

✓ Permit application properly signed, sealed and witnessed in accordance with Section 105.13(g). ____

✓ Application fee in accordance with Section 105.13(b). ____

✓ Evidence of County and Municipal notification. (See reverse side.) ____

✓ A Site Plan including information in accordance with Section 105.13(d)(1). ____

✓ A Location Map of a scale factor of 1:24,000 (standard 7.5 Minute Series U. S. Geological Survey Topographic Map). ____

✓ A Project Description which includes a description of the proposed/existing structure or activity, purpose of the project, the effect of the project on public health, safety or environment and a statement of water dependency of the project. ____

✓ Color Photographs of the proposed site or project area with location and orientation map. ____

✓ Storm Water Management Analysis in accordance with Section 105.13(d)(5). ____

✓ Floodplain Management Analysis in accordance with Section 105.13(d)(6). ____

N/A A Risk Assessment if the Storm Water Management Analysis or the Floodplain Management Analysis indicates increases in peak rates of runoff or flood elevations in accordance with Section 105.13(d)(7). ____

✓ A completed Environmental Assessment Form and attachments, including Impacts Analysis and Alternatives Analysis. ____

N/A A Mitigation Plan of actions to be taken in accordance with the definition of mitigation in Chapter 105. ____

✓ Proof of title or adequate flowage easements for all land area below the top of the dam elevation that is subject to inundation. ____

✓ Data concerning subsoil and rock foundation conditions and the physical properties of the materials entering into the construction of the dam in accordance with Section 105.81(c). ____

✓ Design drawings, technical construction specifications and design report in sufficient detail that a determination of the adequacy of the proposed facility can be made. ____

✓ A Registered Professional Engineer's seal and certification affixed to all plans, specifications and design reports accompanying the application in accordance with Section 105.13(h). ____

✓ Proof of an application for an Earth Disturbance Permit or an Erosion and Sedimentation Control Plan and a copy of a letter of approval from the appropriate County Conservation District(s). ____

✓ A hydrologic and hydraulic analysis for the appropriate design storm in accordance with Section 105.98. ____

✓ An Operation and Maintenance Manual/Document indicating normal operation and maintenance procedures and parties responsible for these procedures. ____

(Continued on reverse side)

DER USE ONLY

✓ An Emergency Action Plan in accordance with Section 105.134. (If required.)

✓ A plan for monitoring performance of the dam by instrument installations in accordance with Section 105.81(a)(5). (If required.)

N/A Proof of financial responsibility in accordance with Section 105.20. (If required.)

N/A For projects involving storage of fluids or semifluids other than water, information concerning the chemical content, viscosity and other pertinent physical characteristic of the fluid or semifluid.

✓ The proposed time for commencement and anticipated start of construction.

✓ The most recent inspection reports if the application pertains to an existing dam.

I have reviewed the application submission material and confirm that the above checked items have been provided.

F. Gregory Nadeau
(Signature - Applicant or Engineer)

F. GREGORY NADEAU
ENGINEER
No. 032198-E

April 2, 1993
(Date)

MUNICIPAL AND COUNTY NOTIFICATION OF PERMIT APPLICATION

ct 14, P.L. 834, enacted February 17, 1984, requires that each applicant for a permit under the Dam Safety and Encroachments Act must give written notice to the municipality(ies) and the county(ies) in which the permitted activity is located. The written notice shall be received by the municipality(ies) and the county(ies) at least 30 days before the Department of Environmental Resources may issue or deny the permit.

You may notify the municipality(ies) and the county(ies) by providing a copy of the application to each municipality and county by CERTIFIED MAIL, RETURN RECEIPT REQUESTED, or by personally delivering a copy to and obtaining a written acknowledgment of receipt from each municipality and county. Letters should be addressed to the office of the Secretary or the Clerk of the municipality and county OR to the Supervisors, Manager or Commissioners as appropriate.

The submission of your application to the Department must include evidence that municipal and county notification has occurred. Acceptable forms of evidence include:

(1) Certified mail receipt and copy of letter sent to each municipality and county, OR

(2) Written acknowledgment from each municipality and county.

Failure to provide evidence of municipal and county notification will delay processing of your application.

401 WATER QUALITY CERTIFICATION

Applications submitted to the Bureau of Dams and Waterway Management for projects requiring a Dam Permit will also be considered a request for Water Quality Certification under Section 401 of the Federal Water Pollution Control Act (33 U.S.C.A. 1341(a)) for either a U.S. Army Corps of Engineers' (ACOE) individual permit or nationwide permit. The applicant is esponsible to provide necessary information to the U.S. Army Corps of Engineers for the termination of what type, if any, federal permit is required.

Certified Mail

Armstrong County Commissioners
Armstrong County Courthouse
Kittanning, PA 16201

RE: Act 14 Notification

Dear County Commissioners:

In accordance with Act 14 notification requirements, this is to inform you that Penelec plans to apply to PaDER for two dam permits.

Pennsylvania Electric Company (Penelec) operates the Keystone Generating Station, located along Crooked Creek in Plumcreek Township, Armstrong County, Pennsylvania. Treated effluent discharges from Keystone Station have occasionally exceeded the permitted thermal discharge limits for the lagoon outfall (NPDES Outfall 003) into Crooked Creek. Penelec has entered into a Consent Order and Agreement with Pennsylvania Department of Environmental Resources for implementation of this project. It has been determined that the exceedances of the Station's thermal discharge limitations can be corrected through rerouting the Station's ash sluice water, replacing the fill material in the four cooling towers, and using the former bottom ash ponds as cooling ponds for the hot wastewater from the station. The use of the cooling ponds is the only modification applicable to the Dam Permits.

Should you have any questions or comments, please contact me at (814) 533-8567.

Sincerely,

Floyd R. Duncan
Environmental Scientist Sr.

Certified Mail

Plumcreek Township Supervisors
R.D. 1, Box 77-C
Shelocta, PA 15774

RE: Act 14 Notification

Dear Township Supervisors:

In accordance with Act 14 notification requirements, this is to inform you that Penelec plans to apply to PaDER for two Dam Permits.

Pennsylvania Electric Company (Penelec) operates the Keystone Generating Station, located along Crooked Creek in Plumcreek Township, Armstrong County, Pennsylvania. Treated effluent discharges from Keystone Station have occasionally exceeded the permitted thermal discharge limits for the lagoon outfall (NPDES Outfall 003) into Crooked Creek. Penelec has entered into a Consent Order and Agreement with Pennsylvania Department of Environmental Resources for implementation of this project. It has been determined that the exceedances of the Station's thermal discharge limitations can be corrected through rerouting the Station's ash sluice water, replacing the fill material in the four cooling towers, and using the former bottom ash ponds as cooling ponds for the hot wastewater from the station. The use of the cooling ponds is the only modification that is applicable to the Dam Permits.

Should you have any questions or comments, please contact me at (814) 533-8567.

Sincerely,

Floyd R. Duncan
Environmental Scientist Sr.

1.0 SUPPLEMENTAL INFORMATION FOR PERMIT APPLICATIONS

1.1 PROJECT DESCRIPTION

Pennsylvania Electric Company (Penelec) operates the Keystone Generating Station, located along Crooked Creek in Plumcreek Township, Armstrong County, Pennsylvania. Treated effluent discharges from Keystone Station have occasionally exceeded the permitted thermal discharge limits for the lagoon outfall (NPDES Outfall 003) into Crooked Creek. Penelec entered into a Consent Order and Agreement (COA) with the Pennsylvania Department of Environmental Resources in September 1992 to establish a schedule for design and construction of facilities necessary to meet effluent thermal limitations. Re-routing the bottom ash filter pond discharge to the former bottom ash disposal ponds (proposed cooling ponds) is scheduled to be complete by September 30, 1994. The Part II Water Quality Management Permit Application for the Thermal Discharge Abatement Project was submitted in February 1993. Sanitary Water Board Permit No. 0369203 for the existing bottom ash disposal ponds was issued on September 10, 1969.

Two additional permits for structures in the area of the cooling ponds were issued to Penelec. Dam and Water Obstruction Permit No. RM-DWM-D3-35 for the stream diversion project, located on the unnamed stream below the cooling ponds, was issued in December 1984. Also, a Joint 105/404 Permit for the entrance road culvert replacement/stream enclosure was issued to Penelec in August 1991.

Four modifications have been or are being implemented to achieve compliance with thermal limitations. One of these modifications consists of re-routing the effluent from the bottom ash filter ponds to the existing "old bottom ash disposal ponds", which will be re-named "cooling ponds". These large ponds provide additional evaporative cooling surface to improve thermal discharge characteristics. The project is not expected to have any effect on public health, safety, or the environment per the Environmental Assessment form (EAF). There are no wetlands regulated by the Commonwealth that exist within the project boundaries (See Attachments). The construction of either cooling pond is not water dependent. The project utilizes the existing old bottom ash disposal ponds and therefore, does not require access or proximity to water to fulfill the basic purposes of the project. Location of the proposed cooling ponds is shown on Drawing S-739-5014.

1.2 DESIGN REPORT

1.2.1 Pond Size and Capacity

The location and preliminary design for the cooling ponds are shown on Drawing D-739-5009. The ponds are designed to maximize available surface area for evaporative cooling. The bottom ash ponds are not currently in use and previously have been cleaned of bottom ash.

Cooling Pond "A" has a storage volume of approximately 5.6 million cubic feet at normal operating level. The available surface area for cooling is approximately 310,000 square feet. Cooling Pond "B" has a storage volume of approximately 4.8 million cubic feet at normal operating level. The available surface area for cooling is approximately 247,000 square feet. The ponds normally operate in parallel, with Pond "A" receiving approximately 54 percent of the flow and Pond "B" receiving 46 percent of the flow. The detention time for the wastewater in the cooling ponds with average flow conditions is approximately 18.5 days. This long detention time mitigates the effects of short spells of very hot weather and daily maximum flow rates.

1.2.2 Pond Inlet Piping

Water pumped from the bottom ash filter ponds is first channeled into a flow division box as shown on Drawing No. D-739-5009. The pumped flow rate is divided at the division box and piped to a distribution box located at the west end of each of the cooling ponds. The discharge lines from the distribution box are valved, so that the flow can be shut-off to one of the ponds, if necessary. At each distribution box the wastewater is evenly divided among a series of smaller pipes spaced at intervals of approximately twenty feet and discharges into the lagoon. The number of inlet pipes per pond varies due to the geometry of the ponds. By utilizing a distribution box with the given pipe configuration, the flow is gently and evenly distributed over a large surface area in order to attain the best heat exchange rates.

1.2.3 Pond Lining

To prevent water from seeping out of the cooling ponds, a synthetic liner is installed beneath each pond. The synthetic liner is a 50-mil thick HDPE liner or equal. The liner is textured on the side slopes to ensure stability of the liner and cover material. To protect the liner from damage, a three-inch thick concrete erosion control revetment is installed on top of the liner on the side slopes and a minimum of two feet of bottom ash is placed on top of the liner on the pond bottom. A nonwoven geotextile and a two-inch layer of sand is installed below the liner. The sand and geotextile prevent the liner from being punctured by the subgrade soils.

Pond and liner construction details are provided on Drawings D-739-5012, -5018, and -5019. Product information on the liner and concrete erosion control revetment is located in Appendix A.

1.2.4 Pond Discharge Piping

The ponds normally discharge through submerged launders which are integrated into the existing discharge structures, as shown on Drawing C-739-5016. The submerged launder consists of a 42-inch diameter pipe, approximately 60 feet long, that runs parallel with and three feet above the pond bottom, and connects to a concrete box adjacent to the existing discharge structure. On the underside of the submerged launder are a series of orifices that draw the coldest water off the pond bottom into the submerged launder. The water entering into the concrete box then overflows into the existing discharge structure and discharges via an 18-inch diameter high density polyethylene pipe that is installed inside the existing 21-inch diameter corrugated metal pipe. The two flows are then combined and discharge through a flume below the diversion dam.

1.2.5 Pond Access and Cleaning

To provide access to the ponds for cleaning and maintenance, a 20-foot wide gravel roadway is provided to and around the pond, along with a 25-foot wide ramp into each of the ponds. The sediment is removed from the pond with front end-loaders and then trucked to the existing permitted coal refuse/ash disposal site. To drain the ponds, each discharge structure has four dewatering pipes and valves that are positioned at different elevations. An underdrain system is provided to dewater the sediment. This underdrain system consists of approximately two feet of bottom ash on the pond bottom and a twelve-inch diameter perforated PVC pipe surrounded by coarse aggregate. The underdrain pipe for each pond flows into the discharge structure.

1.3 DAM CLASSIFICATION

The proposed cooling ponds are Type B-3 dams in accordance with Chapter 105 of the rules and regulations of the Pennsylvania Department of Environmental Resources. The maximum impoundment storage (elev. 1020 feet) of cooling pond "A" is approximately 129 acre-feet and the maximum dam height is 49 feet. The maximum impoundment storage (elev. 1020 feet) of cooling pond "B" is approximately 110 acre-feet and the maximum dam height is 47 feet. Because both ponds hold less than 1,000 acre-feet but are greater than 40 feet in height, their size classifications are B. Additionally, no loss of life is expected in the event of an embankment failure. There are no permanent structures for human habitation downstream of the cooling ponds to the station lagoon's confluence with Crooked Creek. Minimal economic loss is expected in the event of a dam failure. The power plant is of sufficient distance away so that it would not be affected. Minimal damage to the earthen fill embankment supporting the main access road is possible. Because there is no expected loss of life and minimal economic loss in the event of a dam failure, the hazard potential classification for the ponds is 3.

1.4 COLOR PHOTOGRAPHS

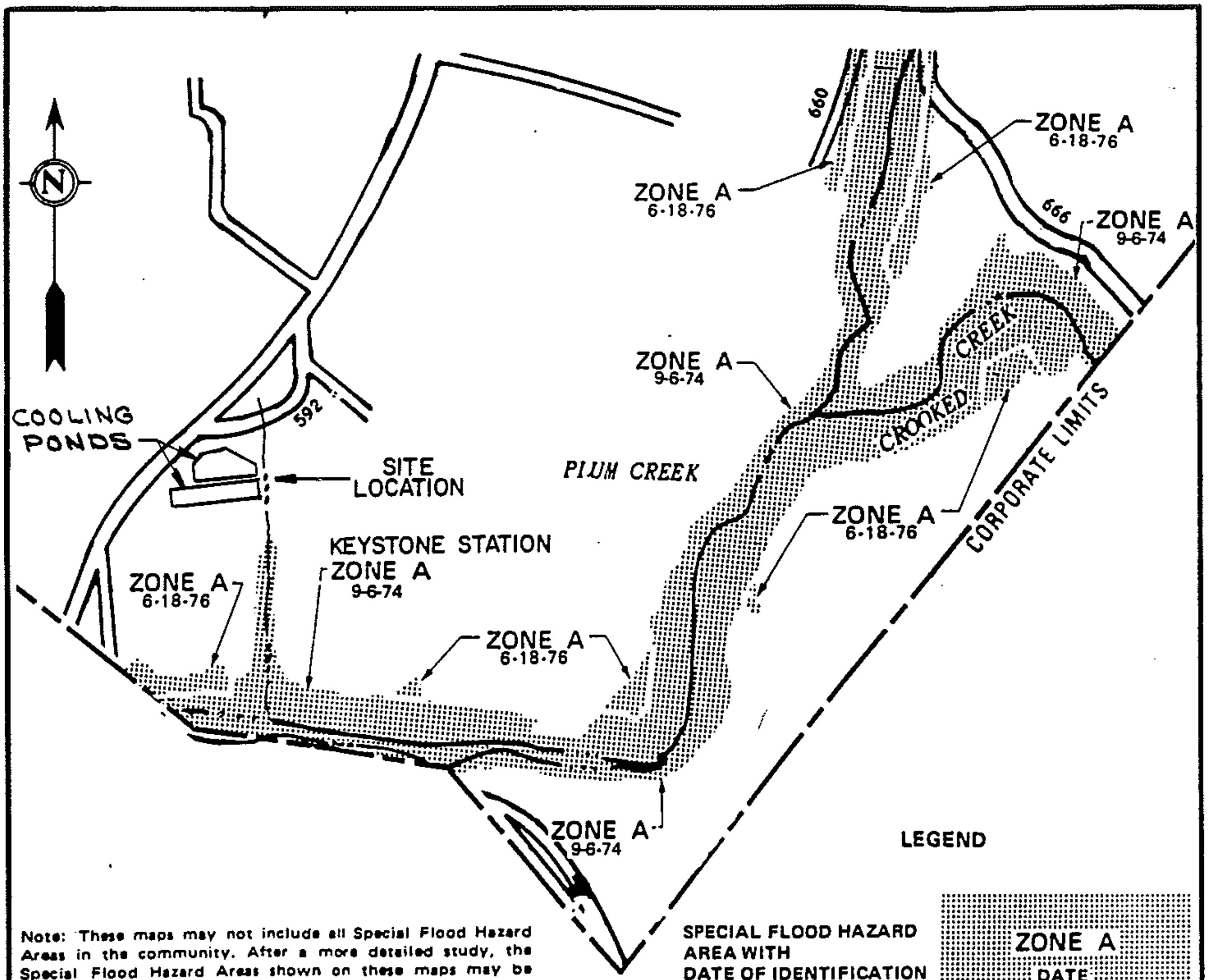
Color photographs of the site and photograph orientation map (Figure 1) are located in Appendix B.

1.5 STORM WATER MANAGEMENT ANALYSIS

The project is not expected to impact the existing storm water drainage on site. Because the cooling ponds utilize the existing bottom ash disposal ponds, the storm water runoff after development is equal to or less than that before development. Permanent erosion control measures are used to ensure that peak runoff rates do not increase after project completion. All existing drainage structures that currently exist on site are unaffected by the development of the cooling ponds.

1.6 FLOODPLAIN MANAGEMENT ANALYSIS

The proposed cooling ponds are not located within the 100-year floodway, as delineated on the FEMA map (Figure 2). The cooling ponds utilize the existing



Note: These maps may not include all Special Flood Hazard Areas in the community. After a more detailed study, the Special Flood Hazard Areas shown on these maps may be modified, and other areas added.

CONSULT NFIA SERVICING COMPANY OR LOCAL INSURANCE AGENT OR BROKER TO DETERMINE IF PROPERTIES IN THIS COMMUNITY ARE ELIGIBLE FOR FLOOD INSURANCE.

INITIAL IDENTIFICATION DATE:

SEPTEMBER 6, 1974

REVISION DATES:

6-18-76 : ADD S.F.H.A., REDUCE S.F.H.A., SHOW CURVILINEAR BOUNDARIES

APPROXIMATE SCALE

1000 0 2000 4000 6000 FEET

PENNSYLVANIA ELECTRIC COMPANY
KEYSTONE GENERATING STATION
THERMAL MODIFICATIONS
FLOOD HAZARD BOUNDARY MAP
FIGURE 2

bottom ash disposal ponds, and thus do not impact the floodway delineation and water surface profiles.

The 100-year flood level upstream of the entrance road culvert, which is located adjacent to the cooling ponds, is elevation 980.7 feet. (This figure was taken from the Joint 105/104 Permit Application for the Proposed Entrance Road Culvert Replacement, prepared by GAI Consultants, Inc. in August, 1991.) This flood level is approximately 40 feet below the top of the cooling pond embankments and the main plant access road, and thus will not impact either the ponds or the road.

1.7 RISK ASSESSMENT

No risk assessment is necessary for this project. The proposed cooling ponds utilize the existing bottom ash disposal ponds, and thereby do not alter peak runoff rates or flood elevations. The ponds represent no increased risk to life, property, or the environment.

1.8 PROOF OF TITLE AND FLOWAGE EASEMENTS

The two cooling ponds and appurtenant works are all located within the lands of Pennsylvania Electric Company as shown on Drawing E-781-084.

1.9 MITIGATION PLAN

No mitigation plan is required for the construction of the cooling ponds. The project will not impact the environment and therefore, reparations, rehabilitation, and restoration of any project areas will not be necessary.

1.10 GROUNDWATER, SOILS, AND GEOLOGY INFORMATION

The "Geological Map of Pennsylvania," as prepared by the Pennsylvania Topographic and Geological Survey in 1980, indicates that the geological formation underlying the site is the Glenshaw Formation of the Pennsylvania Age. The Glenshaw Formation is described as cyclic sequences of shale, sandstone, red beds, and then limestone and coal. It also includes four marine limestone or shale horizons. The red beds are involved in landslides and the base is at the top of Upper Freeport Coal.

The "Soil Survey of Armstrong County, Pennsylvania," Sheet Numbers 68 and 73, indicates that the site soil is Sm, which denotes strip mines. Strip mines consist of sandstone, boulders, fractured shale, and some soil material that has been distributed by mining operations. Slopes range from nearly level to very steep.

A total of twelve borings (Monitoring Well #3A, SD-1 through SD-5, SD-5A, and 92-1 through 92-5) and nine test pits (TP 93-1 through TP 93-9) have been drilled or excavated in the area of the proposed cooling ponds. Logs for the borings and test pits are located in Appendix C.

Four of the borings (92-1, 92-2, 92-4, and 92-5) were drilled recently in the eastern embankment of the cooling ponds. The borings indicate that the embankments are constructed of stiff to very stiff sandy silt and clay with rock fragments. Top of rock encountered in the borings varies from approximately elevation 971.5 feet to elevation 962 feet. The rock appears to be sloped at approximately a 20:1 (horizontal:vertical) grade towards the stream.

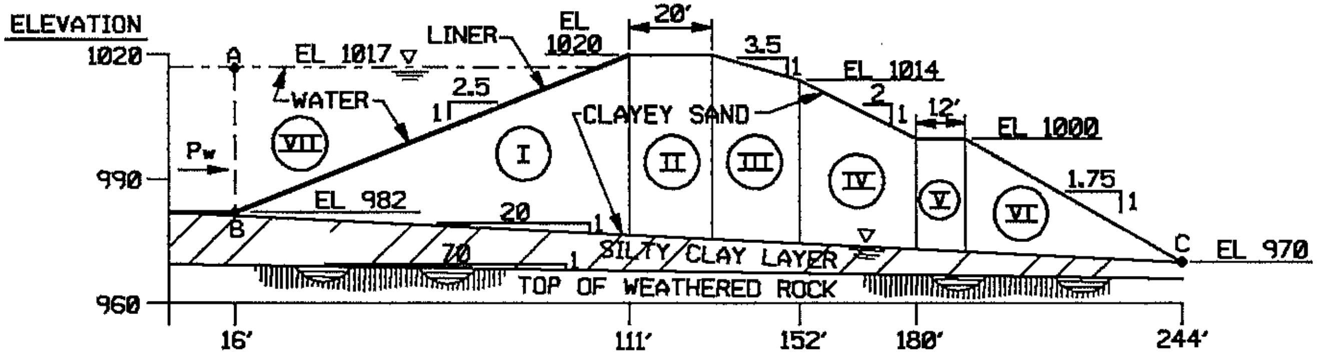
The pond embankments are stable for all anticipated loading conditions. A slope stability analysis was performed for the critical section of the eastern embankment of the cooling ponds. The minimum factor of safety against embankment failure using Bishop's Method of Slices is 1.74 for static conditions and 1.35 for dynamic conditions. (See Section 1.11)

Groundwater data obtained indicates that the groundwater is below the bottom of the proposed liner system for the cooling ponds. The groundwater elevation appears to vary from approximately elevation 984 feet at Monitoring Well #3A (located west of the ponds) to approximately elevation 972 feet at the unnamed stream (located east of the ponds). No groundwater seepage or springs have been observed in any of the embankments for the existing ponds. The liner system for the proposed cooling ponds is placed on top of the existing subgrade of the ponds. For the bottom of Cooling Pond "A", the liner varies from approximately elevation 1002 feet at the western end to elevation 980 feet at the eastern end. For the bottom of Cooling Pond "B", the liner varies from approximately elevation 988 feet at the western end to elevation 980 feet at the eastern end.

1.11 SLOPE STABILITY ANALYSIS

The cooling pond embankment slopes are safe and stable as designed. The east-side embankment of cooling pond "A", being the tallest embankment, is most critical for stability. As this is an existing embankment, its future settlement after the pond construction will be negligible. Two analysis methods are used to determine the factors of safety against sliding: sliding block and slip circle. The minimum factors of safety against sliding with the normal operating water level (elev. 1017 feet) in the pond during static and seismic conditions, using conservative soil parameters, are as follows:

	FACTOR OF SAFETY	
ANALYSIS METHOD	Static	Seismic*
SLIDING BLOCK	3.63	1.79
SLIP CIRCLE	1.74	1.35



F.S. AGAINST SLIDING ≐ (RESISTING FORCES/SLIDING FORCES) ALONG SURFACE BC

= $(cA + W_n \tan\beta) / (P_{wp} + W_p + W_{p(seism)})$

= $\begin{cases} 3.63\ldots\text{STATIC} \\ 1.79\ldots\text{SEISMIC } (a_{max} = 0.1g) \end{cases}$

WHERE, P_{wp} = COMPONENT OF HYDROSTATIC PRESS. P_w // TO BC = 38.3 KIPS/FOOT

W_p = COMPONENT OF TOTAL WT. (I + II + III + IV + V + VI + VII) // TO BC = 40.4 KIPS/FOOT

W_n = COMPONENT OF TOTAL WT. (I + II + III + IV + V + VI + VII) ⊥ TO BC = 805 KIPS/FOOT

$W_{p(seism)}$ = COMPONENT OF HORIZ SEISMIC FORCE // TO BC = 80.5 KIPS/FOOT

A = SURFACE AREA BC = 229 SQ. FT./FOOT

c = COHESION OF SOIL ALONG BC = 1.25 KSF

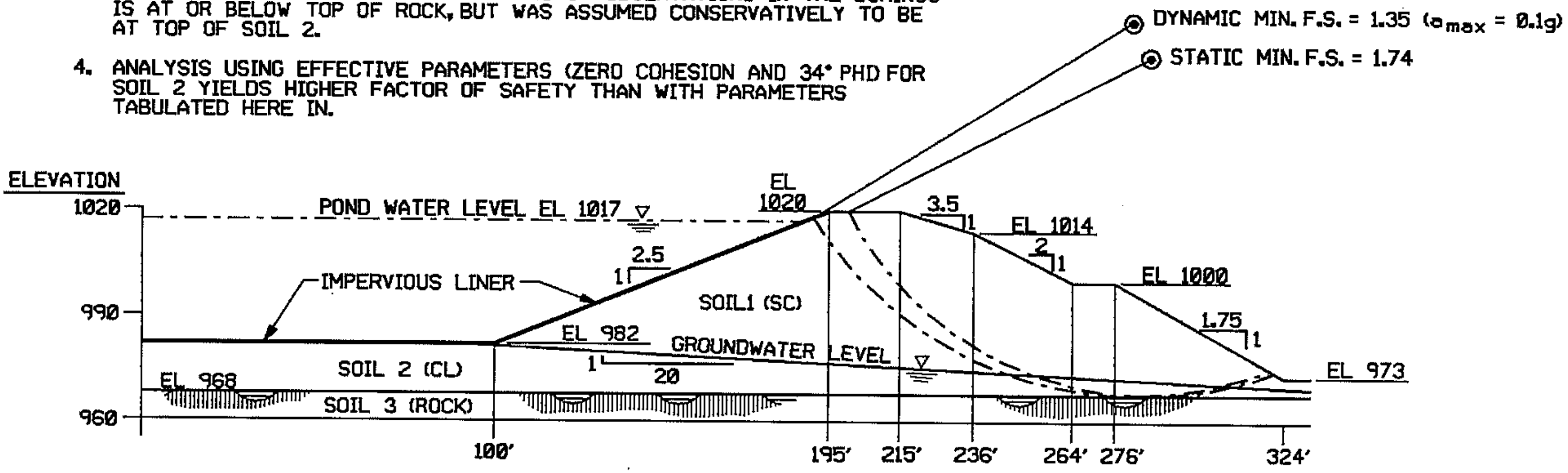
β = FRICTION ANGLE OF SOIL ALONG BC = 0

NOTE: ANALYSIS USING ZERO COHESION AND 20° FRICTION ALONG BC YIELDS GREATER FACTOR OF SAFETY THAN STATED ABOVE.

PENNSYLVANIA ELECTRIC COMPANY
KEYSTONE GENERATING STATION
DAM PERMIT
SLOPE STABILITY ANALYSIS FOR
TRANSLATIONAL FAILURE
FIGURE 3

NOTES:

1. CRITICAL CIRCLE WAS DETERMINED BY THE MODIFIED BISHOP METHOD WITH THE AID OF A COMPUTER PROGRAM.
2. SOIL PROPERTIES WERE DETERMINED BY LABORATORY TESTS AND/OR BASED ON FIELD TEST DATA FROM EXPLORATORY BORINGS. FOR ROCK, THE PROPERTIES WERE ASSUMED CONSERVATIVELY.
3. THE ACTUAL GROUNDWATER LEVEL BASED ON OBSERVATIONS IN THE BORINGS IS AT OR BELOW TOP OF ROCK, BUT WAS ASSUMED CONSERVATIVELY TO BE AT TOP OF SOIL 2.
4. ANALYSIS USING EFFECTIVE PARAMETERS (ZERO COHESION AND 34° PHD FOR SOIL 2 YIELDS HIGHER FACTOR OF SAFETY THAN WITH PARAMETERS TABULATED HERE IN.



SOIL DATA:			
LAYER	EFFECTIVE UNIT WEIGHT (pcf)	COHESION (psf)	PHI (deg)
SOIL 1	125	240	28
SOIL 2	72	1,250	0
SOIL 3	85	8,000	0

PENNSYLVANIA ELECTRIC COMPANY
KEYSTONE GENERATING STATION
DAM PERMIT
SLOPE STABILITY ANALYSIS
BISHOP'S METHOD
FIGURE 4

*Maximum horizontal acceleration = 0.1 g, conservatively

The ponds are lined with a 50-mil thick impervious geomembrane that will not allow water to seep and saturate the embankment soil. The embankment is an existing embankment and has been stable in the past. There are no visible signs of stress or cracking on the embankment.

Soil parameters, criteria, and results of both analysis methods are shown in Figures 3 and 4. Soil laboratory data obtained from borings and test pits that are used in the slope stability analyses are located in Appendix D.

1.12 REGISTERED PROFESSIONAL ENGINEER'S CERTIFICATION

I F. Gregory Nadeau do hereby certify to the best of my knowledge, information, and belief, that the information contained in the accompanying plans, specifications, and reports has been prepared in accordance with accepted engineering practice, is true and correct, and is in conformance with Chapter 105 of the rules and regulations of the Pennsylvania Department of Environmental Resources.

F. GREGORY NADEAU
No. 032198-E

Dam Permit Applications, Proposed Cooling Ponds, Keystone Generating Station, Plumcreek Township, Armstrong County, Pennsylvania, Gilbert/Commonwealth, Inc., Rt. 10 and Pheasant Road, Reading, PA 19603, W.O. 04-4267-230, April 1993.

1.13 PROOF OF APPLICATION FOR EROSION AND SEDIMENTATION PLAN

A soil erosion and sedimentation control plan will be prepared in accordance with the PaDER Erosion and Sediment Pollution Control Manual. The plan will first be submitted to the Armstrong County Conservation District, where it will be reviewed. Upon approval from the Conservation District, the plan will be forwarded to PaDER.

1.14 HYDROLOGIC AND HYDRAULIC ANALYSIS

The storage capacity of the cooling ponds safely accommodates the recommended design flood. The upper limit of the design flood range for a B-3 dam is 1/2 PMF. The only stormwater that enters the cooling ponds is the precipitation that falls directly on the ponds' surface area. Therefore, it can be assumed conservatively that 1/2 PMF is equal to the 24-hr 10 mi^2 PMP. The 24-hr 10-mi^2 PMP for the Keystone Station is 32 inches; therefore, 1/2 PMF or 16 inches, is added to the normal operating water levels of the ponds. The ponds are designed for three feet of freeboard and therefore, easily accommodate the recommended design flood.

1.15 OPERATION AND MAINTENANCE DOCUMENT

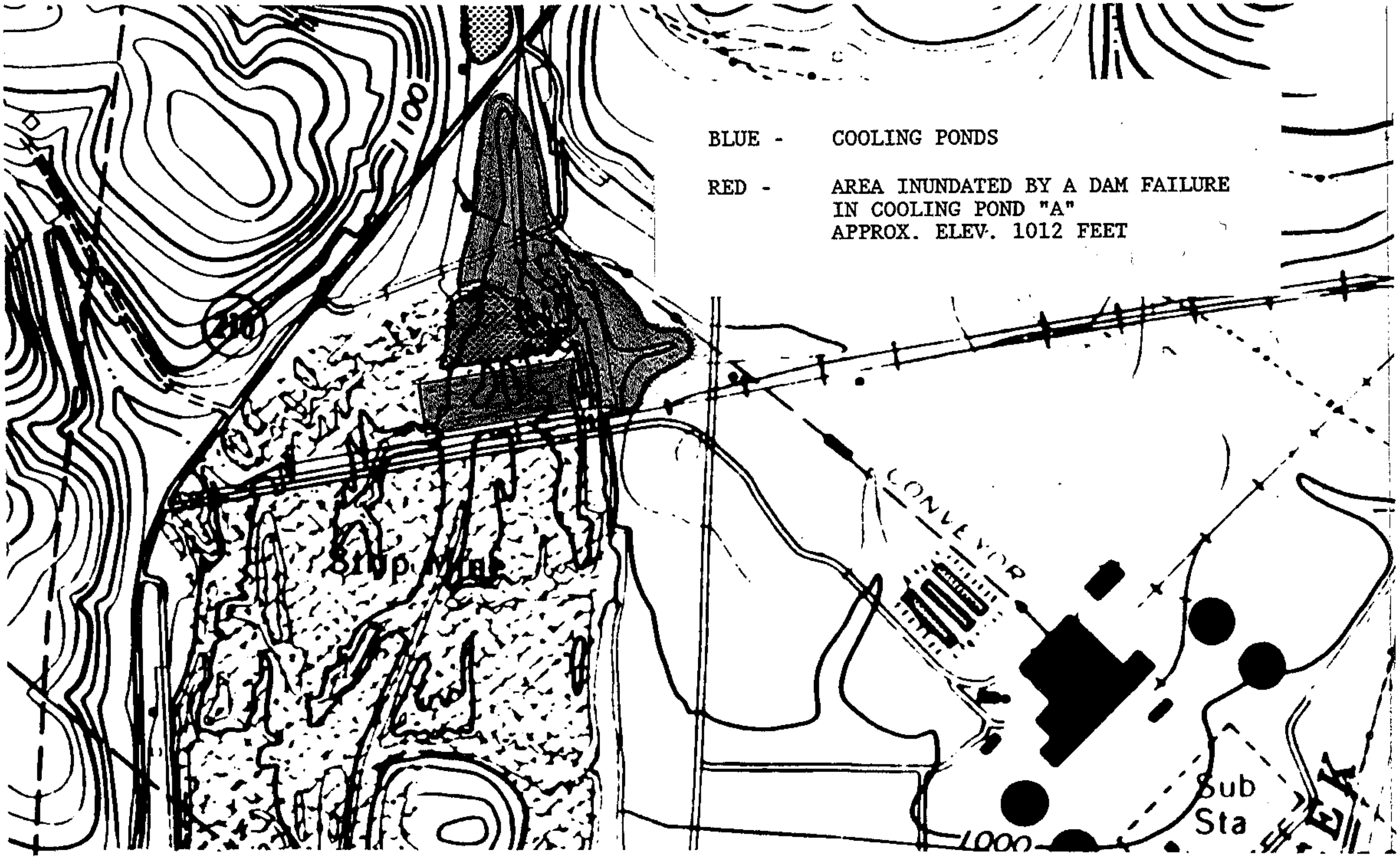
This section provides maintenance guidelines which should result in proper operation of the cooling ponds and related equipment. Station personnel are present in the area of the cooling ponds daily, ensuring the proper functioning of piping, monitoring equipment, and inspecting the dam embankments for any seepage.

Cleaning of the cooling ponds is expected to take place approximately once every five years, due to the precipitation of a small amount of solids. The majority of the solids is removed at the bottom ash filter ponds. During normal operation, cooling pond "A" receives approximately 54 percent and cooling pond "B" approximately 46 percent of the flow discharged from the bottom ash filter ponds. When it is determined that a pond requires cleaning, flow to one pond will be valved off at the flow division box (see Drawing D-739-5009), while the other pond receives 100 percent of the flow. The pond to be cleaned is dewatered by opening three 8-inch dewatering valves contained in the existing discharge structure, to approximately elevation 985 feet. At this point, the pond's underdrain system dewaters the sediment. The underdrain system consists of two feet of bottom ash and a 12-inch diameter perforated PVC pipe surrounded by coarse aggregate. The valve for the underdrain system, located in the discharge structure, is closed during normal operation of the pond and opened when the pond level has been drawn down and dewatering of the sediment is required. A front-end loader removes the dried sediment from the pond and a truck transports it to the existing permitted coal refuse/ash disposal site. The front-end loader operator will exercise care when removing sediment so as not to damage the concrete erosion control revetment on the side slopes or unnecessarily remove bottom ash from the pond bottom. Any bottom ash removed during the cleaning operation will be replaced. Following this, the valves in the discharge structure are closed, and the valve at the division box is opened to resume flow to the newly cleaned pond. The pond then assumes its normal operating level.

1.16 EMERGENCY ACTION PLAN/DAM BREAK ANALYSIS

No emergency action plan is required for the proposed cooling ponds, since no loss of life or serious property damage is anticipated in the event of a dam failure. This supported by the following dam break analysis.

For a conservative analysis, it is assumed that the dam break will occur in cooling pond "A", which has the larger volume and tallest embankment of the two ponds. The volume of cooling pond "A" is approximately 5.6 million cubic feet at normal operating level. Conservatively, the dam failure is instantaneous and causes water to



BLUE - COOLING PONDS

RED - AREA INUNDATED BY A DAM FAILURE
IN COOLING POND "A"
APPROX. ELEV. 1012 FEET

FROM ELDERTON, PA USGS QUADRANGLE
APPROXIMATE SCALE : 1"=830'

PENNSYLVANIA ELECTRIC COMPANY
KEYSTONE GENERATING STATION
DAM PERMIT
DAM BREAK ANALYSIS
FIGURE 5

pond behind the entrance road culvert. The average end area method is used to determine the level to which the water upstream of the culvert will rise. This water level is approximately elevation 1012 feet, so there is no threat of overtopping the main plant acces road or State Route 210. Figure 5 shows the outline of the area subject to inundation in the event of a dam break. There are no inhabitants residing in the proposed area of inundation. Station personnel enter the area of the cooling ponds daily to monitor the performance of the dams and related equipment.

1.17 DAM PERFORMANCE MONITORING

No dam performance monitoring instrumentation is necessary for the proposed cooling ponds. In accordance with Section 1.11 of this dam permit application, the cooling pond embankments have adequate sliding stability and have negligible future settlement. Additionally, the pond embankments will be observed on a daily basis by station personnel and dam inspections will be conducted annually.

1.18 WATER QUALITY

The water entering the two cooling ponds will be treated bottom ash transport water, ash hopper overflow, and seal trough overflow. This water is treated at the bottom ash filter ponds for removal of residual suspended solids, before being pumped to the cooling ponds. Some additional settling of suspended solids may occur in the cooling ponds, requiring periodic cleaning of the ponds. Characteristics for the treated effluent leaving the bottom ash filter ponds are located in Appendix E.

1.19 CONSTRUCTION SPECIFICATIONS AND LINER QA/QC PLAN

The Construction Specifications and Liner QA/QC Plan for the project are located in Appendix F.

1.20 COMMENCEMENT AND ANTICIPATED COMPLETION OF CONSTRUCTION

Construction of the cooling ponds is expected to commence in May 1994 and end in September 1994.

1.21 DAM INSPECTION REPORTS

Attached in Appendix G are PaDER requirements for "Operation, Maintenance, and Inspection" and "Investigation and Correction of Unsafe Conditions--Emergency Procedures" for permitted dams. A comprehensive annual inspection report certified by a registered professional engineer is not required for a B-3 dam, however, an annual inspection will be performed for the cooling ponds, by Penelec Design Engineering. A walkdown of the cooling ponds and appurtenant works will be conducted at least once every three months by station personnel. A check list for a typical annual inspection report for PaDER is also included in Appendix G. This check list will be used as a guideline for the inspections.

APPENDIX D

SOIL LABORATORY DATA

LABORATORY TEST RESULTS

THERMAL DISCHARGE PROJECT
PENELEC KEYSTONE STATION

FOR
GILBERT/COMMONWEALTH, INC.

Prepared By:

Kin Chung

Kin Y C Chung, Ph.D.,P.E.
Managing Director

BY

AMERICAN GEOTECH, INC.

1801 Penn Ave, Wyomissing Hills, PA 19609 /Tel. 215 670-9055 /Fax: 215 678-2719

JANUARY 15, 1993

MOISTURE CONTENT

PROJECT PENELEC Keystone Station Thermal Discharge

DATE 12/21/92

CLIENT G/C

JOB NUMBER 57-1080

BORING NUMBER -

SAMPLE NUMBER -

BORING NUMBER	SAMPLE NO. / DEPTH	DISH NUMBER	WET WT. SAMPLE AND DISH (A)	DRY WT. SAMPLE AND DISH (B)	WATER LOSS (C)	WEIGHT DISH (D)	DRY WT. SAMPLE (E)	MOISTURE CONTENT % (F)
92-2	1 / 0-1.5'	42	87.8	82.2	5.6	31.5	50.7	11.0
92-2	2 / 5-6.5	87	76.0	71.5	4.5	30.8	40.7	11.1
92-2	3 / 10-11.5	88	86.3	81.4	4.9	30.6	50.8	9.6
92-2	4 / 15-16.5	91	77.3	72.8	4.5	30.9	41.9	10.7
92-2	5 / 20-21.5	93	146.3	140.4	5.9	31.1	109.3	5.4
92-2	6 / 25-26.5	94	156.9	155.8	1.1	30.9	124.9	0.9
92-2	7 / 30-31.5	95	92.8	83.6	9.2	31.1	52.5	17.5
92-2	8 / 35-36.5	96	91.2	89.3	1.9	30.8	58.5	3.2
92-5	1 / 0-1.5	99	111.8	104.5	7.3	30.8	73.7	9.9
92-5	2 / 5-6.5	100	102.6	96.2	6.4	30.9	65.3	9.8
92-5	3 / 10-11.5	101	74.2	67.6	6.6	30.6	37.0	17.8
92-5	4 / 15-16.5	104	89.5	82.0	7.5	30.2	51.8	14.5
92-5	5 / 20-21.5	106	85.1	78.6	6.5	31.9	46.7	13.9
92-5	6 / 25-26.5	109	79.8	72.7	7.1	32.0	40.7	17.4
92-5	7 / 30-31.5	111	139.6	133.0	6.6	31.8	101.2	6.5
92-3	S-1 / 0-1.5	114	125.3	119.8	5.5	30.5	89.3	6.2
92-3	S-2 / 5-6.5	115	90.7	81.6	9.1	32.3	49.3	18.5
92-3	S-3 / 10-11.5	116	111.0	93.8	17.2	32.2	61.6	27.9

CALCULATIONS: C = A - B, E = B - D, F = C/D

TECHNICIAN EB

COMPUTED BY EB

CHECKED BY KC

REMARKS

American Geotech, Inc.
1801 Penn Avenue, Wyom. Hills,
Reading, PA 19609

AMERICAN GEOTECH, INC.

TEST RESULTS

CLIENT : GILBERT/COMMONWEALTH
PROJECT : KEYSTONE STATION
JOB NUMBER: ST-1080
DATE : 12/21/92

ATTERBERG LIMITS (ASTM D 4318)

BORING NUMBER	B92-1	B92-1	B92-4	B92-4
SAMPLE NUMBER	BAG 1	BAG 2	BAG 3	BAG 4
DISH NUMBER	93	111	109	114
WT. DIST AND WET SOIL IN g	58.2	71.8	62.85	51.7
WT. DISH AND DRY SOIL IN g	52.7	63.55	56.5	46.7
WT. WATER LOSS (Ww) IN g	5.5	8.25	6.35	5
WT. DISH IN g	31.1	31.9	32.1	30.4
WT. DRY SOIL, (Ws) IN g	21.6	31.65	24.4	16.3
WATER CONTENT % (w)	25.46	26.07	26.02	30.67
NUMBER OF BLOWS, N	23	22	25	20
LIQUID LIMIT, LL	25.21	25.67	26.02	29.86

LL = w * (N/25) ** 0.121

DISH NUMBER	42	96	104	101
WT. DIST AND WET SOIL IN g	40	46.6	51.2	38.8
WT. DISH AND DRY SOIL IN g	38.9	44.1	47.9	37.6
WT. WATER LOSS (Ww) IN g	1.1	2.5	3.3	1.2
WT. DISH IN g	31.3	30.8	30.3	30.5
WT. DRY SOIL, (Ws) IN g	7.6	13.3	17.6	7.1
WATER CONTENT % (w)	14.47	18.80	18.75	16.90
PLASTIC LIMIT, PL	14.47	18.80	18.75	16.90
PLASTICITY INDEX, PI	10.73	6.87	7.27	12.96
	CL	CL-ML	CL	CL

C:\OCPECO1.WK3

AMERICAN GEOTECH
TEL : (215) 670-9055/FAX: (215) 678-2719

PARTICLE-SIZE ANALYSIS OF SOILS (ASTM D 422)

CLIENT : GILBERT/COMMONWEALTH
PROJECT :
JOB NO.: ST-1080
BORING NO.: B92-1
SAMPLE NO. BAG 1
DEPTH OR ELEVATION: 10' - 15'

SIEVE ANALYSIS

SIEVE OPENING		U.S. STANDARD SIEVE SIZE OR NUMBER	WEIGHT RETAINED IN GRAMS	CULUMATIV WEIGHT RETAINED	PERCENT RETAINED	PERCENT FINER BY WEIGHT	REMARKS:	
INCHES	MILLI-METER							
3.00		3"	0		0.000	100.00		
1.50		1 1/2"	0	0	0.000	100.00	0	0
0.75	19.1	3/4"	0	0	0.000	100.00	568.5	568.5
0.375	9.52	3/8"	73.5	73.5	0.089	91.08	592	518.5
0.187	4.76	No. 4	88.5	162	0.197	80.34	594	505.5
0.079	2.00	No. 10	99.6	261.6	0.318	68.25	545	445.4
0.033	0.84	No.20	68.2	329.8	0.400	59.97	497.2	429
0.0165	0.42	No.40	40.98	370.78	0.450	55.00	434.48	393.5
0.0098	0.25	No. 60	34.6	405.38	0.492	50.80	377.7	343.1
0.0059	0.149	No. 100	37.6	442.98	0.538	46.24	396.5	358.9
0.0029	0.074	No. 200	41.95	484.93	0.589	41.14	337.45	295.5
		PAN	339		0.411		686.4	347.4
TOTAL WEIGHT IN GRAMS			823.93					

HYDROMETER ANALYSIS

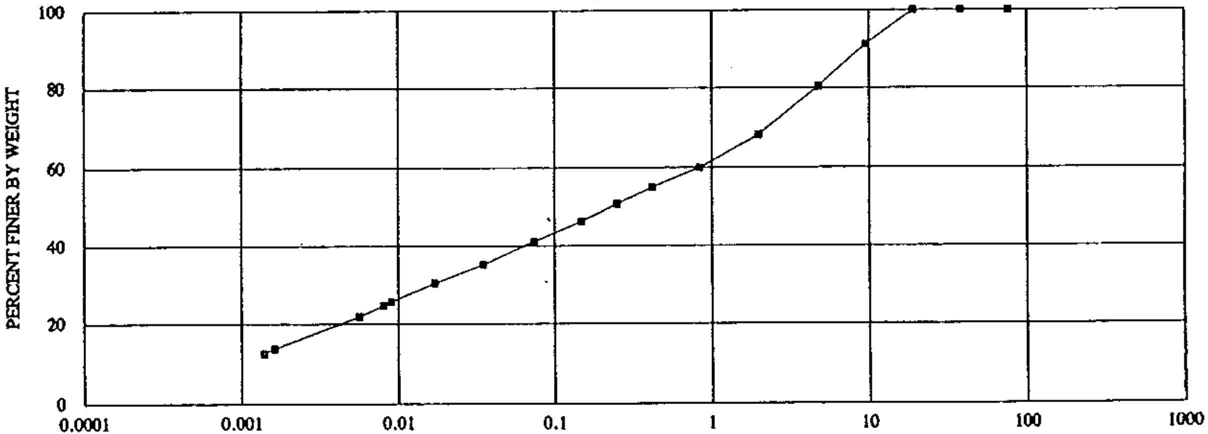
DISH No.
GRADUATE No.
HYDROMETER No: 152H
DISPERSING AGENT: SODIUM HEXAMETAPHOSPH E
QUANITY: 5g
DISPERSING AGENT CORRECTION,Cd: 6.5
MENISCUS CORRECTION,C: 0.5

ELAPSED TIME (min.)	TEMP (C)	HYDRO READING (R')	CORR'D READING (R)	TEMP CORR. (m)	R - (Cd + m)	PERCENT FINER		PARTICLE DIAMETER (mm)
						PARTIAL	TOTAL	
1	19	65	65.5	-0.2	59.2	51.48	35.13	0.034832
5	19	57	57.5	-0.2	51.2	44.52	30.39	0.017086
21	19	49	49.5	-0.2	43.2	37.57	25.64	0.008994
27	19	47.2	47.7	-0.2	41.4	36.00	24.57	0.00809
60	19	42.5	43	-0.2	36.7	31.91	21.78	0.005653
887	19	29	29.5	-0.2	23.2	20.17	13.77	0.001614
1271	19	27	27.5	-0.2	21.2	18.43	12.58	0.001391

Wt. of Sample for Hydrometer Analysis 115
Gs = 2.7
K = 0.01361

GRADATION CURVE

B-92-1, BAG 1, 10'-15'



REMARKS: Clayey SAND w/ gravel

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AMERICAN GEOTECH
TEL : (215) 670-9055/FAX: (215) 678-2719

PARTICLE-SIZE ANALYSIS OF SOILS (ASTM D 422)

CLIENT : GILBERT/COMMONWEALTH
PROJECT :
JOB NO.: ST-1080
BORING NO.: B92-1
SAMPLE NO. BAG 2
DEPTH OR ELEVATION: 25'-30'

SIEVE ANALYSIS

SIEVE OPENING INCHES	SIEVE OPENING MILLI-METER	U.S. STANDARD SIEVE SIZE OR NUMBER	WEIGHT RETAINED IN GRAMS	CULUMATIV WEIGHT RETAINED	PERCENT RETAINED	PERCENT FINER BY WEIGHT	REMARKS:	
3.00		3"	0		0.000	100.00		
1.50		1 1/2"	0	0	0.000	100.00	0	0
0.75	19.1	3/4"	29	29	0.037	96.35	597.5	568.5
0.375	9.52	3/8"	69	98	0.123	87.65	587.5	518.5
0.187	4.76	No. 4	63.6	161.6	0.204	79.64	569.1	505.5
0.079	2.00	No. 10	65.2	226.8	0.286	71.43	510.6	445.4
0.033	0.84	No.20	56.6	283.4	0.357	64.30	485.6	429
0.0165	0.42	No.40	41.35	324.75	0.409	59.09	434.85	393.5
0.0098	0.25	No. 60	30.02	354.77	0.447	55.31	373.12	343.1
0.0059	0.149	No. 100	29	383.77	0.483	51.66	387.9	358.9
0.0029	0.074	No. 200	39.4	423.17	0.533	46.69	334.9	295.5
		PAN	370.67		0.467		718.07	347.4
TOTAL WEIGHT IN GRAMS			793.84					

HYDROMETER ANALYSIS

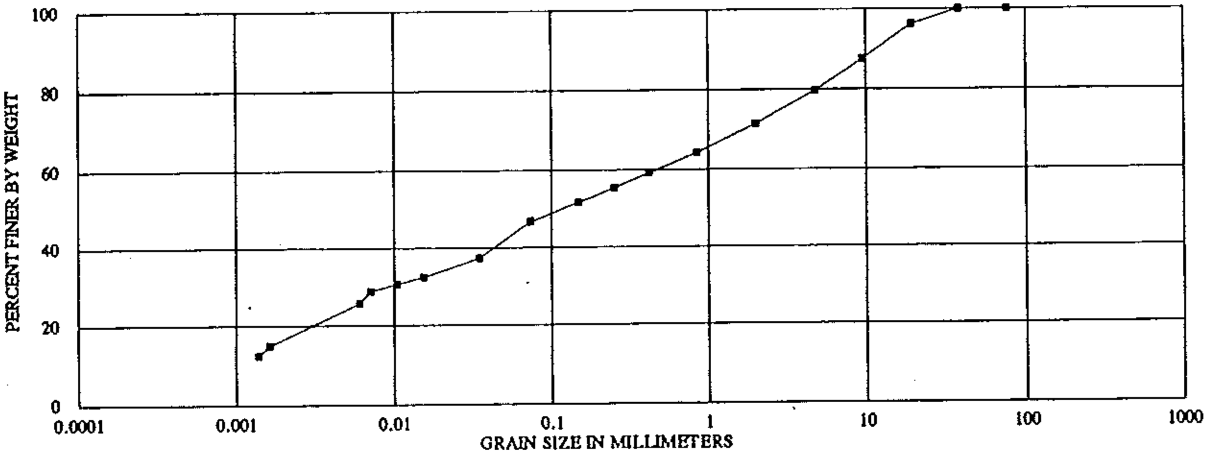
DISH No.
GRADUATE No.
HYDROMETER No. 152H
DISPERSING AGENT: SODIUM HEXAMETAPHOSPHE
QUANITY: 5g
DISPERSING AGENT CORRECTION,Cd: 6.5
MENISCUS CORRECTION,C 0.5

ELAPSED TIME (min.)	TEMP (C)	HYDRO READING (R')	CORR'D READING (R)	TEMP CORR. (m)	R (Cd + m)	PERCENT FINER PARTIAL	PERCENT FINER TOTAL	PARTICLE DIAMETER (mm)
1	19	66	66.5	-0.2	60.2	52.35	37.39	0.034645
6	19	58	58.5	-0.2	52.2	45.39	32.42	0.015498
14	19	55	55.5	-0.2	49.2	42.78	30.56	0.010467
32	19	52	52.5	-0.2	46.2	40.17	28.70	0.007129
48	19	47	47.5	-0.2	41.2	35.83	25.59	0.00608
878	19	30	30.5	-0.2	24.2	21.04	15.03	0.001616
1260	19	26	26.5	-0.2	20.2	17.57	12.55	0.001381

Wt. of Sample for Hydrometer Analysis 115
Gs = 2.7
K = 0.01361

GRADATION CURVE

B-92-1, BAG 2, 25'-30'



REMARKS: clayey SAND w/ gravel

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AMERICAN GEOTECH
TEL : (215) 670-9055/FAX: (215) 678-2719

PARTICLE-SIZE ANALYSIS OF SOILS (ASTM D 422)

CLIENT : GILBERT/COMMONWEALTH PROJECT :
JOB NO.: ST-1080 BORING NO.: B92-4 SAMPLE NO. BAG 3
DEPTH OR ELEVATION: 15'-20'

SIEVE ANALYSIS

SIEVE OPENING INCHES	SIEVE OPENING MILLI-METER	U.S. STANDARD SIEVE SIZE OR NUMBER	WEIGHT RETAINED IN GRAMS	CULUMATIV WEIGHT RETAINED	PERCENT RETAINED	PERCENT FINER BY WEIGHT	REMARKS:	
3.00		3"	0		0.000	100.00		
1.50		1 1/2"	0	0	0.000	100.00	0	0
0.75	19.1	3/4"	0	0	0.000	100.00	568.5	568.5
0.375	9.52	3/8"	76.8	76.8	0.102	89.79	595.3	518.5
0.187	4.76	No. 4	116.7	193.5	0.257	74.27	622.2	505.5
0.079	2.00	No. 10	110.6	304.1	0.404	59.56	556	445.4
0.033	0.84	No.20	62.7	366.8	0.488	51.22	491.7	429
0.0165	0.42	No.40	28.4	395.2	0.526	47.44	421.9	393.5
0.0098	0.25	No. 60	24.1	419.3	0.558	44.24	367.2	343.1
0.0059	0.149	No. 100	27.3	446.6	0.594	40.61	386.2	358.9
0.0029	0.074	No. 200	35.05	481.65	0.641	35.95	330.55	295.5
		PAN	270.3		0.359		617.7	347.4
TOTAL WEIGHT IN GRAMS			751.95					

HYDROMETER ANALYSIS

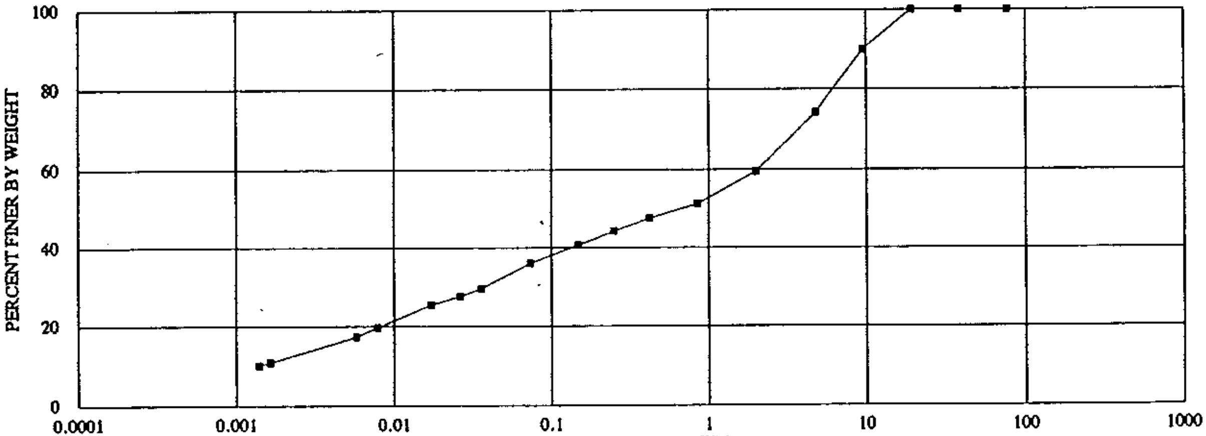
DISH No. GRADUATE No. HYDROMETER No. 152H
DISPERSING AGENT: SODIUM HEXAMETAPHOSPHE QUANITY: 5g
DISPERSING AGENT CORRECTION,Cd: 6.5 MENISCUS CORRECTION,C 0.5

ELAPSED TIME (min.)	TEMP (C)	HYDRO READING (R')	CORR'D READING (R)	TEMP CORR. (m)	R - (Cd + m)	PERCENT FINER PARTIAL	PERCENT FINER TOTAL	PARTICLE DIAMETER (mm)
1	19	63	63.5	-0.2	57.2	49.74	29.62	0.035957
2	19	59	59.5	-0.2	53.2	46.26	27.55	0.026496
5	19	55	55.5	-0.2	49.2	42.78	25.48	0.017301
30	19	44	44.5	-0.2	38.2	33.22	19.78	0.007889
60	19	39.5	40	-0.2	33.7	29.30	17.45	0.005793
891	19	27	27.5	-0.2	21.2	18.43	10.98	0.001636
1277	19	25.5	26	-0.2	19.7	17.13	10.20	0.001382

Wt. of Sample for Hydrometer Analysis 115
Gs = 2.7
K = 0.01361

GRADATION CURVE

B-92-4, BAG 3, 15'-20'



REMARKS: clayey SAND w/ gravel

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AMERICAN GEOTECH
TEL : (215) 670-9055/FAX: (215) 678-2719

PARTICLE-SIZE ANALYSIS OF SOILS (ASTM D 422)

CLIENT : GILBERT/COMMONWEALTH
PROJECT :
JOB NO.: ST-1080
BORING NO.: B92-4
SAMPLE NO. BAG 4
DEPTH OR ELEVATION: 35'-40'

SIEVE ANALYSIS

SIEVE OPENING		U.S. STANDARD SIEVE SIZE OR NUMBER	WEIGHT RETAINED IN GRAMS	CULUMATIV WEIGHT RETAINED	PERCENT RETAINED	PERCENT FINER BY WEIGHT	REMARKS:	
INCHES	MILLI- METER							
3.00		3"	0		0.000	100.00		
1.50		1 1/2"	0	0	0.000	100.00	0	0
0.75	19.1	3/4"	0	0	0.000	100.00	568.5	568.5
0.375	9.52	3/8"	0	0	0.000	100.00	518.5	518.5
0.187	4.76	No. 4	6.7	6.7	0.043	95.69	512.2	505.5
0.079	2.00	No. 10	13.2	19.9	0.128	87.19	458.6	445.4
0.033	0.84	No.20	7	26.9	0.173	82.68	436	429
0.0165	0.42	No.40	4.6	31.5	0.203	79.72	360.6	356
0.0098	0.25	No. 60	5.1	36.6	0.236	76.43	348.2	343.1
0.0059	0.149	No. 100	7.1	43.7	0.281	71.86	366	358.9
0.0029	0.074	No. 200	9.7	53.4	0.344	65.61	305.2	295.5
		PAN	101.9		0.656		449.3	347.4
TOTAL WEIGHT IN GRAMS			155.3					

HYDROMETER ANALYSIS

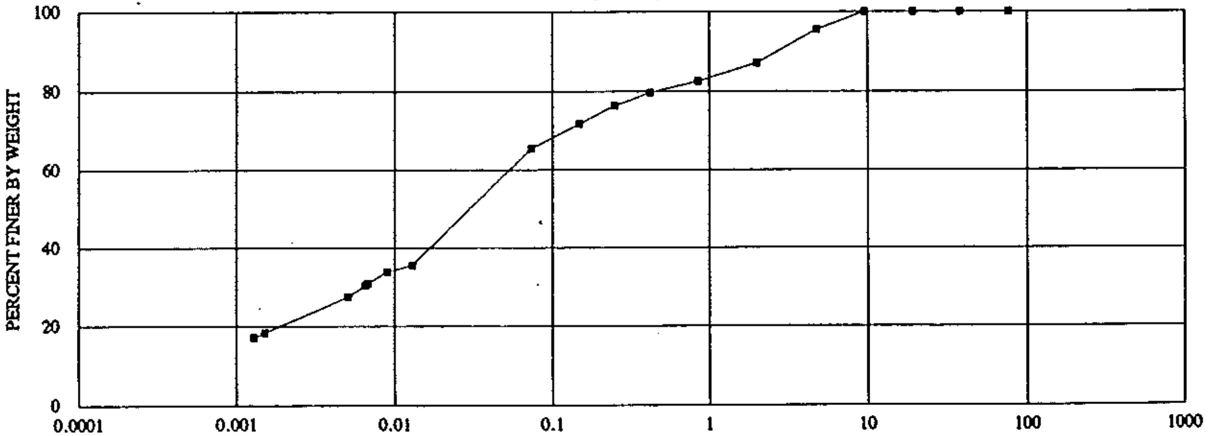
DISH No.
GRADUATE No.
HYDROMETER No.: 152H
DISPERSING AGENT: SODIUM HEXAMETAPHOSPHE
QUANITY: 5g
DISPERSING AGENT CORRECTION,Cd: 6.5
MENISCUS CORRECTION,C 0.5

ELAPSED TIME (min.)	TEMP (C)	HYDRO READING (R')	CORR'D READING (R)	TEMP CORR. (m)	R - (Cd + m)	PERCENT FINER		PARTICLE DIAMETER (mm)
						PARTIAL	TOTAL	
7	19	68	68.5	-0.2	62.2	54.09	35.49	0.012912
15	19	65	65.5	-0.2	59.2	51.48	33.78	0.009014
30	19	60	60.5	-0.2	54.2	47.13	30.92	0.00675
33	19	59	59.5	-0.2	53.2	46.26	30.35	0.006523
60	19	54	54.5	-0.2	48.2	41.91	27.50	0.005086
893	19	38	38.5	-0.2	32.2	28.00	18.37	0.001511
1280	19	36	36.5	-0.2	30.2	26.26	17.23	0.001283

Wt. of Sample for Hydrometer Analysis 115
Gs = 2.7
K = 0.01361

GRADATION CURVE

B-92-4, BAG 4, 35'-40'



REMARKS: LL = 29.9 PL = 16.9 PI = 13
Sandy lean CLAY

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DENSITY DETERMINATIONS

CLIENT: G/C
JOB NUMBER: ST-1080

PROJECT: PENELEC KEYSTONE STATION, THERMAL DISCHARGE PROJECT

DISH #	BORING #	SAMPLE #	DRY WEIGHT OF SAMPLE GM	WEIGHT OF SAND GM	VOLUME OF SOIL CU FT	DRY DENSITY OF SOIL PSF
42	92-2	1	50.3	40.3	0.000927503	119.31
101	92-5	3	28.8	27.7	0.000637514	99.39
104	92-5	4	42.4	41.9	0.000964327	96.73
115	92-3	S-2	49.0	42.7	0.000982739	109.69
116	92-3	S-2	18.5	20.1	0.000462601	87.98
95	92-2	SS-7	25.1	20.2	0.000464902	118.78
	92-1	S-11				121.60

DRY DENSITY OF SAND = 95.59 PCF

AMERICAN GEOTECH, INC.

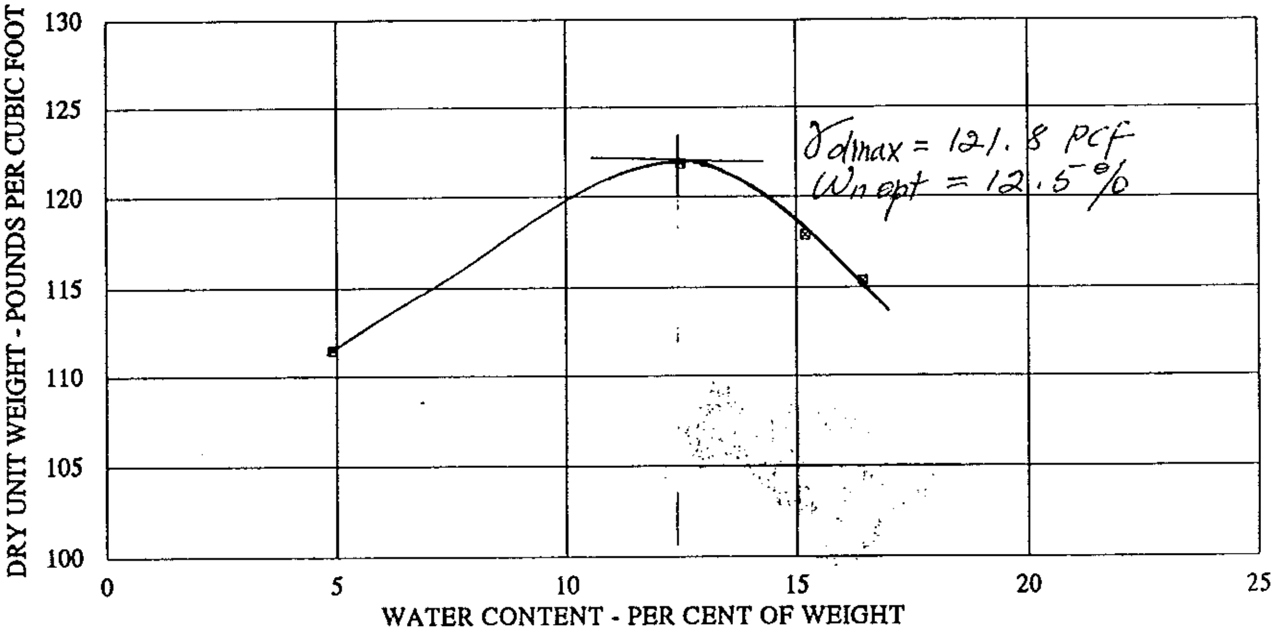
TEST RESULTS

CLIENT : GILBERT/COMMONWEALTH
PROJECT KEYSTONE STATION
JOB NUMB ST-1080
DATE : 1/4/93

BORING NO.: B92-4
SAMPLE NO.: BAG # 4

COMPACTION TEST

IN ACCORDANCE WITH ASTM D698



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STANDARD PROCTOR DENSITY (ASTM D698) FOR BAG SAMPLE #4

SAMPLE NUMBER	TEST 1	TEST 2	TEST 3	TEST 4
DISH NUMBER	80	53	122	61
WT. DIST AND WET SOIL IN g	330.5	325.1	269.9	275.2
WT. DISH AND DRY SOIL IN g	293.7	286.9	245.6	264.7
WT. WATER LOSS (Ww) IN g	36.8	38.2	24.3	10.5
WT. DISH IN g	51.6	54.4	51.3	51.4
WT. DRY SOIL, (Ws) IN g	242.1	232.5	194.3	213.3
WATER CONTENT % (w)	15.20	16.43	12.51	4.92

SAMPLE NUMBER	TEST 1	TEST 2	TEST 3	TEST 4
WT. OF SOIL AND MOLD, LBS	24.73	24.62	24.82	23.314
WT. OF MOLD, LBS	14.54	14.54	14.54	14.54
NET WT. WET SOIL., LBS	10.19	10.08	10.28	8.774
NET WT. DRY SOIL, LBS	8.845461	8.657554	9.137255	8.362351
DRY DENSITY LBS/CU FT	117.91	115.4052	121.7996	111.4701

AMERICAN GEOTECH, INC.

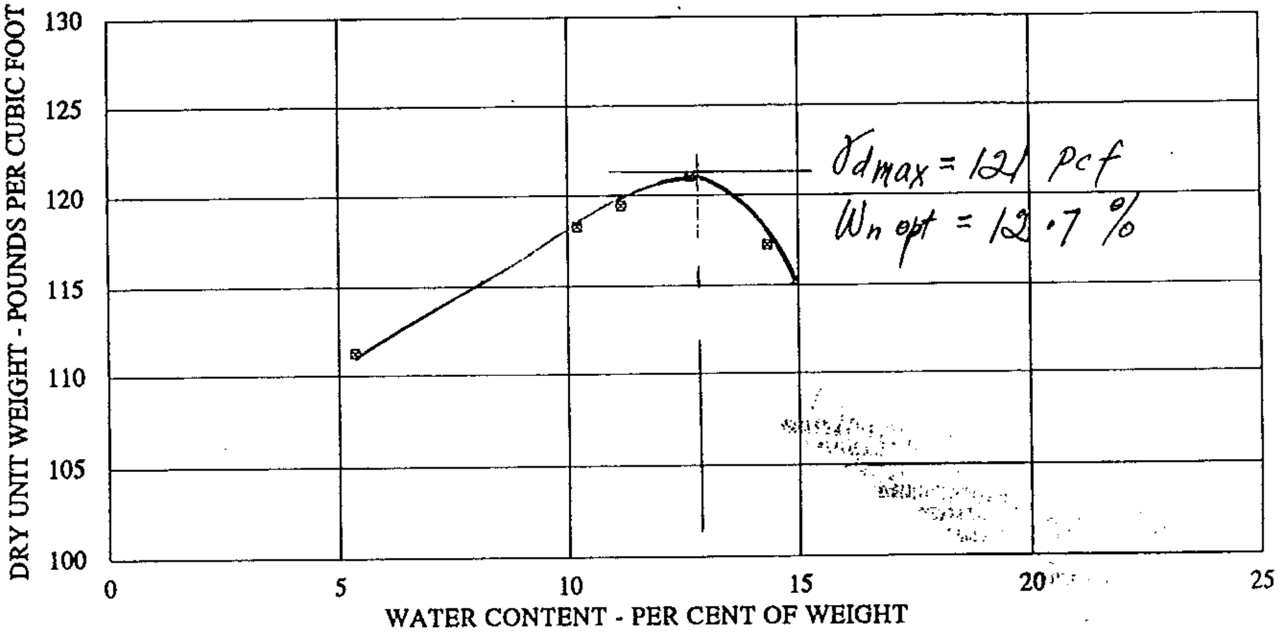
TEST RESULTS

CLIENT : GILBERT/COMMONWEALTH
PROJECT · KEYSTONE STATION
JOB NUMB ST-1080
DATE : 1/4/93

BORING NO.: B92-1
SAMPLE NO.: BAG # 2

COMPACTION TEST

IN ACCORDANCE WITH ASTM D698



$\gamma_{d max}$ = 121 pcf
$W_{n\,opt}$ = 12.7 %

BAG #2 - B92-1

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STANDARD PROCTOR DENSITY (ASTM D698) FOR BAG SAMPLE #2

SAMPLE NUMBER	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
DISH NUMBER	78	128	64	85	60
WT. DIST AND WET SOIL IN g	394.6	345.9	302.52	145.12	289.8
WT. DISH AND DRY SOIL IN g	377.2	318.9	277.4	132.25	260
WT. WATER LOSS (Ww) IN g	17.4	27	25.12	12.87	29.8
WT. DISH IN g	52.2	54.18	52.31	30.67	52.1
WT. DRY SOIL, (Ws) IN g	325	264.72	225.09	101.58	207.9
WATER CONTENT % (w)	5.35	10.20	11.16	12.67	14.33

SAMPLE NUMBER	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
WT. OF SOIL AND MOLD, LBS	23.33	24.32	24.5	24.77	24.6
WT. OF MOLD, LBS	14.54	14.54	14.54	14.54	14.54
NET WT. WET SOIL , LBS	8.79	9.78	9.96	10.23	10.06
NET WT. DRY SOIL, LBS	8.343312	8.874817	8.960059	9.079628	8.798797
DRY DENSITY LBS/CU FT	111.2163	118.3013	119.4376	121.0314	117.288

C:GCUU1.WK3

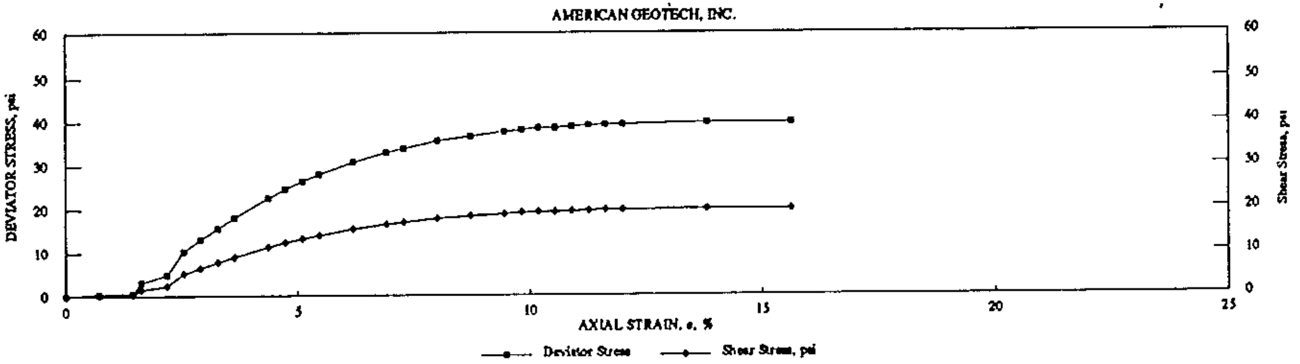
TRIAXIAL COMPRESSION (UU) TEST
AXIAL LOADING DATA
ASTM D 2850

IENT: G/C PROJECT: PENELEC KEYSTONE STATION, THERMAL DISCHARGE PROJECT
NUMBER: ST-1080 BORING NO.: B92-1 SAMPLE NO. : BAG #2 SAMPLE DEPTH: -
ST TYPE: UNCONSOLIDATED-UNDRAINED TRIAXIAL
SAMPLE HEIGHT,HI = 13.97 cm MOISTURE CONTENT, Wnl = 9.51%
SAMPLE AREA, A = 40.98 sq.cm
CONFINING PRES. = 10 PSI

ELAPSED TIME MIN.	MANOMET READING PSI	PORE PRESSURE PSI	CUMULATI CHANGE (dH) IN E-3	P LOAD DIAL READING LB	P AXIAL LOAD LB	AXIAL STRAIN e dH/H %	1 - e	DEVIATOR STRESS SIM1-SIM3 P(1-e)/A PSI	EFFECTIVE SIMA3 PSI	SIMA1 PSI	SIMA1/ SIMA3	(S1 + S3)/2 PSI	SHEAR (S1-S3)/2 PSI
11:30AM		0	0	0	0	0.00	1	0.000	10	10.00	1.00	10.00	0.00
1/8/1993		0	40	4	3.34	0.73	0.9927	0.522	10	10.52	1.05	10.26	0.26
		0	80	5	4.175	1.45	0.9855	0.648	10	10.65	1.06	10.32	0.32
		0	90	25	20.875	1.64	0.9836	3.232	10	13.23	1.32	11.62	1.62
		0	120	38	31.73	2.18	0.9782	4.885	10	14.89	1.49	12.44	2.44
		0	140	81	67.635	2.55	0.9745	10.374	10	20.37	2.04	15.19	5.19
		0	160	103	86.005	2.91	0.9709	13.143	10	23.14	2.31	16.57	6.57
		0	180	123	102.705	3.27	0.9673	15.636	10	25.64	2.56	17.82	7.82
		0	200	142	118.57	3.64	0.9636	17.984	10	27.98	2.80	18.99	8.99
		0	240	180	150.3	4.36	0.9564	22.624	10	32.62	3.26	21.31	11.31
		0	260	197	164.495	4.73	0.9527	24.667	10	34.67	3.47	22.33	12.33
		0	280	212	177.02	5.09	0.9491	26.443	10	36.44	3.64	23.22	13.22
		0	300	225	187.875	5.46	0.9455	27.957	10	37.96	3.80	23.98	13.98
		0	340	250	208.75	6.18	0.9382	30.825	10	40.82	4.08	25.41	15.41
		0	380	269	224.615	6.91	0.9309	32.910	10	42.91	4.29	26.46	16.46
		0	400	278	232.13	7.27	0.9273	33.879	10	43.88	4.39	26.94	16.94
		0	440	294	245.49	8.00	0.9200	35.548	10	45.55	4.55	27.77	17.77
		0	480	306	255.51	8.73	0.9127	36.706	10	46.71	4.67	28.35	18.35
		0	520	316	263.86	9.45	0.9055	37.603	10	47.60	4.76	28.80	18.80
		0	540	321	268.035	9.82	0.9018	38.045	10	48.05	4.80	29.02	19.02
		0	560	326	272.21	10.18	0.8982	38.482	10	48.48	4.85	29.24	19.24
		0	580	328	273.88	10.55	0.8945	38.561	10	48.56	4.86	29.28	19.28
		0	600	332	277.22	10.91	0.8909	38.873	10	48.87	4.89	29.44	19.44
		0	620	335	279.725	11.27	0.8873	39.064	10	49.06	4.91	29.53	19.53
		0	640	338	282.23	11.64	0.8836	39.252	10	49.25	4.93	29.63	19.63
		0	660	340	283.9	12.00	0.8800	39.322	10	49.32	4.93	29.66	19.66
		0	760	350	292.25	13.82	0.8618	39.642	10	49.64	4.96	29.82	19.82
		0	860	358	298.93	15.64	0.8436	39.693	10	49.69	4.97	29.85	19.85

TRIAXIAL COMPRESSION TEST (UU) REPORT

AMERICAN GEOTECH, INC.



95% Proctor Density & 9.51% Moisture
Confining Pressure = 10 psi

TEST TIME TO FAILURE__150__MIN. STRAIN RATE__.2MM/MIN.____TYPE OF FAILURE__BULGING________

TECHNICIAN GB/KC COMPUTED BY________ DATE 1/8 CHECKED BY K C DATE 1/15/93

C:OCUU2.WK3

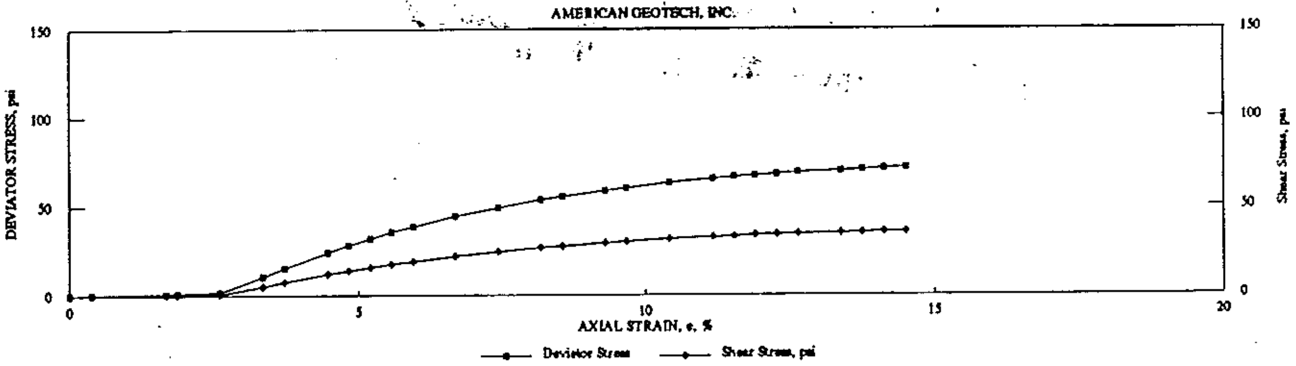
TRIAXIAL COMPRESSION (UU) TEST
AXIAL LOADING DATA
ASTM D 2850

IENT: G/C PROJECT: PENELEC KEYSTONE STATION, THERMAL DISCHARGE PROJECT
B NUMBER: ST-1080 BORING NO.: B92-1 SAMPLE NO. : #2 SAMPLE DEPTH: -
.ċST TYPE: UNCONSOLIDATED-UNDRAINED TRIAXIAL
SAMPLE HEIGHT,Hi = 13.653 cm MOISTURE CONTENT, Wnl = 9.51%
SAMPLE AREA, A = 40.98 sq.cm
CONFINING PRES. = 30 PSI

ELAPSED TIME MIN.	MANOMET READING PSI	PORE PRESSURE PSI	CUMULATI CHANGE (dH) IN E-3	P LOAD DIAL READING LB	P AXIAL LOAD LB	AXIAL STRAIN e dH/H %	1 - e	DEVIATOR STRESS SIM1-SIM3 P(1-e)/A PSI	EFFECTIVE SIMA3 PSI	SIMA1 PSI	SIMA1/ SIMA3	(S1+S3)/2 PSI	SHEAR (S1-S3)/2 PSI
8:35PM 1/8/1993		0	0	0	0	0.00	1	0.000	30	30.00	1.00	30.00	0.00
		0	20	5	4.175	0.37	0.9963	0.655	30	30.65	1.02	30.33	0.33
		0	90	8	6.68	1.67	0.9833	1.034	30	31.03	1.03	30.52	0.52
		0	100	10	8.35	1.86	0.9814	1.290	30	31.29	1.04	30.64	0.64
		0	140	15	12.525	2.60	0.9740	1.920	30	31.92	1.06	30.96	0.96
		0	180	85	70.975	3.35	0.9665	10.797	30	40.80	1.36	35.40	5.40
		0	200	122	101.87	3.72	0.9628	15.437	30	45.44	1.51	37.72	7.72
		0	240	194	161.99	4.46	0.9554	24.358	30	54.36	1.81	42.18	12.18
		0	260	228	190.38	4.84	0.9516	28.515	30	58.52	1.95	44.26	14.26
		0	280	258	215.43	5.21	0.9479	32.141	30	62.14	2.07	46.07	16.07
		0	300	287	239.645	5.58	0.9442	35.613	30	65.61	2.19	47.81	17.81
		0	320	312	260.52	5.95	0.9405	38.563	30	68.56	2.29	49.28	19.28
		0	360	363	303.105	6.70	0.9330	44.512	30	74.51	2.48	52.26	22.26
		0	400	405	338.175	7.44	0.9256	49.266	30	79.27	2.64	54.63	24.63
		0	440	443	369.905	8.19	0.9181	53.455	30	83.45	2.78	56.73	26.73
		0	460	460	384.1	8.56	0.9144	55.281	30	85.28	2.84	57.64	27.64
		0	500	493	411.655	9.30	0.9070	58.765	30	88.77	2.96	59.38	29.38
		0	520	508	424.18	9.67	0.9033	60.305	30	90.30	3.01	60.15	30.15
		0	560	535	446.725	10.42	0.8958	62.987	30	92.99	3.10	61.49	31.49
		0	600	559	466.765	11.16	0.8884	65.265	30	95.27	3.18	62.63	32.63
		0	620	571	476.785	11.53	0.8847	66.387	30	96.39	3.21	63.19	33.19
		0	640	581	485.135	11.91	0.8809	67.266	30	97.27	3.24	63.63	33.63
		0	660	590	492.65	12.28	0.8772	68.019	30	98.02	3.27	64.01	34.01
		0	680	599	500.165	12.65	0.8735	68.764	30	98.76	3.29	64.38	34.38
		0	720	612	511.02	13.39	0.8661	69.658	30	99.66	3.32	64.83	34.83
		0	740	621	518.535	13.77	0.8623	70.378	30	100.38	3.35	65.19	35.19
		0	760	629	525.215	14.14	0.8586	70.978	30	100.98	3.37	65.49	35.49
		0	780	635	530.225	14.51	0.8549	71.344	30	101.34	3.38	65.67	35.67

TRIAXIAL COMPRESSION TEST (UU) REPORT

AMERICAN GEOTECH, INC.



95% Proctor Density & 9.51% Moisture
Confining Pressure = 30 psi

TEST TIME TO FAILURE__150__MIN. STRAIN RATE__.2MM/MIN.____TYPE OF FAILURE__BULGING_______

TECHNICIAN GB/KC COMPUTED BY________ DATE 1/8 CHECKED BY KC DATE 1/13/93

C:OCUU3.WK3

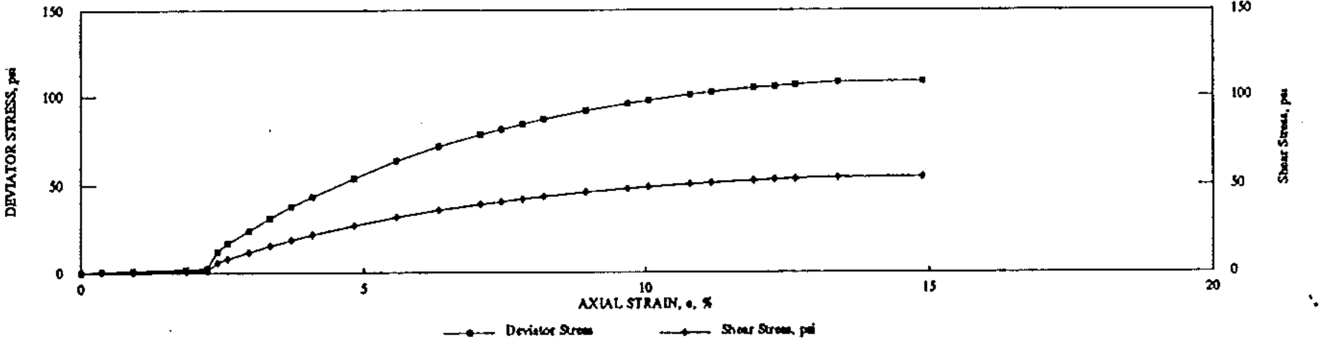
TRIAXIAL COMPRESSION (UU) TEST
AXIAL LOADING DATA
ASTM D 2850

IENT: G/C PROJECT: PENELEC KEYSTONE STATION, THERMAL DISCHARGE PROJECT
B NUMBER: ST-1080 BORING NO.: B92-1 SAMPLE NO. : #3 SAMPLE DEPTH: -
ST TYPE: UNCONSOLIDATED-UNDRAINED TRIAXIAL
SAMPLE HEIGHT,Hi = 13.653 cm MOISTURE CONTENT, Wnl = 9.51%
SAMPLE AREA, A = 40.98 sq.cm
CONFINING PRES. = 50 PSI

ELAPSED TIME MIN.	MANOMET READING PSI	PORE PRESSURE PSI	CUMULATI CHANGE (dH) IN E-3	P LOAD DIAL READING LB	P AXIAL LOAD LB	AXIAL STRAIN e dH/H %	1 - e	DEVIATOR STRESS SIM1-SIM3 P(1-e)/A PSI	EFFECTIVE SIMA3 PSI	SIMA1 PSI	SIMA1/ SIMA3	(S1 + S3)/2 PSI	SHEAR (S1-S3)/2 PSI
9:45PM		0	0	0	0	0.00	1	0.000	50	50.00	1.00	50.00	0.00
1/8/1993		0	20	8	6.68	0.37	0.9963	1.047	50	51.05	1.02	50.52	0.52
		0	50	10	8.35	0.93	0.9907	1.302	50	51.30	1.03	50.65	0.65
		0	100	16	13.36	1.86	0.9814	2.064	50	52.06	1.04	51.03	1.03
		0	120	21	17.535	2.23	0.9777	2.698	50	52.70	1.05	51.35	1.35
		0	130	95	79.325	2.42	0.9758	12.183	50	62.18	1.24	56.09	6.09
		0	140	132	110.22	2.60	0.9740	16.896	50	66.90	1.34	58.45	8.45
		0	160	189	157.815	2.98	0.9702	24.100	50	74.10	1.48	62.05	12.05
		0	180	245	204.575	3.35	0.9665	31.121	50	81.12	1.62	65.56	15.56
		0	200	298	248.83	3.72	0.9628	37.707	50	87.71	1.75	68.85	18.85
		0	220	345	288.075	4.09	0.9591	43.485	50	93.49	1.87	71.74	21.74
		0	260	428	357.38	4.84	0.9516	53.529	50	103.53	2.07	76.76	26.76
		0	300	510	425.85	5.58	0.9442	63.285	50	113.29	2.27	81.64	31.64
		0	340	579	483.465	6.33	0.9367	71.281	50	121.28	2.43	85.64	35.64
		0	380	638	532.73	7.07	0.9293	77.921	50	127.92	2.56	88.96	38.96
		0	400	666	556.11	7.44	0.9256	81.015	50	131.01	2.62	90.51	40.51
		0	420	693	578.655	7.81	0.9219	83.960	50	133.96	2.68	91.98	41.98
		0	440	718	599.53	8.19	0.9181	86.638	50	136.64	2.73	93.32	43.32
		0	480	764	637.94	8.93	0.9107	91.442	50	141.44	2.83	95.72	45.72
		0	520	804	671.34	9.67	0.9033	95.443	50	145.44	2.91	97.72	47.72
		0	540	823	687.205	10.05	0.8995	97.296	50	147.30	2.95	98.65	48.65
		0	580	858	716.43	10.79	0.8921	100.594	50	150.59	3.01	100.30	50.30
		0	600	874	729.79	11.16	0.8884	102.043	50	152.04	3.04	101.02	51.02
		0	640	903	754.005	11.91	0.8809	104.546	50	154.55	3.09	102.27	52.27
		0	660	915	764.025	12.28	0.8772	105.487	50	155.49	3.11	102.74	52.74
		0	680	927	774.045	12.65	0.8735	106.418	50	156.42	3.13	103.21	53.21
		0	720	949	792.415	13.39	0.8661	108.015	50	158.02	3.16	104.01	54.01
		0	800	970	809.95	14.88	0.8512	108.508	50	158.51	3.17	104.25	54.25

TRIAXIAL COMPRESSION TEST (UU) REPORT

AMERICAN GEOTECH, INC.

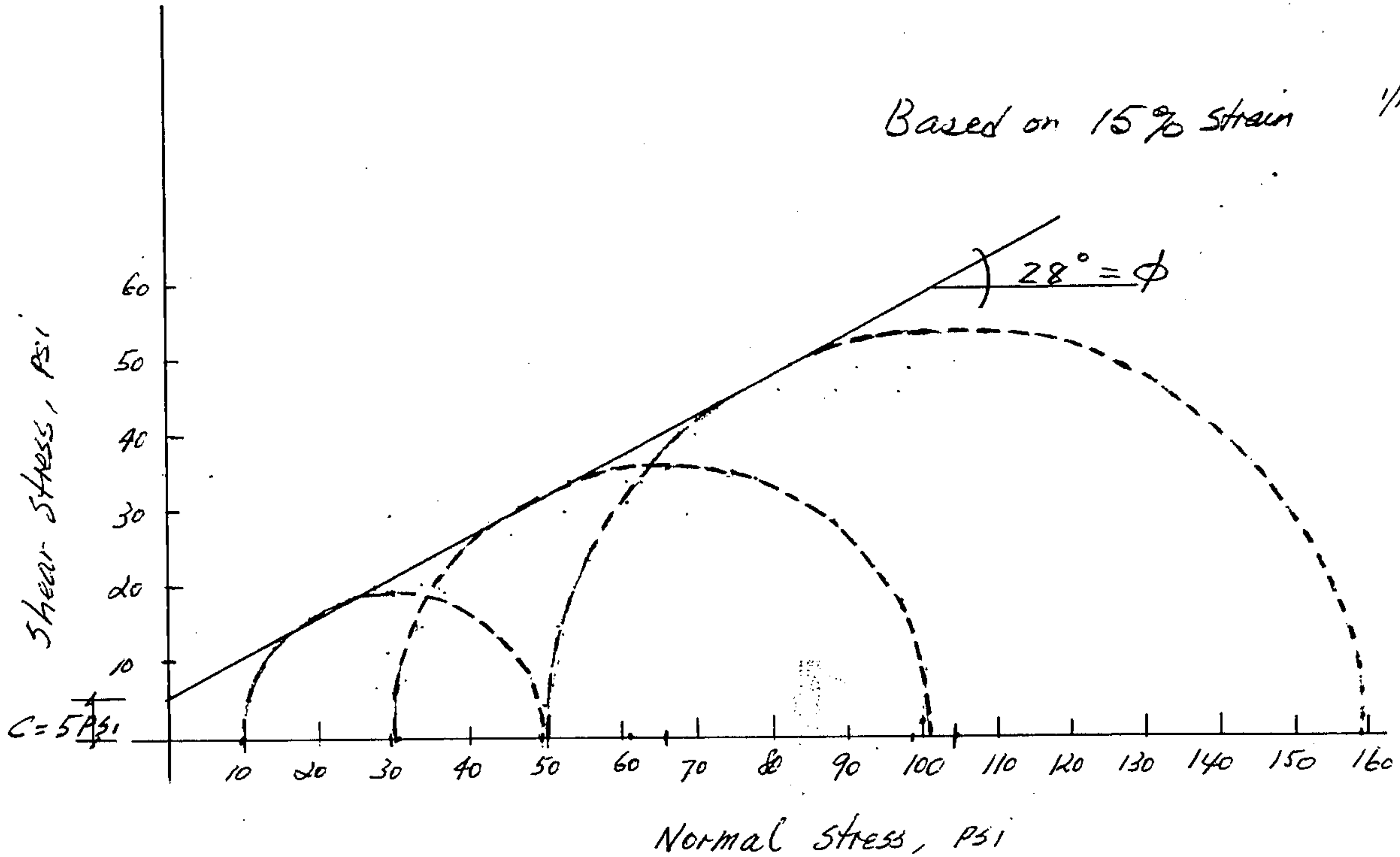


95% Proctor Density & 9.31% Moisture
Confining Pressure = 50 psi

TEST TIME TO FAILURE_150__MIN. STRAIN RATE_.2MM/MIN.____TYPE OF FAILURE_BULGING_______

TECHNICIAN GB/KC COMPUTED BY - DATE 1/8 CHECKED BY KC DATE 1/13/93

Based on 15% strain 1/11/93



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AMERICAN GEOTECH INC
1801 PENN AVE
WYOM HILLS, READING,
PA 19609, 215-670-9055

Client : G/C
PROJECT : PENELEC THERMAL DISCHARGE PROJECT
TECHNICIAN : EB
CHECK : KC
1/11/93

Bag #2, 892-1
95% Standard Proctor
9.5% = Wni

e:\QCm2.xls

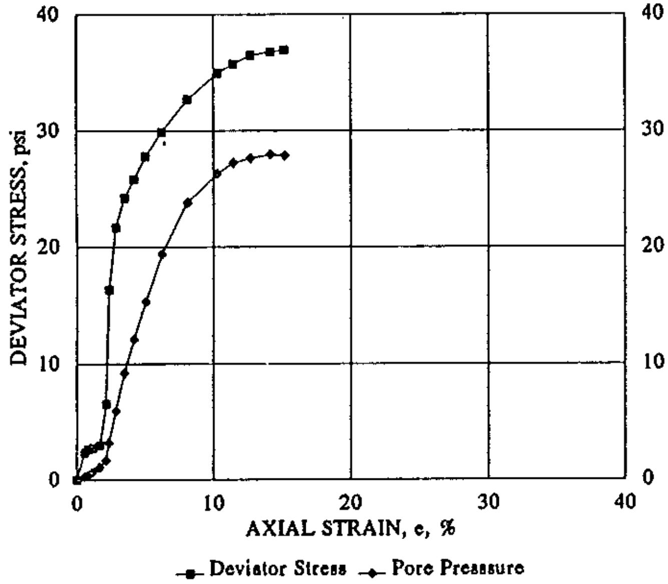
TRIAXIAL COMPRESSION (Q AND R) TEST
AXIAL LOADING DATA

LIENT: G/C PROJECT: PENELEC KEYSTONE STATION, THERMAL DISCHARGE PROJECT
)B NUMBER: ST-1080 BORING NO.: B-92-1,B92-2, B92-4 SAMPLE NO. : MIXED SAMPLE DEPTH: -
ɛST TYPE: CONSOLIDATED-UNDRAINED
SAMPLE HEIGHT,H = 15.081 cm (use Ho for Q teste and Hc for R teste)
SAMPLE AREA, A = 40.98 SQ.cm (use Ao for Q teste and Ac for R teste)
CONFINING PRES. = 40 PSI
SATURATION PRESSURE = 60 PSI

ELAPSED TIME MIN.	MANOMET READING PSI	PORE PRESSURE PSI	CUMULATI CHANGE (dH) IN E-3	P LOAD DIAL READING LB	P AXIAL LOAD LB	AXIAL STRAIN e dH/H %	1 - e	DEVIATOR STRESS SIM1-SIM3 P(1-e)/A PSI	EFFECTIVE SIMA3 PSI	SIMA1 PSI	SIMA1/ SIMA3	EFFECTIVE (S1 + S3)/2 PSI	(S1-S3)/2 PSI
5:00PM	21.00	0.00	0	0	0	0.00	1	0.000	40	40.00	1.00	40.00	0.00
1/14/93	21.27	0.27	34	18	15	0.57	0.9943	2.347	39.73	42.08	1.06	40.90	1.17
	21.41	0.41	50	20	16.66667	0.84	0.9916	2.601	39.59	42.19	1.07	40.89	1.30
	21.68	0.68	70	21	17.5	1.18	0.9882	2.722	39.32	42.04	1.07	40.68	1.36
	22.06	1.06	100	23	19.16667	1.68	0.9832	2.966	38.94	41.91	1.08	40.42	1.48
	22.69	1.69	130	51	42.5	2.19	0.9781	6.543	38.31	44.85	1.17	41.58	3.27
	24.17	3.17	140	128	106.6667	2.36	0.9764	16.393	36.83	53.22	1.45	45.03	8.20
	26.94	5.94	170	170	141.6667	2.86	0.9714	21.659	34.06	55.72	1.64	44.89	10.83
	30.23	9.23	210	191	159.1667	3.54	0.9646	24.166	30.77	54.94	1.79	42.85	12.08
	33.10	12.10	250	205	170.8333	4.21	0.9579	25.756	27.9	53.66	1.92	40.78	12.88
	36.33	15.33	300	223	185.8333	5.05	0.9495	27.771	24.67	52.44	2.13	38.56	13.89
	40.36	19.36	370	243	202.5	6.23	0.9377	29.886	20.64	50.53	2.45	35.58	14.94
	44.74	23.74	480	271	225.8333	8.08	0.9192	32.671	16.26	48.93	3.01	32.60	16.34
	47.25	26.25	610	297	247.5	10.27	0.8973	34.953	13.76	48.70	3.54	31.23	17.48
	48.22	27.22	680	308	256.6667	11.45	0.8855	35.771	12.78	48.55	3.80	30.67	17.89
	48.59	27.59	755	319	265.8333	12.72	0.8728	36.520	12.41	48.93	3.94	30.67	18.26
	48.90	27.90	840	327	272.5	14.15	0.8585	36.822	12.1	48.92	4.04	30.51	18.41
	48.80	27.80	900	332	276.6667	15.16	0.8484	36.945	12.2	49.14	4.03	30.67	18.47

TRIAXIAL COMPRESSION TEST REPORT

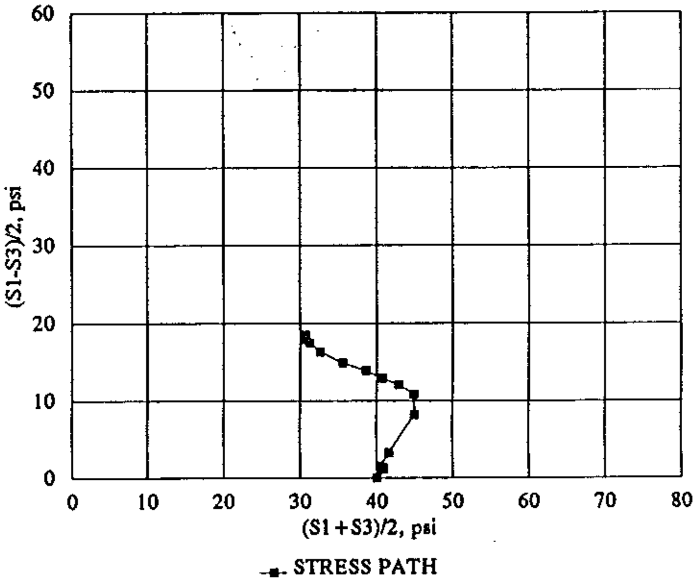
AMERICAN GEOTECH, INC.



CONFINING PRESSURE = 40 PSI

TRIAXIAL COMPRESSION TEST REPORT

STRESS PATH CURVE



CONFINING PRESSURE 40 PSI

INITIAL MOISTURE CONTENT, Wni = 18.1%
SAMPLE COMPACTED TO 95.7% STANDARD PROCTOR
SAMPLE CONSOLIDATED UNDER 40 psi FROM 1/13/93 (3:30 P.M.) TO 1/14/93 (4:35 P.M.)
FINAL MOISTURE CONTENT, Wnf =
FINAL HEIGHT = 12.4619 CM

TEST TIME TO FAILURE_120___MIN. STRAIN RATE_.2MM/MIN______TYPE OF FAILURE__BULGING_____

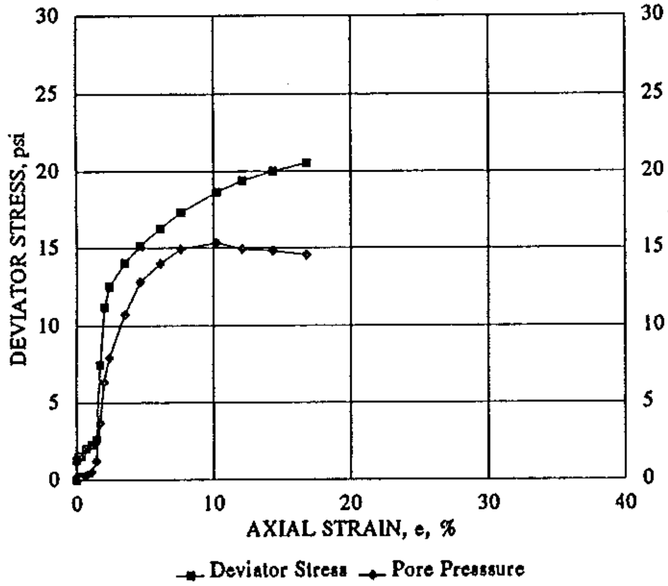
TECHNICIAN GA/K COMPUTED BY — DATE 1/11-93 CHECKED BY KC DATE 1/11/93 e10Cal.wk5

TRIAXIAL COMPRESSION (Q AND R) TEST
AXIAL LOADING DATA

LIENT: G/C PROJECT: PENELEC KEYSTONE STATION, THERMAL DISCHARGE PROJECT
B NUMBER: ST-1080 BORING NO.: B-92-1,B92-2, B92-4 SAMPLE NO. : MIXED SAMPLE DEPTH: -
EST TYPE: CONSOLIDATED-UNDRAINED
SAMPLE HEIGHT,H = 13.653 cm (use Ho for Q tests and Hc for R tests)
SAMPLE AREA, A = 40.98 SQ.cm (use Ao for Q tests and Ac for R tests)
CONFINING PRES. = 20 PSI
SATURATION PRESSURE = 60 PSI

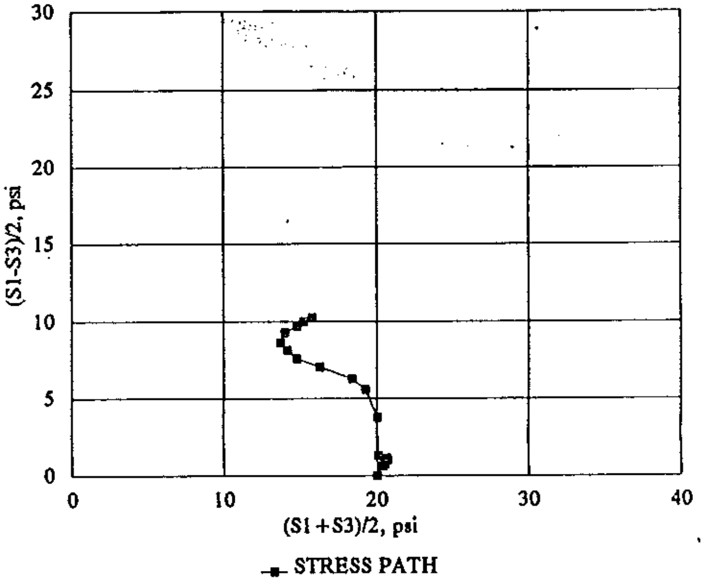
ELAPSED TIME MIN.	MANOMET READING PSI	PORE PRESSURE PSI	CUMULATI CHANGE (dH) IN E-3	P LOAD DIAL READING LB	P AXIAL LOAD LB	AXIAL STRAIN e dH/H %	1 - e	DEVIATOR STRESS SIM1-SIM3 P(1-e)/A PSI	EFFECTIVE SIMA3 PSI	SIMA1 PSI	SIMA1/ SIMA3	EFFECTIVE (S1+S3)/2 PSI	(S1-S3)/2 PSI
8:40AM	41.62	0	0	0	0	0.00	1	0.000	20	20.00	1.00	20.00	0.00
1/11/93	41.84	0.22	1	9.5	7.916667	0.02	0.9998	1.246	19.78	21.03	1.06	20.40	0.62
	41.84	0.22	10	11.5	9.583333	0.19	0.9981	1.506	19.78	21.29	1.08	20.53	0.75
	41.83	0.21	20	11.8	9.833333	0.37	0.9963	1.542	19.79	21.33	1.08	20.56	0.77
	41.91	0.29	40	15.5	12.91667	0.74	0.9926	2.018	19.71	21.73	1.10	20.72	1.01
	42.12	0.5	60	17.5	14.58333	1.12	0.9888	2.270	19.5	21.77	1.12	20.63	1.13
	42.84	1.22	80	20	16.66667	1.49	0.9851	2.584	18.78	21.36	1.14	20.07	1.29
	45.3	3.68	95	58	48.33333	1.77	0.9823	7.473	16.32	23.79	1.46	20.06	3.74
	47.97	6.35	110	87	72.5	2.05	0.9795	11.178	13.65	24.83	1.82	19.24	5.59
	49.54	7.92	130	98	81.66667	2.42	0.9758	12.543	12.08	24.62	2.04	18.35	6.27
	52.38	10.76	190	111	92.5	3.53	0.9647	14.044	9.24	23.28	2.52	16.26	7.02
	54.45	12.83	250	121	100.8333	4.65	0.9535	15.132	7.17	22.30	3.11	14.74	7.57
	55.61	13.99	330	132	110	6.14	0.9386	16.250	6.01	22.26	3.70	14.14	8.13
	56.55	14.93	410	142.5	118.75	7.63	0.9237	17.265	5.07	22.33	4.41	13.70	8.63
	56.93	15.31	550	158	131.6667	10.23	0.8977	18.603	4.69	23.29	4.97	13.99	9.30
	56.53	14.91	650	168	140	12.09	0.8791	19.371	5.09	24.46	4.81	14.78	9.69
	56.41	14.79	770	178	148.3333	14.33	0.8567	20.002	5.21	25.21	4.84	15.21	10.00
	56.15	14.53	900	188	156.6667	16.74	0.8326	20.530	5.47	26.00	4.75	15.73	10.26

TRIAXIAL COMPRESSION TEST REPORT
AMERICAN GEOTECH, INC.



CONFINING PRESSURE = 20 PSI

TRIAXIAL COMPRESSION TEST REPORT
STRESS PATH CURVE



CONFINING PRESSURE 20 PSI

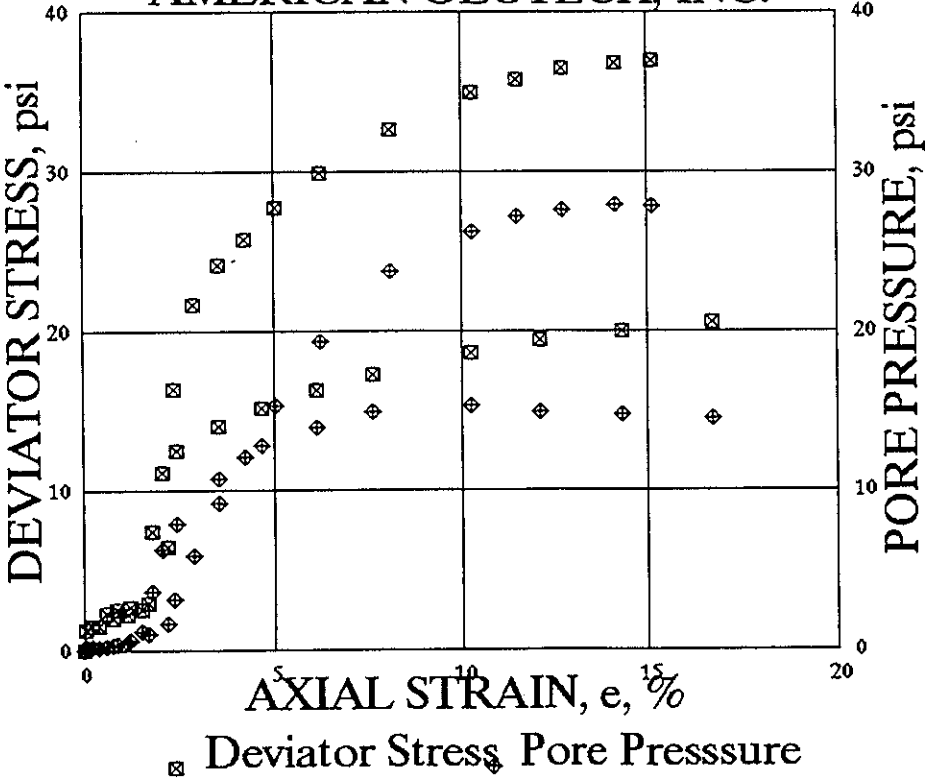
INITIAL MOISTURE CONTENT, Wnl = 18.1%
SAMPLE COMPACTED TO 95.7% STANDARD PROCTOR
SAMPLE CONSOLIDATED UNDER 20 psi FROM 1/10/93 (10:10 A.M.) TO 1/11/93 (8:25 A.M.)
FINAL MOISTURE CONTENT, Wnf =
FINAL HEIGHT = 11.1125 CM

TEST TIME TO FAILURE__150___MIN. STRAIN RATE_.2MM/MIN______TYPE OF FAILURE__BULGING_____

TECHNICIAN EA/KC COMPUTED BY - DATE 1/12-1/12 CHECKED BY KC DATE 1/15/93

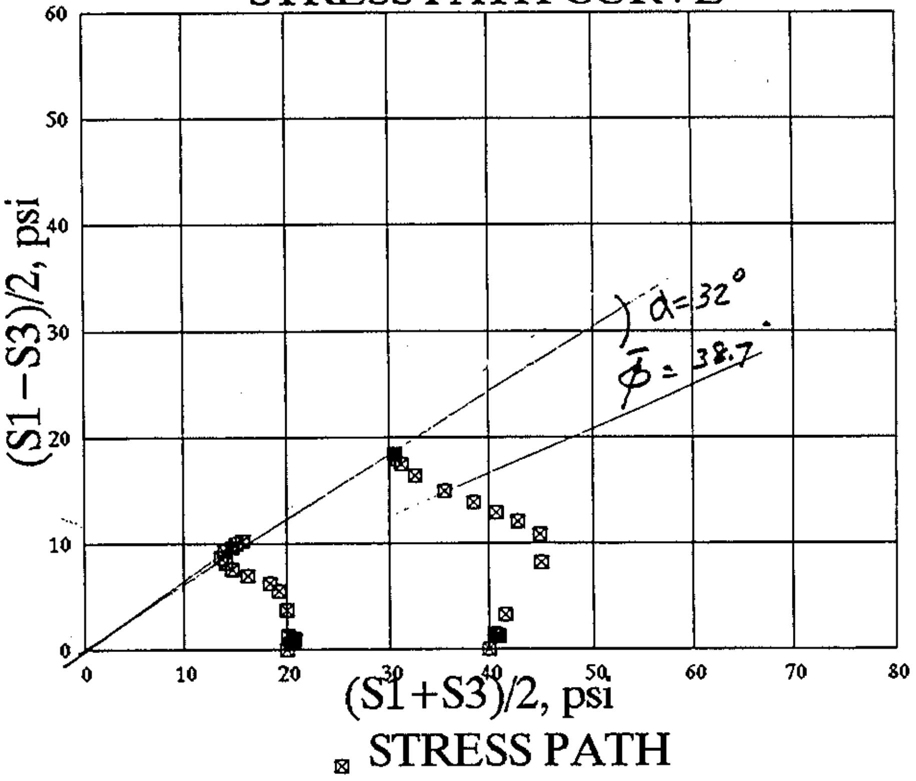
AMERICAN GEOTECH, INC.

TRIAXIAL COMPRESSION TEST REPORT
AMERICAN GEOTECH, INC.



CONFINING PRESSURE = 20 PSI & 40 PSI

TRIAXIAL COMPRESSION TEST REPOF
STRESS PATH CURVE



CONFINING PRESSURE 20 PSI & 40 PSI

APPENDIX G

DAM INSPECTION REQUIREMENTS

(b) Prior to discontinuing use or abandonment, the owner of a structure covered by this chapter, regardless of whether or not it was constructed under a permit from this Department or its predecessors, shall remove all or part of the facility and take other actions as are necessary to protect safety and the environment in accordance with a permit issued by the Department.

Source

The provisions of this § 105.47 adopted September 26, 1980, effective September 27, 1980, 10 Pa.B. 3843.

OPERATION, MAINTENANCE AND INSPECTION

§ 105.51. Operation and maintenance.

The permittee or owner of a dam, water obstruction or encroachment shall operate and maintain the facility and appurtenant structures in a safe condition in accordance with permit terms and conditions and the provisions of this chapter so that the facility cannot imperil life, health, safety or property located above or below the facility.

Source

The provisions of this § 105.51 adopted September 10, 1971, effective September 11, 1971, 1 Pa.B. 1804; amended August 11, 1978, effective August 28, 1978, 8 Pa.B. 2229; amended September 26, 1980, effective September 27, 1980, 10 Pa.B. 3843. Immediately preceding text appears at serial page (38858).

Cross References

This section cited in 25 Pa. Code § 105.131 (relating to operation and monitoring plans).

§ 105.52. Inspection.

Regardless of the date of construction of a dam, water obstruction or encroachment or whether or not it was permitted by the Department or its predecessors, it shall be the duty of the permittee or owner of a dam, water obstruction or encroachment to evaluate the safety of the facility and appurtenant structures and to modify the facility in accordance with the permit requirements of § 105.11 (relating to permit requirements) to ensure protection of life and property in accordance with changed conditions and current safety criteria.

Source

The provisions of this § 105.52 adopted September 26, 1980, effective September 27, 1980, 10 Pa.B. 3843.

Cross References

This section cited in 25 Pa. Code § 105.131 (relating to operation and monitoring plans).

§ 105.53. Inspections by owners and inspection reports.

The permittee or owner of a dam, water obstruction or encroachment shall inspect the facility and appurtenant works according to the following schedule:

(1) Dams, reservoirs and their appurtenant works shall be inspected at least once every 3 months.

(2) For Category 1 dams and Category 2 dams as classified in § 105.91 (relating to classification of dams and reservoirs), which are defined as high hazard dams in § 105.1 (relating to definitions), annual reports regarding the condition of the dam, certified by a registered professional engineer, shall be submitted to the Department on or before December 31 of each year. More frequent reports of dam conditions may be required by the Department if in its discretion conditions indicate the reports are necessary to assure adequate protection of health, safety and property.

(3) For local flood protection projects, annual reports regarding the condition of the flood protection facility shall be submitted to the Department on or before December 31 of each year.

(4) The owner of a water obstruction or encroachment shall conduc periodic inspections to ensure the safe operation, monitoring an maintenance of the facility in accordance with this title, terms an conditions of the permit and approved operating or monitoring plans

(5) The owner shall retain records of the inspections, includin records of actions taken to correct conditions found in the inspections Copies of the records shall be provided to the Department on request

(6) The Department may, through terms and conditions of th permit or by request at any time, require the owner to submit certifie reports regarding the condition of the facility to the Department.

(7) In lieu of inspections conducted by the owner and certifie reports submitted by the owner, the Department may accept reports c equivalent inspections conducted and prepared by governmental age cies. In addition, the Department may accept equivalent inspectio reports certified by the owner and submitted to other government agencies.

Authority

The provisions of this § 105.53 amended under the act of November 26, 1978 (P. L. 13 No. 325) (32 P. S. §§ 693.1-693.27); the act of June 22, 1937 (P. L. 1987, No. 394) (P. S. §§ 691.1—691.1001); section 7 of the act of June 14, 1923 (P. L. 704, No. 294) (P. S. § 597); sections 514, 1901-A, 1908-A, 1917-A and 1920-A of the act of April 9, 19 (P. L. 177, No. 175) (71 P. S. §§ 194, 510-1, 510-8, 510-17 and 510-20); and the act October 4, 1978 (P. L. 851, No. 166) (32 P. S. §§ 679.101—679.601).

Source

The provisions of this § 105.53 adopted September 26, 1980, effective September 27, 1980, 10 Pa.B. 3843; amended October 11, 1991, effective October 12, 1991, 21 Pa.B. 4911. Immediately preceding text appears at serial pages (117668) to (117669).

Cross References

This section cited in 25 Pa. Code § 105.131 (relating to operation and monitoring plans); 25 Pa. Code § 105.132 (relating to inspection); 25 Pa. Code § 105.281 (relating to maintenance and repair of levees or floodwalls); and 25 Pa. Code § 105.445 (relating to waiver of certain requirements).

§ 105.54. Monitoring systems.

The permittee or owner of a dam, water obstruction or encroachment shall set up and implement monitoring systems that are required by the Department in the terms and conditions of the permit.

Source

The provisions of this § 105.54 adopted September 26, 1980, effective September 27, 1980, 10 Pa.B. 3843.

Cross References

This section cited in 25 Pa. Code § 105.131 (relating to operation and monitoring plans).

INVESTIGATION AND CORRECTION OF UNSAFE CONDITIONS—EMERGENCY PROCEDURES

§ 105.61. Procedures for investigations.

The Department may, if it finds there is reasonable cause to suspect the existence of conditions adversely affecting the safety of a dam, water obstruction or encroachment, order the owner to conduct investigations, studies, tests and analyses that may be required to properly evaluate the safety of the structure. The investigations, studies, tests and analyses shall be accomplished under the supervision of a registered professional engineer, experienced in the design, construction, operation and maintenance of the facilities and approved by the Department, and shall be accomplished in accordance with methods the Department may prescribe. Failure to provide the investigation results to the Department on request will constitute adequate grounds for revocation or suspension of a permit.

Source

The provisions of this § 105.61 adopted September 10, 1971, effective September 11, 1971, 1 Pa.B. 1804; amended August 11, 1978, effective August 28, 1978, 8 Pa.B. 2229; amended September 26, 1980, effective September 27, 1980, 10 Pa.B. 3843. Immediately preceding text appears at serial pages (38858) to (38860) and (47990).

§ 105.62. Correction of unsafe conditions.

(a) If the Department determines that a dam, water obstruction o encroachment is unsafe or adversely affects property or the environmen or has not been properly constructed, operated, monitored or maintaine in compliance with legal requirements, it may require the owner of th facility to repair, alter, maintain or remove the facility or take othe actions necessary to carry out the purposes of this chapter within the tim prescribed by the Department.

(b) The Department or its authorized agents may enter and conduc investigations, tests and analyses and take corrective action required t carry out the purposes of this chapter if one or more of the followin conditions exist:

(1) The owner cannot be ascertained or found.

(2) The owner refuses or fails to comply with an order issued by th Department under section 14 of the act (32 P. S. § 693.14) or thi section.

(3) The condition of the facility is so dangerous as to requi immediate remedial action.

(c) The Department may recover from the owner, in the name of th Commonwealth, the expenses incurred in taking the action described i subsection (b) in the same manner as debts are recoverable by law.

Source

The provisions of this § 105.62 adopted September 10, 1971, effective September 1 1971, 1 Pa.B. 1804; reserved August 11, 1978, effective August 28, 1978, 8 Pa.B. 222 added September 26, 1980, effective September 27, 1980, 10 Pa.B. 3843. Immediat preceding text appears at serial page (4584).

§ 105.63. Emergency procedures.

(a) The permittee or owner of a dam, water obstruction or encroac ment shall immediately notify the Department and responsible authoriti in adjacent and downstream communities, including emergency manag ment authorities, of a condition which may threaten the safety of t facility and take necessary actions to protect life and property, includi action required under an emergency plan or Department order issu under the act.

(b) The permittee or owner of a dam or reservoir shall immediate notify the Department and responsible emergency management authoriti in adjacent and downstream communities of conditions which m indicate a potential dam hazard emergency including, but not limited t one or more of the following conditions:

(1) Sliding of upstream or downstream slopes or abutments contig ous to the dam.

(2) Sudd bsidence of the crest of the dam.

(3) Longitudinal or transverse cracking of the crest of the dam.

(4) Unusual release of water from the downstream face or toe of the dam.

(5) Other unusual conditions at the downstream slope of the dam.

(6) Significant landslides in the reservoir area.

(c) In case of emergency, telephone calls should be directed to the Pennsylvania Emergency Management Agency at (717) 783-8150 or the Department's emergency number at (717) 787-4343.

Authority

The provisions of this § 105.63 amended under the act of November 26, 1978 (P. L. 1375, No. 325) (32 P. S. §§ 693.1-693.27); the act of June 22, 1937 (P. L. 1987, No. 394) (35 P. S. §§ 691.1—691.1001); section 7 of the act of June 14, 1923 (P. L. 704, No. 294) (32 P. S. § 597); sections 514, 1901-A, 1908-A, 1917-A and 1920-A of the act of April 9, 1929 (P. L. 177, No. 175) (71 P. S. §§ 194, 510-1, 510-8, 510-17 and 510-20); and the act of October 4, 1978 (P. L. 851, No. 166) (32 P. S. §§ 679.101—679.601).

Source

The provisions of this § 105.63 adopted September 10, 1971, effective September 11, 1971, 1 Pa.B. 1804; reserved August 11, 1978, effective August 28, 1978, 8 Pa.B. 2229; amended September 26, 1980, effective September 27, 1980, 10 Pa.B. 3843; amended October 11, 1991, effective October 12, 1991, 21 Pa.B. 4911. Immediately preceding text appears at serial pages (117671) to (117672).

Cross References

This section cited in 25 Pa. Code § 105.135 (relating to dam hazard emergencies).

§ 105.64. Emergency permit.

The Department may issue emergency permits if it finds that immediate remedial action is necessary to alleviate an imminent threat to life, property or the environment.

(1) The emergency permit will be provided in writing, on a form developed for this purpose.

(2) The emergency permit will contain conditions as the Department determines appropriate.

(3) The Department may institute proceedings, legal or administrative, that it deems appropriate for violations of the emergency permit or conditions of the emergency permit.

(4) If the municipality in which the emergency occurs has waived notice, the emergency permit is effective immediately. If notice has not been waived by the municipality, the emergency permit is effective 30 days after notice is sent to the municipality in which the emergency occurred. The emergency permit will expire in 30 days unless extended in writing by the Department.

(*Editor's Note*: The act of August 14, 1991 (P. L. ___, No. ersedes the first two sentences of § 105.64(4).)

Authority

The provisions of this § 105.64 issued under the act of November 26, 1978 (P. L. 1375, No. 325) (32 P. S. §§ 693.1—693.27); the act of June 22, 1937 (P. L. 1987, No. 394) (35 P. S. §§ 691.1—691.1001); section 7 of the act of June 14, 1923 (P. L. 704, No. 294) (32 P. S. § 597); sections 514, 1901-A, 1908-A, 1917-A and 1920-A of the act of April 9, 1929 (P. L. 177, No. 175) (71 P. S. §§ 194, 510-1, 510-8, 510-17 and 510-20); and the act of October 4, 1978 (P. L. 851, No. 166) (32 P. S. §§ 679.101—679.601).

Source

The provisions of this § 105.64 adopted October 11, 1991, effective October 12, 1991, 21 Pa.B. 4911.

Cross References

This section cited in 25 Pa. Code § 105.21a (relating to public notice).

Subchapter B. DAMS AND RESERVOIRS

GENERAL PROVISIONS

PERMITS

CLASSIFICATION AND DESIGN CRITERIA

APPENDIX G

DAM INSPECTION REQUIREMENTS

PaDER Requirements for "Operation, Maintenance, and Inspection"

PaDER Requirements for "Investigation and Correction of Unsafe Conditions - Emergency Procedures"

Annual Inspection Check List

accordance with Chapter 102 of this title and submitted with and approved as part of his application.

(b) Construction shall be done in a manner so as to minimize erosion of banks and bed of the stream and disturbance of the regimen of the stream.

§ 105.47. Removal of structures.

(a) If all construction work has not been completed within the time specified in the permit and the time limit specified in the permit has not been extended in writing by the Department or if a permit has been revoked for any reason, the permittee shall, at his own expense and in such manner as the Department may prescribe, remove all or any portion of the work as the Department requires and restore the water course and floodplain to their former condition.

(b) Prior to discontinuing use or abandonment, the owner of any structure covered by this chapter, regardless of whether or not it was constructed under a permit from this Department or its predecessors, shall remove all or part of the facility and take other actions as are necessary to protect safety and the environment in accordance with a permit issued by the Department.

OPERATION, MAINTENANCE, AND INSPECTION

§ 105.51. Operation and maintenance.

(a) The permittee or owner of any dam, water obstruction, or encroachment shall at all times operate and maintain the facility and all appurtenant structures in a safe condition in accordance with all permit terms and conditions and the provisions of this chapter so that the facility cannot imperil life, health, safety, or property located above or below the facility.

§ 105.52. Inspection.

Regardless of the date of construction of a dam, water obstruction, or encroachment or whether or not it was permitted by the Department or its predecessors, it shall be the duty of the permittee or owner of a dam, water obstruction, or encroachment to evaluate the safety of the facility and all appurtenant structures and to modify the facility in accordance with the permit requirements of § 105.11 of this title (relating to permit requirements) to ensure protection of life and property in accordance with changed conditions and current safety criteria.

§ 105.53. Inspections by owners and inspection reports.

The permittee or owner of any dam, water obstruction, or encroachment shall inspect the facility and all appurtenant works according to the following schedule:

(1) All dams, reservoirs, and their appurtenant works shall be inspected at least once every three months.

(2) For all Category 1 or Category 2 dams – Hazard Potential Classification as defined in § 105.91 of this title (relating to classifications of dams and reservoirs) – annual reports regarding the condition of the dam, certified by a registered professional engineer, shall be submitted to the Department on or before October 1 of each year. More frequent reports of dam conditions may be required by the Department if in its discretion conditions indicate such reports are necessary to assure adequate protection of health, safety, and property.

(3) For all local flood protection projects, annual reports regarding the condition of the flood protection facility shall be submitted to the Department on or before October 1 of each year.

(4) The owner of any water obstruction or encroachment shall conduct periodic inspections to ensure the safe operation, monitoring, and maintenance of the facility in accordance with the provisions of this title, terms and conditions of the permit, and approved operating or monitoring plans.

(5) The owner shall retain records of such inspections, including records of actions taken to correct conditions found in such inspections. Copies of such records shall be provided to the Department on request.

(6) The Department may, through terms and conditions of the permit or by request at any time, require the owner to submit certified reports regarding the condition of the facility to the Department.

(7) In lieu of inspections conducted by the owner and certified reports submitted by the owner, the Department may accept reports of equivalent inspections conducted and prepared by governmental agencies. In addition, the Department may accept equivalent inspection reports certified by the owner and submitted to other governmental agencies.

§ 105.54. Monitoring systems.

The permittee or owner of any dam, water obstruction, or encroachment shall set up and implement such monitoring systems as are required by the Department in the terms and conditions of the permit.

INVESTIGATION AND CORRECTION OF UNSAFE CONDITIONS–EMERGENCY PROCEDURES

§ 105.61. Procedures for investigations.

The Department may, if it finds there is reasonable cause to suspect the existence of conditions adversely affecting the safety of a dam, water obstruction, or encroachment, order the owner to conduct such investigations, studies, tests, and analyses as may be required to properly evaluate the safety of the structure. Such investigations, studies, tests, and analyses shall be accomplished under the supervision of a registered professional engineer, experienced in the design, construction, operation, and maintenance of such facilities and approved by the Department, and shall be accomplished in accordance with such methods as the Department may prescribe. Failure to provide such investigation results to the Department on request will constitute adequate grounds for revocation or suspension of a permit.

§ 105.62. Correction of unsafe conditions.

(a) If the Department determines that any dam, water obstruction, or encroachment is unsafe or adversely affects property or the environment or has not been properly constructed, operated, monitored, or maintained in compliance with all legal requirements, it may require the owner of the facility to repair, alter, maintain, or remove the facility or take such other action as necessary to carry out the purposes of this chapter within such time as prescribed by the Department.

(b) The Department or its authorized agents may enter and conduct such investigations, tests, and analyses and take such corrective action as required to carry out the purposes of this chapter if one or more of the following conditions exist:

(1) The owner cannot be ascertained or found.

(2) The owner refuses or fails to comply with an order issued by the Department pursuant to section 14 of the act (32 P.S. §697.14) or this section.

(3) The condition of the facility is so dangerous as to require immediate remedial action.

(c) The Department may recover from the owner, in the name of the Commonwealth, the expenses incurred in taking the action described in subsection (b) of this section in the same manner as debts are recoverable by law.

§ 105.63. Emergency procedures.

(a) The permittee or owner of any dam, water obstruction, or encroachment shall immediately notify the Department and responsible authorities in adjacent and downstream communities, including emergency management authorities, of any condition which may threaten the safety of the facility and take all necessary actions to protect life and property, including any action required under an emergency plan or Department order issued pursuant to the act.

(b) The permittee or owner of any dam or reservoir shall immediately notify the Department and responsible Emergency Management authorities in adjacent and downstream communities of any conditions which may indicate a potential dam hazard emergency including, but not limited to, any of the following conditions:

(1) Sliding of upstream or downstream slopes or abutments contiguous to the dam.

(2) Sudden subsidence of the crest of the dam.

(3) Longitudinal or transverse cracking of the crest of the dam.

(4) Unusual release of water from the downstream face or toe of the dam.

(5) Any other unusual conditions at the downstream slope of the dam.

(6) Significant landslides in the reservoir area.

(c) Telephone calls to the Department pursuant to this section should be directed to the following numbers:

Norristown Region -- (215) 631-2422
For the following counties:

Berks
Bucks
Carbon
Chester
Delaware
Lehigh
Monroe
Montgomery
Northampton
Philadelphia
Pike
Schuylkill

Carnegie Region – (412) 276-1111
For the following counties:

Allegheny
Armstrong
Beaver
Butler
Cambria
Cameron
Clarion
Clearfield
Crawford
Elk
Erie
Fayette
Forest
Greene
Indiana
Jefferson
Lawrence
McKean
Mercer
Potter
Somerset
Venango
Warren
Washington
Westmoreland

Harrisburg Region – (717) 783-9726
For the following counties:

Adams
Bedford
Blair
Cumberland
Dauphin
Franklin
Fulton
Huntingdon
Juniata
Lancaster
Lebanon
Mifflin
Perry
York

Wilkes-Barre Region – (717) 826-2371
For the following counties:

Bradford
Centre
Clinton
Columbia
Lackawanna
Luzerne
Lycoming
Montour
Northumberland
Snyder
Sullivan
Susquehanna
Tioga
Union
Wayne
Wyoming

(d) In the event that no contact is made with the Regional Office, calls should be directed to the Harrisburg Central Office at (717) 787-4467 or (717) 783-1384 or to the Pennsylvania Emergency Management Agency at the following number: (717) 783-8150.

Subchapter B. DAMS AND RESERVOIRS

GENERAL PROVISIONS

§ 105.71. Scope.

Except as provided in §§ 105.3 and 105.12 of this title (relating to scope and waiver of permit regulations), provisions of this subchapter shall govern the construction, alteration, enlargement, repair, maintenance, operation, and removal of any dam or reservoir regulated under the Dam Safety and Encroachments Act.

PERMITS

§ 105.81. Permit applications for construction and modification of dams and reservoirs.

(a) In addition to the information required by § 105.13 of this title (relating to permit applications – information and fees), all permit applications pursuant to this subchapter for the construction or modification of dams and reservoirs shall give the following information:

(1) The name and address of the applicant.

(2) The location, type, size, height, and purpose of the proposed dam and reservoir and appurtenant works.

(3) For projects involving storage of fluids or semifluids other than water, information concerning the chemical content, viscosity, and other pertinent physical characteristics of the fluid or semifluid impounded.

(4) The storage capacity and reservoir surface areas for normal pool and maximum high water.

ANNUAL INSPECTION BY OWNER

This annual inspection is intended to be a follow-up of the Phase I inspection report and any other detailed studies which have been brought about by the Phase I inspection. The intent is that the owner perform a comprehensive visual inspection, accompanied by photographs, which informs the Department of conditions prevailing at the dam. A check list for this inspection is attached. This check list should be supplemented by additional sheets giving detailed descriptions, stations, elevations, dimensions, etc. where necessary. The inspection report should also give plans for correcting any deficiencies disclosed by the inspection and schedule for doing the work.

DAM INSPECTION CHECKLIST

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES

DIVISION OF DAM SAFETY

NAME OF DAM: ______________________ DER I.D. NO.: __________

LOCATION: ______________________ ______________________
township county

DER CLASSIFICATION DATA: ______________ ______________
size hazard

PHYSICAL DATA: __________ __________ __________
type of dam height of dam normal pool storage capacity

ELEVATIONS: __________ __________ __________
normal pool pool at inspection tailwater at inspection

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING

DATE OF INSPECTION: ______________

WEATHER: ______________

TEMPERATURE: ______________

This is to certify that the above dam has been inspected and the following are the results of this inspection.

____

SIGNATURE OF REGISTERED PROFESSIONAL ENGINEER

NAME OF DAM: ____________ DER I.D. NO.: ____________ INSPECTION DATE: ____________

EMBANKMENT

1 of 2

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED		
				MONITOR	INVESTI-GATE	REPAIR
CREST	1	SURFACE CRACKING				
	2	SINKHOLE, ANIMAL BURROW				
	3	LOW AREA(S)				
	4	HORIZONTAL ALIGNMENT				
	5	RUTS AND/OR PUDDLES				
	6	VEGETATION CONDITION				
	7					
	8					
UPSTREAM SLOPE	9	SLIDE, SLOUGH, SCARP				
	10	SLOPE PROTECTION				
	11	SINKHOLE, ANIMAL BURROW				
	12	EMB.-ABUT. CONTACT				
	13	EROSION				
	14	VEGETATION CONDITION				
	15					
	16					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

NAME OF DAM: ______________________ DER I.D. NO.: ______________ INSPECTION DATE: __________

EMBANKMENT

2 of 2

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED		
				MONITOR	INVESTI-GATE	REPAIR
DOWNSTREAM SLOPE	17	WET AREA(S) (NO FLOW)				
	18	SEEPAGE				
	19	SLIDE, SLOUGH, SCARP				
	20	EMB.-ABUT. CONTACT				
	21	SINKHOLE, ANIMAL BURROW				
	22	EROSION				
	23	UNUSUAL MOVEMENT				
	24	VEGETATION CONTROL				
	25					
	26					
INSTRUMENTATION	27	PIEZOMETERS/OBSERV. WELLS				
	28	STAFF GUAGE AND RECORDER				
	29	WEIRS				
	30	SURVEY MONUMENTS				
	31	DRAINS				
	32	FREQUENCY OF READINGS				
	33	LOCATION OF RECORDS				
	34					
	35					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

NAME OF DAM: ____________ DER I.D. NO.: ____________ INSPECTION DATE: ____________

DOWNSTREAM AREA AND MISC.

1 of 1

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED		
				MONITOR	INVESTI-GATE	REPAIR
DOWNSTREAM AREA	36	ABUTMENT LEAKAGE				
	37	FOUNDATION SEEPAGE				
	38	SLIDE, SLOUGH, SCARP				
	39	DRAINAGE SYSTEM				
	40					
	41					
	42	DOWNSTREAM HAZARD DESCRIPTION				
	43	DATE OF LAST UPDATE OF EMERGENCY PLAN				
MISCELLANEOUS	44	RESERVOIR SLOPES				
	45	ACCESS ROADS				
	46	SECURITY DEVICES				
	47					
	48					
	49					
	50					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

NAME OF DAM: ______ DER I.D. NO.: ______ INSPECTION DATE: ______

SPILLWAYS

1 of 1

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED MONITOR	INVESTI-GATE	REPAIR
ERODIBLE CHANNEL	51	SLIDE, SLOUGH, SCARP				
	52	EROSION				
	53	VEGETATION CONDITION				
	54	DEBRIS				
	55					
	56					
NON-ERODIBLE CHANNEL	57	SIDEWALLS				
	58	CHANNEL FLOOR				
	59	UNUSUAL MOVEMENT				
	60	APPROACH AREA				
	61	WEIR OR CONTROL				
	62	DISCHARGE AREA				
	63					
	64					
DROP INLET	65	INTAKE STRUCTURE				
	66	TRASHRACK				
	67	STILLING BASIN				
	68					
	69					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

NAME OF DAM: ______________ DER I.D. NO.: ______________ INSPECTION DATE: ______________

OUTLET WORKS

1 of 1

AREA INSPECTED	ITEM NO	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED		
				MONITOR	INVESTI-GATE	REPAIR
OUTLET WORKS	70	INTAKE STRUCTURE				
	71	TRASHRACK				
	72	STILLING BASIN				
	73	PRIMARY CLOSURE				
	74	SECONDARY CLOSURE				
	75	CONTROL MECHANISM				
	76	OUTLET PIPE				
	77	OUTLET TOWER				
	78	EROSION ALONG DAM TOE				
	79	SEEPAGE				
	80	UNUSUAL MOVEMENT				
	81					
	82					
	83					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE

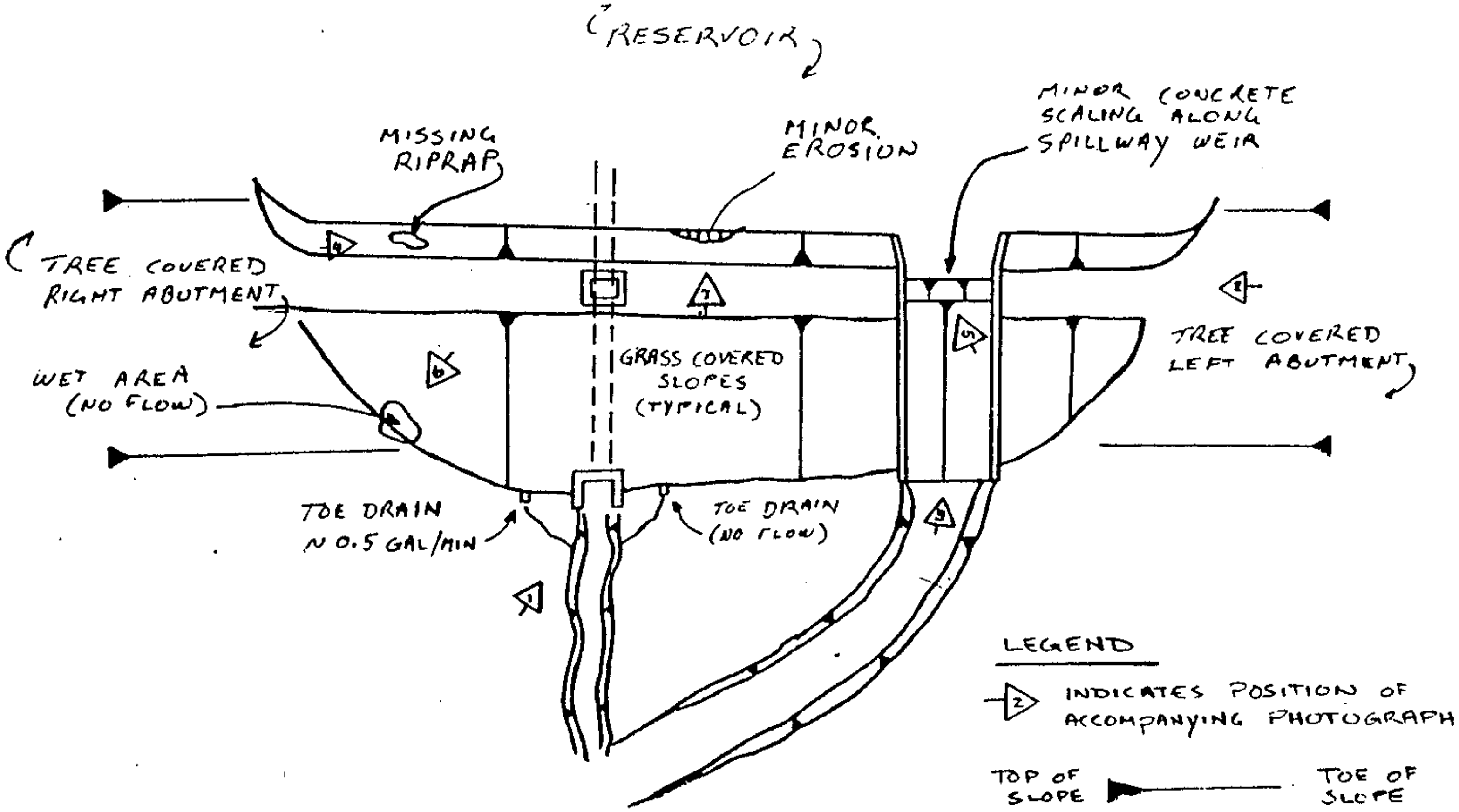
NAME OF DAM: DER I.D. NO.: INSPECTION DATE:

CONCRETE/MASONRY DAMS

1 of 1

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED		
				MONITOR	INVESTI-GATE	REPAIR
UPSTREAM FACE	84	SURFACE CONDITIONS				
	85	CONDITION OF JOINTS				
	86	UNUSUAL MOVEMENT				
	87	ABUTMENT-DAM CONTACTS				
	38					
	89					
DOWNSTREAM FACE	90	SURFACE CONDITIONS				
	91	CONDITION OF JOINTS				
	92	UNUSUAL MOVEMENT				
	93	ABUTMENT-DAM CONTACTS				
	94	DRAINS				
	95	LEAKAGE				
	96					
	97					
CREST	98	SURFACE CONDITIONS				
	99	HORIZONTAL ALIGNMENT				
	100	VERTICAL ALIGNMENT				
	101	CONDITION OF JOINTS				
	102	UNUSUAL MOVEMENTS				
	103					
	104					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE



TYPICAL FIELD SKETCH

APPENDIX A

Document 2

Part D – Pond/Impoundment Systems and Other Wastewater Treatment Operations

OMB Control Number: 2040-0281
Approval Expires: 05/31/2013

Plant ID: 03831
Plant Name: Keystone

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Steam Electric Questionnaire

PART D - POND/IMPOUNDMENT SYSTEMS AND OTHER WASTEWATER TREATMENT OPERATIONS

Table of Contents

Plant ID: 03831
Plant Name: Keystone

Part: D
Section Title: 1. Plant Pond/Impoundment Systems and Wastewater Treatment Systems

CBI?
☐ Yes

D1-1. Have you used, do you use, OR do you plan to use (or begin construction/installation of) by December 31, 2020 any *ponds/impoundments* for the storage, treatment, and/or disposal of *process wastewater*, *residues*, or by-products (or *sludges* or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to *fly ash*, *bottom ash*, boiler slag, or flue gas emission control residues?

Note: This includes ponds/impoundments located on non-adjoining property that are under the operational control of the plant.

● Yes
○ No

CBI?
☐ Yes

D1-2. Do you operate OR plan to operate (or begin construction/installation of) by December 31, 2020 any wastewater treatment systems, other than pond/impoundment systems, for the treatment of process wastewaters from ash handling or FGD operations?

Note: This includes systems located on non-adjoining property that are under the operational control of the plant.

● Yes
○ No

STOP! **If you answered "No" to both Questions D1-1 and D1-2, do NOT complete the remainder of Part D. Skip to the next Questionnaire Part. Otherwise, continue to Part D Section 2.**

Plant ID: 03831
Plant Name: Keystone

Part: D
Section Title: 2. Pond/Impoundment System and Wastewater Treatment System Identification

Instructions: Complete Section 2 (Questions D2-1 through D2-7) for *pond/impoundment systems* and/or *wastewater treatment systems* that the plant operates and/or plans to operate (or begin construction/installation of) by December 31, 2020, including those located on non-adjoining property, for the treatment of *process wastewaters* from ash handling or FGD operations. Please provide all free response answers in the highlighted yellow areas.

CBI? ☐ Yes

D2-1. Has the plant been involved with any ash or FGD wastewater treatment studies (pilot- or full-scale), including studies on pond/impoundment systems, since 2000?

○ Yes (Continue)
● No (Skip to Question D2-4)

CBI? ☐ Yes

D2-2. Are any of these studies ongoing?

○ Yes
○ No

CBI? ☐ Yes

D2-3. Was a summary and/or report describing/documenting the pilot- or full-scale study prepared (including internal and published reports)?

○ Yes (Provide a copy of the summary/report)
○ No (Continue)

Provide a description of the pilot- or full-scale study. Note the types of treatment technologies studied and the analytes measured in influent to and/or effluents from the wastewater treatment system.

CBI?
☐ Yes

D2-4. List any ash or FGD wastewater treatment technologies that have been studied by the plant that are not covered by Questions D2-1 through D2-3 (e.g., those that have been studied in bench-scale studies).

None

CBI?
☐ Yes

D2-5. Do you operate OR plan to operate (or begin construction/installation of) by December 31, 2020 any systems, including those located on non-adjoining property, for the treatment of process wastewaters from ash handling or FGD operations?

● Yes (Continue)
○ No (Skip to Section 4.1)

CBI?
☐ Yes

D2-6. Do you operate OR plan to operate (or begin construction/installation of) by December 31, 2020 any pond/impoundment systems, including those located on non-adjoining property, for the treatment of process wastewaters from ash handling or FGD operations?

● Yes (Continue)
○ No (Skip to Question D2-7)

List these pond/impoundment systems in Table D-1. For each pond/impoundment system, EPA assigned a number (e.g., POND-1, POND-2) in Table D-1, which will be used throughout the remainder of the survey. In the "Plant Designation" column, provide the plant's name for each pond/impoundment system. In the "Individual Ponds/Impoundments Included in the Pond System" column, identify all pond/impoundment units from Table A-4 that are included in the pond system.

NOTE: Do NOT include a pond/impoundment unit in Table D-1 if the pond/impoundment unit is or is planned to be part of a broader wastewater treatment system containing *non-pond wastewater treatment units* (e.g., pond/impoundment unit in a biological wastewater treatment system).

Table D-1. Plant Pond/Impoundment Systems

Pond/ Impoundment System ID	Year Initially Brought Online	Plant Designation	Individual Pond/Impoundments (Identified in Table A-4) Included in the Pond/Impoundment System
Active/Inactive/Open Pond/Impoundment Systems			
POND-1	1994	Bottom Ash Pond System	☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☑ SPD - 7 ☑ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☑ SPD - 8 ☑ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-2			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-3			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-4			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-5			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-6			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-7			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-8			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-9			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14
POND-10			☐ SPD - 1 ☐ SPD - 3 ☐ SPD - 5 ☐ SPD - 7 ☐ SPD - 9 ☐ SPD - 11 ☐ SPD - 13 ☐ SPD - 2 ☐ SPD - 4 ☐ SPD - 6 ☐ SPD - 8 ☐ SPD - 10 ☐ SPD - 12 ☐ SPD - 14

Retired/Closed Pond/Impoundment Systems			
RET-POND-1		Bottom Ash Cooling Pond B	☑ RET SPD - 1 ☐ RET SPD - 3 ☐ RET SPD - 2 ☐ RET SPD - 4
RET-POND-2			☐ RET SPD - 1 ☐ RET SPD - 3 ☐ RET SPD - 2 ☐ RET SPD - 4
RET-POND-3			☐ RET SPD - 1 ☐ RET SPD - 3 ☐ RET SPD - 2 ☐ RET SPD - 4
RET-POND-4			☐ RET SPD - 1 ☐ RET SPD - 3 ☐ RET SPD - 2 ☐ RET SPD - 4
RET-POND-5			☐ RET SPD - 1 ☐ RET SPD - 3 ☐ RET SPD - 2 ☐ RET SPD - 4
Planned Pond/Impoundment Systems			
POND-A			☐ SPD - A ☐ SPD - C ☐ SPD - E ☐ SPD - B ☐ SPD - D
POND-B			☐ SPD - A ☐ SPD - C ☐ SPD - E ☐ SPD - B ☐ SPD - D
POND-C			☐ SPD - A ☐ SPD - C ☐ SPD - E ☐ SPD - B ☐ SPD - D

CBI?
☐ Yes

D2-7. Do you operate OR plan to operate (or begin construction/installation of) by December 31, 2020 any wastewater treatment systems, including those located on non-adjoining property, other than pond/impoundment systems for the treatment of *process wastewaters* from ash handling or FGD operations?

● Yes (Continue)
○ No (Skip to Section 3.1)

List these wastewater treatment systems in Table D-2. For each wastewater treatment system, EPA assigned a number (e.g., WWT-1, WWT-2) in Table D-2, which will be used throughout the remainder of the survey. In the "Plant Designation" column, provide the plant's name for each wastewater treatment system. As an example, if a plant operates a *chemical precipitation* FGD wastewater treatment system that discharges to an ash pond/impoundment system (as shown in EPA example diagrams EPA_D-1 and EPA_D-2 located at the bottom of Part D Section 3.1) the FGD wastewater treatment system should be identified in Table D-2 (e.g., as WWT-1) and the ash pond/impoundment system should have been previously identified in Table D-1 (e.g., as POND-1).

Note that "Approximate Length of Piping from FGD Scrubber System" refers to the length of piping from the *FGD solids separation* overflow storage tank (or *FGD scrubber absorber* if no FGD solids separation) to the beginning of the FGD wastewater treatment system. "Approximate Length of Piping to Subsequent Treatment or Discharge" refers to the length of piping from the end of the FGD wastewater treatment system to either the beginning of the subsequent treatment system or the wastewater discharge point,
as appropriate.

Plant ID: 03831
Plant Name: Keystone
Pond/Impoundment System ID or Wastewater Treatment System ID: POND-1

Part: D
Section Title: 3.1. Wastewater Treatment Diagram

Instructions: Complete Section 3.1 (Question D3-1) for each *pond/impoundment system* or *wastewater treatment system* identified in Table D-1 and Table D-2, including planned systems, systems under construction/installation, or planned to be under construction/installation by December 31, 2020. Enter the pond/impoundment system ID or wastewater treatment system ID in the yellow highlighted space provided above (use the pond/impoundment system ID or wastewater treatment system ID assigned in Table D-1 and Table D-2).

Make a copy of Section 3.1 for each pond/impoundment system or wastewater treatment system identified in Table D-1 and Table D-2 using the "Copy Section 3.1" button below.

Copy Section 3.1

CBI?
☑ Yes

D3-1. Attach a block diagram that shows the pond/impoundment system or wastewater treatment system operations, the process wastewaters that currently enter or are planned to enter the pond/impoundment system or wastewater treatment system, and the ultimate destinations of the pond/impoundment system or wastewater treatment system effluent(s). Specific instructions for the diagram are provided in the checklist below. The diagram should have a similar level of detail as EPA's example diagrams, EPA_D-1 and EPA_D-2.

NOTE: You may use an existing diagram, such as a water balance diagram included in the plant's NPDES Form 2C, and mark the additional required information on the diagram by hand.

Provide as many diagrams as necessary to convey the information requested in the checklist below. Number each block diagram in the upper right corner; the first block diagram should be numbered D-1, the second D-2, etc. Include the plant name, plant ID, and pond/impoundment system ID or wastewater treatment system ID in the upper right hand corner of the diagram.

☑ Diagram attached.

Block Diagram Checklist

Mark the boxes below to verify that you have completed each checklist item...

☑ Include the block diagram number, plant name, plant ID, and pond/impoundment system ID or wastewater treatment system ID on the diagram.

☑ Include each pond/impoundment or wastewater treatment unit operation. Show all influent and effluent streams from the units and label all influent and effluent streams from the pond/impoundment system or wastewater treatment system using the code tables on the "Code Tables" tab provided at the end of this workbook. Note that the "Code Tables" tab provides codes for wastewater treatment units that are operated in series and/or in parallel (e.g., in EPA_D-1, Chemical Precipitation Reaction Tank 1-1 and Chemical Precipitation Reaction Tank 2-1 are in series). Effluent streams may include *process wastewater* and *sludges*.

☑ If applicable, use EPA-assigned numbers from Part A or B (e.g., FGD-1) to label *process operations*. If a process operation does not have an EPA-assigned number (e.g., boiler, air preheater), use the plant-designated name for the process operation. When sources or destinations are not shown on the diagram (i.e., the stream is entering from a location not shown on the diagram), describe the source or destination and add the block diagram number, when appropriate, where the stream's previous location can be seen. Use codes from the code tables on the "Code Tables" tab provided at the end of this workbook.

☑ Indicate where chemical addition occurs (i.e., into or between which wastewater treatment units). For pond/impoundment wastewater treatment units, indicate and note on the diagram where within or near the pond/impoundment the chemical is added (e.g., within the pond/impoundment near the process wastewater influent point, within the pond/impoundment near the effluent, in the effluent/discharge canal). The chemicals indicated should correspond to the chemicals listed in Table D-7 and Table D-13.

☑ Identify the final, general destination of the *treated* process wastewater and waste streams (e.g., treated process wastewater effluent to *POTW* or surface waters; solid wastes to on- or off-site destinations). Use codes from code tables on the "Code Tables" tab provided at the end of this workbook, when applicable.

☑ Indicate, as appropriate, where treated process wastewater is *reused* or *recycled* within the plant (e.g., reuse of settling pond/impoundment water as fly ash sluice).

☑ Include the average annual (2009) flow rates for influent and effluent streams from the wastewater treatment system on the diagram (in gpm or gpd). For planned pond/impoundment systems and wastewater treatment systems, provide the design flow rates for the system. Note that these should be the same flow rates that are entered into Tables D-3 and D-4 in Questions D3-2 and D3-3. If the actual number of days of operation for 2009 is not known, the total annual flow may be divided by 365 days and a comment added to the Comments page. If the process wastewater stream is intermittent, provide amount and frequency; for example "100 gal, twice/day, 100 dpy" or "1000 gpm, 4 hpd, 365 dpy". For sludges, provide amount in tpd.

☑ Include *NPDES permit* outfall numbers, if applicable.

Plant ID: 03831
Plant Name: Keystone
Pond/Impoundment System ID or Wastewater Treatment System ID: POND-1

Part: D
Section Title: 3.2. Wastewater Treatment Wastewater Flows

Instructions: Complete Section 3.2 (Question D3-2 and D3-3) for each *pond/impoundment system* or *wastewater treatment system* identified in Table D-1 and Table D-2, including planned systems, systems under construction/installation, or planned to be under construction/installation by December 31, 2020. Enter the pond/impoundment system ID or wastewater treatment system ID in the yellow highlighted space provided above (use the pond/impoundment system ID or wastewater treatment system ID assigned in Table D-1 and Table D-2).

Make a copy of Section 3.2 for each pond/impoundment system or wastewater treatment system identified in Table D-1 and Table D-2 using the "Copy Section 3.2" button below.

Copy Section 3.2

CBI?
☑ Yes

D3-2. Complete a row in Table D-3 for each *process wastewater* stream or *treated* wastewater stream that enters this pond/impoundment system or wastewater treatment system. For planned pond/impoundment systems and wastewater treatment systems, provide the design flow rates for the system. Use the process and treated wastewater terms provided in the drop down menus. Note that these terms originated from code tables on the "Code Tables" tab provided at the end of this workbook.

Note: The examples in Tables D-3 and D-4 are derived from the EPA examples diagrams, EPA_D-1 and EPA_D-2, provided at the bottom of Part D Section 3.1.

Table D-3. Pond/Impoundment System or Wastewater Treatment System Influent Flows in 2009

Process or Treated Wastewater	Average Annual (2009) Wastewater Flow Rate	Wastewater Treatment Unit ID
Example (from EPA_D-1):		
FGD scrubber purge ▼	**200** gpm **10** hpd **365** dpy	Equalization, Primary ▼
Other:	OR gpd dpy	Other:
Example (from EPA_D-2):		
WWT-1 Effluent ▼	**175** gpm **24** hpd **365** dpy	Pond Unit - 1 ▼
Other:	OR gpd dpy	Other:
Bottom ash sluice ▼	3166 gpm 24 hpd 365 dpy	Pond Unit - 1 ▼
Other:	OR gpd dpy	Other:
Select ▼	gpm hpd dpy	Select ▼
Other:	OR gpd dpy	Other:
Select ▼	gpm hpd dpy	Select ▼
Other:	OR gpd dpy	Other:
Select ▼	gpm hpd dpy	Select ▼
Other:	OR gpd dpy	Other:
Select ▼	gpm hpd dpy	Select ▼
Other:	OR gpd dpy	Other:
Select ▼	gpm hpd dpy	Select ▼
Other:	OR gpd dpy	Other:
Select ▼	gpm hpd dpy	Select ▼
Other:	OR gpd dpy	Other:
Select ▼	gpm hpd dpy	Select ▼
Other:	OR gpd dpy	Other:

CBI?
☐ Yes

D3-3. Complete a row in Table D-4 for each treated wastewater stream or *sludge* stream that exits this pond/impoundment system or wastewater treatment system (i.e., streams that are *discharged*, *recycled*, or disposed). For planned pond/impoundment systems and wastewater treatment systems, provide the design flow rates for the system. Use the treated wastewater, wastewater treatment unit, and destination terms provided in the drop down menus. Note that these terms originated from code tables on the "Code Tables" tab provided at the end of this workbook.

*Provide the *NPDES permit* outfall number of the effluent in the last column of the table, if applicable.

Table D-4. Pond/Impoundment System or Wastewater Treatment System Effluent Flows in 2009

Treated Wastewater	Average Annual (2009) Wastewater Flow Rate	Solids and Sludge			Final Destination		
		Amount (tpd or gpm)		% Moisture	Wastewater Treatment Unit ID	Destination	NPDES Permit Outfall Number*
Example (from EPA_D-1):							
Effluent - 1	175 gpm 24 hpd 365 dpy	NA	○ tpd ○ gpm	NA	NA	POND-1	NA
Other:	OR NA gpd NA dpy				Other:	Other:	
Example (from EPA_D-1):							
Filter backwash	NA gpm NA hpd NA dpy	NA	○ tpd ○ gpm	NA	Equalization, Secondary	NA	NA
Other:	OR 10,000 gpd 365 dpy				Other:	Other:	
Example (from EPA_D-2):							
Sludge	NA gpm NA hpd NA dpy	500	● tpd ○ gpm	30	NA	Hauled off site for reuse (removal fee)	NA
Other:	OR NA gpd NA dpy				Other:	Other:	
Example (from EPA_D-2):							
Effluent - 2	5,000 gpm 24 hpd 365 dpy	NA	○ tpd ○ gpm	NA	NA	Reuse as fly ash sluice	NA
Other:	OR NA gpd NA dpy				Other:	Other:	
Example (from EPA_D-2):							
Effluent - 3	1,175 gpm 24 hpd 365 dpy	NA	○ tpd ○ gpm	NA	NA	Discharge to surface water	001
Other:	OR gpd dpy				Other:	Other:	
Effluent - 1	3166 gpm 24 hpd 365 dpy	0	● tpd ○ gpm		Select	Discharge to surface water	503
Other:	OR gpd dpy				Other:	Other:	
Sludge	gpm hpd dpy	9.3	● tpd ○ gpm	52.80%	Select	On-site company owned landfill	
Other:	OR gpd dpy				Other:	Other:	
Select	gpm hpd dpy		○ tpd ● gpm		Select	Select	
Other:	OR gpd dpy				Other:	Other:	
Select	gpm hpd dpy		○ tpd ● gpm		Select	Select	
Other:	OR gpd dpy				Other:	Other:	
Select	gpm hpd dpy		○ tpd ○ gpm		Select	Select	
Other:	OR gpd dpy				Other:	Other:	
Select	gpm hpd dpy		○ tpd ○ gpm		Select	Select	
Other:	OR gpd dpy				Other:	Other:	
Select	gpm hpd dpy		○ tpd ○ gpm		Select	Select	
Other:	OR gpd dpy				Other:	Other:	
Select	gpm hpd dpy		○ tpd ○ gpm		Select	Select	
Other:	OR gpd dpy				Other:	Other:	
Select	gpm hpd dpy		○ tpd ○ gpm		Select	Select	
Other:	OR gpd dpy				Other:	Other:	

Plant ID: 03831
Plant Name: Keystone
Pond/Impoundment Unit ID: SPD-7

Part: D
Section Title: 4.1. Active/Inactive/Open and Planned Pond/Impoundment Unit Information

Instructions: Complete Section 4.1 (Questions D4-1 through D4-12) for each active/inactive/open *pond/impoundment* unit used OR planned to be used (or constructed/installed), including those located on non-adjoining property, by December 31, 2020 for the storage, treatment, and/or disposal of process wastewater, *residues*, or by-products (or *sludges* or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues. Use the pond/impoundment unit IDs assigned in Table A-4.

Make a copy of Section 4.1 for each active/inactive/open and planned pond/impoundment units used (or planned to be used) for the storage, treatment, and/or disposal of process wastewater, residues, or by-products (or sludges or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues using the "Copy Section 4.1" button below.

NOTE: If a pond/impoundment unit is part of a broader wastewater treatment system containing non-pond wastewater treatment units (e.g., a pond/impoundment unit in a biological wastewater treatment system), complete questions in this section for the pond/impoundment unit.

CBI? ☐ Yes

D4-1. Do you use OR plan to use (or begin construction/installation of) by December 31, 2020, any active/inactive/open ponds/impoundments, including those located on non-adjoining property, for the storage, treatment, and/or disposal of process wastewater, residues, or by-products (or sludges or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues?

● Yes (Continue)
○ No (Skip to Section 4.2)

Copy Section 4.1

CBI? ☐ Yes

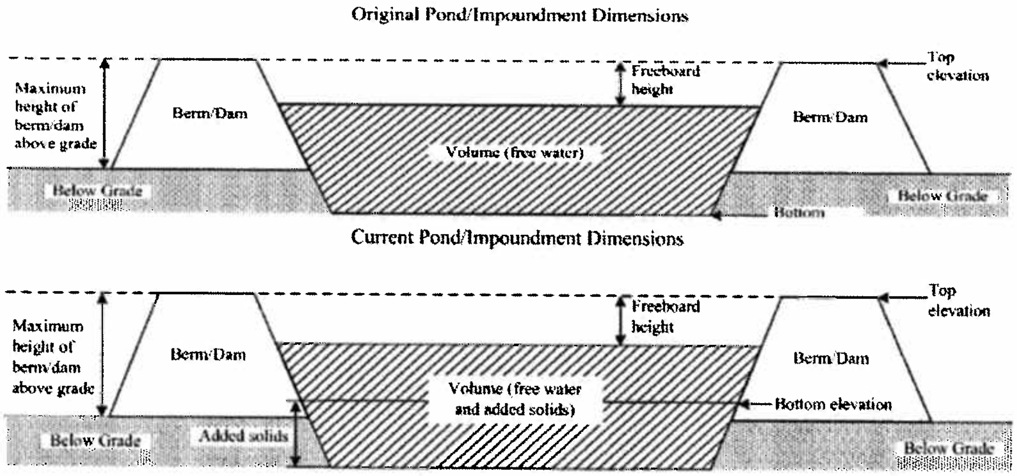
D4-2. Provide the residence time of the process wastewater in the pond/impoundment unit, the life of the pond/impoundment unit (based on the current estimation), and the number of cells in the pond/impoundment unit.

21.4 Residence time, hours (as currently operated)
48 Life of pond/impoundment unit, years (based on current estimation)
1 Number of cells in pond/impoundment unit

CBI? ☐ Yes

D4-3. Complete Table D-5. Provide the pond/impoundment unit's volume, surface area, bottom and top elevation, freeboard height, maximum height of berms and dams above the surrounding grade, and the total quantity of solids placed in the pond/impoundment when it was originally built or planned/designed, at its current status, and at its expected end of life. Additionally, provide the expected year of closure/retirement in the "Expected End of Life" column. Volume should reflect the free water volume, including the stored solids. For planned pond/impoundment units, enter "NA" in **all** fields in the "Current" column. Figure D-1 presents an illustration of pond/impoundment dimensions.

Note: Respondents are not required to take new measurements to provide this data; however, best available information should be used to complete Table D-5.


Original Pond/Impoundment Dimensions

Current Pond/Impoundment Dimensions

Figure D-1. Pond/Impoundment Dimensions

Table D-5. Active/Inactive/Open and Planned Pond/Impoundment Information

	Originally Built or Planned/Designed	Current	Expected End of Life
Volume, ft^3	187,166	167,166	2035
Surface area, ft^2	31,980	31,980	2035
Bottom elevation, ft	1014	1014	2035
Top elevation, ft	1020.5	1020.5	2035
Freeboard height, ft	2	2	2035
Maximum height of berms/dams above grade, ft	10.5	10.5	2035
Total solids placed in the pond/impoundment, tons		455	2035
Expected year of closure/retirement			2035

CBI?
☐ Yes

D4-4. Does the pond/impoundment unit have a *liner*?

● Yes (Complete Table D-6)
○ No (Skip to Question D4-5)
○ NA (Pond/Impoundment is planned to be constructed. Information is currently unavailable. Skip to Question D4-10).

Table D-6. Pond/Impoundment Unit Liner

Liner Layer Number (number from inner to outer layer)	Type of Liner	Thickness of Liner Layer (cm)	Permeability of Liner Layer (cm/sec)
1	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)	107	1.00E-07
	Compacted Clay		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		

CBI?
☐ Yes

D4-5. Has the pond/impoundment unit ever been dredged?

● Yes (Provide following information)

2010 Year of last dredging
3 Frequency of dredging that year, dpy
735 Amount of material removed that year, tons
5 Number of times dredged in the last five years
15 Number of days dredged in the last five years
9095 Amount of material removed in the last five years, tons

○ No (Skip to Question D4-7)
○ NA (Pond/Impoundment is planned to be constructed. Skip to Question D4-10)

CBI?
☐ Yes

D4-6. Indicate where the dredged solids are transferred or are planned to be transferred.

○ Dredged solids used in embankment construction.
● Dredged solids transferred to landfill.
○ Dredged solids marketed/sold for reuse.
○ Other (Explain): ____________________

CBI?
☐ Yes

D4-7. Has the pond/impoundment unit been expanded since the date it was built?

○ Yes (Continue)
● No (Skip to Question D4-10)
○ NA (Pond/Impoundment is planned to be constructed. Skip to Question D4-10)

CBI?
☐ Yes

D4-8. Identify the type of expansion.

○ Lateral expansion
○ Vertical expansion
○ Both lateral and vertical expansion

CBI?
☐ Yes

D4-9. Describe any expansion(s), since January 1, 2000, to the pond/impoundment unit, including the starting and ending dimensions.

____

Provide the total cost associated with the expansion(s). Total costs should include labor, materials, energy, hazardous and nonhazardous waste disposal, purchased equipment, installation, buildings, site preparation, land, engineering costs, construction expenses, and any other costs available.

$ ____________________ Total cost of expansion

CBI?
☐ Yes

D4-10. Indicate the *pollutants* targeted for removal by this pond/impoundment unit using techniques other than solely settling (e.g., adding chemicals to remove certain metals). [Check all boxes that apply.]

☐ Metals (specify): ____________________
☑ TSS
☐ Nitrogen compounds (ammonia, nitrate, nitrite)
☐ Organic Acids
☐ Chlorine or other oxidizing agents
☐ Oil and grease
☐ Other: ____________________
☐ NA (Skip to Question D4-12)

CBI?
☐ Yes

D4-11. Of the pollutants listed in D4-10, which effluent limitation(s) drives/will drive the operation of this pond/impoundment unit? Provide the pollutant and the limitation (mg/L or ug/L).

Pollutant: TSS
Limitation: 30 mg/L ▼
Pollutant: ________
Limitation: ________ Select ▼
Pollutant: ________
Limitation: ________ Select ▼

CBI?
☐ Yes

D4-12. Did the plant add chemicals to this pond/impoundment unit in 2009?

○ Yes (Complete Table D-7)
● No (Skip to Section 4.2)
○ NA (Pond/impoundment is planned to be constructed. Provide information in Table D-7 to the extent possible based on plans.)

Note that "Chemical Type" refers to the generic name of the chemical added to the pond/impoundment (e.g., lime, sodium hydroxide, alum, polymer). "Average Dose Concentration" refers to the average concentration of the chemical within the pond/impoundment unit just after it is added to the unit. In the "Location of Chemical Addition" column, indicate where within or near the pond/impoundment the chemical is added (e.g., within the pond/impoundment near the process wastewater influent point, within the pond/impoundment near the effluent, in the effluent/discharge canal). If chemical addition is known only on a yearly basis, divide the yearly value by the approximate number of days the plant added chemicals (which should be the same estimate for the "Frequency of Addition" column).

Table D-7. Chemicals Used in Pond/Impoundment Unit Operations

Chemical Type	Trade Name	Manufacturer	Purpose	Location of Chemical Addition	Average Dose Concentration (g/L)	Average Addition Rate (gpd or lb/day)			Frequency of Addition (dpy)
none							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	

Plant ID: 03831
Plant Name: Keystone
Pond/Impoundment Unit ID: SPD-8

Part: D
Section Title: 4.1. Active/Inactive/Open and Planned Pond/Impoundment Unit Information

Instructions: Complete Section 4.1 (Questions D4-1 through D4-12) for each active/inactive/open *pond/impoundment* unit used OR planned to be used (or constructed/installed), including those located on non-adjoining property, by December 31, 2020 for the storage, treatment, and/or disposal of process wastewater, *residues*, or by-products (or *sludges* or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues. Use the pond/impoundment unit IDs assigned in Table A-4.

Make a copy of Section 4.1 for each active/inactive/open and planned pond/impoundment units used (or planned to be used) for the storage, treatment, and/or disposal of process wastewater, residues, or by-products (or sludges or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues using the "Copy Section 4.1" button below.

NOTE: If a pond/impoundment unit is part of a broader wastewater treatment system containing non-pond wastewater treatment units (e.g., a pond/impoundment unit in a biological wastewater treatment system), complete questions in this section for the pond/impoundment unit.

CBI?
☐ Yes

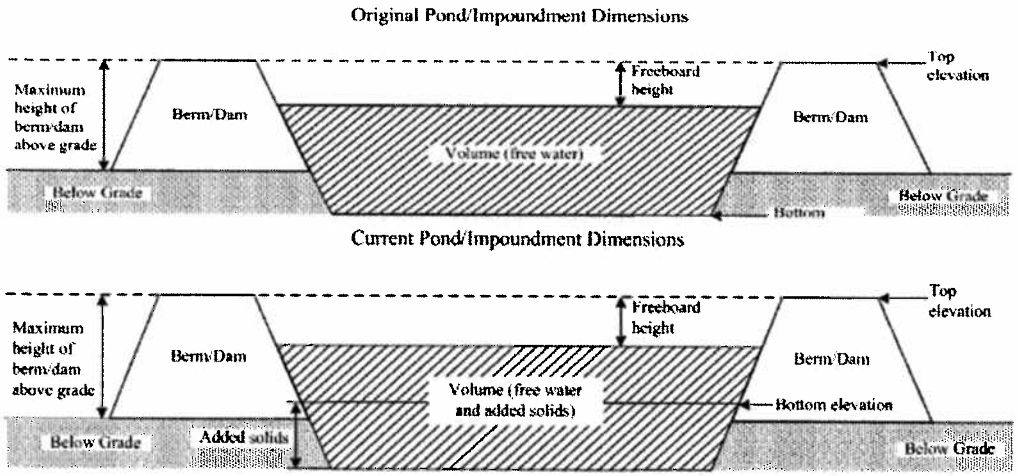
D4-2. Provide the residence time of the process wastewater in the pond/impoundment unit, the life of the pond/impoundment unit (based on the current estimation), and the number of cells in the pond/impoundment unit.

21.4 Residence time, hours (as currently operated)
48 Life of pond/impoundment unit, years (based on current estimation)
1 Number of cells in pond/impoundment unit

CBI?
☐ Yes

D4-3. Complete Table D-5. Provide the pond/impoundment unit's volume, surface area, bottom and top elevation, freeboard height, maximum height of berms and dams above the surrounding grade, and the total quantity of solids placed in the pond/impoundment when it was originally built or planned/designed, at its current status, and at its expected end of life. Additionally, provide the expected year of closure/retirement in the "Expected End of Life" column. Volume should reflect the free water volume, including the stored solids. For planned pond/impoundment units, enter "NA" in all fields in the "Current" column. Figure D-1 presents an illustration of pond/impoundment dimensions.

Note: Respondents are not required to take new measurements to provide this data; however, best available information should be used to complete Table D-5.


Original Pond/Impoundment Dimensions

Current Pond/Impoundment Dimensions

Figure D-1. Pond/Impoundment Dimensions

Table D-5. Active/Inactive/Open and Planned Pond/Impoundment Information

	Originally Built or Planned/Designed	Current	Expected End of Life
Volume, ft^3	187,166	187,166	2035
Surface area, ft^2	31,980	31,980	2035
Bottom elevation, ft	1014	1014	2035
Top elevation, ft	1020.5	1020.5	2035
Freeboard height, ft	2	2	2035
Maximum height of berms/dams above grade, ft	10.5	10.5	2035
Total solids placed in the pond/impoundment, tons		339	2035
Expected year of closure/retirement			2035

CBI?
☐ Yes

D4-4. Does the pond/impoundment unit have a *liner*?

● Yes (Complete Table D-6)
○ No (Skip to Question D4-5)
○ NA (Pond/Impoundment is planned to be constructed. Information is currently unavailable. Skip to Question D4-10).

Table D-6. Pond/Impoundment Unit Liner

Liner Layer Number (number from inner to outer layer)	Type of Liner	Thickness of Liner Layer (cm)	Permeability of Liner Layer (cm/sec)
1	● Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)	107	1.00E-07
	Compacted Clay		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		

CBI?
☐ Yes

D4-5. Has the pond/impoundment unit ever been dredged?

● Yes (Provide following information)

2010 Year of last dredging
3 Frequency of dredging that year, dpy
1155 Amount of material removed that year, tons
5 Number of times dredged in the last five years
15 Number of days dredged in the last five years
10170 Amount of material removed in the last five years, tons

○ No (Skip to Question D4-7)
○ NA (Pond/Impoundment is planned to be constructed. Skip to Question D4-10)

CBI?
☐ Yes

D4-6. Indicate where the dredged solids are transferred or are planned to be transferred.

○ Dredged solids used in embankment construction.
● Dredged solids transferred to landfill.
○ Dredged solids marketed/sold for reuse.
○ Other (Explain): ______________

CBI?
☐ Yes

D4-7. Has the pond/impoundment unit been expanded since the date it was built?

○ Yes (Continue)
● No (Skip to Question D4-10)
○ NA (Pond/Impoundment is planned to be constructed. Skip to Question D4-10)

CBI?
☐ Yes

D4-8. Identify the type of expansion.

○ Lateral expansion
○ Vertical expansion
○ Both lateral and vertical expansion

CBI?
☐ Yes

D4-9. Describe any expansion(s), since January 1, 2000, to the pond/impoundment unit, including the starting and ending dimensions.

____

Provide the total cost associated with the expansion(s). Total costs should include labor, materials, energy, hazardous and nonhazardous waste disposal, purchased equipment, installation, buildings, site preparation, land, engineering costs, construction expenses, and any other costs available.

$ ______________ Total cost of expansion

CBI?
☐ Yes

D4-10. Indicate the *pollutants* targeted for removal by this pond/impoundment unit using techniques other than solely settling (e.g., adding chemicals to remove certain metals). [Check all boxes that apply.]

☐ Metals (specify): ______________
☑ TSS
☐ Nitrogen compounds (ammonia, nitrate, nitrite)
☐ Organic Acids
☐ Chlorine or other oxidizing agents
☐ Oil and grease
☐ Other: ______________
☐ NA (Skip to Question D4-12)

CBI?
☐ Yes

D4-11. Of the pollutants listed in D4-10, which effluent limitation(s) drives/will drive the operation of this pond/impoundment unit? Provide the pollutant and the limitation (mg/L or ug/L).

Pollutant: TSS
Limitation: 30 mg/L
Pollutant:
Limitation: Select
Pollutant:
Limitation: Select

CBI?
☐ Yes

D4-12. Did the plant add chemicals to this pond/impoundment unit in 2009?

○ Yes (Complete Table D-7)
● No (Skip to Section 4.2)
○ NA (Pond/impoundment is planned to be constructed. Provide information in Table D-7 to the extent possible based on plans.)

Note that "Chemical Type" refers to the generic name of the chemical added to the pond/impoundment (e.g., lime, sodium hydroxide, alum, polymer). "Average Dose Concentration" refers to the average concentration of the chemical within the pond/impoundment unit just after it is added to the unit. In the "Location of Chemical Addition" column, indicate where within or near the pond/impoundment the chemical is added (e.g., within the pond/impoundment near the process wastewater influent point, within the pond/impoundment near the effluent, in the effluent/discharge canal). If chemical addition is known only on a yearly basis, divide the yearly value by the approximate number of days the plant added chemicals (which should be the same estimate for the "Frequency of Addition" column).

Table D-7. Chemicals Used in Pond/Impoundment Unit Operations

Chemical Type	Trade Name	Manufacturer	Purpose	Location of Chemical Addition	Average Dose Concentration (g/L)	Average Addition Rate (gpd or lb/day)			Frequency of Addition (dpy)
none							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	

Plant ID: 03831
Plant Name: Keystone
Pond/Impoundment Unit ID: SPD-9

Part: D
Section Title: 4.1. Active/Inactive/Open and Planned Pond/Impoundment Unit Information

Instructions: Complete Section 4.1 (Questions D4-1 through D4-12) for each active/inactive/open *pond/impoundment* unit used OR planned to be used (or constructed/installed), including those located on non-adjoining property, by December 31, 2020 for the storage, treatment, and/or disposal of process wastewater, *residues*, or by-products (or *sludges* or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues. Use the pond/impoundment unit IDs assigned in Table A-4.

Make a copy of Section 4.1 for each active/inactive/open and planned pond/impoundment units used (or planned to be used) for the storage, treatment, and/or disposal of process wastewater, residues, or by-products (or sludges or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues using the "Copy Section 4.1" button below.

NOTE: If a pond/impoundment unit is part of a broader wastewater treatment system containing non-pond wastewater treatment units (e.g., a pond/impoundment unit in a biological wastewater treatment system), complete questions in this section for the pond/impoundment unit.

CBI?
☐ Yes

D4-2. Provide the residence time of the process wastewater in the pond/impoundment unit, the life of the pond/impoundment unit (based on the current estimation), and the number of cells in the pond/impoundment unit.

21.4 Residence time, hours (as currently operated)

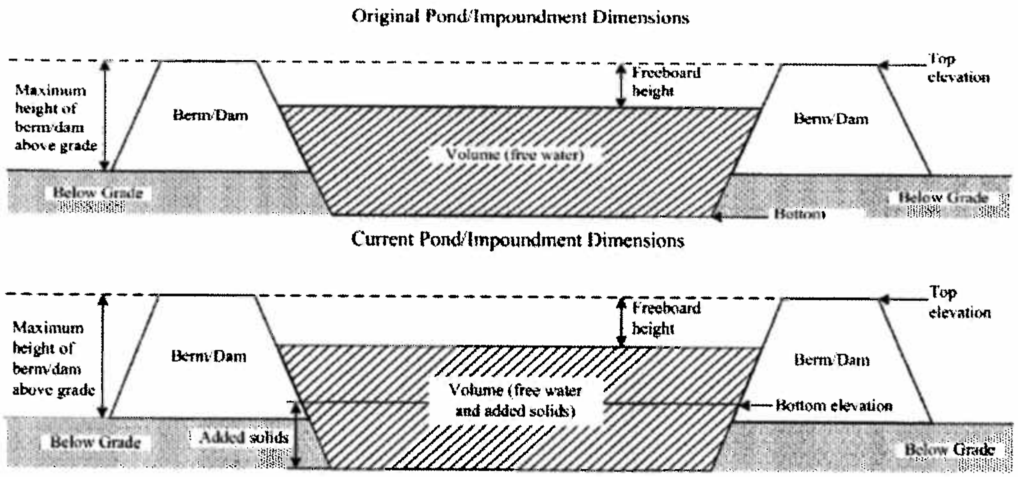
48 Life of pond/impoundment unit, years (based on current estimation)

1 Number of cells in pond/impoundment unit

CBI?
☐ Yes

D4-3. Complete Table D-5. Provide the pond/impoundment unit's volume, surface area, bottom and top elevation, freeboard height, maximum height of berms and dams above the surrounding grade, and the total quantity of solids placed in the pond/impoundment when it was originally built or planned/designed, at its current status, and at its expected end of life. Additionally, provide the expected year of closure/retirement in the "Expected End of Life" column. Volume should reflect the free water volume, including the stored solids. For planned pond/impoundment units, enter "NA" in all fields in the "Current" column. Figure D-1 presents an illustration of pond/impoundment dimensions.

Note: Respondents are not required to take new measurements to provide this data; however, best available information should be used to complete Table D-5.



Original Pond/Impoundment Dimensions

Current Pond/Impoundment Dimensions

Figure D-1. Pond/Impoundment Dimensions

Table D-5. Active/Inactive/Open and Planned Pond/Impoundment Information

	Originally Built or Planned/Designed	Current	Expected End of Life
Volume, ft^3	187,166	187,166	2035
Surface area, ft^2	31,980	31,980	2035
Bottom elevation, ft	1014	1014	2035
Top elevation, ft	1020.5	1020.5	2035
Freeboard height, ft	2	2	2035
Maximum height of berms/dams above grade, ft	10.5	10.5	2035
Total solids placed in the pond/impoundment, tons		618	2035
Expected year of closure/retirement			2035

CBI?
☐ Yes

D4-4. Does the pond/impoundment unit have a *liner*?

● Yes (Complete Table D-6)
○ No (Skip to Question D4-5)
○ NA (Pond/Impoundment is planned to be constructed. Information is currently unavailable. Skip to Question D4-10).

Table D-6. Pond/Impoundment Unit Liner

Liner Layer Number (number from inner to outer layer)	Type of Liner	Thickness of Liner Layer (cm)	Permeability of Liner Layer (cm/sec)
1	● Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)	107	1.00E-07
	Compacted Clay		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		

CBI?
☐ Yes

D4-5. Has the pond/impoundment unit ever been dredged?

● Yes (Provide following information)

2010 Year of last dredging
3 Frequency of dredging that year, dpy
840 Amount of material removed that year, tons
5 Number of times dredged in the last five years
15 Number of days dredged in the last five years
9095 Amount of material removed in the last five years, tons

○ No (Skip to Question D4-7)
○ NA (Pond/Impoundment is planned to be constructed. Skip to Question D4-10)

CBI?
☐ Yes

D4-6. Indicate where the dredged solids are transferred or are planned to be transferred.

○ Dredged solids used in embankment construction.
● Dredged solids transferred to landfill.
○ Dredged solids marketed/sold for reuse.
○ Other (Explain): ______________________

CBI?
☐ Yes

D4-7. Has the pond/impoundment unit been expanded since the date it was built?

○ Yes (Continue)
● No (Skip to Question D4-10)
○ NA (Pond/Impoundment is planned to be constructed. Skip to Question D4-10)

CBI?
☐ Yes

D4-8. Identify the type of expansion.

○ Lateral expansion
○ Vertical expansion
○ Both lateral and vertical expansion

CBI?
☐ Yes

D4-9. Describe any expansion(s), since January 1, 2000, to the pond/impoundment unit, including the starting and ending dimensions.

____

Provide the total cost associated with the expansion(s). Total costs should include labor, materials, energy, hazardous and nonhazardous waste disposal, purchased equipment, installation, buildings, site preparation, land, engineering costs, construction expenses, and any other costs available.

$ ______________________ Total cost of expansion

CBI?
☐ Yes

D4-10. Indicate the *pollutants* targeted for removal by this pond/impoundment unit using techniques other than solely settling (e.g., adding chemicals to remove certain metals). [Check all boxes that apply.]

☐ Metals (specify): ______________________
☑ TSS
☐ Nitrogen compounds (ammonia, nitrate, nitrite)
☐ Organic Acids
☐ Chlorine or other oxidizing agents
☐ Oil and grease
☐ Other: ______________________
☐ NA (Skip to Question D4-12)

CBI?
☐ Yes

D4-11. Of the pollutants listed in D4-10, which effluent limitation(s) drives/will drive the operation of this pond/impoundment unit? Provide the pollutant and the limitation (mg/L or ug/L).

Pollutant: TSS
Limitation: 30 mg/L
Pollutant:
Limitation: Select
Pollutant:
Limitation: Select

CBI?
☐ Yes

D4-12. Did the plant add chemicals to this pond/impoundment unit in 2009?

- ○ Yes (Complete Table D-7)
- ● No (Skip to Section 4.2)
- ○ NA (Pond/impoundment is planned to be constructed. Provide information in Table D-7 to the extent possible based on plans.)

Note that "Chemical Type" refers to the generic name of the chemical added to the pond/impoundment (e.g., lime, sodium hydroxide, alum, polymer). "Average Dose Concentration" refers to the average concentration of the chemical within the pond/impoundment unit just after it is added to the unit. In the "Location of Chemical Addition" column, indicate where within or near the pond/impoundment the chemical is added (e.g., within the pond/impoundment near the process wastewater influent point, within the pond/impoundment near the effluent, in the effluent/discharge canal). If chemical addition is known only on a yearly basis, divide the yearly value by the approximate number of days the plant added chemicals (which should be the same estimate for the "Frequency of Addition" column).

Table D-7. Chemicals Used in Pond/Impoundment Unit Operations

Chemical Type	Trade Name	Manufacturer	Purpose	Location of Chemical Addition	Average Dose Concentration (g/L)	Average Addition Rate (gpd or lb/day)			Frequency of Addition (dpy)
none							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	

Plant ID: 03831
Plant Name: Keystone
Pond/Impoundment Unit ID: SPD-10

Part: D
Section Title: 4.1. Active/Inactive/Open and Planned Pond/Impoundment Unit Information

Instructions: Complete Section 4.1 (Questions D4-1 through D4-12) for each active/inactive/open *pond/impoundment* unit used OR planned to be used (or constructed/installed), including those located on non-adjoining property, by December 31, 2020 for the storage, treatment, and/or disposal of process wastewater, *residues*, or by-products (or *sludges* or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues. Use the pond/impoundment unit IDs assigned in Table A-4.

Make a copy of Section 4.1 for each active/inactive/open and planned pond/impoundment units used (or planned to be used) for the storage, treatment, and/or disposal of process wastewater, residues, or by-products (or sludges or water streams containing the residues or by-products) from the combustion of coal, petroleum coke, or oil, including but not limited to fly ash, bottom ash, boiler slag, or flue gas emission control residues using the "Copy Section 4.1" button below.

NOTE: If a pond/impoundment unit is part of a broader wastewater treatment system containing non-pond wastewater treatment units (e.g., a pond/impoundment unit in a biological wastewater treatment system), complete questions in this section for the pond/impoundment unit.

CBI?
☐ Yes

D4-2. Provide the residence time of the process wastewater in the pond/impoundment unit, the life of the pond/impoundment unit (based on the current estimation), and the number of cells in the pond/impoundment unit.

213.9 Residence time, hours (as currently operated)
41 Life of pond/impoundment unit, years (based on current estimation)
1 Number of cells in pond/impoundment unit

CBI?
☐ Yes

D4-3. Complete Table D-5. Provide the pond/impoundment unit's volume, surface area, bottom and top elevation, freeboard height, maximum height of berms and dams above the surrounding grade, and the total quantity of solids placed in the pond/impoundment when it was originally built or planned/designed, at its current status, and at its expected end of life. Additionally, provide the expected year of closure/retirement in the "Expected End of Life" column. Volume should reflect the free water volume, including the stored solids. For planned pond/impoundment units, enter "NA" in all fields in the "Current" column. Figure D-1 presents an illustration of pond/impoundment dimensions.

Note: Respondents are not required to take new measurements to provide this data; however, best available information should be used to complete Table D-5.

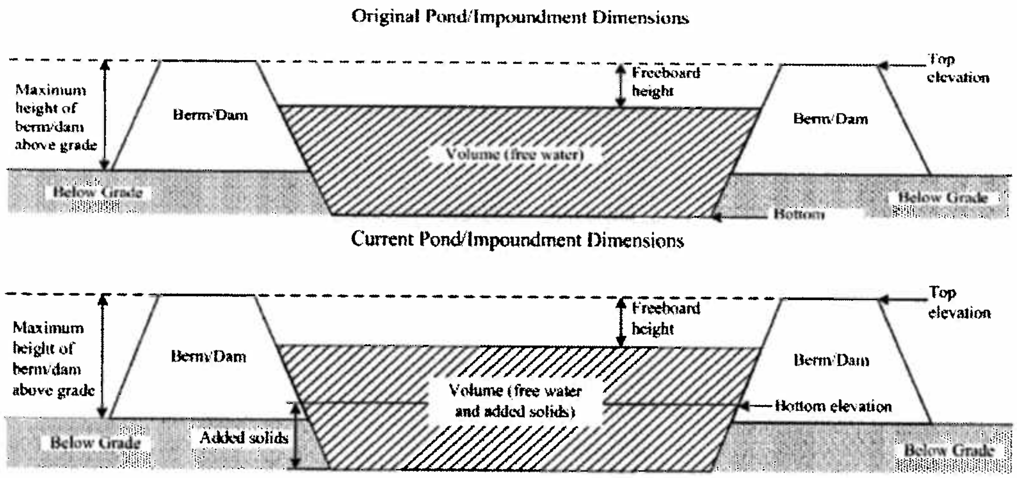


Figure D-1. Pond/Impoundment Dimensions

Table D-5. Active/Inactive/Open and Planned Pond/Impoundment Information

	Originally Built or Planned/Designed	Current	Expected End of Life
Volume, ft^3	5,600,000	5,600,000	2035
Surface area, ft^2	310,000	310,000	2035
Bottom elevation, ft	983	983.5	2035
Top elevation, ft	1020.5	1020.5	2035
Freeboard height, ft	3.5	3.5	2035
Maximum height of berms/dams above grade, ft	44.5	44.5	2035
Total solids placed in the pond/impoundment, tons		916	2035
Expected year of closure/retirement			2035

CBI?
☐ Yes

D4-4. Does the pond/impoundment unit have a *liner*?

● Yes (Complete Table D-6)
○ No (Skip to Question D4-5)
○ NA (Pond/Impoundment is planned to be constructed. Information is currently unavailable. Skip to Question D4-10).

Table D-6. Pond/Impoundment Unit Liner

Liner Layer Number (number from inner to outer layer)	Type of Liner	Thickness of Liner Layer (cm)	Permeability of Liner Layer (cm/sec)
1	○ Compacted clay ○ Geosynthetic clay ● High density polyethylene (HDPE) ○ Other (provide below:)	0.1968	0.00E+00
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		
	○ Compacted clay ○ Geosynthetic clay ○ High density polyethylene (HDPE) ○ Other (provide below:)		

CBI?
☐ Yes

D4-5. Has the pond/impoundment unit ever been dredged?

○ Yes (Provide following information)
__________ Year of last dredging
__________ Frequency of dredging that year, dpy
__________ Amount of material removed that year, tons
__________ Number of times dredged in the last five years
__________ Number of days dredged in the last five years
__________ Amount of material removed in the last five years, tons
● No (Skip to Question D4-7)
○ NA (Pond/Impoundment is planned to be constructed. Skip to Question D4-10)

CBI?
☐ Yes

D4-6. Indicate where the dredged solids are transferred or are planned to be transferred.

- ○ Dredged solids used in embankment construction.
- ○ Dredged solids transferred to landfill.
- ○ Dredged solids marketed/sold for reuse.
- ○ Other (Explain): ____________________

CBI?
☐ Yes

D4-7. Has the pond/impoundment unit been expanded since the date it was built?

- ○ Yes (Continue)
- ● No (Skip to Question D4-10)
- ○ NA (Pond/Impoundment is planned to be constructed. Skip to Question D4-10)

CBI?
☐ Yes

D4-8. Identify the type of expansion.

- ○ Lateral expansion
- ○ Vertical expansion
- ○ Both lateral and vertical expansion

CBI?
☐ Yes

D4-9. Describe any expansion(s), since January 1, 2000, to the pond/impoundment unit, including the starting and ending dimensions.

____

Provide the total cost associated with the expansion(s). Total costs should include labor, materials, energy, hazardous and nonhazardous waste disposal, purchased equipment, installation, buildings, site preparation, land, engineering costs, construction expenses, and any other costs available.

$ ____________________ Total cost of expansion

CBI?
☐ Yes

D4-10. Indicate the *pollutants* targeted for removal by this pond/impoundment unit using techniques other than solely settling (e.g., adding chemicals to remove certain metals). [Check all boxes that apply.]

- ☐ Metals (specify): ____________________
- ☑ TSS
- ☐ Nitrogen compounds (ammonia, nitrate, nitrite)
- ☐ Organic Acids
- ☐ Chlorine or other oxidizing agents
- ☐ Oil and grease
- ☐ Other: ____________________
- ☐ NA (Skip to Question D4-12)

CBI?
☐ Yes

D4-11. Of the pollutants listed in D4-10, which effluent limitation(s) drives/will drive the operation of this pond/impoundment unit? Provide the pollutant and the limitation (mg/L or ug/L).

Pollutant: TSS
Limitation: 30 mg/L
Pollutant:
Limitation: Select
Pollutant:
Limitation: Select

CBI?
☐ Yes

D4-12. Did the plant add chemicals to this pond/impoundment unit in 2009?

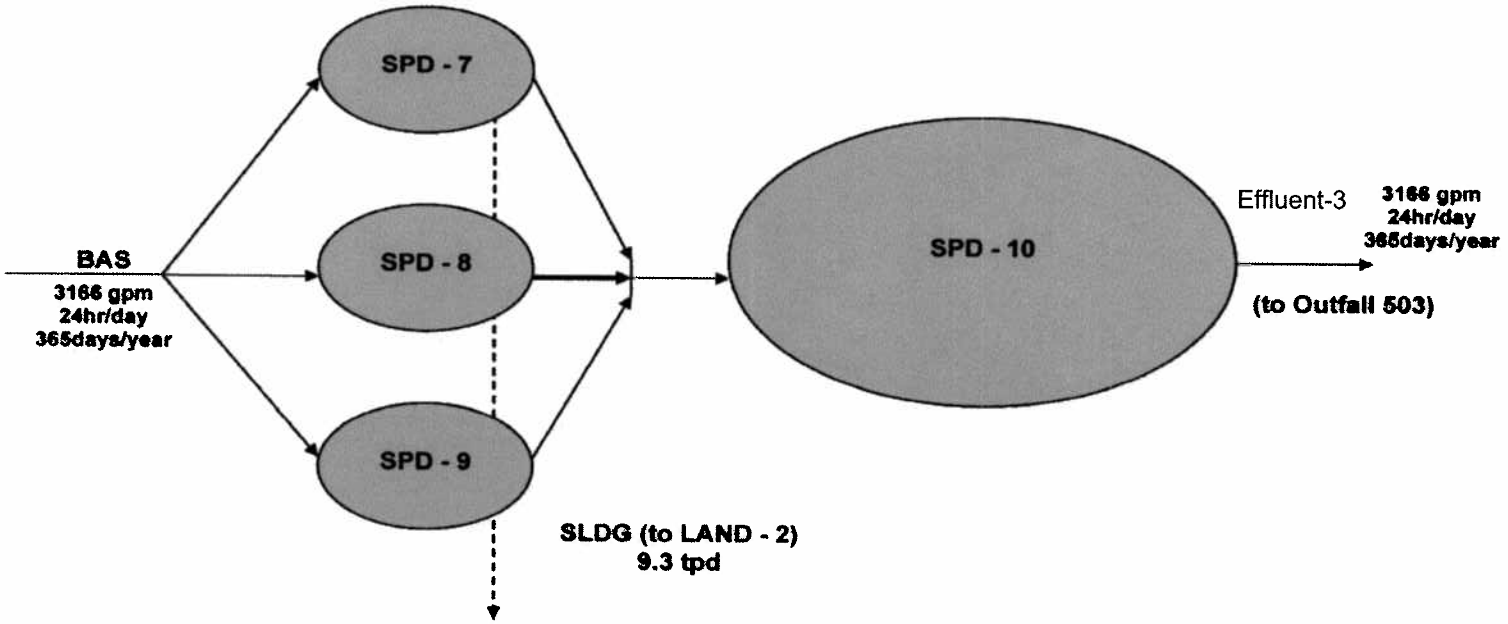
○ Yes (Complete Table D-7)
● No (Skip to Section 4.2)
○ NA (Pond/impoundment is planned to be constructed. Provide information in Table D-7 to the extent possible based on plans.)

Note that "Chemical Type" refers to the generic name of the chemical added to the pond/impoundment (e.g., lime, sodium hydroxide, alum, polymer). "Average Dose Concentration" refers to the average concentration of the chemical within the pond/impoundment unit just after it is added to the unit. In the "Location of Chemical Addition" column, indicate where within or near the pond/impoundment the chemical is added (e.g., within the pond/impoundment near the process wastewater influent point, within the pond/impoundment near the effluent, in the effluent/discharge canal). If chemical addition is known only on a yearly basis, divide the yearly value by the approximate number of days the plant added chemicals (which should be the same estimate for the "Frequency of Addition" column).

Table D-7. Chemicals Used in Pond/Impoundment Unit Operations

Chemical Type	Trade Name	Manufacturer	Purpose	Location of Chemical Addition	Average Dose Concentration (g/L)	Average Addition Rate (gpd or lb/day)			Frequency of Addition (dpy)
none							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	
							○ gpd ○ lb/day	○ Solid ○ Liquid	

POND - 1
Plant: Keystone
Plant ID: 03831



APPENDIX A

Document 3

24 October 2011 Dam Inspection

QUARTERLY DAM INSPECTION CHECKLIST
RRI ENERGY - OPERATIONS TECHNICAL SUPPORT
KEYSTONE STATION

NAME OF DAM: Cooling Pond "A" **DER I.D. NO:** 03-044

LOCATION: Plumcreek Township, Armstrong County

DER CLASSIFICATION: B (size) 3 (hazard)

PHYSICAL DATA:

Type of dam: Earthen
Height of dam: 49 feet
Normal pool storage capacity: 129 acre feet
Normal pool elevation: 1017.0 feet
Pool elevation at inspection: 1017.0'
Elevation in discharge structure:

PERSONS PRESENT AT INSPECTION:

NAME	TITLE/POSITION	REPRESENTING
John Callihan		GenOn Energy

DATE OF INSPECTION: 10/24/2011 9:45 AM

WEATHER: light rain - overcast

TEMPERATURE: ~ 44°

This is to certify that the above dam has been inspected and the following are the results of this inspection.

EMBANKMENT

CREST AND UPSTREAM SLOPE		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	OBSERVATIONS	Monitor	Investigate	Repair
SURFACE CRACKING	Minor deterioration of concrete revetment	X		
SINKHOLE, ANIMAL BURROW	None Observed			
LOW AREA(S)	None Observed			
HORIZONTAL ALIGNMENT	Good Condition			
RUTS AND/OR PUDDLES	None Observed			
VEGETATION GROWTH	Good Condition	X		
CONCRETE REVETMENT	Revetment geotextile is deteriorating	X		
ADDITIONAL COMMENTS:				

EMBANKMENT

DOWNSTREAM SLOPE		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	OBSERVATIONS	Monitor	Investigate	Repair
WET AREA(S)	Flowing water at roadway bench at right groin area. Flow originates along RR embankment.	X		
SEEPAGE	Minor seepage observed on access road bench	X		
SLIDE, SLOUGH, SCARP	None Observed			
SINKHOLE, ANIMAL BURROW	None Observed			
EROSION	None Observed			
UNUSUAL MOVEMENT	None Observed			
VEGETATION CONDITION	Vegetation on downstream slope needs mowed			X
ADDITIONAL COMMENTS:				

DOWNSTREAM AREA AND MISCELLANEOUS

		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
SLIDE, SLOUGH, SCARP	None Observed			
DRAINAGE SYSTEM	Good Condition			
DOWNSTREAM HAZARD DESCRIPTION	None Observed			
DATE OF LAST UPDATE OF EMERGENCY PLAN	N/A EAP not required			
ACCESS ROADS	Good Condition			
SECURITY DEVICES	Good Condition			
MISCELLANEOUS				

ADDITIONAL COMMENTS:

OUTLET WORKS

		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
MONITORING BUILDING	Good Condition			
PARSHALL FLUME	Good Condition - 3504 gpm instrument readout			
DISCHARGE STRUCTURE	Good Condition			
OUTLET PIPE	Good Condition - unobstructed			
EROSION ALONG DAM TOE	None Observed			
SEEPAGE	None Observed			
MISCELLANEOUS				

ADDITIONAL COMMENTS:

APPENDIX A

Document 4

23 February 2012 Dam Inspection

QUARTERLY DAM INSPECTION CHECKLIST
GENON ENERGY - OPERATIONS TECHNICAL SUPPORT
KEYSTONE STATION

NAME OF DAM: Cooling Pond "A" **DER I.D. NO:** 03-044

LOCATION: Plumcreek Township, Armstrong County

DER CLASSIFICATION: B (size) 3 (hazard)

PHYSICAL DATA:

Type of dam: Earthen
Height of dam: 49 feet
Normal pool storage capacity: 129 acre feet
Normal pool elevation: 1017.0 feet
Pool elevation at inspection: 1017.0'
Elevation in discharge structure:

PERSONS PRESENT AT INSPECTION:

NAME	TITLE/POSITION	REPRESENTING
John Callihan		GenOn Energy

DATE OF INSPECTION: 2/23/2012 10:15 AM

WEATHER: Partly Sunny

TEMPERATURE: ~ 44°

This is to certify that the above dam has been inspected and the following are the results of this inspection.

<table>
<tr><th colspan="5">EMBANKMENT</th></tr>
<tr><th colspan="2">CREST AND UPSTREAM SLOPE</th><th colspan="3">CHECK ( ) ACTION NEEDED</th></tr>
<tr><th>CONDITION/ITEMS</th><th>OBSERVATIONS</th><th>Monitor</th><th>Investigate</th><th>Repair</th></tr>
<tr><td>SURFACE CRACKING</td><td>Minor deterioration of concrete revetment</td><td>X</td><td></td><td></td></tr>
<tr><td>SINKHOLE, ANIMAL BURROW</td><td>None Observed</td><td></td><td></td><td></td></tr>
<tr><td>LOW AREA(S)</td><td>None Observed</td><td></td><td></td><td></td></tr>
<tr><td>HORIZONTAL ALIGNMENT</td><td>Good Condition</td><td></td><td></td><td></td></tr>
<tr><td>RUTS AND/OR PUDDLES</td><td>None Observed</td><td></td><td></td><td></td></tr>
<tr><td>VEGETATION GROWTH</td><td>Good Condition</td><td>X</td><td></td><td></td></tr>
<tr><td>CONCRETE REVETMENT</td><td>Revetment geotextile is deteriorating</td><td>X</td><td></td><td></td></tr>
<tr><td colspan="5">ADDITIONAL COMMENTS:</td></tr>
</table>

<table>
<tr><th colspan="5">EMBANKMENT</th></tr>
<tr><th colspan="2">DOWNSTREAM SLOPE</th><th colspan="3">CHECK ( ) ACTION NEEDED</th></tr>
<tr><th>CONDITION/ITEMS</th><th>OBSERVATIONS</th><th>Monitor</th><th>Investigate</th><th>Repair</th></tr>
<tr><td>WET AREA(S)</td><td>Flowing water at roadway bench at right groin area. Flow originates along RR embankment.</td><td>X</td><td></td><td></td></tr>
<tr><td>SEEPAGE</td><td>Minor seepage observed on access road bench</td><td>X</td><td></td><td></td></tr>
<tr><td>SLIDE, SLOUGH, SCARP</td><td>None Observed</td><td></td><td></td><td></td></tr>
<tr><td>SINKHOLE, ANIMAL BURROW</td><td>None Observed</td><td></td><td></td><td></td></tr>
<tr><td>EROSION</td><td>None Observed</td><td></td><td></td><td></td></tr>
<tr><td>UNUSUAL MOVEMENT</td><td>None Observed</td><td></td><td></td><td></td></tr>
<tr><td>VEGETATION CONDITION</td><td>Good Condition</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">ADDITIONAL COMMENTS:</td></tr>
</table>

DOWNSTREAM AREA AND MISCELLANEOUS

		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
SLIDE, SLOUGH, SCARP	None Observed			
DRAINAGE SYSTEM	Good Condition			
DOWNSTREAM HAZARD DESCRIPTION	None Observed			
DATE OF LAST UPDATE OF EMERGENCY PLAN	N/A EAP not required			
ACCESS ROADS	Good Condition			
SECURITY DEVICES	Good Condition			
MISCELLANEOUS				

ADDITIONAL COMMENTS:

OUTLET WORKS

		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
MONITORING BUILDING	Good Condition			
PARSHALL FLUME	Good Condition - 3635 gpm instrument readout			
DISCHARGE STRUCTURE	Good Condition			
OUTLET PIPE	Good Condition - unobstructed			
EROSION ALONG DAM TOE	None Observed			
SEEPAGE	None Observed			
MISCELLANEOUS				

ADDITIONAL COMMENTS:

APPENDIX A

Document 5

6 June Dam Inspection

QUARTERLY DAM INSPECTION CHECKLIST
GENON ENERGY - OPERATIONS TECHNICAL SUPPORT
KEYSTONE STATION

NAME OF DAM: Cooling Pond "A" **DER I.D. NO:** 03-044

LOCATION: Plumcreek Township, Armstrong County

DER CLASSIFICATION: B (size) 3 (hazard)

PHYSICAL DATA:

Type of dam: Earthen
Height of dam: 49 feet
Normal pool storage capacity: 129 acre feet
Normal pool elevation: 1017.0 feet
Pool elevation at inspection: 1017.0'
Elevation in discharge structure:

PERSONS PRESENT AT INSPECTION:

NAME	TITLE/POSITION	REPRESENTING
John Callihan		GenOn Energy

DATE OF INSPECTION: 6/1/2012 11:40 AM

WEATHER: Overcast

TEMPERATURE: ~ 70°

This is to certify that the above dam has been inspected and the following are the results of this inspection.

EMBANKMENT

CREST AND UPSTREAM SLOPE		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
SURFACE CRACKING	Minor deterioration of concrete revetment	X		
SINKHOLE, ANIMAL BURROW	None Observed			
LOW AREA(S)	None Observed			
HORIZONTAL ALIGNMENT	Good Condition			
RUTS AND/OR PUDDLES	None Observed			
VEGETATION GROWTH	Good Condition	X		
CONCRETE REVETMENT	Revetment geotextile is deteriorating	X		
ADDITIONAL COMMENTS:				

EMBANKMENT

DOWNSTREAM SLOPE		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
WET AREA(S)	Flowing water at roadway bench at right groin area. Flow originates along RR embankment.	X		
SEEPAGE	Minor seepage observed on access road bench	X		
SLIDE, SLOUGH, SCARP	None Observed			
SINKHOLE, ANIMAL BURROW	None Observed			
EROSION	None Observed			
UNUSUAL MOVEMENT	None Observed			
VEGETATION CONDITION	Good Condition			
ADDITIONAL COMMENTS:				

DOWNSTREAM AREA AND MISCELLANEOUS

		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
SLIDE, SLOUGH, SCARP	None Observed			
DRAINAGE SYSTEM	Good Condition			
DOWNSTREAM HAZARD DESCRIPTION	None Observed			
DATE OF LAST UPDATE OF EMERGENCY PLAN	N/A EAP not required			
ACCESS ROADS	Good Condition			
SECURITY DEVICES	Good Condition			
MISCELLANEOUS				

ADDITIONAL COMMENTS:

OUTLET WORKS

		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
MONITORING BUILDING	Good Condition			
PARSHALL FLUME	Good Condition - 3680 gpm instrument readout			
DISCHARGE STRUCTURE	Good Condition			
OUTLET PIPE	Good Condition - unobstructed			
EROSION ALONG DAM TOE	None Observed			
SEEPAGE	None Observed			
MISCELLANEOUS				

ADDITIONAL COMMENTS:

APPENDIX A

Document 6

20 August Dam Inspection

QUARTERLY DAM INSPECTION CHECKLIST
GENON ENERGY - OPERATIONS TECHNICAL SUPPORT
KEYSTONE STATION

NAME OF DAM: Cooling Pond "A" **DER I.D. NO:** 03-044

LOCATION: Plumcreek Township, Armstrong County

DER CLASSIFICATION: B (size) 3 (hazard)

PHYSICAL DATA:

Type of dam: Earthen
Height of dam: 49 feet
Normal pool storage capacity: 129 acre feet
Normal pool elevation: 1017.0 feet
Pool elevation at inspection: 1017.0'
Elevation in discharge structure:

PERSONS PRESENT AT INSPECTION:

NAME	TITLE/POSITION	REPRESENTING
John Callihan		GenOn Energy

DATE OF INSPECTION: 8/20/2012 1:30 PM

WEATHER: Partly cloudy

TEMPERATURE: ~ 80°

This is to certify that the above dam has been inspected and the following are the results of this inspection.

EMBANKMENT

CREST AND UPSTREAM SLOPE		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
SURFACE CRACKING	Minor deterioration of concrete revetment	X		
SINKHOLE, ANIMAL BURROW	None Observed			
LOW AREA(S)	None Observed			
HORIZONTAL ALIGNMENT	Good Condition			
RUTS AND/OR PUDDLES	None Observed			
VEGETATION GROWTH	Good Condition	X		
CONCRETE REVETMENT	Revetment geotextile is deteriorating	X		
ADDITIONAL COMMENTS:				

EMBANKMENT

DOWNSTREAM SLOPE		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
WET AREA(S)	Flowing water at roadway bench at right groin area. Flow originates along RR embankment.	X		
SEEPAGE	Minor seepage observed on access road bench	X		
SLIDE, SLOUGH, SCARP	None Observed			
SINKHOLE, ANIMAL BURROW	None Observed			
EROSION	None Observed			
UNUSUAL MOVEMENT	None Observed			
VEGETATION CONDITION	Good Condition			
ADDITIONAL COMMENTS:				

DOWNSTREAM AREA AND MISCELLANEOUS

		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
SLIDE, SLOUGH, SCARP	None Observed			
DRAINAGE SYSTEM	Good Condition			
DOWNSTREAM HAZARD DESCRIPTION	None Observed			
DATE OF LAST UPDATE OF EMERGENCY PLAN	N/A EAP not required			
ACCESS ROADS	Good Condition			
SECURITY DEVICES	Good Condition			
MISCELLANEOUS				

ADDITIONAL COMMENTS:

OUTLET WORKS

		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	**OBSERVATIONS**	**Monitor**	**Investigate**	**Repair**
MONITORING BUILDING	Good Condition			
PARSHALL FLUME	Good Condition - 3540 gpm instrument readout			
DISCHARGE STRUCTURE	Good Condition			
OUTLET PIPE	Good Condition - unobstructed			
EROSION ALONG DAM TOE	None Observed			
SEEPAGE	None Observed			
MISCELLANEOUS				

ADDITIONAL COMMENTS:

APPENDIX A

Document 7

Keystone Thermal Dam Permit D03-044

WRL

PENNSYLVANIA
DER

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
Rachel Carson State Office Building
P.O. Box 8554
Harrisburg, PA 17105-8554

May 3, 1995

717-787-8568

Bureau of Dams, Waterways and Wetlands

MAY 1995

Pennsylvania Electric Company
1001 Broad Street
Johnstown, PA 15907

RE: DER File No. D03-044

Gentlemen:

Receipt is acknowledged of the as-built drawings for the construction of Cooling Pond "A" Dam located across a tributary to Crooked Creek in Plumcreek Township, Armstrong County.

We have reviewed the as-built drawings, and the previously submitted completion Certification, documenting the dam's construction in conformance with the approved plans and specifications. Based upon this information and our final project inspection, all construction requirements of the permit have been fulfilled. The Department considers the construction of the dam completed.

You are reminded that the proper operation and maintenance of the dam is PECO's continuing responsibility. To assist you in this endeavor, we have enclosed the Department's complimentary manual for "The Inspection, Maintenance and Operation of Dams in Pennsylvania." Please review this manual and pay particular attention to Section 2 - Dam Inspections, and Section 3 - Dam Maintenance. (IN EA LIBRARY, UNDER "ALL STATIONS" -- AS-75)

The Department will conduct periodic inspections of the dam, and you will be apprised of our findings.

Also, we request that you notify our office of any future change of ownership of the dam.

Your cooperation and that of your engineer in the accomplishment of this work is appreciated. Should you have any question or need assistance regarding your dam, please feel free to call us at the above number.

Sincerely,

Norman S. Batcheler, P.E.
Chief
Project Inspection Section
Division of Dam Safety

Enclosure

HOGAN & HARTSON L.L.P.

MEMORANDUM

October 21, 1999

TO: File

FROM: Patrick D. Traylor

RE: **GPU/Sithe: Transfer of Water-related Permits at the Conemaugh and Keystone Stations**

The water-related permits for the Conemaugh and Keystone Stations will be automatically transferred at closing in one of two manners.

First, and most easily, all water-related permits currently held by GPU Genco will be automatically transferred at closing to Sithe Northeast Management Company ("SNMC"). This transfer is automatic because all the stock of GPU Genco will be transferred to SNMC at closing. The permits currently held by GPU Genco will be held by the new stock owner, SNMC. We have confirmed the appropriateness of this approach with the legal staff of the Pennsylvania Department of Environmental Protection Southwest Region.

Second, in our review of GPU's permit files, we noted that many of the Conemaugh and Keystone water-related permits were not held by GPU Genco, but some other entity (e.g., Penelec, Met-Ed, etc.). These permits could not have been transferred automatically to SNMC at closing. Therefore, we transferred the permits from the various permit holders to GPU Genco. As a result these permits will now also be transferred automatically at closing from GPU Genco to SNMC.

In both cases, Sithe will need to file a notice after closing with Pennsylvania that notes the name of the new operator, and states that the new owner complied with the Pennsylvania Fictitious Name Act. Moreover, Sithe will be required to submit a copy of the new operating agreement between the owners of the facilities (e.g., Conemaugh Owners Group and Keystone Owners Group), and SNMC.

For closing, permits identified as "Transfer Approved" are those permits that were transferred from some other entity to GPU Genco. These permits will be automatically transferred to SNMC at closing. Permits identified as "Transfer After Closing" are those permits that were already in the name of GPU Genco, and will also be transferred automatically at closing.

PENNSYLVANIA
DER

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

P.O. Box 8554
Harrisburg, PA 17105-8554
April 25, 1995

717-787-8568

Bureau of Dams, Waterways and Wetlands

Mr. William B. Thomas
Engineer Sr. II
Metropolitan Edison Company
Pennsylvania Electric Company
1001 Broad Street
P.O. Box 539
Johnstown, PA 15907-0539

RE: DER File No. D03-044

Dear Mr. Thomas:

Receipt is acknowledged of the Dam Completion Certification for the construction of Cooling Pond "A" Dam located across a Tributary to Crooked Creek in Plumcreek Township, Armstrong County. We have reviewed the Certification form and consider it to be acceptable. However, until the as-built drawings are submitted to us and found to be acceptable, the permitted construction of this dam is not considered complete by the Department.

Your cooperation in providing the as-built plans will be appreciated. Should you have any question or need assistance regarding your dam, please feel free to call us at the above number.

Sincerely,

Norman S. Batcheler, P.E.
Chief
Project Inspection Section
Division of Dam Safety

Note:
see
MAY 3, 1995 LETTER

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

ACKNOWLEDGMENT OF APPRISAL OF PERMIT CONDITIONS

Project Location:

County Armstrong

Township Plumcreek

Gentlemen:

Acknowledgment is made that I, J. G. Herbein
(Permittee Name)

and Khalid H. Khilji, P.E.
(Name, address and telephone of engineer responsible for supervision of work)

570 Beatty Road, Monroeville, PA 15146 412-856-6400

have been apprised of and are familiar with the terms and conditions of Permit No. D03-044

issued to Pennsylvania Electric Company
(Permittee)

giving its consent to modify, operate and maintain a dam (Cooling Pond "A") across
(Work authorized as stated on permit)

a tributary to Crooked Creek in Plumcreek Township, Armstrong County.

Return to:

Department of Environmental Resources
Bureau of Dams, Waterways and Wetlands
Division of Dam Safety
P. O. Box 8554
Harrisburg, PA 17105-8554

5/17/94

(Permittee signature) Date

P.E 061311 MAY 17, 1994.

(Signature of engineer responsible for supervision of work) Date

3630-PM-WQ0016 Rev. 3/97

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER QUALITY PROTECTION
BUREAU OF WATERWAYS ENGINEERING

FOR DEPARTMENT USE ONLY

DEC 13 1999
Date Received

Dennis R. Dickey
Approved by Department

JAN 19 2000
Approval Date

APPLICATION FOR TRANSFER OF PERMIT AND SUBMERGED LANDS LICENSE AGREEMENT

Return 4 executed copies each with original signatures to the appropriate office on the attached list.

TO BE COMPLETED BY PRESENT PERMITTEE

Name of Present Permittee GPU Generation, Inc. (Keystone Generating Station)			Telephone Number (817) 533-8111
Mailing Address 1001 Broad Street	City Johnstown	State PA	Zip 15907

☐ A Private Individual ☒ A Corporation ☐ A Partnership ☐ A Government Agency

Type of Permit: GP ☐ Obstruction ☐ Dam ☒	Permit Number D-03-044	Date Issued 5/6/1994	Stream Tributary of Crooked Creek	Municipality Plumcreek Tship	County Armstrong

The Original (or a copy) of permit is ☒ Attached ☐ Cannot be produced
Has a bond been posted in connection with this project? ☐ Yes ☒ No
Do you presently hold a submerged lands license agreement? ☐ Yes ☒ No (If yes, please fill out the reverse side also)

AFFIDAVIT

I N/A (name change only) being duly sworn according to law depose and say that I ~~(am the permittee)~~ (am an officer of the permittee) ~~(have the authority to make this application for the permittee)~~ named above as the present permittee, that said permittee relinquishes all right, title and interest in said permit, and that the information included in the foregoing application is true to the best of my knowledge and belief. (Inapplicable portions should be crossed out).

Signature of present permittee

Date

Title

Corporate or Government Seal

Witness Signature

TO BE COMPLETED BY NEW APPLICANT

Name of New Applicant Sithe Northeast Management Company			Telephone Number (817) 533-8111
Mailing Address 1001 Broad Street	City Johnstown	State PA	Zip 15907

Federal ID/Social Security No.
25-1753949

☐ A Private Individual ☒ A Corporation ☐ A Partnership ☐ A Government Agency

Statement of Acceptance of Permit: I/We hereby accept the permit herein referred to and agree to be bound by all terms and conditions of said permit.

AFFIDAVIT

I __________ being duly sworn according to law depose and say that I ~~(am the applicant)~~ (am an officer or official of the applicant) ~~(have the authority to make this application for the applicant)~~ named above as the new applicant, and that the information included in the foregoing statement is true to the best of my knowledge and belief. (Inapplicable portions should be crossed out).

Signature of new applicant

11/24/1999
Date

VICE-PRESIDENT, SITHE NE MGMT CO.
Title

Corporate or Government Seal

Witness Signature

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
PITTSBURGH DISTRICT, CORPS OF ENGINEERS
WILLIAM S. MOORHEAD FEDERAL BUILDING
1000 LIBERTY AVENUE, PITTSBURGH, PA 15222

REPLY TO
ATTENTION OF

July 16, 1993

JUL 1993
RECEIVED
ENVIRONMENTAL
AFFAIRS

Regulatory Branch

Mr. J. G. Herbein
Vice President
Pennsylvania Electric Company
1001 Broad Street
Johnstown, Pennsylvania 15907

Dear Mr. Herbein:

I refer to a letter from the Pennsylvania Department of Environmental Resources, received in this office July 2, 1993, regarding your application for authorization to modify two existing bottom ash disposal ponds in Plumcreek Township, Armstrong County, Pennsylvania (DER File Nos. D03-044 and D03-045.)

A Department of the Army Permit is not required for the proposed modifications.

You may begin the work after you have obtained any required State and local permits.

Sincerely,

E. Ray Beringer

E. Raymond Beringer
Chief, Regulatory Branch

PA [illegible]

3630-PM-WQ0016 Rev. 3/97

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER QUALITY PROTECTION
BUREAU OF WATERWAYS ENGINEERING

FOR DEPARTMENT USE ONLY
AUG 26 1999
Date Received
Approved by Department
OCT 7 1999
Approval Date

APPLICATION FOR TRANSFER OF PERMIT AND SUBMERGED LANDS LICENSE AGREEMENT

Return 4 executed copies each with original signatures to the appropriate office on the attached list.

TO BE COMPLETED BY PRESENT PERMITTEE

Name of Present Permittee: **Pennsylvania Electric Company (Keystone Generating Station)**
Telephone Number: **(817) 533-8111**
Mailing Address: **1001 Broad Street** City: **Johnstown** State: **PA** Zip: **15907**

☐ A Private Individual ☒ A Corporation ☐ A Partnership ☐ A Government Agency

Type of Permit: GP ☐ Obstruction ☐ Dam ☒	Permit Number D-03-044	Date Issued 5/6/94	Stream Tributary to Crooked Creek	Municipality Plumcreek Tship	County Armstrong

The Original (or a copy) of permit is ☒ Attached ☐ Cannot be produced
Has a bond been posted in connection with this project? ☐ Yes ☒ No
Do you presently hold a submerged lands license agreement? ☐ Yes ☒ No (If yes, please fill out the reverse side also)

AFFIDAVIT

I R. J. Toole being duly sworn according to law depose and say that I ~~(am the permittee)~~ (am an officer of the permittee) ~~(have the authority to make this application for the permittee)~~ named above as the present permittee, that said permittee relinquishes all right, title and interest in said permit, and that the information included in the foregoing application is true to the best of my knowledge and belief. (Inapplicable portions should be crossed out).

RJ Toole
Signature of present permittee

7-28-99
Date

Vice-President, Pennsylvania Electric Company
Title

Witness Signature

Corporate or Government Seal

TO BE COMPLETED BY NEW APPLICANT

Name of New Applicant: **GPU Generation, Inc.**
Telephone Number: **(817) 533-8111**
Mailing Address: **1001 Broad Street** City: **Johnstown** State: **PA** Zip: **15907**
Federal ID/Social Security No.: **25-1753949**

☐ A Private Individual ☒ A Corporation ☐ A Partnership ☐ A Government Agency

Statement of Acceptance of Permit: I/We hereby accept the permit herein referred to and agree to be bound by all terms and conditions of said permit.

AFFIDAVIT

I R.J. Toole being duly sworn according to law depose and say that I ~~(am the applicant)~~ (am an officer or official of the applicant) ~~(have the authority to make this application for the applicant)~~ named above as the new applicant, and that the information included in the foregoing statement is true to the best of my knowledge and belief. (Inapplicable portions should be crossed out).

RJ Toole
Signature of new applicant

7-28-99
Date

/ice-President, GPU Generation, Inc.
Title

Witness Signature

Corporate or Government Seal

K3

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF DAMS AND WATERWAY MANAGEMENT

Dam Permit No. D03-044

Plum Creek Township, PA

Date: January 30, 1995

DAM COMPLETION REPORT

Department of Environmental Resources
Bureau of Dams and Waterway Management
Division of Dam Safety
P. O. Box 8554
Harrisburg, PA 17105

Gentlemen:

((WE) hereby certify that the dam across a tributary to Crooked Creek (Stream) in Plumcreek Township, Armstrong County, PA, was completed on December 22ND, 19 94 in accordance with the plans and specifications approved by the Department.

Yours very truly,

Signature of Supervising Engineer:

F. Gregory Nadeau

Title: Chief Civil/Geotechnical Engineer

Firm or Agency: Gilbert/Commonwealth, Inc.

Signature of Permittee:

Title: Vice President-Generation

Firm or Agency: Pennsylvania Electric Company

ER-DWW-3: Rev. 4/93

PERMIT NO. D03-044

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF DAMS, WATERWAYS AND WETLANDS

DAM PERMIT

The Department of Environmental Resources "Department", established by the Act of December 3, 1970, (71 P.S. §510-1 *et seq.*) and empowered to exercise certain powers and perform certain duties under and by virtue of the Act of November 26, 1978, P.L. 1375, No. 325, as amended by the Act of October 23, 1979, No. 70, known as the "Dam Safety and Encroachments Act"; and the Administrative Code, Act of April 9, 1929, P.L. 177, *as amended*, which empowers the Department to exercise certain powers and perform certain duties by law vested in and imposed upon the Water Supply Commission of Pennsylvania and the Water and Power Resources Board, hereby issues this permit to:

PENNSYLVANIA ELECTRIC COMPANY
1001 Broad Street, Johnstown, PA 15907

giving its consent to modify, operate and maintain a dam (Cooling Pond "A") across a tributary to Crooked Creek in Plumcreek Township, Armstrong County.

The issuance of this permit also constitutes approval of a Water Quality Certification under Section 401 of the Federal Water Pollution Control Act (33 U.S.C.A. 1341(a)).

This permit is issued in response to an application filed with the Department of Environmental Resources on the 19th day of April A.D. 19 93, and with the understanding that the work shall be performed in accordance with the maps, plans, profiles and specifications filed with and made a part of the application January 10, 1994. Subject, however, to the provisions of the Dam Safety and Encroachments Act, the Administrative Code, and the following conditions, regulations, and restrictions **(YOUR ATTENTION IS DRAWN TO CONDITION NUMBER 12).**

1. This permit does not give any property rights, either in real estate or material, nor any exclusive privileges, nor shall it be construed to grant or confer any right, title, easement, or interest in, to, or over any land belonging to the Commonwealth of Pennsylvania; neither does it authorize any injury to private property or invasion of private rights, nor any infringement of Federal, State, or local laws or regulations; nor does it obviate the necessity of obtaining Federal assent when necessary;

2. The work shall at all times be subject to supervision and inspection by representatives of the Department, and no changes in the maps, plans, profiles and specifications as approved shall be made except with the written consent of the Department. The Department, however, reserves the right to require such changes or modifications in the maps, plans, profiles, and specifications as may be considered necessary. The Department further reserves the right to suspend or revoke this permit if in its opinion the best interest of the Commonwealth will be subserved thereby;

3. All work shall be conducted under the oversight and supervision of a competent engineer approved by the Department, and such engineer or a competent representative shall be on the work site at all times during significant construction activities until completion of the dam;

4. At least 15 days prior to commencement of construction, the permittee shall notify the Department, in writing, of the proposed time of commencement of this work, and a detailed report upon the status of the construction shall be mailed to the "Division of Dam Safety, P.O. Box 8554, Harrisburg, Pennsylvania 17105-8554" monthly until work upon the dam has been completed. Within thirty (30) days after the completion of the work authorized in this permit, the permittee shall file with the Division of Dam Safety, a certified statement signed by the supervising engineer and by the permittee that the work has been performed in accordance with this permit and the approved maps, plans, profiles and specifications. Further, the permittee shall submit to the Division of Dam Safety, within ninety (90) days after the date of completion of the work authorized by this permit, a set of final "as built" plans for the project, showing changes from the original plans and specifications;

5. If this work is not completed on or before the 31st day of December A.D. 19 95 , this permit, if not previously revoked or specifically extended by the Department in writing, shall become void without further notification. If construction work has not been completed within the time specified in the permit and the time limit specified in the permit has not been extended in writing by the Department or if a permit has been revoked for any reason, the permittee shall, at his own expense and in a manner that the Department requires and restore the water course and floodplain to their former condition;

6. No material shall be placed on any portion of the foundation until such portion of the foundation has been approved, in writing, by a representative of the Department; no earth or other embankment material which is in a frozen condition shall be covered or placed in embankments; concrete shall not be placed in freezing weather except under conditions approved by the Department;

7. The Department shall be notified at least one week in advance of the time when it is proposed to begin to store water in the reservoir or pond created by the dam for which this permit is issued. The Department will require the permittee to allow a portion of the natural stream flow to pass the dam while the reservoir or pond is being filled, and this notice is required in order that arrangements may be made to have a representative on the grounds before or during the filling if the Department considers it desirable. Sufficient water to support fish life shall be allowed to flow into the stream below the dam, during the period of its construction or repair and while the reservoir is being filled. The permittee agrees to abide by such rules and regulations as to the storage and discharge of water, and as to the level of the reservoir created by said dam, as may be prescribed from time to time by the Department;

8. All trees of no value and brush cleared from the area under this permit shall be burned at such time and under such conditions as to prevent the fire from spreading to adjoining timber land; provided, however, that before such burning is begun, the Regional Air Pollution Control Engineer of the Department of Environmental Resources in charge of the Region in which the area is located shall be notified;

9. The permittee agrees in accepting this permit, to install, upon the request of the Pennsylvania Fish and Boat Commission, such fishway or fishways as the said Commission may require. (See Section 185, of the Act of May 2, 1925, P.L. 448, as amended by the Act of April 22, 1929, P.L. 621.) Attention is also called to Section 191 of the Act of May 2, 1925, P.L. 448, as amended by Act No. 113, approved May 25, 1935, which provides that no person owning, leasing or maintaining a dam, holding back waters inhabited by fish, shall

draw off such waters without first receiving written permission from the Pennsylvania Fish and Boat Commission;

10. Performance of the work authorized shall constitute an acceptance of the various conditions contained in the permit; provided that if the permittee fails to file acceptance of the permit in accordance with Condition 12, the permit becomes null and void and the permittee shall remove all works constructed and restore the area in a manner specified by the Department;

11. The permittee shall fully inform the engineer or contractor, responsible for the supervision and conduct of work, of the terms, conditions, restrictions and covenants of this permit. Prior to the commencement of construction, the permittee shall file with the Department in writing, on a form provided by the Department, a statement signed by the permittee and an individual responsible for the supervision or conduct of the construction work acknowledging and accepting the general and special conditions contained in the permit. Unless the acknowledgment and acceptance have been filed, the permit is void. A copy of the permit and the acknowledgment shall be available at the work site for inspection upon request by an officer or agent of the Department or another Federal, State, County or Municipal Agency;

12. The permittee shall sign the permit thereby expressly certifying the permittee's acceptance of, and agreement to comply with, the terms and conditions of the permit. The permittee shall return a signed copy of the permit to the Department. The permit will not be effective until the signed copy of the permit is received by the Department;

13. The permittee agrees to operate and maintain the dam embankment, upstream and downstream groin areas, upstream and downstream toe areas and spillway approach channels, control sections and outlet channels free of all trees, shrubs and woody vines. These areas shall be maintained with a perennial sod forming ground cover. Vegetative cover seed mixes must be approved by the Department;

14. The permittee agrees to notify the Department of any future changes in the ownership of the dam, or the lake formed by the dam, or of any portion of the dam or lake, and shall furnish the Division of Dam Safety with the name(s) and address(es), and further agrees to execute an assignment of this permit to the new owner(s);

15. This permit authorizes the construction and/or operation, maintenance and normal repair of the permitted structures conducted within the original specifications for the dam and in accordance with the regulations of the Department and terms and conditions of this permit. Any repairs or maintenance involving modifications of the dam from its original specifications, and any repairs or reconstruction involving a substantial portion of the structure as defined by regulations of the Department shall require the prior written approval and permit of the Department;

16. The permittee shall operate and maintain the structure or work authorized herein in a safe condition in accordance with the permit terms and conditions and the approved maps, plans, profiles and specifications;

17. The permittee is directed to furnish the Department of Environmental Resources, Division of Dam Safety with the names, qualifications and employer of the personnel responsible for the supervision of construction. In addition, the name of the contractor is also required. The permittee is further advised that the Department reserves the right to approve the personnel who will be in charge of supervision of construction. This information is to be submitted to the Division of Dam Safety 15 days in advance of the anticipated start of construction;

18. If the use of explosives in any waterways is required, the permittee shall secure the prior written permit from the Pennsylvania Fish and Boat Commission, pursuant to the Pennsylvania Fish and Boat Code, Act 1980-175 Title 30 Pennsylvania Consolidated Statutes, Section 2906. Requests should be directed to the Pennsylvania Fish and Boat Commission, Division of Environmental Services, 450 Robinson Lane, Bellefonte, PA 16823, 814-359-5147;

19. The permittee shall implement and monitor the Erosion and Sedimentation Control Plan prepared in accordance with Chapter 102 so as to minimize erosion and prevent excessive sedimentation into the receiving watercourse or body of water;

20. The permittee is advised that this project may be subject to the regulation of Section 404 of the Federal Clean Water Act of 1977. The permittee is directed to immediately contact the following District Office of the U.S. Army Corps of Engineers for further information: Pittsburgh District, Room 1817, Federal Building, 1000 Liberty Avenue, Pittsburgh, PA 15222;

21. Prior to commencement of work, the permittee must schedule a pre-construction meeting to review the conditions of the permit and discuss details of the proposed construction. This meeting should be held at the dam site and include the engineer, contractor, permittee and a representative of the Department of Environmental Resources. To schedule this meeting, please contact: Larry Busack, Soils and Waterways Section, Southwest Regional Office, 400 Waterfront Drive, Pittsburgh, PA 15222-4745, Telephone 412-442-4000;

22. The project site shall at all times be available for inspection by authorized officers and employees of the Pennsylvania Fish and Boat Commission. Prior to commencement and upon completion of the work authorized by this permit, the permittee shall notify the Pennsylvania Fish and Boat Commission's Southwest Regional Office, RD 2, Box 39, Somerset, PA 15501-9311, Telephone 814-445-8974;

23. The project site shall at all times be available for inspection by authorized officers and employees of the County Conservation District. Prior to commencement and upon completion of the work authorized by this permit, the permittee shall notify the Armstrong County Conservation District, Armsdale Administration Building, RD 8, Box 294, Kittanning, PA 16201, Telephone 412-548-3425;

24. **SEE SPECIAL CONDITIONS BEGINNING ON PAGE 5 OF THIS PERMIT.**

PERMIT NO. D03-044

SPECIAL CONDITIONS

A. The permittee and his agents will be watchful for archaelogical artifacts and will assure that ground disturbance activities will cease immediately upon discovery of archaelogical artifacts and immediately notify the Department of Environmental Resources and the Pennsylvania Historical and Museum Commission by phone and in writing.

ER-DWW-3: Rev. 4/93

PERMIT NO. D03-044

Permittee hereby accepts and agrees to comply with the terms and conditions of this permit.

J G Herlein
Permittee (signature)

5/2/94
Date

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Joseph J. Ellam
Joseph J. Ellam, P.E.
Director
Bureau of Dams, Waterways and Wetlands

Attest: Susan E Geiger

MAY -6 1994
Issue Date

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF DAMS AND WATERWAY MANAGEMENT

Dam Permit No. D03-044

Plum Creek Township, PA

Date: JANUARY 30, 1995

DAM COMPLETION REPORT

Department of Environmental Resources
Bureau of Dams and Waterway Management
Division of Dam Safety
P. O. Box ~~[illegible]~~ 8554
Harrisburg, PA ~~[illegible]~~ 17105

Gentlemen:

I (WE) hereby certify that the dam across a tributary to Crooked Creek (Stream) in Plumcreek Township, Armstrong County, PA, was completed on December 22ND, 19 94 in accordance with the plans and specifications approved by the Department.

Yours very truly,

Signature of Supervising Engineer: F. Gregory Nadeau

Title: Chief Civil/Geotechnical Engineer

Firm or Agency: Gilbert/Commonwealth, Inc.

Signature of Permittee:

Title: Vice President-Generation

Firm or Agency: Pennsylvania Electric Company

APPENDIX A

Document 8

Part A Keystone Steam Electric Power Plant Operations

OMB Control Number: 2040-0281
Approval Expires: 05/31/2013

Plant ID: 03831
Plant Name: Keystone

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Steam Electric Questionnaire

PART A - STEAM ELECTRIC POWER PLANT OPERATIONS

Table of Contents

Approved: May 20, 2010

Plant ID: 03831
Plant Name: Keystone

PART A. STEAM ELECTRIC POWER PLANT OPERATIONS

INSTRUCTIONS

Complete Part A of the questionnaire for your plant. As you are completing the electronic form, note the following: When you enter your plant name and plant ID on the Part A Table of Contents tab, all name and ID fields throughout Part A will automatically populate. Refer to the overall questionnaire instructions, the glossary, and the acronym list for assistance with completing Part A.

Please provide all free response answers in the highlighted yellow areas. Throughout Part A, you may need to make copies of certain sections/questions. Instructions are provided throughout Part A regarding making copies. Note that outfall number or steam electric generating unit ID must be populated on the copied tab or section, located in the upper right corner under "Plant ID" and "Plant Name", in order to correlate the requested information with the correct outfall or steam electric generating unit.

Where the questionnaire indicates to provide an attachment, an electronic format (e.g., PDF) is preferred; however, hardcopies are also acceptable.

Use the Comments tab at the end of Part A to do the following: provide additional information as requested in certain questions within Part A; indicate atypical data (e.g., if 2009 information is not representative of normal operations); and note methods used to make best engineering estimates in the event that exact data are not available.

Plant ID: 03831
Plant Name: Keystone

Part: A
Section Title: 1.1. Plant Contact Information

Instructions: Throughout Section 1.1 (Questions A1-1 to A1-5), provide information requested on plant contacts. Please provide all free response answers in the highlighted yellow areas.

CBI?
☐ Yes

A1-1. Provide the physical plant address in the yellow spaces provided below.

Plant Name: RRI Energy Keystone Generating Station
Street Address: 313 Keystone Dr.
City: Shelocta
State: PA ▼ Zip Code: 15774-7625

CBI?
☐ Yes

A1-2. Provide the name, title, telephone and fax numbers, and e-mail address of the primary contact for technical information supplied in this questionnaire.

Primary Technical Contact Name: James K. LaFontaine
Primary Technical Contact Title: General Manager
Email: jlafontaine@rrienergy.com
Street Address: 313 Keystone Dr.
City: Shelocta
State: PA ▼ Zip Code: 15774-7625
Telephone Number: 724-354-5450
Fax Number: 724-354-5489
Convenient time to call between (Eastern Time): 8:00 AM am ▼
to 4:00 PM pm ▼

CBI?
☐ Yes

A1-3. Provide the name, title, telephone and fax numbers, and e-mail address of the secondary contact for technical information supplied in this questionnaire.

Secondary Technical Contact Name: Steve Frank
Secondary Technical Contact Title: Senior Environmental Specialist
Email: sfrank@rrienergy.com
Street Address: 121 Champion Way, Suite 200
City: Canonsburg
State: PA ▼ Zip Code: 15317
Telephone Number: 724-597-8310
Fax Number: 724-597-8870
Convenient time to call between (Eastern Time): 8:00 AM am ▼
to 4:00 PM pm ▼

CBI?
☐ Yes

A1-4. Provide the name, title, telephone and fax numbers, and e-mail address of the primary contact for economic/financial information supplied in this questionnaire.

Primary Economic/Financial Contact Name: James K. LaFontaine
Primary Economic/Financial Contact Title: General Manager
Email: jlafontaine@rrienergy.com
Street Address: 313 Keystone Dr.
City: Shelocta
State: PA ▼ Zip Code: 15774-7625
Telephone Number: 724-354-5450
Fax Number: 724-354-5489
Convenient time to call between (Eastern Time): 8:00 AM am ▼
to 4:00 PM pm ▼

CBI?
☐ Yes

A1-5. Provide the name, title, telephone and fax numbers, and e-mail address of the secondary contact for economic/financial information supplied in this questionnaire.

Secondary Economic/Financial Contact Name: Fran Macey
Secondary Economic/Financial Contact Title: Accounts Manager
Email: fmacey@rrienergy.com
Street Address: 121 Champion Way Suite 200
City: Cannonsburg
State: PA ▼ Zip Code: 15317
Telephone Number: 724-597-8909
Fax Number: 724-597-8877
Convenient time to call between (Eastern Time): 8:00 AM am ▼
to 4:00 PM pm ▼

Plant ID: 03831
Plant Name: Keystone

Part: A
Section Title: 1.2. General Plant Operating Characteristics

Instructions: Throughout Section 1.2 (Questions A1-6 to A1-14), provide information requested on general *plant* operating characteristics. Please provide all free response answers in the highlighted yellow areas.

CBI?
☐ Yes

A1-6. Is the plant permanently retired or will it be permanently retired by December 31, 2011?

○ Yes (Stop)
● No (Continue)

STOP

<u>STOP</u>! IF YOU ANSWERED YES TO QUESTION A1-6,
DO <u>NOT</u> COMPLETE THE REMAINDER OF THIS QUESTIONNAIRE.

CBI?
☐ Yes

A1-7. Does the plant generate or have the potential to generate electricity from a steam electric generating unit (i.e., a generating unit that utilizes a thermal cycle employing the steam/water system as the thermodynamic medium (steam turbine))? [NOTE: Combined cycle systems with at least one associated steam turbine are considered steam electric generating units.]

● Yes (Continue)
○ No, this plant does not generate or have the potential to generate electricity from a steam electric generating unit. (Stop)

STOP

<u>STOP</u>! IF YOU ANSWERED NO TO QUESTION A1-7,
DO <u>NOT</u> COMPLETE THE REMAINDER OF THIS QUESTIONNAIRE.

CBI?
☐ Yes

A1-8. Indicate all of the fossil or nuclear fuels that the plant used to generate electricity in 2009 (refer to Table A-17 for a further breakdown of fossil-type fuels in the "Type of Fuel" tab). [NOTE: Do **NOT** include fuels only used for start up or emergency generators when answering this question.]

☑ Coal
☐ Oil
☐ Gas
☐ Petroleum Coke
☐ Nuclear Fuel
☐ None (the plant did not use fossil or nuclear fuels other than for start up in 2009)

STOP

STOP! IF YOU ANSWERED NONE IN QUESTION A1-8,
DO NOT COMPLETE THE REMAINDER OF THIS QUESTIONNAIRE.

CBI?
☐ Yes

A1-9. Identify how the plant uses/handles the electricity generated and indicate the percent of **electricity** by end use/handling. [Check all boxes that apply.]

☑ Used on site	7.00%	%
☑ Distributed for sale	93.00%	%
☐ Other		%

If "Other" was selected, use the yellow space below to provide a description of electricity end use/handling.

CBI?
☐ Yes

A1-10. Provide the primary, secondary, and tertiary six-digit North American Industry Classification System (NAICS) codes that best describe the plant's activities. Refer to the U.S. Census Bureau's website to identify appropriate NAICS codes (http://www.census.gov/eos/www/naics/).

Primary NAICS: 221112
Secondary NAICS: ________
Tertiary NAICS: ________

CBI?
☐ Yes

A1-11. Is the generation of electricity the *primary purpose* (i.e., the predominant source of revenue and principal reason for operation) of the plant?

● Yes
○ No, specify the primary purpose of the plant to the right: ____________

STOP

<u>STOP</u>! IF YOU ANSWERED NO IN QUESTION A1-11,
DO <u>NOT</u> COMPLETE THE REMAINDER OF THIS QUESTIONNAIRE.

CBI?
☐ Yes

A1-12. Identify how the plant uses steam generated at the plant and indicate the percent of <u>steam</u> by use. [Check all boxes that apply.]

☑ Electricity Generation 100.00% %
☐ Heating and/or Cooling ____________ %
☐ Other ____________ %

If "Other" was selected, use the space below to provide a description of the use for steam.

____

CBI?
☐ Yes

A1-13. Provide the total plant nameplate electric generating capacity, as reported in U.S. DOE/EIA Form 860, schedule 3, line 1, and the total electric net summer and winter capacities.

Nameplate capacity 1872 MW
Net summer capacity 1700 MW
Net winter capacity 1700 MW

CBI?
☐ Yes

A1-14. In Table A-1, provide the total net and *gross electrical generation* for all electric generating units at the plant during calendar years 2007 through 2009.

Table A-1. Net and Gross Plant Electrical Generation for 2007-2009

Calendar Year	Net Electrical Generation (MW-hrs)	Gross Electrical Generation (MW-hrs)
2007	12275348 MW-hrs	12911644 MW-hrs
2008	14144351 MW-hrs	14854990 MW-hrs
2009	10539111 MW-hrs	11169961 MW-hrs

Plant ID: 03831
Plant Name: Keystone

Part: A
Section Title: 2.1. Plant Identification and Information on Permits and Studies

Instructions: Throughout Section 2.1 (Question A2-1 to A2-4), provide information requested on plant identity, permits, and studies. Please provide all free response answers in the highlighted yellow areas.

CBI? ☐ Yes

A2-1. Provide the identification code of this plant as reported on U.S. DOE/EIA Form-860, "Annual Electric Generator Report," schedule 2, line 1.

EIA Plant Identification Code: 3136 ☐ Check here if not applicable

CBI? ☐ Yes

A2-2. Provide the identification code of this plant as used when reporting to the Rural Utilities Service (RUS).

RUS Plant Identification Code: ________ ☑ Check here if not applicable

CBI? ☐ Yes

A2-3. Did the plant conduct any Environmental Assessment (EA) or Environmental Impact Statement (EIS) studies on receiving waters or pond/impoundments reported in Table A-4?

○ Yes (Continue)
● No (Skip to Question A2-4)

If yes, please attach results from the study(ies).

☐ I have attached the results from the study(ies)
☐ I did not attach the results from the study(ies). Explain why: ________

CBI? ☐ Yes

A2-4. In Table A-2, provide a list of the plant's most recently approved permits that are associated with industrial activities. If the plant has more than one ID for a permit type, list all IDs in the space provided. Also indicate if the plant has a new/pending permit under development.

Note: Do **NOT** include the following types of permits: permits required for construction of wastewater and/or sanitary sewage facilities, erosion and sediment control permits associated with construction activities, temporary and general permits for hydrostatic testing water, water obstruction and encroachment permits, and/or water allocation permits.

Table A-2. Permit Information

Permit Type	Permit ID(s)	Approval Date		Expiration Date		New/Pending Permit is Under Development
		Month	Year	Month	Year	
National Pollutant Discharge Elimination System (NPDES)	PA0002062	February ▼	2008 ▼	March ▼	2013 ▼	
		Select ▼	Select ▼	Select ▼	Select ▼	Select ▼
		Select ▼	Select ▼	Select ▼	Select ▼	
Resource Conservation and Recovery Act (RCRA)	PAD086204245	Select ▼	Select ▼	Select ▼	Select ▼	
		Select ▼	Select ▼	Select ▼	Select ▼	Select ▼
		Select ▼	Select ▼	Select ▼	Select ▼	
Stormwater		Select ▼	Select ▼	Select ▼	Select ▼	
		Select ▼	Select ▼	Select ▼	Select ▼	Select ▼
		Select ▼	Select ▼	Select ▼	Select ▼	
Air Pollution Operating	03-00027	December ▼	2006 ▼	December ▼	2011 ▼	
		Select ▼	Select ▼	Select ▼	Select ▼	Select ▼
		Select ▼	Select ▼	Select ▼	Select ▼	
Underground Injection Control (UIC)		Select ▼	Select ▼	Select ▼	Select ▼	
		Select ▼	Select ▼	Select ▼	Select ▼	Select ▼
		Select ▼	Select ▼	Select ▼	Select ▼	

If the plant does not have an individual *NPDES permit*, skip to Section 3.

Plant ID: 03831
Plant Name: Keystone
Outfall Number: 003

Part: A
Section Title: 2.2. Outfall Information

Instructions: Throughout Section 2.2 (Questions A2-5 to A2-10), provide information for all internal and final outfalls designated in the plant's NPDES permit. Note: This section does not require information on stormwater outfalls, other than those storm water outfalls that may be identified in the NPDES permit itself. Please provide all free response answers in the highlighted yellow areas.

Make copies of Section 2.2 for each outfall designated in the plant's NPDES permit using the "Copy Section 2.2" button below. Enter the outfall number in the space provided above.

CBI?
☐ Yes

A2-5. Provide the name, latitude/longitude, the typical volume of *discharge* in 2009 (either gpd and gpy OR gpm and hpd if flow is intermittent), and the number of days of discharge in 2009 for the outfall.

Outfall Name: Final Outfall to Crooked Creek

Coordinates	Degrees	Minutes	Seconds
Latitude	40	39	19
Longitude	79	21	6

Discharge Flow:

______ gpy **and** ______ dpy	**OR**	6597300 gpd **and** 365 dpy	**OR**	______ gpm **and** ______ hpd **and** ______ dpy

CBI?
☐ Yes

A2-6. Identify if the outfall is an internal or final outfall.

○ Internal Outfall (Skip to Section 3)
● Final Outfall (Continue)

CBI?
☐ Yes

A2-7. Does the outfall release water to a discharge canal prior to discharging to surface water?

○ Yes
● No

CBI?
☐ Yes

A2-8. Provide the receiving surface water name and type of surface water. If the receiving surface water is unnamed, provide the name(s) of the next receiving water downstream with a designated name.

Receiving Surface Water Name: Crooked Creek

Type of Surface Water: River/Stream ▼ Other, specify: ____

If the receiving surface water is unnamed, provide the name(s) of the next receiving water downstream with a designated name. ____

CBI?
☐ Yes

A2-9. Has a mixing zone been applied to the outfall?

○ Yes
● No

CBI?
☐ Yes

A2-10. In Table A-3, provide the percent contribution that each wastewater listed has to the total outfall flow.

Table A-3. Wastewaters Discharged Through Outfall

Wastewater	Percent Contribution of Outfall Flow
Cooling Water	0.00%
Fly Ash Sluice	0.00%
Bottom Ash Sluice	60.00%
FGD Scrubber Wastewater (slurry blowdown or scrubber purge)	0.00%
Leachate from Coal Combustion Residue Landfills or Ponds/Impoundments	10.00%
Coal Pile Runoff	1.00%
Metal Cleaning Waste	0.00%
Storm Water	1.00%
Other	28.00%
Total	100%

☐ Outfall is used for emergency discharges only. (Respondent still required to answer Table A-3.)

Plant ID: 03831
Plant Name: Keystone
Outfall Number: 203

Part: A
Section Title: 2.2. Outfall Information

Instructions: Throughout Section 2.2 (Questions A2-5 to A2-10), provide information for all internal and final outfalls designated in the plant's NPDES permit. Note: This section does not require information on stormwater outfalls, other than those storm water outfalls that may be identified in the NPDES permit itself. Please provide all free response answers in the highlighted yellow areas.

Make copies of Section 2.2 for each outfall designated in the plant's NPDES permit using the "Copy Section 2.2" button below. Enter the outfall number in the space provided above.

CBI?
☐ Yes

A2-5. Provide the name, latitude/longitude, the typical volume of *discharge* in 2009 (either gpd and gpy OR gpm and hpd if flow is intermittent), and the number of days of discharge in 2009 for the outfall.

Outfall Name: Emergency Overflow of Bottom Ash

Coordinates	Degrees	Minutes	Seconds
Latitude	40	39	32
Longitude	79	20	55

Discharge Flow:

0 gpy **and** 0 dpy **OR** ____ gpd **and** ____ dpy **OR** ____ gpm **and** ____ hpd **and** ____ dpy

CBI?
☐ Yes

A2-6. Identify if the outfall is an internal or final outfall.

● Internal Outfall (Skip to Section 3)
○ Final Outfall (Continue)

CBI?
☐ Yes

A2-7. Does the outfall release water to a discharge canal prior to discharging to surface water?

○ Yes
● No

CBI?
☐ Yes

A2-8. Provide the receiving surface water name and type of surface water. If the receiving surface water is unnamed, provide the name(s) of the next receiving water downstream with a designated name.

Receiving Surface Water Name: ____________________

Type of Surface Water: Select ▼ Other, specify: ________

If the receiving surface water is unnamed, provide the name(s) of the next receiving water downstream with a designated name. ____________________

CBI?
☐ Yes

A2-9. Has a mixing zone been applied to the outfall?

○ Yes
● No

CBI?
☐ Yes

A2-10. In Table A-3, provide the percent contribution that each wastewater listed has to the total outfall flow.

Table A-3. Wastewaters Discharged Through Outfall

Wastewater	Percent Contribution of Outfall Flow
Cooling Water	0.00%
Fly Ash Sluice	0.00%
Bottom Ash Sluice	0.00%
FGD Scrubber Wastewater (slurry blowdown or scrubber purge)	0.00%
Leachate from Coal Combustion Residue Landfills or Ponds/Impoundments	0.00%
Coal Pile Runoff	0.00%
Metal Cleaning Waste	0.00%
Storm Water	0.00%
Other	0.00%
Total	100%

☐ Outfall is used for emergency discharges only. (Respondent still required to answer Table A-3.)

Plant ID: 03831
Plant Name: Keystone
Outfall Number: 503

Part: A
Section Title: 2.2. Outfall Information

Instructions: Throughout Section 2.2 (Questions A2-5 to A2-10), provide information for all internal and final outfalls designated in the plant's NPDES permit. Note: This section does not require information on stormwater outfalls, other than those storm water outfalls that may be identified in the NPDES permit itself. Please provide all free response answers in the highlighted yellow areas.

Make copies of Section 2.2 for each outfall designated in the plant's NPDES permit using the "Copy Section 2.2" button below. Enter the outfall number in the space provided above.

CBI? ☐ Yes

A2-5. Provide the name, latitude/longitude, the typical volume of *discharge* in 2009 (either gpd and gpy OR gpm and hpd if flow is intermittent), and the number of days of discharge in 2009 for the outfall.

Outfall Name: Bottom Ash Transport Water and

Coordinates	Degrees	Minutes	Seconds
Latitude	40	39	50
Longitude	79	21	0

Discharge Flow:

______ gpy **and** ______ dpy	**OR**	4559400 gpd **and** 365 dpy	**OR**	______ gpm **and** ______ hpd **and** ______ dpy

CBI? ☐ Yes

A2-6. Identify if the outfall is an internal or final outfall.

● Internal Outfall (Skip to Section 3)
○ Final Outfall (Continue)

CBI?
☐ **Yes**

A2-7. Does the outfall release water to a discharge canal prior to discharging to surface water?

○ Yes
● No

CBI?
☐ **Yes**

A2-8. Provide the receiving surface water name and type of surface water. If the receiving surface water is unnamed, provide the name(s) of the next receiving water downstream with a designated name.

Receiving Surface Water Name: ____________________

Type of Surface Water: Select ▼ Other, specify: ________

If the receiving surface water is unnamed, provide the name(s) of the next receiving water downstream with a designated name. ____________________

CBI?
☐ **Yes**

A2-9. Has a mixing zone been applied to the outfall?

○ Yes
● No

CBI?
☐ **Yes**

A2-10. In Table A-3, provide the percent contribution that each wastewater listed has to the total outfall flow.

Table A-3. Wastewaters Discharged Through Outfall

Wastewater	Percent Contribution of Outfall Flow
Cooling Water	0.00%
Fly Ash Sluice	0.00%
Bottom Ash Sluice	0.00%
FGD Scrubber Wastewater (slurry blowdown or scrubber purge)	0.00%
Leachate from Coal Combustion Residue Landfills or Ponds/Impoundments	0.00%
Coal Pile Runoff	0.00%
Metal Cleaning Waste	0.00%
Storm Water	0.00%
Other	0.00%
Total	100%

☐ **Outfall is used for emergency discharges only. (Respondent still required to answer Table A-3.)**

Plant ID: 03831
Plant Name: Keystone

Part: A
Section Title: 3. Ponds/Impoundments

Instructions: Throughout Section 3 (Questions A3-1 to A3-3), provide information for all *ponds/impoundments* the plant has or is currently constructing/installing or planning to construct/install by December 31, 2020.

CBI?
☐ Yes

A3-1. Does the plant have or is the plant currently constructing/installing or planning to construct/install by December 31, 2020 any ponds/impoundments used for the storage, treatment, and/or disposal of *process wastewater*, *residues*, or by-products (including *sludge* or water streams containing residues or by-products)?

Note: This includes ponds/impoundments located on non-adjoining property that are under the operational control of the plant.

● Yes (Continue)
○ No (Skip to Section 4)

CBI?
☐ Yes

A3-2. In Table A-4 below list all pond/impoundment units located at the plant, or pond/impoundments the plant is currently constructing/installing or planning to construct/install by December 31, 2020, including those located on non-adjoining property, used for storage, treatment, and/or disposal of process wastewater, residues, or by-products (including sludge or water streams containing residues or by-products). For each pond/impoundment unit, EPA assigned an ID number (e.g., SPD-1, SPD-2) in Table A-4, which will be used throughout the remainder of the survey. In the "Plant Designation" column, provide the plant's name for each pond/impoundment unit.

Additionally, provide the latitude and longitude at the pond outlet (see glossary), the closest distance from the pond/impoundment unit to the nearest surface water, the year the pond/impoundment unit was brought online (or is planned to be brought online), and indicate whether the pond/impoundment is lined or unlined and whether leachate (see glossary) is collected from the pond/impoundment (e.g., the pond/impoundment has a leachate collection system or other means for collecting leaks or seepage, etc.). Note: If the pond/impoundment does not have a pond outlet, provide the latitude and longitude corresponding to the emergency outlet for the pond/impoundment.

Table A-4. Identification of Plant Pond/Impoundment Units

Pond/ Impoundment Unit ID	Plant Designation	Latitude and Longitude at Pond Outlet				Is the Pond Lined?	Is Leachate (including Leaks or Seepage) Collected?	Closest Distance to Nearest Surface Water (ft)	Year Initially Brought Online Or Planned to be Brought Online	Is the Pond/ Impoundment Inactive?
			deg	min	sec					
Active/Inactive/Open Pond/Impoundment Units										
SPD-1	Coal Pile Runoff Pond (East)	Lat:	40	39	554	Yes	Yes	1675	1988	No
		Long:	79	20	693					
SPD-2	Coal Pile Runoff Pond (B)	Lat:	40	39	554	Yes	Yes	1675	1988	No
		Long:	79	20	691					
SPD-3	Low Volume Waste Inlet Pond (A)	Lat:	40	39	377	Yes	No	440	1982	No
		Long:	79	20	496					
SPD-4	Low Volume Waste Inlet Pond (B)	Lat:	40	39	386	Yes	No	485	1982	No
		Long:	79	20	498					
SPD-5	Low Volume Waste Outlet Pond (A)	Lat:	40	39	395	Yes	No	455	1982	No
		Long:	79	20	565					
SPD-6	Low Volume Waste Outlet Pond (B)	Lat:	40	39	405	Yes	No	495	1982	No
		Long:	79	20	568					
SPD-7	Bottom Ash Settling Pond (A)	Lat:	40	39	653	Yes	No	2050	1989	No
		Long:	79	20	651					

SPD-8	Bottom Ash Settling Pond (B)	Lat:	40	39	669	Yes ▼	No ▼	2100	1989	No ▼
		Long:	79	20	633					
SPD-9	Bottom Ash Settling Pond (C)	Lat:	40	39	683	Yes ▼	No ▼	2150	1989	No ▼
		Long:	78	20	615					
SPD-10	Bottom Ash Thermal Pond	Lat:	40	39	842	Yes ▼	No ▼	2850	1994	No ▼
		Long:	79	21	63					
SPD-11	Keystone Lagoon	Lat:	40	39	331	No ▼	No ▼	75	1967	No ▼
		Long:	79	21	133					
SPD-12	Site Contact Stormwater /	Lat:	40	39	350	Yes ▼	No ▼	2450	2002	No ▼
		Long:	79	21	199					
SPD-13	Site Storm Water Pond (A)	Lat:	40	40	468	Yes ▼	Yes ▼	750	1985	Yes ▼
		Long:	79	19	721					
SPD-14	Site Storm Water Pond (B)	Lat:	40	40	463	Yes ▼	Yes ▼	750	1985	Yes ▼
		Long:	79	19	695					
Retired/Closed Pond/Impoundment Units										
RET-SPD-1	Bottom Ash Cooling Pond (B)	Lat:	40	39	884	No ▼	No ▼	2925	1967	
		Long:	79	21	72					
RET-SPD-2	Tower Desilting Basin	Lat:	40	39	576	No ▼	No ▼	140	1967	
		Long:	79	20	125					
RET-SPD-3	Site Energy Dissipator Pond	Lat:	40	40	409	No ▼	No ▼	870	1985	
		Long:	79	19	770					
RET-SPD-4		Lat:				Select ▼	Select ▼			
		Long:								
Planned Pond/Impoundment Units										
SPD-A	Gypsum Storage Area SWRO Pond	Lat:				Select ▼	Select ▼		2010	
		Long:								
SPD-B	Limestone Pile SWRO Pond	Lat:				Select ▼	Select ▼		2010	
		Long:								
SPD-C	FGD WWT SWRO Pond	Lat:				Select ▼	Select ▼		2010	
		Long:								
SPD-D		Lat:				Select ▼	Select ▼			
		Long:								
SPD-E		Lat:				Select ▼	Select ▼			
		Long:								

CBI?
☐ Yes

A3-3. In Table A-5 below, indicate all process wastewater, residues, or by-products (or sludges or water streams containing the wastes, residues or by-products) that are stored, treated, and/ or disposed of in each pond/impoundment unit identified in Table A-4. [Check all boxes that apply.] For solid waste and process wastewater not listed in the checkboxes or the drop down menu provide the name and description in the yellow box provided. Do not include treatment chemicals that are added to the pond/impoundment.

Table A-5. Wastes Stored or Disposed of in Plant Pond/Impoundment Units

Pond/ Impoundment Unit ID	Solid Waste		Process Wastewater	
SPD-1 ▼	☐ Boiler Slag ☐ Bottom Ash ☐ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Coal pile runoff ▼ Select ▼ Select ▼	Select ▼ Select ▼ Select ▼
	Other, specify: coal fines Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	
SPD-2 ▼	☐ Boiler Slag ☐ Bottom Ash ☐ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Coal pile runoff ▼ Select ▼ Select ▼	Select ▼ Select ▼ Select ▼
	Other, specify: coal fines Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	
SPD-3 ▼	☐ Boiler Slag ☐ Bottom Ash ☑ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Air heater cleaning water ▼ Floor drain wastewater ▼ Coal pile runoff ▼	Cooling tower blowdown ▼ Filter Backwash ▼ Boiler blowdown ▼
	Other, specify: Other, specify: Other, specify: Other, specify:		Other, specify: Landfill runoff-capped landfill Other, specify: Landfill runoff-uncapped landfill Other, specify: Other, specify:	
SPD-4 ▼	☐ Boiler Slag ☐ Bottom Ash ☑ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Air heater cleaning water ▼ Floor drain wastewater ▼ Coal pile runoff ▼	Cooling tower blowdown ▼ Filter Backwash ▼ Boiler blowdown ▼
	Other, specify: Other, specify: Other, specify: Other, specify:		Other, specify: Landfill runoff-capped landfill Other, specify: Landfill runoff-uncapped landfill Other, specify: Other, specify:	

SPD-5 ▼	☐ Boiler Slag ☐ Bottom Ash ☑ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Air heater cleaning water ▼ Floor drain wastewater ▼ Coal pile runoff ▼	Cooling tower blowdown ▼ Filter Backwash ▼ Boiler blowdown ▼
	Other, specify: Other, specify: Other, specify: Other, specify:	Precipitated treatment sludge	Other, specify: Landfill runoff-capped landfill Other, specify: Landfill runoff-uncapped landfill Other, specify: Other, specify:	
SPD-6 ▼	☐ Boiler Slag ☐ Bottom Ash ☐ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☑ Solids from Dry FGD	Air heater cleaning water ▼ Floor drain wastewater ▼ Coal pile runoff ▼	Cooling tower blowdown ▼ Filter Backwash ▼ Boiler blowdown ▼
	Other, specify: Other, specify: Other, specify: Other, specify:	Precipitated treatment sludge	Other, specify: Landfill runoff-capped landfill Other, specify: Landfill runoff-uncapped landfill Other, specify: Other, specify:	
SPD-7 ▼	☐ Boiler Slag ☑ Bottom Ash ☐ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Bottom ash sluice ▼ Select ▼ Select ▼	Select ▼ Select ▼ Select ▼
	Other, specify: Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	
SPD-8 ▼	☐ Boiler Slag ☑ Bottom Ash ☐ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Bottom ash sluice ▼ Select ▼ Select ▼	Select ▼ Select ▼ Select ▼
	Other, specify: Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	
SPD-9 ▼	☐ Boiler Slag ☑ Bottom Ash ☐ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Bottom ash sluice ▼ Select ▼ Select ▼	Select ▼ Select ▼ Select ▼
	Other, specify: Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	
SPD-10 ▼	☐ Boiler Slag ☑ Bottom Ash ☐ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Bottom ash sluice ▼ Select ▼ Select ▼	Select ▼ Select ▼ Select ▼
	Other, specify: Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	

SPD-11 ▼	☐ Boiler Slag ☐ Bottom Ash ☐ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Air heater cleaning water ▼ Boiler blowdown ▼ Bottom ash sluice ▼	Coal pile runoff ▼ Cooling tower blowdown ▼ Gypsum pile runoff ▼
	Other, specify: silt Other, specify: Other, specify: Other, specify:		Other, specify: Floor Drain Wastewater Other, specify: Ion Exchange Wastewater Other, specify: General Runoff Other, specify: Yard Drain Wastewater, Ash Site Runoff-capped & uncapped	
SPD-12 ▼	☐ Boiler Slag ☑ Bottom Ash ☑ Fly Ash	☑ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Landfill runoff - capped landfill ▼ Landfill runoff - uncapped landfill ▼ Leachate ▼	Select ▼ Select ▼ Select ▼
	Other, specify: Waste Treatment Sludge Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	
SPD-13 ▼	☐ Boiler Slag ☑ Bottom Ash ☑ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Landfill runoff - capped landfill ▼ Leachate ▼ Select ▼	Select ▼ Select ▼ Select ▼
	Other, specify: Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	
SPD-14 ▼	☐ Boiler Slag ☑ Bottom Ash ☑ Fly Ash	☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD	Landfill runoff - capped landfill ▼ Leachate ▼ Select ▼	Select ▼ Select ▼ Select ▼
	Other, specify: Other, specify: Other, specify: Other, specify:		Other, specify: Other, specify: Other, specify: Other, specify:	

Plant ID: Insert Plant ID
Plant Name: Insert Plant Name

Part: A
Section Title: 3. Ponds/Impoundments

Instructions: Throughout Section 3 (Questions A3-1 to A3-3), provide information for all *ponds/impoundments* the plant has or is currently constructing/installing or planning to construct/install by December 31, 2020.

CBI?
☐ Yes

A3-1. Does the plant have or is the plant currently constructing/installing or planning to construct/install by December 31, 2020 any ponds/impoundments used for the storage, treatment, and/or disposal of *process wastewater*, *residues*, or by-products (including *sludge* or water streams containing residues or by-products)?

Note: This includes ponds/impoundments located on non-adjoining property that are under the operational control of the plant.

○ Yes (Continue)
○ No (Skip to Section 4)

CBI?
☐ Yes

A3-2. In Table A-4 below list all pond/impoundment units located at the plant, or pond/impoundments the plant is currently constructing/installing or planning to construct/install by December 31, 2020, including those located on non-adjoining property, used for storage, treatment, and/or disposal of process wastewater, residues, or by-products (including sludge or water streams containing residues or by-products). For each pond/impoundment unit, EPA assigned an ID number (e.g., SPD-1, SPD-2) in Table A-4, which will be used throughout the remainder of the survey. In the "Plant Designation" column, provide the plant's name for each pond/impoundment unit.

Additionally, provide the latitude and longitude at the pond outlet (see glossary), the closest distance from the pond/impoundment unit to the nearest surface water, the year the pond/impoundment unit was brought online (or is planned to be brought online), and indicate whether the pond/impoundment is lined or unlined and whether leachate (see glossary) is collected from the pond/impoundment (e.g., the pond/impoundment has a leachate collection system or other means for collecting leaks or seepage, etc.). Note: If the pond/impoundment does not have a pond outlet, provide the latitude and longitude corresponding to the emergency outlet for the pond/impoundment.

Table A-4. Identification of Plant Pond/Impoundment Units

Pond/ Impoundment Unit ID	Plant Designation	Latitude and Longitude at Pond Outlet				Is the Pond Lined?	Is Leachate (including Leaks or Seepage) Collected?	Closest Distance to Nearest Surface Water	Year Initially Brought Online Or Planned to be Brought Online	Is the Pond/ Impoundment Inactive?
			deg	min	sec			(ft)		
Active/Inactive/Open Pond/Impoundment Units										
SPD-1	Discharge Treatment Vertical	Lat:	40	39	950	▼	▼	50	2000	▼
		Long:	79	19	882					
SPD-2	Discharge Treatment	Lat:	40	39	921	▼	▼	30	2000	▼
		Long:	79	19	834					
SPD-3	Discharge Treatment	Lat:	40	39	350	▼	▼	80	1989	▼
		Long:	79	21	199					
SPD-4		Lat:				▼	▼			▼
		Long:								
SPD-5		Lat:				▼	▼			▼
		Long:								
SPD-6		Lat:				▼	▼			▼
		Long:								
SPD-7		Lat:				▼	▼			▼
		Long:								

SPD-8		Lat:								
		Long:								
SPD-9		Lat:								
		Long:								
SPD-10		Lat:								
		Long:								
SPD-11		Lat:								
		Long:								
SPD-12		Lat:								
		Long:								
SPD-13		Lat:								
		Long:								
SPD-14		Lat:								
		Long:								
Retired/Closed Pond/Impoundment Units										
RET-SPD-1		Lat:								
		Long:								
RET-SPD-2		Lat:								
		Long:								
RET-SPD-3		Lat:								
		Long:								
RET-SPD-4		Lat:								
		Long:								
Planned Pond/Impoundment Units										
SPD-A		Lat:								
		Long:								
SPD-B		Lat:								
		Long:								
SPD-C		Lat:								
		Long:								
SPD-D		Lat:								
		Long:								
SPD-E		Lat:								
		Long:								

CBI?
☐ Yes

A3-3. In Table A-5 below, indicate all process wastewater, residues, or by-products (or sludges or water streams containing the wastes, residues or by-products) that are stored, treated, and/ or disposed of in each pond/impoundment unit identified in Table A-4. [Check all boxes that apply.] For solid waste and process wastewater not listed in the checkboxes or the drop down menu provide the name and description in the yellow box provided. Do not include treatment chemicals that are added to the pond/impoundment.

Table A-5. Wastes Stored or Disposed of in Plant Pond/Impoundment Units

Pond/ Impoundment Unit ID	Solid Waste	Process Wastewater
▼	☐ Boiler Slag ☐ Bottom Ash ☐ Fly Ash ☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD Other, specify: Acid Mine Drainage Precipitate Other, specify: Other, specify: Other, specify:	▼ ▼ ▼ ▼ ▼ ▼ Other, specify: Acid Mine Drainage Other, specify: Other, specify: Other, specify:
▼	☐ Boiler Slag ☐ Bottom Ash ☐ Fly Ash ☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD Other, specify: Acid Mine Drainage Precipitate Other, specify: Other, specify: Other, specify:	▼ ▼ ▼ ▼ ▼ ▼ Other, specify: Acid Mine Drainage Other, specify: Other, specify: Other, specify:
▼	☐ Boiler Slag ☐ Bottom Ash ☐ Fly Ash ☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD Other, specify: Acid Mine Drainage Precipitate Other, specify: Other, specify: Other, specify:	▼ ▼ ▼ ▼ ▼ ▼ Other, specify: Acid Mine Drainage Other, specify: Other, specify: Other, specify:
▼	☐ Boiler Slag ☐ Bottom Ash ☐ Fly Ash ☐ FGD Calcium Sulfate (Gypsum) ☐ FGD Calcium Sulfite – Not Pozzolanic ☐ FGD Pozzolanic Material ☐ Solids from Dry FGD Other, specify: Other, specify: Other, specify: Other, specify:	▼ ▼ ▼ ▼ ▼ ▼ Other, specify: Other, specify: Other, specify: Other, specify:

Plant ID: 03831
Plant Name: Keystone

Part: A
Section Title: 6. Steam Electric Generating Unit Information

Instructions: Throughout Section 6 (Questions A6-1 to A6-2), provide information requested on each steam electric generating unit that the plant has operated or any steam electric generating units the plant is currently constructing/installing or planning to construct/install by December 31, 2015. Plants do NOT need to include information on units retired before January 1, 2009. Please provide all free response answers in the highlighted yellow areas.

CBI?
☐ Yes

A6-1. In Table A-8, provide information for each steam electric generating unit that commenced operating prior to January 1, 2010. Plants do NOT need to include information on units retired before January 1, 2009. For combined cycle systems, provide EIA Generator IDs for all steam and combustion turbines associated with the combined cycle system. Provide the electric generation for the entire combined cycle system in 2009. In the "Type of Unit" column, if you indicate "Other", provide an explanation in the Comments page. See the glossary for definitions of *base load, peaking*, *cycling*, and *intermediate*.

Table A-8. Steam Electric Units Operated Prior to January 1, 2010

Steam Electric Unit	EIA Generator ID	Operated in 2009	Type of Steam Electric Prime Mover (or Turbine)	Total Unit Electric Generation in 2009 (MW-hrs)	Total Unit Nameplate Capacity: Steam Turbine Capacity (MW)	Total Unit Nameplate Capacity: Combustion Turbine Capacity (MW)	Type of Unit	Is this Unit Now Retired?
SE Unit-1	1	● Yes Calendar days of operation: 266 ○ No Was operated in previous years	Stand-Alone Steam Turbine	5257583	936		● Base load ○ Peaking ○ Cycling ○ Intermediate ○ Other, specify:	○ Yes ● No
SE Unit-2	2	● Yes Calendar days of operation: 299 ○ No Was operated in previous years	Stand-Alone Steam Turbine	5912378	936		● Base load ○ Peaking ○ Cycling ○ Intermediate ○ Other, specify:	○ Yes ● No
SE Unit-3		○ Yes Calendar days of operation: ○ No Was operated in previous years	Select				○ Base load ○ Peaking ○ Cycling ○ Intermediate ○ Other, specify:	○ Yes ○ No

Plant ID: 03831
Plant Name: Keystone
SE Unit ID: SE-1

Part: A

Section Title: 8. Fuel Usage by Steam Electric Generating Unit

Instructions: In Section 8 (Questions A8-1 through A8-3), provide information for all steam electric generating units that were operated in 2009, including units that operated for only part of 2009 (i.e., those units for which you responded "Yes" in Question A6-1, Table A-8, "Operated in 2009" column). Please provide all free response answers in the highlighted yellow areas.

Make copies of Section 8 for each steam electric generating unit ID operated in 2009 using the "Copy Section 8" button below. Enter the steam electric generating unit ID (use unit IDs assigned in Table A-8) in the space above titled "SE Unit ID".

Copy Section 8

CBI?
☐ Yes

A8-1. In Table A-11, provide the types and amounts of fuels used in 2009. [Check all boxes that apply.] Include fuels used for start up. Also provide the BTU generated by each general fuel type reported for the year 2009.

Note: EPA is requesting the BTUs actually generated by the fuel. Additionally, for reporting barrels of oil, use a conversion of one barrel is equal to 42 U.S. gallons, if needed.

Table A-11. Fuel Usage for Steam Electric Power Generation in 2009

Fossil/Nuclear Fuels								
Coal and Petroleum Coke		**Gas**		**Oil**		**Nuclear**		
BTU Generated by Coal and/or Petroleum Coke	4.73E+13	**BTU Generated by Gas**		**BTU Generated by Oil**	1.11E+11	**BTU Generated by Nuclear Fuels**		
Type	**Amount (tons)**	**Type**	**Amount (Million ft^3)**	**Type**	**Amount (barrels)**	**Type**	**Amount**	**Units (Specify)**
☐ Anthracite		☐ Natural Gas		☐ No. 1 Fuel Oil		☐ Nuclear		
☑ Bituminous	1868325	☐ Blast Furnace Gas		☑ No. 2 Fuel Oil	18980	☐ None		
☐ Lignite		☐ Gaseous Propane		☐ No. 4 Fuel Oil				
☐ Subbituminous		☐ Other Gases (Provide Below)		☐ No. 5 Fuel Oil				
☐ Waste Coal				☐ No. 6 Fuel Oil				
☐ Coal Synfuel		☐ None		☐ Diesel Fuel				
☐ Other Coal (Provide below)				☐ Jet Fuel				
				☐ Kerosene				
☐ Petroleum Coke				☐ Waste Oil				
☐ None				☐ Other Oil (Provide below)				
				☐ None				
							Total BTU Generated by Fossil/Nuclear Fuels	4.74E+13
Other Fuels (i.e., Fuels other than Fossil or Nuclear)								
Type	**Amount**	**Units (Specify)**	**Type**	**Amount**	**Units (Specify)**	**Type**	**Amount**	**Units (Specify)**
☐ Municipal Solid Waste			☐ Landfill Gas			☐ None		
☐ Wood			☐ Other Biomass			☐ Other (Provide below)		
							Total BTU Generated by Other Fuels	
							Total BTU Generated by All Fuels	4.74E+13

CBI?
☐ Yes

A8-2. Do the total BTUs generated by the fossil/nuclear fuels comprise 50 percent or more of the total BTUs generated by all fuels for the steam electric generating unit in 2009?

● Yes
○ No

CBI?
☐ Yes

A8-3. Did the plant report a fossil or nuclear fuel as the predominant or second most predominant energy source for this generating unit on Form EIA-860 for reporting year 2009? NOTE: This information is reported in Schedule 3, Part B, lines 9 and 11.

● Yes
○ No

If the plant responded "Yes" to either Question A8-2 or A8-3, then this steam electric generating unit is classified as a "fossil/nuclear electric generating unit" for the purposes of this questionnaire. If the plant responded "No" to both Questions A8-2 and A8-3, then this electric generating unit is classified as an "other electric generating unit" for the purposes of this questionnaire.

NOTE: IF <u>ALL</u> STEAM ELECTRIC GENERATING UNITS IDENTIFIED IN TABLE A-8 ARE CLASSIFIED AS "OTHER ELECTRIC GENERATING UNITS" (BASED ON THE CLASSIFICATION DETERMINED FROM QUESTIONS A8-2 AND A8-3), DO <u>NOT</u> COMPLETE THE REMAINDER OF THIS QUESTIONNAIRE.

Plant ID: 03831
Plant Name: Keystone
SE Unit ID: SE-2

Part: A
Section Title: 8. Fuel Usage by Steam Electric Generating Unit

Instructions: In Section 8 (Questions A8-1 through A8-3), provide information for all steam electric generating units that were operated in 2009, including units that operated for only part of 2009 (i.e., those units for which you responded "Yes" in Question A6-1, Table A-8, "Operated in 2009" column). Please provide all free response answers in the highlighted yellow areas.

Make copies of Section 8 for each steam electric generating unit ID operated in 2009 using the "Copy Section 8" button below. Enter the steam electric generating unit ID (use unit IDs assigned in Table A-8) in the space above titled "SE Unit ID".

CBI?
☐ Yes

A8-1. In Table A-11, provide the types and amounts of fuels used in 2009. [Check all boxes that apply.] Include fuels used for start up. Also provide the BTU generated by each general fuel type reported for the year 2009.

Note: EPA is requesting the BTUs actually generated by the fuel. Additionally, for reporting barrels of oil, use a conversion of one barrel is equal to 42 U.S. gallons, if needed.

Table A-11. Fuel Usage for Steam Electric Power Generation in 2009

Fossil/Nuclear Fuels								
Coal and Petroleum Coke		Gas		Oil		Nuclear		
BTU Generated by Coal and/or Petroleum Coke	5.36E+13	BTU Generated by Gas		BTU Generated by Oil	81737029420	BTU Generated by Nuclear Fuels		
Type	Amount (tons)	Type	Amount (Million ft³)	Type	Amount (barrels)	Type	Amount	Units (Specify)
☐ Anthracite		☐ Natural Gas		☐ No. 1 Fuel Oil		☐ Nuclear		
☑ Bituminous	2124596	☐ Blast Furnace Gas		☑ No. 2 Fuel Oil	13916	☐ None		
☐ Lignite		☐ Gaseous Propane		☐ No. 4 Fuel Oil				
☐ Subbituminous		☐ Other Gases (Provide Below)		☐ No. 5 Fuel Oil				
☐ Waste Coal				☐ No. 6 Fuel Oil				
☐ Coal Synfuel		☐ None		☐ Diesel Fuel				
☐ Other Coal (Provide below)				☐ Jet Fuel				
				☐ Kerosene				
☐ Petroleum Coke				☐ Waste Oil				
☐ None				☐ Other Oil (Provide below)				
				☐ None				
							Total BTU Generated by Fossil/Nuclear Fuels	5.37E+13

Other Fuels (i.e., Fuels other than Fossil or Nuclear)								
Type	Amount	Units (Specify)	Type	Amount	Units (Specify)	Type	Amount	Units (Specify)
☐ Municipal Solid Waste			☐ Landfill Gas			☐ None		
☐ Wood			☐ Other Biomass			☐ Other (Provide below)		
							Total BTU Generated by Other Fuels	
							Total BTU Generated by All Fuels	5.37E+13

CBI?
☐ Yes

A8-2. Do the total BTUs generated by the fossil/nuclear fuels comprise 50 percent or more of the total BTUs generated by **all** fuels for the steam electric generating unit in 2009?

● Yes
○ No

CBI?
☐ Yes

A8-3. Did the plant report a fossil or nuclear fuel as the predominant or second most predominant energy source for this generating unit on Form EIA-860 for reporting year 2009? NOTE: This information is reported in Schedule 3, Part B, lines 9 and 11.

● Yes
○ No

If the plant responded "Yes" to either Question A8-2 or A8-3, then this steam electric generating unit is classified as a "fossil/nuclear electric generating unit" for the purposes of this questionnaire. If the plant responded "No" to both Questions A8-2 and A8-3, then this electric generating unit is classified as an "other electric generating unit" for the purposes of this questionnaire.

NOTE: IF ALL STEAM ELECTRIC GENERATING UNITS IDENTIFIED IN TABLE A-8 ARE CLASSIFIED AS "OTHER ELECTRIC GENERATING UNITS" (BASED ON THE CLASSIFICATION DETERMINED FROM QUESTIONS A8-2 AND A8-3), DO NOT COMPLETE THE REMAINDER OF THIS QUESTIONNAIRE.

Plant ID: 03831
Plant Name: Keystone

Part: A
Section Title: 9. NOx Control Systems

Instructions: Throughout Section 9 (Questions A9-1 to A9-11), provide information for all *NOx control systems* operated on fossil-fueled electric generating units on or after January 1, 2009 and all NOx control systems the plant is currently constructing/installing or planning to construct/install on fossil-fueled electric generating units by December 31, 2020. See Part A Section 8 for unit classifications. You will need to indicate the steam electric generating units that are serviced by these air pollution control systems. Use codes from Table A-8 or Table A-9 to designate the SE Unit ID.

CBI?
☐ Yes

A9-1. Did the plant operate any NOx control systems on fossil-fueled electric generating units after January 1, 2009 or is the plant currently constructing/installing or planning to construct/install any NOx control system on fossil-fueled electric generating units by December 31, 2020? See Part A Section 8 for unit classifications.

● Yes (Complete Table A-12)
○ No (Skip to Section 10)

In Table A-12, provide information for NOx control systems that the plant operated after January 1, 2009, is currently constructing/installing, or planning to construct/install by December 31, 2020 on each operating or planned fossil-fueled electric generating unit (identified in Table A-8 or Table A-9). Provide the steam electric generating unit ID (use codes from Table A-8 or Table A-9), the type of NOx control system(s) operating or planned for the steam electric generating unit, whether the NOx control system(s) are operating or planned, and the date the NOx control was/will be installed. In addition, for the steam electric generating units serviced by a SCR system, identify the date and location (i.e., on- or off-site) of the last and next SCR catalyst replacement/regeneration.

Table A-12. NOx Control Systems

					For Steam Electric Generating Units Serviced by a SCR System					
					Date of Last SCR Catalyst Replacement or Regeneration			Date of Next Planned SCR Catalyst Replacement or Regeneration		
SE Unit ID	Type of NOx Control System	Status of NOx Control System	Date of Installation, Previous or Planned Month	Year	Month	Year	Where Last SCR Catalyst Regeneration Occurred	Month	Year	Where Next SCR Catalyst Regeneration is Planned to Occur
	☑ SCR	Operating	May	2003						
	☐ SNCR	Select	Select		April	2009		September	2010	
SE Unit-1	☑ Overfire Air	Operating	May	1997			Offsite			Offsite
	☑ Low NOx burners	Operating	May	1997	Regenerated			Regenerated		
	☐ Other:	Select	Select							
	☑ SCR	Operating	May	2003						
	☐ SNCR	Select	Select		November	2009		September	2010	
SE Unit-2	☑ Overfire Air	Operating	May	1997			Offsite			Offsite
	☑ Low NOx burners	Operating	May	1997	Regenerated			Regenerated		
	☐ Other:	Select	Select							

	☐ SCR	Select	Select					
	☐ SNCR	Select	Select		Select Select		Select Select	
Select	☐ Overfire Air	Select	Select			Select		Select
	☐ Low NOx burners	Select	Select		Select		Select	
	☐ Other:	Select	Select					
	☐ SCR	Select	Select					
	☐ SNCR	Select	Select		Select Select		Select Select	
Select	☐ Overfire Air	Select	Select			Select		Select
	☐ Low NOx burners	Select	Select		Select		Select	
	☐ Other:	Select	Select					
	☐ SCR	Select	Select					
	☐ SNCR	Select	Select		Select Select		Select Select	
Select	☐ Overfire Air	Select	Select			Select		Select
	☐ Low Nox burners	Select	Select		Select		Select	
	☐ Other:	Select	Select					
	☐ SCR	Select	Select					
	☐ SNCR	Select	Select		Select Select		Select Select	
Select	☐ Overfire Air	Select	Select			Select		Select
	☐ Low NOx burners	Select	Select		Select		Select	
	☐ Other:	Select	Select					
	☐ SCR	Select	Select					
	☐ SNCR	Select	Select		Select Select		Select Select	
Select	☐ Overfire Air	Select	Select			Select		Select
	☐ Low NOx burners	Select	Select		Select		Select	
	☐ Other:	Select	Select					
	☐ SCR	Select	Select					
	☐ SNCR	Select	Select		Select Select		Select Select	
Select	☐ Overfire Air	Select	Select			Select		Select
	☐ Low NOx burners	Select	Select		Select		Select	
	☐ Other:	Select	Select					

CBI?
☐ Yes

A9-2. If the plant has sent an SCR catalyst off site for regeneration, provide the company name, location, and phone number for the company(ies) that performed the last two *SCR catalyst regenerations*.

☐ Plant did not send SCR catalyst offsite for regeneration.

Table A-13. Companies that performed the last two SCR catalyst regenerations

Company Name	City	State	Telephone Number
SCR Tech	Charlotte	NC	704-812-4068
		Select	

CBI?
☐ Yes

A9-3. If the SCR catalyst is regenerated on site, indicate whether process wastewater is generated from the regeneration process.

○ Yes	(Continue)
○ No	(Skip to Question A9-7)
● NA: SCR catalyst is NOT regenerated on site	(Skip to Question A9-7)

CBI?
☐ Yes

A9-4. Provide the typical volume of *SCR catalyst regeneration wastewater* generated (gpy) and the frequency at which the process wastewater is generated.

__________ gpy __________ times every __________ year(s)

CBI?
☐ Yes

A9-5. Is the SCR catalyst regeneration wastewater commingled with other wastewaters? If yes, indicate the wastewaters with which the SCR catalyst regeneration wastewater is commingled. [Check all boxes that apply.]

○ Yes
  - ☐ Fly ash transport water
  - ☐ Bottom ash transport water
  - ☐ FGD scrubber purge
  - ☐ Cooling tower blowdown
  - ☐ Once-through cooling water
  - ☐ Cleaning wastes from cleaning metal process equipment
  - ☐ Other, specify: __________

○ No

CBI?
☐ Yes

A9-6. Indicate all intermediate and final destination(s) of the SCR catalyst regeneration wastewater. If the plant recycles the SCR catalyst regeneration wastewater, indicate the plant process to which this water is recycled. [Check all that apply].

☐ Immediately recycled back to plant process. Please describe how the process wastewater is reused:

____

☐ Transferred to on-site treatment system. Identify the type of treatment system below. [Check all boxes that apply.]

☐ Settling pond
☐ pH adjustment
☐ Chemical precipitation
☐ Constructed wetlands
☐ Other, specify: __________

☐ Discharged to surface water. Provide NPDES permitted outfall number (from Part A Section 2.2): __________

☐ Indirect discharge to a publicly or privately owned treatment works

☐ Other, explain: __________

CBI?
☐ Yes

A9-7. Is the SCR catalyst washed on site?

○ Yes	(Continue)
● No	(Skip to Section 10)

CBI?
☐ Yes

A9-8. Is process wastewater generated from the *SCR catalyst washing* process?

○ Yes (Continue)
○ No (Skip to Section 10)

CBI?
☐ Yes

A9-9. Provide the typical volume of *SCR catalyst washing wastewater* generated (gpy) and the frequency at which the process wastewater is generated.

________ gpy ________ times every ________ year(s)

CBI?
☐ Yes

A9-10. Is the SCR catalyst washing wastewater commingled with other wastewaters? If yes, indicate the wastewaters with which the SCR catalyst washing wastewater is commingled. [Check all boxes that apply.]

○ Yes
- ☐ Fly ash transport water
- ☐ Bottom ash transport water
- ☐ FGD scrubber purge
- ☐ Cooling tower blowdown
- ☐ Once-through cooling water
- ☐ Cleaning wastes from cleaning metal process equipment
- ☐ Other, specify: ________

○ No

CBI?
☐ Yes

A9-11. Indicate all intermediate and final destination(s) of the SCR catalyst washing wastewater. If the plant recycles the SCR catalyst washing wastewater, indicate the plant process to which this water is recycled. [Check all that apply].

☐ Immediately recycled back to plant process. Please describe how the process wastewater is reused:
____

☐ Transferred to on-site treatment system. Identify the type of treatment system below. [Check all boxes that apply.]

- ☐ Settling pond
- ☐ pH adjustment
- ☐ Chemical precipitation
- ☐ Constructed wetlands
- ☐ Other, specify: ________

☐ Discharged to surface water. Provide NPDES permitted outfall number (from Part A Section 2.2): ________

☐ Indirect discharge to a publicly or privately owned treatment works

☐ Other, explain: ________

CBI?
☐ Yes

A13-11. Was any water used in the coal pulverization process, other than that used for sluicing mill rejects?

○ Yes (Continue)
● No (Skip to Question A13-12)

Provide the volume of coal pulverization *process wastewater* generated in 2009 (gpd OR gpy) and the frequency of this process wastewater generation (days).

________ Select ▼ Over ________ days

CBI?
☐ Yes

A13-12. Were mill rejects sluiced in 2009?

● Yes (Continue)
○ No (Skip to Question A13-14)

Provide the volume of *mill rejects sluice* water generated in 2009 (gpd OR gpy) and the frequency of sluice water generation (days).

364752 gpd ▼ Over 365 days

CBI?
☐ Yes

A13-13. Were the mill rejects sluiced separately or were they sluiced with fly and/or bottom ash?

Sluiced with bottom ash ▼

CBI?
☐ Yes

A13-14. Are the mill rejects pyritic?

● Yes
○ No
○ Unknown

CBI?
☐ Yes

A13-15. Indicate how mill rejects are disposed of and provide amount(s). If the mill rejects are sent to a pond/impoundment, indicate whether they are combined with fly and/or bottom ash. [Check all boxes that apply.]

☐ Stored in/transferred to a pond/impoundment reported in Table A-4 ______ tpd
  ☐ Combined with fly ash in pond/impoundment
  ☐ Combined with bottom ash in pond/impoundment
  ☐ Not combined with fly or bottom ash in pond/impoundment

☑ Stored in/transferred to a landfill reported in Table A-6 237 tpd
☐ Hauled off site for disposal ______ tpd
☐ Other, explain: ______ ______ tpd

CBI?
☐ Yes

A13-16. Did the plant gasify coal, petroleum coke, or oil to operate an IGCC generating unit during 2009?

○ Yes
● No

CBI?
☐ Yes

A13-17. Is the plant currently operating, currently constructing/installing, or planning to construct/install by December 31, 2015 an *IGCC generating unit* that was not in operation during 2009?

○ Yes
● No

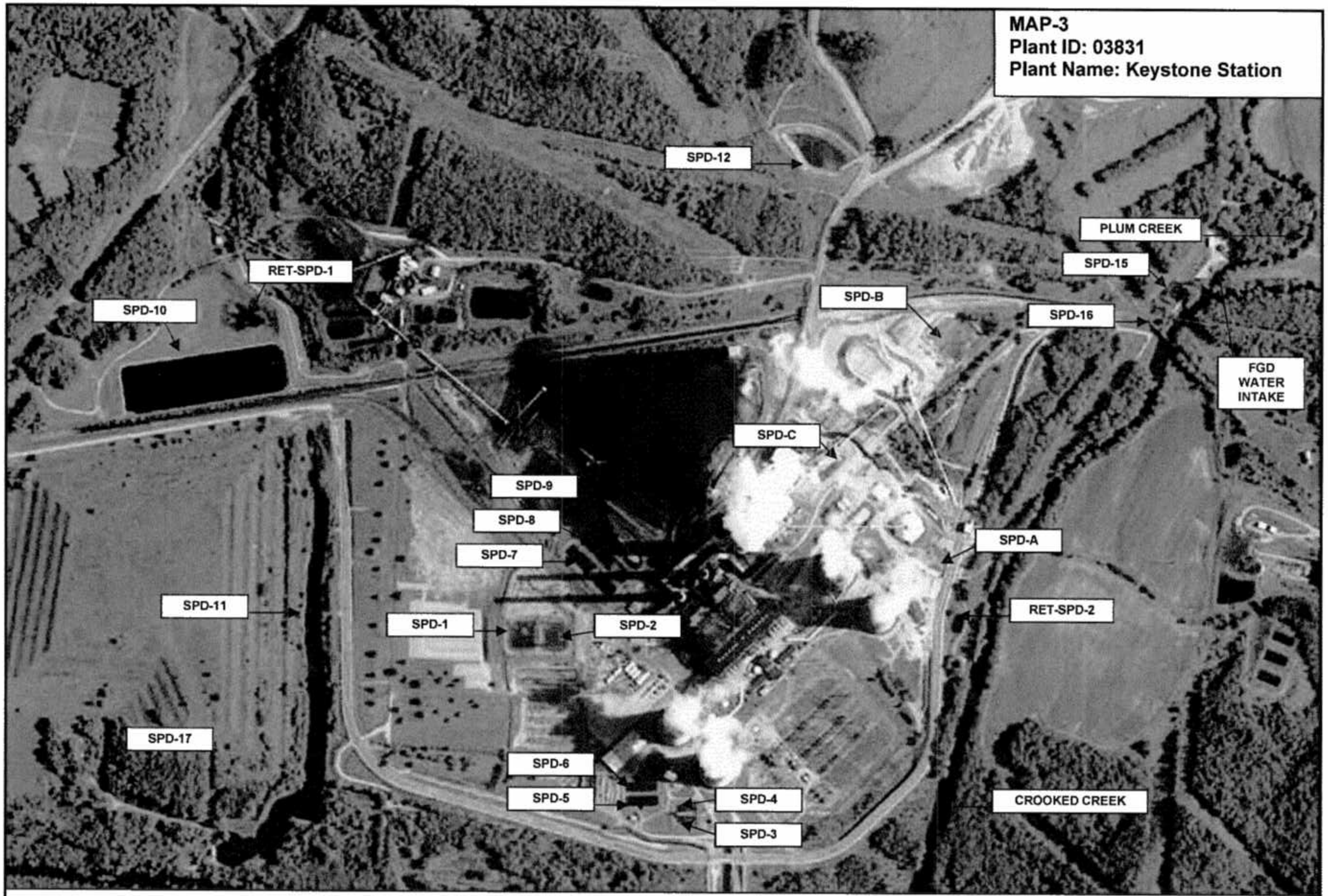
Plant ID: 03831
Plant Name: Keystone

Part: A
Section Title: Part A Comments

Instructions: Cross reference your comments by question number and indicate the confidential status of your comment by checking the box next to "Yes" under "CBI?" (Confidential Business Information).

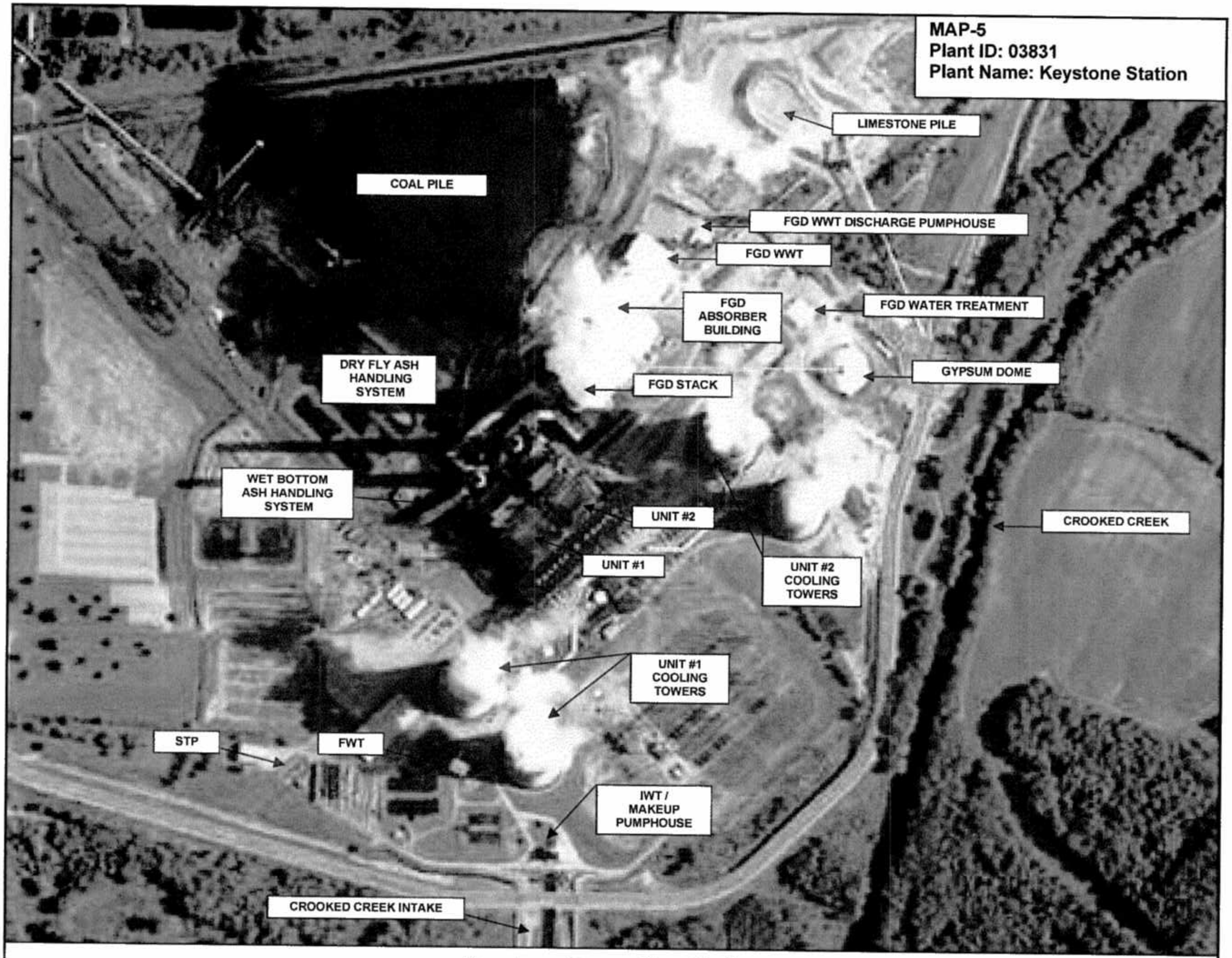
	Question Number	Comment
CBI? ☐ Yes	A13-12	Amount of mill reject pyrite sluice water was reoprted as amount of bottom ash sluice water
CBI? ☐ Yes	A13-15	Tons per day of mill pyrite rejects reported as tons of bottom ash and pyrites reported on 2009 26R report
CBI? ☐ Yes	A2-5	Flow data for Outfalls that have storm water contributions only were estimated from the following formula using precipitation data from the Indiana, PA Airport history for 2009. Q=Drainage Area (sq.ft.)x Runoff Coefficient (0.5) x rainfall (ft) / days of rainfall per year (on days >0.1" of rain) For 2009 there were 51 days that produced 1.7025 ft of precipitation
CBI? ☐ Yes	A3-2 copy 2	Table A-4 copy 2 SPD -1 is SPD-14 clay lined leachate not collected, active impoundment. SPD-2 is SPD-15 clay lined, leachate not collected, active impoundment. SPD-3 is SPD-16 clay lined, leachate not collected, active impoundment.
CBI? ☐ Yes	A2-4	RCRA Permit has no approval or expiration date. ID # only
CBI? ☐ Yes		
CBI? ☐ Yes		
CBI? ☐ Yes		
CBI? ☐ Yes		
CBI? ☐ Yes		
CBI? ☐ Yes		

MAP-3
Plant ID: 03831
Plant Name: Keystone Station



Keystone Generating Station
Ponds / Impoundments 1

MAP-5
Plant ID: 03831
Plant Name: Keystone Station



Keystone Generating Station
Buildings and Structures

APPENDIX A

Document 9

Keystone Ash Filter Ponds O and M Manual

KEYSTONE STATION
ASH FILTER PONDS

OPERATION AND MAINTENANCE MANUAL

Penelec GPU

Prepared for

PENNSYLVANIA ELECTRIC COMPANY
Johnstown, Pennsylvania
June 1989

Gilbert/Commonwealth, Inc.
engineers and consultants - Reading, Pennsylvania

1.0 INTRODUCTION

The purpose of this Operation and Maintenance Manual is to familiarize operating personnel with the improved ash filter pond treatment system at Keystone Station. The manual includes a system description, procedures and guidelines for operation, and maintenance requirements.

1.1 System Function

Bottom ash is sluiced from the ash hoppers to one of four dewatering bins. The dewatering bin overflow and decant water then flows by gravity to the ash filter ponds where the fine suspended solid particles settle to the pond bottom. The overflow from the ash filter ponds is discharged to the station lagoon through NPDES Outfall 503.

The ash filter pond treatment system at Keystone Station is designed to treat bottom ash sluice wastewater by providing sufficient detention time, surface settling area, and sludge storage volume to settle out the fine ash particles escaping the dewatering bins.

1.2 Design Criteria

The design basis for the ash filter pond treatment system is as follows:

(Flow rates and characteristics from dewatering bins)

Average bottom ash sluice flow rate	2,600 gpm
Average daily flow	2,496,000 gpd
Maximum flow rate	11,800 gpm
Bottom ash sluice pH, minimum	7.3 - 8.0
Bottom ash sluice suspended solids, range	500 - 1,000 ppm
Pond liner system permeability	$< 1 \times 10^{-7}$ cm/sec
Number of ponds in service at any time	2

Ponds to be cleaned by truck and front end loader.

Treated Effluent Requirements:

pH	6 - 9
Total suspended solids, average	30
Total suspended solids, maximum daily	100
Oil and grease, average	15
Oil and grease, maximum daily	20

1.3 Summary System Description

Bottom ash is sluiced from the four ash hoppers in each of Units 1 and 2 to one of four dewatering bins using 2,600 gpm ash sluice pumps. The dewatering bin overflow and periodic decant water then flows by gravity to the bottom ash filter ponds. Three ponds are provided, each sized for 50 percent of the bottom ash transport water design flow. Normal operation is two ponds in service at all times, with the third pond being drained, cleaned, and prepared for return to service.

Flow from the dewatering bins is distributed to the ponds through a series of 18-inch knife gate valves at a valving station located between the dewatering bins and the ash ponds.

The ash filter ponds are lined with approximately a two-foot thick bentonite treated clay liner which provides a permeability of less than 1×10^{-7} cm/sec. The clay liner is protected on the bottom by a four-foot layer of coarse aggregate and bottom ash and on the 2H:1V side slopes by an 18-inch layer of rip-rap. An underdrain and filter media is provided to drain the pond and filter out the ash particles during the drain cycle and consists of 1.5 feet of coarse aggregate and 2.5 feet of raw bottom ash. The underdrains above the liner consist of two 8 to 12-inch perforated pipe surrounded by one to two feet of coarse aggregate.

Discharge from the ash filter ponds is over a double-sided weir trough which discharges into a concrete discharge structure. The discharge structure also collects the underdrain flow and is provided with a weir gate for decanting the pond.

The discharge from the three ponds is collected in an 18-inch pipe which flows by gravity to the station lagoon.

The pond treatment facilities also include turbidity curtains which are hung across each pond at its third points to encourage the settlement of fine particles at the inlet end of the pond.

On each pond inlet pipe, a perforated stainless steel basket is provided to contain polymer logs which are used to promote flocculation of the fine ash particles.

2.0 DETAILED SYSTEM DESCRIPTION

2.1 Pond Inlet Distribution System

Overflow from the four dewatering bins is collected and piped through two 18-inch steel pipes. Flow is diverted to the ash filter ponds by operating 18-inch butterfly valves at a valve station located south of pond B. There are six valves, two for each pond as shown in Figure 2-1. The two 18-inch discharge lines for each pond are combined underground into a single 28-inch PE pipe which discharges into the center of each pond. The valve lineup for the inlet valves is presented in Table 3-1. Platforms are provided for valve access.

Design data for the inlet valves is as follows:

● Bill of Material	BN-150
● Manufacturer	Continental Equipment Co.
● Manufacturer Drawing No.	G-12169
● Type	Butterfly Valve
● Model No.	9170, Double R/C, bubble tight shutoff
● No. required	Two for each pond
● Size	18-inch
● Valve operator	#48 Thorn handwheel gear operator
● Materials of construction:	
- body	Iron
- shaft and disc	316 stainless steel
- lining	Hycar (bonded)

A protective splash pad consisting of grouted R-4 rock lining is provided beneath the inlet pipe to prevent erosion.

Each pond inlet pipe is provided with a 1/2-inch thick stainless steel baffle which is designed to dissipate the energy of the inlet flow for a more uniform distribution of wastewater into each pond. The baffle is attached to the inlet pipe. Details are shown on Drawing D-781-072.

KEYSTONE STATION OWNERS GROUP
KEYSTONE STATION UNITS 1 & 2

CIVIL

INLET DISTRIBUTION BOX

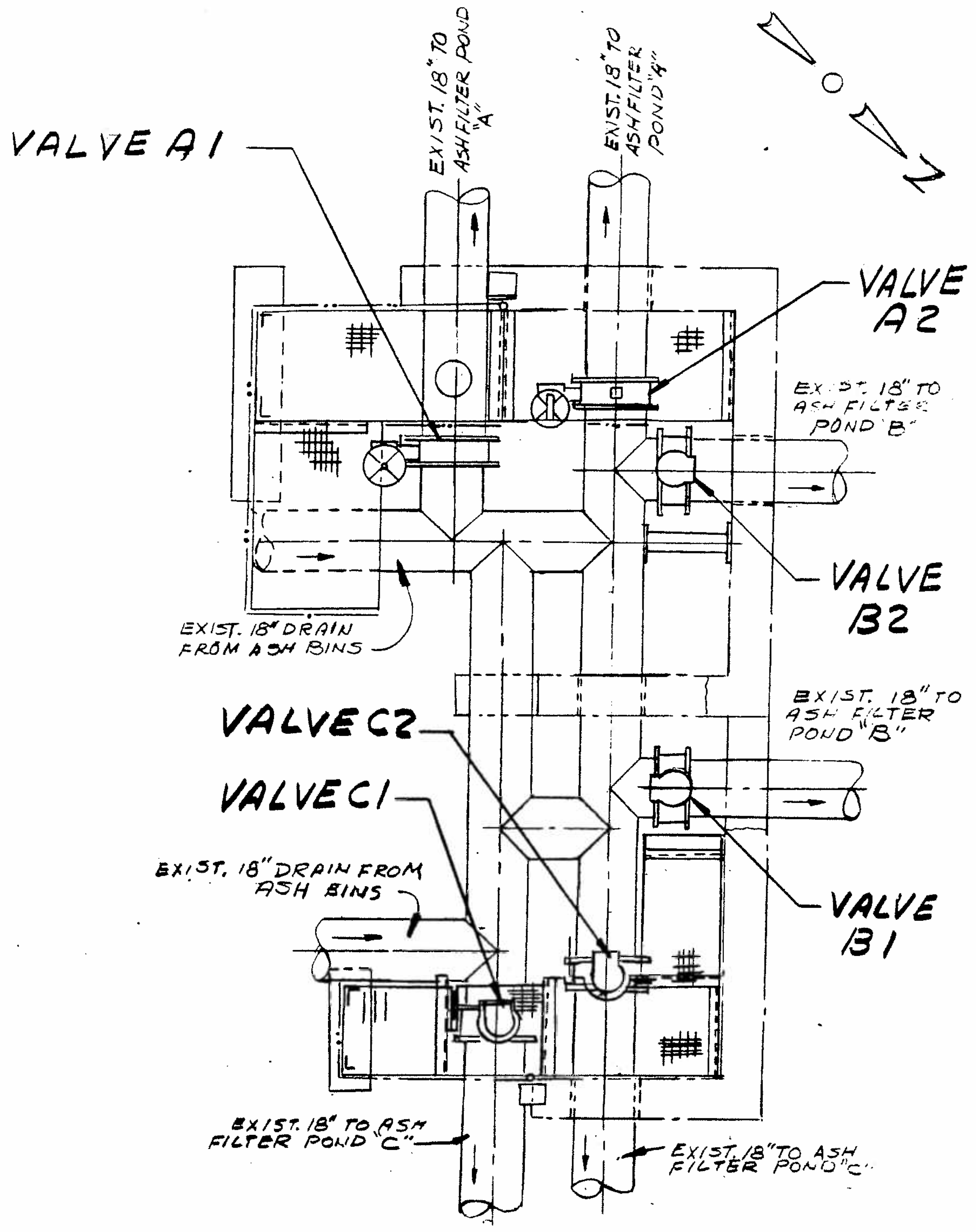
MADE FAC 6-8-87
CHKD
DRAWING NO. FIGURE 2-1
SH. NO.
R
PDS
ENG INTERF 1. 2.

GILBERT ASSOCIATES, IN
ENGINEERS AND CONSULTAN
READING, PA

SCALE AS NOTED
W.O. 044267-182
ENGINEER APPROVAL DEPT DAT

REV	MADE	CH	PDS	APP	DATE	REV	MADE	CH	PDS	APP	D

RELEASED FOR
BIDDING PURPOSES
CONSTRUCTION
ENGR
DATE



PLAN - INLET DISTRIBUTION BOX

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

GAI 2036

● Dimensions at top of pond embankment (El. 1020.5 - 1022.5):	
- Width	90 ft
- Length	410 ft
● Dimensions at normal water level (El. 1018.5):	
- Width	82 ft
- Length	386 ft
● Dimensions at top of bottom ash (El. 1010.35 - 1012.14):	
- Width	53 ft
- Length	370 ft
● Overall depth to top of bottom ash (El. 1020.5 - 1011.0)	9.5 ft
● Max. water depth above top of bottom ash (El. 1018.5 - 1010.25)	8.25 ft
● Allowance for sludge accumulation	4 ft
● Freeboard	2 ft minimum
● Surface area @ water el. 1018.5	31,652 ft^2
● Surface settling rate at average flow rate of 1,300 gpm	0.041 gpm/ft^2
● Maximum detention time at average flow rate (1,300 gpm) and at average sludge depth (2'-0") (El. 1018.5 - 1013.0)	13.8 hrs
● Minimum detention time at design flow rate (5,900 gpm) and at design sludge storage level (4 ft)	2 hrs
● Design sludge storage volume	79,000 ft^3

A 15-foot wide, 12.5 percent grade sloped access ramp with 2 feet of crushed stone structural fill and bottom ash cover is provided on the

A perforated stainless steel basket is provided on each discharge into the pond to hold three polymer logs. Wastewater passes over the polymer logs which slowly dissolve allowing the polymer to mix with the incoming flow. The polymer is used to help flocculate the fine ash particles to enhance particle settling characteristics. The polymer logs are supplied by H.L.&A. - Balsinger, Inc., in Bridgeville, Pennsylvania. A complete description is provided in Appendix B.

A fiberglass walkway is provided from the top of the pond embankment to the inlet pipe and polymer baskets for maintenance.

Polymer log characteristics are as follows:

● Manufacturer	Neutron Products
● Name	Photafloc Polymer gel logs
● Type	Cationic #1132
● Size	9" dia., 20" long
● Weight	40 lbs each
● Number required per pond	Three
● Approximate dosage	0.7 mg/l

2.2 Ash Filter Ponds

Flow from the dewatering bins enters each pond by gravity at the center of the pond inlet end.

Design of the ash filter ponds is shown on Drawings D-781-071 and D-781-072. Design data for the ash filter ponds is as follows:

● Number of ponds	Three
● Materials of construction	Earthen basins with bentonite treated clay liner, covered by No. 8 coarse aggregate and bottom ash, and R-3 rock lining on slopes
● Pond side slopes	2 horizontal; 1 vertical

discharge end of each pond for use by front-end loaders and trucks for cleaning the ponds.

Two turbidity curtains are provided at the third-points of the pond to help settle the ash near the inlet of the pond and disperse flow. The turbidity curtains also provide a thermal advantage by eliminating channelization and allowing the pond surface to dissipate heat. The turbidity curtains are attached to posts on the pond embankment and are removed prior to cleaning the pond. Information on the turbidity curtains is as follows:

• Manufacturer	Acme Products Co.
• Type, Model	Acme "OK Corral"
• Materials of construction	Jaton fabric, 22-ounce, 840 denier nylon, scrim control with PVC
• Length	120 feet w/10" dia. float
• Height	36 inches
• Weight	3/8" galvanized chain

2.2.1 Pond Liner and Underdrain System

Each pond is lined with bentonite treated clay on the bottom and side slopes. The pond liner at the bottom consists of 1'-4" of on-site clay covered by an 8-inch layer of bentonite treated clay covered by 1'-6" of on-site clay. The application rate of bentonite for the 8-inch treated clay layer is 2.4 pounds/square foot.

The side slopes are lined with a 2-foot thick layer of clay and bentonite treated clay installed in 6-inch horizontal lifts with 1'-6" wide overlapping bentonite treated clay layers. The bentonite application rate in the 6-inch lifts is 1.8 pounds/square foot. Reference is made to Drawing D-781-072.

The underdrain system includes two 8 to 12-inch perforated PVC pipes laid just above the bentonite treated clay layer and surrounded by approximately 1-2 feet of No. 57 coarse aggregate along the length of the pipes. Above the pipes and across the bottom of the pond is 1'-6" of finer No. 8 coarse aggregate. Above the coarse aggregate is 2'-6" of raw bottom ash which is the primary filter media.

The underdrain pipes in each pond discharge through 12-inch knife gate valves mounted to the discharge structure.

2.3 Discharge Structure and Overflow Weirs

Wastewater in the pond discharges into the discharge structure through a double-sided weir trough. The discharge structure also receives underdrain flow through two 12-inch knife gate valves mounted to the discharge structure and decanted flow off the ponds through an adjustable weir gate. Design of the discharge structure is shown on Drawing E-423-422, and modifications to the discharge structure are shown on Drawing D-781-073.

2.3.1 Overflow Weirs

A double-sided coated steel discharge trough is provided at the pond outlet to evenly distribute the flow across the pond and to reduce the discharge velocity which reduces suspended solids carryover. The design data for the overflow weir and trough is as follows:

● Materials of construction	steel and fiberglass
● Coating	coal tar epoxy
● Width	2′-3″
● Depth	1′-9 1/2″
● Length to discharge structure (each side)	38′-1 3/4″
● Elevation at invert of weir notch	1018.5 ft
● Weir adjustability	1/4 inch
● Maximum capacity of trough, each side, gpm	6,000
● Overflow velocity at average flow (1,300 gpm)	0.88 ft/sec
● Overflow velocity at maximum flow (11,800 gpm)	1.37 ft/sec

2.3.2 Discharge Structure

The discharge structure has been modified to receive flow from each overflow trough, underdrain system, and decant system. An 18-inch pipe, located at elevation 1005'-2 1/2" at the bottom of the discharge structure carries the overflow to an 18-inch VTC header which discharges into the lagoon at NPDES Outfall 503. Design data for the discharge structure is as follows:

● Material of construction	Concrete
● Coating	Coal tar epoxy
● Dimensions:	
- Width	6'-0"
- Length	8'-0"
- Height	17'-6"
● Discharge pipe	18-inch VTC
● Capacity of discharge pipe	8,100 gpm

A weir gate is installed in the pond side of the discharge structure and is used to decant the ash pond prior to cleaning. Design data for the discharge structure weir gate is as follows:

● Bill of Material	BN-295
● Tag Nos.	V-182-1A V-182-1B V-182-1C
● Manufacturer	Hydro-Gate Corp.
● Manufacturer Drawing No.	860006001
● Model No.	10-00 "316 St. stl."
● No. required	1 per Discharge Structure
● Dimensions:	
- Gate width	54 inches
- Gate height	72 inches
- Overall frame height	114 1/2 inches
- Height from top of frame to full open position	71 1/2 inches

● Gate operator	Crank - counterclockwise to open (lower) gate
● Materials of construction:	
- Slide plate	316L stainless steel
- Frame	316L stainless steel
- Stem	316L stainless steel
- J-seals	Neoprene D2000, Grade 1BE625

Two 12-inch knife gate valves are mounted to the 12-inch underdrain lines which enter the discharge structure. The underdrain system is used to dewater the pond prior to cleaning. The valves are required to prevent backflow of water into the ash pond filter system during cleaning. Design data for the knife gate valve is as follows:

● Bill of Material	BN-299
● Tag Nos.	V-182-A1, V-182-A2 V-182-B1, V-182-B2 V-182-C1, V-182-C2
● Manufacturer	L&M Valve Company Corp.
● Manufacturer Drawing No.	D-870001
● Model No.	M-100 knife gate
● No. required	Two for each discharge structure
● Size	12-inch
● Length - bottom of floor stand to centerline of valve	181.81 inches
● Valve operator	Handwheel
● Material of construction (valve body, gate, and stem)	316 stainless steel

APPENDIX A

Document 10

Design Engineer's Report Keystone Station Feb 1993

DESIGN ENGINEER'S REPORT
KEYSTONE STATION

INDUSTRIAL WASTE TREATMENT MODIFICATIONS: THERMAL DISCHARGE ABATEMENT PROJECT

February 1993

PENNSYLVANIA ELECTRIC COMPANY
Johnstown, Pennsylvania

Gilbert/Commonwealth, Inc.
engineers and consultants - Reading, Pennsylvania

1.0 GENERAL INFORMATION

1.1 FACILITY STATUS

1.1.1 Introduction

Pennsylvania Electric Company (Penelec) operates the Keystone Generating Station, located along Crooked Creek in Plumcreek Township, Armstrong County, Pennsylvania. Treated effluent discharges from Keystone Station have occasionally exceeded the permitted thermal discharge limits for the lagoon outfall (NPDES Outfall 003) into Crooked Creek. The facilities described in this report are intended to assure compliance with thermal limitations.

Four modifications have been or are being implemented to achieve compliance with thermal limitations. The first modification, implemented in early 1992, consisted of using cold side circulating water for ash sluicing rather than hot side circulating water. The second modification involves the replacement of the fill in the cooling towers to increase their efficiency. This is currently being performed during station outages and will be completed in 1994. These two modifications are internal plant process changes which do not require a Water Quality Management Part II Permit.

The third modification consists of re-routing the bottom ash hopper overflow and seal trough overflow to the existing bottom ash filter ponds. This wastewater presently flows by gravity to the industrial waste treatment plant (IWT) and is subsequently discharged through Monitoring Point 403 to the station lagoon, and is then discharged to Crooked Creek through Outfall 003. This wastewater is similar in characteristics to the bottom ash transport water presently treated in the bottom ash filter ponds. The ash ponds will treat this wastewater as well as, or better than, the IWT, while improving the thermal discharge characteristics.

The fourth modification consists of re-routing the effluent from the bottom ash filter ponds to the existing "old bottom ash disposal ponds", which will be re-named "cooling ponds". These large ponds will provide additional evaporative cooling surface to improve thermal discharge characteristics. Monitoring Point 503 will be moved from the bottom ash filter pond discharge to the cooling pond discharge.

This report is a "Design Engineer's Report" as required for an application to the Pennsylvania Department of Environmental Resources (PaDER) for an amended Water Quality Management Part II Permit. The report describes the proposed facilities for the above modifications in the format suggested by the PaDER Industrial Waste Manual. An application for amendment of the existing NPDES Part I Permit has been previously submitted. An application for a Dam Permit for each cooling pond will be submitted to PaDER, Bureau of Dams and Waterway Management.

1.1.2 Regulatory Background

On March 30, 1990, PaDER revised and reissued NPDES Permit No. PA0002062 for Keystone Station. Effluent limitations for Monitoring Point 503 and Outfall 003, the only discharges affected by the facilities described in this report, are as follows:

- Monitoring Point 503
  TSS - 30 mg/l average monthly; 100 mg/l maximum daily
  Oil and Grease - 15 mg/l average monthly; 20 mg/l maximum daily
  pH - not less than 6.0 units

- Outfall 003
  TSS - 30 mg/l average monthly; 100 mg/l maximum daily
  Oil and Grease - 15 mg/l average monthly; 20 mg/l maximum daily; 30 mg/l instantaneous maximum
  pH - 6.0 to 9.0 units
  Temperature -
    July 1 to Dec. 31 - Maximum daily heat rejection 7.0 x 10^8 BTU/day
    Jan. 1 to June 30 - Maximum daily heat rejection 14.0 x 10^8 BTU/day

Penelec has entered a Consent Order and Agreement (COA) with PaDER establishing a schedule for design and construction of facilities necessary to meet effluent thermal limitations. Schedule requirements of the COA include the following:

- Convert the source of ash sluice water for Unit 2 to cooled water downstream of the cooling towers no later than August 31, 1992.

- Convert the source of ash sluice water for Unit 1 to cooled water downstream of the cooling towers no later than May 31, 1993.

- Replace fill material in the cooling towers as follows:
  - Two of four cooling towers by May 31, 1992
  - Three of four cooling towers by May 31, 1993
  - All four cooling towers by May 31, 1994

- Re-route bottom ash filter pond discharge to former ash settling ponds (cooling ponds) no later than September 30, 1994. Amendment applications for the Part I and Part II permits must be submitted within 150 days of the date of execution of the COA.

This report and application fulfill that portion of Paragraph 5 of the COA which requires submittal of a Part II Permit application within 150 days of execution of the COA, which means by February 12, 1993.

1.1.3 Source, Volume, and Nature of Wastewater

The wastewater presently treated in the bottom ash filter ponds is bottom ash transport water. Circulating water from the cooling towers is used, under pressure, to sluice ash from the ash hoppers at the bottom of the boilers to the bottom ash dewatering bins. Most of the bottom ash solids are removed in the dewatering bins. Dewatering bin overflow and decant water then flows by gravity to the bottom ash filter ponds for removal of residual suspended solids.

The wastewater which is proposed to be re-routed to the bottom ash filter ponds is ash hopper overflow and seal trough overflow. Both of these result from circulating water used in the ash handling system at the bottom of the boilers, and both are collected in boiler sumps located near the ash hoppers in each unit. Ash hopper overflow is primarily refractory cooling water that overflows the ash hopper when ash is not being sluiced. Seal trough overflow is cooling water that forms a water seal in a trough between the bottom of the boiler and the ash hopper. Both of these wastewaters have characteristics similar to the bottom ash transport water, except for a lower suspended solids concentration.

Wastewater flow rates for the bottom ash transport water are based on actual measured flow data at Monitoring Point 503 for the period of January 1991 through August 1992. Wastewater flow rates for bottom ash hopper overflow and seal trough overflow are estimated based on analysis of wastewater sources and flow rates at Monitoring Point 403. Flow rate for these sources is estimated to be a continuous flow of 1000 gpm (500 gpm for each unit). Discharge rates for Monitoring Point 503, as reported in the NPDES Part I Permit application, are as follows:

- <u>Long term average discharge rate -</u>

  - Bottom ash transport water = 2.75 mgd
  - Ash hopper overflow/seal trough overflow = <u>1.45 mgd</u>

    4.20 mgd

- <u>Maximum daily discharge rate -</u>

  - Bottom ash transport water = 5.75 mgd
  - Ash hopper overflow/seal trough overflow = <u>1.45 mgd</u>

    7.20 mgd

1.2 GENERAL FACILITY LAYOUT DIAGRAM

Drawing E-781-084 shows the general layout of Keystone Station, including the existing bottom ash filter ponds and the proposed cooling ponds. Project location is further identified by the attached U.S.G.S. topographic map reproduction.

1.3 GENERAL PROJECT DESCRIPTION

1.3.1 <u>Existing Bottom Ash Filter Ponds</u>

Three existing bottom ash filter ponds are provided, each sized for 50 percent of the design flow rate. Normal operation is two ponds in service at all times, with the third pond being drained, cleaned, and prepared for return to service.

This project does not involve any modifications to the existing bottom ash filter ponds. However, a new inlet distribution box will be provided to improve flow distribution between the ponds.

1.3.2 Proposed Modifications

The proposed modifications described in this application are as follows:

- Boiler Sump Pumps and Piping

  Ash hopper overflow and seal trough overflow will be re-routed to the bottom ash filter ponds by installing two 100 percent capacity sump pumps in each of the two boiler sumps. Each pump will have a design capacity of 500 gpm, for a total capacity of 1000 gpm from two units (two boiler sumps). Pump discharge piping will generally follow the routing of the bottom ash sluice piping to the dewatering bins, where it will bypass the dewatering bins and follow the bin overflow piping to the bottom ash filter ponds. The existing boiler sump overflow piping to the industrial wastewater treatment plant will be retained for emergency and upset flow conditions.

- Ash Filter Pond Pump Station and Piping

  Treated effluent from the bottom ash filter ponds will be directed to a new pump station to be located near the effluent end of the ponds. The pump station will be provided with three 50 percent capacity pumps. Each pump will have a nominal design capacity of 2,800 gpm, for a total capacity of 8,400 gpm with all three pumps operating. However, a single pump operating alone will run out on its operating curve and deliver approximately 3,500 gpm. Pump discharge piping will generally parallel the plant entrance road to the proposed cooling ponds. The existing gravity discharge line from the bottom ash filter ponds to the station lagoon will be retained for an emergency overflow from the pump station.

- Cooling Ponds

  The two existing "old bottom ash disposal ponds" will be upgraded and modified for use as cooling ponds. Normal operation will be both ponds operating simultaneously, in parallel. The ponds will be provided with an impervious lining and an underdrain system to facilitate cleaning. The ponds will be designed to be cleaned once every five years, at a time when having one pond out of service will not affect the ability to meet thermal discharge limitations. It will not be practical to clean out the ponds on a more frequent basis, since only a small amount of solids will settle out on a yearly basis. NPDES Monitoring Point 503 will be moved from the bottom ash filter pond discharge to the cooling pond discharge.

The sequence of construction of the proposed modifications is not a significant concern for this project. It will not be necessary to remove any existing treatment units from operation during construction, and current treatment efficiency will not be affected.

The project schedule will be in accordance with the Consent Order and Agreement (COA). The COA requires the cooling ponds to be placed into service on or before September 30, 1994. The COA further requires Penelec to achieve full compliance with thermal limitations of NPDES Permit No. PA0002062 for Outfall 003 by November 30, 1994.

1.3.3 Wastewater Characteristics

The characteristics of the wastewater to be treated in the bottom ash filter ponds and cooling ponds are discussed in Section 1.1.3 and further presented in Module B. Effluent from the proposed system will meet existing effluent limitations for Monitoring Point 503 and will enable compliance with thermal limitations for Outfall 003.

1.4 SCHEMATIC FLOW DIAGRAM

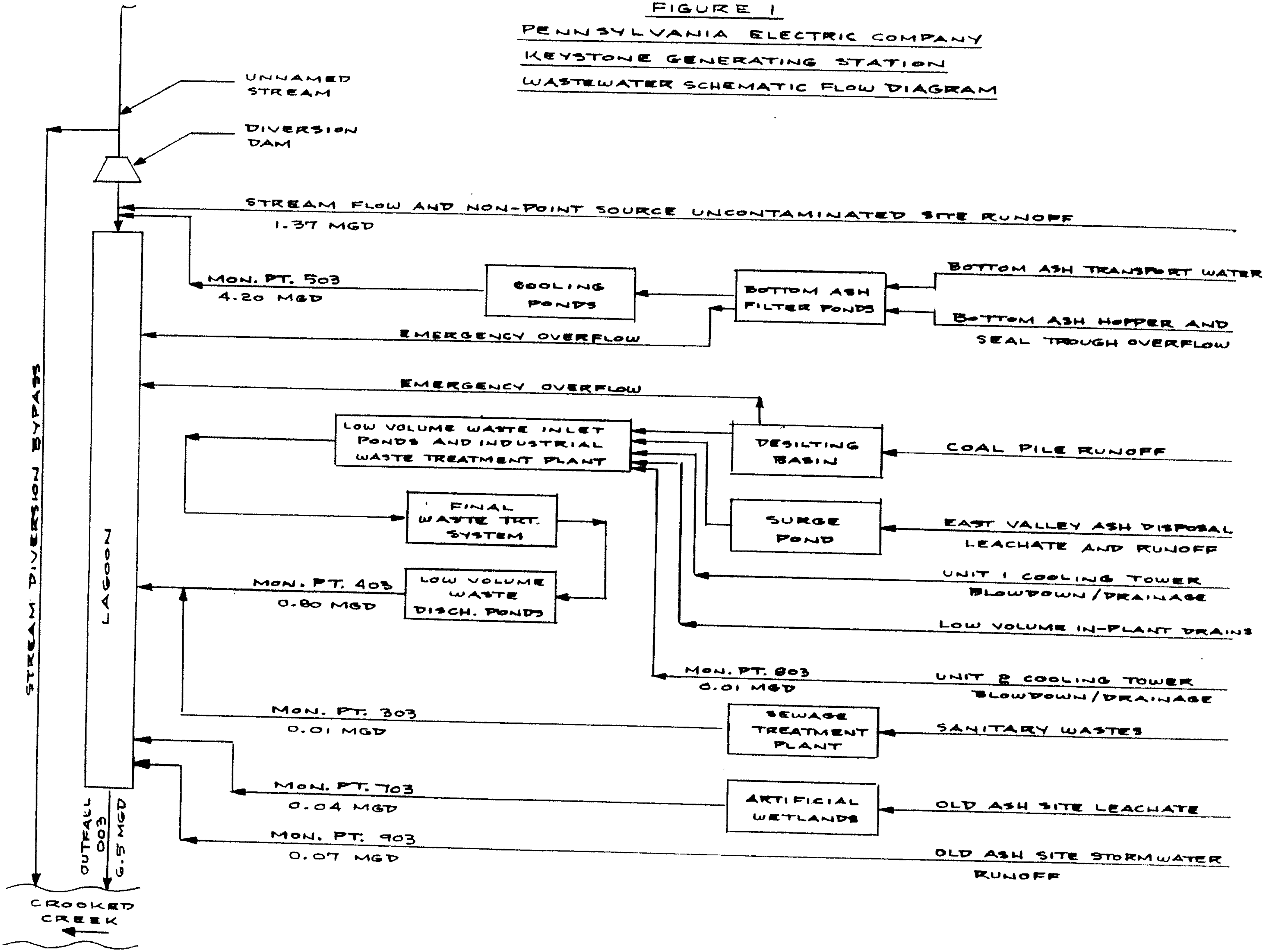
Figure 1 is a schematic flow diagram showing the relationship of the proposed facilities to other Keystone Station wastewater treatment systems. Figure 2 is a schematic flow diagram for the systems covered by this application, including the boiler sumps and pumps, bottom ash filter ponds, ash filter pond pump station, cooling ponds, and Monitoring Point 503. The functional relationship between existing and proposed treatment units is shown. The new pumps, piping arrangements, and new monitoring station for Monitoring Point 503 are also shown. Emergency overflows for each sump are shown.

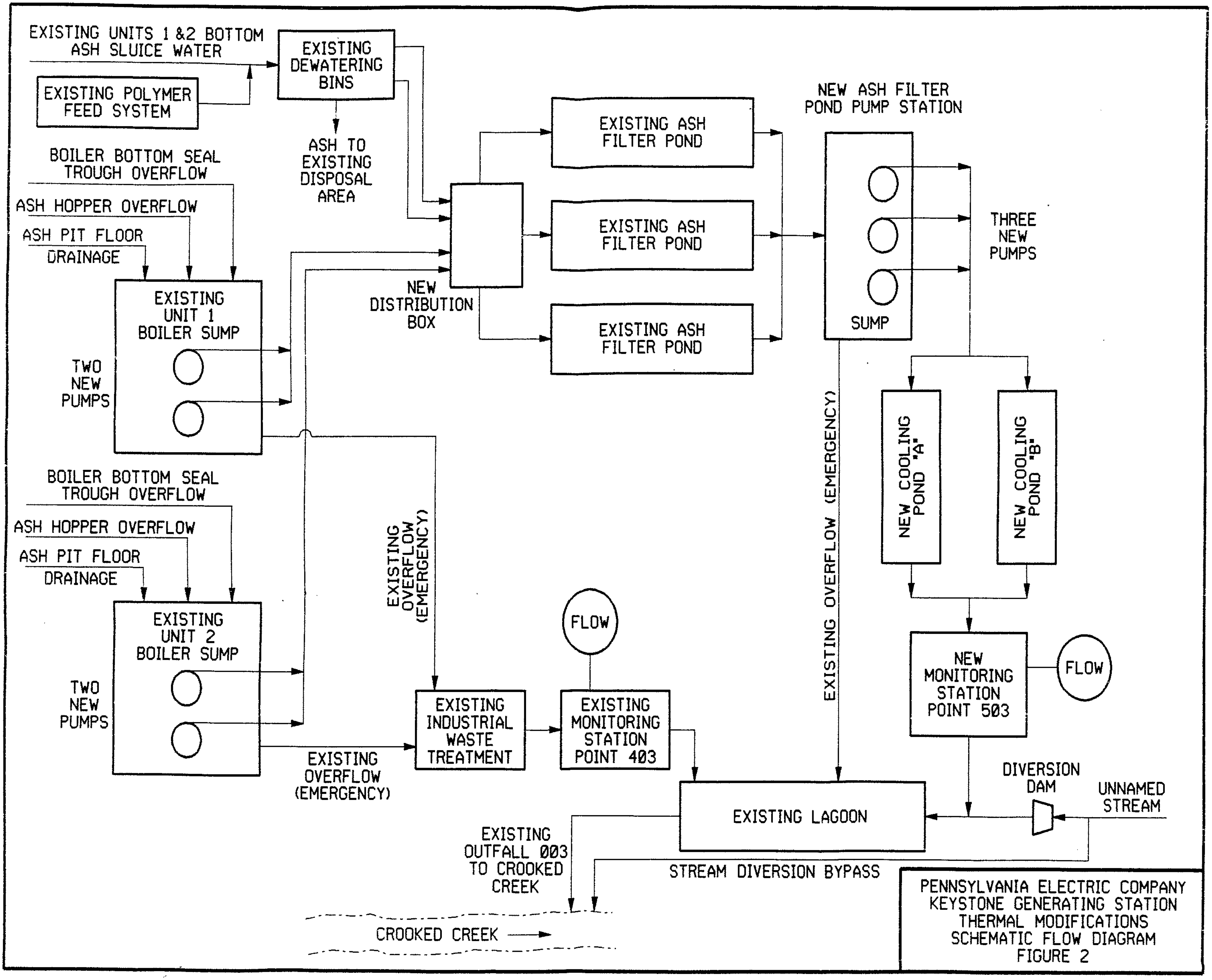
1.5 TREATMENT FACILITY SIZE, CAPACITY, AND DIMENSION DIAGRAM

Figure 3 is a schematic flow diagram showing the size, capacity, and dimensions of each treatment unit.

FIGURE 1

PENNSYLVANIA ELECTRIC COMPANY
KEYSTONE GENERATING STATION
WASTEWATER SCHEMATIC FLOW DIAGRAM





PENNSYLVANIA ELECTRIC COMPANY
KEYSTONE GENERATING STATION
THERMAL MODIFICATIONS
SCHEMATIC FLOW DIAGRAM
FIGURE 2

4.0 SUBSURFACE INFORMATION

4.1 GENERAL GEOLOGY, SOILS, AND GROUNDWATER INFORMATION

The "Geological Map of Pennsylvania," as prepared by the Pennsylvania Topographic and Geological Survey in 1980, indicates that the geological formation underlying the site is the Glenshaw Formation of the Pennsylvania Age. The Glenshaw Formation is described as cyclic sequences of shale, sandstone, red beds, and then limestone and coal. It also includes four marine limestone or shale horizons. The red beds are involved in landslides and the base is at the top of Upper Freeport Coal.

The "Soil Survey of Armstrong County, Pennsylvania," Sheet Numbers 68 and 73, indicates that the site soils are Sm and WkF. Sm denotes Strip Mines and WkF denotes Weikert and Gilpin soils with 25 to 70 percent slopes.

Strip mines consist of sandstone, boulders, fractured shale, and some soil material that has been distributed by mining operations. Slopes range from nearly level to very steep.

WkF is described as shallow, well drained, and gently sloping to very steep soils on uplands. These areas consist of Weikert shaley silt loam and Gilpin channery silt loam. Typically, the surface layer consists of shaley or channery silt loam and is about 4 inches thick. The subsoil is 22 inches thick. It is weak, yellowish-brown silt loam in the upper 5 inches; moderate, heavy, yellowish-brown silt loam in the lower 17 inches. The substratum is yellowish-brown, shaley silt loam with 30% coarse fragments, to a depth of 34 inches. Surface runoff is rapid. Permeability is moderate to moderately rapid, and available moisture capacity is very low to moderate. The hazard of erosion is high if the soil is cultivated.

A total of twelve borings (Monitoring Well #3A, SD-1 through SD-5, SD-5A, and 92-1 through 92-5) and nine test pits (TP 93-1 through TP 93-9) have been drilled or excavated in the area of the proposed cooling ponds. Logs for the borings and test pits are included in Appendix A.

Four of the borings (92-1, 92-2, 92-4, and 92-5) were drilled recently in the eastern embankment of the cooling ponds. The borings indicated that the embankments were constructed of stiff to very stiff sandy silt and clay with rock fragments. Top of rock encountered in the borings varied from approximately elevation 971.5' to 962'. The rock appeared to be sloped at a 20:1 (horizontal:vertical) grade towards the stream.

The pond embankments are stable for all anticipated loading conditions. A slope stability analysis was performed for the critical section of the eastern embankment of the cooling ponds. The minimum factor of safety against embankment failure using Bishop's Method of Slices was 1.74 for static conditions and 1.35 for dynamic conditions.

Groundwater data obtained indicates that the groundwater will be below bottom of the proposed liner system for the cooling ponds. The groundwater elevation appears to vary from approximately elevation 984' at Monitoring Well #3A (located west of the ponds) to approximately elevation 972' at the stream (located east of the ponds). No groundwater seepage or springs has been observed in any of the embankments for the existing ponds. The liner system for the proposed cooling ponds is going to be placed on top of the subgrade for the existing ponds. For the bottom of Cooling Pond

"A", the liner varies from approximately elevation 1002' at the western end to elevation 980' at the eastern end. For the bottom of Cooling Pond "B", the liner varies from approximately elevation 988' at the western end to elevation 980' at the eastern end.

The cooling ponds are not located in the floodway boundaries as indicated on maps from flood insurance studies provided by the municipality (FEMA mapping). The flood hazard boundaries are shown on Figure 5.

4.2 MONITORING WELLS

No monitoring wells are planned, because the only purpose of the proposed cooling ponds is thermal abatement.

APPENDIX B

Product Information for Liner and Cover

NSC

HDPE GEOMEMBRANE

National Seal Company's High Density Polyethylene (HDPE) geomembranes are extruded using virgin, first-quality, high molecular weight, polyethylene resin and are manufactured specifically for the purpose of containment in hydraulic structures. The HDPE compound used in **NSC** geomembranes has been formulated to be chemically resistant, free of leachable additives and resistant to ultraviolet degradation.

50 MIL (1.25mm) PHYSICAL PROPERTIES

ALL PROPERTIES MEET OR EXCEED NSF STANDARD 54 SPECIFICATIONS FOR HDPE

PROPERTY	MINIMUM AVERAGE ROLL VALUES (unless otherwise indicated)			
	ENGLISH		METRIC	
	UNITS	VALUE	UNITS	VALUE
THICKNESS, ASTM D 751, NSF Mod., Nominal	mils	50.0	mm	1.25
Minimum Average	mils	50.0	mm	1.27
Lowest Individual Reading	mils	47.5	mm	1.21
DENSITY, ASTM D 1505			g/cm^3	0.940
MELT FLOW INDEX, ASTM D 1238, Cond. E, Max.			g/10 min	1.0
CARBON BLACK CONTENT, ASTM D 1603	percent	2.0 to 3.0	percent	2.0 TO 3.0
CARBON BLACK DISPERSION, ASTM D 3015	rating	A1 or A2	rating	A1 or A2
MINIMUM TENSILE PROPERTIES, ASTM D 638				
Stress at Yield	psi	2200	MPa	15.2
	ppi	110	N/cm	193
Stress at Break	psi	3800	MPa	26.2
	ppi	190	N/cm	333
Strain at Yield	percent	13	percent	13
nominal gage of 1.30" per NSF Mod.				
Strain at Break	percent	700	percent	700
nominal gage of 2.5" per NSF Mod.	percent	560	percent	560
TEAR RESISTANCE, ASTM D1004	ppi	700	N/cm	1230
	lbs	35	N	156
PUNCTURE RESISTANCE, FTMS 101, 2065	ppi	1300	N/cm	2280
	lbs	65	N	289
ESCR, ASTM D 1693, NSF Mod., Pass	hours	1500	hours	1500
DIMENSIONAL STABILITY, ASTM D1204, NSF Mod, Max.	percent	2.0	percent	2.0

NATIONAL SEAL SEAMING PROPERTIES
(All NSC seams will demonstrate a Film Tearing Bond in Peel and Shear)

SHEAR STRENGTH, ASTM D 4437, NSF Mod.	psi	2000	MPa	13.8
	ppi	100	N/cm	175
PEEL ADHESION, ASTM D 4437, NSF Mod.	psi	1500	MPa	10.3
(Hot wedge fusion weld)	ppi	75	N/cm	131
PEEL ADHESION, ASTM D 4437, NSF Mod.	psi	1300	MPa	8.97
(fillet extrusion weld)	ppi	65	N/cm	114

HD-50-0391C

NSC

NATIONAL SEAL COMPANY
1245 Corporate Blvd., Suite 300
Aurora, IL 60504
800/323-3820 708/898-1161
Fax: 708/898-3461

NSC

HDPE GEOMEMBRANE

50 MIL (1.25mm) CHARACTERISTICS

PROPERTY	MINIMUM AVERAGE ROLL VALUES (unless otherwise indicated)			
	ENGLISH		METRIC	
	UNITS	VALUE	UNITS	VALUE
MODULUS OF ELASTICITY, ASTM D 882	psi	80,000	MPa	552
HYDROSTATIC RESISTANCE, ASTM D 751 A	psi	375	MPa	2.59
COEF. LINEAR THERMAL EXPANSION, Nominal	/°F	6.7×10^{-5}	/° C	1.2×10^{-4}
BRITTLENESS TEMP, ASTM D 746 B, Pass	°F	-103	°C	-75
SOIL BURIAL RESISTANCE, NSF 54, Max. Change	percent	10	percent	10
OIT, 200° C, 1 atm 0_2 Al pan	minutes	100	sec	6,000
PUNCTURE RESISTANCE, ASTM D 4833	ppi	1800	N/cm	3150
	lbs	90	N	400
TENSILE IMPACT, ASTM D 1822	ft lbs/in²	238	kJ/m²	500
VOLATILE LOSS, ASTM D 1203A, Max.	percent	0.1	percent	0.1
OZONE RESISTANCE, ASTM D 1149, 168 hrs, 100 pphm		No Cracks		No Cracks
WATER ABSORPTION, ASTM D 570, 23° C	percent	0.1	percent	0.1
WATER VAPOR TRANSMISSION, ASTM E 96, Max.			g/hr m²	0.007
PERMEABILITY, WATER, ASTM E 96, Max.			cm/sec Pa	1.6×10^{-13}

STANDARD ROLL DIMENSIONS*	TYPICAL ROLL VALUE			
WEIGHT	lbs	5,000	kg	2,270
WIDTH	ft	15.0	m	4.57
LENGTH	ft	1,340	m	408
AREA	ft²	20,100	M²	1,867

*Values Are Approximate
Custom Roll Sizes And Half Size Rolls Are Available
Sheet is Rolled on 12" Diameter Cores

HD-50-0391C

NSC does not generally perform conformance testing for properties on this page.

FRICTION SEAL ™ HD

FRICTION SEAL HD, National Seal Company's advanced textured high density polyethylene (HDPE) geomembrane, is manufactured by attaching an HDPE friction surface to NSC's high quality HDPE geomembrane. The friction surface is made from high molecular weight polyethylene resin compounded specifically for use in NSC geomembranes. The resin has been formulated to provide stress crack, chemical and ultraviolet resistance for fluid containment. NSC produces FRICTION SEAL HD with a textured surface on one or both sides of the parent sheet.

50 MIL (1.25mm) PHYSICAL PROPERTIES

PROPERTY	MINIMUM AVERAGE ROLL VALUES* (unless otherwise indicated)			
	ENGLISH		METRIC	
	UNITS	VALUE	UNITS	VALUE
MASS PER UNIT AREA	lb/ft^2	>0.25	kg/m^2	>1.22
CORE THICKNESS, ASTM D 751, NSF Mod., Nominal	mils	50.0	mm	1.25
Lowest Individual Reading	mils	47.5	mm	1.21
CORE DENSITY, ASTM D 1505			g/cm^3	0.940
MELT FLOW INDEX, ASTM D 1238, Cond. E, Max.			g/10 min	1.0
CARBON BLACK CONTENT, ASTM D 1603	percent	2.0 to 3.0	percent	2.0 to 3.0
CARBON BLACK DISPERSION, ASTM D 3015	rating	A1 or A2	rating	A1 or A2
MINIMUM TENSILE PROPERTIES, ASTM D 638				
Stress at Yield	psi	2200	MPa	15.2
	ppi	110	N/cm	193
Stress at Break	psi	2200	MPa	15.2
	ppi	110	N/cm	193
Strain at Yield, nominal gage of 1.30" per NSF Mod.	percent	13	percent	13
Strain at Break	percent	300	percent	300
nominal gage of 2.5" per NSF Mod.	percent	240	percent	240
TEAR RESISTANCE, ASTM D1004	ppi	700	N/cm	1230
	lbs	35	N	156
PUNCTURE RESISTANCE, FTMS 101, 2065	ppi	1300	N/cm	2280
	lbs	65	N	289
ESCR, ASTM D 1693, NSF Mod., Pass	hours	1500	hours	1500
DIMENSIONAL STABILITY, ASTM D1204, NSF Mod, Max.	percent	2.0	percent	2.0

NATIONAL SEAL SEAMING PROPERTIES

(All NSC seams will demonstrate a Film Tearing Bond in Peel and Shear)

SHEAR STRENGTH, ASTM D 4437, NSF Mod.	psi	2000	MPa	13.8
	ppi	100	N/cm	175
PEEL ADHESION, ASTM D 4437, NSF Mod.	psi	1500	MPa	10.3
(hot wedge fusion weld)	ppi	75	N/cm	131
PEEL ADHESION, ASTM D 4437, NSF Mod.	psi	1300	MPa	8.97
(fillet extrusion weld)	ppi	65	N/cm	114

*Stress and strength values are normalized to the nominal base sheet thickness. NSC certifies properties based on values calculated using nominal thickness only. Stress values calculated using actual product thickness is not guaranteed due to the lack of industry accepted thickness test procedures for friction sheet.

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800/323-3820 708/898-1161
Fax 708/898-3461

NSC

FRICTION SEAL™ HD

50 MIL (1.25mm) CHARACTERISTICS

PROPERTY	MINIMUM AVERAGE ROLL VALUES (unless otherwise indicated)			
	ENGLISH		METRIC	
	UNITS	VALUE	UNITS	VALUE
MODULUS OF ELASTICITY, ASTM D 882	psi	80,000	MPa	552
HYDROSTATIC RESISTANCE, ASTM D 751 A	psi	375	MPa	2.59
COEF. LINEAR THERMAL EXPANSION, Nominal	/°F	6.7×10^{-5}	/° C	1.2×10^{-4}
BRITTLENESS TEMP, ASTM D 746 B, Pass	°F	-103	°C	-75
SOIL BURIAL RESISTANCE, NSF 54, Max. Change	percent	10	percent	10
OIT, 200° C, 1 atm O_2, Al pan	minutes	100	sec	6,000
PUNCTURE RESISTANCE, ASTM D 4833	ppi	1800	N/cm	3150
	lbs	90	N	400
TENSILE IMPACT, ASTM D 1822	ft lbs/in²	238	kJ/m²	500
VOLATILE LOSS, ASTM D 1203A, Max.	percent	0.1	percent	0.1
OZONE RESISTANCE, ASTM D 1149, 168 hrs, 100 pphm		No Cracks		No Cracks
WATER ABSORPTION, ASTM D 570, 23° C	percent	0.1	percent	0.1
WATER VAPOR TRANSMISSION, ASTM E 96, Max.			g/hr m²	0.007
PERMEABILITY, WATER, ASTM E 96, Typical			cm/sec Pa	1.6×10^{-13}
FRICTION ANGLE, Tilt Table, ASTM D35 Proposed, Industry Standard Carpet, Typical	degrees	58	degrees	58

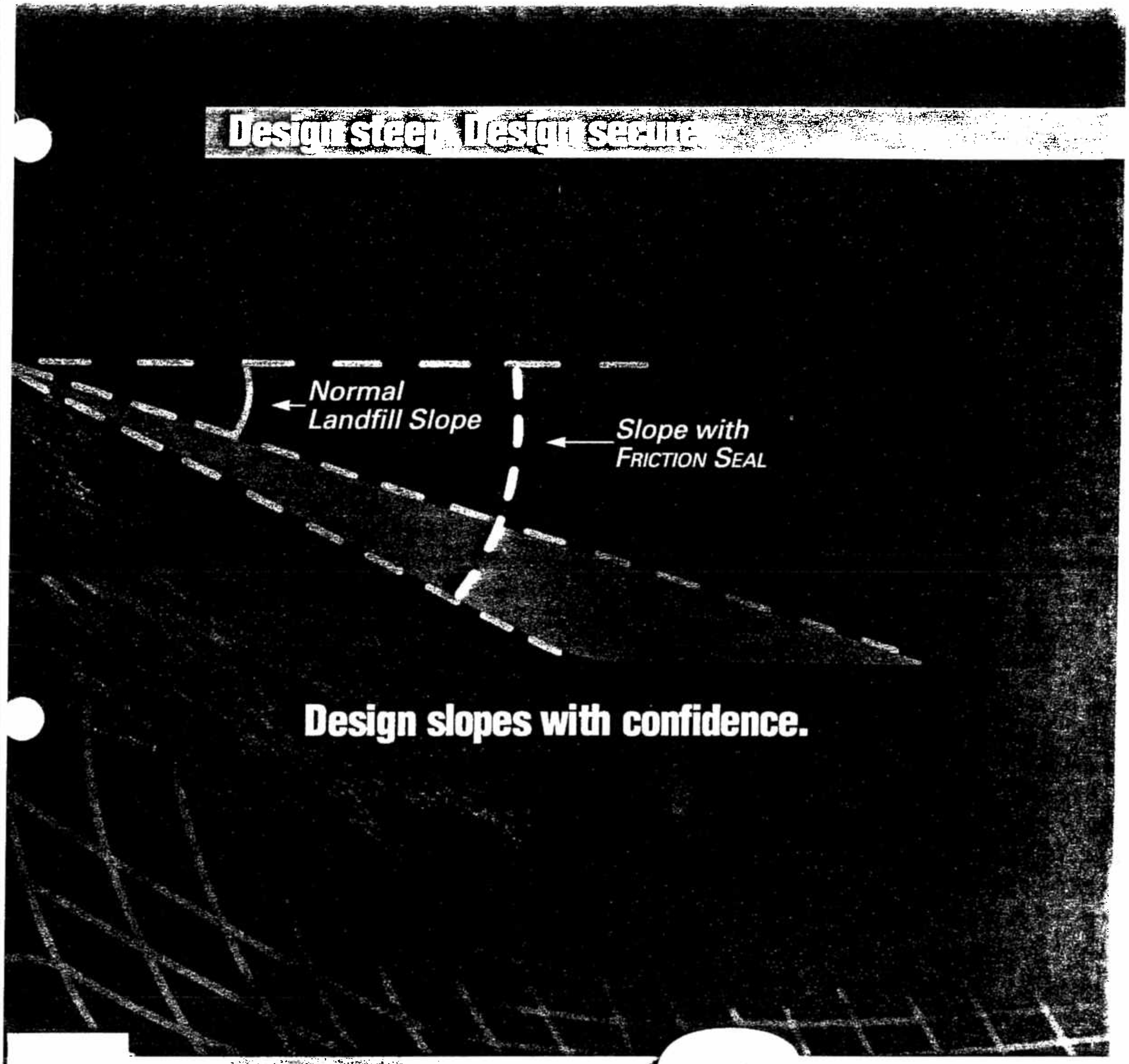
STANDARD ROLL DIMENSIONS

FRICTION SEAL HD geomembranes are manufactured in 15 foot widths.
Approximately 6 - 10 inches are left smooth on each edge providing ideal seaming surfaces.
FRICTION SEAL HD is rolled on 12" diameter cores.

FS-50-0491B

NSC does not generally perform conformance testing for properties on this page.

Design steep. Design secure.



Design slopes with confidence.

National Seal Company

National Seal Company (NSC), a leading manufacturer of waste containment systems, has developed a complete line of high-performance textured geomembranes called FRICTION SEAL™. FRICTION SEAL's textured surface increases the safety factor for steep slope designs by increasing friction angles between layers. As a result, the steeper slopes may increase the site's total airspace.

FRICTION SEAL is manufactured using a secondary manufacturing process. This method attaches a high performance textured surface to an NSC base sheet. By applying the surface separately, FRICTION SEAL offers many distinct advantages.

FRICTION SEAL

	Stress Crack Resistance	Puncture Properties	Ultraviolet Resistance	Chemical Resistance	Multi-Axial Seam Properties
FRICTION SEAL HD	2	3	1	1	3
FRICTION SEAL VL	1	1	3	3	2
FRICTION SEAL CX*	1	2	1	2	1

1 = Highly Recommended 2 = Excellent 3 = Good with Proper Design

*CX = COEX SEAL, a coextruded geomembrane consisting of a VLDPE core layered between HDPE.

The chart above can assist in selecting the best liner material depending on which physical properties are most critical.

HIGHEST COEFFICIENT OF FRICTION

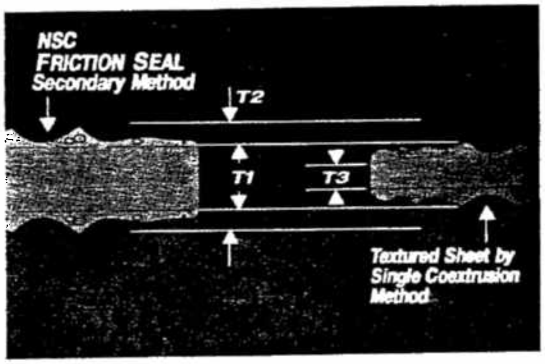
FRICTION SEAL AGAINST	FRICTION ANGLE (degrees)	ADHESION* (pounds per sq. ft.)
DRAINAGE SAND	37°	25psf
CLAY	29°	150psf
NONWOVEN GEOTEXTILE	32°	55psf

Test was run on a 12" x 12" direct shear box at strain rates of 0.04 in./min. on the soil profiles and 0.20 in./min. on the geotextile profile. Normal compressive loads of 3psi, 6psi, and 9psi were used.

ıaı Seal Company's manufactur-
ocess adds a friction coating to
:, VLDPE, or COEX SEAL™, a
uded geomembrane. This capa-
allows the design engineer to
the textured sheet most suit-
for the application at hand.
nding on the application,
TION SEAL can be textured on
r both sides of any of NSC's
hylene geomembranes.

QUALITY CONTROL ASSURANCE

Base Sheet Measurement vs. Peak to Peak Measurement



T1: Compares FRICTION SEAL's minimum thickness (base sheet thickness) to the minimum thickness of the textured sheet by single coextrusion method (total sheet thickness)

T2: Overall FRICTION SEAL thickness

T3: Actual textured sheet base thickness by single coextrusion method

National Seal Company's exclusive secondary process permits conclusive quality control testing of both the parent sheet and the friction coating. This ensures that all base properties and friction properties are met. National Seal Company guarantees FRICTION SEAL's minimum thickness will never be less than the core thickness at any given point throughout the entire sheet.

Like all National Seal geomembranes, FRICTION SEAL's base sheet is manufactured using a computer controlled, flat sheet extruder. This process guarantees a material thickness of ±5% from target, the most stringent quality control available in the industry. FRICTION SEAL is available in 40 mil (1mm), 60 mil (1.5mm), 80 mil (2mm), and 100 mil (2.5mm) for a wide range of applications.

TION SEAL offers a superior
icient of friction with soils and
ynthetics. By using FRICTION
L with a geocomposite, the
sion between the various layers
e greatly increased. As a result,
critical failure plane can be
ed into the soil improving slope
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taining high safety factors. The
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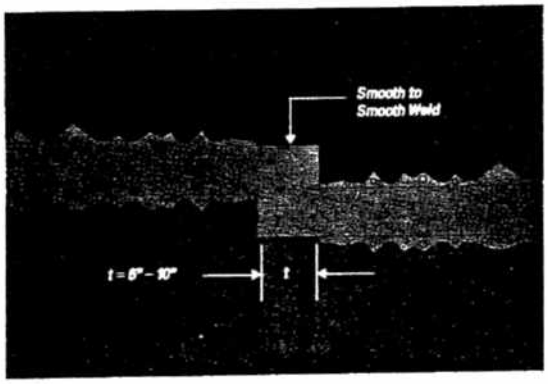
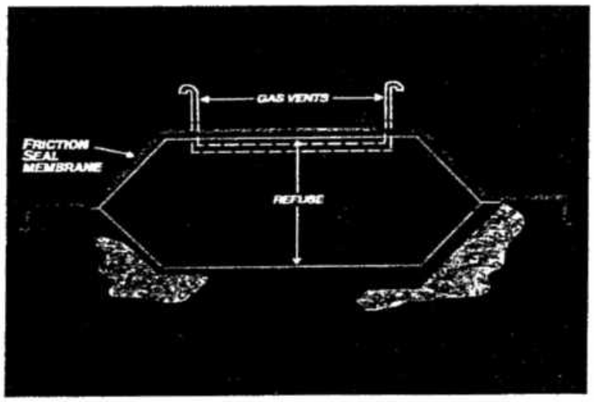
HIGH QUALITY SEAMING



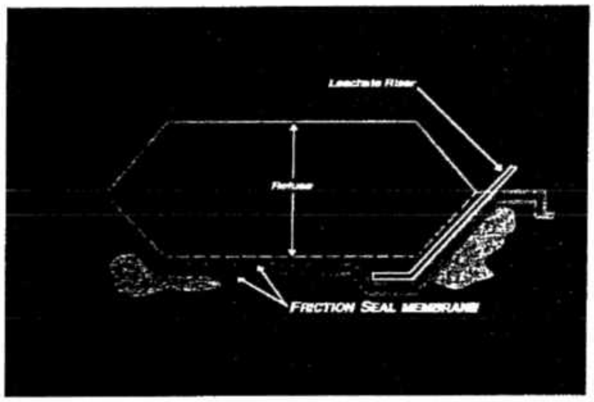
FRICTION SEAL is produced with a 6"-10" smooth edge on both sides of the sheet, top and bottom. The smooth surfaces provide a better weld, ensuring the same high quality seams found in all of National Seal's geomembrane systems. Some other textured sheets weld two rough surfaces together. This may cause a decrease in welding speed and an increase in "squeeze out" due to the melt-through of the friction coating to the base sheet. By keeping FRICTION SEAL's edges smooth, there is never a concern about the various heights of the peaks and valleys. The smooth edges also permit quick verification of the core's thickness and strength before installation.

Applications

Caps and Closures — Landfill caps are one of the most common uses of FRICTION SEAL. The textured coating permits the design of steeper slopes providing maximum airspace within the cell and greater safety factors against slope failure. FRICTION SEAL VL, a textured sheet with a VLDPE core, is well suited for this application due to its high elongation. Landfills can settle over time and the VLDPE composition is better able to conform to settlement than HDPE, without jeopardizing the integrity of the liner.

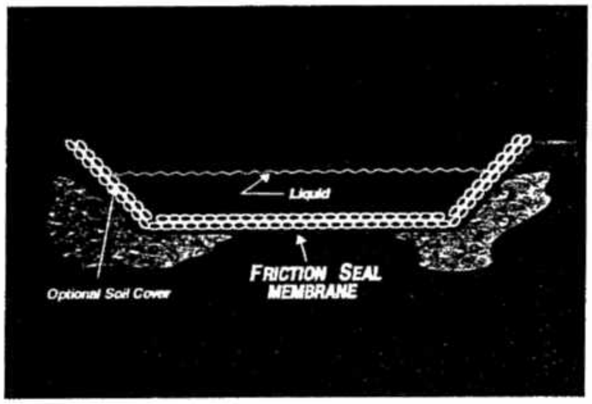


Landfills — FRICTION SEAL is ideal for steep slopes within landfill cells. It's unique design provides greater airspace on steep slopes while improving safety factors against slippage. Both FRICTION SEAL HD, a textured sheet with an HDPE core, and FRICTION SEAL CX, a textured sheet with a coextruded core consisting of HDPE and VLDPE, are excellent for landfill applications. Their excellent chemical resistance properties along with the friction coating, secures the geosynthetic site.



FRICTION SEAL CX is also superb for vertical expansions of new landfills over existing landfills. The HDPE composition provides chemical resistance to leachate, while the VLDPE exhibits the elongation needed for differential settlement created by the existing cell.

Ponds and Lagoons — FRICTION SEAL CX is recommended for pond and lagoon applications. The VLDPE composition provides excellent flexibility, while the HDPE offers superb ultraviolet resistance. FRICTION SEAL CX will improve the friction resistance of the geosynthetic lining system.



NSC

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ARMORFORM® THE ENGINEERED SYSTEM

THE ARMORFORM SYSTEM DESIGNED FOR ECONOMY, STRENGTH, AND DURABILITY

The ARMORFORM system provides numerous advantages over conventional erosion control methods including; cost effectiveness, strength, durability, and minimal maintenance. ARMORFORM revetments and linings are constructed of water permeable, double-layer, woven fabric forms, filled with a high strength fine aggregate concrete (structural grout) which combines cement, fine aggregate (sand), and water into a mix designed to provide a readily pumpable structural grout. Unlike other cast-in-place concrete methods, which are cast into open forms, ARMORFORM is pumped and formed under pressure thereby providing superior quality in terms of physical strength and durability.

ARMORFORM fabrics are designed to serve as filters as well as forms. Structural grout is mixed with a typical water/cement ratio of 0.65 to 0.75. Excess mixing water is expelled through the specially designed permeable fabrics, allowing a substantial reduction in the water/cement ratio of the in-place grout thereby providing increased strength and durability.

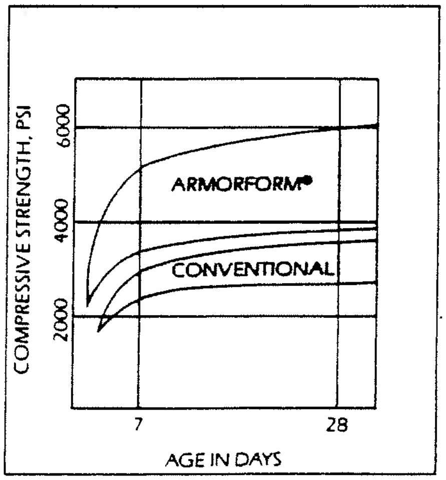
ARMORFORM revetments and linings provide superior physical properties. Structural grout pumped into ARMORFORM fabric forms is 1.5 to 1.75 times stronger than companion specimens taken from conventional forms. In addition, the structural grout has less than 5% water absorption. The ARMORFORM system is the ideal choice in applications requiring resistance to mild concentrations of acid, alkali, salt or petrochemicals. With minimal water absorption, the ARMORFORM system is also resistant to freeze thaw action. This prolongs the installation's life while reducing the chance of concrete "breakup" caused by extreme temperature changes.

The higher compressive strengths achieved by the ARMORFORM system permits revetments and linings to be constructed without steel reinforcement. This strength factor eliminates the need for costly materials and specialized labor, making it ideal for a diversity of demanding applications.

ENGINEERED FOR PERFORMANCE

The ARMORFORM system is engineered for hydraulic efficiency. Unlike stone rip-rap linings or gabions, the ARMORFORM system permits design for maximum channel velocities by offering less resistance to flow. They are self-cleaning, require minimum maintenance, and provide a clean and environmentally attractive appearance which is far less hazardous to pedestrians and animals than stone rip-rap. The result is a less expensive erosion control system which can remove water up to three times as fast as stone rip-rap linings. Thus, large areas can be drained more efficiently, quickly, and at a lower installed cost with an ARMORFORM system.

ARMORFORM CONCRETE -vs- CONVENTIONAL CONCRETE



Note: Compressive strength varies as a function of mix design

ARMORFORM® MANUFACTURE AND FABRICATION

ARMORFORM FABRIC

Nicolon Corporation's manufacturing plant in Cornelia, Georgia is equipped with the most modern weaving equipment available in the world today. Our goal at Nicolon is to supply the customer with the best engineered and highest quality products on the market.

MATERIALS USED ARE SECOND TO NONE

At Nicolon, we buy the finest raw materials available. We extrude our own polypropylene yarn in-house and have polyester and nylon yarns extruded and spun to our stringent specifications to insure greater quality control in the materials used to weave ARMORFORM fabric forms.

CONTROLLED WEAVING AND INSPECTION

The yarn is woven on high-speed looms, the most modern and efficient machines available for weaving engineered fabrics in the industry. Trained professionals visually inspect each square inch of ARMORFORM fabric forms.

All ARMORFORM fabric forms are subjected to rigorous quality control testing following production. Samples of the fabrics are taken at regular intervals and tested at Nicolon's laboratory in strict accordance with ASTM procedures. A copy of the fabric certification is provided with each order of ARMORFORM fabric.

ARMORFORM® is a NICOLON® product.

U.S. Patent No. 4,502,815 and 4,449,847
Other U.S. and foreign patents issued and pending

FABRICATION OF PANELS

After weaving and inspection, the mill width rolls of fabric forms are ready for factory fabrication. In this step the fabric rolls are sewn together to form larger multiple mill width panels. Factory fabrication reduces the number of seams which will have to be made in the field. If the area to be protected is small enough, the entire finished panel may be prefabricated in one piece, eliminating field seaming altogether. Optional factory installed zippers can be installed for joining panels together in the field, or the installer can use a hand held sewing machine to make field seams.

SUPPLY

An inventory of standard ARMORFORM styles and sizes is carried at our manufacturing facilities and can be shipped to any job site around the world. Fabric properties are selected to meet the structural requirements of the ARMORFORM style specified.

Nicolon Erosion Control Systems are currently in service around the world. Their uses range from channel linings to riverbank protection, and from subaqueous pipeline protection to major shoreline revetments. The positive results achieved by Nicolon in providing erosion control systems for civil engineering projects supply convincing proof of the benefits you may attain from Nicolon's broad spectrum of Erosion Control Systems.

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ARMORFORM® THE ENGINEERED SOLUTION TO EROSION CONTROL

Erosion control has traditionally been handled by stone rip-rap, gabions, or concrete slope paving. During installation these conventional erosion control methods require heavy machinery, forming and stripping, and considerable labor costs. Once in place, conventional methods require continuous maintenance due to loss of stone rip-rap, and corrosion of reinforcement steel.

Since the mid-1960's, engineers, architects and contractors have specified and installed superior cost effective alternatives: concrete forming systems that eliminate the problems associated with conventional erosion control installations. ARMORFORM is a unique system that provides a complete and engineered solution for erosion control, a solution that by design solves the installation, deterioration, and maintenance problems encountered with conventional erosion control methods.

ARMORFORM results in a stable erosion control system available in three styles; Filter Point Mat (FPM), Uniform Section Mat (USM), and Articulating Block Mat (ABM), to accommodate various design conditions.

ENGINEERED DESIGN

Nicolon Corporation's professional staff of engineers, designers, and sales representatives are available to help you plan and select the ARMORFORM system that is right for your application. Our engineering department will prepare shop drawings for the project engineer's review and approval. Pre-bid and pre-construction conferences with contractors and on site construction assistance are also provided by Nicolon's construction service and sales representative groups.

ENGINEERED FOR PERFORMANCE

ARMORFORM is technically and economically superior to conventional erosion control methods. Where conditions such as limited access, remote region construction, or quick delivery require fast installation using unskilled labor, even under water, ARMORFORM is the design solution.

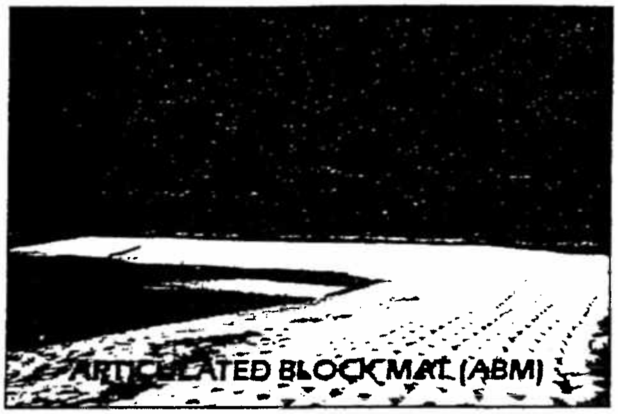
ENGINEERED FOR EASY INSTALLATION

ARMORFORM is the cost saving answer for almost any application, revetment or lining. It can be installed for substantially less than conventional methods since all construction is performed in place. The ARMORFORM fabric forms are positioned on the area to be protected, where they are filled with a pumpable fine aggregate concrete (structural grout). And, to make installation even easier and more cost effective, no heavy equipment or skilled labor is required for installation.

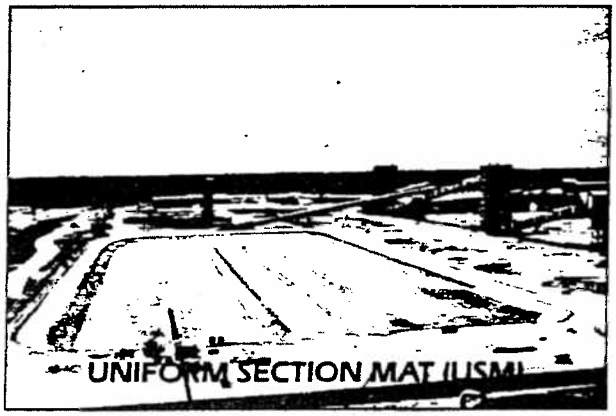
ARMORFORM® APPLICATIONS

APPLICATIONS

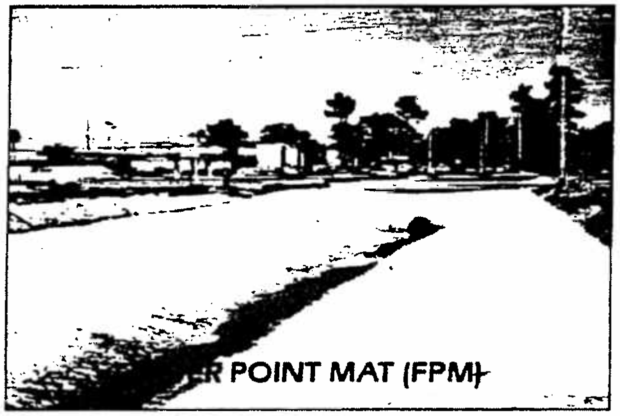
- Ponds & Holding Basins
- Earthen Dams
- Storm Channels & Ditches
- Lakes & Reservoirs
- Bulkheads
- Pipeline Crossings
- Rivers, Streams & Bayous
- Dikes & Levees
- Coastal Shorelines
- Bridge Abutments
- Water Control Structures
- Embankments
- Spillways
- Subaqueous Pipelines
- Culvert Inlets & Discharges
- Boat Launching Ramps


ARTICULATED BLOCKMAT (ABM)

ARMORFORM's Articulating Block Mat (ABM) is designed for rivers and shorelines. High strength cables embedded in the concrete blocks tie the revetment together and provide for block articulation.


UNIFORM SECTION MAT (USM)

ARMORFORM's Uniform Section Mat (USM) is ideal for ponds and holding basins. Uniform Section Mat (USM) is impermeable for improved seepage control.


R POINT MAT (FPM)

ARMORFORM's Filter Point Mat (FPM) exhibits a high coefficient of hydraulic friction. Filter Point Mat (FPM) is woven with filter points between cobbles to relieve hydrostatic uplift pressure.

ARMORFORM® is a NICOLON® product.

U S Patent No 4,502,815 and 4,449,847
Other U S and foreign patents issued and pending.

The information presented herein will not apply to every installation. Dimensions and quantities shown are approximate only and will vary as a result of site conditions and installation procedures. No warranty or guarantee expressed or implied is made regarding the performance of any product, since the manner of use and handling are beyond our control.

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ARMORFORM® AVAILABLE STYLES

The ARMORFORM Erosion Control System uses double-layer woven fabrics engineered exclusively to serve as forms for casting concrete erosion control revetments and linings. The fabric forms are woven from polypropylene, polyester or nylon yarns and are designed with the required strength, stability and filtration properties of a superior fabric form. ARMORFORM is positioned on the area to be protected, where it is filled with a pumpable fine aggregate concrete (structural grout) to form an erosion control mat. Final appearance of the various styles of hardened mats is suggested by the drawings below.

TYPICAL DIMENSIONS, WEIGHTS AND VOLUMES

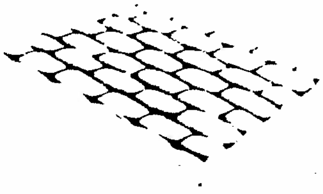
(Values shown are typical only, and will vary with field conditions.)

FILTER POINT MAT (FPM)

Filter Point Size	Filter Point Spacing	Average Thickness	Weight/ Sq. Ft.	Coverage/ Cu. Yd. Concrete	Availability
5″ FPM	5″	2.2″	26 lbs.	133 ft.^{2}	Inventory
8″ FPM	8″	4.0″	47 lbs.	73 ft.^{2}	Inventory
10″ FPM	10″	6.0″	70 lbs.	49 ft.^{2}	Inventory

Filter Point Mat (FPM) is formed with a double-layer woven fabric, joined together by interwoven filter points. These spaced points serve as filter points to relieve hydrostatic uplift pressure. A filter fabric should be placed under FPM linings.

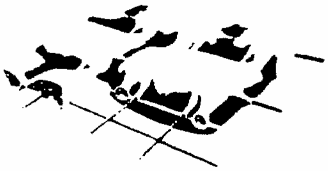
UNIFORM SECTION MAT (USM)



Uniform Section Size	Cord Spacing	Nominal Thickness	Weight/ Sq. Ft.	Coverage/ Cu. Yd. Concrete	Availability
3″ USM	3″ x 3″	3.0″	35 lbs.	97 ft.^{2}	Inventory
4″ USM	3″ x 3″	4.0″	47 lbs.	73 ft.^{2}	Inventory
6″ USM	3″ x 4″	6.0″	70 lbs.	49 ft.^{2}	Inventory
8″ USM	3″ x 5″	8.0″	93 lbs.	36 ft.^{2}	Special Order

Uniform Section Mat (USM) is formed with a double-layer woven fabric, joined together by spacer cords on closely spaced centers. Relief of hydrostatic uplift pressure, where required, may be provided by inserting plastic weep tubes through the mat at specified centers. When weep tubes are used, the lower end of the weep tube should be covered by filter fabric or a filter fabric should be placed under USM linings.

ARTICULATING BLOCK MAT (ABM)



Articulating Block Size	Nominal Block Dimensions	Weight/ Block	Weight/ Sq. Ft.	Coverage/ Cu. Yd. Concrete	Availability
4″ ABM	24″ x 12″ x 4″	93 lbs.	41 lbs.	82 ft.^{2}	Inventory
6″ ABM	24″ x 18″ x 6″	210 lbs.	64 lbs.	53 ft.^{2}	Inventory
8″ ABM	24″ x 24″ x 8″	373 lbs.	86 lbs.	40 ft.^{2}	Special Order

Articulating Block Mat (ABM) is formed with a double-layer woven fabric, joined together into a matrix of rectangular compartments each separated by a narrow perimeter of interwoven fabric. High strength cables may be threaded between the two layers of fabric to interconnect the concrete filled compartments (blocks), and provide for block articulation. Relief of hydrostatic uplift pressure is provided by slits cut between adjacent blocks and/or inserting plastic weep tubes through the mat at specified centers. A filter fabric should be placed under ABM revetments.

ARMORFORM®

STYLE SELECTION

IMPORTANT FACTORS IN SELECTING THE PROPER ARMORFORM STYLE FOR YOUR JOB

The steps involved and the subjects covered before final ARMORFORM style selection are very important. Advance preparation of a comprehensive set of specifications will greatly enhance the probability of satisfactory installation and performance.

Common information which must be gathered includes:

- Velocity and/or flow rate, plus width, depth, longitudinal slope, and side slope of channel, stream or ditch.
- Significant or maximum wave height, plus wave period and angle of slope inclination.
- Type and condition of the soil, ground water table, and surrounding terrain.
- The location of the installation and the temperatures experienced in the area. Also, whether the locality is subject to high winds and the fetch of open water across from the installation.
- Accessibility of installation.
- Expected completion date.

A bid specification should then be prepared including the following:

I. THE FABRIC FORM:

- Style and size of the ARMORFORM fabric form, after calculating hydraulic stability requirements and evaluation of other conditions.
- Required standards of quality.
- Thickness, weight and overall dimensions as well as physical property requirements for fabric forms, structural grout, and filter fabric when required.

II. FABRICATION:

- Specify the acceptable method of fabrication, seam strength, zipper strength and width of permissible panel lap joints.
- Stipulate minimum required fabric mill width.
- Require all seams to be downward facing.

III. SITE PREPARATION:

- Provide suitable drawings including lines, grades and cross-sections, as well as other details of the specific site involved.

IV. ARMORFORM INSTALLATION:

- Responsibilities of the fabric form manufacturer and installer.
- Methods of field joining of panels.
- Specify the minimum spacing between expansion joints as required by field conditions.
- Specify inspection of all field seams.
- Methods of checking integrity of installation.

COSTS

Installed cost is a more important consideration than material cost alone. Included in these considerations are such factors as: weight or thickness of the ARMORFORM revetment or lining, whether it has cables, local labor and structural grout costs, special requirements based upon soil conditions, filter fabric when required, and all the job and site-oriented details that contribute to a final installed cost. Complete specifications must be developed before detailed costs can be determined.

Nicolon's engineering and sales representative groups are available to aid in the preparation of estimates and technical field services for potential projects.

The information presented herein will not apply to every installation. Dimensions and quantities shown are approximate only and will vary as a result of site conditions and installation procedures. No warranty or guarantee expressed or implied is made regarding the performance of any product, since the manner of use and handling are beyond our control.

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U.S. Patent No. 4,502,815 and 4,449,847
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ARMORFORM® INSTALLATION

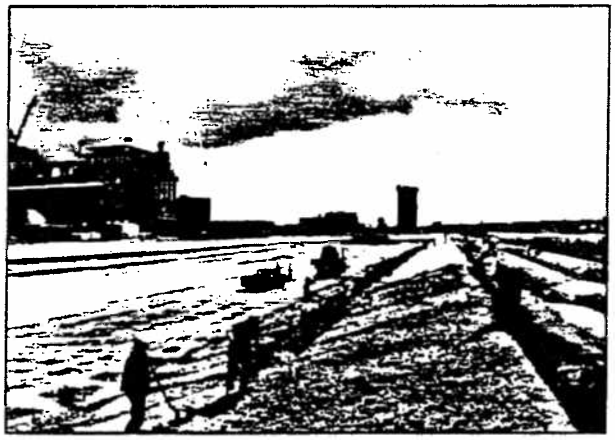
The successful ARMORFORM installation begins with thorough planning and culminates in well engineered materials properly installed. After the yarns are produced, woven into mill width rolls, and factory fabricated into panels, the installation is the final step. The importance of sound installation techniques in any erosion control project cannot be over emphasized. Regardless of the type of erosion control method used, the success or failure of any job will depend to a very large extent on the proper execution of the installation.

Once an installer has been chosen there are four basic steps to be taken in any ARMORFORM erosion control installation:

1. Site Preparation
2. Panel Placement and Field Assembly
3. Structural Grout Pumping
4. Inspection

SITE PREPARATION

Slope grading equipment, such as backhoes or drag lines, is used to excavate to required depths, contour the slopes to the specified slope ratio, and form the anchor, toe, and terminal trenches around the periphery of the installation. The area to be protected must be free of rock, brush, roots, or large soil clods.



The fabric forms are usually anchored into a trench approximately two feet deep, by one foot wide, at the top of the slope. The trench should be located one to three feet from the top edge of the slope. The exposed soil beyond the anchor trench should be sloped away from the trench, or a drainage ditch should be excavated so surface water will run off and not saturate the slope.

The graded slope should be jointly inspected by the installer, owner's representative, and excavation contractor. If slope conditions are unacceptable for the fabric forms, corrective measures should be taken.

PANEL PLACEMENT AND FIELD ASSEMBLY

Once the slope and other related excavation conforms to finished grade and elevation specifications, installation of filter fabric, if required, and the ARMORFORM fabric forms may begin. First, the ARMORFORM panels are removed from their packages and placed in position for installation. The panels can be quite large to minimize joining on the site, sometimes weighing as much as 500 pounds per panel.

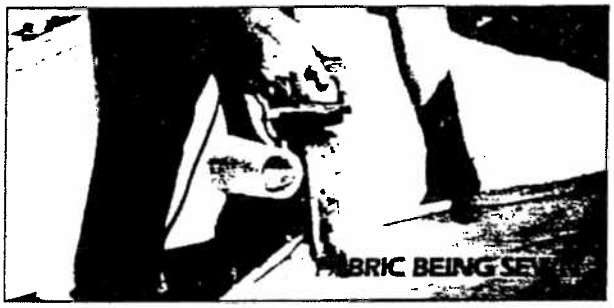
Next, a panel is rolled down the slope and positioned for unfolding. The panels are positioned according to a carefully prepared drawing where each panel is identified for placement. The panel is then unfolded by a work crew and pulled into position. The ARMORFORM panels should be positioned loosely along the slope.

Once positioned, the upper edge of the ARMORFORM panel is folded into the anchor trench atop the slope. The extra fabric provided for contraction during pumping should be accumulated and held at the top of the slope and gradually released as the form is filled.

ARMORFORM® INSTALLATION (Cont'd)

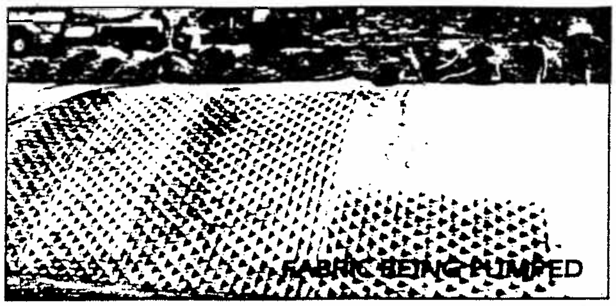
Adjacent panels are joined by field sewing or zippering the double-layer fabric forms, bottom edge to bottom edge, and top edge to top edge. When installing Articulated Block Mat (ABM), optional transverse high strength cables should be spliced prior to joining of the top layers of fabric.

As the first two panels are being joined, the third is positioned so that the seaming crew can start on it, upon completion of the first seam. This procedure is continued until all field seams are made. No more material than can be pumped in one day should be unrolled and positioned.



STRUCTURAL GROUT PUMPING

The upper edge of the ARMORFORM panel which has been placed into the anchor trench should be pumped first, thus forming an anchor to prevent the remainder of the form from sliding down the slope as it is pumped with structural grout. The pumping crew should then inject grout into the lower mat area, proceeding gradually up the slope until the fabric form has been filled.



Structural grout is injected into the ARMORFORM fabric form by inserting a 2" diameter grout injection pipe through a small slit cut in the upper layer of fabric. A grout tight seal is formed by wrapping the injection pipe with burlap, which is held in place by a laborer as grout is being injected. When the pipe is withdrawn, the burlap is stuffed in the hole where it remains until the grout stiffens to a point that it is no longer fluid. The burlap is then removed and the concrete surface at the hole smoothed by hand.

INSPECTION

When inspecting the panels prior to pumping, wrinkles and loose fabric should be expected as they are necessary to compensate for form contraction. (As much as 10% contraction in each direction may be expected.) Nicolon should be contacted to determine the appropriate contraction factor for your site conditions.

All field sewn seams, zipper connections, and lap joints must be carefully inspected. Colored thread is advised for all field sewn seams to facilitate inspection.

For detailed installation guidelines contact Nicolon Corporation.

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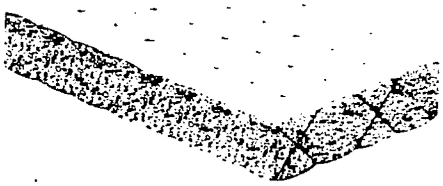
UNIFORM SECTION MAT (USM)

Uniform Section Mat fabric is a double-layer woven fabric, joined together by spacer cords and engineered exclusively to serve as a form for casting concrete erosion control linings. The fabric is woven from polypropylene, slit film yarns, and designed with the required strength, stability and filtration properties of a superior fabric form. Uniform Section Mats (USM) have a bonded cobble surface and conform to the dimensions, weights and volumes listed in the following table and the fabric properties indicated below.

Typical Dimensions, Weights and Volumes

(Values shown are typical only, and will vary with field conditions.)



Uniform Section Size	Cord Spacing	Nominal Thickness	Weight/ Sq. Ft.	Coverage/ Cu. Yd. Concrete[1]	Availability
3″ USM	3″ x 3″	3.0″	35 lbs.	97 ft.^{2}	Inventory
4″ USM	3″ x 3″	4.0″	47 lbs.	73 ft.^{2}	Inventory
6″ USM	3″ x 4″	6.0″	70 lbs.	49 ft.^{2}	Inventory
8″ USM	3″ x 5″	8.0″	93 lbs.	36 ft.^{2}	Special Order

Typical Property Values

(Typical property values are statistical mean (averages) of test data.
For minimum certified values contact NICOLON CORPORATION.)

Property	Test Method	Unit	Values USM
Physical:			
Composition			PP[2]
Weight	ASTM D-3776-79	oz/yd	10
Thickness	ASTM D-1777-75	mils	20
Mill Width		in	84/172
Mechanical:			
Grab Tensile Strength	ASTM D-1682-75	lbs	
Warp			200
Fill			200
Grab Tensile Elongation	ASTM D-1682-75	%	
Warp			20
Fill			20
Diaphragm Burst Strength	ASTM D-3786-80 a	psi	475
Trapezoid Tear Strength	ASTM D-1117-80	lbs	
Warp			65
Fill			75
Puncture Strength	ASTM D-3787-80	lbs	60
Hydraulic:			
Water Flow Rate	ASTM Proposed[3]	gal/min/sf	80
Coefficient of Permeability (k)	ASTM Proposed[3]	cm/sec	0.05
Permittivity (k/1)	ASTM Proposed[3]	1/sec	1.0
Porosity	ASTM D-737-75	cf/min/sf	125
Spacer Cord:			
Break Strength	ASTM D-2256	lbs/cord	75 (2)

[1] Concrete - Fine aggregate concrete (structural grout).
[2] PP - Polypropylene
[3] Test method proposed by the ASTM Subcommittee on Mechanical Reports for Geotextiles (03501). The procedure calls for property determined using 5 cm constant head.

ARMORFORM® is a NICOLON® product.

U.S. Patent No. 4,502,815 and 4,449,847
Other U.S. and foreign patents issued and pending.

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GUIDE SPECIFICATION FOR
UNIFORM SECTION MAT (USM)

1.0 GENERAL

1.1 SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment, and incidentals required to perform all operations in connection with the installation of the proposed Uniform Section Mat (USM) lining in accordance with the lines, grades, design and dimensions shown on the Contract Drawings and as specified herein.

1.2 DESCRIPTION

The work shall consist of installing an unreinforced concrete mat lining, by positioning a specially woven double-layer synthetic fabric form on the surface to be protected and filling it with a pumpable fine aggregate concrete (structural grout) in such a way as to form a stable mat of required thickness, weight and configuration.

2.0 MATERIALS

2.1 FINE AGGREGATE CONCRETE

Fine aggregate concrete shall consist of a mixture of portland cement, fine aggregate (sand), and water so proportioned and mixed as to provide a pumpable grout. Pozzolan and grout fluidifier conforming to these Specifications may be used at the option of the Contractor. The mix shall exhibit a compressive strength of 2000 psi at 28 days when made and tested in accordance with ASTM C-31 and C-39.

Note: The average compression strength of ARMORFORM cast fine aggregate concrete shall be at least 20% higher at 7 days than that of the companion test cylinders made in accordance with ASTM C-31, and not less than 2,500 psi at 28 days.

2.1.1 Portland cement shall conform to ASTM C-150, Type I or Type II.

2.1.2 Fine aggregate shall conform to ASTM C-33, except as to grading. Aggregate grading shall be reasonably consistent and shall be well graded from the maximum size which can be conveniently handled with available pumping equipment.

2.1.3 Water for mixing shall be clean and free from injurious amounts of oil, acid, salt, alkali, organic matter or other deleterious substances.

2.1.4 Pozzolan, if used, shall conform to ASTM C-350.

2.2 FABRIC FORM

The fabric forms shall be, as specified, ARMORFORM (note a) Uniform Section Mat as manufactured by Nicolon Corporation, or approved equal. Each layer of fabric shall meet the following statistical mean (average) results:

Property	Test Method	Unit	Values USM
Physical:			
Composition			PP[2]
Weight	ASTM D-3776-79	oz/yd	10
Thickness	ASTM D-1777-75	mils	20
Mill Width		in	84/172
Mechanical:			
Grab Tensile Strength	ASTM D-1682-75	lbs	
Warp			200
Fill			200
Grab Tensile Elongation	ASTM D-1682-75	%	
Warp			20
Fill			20
Diaphragm Burst Strength	ASTM D-3786-80 a	psi	475
Trapezoid Tear Strength	ASTM D-1117-80	lbs	
Warp			65
Fill			75
Puncture Strength	ASTM D-3787-80	lbs	60
Hydraulic:			
Water Flow Rate	ASTM Proposed[3]	gal/min/sf	80
Coefficient of Permeability (k)	ASTM Proposed[3]	cm/sec	0.05
Permittivity (k/l)	ASTM Proposed[3]	1/sec	1.0
Porosity	ASTM D-737-75	cf/min/sf	125
Spacer Cord:			
Break Strength	ASTM D-2256	lbs/cord	75 (2)

[1] Concrete - Fine aggregate concrete (structural grout).

[2] PP - Polypropylene

[3] Test method proposed by the ASTM Subcommittee on Mechanical Reports for Geotextiles (03501). The procedure calls for property determined using 5 cm constant head.

The Contractor shall furnish the Engineer, in duplicate, manufacturer's certified test results showing actual test values obtained when the above physical properties were tested for compliance with the Specifications.

Note a: The Engineer shall indicate the Uniform Section Mat size required.
Example: 4" USM

2.2.1 Fabric form material shall consist of double-layer woven fabric joined together by spacer cords, of uniform length, to produce a mat with a finished nominal thickness of$_2$(note b) inches, and a weight of (note b) lbs./ft.^{2} Spacer cords shall connect the two layers of fabric on (note c) centers. Points of connection shall be staggered to provide a bonded cobble surface appearance.

Note b: The Engineer shall indicate the nominal mat thickness and weight/sq.ft. for the Uniform Section Mat required.

Note c: The Engineer shall indicate the cord spacing for the Uniform Section Mat required.

2.2.2 Individual mill width rolls of fabric form shall be a minimum width of 84 inches. Mill width rolls shall be cut to the length required, and the two layers of fabric separately joined edge to edge by means of sewing thread, to form multiple mill width panels. All sewn seams shall be downward facing as shown on the Contract Drawing. The grab tensile strength of all sewn seams shall be not less than 100 lbs./in. when tested in accordance with ASTM D-1692-75.

2.2.3 Grout stops shall be installed at predetermined, mill width, intervals to regulate the flow of fine aggregate concrete.

2.2.4 Plastic weep tubes, for relief of hydrostatic uplift pressure, shall be inserted through the mat, at (note d) foot centers, at locations shown on the Contract Drawings. Where weep tubes are required, the lower end of the weep tube shall be covered by filter fabric held securely in place or the mat shall be placed over filter fabric as specified elsewhere in these Specifications.

Note d: Plastic weep tubes are normally inserted in Uniform Section Fabric on approximately 5' x 5' centers, or as specified by the Engineer.

2.2.5 Immediately following receipt of fabric forms to the job site, forms should be inspected and stored in a clean dry area where they will not be subject to mechanical damage, exposure to moisture or direct sunlight.

3.0 INSTALLATION

3.1 SITE PREPARATION

3.1.1 Areas on which fabric forms are to be placed shall be constructed to the lines and grades shown on the Contract Drawings. Where such areas are below the allowable grades they shall be brought to grade by placing layers of selected material and compaction. The depth of layers and amount of compaction shall be as specified by the Engineer. All obstructions such as roots and projecting stones shall be removed.

3.1.2 Excavation and preparation of anchor trenches, terminal trenches, and toe trenches or aprons shall be done in accordance with the lines, grades and dimensions shown on the Contract Drawings.

3.1.3 Immediately prior to placing the fabric forms, the prepared area shall be inspected by the Engineer and no forms shall be placed thereon until the area has been approved.

3.2 FABRIC FORM PLACEMENT

3.2.1 Fabric form panels, as specified in Section 2.2 of this Specification shall be placed within the limits shown on the Contract Drawings.

3.2.2 Adjacent fabric form panels shall be joined before fine aggregate concrete injection, by field sewing or zippering the two bottom layers of fabric together and the two top layers of fabric together. All sewn seams shall be downward facing as shown on the Contract Drawings.

3.2.3 When conventional joining of panels is impractical, or where called for on Contract Drawings, adjacent panels may be overlapped a minimum of two feet pending approval by the Engineer. In no case shall simple butt joints between panels be permitted.

3.2.4 Lap joints and expansion joints shall be provided as shown on the Contract Drawing, or as specified by the Engineer. Filter fabric with a minimum width of six feet shall be placed under all lap joints and expansion joints and shall extend continuously along the length of the joint.

3.2.5 Immediately prior to injection of fine aggregate concrete, the assembled fabric form panels shall be inspected by the Engineer and no fine aggregate concrete shall be pumped therein until the fabric seams and panel connections have been approved.

3.3 FINE AGGREGATE CONCRETE PLACEMENT

3.3.1 Following panel placement, small slits shall be cut in the top layer of the fabric form to allow for the insertion of the injection pipe. Fine aggregate concrete shall be injected between the top and bottom layers of fabric, filling the panel to the recommended thickness and configuration.

3.3.2 Fine aggregate concrete shall be injected in such a way that excessive pressure on the fabric form and cold joints are avoided.

3.3.3 Holes in the fabric left by the removal of the injection pipe shall be temporarily closed by inserting a piece of burlap or similar material. The burlap shall be removed when the concrete is no longer fluid and the concrete surface at the hole smoothed by hand. Foot traffic on the filled mat shall be restricted to an absolute minimum for one hour after pumping.

3.3.4 Upon completion of the fine aggregate concrete placement, all the anchor trenches, terminal trenches and toe trenches shall be back-filled and compacted, as specified by the Engineer.

The information presented herein will not apply to every installation. Dimensions and quantities shown are approximate only and will vary as a result of site conditions and installation procedures. No warranty or guarantee expressed or implied is made regarding the performance of any product, since the manner of use and handling are beyond our control.

APPENDIX A

Subsurface Information

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

SHEET *1 of 2*
LOG NO. *92-1*
ELEVATION *1019.9*
COORDINATES *S 13,690 approx.*
W 61,315 approx.
GWL *dry (caved in @ 45 ft)*
DATE *12-9-92*
W.O. NO. *04-4267-230*

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR *KIMBALL ASSOCIATES*
DRILLER *F. HARRIS*
LOGGED BY *M. SKYRMAN*
EQUIPMENT *SIMCO TRACK DRILL AND HOLLOW STEM AUGER*

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
	SS-1	5-7-11	1.3'	TOPSOIL 0.3'	6 in. hollow-stem auger
				CLAYEY SAND WITH ROCK FRAGMENTS low plasticity fines flat shale and sandstone rock fragments brown and gray moist	
5					
	SS-2	17-36-26	1.5'	same as above, more sandy, large sandstone fragments	
10					
	SS-3	9-12-16	0.2'	same as above, large sandstone fragments	Bag sample #1 (10'-15')
15					
	SS-4	10-11-17	0.5'	same as above, weathered shale and sandstone fragments	
20					
	SS-5	15-16-14	1.0'	same as above, weathered shale and sandstone fragments	
25					
	SS-6	10-11-12	1.0'	same as above, weathered shale and sandstone fragments, trace coal	Bag sample #2 (25'-30')
30					
	SS-7	5-7-11	1.1'	same as above, weathered shale fragments, trace coal	
35					

SS-Split Spoon Sample   ST-Shelby Tube Sample   NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT THERMAL DISCHARGE
CLIENT PENELEC (KEYSTONE)
CONTRACTOR KIMBALL ASSOCIATES
DRILLER F. HARRIS
LOGGED BY M. SKYRMAN
EQUIPMENT SIMCO TRACK DRILL AND HOLLOW STEM AUGER

SHEET 2 of 2
LOG NO. 92-1
ELEVATION 1019.9
COORDINATES S 13,690 approx.
W 61,315 approx.
GWL dry (caved in @ 45 ft)
DATE 12-9-92
W.O. NO. 04-4267-230

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
	SS-8	6-8-10	1.3'	same as above, weathered shale and sandstone fragments, trace coal	6 in. hollow-stem auger
40					
	SS-9	7-7-7	0.7'	same as above, weathered shale fragments, trace coal	
45				45.0'	
	SS-10	6-6-6	1.0'	SILTY CLAY some sand little weathered shale fragments brown moist	
50					
	SS-11	4-6-6	1.5'	same as above, more shale fragments, saturated 51.5'	
				WEATHERED SHALE gray and brown saturated	
55				55.0'	Auger refusal
	SS-12	50/2"		BOTTOM OF BORING	
60					
65					
70					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR *KIMBALL ASSOCIATES*
DRILLER *F. HARRIS*
LOGGED BY *M. SKYRMAN*
EQUIPMENT *SIMCO TRACK DRILL AND HOLLOW STEM AUGER*

SHEET *1 of 2*
LOG NO. *92-2*
ELEVATION *1000.2*
COORDINATES *S 13,725 approx.*
W 61,225 approx.
GWL *dry (caved in @ 28.2 ft)*
DATE *12-9-92*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
	SS-1	*3-9-12*	*1.5'*	*FILL* *silty sandy gravel* *0.75'*	*6 in. hollow-stem auger*
5					
	SS-2	*2-3-4*	*1.1'*	*CLAYEY SAND WITH ROCK FRAGMENTS* *low plasticity fines* *some shale fragments, trace coal* *brown* *moist*	
10					
	SS-3	*7-3-5*	*1.0'*	*same as above, more shale fragments*	
15					
	SS-4	*7-7-10*	*0.4'*	*same as above*	
20					
	SS-5	*7-9-7*	*0.5'*	*same as above, little to some weathered sandstone and shale rock fragments*	
25					
	SS-6	*13-40-10*	*1.3'*	*same as above, some weathered shale fragments, moist to wet*	
30				*30.0'*	
	SS-7	*3-4-6*	*1.0'*	*SANDY CLAYEY SILT* *little to some shale fragments* *brown* *wet*	
				33.0'	*Harder to auger at 33.0'*
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT	*THERMAL DISCHARGE*
CLIENT	*PENELEC (KEYSTONE)*
CONTRACTOR	*KIMBALL ASSOCIATES*
DRILLER	*F. HARRIS*
LOGGED BY	*M. SKYRMAN*
EQUIPMENT	*SIMCO TRACK DRILL AND HOLLOW STEM AUGER*

SHEET	*2 of 2*
LOG NO.	*92-2*
ELEVATION	*1000.2*
COORDINATES	*S 13,725 approx.* *W 61,225 approx.*
GWL	*dry (caved in @ 28.2 ft)*
DATE	*12-9-92*
W.O. NO.	*04-4267-230*

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
	SS-8	*50/3"*	*0.3'*	*WEATHERED SHALE, trace coal*	*6 in. hollow-stem auger*
				38.3'	*Auger refusal*
				BOTTOM OF BORING	
40					
45					
50					
55					
60					
65					
70					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR *KIMBALL ASSOCIATES*
DRILLER *F. HARRIS*
LOGGED BY *M. SKYRMAN*
EQUIPMENT *SIMCO TRACK DRILL, HOLLOW STEM AUGER, AND NX CORING*

SHEET *1 of 1*
LOG NO. *92-3*
ELEVATION *976.8'*
COORDINATES *S 13,875 approx.*
W 61,130 approx.
GWL *-*
DATE *12-10-92*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE TYP NO.	SAMPLE BLOWS/6" or RQD	SAMPLE REC.	SOIL or ROCK DESCRIPTION	REMARKS
	SS-1	*14-14-50/2"*	*0.7'*	*FILL, gravelly* *1.0'*	*6 in. hollow-stem auger*
5					
	SS-2	*5-5-6*	*1.5'*	*SILTY CLAY* *little shale fragments* *brown* *moist*	
10				*same as above, grayish, wet*	
	SS-3	*4-4-50/5"*	*1.5'*	*11.0'*	
				WEATHERED SHALE *gray* *13.7'*	*Auger refusal*
15	*NX-1*	*52%*	*4.9'*	*SHALE, slightly weathered, gray, hard, horizontal cleavages, 4" thick coal layer at bottom* *16.6'*	*No clay seams*
				LIMESTONE *gray* *19.5'*	
20				*BOTTOM OF BORING*	
25					
30					
35					

SS-Split Spoon Sample   ST-Shelby Tube Sample   NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

SHEET *1 of 2*
LOG NO. *92-4*
ELEVATION *1020.5*
COORDINATES *S 13,370*
W 61,375
GWL *39.5' (0 hrs)*
DATE *12-10-92*
W.O. NO. *04-4267-230*

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR *KIMBALL ASSOCIATES*
DRILLER *F. HARRIS*
LOGGED BY *M. SKYRMAN*
EQUIPMENT *SIMCO TRACK DRILL AND HOLLOW STEM AUGER*

DEPTH (FT)	SAMPLE TYP NO.	SAMPLE BLOWS/6" or RQD	SAMPLE REC.	SOIL or ROCK DESCRIPTION	REMARKS
	SS-1	4-5-26	1.0'	TOPSOIL 0.3'	6 in. hollow-stem auger
				SILTY CLAY some shale fragments low plasticity fines brown moist to wet	
5	SS-2	5-26-12	1.3'	same as above, little sand, sandstone and shale fragments	
10				10.0'	
	SS-3	20-20-9	1.1'	CLAYEY SAND some shale and sandstone fragments gray and brown humid	
15	SS-4	9-2-8	0.8'	same as above	Bag samples #3 (15'-20')
20	SS-5	4-9-14	1.3'	same as above, trace coal, wet	
25	SS-6	5-5-8	0	(no sample recovered)	
30				30.0'	
	SS-7	4-5-8	0.8'	SILTY CLAY little shale fragments low plasticity fines brown wet	
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT	*THERMAL DISCHARGE*	SHEET	*2 of 2*
CLIENT	*PENELEC (KEYSTONE)*	LOG NO.	*92-4*
CONTRACTOR	*KIMBALL ASSOCIATES*	ELEVATION	*1020.5*
DRILLER	*F. HARRIS*	COORDINATES	*S 13,370* *W 61,375*
LOGGED BY	*M. SKYRMAN*	GWL	*39.5' (0 hrs)*
EQUIPMENT	*SIMCO TRACK DRILL AND HOLLOW STEM AUGER*	DATE	*12-10-92*
		W.O. NO.	*04-4267-230*

DEPTH (FT)	SAMPLE TYP NO.	SAMPLE BLOWS/6" or RQD	SAMPLE REC.	SOIL or ROCK DESCRIPTION	REMARKS
	SS-8	12-17-12	0.6'	SILTY CLAY some shale and sandstone fragments brown and gray moist to wet	6 in. hollow-stem auger
					Bag sample #4 (35'-40')
40	SS-9	13-13-10	0.8'	same as above some shale fragments brown saturated	
45	SS-10	5-5-9	0.8'	same as above 46.0'	
				WEATHERED SHALE gray 49.1'	Auger refusal
50				BOTTOM OF BORING	
55					
60					
65					
70					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT	THERMAL DISCHARGE	SHEET	1 of 1
CLIENT	PENELEC (KEYSTONE)	LOG NO.	92-5
CONTRACTOR	KIMBALL ASSOCIATES	ELEVATION	1002.1
DRILLER	F. HARRIS	COORDINATES	S 13,330 approx. W 61,345 approx.
LOGGED BY	M. SKYRMAN	GWL	dry (caved in @ 20.2 ft)
EQUIPMENT	SIMCO TRACK DRILL AND HOLLOW STEM AUGER	DATE	12-9-92
		W.O. NO.	04-4267-230

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
	SS-1	4-8-10	1.3'	FILL, silty sandy gravel	
				0.75'	6 in. hollow-stem auger
5					
	SS-2	5-5-4	1.5'	SANDY SILTY CLAY some shale rock fragments brown moist	
10					
	SS-3	2-3-5	1.2'	same as above, moist to wet, smaller shale fragments	
15					
	SS-4	12-5-4	0.5'	same as above	
20					
	SS-5	3-3-4	1.3'	same as above	
25				same as above, more silty	
	SS-6	3-4-4	0.2'		
30				30.0'	
	SS-7	44-50/3"	0.8'	WEATHERED SHALE gray	
				34.0'	Auger refusal
				BOTTOM OF BORING	
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR
DRILLER
LOGGED BY *M. SKYRMAN*
EQUIPMENT *CASE 580E BACKHOE*

SHEET *1 of 1*
LOG NO. *TP 93-1*
ELEVATION *982.0*
COORDINATES *S 13,740 approx.*
W 61,610 approx.
GWL *1.5 ft (22 hrs)*
DATE *1-14-93*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE TYP NO.	 BLOWS/6" or RQD	 REC.	SOIL or ROCK DESCRIPTION	REMARKS
				TOPSOIL, clayey, light brown, wet	
				1.0'	
				SILTY CLAY, large shale fragments, trace coal, brown, wet	
5					
				7.0'	
				BOTTOM OF TEST PIT	
10					
15					
20					
25					
30					
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR
DRILLER
LOGGED BY *M. SKYRMAN*
EQUIPMENT *CASE 580E BACKHOE*

SHEET *1 of 1*
LOG NO. *TP 93-2*
ELEVATION *986.0 approx.*
COORDINATES *S 13,785 approx.*
W 61,820 approx.
GWL *5.0' (22 hrs)*
DATE *1-14-93*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
				TOPSOIL, silty, brown, wet ***1.0'***	
				SANDY SILTY CLAY, some large shale fragments, brown, moist to wet	
5					
				7.0'	
				BOTTOM OF TEST PIT	
10					
15					
20					
25					
30					
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT ***THERMAL DISCHARGE***
CLIENT ***PENELEC (KEYSTONE)***
CONTRACTOR
DRILLER
LOGGED BY ***M. SKYRMAN***
EQUIPMENT ***CASE 580E BACKHOE***

SHEET ***1 of 1***
LOG NO. ***TP 93-3***
ELEVATION ***1002.5 approx.***
COORDINATES ***S 13,880 approx.***
W 62,380 approx.
GWL ***dry (24 hrs)***
DATE ***1-14-93***
W.O. NO. ***04-4267-230***

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
				BOTTOM ASH, sandy, gray, moist	
				2.5'	
				SILTY CLAY WITH LARGE SHALE AND SANDSTONE FRAGMENTS, brown, moist to wet	
5					
				9.0'	
				BOTTOM OF TEST PIT	
10					
15					
20					
25					
30					
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR
DRILLER
LOGGED BY *M. SKYRMAN*
EQUIPMENT *CASE 580E BACKHOE*

SHEET *1 of 1*
LOG NO. *TP 93-4*
ELEVATION *1019.5' approx.*
COORDINATES *S 13,620 approx.*
W 61,890 approx.
GWL *dry (24 hrs)*
DATE *1-15-93*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
				TOPSOIL, clayey, brown, moist	
				6"	
				SILTY SAND/SANDY SILT WITH LARGE SHALE FRAGMENTS, brown, moist	
5					
					3' diameter shale fragments @ 6' approx.
				7.5'	
				BOTTOM OF TEST PIT	
10					
15					
20					
25					
30					
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR
DRILLER
LOGGED BY *M. SKYRMAN*
EQUIPMENT *CASE 580E BACKHOE*

SHEET *1 of 1*
LOG NO. *TP 93-5*
ELEVATION *982.0 approx.*
COORDINATES *S 13,540 approx.*
W 61,690 approx.
GWL *3.0' (0 hrs)*
DATE *1-15-93*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
				CLAYEY SILT WITH LARGE SANDSTONE AND SHALE FRAGMENTS, brown, moist to wet	
				3.0'	*Solid rock @ 3.0' (Could be a boulder)*
				BOTTOM OF TEST PIT	
5					
10					
15					
20					
25					
30					
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR
DRILLER
LOGGED BY *M. SKYRMAN*
EQUIPMENT *CASE 580E BACKHOE*

SHEET *1 of 1*
LOG NO. *TP 93-6*
ELEVATION *986.0 approx.*
COORDINATES *S 13,400 approx.*
W 61,870 approx.
GWL *4.5' (0 hrs)*
DATE *1-15-93*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
				CLAYEY SILT WITH LARGE SHALE AND SANDSTONE FRAGMENTS, little sand, brown, moist to wet	
5					*Harder to dig @ 5'*
				7.0'	
				BOTTOM OF TEST PIT	
10					
15					
20					
25					
30					
35					

SS - Split Spoon Sample ST - Shelby Tube Sample NX - NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR
DRILLER
LOGGED BY *M. SKYRMAN*
EQUIPMENT *CASE 580E BACKHOE*

SHEET *1 of 1*
LOG NO. *TP 93-7*
ELEVATION *1020.0' approx.*
COORDINATES *S 13,110 approx.*
W 61,760 approx.
GWL *dry (0 hrs)*
DATE *1-15-93*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE TYP NO.	SAMPLE BLOWS/6" or RQD	SAMPLE REC.	SOIL or ROCK DESCRIPTION	REMARKS
				TOPSOIL, clayey, brown, moist 6"	
				SILTY CLAY/CLAYEY SILT WITH LARGE SANDSTONE AND SHALE ROCKS, brown, moist to wet	
5					
				8.0'	
				BOTTOM OF TEST PIT	
10					
15					
20					
25					
30					
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR
DRILLER
LOGGED BY *M. SKYRMAN*
EQUIPMENT *CASE 580E BACKHOE*

SHEET *1 of 1*
LOG NO. *TP 93-8*
ELEVATION *1015.5' approx.*
COORDINATES *S 13,440 approx.*
W 62,020 approx.
GWL *3.5' (0 hrs)*
DATE *1-15-93*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE TYP NO.	SAMPLE BLOWS/6" or RQD	SAMPLE REC.	SOIL or ROCK DESCRIPTION	REMARKS
				TOPSOIL, clayey, brown, moist *6"*	
				SILTY SAND/SANDY SILT WITH LARGE SHALE FRAGMENTS, brown, moist to wet	
5				*5.0'*	*Difficult to dig*
				BOTTOM OF TEST PIT	
10					
15					
20					
25					
30					
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT/COMMONWEALTH, INC.
SOIL/ROCK CLASSIFICATION SHEET

PROJECT *THERMAL DISCHARGE*
CLIENT *PENELEC (KEYSTONE)*
CONTRACTOR
DRILLER
LOGGED BY *M. SKYRMAN*
EQUIPMENT *CASE 580E BACKHOE*

SHEET *1 of 1*
LOG NO. *TP 93-9*
ELEVATION *1020.0' approx.*
COORDINATES *S 13,910 approx.*
W 62,450 approx.
GWL *dry (0 hrs)*
DATE *1-15-93*
W.O. NO. *04-4267-230*

DEPTH (FT)	SAMPLE			SOIL or ROCK DESCRIPTION	REMARKS
	TYP NO.	BLOWS/6" or RQD	REC.		
				SAND, little rock fragments, brown, moist	
5					
				8.5'	
				BOTTOM OF TEST PIT	
10					
15					
20					
25					
30					
35					

SS-Split Spoon Sample ST-Shelby Tube Sample NX-NX Rock Core Sample

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 1 OF 2

PROJECT: Keystone Station W.O. 04-4267-187 SITE AREA Old Ash Site

DRILL HOLE NO. #3A

CONTRACTOR: PA Drilling

COORDINATES

ELEVATION 1014.49

RILLER: K. Baumgartner

GWL 0 HRS

CLASSIFIED BY: T. DuGuay

DATE: 8-26-85

24 HRS

Depth Ft.	Sample No.	SPT Blows/ 6 In. 6	12	18	Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock Range Size Core Run	Grain Shape Rec. Core	REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
	1	5	16	17			0.3 TOPSOIL - Clayey, silty, sand some gravel, brown (SM-SC)					
							2.0 FILL - Gravelly silty sand, brown (GM-SM)					
5	2	4	4	6			5.7 FILL - Shale, grey, siltstone, grey					
							8.0 FILL - Gravelly silty sand; some cobbles, brown (GM-SM)					
10	3	3	3	5			10.7 FILL - Shale, grey					
							12.0 FILL - Gravelly, silty, sand; some cobbles, brown (GM-SM)					
15	4	1	2	3			15.5 FILL - Silty clay, mod. plastic, yellow-brown, saturated (CL)					
							16.0 FILL - Sandy clay, low plasticity, yellow-brown, saturated (CL)					
20	5	2	3	4			17.0 FILL - Silty clay, mod. plastic, brown yellow, saturated (CL)					
25	6	5	8	6			20.0 Sandy clay, moderately plastic, orange & grey, saturated (some cobbles, shale) (CL)					
							26.0 Silty, sandy clay, mod. to high plasticity, orange & grey, saturated (CL,CH)					
30	7	12	18	5			28.0 Siltstone, dark grey					
							29.0 Gravelly silty sand, some clay, brown (SM-SC)					Water @ 32'
35	8	16	6	7			31.0 Shale, dark grey, med. soft & sandstone, lt. grey, fine to med. grained, medium hard					
							36.5 Shale, dark grey, medium soft					
40	9	5	16	50			40.5 COAL (overlain by clay seam)					
							41.3 Sandstone, fine to med. grained, grey; siltstone, dark grey; some clayey shale					
45												
50												

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 2 OF 2

PROJECT: Keystone Station W.O. 04-4267-187 SITE AREA Old Ash Site

DRILL HOLE NO. #3A

CONTRACTOR: PA Drilling

COORDINATES

ELEVATION

DRILLER: K. Baumgartner

GWL 0 HRS

24 HRS

CLASSIFIED BY: T. DuGuay

DATE: 8-26-85

Depth Ft.	Sample No.	SPT Blows/ 6 In. 6	12	18	Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock Range Size Core Run	Grain Shape Rec. Core	REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
5												
10												
							62.0 Limestone, (micrite) brown					
							63.5 Claystone, grey, very soft					
15												
20												
							72.0 Sandstone, medium grained, grey, hard; some siltstone, dark grey					
25												
30												
							82.0—— BOTTOM OF HOLE ——					
35												
40												
45												
50												

GAI

ER–SWM–22: Rev. 1/80

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF SOLID WASTE MANAGEMENT

DATE PREPARED 8-27-85

I. D. NUMBER

GROUND WATER MODULE
MONITORING POINTS
MODULE NO. 8

PHASE II

Facility Identification

Name Keystone Generating Station

Municipality Plum Creek Twp.

County Armstrong

Reviewed by ________ Date ________

Recommend approval ________ disapproval ________

Conditions ________

TO BE SUBMITTED ON COMPLETION OF GROUND WATER MONITORING SYSTEM

I. For approved monitoring sites complete the following:

A. Wells

1. Location

Monitoring Point Numbers*	Background or Down Gradient	Name and Date of Topographic Map	Measured from Southeast Corner		Latitude	Longitude
			Inches North	Inches West		
#2A	Down Gradient	Elderton, PA 1964 Photo Rev.1973	6.0	14.7	40°39'28"	79°21'22"
3A	~~Down~~ Gradient	Elderton, PA 1964 Photo Rev.1973	6.9	14.6	40°39'47"	79°21'21"
	UP					

* Number all monitoring points consecutively. These numbers must not be changed; they will be used in all subsequent reports and communications (use numbers only.).

2. Completion Data

Monitoring Point Numbers*	Method Drilled	Date Completed	Depth	Surface Elevation	Depth to Static Water Level	Date of Measurement
#2A	Air Rotary	8-16-85	52'	1005.34	23.8'	8-16-85
#3A	Air Rotary	8-13-85	82'	1014.49	30.5'	8-13-85

ER-SWM-22A: Rev. 1/80

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF SOLID WASTE MANAGEMENT

DATE PREPARED
8-27-85

I. D. NUMBER

GROUND WATER MODULE
MONITORING POINTS
MODULE NO. 8

PHASE II

2. Completion Data (continued)

Monitoring Point Numbers*	Casing:				Grouting:	
	Material (Type)	Size Diameter	Zones Cased	Zones Perforated	Zones Grouted	Type of Grouting
#2A	PVC	4"	0-10	10-50	0-8	Neat Cement Grout
#3A	PVC	4"	0-10	10-70	0-8	Neat Cement Grout

a. Does each well have a minimum of 3.5 inch diameter entrance port for samplers? X Yes ___ No

b. If the entrance port is not provided, indicate how samples of the upper foot of ground water will be secured. ___

* Number all monitoring points consecutively. These numbers must not be changed; they will be used in all subsequent reports and communications (use numbers only).

ER–SWM–22B: Rev. 1/80

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF SOLID WASTE MANAGEMENT

DATE PREPARED
8-27-85

GROUND WATER MODULE
MONITORING POINTS
MODULE NO. 8

I. D. NUMBER

PHASE II

3. Pump Test Data

Monitoring Point Number	#2A	#3A			
Use of water other than monitoring (fire, domestic, sanitary facilities, etc.)					
Pump					
Type					
Rated Capacity					
Depth to Pump (ft.)					
Depth to Water Intake (ft.)					
Pump Test Data					
Bailed or Pumped at (GPM-Uniform Rate)	3 gpm	3 gpm			
Static Water Level (prior to start of pumping) (ft.)	23.8	30.5			
Pumping Water Level (at end of pump test) (ft.)	24.9	31.6			
Drawdown (ft.)	1.1	1.1			
Length of Pump Test (hrs.)	0.83 hrs.	0.33 hrs.			
Specific Capacity (GPM/FT)					
Pumping Rate / Drawdown	2.7	2.7			

a. Are the required geologic logs attached for each well?

Yes X No ______

Gilbert/Commonwealth
ENGINEERS/CONSULTANTS

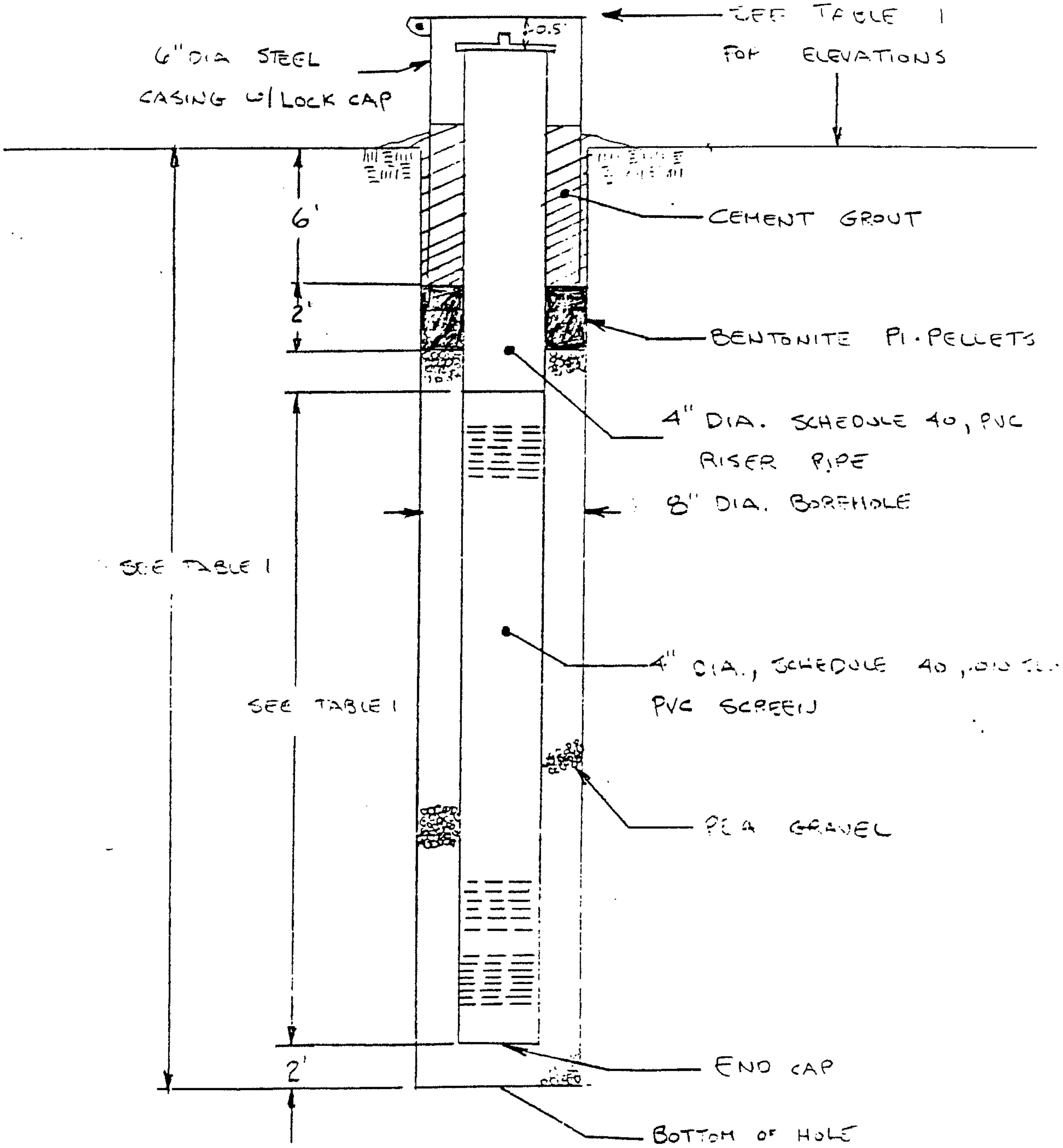
CALCULATION

SUBJECT KEYSTONE STA - OLD ASH SITE
MONITORING WELLS

IDENTIFIER

PAGE 1 OF 2 PAGES

REV.	0	1	2	3
MICROFILMED				
ORIGINATOR	T. DUGUAY			
DATE	9-20-85			



Gilbert/Commonwealth
ENGINEERS/CONSULTANTS
CALCULATION

SUBJECT KEYSTONE STA. - OLD ASH SITE MONITORING WELLS
IDENTIFIER
PAGE 2 OF 2 PAGES
REV. 0 1 2 3
MICROFILMED
ORIGINATOR T. DuGUAY
DATE 9.22-85

TABLE 1

WELL #	DEPTH	LENGTH OF P/C SCREEN	GROUND ELEVATION	ELEVATION AT TOP OF CASING	
#2A	52'	40'	1005.34'	1008.14	
# 3A	82'	70'	1014.49'	1017.21	

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 1 OF 1

PROJECT: Stream Diversion W.O. 04-4267-162 SITE AREA Keystone Station

DRILL HOLE NO. SD-1

ONTRACTOR: Penn. Drilling

COORDINATES

ELEVATION 1005.2

RILLER: P. Waddell

GWL 0 HRS 17' - 0"

CLASSIFIED BY: Y. Shah

DATE: 9-13-84

24 HRS

Depth Ft.	Sample No.	SPT Blows/ 6 In.			Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock		REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
		6	12	18						Range Size Core Run	Grain Shape Rec. Core	
						1'	Top soil (humus + silty sand)					
	S1	9	7	8			Silty fine-med sand & gravel + cobbles (grey, silt/sand-stone rock fragments), trace clay, brown, moist (fill).	GM SM				
5'	S2	4	31	13			Same, grey & damp (intermittently hard,indicating the presence of cobbles)					
						9½'	---					
10'	S3	1	9	5			Same, less gravel	SM				
15'	S4	2	4	10			Same, more silt, less gravel					
20'	S5	2	2	2		20'	Silty fine sand, little gravel (rock fragments), trace (to little) clay, brown, wet	SM ML				Wet spoon in S5 & S6
22½'						22'	Clayey fine sandy silt, trace coarse sand & gravel (rock fragments), brown & grey, wet	CL ML				
25'	S6	11	6	7			Hole terminated @ 26½'					

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 1 OF 2

PROJECT: Stream Diversion W.O. 04-4267-162 SITE AREA Keystone Station

DRILL HOLE NO. SD-2

CONTRACTOR: Penn. Drilling COORDINATES

ELEVATION 1020.3

DRILLER: P. Waddell

GWL 0 HRS None

CLASSIFIED BY: Y. Shah DATE: 9-12-84

24 HRS None*

Depth Ft.	Sample No.	SPT Blows/6 In.			Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock		REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
		6	12	18						Range Size Core Run	Grain Shape Rec. Core	
	S1	3	5	7			Silty fine to medium sand, gravel & cobbles (mostly broken, weathered silt/sand-stone rock), trace clay trace coarse sand, brown, damp	GM SM				
5'	S2	8	10	10			Same as above, more gravel Grey from 6' to 8' and contains trace ash/coal					
10'	S3	9	18	12			Same, grey & brown and damp					Resistance to SPT in S3 intermittently high, indicating presence of hard rock fragments
15'	S4	4	6	7			Same, more silty and moist to wet					
20'	S5	8	5	3			Same as above					*Hole filled up next day (9-13-84) to 33'-6" and was dry.
25'						24½'						

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 2 OF 2

PROJECT: ______ W.O. 04-4267-162 SITE AREA ______

DRILL HOLE NO. SD-2

ONTRACTOR: ______ COORDINATES ______

ELEVATION ______

ILLER: ______

GWL 0 HRS ______

CLASSIFIED BY: ______ DATE: 9-12-84

24 HRS ______

Depth Ft.	Sample No.	S P T Blows/ 6 In. 6	12	18	Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock Range Size Core Run	Grain Shape Rec. Core	REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
25'												
	S6	2	2	4			Silty fine (to medium) sand, trace coarse sand (weathered grey shale fragments), grey, wet	SM				Soil similar to that in S7 is exposed at water level at the adjacent stream banks. The bank surface is riprapped with dumped siltysandstone rocks (boulder size). Apparently, the west bank is made up of soils similar to those in this hole.
30'	S7	2	3	4			Same, yellowish brown with grey spots					
35'	S8	2	3	3		34½	Clayey fine sandy silt, trace coarse sand (weathered grey shale fragments), yellowish brown, wet (residual?)	CL				
							Hole terminated at 36½'.					

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 1 OF 2

PROJECT: Stream Diversion W.O. 04-4267-162 SITE AREA Keystone Station

DRILL HOLE NO. SD-3

CONTRACTOR: Penn. Drilling COORDINATES

ELEVATION 1019.8

RILLER: P. Waddell

GWL 0 HRS None

CLASSIFIED BY: Y. Shah DATE: 9-13-84

24 HRS

Depth Ft.	Sample No.	SPT Blows/ 6 In.			Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock		REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
		6	12	18						Range Size Core Run	Grain Shape Rec. Core	
	S1	10	8	9			Clayey fine sandy silt, trace to little gravel (rock fragments), brown, damp (fill)	ML•CL				
						3'	Silty fine sand/sandy silt, & gravel (rock fragments), trace clay, trace to little medium to coarse sand, grey, damp to moist (probably fill)	SM•GM				Rock fragments of grey shale or silty fine-grained sandstone.
5'	S2	4	8	10								
10'	S3	7	9	9			Same					
15'	S4	7	9	10			Same					
20'	S5	6	6	5			Same, moist to wet					
25'												

GAI

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 2 OF 2

PROJECT: ______ W.O. 04-4267-162 SITE AREA ______

DRILL HOLE NO. SD-3

ONTRACTOR: ______ COORDINATES ______

ELEVATION ______

RILLER: ______

GWL 0 HRS ______

CLASSIFIED BY: Y. Shah DATE: 9-13-84

24 HRS ______

Depth Ft.	Sample No.	SPT Blows/ 6 In.			Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock		REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
		6	12	18						Range Size Core Run	Grain Shape Rec. Core	
	S6	18	6	6		25½'	Silty, fine-medium sand, trace clay trace coarse sand & gravel (rock fragments) yellowish brown with grey spots, moist to wet	SM				Cobble at 25'±
							Same					Intermittently hard in S7, indicating intermitten hard and soft materi
	S7	4	7	8								
							Hole terminated at 31½'.					

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 1 OF 2

PROJECT: Stream Diversion W.O. 04-4267-162 SITE AREA Keystone Station

DRILL HOLE NO. SD-4

CONTRACTOR: Penn. Drilling

COORDINATES

ELEVATION 1019.5

ILLER: Paul Waddell

GWL 0 HRS None

CLASSIFIED BY: Y. S. Shah

DATE: 9-10-84

24 HRS

Depth Ft.	Sample No.	SPT Blows/ 6 In.			Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock		REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
		6	12	18						Range Size Core Run	Grain Shape Rec. Core	
	S1	7	6	8			Silty fine to medium sand, trace clay, trace coarse sand, trace to little gravel, grey, damp (fill)	SM				
							Clayey from 3½' to 4½' and wet					
5	S2	2	4	6		4½'	Clayey silt or silty clay, trace coarse sand & gravel (decomposed rock fragments & rounded particles) yellow to reddish brown, moist to wet (probably fill)	CL				The rock fragments are derived from grey silty f-sandstone or or grey or light brown shale. The latter is micaceaous.
10	S3	2	3	3			Same, slightly more clayey, grey & brown, wet					
15	S4	2	3	2		12½'	Clayey fine sandy silt, trace medium sand, trace coarse sand, trace to little gravel (rock fragments), yellow to reddish brown & grey, wet (probably fill)	CL-ML				
20	S5	7	7	5		18'	Clayey silty fine sand/sandy silt, trace to little coarse sand, little gravel (rock fragments), yellow to reddish brown & grey, wet	CL-SC				
25												

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 2 OF 2

PROJECT: ____ W.O. 04-4267-162 SITE AREA ____ DRILL HOLE NO. SD-4

CONTRACTOR: ____ COORDINATES ____ ELEVATION ____

/LLER: Paul Waddell

GWL 0 HRS ____

CLASSIFIED BY: Y. S. Shah DATE: 9-11-84 24 HRS ____

Depth Ft.	Sample No.	SPT Blows/ 6 In. 6	12	18	Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock Range Size / Core Run	Grain Shape / Rec. Core	REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
	56	2	5	6								
						27½'	Clayey silt, trace to little fine sand, trace coarse sand (weathered grey shale), yellowish to reddish brown & grey, wet	CL				
30												
	57	5	6	9								
	58	5	7	9			Same as above					
35							Hole terminated at 35'.					

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 1 OF 2

PROJECT: Stream Diversion W.O. 04-4267-162 SITE AREA Keystone Station

DRILL HOLE NO. SD-5

CONTRACTOR: Penn. Drilling COORDINATES

ELEVATION 1021.2

ILLER: Paul Waddell

GWL 0 HRS None

CLASSIFIED BY: Y. S. Shah DATE: 9-11-84

24 HRS *

Depth Ft.	Sample No.	SPT Blows/ 6 In.			Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock		REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
		6	12	18						Range Size Core Run	Grain Shape Rec. Core	
							Silty sand & gravel + slag, grey (fill)	GM SM				W.L. in the adjacent stream at El. 970±
	S1	6	9	9		1½'	Clayey silt, little to some coarse sand & gravel (highly weathered shale rock fragments) yellowish to reddish brown & grey, moist (fill)	CL				*On 9-12-84, the hole was filled up to 29' and had 2' of water - probably rain water collected overnight.
5	S2	3	2	5			Same, with little fine sand, wet					
						6½'	Fine to coarse sand & slag, grey (fill)	SP				
10	S3	2	2	3		7½'	Clayey fine sandy silt, little to some coarse sand & gravel (weathered shale rock fragments), yellowish to reddish brown, moist to wet (probably fill)	CL•ML				
15	S4	2	2	3		13'	Clayey silty fine sand/sandy silt some coarse sand & gravel (grey shale & siltstone rock fragments) grey & brown, moist to wet (probably fill)	CL•SC				
20	S5	2	5	6		19½'	Harder rock fragments below 19½'.	SC•GC				
25												

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 2 OF 2

PROJECT: W.O. 04-4267-162 SITE AREA

DRILL HOLE NO. SD-5

ONTRACTOR: COORDINATES

ELEVATION

RILLER: Paul Waddell

GWL 0 HRS

CLASSIFIED BY: Y. S. Shah DATE: 9-11-84

24 HRS

Depth Ft.	Sample No.	SPT Blows/ 6 In.			Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock		REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
		6	12	18						Range Size Core Run	Grain Shape Rec. Core	
	S6	7	8	10			Same as above; contains trace coal fragments					
						27'	Grey Shale, highly weathered & fractured, horizontally bedded with clayey silt pockets, damp to moist					
30	S7	10	9	4								Intermittently harder augering below 27', indicating differrential weathering & horizontal bedding.
35	S8	4	7	7			Same as above, but silty & lighter grey					
							Hole terminated at 36.5'.					

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 1 OF 2

PROJECT: Stream Diversion W.O. 04-4267-162 SITE AREA Keystone Station

DRILL HOLE NO. SD-5A

NTRACTOR: Penn. Drilling

COORDINATES

ELEVATION 1015.0

LLER: Paul Waddell

GWL 0 HRS 30'-6"

CLASSIFIED BY: Y. S. Shah

DATE: 9-13-84

24 HRS

Depth Ft.	Sample No.	SPT Blows/ 6 In. 6	12	18	Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock Range Size / Core Run	Grain Shape / Rec. Core	REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
	S1	4	3	5			Silty fine sand/sandy silt, trace clay, trace coarse sand, yellowish brown, moist to wet	ML SM				
5	S2	9	9	15		3½'	Clayey fine sandy silt, trace medium to coarse sand, some gravel (grey siltstone rock fragments), trace organic, grey, moist to wet (probably fill)	ML CL				
10	S3	6	12	11			Same (appears like decomposed grey siltstone)	ML				
						12'	Silty fine sand, trace clay, trace medium sand, little coarse sand & gravel (weathered light brown & grey shale), yellowish brown & grey, moist to wet	SM ML				
15	S4	3	6	5								
20	S5	6	7	5		20½'	Highly weathered & fractured grey f-sandstone, with coal partings & fractures filled with clayey silty fine sand, damp.					
25												

GILBERT ASSOCIATES, INC.

SOIL AND ROCK CLASSIFICATION SHEET

SHEET 2 OF 2

PROJECT: ______ W.O. 04-4267-162 SITE AREA ______

DRILL HOLE NO. SD-5A

NTRACTOR: ______

COORDINATES ______

ELEVATION ______

ILLER: ______

GWL 0 HRS ______

CLASSIFIED BY: ______

DATE: ______

24 HRS ______

Depth Ft.	Sample No.	SPT Blows/ 6 In. 6	12	18	Ft. Rec.	Profile	DESCRIPTION Density (or Consistency), Color Rock Or Soil Type - Accessories	U.S.C.S.	R.Q.D.	Soil Or Rock Range Size Core Run	Soil Or Rock Grain Shape Rec. Core	REMARKS Chemical Comp, Geologic Data, Ground Water, Construction Problems, etc.
	S6	4	4	4			Same as above (except shale, instead of s. stone).					Easy augering in rock.
30	S7	3	5	4			Same as above (without coal partings; sandstone instead of shale)					Wet spoon in S7 & S8.
35	S8	9	13	10			Same as above (harder rock)					
							Hole terminated at 36½'.					

APPENDIX A

Document 11

Geotechnical and Hydraulic Assessment Report, Keystone Generating Station – Ash Filter Ponds and Thermal Pond by Geosyntec, November 2013

Geosyntec consultants

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19 November 2013

NRG Energy Southpointe Operations Center
121 Champion Way, Suite 300
Canonsburg, PA 15317

Attention: Mr. Stephen Frank
Senior Environmental Specialist

Subject: Geotechnical and Hydraulic Assessment Report
Keystone Generating Station – Ash Filter Ponds and Thermal Pond
Shelocta, Pennsylvania

Dear Mr. Frank:

Geosyntec Consultants (Geosyntec) is pleased to submit this letter report presenting the findings of an assessment of the coal combustion waste (CCW) impoundments at the Keystone Generating Station (Site). The assessment was performed to address the recommendations of the draft report issued by the United States Environmental Protection Agency (EPA) regarding the condition of the impoundments. This report presents the results of the following assessment activities: (i) field investigation of soil properties of the impoundment embankments; (ii) general assessment of the geotechnical stability of the pond embankments; (iii) hydrologic/hydraulic evaluation of these ponds; and (iv) results and recommendations of a seepage evaluation of the thermal pond. This letter report was prepared by Dr. Chunling Li, P.E., and Mr. Wade Tyner, P.E. and it was reviewed by Dr. Lucas de Melo, P.E., and Mr. Michael Houlihan, P.E., in accordance with Geosyntec's peer review policy.

1. BACKGROUND

The CCW system at the site includes a cluster of three contiguous Ash Filter Ponds and a separate Thermal Pond. These CCW impoundments were recently evaluated by the EPA as part of its ongoing national effort to assess the management of coal combustion waste (CCW). The draft EPA report, prepared by Dewberry & Davis, LLC (Dewberry) and dated November 2012, provides a Condition Assessment for each of the impoundments. According to EPA's guidelines, the Condition Assessment result can be "Satisfactory", "Fair", "Poor", or "Unsatisfactory" based on the availability of data, analysis, loading condition, and several other factors. The EPA draft report for the Keystone site [Dewberry, 2012] provides a Condition Assessment result of "Fair" to both the Ash Filter Ponds and the Thermal Pond. The report states that the “rating is influenced by the lack of some formal documentation of engineering analyses and the discrepancy in slope geometry that needs to be resolved.”

Section 1.2.3 of the draft EPA report also provides the following recommendations for each of the impoundments:

Ash Filter Ponds:

Recommendation 1: “Prepare and maintain on file formal documentation of slope stability analyses. (This need not be a rigorous analysis.)”

Recommendation 2: “Prepare and maintain on file formal documentation of hydrologic/hydraulic safety. (This need not be a rigorous analysis).”

Thermal Pond:

Recommendation 1: “Provide PE or RLS certified documentation of the actual downstream slope geometry. If the actual slope geometry is found to be steeper or more critical than what was assumed in slope stability analyses, re-calculate the slope stability analyses to verify that acceptable safety margins exist.”

Recommendation 2: “Investigate and provide documented field evidence that the source of the seep area observed along the access road berm ditch on the downstream right side of the main dam is not seepage through the embankment due to liner failure. It is suggested that this investigation include at least two temporary observation wells, with one of these installed on the dam crest above the seep area to check for a phreatic surface or line of seepage through the dam embankment. The other observation well would preferably be installed on the railroad embankment, if feasible, or on the berm next to the seep area.”

NRG retained Geosyntec to perform an assessment of these CCW impoundments. The purpose of this assessment is to:

- Evaluate the conditions that led to the assessment outcome of “Fair”; and
- Address the recommendations provided in the EPA report.

The findings of the assessment are presented in this letter report.

2. SUMMARY OF WORK

Geosyntec's work conducted in response to EPA's comments is summarized in the following table.

TABLE 1
SUMMARY OF WORK

Keystone Generating Station
Shelocta, Pennsylvania

Impoundment	EPA Recommendation	Work Conducted	Relevant Portion in this Report
Ash Filter Ponds	1	• Field investigation and laboratory tests • Slope stability analyses • Liquefaction potential evaluation	Section 3, Appendices B and C Section 4, Appendix D Section 6
	2	• Hydrologic/Hydraulic analysis	Section 7
Thermal Pond	1	• Field investigation and laboratory tests • Slope stability analyses • Liquefaction potential evaluation	Section 3, Appendices B and C Section 4, Appendix D Section 6
	2	• Two piezometers installed and monitored	Section 5

3. GEOTECHNICAL FIELD INVESTIGATION

On 17 October 2013, Geosyntec conducted a geotechnical field investigation to collect data needed to assess the characteristics and properties of the Ash Filter Pond and Thermal Pond embankments. The geotechnical field investigation consisted of drilling four test borings, identified as B–1 through B–3, and TH–1, at the locations shown in Figures 1 and 2. These borings were all drilled from the crest of the exterior slope of the embankments. Boring TH–1, drilled near where a seep was observed at the Thermal Pond, was converted to a piezometer (PZ–1) for groundwater table monitoring. One additional piezometer (i.e., PZ–2) was installed on the railroad embankment but no soil samples were taken at the time of drilling because no relevant geotechnical information for the scope of this report could be obtained from this location. Borings B–1 through B–3 were drilled to an approximate depth of 16 to 21 feet below the existing ground surface (ft-bgs). Piezometer PZ–1(TH–1) was drilled to a depth of approximately 30 ft-bgs and piezometer PZ–2 to depth of approximately 25 ft-bgs.

A track-mounted hollow-stem auger was used to advance the test borings. The drill bit has an internal diameter of 3.25 inches and outside diameter of 6 inches. Soil samples were obtained using a split-spoon sampler in accordance with ASTM D 1586 [ASTM, 2009]. At each boring location, soil samples were obtained every 2 ft. Sampling was conducted continuously in all of the four borings. The soil penetration resistance was measured at all sample locations using the Standard Penetration Test (SPT) and recording blow counts (i.e., N-values). The N-value is the number of blows required for a 140-pound (lb.) hammer dropping 30 inches (in.) to drive the sampler through a 12-in. interval. Boring logs are included in Appendix B of this report. The geotechnical boreholes were backfilled to ground surface using a cement grout.

Based on the boring logs for B–1 through B–3, the Ash Filter Ponds' embankments were constructed using silty or clayey soils, which classifies under the Unified Soils Classifications system as CL (i.e., low-plasticity clay) and ML (i.e., sandy silt). The SPT N-values varied between 10 and 45 blows/ft. The soils below the original ground surface prior to pond construction have similar appearance and comparable SPT-N value; thus, they are considered to have similar physical properties to the fill material used for embankment construction. Indication of rock formation was encountered at approximately 20 ft-bgs; i.e., at the bottom of the three boring locations (i.e., B–1 through B–3), where refusal (likely rock blocks) was encountered.

At the Thermal Pond, soils in the upper 14 ft from the top of the embankment consists of silty sand (SM) or silty gravel (GM) and the SPT-N values ranges from 2 to 31 blows/ft (boring TH–1). The soils below the original ground surface prior to pond construction consist mainly of low plasticity clay with pockets of high-plasticity clay. The SPT-N values of the foundation soils below the embankment were between 6 and 20. The boring was terminated at a depth of 30 ft-bgs and no bedrock encountered at this location.

Laboratory test results were conducted to classify the soil samples collected from boring investigation. The tests conducted include:

- Water content tests (ASTM D2216)
- Grain size distribution tests (ASTM D1140)
- Atterberg Limit tests (ASTM D4318)

The results of laboratory tests are shown in Appendix C.

Shear strength properties for the embankment and foundations soils were derived from data collected during this field investigation and previous studies conducted as a part of the dam permit application [Gilbert, 1993]. The shear strength parameters and other soil parameters are presented in Appendix D (i.e., Stability Analysis).

The groundwater table was not encountered during drilling or after completion of the four borings.

4. STABILITY EVALUATION

Geosyntec performed a stability analysis for the Filter Ash Pond and Thermal pond embankments. Two representative cross sections were selected at each of the impoundments for the analysis based on review of subsurface conditions, visual inspection, and pond geometry. The locations of the selected cross sections are shown in Figures 1 and 2. These sections were selected because the embankment heights at these locations are the highest and the slopes are the steepest or longest. The most critical subsurface condition identified during the sub-surface investigation for each of the ponds was conservatively assumed to be present at these cross sections. Thus, the selected cross sections represent the most critical conditions and the analysis results will likely represent the lowest expected factor of safety against failure of the pond embankments.

Design drawings for the Thermal Pond were prepared by Gilbert Associates, Inc. dated August 1993. The exterior slope of the Thermal Pond was constructed with a slope steeper than design. Thus, the geometry for the Thermal Pond was selected from the aerial survey drawings provided by NRG on 8 October 2013. The Thermal Pond design drawings also show the grades of Ash Filter Ponds at the time the drawings were prepared. These grades were used to obtain the geometry of the Ash Filter Pond for this slope stability analysis.

Stability was analyzed under both static and seismic loading conditions. The impoundments were considered to be full because this is the critical failure scenario. No rapid drawdown analysis was found to be necessary because, under this loading condition, the inner slope of the empty pond would represent the critical failure condition, which would not cause ash release or result in a hazard of the type that is contemplated in the EPA assessment. The major static load applied to the foundation soils is the gravity load exerted by the weight of the berm. A surcharge load of 250 psf was applied to the top of the embankment to model traffic loading on top of the embankment. This is a conservative assumption, because traffic loads are not permanent loads. Seismic loading was modeled considering the maximum horizontal acceleration in bedrock for the Keystone facility site of 0.050*g* (where *g* is the gravitational acceleration) and seismic coefficient of 0.041. Details on the derivation of these parameters are included in Appendix D (i.e., Stability Analysis).

No phreatic surface would be expected to develop in the pond embankments if the liners at both the Filter Ash Ponds and the Thermal Pond perform as designed. To model the water pressure acting on the embankment, material inside the impoundments were represented by a no-shear strength material with unit weight of 62.4 lbs/ft^3.

If the seep at the Thermal Pond resulted from the leakage of the lined Thermal Pond, the seepage through the pond would negatively affect the stability of the embankment. However, because readings collected at the two piezometers installed near the seep indicated that water encountered at the impounded water location is likely not due to seepage (see Section below), seepage through the embankment was not considered in this slope stability analyses. Should future piezometer readings identify seepage through the embankment, slope stability should be reevaluated by a geotechnical engineer.

A summary of stability analyses results are presented in Table 2. Complete analyses are included in Appendix D (i.e., Stability Analysis).

TABLE 2
RESULTING FACTOR OF SAFETY – SLOPE STABILITY ANALYSIS

Keystone Generating Station
Shelocta, Pennsylvania

Cross Sections	Loading Conditions	Failure Mode	Calculated F.S.	Target F.S.
A-A (Ash Filter Pond)	Static (undrained)	Block	6.73	1.30
		Circular	6.83	1.30
	Static (drained)	Block	1.74	1.50
		Circular	1.96	1.50
	Seismic	Block	5.79	1.20
		Circular	5.78	1.20
B-B (Thermal Pond)	Static (undrained)	Block	1.87	1.30
		Circular	1.64	1.30
	Static (drained)	Block	1.67	1.50
		Circular	1.70	1.50
	Seismic	Block	1.69	1.20
		Circular	1.53	1.20

5. THERMAL POND GROUNDWATER MONITORING

In response to EPA's recommendations in the draft report, two piezometers were installed at the Thermal Pond area to assess potential groundwater flow near where the seep was observed and identify whether observed ponded water was due to seepage through the pond's liner system. Locations of the installed piezometers are shown in Figure 2. The as-built information for these piezometers, PZ-1, and PZ-2, are summarized below:

TABLE 3
PIEZOMETERS AS-BUILT INFORMATION

Keystone Generating Station
Shelocta, Pennsylvania

Piezometer	Total Depth Below Ground Surface (ft)	Depth to Bottom of Screen (ft)	Screen Interval Length (ft)	Ground Elevation (ft-msl)	Top of Casing Elevation (ft-msl)
PZ–1	29.73	29.73	25	1020.38	1021.5
PZ–2	25.75	25.75	20	1018.82	1020.7

The piezometers were found to be dry at completion of the monitoring well installation. On 30 October 2013 (i.e., two weeks after piezometer installation), Geosyntec field personnel collected reading at these piezometers. Both readings showed that the two piezometers were dry. At time of the second reading (i.e., on 30 October 2013), moist soils were found at the location previously identified by Dewberry [2012] as a potential seep location. Based on the results of the findings at the piezometers, it appears that the seep at this location is not the result of leakage through the Thermal Pond liner. The seep observed by Dewberry [2012] are likely due to other reasons other than leak through the liner, including perching water at a localized more-permeable soil pocket created by infiltrating surface water or leak from the piping system installed in the berm.

6. LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon where soil substantially loses strength and stiffness in response to cyclic loads (e.g., earthquake) or change in stress state. Generally, liquefiable soils are saturated or nearly saturated loose sand with relatively low fines content. According to the boring logs, the soils present at the site below groundwater table are cohesive. Therefore, the soils at the site are not considered liquefiable. Additionally, the site is located in an area with low seismic activity. The potential for liquefaction in this site is considered negligible.

7. HYDROLOGIC/HYDRAULIC EVALUATION

Section 1.2.2 of the draft EPA report recommends that a hydrologic/hydraulic safety analysis be prepared for formal documentation purpose.

In response to this recommendation, Geosyntec has performed an evaluation of the hydrologic/hydraulic performance of the impoundments. Neither the Filter Ash Ponds nor the Thermal Ponds are designed to receive stormwater runoff from outside their footprints. The normal freeboard is maintained at least 2 ft below the top of the embankment in both the Ash Filter Ponds and the Thermal Pond, based on the drawings by Gilbert Associates, Inc. [1993]. The design precipitation depth at the high end of the design range (100-year frequency) is 5.77 inches or 0.48 ft, which is considerably less than the available freeboard. Thus, there is ample available surcharge storage for safe containment of the design precipitation over the pond area.

8. CONDITION ASSESSMENT

Condition Assessment definitions, as accepted by EPA, are as follows:

- *Satisfactory:* *No existing or potential management unit safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable criteria. Minor maintenance items may be required.*

- *Fair:* *Acceptable performance is expected under all required loading conditions (static, hydrologic, seismic) in accordance with the applicable safety regulatory criteria. Minor deficiencies may exist that require remedial action and/or secondary studies or investigations.*

- *Poor:* *A management unit safety deficiency is recognized for a required loading condition (static, hydrologic, seismic) in accordance with the applicable dam safety regulatory criteria. Remedial action is necessary. "Poor" also applies when further critical studies or investigations are needed to identify any potential dam safety deficiencies.*

- *Unsatisfactory:* *Considered unsafe. A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution. Reservoir restrictions may be necessary."*

Based on the assessment conducted in this analysis, the embankments at the site are sufficiently stable. The Ash Filter Pond and Thermal Pond can safely contain the rainfall resulting from a 100-year precipitation event. It is our opinion that, with the additional information that is now made available in this report, it would be appropriate for the EPA to report a condition of “Satisfactory”, instead of “Fair”, for the ponds at the site.

9. CONCLUSIONS

Based on the assessment described in this letter (as summarized in Table 1), Geosyntec concludes that the appropriate Condition Assessment result is “Satisfactory”. Other than routine inspection for potential seep at the Thermal Pond, no other action is recommended at this time.

Geosyntec is confident that the findings discussed in this report address each of the EPA’s comments provided in the Condition Assessment draft report for the Keystone facility. If EPA has additional comments or requests, we would be happy to address those.

Geosyntec appreciates the opportunity to be of assistance to NRG on this project. Please call any of the undersigned if you have any questions.

Sincerely,

Lucas de Melo

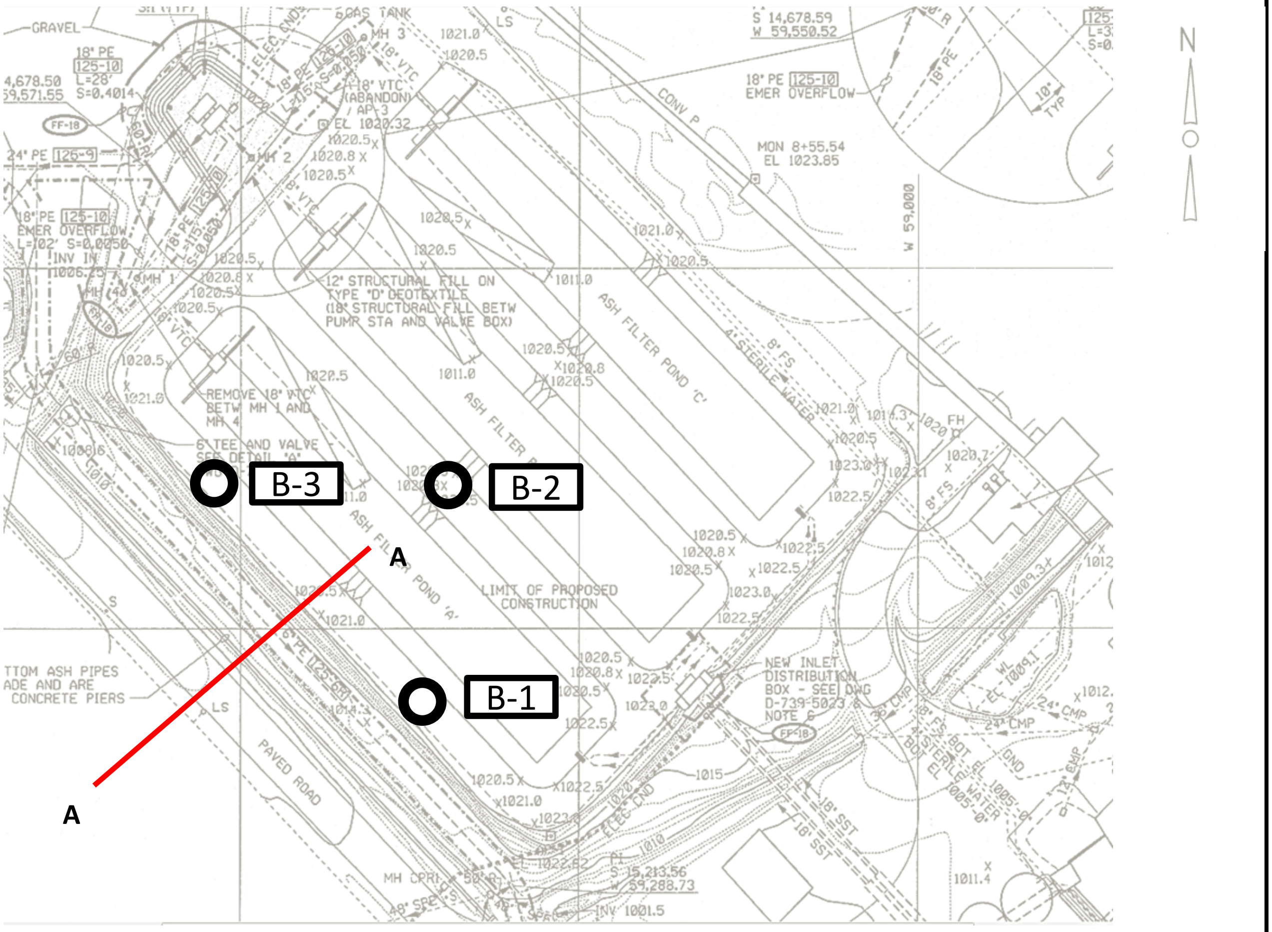
Lucas de Melo, Ph.D., P.E.
Senior Engineer

MJ Houlihan

Mike Houlihan, P.E.,
Principal

Attachments: Appendix A – References
Appendix B – Boring Logs
Appendix C – Laboratory Test Results
Appendix D – Stability Analysis

FIGURES



Legend

○ B-1 Approximate Boring Location

FIGURE 1 - SOIL BORING LOCATION

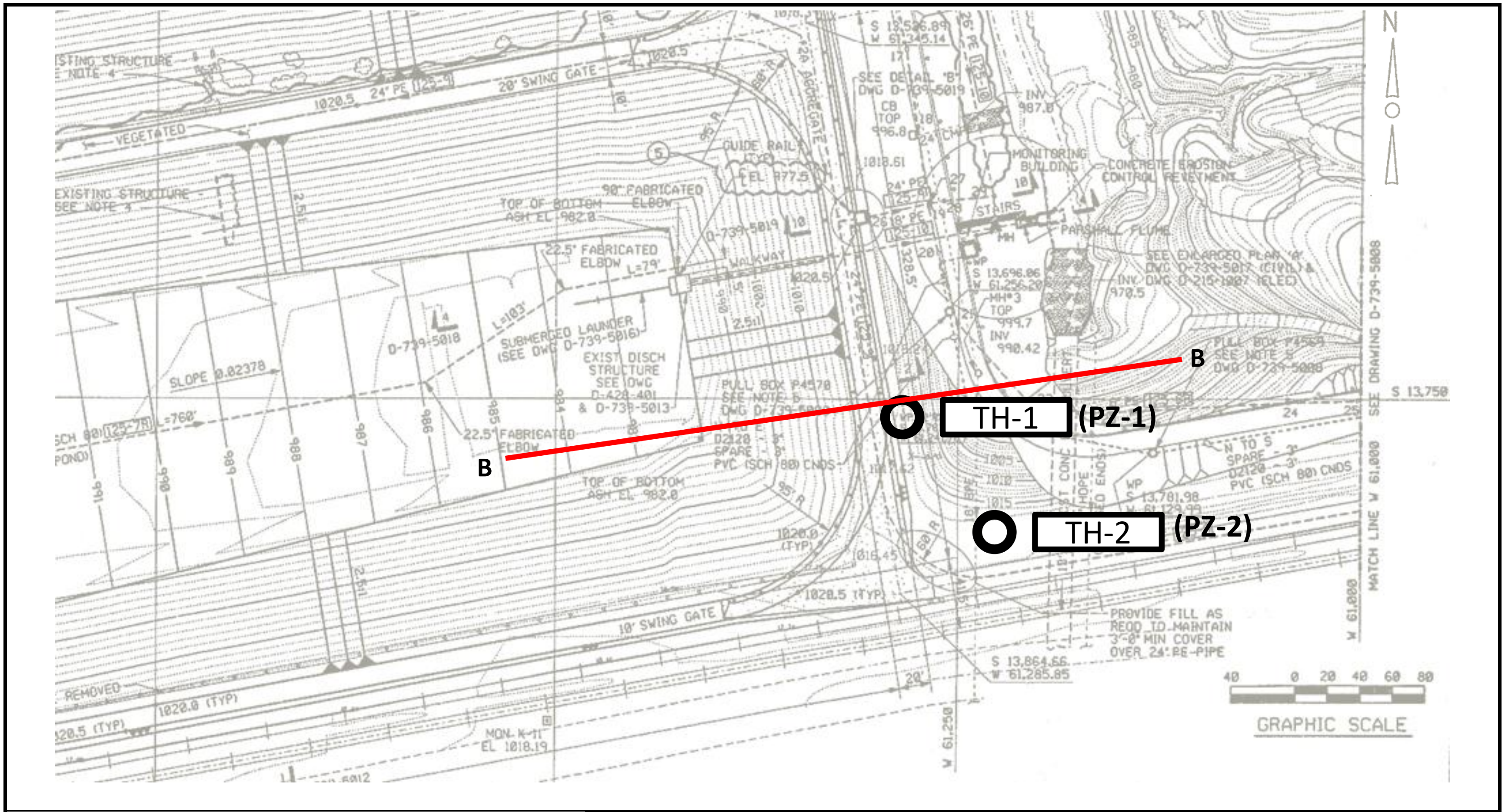
Keystone Generating Station – Ash Filter Pond

Shelocta, PA

Geosyntec consultants

COLUMBIA, MARYLAND

DATE:	Oct 2013
PROJECT NO.	ME1000
DOCUMENT NO.	
FIGURE NO:	1



Legend

○ B-1 Approximate Piezometer Location

FIGURE 2 - PIEZOMETER LOCATION

Keystone Generating Station – Thermal Pond

Shelocta, PA

Geosyntec consultants
COLUMBIA, MARYLAND

DATE:	Oct 2013
PROJECT NO.	ME1000
DOCUMENT NO.	
FIGURE NO:	2

APPENDIX A

REFERENCES

List of References

Dewberry & Davis, Inc. (2012)., “Coal Combustion Residue Impoundment Round 12 - Dam Assessment Report, Keystone Generating Station Ash Filter Ponds & Thermal Pond, GenOn Energy Shelocta, PA.” prepared for United States Environmental Protection Agency, November, 2012 (draft).

Gilbert/Commonwealth, Inc. (1993), “Dam Permit Application, Industrial Waste Treatment Modifications: Thermal Discharge Abatement Project Cooling Ponds”, Pennsylvania Electric Company Keystone Station, April, 1993.

Rocscience. (2012). “Slide (Version 6.0): A 2D Slope Stability Analysis for Soil and Rock Slopes”, Toronto, Canada.

USGS (2008). “2008 United States National Seismic Hazard Maps”, United States Geological Survey, http://earthquake.usgs.gov/research/hazmaps/products_data/2008/

APPENDIX B

BORING LOGS

Geosyntec consultants
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BORING LOG

Boring ID: B-1
Logged By: L. Chai
Date: 10/16/2013
Elevation: 90 feet from water monitoring well
Northing:
Easting:
Project No.: ME1000
Project Name: Keystone Power Plant
Drilling Method: HSA
Drilling Co.: Eichelbergers, Inc.
Bore Hole Diameter: 6 inches
Driller(s): Tom Growden
Cave Depth: N/A
Rig Type: Track Mounted HSA
Depth to Water: Not Encountered

Elevation	Depth (ft)	Blow Counts				N- Value	Material Description	USCS	Sample No.	Recovery
	0-2	6	10	12	10	22	Top 3": black topsoil, middle 1': gravel with sand, bottom 0.7': gray clay	GP CL	1	100%
	2-4	8	9	12	12	21	Multicolored yellowish orange, gray and black sility clay	CL	2	95%
	4-6	7	8	7	7	15	Light brown sility clay	CL	3	90%
	6-8	6	7	7	8	14	Light brown sility clay	CL	4	85%
	8-10	8	10	10	11	20	Light brown sility clay, with gray clay from 8.5' to 9.5'	CL	5	100%
	10-12	4	5	7	7	12	Yellowish orange silty clay, with trace black soil	CL	6	95%
	12-14	10	10	13	12	23	Yellowish orange silty clay, with trace black soil	CL	7	85%
	14-16	8	24	21	18	45	Top 1': Yellowish orange silty clay, with trace black silt (possibly ash), Bottom 1': coarse gravel with sandy silt	CL GM	8	100%
	16-18	REFUSE					No recovery, sampler refused at 16.3', N>50	N/A	9	0%
							BORING COMPELETE AT 16.3 FEET SAMPLE TUBE REFUSED BACKFILLED WITH CEMENT GROUT			

BORING LOG

Geosyntec consultants
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Boring ID B-2
Logged By L. Chai
Date 10/16/2013

Elevation N/A
Northing N/A
Easting N/A

Project No. ME1000
Project Name Keystone Power Plant

Drilling Method HSA
Bore Hole Diameter 6 inches
Cave Depth N/A
Depth to Water Not Encountered

Drilling Co. Eichelbergers, Inc.
Driller(s) Tom Growden
Rig Type Track Mounted HSA

Elevation	Depth (ft)	Blow Counts				N- Value	Material Description	USCS	Sample No.	Recovery
	0-2	7	9	7	9	16	top 2": Black top soil, middle 8": coarse gravel with sand, bottom 1': clayey silt	GM ML	1	90%
	2-4	8	10	11	10	21	Light brown silty clay with trace sand	CL	2	95%
	4-6	3	5	8	10	13	Light brown silty clay with few gray clay	CL	3	80%
	6-8	8	7	9	10	16	Light brown silty clay with few gray clay	CL	4	90%
	8-10	8	9	9	11	18	Light brown silty clay with little gray clay	CL	5	75%
	10-12	6	7	10	13	17	Top 0.5': silty sand with trace black soil Bottom 1.5': Light brown silty clay with little gray clay	SM CL	6	100%
	12-14	10	10	12	11	22	Light brown silty clay with few gray clay	CL	7	90%
	14-16	4	5	6	7	11	Light brown silty clay with few gray clay, 1" thick layer of sand at around 15.3'	CL	8	100%
	16-18	5	9	9	9	18	Top 1': Yellowish silty clay Bottom 1': Sandy silt with coarse gravel	CL SM	9	90%
	18-20	6	10	15	22	25	Yellowish orange clay with fine gravel, wet clay at from 18.0' to 18.2' Bottom 2": gravel	CL	10	90%
	20-22	REFUSE					Sandy silt with little coarse gravel, sample tube refused at 21.2'	GM	11	60%
							BORING COMPLETE AT 21.2 FEET SAMPLE TUBE REFUSED BACKFILLED WITH CEMENT GROUT			

BORING LOG

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Boring ID: B-3
Logged By: L. Chai
Date: 10/16/2013
Elevation: 125 feet from water
Northing: monitoring well
Easting:
Project No.: ME1000
Project Name: Keystone Power Plant
Drilling Method: HSA
Drilling Co.: Eichelbergers, Inc.
Bore Hole Diameter: 6 inches
Driller(s): Tom Growden
Cave Depth: N/A
Rig Type: Track Mounted HSA
Depth to Water: Not Encountered

Elevation	Depth (ft)	Blow Counts				N- Value	Material Description	USCS	Sample No.	Recovery
	0-2	5	7	9	13	16	Top 3": black top soil.	ML	1	90%
							Below: clayey silt with few coarse gravel			
	2-4	9	9	10	10	19	Light brown clayey silt.	ML	2	100%
							Bottom 1': greenish sility clay	CL		
	4-6	4	5	8	7	13	Light brown silty clay with few sand	CL	3	70%
	6-8	5	7	9	10	16	Light brown silty clay with gray clay	CL	4	80%
	8-10	10	8	8	9	16	Gray clay with light brown clayey silt, and with trace coal	CL	5	95%
	10-12	3	4	6	9	10	Gray clay with light brown clayey silt, with trace gravel	CL	6	85%
	12-14	4	7	10	10	17	Light brown silty clay, with gray clay	CL	7	80%
	14-16	7	8	10	12	18	Light brown silty clay, with gray clay	CL	8	100%
							bottom 1': yellowish orange silty clay	CL		
	16-18	8	12	13	18	25	Yellowish orange sility clay with trace sand	CL	9	90%
	18-20	REFUSE					Yellowish orange sility clay with trace sand, 1" thick of wet clay at 19'	CL	10	45%
							Bottom 0.5': gravel sheet, Refused at 18.9'	GP		
							BORING COMPLETE AT 18.9 FEET			
							SAMPLE TUBE REFUSED			
							BACKFILLED WITH CEMENT GROUT			

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BORING LOG

Boring ID TH-1 (Piezometer 1)
Logged By L. Chai
Date 10/17/2013
Elevation N/A
Northing N/A
Easting N/A
Project No. ME1000
Project Name Keystone Power Plant
Drilling Method HSA
Drilling Co. Eichelbergers, Inc.
Bore Hole Diameter 6 inches
Driller(s) Tom Growden
Cave Depth N/A
Rig Type Track Mounted HSA
Depth to Water Not Encountered

Elevation	Depth (ft)	Blow Counts				N- Value	Material Description	USCS	Sample No.	Recovery
	0-2	3	4	4	8	8	Top 1": black top soil. Below: fine to coarse gravel with silty sand	GM	1	80%
	2-4	5	4	2	1	6	Clayey silt with some gravel	SM	2	20%
	4-6	3	1	1	1	2	Coarse gravel with clayey silt	GM	3	20%
	6-8	1	1	1	6	2	Yellowish orange clayey silt with some fine to coarse gravel, well graded, bottom 4": wet silt	SC	4	50%
	8-10	6	9	11	26	20	Gravel with sandy silt with clay, bottom 6": gravel sheets with sand	GM	5	90%
	10-12	3	6	8	11	14	Sandy silt with little gravel	SM	6	80%
	12-14	9	14	17	17	31	Sandy silt with some gravel, well graded	SM	7	100%
	14-16	5	7	5	3	12	Mottled gray and yellowish sandy clay with few gravel Bottom 8": wet clay	CL	8	100%
	16-18	5	6	8	8	14	High plastic mottled gray and yellowish clay	CH	9	85%
	18-20	7	6	8	9	14	High plastic mottled gray and yellowish clay Bottom 1': very moist	CH	10	100%
	20-22	6	8	6	7	14	Yellowish silty clay with some gravel Bottom 6": Dark gray silty clay with some gravel	CL	11	95%
	22-24	8	11	9	7	20	Dark gray silty clay with some gravel	CL	12	100%
	24-26	6	4	3	4	7	Dark gray silty clay with little gravel	CL	13	75%
	26-28	4	3	3	4	6	Dark gray silty clay with some gravel	CL	14	75%
	28-30	4	6	4	7	10	Dark gray silty clay with some gravel	CL	15	20%
							BORING COMPLETE @ 30 FEET, PIEZOMETER INSTALLED			

APPENDIX C

LABORATORY TEST RESULTS

TRI/ENVIRONMENTAL, INC.

A Texas Research International Company

Client: Geosyntec Consultant

Project: NRG (Keystone): ME 1000

TRI Log No.: E2377-48-01

Test Methods: As-Noted

Jeffrey A. Kuhn, Ph.D., P.E., 10/25/13

Quality Review/Date

Tested by: Tierra Jackson and Kahlil Hart

	ASTM Standard							
	D2216			D1140	D4318			
Sample ID	w (%)	γ_{total} (pcf)	γ_{dry} (pcf)	Percent Fines	Liquid Limit	Plastic Limit	Plastic Index	USCS**
B-1 (10-12) (12-14)	18.8	-	-	71.6	33	21	12	CL
B-2 (4-6) (20-21.2)	10.0	-	-	63.7	30	19	11	CL
B-3 (10-12)*	18.0	-	-	-	31	19	12	-
TH-1 (4-6, 16-18, 26-28)	18.2	-	-	30.7	27	19	8	SC

*As per clients instructions, grain size analsis was not performed due to limited sample quantity.

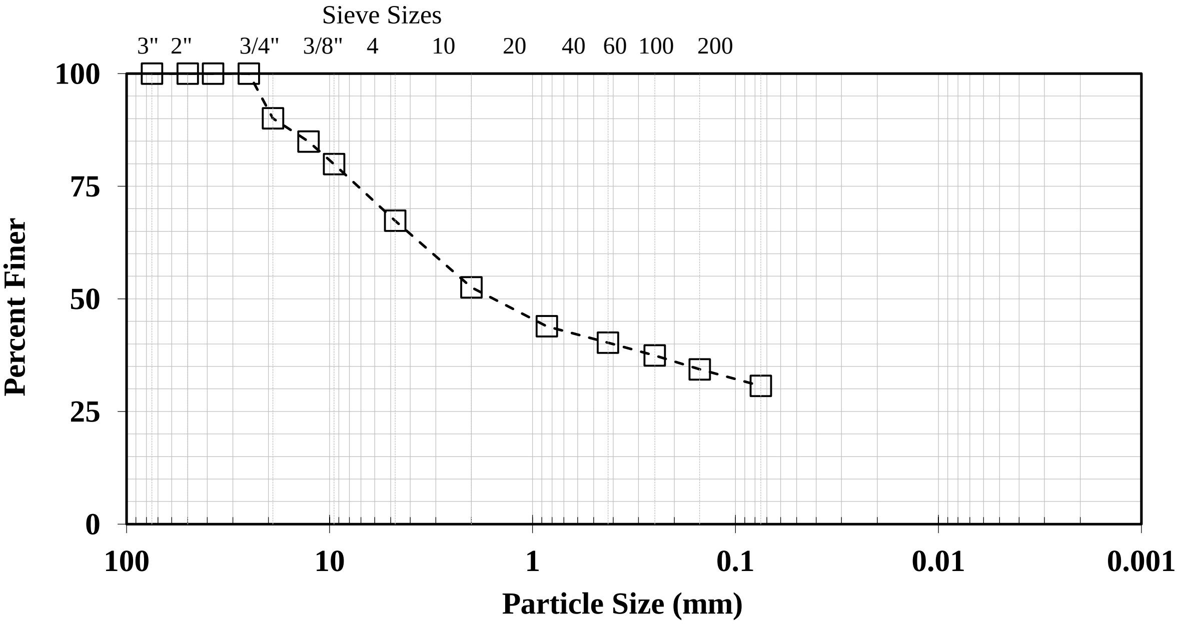
**For full USCS classification/description, please refer to D422-D2216-D4318 reports.

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

Particle Size Analysis for Soils

Client: Geosyntec Consultant
Project: NRG (Keystone)
Sample: TH-1 (4-6, 16-18, 26-28)

TRI Log#: E2377-48-01
Test Method: D422
Test Date: 10/22/13



Sieve Analysis	
Sieve Size	Percent Passing
3 in.	100.0
2 in.	100.0
1.5 in.	100.0
1 in.	100.0
3/4 in.	90.1
1/2 in.	84.9
3/8 in.	79.9
No. 4 (4.75 mm)	67.3
No. 10 (2.00 mm)	52.5
No. 20 (850 µm)	43.9
No. 40 (425 µm)	40.3
No. 60 (250 µm)	37.4
No. 100 (150 µm)	34.3
No. 200 (75 µm)	30.7
Hydrometer Analysis	
Particle Size	Percent Passing
0.074 mm	- -
0.005 mm	- -
0.001 mm	- -

USCS Classification (ASTM D2487)	Clayey Sand (SC)	
As-Received Moisture Content (%)	(ASTM D2216)	18.2
Atterberg Limits (ASTM D 4318, Method A : Multipoint)	Liquid Limit (3 pt)	27
	Plastic Limit	19
	Plastic Index	8
Notes: Specimen was air dried, 3 point Liquid Limit procedure was used. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM 4373)	- -

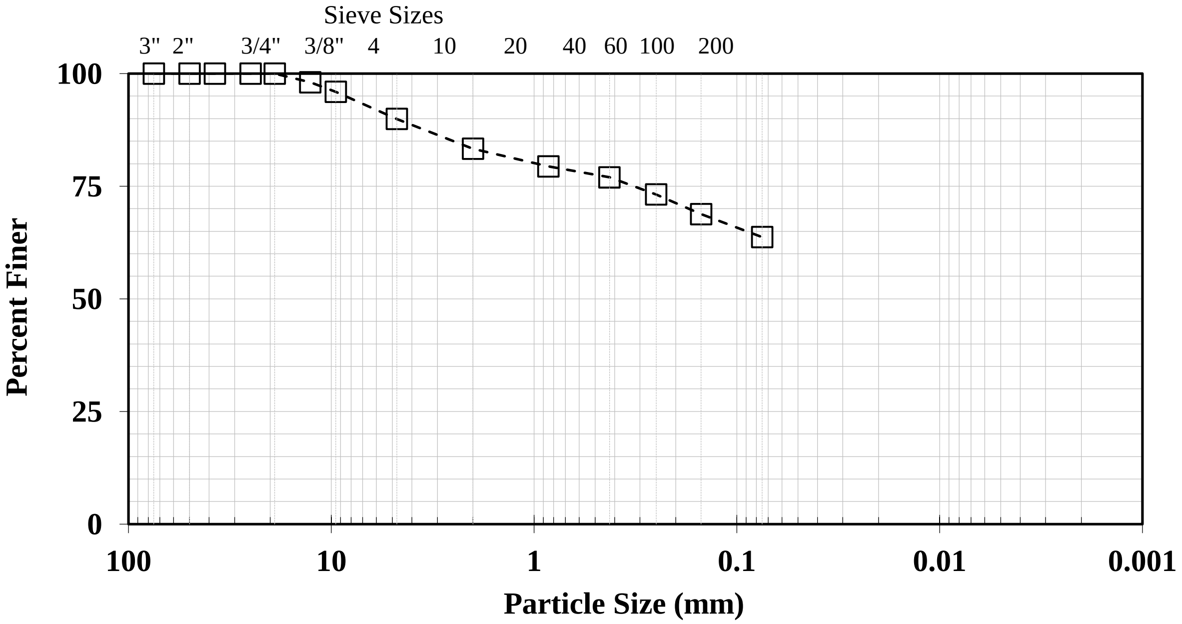
Jeffrey A. Kuhn, Ph.D., P.E., 10/25/2013
Quality Review/Date
Tested by: Kahlil Hart & Tierra Jackson

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

Particle Size Analysis for Soils

Client: Geosyntec Consultant
Project: NRG (Keystone): ME 1000
Sample: B-2 (4-6, 20-21.2)

TRI Log#: E2377-48-01
Test Method: D422
Test Date: 10/22/13



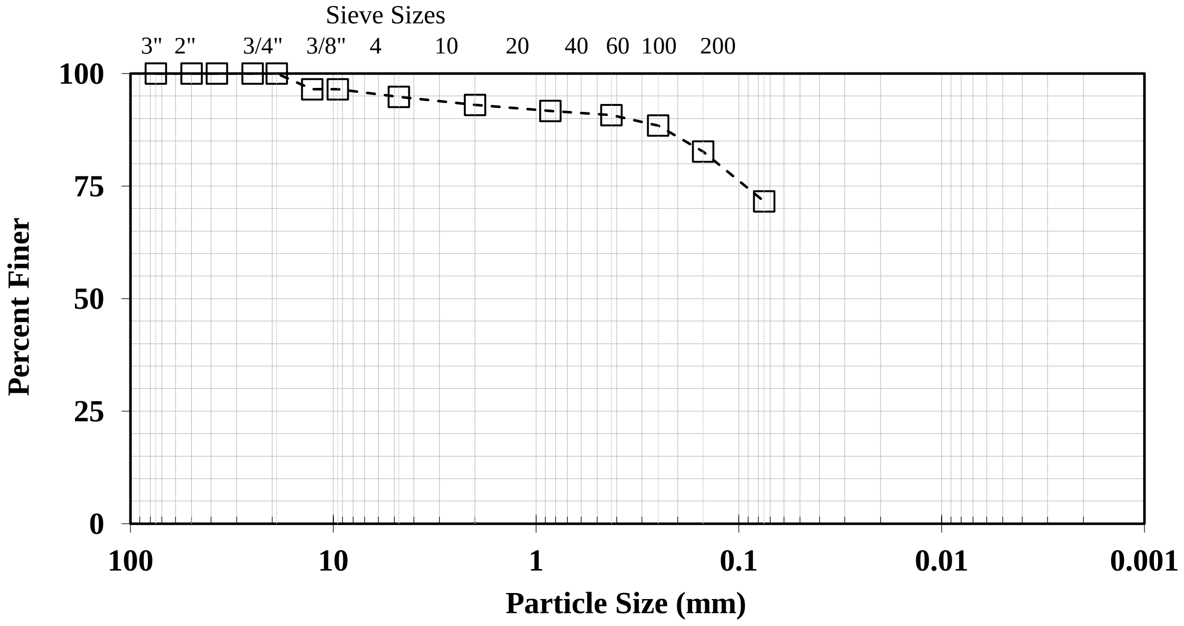
Sieve Analysis	
Sieve Size	Percent Passing
3 in.	100.0
2 in.	100.0
1.5 in.	100.0
1 in.	100.0
3/4 in.	100.0
1/2 in.	98.1
3/8 in.	96.0
No. 4 (4.75 mm)	89.9
No. 10 (2.00 mm)	83.3
No. 20 (850 µm)	79.4
No. 40 (425 µm)	77.0
No. 60 (250 µm)	73.2
No. 100 (150 µm)	68.8
No. 200 (75 µm)	63.7
Hydrometer Analysis	
Particle Size	Percent Passing
0.074 mm	- -
0.005 mm	- -
0.001 mm	- -

USCS Classification (ASTM D2487)	Sandy Lean Clay	
As-Received Moisture Content (%)	(ASTM D2216)	10.0
Atterberg Limits (ASTM D 4318, Method A : Multipoint)	Liquid Limit (3 pt)	30
	Plastic Limit	19
	Plastic Index	11
Notes: Specimen was air dried, 3 point Liquid Limit procedure was used. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM 4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 10/25/2013
Quality Review/Date
Tested by: Kahlil Hart & Tierra Jackson

Particle Size Analysis for Soils

Client:	Geosyntec Consultant	TRI Log#:	E2377-48-01
Project:	NRG (Keystone): ME 1000	Test Method:	D422
Sample:	B-1 (10-12, 12-14)	Test Date:	10/22/13



Sieve Analysis	
Sieve Size	Percent Passing
3 in.	100.0
2 in.	100.0
1.5 in.	100.0
1 in.	100.0
3/4 in.	100.0
1/2 in.	96.5
3/8 in.	96.5
No. 4 (4.75 mm)	94.8
No. 10 (2.00 mm)	93.0
No. 20 (850 µm)	91.7
No. 40 (425 µm)	90.8
No. 60 (250 µm)	88.5
No. 100 (150 µm)	82.7
No. 200 (75 µm)	71.6
Hydrometer Analysis	
Particle Size	Percent Passing
0.074 mm	- -
0.005 mm	- -
0.001 mm	- -

USCS Classification (ASTM D2487)	Lean Clay with Sand (CL)	
As-Received Moisture Content (%)	(ASTM D2216)	18.8
Atterberg Limits (ASTM D 4318, Method A : Multipoint)	Liquid Limit (3 pt)	33
	Plastic Limit	21
	Plastic Index	12
Notes: Specimen was air dried, 3 point Liquid Limit procedure was used. (NL = No Liquid Limit, NP = No Plastic Limit)		
Specific Gravity	(ASTM D854)	- -
Organic Content (%)	(ASTM D2974)	- -
Carbonate Content (%)	(ASTM 4373)	- -

Jeffrey A. Kuhn, Ph.D., P.E., 10/25/2013
Quality Review/Date
Tested by: Kahlil Hart & Tierra Jackson

Geosyntec
consultants

COMPUTATION COVER SHEET

Client: NRG **Project:** Keystone Impoundment Evaluation **Project/Proposal #:** ME1000 **Task #:** ____

TITLE OF COMPUTATIONS Stability Analysis for CCW Impoundments at Keystone Generating Station

COMPUTATIONS BY:
Signature
11/1/2013
DATE
Printed Name Chunling Li
and Title Project Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature Lucas de Melo
11/1/2013
DATE
Printed Name Lucas de Melo
and Title Senior Engineer

COMPUTATIONS CHECKED BY:
Signature
11/1/2013
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Printed Name Lin Chai
and Title Staff Engineer

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature
11/1/2013
DATE
Printed Name Chunling Li
and Title Project Engineer

APPROVED BY:
(PM or Designate)
Signature MJ Houlihan
11/1/2013
DATE
Printed Name Michael Houlihan
and Title Principal

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

STABILITY ANALYSIS FOR CCW IMPOUNDMENTS
AT KEYSTONE GENERATING STATION

1. PURPOSE

As an ongoing national effort by the United States Environmental Protection Agency (EPA) to assess the management of coal combustion waste (CCW), the stability of CCW impoundment at the Keystone Generation Station in Shelocta, Pennsylvania was recently reviewed by EPA. The review was documented in a draft report by Dewberry & Davis, LLC dated November 2012. In response to the comments and recommendation in the report, Geosyntec was engaged by NRG Energy, Inc. (NRG) to review the stability condition of the CCW impounds at the Keystone Generation Station (the site). This calculation package presents the details of the slope stability analysis.

2. BACKGROUND

The CCW system at the site includes a cluster of three contiguous Ash Filter Ponds and a separate Thermal Pond.

Each individual cell of the Ash Filter Ponds is nominally 82 ft wide by 386 ft long with a high water surface elevation at 1017 ft above mean sea level (ft-msl). The Thermal Pond has a surface area of 310,000 square feet with maximum water elevation of 1017 ft-msl.

As a part of this impoundment stability assessment project, Geosyntec drilled four borings at the site, at locations shown in Figures 1 and 2. Design drawings for both the Ash Filter Pond and Thermal Pond were prepared by Gilbert Associates, Inc. dated August 1993. The exterior slope of the Thermal Pond was constructed with a slope steeper than design. Thus, the geometry for the Thermal Pond was selected from an aerial survey provided by NRG on 8 October 2013. The geometry for Ash Filter Ponds was obtained from original design drawings.

3. CROSS SECTIONS ANALYSED

Two critical cross sections, one at Ash Filter Pond (denoted as Section A-A) and one at the Thermal Pond (denoted as Section B-B), were selected for the analysis based on review of subsurface condition and impoundment geometry. The locations of the selected cross sections are also shown in Figure 1.

These cross-sections were selected because the embankment heights at these locations are the highest. As a conservative approach, the weakest foundation soil layer as identified from the subsurface investigation and review of construction data, was assumed to be present at these locations.

4. STABILITY CRITERIA

According to the US Corps of Engineers [2003], the minimum recommended factor of safety (FS) against global slope stability failure for permanent conditions under static loading is 1.5 (EM 110-2-1902). For seismic condition, the minimum acceptable FS is selected to be 1.2, based on recommendation of presented by the Mine Safety and Health Administration document entitled Engineering and Design Manual: Coal Refuse Disposal Facilities [2009].

5. LOADING CONDITIONS

5.1 Static Loads

The major static load applied to the foundation soils is the gravity load exerted by the weight of the berm. A surcharge load of 250 pound per square feet (psf) is applied to the top of the embankment to represent traffic loading on top of the embankment.

5.2 Seismic Loads

The maximum horizontal acceleration in bedrock for the Keystone facility site is estimated to be 0.0501g (g is the gravitational acceleration), based on a seismic hazard map with contours of peak acceleration with 2% probability of exceedance in 50 years as indicated in Figure 3 [USGS, 2008]. This represents the peak ground acceleration in bedrock.

The peak ground acceleration at a soil site should be adjusted to account for the stiffness of soil material overlying the bedrock, which is represented by a site classification in the International Building Code. Using the International Building Code (IBC) 2006 soil classification table, the lithology at the Keystone facility site classifies as a site classification D (stiff soil profile). This classification is selected based on the average standard penetration resistance (N-value) within the upper 100 foot soil profile. An IBC 2006 site classification of D pertains to a soil profile with an average N-value between 15 and 50. This site classification table is attached as Figure 4. The bedrock at the site is located at approximately 20 to 30 ft below ground surface. Considering that the bedrock has high SPT blow counts, the average blow counts for the upper 100 ft shall be greater than 15. Using the site coefficient chart for site Class D the value of 1.6

is obtained as shown in Figure 5. Based on the site coefficient and the PGA in rock, the PGA in soil site is estimated to be 0.080g.

In slope stability analysis, the horizontal seismic loading is typically considered as the weight of the soil mass multiplied by seismic coefficient, *k*. Because the peak ground acceleration will only occur for a short duration, the seismic coefficient *k* used in the design analysis will be smaller than the PGA. A seismic design guidance provided by USEPA [Richardson et. al.,1995] recommends to use approximately half of PGA as seismic coefficient. For a design PGA of 0.080g, a seismic coefficient of 0.04 was used in this analysis.

6. STRATIGRAPHY

Ash Filter Pond

The borings conducted at the Ash Filter Pond (B-1 through B-3) shows that the embankment soils are sandy silt or lean clays. The lower bound of the SPT blow counts is 10 blows/ft. The indication of bedrock was encountered near the bottom of the boring where refusal (likely rock blocks) was encountered during this boring investigation. The depth to bedrock is assumed to be 20 ft.

Thermal Pond

Based on the Boring logs for TH-1, the upper 14 feet of the Thermal Pond embankment are mainly composed of silty sand that classifies as SM or GM with lower bound SPT-N of 2 blows/ft. Below this layer there is a clay layer with SPT-N between 6 and 20 blows/ft. Boring TH-1 did not reach the bedrock. The bedrock is assumed to be located at elevation of 968 ft-msl based on the stratigraphy studied by Gilbert/Commonwealth Inc. [1993], included in the original permit application for the site.

7. MATERIAL PARAMETERS

The selection for material parameters used for the slope stability analysis is described below:

Embankment Fill (Ash Filter Pond)

The embankment at the Filter Ash Pond was constructed using fill material. Based on the boring logs, the material used for the embankment construction is primarily silt and clay.

For temporary undrained condition analysis, the undrained shear strength is selected based on the empirical correlation of the Standard Penetration Test blow counts (SPT-N) by Kulhawy and Mayne [1990]:

$$S_u/P_a = 0.06\ \mathrm{N} \qquad (1)$$

where: S_u = undrained shear strength;
P_a = atmospheric pressure (= 2,116 psf)
N = SPT-N value (blows/ft)

The lower bound of the SPT-N is 10 blows/ft at the Ash Filter Pond. Using the empirical correlations in equation (1), the undrained shear strength of the embankment material at the Filter Ash Pond is assumed to be 1,250 psf.

The drained shear strength of the embankment soil at the Filter Ash Pond is assumed based on the empirical correlations between friction angle and plasticity index (PI) for normally consolidated clay (see Figure 5). Laboratory test results shows that the upper bound of PI for soil samples collected within this area is 12%. Independent verification tests conducted by Geosyntec personnel shows that some soil pockets may have PI as high as 17%. A friction angle of 32 degrees was conservatively assumed based on a PI of 17%.

Foundation Soil (Ash Filter Pond)

The foundation soil at the Ash Filter Pond is silt and clay with similar SPT-N values at embankment soil. Thus, the undrained and drained shear strength was assumed to be the same as the embankment soil (i.e., undrained shear strength of 1,200 psf and drained friction angle of 32 degrees).

Embankment Soil (Thermal Pond)

The material parameters for the embankment soil are selected to be the same as previous slope stability analysis by Gilbert/Commonwealth, Inc. [1993], which used a friction angle of 28 degrees and a cohesion of 240 psf. Based on the empirical correlations between SPT-N and friction angle (see Figure 7), the friction angle of 28 degrees used by Gilbert/Commonwealth, Inc. is considered reasonable.

Foundation Soil (Thermal Pond)

The material parameters for the foundation soil are also selected to be consistent with previous analysis by Gilbert/Commonwealth, Inc. [1993], which used an undrained shear strength of 1,250 psf. This undrained shear strength coincides well with the undrained shear strength predicted using Equation (1) for an average SPT-N of approximately 10 blows/ft. No drained shear strength was used in the analysis by Gilbert [1993]. Based on empirical correlations between Plasticity Index and friction angle (see Figure 6), a friction angle of 32 degrees was estimated using the upper bound of Plasticity Index obtained from the laboratory tests.

Bedrock

Consistent with previous analysis by Gilbert [1993], the weathered bedrock was conservatively assumed to have a shear strength of 8,000 psf.

Table 1 summaries the material properties used in the slope stability analysis.

Table 1. Material Properties Used in Slope Stability Analyses

Material	**Moist Unit Weight (lb/ft^3)**	**Saturated Unit Weight (lb/ft^3)**	**Drained Shear Strength**		**Undrained Shear Strength (psf)**
			Cohesion (psf)	**Friction Angle (deg)**	
Embankment Soil (Ash Filter Pond)	120	-	0	32	1250
Foundation Soil (Ash Filter Pond)	135	135	0	32	1250
Embankment Soil (Thermal Pond)	120	-	240	28	-
Foundation Soil (Thermal Pond)	135	135	0	32	1250
Weathered rock	145	145	8000	0	-

8. GROUNDWATER CONDITION

Consistent with previous analysis by Gilbert [1993], the groundwater table is assumed to be shallow at approximately the bottom of the thermal ponds and conservatively assumed to be at ground surface outside the exterior slope.

For this analysis, the water level in the CCW impoundment is assumed based on the high water table shown in the design drawings [Gilbert, 1993], which is 1017 ft-msl in both the

Ash Filter Pond and Thermal Pond areas. The material in the lined ponds is modeled as material with no shear strength in the analysis.

In the EPA assessment report by Dewberry & Davis Inc [2012], a seep was observed at the exterior slope of the thermal pond. If the seep resulted from the leakage of the lined Thermal Pond it would negatively affect the stability of the embankment. Two piezometers were installed to monitor the groundwater condition near where the seep was observed. Two readings taken immediately after installation and two weeks after installation indicated that the two piezometers were dry. Thus, no seepage through the embankment was considered in this slope stability evaluation. Should future piezometer readings identify seepage through the embankment, the slope stability analysis should be reevaluated by a geotechnical engineer.

9. METHOD OF SLOPE STABILITY ANALYSIS

The stability of the selected cross sections was evaluated using the limit equilibrium method. The analyses were conducted using SLIDE [Rocscience, 2002], a two-dimensional (2D) slope stability computer program. The factors of safety for both circular and non-circular potential slip surface were evaluated. The Spencer's Method [Spencer, 1967], was used in the analysis. The interslice force assumption made in the Spencer's Method satisfies force equilibrium in horizontal and vertical directions as well as moment equilibrium. Therefore, Spencer's method is considered as a rigorous methods, which generally provide more precise results for factor of safety than non-rigorous method. The factors of safety reported herein are from Spencer's method.

Thousands of potential failure surfaces were analyzed to find the critical failure surface resulting in the minimum factor of safety for the slope. For the circular slip surface search, a search grid with 25 horizontal increments and 25 vertical increments was used. For the block failure analysis, two search windows were used for searching the most critical failure surface. SLIDE provides results graphically and as output text files. SLIDE graphical provides both the minimum factor of safety and contours of the calculated factors of safety. For each case analyzed, a figure and text are generated and presented in Attachment I of this calculation package.

10. RESULTS OF SLOPE STABILITY

The results of the SLIDE analyses using the material properties listed in Table 1 are summarized in Table 2.

Table 2. Summary of Slope Stability Results

Cross Sections	Loading Conditions	Failure Mode	Calculated F.S.	Target F.S.
A-A (Ash Filter Pond)	Static (undrained)	Block	6.73	1.30
		Circular	6.83	1.30
	Static (drained)	Block	1.74	1.50
		Circular	1.96	1.50
	Seismic	Block	5.79	1.20
		Circular	5.78	1.20
B-B (Thermal Pond)	Static (undrained)	Block	1.87	1.30
		Circular	1.64	1.30
	Static (drained)	Block	1.67	1.50
		Circular	1.70	1.50
	Seismic	Block	1.69	1.20
		Circular	1.53	1.20

11. SUMMARY

The stability of the both the Ash Filter Ponds and Thermal Pond of the Keystone facility was evaluated for several scenarios. The results of these analyses show factors of safety exceeding the minimum recommended factors of safety. Thus, the CCW impoundments at the Keystone facility are considered to be stable.

12. REFERENCES

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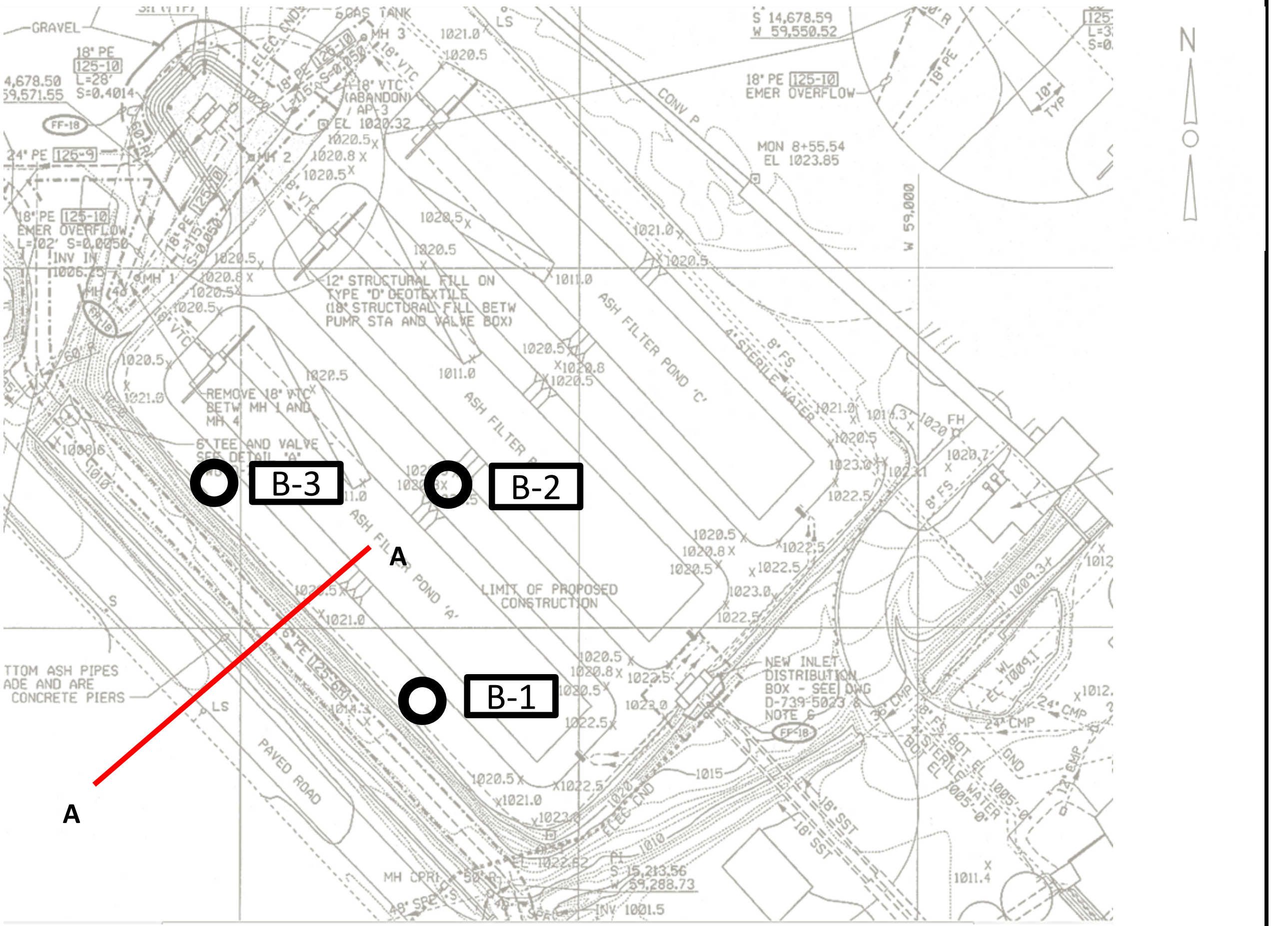
APPENDIX D

STABILITY ANALYSIS



Legend

● B-1 Approximate Boring Location

FIGURE 1 - SOIL BORING LOCATION

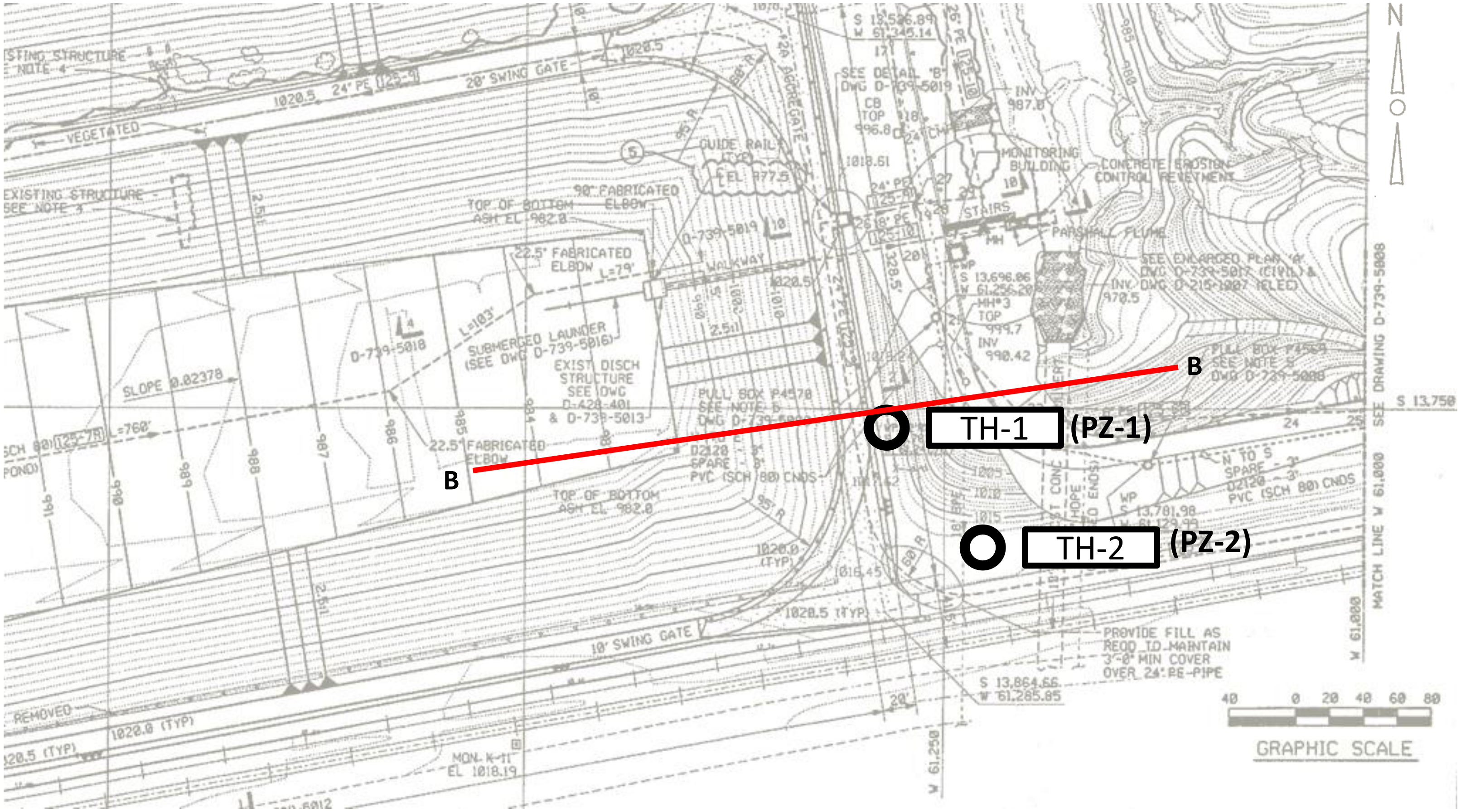
Keystone Generating Station – Ash Filter Pond

Shelocta, PA

Geosyntec consultants

COLUMBIA, MARYLAND

DATE:	Oct 2013
PROJECT NO.	ME1000
DOCUMENT NO.	
FIGURE NO:	1



Legend

○ B-1 Approximate Piezometer Location

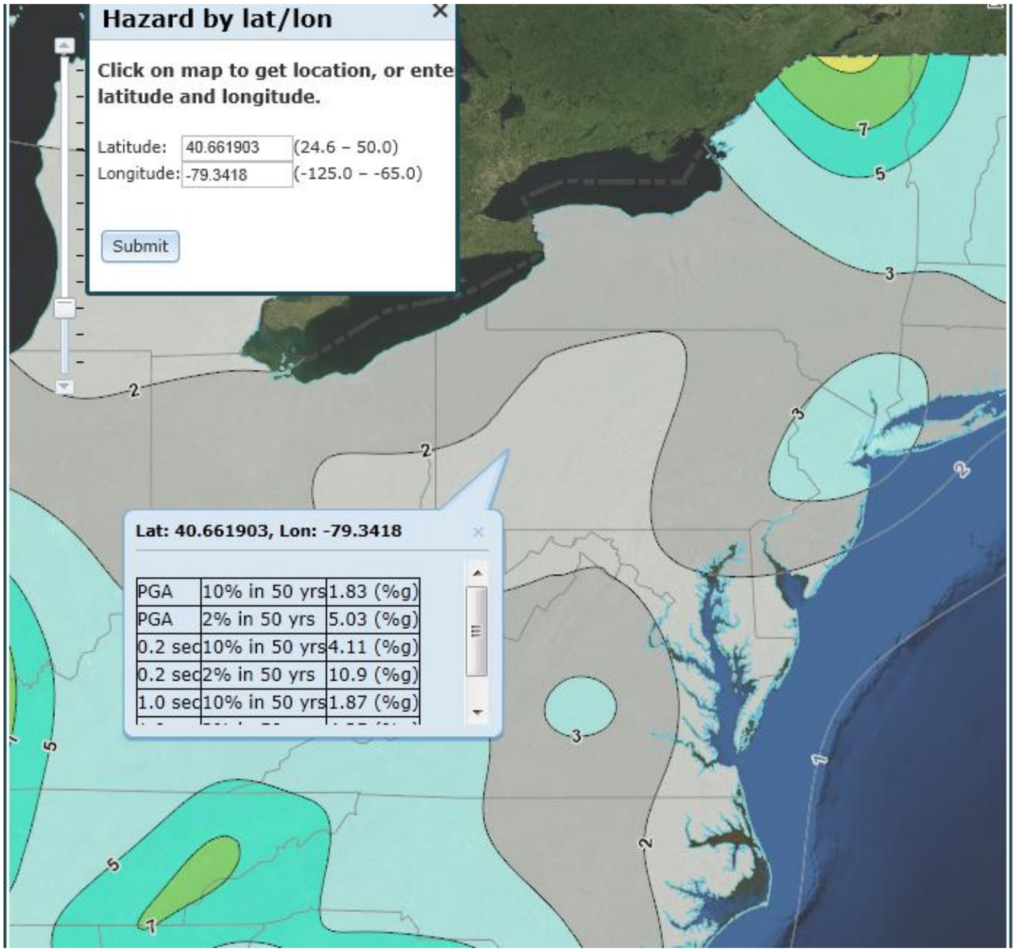
FIGURE 2 - PIEZOMETER LOCATION

Keystone Generating Station – Thermal Pond

Shelocta, PA

Geosyntec consultants
COLUMBIA, MARYLAND

DATE:	Oct 2013
PROJECT NO.	ME1000
DOCUMENT NO.	
FIGURE NO:	2



Hazard by lat/lon

Click on map to get location, or ente
latitude and longitude.

Latitude: 40.661903 (24.6 – 50.0)
Longitude: -79.3418 (-125.0 – -65.0)

Submit

Lat: 40.661903, Lon: -79.3418

PGA	10% in 50 yrs	1.83 (%g)
PGA	2% in 50 yrs	5.03 (%g)
0.2 sec	10% in 50 yrs	4.11 (%g)
0.2 sec	2% in 50 yrs	10.9 (%g)
1.0 sec	10% in 50 yrs	1.87 (%g)

Source: USGS [2008]

Figure 3. USGS Seismic Hazard Map

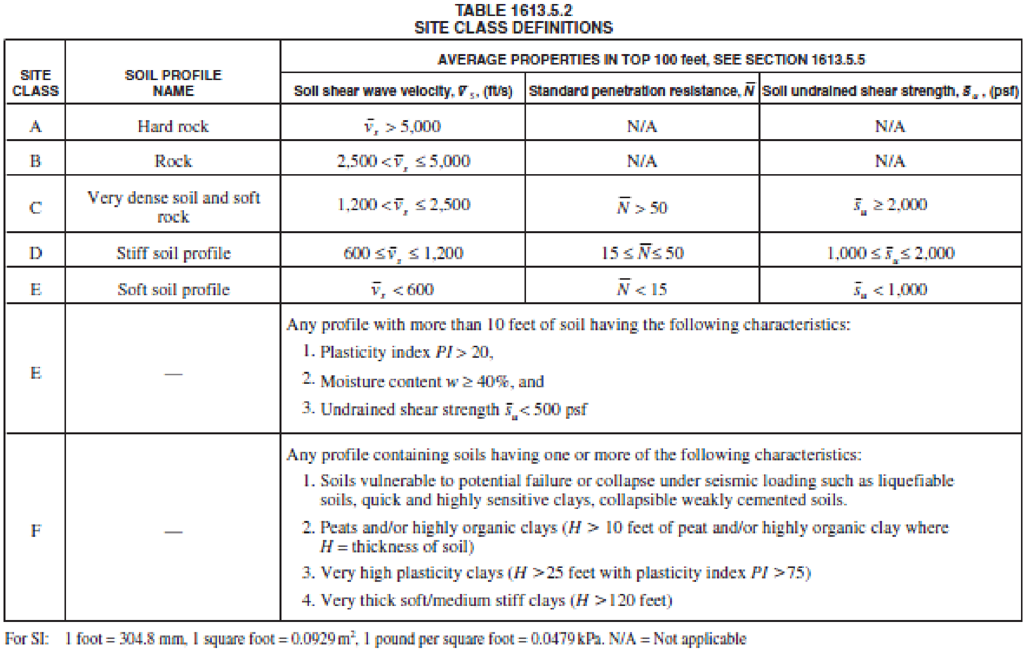


TABLE 1613.5.2
SITE CLASS DEFINITIONS

SITE CLASS	SOIL PROFILE NAME	AVERAGE PROPERTIES IN TOP 100 feet, SEE SECTION 1613.5.5		
		Soil shear wave velocity, $\bar{v}_s$, (ft/s)	Standard penetration resistance, $\bar{N}$	Soil undrained shear strength, $\bar{s}_u$, (psf)
A	Hard rock	$\bar{v}_s > 5,000$	N/A	N/A
B	Rock	$2,500 < \bar{v}_s \leq 5,000$	N/A	N/A
C	Very dense soil and soft rock	$1,200 < \bar{v}_s \leq 2,500$	$\bar{N} > 50$	$\bar{s}_u \geq 2,000$
D	Stiff soil profile	$600 \leq \bar{v}_s \leq 1,200$	$15 \leq \bar{N} \leq 50$	$1,000 \leq \bar{s}_u \leq 2,000$
E	Soft soil profile	$\bar{v}_s < 600$	$\bar{N} < 15$	$\bar{s}_u < 1,000$
E	—	Any profile with more than 10 feet of soil having the following characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content $w \geq 40\%$, and 3. Undrained shear strength $\bar{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays ($H > 10$ feet of peat and/or highly organic clay where H = thickness of soil) 3. Very high plasticity clays ($H > 25$ feet with plasticity index $PI > 75$) 4. Very thick soft/medium stiff clays ($H > 120$ feet)		

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kPa. N/A = Not applicable

Source: International Building Code 2006

Figure 4. Site Classification

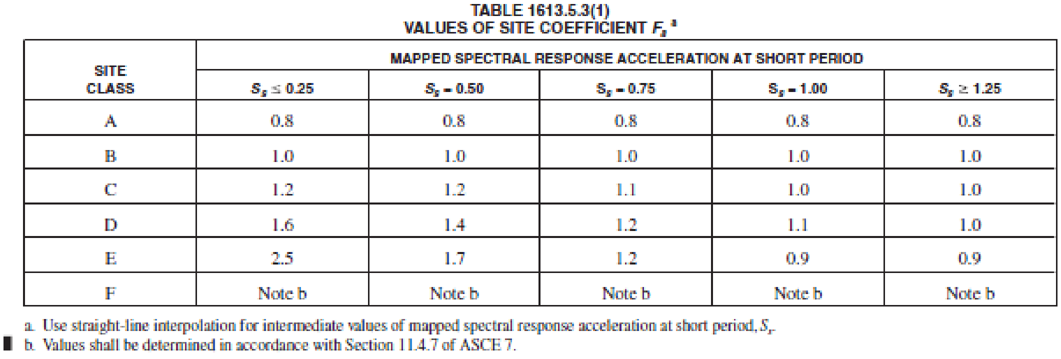


TABLE 1613.5.3(1)
VALUES OF SITE COEFFICIENT F_a [a]

SITE CLASS	MAPPED SPECTRAL RESPONSE ACCELERATION AT SHORT PERIOD				
	$S_s \leq 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at short period, S_s.
b. Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

Source: International Building Code 2006

Figure 5. Site Coefficient

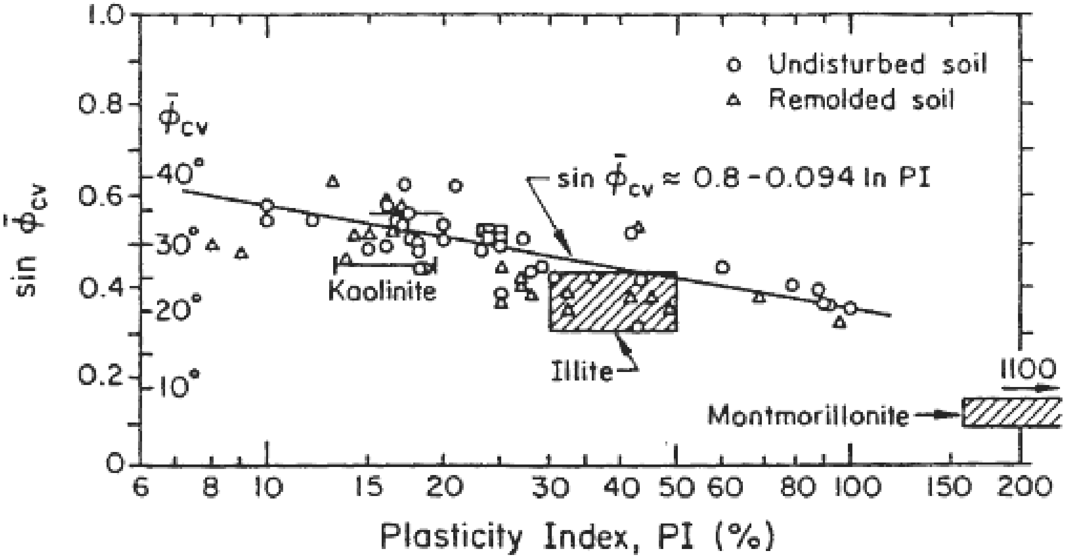


Figure 4-20. $\bar{\phi}_{cv}$ for NC Clays versus PI

Source: Mitchell (22), p. 284.

Reproduced from Kulhawy and Mayne [1990]

Figure 6. Empirical Correlations between Critical Void Ratio Friction Angle and Plasticity Index

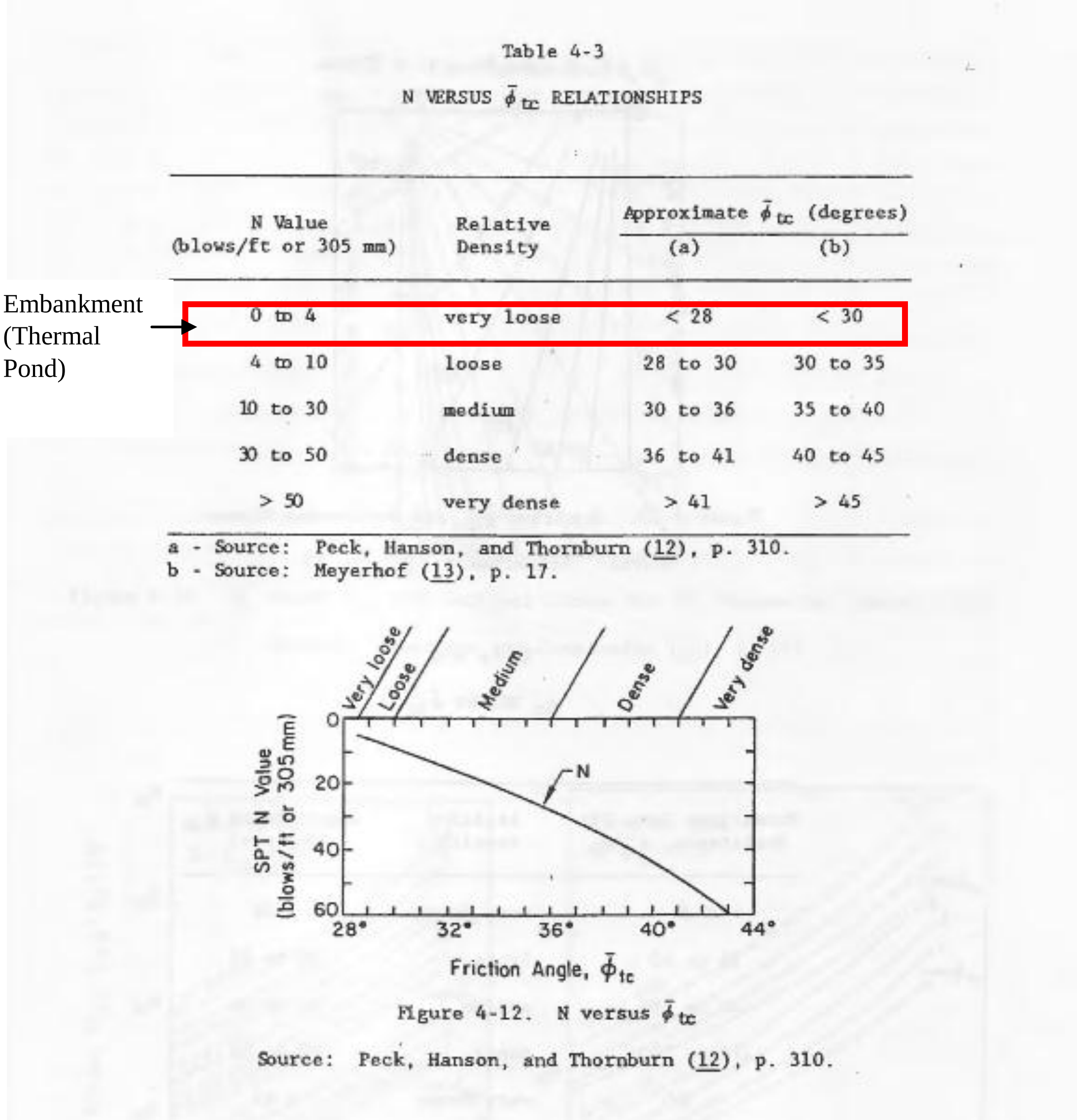


Table 4-3

N VERSUS $\bar{\phi}_{tc}$ RELATIONSHIPS

N Value (blows/ft or 305 mm)	Relative Density	Approximate $\bar{\phi}_{tc}$ (degrees) (a)	Approximate $\bar{\phi}_{tc}$ (degrees) (b)
0 to 4	very loose	< 28	< 30
4 to 10	loose	28 to 30	30 to 35
10 to 30	medium	30 to 36	35 to 40
30 to 50	dense	36 to 41	40 to 45
> 50	very dense	> 41	> 45

Embankment (Thermal Pond)

a - Source: Peck, Hanson, and Thornburn (12), p. 310.
b - Source: Meyerhof (13), p. 17.

Figure 4-12. N versus $\bar{\phi}_{tc}$

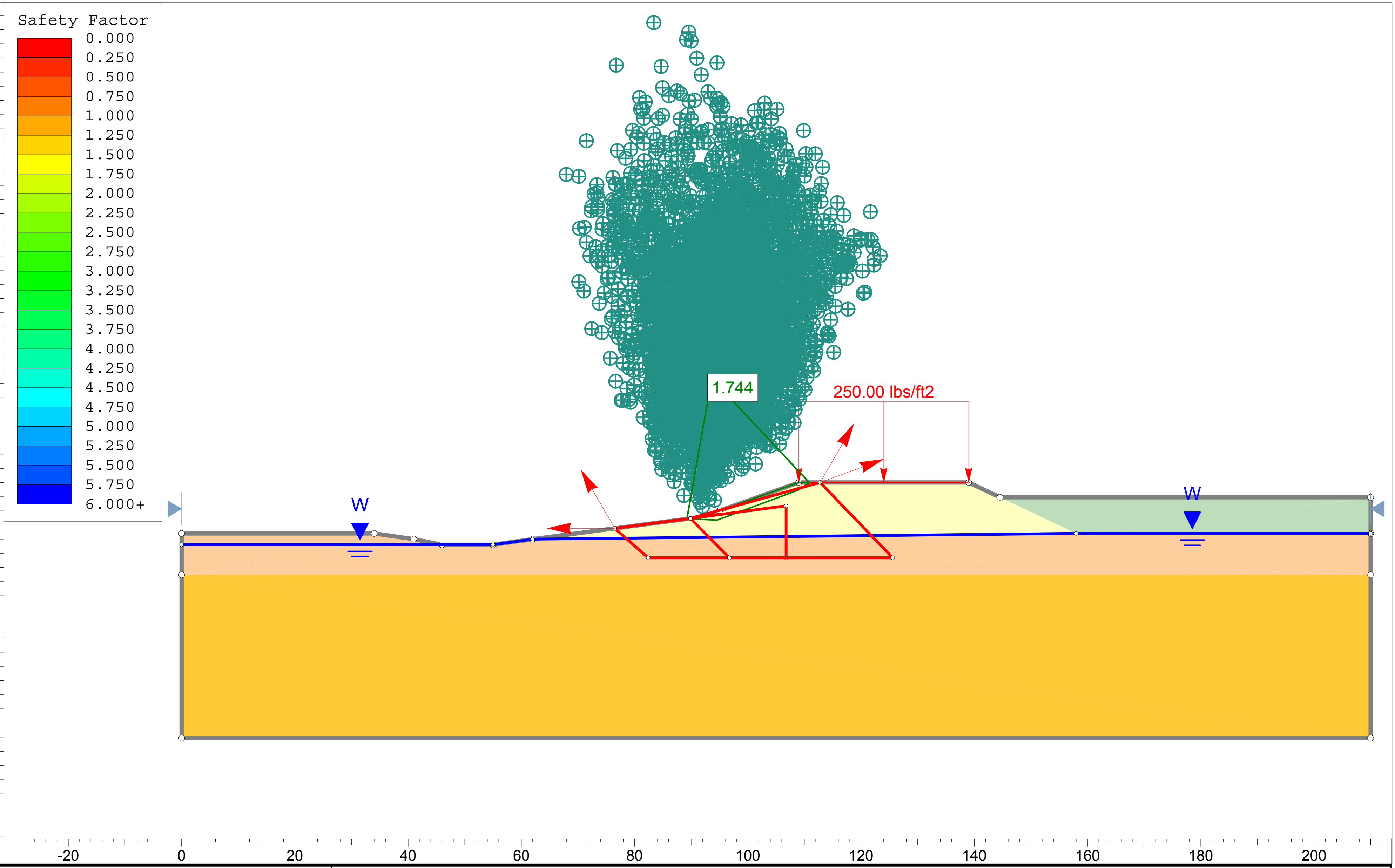
Source: Peck, Hanson, and Thornburn (12), p. 310.

Reproduced from Kulhawy and Mayne [1990]

Figure 7. Empirical Correlation between SPT-N and Friction Angle

Attachment I

SLIDE Output



Project
SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:285

Company

Date 10/16/2013, 3:13:47 PM

File Name A-A_ Keystone_drained block.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: A-A_ Keystone_drained block
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 120
Left Projection Angle (End Angle): 180
Right Projection Angle (Start Angle): 20
Right Projection Angle (End Angle): 60
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	embankment soil	water	Foundation soil	bedrock
Color	🟨	🟩	🟧	🟧
Strength Type	Mohr-Coulomb	No strength	Mohr-Coulomb	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion [psf]	0		0	
Friction Angle [deg]	32		32	
Cohesion Type				8000
Water Surface	Water Table	None	Water Table	None
Hu Value	1		0	
Ru Value		0		0

Global Minimums

Method: spencer

FS: 1.744260
Axis Location: 93.612, 1038.400
Left Slip Surface Endpoint: 89.232, 1013.573
Right Slip Surface Endpoint: 110.846, 1020.000
Resisting Moment=49356.5 lb-ft

Driving Moment=28296.6 lb-ft
Resisting Horizontal Force=1889.64 lb
Driving Horizontal Force=1083.35 lb
Total Slice Area=24.5947 ft2

Global Minimum Coordinates

Method: spencer

X	Y
89.2324	1013.57
94.5861	1013.36
108.998	1018.69
110.846	1020

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4239
Number of Invalid Surfaces: 761

Error Codes:

Error Code -105 reported for 27 surfaces
Error Code -107 reported for 7 surfaces
Error Code -108 reported for 430 surfaces
Error Code -111 reported for 177 surfaces
Error Code -112 reported for 120 surfaces

Error Codes

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.74426

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base [psf]	Base Friction Angle [degrees]	Shear [psf]	Shear [psf]	Base Normal Stress [psf]	Pore [psf]	Effective Normal Stress [psf]
1	0.892285	8.16164	embankment soil	0	32	3.86616	6.74359	10.792	0	10.792
2	0.892285	24.4849	embankment soil	0	32	11.5985	20.2308	32.376	0	32.376
3	0.892285	40.8082	embankment soil	0	32	19.3308	33.7179	53.96	0	53.96
4	0.892285	65.1313	embankment soil	0	32	30.8526	53.815	86.122	0	86.122
5	0.892285	102.832	embankment soil	0	32	48.7115	84.9655	135.973	0	135.973
6	0.892285	140.742	embankment soil	0	32	66.6695	116.289	186.1	0	186.1
7	0.84777	151.191	embankment soil	0	32	56.2103	98.0454	156.905	0	156.905
8	0.84777	150.114	embankment soil	0	32	55.8099	97.3469	155.788	0	155.788
9	0.84777	149.037	embankment soil	0	32	55.4094	96.6484	154.669	0	154.669
10	0.84777	147.96	embankment soil	0	32	55.0089	95.9499	153.552	0	153.552
11	0.84777	146.883	embankment soil	0	32	54.6085	95.2514	152.435	0	152.435
12	0.84777	145.806	embankment soil	0	32	54.208	94.5529	151.316	0	151.316
13	0.84777	144.728	embankment soil	0	32	53.8076	93.8544	150.198	0	150.198
14	0.84777	143.651	embankment soil	0	32	53.4071	93.1559	149.081	0	149.081
15	0.84777	142.574	embankment soil	0	32	53.0067	92.4574	147.962	0	147.962
16	0.84777	141.497	embankment soil	0	32	52.6062	91.7589	146.845	0	146.845
17	0.84777	140.42	embankment soil	0	32	52.2057	91.0604	145.728	0	145.728
18	0.84777	139.343	embankment soil	0	32	51.8053	90.3619	144.609	0	144.609
19	0.84777	138.266	embankment soil	0	32	51.4048	89.6634	143.491	0	143.491
20	0.84777	137.189	embankment soil	0	32	51.0044	88.9649	142.374	0	142.374
21	0.84777	136.111	embankment soil	0	32	50.6039	88.2664	141.255	0	141.255
22	0.84777	135.034	embankment soil	0	32	50.2035	87.5679	140.138	0	140.138
23	0.84777	133.957	embankment soil	0	32	49.803	86.8694	139.021	0	139.021
24	0.923746	109.087	embankment soil	0	32	95.558	166.678	266.74	0	266.74
			embankment							

soil

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.74426

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	89.2324	1013.57	0	0	0
2	90.1246	1013.54	3.83695	1.35126	19.4008
3	91.0169	1013.5	15.3478	5.40503	19.4007
4	91.9092	1013.47	34.5326	12.1613	19.4007
5	92.8015	1013.43	65.1521	22.9446	19.4007
6	93.6938	1013.4	113.496	39.9697	19.4007
7	94.5861	1013.36	179.661	63.2712	19.4007
8	95.4338	1013.67	178.221	62.7641	19.4007
9	96.2816	1013.99	176.792	62.2607	19.4007
10	97.1294	1014.3	175.372	61.7609	19.4008
11	97.9771	1014.61	173.963	61.2646	19.4007
12	98.8249	1014.93	172.565	60.772	19.4007
13	99.6727	1015.24	171.176	60.283	19.4007
14	100.52	1015.55	169.798	59.7977	19.4007
15	101.368	1015.87	168.43	59.3159	19.4007
16	102.216	1016.18	167.072	58.8377	19.4007
17	103.064	1016.49	165.725	58.3632	19.4007
18	103.912	1016.81	164.387	57.8923	19.4008
19	104.759	1017.12	163.06	57.4249	19.4008
20	105.607	1017.43	161.744	56.9612	19.4007
21	106.455	1017.75	160.437	56.5011	19.4007
22	107.303	1018.06	159.141	56.0447	19.4007
23	108.15	1018.37	157.855	55.5918	19.4007
24	108.998	1018.69	156.579	55.1425	19.4008
25	109.922	1019.34	69.991	24.6487	19.4007
26	110.846	1020	0	0	0

List Of Coordinates

Water Table

X	Y
0	1009
55	1009
62	1010
158	1011
210	1011

Line Load

X	Y
139	1020
109	1020

Block Search Window

X	Y
76.4952	1011.9
82.401	1006.7
106.769	1006.7
106.769	1015.87

Block Search Window

X	Y
89.8588	1013.66
96.7216	1006.7
125.594	1006.7
112.774	1020

External Boundary

X	Y
144.542	1017.38
139	1020
109	1020
95	1015
92.0333	1013.94
62	1010
55	1009
46	1009
41	1010
34	1011
0	1011
0	1003.69
0	974.831
210	974.831
210	1003.69
210	1011
210	1017.38

Material Boundary

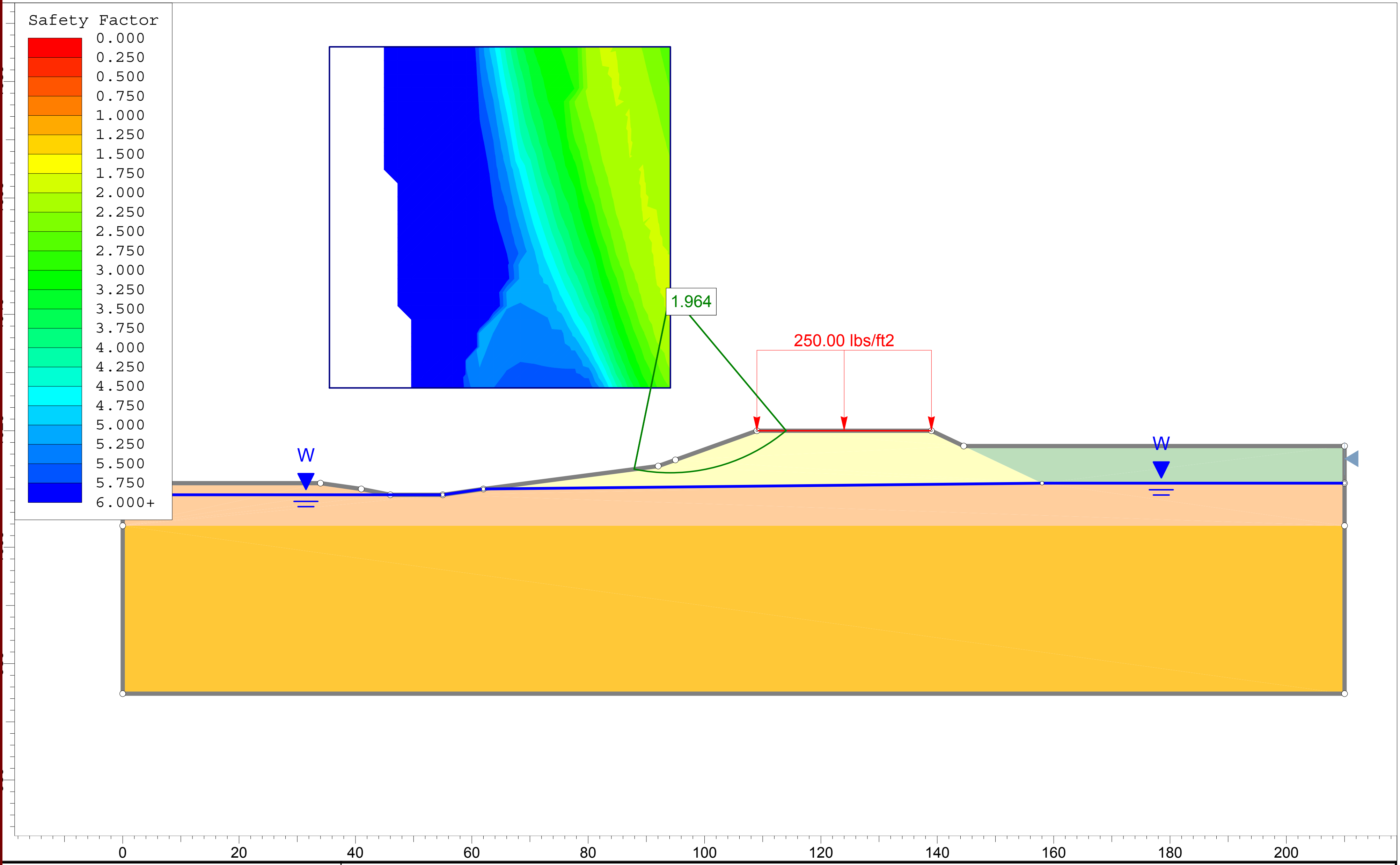
X	Y
62	1010
158	1011

Material Boundary

X	Y
0	1003.69
210	1003.69

Material Boundary

X	Y
144.542	1017.38
158	1011
210	1011



Project
SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:277

Company

Date 10/16/2013, 3:13:47 PM

File Name A-A_ Keystone_drained Circular.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: A-A_ Keystone_drained Circular
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: 2

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	embankment soil	water	Foundation soil	bedrock
Color	🟨	🟩	🟧	🟨
Strength Type	Mohr-Coulomb	No strength	Mohr-Coulomb	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion [psf]	0		0	
Friction Angle [deg]	32		32	
Cohesion Type				8000
Water Surface	Water Table	None	Water Table	None
Hu Value	1		0	
Ru Value		0		0

Global Minimums

Method: spencer

FS: 1.964350
Center: 94.127, 1043.775
Radius: 31.006
Left Slip Surface Endpoint: 87.907, 1013.399
Right Slip Surface Endpoint: 114.030, 1020.000
Resisting Moment=170070 lb-ft
Driving Moment=86578.2 lb-ft
Resisting Horizontal Force=5104.71 lb

Driving Horizontal Force=2598.68 lb
Total Slice Area=64.491 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4608
Number of Invalid Surfaces: 2828

Error Codes:

Error Code -103 reported for 817 surfaces
Error Code -107 reported for 1290 surfaces
Error Code -108 reported for 256 surfaces
Error Code -115 reported for 465 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-115 = Surface too shallow, below the minimum depth.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.96435

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	1.04493	20.844	embankment soil	0	32	8.03915	15.7917	25.272	0	25.272
2	1.04493	60.2278	embankment soil	0	32	22.6192	44.432	71.1061	0	71.1061
3	1.04493	95.0388	embankment soil	0	32	34.7896	68.3389	109.365	0	109.365
4	1.04493	125.378	embankment soil	0	32	44.7708	87.9456	140.742	0	140.742
5	1.04493	167.478	embankment soil	0	32	58.3806	114.68	183.527	0	183.527
6	1.04493	218.484	embankment soil	0	32	74.392	146.132	233.859	0	233.859
7	1.04493	265.068	embankment soil	0	32	88.2022	173.26	277.275	0	277.275
8	1.04493	307.232	embankment soil	0	32	99.9506	196.338	314.206	0	314.206
9	1.04493	344.959	embankment soil	0	32	109.755	215.597	345.028	0	345.028
10	1.04493	378.218	embankment soil	0	32	117.719	231.241	370.064	0	370.064
11	1.04493	406.961	embankment soil	0	32	123.931	243.444	389.592	0	389.592
12	1.04493	431.125	embankment soil	0	32	128.467	252.355	403.853	0	403.853
13	1.04493	450.627	embankment soil	0	32	131.396	258.107	413.057	0	413.057
14	1.04493	465.366	embankment soil	0	32	132.772	260.81	417.383	0	417.383
15	1.04493	475.218	embankment soil	0	32	132.645	260.562	416.987	0	416.987
16	1.04493	480.036	embankment soil	0	32	131.059	257.446	411.999	0	411.999
17	1.04493	479.645	embankment soil	0	32	128.047	251.53	402.531	0	402.531
18	1.04493	473.84	embankment soil	0	32	123.64	242.873	388.678	0	388.678
19	1.04493	462.376	embankment soil	0	32	117.863	231.524	370.515	0	370.515
20	1.04493	444.969	embankment soil	0	32	110.734	217.521	348.106	0	348.106
21	1.04493	405.795	embankment soil	0	32	150.1	294.848	471.855	0	471.855
22	1.04493	329.439	embankment soil	0	32	139.745	274.509	439.306	0	439.306
23	1.04493	245.102	embankment soil	0	32	116.61	229.063	366.577	0	366.577
24	1.04493	153.018	embankment soil	0	32	92.7375	182.169	291.532	0	291.532
25	1.04493	52.4801	embankment soil	0	32	68.5855	134.726	215.606	0	215.606

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.96435

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	87.9066	1013.4	0	0	0
2	88.9515	1013.2	13.3422	4.07449	16.9818
3	89.9964	1013.05	48.2688	14.7405	16.9818
4	91.0414	1012.92	98.0305	29.937	16.9819
5	92.0863	1012.84	157.037	47.9566	16.9818
6	93.1312	1012.78	227.473	69.4669	16.9819

7	94.1761	1012.77	308.977	94.3569	16.9819
8	95.2211	1012.79	395.845	120.885	16.9819
9	96.266	1012.84	483.195	147.56	16.9818
10	97.3109	1012.93	566.872	173.114	16.9819
11	98.3558	1013.06	643.376	196.477	16.9819
12	99.4008	1013.22	709.802	216.762	16.9818
13	100.446	1013.42	763.792	233.25	16.9818
14	101.491	1013.66	803.506	245.378	16.9818
15	102.536	1013.93	827.594	252.734	16.9818
16	103.58	1014.25	835.185	255.052	16.9818
17	104.625	1014.6	825.882	252.212	16.9819
18	105.67	1015	799.768	244.237	16.9819
19	106.715	1015.44	757.422	231.305	16.9819
20	107.76	1015.93	699.948	213.753	16.9818
21	108.805	1016.46	629.018	192.092	16.9818
22	109.85	1017.05	508.537	155.299	16.9818
23	110.895	1017.69	372.179	113.658	16.9819
24	111.94	1018.4	236.678	72.2777	16.9818
25	112.985	1019.16	110.167	33.6432	16.9818
26	114.03	1020	0	0	0

List Of Coordinates

Water Table

X	Y
0	1009
55	1009
62	1010
158	1011
210	1011

Line Load

X	Y
139	1020
109	1020

External Boundary

X	Y
144.542	1017.38
139	1020
109	1020
95	1015
92.0333	1013.94
62	1010
55	1009
46	1009
41	1010
34	1011
0	1011
0	1003.69
0	974.831
210	974.831
210	1003.69
210	1011
210	1017.38

Material Boundary

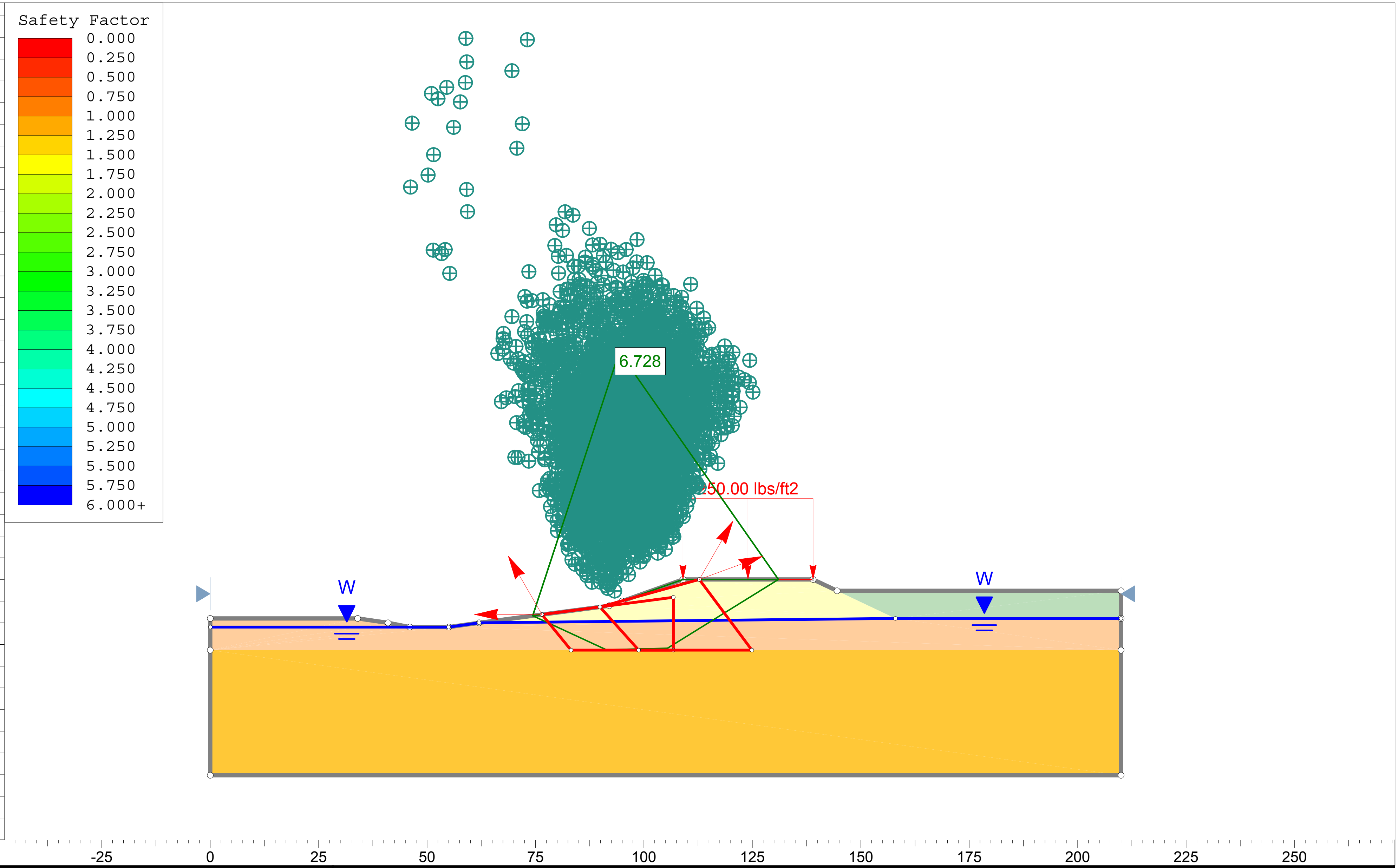
X	Y
62	1010
158	1011

Material Boundary

X	Y
0	1003.69
210	1003.69

Material Boundary

X	Y
144.542	1017.38
158	1011
210	1011



Project
SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:373

Company

Date 10/16/2013, 3:13:47 PM

File Name A-A_ Keystone_undrained block.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: A-A_ Keystone_undrained block
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 120
Left Projection Angle (End Angle): 180
Right Projection Angle (Start Angle): 20
Right Projection Angle (End Angle): 60
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	embankment soil	water	Foundation soil	bedrock
Color	🟨	🟩	🟧	🟨
Strength Type	Undrained	No strength	Undrained	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion Type	1250		1250	8000
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS: 6.728310
Axis Location: 94.313, 1072.462
Left Slip Surface Endpoint: 74.365, 1011.622
Right Slip Surface Endpoint: 131.016, 1020.000
Resisting Moment=5.10355e+006 lb-ft
Driving Moment=758518 lb-ft
Resisting Horizontal Force=70814.2 lb
Driving Horizontal Force=10524.8 lb
Total Slice Area=459.352 ft2

Global Minimum Coordinates

Method: spencer

X	Y
74.3649	1011.62
91.3283	1003.76
105.443	1004.13
131.016	1020

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4077
Number of Invalid Surfaces: 923

Error Codes:

Error Code -105 reported for 10 surfaces
Error Code -107 reported for 16 surfaces
Error Code -108 reported for 667 surfaces
Error Code -111 reported for 171 surfaces
Error Code -112 reported for 59 surfaces

Error Codes

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 6.72831

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	3.15207	354.464	embankment soil	1250	0	185.782	1250	227.817	0	227.817
2	2.3019	725.585	Foundation soil	1250	0	185.782	1250	440.457	0	440.457
3	2.3019	1141.32	Foundation soil	1250	0	185.782	1250	629.867	0	629.867
4	2.3019	1557.06	Foundation soil	1250	0	185.782	1250	819.276	0	819.276
5	2.3019	1972.8	Foundation soil	1250	0	185.782	1250	1008.69	0	1008.69
6	2.3019	2388.54	Foundation soil	1250	0	185.782	1250	1198.1	0	1198.1
7	2.3019	2804.27	Foundation soil	1250	0	185.782	1250	1387.5	0	1387.5
8	2.35239	3149.23	Foundation soil	1250	0	185.782	1250	1348.98	0	1348.98
9	2.35239	3360.98	Foundation soil	1250	0	185.782	1250	1438.76	0	1438.76
10	2.35239	3579.47	Foundation soil	1250	0	185.782	1250	1531.4	0	1531.4
11	2.35239	3797.95	Foundation soil	1250	0	185.782	1250	1624.03	0	1624.03
12	2.35239	4016.44	Foundation soil	1250	0	185.782	1250	1716.67	0	1716.67
13	2.35239	4234.92	Foundation soil	1250	0	185.782	1250	1809.3	0	1809.3
14	2.07235	3739.48	Foundation soil	1250	0	185.782	1250	1607.78	0	1607.78
15	2.07235	3557.04	Foundation soil	1250	0	185.782	1250	1591.61	0	1591.61
16	2.07235	3245.2	Foundation soil	1250	0	185.782	1250	1618.59	0	1618.59
17	2.07235	2886.09	Foundation soil	1250	0	185.782	1250	1455.44	0	1455.44
18	2.07235	2526.99	Foundation soil	1250	0	185.782	1250	1292.29	0	1292.29
19	2.17311	2285.75	embankment soil	1250	0	185.782	1250	1134.54	0	1134.54
20	2.17311	1934.1	embankment soil	1250	0	185.782	1250	982.18	0	982.18
21	2.17311	1582.44	embankment soil	1250	0	185.782	1250	829.821	0	829.821
22	2.17311	1230.79	embankment soil	1250	0	185.782	1250	677.466	0	677.466
23	2.17311	879.136	embankment soil	1250	0	185.782	1250	525.107	0	525.107
24	2.17311	527.481	embankment soil	1250	0	185.782	1250	372.749	0	372.749
25	2.17311	175.827	embankment soil	1250	0	185.782	1250	220.649	0	220.649

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 6.72831

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	74.3649	1011.62	0	0	0
2	77.5169	1010.16	918.22	92.2816	5.73899
3	79.8188	1009.09	1815.6	182.469	5.73899
4	82.1207	1008.03	2915.03	292.962	5.73898
5	84.4226	1006.96	4216.5	423.76	5.73898
6	86.7245	1005.89	5720.01	574.864	5.73899
7	89.0264	1004.83	7425.56	746.273	5.73899
8	91.3283	1003.76	9333.16	937.987	5.73898
9	93.6807	1003.82	9687.09	973.557	5.73898
10	96.0331	1003.88	10035.5	1008.57	5.73897

11	98.3855	1003.95	10378.2	1043.01	5.73896
12	100.738	1004.01	10715.2	1076.88	5.73897
13	103.09	1004.07	11046.5	1110.18	5.73899
14	105.443	1004.13	11372.1	1142.9	5.73898
15	107.515	1005.42	9689.45	973.795	5.73899
16	109.587	1006.7	8027.59	806.777	5.73899
17	111.66	1007.99	6331.03	636.271	5.73898
18	113.732	1009.27	4844.27	486.851	5.73898
19	115.804	1010.56	3567.32	358.517	5.73898
20	117.978	1011.91	2441.01	245.323	5.73899
21	120.151	1013.26	1520.16	152.777	5.73899
22	122.324	1014.61	804.768	80.8795	5.73898
23	124.497	1015.95	294.828	29.6304	5.73899
24	126.67	1017.3	-9.65531	-0.970364	5.73899
25	128.843	1018.65	-108.683	-10.9227	5.73899
26	131.016	1020	0	0	0

List Of Coordinates

Water Table

X	Y
0	1009
55	1009
62	1010
158	1011
210	1011

Line Load

X	Y
139	1020
109	1020

Block Search Window

X	Y
76.4952	1011.9
83.2094	1003.69
106.769	1003.69
106.769	1015.87

Block Search Window

X	Y
89.8588	1013.66

98.8	1003.69
124.901	1003.69
112.774	1020

External Boundary

X	Y
144.542	1017.38
139	1020
109	1020
95	1015
92.0333	1013.94
62	1010
55	1009
46	1009
41	1010
34	1011
0	1011
0	1003.69
0	974.831
210	974.831
210	1003.69
210	1011
210	1017.38

Material Boundary

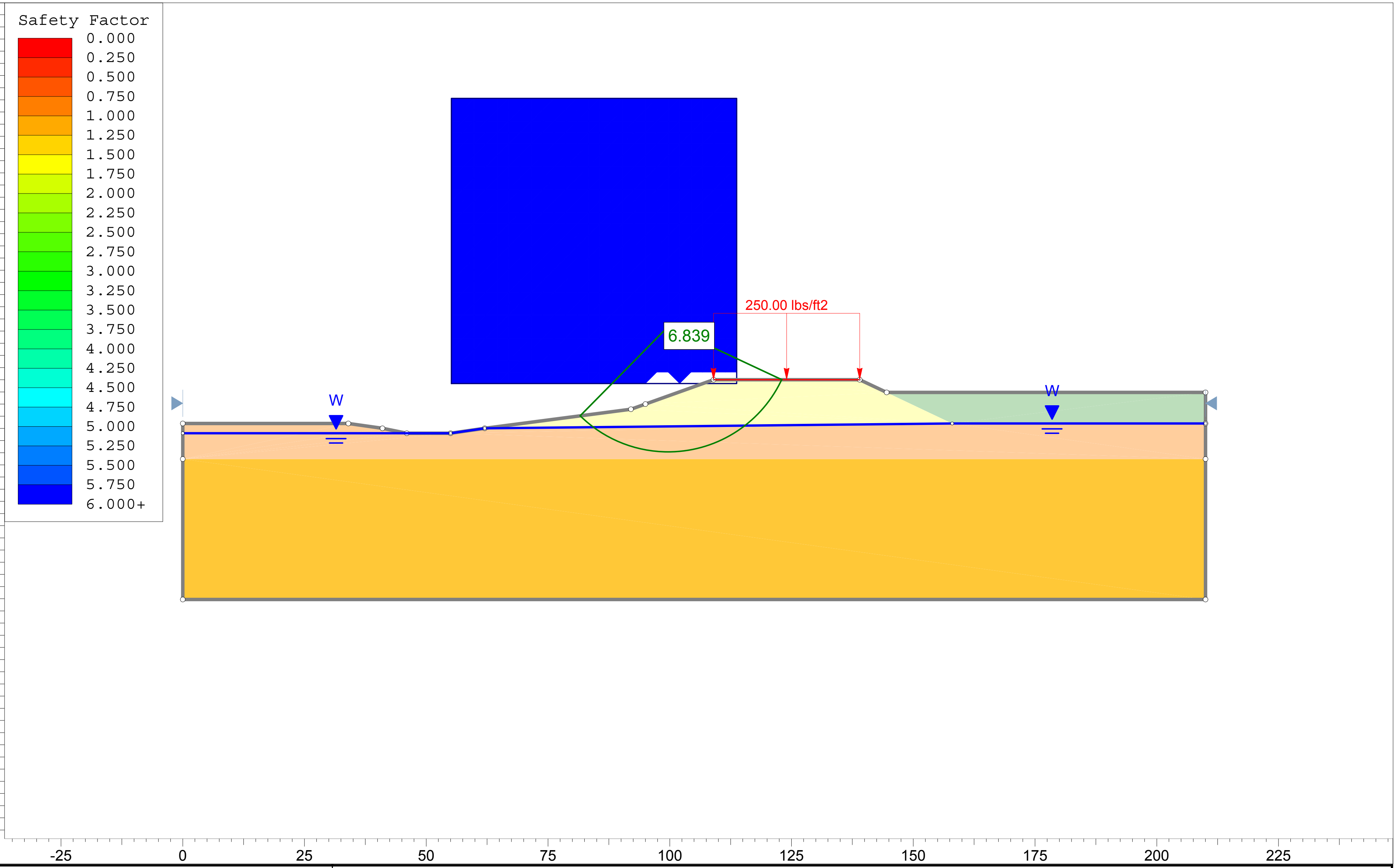
X	Y
62	1010
158	1011

Material Boundary

X	Y
0	1003.69
210	1003.69

Material Boundary

X	Y
144.542	1017.38
158	1011
210	1011



Project SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:332

Company

Date 10/16/2013, 3:13:47 PM

File Name A-A_ Keystone_undrained Circular.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: A-A_ Keystone_undrained Circular
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: 2

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	embankment soil	water	Foundation soil	bedrock
Color	🟨	🟩	🟧	🟨
Strength Type	Undrained	No strength	Undrained	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion Type	1250		1250	8000
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS: 6.838840
Center: 99.689, 1030.913
Radius: 25.764
Left Slip Surface Endpoint: 81.596, 1012.571
Right Slip Surface Endpoint: 123.027, 1020.000
Resisting Moment=1.58614e+006 lb-ft
Driving Moment=231932 lb-ft
Resisting Horizontal Force=51788.9 lb
Driving Horizontal Force=7572.76 lb
Total Slice Area=353.118 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 5021
Number of Invalid Surfaces: 2415

Error Codes:

Error Code -103 reported for 2082 surfaces
Error Code -108 reported for 44 surfaces
Error Code -112 reported for 150 surfaces
Error Code -115 reported for 139 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-115 = Surface too shallow, below the minimum depth.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 6.83884

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	1.36372	117.065	embankment soil	1250	0	182.78	1250	300.342	0	300.342
2	1.36372	337.691	embankment soil	1250	0	182.78	1250	448.332	0	448.332
3	1.6399	676.294	Foundation soil	1250	0	182.78	1250	597.968	0	597.968
4	1.6399	948.51	Foundation soil	1250	0	182.78	1250	747.106	0	747.106
5	1.6399	1184.75	Foundation soil	1250	0	182.78	1250	873.473	0	873.473
6	1.6399	1389.01	Foundation soil	1250	0	182.78	1250	979.711	0	979.711
7	1.6399	1567.4	Foundation soil	1250	0	182.78	1250	1069.78	0	1069.78
8	1.6399	1770.52	Foundation soil	1250	0	182.78	1250	1175.39	0	1175.39
9	1.6399	1966.09	Foundation soil	1250	0	182.78	1250	1275.84	0	1275.84
10	1.6399	2137.28	Foundation soil	1250	0	182.78	1250	1360.61	0	1360.61
11	1.6399	2284.79	Foundation soil	1250	0	182.78	1250	1430.21	0	1430.21
12	1.6399	2409.03	Foundation soil	1250	0	182.78	1250	1484.94	0	1484.94
13	1.6399	2510.1	Foundation soil	1250	0	182.78	1250	1524.89	0	1524.89
14	1.6399	2587.81	Foundation soil	1250	0	182.78	1250	1549.99	0	1549.99
15	1.6399	2641.7	Foundation soil	1250	0	182.78	1250	1559.95	0	1559.95
16	1.6399	2670.95	Foundation soil	1250	0	182.78	1250	1554.26	0	1554.26
17	1.6399	2674.38	Foundation soil	1250	0	182.78	1250	1532.18	0	1532.18
18	1.6399	2598.04	Foundation soil	1250	0	182.78	1250	1690.31	0	1690.31
19	1.6399	2429.08	Foundation soil	1250	0	182.78	1250	1574.8	0	1574.8
20	1.6399	2227.08	Foundation soil	1250	0	182.78	1250	1427.91	0	1427.91
21	1.6399	1987.82	Foundation soil	1250	0	182.78	1250	1258.47	0	1258.47
22	1.8864	1954.78	embankment soil	1250	0	182.78	1250	1056.41	0	1056.41
23	1.8864	1548	embankment soil	1250	0	182.78	1250	811.11	0	811.11
24	1.8864	1041.78	embankment soil	1250	0	182.78	1250	510.779	0	510.779
25	1.8864	379.775	embankment soil	1250	0	182.78	1250	121.594	0	121.594

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 6.83884

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	81.596	1012.57	0	0	0
2	82.9598	1011.32	625.075	63.9209	5.83884
3	84.3235	1010.23	1361.41	139.219	5.83882
4	85.9634	1009.11	2332.44	238.518	5.83884
5	87.6033	1008.16	3341.73	341.729	5.83883
6	89.2432	1007.36	4338.28	443.638	5.83884
7	90.8831	1006.7	5285.4	540.491	5.83883
8	92.523	1006.17	6157.26	629.649	5.83884
9	94.1629	1005.75	6946.96	710.405	5.83884
10	95.8028	1005.44	7635.44	780.809	5.83884
11	97.4427	1005.25	8202.58	838.806	5.83884
12	99.0826	1005.16	8632.24	882.743	5.83884
13	100.722	1005.17	8911.59	911.31	5.83884
14	102.362	1005.29	9030.68	923.488	5.83884
15	104.002	1005.51	8982.18	918.528	5.83884
16	105.642	1005.85	8761.31	895.942	5.83884
17	107.282	1006.29	8365.94	855.511	5.83884
18	108.922	1006.86	7796.86	797.316	5.83884
19	110.562	1007.56	6920.85	707.734	5.83884
20	112.202	1008.39	5903.99	603.749	5.83884
21	113.842	1009.38	4786.01	489.423	5.83884
22	115.482	1010.56	3610.06	369.169	5.83884
23	117.368	1012.17	2248.54	229.939	5.83885

24	119.254	1014.15	987.976	101.032	5.83886
25	121.141	1016.64	58.9126	6.02447	5.83884
26	123.027	1020	0	0	0

List Of Coordinates

Water Table

X	Y
0	1009
55	1009
62	1010
158	1011
210	1011

Line Load

X	Y
139	1020
109	1020

External Boundary

X	Y
144.542	1017.38
139	1020
109	1020
95	1015
92.0333	1013.94
62	1010
55	1009
46	1009
41	1010
34	1011
0	1011
0	1003.69
0	974.831
210	974.831
210	1003.69
210	1011
210	1017.38

Material Boundary

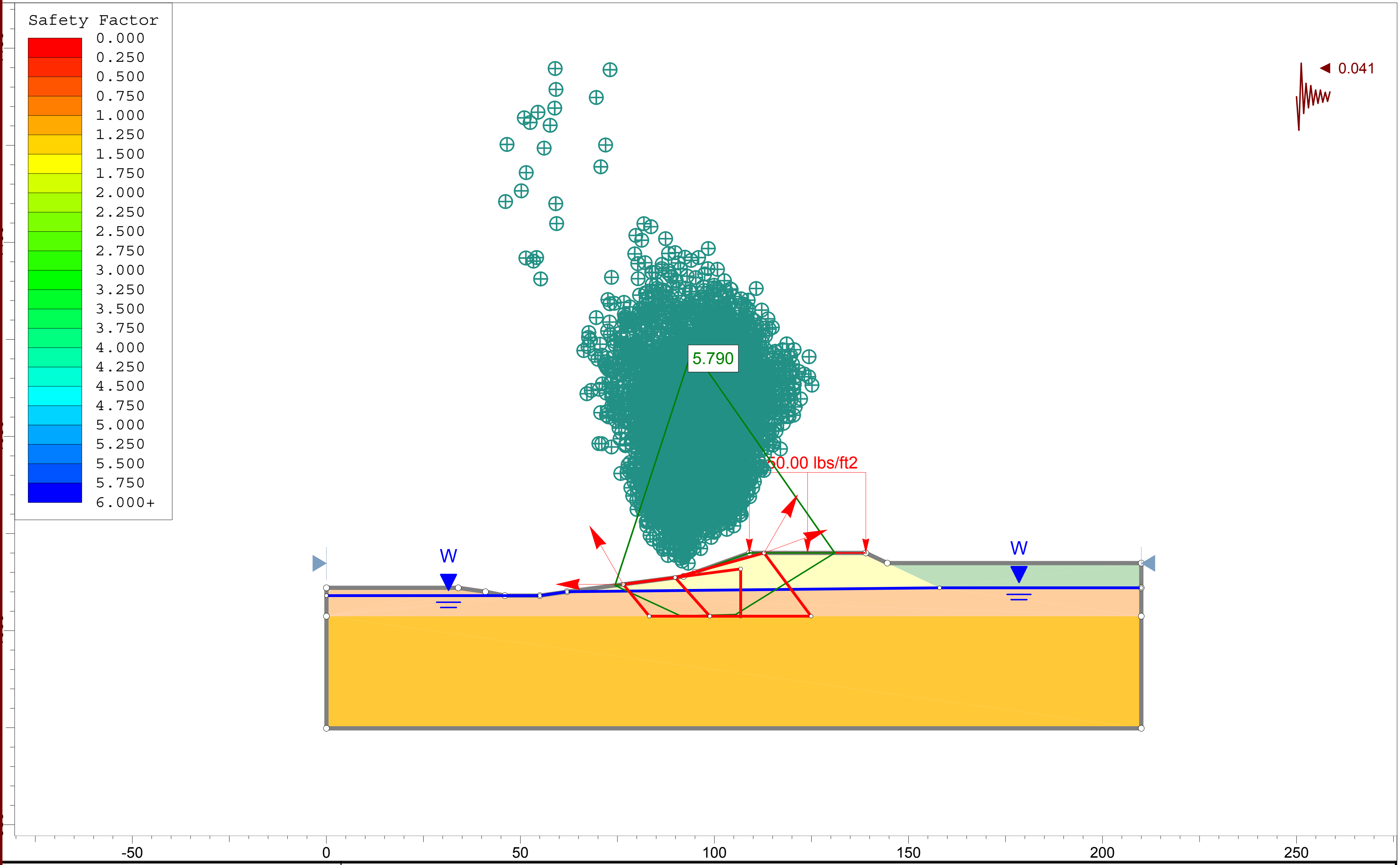
X	Y
62	1010
158	1011

Material Boundary

X	Y
0	1003.69
210	1003.69

Material Boundary

X	Y
144.542	1017.38
158	1011
210	1011



Project

SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:415

Company

Date 10/16/2013, 3:13:47 PM

File Name A-A_ Keystone_undrained block_seismic.slim

DEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: A-A_ Keystone_undrained block_seismic
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 120
Left Projection Angle (End Angle): 180
Right Projection Angle (Start Angle): 20
Right Projection Angle (End Angle): 60
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.041
1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	embankment soil	water	Foundation soil	bedrock
Color	🟨	🟩	🟧	🟧
Strength Type	Undrained	No strength	Undrained	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion Type	1250		1250	8000
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS: 5.790160
Axis Location: 94.313, 1072.462
Left Slip Surface Endpoint: 74.365, 1011.622
Right Slip Surface Endpoint: 131.016, 1020.000
Resisting Moment=5.1012e+006 lb-ft
Driving Moment=881013 lb-ft
Resisting Horizontal Force=70814.2 lb
Driving Horizontal Force=12230.1 lb

Total Slice Area=459.352 ft2

Global Minimum Coordinates

Method: spencer

X	Y
74.3649	1011.62
91.3283	1003.76
105.443	1004.13
131.016	1020

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4119
Number of Invalid Surfaces: 881

Error Codes:

Error Code -105 reported for 10 surfaces
Error Code -107 reported for 4 surfaces
Error Code -108 reported for 615 surfaces
Error Code -111 reported for 194 surfaces
Error Code -112 reported for 58 surfaces

Error Codes

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 5.79016

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
			embankment							

			soil							
2	2.3019	725.585	Foundation soil	1250	0	215.883	1250	466.602	0	466.602
3	2.3019	1141.32	Foundation soil	1250	0	215.883	1250	657.091	0	657.091
4	2.3019	1557.06	Foundation soil	1250	0	215.883	1250	847.581	0	847.581
5	2.3019	1972.8	Foundation soil	1250	0	215.883	1250	1038.07	0	1038.07
6	2.3019	2388.54	Foundation soil	1250	0	215.883	1250	1228.56	0	1228.56
7	2.3019	2804.27	Foundation soil	1250	0	215.883	1250	1419.05	0	1419.05
8	2.35239	3149.23	Foundation soil	1250	0	215.883	1250	1348.48	0	1348.48
9	2.35239	3360.98	Foundation soil	1250	0	215.883	1250	1437.75	0	1437.75
10	2.35239	3579.47	Foundation soil	1250	0	215.883	1250	1529.87	0	1529.87
11	2.35239	3797.95	Foundation soil	1250	0	215.883	1250	1621.98	0	1621.98
12	2.35239	4016.44	Foundation soil	1250	0	215.883	1250	1714.1	0	1714.1
13	2.35239	4234.92	Foundation soil	1250	0	215.883	1250	1806.22	0	1806.22
14	2.07235	3739.48	Foundation soil	1250	0	215.883	1250	1568.9	0	1568.9
15	2.07235	3557.04	Foundation soil	1250	0	215.883	1250	1553.34	0	1553.34
16	2.07235	3245.2	Foundation soil	1250	0	215.883	1250	1580.69	0	1580.69
17	2.07235	2886.09	Foundation soil	1250	0	215.883	1250	1420.39	0	1420.39
18	2.07235	2526.99	Foundation soil	1250	0	215.883	1250	1260.09	0	1260.09
19	2.17311	2285.75	embankment soil	1250	0	215.883	1250	1105.09	0	1105.09
20	2.17311	1934.1	embankment soil	1250	0	215.883	1250	955.396	0	955.396
21	2.17311	1582.44	embankment soil	1250	0	215.883	1250	805.7	0	805.7
22	2.17311	1230.79	embankment soil	1250	0	215.883	1250	656.008	0	656.008
23	2.17311	879.136	embankment soil	1250	0	215.883	1250	506.312	0	506.312
24	2.17311	527.481	embankment soil	1250	0	215.883	1250	356.616	0	356.616
25	2.17311	175.827	embankment soil	1250	0	215.883	1250	207.324	0	207.324

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 5.79016

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	74.3649	1011.62	0	0	0
2	77.5169	1010.16	1035	126.884	6.9892
3	79.8188	1009.09	1999.83	245.164	6.98915
4	82.1207	1008.03	3150.8	386.265	6.98917
5	84.4226	1006.96	4487.93	550.186	6.98915
6	86.7245	1005.89	6011.21	736.929	6.98916
7	89.0264	1004.83	7720.63	946.492	6.98916
8	91.3283	1003.76	9616.21	1178.88	6.98919

9	93.6807	1003.82	9911.88	1215.12	6.98915
10	96.0331	1003.88	10193.4	1249.63	6.98913
11	98.3855	1003.95	10460.2	1282.35	6.9892
12	100.738	1004.01	10712.5	1313.27	6.98915
13	103.09	1004.07	10950.1	1342.4	6.98916
14	105.443	1004.13	11173.1	1369.73	6.98912
15	107.515	1005.42	9449.48	1158.44	6.98919
16	109.587	1006.7	7753.38	950.506	6.98916
17	111.66	1007.99	6034.9	739.834	6.98916
18	113.732	1009.27	4537.29	556.238	6.98916
19	115.804	1010.56	3260.54	399.718	6.98916
20	117.978	1011.91	2145.65	263.041	6.98917
21	120.151	1013.26	1247.05	152.879	6.98916
22	122.324	1014.61	564.726	69.2312	6.98916
23	124.497	1015.95	98.6875	12.0983	6.98913
24	126.67	1017.3	-151.069	-18.5199	6.98915
25	128.843	1018.65	-184.542	-22.6235	6.98917
26	131.016	1020	0	0	0

List Of Coordinates

Water Table

X	Y
0	1009
55	1009
62	1010
158	1011
210	1011

Line Load

X	Y
139	1020
109	1020

Block Search Window

X	Y
76.4952	1011.9
83.2094	1003.69
106.769	1003.69
106.769	1015.87

Block Search Window

X	Y
89.8588	1013.66
98.8	1003.69
124.901	1003.69
112.774	1020

External Boundary

X	Y
144.542	1017.38
139	1020
109	1020
95	1015
92.0333	1013.94
62	1010
55	1009
46	1009
41	1010
34	1011
0	1011
0	1003.69
0	974.831
210	974.831
210	1003.69
210	1011
210	1017.38

Material Boundary

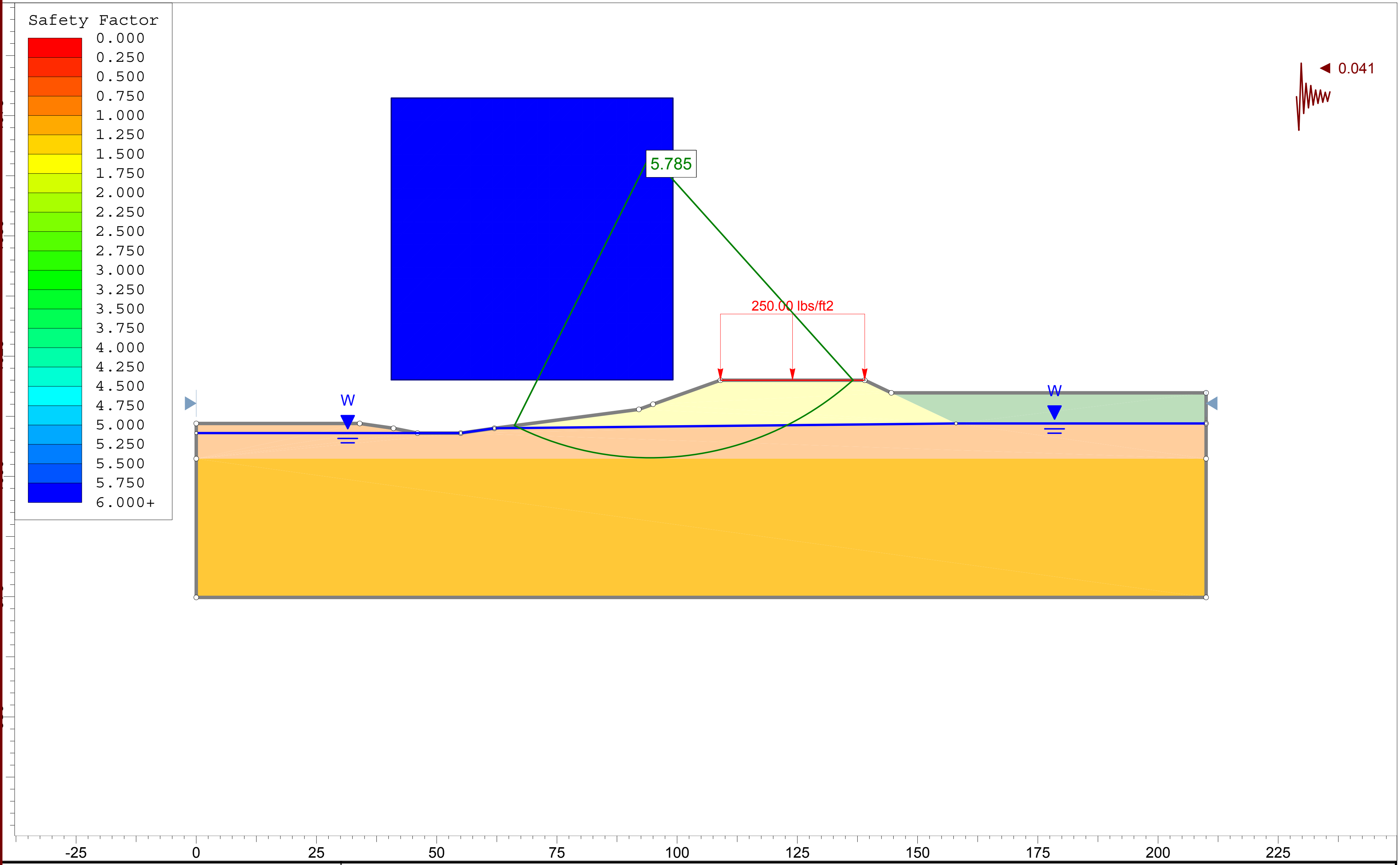
X	Y
62	1010
158	1011

Material Boundary

X	Y
0	1003.69
210	1003.69

Material Boundary

X	Y
144.542	1017.38
158	1011
210	1011



Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By		*Scale* 1:335	*Company*
Date 10/16/2013, 3:13:47 PM		*File Name* A-A_ Keystone_undrained Circular_seismic.slim	

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: A-A_ Keystone_undrained Circular_seismic
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: 2

Loading

Seismic Load Coefficient (Horizontal): 0.041
1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	embankment soil	water	Foundation soil	bedrock
Color	🟨	🟩	🟧	🟧
Strength Type	Undrained	No strength	Undrained	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion Type	1250		1250	8000
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS: 5.784620
Center: 94.445, 1066.925
Radius: 63.075
Left Slip Surface Endpoint: 66.162, 1010.546
Right Slip Surface Endpoint: 136.594, 1020.000
Resisting Moment=5.94799e+006 lb-ft
Driving Moment=1.02824e+006 lb-ft
Resisting Horizontal Force=88040.3 lb
Driving Horizontal Force=15219.7 lb
Total Slice Area=608.899 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 5324
Number of Invalid Surfaces: 2112

Error Codes:

Error Code -103 reported for 1304 surfaces
Error Code -107 reported for 253 surfaces
Error Code -108 reported for 137 surfaces
Error Code -111 reported for 2 surfaces
Error Code -112 reported for 93 surfaces
Error Code -115 reported for 323 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-115 = Surface too shallow, below the minimum depth.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 5.78462

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	1.00325	37.5527	embankment soil	1250	0	216.09	1250	179.578	0	179.578
2	2.93359	548.682	Foundation soil	1250	0	216.09	1250	326.355	0	326.355
3	2.93359	1172.36	Foundation soil	1250	0	216.09	1250	532.375	0	532.375
4	2.93359	1729.09	Foundation soil	1250	0	216.09	1250	712.776	0	712.776
5	2.93359	2222.38	Foundation soil	1250	0	216.09	1250	869.314	0	869.314
6	2.93359	2655.03	Foundation soil	1250	0	216.09	1250	1003.39	0	1003.39
7	2.93359	3029.24	Foundation soil	1250	0	216.09	1250	1116.13	0	1116.13
8	2.93359	3346.69	Foundation soil	1250	0	216.09	1250	1208.41	0	1208.41
9	2.93359	3608.62	Foundation soil	1250	0	216.09	1250	1280.92	0	1280.92
10	2.93359	3847.76	Foundation soil	1250	0	216.09	1250	1345.04	0	1345.04
11	2.93359	4207.55	Foundation soil	1250	0	216.09	1250	1449.42	0	1449.42
12	2.93359	4539.79	Foundation soil	1250	0	216.09	1250	1543.34	0	1543.34
13	2.93359	4817.66	Foundation soil	1250	0	216.09	1250	1617.85	0	1617.85
14	2.93359	5040.56	Foundation soil	1250	0	216.09	1250	1672.95	0	1672.95
15	2.93359	5207.49	Foundation soil	1250	0	216.09	1250	1708.48	0	1708.48
16	2.93359	5216.25	Foundation soil	1250	0	216.09	1250	1870.4	0	1870.4
17	2.93359	4910.24	Foundation soil	1250	0	216.09	1250	1811.11	0	1811.11
18	2.93359	4530.02	Foundation soil	1250	0	216.09	1250	1664.9	0	1664.9
19	2.93359	4085.04	Foundation soil	1250	0	216.09	1250	1498.46	0	1498.46
20	2.93359	3571.46	Foundation soil	1250	0	216.09	1250	1310.83	0	1310.83
21	2.73815	2835.8	embankment soil	1250	0	216.09	1250	1118.73	0	1118.73
22	2.73815	2322.96	embankment soil	1250	0	216.09	1250	923.278	0	923.278
23	2.73815	1747.66	embankment soil	1250	0	216.09	1250	707.863	0	707.863
24	2.73815	1103.34	embankment soil	1250	0	216.09	1250	470.739	0	470.739
25	2.73815	381.501	embankment soil	1250	0	216.09	1250	209.735	0	209.735

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 5.78462

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	66.1616	1010.55	0	0	0
2	67.1649	1010.05	303.623	36.2929	6.81638
3	70.0985	1008.74	1344.56	160.718	6.81634
4	73.0321	1007.6	2538.47	303.43	6.81637
5	75.9657	1006.62	3798.64	454.062	6.81638
6	78.8993	1005.8	5055.9	604.345	6.81637
7	81.8328	1005.12	6255.11	747.691	6.81639
8	84.7664	1004.6	7352.73	878.892	6.81638
9	87.7	1004.21	8314.96	993.91	6.81638
10	90.6336	1003.96	9116.48	1089.72	6.81639
11	93.5672	1003.86	9739.37	1164.17	6.81636
12	96.5008	1003.88	10161	1214.57	6.81637
13	99.4344	1004.05	10355.4	1237.8	6.81633
14	102.368	1004.35	10303.2	1231.56	6.81633
15	105.302	1004.79	9991.28	1194.28	6.81635
16	108.235	1005.38	9412.84	1125.14	6.81636
17	111.169	1006.11	8464.53	1011.79	6.81639
18	114.102	1006.99	7296.27	872.143	6.81638
19	117.036	1008.03	6007.8	718.129	6.81638
20	119.97	1009.24	4659.72	556.989	6.81638

21	122.903	1010.63	3325.71	397.531	6.81638
22	125.641	1012.1	2156.42	257.762	6.81636
23	128.379	1013.76	1128.04	134.838	6.81639
24	131.118	1015.61	338.248	40.4317	6.81638
25	133.856	1017.68	-90.5347	-10.8219	6.8164
26	136.594	1020	0	0	0

List Of Coordinates

Water Table

X	Y
0	1009
55	1009
62	1010
158	1011
210	1011

Line Load

X	Y
139	1020
109	1020

External Boundary

X	Y
144.542	1017.38
139	1020
109	1020
95	1015
92.0333	1013.94
62	1010
55	1009
46	1009
41	1010
34	1011
0	1011
0	1003.69
0	974.831
210	974.831
210	1003.69
210	1011
210	1017.38

Material Boundary

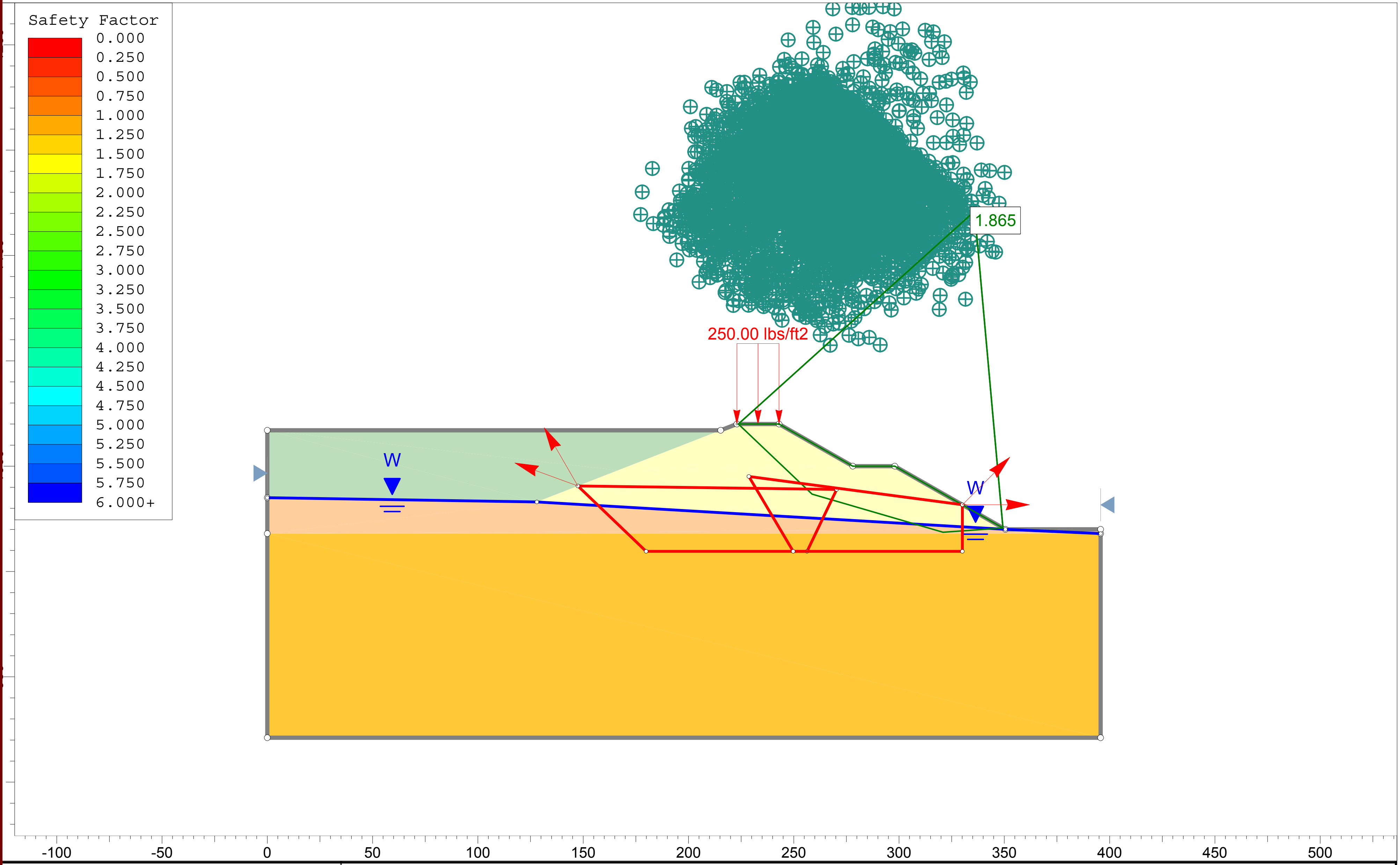
X	Y
62	1010
158	1011

Material Boundary

X	Y
0	1003.69
210	1003.69

Material Boundary

X	Y
144.542	1017.38
158	1011
210	1011



Project
SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:764

Company

Date 10/16/2013, 3:13:47 PM

File Name B-B_ Keystone_drained_Block.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: B-B_ Keystone_drained_Block
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 120
Left Projection Angle (End Angle): 160
Right Projection Angle (Start Angle): 0
Right Projection Angle (End Angle): 45
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	soil 1	water	Soil 2	bedrock
Color	🟨	🟩	🟧	🟨
Strength Type	Mohr-Coulomb	No strength	Mohr-Coulomb	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion [psf]	240		0	
Friction Angle [deg]	28		32	
Cohesion Type				8000
Water Surface	None	None	Water Table	None
Hu Value			0	
Ru Value	0	0		0

Global Minimums

Method: spencer

FS: 1.865460
Axis Location: 335.838, 1121.020
Left Slip Surface Endpoint: 223.654, 1020.000
Right Slip Surface Endpoint: 349.344, 970.661
Resisting Moment=2.49857e+007 lb-ft

Driving Moment=1.33939e+007 lb-ft
Resisting Horizontal Force=150053 lb
Driving Horizontal Force=80437.8 lb
Total Slice Area=2116.9 ft2

Global Minimum Coordinates

Method: spencer

X	Y
223.654	1020
258.696	986.739
320.891	968.637
349.344	970.661

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4238
Number of Invalid Surfaces: 762

Error Codes:

Error Code -107 reported for 149 surfaces
Error Code -108 reported for 531 surfaces
Error Code -111 reported for 54 surfaces
Error Code -112 reported for 28 surfaces

Error Codes

The following errors were encountered during the computation:

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.86546

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.00609	1427.21	soil 1	240	28	215.098	401.257	303.28	0	303.28
2	5.00609	4281.64	soil 1	240	28	321.556	599.849	676.777	0	676.777
3	5.00609	7136.07	soil 1	240	28	428.012	798.44	1050.27	0	1050.27
4	5.00609	9974.73	soil 1	240	28	527.559	984.14	1399.53	0	1399.53
5	5.00609	11752.9	soil 1	240	28	553.524	1032.58	1490.63	0	1490.63
6	5.00609	12888.9	soil 1	240	28	595.89	1111.61	1639.26	0	1639.26
7	5.00609	14024.8	soil 1	240	28	638.256	1190.64	1787.9	0	1787.9
8	5.43335	15341.7	soil 1	240	28	873.42	1629.33	2612.94	0	2612.94
9	5.43335	14348.4	soil 1	240	28	825.405	1539.76	2444.48	0	2444.48
10	5.43335	13355.1	soil 1	240	28	777.385	1450.18	2276.01	0	2276.01
11	5.43335	12564.2	soil 1	240	28	739.153	1378.86	2141.89	0	2141.89
12	5.43335	13286	soil 1	240	28	774.045	1443.95	2264.3	0	2264.3
13	5.43335	14317	soil 1	240	28	823.888	1536.93	2439.18	0	2439.18
14	5.43335	15348.1	soil 1	240	28	873.731	1629.91	2614.04	0	2614.04
15	5.43335	15784.9	soil 1	240	28	894.846	1669.3	2688.12	0	2688.12
16	5.43335	14846.9	soil 1	240	28	849.501	1584.71	2529.04	0	2529.04
17	4.43151	11408.1	Soil 2	0	32	798.023	1488.68	2382.38	0	2382.38
18	4.43151	10815.9	Soil 2	0	32	756.596	1411.4	2258.71	0	2258.71
19	4.43151	10223.7	Soil 2	0	32	715.169	1334.12	2135.03	0	2135.03
20	4.77462	9795.18	Soil 2	0	32	837.273	1561.9	2499.56	0	2499.56
21	4.77462	7993.12	Soil 2	0	32	683.236	1274.55	2039.71	0	2039.71
22	4.77462	6191.06	Soil 2	0	32	529.2	987.202	1579.85	0	1579.85
23	4.77462	4389	Soil 2	0	32	375.164	699.853	1120	0	1120
24	4.77462	2586.94	Soil 2	0	32	221.127	412.503	660.143	0	660.143
25	4.57945	808.501	soil 1	240	28	207.167	386.462	275.455	0	275.455

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.86546

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	223.654	1020	0	0	0
2	228.66	1015.25	362.58	138.886	20.9593
3	233.666	1010.5	1966.09	753.111	20.9593
4	238.672	1005.75	4810.54	1842.68	20.9594
5	243.678	1000.99	8815.37	3376.72	20.9593
6	248.684	996.242	13122.9	5026.71	20.9593
7	253.69	991.49	17924.2	6865.86	20.9593
8	258.696	986.739	23219.4	8894.17	20.9593
9	264.13	985.158	22598.4	8656.29	20.9593
10	269.563	983.576	21972.2	8416.45	20.9593
11	274.996	981.995	21341	8174.66	20.9593
12	280.43	980.413	20705.7	7931.32	20.9593
13	285.863	978.832	20074.2	7689.39	20.9593
14	291.296	977.251	19447.9	7449.5	20.9593
15	296.73	975.669	18826.9	7211.63	20.9593

16	302.163	974.088	18208.1	6974.61	20.9593
17	307.597	972.507	17584.6	6735.76	20.9593
18	312.028	971.217	17115.3	6556.01	20.9593
19	316.46	969.927	16670.4	6385.6	20.9593
20	320.891	968.637	16249.9	6224.52	20.9593
21	325.666	968.977	11397.3	4365.73	20.9593
22	330.44	969.316	7437.44	2848.91	20.9593
23	335.215	969.656	4370.34	1674.06	20.9594
24	339.99	969.996	2195.99	841.173	20.9593
25	344.764	970.335	914.398	350.26	20.9593
26	349.344	970.661	0	0	0

List Of Coordinates

Water Table

X	Y
0	985
128	983
350.5	970
395.703	968

Line Load

X	Y
243	1020
223	1020

Block Search Window

X	Y
147.491	990.591
179.921	959.521
256.328	959.521
270.38	988.942

Block Search Window

X	Y
228.663	995.09
249.741	959.521
330.1	959.521
330.1	981.657

External Boundary

X	Y
243	1020
223	1020
215.297	1017
0	1017
0	985
0	968
0	871.073
395.703	871.073
395.703	968
395.703	970
350.5	970
298	1000
278	1000

Material Boundary

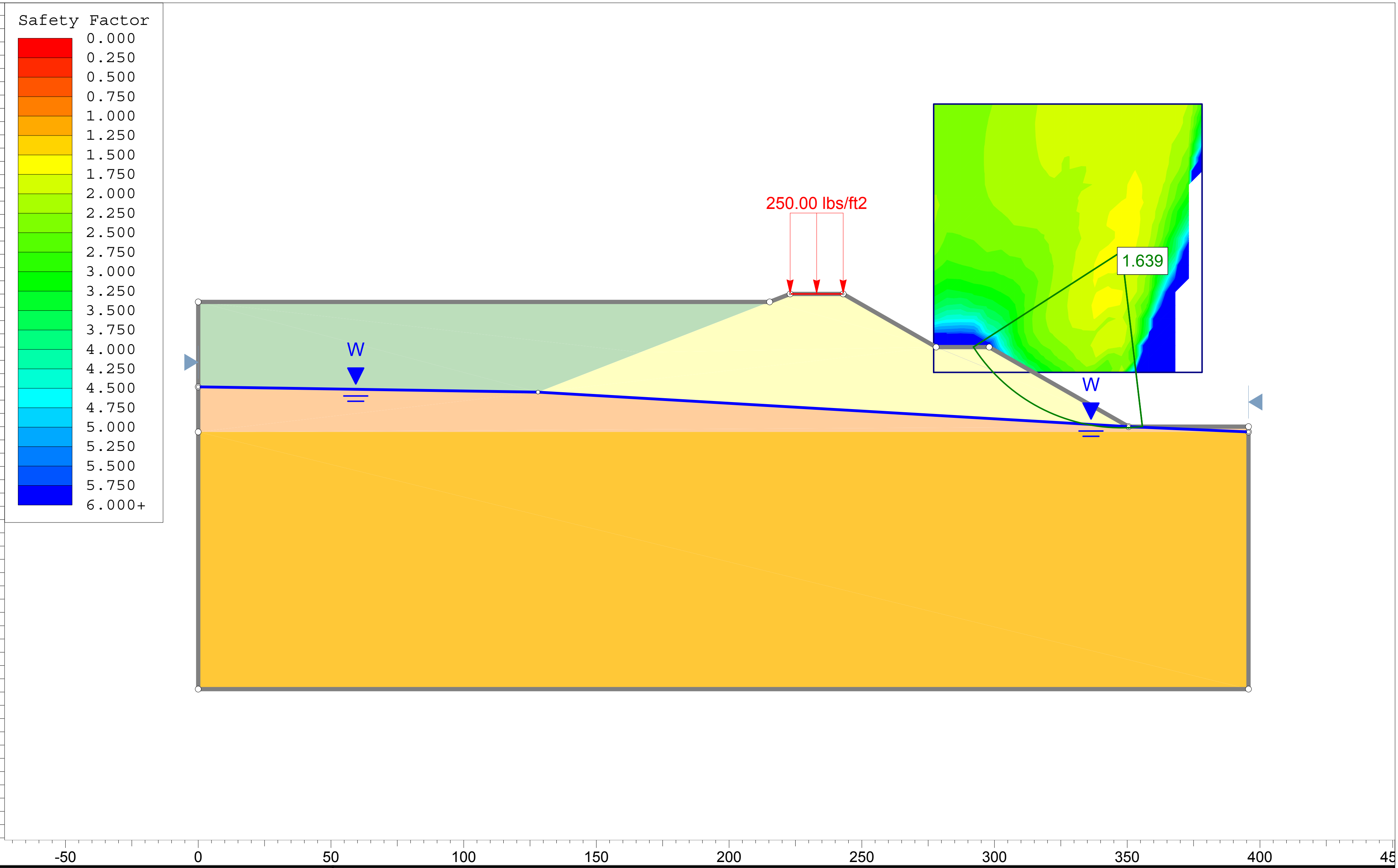
X	Y
0	985
128	983
166.514	998
215.297	1017

Material Boundary

X	Y
128	983
350.5	970

Material Boundary

X	Y
0	968
395.703	968



Project

SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:610

Company

Date 10/16/2013, 3:13:47 PM

File Name B-B_ Keystone_drained_circular.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: B-B_ Keystone_drained_circular
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	soil 1	water	Soil 2	bedrock
Color	🟨	🟩	🟧	🟧
Strength Type	Mohr-Coulomb	No strength	Mohr-Coulomb	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion [psf]	240		0	
Friction Angle [deg]	28		32	
Cohesion Type				8000
Water Surface	None	None	Water Table	None
Hu Value			0	
Ru Value	0	0		0

Global Minimums

Method: spencer

FS: 1.638630
Center: 347.861, 1035.958
Radius: 66.423
Left Slip Surface Endpoint: 292.012, 1000.000
Right Slip Surface Endpoint: 355.706, 970.000
Resisting Moment=2.80637e+006 lb-ft
Driving Moment=1.71263e+006 lb-ft
Resisting Horizontal Force=36446.3 lb

Driving Horizontal Force=22242 lb
Total Slice Area=492.389 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4219
Number of Invalid Surfaces: 632

Error Codes:

Error Code -107 reported for 17 surfaces
Error Code -108 reported for 386 surfaces
Error Code -111 reported for 78 surfaces
Error Code -112 reported for 151 surfaces

Error Codes

The following errors were encountered during the computation:

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.63863

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	2.48265	534.898	soil 1	240	28	155.981	255.595	29.3307	0	29.3307
2	2.48265	1538.55	soil 1	240	28	235.578	386.025	274.632	0	274.632
3	2.48265	2350.53	soil 1	240	28	307.808	504.384	497.234	0	497.234
4	2.48265	2753.18	soil 1	240	28	352.303	577.295	634.36	0	634.36
5	2.48265	3039.96	soil 1	240	28	389.293	637.907	748.354	0	748.354
6	2.48265	3257.96	soil 1	240	28	421.728	691.056	848.312	0	848.312
7	2.48265	3415.56	soil 1	240	28	449.726	736.934	934.597	0	934.597
8	2.48265	3519.21	soil 1	240	28	473.359	775.66	1007.43	0	1007.43
9	2.48265	3573.99	soil 1	240	28	492.665	807.295	1066.92	0	1066.92
10	2.48265	3583.96	soil 1	240	28	507.648	831.847	1113.1	0	1113.1
11	2.48265	3552.42	soil 1	240	28	518.288	849.282	1145.89	0	1145.89
12	2.48265	3482.07	soil 1	240	28	524.533	859.515	1165.14	0	1165.14
13	2.48265	3375.16	soil 1	240	28	526.307	862.422	1170.61	0	1170.61
14	2.48265	3233.55	soil 1	240	28	523.506	857.832	1161.97	0	1161.97
15	2.48265	3058.79	soil 1	240	28	515.996	845.527	1138.83	0	1138.83
16	2.48265	2852.18	soil 1	240	28	503.613	825.236	1100.67	0	1100.67
17	2.48265	2614.78	soil 1	240	28	486.158	796.633	1046.87	0	1046.87
18	2.68609	2533.69	Soil 2	0	32	363.66	595.905	953.647	0	953.647
19	2.68609	2195.67	Soil 2	0	32	326.324	534.725	855.738	0	855.738
20	2.68609	1816.94	Soil 2	0	32	279.736	458.383	733.565	0	733.565
21	2.68609	1398.13	Soil 2	0	32	223.119	365.61	585.098	0	585.098
22	2.68609	939.65	Soil 2	0	32	155.553	254.894	407.917	0	407.917
23	2.68609	441.705	Soil 2	0	32	75.9262	124.415	199.106	0	199.106
24	2.68609	124.82	Soil 2	0	32	22.3057	36.5508	58.4933	0	58.4933
25	2.68609	47.9148	Soil 2	0	32	8.59785	14.0887	22.5467	0	22.5467

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.63863

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	292.012	1000	0	0	0
2	294.495	996.409	-281.926	-120.97	23.2234
3	296.978	993.262	-2.56074	-1.09878	23.2235
4	299.46	990.467	623.039	267.337	23.2235
5	301.943	987.962	1337.28	573.809	23.2235
6	304.426	985.705	2060.47	884.116	23.2234
7	306.908	983.662	2746.52	1178.49	23.2234
8	309.391	981.809	3361.23	1442.25	23.2234
9	311.874	980.129	3879.31	1664.56	23.2235
10	314.356	978.604	4282.48	1837.55	23.2235
11	316.839	977.224	4558.19	1955.85	23.2234
12	319.321	975.979	4698.78	2016.18	23.2235
13	321.804	974.859	4700.86	2017.07	23.2235
14	324.287	973.859	4564.98	1958.77	23.2235
15	326.769	972.973	4295.38	1843.09	23.2235
16	329.252	972.195	3899.9	1673.39	23.2235
17	331.735	971.522	3389.97	1454.59	23.2235
18	334.217	970.951	2780.72	1193.17	23.2235
19	336.903	970.445	2286.7	981.192	23.2235
20	339.59	970.052	1746.48	749.388	23.2234
21	342.276	969.77	1201.77	515.661	23.2234
22	344.962	969.598	703.042	301.665	23.2235
23	347.648	969.535	310.89	133.398	23.2234
24	350.334	969.581	97.841	41.9822	23.2235
25	353.02	969.736	28.8819	12.3928	23.2235
26	355.706	970	0	0	0

List Of Coordinates

Water Table

X	Y
0	985
128	983
350.5	970
395.703	968

Line Load

X	Y
243	1020
223	1020

External Boundary

X	Y
243	1020
223	1020
215.297	1017
0	1017
0	985
0	968
0	871.073
395.703	871.073
395.703	968
395.703	970
350.5	970
298	1000
278	1000

Material Boundary

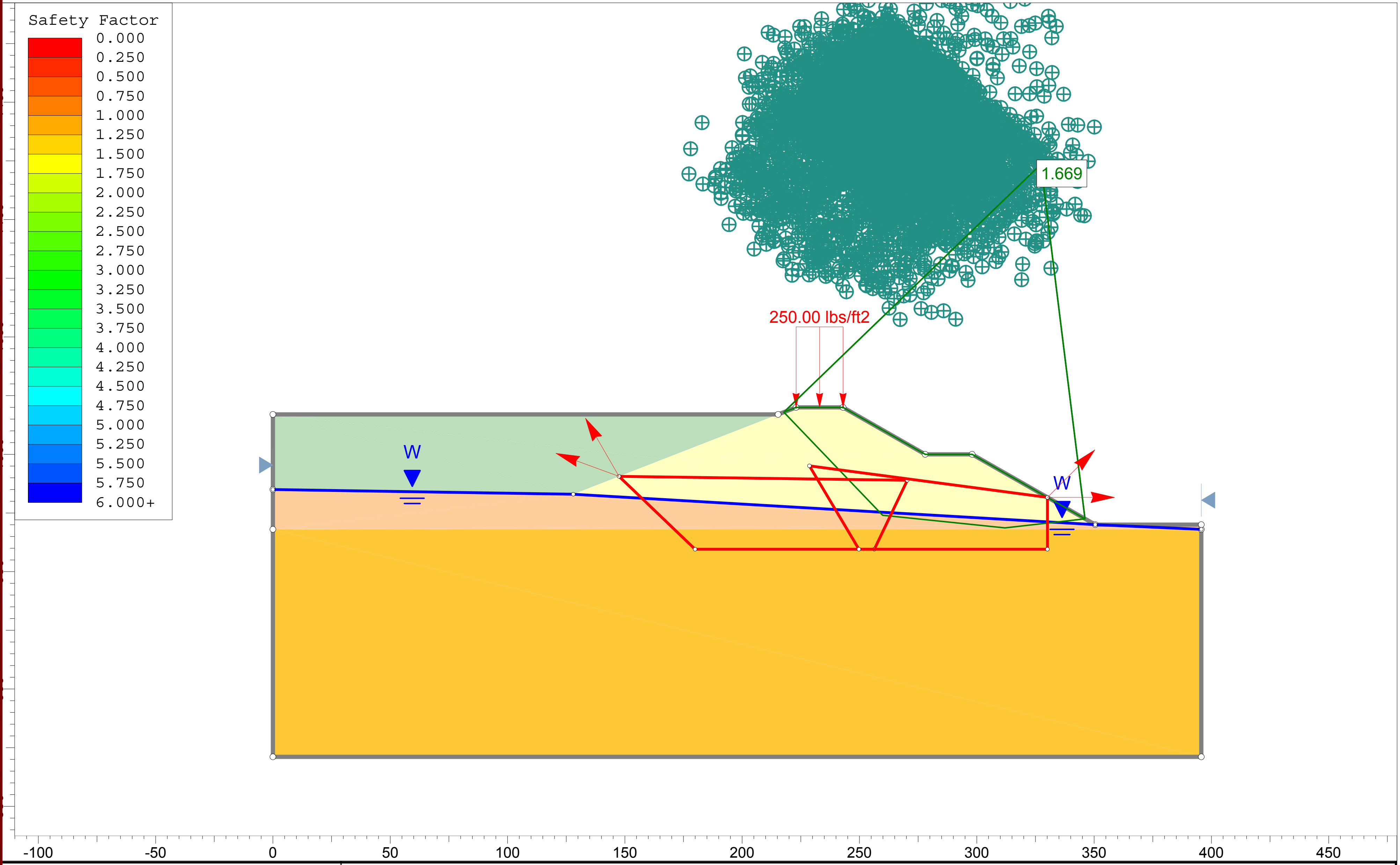
X	Y
0	985
128	983
166.514	998
215.297	1017

Material Boundary

X	Y
128	983
350.5	970

Material Boundary

X	Y
0	968
395.703	968



Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By		*Scale* 1:686	*Company*
Date	10/16/2013, 3:13:47 PM	*File Name*	B-B_ Keystone_Undrained_Block.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: B-B_ Keystone_Undrained_Block
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 120
Left Projection Angle (End Angle): 160
Right Projection Angle (Start Angle): 0
Right Projection Angle (End Angle): 45
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	soil 1	water	Soil 2	Material 4
Color	🟨	🟩	🟧	🟨
Strength Type	Mohr-Coulomb	No strength	Undrained	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion [psf]	240			
Friction Angle [deg]	28			
Cohesion Type			1250	8000
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS: 1.668750
Axis Location: 327.356, 1123.592
Left Slip Surface Endpoint: 217.740, 1017.952
Right Slip Surface Endpoint: 346.099, 972.515
Resisting Moment=2.59994e+007 lb-ft
Driving Moment=1.55802e+007 lb-ft
Resisting Horizontal Force=147497 lb

Driving Horizontal Force=88387.8 lb
Total Slice Area=2856.41 ft2

Global Minimum Coordinates

Method: spencer

X	Y
217.74	1017.95
259.855	974.028
312.01	968.625
346.099	972.515

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4248
Number of Invalid Surfaces: 752

Error Codes:

Error Code -107 reported for 149 surfaces
Error Code -108 reported for 521 surfaces
Error Code -111 reported for 51 surfaces
Error Code -112 reported for 31 surfaces

Error Codes

The following errors were encountered during the computation:

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.66875

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.10329	2238.34	soil 1	240	28	212.133	353.997	214.397	0	214.397
2	5.10329	6143.13	soil 1	240	28	420.574	701.833	868.581	0	868.581
3	5.10329	9403.18	soil 1	240	28	554.323	925.026	1288.35	0	1288.35
4	5.10329	12662.7	soil 1	240	28	686.464	1145.54	1703.07	0	1703.07
5	5.10329	15919.9	soil 1	240	28	815.91	1361.55	2109.34	0	2109.34
6	5.10329	18198.8	soil 1	240	28	859.182	1433.76	2245.13	0	2245.13
7	5.10329	19672.5	soil 1	240	28	918.921	1533.45	2432.63	0	2432.63
8	5.10329	21146.1	soil 1	240	28	978.667	1633.15	2620.13	0	2620.13
9	1.2882	5583.01	Soil 2	1250	0	749.064	1250	2887.76	0	2887.76
10	5.21547	22089	Soil 2	1250	0	749.064	1250	4246.67	0	4246.67
11	5.21547	20580.4	Soil 2	1250	0	749.064	1250	3965.74	0	3965.74
12	5.21547	19071.7	Soil 2	1250	0	749.064	1250	3684.82	0	3684.82
13	5.21547	17816.2	Soil 2	1250	0	749.064	1250	3451.02	0	3451.02
14	5.21547	17958.7	Soil 2	1250	0	749.064	1250	3477.55	0	3477.55
15	5.21547	18315.3	Soil 2	1250	0	749.064	1250	3543.95	0	3543.95
16	5.21547	18671.9	Soil 2	1250	0	749.064	1250	3610.36	0	3610.36
17	5.21547	18589.4	Soil 2	1250	0	749.064	1250	3594.99	0	3594.99
18	5.21547	17172.6	Soil 2	1250	0	749.064	1250	3331.17	0	3331.17
19	5.21547	15663.9	Soil 2	1250	0	749.064	1250	3050.25	0	3050.25
20	5.25086	13841	Soil 2	1250	0	749.064	1250	3035.63	0	3035.63
21	5.25086	11501.5	Soil 2	1250	0	749.064	1250	2575.02	0	2575.02
22	5.25086	9161.9	Soil 2	1250	0	749.064	1250	2114.41	0	2114.41
23	5.25086	6822.34	Soil 2	1250	0	749.064	1250	1653.8	0	1653.8
24	6.54281	5282.52	soil 1	240	28	472.052	787.736	1030.14	0	1030.14
25	6.54281	1760.84	soil 1	240	28	266.033	443.942	383.558	0	383.558

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.66875

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	217.74	1017.95	0	0	0
2	222.844	1012.63	57.7064	16.5241	15.9789
3	227.947	1007.31	2532.75	725.247	15.9789
4	233.05	1001.98	6558.9	1878.13	15.979
5	238.154	996.661	12117.5	3469.83	15.979
6	243.257	991.339	19177.4	5491.4	15.9789
7	248.36	986.016	26739	7656.67	15.979
8	253.463	980.694	34993.5	10020.3	15.9789
9	258.567	975.371	43940.9	12582.4	15.979
10	259.855	974.028	46855	13416.8	15.9789
11	265.07	973.488	45239.7	12954.3	15.979
12	270.286	972.947	43472.7	12448.3	15.9789
13	275.501	972.407	41553.8	11898.9	15.979
14	280.717	971.867	39508.7	11313.2	15.9789
15	285.932	971.326	37477.8	10731.7	15.979
16	291.148	970.786	35482.9	10160.4	15.9789
17	296.363	970.246	33523.8	9599.46	15.9789

18	301.579	969.705	31556.4	9036.11	15.979
19	306.794	969.165	29446.5	8431.94	15.9789
20	312.01	968.625	27184.8	7784.3	15.9789
21	317.26	969.224	21429.4	6136.26	15.9789
22	322.511	969.823	15950	4567.26	15.979
23	327.762	970.422	10746.7	3077.29	15.9789
24	333.013	971.022	5819.36	1666.36	15.9789
25	339.556	971.768	1959.2	561.013	15.979
26	346.099	972.515	0	0	0

List Of Coordinates

Water Table

X	Y
0	985
128	983
350.5	970
395.703	968

Line Load

X	Y
243	1020
223	1020

Block Search Window

X	Y
147.491	990.591
179.921	959.521
256.328	959.521
270.38	988.942

Block Search Window

X	Y
228.663	995.09
249.741	959.521
330.1	959.521
330.1	981.657

External Boundary

X	Y
243	1020
223	1020
215.297	1017
0	1017
0	985
0	968
0	871.073
395.703	871.073
395.703	968
395.703	970
350.5	970
298	1000
278	1000

Material Boundary

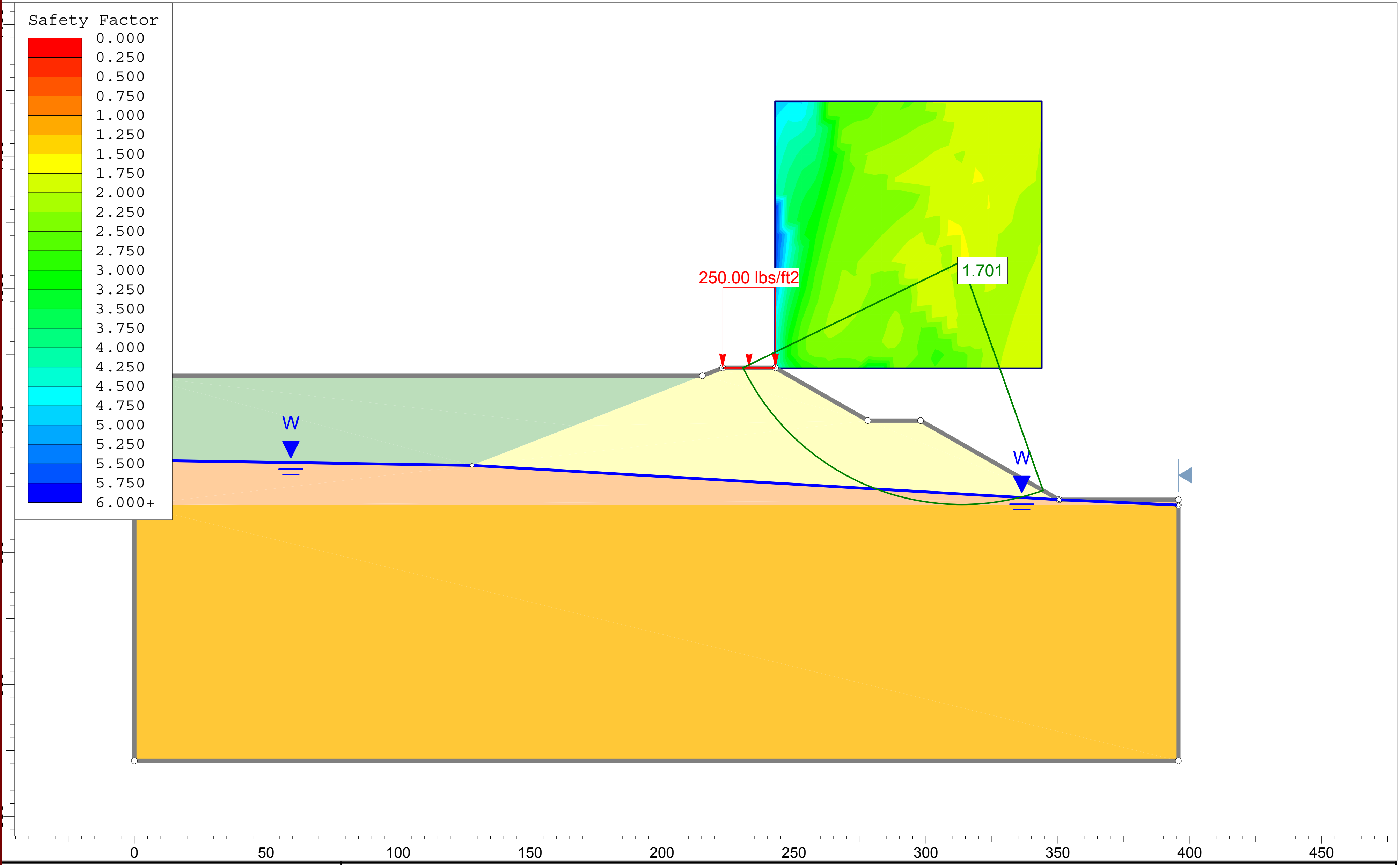
X	Y
0	985
128	983
166.514	998
215.297	1017

Material Boundary

X	Y
128	983
350.5	970

Material Boundary

X	Y
0	968
395.703	968



Project
SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By
Scale 1:610
Company

Date 10/16/2013, 3:13:47 PM
File Name B-B_ Keystone_Undrained_Circular.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: B-B_ Keystone_Undrained_Circular
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	soil 1	water	Soil 2	Material 4
Color	🟨	🟩	🟧	🟨
Strength Type	Mohr-Coulomb	No strength	Undrained	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion [psf]	240			
Friction Angle [deg]	28			
Cohesion Type			1250	8000
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS: 1.701460
Center: 313.610, 1060.322
Radius: 92.182
Left Slip Surface Endpoint: 230.715, 1020.000
Right Slip Surface Endpoint: 344.455, 973.454
Resisting Moment=1.40721e+007 lb-ft
Driving Moment=8.27059e+006 lb-ft
Resisting Horizontal Force=134120 lb
Driving Horizontal Force=78826.4 lb
Total Slice Area=2324.93 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4814
Number of Invalid Surfaces: 37

Error Codes:

Error Code -103 reported for 2 surfaces
Error Code -108 reported for 18 surfaces
Error Code -111 reported for 17 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.70146

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.58282	2283.81	soil 1	240	28	223.697	380.612	264.453	0	264.453
2	4.58282	6410.63	soil 1	240	28	397.549	676.413	820.773	0	820.773
3	4.58282	9728.45	soil 1	240	28	545.747	928.567	1295.01	0	1295.01
4	4.58282	11499.5	soil 1	240	28	621.155	1056.87	1536.31	0	1536.31
5	4.58282	12544.4	soil 1	240	28	700.979	1192.69	1791.74	0	1791.74
6	4.58282	13271.9	soil 1	240	28	768.082	1306.86	2006.46	0	2006.46
7	4.58282	13732.5	soil 1	240	28	823.217	1400.67	2182.91	0	2182.91
8	4.58282	13961.8	soil 1	240	28	866.92	1475.03	2322.74	0	2322.74
9	4.58282	13986	soil 1	240	28	899.527	1530.51	2427.1	0	2427.1
10	4.58282	13824.7	soil 1	240	28	921.256	1567.48	2496.62	0	2496.62
11	4.58282	13828.3	soil 1	240	28	951.877	1619.58	2594.61	0	2594.61
12	4.5584	14670.5	Soil 2	1250	0	734.663	1250	2876.23	0	2876.23
13	4.5584	15545.4	Soil 2	1250	0	734.663	1250	3138.75	0	3138.75
14	4.5584	16263.3	Soil 2	1250	0	734.663	1250	3374.22	0	3374.22
15	4.5584	16767.2	Soil 2	1250	0	734.663	1250	3569.99	0	3569.99
16	4.5584	16114.5	Soil 2	1250	0	734.663	1250	3526.27	0	3526.27
17	4.5584	14968.4	Soil 2	1250	0	734.663	1250	3373.95	0	3373.95
18	4.5584	13682	Soil 2	1250	0	734.663	1250	3185.14	0	3185.14
19	4.5584	12256.5	Soil 2	1250	0	734.663	1250	2958.98	0	2958.98
20	4.5584	10692	Soil 2	1250	0	734.663	1250	2694.25	0	2694.25
21	4.5584	8987.56	Soil 2	1250	0	734.663	1250	2389.31	0	2389.31
22	4.5584	7141.27	Soil 2	1250	0	734.663	1250	2041.98	0	2041.98
23	4.5584	5149.99	Soil 2	1250	0	734.663	1250	1649.57	0	1649.57
24	4.31454	2952.81	soil 1	240	28	470.205	800.035	1053.27	0	1053.27
25	4.31454	1004.13	soil 1	240	28	285.49	485.75	462.19	0	462.19

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.70146

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	230.715	1020	0	0	0
2	235.297	1011.69	1174.26	382.75	18.0534
3	239.88	1004.99	4858.92	1583.76	18.0533
4	244.463	999.361	9656.65	3147.58	18.0534
5	249.046	994.527	14245.2	4643.21	18.0533
6	253.629	990.324	18573.1	6053.9	18.0534
7	258.212	986.643	22447.6	7316.78	18.0533
8	262.794	983.411	25741.8	8390.52	18.0533
9	267.377	980.572	28374.5	9248.66	18.0534
10	271.96	978.086	30298.7	9875.82	18.0533
11	276.543	975.921	31493.7	10265.4	18.0534
12	281.126	974.053	31989.7	10427	18.0533
13	285.684	972.472	33199.4	10821.3	18.0533
14	290.242	971.151	34005.9	11084.2	18.0533
15	294.801	970.079	34282.5	11174.4	18.0534
16	299.359	969.248	33910.4	11053.1	18.0534
17	303.918	968.651	32677.2	10651.1	18.0533
18	308.476	968.283	30579.2	9967.27	18.0533
19	313.034	968.142	27690	9025.52	18.0533
20	317.593	968.226	24101.3	7855.81	18.0534
21	322.151	968.537	19925.6	6494.73	18.0533
22	326.71	969.076	15298.6	4986.57	18.0533
23	331.268	969.847	10383.9	3384.62	18.0533
24	335.826	970.857	5378.36	1753.07	18.0533
25	340.141	972.041	2109.18	687.486	18.0533
26	344.455	973.454	0	0	0

List Of Coordinates

Water Table

X	Y
0	985
128	983
350.5	970
395.703	968

Line Load

X	Y
243	1020
223	1020

External Boundary

X	Y
243	1020
223	1020
215.297	1017
0	1017
0	985
0	968
0	871.073
395.703	871.073
395.703	968
395.703	970
350.5	970
298	1000
278	1000

Material Boundary

X	Y
0	985
128	983
166.514	998
215.297	1017

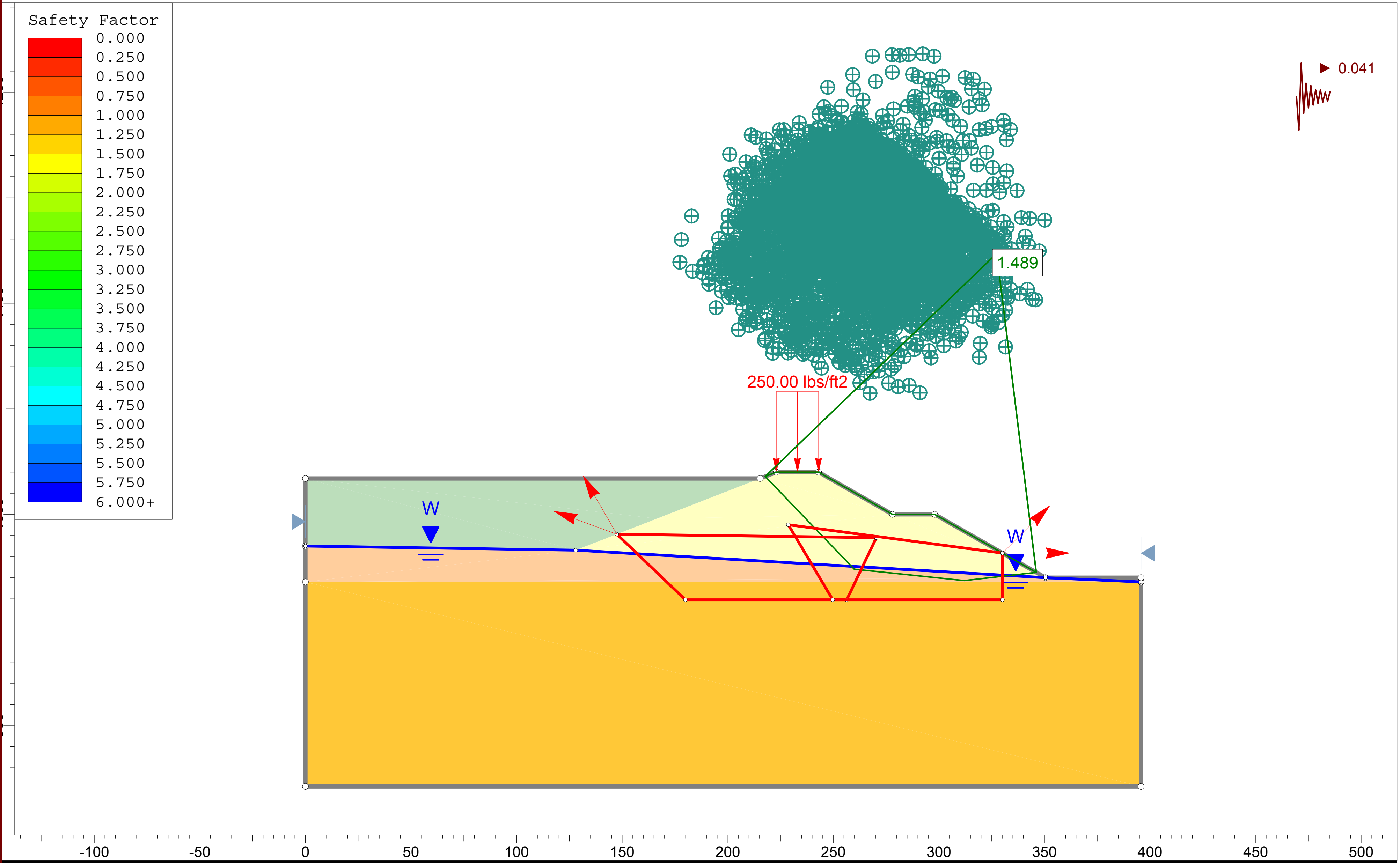
Material Boundary

X	Y
128	983
350.5	970

Material Boundary

X	Y

0	968
395.703	968



Project

SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:762

Company

Date 10/16/2013, 3:13:47 PM

File Name B-B_ Keystone_Undrained_Block_Seismic.slim

IDEINTERPRET 6.019

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: B-B_ Keystone_Undrained_Block_Seismic
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 5000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 120
Left Projection Angle (End Angle): 160
Right Projection Angle (Start Angle): 0
Right Projection Angle (End Angle): 45
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.041
1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	soil 1	water	Soil 2	Bedrock
Color	🟨	🟩	🟧	🟨
Strength Type	Mohr-Coulomb	No strength	Undrained	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion [psf]	240			
Friction Angle [deg]	28			
Cohesion Type			1250	8000
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS: 1.489270
Axis Location: 327.356, 1123.592
Left Slip Surface Endpoint: 217.740, 1017.952
Right Slip Surface Endpoint: 346.099, 972.515
Resisting Moment=2.5618e+007 lb-ft
Driving Moment=1.72017e+007 lb-ft

Resisting Horizontal Force=145718 lb
Driving Horizontal Force=97845 lb
Total Slice Area=2856.41 ft2

Global Minimum Coordinates

Method: spencer

X	Y
217.74	1017.95
259.855	974.028
312.01	968.625
346.099	972.515

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4397
Number of Invalid Surfaces: 603

Error Codes:

Error Code -107 reported for 51 surfaces
Error Code -108 reported for 416 surfaces
Error Code -111 reported for 102 surfaces
Error Code -112 reported for 34 surfaces

Error Codes

The following errors were encountered during the computation:

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.48927

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	5.10329	2238.34	soil 1	240	28	232.246	345.877	199.126	0	199.126
2	5.10329	6143.13	soil 1	240	28	453.381	675.206	818.505	0	818.505
3	5.10329	9403.18	soil 1	240	28	594.81	885.832	1214.63	0	1214.63
4	5.10329	12662.7	soil 1	240	28	734.514	1093.89	1605.93	0	1605.93
5	5.10329	15919.9	soil 1	240	28	871.333	1297.65	1989.14	0	1989.14
6	5.10329	18198.8	soil 1	240	28	916.328	1364.66	2115.18	0	2115.18
7	5.10329	19672.5	soil 1	240	28	979.493	1458.73	2292.09	0	2292.09
8	5.10329	21146.1	soil 1	240	28	1042.65	1552.79	2469	0	2469
9	1.2882	5583.01	Soil 2	1250	0	839.337	1250	2685.9	0	2685.9
10	5.21547	22089	Soil 2	1250	0	839.337	1250	4227.54	0	4227.54
11	5.21547	20580.4	Soil 2	1250	0	839.337	1250	3952.18	0	3952.18
12	5.21547	19071.7	Soil 2	1250	0	839.337	1250	3676.83	0	3676.83
13	5.21547	17816.2	Soil 2	1250	0	839.337	1250	3447.64	0	3447.64
14	5.21547	17958.7	Soil 2	1250	0	839.337	1250	3473.66	0	3473.66
15	5.21547	18315.3	Soil 2	1250	0	839.337	1250	3538.75	0	3538.75
16	5.21547	18671.9	Soil 2	1250	0	839.337	1250	3603.84	0	3603.84
17	5.21547	18589.4	Soil 2	1250	0	839.337	1250	3588.77	0	3588.77
18	5.21547	17172.6	Soil 2	1250	0	839.337	1250	3330.18	0	3330.18
19	5.21547	15663.9	Soil 2	1250	0	839.337	1250	3054.82	0	3054.82
20	5.25086	13841	Soil 2	1250	0	839.337	1250	3106.36	0	3106.36
21	5.25086	11501.5	Soil 2	1250	0	839.337	1250	2649.13	0	2649.13
22	5.25086	9161.9	Soil 2	1250	0	839.337	1250	2191.89	0	2191.89
23	5.25086	6822.34	Soil 2	1250	0	839.337	1250	1734.67	0	1734.67
24	6.54281	5282.52	soil 1	240	28	550.703	820.145	1091.09	0	1091.09
25	6.54281	1760.84	soil 1	240	28	310.409	462.283	418.055	0	418.055

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.48927

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	217.74	1017.95	0	0	0
2	222.844	1012.63	-35.275	-12.1423	18.9944
3	227.947	1007.31	2256.09	776.589	18.9944
4	233.05	1001.98	6066.75	2088.29	18.9944
5	238.154	996.661	11379.8	3917.14	18.9944
6	243.257	991.339	18166.8	6253.36	18.9944
7	248.36	986.016	25488.2	8773.51	18.9944
8	253.463	980.694	33488.7	11527.5	18.9945
9	258.567	975.371	42168.6	14515.2	18.9944
10	259.855	974.028	44923.3	15463.5	18.9945
11	265.07	973.488	43729.4	15052.5	18.9944
12	270.286	972.947	42324.9	14569	18.9944
13	275.501	972.407	40709.7	14013	18.9944
14	280.717	971.867	38919.2	13396.7	18.9944
15	285.932	971.326	37148.6	12787.3	18.9945
16	291.148	970.786	35427.9	12194.9	18.9944

17	296.363	970.246	33756.9	11619.8	18.9945
18	301.579	969.705	32074.3	11040.6	18.9945
19	306.794	969.165	30194	10393.4	18.9945
20	312.01	968.625	28103	9673.6	18.9945
21	317.26	969.224	22395.6	7709	18.9945
22	322.511	969.823	16866.2	5805.68	18.9945
23	327.762	970.422	11515	3963.66	18.9943
24	333.013	971.022	6341.72	2182.94	18.9944
25	339.556	971.768	2135.37	735.035	18.9944
26	346.099	972.515	0	0	0

List Of Coordinates

Water Table

X	Y
0	985
128	983
350.5	970
395.703	968

Line Load

X	Y
243	1020
223	1020

Block Search Window

X	Y
147.491	990.591
179.921	959.521
256.328	959.521
270.38	988.942

Block Search Window

X	Y
228.663	995.09
249.741	959.521
330.1	959.521
330.1	981.657

External Boundary

X	Y
243	1020
223	1020
215.297	1017
0	1017
0	985
0	968
0	871.073
395.703	871.073
395.703	968
395.703	970
350.5	970
298	1000
278	1000

Material Boundary

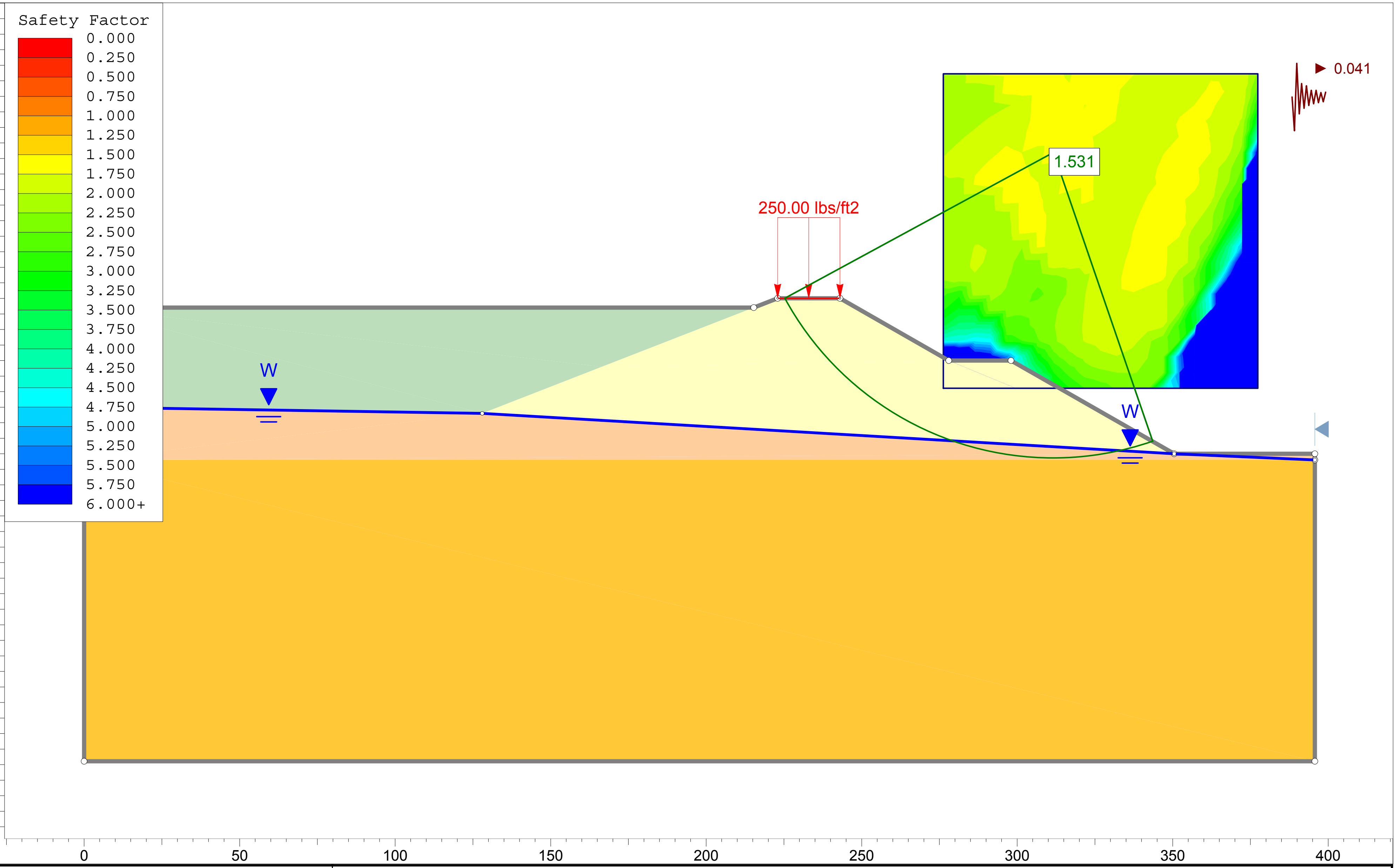
X	Y
0	985
128	983
166.514	998
215.297	1017

Material Boundary

X	Y
128	983
350.5	970

Material Boundary

X	Y
0	968
395.703	968



IDEINTERPRET 6.019

Project
SLIDE - An Interactive Slope Stability Program

Analysis Description

Drawn By

Scale 1:520

Company

Date 10/16/2013, 3:13:47 PM

File Name B-B_ Keystone_Undrained_Circular_seismic.slim

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name: B-B_ Keystone_Undrained_Circular_seismic
Slide Modeler Version: 6.019
Project Title: SLIDE - An Interactive Slope Stability Program
Date Created: 10/16/2013, 3:13:47 PM

General Settings

Units of Measurement: Imperial Units
Time Units: days
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 1
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Loading

Seismic Load Coefficient (Horizontal): 0.041
1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 250
Orientation: Normal to boundary

Material Properties

Property	soil 1	water	Soil 2	Bedrock
Color	🟨	🟩	🟧	🟧
Strength Type	Mohr-Coulomb	No strength	Undrained	Undrained
Unsaturated Unit Weight [lbs/ft3]			135	145
Saturated Unit Weight [lbs/ft3]			135	145
Cohesion [psf]	240			
Friction Angle [deg]	28			
Cohesion Type			1250	8000
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: spencer

FS: 1.531230
Center: 311.639, 1066.922
Radius: 98.299
Left Slip Surface Endpoint: 225.262, 1020.000
Right Slip Surface Endpoint: 343.576, 973.957
Resisting Moment=1.57758e+007 lb-ft
Driving Moment=1.03027e+007 lb-ft
Resisting Horizontal Force=141950 lb
Driving Horizontal Force=92702.7 lb

Total Slice Area=2483.76 ft2

Valid / Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 4485
Number of Invalid Surfaces: 366

Error Codes:

Error Code -108 reported for 129 surfaces
Error Code -111 reported for 103 surfaces
Error Code -112 reported for 134 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.53123

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4.8924	2365.67	soil 1	240	28	246.082	376.808	257.298	0	257.298
2	4.8924	6678.4	soil 1	240	28	430.064	658.527	787.136	0	787.136
3	4.8924	10278.2	soil 1	240	28	608.293	931.436	1300.4	0	1300.4
4	4.8924	13243.2	soil 1	240	28	755.075	1156.19	1723.11	0	1723.11
5	4.8924	14595.7	soil 1	240	28	822.117	1258.85	1916.17	0	1916.17
6	4.8924	15291.6	soil 1	240	28	895.875	1371.79	2128.59	0	2128.59
7	4.8924	15701.6	soil 1	240	28	956.773	1465.04	2303.95	0	2303.95
8	4.8924	15861.3	soil 1	240	28	1005.16	1539.13	2443.31	0	2443.31
9	4.8924	15797.3	soil 1	240	28	1041.21	1594.33	2547.13	0	2547.13
10	4.8924	15529.6	soil 1	240	28	1064.96	1630.7	2615.51	0	2615.51
11	4.8924	15113.8	soil 1	240	28	1078.73	1651.78	2655.18	0	2655.18
12	4.50813	14407.7	Soil 2	1250	0	816.337	1250	2841.56	0	2841.56
13	4.50813	15207.8	Soil 2	1250	0	816.337	1250	3088.9	0	3088.9
14	4.50813	15867.6	Soil 2	1250	0	816.337	1250	3313.14	0	3313.14
15	4.50813	16392	Soil 2	1250	0	816.337	1250	3514.52	0	3514.52
16	4.50813	16335.5	Soil 2	1250	0	816.337	1250	3599.33	0	3599.33
17	4.50813	15232.5	Soil 2	1250	0	816.337	1250	3463.39	0	3463.39
18	4.50813	13975.4	Soil 2	1250	0	816.337	1250	3288.49	0	3288.49
19	4.50813	12592	Soil 2	1250	0	816.337	1250	3079.36	0	3079.36
20	4.50813	11082.6	Soil 2	1250	0	816.337	1250	2834.75	0	2834.75
21	4.50813	9446.57	Soil 2	1250	0	816.337	1250	2553.07	0	2553.07
22	4.50813	7682.43	Soil 2	1250	0	816.337	1250	2232.32	0	2232.32
23	4.50813	5787.88	Soil 2	1250	0	816.337	1250	1870.03	0	1870.03
24	5.19984	4207.2	soil 1	240	28	601.723	921.377	1281.48	0	1281.48
25	5.19984	1434.53	soil 1	240	28	355.534	544.404	572.501	0	572.501

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.53123

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	225.262	1020	0	0	0
2	230.155	1011.94	967.119	360.043	20.4195
3	235.047	1005.31	4358.76	1622.7	20.4195
4	239.94	999.678	9126.88	3397.79	20.4195
5	244.832	994.815	14356.2	5344.59	20.4195
6	249.724	990.573	19062.6	7096.72	20.4195
7	254.617	986.853	23226.9	8647	20.4195
8	259.509	983.585	26721	9947.81	20.4195
9	264.402	980.718	29461.6	10968.1	20.4195
10	269.294	978.212	31399.5	11689.5	20.4194
11	274.186	976.038	32513.7	12104.3	20.4194
12	279.079	974.173	32810.7	12214.9	20.4195
13	283.587	972.711	33875.7	12611.4	20.4195
14	288.095	971.485	34609.1	12884.4	20.4195
15	292.603	970.484	34895.5	12991	20.4194
16	297.111	969.703	34634.9	12894	20.4195
17	301.62	969.136	33668.5	12534.3	20.4196
18	306.128	968.778	31852.1	11858	20.4195
19	310.636	968.629	29238	10884.9	20.4196
20	315.144	968.686	25899	9641.77	20.4195
21	319.652	968.951	21924.5	8162.14	20.4195
22	324.16	969.424	17424.1	6486.7	20.4195
23	328.668	970.11	12529.9	4664.7	20.4196
24	333.176	971.012	7401.55	2755.48	20.4195
25	338.376	972.33	2757.88	1026.71	20.4194
26	343.576	973.957	0	0	0

List Of Coordinates

Water Table

X	Y
0	985
128	983
350.5	970
395.703	968

Line Load

X	Y
243	1020
223	1020

External Boundary

X	Y
243	1020
223	1020
215.297	1017
0	1017
0	985
0	968
0	871.073
395.703	871.073
395.703	968
395.703	970
350.5	970
298	1000
278	1000

Material Boundary

X	Y
0	985
128	983
166.514	998
215.297	1017

Material Boundary

X	Y
128	983
350.5	970

Material Boundary

X	Y
0	968
395.703	968

APPENDIX A

Document 12

Email from Frank Stephens, GenOn, to Stephen Hoffman and Jana Englander, USEPA, November 25, 2013

From: Frank, Stephen
To: Hoffman, Stephen; Englander, Jana
Subject: Comment Request on Coal Ash Site Assessment Round 12 Draft Report - Keystone Generating Station
Date: Monday, November 25, 2013 10:43:46 AM
Attachments: Final MD13353_Keystone 11.19.13.pdf
Keystone - Ash Recycle Ponds Inspection Report.pdf
Keystone text revision.pdf

Dear Mr. Hoffman and Ms. Englander,

As requested, NRG has reviewed and is providing the following comments on the Draft Report for Keystone Generating Station:

1. The station operator is GenOn Northeast Management Company (GenOn), a subsidiary of NRG Energy, Inc. (NRG).
2. Revised text reflecting the ownership is attached.
3. The surveillance program has been formalized and expanded to include the Ash Filter Ponds (Example Inspection Report attached). The surveillance program includes a complete mowing of the embankments prior to the quarterly inspections.
4. Work is scheduled to paint corroded metal parts and hardware at the discharge structures.
5. Based on the assessment conducted by Geosyntec (attached), the embankments for the Ash Filter Ponds and Thermal Pond are sufficiently stable, and it is appropriate for the EPA to report a condition of “Satisfactory,” instead of “Fair,” for continued safe and reliable operations of the impoundments at the Keystone Generating Station.
6. An investigation of the seep area (Figure 5.3.3-1) observed along the access road berm ditch was evaluated by Geosyntec (attached) and was not found to be associated with a phreatic surface/line of seepage from the impounded water through the dam embankment.

Please do not hesitate to contact me with any questions or comments.

Thank you, Steve

NRG Energy

Stephen M. Frank, PE
Senior Environmental Specialist
NRG Energy Southpointe Operations Center
121 Champion Way, Suite 300
Canonsburg, PA 15317
P 724.597.8310
M 724.249.3610

APPENDIX A

Document 13

Quarterly Ash Recycle ponds Inspection Checklist

QUARTERLY ASH RECYCLE PONDS INSPECTION CHECKLIST
NRG ENERGY - OPERATIONS TECHNICAL SUPPORT
KEYSTONE STATION

NAME OF IMPOUNDMENT: Ash Recycle Ponds

LOCATION: Plumcreek Township, Armstrong County

PERSONS PRESENT AT INSPECTION:

NAME	**TITLE/POSITION**	**REPRESENTING**
		NRG Energy

DATE OF INSPECTION: **TIME:**
WEATHER:
TEMPERATURE:

This is to certify that the above ponds have been inspected and the following are the results of this inspection.

EMBANKMENT

CREST AND INTERIOR SLOPES		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	OBSERVATIONS	Monitor	Investigate	Repair
SURFACE CRACKING				
LOW AREA(S)				
HORIZONTAL ALIGNMENT				
RUTS AND/OR PUDDLES				
VEGETATION GROWTH				

ADDITIONAL COMMENTS:

EMBANKMENT

EXTERIOR SLOPES		CHECK ( ) ACTION NEEDED		
CONDITION/ITEMS	OBSERVATIONS	Monitor	Investigate	Repair
WET AREA(S)				
SEEPAGE				
SLIDE, SLOUGH, SCARP				
SINKHOLE, ANIMAL BURROW				
EROSION				
UNUSUAL MOVEMENT				
VEGETATION CONDITION				

ADDITIONAL COMMENTS:

APPENDIX B

Document 14

Dam Inspection Check List Form Ash Ponds

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name:	**Keystone Station**	Date:	**September 13, 2012**
Unit Name:	**Ash Filter Ponds**	Operator's Name:	**GenOn**
Unit I.D.:	**03831**	Hazard Potential Classification:	**High** ☐ **Significant** ☐ **Low** ☒
	Inspector's Name:	Fred Tucker, P.E. and Edward Farquhar	

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

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?		√	18. Sloughing or bulging on slopes?		√
2. Pool elevation (operator records)?	√		19. Major erosion or slope deterioration?		√
3. Decant inlet elevation (operator records)?	1018.5		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		N/A
5. Lowest dam crest elevation (operator records)?	1020.5		Is water exiting outlet, but not entering inlet?		N/A
6. If instrumentation is present, are readings recorded (operator records)?	N/A		Is water exiting outlet flowing clear?	N/A	
7. Is the embankment currently under construction?		√	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	N/A		From underdrain?		N/A
9. Trees growing on embankment? (If so, indicate largest diameter below)		√	At isolated points on embankment slopes?		√
10. Cracks or scarps on crest?		√	At natural hillside in the embankment area?		√
11. Is there significant settlement along the crest?		√	Over widespread areas?		√
12. Are decant trashracks clear and in place?	N/A		From downstream foundation area?		√
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		√	"Boils" beneath stream or ponded water?		√
14. Clogged spillways, groin or diversion ditches?		√	Around the outside of the decant pipe?		√
15. Are spillway or ditch linings deteriorated?		√	22. Surface movements in valley bottom or on hillside?		√
16. Are outlets of decant or underdrains blocked?		√	23. Water against downstream toe?		√
17. Cracks or scarps on slopes?		√	24. Were Photos taken during the dam inspection?	√	

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

Issue #	Comments
1	No formal records or protocol is in place for inspections. However, maintenance Contractor of the ponds does inspect the ponds on a daily basic.
5	Lowest elevation is along inside edge of crest. Outside edge is 1021.0
20	Overflow from each pond (3 cells) is through “saw tooth” weirs into weir trough to concrete riser with bottom discharge through 18 inch VTC pipe to a pump station that pumps water to thermal pond. Only overflow into weir trough is visible.
21	Any seepage from underdrain pipes in pond bottom is not visible. Underdrain pipes discharge into outlet structure. Underdrain is associated with dewatering of settled ash pond and not associated with the dikes.

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit PA0002062 **INSPECTOR** Fred Tucker, P.E. and Edward Farquhar

Date September 13, 2012

Impoundment Name Ash Filter Ponds

Impoundment Company GenOn (part owner) et al.

EPA Region 3

State Agency (Field Office) Address
Pennsylvania Department of Environmental Protection
Bureau of Waste Management
286 Industrial Park Road
Ebensburg, PA 15931

Name of Impoundment Ash Filter Ponds: Ash Filter Pond A (SPD-7); Ash Filter Pond B (SPD-8); Ash Filter Pond (SPD-9)

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

New ☐ **Update** ☒

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

IMPOUNDMENT FUNCTION:

Nearest Downstream Town Name: South Bend, PA

Distance from the impoundment: 3.5 Miles

Location:

Latitude	40	Degrees	39	Minutes	38.7	Seconds	**N**
Longitude	-79	Degrees	20	Minutes	36.82	Seconds	**W**

State Pennsylvania **County** Armstrong

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

If So Which State Agency?	Department of Environmental Resources - Bureau of Waste Management; (water quality only) not regulated for dam safety.

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

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

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

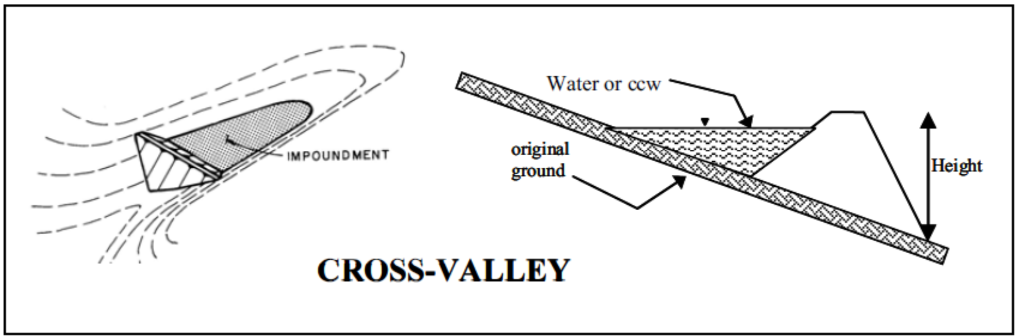
☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.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

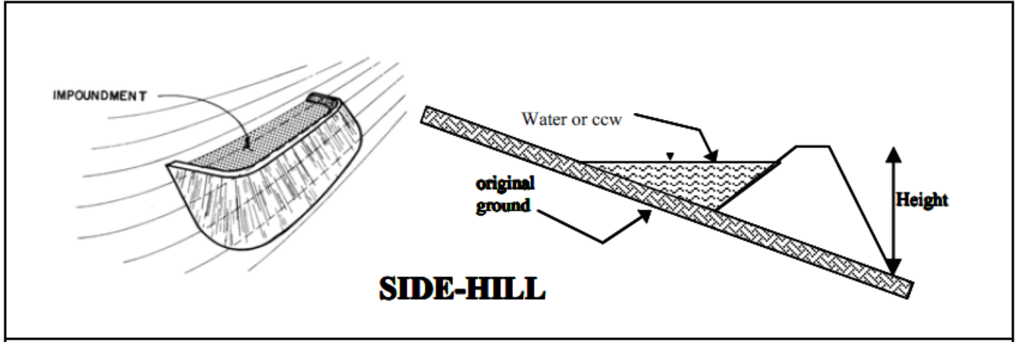
☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

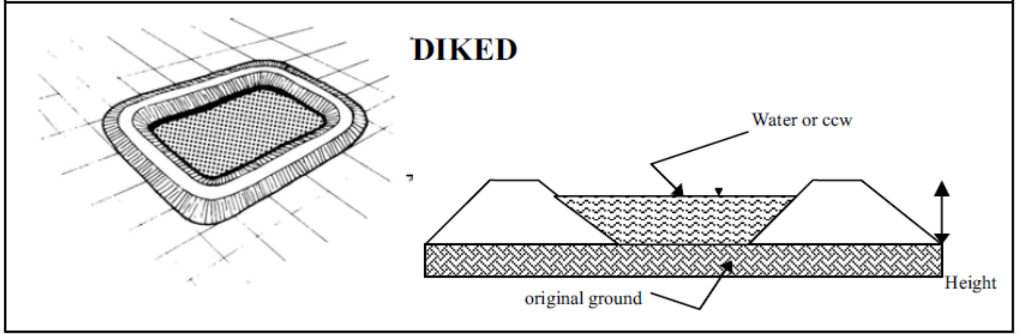
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

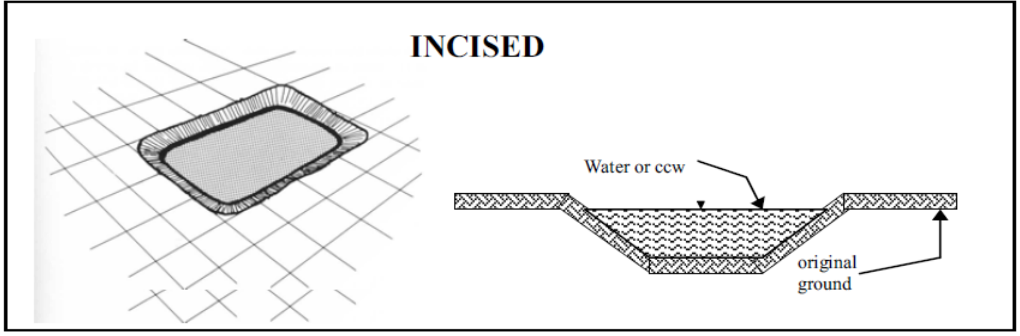
Low hazard potential classification for failure or release of some bottom ash into the immediate surrounding environment. There would be no significant risk of loss of human life. If failure occurred, ash would remain on GenOn property.

CONFIGURATION:









☐ Cross-Valley ☐ Side-Hill ☐ Diked

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

Embankment Height (ft) Varies from 0 to 11 ft

Embankment Material N/A

Pool Area (ac) 2 acres

Liner Side Slopes 1.5 ft R-3 Rock lining over 2 ft impervious fill

			treated with bentonite. Bottom: 2.5 ft bottom ash over 1.5 ft #8 coarse aggregate over 1.5 ft of impervious fill over 6 inches of impervious fill treated with bentonite over 1.5 ft of impervious fill over prepared subgrade.
Current Freeboard (ft)	2.0 Ft.	**Liner Permeability**	1.00E-07 cm/sec

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

☐ Rectangular

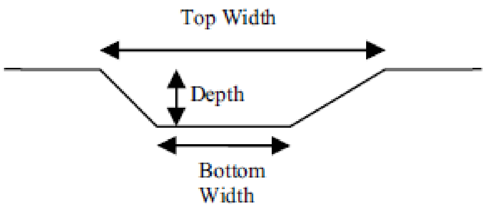
☐ Irregular

depth (ft)

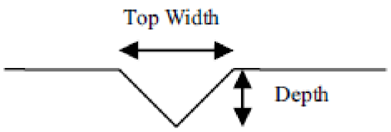
average bottom width (ft)

top width (ft)

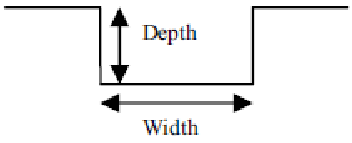
TRAPEZOIDAL



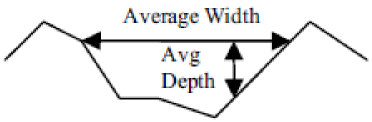
TRIANGULAR



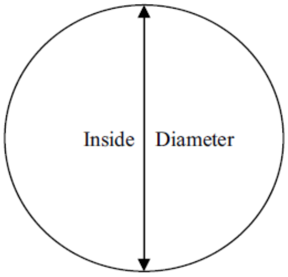
RECTANGULAR



IRREGULAR



☒ **Outlet**



Material

☐

☐ welded steel

☐ concrete

☐ plastic (hdpe, pvc, etc.)

☒ other (specify): 18 inch Vitrified Clay Pipe (VCP) pipe

	Yes	**No**
Is water flowing through the outlet?	☒	☐

☐ **No Outlet**

☐ **Other Type of Outlet** (specify):

The Impoundment was Designed By Not Known at this time.

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

If So When?

If So Please Describe :

	Yes	No
Has there ever been significant seepages at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

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

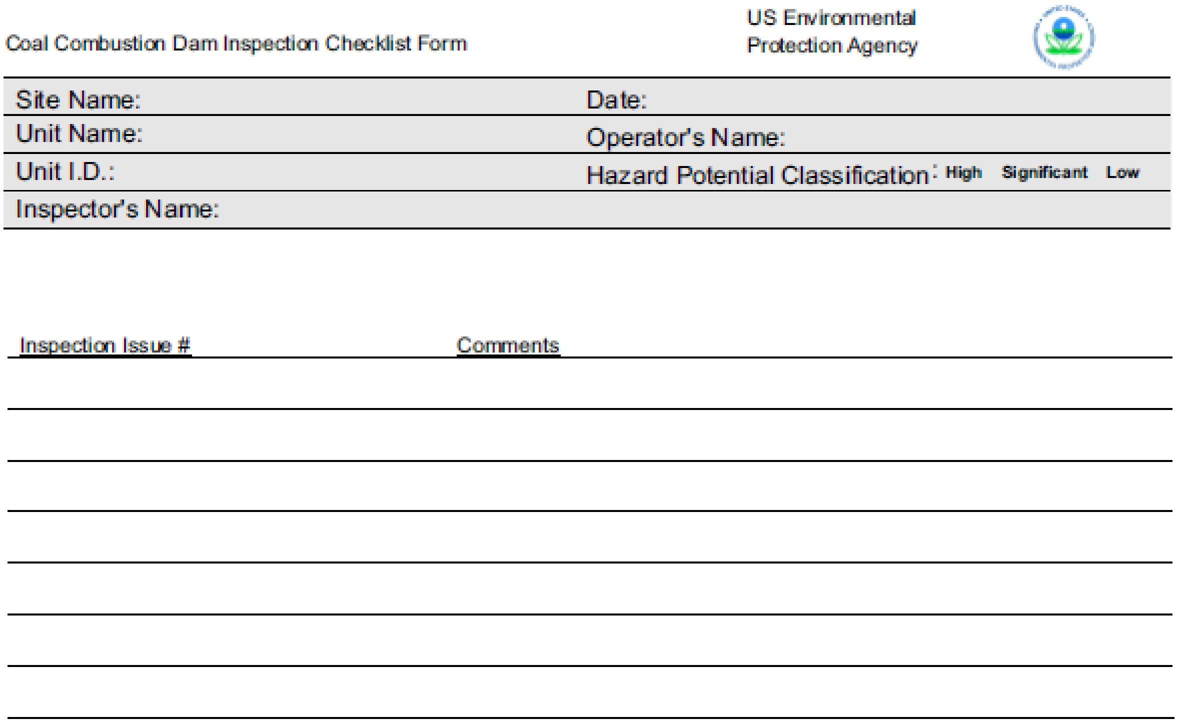
No

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

No

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

No



Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name:	Date:
Unit Name:	Operator's Name:
Unit I.D.:	Hazard Potential Classification: High Significant Low
Inspector's Name:	

Inspection Issue # Comments

APPENDIX B

Document 15

Dam Inspection Check List Form Thermal Pond

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name:	**Keystone Station**	Date:	**September 13, 2012**
Unit Name:	**Thermal Pond**	Operator's Name:	**GenOn**
Unit I.D.:	**DER I.D. No: 03-044**	Hazard Potential Classification:	**High** ☐ **Significant** ☐ **Low** ☒
	Inspector's Name:	Fred Tucker, P.E. and Edward Farquhar	

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

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	√		18. Sloughing or bulging on slopes?		√
2. Pool elevation (operator records)?	√		19. Major erosion or slope deterioration?		√
3. Decant inlet elevation (operator records)?	1017		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		√
5. Lowest dam crest elevation (operator records)?	1020		Is water exiting outlet, but not entering inlet?		√
6. If instrumentation is present, are readings recorded (operator records)?	N/A		Is water exiting outlet flowing clear?	√	
7. Is the embankment currently under construction?		√	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	N/A		From underdrain?		N/A
9. Trees growing on embankment? (If so, indicate largest diameter below)		√	At isolated points on embankment slopes?	√	
10. Cracks or scarps on crest?		√	At natural hillside in the embankment area?		√
11. Is there significant settlement along the crest?		√	Over widespread areas?		√
12. Are decant trashracks clear and in place?			From downstream foundation area?		√
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		√	"Boils" beneath stream or ponded water?		√
14. Clogged spillways, groin or diversion ditches?		√	Around the outside of the decant pipe?		√
15. Are spillway or ditch linings deteriorated?		√	22. Surface movements in valley bottom or on hillside?		√
16. Are outlets of decant or underdrains blocked?		√	23. Water against downstream toe?		√
17. Cracks or scarps on slopes?		√	24. Were Photos taken during the dam inspection?	√	

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

Issue #	Comments
5	Lowest elevation is along inside edge of crest; outside edge is 1020.5.
21	Observed minor seepage on access road bench. Quarterly Dam Inspection Check lists reported minor seepage observed on access road bench from October 2011 to last inspection August 2012. Underdrain is associated with dewatering of settled ash and not associated with the dike. The underdrain pipes discharge into the outlet structure. Any seepage from the underdrain pipes in the pond bottom is not visible.

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit PA0002062 **INSPECTOR** Fred Tucker , P.E. and Edward Farquhar

Date September 13, 2012
Impoundment Name Thermal Pond

Impoundment Company GenOn (part owner) et al.
EPA Region 3

State Agency (Field Office) Address
Pennsylvania Department of Environmental Protection
Bureau of Waste Management
286 Industrial Park Road
Ebensburg, PA 15931

Name of Impoundment Thermal Pond (aka Cooling Pond A)

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

New ☐ **Update** ☒

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

IMPOUNDMENT FUNCTION:

Nearest Downstream Town Name: South Bend, PA

Distance from the impoundment: 3.5 Miles

Location:

Latitude	40	Degrees	39	Minutes	49.36	Seconds	**N**
Longitude	-79	Degrees	21	Minutes	9.27	Seconds	**W**

State Pennsylvania **County** Armstrong

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

If So Which State Agency? Department of Environmental Resources
Bureau of Dams, Waterways and Wetlands
(dam safety)

Bureau of Waste Management (water quality)

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

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

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

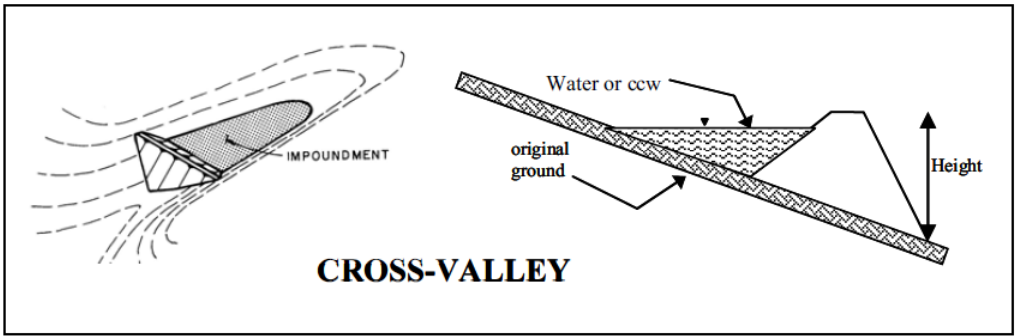
☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.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

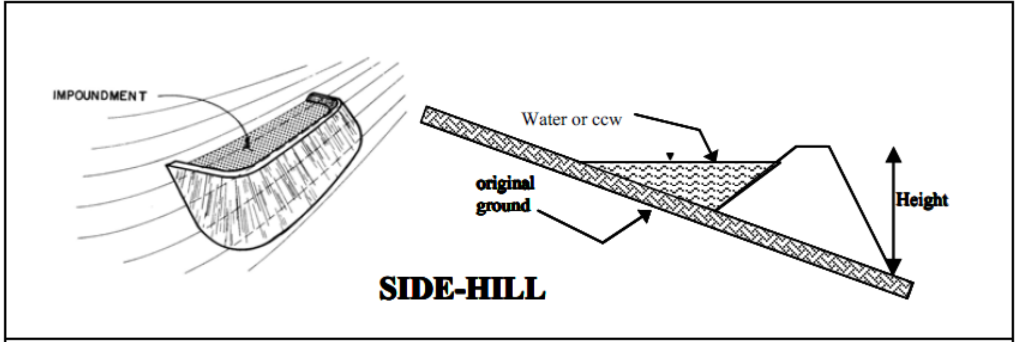
☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

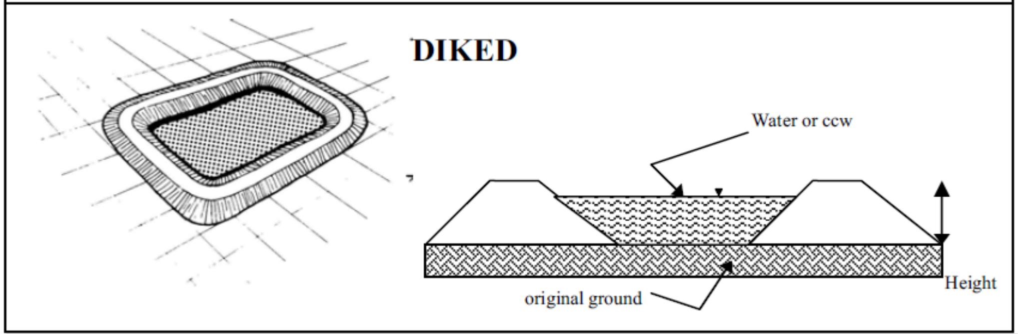
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

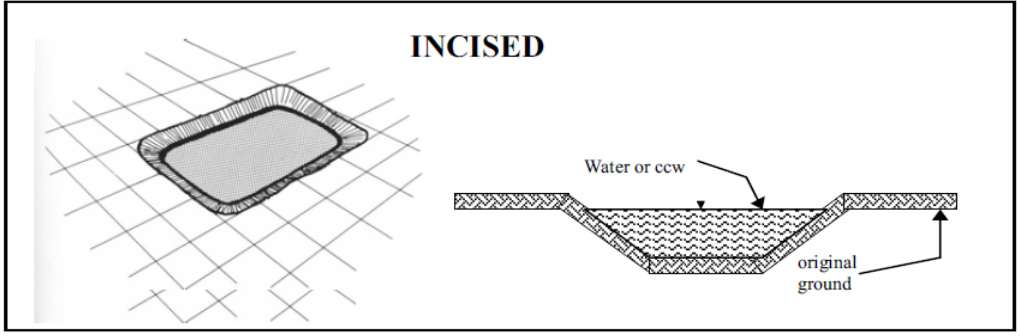
Low hazard potential classification for failure or release of very little bottom ash and water into a lagoon that discharges into Crooked Creek. There would be no significant risk of loss of human life. If failure occurred, ash would principally remain on GenOn property and no substantial flood wave would occur in Crooked Creek due to attenuation effects of an intervening railroad embankment with culvert and an onsite lagoon.

CONFIGURATION:









☒ Cross-Valley ☐ Side-Hill ☐ Diked

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

Embankment Height (ft) 49.0 ft

Embankment Material

Pool Area (ac) 129 acre feet

Liner Side Slopes 3” thick concrete erosion control revetment, 50 Mil HDPE Liner (Textured on

			side slopes) Type “C” Geotextile, 2-inch thick sand bedding on prepared subgrade. Bottom Type “A” Geotextile, 50 Mil HDPE Liner, Type “C” Geotextile, 2-inch thick sand bedding on prepared subgrade.
Current Freeboard (ft)	3.0 Ft.	**Liner Permeability**	N/A

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

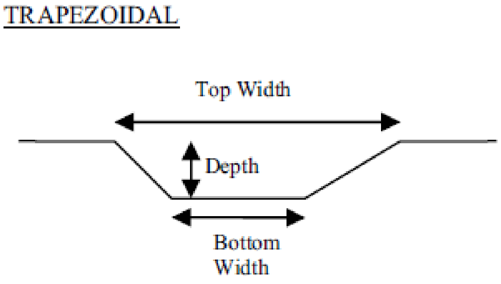
☐ Rectangular

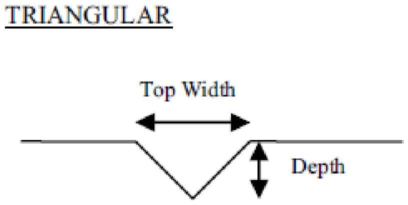
☐ Irregular

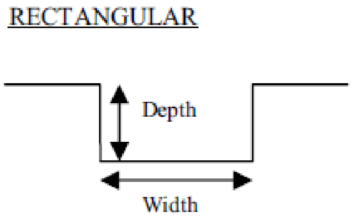
depth (ft)

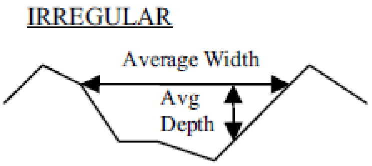
average bottom width (ft)

top width (ft)

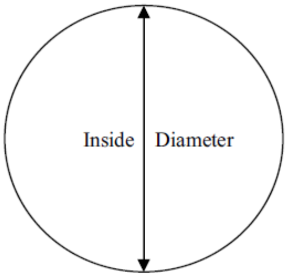








☒ **Outlet**



Material

corrugated metal 21" Dia CMP

☒ slip-lined with 18" Dia. HDPE pipe

☐ welded steel

☐ concrete

☒ plastic (hdpe, pvc, etc.) (See above note)

☐ other (specify):

	Yes	**No**
Is water flowing through the outlet?	☒	☐

☐ **No Outlet**

☐ **Other Type of Outlet**
(specify):

The Impoundment was Designed By **Not Known at this time.**

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

If So When?

If So Please Describe :

	Yes	No
Has there ever been significant seepages at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

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

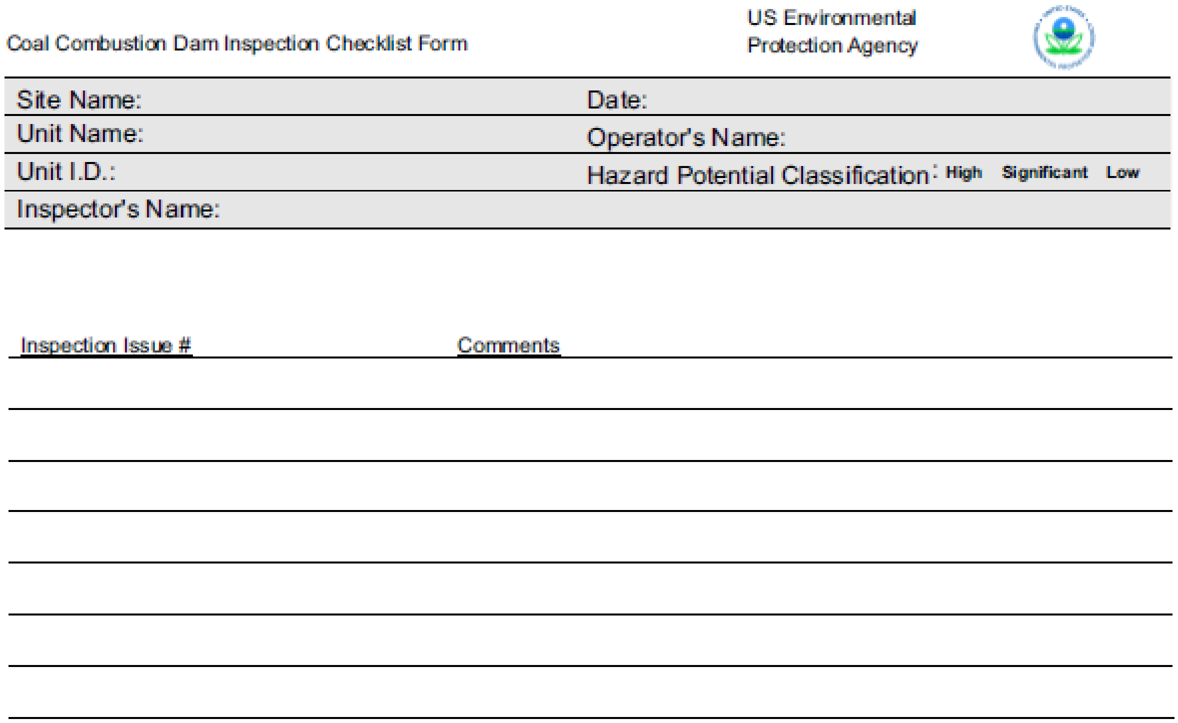
No

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

No

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

No



Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name:	Date:
Unit Name:	Operator's Name:
Unit I.D.:	Hazard Potential Classification: High Significant Low
Inspector's Name:	

Inspection Issue # Comments