DRAFT

Coal Combustion Residue Impoundment
Round 9 - Dam Assessment Report

H. B. Robinson Power Station

Progress Energy Carolinas
Hartsville, South Carolina

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

Dewberry & Davis, LLC
Fairfax, Virginia

Under Contract Number: EP-09W001727
April 2011

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 flooded more than 300 acres of land, damaging homes and property. To prevent such catastrophic failure and damage, the U.S. EPA is assessing the stability and functionality of ash impoundments and other units nationwide, and quickly taking any needed corrective measures.

This assessment of the stability and functionality of the H.B. Robinson Power Station coal combustion residue (CCR) management unit is based on a review of available documents and on the site assessment conducted by Dewberry personnel on February 24, 2011. We found the supporting technical documentation to be adequate (Section 1.1.3). As detailed in Subsection 1.2.5, there are six minor recommendations based on field observations that may help to maintain a safe and trouble-free operation.

In summary, the H.B. Robinson Power Station CCR management unit (Ash Pond) is SATISFACTORY for continued safe and reliable operation, with no recognized existing or potential management unit safety deficiencies.

PURPOSE AND SCOPE

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

In March 2009, the EPA sent a wave of 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**. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner.

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

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

LIMITATIONS

The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion 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.

DRAFT

Table of Contents

Page

DRAFT

EXHIBITS

APPENDIX A

APPENDIX B

1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit on February 24, 2011, and review of technical documentation provided by Progress Energy Carolinas (PEC).

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

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

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

Hydrologic and hydraulic analyses provided to Dewberry indicate adequate flood storage and spillway capacity to pass the appropriate spillway design flood based on the 50-year design storm without overtopping the dike. Under current ash sedimentation levels and operating water level conditions, the ash pond appears to still have adequate flood storage capacity to meet the requirements of the flood-routing analysis. As the pond fills further with ash, the volume available for flood storage will diminish, and could eventually be less than used in the analysis, unless ash is excavated or other measures taken to restore available flood storage.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

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

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

The description of the management unit provided by the owner was overall an accurate representation of what Dewberry observed in the field. However, there appears to be a discrepancy concerning the size of the overflow riser between what is shown in original plans (36-inch diameter RCP) and what is shown in design drawings for the last dike raise in 2002

(48-inch diameter RCP). Record drawings should be corrected or amended, as appropriate, to eliminate confusion as to the size of the buried portion of the riser.

1.1.5 Conclusions Regarding the Field Observations

Dewberry staff was provided access to all areas in the vicinity of the management unit required to conduct a thorough filed observation. The visible parts of the embankment dike and outlet structure were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability. The dike embankment appeared structurally sound. There are no apparent indications of unsafe conditions or conditions needing emergency remedial action. Some minor maintenance is needed (see Subsection 1.2.5).

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The current maintenance and methods of operation appear to be adequate for the CCR management unit. There was no evidence of significant embankment repairs or prior releases observed during the field inspection.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The surveillance program overall is adequate. However, it would be prudent to include periodic interior inspection of the outlet structure with a “borehole” video camera as part of PEC’s inspection program for the ash pond dike (see Subsection 9.3.1 for discussion). The piezometer monitoring program is adequate. In the absence of problem or suspect conditions, there is no need for additional performance monitoring instrumentation at this time.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

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

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Hydrologic/Hydraulic Safety

No recommendations appear warranted at this time. However, at some point in time before the sedimented ash begins to encroach on flood storage capacity in the pond, PEC will need a plan to restore flood storage capacity or alternative plan(s) for disposition of the ash.

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

It is recommended that record drawings be corrected or amended, as appropriate, to eliminate confusion as to the size of the buried portion of the overflow riser at the Ash Pond.

1.2.3 Recommendations Regarding the Field Observations

It is recommended that routine maintenance pay particular attention to:

a. Re-establishing good grass cover in areas of sparse grass growth and in areas damaged by mowers;

b. Filling holes in the embankment slope just above the downstream toe riprap with suitable filter materials to minimize continuing erosion of embankment soil into the voids of the riprap; lining the larger holes with filter fabric before filling them with coarse filter stone may be beneficial;

c. Re-establishing soil cover and good grass growth where erosion of backfill soil has exposed an ash sluice line in the slope, in order to arrest continued erosion, which unchecked could eventually result in the development of gullies in the embankment slope along the sluice line(s);

d. Improving drainage from the right (south) downstream toe swale in order to dry up the persistent wet area, which would allow ease of mowing and facilitate inspections;

e. Controlling growth of woody vegetation in the riprap on the upstream slope of the north portion of the dike; and

f. Arresting erosion and undermining at the end of the outfall pipe.

1.2.4 Recommendations Regarding the Surveillance and Monitoring Program

It is recommended that periodic interior inspection of the outlet structure with a “borehole” video camera be included as part of PEC’s inspection program for the ash pond dike (see Subsection 9.3.1 for discussion).

1.2.5 Recommendations Regarding Continued Safe and Reliable Operation

None of the above recommendations is currently considered urgent but should be done within a reasonable time frame, so that some of them do not grow into bigger issues.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Craig Dufficy, U.S. EPA
Ken Kirkland, Progress Energy
Stephen Cahoon, Progress Energy
Bill Foster, Progress Energy
Willie Gilbert, Progress Energy
Fred Holt, Progress Energy
Robert Miller, Progress Energy
Fred Tucker, Dewberry
Anne Lee, Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on February 24, 2011.

Fred Tucker, P.E.
Registered, SC 6836

Anne Lee, Civil Engineer

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

2.1 LOCATION AND GENERAL DESCRIPTION

The H. B. Robinson Power Station (H. B. Robinson) is located on West Entrance Road, Hartsville, South Carolina 29550. Lake Robinson is just east of H. B. Robinson in Darlington County, South Carolina. The plant site is situated next to the lake just north of the west end of the dam that impounds Lake Robinson. See Doc 01 in Appendix A for location of the H. B. Robinson site on an aerial map.

H. B. Robinson has one CCR management unit, Ash Pond, designed to contain fly ash, bottom ash, boiler slag, storm water, and other chemical metal cleaning liquids. The dike that impounds the Ash Pond is physically located just west of the cooling water discharge canal along the west side of Lake Robinson. The ash pond dike is approximately 3.8 miles northeast of Hartsville, South Carolina. A CSX Railroad spur loop to the plant is located parallel to the discharge canal between the downstream toe of the dike embankment and the discharge canal.

The ash pond dike is a cross-valley embankment along the east side of the pond. The pond is divided into two sides (north and south) by a finger dike. The sluice line discharges into the south portion of the pond, and the discharged slurry circulates around the west end of the finger dike to the north portion of the pond, where the outlet structure is located. See Doc 02 in Appendix A for Ash Pond aerial and dike locations.

Table 2.1 shows the summary of the size and dimensions of Ash Pond dike. The embankment ties into high ground in the north and south ends of the embankment.

Table 2.1: Summary of Dam Dimensions and Size

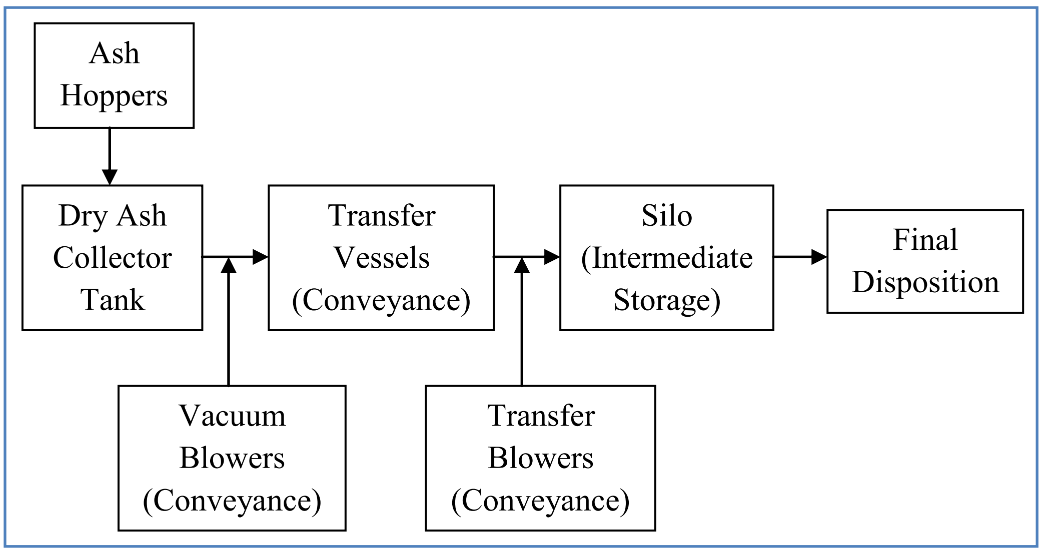
	Ash Pond
Dam Height (ft)	31
Crest Width (ft)	15
Length (ft)	1,800
Side Slope (upstream) H:V	2:1
Side Slope (downstream) H:V	2:1

2.2 COAL COMBUSTION RESIDUE HANDLING

2.2.1 Fly Ash

At present, 100 percent of fly ash produced at H. B. Robinson is sold to manufacturers. The fly ash system (a closed system) collects drop out ash particles from flue gas and is conveyed from the economizer, air heater hoppers, and precipitator ash hoppers to an ash silo. In this method of handling the fly ash is removed from the hoppers by vacuum through diverter valves to collector tanks. From the collector tanks the fly ash is conveyed to a remote storage silo using transfer vessels and transfer blowers. Under the silo is a truck load-out station, where the fly ash is loaded onto trucks and transported to final disposition (primarily to market). When appropriate, the dry fly ash is conditioned with water for better handling. See Image 2.1 for fly ash collection system flow path.

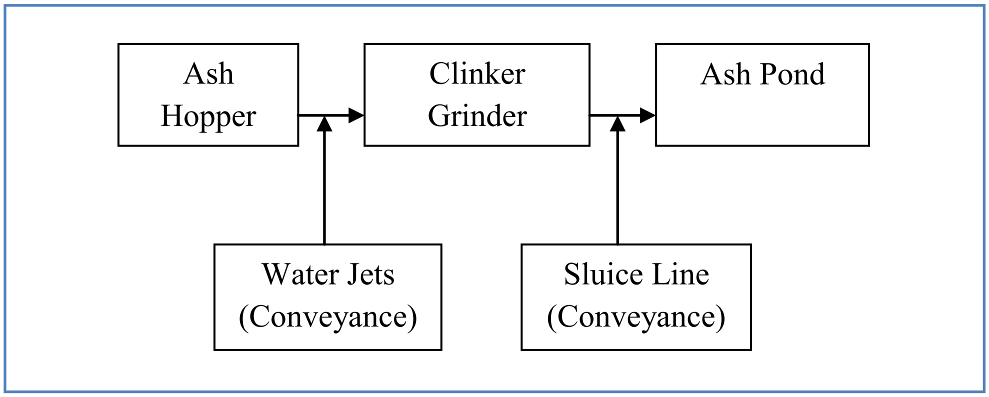
Image 2.1: Fly Ash Collection System Flow Path



2.2.2 Bottom Ash

Bottom ash is collected and sluiced to the Ash Pond via a closed system process. Ash collected in the bottom ash hopper is removed with the assistance of water jets, creating an ash slurry. A jetpulsion pump is used to draw the slurry from the hopper through a clinker grinder into a sluice line, and discharges to the Ash Pond. See Image 2.2 for bottom ash collection flow path and Section 8.1 for more detailed description of the bottom ash handling operation.

Image 2.2: Bottom Ash Collection System Flow Path



2.2.3 Boiler Slag

Boiler slag conveyance follows the bottom ash flow path, from the boiler and is sluiced to the Ash Pond.

2.2.4 Flue Gas Desulfurization Sludge

H. B. Robinson does not have flue gas desulfurization equipment.

2.3 SIZE AND HAZARD CLASSIFICATION

The H. B. Robinson ash pond dike is not regulated for dam safety by a federal or state agency and currently does not have federal or state hazard potential classifications. However, Progress Energy Carolina's (PEC's) engineer, MACTEC, has made size and hazard potential classifications for the ash pond dike in accordance with U.S. Army Corps of Engineers (USACE) guidelines, as indicated in their draft 2010 5-Year Inspection Report, included as Doc 03 in Appendix A. The report indicates Small Size classification and Low Hazard Potential classification. The USACE criteria for size classification and hazard potential classification are shown in Table 2.2a and Table 2.2b, respectively. See Table 2.1 and Table 2.3 for embankment height and pond storage capacity, respectively.

DRAFT

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

* *Size classification may be determined by either storage or height of structure, whichever gives the higher category.*

Table 2.2b: USACE ER 1110-2-106 Hazard Potential Classification		
Category	**Loss of Life (Extent of Development)**	**Economic Loss (Extent of Development)**
Low	None Expected (No permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Few (No urban development and no more than a small number of habitable structures)	Appreciable (Notable agriculture, industry, or structures)
High	More than a few	Excessive (extensive community, industry, or agriculture)

For reference, the hazard potential classification system used by the EPA is shown in Table 2.2c. As discussed in more detail in Subsection 6.1.4, failure of the dike embankment would release a relatively small volume of water and likely result in erosion of CCR onto the railroad spur siding and erosion of some of the CCR into the nearby cooling water discharge canal. The failure would not likely cause loss of life but would cause some onsite environmental damage and possible disruption of plant operations. Thus, according to the hazard potential classification used by EPA, the ash pond dike would still be classified Low Hazard Potential, in Dewberry's opinion.

DRAFT

Table 2.2c: Dam Hazard Potential Classification Used by EPA	
Category	**Hazard Potential Description**
High Hazard Potential	Dams where failure or misoperation will probably cause loss of human life.
Significant Hazard Potential	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.
Low Hazard Potential	Dams 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.
Less Than Low Hazard Potential	Dams where failure or misoperation results in no probable loss of human life or economic or environmental losses.

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

The amount of CCRs currently stored in the unit and maximum capacity are summarized in Table 2.3. The Ash Pond has received fly ash, bottom ash, boiler slag, ash sluice water, stormwater, and metal cleaning chemicals. The pond is currently active and receives predominantly bottom ash. Approximately 20 acres of the total area of the pond has been used for dry stacking of ash in the western portion of the pond and is not part of the active area of the pond that receives sluiced ash. The active area of the pond at maximum operating water level is 55 acres. CCR is sluiced into the southern portion of the Ash Pond, and water flows to the northern portion.

Table 2.3: Amount of Residuals and Maximum Capacity of Unit	
Ash Pond	
Surface Area (acre)	75 (incl. 20-acre dry-stack area)
Current Storage Volume (cubic yards)[1]	627,587
Current Storage Volume (acre-feet)[1]	389
Total Storage Capacity (cubic yards)[2]	1,016,400
Total Storage Capacity (acre-feet)[2]	630
Crest Elevation (feet)	272.0
Maximum Operating Water Level (feet)	269.5

[1]*Based on data in PEC response to EPA's RFI dated March 17, 2009*
[2]*Based on data in Design Report prepared by Law Engineering and Environmental Services, Inc. dated October 10, 2001*

2.5 PRINCIPAL PROJECT STRUCTURES

2.5.1 Earth Embankment

The Ash Pond embankment, located on the east side of the pond, ties into high ground on the north and south end of the embankment. The embankment has 2 horizontal (H) to 1 vertical (V) side slopes and 15-foot wide crest. As subsequently described, the dike embankment has been raised twice since original construction. The original and first raise embankment fills consist of predominantly dense fine to medium sands with interlayered seams of clayey silt and silty fine sand, although some looser soils were encountered at shallow depth beneath the outside slope of the embankment prior to the last dike raise in 2002. A section of the dike prior to the 2002 dike raise is included in Exhibit 01, illustrating the findings of borings made at the section. The last dike raise utilized fill materials from a sandy borrow area located on the south edge of the pond. A representative section of the embankment is shown in the MACTEC 2010 5-Year Inspection Report (see Exhibit 9 of Doc 03 in Appendix A). The design included a blanket drain between the pre-existing embankment outside slope and the new fill placed for the last embankment raise. A rock toe was constructed over the end of the drainage blanket at the base of the new outside slope. In addition, the soils in the outer part of the new slope were reinforced with geogrids as a precaution against shallow slumps occurring in the sandy embankment soils under the 2 H to 1 V slope.

2.5.2 Outlet Structure

CCR water passes through an overflow structure located in the north part of the pond. The visible part of the overflow structure consists of a 48-inch diameter reinforced concrete pipe (RCP) drop inlet with a metal skimmer. Discharge from the overflow structure flows into a 36-inch diameter RCP to a manhole located on the downstream slope. A 36-inch high density polyethylene (HDPE) pipe discharges from the manhole to a catch basin at the downstream toe. The catch basin serves as a junction box for the discharge from the Ash Pond and from a 24-inch diameter ADS storm sewer from the north buried along the toe of the dike. From the junction box the combined stormwater sewer and Ash Pond discharges flow through a 36-inch diameter HDPE pipe about 120 feet to the outfall location at a channel that leads to the cooling water discharge canal along the west side of Lake Robinson. The outlet works prior to the last dike raise in 2002 are illustrated in Exhibit 02.

2.6 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

A regional map showing the H. B. Robinson Ash Pond in relationship to "critical" infrastructure within a 5-mile radius was provided by Progress Energy. "Critical" infrastructure includes facilities such as schools and hospitals. There are 3 schools and no hospitals located within a 5-mile downstream gradient. These facilities are noted on the 5-mile radius map included in Doc 01 in Appendix A. In general, the land use downstream from this particular site is Lake Robinson.

Flood from postulated failure of the ash pond dike would primarily impact Lake Robinson, which, due to its large size in relationship to the Ash Pond, appears capable of absorbing with little consequence the relatively small volume of flood water that could be released from the Ash Pond.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

3.1 SUMMARY OF REPORTS ON THE SAFETY OF THE MANAGEMENT UNIT

Furnished reports of bi-monthly inspections, conducted by Progress Energy personnel for the period of January 2010 through January 2011 indicate no major structural or operational problems (see Doc 04 in Appendix A). No significant deterioration was indicated in the documentation reviewed. Five-year inspection reports, from 1985 to 2010, indicate no major structural or operational problems. No significant deterioration associated with the ash pond dike was indicated in the documentation reviewed.

A furnished Design Report, prepared by Law Engineering and Environmental Services, Inc. (Law) for the 2002 ash pond dike raise includes stability analyses of the embankment (see Doc 05 in Appendix A and see Section 7.1 for discussion).

3.2 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS

Discharge from the impoundment is regulated by the South Carolina Department of Health and Environmental Control (SCDHEC) and the impoundment has been issued a National Pollutant Discharge Elimination System Permit. Permit No. SC0002925 was issued March 8, 2007.

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 dike over the last 10 years. The MACTEC 2010 5-Year Inspection Report (Doc 03 in Appendix A) indicates seepage from the joints of the overflow structure was observed. The joints of the 48-inch RCP overflow structure were sealed in 2002, and grouting was performed around the outfall pipe.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

No records of original construction are available. Therefore little is known of the original construction other than the approximate year the pond was commissioned - 1960.

The dike was constructed across a natural valley area. A finger dike was constructed to lengthen the retention time. According to the cross-section detail shown on Exhibit 6 of Doc 03 in Appendix A, the original crest of the dike was at elevation 259 feet. Top of the overflow riser structure prior to the 1982 dike modification was at 254.0 feet. Approximate height of the dike was 13 feet.

4.1.2 Significant Changes/Modifications in Design since Original Construction

The dike embankment was raised two times, in 1982 and 2002. The dikes were raised by constructing upward and outward in the downstream direction, so the new embankments of the impounding dike were not founded on ash.

In 1982, the dike was raised 7 feet to provide an additional 10 years of storage capacity. The crest elevation was raised to 266.0 feet (see Exhibit 6 of Doc 03 in Appendix A). The design and construction of the raised embankment was by Carolina Power & Light Company. The overflow structure is shown on the original plans to be a 36-inch diameter RCP riser with a top elevation of 264.0 feet, up from the original 254.0 feet. (This 36-inch riser is a discrepancy with the 48-inch riser indicated in the design of 2002 dike raise.) A previously existing 24-inch diameter catch basin riser extending down to the outlet pipe was abandoned in place and a new 24-inch catch basin riser was constructed further downstream along the outlet structure. The outlet pipe is shown on the original plans to be a 36 inch diameter RCP extending to the discharge canal.

In 2002, the dike was raised 6 feet to again increase storage capacity within in the pond. The dike raise was designed by MACTEC. The sandy borrow soils used in the dike raise were compacted in lifts to 95 percent of the standard Proctor maximum dry density (ASTM D 698) or greater. The dike raise construction was monitored by MACTEC. The crest elevation was raised to 272.0 feet (see Exhibit 9 of Doc 03 in Appendix A). The overflow structure is shown to be a 48-inch diameter RCP riser raised with precast concrete pipe sections to a top elevation of 269.5 feet (see Exhibits 10 and 11 of Doc 03 in Appendix A). The previously existing metal skimmer was reused. The 36-inch diameter outlet extending from the riser to the outfall channel is as described in Subsection 2.5.2.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

There have been no significant repairs/rehabilitation made to the ash pond dike or the overflow structure since the original construction.

As previously noted, a minor repair in 2002 was made to seal leaking joints in the 48-inch RCP overflow structure and to grout around the outfall pipe. At the same time repairs were made to correct a separated joint in the storm drain pipe buried along the toe of the dike, which had caused a sinkhole to develop due to loss of soil through the separated joint. Another minor repair included placement of rock check-dams across the right (south) abutment drainage ditch and elsewhere to control erosion caused by high-velocity flow of concentrated storm runoff.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

Furnished documents do not include the original operational procedures. It is presumed that the pond was originally operated as a wet pond wherein CCR wastes were transported and disposed by sluicing with water into the pond, where the suspended particles were allowed to settle out and the water detained temporarily in the pond for neutralization and equalization prior to discharge through the gravity-flow overflow structure.

4.2.2 Significant Changes in Operational Procedures and Original Startup

Fly ash is now pneumatically transported to silos for temporary storage until sold. A sprinkler system was installed in the south portion of the Ash Pond to control dusting of ash from the pond.

4.2.3 Current Operational Procedures

The Ash Pond receives sluiced bottom ash, boiler slag, ash sluice water, stormwater, and metal cleaning chemicals. Currently, 100 percent of the fly ash is sold and no fly ash is discharged into the pond. Bottom ash is the primary substance discharged into the pond. More detailed discussion of current operating procedures is included in Subsection 8.1.

4.2.4 Other Notable Events since Original Startup

Based on furnished information, there are no other notable events since original startup of the Ash Pond to report at this time.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Fred Tucker, P.E. and Anne Lee performed a site visit on Thursday, February 24, 2011 in company with the participants listed in Section 1.3.1.

The site visit began mid-morning. The weather conditions during the visit were 71 degrees Fahrenheit, sunny, and dry. Photographs were taken of conditions observed. Please refer to the Dam Assessment Checklist in Appendix B. Selected photographs are included here for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit.

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

5.2 EARTH EMBANKMENT

5.2.1 Crest

The crest of the ash pond dike is accessible with automobiles. The fine aggregate-surfaced crest of the embankment was observed to be in good condition. See Photograph 5.1 for typical view of the crest. It was observed that the water supply line for the dust-control sprinkler system is laid out along the upstream edge of the crest. The sprinklers in the south part of the pond were in operation at the time of the site visit. Protective covers over replacement piezometers that were installed along the approximate centerline of the embankment during the dike raise construction in 2002 were noted on the crest. The crest elevation at the sluice line was observed to be greater than the design crest elevation due to a protective soil cover over the sluice line that allows vehicles on the crest to traverse over the line. Minor erosion was noted along the upstream edge of crest on the south side embankment that wraps around to the west, as shown in Photograph 5.2. Riprap has been placed for preventative maintenance. No major depressions, sags, tension cracks, or other signs of significant settlement or mass soil movement were observed in the dike crest.

Saddle dikes, located on the north and south sides of the Ash Pond, near towers that support the Darlington County Plant transmission lines were observed during the site visit. The dikes were constructed to keep water

DRAFT

within the pond from inundating the steel transmission tower legs. No indications of seepage or erosion were observed at these very low dikes.

Photograph 5.1. Typical view of crest, looking south.

Photograph 5.2. Minor erosion at the upstream edge of crest at south side of embankment, looking west.

5.2.2 Upstream/Inside Slope

The upstream slope of the north portion of the dike embankment (north of the finger dike) was observed to be lined with riprap with a minor amount of dormant vegetation, including woody vegetation, growing in it, as shown in Photograph 5.3a. The upstream slope of the embankment south of the finger dike was observed to have a dormant cover of grass and weeds (see Photograph 5.2). A small-diameter metal pipe from the Darlington County Plant on the north side of the pond conveys discharge from an oil-water separator through the north side dike embankment extension and into the pond, as shown in Photograph 5.3b. Former erosion at the discharge location had been repaired with the riprap shown in the photograph. The upstream toe and much of the upstream slope is buried with ash, particularly along the south portion of the dike, as shown in Photograph 5.3c; this photograph also shows where the ash is sluiced into the pond and the dust-control sprinkler system in operation in the background. Only a small amount of water was observed in the pond, mostly at the north end next to the dike (see Photograph 5.3a). No slumps, slides, or other signs of shear failure were observed in the visible parts of the slope above the ash and water levels. No significant erosion was noted.

Photograph 5.3a. Upstream slope of north portion of dike, looking south.

Photograph 5.3b. Discharge pipe from oil-water separator through north end of Ash Pond embankment.

Photograph 5.3c. View of ash-sluice discharge line and ash-filled south portion of pond, looking south. (Note operation of sprinklers for dust control in south portion of pond).

5.2.3 Downstream/Outside Slope and Toe

The downstream slope was observed to have a cover of dormant grass and weeds, and the downstream toe was observed to be lined with riprap. The grass on the downstream slope typically was observed to be well maintained, as shown in Photographs 5.4a, 5.4b, and 5.4c. Minor erosion from mowing equipment was observed on the slope. A portion of the buried sluice line along the downstream slope face was observed to be exposed due to erosion, and minor erosion was observed elsewhere along the soil-covered sluice line, as shown in Photograph 5.5. Progress Energy personnel indicated that the soil cover over the sluice line was not compacted. Local embankment soil material loss due to erosion into the riprap and minor depressions were observed at a number of locations on the downstream slope above the riprap; one of the worst of these is shown in Photograph 5.6a. It was noted that in a number of locations soil had eroded (or moved by creep) onto the surface of the riprap. Some areas of sparse grass growth on the outside slope were also observed (see Photograph 5.4a), but no major areas of erosion were noted. No slumps, slides, bulges, tension cracks, or other obvious signs of shear failure were observed on the downstream slope. No seepage or active animal holes were observed. Wet soils were observed in the shallow swale along the right (south) toe of the dike, but no seepage or flowing water appeared to be associated with this wet area, as shown in Photograph 5.6b. It appeared to be due to poor drainage. The catch basin at the low point of the toe (see Photograph 5.8) was observed to be surrounded with stone and a fine filter that apparently tends to easily clog with vegetation and grass clippings, which retards flow from the toe swale into the catch basin.

Photograph 5.4a. Downstream slope and toe of north portion of dike, looking south.

DRAFT

Photograph 5.4b. Downstream slope and toe of north portion of dike, looking north.

Photograph 5.4c. Downstream slope and toe of south portion of dike, and south abutment, looking south.

Photograph 5.5. Minor erosion observed along buried sluice line on the downstream slope, looking east.

Photograph 5.6a. Hole due to soil material loss into riprap voids, observed on downstream slope above riprap at toe.

Photograph 5.6b. Wet soils in shallow swale along right (south) toe of dike embankment, looking north.

5.2.4 Abutments and Groin Areas

No erosion or displacements were observed where the finger dike intersects the embankment. No erosion, displacements, or noticeable seepage was observed where the embankment ties into high ground at the north and south ends. Previous erosion of the lower part of the right (south) abutment ditch located beyond the outside toe of the dike was observed. However, it was noted that rock check dams had been placed at intervals across the ditch to control the erosion. The abutment ditch with check dams is visible in Photograph 5.4c.

5.3 OUTLET STRUCTURES

5.3.1 Overflow Structure

The Ash Pond overflow structure was observed on the northeast side of the pond just upstream of the dike. The 48-inch diameter RCP overflow structure with a metal skimmer was observed to be in good condition. The skimmer had rust on its surface, but it appeared sound. No water was flowing into the structure and was not even impounded around the structure at the time of the visit, as shown in Photograph 5.7.

Photograph 5.7. Ash Pond overflow structure, looking west.

5.3.2 Outlet Conduit

The overflow structure has bottom discharge into a 36-inch diameter RCP conduit to a manhole located on the downstream slope. The manhole is surrounded on three sides by a retaining wall, shown in Photograph 5.8, which was made necessary by the 2002 dike raise. The retaining wall appeared to be in good, sound condition. A 36-inch diameter HDPE conduit continues from the manhole to a covered catch basin at the downstream toe of the dike, as shown at the bottom of Photograph 5.8. A 24-inch diameter ADS storm drain pipe also discharges into the catch basin from the north side. None of the underground conduits and pipes could be viewed. The catch basin was observed to be in good condition, and the inside of the catch basin appeared to be dry, based on limited views through the open sides. A 36-inch diameter HDPE conduit continues from the catch basin 120 feet, passing under the railroad spur tracks and the toe access road, to the outfall channel. The end of the HDPE outfall pipe is shown in Photograph 5.9. The limited part of the HDPE pipe that could be observed at the outfall end appeared to be in good condition. A small amount of clear water was observed flowing from the end of the pipe. The source of this water is unknown, since no water was flowing into the overflow riser and the catch basin appeared to be dry. The invert of the black HDPE pipe was rust colored, apparently due to the presence of iron bacteria. The soil bank at the outfall was observed to be very steep, and the small riprap that had been placed around the end of the outfall had eroded off its geotextile bedding.

Photograph 5.8. Showing manhole access to outlet conduit on the slope, and covered catch basin at the downstream toe of the embankment of the ash pond dike, looking west.

Photograph 5.9. HDPE outlet into outfall channel downstream of junction box, looking west. (Note steep bank and eroded small riprap around end of pipe,)

5.3.3 Emergency Spillway

The Ash Pond does not have an emergency spillway.

5.3.4 Low Level Outlet

The overflow structure does not have a low level outlet, other than the bottom discharge pipe, which is not valved or gated.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation was provided to address the maximum water surface elevation in the ash pond. Hearsay evidence is that plant personnel have observed the water surface in the pond to reach within about 6 to 8 inches of the top of the riser due to rainfall, but no overflow into the riser has been observed since the riser was raised as part of the dike raise in 2002. Therefore, the water surface presumably has been below the overflow weir elevation of 269.5 feet (according to design drawings) since 2002, leaving more than 2.5 feet of freeboard.

6.1.2 Inflow Design Flood

Engineering studies were performed by Law Engineering and Environmental Services, Inc. (Law) for the dike raise in 2002. Hydrologic/hydraulic analyses performed as part of those studies are documented in Law's Design Report dated October 19, 2001, included as Doc 05 in Appendix A. Law designed the dike raise and set the spillway riser elevation to be adequate for the 50-year storm event, in accordance with the requirements of the South Carolina Department of Health and Environmental Control (SCDHEC) for existing dams, such as the ash pond dike, with Small Size Classification and Low Hazard Potential Classification. Law used an inflow design flood (IDF) based on 50-year frequency, 24-hour duration precipitation of 7.5 inches and a peak rainfall intensity of 2.5 inches/hour. The computed peak inflow from Law's flood routing through the pond was 307.5 cubic feet per second (cfs) and the peak outflow was 53.9 cfs. Law revised the initially selected riser elevation of 270.0 feet downward to a final elevation 269.5 feet, to assure at least 1 foot of freeboard at peak pond water surface elevation during the design storm, in accordance with SCDHEC requirements.

6.1.3 Spillway Rating

The spillway rating for the outlet structure is given by the minimum flows derived from the outflow equations for riser weir flow, riser orifice flow, and barrel flow shown in Law's 2001 Design Report (p. B2-2)(see Doc 05 in Appendix A).

6.1.4 Downstream Flood Analysis

No downstream flood analysis has been provided for the ash pond. A qualitative analysis based on field observations and review of available data is provided below.

Failure of the ash pond dike would discharge water and coal combustion residue onto relatively flat ground immediately beyond the dike toe and likely over the railroad tracks and into the outlet channel located about 120 feet from the toe of the dike. Water released through a breach in the dike would likely carry some eroded ash down the channel and into the cooling water discharge canal along the west side of Lake Robinson, which is owned by Progress Energy Carolinas. The failure would not likely cause loss of life but would cause some onsite environmental damage and possible disruption of plant operations. Because the volume of water in the ash pond would be very small in relationship to the size of Lake Robinson, the release of water through a breach in the ash pond dike would likely have little impact on the Lake Robinson water level.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

The supporting hydrologic/hydraulic documentation is adequate for this small ash pond dike with low hazard potential.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

The supporting documentation indicates that the ash pond has adequate hydrologic safety. Note the ash surface in the south portion of the ash pond has built up to within about 1 foot of the crest elevation, which reduces flood storage above the riser top elevation, the starting elevation in Law's flood routing calculations. However, the ash surface in the north portion of the pond is still well below the riser top elevation, and it appears that the normal operating water level in the pond is actually below the riser top elevation, since there reportedly has been no flow into the riser since the dike was raised in 2002. Thus, the ash pond still appears to have adequate hydrologic safety under current sedimentation levels and operating water level conditions. As the pond fills further with ash, the volume available for flood storage will diminish, and could eventually be less than used in Law's analysis, unless ash is excavated or other measures taken to restore available flood storage. If the ash is allowed to build up throughout the pond to within 1 foot of the dam crest elevation, the pond most likely would not be able to pass the 50-year design storm without overtopping the dike. However, the volume of water that could potentially be released would be relatively small (less than approximately 55 acre feet) and may not cause sufficient erosive force of long enough duration to actually breach the main body of the dike embankment.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

A subsurface investigation and stability analyses were performed as part of engineering studies for the 2002 dike raise, which are documented in Law's Design Report dated October 19, 2001(see Doc 05 in Appendix A).

Effective stress analyses were performed. (Both the foundation soils and the embankment soils are composed of sandy soils.) The modified Bishop method of analysis was used in the STABL computer program (Versions 6H & 5M) to compute slope stability factors of safety for randomly searched circular-arc potential failure surfaces. Only the outside slope was analyzed; the inside slope was not as critical, since the lower existing part of the slope was buried in ash. The cases analyzed for the maximum section with 2H to 1V slope were:

1. Static w/o Geogrid Reinf. (pond full @ El. 269.7')
2. Static w/ Geogrid Reinf. (pond full @ El. 269.7')
3. Earthquake w/ Horiz. Accel. = 0.10g (pond full @ El. 269.7')

The design included a blanket drain between the old embankment surface and the new compacted fill to be placed for the dike raise, in order to keep the phreatic surface drawn down so it would not crop out on the new slope (i.e., because a phreatic surface exiting a 2H to 1V slope constructed of sandy soil would not be stable.) The design also included a rock toe over the end of the blanket drain. The Case 1 analysis showed unsatisfactory factors of safety for shallow potential failure surfaces in the sandy embankment soil. Therefore, even though the then existing 2H to 1V slope constructed of similar sandy soils showed no signs of shallow slumping, geogrid reinforcement of the outer portion (approximately 5 feet horizontally) of the slope was incorporated in the design to minimize the chance of shallow slumping in case grass did not become quickly established on the new slope.

7.1.2 Design Parameters and Dam Materials

Both the foundation soils (including the old dike embankment and soils below natural ground) and the borrow soils used in the dike raise consist predominantly of sands, although some clayey silt and silty fine sand were found to be interlayered in the old embankment. Typical Unified Soil Classification is SM. Based on laboratory testing, design properties and parameters used in the analyses were as shown in the following Table 7.1:

Table 7.1: Design Properties and Parameters of Materials used in Analyses

Material	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Drained Strength Parameters	
			C´ (psf)	Ø´ (deg)
Foundation	120	125 & 127	0	35
Fill	123 & 126.5	131 & 132	0	35
Unreinf. Outer Fill	122	129	0	31

See analysis sections in Doc 05 in Appendix A for source of information in this table.

7.1.3 Uplift and/or Phreatic Surface Assumptions

The phreatic surface in the embankment slope stability analysis section was assumed to be drawn down from the full pond elevation to the new drainage blanket between the old and new embankment fills and to follow along the drainage blanket to the toe of the embankment (see pp. B1-1, 2, & 3 of Doc 05 in Appendix A).

From visual observations in the field, the phreatic surface does not crop out on the outside slope of the dike, although a wet area was observed in the toe area just right (south) of the midpoint along the toe of the dike. Based on the flat topography in the area and piezometer readings that show the groundwater well below the ground surface, the wet area appears to be due to poor surface drainage.

7.1.4 Factors of Safety and Base Stresses

The computed factors of safety (FS) for the load cases analyzed in the slope stability analyses are shown in the following Table 7.2. Conventional minimum FS criteria are 1.5 for static long-term stability and 1.0 for earthquake stability (by pseudo-static method). The low computed FS for Case 1 was for shallow (surficial) potential failure surface; acceptable FS was obtained for deeper, more significant potential failure surfaces. In order to minimize the possibility of shallow nuisance slumps occurring, the geogrid reinforcement of the outer part of the new fill slope was incorporated in the design of the dike embankment.

Table 7.2: Slope Stability Factors of Safety (Outside Slope)	
Load Case	**Calculated Minimum Factor of Safety (FS)**
1. Static Long Term – no Geogrid Reinf.	1.04
2. Static Long Term – with Geogrid Reinf.	1.59
3. Earthquake – 0.1g	1.26

See analysis sections in Doc 05 in Appendix A for source of information in this table.

7.1.5 Liquefaction Potential

Available subsurface information indicates that the foundation soils typically consist of firm to dense and very dense sands. No liquefaction potential analyses have been performed specifically for the ash pond dike. However, the sandy soils appear to be too firm and compact to be susceptible to liquefaction during an earthquake. According to a 2010 draft 5-year inspection report by MACTEC, Carolina Power and Light (CP&L now known as Progress Energy Carolinas) performed a review of the potential for liquefaction at the adjacent Robinson Nuclear Plant, including the cooling lake dam (Lake Robinson Dam), in 1995-96 in response to a request of the Nuclear Regulatory Commission (NRC). The review concluded that liquefaction was not of concern for the cooling lake dam, and the NRC concurred with the assessment. Thus, in the absence of loose saturated sands or very soft clays in the embankment or foundation, liquefaction also does not appear to be a concern for the ash pond dike.

7.1.6 Critical Geological Conditions

The ash pond site is located in the Coastal Plain Physiographic Province of South Carolina. Law's 2001 Design Report references "Hydrogeologic studies conducted in conjunction with the Robinson Unit 2 licensing" that "indicate about 30 feet of recent alluvial sands and gravels underlie the ash pond area. These surficial deposits overlie Upper Cretaceous sediments of the Middendorf Formation. The Middendorf Formation consists of interlayered sands and clays with some slightly cemented layers possible." The formation materials are firm and compact. The Mindendorf is permeable and groundwater occurs within the formation in both water table and artesian conditions. According to a 2010 draft 5-year inspection report by MACTEC, the Upper Cretaceous is approximately 460 feet thick and lies unconformably on crystalline basement rocks of Pre-Cambrian and Paleozoic Age.

Seismicity – The site of the Robinson ash pond dike is in an area of generally low seismic hazard characterized by light earthquake activity resulting in minor damage. Based on USGS Seismic-Hazard Maps for Central and Eastern United States, dated 2008, the ash pond dike is located in an area anticipated to experience 0.20g peak (horizontal) ground acceleration with a 2-percent probability of exceedance in 50 years. It is noted that the maps are based on uniform firm-rock site conditions, i.e., site conditions with average shear wave velocity of 2500 feet per second in the upper 100 feet below the surface. The alluvial soils and the Upper Cretaceous sediments that form the foundation for the dike embankment would be expected to have a lower shear wave velocity; therefore, the expected horizontal ground acceleration at the dike, derived from a site response analysis, would be higher than the indicated map value.

According to MACTEC's 2010 draft 5-year inspection report, "The seismicity of the site was thoroughly investigated in connection with the licensing of the 1970 nuclear unit. The conclusions of these studies indicated that the amplitude of ground motion at the site from credible design earthquakes would not cause damage to any reasonably well built structure…Active faults are unknown in the area.

The seismic design criteria adopted for Unit 2, the nuclear installation, are as follows:

> Design Earthquake - Maximum horizontal ground acceleration of 0.1 g with a vertical component of 2/3 of 0.1 g.
>
> Hypothetical Earthquake - Maximum horizontal ground acceleration of 0.2 g with a vertical component of 2/3 of 0.2 g."

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Structural stability documentation for the ash pond dike is adequate.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

The structural stability of the dam appears to be satisfactory based on the following:

- Documented slope stability analyses showing satisfactory factors of safety under both credible static long term and earthquake (pseudo-static) loading conditions.
- Liquefaction potential does not appear to be a concern due to the firm, compact nature of the foundation and embankment soils.
- No indications of scarps, sloughs, major depressions or bulging anywhere along the slopes of the dike.
- No indications of boils, sinks, or uncontrolled seepage along the outside slope or toe of the dike.
- No major depressions and no significant vertical or horizontal alignment variations in the crest of the dike.

The outlet structure appeared to be in generally sound and stable condition with no evidence of significant deterioration of the limited visible parts of the structure that could be seen at the riser and at the outfall. It would be prudent to include periodic interior inspection of the outlet structure with a "borehole" video camera as part of PEC's inspection program for the ash pond dike (see Subsection 9.3.1). Bank erosion observed at the outfall does not appear to currently threaten undermining of the end of the outfall pipe. However, the bank should be protected to prevent further erosion that could eventually undermine the end of the outfall pipe.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

As described in Section 2.2, the ash pond receives sluiced ash from the bottom ash handling system. The pond previously also received sluiced ash from the fly ash handling system. When the fly ash was disposed in the ash pond, it was pneumatically conveyed from each hopper with a hydroveyer exhauster where the fly ash and air mix with water at the inlet section of the hydroveyer exhauster. The mix of air, fly ash, and water was then discharged to an air separator tank, where the air was discharged to the atmosphere, and the ash/water slurry flowed by gravity to a common header, where the ash/water slurry was pumped with a jet pump to the ash pond.

The finger dike at the ash pond separates the pond into a north portion and a south portion. The ash slurry is discharged into the north portion, which is nearly filled with ash. The flow pattern is around the west end of the finger dike to the north portion, where the overflow riser of the outlet structure is located on the upstream side of the main dike near the juncture of the finger dike with the main dike. This pattern of circulation is promoted by maintaining drainage ditches in the ash surface. According to MACTEC's draft 2010 5-year inspection report, there has been no flow into the riser since it was raised for the last dike raise in 2002.

Only a very small amount of water is impounded in the ash pond, primarily in the north portion against the north end of the dike. In the essentially filled-to-capacity south portion of the ash pond a sprinkler system has been installed and operated as needed to control dust from the exposed ash surface.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

There is no written maintenance plan. Maintenance of the impounding embankment and outlet works of the ash pond, and essential operating equipment, such as the piping (ash sluice lines), pumps, and other equipment (e.g., sprinkler system) is performed, as needed, based on routine inspections by plant personnel. Such maintenance includes erosion repairs, filling animal holes, and repairing the dust-control sprinkler system. Rim ditches inside the ash pond are periodically excavated to maintain free-flow. Vegetation on the embankment slopes is generally mowed quarterly.

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, operating procedures at the ash pond appear to be adequate.

8.3.2 Adequacy of Maintenance

Overall, maintenance of the impounding embankment and outlet works of the ash pond appears to be adequate. No major maintenance issues were noted from review of dike inspection reports. Based on field observations, some minor maintenance of eroded areas on the lower part of the outside slope of the dike is needed.

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Progress Energy laboratory personnel inspect the ash pond dike twice a month in accordance with procedures in a written inspection plan, included for reference as Doc 06 in Appendix A. These semi-monthly inspections are documented on a checklist form; the results of inspections conducted through 2010 into January 2011 are included for reference as Doc 07 in Appendix A.

In addition, inspections are performed annually and every 5 years by third party contractors (outside consultants) as required by Progress Energy's *Non-Hydroelectric Dam and Dike Inspection Program Manual*, included as Doc 07 in Appendix A. These inspections are documented in written reports prepared by the outside consultants. The 5-year inspections and reports are more exhaustive. The 2009 annual inspection report and the 2010 5-year inspection report (draft) prepared by MACTEC are included for reference as Doc 08 and Doc 03, respectively, in Appendix A. (These inspections and reports cover the ash pond dike along with the main dam that impounds the cooling lake, Lake Robinson.)

Miscellaneous Inspections – Progress Energy chemistry laboratory personnel make general observations of the ash pond dike during weekly visits to inspect the ash discharge pipe.

9.2 INSTRUMENTATION MONITORING

Dam performance monitoring instrumentation includes 6 piezometers in place in the crest, outside slope, and outside toe area below the dike; there also is one water quality monitoring well located in the outside toe area of the dike. Groundwater levels are measured semiannually. The groundwater elevations for the period of record from July 1996 to January 2009 are tabulated on an exhibit in Doc 09 in Appendix A; an accompanying plan in Doc 09 shows the locations the instruments. The piezometers in the dike were always dry when observed; those in the outside toe area had groundwater well below the ground surface (more than 10 feet).

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Progress Energy's inspection program for the ash pond dike is adequate overall. No major safety issues were noted in any of the inspection reports or check forms. As previously noted, during the site visit it was observed that there was some flow from the ash discharge pipe, even though there was no flow into the riser inlet in the ash pond. Since storm water lines are buried along the outside toe of the dike tie-in to the ash pond drain pipe, it is possible that the source of water is residual storm water flow or groundwater infiltration along one of the storm drains. However, MACTEC's 2010 draft 5-year inspection report noted the same condition, even though there had been no rain in the past 7 days, and as noted in the previous subsection, the groundwater in the toe area is well below the ground surface, suggesting that at least local groundwater infiltration may not be the source. The MACTEC report recommended that "further checks of the pipe be made to confirm the source is not from leakage around the ash pond drain pipe." Therefore, based on the above and the fact that previous repairs were made to stop small leaks in the riser, specific attention should be paid to the ash pond outlet in the inspection program by performing interior inspections with a "borehole" video camera at a suitable frequency that should be established after performing the first inspection and reviewing the results. If the interior is found to be clear and free of sediment with no evidence of infiltration or other issues, and if flow from the ash pond into the outlet is very infrequent, the interior inspections might be established at a low frequency but not less frequent than once every 10 years.

9.3.2 Adequacy of Instrumentation Monitoring Program

The instrumentation monitoring program, which includes bi-annual measurement of groundwater levels in piezometers installed in the ash pond dike and outside toe area, is adequate. No problem or suspect condition, such as excessive settlement, major seepage, shear failure, or displacement was observed in the field that might be reason for installation of additional or different instrumentation. In the absence of stability problems or major seepage issues, there is no need for additional performance monitoring instrumentation at this time.

DRAFT

Exhibit 01: Typical Cross-Section of Dike (before 2002 dike raise).

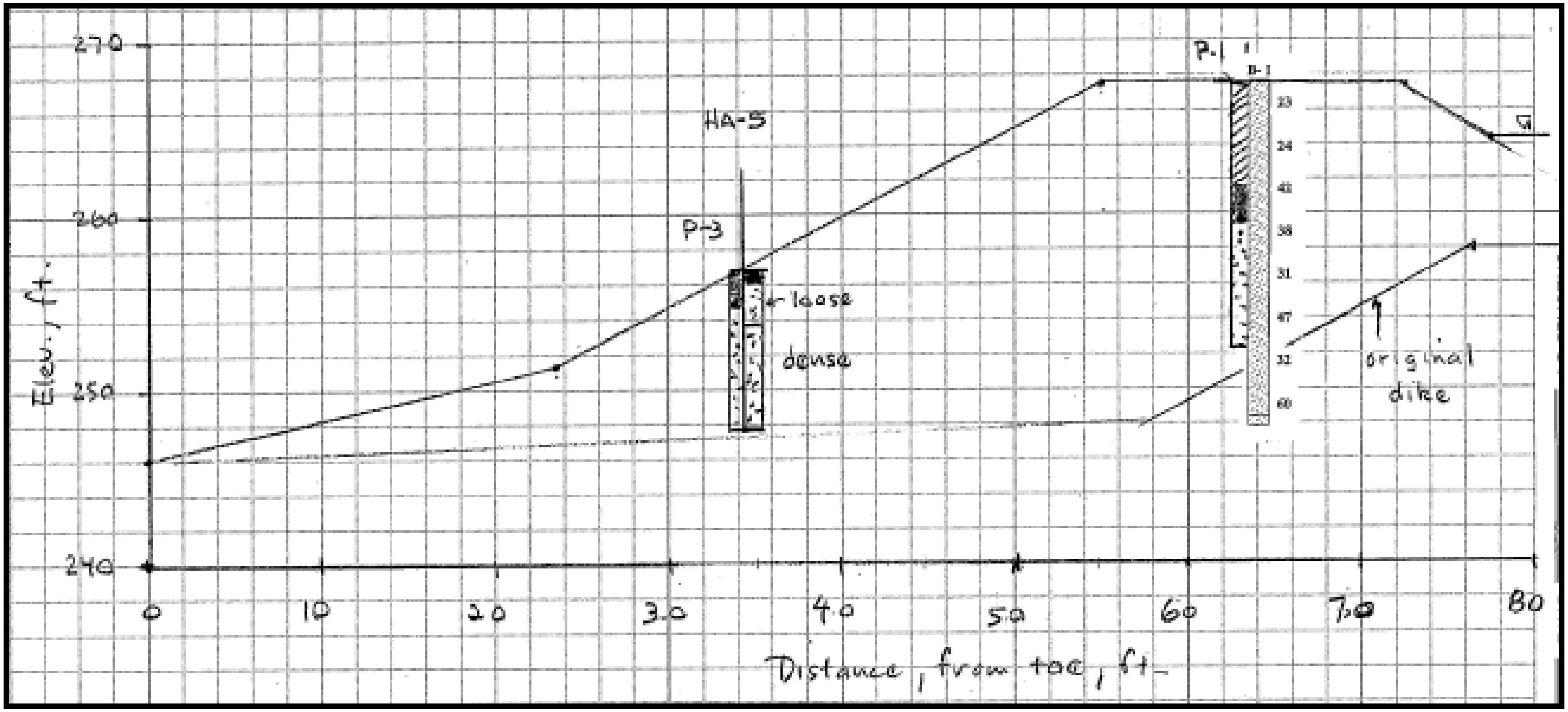


Image from Law Engineering Design Report – Modifications to Ash Pond Dam, Doc 05 Appendix A.

DRAFT

Exhibit 02: Outlet Structure (before 2002 dike raise).

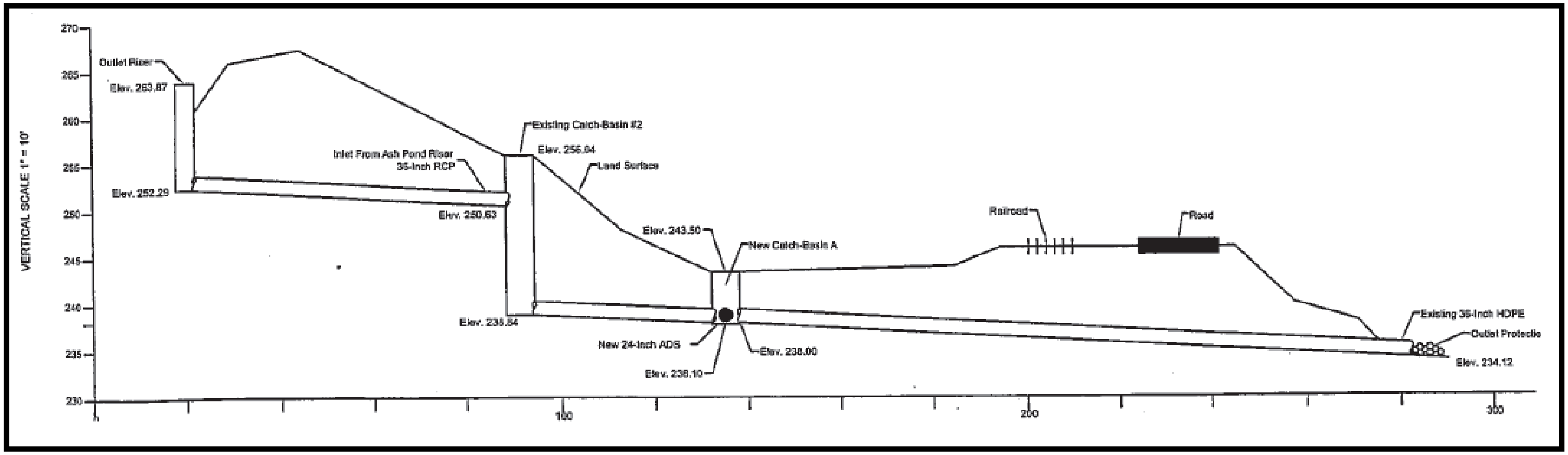


Image from MACTEC 2010 5-Year Inspection Report (Draft), Doc 03 Appendix A.

Appendix A

Reference Documents

Appendix A

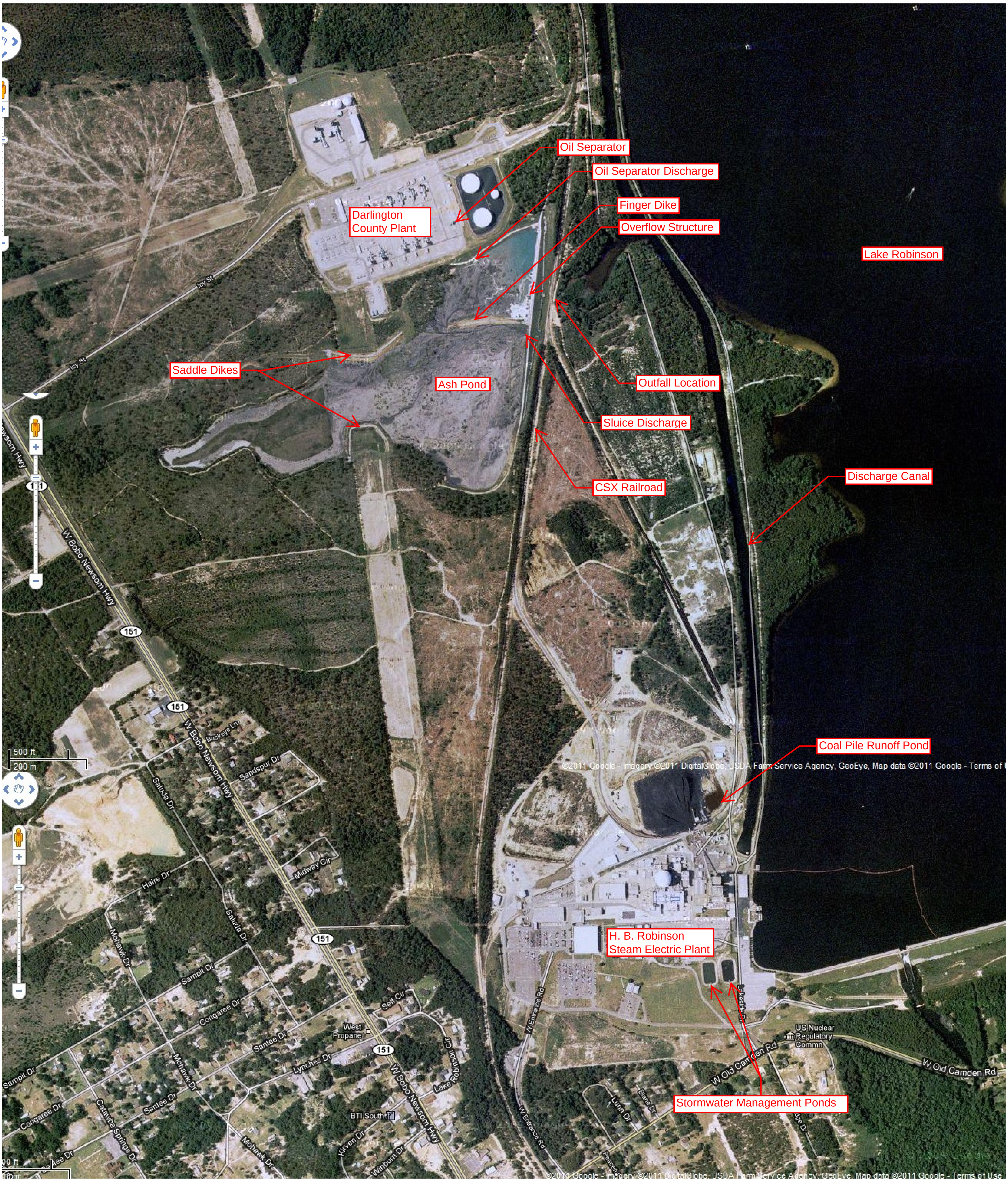
Doc 01: H. B. Robinson Vicinity Map

H.B. Robinson Power Station Vicinity Map

Appendix A

Doc 02: Ash Pond Aerial Map

Ash Pond Aerial Map



Appendix A

Doc 03: MACTEC 2010 5-Year Inspection Report

FIVE-YEAR INDEPENDENT CONSULTANT INSPECTION

COOLING LAKE DAM AND ASH POND DIKES

H. B. ROBINSON STEAM ELECTRIC PLANT

HARTSVILLE, DARLINGTON COUNTY, SOUTH CAROLINA

Prepared For:

PROGRESS ENERGY CAROLINAS
RALEIGH, NORTH CAROLINA

Prepared By:

MACTEC ENGINEERING AND CONSULTING. INC.
RALEIGH, NORTH CAROLINA

December 22, 2010

MACTEC PROJECT NO. 6468-10-0025(02)

PROGRESS ENERGY CAROLINAS

H.B. ROB1NSON STEAM ELECTRIC PLANT

COOLING LAKE DAM AND ASH POND DIKE

HARTSVILLE, SOUTH CAROLINA

MACTEC PROJECT NO. 6468-10-0025(02)

FIVE-YEAR INDEPENDENT CONSULTANT INSPECTION

December 22, 2010

BY MACTEC ENGINEERING AND CONSULTING

RALEIGH, NORTH CAROLINA

REPORT PREPARED BY

J. Allan Tice, P.E.
Senior Principal Engineer
Registered, South Carolina 5512

TABLE OF CONTENTS

PAGE

1.0 SUMMARY

1.1 General

As part of its on-going dam safety program, Progress Energy Carolinas (Progress Energy) conducts independent dam safety inspections at its fossil plants on five year intervals. This report presents findings of the 2010 independent consultant dam safety inspection of Progress Energy's H.B. Robinson Steam Electric Plant cooling lake dam and ash pond dike.

The purpose of this dam safety inspection and report is to identify, within the limitations of visual field inspection and office review of available data, records and operating history, any actual or potential deficiencies, whether in the condition of the project works, the quality and adequacy of project maintenance, surveillance, or in the methods of operation, that might endanger public safety. The objective is to recommend immediate action for public protection where necessary, further studies and analyses where required, and acceptance of the present condition of the dam if the engineering data and inspections so justify.

This inspection was performed in general accordance with the recommended guidelines for a Phase I dam safety inspection published by the U.S. Army Corps of Engineers [1]*. The H.B. Robinson Steam Electric Plant facilities include a cooling lake dam and spillway, ash pond dike and cooling water discharge canal. The cooling lake is also a source of emergency cooling water for the adjacent H. B. Robinson Nuclear Plant. However, the cooling water discharge canal, which is physically separated from the cooling lake, is designed to provide sufficient water for emergency shutdown. Thus, the cooling lake is not a Class I structure, and the inspection did not assess the dam's condition in the context of a nuclear-safety related structure.

Previous independent consultant inspections have been conducted by William Wells in 1980[2], Charles T. Main Inc. in 1985 [3] and LAW Engineering (now known as MACTEC Engineering and Consulting (MACTEC)) in l990 [4], 1995[5], 2000[6], and 2005[7]. In addition, MACTEC has performed limited inspections annually since 2003.

---

* Numbers refer to references listed in Section 5

1.2 Conclusions

Based on the information collected during the field inspection and office review, the following conclusions are warranted.

<u>1.2.1 Cooling Lake Dam/Cooling Water Discharge Canal</u>

1. The H.B. Robinson Cooling Lake Dam is adequately designed and adequately constructed. It is in good condition with no visible dips, sags, slumps, sinks or other evidence of distress. The upstream rip rap is sound, and the downstream grass cover is well established. Maintenance of the dam by plant personnel is excellent, and the dam is routinely inspected by plant personnel.

2. The cooling lake spillway is adequately designed and constructed. The spillway can pass the entire flow of the PMF event when the tainter gates are fully opened. This approach does not rely on the available storage between the normal pool elevation and the dam crest. However, under the operating license for the Robinson nuclear plant, the maximum lake level allowed is elevation 222 feet. The storage volume between the normal pool elevation and the maximum allowed lake elevation is equivalent to approximately 1.5 hours of inflow at the peak design storm rate into the lake.

3. The current operating procedure for the spillway gates is satisfactory with respect to dam safety.

4. Gaps/offsets of up to 2 inches, suggesting movement, were observed at the downstream spillway retaining walls which support the embankment during MACTEC's first inspection of the dam in 1990. No significant change in the openings has been reported in subsequent inspections or was observed during the current inspection. The observed movements are common for cantilever retaining walls of these heights. Monitoring of the movements with crack gages has been discontinued due to minimal movements recorded over several years.

5. In general, the condition of the spillway concrete is adequate. An area of cracked concrete under two of the spillway bridge beam seats noted in previous inspections was repaired in 2004.

6. The spillway Tainter gates are in fair condition but need some repairs as documented by Progress Energy's 2007/2008 inspections. Progress Energy has made plans to perform the repairs in 2011 for Tainter Gate B (West Tainter Gate) and in 2012 for Tainter Gate A (East Tainter Gate).

7. Rip rap on the upstream slope is in good condition. Local spots where slight subsidence or crest edge depressions occur are routinely filled by plant personnel. No local depressions were observed during the current inspection.

8. The area along the downstream toe of the dam is being maintained clear of brush and trees. Minor ground cover vegetative growth is present in the rip rap east of the spillway.

9. The cooling water discharge canal dikes, natural and man-made side slopes and the exit weir structure are in generally good condition. Local slides in cut slopes on the west side of the canal do not pose a significant concern for loss of capacity. Clearing of a short section of the slopes was done in 2009 as part of a firing range project. Cleared areas have minimal vegetation.

10. Visual inspections currently being performed by plant personnel on a bi-monthly frequency provide an adequate method of assessing the general condition of the cooling lake dam.

<u>1.2.2 Ash Pond Dike</u>

I. The ash pond dikes have a good grass cover on the exterior slope and there is no sign of significant dips, sags, slumps, sinks or other visual evidence of distress.

2. Sedimented ash only is present against the dike in the southern section of the ash pond area. Some water is currently impounded against the northern portion of the ash pond dike, although no water is present around the outlet riser.

3. The ash pond vertical riser spillway which serves as the discharge structure was originally designed for a storm with an expected frequency of once every ten years and a 70 acre drainage basin. The 2002 dike raise re-evaluated the hydrology and provided for adequate storage and discharge combined to handle a 50-year, 24-hour storm of 7.5 inches of rain with the normal pool at elevation 269.5 feet.

4. The discharge pipe for the ash pond vertical riser is in good condition, but it receives no flow from the ash pond due to the water level in the pond being below the top of the riser pipe.

5. Storm water surface drainage was re-routed as part of the 2002 dike raise such that some storm water now enters the ash pond discharge pipe. The ground at the outlet end of the discharge pipe has experienced some erosion, possibly related to the storm water flows.

6. Visual inspections are currently being performed by plant personnel bi-monthly in accordance with Progress Energy procedures. Progress Energy lab personnel also have a weekly opportunity to observe the dike during ash discharge pipe inspections.

8. Monitoring of piezometers installed in the ash pond dike (done semi-annually) has not recorded presence of water due to the lack of significant depth of impounded water against the dike.

1.3 Recommendations

1.3.1 Cooling Lake Dam/Cooling Water Discharge Canal

1. Control/removal of vegetation in the rip-rap along the toe drain and on the crest and slopes of the dam should continue.

2. Areas of slight depressions in the slope adjacent to the west spillway training wall that have previously been filled with gravel should be visually monitored by plant personnel to see if further depressions occur.

3. The outlet of the artesian flow relief drain should be cleaned of the iron-cemented material accumulating in the pipe at least every other year.

4. Spillway gates are lifted approximately one inch monthly using both the electric drive and propane system in accordance with plant procedures. Maintenance of the system should be performed at any time the electric drive or propane system fail to adequately lift the gates.

5. Progress Energy should complete the Tainter gate repairs as planned in 2011 and 2012.

6. The gaps/offsets between the spillway retaining walls and the downstream spillway training walls should be visually checked by plant personnel at least quarterly to see that no changes are occurring. Apparent changes should be reported, and reactivation or re-installation of the crack monitors and readings should be done.

7. The cleared slope areas of the discharge canal adjacent to the firing range should be vegetated with ground cover to reduce potential erosion.

8. The area surrounding the yard inlet that is producing sediment flow through the pipe culvert near the firing range should be stabilized to minimize further sedimentation of the discharge canal.

<u>1.3.2 Ash Pond Dike</u>

1. The bi-monthly annual inspection frequency should be increased to monthly if water levels in the north pond area continue to rise and remain against the dike. These inspections should look for any cracks, slumps or new seepage. Any unusual findings

should be reported immediately to a designated engineer for evaluation.

2. The semi-annual frequency of reading the piezometers in the dike should continue. If water is detected and the pond water levels are rising, the reading frequency should be increased to monthly, and Progress Energy engineers should be furnished the readings for review.

3. The junction of the north dike exterior slope and the rip rap toe drain should be checked for presence of local erosion loss of ground into the rip rap during the regular inspections. Local depressions should be filled with gravel. Similarly, the interior edge of the north dike crest should be observed for local loss of ground into the interior slope rip rap and local depressions filled with gravel if found.

4. Spraying to control minor vegetation growth in the rip rap on the interior slope of the north dike is recommended.

5. The storm drainage pipe along the toe of the north dike should be checked using video methods to see if water is infiltrating into the pipe joints. Similarly, a video camera should be used to check the pipes leading from the catch basin at the toe of the slope over the discharge pipe back toward the ash pond vertical riser to see if there are leaks.

6. The erosion at the outlet end of the pond discharge pipe should be monitored for change in area of impact. If the erosion is expanding, filling the area with rip rap on top of geotextile should be considered.

7. The existing erosion ditches along the toe of the north dike and the drainage ditch parallel to the toe of the south dike should be checked during the regular inspections for signs of increased activity. Placement of additional rock check dams may be necessary if erosion is increasing.

8. The rock filter berm around the drop inlet where the storm water runoff enters the discharge pipe should be cleaned as needed to remove accumulated dead vegetation and

mulch to allow water to flow through into the drop inlet.

2.0 PROJECT INFORMATION

Information in this section is summarized from prior inspection reports by William L. Wells[2], Charles T. Main, Inc.[3] and LAW Engineering, Inc.[4]. Due to the format adopted for this report, only summary historical information about design and construction is provided. The referenced reports contain more detailed information.

2.1 Location

The H.B. Robinson Steam Electric Plant is located at 34° - 24' north latitude and 80° - 9' west longitude on Black Creek in Darlington County, South Carolina, adjacent to State Highways 1623 and 131, about five miles northwest of Hartsville, South Carolina (Exhibit No. 1). The plant is owned and operated by Progress Energy. A fossil fuel unit (Unit 1) and a nuclear unit (Unit 2) are both present on the site.

2.2 General Description

2.2.1 Cooling Lake Dam

The cooling lake dam was completed in 1959. The dam is an earthfill structure about 4,000 feet long with a maximum structural height of about 55 feet. A concrete overflow spillway with two Tainter gates is provided about 400 feet west of the old stream bed of Black Creek. The lake impounded by the dam is about 7.3 miles long in the north-south direction and has an average width of about 2,500 feet. At the normal water surface elevation of 220 feet msl, the surface area of the lake is 2,242 acres.

2.2.2 Ash Pond Dike

Approximately one mile northwest of the plant, there is an ash pond dike approximately 1,800 feet long with a maximum structural height of approximately 31 feet. A drop inlet/vertical riser structure is provided as a spillway for the ash pond. As modified in 1982, the pond had a surface area of 55 acres at crest level and a storage capacity of approximately 410 acre feet of ash. In

1992, ash was removed from the eastern end of the pond and stacked in the western end, reducing the active portion of the ash pond to approximately 35 acres. In 2002, the dike for the pond was raised to increase the storage area at maximum pond level to about 55 acres.

2.2.3 Cooling Water Discharge Canal

A cooling water discharge canal conveys condenser cooling water from both units to a point approximately 4.2 miles up the lake where the water is returned to the lake for cooling. The canal is separated from the cooling lake by a combination of natural ground and low height earth dikes. At the confluence with the cooling lake, a concrete weir structure retains a minimum water level in the canal to provide emergency cooling water for the nuclear power plant (Unit No. 2).

2.3 Size Classification

The size classification is determined by the height of the dam or the maximum storage capacity, whichever gives the larger size category. The cooling lake dam is 55 feet high and has a maximum storage potential of 55,500 acre-feet at the crest of the dam. A large size dam is greater than 100 feet in height or has more than 50,000 acre-feet of maximum storage capacity in accordance with the USACOE guidelines'. The H.B. Robinson Dam is therefore classified as a large size based on maximum storage capacity.

The ash pond dike is 31 feet high and presently has a maximum storage potential estimated as 630 acre-feet at the crest of the dam. A small size dam is less than 40 feet in height or less than 1,000 acre-feet in maximum storage capacity in accordance with the USACOE guidelines[1]. The ash pond dike is therefore classified as small size based on both height and maximum storage capacity.

2.4 Hazard Potential Classification

The cooling lake dam is classified as a "High Hazard Potential Dam" in accordance with the system adopted by the USACOE guidelines. High Hazard Potential refers to the potential for major property damage or loss of life in the event of a dam failure for any reason and does not infer that the dam is unsafe. The H.B. Robinson downstream channel is a meandering, heavily forested natural channel. There are numerous occupied houses adjacent to the channel including two less than 1,000 feet downstream of the dam which could be damaged by failure of the dam with resultant risk of loss of life. State Highway 1623 would likely be closed suddenly. Sudden failure of the H.B. Robinson Dam could result in cascade failure of the Prestwood Lake Dam five miles downstream at Hartsville, South Carolina.

The ash pond dike is classified as a "Low Hazard Potential" dam in accordance with the USACOE guidelines. There are no inhabited or uninhabited dwellings downstream from the dam. The discharge from the ash pond spillway crosses under a rail spur used to deliver coal for Unit No. 1 and then enters a cove which is part of the plant cooling water canal. Failure of the ash pond dike could temporarily close the rail spur and ash released from the pond could partially block the cooling water canal. Blocking the cooling water canal could lead to backwater flooding along the canal but would not restrict the intake of cooling water from the lake.

2.5 Historical Summary

The cooling lake dam was designed by, and constructed under the supervision of, Ebasco Services, Incorporated of New York. Construction extended from May 1958 to June 1959. The only maintenance of the dam proper required in the past has been filling of rain washes in the downstream slope which occurred prior to the development of a grass protective growth. Maintenance of the spillway structure has been confined to painting the steel parts. Repairs, as necessary, have been made from time to time to the gate hoisting equipment, machinery, and control system. The Tainter gate seals were repaired in 1980. In 1963, the area downstream of the dam extending east of Black Creek for a distance of about 1,500 feet was reshaped for erosion control and to allow adequate drainage of runoff from the area.

Since the 2005 inspection, Progress Energy has conducted a full structural inspection of the Tainter gates and conducted some structural repairs deemed critically necessary. Further repair work is scheduled to occur in 2011 and 2012. Section 4.5.2 discusses this inspection activity.

Fly ash from Unit No. 1 is pumped through a pipeline to the ash pond. In June-December 1982, the original ash pond dike was raised 7 feet to provide 10 years additional storage of ash. The raising of the dam was designed and constructed by CP&L (now known as Progress Energy). In 1992, sedimented ash was excavated from the pond and stacked in the western portion of the ash pond. The discharge pipe from the drop inlet structure was refurbished and the outlet reworked to provide an unobstructed discharge.

In February, 2002, Progress Energy personnel noticed two depressions and surface voids in the area below the toe of the north dike. Examination and inspection by MACTEC and Progress Energy personnel found evidence that a separated joint in the stormwater pipe was the cause of the depressions. A small leak in the vertical riser in the ash pond was also found. Progress Energy contracted to have the area around the ash outlet pipe grouted as a preventive measure, sealed the leak in the riser, and included rerouting of the stormwater line in the dike raise work that was done later in 2002.

In order to increase pond storage capacity, MACTEC designed a 6-foot vertical raise of the pond dikes in 2002 and included rerouting of the stormwater line as mentioned above. The design of the raise is discussed further in section 3.3.3.

2.6 Geology and Seismicity

2.6.1 Geology

The site lies in the coastal plain of South Carolina, approximately 15 miles southeast of the Fall Zone. In the general vicinity of the site, surficial deposits S to 30 feet thick, consisting of sand and clay, overlie Upper Cretaceous sediments of the Middendorf Formation. The Upper Cretaceous sediments are approximately 460 feet thick and rest unconfornnably upon the crystalline basement of Pre-Cambrian and Paleozoic Age.

The surficial materials at the site are sands and clays derived from the Middendorf It is difficult in most parts of the area to distinguish the surficial material from the weathered Middendorf. The Middendorf consists of light colored feldspathic and slightly micaceous quartz sand and red, purple, gray, and brown silty sand and clay. Some layers have been cemented into semi-consolidated sandstone. The sand and clay beds are lenticular and grade laterally into one another and pinch out within comparatively short distances.

The Middendorf is a permeable formation and, in several areas of the Coastal Plain, yields up to 2,000 gpm from individual wells. Ground water occurs under both water table and artesian conditions.

From a geological standpoint, the Middendorf is considered to be an unconsolidated sediment. However, from an engineering point of view, the materials are firm and compact, ranging in texture from a hard, compact soil to a soft rock.

2.6.2 Seismicity

The seismicity of the site was thoroughly investigated in connection with the licensing of the 1970 nuclear unit. The conclusions of these studies indicated that the amplitude of ground motion at the site from credible design earthquakes would not cause damage to any reasonably well built structure. In addition, the site is located in Zone 2 according to Corps of Engineers[8]. Zone 2 is characterized as a zone of light earthquake activity which would result in only minor damage. The suggested maximum horizontal acceleration for an earthquake in Zone 2 is 0. 10 g. Active faults are unknown in the area.

The seismic design criteria adopted for Unit 2, the nuclear installation, are as follows:

> Design Earthquake - Maximum horizontal ground acceleration of 0.1 g with a vertical component of 2/3 of 0.1 g.
>
> Hypothetical Earthquake - Maximum horizontal ground acceleration of 0.2 g with a vertical component of 2/3 of 0.2 g.

A review of the potential for liquefaction at the Robinson Nuclear Plant, including the cooling lake dam, was conducted by CP&L in 1995-96 in response to the Nuclear Regulatory Commissions' Seismic IPEEE program. CP&L's review concluded that liquefaction was not of concern for the dam, and the NRC concurred in the assessment.

3.0 DESIGN AND CONSTRUCTION

Design and construction information are summarized briefly in this section. More details can be obtained from the 1980 inspection report by Mr. William L. Wells[2] and from the 1990 inspection report prepared by Law Engineering, Inc[4].

3.1 Cooling Lake Dam

3. 1 .1 Specific Site Conditions

A site exploration by Eustis Engineering Company of New Orleans found interlayered lenticular and erratic layers of sand and clay. A relatively thick and extensive layer of clay was found near elevation 175. The spillway structure is founded on this layer and the dam is tied to this layer for underseepage control. A stratum of very stiff to hard silty or sandy clay found in the plant area between approximately elevations 170 and 150 feet, hereinafter called the lower clay stratum, was also found in the dam area overlain by silty clay and loose fine to coarse sand. Borings that penetrated the lower clay stratum encountered large artesian flows with the piezometric head rising to elevation 213.

3. 1 .2 Design Provisions

A longitudinal profile along the axis of the cooling lake dam and cross sections are contained on Exhibit No. 2 (Ebasco Drawing No. G-158002). Section AA-AA is a typical section of the dam taken in the central portion of the valley.

The crest elevation is 230 feet, and the crest width is 15 feet. The design normal water elevation is 220 feet. Side slopes are 3 (horizontal) to 1 (vertical) upstream and 2.5:1 on the downstream side. A 15-foot wide berm was added to the downstream face where the ground surface was at or below elevation 200 feet.

The downstream face of the berm is protected against wave wash during flood periods and against backwater currents by rip-rap underlain by a crushed stone filter layer placed below elevation 195 feet. A crushed stone toe drain was provided at the toe of the berm.

The upstream slope face of the dam is covered with rip rap between the crest and elevation 205 feet. From elevation 205 feet down the slope to natural ground, a 2-inch sand-asphalt blanket was placed for wave wash protection during reservoir filling.

The dam is constructed of sandy soils with a central vertical core of compacted impervious material (clay) that extends from elevation 225 feet to the base of the dam where it connects with a cutoff trench which, in the western portion of the dam, extended to the lower clay stratum at elevation 170 feet. A blanket of clean sand 10 feet thick was placed at the base of the dam downstream of the vertical clay core.

The eastern part of the dam, east of about Station 29, was of similar construction, except that the cutoff trench was not carried to the lower clay stratum at elevation 170 feet but was excavated to the surface of an upper irregular silty clay stratum found in this area. In order to reduce the quantity of underseepage which might pass through the sand strata found between the two clay strata, a zone of impervious material was created to tie the two clay strata together. This was accomplished by means of a trench and clay backfill which extended upstream for a distance of about 700 feet.

As mentioned previously, the west abutment of the dam consists of sandy soils overlying the lower clay stratum. The abutment was blanketed with a 5-foot thickness of clay between the end of the dam and the plant intake structure, a distance of about 600 feet. Details are shown on Sections EA-EA, DA-DA, and FA-FA of Exhibit No. 2.

<u>3.1.3 Stability Analysis</u>

A stability analysis of the cooling lake dam was performed by Charles T. Main in 1985[3] using a circular arc and the method of slices. The indicated factors of safety were found to be 2.10 for the upstream slope and 1.75 for the downstream slope, under normal conditions. The earth dam was analyzed using the circular arc method of slices and a pseudo-static analysis under the assumed hypothetical earthquake (maximum horizontal ground acceleration of 0.2g), with two-thirds of the horizontal acceleration in the vertical direction. The ratio of the sum of all the resisting forces divided by the sum of all the forces tending to cause displacement was 1.08. The dam was also analyzed by the Newmark method. This indicated that no appreciable displacement or yielding of the embankment would be expected when it is subjected to the hypothetical earthquake.

3.1.4 Construction

Construction of the dam was started in May, 1958, and it was completed June 22, 1959. Water impoundment was started in March, 1959, and the lake reached elevation 220 feet in February, 1960. Clayey soil for construction of the compacted clay core was obtained from a ridge about 2,500 feet east of the east end of the dam.

Much difficulty was experienced during construction of the cutoff wall to the underlying clay strata at several points. In many areas, large flows of water were encountered and the side slopes of the excavation were not stable. The core trench excavation between Stations 13+00 and 14+00, near the west abutment, contained a mixture of sand, clay, and water with a consistency of a slurry. Gravel was placed in this slurry, then compacted until point-to-point contact existed.

Sheet piling was then driven through this backfill a minimum of 1-1/2 feet into the lower clay stratum and extended 3 feet above the gravel backfill. Clay was then placed and hand tamped around the 3-foot extension. A tee pile was driven at Station 13+30 to be the start of the west abutment cutoff wall, Sheet piling was used for this wall in lieu of the clay cutoff zone shown on the drawings.

At the east cutoff wall, the northern 360 linear feet of the cutoff wall was constructed as designed; however, because of water problems and caving trench walls, the next 320 feet were constructed using sheet piling. The last 195 feet were constructed as designed. This tied into the core of the dam at Station 29+30.

The quality of the earthwork was controlled by Ebasco through field inspections and tests by soils technicians. Testing consisted principally of gradation, in-place density, compaction, and permeability. The average degree of compaction obtained on all fills was greater than that required by the specifications, and any areas which did not meet the specification were rerolled and retested.

3.2 Cooling Lake Spillway

3.2.1 Description

The spillway is located about 400 feet west of the former Black Creek channel. A discharge canal leading back eastward to the creek channel was provided downstream of the stilling basin. The spillway consists of an approach channel, an overflow section with two tainter gates, a sluice controlled by two 36-inch Howell-Bunger valves (which are installed at the downstream end of the center pier), and a stilling basin. A ten-foot wide two-span bridge constructed of steel girders with a concrete deck crosses the overflow structure. A general plan, and sections of the spillway structure are contained on Exhibit No. 3 (Ebasco Drawing No. G-158005). The structure is founded upon and is keyed into the lower stiff to hard clay stratum at elevation 163 feet. The outside faces of the two end piers were constructed on a vertical batter of 1:10. A cutoff wall, 2 feet thick, extending 6 feet into the clay core of the dam was provided on the outside face of each end pier.

The clay core was thickened to include the cutoff walls for a distance of 20 feet on each side of the spillway.

In connection with the preparation of the FSAR for the nuclear unit, the spillway was analyzed by conventional methods, under hypothetical earthquake conditions, and a ratio of resisting forces to displacement forces of 1.38 was obtained.

The spillway is provided with two Tainter gates, each of which is 25 feet wide and 35 feet high. The Tainter gates are operated by electric hoists with a standby propane motor. Provision is made on the hoists of both gates for connection of the propane motor drive so that they may be operated if a power failure occurs. Gate No. 1 (also referred to as Gate B or the west gate) can be operated from the plant control room, but only up to an opening of four feet. To open the gate to a greater height or to operate Gate No. 2 (also referred to as Gate A or the east gate), the operator must go to the spillway bridge.

Spillway rating curves are shown on Exhibit 3. The cooling lake spillway is capable of passing 40,000 cfs with the lake at elevation 221.67. This spillway capacity is based on both tainter gates being raised 30 feet above the ogee crest. Raising the gates and allowing this magnitude of release would likely flood the residences immediately downstream.

The operating license for the nuclear Unit 2 specifies a maximum lake level for the Cooling Lake of elevation 222.0 feet in order to maintain circulation in the cooling water canal. This requirement affects the flood storage capacity of the dam. The storage available between the normal pool elevation 220 feet and the regulatory maximum elevation of 222 feet is sufficient to store 1.5 hours of the design storm peak flow.

<u>3.2.2 Design Flood</u>

In October, 1959, a gauging station was established on Black Creek by the USGS at a point near McBee. Examination of the records from the gauging station yielded several well-defined flood hydrographs which were considered suitable for determination of a unit hydrograph. These hydrographs were used to calculate a peak flow which would result from the Probable Maximum Precipitation (PMP) for the area taken from charts prepared by the Hydrometeorological Section of the Weather Bureau. This calculation yielded a peak discharge into the lake of 39,000 cfs,

<u>3.2.3 Spillway Area Drainage</u>

In 1961, a point source of water was noted about 100 feet west of the west spillway wall and 20 feet south of the toe of the dam. A water sample was taken and analyzed for comparison with the lake water. It was concluded that the flow was not lake water but was from the artesian layer in the foundation, posing no threat to the dam. In September 1961, a pit 4 feet deep was dug at the seep location and partially filled with crushed stone and rip-rap. A cap of sand-clay was provided.

A 105-foot long drain tile was laid from the pit to the bank of Black Creek at the spillway stilling basin training wall to allow for relief of the artesian condition.

3.3 Ash Pond Dike

3.3.1 Design Provisions

The original ash pond dike was raised seven feet in 1982 using designs prepared by CP&L. In 2002, the dike was raised another 6 feet to a crest elevation of 272 feet. Exhibits 8 through 11 show plans, sections and details of the 2002 design. The present ash pond dike has a crest width of 15 feet, an upstream slope of 2(H):1(V) and a downstream slope of 2(H): 1(V). The raise was accomplished by adding compacted fill to the crest and downstream side of the existing structure. The separator dike was also raised. The separator dike is intended to lengthen the retention time by substantially increasing the distance from the ash pipe outfall to the skimmer/drop inlet spillway structure. The hydrology was updated to include stormwater contributions from the Darlington Plant. A 50-year, 24-hour storm was used with 7.5 inches of rainfall. To maintain at least 1 foot of freeboard at the peak inflow during the design storm, a distance of 2.5 feet was required between the crest of the dike and the top of the riser.

3.3.2 Stability Analysis

Stability analyses were conducted as part of the design for the 2002 dike raise. The results indicated a downstream slope factor of safety of 1.59 for normal conditions. The free draining nature of the sandy fill material and foundation as well as a toe drain enhance the stability. Upstream slope stability is not considered critical since the pond is generally dry and filled with fly ash next to the dike.

3.3.3 Construction

The 2002 dike raise used fill materials from a borrow area located on the south edge of the pond. The soils were sandy and were compacted in lifts to a specified 95 percent of the standard Proctor maximum dry density (ASTM D 698) or greater. The construction was monitored by representatives of MACTEC.

As part of the 2002 work, storm water collection facilities were improved, new piping placed where damaged pipes were found in February, 2002, and the storm piping was connected to the ash pond discharge pipe. Exhibits 8 and 10 show the plan and details.

3.4 Cooling Water Discharge Canal

Condenser discharge water from both Unit No. I and Unit No. 2, is discharged into a cooling water discharge canal which extends along the west reservoir shore to a point some 4.2 miles upstream where the water is returned to tile lake. A sheetpile and concrete weir maintains the water level in the canal at a minimum elevation of 208.5. However, the normal water level is elevation 220.0. The canal is generally an excavated section and is contained by a combination of natural ground and low height dike between the canal and the main reservoir. The canal has a bottom width of 20 feet, side slopes of 3(H): 1(V) and an average depth of flow of about 13 feet. Side slopes to the reservoir side vary from 3(H): 1(V) to 6(H): 1(V). The original canal ended at a sluice structure approximately 1 .2 miles upstream of the plant and served only Unit No. 1. In 1970, the canal was extended to its current 4.2 miles length to serve both Unit Nos. 1 and 2. Water velocity in the canal is a maximum 1 .75 fps.

In 2009, portions of the discharge canal side slopes were cleared of their vegetation as part of improvements to a firing range located on the west side of the canal.

4.0 FIELD INSPECTION OBSERVATIONS

4.1 Method of Inspection

The field inspection was conducted April 13-14, 2010 by Al Tice of MACTEC accompanied by Mr. Wellie Gilbert, the Plant Environmental Coordinator. Mr. David Guinn accompanied us during portions of the inspection. Mr. John Gainey, Chemistry Technician, assisted in discussing plant records and the maintenance schedule.

The cooling lake dam, spillway, toe area, and ash pond dike were inspected on foot. The slopes along the cooling water discharge canal were observed from a slowly moving vehicle with areas of interest inspected on foot. At the time of the inspection, the cooling lake was at elevation 220.83 feet. The following subsections present the findings and observations made during the inspection.

Photographs were taken of existing conditions. Appendix A contains photograph locations maps. Appendix B contains the photographs.

4.2 Cooling Lake Dam

The cooling lake dam crest, upstream slope and downstream slope are in good condition with no visible dips, sags, slumps, sinks or other evidence of distress (Photographs 1 through 5). The upstream slope above water level is covered with rip rap to within about 3 feet of the crest, The soil portion of the upstream slope and the downstream slope have a well established grass cover. A crushed stone gravel surface covers the crest and provides the erosion protection for the crest. Previous inspections have seen a few instances where it appeared the riprap on the upstream crest had subsided slightly near the crest or crept down slope. The current inspection did not see crest edge depressions, indicating the previous depressions were routinely filled by the maintenance personnel. Any marked increase in the occurrence or the size of the depressions should be brought to the attention of Progress Energy engineers.

The downstream slope has had minor areas of sparse vegetation in the past located west of the spillway on the upper third of the slope. Very few sparse grass areas were observed; the downstream slope is well vegetated on both east and west sides of the spillway (Photographs 4 and 5).

The lower portion of the downstream slope, on which the rip rap flood protection layer is present, is in good condition. The rip rap west of the spillway has negligible vegetation growth (Photograph 6). The area below the dam has been cleared of trees for security purposes. From near the spillway west for about 300 feet, the natural ground is slightly depressed relative to the adjacent natural ground. Wet conditions due to the poor surface drainage have been observed during some inspection visits. The area was generally dry at the time of the present inspection. The sporadic wet conditions are not interpreted as seepage and appear to present no dam safety concerns.

East of the spillway, the rip rap on the lower part of the dam is in good condition with some minor vegetation (Photograph 7). Progress Energy continues to cut and spray the vegetation in the rip rap to control growth. Some standing water was noted in the natural ground just beyond the toe of the dam in an area of low topography and ruts from mowing equipment (Photograph 8). The area is evident by color change in vegetation (Photograph 9). A walk along the toe of the dam did not find water emerging from the riprap. These areas have been observed during past inspections.

A soil berm is in place perpendicular to the dam at the downstream toe about 500 feet west of the east end of the dam as a traffic barrier. The ground adjacent to the toe of the dam has had some standing water in the past; no standing water was present at the time of the current inspection. The past standing water appeared to be caused by back-up from natural drainages in the wooded area south of the dam. There does not appear to be a natural grading approach that would redirect the water. The standing water is not a significant concern for dam safety.

The spillway structure for the dam is in good condition (Photograph 10). The concrete entry walls do not show cracking (Photographs 11 and 12). Two areas of concrete scaling first noted in 1990 on the eastern bridge beam seats of the west spillway bridge were repaired in 2003 in general accordance with plans prepared by Progress Energy and shown in Exhibit 12. Photograph 13 shows the typical repair.

The spillway training/retaining walls are in good visual condition (Photographs 14, 15 and 16). The offsets in the spillway side retaining walls noted in previous inspections appeared to show no change. A crack movement gauge (now broken) was placed on the west wall offset in 1996 (Photograph 17). A similar monitor was placed on the east wall at the request of the State of South Carolina Department of Health and Environmental Control after their routine inspection conducted in 1999. Movements monitored since 1996 (west wall) and since 2000 (east wall) were erratic, but less than 1 millimeter in any direction. There are no signs of wall distress and the movements seen are not unusual for walls of their design and height. After review of the monitoring records in 2004 by MACTEC, a recommendation was made to discontinue monitoring based on the lack of change. The South Carolina Department of Health and Environmental Control agreed with the recommendation.

Along the junction of the west spillway wall and the downstream slope, the slight depressions noted in 2005 have been filled and show no indications of additional settlement (Photograph 18). Some loss of ground was noted around the post of the chain link security fence on the east side of the spillway adjacent to the retaining wall (Photograph 19). No indications of settlement adjacent to the retaining wall were seen (Photograph 20).

Lake water flows over the top of the closed Tainter gates during normal operations. The Howell-Bunger valves are used to control minor lake level changes and to provide low flow release. The water exits the spillway along a concrete lined channel. During the inspection, plant personnel were performing regular monthly operational checks[8] . The electric motor on the west gate was found to not operate; the backup propane-operated motor was used. Plant personnel reported the inoperative motor on their report. Both gates were operated by plant personnel, and normal water flow was observed. Photographs 21 through 28 show the conditions of the above-water portions of the Tainter gate arms and hoist chains.

No indications of unusual water circulation patterns suggestive of erosion at the end of the spillway channel were seen. An underwater inspection of the submerged portions of the spillway and around the ends of the training walls was conducted October 4, 2005 by Eason Diving. No formal report was prepared; however, Progress Energy personnel were present during the inspection and the divers reported to them that no adverse conditions or discrepancies from the original design were seen.

Water discharged from the spillway flows into a downstream channel lined with rip rap (Photograph 14). The banks of the channel appear stable and adequately maintained. The artesian water flow encountered during construction in 1961 was piped through the 6-inch diameter drain line at the spillway channel (Photograph 29). The drain line is flowing at a rate approximately the same as observed in previous inspections. Iron sediment deposits accumulate inside the pipe (Photograph 30). It appeared these deposits had been partly cleared since the last site visit in 2009. We recommend the pipe be cleaned of accumulated deposits when they block approximately 50% of the pipe opening.

4.3 Cooling Lake Discharge Canal

The circulating water withdrawn from the Cooling Lake exits through a concrete structure (Unit 1) and an underwater pipe (Unit 2) into a canal that directs the water back to the Cooling Lake. No active discharge from either unit was occurring at the time of our inspection. The Unit 1 concrete discharge structure did not show indications of distress (Photograph 31). An underwater inspection of the discharge structure was made in 1996 with no problems reported.

A slow drive with stops at points of interest was made along the combined natural ground/fill area separating the cooling water return canal from the lake. Because Unit 2 was offline, the water level in the canal was lower than had been seen during past inspections, allowing closer examination of portions of the slopes normally below water. Local undercutting of the slopes just below the normal water line was seen in many areas (Photographs 32 and 33). The undercutting appeared to extend about 12 inches into the slope. At one location, it appeared there was an animal burrow below the normal water line as well (Photograph 34).

The undercutting is not unusual. There is a general growth of small bushes and trees on the cut slopes; the root structures of the vegetation helps provide stability against slumping. No slumping related to undercutting has been seen during previous inspections. If dike slumping does begin to occur, placement of riprap against the underwater sections of the canal slopes could become necessary. Animal burrows could cause local loss of ground, but would not be likely to create a slope failure of significant extent. Unlike a dam, no water is retained by the dike slopes outside of the canal side. No actions are recommended related to the animal burrows.

As part of a recent construction for the security firing range, vegetation was cut off the canal slopes. The cutting left the slope relatively bare and unprotected against erosion (Photograph 35). There is a low-height soil berm at the edge of the top of the east slope of the canal that aids in reducing water from the road washing directly down the slope; however, we recommend the exposed soils be protected with a grass cover. Near the northern end of the clearing for the firing range, there is a concrete culvert for yard drainage to enter the discharge canal. A moderate amount of sediment is in the canal (Photograph 36). We recommend the yard drain entry be provided with a sediment filtering measure to reduce inflow of sediment into the canal.

Local slides previously seen on the natural ground cut slopes on the west side of the canal appeared little changed from the 2005 and earlier observations. These slides appear to be occurring along clay lenses in the sandy soil. They are relatively minor and present minimal concerns of canal blockage or loss of cooling volume capacity. Photographs 37 and 38 show typical conditions observed.

A natural creek enters the discharge canal from the west about 2 miles from the canal start. Sediment has accumulated at the junction of the creek and the canal forming a small island (Photograph 39). The island does not appear to create a flow blockage because of the width of the canal at this point.

The discharge canal has a strip of natural ground between the lake and the canal. The lake side slope has riprap and natural vegetation (Photograph 40) that is in satisfactory condition.

The weir at the end of the cooling water return canal was submerged, but no surface indications of distress were seen, and the weir end structures were in apparently good condition (Photograph 41).

4.4 Ash Pond Dike

The ash pond is divided by a separator dike into southern and northern sections. The southern section has mostly been filled with sedimented ash that has a firm, dry surface capable of supporting foot traffic and light truck traffic. In the northern section, sedimented ash is present around the riser structure with impounded water present in the north end of the pond. Since the 2005 5-year inspection, Progress Energy has installed a sprinkler system across the sedimented ash for dust control. The present ash discharge is at the south side of the separator dike. Discharged ash is directed alongside the separator dike to the west in a canal excavated in the ash. At the end of the separator dike, the ash slurry spreads out into the northern section.

The crests of the northern and southern ash pond dike sections and the separator dike are in good visual condition with no significant visible dips or other evidence of distress (Photographs 42 through 45). A gravel road is present in the center of the dikes with sparse grass growth in the gravel and moderate grass growth where there is no gravel.

Because of the sedimented ash, the interior slope of the south section has no impounded water against it. The slope is has been cleared of small trees and briers; a grass cover remains and is in good condition (Photograph 44). The vegetation is effective for controlling erosion from surface runoff. Progress Energy cuts small trees if they begin to appear. Evidence of active animal burrows has been reported on the interior slope of the south dike in some previous inspection reports. No burrows were seen during the present inspection. Progress Energy fills in animal burrows when they are observed.

The sedimented ash has reduced the available freeboard for the south dike in an area near the ash discharge line (Photograph 46). In this area, the freeboard appears to be as little as 12 inches below the top of the dike. From the hydrologic studies made during the design of the dike raise in 2002, this is the minimum freeboard needed under the design storm (50-year, 24-hour). Further ash accumulation in this area appears unlikely because the ash discharge and flow direction is away from the area.

The interior slope of the north section is in good condition (Photographs 42 and 47). There is minor vegetative growth in the slope rip rap. Spraying is recommended to keep the vegetation under control. Sedimented ash has accumulated in the pond; the ash level is approximately 38 inches below the top of the riser pipe, or approximately elevation 266.3 feet. Some water is ponded in the north end of the pond and is against the dike. Progress Energy reported that the water level in the pond had risen to within about six to eight inches of the top of the riser during some extended rain events, but had not overtopped the riser.

The dike raise in 2002 created a low height dike on the north end of the pond that continues west from the main dike. The crest, interior and exterior slopes of this dike are in good condition (Photograph 48). There has been a continuing minor erosion condition where a drain pipe from the Darlington oil-water separator penetrates the dike to discharge into the ash pond. The erosion has been stabilized reasonably well with rip rap (Photograph 49). The outflow from the Darlington pipe discharge has created an erosion channel in the ash adjacent to the dike that can be seen in photograph 48, but it does not pose a safety risk for the dike. At the intersection of the west extension with the north dike, the riprap placed in 2005 is in reasonably good condition (Photograph 50). Similar erosion at the intersection of the north dike and the separator dike that was also repaired with rip rap is in good condition.

The exterior slope of the south dike is in good visual condition with a good grass cover (Photograph 51). No trees were noted. No indications of seepage, slumps or significant surface erosion were seen. A surface drainage ditch was constructed roughly parallel to the toe of the south dike and about 25 to 50 feet away. There has been erosion in the ditch resulting in deepening. Rock check dams were constructed in 2003. These are generally retarding the erosion and grass has taken root in the ditch and adjacent areas (Photograph 51). Some erosion is still present near the lower end of the ditch (Photograph 52). The ditch erosion is not impacting dam safety. If further erosion deepening or bypassing of rock check dams occurs, additional rock placement may be necessary.

The exterior slope of the north dike is in good visual condition with a good grass cover (Photographs 53 and 54). Small spots where soil above the toe rip rap had eroded into the rip rap have been noted during some past site visits. These are routinely filled with gravel by Progress Energy. A few similar spots were noted in the area north of the catch basin (Photograph 55) and will be filled. A storm drain culvert passes under the north end of the north dike and outlets onto a rip rap apron. The apron was in good condition; grass has grown up in the rip rap, but the grass does not affect its function (Photograph 54). There was some ditching erosion adjacent to the downstream toe prior to a good vegetative cover being established. This ditching now has vegetation, and some rock check dams have been constructed (Photograph 56). The erosion appears inactive.

Surface water drains into a drop inlet located above the stormwater and pond discharge piping. A rock filter berm surrounds the inlet. Vegetation tends to accumulate around the filter berm, although it was generally clear at the time of the inspection (Photograph 57). Accumulated vegetation and mulch should be removed as needed so the filter berm allows water access to the inlet.

Standing water was observed in a low area adjacent to the rail line, approximately 100 feet from the toe of the dike (Photograph 58). This area collects rainfall runoff from the drainage ditch beside the rail line, and the presence of the standing water is not considered related to seepage from the ash pond.

The ash pond discharge line is supported on a timber trestle and appears in good condition (Photograph 59). The discharge structure for the pond is in the north section and consists of a vertical riser connected to a culvert under the dike and the adjacent railroad embankment. The riser has not had water pass through it yet. The vertical riser is in good condition (Photograph 60).

The outlet pipe appears to be in good condition at the exit point (Photograph 61). A slight flow was emerging from the pipe even though there had been no rain the past seven days. From looking in the drain inlets along the north dike toe, it appeared the flow was possibly from infiltration of groundwater into the stormwater drainage portion of the pipe that is parallel to the dike toe. We recommend that further checks of the pipe be made to confirm the source is not from leakage around the ash pond drain pipe. At the outlet end of the pipe, there has been erosion below the outlet creating near-vertical slopes and slight undermining of the concrete placed some time ago as an energy dissipation pad. The erosion is caused by stormwater flows that share the outlet pipe. Continued erosion has a risk of causing slope retrogression and undermining of the pipe outlet end. While the area has changed little since the 2005 inspection, we recommend that rip rap and goetextile be placed in the eroded area.

Protective dikes were built around transmission towers on the north and south sides of the pond when the dikes were raised to keep pond water from impacting the tower legs. These dikes are in good condition.

4.5 Maintenance/Inspection Activities

4.5.1 Cooling Lake

Progress Energy personnel conduct bi-monthly visual inspections of the Cooling Lake dam. Review of these reports did not indicate safety concerns. Monthly, the Howell-Bunger values are opened fully and the Tainter gates are raised approximately one inch in accordance with Progress Energy Operating Procedure OPS-RFPC-00014[9]. As noted earlier, one of the regular inspections was being conducted at the time of our site visit.

Routine maintenance of the dam consists of mowing grass and repairing local depressions in the rip rap if seen. Vegetation in the rip rap areas is regularly sprayed. The condition of the dam reflects good maintenance.

The State of South Carolina typically conducts annual or biennial inspections; copies of field visit reports were found in the plant files. The last visit by the State of South Carolina was on December 15, 2008. The inspection report (Exhibit 13) noted no deficiencies and that the gates were tested under normal and emergency power.

4.5.2 Spillway Gate Inspection

In late 2007 and early 2008, Progress Energy conducted a visual inspection and functional testing of the Tainter gates. Stop logs were placed in the slots designed for that purpose to allow the inspection to be performed in the dry. The inspection was performed by Winston Stewart of Progress Energy assisted by Tommy Bragwell and Jimmy Dale Smith, TVA Quality Control Inspectors. The inspection reports were supplied to MACTEC subsequent to our field visit for review. Some structural conditions requiring immediate repairs were identified; those repairs were conducted during the inspection. Other conditions were noted as needing future repairs. Exhibit 14 is a copy of the report summary sheets. Progress Energy has scheduled work on these items for 2011 (Gate 2) and 2012 (Gate 1).

The functional testing experienced some difficulties with limit switches on electric motors and sticking due to dry seals. The gates were able to be opened to their full travel and closed. Other than those equipment issues, no abnormal noise or movements attributable to the trunnion pins or side rollers were reported.

4.5.3 Ash Pond Dike

In 2009, Progress Energy issued a new procedure for conducting the dam inspections (EVC-RFPC-00027 [10]). A copy of the procedure is included as Exhibit 15. The procedure calls for the Robinson Fossil Plant laboratory staff to conduct visual inspections of both dams on a bi-monthly basis. Piezometer readings at the ash pond dam are to be taken semi-annually. In addition to the annual inspections, Progress Energy chemistry lab personnel also perform weekly inspections of the ash discharge pipe. During these inspections, the dike is generally observed. The weekly discharge pipe inspections provide an opportunity to observe significant changes in dike condition that can be further checked if needed. Review of the inspection records in plant files did not indicate any safety concerns. The inspection frequency is appropriate for the present conditions; however, if water impoundment against the north dike shows a continuing increase, the inspection frequency should be changed to monthly for the first year of impoundment.

Four water-level monitoring casings were installed in the dike (two on the south dike and two on the north dike) as part of the 2002 dike raise (see Exhibit 10). Semi-annual water level readings made since 2006 have never found water present.

5.0 REFERENCES

1. "Recommended Guidelines for Safety Inspection of Dams", Department of Army, Office of the Chief of Engineers, Washington, D.C., 1976.

2. William H. Wells, "Safety Inspection of Cooling Lake Dam and Appurtenant Structures, H.B. Robinson Steam Electric Plant', report to CP&L, November, 1980.

3. Charles T. Main, Inc., "Safety Inspection of H.B. Robinson Steam Electric Plant, Cooling Pond Dam and Ash Pond Dam", report to CP&L, September, 1985.

4. LAW Engineering, "Safety Inspection of Cooling Pond and Ash Pond Dike", report to CP&L, December, 1990.

5. LAW Engineering, "Safety Inspection of Cooling Lake Dam and Ash Pond Dike, report to CP&L, December, 1995.

6. LAW Engineering, "Independent Consultant Inspection Cooling Lake Dam and Ash Pond Dike, report to CP&L, November, 2000.

7. MACTEC Engineering and Consulting, Inc., "Five-Year Independent Consultant Inspection", report to Progress Energy Carolinas, December, 20, 2005.

8. "Engineering and Design: Earthquake Design & Analysis for Corps of Engineers Projects." U.S. Army Corps of Engineers Regulation ER 1110-2-1806, May 16, 1983.

9. Progress Energy, "Robinson Fossil Plant Impoundment Operation, Operating Procedure OPS-RFPC-00014, Revision 3," September, 2004.

10. Progress Energy, "Robinson Fossil Power Plant Dam and Dike Inspection", EVC-RFPC-00027, Rev. 0, September 2009.

EXHIBITS

LIST OF EXHIBITS

1. Site Location Map
2. Ebasco Drawing G-158002, Earth Dam & Spillway, Profile & Sections, July 16, 1959.
3. Ebasco Drawing G-158005, Spillway General Plan & Sections, July, 1959.
4. Progress Energy Operating Procedure OPS-RFPC-00014 – Robinson Fossil Plant Impoundment Operation, Rev. 3, September, 2004.
5. CP&L Drawing D-1776, H. B. Robinson SEP – Ash Pond Expansion Site Plan, As Built, April 21, 1982.
6. CP&L Drawing D-1777, H. B. Robinson SEP – Ash Pond Expansion Dike Sections and Details, As Built, April 21, 1982.
7. CP&L Drawing D-7471, H. B. Robinson Unit No. 1 SEP – Ash Pond Restacking Plan and Sections, June 5, 1992.
8. LAW Drawing No. 2, Overall Topographic Map, Modifications to Ash Pond Dam, As Built, December, 2002.
9. LAW Drawing No. 3, Dike Cross Section Details, Modifications to Ash Pond Dam, As Built, December, 2002.
10. LAW Drawing No. 4, Stormwater Drainage Improvements, Modifications to Ash Pond Dam, As Built, December, 2002.
11. LAW Drawing No. 5, Weir Drainage and Riser Details, Modifications to Ash Pond Dam, As Built, December, 2002.
12. Progress Energy Drawing SK-ROB-U1-CL-001, H. B. Robinson Cooling Lake Spillway Center Pier Concrete Repairs, September, 3, 2003.
13. South Carolina Department of Health and Environmental Control, Letter dated January 14, 2009 from Gary L. Stowe, District Engineer, subject "Reinspection of Dam D-0010, Lake Robinson Dam, Darlington County".
14. Lake Robinson Spillway Tainter Gate Inspection, Excerpts from Attachment A.
15. Robinson Fossil Power Plant Dam and Dike Inspection, EVC-RFPC-00027, Rev. 0, September, 2009.

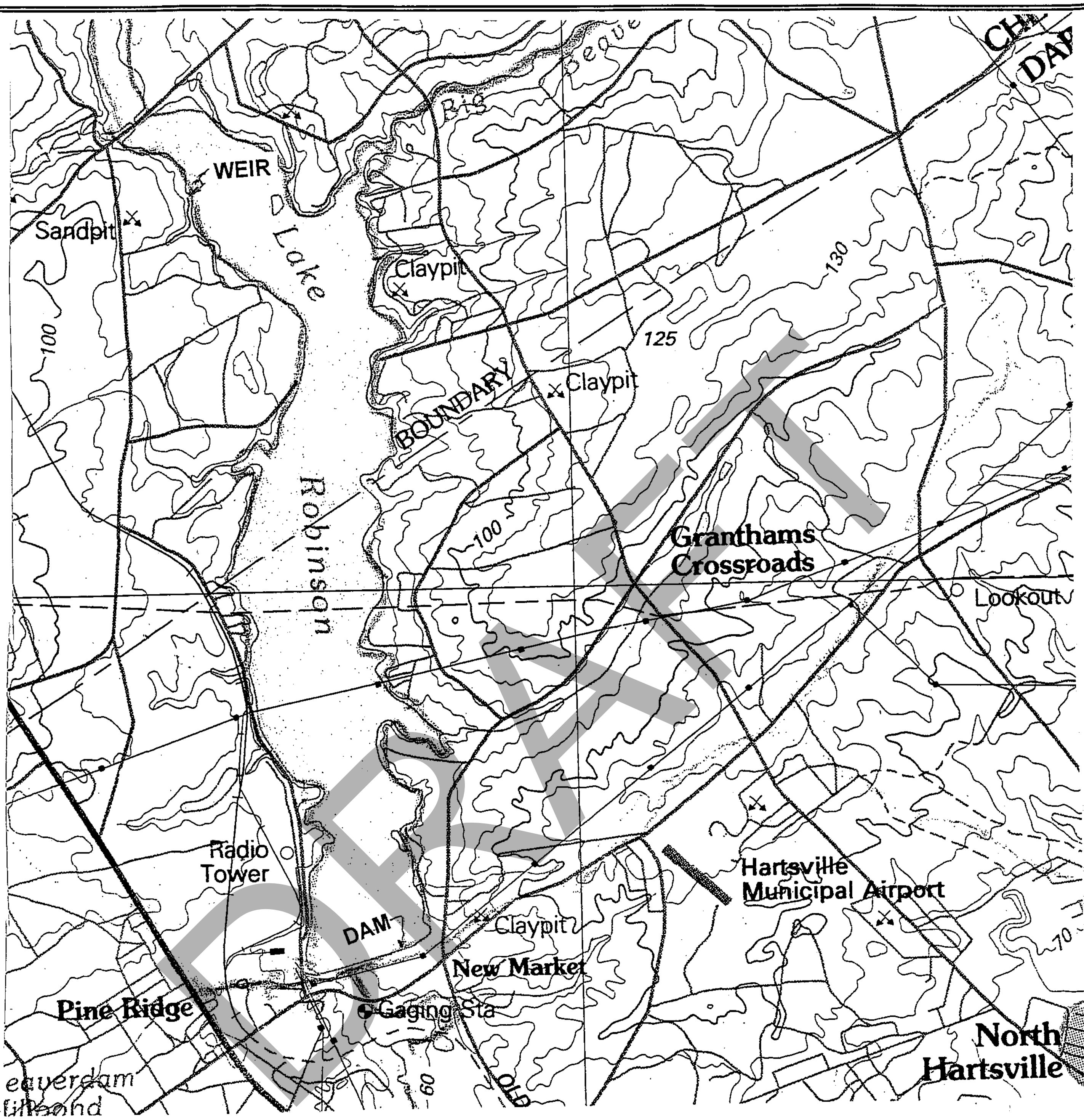
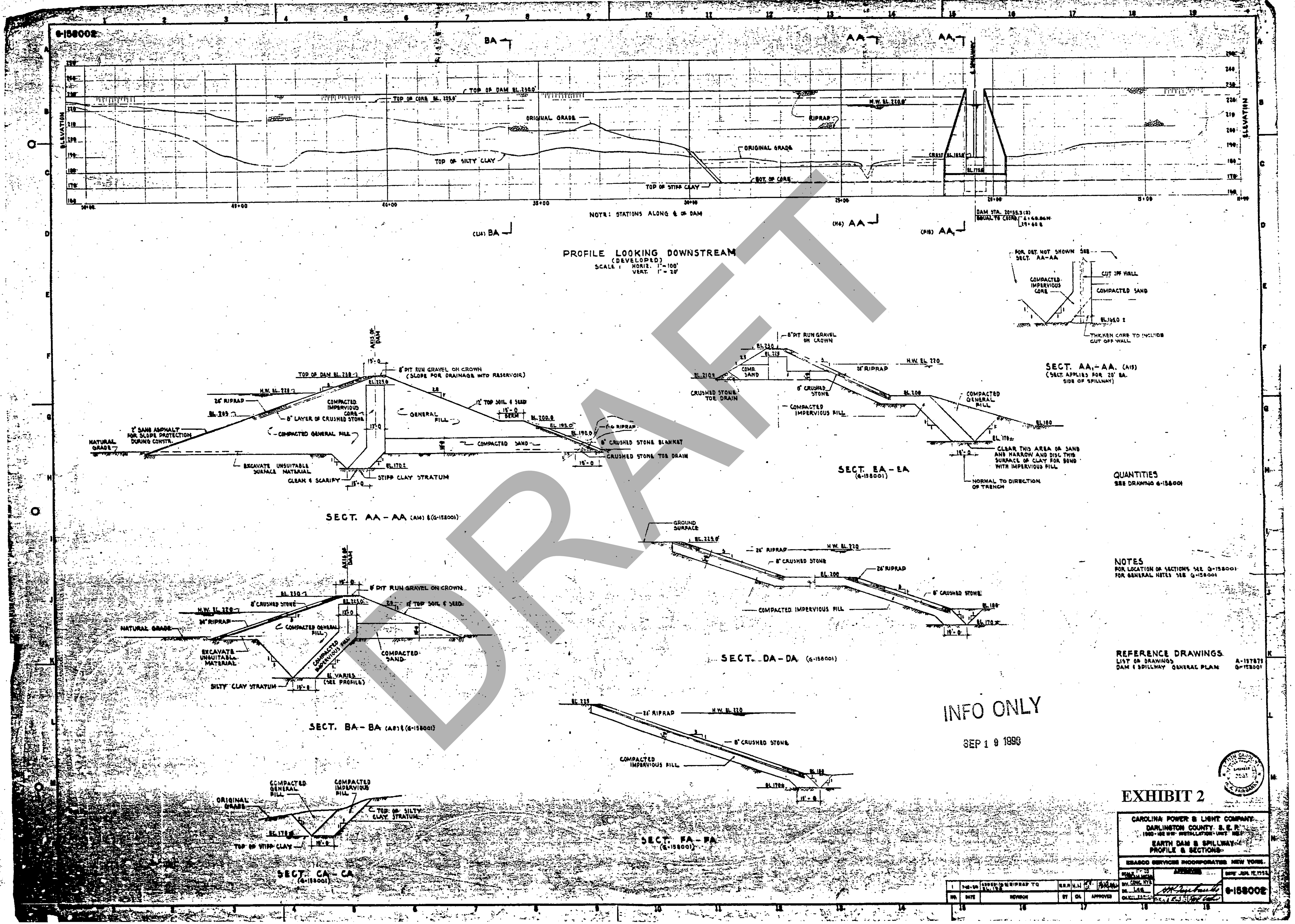


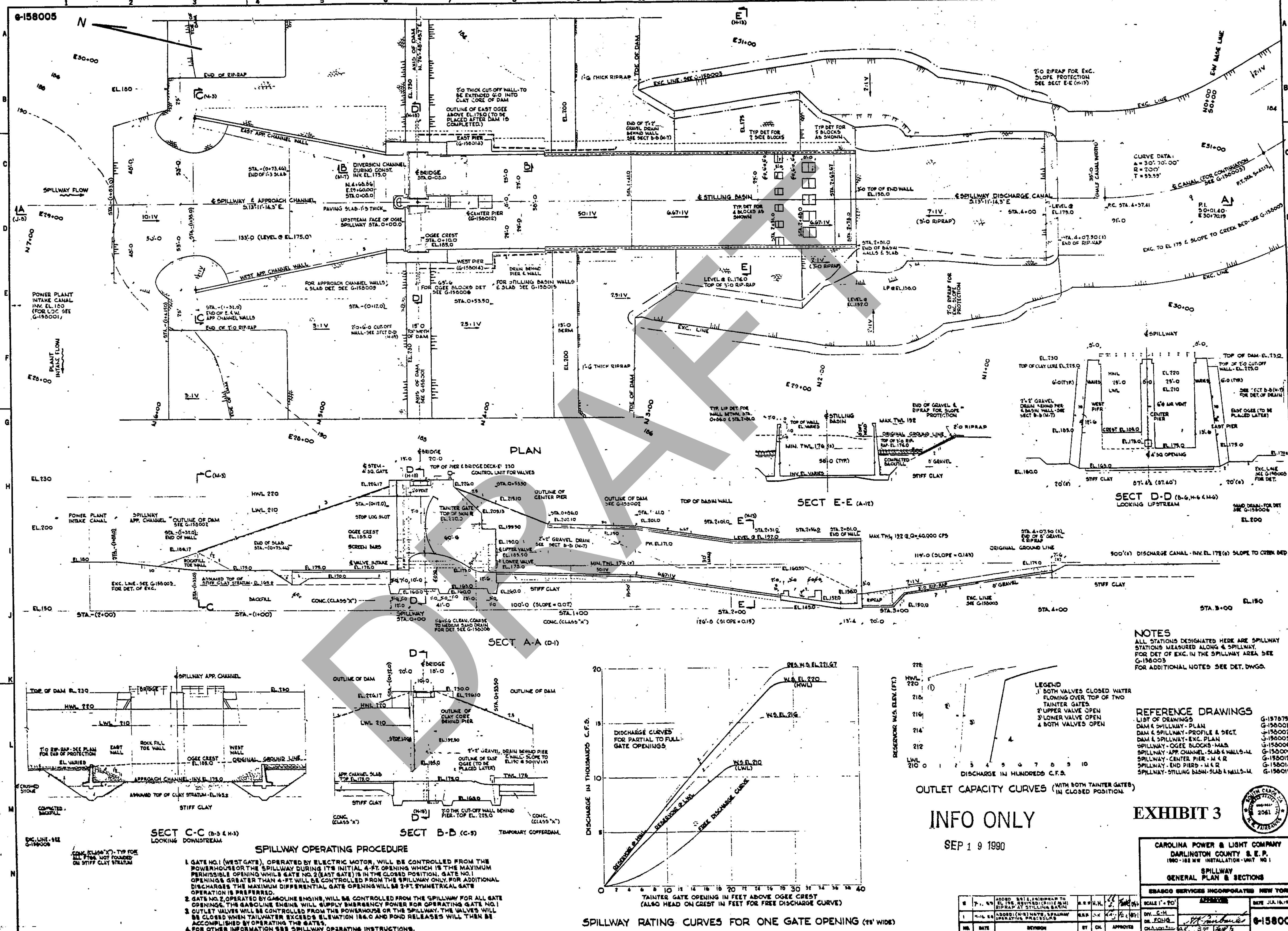
EXHIBIT 1

MACTEC
RALEIGH, NORTH CAROLINA

SITE LOCATION MAP H. B. ROBINSON STEAM ELECTRIC PLANT DAMS HARTSVILLE, SOUTH CAROLINA	**DRAWN:**	**DATE:**	Oct., 2010
	DFT CHECK:	**SCALE:**	NONE
	ENG CHECK:	**JOB:**	6468-10-0025
	APPROVAL:	**EXHIBIT**	1

REFERENCE: USGS Camden 1:100,000 Quadrangle Map


G-158002
PROFILE LOOKING DOWNSTREAM
(DEVELOPED)
SCALE: HORIZ. 1"=100' VERT. 1"=20'
NOTE: STATIONS ALONG ℄ OF DAM
TOP OF DAM EL. 230.0'
TOP OF CORE EL. 225.0'
ORIGINAL GRADE
TOP OF SILTY CLAY
TOP OF STIFF CLAY
BOT. OF CORE
RIPRAP
H.W. EL. 220.0'
ELEVATION
SECT. AA - AA (A14) & (G-158001)
SECT. BA - BA (A8) & (G-158001)
SECT. CA - CA (G-158001)
SECT. DA - DA (G-158001)
SECT. EA - EA (G-158001)
SECT. FA - FA (G-158001)
SECT. AA1 - AA (A15)
(SECT. APPLIES FOR 20' EA. SIDE OF SPILLWAY)
8" PIT RUN GRAVEL ON CROWN
24" RIPRAP
8" CRUSHED STONE
COMPACTED IMPERVIOUS CORE
COMPACTED GENERAL FILL
COMPACTED SAND
COMPACTED IMPERVIOUS FILL
CRUSHED STONE TOE DRAIN
STIFF CLAY STRATUM
SILTY CLAY STRATUM
NATURAL GRADE
EXCAVATE UNSUITABLE MATERIAL
QUANTITIES
SEE DRAWING G-158001
NOTES
FOR LOCATION OF SECTIONS SEE G-158001
FOR GENERAL NOTES SEE G-158001
REFERENCE DRAWINGS
LIST OF DRAWINGS
DAM & SPILLWAY GENERAL PLAN
CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S.E.P.
EARTH DAM & SPILLWAY
PROFILE & SECTIONS
EBASCO SERVICES INCORPORATED NEW YORK
G-158002
INFO ONLY
SEP 1 9 1990
EXHIBIT 2


G-158005
PLAN
SECT A-A (D-1)
SECT E-E (A-12)
SECT D-D (B-6, H-6 & H-6)
LOOKING UPSTREAM
SECT C-C (B-3 & H-3)
LOOKING DOWNSTREAM
SECT B-B (C-5)
SPILLWAY OPERATING PROCEDURE
1. GATE NO. 1 (WEST GATE), OPERATED BY ELECTRIC MOTOR, WILL BE CONTROLLED FROM THE POWERHOUSE OR THE SPILLWAY DURING ITS INITIAL 4-FT. OPENING WHICH IS THE MAXIMUM PERMISSIBLE OPENING WHILE GATE NO. 2 (EAST GATE) IS IN THE CLOSED POSITION. GATE NO. 1 OPENINGS GREATER THAN 4-FT. WILL BE CONTROLLED FROM THE SPILLWAY ONLY. FOR ADDITIONAL DISCHARGES THE MAXIMUM DIFFERENTIAL GATE OPENING WILL BE 2-FT. SYMMETRICAL GATE OPERATION IS PREFERRED.
2. GATE NO. 2, OPERATED BY GASOLINE ENGINE, WILL BE CONTROLLED FROM THE SPILLWAY FOR ALL GATE OPENINGS. THE GASOLINE ENGINE WILL SUPPLY EMERGENCY POWER FOR OPERATING GATE NO. 1
3. OUTLET VALVES WILL BE CONTROLLED FROM THE POWERHOUSE OR THE SPILLWAY. THE VALVES WILL BE CLOSED WHEN TAILWATER EXCEEDS ELEVATION 186.0 AND POND RELEASES WILL THEN BE ACCOMPLISHED BY OPERATING THE GATES.
4. FOR OTHER INFORMATION SEE SPILLWAY OPERATING INSTRUCTIONS.
SPILLWAY RATING CURVES FOR ONE GATE OPENING (25' WIDE)
DISCHARGE IN THOUSANDS C.F.S.
TAINTER GATE OPENING IN FEET ABOVE OGEE CREST
(ALSO HEAD ON CREST IN FEET FOR FREE DISCHARGE CURVE)
DISCHARGE CURVES FOR PARTIAL TO FULL GATE OPENINGS
FREE DISCHARGE CURVE
OUTLET CAPACITY CURVES (WITH BOTH TAINTER GATES IN CLOSED POSITION.)
RESERVOIR W.S. ELEV. (FT.)
DISCHARGE IN HUNDREDS C.F.S.
LEGEND
1 BOTH VALVES CLOSED WATER FLOWING OVER TOP OF TWO TAINTER GATES
2 UPPER VALVE OPEN
3 LOWER VALVE OPEN
4 BOTH VALVES OPEN
NOTES
ALL STATIONS DESIGNATED HERE ARE SPILLWAY STATIONS MEASURED ALONG ℄ SPILLWAY.
FOR DET OF EXC. IN THE SPILLWAY AREA SEE G-158003
FOR ADDITIONAL NOTES SEE DET. DWGS.
REFERENCE DRAWINGS
LIST OF DRAWINGS G-157675
DAM & SPILLWAY - PLAN G-158001
DAM & SPILLWAY - PROFILE & SECT. G-158002
DAM & SPILLWAY - EXC. PLAN G-158003
SPILLWAY - OGEE BLOCKS - M&R G-158006
SPILLWAY - APP. CHANNEL - SLAB & WALLS - M. G-158009
SPILLWAY - CENTER PIER - M & R G-158012
SPILLWAY - END PIERS - M & R G-158014
SPILLWAY - STILLING BASIN - SLAB & WALLS - M. G-158015
INFO ONLY
SEP 19 1990
EXHIBIT 3
CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S. E. P.
1960 - 182 MW INSTALLATION - UNIT NO 1
SPILLWAY
GENERAL PLAN & SECTIONS
EBASCO SERVICES INCORPORATED NEW YORK
SCALE 1" = 20'
DIV. C-H
DR. FONG
APPROVED
DATE JUL 16, 1958
G-158005
DRAFT

Document title

Robinson Fossil Plant Impoundment Operation

Document number

OPS-RFPC-00014

Applies to: Robinson Fossil Plant - Carolinas

Keywords: operations

Legend:

OPS	Operations
ENG	Engineering
WMT	Work Management
TRN	Training
ENV	Environmental
FIN	Financial
ICT	Combustion Turbine
ADM	Administrative

Organizational Applicability							
OPS	ENG	WMT	TRN	ENV	FIN	ICT	ADM
X							

1.0 PURPOSE

1.1 Provide instruction for controlling impoundment level and stream flows.

2.0 TERMS AND DEFINITIONS

None

3.0 RESPONSIBILITIES

None

4.0 PRECAUTIONS AND LIMITATIONS

None

5.0 PREREQUISITES

5.1 Impoundment Operation is of extreme importance due to the mandatory requirement to supply adequate cooling water at all times to the Plant and due to the obligation to supply adequate water to downstream users.

5.2 This procedure is to be followed as necessary to maintain proper impoundment level, stream flow, temperatures, and comply with Water Pollution Control Permits.

5.3 The O&R Superintendent or the Plant Manager is to be notified of changes in the status of Robinson impoundment flow and level control (such as opening Howell-Bunger valves or Tainter Gates).

6.0 MATERIAL AND SPECIAL EQUIPMENT

None

7.0 PROCEDURE

7.1 NORMAL LEVEL AND FLOW CONTROL

7.1.1 The spillage over "A" and "B" Tainter Gates will maintain proper downstream flow when Robinson impoundment levels are between elevation 220.7 and 221.5 feet mean sea level (MSL).

7.1.2 The normal downstream flow has a daily maximum temperature limit of 33°C. (91.4°F) measured at the gauging station located at SC Highway 23 bridge.

7.1.3 The daily maximum temperature limit is a 24-hour average.

7.1.4 The discharge from Robinson Impoundment Spillway during the months of June through September may need mixing of cooler water from "B" Howell-Bunger Valve to assure this temperature limit is **not** exceeded.

7.2 LOWER THAN NORMAL LEVEL AND FLOW

IMPORTANT
If the lake level decreases to 220.7, notify the RNP Control Room.

7.2.1 WHEN Robinson impoundment level falls below 220.7 feet MSL, either "A" or "B" Howell-Bunger valve should be opened enough to maintain a downstream flow of approximately 65 CFS, measured at the gauging station located at SC Highway 23 bridge. **NOTIFY** RFP and RNP shift management when the Howell-Bunger Valves are required.

7.2.2 When Robinson impoundment level is between 220.0 and 219.0 feet MSL, the downstream flow should be maintained at approximately 30 CFS, measured at the gauging station located at SC Highway 23 bridge, using either "A" or "B" Howell-Bunger Valve.

7.2.3 When Robinson impoundment level reaches 219.0 feet MSL, Section and Department Management will be involved in decisions involved in spillway operation.

7.3 Higher than Normal/Flood Conditions

> **NOTE**
>
> **NOTIFY the RNP Superintendent of Shift Operations and Plant Manager if and when the Tainter Gates are opened.**
>
> **REFER to procedure RFP Fossil Power Plant Ash Pond, Cooling Lake, and Dam Emergency Notification (EMG-RFPC-00002).**

7.3.1 If Head flow exceeds 750 CFS and Lake Level is above 221.2 ft., **INCREASE** Tail Flow discharge rates to equal Head Flow supply rate, **NOTIFY** the O&R Superintendent or the Plant Manager.

7.3.2 If the Head Flow reaches 900 CFS and the Lake Level is still rising, **NOTIFY** the O&R Superintendent and the Plant Manager who will in turn notify Unit 2 Plant Manager.

7.3.3 When the Tail Flow Discharge Rates reach 900 CFS notify the RNP Emergency Preparedness Group. Refer to EMG-RFPC-00002.

7.3.4 When the Lake Level reaches 221.5 ft. and the Head Flow is greater than 900 CFS, **MAINTAIN** the Lake Level between 221.5 to 221.65 ft., utilizing the Spillway Equipment.

7.3.5 When the Tail Flow Discharge rate reaches 1100 CFS, **NOTIFY** the O&R Superintendent and the Plant Manager.

> **NOTE**
>
> **O&R Superintendent with concurrence of the Plant Manager can change the Lake Level or discharge rates depending upon Hydrological Conditions.**

7.4 TESTING

7.4.1 Both H-B valves are to be opened fully and both Tainter Gates partially operated (raised approximately one inch) once per month.

7.5 SPILLWAY OPERATION OF TAINTER GATES

> **NOTE**
>
> **Prior to performing this task, a Pre-job Briefing is required.**
>
> **Prior to operating any of the Spillway equipment, PERFORM all pre-start checks.**

7.5.1 An Operator needs a lock valve and the gas engine key for operation purposes.

7.5.2 Requirement of two operators, one for operating the equipment and the other to have visual contact of the chains and gates.

7.5.3 To raise the Tainter gates electronically, **DEPRESS** the raise button for that particular gate. To lower the gate, **DEPRESS** the lower button for that particular gate.

NOTE
When closing the Tainter gates electronically, do not rely on Limit switches to be made. REFER to the red reference marks on the shroud and chain for proper indication that gate is closed. This will prevent damage to the chain caused by over travel.

7.5.4 When operating the Tainter gates via gas engine, you must first **RELEASE** the motor brakes.

7.5.5 After releasing the brakes, **OPEN** your gas supply valve from one of the tanks and start the gas engines.

7.5.6 After selecting a particular Tainter gate, **ENGAGE** clutch in the raise position to start raising the gate.

7.5.7 Once desired position is reached, **DISENGAGE** clutch.

7.5.8 To lower the Tainter gate, **ENGAGE** clutch to lower the position.

NOTE
There are no limit switches with the gas engine engaged or disengaged. Disengage clutch when red reference marks on chain and shroud align to prevent damage to chain caused by over travel.

7.5.9 Before stopping gas engine, **CLOSE** supply valve from gas bottle in service. This will allow gas in lines to exhaust and engine shut down then **RE-APPLY** electric motor brakes.

7.6 RECORDS

7.6.1 Log in the RFP Shift Log and Control Operator's Logs all valve and gate position changes, recording the time and the new position.

7.6.2 In the event that the continuous temperature recorder(s) are inoperative for periods in excess of 8 hours, manual temperature observations shall be obtained at a frequency of **not** less than once per four hours at approximately equal time increments.

7.6.3 Upon notification that the Weir discharge temperature is out of service, **VERIFY** that the backup is operative. If the backup recorder is out of service, the YSI is to be used to measure the Weir discharge temperature. This instrument is located in the RFP Lab. During normal working hours, the lab personnel will **OBTAIN** the necessary readings. On night shift and weekends Operations personnel will **OBTAIN**, **LOG**, and **ROUTE** the necessary readings to the RFP Lab.

7.6.4 **SEE Attachment 1** for the authorized discharge temperatures from outfall number 001 (Discharge Canal Weir Temperature Monitor).

8.0 RETURN TO NORMAL

None

9.0 DOCUMENTATION

None

10.0 REFERENCES

10.1 EMG-RFPC-00002, Fossil Power Plant Ash Pond, Cooling Lake, and Dam Emergency Notification Procedure

10.2 RNP PLP-023, Environmental Regulatory Compliance Responsibilities, NPDES Discharge Temperature Compliance Plan

11.0 ATTACHMENTS/FORMS

11.1 Expected Spillway Valve Discharge Rates "A" Spillway Valve Only (**Attachment 1**)

11.2 (**Attachment 2**)

11.3 Expected Tainter Gate Discharge Flow Rate (**Attachment 3**)

11.4 (**Attachment 4**)

11.5 (**Attachment 5**)

11.6 WEIR Discharge Temperature Limits (**Attachment 6**)

ATTACHMENT 1: Expected Spillway Valve Discharge Rates "A" Spillway Valve Only

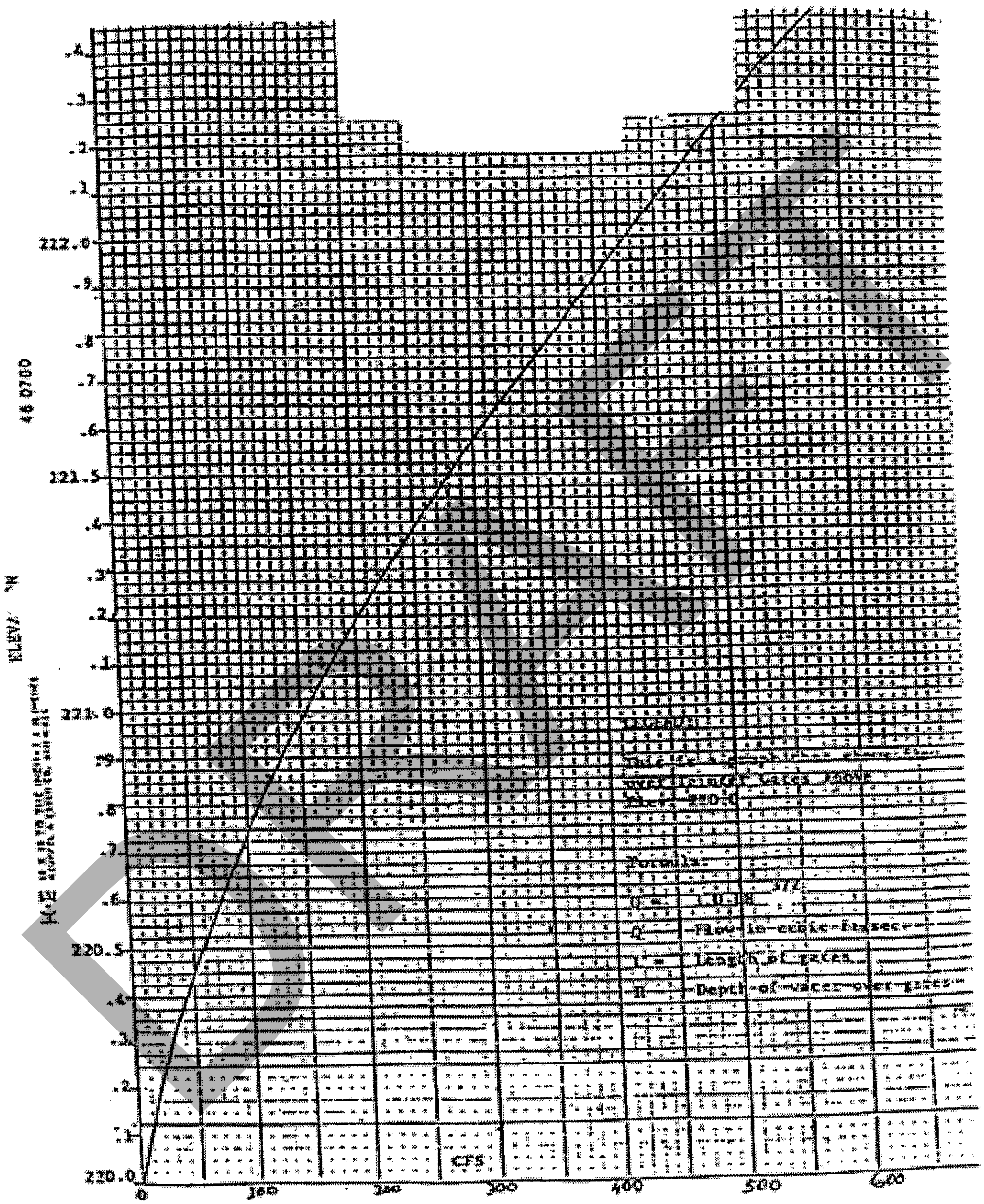
Expected Spillway Valve Discharge Rates
"A" Spillway Valve Only

Lake Level	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
222	50	87		128	196	222	242	257	266	270
221.5	49	86	126	163	194	221	241	255	265	269
221	49	86	124	163	190	220	240	252	264	268
220.5	48	84	124	160	186	219	239	251	262	268
220	48	84	123	160	184	218	238	250	260	267
Valve Opening	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**

"A" Spillway Valve Open 100% Plus "B" Spillway Valve

Lake Level	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
222	314	362	398	430	458	482	500	510	519	525
221.5	310	361	395	428	454	480	499	509	517	524
221	309	359	390	426	450	478	497	507	515	523
220.5	308	358	386	424	448	474	495	504	512	521
220	308	354	385	422	446	470	490	502	511	520
Valve Opening	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**

ATTACHMENT 2:



ATTACHMENT 3: Expected Tainter Gate Discharge Flow Rate

Expected Tainter Gate Discharge Flow Rate (Gate Raised)

Gate Raised-Inches	One Gate	Two Gates
1	260	680
2	400	900
3	445	1000
4	485	1085
5	510	1270
6	600	1375
7	685	1600
8	735	1700
9	750	1750
10	765	1780
11	825	1900
12	935	2070
15	1125	2500
18	1300	2865
21	1500	3250
24	1700	3625
27	1825	4000
30	2030	4375
33	2240	4750
36	2400	5100

ATTACHMENT 4: Page 1 of 4

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION
EXPANDED RATING TABLE
DATE PROCESSED: 02-11-1998 @ 10:53 BY bwchurch

PAGE 1
TYPE: LOG

02130910
BLACK CREEK NEAR HARTSVILLE, SC
OFFSET: .00

DD: 4 TYPE: 001 RATING NO: 10.0
START DATE/TIME: 10-01-80 (0030)

BASED ON ______ DISCHARGE MEASUREMENTS, NOS ________, AND ________, AND IS ______ WELL DEFINED BETWEEN ______ AND ______ CFS
COMP BY ______ DATE ________ CHK. BY ______ DATE ________
RATING REACTIVATED FOR USE BEGINNING 10/01/86

DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)

GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
.70	28.00*	28.21	28.41	28.61	28.82	29.02	29.22	29.41	29.61	29.81	2.000
.80	30.00*	30.20	30.41	30.61	30.81	31.01	31.21	31.41	31.61	31.80	2.000
.90	32.00*	32.20	32.41	32.61	32.81	33.01	33.21	33.41	33.61	33.80	2.000
1.00	34.00*	34.22	34.43	34.65	34.87	35.08	35.29	35.51	35.72	35.93	2.140
1.10	36.14	36.35	36.56	36.77	36.98	37.19	37.40	37.60	37.81	38.01	2.080
1.20	38.22	38.42	38.63	38.83	39.03	39.23	39.43	39.63	39.83	40.03	2.010
1.30	40.23	40.43	40.63	40.83	41.02	41.22	41.41	41.61	41.80	42.00	1.960
1.40	42.19	42.38	42.58	42.77	42.96	43.15	43.34	43.53	43.72	43.91	1.910
1.50	44.10*	44.34	44.59	44.83	45.07	45.32	45.56	45.80	46.04	46.29	2.430
1.60	46.53	46.77	47.01	47.25	47.49	47.73	47.97	48.21	48.45	48.69	2.400
1.70	48.93	49.17	49.41	49.65	49.88	50.12	50.36	50.60	50.83	51.07	2.380
1.80	51.31	51.55	51.78	52.02	52.25	52.49	52.72	52.96	53.20	53.43	2.350
1.90	53.66	53.90	54.13	54.37	54.60	54.83	55.07	55.30	55.53	55.77	2.340
2.00	56.00*	56.30	56.60	56.89	57.19	57.49	57.79	58.09	58.39	58.68	2.980
2.10	58.98	59.28	59.58	59.88	60.18	60.48	60.78	61.08	61.38	61.67	2.990
2.20	61.97	62.27	62.57	62.87	63.17	63.47	63.77	64.07	64.37	64.67	3.000
2.30	64.97	65.28	65.58	65.88	66.18	66.48	66.78	67.08	67.38	67.68	3.010
2.40	67.98	68.28	68.59	68.89	69.19	69.49	69.79	70.09	70.40	70.70	3.020
2.50	71.00*	71.37	71.74	72.11	72.48	72.85	73.22	73.60	73.97	74.34	3.720
2.60	74.72	75.09	75.46	75.84	76.21	76.59	76.97	77.34	77.72	78.10	3.750
2.70	78.47	78.85	79.23	79.61	79.99	80.37	80.75	81.13	81.51	81.89	3.810
2.80	82.28	82.66	83.04	83.42	83.81	84.19	84.58	84.96	85.35	85.73	3.840
2.90	86.12	86.50	86.89	87.28	87.67	88.05	88.44	88.83	89.22	89.61	3.880
3.00	90.00*	90.38	90.77	91.15	91.54	91.92	92.31	92.69	93.08	93.47	3.850
3.10	93.85	94.24	94.63	95.01	95.40	95.79	96.18	96.57	96.96	97.35	3.890
3.20	97.74	98.13	98.52	98.91	99.30	99.70	100.1	100.5	100.9	101.3	3.960
3.30	101.7	102.1	102.4	102.8	103.2	103.6	104.0	104.4	104.8	105.2	3.900
3.40	105.6	106.0	106.4	106.8	107.2	107.6	108.0	108.4	108.8	109.2	4.000
3.50	109.6*	110.0	110.4	110.8	111.2	111.6	112.0	112.4	112.8	113.2	4.000
3.60	113.6	114.0	114.4	114.8	115.2	115.6	116.0	116.5	116.9	117.3	4.100
3.70	117.7	118.1	118.5	118.9	119.3	119.7	120.1	120.5	120.9	121.3	4.000
3.80	121.7	122.2	122.6	123.0	123.4	123.8	124.2	124.6	125.0	125.4	4.200
3.90	125.9	126.3	126.7	127.1	127.5	127.9	128.3	128.8	129.2	129.6	4.100
4.00	130.0*	130.5	131.0	131.4	131.9	132.4	132.9	133.4	133.9	134.3	4.800
4.10	134.8	135.3	135.8	136.3	136.8	137.3	137.8	138.2	138.7	139.2	4.900
4.20	139.7	140.2	140.7	141.2	141.7	142.2	142.7	143.2	143.7	144.2	5.000
4.30	144.7	145.2	145.6	146.1	146.6	147.1	147.6	148.1	148.6	149.1	4.900
4.40	149.6	150.2	150.7	151.2	151.7	152.2	152.7	153.2	153.7	154.2	5.100

ATTACHMENT 4: Page 2 of 4

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION
EXPANDED RATING TABLE
DATE PROCESSED: 02-11-1998 @ 10:53 BY bwchurch

PAGE 2
TYPE: LOG

02130910
BLACK CREEK NEAR HARTSVILLE, SC
OFFSET: .00

DD: 4 TYPE: 001 RATING NO: 10.0
START DATE/TIME: 10-01-80 (0030)

RATING REACTIVATED FOR USE BEGINNING 10/01/86

DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)

GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
4.50	154.7*	155.3	155.8	156.4	157.0	157.5	158.1	158.7	159.3	159.8	5.700
4.60	160.4	161.0	161.5	162.1	162.7	163.3	163.9	164.4	165.0	165.6	5.800
4.70	166.2	166.8	167.3	167.9	168.5	169.1	169.7	170.3	170.9	171.5	5.800
4.80	172.0	172.6	173.2	173.8	174.4	175.0	175.6	176.2	176.8	177.4	6.000
4.90	178.0	178.6	179.2	179.8	180.4	181.0	181.6	182.2	182.8	183.4	6.000
5.00	184.0*	184.9	185.9	186.8	187.7	188.7	189.6	190.6	191.5	192.5	9.400
5.10	193.4	194.4	195.3	196.3	197.3	198.2	199.2	200.2	201.2	202.1	9.700
5.20	203.1	204.1	205.1	206.1	207.1	208.1	209.1	210.1	211.1	212.1	10.00
5.30	213.1	214.1	215.2	216.2	217.2	218.2	219.3	220.3	221.3	222.4	10.30
5.40	223.4	224.5	225.5	226.6	227.6	228.7	229.7	230.8	231.9	232.9	10.60
5.50	234.0*	235.2	236.4	237.7	238.9	240.1	241.4	242.6	243.9	245.1	12.40
5.60	246.4	247.6	248.9	250.1	251.4	252.7	254.0	255.3	256.5	257.8	12.70
5.70	259.1	260.4	261.7	263.0	264.4	265.7	267.0	268.3	269.6	271.0	13.20
5.80	272.3	273.7	275.0	276.4	277.7	279.1	280.4	281.8	283.2	284.6	13.60
5.90	285.9	287.3	288.7	290.1	291.5	292.9	294.3	295.7	297.2	298.6	14.10
6.00	300.0*	301.9	303.7	305.6	307.5	309.4	311.3	313.2	315.1	317.0	19.00
6.10	319.0	320.9	322.9	324.8	326.8	328.8	330.8	332.8	334.8	336.8	19.80
6.20	338.8	340.9	342.9	345.0	347.0	349.1	351.2	353.3	355.3	357.5	20.80
6.30	359.6	361.7	363.8	366.0	368.1	370.3	372.4	374.6	376.8	379.0	21.60
6.40	381.2	383.4	385.7	387.9	390.1	392.4	394.7	396.9	399.2	401.5	22.60
6.50	403.8*	406.3	408.8	411.3	413.8	416.3	418.8	421.4	424.0	426.5	25.30
6.60	429.1	431.7	434.3	436.9	439.6	442.2	444.9	447.5	450.2	452.9	26.50
6.70	455.6	458.3	461.0	463.8	466.5	469.3	472.1	474.8	477.6	480.4	27.70
6.80	483.3	486.1	489.0	491.8	494.7	497.6	500.5	503.4	506.3	509.2	28.90
6.90	512.2	515.2	518.1	521.1	524.1	527.1	530.2	533.2	536.3	539.3	30.20
7.00	542.4*	545.4	548.4	551.4	554.4	557.5	560.5	563.6	566.7	569.8	30.50
7.10	572.9	576.0	579.1	582.2	585.4	588.6	591.7	594.9	598.1	601.3	31.70
7.20	604.6	607.8	611.1	614.3	617.6	620.9	624.2	627.5	630.8	634.2	33.00
7.30	637.6	640.9	644.3	647.7	651.1	654.5	658.0	661.4	664.9	668.4	34.30
7.40	671.9	675.4	678.9	682.4	685.9	689.5	693.1	696.7	700.3	703.9	35.60
7.50	707.5*	711.0	714.6	718.1	721.7	725.2	728.8	732.4	736.1	739.7	35.80
7.60	743.3	747.0	750.6	754.3	758.0	761.7	765.4	769.2	772.9	776.7	37.20
7.70	780.5	784.2	788.0	791.8	795.7	799.5	803.4	807.2	811.1	815.0	38.40
7.80	818.9	822.8	826.8	830.7	834.7	838.7	842.7	846.7	850.7	854.7	39.90
7.90	858.8	862.8	866.9	871.0	875.1	879.2	883.3	887.5	891.6	895.8	41.20
8.00	900.0*	904.1	908.3	912.5	916.7	920.9	925.1	929.3	933.6	937.8	42.10
8.10	942.1	946.4	950.7	955.0	959.3	963.7	968.0	972.4	976.8	981.2	43.50
8.20	985.6	990.1	994.5	999.0	1003	1008	1012	1017	1021	1026	45.40

ATTACHMENT 4: Page 3 of 4

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION
EXPANDED RATING TABLE
DATE PROCESSED: 02-11-1998 @ 10:53 BY bwchurch

PAGE 3
TYPE: LOG

02130910
BLACK CREEK NEAR HARTSVILLE, SC
OFFSET: .00

DD: 4 TYPE: 001 RATING NO: 10.0
START DATE/TIME: 10-01-80 (0030)

RATING REACTIVATED FOR USE BEGINNING 10/01/86

DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)

GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
8.30	1031	1035	1040	1044	1049	1054	1058	1063	1068	1072	46.00
8.40	1077	1082	1087	1091	1096	1101	1106	1110	1115	1120	48.00
8.50	1125*	1130	1135	1140	1145	1151	1156	1161	1166	1171	51.00
8.60	1176	1182	1187	1192	1198	1203	1208	1214	1219	1224	54.00
8.70	1230	1235	1241	1246	1251	1257	1262	1268	1274	1279	55.00
8.80	1285	1290	1296	1301	1307	1313	1318	1324	1330	1336	56.00
8.90	1341	1347	1353	1359	1365	1370	1376	1382	1388	1394	59.00
9.00	1400*	1406	1411	1417	1422	1428	1433	1439	1445	1450	56.00
9.10	1456	1461	1467	1473	1479	1484	1490	1496	1502	1507	57.00
9.20	1513	1519	1525	1531	1537	1542	1548	1554	1560	1566	59.00
9.30	1572	1578	1584	1590	1596	1602	1608	1614	1620	1627	61.00
9.40	1633	1639	1645	1651	1657	1664	1670	1676	1682	1689	62.00
9.50	1695*	1701	1708	1714	1720	1727	1733	1740	1746	1752	64.00
9.60	1759	1765	1772	1778	1785	1792	1798	1805	1811	1818	66.00
9.70	1825	1831	1838	1845	1851	1858	1865	1872	1878	1885	67.00
9.80	1892	1899	1906	1912	1919	1926	1933	1940	1947	1954	69.00
9.90	1961	1968	1975	1982	1989	1996	2003	2011	2018	2025	71.00
10.00	2032*	2039	2046	2054	2061	2068	2076	2083	2090	2098	73.00
10.10	2105	2112	2120	2127	2135	2142	2150	2157	2165	2172	75.00
10.20	2180*	2188	2195	2203	2210	2218	2226	2234	2241	2249	77.00
10.30	2257	2265	2272	2280	2288	2296	2304	2312	2320	2328	79.00
10.40	2336	2344	2352	2360	2368	2376	2384	2392	2400	2408	80.00
10.50	2416	2424	2433	2441	2449	2457	2466	2474	2482	2491	83.00
10.60	2499	2507	2516	2524	2533	2541	2549	2558	2566	2575	85.00
10.70	2584	2592	2601	2609	2618	2627	2635	2644	2653	2662	86.00
10.80	2670	2679	2688	2697	2706	2714	2723	2732	2741	2750	89.00
10.90	2759	2768	2777	2786	2795	2804	2813	2823	2832	2841	91.00
11.00	2850*	2860	2870	2880	2891	2901	2911	2921	2932	2942	102.0
11.10	2952	2963	2973	2983	2994	3004	3015	3025	3036	3047	105.0
11.20	3057	3068	3079	3089	3100	3111	3122	3132	3143	3154	108.0
11.30	3165	3176	3187	3198	3209	3220	3231	3242	3253	3264	110.0
11.40	3275	3287	3298	3309	3320	3332	3343	3355	3366	3377	114.0
11.50	3389	3400	3412	3423	3435	3447	3458	3470	3482	3493	116.0
11.60	3505	3517	3529	3541	3552	3564	3576	3588	3600	3612	119.0
11.70	3624	3636	3649	3661	3673	3685	3697	3710	3722	3734	122.0
11.80	3746	3759	3771	3784	3796	3809	3821	3834	3846	3859	126.0
11.90	3872	3884	3897	3910	3923	3935	3948	3961	3974	3987	128.0

ATTACHMENT 4: Page 4 of 4

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION PAGE 4
EXPANDED RATING TABLE TYPE: LOG
DATE PROCESSED: 02-11-1998 @ 10:53 BY bwchurch

02130910
BLACK CREEK NEAR HARTSVILLE, SC DD: 4 TYPE: 001 RATING NO: 10.0
OFFSET: .00 START DATE/TIME: 10-01-80 (0030)

RATING REACTIVATED FOR USE BEGINNING 10/01/86

DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)

GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
12.00	4000*	4012	4025	4037	4049	4062	4074	4087	4099	4112	124.0
12.10	4124	4137	4150	4162	4175	4188	4200	4213	4226	4239	127.0
12.20	4251	4264	4277	4290	4303	4316	4329	4342	4355	4368	130.0
12.30	4381	4395	4408	4421	4434	4447	4461	4474	4487	4501	133.0
12.40	4514	4528	4541	4555	4568	4582	4595	4609	4623	4636	136.0*
12.50	4650*										

DRAFT

ATTACHMENT 5: Page 1 of 3

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION
EXPANDED RATING TABLE
DATE PROCESSED: 02-11-1998 @ 09:57 BY bwchurch

PAGE 1
TYPE: LOG

02130900
BLACK CREEK NEAR MCBEE, S. C.
OFFSET: .00

DD: 4 TYPE: 003 RATING NO: 10
START DATE/TIME: 10-10-96 (1600)

BASED ON _______ DISCHARGE MEASUREMENTS, NOS _________, AND _________, AND IS ______ WELL DEFINED BETWEEN ______ AND _______ CFS
COMP BY _____ DATE _________ CHK. BY _____ DATE __________
Same as Rating No.9 above 8.00 ft G.H.

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND .00	.01	.02	.03	.04	.05	(EXPANDED PRECISION) .06	.07	.08	.09	DIFF IN Q PER TENTH FT
2.90	19.00*	19.10	19.20	19.30	19.40	19.50	19.60	19.70	19.80	19.90	1.000
3.00	20.00*	20.15	20.29	20.44	20.59	20.73	20.88	21.03	21.18	21.33	1.480
3.10	21.48	21.64	21.79	21.94	22.09	22.25	22.40	22.56	22.71	22.87	1.550
3.20	23.03	23.18	23.34	23.50	23.66	23.82	23.98	24.14	24.30	24.46	1.600
3.30	24.63	24.79	24.95	25.12	25.28	25.45	25.61	25.78	25.95	26.11	1.650
3.40	26.28	26.45	26.62	26.79	26.96	27.13	27.31	27.48	27.65	27.83	1.720
3.50	28.00*	28.18	28.37	28.55	28.74	28.92	29.11	29.30	29.49	29.67	1.860
3.60	29.86	30.05	30.24	30.44	30.63	30.82	31.01	31.21	31.40	31.60	1.930
3.70	31.79	31.99	32.19	32.39	32.59	32.79	32.99	33.19	33.39	33.59	2.000
3.80	33.79	34.00	34.20	34.41	34.61	34.82	35.03	35.23	35.44	35.65	2.070
3.90	35.86	36.07	36.28	36.50	36.71	36.92	37.14	37.35	37.57	37.78	2.140
4.00	38.00*	38.24	38.48	38.72	38.96	39.20	39.44	39.68	39.93	40.17	2.420
4.10	40.42	40.66	40.91	41.16	41.41	41.66	41.91	42.16	42.42	42.67	2.510
4.20	42.93	43.18	43.44	43.70	43.95	44.21	44.47	44.74	45.00	45.26	2.590
4.30	45.52	45.79	46.06	46.32	46.59	46.86	47.13	47.40	47.67	47.94	2.700
4.40	48.22	48.49	48.77	49.04	49.32	49.60	49.88	50.15	50.44	50.72	2.780
4.50	51.00*	51.28	51.56	51.84	52.12	52.40	52.68	52.96	53.25	53.53	2.820
4.60	53.82	54.10	54.39	54.68	54.97	55.26	55.55	55.84	56.14	56.43	2.910
4.70	56.73	57.02	57.32	57.62	57.91	58.21	58.51	58.82	59.12	59.42	3.000
4.80	59.73	60.03	60.34	60.64	60.95	61.26	61.57	61.88	62.19	62.50	3.090
4.90	62.82	63.13	63.45	63.76	64.08	64.40	64.72	65.04	65.36	65.68	3.180
5.00	66.00*	66.30	66.60	66.91	67.21	67.51	67.82	68.12	68.43	68.74	3.040
5.10	69.04	69.35	69.66	69.97	70.28	70.60	70.91	71.22	71.54	71.85	3.130
5.20	72.17	72.48	72.80	73.12	73.44	73.76	74.08	74.40	74.72	75.04	3.200
5.30	75.37	75.69	76.02	76.34	76.67	77.00	77.32	77.65	77.98	78.31	3.270
5.40	78.64	78.98	79.31	79.64	79.98	80.31	80.65	80.98	81.32	81.66	3.360
5.50	82.00*	82.41	82.82	83.23	83.64	84.05	84.47	84.88	85.30	85.72	4.140
5.60	86.14	86.56	86.98	87.40	87.83	88.25	88.68	89.11	89.54	89.97	4.260
5.70	90.40	90.84	91.27	91.71	92.15	92.59	93.03	93.47	93.91	94.36	4.400
5.80	94.80	95.25	95.70	96.15	96.60	97.05	97.50	97.96	98.42	98.87	4.530
5.90	99.33	99.79	100.3	100.7	101.2	101.6	102.1	102.6	103.1	103.5	4.670
6.00	104.0*	104.5	105.0	105.5	105.9	106.4	106.9	107.4	107.9	108.4	4.900
6.10	108.9	109.4	109.9	110.4	110.9	111.4	111.9	112.4	112.9	113.4	5.100
6.20	114.0	114.5	115.0	115.5	116.0	116.5	117.1	117.6	118.1	118.6	5.200
6.30	119.2	119.7	120.2	120.7	121.3	121.8	122.3	122.9	123.4	124.0	5.300
6.40	124.5	125.0	125.6	126.1	126.7	127.2	127.8	128.3	128.9	129.4	5.500
6.50	130.0*	130.6	131.1	131.7	132.3	132.8	133.4	134.0	134.5	135.1	5.700

ATTACHMENT 5: Page 2 of 3

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION
EXPANDED RATING TABLE
DATE PROCESSED: 02-11-1998 @ 09:57 BY bwchurch

PAGE 2
TYPE: LOG

02130900
BLACK CREEK NEAR MCBEE, S. C.
OFFSET: .00

DD: 4 TYPE: 001 RATING NO: 10
START DATE/TIME: 10-10-96 (1600)

Same as Rating No.9 above 8.00 ft G.H.

DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)

GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
6.60	135.7	136.3	136.8	137.4	138.0	138.6	139.2	139.8	140.3	140.9	5.800
6.70	141.5	142.1	142.7	143.3	143.9	144.5	145.1	145.7	146.3	146.9	6.000
6.80	147.5	148.1	148.7	149.3	150.0	150.6	151.2	151.8	152.4	153.1	6.200
6.90	153.7	154.3	154.9	155.6	156.2	156.8	157.5	158.1	158.7	159.4	6.300
7.00	160.0*	160.7	161.5	162.2	163.0	163.7	164.5	165.2	166.0	166.7	7.500
7.10	167.5	168.3	169.0	169.8	170.6	171.4	172.1	172.9	173.7	174.5	7.800
7.20	175.3	176.1	176.8	177.6	178.4	179.2	180.0	180.8	181.6	182.4	8.000
7.30	183.3	184.1	184.9	185.7	186.5	187.3	188.2	189.0	189.8	190.7	8.200
7.40	191.5	192.3	193.2	194.0	194.9	195.7	196.6	197.4	198.3	199.1	8.500
7.50	200.0*	200.8	201.6	202.5	203.3	204.1	205.0	205.8	206.6	207.5	8.300
7.60	208.3	209.2	210.0	210.9	211.7	212.6	213.4	214.3	215.2	216.0	8.600
7.70	216.9	217.8	218.6	219.5	220.4	221.3	222.1	223.0	223.9	224.8	8.800
7.80	225.7	226.6	227.5	228.4	229.3	230.2	231.1	232.0	232.9	233.8	9.000
7.90	234.7	235.6	236.6	237.5	238.4	239.3	240.3	241.2	242.1	243.1	9.300
8.00	244.0*	245.5	247.1	248.6	250.1	251.7	253.3	254.8	256.4	258.0	15.60
8.10	259.6	261.2	262.8	264.4	266.1	267.7	269.3	271.0	272.7	274.3	16.40
8.20	276.0*	277.9	279.8	281.7	283.6	285.6	287.5	289.5	291.5	293.5	19.40
8.30	295.4	297.4	299.5	301.5	303.5	305.6	307.6	309.7	311.8	313.9	20.60
8.40	316.0*	318.3	320.7	323.0	325.4	327.8	330.2	332.6	335.1	337.5	24.00
8.50	340.0*	342.6	345.1	347.7	350.4	353.0	355.6	358.3	361.0	363.7	26.40
8.60	366.4	369.1	371.9	374.7	377.4	380.2	383.1	385.9	388.7	391.6	28.10
8.70	394.5	397.4	400.3	403.3	406.3	409.2	412.2	415.3	418.3	421.3	29.90
8.80	424.4	427.5	430.6	433.8	436.9	440.1	443.3	446.5	449.7	452.9	31.80
8.90	456.2	459.5	462.8	466.1	469.5	472.9	476.2	479.7	483.1	486.5	33.80
9.00	490.0*	493.3	496.6	499.9	503.3	506.7	510.0	513.5	516.9	520.3	33.80
9.10	523.8	527.3	530.8	534.3	537.8	541.4	545.0	548.6	552.2	555.8	35.70
9.20	559.5	563.2	566.9	570.6	574.3	578.1	581.9	585.7	589.5	593.3	37.70
9.30	597.2	601.1	605.0	608.9	612.9	616.9	620.8	624.9	628.9	632.9	39.80
9.40	637.0	641.1	645.3	649.4	653.6	657.7	662.0	666.2	670.5	674.7	42.00
9.50	679.0	683.4	687.7	692.1	696.5	700.9	705.3	709.8	714.3	718.8	44.30
9.60	723.3	727.9	732.5	737.1	741.7	746.4	751.0	755.7	760.5	765.2	46.70
9.70	770.0*	774.3	778.6	783.0	787.4	791.7	796.2	800.6	805.0	809.5	44.00
9.80	814.0	818.5	823.0	827.6	832.1	836.7	841.3	846.0	850.6	855.3	46.00
9.90	860.0*	864.6	869.2	873.8	878.5	883.2	887.9	892.6	897.3	902.1	46.90
10.00	906.9	911.7	916.5	921.3	926.2	931.1	936.0	940.9	945.8	950.8	48.90
10.10	955.8	960.8	965.8	970.8	975.9	981.0	986.1	991.3	996.4	1002	51.20
10.20	1007	1012	1017	1023	1028	1033	1038	1044	1049	1055	53.00
10.30	1060*	1066	1071	1077	1082	1088	1093	1099	1105	1111	56.00

ATTACHMENT 5: Page 3 of 3

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION PAGE 3
TYPE: LOG
EXPANDED RATING TABLE
DATE PROCESSED: 02-11-1998 @ 09:57 BY bwchurch

02130900
BLACK CREEK NEAR MCBEE, S. C.
OFFSET: .00

DD: 4 TYPE: 001 RATING NO: 10
START DATE/TIME: 10-10-96 (1600)

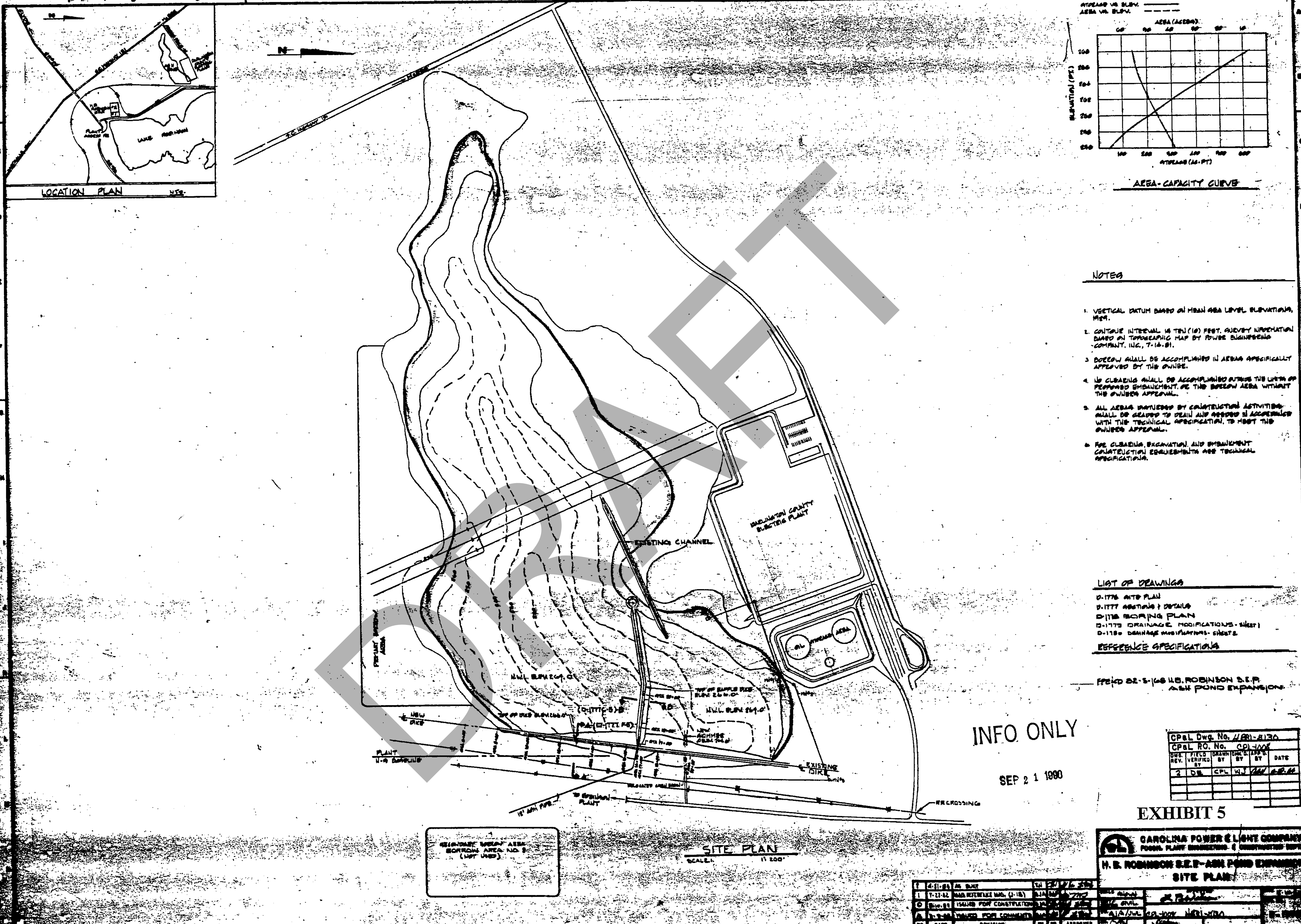
Same as Rating No.9 above 8.00 ft G.H.

GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
	DISCHARGE IN CUBIC FEET PER SECOND					(EXPANDED PRECISION)					
10.40	1116	1122	1128	1134	1139	1145	1151	1157	1163	1169	59.00
10.50	1175*	1181	1187	1194	1200	1206	1213	1219	1225	1232	63.00
10.60	1238	1245	1251	1258	1264	1271	1278	1284	1291	1298	66.00
10.70	1304	1311	1318	1325	1332	1338	1345	1352	1359	1366	69.00
10.80	1373	1380	1387	1394	1402	1409	1416	1423	1430	1438	72.00
10.90	1445	1452	1460	1467	1475	1482	1490	1497	1505	1512	75.00
11.00	1520*	1528	1536	1544	1552	1559	1567	1575	1584	1592	80.00
11.10	1600	1608	1616	1624	1633	1641	1649	1658	1666	1674	83.00
11.20	1683	1691	1700	1709	1717	1726	1735	1743	1752	1761	87.00
11.30	1770	1779	1787	1796	1805	1814	1823	1833	1842	1851	90.00
11.40	1860*	1870	1879	1889	1899	1909	1919	1929	1939	1949	99.00
11.50	1959	1969	1979	1989	1999	2010	2020	2030	2041	2051	103.0
11.60	2062	2072	2083	2093	2104	2115	2126	2136	2147	2158	107.0
11.70	2169	2180	2191	2202	2213	2225	2236	2247	2259	2270	112.0
11.80	2281	2293	2304	2316	2327	2339	2351	2363	2374	2386	117.0
11.90	2398	2410	2422	2434	2446	2458	2471	2483	2495	2508	122.0
12.00	2520*	2534	2548	2562	2576	2590	2604	2619	2633	2648	142.0
12.10	2662	2677	2691	2706	2721	2736	2750	2765	2780	2796	149.0
12.20	2811	2826	2841	2857	2872	2888	2903	2919	2935	2951	155.0
12.30	2966	2982	2998	3015	3031	3047	3063	3080	3096	3113	163.0
12.40	3129	3146	3163	3180	3197	3214	3231	3248	3265	3283	171.0
12.50	3300*	3319	3337	3356	3375	3394	3413	3432	3452	3471	191.0
12.60	3491	3510	3530	3549	3569	3589	3609	3629	3650	3670	199.0
12.70	3690	3711	3731	3752	3773	3794	3815	3836	3857	3879	210.0
12.80	3900	3921	3943	3965	3987	4009	4031	4053	4075	4097	220.0
12.90	4120	4142	4165	4188	4211	4234	4257	4280	4303	4326	230.0
13.00	4350*	4372	4393	4415	4437	4459	4481	4503	4525	4548	220.0*
13.10	4570*										

ATTACHMENT 6: WEIR Discharge Temperature Limits

WEIR DISCHARGE TEMPERATURE LIMITS
(Daily Maximum)

Month	Limit (°F)
December - February	90.0
March	92.0
April	100.0
May	106.0
June - September	111.2
October	108.0
November	100.0

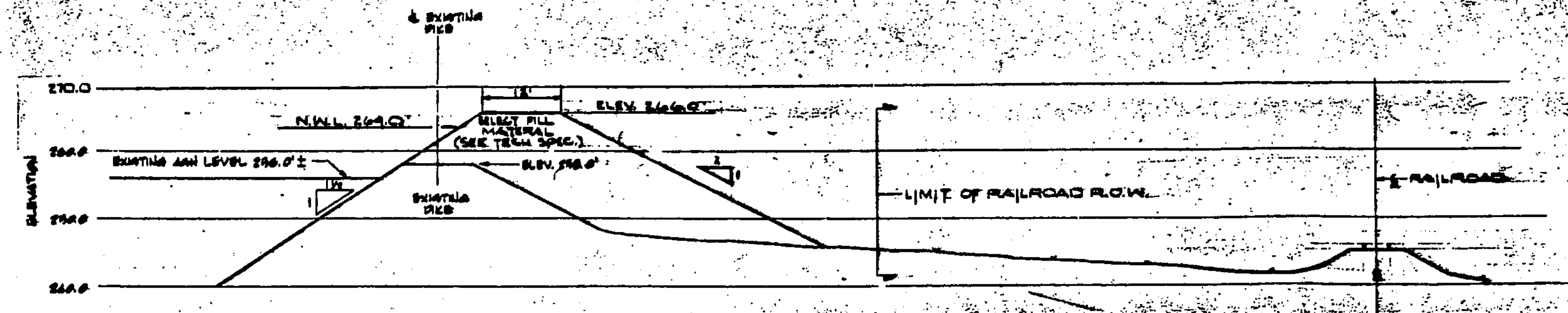


DRAFT

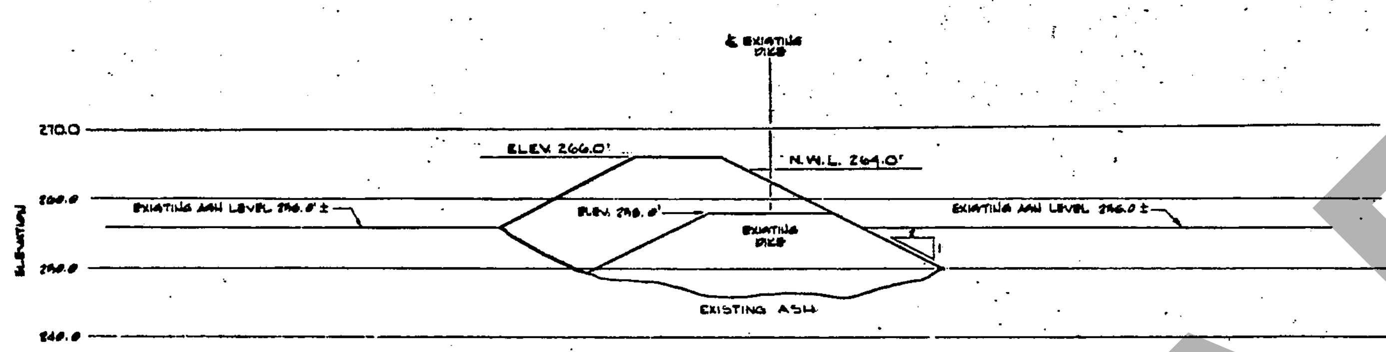
INFO ONLY

SEP 21 1990

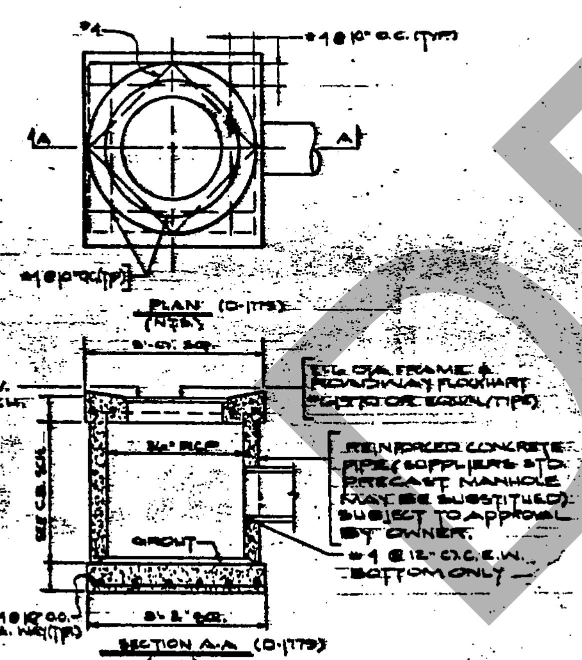
EXHIBIT 5



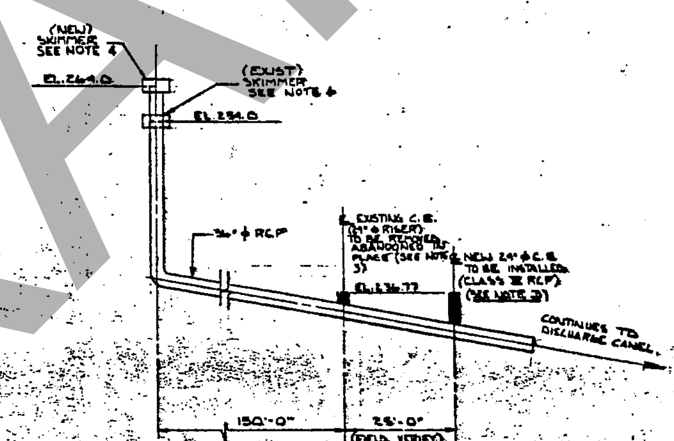
MAIN DIKE SECTION A-A (D-1176 L-3)
SCALE: 1" = 10'



BAFFLE DIKE SECTION B-B (D-1176 K-10)
SCALE: 1" = 10'



MANHOLE
(FOR LOCATION SEE D-1178)



DECANT PIPE OUTLET WORKS DETAIL
1" = 20'

QUANTITIES

SELECT FILL MATERIAL	64110 CU YD
STRIPPING	4218 CU YD
24" ϕ RCP CLASS III PIPE	1976 LIN FT
36" ϕ RCP FOR SKIMMER	10 LIN FT

NOTES

1. 36" ϕ REINFORCED CONCRETE PIPE TO BE USED FOR RAISING EXISTING SKIMMER SHALL BE CLASS III PER ASTM C-76.
2. RIP-RAP SHALL CONFORM TO THE REQUIREMENTS OF SOUTH CAROLINA STATE HIGHWAY DEPARTMENT STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION SECTION 804.03, AND BE PLACED IN ACCORDANCE WITH SECTION 804.10
3. REINSTALL GRATED TOP FROM OLD CATCH BASIN TO RELOCATED CATCH BASIN. ABANDONED CATCH BASIN SHALL BE FITTED WITH SOLID TOP AND LEFT IN PLACE. NEW CATCH BASIN SHALL BE INSTALLED BY CHIPPING INTO EXISTING 36" ϕ DECANT PIPE AND GROUTING 24" ϕ RISER IN PLACE.
4. 36" ϕ RISER BARREL SHALL BE EXTENDED BY REMOVING ANY PARTIAL JOINTS OF PIPE AND ADDING FOUR-FOOT LENGTHS OF NEW PIPE TO ELEVATION 264.0'. ONLY LAST SECTION OF PIPE MAY BE PARTIAL JOINT.

MANHOLE SCHEDULE *

M. H.	LOCATION	TOP OF GRATE	INVERT ELEVATION IN A	IN B	OUT
EXISTING CATCH BASIN	N 40 + 09 E 40 + 15	270.64	[illegible]	—	[illegible]
1	N 40 + 25 E 42 + 35	266.98	257.49	—	247.48
2	N 40 + 70 E 45 + 26	265.90	[illegible]	—	[illegible]
3	N 41 + 10 E 49 + 30	264.07	[illegible]	—	[illegible]
RELOCATED CATCH BASIN	FIELD LOCATE	236.77	12" ABOVE 36" ϕ RCP	—	—

* FOR MANHOLE LOCATIONS SEE D-1178

INFO ONLY
SEP 19 1990

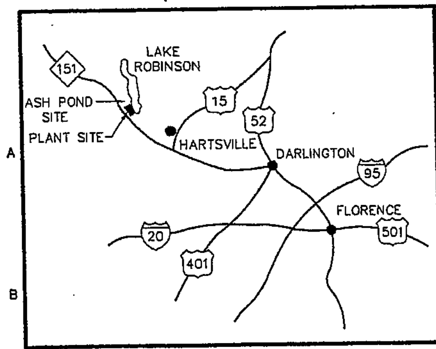
CP&L Dwg. No. HBRI-5131					
CP&L P.O. No. CPL-1007					
DWG. REV.	FIELD VERIFIED BY	DRAWN BY	CHK'D BY	APP'D BY	DATE
2	DB	CPL	WJ	[illegible]	[illegible]

EXHIBIT 6

CAROLINA POWER & LIGHT COMPANY
FOSSIL PLANT ENGINEERING & CONSTRUCTION DEPT.
H.B. ROBINSON S.E.P. – ASH POND EXPANSION
DIKE SECTIONS & DETAILS

NO.	DATE	REVISION	BY	CH.	APPROVED
2	4/11/85	AS BUILT	[illegible]	[illegible]	[illegible]
1	6-4-82	ADDED DETAIL AT (K-10)	[illegible]	[illegible]	[illegible]
0	6-16-82	ISSUED FOR CONSTRUCTION	[illegible]	[illegible]	[illegible]
A	5-9-82	ISSUED FOR COMMENTS	[illegible]	[illegible]	[illegible]

CIVIL
CPL-1007 HBRI-5131
D-1179



ROBINSON PLANT & ASH POND VICINITY MAP

LEGEND:

- ASH REMOVAL AREA
- BORROW/FILL AREA
- FILL AREA
- AREA COVERED WITH 4" OF SAND OR SOIL (SEE NOTE 4)

REFERENCE NOTES

1. COORDINATES SHOWN ARE H. B. ROBINSON PLANT COORDINATES.
2. EXCAVATE ASH FROM REMOVAL AREA TO A DEPTH OF 10' (EL. 250'). EXCAVATION SHALL BE NO CLOSER THAN 50' FROM THE TOE OF THE SEPARATION DIKE AND 100' FROM THE TOE OF THE MAIN DIKE. A BUFFER ZONE OF 200' SHALL BE ALLOWED FROM THE CENTERLINE OF THE OUTERMOST POWERLINE CROSSING THE ASH POND AREA.
3. PLACE AND COMPACT ASH TO A MINIMUM OF 90% PROCTOR COMPACTION.
4. AT COMPLETION OF EXCAVATION AND ASH PLACEMENT, THE AREA BETWEEN THE REMOVAL AREA AND THE FILL AREA SHALL BE COVERED WITH 4" OF SAND OR SOIL OBTAINED FROM THE BORROW AREA. THE FILL AREA SHALL BE COVERED WITH 6" OF SAND OR SOIL OBTAINED FROM THE BORROW AREA.
5. PREPARE FILL AREA BY REMOVING ALL VEGETATION AND COMPACTING WITH TWO PASSES OF ROLLER TO INSURE SOUND SURFACE.
6. ALL BORROW AREAS SHALL BE CUT TO EL. 260' (AS A MAX. ELEVATION) PRIOR TO PLACING ASH IN THOSE AREAS.
7. AREAS EXCAVATED OR COVERED WITH SAND/SOIL, SHALL BE SEEDED WITH THE FOLLOWING SEED MIX:

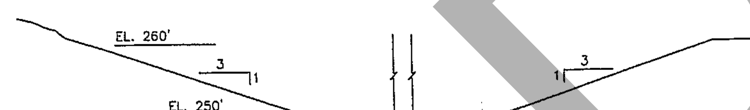
SERICEA LESPEDEZA	100 LBS./ACRE
WEEPING LOVEGRASS	15 LBS./ACRE
COMMON BERMUDA (UNHULLED)	10 LBS./ACRE
BROWNTOP MILLET	50 LBS./ACRE

APPLY FERTILIZER AND MULCH AS FOLLOWS:

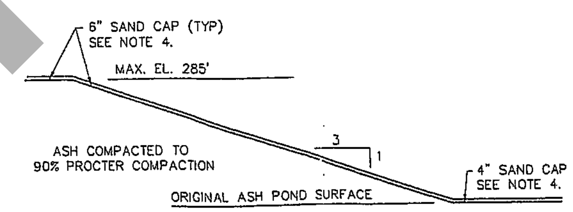
10-10-10 FERTILIZER	1200 LBS./ACRE
MULCH	AS REQUIRED

REFERENCE DRAWINGS

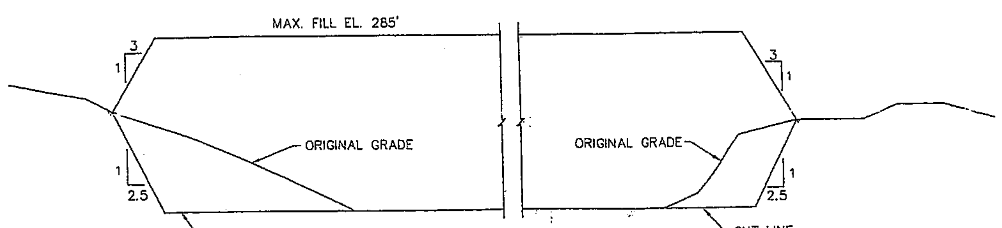
REFERENCE SPECIFICATION



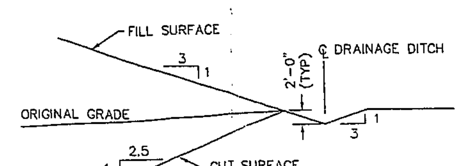
1 SECT. @ ASH REMOVAL AREA (TYP)
SCALE: 1" = 10'



2 TYP. SECT. @ END OF FILL
SCALE: 1" = 10'



3 SECT. THRU FILL AREA (TYP)
HORIZ. SCALE: 1" = 50'
VERT. SCALE: 1" = 10'



4 TYP. DRAINAGE DITCH
SCALE: 1" = 10'

EXHIBIT 7

CAROLINA POWER & LIGHT COMPANY
FOSSIL PLANT BETTERMENT DEPT.

H. B. ROBINSON UNIT NO. 1
ASH POND RESTACKING
PLAN AND SECTIONS

NO.	DATE	REVISION				APPROVED
0	6-5-92	APPROVED FOR CONSTRUCTION	EDS	AS		
A	4-3-92	ISSUED FOR COMMENTS	EDS	AS	BLA	

SCALE: NOTED
UNIT/SECTION: CIVIL
DR.: WDP/EDS
CK.: AS
DATE: 6-5-92
DWG. NO.: D-7471

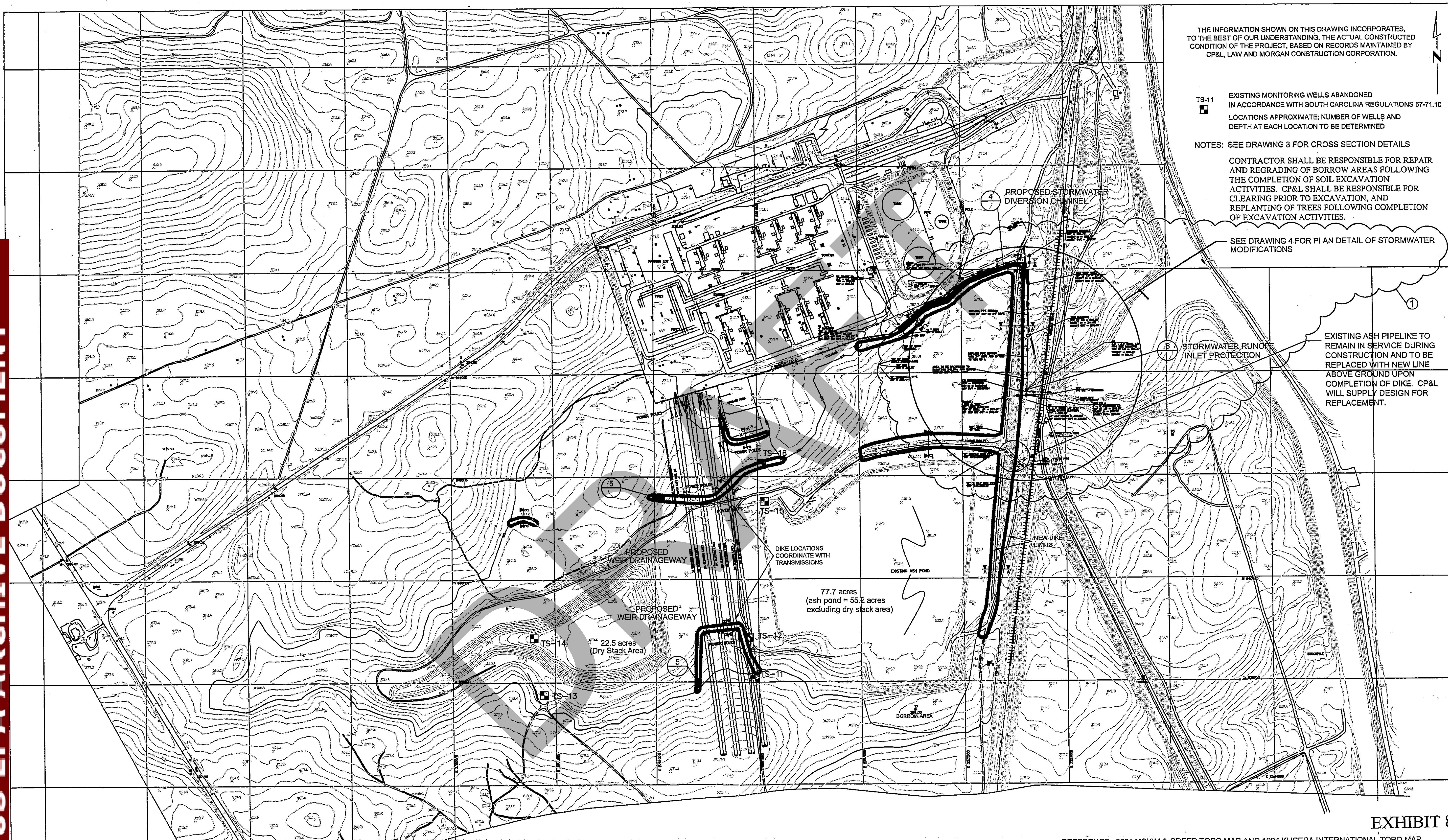


EXHIBIT 8

REFERENCE: 2001 MCKIM & CREED TOPO MAP AND 1994 KUCERA INTERNATIONAL TOPO MAP

TOPO PLAN

REV.	DATE	BY	SUB.	APP.	DESCRIPTION
2	12/02	JAM			AS-BUILT
1	3/02	JAM			REVISE STORMWATER PIPING ALONG TOE OF DAM TO REFLECT ACTUAL CONDITIONS

DESIGNED
DRAWN BY
CHECKED
APPROVED
DATE DEC-2002

SEAL

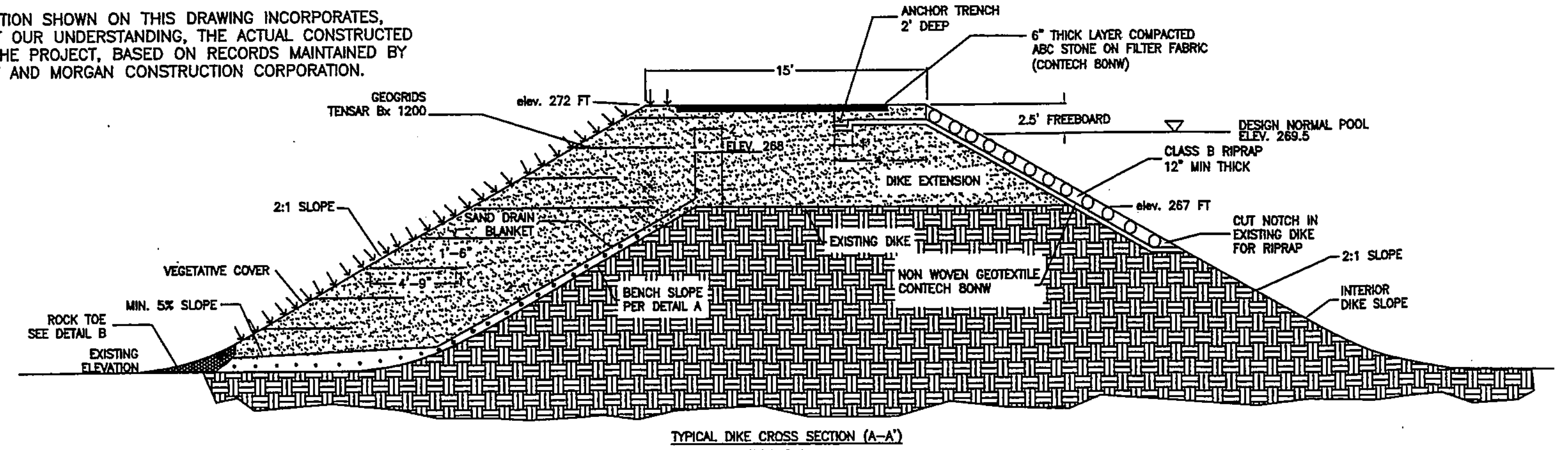
LAW
LAWGIBB Group Member
LAW ENGINEERING AND ENVIRONMENTAL SERVICES, Inc.
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27604

CP&L
RALEIGH, NORTH CAROLINA

OVERALL TOPOGRAPHIC PLAN
MODIFICATIONS TO ASH POND DAM
CP&L ROBINSON PLANT
HARTSVILLE, SOUTH CAROLINA

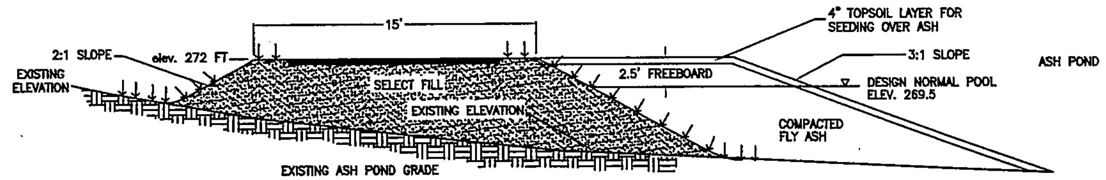
SCALE 1"=200'
JOB NO. 30720-1-4776
DWG 2

THE INFORMATION SHOWN ON THIS DRAWING INCORPORATES, TO THE BEST OF OUR UNDERSTANDING, THE ACTUAL CONSTRUCTED CONDITION OF THE PROJECT, BASED ON RECORDS MAINTAINED BY CP&L, LAW AND MORGAN CONSTRUCTION CORPORATION.

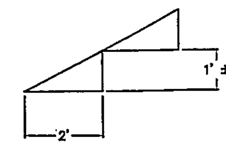


TYPICAL DIKE CROSS SECTION (A-A')
Not to Scale

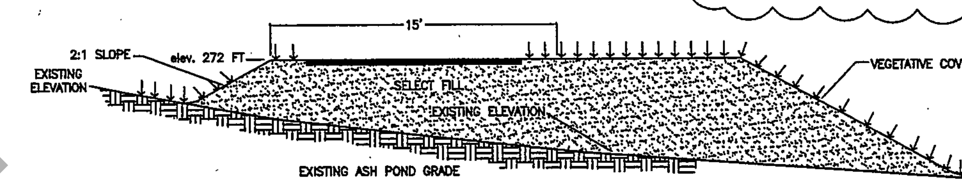
NOTE: RIPRAP REQUIRED ONLY FOR NORTHERN FACE OF SEPARATOR DIKE.



TYPICAL DIKE CROSS SECTION (B-B')
Not to Scale

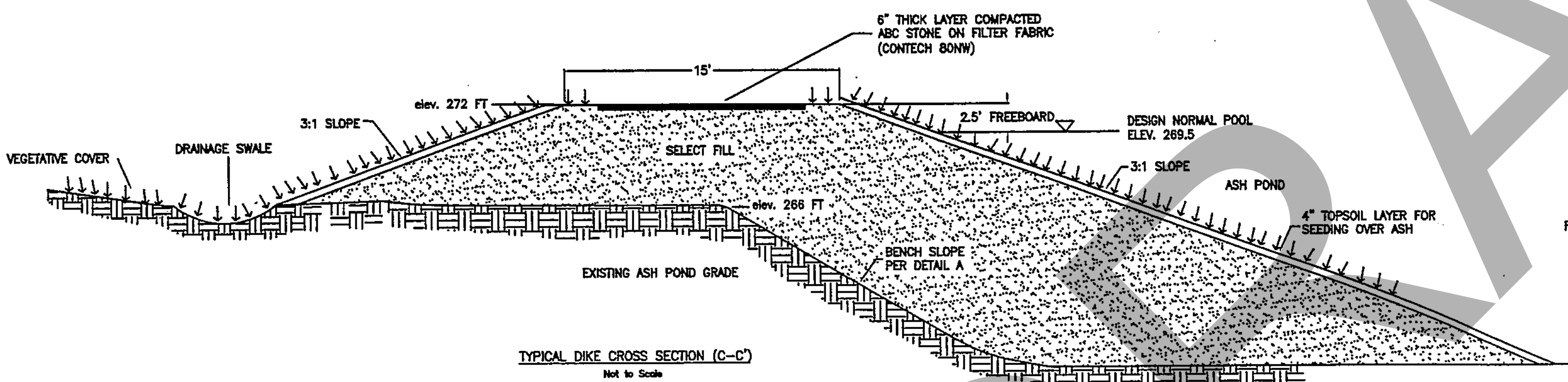


SLOPE BENCH DETAIL A
Not to Scale

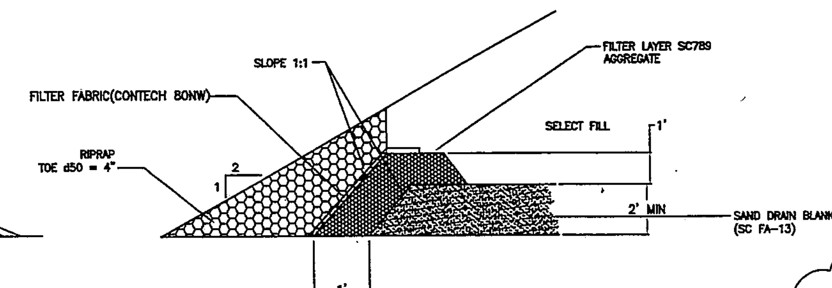


CROSS SECTION (E-E')
Not to Scale

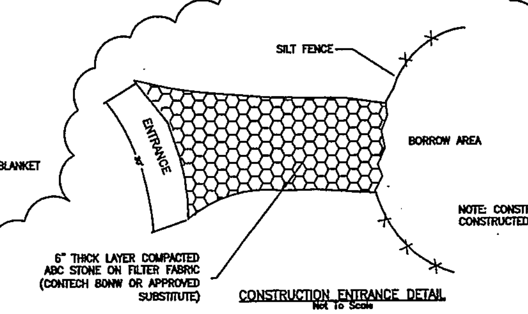
EXHIBIT 9



TYPICAL DIKE CROSS SECTION (C-C')
Not to Scale

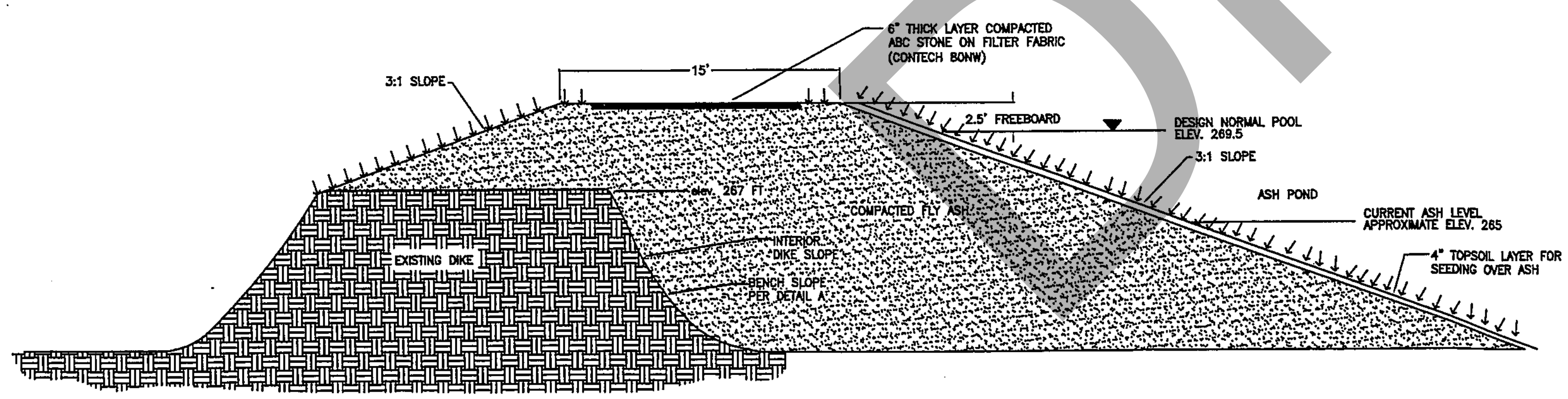


ROCK TOE DETAIL B
Not to Scale

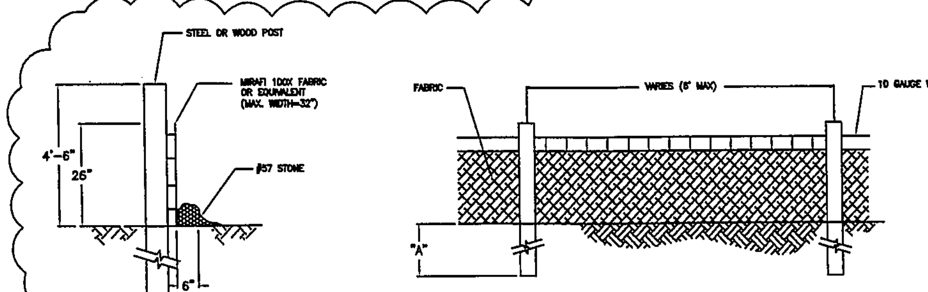


NOTE: CONSTRUCTION ENTRANCES SHOULD BE CONSTRUCTED AT ALL SOIL BORROW AREAS.

CONSTRUCTION ENTRANCE DETAIL
Not To Scale



TYPICAL DIKE CROSS SECTION (D-D')
Not to Scale



SILT FENCE DETAIL
Not To Scale

CONSTRUCTION GUIDE SPECIFICATIONS

Dike Construction

1) Install sediment erosion control measures shown on plans.

2) Remove debris and deleterious organics (i.e. roots, vegetation. etc.) from the existing slopes and properly dispose offsite. Disposal within existing ash pond may be allowed by owner.

3) Abandon existing piezometers in dike by removing steel casings and grouting with cement-bentonite grout.

4) Prepare, shape and grade subgrade of existing slope prior to placement of fill material by benching as shown. Subgrade shall be inspected by engineer prior to construction of the dikes.

5) Construct the dike sections as shown in appropriate cross sections on drawing.

6) Install weir drainageways in appropriate dike sections as shown on Drawing 5.

7) Select fill shall consist of soil with Unified Soil Classification symbols SC, SM, ML or CL. Soil in indicated borrow areas is acceptable. Offsite soils proposed for use shall be tested and approved by engineer prior to use. Ash fill may be obtained from any accessible area of existing pond or dry stock.

8) Backfill shall be placed in 8-inch loose lifts (maximum) and compacted to 95 percent of the maximum dry density (MDD) of the standard Proctor appropriately representing the backfill material. For sands with less than 20 percent finer than No. 200 sieve (the typical on-site borrow soil), compaction shall be to 80 percent relative density.

9) Moisten fill materials as required for proper compaction. Scarify, disc, moisten or dry fill lifts as required for successive lifts to properly bond.

10) Install drain blanket and rock toe in conjunction with fill placement.

11) Install geogrids in accordance with manufacturer's guidelines.

12) Engineer will conduct field density testing at a frequency of at least one field density test per 10,000 square feet per lift of fill material. Coordinate fill placement with engineer to allow testing in a timely manner.

13) Install 2 piezometers on crest of dike and 2 on slope at locations to be directed by engineer. Piezometers to consist of 2" PVC casing with 0.1 mm slotted screen (5'), sand, bentonite seal above screen and grout to surface. Install 4" steel surface casing with 2' in ground and 2' stickup and with locking cap.

14) Upon completion of construction activities, dikes and dike extensions shall be properly seeded in accordance with the seeding specifications. Final cover shall be installed as soon as possible but no later than 14 days from reaching final grade. All denuded, rilled or rutted areas resulting from construction traffic shall be reworked and properly reseeded.

15) All ash fill surfaces shall be covered with at least 4" of topsoil disked to mix with ash prior to seeding.

1

Seeding

1) Temporary seeding (summer), if necessary, shall be German Millet applied at 40 lbs. per acre. Apply 3,000–5,000 lbs. per acre ground agricultural limestone and 750 lbs./acre 10-10-10 fertilizer to a properly prepared seedbed as described in the North Carolina Erosion and Sediment Control Planning and Design Manual. Temporary seeding shall be required for denuded areas that will not be brought to final grade within 30 days or in areas where surface stabilization is needed due to construction activities.

2) Permanent seeding shall be applied by hydro seeding in accordance with the following requirements:

Species	Rate (lb/acre)
Pensacola Bahiagrass -	50
Common Bermudagrass	10
German Millet	10

Notes:

1. Where a neat appearance is desired, omit sericea.
2. Use common Bermudagrass only on isolated sites where it cannot become a pest.
3. Bermudagrass may be replaced with 5 lb/acre centipedegrass.

Seedbed Preparation

Seedbed shall be prepared to allow for establishment of temporary and final covers (Reference North Carolina Erosion and Sediment Control Planning and Design Manual for additional information on seedbed preparation if needed). Apply soil amendments and mulch as described in the following sections.

Seeding Dates:

April 1–July 15

Soil Amendments

Apply lime and fertilizer according to soil tests, or apply 3000-lb/acre ground agricultural limestone and 500-lb/acre 10-10-10 fertilizer.

Mulch

Apply 4,000-lb/acre grain straw or equivalent cover of another suitable mulch. Anchor by tacking with asphalt, roving, or netting or by crimping with a mulch-anchoring tool. A disk with blades set nearly straight can be used as a mulching tool.

Maintenance

Refertilize the following April with 50 lb/acre nitrogen. Repeat as growth requires. May be mowed only once per year. If sericea is omitted, mow as often as needed.

1

NOTES:

DISTURBED AREA = ±4.8 ACRES

SILT FENCE CONSTRUCTION

1) TEMPORARY SILT FENCING SHALL BE PLACED AROUND THE PERIMETER OF BORROW ARES, AS SHOWN ON DRAWING NO. 2.

2) FILTER FABRIC SHALL BE A MAXIMUM 32-INCH WOVEN OR NON-WOVEN POLYPROPYLENE, NYLON OR POLYESTER CONTAINING ULTRAVIOLET STABLIZERS.

3) STAKES SHALL BE 2 TO 4 INCH DIAMETER SEASONED WOOD OR 1.33 POUNDS PER FOOT METAL STEEL POSTS, AT A MAXIMUM SPACE OF 6 FT ON CENTER.

4) FILTER FABRIC SHALL BE SECURED TO THE STAKES USING 10 GAUGE WIRE MESH WITH STAPLES, TIE WIRE OR HOG RINGS.

5) A 6-INCH FILTER FABRIC SKIRT SHALL BE LAID ON THE GROUND (RUNNING THE ENTIRE LENGTH OF THE FENCE) AND COVERED WITH A 6-INCH LAYER OF #57 STONE.

SILT FENCE MAINTENANCE

1) SILT FENCING SHALL BE INSPECTED ON A WEEKLY BASIS AND AFTER EACH SIGNIFICANT RAINFALL DURING ACTIVE SOIL EXCAVATION PERIODS.

2) SEDIMENT DEPOSITS MUST BE REMOVED FROM THE THE UPSTREAM SIDE OF THE SILT FENCES WHEN THEY REACH ONE-THIRD OF THE HEIGHT OF THE FENCE.

3) DAMAGED SILT FENCING SHALL BE REPAIRED OR REPLACED IMMEDIATELY.

4) UPON COMPLETION OF EXCAVATION ACTIVITIES THE SILT FENCING MAY BE REMOVED, PROVIDED THAT A PERMANENT VEGETATION STAND IS STABLE.

DIKE DETAIL

REV.	DATE	BY	SUB.	APP.	DESCRIPTION
2	12/02	JAM			AS-BUILT
1	3/02	JAM			MOVED SEDIMENT AND EROSION CONTROL HERE FROM ORIGINAL SHEET 6

DESIGNED
DRAWN BY
CHECKED
APPROVED
DATE DEC-2002

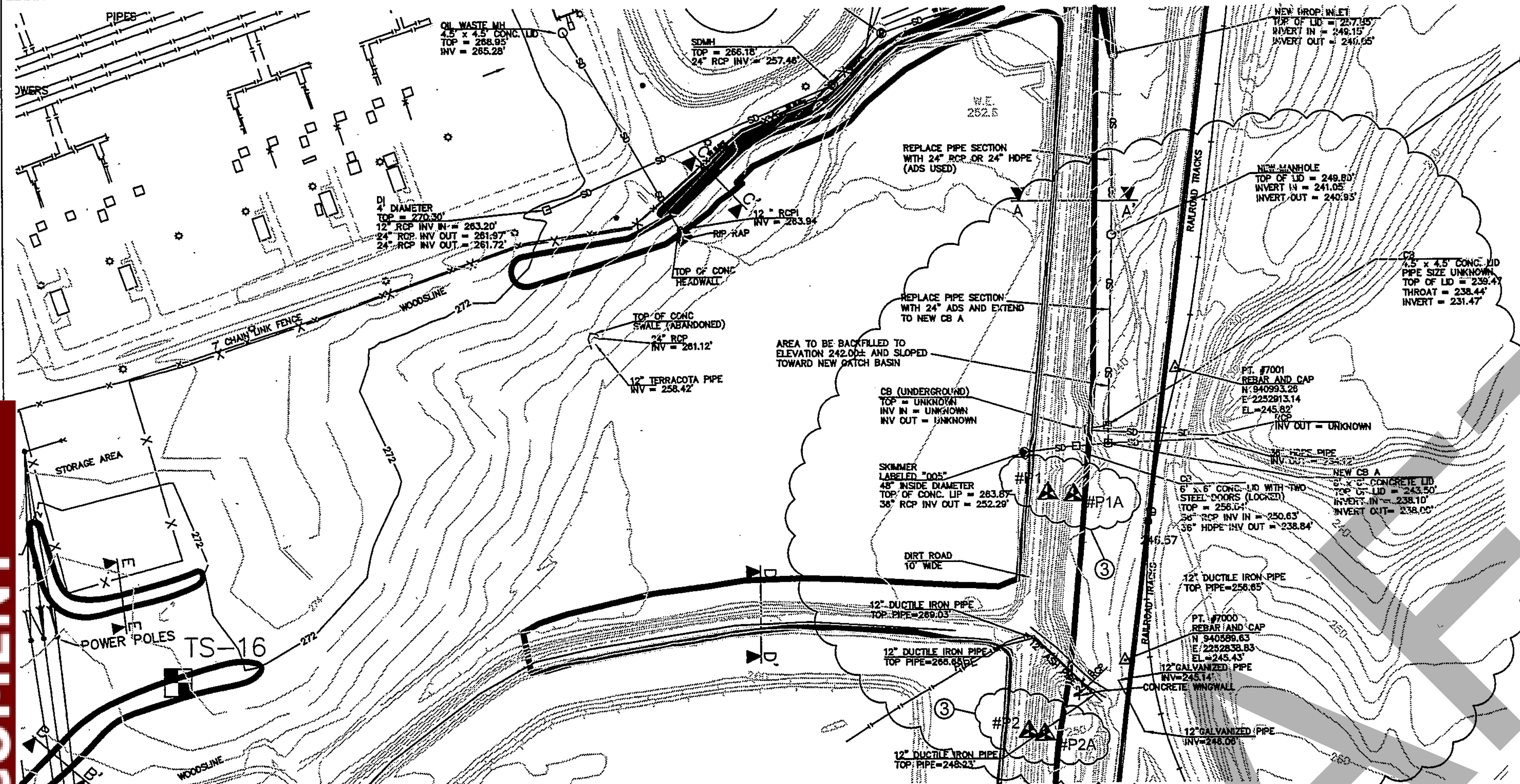
SEAL

LAW
LAWGIBB Group Member
LAW ENGINEERING AND ENVIRONMENTAL SERVICES, Inc.
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27604

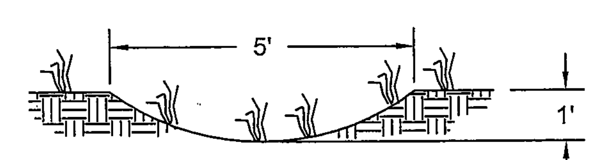
CP&L
RALEIGH, NORTH CAROLINA

DIKE CROSS SECTION DETAILS
MODIFICATIONS TO ASH POND DAM
CP&L ROBINSON PLANT
HARTSVILLE, SOUTH CAROLINA

SCALE AS SHOWN
JOB NO. 30720-1-4776
DWG 3

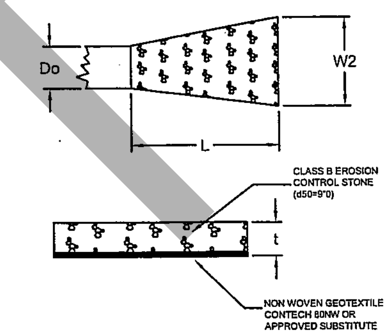


SCALE: 1" = 100'

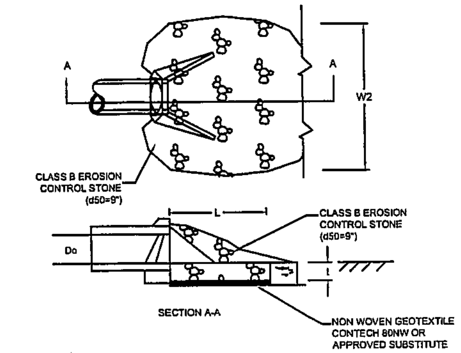


TYPICAL CHANNEL CROSS SECTION
N.T.S

NOTE: SEE DRAWING 3 FOR VEGETATIVE LINING SEEDING SPECIFICATIONS



CHANNEL OUTLET PROTECTION
N.T.S.



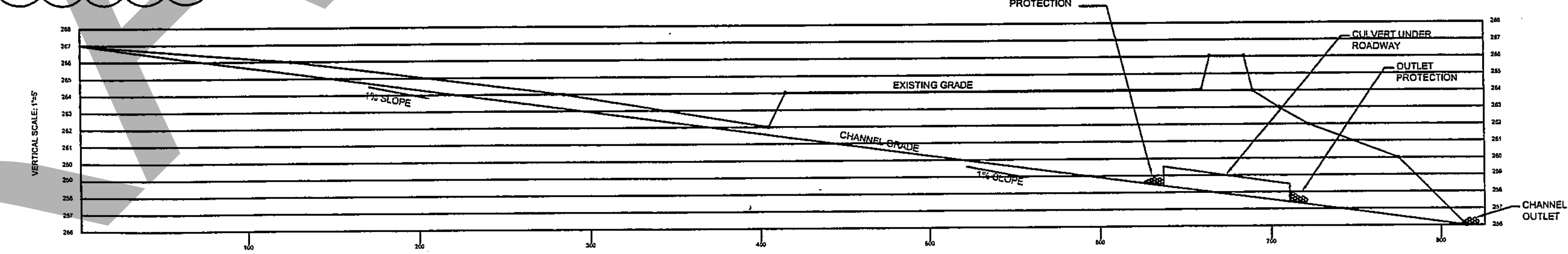
CULVERT INLET/OUTLET PROTECTION
N.T.S.

INLET/OUTLET PROTECTION SCHEDULE				
LOCATION	W2 (FT.)	Do (FT.)	L (FT.)	t (FT.)
CULVERT INLET	5.0	2.0	10.0	2.0
CULVERT OUTLET	5.0	2.0	10.0	2.0
CHANNEL OUTLET	9.0	5.0	10.0	2.0

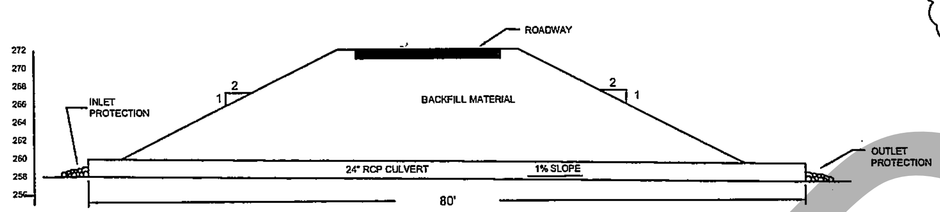
3

PIEZOMETER ELEVATIONS, FEET, MSL
(TOP OF WELL CASING)

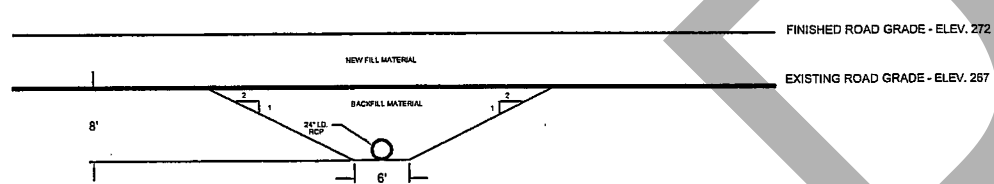
P-1	272.03
P-1A	261.85
P-2	272.09
P-2A	265.86



PROFILE E-E'

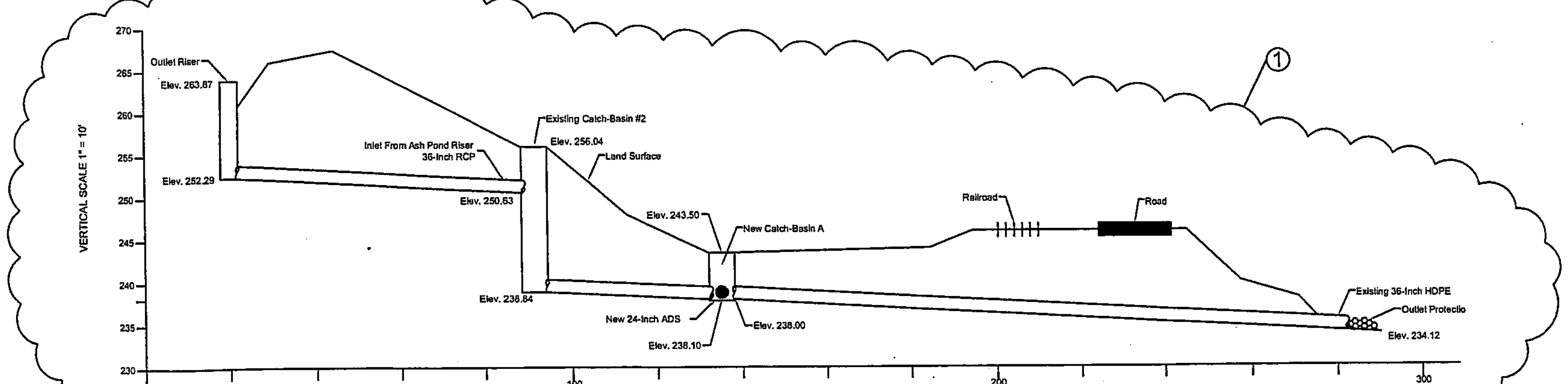


SECTION E-E'



SECTION F-F'

CULVERT DETAIL
SCALE: 1" = 10'



SECTION H-H'
HORIZONTAL SCALE 1" = 20'

THE INFORMATION SHOWN ON THIS DRAWING INCORPORATES, TO THE BEST OF OUR UNDERSTANDING, THE ACTUAL CONSTRUCTED CONDITION OF THE PROJECT, BASED ON RECORDS MAINTAINED BY CP&L, LAW AND MORGAN CONSTRUCTION CORPORATION.

EXHIBIT 10

DRAFT

CHANNEL DETAIL

REV.	DATE	BY	SUB.	APP.	DESCRIPTION
3	4/03	JAT			ADD PIEZOMETER INFORMATION
2	12/02	JAM			AS-BUILT
1	3/02	JAM			GENERAL REVISIONS

DESIGNED
DRAWN BY
CHECKED
APPROVED
DATE DEC-2002

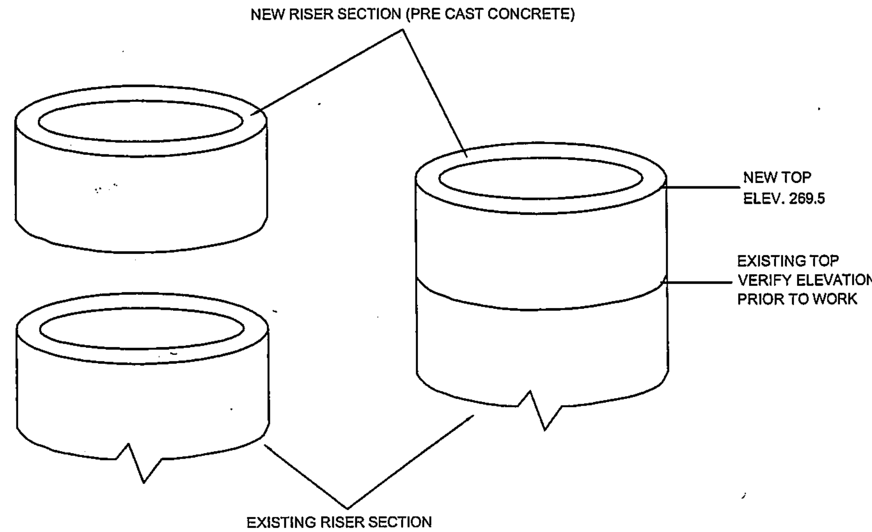
SEAL

LAW
LAWGIBB Group Member
LAW ENGINEERING AND ENVIRONMENTAL SERVICES, Inc.
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27604

CP&L
RALEIGH, NORTH CAROLINA

STORMWATER DRAINAGE IMPROVEMENTS
MODIFICATIONS TO ASH POND DAM
CP&L ROBINSON PLANT
HARTSVILLE, SOUTH CAROLINA

SCALE AS SHOWN
JOB NO. 30720-1-4776
DWG 4



RISER EXTENSION CONNECTION DETAIL
Not To Scale

NOTES:

RISER CONNECTION

1) REMOVE EXISTING SKIMMER.

2) PLACE NEW RISER SECTION ON TOP OF EXISTING RISER SECTION, AS SHOWN ON DRAWING.

3) PLACE CADILLOC EXTERNAL SEALING BAND AROUND JOINT CONNECTION OF EXISTING RISER AND NEW RISER EXTENSION, AS SHOWN ON DRAWING.

4) PLACE COUPLING BAND AROUND RISER JOINT AND EXTERNAL SEALING BAND AS SHOWN ON DRAWING.

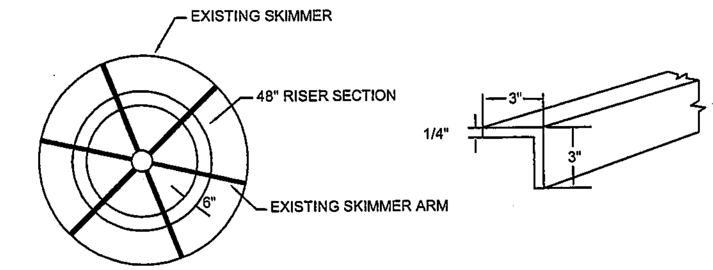
5) APPLY CORROSION PROTECTIVE COATING IN COUPLING BAND, AS SPECIFIED ON DRAWING.

6) FINISHED RISER EXTENSION SHALL BE 2.5 FEET BELOW THE FINISHED DIKE CREST ELEVATION OF THE ASH POND.

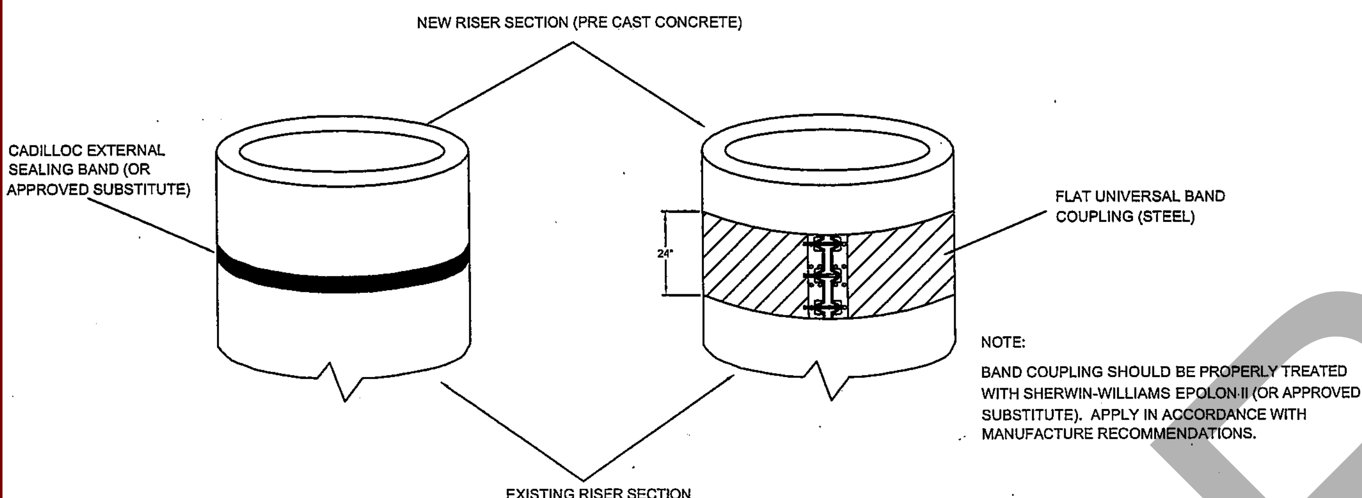
SKIMMER - RISER CONNECTION

1) SAW CUT KEYS (6) INTO RISER EXTENSION, FOR PLACEMENT OF SKIMMER ARMS.

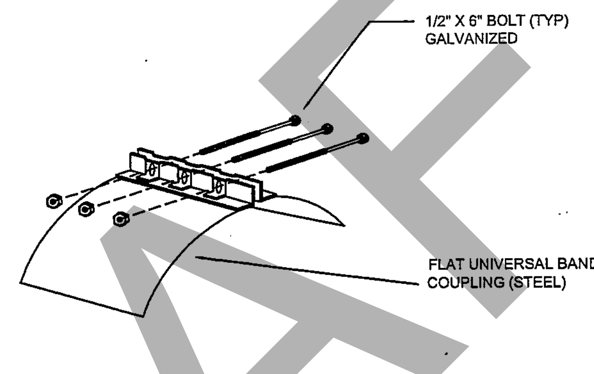
2) INSERT SKIMMER ARMS INTO KEYS FOR PLACEMENT OF SKIMMER ON NEW RISER SECTION.



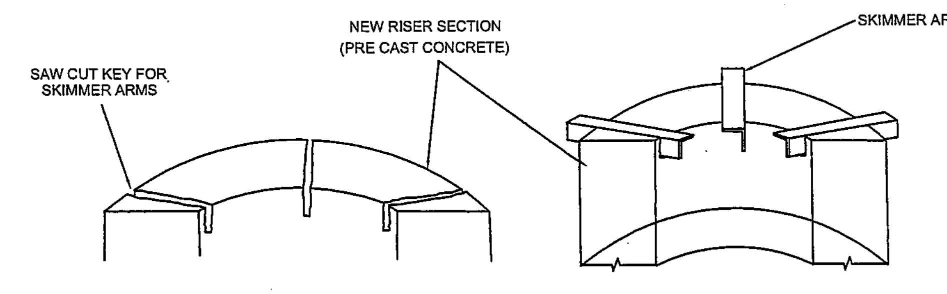
EXISTING SKIMMER DETAIL
Not To Scale



NOTE:
BAND COUPLING SHOULD BE PROPERLY TREATED WITH SHERWIN-WILLIAMS EPOLON II (OR APPROVED SUBSTITUTE). APPLY IN ACCORDANCE WITH MANUFACTURE RECOMMENDATIONS.

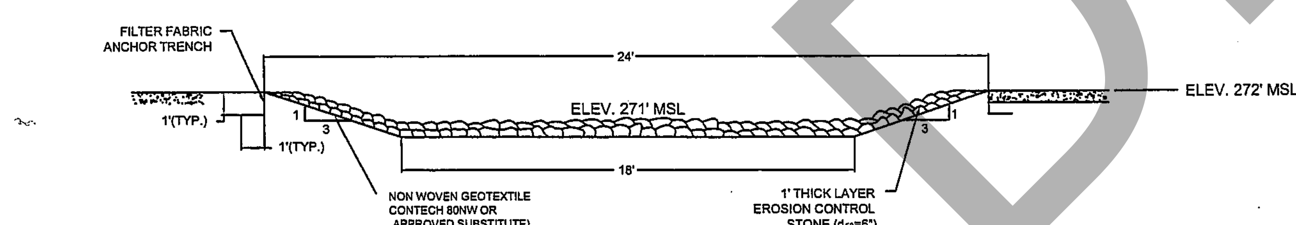


BAND COUPLING CONNECTOR DETAIL
Not To Scale

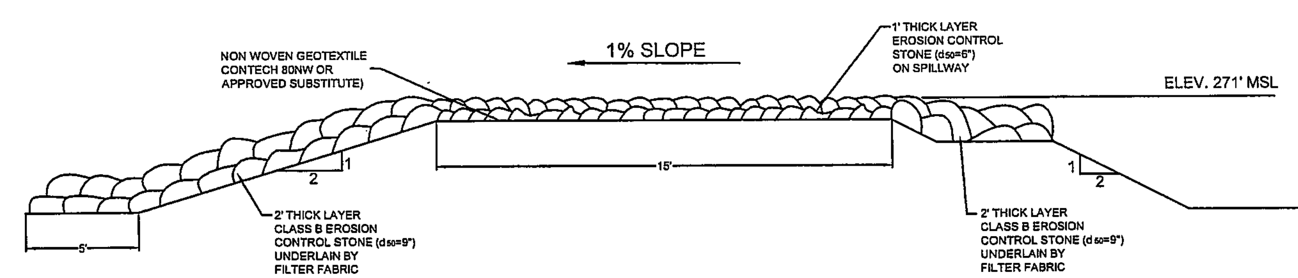


SKIMMER-RISER CONNECTION DETAIL
Not To Scale

WEIR DRAINAGEWAY DETAILS



DRAINAGEWAY SECTION (PERPENDICULAR TO FLOW)



DRAINAGEWAY TRANSVERSE SECTION (PARALLEL TO FLOW)

THE INFORMATION SHOWN ON THIS DRAWING INCORPORATES, TO THE BEST OF OUR UNDERSTANDING, THE ACTUAL CONSTRUCTED CONDITION OF THE PROJECT, BASED ON RECORDS MAINTAINED BY CP&L, LAW AND MORGAN CONSTRUCTION CORPORATION.

NOTE: DRAINAGEWAYS LOCATED WITHIN SADDLE DIKES PROXIMAL TO HIGH-VOLTAGE POWER POLES (SEE DRAWING 2)

EXHIBIT 11

RISER DETAIL

REV.	DATE	BY	SUB.	APP.	DESCRIPTION
1	12/02	JMA			AS-BUILT

DESIGNED
DRAWN BY
CHECKED
APPROVED
DATE DEC-2002

SEAL

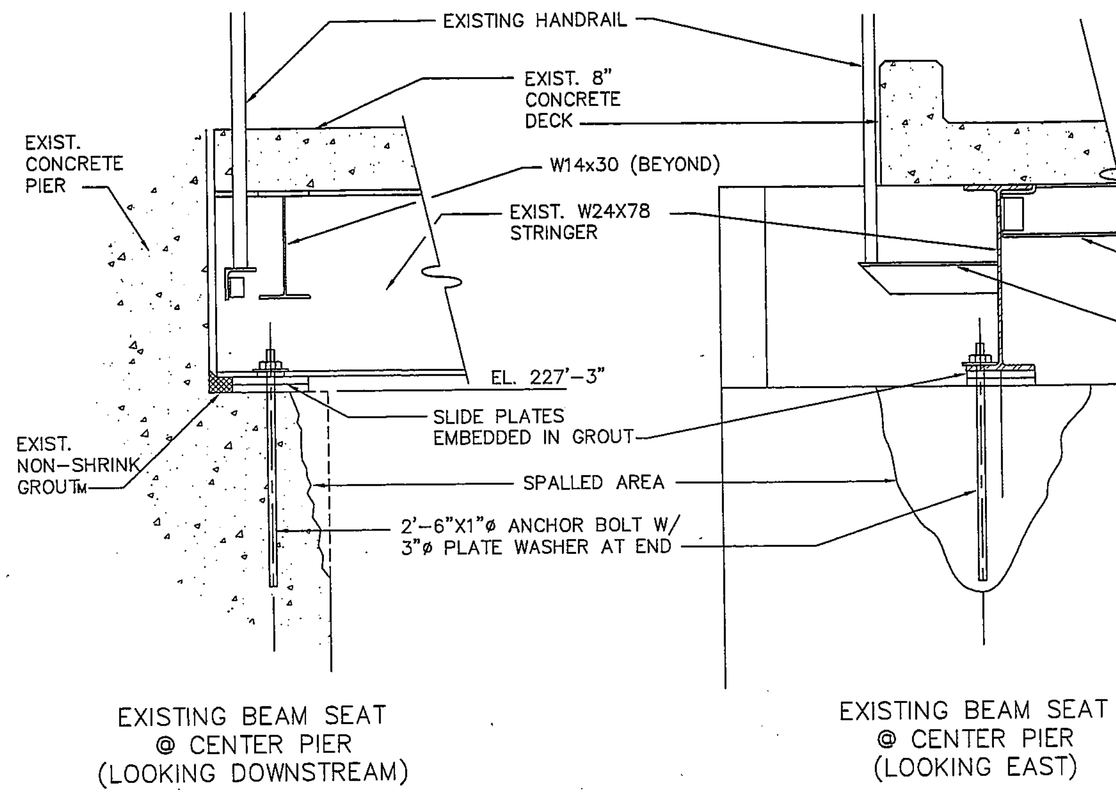
LAW
LAWGIBB Group Member
LAW ENGINEERING AND ENVIRONMENTAL SERVICES, Inc.
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27604

CP&L
RALEIGH, NORTH CAROLINA

WEIR DRAINAGEWAY AND RISER DETAILS
MODIFICATIONS TO ASH POND DAM
CP&L ROBINSON PLANT
HARTSVILLE, SOUTH CAROLINA

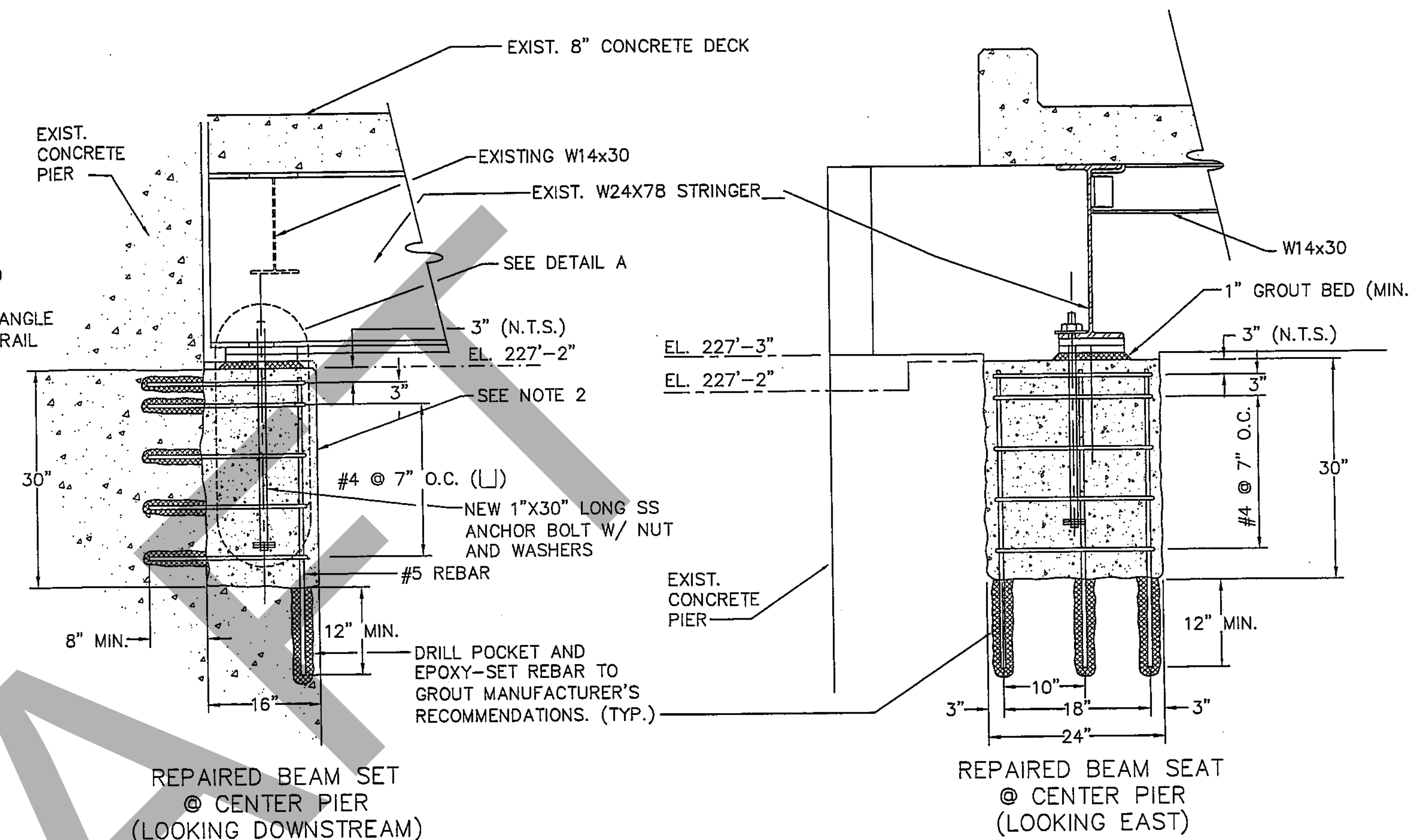
SCALE NTS
JOB NO. 30720-1-4776
DWG 5

FRM-PDGC-00021, Rev.4



BEAM SEAT – EXISTING CONDITIONS

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

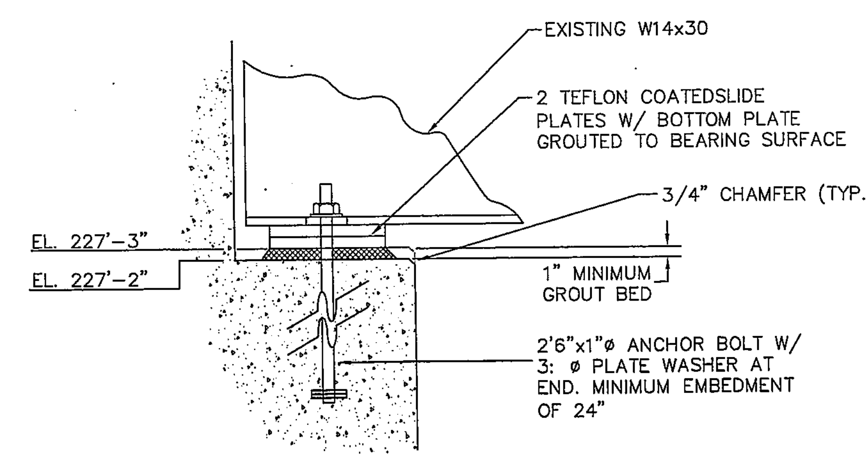


BEAM SEAT – BEAR PLATE MODIFICATIONS

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

NOTES:

1. PROVIDE TEMPORARY SHORING FOR THE CONCRETE BRIDGE STRUCTURE PRIOR TO ANY DEMOLITION OF THE CONCRETE. TEMPORARY SHORING PLAN WITH CALCULATIONS SHALL BE SUBMITTED AND APPROVED PRIOR TO ANY DEMOLITION.
2. REMOVE BEARING HARDWARE AFTER THE COMPLETION OF THE DEMOLITION OF THE BEARING LEDGE POCKET.
3. SAW CUT JOINTS AND CAREFULLY CHIP OUT EXISTING CONCRETE 30" DEEP (TOP TO BOTTOM), 16" DEEP (FRONT TO BACK), AND 24" WIDE (SIDE TO SIDE) OR UNTIL SOLID SECURE CONCRETE IS ENCOUNTERED, WHICHEVER IS LARGER.
4. INSTALL NEW STAINLESS STEEL ANCHOR BOLTS, TEFLON SLIDE PLATES, AND ASSOCIATED HARDWARE DURING THE PLACEMENT OF NEW REPAIR GROUT.
5. DOWEL IN REBAR TO DEPTHS AS SHOWN ON PLAN. USE HILTI C100 OR AN APPROVED EQUAL EPOXY ADHESIVE TO ANCHOR THE DOWELS INTO PLACE. ALL REBAR / DOWELS SHALL HAVE A MINIMAL CLEARANCE OF 2" FROM ALL EXPOSED EDGES OF THE CONCRETE PATCH.
6. CONCRETE SHALL BE A HIGH-EARLY STRENGTH MIX (MINIMUM f'c=4000psi). WITH PRIOR APPROVAL BY OWNER, CONTRACTOR SHALL HAVE THE OPTION OF USING A VENDOR SUPPLIED STRUCTURAL CONCRETE BY 5 STAR OR AN APPROVED EQUAL IN LIEU OF BATCHED CONCRETE. THE CONTRACTOR SHALL SUBMIT MIX DESIGNS TO THE OWNER PRIOR TO ORDERING ANY CONCRETE.
7. PRIOR TO PLACING NEW CONCRETE, ROUGHEN ALL SURFACES TO A MINIMUM ½" APPLITUDE, REMOVE ALL LOOSE MATERIAL, AND APPLY BONDING AGENT.
8. INJECT AREAS EXHIBITING CRACKING AND EFFLORESENCE WITH EPOXY CRACK FILLER. ALL CHEMICAL MATERIALS SHALL BE APPROVED PRIOR TO ARRIVAL ON SITE BY THE OWNER.
9. SEAL ALL CONCRETE SURFACES WITH SILOXANE SEALER AFTER STRUACTURAL REPAIRS ARE MADE.
10. SEE SPECIFICATIONS FOR ALL APPLICALBLE CODES AND CONSTRUCTION REQUIREMENTS.



DETAIL 'A' – ANCHOR BOLT DETAIL

SCALE: 3/4" = 1'-0"

EXHIBIT 12

DRAFT

DID NO.: AAA-NNN-ANN-NNNNN

REV	DESCRIPTION	DRAWN	CHKD	APPRVD	DATE
0	APPROVED FOR CONSTRUCTION	WGF	CNH	WGF	09/03/2003
A	ISSUE WITH BID PACKAGE SPECIFICATION	WGF	CNH	TSH	08/13/2003

CONTRACTOR/VENDOR INFORMATION

VENDOR'S LOGO, NAME, ADDRESS, TELEPHONE NUMBER AND ANY REFERENCE NUMBERS IN SPACE ABOVE. ALL DRAWINGS TO BE PRODUCED IN AUTOCAD RELEASE 2000 OR LATER.

Progress Energy

PROGRESS ENERGY CAROLINAS, INC.

POWER OPERATIONS GROUP

FACILITY: H.B. ROBINSON	PROJ NO:	TITLE: H.B. ROBINSON UNIT 1 COOLING LAKE SPILLWAY CENTER PIER CONCRETE REPAIRS
UNIT: UNIT 1	EC NO:	
SYSTEM: COOLING LAKE	W.O. NO:	DWG NO: SK-ROB-U1-CL-001
SCALE: AS SHOWN	PLOT: 1=24	SIZE: ANSI-B; SHEET: 1 OF 1; REV: A

D H E C
PROMOTE PROTECT PROSPER
C. Earl Hunter, Commissioner
Promoting and protecting the health of the public and the environment.

January 14, 2009

Wellie L. Gilbert
CP&L, Progress Energy
Fossil Generation
3512 Lakeside Drive
Hartsville, SC 29550

Re: Reinspection of Dam D-0010
Lake Robinson Dam
Darlington County

Dear Mr. Gilbert:

On December 15th, a reinspection of the above dam was performed. Thank you and Winston Stewart for your time.

No deficiencies were noted. Your routine inspections were discussed. The gates were tested under normal power and emergency power.

We ask that you review and update your Emergency Alert Notification Plan. For the DHEC regional office, please list the office number (843-661-4825 and twenty-four hour emergency number 888-481-0125).

If you have any questions, please feel free to contact this office.

Sincerely,

Gary L. Stowe
District Engineer

cc: James E. Owens, Region 4- Florence
Bureau of Water File

EXHIBIT 13

Extracted from Progress Energy Report
Lake Robinson Spillway Tainter Gate Inspection - Dated 12-19-07

Attachment A

Tainter Gate: A(East) B(West)
Inspector: Winston Stewart / Tommy Bragwell (TVA – QC Inspector)
Date: 12-04-07 thru 12-06-07
Weather: Partly Sunny to Sunny (30ºF to 65ºF)

West Frame

Member	Type	Web t_w (in)	Flange t_f (in)	Comments
1	W 12x50	3/8	5/8	100% rust bloom on the wall side flange; Maximum ¼" loss of metal on bottom inside flange
2	W 12x72	7/16	11/16	Rust bloom over much of the wall side flange (max. 1/32" loss of metal at girder connection)
3	W 12x72	7/16	11/16	Rust bloom over much of the wall side flange with no significant damage
4	I 10x25.4	5/16	1/2	50% average loss of metal on the entire length of wall side flange
5	I 10x25.4	5/16	1/2	Satisfactory – blast and paint
6	W 10x33	1/8	5/16	Satisfactory – blast and paint
7	W 10x33	1/8	5/16	100% rust bloom on the wall side flange and web (max. 1/32" loss of metal)
8	C 10x15.3	1/4	7/16	Localized rust max 1/16" loss inside flange, 1/32" wall side flange; 100% rust bloom 1/32" loss on web
9	C 10x15.3	1/4	7/16	100% rust bloom on the wall side flange with 1/32" max loss of metal
10	L 2½x2½ x 5/16			Satisfactory – blast and paint
11	L 2½x2½ x 5/16			Satisfactory – blast and paint
12	L 2½x2½ x 5/16			Satisfactory – blast and paint
13	L 2½x2½ x 5/16			Satisfactory – blast and paint

East Frame

Member	Type	Web t_w (in)	Flange t_f (in)	Comments
1	W 12x50	3/8	5/8	Satisfactory – blast and paint
2	W 12x72	7/16	11/16	Satisfactory – blast and paint
3	W 12x72	7/16	11/16	Satisfactory – blast and paint
4	I 10x25.4	5/16	1/2	Satisfactory – blast and paint
5	I 10x25.4	5/16	1/2	100% rust bloom on the wall side flange with max 1/32" metal loss
6	W 10x33	1/8	5/16	100% rust bloom on the wall side flange and web (max. 1/4" loss of metal)
7	W 10x33	1/8	5/16	Satisfactory – blast and paint
8	C 10x15.3	1/4	7/16	Satisfactory – blast and paint
9	C 10x15.3	1/4	7/16	100% rust bloom on the wall side flange with max 1/32" metal loss
10	L 2½x2½ x 5/16			100% rust bloom for entire length with max 1/8" metal loss
11	L 2½x2½ x 5/16			Satisfactory – blast and paint
12	L 2½x2½ x 5/16			Satisfactory – blast and paint
13	L 2½x2½ x 5/16			Satisfactory – blast and paint

Girders, Ribs and Truss

Member	Type	Web t_w (in)	Flange t_f (in)	Comments
14	W 33x141	5/8	15/16	Localized rust on the downstream east corner with 1/32 average loss of metal
15	W 36x245	13/16	1-3/8	Satisfactory – blast and paint
16	W 36x245	13/16	1-3/8	Satisfactory – blast and paint
Vertical Rib (typ)	C 15x33.9	3/8	5/8	Several locations with severe rust with max 50% loss of downstream flanges
Vertical Truss (typ)	L 4x4 x 3/8			Satisfactory – blast and paint

***See Pages 4 thru 10 of this attachment for more detail and for the condition of the connections (gusset plates and rivets / bolts)**

Attachment A

Tainter Gate: **A (East Gate)**
Inspector: **Winston Stewart / Jimmy Dale Smith (TVA – QC Inspector)**
Date: **01-29-08 thru 02-01-08**
Weather: **Partly Sunny to Sunny (30°F to 65°F)**

West Frame

Member	Type	Web t_w (in)	Flange t_f (in)	Comments
1	W 12x50	3/8	5/8	Rust bloom over much of the wall side flange (max. 1/16" loss of metal on bottom inside flange -spots)
2	W 12x72	7/16	11/16	Rust bloom over much of the wall side flange with no significant damage
3	W 12x72	7/16	11/16	Rust bloom over much of the wall side flange with no significant damage
4	I 10x25.4	5/16	1/2	50% average loss of metal on the entire length of wall side flange
5	I 10x25.4	5/16	1/2	Satisfactory – blast and paint
6	W 10x33	1/8	5/16	Satisfactory – blast and paint
7	W 10x33	1/8	5/16	Satisfactory – blast and paint
8	C 10x15.3	1/4	7/16	Rust bloom over much of the wall side flange (max. 3/32" loss of metal on 2ft section of flange)
9	C 10x15.3	1/4	7/16	Satisfactory – blast and paint
10	L 2½x2½ x 5/16			Satisfactory – blast and paint
11	L 2½x2½ x 5/16			Satisfactory – blast and paint
12	L 2½x2½ x 5/16			Satisfactory – blast and paint
13	L 2½x2½ x 5/16			Satisfactory – blast and paint

East Frame

Member	Type	Web t_w (in)	Flange t_f (in)	Comments
1	W 12x50	3/8	5/8	Satisfactory – blast and paint
2	W 12x72	7/16	11/16	Satisfactory – blast and paint
3	W 12x72	7/16	11/16	Satisfactory – blast and paint
4	I 10x25.4	5/16	1/2	Satisfactory – blast and paint
5	I 10x25.4	5/16	1/2	100% rust bloom on the wall side flange with max 3/32" on 2 ft section of flange
6	W 10x33	1/8	5/16	Satisfactory – blast and paint
7	W 10x33	1/8	5/16	Satisfactory – blast and paint
8	C 10x15.3	1/4	7/16	Rust bloom on 3 ft portion of wall side flange with max 1/8" metal loss
9	C 10x15.3	1/4	7/16	Rust bloom on 2 ft portion of wall side flange with max 1/32" metal loss
10	L 2½x2½ x 5/16			Satisfactory – blast and paint
11	L 2½x2½ x 5/16			Satisfactory – blast and paint
12	L 2½x2½ x 5/16			Satisfactory – blast and paint
13	L 2½x2½ x 5/16			Satisfactory – blast and paint

Girders, Ribs and Truss

Member	Type	Web t_w (in)	Flange t_f (in)	Comments
14	W 33x141	5/8	15/16	Satisfactory – blast and paint
15	W 36x245	13/16	1-3/8	Satisfactory – blast and paint
16	W 36x245	13/16	1-3/8	Satisfactory – blast and paint
Vertical Rib (typ)	C 15x33.9	3/8	5/8	Several locations with severe rust with max 50% loss of downstream flanges
Vertical Truss (typ)	L 4x4 x 3/8			Satisfactory – blast and paint

***See notes on Pages 3 thru 10 of this attachment for more detail and for the condition of the connections (gusset plates and rivets / bolts)**

Document title

Robinson Fossil Power Plant Dam and Dike Inspection

Document number

EVC-RFPC-00027

Applies to: Robinson Fossil Plant - Carolinas

Keywords: emergency; Robinson fossil plant - environmental

Legend:
OPS Operations
ENG Engineering
WMT Work Management
TRN Training
ENV Environmental
FIN Financial
ICT Combustion Turbine
ADM Administrative

Organizational Applicability							
OPS	ENG	WMT	TRN	ENV	FIN	ICT	ADM
X	X			X			

1.0 PURPOSE

To establish effective and consistent Dam and Dike Inspections to ensure the safety of plant personnel and the general public. Dam safety issues at H. B. Robinson Plant fall under the regulatory jurisdiction of the South Carolina Department of Health and Environmental Control (SCDHEC). This procedure specifies how the H. B. Robinson Plant complies with regulatory requirements, completes and documents dam and dike inspections. In the event an emergency condition described in section 2.1.1 or 2.1.2 occurs plant personnel **SHALL** reference EMG-RFPC-00002 Robinson Fossil Power Plant Ash Pond, Cooling Lake, and Dam Emergency Notification Procedure.

2.0 TERMS AND DEFINITIONS

2.1 Emergency Condition Classifications

2.1.1 Dam failure has occurred - This emergency condition classification will be used to indicate that a breach of the dam has occurred which will release the impoundment in an uncontrolled manner.

2.1.2. Potentially Hazardous Situation - This emergency condition classification will be used to indicate a situation that may ultimately lead to failure of a dam. This could include events such as the following:

- Slope failures for earth embankments that threaten to breach the dam.
- Significant increase in leakage or seepage that is progressively increasing and potentially uncontrollable.
- Cracks or damage to structural features that appear to threaten the stability or integrity of the dam.
- High flows from gate operations or spillway operations that could cause damage to downstream property or pose a hazard to downstream residents.

3.0 RESPONSIBILITIES

3.1 O&M Superintendent

3.1.1 The Robinson Fossil Plant O&M Superintendent **SHALL** verify corresponding PM work orders are generated, scheduled and dispositioned.

3.2 Environmental Specialist

3.2.1 The Robinson Fossil Plant Environmental Specialist **SHALL** have primary responsibility for ensuring program over-site.

3.2.2 The plant environmental coordinator will assist in ensuring that inspection recommendations and deficiencies are addressed in a timely manner. The plant environmental coordinator will contact the Dam and Dike Program Manager – Field Engineering of conditions found during inspection (including construction on or in close proximity to dams) and if inspection results indicate any significant problem(s).

3.3 Chemistry Technicians

3.3.1 The Robinson Fossil Plant Laboratory staff **SHALL** have the primary responsibility for Bi-monthly dam and dike Inspections and semiannual Piezometer measurements.

3.4 PGC Field Engineering

3.4.1 PGC Field Engineering staff **SHALL** have the responsibility for the Robinson Fossil Plant one and five year dam and dike inspections.

4.0 PRECAUTIONS AND LIMITATIONS

None

5.0 PREREQUISITES

5.1 Dam and dike Inspection training. Training will be provided by Mactec Engineering on an as needed basis. (Robinson Dam Inspection Training Materials)

6.0 MATERIAL AND SPECIAL EQUIPMENT

None

7.0 PROCEDURE

7.1 Main Dam:

7.1.1 Main Dam **SHALL** be inspected Bi monthly.

7.1.2 **Notify** Robinson 1 control room.

7.1.3 **Obtain** spillway access key from Robinson 1 Control Room.

7.1.4 **Notify** Robinson Unit 2 Security prior to Inspection.

7.1.5 **Proceed** to the main dam. **Inspect** the spillway structure, noting any deterioration or cracking of the concrete.

7.1.6 **Proceed** to the toe of the main dike, noting any erosion, seepage, cracking, or settling of the dike.

7.1.7 **Complete** bi monthly dam and dike inspection form (Attachment 1).

7.1.8 Any seepage should be visually estimated and compared to previous Inspections and noted on Attachment 1.

7.1.9 **Return** access key to Robinson 1 Control Room.

7.1.10 Environmental Specialist or designee **SHALL** review inspection log noting any issues or concerns requiring follow up.

7.1.11 **File** main dam and dike inspection form in Unit 1 lab (File Point 13580C).

7.2 Ash Pond:

7.2.1 Ash Pond dike **SHALL** be inspected Bi monthly.

7.2.2 **Proceed** to the Ash Pond located southeast of Darlington Co. Plant.

7.2.3 **Inspect** outfall 005 for discharge. If discharging initiate sampling per NPDES requirements for outfall 005. If no discharge log on NPDES field data sheet and in the NPDES log book noting, conditions, date, time and initials of person completing the inspection.

7.2.4 **Proceed** to the toe of the ash pond dike, noting any erosion, seepage, cracking, or settling of the dike.

7.2.5 **Complete** bi monthly dam and dike inspection form (Attachment 2).

7.2.5 Any seepage noted should be visually estimated and compared to previous inspections and noted on attachment 2.

7.2.6 Environmental Specialist or designee **SHALL** review inspection log noting any issues or concerns requiring follow up.

7.2.7 **File** ash pond dam and dike inspection form in Unit 1 lab (File Point 13580C).

7.3 Ash Pond Semi Annual Piezometer Water levels:

7.3.1 Robinson ash pond piezometer water levels **SHALL** be measured semi annually.

7.3.2 **Obtain** access key for piezometers from Robinson 1 Lab.

7.3.3 **Proceed** to the Ash Pond located southeast of Darlington County Plant.

7.3.4 **Measure** distance from top of casing to water for piezometers P1, P2, P1A, P2A, P4 and P8

7.3.5 **Log** data on Robinson Ash Pond Piezometer Semi Annual Inspection log (Attachment 3).

7.3.6 Environmental Specialist or designee **SHALL** review inspection log noting any issues or concerns requiring follow up.

7.3.7 **File** Robinson Ash Pond Piezometer Semi Annual inspection form in Unit 1 lab (File Point 13580C).

7.3.8 **Return** access key to Robinson 1Lab.

8.0 RETURN TO NORMAL

None

9.0 DOCUMENTATION

Attachment 1: Progress Energy Carolinas Robinson Plant Main Dam and Dike Inspection Worksheet.

Attachment 2: Progress Energy Carolinas Robinson Plant Ash Pond Dam and Dike Inspection Worksheet.

Attachment 3: Progress Energy Carolinas Robinson Plant Piezometer Semi Annual Inspection Log.

10.0 REFERENCES

EMG-RFPC-00002 Robinson Fossil Power Plant Ash Pond, Cooling Lake, and Dam Emergency Notification Procedure.

Non-Hydroelectric Dam and Dike Inspection Program Manual

Robinson Dam Inspection Training Materials

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 1
File No.13580C

Progress Energy Carolinas
Robinson Plant
Main Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: ____________________ Inspected by: ______________________

Date reviewed: ____________________ Reviewed by: ______________________

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is erosion present?	_____	_____
2. Are wet areas or seepage visible at toe area?	_____	_____
3. Has ground cover been disturbed?	_____	_____
4. Is spillway deterioration (spalling, or cracking) present?	_____	_____
5. Is drainage from pipe below dam obstructed or cloudy?	_____	_____
6. Is there excessive vegetation in rocks at toe area?	_____	_____
7. Are trees and/or brush present in the dam structure?	_____	_____

Comments: ____

____

____

____

____

____

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: ____________________ Inspected by: ____________________

Date reviewed: ____________________ Reviewed by: ____________________

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?	_____	_____
2. Is erosion present?	_____	_____
3. Has ground cover been disturbed?	_____	_____
4. Are wet areas or seepage visible at toe area?	_____	_____
5. Is there excessive vegetation in rocks at toe area?	_____	_____
6. Are trees and/or brush present in the dam structure?	_____	_____

Comments: ____

____

____

____

____

____

11.0 ATTACHMENTS/FORMS

Attachment 3
File No.13580C

Progress Energy Carolinas
Robinson Ash Pond
Piezometer
Semi Annual Inspection Log

Date inspected: ____________________ Inspected by: ____________________

Date Reviewed: ____________________ Reviewed by: ____________________

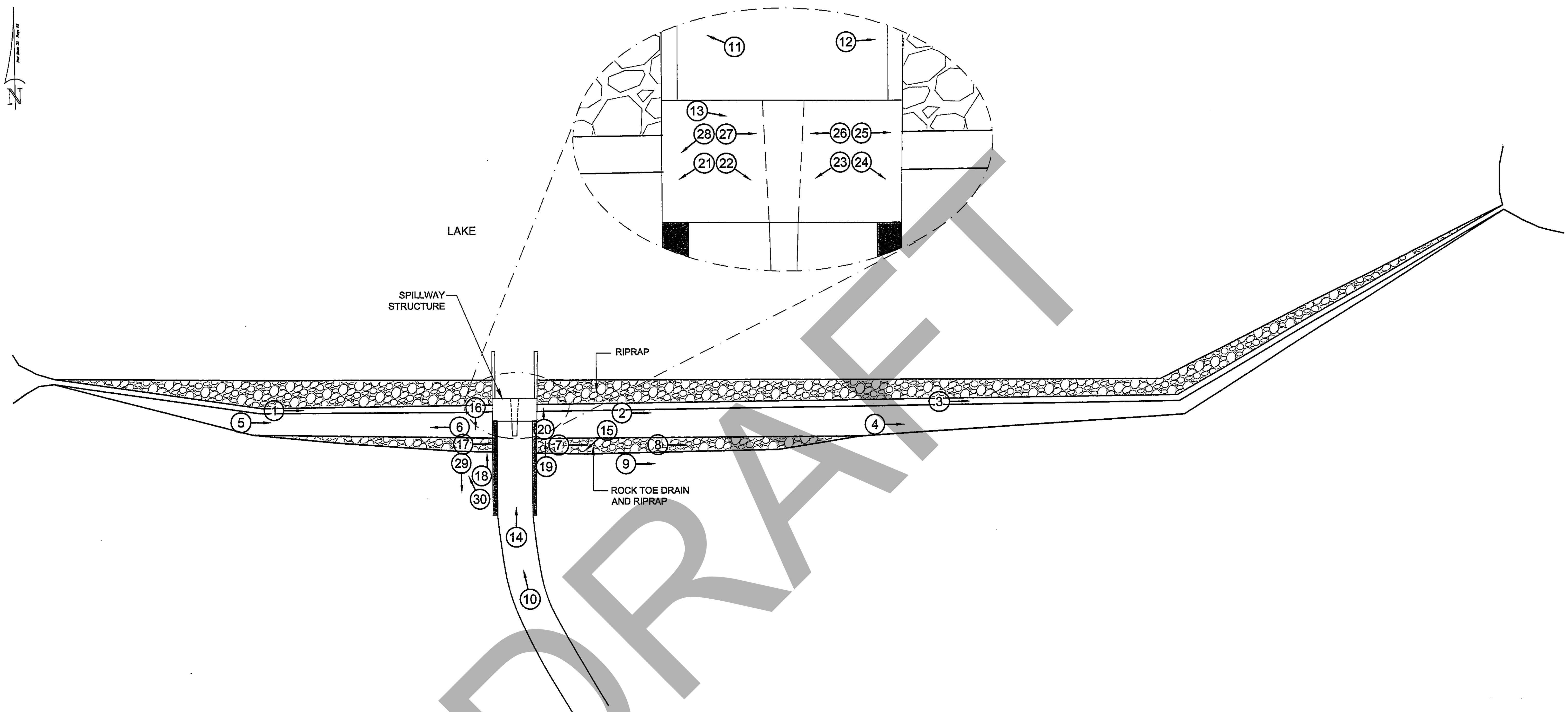
Piezometer No.	top of casing elev. (ft)	distance to water (ft.)	Water level elev. (ft.)
P1			
P1A			
P2			
P2A			
P4			
P8			

EXHIBIT 15 (7 Pages)

APPENDIX A

PHOTOGRAPH LOCATION PLANS

P-1 MAIN DAM
P-2 COOLING LAKE DISCHARGE CANAL
P-3 ASH POND



LEGEND:

(#) PHOTOGRAPH LOCATION AND DIRECTION
(PHOTOGRAPHS TAKEN APRIL 13, 2010)

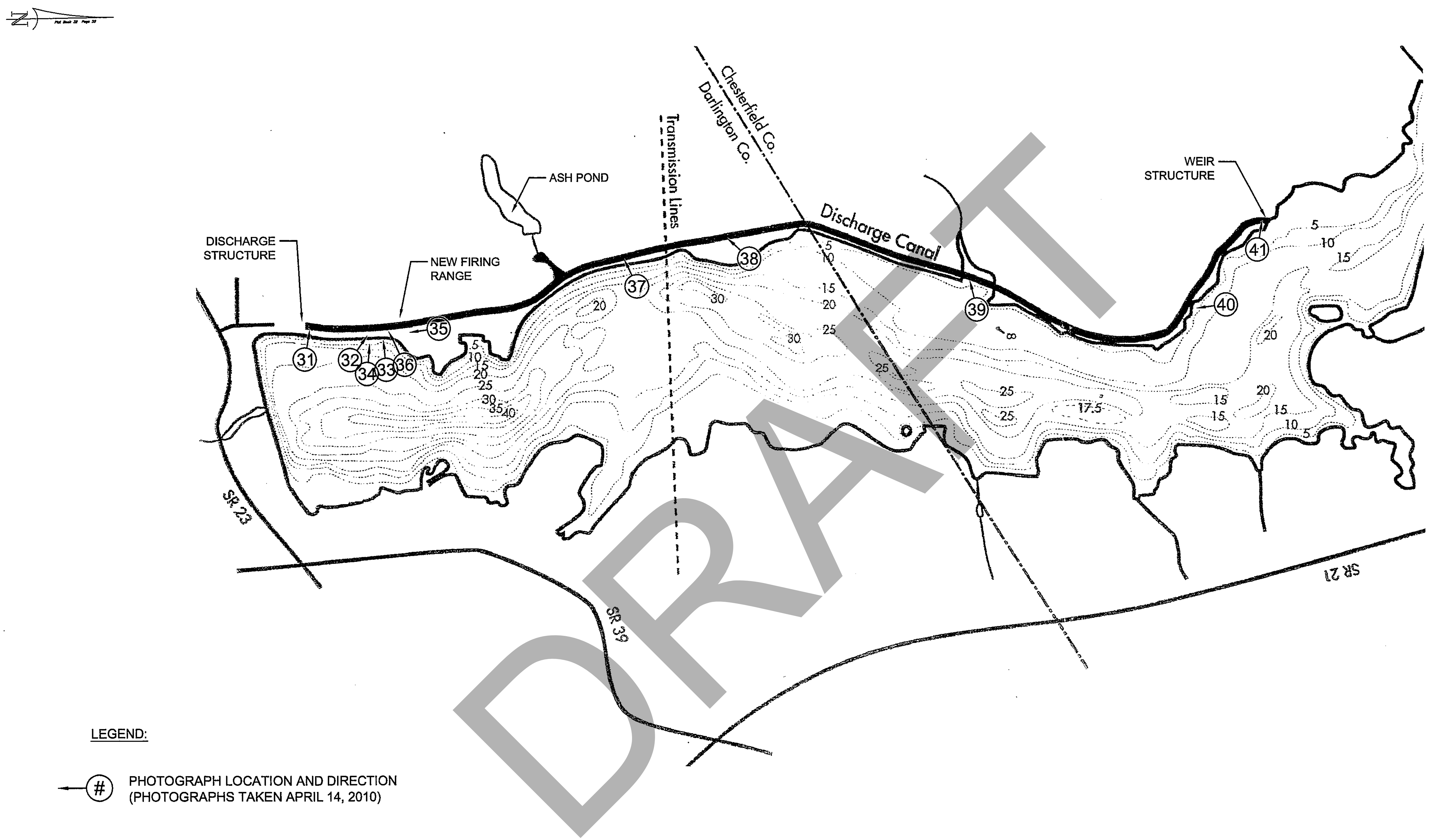
MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.
3301 ATLANTIC AVENUE RALEIGH, NORTH CAROLINA

PHOTOGRAPH LOCATION PLAN
MAIN DAM
H.B. ROBINSON PLANT

DRAWN:	R.R.	DATE:	OCTOBER 2010	DRAWING
DFT CHECK:	JB	SCALE:	N.T.S.	P-1
APPROVAL:	J	JOB:	6468-10-0025.02	

REFERENCE: Ebasco drawing G-158001, Dam & Spillway Plan.



LEGEND:

(#) PHOTOGRAPH LOCATION AND DIRECTION (PHOTOGRAPHS TAKEN APRIL 14, 2010)

MACTEC

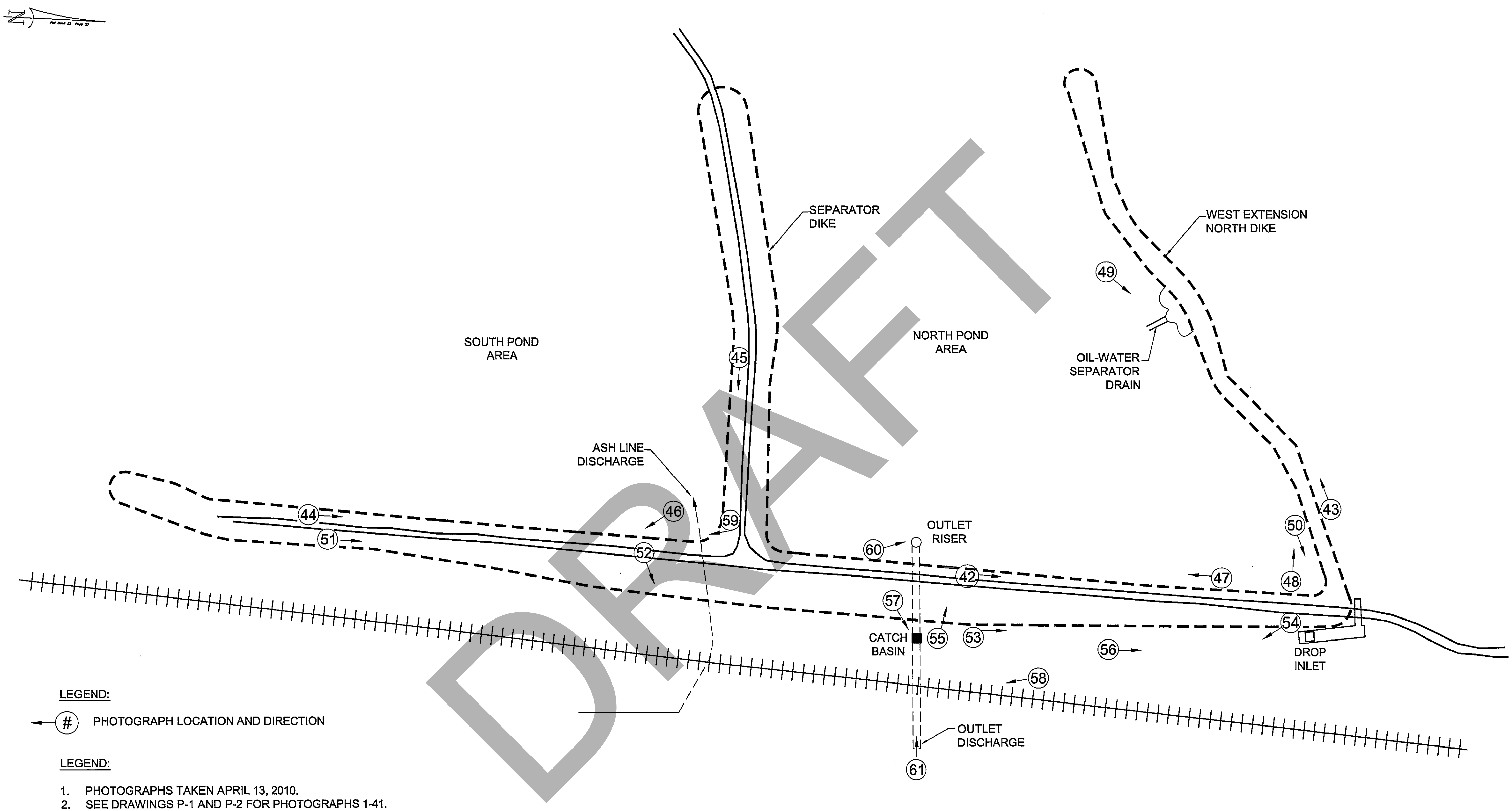
MACTEC ENGINEERING AND CONSULTING, INC.
3301 ATLANTIC AVENUE RALEIGH, NORTH CAROLINA

PHOTOGRAPH LOCATION PLAN
DISCHARGE CANAL
H.B. ROBINSON PLANT

DRAWN:	R.R.	DATE:	OCTOBER 2010
DFT CHECK:	JAV	SCALE:	1" = 2000'
APPROVAL:	JD	JOB:	6468-10-0025.02

DRAWING
P-2

REFERENCE: Lake Robinson Information Map.



MACTEC MACTEC ENGINEERING AND CONSULTING, INC. 3301 ATLANTIC AVENUE RALEIGH, NORTH CAROLINA	PHOTOGRAPH LOCATION PLAN ASH POND ROBINSON PLANT	DRAWN: R.R. DFT CHECK: JBJ APPROVAL: JBJ	DATE: OCTOBER 2010 SCALE: N.T.S. JOB NO.: 6468-10-0025.02

DRAWING
P-3

REFERENCE: LAW ENGINEERING DRAWING NO. 2; MODIFICATIONS TO ASH POND DAM.

APPENDIX B

PHOTOGRAPHS

Photograph 1:

Photograph 2:

Photographs by J.A. Tice
April 13-14, 2010

Photograph 3:

Photograph 4:

Photographs by J.A. Tice
April 13-14, 2010

Photograph 5:

Photograph 6:

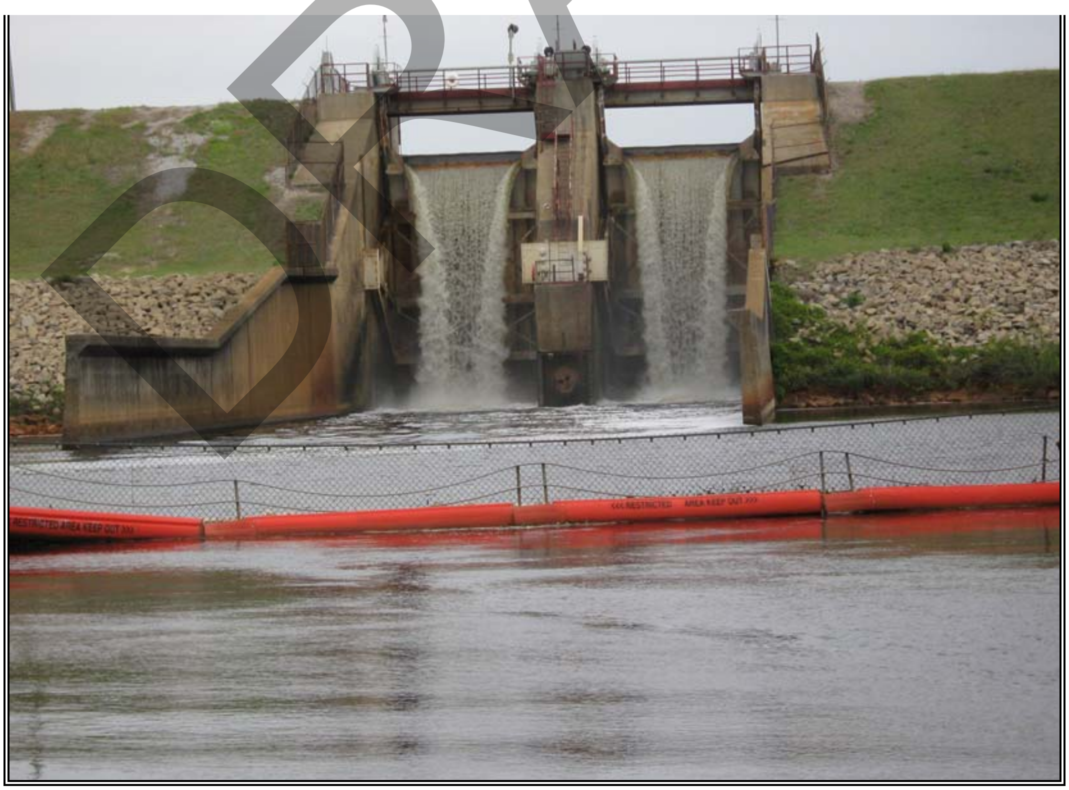
Photographs by J.A. Tice
April 13-14, 2010

Photograph 7:

Photograph 8:

Photographs by J.A. Tice
April 13-14, 2010

Photograph 9:



Photograph 10:

Photographs by J.A. Tice
April 13-14, 2010

Photograph 11:

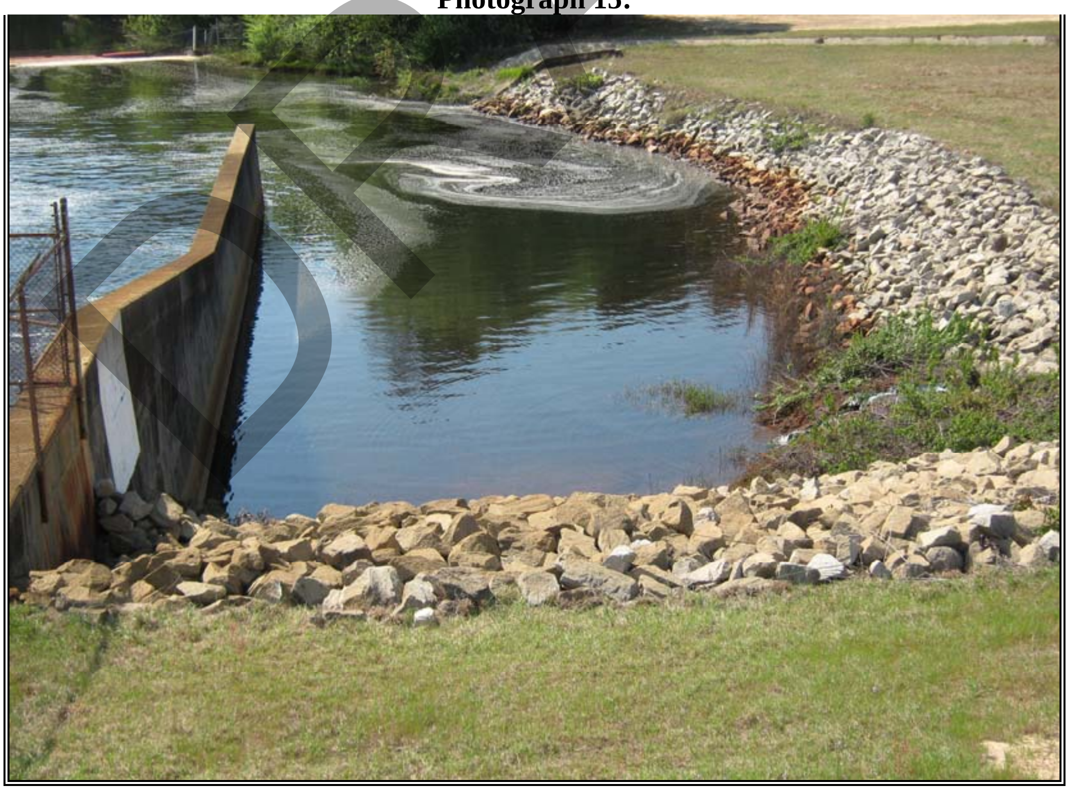
Photograph 12:

Photograph 13:

Photograph 14:

Photographs by J.A. Tice
April 13-14, 2010

Photograph 15:



Photograph 16:

Photograph 17:

Photograph 18:

Photographs by J.A. Tice
April 13-14, 2010

Photograph 19:

Photograph 20:

Photographs by J.A. Tice
April 13-14, 2010

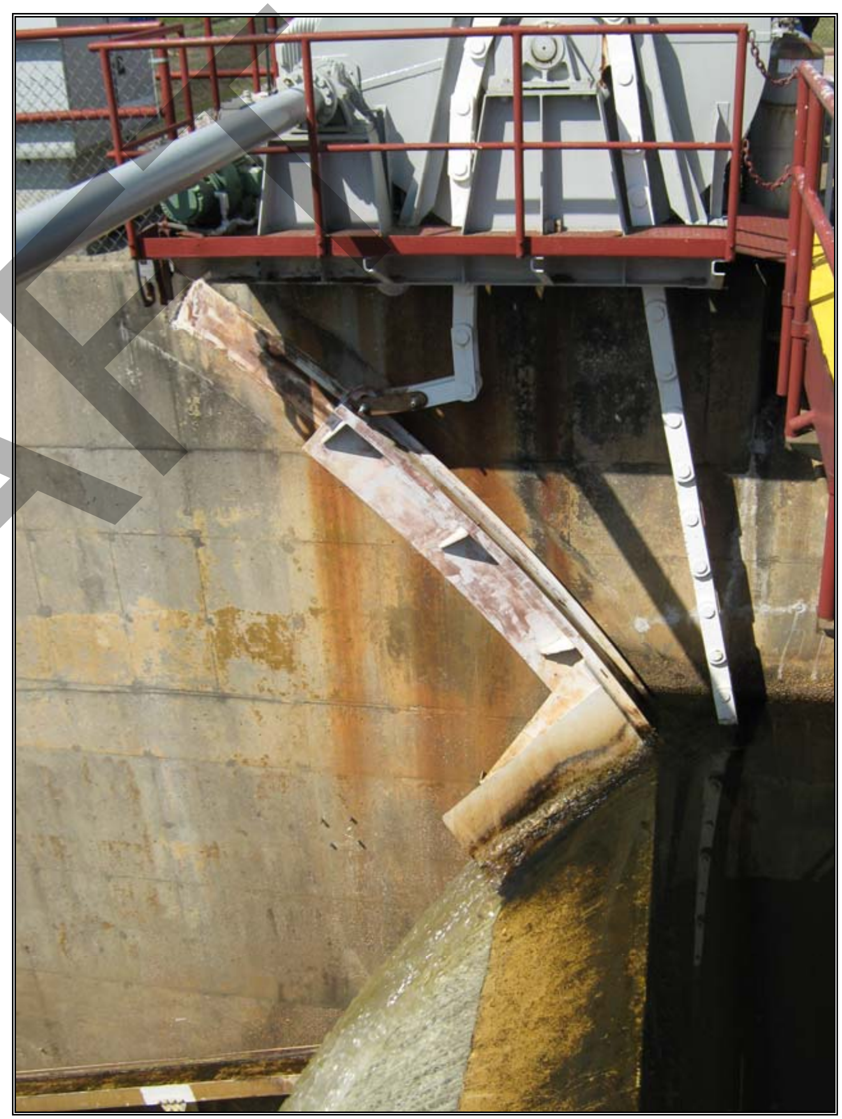
Photograph 21:

Photograph 22:

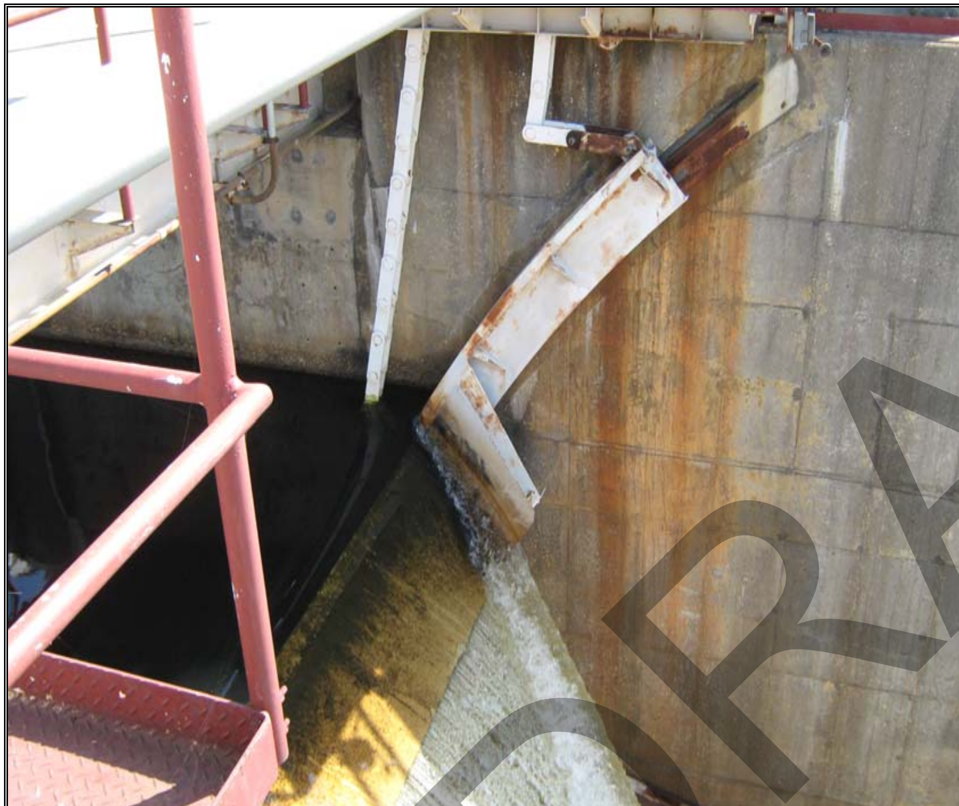
Photograph 23:

Photograph 24:

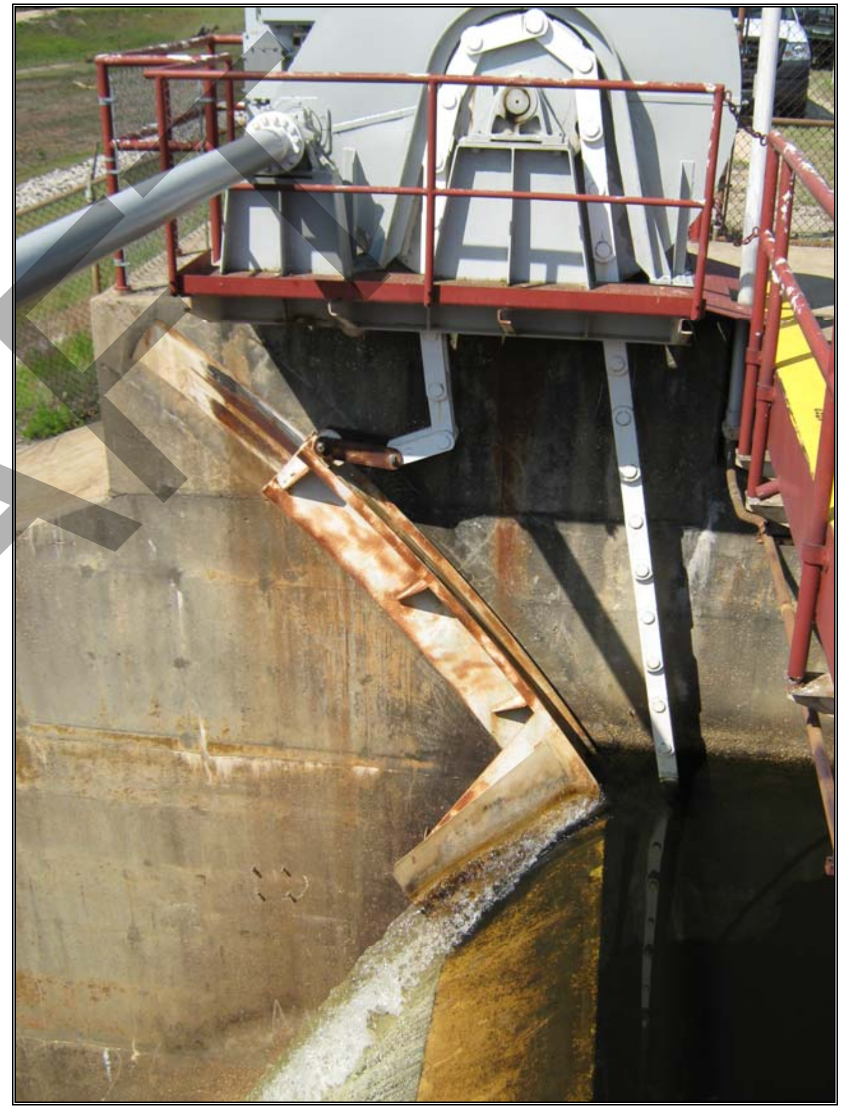
Photograph 25:



Photograph 26:



Photograph 27



Photograph 28:

Photograph 29:

Photograph 30:

Photograph 31:

Photograph 32:

Photograph 33:

Photograph 34:

Photograph 35:

Photograph 36:

Photograph 37:

Photograph 38:

Photograph 39:

Photograph 40:

Photograph 41:

Photograph 42: Crest and upstream slope of North Pond dike.

Photograph 43: Crest and exterior of northern extension dike at North Pond.

Photographs by J.A. Tice
April 13, 2010

Photograph 44: Crest and interior slope of South Pond dike.

Photograph 45: Crest and south side of separating dike between North and South Ponds.

Photographs by J.A. Tice
April 13, 2010

Photograph 46: Limited freeboard of South Pond dike near ash line discharge.

Photograph 47: Interior slope of North Pond dike. Note minor vegetation.

Photographs by J.A. Tice
April 13, 2010

Photograph 48: Interior slope of northern extension dike at North Pond.

Photograph 49: Rip rap at Darlington County Plant water discharge pipe.

Photographs by J.A. Tice
April 13, 2010

Photograph 50: Rip rap in good condition at junction of North Pond dike and northern extension dike.

Photograph 51: Exterior of South Pond dike. Note good vegetative cover of slope and drainage ditch adjacent to dike toe.

Photographs by J.A. Tice
April 13, 2010

Photograph 52: Old erosion in drainage ditch area adjacent to South Pond dike toe.

Photograph 53: Exterior slope and rock toe of North Pond dike.

Photograph 54: Rock toe and rip rap blanket at culvert outlet near north end of North Pond dike. Note lack of erosion.

Photograph 55: Local spot in North Pond dike rock toe – soil slope where slight loss of material. Typical of conditions addressed as necessary by Plant.

Photographs by J.A. Tice
April 13, 2010

Photograph 56: Rock toe and rock check dams at toe of North Pond dike.

Photograph 57: Rock filter around catch basin over pipe outlet of discharge riser.

Photograph 58: Standing water adjacent to railroad in topographic low area. A normal condition not related to seepage.

Photograph 59: Ash discharge line.

Photograph 60: Vertical riser and skimmer for ash pond discharge. Ash level is approximately 38 inches below top of riser.

Photograph 61: Outlet end of discharge facility. Stormwater from Darlington Plant also discharges from this pipe.

Photographs by J.A. Tice
April 13, 2010

Appendix A

Doc 04: Progress Energy H. B. Robinson Bi-Monthly Inspection Reports

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 1-13-10 Inspected by: K. Dav..

Date reviewed: 1-18-2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 1-27-10 Inspected by: K. D[illegible]

Date reviewed: 1-28-2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 2-10-10 Inspected by: K. Davis

Date reviewed: Willie L. Gilbert Reviewed by: 2/17/2010

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 2-22-10 Inspected by: K. Davis / J. Going

Date reviewed: 2-24-10 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: ______________________________

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 3-10-10 Inspected by: K. Davis / J. Go

Date reviewed: 3-15-2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		

Comments: ______________________________

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 3-31-10 Inspected by: K. D[illegible]

Date reviewed: 4/6/2010 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: ______________________________

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 4/13/2010 Inspected by: A Tice / W. Gilbert

Date reviewed: 4-14-10 Reviewed by: [signature]

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Several areas above the rocks along the toe area need to be filled with gravel. Need to spray vegetation in rocks on both interior and exterior areas of dam to prevent vegetation from getting out of hand. Discussed recommendations with Bartlett Supervisor 4/14/2010.

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 4-28-10 Inspected by: K. Davis

Date reviewed: 5/4/2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 5-12-10 Inspected by: K. Davis

Date reviewed: 5-24-2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 5/24/2010 Inspected by: W. Gilbert

Date reviewed: 5-24-10 Reviewed by: [signature]

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		* ✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: * Some vegetation in rocks.

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 6-9-10 Inspected by: [signature]

Date reviewed: 6-14-2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		* ✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: * Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 6-21-10 Inspected by: K. Davis / J. Gomez

Date reviewed: 6-29-2010 Reviewed by: Willie Gilliat

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		* ✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: * Some vegetation in rocks Discussion with Bartlett Supervisor. Chemicals on order to Spray Vegetation in rocks. WGG 6/29/2010.

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 7-9-10 Inspected by: K. Davis

Date reviewed: 7-12-10 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		* ✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: * Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 7-26-10 Inspected by: K. Davis / J. Gray

Date reviewed: 7-28-2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		* ✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: * Some vegetation in rocks Maintenance Spraying scheduled for first week of August. 7/28/2010 wfg

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 8-11-10 Inspected by: K. Davis

Date reviewed: 8/23/2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		* ✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: * Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 8-23-10 Inspected by: K. D[illegible]

Date reviewed: 8-26-2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		* ✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: * Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 9/1/10 Inspected by: John Garvey

Date reviewed: 9/13/2010 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks.

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 9/20/10 Inspected by: J. [illegible]

Date reviewed: 9/23/2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Small amount of vegetation in rocks.

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 10-13-10 Inspected by: K. Davis

Date reviewed: 10/14/2010 Reviewed by: W. Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 10/20/10 Inspected by: John Gainey

Date reviewed: 10/21/2010 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Small amounts of vegetation in rocks.

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 11-8-10 Inspected by: K. Davis

Date reviewed: 11/9/2010 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 11/17/10 Inspected by: John Gainey

Date reviewed: 11/18/2010 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		

Comments: Some minor vegetation in rocks.

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 12-8-10 Inspected by: K. Dorr

Date reviewed: 12/13/2010 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 12-22-10 Inspected by: K. Davis

Date reviewed: 1-4-2011 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 2/7/11 Inspected by: [signature]

Date reviewed: 2/14/2011 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?	✓	
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some wet areas at NE end, may be due to rainfall.
Some vegetation in rocks.

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 1-19-11 Inspected by: K. Davis / J. Gray

Date reviewed: 1/25/2011 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)

Condition	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: Some vegetation in rocks

AUTHORIZED COPY

11.0 ATTACHMENTS/FORMS

Attachment No. 2
File No.13580C

Progress Energy Carolinas
Robinson Plant
Ash Pond Dam and Dike Inspection Worksheet

Bi Monthly Inspection

Date inspected: 1-5-11 Inspected by: K. Dow

Date reviewed: 1/11/2011 Reviewed by: Willie Gilbert

Conditions monitored: (if answer is yes explain in comments section below)	Yes	No
1. Is ash pond discharge occurring?		✓
2. Is erosion present?		✓
3. Has ground cover been disturbed?		✓
4. Are wet areas or seepage visible at toe area?		✓
5. Is there excessive vegetation in rocks at toe area?		✓
6. Are trees and/or brush present in the dam structure?		✓

Comments: ______

Appendix A

Doc 05: Law Engineering Design Report – Modifications to Ash Pond Dam

LAWGIBB
GROUP

DESIGN REPORT
MODIFICATIONS TO ASH POND DAM
H. B. ROBINSON STEAM ELECTRIC PLANT
HARTSVILLE, SOUTH CAROLINA

OWNER: CP&L.
3512 LAKESIDE DRIVE
HARTSVILLE, SOUTH CAROLINA 29550

ENGINEER: LAW ENGINEERING AND ENVIRONMENTAL
SERVICES, INC.
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA

DATE: OCTOBER 19, 2001

SOUTH CAROLINA
REGISTERED PROFESSIONAL ENGINEER
J. ALLAN TICE
10.19-01

1.0 PROJECT DESCRIPTION

1.1 Location: The Robinson Ash Pond Dam is located at approximately north latitude 34° 24'; west longitude 80° 9', about 8 miles northwest of the town of Hartsville, South Carolina. The dam is owned by CP&L, 3512 Lakeside Drive, Hartsville, South Carolina. A map showing the location of the dam, the county name, the state roads, the access to the site and the outline of the reservoir is included on the plan cover sheet.

1.2 Dam: The existing Ash Pond Dam is an earth structure with a vertical concrete riser and pipe spillway. The dam has a crest elevation of 267.1 feet (msl) and the top of the riser is at elevation 263.87 feet. The pond is separated into a northern half and a southern half by a separator dike. The riser structure is in the northern half of the pond. Under the present operation, ash tends to settle out in the southern half, and little ash or water is impounded in the northern half. The portion of the dike south of the separator dike has mostly sedimented ash against it with little water.

The existing dam is used to create a storage area for ash transported in slurry form from Robinson Unit No. 1. Sedimented ash presently occupies much of the storage capacity.

No construction easements are necessary as CP&L has the right of eminent domain

1.3 Downstream Conditions: The dam lies about 800 feet west of Lake Robinson. The area between the dam and the lake is wooded, uninhabited and mainly owned by CP&L. A spur line of the CSX Railroad leading to the Robinson Plant crosses the area between the dam and Lake Robinson. CSX owns the land under the spur, a strip about 100 to 150 feet wide. The proposed modifications will not encroach on the CSX property. Failure of the dam could cause damage to the railroad, but no loss of life. A low hazard classification is appropriate for the dam.

1.4 Proposed Modifications: To provide for increased ash storage capacity, CP&L proposes to raise the crest of the existing dam by approximately 5 feet, to elevation 272 feet (msl). The maximum height for the modified dam will be 32 feet, and the storage volume will be 630 acre feet for the 55.2-acre impoundment area. The modified dam will continue to serve as an ash impoundment. Based on the planned height and storage capacity, the modified dam will be a small dam under the South Carolina definitions.

The work will include placing earth fill on the crest and downstream side of the existing dam, extending the existing riser structure and providing a grassed drainage swale on the north side of the pond to route stormwater flows from the adjacent Darlington Plant past the Ash Pond. As part of the project, but not part of the dam, the existing separator dike between the north and south sections of the pond will be raised and shortened. Small saddle dikes will be constructed around the edges of the pond to protect existing transmission tower foundations from the higher water level.

The existing ash discharge lines will be relocated to the surface of the new dike slope.

Work is planned separately by CP&L to modify the discharge of the adjacent Darlington Plant's oil-water separator so the increased pond level does not prevent proper operation of the oil-water separator system. That work is not part of this application, and does not affect the dam.

Design plan drawings with technical specification notes accompany this report.

2.0 DESIGN CRITERIA

2.1 Watershed: Based on USGS quadrangle maps, the contributing watershed area is 398 acres. The watershed outside the existing ash pond is comprised of mainly wooded area with sandy soils of high infiltration capacity. Approximately 25.6 acres of the watershed is occupied by CP&L's Darlington Plant. Storm water from the plant areas where oil spills or leaks are not likely to occur is collected through inlets and piping and routed around the ash pond. Therefore, the watershed contributing to runoff into the pond is 375 acres.

Information provided by CP&L shows inflows into the ash pond in addition to rainfall runoff are 1.58 million gallons per day from the ash disposal and 70,000 gallons per day from the Darlington plant. For purposes of analysis, these flows were added to the rainfall runoff as a base flow of 2.54 cubic feet per second (cfs).

2.2 Geology: The site is in the Coastal Plain. Hydrogeologic studies conducted in conjunction with the Robinson Unit 2 licensing indicate about 30 feet of recent alluvial sands and gravels underlie the ash pond area. These surficial deposits overlie Upper Cretaceous sediments of the Middendorf Formation. The Middendorf Formation consists of interlayered sands and clays with some slightly cemented layers possible. Information from the Unit 2 FSAR describing the ash pond area hydrogeology is included in Appendix A.

2.3 Seismicity: Studies conducted for the nearby Robinson Nuclear Power Plant concluded that a design earthquake horizontal acceleration of 0.1 g was appropriate for the area. Active faults are unknown in the area.

2.4 Construction Materials:

2.4.1 Soils: Sandy soils from nearby borrow pits are expected to be used for the extension. Samples were obtained and tested for classification, Proctor compaction, permeability and shear strength. Test results are included in Appendix A. The soil has a friction angle of 39° (total stress) and 33° (effective stress). The permeability of a sample compacted to 96 percent of the maximum dry density was $6x10^{-4}$ cm/sec.

Ash from the dry stack area or the sedimented areas within the existing pond is planned for use in parts of the expansion of the separator dike and the saddle dikes. The properties of compacted fly ash, based on testing of ash at other plants, are assumed as a friction angle of at least 32° and a permeability of less than 10^{-4} cm/sec.

2.4.2 Riser: A precast concrete section is planned for extending the existing concrete riser.

2.4.3 Miscellaneous: Rip rap, geotextile, and geogrid materials will be used for slope protection, stabilization and drainage swale lining. Requirements for these are shown on the drawings.

3.0 FOUNDATION INVESTIGATION

3.1 Exploration: Four soil borings were made in the existing dike to confirm soil conditions. The boring locations are shown on a plan included in Appendix A. Standard penetration tests were conducted at routine intervals in the borings. Boring records showing the soil descriptions and test data are included in Appendix A.

3.2 Subsurface Conditions: Profiles and cross sections showing the general subsurface conditions are included in Appendix A. The existing dam consists of dense, fine to medium sand interlayered with clayey silt and silty fine sand. The upper three to four feet of soil on the slope face is looser. The natural ground below the dike is also firm to dense sand. Laboratory grain size distribution tests on selected samples are included in Appendix A.

Water-level observation casings were set in the borings to allow checks for the phreatic surface. At the time of the exploration, no water was impounded against the dam. No water was encountered in any of the casings. A check made in August, 2001 also found the casings to be dry. The sandy soils below the pond and dam are very permeable. These permeable foundation soils allow downward infiltration; thus creating a low phreatic surface. Visual inspections of the dams in 1995 and 2000 did not see any seepage emerging from the slope or toe of the dam.

4.0 DESIGN ANALYSIS

4.1 Stability: The stability of the proposed modifications was evaluated using circular arc failure surfaces and a random search pattern. The modified Bishop method of analysis was used in the program STABL-5. Soil properties from the laboratory tests were used. Initial analyses showed that an internal drainage system would be necessary to keep the phreatic surface lowered. For the sandy soils expected as fill in the exterior slope, a high phreatic line and the 2(H) : 1(V) slope do not have satisfactory factors of safety.

The original dam section included a gravel toe drain. When the dike was raised inn 1982, the piping was placed to route any flow from the toe drain into the discharge piping. The gravel toe drain will provide some internal drainage, but for the new section, a separate drain blanket is proposed as described in Section 4.3.1. For the internal drainage layer, analyses show a minimum factor of safety of 1.59 for the static condition and 1.26 for the earthquake condition. These are considered acceptable. Calculations for the stability analyses are included in Appendix B.

Because the fill soils are sandy and have no cohesion, local, shallow sliding of the surface of the exterior slope is indicated by the computer analysis. The existing slope which has a fair grass cover, has not shown indications of such sliding. However, to provide resistance to sliding in case new vegetation is slow to become established, the exterior portion of the slope is proposed to be reinforced using geogrids.

4.2 Hydrologic and Hydraulic

4.2.1 Design Basis: Based on the size and hazard conditions, the dam is a small dam with a low hazard rating. According to South Carolina Department of Health and Environmental Control (SCDHEC), such a dam must have a spillway capable of passing a 50-year storm event and maintaining at least one foot of freeboard above the peak flow level.

4.2.2 Design Approach: The hydrologic design was done in general accordance with procedures outlined in the North Carolina Erosion and Sediment Control Planning and Design Manual, published by the North Carolina Department of Environment and Natural Resources, Land Quality Section in December 1993. Hydrologic routing also used material from published notes from Course CE 383 by Dr. Rooney Malcolm of N. C. State University, 1994. Calculations are included in Appendix B.

4.2.3 Rainfall Event: A 50-year, 24-hour storm amount of 7.5 inches was taken from published charts. The peak intensity of the 50-year storm was taken from charts for Wilmington, North Carolina as 2.5 inches per hour. The Wilmington area charts are considered conservative for the Hartsville area.

4.2.4 Outflow Conditions: The existing discharge from the pond is through a 48-inch diameter (ID) concrete pipe riser connected to a 36-inch diameter (ID) outflow pipe under the dam. The outflow pipe type transitions to HDPE at a manhole near the toe of the dam. The existing pipe was installed in 1992 by boring and jacking below the existing dike, the area downstream of the dike, and the railroad. There are no anti-seepage collars shown on the plans for the discharge pipe. The manhole does serve as a barrier to flow along the pipe. No modifications to the discharge pipe are planned; the manhole and the long flow path to the pipe outlet as noted below combine to minimize potential for seepage flow along the pipe to affect the dam.

The outflow pipe discharges into an open channel about 120 feet beyond the toe of the dam with no restrictions to flow. The flow in the outlet channel goes into Lake Robinson.

4.2.5 Analysis: The routing procedure developed an outflow hydrograph based on the incremental changes in stage, storage, and discharge during the design storm. The inflow hydrograph was developed for the design storm using a step-function approximation to the SCS dimensionless unit hydrograph. The storm hydrograph was added to the inflow contributed by the plant process. CP&L provided information on ash and wastewater flows that indicates a daily flow of 2.54 cubic feet per second (cfs). The contribution from the plant is a very small percentage of the total inflow. The stage-storage function was developed assuming that the initial stage would be at the top of a riser at elevation 270 feet msl.

4.2.6 The design storm was routed through the reservoir and outlet structure using the chain-saw method where the incremental storage required for a given time interval equals the incremental inflow (runoff) less the outflow through the spillway. The total inflow amount was taken as the rainfall runoff plus the plant number for daily wastewater flow. The results of the analysis are shown on the spreadsheet in Appendix B.

Based on the analysis, the maximum pond level is 1.27 feet above the top of the riser. In order to maintain the required 1-foot of freeboard above the maximum pond level, the top of the riser must be set no higher than elevation 269.73 feet for a dam crest elevation of 272.0 feet. For purposes of design, the proposed normal pool level is elevation 269.5 feet

4.3 Seepage:

4.3.1 The natural soils below the dam are sandy and have a high infiltration capacity based on observation of rapid rainfall infiltration. These soils will aid in reducing the phreatic surface through the dam. Using the conservative assumption of an impermeable base, an approximate flow net indicates a seepage rate of 6.9 x 10^{-3} cubic feet per minute per foot While the quantity of seepage is low, the position of the phreatic line is indicated to emerge on the slope of the dam. As discussed in 4.1, under a high phreatic line condition, the slope stability is reduced to an unacceptable level.

To provide protection against a high phreatic line, an internal drain blanket consisting of clean sand with the following properties is included:

Percent Passing No. 200 sieve - < 3%
D_{15} size - </= 2.5 mm.

Material meeting South Carolina Department of Transportation specifications for size FA-13 fine aggregate is acceptable.

The drain blanket will be placed on the existing slope after stripping and brought up with the dike fill. The gradation of the drain is such that no separate filter layer is needed. Above the original crest, the drain will be extended upward as a near-vertical chimney drain to within 3 feet of the crest elevation. The drain blanket is designed to carry at least three times the calculated seepage quantity. Calculations are attached in Appendix B.

To protect the exit end of the drain from loss of material, a rock toe is proposed as shown on the plans. The sand drainage blanket end will be covered with a layer of coarse aggregate that meets accepted criteria for a natural filter. Rip rap will be placed over the coarse aggregate. A layer of geotextile will be placed between the coarse aggregate and the rip rap for protection against loss of aggregate.

4.4 Slope Protection:

4.4.1 The existing sandy soil interior slopes with vegetation have performed well along the southern half of the impoundment, south of the separator dike, where little water tends to accumulate. The planned operation will continue to direct ash away from this part of the dike. Vegetation is planned as the interior slope protection on this part of the extended dike.

For the dike section north of the separator dike, wave action is possible as the water collects at the riser end of the pond. Interior slope protection consisting of riprap over geotextile is planned if the sandy, on-site borrow soils are used. If off-site clay is used, only vegetation is planned.

Exterior slopes will be seeded. The existing exterior slopes with grass have performed well.

5.0 SCHEDULES

5.1 Construction: Assuming plan approval is received in January, 2002, construction is tentatively expected to begin in mid 2002. Construction is expected to require eight to 10 weeks.

5.2 Filling: The ash pond will remain in service during the construction period. The last construction activity will be to place the riser extension. Water level rise to the new pond elevation is expected to take one to two years based on observation of the current pond performance.

5.3 Estimated Design Life: The earth and concrete components in the planned design are estimated to have a design life of at least 50 years. The useful life of the reservoir for receiving slurry ash is estimated at about 10 years, based on current and projected coal burning rates.

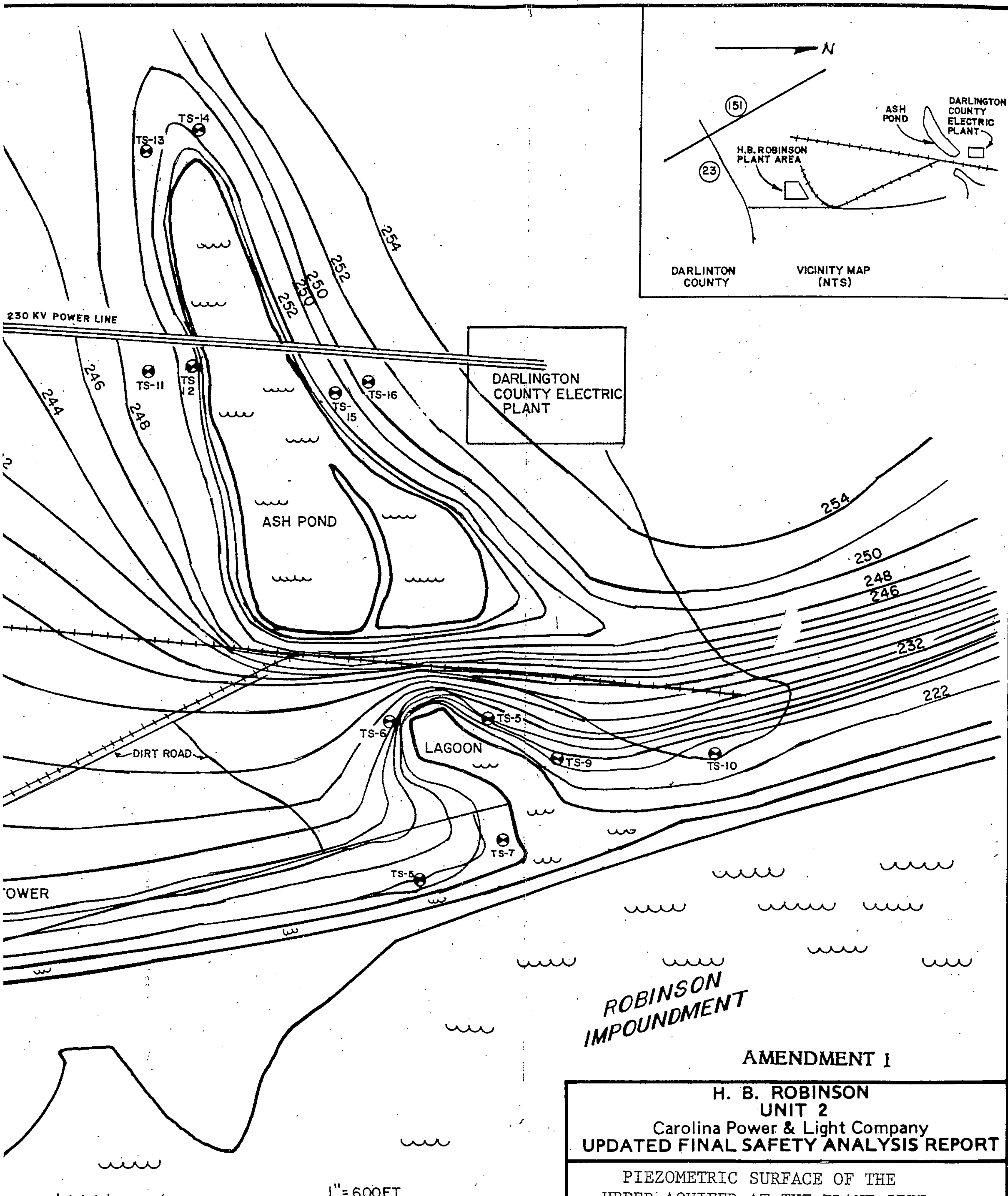
6.0 MAINTENANCE PLAN

6.1 Maintenance Plan: CP&L personnel at the Robinson Plant conduct maintenance activities as needed. Minimal maintenance is expected to be necessary, consisting of brush cutting as required. Mowing has not been necessary on the existing dam, and is not expected to be required on the expansion.

APPENDIX A
PROJECT INFORMATION:

- EXCERPTS FROM ROBINSON UNIT 2 FINAL SAFETY ANALYSIS REPORT
- SUBSURFACE BORING LOGS AND PROFILES
- LABORATORY TEST DATA FOR EXISTING DIKE SOILS
- LABORATORY TEST DATA FOR ON-SITE BORROW SOILS

EXCERPTS FROM ROBINSON UNIT 2 FINAL SAFETY ANALYSIS REPORT

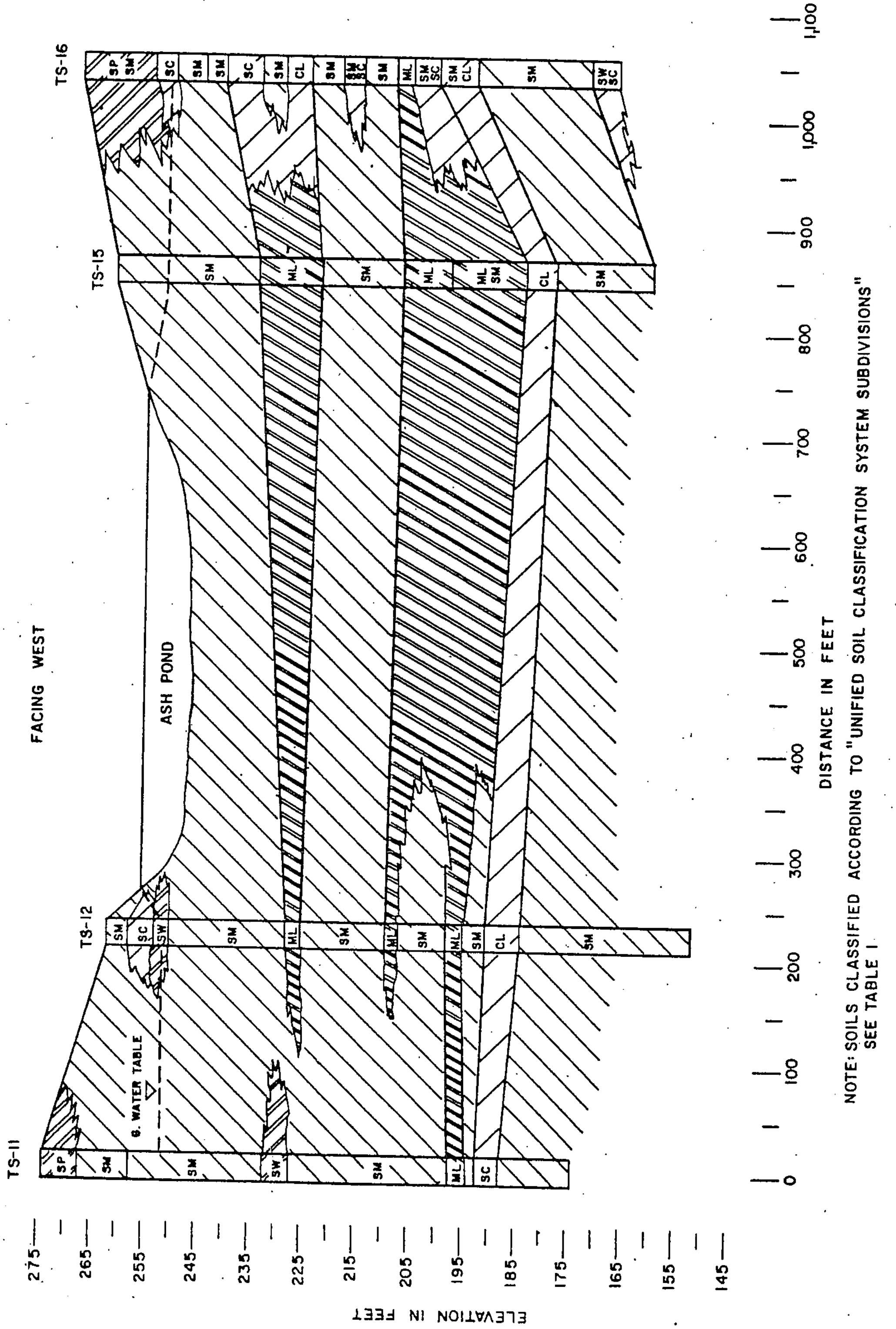


AMENDMENT 1

H. B. ROBINSON
UNIT 2
Carolina Power & Light Company
UPDATED FINAL SAFETY ANALYSIS REPORT

PIEZOMETRIC SURFACE OF THE
UPPER AQUIFER AT THE PLANT SITE,
MARCH 24, 1983
FIGURE 2.4.7-7

A1-1



A1-2

Amendment No. 1

H. B. ROBINSON UNIT 2 Carolina Power & Light Company UPDATED FINAL SAFETY ANALYSIS REPORT	GEOLOGIC CROSS SECTION AT WELLS 11, 12, 15 AND 16	FIGURE 2.4.7 - 2

is about 330 ft above mean sea level at Bethune---the gradient in this part of the coastal plain amounts to about 2.9 ft per mile." Because Lake Robinson is approximately 10 miles down dip from Bethune, the static head in the interfluvial ridges bounding Black Creek should be about 300 ft above mean sea level or about 80 ft above the maximum lake level (222 ft).

2.4.7.2 Hydrological Test Program

A program was conducted in order to evaluate ground water conditions in the vicinity of the plant site. The area of investigation included the H. B. Robinson Plant site, the ash disposal pond and the area in between. It is bounded on the east side by Lake Robinson and on the west side by a line 1500 feet east of and parallel to Highway 151 as shown on Figure 2.4.7-1.

As a part of the investigation, test borings were made at 18 sites in the vicinities of the plant and ash pond. Piezometers were installed at each site, and at sites No. 7 and 13, test wells were constructed for pumping tests.

Pumping tests were made at wells, 7, 13, and production well B at the plant. Also, permeability tests were made in the upper 5-feet of soil at the plant site and in the ash-disposal pond.

The results of the tests reflect the heterogeneous character of the geologic structures and the low values of veritical permeabilities. Transmissivities of the aquifers tested range from 1600 gpd/ft^2 to 40,000 gpd/ft^2 in the deeper zones where the plant wells are finished. The coefficients of Storage range from 5×10^{-3} to 1.6×10^{-4}. Vertical permeabilities in the upper five feet
1 of soil are in the range of 7.31 gpd/ft^2. In the ash disposal pond the vertical permeability of the uppermost layer of ash was measured, by laboratory methods, to be 2.1 gpd/ft and 15.7 gpd/ft in two different locations.

The geogolic section shown on Figure 2.4.7-2 is typical of the subsurface conditions at the plant site. This section includes approximately 30 feet of recent alluvial sands and gravels. Below this is the Middendorf Formation of Cretaceous age. It includes sands, silty and sandy clays, sandstones and mudstones. Underlying the Middendorf Formation is the preCambrian crystalline rocks.

Figures 2.4.7-3 and 2.4.7-4 are graphs of the pumping test records from wells 7B and 14A. The graphs compare the drawdown of water in the wells with the time pumped at a given rate of discharge.

The graph of test 7B (Figure 2.4.7-3) indicates the transmissivity of the screened zone is 2050 gpd/ft^2. However, after about 25 minutes of pumping, leakage from other zones began, and the effective transmissivity becomes 3400 gpd/ft^2.

The graph of test shown in Figure 2.4.7-4 shows the drawdown in well 14A that is screened in the same zone but is 290 feet from the pumped well as shown in Figure 2.4.7-5. The plotted curve is typical of a leaky artesian aquifer. Note that during the first 200 minutes of the test, the drawdown progressed uniformly and reflected a transmissivity value of 3200 gpd/ft^2. After 200 minutes of pumping at 20.5 gpm, leakage developed, and the effective transmissivity changed to 11,500 gpd/ft^2. The permeability of this zone is approximately 194 gpd/ft^2.

The transmissivity and coefficient of storage for the deeper aquifer is estimated from a specific capacity test made on plant well B in September, 1982. The specific capacity values at various pumping rates, as determined by the test, are illustrated in Figure 2.4.7-6. The specific capacity values indicate that the transmissivity of the aquifer should be in the range of 40,000 gpd/ft^2, and its coefficient of storage is approximatley 5×10^{-3}.

With the assumption that the permeability value of 194 gpd/ft^2 is representative for the upper aquifers at the site, the velocity of ground water movement can be computed. In Figure 2.4.7-7, a map of the piezometric surface of ground water is shown. The direction of ground water flow is normal to the piezometric contours, and its velocity is a function of gradient and permeability. The general flow lines on the map indicate that ground water moves toward the ash pond from its north side and utlimately toward Lake Robinson.

The shortest route of travel from the ash pond to the lake is from the dam to the lagoon, a distance of 400 feet. From the mid-point of the west bank of the ash pond, the route of flow is rather circiutous, as shown on the map (Figure 2.4.7-7), and is approximately 3550 feet in length, ending at the discharge canal.

The travel times are computed as follows:

$$V = \frac{P\frac{dh}{dl}}{7.5a}$$ 1

Where: V = velocity, in feet per day
P = permeability, in gpd/ft^2
$\frac{dh}{dl}$ = gradient, in ft/ft
a = effective porosity, in percent of volume (assumed 25%)
7.5 = gallons per cubic foot

For shortest route,

$$V = \frac{194\frac{34.5}{400}}{7.5\ (.25)} = \frac{16.73}{1.875} = 8.92 \text{ ft/day}$$

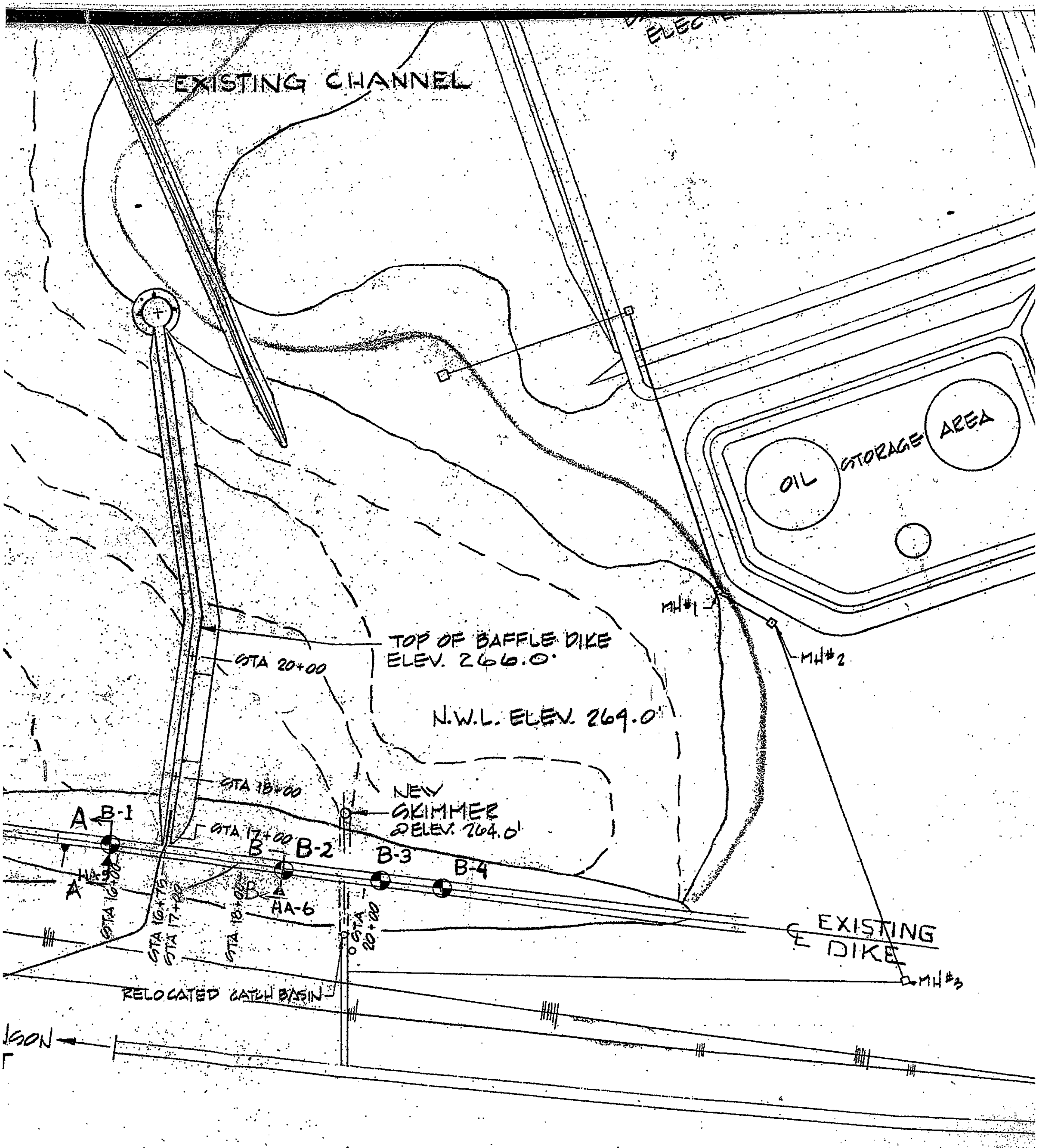
The time required for ground water to travel from the ash pond to the lagoon is approximately 45 days.

For the 3550-foot route,

$$V = \frac{194\frac{34.5}{3550}}{7.5\ (.25)} = \frac{1.885}{1.875} = 1.00 \text{ ft/day}$$

A1-4

SUBSURFACE BORING LOGS AND PROFILES



AZ-1

SITE PLAN

SCALE: 1" = 200'

BORING PLAN

FIG. 2

LAWGIBB GROUP

LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

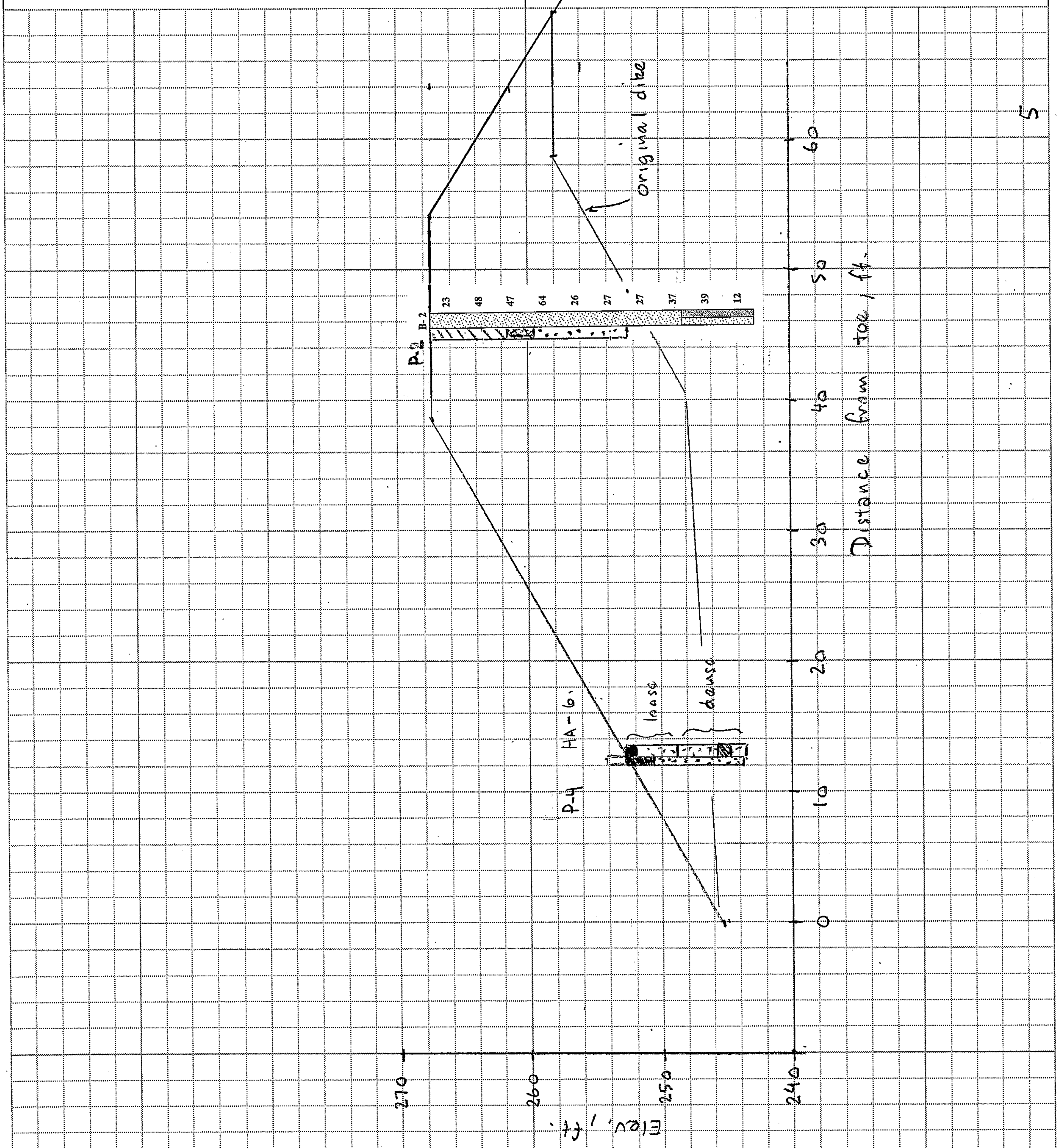
JOB NO. 30720-1-4728 SHEET 3 OF ______

PHASE SECTION B-B TASK ______

JOB NAME Robinson Ash Pond Dike Stability

BY PCL DATE 6/7/01

CHECKED BY ______ DATE ______



A2-2

LAWGIBB GROUP

LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

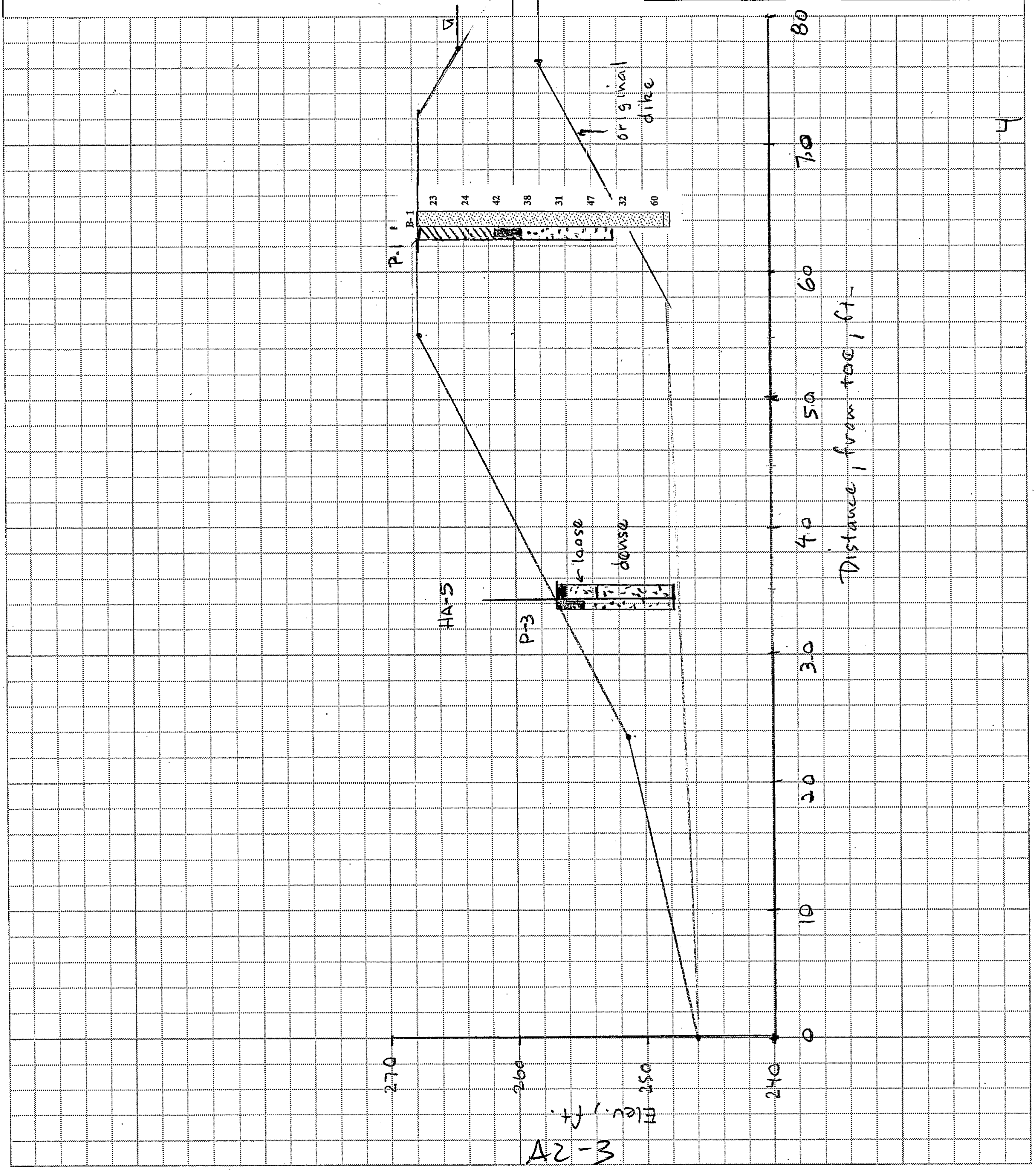
JOB NO. 30720-1-4728 SHEET ______ OF ______

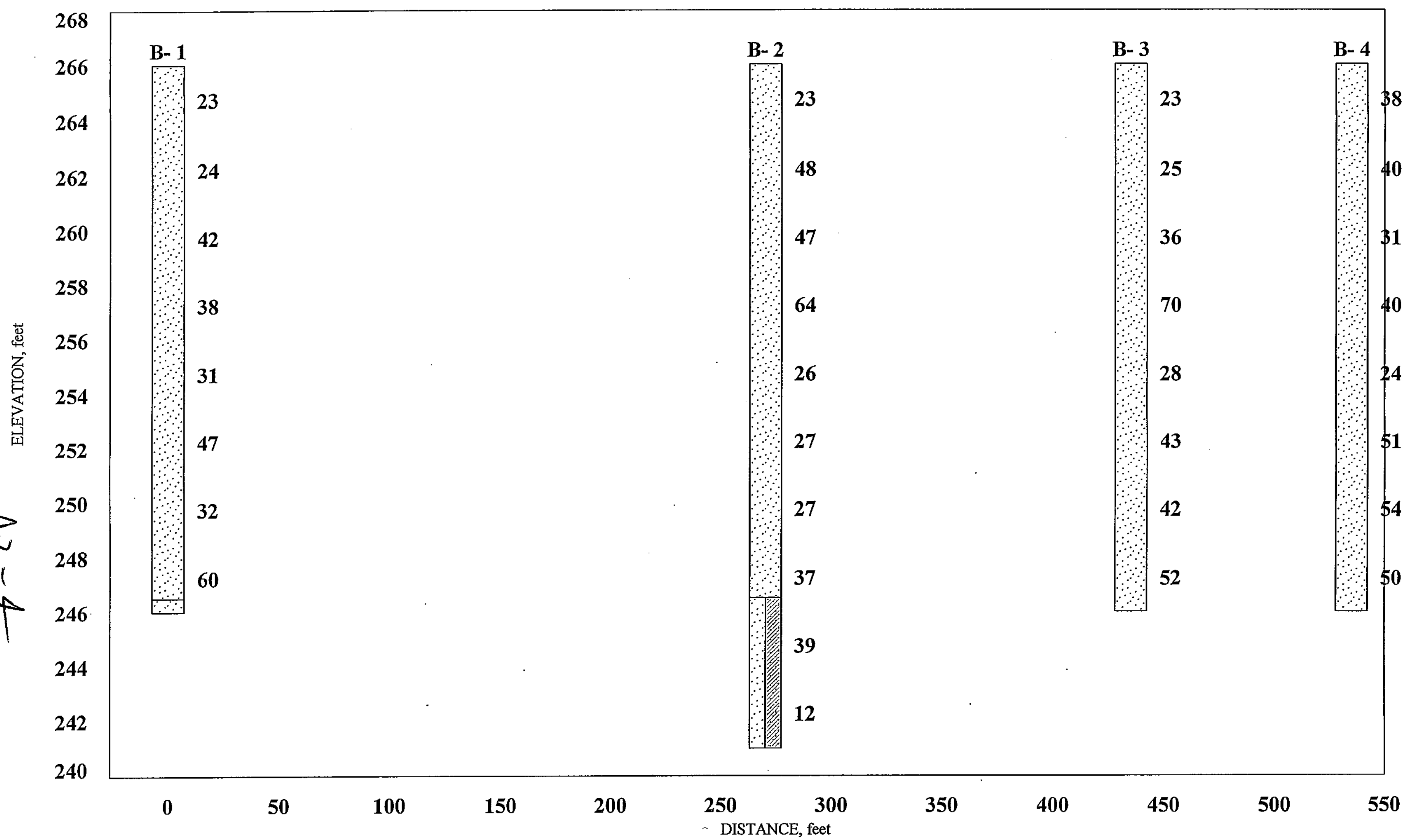
PHASE SECTION A-A TASK ______

JOB NAME Robinson Ash Pond Dike Stability

BY ______ DATE ______

CHECKED BY ______ DATE ______





A2-4

NOTES:

SUBSURFACE PROFILE

FIGURE 3

PROJECT Robinson Ash Pond Dike Stability

PROJECT NO. 30720-1-4728

LAW ENGINEERING

KEY TO SYMBOLS AND DESCRIPTIONS

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	GW	Well graded gravels, gravel - sand mixtures, little or no fines.
			GP	Poorly graded gravels or grave - sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel - sand - silt mixtures.
			GC	Clayey gravels, gravel - sand - clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 Sieve Size)	CLEAN SANDS (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand - silt mixtures
			SC	Clayey sands, sand - clay mixtures.
FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)		ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts and with slight plasticity.
			CL	Inorganic lays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (Liquid limit GREATER than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils.

Undisturbed Sample	Auger Cuttings
Split Spoon Sample	Bulk Sample
Rock Core	Crandall Sampler
Dilatometer	Pressure Meter
Packer	No Recovery
Water Table at time of drilling	Water Table after 24 hours

Correlation of Penetration Resistance with Relative Density and Consistency

SAND & GRAVEL		SILT & CLAY	
No. of Blows	Relative Density	No. of Blows	Consistency
0 - 4	Very Loose	0 - 1	Very Soft
5 - 10	Loose	2 - 4	Soft
11 - 20	Firm	5 - 8	Firm
21 - 30	Very Firm	9 - 15	Stiff
31 - 50	Dense	16 - 30	Very Stiff
Over 50	Very Dense	Over 31	Hard

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

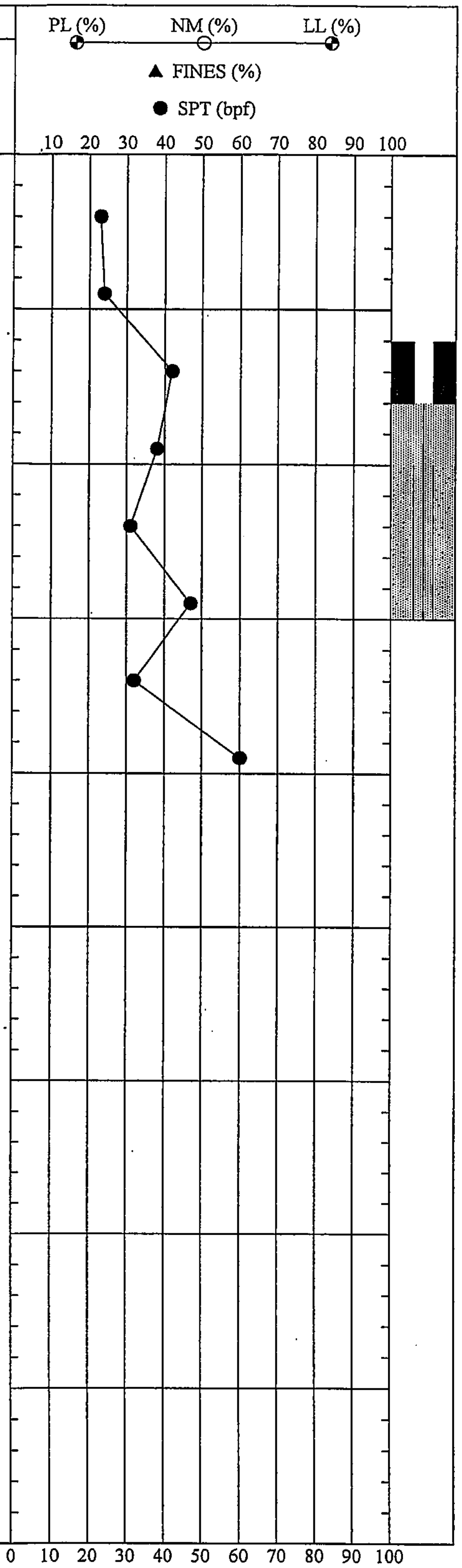
Reference: The Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953 (Revised April, 1960)

LAW

LAWGIBB Group Member

A2-5

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS (SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.)	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	N-COUNT (1st 6" 2nd 6" 3rd 6")
0	Very firm to dense, brown, fine to medium SAND (SP) with 6-12 inches brown, silty, fine sand (SM) and 1-2 inch gray, clayey silt (ML) layers					
				SS		8-12-11
5				SS		5-10-14
				SS		25-22-20
10				SS		20-22-16
				SS		10-12-19
15				SS		15-22-25
				SS		15-15-17
20	Very dense, tan, fine SAND (SP)			SS		15-25-35
	Boring terminated at 20 feet. Installed 2" PVC well P-1. 2" screen 15-10 Sand 15-8 Bentonite 8-6					
25						
30						
35						
40						
45						



DRILLER: Carolina Drilling
EQUIPMENT: CME 55
METHOD: HSA
HOLE DIA.: 4-1/4"
REMARKS: Dry at time of boring.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

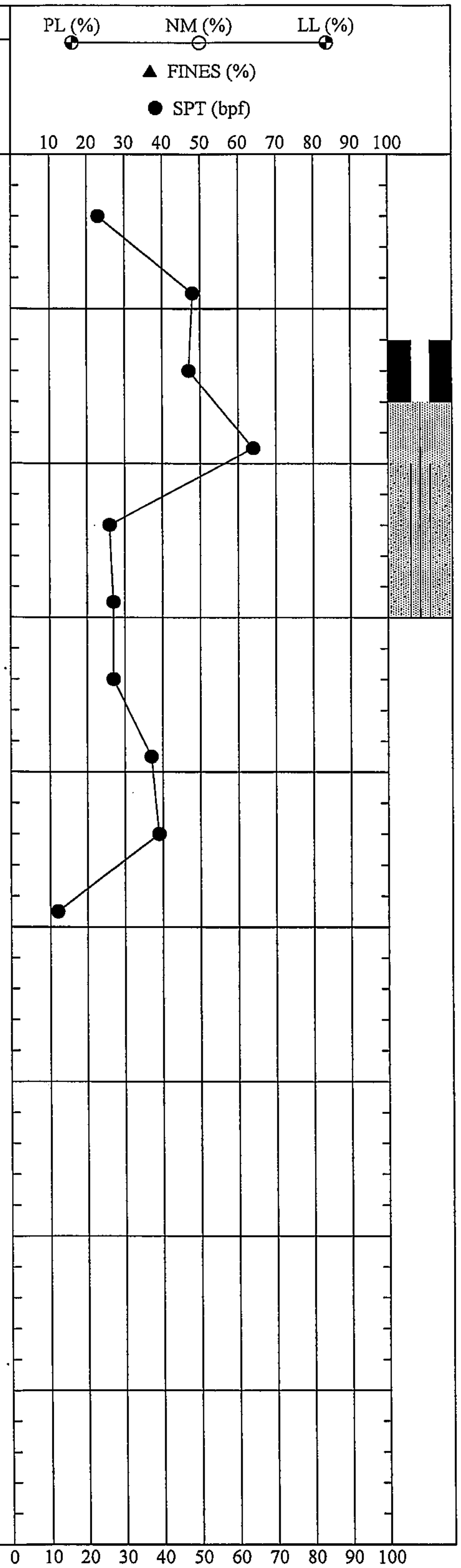
Project: Robinson Ash Pond Dike Stability **Boring No:** B- 1
Coord N:
Coord E:
Drilled: June 1, 2001
Project #: 30720-1-4728 **Page** 1 **of** 1

LAW
LAWGIBB Group Member

SOIL 4728ROBI.GPJ LAW_GIBB.GDT 6/6/01

A2-6

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	N-COUNT (1st 6", 2nd 6", 3rd 6")
0	Very firm to very dense, brown, fine to medium SAND (SP) with 1-2 inch thick gray, clayey silt (ML) and 6-12 inches brown, silty, fine sand (SM) layers		266.0			
				SS		4-10-13-16
				SS		16-22-26
5			261.0			
				SS		19-21-26
				SS		30-29-35
10			256.0			
				SS		8-15-11
				SS		10-14-13
15			251.0			
				SS		5-12-15
				SS		12-17-20
20	Firm to dense, dark brown, fine SAND (SP) and clayey SAND (SC)		246.0			
				SS		9-16-23
				SS		6-5-7
25	Boring terminated at 25 feet. Installed 2" PVC well P-2. 2" screen 15-10 Sand 15-8 Bentonite 8-6		241.0			
30			236.0			
35			231.0			
40			226.0			
45			221.0			



SOIL 4728ROBI.GPJ LAW_GIBB.GDT 6/8/01

DRILLER: Carolina Drilling
EQUIPMENT: CME 55
METHOD: HSA
HOLE DIA.: 4-1/4"
REMARKS: Dry at time of boring.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

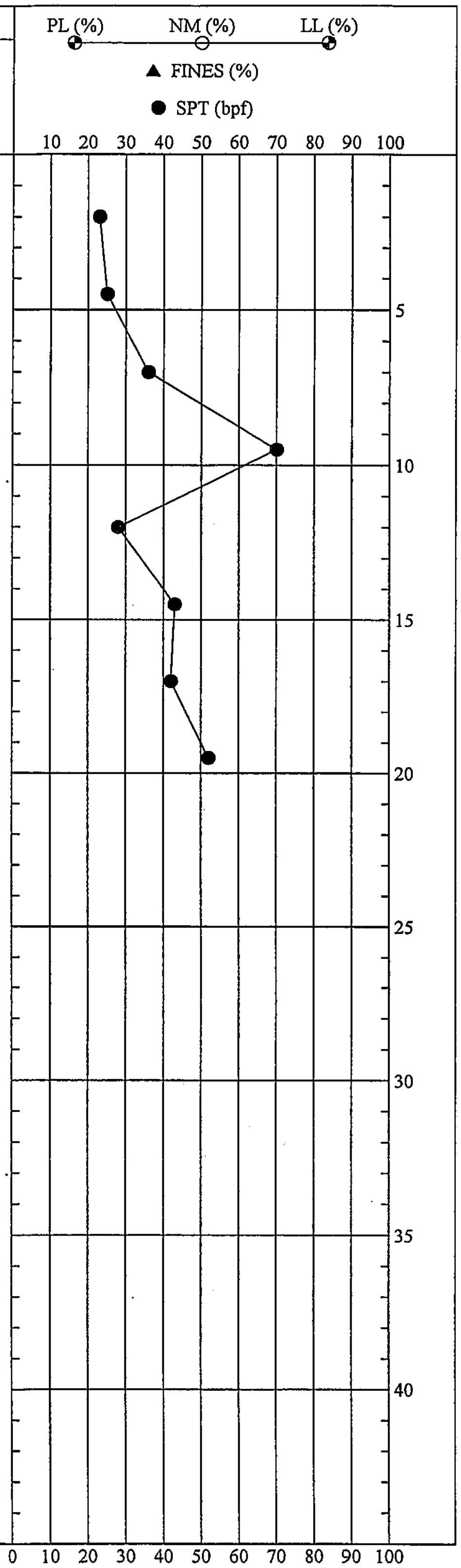
SOIL TEST BORING RECORD

Project: Robinson Ash Pond Dike Stability **Boring No:** B- 2
Coord N:
Coord E:
Drilled: May 31, 2001
Project #: 30720-1-4728 **Page** 1 **of** 1

LAW
LAWGIBB Group Member

A2-7

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	N-COUNT (1st 6" 2nd 6" 3rd 6")
0	Very firm to very dense, brown, fine to medium SAND (SP) with 6-12 inches brown, silty, fine sand (SM) layers					
				SS		8-8-15
5				SS		40-11-14
				SS		25-19-17
10				SS		35-38-32
				SS		34-13-15
15				SS		9-20-23
				SS		16-16-26
20				SS		16-23-29
20	Boring terminated at 20 feet.					
25						
30						
35						
40						
45						



SOIL 4728ROBI.GPJ LAW_GIBB.GDT 6/6/01

DRILLER: Carolina Drilling
EQUIPMENT: CME 55
METHOD: HSA
HOLE DIA.: 2-1/4"
REMARKS: Dry at time of boring.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

Project: Robinson Ash Pond Dike Stability **Boring No:** B- 3
Coord N:
Coord E:
Drilled: May 31, 2001
Project #: 30720-1-4728 **Page** 1 **of** 1

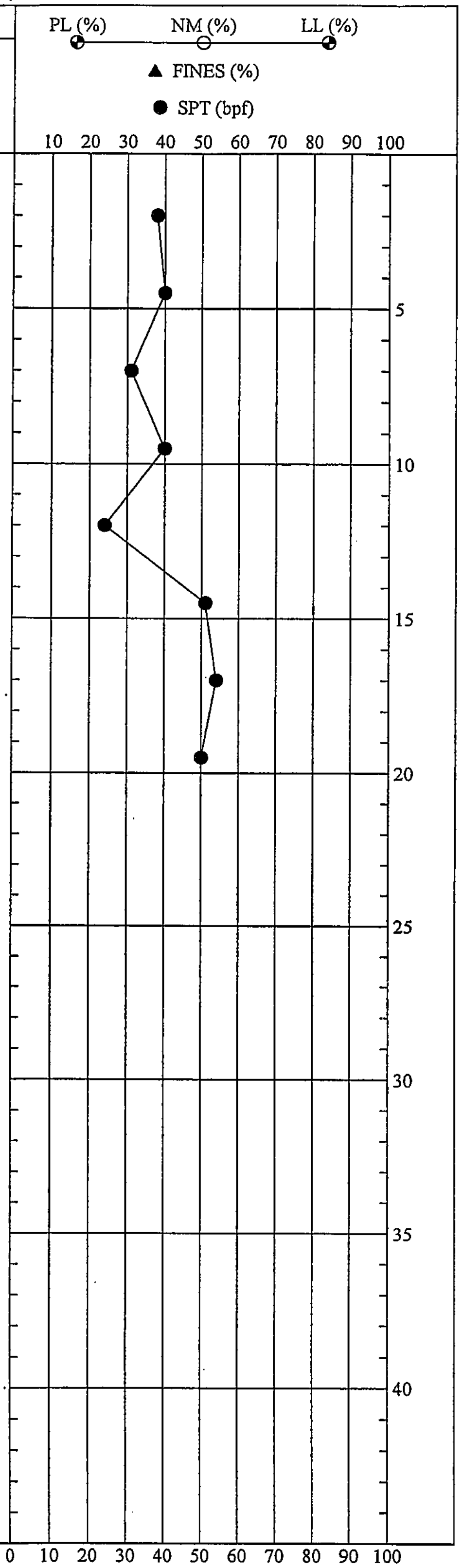
LAW
LAWGIBB Group Member

A2-8

SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
0	Very firm to dense, brown, fine to medium SAND (SP) with 1-2 inches thick gray, clayey silt (ML) and 6-12 inches brown, silty, fine sand (SM) layers					
				SS		10-14-24
				SS		12-17-23
				SS		13-14-17
				SS		10-18-22
				SS		9-10-14
				SS		19-25-26
				SS		12-25-29
				SS		23-25-25
20	Boring terminated at 20 feet.					



DRILLER: Carolina Drilling
EQUIPMENT: CME 55
METHOD: HSA
HOLE DIA.: 2-1/4"
REMARKS: Dry at time of boring.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

Project: Robinson Ash Pond Dike Stability **Boring No:** B- 4
Coord N:
Coord E:
Drilled: May 31, 2001
Project #: 30720-1-4728 **Page** 1 **of** 1

LAW
LAWGIBB Group Member

SOIL 4728ROBI.GPJ LAW_GIBB.GDT 6/6/01

A2-9

HAND AUGER BORING SUMMARY
ROBINSON ASH POND
LAW PROJECT NO. 30720-1-4728

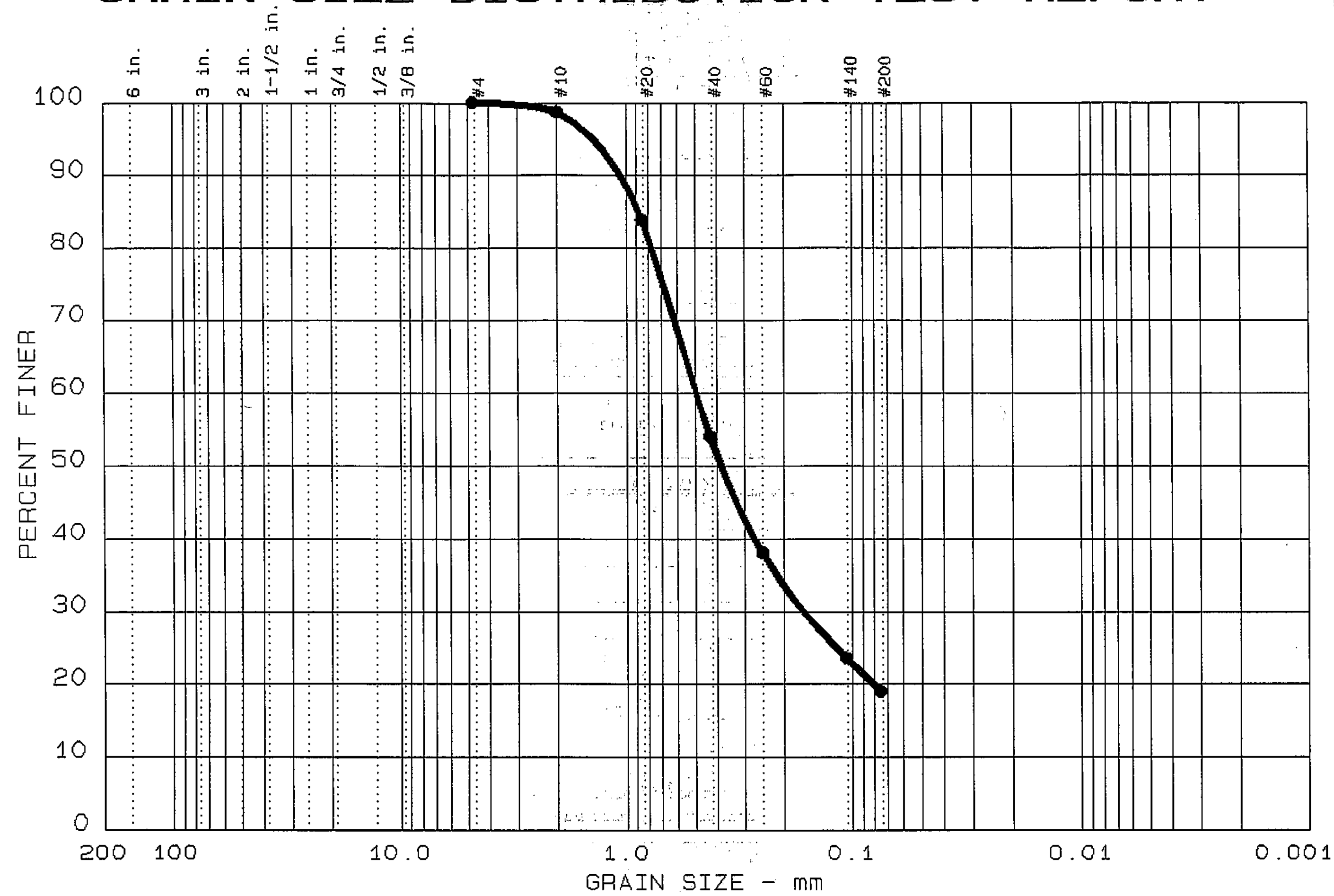
HAND AUGER	DEPTH (feet)	DCP	DESCRIPTION
HA-5	0-0.75	-	Topsoil
	0.75-1.5	-	Dark brown organically stained fine sand (SP)
	1.5-4.0	-	Loose brown fine to medium sand (SP)
	4.0-9.0	-	Dense brown fine to medium sand (SP)
			Terminated at 9.0 feet and no groundwater at time of boring Installed 2” PVC well P-3 2” screen 9-4 Sand 9-2 Bentonite 2-0
HA-6	0-0.5	-	Topsoil
	0.5-3.0	-	Loose brown fine sand (SP)
	3.0-6.0	-	Dense brown fine to medium sand (SP)
	6.0-6.5	-	Dense brown fine sand (SP)
	6.5-7.0	-	Dense brown fine sand with trace organics (SP)
	7.0-8.0	-	Stiff dark brown sandy clay (CL)
	8.0-9.0	-	Dense brown fine sand with roots at 8’ (SP)
			Terminated at 9.0 feet and no groundwater at time of boring Installed 2” PVC well P-4 2” screen 9-4 Sand 9-2 Bentonite 2-0

LABORATORY TEST DATA FOR EXISTING DIKE SOILS

Table 1
Summary of Sieve Analysis Tests
LAW Job #30720-1-4728

Boring	Depth feet	N bpf	Sand			Silt & Clay	USCS
			Coarse	Medium	Fine		
B-1	19.5	60	1.3	44.7	35	19	SM
B-2	2	23	0.3	33.2	44.7	21.8	SM
B-2	4.5	48	0.4	43.4	42.6	13.6	SM
B-2	9.5	64	0.1	31.6	55.1	13.2	SM
B-2	24.5	12	0.3	24.2	46.5	29	SM
B-3	19.5	52	1.2	34.2	36.6	28	SM
B-4	12	24	0.7	20.7	44.9	33.7	SM

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	81.0	19.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.88	0.49	0.38	0.164				

MATERIAL DESCRIPTION	USCS	AASHTO
● B-1 SS-8 19.5'	ND	ND

Project No.: 30720-1-4728
Project: CP&L ASH POND STABILITY
● Location: B-1 SS-8 19.5'

Date: 06-06-01

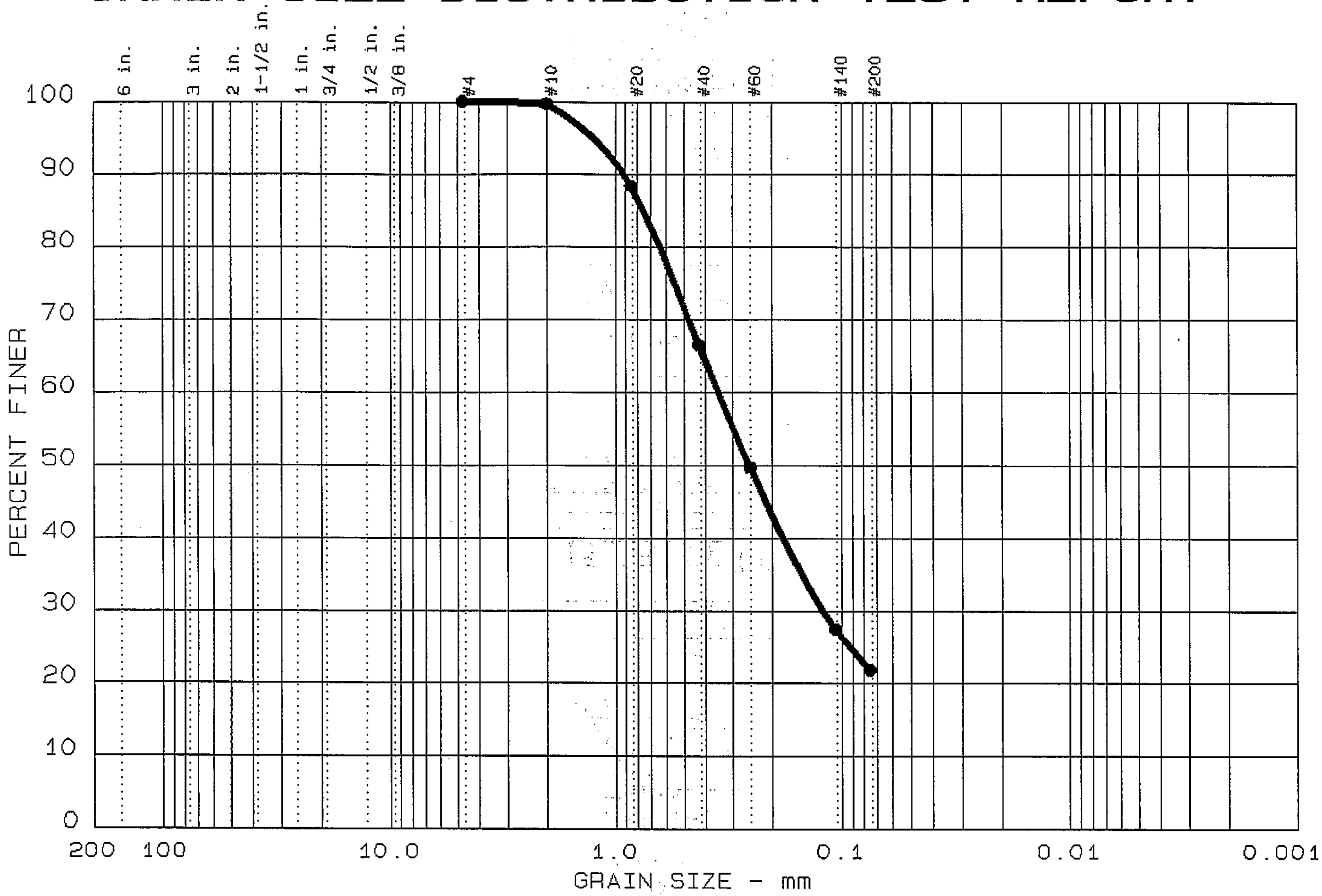
Remarks:
ND=NOT DETERMINED.

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

A3-2
Figure No. 01

REVIEWED BY: John Reilly

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	78.2	21.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.75	0.35	0.25	0.121				

MATERIAL DESCRIPTION	USCS	AASHTO
● B-2 S-1 1-3'	ND	ND

Project No.: 30720-1-4728
Project: CP&L ASH POND STABILITY
● Location: B-2 S-1 1-3'

Date: 06-06-01

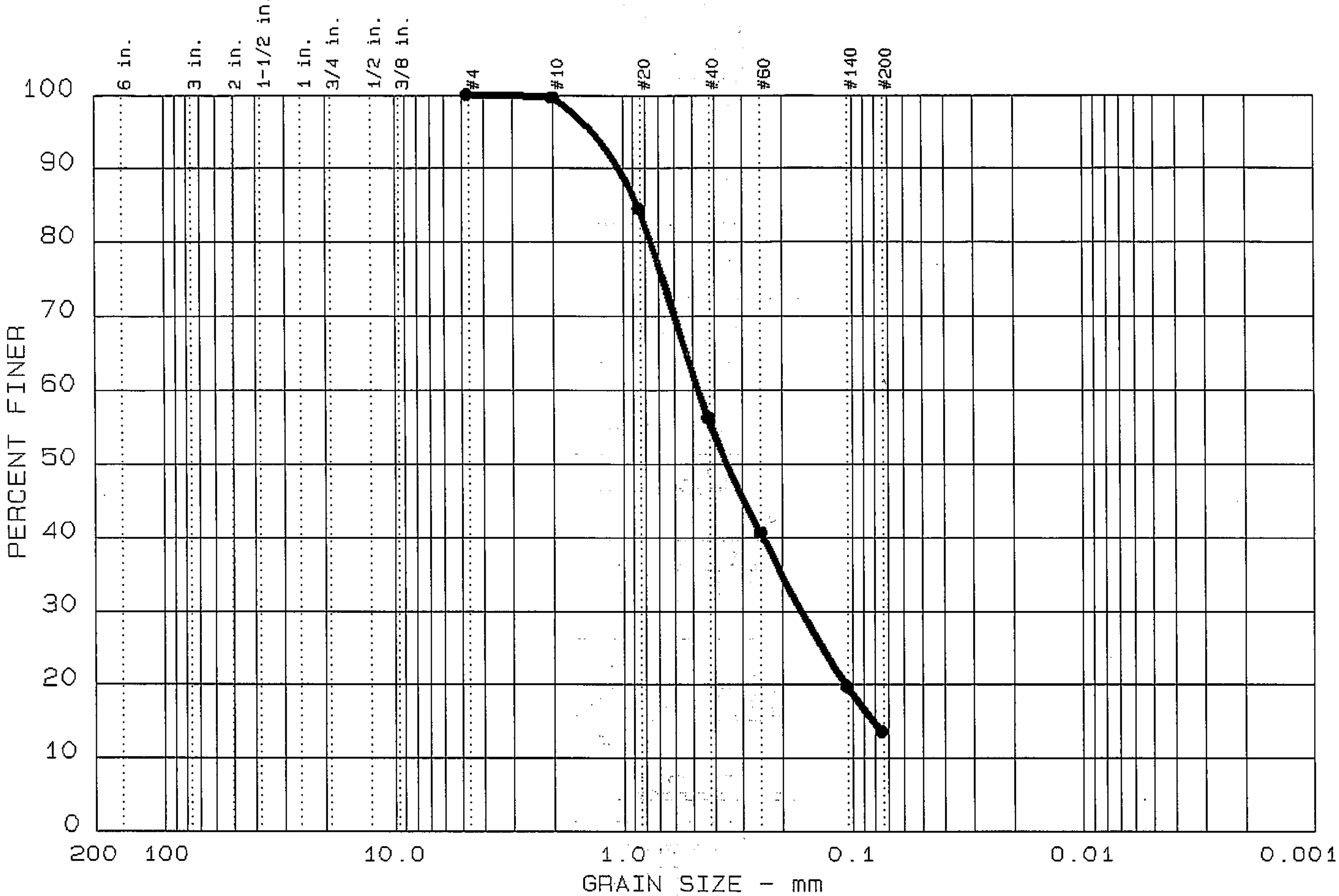
Remarks:
ND=NOT DETERMINED.

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

A3-3
Figure No. 02

REVIEWED BY: [signature]

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	86.4	13.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.86	0.47	0.35	0.166	0.0813			

MATERIAL DESCRIPTION	USCS	AASHTO
● B-2 S-2 4.5'	ND	ND

Project No.: 30720-1-4728
Project: CP&L ASH POND STABILITY
● Location: B-2 S-2 4.5'

Date: 06-06-01

Remarks:
ND=NOT DETERMINED.

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

A3-4

Figure No. 03

REVIEWED BY: [signature]

GRAIN SIZE DISTRIBUTION TEST REPORT

	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	86.8	13.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.68	0.33	0.25	0.142	0.0818			

MATERIAL DESCRIPTION	USCS	AASHTO
● B-2 S-4 9.5'	ND	ND

Project No.: 30720-1-4728
Project: CP&L ASH POND STABILITY
● Location: B-2 S-4 9.5'

Date: 06-06-01

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

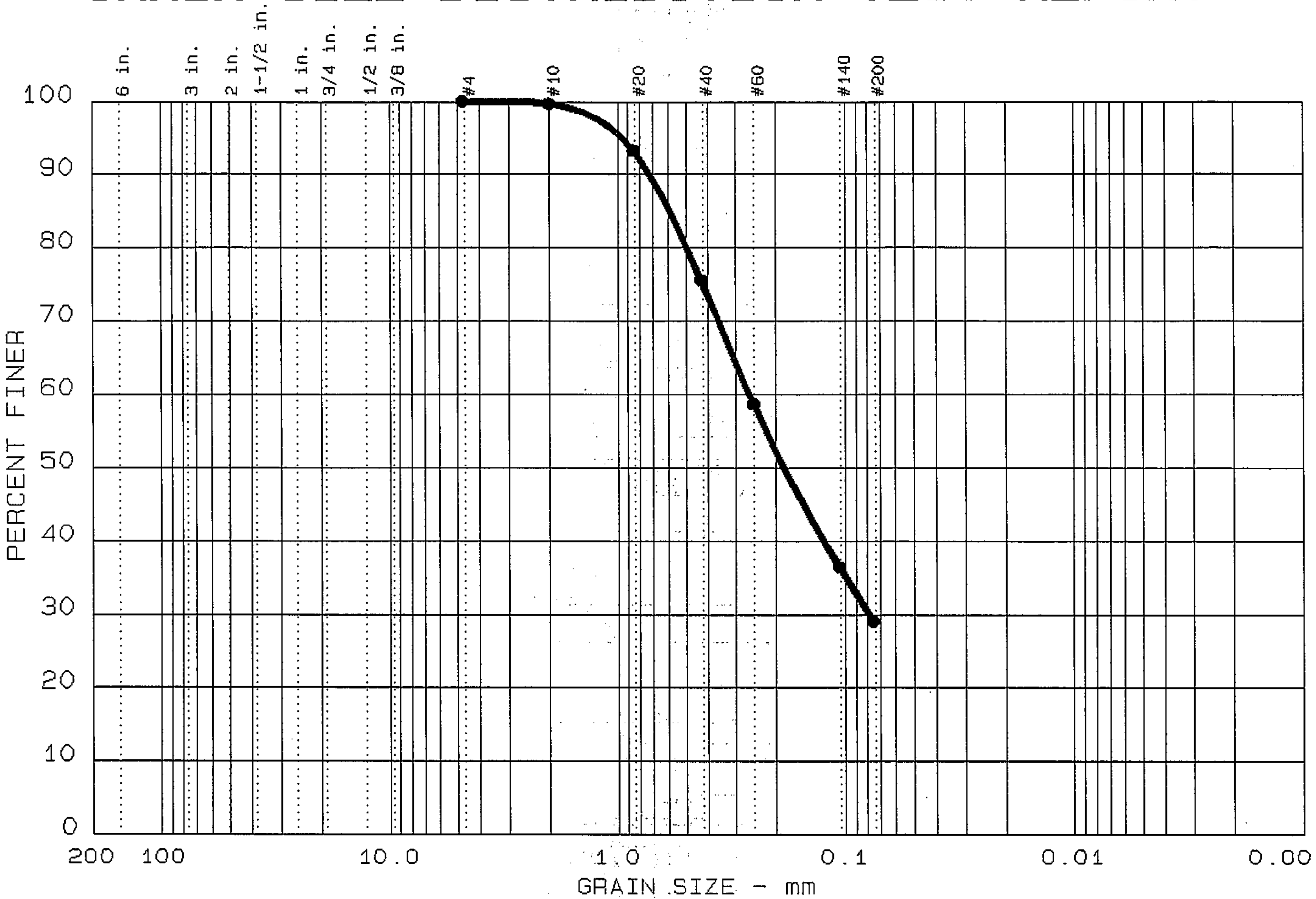
Remarks:
ND=NOT DETERMINED.

A3-5

Figure No. 04

REVIEWED BY: John Reilly

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	71.0	29.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.59	0.26	0.18	0.078				

MATERIAL DESCRIPTION	USCS	AASHTO
● B-2 S-10 24.5'	ND	ND

Project No.: 30720-1-4728
Project: CP&L ASH POND STABILITY
● Location: B-2 S-10 24.5'

Date: 06-06-01

Remarks:
ND=NOT DETERMINED.

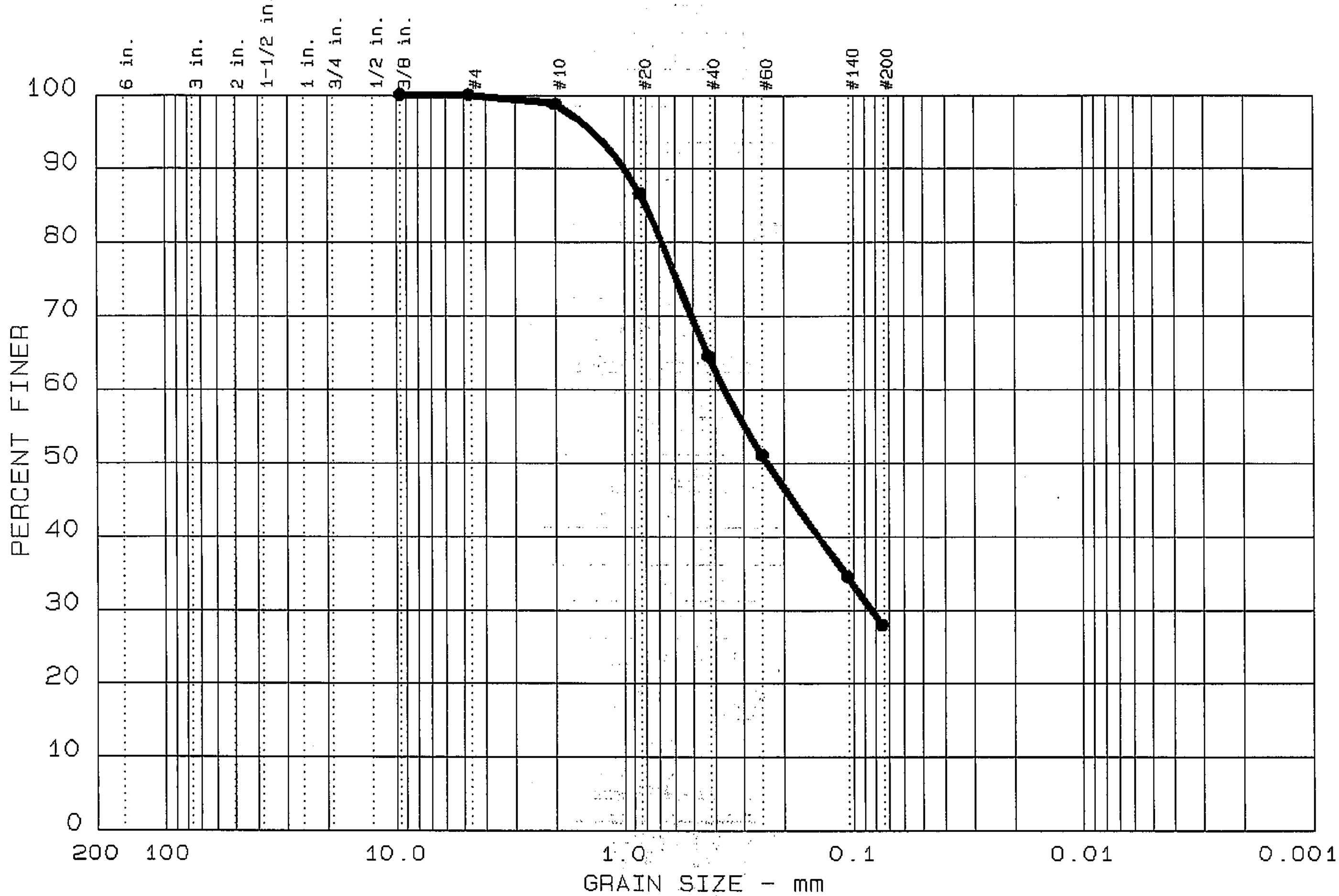
GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

A3-6

Figure No. 05

REVIEWED BY: John Dailly

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	72.0	28.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.80	0.36	0.24	0.083				

MATERIAL DESCRIPTION	USCS	AASHTO
● B-3 S-8 19.5'	ND	ND

Project No.: 30720-1-4728
Project: CP&L ASH POND STABILITY
● Location: B-3 S-8 19.5'

Date: 06-06-01

Remarks:
ND=NOT DETERMINED.

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

A3-7

Figure No. 06

REVIEWED BY: John Railly

GRAIN SIZE DISTRIBUTION TEST REPORT

	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	66.3	33.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.56	0.21	0.15					

MATERIAL DESCRIPTION	USCS	AASHTO
● B-4 S-5 12'	ND	ND

Project No.: 30720-1-4728
Project: CP&L ASH POND STABILITY
● Location: B-4 S-5 12'

Date: 06-06-01

Remarks:
ND=NOT DETERMINED.

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

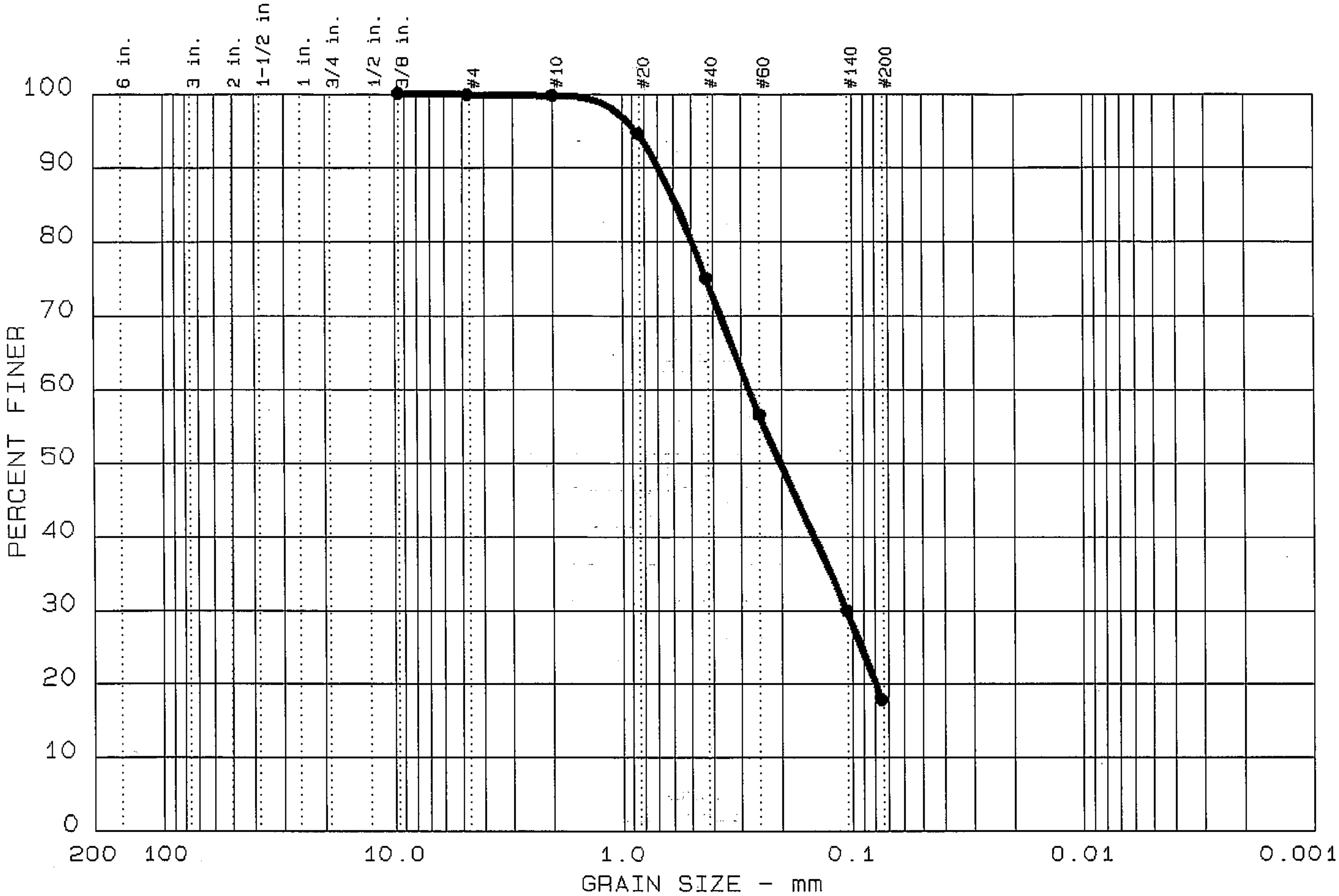
A3-8

Figure No. 07

REVIEWED BY: [signature]

LABORATORY TEST DATA FOR ON-SITE BORROW SOILS

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.1	82.0	17.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.57	0.28	0.20	0.106				

MATERIAL DESCRIPTION	USCS	AASHTO
● PLPID (1) SOIL	ND	ND

Project No.: 30720-1-4476-02-800
Project: CP&L ROBINSON
● Location: PLPID (1) SOIL

Date: 08-02-01

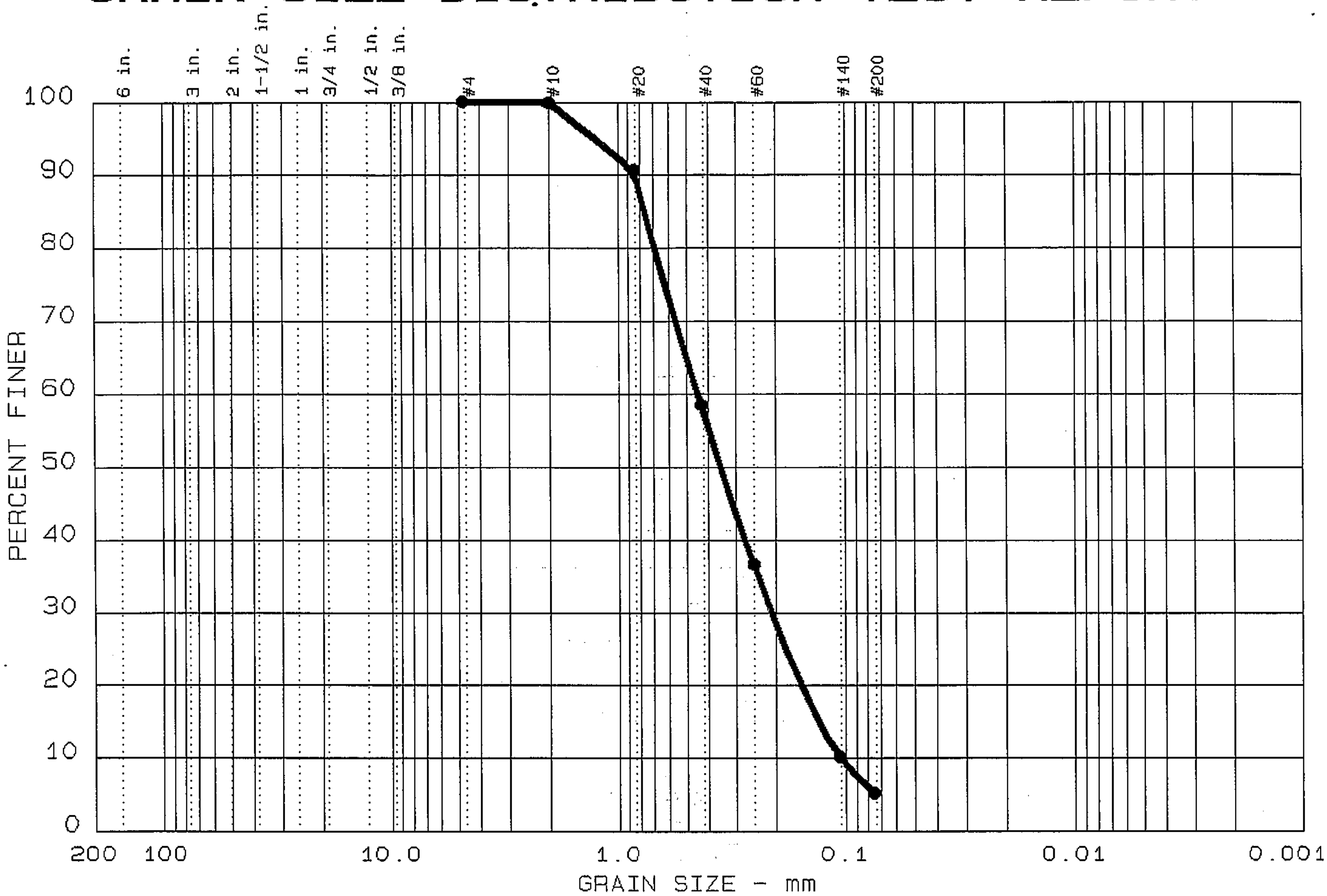
Remarks:
ND=NOT DETERMINED.

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

A4-1
Figure No. 01

REVIEWED BY: [signature]

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	94.8	5.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	ND	ND	0.76	0.44	0.35	0.209	0.1303	0.1047	0.94	4.2

MATERIAL DESCRIPTION	USCS	AASHTO
● PLPID (2) SOIL	ND	ND

Project No.: 30720-1-4476-02-800
Project: CP&L ROBINSON
● Location: PLPID (2) SOIL

Date: 08-02-01

Remarks:
ND=NOT DETERMINED.

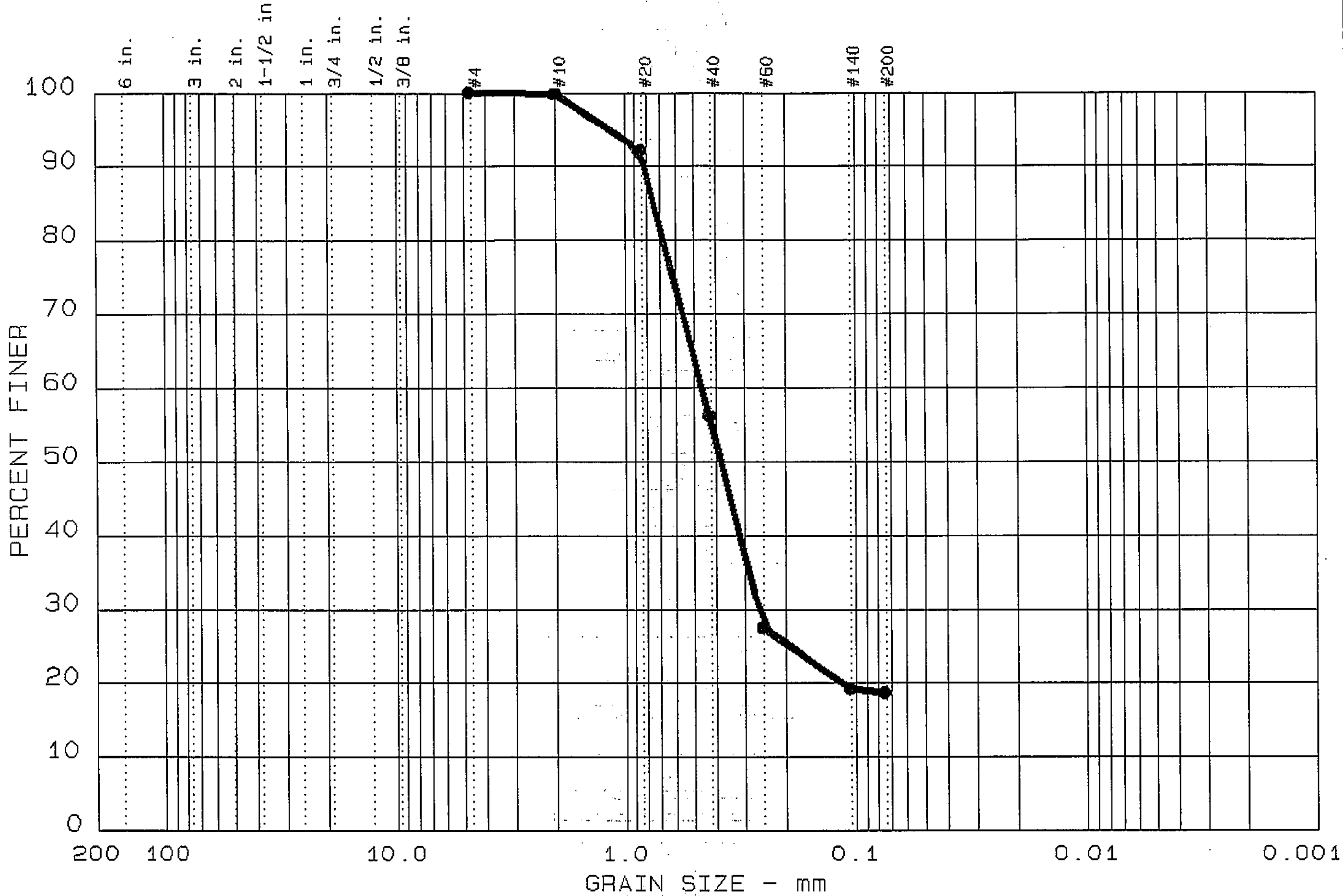
GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

A4-2

Figure No. 02

REVIEWED BY: [signature]

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	81.3	18.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	28	13	0.74	0.46	0.38	0.262				

MATERIAL DESCRIPTION	USCS	AASHTO
● P30 (3) SOIL	SC	ND

Project No.: 30720-1-4476-02-800
Project: CP&L ROBINSON
● Location: P30 (3) SOIL

Date: 08-02-01

Remarks:
ND=NOT DETERMINED.

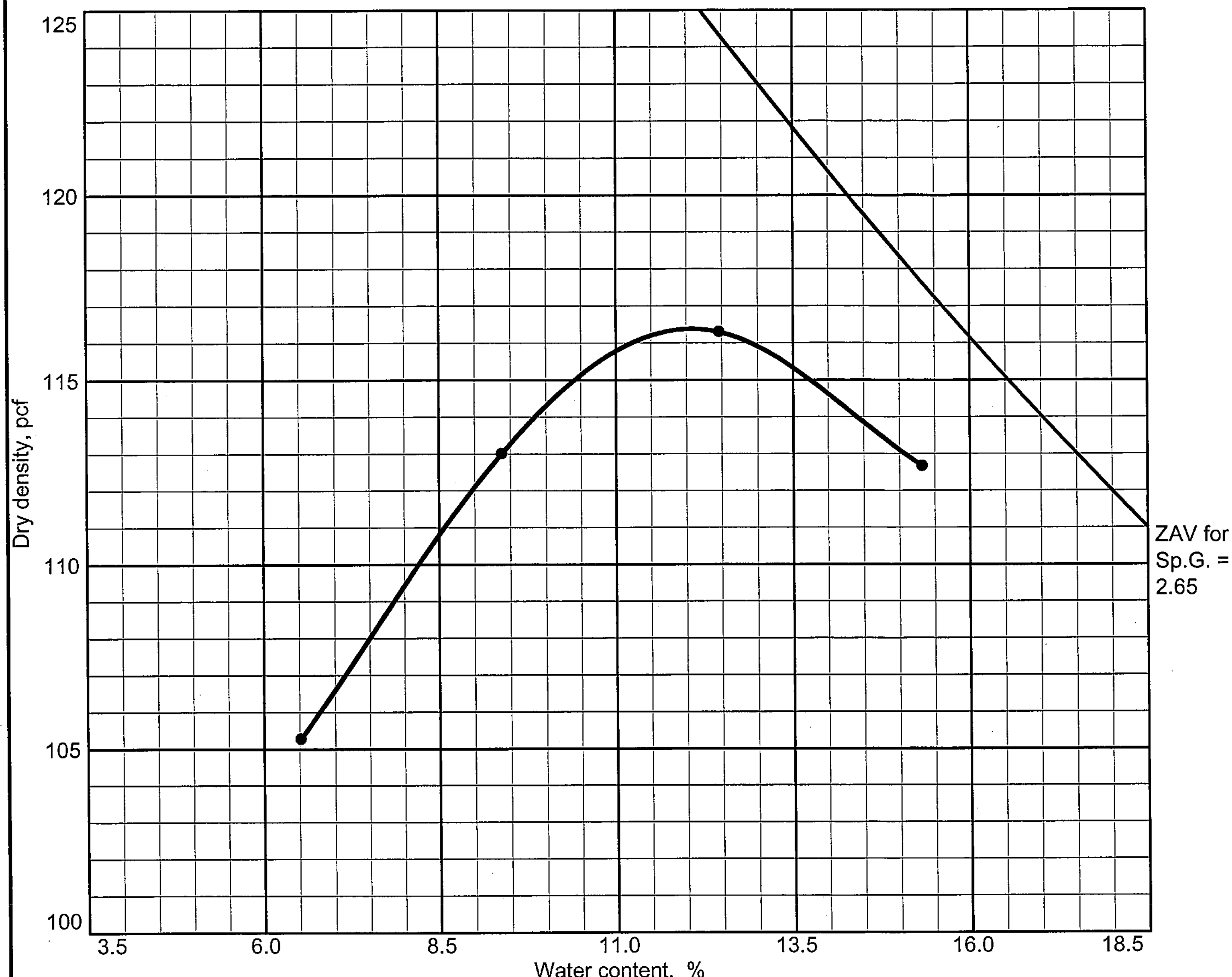
GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

A4-3

Figure No. 03

REVIEWED BY: [signature]

COMPACTION TEST REPORT



Test specification: ASTM D 698-00a Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	ND	ND	ND	ND	ND	ND	ND	ND

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 116.4 pcf Optimum moisture = 12.1 %	(VISUAL) YELLOW RED SILTY SAND

Project No. 14776-02 **Client:** 30720
Project: CP&L ROBINSON

● **Location:** 01-080901: P30(3) SOIL

COMPACTION TEST REPORT

LAW ENGINEERING & ENVIRONMENTAL SERVICES, INC.

Remarks:
ND=NOT DETERMINED.
08-24-01

A4 - 4

REVIEWED BY: [signature]

LAW ENGINEERING & ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA
REPORT OF HYDRAULIC CONDUCTIVITY TESTING (FALLING HEAD-RISING TAILWATER) ASTM D5084-90(97) METHOD C

PROJECT NAME: CP&L / ROBINSON
LAW ENGINEERING & ENVIRONMENTAL SERVICES PROJECT NUMBER: 30720-1-4776-02
DATE: AUGUST 24, 2001

SAMPLE IDENTIFICATION: 01-080901: P30(3)
LABORATORY ID: 01-080901: P30(3)

REMARKS: b value: MAXIMUM OBTAINED = 0.88. CELL # :	4
STATION # :	1, 2
(a) AREA OF BURETTE, cm^2:	1.26
LENGTH OF SAMPLE, cm :	5.560
DIAMETER OF SAMPLE, cm :	7.234
(A) AREA OF SAMPLE, cm^2:	41.100
CELL PRESSURE, psi :	52.8
INFLUENT GAUGE PRESSURE, psi :	48.7
INFLUENT STATION CORRECTION, cm :	23.8
INITIAL INFLUENT BURETTE READING, cm :	27.60
INITIAL INFLUENT BURETTE READING + CORRECTION, cm :	51.40
EFFLUENT GAUGE PRESSURE, psi :	48.7
EFFLUENT STATION CORRECTION, cm :	23.2
INITIAL EFFLUENT BURETTE READING, cm :	16.45
INITIAL EFFLUENT BURETTE READING + CORRECTION, cm :	39.65
PRESSURE HEAD ON SAMPLE, cm :	0.0

START OF TEST			
08/24/01	10:15:00 AM	INITIAL HEAD ACROSS SAMPLE (H1), cm :	11.75
		INITIAL HYDRAULIC GRADIENT (H1/L) :	2.1

UNIT WEIGHT DATA:

LENGTH OF SAMPLE, in:	2.189
DIAMETER OF SAMPLE, in:	2.848
WET WEIGHT OF SOIL, g:	457.5
CALCULATED DRY WEIGHT OF SOIL, g:	408.3

MOISTURE DETERMINATION:

WET SOIL & TARE, g:	412.50
DRY SOIL & TARE, g:	369.02
TARE WEIGHT, g:	8.19

WET UNIT WEIGHT (pcf):	125.0
DRY UNIT WEIGHT (pcf):	111.5
MOISTURE CONTENT (%):	12.0

INFORMATION FROM STANDARD PROCTOR TEST:

Maximum Dry Density (pcf):	116.4
Optimum Moisture Content (%):	12.1

TEST SPECIMEN COMPACTION RESULTS

% Compaction of MDD:	95.8
% Wet of Optimum Moisture:	-0.1

DATE OF READING	TIME OF READING	INCREMENTAL TIME (sec)	TOTAL TIME (sec)	BURETTE READING (cm) L1	BURETTE READING (cm) L2	CORRECTED READING (cm) L1	CORRECTED READING (cm) L2	HEAD ACROSS SAMPLE (cm)	INCREMENTAL PERMEABILITY (K) (cm/s)	TOTAL PERMEABILITY (K) (cm/s)
08/24/01	10:15:30 AM	30	30	26.45	17.60	50.25	40.80	9.45	6.2E-04	6.2E-04
08/24/01	10:16:00 AM	30	60	25.55	18.50	49.35	41.70	7.65	6.0E-04	6.1E-04
08/24/01	10:16:30 AM	30	90	24.80	19.20	48.60	42.40	6.20	6.0E-04	6.1E-04
08/24/01	10:17:00 AM	30	120	24.30	19.70	48.10	42.90	5.20	5.0E-04	5.8E-04
									K AVG = 5.8E-04	

A4-5

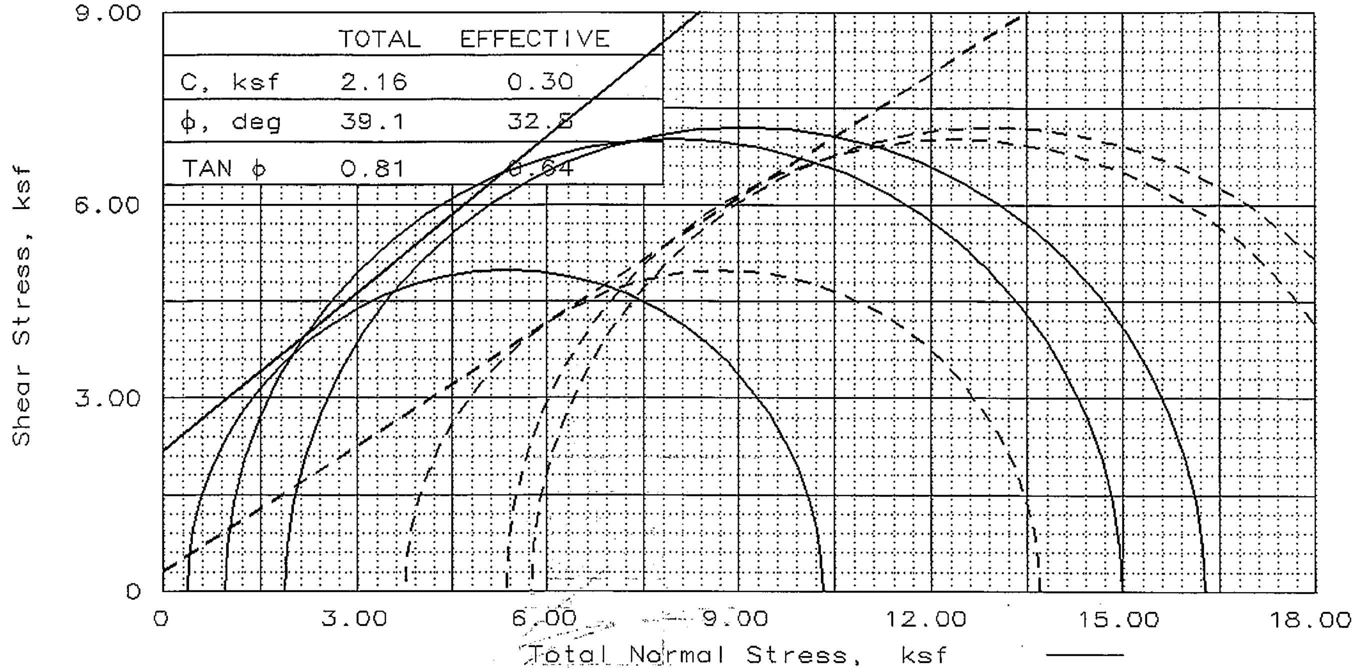
DATE & TIME PRINTED: 08/24/01 11:15 AM

L1 = INFLUENT H20 HEAD, L2 = EFFLUENT H20 HEAD

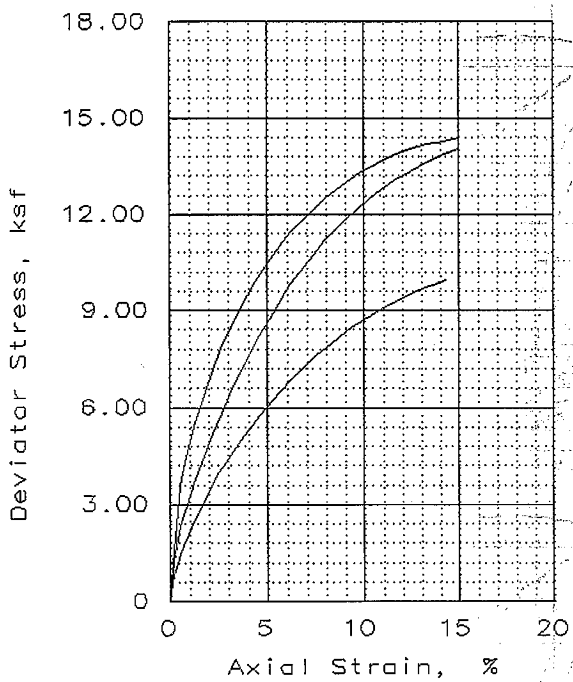
K = (aL)/(2At) x ln(H1/H2)

REVIEWED BY: John Reilly

\01-14776-02d01.xls



	TOTAL	EFFECTIVE
C, ksf	2.16	0.30
ϕ, deg	39.1	32.5
TAN ϕ	0.81	0.64



	SAMPLE NO.	1	2	3
INITIAL	WATER CONTENT, %	12.0	11.9	12.0
	DRY DENSITY, pcf	110.5	111.2	110.0
	SATURATION, %	64.1	64.8	63.3
	VOID RATIO	0.497	0.487	0.504
	DIAMETER, in	2.82	2.81	2.82
	HEIGHT, in	5.59	5.60	5.61
AT TEST	WATER CONTENT, %	18.1	17.5	18.3
	DRY DENSITY, pcf	111.9	112.9	111.5
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.479	0.465	0.484
	DIAMETER, in	2.80	2.79	2.79
	HEIGHT, in	5.60	5.61	5.62
	BACK PRESSURE, ksf	8.01	7.98	7.99
	CELL PRESSURE, ksf	8.40	8.94	9.88
	FAILURE STRESS, ksf	9.94	14.02	14.40
	PORE PRESSURE, ksf	4.62	3.59	4.12
	STRAIN RATE, %/min.	0.804	0.803	0.801
	ULTIMATE STRESS, ksf			
	PORE PRESSURE, ksf			
	$\bar{\sigma}_1$ FAILURE, ksf	13.71	19.38	20.16
	$\bar{\sigma}_3$ FAILURE, ksf	3.77	5.36	5.76

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: LAB-COMPACTED
DESCRIPTION: (VISUAL) YELLOW RED SILTY SAND
LL= ND PL= ND PI= ND
SPECIFIC GRAVITY= 2.65
REMARKS: ND=NOT DETERMINED.
SPECIFIC GRAVITY IS ASSUMED.

FIG. NO.

CLIENT:

PROJECT: CP&L / ROBINSON

SAMPLE LOCATION: 01-080901: P30(3)

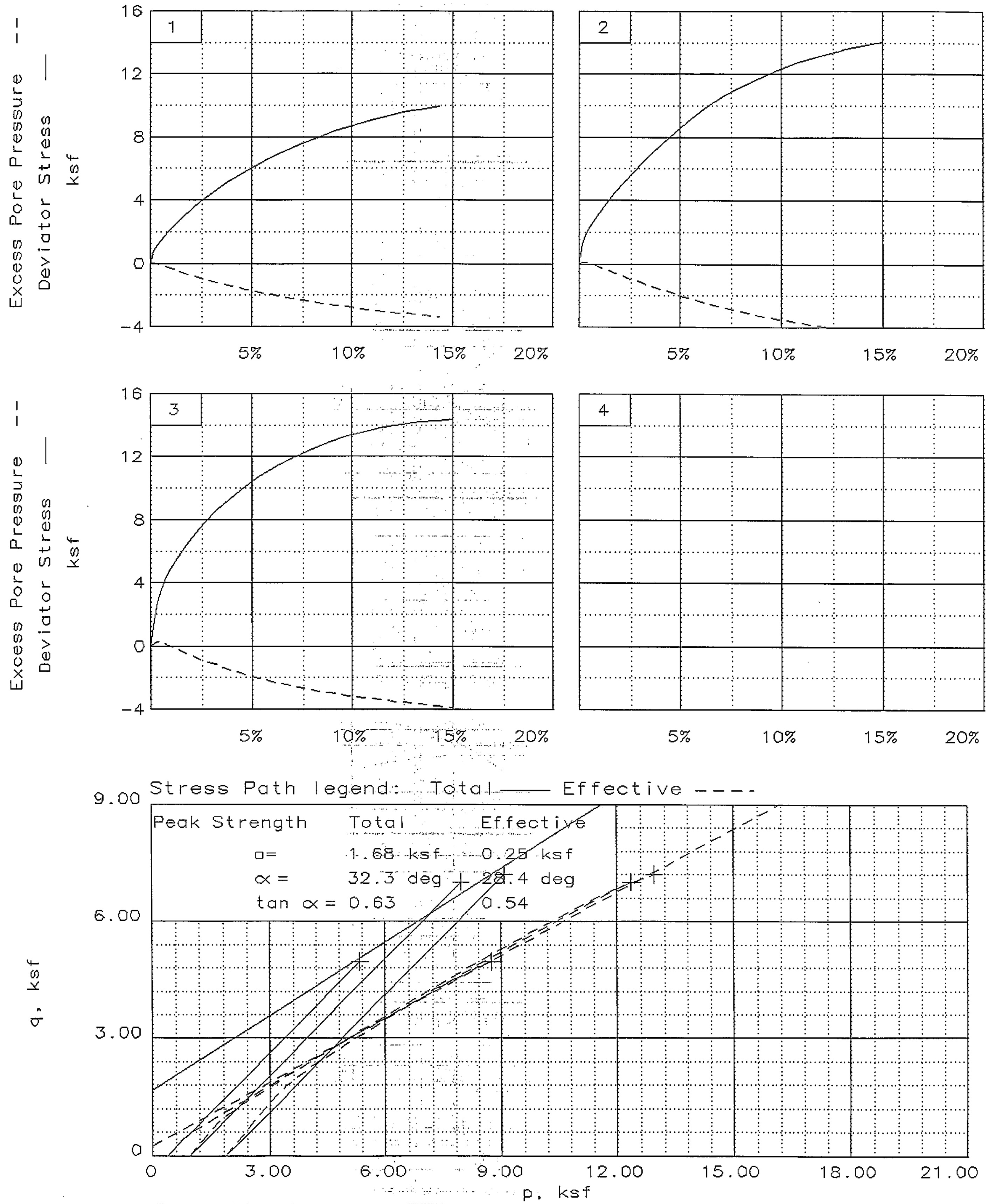
PROJ. NO.: 3072014766 DATE: 08-29-01

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING

A4-6

REVIEWED BY: John Dailly



Client:
Project: CP&L / ROBINSON
Location: 01-080901: P30(3)
File: 14766-01 Project No.: 3072014766 Page 2/2 Fig. No. A4-7

TRIAXIAL COMPRESSION TEST 8-29-19:1
CU with pore pressures 10:32 am

Project Data

Project No.: 3072014766 Date: 08-29-01 Data file: 14766-01
Client:
Project: CP&L / ROBINSON
Sample location: 01-080901: P30(3)
Sample description: (VISUAL) YELLOW RED SILTY SAND
Remarks: ND=NOT DETERMINED. SPECIFIC GRAVITY IS ASSUMED.
COMPACTED TO 94.9% MDD AT OPTIMUM MOISTURE -0.1%. Fig No.

Sample No. 1 Data

Type of sample: LAB-COMPACTED
Specific Gravity= 2.65 LL= ND PL= ND PI= ND

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.82	2.80	
Height change, in		-0.01	
Height, in	5.59	5.60	
Weight, grams	1131.7		
Water volume change, cc		-60.92	
Moisture, %	12.0	18.1	16.2
Dry density, pcf	110.5	111.9	
Saturation, %	64.1	100.0	
Void ratio	0.497	0.479	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.68017 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.804 % per minute
Consolidation cell pressure = 58.3 psi
Consolidation back pressure = 55.6 psi
Consolidation effective confining stress = 0.3888 ksf
Peak deviator stress = 9.94 ksf at reading no. 23
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Effective Stresses Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
0	0.0370	0.000	19.0	0.0	0.0	0.00	0.39	0.39	1.00	55.6	0.39	0.00
1	0.0470	0.010	71.0	35.4	0.2	0.83	0.36	1.19	3.30	55.8	0.77	0.41
2	0.0570	0.020	93.0	50.3	0.4	1.18	0.42	1.59	3.81	55.4	1.01	0.59
3	0.0670	0.030	111.0	62.6	0.5	1.46	0.50	1.96	3.89	54.8	1.23	0.73
4	0.0770	0.040	128.0	74.1	0.7	1.72	0.59	2.31	3.92	54.2	1.45	0.86
5	0.0870	0.050	144.0	85.0	0.9	1.97	0.66	2.64	3.98	53.7	1.65	0.99

LAW ENGINEERING

A4-8

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
6	0.1000	0.063	165.0	99.3	1.1	2.30	0.76	3.06	4.01	53.0	1.91	1.15
7	0.1250	0.088	203.0	125.2	1.6	2.89	0.98	3.87	3.95	51.5	2.42	1.44
8	0.1500	0.113	237.0	148.3	2.0	3.40	1.15	4.56	3.95	50.3	2.85	1.70
9	0.1750	0.138	269.0	170.0	2.5	3.89	1.31	5.20	3.97	49.2	3.25	1.94
10	0.2000	0.163	297.0	189.1	2.9	4.30	1.48	5.78	3.90	48.0	3.63	2.15
11	0.2500	0.213	352.0	226.5	3.8	5.10	1.76	6.86	3.91	46.1	4.31	2.55
12	0.3000	0.263	400.0	259.1	4.7	5.79	2.02	7.80	3.87	44.3	4.91	2.89
13	0.3500	0.313	448.0	291.8	5.6	6.45	2.26	8.71	3.85	42.6	5.49	3.23
14	0.4000	0.363	490.0	320.4	6.5	7.02	2.49	9.51	3.82	41.0	6.00	3.51
15	0.4570	0.420	533.0	349.6	7.5	7.58	2.71	10.28	3.80	39.5	6.50	3.79
16	0.5000	0.463	562.0	369.3	8.3	7.94	2.85	10.79	3.78	38.5	6.82	3.97
17	0.5500	0.513	598.0	393.8	9.2	8.38	3.04	11.42	3.76	37.2	7.23	4.19
18	0.6000	0.563	628.0	414.2	10.1	8.73	3.18	11.91	3.74	36.2	7.55	4.36
19	0.6500	0.613	656.0	433.3	11.0	9.04	3.33	12.37	3.72	35.2	7.85	4.52
20	0.7000	0.663	682.0	451.0	11.8	9.31	3.46	12.77	3.69	34.3	8.11	4.66
21	0.7500	0.713	709.0	469.3	12.7	9.59	3.57	13.17	3.69	33.5	8.37	4.80
22	0.8000	0.763	730.0	483.6	13.6	9.79	3.69	13.47	3.65	32.7	8.58	4.89
23	0.8390	0.802	747.0	495.2	14.3	9.94	3.77	13.71	3.63	32.1	8.74	4.97

LAW ENGINEERING

TRIAXIAL COMPRESSION TEST
CU with pore pressures

8-29-19:1
10:45 am

Project Data

Project No.: 3072014766   Date: 08-29-01   Data file: 14766-01
Client:
Project: CP&L / ROBINSON
Sample location: 01-080901: P30(3)
Sample description: (VISUAL) YELLOW RED SILTY SAND
Remarks: ND=NOT DETERMINED. SPECIFIC GRAVITY IS ASSUMED.
COMPACTED TO 95.5% MDD AT OPTIMUM MOISTURE -0.2%.   Fig No.

Sample No. 2 Data

Type of sample: LAB-COMPACTED
Specific Gravity= 2.65   LL= ND   PL= ND   PI= *ND*

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.81	2.79	
Height change, in		-0.01	
Height, in	5.60	5.61	
Weight, grams	1134.9		
Water volume change, cc		-57.08	
Moisture, %	11.9	17.5	16.3
Dry density, pcf	111.2	112.9	
Saturation, %	64.8	100.0	
Void ratio	0.487	0.465	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.67774 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.803 % per minute
Consolidation cell pressure = 62.1 psi
Consolidation back pressure = 55.4 psi
Consolidation effective confining stress = 0.9648 ksf
Peak deviator stress = 14.02 ksf at reading no. 24
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Effective Stresses Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
0	0.0000	0.000	19.0	0.0	0.0	0.00	0.96	0.96	1.00	55.4	0.96	0.00
1	0.0100	0.010	99.0	54.2	0.2	1.28	0.86	2.14	2.48	56.1	1.50	0.64
2	0.0200	0.020	140.0	82.0	0.4	1.93	0.85	2.78	3.27	56.2	1.81	0.96
3	0.0300	0.030	165.0	99.0	0.5	2.32	0.92	3.24	3.52	55.7	2.08	1.16
4	0.0400	0.040	187.0	113.9	0.7	2.67	0.99	3.66	3.69	55.2	2.33	1.33
5	0.0500	0.050	208.0	128.1	0.9	3.00	1.09	4.09	3.74	54.5	2.59	1.50

LAW ENGINEERING

A4-10

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
6	0.0750	0.075	258.0	162.0	1.3	3.77	1.32	5.10	3.85	52.9	3.21	1.89
7	0.1000	0.100	305.0	193.8	1.8	4.49	1.56	6.05	3.89	51.3	3.80	2.25
8	0.1250	0.125	352.0	225.7	2.2	5.21	1.79	6.99	3.92	49.7	4.39	2.60
9	0.1500	0.150	393.0	253.5	2.7	5.82	2.00	7.82	3.91	48.2	4.91	2.91
10	0.1750	0.175	434.0	281.3	3.1	6.43	2.19	8.62	3.94	46.9	5.40	3.22
11	0.2000	0.200	471.0	306.3	3.6	6.97	2.39	9.36	3.92	45.5	5.88	3.49
12	0.2500	0.250	543.0	355.1	4.5	8.01	2.75	10.76	3.91	43.0	6.75	4.00
13	0.3000	0.300	610.0	400.5	5.4	8.95	3.10	12.04	3.89	40.6	7.57	4.47
14	0.3500	0.350	675.0	444.6	6.2	9.84	3.43	13.27	3.87	38.3	8.35	4.92
15	0.4000	0.400	729.0	481.2	7.1	10.55	3.72	14.26	3.84	36.3	8.99	5.27
16	0.4500	0.450	780.0	515.8	8.0	11.20	3.97	15.17	3.82	34.5	9.57	5.60
17	0.5000	0.500	825.0	546.3	8.9	11.74	4.22	15.96	3.78	32.8	10.09	5.87
18	0.5500	0.550	868.0	575.4	9.8	12.25	4.44	16.68	3.76	31.3	10.56	6.12
19	0.6000	0.600	906.0	601.2	10.7	12.67	4.64	17.31	3.73	29.9	10.97	6.34
20	0.6500	0.650	941.0	624.9	11.6	13.04	4.81	17.85	3.71	28.7	11.33	6.52
21	0.7000	0.700	970.0	644.5	12.5	13.31	4.97	18.28	3.68	27.6	11.62	6.66
22	0.7500	0.750	1003.0	666.9	13.4	13.64	5.13	18.76	3.66	26.5	11.94	6.82
23	0.8000	0.800	1030.0	685.2	14.3	13.87	5.26	19.12	3.64	25.6	12.19	6.93
24	0.8390	0.839	1050.0	698.7	15.0	14.02	5.36	19.38	3.62	24.9	12.37	7.01

LAW ENGINEERING

TRIAXIAL COMPRESSION TEST
CU with pore pressures

8-29-19:1
10:49 am

Project Data

Project No.: 3072014766   Date: 08-29-01   Data file: 14766-01
Client:
Project: CP&L / ROBINSON
Sample location: 01-080901: P30(3)
Sample description: (VISUAL) YELLOW RED SILTY SAND
Remarks: ND=NOT DETERMINED. SPECIFIC GRAVITY IS ASSUMED.
COMPACTED TO 94.5% MDD AT OPTIMUM MOISTURE -0.1%.   Fig No.

Sample No. 3 Data

Type of sample: LAB-COMPACTED
Specific Gravity= 2.65   LL= ND   PL= ND   PI= ND

Sample Parameters	Before Test	At Testing	After Test
Diameter, in	2.82	2.79	
Height change, in		-0.01	
Height, in	5.61	5.62	
Weight, grams	1129.7		
Water volume change, cc		-62.81	
Moisture, %	12.0	18.3	16.4
Dry density, pcf	110.0	111.5	
Saturation, %	63.3	100.0	
Void ratio	0.504	0.484	

Test Data

Deformation dial constant= 1 in per input unit
Primary load ring constant= 0.6775 lbs. per input unit
Secondary load ring constant= 0 lbs. per input unit
Crossover reading for secondary load ring= 0 input units
Rate of strain= 0.801 % per minute
Consolidation cell pressure = 68.6 psi
Consolidation back pressure = 55.5 psi
Consolidation effective confining stress = 1.8864 ksf
Peak deviator stress = 14.40 ksf at reading no. 23
Ult. deviator stress =

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Effective Stresses Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
0	0.0000	0.000	22.0	0.0	0.0	0.00	1.89	1.89	1.00	55.5	1.89	0.00
1	0.0100	0.010	125.0	69.8	0.2	1.64	1.73	3.36	1.95	56.6	2.55	0.82
2	0.0200	0.020	197.0	118.6	0.4	2.77	1.64	4.42	2.69	57.2	3.03	1.39
3	0.0300	0.030	248.0	153.1	0.5	3.58	1.64	5.22	3.18	57.2	3.43	1.79
4	0.0400	0.040	283.0	176.8	0.7	4.12	1.73	5.85	3.39	56.6	3.79	2.06
5	0.0500	0.050	315.0	198.5	0.9	4.62	1.83	6.45	3.53	55.9	4.14	2.31

LAW ENGINEERING

A4-12

No.	Def. Dial Units	Def. in	Load Dial Units	Load lbs.	Strain %	Deviator Stress ksf	Effective Stresses Minor ksf	Major ksf	1:3 Ratio	Pore Pres. psi	P ksf	Q ksf
6	0.0750	0.075	375.0	239.2	1.3	5.54	2.10	7.64	3.64	54.0	4.87	2.77
7	0.1000	0.100	430.0	276.4	1.8	6.38	2.36	8.74	3.70	52.2	5.55	3.19
8	0.1250	0.125	482.0	311.7	2.2	7.16	2.61	9.76	3.75	50.5	6.18	3.58
9	0.1500	0.150	527.0	342.1	2.7	7.82	2.84	10.66	3.76	48.9	6.75	3.91
10	0.1800	0.180	576.0	375.3	3.2	8.53	3.02	11.56	3.82	47.6	7.29	4.27
11	0.2000	0.200	606.0	395.7	3.6	8.96	3.24	12.20	3.77	46.1	7.72	4.48
12	0.2500	0.250	674.0	441.7	4.4	9.91	3.60	13.51	3.75	43.6	8.56	4.96
13	0.3000	0.300	735.0	483.1	5.3	10.74	3.92	14.66	3.74	41.4	9.29	5.37
14	0.3500	0.350	788.0	519.0	6.2	11.43	4.20	15.63	3.72	39.4	9.92	5.71
15	0.4000	0.400	832.0	548.8	7.1	11.97	4.44	16.41	3.70	37.8	10.42	5.99
16	0.4500	0.450	876.0	578.6	8.0	12.50	4.65	17.15	3.69	36.3	10.90	6.25
17	0.5000	0.500	912.0	603.0	8.9	12.90	4.84	17.74	3.67	35.0	11.29	6.45
18	0.5500	0.550	949.0	628.0	9.8	13.31	5.01	18.32	3.66	33.8	11.66	6.65
19	0.6500	0.650	1007.0	667.3	11.6	13.86	5.31	19.17	3.61	31.7	12.24	6.93
20	0.7000	0.700	1031.0	683.6	12.5	14.05	5.44	19.50	3.58	30.8	12.47	7.03
21	0.7500	0.750	1051.0	697.1	13.3	14.19	5.56	19.75	3.55	30.0	12.65	7.09
22	0.8000	0.800	1069.0	709.3	14.2	14.29	5.67	19.96	3.52	29.2	12.82	7.14
23	0.8430	0.843	1087.0	721.5	15.0	14.40	5.76	20.16	3.50	28.6	12.96	7.20

LAW ENGINEERING

APPENDIX B
CALCULATIONS

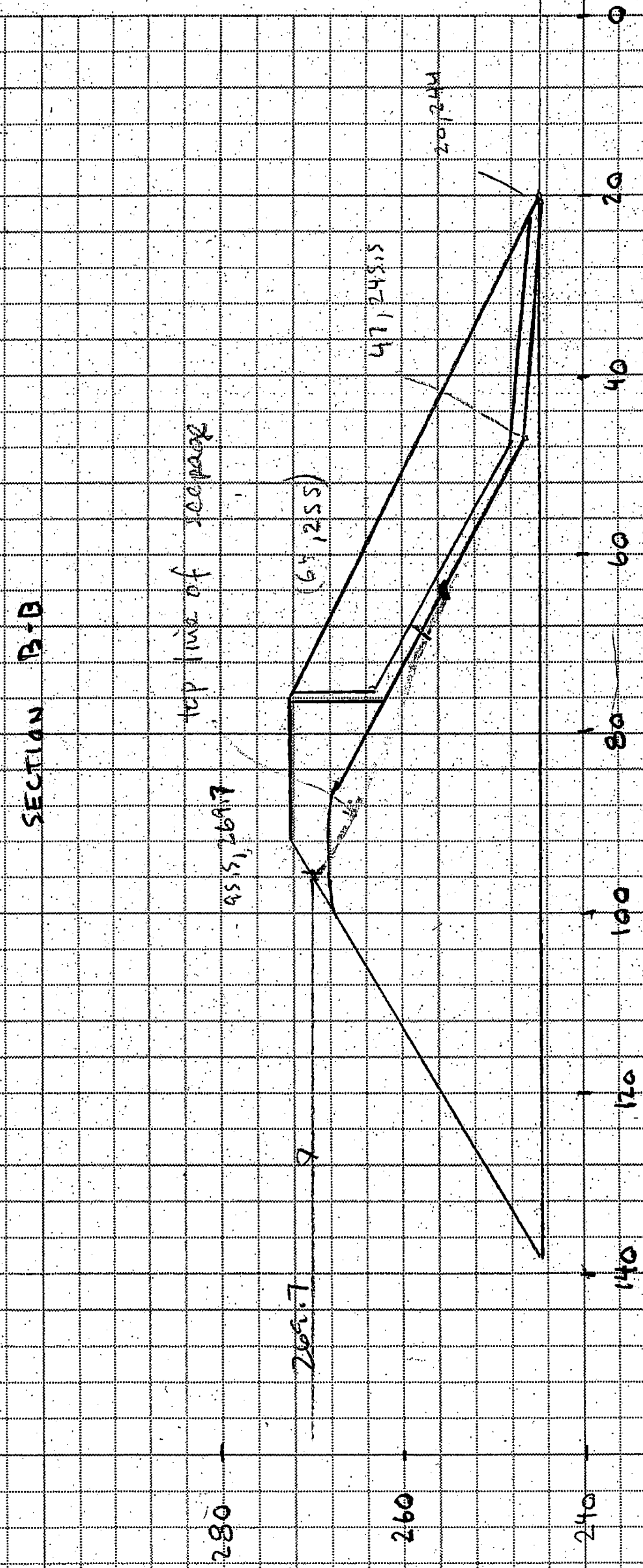
- SLOPE STABILITY
- HYDROLOGIC ROUTING
- INTERNAL DRAIN BLANKET
- STORM WATER BYPASS CHANNEL
- WEIR DRAINAGEWAYS

SLOPE STABILITY

LAWGIBB GROUP

LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

JOB NO. 30720-1-4776 SHEET 1 OF 5
PHASE ______ TASK 800
JOB NAME Robinson Ash Dike Design
BY PCL DATE ______
CHECKED BY [signature] DATE 10/5/01

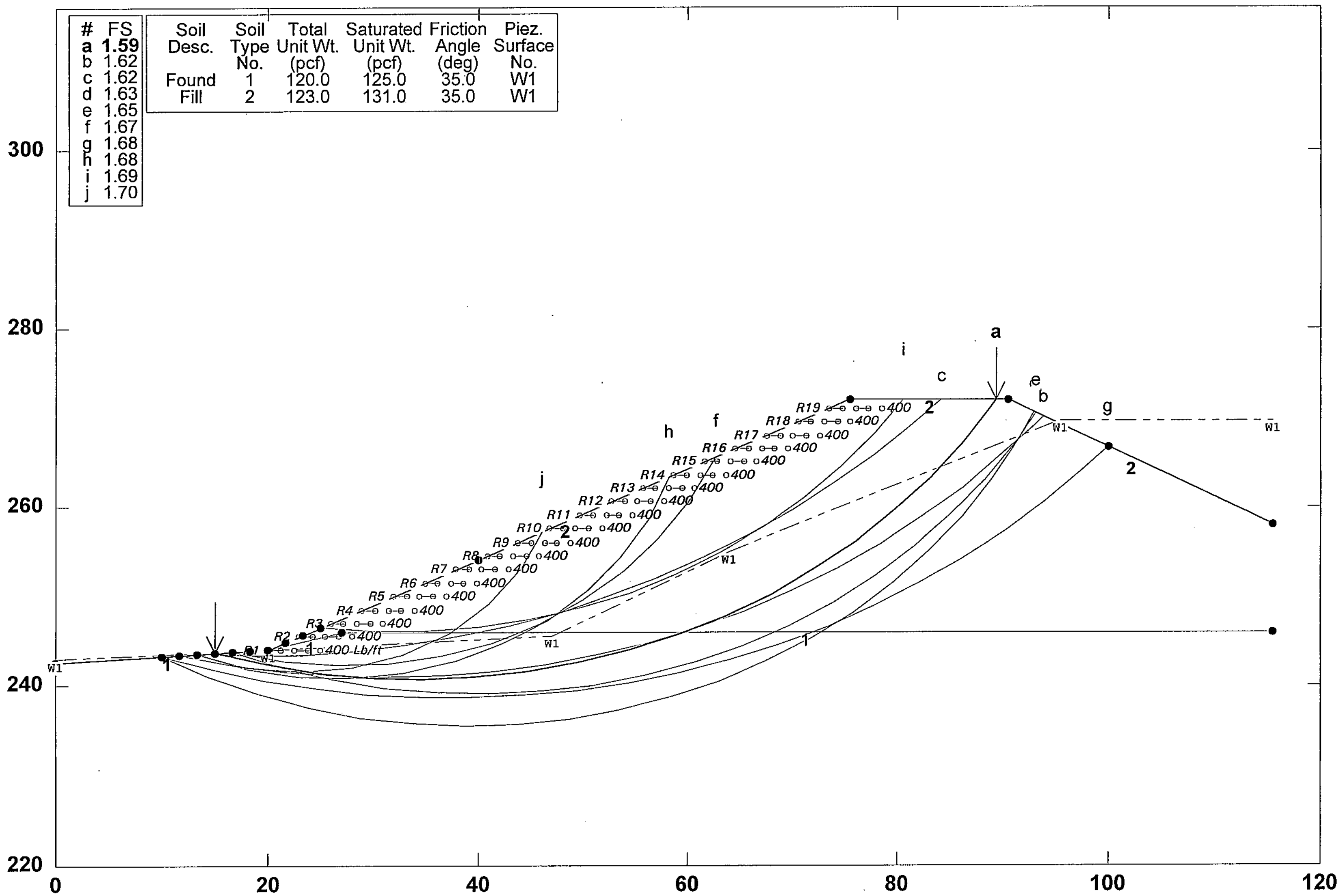


Analysis Section
for Stabl input
include geogrids
1½' spacing
Tensile load 410 #/ft
for B = 1200

BD-1

Robinson Ash Pond Dam Stability, Case 2ALAW Project No. 30720-1-4776

G:\GEOTECH\PROGRAMS\STED\4776CS2A.PL2 Run By: PCL 10/3/01 5:26PM



STABL6H FSmin=1.59

Safety Factors Are Calculated By The Modified Bishop Method

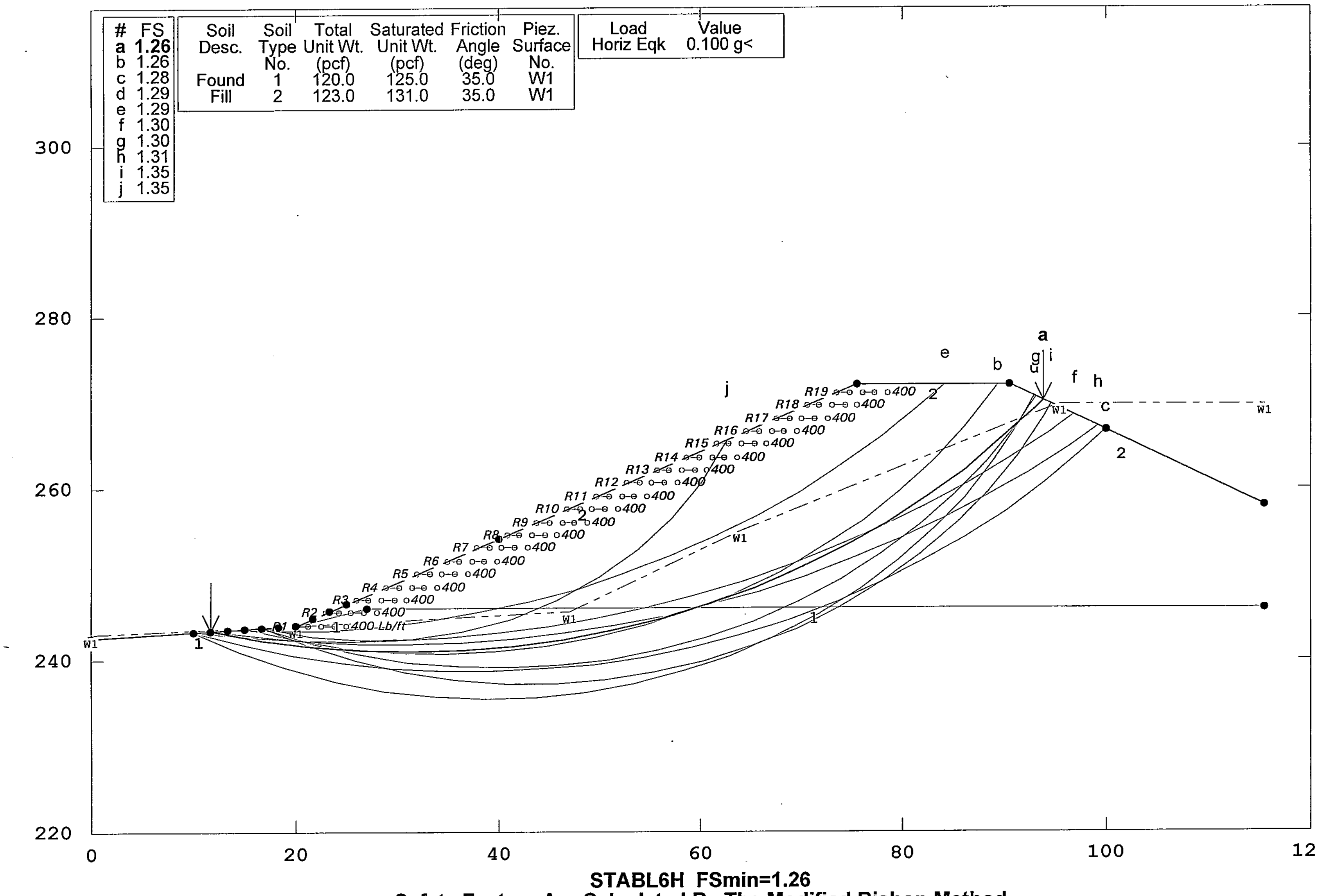
STED

B1-2

295

Robinson Ash Pond Dam Stability, Case 2ALAW Project No. 30720-1-4776

G:\GEOTECH\PROGRAMS\STED\4776CS2A.PL2 Run By: PCL 10/3/01 5:24PM



STED

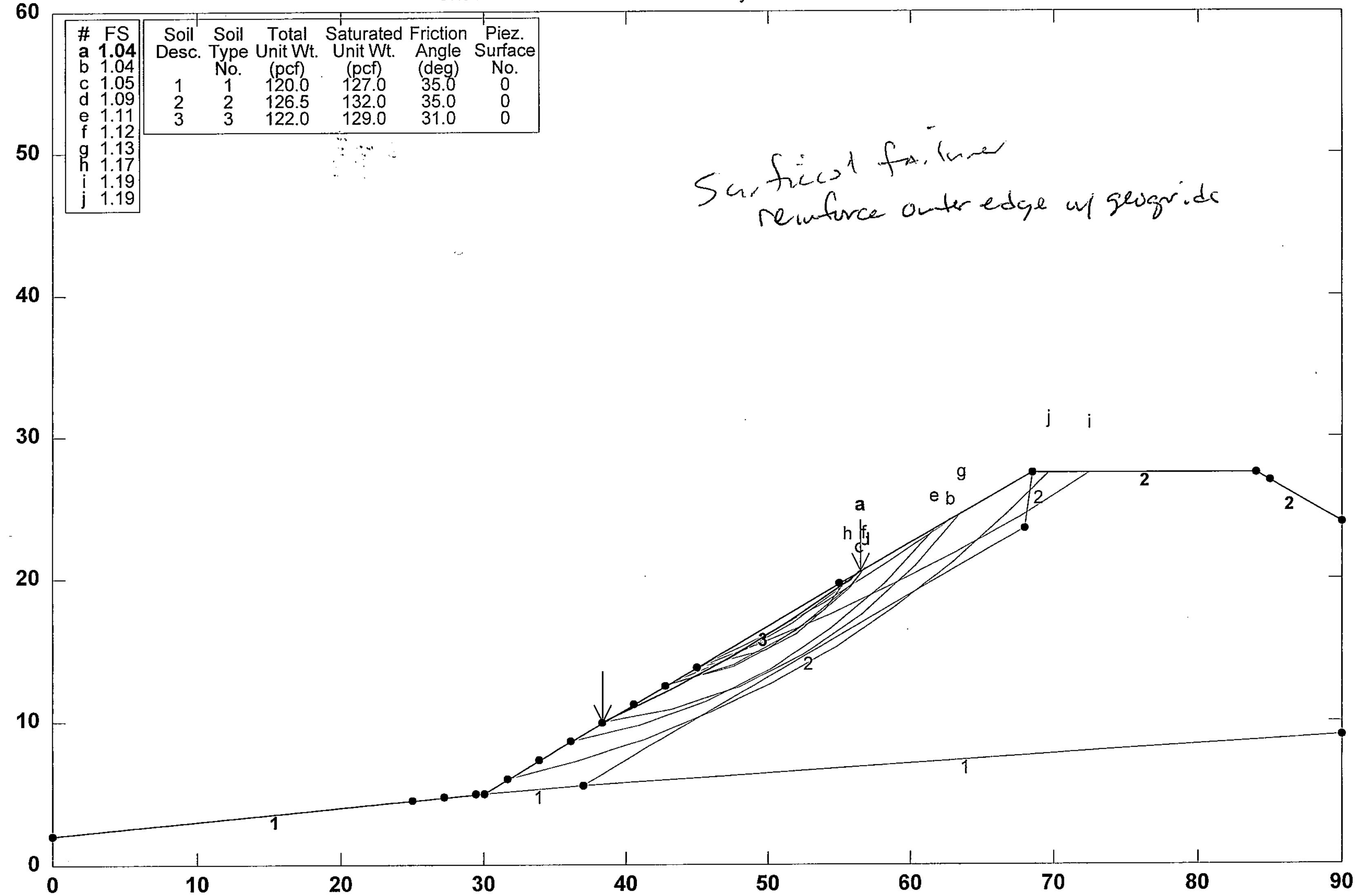
E Jan

Bi-3

3 of 5

Robinson Dike extension With internal Drainage

C:\STEDWIN\ROXBORO.PL2   Run By: LAW   9/30/01   12:04PM



PCSTABL5M/si FSmin=1.04
Safety Factors Are Calculated By The Modified Bishop Method

STED

B1-4

4 of 5

LAW ENGINEERING
P.O. BOX 18288 3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27619

5 of 5

TELECON RECORD

Date: 10/1/01 Time: 2:30

Tice of LETCO Placed ( ) call.

Received (✓) call.

Talked To: John Bolton Of: Tensar

Concerning: Tensar Geogrid edge slope reinforcement

Phone No.: ( ) 704-895-5050

Message:

Asked about their recommendations for surficial sliding reinforcing in sandy soil slope 2:1

John says they have good success using BX1100 1 1/2' layers 8' long (1/2 roll).

key is get vegetated quickly

Action:

B1-5

HYDROLOGIC ROUTING

HYDROLOGIC SUMMARY

Watershed area taken from CADD computation of outline on USGS quadrangle sheet as 398 acres, including area occupied by Darlington Plant.

Storm water from runoff at Darlington is piped and routed so as to bypass pond. Area of plant from planimeter off quad sheet is approximately 23 acres, deduct from watershed, leaving 375 acres for pond contribution.

Watershed is composed of sandy soils with woods.

Analysis is by methods in North Carolina Erosion and Sediment Control Planning and design Manual, with routing by chain-saw method of Dr. Rooney Malcolm, as presented in his course notes from CE 383, N. C. State University, 1993.

Subsequent to analysis, it was learned that CP&L has quantified the Darlington Plant area as 25.6 acres. The small difference is inconsequential to the hydrologic analysis, and no corrections were made.

APPENDIX A
CALCULATIONS
CP&L ROBINSON
LAW PROJECT NO. 30720-0-4728

EVALUATE FEASIBILITY OF 48"RISER TO ACCOMMODATE 50-YR STORM EVENT

CALCULATIONS REFERENCE: NORTH CAROLINA EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL, DECEMBER, 1993

DESIGN CALCULATIONS — Calculations by TLL 05-30-01, modified by JAT 10-05-01 for revised plant inflow.
Calculations Checked by J. Mann 10-05-01

JAM

DESIGN STORM HYDROGRAPH

DRAINAGE AREA =	17,336,000 ft^2		375 ac			
RATIONAL COEFF. (C) =	0.325					
RAINFALL INTENSITY (I) =	2.5 (in/hr)	IDF curves, SECPM, p. 8.03.05		tc =	110 min	(nomograph) SECPM, p.8.03.04

*** TOTAL INFLOW INCLUDES ASH SLUICE INFLOW (1.58 MGD), WASTEWATER FROM PLANT (.07MGD) and STORM HYDROGRAPH.
TOTAL NON-RAIN INFLOW IS 2.54 CFS. INFLOW DOES NOT INCLUDE STORMWATER FROM DARLINGTON PLANT WHICH BYPASSES POND

USE STEP FUNCTION TO DEVELOP INFLOW HYDROGRAPH — Malcolm, p. III-3
Course Notes CE 383, Hydrology and Urban Systems
NC State University, 1993

For 0 </= t </= 1.25Tp,
Q = Qp/2 *[1-cos(3.1415*t/Tp)]
For t > 1.25Tp,
Q = 4.34*Qp*exp[-1.30*(t/Tp)]

Qp = CIA
304.6875 cfs — CN= 50
Tp = Vol/(1.39*Qp)
Vol = (Q*) *A
Q* = Runoff Depth (in)
= (P-.2S)^2/(P+.8S)
P = 7.5 in — SECPM, p. 8.03.15, extrapolated to Hartsville.
S = 1000/CN -10
S= 10
Q* = 1.951612903 in

Vol = 2819430.108
Tp = 6657.20446 sec
110.9534077 min -------> 111 min — 1.25 Tp = 138.9 min, say 140

STAGE-STORAGE FUNCTION

S = Ks*Z^b
S = STORAGE (ft^3)
Z = STAGE (ft)
Ks = (S)/(Z^b)
b = ln(S2/S1)/ln(Z2/Z1)

S1 =	1819539 ft^3	b =	1.042265802
Z1 =	1 ft		
S2 =	3747267 ft^3	Ks =	1819539
Z2 =	2 ft		

Z = (S /1819539)^(1/1.0423)

OUTFLOW EQUATIONS

TOTAL OUTFLOW IS THE MINIMUM FLOW CALCULATED FOR THE RISERS AT WEIR FLOW, RISERS AT ORIFICE FLOW AND BARRELS.

Q (riser -w) = (Cw*L*H^(3/2))
Cw = 3 — Malcom, p. III-10
L = 2*3.1415* r
12.5664 ft
H = Z-0 ft

Q (riser-o) = (Cd*A*(2*g*H)^(1/2))
Cd = 0.6 — Malcom, p. III-11
A = 3.1415*r^2
12.5664 ft^2
g = 32.2 ft/s^2
H = Z-0 ft

Q (barrels) = (.0437*Cd*D^2*(Z+EI-D/24)^1/2)
Cd = 0.6 — Malcom, p. III-13
A = 3.1415*r^2
7.0686 ft^2
g = 32.2 ft/s^2
D = 36 in — Ei = 19 ft

B2-1

ROUTING EQUATIONS

USE "CHAINSAW METHOD"

Malcom, p. III-18

STEP 1: deltaS ij = (Ii-Oi)*deltaTij

STEP 2: Sj = Si+deltaSij

STEP 3: Zj = (Sj/Ks)^(1/b)

STEP 4: Oj = Minimum (Qrisers-w : Qrisers-o : Qbarrels)

50-YR, 24-HR HYDROGRAPH ---------- 1, 48" RISER AND 1, 36" BARREL

TIME (min)	STORM INFLOW (cfs)	TOTAL INFLOW (cfs)	STORAGE (ft^3)	STAGE (ft)	RISER (cfs)	RISER-0 (cfs)	BARREL (cfs)	OUTFLOW (cfs)
0	0.00	2.54	0.00	0.000000	0.000000	0.000000	0.000000	2.540000
5	1.30	3.84	0.00	0.000000	0.000000	0.000000	142.153224	0.000000
10	5.20	7.74	1153.37	0.000854	0.000942	1.768634	142.156694	0.000942
15	11.61	14.15	3473.89	0.002461	0.004603	3.001594	142.163219	0.004603
20	20.43	22.97	7716.82	0.005293	0.014516	4.401846	142.174719	0.014516
25	31.51	34.05	14603.45	0.009760	0.036352	5.977597	142.192861	0.036352
30	44.66	47.20	24808.09	0.016228	0.077935	7.707780	142.219121	0.077935
35	59.66	62.20	38945.83	0.025015	0.149149	9.569554	142.254787	0.149149
40	76.25	78.79	57561.27	0.036391	0.261700	11.542136	142.300948	0.261700
45	94.14	96.68	81118.53	0.050575	0.428771	13.606930	142.358488	0.428771
50	113.02	115.56	109992.67	0.067736	0.664579	15.747101	142.428069	0.664579
55	132.59	135.13	144462.62	0.087985	0.983858	17.947170	142.510129	0.983858
60	152.49	155.03	184705.96	0.111380	1.401293	20.192716	142.604878	1.401293
65	172.40	174.94	230795.45	0.137921	1.930916	22.470166	142.712293	1.930916
70	191.96	194.50	282697.47	0.167553	2.585514	24.766659	142.832123	2.585514
75	210.85	213.39	340272.40	0.200167	3.376037	27.069954	142.963895	3.376037
80	228.74	231.28	403276.91	0.235601	4.311064	29.368377	143.106924	4.311064
85	245.33	247.87	471368.14	0.273644	5.396327	31.650790	143.260325	5.396327
90	260.33	262.87	544109.70	0.314040	6.634320	33.906577	143.423034	6.634320
95	273.48	276.02	620979.29	0.356491	8.024010	36.125646	143.593820	8.024010
100	284.56	287.10	701377.96	0.400663	9.560656	38.298435	143.771317	9.560656
105	293.39	295.93	784640.66	0.446193	11.235756	40.415929	143.954039	11.235756
110	299.80	302.34	870048.00	0.492692	13.037112	42.469675	144.140412	13.037112
115	303.69	306.23	956838.97	0.539755	14.949027	44.451810	144.328801	14.949027
120	305.00	307.54	1044224.33	0.586965	16.952613	46.355082	144.517533	16.952613
125	303.70	306.24	1131400.55	0.633903	19.026212	48.172877	144.704931	19.026212
130	299.81	302.35	1217563.86	0.680151	21.145915	49.899244	144.889340	21.145915
135	293.40	295.94	1301924.38	0.725303	23.286154	51.528922	145.069151	23.286154
140	284.58	287.12	1383719.85	0.768969	25.420362	53.057370	145.242833	25.420362
145	275.16	277.70	1462228.88	0.810782	27.521661	54.480784	145.408950	27.521661
150	260.65	263.19	1537282.38	0.850670	29.577386	55.804823	145.567240	29.577386
155	246.91	249.45	1607366.76	0.887845	31.537269	57.011154	145.714613	31.537269
160	233.89	236.43	1672740.25	0.922462	33.399597	58.111963	145.851711	33.399597
165	221.56	224.10	1733649.50	0.954666	35.163783	59.117628	145.979135	35.163783
170	209.88	212.42	1790329.88	0.984593	36.830140	60.037084	146.097449	36.830140
175	198.81	201.35	1843005.80	1.012371	38.399696	60.878096	146.207183	38.399696
180	188.33	190.87	1891891.09	1.038121	39.874050	61.647469	146.308833	39.874050
185	178.40	180.94	1937189.33	1.061958	41.255247	62.351207	146.402866	41.255247
190	168.99	171.53	1979094.28	1.083989	42.545679	62.994643	146.489722	42.545679
195	160.08	162.62	2017790.25	1.104316	43.748003	63.582541	146.569815	43.748003
200	151.64	154.18	2053452.45	1.123035	44.865071	64.119174	146.643535	44.865071
205	143.65	146.19	2086247.39	1.140238	45.899878	64.608399	146.711249	45.899878
210	136.07	138.61	2116333.26	1.156010	46.855509	65.053703	146.773304	46.855509
215	128.90	131.44	2143860.29	1.170433	47.735107	65.458257	146.830027	47.735107
220	122.10	124.64	2168971.08	1.183583	48.541837	65.824950	146.881726	48.541837
225	115.66	118.20	2191800.99	1.195533	49.278858	66.156423	146.928692	49.278858
230	109.57	112.11	2212478.41	1.206352	49.949307	66.455096	146.971201	49.949307
235	103.79	106.33	2231125.17	1.216105	50.556278	66.723195	147.009510	50.556278
240	98.32	100.86	2247856.76	1.224854	51.102809	66.962768	147.043865	51.102809
245	93.13	95.67	2262782.70	1.232656	51.591870	67.175704	147.074497	51.591870
250	88.22	90.76	2276006.79	1.239567	52.026353	67.363751	147.101624	52.026353
255	83.57	86.11	2287627.38	1.245639	52.409070	67.528529	147.125452	52.409070
260	79.16	81.70	2297737.70	1.250920	52.742742	67.671536	147.146176	52.742742
265	74.99	77.53	2306426.03	1.255458	53.029999	67.794169	147.163981	53.029999
270	71.04	73.58	2313775.98	1.259296	53.273378	67.897724	147.179038	53.273378
275	67.29	69.83	2319866.76	1.262477	53.475319	67.983408	147.191514	53.475319
280	63.74	66.28	2324773.32	1.265039	53.638167	68.052348	147.201562	53.638167
285	60.38	62.92	2328566.64	1.267019	53.764170	68.105594	147.209329	53.764170
290	57.20	59.74	2331313.90	1.268453	53.855483	68.144129	147.214954	53.855483
295	54.18	56.72	2333078.67	1.269374	53.914164	68.168870	147.218567	53.914164
300	51.33	**53.87**	**2333921.08**	**1.269814**	**53.942183**	**68.180677**	**147.220292**	**53.942183**
305	48.62	51.16	2333898.05	1.269802	53.941417	68.180354	147.220245	53.941417
310	46.06	48.60	2333063.40	1.269366	53.913657	68.168656	147.218536	53.913657
315	43.63	46.17	2331468.03	1.268534	53.860607	68.146290	147.215270	53.860607
320	41.33	43.87	2329160.08	1.267329	53.783891	68.113920	147.210545	53.783891
325	39.15	41.69	2326185.05	1.265776	53.685051	68.072169	147.204453	53.685051
330	37.08	39.62	2322585.98	1.263897	53.565551	68.021624	147.197083	53.565551
335	35.13	37.67	2318403.52	1.261713	53.426784	67.962834	147.188517	53.426784
340	33.28	35.82	2313676.11	1.259244	53.270069	67.896318	147.178834	53.270069
345	31.52	34.06	2308440.05	1.256510	53.096656	67.822562	147.168107	53.096656
350	29.86	32.40	2302729.66	1.253528	52.907730	67.742026	147.156407	52.907730
355	28.29	30.83	2296577.33	1.250314	52.704413	67.655140	147.143798	52.704413
360	26.79	29.33	2290013.69	1.246885	52.487767	67.562312	147.130344	52.487767

8.03 ESTIMATING RUNOFF

Estimating peak rate of runoff, volume of runoff, and soil loss are basic to the design of erosion and sedimentation control facilities.

There are many methods of determining runoff. Two acceptable methods, the rational method and the Soil Conservation Service (SCS) peak discharge method, are described in this section.

The rational method is very simple in concept but relies on considerable judgment and experience to evaluate all factors properly. It is used primarily for small drainage areas (less than 50 acres). The SCS method is more sophisticated hydrologically and offers a more accurate approximation of runoff, particularly for areas larger than 20 acres. Choice of method for small areas depends primarily on the experience of the designer.

Rational Method

The rational formula is:

$$Q = CiA$$

where:

Q = peak rate of runoff in cubic feet per second (cfs).

C = runoff coefficient, an empirical coefficient representing the relationship between rainfall rate and runoff rate.

Used for 50-year Storm

i = average intensity of rainfall in inches/hour, for a storm duration equal to the time of concentration, T_C.

T_C = time of concentration, in minutes; the estimated time for runoff to flow from the most remote part of the watershed to the point under consideration. It consists of the total time for overland sheet flow and concentrated flow (channel and/or pipe flow).

A = drainage area in acres.

The general procedure for determining peak discharge using the rational formula is presented below and illustrated in Sample Problem 8.03a.

Step 1. Determine the drainage area in acres.

Step 2. Determine the runoff coefficient, C, for the type of soil/cover in the drainage area (Table 8.03a).

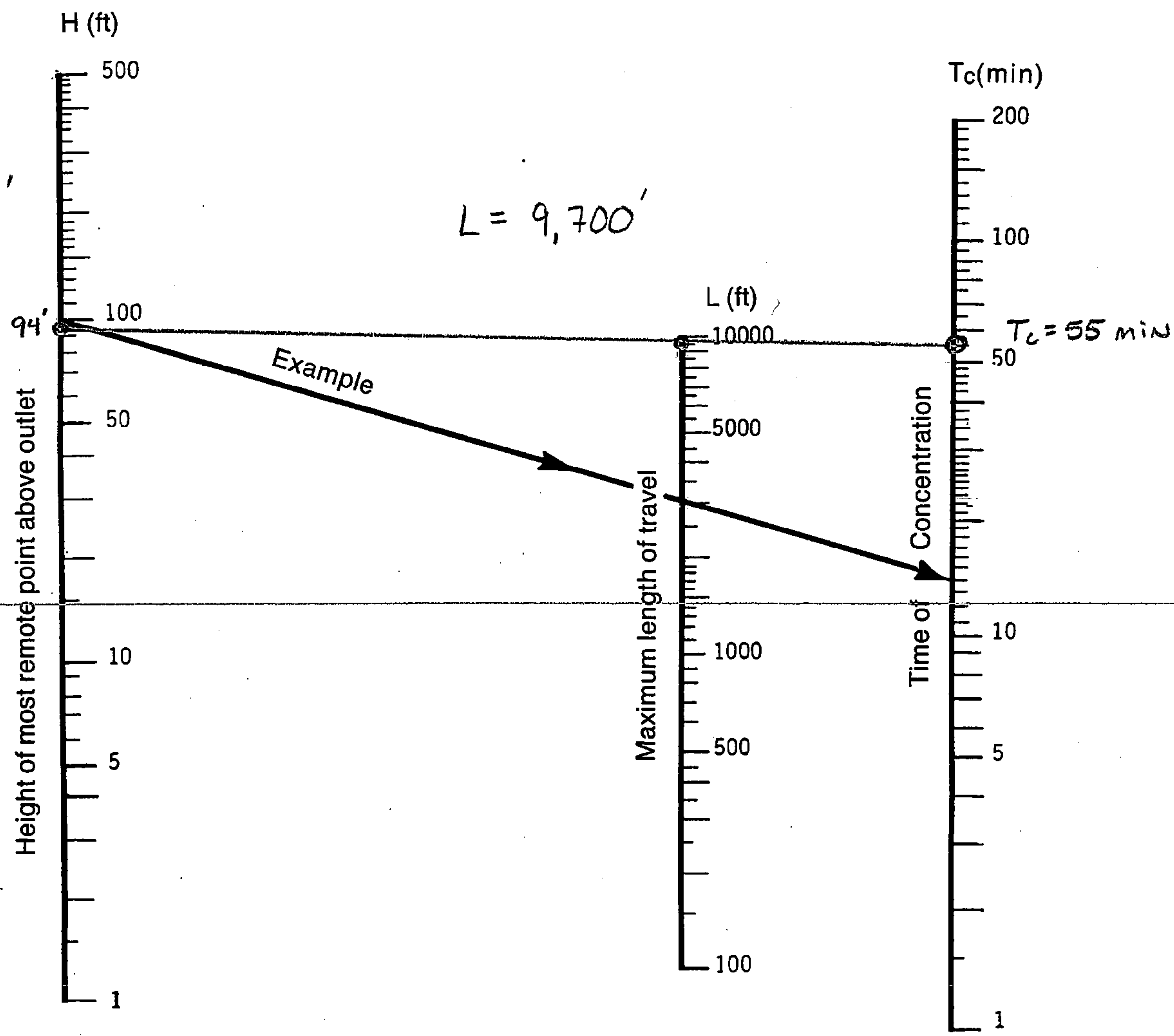
If the land use and soil cover is homogenous over the drainage area, a C value can be determined directly from Table 8.03a. If there are multiple soil cover conditions, a weighted average must be calculated, or the area may be subdivided.

Step 3. Determine the time of concentration, T_C, for the drainage area (i.e., the time of flow from the most remote point in the basin to the design point, in minutes).

B2 - 4

$H = 360' - 266'$

$H = 94'$



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

* For overland flow, grassed surfaces, multiply Tc by 2.

Therefore: $T_c = 2 * 55$ min
$= 110$ min

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

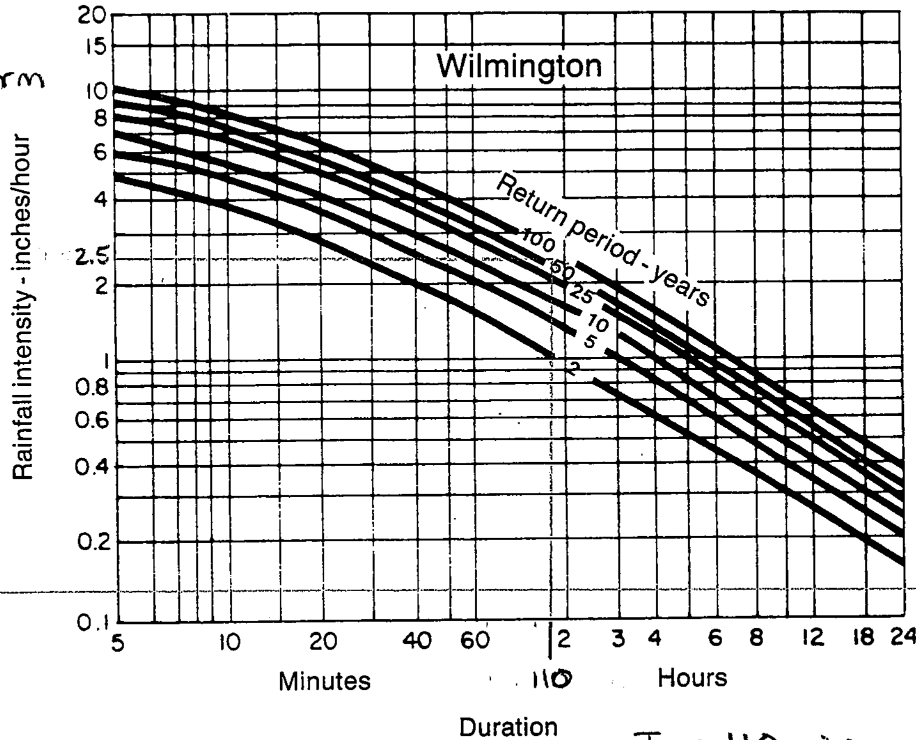
For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

B2-5

50-year storm

$I = 2.5$ in/hr



$T_c = 110$ min

Figure 8.03b Rainfall intensity duration curves—Wilmington.

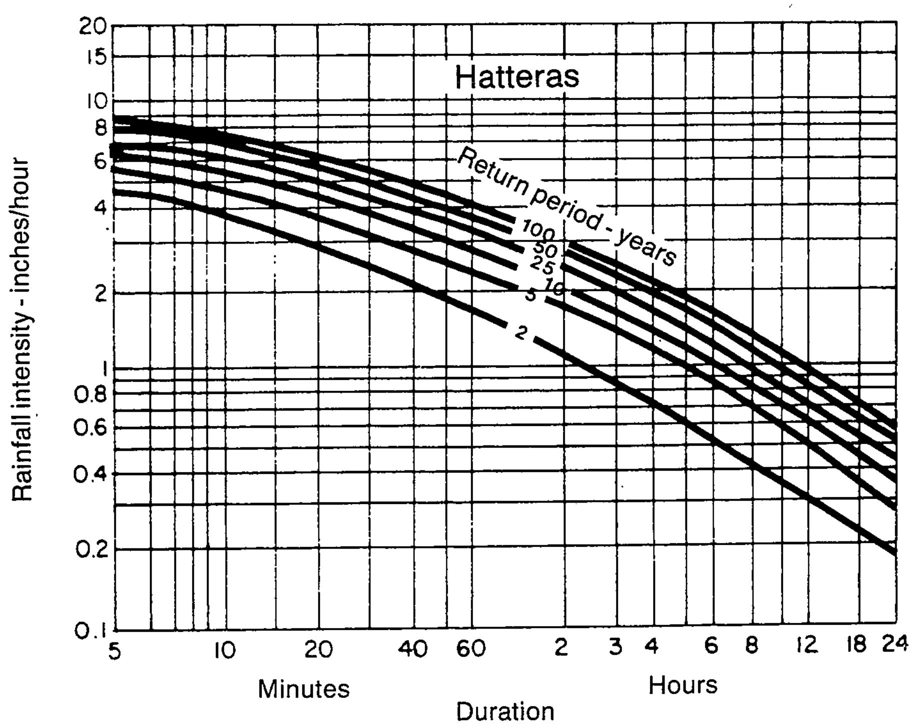


Figure 8.03c Rainfall intensity duration curves—Hatteras.

B2-6

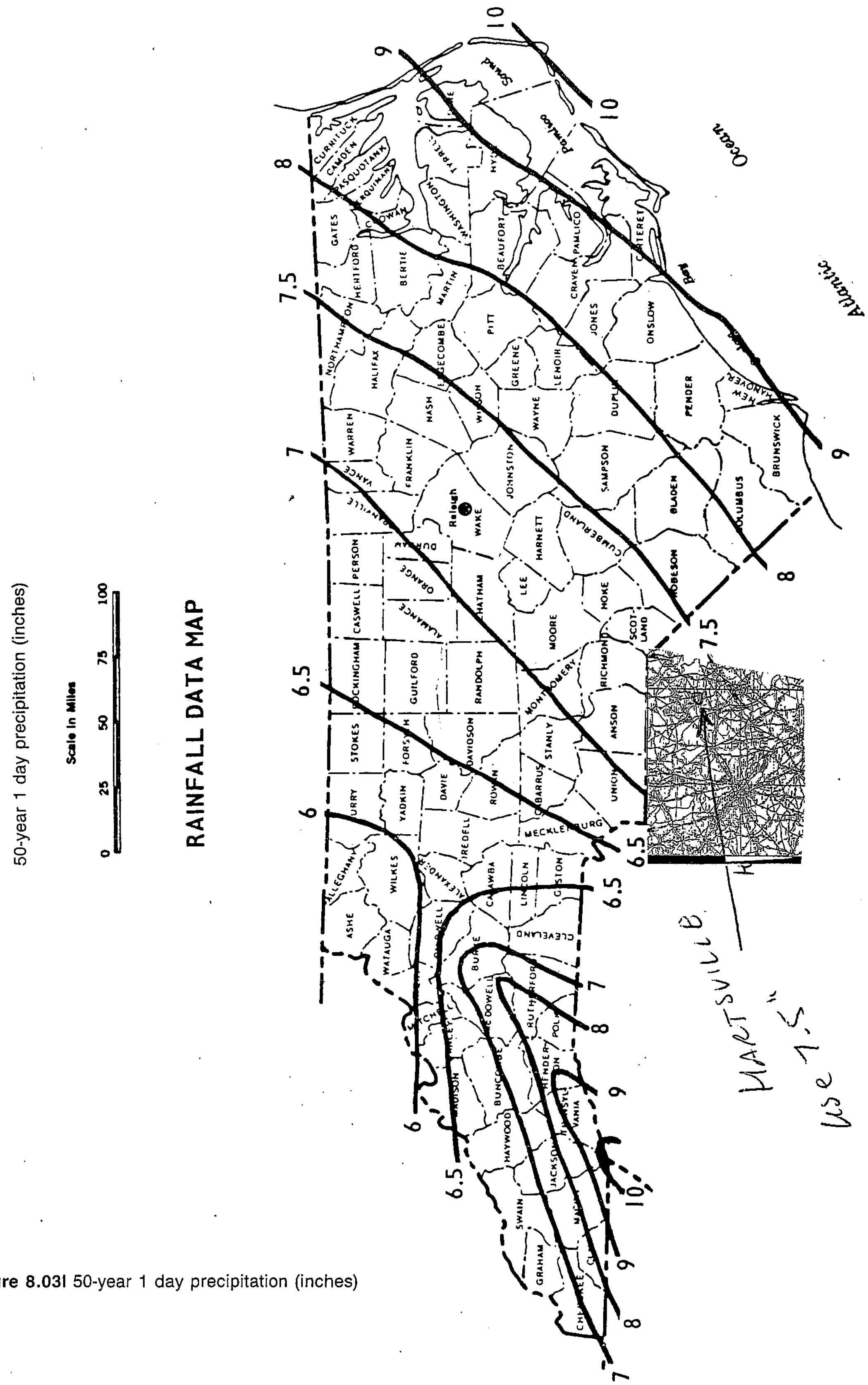


Figure 8.03l 50-year 1 day precipitation (inches)

B2-7

Alternate Hydrograph Formulation Methods

Methods exist in large variety. Perhaps the most detailed are the computerized watershed models such as HEC1 of the Corps of Engineers and TR-20 of the Soil Conservation Service. For smaller watersheds, the methods of TR-55 are useful (SCS, 1986). Desktop methods, such as unit-hydrograph synthesis, are described in most hydrology texts. Many of these require a heavy investment of time and effort in field data gathering and data set preparation. Such precision may not be justified for small facilities and early feasibility studies.

Small-Watershed Hydrograph-Formulation Method

The author has proposed a method for use in routine design of small systems and for feasibility studies and site selection studies of larger watersheds (Malcom, et al, 1986). A variation of the method was adopted for use in design of facilities in the Houston area (Harris County, TX, 1984).

The method is based upon the observation that there are three important aspects of the hydrograph on which the design will depend. These are the peak discharge, the volume of water under the hydrograph, and the shape of the hydrograph. Separate decisions may be made regarding these, and the hydrograph will be determined. The necessary decisions, and the author's suggestions are:

1. Accept as a pattern function a step-function approximation to the SCS dimensionless unit hydrograph (see McCuen, 1982, for a listing and discussion). The step-function devised by the author is

For $0 \leq t \leq 1.25\,Tp$

$$Q = \frac{Qp}{2}\left[1 - \cos\left(\frac{\pi t}{Tp}\right)\right] \qquad \text{(III-1)}$$

For $t > 1.25\,Tp$

$$Q = 4.34\,Qp\,\exp\left[-1.30\left(\frac{t}{Tp}\right)\right] \qquad \text{(III-2)}$$

in which

Qp = Peak discharge of the design hydrograph

Tp = Time to peak of the design hydrograph, measured from the time of significant rise of the rising limb to the time at which the estimated peak occurs

t = Time of interest at which the discharge is to be estimated.

The argument of the cosine is in units of radians.

The volume of water under this hydrograph is, in consistent units,

$$Vol = 1.39\,Qp\,Tp \qquad \text{(III-3)}$$

expected range of water level variation in the reservoir, the total outflow downstream of the dam is computed for each value of stage, and stage versus total discharge is plotted.

Weirs

Most popularly, two kinds of weirs are used -- sharp-crested and broad-crested weirs. For both, the basic equation is:

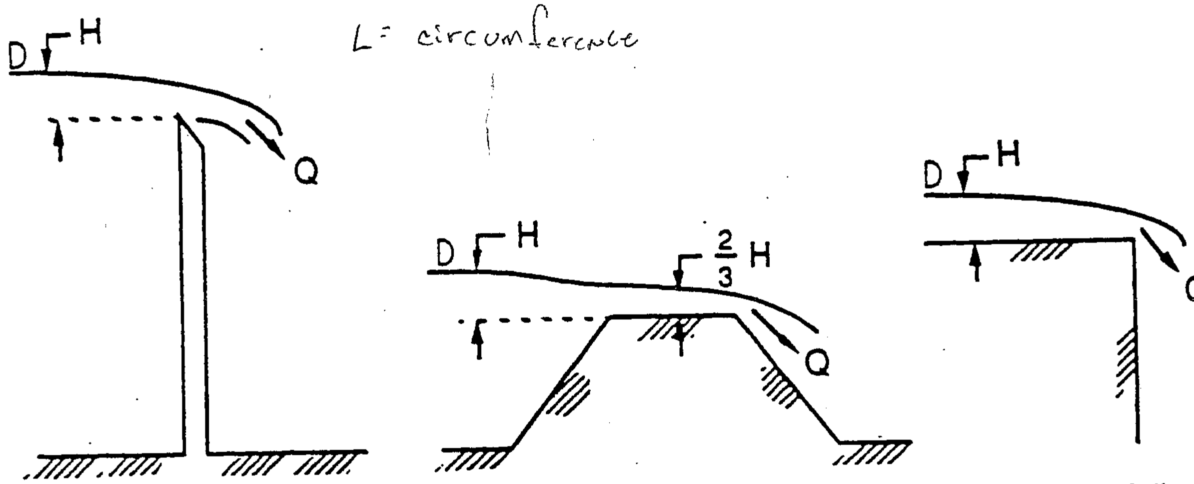
$$Q = Cw\ L\ H^{3/2} \qquad \text{(III-11)}$$

where:

- Q = Discharge (cfs).
- Cw = Weir coefficient (dimensionless). See sketches below.
- L = Length of weir (ft), measured along the crest.
- H = Driving head (ft), measured vertically from the crest of the weir to the water surface at a point far enough upstream to be essentially level.

The weir coefficient depends on the conditions that exist at the crest. For sharp-crested weirs, the value of Cw is theoretically 3.33. For broad-crested weirs Cw is 3.0. For the case of the free overfall, use Cw = 3.0. A useful reference is King, 1963.

L = circumference



Sharp-crested weir $C_w = 3.33$ | Broad-crested weir $C_w = 3.0$ | Free overfall $C_w = 3.0$

Figure III-4 Schematic sections through weirs.

B2-9

11-3-94

Orifices

The basic equation for orifices is:

$$Q = C_D A \sqrt{2gh} \qquad \text{(III-12)}$$

where:

Q = Discharge (cfs).

C_D = Coefficient of discharge (dimensionless). See below.

A = Cross-sectional area of flow at the orifice entrance (sq ft).

g = Acceleration of gravity (32.2 ft/sec2).

h = Driving head (ft), measured from the centroid of the orifice area to the water surface.

An idealized sketch of a culvert under inlet control illustrates the orifice application.

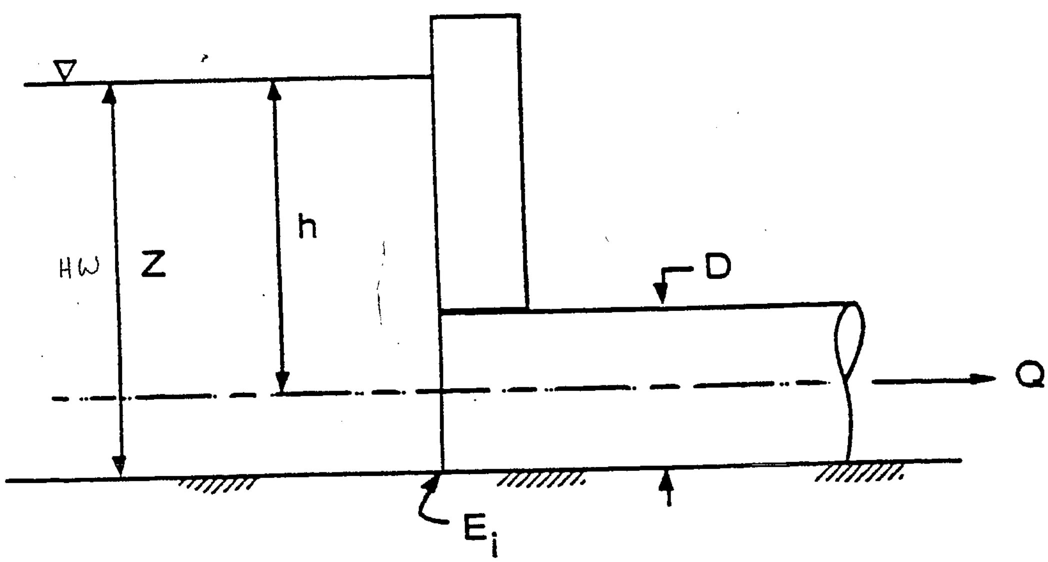


Figure III-5 Schematic section through an orifice.

Table III-2

Values of Coefficient of Discharge, Cd

Entrance Condition	Cd
Typical default value	0.60
Square-edged entrance	0.59
Concrete pipe, grooved end	0.65
Corr mtl pipe, mitred to slope	0.52
Corr mtl pipe, projecting from fill	0.51

Source: These values were back-calculated from the inlet-control culvert-capacity charts of Exhibits 11 and 12 for HW/D = 2. always use chart for a one pipe basis

BZ-10

The orifice equation applies only when the orifice is submerged. When the water surface is below the top of the pipe, a useful approximation of the behavior can be obtained by assuming discharge to be proportional to the three-halves power of depth and fitting the expression to the orifice result at full depth.

The following is a summary step function of stage-discharge for a culvert under inlet control arranged for use in commonly encountered units:

Barrels

For $Z \leq Ei$ (III-13)

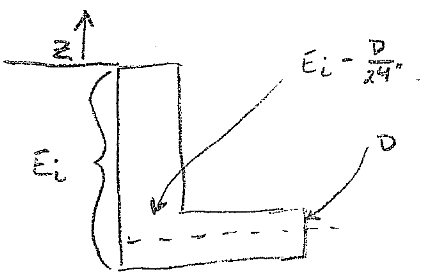
$$Q = 0$$

For $Ei \leq Z \leq \left(\frac{D}{12} + Ei\right)$

$$Q = 0.372\, C_D\, D\, (Z - Ei)^{3/2}$$

For $Z > \left(\frac{D}{12} + Ei\right)$

$$Q = 0.0437\, C_D\, D^2 \left(Z - \frac{D}{24} - Ei\right)^{1/2}$$



$Q = 0.0437 \cdot C_D \cdot D^2 \left(Z + E_i - \frac{D}{24}\right)$

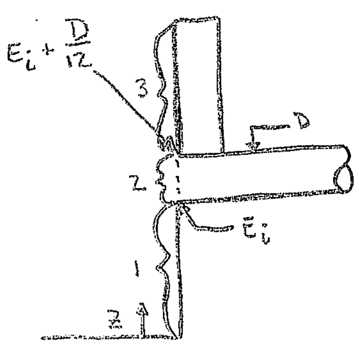
$Z > E_i$

Q = [cfs] Z = [ft]

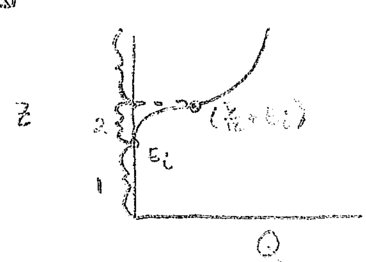
D = [in] Ei = [ft] See Figure III-5

The stage-discharge function for pipes under inlet control can be obtained using the Culvert Capacity Charts of the Federal Highway Administration (See Exhibits 11-14 and FHWA, 1985). Figure III-6 illustrates the differences likely to be experienced with the function and chart. While the differences appear to be large, there is usually no significant difference between the two versions in routing results.

NOTES



1. $Z \leq E_i \Rightarrow Q = 0$
2. $E_i \leq Z \leq \left(\frac{D}{12} + E_i\right) \Rightarrow Q = (0.372)(C_D)(D)(Z - E_i)^{3/2}$
3. $Z > \left(\frac{D}{12} + E_i\right) \Rightarrow Q = (0.0437)(C_D)(D)^2 \left(Z - \frac{D}{24} - E_i\right)^{1/2}$



* for two or more pipes, multiply equation by N = to number of pipes

11-3-94

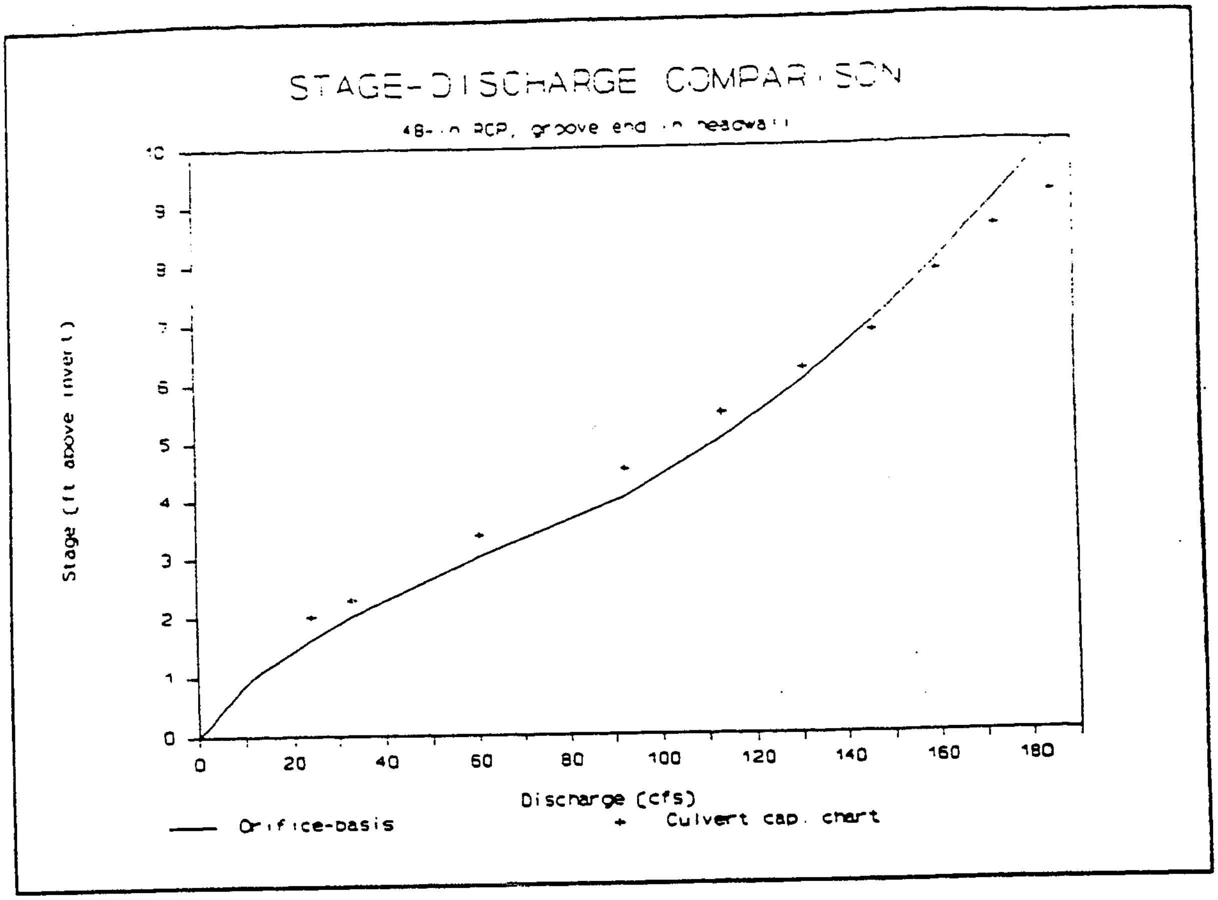


Figure III-6

Composite Stage-Discharge Functions

The typical case to be routed involves combinations of the fundamental orifices and weirs. The composite stage-discharge function can be prepared by applying the fundamental relationships to the outlet components and combining the results as the system behaves. Frequently encountered cases are the overtopped roadway at a culvert, and various combinations of pond spillways, including the riser/barrel spillway.

Culvert and Overtopped Road: The case of a pipe or pipes under a road or dam is illustrated in the schematic section of Figure III-7. For upstream water levels at or below the crest of the weir (top of road), outflow is computed for the pipe acting under inlet control. After the crest of the weir is overtopped, the outflow below the facility is the sum of the flow through the pipe and the flow over the broadcrested weir. Thus for any upstream water level, the outflow can be determined.

INTERNAL DRAIN BLANKET

LAWGIBB GROUP

LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

JOB NO. 30720-1-4776 SHEET 1 OF
PHASE TASK 800
JOB NAME Robinson Dam Design
BY PCL DATE 9/26/01
CHECKED BY [signature] DATE 10/1/01

- Review of Documents
  - × Cross Sections A to L 20 Scale
    use Section B for design
    20' So of B-4
  - × Site Plan July 2001
  - × Triaxial test result.

$c' = 0$
$\phi' = 35°$

95%

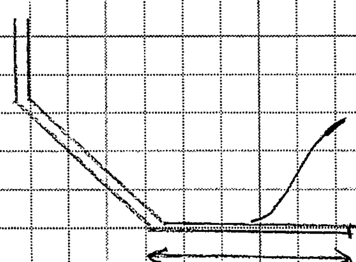
$\gamma = 110 \times 1.12 = 123.2$ pcf

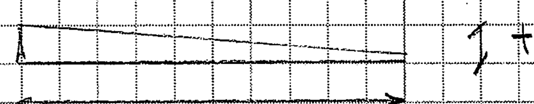
$e = 0.5$

$S = \frac{G w}{e} = 64\%$

- Seepage thru dam — use Section B-B

$q = 7 \times 10^{-3}$ ft³/min / ft.





$L = 25'$ — distance toe move out.

$$q = k_{drain} \cdot \underbrace{\frac{t}{L}}_{i} \cdot \underbrace{\frac{t}{2}}_{A} = \frac{t^2}{2L} k = 7 \times 10^{-3} \text{ ft}^3/\text{min}/\text{ft}$$

$$t = \sqrt{\frac{7 \times 10^{-3}}{k} \cdot 2L}$$

$L = 25'$ $\quad t = \frac{0.59}{\sqrt{k_{dr}}}$ $\quad \frac{ft}{min}$

B3-1

LAWGIBB GROUP
LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

PHASE TASK
JOB NAME
BY 8CL DATE 9/28/01
CHECKED BY JE DATE 10/1/01

for blanket drain.

Cedergren.

$1\frac{1}{2}" - 1"$ gravel $\qquad k = \frac{0.015}{0.01} = 1.5 \frac{ft}{sec} = 90 \frac{ft}{min}$

$1 - \frac{1}{2}"$ $\qquad .5 \qquad 30$

$\frac{3}{8}" - \#4$ $\qquad .08 \qquad 4.8$

#57 1 to #4

#67 3/4 to #4 → $D_{85} = 0.7"$

$D_{10} = 4.75$ mm #4 .2"

10,000 ,20,000 ft/day

7 – 14 ft/min 10 ft/min

1' thick

$k_{dr} = \frac{0.59}{1^2} = 0.59$ ft/min

filter criteria $D_{85} = 0.56$ to .88 mm

use 0.5 mm

$D_{15}/d_{85} \leq 5.$

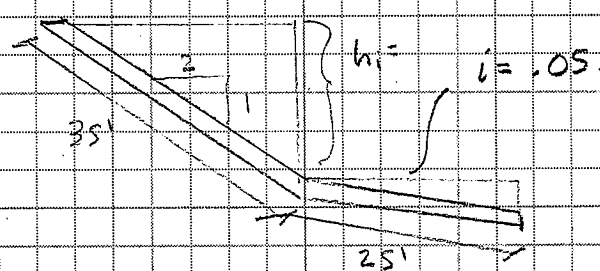
$D_{15} \leq 5(0.5) = 2.5$ mm → #10 sieve

B3-2

Blanket Drain

maintain

$q = 7 \times 10^{-3}$ ft³/min/ft through dam.



i

$$k(0.5)(1') + k(.05)\,1 = 7. \times 10^{-3} \text{ ft}^3/\text{min}/\text{ft}.$$

$$k(.5 + .05) = 7 \times 10^{-3} \text{ ft}^3/\text{min}/\text{ft}$$

$$k \geq 1.27 \times 10^{-2} \text{ ft/min}$$

use $k = 5 \times 10^{-2}$ ft/min $=$ .025 cm/sec

(72 ft/day) — need $D_{10} \geq 0.2$ mm.

Clean Sand Blanket $\geq$ # 40 sieve

		D_{15}	D_{10}	
SCDOT	FA-13	$.03 < D_{15} < 1.2$	$D_{10} > 0.3$	use FA-3.
	FA-12	$.15 < D_{15} < 1.2$	$D_{10} > .15$	
	FA-10	$. < D_{15} < .6$	$D_{10} > .15$	

SCDOT Standard Specifications for Highway Construction Edition of 2000

GRADATION OF COARSE AGGREGATES

Percentage by Weight Passing Sieves Having Square Openings

Sieve Designation	Aggregate No.							
	CR-14	5	57	67	6M	8M	789	89M
2 inches	*100*	--	--	--	--	--	--	--
1 1/2 inches	95 - 100	100	100	--	--	--	--	--
1 inch	70 - 100	90 - 100	95 - 100	100	100	--	--	--
3/4 inch	--	20 - 55	--	90 - 100	90 - 100	100	100	--
1/2 inch	35 - 65	0 - 10	25 - 60	--	--	95 - 100	95 - 100	100
3/8 inch	--	0 - 5	--	20 - 55	0 - 20	75 - 100	80 - 100	98 - 100
No. 4	10 - 40	--	0-10	0 - 10	0 - 5	10 - 35	20 - 50	20 - 70
No. 8	--	--	0-5	0-5	--	--	--	2 - 20
No. 16	--	--	--	--	--	0-5	0 - 6	--
No. 100	--	--	--	--	--	0-2	0 - 2	0 - 3

GRADATION OF FINE AGGREGATES

Percentage by Weight Passing Sieves Having Square Openings

Sieve Designation		Aggregate No.		
		FA-10	FA-12	FA-13
1/2 Inch		--	--	--
3/8 Inch		100	100	100
No. 4	4.75	96 - 100	90 - 100	90 - 100
No. 8	2.36	75 - 100	--	--
No. 16	1.18	55 - 98	50 - 86	40 - 80
No. 30	0.6	25 - 75	--	--
No. 50	0.3	8 - 30	2 - 20	0 - 10
No. 100	0.15	0 - 9	0 - 5	0 - 3
No. 200	0.075	0 - 3	--	--

AGGREGATE USES

Aggregate No.	Applications
5	Bituminous Surfacing (double Treatment Types 1 and 3) Bituminous Surfacing (triple treatment) Type 1
6M	Bituminous Surfacing (single treatment) Types 1 and 2 Bituminous Surfacing (triple treatment) Type 2
57	Portland cement concrete for structures
67	Portland Cement concrete pavement
89M	Bituminous surfacing (triple treatment) Type 2 Bituminous Surfacing (single treatment) Type 3 Bituminous Surfacing (double treatment - Class A Special)
789	Aggregate underdrains Bituminous Surfacing (double treatment) Types 1, 2, and 3 Bituminous surfacing (triple treatment) Type 1 Pipe underdrains
CR-14	Soil-aggregate subbase
FA-10	Portland cement concrete for structures Portland cement concrete pavement
FA-12	Aggregate underdrains
FA-13	Aggregate underdrains Bituminous surfacing (triple treatment) Types 1 and 2

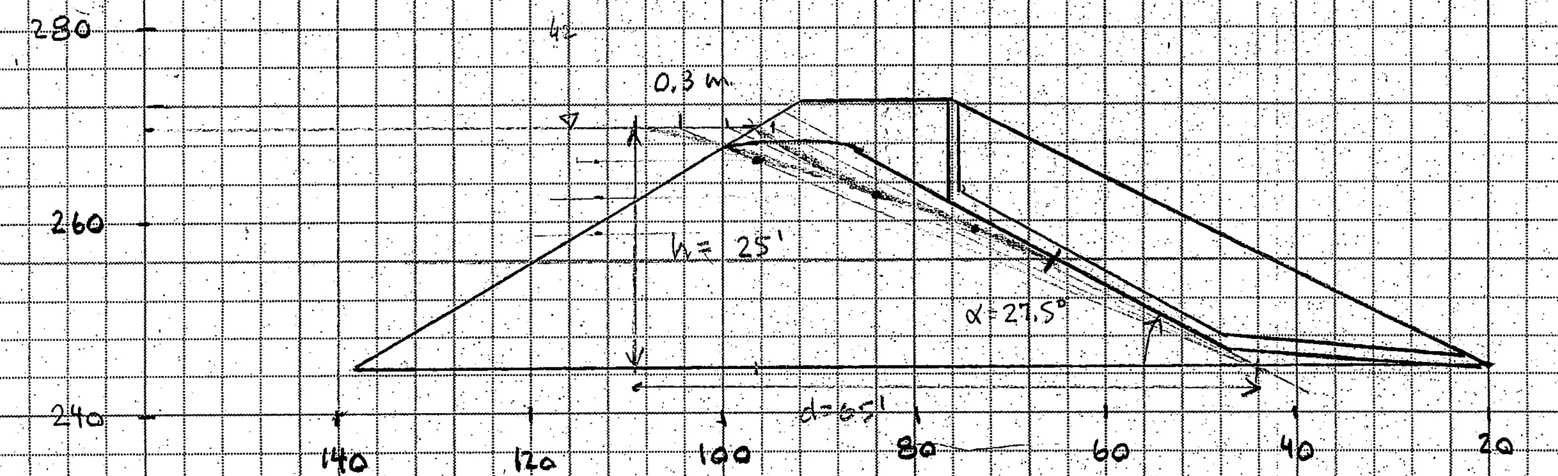
B3-4

LAWGIBB GROUP

LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

JOB NO. 30720-1-4776 SHEET 1 OF 2
PHASE
TASK 800
JOB NAME Robinson Ash Dike Design
BY PCL DATE 9/10/01
CHECKED BY [signature] DATE 10/1/01

SECTION B-B



Schaffernak Iterson

$d = 65'$
$h = 25'$
$\alpha = 27.5°$ →

$$a = \frac{d}{\cos\alpha} - \sqrt{\frac{d^2}{\cos^2\alpha} - \frac{h^2}{\sin^2\alpha}} = 23.9'$$

$$\frac{65}{\cos(27.5°)} = 73.28$$

$$\frac{25}{\sin(27.5°)} = 54.14$$

$$q = k\,a \sin\alpha \tan\alpha = \underline{\underline{2.74\,k}}\ \frac{ft^2}{min}$$

$k = 12 \times 10^{-4}$ ft/min ← perme. test

$q = 6.88 \times 10^{-3}$ ft^3/min/ft.

B3-5

LAWGIBB GROUP
LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

JOB NO. ______ SHEET ____ OF ____
PHASE ______ TASK ______
JOB NAME ______
BY JAT DATE 10/7/01
CHECKED BY ______ DATE ______

Rock Toe

Check size for rock

Sand blanket is FA 13 $D_{85} = .4$

$D_{15} = 2.36$

Try SC 789 $D_{85} = 7.62$

D_{15} 2.36

$\frac{D_{15}\text{ filt}}{D_{85}\text{ soil}} = \frac{2.36}{2.36} < 4$ ok

$\frac{D_{15}\text{ filt}}{D_{15}\text{ soil}} = \frac{2.36}{.4} = 5.9 > 5$ OK

ref Cedergren text p 175

For rock toe to rip rap -

Minimal flow expected - No gradation on rip rap available.

Could put geotextile between the SC 789 & rip rap but not a significant risk

But to protect against possible risk put in

Contech 80 NW AOS = .15 mm

Dike Sand $D_{85} \approx .6$ to .8 mm $\frac{AOS}{D_{85}} = .15/.6 = 2.5$ OK

Other rip-rap use Contech 80 NW for protecting sand

B3-6

in a deep trunk sewer in Seattle, Washington, a tremendous cavity formed in the soil above it, causing a major repair problem. Piping is a common cause of failure in overflow weirs, earth dams, reservoirs, and other hydraulic structures (Chap. 1). Whenever filters and drains are required for the contrtol of seepage and groundwater in relation to structures, they should have a high degree of resistance to piping.

Grading of Drainage Aggregates to Control Piping

To prevent the movement of erodible soils and rocks into or through filters, the pore spaces between the filter particles should be small enough to hold some of the larger particles of the protected materials in place. Taylor (1948) shows that if three perfect spheres have diameters greater than six and one-half times the diameter of a smaller sphere (Fig. 5.1*a*), the smaller spheres can move through the larger. Soils and aggregates are always composed of *ranges* of particle sizes, and if the pore spaces in filters are small enough to hold the 85% size (D_{85}) of adjacent soils in place, the finer soil particles will also be held in place (Fig. 5.1*b*). Exceptions are gap-graded soil and soil-rock mixtures (Sec. 5.3).

Bertram (1940), with the advice of Terzaghi and Casagrande, made laboratory investigations at the Graduate School of Engineering, Harvard University, to test filter criteria that had been suggested by Terzaghi; he established the validity of the following criteria for filter design:

$$\frac{D_{15}(\text{of filter})}{D_{85}(\text{of soil})} < 4 \text{ to } 5 < \frac{D_{15}(\text{of filter})}{D_{15}(\text{of soil})} \tag{5.1}$$

The left half of Eq. 5.1 may be stated as follows.

Criterion 1. The 15% size (D_{15}) of a filter material must be not more than four or five times the 85% size (D_{85}) of a protected soil. The ratio of D_{15} of a filter to D_{85} of a soil is called the *piping ratio.*

The right half of Eq. 5.1 may be stated as follows.

Criterion 2. The 15% size (D_{15}) of a filter material should be at least four or five times the 15% size (D_{15}) of a protected soil.

The intent of criterion 2 is to guarantee sufficient permeability to prevent the buildup of large seepage forces and hydrostatic pressures in filters and drains. This criterion is discussed in detail in Sec. 5.4.

The work of Bertram was expanded by further experiments by the U. S. Army Corps of Engineers (1941) and the U. S. Bureau of Reclamation (Karpoff, 1955) and others. Frequently some requirements in addition to criteria 1 and 2 are placed on the grading of

B3-7

CONTECH
CONSTRUCTION PRODUCTS INC.

Material Property Data Sheet

CONTECH C-80NW Nonwoven Geotextile

CONTECH C-80NW is a polypropylene, staple fiber, needle punched nonwoven geotextile. The fibers are needled to form a stable network that retain dimensional stability relative to each other. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments normally found in soils. CONTECH C-80NW meets the requirements for a Class 1 Permanent Erosion Control geotextile and Stabilization geotextile. CONTECH C-80NW conforms to the property values listed below[1] which have been derived from quality control testing.

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUES[2] English	Metric
Physical			
Weight	ASTM D4533	6.5 oz/sy	220 g/m²
Thickness	ASTM D5199	70 mils	1.778 mm
Mechanical			
Grab Tensile Strength	ASTM D4632	205 lbs	912 N
Grab Elongation	ASTM D4632	50 %	50 %
Puncture Strength	ASTM D4833	110 lbs.	490 N
Mullen Burst	ASTM D3786	350 psi	2413 kPa
Trapezoidal Tear	ASTM D4533	85 lbs.	378 N
Hydraulic			
Apparent Opening Size (AOS)	ASTM D4751	80 US Std Sieve	0.180 mm
Permittivity	ASTM D4491	1.50 sec^{-1}	1.50 sec^{-1}
Permeability	ASTM D4491	0.38 cm/sec	0.38 cm/sec
Water Flow Rate	ASTM D4491	110 gpm/ft^2	4482 $l/min/m^2$
Endurance			
UV Resistance (% retained after 500 hours)	ASTM D4355	70%	70%

NOTES:

1 The property values listed above are effective 11/09/99 and are subject to change without notice.

2 Values shown are in weaker principal direction. Minimum average rolls values are calculated as the typical minus two standard deviations. Statistically, it yields a 97.5% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.

B3-8

STORM WATER BYPASS CHANNEL

LAWGIBB GROUP

LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

JOB NO. 30720-1-4776		SHEET 1	OF 1
PHASE 02		TASK 800	
JOB NAME CP&L Robinson			
BY JAM		DATE 9/26/01	
CHECKED BY AMR		DATE 9/27/01	

Stormwater Runoff Channel Design

$Q = 3$ cfs provided by Jacobs Engineering (Tom Sullivan 9/25/01)

Slope: $S = 0.01$ (1%)

Permissible Velocity $V_p = 3.5$ ft/sec (ESCPDM Table 8.05 a)

$A = \frac{Q}{V_p} = \frac{3.0 \text{ cfs}}{3.5 \text{ fs}} = 0.857 \text{ ft}^2$ ✓

Parabolic Channel: assume depth $d = 1$ ft

$A = \frac{2}{3} \cdot T \cdot d$ so $T = \frac{A}{\frac{2}{3} \cdot d} = 1.286$ ft ✓ (Top Width)

Assume: $T = 5$ ft $d = 1$ ft

$A = (\frac{2}{3})(5 \text{ ft})(1 \text{ ft}) = 3.33 \text{ ft}^2$ ✓

$R = \frac{T^2 \cdot d}{1.5T^2 + 4d^2} = \frac{(5\text{ ft})^2(1\text{ ft})}{(1.5)(5\text{ft})^2 + (4)(1\text{ft})^2} = 0.602$ ✓

Roughness Coefficient:

use Figure 8.05 c (ESCPDM) Velocity: $V = \frac{Q}{A} = \frac{3.0 \text{ cfs}}{3.33 \text{ ft}^2} = 0.9$ ft/sec

$V \cdot R = (0.9 \text{ ft/sec})(0.602) = 0.542$ ✓ using Retardance Class D

$n = 0.076$

Velocity: $V = \left(\frac{1.49}{n}\right)(R)^{2/3}(\sqrt{S}) = \left(\frac{1.49}{0.076}\right)(0.602)^{2/3}(\sqrt{0.01}) = 1.398$ ft/sec ✓

Allowable Flow: $Q_a = V \cdot A = (1.398 \text{ ft/sec})(3.33 \text{ ft}^2) = 4.66 \text{ ft}^3/\text{sec}$ ✓

$V < V_p$ OK $Q < Q_a$ OK

~~BA~~-1

LAWGIBB GROUP
LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

JOB NO. 30720-1-4776 SHEET 1 OF 1
PHASE 02 TASK 800
JOB NAME CPiL - Robinson
BY JAM DATE 9/27/01
CHECKED BY AMR DATE 9/27/01

Culvert Design

$Q = 4.66\ ft^3/sec$ from channel design

say $Q = 5.0\ ft^3/sec$

Slope: $S = 0.01$ (1%)

Roughness Coefficient: $n = 0.015$ for Reinforced Concrete Pipe (RCP)

Assume: RCP diameter = 1 ft

Area: $A = \pi r^2 = (\pi)(0.5)^2 = 0.785\ ft^2$ ✓

Hydraulic Radius: $R = \frac{1}{2} r = (0.5)(0.5) = 0.25$ ✓

Allowable Flow: $Q_a = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot \sqrt{S} = \left(\frac{1.49}{0.015}\right)(0.785)(0.25)^{2/3}(\sqrt{0.01})$

$Q_a = 3.09\ ft^3/sec$ ✓

$Q_a < Q$ no good

Assume: d = 15" RCP = 1.25 ft

$A = 1.227\ ft^2$ ✓

$R = 0.3125$ ✓

$Q_a = \left(\frac{1.49}{0.015}\right)(1.227)(0.3125)^{2/3}(\sqrt{0.01}) = 5.61\ ft^3/sec$ ✓

$Q_a < Q$ ok

WEIR DRAINAGEWAYS

LAWGIBB GROUP

LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

JOB NO. 30720-1-4776 SHEET 1 OF 2
PHASE 02 TASK 800
JOB NAME CP&L Robinson
BY JAM DATE 9/26/01
CHECKED BY AMR DATE 9/27/01

Weir Spillway Design

Peak Runoff

length of travel : $L = 1310$ ft

elevation difference : $H = 296' - 266' = 30$ ft

Time of Concentration : $T_c = 22$ min Fig. 8.03a ESCPDM

Rainfall Intensity : $I = 5.5$ in/hr Wilmington IDF Curve ESCPDM 8.03b 50-year storm

Rational Coefficient : $C = 0.325$

Area : $A = 626,994\ ft^2$

Runoff for 50-year storm : $Q = C \cdot I \cdot A$

$$= (0.325)\left(\frac{5.5\ in}{hr}\left|\frac{hr}{60\ min}\right|\frac{min}{60\ sec}\left|\frac{ft}{12\ in}\right.\right)(626,994\ ft^2)$$

$$= 25.94\ ft^3/sec$$ ✓

Spillway Design

$Q = 25.94\ ft^3/sec$ Maximum Permissible Velocity : $V_p = 5.0$ ft/sec (Coarse Gravel - ESCPDM 8.05d)

Area : $A = \frac{Q}{V_p} = \frac{25.94}{5.0} = 5.188\ ft^2$ ✓

Trapezoidal Channel

depth : $d = 1$ ft (restricted by allowable free board)

side slope : $z = 3:1$

bottom width : $b = \frac{A - (z)(d)^2}{d} = \frac{(5.188) - (3)(1)^2}{1} = 2.188$ ft * ✓

* bottom width not realistic

BS-1

LAWGIBB GROUP
LAW Engineering & Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604

JOB NO. 30720-1-4776 SHEET 2 OF 2
PHASE 02 TASK 800
JOB NAME CP & L Robinson
BY JAM DATE 9/26/01
CHECKED BY AMR DATE 9/27/01

Weir Spillway Design

Assume: bottom width $b = 15$ ft

Area: $A = b \cdot d + z \cdot d^2 = (15)(1) + (3)(1)^2 = 18 \text{ ft}^2$

Hydraulic Radius: $R = \dfrac{b \cdot d + z \cdot d^2}{b + 2 \cdot d \cdot \sqrt{z^2+1}} = \dfrac{(15)(1) + (3)(1)^2}{(15) + (2)(1)(\sqrt{(3)^2+1})} = 0.844$ ✓

Roughness Coefficient: $n = 0.104$ for $D_{50} = 6''$ stone ESCPDM 8.05f

Slope: $S = 0.01 = 1\%$

Velocity: $V = \dfrac{1.49}{n} \cdot R^{2/3} \cdot \sqrt{S} = \left(\dfrac{1.49}{0.104}\right)(0.844)^{2/3}(\sqrt{0.01}) = 1.28 \text{ ft/sec}$ ✓

Allowable Flow: $Q_a = V \cdot A = (1.28 \text{ ft/sec})(18 \text{ ft}^2) = 23.04 \text{ ft}^3/\text{sec}$ ✓

$V < V_p$ OK $Q_a < Q$ no good

Assume: bottom width $b = 18$ ft

$A = (18)(1) + (3)(1)^2 = 21 \text{ ft}^2$ ✓

$R = \dfrac{(18)(1) + (3)(1)^2}{(18) + (2)(1)(\sqrt{(3)^2+1})} = 0.863$ ✓

$V = \left(\dfrac{1.49}{0.104}\right)(0.863)^{2/3}(\sqrt{0.01}) = 1.299 \text{ ft/sec}$ ✓

$Q_a = (1.299 \text{ ft/sec})(21 \text{ ft}^2) = 27.28 \text{ ft}^3/\text{sec}$ ✓

$V < V_p$ OK $Q_a > Q$ OK

Channel Dimensions

bottom width: $b = 18$ ft

depth: $d = 1$ ft side slope: $z = 3:1$

top width: $T = 24$ ft ✓

BS-2

Appendix A

Doc 06: Safety Inspection of H. B. Robinson Steam Electric Plant

Cooling Lake Dam and Ash Pond Dam

MAIN
1893

CHAS. T. MAIN, INC.
PRUDENTIAL CENTER, BOSTON, MASSACHUSETTS 02199 • TELEPHONE 617-262-3200

September 27, 1985 2866-20-1000

SUBJECT: H. B. Robinson Steam Electric Plant
Dam Safety Inspection

Mr. A. B. Cutter
Vice President
Carolina Power & Light Company
P. O. Box 1551
Raleigh, NC 27602

Dear Mr. Cutter:

MAIN is pleased to submit this report covering our inspection of your H. B. Robinson Steam Electric Plant cooling lake dam and ash pond dam. The inspection of the project was conducted during the period 4-6 June 1985. The assistance of your staff and plant personnel in obtaining project data is gratefully acknowledged.

All structures inspected were found to be in good condition except that minor concrete spalling has occurred at the main dam spillway. Further, some riprap replacement upstream of the spillway is required. The only significant finding was that the standby motor for operating the project tainter gates was not operational at the time of the inspection. It is recommended that this unit be replaced with a standby electric generator. To insure that the standby equipment is operational, it is recommended that the unit be load tested annually by lifting one gate slightly.

All findings and recommendations presented in this report have been made by the undersigned independent of the owner or his representatives. If you have any questions concerning the contents of this report, I would be pleased to discuss them with you.

SOUTH CAROLINA
REGISTERED PROFESSIONAL ENGINEER
No. 10589
ALTON P. DAVIS, JR.

Very truly yours,

CHAS. T. MAIN, INC.

Alton P. Davis, Jr., P.E.
Project Manager

APD/lem

Encl.

SAFETY INSPECTION OF

H. B. ROBINSON STEAM ELECTRIC PLANT

COOLING LAKE DAM AND ASH POND DAM

FOR

CAROLINA POWER & LIGHT COMPANY

CHAS. T. MAIN, INC.
CHARLOTTE, NORTH CAROLINA

SEPTEMBER 1985

TABLE OF CONTENTS

Air Photo 14 June 1985
H. B. Robinson Steam Electric Plant

1. SUMMARY

1.1 Purpose and Scope

As part of its on-going dam safety program, Carolina Power & Light Company (CP&L) conducts independent dam safety inspections of its projects at five year intervals. This report presents findings of the June 1985 independent consultant dam safety inspection of CP&L H. B. Robinson Steam Electric Plant dam.

The scope of this inspection has been as generally outlined for a Phase I dam safety inspection in the Corps of Engineers publication "Recommended Guidelines for Safety Inspection of Dams." The H B Robinson Steam Electric Plant facilities include a main dam, spillway, ash pond dam and cooling water canal. A review has been made of pertinent available geologic and engineering data as well as available design, construction and operating information for the critical project features. A detailed visual inspection has been made of the critical water-retaining facilities relative to stability, operational adequacy and safety.

1.2 Size Classification

The size classification is determined by the height of the dam or the maximum storage capacity, whichever gives the larger size category. The H B Robinson Main Dam is 55 feet high and has a maximum storage potential of 55,500 acre-feet at the crest of the dam, Appendix D. An intermediate size dam is from 40 to 100 feet in height or from 1,000 to 50,000 acre-feet in maximum storage capacity in accordance with U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams." The H. B. Robinson Dam is therefore classified as Intermediate Size based on both height of dam and maximum storage capacity.

The Ash Pond Dam is 20 feet high and has a maximum storage potential of 510 acre-feet at the crest of the dam, Appendix D. A small size dam is less than 40 feet in height or less than 1,000 acre-feet in maximum storage capacity. The Ash Pond Dam is therefore classified as small size based on both height of dam and maximum storage capacity.

1.3 Hazard Potential Classification

The H. B. Robinson Main Dam is a Class "C" dam according to the system adopted by some states such as North Carolina or a "High Hazard Potential Dam" in accordance with the system adopted by the U.S. Army Corps of Engineers in "Recommended Guidelines for Safety Inspection of Dam." Class "C" or High Hazard Potential refers to the potential for damage or loss of life in the event of a dam failure for any reason and does not infer that the dam is unsafe. The H. B. Robinson downstream channel is a meandering, heavily forested natural channel. There are numerous occupied houses adjacent to the channel which could be damaged by failure of the dam with resultant risk of loss of life. Two occupied dwellings are located less than 1,000 feet downstream of the dam. State Highway 1623 would be closed. Failure of the H. B. Robinson Dam could result in cascade failure of the Prestwood Lake Dam 5 miles downstream at Hartsville, South Carolina.

The Ash Pond Dam is a Class "A" or Low Hazard Potential dam. The Ash Pond Dam downstream channel enters a cove which is part of the plant cooling water canal after crossing a rail spur used to deliver coal for Unit No. 1. Failure of the Ash Pond Dam would temporarily close the rail spur and ash released from the pond could partially block the cooling water canal.

1.4 Conclusions

1.4.1 The H. B. Robinson Main Dam is adequately designed, adequately constructed and in good condition with no dips, sags, slumps, sinks or other evidence of distress. The upstream riprap is sound and the downstream grass cover is well established.

1.4.2 The project spillway is adequately designed and constructed. The spillway can pass the PMF event with adequate freeboard. Movements of up to 2-inches have been observed at the upstream and downstream spillway retaining walls which support the embankment fill. These are common movements for cantilever retaining walls of this height, however, the movement should be monitored to detect any trends.

1.4.3 The spillway gates and primary hoists are well maintained and performed properly when tested during this inspection. The standby gas motor drive unit intended to operate the gates during a power outage was not functioning properly at the time of the inspection. This unit should be repaired or replaced.

1.4.4 No annual tests or regular operations of the spillway gates have been conducted since the 1980 independent consultant inspection. The gates were fully tested and overhauled in 1982. Such tests should be conducted annually using the recommended standby operator.

1.4.5 Riprap has been displaced upstream of the spillway training walls. This riprap should be replaced with heavy stones to prevent future displacement.

1.4.6 The concrete under the spillway bridge beam seats has cracked and this should be investigated and repaired if required.

1.4.7 There was no evidence of slides or other distress on the reservoir shoreline.

1.4.8 The area downstream of the H. B. Robinson Dam was dry at the time of the inspection. The east drainage ditch was flowing as previously reported but appears to be transporting sediment. The source of this sediment should be determined. The flow in this ditch should be monitored monthly.

1.4.9 The station drainage outfall and concrete lined ditch are in good condition.

1.4.10 The flow from the 8-inch tile drain opposite the west side of the spillway stilling basin appeared unchanged from the 1980 inspection report.

1.4.11 Two houses immediately downstream of the H. B. Robinson Dam have artesian wells. Almost all of the cottages along the reservoir east shoreline similarly have artesian wells in their front yards. The source of this artesian water appears to be sandy layers in the foundation soils confined by clay beds. These artesian water sources were detected at or below elevation 140 and 104 at the dam. These conditions present no problem except if uncontrolled flow occurs at the surface where material transport could occur.

1.4.12 The ash pond dam is adequately designed and constructed for its intended purpose. There is a good grass cover on the downstream slope and there is no sign of dips, sags, slumps, sinks or other evidence of distress.

1.4.13 The ash pond dam spillway was designed for a ten year return period storm on a 70 acre drainage basin. The impact of a one half PMF event should be evaluated considering the drainage area of approximately 600 acres. The downstream railroad, cooling water canal and the impact on Unit 1 operation should be evaluated. It is likely that the dam could resist limited overtopping during such an event.

1.4.14 The outfall for the ash pond dam drop inlet spillway could not be located due to sediment deposition. The outfall should be located and determination should be made if storm water can be routed through the drop inlet and conduit without overtopping the dam.

1.4.15 The project cooling water canal dikes, side slopes and discharge structure are in good condition.

1.5 Recommendations

1.5.1 Wall movement monitoring should be established on the spillway upstream and downstream training walls. For the first year, monthly readings should be taken to establish any annual cycles of movement.

1.5.2 The spillway gas driven standby motor should be repaired or replaced.

1.5.3 Spillway gates should be tested annually using the standby motor.

1.5.4 The cracked concrete under the spillway deck beam seats should be removed and replaced. Annual inspection of the new concrete beam seats is recommended.

1.5.5 The displaced riprap upstream of the spillway structure should be replaced using the next larger class stone.

1.5.6 The east drainage ditch flow should be monitored monthly and the source of observed sediment transport determined.

1.5.7 The ash pond dam should be evaluated to determine if it can safely pass up to one half of a PMF inflow event on its 600 acre drainage basin. Limited overtopping of the dam should be allowed under this extreme event.

1.5.8 The ash pond dam spillway outlet should be located and determination should be made if storm water can be routed through the drop inlet and conduit without overtopping the dam.

1.5.9 Visual inspection of the H. B. Robinson Dam, spillway and ash pond dam should be conducted monthly to detect any cracks, slumps or new seepage. All inspections should be recorded in a log book with key observations noted. Any unusual findings should be reported immediately to a designated engineer for evaluation.

2. PROJECT DESCRIPTION

This section is extracted from a report entitled "Safety Inspection of Cooling Lake Dam and Appurtenant Structures, H. B. Robinson Steam Electric Plant," by Mr. William L. Wells in November 1980. The subsections on the Ash Pond Dam and cooling water canal plus some miscellaneous notes have been added as part of this inspection.

2.1 Project Location and Description

2.1.1 Location

The H. B. Robinson Steam Electric Plant is located at 34°-24' north latitude and 80°-9' west on Black Creek in Darlington County, South Carolina, adjacent to State Highways 1623 and 151, about five miles northwest of Hartsville, South Carolina, Plate No. 1. The nearest town is Pine Ridge, South Carolina, Plate No. 2. The project is owned and operated by Carolina Power & Light Company.

2.1.2 Description

The original plant and cooling lake were completed in 1960. The original plant (Unit No. 1) is a 182 MW coal-fired unit. During the period 1966 to 1970, a second unit was constructed. It is a 700 MW nuclear unit.

The main dam is about 4,000 feet long and has a maximum structural height of about 55 feet. A gated concrete overflow spillway is provided near the old streambed of Black Creek. The lake impounded by the dam is about 7.3 miles long in the north-south direction and has an average width of about 2,500 feet. At the normal water surface elevation of 220 feet msl, the surface area of the lake is 2,242 acres. Approximately one mile northwest of the plant, there is an ash pond dam approximately 1,800 feet long with a maximum structural height of approximately 20 feet. A drop inlet structure is provided as a spillway for the ash pond. The pond has a surface area of 55 acres at crest level and a storage capacity of approximately 410 acre-feet of ash. A cooling water discharge canal conveys condenser cooling water from the plant to a point approximately 4.2 miles up the lake where the water is returned to the lake for cooling.

2.2 Geology of the Site

2.2.1 General

The site lies in the coastal plain of South Carolina, approximately 15 miles southeast of the Fall Zone. In the general vicinity of the site, surficial deposits 5 to 30 feet thick, consisting of sand and clay, overlie Upper Cretaceous sediments of the Tuscaloosa (Middendorf) Formation. The Upper Cretaceous sediments are approximately 460 feet thick and rest unconformably upon the crystalline basement of Pre-Cambrian and Paleozoic Age.

The surficial materials at the site are sands and clays derived from the Tuscaloosa. It is difficult in most parts of the area to distinguish the surficial material from the weathered Tuscaloosa. The Tuscaloosa consists of light colored feldspatic and slightly micaeous quartz sand and red, purple, gray, and brown silty sand and clay. Some layers have been cemented into semiconsolidated sandstone. The sand and clay beds are lenticular and grade laterally into one another and pinch out within comparatively short distances.

The Tuscaloosa is a permeable formation and, in several areas of the Coastal Plain, yields up to 2,000 gpm from individual wells. Groundwater occurs under both water table and artesian conditions. During the 1985 inspection, a large number of artesian wells were observed along the east shore of the reservoir. Two artesian wells were observed downstream of the dam along State Highway 1623 next to the downstream river channel. These are all believed to derive from below a confining clay layer at about elevation 140.

From a geological standpoint, the Tuscaloosa is considered to be an unconsolidated sediment. However, from an engineerilng point of view, the materials are firm and compact, ranging in texture from a hard or compact soil to a soft rock.

2.2.2 Seismicity

The seismicity of the site was thoroughly investigated by several experts in the field of seismology in connection with the licensing of the 1970 nuclear unit. Studies were made by Dames & Moore (2), Drs. J. L. Stuckey and L. L. Smith (3), Dr. Perry Byerly (4), Dr. George W. Housner (5), and by the Savannah River Operations Office of the U.S. Atomic Energy Commision (6). Conclusions reached from these studies are summarized as follows: Only one earthquake of intensity V or greater has ever been recorded within 50 miles of the site. This shock occurred on October 26, 1959, near McBee with an intensity of Modified Mecalli VI. the epicenter was located about 15 miles from the site. The estimated intensity at the site was about V.

The epicenters of two other shocks are located within 160 miles of the site. The epicenter of the 1913 earthquake in Union County (MM VII-VIII) was approximately 90 miles from the site and that of the 1945 Lake Murray shock (MM VI) was approximately 70 miles distant. Damage was slight in both epicentral areas and nonexistent at the site.

The 1886 Charleston earthquakes occurred about 120 miles from the site. Damage was confined to the epicentral area and it is unlikely that intensity at the site exceeded VI for the largest Charleston shock. While the aforementioned shocks were probably felt in the locality of the site, no damaging effects were reported. The amplitude of ground motion at the site would not cause damage to any reasonably well built structure. In addition, the site is located in Zone 2 according to Corps of Engineers Regulation ER 1110-2-1806 dated 16 May 1983 "Engineering and Design: Earthquake Design & Analysis for Corps of Engineers Projects." Zone 2 has a potential for 0.10 g earthquakes. Zone 2 is characterized as a zone of light earthquake activity which would result in only minor damage. Therefore, on a historical basis, it would appear that the site will not experience damaging earthquake motion during the life of the facilities. The sediments underlying the site are quite thick and apparently undisturbed. Active faults are unknown in the area.

The seismic design criteria adopted for the nuclear installation are as follows:

Design Earthquake - Maximum horizontal ground acceleration of 0.1 g with a vertical component of 2/3 of 0.1 g.

Hypothetical Earthquake - Maximum horizontal ground acceleration of 0.2 g with a verical component of 2/3 of 0.2 g.

2.3 Design of H. B. Robinson Dam

2.3.1 General

The dam was designed by and constructed under the supervison of Ebasco Services, Incorporated of New York. It is an earth dam approximately 4,000 feet long, having a maximum structural height of 55 feet and a maximum hydraulic head of about 40 feet. A gated overflow spillway is provided near the location of the old creek bed.

2.3.2 Specific Site Conditions

The site was explored by Eustis Engineering Company of New Orleans by means of 50 undisturbed soil borings, 103 wash borings, and 298 auger borings. Shelby tube samples of clays and piston tube samples of sands were obtained from the undistrubed soil borings. The wash borings were made for the purpose of tracing out the location, thickness, and extent of clay deposits in the foundation of the dam. These were found to be mostly lenticular and erratic. A relatively thick and extensive layer of clay was found near Elevation 175. The spillway structure is founded on this layer and the dam tied to this layer for underseepage control. The auger borings were made for the purpose of locating suitable borrow material for the dam.

Since the dam is located on the Tuscaloosa formation, which was known to be highly pervious in part, one of the first considerations was to evaluate potential water loss through the reservoir rims and abutments of the dam. For this purpose, two deep borings were made initially on the east and west valley ridges at points well above the proposed lake elevation of 220 feet msl to evaluate groundwater conditions. DH-1 was made at a location on the east ridge about 1,000 feet beyond the east end of the dam. The ground surface elevation was 274.00 feet and the water table was found at Elevation 221.00 feet. DH-7 was located on the west valley ridge at a point about 1,200 feet west of the west end of the dam. The ground surface elevation was 248.1 feet, and the water table was found at Elevation 237.1 feet. Materials found in these borings were mostly sands or clayey sands. Exceptionally at DH-1, a stiff to hard clay stratum was found between Elevations 175 and 156 feet.

Locations of the other borings are shown on Plate No. 3, a plan of the dam, spillway, and plant area (Ebasco Drawing No. G-158001). Logs of the borings in the plant area are shown on Exhibit 2 (Ebasco Drawing No. G-157988). It may be noted that a stiff to hard silty clay stratum was found in this area between approximately Elevation 170 and 150 feet. The water table in the area was at Elevation 213 and 215 feet.

The results of the borings made at or near the location of the dam are shown in the form of a geologic profile and cross sections on Plate No. 4 (Ebasco Drawing No. G-158004). As may be noted on the profile, four deep borings (5, 5B, 5G, and 2C) were made along the axis of the dam. The underlying stratum of very stiff to hard silty or sandy clay found in the plant area between approximately Elevations 170 and 150 feet was also found in these borings. Boring 5 was located at the west abutment of the dam, Station 11+95.0. About 13 feet of loose fine sand was found on the surface, underlain by about 42 feet of very dense fine and medium sands. At Elevation 170.6 feet, the stratum of very stiff to hard clay was encountered, hereinafter called the lower clay stratum. This was underlain by a clayey sand at Elevation 138.1 feet. At Boring 5-B, the lower clay stratum was found at Elevation 171.1 feet overlain largely by loose fine to coarse sand. Boring 5-G was located at the proposed spillway location. The lower clay stratum was found at Elevation 168.7 feet, overlain by alternate deposits of sand and clay. The water table or piezometric head in these borings was at Elevation 213.0 feet. Those drilled at lower elevations produced large artesian flows upon penetration of the lower clay stratum.

From Boring 2-C along the proposed axis to the west, a total of 13 wash borings were made, as shown on Plate No. 4. All of these were carried to the lower clay stratum at about Elevation 170 feet. It may be noted that a very irregular stratum of silty clay was found along this portion of the dam alignment, generally at about Elevation 190 feet. Its thickness was irregular, varying from 2 feet to as much as 12 feet, but it was apparently continuous. West of the last boring described above (4C), there was a heavily overgrown swamp extending westward across Black Creek to the spillway location. It was not possible to drill in this area with the heavy truck-mounted drilling equipment available at the time. However, drilling downstream and upstream of the swampy area was possible and this was done. Boring 22, located on the right bank of Black Creek upstream of the axis, encountered the lower clay stratum at Elevation 172.7 feet. Borings 4 and 4A, located on the left bank of Black Creek downstream of the axis, encountered the lower clay stratum at Elevations 169.3 and 166.1 feet, respectively. The upper silty clay stratum, hereinafter called the upper clay stratum, was also found in these borings. An artesian flow was also encountered in these holes when the lower clay stratum was drilled through. This flow was likewise encountered in all of the borings which penetrated through the lower clay stratum and which were located at Elevation 213 or lower. The piezometer head in the formations below the lower clay stratum thus was at practically the same elevation as that of the upper water table in the plant area.

Two transverse lines of holes were also drilled at the dam site, as shown on Plate No. 4. Section A-A was located on the left or east side of the creek, as shown on Plate No. 3 and Section B-B was located near the west abutment. The same conditions as previously described were found. It may be noted on Section B-B that, at Boring 5A located near the abutment, the material overlying the lower clay stratum is largely sand.

Two possible borrow areas were also explored, as shown on Plate No. 3. One was located west of the dam in a search for clay or impervious material. It was called the West Clay Borrow Pit, but practically none was found within the depth explored, about 15 feet. The other borrow area was located upstream of the eastern portion of the dam. It was called the East Borrow Pit. Again, very little clay was found in the eastern area.

Laboratory tests performed on undisturbed samples removed from the lower clay stratum at the spillway location indicated unconfined comprehensive strengths varying from 1515 and 8415 lbs/sq. ft. Consolidation tests on other samples removed from the stratum indicated a high degree of overconsolidation. Sandy clays found in the east borrow pit were found to have liquid limits ranging from 21 to 29 and plastic indices ranging from 8 to 13.

Coefficients of permeability in the compacted state varied from 0.9 to 17 x 10^{-8} cm/sec. Permeability tests on various samples of sands removed from the upper levels of the dam foundation indicated coefficients ranging from 10 to 1 x 10^{-3} cm/sec. Dynamic soil tests performed on the soils at the site at a later date in connection with licensing of the nuclear unit indicated only minor strength loss under dynamic loading (2).

2.3.3 Design Provisions

A longitudinal profile along the axis of the dam and cross sections are contained on Plate No. 5 (Ebasco Drawing No. G-158002). Section AA-AA is a typical section of the dam taken in the central portion of the valley.

Crest elevation is 230 feet, and the crown width is 15 feet. High water elevation is 220 feet. Side slopes are 3:1 upstream and 2.5:1 on the downstream side. A 15-foot wide berm was provided on the downstream face at Elevation 200 feet, where the ground surface was at or below that elevation. The face of the berm was protected against wavewash during flood periods and against backwater currents by an 18-inch thickness of riprap underlain by 8 inches of crushed stone placed below Elevation 195 feet. A crushed stone toe drain, 15 feet in width at its base, was provided at the toe of the berm. Wavewash protection on the upstream face of the dam was provided between the crest and Eleation 205 feet by 24 inches of riprap underlain by 8 inches of crushed stone. From Elevation 205 feet down the slope to natural ground, a 2-inch sand-asphalt blanket was placed for wavewash protection during reservoir filling. A central vertical core of compacted impervious material (clay) 12 feet wide was provided from Elevation 225 feet to the base of the dam proper thence extending downward along the downstream slope of a cutoff trench which, in the western portion of the dam, extended to the lower clay stratum at Elevation 170 feet. The shells of the dam are largely sand. A blanket of clean, impervious sand 10 feet thick was placed on the surface of the base of the dam downstream of the vertical core.

The eastern part of the dam, east of about Station 29, was of similar construction, except that as shown on Section BA-BA, Plate No. 5 and the longitudinal profile, the cutoff trench was not carried to the lower clay stratum at Elevation 170 feet but was excavated to the surface of the upper irregular silty clay stratum found in this area and described previously. In order to reduce the quantity of underseepage which might pass through the sand strata found between the two clay strata, a very long path of percolation was created by tying the two clay strata together by means of a trench and clay facing backfill (see Section CA-CA, Plate No. 5) extending upstream for a distance of about 700 feet. This is shown in plan on Plate No. 3. As mentioned previously, the west abutment of the dam consists almost entirely of sand. In order to minimize seepage through it, the abutment was blanketed with a 5-foot thickness of clay between the end of the dam and the plant intake structure, a distance of about 600 feet. Details are shown on Sections EA-EA, DA-DA, and FA-FA of Plate No. 5. Locations of these sections are shown on Plate No. 3.

2.3.4 Stability Analyses

The original computations of stability could not be located. However, since the dam consists largely of compacted sand founded on a competent foundation, a simple analysis can be made. The indicated factor of safety of the upstream slope thus found is 2.10, and that of the downstream slope is 1.75, under normal conditions. This matter was reviewed in connection with the FSAR for the nuclear unit (2). The earth dam was analyzed using the circular arc "method of slices" under the assumed hypothetical earthquake, with two-thirds of the horizontal acceleration in the vertical direction. The ratio of the sum of all the resisting forces divided by the sum of all the forces tending to cause displacement is 1.08. The dam was also analyzed by the Newmark method. This indicated that no appreciable displacement or yielding of the embankment could be expected when it is subjected to the hypothetical earthquake.

2.3.5 Construction Specifications

Complete specifications covering the dam and spillway are contained in the construction contract (7). The more important provisions relating to the dam are summarized herein.

Materials - The core of the dam, including impervious fill in the cutoff trenches and the west abutment blanket, was specified to be a clay or clayey sand. The material used in the sand drain at the base of the downstream portion of the dam was specified to be clean sand. There was no specification for the gradation of the general fill but, as it was obtained from the east and west borrow pits, it was largely sand. Crushed rock for the toe drain and riprap beds was specified to consist of sound rock having a maximum size of 3 inches with at least 50 percent retained on the 2-inch sieve and at least 90 percent retained on the Number 4 sieve.

Riprap was specified to consist of quarried, hard, durable, angular, well-graded rock, ranging in size from 3 inches to 28 inches, and having an average (50 percent) size of not less than 15 inches.

Placement - It was specified that the impervious core and blanket materials be spread in approximately horizontal layers not thicker than 8 inches, brought to optimum water content, and compacted to a density of at least 95 percent of modified AASHO by means of sheepsfoot rollers. General fill and sand fill were specified to be spread in layers not exceeding 12 inches in thickness, brought to optimum water content, and compacted to a density of at least 95 percent of modified AASHO by means of 35 to 50 ton rubber-tired rollers or vibrating drum rollers.

2.4 Construction of H. B. Robinson Dam

2.4.1 General

Construction of the dam was started in May, 1958, and it was completed June 22, 1959. Water impoundment was started in March, 1959, and the lake reached Elevation 220 feet in February, 1960. Because of a lack of clay in the east and west borrow pits, it was necessary to utilize a clay pit located on the ridge about 2,500 feet east of the east end of the dam. The material in this borrow area was exposed in a road cut and no borings were made.

2.4.2 Design Deviations

Much difficulty was experienced during construction of the cutoff wall to the underlying clay strata at several points (8). In many areas, large flows of water were encountered and the side slopes of the excavation were not stable. The core trench excavation between Stations 13+00 and 14+00, near the west abutment, contained a mixture of sand, clay, and water with a consistency of a slurry. Gravel was placed in this slurry, then compacted until point-to-point contact existed.

Sheet piling was then driven through this backfill a minimum of 1-1/2 feet into the lower clay stratum. It extended 3 feet above the gravel backfill; clay core was placed and hand tamped around the 3-foot extension. A tee pile was driven at Station 13+30 to be the start of the west abutment cutoff wall. Sheet piling was used for this wall in lieu of the clay blanketed cutoff trench shown on the drawings.

At the east cutoff wall, the northern 360 linear feet of the cutoff wall was constructed as designed; however, because of water problems and caving trench walls, the next 320 feet were constructed using sheet piling. The last 195 feet were constructed as designed. This tied into the core of the dam at Station 29+30.

The quality of the earthwork was controlled by Ebasco through field inspections and soils technicians (8). Laboratory tests consisted principally of gradation, in-place density, compaction, and permeability. The results are summared as follows:

A sandy clay with a gradation of 100 percent passing the No. 8 sieve and 20 to 50 percent passing the 200 sieve was used for all impervious fills. Its coefficient of permeability was stated to be 10^{-7} cm/sec. A clean sand with a gradation of 95 percent passing the No. 8 sieve but not more than 5 percent passing the 200 sieve was used in the downstream base drain, having a coefficient of permeability of 10^{-2} cm/sec. The general fill had a gradation of 95 percent passing the No. 8 sieve and a range of 5 to 15 percent passing the 200 sieve. The coefficient of permeability was stated to be 10^{-3} cm/sec. The various types of materials and fills required compaction of 95 percent of modified AASHO. The average degree of compaction obtained on all fills was greater than that requirement and any areas which did not meet the specification were rerolled and retested.

2.5 H. B. Robinson Spillway

2.5.1 Design Flood

In October, 1959, a gaging station was established on Black Creek by the USGS at a point near McBee. Examination of the records from the gaging station yielded several well-defined flood hydrographs which were considered suitable for determination of a unit hydrograph. This was done and two different peak flows were calculated using it. The first was based on the July, 1916, tropical storm, transposed from its actual location near Asheville, North Carolina, and centered on the Black Creek drainage area. Indicated peak discharge into the lake for an equivalent storm on the H. B. Robinson drainage basin was 23,000 cfs. The second peak flow determined was the one which would result from the Probable Maximum Precipitation (PMF) for the area taken from charts prepared by the Hydrometeorological Section of the Weather Bureau. This calculation yielded a peak discharge into the lake of 39,000 cfs. The project spillway is capable of passing 40,000 cfs at elevation 221.67.

2.5.2 Description

As may be noted on Plate No. 3, the spillway is located about 400 feet west of the former Black Creek channel. A discharge canal leading back eastward to the creek channel was provided downstream of the stilling basin. The spillway consists of an approach channel, a two tainter gate controlled overflow section, a sluice controlled by two 36-inch Howell-Bunger valves (which are installed at the downstream end of the center pier), and a stilling basin. A ten-foot wide steel girder with concrete deck, two span bridge crosses the overflow structure. A general plan, and sections of the spillway structure are contained on Plate No 6 (Ebasco Drawing No. G-158005). The structure is founded upon and is keyed into the lower stiff to hard clay stratum at Elevation 163 feet. The outside face of the two end piers were constructed on a vertical batter of 1:10. A cutoff wall, 2 feet thick, extending 6 feet into the clay core of the dam was provided on the outside face of each end pier.

The clay core was thickened to include the cutoff walls for a distance of 20 feet on each side of the spillway.

All concrete structures were heavily reinforced and all structural concrete was specified to have a minimum 28-day compressive strength of 3000 psi. Complete specifications for the concrete work are contained in Reference 7 and detailed drawings are contained in the appendix. In connection with the preparation of the FSAR for the nuclear unit, the spillway was analyzed by conventional methods, under hypothetical earthquake conditions, and a ratio of resisting forces to displacement forces of 1.38 was obtained.

The spillway is provided with two tainter gates, each of which is 25 feet wide and 35 feet high. They will discharge the design flood of 39,000 cfs with the lake at Elevation 221.67 feet. That elevation is apparently somewhat higher than originally contemplated by the designers (El. 200 feet), but at that lake elevation the freeboard is 8.33 feet and the lake level is 3.33 feet below the top of the clay core. The tainter gates are operated by electric hoists with a standby gas motor. Provision is made on the hoists of both gates for connection of the gas motor drive so that they may be operated if a power failure should occur. Spillway rating curves are presented in Appendix A.

Controls for gate No. 1 are located on the BTG board in the plant control room. This is a push button control, and the gate can be raised and lowered from this point only within an initial four foot range. To open the gate to a greater height, the operator must go to the spillway bridge. The push button control for gate No. 1, which is located in the gate control station on the center pier, will override the control located on the BTG board. The gas driven hoist can be started only from the control center on the spillway bridge. The engine is engaged with the hoists by a manually operated clutch.

Plate Nos. 10, 11, 12, 13 and 14 show excavation and structural details of the H. B. Robinson Spillway. Gate position and lake level indicators are installed in the plant control room and at the gate control center on the spillway bridge to guide the operator in his operation of the gates. An alarm bell and light are also located in the plant control room and in the spillway control center to alert the operator when the lake level rises or drops outside a limited range near Elevation 220.0.

2.6 Observations and Maintenance, 1960 - 1985

2.6.1 General

The only maintenance of the dam proper required in the past has been filling of rain washes in the downstream slope which occurred prior to the development of a grass protective growth. Maintenance of the spillway structure has been confined to painting of the steel parts. Repairs, as necessary, have been made from time to time to the gate hoisting equipment, machinery, and control system. In 1963, the area downstream of the dam extending east of Black Creek for a distance of about 1,500 feet was reshaped for erosion control and to allow adequate drainage of runoff from the area. Both tainter gates were repainted in 1980 and gate seals repaired (Appendix B).

2.6.2 Storm Drainage Channel Repairs

Storm drainage from the plant area is collected by means of a peripheral ditch constructed around the plant area, as shown on Plate No. 7 (Ebasco Drawing No. G-157990). The drainage is conducted to the south and east of the plant area by means of a buried 48-inch concrete pipe which crosses the access road, the picnic area, and the area downstream of the west abutment of the dam. The pipe feeds into a paved channel which runs eastward to Black Creek near the spillway stilling basin. The plan of the channel and profile (Section B-B) are shown on the exhibit. The channel has a flat bottom and sloping side walls. Contraction joints were spaced at 25 feet and in the first section beyond the chute drop, shown on Section B-B, two 1-1/2 inch weep holes were provided in each side wall. There was a buildup of hydrostatic pressure behind the side walls of the channel and loss of support because of piping of the backfill to the channel through construction joints at various points. These factors resulted in displacement of some of the wall slabs and damage to the concrete floor at some locations. In 1978, repairs were made and a more extensive weep hole system was installed, as shown on Plate No. 8 (CP&L Drawing No. RCD-996).

In connection with the above, the position of Drill Hole 5-A has been superimposed on Plate No. 7. The ground elevation at this hole was 197.1 feet. It was a deep hole penetrating through the lower clay stratum. At elevation 130 feet, an artesian flow of water was encountered which increased greatly in volume at Elevation 106 feet. Above the lower clay stratum, only medium to coarse sands were found. As may be noted on Plate No. 7, the hole was located very near the crest of the chute shown on Section B-B. There is no record that it was sealed but it was covered up by construction fill. It appears extremely probable that this old flowing well is the source of the high water table experienced in this area. The seepage could also be from open joints in the concrete pipe upstream of the outfall structure.

2.6.3 Spillway Area Drainage

There formerly was a large wet area near the downstream toe of the dam just east of the spillway location, as shown on Plate No. 9 (CP&L Drawing No. RCD-1044). Water collecting in this area flowed west to the spillway cut.

In order to correct this situation, a drainage ditch was constructed in 1978 to intercept the southward flow in the existing ditch, as shown on Plate No. 9. It appears quite possible that some or all of this flow originates from Drill Hole No. 4, the location of which has been superimposed on Plate No. 9. That was a deep hole which encountered a strong artesian flow at Elevation 103 feet in a coarse sand. Top elevation of the hole was 193.8 feet.

During construction of the dam, the flow was diverted to the toe drain of the dam by means of a gravel filled ditch, as indicated on Plate No. 9.

At the drill hole, a coarse sand was found between Elevations 188.3 and 174.3 feet. Some or all of the discharge from the drill hole may be flowing laterally, westward and down gradient through the sand formation to the wet area which developed, or it may be flowing westward through the dam toe drain to a point of emergence at the former wet area.

2.6.4 Flowing Pipe - West Side of Spillway

On May 12, 1961, an artesian well approximately 4 inches in diameter was found at a point about 100 feet west of the west spillway wall and 20 feet south of the toe of the dam. A water sample was taken and analyzed for comparison with the lake water. It was concluded that the flow was not lake water but from the artesian layer in the foundation, posing no threat to the dam. On September 24, 1961, a pit 4 feet deep was dug at the well location and partially filled with crushed stone and riprap. A cap of sand-clay was provided. A 105-foot section of drain tile was laid from the pit to the bank of Black Creek at the spillway stilling basin training wall. The flow through the pipe was measured and found to be 36 gpm. Another water analysis was made and it was again concluded that it was artesian water.

There is no record of a drill hole being made at this location.

2.7 Ash Pond Dam

2.7.1 General

Fly ash from the H. B. Robinson Steam Electric Plant Unit No. 1 is transported by hydraulic means to an ash pond located approximately one mile northwest of the plant. In June-December 1982, the ash pond dam was raised 7 feet to provide 10 years additional storage of ash. The dam was designed and constructed by CP&L, Plate Nos. 15, 16 and 17.

2.7.2 Geology and Seismicity

Geology and seismicity of the ash pond dam are generally as described for the main dam in subsections 2.2.1 and 2.2.2. The ash pond dam is higher in the geologic profile than the main dam and therefore is founded on sandier deposits typical of the higher elevations around the lake. The site was investigated by a series of fifteen borings to define the dam foundation and borrow sources. Laboratory tests showed the borrow materials to generally be gap graded medium sands with 5 to 30 percent fines. In general, the foundation appears to be relatively pervious.

2.7.3 Design Provisions

The ash pond dam has a crest width of 12 feet, upstream slope of 1.5H:1.0V and downstream slope of 2.5H:1.0V. The 7 feet raising was accomplished by adding compacted fill to the downstream side of the existing structure. A baffle dike was raised in 1981 in preparation for the dam construction. This baffle dike is designed to lengthen the retention time by substantially increasing the distance from the ash pipe outfall to the skimmer/drop inlet spillway structure. Provision of two feet of freeboard is made to provide surcharge storage routing of the inflow design flood. The design storm is a ten year - 30 minute storm at 4.48 inches per hour on the 70 acre pond.

2.7.4 Stability

Stability analysis of the dam was not available. The free draining nature of the sandy fill material and foundation as well as a toe drain provide assurance of stability. A brief analysis using infinite slope computations indicates a downstream slope factor of safety of 1.4 for normal conditions. Upstream slope stability is not critical since the pond is generally dry and filled with fly ash next to the dam.

2.7.5 Deviations from Design

During construction of the ash pond dam raising, the contractor encountered a gravel toe drain running along the original dike downstream toe. This toe drain was incorporated into the new construction by extending an outfall pipe to the new catch basin downstream of the dam.

2.7.6 Specifications and Quality Control

Fill materials and foundation preparation were conducted in accordance with CP&L specification "FPE&CD 82-S-168 H. B. Robinson SEP Ash Pond Expansion." Materials were compacted in lifts to specified 95 percent standard proctor ASTM D698 Method A. Tests during construction showed fill in situ densities of 95-96 percent in the lower lifts and 96-99 percent in the upper lifts.

2.8 Cooling Water Canal

Condenser discharge water from the plant is conveyed by a canal along the west reservoir shore to a point some 4.2 miles upstream where the water is returned to the lake. The canal is generally an excavated section and contained by a dike between the canal and the main reservoir. The canal has a bottom width of 20 feet, side slopes of 3H:IV and an average depth of flow of about 13 feet. Side slopes to the reservoir side vary from 3.0H:1.0V to 6.0H:1.0V. The original canal ended at a sluice structure approximately 1.2 miles upstream of the plant and served only Unit No. 1. In 1970, the canal was extended to its current 4.2 miles to serve both Unit No. 1 and Unit No. 2. Water velocity in the canal is a maximum 1.75 fps. Plate Nos. 18, 19, 20 and 21 show details of the cooling water canal.

3. RESULTS OF FIELD INSPECTION

3.1 General

Visual inspection of the H B Robinson plant was conducted during the period 4 to 6 June 1985. The main dam, spillway, reservoir shoreline, upstream basin, downstream flood channel, cooling canal and ash pond dam were inspected by foot, boat and helicopter reconnaissance. A representative of Carolina Power & Light Company accompanied the inspector and site personnel provided data and documents concerning the project. At the time of the inspection, 4 June 1985, the reservoir was at elevation 220.2. The following subsections present the findings and observations made during the inspection.

3.2 H. B. Robinson Dam

Photo No. 1 presents a general view of the main dam spillway and downstream channel. The dam is considered to be in good condition. The crest was true to line and grade with no dips, sags, settlement, cracking or other evidence of distress. The crest dips upstream for drainage and has some local wheel rutting.

Photo No. 2 shows the upstream riprap. The riprap is sound with no evidence of deterioration or displacement. The upstream face was inspected by boat. Minor riprap displacement was observed on both sides of the spillway structure as seen in Photo No. 3. This may be due to fishermen, as there is little evidence of heavy wave activity on the reservoir.

The downstream slope was in excellent condition with a well established grass cover. There were no slides, slumps, sinkholes or other evidence of distress. At two locations, four wheel drive vehicles have used the slope for recreational purposes, Photo No. 4. Efforts by CP&L seem to have minimized this activity as grass has been re-established on the affected areas. Trees and shrubs previously observed on the slope during the 1980 inspection have been removed.

Areas downstream of the dam were inspected for seepage, springs and other evidence of uncontrolled water flow. Station drainage discharges from an outfall structure downstream of the right abutment as seen in Photo No. 5. A number of weep holes along the initial portion of the paved ditch were releasing water. It was observed that the joints in the 36 inch diameter concrete station drainage pipe upstream of the outfall were somewhat open and this may partly explain the weep hole flows which increase in quantity nearer the outfall.

Photo No. 6 shows the concrete paved ditch leading to Black Creek. As noted by previous inspectors, some of the slab construction joints are displaced but overall, the pavement is in good condition. No wet areas were observed downstream of the right section of the dam.

The 8 inch diameter drain tile pipe noted in the 1980 inspection report was inspected. No change in condition of quantity of flow was seen from that previously reported. This drain pipe reportedly carries flow from a gravel pack in a wet area 100 feet to the west believed associated with artesian flow from an abandoned exploratory drill hole or well in this area.

Downstream of the left embankment, the toe area drainage ditch was inspected, Photo No. 7. The ditch side slopes have stabilized since the 1980 inspection with a grass cover now developed. In general, the ditch flow appears as reported in the 1980 inspection. At the time of the 1985 inspection, it was noted that a significant amount of sediment was being transported in the ditch which could not be explained by recent weather conditions. An effort was made to follow the ditch as far upstream as possible, and there was no significant change in flow for the first 500-800 feet. At this point, the ditch becomes heavily overgrown and the area could not be further inspected without waders. All remaining areas downstream of the dam were dry.

Along State Highway 1623 downstream of the dam, Photo No. 1, two houses just left of the highway bridge across Black Creek have artesian wells in their backyards. The source of water is believed a sandy layer below elevation 140 which was found to have artesian pressures during the original project exploration program. Photo No. 8 shows a typical installation. No evidence of sediment transport was found next to the wells.

3.3 H. B. Robinson Spillway

The spillway structure, Photo No. 9, was inspected for condition of gates, operating equipment and concrete condition. The concrete structure was found to be in generally good condition. It was observed that the upstream and downstream retaining walls had moved relative to the central more rigid ogee block, Photo No. 11. These walls support the upstream and downstream embankment fills and this is typical performance for cantilever retaining walls. At the time of the 1985 inspection, the offsets varied from 3/4-inches on the upstream walls to 2-inches on the downstream walls.

A few areas of spalled concrete were observed on the spillway structure. An area approximately 1 foot square was observed downstream of gate No.2's left trunnion. At three points under the steel beams for the spillway bridges, the concrete was broken out and/or cracked back to the beam anchor bolts. It is reported that this cracking was not observed during the 1982 gate repairs, Appendix "B".

As part of the inspection, site personnel were requested to operate the two tainter gates using the standby gas motor drive. This drive unit is tested monthly under no load conditions. Repeated attempts to lift either gate proved unsuccessful. Both gates were lifted about two inches and immediately reset using the normal electric drives. Both gates sealed adequately after testing. The gas motor standby unit is considered inadequate for its intended use and should be repaired or replaced. No gate operational tests have been conducted since the 1980 inspection.

Plant personnel stated that the maximum discharge to date was handled by the two Howell-Bunger valves Photo No. 10 and passing water over the top of the gates at reservoir elevation 222 or an estimated 950 cfs outflow. It is reported that the project operators typically hold the reservoir up to elevation 222 with flows over the tops of the gates. This operational procedure appears to be different than previously reported.

3.4 Upstream Basin

The reservoir drainage basin was inspected by helicopter reconnaissance. Photo No. 12 shows a typical view of the drainage basin which has minor vertical relief. The river channel meanders in a swampy and heavily wooded natural channel. There is some farming and orchards in the basin, with the farms being contour plowed. Photo No. 13 shows a highway bridge and gage station upstream of the reservoir. The upstream basin extends some 30 miles upstream and is sandy with pine and deciduous forests. There are numerous small man-made ponds upstream of the reservoir.

3.5 Reservoir Shoreline

The east and west reservoir shorelines were inspected by boat reconnaissance. There are no high slopes or evidence of shoreline instability. The west reservoir shoreline is mainly occupied by plant facilities and the cooling water discharge canal, Subsection 3.8. The east reservoir shoreline is heavily developed with cottages and seasonal residences. All permanent structures are well above the maximum reservoir level. Most cottages have boat docks which could be affected by water levels exceeding elevation 222.

A high percentage of the residences had artesian wells in the yards which seems to be the principal potable water source. Most wells were from 10 to 15 feet in elevation above the lake indicating a relatively high artesian head.

The cooling canal dikes were in good condition with good riprapping on both faces (see Subsection 3.8). At a point approximately one mile upstream of the plant, a high red sandy bank is being eroded by wave action. This poses no problem to the plant and no remedial action is required.

3.6 Downstream Channel

The channel downstream of the dam was inspected by helicopter reconnaissance. Photo No. 14 shows the 108 feet long timber trestle of State Highway 1623 bridge approximately 0.2 miles downstream of the dam. Photo No. 15 shows an abandoned railroad fill that constricts the river channel approximately 0.6 miles downstream of the dam, Plate No. 2. Both of these structures constrict river flow and cause rapid tailwater changes at the dam during spillway discharges.

Downstream of the railroad fill, the river channel is relatively flat and meanders through a forested swamp. There are a number of houses and business developments adjacent to the river that would be impacted by major releases. Approximately 5 miles downstream of the dam, the river enters the headwaters of Prestwood Lake and Dam operated by Sunoco Products Company in Hartsville, South Carolina, Photo No. 16.

3.7 Ash Pond Dam

The Ash Pond Dam, Photo No. 17, was inspected by foot reconnaissance along the crest, downstream toe and from the baffle dike. The crest was true to grade with no dips or sags. The downstream slope had a well established vegetative cover and the downstream toe area was dry. There was no sign of slides, slumps, sinkholes or other evidence of distress.

The baffle dike was true to grade with no evidence of significant settlement. The bypass channel which returns ash water to the drop inlet spillway structure was dry and in good condition. Photo No. 19 shows the drop inlet spillway structure with skimmer device and Photo No. 20 shows the downstream channel. During the inspection, the outfall for the drop inlet spillway could not be located as it was covered by debris and surface erosion deposits.

3.8 Cooling Water Canal

The cooling water canal runs approximately 4.2 miles along the west shoreline from the plant to the discharge weir. The canal is a cut/fill section with the reservoir side contained by a dike and natural ground. Photo No. 21 shows the plant cooling water discharge. Photo No. 22 shows the southern section of the canal, Photo No. 23 shows the canal opposite the Ash Pond Dam (Photo No. 20) and Photo No. 24 shows the discharge weir at the north end of the canal. The east dike section crest was inspected by car and the H. B. Robinson Lake shoreline side by boat. The dike and all riprapped faces were in excellent condition.

At the point opposite the Ash Pond Dam, Photo No. 23, the sluice structure formerly used to discharge cooling water was inspected, Plate No. 19. This structure was abandoned when Unit No. 2 was constructed at the plant and the cooling water canal extended. The structure is blocked by heavy sediment on the lake side but is otherwise in good condition.

The discharge weir structure, Photo No. 24, was in good condition. At the time of the inspection, there was approximately 1.5 feet of head difference across the discharge weir.

During the cooling water canal inspection, a number of corrugated metal pipes were seen along the west canal bank with a few exceeding 36-inches in diameter. These appear designed to control sedimentation in the canal from surface runoff from the west shoreline. A number of the pipes were corroded away to the splash line of the cooling canal water level.

There was no evidence of shoreline slides along the canal. There was some minor undercutting and surface runoff erosion along the west bank.

INSPECTION PHOTOGRAPHS

4-6 JUNE 1985

Photo No. 1

General View of Main Dam and Spillway. Note Highway Bridge Downstream.

Photo No. 2

Upstream Slope Viewed from Spillway. Note High Quality Riprap.

Photo No. 3

Displaced Riprap on Left Upstream Face of Spillway (Similar on Right Upstream Face).

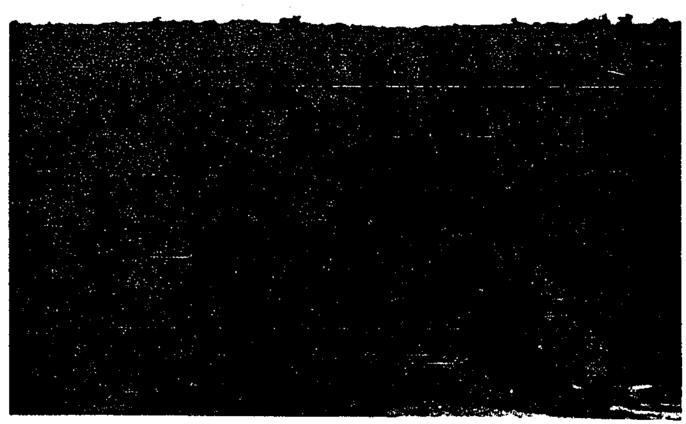


Photo No. 4

Downstream Slope Left Side. Note Wheel Tracks.

Photo No. 5

Station Drainage Outfall Structure.
Note weep holes in Invert.

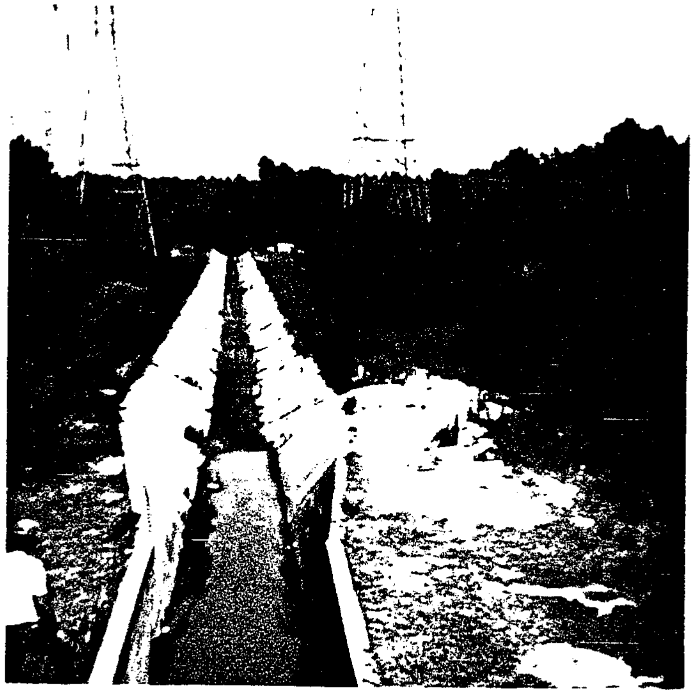


Photo No. 6

Paved Ditch leading from Station
Drainage Outfall to Black Creek.

Photo No. 7

Drainage Ditch Downstream of Left
Dam. Note vegetation along banks.

Photo No. 8

Artesian Well on State Highway
1623 Downstream of Dam.

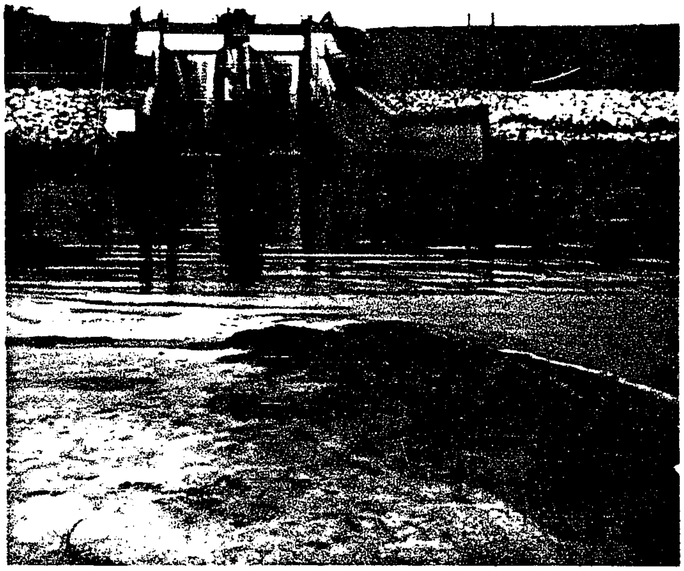


Photo No. 9

View of Spillway from Downstream.

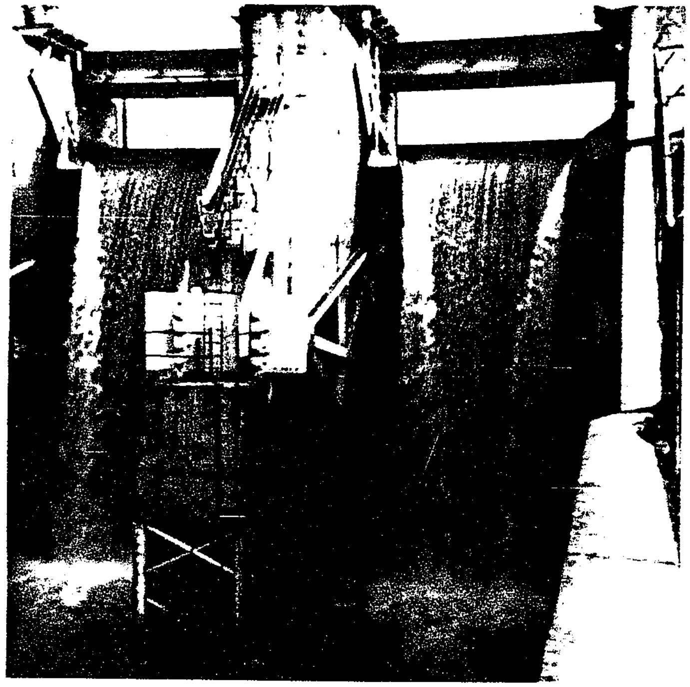


Photo No. 10

Discharge Over Top of Gates.
Note Upper Howell Bunger
Valve Under Center Pier.

Photo No. 11

Offset of Retaining Wall Downstream
of No. 2 Gate.

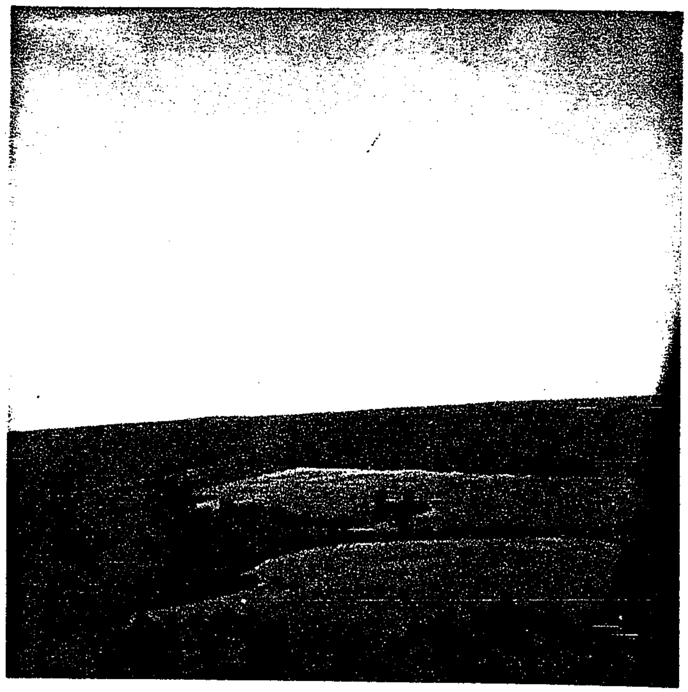


Photo No. 12

Upstream Drainage Basin.
Note Wheat Fields.

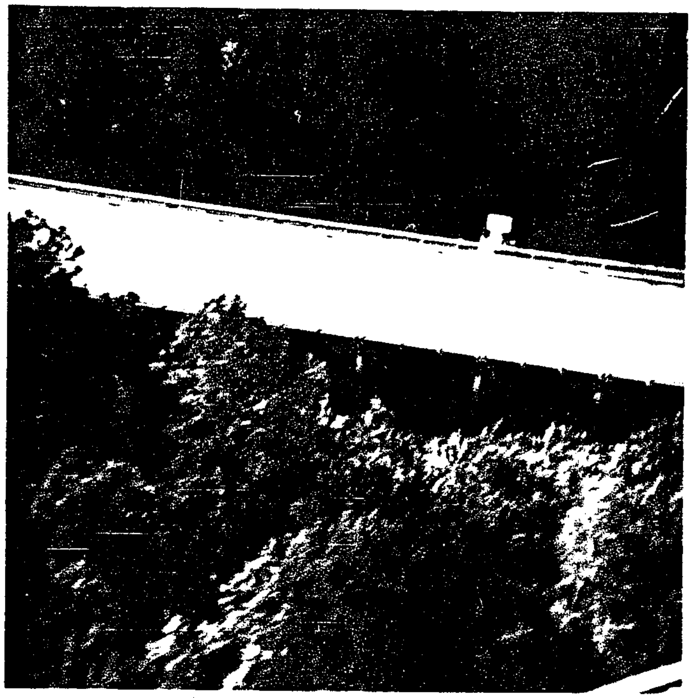


Photo No. 13

Highway Bridge Upstream of Reservoir.
Note River Gage Station.

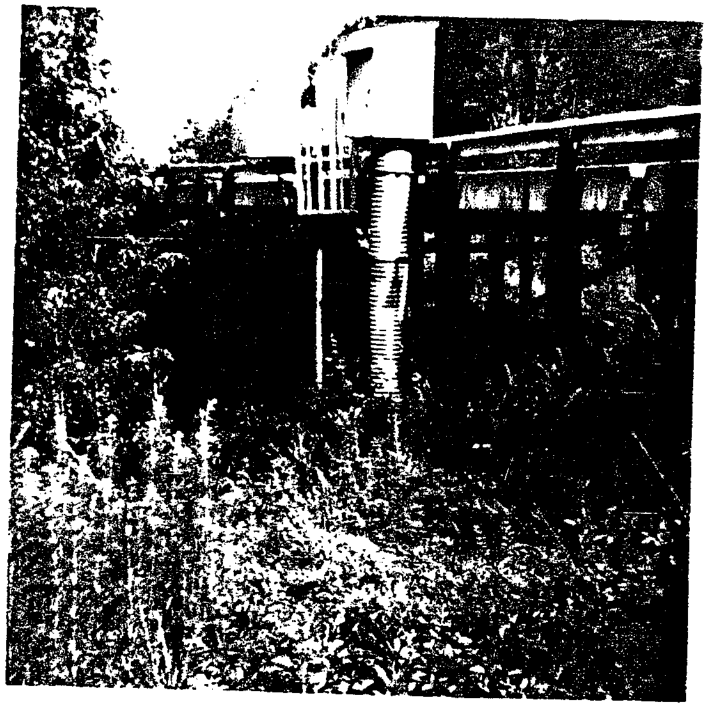


Photo No. 14

State Highway 1623 Bridge Down-
stream of Dam. Note Timber Piling,
River Level Gage and Water
Temperature Gage.

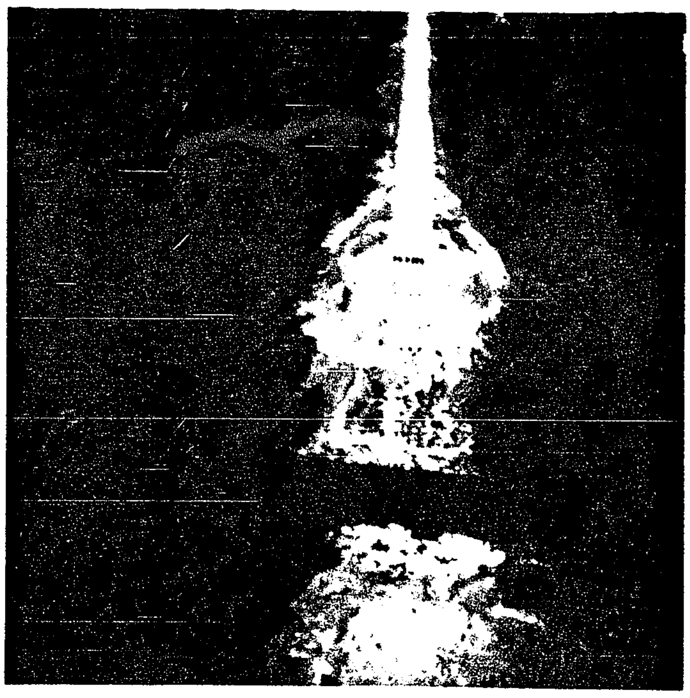


Photo No. 15

Abandoned Railroad Bridge Site
Downstream of Dam.

Photo No. 16

SUNOCO Dam and Reservoir
Downstream of Dam, Hartville,
So. Carolina.

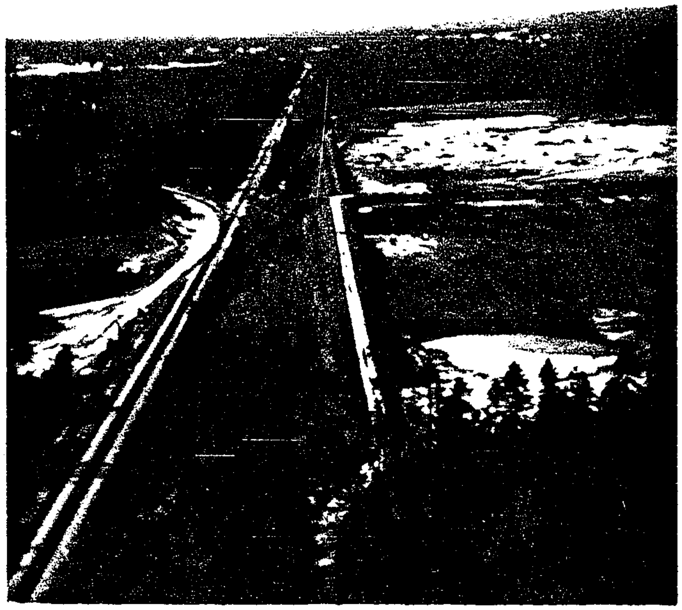


Photo No. 17

Ash Pond Dam looking South.
Note Baffle Dike.

Photo No. 18

Ash Pond Dam and Ash Pipe
Outfall.

Photo No. 19

Ash Pond Dam Drop Inlet
Spillway with Skimmer Device.

Photo No. 20

Ash Pond Dam Showing Downstream
Channel to Cooling Water
Discharge Canal.

Photo No. 21

Cooling Water Canal at Plant End.

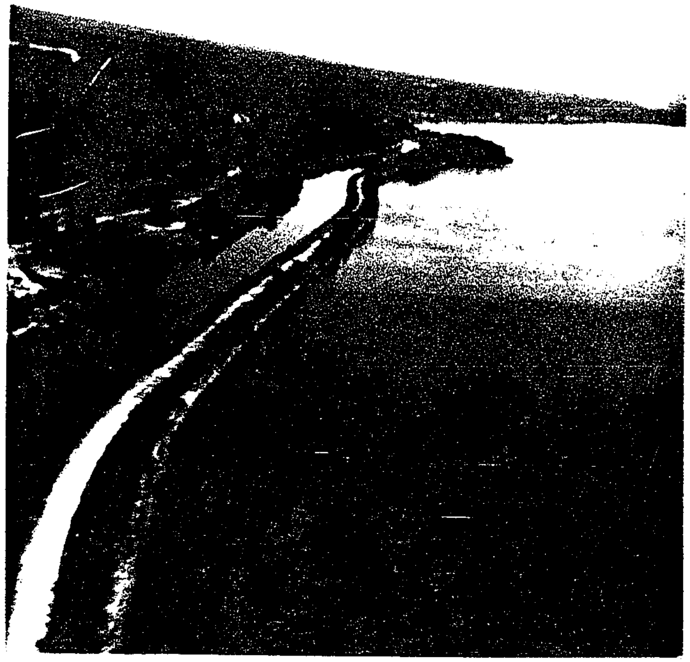


Photo No. 22

Cooling Water Canal Looking North from Plant End.

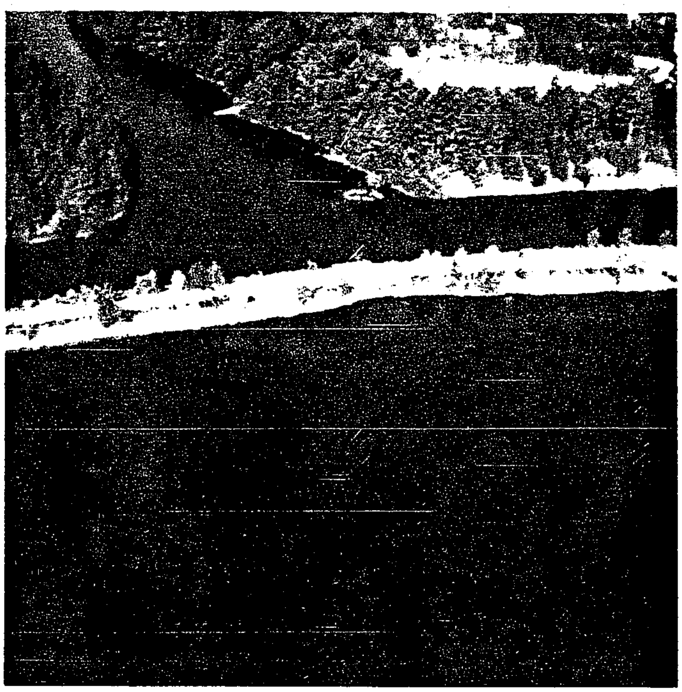
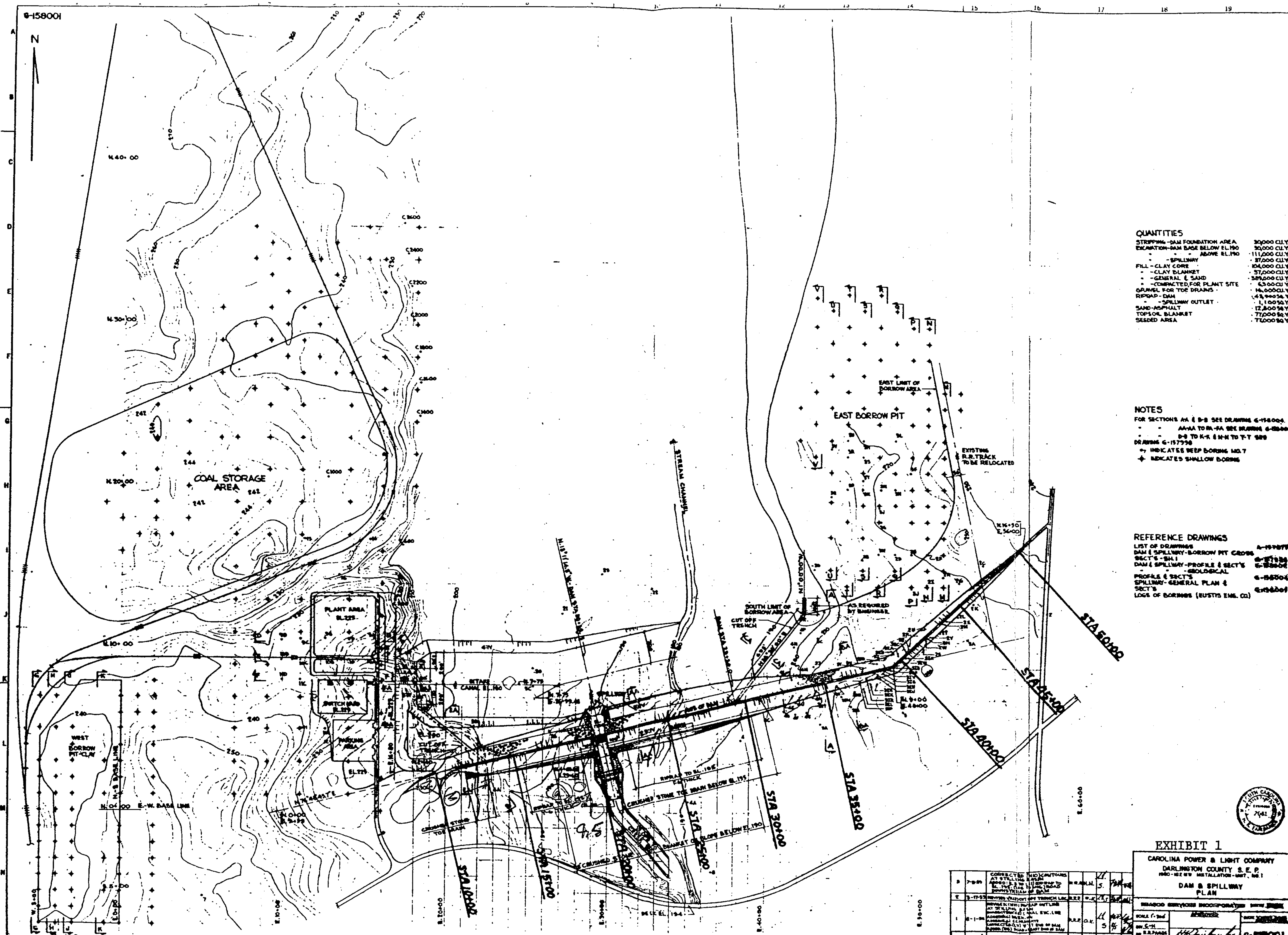


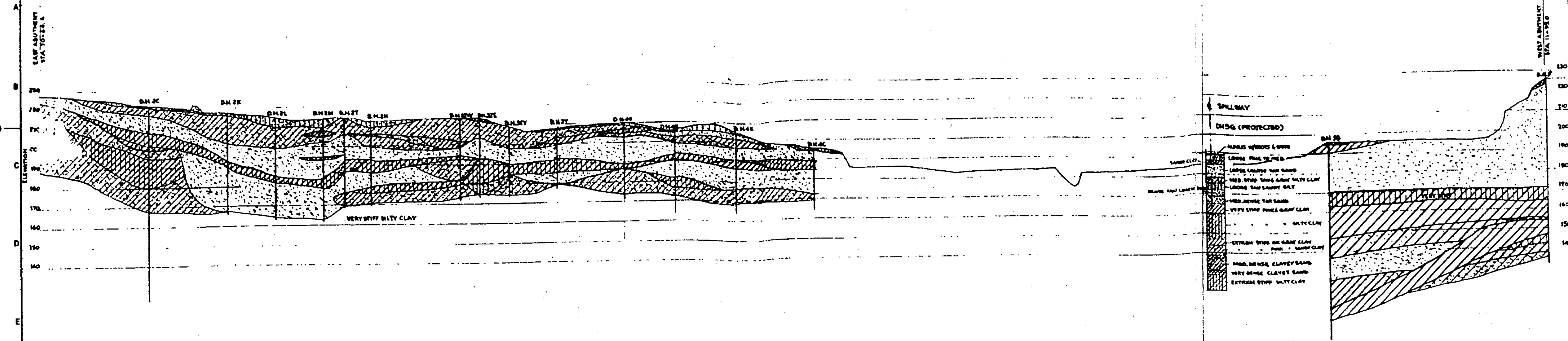
Photo No. 23
Cooling Water Canal at Ash Pond Dam. Note Sluice Structure in Dike (center of photo).

Photo No. 24
Cooling Water Canal Discharge Weir.

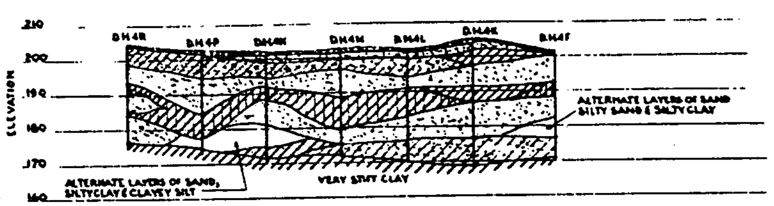
PROJECT PLATES


G-158001
N
COAL STORAGE AREA
PLANT AREA
SWITCH YARD
PARKING AREA
WEST BORROW PIT-CLAY
E.-W. BASE LINE
EAST BORROW PIT
EAST LIMIT OF BORROW AREA
SOUTH LIMIT OF BORROW AREA
EXISTING R.R. TRACK TO BE RELOCATED
STREAM CHANNEL
CUT OFF TRENCH
AS REQUIRED BY ENGINEER
INTAKE CANAL
CRUSHED STONE TOE DRAIN BELOW EL.195
RIPRAP TO EL.
BLANKET ON SLOPE BELOW EL.190
CRUSHED STONE
STA 10+00
STA 15+00
STA 20+00
STA 25+00
STA 30+00
STA 35+00
STA 40+00
STA 45+00
STA 50+00
N.40+00
N.30+00
N.20+00
N.10+00
E.20+00
E.30+00
E.40+00
E.50+00
E.60+00
QUANTITIES
STRIPPING -DAM FOUNDATION AREA 30,000 CU.YD.
EXCAVATION-DAM BASE BELOW EL.190 30,000 CU.YD.
" " " ABOVE EL.190 ·111,000 CU.YD.
" -SPILLWAY · 37,000 CU.YD.
FILL - CLAY CORE · 104,000 CU.YD.
" -CLAY BLANKET · 57,000 CU.YD.
" -GENERAL & SAND · 389,000 CU.YD.
" -COMPACTED,FOR PLANT SITE · 6,300 CU.YD.
GRAVEL FOR TOE DRAINS · · 16,000 CU.YD.
RIPRAP - DAM · 43,900 SQ.YD.
" -SPILLWAY OUTLET · · 1,100 SQ.YD.
SAND-ASPHALT · 12,800 SQ.YD.
TOPSOIL BLANKET · 77,000 SQ.YD.
SEEDED AREA · 77,000 SQ.YD.
NOTES
FOR SECTIONS A-A & B-B SEE DRAWING G-158004.
" " AA-AA TO FA-FA SEE DRAWING
" " B-B TO K-K & N-N TO T-T SEE
DRAWING G-157998
INDICATES DEEP BORING NO.7
INDICATES SHALLOW BORING
REFERENCE DRAWINGS
LIST OF DRAWINGS
DAM & SPILLWAY-BORROW PIT CROSS SECT'S-SH.1
DAM & SPILLWAY-PROFILE & SECT'S
" " -GEOLOGICAL PROFILE & SECT'S
SPILLWAY- GENERAL PLAN & SECT'S
LOGS OF BORINGS (EUSTIS ENG. CO.)
EXHIBIT 1
CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S.E.P.
DAM & SPILLWAY
PLAN
REVISED CUT OFF TRENCH LOC.
NO.
DATE
REVISION
BY
CK.
APPROVED

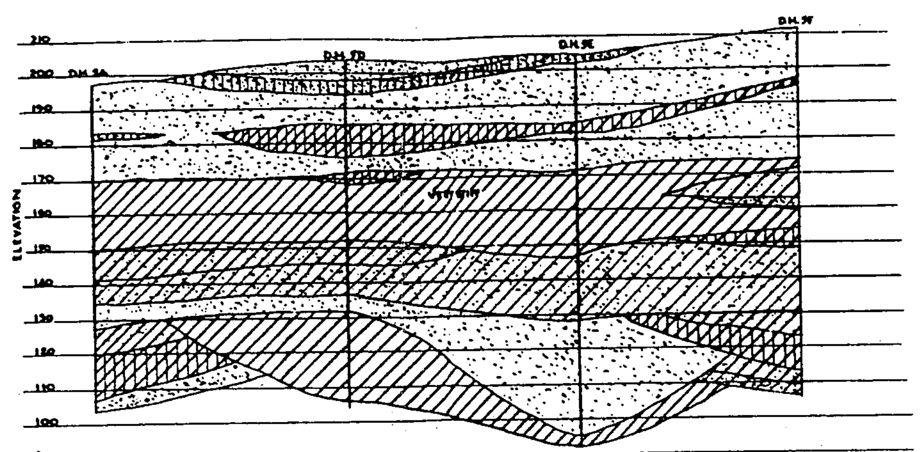
G-158004



PROFILE ALONG AXIS OF DAM (LOOKING DOWNSTREAM)



SECT. A-A (G-158001)



SECT. B-B (G-158001)

NOTES
FOR LOCATION OF DRILL HOLES & SECT SEE G-158001

LEGEND:
SAND, SILTY SAND, SANDY CLAY, SILT, CLAYEY SAND, CLAY, SILTY CLAY

REFERENCE DRAWINGS

LIST OF DRAWINGS	A-157875
EARTH DAM & SPILLWAY PLAN	G-158001
LOGS OF BORINGS - EUSTIS ENG. CO.	

SOUTH CAROLINA REGISTERED 2061 H. K. FAIRBANKS

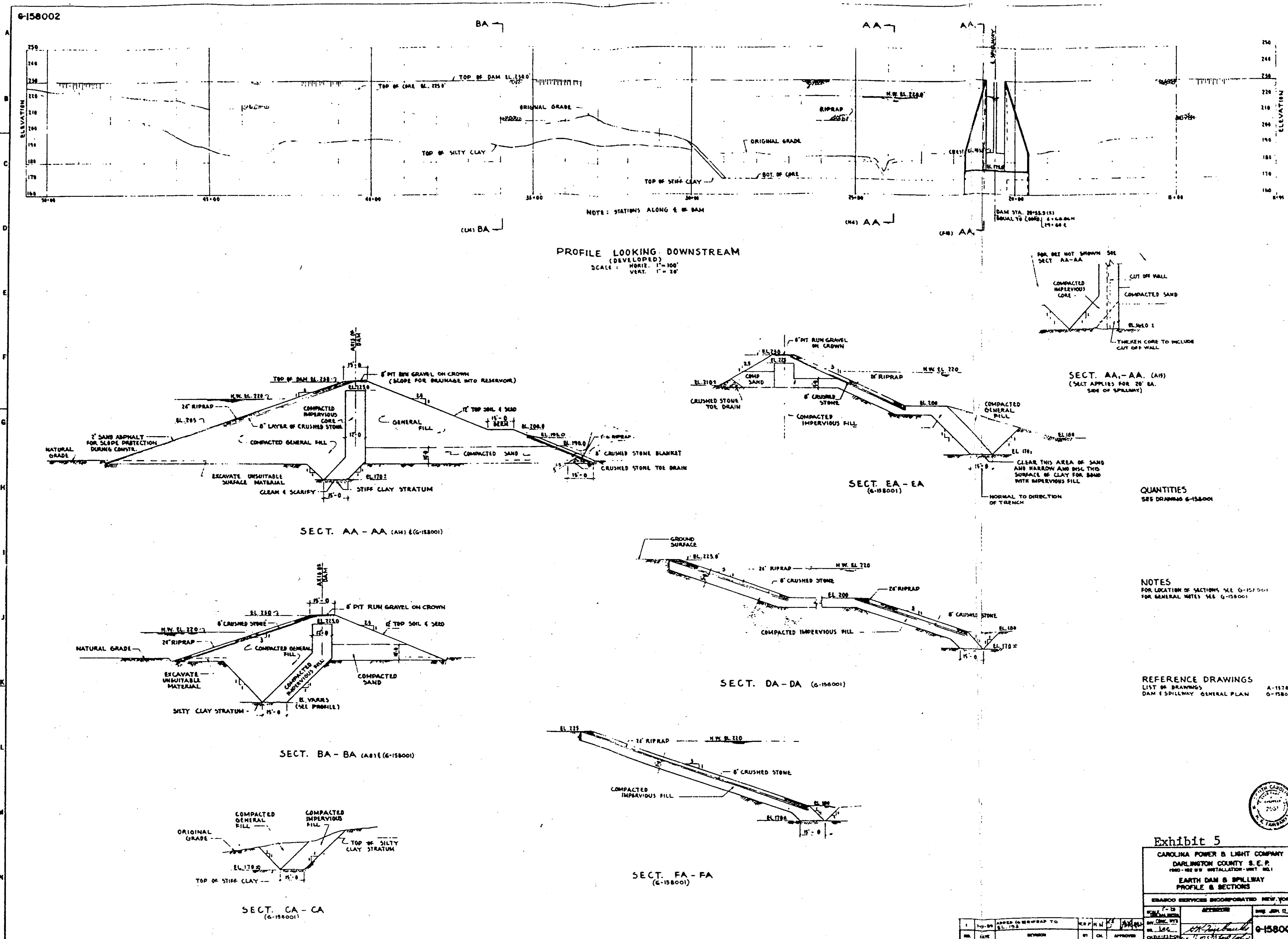
Exhibit 3

CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S.E.P.
1960 - 182 MW INSTALLATION - UNIT NO 1
DAM & SPILLWAY
GEOLOGIC PROFILE & SECTIONS

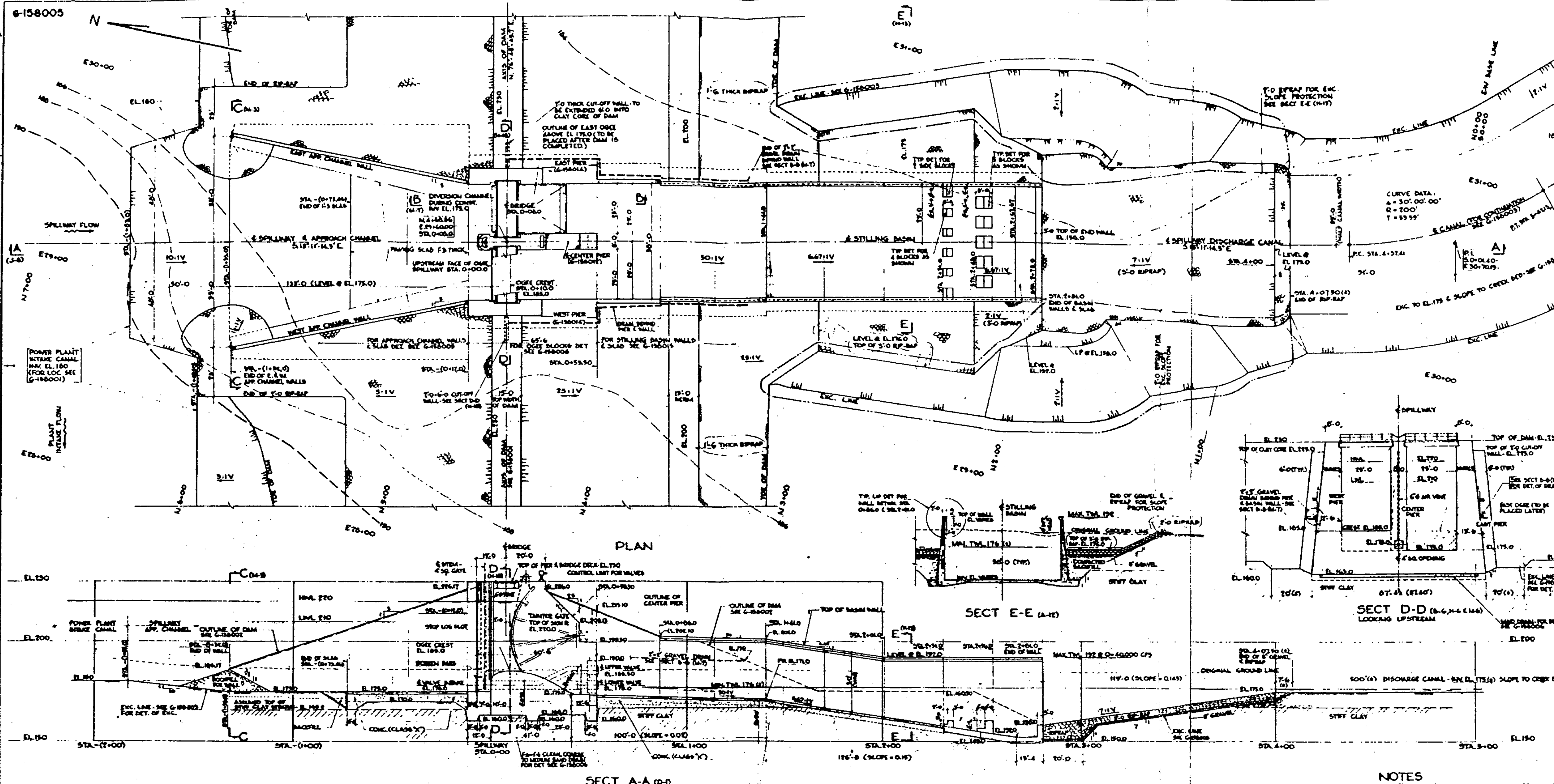
EBASCO SERVICES INCORPORATED NEW YORK

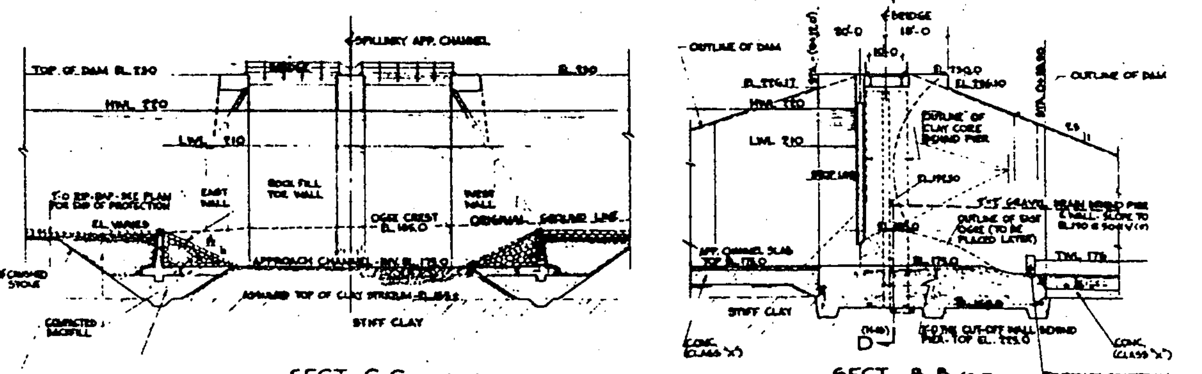
SCALE 1"=100'H 1"=10'V
DR. C-H
CH. SPITZ
DATE MAY 28 1959
H.K. Fairbanks
G-158004

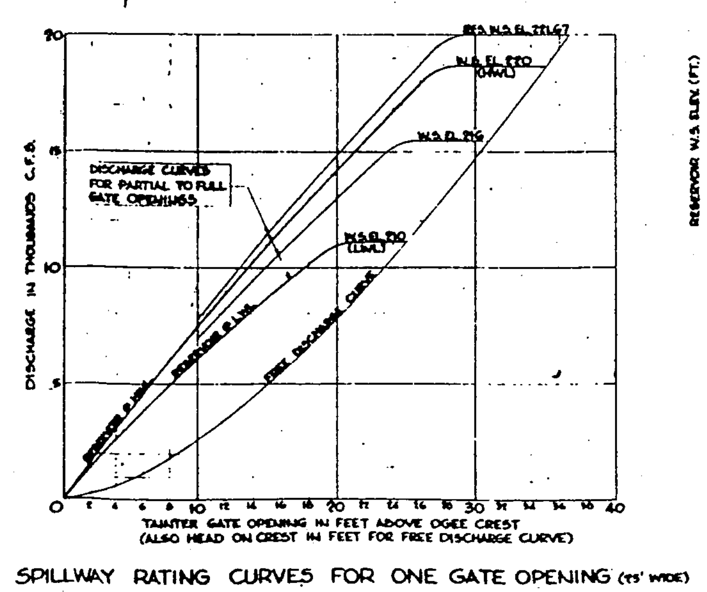
NO. DATE REVISION BY CH. APPROVED


G-158002
PROFILE LOOKING DOWNSTREAM
(DEVELOPED)
SCALE: HORIZ. 1"=100' VERT. 1"=20'
NOTE: STATIONS ALONG ℄ OF DAM
TOP OF DAM EL. 230.0'
TOP OF CORE EL. 225.0'
ORIGINAL GRADE
TOP OF SILTY CLAY
TOP OF STIFF CLAY
ORIGINAL GRADE
BOT. OF CORE
RIPRAP
N.W. EL. 220.0'
ELEVATION
SECT. AA - AA (A14) & (G-158001)
8" PIT RUN GRAVEL ON CROWN (SLOPE FOR DRAINAGE INTO RESERVOIR)
24" RIPRAP
2" SAND ASPHALT FOR SLOPE PROTECTION DURING CONSTR.
COMPACTED IMPERVIOUS CORE
8" LAYER OF CRUSHED STONE
GENERAL FILL
COMPACTED GENERAL FILL
COMPACTED SAND
12" TOP SOIL & SEED
8" CRUSHED STONE BLANKET
CRUSHED STONE TOE DRAIN
EXCAVATE UNSUITABLE SURFACE MATERIAL
CLEAN & SCARIFY
STIFF CLAY STRATUM
NATURAL GRADE
SECT. BA - BA (A8) & (G-158001)
8" PIT RUN GRAVEL ON CROWN
8" CRUSHED STONE
24" RIPRAP
12" TOP SOIL & SEED
COMPACTED GENERAL FILL
COMPACTED IMPERVIOUS FILL
COMPACTED SAND
EXCAVATE UNSUITABLE MATERIAL
SILTY CLAY STRATUM
EL. VARIES (SEE PROFILE)
SECT. CA - CA (G-158001)
COMPACTED GENERAL FILL
COMPACTED IMPERVIOUS FILL
ORIGINAL GRADE
TOP OF SILTY CLAY STRATUM
TOP OF STIFF CLAY
SECT. EA - EA (G-158001)
8" PIT RUN GRAVEL ON CROWN
COMP. SAND
8" RIPRAP
8" CRUSHED STONE
CRUSHED STONE TOE DRAIN
COMPACTED IMPERVIOUS FILL
COMPACTED GENERAL FILL
CLEAR THIS AREA OF SAND AND HARROW AND DISC THIS SURFACE OF CLAY FOR BOND WITH IMPERVIOUS FILL
NORMAL TO DIRECTION OF TRENCH
SECT. AA₁ - AA. (A15)
(SECT APPLIES FOR 20' EA. SIDE OF SPILLWAY)
CUT OFF WALL
COMPACTED IMPERVIOUS CORE
COMPACTED SAND
THICKEN CORE TO INCLUDE CUT OFF WALL
SECT. DA - DA (G-158001)
GROUND SURFACE
24" RIPRAP
8" CRUSHED STONE
COMPACTED IMPERVIOUS FILL
SECT. FA - FA (G-158001)
24" RIPRAP
8" CRUSHED STONE
COMPACTED IMPERVIOUS FILL
QUANTITIES
SEE DRAWING G-158001
NOTES
FOR LOCATION OF SECTIONS SEE G-157501
FOR GENERAL NOTES SEE G-158001
REFERENCE DRAWINGS
LIST OF DRAWINGS A-157875
DAM & SPILLWAY GENERAL PLAN G-158001
Exhibit 5
CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S.E.P.
EARTH DAM & SPILLWAY
PROFILE & SECTIONS
EBASCO SERVICES INCORPORATED NEW YORK
G-158002

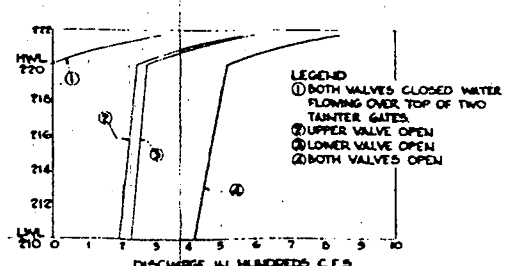
G-158005







SPILLWAY RATING CURVES FOR ONE GATE OPENING (35' WIDE)



OUTLET CAPACITY CURVES (WITH BOTH TAINTER GATES IN CLOSED POSITION)

NOTES

ALL STATIONS DESIGNATED HERE ARE SPILLWAY STATIONS MEASURED ALONG ℄ SPILLWAY.
FOR DET OF EXC. IN THE SPILLWAY AREA SEE G-156003
FOR ADDITIONAL NOTES SEE DET. DWGS.

REFERENCE DRAWINGS

LIST OF DRAWINGS	G-157875
DAM & SPILLWAY - PLAN	G-156001
DAM & SPILLWAY - PROFILE & SECT.	G-156002
DAM & SPILLWAY - EXC. PLAN	G-156003
SPILLWAY - OGEE BLOCKS - M&S	G-156006
SPILLWAY - APP. CHANNEL - SLAB & WALLS - M	G-156009
SPILLWAY - CENTER PIER - M & R	G-156012
SPILLWAY - END PIERS - M & R	G-156014
SPILLWAY - STILLING BASIN - SLAB & WALLS - M	G-156015

SPILLWAY OPERATING PROCEDURE

1. GATE NO. 1 (WEST GATE), OPERATED BY ELECTRIC MOTOR, WILL BE CONTROLLED FROM THE POWERHOUSE OR THE SPILLWAY DURING ITS INITIAL 4-FT. OPENING WHICH IS THE MAXIMUM PERMISSIBLE OPENING WHILE GATE NO. 2 (EAST GATE) IS IN THE CLOSED POSITION. GATE NO. 1 OPENINGS GREATER THAN 4-FT. WILL BE CONTROLLED FROM THE SPILLWAY ONLY. FOR ADDITIONAL DISCHARGES THE MAXIMUM DIFFERENTIAL GATE OPENING WILL BE 2-FT. SYMMETRICAL GATE OPERATION IS PREFERRED.
2. GATE NO. 2, OPERATED BY GASOLINE ENGINE, WILL BE CONTROLLED FROM THE SPILLWAY FOR ALL GATE OPENINGS. THE GASOLINE ENGINE WILL SUPPLY EMERGENCY POWER FOR OPERATING GATE NO. 1
3. OUTLET VALVES WILL BE CONTROLLED FROM THE POWERHOUSE OR THE SPILLWAY. THE VALVES WILL BE CLOSED WHEN TAILWATER EXCEEDS ELEVATION 186.0 AND POND RELEASES WILL THEN BE ACCOMPLISHED BY OPERATING THE GATES.
4. FOR OTHER INFORMATION SEE SPILLWAY OPERATING INSTRUCTIONS.

SOUTH CAROLINA REGISTERED ENGINEER 2061 H. C. FAIRBANKS

EXHIBIT 6

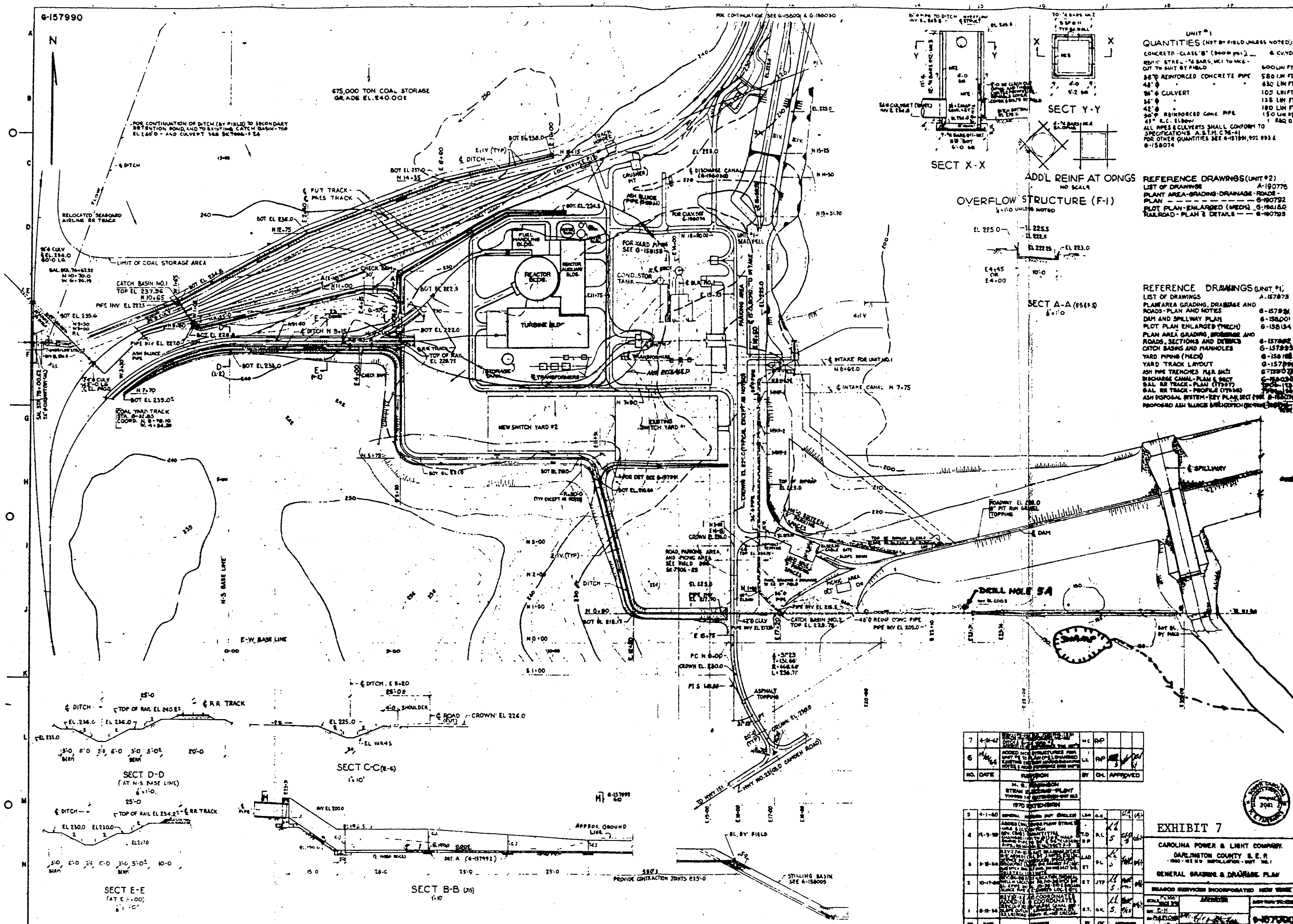
CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S. E. P.
1960 - 182 MW INSTALLATION - UNIT NO 1

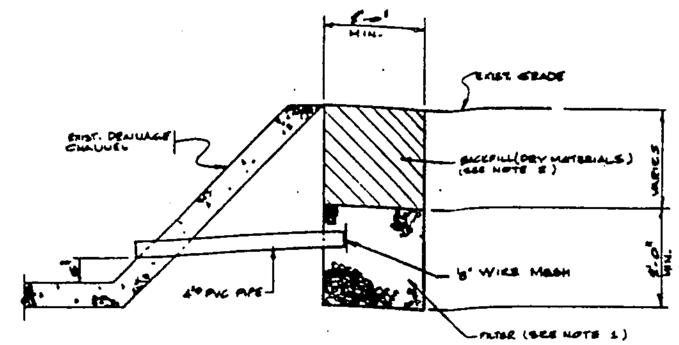
SPILLWAY
GENERAL PLAN & SECTIONS

EBASCO SERVICES INCORPORATED NEW YORK

NO.	DATE	REVISION	BY	CK.	APPROVED
2	7-10-59	ADDED: (B-9) & (E-9) RIPRAP TO EL. 195, REVISED: (F-11) & (B-14) RIPRAP AT STILLING BASIN	R.R.R.	H.H.	
1	9-16-59	ADDED: (N-5) NOTE, SPILLWAY OPERATING PROCEDURE	R.R.R.	O.K.	

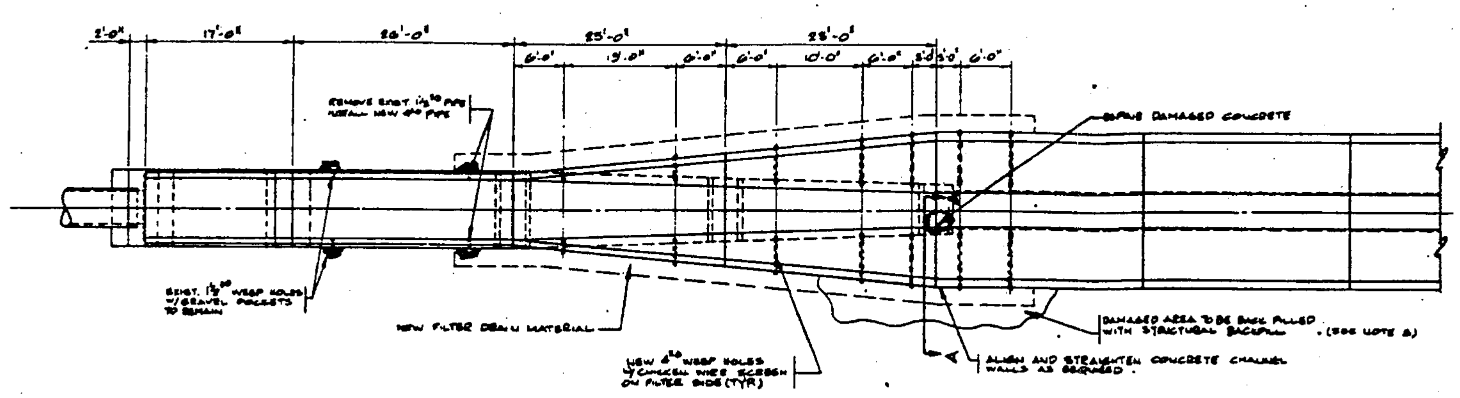
SCALE 1" = 20' | APPROVED | DATE JUL 14, 1960
DR. C-H
CH. FONG
G-158005


G-157990
N
675,000 TON COAL STORAGE
GRADE EL. 240.0±
RELOCATED SEABOARD AIRLINE RR TRACK
LIMIT OF COAL STORAGE AREA
CATCH BASIN NO.1
FUEL HANDLING BLDG.
REACTOR BLDG.
REACTOR AUXILIARY BLDG.
TURBINE BLDG
COND. STOR TANK
CRUSHER PIT
NEW SWITCH YARD #2
EXISTING SWITCH YARD #1
E-W BASE LINE
N-S BASE LINE
CATCH BASIN NO. 2
DRILL HOLE 5A
SWAMP
SPILLWAY
DAM
ASPHALT TOPPING
TO HWY 151
HWY NO. 23 (OLD CAMDEN ROAD)
SECT X-X
SECT Y-Y
ADD'L REINF AT OPNGS
OVERFLOW STRUCTURE (F-1)
SECT A-A
QUANTITIES
REFERENCE DRAWINGS (UNIT #2)
REFERENCE DRAWINGS (UNIT #1)
SECT D-D
SECT C-C
SECT E-E
SECT B-B
PROVIDE CONTRACTION JOINTS @ 25'-0
STILLING BASIN SEE G-158005
EXHIBIT 7
1970 EXTENSION
CAROLINA POWER & LIGHT COMPANY.
DARLINGTON COUNTY S. E. P.
GENERAL GRADING & DRAINAGE PLAN



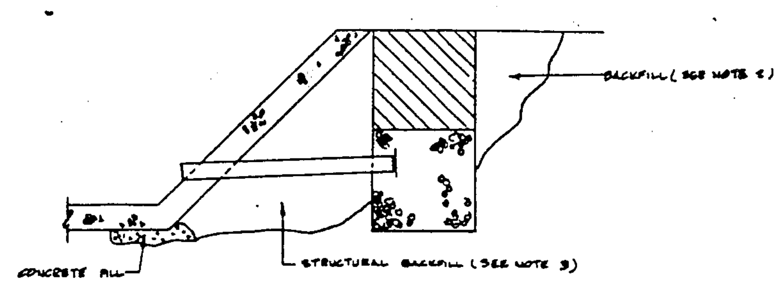
TYP. @ NEW 4"Ø WEEP HOLES

SCALE: ½"=1'-0"



PLAN - EXISTING DRAINAGE CHANNEL

SCALE: ⅛"=1'-0"



SECTION A-A

SCALE: ¾"=1'-0"

QUANTITIES (Est by Field)

30 cu. yds.	-	filter materials
100 lin. ft.	-	4" Ø PVC pipe
30 cu. yds.	-	structural backfill

NOTES

1. The filter material shall meet the following gradation requirements:

% Passing	Sieve
100	3/4"
100 - 90	1/2"
100 - 75	3/8"
60 - 30	#4
10 - 0	#16
0	#200

2. Local backfill material shall consist of available soils and be dry and free from large wood, sticks, or other undesirable organic material.

3. The material for the structural backfill shall consist mainly of selected fine sand and silt. Any particle larger than 2" shall be removed.

The structural backfill shall be placed in 8" loose layers and shall be compacted to 90 percent of maximum dry density as determined by ASTM-D-1557 (Modified Proctor) with the moisture content no more than 2 percentage points above or below optimum moisture content.

REFERENCE DRAWINGS

EBASCO DRAWINGS NO. G-197992
NO. G-197990

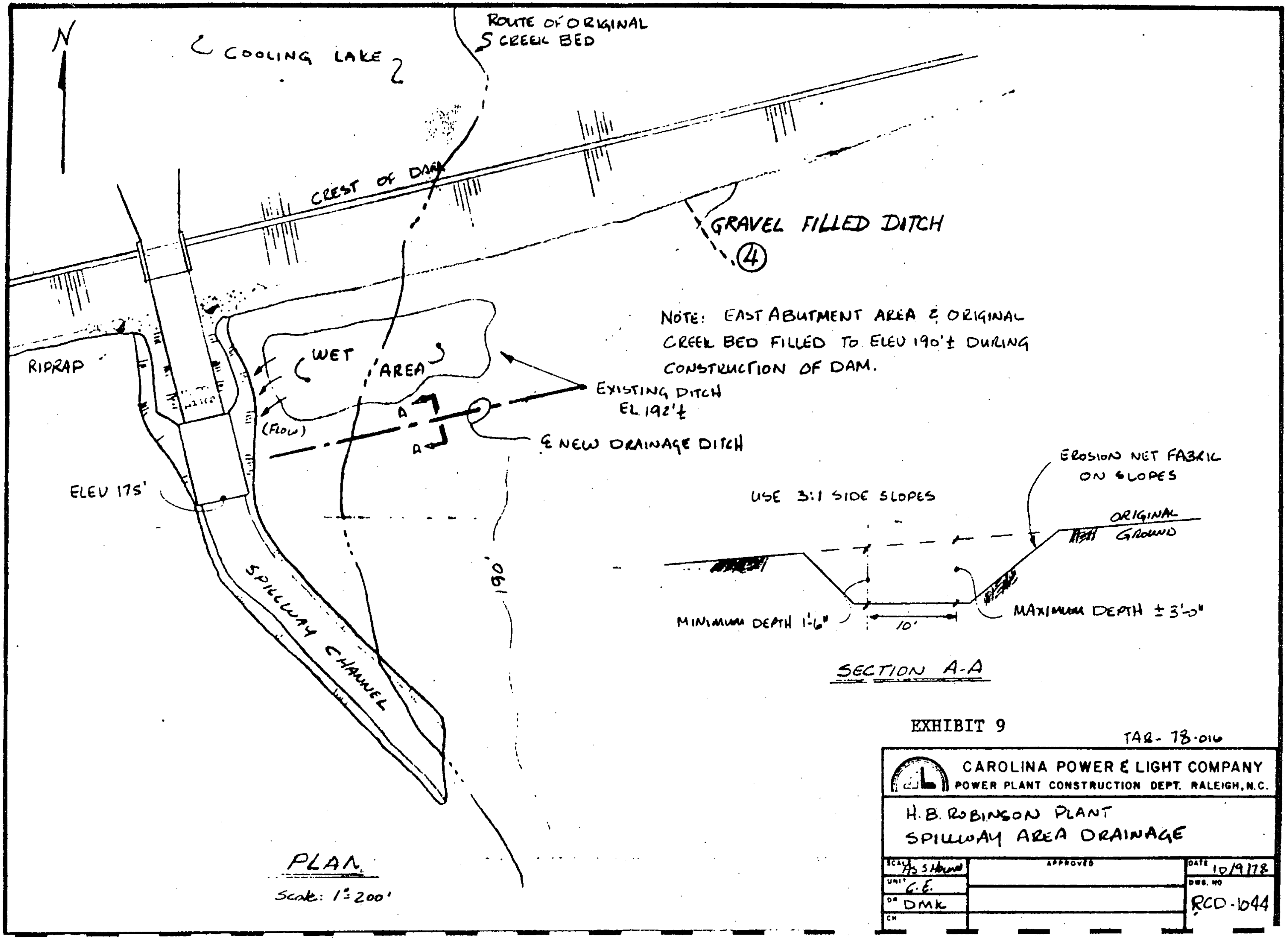
EXHIBIT 8

CAROLINA POWER & LIGHT COMPANY
POWER PLANT CONSTRUCTION DEPT. RALEIGH, N.C.

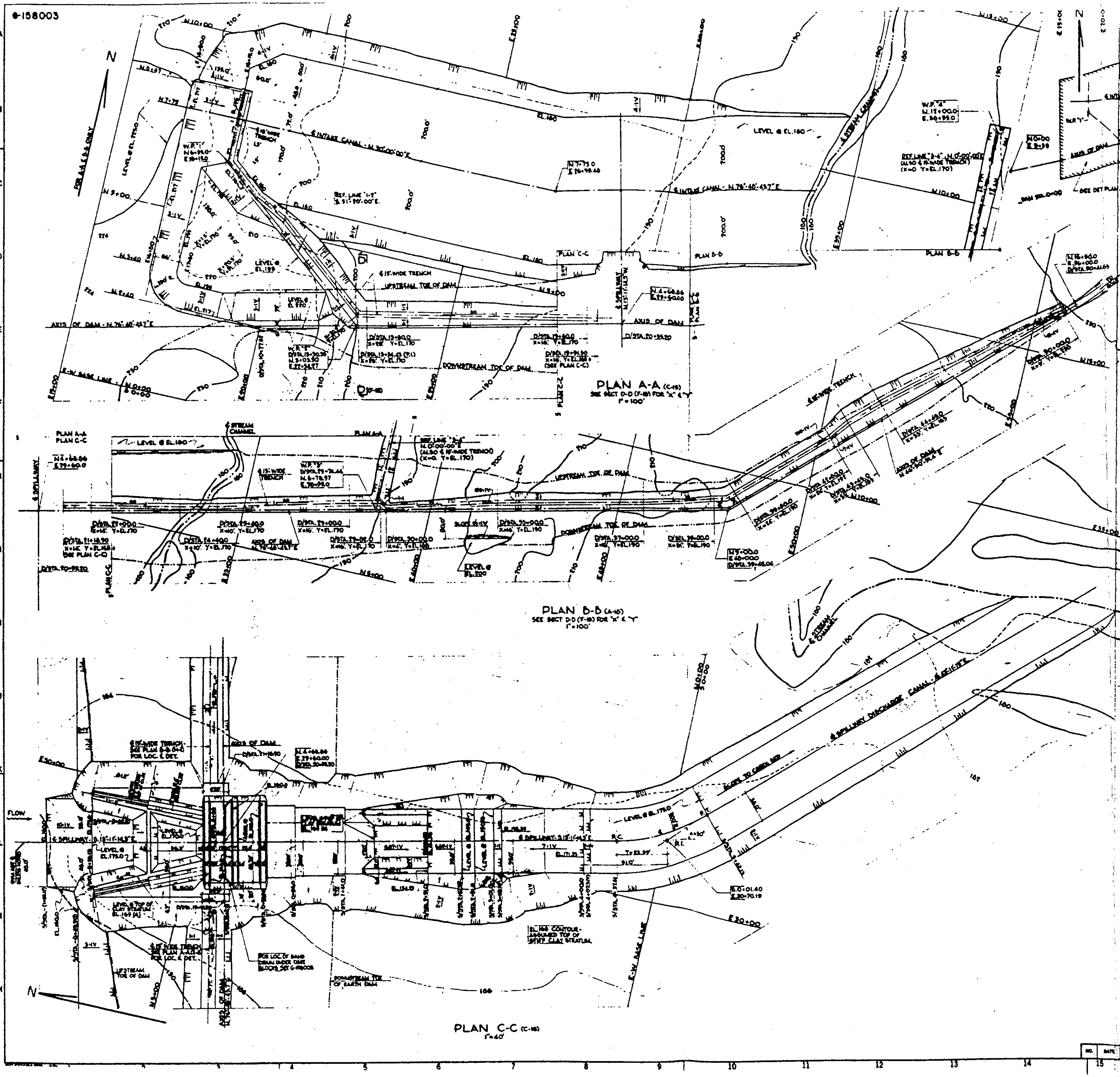
H.B. ROBINSON STEAM ELECTRIC PLANT
STORM DRAINAGE CHANNEL REPAIRS

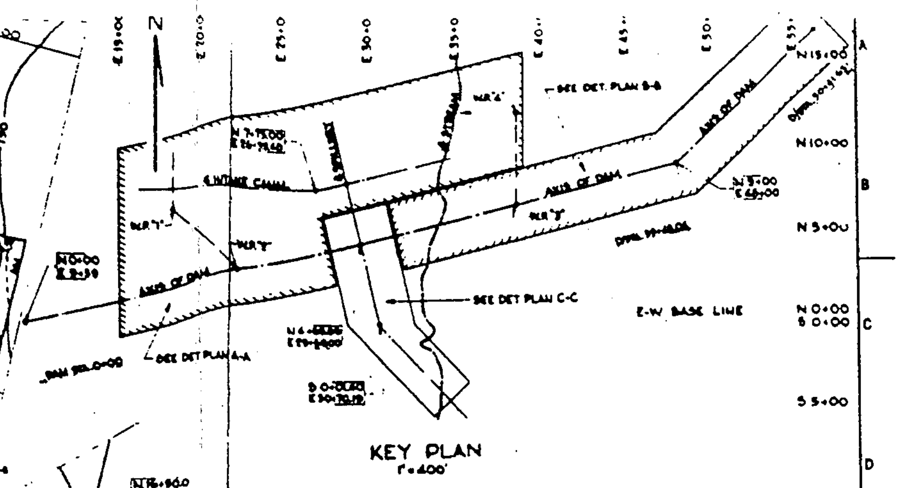
SCALE AS NOTED	APPROVED L. B. Wilson 8/13/79	DATE 8/13/79
UNIT C. E.		DWG. NO.
DR. RDH		RCD-996
CK. DMK		

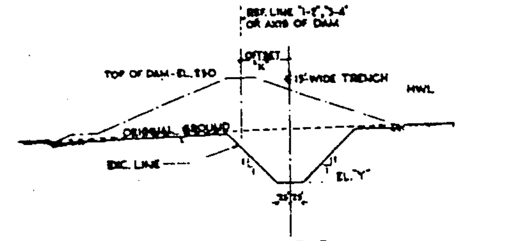
NO.	DATE	REVISION	BY	CK	APPROVED


N
COOLING LAKE
ROUTE OF ORIGINAL CREEK BED
CREST OF DAM
GRAVEL FILLED DITCH
4
RIPRAP
WET AREA
(FLOW)
NOTE: EAST ABUTMENT AREA & ORIGINAL CREEK BED FILLED TO ELEV 190'± DURING CONSTRUCTION OF DAM.
EXISTING DITCH EL 192'±
℄ NEW DRAINAGE DITCH
A
A
ELEV 175'
190'
SPILLWAY CHANNEL
PLAN
Scale: 1"=200'
USE 3:1 SIDE SLOPES
EROSION NET FABRIC ON SLOPES
ORIGINAL GROUND
MINIMUM DEPTH 1'-6"
10'
MAXIMUM DEPTH ±3'-0"
SECTION A-A
EXHIBIT 9
TAR-78-016
CAROLINA POWER & LIGHT COMPANY
POWER PLANT CONSTRUCTION DEPT. RALEIGH, N.C.
H.B. ROBINSON PLANT
SPILLWAY AREA DRAINAGE
SCALE As Shown
UNIT C.E.
DR DMK
CH
APPROVED
DATE 10/9/78
DWG. NO RCD-1044

G-158003







QUANTITIES

FOR EXC. QTY SEE G-158001.

NOTES

FOR GENERAL DET OF EARTH DAM & GROUND CONTOURS SEE G-158001 & G-158002.
FOR GENERAL DET OF SPILLWAY SEE G-158005.
FOR ADDITIONAL SECT'S SHOWING EXC. DET. IN SPILLWAY AREA SEE G-158006, G-158009 & G-158015.
D/STA = DAM STATION MEASURED ALONG AXIS OF DAM.
S/STA = SPILLWAY STATION MEASURED ALONG ℄ SPILLWAY.
AREAS SHOWN THUS [ ] INDICATE EXC. RESULTING IN UNCOVERING OF STIFF CLAY OR SILTY CLAY STRATUM.
SEAL COAT OF CONC. TO BE PLACED OVER CLAY IMMEDIATELY AFTER CLAY IS UNCOVERED.
EXC. SLOPE, IF UNSPECIFIED, SHALL BE DETERMINED BY FIELD.
FIELD TO ENSURE THAT COMPACTED IMPERVIOUS CORE (SEE G-158002) AT ALL POINTS RESTS SECURELY ON STIFF CLAY STRATUM @ EL. 170± (EL. 165± IN SPILLWAY AREA) WEST OF D/STA. 29+02, & EAST OF D/STA. 29+02 ON SILTY CLAY STRATUM @ EL. AS GIVEN ON THIS DWG & G-158002.

REFERENCE DRAWINGS

LIST OF DRAWINGS	A-157073
FDN INVESTIGATION - SH. NO. 1	G-157908
FDN INVESTIGATION - SH. NO. 2	G-157909
DAM & SPILLWAY - PLAN	G-158001
DAM & SPILLWAY - PROFILES & SECTIONS	G-158002
DAM & SPILLWAY - GEOL. PROFILE & SECT'S	G-158004
SPILLWAY - GEN. PLAN & SECT'S	G-158005
SPILLWAY - OGEE BLOCKS - MAS	G-158006
SPILLWAY - APP. CHANNEL - SLAB & WALLS - M.	G-158009
SPILLWAY - STILLING BASIN - SLAB & WALLS - M.	G-158015

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER 2061 H. C. FAIRBANKS

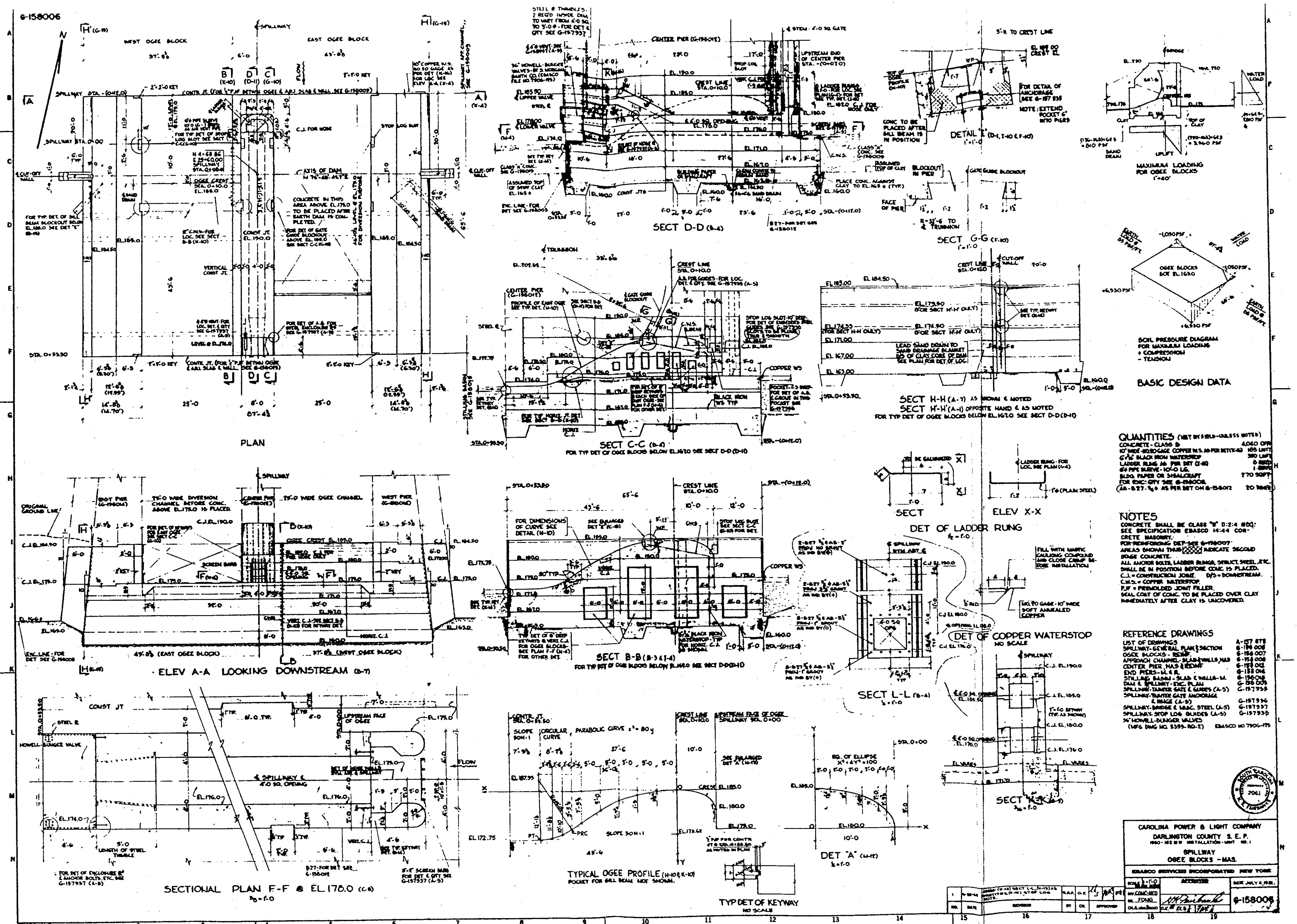
NO.	DATE	REVISION	BY	CH.	APPROVED

CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S. E. P.
1960 - 162 MW INSTALLATION - UNIT NO. 1

DAM & SPILLWAY
EXCAVATION PLAN

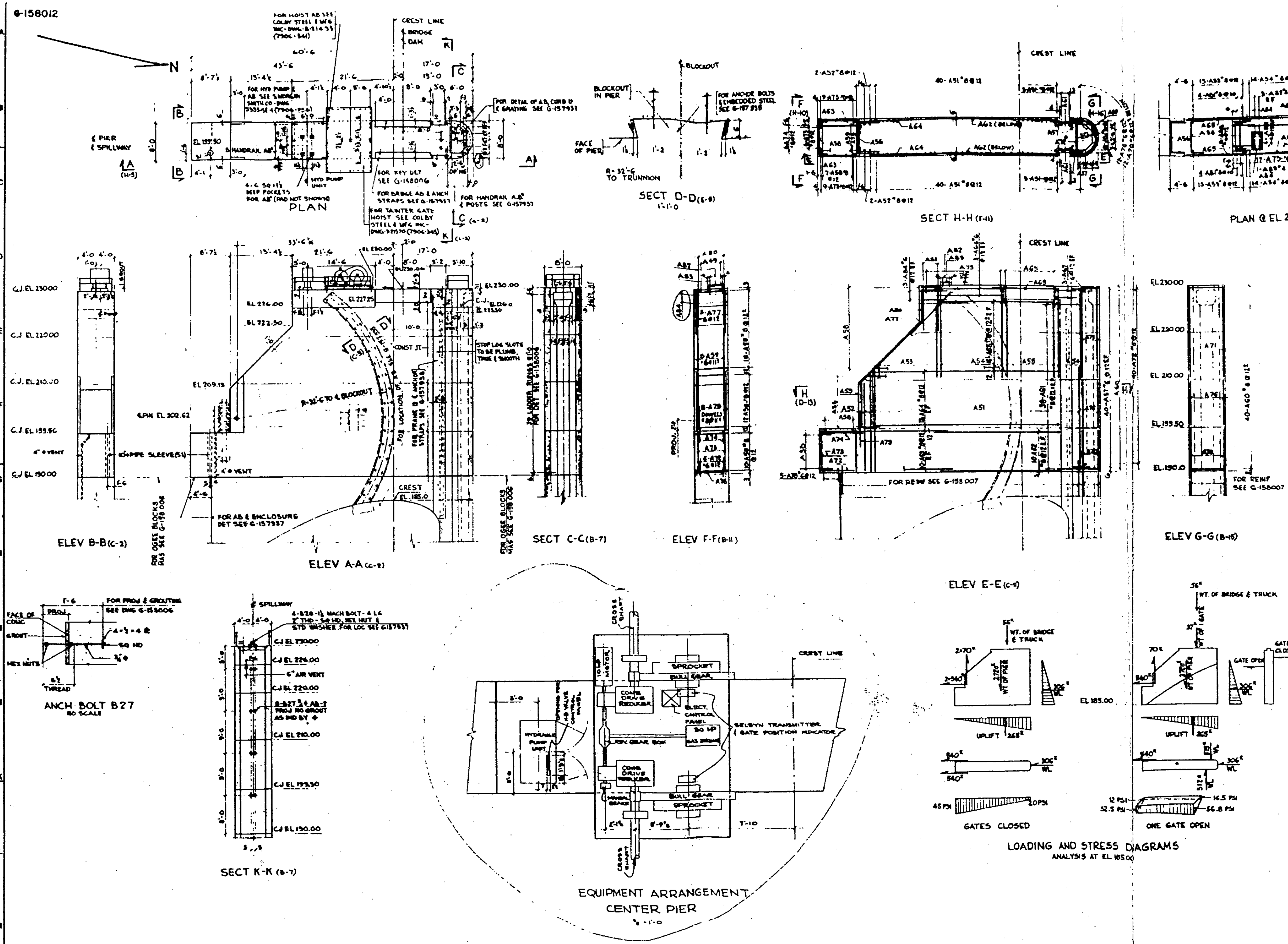
EBASCO SERVICES INCORPORATED NEW YORK

SCALE AS NOTED | APPROVED | DATE AUG 15, 1958
DR. C.H.
CH. FONG
G-158003



G-158006
PLAN
ELEV A-A LOOKING DOWNSTREAM
SECTIONAL PLAN F-F @ EL.178.0
SECT D-D
DETAIL "E"
SECT G-G
MAXIMUM LOADING FOR OGEE BLOCKS
SECT C-C
SECT H-H
SECT H-H' (A-1) OPPOSITE HAND & AS NOTED
SOIL PRESSURE DIAGRAM FOR MAXIMUM LOADING
+ COMPRESSION
- TENSION
BASIC DESIGN DATA
SECT B-B
DET OF LADDER RUNG
ELEV X-X
SECT L-L
DET OF COPPER WATERSTOP
NO SCALE
SECT K-K
TYPICAL OGEE PROFILE
DET "A"
TYP DET OF KEYWAY
QUANTITIES (NET IN FIELD-UNLESS NOTED)
CONCRETE - CLASS B 4040 CY
NOTES
CONCRETE SHALL BE CLASS "B" 1:2:4 MOQ: SEE SPECIFICATION EBASCO 14:44 CONCRETE MASONRY.
AREAS SHOWN THUS INDICATE SECOND STAGE CONCRETE.
ALL ANCHOR BOLTS, LADDER RUNGS, STRUCT. STEEL, ETC. SHALL BE IN POSITION BEFORE CONC. IS PLACED.
C.J. = CONSTRUCTION JOINT. D/S = DOWNSTREAM.
C.W.S. = COPPER WATERSTOP.
P.J.F. = PREMOLDED JOINT FILLER.
SEAL COAT OF CONC. TO BE PLACED OVER CLAY IMMEDIATELY AFTER CLAY IS UNCOVERED.
REFERENCE DRAWINGS
LIST OF DRAWINGS
SPILLWAY-GENERAL PLAN & SECTION
OGEE BLOCKS - REINF.
CENTER PIER MAS & REINF
END PIERS-M. & R.
DAM & SPILLWAY-EXC. PLAN
SPILLWAY-TAINTER GATE & GUIDES (A-5) G-157935
SPILLWAY-TAINTER GATE ANCHORAGE & HINGE (A-5) G-157936
SPILLWAY-BRIDGE & MISC. STEEL (A-5) G-157937
SPILLWAY-STOP LOG GUIDES (A-5)
36" HOWELL-BUNGER VALVES
2061
CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S. E. P.
SPILLWAY
OGEE BLOCKS - MAS.
EBASCO SERVICES INCORPORATED NEW YORK
G-158006

G-158012



QUANTITIES (NET BY FIELD - UNLESS NOTED)

CONCRETE (CLASS B)	620 CU.YD
LADDER RUNGS AS PER DET. ON G-158006	39 REQ'D
6" VENT PIPE (SCHED. #40)	40 LIN. FT.
6" 90° ELBOW (SCHED. #40)	1 REQ'D
10" Φ PIPE SLEEVE - 9'-6 LG (S1)	1 REQ'D
AB-B27 - ¾ Φ AS PER DET (J-1)	8 REQ'D
B28 - AS PER SECT K-K (J-5)	4 REQ'D
FOR REINF SEE BAR BENDING SCH B-157367-2	

NOTES

CONCRETE SHALL BE CLASS "B" (1:2:4 MIX). SEE SPECIFICATION EBASCO 14:44 CONCRETE MASONRY.

PLACING DIMENSIONS ARE GIVEN TO CENTER OF BARS UNLESS NOTED.

ALL BARS, WHEN SPLICED, SHALL LAP 24 DIAMETERS UNLESS NOTED.

REINFORCING BARS SHALL CONFORM TO THE CURRENT REQUIREMENTS OF THE STANDARD SPECIFICATIONS FOR BILLET STEEL, CONCRETE REINFORCING BARS, INTERMEDIATE GRADE, OPEN HEARTH STEEL (SERIAL DESIGNATION A15) OF THE A S T M. ALL BARS SHALL BE DEFORMED. NO REROLLED MATERIAL WILL BE ACCEPTED.

ALL BARS TO HAVE 2½" CONC. COVER UNLESS NOTED.

REFERENCE DRAWINGS

LIST OF DRAWINGS	A-157 875
SPILLWAY GENERAL PLAN & SECTIONS	G-158 005
OGEE BLOCKS - MAS	G-158006
OGEE BLOCKS - REINF	G-158007
TAINTER GATES & GUIDES	G-157 938
BRIDGE & MISCELLANEOUS STEEL	G-157 937
BAR BENDING SCHEDULE	B-157367-2
(DAM & SPILLWAY CND-GRDG & LIGHTING	G-158291

SOUTH CAROLINA REGISTERED ENGINEER 2061 K. K. FAIRBANKS

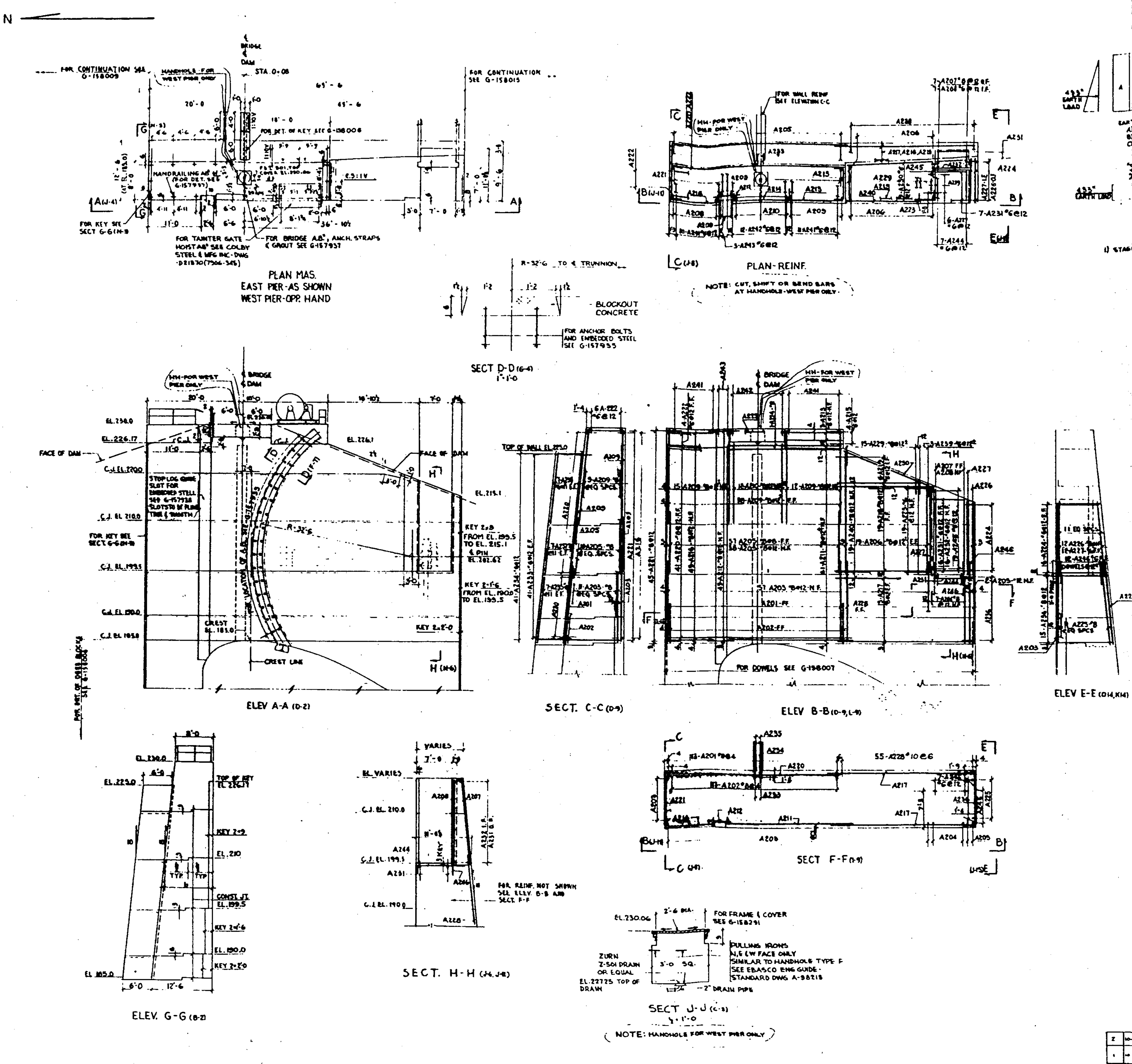
NO.	DATE	REVISION	BY	CK.	APPROVED	
4	1-6-59	ADDED (M-3) EQUIP. ARR. CTR. PIER	A.W.	O.K.		
3		CHANGED: (D-4), (D-13), (B-17) LOCATION OF HYD PUMP UNIT & REVISED SMITH END TOP OF PIER	R.R.P.	O.K.		
2		REMOVED: (B-4) ... ZURN DRAIN ... CHANGED: (D-4) AB SPACING	R.R.P.	O.K.		
1		ADDED (E-7) ... AREA ABOVE CONST JOINT EL 226.00 ... STOP LOG SLOTS ... 10" Φ PIPE SLEEVE, (J-1) AB DET ... SECT K-K ... 6" Φ VENT	R.R.P.	A.W. O.K.		

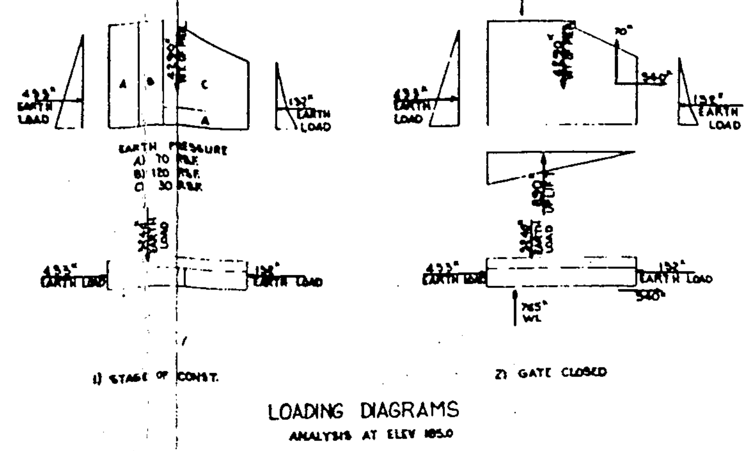
CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S. E. P.
1960 - 182 MW INSTALLATION - UNIT NO. 1
SPILLWAY
CENTER PIER-MAS & REINF.

EBASCO SERVICES INCORPORATED NEW YORK

SCALE ⅛" = 1'-0 UNLESS NOTED
DES CONC-HOOD
DR. K. THIEME
CK. E. LOC
APPROVED
DATE AUG. 1, 1958
G-158012

G-158014





QUANTITIES (FOR 2 PIERS)

CONCRETE (CLASS "B") ABOVE EL. 185.0 — 2120 CU YD
FOR REINF. STEEL SEE BAR BENDING SCHEDULE B-157908
FOR QUANTITIES OF HANDRAILING, POSTS & A.B. SEE G-157937
2-501 FL DRAIN WITH 2" I.P.S. OUTLET OR EQ — 1 REQD
2" PIPE — 5 LIN. FT

NOTES:

REINFORCING BARS SHA... CONFORM TO THE CURRENT REQUIREMENT... THE STANDARD SPECIFICATIONS FOR BILLET STEEL, CONCRETE REINFORCING BARS, INTERMEDIATE GRADE, OPEN HEARTH STEEL (SERIAL DESIGNATION A15) OF THE A.S.T.M. ALL BARS SHALL BE DEFORMED. NO REROLLED MATERIAL WILL BE ACCEPTED.
REINFORCING BARS SHALL HAVE A MIN. CONC. COVER OF 2½ UNLESS NOTED.
ALL BARS WHEN SPLICED SHALL LAP 24 DIAMETERS.
ALL EMBEDDED STEEL, ANCHOR BOLTS, ETC., SHALL BE IN POSITION BEFORE CONCRETE IS PLACED.
CONCRETE SHALL BE CLASS "B" (1:2:4 MIX) SEE SPECIFICATION EBASCO 14-44 CONCRETE, MASONRY.
PLACING DIMENSIONS ARE GIVEN TO CENTER OF BARS UNLESS NOTED.

REFERENCE DRAWINGS

LIST OF DRAWINGS	A-157878
SPILLWAY GENERAL PLAN & SECT'S	G-158006
OGEE BLOCKS - MASONRY	G-158009
OGEE BLOCKS - REINF.	G-158007
APPROACH CHANNEL - SLAB & WALLS - MAS.	G-158008
STILLING BASIN - SLAB & WALLS - MAS.	G-158012
SPILLWAY - TAINTER GATE & GUIDES	G-157955
SPILLWAY - BRIDGE & MISC. STEEL	G-157937
SPILLWAY STOP LOGS & GUIDES	G-157938
BAR BENDING SCHEDULE	B-157987-8
DAM & SPILLWAY CND. - GRDG & LIGHTING	G-158291

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER 2061 W. K. FAIRBANKS

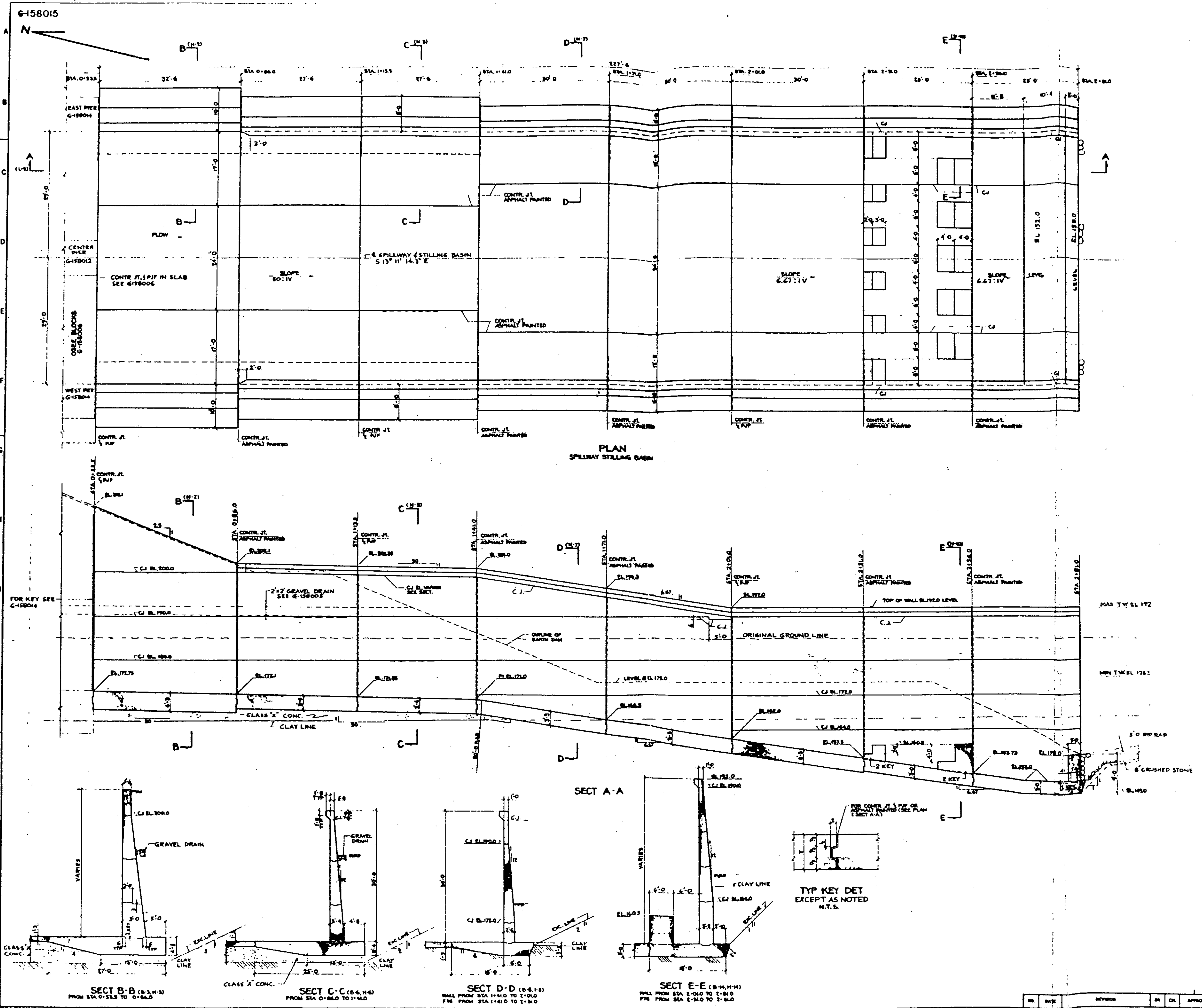
NO	DATE	REVISION	BY	CK	APPROVED
2	10-27-58	ELIMINATED (B-3), (H-10), (H-15) HANDHOLE IN EAST PIER	R.R.R.	O.K.	
1	10-15-58	RELEASED (F-2) AREA ABOVE CONST JT EL. 226.17 ADDED (B-3) STOP LOG NOTE	AW	O.K.	

CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY P. & E. P.
1960 - 102 MW INSTALLATION
SPILLWAY
END PIERS - MAS & REINF.

EBASCO SERVICES INCORPORATED NEW YORK

SCALE ⅛"-1'-0" — DATE Jul. 29 1958
DR. CONK
CK. E. Lee
G-158014

G-158015



QUANTITIES:

CONC. CLASS "B"	2815 CU.YD.
½ PJF	1050 SQ.FT.
CONC. CLASS "X"	450 CU.YD.

FOR EXCAVATION SEE G-158003

NOTES

CONCRETE SHALL BE CLASS "B" (1:2:4 MIX). SEE SPECIFICATION EBASCO 14:44 CONCRETE MASONRY.

CJ - CONSTRUCTION JOINT

CONTR. JT - CONTRACTION JOINT

PJF PREMOLDED JOINT FILLER

FOR REINFORCING SEE G-158016 & G-158017

SOIL BETWEEN TOP OF CLAY & BOTTOM OF WALL FOOTINGS TO BE REPLACED BY CLASS "X" CONC.

FOR EXC. SEE G-158003

REFERENCE DRAWINGS

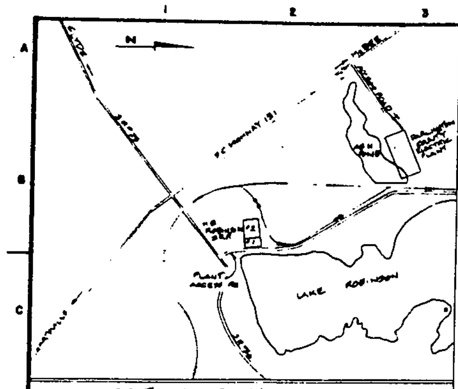
LIST OF DRAWINGS	A-157875
DAM & SPILLWAY EXCAVATION PLAN	G-158003
SPILLWAY - GENERAL PLAN & SECTIONS	G-158005
OGEE BLOCKS - MAS.	G-158006
STILLING BASIN SLAB - REINF	G-158016
" " WALL "	G-158017
END PIERS - MAS. & REINF.	G-158014

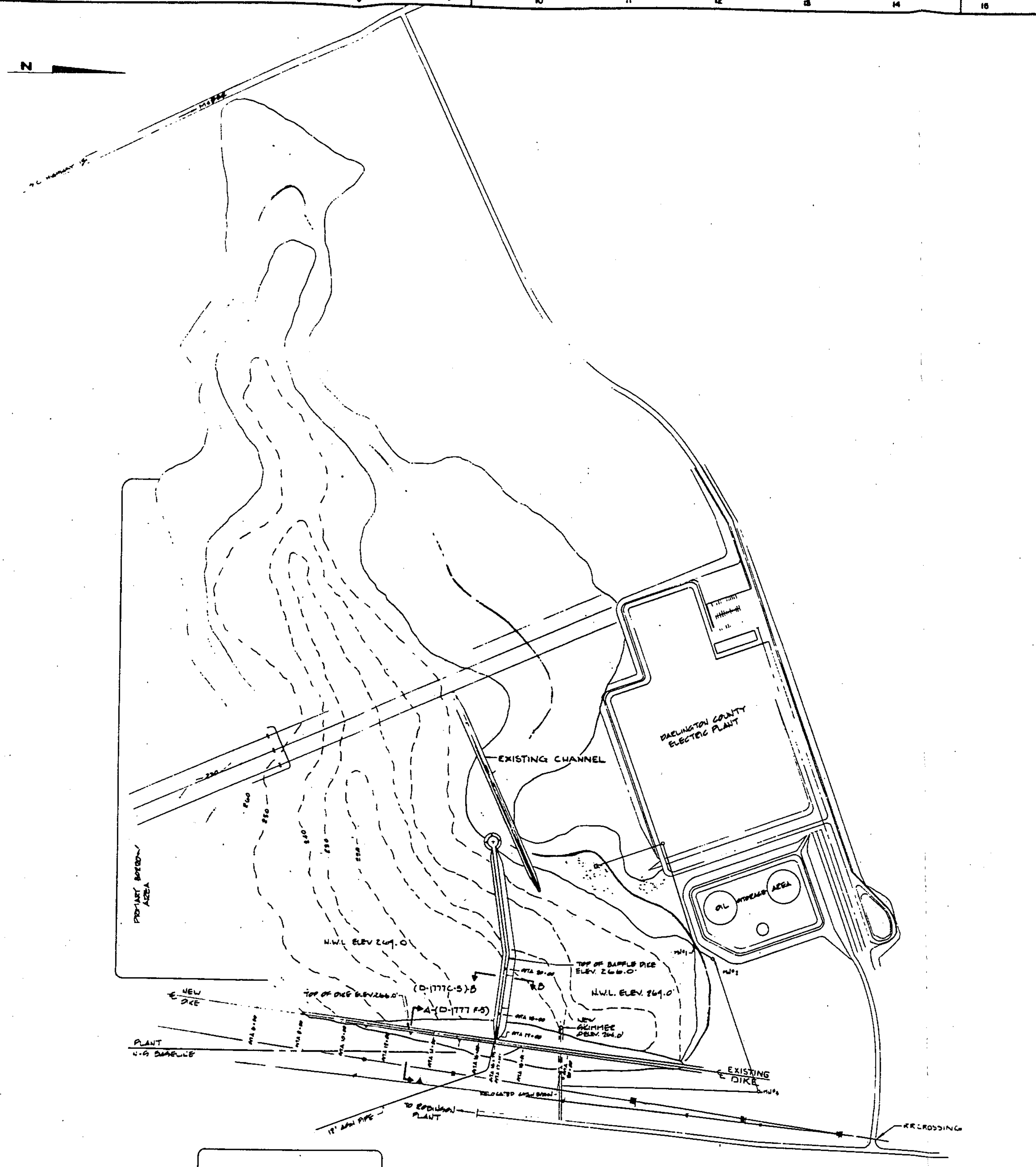
2061

CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S.E.P.
1960 - 162 MW INSTALLATION - UNIT NO 1
SPILLWAY
STILLING BASIN - SLAB & WALLS - MAS.

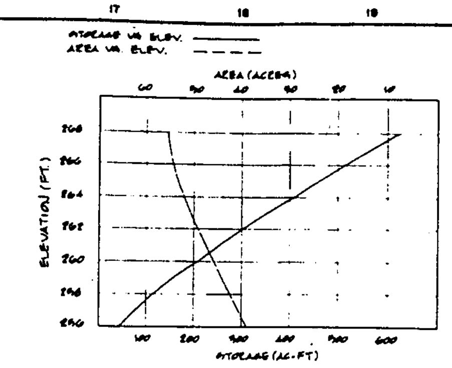
EBASCO SERVICES INCORPORATED NEW YORK.

SCALE ⅛" = 1'-0 | ACCEPTED | DATE JUL 22, 1958
DR. G.H.
CH. E. SPEED
G-158015





SITE PLAN
SCALE: 1":200'



AREA-CAPACITY CURVE

NOTES

1. VERTICAL DATUM BASED ON MEAN SEA LEVEL ELEVATIONS, MSL.
2. CONTOUR INTERVAL IS TEN (10) FEET. SURVEY INFORMATION BASED ON TOPOGRAPHIC MAP BY POWER ENGINEERING COMPANY, INC., 7-14-81.
3. BORROW SHALL BE ACCOMPLISHED IN AREAS SPECIFICALLY APPROVED BY THE OWNER.
4. NO CLEARING SHALL BE ACCOMPLISHED OUTSIDE THE LIMITS OF PROPOSED EMBANKMENT OR THE BORROW AREA WITHOUT THE OWNERS APPROVAL.
5. ALL AREAS DISTURBED BY CONSTRUCTION ACTIVITIES SHALL BE GRADED TO DRAIN AND SEEDED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATION, TO MEET THE OWNERS APPROVAL.
6. FOR CLEARING, EXCAVATION, AND EMBANKMENT CONSTRUCTION REQUIREMENTS SEE TECHNICAL SPECIFICATIONS.

LIST OF DRAWINGS

D-1776 SITE PLAN
D-1777 SECTIONS & DETAILS
D-1778 BORING PLAN
D-1779 DRAINAGE MODIFICATIONS - SHEET 1
D-1780 DRAINAGE MODIFICATIONS - SHEET 2

REFERENCE SPECIFICATIONS

FPE&CD 82-S-168 H.B. ROBINSON S.E.P. ASH POND EXPANSION

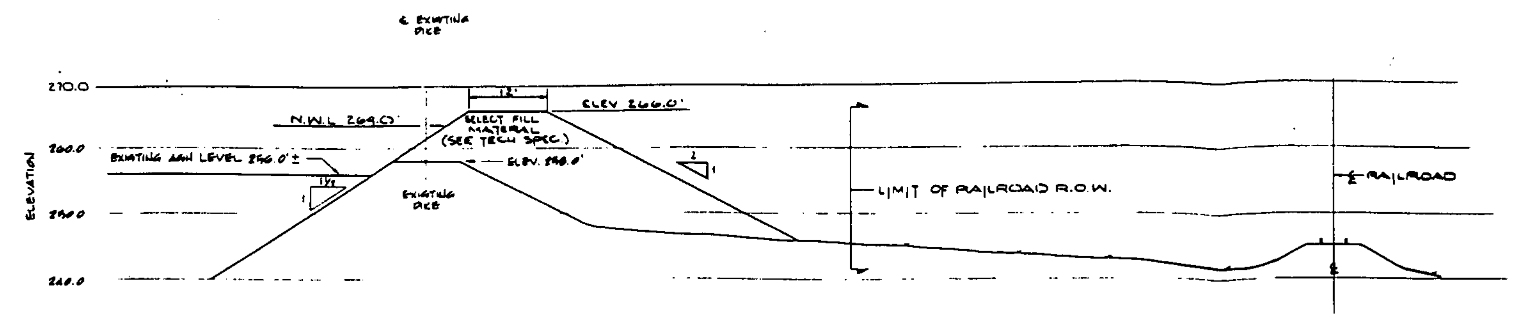
AS BUILT

NO.	DATE	REVISION	BY	CK	APPROVED
2	4-21-85	AS BUILT			
1	7-22-82	ADD REFERENCE DWG. (J-18)	AJA	BAF	
0	5-10-82	ISSUED FOR CONSTRUCTION	AJA		
A	3-9-82	ISSUED FOR COMMENTS	AJA		

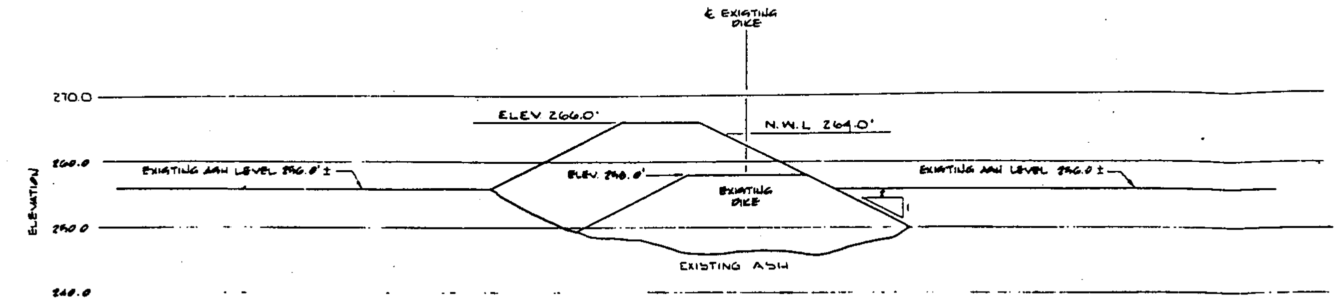
CAROLINA POWER & LIGHT COMPANY
FOSSIL PLANT ENGINEERING & CONSTRUCTION DEPT.

H. B. ROBINSON S.E.P.-ASH POND EXPANSION
SITE PLAN

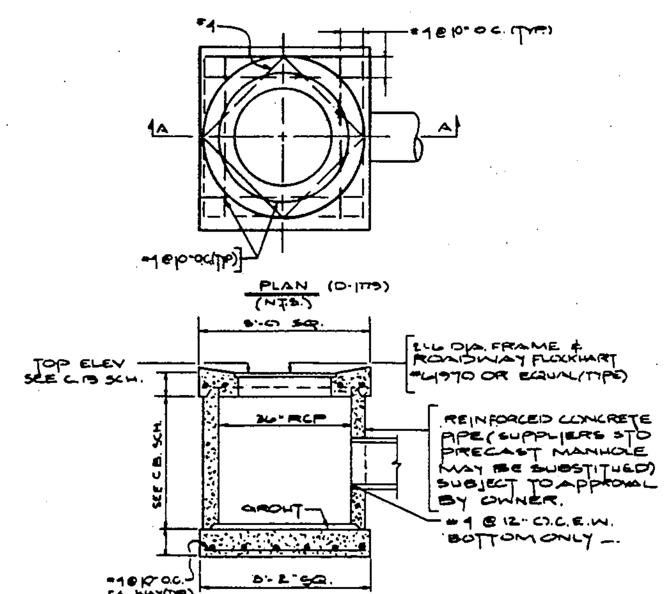
SCALE: SHOWN
UNIT/SECTION: CIVIL
DR.: AJA/JWL
APPROVED
DATE: 5-10-82
DWG. NO.: D-1776



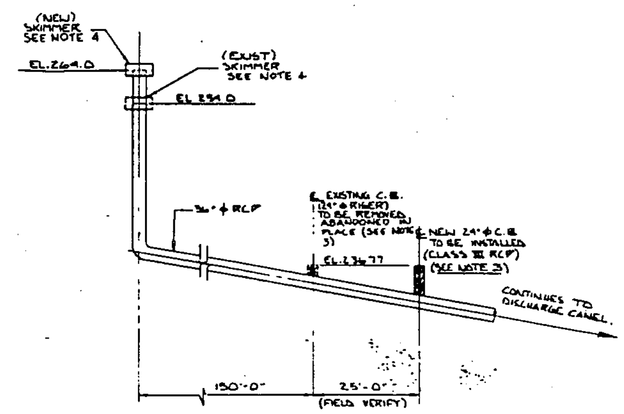
MAIN DIKE SECTION A-A (D-1776 L-5)
SCALE: 1" = 10'



BAFFLE DIKE SECTION B-B (D-1776 K-10)
SCALE: 1" = 10'



MANHOLE
(FOR LOCATION SEE D-1779)



DECANT PIPE OUTLET WORKS DETAIL
1" = 20'

QUANTITIES

SELECT FILL MATERIAL	60110 CU YD
STRIPPING	4,718 CU YD
24" ∅ RCP CLASS III PIPE	1970 LIN FT
36" ∅ RCP FOR SKIMMER	10 LIN FT.

NOTES

1. 36" ∅ REINFORCED CONCRETE PIPE TO BE USED FOR RAISING EXISTING SKIMMER SHALL BE CLASS II PER ASTM C-76.
2. RIP-RAP SHALL CONFORM TO THE REQUIREMENTS OF SOUTH CAROLINA STATE HIGHWAY DEPARTMENT STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION SECTION 804.03, AND BE PLACED IN ACCORDANCE WITH SECTION 804.10
3. REINSTALL GRATED TOP FROM OLD CATCH BASIN TO RELOCATED CATCH BASIN. ABANDONED CATCH BASIN SHALL BE FITTED WITH SOLID TOP AND LEFT IN PLACE. NEW CATCH BASIN SHALL BE INSTALLED BY CHIPPING INTO EXISTING 36" ∅ DECANT PIPE AND GROUTING 24" ∅ RISER IN PLACE.
4. 36" ∅ RISER BARREL SHALL BE EXTENDED BY REMOVING ANY PARTIAL JOINTS OF PIPE AND ADDING FOUR-FOOT LENGTHS OF NEW PIPE TO ELEVATION 264.0'. ONLY LAST SECTION OF PIPE MAY BE PARTIAL JOINT.

MANHOLE SCHEDULE *

M. H.	LOCATION	TOP OF GRATE	INVERT ELEVATION IN A	IN B	OUT
EXISTING CATCH BASIN	N 40+00 E 40+15	270.24	242.16	—	241.09
1	N 40+25 E 42+35	266.08	257.59	—	247.48
2	N 40+70 E 45+20	265.96	256.6	—	256.01
3	N 41+10 E 49+20	264.67	255.59	—	255.40
RELOCATED CATCH BASIN	FIELD LOCATE	238.77	12" ABOVE 36" ∅ RCP	—	—

* FOR MANHOLE LOCATIONS SEE D-1779

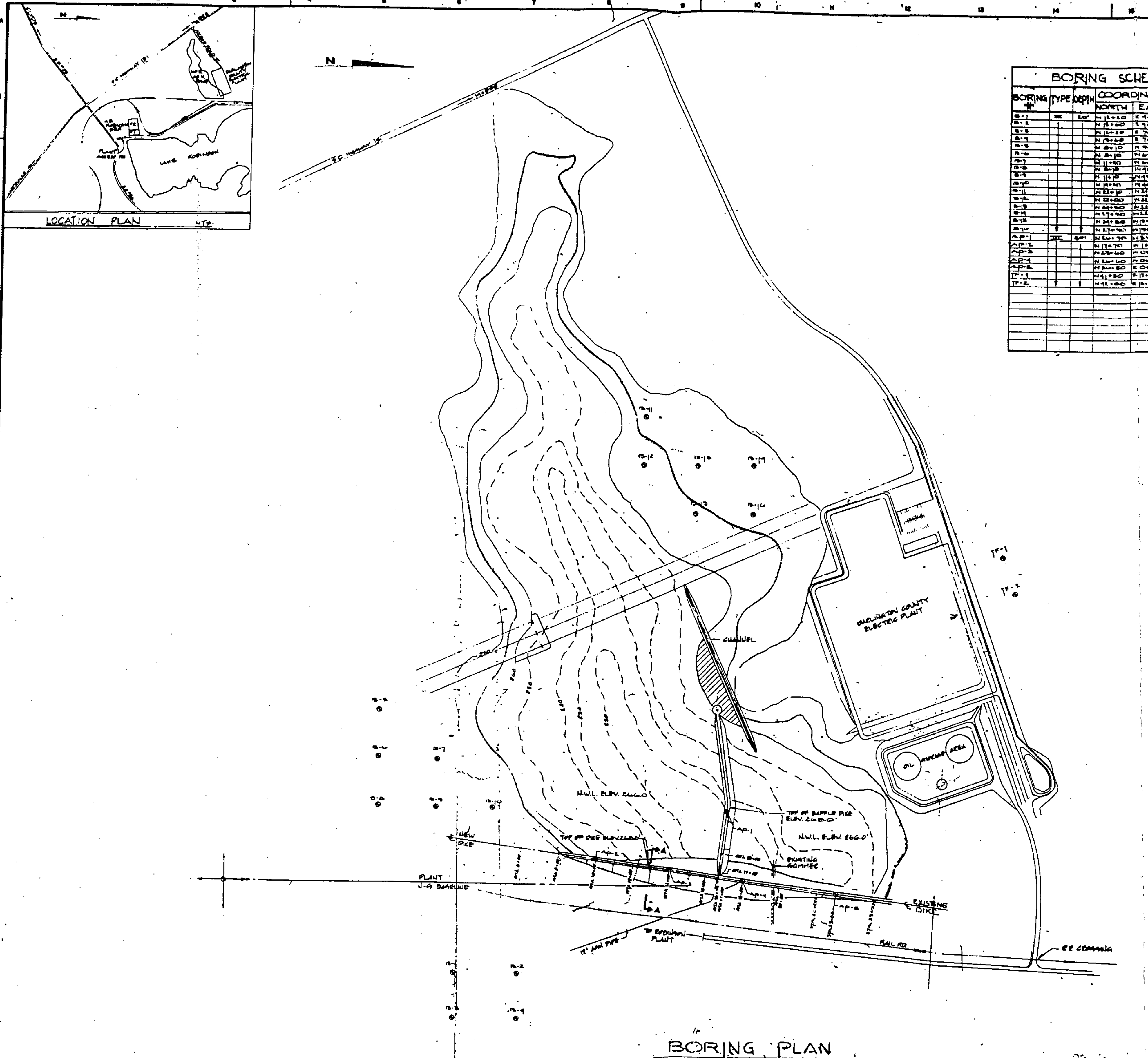
AS BUILT

NO.	DATE	REVISION	BY	CH	APPROVED
2	6/11/85	AS BUILT	JW		
1	6-4-82	ADDED DETAIL AT (K-10)	AJA		
0	5-16-82	ISSUED FOR CONSTRUCTION	AJA		
A	5-9-82	ISSUED FOR COMMENTS	AJA		

CAROLINA POWER & LIGHT COMPANY
FOSSIL PLANT ENGINEERING & CONSTRUCTION DEPT.

H.B. ROBINSON S.E.P. – ASH POND EXPANSION
DIKE SECTIONS & DETAILS

SCALE: SHOWN
UNIT/SECTION: CIVIL
DR.: AJA/JWL
CH.:
APPROVED:
DATE: 5-12-82
DWG. NO.: D-1777



BORING PLAN

1" = 200'

BORING #	TYPE	DEPTH	COORDINATES NORTH	COORDINATES E & W.	REMARKS
B-1	SS	60'	N 12+20	E 9+80	
B-2	↓	↓	N 13+60	E 9+70	
B-3			N 14+20	E 7+10	
B-4			N 19+60	E 7+20	
B-5			N 8+10	N 9+[illegible]	
B-6			N 8+10	W 6+60	
B-7			N 11+80	W 6+80	
B-8			N 8+15	W 4+10	
B-9			N 11+10	W 4+00	
B-10			N 18+20	W 4+60	
B-11			N 21+10	W 14+90	NOT DRILLED
B-12			N 22+00	W 22+20	NOT DRILLED
B-13			N 24+90	W 22+80	NOT DRILLED
B-14			N 27+90	W 22+20	NOT DRILLED
B-15			N 24+80	W 19+70	NOT DRILLED
B-16	↓	↓	N 27+90	W 17+60	NOT DRILLED
AP-1	III	60'	N 24+70	W 3+90	
AP-2	↓	↓	N 17+70	W 1+60	
AP-3			N 26+60	W 07+90	
AP-4			N 24+60	W 04+80	
AP-5			N 34+60	E 04+60	
TP-1			N 41+80	E 17+70	
TP-2	↓	↓	N 42+00	E 16+70	

NOTES

1. BORING LOCATION CO-ORDINATES ARE BASED ON ASSUMED PLANT CO-ORDINATE SYSTEM AND WILL BE STAKED IN FIELD BY OWNER.
2. ALL BORINGS SHALL BE MADE IN ACCORDANCE WITH CP&L SPECIFICATION NO. PPCD-75-5-005 SUBSURFACE INVESTIGATION DRILLING AND TESTING.
3. [illegible] -FOUR [illegible] LEVEL SHALL [illegible] BORING LOGS.

REFERENCE DWGS & SPECS

SEE DWG. 1776 SITE PLAN

AS BUILT

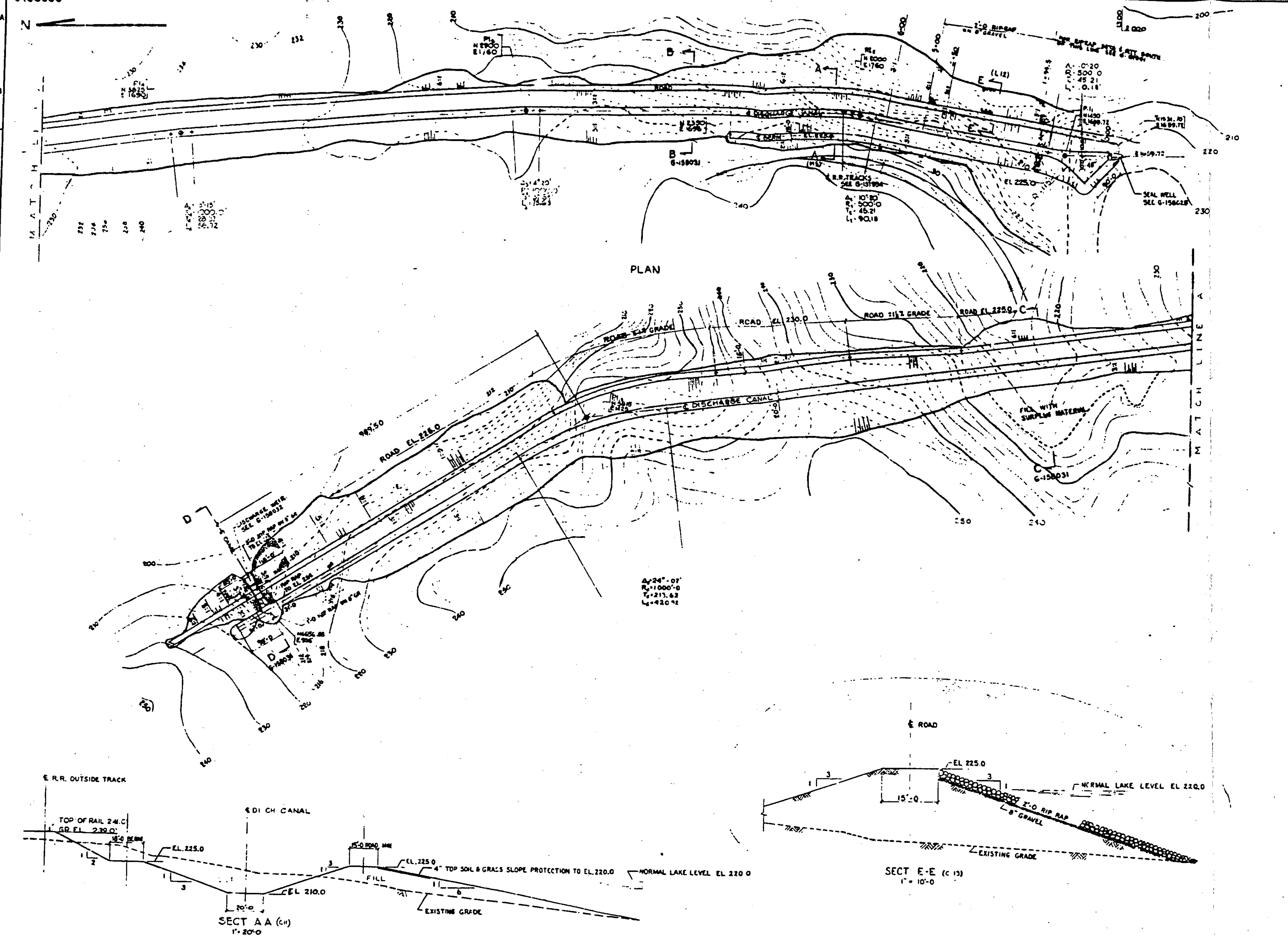
NO.	DATE	REVISION	BY	CK	APPROVED
1	6-11-82	AS BUILT			
0	3/3/82	FOR CONSTRUCTION			

CAROLINA POWER & LIGHT COMPANY
FOSSIL PLANT ENGINEERING & CONSTRUCTION DEPT.

H. B. ROBINSON S.E.P. - ASH POND EXPANSION
BORING PLAN

SCALE: AS NOTED
DATE: 3/3/82
DWG. NO. D-1778

G-158030



QUANTITIES (NET, BY FIELD EXCEPT AS NOTED)

EXCAVATION	282,500 C.Y.
FILL	73,600 C.Y.
2'-0 RIPRAP ON 8" GRAVEL	3,900 SQ YDS.
4" TOP SOIL & GRASS SLOPE PROTECTION	9,800 SQ YDS.
1'-0 RIP RAP ON 8" GRAVEL	170 SQ YDS.

NOTES:

EMBANKMENT

PREPARATION OF BASE:

ALL AREAS WHICH ARE TO BE FILLED SHALL BE STRIPPED OF VEGETATION, TOP SOIL, ORGANIC MATTER AND EXCESSIVELY WET OR SOFT MATERIALS. THE BASE AREA OF THE FILL SHALL BE ROUGHLY LEVELLED AND THOROUGHLY COMPACTED TO A DENSITY OF AT LEAST 95 % OF THAT OBTAINED IN THE MODIFIED AASHO COMPACTION TEST. AT THE TIME OF COMPACTION THIS MATERIAL SHALL BE AT OPTIMUM WATER CONTENT FOR COMPACTION AS DETERMINED BY THE ENGINEER.

PLACING COMPACTED FILL:

FILL SHALL BE PLACED ON THE PREPARED BASE IN HORIZONTAL LAYERS NOT EXCEEDING 8" IN THICKNESS PRIOR TO COMPACTION. ALL LUMPS SHALL BE THOROUGHLY PULVERIZED BY MEANS OF GANG PLOWS OR DISC HARROWS. WATER SHALL THEN BE ADDED AS NECESSARY TO PRODUCE OPTIMUM WATER CONTENT FOR COMPACTION, AND UNIFORMITY OF WATER CONTENT THROUGHOUT THE THICKNESS OF THE LIFT SHALL BE OBTAINED BY DISCING AND HARROWING AS NECESSARY. THE LIFT SHALL THEN BE THROUGHLY COMPACTED TO THE MINIMUM DENSITY SPECIFIED ABOVE. NO MATERIAL HAVING A WATER CONTENT GREATER THAN OPTIMUM SHALL BE PLACED IN FILL, NOR SHALL ANY MATERIAL IN PLACE IN THE FILL BE COMPACTED AT A WATER CONTENT GREATER THAN OPTIMUM. IN RESTRICTED AREAS WHERE COMPACTION BY ROLLING IS NOT FEASIBLE THE FILL SHALL BE PLACED IN 4" LAYERS AND COMPACTED TO THE MINIMUM DENSITY SPECIFIED ABOVE BY MEANS OF PNEUMATIC TAMPERS

REFERENCE DRAWINGS

LIST OF DRAWINGS	G-157875
CWS SEAL WELL-MRS.	G-158028
DISCH CANAL TOPOGRAPHY (SK7906-F2) 7906-110	
(SK7906-F3) 7906-111	
GENERAL GRADING & DRAINAGE PLAN	G-157990
PLANT AREA-GRADING, DRAINAGE & ROADS-PLAN	G 157909
YARD TRACK LAYOUT	G-157994
DISCHARGE WEIR	G-158032
DISCHARGE CANAL - PROFILE & SECTS	G-158031

NO.	DATE	REVISION	BY	CK.	APPROVED
1	2-11-59	ADD (L12, & 13) SECT E-E, CHG'D (I4) DISCH WEIR, ROAD & SLOPES, (C19) RIP RAP QUANTITIES	G.M.	A.C.	

CAROLINA POWER & LIGHT COMPANY
ARLINGTON COUNTY S. E. P.
1960 - 162 MW INSTALLATION - UNIT NO. 1

CIRCULATING WATER SYSTEM
DISCHARGE CANAL - PLAN & SECTS

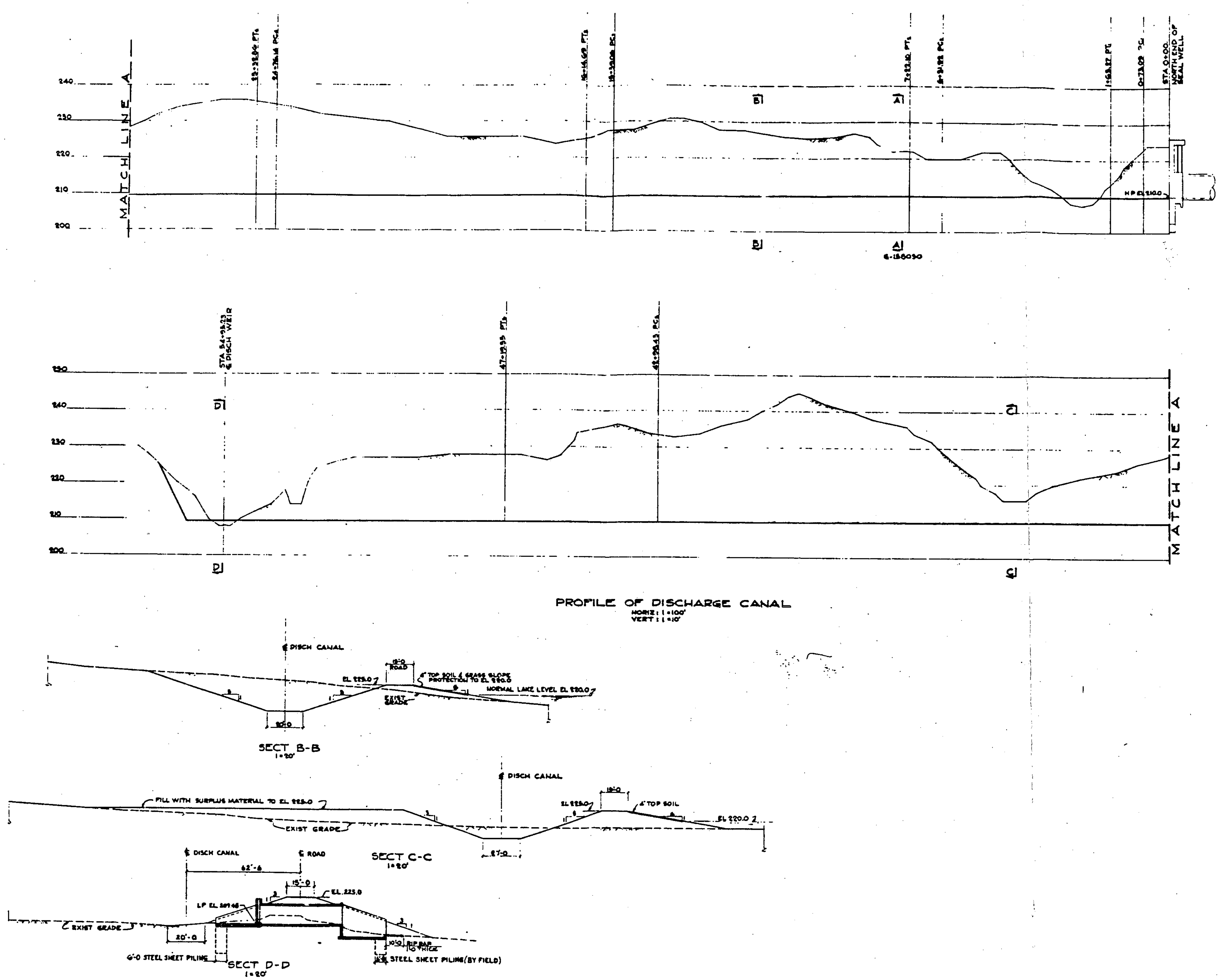
EBASCO SERVICES INCORPORATED NEW YORK

CK. CAPUTO

DATE JAN 28 1958

G-158030

G-158031



NOTES:
FOR NOTES & QUANTITIES SEE 6-158030

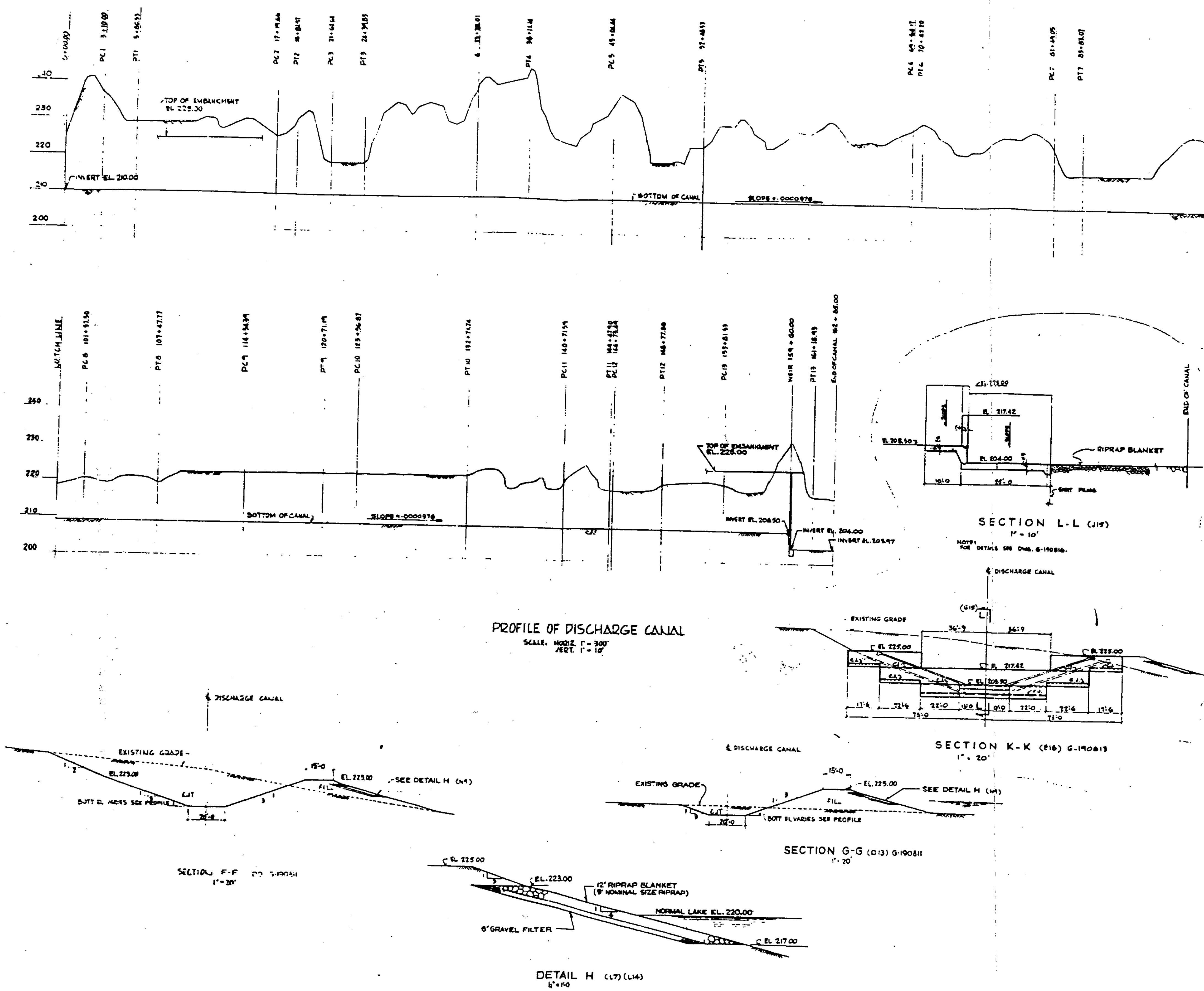
REFERENCE DRAWINGS:

LIST OF DRAWINGS	A-157679
CWS DISCH CANAL-PLAN & SECTS	G-158030
FOR ADDITIONAL REF DWGS SEE	G-158030

CAROLINA POWER & LIGHT COMPANY
DARLINGTON COUNTY S.E.R.
CIRCULATING WATER SYSTEM
DISCHARGE CANAL - PROFILE & SECTS
EBASCO SERVICES INCORPORATED NEW YORK

SCALE AS NOTED
DATE FEB 17, 1930
DR C-H
T. KOPPING
CH CAPUTO
G-158031

G-190814



QUANTITIES:

FOR QUANTITIES SEE DWG. G-190811
FOR QUANTITIES OF CANAL OUTLET STRUCTURE SEE DWG. G-190816.

NOTES:

FOR NOTES SEE DWG. G-190811

REFERENCE DRAWINGS:

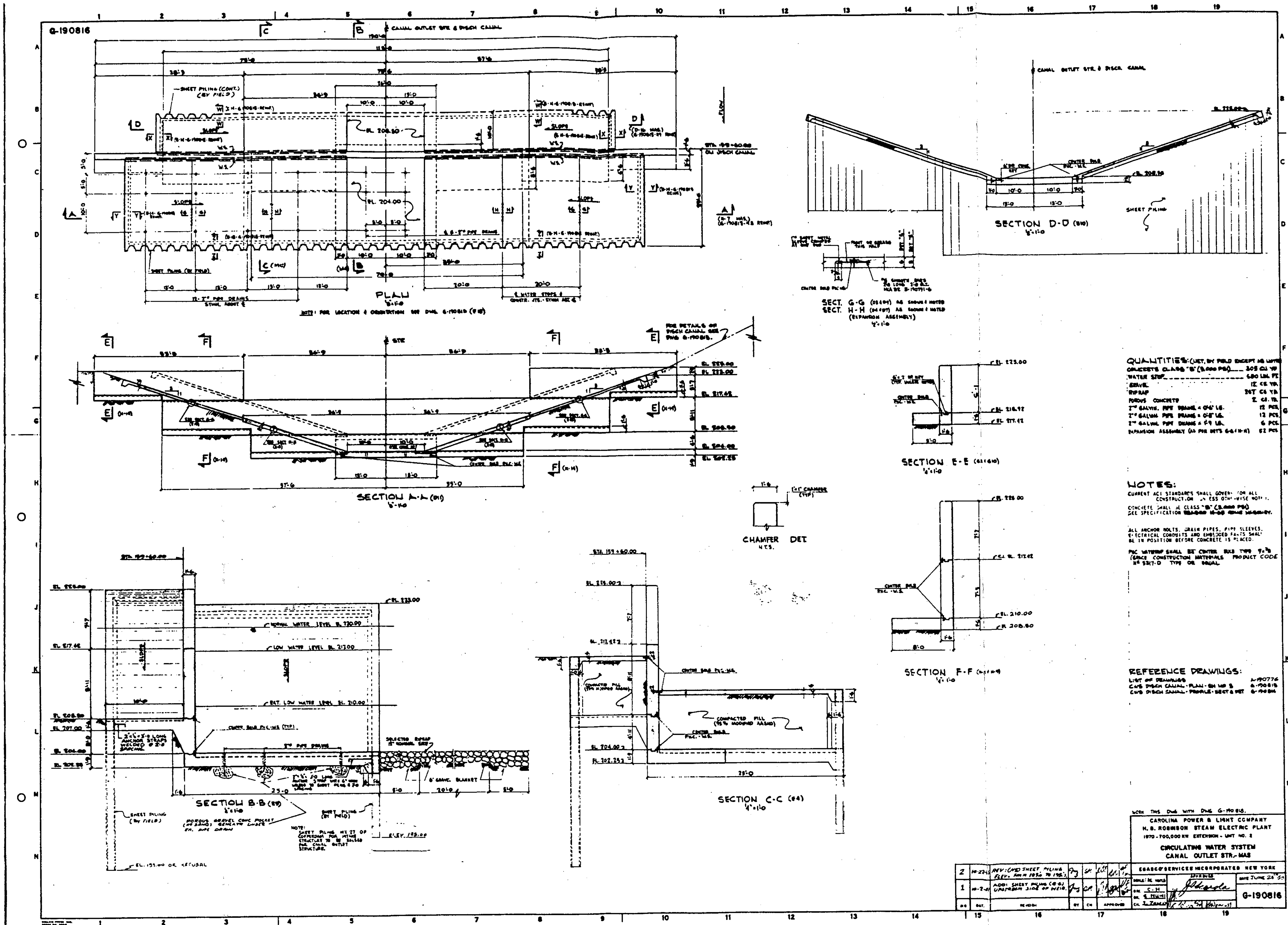
LIST OF DRAWINGS — — — — A-190776
C.W.S. CANAL OUTLET STR.-MAS. — — G-190816
FOR ADD'L REF. DWG'S. SEE — — — G-190811

CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON STEAM ELECTRIC PLANT
NPO-700,000 KW EXTENSION UNIT NO 2
CIRCULATING WATER SYSTEM
DISCHARGE CANAL - PROFILE - SECT'S & DET'S

EBASCO SERVICES INCORPORATED NEW YORK

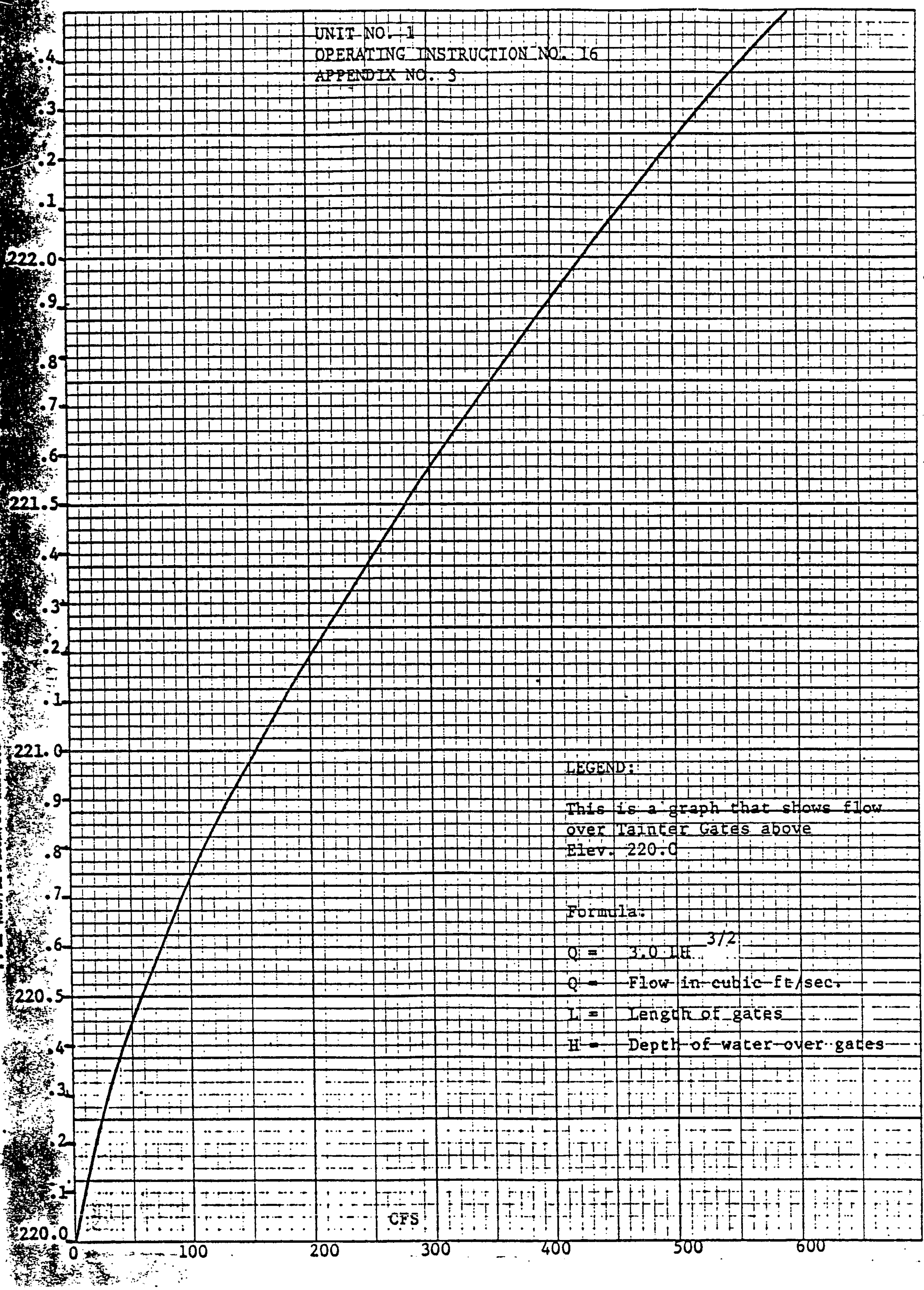
SCALE AS NOTED
APPROVED
DATE DEC 22, 1966
DR. C-H
CK. H.K.
CH. TSAI

G-190814

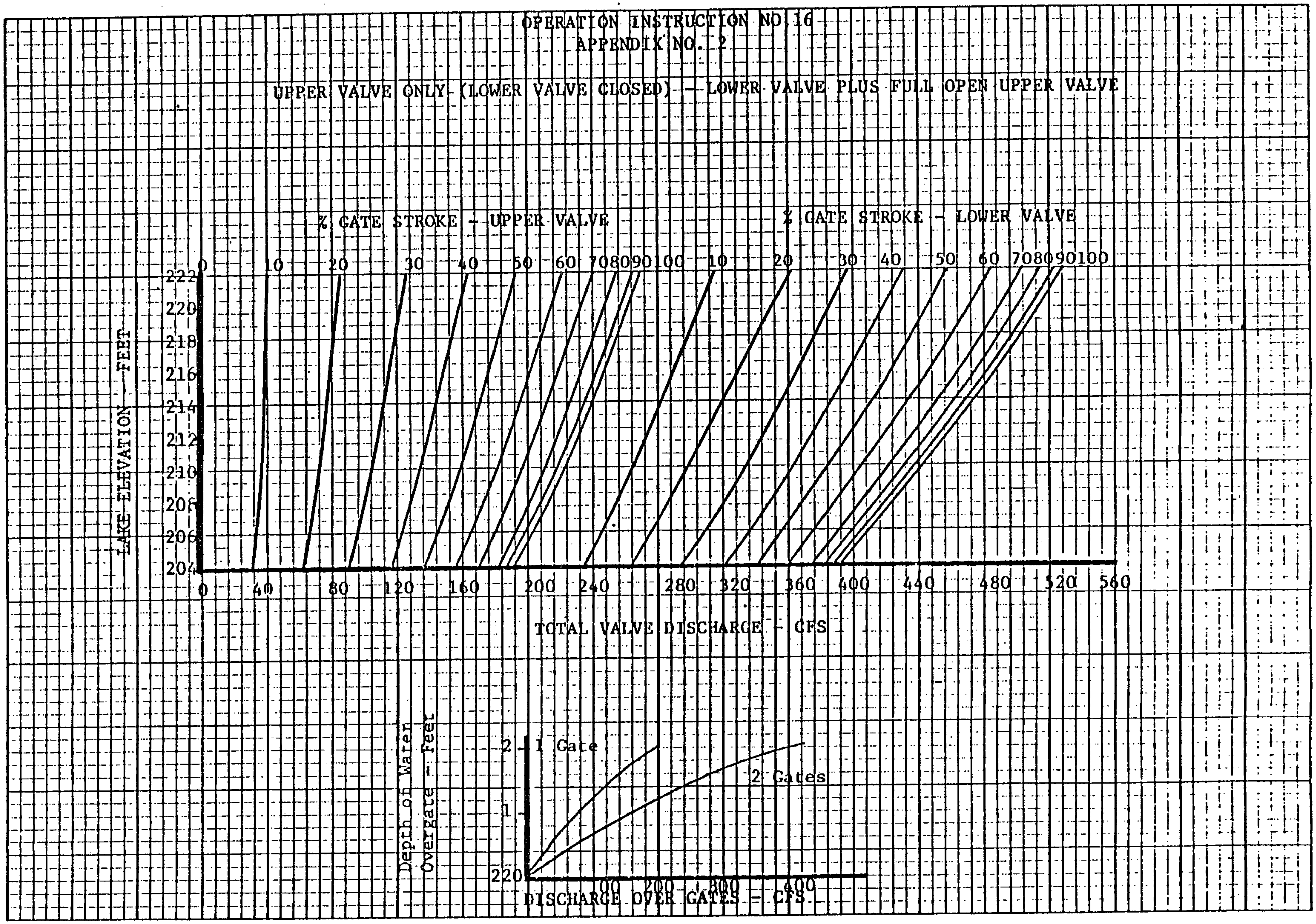

G-190816
PLAN
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION F-F
SECT. G-G
SECT. H-H
(EXPANSION ASSEMBLY)
CHAMFER DET.
N.T.S.
COMPACTED FILL
SHEET PILING
QUANTITIES:
CONCRETE CLASS "B"
WATER STOP
GRAVEL
RIPRAP
POROUS CONCRETE
EXPANSION ASSEMBLY
NOTES:
CURRENT ACI STANDARDS SHALL GOVERN FOR ALL CONSTRUCTION UNLESS OTHERWISE NOTED.
ALL ANCHOR BOLTS, DRAIN PIPES, PIPE SLEEVES, ELECTRICAL CONDUITS AND EMBEDDED PARTS SHALL BE IN POSITION BEFORE CONCRETE IS PLACED.
REFERENCE DRAWINGS:
LIST OF DRAWINGS
CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON STEAM ELECTRIC PLANT
1970 - 700,000 KW EXTENSION - UNIT NO. 2
CIRCULATING WATER SYSTEM
CANAL OUTLET STR.-MAS
EBASCO SERVICES INCORPORATED NEW YORK
G-190816

APPENDIX A

SPILLWAY RATING CURVES


UNIT NO. 1
OPERATING INSTRUCTION NO. 16
APPENDIX NO. 3
LEGEND:
This is a graph that shows flow over Tainter Gates above Elev. 220.0
Formula:
Q = $3.0\ LH^{3/2}$
Q = Flow in cubic ft/sec.
L = Length of gates
H = Depth of water over gates
CFS
0
100
200
300
400
500
600
220.0
220.5
221.0
221.5
222.0

UNIT NO. 1



OPERATION INSTRUCTION NO 16
APPENDIX NO. 2
UPPER VALVE ONLY (LOWER VALVE CLOSED) — LOWER VALVE PLUS FULL OPEN UPPER VALVE
% GATE STROKE - UPPER VALVE
% GATE STROKE - LOWER VALVE
0 10 20 30 40 50 60 70 80 90 100
10 20 30 40 50 60 70 80 90 100
LAKE ELEVATION — FEET
222 220 218 216 214 212 210 208 206 204
0 40 80 120 160 200 240 280 320 360 400 440 480 520 560
TOTAL VALVE DISCHARGE - CFS
Depth of Water Overgate - Feet
2 1
1 Gate
2 Gates
220 100 200 300 400
DISCHARGE OVER GATES - CFS

APPENDIX B

TAINTER GATE INSPECTION
REPORT 1 SEPTEMBER 1982

H. B. ROBINSON STEAM ELECTRIC PLANT

TAINTER GATE INSPECTION

TAR 81-081

SEPTEMBER 1, 1982

CAROLINA POWER & LIGHT COMPANY

FOSSIL PLANT ENGINEERING & CONSTRUCTION DEPARTMENT

H. B. ROBINSON STEAM ELECTRIC PLANT
TAINTER GATE INSPECTION

General

During the reconditioning and refinishing of the tainter gates at the H. B. Robinson Plant, FPE&CD was asked to conduct an overall inspection of the tainter gates to determine if any structural deficiencies exist and, if necessary, recommend any required repairs. The west tainter gate was inspected on November 10, 1981, and the east tainter gate was inspected on August 5, 1982. These inspections were conducted with the front side or forebay area dewatered and were scheduled by plant personnel to coincide with ongoing maintenance work on the gates.

Inspection Scope

FPE&CD engineers were requested by H. B. Robinson Plant personnel to conduct these inspections and to make recommendations as to what remedial structural work, if any, should be done. The inspections focused on the hinge or "pivot point" of the gate, all structural connections, and the hoisting chain and mechanism which operates the gates. FPE&CD engineers also inspected the rubber seals which prevent the gate from leaking water around the sides and bottom.

Findings

Inspection of the west gate found numerous nuts which connect the hinge to the concrete thrust block along the sidewalls and center pier tube severely corroded. Replacement of these nuts was recommended and accomplished. The gusset plate which connects the "spokes" or arms of the gate to the hinge was inspected and it was found that the majority of the bolted connections were moderately corroded and would require replacement. Other structural members on the west gate were inspected and except for some minor corrosion of individual secondary structural members, the gate is in good condition having been in operation since 1961. Plant personnel replaced the seals along the sides and bottoms of the gate. Inspection of the east gate found that basically the same areas as those noted on the west gate showed corrosion. However, it was noted that corrosion of the east gate did not appear to be of the same degree or extent as that noted on the west gate. Approximately six corroded nuts were recommended to be replaced on structural connections to the concrete walls and pier. Both gusset plates at the hinges were inspected and it was recommended that corroded nuts and bolts be replaced there also. The lifting chain was also inspected and was found to be in very good condition. The only concern that was identified with the lifting chains was the fact that three spring-steel snap rings that secure the link and pin of the chain together needed replacing. This section of chain is located in the zone of reservoir water level fluctuations. Chain lengths above the normal water level and those completely submerged showed no significant deterioration due to rust or corrosion.

The seals along the side and bottom of the gates were inspected and considering the apparently good condition of the old seals it was not recommended that these seals be replaced. The older seals actually looked as good and were as flexible as the newer seals which are very difficult to install. Some concerns were expressed by plant personnel about the trial operation of the gates on a monthly basis to ensure proper operation. This practice was apparently discontinued sometime ago because of fear that damage would result to the bottom seal of the tainter gate. However, due to the fact that very little if any trash passes under these tainter gates during normal flow conditions, operation of the gate on a monthly basis for inspection and maintenance purposes is recommended and damage to the bottom seal would be expected to be minimal.

Follow-Up Action

Prior to installation of new seals on the west gate, it was noted that some minor leakage was occuring along the sides of the gate between the concrete pier and the rubber tainter gate seals. The approximate location of these areas were identified so as to allow inspection at a later date to determine if the leakage rate has reduced or stopped. With monthly operation of the gates, these leaks should decrease substantially as the rubber seal conforms to minor irregularities of the concrete piers and sidewalls that isolate the separate gates.

During the inspection of these gates, it was noted that maintenance work on the west gate had been completed and the gate was back in service. The gate had a very nice appearance and appeared to be operating satisfactorily. Divers employed by the plant were inspecting the lower Howell-Bunger valve at Elevation 178.0 and indicated that there was severe corrosion and or erosion of the metal from the mechanical connections that hold the valve together. This was reported to the plant and they will replace these connections.

PREPARED BY: ______________________

APPROVED BY: L B Wilson
L. B. Wilson - Manager
Fossil Plant Engineering & Construction

APPENDIX C

INSPECTION CHECKLISTS
4-6 JUNE 1985

VISUAL INSPECTION CHECKLIST

1. Name of Dam: H.B. ROBINSON DAM
2. Inventory No.: SC-00632
3. Hazard Category: CLASS C (HIGH HAZARD POTENTIAL)
4. Size Classification: LARGE
5. Owner: CAROLINA POWER & LIGHT Co.
   411 FAYETTVILLE STREET
   RALEIGH, N.C. 27602
   919-836-6141
   ~~Attn: Mr. David Koss~~
   ATTN Mr. A B Cutter
6. Date Inspected: 4-5 June 1985
7. Pool Elevation: 220.2
8. Tailwater Elevation:
9. Purpose of Dam: COOLING WATER
10. Weather: Very Hot & 4-5 June Clear, light rain during night of 4-5 June 85
    Past 2 weeks very dry & hot (100°F+)

Directions: Mark an "X" in the "YES" or "NO" column.
If item does not apply, write "N/A" in "REMARKS" column.
Use "Other Comments" space to amplify "REMARKS".

ITEM	YES	NO	REMARKS
RESERVOIR			HB Robinson Ash Pond Dam Inventory No.: SC01929
1. Any Upstream Development?	X		
2. Any Upstream Impoundments?		X	
3. Shoreline Slide Potential?		X	
4. Significant Sedimentation?		X	
5. Any Trash Boom?		X	
6. Any Ice Boom?		X	
7. Operating Procedure Changes?	X		See Comment
DOWNSTREAM CHANNEL			
1. CHANNEL			
a. Eroding or Backcutting?		X	
b. Sloughing?		X	
c. Obstructions?		X	
d. Bridging?	X		Bridge
2. DOWNSTREAM FLOODPLAIN			
a. Occupied Housing?			
b. Farming?			
c. Recreation Areas?			
d. Changed Hazard Potential?			
e. New Development?			
INSTRUMENTATION			
1. Are there			There is no instrumentation
a. Piezometers?			N/A
b. Weirs?			
c. Settlement Pins?			
d. Observation Wells?			
e. Other?			
2. Are readings			
a. Available?			
b. Plotted?			
c. Taken Periodically?			

7. Project Personnel currently use up to 2' of reservoir surcharge storage with valves to pass inflows, This procedure seems sufficient to

Inventory No. HBRobinson Da...
Sheet 2 of 4

ITEM	YES	NO	REMARKS
FILL DAMS			TYPE: Earth Fill, Central Core
1. CREST			Crest pitches to drain upstr...
a. Any Settlement?		X	
b. Any Misalignment?		X	
c. Any Cracking?		X	
d. Adequate Freeboard?	X		Fetch: Az:
2. UPSTREAM SLOPE			
a. Adequate Slope Protection?	X		Type: Granit Riprap 18" size
b. Any Erosion or Beaching?	X		Slight near U/S corners of Sp...
c. Trees Growing on Slope?		X	
d. Deteriorating Slope Protection?		X	
e. Visual Settlements?		X	
f. Any Sinkholes?		X	
3. DOWNSTREAM SLOPE			
a. Adequate Slope Protection?	X		Type: Grass
b. Any Erosion?		X	See comments
c. Trees Growing on Slope?		X	
d. Animal Burrows?		X	
e. Sinkholes?		X	
f. Visual Settlement?		X	
g. Surface Seepage?		X	
h. Toe Drains Dry?			N/A
i. Relief Wells Flowing?			N/A
j. Slides or Slumps?		X	
4. ABUTMENT CONTACTS			
a. Any Erosion?		X	
b. Seepage Present?		X	
c. Boils or Springs Downstream?		X	
5. FOUNDATION			Type: Overburden
a. If Dam Founded on Permafrost			N/A
(1) Is Fill Frozen?			
(2) Are Internal Temperatures Monitored?			
b. If Dam Founded on Bedrock			Type:
(1) Is Bedrock adversely bedded?			
(2) Does Bedrock contain Gypsum?			
(3) Weak Strength Beds?			
c. If Dam Foundation Overburden			Type: Deep Sands & clayey Sa...
(1) Pipable?		X	
(2) Compressive?		X	
(3) Low Shear Strength?		X	

Other Comments: 3b) There were two tracks up downstream slope made by 4 w... drive vechicles. They do not appear to be recently used & no action is required

2b). At the U/s left side of the spillway, the riprap has displaced possibly by wave action. This area has now exposed the sand fill of the dam & should be fixe... Larger size riprap required (Possibly 36" pieces).

Inventory No. H B Robinson Dam
Sheet 3 of 4

ITEM	YES	NO	REMARKS
SPILLWAYS			TYPE:
1. CREST			TYPE:
a. Any Settlements?		X	
b. Any Misalignments?		X	
c. Any Cracking?		X	
d. Any Deterioration?		X	
e. Exposed Reinforcement?		X	
f. Erosion?		X	
g. Silt Deposit Upstream?		X	
2. CONTROL STRUCTURES			TYPE: NO.
a. Mechanical Equipment Operable?	X		
b. Are Gates Maintained?	X		
c. Will Flashboards Trip Automatically?			
d. Are Stanchions Trippable?			
e. Are Gates Remotely Controlled?			
3. CHUTE			TYPE:
a. Any Cracking?		X	
b. Any Deterioration?		X	
c. Erosion?		X	
d. Exposed Reinforcement?		X	
e. Seepage at Lift Lines or Joints?		X	
4. ENERGY DISSIPATORS			TYPE:
a. Any Deterioration?		X	
b. Erosion?		X	
c. Exposed Reinforcement?		X	
5. METAL APPURTENANCES			
a. Corrosion?		X	
b. Breakage?		X	
c. Secure Anchorages?	X		
6. EMERGENCY SPILLWAY			TYPE:
a. Adequate Grass Cover?	X		
b. Clear Approach Channel?	X		
c. Erodible Downstream Channel?		X	
d. Erodible Fuse Plug?	X		
e. Stable Side Slopes?	X		

Other Comments:

Inventory No. HBRobinson Dam

Sheet 4 of 4

ITEM	YES	NO	REMARKS
LOW LEVEL OUTLET			TYPE: Sluiceway to HB Valves
1. GATES			Upstream Sluicegate
a. Mechanical Equipment Operable?	X		
b. Are Gates Remotely Controlled?		X	
c. Are Gates Maintained?			Submerged at time of inspection
2. CONCRETE CONDUITS			
a. Any Cracking?			Submerged at time of inspection
b. Any Deterioration?			
c. Erosion?			
d. Exposed Reinforcing?			
e. Are Joints Displaced?			
f. Are Joints Leaking?			
3. METAL CONDUITS			N/A
a. Is Metal Corroded?			
b. Is Conduit Cracked?			
c. Are Joints Displaced?			
d. Are Joints Leaking?			
4. ENERGY DISSIPATORS		2-	36" ϕ Howell Bunger Valves
a. Any Deterioration?		X	w/ orifice plate
b. Erosion?		X	
c. Exposed Reinforcement?		X	
5. METAL APPURTENANCES			
a. Corrosion?		X	
b. Breakage?		X	
c. Secure Anchorages?	X		

Other Comments:

VISUAL INSPECTION CHECKLIST

1. Name of Dam: HB Robinson Ash Pond Dam
2. Inventory No.: SC-01929
3. Hazard Category: Low
4. Size Classification: Small
5. Owner: Carolina Power & Light Company
   411 Fayetteville Street
   Raleigh N.C. 27602
   Mr. AB Cutter
   919-836-6141
6. Date Inspected: 4 June 1984
7. Pool Elevation: 256±
8. Tailwater Elevation: —
9. Purpose of Dam: Ash Retention
10. Weather: Hot & Clear
    Last 2-week Period very dry.

Directions: Mark an "X" in the "YES" or "NO" column.
If item does not apply, write "N/A" in "REMARKS" column.
Use "Other Comments" space to amplify "REMARKS".

ITEM	YES	NO	REMARKS
RESERVOIR			
1. Any Upstream Development?		X	Inventory No.:
2. Any Upstream Impoundments?		X	
3. Shoreline Slide Potential?		X	
4. Significant Sedimentation?	X		Fly ash pond
5. Any Trash Boom?			N/A
6. Any Ice Boom?			N/A
7. Operating Procedure Changes?		X	Dam Raised 8' in 1982
DOWNSTREAM CHANNEL			Outfall Pipe Obscured 1-2 gpm Seepage flow
1. CHANNEL			
a. Eroding or Backcutting?		X	
b. Sloughing?		X	
c. Obstructions?		X	
d. Bridging?		X	
2. DOWNSTREAM FLOODPLAIN			
a. Occupied Housing?		X	
b. Farming?		X	
c. Recreation Areas?		X	
d. Changed Hazard Potential?		X	
e. New Development?		X	SCL Spur to HB Robinson Plant Downstream of Dam
INSTRUMENTATION			
1. Are there		X	
a. Piezometers?			N/A
b. Weirs?			
c. Settlement Pins?			
d. Observation Wells?			
e. Other?			
2. Are readings			
a. Available?			N/A
b. Plotted?			
c. Taken Periodically?			

Inventory No. HB Robinson Ash Pon.
Sheet 2 of 3

ITEM	YES	NO	REMARKS
FILL DAMS			TYPE: Compacted Fill
1. CREST			
a. Any Settlement?		X	
b. Any Misalignment?		X	
c. Any Cracking?		X	
d. Adequate Freeboard?	X		Fetch: Zero Az: N/A
2. UPSTREAM SLOPE			
a. Adequate Slope Protection?	X		Type: Grass
b. Any Erosion or Beaching?		X	
c. Trees Growing on Slope?		X	
d. Deteriorating Slope Protection?		X	
e. Visual Settlements?		X	
f. Any Sinkholes?		X	
3. DOWNSTREAM SLOPE			
a. Adequate Slope Protection?	X		Type: Grass
b. Any Erosion?		X	
c. Trees Growing on Slope?		X	
d. Animal Burrows?		X	
e. Sinkholes?		X	
f. Visual Settlement?		X	
g. Surface Seepage?		X	
h. Toe Drains Dry?			N/A
i. Relief Wells Flowing?			N/A
j. Slides or Slumps?		X	
4. ABUTMENT CONTACTS			
a. Any Erosion?		X	light ditch erosion @ D/S To
b. Seepage Present?		X	
c. Boils or Springs Downstream?		X	
5. FOUNDATION			Type: Dense to Medium Dense
a. If Dam Founded on Permafrost			Silty Sand - Clayey San
(1) Is Fill Frozen?			
(2) Are Internal Temperatures Monitored?			
b. If Dam Founded on Bedrock			Type:
(1) Is Bedrock adversely bedded?			
(2) Does Bedrock contain Gypsum?			
(3) Weak Strength Beds?			
c. If Dam Foundation Overburden	X		Type: Silty Sands
(1) Pipable?		?	
(2) Compressive?		X	
(3) Low Shear Strength?		X	

Other Comments:

Inventory No. HB Robinson Ash Pond Dam

Sheet 3 of 3

ITEM	YES	NO	REMARKS
SPILLWAYS			TYPE: Drop Inlet
1. CREST			TYPE: Skimmer Weir to Drop Inlet Pipe 36"ϕ
a. Any Settlements?		X	
b. Any Misalignments?		X	
c. Any Cracking?		X	
d. Any Deterioration?		X	
e. Exposed Reinforcement?		X	
f. Erosion?		X	
g. Silt Deposit Upstream?		X	
2. CONTROL STRUCTURES			TYPE: N/A NO.
a. Mechanical Equipment Operable?			
b. Are Gates Maintained?			
c. Will Flashboards Trip Automatically?			
d. Are Stanchions Trippable?			
e. Are Gates Remotely Controlled?			
3. CHUTE			TYPE:
a. Any Cracking?			
b. Any Deterioration?			
c. Erosion?			
d. Exposed Reinforcement?			
e. Seepage at Lift Lines or Joints?			
4. ENERGY DISSIPATORS			TYPE:
a. Any Deterioration?			
b. Erosion?			
c. Exposed Reinforcement?			
5. METAL APPURTENANCES			
a. Corrosion?			
b. Breakage?			
c. Secure Anchorages?			
6. EMERGENCY SPILLWAY			TYPE:
a. Adequate Grass Cover?			
b. Clear Approach Channel?			
c. Erodible Downstream Channel?			
d. Erodible Fuse Plug?			
e. Stable Side Slopes?			

Other Comments: Under normal usage, water used to transport ash to pond drains through reservoir floor so that decant drop inlet spillway seldom functions.

APPENDIX D

H. B. ROBINSON STEAM ELECTRIC PLANT
MAIN DAM

PROJECT DATA FORM

A. GENERAL

Name	H. B. Robinson Dam
Location	Hartsville, S.C.
Year Built	May 1958 - June 1959
Purpose	Cooling Water Supply
Inventory of dams I.D. Number	
Hazard Potential Classification	Class "C" (High Hazard Potential)
Size Classification	Intermediate
Owner	

Carolina Power & Light Company
R. E. Morgan
Plant Manager H. B. Robinson S.E.P.
803-383-4524

B. DAM

Type	Earth Fill
Crest Length	4,000 ft.
Crest Width	15 ft.
Crest Elevation	230 ft.
Height	55 ft.

C. SPILLWAY

Type	2 tainter gates (25' W x 35' H)
Location	In Dam
Side Slopes	Vertical
Crest Elevation	185 ft.

Bottom Width	50 ft.
Length	414 ft.
Discharge Capacity at Dam Crest	40,000 cfs (PMF) at El. 221.67

D. OUTLET WORKS

Type	2 - Howell Bunger Valves
Location	Center of Spillway
Invert Elevation	176.0 ft.
Size	36" Ø
Length	60.5 ft.
Outlet Invert Elevation	El. 176.5 & El. 184.0
Discharge Capacity at Dam Crest	510 cfs

E. RESERVOIR

Normal Maximum Water Surface Elevation	220 ft.
Water Surface Elevation at Dam Crest	230 ft.
Maximum Storage Volume at Dam Crest	55,500 AF±
Maximum Surface Area at Dam Crest	3,110 AC
Storage Volume at Spillway Crest	28,800 AF
Surface Area at Spillway Crest	2,242 AC

F. HYDROLOGIC DATA

Drainage Area	173 sq. mi.
Average Annual Discharge	169 cfs
Flood of Record	1,100 cfs
Project Design Flood	40,000 cfs
Probable Maximum Flood	40,000 cfs

H. B. ROBINSON STEAM ELECTRIC PLANT
ASH POND DAM

PROJECT DATA FORM

A. GENERAL

Name	H. B. Robinson Ash Pond Dam
Location	Hartsville, S.C.
Year Built	1981 (Raised Dam)
Purpose	Fly Ash Containment
Inventory of dam I.D. Number	-
Hazard Potential Classification	Class A (Low Hazard Potential
Size Classification	Small
Owner	

Carolina Power & Light Company
R. E. Morgan
Plant Manager H. B. Robinson S.E.P.
803-383-4524

B. DAM

Type	Compacted Fill
Crest Length	1,700 ft.
Crest Width	12 ft.
Crest Elevation	266 ft.
Height	20 ft.

C. SPILLWAY

Type	36" Ø Drop Inlet
Location	Upstream of Dam
Side Slopes	-
Crest Elevation	264 ft.
Bottom Width	-

H. B. ROBINSON STEAM ELECTRIC PLANT

ASH POND DAM (con't)

Length	-
Discharge Capacity at Dam Crest	80 cfs

D. RESERVOIR

Normal Maximum Water Surface Elevation . . .	264 ft.
Water Surface Elevation at Dam Crest	266 ft.
Maximum Storage Volume at Dam Crest	520 AF
Maximum Surface Area at Dam Crest	55 AC
Storage Volume at Spillway Crest	410 AF
Surface Area at Spillway Crest	52 AC

E. HYDROLOGIC DATA

Drainage Area	0.94 sq. mi.
Average Annual Discharge	-
Flood of Record	-
Project Design Flood	260 cfs
Probable Maximum Flood	4,000 cfs ±

Appendix A

Doc 07: Non-Hydroelectric Dam and Dike Inspection

Program Manual

AUTHORIZED COPY

Document title

Non-Hydroelectric Dam and Dike Inspection Program Manual

Document number

EVC-FGDC-00006

Applies to: Progress Energy Carolinas (non-hydroelectric operating facilities)

Keywords: environmental; fossil generation – environmental; drought; flooding; hurricane preparedness; low water supply; water conservation; plant water consumption; 5 year dam and dike inspection; utility commission reporting requirements

---

Table of Contents

Appendices

		Dam and Dike Inspection Procedures	Dam Emergency Notification Procedures
1.0	Asheville	EVC-ASHC-00024	EMG-ASHC-00001
2.0	Cape Fear	EVC-CFRC-00021	EMG-CFRC-00004
3.0	Lee	EVC-LEEC-00033	EMG-LEEC-00001
4.0	Mayo	EVC-MAYC-00011	EMG-MAYC-00002
5.0	Robinson	EVC-RFPC-00027	EMG-RFPC-00002
6.0	Roxboro	EVC-ROXC-00017	EMG-ROXC-00001
7.0	Sutton	EVC-SUTC-00038	EMG-SUTC-00003
8.0	Weatherspoon	EVC-WSPC-00029	EMG-WSPC-00003

1.0 Purpose

The purpose of this program manual is to define the processes, application, implementation, and associated procedures used by the Non-Hydro-electric operating facilities to assure the continued operating condition of dikes and dams at generation plants.

This procedure also is intended to describe the specific components and the requirements to fulfill the regulatory required inspection of all dams and dikes for the Non-Hydro-electric operating facilities

Due to the potential problems that could be caused by a dike failure, formal engineering inspection of the dikes at generation plants is required by Federal and State regulatory agencies. This includes main dams or dikes for cooling water impoundments, active and inactive ash pond dikes, and process pond dikes. In between these engineering inspections, supplemental operational monitoring of conditions is necessary to ensure that changes are not occurring. This procedure provides an overall program management for the operating facilities fleet.

2.0 Format of procedure

Because the specific applications, installations and conditions of dikes can vary widely, this procedure is designed to define the program overall responsibilities for inspecting and maintaining the various non-hydroelectric dams/dikes in the Progress Energy Carolinas system. Each generation plant will have a site specific procedure outlining the specific operating facility responsibilities, inspection requirements, and responses to an emergency situation caused by dam and dike abnormalities

3.0 Application

This procedure applies to all Progress Energy Carolinas System Dam and Dike containment systems that are currently permitted as retention basins for both cooling water and coal combustion by-products.

4.0 Terms and Definitions

4.1 Document Repository

The file copy of each of the annual and 5 year dam and dike inspections are located in the Condition Assessment area of the plantview application. The electronic copy of this file should be accessible by all plant environmental coordinators and is to serve as the official report as required in the NPDES permit reporting requirements.

4.2 Monthly Dam and Dike Inspection

Monthly dam and dike inspections are to be performed by facility personnel trained in what to observe during the monthly visual inspection. The inspection is documented by the facility Dam and Dike Monthly Checklist.

4.3 Annual Dam and Dike Inspection

Annual dam and dike inspection shall be performed on an annual frequency at approximately the same time of year, and during a period of dry weather to allow for the optimum conditions to observe the condition of the dam and dike structures. The inspection shall be performed by a trained third party contractor so that shall inspected as to provide a comprehensive inspection of the permitted, regulated dam and dikes to be operated by the specific PGC facility.

4.4 Five Year Dam and Dike Inspection

The five year dam and dike inspection shall be performed on five year frequency at approximately the same time of year, and during a period of dry weather to allow for the optimum conditions to observe the condition of the dam and dike structures. The inspection shall be performed by a trained third party contractor so as to provide a comprehensive inspection of the permitted, regulated dam and dikes to be operated by the specific PGC facility. The five year inspection is forwarded to the NC Utility commission for their records.

4.5 Condition Assessment Inspection

The condition assessment form is a component of the annual and five year inspection that is used by non-technical personnel and management to get a snapshot perspective of the last inspection condition of the dam and dikes. This inspection form is filled out by the dam and dike program manager, and is incorporated in the Passport electronic storage program.

4.6 Dam and Dike Inspection Matrix

The dam and dike inspection matrix is an annual document that is a conglomeration of the recommendations in each of the annual and five year inspections performed within a calendar year. This document will be presented to facility and department management to give management a perspective of the current condition and areas of concern for each of the facility dam and dikes. This document will be prepared by the dam and dike program manager.

4.7 Dam and Dike

The definition of a Dam or Dike for the purposes of this manual is the utilization of the official definition as defined by the North Carolina Department of Environmental and Natural Resources – Division of Land Resources – Land Quality Section, which is as follows:

Dam – An artificial barrier with appurtenant (or associated) works constructed to impound or divert water or liquefied material. Dams may be constructed to retain normal run-off from streams and land surfaces: flood waters; brine; water pumped from a stream or well; or waste from industrial processes, chemical processes, and mining operations.

Dike (*or Levee*) – Any artificial barrier together with appurtenant works that will divert or restrain the flow of a stream or other body of water for the purposes of protecting an area from inundation by flood waters.

5.0 Dam and Dike Inspection Program Participants

5.1 Manager – Field Engineering - POG

Provide an engineering resource to provide the overall program management and dedicate resources for the performance of the annual and five-year dam/dike inspections.

Provide ownership of this PGC Department Inspection Program Manual.

5.2 Dam and Dike Program Manager – Field Engineering – POG

Provide ownership of the Dam and Dike Inspection Program in the areas of assurance of program implementation, reporting and follow-up. All individual actions associated with the program are to be approved by the program manager prior to application.

Provide guidance and direction to the specific facilities in the areas associated with the maintenance, inspection, and remediation actions under this procedure.
Ensure that inspections are completed on the specified frequency.

Ensure appropriate funding is budgeted from regional funds to perform the 5 year inspections, and non-routine remediation.

Ensure that regulatory documentation for the 5 year dam and dike inspections are delivered in a timely manner to the appropriate sate regulatory body.

5.3 Power Plant Manager

Develop and maintain supplemental site-specific dike inspection procedures. The plan may be part of an operating department procedure, or may be a plant procedure.

Ensure that inspections are completed on the specified frequency.

Ensure appropriate funding is available from plant base budgets to perform the annual inspections, and routine maintenance remediation.

Ensure that actions to correct inspection recommendations and deficiencies are completed in a timely manner

To assure designated plant personnel are trained to be able to be considered a competent person for the monthly dam and dike inspections.

Provide ownership of the plant specific Dam and Dike Inspection Procedure.

5.4 Facility Environmental Coordinator

Provide guidance for the facility specific dam and dike inspection program requirements for their specific facility.

Provide guidance, implementation, and ownership of the plant specific dam and dike emergency action plan and site specific procedures.

Assure that facility specific inspections, inspection recommendations, and dam and dike deficiencies are addressed in a timely manner.

Assure that any anomalies identified during the plant inspections are reported to the program manager to assure that the remediation is performed to engineering specifications.

Assure that identified recommended action items are inputted in Passport software for designation as a work task to be resolved as per inspection recommendations. All work orders shall include the dam repair attribute.

Attend training on a 3 year basis on the requirements needed to be able to become a competent person in the area of dam and dike inspection training who can serve as a back-up trainer of the monthly inspectors.

5.5 Facility Monthly Inspector

Attend annual training to allow the employee to be considered a competent person in the area of the monthly dam and dike inspection program and process.

Perform the monthly inspection of the different dam and dikes and associated components and record the results to the facility environmental coordinator.

Provide a hard copy of the completed dam and dike inspection report to the facility environmental coordinator.

5.6 Environmental Health and Safety Services – Technical Reviewer

Review the 5 year dam and dike inspection report prior to the issuance to the plant for file, and the NCUC to ensure that all current conditions, recommendations, and other report issues are in compliance with current applicable environmental laws and rulings, and is incorporated with any other environmental issues currently in place within the individual facilities. The scope of this review will be associated with environmental aspects.

6.0 Program Funding

6.1 Program Funding – Annual inspections

The annual inspections shall be funded by the plant manager as part of the base facility budget. The dam and dike program manager shall inform the facility management of the appropriate amount to be funded in order to perform the inspection and fund any routine maintenance activities identified in the previous inspection reports.

6.2 Program Funding – 5 Year Inspections

The 5 year inspections shall be funded by the Dam and Dike Program Manager as part of the annual budgeting practice. The inspection budget shall include repairs or recommendations made during the previous year's dam and dike inspection report. In addition to the funding it will be the responsibility of the program manager to make sure that all recommendations and repairs are performed prior to the performance of the 5 year inspection.

6.3 Program Funding – Recommendations / Modifications / Major Repairs

The items identified in the annual and 5 year reports that are of sufficient cost and are not of a significant nature to have to be performed on an emergent basis and justify a separate budget package will be budgeted as part of the annual budgeting practice by the program manager.

The items identified in the annual and 5 year reports that are of sufficient cost and require immediate or cannot wait until the next calendar year will be budgeted by the program through the emergent process by sending a budget package through the regional or department PRG (Project Review Group) for approval of emergent funding.

7.0 Program Implementation

7.1 Monthly Dam and Dike Inspection

Monthly dam and dike inspection is to be performed by a PGC facility employee or designee that has been trained on how to perform the applicable aspects of the components to be inspected within the scope of the monthly inspection. The results and observations of the monthly inspection are to be recorded on the monthly inspection checklist.

The monthly inspection checklist is to be given to the facility environmental coordinator for review, and storage. Any abnormal observed conditions should be discussed with the environmental coordinator and the dam and dike inspection program manager to address if necessary.

7.2 Annual Dam and Dike Inspection

Annual dam and dike inspection shall be performed on an annual frequency at approximately the same time of year, and during a period of dry weather to allow for the optimum conditions to observe the condition of the dam and dike structures. The inspection shall be performed by a trained third party contractor so as to provide a comprehensive inspection of the permitted, regulated dam and dikes to be operated by the specific PGC facility.

The inspection shall also be attended by the program manger, or a representative that is to serve as the Single Point of Contact (SPC) and follow-up coordinator for inspection findings.

Upon completion of the inspection the third party inspector shall provide a download of the observations made during the inspections with special consideration given to those items that will be included in the recommended follow-up actions or are significant in nature, and need to be addressed in a timely manner. After the field inspection is complete the third party inspector will provide the program director with a draft inspection report that will be reviewed prior to official approval. Once the final document is agreed upon, the third party inspector will provide the program manager with 3 hard copies, and one electronic copy of the report for record keeping.

Upon receipt of the final inspection report the program manager is to internally review the report with a POG Environmental Health and Safety Services (EHSS) technical reviewer for agreement on the environmental aspects of the plan. Upon approval from EHSS a letter will be drafted by the program manager that summarize the recommended findings, and PGN's response including corrections and time frame in a cover letter to the plant management and the Facility Environmental Coordinator with 2 hard copies.

7.3 Five Year Dam and Dike Inspection

The five year dam and dike inspection shall be performed on five year frequency at approximately the same time of year, and during a period of dry weather to allow for the optimum conditions to observe the condition of the dam and dike structures. The inspection shall be performed by a third party contractor that is trained on the specific aspects that need to be inspected as to provide a comprehensive inspection of the regulated dam and dikes permitted to be operated by the specific PGC facility.

The inspection shall also be attended by the program manger, or a representative that is to serve as the designated representative and follow-up coordinator for inspection findings.

Upon completion of the inspection the third party inspector shall provide a download of the observations made during the inspections with special consideration given to those items that will be included in the recommended follow-up actions or are significant in nature, and need to be addressed in a timely manner. After the field inspection is complete the third party inspector will provide the program director with a draft inspection report that will be reviewed prior to official approval. Once the final document is agreed upon, the third party inspector will provide the program manager with 3 hard copies, and one electronic copies of the report for record keeping.

Upon receipt of the final inspection report the program manager is to internally review the report with a POG Environmental Health and Safety Services (EHSS) technical reviewer for agreement on the environmental aspects of the plan. Upon approval from EHSS a letter will be drafted by the program manager that summarize the recommended findings, and PGN's response including corrections and time frame in a cover letter to the plant management and to the NC Utility Commission Chief Engineer along with 3 hard copies of the report for their records. This task is to be completed within 90 days of the issuance of the final report.

South Carolina does not currently have a requirement to supply report findings to their state agency. All reports performed in South Carolina are performed in the exact same manner with the exception of submitting the report to the state agency.

7.4 Condition Assessment Inspection

The condition assessment form is a component of the annual and five year inspection that is used by non-technical personnel and management to get a snapshot perspective of the last inspection condition of the dam and dikes. This inspection form is filled out by the dam and dike program manager, and is incorporated in the Passport electronic storage program.

7.5 Dam and Dike Inspection Matrix

The dam and dike inspection matrix is an annual document that is a conglomeration of the recommendations in each of the annual and five year inspections within a calendar year. This document will be presented to facility and department management during the first quarter of each year to give management a perspective of the current condition and areas of concern for each of the facility dam and dikes. This document will be prepared by the dam and dike program manager.

The document will give a detail for the recommendations, the schedule for completing the recommendations, and the actions and funding required to complete the recommendations. Each item will be ranked on a stop light basis to inform the reader of the amount of risk for each of the recommendations in the report.

8.0 Regulatory reporting requirements

8.1 North Carolina Utility Commission

As required Per North Carolina Utilities Commission Order in Docket No. E-100, Sub 23 dated April 5, 1976 and October 11, 1976, Progress Energy is required to provide an inspection report to the Chief Engineer of the North Carolina Utilities Commission for review and comment on a 5 year calendar timeframe for the dams and dikes for each of the facilities in North Carolina. The report is to be performed by a NC licensed professional engineer trained in the area of dam and dike construction and maintenance. The report is to be issued with a cover letter that includes current status of the dam or dike, recommendations, timeframe for correcting the recommendations, and how the recommendations are to be addressed.

Upon receipt of the final inspection report the program manager is to review the report, summarize the recommended findings, and PGN's response including corrections and time frame in a cover letter to the NC Utility Commission Chief Engineer along with 3 hard copies of the report for their records. This task is to be completed within 90 days of the issuance of the final report.

8.2 South Carolina Utility Commission

South Carolina does not currently have a requirement to supply report findings to their state agency. All reports performed in South Carolina are performed in the exact same manner with the exception of submitting the report to the state agency.

9.0 Recordkeeping and Document Control

9.1 Monthly Dam and Dike Inspection Checklist

Upon completion the monthly inspection checklist is to be given to the facility environmental coordinator for review, and storage in a dedicated file under the PGC corporate file point 13585-C, and stored for future observations. Any abnormal observed conditions should be discussed with the environmental coordinator and the dam and dike inspection program manager to address if necessary. The file shall be provided to the independent inspector at the time of the annual and 5 year inspections to look at prior to the performance of the inspection.

These records shall be maintained for a minimum record retention time of 5 years from the latest 5 year inspection report.

9.2 Annual Dam and Dike Inspection Checklist

Upon Completion and final approval of the annual dam and dike inspection report, the documentation shall be reviewed, and a cover letter with the findings identified with schedule, recommendations, and the recommendations ownership established. The letter and two (2) hard copies of the report shall be issued to the plant manager and environmental coordinator for annual issuance. The official file copy will be scanned and placed in the plantview electronic database program for record retention by the program manager. Based on the report information a condition assessment will be performed, and the results will be included in the electronic file copy.

These records shall be maintained for a minimum record retention time of 5 years from the latest 5 year inspection report.

9.3 5 Year Dam and Dike Inspection Checklist

Upon completion and final approval of the 5 year dam and dike inspection report, the documentation shall be reviewed by the program manager, EHSS, and a cover letter with the findings identified shall be issued to the, Utility Commission Chief Engineer for issuance, with a carbon copy sent to the plant manager and environmental coordinator for issuance. The official file copy will be scanned and placed in the plantview electronic database program for record retention. Based on the report information a condition assessment will be performed, and the results will be included in the electronic file copy.

These records shall be maintained for a minimum record retention time of 6 years.

Upon receipt of the final inspection report the program manager is to review the report, summarize the recommended findings, and PGN's response including corrections and time frame in a cover letter to the NC Utility Commission Chief Engineer along with 3 hard copies of the report for their records. This task is to be completed within 90 days of the issuance of the final report.

10.0 Training

10.1 Monthly Dam and Dike Inspection Inspector

The Monthly Dam and Dike Competent inspector should receive annual training. The training is to be provided by the technical consultant that is performing the annual inspection. The training is to occur during the annual inspection filed data gathering, and will be scheduled through the facility environmental coordinator and the technical consultant. The plant manager is responsible for assuring that designated personnel are available for the training.

In the event the designated personnel is not able to attend the training, a special training session will be provided in which the facility environmental coordinator will provide the training to the individual. This is for special circumstances only, and should not be a normal training situation.

10.2 Train the Trainer - Monthly Dam and Dike Inspection Inspector

The Environmental Coordinator will be trained as a train the trainer at each facility as part of the ongoing ORC contact hours of training required as part of the ongoing certification by to be an NPDES facility representative. The training shall be coordinated between the ORC coordinator and technical consultant that are performing the annual inspection to provide the training and resources needed to be considered competent to be able to train the designated plant employees on how to perform the monthly dam and dike inspections.

The program manager will attend the training to audit the course, and determine if additional information is required to satisfy the individual aspects of the inspection program.

10.3 Additional Training

Specific training for the improvement or the enhancement of the inspection program will be looked at on a case by case basis.

11.0 Plant-Specific Dike Inspection Procedures

Each generating facility shall develop and maintain a site-specific dike inspection procedure that supplements annual and five-year inspections performed by Field Engineering - POG. These procedures shall be formalized either as elements in a department-wide procedure, or as plant procedures. The procedures should, as a minimum, meet the following requirements.

Be maintained as a controlled document within the corporate procedure system.

Include specific roles and responsibilities for plant personnel.

Reference this procedure.

Identify each individual dike structure.

Identify frequency of inspection.

Include assessment of the following elements as applicable to the specific dike structure:

Concrete structures;

Earthen dam and dikes;

Embankment structures;

Spillway structures;

Outlet works;

Safety and performance instrumentation;

Reservoir;

Operation and maintenance features;

Downstream channel.

Miscellaneous structures or apertures

Note significant weather events since last inspection.

Note erosion or any changed physical features utilizing annual and five-year inspection reports as appropriate.

Provide a record of the inspection (e.g. checklist or form).

Forward record of conditions found to Field Engineering – POG in a timely manner.

Specify the initiation of work requests in the work management system to address abnormal conditions.

12.0 End of procedure

Appendix A

Doc 08: MACTEC Report of 2009 Limited (Annual) Field Inspection

MACTEC

engineering and constructing a better tomorrow

September 23, 2009

Mr. Bill Forster
Progress Energy
7001 Pinecrest Road
Raleigh, North Carolina 27613

**Subject: REPORT OF 2009 LIMITED (ANNUAL) FIELD INSPECTION
ASH POND DAM
H. B. ROBINSON STEAM ELECTRIC PLANT
HARTSVILLE, SOUTH CAROLINA
MACTEC PROJECT 6468-09-2351 (05)**

Dear Mr. Forster:

On March 11, 2009, Mr. Al Tice of MACTEC Engineering and Consulting, Inc. (MACTEC) conducted a limited (annual) field inspection of the Ash Pond Dam at the Robinson Plant. The inspection was coordinated in the field by Mr. Willie Gilbert representing Progress Energy. Mr. John Gainey and Mr. Kirk Davis, Chemistry Lab technicians who perform routine inspections, were interviewed. Preliminary findings from the inspection were reviewed with Mr. Gilbert. The next 5-year independent consultant inspection is scheduled to be done in 2010.

The field inspection included discussion with Mr. Gilbert of activities since the last inspection visit and a driving/walking reconnaissance of the Ash Pond Dam accompanied by Mr. Gilbert and Mr. Gainey. This letter report summarizes the observations during the limited inspection and provides our recommendations for any follow-up actions. Photographs of selected conditions and updated dam assessment forms are attached in Appendices A and B, respectively.

According to Mr. Gilbert a twice weekly visit of the ash pond dam occurs mainly for NPDES purposes, but that a quick check of the ash pond Dam happens at the same time. There is no inspection check list for the ash pond dam according to Mr. Gilbert.

SUMMARY

Based on the current inspection, there is no significant change in the condition of the ash pond dam from the 2008 limited field inspection. No new recommendations are made. The status for addressing recommendations in the 2005 (5-year) inspection report and 2006 limited inspection report is included under inspection results along with any new recommendations. No new recommendations were added in the 2007 or 2008 reports.

Since the 2008 inspection, a water spray system to retard ash dust blowing has been completed and placed in operation in the south pond. Water for the spray system is pumped from the north pond area at the northeast corner. The sprinklers were operational during the inspection.

LOCATION AND GENERAL DESCRIPTION

The H. B. Robinson Steam Electric Plant is located at 34° 24'north latitude and 80°-9' west longitude on Black Creek in Darlington County, South Carolina. adjacent to State Highway 1623 and 131, about five miles northwest of Hartville, South Carolina. The plant is owned and operated by Progress Energy. A fossil fuel unit (Unit 1) and a nuclear unit (Unit 2) are both present on the site. The ash pond is located approximately a mile north of the plant.

The ash pond is retained by an earth dike approximately 1,800 feet long with a maximum structural height of approximately 31 feet. A drop inlet/vertical riser structure is provided as a spillway for the ash pond. As modified in 1982, the pond had a surface area of 55 acres at crest level and a storage capacity of approximately 410 acre feet of ash. In 1992, ash was removed from the eastern end of the pond and stacked in the western end, reducing the active portion of the ash pond to approximately 35 acres.

The ash pond dikes were raised six feet during 2002 under a design prepared by LAW Engineering and Environmental Services, Inc. (now MACTEC). The raise increased the storage area at maximum pond level to about 55 acres. The construction work was completed in December, 2002.

DESIGN AND CONSTRUCTION SUMMARY

The original dam was constructed of compacted sandy soil. No internal drainage features were included. The 2002 raise was constructed of sandy soils obtained from excavating on the south edge of the ash pond. The existing interior slopes were extended upward and the new crest was offset toward the exterior, with new exterior slopes on 3(H) : 1(V) angles. This method of raising dams is called and exterior raise. Geogrid reinforcing strips were placed in the exterior slope to protect against shallow-seated slope raveling. A drainage blanket was placed between the old exterior slope and the new one. The drainage blanket was connected to a horizontal drainage blanket and a rock toe.

The dam raise incorporated the existing below-grade outlet piping and simply extended the original vertical riser upward.

RECORDS

Four piezometers were placed in the ash pond dam upon completion of the raising project. The 2003 inspection report contains information on the locations and elevations of these piezometers. Approximate locations are shown on the Photograph Location Map in Appendix A. The 2005 5-year inspection report recommended obtaining a baseline reading of the piezometers once a year even if no significant change in the water levels occurred. A tabulation of piezometer readings for the dam as well as for nearby piezometers and a monitoring well is attached as Exhibit 1. The piezometers in the dam have remained dry because water levels in the pond typically have not been up against the inside slope of the dam. Two piezometers and a monitoring well are located between the toe of the north dam and the railroad and are installed into the natural groundwater. Water level measurement recorded from July 2006 to January 2009 show little changes in the depth to groundwater. Piezometer P8 and monitoring well MW2 show and increase in the depth to groundwater between July 2006 and present.

As indicated by photos from the current inspection, water has begun to collect in the north pond area, but there is still no overflow from the ash pond discharge structure. Previous inspections have recommended increasing the inspection and piezometer reading frequency if the water level rises. Readings are currently being taken on an approximate 6-month frequency. That frequency is satisfactory if the pond water level remains at about the present level.

FIELD OBSERVATIONS

The ash pond consists of south and north areas with a separator dike extending out into the pond area. At the time of our visit, there was water in the north pond section, but the water level was about 2 feet below the top of discharge structure. The south pond area did not have water at the dam; the ash level was approximately 7 feet below the dam crest.

The crest and interior slopes of both the north and south pond areas and the new dike section added on the north end of the north pond are in generally good condition (Photographs 1, 2 and 3).

The rip rap on the interior slope of the north pond dam appeared to be in good condition (Photograph 1).

The oily waste discharge pipe from Darlington County Plant on the north dike appeared to be in good condition with the slope adequately protected by riprap (Photograph 4).

The separator dike and the small dike extension on the north side of the pond continue to be in good condition.

The exterior slopes of the dams generally appeared to be stable with good vegetative cover for erosion protection (Photographs 5 and 6). The vegetation on the exterior slopes had recently been cut. Continued mowing of the exterior slopes is recommended to discourage growth of brush and trees, and to facilitate inspection. Localize erosion rills observed during past inspections did not show signs of worsening. Continue to observe and fill damaged areas with crushed stone as a routine maintenance activity. Local small depressions have been observed at the top of the exterior slope, rock toe along the north dam. Filling with gravel has been done to address these. Five new holes were seen (Photograph 7 is an example); these were marked for filling. The plant should continue to check for such holes and fill them with gravel as a routine maintenance activity.

The toe area below the north dam has been graded to drain toward the drop inlet and continues to be in good condition. Drainage from the Darlington Plant on the north side of the pond is routed through a culvert under the north corner of the new dam and into the drop inlet connecting to the storm drain piping that runs along the toe of the dam. The drop inlet appeared to be in good condition. Previous inspection reports have recommended removal of the rock filter berm around the drop inlet provided for the ash pond discharge and toe drainage collection. The rock filter berm was still in place at the time of inspection and there were wet areas observed adjacent to the berm. Discussions with Mr. Gilbert indicated removal of the berm could create potential impact to the NPDES permit if discharge from the pond riser occurs, because the flow from the toe drainage is directed to the pond outlet pipe. Suspended solids from surface water runoff could affect the

NPDES limits. The standing water is not judged to be affecting the dam stability. Thus removal of the berm will not be recommended.

A drainage swale is present about 15 to 20 feet outside of and generally parallel to the toe of the south pond dam. This swale had problems with erosion shortly after the completion of the dam raise in 2003. Rock check dams were placed to control the erosion. The rock check dams have been effective, and vegetation appears to be well established (Photograph 6).
The ash discharge point is located on the south side of the separator dike (Photograph 8). While no indications of excessive erosion were seen, this area should be observed during routine inspections for signs of erosion of the dam slope. If erosion is seen, riprap placement may become necessary.

The existing pond outlet structure consists of a riser pipe and skimmer which was raised when the dams were raised. No overflow discharge has occurred through the new structure to date. The structure appeared in good condition (Photograph 9).

The pipe from the outlet structure goes under the dam and leads to a discharge point east of the railroad about 150 feet beyond the dam toe. The outlet pipe also serves as the discharge for the surface runoff along the north dam toe and from the Darlington plant. No signs of leakage under the pipe were seen. (Photograph 10) Consistent with previous reports, we observed erosion of the channel bank about 30 feet downstream from the discharge pipe end. This erosion is not presently threatening the pond outlet pipe and no enlargement of the erosion appears to have occurred over the past few years. Previous reports have recommended stabilizing the eroded area with riprap to reduce potential for undermining the discharge pipe. We currently recommend continuing to check for any increase in erosion area with placement of rip rap on an as-needed basis.

Based on the current inspection results, the status for addressing recommendations in the 2005 5-year inspection report and the 2006 annual report is summarized below. The 2007, 2008 and this 2009 report have no new recommendations.

Ref No.	Recommendations	Recomm Time for Impl	Current Status
AP-2005-1 & 4	If the elevation of the ash pond rises so that water begins to impound against the dam, piezometer readings should begin following the schedule in the dam raise design. A baseline check of piezometric levels should be made once a year if no water is impounding against the dam.	Review schedule with next inspection.	Baseline readings were taken in July, 2006. And readings have continued on about 6-month frequency since. Piezometers show no water. Current inspection found water level in north pond slightly up against the dam. No indications of water in piezometers in January, 2009. Recommend continue the 6-month frequency and evaluate during 2010 5-year inspection.
AP-2005-2	Animal burrows on the interior slope should be	Routine	Vegetation on slopes is

	filled. Trapping of burrowing animals should be done. No holes observed in our 2008 inspection.	maintenance	being maintained and facilitates inspection and location of animal burrows. Burrows rarely seen.
AP-2005-3	The annual inspection frequency should be increased to monthly if water levels rise to a point that places water against the dam. These inspections should look for any cracks, slumps or new seepage. Any unusual findings should be reported immediately to a designated engineer for evaluation.	Review schedule with next inspection in 2010.	Water has begun to impound in north pond with shallow depth at dam. No signs of concerns on exterior dam slopes. No change in the inspection schedule appears to be warranted at this time.
AP-2005-5	The junction of the north dam exterior slope and the rip rap toe drain should be checked for presence of local erosion loss of ground into the rip rap during the regular inspections. Local depressions should be filled with gravel. Similarly, the interior edge of the north dam crest should be observed for local loss of ground into the interior slope rip rap and local depressions filled with gravel if found.	Routine inspection and maintenance.	Vegetation on slope is cut and junction easily seen. Local erosion loss of ground seen in 5 spots; continuing maintenance item.
AP-2006-1	Fill burrow on north dam seen at top of rip rap on interior slope.	Routine maintenance	Action closed. Continue to watch for animal burrows and fill in if seen.
AP-2006-2	Consider removing gravel berm around drop inlet at toe of north dam to allow better drainage.	Confirm schedule with plant	Discussion with Mr. Gilbert established that removal of filter berm could affect future suspended solids if water begins to discharge from riser structure; removal of the berm taken off list of recommendations.
AP-2006-3	Fill in erosion below outlet from riser with rip rap.	Confirm schedule with plant	Erosion was not observed to be a problem with current inspection (no change).

MACTEC is pleased to continue assisting Progress Energy with inspections of the ash pond dams at the Robinson Plant. Please contact us if you have any questions about this report.

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

James A. Schiff
Project Professional

J. Allan Tice, P.E.
Senior Principal Engineer
Registered, South Carolina 5512

SOUTH CAROLINA
REGISTERED PROFESSIONAL ENGINEER
5512
J. ALLAN TICE

JAS/jat

Cc: File copy with attached appendix

(Transmittal to include 3 print copies and 1 electronic (CD/PDF) copy with attached appendices)

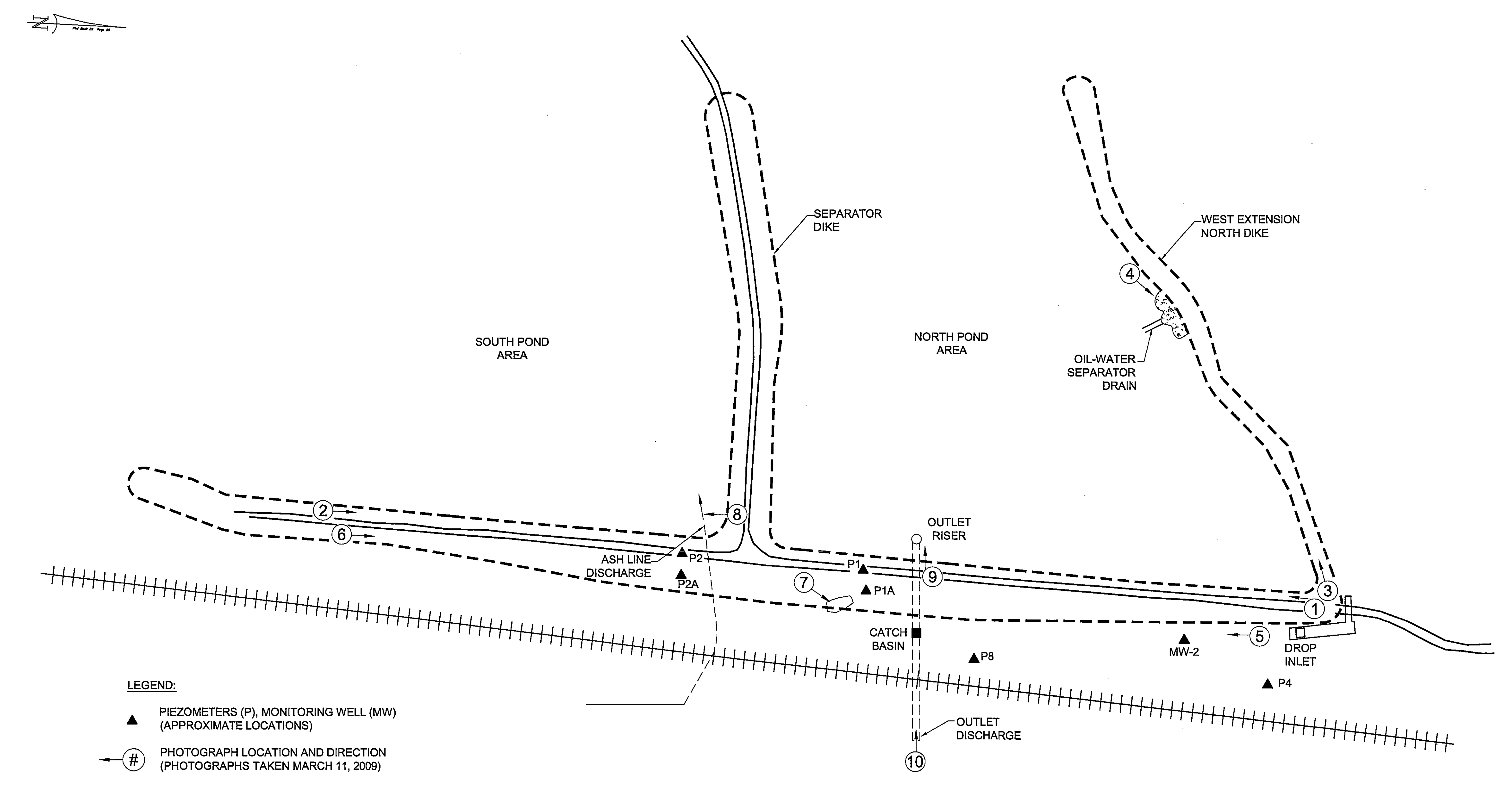
EXHIBIT Summary of Piezometer Water Level Readings

APPENDICES: A. Photographs and Photograph Location Maps-Ash Pond
B. Summary Dam Assessment Form

EXHIBIT 1
Water Elevations in Robinson Ash Pond Monitoring Wells

Date:	P 1	P 1A	P 2	P 2A	P4	P8	MW 2
TOC Elev	272.03	261.85	272.09	265.85	259.16	244.25	256.94
07/31/06	Dry	Dry	Dry	Dry	246.56	231.35	234.64
02/05/07	Dry	Dry	Dry	Dry	246.85	232.06	235.54
07/24/07	Dry	Dry	Dry	Dry	246.57	230.71	232.94
01/14/08	Dry	Dry	Dry	Dry	246.96	230.37	235.44
07/07/08	Dry	Dry	Dry	Dry	246.61	230.25	233.24
01/19/09	Dry	Dry	Dry	Dry	246.56	229.07	231.49
Max	0.00	0.00	0.00	0.00	246.96	232.06	235.54
Min	0.00	0.00	0.00	0.00	246.56	229.07	231.49
Avg	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	246.69	230.64	233.88

APPENDIX A
Photographs and Photograph Location Map
Ash Pond



MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.
3301 ATLANTIC AVENUE RALEIGH, NORTH CAROLINA

PHOTOGRAPH LOCATION PLAN
ASH POND
ROBINSON PLANT

DRAWN: R.R.	DATE: SEPTEMBER 2009	DRAWING
DFT CHECK: Jon	SCALE: N.T.S.	1
APPROVAL: Jr	JOB NO.: 6468-09-2351.05	

REFERENCE: LAW ENGINEERING DRAWING NO. 2; MODIFICATIONS TO ASH POND DAM.

P:\6468\Progress Energy\CP&L Projects 09\6468092351 Dam Inspections 2009\Drawings\Robinson\Rob Ash Pond Loc Plan 2009.dwg Wed, 23 Sep 2009 - 3:22pm rrahie

1. ASH POND - Crest and interior slope of north pond area looking south.

2. ASH POND – Crest and interior slope of south pond area looking north.

3. ASH POND – Crest and interior slope of north dike of north pond looking west.

4. ASH POND – View of oil-water separator drain along the interior slope of north pond adjacent to Darlington County Plant.

5. ASH POND – Toe of north pond area exterior slope looking south.

6. ASH POND – Exterior slope of South Pond looking north from southern end.

7. ASH POND – Typical local erosion hole at top of North Pond rock toe. Fill with gravel as a routine maintenance activity.

8. ASH POND – Ash discharge location in South Pond.

9. ASH POND – Vertical riser and trash guard at inlet point.

10. ASH POND – Outlet end of ash pond discharge pipe.

.

Appendix B
Summary Dam Assessment Form

FOSSIL GENERATION COOLING AND ASH POND DAM ASSESSMENT FORM

Last Revised: 09/20/09

PLANT & UNIT: H. B. Robinson

ASH POND:

VENDOR: MACTEC Engineering and Consulting, Inc.

OTHER INFORMATION:

Comments: Based on previous dam inspections and 2009 inspection.

CONCRETE STRUCTURES	RED	YEL	GRN	Date Revised: 05/01/09 Initials: JAS
CONCRETE SURFACES				NA
STRUCTURAL CRACKING				NA
MOVEMENT				NA
JUNCTIONS				NA
DRAINS				NA
WATER PASSAGES				NA
SEEPAGE				NA
JOINTS				NA
FOUNDATION				NA
ABUTMENTS				NA

EMBANKMENT STRUCTURES	RED	YEL	GRN	Date Revised: 09/20/09 Initials: JAT
SETTLEMENT				
SLOPE STABLITY				
SEEPAGE				
DRAINAGE SYSTEM				NA
SLOPE PROTECTION				

SPILLWAY STRUCTURES	RED	YEL	GRN	Date Revised: 05/01/09 Initials: JAS
CONTOL GATES				NA
UNLINED SPILLWAYS				NA
APPROACH CHANNEL				NA
OUTLET CHANNEL				NA
STILLING BASIN				NA

OUTLET WORKS	RED	YEL	GRN	Date Revised: 09/20/09 Initials: JAT
INTAKE STRUCTURE				
GATES				NA
SLUICES/WATER PASSAGES				
STILLING BASIN				NA
APPROACH CHANNEL				NA
OUTLET CHANNEL				Provide riprap stabilization for outlet pipe
DRAWDOWN FACILITIES				NA

SAFETY/PERFORMANCE INSTRUMENTATION	RED	YEL	GRN	Date Revised: 09/20/09 Initials: JAS
HEADWATER/TAILWATER GAGES				NA
ALIGNMENT INSTRUMENTATION				NA
MOVEMENT INSTRUMENTATION				Continue 6-month piezometer readings
UPLIFT INSTRUMENTATION				NA
DRAINAGE INSTRUMENTATION				NA
SEISMIC INSTRUMENTATION				NA

RESERVOIR	RED	YEL	GRN	Date Revised: 09/20/09 Initials: JAT
SHORE LINE				NA
SEDIMENTATION				NA
HAZARD AREAS				NA
WATERSHED RUNOFF				

OPS & MAINT FEATURES	RED	YEL	GRN	Date Revised: 05/01/09 Initials: JAS
RESERVOIR REG. PLAN				NA
MAINTENANCE				NA

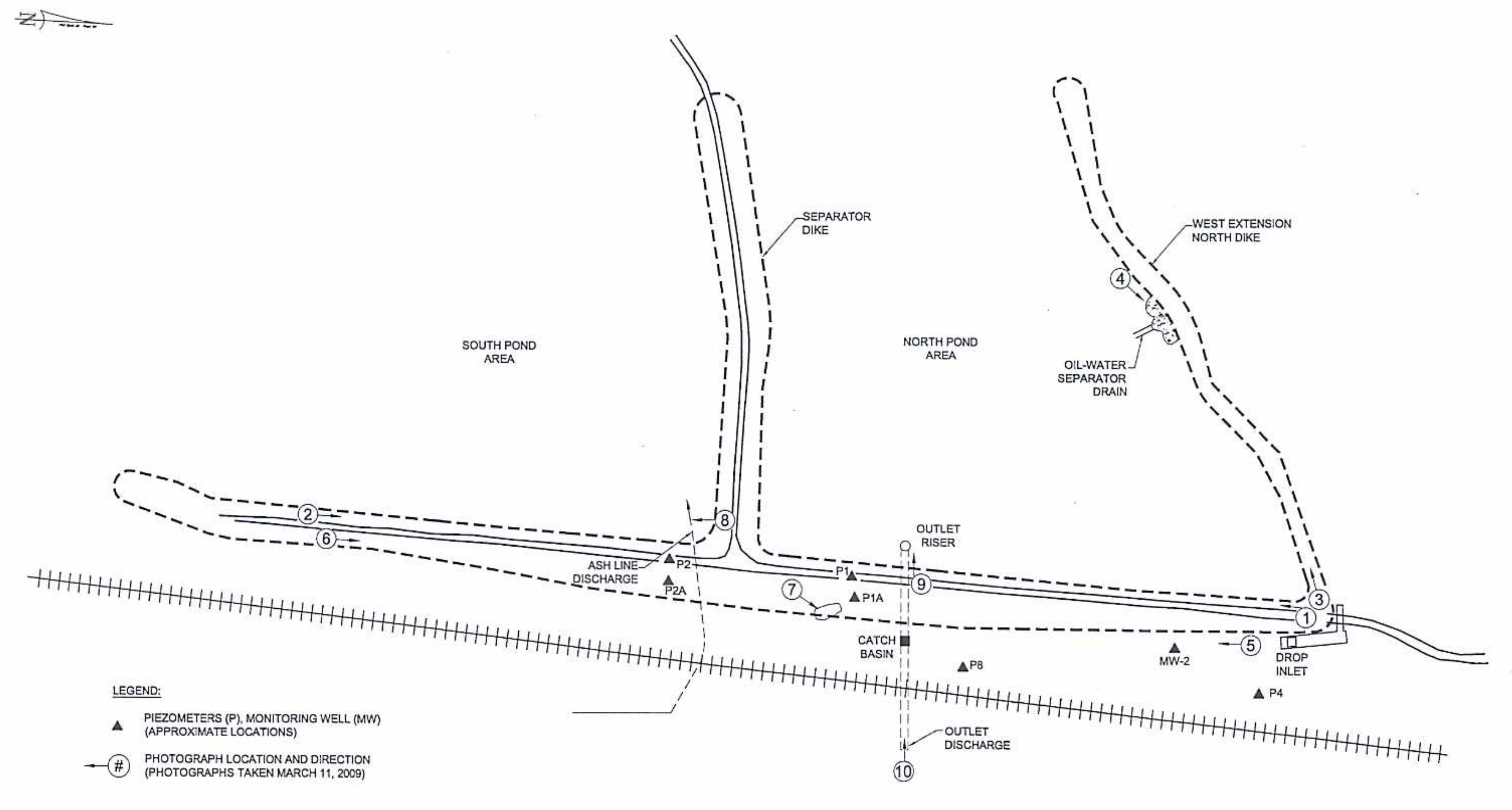
DOWNSTREAM CHANNEL	RED	YEL	GRN	Date Revised: 05/01/09 Initials: JAS
DOWNSTREAM CHANNEL				NA

Appendix A

Doc 09: H. B. Robinson Piezometer Readings

EXHIBIT 1
Water Elevations in Robinson Ash Pond Monitoring Wells

Date:	P 1	P 1A	P 2	P 2A	P4	P8	MW 2
TOC Elev	272.03	261.85	272.09	265.85	259.16	244.25	256.94
07/31/06	Dry	Dry	Dry	Dry	246.56	231.35	234.64
02/05/07	Dry	Dry	Dry	Dry	246.85	232.06	235.54
07/24/07	Dry	Dry	Dry	Dry	246.57	230.71	232.94
01/14/08	Dry	Dry	Dry	Dry	246.96	230.37	235.44
07/07/08	Dry	Dry	Dry	Dry	246.61	230.25	233.24
01/19/09	Dry	Dry	Dry	Dry	246.56	229.07	231.49
Max	0.00	0.00	0.00	0.00	246.96	232.06	235.54
Min	0.00	0.00	0.00	0.00	246.56	229.07	231.49
Avg	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	246.69	230.64	233.88



LEGEND:

▲ PIEZOMETERS (P), MONITORING WELL (MW) (APPROXIMATE LOCATIONS)

(#) PHOTOGRAPH LOCATION AND DIRECTION (PHOTOGRAPHS TAKEN MARCH 11, 2009)

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.
3301 ATLANTIC AVENUE RALEIGH, NORTH CAROLINA

PHOTOGRAPH LOCATION PLAN
ASH POND
ROBINSON PLANT

DRAWN: R.R.	DATE: SEPTEMBER 2009	DRAWING
DFT CHECK: Jon	SCALE: N.T.S.	1
APPROVAL: [signature]	JOB NO.: 6468-09-2351.05	

REFERENCE: LAW ENGINEERING DRAWING NO. 2; MODIFICATIONS TO ASH POND DAM.

Appendix B

Checklist

Appendix B

Doc 10: Dam Assessment Checklist

Site Name:	**HB Robinson Power Station**	**Date:**	**24 February 2011**
Unit Name:	**Ash Pond**	**Operator's Name:**	**Progress Energy**
Unit I.D.:		**Hazard Potential Classification:**	**High** ☐ **Significant** ☐ **Low** ☒[1]
	Assessor's Name:	**Frederic C. Tucker, PE; Anne Lee**	

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?	Bi-weekly[2]		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	263.0'[3]		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	~269.5'		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?		X	Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	272.0'		Is water exiting outlet, but not entering inlet?	X[6]	
6. If instrumentation is present, are readings recorded (operator records)?	X[4]		Is water exiting outlet flowing clear?	X[6]	
7. Is the embankment currently under construction?		X	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)?	X[5]		From underdrain?	N/A[7]	N/A[7]
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	X		From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		X	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		X	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

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

N/A = Not Applicable or Not Accessible

Note #	Comments
1	Hazard potential classification determined by a professional engineering consultant to Progress Energy, using US Army Corps of Engineers guidelines. The hazard potential classification would still be “low”, based on Dewberry’s interpretation of EPA criteria shown on page 3.
2	Progress Energy conducts bi-weekly internal inspections by plant operating personnel. Annual inspections and five-year inspections are conducted by third-party professional engineering consultants.
3	Design water surface elevation is approximately 269.5’ (top of overflow riser); however, no water was present in the basin at the riser location. During the site visit, the dry ash surface was observed to be approximately 2 feet below the trash rack (skimmer) on the riser. A small pool of water was observed at a low point in the ash surface at the north corner of the basin. The water surface appeared to be approximately 9’ below the dike crest or at about

	elevation 263.'
4	Piezometers in crest and downstream slope are read semiannually.
5	Foundation preparation information during original construction around 1960 and during raising of dike in 1982 not available. Construction guide specifications for raising of dike in 2002 indicate that debris and deleterious organics were to be removed from existing slopes. Before placing new embankment soil.
6	Water is exiting the outlet of junction box, but apparently not from outfall structure. Outfall structure discharges into a junction box, which connects to a storm drain system. Progress Energy personnel indicate the spillway has been lined and there is no seepage, however source of discharge is unknown. Progress Energy testing indicates discharge is stormwater.
7	Underdrain outlet(s) not observed during the site visit. A furnished pond summary dated January 25, 2011 indicates that a gravel toe drain was found at the base of the original dike downstream slope during raising of the dike, which presumably was the first raising in 1982, and the drain was extended by a pipe to a catch basin (junction box) downstream of the dike. Furnished drawings of the second raising of the dike in 2002 indicate that the downstream toe of the raised embankment was to have a rock toe covering the end of a filtered sand blanket drain placed between the pre-existing downstream slope and the new embankment fill for the raised dike.

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit SC0002925

ASSESSOR Frederic C. Tucker, PE; Anne Lee

Date May 1, 2007
Impoundment Name Ash Pond

Impoundment Company Progress Energy
EPA Region 4

State Agency (Field Office) Address 2600 Bull Street
Columbia, SC 29201
Name of Impoundment Ash Pond

(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 ccr currently being pumped into the impoundment?	☒	☐

IMPOUNDMENT FUNCTION: Designed to contain fly ash, bottom ash, boiler slag, ash sluice water, storm water, and chemical metal cleaning discharge.

Nearest Downstream Town Name: Hartsville, South Carolina

Distance from the impoundment: 8 miles

Location:

Latitude	34	Degrees	24	Minutes	50.8	Seconds	**N**
Longitude	80	Degrees	09	Minutes	44.0	Seconds	**W**

State South Carolina **County** Darlington

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

If So Which State Agency? SCDHEC, Bureau of Water/Compliance Assurance Division. For water quality only.

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.

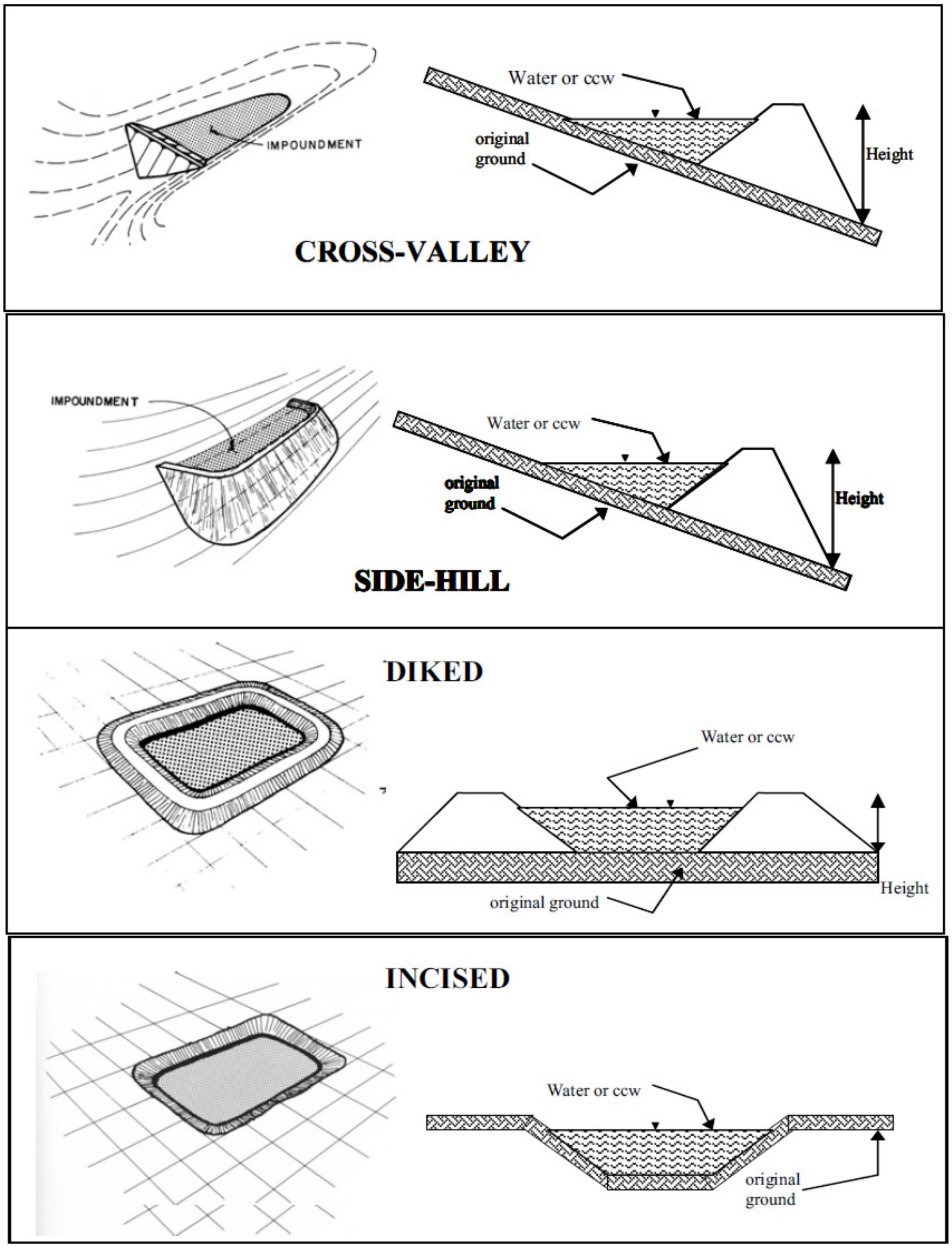
☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. 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:

Dam failure would discharge coal combustion residue into the discharge canal along west side of Lake Robinson and ultimately into Lake Robinsion but cause no loss of life. Failure would be contained within Progress Energy property but may disrupt/damage the railroad spur into the plant.

CONFIGURATION:



☒ Cross-Valley ☐ Side-Hill ☐ Diked

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

Embankment Height (ft) 32 (max) **Embankment Material** Earth

Pond Area (ac) 55 **Liner** None

Current Freeboard (ft) ≥2.5’

Liner Permeability

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

☐ Rectangular

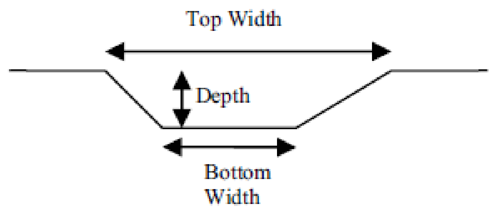
☐ Irregular

depth (ft)

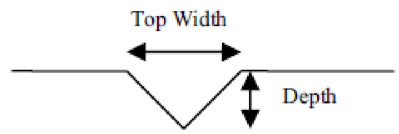
average bottom width (ft)

top width (ft)

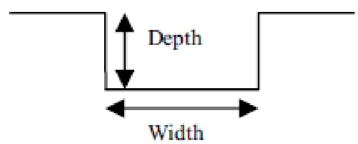
TRAPEZOIDAL



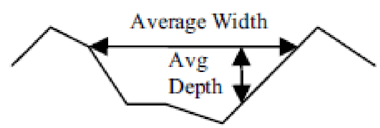
TRIANGULAR



RECTANGULAR

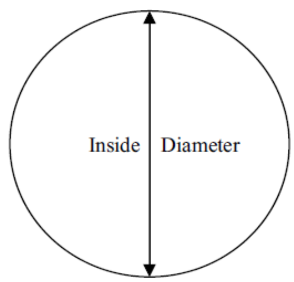


IRREGULAR



☒ **Outlet**

36” inside diameter
(smooth lined)



Material

☐ corrugated metal

☐ welded steel

☒ concrete

☒ plastic (hdpe, pvc, etc.)

☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☐	☒ No overflow at riser inlet

☐ **No Outlet**

☐ **Other Type of Outlet** (specify):

The Impoundment was Designed By	Unknown for original dike construction. Dike raise in 1982 was designed by CP&L with input from William Wells. Dike raise in 2002 was designed by Law Engineering and Environmental Services, Inc.

	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 information is available for original construction or for the 1982 dike raise.

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

Only for the dike raise in 2002 in which specifications called for removal of debris and deleterious organics from the existing slopes.

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

There was no indication of prior releases, failures, or patchwork on the dikes.