FINAL

Coal Combustion Waste Impoundment

Dam Assessment Report

Martins Creek Steam Electric Station
PPL Generation
Bangor, Pennsylvania

Project # 0-381

Assessment of Dam Safety
Coal Combustion Surface Impoundments
for the REAC Program

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INTRODUCTION

The release of over 5 million cubic yards of coal ash from the Tennessee Valley Authority's Kingston, Tennessee, facility in December 2008 serves as an important reminder of the need for our continued diligence on disposal units where coal combustion wastes are managed. The coal ash from the facility flooded more than 300 acres of land, damaging homes and property. It is critical that we all work to the best of our abilities to prevent a similar catastrophic failure and resultant environmental damage. One of the first steps in this effort is to assess the stability of the impoundments and similar units that contain coal combustion residuals and by-products to determine if and where corrective measures may be needed and then to carry out those measures as expeditiously as possible.

This report for the Martins Creek facility assesses the stability of two management units. The Martins Creek facility experienced a discharge water system failure in August 2005, causing a significant release of water and fly ash. Water and fly ash spread into surrounding fields and into Oughoughton Creek; fly ash was discharged into the Delaware River as well.

This assessment is based on site observations made on Wednesday, September 2, 2009 by Dewberry and Dewberry's review of furnished documentation, much of which is included as Doc. 2 through Doc. 45 in Appendix A. Selected documents are referenced in the text of this report, as appropriate.

PURPOSE AND SCOPE

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

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

> "Surface Impoundment or impoundment means a facility or part of a facility which is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), which is designed to hold an accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons."
>
> For this study, the earthen materials could include coal combustion residuals. EPA did not provide an exclusion for small units or based on whether the placement was temporary or permanent. Furthermore, the study covers not only waste units designated as surface impoundments, but also other units designated as landfills which receive free liquids.
>
> EPA is addressing any land based units that receive fly ash, bottom ash, boiler slag, or flue gas emission control wastes along with free liquids. If the landfill is receiving coal combustion wastes with liquids limited to that for proper compaction, then there should not be free liquids present and EPA did not seek information on such units which are appropriately designated a landfill.
>
> In some cases coal combustion wastes are separated from the water, and the water containing de minimus levels of fly ash, bottom ash, slag, or flue gas emission control wastes, are sent to an impoundment. EPA is including such impoundments in this study, because chemicals of concern may have leached from the solid coal combustion wastes into the waste waters, and suspended solids from the coal combustion wastes remain.

The purpose of this report is to evaluate the condition and potential of waste release from the selected High Hazard Potential 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 and e-mail communication with the a management unit supervisor.

EPA sent two engineers, one of whom was a professional engineer (PE), for a one-day site visit. The two-person team met with the owner of the management unit as well as several other management unit supervisors to discuss the engineering characteristics of the unit as part of the site visit. During the site visit, the team collected additional information about the management unit to be used in determining the hazard potential classification of the management unit(s).

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). The team considered criteria in evaluating dams under the National Inventory of Dams, in making these determinations.

LIMITATIONS

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

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from our a-day site visit and review of technical and historical documentation provided by PPL Generation (PPL) and by the Pennsylvania (PA) Department of Environmental Protection (DEP). These conclusions are also influenced by the fact that the subject coal combustion waste (CCW) impoundments are in the process of being closed and will not function as surface impoundments after closure .

Only the Ash Basin No. 1 Dam and the Ash Basin No.4 Dam are assessed in this report, since they are regulated dams that are open and can potentially impound water; they no longer receive coal combustion waste (CCW).

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

Ash Basin No. 1 Dam – On the basis of Dewberry engineers' review of available stability analyses and visual observations, the embankment dam appears to have adequate stability for conditions that will prevail after closure. There is a potential issue concerning the possibility of liquefaction occurring under the main cross dike, which is founded on ash, should a strong earthquake take place. However, the risk of a release from the basin should the main cross dike fail appears small due to the likely low mobility of predominantly bottom ash existing in a dry state behind (north of) the dike (see discussion for Basin No. 1 in Subsection 7.1.5). Post–closure loading conditions of the dam will generally be less severe than those checked in the stability analyses. See Dewberry's assessment in Section 7.3. The outlet structure is constructed of durable materials and no evidence of structural weakness or failure was observed in the field. The structure can be expected to have a long service life, but not a perpetual one. Final closure of the basin should consider completely plugging the structure with concrete and accommodating surface drainage by overland flow/shallow drainage pipe methods, if possible; the plug should completely fill the standpipe below final grade and the portion of the outlet pipe that extends through the dam. If the outlet structure must be relied upon for storm water drainage of the basin area after closure, the post-closure plan should include routine internal inspection of the structure as recommended in Subsection 1.2.7.

Ash Basin No. 4 Dam - On the basis of Dewberry engineers' review of available stability analyses and visual observations, the embankment dam has adequate stability. Post–closure loading conditions of the dam should be less severe than those checked in the stability analyses. See Dewberry's assessment in Section 7.3. The outlet structure is in sound condition with no visual evidence of significant deterioration. Adequate, redundant safeguards have been put in place to prevent a release from the basin like the 100 million-gallon release that occurred in 2005. The structure can be expected to have a long service life, but not a perpetual one. Final closure of the basin should consider completely plugging the structure with concrete and accommodating surface drainage by overland flow/shallow drainage pipe methods, if possible; the plug should completely fill the portion of the decant tower below final grade and the portion of the outlet pipe that extends through the dam. If the outlet structure must remain functional after closure,

as may potentially be required as a permit condition, the post-closure plan should include routine internal inspection of the structure as recommended in Subsection 1.2.7.

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

Ash Basin No. 1 Dam – On the basis of Dewberry's calculations and assumptions, adequate capacity and freeboard exist for the basin in its existing configuration to safely contain runoff from the 100-year storm, which is the required design according to Pennsylvania dam safety regulations. See our assessment is in Section 6.3.

Ash Basin No. 4 Dam - On the basis of Dewberry's calculations and assumptions, adequate capacity and freeboard exist for the basin in its existing configuration to safely contain runoff from the Probable Maximum Flood (PMF), which is the required design according to Pennsylvania dam safety regulations. See our assessment is in Section 6.3.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

Table 1.1.3 – Adequacy of Supporting Technical Documentation

	Ash Basin No. 1 Dam	Ash Basin No. 4 Dam
Hydrologic/Hydraulic Safety	Insufficient	Insufficient
Structural Stability	Adequate	Adequate

Insufficient technical analyses were available to support a conclusion regarding hydrologic/hydraulic safety of either Ash Basin No. 1 or Ash Basin No. 4. However, based on calculations using available data a conclusion was able to be reached as given above in Subsection 1.1.2.

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

Ash Basin No. 1 Dam - Descriptions provided are appropriate.

Ash Basin No. 4 Dam - Descriptions provided are appropriate.

1.1.5 Conclusions Regarding the Field Observations

Ash Basin No. 1 Dam – The dam appeared sound. The visible parts of the embankment dam and outlet structure were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability, although visual observations were severely hampered by the presence of thick vegetation. No seepage was observed, but the basin had no water in it at the time of the site visit. However, the basin does not normally impound water, since it is no longer actively used for disposal of CCW. A shallow depression or wallowed-out area at the outside toe of the roadway embankment next to

the southeast corner of the embankment dam appears to be a minor feature at this time and requires no action other than visual monitoring in future inspections (see Exhibit 3 for location). The depression possibly is an old erosional remnant from a past high stage flow in the adjacent Delaware River. There is an unlikely possibility that the depression is a surface reflection of sinkhole activity; this is believed to be unlikely because an available study of potential sinkhole activity at the site indicates low risk of sinkhole activity on the low terrace next to the river, where the bedrock is deep and covered with a thick layer of sand and gravel.

Ash Basin No. 4 Dam - The dam appeared sound. The visible parts of the embankment dam and outlet structure were observed to have no signs of overstress, significant settlement, significant shear failure, or other signs of instability, although visual observations of the outside slope were severely hampered by the presence of thick vegetation on the slope. The basin has a synthetic liner. No seepage was observed; the basin had little water in it at the time of the site visit. The basin currently impounds stormwater, since it is no longer actively used for disposal of CCW. Storm water accumulation is maintained below elevation 330 feet during closure operations by pumping the water to the Industrial Waste Treatment Basin (IWTB). The slight bulges (apparent slumps) noted under the synthetic liner are minor and require no action other than visual monitoring in future inspections. The wrinkles observed in the synthetic liner do not appear to unduly affect the serviceability of the liner at this time but could potentially be subject to more advanced deterioration due to added stress along the fold lines when the liner is buried. Animal burrows were not visible during the site visit, but an inspection performed by an independent consultant earlier in the year noted at least a dozen new wood-chuck burrows very soon after many previously observed burrows had been filled in. Thus, it appears that animal control measures such as trapping and relocation or eradication need to be implemented.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

Ash Basin No. 1 Dam - Maintenance and methods of operation are generally adequate, except for the lack of vegetation maintenance on the crest and outer slopes of the perimeter embankment dam. As long as the basin is capable of impounding water, the embankment dam should be routinely inspected; this will require maintenance of vegetation to allow effective observations. (See discussion in Subsection 8.3.2 of the potential of the basin to impound water.)

Ash Basin No. 4 Dam - Maintenance and methods of operation are generally adequate, except for frequency of mowing of the outer slope. The slope should be mowed more frequently as subsequently recommended. As noted above, it also appears that burrowing animal control needs to be implemented.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

Ash Basin No. 1 Dam – The surveillance program is generally inadequate. The monthly drive-by inspections should continue, but a more detailed walk-around inspection should be performed at least once annually. As stated in Subsection 1.1.1, internal inspection of the outlet structure should be performed routinely after closure of the basin, if the outlet is to be relied upon for storm drainage from the closed basin area. There is no dam monitoring program in place that includes such instruments as observation wells/piezometers,

settlement monitoring points, inclinometers, seepage monitoring points, etc. and none appears warranted at this time, now that the embankment no longer impounds an operating pool. A program of groundwater quality monitoring is in place and will continue in accordance with PA DEP Bureau of Waste Management permit requirements.

Ash Basin No. 4 Dam - The surveillance program is generally adequate. As noted in Subsection 1.1.1, internal inspection of the outlet structure should be performed routinely after closure of the basin, if the outlet is to remain functional after closure. There is no dam monitoring program in place that includes such instruments as observation wells/piezometers, settlement monitoring points, inclinometers, seepage monitoring points, etc. and none appears warranted at this time, now that the embankment no longer impounds a significant operating pool. A program of groundwater quality monitoring is in place and will continue in accordance with PA DEP Bureau of Waste Management permit requirements.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

Ash Basin No. 1 Dam - Facility is SATISFACTORY for continued safe and reliable operation while final closure is implemented.

Ash Basin No. 4 Dam - Facility is SATISFACTORY for continued safe and reliable operation while final closure is implemented.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Structural Stability

Ash Basin No. 1 Dam - None appear warranted at this time for the embankment dam. Although the visible parts of the outlet structure appeared sound, the structure cannot be expected to remain perpetually sound after closure. Therefore, it is recommended that the outlet structure be completely plugged with concrete as part of final closure, if possible. As discussed in Subsection 1.1.1, it is recommended that the plug completely fill the standpipe below final grade and completely fill the portion of the outlet pipe that extends through the dam. If the outlet structure must remain functional after closure, the post-closure plan should include routine internal inspection of the outlet structure as recommended in Subsection 1.2.7, below.

Ash Basin No. 4 Dam – None appear warranted at this time for the embankment dam. Although the visible parts of the outlet structure appeared sound, the structure cannot be expected to remain perpetually sound after closure. Therefore, it is recommended that the decant tower and outlet pipe be completely plugged with concrete as part of final closure, if possible. As discussed in Subsection 1.1.1, it is recommended that the plug completely fill the decant tower below final grade and completely fill the portion of the outlet pipe that extends through the dam. If the outlet structure must remain functional after closure, the post-closure plan should include routine internal inspection of the outlet structure as recommended in Subsection 1.2.7, below.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

Ash Basin No. 1 Dam - None appear warranted at this time.

Ash Basin No. 4 Dam - None appear warranted at this time.

1.2.3 Recommendations Regarding the Supporting Technical Documentation

Ash Basin No. 1 Dam - None appear warranted at this time.

Ash Basin No. 4 Dam - None appear warranted at this time.

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

Ash Basin No. 1 Dam - None appear warranted at this time.

Ash Basin No. 4 Dam - None appear warranted at this time.

1.2.5 Recommendations Regarding the Field Observations

Ash Basin No. 1 Dam – None appear warranted at this time, other than maintaining vegetation on the crest and outside slope and visual monitoring of the shallow depression at the outside toe of the embankment at the southeast corner as recommended in Subsection 1.2.6, below.

Ash Basin No. 4 Dam - None appear warranted at this time, other than more frequent mowing of the outside slope and implementing a burrowing animal control program as recommended in Subsection 1.2.6, below.

1.2.6 Recommendations Regarding the Maintenance and Methods of Operation

Ash Basin No. 1 Dam – As long as the embankment dam is capable of impounding water, it is recommended that the crest be cleared and maintained clear of trees, and it is recommended that the vegetation on the outside slope of the dam (excluding the more remote slope below the access road on the east side of the dam) be cut at least once a year to prevent large woody growth on the slope and allow visual inspection of the condition of the slope; the clearing should be coordinated with a programmed inspection, preferably one with a PA DEP dam safety inspector present. At the time the slope is cleared it is recommended that a trail be cleared to the shallow depression on the outside toe of the embankment at the southeast corner to facilitate access for inspectors. The post-closure maintenance program should also include repair of eroded areas that may develop on the outside slope or crest and control of burrowing animals, as necessary. If the standpipe and outlet pipe through the dam are to remain open and functional after closure, it is recommended that these structures be maintained or repaired as needed, based on the results of routine inspections.

Ash Basin No. 4 Dam - It is recommended that the outside slope be mowed at a frequency of 3 times per year: one time each during spring, summer, and fall. PPL's quarterly inspections and the annual inspection by the independent consultant should be coordinated with the mowing schedule. On the basis of observations made by an outside consultant in June 2009, it is recommended that a burrowing animal control program be implemented. It appears that the animals should be trapped and moved to a different location or eradicated. It is recommended that the control program be implemented within a time frame of one year. Filling of their burrows apparently is not effective and only encourages the animals to make new burrows. The post-closure maintenance program should also include repair of eroded areas that may develop on the outside slope or final closure cap. If the decant tower and outlet pipe are to remain open and functional after closure, it is recommended that these structures be maintained or repaired as needed, based on the results of routine inspections.

1.2.7 Recommendations Regarding the Surveillance and Monitoring Program

Ash Basin No. 1 Dam – In addition to the monthly drive-by inspections it is recommended that a more detailed walk-around inspection be performed at least once annually by a PPL engineer and documented by a written report or checklist. As long as the dam is capable of impounding water and is regulated by the PA DEP, it should also be inspected in accordance with the PA DEP manual titled, "Inspection, Maintenance, and Operation of Dams in Pennsylvania." If the outlet structure must remain functional to allow storm water drainage after closure of the basin, it is recommended that post-closure surveillance include internal inspection of the outlet structure on a frequency of at least once every five years to check for deterioration and structural defects that could develop in the interim; the information obtained would be used for assessing performance of the structure and judging when remedial work may be needed. Consideration may be given to using borehole cameras for inspection, particularly of the outlet pipe. Confined space techniques must be used by qualified, experienced personnel if the inspection is done by a person. In future inspections it is recommended that visual monitoring of the shallow depression observed at the outside toe of the embankment at the southeast corner be done. The visual monitoring may be discontinued if no adverse changes are noted after two years of monitoring, or sooner if so advised by an independent consultant or the PA DEP Division of Dam Safety.

Ash Basin No. 4 Dam – If the outlet structure must remain functional after closure of the basin, it is recommended that post-closure surveillance include internal inspection of the outlet structure on a frequency of at least once every five years as discussed above for the Ash Basin No. 1 outlet structure. As long as the dam is capable of impounding water and is regulated by the PA DEP, it should continue to be inspected in accordance with the PA DEP manual referenced above.

1.2.8 Recommendations Regarding Continued Safe and Reliable Operation

Ash Basin No. 1 Dam – No additional recommendations for continued safe and reliable operation appear warranted at this time.

Ash Basin No. 4 Dam – No additional recommendations for continued safe and reliable operation appear warranted at this time.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Fred Tucker, Dewberry
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1.3.2 Acknowledgement and Signature

We acknowledge that the management units referenced herein have been assessed on September 2, 2009.

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

2.1 LOCATION AND GENERAL DESCRIPTION

The Martins Creek Steam Electric Station (Martins Creek SES) is physically located on the west bank of the Delaware River in Lower Mt. Bethel Township, Northampton County, Pennsylvania, approximately 2 miles east of Martins Creek, Pennsylvania. The State of New Jersey lies across the river from the Martins Creek SES. The Martins Creek SES address is 6605 Foul Rift Road, Bangor, PA 18013-4857. Easton, Pennsylvania is approximately 9.4 miles downstream of Martins Creek SES. See Figure 1 for location of the Martins Creek Power Plant on a vicinity map.

The Martins Creek SES has five basins, four of which were used for disposal of coal combustion waste and are designated as Ash Basins No. 1, No. 2, No. 3 and No.4; one basin, designated as the Industrial Waste Treatment Basin (IWTB), is used for temporary storage and treatment of water from the Martins Creek Power Plant and from the adjacent Lower Mt. Bethel Power Plant. None of the ash basins is active, since there no longer are any coal-fired units at the Martins Creek Power Plant; the coal-fired units were taken out of service and removed in 2007 along with demolition of the smoke stacks. See Figure 2 for relative locations of the basins on an aerial view map of the Martins Creek Power Plant.

It is noted that all location references made in descriptions in this report are relative to "Plant North," which is actually northeast of "True North."

All of the basins were manmade by excavating the interior area of the basins and building a perimeter dike (dam) around the excavated areas; therefore, a substantial part of the storage volume in the basins is below original grade.

Ash Basin No. 1 has a surface area of approximately 23 acres. The maximum height of the perimeter dam is 35 feet above the outside toe. It is an unlined basin that received predominantly fly ash and bottom ash. The basin has been retired and is generally overgrown with vegetation, including some sizable trees. Basin No. 1 is regulated by the PA DEP Bureau of Waste Management and has recently come under regulation by the PA DEP Division of Dam Safety. The south end area of the basin has been closed by an alternate closure plan approved by the PA DEP. A final alternate closure plan has been developed by PPL for the entire basin including the north end area; the alternate closure plan is currently being reviewed by the PA DEP.

Ash Basin No. 2 has a surface area of approximately 22 acres. It is an unlined basin that received predominantly fly ash and bottom ash. The maximum height of the perimeter dam is 56 feet above the outside toe at one location of limited extent; most of the dam length is less than 20 feet high above the outside toe. This basin was permanently closed and covered in 1978-79 with a soil cap to the top of the perimeter dam and (presumably) graded it appropriately for surface drainage. The cap is currently covered with a dense growth of both herbaceous and woody vegetation, including tall weeds and grasses, bushes, and small trees. Three outlet structures (decant towers) along the east side of this basin are still in service and are used for pass-through flow of discharge from the IWTB. According to PPL, these former decant towers are outside of the closed basin. PPL indicated that a new dike was built along the edge of the former Basin No. 2 during closure, which put the

decant towers outside of the closed basin. The decant towers are square reinforced concrete risers fitted with wood stop logs on the west side. The stop log (west) side of each tower was sealed and reinforced on the interior side of the stop logs with a heavy steel plate bulkhead braced against the opposite reinforced concrete wall using structural steel struts. The three drainage towers are interconnected at the bottom with 24-inch diameter reinforced concrete pipes (RCPs). The northernmost tower receives drainage from a 42-inch diameter corrugated metal pipe (CMP) from the IWTB. The flow from the southernmost tower is through a 24-inch diameter RCP to a 5-foot diameter standpipe; from the standpipe the flow is through a pipe through the dam near the southeast corner of the basin to a manhole at the outside toe of the dam and from there to a Combining Structure. At the Combining Structure the flow from the IWTB formerly was combined with flow from Ash Basin No.4, and discharged into a 42-inch diameter CMP to an outfall into a grouted riprap channel to the river. This basin is not regulated by the PA DEP Bureau of Waste Management or the Division of Dam Safety and has never been under their purview.

Ash Basin No. 3 has a surface area of approximately 30 acres. It is a Hypalon-lined basin that received predominantly fly ash. The maximum height of the perimeter dam is 30 feet above the outside toe. This basin was permanently closed in the late 1980s. A soil cap was placed over the ash surface by "mud-waving" a thick soil layer into place. The outlet structure was filled with concrete. The soil cover was not placed to the height of the perimeter dam, but was graded to direct surface runoff to an interior drainage swale that encircles the area and outfalls into a catch basin with bottom discharge through a 24-inch diameter pipe to the river. The cap is currently covered with a dense growth of weeds, grass and other herbaceous vegetation and some woody vegetation, including clumps of bushes, and some small trees but generally has less woody vegetation than Basin No. 2. Basin No. 3 is not regulated by the PA DEP Bureau of Waste Management or the Division of Dam Safety and has never been under their purview.

Ash Basin No. 4 has a surface area of approximately 38.5 acres at top of dam elevation 355 feet, based on a furnished elevation-surface area curve. The impoundment surface area given by PPL is 37 acres; this is presumed to be the surface area at maximum storage capacity. The maximum height of the perimeter dam is 43 feet above the outside toe. It is a Hypalon-lined basin that received predominantly fly ash. The basin no longer receives ash, even though it has large remaining capacity, because the power plant no longer burns coal. This basin is not yet closed but a closure plan has been developed by PPL, and it is currently being reviewed by the PA DEP. Basin No. 4 is regulated by the PA DEP Bureau of Waste Management and the DEP Division of Dam Safety. The basin is currently being dewatered in preparation for closure; the water is filtered through a thick gravel layer around the decant tower and pumped to the IWTB. Water is no longer allowed to discharge through the outlet pipe in the bottom of the decant tower.

The IWTB has a surface area of approximately 15 acres. The basin is generally incised except on the west side, which is contained by an embankment dam that has a maximum height of 15 feet above the outside toe, but it typically is less than 15 feet. The IWTB is a lined basin that receives stormwater and wash waters from both the Martins Creek Power Plant and the adjacent Lower Mt. Bethel Power Plant; drainage from the plant area historically included surface runoff from the coal pile area, which no longer exists. It also receives filtered water pumped from the Ash Basin No. 4, which is being dewatered for closure. The liner originally was Hypalon, but it was replaced in 2008 with an oil resistant synthetic liner after sediment was dredged from the impoundment. The IWTB is regulated by the PA DEP Water Management Program. The DEP Division of Dam Safety is currently

reviewing the structure to determine whether it is regulated by the State's Dam Safety and Encroachments Act, Act No. 325.

Only the Ash Basin No. 1 Dam and the Ash Basin No.4 Dam are assessed in this report, since they are regulated dams that are still open and can potentially impound water, even though they no longer receive coal combustion waste (CCW).

Ash Basin No. 2 and Ash Basin No. 3 are not assessed in this report, since they have been closed for many years, no longer serve as impoundments, and are not and have not been regulated. However, some assessment is made with regard to the IWTB discharge through pipes, decant tower structures, and standpipe embedded in the east side of Ash Basin No. 2.

The IWTB is not assessed in this report, since it does not and has not received CCW. The water that is pumped from Ash Basin No. 4 is filtered before it is pumped to the IWTB, and thus it does not receive any appreciable CCW solids in that manner.

2.2 SIZE AND HAZARD CLASSIFICATION

Ash Basin No. 1 Dam - The PA DEP Division of Dam Safety currently classifies this dam as a Size Category "C" and Hazard Potential Category "3" dam, i.e., C-3. See explanation of the classification system below. The C-3 classification is equivalent to Small Size, Low Hazard Potential classification according to the USACE Recommended Guidelines for Safety Inspection of Dams ER 1110-2-106 criteria.

Ash Basin No. 4 Dam - The PA DEP Division of Dam Safety has classified this dam as a Size Category "B" and Hazard Potential Category "1" dam, i.e., B-1. See explanation of the classification system below. The B-1 classification is equivalent to Intermediate Size, High Hazard Potential classification according to the USACE criteria.

Pertinent physical data are presented in the following Table 2.1.

Table 2.1: Summary of Dam Dimensions and Size

	Ash Basin No. 1 Dam	Ash Basin No. 4 Dam
Dam Height	35'	43'
Crest Width	10'	15'
Length	4,240'	5,600'
Side Slopes (inside)	2.5:1	3:1
Side Slopes (outside)	2:1	2:1 Upper & 4:1 Lower
Hazard Classification	Low	High

The PA DEP Classification System is presented below.

Table 2.2: Size Classification*		
Class	Impoundment Storage (Acre-Feet)	Dam Height (Feet)
A	Equal to or greater than 50,000	Equal to or greater than 100
B	Less than 50,000 but greater than 1,000	Less than 100 but greater than 40
C	Equal to or less than 1,000	Equal to or less than 40

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

Table 2.3: Hazard Potential Classification Classification		
Category	Loss of Life	Economic Loss
1	Substantial	Excessive (extensive residential, commercial, agricultural, and substantial public inconvenience
2	Few (no rural communities or urban developments and no more than a small number of habitable structures)	Appreciable (damage to private or public property an short term public inconvenience)
3	None expected (no permanent structure for human habitation)	Minimal (undeveloped or occasional structures with significant effect on public inconvenience)

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

Ash Basin No. 1 - Based on information from PPL, this basin contains predominantly fly ash and bottom ash deposited in phased cells over a 40-year service life. The basin was last used in 2005 for emergency disposal of fly ash and dredged material from the Delaware River and Oughoughton Creek during clean up operations following a release from Ash Basin No. 4. The PA DEP approved use of the north end area of Basin No. 1 for this emergency disposal. As previously mentioned, this basin is currently retired; a closure plan that proposes an alternate closure process is in review by the PA DEP. A normal pool of water is not maintained in the basin. The amount of ash disposed in the basin has not been provided. However, a gross estimate of 660 acre-feet is derived, assuming an average area of 7 acres and average depth of 20 feet for the south basin area, and an average area of 13 acres and average depth of 40 feet for the north basin area.

Ash Basin No. 4 - Based on information from PPL, this basin contains predominantly fly ash with incidental amounts of soils, rocks, concrete, and plant residual waste. This was the active basin until the coal-fired units were taken out of service in 2007. Thus, this basin is only partly filled, perhaps between 1/3 and 1/2 of total capacity. As previously mentioned, the basin is currently being dewatered in preparation for closure; a closure plan is in review by PA DEP. PPL has indicated that the amount of waste disposed in the basin is 1,038,727 tons, as reported in their last submittal to PA DEP on June 30, 2008. Assuming an average unit weight of ash of 110 pcf,

the estimated volume of waste is 434 acre-feet. PPL has reported that the total storage capacity is estimated at 12.75 million gallons above grade, equivalent to 39 acre-feet, which seems low. The maximum potential storage volume (to top of dam above outside grade) is approximately estimated to be 1,085 acre-feet, assuming an average area of 31 acres and average depth of 35 feet.

Table 2.4: Amount of Residuals and Maximum Capacity of Unit

	Ash Basin No. 1 Dam	Ash Basin No. 4 Dam
Surface Area (acre)	23	37*
Current Storage Volume (acre-feet)	Not Reported (660 Est)	434*
Total Storage Capacity (acre-feet)	Not Reported (>660 Est)	Not Reported (1,085 Est)

*Based on data in PPL response to ICR,

2.4 PRINCIPAL PROJECT STRUCTURES

2.4.1 Earth Embankment Dam

Ash Basin No. 1 Dam - The dam embankment is compacted earth fill constructed primarily of native soils excavated on and near the site. The soils used for earth fill consist variously of silty sand and gravel and silty clay with coarse fragments ranging from sand size up to cobble size. Based on a section view of the embankment, the initial embankment with crest elevation 245 feet was designed to have a compacted fly ash layer within the inside flank of the embankment (under inside slope), presumably to provide a seepage barrier (see Exhibit 1). The total length of the perimeter dam is approximately 4,240 feet. Because the basin is totally enclosed by the perimeter dam, the basin does not receive surface runoff from outside the basin area. That is, the drainage area for the basin is the area of the basin itself. The embankment around the northern two-thirds of the basin was raised three times in stages of 5 feet, 8 feet, and 5 feet to an ultimate crest elevation of 263 feet; the cross dike dividing the northern two-thirds from the southern one-third of the basin was constructed over ash. The berm for each dam raise was constructed over ash on the interior side. The ash used for foundation support was indicated to be firm fly ash and bottom ash or well-compacted bottom ash. The geometry of the initial dam and each dam raise consisted of 2 horizontal (H) to 1 vertical (V) outside slope 2.5 H to 1 V inside slope and 10-foot wide crest. Drainage from the northern part of the basin to the southern part was through multiple 12-inch diameter CMPs constructed in rows at each berm level as the dam was raised around the northern part. The basin was not lined. No internal drainage blankets or toe drains were used for seepage control. However, the bottom of the basin is generally in a natural sand and gravel layer that served to drain the water from the ash sluiced into the basin. A representative section of the embankment around the northern part of the basin is shown in Exhibit 1.

Ash Basin No. 4 Dam - The dam embankment is compacted earth fill constructed primarily of native soils excavated on site. The entire basin, including the inner slopes of the embankment, is lined with 36-mil scrim-reinforced Hypalon liner bedded on geotextile. The embankment was designed to consist primarily of random fill but with select fill in a 2-foot thick zone under the liner system. The random fill zone was specified to "consist of a miscellaneous mixture of clay, silt, sand, gravel, cobbles and rock fragments not

exceeding 6 inches in maximum dimension." Boulders and rock fragments larger than 6 inches were to be excluded. "Nests of rocks or cobbles, and gravels and coarse-grained soils with less than 12% fines...after blending" were also to be excluded, although nested rocks and cobbles were allowed in the toe area of the dam if placed in 12-inch lifts and compacted with four passes of a roller. The select fill zone was specified to "consist of select material from the excavation," excluding "pervious materials or cobbles or rock fragments larger than 3 inches in maximum dimension." Both the random fill and the select fill were specified to be placed in 8-inch thick loose lifts with each lift compacted to at least 95 percent of the standard Proctor (ASTM D 698) maximum dry density. The embankment was constructed on a prepared foundation. Extensive grouting of shallow limestone was performed in an area approximately 200 feet wide by 800 feet long along the northeast section of the dam and basin. A geophysical survey had been performed to help delineate the sink-hole prone area. A couple of sink holes developed during foundation preparation. These were grouted and concrete was placed over them. Any weathered limestone exposed in the excavation was treated with dental grout. No sinkhole problems have reportedly developed over the 19 years since its construction. The embankment dam was constructed full height to crest elevation 355 feet and has not been altered since original construction. Gravel surfacing was placed on the crest and on a perimeter road along the outside toe, and Crown Vetch was established on the outer slope. The total length of the perimeter dam is approximately 5,600 feet. Because the basin is totally enclosed by the perimeter dam, the basin does not receive surface runoff from outside the basin area, so that the drainage area for the basin is the area of the basin itself. The geometry of the dam consists of 2 H to 1 V outside slope from the crest down to elevation 335 feet and 4 H to 1 V below this elevation, 4 H to 1 V inside slope, and 15-foot wide crest. The zone where nested rocks and cobbles were allowed in the embankment dam is located under the 4 H to 1 V lower portion of the outside slope. No internal drainage blankets or formal toe drains were used for seepage control. A representative section of the embankment dam is shown in Exhibit 2.

2.4.2 Outlet Structures

Ash Basin No. 1 - The outlet works consist of a 48-inch diameter extra strong RCP riser (standpipe) with bottom discharge through an approximately 440-foot long, extra strong 36-inch diameter RCP conduit through the perimeter dam and through the adjacent roadway embankment to outfall near the Delaware River; beyond the toe of the roadway embankment the outlet pipe is encased in large dumped riprap (3-foot minimum cover), presumably to protect the pipe against high river stages. The standpipe is located at the southeast corner of the basin (southern portion), and the outlet pipe extends east to the river. The standpipe is accessed with a steel catwalk. When water flows into the standpipe it first passes through a V-notch weir that has an invert 1.75 feet below the top of the standpipe, which is stated to be at elevation 241.44 feet, based on a notation on the drawings; thus, the invert of the V-notch weir would to be at approximate elevation 239.7 feet. The top of the standpipe is covered with a steel mesh screen. Partial plan and section views of the outlet are shown in Exhibits 3 and 4.

Ash Basin No. 4 - The outlet works consists of a two-chamber rectangular reinforced concrete decant tower with bottom discharge into a 33-inch diameter RCP that extends through the bottom of the perimeter dam to a manhole located beyond the outside toe of the embankment dam. The decant tower is located at the southeast corner of the basin, and the outlet pipe extends through the embankment dam in a

southeasterly direction to the manhole. The invert of the 33-inch diameter RCP at its inlet end in the bottom of the decant tower is 311.0 feet. The 33-inch diameter RCP continues downgradient through several manholes and eventually reaches the combining structure (concrete basin) where flow from Ash Basin No. 4 formerly was combined with flow from the IWTB and discharged through a CMP to the outfall near the river. Exhibit 5 illustrates the route of the pipeline, as well as the locations of the various basins at the Martins Creek SES. The top of the decant tower is accessed from the top of the dam with a steel catwalk (footbridge). The overall inside dimensions of the decant tower in plan view are 7 feet by 10.58 feet, with the long dimension oriented the same as the discharge pipe (NW-SE). The middle of the decant tower was originally fitted with creosote-treated wood stop logs across (perpendicular to) the long dimension; the stop logs fit in guide slots formed in the walls. A steel plate skimmer gate fits in gate guides on the open (NW) side of the decant tower. The skimmer gate is used to block entry of floating ash particles into the first chamber. From the first chamber, water overflowed the stop logs into the second chamber, where the water flowed out through the bottom discharge pipe. The stop logs were used to control the pool level in the basin.

The second from the bottom stop log failed in August 2005, causing a significant release of water and fly ash that overwhelmed the downgradient manholes, which overflowed and fly ash spread into surrounding fields and into Oughoughton Creek; fly ash was discharged into the Delaware River as well. (See Section 3.3 and Appendix A for further discussions of the release)

As a result of this failure a number of modifications were made to the outlet structure. The principal modifications included:

1. Sliplining the 33-inch diameter outlet pipe from the decant tower to a new manhole (reinforced concrete vault) located on the pipeline beyond the outside toe of the dam and fitting each end of the sliplined pipe with a knife gate valve.
2. Replacing the wooden stop logs with steel reinforced precast concrete panels and stop logs, with the lowest panels horizontally braced with steel struts.
3. Installing heavy duty reinforced steel skimmer slot plates on the open side of the decant tower, to form a steel wall on the open side as the ash level builds up in the basin.

Additional modifications included installing a bar screen barrier at the inlet end of the outlet pipe at the bottom of the decant tower and installing basin water level monitoring instruments. Also, two short sections of the downgradient discharge pipeline were replaced where video inspection found them to be slightly collapsed, and a couple of the downgradient manholes were replaced, one due to damage caused by the force of the excessive water flow and the other in order to repair sinkholes that had developed along the pipeline during the incident. The schematic section Exhibit 6 illustrates the outlet structure and the principal modifications that were made as a result of the release incident.

The outlet structure is no longer used, not even for discharge of stormwater from the basin. Currently, residual water and stormwater are pumped to the IWTB. The amount of water in the basin at the time of the site visit was minimal at a level of 327 feet, which was 28 feet below the dam crest and 21 feet below

the former operating pool elevation. The proposed closure plan calls for plugging the outlet structure with concrete.

2.5 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

Using Microsoft's Bing Maps dated 2009, no "critical" infrastructure was observed within a 5 mile down gradient radius. "Critical" infrastructure would include facilities such as schools and hospitals. There is an animal hospital located within the 5 mile down gradient radius. In general, the land use downstream from this particular site is agricultural with some cemeteries and recreational parks. These facilities have been called out within Documents A1.1 through A1.10 in Appendix A of this report.

Documents A1.1 through A1.10 within Appendix A of this report depict relevant maps within the region of Martins Creek SES. Specifically, Documents A1.3-A1.10 depict snapshots down gradient from the Plant. The aerial photography used accurately represents what exists down gradient of the site. These locations were verified as being down gradient using sections of the USGS quadrangles relevant to the region.

Flood impacts from postulated failure of the basins at the Martins Creek SES would be local in nature, as illustrated by a copy of the Inundation Map for Ash Basin No. 4 shown in Exhibit 8. This map presumably is based on a basin-full situation, which is highly unlikely to occur now that the basin is no longer used for fly ash disposal.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS AND INCIDENTS

3.1 SUMMARY OF REPORTS ON THE SAFETY OF THE MANAGEMENT UNIT(S)

Ash Basin No. 1 - According to the PA DEP's Dam Safety Inspection notice (Doc. 6, p. A-41 in Appendix A) dated September 2, 2009, there were no significant violations noted at Ash Basin No. 1. DEP representative, Richard Reisinger, who completed this inspection notice commented, "[Ash] Basin [No. 1] is mostly covered with vegetation, trees and brush and does not appear to impound water on a routine basis...Dam permit application for closure of the Basin has been submitted and is currently under review by the Division [PA DEP]."

With respect to environmental safety, the following information was taken from the HELP Scenarios Model Report (Doc. 3, p. A-17 in Appendix A): Ash Basin No. 1 was analyzed using the US EPA model - HELP (Hydrologic Evaluation of Landfill Performance) Version 3.07, HELP is a quasi two-dimensional hydrologic model of water movement across, into, through and out of landfills. By manually inputting weather, soil and design data, the HELP model accounting for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembrane or composite liners, the program developed for the EPA will conduct water balance analysis of landfills, cover systems and solid waste facilities.

The HELP model was used to evaluate saturation within Ash Basin No. 1, deriving a water balance for a hypothetical extreme 7-day, 42 inch rain event (77.20 inches total annual precipitation; almost twice the normal precipitation). Estimates of runoff, evapotransporation, and percolation/leakage rates were found. The results are seen below in Table 3.1a.

Table 3.1A: HELP Model Saturation Results: Ash Basin No. 1 (Feb. 2008)

Profile	Profile Description	Layer Name	Layer Thickness (ft)	Post Storm water thickness (ft)	Total Porosity (vol/vol)	Post-Storm Water Storage (vol/vol)	Layer Saturation (%)
1	Fly Ash Underlain by Sand	Fly Ash	35	13.81	0.54	0.39	73
		Coarse Sand	10	1.09	0.42	0.11	26
2	Bottom Ash Underlain by Sand	Bottom Ash	35	8.72	0.45	0.25	55
		Coarse Sand	10	1.23	0.42	0.12	33
3	Bottom Ash interbedded in Fly Ash; underlain by Sand	Fly Ash	10	5.39	0.54	0.54	100
		Bottom Ash	15	3.07	0.45	0.20	45
		Fly Ash	10	3.15	0.54	0.32	58
		Coarse Sand	10	1.23	0.42	0.12	30
4	Fly Ash interbedded in Bottom Ash; underlain by Sand	Bottom Ash	10	2.86	0.45	0.29	64
		Fly Ash	15	6.79	0.54	0.45	84
		Bottom Ash	10	1.41	0.45	0.14	31
		Coarse Sand	10	1.24	0.42	0.12	30

The HELP model was also used to predict amounts of vertical leakage or percolation from the bottom layer of ash to the underlying sand and gravel. These results for the hypothetical extreme wet year are seen below in Table 3.1b.

Table 3.1B: HELP Model Percolation Results: Ash Basin No. 1 (Feb. 2008)

Profile	Profile Description	Leakage into Groundwater		Equivalent Rise of Water Table*
		(inches)	(feet)	(feet)
1	Fly ash underlain by sand	3.02	0.25	0.60
2	Bottom ash underlain by sand	23.00	1.92	4.56
3	Bottom ash interbedded in fly ash; underlain by sand	7.77	0.65	1.54
4	Fly ash interbedded in bottom ash underlain by sand	14.81	1.23	2.94

***Calculated on the basis of sand layer porosity of 42%. Each foot of leakage corresponds to 2.38 feet rise of the water table (1 foot/0.42=2.38 ft).**

Both models confirm that even in the hypothetical wet year, worst possible case scenario, there would still not be enough water present to saturate Ash Basin No. 1 or bring the water table up to an elevation in contact with the bottom of the ash.

Ash Basin No. 4 - The PA DEP Dam Safety Inspection reports from 2000-20009 are posted as Doc. 44 (p. A-811) within Appendix A. These reports were used as references in addition to Doc. 29, Appendix A to complete the following summary:

The 2009 Annual Inspection of Martins Creek Ash Bain No. 4 (Doc. 29, p. A-478 in Appendix A) was performed by HDR/DTA. This document states that "Ash Basin No. 4 is no longer in service and is in the process of being closed." It was noted that the water level was drawn down approximately 20 feet since the previous year with the intent to maintain the maximum water level within the basin at or below elevation 330 feet (approximately 20 feet below the historic full operating level). Ash Basin No. 4 "is still classified as a medium-sized, high hazard potential dam by the PA DEP and is therefore required to have annual inspections."

The inspection reports that "the embankment was in good condition, with no evidence of seepage, movement, or instability." Regarding stability, "the overall reduction in water level represents a significant increase in the stability and security of the embankment with respect to dam safety issues."

The discharge structure was reported as being worked on during the inspection, however, it was noted that "the concrete and bridge were in good condition."

"The downstream slope of the east embankment…appeared to be in good condition with little to no evidence of movement, sinkholes, distress, seepage, wet areas, or erosion." PPL reported that several animal burrows had been filled in on the east embankment prior to the inspection. The inspection however still notes the presence of several more animal burrows observed. "The liner was generally found to be in good condition on this section of the embankment."

The Northeast (north according to plant north) Embankment upstream and downstream slopes "appeared to be in good condition with little to no evidence of movement, sinkholes, distress, or erosion," This was generally true for the East, Southeast (South) and West embankments as well. Several 1-foot-high apparent slumps under the liner extending 200 feet were observed in the upstream slope of the West embankment. However, "there was no evidence of movement, settlement, cracking, or other distress in the 15-foot-wide gravel surfaced crest." Bulges suggesting slumps under the liner on the upstream slope of the East embankment were also observed. "It is not clear what caused these slumps, but paint marks on the liner indicate that at least one slump was observed in 1995." With respect to the apparent slump areas it was noted that "No action in either of these areas is considered necessary except that the liner should be cut to relieve tension and then patched in any areas that are to be filled."

At the time of the 2009 Annual inspection, the impoundment had been drained and PPL was in the process of capping the ash basin. PPL intended to leave a small 3- to 4-acre area as a settling basin to treat rainwater discharge. "Ditches [have] been cut in the [ash] fill to increase drainage."

"PPL noted that a number of monitoring wells were planned in the impoundment as part of the closure plan, although these had not been installed," at the time of the 2009 annual inspection.

The 2009 annual inspection provided several recommendations regarding the presence of burrowing animals at Ash Basin No. 4. It was also suggested that vegetation be trimmed for as long as the Basin is considered to have a "high hazard potential."

3.2 SUMMARY OF LOCAL, STATE AND FEDERAL ENVIRONMENTAL PERMITS

The Martins Creek facility is currently regulated under NPDES Permit No. PA-0012823. This permit became effective December 1, 2006 and will expire at midnight on November 30, 2011.

Ash Basin No. 1 – The basin is regulated by the PA DEP Bureau of Waste Management. During active operation, the basin was regulated as a local, captive Class II residual waste disposal impoundment under PA DEP Permit No. 301256, which was effective on October 30, 2000 and expired on August 12, 2009. The conditions in effect under that permit are included in Doc. 23 (p. A-352) in Appendix A for reference. The PA DEP is currently reviewing PPL's proposed closure plan for the basin and presumably will develop approved permit conditions for closure in an updated permit.

According to Permit No. 301256, the categories of waste were limited to the following:

- Bottom ash
- Fly ash
- Uncontaminated, nonwaste, river sediment from the Martins Creek Steam Electric Station's water intakes

Selected conditions of the Permit No. 301256 are quoted or summarized below for information (see Doc. 23 in Appendix A for all conditions).

"The Liner System and Leachate management requirements for a Class II residual waste impoundment, such as Ash Basin No. 1 have been modified and are contingent upon the continued stability of the basin dikes, and the absence of groundwater degradation. Specifically, the approved liner system and leachate management requirements entail the following:

- Coal bottom ash structural fill/subgrade.
- No liner.
- Earthen base composed of in-place river sands.
- Earthen dikes.
- No leachate detection zone.
- No leachate collection or treatment except as required for NPDES discharge permit."

"Ash Basin No. 1's North End may be utilized as a source and stockpile area for bottom ash used for beneficial use." Only bottom ash was allowed be removed from the basin, pending that it did not interfere with the

operations and/or construction of the basin. "Non-bottom ash waste materials may not be removed from this basin without written Department approval."

According to this permit, no cap has yet been permitted for the authorized disposal area (the North End of Ash Basin No. 1). "Within six months of North End closure, the permittee shall submit for approval, an updated closure plan/closure schedule addressing all regulatory requirements including erosion and sedimentation control requirements." During efforts to reach closure grades, the permit specifies that "no non-bottom ash may be used as fill…without written Department approval."

The South End of Ash Basin No. 1 was originally to be closed by the re-grading and placement of one foot of re-vegetated final cover. The South End was actually closed without the placement of one foot of cover soil and re-grading, in accordance with a DEP-approved alternate closure plan. The permit indicated that, "This cap waiver authorization does not cover the re-permitted North End disposal area covered [in] this permit."

The permit discusses several monitoring points throughout Ash Basin No. 1. It is stated that no monitoring points may be eliminated without approval of the Department. Regarding groundwater sampling, the permit requires that "the permittee will conduct quarterly and annual sampling of the monitoring wells for the parameters listed on Form 14R with the following modifications: Boron, Magnesium and Lithium will be analyzed quarterly. All metals will be analyzed for total and dissolved concentrations." The permit goes on to say that "water quality monitoring reports must be submitted to the Department for all approved monitoring points."

The final closure plan currently under review by the PA DEP will incorporate all South End post-closure obligations as well as North End closure/post-closure requirements, including any basin-wide requirements such as the outfall structure.

Ash Basin No. 4 - The basin is regulated by the PA DEP Bureau of Waste Management. During active operation, the basin was regulated as a local, captive Class II residual waste disposal impoundment under PA DEP Permit No. 301256, which was effective on October 30, 2000 and expired on June 6, 2009. The conditions in effect under that permit are included in Doc. 37 (p. A-663) in Appendix A for reference. The PA DEP is currently reviewing PPL's proposed closure plan for the basin and presumably will develop approved permit conditions for closure in an updated permit.

Selected conditions of the Permit No. 301257 are quoted or summarized below for information (see Doc. 37 in Appendix A for all conditions).

This permit granted approval for limited disposal of coal ash and other approved residual wastes meeting the minimum acceptability criteria. The following categories of waste were within the limits of this approval:

- Fly ash
- Bottom ash
- Sediment from the Industrial Waste Treatment Basin
- Iron sludge from boiler cleaning

No closure cap waiver was granted at the time of this permitting. "Within six months of closure, [Martins Creek, LLC] shall submit for approval an updated closure plan/closure schedule addressing all regulatory requirements including erosion and sedimentation control requirements." The permit states that "no bottom ash may be used as fill to reach closure grades without written Department approval."

Groundwater monitoring/sampling is to be conducted at several specified points around Ash Basin No. 4. No modifications to these locations are to be made without written approval from the Department.

As specified in a letter from the PA DEP dated October 31, 1996 (end of Doc. 37 within Appendix A), "To receive a Dam Permit to abandon a waste impoundment dam, the applicant must submit a reclamation closure plan approved by all appropriate Department programs."

December 2005, Permit No. 301257 was modified addressing design, construction, and operational changes at Ash Basin No. 4 following the August 23, 2005 Ash Basin discharge tower failure. These modifications are specified in Doc. 38 (p. A-678) within Appendix A. In this document it is stated that "Design and construction changes, along with required repairs, have been made by PPL in order to provide additional safeguards against the recurrence of any similar type of incident." The document specifies changes and understandings necessary for the start-up and operation of Ash Basin No. 4 since the August 2005 discharge.

Modifications to permit # 301257 regarding the design specify the installation of the following:

- Concrete logs/panels in the discharge structure
- Additional metal skimmer plate barrier in the discharge structure
- New knife gate/valve within the discharge structure
- New manhhole with additional knife gate/valve outside the basin disposal area
- Insitu lining of the concrete pipe between the discharge structure and new manhole
- Water level monitoring instruments within the discharge structure

3.3 SUMMARY OF SPILL/RELEASE INCIDENTS (IF ANY)

Ash Basin No. 1- There have been no reported spill/release incidents at this basin.

Ash Basin No. 4 - Tuesday August 25. 2005, Ash Basin No. 4 had a release of approximately 100 million gallons of water and fly ash into the Delaware River and surrounding public and plant property. It has been determined that the cause of this release was due to a failure of a wooden stop log (stop log #2) in the discharge structure of Martins Creek Ash Basin No. 4. The release occurred over a span of 3 days.

A multi-disciplined team composed of individuals with backgrounds in fossil plant engineering, fossil plant operations, environmental management, nuclear management, and internal auditing was created at the request of PPL Generation, LLC to analyze the root cause of this failure. Based upon a review of this team, it was concluded that the release resulted from the failure of stop log #2, which failed due to a fabrication defect, dating back to the original construction of the basin in the 1980s.

Stop log #2 was the second from the bottom of a stack of approximately 40 logs. The fabrication defects in this log were not identified by the periodic dam inspections. Once the log failed, there was no shutoff valve in the discharge pipe or other secondary barrier to prevent the subsequent release of water and ash.

Full documentation of the Martins Creek Basin No. 4 Root Cause Analysis Report can be found within Appendix A of this report.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

Ash Basin No. 1 – The original construction on the basin began in 1955 using local materials excavated from the basin interior to construct the embankment dam. The basin was incised below original ground and was originally bound on the north side by the oldest of three existing median dikes. This original dike rose to an elevation of 245 feet. The lowest elevation on the basin's floor was at an approximate elevation of 213 feet. The basin was unlined; "the earth underlying Ash Basin No. 1 is gravely sand with cobbles" (Doc. 8 in Appendix A).

Ash Basin No. 4 – This man-made basin was permitted for construction on March 31, 1988 by the PA DEP Dam Safety Program. It was constructed to be approximately 40 acres in area and 65 feet in depth with the bottom incised below original grade. The basin was constructed to have a "36-mil [scrim]-reinforced Hypalon liner" (Doc. 34 in Appendix A). "The discharge structure [decant tower] at Ash Basin No, 4 is a 45-foot high concrete tower" constructed to have two chambers (Doc. 24 in Appendix A). There were originally wooden stop logs "fitted into a steel reinforced channel," dividing the inner chamber from the outer chamber and allowing adjustment of operating water levels in the basin (Doc. 24 in Appendix A). Water overflowing the stop logs into the inner chamber discharged through a bottom outlet pipe that was connected to a piping system, which ultimately discharged to the Delaware River. "The original wooden stop logs were treated with creosote to prevent underwater deterioration" (Doc. 24 in Appendix A). The open side of the outer chamber was fitted with an adjustable steel skimmer plate, which served to block floating ash material from the outlet structure.

4.1.2 Significant Changes/Modifications in Design since Original Construction

Ash Basin No. 1 – The following information was referenced from Doc. 8 (p. A-67) in Appendix A. In 1964, a second median dike was constructed parallel to the original median dike. This new dike and the existing original dike were joined to fully enclose the entire north side of the basin at a higher elevation than the south side. The height of these dikes was elevation 250 feet. These dikes were partly constructed over stable mixture of fly ash and bottom ash.

In 1969, both the original median dike and the 1964 median dike were intentionally breached. This was done presumably to make use of ash storage volume available south of the 1964 median dike. A large channel was formed by water and bottom ash flowing through the breech.

In 1973, the construction of the third and final median dike began. This median dike was constructed atop existing bottom ash in the basin. The start of the existing north-south overflow pipes was built into this new median dike. These pipes were installed directly over the top of the channel created by the 1969 intentional breach of the original two median dikes.

In 1974, the existing exterior dikes along the north end of the basin were raised to 258 feet in elevation. In 1975 these north end dikes were again raised to their final elevation of 263 feet. These dikes also were partly constructed over stable bottom ash.

Through the 1970s and 1980s, bottom ash accumulated in the North end of Ash Basin No. 1. Later in the 1980s, much of this accumulated bottom ash was excavated to be used in the construction of Ash Basin No. 4 as bedding or cushion layer for the synthetic liner. During this time, a second channel was constructed along the railroad side (west side) of the basin.

This second channel was directed to the pipes installed within the final median dike to provide overflow connection from the north to the south ends of the basin. This channel enhanced the already occurring channeling flow (which began spontaneously during the ash accumulation in the northern end of the basin in the 1970s-1980s) away from the river side (east side) of the basin. Over time, this channel filled with coarse bottom ash. Since the construction of this channel, there has been a vein of relatively coarse ash providing a pathway for subsurface water flow from the far north end of the basin to the depression near the outlet structure at the far south end of the basin.

Ash Basin No. 4 – Following the release from Ash Basin No. 4 in August of 2005, major modifications were made to the original construction of the basin. Specifically, the discharge structure was modified to have four levels of protection. These modifications are described in greater detail, below in Subsection 4.1.3, since they were technically repairs to the original construction of Ash Basin No. 4.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

Ash Basin No. 1 – There has been no significant repairs/rehabilitation made to this basin since the original construction. Several modifications in construction and operational procedures have occurred and are described in Subsection 4.1.2 and 4.2.2, respectively.

Ash Basin No. 4 – The following information was referenced primarily from Doc. 24 (p. A-373) in Appendix A. Modifications/Repairs/Rehabilitations since the original construction of Ash Basin No. 4 are numerous and significant. Steel reinforced skimmer slot plates have since been installed. Concrete panels and concrete stop logs now replace the original wooden stop-log system. A structural steel frame was added to the downstream side of the bottom two newly installed concrete panels. "The steel frame extends up from the sill at the bottom of the stop log slots (elevation 320 feet) to elevation 330 feet" (Doc. 24 in Appendix A).

An additional modification was a stainless steel slide (knife) gate which was placed over the inlet to the discharge pipe leaving the discharge structure. "The gate is 39 inches wide to cover the 33 inch diameter discharge pipe" (Doc. 24 in Appendix A). Another knife gate valve was constructed on the outlet pipe in a new vault located beyond the outside toe of the dam.

"The steel-reinforced concrete discharge pipe between the discharge structure and the vault was slip-lined with a heat hardened plastic liner" (Doc. 24 in Appendix A). This liner would help to make the pipe

water-tight under the static water pressure of a full basin. The pipe was not originally designed to have that specification. The liner ensures that the joints will remain water tight under full head from a maximum basin water level.

A final modification since the release in August of 2005 was the addition of water level indicators at the discharge structure. These indicators were installed to monitor water levels in the basin. The data monitored by these indicators are sent to both the control house at the basin as well as the plant's control room. Additionally, a staff gage is mounted on the outside wall of the discharge structure which allows for "visual verification of the electronic device readings" (Doc. 24 in Appendix A).

4.2 SUMMARY OF OPERATIONAL HISTORY

4.2.1 Original Operational Procedures

Ash Basin No. 1 and Ash Basin No. 4 are man-made basins that were designed and operated primarily for the disposal of mainly fly ash and bottom ash. The principal means of filling the basins with coal ash/waste mixtures was by sluicing with water, although the original filling operations allowed disposal of trucked wastes to both basins. These basins were designed, operated, and inspected under PA DEP approved permits.

Ash Basin No. 4 operation consisted of mixing fly ash with water at the plant and pumping the slurry to the basin. Within the basin, gravity settling separated the fine from the coarser materials. The fly ash settled to the bottom of the basin and the water then flowed to the discharge structure, entering the 33 inch diameter discharge pipe.

The design of the stop logs within the discharge structure at Ash Basin No. 4 allowed for operators to add or remove stop logs to adjust the water level within the basin. Normal operation at the Basin resulted in water and ash being pumped into the basin, water flowing under a metal skimmer plate (which was used to block any floating debris), and then finally over top of the stop log wall and into the second chamber of the discharge structure. From there, the outflow would enter the pipe that discharges to the Delaware River. The above information was referenced from, Doc. 30 (A-513) in Appendix A.

4.2.2 Significant Changes in Operational Procedures since Original Startup

Ash Basin No. 1 – The following information was referenced from Doc. 8 (p. A-67) in Appendix A. From 1964 onwards, Ash Basin No. 1 received only bottom ash. Prior to that time, the basin received a mixture of fly ash and bottom ash. As mentioned in subsection 4.1.2, bottom ash began accumulating in the north end of the basin during the 1970s and 80s. This ash was excavated for use in the construction of Ash Basin No. 4.

In the late 1980s, the southern corner of the north end of Ash Basin No. 1 began receiving "ash, sediment and debris from cleaning of river intakes, etc" (Doc. 8 in Appendix A). This material was trucked into the Basin.

Each time new materials were added to Ash Basin No. 1, the ash "self-segregated", separating itself from the other particles settling out of the incoming slurry (Doc. 8 in Appendix A). The coarsest materials remained closest to the inlet. The finer materials, including bottom ash and fly ash, would settle out into the open water. As a result, with exception in the main channel areas, "the basin floor is covered in relatively old, relatively fine ash" (Doc. 8 in Appendix A).

Fly ash was pumped into Ash Basin No. 1 on an emergency basis in August-September 2005, along with other dredge materials during cleanup operations undertaken after the release from Ash Basin No. 4 in August 2005 (Doc. 8 in Appendix A).

Ash Basin No. 4 – The following information was referenced from Doc. 24 (p. A-373) in Appendix A. Following the release from Ash Basin No. 4, several operations procedures were modified in an attempt to ensure the future safety and stability of the Basin. Namely, the discharge structure would now have four levels of protection. Each level would be capable of stopping or significantly reducing the flow out of the basin through the structure itself as well as the discharging pipe.

There were steel reinforced skimmer slot plates installed designed to "slow down water flow in the event of a downstream failure" (Doc. 24 in Appendix A). The skimmer plates also prevent cenospheres from escaping the basin. "These plates were not designed to be 100 percent water tight", however (Doc. 24 in Appendix A). Additionally, concrete panels and stop logs were installed as replacements to the original wooden stop logs used in the discharge structure to hold back the water. The panels were placed at the bottom of the stop log slots and extend up to elevation 340 feet. The stop logs were then placed on top of the panels to control the water level above the elevation of 340 feet. The top of the basin dike is at elevation 355 feet, and the normal operating water level for the basin would be between 348 feet and 350 feet. Both the panels and new stop logs were designed assuming an operating water level up to Elevation 355 feet. A structural steel frame was added to the downstream side of the bottom two newly installed concrete panels. This frame provided additional support to the bottom two concrete panes, as they are under the highest stress. The stop logs and the panels serve as the primary barrier for holding the basin water at the discharge structure.

"A stainless steel slide (knife) gate…was placed over the inlet to the discharge pipe leaving the discharge structure" (Doc. 24 in Appendix A). This gate would be operated manually from above. This gate is not designed to have 100 percent shut off capabilities. The expected leakage of this custom designed gate is "approximately 100 gpm or less" (Doc. 24 in Appendix A).

A vault with knife gate valve was also constructed. The vault was installed just outside Ash Basin No. 4, along the discharge line. "A cast iron and stainless steel knife gate valve assembly was installed to block flow before it would enter the vault", which bisects the discharge pipeline such that when the valve is open the flow would enter past the gate and exit out the downstream end of the vault (Doc. 24 in Appendix A).

Before refilling Ash Basin No. 4 and placing it back in service after the August 2005 release, all modifications to the Basin were tested under full head conditions and approved by the PA DEP.

The revised operations and monitoring controls for Ash Basin No. 4 after implementing repairs and resuming operations are listed below (Doc. 24 in Appendix A):

- PPL installed local level controls on Ash Basin No. 4 discharge structure.
- PPL established a remote monitoring device to provide signal back to plant control room for monitoring Ash Basin No. 4 level.
- PPL will follow the steps outlined below in the event of a problem at the Ash Basin No. 4 discharge:
  - Upon receipt of a level alarm or observations at Basin 4 the ash slurry, system will be shutdown.
  - Discharge gate valve in the basin discharge structure shall be closed.
  - Slide gate on skimmer wall will be closed.
  - PPL will monitor manhole to ensure that flow is under control.
  - Valve in manhole will be closed if flow is still detected.
- PPL will submit a revised SPCC/PPC contingency plan to the PA DEP with appropriate changes regarding notification lists.
- PPL submitted to the DEP PE certification that all repairs have been competed according to all approved drawings and basin is ready for return to service.

4.2.3 Current Operational Procedures

Ash Basin No. 1 – The operational procedures for this Basin were defined based on the classification of this basin as "a local, captive Class II residual waste disposal impoundment," as specified in the October 2000 permit which expired August 2009 (Doc. 23, p. A-352 in Appendix A). This permit approved disposal of a limited selection of coal ash and other residual wastes within Ash Basin No. 1. These permit conditions can be found in-full within Doc. 23 (p. A-352) of Appendix A at the end of this report. The basin currently is inactive and has been since 2005. PPL has submitted a final alternate closure plan, which currently is under review by the PA DEP (Docs. 5 and 6 in Appendix A).

Ash Basin No. 4 – This Basin is no longer in service and is currently in the process of being permanently closed. The entire Basin is lined with a 36-mil, synthetic, reinforced-rubber (Hypalon) liner system (Doc. 34 in Appendix A). The water has been pumped out of the Basin to ensure that the maximum water level remains at or below elevation 330 feet. "Ash Basin No. 4 is still classified as B-2 by the PA DEP, which is

equivalent to an intermediate-size, high hazard potential dam, and therefore requires annual inspections" (Doc. 29 in Appendix A).

"The ash will be dewatered to the extent needed to make the ash workable and capable of supporting cap loads" (Doc. 28 in Appendix A). The dewatering will be done using progressive trenching techniques. Trenches will be excavated allowing water to flow from the north to the south end of the basin. Lowering the water level has left much ash exposed, and as of the June 2009, PPL was in the process of stabilizing the exposed ash by a process of installing drainage and covering it. PPL also takes measures to prevent windblown ash dust or turbid rainwater runoff from being released. The above information was referenced from Docs. 24, 28, and 38 (pp. A-373, A-461, and A-678, respectively) in Appendix A.

4.2.4 Other Notable Events since Original Startup

Ash Basin No.1 – There are no other notable events since original startup of Ash Basin No. 1 to report at this time.

Ash Basin No. 4 – There was a release from this basin in August of 2005. See Section 3.3 for more in-depth details,

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Frederic C. Tucker, PE and Lauren Ohotzke collected available data and documents and made field observations during a site visit on Wednesday, September 2, 2009, in company with the participants listed in Section 1.3. Mr. Andrew Spear, PE, the designer of record for Ash Basin No. 4, as well as the IWTB, was present and available to assist with answering questions about these basins.

The site visit began at 9:00 AM. Weather conditions during the visit were sunny and dry with mild temperatures changing to warm by afternoon. Photographs were taken of conditions observed. Photographs referenced below are contained at the end of this chapter and mainly cover Ash Basin No. 1 and Ash Basin No. 4, which are the focus of this assessment. Additional photographs showing these basins and other basins and features at the Martins Creek SES are contained in Appendix B for reference.

Again, it is noted that all location references made in descriptions in this report are relative to "Plant North," which is actually northeast of "True North."

The overall visual assessment of the subject dams is that the Ash Basin No, 1 Dam is in satisfactory condition and the Ash Basin No. 4 Dam is in good condition. No visual signs of imminent instability or inadequacy of the principal structures at these basins that would require emergency remedial action were observed. No evidence of past repairs was observed, other than routine patching of holes that develop in the Hypalon liner at Ash Basin No. 4. No significant findings were noted, other than the tall vegetation growing on the outer slopes of both basins and woods with understory growing over much of the ash surface in Ash Basin No. 1, which hampered viewing of embankment surfaces to check for potential problem conditions.

5.2 ASH BASIN NO. 1

Ash Basin No. 1 is inactive but has not yet been formally closed. It last received ash waste material in the third quarter of 2005 in the upper, north end area (NEA). The lower, south end area (SEA) was effectively filled to capacity with ash by 1985 and received essentially no waste material afterward. The basin area has been allowed to re-vegetate; the SEA is almost completely covered with trees and underbrush and the NEA is largely covered with vegetation. There is less growth in the areas that received waste material from clean-up operations carried out in 2005 in response to the release from Ash basin No. 4 and vegetation is essentially non-existent where bottom ash had been mined for anti-skid material at the north end of the basin. No water was observed in the basin at the time of the site visit, although viewing of some of the lower parts of the basin in the SEA was obscured by the dense vegetation. In areas of sparse vegetation where the ash surface could be viewed the surface appeared dry and stable.

5.2.1 Embankment Dam and Basin Area

Crest

The crest around the NEA of Ash Basin No. 1 is usually accessible with automobiles, but fallen trees across the crest prevented making a complete circuit around the NEA with vehicles. The crest around the SEA was observed to be generally wooded. Typical views of the crest around the NEA are shown on the north embankment and east embankment in Photos B1-1 and B1-2, respectively. Where it could be viewed, no major depressions, sags, tension cracks or other signs of settlement or mass soil movement were observed.

Outside Slope and Toe

The outside slope of the east embankment of Ash Basin No. 1 is visible in Photo B1-2, and that of the west embankment is shown in Photo B1-3. As shown, the outside slopes typically were observed to have a lush, tall growth of herbaceous vegetation, although some woody vegetation, such as bushes and small trees, was also observed. No areas of significant erosion were observed. No obvious signs of slumps, slides, bulges, tension cracks, seepage, or animal holes were observed, but observation for these conditions was severely hampered by the thick vegetation.

The outside toe area below the southeast corner of the SEA embankment near where the outfall pipe passes through the embankment is shown in Photo B1-4. This area actually is the toe of the embankment that supports the access road around the east side of the basin. As shown, the toe area and slope above are generally wooded; no signs of slope failure or seepage were observed. A relatively shallow (1.5- to 2-foot) depression or wallowed-out area approximately 8 to 10 feet in diameter with sparse vegetation was observed just behind the foreground trees in Photo B1-4 (see Exhibit 3 for location). There appeared to be no active erosion, raveling, or seepage associated with this feature. Old tree limbs and twigs wedged against the down-gradient edge of the depression seem to suggest they were carried there by water flow, possibly from an unusually high river stage.

Inside Slope and Basin Area

The inside slope of the Ash Basin No. 1 embankment dam is generally buried with ash. A view of the ash surface in the NEA where the bottom ash was sluiced into the basin is shown in Photo B1-5; the vegetation is sparse in this area, presumably because this is the location that bottom ash has been mined for anti-skid material. The surface of the ash basin fill in the central area just north of the main cross dike dividing the NEA from the SEA is at or slightly higher than the perimeter embankment and generally covered with tall weeds and low-growing bushes as shown in Photo B1-6, although some of the area has a bare surface with no vegetation; no significant erosion was noted. This is the area where dredged material from the Delaware River was placed during clean-up operations after the 2005 release from Ash Basin No. 4. Photo B1-7 shows the discharge ends of some of the multi-level 12-inch diameter corrugated metal pipes (CMPs) through the west part of the main cross dike that allowed drainage from the NEA to the SEA. It appears that the uppermost pipes would still allow drainage of storm water from the NEA to the SEA, if the water

built up high enough against the cross dike on the west side of the NEA, where the surface of the basin fill is lower than the crests of the perimeter embankment and the cross dike. The CMPs were observed to be generally corroded with invert of the uppermost pipes completely corroded through at the inlet ends. Photo B1-8 shows the dense growth of trees and understory in the SEA just below the west part of the main cross dike. Photo B1-9 shows the top of a small cross dike (median dike) across the SEA and the typical degree of vegetation establishment in the SEA. One of the lowest areas in the SEA is relatively open and free of tree growth, but covered with tall herbaceous vegetation, (Photo B1-10).

Abutments and Groin Areas

Because the subject embankment dam completely encircles the basin area, there are no abutments or groins as there are at dams constructed across valleys.

5.2.2 Outlet Structures

Overflow Structure

The overflow structure (standpipe) located at the southeast corner of the SEA was generally obscured by vegetation, as shown by the view of the overgrown footbridge leading to the top of the standpipe in Photo B1-11. The grate on top of the structure was observed to be rusted but still sound and serviceable. The steel plate V-notch overflow weir at top of the structure was observed to be in relatively good condition (Photo B1-12). The 4-foot diameter standpipe, which is made of RCP sections, was observed to be in good condition with no obstructions (as far as could be viewed). The basin had no water in it at the time of the site visit; no water was observed flowing into the standpipe. According to information from PPL, water flows into the standpipe only during extreme wet weather or snowmelt. The last time water flowed into the standpipe is unknown, but PPL believes it probably was many years ago or even decades.

Outlet Conduit

As previously described, the standpipe has bottom discharge into a 36-inch diameter RCP that extends through the perimeter embankment dam and adjacent roadway embankment to the Delaware River. The outlet pipe is buried all along its 440-foot length to its outfall end. The outfall end was inaccessible due to very dense vegetation and thus could not be viewed. No obvious problems, such as erosion of the heavy riprap cover or cave-ins, were observed along the apparent alignment of the buried pipe, but observation was severely hampered by thick vegetation.

Emergency Spillway (If Present)

There is no emergency spillway.

Low Level Outlet

There is no low level outlet.

5.3 ASH BASIN NO. 4

Ash Basin No. 4 is inactive but has not yet been formally closed. It last received ash waste material from production operations in about September 2007. The former operating water level in the basin was at elevation 348 feet to a maximum of 350 feet. The water level now is typically maintained below 330 feet. It was approximately 327 feet on the day of the site visit; so the basin was nearly empty of water. The storm water that accumulates in the basin is pumped to the IWTB, after being filtered through a crushed rock layer that has been placed around the base of the decant tower. The basin appeared to be filled to less than one-half of total capacity with fly ash. The fly ash surface was observed to be wettest and lowest around the vicinity of the decant tower at the southeast corner of the basin or around elevation 325 feet; the ash surface was observed to rise in elevation to the north and northeast to a maximum elevation of what appeared to be approximately 350 feet at the northwest corner, where the ash surface had been shaped and graded in preparation for closure. The grading and shaping will continue across the entire basin as the fly ash is gradually dewatered and stabilized in the lower areas.

5.3.1 Embankment Dam and Basin Area

Crest

Typical views of the crest along the east embankment, north embankment, west embankment, and south embankment (partial view) are shown in Photos B4-1, B4-2, B4-3, and B4-4, respectively. Overall the gravel-surfaced crest was observed to be in good condition with some minor potholes noted on the crest of the north embankment (Photo B4-2). No major depressions, sags, or drop-outs, which might suggest excessive settlement or internal erosion, were observed in the crest. No tension cracks which might suggest soil shear failure were observed in the crest or along the edge of the crest.

Outside Slope and Toe

Typical views of the outside slope along the east embankment, north embankment, west embankment, and south embankment (including toe area) are shown in Photos B4-5, B4-6, B4-7, and B4-8, respectively. As shown, the slopes were observed to have a tall, thick growth of mostly herbaceous vegetation, such as Sericea Lespedeza, Crown Vetch (the lower-growing originally specified vegetation), and various volunteer weeds. Some briars and small bushes were also observed. The slope had not been mowed since May 2009. Mr. Steve Holler with PPL indicated the slope was normally mowed once annually. No obvious slumps, slide scarps, tension cracks, major bulges, or other signs of slope shear failure were observed, and no depressions, drop-outs, seepage, or major wet areas were observed on the slope or in the toe area, but the tall thick growth of vegetation severely hampered observations for these conditions. No animal holes were obvious either, due to the thick vegetation; however, a previous inspection performed by an outside consultant (HDR/DTA) on June 15, 2009 identified over a dozen new woodchuck burrows after PPL had completed filling 35 previously identified burrows on June 11, 2009. The HDR/DTA inspection also noted wet areas and standing water along the east and northeast (north) embankments, which they noted was likely due to limited (poor) drainage.

Overall, the outside slope appeared stable, but the slope needs to be mowed more frequently to allow unobstructed observations to facilitate PPL's quarterly inspections and the outside consultant's annual inspections.

Inside Slope and Basin Area

The inside of Ash Basin No. 4 is lined with a Hypalon synthetic liner. The lined inside slope of the east embankment is shown in Photo B4-9, which also shows the rising ash surface in the basin, as viewed to the north from the decant tower. The former operating water level in the basin is indicated by the "mud line" visible on the liner. Wrinkles were commonly observed in the synthetic liner running "vertically" (i.e., oriented up and down the slope). A slight "linear bulge" or "ridge" under the liner was observed along the former operating water level (mud line on the liner) on the east embankment inside slope approximately 430 feet (Station 4+30) north of the decant tower, as shown in Photo B4-10. (Decant tower assumed at 0+00.) The HDR/DTA inspection in June 2009 also noted this bulge, as well as a bulge between Stations 8+00 and 12+00, near Station 27+00 (northwest corner), and Station 34+30 (west embankment inside slope). They called these bulges "slumps" under the liner but indicated it was not clear what caused them. Possibly they were caused by wave action on the liner and/or local saturation of the supporting slope soils as a result of small leakages through holes in the liner. The HDR/DTA inspection noted a number of holes in the liner and past inspections by PPL have identified holes, resulting from various causes, such as deer walking on the liner, sharp gravel eroding onto the liner from the crest, and abrasion of pipes and hoses pulled over the liner; such holes are routinely identified with white marker and subsequently repaired by patching. The inside slope of the north embankment is shown in Photos B4-11 and B4-12 (northwest corner). As shown, the ash surface is much higher on the slope at the north end of the basin, particularly at the northwest corner, where it appeared to be at approximately 5 feet below the crest or approximately elevation 350 feet; the ash surface at this end of the basin has been shaped and graded with a small dozer. White marks on the liner visible in Photo B4-12 indicate holes or other defects that required patching. The inside slope of the west embankment is shown in Photo B4-13 and is also visible in Photo B4-3 in an opposite view. These photos show some of the gravel that has eroded onto the liner. Photo B4-14 shows where a swale had been excavated through fly ash to facilitate drainage of ash in the west part of the basin. As shown in this photo, the sides of the swale have sloughed and eroded due to the unstable nature of the wet ash. The inside slope of the south embankment is shown in Photo B4-15 and is visible in Photo B4-4 in an opposite view. The excavator shown on the crest in these photos is located at the former truck turnaround fill next to the top of a crushed brick access causeway that was constructed over the liner and down the slope to provide equipment access into the basin around the decant tower. There appeared to be a relatively thick synthetic fabric separation layer between the crushed brick and the Hypalon liner.

The inside slope is in overall good condition. The slight bulges (apparent slumps) noted under the liner are minor and require no action at this time. The synthetic liner is serviceable as long as routine maintenance patching is performed. Since the water level in the basin is now maintained below elevation 330 feet, the serviceability of the liner well above that elevation is less critical. However, during closure all portions of exposed liner planned for burial should be cleaned of all debris, thoroughly inspected, and repaired where needed prior to burial with closure fill.

Abutments and Groin Areas

Because the subject embankment dam completely encircles the basin area, there are no abutments or groins as there are at dams constructed across valleys.

5.3.2 Outlet Structures

Overflow Structure

Photos B4-16 and B4-17 provide outside views of the overflow structure (decant tower) located at the southeast corner of Ash Basin No. 4. A view of the outer chamber through the top walkway grate is shown in Photo B4-18, and a partial view of the inner chamber through the top grate is shown in Photo B4-19. The structure was observed to be in overall good visual condition. As previously described, major modifications were made to the structure after the uncontrolled release in 2005 (see Subsections 2.4.2 and 3.3). The structure is not currently used for outflow through the bottom discharge pipe, but it is still functional and could potentially be used during closure/post-closure operations. It now is used basically as a sump pit from which filtered storm water is pumped to the IWTB. The crushed stone layer, which was reported by PPL to be 10 feet thick, is shown surrounding the decant tower in Photos B4-16 and B4-17. The equipment access causeway constructed of crushed brick from demolition of the smoke stacks for the former coal burning units is also shown in Photo B4-17.

Outlet Conduit

The decant tower has a 33-inch diameter RCP bottom discharge pipe that extends through the perimeter embankment dam to a manhole (vault) just beyond the outside toe of the embankment dam; the pipe continues through a series of manholes to the Combining Structure, and from there flow is piped to the outfall point near the Delaware River. The outlet conduit was not viewable. However, flow is no longer allowed through the outlet conduit, which has a closed gate valve at the inlet end in the bottom of the decant tower and a closed gate valve in the vault just beyond the outside toe of the dam; the building housing the operator for the valve in the vault is shown in Photo B4-20. The operator stand inside the building was not viewed; the operator stand at the top of the decant tower and visible parts of the gate control stem and hardware were observed to be in good condition. No obvious problems, such as seepage or drop-outs, were observed along the apparent alignment of the buried pipe at the toe of the dam.

Emergency Spillway (If Present)

There is no emergency spillway.

Low Level Outlet

There is no low level outlet.

5.4 ADDITIONAL OBSERVATIONS

The following structures do not fall within the scope of this dam assessment, either because they are closed and no longer serve as surface impoundments or because they do not contain coal combustion waste. The photos and comments are offered as background or associated information.

5.4.1 Industrial Waste Treatment Basin

Photos I-1 through I-4 show various views of the Industrial Waste Treatment Basin (IWTB). Some algae were noted floating on the water surface. The new oil-resistant synthetic liner was observed to have "vertical" wrinkles, much like what was observed in the Hypalon liner at Ash Basin No. 4, (Photo I-2). Photo I-2 also shows the entrance to the reinforced concrete outlet structure, which discharges into a 42-inch diameter CMP that extends to the northernmost decant tower on the east edge of the closed Ash Basin No. 2. Flow into the CMP is controlled with a gate valve. Cooling tower blowdown from the plant is discharged into the IWTB at the east end, (Photo I-3); the discharge flows onto a mat of Fabriform (grout-filled fabric form) that protects the synthetic liner from abrasion and erosion. As shown in Photo I-3, the synthetic liner extends up higher on the north half of the east slope; PPL indicated that this was done when the new liner was installed in 2008 to cover a former sinkhole area in shallow rock at that location. Plant drainage from Martins Creek SES is discharged into the IWTB on the east side after passing through an oil/water separator, as shown in Photo I-4 (larger diameter, green fiberglass pipes). This photo also shows drainage from the Lower Mt. Bethel Power Plant (smaller diameter, brown fiberglass pipe) and from Ash Basin No. 4 (black HDPE pipe, below others). As previously mentioned, the IWTB is incised on the north, east, and south sides, but an embankment dam forms the west side of the basin. The crest of this dam is shown in Photo I-5, and the outside slope is shown in Photo I-6. Tall herbaceous vegetation and some large bushes were observed on the embankment, primarily on the outside slope.

5.4.2 Ash Basin No. 2 and Discharge Pipelines

Photo B2-1 presents a typical view of dense vegetation growing on the soil cover of the closed Ash Basin No. 2 along with a view of the footbridge to the northernmost decant tower on the east edge of this basin. Photo B2-2 provides a view of the top of the reinforced steel plate bulkhead that seals off the former wood stop log side of the tower. As previously mentioned, drainage from the IWTB passes through this drainage tower and two other former drainage towers on the east edge of the closed Ash Basin No. 2, as well as through the former standpipe at the southeast corner of Ash Basin No. 2, on the way to the Combining Structure.

A view of the NPDES Monitoring Control Building at the Combining Structure is shown in Photo B2-3, and a view inside the Combining Structure basin is shown in Photo B2-4. The treated water flows over a weir in the basin and into a 42-inch diameter CMP that leads to the outfall point near the river. As previously mentioned, discharge from Ash Basin No. 4 is no longer combined with the IWTB discharge at this structure; it is now pumped into the IWTB. Farther down-gradient the 42-inch diameter discharge line is above ground, as shown in Photo B2-5. At the outfall, where the water is discharged into the grouted

riprap channel, the end of the discharge line is protected with a reinforced concrete end wall, as shown in Photo B2-6. A bar screen over the outfall port through the end wall was observed to be rusty but sound.

5.4.3 Ash Basin No. 3

Partial views of the outside slopes of the west embankment and east embankment of the closed Ash Basin No. 3 are shown in Photos B3-1 and B3-2, respectively. As shown, the slopes have a thick cover of herbaceous vegetation; the west slope also has tall bushes.

Photo B1-1: Ash Basin No. 1 Crest of North Embankment – Viewed West.

Photo B1-2: Ash Basin No. 1 Crest and Outside Slope of East Embankment North End - Viewed South.

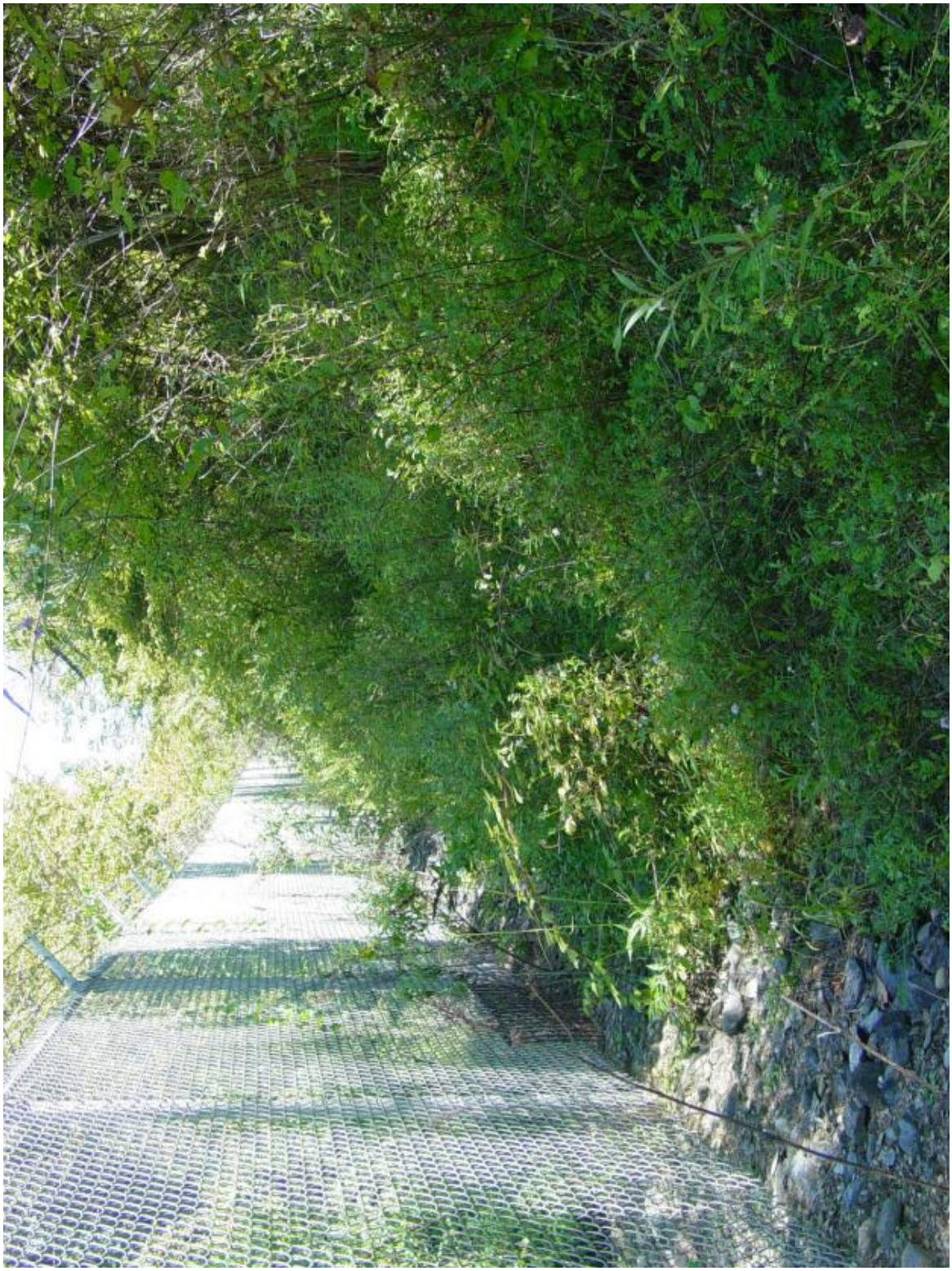

Photo B1-3: Ash Basin No. 1 Outside Slope of West Embankment at West End of Main Cross Dike End - Viewed North.

Photo B1-4: Ash Basin No. 1 Outside Toe of Embankment Below Paved Access Road outside Southeast Corner of Basin
Near where Outlet Pipe Passes Through Embankment- Viewed West.

Photo B1-5: Ash Basin No. 1 North End Area where Bottom Ash Formerly was Sluiced into Basin – Viewed West.

Photo B1-6: Ash Basin No. 1 Central Area North of Main Cross Dike where Dredged Material from Delaware River was Pumped into Basin during Clean-up Operations after 2005 Release from Basin No. 4– Viewed West.

Photo B1-7: Ash Basin No. 1 View of Discharge End of 12" CMP Drains through Main Cross Dike that Divides the Higher Northern Two-Thirds of the Basin from the Lower Southern One-Third.

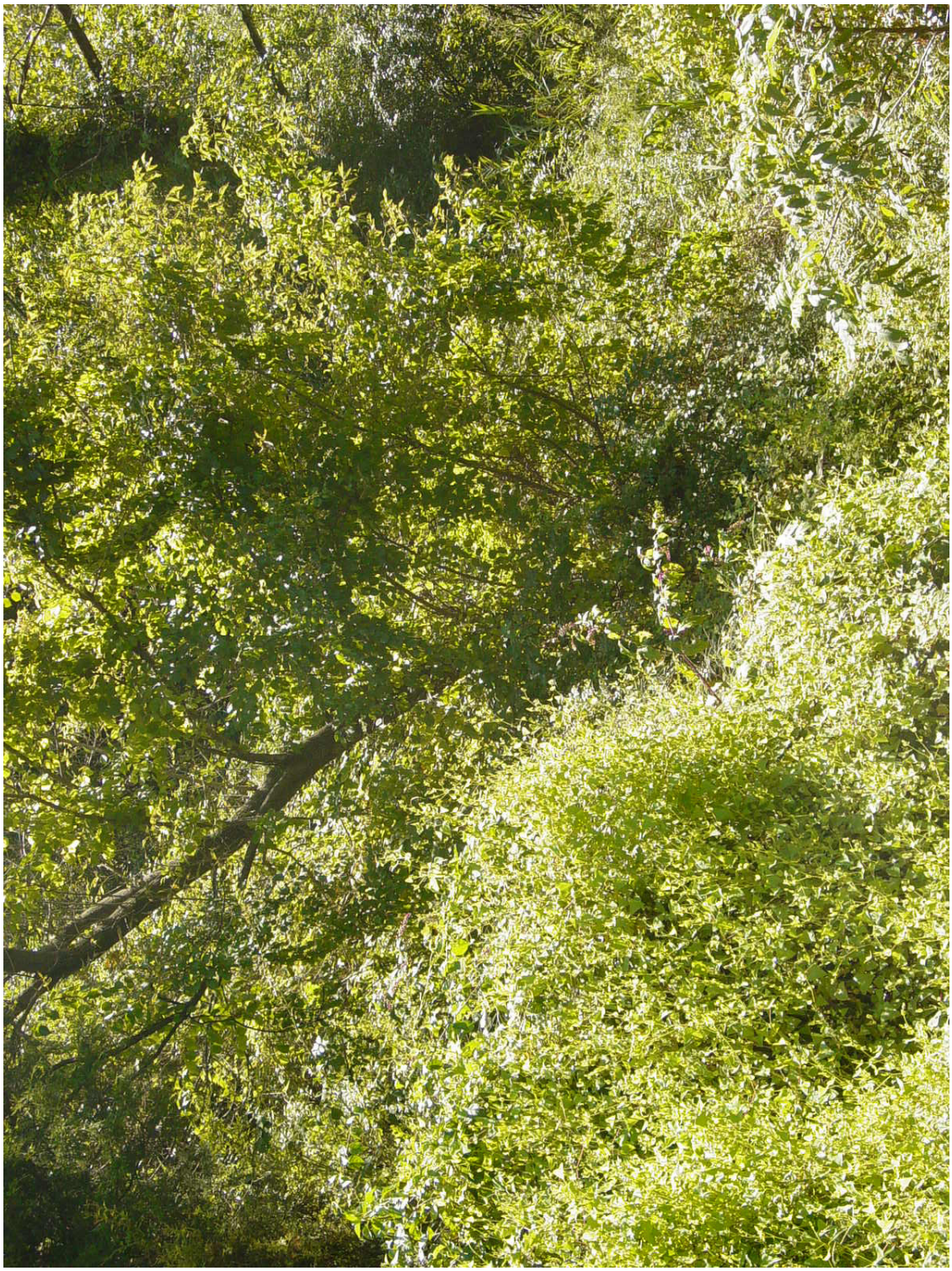

Photo B1-8: Ash Basin No. 1 View of Tree Growth and other Vegetation in Lower Southern Part of Basin Just Downstream of West Part of Main Cross Dike – Viewed East.

Photo B1-9: Ash Basin No. 1 Top of Small Cross Dike in Lower Southern Part of Basin - Viewed West.

Photo B1-10: Ash Basin No. 1 Relatively Open Low Area within Lower Southern Part of Basin Just Upstream of Drain Pipe Through Small Cross Dike- Viewed Northwest.

Photo B1-11: Ash Basin No. 1 Overgrown Footbridge to Outlet Standpipe inside Southeast Corner of Basin - Viewed West.

Photo B1-12: Ash Basin No. 1 V-Notch Weir at Top West Side of 4-foot Diameter RCP Outlet Standpipe.

Photo B4-1: Ash Basin No. 4 Crest of East Embankment – Viewed North.

Photo B4-2: Ash Basin No. 4 Crest of North Embankment – Viewed Northwest.

Photo B4-3: Ash Basin No. 4 Crest and Inside Slope of West Embankment – Viewed South.

Photo B4-4: Ash Basin No. 4 Crest and Inside Slope of South Embankment – Viewed Northwest.

Photo B4-5: Ash Basin No. 4 Outside Slope of East Embankment – Viewed North.

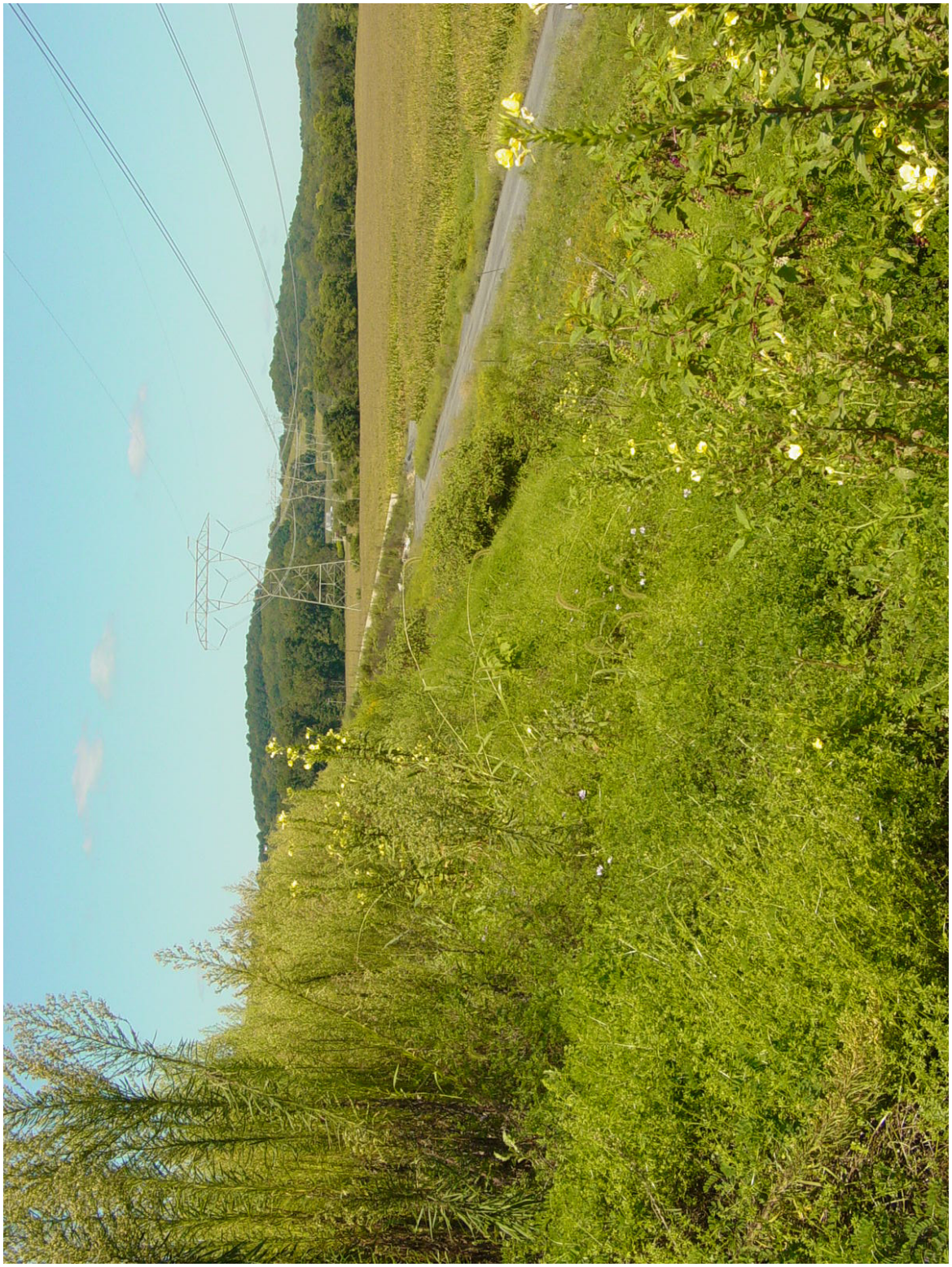

Photo B4-6: Ash Basin No. 4 Outside Slope of North Embankment – Viewed Northwest.

Photo B4-7: Ash Basin No. 4 Outside Slope of West Embankment – Viewed South.

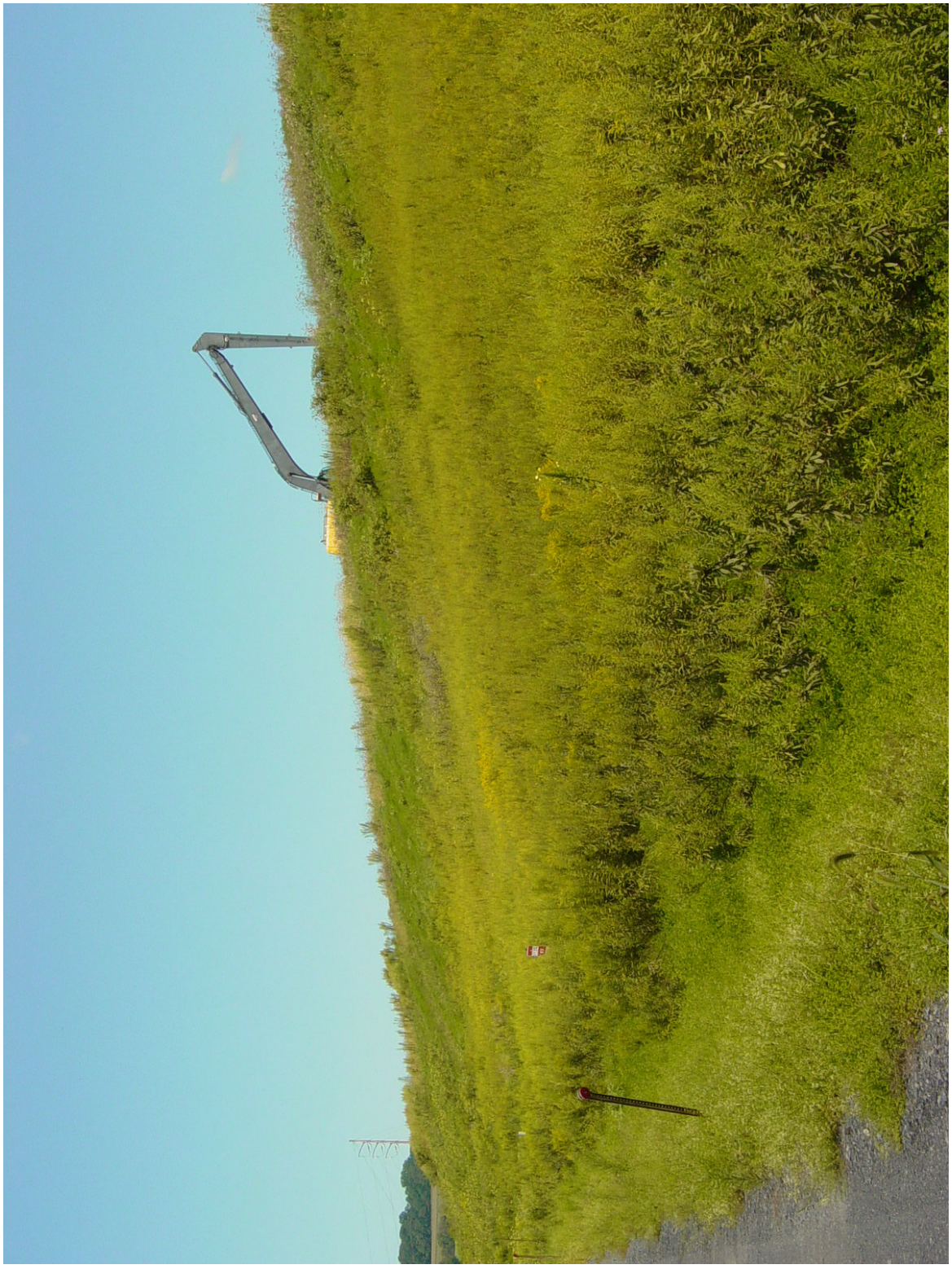

Photo B4-8: Ash Basin No. 4 Outside Slope of South Embankment – Viewed Northwest.

Photo B4-9: Ash Basin No. 4 Inside Slope of East Embankment and View of Ash Surface in Basin– Viewed North from Top of Decant Tower – Note Vertical Wrinkles in Liner (Commonly Occurs Throughout).

Photo B4-10: Ash Basin No. 4 View of Slight Linear Bulge Under Liner along Former Operating Water Level on Inside Slope of East Embankment Approximately 430' North of Decant Tower Footbridge.

Photo B4-11: Ash Basin No. 4 Inside Slope of North Embankment – Viewed Northwest.

Photo B4-12: Ash Basin No. 4 Inside Slope of North Embankment at Northwest Corner – Note Highest Point of Ash in the Basin Spread in Place by Dozer in Preparation for Closure; White Marks on Liner from PPL Inspection Indicating Holes and Defects to be Patched.

Photo B4-13: Ash Basin No. 4 Inside Slope of West Embankment – Viewed North.

Photo B4-14: Ash Basin No. 4 View of Swale Cut Through Ash to Allow Drainage from West Part of Basin – Note Sloughing and Erosion of the Side Slopes of the Swale.

Photo B4-15: Ash Basin No. 4 Inside Slope of South Embankment – Viewed Southeast – Note Vertical Wrinkles.

Photo B4-16: Ash Basin No. 4 View of South and West Sides of Decant Tower – Viewed Northeast Note Crushed Stone Filter Around Base of Tower.

Photo B4-17: Ash Basin No. 4 View of East and North Sides of Decant Tower – Viewed Southwest Note Crushed Brick Access Causeway to Filter Around Base of Tower (Brick from Demolition of Smoke Stacks).

Photo B4-18: Ash Basin No. 4 View Through Top Grate into Outer Chamber of Decant Tower.

Photo B4-19: Ash Basin No. 4 View Through Top Grate into Inner Chamber of Decant Tower (Behind Concrete Stop Logs).

Photo B4-20: Ash Basin No. 4 View of Building Housing Operator for New Gate Valve in Underlying Concrete Vault.

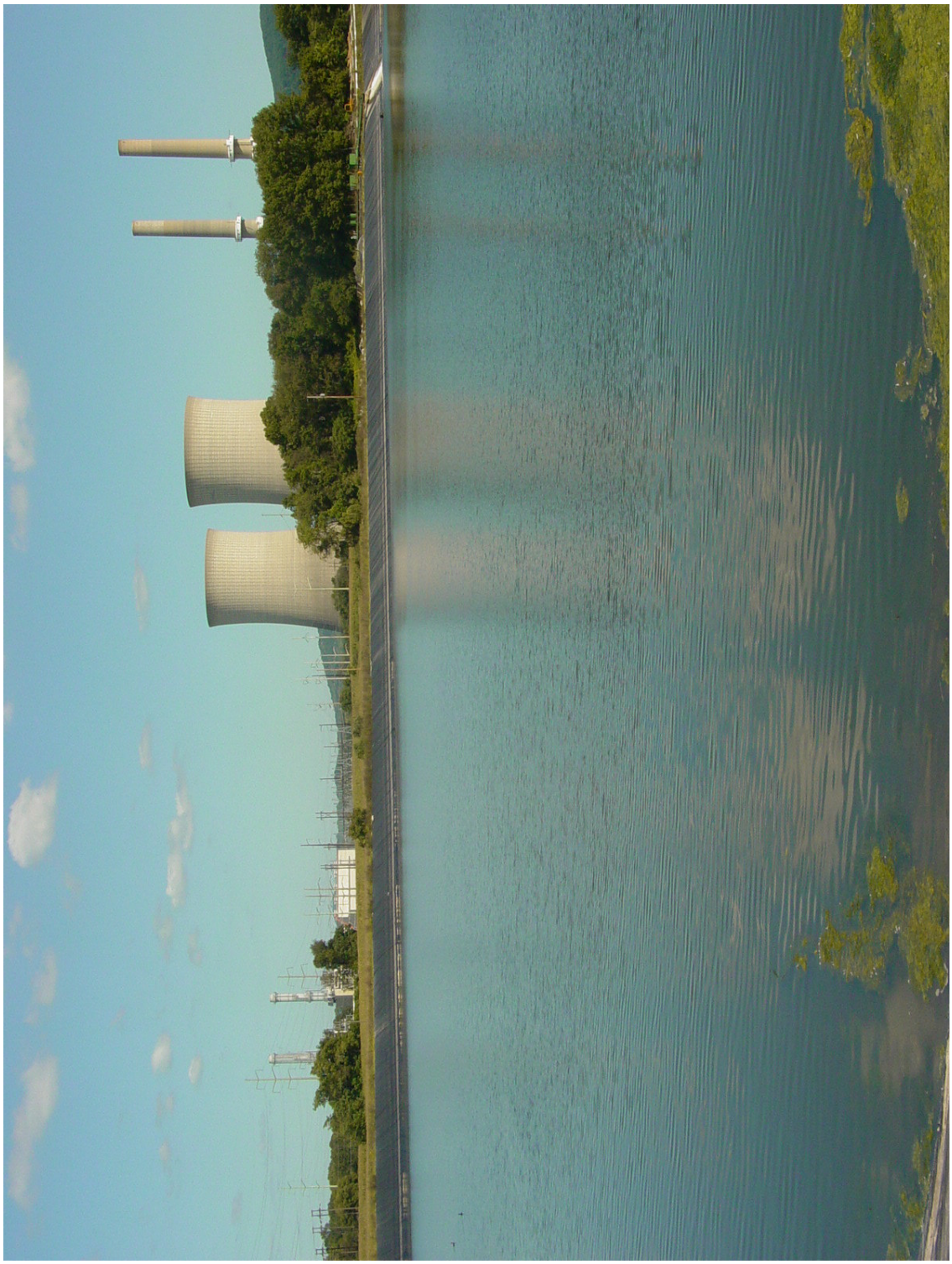

Photo I-1: Industrial Waste Treatment Basin (IWTB) General View across Basin toward North Incised Slope– Viewed Northeast – Note Some Algae on Surface of Water.

Photo I-2: IWTB South Incised Slope with Outlet Structure in Foreground – Viewed East – Note Vertical Wrinkles in Liner.

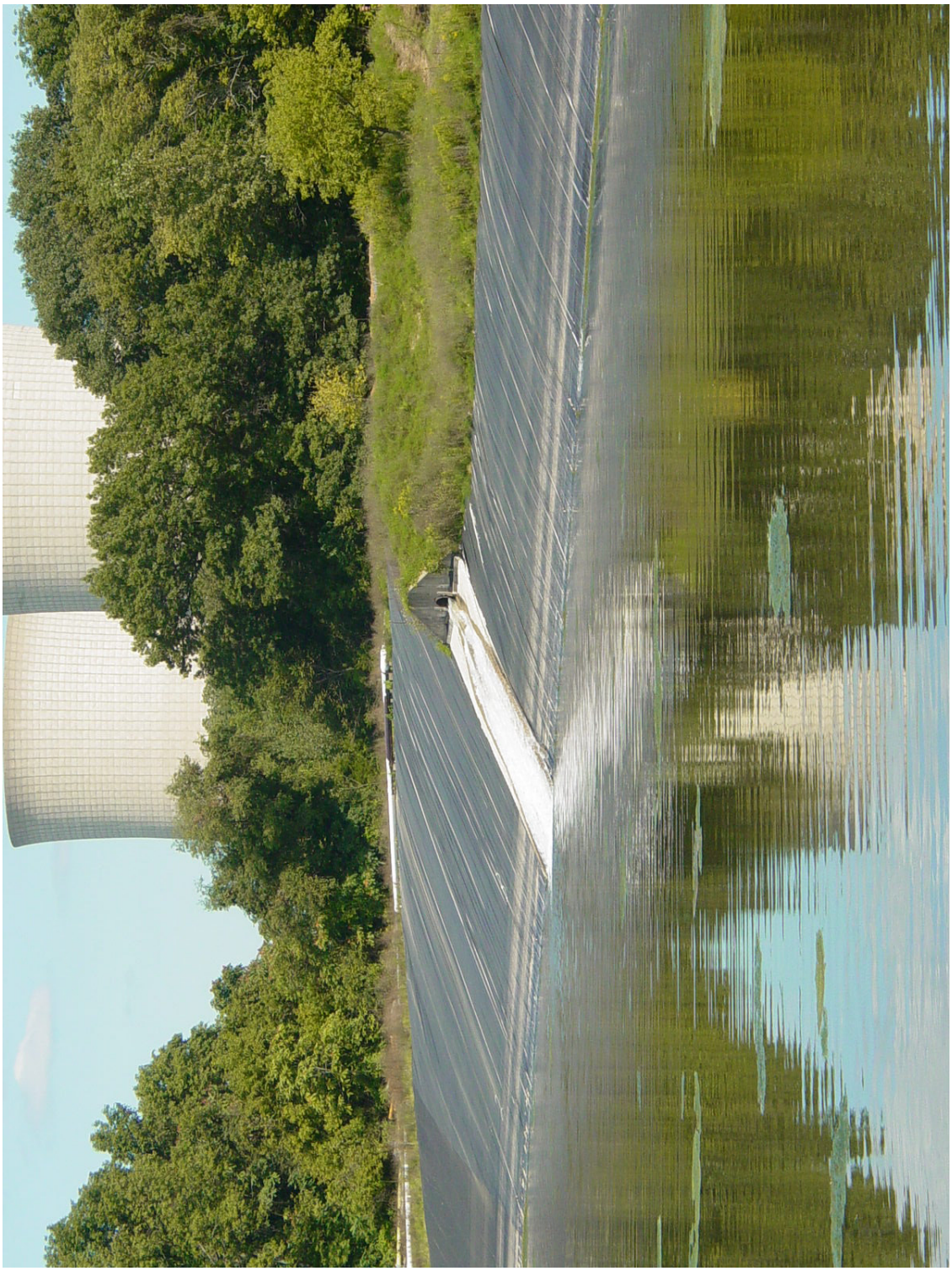

Photo I-3: IWTB East Incised Slope and Cooling Tower Blow-down Discharge into Basin – Viewed Northeast– Note Liner Extends Higher on North Half to Cover former Sinkhole Area in Shallow Rock.

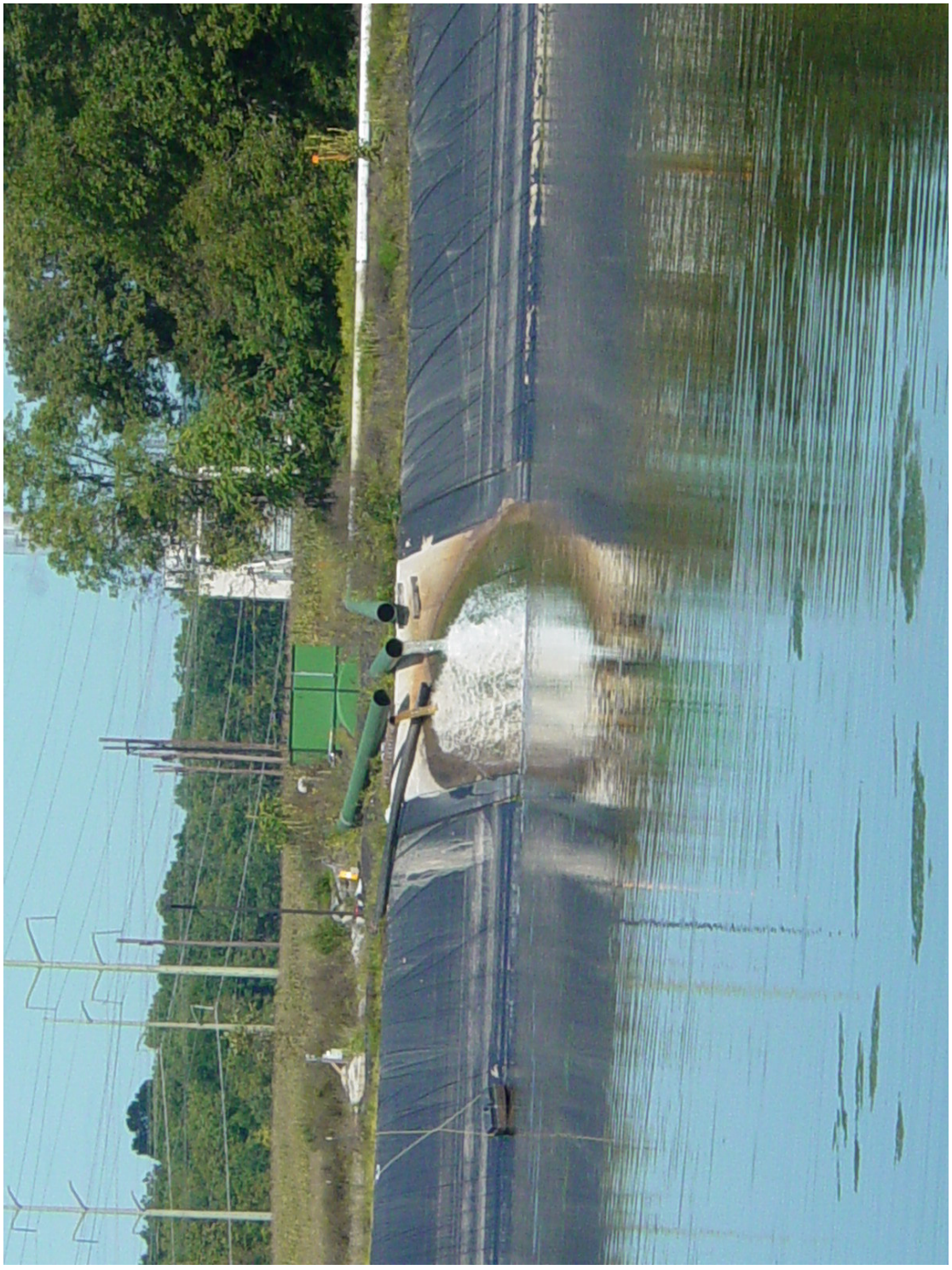

Photo I-4: IWTB North Incised Slope and Plant Drainage Discharge into Basin– Viewed North – Drainage Comes from both Martins Creek Power Plant via Oil/Water Separator (Green Fiberglass Pipes) and Lower Mt. Bethel Power Plant (Brown Fiberglass Pipe); Drainage also Comes from Ash Basin No. 4 (Black HDPE Pipe).

Photo I-5: IWTB Top of Earth Embankment Dam across South End of Basin– Viewed North.

Photo I-6: IWTB Outside Slope of Earth Embankment Dam across South End of Basin– Viewed South.

Photo B2-1: View of former Footbridge to North Decant Tower at Ash Basin No. 2 – Viewed West – Note Dense Vegetation on the Soil Cover over the Closed Basin.

Photo B2-2: View of Top of Reinforced Steel Plate Bulkhead that Seals off the Wood Stop Log Side of the North Decant Tower at Ash Basin No. 2 – This and Two other Drainage Towers at the Closed Basin No. 2 are used for Drainage from the IWTB to the

Photo B2-3: View of NPDES Monitoring Control Building at Combining Structure, which is a Below-grade Concrete Basin with Outflow Weir for Measuring Total Discharge from the Plant; Steel Plates Cover Top of the Basin for Safety– Note Bucket for Grabbing Water

Photo B2-4: View Inside Combining Structure Basin at location of Weir

Photo B2-5: View of Above Ground 42" CMP Discharge Line from Combining Structure to Outfall Near the Delaware River.

Photo B2-6: View of Outfall of 42" CMP Discharge Line into Grouted Riprap Channel to the Delaware River.

Photo B3-1: Ash Basin No. 3 View of Outside Slope of West Embankment of the Closed Basin– Viewed Southeast.

Photo B3-2: Ash Basin No. 3 View of Outside Slope of East Embankment of the Closed Basin– Viewed Southwest.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Floods of Record

Ash Basin No. 1 Dam – According to information received from PPL, the Flood of Record was in 1955 with Hurricane Diane. The Flood Crest at Martins Creek during Hurricane Diane was EL 234.7 feet at the Plant. Based on PPL DWG LD-65827, the railroad bed is at EL 233 feet and the original dike crest was at EL 245 feet. Therefore Basin 1 never flooded. The top of the north end dike is now at EL 263 feet. This pond forms an enclosed basin and because it has been retired the only source of inflow is from direct precipitation and internal runoff. Reportedly, water from internal runoff does not build up enough to overflow into the pond outlet because of high permeability of ash material and the foundation soils.

Ash Basin No. 4 Dam - No recorded floods with estimates of peak flows is available for this basin. According to the information received from PPL, the Flood of Record in the area was in 1955 with Hurricane Diane, but Ash Basin No. 4 did not exist then. This pond forms an enclosed basin and because it has been retired the only source of inflow is from direct precipitation and internal runoff. There was a release incident in 2005 due to failure of wooden stop logs in the decant tower. This caused the release of water and fly ash through the discharge pipeline. The discharge structure is no longer in use and both the inlet and the outlet of the pipe are currently blocked with closed valves.

6.1.2 Inflow Design Flood

Ash Basin No. 1 Dam – The inflow design flood was not provided for this facility. According to the Pennsylvania dams and reservoirs size and hazard potential classification system, this basin is classified as C-3, which indicates a maximum reservoir storage of less than 1000 acre-feet, a maximum dam height of less than 40' with no expected loss of life and minimal economic loss in case of failure. The Pennsylvania dam safety regulations require the 100-year design as the maximum design flood for a C-3 reservoir.

Ash Basin No. 4 Dam - The inflow design flood was not provided for this facility. According to the Pennsylvania dams and reservoirs size and hazard potential classification system, this basin is classified as B-1, which indicates a maximum reservoir storage from 1000 to 50,000 acre-feet, a maximum dam height from 40' to 100' with substantial expected loss of life and appreciable economic loss in case of failure. The Pennsylvania dam safety regulations require the PMF (Probable Maximum Flood) design as the maximum design flood for a B-1 reservoir.

6.1.3 Spillway Rating

Ash Basin No. 1 Dam - No spillway rating was provided.

Ash Basin No. 4 Dam - No spillway rating was provided.

6.1.4 Downstream Flood Analysis

Ash Basin No. 1 Dam - No downstream flood analysis has been provided.

Ash Basin No. 4 Dam – There is a dam break analysis and inundation map for Ash Basin No. 4 dated August 21, 2002 prepared by a professional engineer for PPL Generation, LLC. This analysis shows that in case of a dam break under PMF conditions, the rise in stream level just downstream of the pond compared with no dam-break conditions would be about 3.56 feet. However, the incremental rise in stream level decreases in the downstream direction and at the confluence of Oughoughton Creek with the Delaware River the rise would be only 0.74 feet. The dam break inundation map shows that only a limited area around the basin and in Oughoughton Creek floodplain would be inundated and flood waters would quickly discharge to the Delaware River within approximately one mile from the basin. The pond is currently out of operation and a new assessment shows that a dam breach is unlikely to occur under existing conditions (see Section 6.3).

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Ash Basin No. 1 Dam – An analysis of the facility's ability to safely store and pass the inflow design flood was not provided for this facility. Basin elevation-storage curve, spillway rating curve and a dam break analysis are not available for this basin.

Ash Basin No. 4 Dam - An analysis of the facility's ability to safely store and pass the inflow design flood was not provided for this facility.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

Ash Basin No. 1 Dam – An analysis of the facility's ability to safely store and pass the inflow design flood was not provided for this facility. Therefore, an approximate calculation for this facility was performed to assess the hydrological/hydraulic safety of the facility based on available information and engineering approximations. The only source of inflow to this pond is from direct precipitation generating internal runoff. The design event for this facility is the 100-year flood due to the 100-year precipitation. Using the NOAA Atlas 14, the 100-year 24-hr precipitation for this location was found to be 7.64 inches (0.64 feet). An approximate calculation of the water accumulation over the basin surface (ponding) was performed to conservatively estimate the maximum ponding depth in the "Outlet Basin" portion of the South part (SEA) in front of the outlet riser structure. The factors considered included areas contributing to runoff in the South and North portions, pond internal drainage systems and dikes, estimate of low-lying areas in the South part that will inundate with flood water, impact of the trees and vegetation in the basin on reducing available storage and abstracting rainfall, and a conservative runoff coefficient for the ash material covering the pond surface. The porosity of the ash deposits in the basin is rather high resulting in a low runoff coefficient. Shaw Environmental, Inc has recently completed a study for PPL in which they applied the US EPA Hydrologic Evaluation of Landfill Performance (HELP) model to Ash Basin No.1 (see Doc. 3, p. A-17 in Appendix A). According to the results from this study, even for extreme storm events during an unusually wet year, the combined fly ash and bottom ash profile is not fully saturated. However, to be conservative the runoff coefficient in ponding calculations was set to 0.8

reflecting extreme wet conditions prior to occurrence of the design storm. It also prudently reflects unknown conditions concerning weathering and leaching of the ash deposits and the effects of these "aging" processes on long-term infiltration/runoff characteristics. This calculation showed that under the 100-year precipitation event approximately 5.90 feet of water may pond in the low lying areas of the south portion of the basin. This assumes that 80 percent of the rainfall falling over the entire basin area, including the north end and south end areas, accumulates and ponds in the low-lying portion of the south end area, which was estimated to be 25 percent of the south end area. Based on area ratios the ponding depth in the low-lying portion is magnified to 11.5 times the runoff depth. Since the low lying portion generally lies 15-20 feet below the dam crest elevation, the dam will not be overtopped by the 100-year flood and a dam failure due to overtopping is very unlikely.

The available free board in the outlet basin is expected to be over 8 feet during the 100-year flood. Also, since the water surface elevation will remain more than 3 feet below the invert elevation of the V-notch weir in the outlet riser structure, no outflow from the outlet structure is expected. Therefore, Ash Basin No. 1 seems to be safe from a hydrologic/hydraulic stand point, based on a 100-year design flood. It must be noted that this analysis and conclusion are relevant to the existing conditions of the basin. Any change in the existing conditions due to basin filling or other facility closure activities would require a new analysis. It is further noted that under the assumptions of this approximate analysis the Probable Maximum Flood may overtop the south end area embankment dam. However, a rigorous analysis of the PMF could possibly show a different result.

Ash Basin No. 4 Dam - An analysis of the facility's ability to safely store and pass the inflow design flood was not provided for this facility. Therefore, an approximate calculation for this facility was performed to assess the hydrological/hydraulic safety of the facility based on available information and engineering approximations. The only source of inflow to this pond is from direct precipitation generating internal runoff. The design event for this facility is the PMF (Probable Maximum Flood) due to the PMP (Probable Maximum Precipitation). The PMP for this location is 34 inches (2.83 feet) from HMR-51. An approximate water ponding calculation inside the basin was performed to conservatively estimate the maximum water surface elevation in the basin due to the PMP. Because the basin is lined and the ash deposits in the basin are currently being shaped and compacted it was conservatively assumed that the entire rainfall depth would convert to runoff and raise the water level in the pool. The starting water surface elevation for the calculation was set to 343.20 feet from the basin profiles dated 7/31/1996. Under current operation, the water level in the basin is kept below 330.00 feet and the basin is no longer used for ash disposal. Therefore, the assumption of starting water level 13.20 feet above the maximum operating water level is very conservative and reflects the conditions of the basin almost full with water from previous rainfalls that has not been pumped out. Elevation-area points for the basin are available that reflect the conditions prior to accumulation of ash deposits in the basin. However, because the starting water surface elevation was set above the elevation of ash deposits the surface area corresponding to the average water elevation during basin ponding was interpolated from the available elevation-area rating curve shown in Doc. 39 (p. A-691) in Appendix A. The basin surface area that receives rainfall and contributes to internal flooding is greater that the basin surface area during ponding. The ratio of the basin area at the elevation of the dam crest to the average surface area during ponding was used to convert the PMP rainfall depth to the water rise in the basin. This calculation showed that the maximum rise in the water surface elevation due to the PMP would approximately be 3.20 feet. Therefore, even if the basin is already full to elevation 343.20 feet at the start of the storm, the maximum water level in the pond would not go over

346.40 feet. This level is still 8.60 feet below the crest elevation of the embankment. This means that even under the most extreme inflow and water accumulation conditions there would be at least 8.0 feet of freeboard below the top of dam and the potential for dam breach due to overtopping at this site is very limited. Therefore, Ash Basin No. 4 seems to be safe from a hydrologic/hydraulic stand point. Because the basin outlet structure is not currently used, the water accumulating in the pond due to heavy rainfall needs to be pumped out after each major inflow to maintain a safe freeboard. It must be noted that this analysis and conclusion are relevant to the existing conditions of the basin. Any change in the existing conditions due to basin filling or other facility closure activities would require a new analysis.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

Ash Basin No. 1 Dam – No stability analyses were performed for original design and construction in the mid-1950s. In fulfillment of a permit condition, a stability analysis was performed in 1999. The permit condition required analysis of stability of the "external dikes subjected to the external loading of the 100 year flooding event." PPL's analysis in response to this condition is included as Doc. 18 (p. A-249) in Appendix A. Since the 100-year flood elevation is below the dam toe elevation of 235 feet, PPL conservatively assumed a flood elevation of 250 feet, which is 15 feet higher than any recorded flood at Martins Creek. The load case analyzed was a rapid drawdown condition on the outside slope. The Modified Bishop Method of analysis was used to compute factors of safety using a computer software application. The results are presented in Doc. 18 and summarized in Subsection 7.1.4.

During clean-up operations after the accidental release of CCW waste materials from Ash Basin No. 4 in 2005, dredge materials from the Delaware River were pumped at a relatively high rate of discharge into Ash Basin No. 1 NEA, which served as an emergency disposal area. Water eventually built up to a high level in the NEA, within about 3 feet of the crest. With the water at that level, seepage was observed emerging from the outside slope of the north portion of the embankment dam on the east side of the basin. After that observation dredge spoil disposal into the basin was ceased and the water level in the NEA dropped relatively rapidly. Because of this situation, additional stability analyses were conducted on a representative section of the outside slope of the dam in the seep area. The model section with crest at elevation 263 feet and base elevation of 205 feet (at or near the river) had overall height of 58 feet. The section included the access road berm at about elevation 250 feet, with slope up to crest at 2 H to 1 V and slope down to natural ground at approximately 1.4 H to 1 V to about elevation 227 feet and natural ground slope of 3 H to 1 V extending to the base at elevation 205 feet. Four model conditions or cases were analyzed. Each case was analyzed without earthquake loading (static analysis) and with earthquake loading (earthquake analysis); that is, eight separate analyses were performed. The model conditions for each case were as follows:

Case 1: Groundwater at typical (normal) elevation 210 feet and basin ash level at elevation 248 feet.
Case 2: Pool water at elevation 260 feet, fully-developed phreatic line, and ash at elevation 248 feet.
Case 3: Groundwater at normal elevation 210 feet and basin full with ash at elevation 263 feet.
Case 4: Groundwater at unusual elevation 230 feet in bottom of dam and extending up to surface of ash at elevation 248 feet.

The term "normal" used in the above descriptions refers to the typical groundwater level that occurs during day-to-day operations. The term "unusual" refers to higher than normal pool water level and/or groundwater level occurring as a result an unusual meteorological event, such as the design storm or prolonged wet weather with periods of high rainfall.

A horizontal acceleration of 0.3g was used in the earthquake analysis. The Modified Bishop Method of analysis was used to compute factors of safety using a computer software application. The results of the analyses are shown on the analysis sections in Doc. 19 (p. A-260) in Appendix A, along with soil parameters used in the analyses; the computed factors of safety are also summarized in Subsection 7.1.4.

Ash Basin No. 4 Dam – Static slope stability analyses were conducted during design of the ash basin dam. It does not appear that seismic stability (earthquake) analyses were performed. Only the steeper, outside slope was analyzed. Both circular arc and sliding wedge stability analyses were performed by computer methods using STABL software. Factors of safety were computed for various combinations of the strength parameters, cohesion (C in psf) and friction angle (Ø in degrees) and the results were plotted in graphs that could be used to determine for the commonly accepted factor of safety factor of safety = 1.5 for long term stability, what Ø would be required for a given C and what C would be required for a given Ø. The sliding wedge analysis produced a more critical failure surface than the circular arc analysis; that is, it resulted in lower computed factors of safety for the same set of strength parameters. The furnished stability analyses are included for reference as Doc. 41 (p. A-740) in Appendix A; only the analysis section for the sliding wedge analysis was provided.

7.1.2 Design Properties and Parameters of Materials

Ash Basin No. 1 Dam – In the 1999 slope stability analyses performed to satisfy a permit condition, the minimum computed factor of safety was based on both embankment and foundation soils having the following parameters and properties (i.e., no distinction made between embankment and foundation in the analysis section):

Total Unit Weight (γ) = 110 pcf
Saturated Unit Weight (γ_{sat}) = 120 pcf
Cohesion Intercept (C) = 150 psf
Friction Angle (Ø) = 30°

See computer printout in Doc. 18 in Appendix A for the source of the above information. These soil parameters were based on results of laboratory tests conducted on soils from the Ash Basin No. 4 area, since soil test data were not available at that time for soils from the Ash Basin No. 1 area.

The material properties and parameters used in the 2005-06 stability analyses of the section that experienced seepage are shown in the following Table 7.1.2A.

Table 7.1.2A: Design Properties and Parameters of Materials (2005-06 Seep Section Analyses)					
Material	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Soil Strength Parameters	
				C (psf)	Φ (deg)
Native Foundation Soil	1	125.0	135.0	0	38
Dam Embankment	2	120.0	125.0	500	26
Ash	3	100.0	100.0	0	28

See analysis sections in Doc. 19 in Appendix A for source of information in this table.

Ash Basin No. 4 Dam – Although not specifically stated in the calculations, the selected soil design properties and parameters appear to be as shown in the following Table 7.1.2B.

Table 7.1.2B: Design Properties and Parameters of Materials (1986 Analyses, Basin 4)					
Material	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Soil Strength Parameters	
				C (psf)	Φ (deg)
Native Foundation Soil	1	120.0	130.0	250	25
Dam Embankment	2	127.0	135.0	250	25

See soil input data in Doc. 41 (p. A-740) in Appendix A for source of information in this table.

7.1.3 Uplift and/or Phreatic Surface Assumptions

Ash Basin No. 1 Dam – In the 1999 slope stability analyses performed to satisfy a permit condition, the phreatic line was assumed to fully develop and extend through the embankment dam at the conservatively assumed flood elevation 250 feet and to remain at that elevation after the flood water subsided, and the water line was assumed to follow the ground line below elevation 250 feet (see analysis sections at the end of the computer printout in Doc. 18 in Appendix A).

In the 2005-06 stability analyses of the section that experienced seepage, only Case 2, with assumed pool elevation at 260 feet, had a fully developed phreatic line through the embankment. The phreatic line was assumed to be tangent to the outside slope at the inside edge of the access road berm, extend under the road, crop out at the toe of the embankment where it intersects the natural ground line, and then follow the natural ground line down to the base of the section (see analysis sections for Case 2 in Doc. 19 in Appendix A).

Ash Basin No. 4 Dam – A phreatic surface or line was not assumed in the stability analyses, apparently because the presence of the liner was assumed to prevent development of a phreatic line through the embankment.

7.1.4 Factors of Safety and Base Stresses

Ash Basin No. 1 Dam – A minimum factor of safety of 1.4 was computed in the 1999 slope stability analyses performed to satisfy the permit condition previously discussed.

The computed factors of safety for the various cases analyzed in the 2005-06 stability analyses of the section that experienced seepage are shown in the following Table 7.1.4.

Table 7.1.4: Factors of Safety (2005-06 Seep Section Analyses)

	Calculated Factor of Safety			
	Case 1 - Normal Operating	**Case 2 – Unusual Operating**	**Case 3 – Normal Closure**	**Case 4 – Unusual GW Operating**
Static Loading	2.01	1.19	1.99	1.51
Seismic Loading	1.05	0.55	1.02	0.78

See analysis sections in Doc. 19 in Appendix A for source of information in this table.
See Subsection 7.1.1 for descriptions of the four model cases.

Ash Basin No. 4 Dam – A minimum factor of safety of 1.90 was computed in the 1986 slope stability analyses performed during original design, for the presumed design properties and strength parameters shown in Table 7.1.2B.

7.1.5 Liquefaction Potential

Ash Basin No. 1 Dam – On the basis of review of the provided information, no liquefaction potential analyses appear to have been performed. However, review of available test borings, well logs, and geology information included in Appendix A does not reveal the presence of significant deposits of very loose to loose uniformly graded granular deposits below the water table that would present a potential concern for liquefaction under seismic shaking. The sand, gravel, and cobbles of the glacial and fluvio-glacial deposits that typically underlie the embankment dam are not expected to be susceptible to liquefaction under the level of seismic activity that could potentially occur in the region. Some relatively thin alluvial sand layers appear to be present under the embankment in some locations, but these layers are above the water table; they typically have at least medium dense relative density and thus do not appear to be susceptible to liquefaction.

The performance of ash, particularly fly ash, under seismic shaking is an open question. The main cross dike is founded on ash, and the upper stage perimeter embankments around the NEA are partly founded on ash, but predominantly bottom ash. Because the ash is located above the water table and has compressed under its own weight for many years, its susceptibility to liquefaction may be minimal, but no definitive evaluation can be made without detailed study that goes beyond the scope of this assessment. However, even if the main cross dike were to fail as a result of liquefaction in a deep layer of fly ash during a strong

earthquake event, the mobility of dry, predominantly bottom ash behind (north of) the main cross dike is likely to be very limited, and the ash would not likely override the lower part of the basin (SEA) to the extent that the ash would leave the basin. In addition, it appears that much of the fly ash, which might have potentially higher mobility, is located within the incised part of the basin and would not be able to move out of the basin. Thus, the risk of a release due to this cause seems low.

Ash Basin No. 4 Dam – On the basis of review of the provided information, no liquefaction potential analyses appear to have been performed. However, review of available test borings, well logs, and geology information does not reveal the presence of significant deposits of very loose to loose uniformly graded granular deposits below the water table that would present a potential concern for liquefaction under seismic shaking. The generally heterogeneous mixture of soil types with various grain sizes, including sand and gravel, cobbles, with varying amounts of silt and clay, of the glacial deposits that typically form the foundation for the embankment are not expected to be susceptible to liquefaction under the level of seismic activity that could potentially occur in the region.

7.1.6 Critical Geological Conditions and Seismicity

Ash Basin No. 1 Dam – Carbonate geology exists beneath the basin and embankment dam. The carbonate bedrocks in the vicinity have produced sinkholes and are known to pose a potential threat of new sinkhole development. Many sinkholes have been mapped in the region. However, Basin No. 1 is located on a lower terrace next to the Delaware River. At this location the top of the carbonate bedrock is relatively deep and located at least 20 feet below the water table; it is covered with a thick overburden of cobbles and boulders grading upward to sand and gravel. Under these conditions the risk of sinkhole development is small. PPL had a sinkhole evaluation of the site performed by Van Ness & Associates. A Sinkhole Evaluation Report prepared by Van Ness indicated, "It is unlikely that sinkholes would develop on the lower terrace." The Sinkhole Evaluation Report is included as Doc. 16 (p. A-206) in Appendix A. Nevertheless, a Sinkhole Contingency Plan was developed in response to a permit condition; this plan is included as Doc.15 (p A-203) in Appendix A. Detailed geologic information is included in Doc. 7 (p A-42) in Appendix A.

Ash Basin No. 4 Dam - Carbonate geology exists beneath the basin and embankment dam. The carbonate bedrocks in the vicinity have produced sinkholes and are known to pose a potential threat of new sinkhole development. Many sinkholes have been mapped in the region. Basin No. 4 is located on higher ground away from the Delaware River in an area where special care had to be exercised in siting the basin, because the known potential sinkhole hazard in the region. A siting study was performed; this study is included for reference as Doc. 43 (p. A-790) in Appendix A. Through investigation with both invasive methods (test borings, wells, etc.) and non-invasive (geophysical) methods, the basin was located in an area believed to be free of sinkhole hazards. Nevertheless, a synthetic liner was incorporated into the design to reduce the risk of seepage from the basin opening up sinkholes by raveling, and a sinkhole contingency plan was developed; the sinkhole contingency plan is included for reference as Doc. 40 (p. A-692) in Appendix A. During construction, shallow bedrock was encountered in the northeast part of the basin, and some sinkholes opened up; these were treated by an extensive program of grouting and dental concreting. No sinkholes opened up during the operational history of the basin. Detailed geologic information is included in Doc. 7 (p. A-42) in Appendix A.

Seismicity - Based on USGS Seismic-Hazard Maps for Central and Eastern United States, dated 2008, the Martins Creek SES, including both Ash Basins No. 1 and No. 4, is located in an area anticipated to experience 0.12g peak ground acceleration with a 2-percent probability of exceedance in 50-years.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Ash Basin No. 1 Dam – Structural stability documentation is adequate, particularly since the basin is retired and will no longer impound a normal pool of water. The methods used in the stability analyses are acceptable. The cohesion value of 500 psf used for the embankment soil in the 2005-06 stability analysis of the section that experienced seepage seems too high for "drained" strength conditions, which are appropriate for steady-state operating conditions in the static analyses. However, the potential failure arcs passed mostly through the ash materials and foundation soils, which were assumed to have no cohesion. The Case 2 and Case 4 conditions, in which failure is indicated (Factor of Safety << 1.0) under earthquake loading are conditions that will likely never exist in the closed basin. Either Case 1 or Case 3, which have acceptable computed factors of safety, will be the typical condition that will exist after closure.

Ash Basin No. 4 Dam – Structural stability documentation is generally adequate, particularly since the basin is retired and will no longer impound a normal high pool of water. There is no documented seismic stability analysis. However, with a computed static factor of safety well exceeding the conventional acceptable factor of safety of 1.5, acceptable seismic stability usually exists in regions that do not have high seismicity. In addition, review of the laboratory direct shear test data in Doc. 42 (p. A-748) indicates shear strength parameters of all tested samples that yield shear strengths in excess of the shear strengths defined by the apparent design shear strength parameters, although cohesion intercepts in the test results generally seem to be too high for "drained" strength conditions, possibly indicating that the test specimens were sheared too quickly. Nevertheless, an acceptable factor of safety of 1.5 exists even assuming no cohesion (C) and friction angle (Ø) of 27 degrees. The methods of analyses used in the stability analyses are acceptable.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Ash Basin No. 1 Dam – Structural stability appears adequate in consideration of current and future conditions in which a "dry" basin will normally prevail, the available stability documentation, and the absence of visual evidence of stability problems in the field.

Ash Basin No. 4 Dam – Structural stability appears adequate in consideration of current and future conditions in which an essentially "dry" basin will normally prevail, the available stability documentation, and the absence of visual evidence of significant stability problems in the field.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATIONAL PROCEDURES

Ash Basin No. 1 Dam – The basin is no longer used for disposal of CCW. Ash waste material was last placed in the basin in the third quarter of 2005 as an emergency disposal area during clean up of CCW materials accidentally released from Ash Basin No. 4 in August 2005. Thus, there are no current on-going operations, other than activities to comply with PA DEP Bureau of Waste Management permit conditions, e.g., groundwater quality monitoring. The basin is dormant and has been allowed to naturally re-vegetate. Some mining of bottom ash on the northeast portion of the basin for beneficial use has been allowed. The basin as a whole has not yet been formally closed. A closure plan that proposes alternate closure procedures has been prepared by PPL, and the plan is currently under review by the PA DEP. The proposed alternate closure plan is included as Doc. 4 (p. A-35) and Doc. 5 (p. A-40) in Appendix A. PPL is seeking to close the north end area (NEA) of the basin by essentially re-vegetating the ash basin area with trees and other native plant species and letting natural soil formation processes take place, as was done in the south end area (SEA); only nominal surface grading and reshaping would be done so as not to disturb the vegetation that has already become well established; existing drainage patterns would be maintained. The crest would be scarified, graded to promote surface drainage into the basin area, and established with a grass cover. The viability of the ash to support vegetation growth and soil formation was investigated in a 6-year study of the SEA by the Soil Scientist, Bryce F. Payne Jr., PhD. The results of the study were presented in "Final Report South End Experimental Process Ash Basin 1," dated November 2006; it showed that plant growth and soil formation are viable and able to secure the ash in the SEA with the "same or better effectiveness than imported local cover soils and reclamation vegetation." The Executive Summary of this study is included as Doc. 17 (p. A-242) in Appendix A.

Ash Basin No. 4 Dam – The basin is no longer used for disposal of CCW. Ash waste material from production operations was last placed in the basin in September 2007, when the two coal-fired steam electric generating units were taken out of service. The PA DEP allowed PPL to place some additional ash from the closure of the coal-fired units into the basin after cessation of coal burning for steam electric generation. Thus, there are no current on-going operations other than activities to comply with PA DEP Bureau of Waste Management permit conditions, e.g., groundwater quality monitoring. The basin has not yet been formally closed. The basin is currently being dewatered and prepared for closure. A closure plan has been prepared by PPL, and the plan is currently under review by the PA DEP. The proposed closure plan is described in the narratives included within the forms in Doc. 4 (p. A-461) in Appendix A. The proposed closure includes a 2-foot thick soil cap and underlying 60 mil PVC geomembrane. Specifically the cap is proposed to consist of (from top to bottom):

- Vegetative cover
- 4" topsoil
- 20" cover soil
- Geocomposite drainage layer
- 60 mil geomembrane liner
- Geotextile (contingency), as may be required based on subgrade conditions

The ash in the north part of the basin is currently being graded and reshaped to prepare the subgrade for the cap. The exposed synthetic liner on the inside slopes is being washed clear of a thin veneer of ash sediment gravel, and other debris in preparation for closure. The closure plan describes the sequence of construction and the management of surface water during closure and after completion of the closure cap. PPL proposes that storm water from the final cap be collected with interior swales that direct the runoff to a low point at the southeast corner, where the water would flow into a new, relatively shallow-buried 42-inch diameter pipe that would extend through the upper part of the containment berm (embankment dam) and down-gradient to connect with the 33-inch diameter discharge pipeline system that extends to the Combining Structure and from there to the regulated outfall near the Delaware River; the new 42-inch diameter outlet would have a protective concrete endwall at the entrance end. It is understood from PPL that the existing decant tower and outlet pipe through the embankment dam would be permanently plugged.

The operating instructions that applied during the last years of active disposal of ash waste in the basin are included for reference as Doc. 30 (p. A-514) in Appendix A. An Emergency Action Plan that was revised after the 2005 release incident also is included for reference as Doc. 25 (p. 394) in Appendix A.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

Ash Basin No. 1 Dam – Essentially no regular or routine maintenance is currently done at this inactive basin; vegetation on the embankment slopes and crest is not mowed or cut.

Ash Basin No. 4 Dam – The latest available maintenance plan for the basin is included in Doc. 26 (p. A-413) in Appendix A. The plan includes no mention of a mowing schedule or other maintenance check items for the vegetated outside slope. The maintenance plan deals mainly with the discharge structure and outlet pipe. However, it is understood from Mr. Steve Holler with PPL that there generally is annual mowing of the slope and that the slope was last mowed in May 2009. A later inquiry indicated that the slope is mowed twice annually. Based on discussion with Mr. Holler, maintenance of the liner has included patching of holes and defects that are detected and marked in the field during PPL's quarterly inspections. Review of the last annual inspection report by an outside consultant indicates that PPL filled 35 animal burrows in early June 2009, but at least a dozen new ones appeared by the time of the consultant's inspection in mid-June.

Miscellaneous – There is no mowing of the embankment dam at the IWTB and at the closed Basin No. 2; PPL noted that mowing of the slopes at the closed Basin No. 3 will be done later in the year (2009).

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATION

8.3.1 Adequacy of Operational Procedures

Ash Basin No. 1 Dam – Assessment of operational procedures as related to active ash disposal is not applicable, since the basin is no longer used for ash disposal. Operational procedures as related to closure appear to be adequately following the PA DEP regulatory process.

Ash Basin No. 4 Dam – Assessment of operational procedures as related to active ash disposal is not applicable, since the basin is no longer used for ash disposal. Operational procedures as related to closure appear to be adequately following the PA DEP regulatory process.

8.3.2 Adequacy of Maintenance

Ash Basin No. 1 Dam – The lack of maintenance of vegetation on the crest and outside slope is not adequate. As long as the basin has the capability to impound storm water from severe rainfall storms, the vegetation on the crest and outside slope should be maintained to allow unobstructed observation of the visible parts of the embankment dam. The post-closure maintenance program should also include repair of eroded areas that may develop on the outside slope or crest and control of burrowing animals, as necessary. In addition, if the standpipe and outlet pipe are to remain open and functional after closure, these structures should be maintained or repaired as needed, based on the results of routine inspections.

PPL, based on experience and results of the HELP model analysis, does not believe the basin will ever impound water and thus does not propose to maintain the dam and outlet works. If the basin is essentially abandoned and allowed to re-vegetate over the embankments and ash fill, then the appropriate "design" flood for the untended basin should be the PMF, rather than the 100-year flood. The HELP model does not appropriately simulate the flood response in the basin due to the input of a large amount of rainfall over a short period of time. As previously mentioned, approximate calculations indicate that the south end area embankment dam may be overtopped during the PMF. Thus, given the possibility that the dam could temporarily impound a significant amount of water and be overtopped during such an unusual event, it is believed that the embankment dam and outlet works should be maintained and inspected on a routine basis (see Subsection 9.3.1).

Ash Basin No. 4 Dam – The maintenance program is generally adequate. However, the outside slope should be mowed more frequently, to allow unobstructed observations during PPL's quarterly inspections and the outside consultant's annual inspections, as well as PA DEP's inspections. The post-closure maintenance program should also include repair of eroded areas that may develop on the outside slope and closure cap and control of burrowing animals, as necessary. In addition, if the decant tower and outlet pipe are to remain open and functional after closure, these structures should be maintained or repaired as needed, based on the results of routine inspections.

Miscellaneous – The crest and outside slope of the embankment dam on the west side of the IWTB should be mowed on a frequency of at least once annually, to keep trees and other woody vegetation from becoming established and to allow unobstructed observations during inspections by PPL personnel.

9.0 SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Ash Basins No. 1 Dam – A drive-around inspection is made by PPL personnel on a monthly basis. The PA DEP Division of Dam Safety plans to make periodic inspections, since the determination that the dam falls under PA dam safety regulations. The jurisdictional determination is given in a PA DEP letter dated February 26, 2009, which is included as Doc. 12 (p. 191) in Appendix A. A Dam Safety Inspection Notice prepared by PA DEP dam safety personnel based on our September 02, 2009 site visit is included as Doc. 6 (p. A-41) in Appendix A. The Notice noted no deficiencies or violations and made note of the vegetation covering the basin and stated that the basin "does not appear to impound water on a routine basis;" it also noted that a dam permit application for closure is currently under review by the Division.

Ash Basin No. 4 Dam – PPL operating personnel make daily observations and document the observations on a Daily Operations Log Sheet. PPL engineers inspect the dam and basin works quarterly and document the inspection on a quarterly Inspection Checklist; in addition annual inspections are documented on Annual Inspection Checklists. The log sheet and checklists used for documentation are included for reference in the maintenance plan in Doc. 26 (p. A-413) in Appendix A. Outside consultants inspect the facility on an annual basis. The 2009 annual inspection report, prepared by HDR/DTA, is included for reference as Doc. 29 (p. A-478) in Appendix A; their most significant findings are noted in discussion of observations at Ash Basin No. 4 in Chapter 5.0. Annual inspections are also conducted by PA DEP Division of Dam Safety; their inspection reports for the years 2003 through 2009 are included for reference as Doc. 44 (p. A-811) in Appendix A, and Dam Safety Inspection Notices prepared by PA DEP dam safety personnel based on our September 02, 2009 site visit are included as Doc. 45 (p. A-875) in Appendix A. The PA DEP inspections reported no major deficiencies. The most re-occurring issue was tall vegetation and the need for more frequent mowing.

Miscellaneous – At the IWTB PPL operating personnel make daily observations, and PPL engineers make quarterly inspections. At the closed Ash Basin No. 3 a monthly drive-around inspection is made by PPL personnel. At the closed Ash Basin No. 2 no inspections are conducted. None of these three facilities are regulated by PA DEP Division of Dam Safety, although the Division of Dam Safety is reviewing whether the IWTB dam falls under the regulations. The IWTB is regulated by the PA DEP Water Management Program.

9.2 INSTRUMENTATION MONITORING

9.2.1 Instrumentation Plan

Ash Basin No. 1 Dam – There is no dam performance monitoring instrumentation in place. Groundwater monitoring wells have been installed at various locations in and around the basin for hydrogeologic assessments and compliance monitoring of groundwater quality. Monitoring point plans showing locations of monitoring wells are included for reference as Doc. 13 (p. A-193) and Doc. 14 (p. A-196) in Appendix A; these documents also include subsurface sections through the basin, groundwater contour maps and other information. Original hydrogeologic information and evaluation submitted during permitting are included as Doc. 9 (p. A-74) and Doc. 10 (p. A-112) I Appendix A.

Ash Basin No. 4 Dam – There is no dam performance monitoring instrumentation in place. Groundwater monitoring wells have been installed at various locations around the basin for hydrogeologic assessments and compliance monitoring of groundwater quality.

9.2.2 Instrumentation Monitoring Results

Ash Basin No. 1 Dam – There are no dam performance monitoring instruments and, thus, no results of dam monitoring. Monitoring of groundwater quality for a multitude of contaminant constituents, as well as indicator parameters, has shown no exceedances at the compliance point (most down-gradient well). Based on analytical data from the monitoring program, some exceedances for selenium have occurred in the past at a well just below the outside toe of the embankment at the southeast corner, but up-gradient of the compliance point. The groundwater monitoring wells show that the natural groundwater table is well below the bottom of ash in the unlined basin. HELP Model results indicate that groundwater mounding as a result extreme precipitation events combined with long term wet-weather assumptions would not reach the bottom of the ash. The HELP Model analyses are included in Doc. 2 (p. A-11) and Doc. 3 (p. A-17) in Appendix A.

Ash Basin No. 4 Dam – There are no dam performance monitoring instruments or results of dam monitoring. PPL noted no exceedances in groundwater monitoring wells around this basin.

9.2.3 Evaluation

Ash Basin No. 1 Dam – Not applicable, since there are no dam performance data to evaluate. In-depth evaluation of groundwater quality monitoring results is beyond the scope of this structural/stability assessment. A superficial look at available groundwater monitoring data suggests no apparent gross contamination of the groundwater.

Ash Basin No. 4 Dam - Not applicable, since there are no dam performance data to evaluate. In-depth evaluation of groundwater quality monitoring results is beyond the scope of this structural/stability assessment.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Ash Basin No. 1 Dam – The inspection program is generally inadequate. As long as the dam is capable of impounding storm water as a result of extreme rainfall events, the dam should receive more than a drive-by inspection. (See discussion in Subsection 8.3.2 of the potential of the basin to impound water.) The monthly drive-by inspections should continue, but a more detailed walk-around inspection should be performed at least once annually by a PPL engineer and documented by a written report or checklist. If the outlet structure must be relied upon for storm water drainage of the basin area after closure, the

post-closure plan should include routine internal inspection of the structure as recommended in Subsection 1.2.7.

Ash Basin No. 4 Dam – The inspection program is generally adequate. If the outlet structure must remain functional after closure, as may potentially be required as a permit condition, the post-closure plan should include routine internal inspection of the structure as recommended in Subsection 1.2.7.

9.3.2 Adequacy of Instrumentation Monitoring Program

Ash Basin No. 1 Dam – As noted above, there is no dam performance monitoring instrumentation in place. However, the dam does not impound water on a routine basis, and the basin is scheduled to be closed. No problem or suspect condition, such as excessive settlement, seepage, shear failure, or displacement was observed in the field that might be reason for installation of one or more types of instrumentation. In the absence of stability problems or seepage issues, there is no need for performance monitoring instrumentation at this time.

Ash Basin No. 4 Dam – Similarly for this basin there is no dam performance monitoring instrumentation in place. The water in the basin is maintained at a very low level, and the basin is scheduled to be closed. No problem or suspect condition, such as excessive settlement, seepage, shear failure, or displacement was observed in the field or noted in previous inspection reports that might be reason for installation of one or more types of instrumentation. In the absence of stability problems or seepage issues, there is no need for performance monitoring instrumentation at this time.