

# PPL Martins Creek Natural Resource Damage Assessment

## Environmental Assessment and Restoration Plan

### PREFACE

This is an assessment of PPL's Phase IV Completion Report and the impacts to natural resources associated with the August 2005 unpermitted release from Ash Basin No. 4 at the PPL Martins Creek Steam Electric Station in Lower Mount Bethel Township, Northampton County, PA. This Report was developed by the Pennsylvania Department of Environmental Protection ("PADEP"), working with members of a Natural Resource Damage Assessment Team. The Report concludes that there were impacts to natural resources associated with the release and cleanup and that dam removal and mussel restoration projects will provide sufficient compensation to the public for natural resource injuries. Although specific dam removal projects identified in the Report have changed since the Report was authored in August 2011, settlement agreements involving the PADEP, the PA Fish and Boat Commission, the Delaware River Basin Commission and the New Jersey Department of Environmental Protection provide sufficient flexibility to allow for alternate dam removal projects and ensure that adequate compensation for natural resource damages will be received.

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**PPL Martins Creek Natural Resource Damage Assessment**

**Environmental Assessment and Restoration Plan**

**Produced by**

**Pennsylvania Department of Environmental Protection**

**Reviewed By**

**New Jersey Department of Environmental Protection**

**Pennsylvania Fish and Boat Commission**

**Delaware River Basin Commission**

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## **Executive Summary**

On August 23, 2005 a failure of wooden stop logs in the discharge structure of Ash Basin No. 4 at the PPL Martins Creek Steam Electric Station, located in Lower Mount Bethel Township, Northampton County, caused an uncontrolled release of fly ash slurry from the Basin that continued for several days. Over the course of the discharge, PPL estimated 100 million gallons of fly ash was deposited onto the land, into Oughoughton Creek, and into the Delaware River. A number of emergency response actions were taken by PPL Martins Creek, LLC and various resource agencies from August 23 to August 26, 2005 during the period that the basin was still discharging. PPL's response actions to recover as much fly ash as possible from affected land and waterways continued following the active discharge and were completed in March 2006. Those response actions were preceded by work plan proposals and were documented by PPL in three reports (Phase I, Phase II and Phase III). Environmental assessment work, which also occurred during and after major cleanup activities ended, continued into September 2006 and is outlined in PPL's Phase IV Completion Report.

The Phase IV Completion Report includes details on the presence, extent, and potential impacts of fly ash on the sediments, surface water, and biological communities in the Delaware River. The Phase IV Completion Report also summarizes a number of studies performed in 2005 and 2006. These studies involve evaluating metals concentrations in the surface water, river sediments, and concentrations of metals in fish and mussel tissue. The report also contains aquatic surveys of fishes, benthic macroinvertebrates, mussels, and periphyton.

Since the release, the Pennsylvania Department of Environmental Protection (PA DEP) has acted as the lead agency for the PPL Martins Creek Natural Resource Damage Assessment (NRDA) process. In addition to PA DEP, the active NRDA trustees are the New Jersey

Department of Environmental Protection (NJ DEP), the Pennsylvania Fish and Boat Commission (PFBC), and the trustee team consultant, the Delaware River Basin Commission (DRBC).

The Phase IV Completion Report was reviewed by the Natural Resources Damages Assessment Trustee Team to evaluate the natural resource damages resulting from the release. The NRDA Team did not agree entirely with all of the conclusions presented in PPL's Phase IV Completion Report and has determined that PPL is responsible for injury to natural resources in the Commonwealth of Pennsylvania and the State of New Jersey. The NRDA Team has determined that restoration measures for natural resource damages are necessary. The selected restoration plan includes dam removals in New Jersey and Pennsylvania and a mussel restoration component, which will contribute to the health of the aquatic ecosystem.

## **Overview of the Release and PPL Phase I, II, III and IV Reports**

The PPL Martins Creek Steam Electric Station is located in Lower Mount Bethel Township, Northampton County, Pennsylvania (Facility). In 2005, the Facility included two coal fired units which had a generating capacity of approximately 150 megawatts each. Bottom ash and fly ash were generated from the combustion of pulverized coal in Units 1 and 2 during the electricity generation process. The ash was mixed with water and stored as ash slurry in large outdoor impoundments, including Ash Basin No. 4. Ash Basin No. 4 is approximately 40 acres in size and was constructed by PPL Martins Creek in 1989. At that time, PPL Martins Creek was permitted by the PA DEP to dispose of fly ash, as well as other types of waste from the facility, including bottom ash, sediment from the facility's industrial waste treatment basin and iron sludge from boiler cleaning activities in Ash Basin No. 4. In 2007, the coal fired power plant was shut down. Waste is no longer discharged to Ash Basin No. 4 and the basin is currently undergoing final closure (Figure 1: A schematic diagram of the PPL Martins Creek Facility).

On August 23, 2005, wooden stop logs in the discharge structure in Ash Basin No. 4 failed and an uncontrolled release of fly ash slurry ran across Depue Ferry Road, blanketing adjacent fields and entering Oughoughton Creek and the Delaware River. PPL began taking measures to stop the discharge from Ash Basin No. 4 and to remove fly ash deposited on the ground, in the Oughoughton Creek, and in the Delaware River. PPL estimated the release at 100 million gallons of fly ash slurry (Photograph 1: Aerial view of the fly ash release in the Delaware River).

A number of emergency response actions were taken by PPL Martins Creek, LLC and various resource agencies from August 23 to August 26, 2005 during the period that the basin was still discharging. PPL's response actions to recover as much fly ash as possible from affected land and waterways were completed in March 2006 and documented by PPL in three reports (Phase I, Phase II and Phase III). Environmental assessment work, which also occurred during and

after major cleanup activities ended, continued into September 2006 and is outlined in PPL's Phase IV Completion Report.

PPL responded to the event by implementing the following activities:

1) an initial emergency response (August 25, 2005 through September 15, 2005) consisting of containment and removal of bulk ash deposits from along the Delaware River shoreline using booms, straw bales, vacuum trucks, and laborers using hand tools (e.g., shovels, pumps), which resulted in removal of 19,000 cubic yards of material (ARCADIS 2007);

2) a Phase I Excavation "in the wet" cleanup (September 2005) consisting of removal of suspected fly ash and impacted river sediment from along and within the Delaware River in the immediate vicinity of the Ash Basin 4 discharge structure, which resulted in removal of more than 400 tons of material (ARCADIS 2007);

3) a cleanup of more than 2,500 cubic yards of fly ash from the adjacent intermittent Oughoughton Creek stream bed (ARCADIS 2007);

4) a Phase II Excavation "in the dry" cleanup (September 2005 to November 2005) consisting of excavation and removal of suspected fly ash and impacted river sediment. This work was conducted in approximately 2.5 acres of the Delaware River from within a temporary Portadam structure. (Photograph 2: Restoration work within the Portadam). Approximately 1,300 cubic yards of fly ash was removed (ARCADIS 2007);

5) a Phase III cleanup (November 2005 through March 2006) consisting of the removal of recoverable (i.e., bulk) suspected fly ash deposits and impacted river sediment. The suspected fly ash deposits were located largely in two discrete areas located in a stretch of the Delaware River beginning immediately downstream from the Ash Basin 4 discharge structure to approximately 1½ miles downstream from the discharge structure. The discrete areas were



referred to as Pool 1 and Pool 2. Cleanup in these areas included the use of divers vacuuming the fly ash from the river bed (Photograph 3: An aerial depiction of the location of the Portadam, Pool 1 and Pool 2);

6) several scientific investigations to assist in the cleanup efforts, and

7) communication with various local, state, and federal agencies and groups of interest to discuss work plans, necessary permitting, cleanup activities, and sample results.

The PA DEP, with input from the other NRDA Team members, reviewed, commented on and approved work plans for the four phases of the cleanup and damage assessment that were submitted to PA DEP by PPL Martins Creek.

PPL performed extensive sampling, supplied bottled water to residents, made presentations at public meetings, and developed a newsletter and website that updated the public on the cleanup operations. PPL also worked with its consultants, the Academy of Natural Sciences and the NRDA Team to address damages to the natural resources.

The NRDA Team was formed following the August 2005 discharge and included the United States Fish and Wildlife Service, the United States National Park Service, the United States Environmental Protection Agency, United States Army Corps of Engineers, the National Oceanic and Atmospheric Administration, the Pennsylvania Fish and Boat Commission, the Pennsylvania Game Commission, the Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Department of Environmental Protection, New Jersey Department of Environmental Protection, and the NRDA team's consultant, the Delaware River Basin Commission. As the cleanup progressed, several team members opted out of active participation and the NRDA Team currently includes the New Jersey Department of Environmental Protection, the Pennsylvania Fish and Boat Commission, the Pennsylvania Department of Environmental Protection, and the NRDA team's consultant, the Delaware River

Basin Commission. These team members provided useful and impartial review and comment on the three phases of the cleanup, as well as the Phase IV Completion Report. The NRDA Team participation has played a significant role in ensuring that the spill and its after effects have been properly addressed.

PPL's Phase IV Completion Report summarizes a number of studies performed in 2005 and 2006 and includes details on the presence, extent, and potential impacts of fly ash on the sediments, surface water, and biological communities in the Delaware River. These studies involve evaluating metals concentrations in the surface water, river sediments, and concentrations of metals in fish and mussel tissue. The report also contains aquatic surveys of fishes, benthic macroinvertebrates, mussels, and periphyton.

The Phase IV Completion Report concluded that the data collected from the biological community studies did not indicate that the release adversely affected the ecological communities of the Delaware River or of any representative species studied (ARCADIS 2007). The increase in metals concentrations did not result in a widespread exceedance of ecological screening values for surface water and sediment (ARCADIS 2007). The fly ash released resulted in temporary increased loadings for select metals in the Delaware River and the concentration of metals in fish and mussel tissue were below risk-based concentrations (ARCADIS 2007). Based on the Phase IV investigation results, PPL determined that additional data collection or remedial action is not warranted or recommended (ARCADIS 2007).

The NRDA Trustee Team does not agree with the conclusion reached in the Phase IV Completion Report regarding the impacts to the ecological communities and concluded that there were impacts to natural resources requiring additional remedial measures.

## **Summary of Natural Resources, Injuries, and Service Losses**

The natural resource damage assessment process seeks to:

- 1) determine whether injury to, or loss of, trust resources has occurred;
- 2) ascertain the magnitude of the injury or loss;
- 3) calculate the appropriate compensation for the injury, including the cost of restoration;  
and
- 4) develop a restoration plan that will restore, rehabilitate, replace, and/or acquire equivalent resources for those resources that were injured or lost.

After undertaking this type of a review, taking into consideration field observations and data collected both during and after the spill, which is discussed further below, the NRDA Team has concluded that there were natural resource damages as a result of the spill and has evaluated the magnitude of the loss. The NRDA Team has also determined appropriate compensation for the injury and identified a restoration plan that will help restore, rehabilitate and replace the injury and loss to natural resources.

### **Water Quality**

The Delaware River water samples were taken by the different resource agencies and PPL and showed exceedences of certain water quality standards (Yagecic 2006). Water quality results were compared to the following criteria at the time of release: PA Title 25 Chapter 16. Water Quality Toxics Management Strategy- Statement of Policy (now incorporated into PA Title 25 Chapter 93. Water Quality Standards); NJ Surface Water Quality Standards N.J.A.C. 7:9B (NJ defers to DRBC where DRBC has criteria for the Delaware River); and NJ FW2-NT criteria (Yagecic 2006). The metal arsenic had apparent exceedances of PA Human Health Criteria

immediately after the release of fly ash in Delaware River water samples. Any quantifiable concentration of arsenic exceeds the NJ criteria (Yagecic 2006). The water samples had apparent exceedances of PA and NJ lead criteria immediately after the release in the vicinity of the release (Yagecic 2006). Most quantifiable lead concentrations exceeded the PA criteria including water samples collected upstream from the fly ash spill. Copper had short term exceedances of PA criteria at the fly ash release point and downriver (Yagecic 2006). Aluminum had short term local exceedances of PA aluminum criteria from the release, but background and high flows account for most of the observed concentration (Yagecic 2006). Based on the data collected, the NRDA Trustee Team determined that there was a loading of metals especially arsenic, to the Delaware River. The team concluded that the fly-ash spill resulted in numerous exceedances of applicable PA DEP and NJ DEP water quality standards for aquatic life, human health, and/or drinking water standards.

### **Sediment**

Overall, the September 2005 and June 2006 river bank sampling sediment results indicated that the levels of arsenic, beryllium, and vanadium likely related to the fly ash release were statistically higher downstream of the release compared to the background river bank sediments (ARCADIS 2007). These sediment concentrations of potential fly ash related metals in samples from 2005 and 2006 on both sides of the river were below the human-health-based direct contact standards published by Pennsylvania and New Jersey (ARCADIS 2007). The river bank sediment results compared to ecological screening benchmarks recommended by NJ DEP indicate that the only metal with results higher than the lowest effect level (LEL) was arsenic. The exceedances slightly above the LEL (6 mg/kg) for arsenic were in three of 29 river bank sediment samples in 2005 and four of 56 river bank sediment samples in 2006 (ARCADIS 2007). No severe effect level (SEL) (33 mg/kg) exceedances for arsenic were identified in the river bank sediment samples (ARCADIS 2007).

Two of six in-river sediment samples collected in September 2005 downriver of Pool 2 and upriver of Easton, PA contained arsenic levels above the LEL (6 mg/kg), with one being above the SEL (33 mg/kg) (ARCADIS 2007). One of the five Delaware River background in-stream sediments samples collected in September 2005 exceeded the arsenic LEL (ARCADIS 2007).

Two of six in-river sediment samples collected in November 2005 downriver of Pool 2 and upriver of Easton, PA contained arsenic slightly above the LEL, with all samples being below the SEL (ARCADIS 2007).

A peer-reviewed paper was used by the NRDA Team to provide an indication of relative predicted toxicity of sediments. The Threshold Effects Concentration (TEC) and Probable Effects Concentration (PEC) values for arsenic in sediments are 9.79 mg/kg and 33.0 mg/kg (MacDonald et al. 2000). Two in-river sediment samples that were collected in September 2005 below Pool 2 had arsenic concentrations of 14.4 mg/kg and 44.9 mg/kg (ARCADIS 2007). The remaining six samples collected in September 2005 between Pool 2 and Easton, PA contained arsenic concentrations of 2.6 to 4.2 mg/kg (ARCADIS 2007). Two of the arsenic in-river sediment concentrations are above the TEC and PEC values which toxic effects would be expected and can be used to predict the presence of sediment toxicity (MacDonald et al. 2000). All six of the November 2005 in-river sediment samples below Pool 2 were below the TEC and PEC screening criteria (ARCADIS 2007).

### **Natural Resources**

The Phase IV Completion Report results of the mussel community assessment conducted by PPL are inconclusive, in as much as the results indicate either an impact from the fly-ash spill or merely natural variability in the mussel fauna. Fish and mussel tissue sampling and analyses indicate that metals found are below the threshold for ecological damage, but there was a difference between upriver and downriver stations, particularly the first downstream station

(Academy of Natural Sciences of Philadelphia 2007). The fly ash spill caused a loading of metals especially arsenic, barium, beryllium, and vanadium to the Delaware River.

The Phase IV Completion Report did not document the acute impacts to the natural resources along the first 4,000 feet of Oughoughton Creek and portions of the Delaware River in the Portadam area, Pool 1 and Pool 2. The inundation deposition within the 2.5 acre Portadam area of the Delaware River and documented amounts of deposited fly ash as well as excavation activities within the approximately 20 acres of Pool 1 and 19 acres of Pool 2 during August and September 2005 (ARCADIS 2007) and the removal of fly ash in the Delaware River in smaller areas (approximately 3.4 acres) would have caused substantial to complete mortality of sedentary macroinvertebrates due to excavation activities and/or physical smothering and/or metals toxicity.

In the Portadam area and in Pool 1 and Pool 2 where significant amounts of fly ash accumulated, the trustee consultant believes that the periphyton community was impacted 100% due to smothering and/or subsequent removal. Benthic macroinvertebrate community mortality would occur as a result of both the fly ash spill itself as well as the subsequent activities PPL undertook to remove the fly ash from the Delaware River in the Portadam area and in Pool 1 and Pool 2. Mussel impacts may have occurred by acute mortality due to physical smothering, excavation, chronic stress, and reduced population due to physical smothering, choking and acute or chronic effects of metals toxicity.

### **Analysis**

The information concerning water quality, sediment and natural resources discussed above has led the NRDA team to conclude that restoration measures for natural resource injury damages are necessary and appropriate as a result of the 2005 fly ash spill. In an effort to develop an assessment of natural resource injury damages, the NRDA Team focused on impacts to fresh

water mussels, which it considers to be the most sensitive or representative species. The team also used information on the acreage of impacted areas, estimated reductions in ecological function, and estimates on recovery time in arriving at an injury assessment. Data on these parameters were utilized in the Habitat Equivalency Analysis (HEA) model as well as expected ecological uplift from prospective restoration projects to determine the amount of acreage for restoration necessary to address natural resource damages.

For the HEA assumptions, the NRDA Team estimated the total injury area of the Delaware River to be from the PPL Martins Creek Steam Electric Station to the confluence of the Lehigh River. To account for the diminishing level of injury as the distance downriver increased from the source of the spill, the zone of impact of the Delaware River was divided into an upper section and a lower section.

Using fresh water mussels as the most sensitive species for the HEA assumptions, the NRDA Team reviewed the direct impacts in the areas of the Portadam, Pool 1 and Pool 2 and additional impacts to fresh water mussels including smothering and loss of fecundity in the Delaware River from the spill's point of origin to the confluence of the Lehigh River. In the HEA assumption model, the team used the area of impacts, the change in pre-injury service level, and the total recovery time for freshwater mussels in the assumed injury area. The NRDA Team then used the model to calculate the total area of restoration necessary based on theoretical dam removal projects to restore pre-injury service level in the area of impact. The total area of restoration necessary based on theoretical dam removal projects was determined to be 146 acres.

The NRDA Team recommendation for mitigation is to undertake direct actions to boost overall population biomass of freshwater mussels and/or to broaden the range of the existing populations of freshwater mussels to boost population resiliency. Freshwater mussels have a

complex life history that limits their ability to rebound following disturbance. Many tributaries of the Delaware River Basin are now devoid of mussels, even common species, where they once held numerous species that occupied different ecological niches (Kreeger 2008). Fresh water mussels become extirpated from many streams mainly due to anthropogenic causes. Mussels are not able to recolonize these streams because either there is no longer mussel brood stock nearby and/or dams and other impediments to fish passage that interrupt the life cycle of freshwater mussels by impeding the redistribution of juvenile mussels via the fish host. Mussels have a long lifespan and so even if conditions permit redistribution via fish hosts, population development can take decades (Kreeger 2008).

The NRDA Trustee Team considered a number of restoration projects to offset the natural resources injuries. Restoration projects considered included the restoration of the Oughoughton Creek (intermittent stream) in accordance with natural stream channel design principles, stream bank fencing in the surrounding watersheds near the PPL Martins Creek facility, fresh water mussel restoration projects in Pennsylvania and New Jersey, and dam removal projects in Pennsylvania and New Jersey. The NRDA Trustee Team decided on dam removal projects on the Little Lehigh Creek and Bushkill Creek in Pennsylvania, dam removal projects on the Musconetcong River in New Jersey, and a freshwater mussel restoration component. The streams targeted for the dam removals have suitable water quality and/or have historically supported a mussel population.

The NRDA Team believes the best mitigation would be dam removal projects and a project to reintroduce freshwater mussels where they have become extirpated or impaired over time in an effort to expand their range and boost overall metapopulation biomass.



## **Restoration Summary**

The selected restoration projects for the reparations for natural resource injury are dam removals in New Jersey and Pennsylvania and a mussel restoration project. Dams impede the movement of fish and other aquatic species and alter water quality. Dam removals aid in fresh water mussel restoration due to habitat improvement and the ability to recolonize areas that were impeded by existing dams (Kreeger 2008). The dam removal projects will allow fish and other aquatic organisms to move freely both in the local area as well as between these tributaries and the Delaware River. In addition, all of the dam removals selected will address a potential public safety hazard.

The HEA assessment indicated that a total area of restoration based on theoretical dam removal projects is 146 acres. The restoration acres gained by the preferred dam removal activities listed below are calculated at 131.5 acres. A fresh water mussel restoration project and a feasibility study on the Bloomsbury Graphite Mill Dam are not included in the HEA calculated acreage, but are included in the list of projects to be completed and are also factored into the restoration plan. Maps showing each dam are included in Figure 1A, Figure 1B, and Figure 1C.

### **Dam Removals in Pennsylvania**

The Pennsylvania dams are located on the Little Lehigh Creek and Bushkill Creek. These streams are classified by the PA DEP as a High Quality-Cold Water Fishes that support natural reproduction of trout. Bushkill Creek and the Little Lehigh Creek are adversely impacted by run of the river dams. Dams impede the movement of fish and other aquatic species and alter water quality.

### Martin Luther King Dam (DEP Number 39-035)

The Martin Luther King (MLK) Dam is the first barrier to the Lehigh River along the Little Lehigh Creek in Allentown (Figure 1A). The Martin Luther King Dam is the only one located downstream of Cedar Creek. If both the Little Lehigh Creek main stem and Cedar Creek are considered, the removal of the MLK dam results in a gain of 15,700 feet of channel and 39 acres. The dam is located 8300 feet upstream of the confluence with the Lehigh River adjacent to Fountain Park, part of Allentown's municipal park system. Consequently the dam creates a potential hazard to those fishing or playing in the vicinity. The dam is approximately 8 feet high and 120 feet wide, constructed of concrete. The dam streambed topography indicates that the impoundment has only a 600 foot length but appears to have potentially 3 to 4 feet of accumulated fine-grained sediment in the bed. This could result in greater than 5000 CY of sediment present behind the dam. Quality of the sediment is not known. Benefits cited of the overall project to restore free flowing conditions in the river include reduction in upstream flooding potential, improved water quality, and benefits both to migrating and resident fish species, including naturally reproducing brown trout.

The City of Allentown's water intake pipe is located within the impoundment. While dam removal and the consequential reduction in accumulated fines would improve water quality, lowering of the water level may result in the necessity to alter the intake infrastructure.

Wildlands Conservancy identified the cost associated with modifications to the intake structure as an item that PPL could assist with as other sources of funding generally concentrate on the costs directly associated with the removal of the dam and related environmental restoration. The NRDA Team estimate for dam removal, not including costs related to sediment removal or disposal if determined necessary, is \$307,000. A portion of this would be provided by the City

of Allentown as in-kind construction related contributions valued at \$110,000, but the remaining \$197,000 is needed to ensure that the project can be completed.

#### Bushkill Creek Dam 1 (DEP Number 48-027)

This dam is the most downstream dam along the Bushkill Creek and is located approximately 1500 feet upstream of the confluence with the Delaware River (Figure 1B). The dam is located in Easton within the backwater of the Delaware River and, during high flow events within the river; water levels are high enough that the dam has no effect on flow. Downstream of the dam, the creek is constrained with vertical walls constructed along the banks, with buildings adjacent to the walls. Lafayette College is the owner of Dam 1 and is not opposed to removal but has expressed concern over potential impacts and secondary costs. The dam is 6 feet high and 70 feet wide constructed of concrete and stone. Water is impounded for approximately 1500 feet. Removal of the dam will open approximately 2300 feet of free flowing stream and gain 7.4 acres. Accessibility is not an issue at this location with street access and a parking lot located immediately adjacent to the dam. Because of the ease of access, and the dam limiting upstream migration of fish, this location is a popular fishing spot. Removal of the dam would significantly lessen a potential safety hazard. Estimated costs for removal of Dam 1 are \$227,000, including \$90,000 in design and other pre-construction activities.

#### Bushkill Creek Dam 2 (DEP Number 48-026)

The next dam along the Bushkill is located approximately 3800 feet upstream of the confluence with the Delaware River and 2300 feet upstream of Dam 1 (Figure 1B). The stone and concrete dam is 8 feet high and 130 feet across. Water during normal flow is impounded for approximately 2000 feet. The dam is owned by the City of Easton and is located adjacent to the City's recycling facility. The recycling facility provides ready access for equipment and staging

for the removal. The banks in the vicinity of the dam are steep and erosion and bank failure is evident downstream of the wingwalls along the recycling property. The steepness of the banks and existing instability may indicate that substantial bank restoration and stabilization may be required as part of the post removal channel maintenance activity, however, the presence of bedrock may limit the necessity or options available for stabilization of the banks. Removal of this dam opens 6000 feet of creek. The estimated acreage gain is 19.3 acres. Funding was sought in 2010 by Bushkill Stream Conservancy/Nurture Nature Foundation for the removal of Dams 2 and 3 and the total project cost for the removal of the two dams was \$200,000. The NRDA Team estimate of removal costs for Dam 2 alone is \$175,000, including \$45,000 in design and pre-construction activity.

#### Bushkill Creek Dam 3 (DEP Number 48-024)

The third dam along the Bushkill is located downstream of the 13<sup>th</sup> Street Bridge (Figure 1B). The dam and property on both banks is owned by the City of Easton. This is the first dam above the Delaware River high flow backwater conditions. The dam is 5 feet tall and 110 feet long, with impoundment effects extending back approximately 1500 feet. The dam can be accessed via a footpath from a parking area next to the 13<sup>th</sup> Street Bridge. There are reported plans to improve this path and, if this route were to be used for access, it may be advantageous to coordinate with the path improvement process and use it for access for the dam removal work prior to the path improvement work. However, this route extends nearly 1000 feet to the dam. There appears to be a more convenient access from a commercial buildings parking lot adjacent to the dam on Bushkill Drive. The quantity and quality of sediments accumulated behind the dam is uncertain at this time. Dam Removal would open approximately 3200 feet of channel and 10.3 acres. As noted earlier for Dam 2, funding was sought in 2010 by Bushkill

Stream Conservancy/Nurture Nature Foundation for the removal of Dams 2 and 3 and the total project cost for the removal of the two dams was \$200,000. The NRDA Team estimate of removal for Dam 3 alone is \$142,000, including \$45,000 in design and preconstruction activity.

### **Dam Removals in New Jersey**

The New Jersey dams are located on the Musconetcong River. The Musconetcong River is adversely impacted by run of the river dams. Planning for dam removal activity is on-going in the lower Musconetcong River. Removal of the most downstream barrier, the former dam remnants in Riegelsville, is now fully funded by the National Fish and Wildlife Foundation and pending permitting from NJ DEP.

#### **Finesville Dam**

The next upstream structure is Finesville Dam (Figure 1C). The feasibility study for the Finesville Dam has previously been completed and funding has been obtained from American Rivers and others that will cover the majority of construction related costs (~\$380,000).

Removal of the dam could start as early as fall 2011, if it were fully funded. In conversations between the Musconetcong Watershed Association (MWA) and PPL in January 2011, the need for an additional \$82,000 in construction related funding was expressed. Removal of the Finesville Dam opens 39 acres and approximately three miles of river.

#### **Hughesville Dam**

The Hughesville Dam is approximately 125 feet wide and 12 feet high and is located upstream of Finesville Dam (Figure 1C). It was originally constructed in the 1800s to provide water to a paper mill in Hughesville and includes a long 1.5 mile millrace. No Feasibility Study has been started, or funded, for Hughesville Dam. Estimated costs for a Feasibility Study are \$250,000.

The MWA has applied for a matching grant from NOAA for half the funds but non-Federal funding in the amount of \$125,000 is needed to ensure that the project can be completed. The Hughesville Dam has many site-specific considerations making preparation of the Feasibility Study vital to accurately forecasting the costs and technical approach to its removal. Removal of the Hughesville dam would open approximately one mile of river and 16.4 acres.

### **Dam Removal Feasibility Study**

The Bloomsbury Graphite Mill Dam in New Jersey is approximately 9 ft high and 175 ft wide. It is located approximately 3.5 miles upstream of Hughesville Dam (Figure 1C). Warren Glen Dam is located between Hughesville and Bloomsbury (Figure 1C). While removal of Bloomsbury would not immediately increase connectivity with the Delaware River, it would serve to open a contiguous 8-mile reach from Warren Glen upstream to Main Street Dam. Similar to Finesville Dam, the dam is located within a village environment. A Feasibility Study, estimated to cost \$100,000, has yet to be initiated for the Bloomsbury Dam.

### **Mussel Restoration**

A fresh water mussel restoration project will be part of the restoration plan. The mussel restoration project is anticipated to include either mussel transplanting from the main-stem Delaware River into the project tributary areas, mussel propagation or a combination of both. The mussel restoration project will include both PA and NJ tributaries. The process for propagating mussels has been developed and refined over the past two decades and is currently at a state where most mussel species can be propagated (O'Beirn et al. 1998). The environmental consequences of propagating and stocking freshwater mussels in order to restore populations are decidedly positive. Mussel propagation activities provide several benefits in addition to reestablishing extirpated populations. Propagation and release of mussels help to: 1) increase the re-colonization rates of species into suitable habitat, 2)

increase the likelihood of recruitment into currently occupied habitat, 3) increase the chance of species continued existence in currently occupied river reaches, and 4) stabilize declining populations of mussel species (US FWS & Commonwealth of Virginia 2004).

**Conclusion**

The NRDA Trustees believe that the dam removal and mussel restoration projects outlined above provide sufficient compensation to the public for natural resource injuries caused by the 2005 PPL Martins Creek fly ash release. The Trustees believe that the most significant of these injuries resulted from the ecological effects of fly ash deposits on the mussel community. Dam removal provides widespread ecological benefits. It can restore a river’s ecological functions and critical habitat by improving sediment transport and water quality, allowing greater movement of fish and other riverine species, and restoring natural flow. When river habitat and natural flow fluctuations are restored, natural diversity and populations of river and riparian species increase. The combination of ecological and habitat improvements from dam removal and mussel restoration will be a positive improvement to the natural resources and public enjoyment of those resources.

A summary of the costs that PPL has agreed to pay for the completion of these projects is shown in the table below.

<b>PPL Martins Creek Fly Ash Release NRDA Restoration Projects</b>						
<b>River</b>	<b>Dam</b>	<b>Distance Gained (ft)</b>	<b>Cumulative Distance Gained (ft)</b>	<b>Acres Gained</b>	<b>Cumulative Acres Gained</b>	<b>Total Proposed PPL Funding</b>
Musconetcong (NJ)	Finesville Dam	15,500	15,500	39.1	39.1	\$82,000
	Hughesville Dam	5,700	21,200	16.4	55.5	\$125,000
	Bloomsbury Dam	NA	NA	NA	NA	\$100,000



Bushkill (PA)	Dam #1	2,300	23,500	7.4	62.9	\$227,000
	Dam #2	6,000	29,500	19.3	82.2	\$175,000
	Dam #3	3,200	32,700	10.3	92.5	\$142,000
Little Lehigh (PA)	Martin Luther King Dam	15,700	48,400	39	131.5	\$197,000
Mussel Restoration						\$50,000
15% Contingency <sup>1</sup>						\$157,200
Administrative Fees <sup>2</sup>						\$70,000
<b>Total</b>			<b>48,400</b>		<b>131.5</b>	<b>\$1,325,200</b>

<sup>1</sup>The NRDA Team and PPL agreed to a 15% contingency over PPL's estimated costs to account for unforeseen conditions during the dam removal projects.

<sup>2</sup>The work will be administered by NJDEP for the New Jersey projects and by the DRBC for the Pennsylvania projects. Administrative fees of \$20,000 to NJDEP and \$50,000 to DRBC will be utilized to administer the work.

It is also noteworthy that in addition to the benefits gained as a result of the dam projects and mussel restocking, several community/environmental projects have already been completed by PPL after the 2005 fly ash release and are listed in Exhibit A. Although these projects are not part of the NRDA process, they have provided both community and environmental benefits in areas impacted by the spill and some have contributed to the Delaware River ecosystem.

## **References**

Academy of Natural Sciences of Philadelphia 2007. Comments on Section 3 of the PPL Phase IV Report Following the Fly-Ash Spill at PPL Martins Creek LLC. Comments to PPL Martins Creek, LLC, Bangor, Pennsylvania.

ARCADIS 2007. Phase IV Completion Report Martins Creek Steam Electric Station. Report to PPL Martins Creek, LLC, Bangor, Pennsylvania.

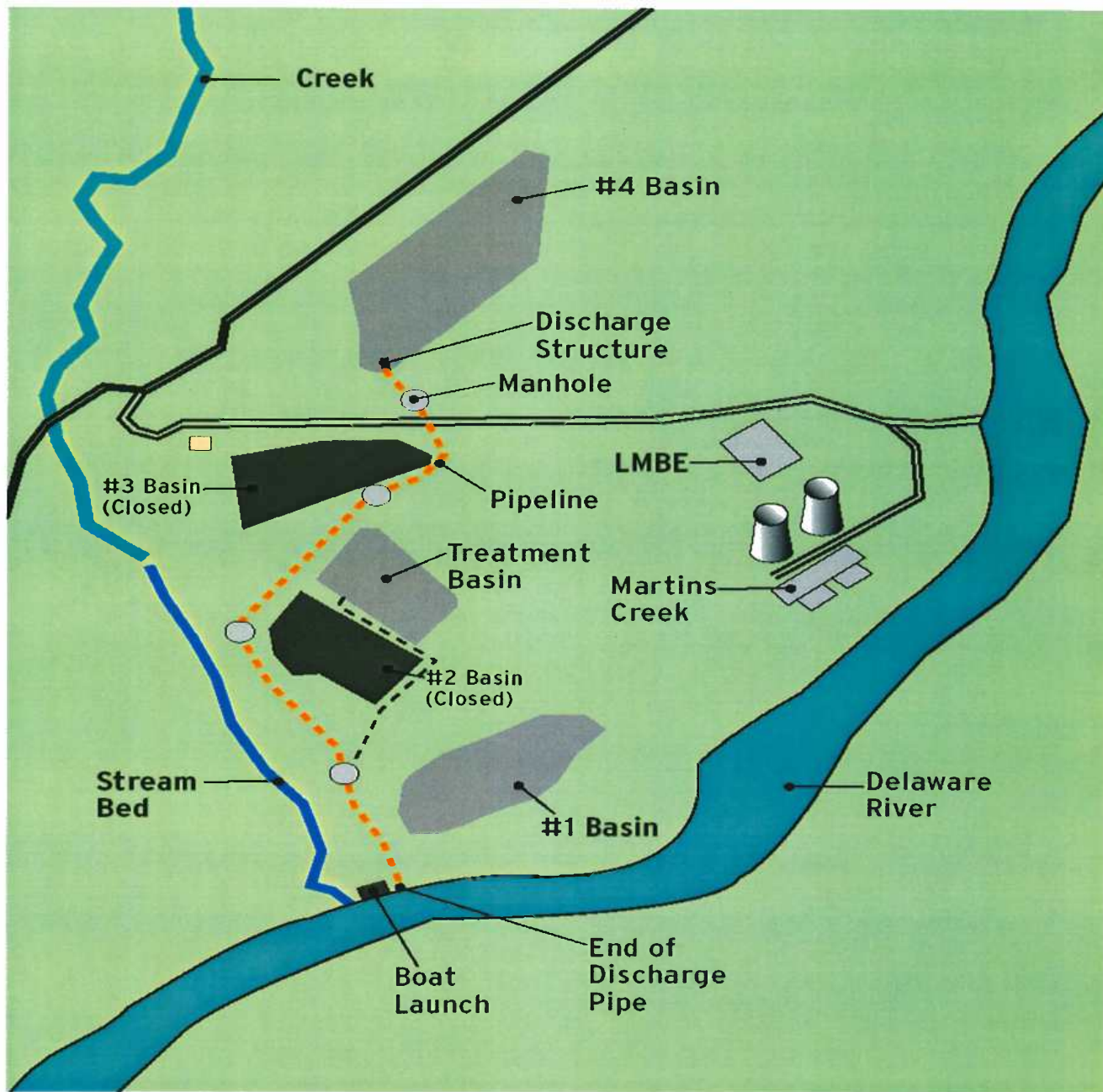
Kreeger D. 2008. Personal Communication. Partnership for the Delaware Estuary, Wilmington, Delaware.

MacDonald et. al 2000. Development and evaluation of consensus based sediment quality guidelines for freshwater systems. Arch. Environ. Contam. Toxicol. 39:20-31.

O'Beirn, F.X., R.J. Neves, and M.B. Steg. 1998. Survival and growth of juvenile freshwater mussels in a recirculating aquaculture system. American Malacological Bulletin, Vol 14(2):165-171.

U.S. Fish and Wildlife Service and the Commonwealth of Virginia 2004. Final Restoration Plan and Environmental Assessment for the Certus Chemical Spill Natural Resource Damage Assessment. Gloucester, Virginia.

Yagecic J.R. 2006. Assessment of Water Column Data Collected in Response to a Fly Ash Release on the Delaware River. Delaware River Basin Commission, Trenton, New Jersey.



Map by PPL

Figure 1: Map of PPL's Martins Creek Steam Electric Station's located in Lower Mount Bethel Township, Northampton County.

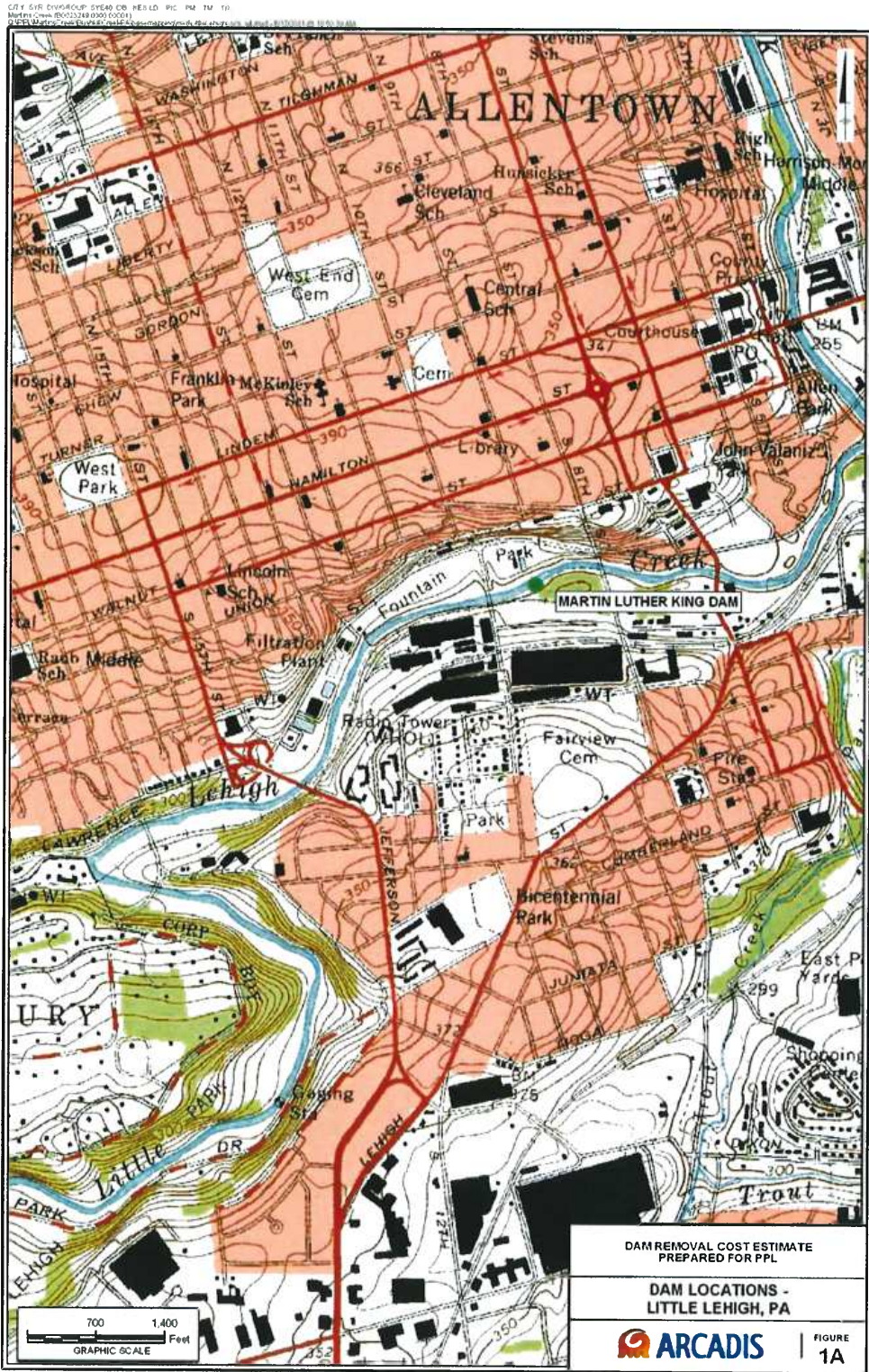


Figure 1A: Location of the proposed removal of the Martin Luther King Dam on the Little Lehigh Creek

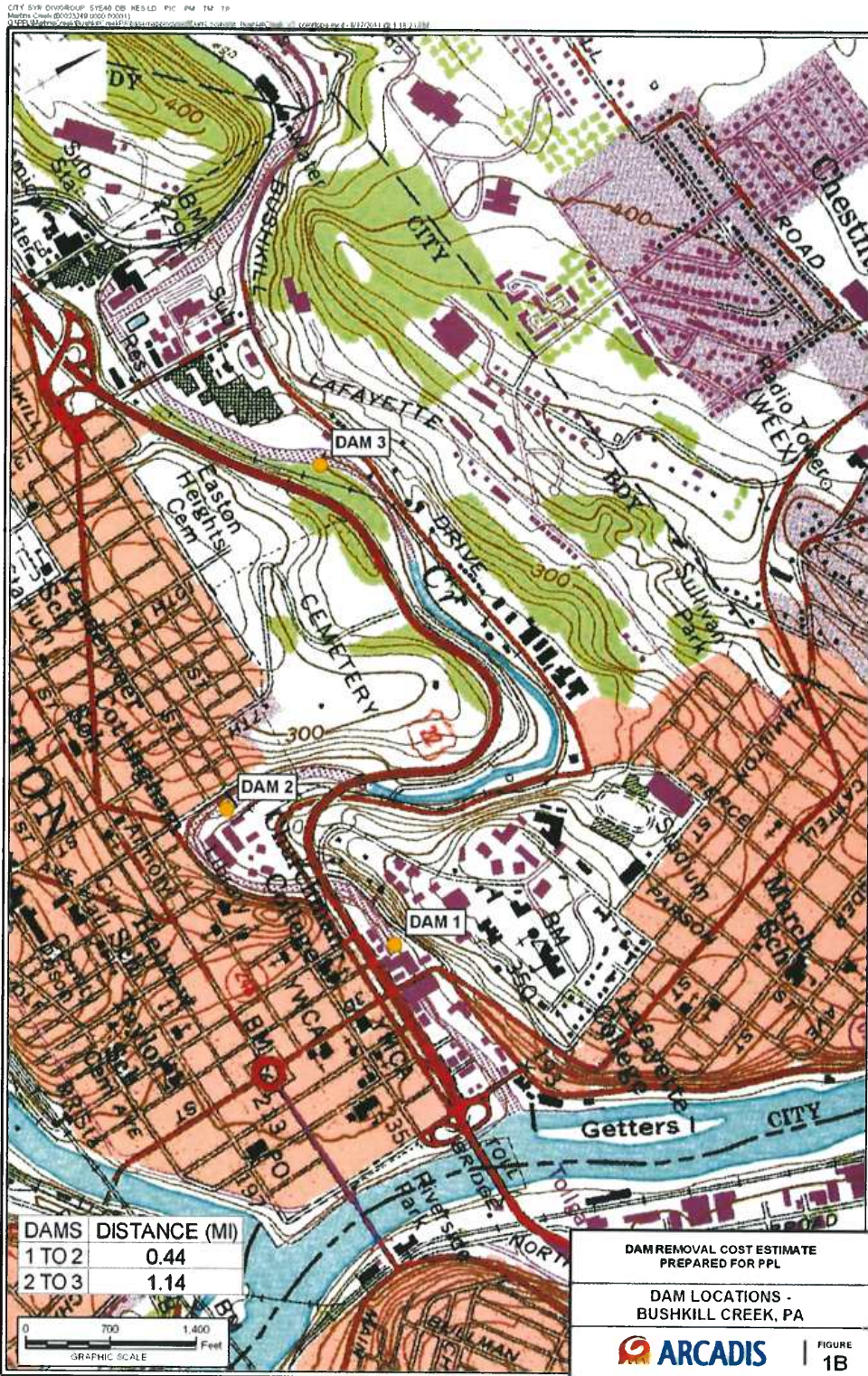


Figure 1B: Location of the proposed removals on the Bushkill Creek Dams 1, 2, and 3.

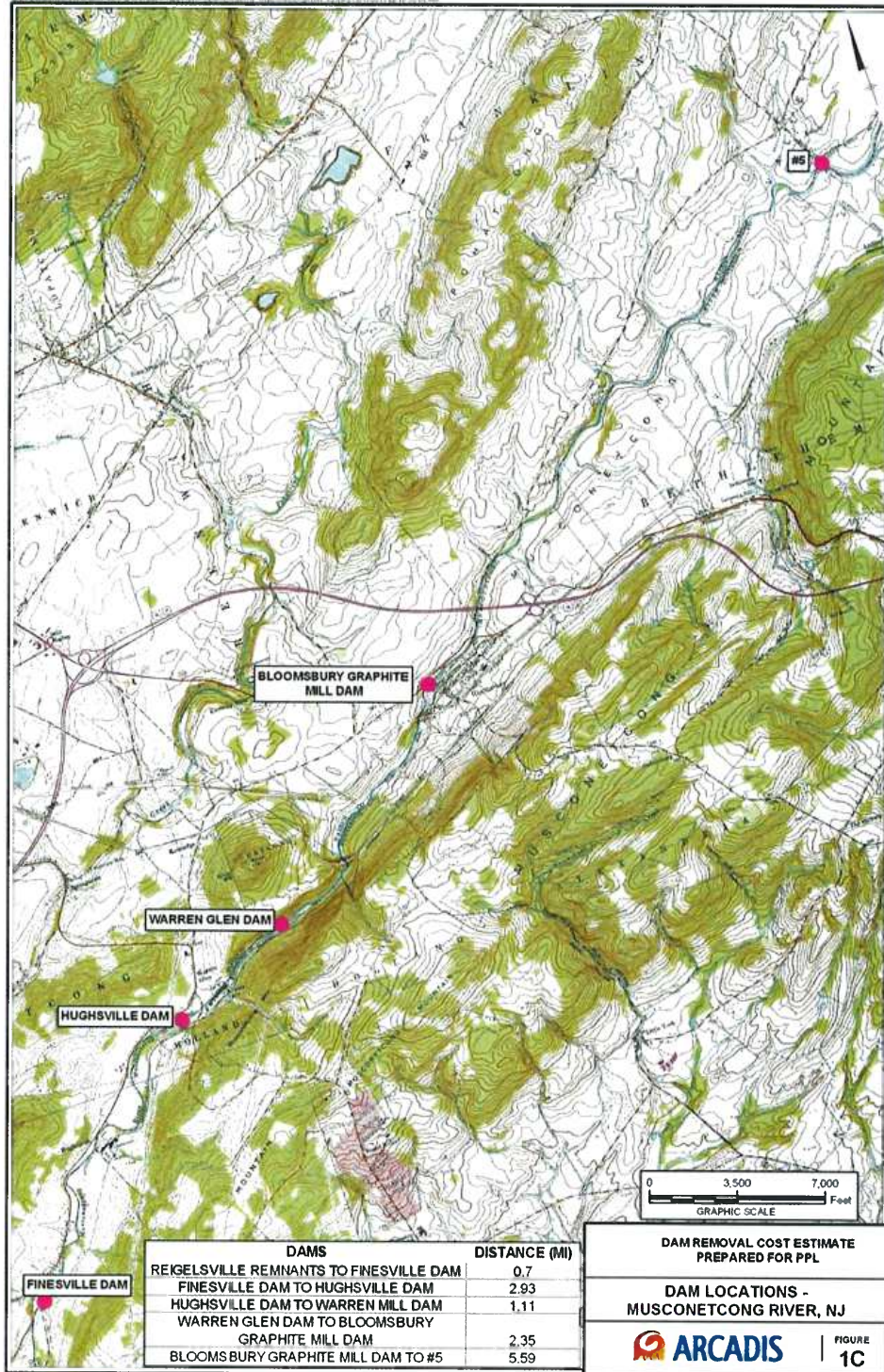


Figure 1C: Location of the proposed dam removals on the Musconetcong River.



Photo: PADEP

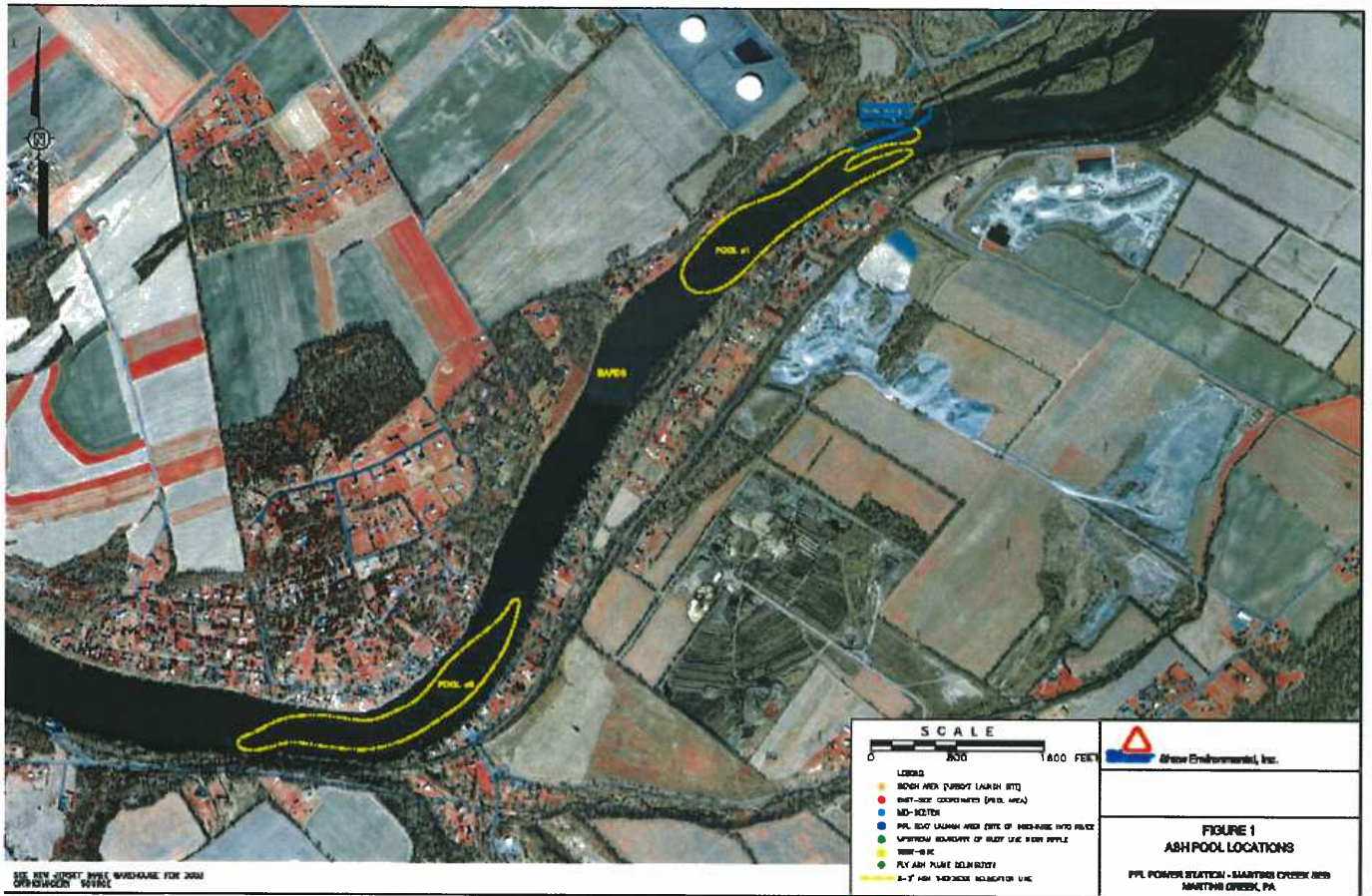
Photograph 1: The Delaware River at the PPL's boat launch and the mouth of Oughoughton Creek during the fly ash spill. The gray color plume in the river is fly ash.



Photo: PADEP

Photograph 2: Portadam located on the Delaware River at the PPL boat launch near the mouth of Oughoughton Creek





Photograph 3: The Delaware River with Pool 1 and Pool 2 indicated in yellow and the Portadam area indicated in blue

**Exhibit A – Community Projects Completed by PPL**

<b>2005</b>	
Martins-Jacoby Watershed Association	\$3,000
Lower Mt. Bethel Civics Association	\$500
Lower Mt. Bethel Recreation Association	\$1,000
Improvements to Fire Company Access to River	-
<b>Total for 2005</b>	<b>\$4,500</b>

<b>2006</b>	
Martins-Jacoby Watershed Association (stream bank rehabilitation)	\$4,000
Harmony Township Athletic Association	\$8,000
Belvidere Library	\$4,000
Martins Creek "Creekers"	\$1,000
Lower Mt. Bethel Civics Association	\$500
Lower Mt. Bethel Recreation Association	\$1,000
Cleanup of large trees from logjam on Martins Creek	-
Martins-Jacoby Watershed Association	-
Improvements to picnic area	-
Improvements to boat launch	\$66,600
Improvements to DuPue Road	-

Improvements to Martins Creek stream bank	-
Restored 18 acres of farmland effected by the spill (additional habitat enhancements for species of special concern)	\$17,829
Installed Barn Owl Box and Kestrel Boxes	-
<b>Total for 2006</b>	<b>\$102,929</b>

<b>2007</b>	
Martins-Jacoby Watershed Association (stream improvement projects)	\$75,000
Martins-Jacoby Watershed Association	\$2,500
Martins-Jacoby Watershed Association (for environmental center)	\$25,000
Martins-Jacoby Watershed Association (donation of 9 acres of land for environmental center)	\$150,000
Martins-Jacoby Watershed Association (rights for addition of 2.5 miles of trails)	\$5,000
Cleanup of large trees from logjam on Martins Creek	\$960
Bushkill Conservancy (watershed protection)	\$25,000
Shad Fisherman's Association (shad migration enhancements)	\$20,000
New Jersey Environmental Projects	\$10,000
Brodhead Creek Watershed Association	\$2,500
Lehigh Valley Greenway Initiative (matching funds)	\$20,000
Delaware River Greenway Partnership	\$3,000
Lower Mt. Bethel Civics Association	\$500
Lower Mt. Bethel Recreation Association	\$1,000

Enrolled 4 acres into Warren County CREP for riparian buffer project along Buckhorn Creek	-
Living roof at Environmental Center	\$3,000
<b>Total for 2007</b>	<b>\$343,460</b>

**2008 & 2009**

Additional funds for environmental center	\$25,000
Funds for signage on the trail and at the trailhead	\$5,000
Shad Fisherman's Association (shad migration enhancements)	\$40,000
Additional funds for environmental center	\$25,000
Donated land for a boat launch near environmental center	-
<b>Total for 2008 &amp; 2009</b>	<b>\$95,000</b>
<b>Total Known Costs for Environmental Projects</b>	<b>\$541,389</b>