2007 INTERIM REPORT FOR THE LIMERICK GENERATING STATION WATER SUPPLY MODIFICATION DEMONSTRATION PROJECT AND WADESVILLE MINE POOL WITHDRAWAL AND STREAMFLOW AUGMENTATION DEMONSTRATION PROJECT

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EXECUTIVE SUMMARY

This interim report presents the results for the fifth year, 2007, of the Wadesville Mine Pool Withdrawal and Streamflow Demonstration Project (Demonstration). During the Demonstration, water pumped from the Wadesville Mine Pool at Pottsville and water released from Still Creek Reservoir at Tamaqua augmented the flow of the Schuylkill River for use as consumptive cooling makeup water by Exelon's Limerick Generating Station (LGS) some 75 miles downriver near Pottstown. Low flows were experienced during much of the 2007 Demonstration period in contrast to the higher flows during the 2006 Demonstration. As a result, the Wadesville Mine Pool and Still Creek Reservoir were used for much of the Demonstration Period.

The Demonstration was governed by Docket Revision 12 which was approved by the Delaware River Basin Commission (DRBC) in October 2004. This Revision allows the Demonstration to extend through 2007, and possibly 2008, in order to monitor for potential environmental impact during more representative low-flow conditions and under modified water augmentation conditions than were experienced in 2003, the first year of the Demonstration.

The main objectives of the first two years of the Demonstration had been to show that water pumped from the Wadesville Mine Pool and released from Still Creek Reservoir (for non-emergency use) can provide a viable supply of water to the Schuylkill River for consumptive use by LGS, allow a corresponding reduction in the amount of water withdrawn from the Delaware River via the Point Pleasant Diversion, and have positive or insubstantial ecological effects. For 2005 through 2007 the Project sought to also demonstrate that withdrawal of unaugmented consumptive cooling makeup water from the Schuylkill River by LGS would not have a substantial effect on downstream dissolved oxygen (DO) when ambient river temperatures exceed 59^{o}F and river flows at the Pottstown Gage are above 560 CFS.

The fifth year of the Demonstration was conducted from May 5 through November 26, 2007 following an Operation and Monitoring Plan approved by the DRBC as part of Docket Revision 12. This Plan provides rules for conducting the Demonstration, including operational as well as environmental monitoring responsibilities. The environmental monitoring focused on water quality and aquatic biology.

Several watercourses conveyed water to LGS and were monitored during the Demonstration Project. East Norwegian/Norwegian Creek and the Schuylkill River conveyed Wadesville Mine Pool water. The East Branch Perkiomen Creek and Perkiomen Creek conveyed Delaware River water via the Point Pleasant Diversion Project. In addition, water from Still Creek Reservoir, located near Tamaqua, was conveyed to the Schuylkill River by way of Still Creek and the Little Schuylkill River. Monitoring was performed in the Schuylkill River downstream of LGS to determine if the water withdrawals at LGS would effect downstream DO levels.

The following is a summary list of the environmental monitoring that was conducted:

- Wadesville Pool water level, discharge rate and quality
- Schuylkill River flow and rainfall
- Lower Schuylkill River DO and other water quality measures
- Pottstown Water Treatment Plant and Pennsylvania American intake water quality
- East Norwegian Creek water quality
- Upper Schuylkill River biology and water quality
- Still Creek Reservoir discharge rate and water quality

- Little Schuylkill River biology, flow, and water quality
- Perkiomen Creek water quality
- East Branch Perkiomen Creek water quality and biology

Water was pumped for LGS augmentation from the Wadesville Mine Pool into East Norwegian/Norwegian Creek on 78 days during the period from July 15 through October 25 during which time the mine water surface level decreased approximately 111 feet. Daily volume of water pumped ranged up to 8.10 million gallons (MG), with most volumes in the range of 6 to 8 MGD. The total volume discharged for this year's Demonstration was 521.4 MG.

The mine water was sampled monthly for many water quality parameters, including constituents listed in the Mine's NPDES permit. All measurements were within the ranges expected based on the recent historical Wadesville Mine Pool data. Over the 5 years of the Demonstration, total dissolved solids (TDS) and pH varied within a similar range from year to year and, on average, have been fairly stable. Specific conductance was higher than previous years and has varied from year to year based on the amount and duration of pumping. The concentration of manganese continued to trend downward and the concentration of iron was lower than the previous 3 years. The data for all parameters remained in an expected range of variability with no cause for concern.

Water quality results were as expected in East Norwegian Creek and in the Schuylkill River upstream and downstream of the confluence. Generally higher downstream measurements of total dissolved solids, specific conductance, total alkalinity, and pH and generally lower downstream concentrations of total and dissolved iron were observed in 2007, similar to the observations made during the previous 4 years of the Demonstration.

Biological resources in the Schuylkill River upstream and downstream of the Norwegian Creek confluence were monitored during May, August, and November. The fish communities at both locations contained a mixture of cool and warmwater species, with blacknose dace, creek chub, white sucker, and green sunfish most abundant. A mixture of wild and stocked rainbow, brown, and brook trout were collected from both locations with greater numbers collected downstream. Low numbers of macroinvertebrate taxa were collected at both Schuylkill River locations, and more taxa and more individuals were present downstream than upstream. The positive results in 2007, with extensive use of the Mine Pool, were comparable to those reported for 2003 through 2006 and support the continued use of the Wadesville Mine Pool.

Dissolved oxygen concentrations were monitored at the LGS Intake, Pennsylvania American Intake, Black Rock Dam, and Norristown Pool from May through November and at Vincent Dam Intake, from May to October. The data indicate that fluctuations in DO were not correlated to changes in Schuylkill River discharge during periods of low flow (less than 560 CFS). River discharge remained below 560 CFS for 74 days during mid-July through early- October and dropped to a record low for the entire Demonstration of 319 CFS on October 2. The instantaneous minimum DO concentrations at the four Exelon monitoring stations did not drop below the water quality standard (4.0 mg/l) at any time during the Demonstration period.

Schuylkill River flow was also augmented by discharges from Still Creek Reservoir during the Demonstration. Total volume released was 1005.4 MG from May to mid-November which temporarily lowered the Reservoir water surface elevation by 7.7 feet. The discharges from Still Creek appeared to have a small positive effect on the Little Schuylkill River.

The Bradshaw Reservoir pumped releases to the East Branch Perkiomen Creek for augmentation or to maintain a minimum stream flow of approximately 10 CFS throughout the Demonstration. Water quality monitoring performed in the East Branch and in Perkiomen Creek indicated no adverse impact due to reduced water flow from Bradshaw. Likewise, benthic macroinvertebrate and fish monitoring performed prior to and during the Demonstration indicated little change in either community in the EBPC.

The fifth year of the Demonstration Project again showed that the Wadesville Mine Pool and Still Creek Reservoir are operationally reliable and environmentally suitable sources of consumptive cooling makeup water for LGS. Both augmentation sources were used extensively during the 2007 Demonstration. The biological community was similar in 2007 to the previous 4 years of the Demonstration and this is important evidence that confirms the augmentation sources as environmentally sound. In addition, the expanded Demonstration showed that withdrawal from the Schuylkill River of the consumptive water needed by LGS without the restriction related to ambient river temperature did not affect downstream dissolved oxygen compliance with the Water Quality Standards. The results from 2005 thru 2007 support long term restructuring of the temperature restriction so that LGS can withdraw the full amount of consumptive makeup water needs with no augmentation until river flows decrease to 560 CFS as provided for in Docket Revision 12. Additionally, the Demonstration monitoring supports lowering the low flow trigger point from 560 CFS to at 460 CFS without affecting dissolved oxygen levels in the river. Lowering the low flow trigger point will have a positive impact to the basin, reducing inner basin transfers, preserving augmentation sources for true low flow/drought events, and providing additional funding to the Restoration and Monitoring Fund which supports water quality improvement projects in the Schuykill basin.

In 2007, the Demonstration Project resulted in a contribution of about $162,123 to the Restoration and Monitoring Fund. The Fund supports environmental restoration projects that target water quality improvements within the Schuylkill Basin.

Projects awarded with monies from the 2006 fund included:

- The Berks County Conservancy - $98,500 for work to implement agricultural best management practices (BMPs) on two Berks County farms located on Schuylkill River tributaries,
- The Delaware Riverkeeper Network - $90,634 for the installation of appropriate agricultural improvements work on a Berks County farm located along Mill Creek, and
- The Schuylkill Headwaters Association - $61,141 to upgrade three abandoned/acid mine drainage (AMD) remediation systems to improve the quality of water that drains into the headwaters of the Schuylkill River in Schuylkill County.

These projects resulted from a stimulus of $250K, from the Restoration and Monitoring Fund and additional funding of $160K from various organizations.

Based on the past 5 years of the Demonstration, the data supports:

- Long term approval of augmentation from Wadesville Mine Pool,
- Long term approval of augmentation from Still Creek Reservoir,
- Long term restructuring of the 59° F augmentation requirement,
    1. Long term approval of the Restoration and Monitoring Fund,
- Reduction of the Schuylkill River low flow trigger point, and
- Year round maintenance of a 10 CFS minimum flow limit in the East Branch Perkiomen Creek.

1.0 INTRODUCTION

1.1 Overview of the Demonstration Project

In June 2003, Exelon Generation Company LLC (Exelon) received approval from the DRBC via Revision 11 to Docket D-69-210 CP (Final) to conduct a Demonstration Project involving supplementing the flow of the Schuylkill River by pumping water from the Wadesville Mine Pool into the headwaters of the Schuylkill River at Pottsville (Figure 1.1-1). The intent of the project was to augment the flow of the Schuylkill River during the yearly season associated with low river flow and when river temperatures exceed 59^oF, and thereby increase the time that LGS would be allowed to withdraw consumptive cooling water from the river. This increase in the use of the Schuylkill River for consumptive cooling use at LGS would allow a corresponding reduction in the amount of water diverted for the same purpose from the Delaware River into the East Branch Perkiomen Creek (EBPC) via the Point Pleasant Diversion Project.

A DRBC-approved Operating and Monitoring Plan was implemented to govern the conduct of the Demonstration and verify that use of the mine water or Still Creek Reservoir water would not cause unacceptable environmental impact. The Delaware River water diversion system was maintained in operation during the pumping Demonstration, in accordance with the requirements of the approved Operating Plan, so that it could be provide the full amount of water required by LGS if necessary. In addition, the Docket revision allowed for releases from Tamaqua's Still Creek Reservoir (subject to its yield curve limitations) at any time rather than only during emergency conditions.

Initially, the Demonstration was scheduled to extend over only one (the 2003) pumping season. However, due primarily to abnormally high ambient streamflow conditions in the watershed which made it difficult, if not impossible, to definitively determine if environmental impacts would develop, the Demonstration was extended to a second (the 2004) pumping season in order to provide additional assurance that the predicted negligible environmental effects would occur from the use of the mine pool source. Again, abnormally high ambient flow conditions prevailed during the 2004 pumping season.

In mid-2004 Exelon applied to the DRBC for approval to extend and expand the Wadesville and Still Creek Demonstration Project by modifying Schuylkill River withdrawal restrictions related to ambient water temperature, instead relying on a Schuylkill River low flow threshold to trigger flow augmentation from the up-basin sources. In October 2004 the DRBC approved Revision 12 to the Docket which allowed the expanded Demonstration to continue through 2007 with an option to extend through 2008 to demonstrate, under controlled conditions, that withdrawal of Schuylkill River water would not cause adverse impact when ambient water temperatures exceed 59^oF, the maximum temperature at which unaugmented withdrawals were permitted under Docket Revision 11. In addition, the project intends to show that no adverse impacts will occur in the East Branch Perkiomen Creek due to replacing the minimum flow requirement of 27 cubic feet per second (CFS) after initiation of pumping at Bradshaw Reservoir with a 10 CFS requirement.

A significant feature of the Demonstration Project which was added in Revision 12 of the Docket is the creation of a Restoration and Monitoring Fund (RMF). Exelon will contribute to the RMF based on the quantities of consumptive cooling water that are not required to be augmented. The objective is to use the RMF to support restoration projects which can make a significant improvement in water quality within the Schuylkill River Basin.

Interim reports for each Demonstration period have been issued annually. The data and analyses for the fifth Demonstration period which extended from May 6 to November 26, 2007 are contained in this report.

1.2 Basis for the Project

At full power operation, LGS's per unit consumptive cooling use rates are 17.5 million gallons per day (MGD) average and 21 MGD maximum. These are equivalent to approximately 24,300 gallons per minute (GPM) average and 29,200 GPM maximum for the two units at LGS. The anticipated maximum mine pool yield was approximately 9,000 to 10,000 GPM, which represents approximately 40 percent of the average consumptive cooling makeup requirement for LGS. The balance of the makeup requirement would be provided from Tamaqua's Still Creek Reservoir and the diversion system from the Delaware River. Exelon would operate the mine pool as an underground reservoir with pumping over an approximately 6-month period followed by 6 months of recharge. By using this plan, the pool would be managed as a renewable resource.

The primary drivers for identifying one or more additional sources of consumptive cooling makeup were:

- To expand the source water options available to LGS (thus providing increased reliability and operational flexibility),
- Obtain net environmental benefits to the Delaware River Basin, and
- Reduce Exelon's costs associated with the operation and maintenance of the diversion system.

The project is compatible with Pennsylvania's policy to encourage the use of a mine water source for cooling water purposes in the generation of electricity and, as such, was actively supported by the Pennsylvania Department of Environmental Protection (PADEP). The policy is intended to address the problems associated with the release of acid mine drainage from abandoned, inactive, or underutilized coal mines, which has caused severe adverse effects on the water quality and beneficial uses of Pennsylvania's rivers and streams. This pollution limits the ability of the streams to support abundant aquatic life and recreational activities, and transforms a natural asset into a liability.

The process of searching for a viable water source within the Schuylkill River Basin began in 2002 and led to Wadesville being selected as the leading candidate. The search for alternate water sources found that only mine waters were capable of reliably supplying the sizeable quantities of water required. The Wadesville Mine Pool was the most advantageous source of augmentation water for the Demonstration Project in comparison to other sources considered. Among the reasons that Wadesville was selected were:

- Significant capital improvements were not required to commence pumping in 2003.
- The mine pool water is naturally high in alkalinity, which improves the buffering capacity of the receiving stream.
- The mining company (Reading Anthracite Company or RAC) was willing to commit resources and enter into a binding contract for providing the service of water pumping.
- The discharge had an approved NPDES permit and met its conditions.

2.0 DESCRIPTION OF THE WADESVILLE MINE SITE

2.1 Project Setting

The productive coal areas in the anthracite region of Pennsylvania are in four distinct fields: Northern, Eastern Middle, Western Middle and Southern. The Southern anthracite field, in which the Wadesville Mine is situated, has an area of about 200 square miles, extending about 70 miles in the east-west direction and 1 to 6 miles wide in Carbon, Schuylkill, Dauphin, and Lebanon Counties from Jim Thorpe and the Lehigh River on the east to the Susquehanna River on the west. The Wadesville mining operation is in the Beechwood-Wadesville-Pine Forest Basin of the Southern Middle Anthracite Field in Schuylkill County (near Pottsville), Pennsylvania, and geologically, in the Llewellyn Formation.

The anthracite region has a long history of extensive deep shaft mining since the early 1800s and surface (strip) mining since the 1940s. These past and ongoing mining operations allow surface water to enter the mine workings and accumulate. The water is impounded in underground pools and in abandoned stripping excavations. Barrier pillars separate the mine pools from each other. The impounded water has to be pumped to the surface or overflows by gravity through drainage tunnels or breaches upon reaching an elevation that varies from pool to pool. There are approximately 31 major underground pools in the Southern field, including Wadesville, plus a larger number of surface pools from stripping operations.

2.2 Wadesville Mine Pool Water Quality

Mining operations allow moisture and air to come into contact with sulfur-bearing minerals (iron sulfides, pyrite, and marcasite) that naturally occur in this region. As a result, chemical reactions take place which lead to the formation of sulfuric acid. Most of the water in the deep mine pools becomes highly acidic and, if allowed to drain into surface waters, the acid mine drainage or AMD becomes an appreciable source of stream pollution. The water in the Wadesville Mine Pool is an exception in that it has a pH in the neutral range (typically 6 to 8) and a moderate level of alkalinity. These characteristics made this source of augmentation water much superior in comparison to several other candidate mine pool sources.

Historically prior to the Demonstration, the acidity levels of the Pool water were negligible [<1 milligram per liter (mg/l)] and the alkalinity levels were on the order of 300-400 mg/l. Specific conductance levels ranged about 1,500-1,800 micromhos per centimeter (µmhos/cm), sulfate 500-700 mg/l, and water temperatures 55-60°F.

2.3 Wadesville Mine Works History

The deep mine operation at the Wadesville Colliery was discontinued in 1930, and with the cessation of pumping, the water pool within the mine increased to such a high level that the overflow discharged into Mill Creek at Saint Clair from an abandoned Saint Clair Colliery shaft. In 1949, the now RAC started stripping operations for recovery of coal and installed deep well pump equipment to discharge excess mine water into the Schuylkill River via Norwegian Creek. RAC has continued stripping operations with several interruptions up to the present time period. RAC's future plans to continue mining at Wadesville are not clearly defined. However, without continued pumping, the mine pool elevation would increase until it overflows into Mill Creek.

The potential for this overflow is of concern because of development that has occurred in Saint Clair in the vicinity of the overflow site since the last period of overflow.

2.4 Mine Dewatering Facilities

The existing pump house, which is located at the Wadesville vertical borehole shaft approximately ¼-mile from the open pit, contains pumping equipment used for dewatering of the mine to support present-day surface mining operations. The top of the shaft is at elevation (El) 782 feet above Mean Sea Level (MSL) and the elevation of the bottom of the pool is at approximately 85 feet MSL. The overflow elevation through an existing pipe at the abandoned Saint Clair shaft is at El 732 feet MSL. A federal government agency estimate of the water volume in the workings in 1953 was 3.4 billion gallons.

Two vertical turbine pumps are installed in the Wadesville mineshaft. Together they have a maximum design discharge rate in the range of 9,000 to 10,000 GPM. Note that the design pumping rates may have increased because both pumps had major overhauls since the Demonstration began. Prior to the Demonstration, the pumps operated periodically to maintain the water level at approximately 450 feet (El 332 feet MSL) below the surface to support active strip mining. In the first pumping season the bottoms of the pumps were approximately 500 feet (El 282 feet MSL) below the surface. During 2004 one of the pumps was refurbished and lowered to 600 feet (El 182 feet MSL) below the surface to gain access to additional pool volume. In 2005 and 2006, both pumps were used as needed. For the 2007 Demonstration, only the deep pump was operated.

The discharge path from the pump house to the Schuylkill River is initially open-channel flow via a dry swale which leads to what is locally known as East Norwegian Creek until it reaches the northern end of Pottsville. At this point, a subsurface conduit channels the flow through Pottsville until it daylights on the southern end where it immediately discharges to the Schuylkill River.

3.0 THE DEMONSTRATION PROJECT

3.1 Operation Plan

Part I of the DRBC-approved Demonstration Operation and Monitoring Plan which was included as Attachment 3 to Docket Revision 12, provides rules for continuing the Demonstration of stream flow augmentation using the Wadesville Pool and Still Creek Reservoir and for increased withdrawals from the Schuylkill River for some or all of the consumptive cooling makeup at LGS after the 59°F temperature restriction is reached, as long as the Schuylkill River flow at Pottstown is higher than a daily average of 560 CFS (or 530 CFS if only one LGS unit is operating). It identifies the plan of operation; responsibilities of Exelon, RAC, and DRBC during the Demonstration Project; and specifies the pumping equipment configuration, evaluation criteria, and reporting requirements. In addition, it describes the Restoration and Monitoring Fund that LGS has established to fund projects designed to improve water quality within the Schuylkill River Basin.

3.2 Monitoring Plan

Part II of the Plan specifies the parameters to be monitored, the methodologies, the frequency, and locations to be sampled in order to provide the data necessary to assess the impacts of the mine water and reservoir releases on Norwegian Creek and the Schuylkill River, the increased consumptive withdrawals from the Schuylkill River at LGS, and the decreased diversion flows to East Branch Perkiomen Creek. In short, the monitoring plan was designed to measure water quality and aquatic biological impacts to these waters.

3.3 Affected Surface Waters

Several watercourses conveyed water to LGS during the Demonstration Project. These include East Norwegian/Norwegian Creek, tributary to the Schuylkill River at Pottsville, and the main stem Schuylkill River. Other surface waters were affected by the Demonstration Project as well. Water from Still Creek Reservoir, a public water supply operated by the Tamaqua Water Authority, was discharged via Still Creek to the Little Schuylkill River, which joins the Schuylkill River at Port Clinton some 15 miles downriver of Pottsville. The East Branch Perkiomen Creek and Perkiomen Creek, components of the Point Pleasant Diversion Project, received reduced amounts of water from Bradshaw Reservoir.

Wadesville Mine Pool water was discharged to a swale that ordinarily would be dry, except when it conveys surface runoff in wet periods. The swale connects to East Norwegian Creek, which mostly flows within a constructed channel to the north part of Pottsville where it enters a long underground conduit. Within this conduit, East Norwegian Creek joins with West Norwegian Creek to form Norwegian Creek, which flows through the conduit to the Schuylkill River in Pottsville (Figure 4.5-1). LGS withdraws cooling water from the Schuylkill River approximately 75 miles downriver of Pottsville.

The East Branch Perkiomen Creek receives water from the Point Pleasant Pumping Station on the Delaware River via the intermediate Bradshaw Reservoir. This water is discharged via pipeline to the headwaters of East Branch and then flows to the Perkiomen Creek. From here, the water continues downstream to the Perkiomen Pumping Station at Graterford for conveyance by pipeline to LGS or, if only the minimum flow of approximately 10 CFS is being released, it is allowed to continue flowing down the Perkiomen Creek to the Schuylkill River. This system for supply of evaporative make-up water to LGS is known as the Point Pleasant Diversion Project.

4.0 MONITORING PROGRAM AND RESULTS

During operation of the Demonstration Project, the following data collection and monitoring was conducted in order to assess potential environmental impacts:

- Wadesville Pool water level, discharge rate, and quality
- Schuylkill River flow and rainfall
- Lower Schuylkill River dissolved oxygen (DO) and other water quality measures
- Pottstown Water Treatment Plant and Pennsylvania American intake water quality
- East Norwegian Creek water quality
- Upper Schuylkill River biology and water quality
- Still Creek Reservoir discharge rate and water quality
- Little Schuylkill River biology, flow rates, and water quality
- Perkiomen Creek water quality
- East Branch Perkiomen Creek biology and water quality

These programs encompassed measurement of a wide range of parameters at differing frequencies. A description of each program element and results obtained during the Demonstration Project follow.

4.1 Wadesville Pool Water Level, Discharge Rate and Quality

Pumping of Wadesville Mine Pool water into East Norwegian Creek for augmentation started on July 15 and continued to October 25, 2007. The daily total volume of water pumped and the resulting change in mine pool water level were measured. In addition, measurements of conductivity were made in the pump discharge flow at the pumphouse. Daily measurements of temperature, pH, and DO were not required or recorded in 2007, similar to 2005 and 2006, given that these parameters varied within a narrow range in 2003 and 2004 and were no longer of concern.

During the entire 2007 Demonstration, mine pool water augmentation was credited on 78 days (Table 4.1-1). The daily total volume of water pumped from the mine pool for LGS use ranged up to 8.10 MGD and totaled 521.4 MG through the end of the pumping period (Table 4.1-1 and Figure 4.1-1). Most daily volumes pumped were in the range of 6 to 8 MGD and the average volume pumped per day was 6.7 MG. By the end of October pumping had lowered the pool approximately 111 feet but by mid-November, once pumping ceased, the pool had recharged 17 feet which was similar to the findings of previous years. All of the years of the demonstration including 2007 confirmed our hypothesis that the mine pool could be operated as an underground reservoir. The overall mine pool levels for the Demonstration period and the pumping amounts for augmentation are shown in Table 4.1-1 and Figure 4.1-1.

Specific conductance varied from 1,134 to 1,733 µmhos/cm with distinct groupings of values during July-August and September-October (Table 4.1-1 and Figure 4.1-2). Mean conductivity was slightly higher than the means observed in any of the previous years. During September-October, conductivity steadily increased as pool level decreased, a pattern similar to that observed during the 2005 Demonstration.

Several other water quality parameters were determined on a monthly basis and included those required by the mine's NPDES permit plus total organic carbon (TOC), TDS, DO, pH, specific conductance and temperature. Water samples were collected from the pump discharge for analysis.

In general, Wadesville Pool water was neutral in pH with low acidity and relatively high alkalinity (Tables 4.1-2 and 4.1-3). All measurements of the parameters commonly associated with mine water (iron, manganese, and sulfate) were within the expected historical range[1].

Over the 5 years of the Demonstration, TDS and pH varied within a similar range from year to year and on average have been fairly stable (Tables 4.1-2 and 4.1-3). Average values of manganese have continued to trend downward over the 5 years, while average values of iron were variable with the average value lower in 2007 than in the previous 3 years.

4.2 Schuylkill River Discharge and Local Rainfall

Schuylkill River discharge is measured by the U.S. Geological Survey (USGS) at Landingville, Berne, Reading, and Pottstown. These gages are located between the Norwegian Creek confluence and LGS. In addition, rainfall is measured at the Landingville gage. Data for these locations are presented in Table 4.2-1.

Hydrographs for the Schuylkill River at Landingville (gage located nearest to the Norwegian Creek confluence) and at Pottstown (Figure 4.2-1) show that the 2007 Demonstration was characterized by below average river flow during the entire Demonstration period. Mean monthly Schuylkill River flow at Pottstown in 2007 was lower than the period of record for May through November (Table 4.2-2). Mean daily discharge was below 560 CFS for 74 days during the Demonstration, mainly from mid-July to early-October, and reached a record low for all years of the Demonstration of 319 CFS on October 2. Similarly, at Landingville, discharge was lower than the period of available flow records for this gage in May through November.

Overall, Schuylkill River Basin hydrology in 2007 can be characterized as being unusually dry. Rainfall at Landingville during the 2007 Demonstration period was 26.45 inches. This is much lower than 2006 (41.07 inches), similar to rainfall recorded in 2005 (21.80 inches) and lower than rainfall amounts recorded during 2004 (40.30 inches).

4.3 Lower Schuylkill River Water Quality

Dissolved Oxygen (DO), temperature, and pH were monitored hourly using Hydrolab Minisonde 4A instruments at four locations on the lower Schuylkill River: in front of the LGS cooling water intake, at the Pennsylvania American Water Company intake, at Black Rock Dam, and in the Norristown Pool. Additionally, there is a DO monitor in the Vincent USGS station. (Figure 4.3-1). At the LGS intake, the instrument was suspended just below the water surface from a floating dock located just in front of the intake structure. The monitor in Black Rock Pool was installed within a perforated pipe enclosure affixed to the Dam so that the monitor sampled the water about

[1] Note that when a discharge from an area disturbed by mining activity without chemical or biological treatment has a pH greater than 6.0 and a total iron concentration of less than 10.0 mg/l, as is the case with Wadesville, the PADEP manganese limitations (2.0 mg/l 30-day average and 4.0 mg/l daily maximum) do not apply [ref. 25 PA Code §88.9(c)(2)].

to flow over the dam. At the Pennsylvania American Water Company intake, the Hydrolab was installed inside a perforated pipe enclosure that was mounted to the upstream side of the intake structure. In Norristown Pool, the monitor was installed in a similar enclosure mounted to a support structure on the Norristown (Montgomery County) side of the road bridge leading to Barbados Island. Monitoring began on May 6 and ended on November 26.

In addition, DO data are available from a USGS monitoring station in the small pool formed by the partially breached Vincent Dam near Linfield below LGS (Figure 4.3-1). The natural breaching has been underway for several years. As the breaching process continues, the size of the pool has decreased and the main flow of the river has moved away from the gage site. This has resulted in the DO readings being performed on water that is not part of the main flow of the river at low discharge rates. Data from this site are presented for the period from May 23 to October 2. USGS's monitoring program is discontinued at this station annually from fall to late spring.

Dissolved Oxygen concentrations generally followed the same trend at each of the five stations throughout the Demonstration period (Figures 4.3-2 through 4.3-8, Table 4.3-1). In general, the lowest monthly mean DO concentrations were recorded in August and the lowest instantaneous minimum DO values were variable with lows recorded in July for Norristown Pool, August for Limerick Intake and Vincent Dam, September for Black Rock Pool, and October for Pennsylvania American Intake. Note that the Vincent Dam August minimum value of 2.40 mg/l is questionable, perhaps arising from an instrumentation issue (a relatively common occurrence at this monitor). Minimum DO values for the other four stations were never below 4.48 mg/l.

The lowest mean daily DO value (5.40 mg/l) for all Exelon stations was recorded in Black Rock Pool on July 20 and is above the minimum value (5.00 mg/l) established as a trigger level for the Demonstration. The lowest instantaneous DO concentration (4.48 mg/l) was recorded at Black Rock Pool in September (Table 4.3-1) and was above the minimum instantaneous Pennsylvania water quality standard of 4.0 mg/l.

During the Demonstration period, DO concentrations usually cycled over 24-hour (diel) periods with the highest concentrations found during the late afternoon to early evening hours and lowest concentrations during the early morning hours (Figure 4.3-9). This diel oscillation in DO concentrations is typical of rivers and is primarily due to aquatic vegetation photosynthesis in excess of aquatic organism respiration during daylight and continued respiration with no photosynthesis during the night. Disruptions to the normal diel cycle usually were related to rainfall events and the resulting rise in river flow.

The 2007 monitoring program offered an exceptional opportunity to evaluate the relation of Schuylkill River low flows to DO. For much of July through October, Schuylkill River discharge was less than 560 CFS. Several regression analyses were performed to determine the relation of DO to Schuylkill River discharge. Mean daily DO was not well correlated to Schuylkill River discharge at any of the four Exelon monitoring stations during the 2007 Demonstration (Figure 4.3-10). Similarly, mean daily DO was not significantly correlated to Schuylkill River discharge less than 560 CFS (Figure 4.3-11). A third and final analysis was completed to assess the relation of instantaneous minimum dissolved oxygen concentrations to Schuylkill River discharge less than 560 CFS. Similar to the two previous analyses, instantaneous minimum DO was not significantly correlated to Schuylkill River discharge less than 560 CFS (Figure 4.3-12).

In general, mean pH over the Demonstration period was similar for all four stations with lowest mean (7.18) and instantaneous minimum (6.67) values recorded from Norristown Pool during

July. The highest instantaneous maximum (9.09) pH was recorded from the Limerick Intake in October (Table 4.3-2). The largest recorded variation in daily pH measures was 1.24 at the Limerick Intake on July 22 (Figure 4.3-5). This diel variation in pH was observed at all stations, as expected, coincident with the cycling of DO (Figure 4.3-4 - 4.3-8). Photosynthesis by aquatic plants removes carbon dioxide from water during daylight, thus causing a rise in pH. Then, during the night, aquatic plant respiration produces carbon dioxide which decreases the pH.

Temperatures for all of the stations were similar with July and August being the warmest months for all four stations. Temperature for Limerick Intake, PA American, Black Rock Pool, and Norristown Pool are provided in Table 4.3-3 Figure 4.3-4- 4.3-8).

4.4 Lower Schuylkill River Water Treatment Facilities

Pottstown Water Treatment Plant

The Borough of Pottstown's Water Treatment Plant is the first drinking water intake on the Schuylkill downstream of Pottsville and, therefore, the first intake potentially affected by water pumped from the Wadesville Mine Pool. Pottstown routinely measures the pH and specific conductance of the raw water withdrawn from the Schuylkill River. We utilized their data to supplement our own data collection efforts. The pH of the intake water is recorded at 2-hour intervals each day. The observed daily ranges are shown in Table 4.4-1. During the Demonstration, intake water pH ranged from 7.2 to 8.9 standard units. Although the daily range on most dates was 0.5 standard units or less, the greatest range observed was 1.3 standard units on May 7, prior to initiation of Wadesville Mine Pool pumping.

The daily measurements of specific conductance ranged from 370 to 560 µmhos/cm, with most readings in the 400s. Conductivity was negatively correlated to river discharge (Figure 4.4-1). In general, at the lowest river discharges conductivity was the highest. All river discharges in Figure 4.4-1 were below 600 CFS and most of the conductivity measures were between 400-500 µmhos/cm. At the lowest flows, around 400 CFS, conductivity varied from 500 to 560 µmhos/cm. Overall, conductivity and pH values measured during the 2007 Demonstration were within the same range of values observed during the previous four Demonstration years.

Sampling of additional parameters, i.e., TDS, iron, manganese, total organic carbon (TOC), and sulfides was scheduled to take place at the Pottstown water intake when river flows at the USGS Pottstown gage decreased below 560 CFS for four consecutive days. The purpose of this sampling was to assure that Borough personnel were informed about water quality trends that could result in increased treatment costs or potentially cause a violation of the drinking water quality limits applicable to the finished water. Low flow sampling occurred on 13 days from July 25 to October 4. Maximum concentrations found during the 13 sampling events were: iron, 0.26 mg/l; manganese, 0.133 mg/l; copper, < 0.01 mg/l; TOC, 3.2 mg/l; and TDS, 351mg/l (Table 4.4-2). Pottstown water treatment plant was not required to make any changes to public water supply treatment during the Demonstration in 2007.

Pennsylvania American Water Company

The Pennsylvania American water intake on the Schuylkill River near Linfield (below LGS but upstream of the Vincent Pool USGS monitoring site) was sampled for TDS on 21 occasions from May 15 to November 5. Monthly sampling was to be completed unless river flows at Pottstown were below 560 CFS, then weekly sampling was to be performed. River flows during 2007 were below 560 CFS for much of August through October and, thus, samples were taken weekly during most of this period.

Measures of TDS over the entire Demonstration ranged from 146 to 351 mg/l with all values being below the threshold limit for finished drinking water. At river flows less than 600 CFS TDS was not significantly correlated to river discharge (Figure 4.4-2) indicating that similar TDS values were observed for all low flow measurements. Similarly, no significant difference in TDS was observed between river flows of 460-560 CFS. Lowering the low flow trigger to 460 CFS at the Pottstown gage, Limerick by-pass flow of 400 CFS, would not significantly change TDS in the Schuylkill River.

Conductivity measured at the Pennsylvania American intake was not significantly correlated to Schuylkill River low flow (Figure 4.4-3). This relationship is contrary to that which was observed at the Pottstown Water Treatment Plant (Figure 4.4-1). Conductivity measured at the Pottstown Plant (upstream) was generally higher than conductivity measures at Pennsylvania American (downstream) and was significantly correlated to flows less than 600 CFS.

In addition, DO, pH, and temperature were also determined at the Pennsylvania American Intake (Table 4.4-3).

4.5 East Norwegian Creek and Upper Schuylkill River Water Quality

Water quality sampling was conducted at single locations in East Norwegian Creek and in the Schuylkill River upstream and downstream of the confluence, coincident with Schuylkill River biological monitoring (Figure 4.5-1). The East Norwegian Creek station is located near Coal Street in Pottsville, immediately upstream of the long culvert which conveys the stream underground through Pottsville. Schuylkill River Station 106 is located approximately 0.5 miles upstream of the mouth of Norwegian Creek, Station 107 is between Station 106 and the mouth of Norwegian Creek, while Station 109 is located approximately 3 miles downstream of the confluence. The numbering and location of these stations correspond to site sampled previously by the PA Fish and Boat Commission. For the upstream stations, temperature data was recorded at Station 107 and water quality data was collected at Station 106. At Station 109 (downstream) both water quality and temperature data were collected.

Based on our data, mixing Norwegian Creek water with the Schuylkill River seemed to have a small positive effect downstream of the confluence (Table 4.5-1). In general, total dissolved solids, specific conductance, total alkalinity, and pH were higher downstream. These same relationships were observed during the previous years of the Demonstration. Norwegian Creek water adds buffering capacity to the river (higher total alkalinity) and has a higher pH. This addition of water acts to improve the water quality of the Schuylkill River.

Daily water temperature measurements were recorded using Onset StowAway temperature loggers in East Norwegian Creek and at Schuylkill River Station 107 and 109. The monitoring stations are the identical locations that were monitored for ambient river temperature in prior years of the Demonstration. Temperatures for all three stations were recorded from May to November.

As expected, the East Norwegian Creek discharge had a slight cooling effect on the Schuylkill River, but this effect did not persist very far downstream. Daily mean temperatures in East Norwegian Creek (43-69 °F) were regularly lower than the Schuylkill River at Stations 107 (41-71 °F) and 109 (42-73 °F) (Figure 4.5-2). The water temperature at Station 109, approximately 3 miles downstream of the Norwegian Creek confluence, was generally the warmest.

4.6 Upper Schuylkill River Biological Monitoring

Schuylkill River biological monitoring was completed on three days from May to November. The first sampling event was prior to initiation of Mine pool pumping, the second occurred during the pumping season, and the final sampling event was completed after cessation of pumping. The biological monitoring consisted of sampling fish and benthic macroinvertebrates (aquatic insects and other organisms that live on or in the river bottom) at indicator stations in the Schuylkill River upstream (Station 106) and downstream (Station 109) of the Norwegian Creek confluence (Figure 4.5-1). Stations 106 and 109 are part of the array of Schuylkill River locations previously sampled by the Pennsylvania Fish and Boat Commission.

Fish were captured by electrofishing, with two tow boats, in approximately equal lengths of river at both stations. Captured fish were identified, counted, measured for total length, and released live to the river. Benthic macroinvertebrates were collected during single 15-second kick samples in two fast water velocity riffles and two slower water velocity riffle/runs using a D-frame kicknet (500µm). The kick samples for each station were combined and were preserved with isopropanol for transport to the laboratory where all macroinvertebrates were sorted from sample residue, identified, and counted. Both the fish and benthic macroinvertebrate sampling methods are standard procedures in aquatic biological investigations and were used in the previous Demonstration periods.

Similar fish species composition was present at both stations (Table 4.6-1). A total of 12 species were collected at Station 106 while 15 species were collected at Station 109. Excluding hatchery-reared trout, the most common species were blacknose dace, creek chub, white sucker, and green sunfish. Roughly equal numbers of individuals were captured at both locations during May 22 and November 1. During the August 2 sampling event large numbers of juvenile white suckers were collected at station 109 which resulted in much greater overall numbers of fish at this station when compared to station 106.

Rainbow, brown, or brook trout were captured at both stations on each sampling date, but salmonids were only a small proportion of the total fish collected (excluding the stocked fingerlings). A fairly large number of stocked rainbow trout fingerlings were collected from Station 109 during the August 2 and November 1 collections. Greater numbers of salmonids were found at Station 109 than Station 106.

The results for 2007 are similar to what was observed in previous years and indicate little effect of the Norwegian Creek discharge (Tables 4.6-2 and 4.6-3). There was little difference in species composition and in which species were most abundant between the stations or among years. Station 109 richness ranged from 12 to 15 taxa and Station 106 richness ranged from 9 to 12 taxa. Furthermore, relatively similar total numbers of fish were captured at both stations during all sample years.

Benthic macroinvertebrates were collected on the same three days as the fish sampling. Overall, more taxa and greater total numbers of macroinvertebrates were collected downstream than upstream of the Norwegian Creek confluence (Table 4.6-4). Total number of taxa collected during 2007 was higher at Station 109 (n = 25) than at Station 106 (n = 22). Similarly, total numbers of macroinvertebrates collected was higher at Station 109 (n = 4,277) than Station 106 (n = 1,700).

In general, totals of 22 and 25 macroinvertebrate taxa can be considered low compared to other streams within the region not impaired by acid mine drainage which affects the upper Schuylkill River. Of the insect taxa considered intolerant of environmental disturbance, few mayflies (Ephemeroptera) and only one stonefly (Plecoptera) taxon were collected at either station. However, of the mayflies collected, two mayfly genera were collected downstream and one mayfly genus was collected upstream of the East Norwegian Creek confluence. The single stonefly taxon was collected upstream. Three caddisfly (Trichoptera) taxa, also considered disturbance-intolerant, were collected at each station, with similar numbers of individuals collected at both stations.

Other macroinvertebrate taxa present at one or both stations included such crustaceans as crayfish (Decapoda), scuds (Amphipoda), sowbugs (Isopoda), and worms (Oligochaeta), in addition to several more insect groups. Most noteworthy among the insects, other than the intolerant groups discussed above, were the midges (Chironomidae). Midges were the dominant taxon for all sample dates at the downstream station and were dominant on two of the three sample dates for the upstream station. The midges are composed of many species, are widespread in distribution, and their presence in relatively large numbers is not unusual.

Macroinvertebrate richness has also been fairly constant for each station over the past 5 years while abundance has shown a general increase, especially over the last few years (Table 4.6-5 and 4.6-6). For Station 106, species richness ranged from 19 to 25 taxa and relative abundance for each taxon was similar, except for the caddisfly *Hydropsyche* in 2007, which was more abundant than any of the previous years. Station 109 species richness ranged from 22 to 27 taxa and relative abundance of taxa was similar among the years. For Station 109 during all years the most abundant macroinvertebrate was the chironomid. Similarly, for Station 106 chironomids were the dominant taxon for most years, except 2007 when *Hydropysche* and Chironomidae were essentially co-dominant. Dominance by one taxon is indicative of a stressed macroinvertebrate community and this is clearly evident for this segment of the Schuylkill River.

Overall, pumping water from the Wadesville Mine Pool appears to benefit the macroinvertebrate community, noting that more macroinvertebrate taxa and individuals were collected downstream than upstream. This enhanced macroinvertebrate community equates to a more abundant food resource for fish.

4.7 Still Creek Reservoir Discharge Rate and Water Quality

Discharges from Still Creek Reservoir were used to augment Schuylkill River water volume, not for water quality enhancement or TDS management. During the Demonstration, water was released to augment Schuylkill River flows on 86 days from May to mid-November. Daily discharge reached a maximum of approximately 38.7 MG and totaled 1005.4 MG for the 2007 Demonstration period (Table 4.7-1). The reservoir water elevation was lowered approximately 7.7 feet from initiation to cessation of augmentation.

Measurements of DO in Still Creek below the reservoir were made weekly when releases were occurring and ranged from 8.6 to 10.10 mg/l. The range of DO concentrations was similar to the values recorded during the previous Demonstration periods.

4.8 Little Schuylkill River Water Quality and Discharge

Water quality sampling was conducted at three locations within the upper Little Schuylkill River watershed, upstream of Tamaqua, on a monthly basis when releases were being made from Still Creek Reservoir. The sampling stations were located in the Little Schuylkill River upstream of the Still Creek confluence and below the SR 1020 bridge, in Still Creek near the PA Route 309 bridge (about 0.4 mile below Still Creek Reservoir), and in the Little Schuylkill River near the PA Route 54 bridge downstream of Still Creek and just above the confluence with Pine Creek (Figure 4.8-1). These locations were selected to determine the influence of Still Creek Reservoir releases on the Little Schuylkill River which has very poor water quality due to acid mine drainage above the Still Creek confluence. Water samples were collected for lab analysis of TDS and total alkalinity; field determinations of DO, specific conductance, temperature, and pH were performed at the time of sampling.

Onset temperature loggers were installed at the same locations where water quality sampling was conducted and an additional logger was placed at a downstream location in the Little Schuylkill River about 1.3 miles north of Tamaqua. Field determinations of DO, specific conductance, temperature, and pH were performed and aquatic habitat observations were recorded at each of the four stations when the temperature recorders were downloaded monthly. Temperatures were recorded from May 5 to October 28 for the LSR upstream station and from May 5 to November 21 for the other three stations.

For all sampling dates, pH and total alkalinity in the Little Schuylkill River were higher (in one case equal) downstream of the Still Creek confluence than above (Table 4.8-1). Likewise, DO, TDS, and specific conductance were lower downstream of Still Creek for most of the sampling dates. The Still Creek reservoir discharge has a positive effect on the chemical quality of the water in relation to it's suitability for aquatic life. The Still Creek discharge dilutes the acid mine drainage that contributes a majority of the stream flow to the LSR. These relationships are similar to those observed during the previous years of the Demonstration.

Water temperatures at the two Little Schuylkill River stations downstream of Still Creek and in Still Creek were warmer than in the Little Schuylkill River upstream of Still Creek (Figure 4.8-2). For the study period, mean temperatures were 59°F in Still Creek, 56°F in the Little Schuylkill upstream, 59°F in the LSR downstream, and 60°F in the LSR at Tamaqua. The warmest temperatures at all four stations were recorded in August and early-September. During most of the study period the upper Little Schuylkill River station was generally 5°F or more cooler than the other three stations and had the smallest variation in temperature. Flow at this location appeared to be dominated by mine drainage. The higher temperatures and wider range of temperatures at the lower sites appears to reflect natural warming that takes place as rivers flow downstream.

Water quality measurements taken during temperature logger downloads followed the same trends as described previously (Table 4.8-1). Aquatic habitat observations indicated minimal changes at the four stations during the Demonstration period (Table 4.8-2).

During the 2007 Demonstration, Onset U20 pressure transducers were placed in the Little Schuylkill River both upstream (75 ft) and downstream (200 ft) of Still Creek and in Still Creek just upstream (150 ft) of the confluence with the Little Schuylkill River (Figure 4.8-3). The recorder was used to measure pressure hourly and record it at each location. Pressure was then converted to water depth (feet) above the pressure recorder. Pressure measurements were recorded throughout the data collection period and manual stream discharge estimates were determined on eight separate days over a range of flows in order to generate a rating curve to convert pressure readings to stream flow. A simple regression model was used to develop an equation that was then used to estimate stream discharge at a given pressure. Note that extreme high or low flows are not accounted for in the estimates because these values are outside of the range of values used to develop the regression equation.

Little Schuylkill River downstream and Still Creek pressure values were recorded from May 6 to November 27 and LSR upstream values were recorded from May 6 to October 13. The LSR upstream monitor was unrecoverable and data were not available after October 13. Additionally, stream discharge is recorded by the USGS, near Tamaqua, several miles downstream of the aforementioned stations. During the entire study period Still Creek estimated mean discharge was 6 CFS, LSR upstream estimated mean discharge was 5 CFS, and LSR estimated mean discharge was 14 CFS. During the same time period LSR mean discharge at the USGS gage was 39 CFS. Releases from Still Creek Reservoir contributed a large portion of the total estimated flow of the Little Schuylkill station just downstream of Still Creek. Reservoir discharges measured at the Still Creek station during non-augmentation periods were typically less than 2 CFS. Estimated daily discharge for the three Exelon stations and the USGS station daily discharge followed a similar trend throughout the Demonstration period (Figure 4.8-4).

4.9 Little Schuylkill River Biological Monitoring

Fish communities were surveyed at two different locations downstream of the Still Creek confluence with the Little Schuylkill River in May, July, and October. The most upstream site was near the Tamaqua water plant with the downstream boundary being a few hundred meters downstream of the confluence with Still Creek. The second site was farther downstream and started approximately 200 meters upstream of the Pine Creek confluence (Figure 4.9-1). Sampling in previous years determined that no fish were present upstream of the Still Creek confluence in the LSR, thus no additional sampling was performed upstream of Still Creek. An electrofishing tow boat that produced DC current was used to complete the fish surveys. Captured fish were identified, measured for length, enumerated and released. In addition, water temperature, DO, pH, and specific conductance were recorded during sampling (Table 4.9-1).

Few fish were captured at the most upstream station (Table 4.9-1). The fish that were collected (pumpkinseed, chain pickerel, yellow perch) most likely originated from Still Creek Reservoir. At the downstream station, more species and greater numbers of fish were collected. Brook trout was the most abundant species, similar to the community structure observed during previous years of sampling. Similar to the upstream station, the bluegill and pumpkinseed captured downstream were most likely washed down from the reservoir. The greater number and density of fish species at the downstream station can be attributed to the higher pH downstream than upstream. During all sampling visits to these stations (2005-2007), the pH was higher downstream. The higher pH downstream resulted from Niefert Creek and other smaller tributaries which contribute higher pH water to the LSR.

4.10 Perkiomen Creek Water Quality

Monthly water quality measurements were made in Perkiomen Creek upstream and downstream of the East Branch Perkiomen Creek (EBPC) confluence from May 10 to November 9. The observations generally indicated small differences in the measured parameters between these locations (Figure 4.10-1, Table 4.10-1). However, during one sampling event, October 18, bacterial concentrations were approximately seven times higher upstream of the EBPC confluence (out of the possible Demonstration project impact zone) than at the downstream station. Overall, mean and maximum *E. coli* and fecal coliforms concentrations were lower in 2007 than during the previous years at the downstream of EBPC station (Table 4.10-1). Upstream of the confluence mean *E. coli* and fecal coliform concentrations were higher than those measured during the 2004 and 2006 collections. Measurements of DO and temperature during 2007 were similar to those observed previously at both stations.

4.11 East Branch Perkiomen Creek water quality

Measurements of selected water quality parameters were made in the outfall from Bradshaw Reservoir as well as at three locations in East Branch Perkiomen Creek from May 9 to November 15 (Figure 4.10-1). Both *E. coli* and fecal coliform numbers were much higher in the East Branch upstream of the Bradshaw Reservoir outfall, compared to downstream, on most of the sample dates (Table 4.11-1). Similarly, the highest mean *E. coli* and fecal coliform counts for the sample period were recorded upstream of the outfall. DO levels were generally higher downstream of the Bradshaw Reservoir outfall in 2007. Mean *E. coli* and fecal coliform counts in 2007 were within the range of average values recorded during the previous years. Overall, the general patterns of bacteria and DO concentrations observed among these stations in 2007 are similar to those observed during 2003 through 2006 sampling. These results suggest that the reduced minimum flows from Bradshaw outfall into the East Branch Perkiomen Creek are not having an effect on bacteria levels within the stream.

4.12 East Branch Perkiomen Creek Discharge

EBPC flows are recorded by the USGS at the Bucks Road gage and are included here from May 6 to November 27 (Figure 4.12-1). The flows in the upper East Branch Perkiomen Creek, as monitored by the USGS gage, closely reflect the discharge rate from Bradshaw Reservoir except during precipitation events. Bradshaw Reservoir discharge rate was approximately 10 CFS from May 6 to July 18, 30 CFS from July 19 to October 28, and 10 CFS from October 28 to November 27.

Monthly flows in EBPC during 2007 were similar to 2005 and 2006 flows (Table 4.12-1). The reduction in Bradshaw Reservoir discharge rate was most evident when the May through September discharges during 2005-2007 were compared to the historical discharges during this same seasonal period. Prior to 2005 EBPC discharges during the May-September timeframe were typically between 45-60 CFS; whereas, the 2005-2007 discharges ranged between 13-35 CFS.

4.13 East Branch Perkiomen Creek Erosion Study

A set of channel transects in the upper EBPC has been surveyed annually or more often after flood events since prior to operation of the Point Pleasant Diversion. This work is performed in the stream channel just upstream of the outfall from Bradshaw Reservoir to approximately 400 feet downstream of the USGS gage at Bucks Road. Channel erosion is measured by determining the channel width and depth (cross-section) at nine locations along the EBPC. The results from the most recent year are then compared to previous surveys to determine the amount of channel migration and erosion. These surveys focus on changes in the stream channel resulting from the Bradshaw Diversion discharge and from flood events. During the course of study the most apparent changes to channel geometry have occurred following the most severe storm events, those that elevated flow at the gage at Bucks Road above 1,000 CFS. It has been during such short-term disturbances that most of the bank recession occurs. The reduction in Diversion discharge has had no negative affect on EBPC channel erosion.

4.14 East Branch Perkiomen Creek Biological Sampling

Historic sampling of benthic macroinvertebrates and fish in EBPC had been performed prior to and during the Wadesville Demonstration. This work is a continuation of a sampling program that has been in place for many years to monitor the aquatic community subsequent to water releases from Bradshaw Reservoir. The results of this monitoring effort are reported separately to PA DEP. Over the last few years sampling for benthic macroinvertebrates has occurred twice annually, in the summer and late fall, at four locations distributed throughout the EBPC. Fish sampling has occurred annually at four locations in the late fall.

Macroinvertebrate sampling stations are positioned throughout the length of the EBPC (Figure 4.14-1). Here we report results of the bi-annual sampling from 1999 to 2006 by reducing the data into two commonly used metrics, total taxa and density. Over this 8-year timeframe total numbers of macroinvertebrate taxa has varied at all four stations (Figure 4.14-2). During the Wadesville Demonstration total taxa has varied within or close to the ranges observed prior to the reduction in Diversion discharges. For example, at station E23000 in the summer total taxa ranged from 21-27 prior to the Demonstration and from 26-33 during the Demonstration. Similarly, macroinvertebrate density has been comparable among the years at all four stations (Figure 4.14-3).

Fish sampling stations are located throughout the length of the EBPC (Figure 4.14-4). Here we report results of the annual sampling effort from 2002 through 2006, a timeframe in which comparable sampling methodologies were used. For ease of reporting, the data were reduced into two commonly used metrics, total fish taxa and abundance. Total number of fish taxa has been fairly stable with total taxa similar prior to and during the changes in the Diversion discharge (Figure 4.14-5). At station E22240, total fish taxa collected was 21 prior to the Demonstration and ranged from 15-22 during the Demonstration. Overall fish abundance has also been similar with pre-Demonstration values being similar to values observed during the Demonstration (Figure 4.14-6).

No changes in the benthic macroinvertebrate or fish communities that could be linked to the reduced Diversion flows to the EBPC as part of the Wadesville Mine Water Demonstration Project were observed.

4.15 East Branch Perkiomen Creek Stakeholders

The Perkiomen Creek Watershed Conservancy expressed concern during 2007 over the potential impact of reduced discharge from Bradshaw Reservoir. Their concern was focused on how the reduction in discharge could impact water quality and potentially affect the EBPC biological community. The concerns of the Conservancy were addressed via an informational meeting held on October 25, 2007 in which Exelon presented the results of recent benthic macroinvertebrate monitoring. The meeting focused on recent trends in the benthic data and how they may relate to changing Diversion flows. Exelon addressed the Conservancy’s concerns and will continue to provide a Conservancy with monitoring data as it becomes available

We received no other comments of concern from the public or other stakeholders.

5.0 CONCLUSIONS

The fifth Demonstration period was successfully completed in 2007. As we close the fifth year of the demonstration we have now achieved all of its objectives that the demonstration was designed to meet. These include:

- Provide monitoring under all (high and low flow) flow conditions
- Monitor and show long-term stability of using alternative augmentations sources (Tamaqua and Wadesville)
- Monitor and analyze potential effects on water quality, aquatic life, and flow resulting from the new conditions
- Confirm the hypothesis that a mine can be operated as an underground reservoir
- Provide an inclusive and open process where all stakeholders and groups have access to the data and provide input.

The demonstration data continues to show that the Demonstration project provides significant benefit to the Delaware basin during all flow conditions. The data and analysis presented in this report indicate continued positive impacts from headwater augmentation (Wadesville and Still Creek), no detrimental effects from continued management of diversion system flows, and no measurable effects from consumptive water use by LGS.

Restructuring of the temperature augmentation requirement which allowed withdrawal of the full amount of consumptive makeup water required by LGS had no measurable affect on DO levels in the lower Schuylkill River. DO levels were not correlated to flow reductions related to water withdrawal by LGS and DO levels met the Water Quality Criteria.

The minimum flow releases to EBPC maintained stream flow in the East Branch and enhanced the flow in the Perkiomen Creek downstream of LGS's Graterford intake. There were no adverse impacts to water quality as a result of the reduced releases from Bradshaw Reservoir.

Based on the 5 years of the Demonstration, the data supports:

- Long term approval of augmentation from Wadesville,
- Long term approval of augmentation from Still Creek,
- Long term restructuring of the 59°F augmentation requirement,
- Continuation of the Restoration and Monitoring Fund,
- Reduction of the Schuylkill River low flow trigger point
- Year round maintenance of a 10 CFS minimum flow limit in the East Branch Perkiomen Creek, and
- Long term approval of scheduled recreational releases of water in the East Branch Perkiomen Creek as requested by citizens groups.

We believe the data and analysis shows that the Demonstration approved by Docket Revision 12 is beneficial to the Delaware River basin and should be approved on a long-term basis. Five years of the demonstration have shown significant benefits from the demonstration and fully support its long-term continuation. Long-term continuation of the provisions of the demonstration will provide a number of important direct and indirect benefits to the water resources of the basin. Included in those benefits are:

- Augmenting flows in the lower portion of the Perkiomen Creek.
- Improving water quality by performing basin restoration projects.
- Providing long term private funding for basin restoration projects.
- Continued collaboration and input from various stakeholders on conducting and prioritizing water quality improvement/restoration projects.
- Optimizing regional water use.
- Extend the time augmentation sources can be used during drought/low flow periods.
- Maintaining increased water flow in the Delaware River.

The Demonstration continues to be very successful with no significant issues noted to date that would preclude moving to a long term adoption of the revised Docket criteria. There are significant water quality improvement projects underway with more to follow in the basin because of the Restoration and Monitoring Fund monies generated from continuation of this project.