2012

Lower Lackawanna River Watershed Restoration and Assessment Plan Report

Lackawanna River Corridor Association

EPCAMR

Eastern PA Coalition for Abandoned Mine Reclamation

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- The Willary Foundation
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Staff from SRBC, EPCAMR, LRCA, and PA Tectonics have conducted extensive field work to collect and analyze data from the Old Forge Borehole (OFB), the Duryea Breach (DB), and over twenty monitoring boreholes in the area of the Metropolitan Scranton Mine Pool (MSMP). This work has included the unique, difficult, and dangerous work to install and maintain monitoring equipment in OFB and immersion in chest waders in the outflow channel of the DB and in the Lackawanna River in all seasons and weather conditions.

Study team collecting a water quality and flow sample from the Duryea Outfall.

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1 Introduction

1.1 Executive Summary: A Tale of Two Rivers

The confluence of the Lackawanna River with the North Branch Susquehanna River at Coxton Point in the Lackawanna-Wyoming Valley (LWV) of Northeast PA has many distinctions of a historical, cultural, and aesthetic nature. It is also distinct due to the bright orange and yellow plume of iron (Fe) oxide laden water and sediments flowing from the Lackawanna River into the North Branch Susquehanna River. This legacy from the anthracite coal industry continues to mark the confluence located in Luzerne County, between the City of Pittston and the Borough of Duryea, with a special and not necessarily welcome distinction.

Geologists refer to the LWV as the Lackawanna Syncline. It is two valleys in name only. In actuality, it is one physical feature in the Ridge and Valley Physiographic Province of Eastern Pennsylvania. It appears, with some imagination, like a great “stone canoe” running 75 miles from Forest City in the northeast, to Shickshinny in the southwest. It is 5.0 miles athwart at Scranton and 7.0 miles at Wilkes-Barre. Beneath its surface was found the largest and richest anthracite coal basin on the planet, the Northern Anthracite Field (NAF).

Since November 1961, when the last of the deep mine collieries closed down and turned off their pumps, the extensive system of NAF underground mine voids flooded with groundwater as well as river and stream water infiltrating from the surface. What has resulted is a system of subterranean water bodies known as mine pools in a configuration somewhat like the subway system under Manhattan on steroids, 75 miles long and greater than 1,000 feet deep.

The major mine pools in the Lower Lackawanna River are the Metropolitan Scranton Mine Pool (MSMP), the Central Mine Pool (CMP), and the No. 9 Mine Pool (#9MP). MSMP extends from Old Forge upstream under Scranton, Dunmore, and several other mid-valley boroughs to Archbald. CMP and #9MP underlie portions of Duryea, Avoca, Dupont, Hughestown and Pittston Township (Figure 1-1).

It has been anecdotally described as the largest and most visible point source of pollution in the entire Chesapeake Bay Watershed. The source of this Fe loading is primarily from two abandoned mine drainage (AMD) discharges that drain several of these NAF mine pools, the Old Forge Borehole (OFB) and the Duryea Breach (DB) (Figure 1-2 and 1-3). The OFB drains the MSMP and DB drains the CMP and #9MP. These AMD points are respectively the second and sixth highest priority AMD sources impacting the Susquehanna River in the Anthracite Region (Clark 2011).

OFB is 3.0 miles upstream of the Lackawanna/Susquehanna Confluence Area (LSCA), adjacent to Union Street in the Borough of Old Forge, Lackawanna County. OFB discharges an average of ~60.7 million gallons per day (MGD) (~94 cubic feet per second (CFS)) with a Fe loading of ~7,700 pounds per day (lbs/day).

DB discharges an average of ~14.5 MGD (~22.5 CFS) with a loading of ~2,260 lbs/day of Fe. DB is located 0.75 miles upstream of the LSCA.

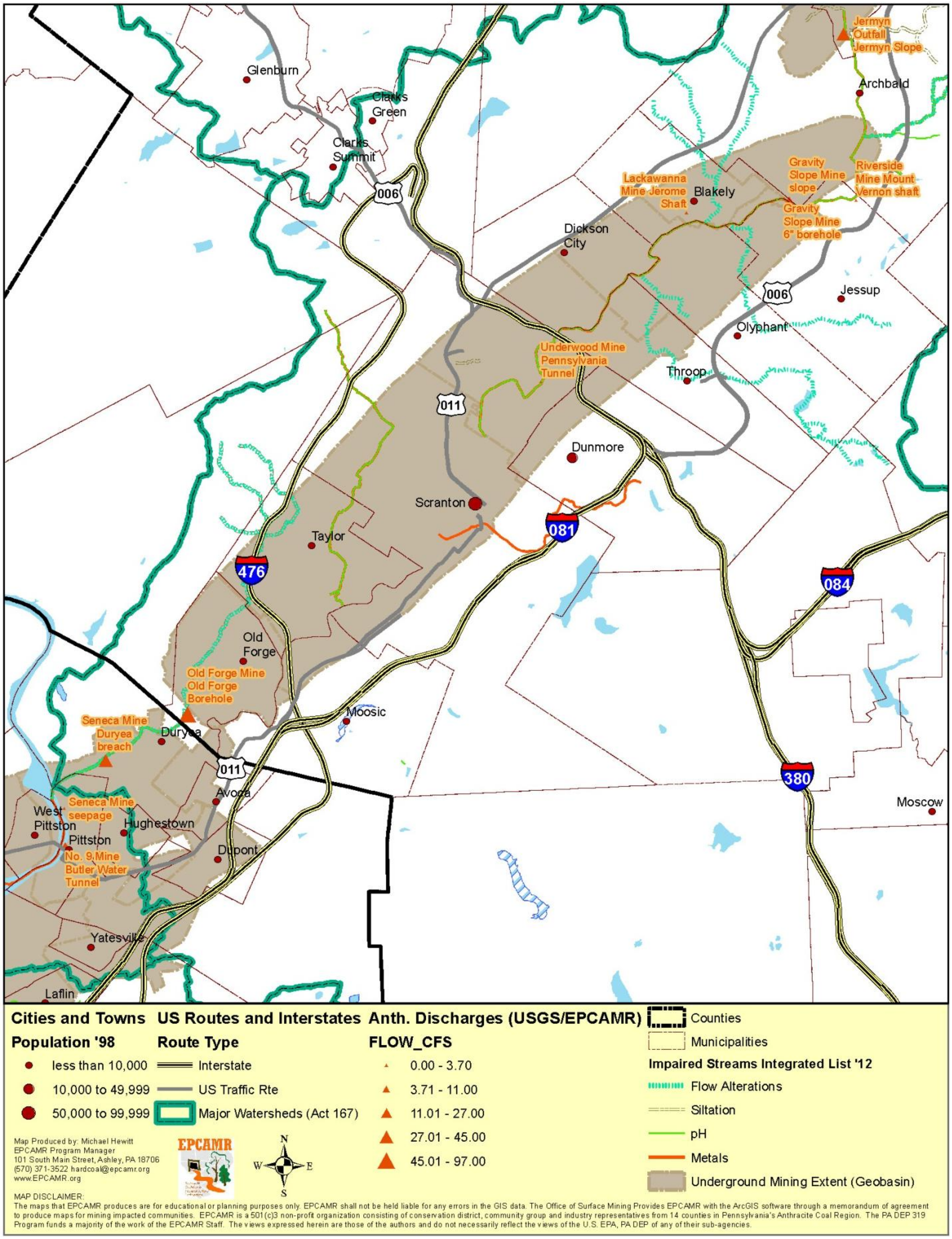

Figure 1-1 The major mine pools in the Lower Lackawanna River (larger version available in appendix).

Figure 1-2 The Old Forge Borehole entering the Lackawanna River's western bank.

Figure 1-3 The Duryea Breach discharge below beaver dam where sampling occurred.

A view from the air shows a large plume of orange colored water flowing into the Susquehanna River from the Lackawanna River just as the North Branch Susquehanna enters the LWV through what we should properly call the Wyoming Gap (Figure 1-4).

Recent monitoring data indicates that OFB and DB are now characterized as very net alkaline, after many years being characterized as net acidic. The amount of metals, particularly Fe, in both discharges is also slowly declining from levels recorded in the 1970's (Table 1-1). However, PA DEP, acting under requirements of the Clean Water Act (CWA), completed a study to assess the Total Maximum Daily Load (TMDL) for several pollutants in the Lackawanna River. Even with the improvement in alkalinity and Fe loading, the TMDL calls for an Fe loading reduction of 92 percent at the Lackawanna River mouth to meet water quality standards (PA DEP 2005). The vast majority of this loading originates from OFB and DB.

Table 1-1 The change of Old Forge Borehole and Duryea Breach quality over time.

	OFB pH	OFB Net Acidity	OFB Fe	DB pH	DB Net Acidity	DB Fe
1970s	5.60	210.00	40.00	5.70	233.00	48.00
1980s	5.96	0.84	30.51	5.97	2.11	37.12
2010s	6.54	-69.80	15.18	6.53	-62.75	18.65

SRBC has also recently characterized anthracite mine drainage via the 2011 Anthracite Region Mine Drainage Remediation Strategy. This work recognizes the significance of OFB and DB as contributing ~25 percent of the Fe loading entering the North Branch Susquehanna (Clark 2011). This work also ranks OFB and DB as the second and sixth highest priority discharges in the entire Susquehanna River Anthracite Region.

The Lower Lackawanna River Watershed Restoration and Assessment Plan (LLR-WRAP) contains the information needed to draft a Qualified Hydrologic Unit Plan (QHUP) developed by the Office of Surface Mining (OSM) and implemented by PA DEP. QHUPs assist in prioritizing and qualifying AMD and abandoned mine land (AML) sites for projects funded by the Surface Mining Control and Reclamation Act (SMCRA) as reauthorized by Congress and signed into law by the President in 2008. The Lower Lackawanna River QHUP, which will be drafted in the near future using this LLR-WRAP, will demonstrate that OFB and DB are QHUs that should be recognized by PA DEP and OSM.

The physical conditions and developmental constraints of the ~2,000 acre LSCA between Old Forge, Duryea, and Pittston are the second essential aspect of this LLR-WRAP. In addition to the degraded aesthetics and aquatic habitats affected by AMD, the physical disruption of the landscape and deficiencies in a LSCA transportation network are also a main focus.

In addition, as the first phase of this plan was underway, Duryea and West Pittston Boroughs experienced flood damage resulting from Tropical Storm Lee, a "Flood of Record" for the Susquehanna Basin.

Therefore, this plan makes a series of recommendations for AMD and AML reclamation and reuse, economic development, transportation improvements, flood protection, and natural

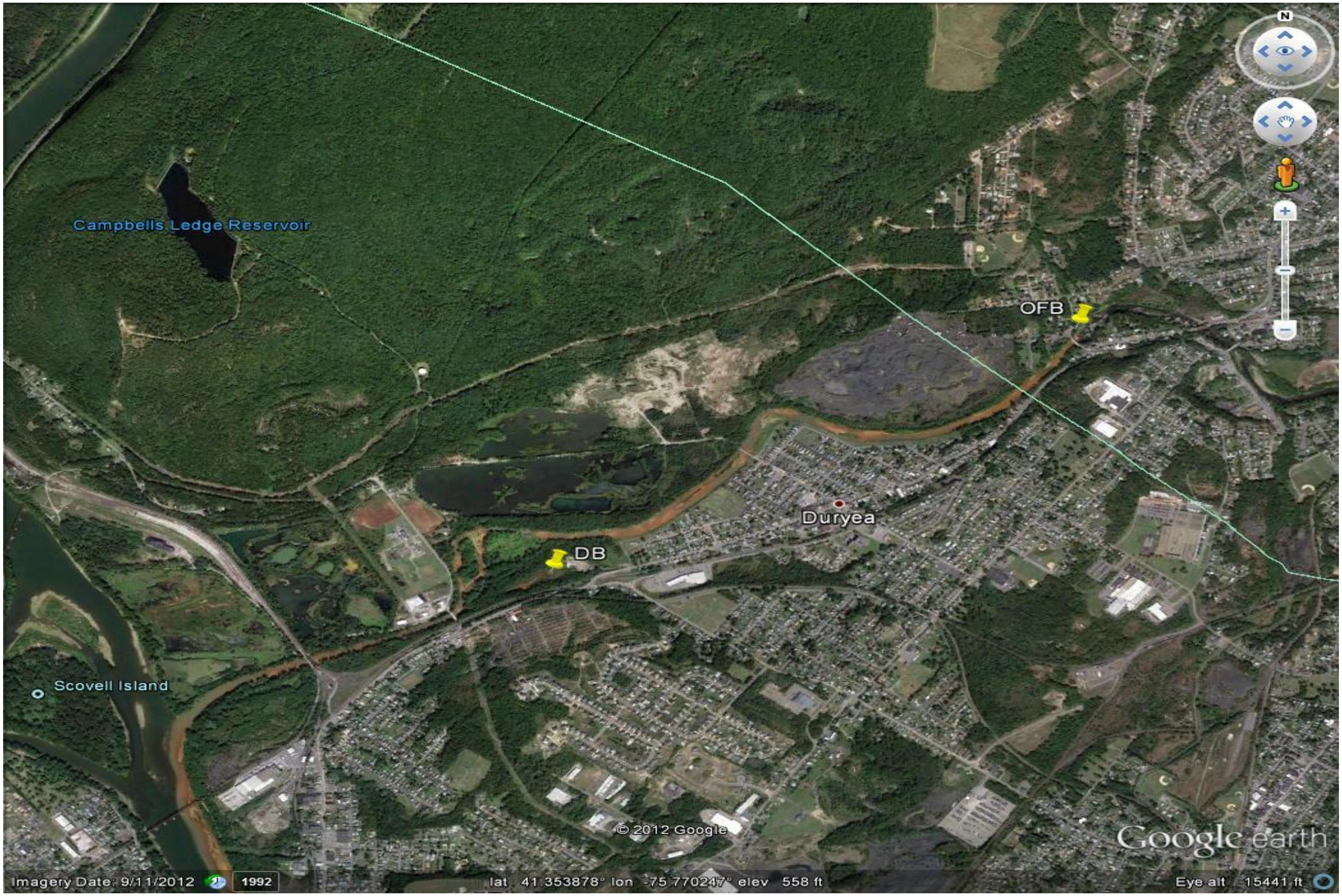

Figure 1-4 Location of the Old Forge Borehole and Duryea Breach. Notice iron staining in the Lackawanna River, mixing into the Susquehanna River in the lower left.

resource conservation and recreation. These recommendations are offered for consideration by local residents, property owners, business interests and municipal, county, state, and federal governments.

This plan and recommendations have been developed by LRCA working with SRBC, EPCAMR, and community stakeholders.

In order to treat the AMD problem in the Lower Lackawanna River, eliminate the Fe loading needed to meet water quality standards, and to utilize the maximum resources to achieve the intent of the reauthorized SMCRA, an active AMD treatment plant is probably a necessity. Passive wetland treatment can be a component of the overall process, but due to the volumes and Fe loading of OFBH and DB, an active treatment plant is more than likely needed to effectively accelerate rates of precipitation to remove a majority of the precipitated metals.

1.2 Executive Summary: Recommendations

- The LLR-WRAP recommends that the PA DEP BAMR and the new BCR utilize the future QHUP and related information in this document to approve QHU status for the Lower Lackawanna River (OFB and DB). The LLR-WRAP then recommends that PA DEP work with the community, the Lower Lackawanna Watershed Stakeholders Group (LLWSG), and eventually a Lower Lackawanna Confluence Coalition (LLCC) to design, build, and operate a mine drainage treatment facility that jointly treats flows from OFB and DB on a site to be determined, but likely along the west bank of the Lackawanna River in the proximity of Stevenson Street in Duryea.

- This LLR-WRAP recommends that the municipal and county governments in Lackawanna County and Luzerne County consider a collaboration to complete a comprehensive master plan that will promote the redevelopment of the ~2,000 acre LSCA. This area encompasses such locally named places and neighborhoods as the Confluence, Coxton Point, Pittston Junction, Coxton, Coxton Rail Yards, Falling Springs, Campbell's Ledge Reservoirs, Red Spring Run, Airport Sand and Gravel quarries, "the Duryea Swamps", Canal Street, West Stevenson Street, the Hallstead Colliery, the William A Colliery, Connell's Patch and Rosemont Estates.

- The LLR-WRAP also recommends that, as part of the comprehensive plan or as a stand-alone plan, a transportation improvement initiative is needed to plan and secure the resources to construct significant roadway, bridge, and traffic circulation improvements, particularly in and surrounding the LSCA.

- Discussions with elected officials indicate that there is no consensus supporting the creation of a public authority to lead the further work to plan and implement a treatment plant or associated economic development at the present time. Therefore, this plan recommends that the study partner agencies and interested stakeholders consider the establishment of a not-for-profit community development corporation with a mission to develop and operate a mine drainage treatment plant and conduct other economic development and environmental restoration needed at the LSCA. The LLR-WRAP proposes to name this entity the Lower Lackawanna Confluence Coalition (LLCC). The LLCC could form limited liability equity partnerships with several of the larger property owners to fund and build transportation improvements and develop and market multi-use subdivisions for industrial, commercial, residential, and recreational purposes.

- The LLR-WRAP recommends developing the AMD treatment plant as a magnet facility to attract business investment for synergistic industrial uses of adjacent properties for sustainable water and energy related business. Specialized plan and investment studies are recommended to facilitate development of hydroelectric, geothermal, and other renewable energy resources associated with the site. The LLCC and the private consortium should engender collaborations to develop these resources in surplus to what may be developed or required to support the recommended active AMD treatment plant.

- The LLR-WRAP recommends that the existing open space resources of the LSCA include a habitat conservation management program that integrates habitat and aquatic features into the design of the build out environment. The LLR-WRAP also endorses the identification, protection, conservation, and interpretation of historic and prehistoric cultural resources that are present. Open space habitat management and recreational access programs should be initiated to protect resources and create recreational opportunities. The LSCA is linked with several state and federal Heritage Areas, the Lackawanna Heritage Valley, and the Delaware Lehigh Heritage Corridor. The Susquehanna River Greenway Plan also links the LSCA to the Susquehanna River Greenway and other heritage areas. The LLR-WRAP recommends that the recreational and cultural opportunities represented in the LSCA be further developed as part of the proposed comprehensive plan.

- The LLR-WRAP recommends that existing flood plain elevations and values be maintained within the elevations recorded from the 2011 flood event. The plan supports the completion of flood control protection for Duryea and the design and construction of a flood control program for West Pittston. This plan recommends that flood protection and flood proofing be developed for the Lower Lackawanna Valley Sewer Authority (LLVSA) plant on Coxton Road. Flood proofing and flood damage reduction capacities need to be included in the overall development parameters for active and passive AMD treatment facilities proposed for the LSCA.

- The LLR-WRAP also recommends the collaboration of municipalities with the LLVSA and the LRCA to promote community compliance with long-term-controls for the combined sewer overflows (CSO) and additional collaboration with the municipalities for the Municipal Separate Storm Sewer System (MS4).

- The LLR-WRAP recommends that the LLVSA collaborate with LRCA, EPCAMR, and SRBC to advance the development of the LLCC to advance the construction and operation of a mine water treatment plant and related programs.

- The LLR-WRAP recommends that LLWSG continue all efforts to develop and fund feasibility studies and transportation improvement plans for the LSCA and collaborate with property owners to maximize sustainable resource and economic development opportunities. This can include a research and development consortium with local regional universities, resource conservation and development agencies, and economic development agencies.

- The LLR-WRAP recommends that LRCA continue in collaboration with EPCAMR, SRBC, and local and state agencies as appropriate to identify and secure funding for feasibility studies. Comprehensive planning is necessary to address site constraints and facilitate a sustainable development program for the long-term operation of the treatment facility and related industries.

1.3 Consideration for Implementation

SMCRA is providing over one billion dollars in Mine Reclamation Trust Fund payments to PA. PA DEP may, at its discretion, set aside up to 30 percent of the funding it receives to address AMD pollution. OSM has established the QHUP process to guide the states in prioritizing and allocating the funding. PA DEP has established a prioritization policy to recapitalize existing treatment plants that it had constructed in the 1970's, followed by recapitalization for plants acquired from private sector operators through bankruptcy and /or bond forfeiture.

After those priorities are addressed, the remaining funds are available to develop new treatment systems for sites that have established QHUP's. When the SMCRA reauthorization expires in 2022, there will no longer be a source of federal funds specifically allocated to construct and operate AMD treatment facilities. Consequently, the LRCA suggests that time is of the essence in securing the QHU status and prioritization by PA DEP so that OFB and DB can be treated.

The environmental pollution so evident at the LSCA has been the subject of study by PA going back to at least 1904 as evidenced by the Dodge report. The most recent study by SRBC (2011) demonstrates that the OFB is the largest single source of AMD by volume and, together with the nearby DB, is the source of 25 percent of the total Fe loading in the entire North Branch Susquehanna River. A treatment facility for these two discharges is the top priority of the SRBC study and this LLR-WRAP.

It is incumbent on all elected officials in the Lower Lackawanna Valley to join with LRCA and our fellow stakeholders to prioritize local and state government policy leading to treatment plant development and operation in a long-term sustainable fashion.

LRCA further suggests that a long-term program is necessary to provide perpetual funding sources to insure continuous operation of a treatment plant. Multiple sources of funding may be available through the development of adjacent private investment sites to support related industries in the water resource and energy sectors.

A not-for-profit community development corporation is suggested as a way to maximize the opportunities that can result in a thoughtful and well-planned development of the LSCA.

A development program, such as the one suggested, could engender numerous private investment opportunities that may develop environmentally sustainable businesses, providing family supporting and green technology employment.

Lastly, sustainable development at the LSCA can help restore the value of this site as a strategic crossroads in the heart of the LWV, halfway between our historic downtowns of Scranton and Wilkes-Barre. This development will also build value for Pittston, West Pittston, Duryea, and other nearby communities by providing new economic opportunities and revitalized infrastructure integrated with a rebirth of our rivers and the lands around their confluence.

1.4 Vision for a Revitalized River

The LLR-WRAP suggests a strategy to clean up and revitalize one of the most visible sources of pollution in the watershed of the Chesapeake Bay. The lower three miles of the Lackawanna River in Northeast Pennsylvania flow with the bright orange and yellow staining of Fe oxide from two sources of AMD (OFBH and DB). OFBH and DB combined average ~75 MGD (116 CFS) and discharge almost 5 tons/day of Fe into the Lackawanna River. As the Lackawanna River flows into the North Branch Susquehanna River at Coxton Point, this Fe trace is visible for quite a length along the eastern bank. It is a visible challenge that can inspire a creative and imaginative response benefiting both our rivers and our community.

The LLR-WRAP is the result of collaborations among local residents, property owners, business interests, and elected officials in dialogue with staff from local, state, and federal agencies. This plan has not been written by consultants, rather it is the product of local people who have been working along the rivers of the NAF for many years.

Twenty-five years ago, in 1987, the people of our communities created the LRCA to speak out for a revitalized river. The LRCA developed a Citizens Master Plan for the Lackawanna River in 1990. The plan does not reside on a shelf. It flows with the water. It is living as the river is living. It looks at the negative impacts from nearly 200 years of abuse and it suggests ways to heal our environment from the abuse of our coal mining legacy, to involve the community with that healing, and to create lasting value with the outcome.

This LLR-WRAP envisions the LSCA revitalized and integrating multiple land uses for conservation, industrial, commercial, and residential developments.

The plan envisions an AMD treatment plant treating the combined flows of OFB and DB. The plant is surrounded by ponds and wetland habitats that provide additional natural treatment of the AMD flows before discharging as clean water back into the Lackawanna River.

This plan envisions other economic investments adjacent to the AMD treatment Plant. An Fe oxide processing plant could take the oxides removed from the AMD flows to market as feedstock for several other industries. A bio-fuels plant could convert waste products from PA agriculture and timber industries into motor vehicle fuels. Several other energy production uses could be associated with the site including vertical axis windmills, geothermal heating, and hydroelectric generation. These industries could help the establishment of a development district at the LSCA.

Additional wastewater treatment facilities and a water withdrawal point related to the nearby Marcellus shale gas industry could provide an income stream to help fund operation of the AMD plant. The management of the treatment flows and mine pool elevations could provide a source of clean water to augment the flows in the Susquehanna River during low flow conditions and provide another income source for the AMD treatment plant. The flows of the AMDs can also provide opportunities for hydroelectric generation potentially producing a surplus of power for the treatment plant and adjacent users. For example, assuming an average OFB flow of 95 CFS, head pressure of 5 feet, and 75 percent efficiency, ~30 kilowatts (KW) could be generated. An additional 30 KW could then be produced for every additional 5 feet of head.

The plan further envisions an improved roadway network to safely expedite truck and automobile traffic through the LSCA and out to regional arterial roadways and highways. An expansion of shipping and transshipping opportunities is also envisioned for the Reading and Northern Coxton Rail Yard. Long term, the plan also envisions a land reclamation program addressing AML issues along the line of coal outcrops in the upland portions of the site. This could support new residential opportunities, perhaps with a neo-traditional village center and mixed-use housing along the flanks of Campbell's Ledge and West Mountain where Duryea, Old Forge, and Ransom Township boundaries converge.

The comprehensive plan that is recommended can create design parameters to enhance and protect green space and natural habitats such as the wooded ridgeline and the stream corridors of Campbell's Ledge Run and Red Spring Run. All of these new residential sites would overlook the treatment plant and associated industrial sites on the upland terraces, with the wetlands preserved to allow flood storage capacity, and habitats restored with the practices of conservation ecology. These activities will provide wildlife habitat, river access sites, and open space recreation opportunities all throughout the LSCA.

1.5 Scope of Work

The scope of work for the LLR-WRAP includes the following elements:

- A historical review of previous relevant plans and studies
- A characterization of the issues related to the aquatic and terrestrial resources
- A characterization of the mine pools and drainage points
- An active monitoring, data collection, and analysis program
- A community stakeholders committee process and a key-person interview process to develop input, review findings, and build consensus for recommendations
- Publication of the LLR-WRAP as per stakeholders consensus
- All leading to the eventual completion of a QHUP for the Lower Lackawanna River

Primarily, staff from the LRCA, EPCAMR, and SRBC have conducted the research and fieldwork with additional technical field services provided by PA Tectonics. A community stakeholders committee, LLWSG, has been convened at the invitation of LRCA. The LLWSG have met several times during the course of the planning work and have provided review and input into the LLR-WRAP development and its recommendations.

The primary objectives of this scope of work are to produce all of the information necessary to complete the Lower Lackawanna QHUP, which will then be prioritized by PA DEP for the installation and operation of an AMD treatment system and to convene a community-based stakeholders group to support and advance that objective.

The development of additional recommendations is dependent on securing the QHU and building the AMD treatment facility.

2 Lower Lackawanna River Watershed Background

2.1 Hydrology, Geology, and Soils

The Lackawanna River flows for nearly 60 miles through a 350 square mile watershed in four counties in Northeastern Pennsylvania to its confluence with the North Branch Susquehanna River at Coxton near Pittston, Pennsylvania. The Lackawanna rises in a series of glacial ponds and wetland bogs along the border areas of Wayne and Susquehanna counties in the glaciated plateau province of the Appalachian Mountains (Figure 2-1).

The source ponds and bogs lay in an arc approximately twelve miles to the northwest, north and northeast of Forest City, Susquehanna County. The source ponds of the West Branch Lackawanna River are Sink Hole Swamp, Lake Romobe, Ball Lake, Hathaway Lake, Fiddle Lake, Lowe Lake, and Lewis Lake. The East Branch Lackawanna River source ponds are Bone Pond, Independent Lake, Dunn's Pond, Mud Pond, Lake Lorain, and Orson Pond.

The East and West Branches of the Lackawanna River flow together at Stillwater Dam, a flood control impoundment constructed by the U.S. Army Corps of Engineers in 1960, located one mile south of Union Dale along PA Route 171. After flowing through Stillwater Dam and Old Stillwater Lake, a water supply reservoir, the river flows through Stillwater Cliffs, the Lackawanna Water Gap, and begins its 39 mile course through the Lackawanna Valley to the LSCA.

The Lackawanna Valley is the northern-most portion of the Appalachian Ridge and Valley Province. It also forms the northern half of the Lackawanna/Wyoming Syncline, a large geo-synclinal fold in the Allegheny Front Range, which doubles back on itself to form the east and west rims of the synclinal valley.

The LSCA occurs at the midpoint in the 75 mile long Lackawanna/Wyoming Valley. The Susquehanna River enters the valley through a water gap marked by a cut in the western rim of the syncline. The cut creates an escarpment known as Campbell's Ledge, which is located 0.75 miles north of the LSCA.

Roaring Brook, the Lackawanna's largest tributary, rises on the Pocono Plateau along the Lackawanna and Wayne county boarder immediately west of the headwaters of the Lehigh River. Roaring Brook flows west through Cobb's Gap in the Moosic Mountains. Stafford Meadow Brook and Spring Brook also rise on the Pocono Plateau and flow west through the Moosic Mountains into the Lackawanna Valley. The balance of Lackawanna's tributary streams rise in spring seeps and wetland bogs along the flanks of the West and Moosic Mountains.

The perennial base flow of the Lackawanna River is relative to hydro-geologic interactions, soil conditions, and the climatic precipitation cycles in the northern Appalachian region. The glaciated features such as the swamps, bogs, ponds, and lakes at the headwaters of the river and tributary streams serve as reservoirs interrelated to regional groundwater flows. The geological conditions and soils of the Lackawanna watershed influence the quality of groundwater as well as its quantity.

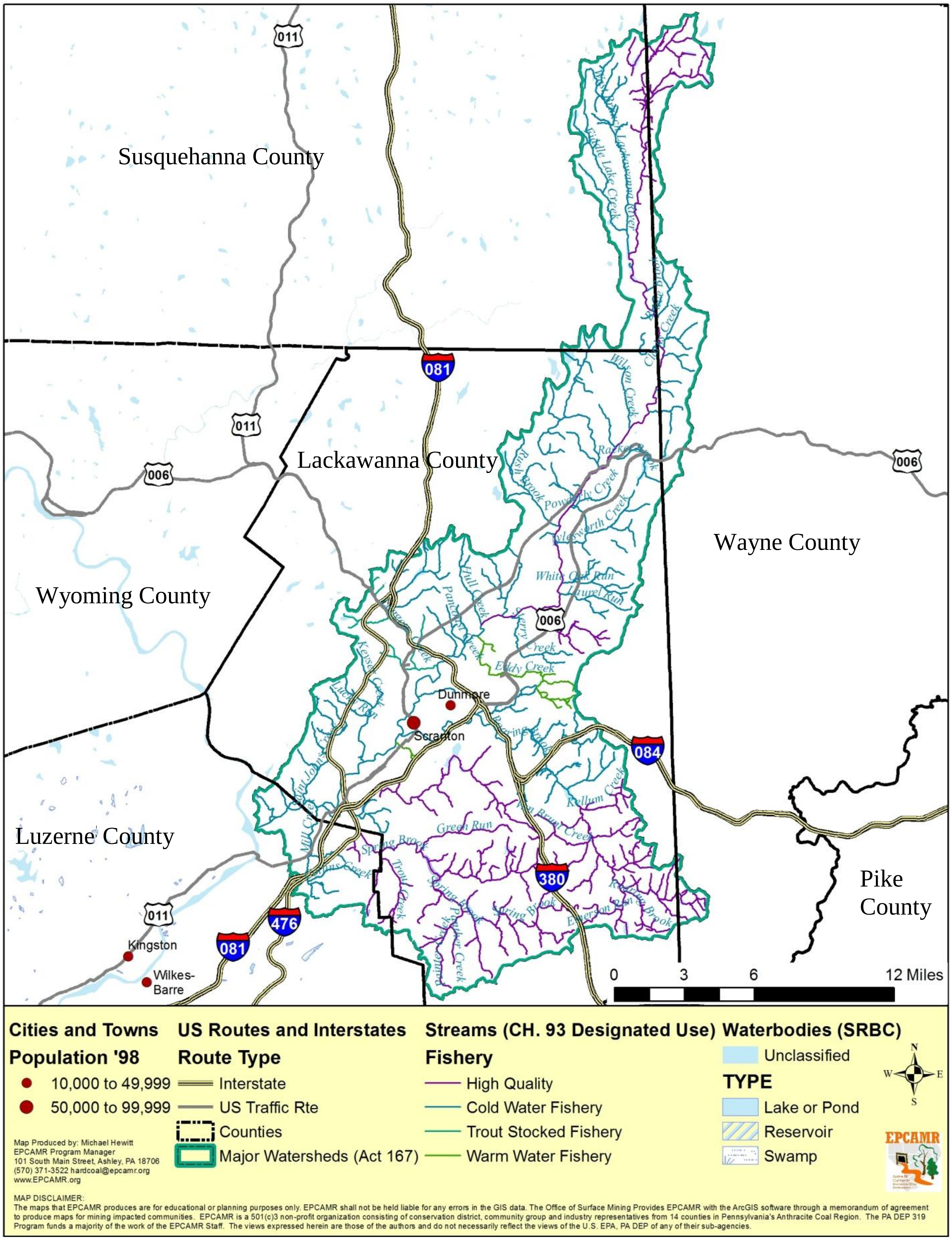

Figure 2-1 Lackawanna Watershed Map and Chapter 93 Designated Uses of Streams.

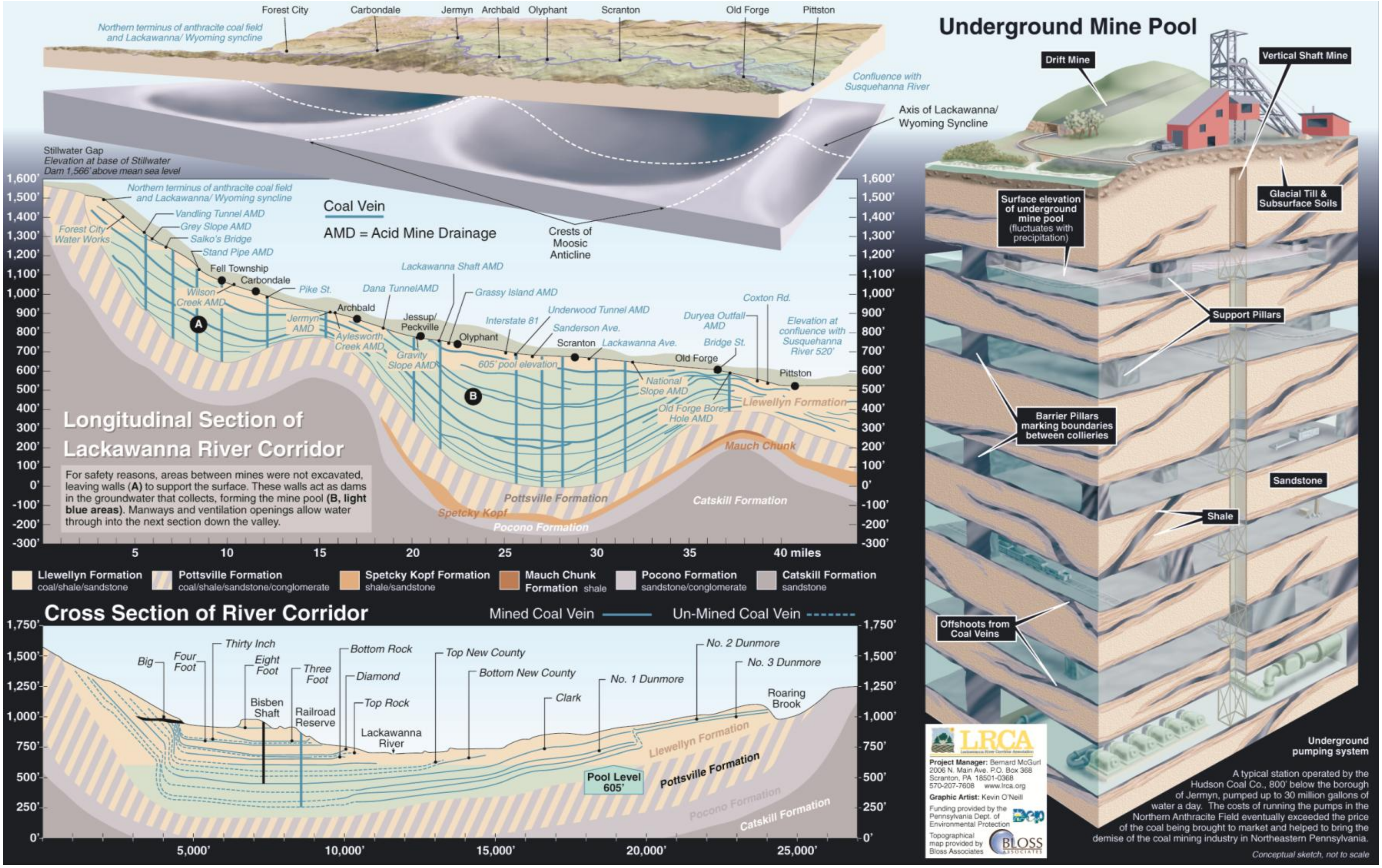

Figure 2-2 A 3-D Model of the Lackawanna River Valley.

Much of the river's flow from the glacial wetlands and ponds is recharged from groundwater stored in deposits of glacial till (boulders, cobble stones, sand, and gravel deposits) and in faults and fissures in sandstone and shale strata. The groundwater is recharged by percolation of rain and snowfall from rocky less permeable soils in upland areas along the Moosic and West Mountains and along the Allegheny/Pocono Plateaus.

Groundwater flows along the river and lower reaches of many tributary streams are also impacted by the manmade conditions of the flooded subterranean abandoned mine network which underlies the Lackawanna and Wyoming Valley's. In addition, large quantities of mine refuse, overburden piles, and stripping pits form significant surface features in the valley that impact groundwater quality and quantity.

The periodic glaciations that occurred during the past 500,000 years have influenced the surface hydrologic conditions and some of the stream flow patterns of the Lackawanna Valley. The presence of anthracite coal along the main portion of the Lackawanna Watershed is a much older legacy, dating back 300 million years in geologic time to the Paleozoic era. Continental drift and plate tectonics created a repetitive pattern of mountain building, rising, and lowering of seabeds and the emergence and disappearance of vast Everglade-like swamps.

The vegetation of these swamps built up layers of decaying organic material or peat, which were successively covered with sediments as oceans rose to submerge the swamp. After 150 to 200 million years of this repetitive process, the area of Northeast Pennsylvania was subject to tectonic plate movements, which created the Appalachian Mountains. The mountain orogeny caused tremendous physical pressures on the coal deposits of Northeast Pennsylvania driving out volatile organic compounds and increasing the carbonization of the coals. This resulted in the creation of anthracite, the hardest of all coals.

The mountain orogeny also created the unique landform of the Lackawanna Syncline, which dominates the watersheds topography. The mountain building resulted in the uplifting of the Allegheny Plateau and the folding of the Ridge and Valley Province. The Lackawanna syncline forms the LWV. While the valleys have separate names, they are actually the southern (Wyoming) and northern (Lackawanna) portions of the syncline. The syncline is formed of concave folded rock strata similar in some ways to the bottom or trough portion of a wave. The crest portions of the wave known as anticlines have eroded away from the ridgelines on the east and west of the valley (Figure 2-2).

There is an anticline feature that lies under the base of the syncline and perpendicular to its axis. Known as the Moosic Anticline, it is evident by its crest of sandstone rocks visible in the riverbed at Old Forge and at Campbell's Ledge on the ridgeline above the LSCA. This feature, roughly along the Lackawanna-Luzerne County border, also serves to divide the valley into its two parts.

The anthracite coals are contained in the Llewellyn Formation, which consists of alternate layers of sedimentary rocks (sandstone and shale) and the metamorphic anthracite coal. The Llewellyn Formation is underlain by the Pottsville, Mauch Chunk, Pocono, and Catskill Formations. The Pottsville contains coal, shale, sandstone, and conglomerate. The Mauch Chunk is characterized by reddish sandstones and shales. The Pocono Formation is composed of very dense sandstones and conglomerates. The Pocono Formation outcrops along the ridge tops of the Moosic and West Mountains and is underlain with Catskill sandstones and shale. The Catskill Formation predominates on the outer perimeter of the watershed to the Pocono Plateau in the east and the Endless Mountains/Allegheny Plateau to the north and west (Figure 2-3).

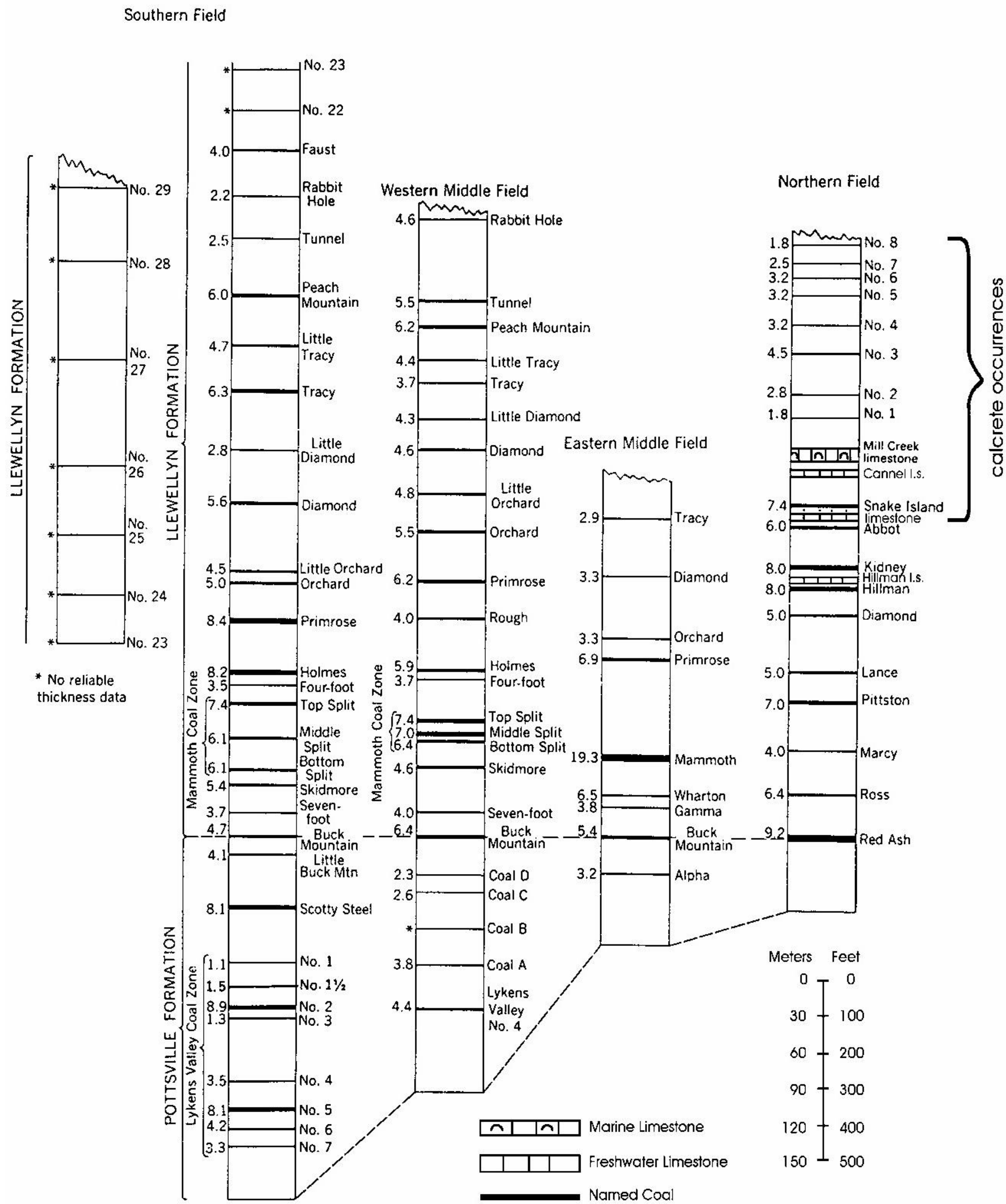

Figure 2-3 Generalized columnar sections showing names, average thickness of coals (in ft), and intervals between beds in the Pennsylvania Anthracite fields from Wood et al. (1986). Calcareous zones have been supplemented by data from Edmunds et al. (1999) and Inners and Fabiny (1997).

The following soils and associations are listed in the USDA soils survey for the Lower Lackawanna River Watershed (Figure 2-4).

- Ag Alluvial land (hydric soil)
- ArC Arnot very channery silt loam, very rocky, 3% to 15% slopes
- AsD Arnot-Rock outcrop complex, 8% to 25% slopes
- ASE Arnot_Rock outcrop complex, steep
- BrB Braceville gravelly loam, 3% to 8% slopes (hydric soils)
- CF Cut and fill land
- ChB Chenango gravelly loam, 3 & to 8% slope
- ChC Chenango gravelly loam, 8% to 15% slopes
- Da Dumps, mine
- Ho Holly silt loam (hydric soil)
- Ln Linden soils (hydric soils)
- Mg Mine dump
- Mh Mine dump, burned
- OXF Oquaga and Lordstown extremely stony silt loams steep
- Pp Pope soils, rarely flooded (hydric soil)
- Ps Pope soils (hydric soils)
- Sm Strip mine
- UA Udorthents, strip mine
- Ub Urban land
- Uf Urban land, rarely flooded
- Ur Urban land
- Us Urban land occasionally flooded (hydric soil)
- VoC Volusia channery silt loam, 3 % to 8% slopes (hydric soil)
- W Water
- WrB Wurtsboro channery loam 3% to 8% slopes (hydric soil)
- WrC Wurtsboro channery loam 3% to 15% slopes (hydric soil)
- WrD Wurtsboro channery loam 15 % to 25% slopes (hydric soil)
- WyA Wyoming gravelly sandy loam 0% to 3 % slopes
- WyB Wyoming gravelly sandy loam 3% to 8 % slopes
- WyC Wyoming gravelly sandy loam 8% to 15 % slopes
- WyD Wyoming gravelly sandy loam 15% to 25 % slopes
- WyE Wyoming gravelly sandy loam 25% to 45 % slopes
- WyF Wyoming gravelly sandy loam 45% to 60 % slopes

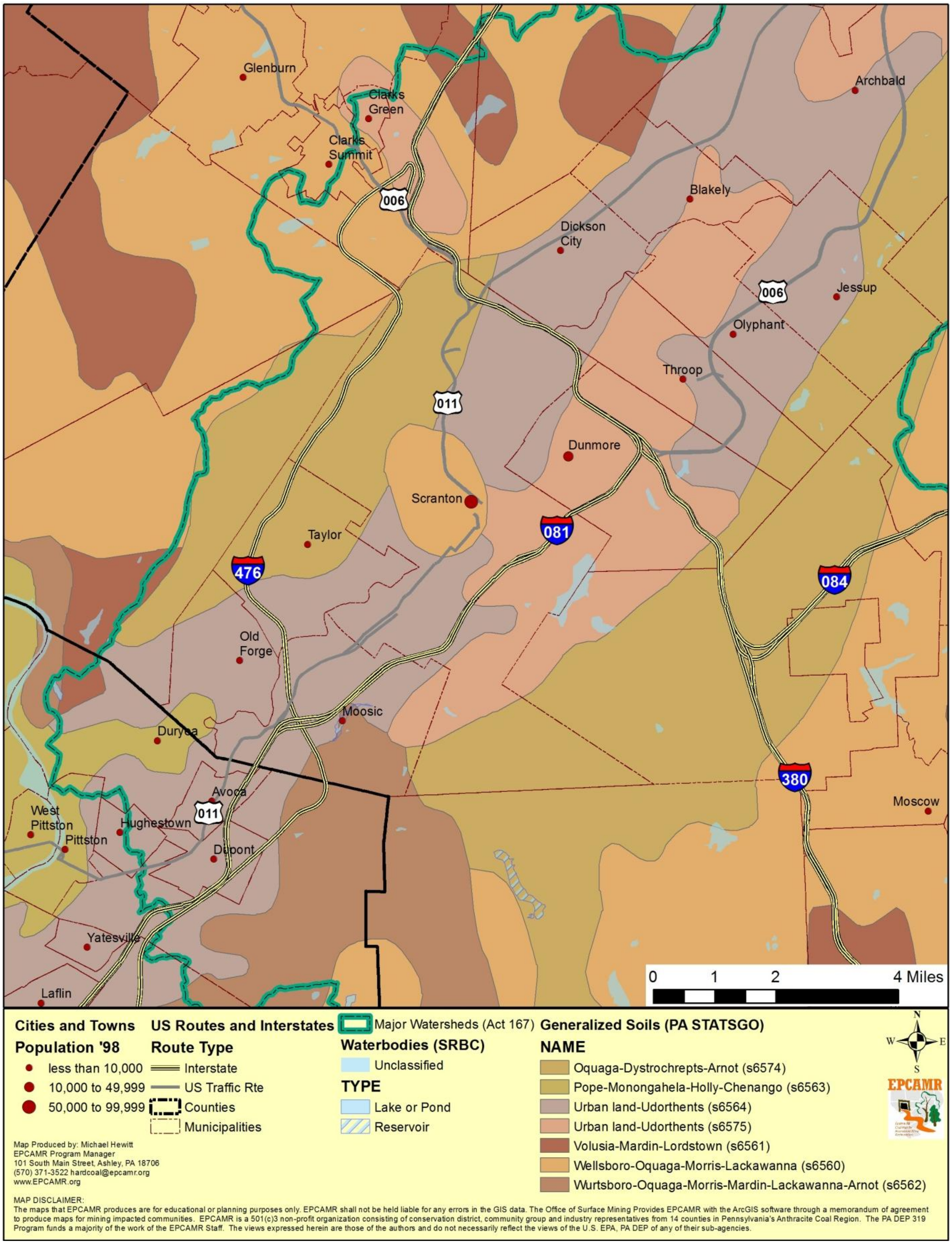

Figure 2-4 Generalized Soils for the Lower Lackawanna Valley

Water gaps form some significant visual and topographic features and act as gateways to the valley. Some of the water gaps are:

- The Lackawanna Water Gap at Stillwater Cliffs north of Forest City is the point of entry of the upper Lackawanna River into the synclinal portion of the watershed.
- Cobb's Gap in the Moosic Mountain allows passage of Roaring Brook from its headwaters on the Pocono Plateau to its confluence with the Lackawanna River in Scranton.
- The Notch or Leggett's Gap allows passage of Leggett's Creek through the West Mountain to its confluence with the Lackawanna River in North Scranton.

Campbell's Ledge or the Susquehanna Water Gap allows the passage of the North Branch Susquehanna River into the syncline Wyoming Valley just upstream of the LSCA. The geologic boundary of the Llewellyn and Pocono/Pottsville Formations runs roughly at about 1500 feet in elevation along the east and west flanks of the valley. Many of the Lackawanna tributary streams have created waterfalls, serpentine rock cuts, and ravines at these geologic intersections. Some better known waterfall sites are Nay Aug Falls and Gorge on Roaring Brook in Scranton, Fallbrook in Carbondale, Panthers Bluff in Simpson, and Blakely Falls on Hull Creek.

2.2 Flora and Fauna

The Lackawanna watershed supports a diverse temperate mixed forest with a variety of habitats influenced by location, elevation, soils, and human impacts. The watershed provides opportunities for both northern and southern forest communities. The forest is in a secondary succession as virtually all of the native forest was cut for lumber during the 19th Century.

The forest communities transition from southern with mixed oak (chestnut) to northern with maple, ash and hickory. Some representatives of arctic and boreal communities are also present due to elevation and soils.

Appalachian heath barrens along the Moosic and West Mountains are influenced by shallow soils and wind exposure. Scrub oak and pitch pine communities thin out to acidic rocky summit communities hosting sedges and lichens. Wetlands in the Roaring Brook and Spring Brook watersheds and in the headwaters of the Lackawanna provide habitat for some boreal forest trees such as tamarack, black spruce, and paper birch. The wetlands also contain some bogs with a variety of plants such as pitcher plant, lady's slipper, leather leaf, rhododendron, huckleberry, and mountain laurel.

The watershed habitat supports a variety of game and non-game aquatic, terrestrial, and avian fauna. Common mammals are whitetail deer, black bear, raccoon, fox, mink, beaver, and muskrat. There have been several reported sightings of river otter in the Lackawanna.

The river corridor provides habitat for numerous waterfowl with mallard, black, and wood ducks being the most commonly sighted ducks. Great blue heron, green backed heron, and belted kingfisher are regularly seen. Osprey, barred owl, red-tail hawk, coopers hawk, and sharp-shinned hawk are also found in the watershed. The American Bald Eagle has been reintroduced into the Susquehanna and Delaware Watersheds and there are numerous sittings of Bald Eagle along the Lackawanna. The Lackawanna watershed is part of the Atlantic Flyway and hosts numerous migratory species with the river corridor and wetlands being important to water fowl migrations, while the ridgelines of the West and Moosic Mountains are important migration corridors for both raptors and neo-tropical migratory songbirds.

The fishery of the Lackawanna provides a classic habitat for trout. The Lackawanna was noted historically as a fishery for brook trout. The river and its fishery habitat were nearly completely destroyed by 150-years of anthracite mining. During the past thirty years, the river has recovered in areas and the brook trout have reestablished. The native brook trout, common to the river and many of its tributaries, have been displaced in areas by the introduced brown trout. Brown trout are now the dominant indicator species in the main stem of the Lackawanna as well as the East and West Branches and the larger tributary streams.

The Pennsylvania Fish and Boat Commission (PFBC) classifies a 16-mile reach of the Lackawanna from Fallbrook in Carbondale to Green Ridge Street in Scranton as a Class “A” fishery for trout (Figure 2-5). This classification is based on a fishery study in 1992, and a follow up study conducted in 2010, which noted a reproducing population of brown trout and brook trout in the 16-mile reach.

According to the fishery study the river begins a transition from a predominantly coldwater fishery to a warm water fishery at the border between the Boroughs of Throop, Dickson City, and the City of Scranton, at around River Mile (RM) 15 where Interstate 81 crosses the Lackawanna.

Other fish common in the Lackawanna include a variety of darters and dace, smallmouth bass, sunfish, crappies, carp and suckers. The Lackawanna watershed also provides habitat for a variety of amphibians such as spotted salamanders and green frogs. Common reptiles are rattlesnake and snapping turtle.

Several studies, including two conducted by the LRCA, have shown that the fishery and aquatic habitat become completely degraded in the lower three miles between OFB and the LSCA. Fe loading and disposition from the OFB’s ~60.7 MGD mine drainage flow are largely responsible for the loss of fishery, aquatic habitat, and water quality in the Lower Lackawanna.

A *Natural Areas Inventory of Lackawanna County* was completed by the Nature Conservancy’s Pennsylvania Science Office in 1997. Luzerne and Lackawanna Counties completed a Bi County Open Space Conservation and Recreation Plan in 2005 to develop management programs involving property owners and public and private conservation agencies dealing with the long-term protection of natural habitat and open space lands.

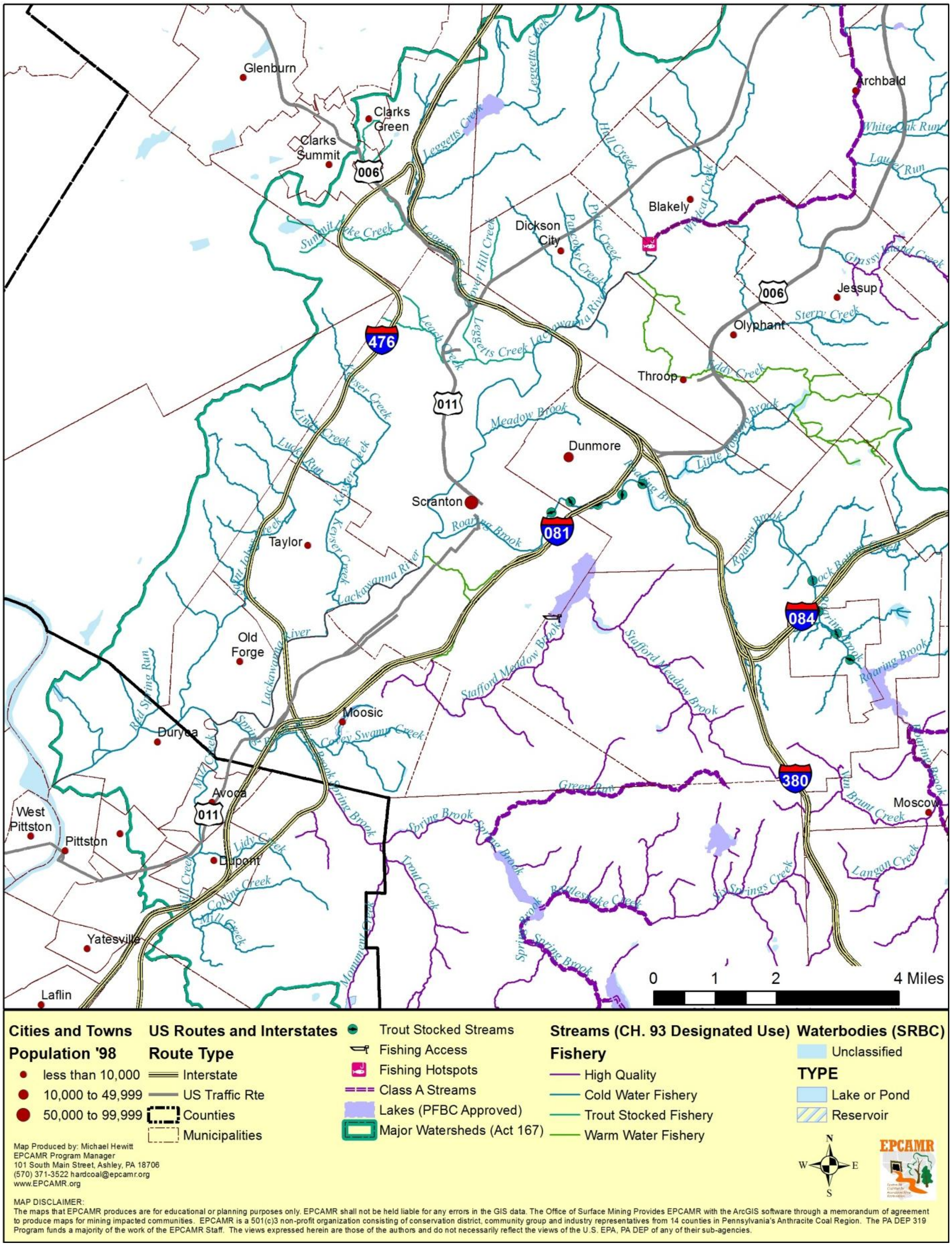

Figure 2-5 PA FBC Class A Trout Fisheries, Trout Stocked Streams and Fishing Access/Hotspots.

2.3 Socio-Economic and Cultural History

The Frances Dorrance Chapter of the Pennsylvania Society of Archeology has documented the earliest human evidence in the Lackawanna Watershed. A dig site at the LSCA has produced artifacts from the pre-contact Woodlands Period 800 to 1400 A.D. to the Archaic 9000 B.C. Period. There have been other documented discoveries along the ridgelines of the valley at sites known as rock shelters. Due to the development of towns and mining sites along the floor of the Lackawanna Valley, the integrity of most of the built-up area for archeological value has been destroyed. Horace Hollister in his 1857 *History of the Lackawanna Valley* relates the discovery and despoliation of Lenape gravesites in the vicinity of the Tripp Homestead in Scranton.

The historic record also contains the heritage of Native American paths and trails. The Susquehanna Warrior Path followed the Susquehanna from the Chesapeake to the Finger Lakes Region. The Lackawanna Path and the Oquaqa Path were a short-cut up the valley to the Lake Otsego headwaters of the Susquehanna at present day Cooperstown, New York.

The region was settled by people from Connecticut and the Philadelphia region between the 1760's and 1780's. These groups fought skirmishes with one another and with Lenape and Iroquois groups during the period. The conflicts known as the Yankee - Pennamite Wars were resolved by 1787 and Connecticut relinquished its claims. The settlers were given land title under Pennsylvania law and Luzerne County was founded.

An important battle, known as the Wyoming Massacre, occurred in the valley during the American Revolution. In July 1777 a war party of approximately 800 Loyalist Tories and 1200 Iroquois moved down river from New York, besieged, and sacked the Wyoming Valley farms and settlements at Wilkes-Barre, Forty Fort, and Pittston.

The Continental Congress commissioned John Sullivan to conduct a punitive campaign the following year. After successive battles, Sullivan's Army defeated the Iroquois as a fighting force and laid waste to their villages and crops. The removal of the Iroquois as a political-military presence on the Pennsylvania-New York frontier was a strategic victory in the nation's war of independence.

Following the Revolutionary War, the region developed primarily with an agricultural economy. Economic development was hindered by the difficulties of transportation through the mountains between the valley and coastal settlements. The presence of anthracite coal began to attract the attention of capitalist entrepreneurs after the War of 1812. By the 1820's, anthracite coal was recognized as both an industrial and domestic fuel, more economical and practical in its uses than wood or charcoals.

The area's rivers became avenues of commerce as coal was shipped down the Lackawanna and Susquehanna or taken in ox carts to the Lackawaxen, Lehigh, and Delaware Rivers. The Commonwealth of PA operated a canal system along the Susquehanna River during the 19th century. The LSCA was an important junction on that canal system. The Lackawanna River was impounded near the present day location of the Luzerne-Lackawanna county boundary as a source of water for the Wyoming division of the Canal. A boat basin was located in Duryea where the Duryea Breach is presently located. A section of canal prism is found nearby along the Lackawanna just downstream of the Duryea flood levee.

The Scranton Brothers and other investors developed the Delaware, Lackawanna, and Western Railroad (DL&W) in 1852. The DL&W provided an alternative means of transportation, which further accelerated the valley's development. Later the Pennsylvania Coal Company developed a Gravity Rail Road connecting to the D&H Canal at Hawley and the Susquehanna Canal at Pittston. The Lehigh Valley Railroad traversed the Penobscot Mountain to establish the rail yard at Coxton as the upper division of the Susquehanna Canal was abandoned after the Civil War.

The Erie Railroad had several routes into the Lackawanna Valley. The New York, Ontario and Western Railway was the last railroad to develop a route into the Lackawanna Valley in 1890.

The demand for anthracite coal as a primary fuel accelerated as America underwent the industrial revolution in the mid-19th Century. Coal mining activities increased at a feverish pace in the watershed. Coal, iron, and rail industries were intertwined along the valley even as they competed for markets. The impacts of the infrastructure and coal mining process caused a tremendous amount of ecological, geological, and hydrological damage to the watershed. This damage expanded with the advent of strip mining and wet process coal preparation in the early to mid-20th Century.

The production of anthracite coal peaked in 1917 at more than 100 million tons. The human population of the region, which had grown exponentially with large European migration in the 19th Century, peaked in the 1930's. The combined populations of Luzerne and Lackawanna Counties at the 1930 Census was 755,506. The human population of the Lackawanna Valley evolved into a diverse spectrum of ethnic, cultural, and religious groups. English, Welsh, Irish, and German were the predominant early migration groups with Southern and Eastern European groups arriving in large numbers between the 1880's and 1920's.

The conflicts between industrialists and the working classes in the anthracite region contributed to the evolution of the American Labor Movement. These conflicts helped to institutionalize and legitimize collective bargaining agreements. By the 1920's, through numerous strikes in the previous fifty years, regional coal and rail workers had finally achieved a reasonable standard of living.

The Great Depression of 1929-1940 had a profound effect on the regional economy. The market for anthracite coal began to diminish along with employment in the mining and rail industries. Strip mining became a more common practice as underground mining became more expensive to conduct. Social dislocations became endemic as workers left the region for better and safer employment opportunities with manufacturing industries in nearby states. The out-migration increased during and after World War II and remained evident into the 2000 Census. By the 2010 Census, the population of Lackawanna and Luzerne counties stabilized at 535,355 and showed a very slight rise.

The fuel dependence of the US shifted away from coal to oil and natural gas after World War II. By 1957, the costs of mining exceeded the price per ton of underground-mined anthracite coal.

In 1959, the tragic Knox Mine Disaster occurred at Pittston when the Susquehanna River broke into the underground workings and flooded all deep mines in the Wyoming Valley.

On November 1, 1960, the Hudson, Moffat, and Glen Alden operations ceased underground pumping in the Lackawanna Basin.

The mine voids flooded creating the MSMP between Old Forge and Archbald; the Central and No. 9 Pools in the Duryea, Avoca, Dupont area; the Jermyn Pool in the Carbondale area; and the Hillside and Klondike Pools in the Forest City Area.

On November 1, 1966, the Continental Mine at the base of West Mountain was closed, ending all underground mining in the Lackawanna Valley. This mine is now open as the Lackawanna Coal Mine Tour at McDade Park, operated by Lackawanna County.

Marginal coal strip mining and culm bank reclamation projects have occurred from time to time since the 1960's. Numerous PA DEP BAMR projects were completed based in part on the Scarlift program of 1970.

The communities in the LWV engendered their own recovery from the Anthracite Industry. Local chambers of commerce, business and local governments have cooperated to create an economic diversity of manufacturing, logistical, and high tech industries. This economic growth has expanded at the beginning of the 21st Century with a larger role for the information industry and institutions of higher education. The recent economic marketing initiatives promote the area's communications and technological infrastructure and quality of life issues such as small town values, open space-natural areas, and recreational opportunities as a foundation for smart economic growth.

While working to recover from the demise of the Anthracite Industry, the City of Wilkes-Barre and the entire Wyoming Valley experienced a cataclysm in June 1972 with the then record Hurricane Agnes Flood. Following a flood recovery period of several years in the 1970's, the Wyoming Valley moved apace with the Lackawanna Valley in continuing to seek new development opportunities. The development of the tourism industry and agencies such as the Lackawanna Heritage Valley Authority and community groups like the LRCA, The Wyoming Valley Wellness Coalition, rails-to-trails groups, and land conservancies have all highlighted our communities' interdependence and the connections we have with our local environment.

Luzerne and Lackawanna Counties have continued to collaborate, most recently in completing a joint comprehensive plan. This plan emphasizes the importance of mine reclamation work to restore land and water resources in the LWV. These lands could then be available for new uses contributing to the economic advancement of the region. The plan also suggests a long-term transportation improvement program focused on renewal of transportation infrastructure in the developed core of the LWV.

The LSCA, in the heart of the Scranton/Wilkes-Barre/Hazleton Metropolitan Area, is well positioned for economic growth in the near term relative to the growth of the Marcellus Shale Gas Industry in adjacent portions of the Northeast Pennsylvania.

3 Review of Previous Studies and Plans

3.1 Dodge Report - 1904

At the beginning of the 20^{th} Century, the social, cultural, economic, and environmental effects of the industrial revolution on the population and landscapes of America had become evident. In PA, the coal and steel industry had hollowed out mountains and befouled rivers with increasing rapaciousness. Following the Avondale Mine Disaster of 1869, which took 110 lives in Plymouth, the PA General Assembly enacted a Mine Safety Inspection Program. The annual reports of the PA mine inspectors, published by the Commonwealth, illustrate a wide range of assessments related to accidents and their human and physical effects.

By 1900, the Progressive Movement across America began to take a second look at what industrial activities were doing to our communities, their residents, and environments. One manifestation of this effort was the commissioning by the Commonwealth of an engineering assessment on the impacts of mine drainage and coal processing operations in the NAF. This work was conducted by F. M. Dodge. He issued a report in 1904 that described the scope of the problems as they affected the Lackawanna and Susquehanna Rivers. This was the first comprehensive report on the problem in what would become a long line of reports every 10 or 15 years through the 20^{th} century.

3.2 Ash Reports – 1950s

In the 1940's and 1950's the U.S. Bureau of Mines conducted a series of seminal studies of the anthracite regional mines and drainage led by S. H. Ash. This work was published as Bureau of Mines Bulletins #517 & #518. Additional related work was published in various Report of Investigations, Technical Reports, and Circulars.

The catalyst for this work was the public policy importance of the economic and national security aspects of the anthracite industry. By 1940, the extensive effects of mining and the impacts of the financial and engineering challenges of managing mine drainage were causing concerns that long-term pumping costs or a set of mining accidents could combine to hasten the demise of anthracite as a critical energy source in the northeastern US.

A huge public works project, "The Conowingo Tunnel Project", was proposed to solve the anthracite drainage problem. A ~200 mile long underground tunnel, twelve feet in diameter, was proposed to run from the east bank of the Susquehanna River below the Conowingo Dam in a north–northeast bearing to drain all of the anthracite mine fields from Dauphin northward through Lackawanna County. This project was unable to achieve a policy consensus before the end of underground mining came to the Anthracite Region.

The "Ash Reports" and associated work provide a valuable perspective on the eventual failure of the anthracite industry. This failure eventually occurred with an economic intersection in 1957 when the overall costs of mine drainage pumping in the NAF exceeded the price per ton available at market. This was followed sadly by the criminally involved disaster at the Knox Mine in Pittston in January 1959.

3.3 Old Forge Borehole Installation – 1962

By 1960, one-by-one the major anthracite operators in the NAF closed down their underground operations. Glen Alden, Hudson, Pennsylvania, Penn Anthracite, and numerous smaller operators abandoned their pumping facilities. In the Lackawanna Basin, a "Tontine" arrangement for mine drainage pumping left Moffat Coal Company as the last man standing. Moffat notified the Commonwealth of PA that it was ceasing pumping operations in the basin on November 1, 1961.

During the winter of 1961-1962, the mine complex under the Lackawanna Valley filled with water and began to surcharge out just about any and every available opening, shaft, slope, borehole, or airshaft. When these outfalls were near the river or a tributary stream, the drainage generally did not cause much public concern. However, there was no single outfall of sufficient capacity or location to serve as a control point to alleviate the numerous drainage outlets that were causing property damage and threatening public safety.

Mine water discharged at higher elevations and flowed through neighboring properties and streets to reach nearby watercourses. In low-lying areas, the mine water raised the ground water table causing basement flooding and ponding in low-lying neighborhoods. A collapse of the Phoenix Shaft in Duryea led to the ground rupture and an upwelling of mine drainage that continues today as the Duryea Breach (DB).

In order to address public safety issues and stabilize the mine pool under the City of Scranton and the central Lackawanna Valley, the Commonwealth and federal mining engineers collaborated to propose, design, and build an outlet along the Lackawanna River in Old Forge now known as the OFB. This structure was designed by the Division of Flood Control of the Department of Forests and Waters for the Department of Mines and Mineral Industries. It was constructed between May and September 1962 by the Ezra Stipp Construction Company of Scranton. The 42 inch diameter borehole penetrates through 107 feet of sandstone in the crest of the Moosic Anticline into the Red Ash Vein of the Old Forge Colliery on the west bank of the Lackawanna River approximately 800 feet upstream of the Union Street Bridge. Design drawings of OFB can be found in Appendix A.

Following the cessation of underground mining and pumping in the northern field in 1961 and the initiation of gravity drainage at the OFB and DB, most mine drainage in the Lackawanna Basin became concentrated at these points and several smaller points including the Lackawanna Shaft, Gravity Slope, and Dana Tunnel in the upper end of the main Lackawanna Basin. This mine pool complex is the MSMP. The mines in the area of Carbondale form the Upper Lackawanna Mine Pool complex and discharge primarily at the Jermyn Outfall. There are several mine pools in the Simpson/Forest City area that discharge at the Vandling Outfall and several smaller discharges such as the Grey Slope and Klondike Outfalls (Figure 3-1).

3.4 Sanitary Water Board Butler Tunnel Study - 1967

The Sanitary Water Board of the Commonwealth of PA established an Advisory Committee on the *Abatement of Mine Drainage Pollution on the North Branch of the Susquehanna River* in the early 1960's. The work of this committee led to several feasibility studies during the 1960's to look at possible solutions and costs.

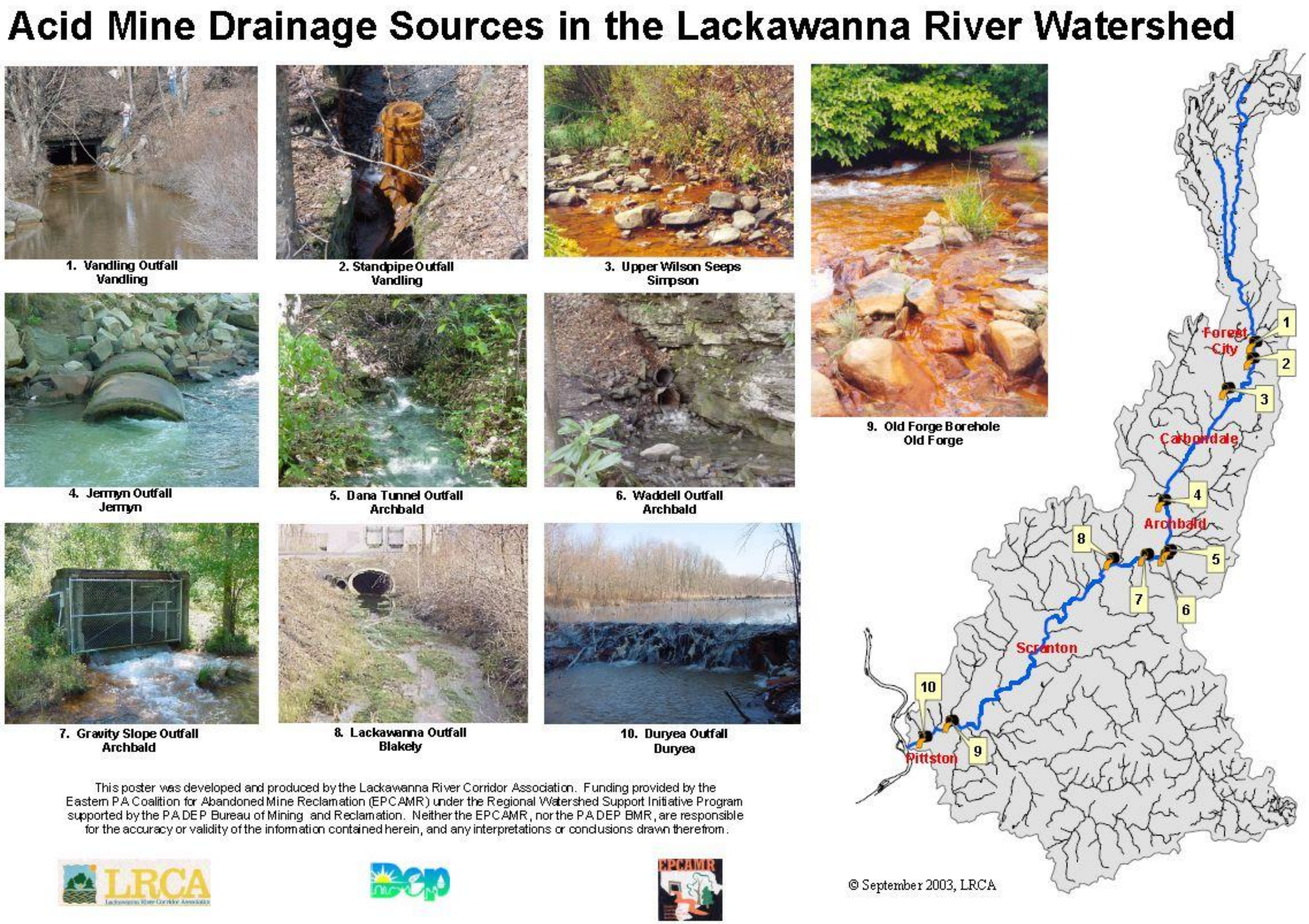

Figure 3-1 Map and pictures of the largest AMD outfalls in the Lackawanna River Watershed.

The PA Department of Health and Sanitary Water Board commissioned an engineering study by the firm Gannett Fleming in 1965. This study was to develop a feasibility assessment for a treatment plant that would treat the Butler Water Tunnel (BWT) Discharge entering the Susquehanna River at Pittston. BWT does not impact the Lackawanna River. This work was amended to include a plan to tap and treat the OFB and DB as well. This study was completed in 1967. It recommended that a large mine drainage treatment plant using an oxidation and neutralization process be constructed and placed in operation near the LSCA. There were numerous policy questions related to capitalization as well as long-term operation and management that the Gannett Fleming plan could not address. PA was in the process of adopting more stringent mining and reclamation laws. These laws did not provide a mechanism to address mine drainage treatment from abandoned mines. Without a clear mechanism to fund construction and guarantee long-term operation, there was no support to build such a treatment plant.

3.5 United States Geologic Service Studies – 1960's

The United States Geologic Service (USGS) produced a number of field investigation reports beginning with a 1964 report on *Mine Waters in the Northern Anthracite Field* by Ivan Barnes, W.T. Stewart, and Donald W. Fisher. This report established a baseline on water chemistry that serves as a point of comparison to contemporary studies on the water quality of these waters.

3.6 PA DER Scarlift Reports - 1972 and 1978

By 1970, PA underwent a change in administration and a reorganization of several departments. The new Department of Environmental Resources (PA DER) combined the functions of the previous Departments of Forests and Waters, Mines and Mineral Industries, with some functions of the Department of Health and the Sanitary Water Board. On the federal level, the PA Clean Streams Act of 1937 served as a template for the Clean Water Act enacted by Congress in 1972. PA mine reclamation regulations likewise helped to inform the Surface Mine Control and Reclamation Act of 1977.

Also during the 1970's, PA DER initiated the Operation Scarlift Program to assess AMD and AML across PA. Scarlift produced two reports in the Lackawanna Basin conducted by Albert E. Peters & Company of Scranton. The Part One Report was published in 1972. It focused on the smaller perched pool outfalls in the Forest City to Simpson area of the Upper Lackawanna Basin.

Scarlift Report Part Two for the Lackawanna River was published in 1978. It was a comprehensive assessment of all of the larger outfalls that included Jermyn Tunnel, Dana Tunnel, Gravity Slope, Lackawanna Shaft, OFB, and DB. Several smaller outfalls were included as well. Water chemistry data was collected and assessed at all discharge points. The river and major named and unnamed tributary streams were assessed for infiltration points and losing reaches. Upland stripping areas were assessed and recommendations were made for regrading and drainage improvements.

This Scarlift Report continues to serve as a baseline for our ongoing work on the MSMP, OFB, and DB. The Scarlift recommendations for stream channelization's and stream channel sealing have been incorporated into numerous Commonwealth funded flood control projects over the past 30 years as well as several newer PA DEP BAMR stream projects that combined stream channel sealing using ethylene propylene diene monomer (EPDM) fabrics with natural stream morphology based restorations.

The final recommendation from Scarlift Part Two for the Lackawanna River did not include a treatment or abatement of mine drainage. It proposed a 24 mile long concrete culvertization of the Lackawanna River. This plan would intercept mine drainage in one concrete channel and convey river water in a parallel channel. At the LSCA, this plan suggested routing the mine water into a french drain to discharge it into the bed of the Susquehanna. There were no clear costs established for this proposal and, fortunately, it was never implemented. It would have placed the Lackawanna River into a concrete lined channel system, totally devoid of natural habitat and morphological value and very similar to that imposed on the Los Angeles River. This would have destroyed the real Lackawanna River and swept the issue of mine drainage "under the carpet" or rather under the bed of the Susquehanna.

3.7 Other USGS Studies – 1970s and 1980s

The Pennsylvania Geologic Survey published a *Report on Ground Water Resources of Lackawanna County* in 1975 that examined the mine drainage problems in the Lackawanna River. This report by Jerrald Hollowell and Harry Koester also includes a look back at historic mine drainage data from the 1940's for comparative purposes. It provides confirmation that there continued to be a decline in acidity and Fe loading from early data sets of OFB and DB.

During the 1980's the USGS revisited the Lackawanna with another Water Resources Investigative Report by D. Growitz, L. Reed and M. Beard. This work again confirmed a decrease in acidity and Fe and a rise in alkalinity and pH at OFB and DB.

3.8 Other PA DER Studies – 1970s and 1990s

PA DER Bureau of Water Quality conducted two investigations of the Lackawanna in 1979 and 1991. The 1991 report by E. Kupsky and S. Wills was focused on establishing parameters for metals management for NPDES permits in the Lackawanna Basin. It identified mine drainage both from the mine pool complexes and from surface runoff on coal waste piles as significant contributors to metals loading.

3.9 PAFBC Studies – 1970s and 1990s

PAFBC conducted fisheries habitat studies on the Lackawanna in 1975 (D.W. Daniels) and in 1991 (R. Moase and T. Copeland). These studies identified a decline in acidity and metals in the upper watershed, but persistent metals loading problem from OFB and DB and a continuing related degradation of water and habitat quality in the Lower Lackawanna River.

3.10 SRBC's Lackawanna River Priority Water Body Survey Report – 1989

SRBC published a *Lackawanna River Priority Water Body Survey Report and Water Quality Review* by C.P. McMorran (SRBC Publication 124, 1989). This work identified two AMD sources (OFB and DB) and three sewer plants as primary contributors to water quality degradation to the Lackawanna River.

3.11 Lackawanna River Plan – 1989

Local residents organized the LRCA with a mission to conserve and restore the Lackawanna River in 1987. The LRCA developed a Citizens Master Plan for the Lackawanna River in 1989 that identified AMD as a major issue to be addressed to advance the restoration.

3.12 Lackawanna Heritage Plan – 1991

A related plan for the Lackawanna Heritage Valley was developed by Lackawanna County and a Community Heritage Task Force in 1990. This plan also identified AMD and AML issues as problems that need to be addressed by local, state, and federal governments.

3.13 Lackawanna River Greenway Plan - 1993

The LRCA collaborated with the United States Army Corps of Engineers to produce a *Reconnaissance Report for the Lackawanna River Corridor Greenway* in 1993. This report identified a direct Federal interest in the Lackawanna River AMD problems.

3.14 National Oceanic and Atmospheric Administration Study - 1995

LRCA collaborated with the University of Scranton on a research project to characterize pollution sources and impacts in an upper Chesapeake Bay watershed funded by the National Oceanic and Atmospheric Administration in 1995. Among other findings, this report identified excessive Fe precipitation and low dissolved oxygen levels as degrading factors on macroinvertebrate and fisheries habitat in the Lower Lackawanna.

3.15 Lackawanna River Conservation Plan - 2001

LRCA conducted an assessment of the Lackawanna River between 1999 and 2001 to produce the Lackawanna River Watershed Conservation Plan. This plan identifies the cleanup of the OFB and DB and the development of a confluence resource management area as recommended outcomes.

3.16 Lackawanna River TMDL – 2005

The PA DEP Bureau of Water Quality conducted a TMDL assessment of the Lackawanna River and several of its tributary streams (C. DeLuca 2005). It established that the Lackawanna River was degraded primarily from AMD and AML. The TMDL found that Fe loading needs to be reduced by 92 percent at the mouth of the Lackawanna to meet water quality standards. This study also established TMDL reductions for manganese, aluminum, and pH to meet water quality standards in other sections of the Lackawanna River.

3.17 Susquehanna River Greenway and Conservation Landscapes - 2004

PA Department of Conservation and Natural Resources (DCNR) and the Susquehanna River Greenway Coalition developed a Susquehanna River Greenway Plan in 2004 that identified sites like the LSCA as having potential for recreation and heritage tourism.

3.18 SRBC Subbasin Year 2 Study – 2010

SRBC conducted a Middle Susquehanna Subbasin Year 2 Survey for the Lackawanna River (L. Steffy 2010) following a Year 1 study of the Middle Susquehanna (S. Buda, 2009). Both of these studies document the effects of AMD in the Lackawanna River.

3.19 Luzerne-Lackawanna Bi County Comp Plan – 2010

Luzerne and Lackawanna Counties completed and adopted a Joint Bi-County Comprehensive Plan in 2010. This plan identifies the remediation of AML and AMD issues as an important element in the economic redevelopment of the bi-county area. The plan also encourages "in-fill type" development in areas where urban infrastructure is already present. The LSCA, situated mid-way in the Scranton/Wilkes-Barre urban corridor, provides a strategic location to implement key tenants of the Bi-County Plan.

3.20 SRBC Anthracite Remediation Strategy – 2011

SRBC, in partnership with EPCAMR, published a Technical Report titled *Anthracite Region Mine Drainage Remediation Strategy* (T. Clark, 2011) that surveys the entire Anthracite Region and its AML and AMD impacts to the Susquehanna basin and tributary streams. This work ranked the 320 Susquehanna River Basin Anthracite Region Discharges and prioritized the 20 most impacted outfalls. It also investigates the proximity of discharges and potential treatability and established a strategic methodology suggesting a range of recommendations. The overall recommendation was the construction of 10 active treatment plants throughout the Anthracite Region. These 10 plants would treat 68 percent of the Fe loading, 72 percent of the manganese loading, 79 percent of the aluminum loading, and 60 percent of the acidity loading in the entire Susquehanna River Basin Anthracite Region.

In this study, OFB and DB emerges as the second and sixth highest priority AMD discharges in the Anthracite Region respectively. Their close proximity at only 1.7 miles between and their similar water chemistry and hydrogeological linkages, indicate that they are amenable to treatment at a single common facility. This was also suggested by the Gannet Fleming Study in 1967.

The Anthracite region strategy further documents that, taken together, Duryea and Old Forge are producing ~25 percent of the iron loadings entering the Susquehanna River via the anthracite fields.

3.21 EPCAMR Mine Water Resources of the Anthracite Coal Region – 2011

EPCAMR and a team of experts from PADEP, USGS, and OSM, completed a four year study of water quantity, quality, and potential usage from underground mines in the Anthracite Region. A majority of this study was funded by a Growing Greener grant from PADEP and a grant from FPW. The objective of this project was to determine the immediate and long-term availability (water quantity and water quality) of mine-water resources in the Western-Middle and Southern Anthracite Fields of Eastern Pennsylvania; however its methodologies and applications were carried forward to the Northern and Eastern-Middle Anthracite Coal Fields at the completion of the project in 2011.

The project involved the compilation, evaluation, and synthesis of data on the hydrogeology of flooded underground mines. Information maintained in paper files by State and Federal authorities was digitized and combined with other available data to develop a comprehensive geographic information system (GIS) database containing the locations, topographic elevations, water-level elevations, flow rates, and water quality in wells, boreholes, AMD sources, and associated stream reaches throughout the region. Additional data on the locations of coal outcrops, barrier pillars, and mine boundaries will be included in the GIS database. These data were evaluated to delineate horizontal and vertical boundaries and to estimate corresponding current flooded volumes for the major mine pools, also known as multi-colliery hydrogeological units (MCHU). The associated recharge area(s) and primary discharge points for each of the major mine pools were identified considering digital topographic, mine map, and aerial photography data.

3.22 PEC's North Branch Susquehanna River Conservation Plan – 2004

The Pennsylvania Environmental Council (PEC), Northeast Regional Office, and SRBC have prepared a Rivers Conservation Plan for a two-mile wide corridor along the North Branch of the Susquehanna River. The study corridor extends from Jenkins Township and Wyoming Borough in Luzerne County to the New York border and includes the Great Bend area in Susquehanna County. A significant portion of the scope of work includes identifying the visions, issues, and concerns of the local residents through a series of public participation activities that included public meetings, surveys, and steering committee meetings. Extensive GIS based maps have been prepared by SRBC detailing historic, cultural, and recreational sites, land use, population data, and hazardous waste sites.

Historic mining activities, combined sewer overflows, and industrial pollution have impacted the southern section of the study corridor; however, the steering committee recognized early on in the project that eco-tourism currently benefits the region and could be greatly enhanced. The study corridor and the surrounding region is historically significant and largely rural with many beautiful vistas, particularly of the Susquehanna River. Eco-tourism opportunities abound. The steering committee suggested multiple projects including study corridor wide projects and site-specific projects. The study corridor for this project is immensely rich with historic sites ranging in age from pre-historic to colonial to early Americana. A significant amount of effort was made by the steering committee to provide information on the historic sites within the study corridor. The steering committee believed that preserving and enhancing historical aspects of the communities would not only provide educational opportunities, but also bring economic opportunities to the region through the development of eco-tourism. Action plans were developed that highlighted projects within the LLR-WRAP project area.

3.23 PEC's Wyoming Valley (Susquehanna) River Conservation Plan – 2000

The project area encompasses a two-mile wide corridor (1 mile on each side of the river) from the southern border of the study area, approximately four miles south of the confluence of the Lackawanna River terminating at Exeter Borough on the west side of the river and Jenkins Township on the east side of the river. The northern terminus is the Susquehanna River to the Pennsylvania/ New York border and the section of the river known as the Great Bend area of Susquehanna County. The last section of the study corridor is from the confluence of the

Lackawanna River and Wyoming Borough is degraded from AMD, AMLs, and culm piles. A significant tributary to the Susquehanna River, the lower reach of the Lackawanna River is severely degraded by AMD, municipal and industrial point source discharges, and siltation from strip-mined areas (Rudisill, 1979). In turn, the biological community is stressed from Fe precipitate, siltation, and the effects of other mine drainage constituents.

Although only a short sub-reach of the Corridor extends into the Wyoming Valley, the Susquehanna River is the recipient of major pollution from AMD, treated and untreated sewage, urban runoff, and poor quality water from several tributaries in the area. The effect is a significant degradation of both the water quality and biological conditions as compared to the reach above the Wyoming Valley. Malione and others (1984) reported a moderate biological community that was an improvement when compared to the results found in the LuBuy (1967) study. The improvement is attributed to the institution of municipal and industrial waste treatment and the natural improvement of AMD.

Common themes presented throughout the corridor were the need for education, along with developing a balance between private landowners and public use, and the need for economic development along the river.

Noted in the Plan is a reference to the vitally important and culturally distinct, Lackawanna Heritage Valley, the state's first heritage park which centers on the coal mining history of the region. This heritage park also includes a section of the Susquehanna River along the Lackawanna-Luzerne County border.

An interesting response to a PEC survey question to municipalities who responded over a decade ago, was that if inter-governmental cooperation was necessary to implement the Rivers Conservation Plan, the majority of the survey respondents favored either informal relationships or the formation of a commission or authority. The creation of a state park near the river was the second highest choice for the question. Action plans were developed highlighting projects.

4 Non-Mining Pollution

4.1 Storm Water

This plan considers storm water management needs relative to the new requirements for MS4. Under the amended CWA, municipalities classified in an urban environment are now required by the Environmental Protection Agency (EPA) and PA DEP to apply for and secure a discharge permit through the National Pollution Discharge and Elimination System (NPDES) for all of the separate storm water collection conveyance systems within the physical bounds of their jurisdiction. This includes municipally and privately owned catch basins, culverts, inlets, pipes, swales, detention ponds and appurtenances. All of the municipalities within the NAF are classified as MS 4 municipalities.

Previously, the extent of storm water management requirements was contained in the Storm Water Management Plan for the Lackawanna River Watershed prepared by the Lackawanna County Regional Planning Commission in 1991 in compliance with Pennsylvania Act 67 for Storm Water Management. Its direction was to manage storm water quantatively. The new requirements for MS4 now incorporate progressive attention to the quality of the water discharged through municipal systems. The permits will increasingly require municipalities to take progressive and proactive measures to educate and involve their residents and business with practices and technologies that provide water quality benefits. The introduction of new installations referred to as green infrastructure and community-wide best management practices will be outcomes of the MS4 Program.

The AML reclamation and AMD restoration programs recommended in this plan will engender opportunities to include sustainable green infrastructure and facility best management practices involving all aspects of the built environment and restored habitat systems in and adjacent to the LSCA. This plan recommends that all entities engaged in the LSCA agree to integrate sustainable green infrastructure practice into their operations.

4.2 Flood Control

The LSCA experienced record flooding in September 2011 as Tropical Storm Lee inundated the Upper Susquehanna Basin with over eight inches of rainfall, less than two weeks after rains from the remnants of Hurricane Irene had saturated the watershed. The river crest from the Lee flood exceeded the previous storm of record, Hurricane Agnes of 1972, by upwards of eight inches (Figure 4-1).

The flood levees in the Wyoming Valley were taxed to their capacity, but held. Flooding affected areas above and below the area of levee protection. West Pittston, Duryea and the LSCA were flooded several feet above the Agnes level. In fact, Duryea itself, which had not been flooded by Agnes, was overcome by the induced flood crest of the Susquehanna running up the Lackawanna. The losses sustained by residents of West Pittston and Duryea are all the more difficult since the availability of state and federal disaster assistance is restricted due to the demands from so many recent natural disasters. Personal observation indicated a crest at Coxton Rail Yard six feet above the top of rail structure. Agnes had crested at the same location below this grade. The Lower Lackawanna Sewer Treatment Plant on Coxton Road was flooded up to eight feet and was placed out of commission for over a month afterwards.

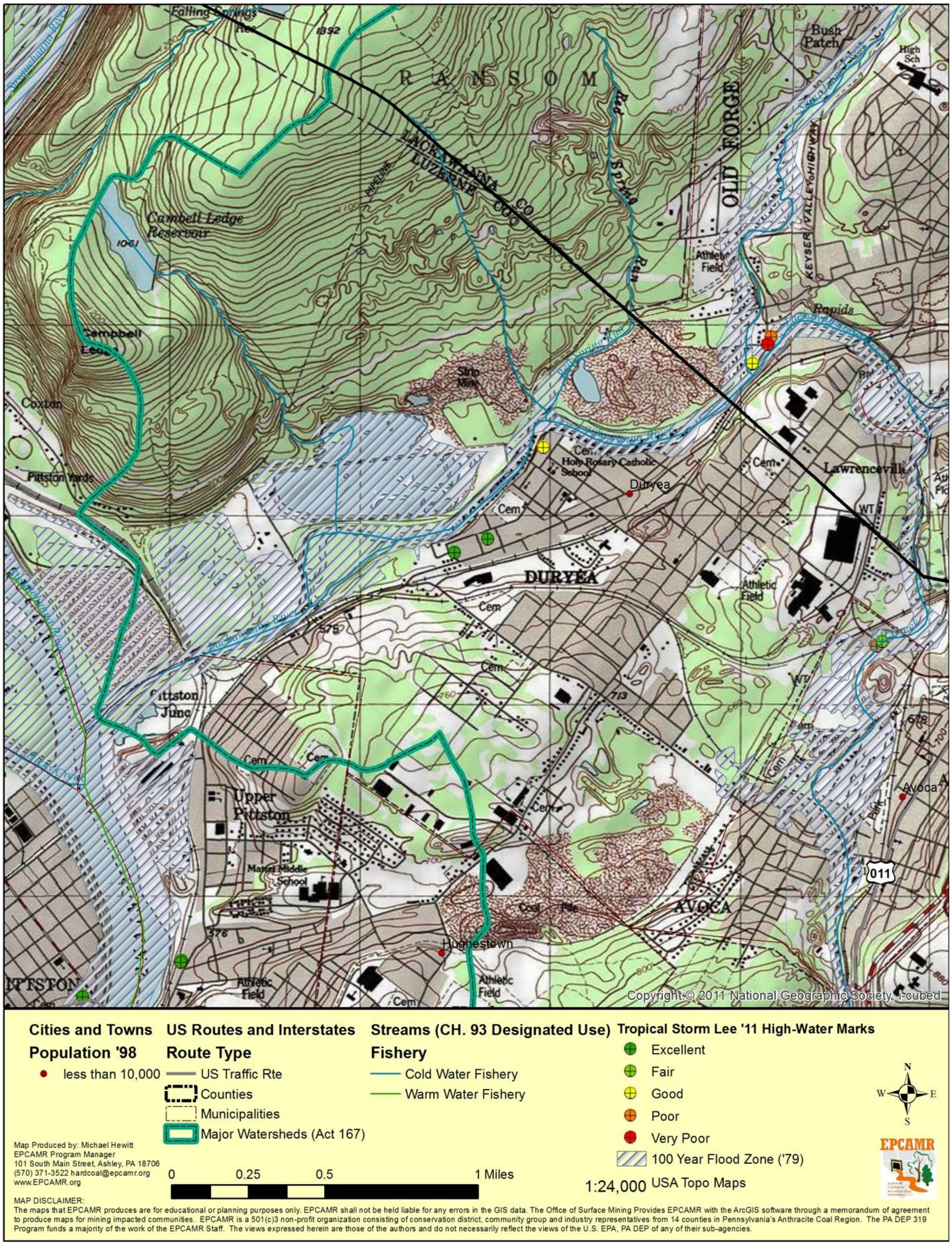

Figure 4-1 Tropical Storm Lee 2011 High-water Marks and 100 Year Flood Zones in LSCA.

This plan recognizes the importance of maintaining the natural flood plain functions in LSCA. The facilities recommended and suggested in this plan are located above the 500 year flood plain. Some portions of passive treatment wetlands may be within the 500 year flood plain. These wetlands and associated infrastructure will be designed with an understanding that flooding and flood damage restoration are to be anticipated in their operation and management.

This plan supports the policies of West Pittston and Duryea to install and upgrade flood control works in the developed portions of the communities. This plan also supports work to protect the Lower Lackawanna Sewer Plant from future flooding.

4.3 Sewage

The Lower Lackawanna Valley Sewer Authority (LLVSA) provides sewer collection and treatment service to all municipalities in the Lower Lackawanna Watershed Area. LLVSA operates an interceptor collection system and a treatment plant on Coxton Road in Duryea. The plant serves a 20 square mile area including Duryea, Taylor, Old Forge, Avoca, Dupont, Hughestown, and a portion of Pittston Township and Moosic (Figure 4-2). Service to Moosic is provided by an agreement with the Lackawanna River Basin Sewer Authority (LRBSA) through a bypass at the Moosic Sewer Plant that had been closed by LRBSA in 1997.

The LLVSA plant has a dry flow treatment capacity of 6 MGD and a wet weather capacity of 26 MGD. LLVSA is presently conducting an upgrade to its treatment works to meet Chesapeake Bay Program requirements for Biological Nutrient Reduction.

This plan recommends that the LLVSA treatment plant be retrofitted and protected from a flooding event the extent of Tropical Storm Lee. The location and footprint of the plant is such that it could be protected with a floodwall, levee system, and a pumping installation to insure that it can be kept operational should an event of that nature occur again.

The sewer collection system of the LLVSA consists of a main interceptor trunk line in and along the banks of the Lackawanna River from the treatment works at Coxton Road upstream to the vicinity of Keyser Creek in Taylor. Branch interceptor lines follow Saint John's Creek, Mill Creek and Keyser Creek. The LLVSA serves communities with historic Combined Storm and Sanitary Sewers (CSS). There are 26 active CSO points on the system. Recently, 14 other CSO points have been deactivated.

The LLVSA implements the nine minimum controls to maintain the CSO's and limit the number of CSO events. Several CSO points on the St John's Creek Line were eliminated and consolidated into an automated High Rate Treatment Unit in 2006 with funding from the Lackawanna Watershed 2000 Program. This unit provides only primary treatment: solids removal and disinfection. It discharges into a portion of St John's Creek where there is an excessive rate of infiltration into the mine pool. This reach of St. John's Creek runs dry quickly after the runoff from a rain or snow event dissipates.

The Tropical Storm Lee event demonstrated several other matters of concern with the LLVSA Collection System. As the treatment plant flooded, the entire collection system was surcharged and, as no outlets were available, sewer flows backed up municipal lines and inundated low lying residences that otherwise may have been spared flood damages. This plan suggests that the municipalities and LLVSA investigate the installation of storage culverts and automated back flow prevention valves at key points along the collection system. The potential use of the LRBSA Moosic Plant to store and possibly treat storm and flood flows from the Mill Creek interceptor should be considered as part of this work.

4.4 Water Supply

Public Water Supply in the Lower Lackawanna Watershed is provided by the Pennsylvania American Water Company (PAWC). This public utility operates a system of 36 reservoirs and 10 water filtration plants serving approximately 300,000 customers in Luzerne and Lackawanna Counties.

The water supply for the region had once been provided by the Pennsylvania Gas and Water Company (PG&W). This company sold 36 of its reservoirs and treatment plants to the PAWC in 1998. The re-named PG Energy, a gas utility, retained stock ownership of a subsidiary, the Theta Corporation, which held real estate title to the reservoirs and 54,000 acres of watershed lands. As part of the conditions allowing the sale of the PG&W water business to the PAWC, the Public Utility Commission ordered that a Land Use Management Plan be developed by PG Energy for the Theta owned lands. Some of the Theta lands, including some parcels around Falling Springs Reservoir, had previously been sold by PG&W/Theta to private parties. Other parcels were included in the land use plan. The plan recommended the use of these lands for forest management and low impact residential development.

Water supply in the Lower Lackawanna is provided from reservoirs on Spring Brook through the Nesbitt Water Filtration Plant. A water storage tank is located along Campbell's Ledge access road. Reservoirs at Campbell's Ledge and Falling Springs, located along the ridge top to the west of the confluence, now function as reserve reservoirs but are not owned by the PAWC (Figure 4-2). PG&W had installed a water intake on Scovell Island in the 1960's but never developed a filtration plant to allow use of the intake as public water supply. A Falling Springs water supply company has recently announced plans to provide water withdrawals to the shale gas industry.

This plan recommends that the reserve reservoirs and other former PG&W parcels continue to be maintained for reserve water supply and forestry management. Low impact residential development should only be allowed in the context of the Luzerne–Lackawanna Bi-County Open Space Conservation and Outdoor Recreation Plan, local municipal plans and ordinances.

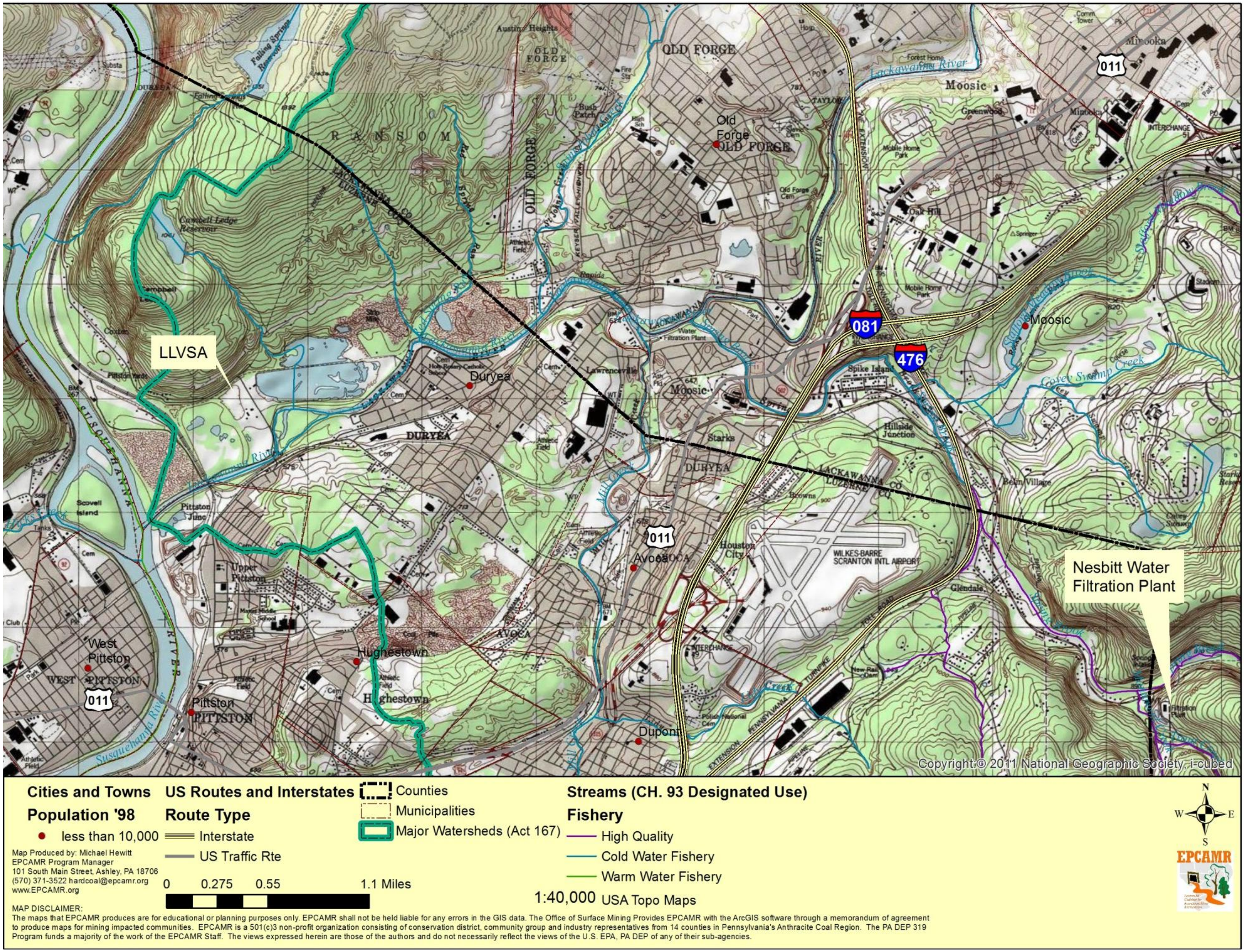

Figure 4-2 Sewer and Water Treatment Plants serving the LSCA

5 Mine Pools

5.1 Mine Pool Formation

The source of the hydrology for the mine pools in the Lackawanna is partially from natural groundwater flows ruptured by tunneling and mining work. The overwhelming source is surface infiltration from subsidence fractures communicating to the beds of the river and its tributary streams. Numerous tributaries lose flow entirely to the mine pool at certain points or over consecutive reaches. They exhibit dry beds most days except during and immediately after storm events. Other points of infiltration are diffuse throughout the watershed where natural topography and sub strata have been undermined and surface strip mined.

The Scarlift Report, the Bureau of Mines Bulletin Number 518, and the Lackawanna River Watershed Conservation Plan Appendix B (Mine Reclamation Plan), and Appendix C (River and Tributary Stream Report) all discuss the stream loss situation in detail. This plan recommends that the following streams and affected reaches of their tributaries be considered as part of the QHUP for the lower Lackawanna River (Figure 5-1).

- Eddy Creek loses all of its flow at one point adjacent to the Marshwood Road exit of US Route 6 in Throop. From the Marshwood Road exit to Underwood Road, the Eddy Creek channel has been totally obliterated by subsequent land development. From near Underwood Road to the Schoolside Subdivision, the creek flows with local storm water flows in a degraded remnant of its original channel. From Schoolside through South Valley Avenue to its confluence, Eddy Creek flows in a constructed channel installed by PA DEP BAMR. Eddy Creek is the largest single point source of infiltration into the MSMP. This plan recommends the restoration of Eddy Creek as a High Priority.

- St John's Creek and Keyser Creek lose flow over several reaches. Due to their proximity to OFB, this plan recommends that they also be included in the QHUP.

- Several sections of Mill Creek have been reconstructed into an artificial channel for flood control purposes. Several other reaches show evidence of infiltration. Additional channel restoration or remediation is recommended for Mill Creek.

- Leach Creek, a tributary of Leggett's Creek in Scranton, also demonstrates total flow loss over a defined reach from the Morgan Highway to its confluence with Leggett's Creek. This plan recommends that Leach Creek receive channel restoration work.

- Several sections of Sterry Creek in Jessup have had channel restoration work completed. There are several interval reaches of Sterry Creek that should be addressed with some form of flow loss prevention.

- Several streams in the vicinity of Carbondale infiltrate directly into the Jermyn/Carbondale Mine Pool and thereby indirectly into the MSMP. This plan recommends that an additional QHUP be developed for the Upper Lackawanna including Powderly Creek, Fall Brook, Coal Brook and Wilson Creek.

Information from the Lackawanna River Conservation Plan related to infiltration points:

- The lower reaches of Spring Brook in Moosic, Spike Island, and Belin Village offer opportunities for educational interpretation of the various types of structural and nonstructural responses to issues related to bank stabilization, flood control, and mine water infiltration. The U. S. Bureau of Mines published a definitive assessment of mine drainage and surface infiltration in the Lackawanna Basin in 1952.

- Identify and seal remaining infiltration points on Sterry Creek and complete BAMR channel restoration from the Robert Casey Highway to PA Rte. 247.

- Highway mitigation could be matched with abandoned mine reclamation work to identify and eliminate Hull Creek flow infiltration.

- A complete channel restoration of Wilson Creek is recommended to eliminate infiltration into the mine pool from Richmondale to Simpson.

- Stream bed sealing and restoration at McDade Park to prevent infiltration of Lucky Run at McDade Coal Mine Tour has been completed.

- The original confluence of Campbell's Ledge Run with the river has been obliterated by extensive soil and gravel excavations along the flood plain. These pits are flooded with Campbell's Ledge Run providing the base hydrology. The flooded pits are known as the Duryea Swamps. Between the swamps and the ridge top reservoirs, Campbell's Ledge Run drops precipitously along the reservoir access road off Coxton Road. The run loses flow to infiltration just prior to entering the swamps.

- Due to infiltration into the underground mine pool, St. Johns and its tributaries lose their base flow to the mines. The main stem loses flow along the north side of the landfill. Sawmill Creek loses flow between the landfill and Keyser Avenue. Race Brook loses flow where its channel was altered by the developer of homes in Austin Heights.

- From O'Hara Road to Interstate 81 the dry Mill Creek streambed exhibits evidence of past surface mining and contemporary urban storm water flows. There is a concrete channel liner between Interstate 81 and the PA 315-Suscon Road intersection in Dupont. This liner was ruptured in several places during the flood of 1996. These ruptures provide direct access for stream flow infiltration into underground mine voids.

- Eddy Creek drops from an elevation of 1540 feet at Marshwood Reservoir along Marshwood Road. The loss of stream flow becomes more evident between 1200 feet and 1100 feet, where the stream loses flow completely via infiltration to the subterranean mine pool. All flow is lost into a noticeable void at about the 1100 feet elevation approximately 800 to 1200 feet upstream of the U.S. Route 6, Robert Casey Highway exit at Marshwood Road.

The subsurface mine drainage hydrology in the NAF is difficult and challenging to understand and manage. There are many unknowns due to the extent and character of the geology and hydrology and to the history and practice of mining activities. This is particularly the case in the LSCA and around the area of Pittston. In a related investigation, EPCAMR and SRBC are developing a GIS based three dimensional (3D) model of the NAF mine pools. They are preparing draft versions of graphics depicting portions of this work and expect to publish them later in 2013.

The 3D modeling will help all parties gain a better understanding of the variables related to the mine pools. A major variable is the presence or absence, location, direction and functionality of the system of mine colliery boundary barrier pillars. Other significant variables are:

- the functional elevations of the pillars and or communicability through, around, or over the pillars
- the subterranean topography in the strata of anticlinal and synclinal features, their pitch and direction
- the conditions of the mine void and tunnel system
- the effects of subsidence
- mine flushing
- mine disaster related features
- human activities such as violations of mine regulations or other laws that have left long term impacts.

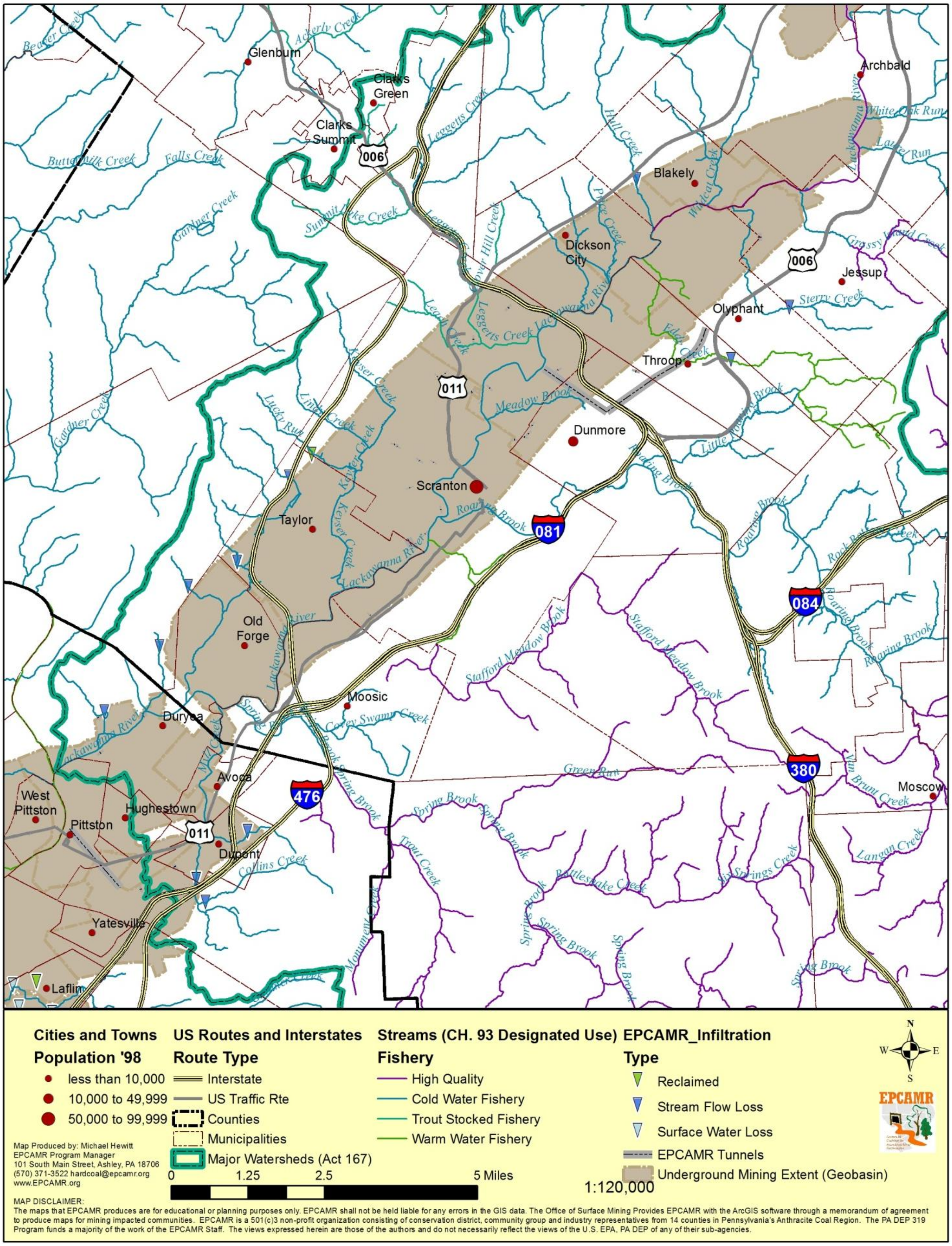

Figure 5-1 Stream and Surface Water Infiltration Points to Underground Mines in the MSMP.

5.2 Metropolitan Scranton Mine Pool

MSMP covers an area of approximately 21,000 acres or 33 square miles, extending upstream of the OFB at RM 3.0 at the Old Forge crest of the Moosic Anticline to the vicinity of the Archbald Sewer Treatment Plant at RM 23.5 on the downslope of the Jermyn crest of the Moosic Anticline. It lies under portions of Old Forge, Moosic, Taylor, Scranton, Dunmore, Throop, Dickson City, Olyphant, Blakely, Peckville, Jessup, and Archbald (Figure 5-2).

The MSMP lies in the mine void complex for up to a mile on either side of the Lackawanna River as a central axis. The mine pool exhibits a number of variations in its surface elevations governed by the variables of the barrier pillars. The barrier pillars are a system of solid blocks of un-mined coal set by mutual agreement of the mining companies upwards of 150 feet on either side of their property lines extending downward, in theory, from the surface through all mined and un-mined veins of coal. In practice, many barrier pillars were penetrated with airways, gangways, haulage roads, or boreholes for communication and utilities. More seriously, many barrier pillars were robbed to some degree either illegally or by mutual consent of the owners. Thus, the integrity of barrier pillars to function as dams is limited but their presence and extent is sufficient to contribute towards holding the pool at differing elevations somewhat in the manner of riffles in the surface plane of the river.

The upper end of the MSMP features several "perched" pools that are drained by several smaller outlets. These outlets include the Gravity Slope Outfall in Peckville, the Dana Tunnel outfall in Archbald, the Waddell Tunnel outfall in the Winton section of Jessup, and the Lackawanna Outfall in Peckville. While these perched pools drain through the outlets, there is also drainage below the outlet level into the main body of the MSMP.

The Gravity Slope is the largest of the perched outfalls discharging upwards of 20 MGD according to Scarlift. The pollutant loading of the perched outfalls and the Upper Lackawanna Outfalls is a slight Fe concern. However, the loadings are not a serious factor that negatively impacts the river's aquatic habitat. In fact, recent fishery studies have indicated that the mine outfalls contribute to lowering ambient water temperatures, which enhance the river's cold-water fishery. The other drainage points in the upper MSMP are seasonal and, from the perspective of the LRCA, do not contribute enough pollutant loading to warrant consideration for treatment at this time, or possibly ever.

The pool elevations of the MSMP are accessible through a system of 15 monitoring boreholes installed by PA DER during the 1970's and 1980's. PA DER or PA DEP staff have collected pool elevation data by measuring from surface bench marks of each borehole to the water surface with an electronic diode reporting tape. LRCA, EPCAMR, and SRBC have continued this monitoring program as part of this study and the related mine pool mapping project.

The DEP monitoring boreholes are located within the right-of-ways of low traffic public streets and courts throughout the NAF. While many are still accessible, some have been paved-over inadvertently by municipalities as the bores are not listed in the utility one-call system. Several municipal public works departments have collaborated with the study team to daylight the paved-over access plates of boreholes in Jermyn, Archbald, and Duryea. The pool elevations across the length and width of the MSMP including the upper-perched pools are presented in the Figures 17-20 and more fully in the Appendix B.

There are 4 distinct mine pool levels within the MSMP.

- The furthest south, Central Borehole #130, measures the level of the Central Pool, below the Moosic Anticline, and downstream of OFB. This is believed to be the pool that discharges at the Duryea Breach, but it also accepts overflow from the OFB during higher precipitation as seen by the Duryea Breach's bimodal flow statistics. The elevation fluctuates between ~562-582 ft (Figure 5-3).
- Moving upstream, the next pool elevation spans from the Sibley Borehole #127 to the Underwood Borehole #116. This pool discharges directly to the OFB and holds an elevation between ~580-660 ft. Within this pool there is a gradient in the pool across the valley as pools on each side of the valley (i.e. Green Ridge #121 and Capouse #124) maintain a slightly higher elevation than those in the interior of the valley (i.e. Taylor #51) (Figure 5-4).
- The Olyphant #113A and #109 and Miles #110 hold a pool between ~700-740 ft and discharge by overtopping barrier pillars dams to the downstream mine pools mentioned above (Figure 5-5).
- The Sterrick #107 and Peck Shaft #106A hold a final pool at ~740-770 ft., which discharges over top barrier pillar dams and eventually to the OFB (Figure 5-6).

These mine pool elevation graphs are followed by hydrographs of the USGS river gages at Old Forge and yearly precipitation data (Figures 5-7 & 5-8 and a complete listing in Appendix B). Pressure transducer and flow data from the OFB and flow data from the DB can be found in Section 6 and in more detail in Appendix C.

In addition, as part of this study and as part of ongoing work with SRBC across the Anthracite Region, EPCAMR is digitizing available mine maps from federal, state and private sources to develop a GIS database. Two and three dimensional maps and models of the NAF are being developed including the Lackawanna mine pools.

As part of this work, in addition to digitizing mine maps, EPCAMR staff have translated the graphic and narrative information from the U.S. Bureau of Mines Bulletins regarding mine pools and barrier pillars into plotted information for the three dimensional models of the current mine pools. Work is scheduled to be completed in 2013.

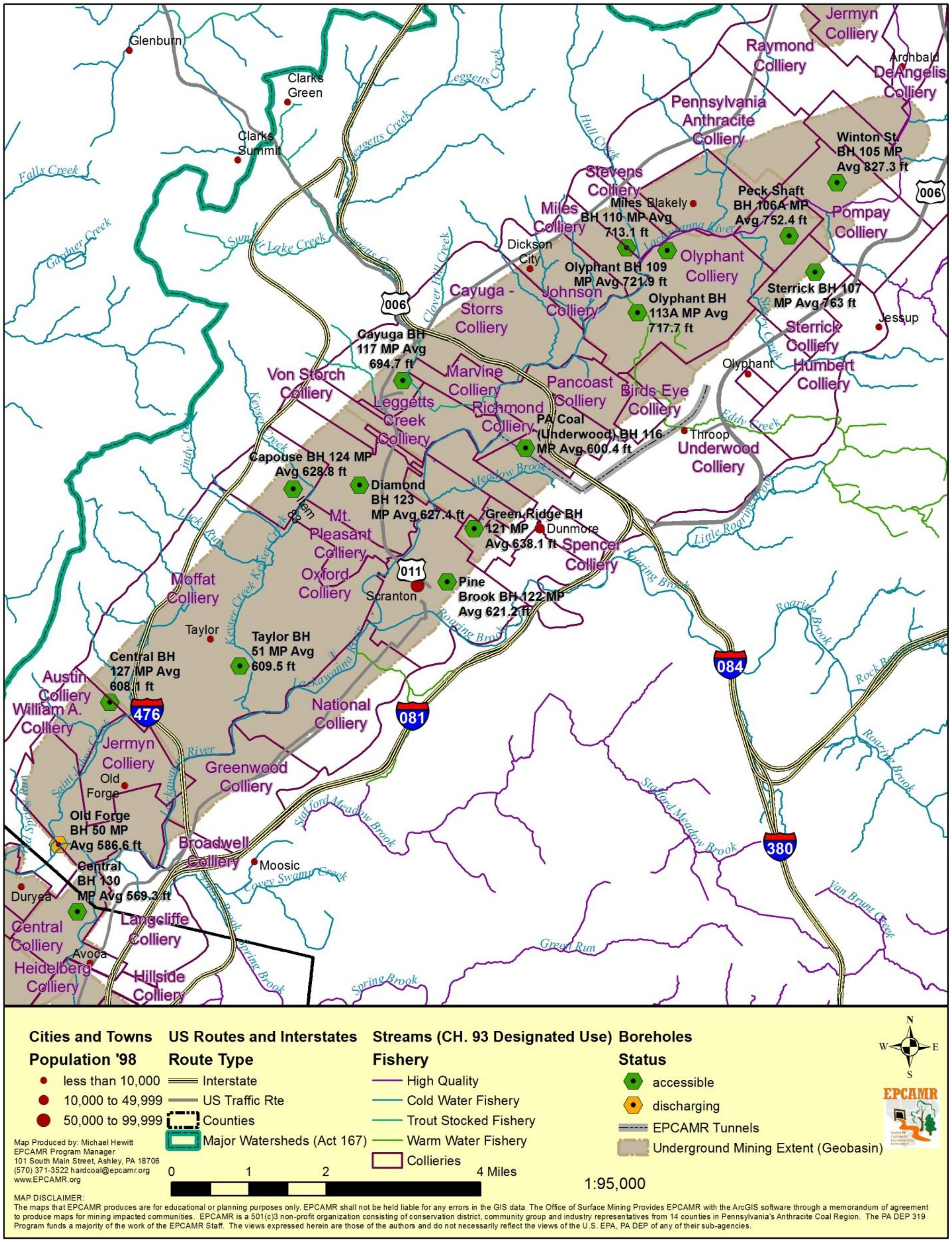

Figure 5-2 Scranton Metropolitan Mine Pool, Location and Average Water Level of Accessible Monitoring Boreholes (larger more detailed map available in Appendix B)

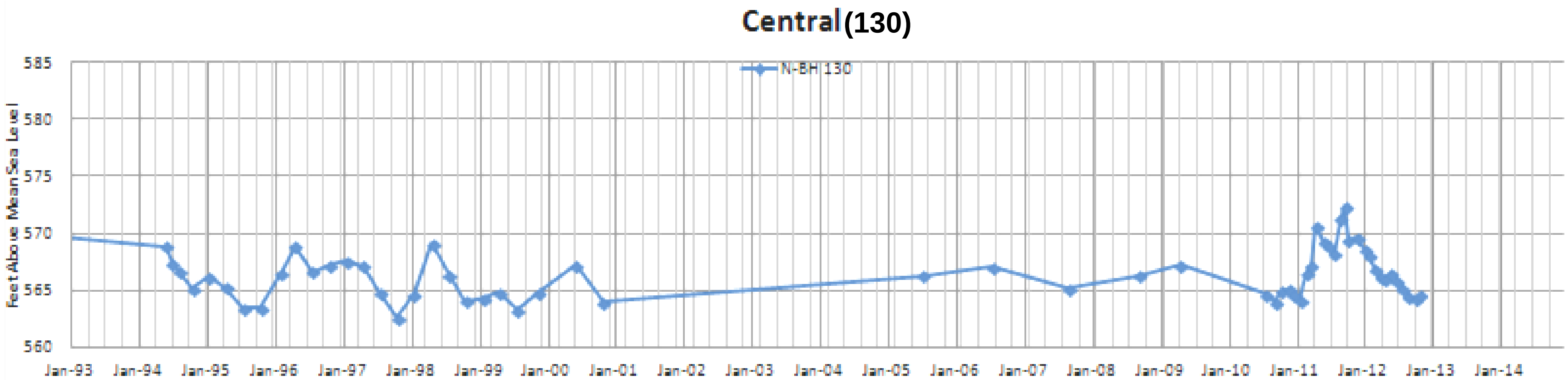

Figure 5-3 Central Borehole #130 Mine Pool Elevation Hydrograph: Average 569.28 ft., Maximum 582.36 ft., Minimum 562.62 ft., Range 19.74 ft., Standard Deviation 1.88 ft., Time Period 44 years 11 mos. & 6 days.

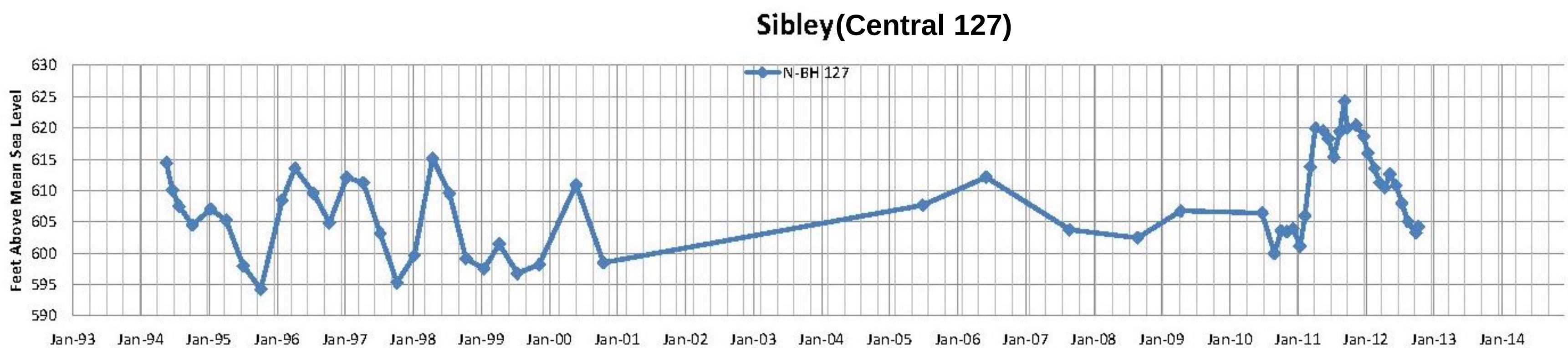

Figure 5-4 Sibley Borehole #127 Mine Pool Elevation Hydrograph: Average 608.09 ft., Maximum 624.28 ft., Minimum 594.28 ft., Range 30 ft., Standard Deviation 6.08 ft., Time Period 18 years 5 mos. & 24 days.

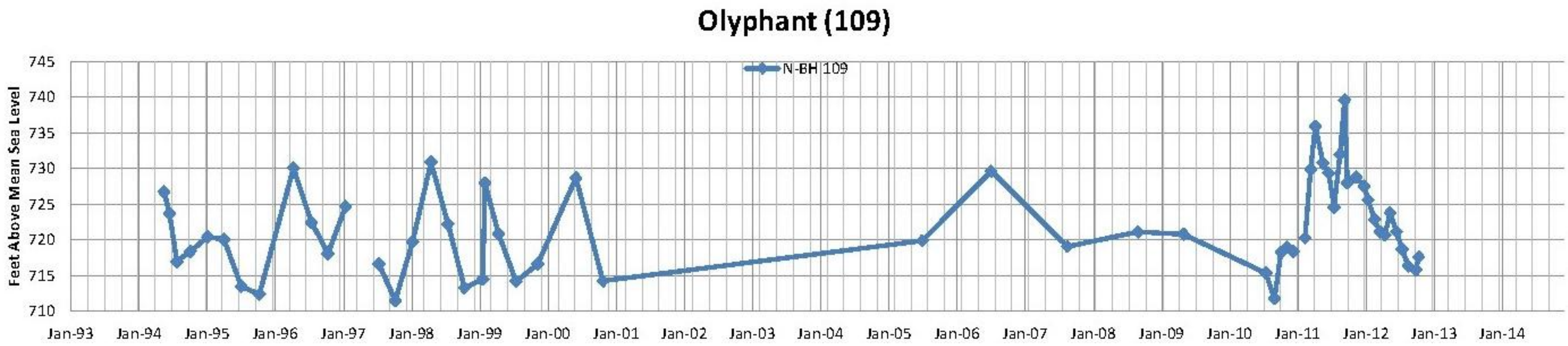

Figure 5-5 Olyphant Borehole #109 Mine Pool Elevation Hydrograph: Average 721.85 ft., Maximum 739.61 ft., Minimum 711.51 ft., Range 28.10 ft., Standard Deviation 6.02 ft., Time Period 18 years 5 mos. & 26 days.

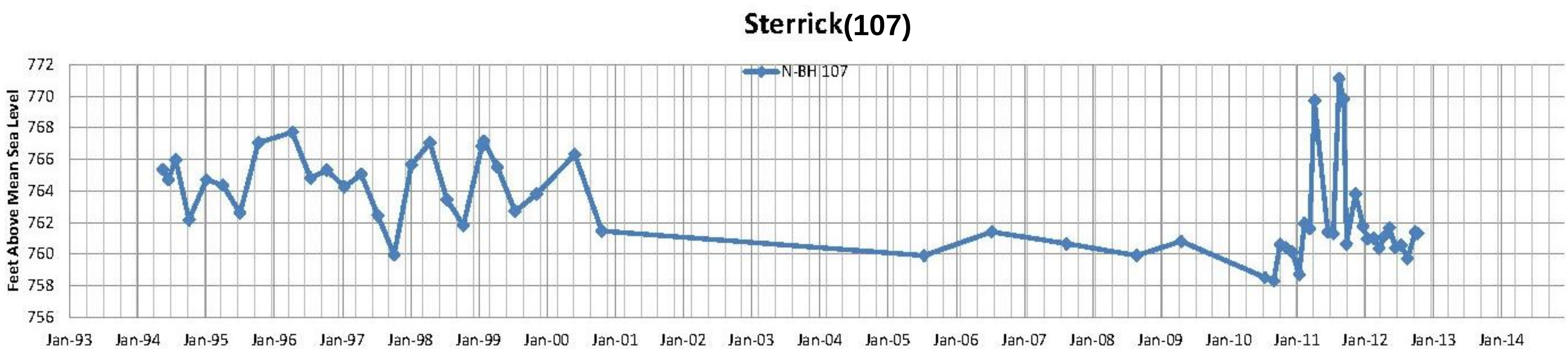

Figure 5-6 Sterrick Borehole #107 Mine Pool Elevation Hydrograph: Average 762.97 ft., Maximum 771.11 ft., Minimum 758.31 ft., Range 12.80 ft., Standard Deviation 2.87 ft., Time Period 18 years 5 mos. & 26 days.

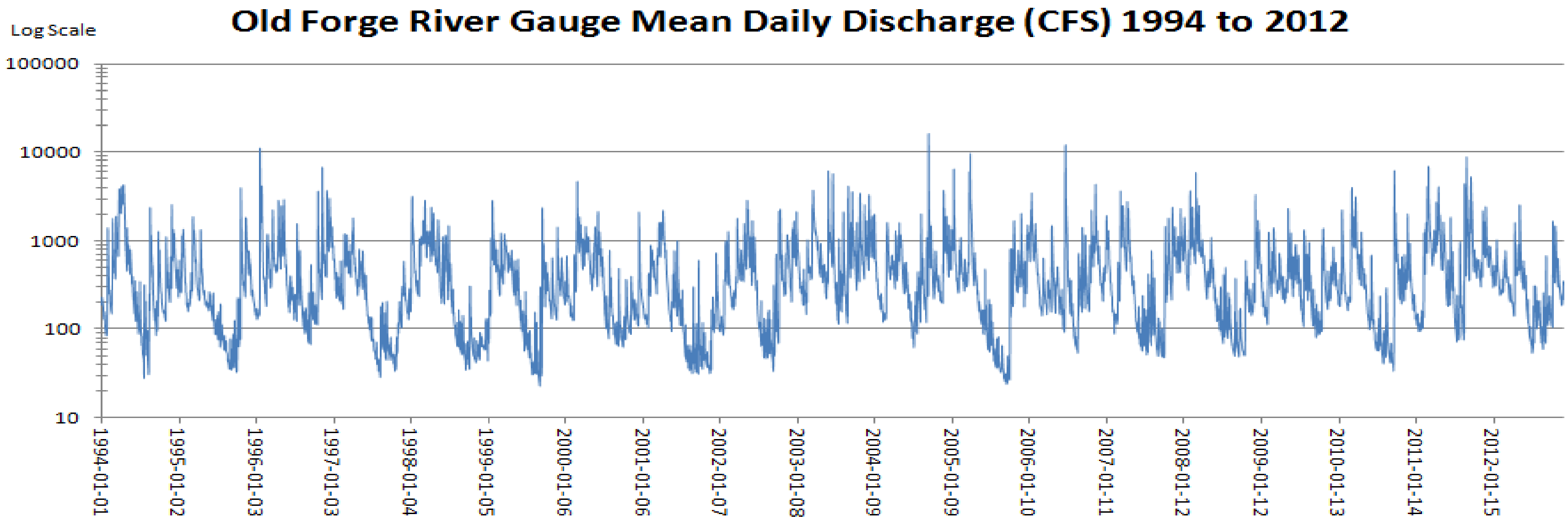

Figure 5-7 USGS Old Forge River gauge flows during the mine pool borehole monitoring time period.

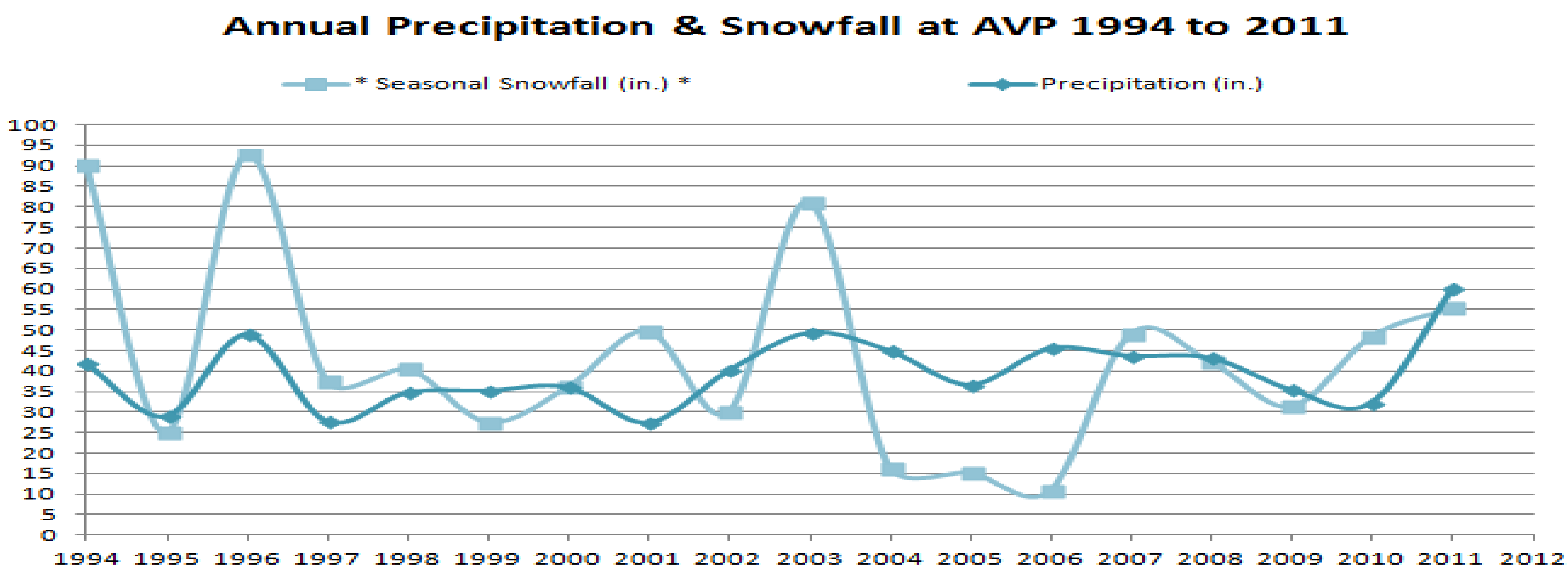

Figure 5-8 Precipitation and snowfall during the mine pool borehole monitoring time period.

5.3 Central, Seneca, and No. 9 Mine Pools

The Central, Seneca, and No. 9 Mine Pool complex discharges into the Lackawanna River through DB (Figure 5-9). It is located at RM 0.8 along the east bank of the river, 100 feet upstream of the Coxton Road Bridge. The Heidelberg, Hallstead, No. 9, Central and Seneca collieries are part of this pool. The discharge point is also referred to as the Seneca Breach or the Phoenix Shaft Discharge in some previous studies. The pool covers an area of 2,000 acres underlying portions of Duryea, Avoca, Hughestown, Dupont, and Pittston Township. In the US Bureau of Mines Technical Paper 727, the Central and No. 9 Pool complex had a volume of 1.8 billion gallons below the level that was pumped prior to 1961. EPCAMR has conducted a volumetric assessment using GIS that estimates a volume of ~3 billion gallons of water.

There is communication through passages and breaches along the Moosic Anticline from the MSMP into the Central Pool. There is also some communication and flow from the Central Pool into the Butler Tunnel Pool that discharges into the Susquehanna downstream of the LSCA. The primary infiltration into the Central and No. 9 Pool is from the Lackawanna River, Mill Creek and its tributaries, as well as surface infiltration through strip-mined areas in the Mill Creek watershed and along the West Mountain.

The area on the west side of the Lackawanna that contributes to the Central and No. 9 Pool includes strip-mined portions of the William 'A' Colliery, the Marcy Shaft, and the Hallstead Colliery. Infiltration into the pool also comes from Campbell's Ledge Run and Red Spring Run as they descend from reservoirs and springs on the West Mountain Ridge.

Several surface ponds are located along the western bank of the Lackawanna River in flooded strip mine pits and sand and gravel quarry pits. These flooded pits may receive flow from Campbell's Ledge Run and from seeps from the Central and No. 9 Pool. There is also some communication from these ponds and the river through saturated soils and gravel deposits constituting what may be described as a shared hyporheic zone. These ponds are of further interest as they may have value as a passive aspect of the proposed mine water treatment system being recommended as part of this LLR-WRAP.

The Moosic Anticline serves as an important natural feature providing a distinct separation between the MSMP and the Central and No. 9 Pool Complex. While there is some communication across the anticline between those pools, it may be possible to determine where and when these flows are occurring and also determine whether some method of control is feasible.

There is no discernible feature controlling communication through the majority of the Central and No. 9 Pools into pools further south in the Wyoming Valley. Our estimates and information on DB, and the estimates of the drainage area and volume of the pools controlled by the breach, indicated that most of the pool volume discharges at DB. Some drainage flows further southwestward through the No. 9 Pool, discharging at the Plains Township Borehole and along seeps on the east bank of the Susquehanna River above and below the City of Pittston.

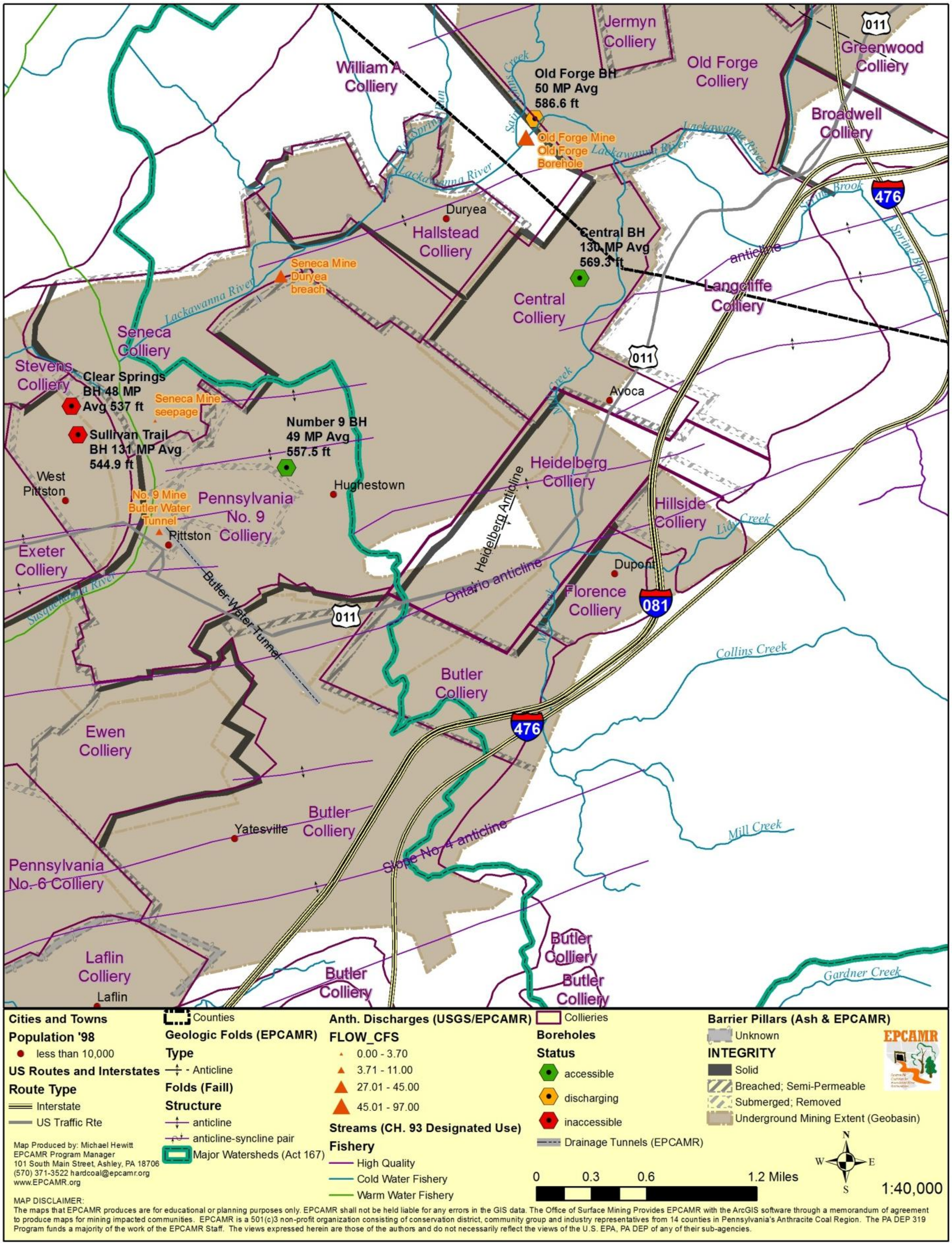

Figure 5-9 Central, Seneca & No. 9 Mine Pool Complex and Butler Mine Pool Complex s showing mine discharges, drainage tunnels, barrier pillars and geologic folds (larger more detailed map available in Appendix B).

5.4 Twin Shaft

Another significant variable related to the DB and the Central and No. 9 Pool Complex is the Twin Shaft Disaster of 1896. The Twin Shaft was located in Pittston Junction. It operated immediately under the LSCA adjacent to Coxton Point. The mine experienced a failure of its support pillar system due to inadequate sizing and placement of pillars in vertical elevation. This led to a general failure of the roof and floor, producing a squeeze in multiple veins over an area of several hundred acres in extent, immediately at and around the LSCA. Forty-six miners were lost and never recovered.

The disruption of several coal and interval strata and the lack of integrity of Barrier Pillar CIV (104), which lies directly under the Susquehanna River bed at the confluence, and known deficiencies of several adjacent barrier pillars, may indicate that there is communication of mine pool waters from the west side of the Wyoming Valley (West Pittston/Exeter) under the Susquehanna River at this point. Plans by EPCAMR and SRBC to daylight a monitoring borehole at the Sullivan Trail Colliery in West Pittston may soon help to clarify the status of pool elevation and possible flow relationships in this vicinity.

There are several seeps along the eastern shoreline of the Susquehanna River between the LSCA and the Fort Jenkins Bridge that are outlets for the Twin Shaft portion of the Central and No. 9 Pool Complex. Due to the low volumes of flow, it may not be cost effective to treat these seeps at this time. If there are opportunities to divert these seeps to a portion of the flood plain where wetland ponding may be developed, perhaps passive treatment may be possible. There are several other seeps from the Twin Shaft Mine that discharge on the west side of the Lackawanna at Coxton Point. These seeps discharge into a wetland area of flooded topsoil pits that have been planted with wetland plants by Waste Management as part of a wetlands mitigation project related to the Alliance Landfill Site in Taylor. This wetland mitigation project has created viable habitat and functions to mitigate the AMD discharge that is the source if its hydrology.

5.5 Low Flow Augmentation and Accelerated Flow Utilization

The mine pools in the Lackawanna Watershed, and indeed across the entire Anthracite Region, represent a tremendous untapped water resource that can have greater value for the Susquehanna Basin if developed in a sustainable manner. The Bureau of Mines Reports estimate that the Lower Lackawanna Basin Pools of the NAF held a total of 5.5 billion gallons of water (Table 5-1). At the time of the Bureau of Mines Reports, an average of 43,759,370,000 gallons of mine water was pumped from the coal veins in the Lackawanna Basin per year to keep them workable. Although EPCAMR's current study to updated these numbers is not complete, we estimated that these numbers can be conservatively doubled. Compare the number of mine pools in Table 5-1 with missing volumes (not calculated due to pumping) and original vs. current water level elevations. Another comparison can be made between MSMP and the Western Middle Anthracite Field, of which current mine pool volumes were recently calculated by the USGS. The underground mined area in the Western Middle Field equates to approximately 53.8 square miles and holds an estimated range of 60 to 220 billion gallons of water. In comparison, the MSMP covers approximately 33 square miles and has a similar synclinal basin structure with troughs that are approximately 1/3 as deep as those in the Shenandoah Coal Basin of the Western Middle Coal Field. Following this comparison, we can roughly estimate that the MSMP, today, holds a range from 12 to 45 billion gallons.

Two uses suggested by this plan for further feasibility study are low-flow augmentation and accelerated flow utilization. Low Flow Augmentation would establish a flow release and elevation control on the OFB to maintain a higher pool elevation and thus hold more water in the MSMP. During drought periods, additional amounts of water could be released from the MSMP to augment the flows in the Susquehanna River. There may be an opportunity to utilize the Consumptive Use Regulatory Program of the SRBC to draw compensation from consumptive users to offset their intake with augmented releases from mine pool reservoirs.

Accelerated Flow Utilization would establish flow release control at OFB and install hydroelectric generation equipment to create electricity from the discharge of the MSMP either at existing flow and elevation conditions or within the regime of a higher pool elevation management program. If the average flow of OFB is dropped only 5 ft, ~30 kilowatts could be generated.

The variety of flow and elevation data collected and assessed as part of this plan indicates that further study of the storage capacity and utilization of the MSMP is warranted. The data indicates that the mine pool elevation fluctuates over a 20 to 30 foot freeboard under natural precipitation conditions recorded during the study period in 2011 and 2012. Historical pool elevation data from PA DEP has also been examined. Elevation data collection is continuing to inform a longer time line of elevation behavior. As long as the instrumentation installed at OFB continues to function, the study team will continue to be able to correlate flow and elevation data on the MSMP and relate that with regional precipitation data and USGS stream gage hydrographs. The hydrologic year of 2011-2012 offered a diversity of flows from draught conditions to floods of record.

Key questions remain to be answered about the capacity and capability of the MSMP to function as a storage reservoir that would allow for low flow augmentation. A feasibility study is suggested that would explore some of these questions. What maximum elevation may be attainable and manageable in such a way as not to surcharge local ground waters and affect private properties? What is the additional storage capacity thereby provided? Is there an effect on water chemistry of the discharge? If so, is that an acceptable effect assuming that a treatment plant is in operation? Is there any observable or empirical effect on surface or subsurface stability by carrying a larger storage volume? Is there a significant expansion of the water surface area of the pool? What effects may arise from that expanded surface area? How much of an increase in head pressure may result from maintaining a higher pool elevation? What type of outlet control structures would be necessary to manage discharge for low flow augmentation releases? Would there be an effect of concern from rapid drawdown of pool elevation on support and barrier pillar stability and function? What effects may be expected from normal operation of low flow release assuming a mimic of natural fluctuations although at a slightly higher average pool elevation?

Both of these flow management opportunities also assume that the existing outlets of the OFB and DB will be diverted or sealed when replaced by a new outlet scheme, which is a major recommendation of this plan.

Table 5-1 Mine Pool Volumes, Water Level and Acreages from S. H. Ash Bureau of Mines Report 517 and Technical Paper 727 (blank volumes were not calculated).

Pool Name and Number	Drains to	Water Level (ft)	Area (Acres)	Flooded Volume (Gal)	Current Level (ft)
Scranton Anthracite - Greenwood (20)	Old Forge Borehole	603	293.5	413,500,000	614
Pyne (21)	Old Forge Borehole	475	161.8	148,500,000	609
Pine Brook (25 & 26)	Old Forge Borehole	465	424.9	4,356,000	621
Oxford (24)	Old Forge Borehole	275	72.8	-	612
Mt. Pleasant (22 & 23)	Old Forge Borehole	415	116.7	312,030,000	612
Diamond (27)	Old Forge Borehole	405	773.6	406,742,000	672
Bulls Head	Old Forge Borehole	250	22.8	-	-
Von Storch	Old Forge Borehole	250	76.1	-	-
Legitts Creek	Old Forge Borehole	250	343.9	-	-
Marvine (28)	Old Forge Borehole	250	338.1	924,470,000	-
Richmond (29)	Old Forge Borehole	300	71.5	-	600
Storrs - Cayuga (30)	Old Forge Borehole	235	880.6	967,932,000	628
Price - Pancoast (31)	Old Forge Borehole	310	188.5	216,480,000	-
Underwood (32A)	Old Forge Borehole	325	17.5	-	-
Johnson (32)	Old Forge Borehole	486	361.8	196,813,000	715
Sterrick Creek (35A)	Old Forge Borehole	544	155.0	-	763
Peck Shaft (35)	Old Forge Borehole	320	98.4	68,000,000	752
Sterrick Creek - Rought (35B)	Old Forge Borehole	620	29.2	-	763
				3,658,823,000	

Pool Name and Number	Drains to	Water Level (ft)	Area (Acres)	Flooded Volume (Gal)	Current Level (ft)
Number 9 (19B)	Duryea Breach	200	70.4	-	557
Number 9 (19A)	Duryea Breach	192	62.2	-	557
NUMBER 9 (19)	Duryea Breach	177	63.9	-	557
CENTRAL (18B)	Duryea Breach	425	166.6	-	569
SENECA (18)	Duryea Breach	356	651.6	1,865,200,000	552
HALLSTEAD (18)	Duryea Breach	391	326.8	-	-
				1,865,200,000	

6 Mining Impacts

6.1 Old Forge Borehole Quantity and Quality

SRBC hydrologic staff has assisted in the final design approach to our pressure transducer and flow data collection work at OFB. Four different approaches were attempted at OFB using Doppler based equipment and then pressure transducers installation. The challenge has been to devise a methodology to collect data to record the volume of flow discharging from the OFB.

The top of the borehole is enclosed in a “dissipation chamber” cut in rock with a one foot thick cap of poured-in-place reinforced concrete at the surface of the ledge on the river bottom (Figure 6-1 and Appendix A). The discharge then flows through a gate valve in a reinforced concrete riser structure with a steel mesh deck and man-way. The gate valve has never been closed since the day it was opened in September 1962. It is now incapable of being operated due to corrosion and a total lack of maintenance.

From the gate valve riser chamber, the flow is directed through a trench cut and blasted through ledge stone for a distance of 800 feet along the western shoreline of the river. The trench is capped with a one foot thick concrete cap to its point of discharge at the western abutment of the Union Street Bridge. From this point, the Fe oxidation precipitation onto the bed of the River becomes a visually predominant aspect of the Lackawanna for approximately three miles into and through the confluence with the Susquehanna.

The study team installed two In-Situ Inc. pressure transducers into the vertical borehole at a depth of 22 feet and 30 feet secured to 1 ½” steel drill string pipe, threaded and assembled in five foot sections. These units and communication wire from the units were secured to the pipe string with plastic zip ties. The communications cables were housed in conduit from a metal lock box at the top of the borehole cap. The cables terminated with download connectors and desiccant cylinders housed in a similar equipment box bolted to the metal deck grate on the gate valve riser (Figure 6-2).

The units were put into operation on August 28th 2011. Within three weeks, the region experienced flooding of record from Tropical Storm Lee. The units remained operational during the next two months. Staff stopped at the site every two weeks to inspect the desiccant and download data. The pressure data presented in graphic form matched the river hydrograph with a ~12 hour delay. The pressure transducer data was converted into flow data by running the difference in the two unit’s pressure at depth readings as variables in a Bernoulli equation and a modified Darcy –Weisbach formula. However, this method is still inconclusive in terms of success. This data will be furthered scrutinized and possibly added to the future Lower Lackawanna River QHUP.

The fall of 2011 remained wet with frequent precipitation events that kept rivers running high and discharge from mine pools high as well. On or about October 25th, 2011 both units failed. We discovered this on a site visit on November 1st. We arranged with our technical contractor to bring in a crane truck and pull the drill string and the units. This was accomplished on November 15th.

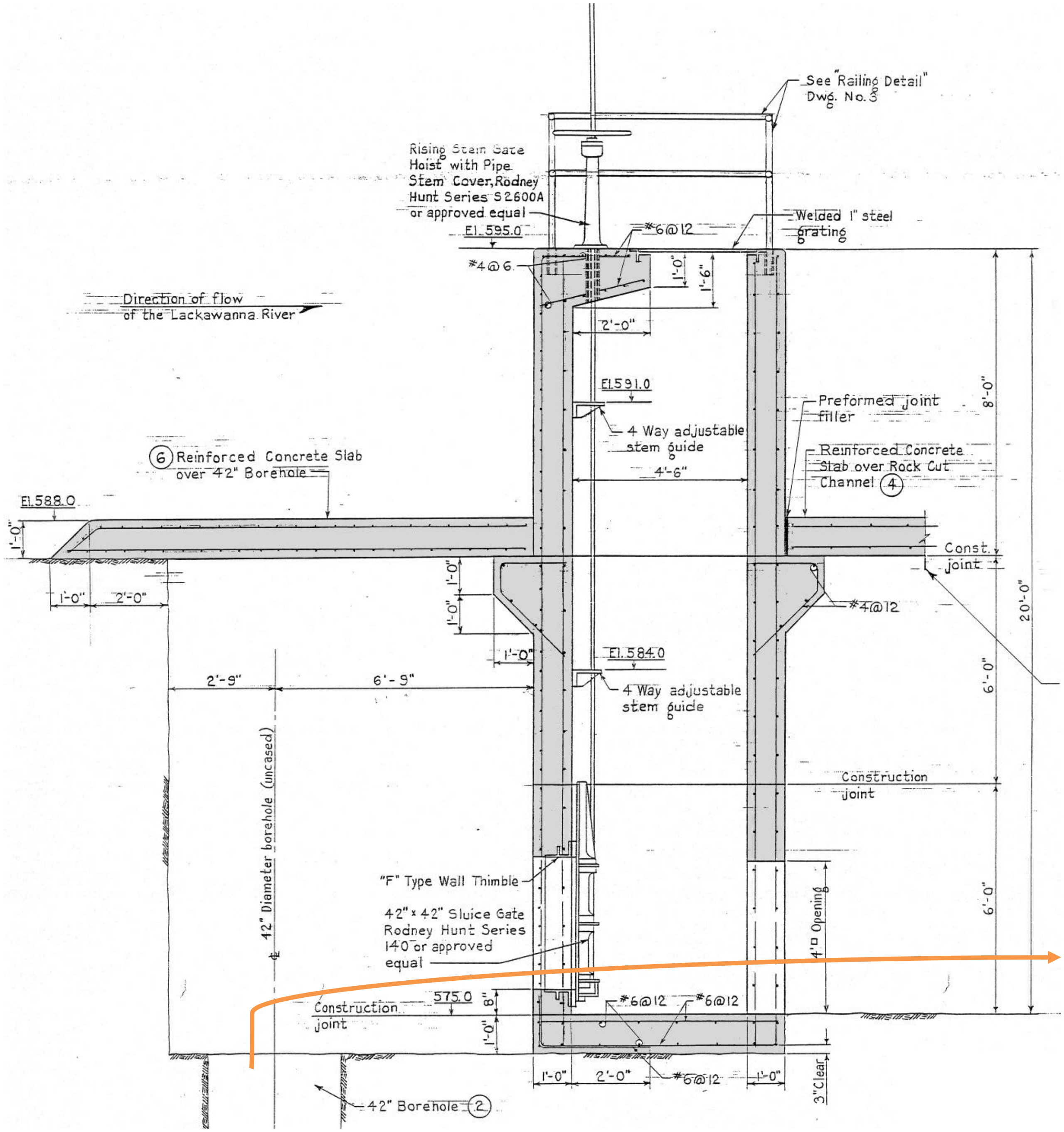

Figure 6-1 Old Forge Borehole Dissipation Chamber and Control Manhole and Rock Cut Channel Cross-Section enlarged portion of the original design plans from 1962 (Original plans in Appendix A). Orange line indicates flow of mine drainage from underground mines via 42" borehole.

Figure 6-2 Study team members attaching the pressure transducers to the drill string.

As the drill string was pulled out, we discovered that the threaded joints connecting several of the five foot lengths of pipe had become loosened (Figure 6-3). The drill string composed of eight five foot sections had been hand torqued during installation. It was clamped to a 6 inch steel bushing collar that we installed to cover the drill hole penetrating the reinforced concrete cap over the borehole and to provide for an anchoring point. The string was immersed 30 feet down into the center of the bore. There was no anchoring mechanism feasible at depth. Physical observation indicated that the string was affected by severe oscillation and jarring from the high velocities.

The string oscillation and related movements and forces from the discharge velocity also appear to have caused the pressure transducer units to fail. When the drill string was extricated from depth, it revealed that the lower unit and 10 feet of communication wire had torn free of the over 50 cable zip ties that had been binding them to the string. The unit was running wild in the discharge current banging against the drill string and possibly the circumference of the borehole. The unit itself had failed from percussion damage fracturing the sensor seal. It had further lacerated the cable of the upper unit causing that unit to fail as well.

The units were cleaned and shipped back to In-Situ Inc. for inspection, download of any retrievable data, and repair estimates. No data was retrieved post October 25. In-Situ Inc. was able to repair one unit and re-terminal the lacerated cable.

Figure 6-3 Study team members inspecting the transducers post TS Lee. Note: Camera posted incorrect date on photo.

The study team assessed other options that would allow flow and pressure data to be collected. A field visit to OFB was conducted on February 26th 2012. At that time, several alternate data collection approaches were discussed. Several three inch instrument ports in the cap of the outfall channel left by previous studies were examined to determine if flow meters could be inserted. None of these ports were adequate. An expansion joint located in the concrete slab was identified at a convenient location. It was decided that a concrete saw and jackhammer would be used to cut a slot 6 inches parallel to the joint (Figure 6-4). This would allow access across the outflow channel transect. Regular methodologies to measure open channel flow could be employed using available flow meters. The remaining pressure transducer would be reinstalled at mid depth on the inside of the channel so that a rating curve could be built and used for transducer depth measurements.

The reinstallation work was conducted in March 2012 to cut a slot through the concrete cap along an expansion joint. The pressure transducer was installed in a stilling well (pipe) and a steel cover plate was attached to cover the slot and equipment. The communications cable was run in conduit from the slot upgrade about 10 feet to a metal drum anchored in concrete on the riverbank at 100 year flood elevation (Figure 6-5).

The methodology for data collection is to visit the site every two weeks and download pressure and depth data from the transducer. The slot is then opened and flow measurements are taken across the seven foot transect at two depths (80% and 20% of water depth) and at one foot intervals. This data collection will be continued following the completion of this plan to capture a full hydrologic year. The flow data and depth data are correlated to establish a ratings curve so that the pressure transducer depth readings (taken every 15 minutes) will eventually become indicative of flow over the long term (Figures 6-6). Transducer flow details can be found in Appendix C.

Figure 6-4 Study team decides how to take flow measurements and install transducer in concrete cap opening.

Figure 6-5 Metal drum anchored in concrete on the riverbank containing transducer hookup.

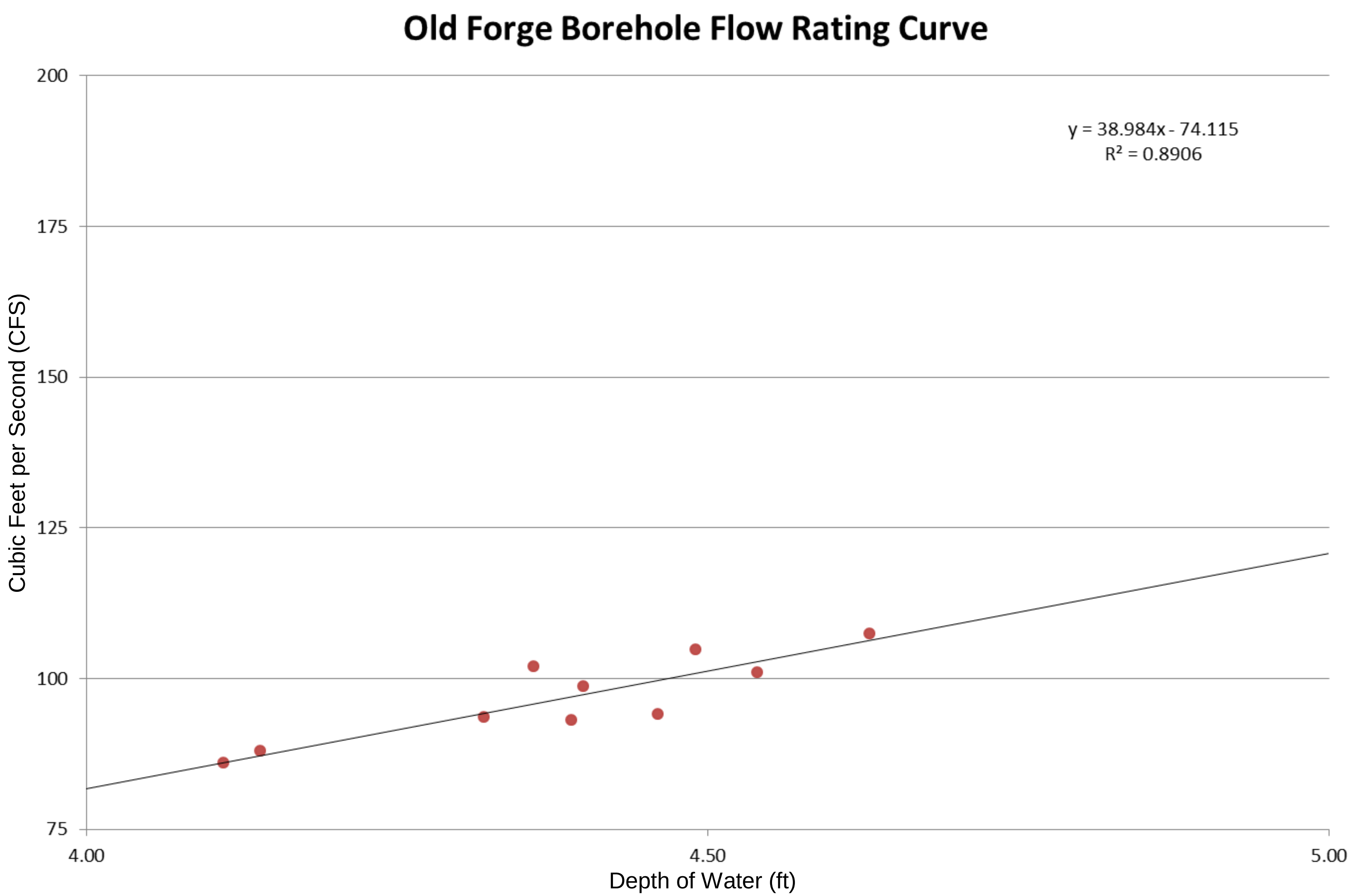

Figure 6-6 OFB flow rating curve with flow equation and R^2 value included.

An analysis of OFB transducer flow data from April to December 2012 indicates flows ranging from ~49 MGD (~76 CFS) to ~76 MGD (~118 CFS) with average flow at 58 MGD (~90 CFS) (Table 6-1). A comparison of flow data presented in the 2011 SRBC Anthracite Strategy document indicates that OFB is the largest flowing mine drainage point in the Anthracite Region (Clark 2011).

Table 6-1 Summary of 4/18/2012-11/07/12 transducer flows (CFS) taken every 15 minutes using the flow rating curve equation of y = 38.984x - 74.115

Flow Count	Max	Avg and Median	Min	75% Quartile	Stand. Dev.
19489	118	90	76	98	8.81

Our present flow data may suggest that as OFB exceeds ~90 CFS or ~58 MGD, the MSMP surcharges through fractures and passages in the barrier pillars along the Moosic Anticlinal saddle and moves into the Central and No. 9 pools causing an increase of discharge from DB.

The water quality of OFB has improved over time; however, it still discharges ~7,700 lbs/day of Fe into the Lackawanna River. The OFB is now very net alkaline, which was not always the case. Consequently, treatment would only have to center on the addition of dissolved oxygen and the removal of Fe concentration (Table 6-2).

Table 6-2 Manual flow measurements and field and lab water quality of OFB over the 2011-2012 hydrologic year.

Date	Q	F. pH	L. pH	Net Acid.	Cond	T. Fe	T. Mn	T. Al	SO_4	DO
	CFS	SU	SU	mg/l	uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l
10/25/2011	85	6.39	6.80	-78.00	1070.00	13.50	1.72	0.05	252.00	4.90
2/23/2012		6.30	6.50	-54.00	1080.00	14.27	1.88	0.05	290.00	
3/8/2012	120	6.50	6.40	-65.00	1080.00	15.53	2.03	0.05	309.00	
3/16/2012	101									
3/29/2012	105									
4/10/2012	99									
4/25/2012	85									
5/10/2012	93									
5/18/2012	107	6.41	6.60	-80.00	1090.00	16.24	1.94	0.05	317.00	2.71
6/21/2012	94									
7/5/2012	102									
7/11/2012	94									
8/10/2012	88									
8/17/2012	86	6.50	6.40		1040.00	16.36	1.94	0.05	298.00	
9/12/2012	81									
10/12/2012	77									
Max	**120**	**6.50**	**6.80**	**-54.00**	**1080.00**	**16.36**	**2.03**	**0.05**	**317.00**	**4.90**
Ave	**94**	**6.42**	**6.54**	**-69.25**	**1072.00**	**15.18**	**1.90**	**0.05**	**293.20**	**3.81**
Min	**77**	**6.30**	**6.40**	**-80.00**	**1040.00**	**13.50**	**1.72**	**0.05**	**252.00**	**2.71**

6.2 Duryea Breach Quantity and Quality

DB flow and water chemistry data is also represented in historical data and contemporary measurements as part of this study. SRBC's Anthracite Remediation Strategy classifies the DB as the sixth highest priority discharge in the Susquehanna Anthracite Region. DB is the outlet to the Hallstead, Seneca, Central, and No. 9 mine pool complexes. Also, the Langcliffe and half of the Heidelberg mine (north of a local anticlinal ridge, the other half drains to the Butler Tunnel) drain to the DB via the Central Mine.

These mines extend from the downslope of the Moosic Anticline on the north to the outcrop of coal along the flank of the mountain east of the Avoca Airport, southward to the vicinity of Dupont and Pittston Township and westerly to the Llewellyn-Pottsville boundary along Campbell's Ledge and the West Mountain. An analysis of mine maps and barrier pillars in Mine Bulletin #518 indicates that there is some seepage from the MSMP through barrier penetrations along the Moosic anticline into the DB. There may also be some communication from the Central and No.9 pool complex into the mines in Pittston and Pittston Township that are drained by the Butler Mine Tunnel. Communication between pools through barrier pillars is somewhat dependent on precipitation and pool elevation.

DB emanates from a crop fall in the Pittston Vein. It is a result of the collapse of the Phoenix Shaft of the Seneca Colliery located ~1,000 feet to the north of DB. The flow collects in a beaver dam in what once was the Duryea Canal Boat Basin of the Susquehanna Canal in the early to mid-19th century. The Checker Vein was strip mined in the canal basin area in the 1950's further weakening the area and eventually causing the breach. The flow discharges to the Lackawanna River in a ditch eroded from the canal prism and enters the river adjacent to the Coxton Road Bridge.

There are additional seeps in the large ~90 acre flooded gravel pit complex known as the Duryea Swamps on the west side of the Lackawanna across from the Duryea outfall. The numerous seeps are near the Marcy Shaft which is submerged by the flooded pit. Pool elevation data indicates similar elevation to the DB outfall. A study of mine mapping and stratigraphy may indicate ready communication through the mine under the bed of the Lackawanna between the Phoenix and Marcy shaft areas.

Differently from OFB, flow data for the DB has been collected accurately since 1975. Flow data collected at DB indicates flows ranging from ~1.6 MGD (2.5 CFS) to ~40 MGD (62.1 CFS) with average flows at ~14.5 MGD or 22.4 CFS (Table 6-3). The low flow was measured in November 1999.

As at OFB, the water chemistry of DB has improved over time. DB is now very net alkaline with Fe as the only main pollution constituent. However, the Fe concentration of DB is slightly higher than OFB by ~18 percent. DB inputs ~2,260 lbs/day of iron into the Lackawanna River (Table 6-3).

Another aspect of the NAF mine pools that may have some bearing on long-term considerations for water quality and flow management is the effect of changes in surface elevation, pool depth, and stratification and the relationships of flow and stagnancy. The active part of the mine pools are those waters that infiltrate and flow on the surface strata of the pools, along a horizon that rises and falls with surface precipitation. Below this horizon, there is an interface with deeper pool waters that are increasingly more stagnant and anaerobic at greater depths with the potential for greater amounts of dissolved and suspended solids. Further study of these "sinks" may be warranted.

Table 6-3 Manual flow measurements and field and lab water quality of DB over the 2011-2012 hydrologic year.

Date	Q	F. pH	L. pH	Net Acid.	Cond.	T. Fe	T. Mn	T. Al	SO_4	DO
	CFS	SU	SU	mg/l	uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l
7/7/2011	22.44									
7/22/2011	15.18									
7/22/2011	22.28									
8/12/2011	10.86									
9/2/2011	16.50									
10/7/2011	62.08									
10/25/2011	20.00	6.52	6.70	-72.00	955.00	10.60	2.27	0.10	143.00	4.70
11/7/2011	27.24									
11/18/2011	15.24									
1/19/2012	13.46									
2/8/2012	12.92									
2/23/2012	11.26	5.92	6.40	-39.00	933.00	20.25	2.24	0.14	255.00	3.65
3/16/2012	10.30									
3/29/2012	11.17									
4/13/2012	8.45									
4/25/2012	11.41									
5/10/2012	11.03									
5/17/2012	19.85	5.83	6.60	-68.00	938.00	20.53	2.24	0.12	277.00	2.44
6/21/2012	9.24									
7/5/2012	6.35									
7/11/2012	5.94									
8/10/2012	5.48									
8/16/2012	5.90	6.50	6.40	-72.00	931.00	23.21	2.45	0.05	287.00	
9/12/2012	4.31									
10/12/2012	4.42									
11/7/2012	8.42									
Max	**62.08**	**6.52**	**6.70**	**-39.00**	**955.00**	**23.21**	**2.45**	**0.14**	**287.00**	**4.70**
Avg	**14.30**	**6.19**	**6.53**	**-62.75**	**939.25**	**18.65**	**2.30**	**0.09**	**240.50**	**3.60**
Min	**4.31**	**5.83**	**6.40**	**-72.00**	**931.00**	**10.60**	**2.24**	**0.05**	**143.00**	**2.44**

With regard to pool surface elevation changes, the function of the pool surface to act as a diaphragm and the interaction with atmosphere may also be a useful field of study. The physical morphology of flow and elevation change related to natural and manipulated conditions, effects on water chemistry, and the geophysical aspects relative to surface stability are also an area of long term interest.

6.3 Old Forge Borehole and Duryea Breach Combined Quantity and Quality

If treatment of OFB and DB can be accomplished in one treatment plant as this plan recommends, an analysis of the chemistry of the combined flows is warranted. The following table demonstrates the projected flows and chemistry of the combined average flows of OFB and DB using the data in Table 6-4.

Table 6-4 Projected average water quantity and quality of OFB and DB combined flows.

	Avg Q	Avg Net Alk.	Avg T. Fe	Avg T. Mn	Net Alk. Load	T. Fe Load	T. Mn Load
	CFS	mg/l	mg/l	mg/l	tons/day	tons/day	tons/day
OFB	94.0	69.00	15.18	1.90	17.49	3.85	0.48
DB	14.3	62.75	18.65	2.30	2.42	0.72	0.09
OFB + DB	**108.3**	**68.16**	**15.64**	**1.95**	**19.91**	**4.57**	**0.57**

Further, it has been suggested by Thomas J. Clark, SRBC Mine Drainage Program Coordinator, that if only OFB was treated to possible permit standards for Fe (3.0 or 1.5 mg/l) via an active plant, the treated OFB flow, because it is so large, could then be combined with the untreated flow of DB to make a water product that could be amendable to typical passive treatment (Table 6-5).

Table 6-5 Projected average water quantity and quality of OFB and DB combined flows if only OFB is treated to possible permit standards for Fe (3.0 and 1.5 mg/l)

	Avg Q	Avg T. Fe	T. Fe Load
	CFS	mg/l	tons/day
OFB	94	3.00	0.76
DB	14.3	18.65	0.72
OFB + DB	**108.3**	**5.07**	**1.48**
	Avg Q	**Avg T. Fe**	**T. Fe Load**
	CFS	**mg/l**	**tons/day**
OFB	94	1.50	0.38
DB	14.3	18.65	0.72
OFB + DB	**108.3**	**3.76**	**1.10**

6.4 Abandoned Mine Lands

The surface conditions of land cover and impacts of mining practices in the Lackawanna Valley are a major variable affecting the infiltration of surface flows and groundwater into the mine pools. This plan recommends a number of surface and tributary stream reclamation projects that will reduce some of the infiltration into the mine pools and should also reduce overall discharge.

The Lackawanna River Scarlift Part 2 Report published by PA DER in 1978 contains a comprehensive and still very useful assessment of surface and tributary stream conditions that allow for infiltration of surface waters into the Lackawanna Mine Pools. Some sources of infiltration such as mine fissures into the beds of the river and tributary streams are so numerous and widespread as to be prohibitive when assessed on a cost/benefit basis. Other sources of infiltration such as the vast acreages of stripping pits that provide communication with the mine pool may have wider benefit variables and are more cost effective. Several reaches of tributary streams do present high benefit values relative to costs. Therefore, this report will recommend that stream channel restorations should be considered for these streams. Several of these have very noticeable points of infiltration. Several others have infiltration over several adjacent reaches where restoration can achieve a number of benefits related to public health and safety, flood control, storm water management, environmental restoration and recreation.

The PA DEP Abandoned Mine Land Inventory System (AMLIS) is a GIS database that catalogues much of the flow loss information included in Scarlift as well as an extensive inventory of AML features such as culm banks, shafts and mine openings, strip pits, hazardous structures, and other AML attributes classified by SMCRA priority. As PA DEP or others address reclamation work, the AMLIS database is updated. A map of representing some of the larger Lackawanna AMLs can be found in Figure 6-7.

Priority 1 and 2 AMLs must be reclaimed by PA DEP through the annual SMCRA funding award. Priority 3 AMLs can only be funded by the Set-A-Side funding mechanism or if a hydrolic connection to a Prioirty 1 or 2 AML site can be proved.

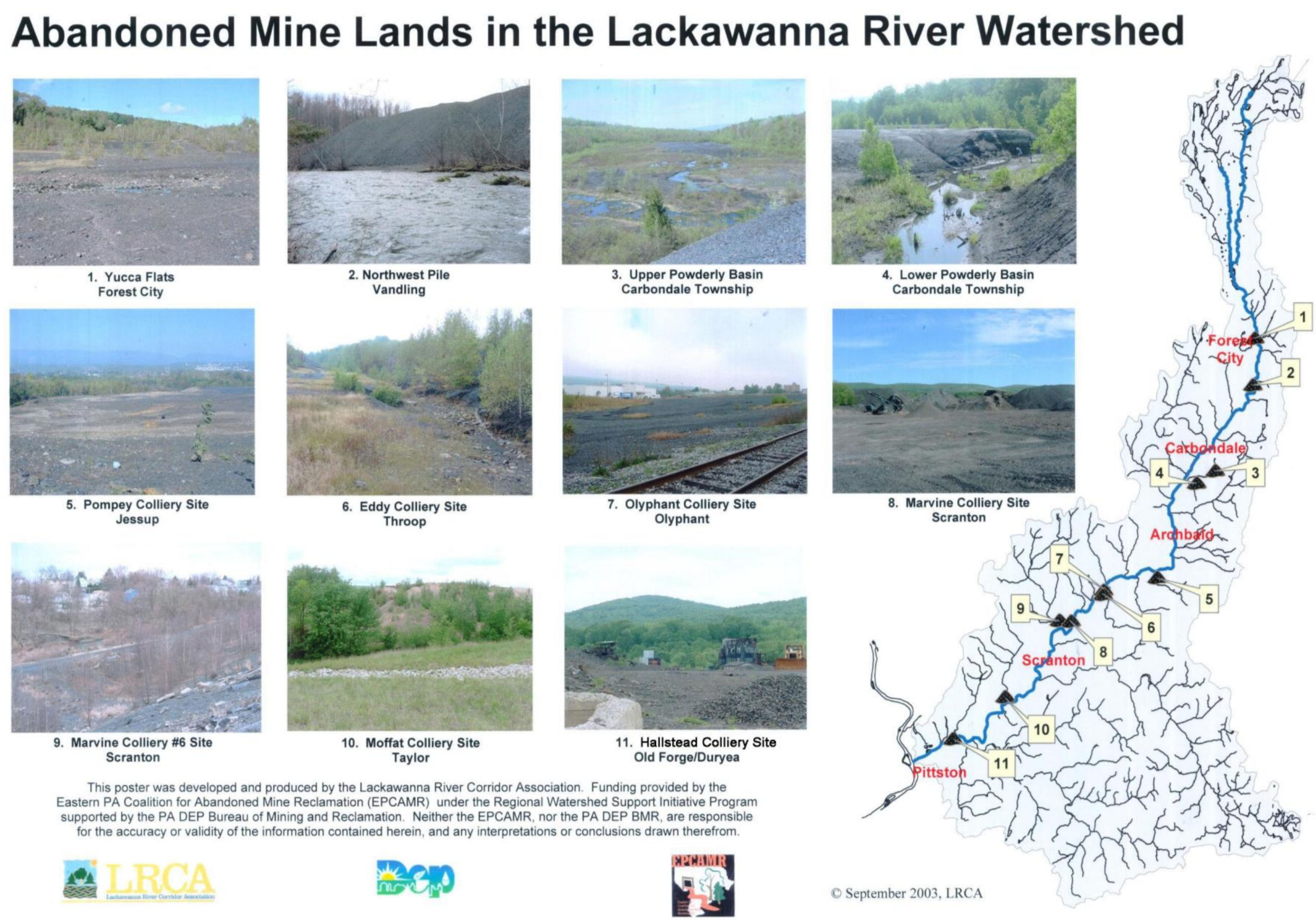

Figure 6-7 Locations and pictures of large AML sites located in the Lackawanna River Watershed.

7 Land Resources

7.1 Abandoned Mine and Quarry Sites

The dominant land cover of the LSCA is surface mining features resulting from topsoil, sand, and gravel quarries along the flood plain and coal strip mining on the terraces and mountain slopes. The area is underlain with abandoned underground mining voids, some flooded, and some above the elevations of the mine pool. Some of the mine voids lying closer to the surface and towards the outcrops along the slope of the West Mountain Ridge have been day-lighted by strip mining.

The surface stability of the undermined areas will remain a challenge for redevelopment of the LSCA. However, the greater overall challenge will be in the topographic disruptions related to un-reclaimed coal strip mines and less than adequate reclamation grading in many areas of topsoil and gravel quarries. The disruption that the mining and quarrying activities have had on the drainage and hydrological functions of the LSCA is pervasive and extensive.

A reclamation program for the area should include restoration of the stream channels of Campbell's Ledge Run and Red Spring Run and its unnamed tributary. This work may also serve to reduce inflow to DB.

The flooded topsoil and gravel quarries adjacent to Coxton Road will require some hydrological studies to determine the sources and direction of their flows. These water bodies have developed as a result of mining and quarry activities during the past fifty years and they show a relationship to the river and the flooded mine pools as well as the above referenced tributary streams.

These ponds have been created incidentally to the quarrying work. Several have functioned to hold water for gravel processing, others are just the result of happenstance where unreclaimed quarry pits have interfaced with hydrological flow and drainage patterns.

Presently these ponds provide only a minimum of ecological habitat value, water quality value, or hydrological regime value. Therefore, this plan recommends that if a major reclamation and redevelopment program is implemented in this area, that a significant element of that comprehensive plan should include a major reconfiguration of these ponds to allow for the improvement of ecological and hydrological functions and that certain portions of these ponds be included in the overall mine drainage treatment program to supplement active treatment.

There are over ten active and several dormant non coal-mining permits and several coal mining and bank reclamation permits across the confluence site in Duryea and in Old Forge (Figure and Table 7-1). The status of these permits will affect the overall needs to cohesively reclaim and repurpose the land uses in this area. Along with the physical aspects of mining and quarrying on the several private properties here, the status of the permits will be a factor in valuation of the real estate. These will also be factors affecting some aspects of the reclamation and redevelopment of the sites.

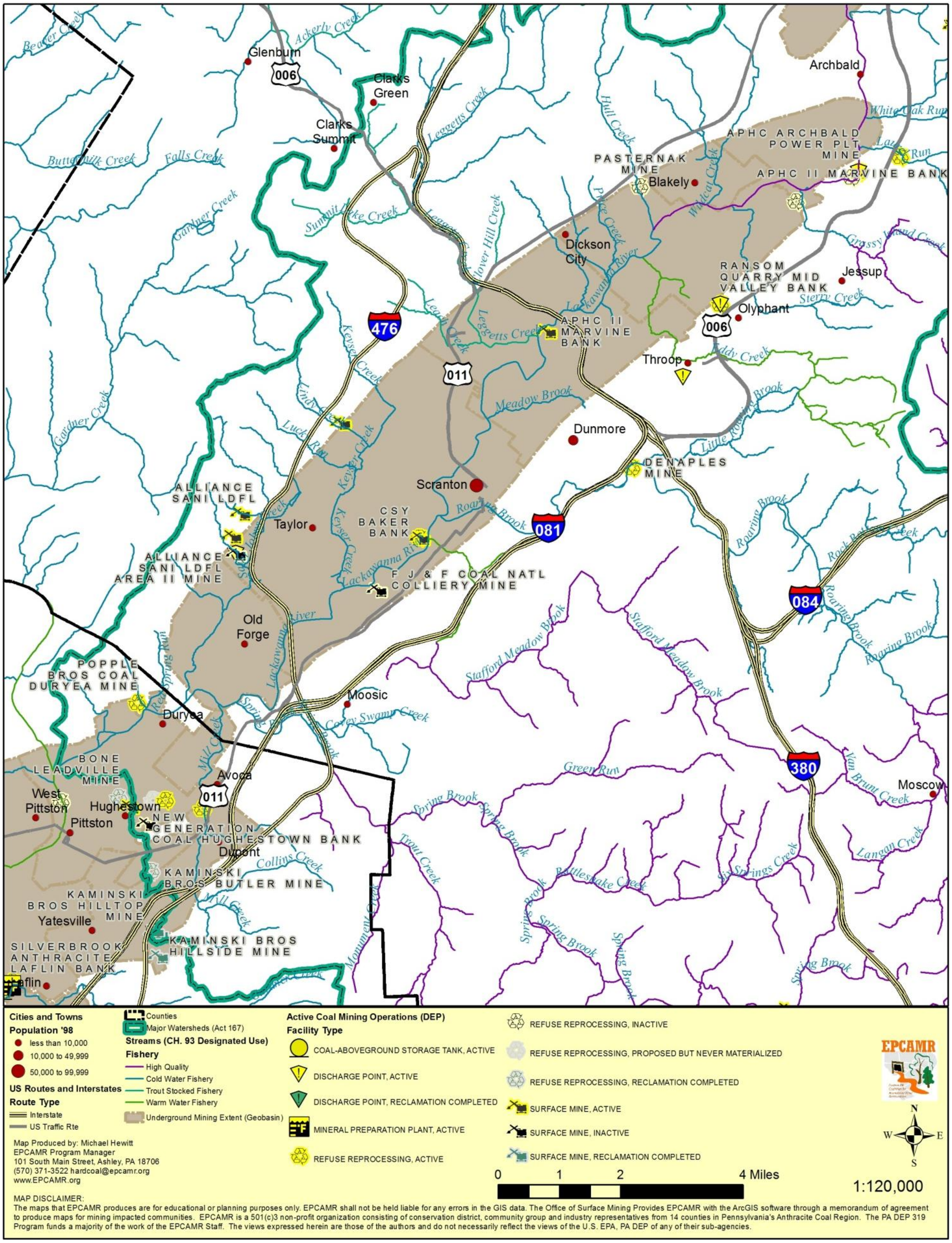

Figure 7-1 Active Coal Mine Permits in the Lower Lackawanna Watershed.

Table 7-1 Active Coal Mining Operations in the Lower Lackawanna (and vicinity).

PRIMARY FACILITY	TYPE	SUBTYPE	CLIENT RELATION	SITE STATUS
PASTERNAK BROS PASTERNAK MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	INACTIVE
SILVERBROOK ANTHRACITE TAYLOR B MINE	SURFACE	SURFACE MINE	Owner	ACTIVE
SILVERBROOK ANTHRACITE SENECA MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	INACTIVE
ALLIANCE SANI LDFL QUARRY	SURFACE	SURFACE MINE	Owner	ACTIVE
ALLIANCE SANI LDFL QUARRY	SURFACE	NPDES DISCHARGE POINT	Owner	ACTIVE
ALLIANCE SANITARY LDFL AREA II MINE	SURFACE	SURFACE MINE	Owner	INACTIVE
APHC ARCHBALD MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	ACTIVE
APHC ARCHBALD MINE	REFUSE REPROCESSING	NPDES DISCHARGE POINT	Owner	ACTIVE
ARCHBALD POWER CORPORATION	SURFACE	SURFACE MINE	Owner	ACTIVE
DENAPLES MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	ACTIVE
DENAPLES MINE	REFUSE REPROCESSING	NPDES DISCHARGE POINT	Owner	ACTIVE
CJC POMPEY BANK 1 MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	INACTIVE
NEW GENERATION COAL HUGHESTOWN MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	PROPOSED BUT NEVER MATERIALIZED
ALLIANCE SANI LDFL AREA II MINE	SURFACE	SURFACE MINE	Owner	ACTIVE
PIONEER EQUIP RENTALS MCCLURE 9 BANK	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	ACTIVE
KAMINSKI BROS BUTLER MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	RECLAMATION COMPLETED
RANSOM MID VALLEY BANK	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	ACTIVE
APHC II MARVINE BANK	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	ACTIVE
ABC COAL HUGHESTOWN MINE	SURFACE	SURFACE MINE	Owner	INACTIVE
F J & F COAL NATL COLLIERY MINE	SURFACE	SURFACE MINE	Owner	INACTIVE
BONE LEADVILLE MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	RECLAMATION COMPLETED
CSY BAKER MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	ACTIVE
LOMBARDO BROS DEV LOMBARDO MINE	SURFACE	SURFACE MINE	Owner	ACTIVE
POPPLE BROS COAL DURYEA MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	ACTIVE
CSY BAKER MINE	REFUSE REPROCESSING	SURFACE MINE	Owner	ACTIVE
RANSOM MID VALLEY BANK	REFUSE REPROCESSING	NPDES DISCHARGE POINT	Owner	ACTIVE
AMERICAN SILT PROC CO/AMERICAN BANK #1 MINE	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	INACTIVE
MINERAL RECLAMATION HEIDELBURG BANK	REFUSE REPROCESSING	REFUSE REPROCESSING	Owner	ACTIVE

7.2 Property Ownership

There are twelve privately owned properties larger than 30 acres that are presently underutilized and that may be considered as important real estate resources for an overall comprehensive restoration and redevelopment plan associated with the development of a mine drainage treatment plant (Figure 7-2). There are another 30 to 40 smaller parcels to residential lot size properties within the planning area which will be directly impacted and may benefit from the reclamation and redevelopment of areas in immediate proximity to the LSCA. There will be secondary impacts and benefits to the wider area in the Connell's Patch and Rosemont Estates neighborhoods in Old Forge, Pittston Junction, Coxton, and Duryea Borough along Main Street and Stevenson Street.

There are five properties, which have the potential to support the installation of a mine drainage treatment plant and subsequently, with additional investment, support related industrial, commercial and conservation uses (Figure 7-2). There are portions of these properties, and possibly several others, which would need to have easements created if horizontal boreholes are necessary to transmit mine pool flows away from their present outfall locations and to a centralized treatment plant. It will be necessary to secure rights-of-way for that purpose which will not interfere with the surface use and enjoyment of the properties by current or future owners. The implications to mineral rights holders will also need to be determined to secure the underground rights-of-way in the interests of developing a treatment works.

For the purposes of this plan the ownership of private real estate remains confidential. The properties considered in this assessment strategic to the development of a treatment works are designated with letters and are described to illustrate their constraints and opportunities relative to the development of the mine drainage treatment plant and potential associated development only. These property descriptions and parcelization may contain actual parcels with separate ownerships and are grouped together for planning purposes. Market valuations of the properties are not included or considered nor are they associated with the immediate goals of this plan. Additional detailed title abstract studies, subsequent market analysis, and availability assessments are needed to further determine future interests in any particular privately owned parcel for the siting of a mine drainage treatment plant.

- SITE A is a 40 to 60 acre parcel fronting along Coxton Road across from the Lower Lackawanna Valley Sanitary Sewer Plant. A 20 plus acre portion of the property contains part of the largest of the pond areas described in previous sections of this plan. Portions of this property could accommodate a treatment plant and associated secondary passive treatment wetlands.

- SITE B is an approximate 180 acre property accessible along Swamp Road and Stevenson Street. Swamp Road, north of its intersection with Coxton Road, is the remnant of a railroad right-of-way associated with the former Lehigh Valley Railroad's Sibley Branch. There are flooded quarry pits on both sides of this right-of-way along the subject property including the upper portion of the larger pond mentioned in the SITE A description above. The topography of this parcel rises in elevation to the west towards the flank of the Campbell's Ledge/West Mountain Ridge. There are extensive and as yet un-reclaimed gravel quarry pits and pre 1977 coal strip mine pits along these terraces.

Quarry operations on a portion of SITE B have recently been closed out. However there are several permits still open on SITE B associated with non-coal mining operations. Closer to the Stevenson Street Bridge near the entrance to the quarry pits there is a cellular communications tower. This portion of SITE B offers several sites where the feasibility of a mine drainage treatment plant should be investigated. This location is approximately one mile equidistant from OFB to the north and DB to the southeast. It is readily accessible from Stevenson Street and Main Street in Duryea.

- SITE C lies on a portion of a 100+ acre anthracite coal bearing property referred to as the William "A" Colliery. The portion of this parcel that is located adjacent to Swamp Road and Stevenson Street offers another preferred location for a treatment plant being immediately adjacent to that site just described on SITE B. This area of SITE C should be included in the considerations for a feasibility study. SITE C includes a number of sub-parcels including apparently a small one that features OFB itself. Additional title abstract work will be needed to confirm this preliminary assessment.

- SITE D lies just to the north of SITE C. It consists of a number of sub parcels together comprising ~100 acres. It is referred to as the Bel-Air Yards of the William "A" Colliery. It lies partially in Duryea in Luzerne County and partially in Old Forge in Lackawanna County. It is accessible from Connell Street in Old Forge. There are several open coal mining permits on this parcel. The parcel features several piles of culm materials. Several tenants occupy portions of the parcel conducting mining, equipment repair, and environmental response services. SITE D features several sites which should be considered for a feasibility assessment for a treatment plant. The lower portion of the parcel could be made accessible from Swamp Road and Stevenson Street with some roadway and driveway improvements. The lower portion of the parcel should be considered in a feasibility study as an alternative site for a treatment plant.

- SITE E includes several parcels of different ownership along the east bank of the river. One of these parcels holds DB. A preliminary review of Luzerne County tax parcel records shows that DB may be located on a privately owned parcel and that its outfall channel runs into what may be considered the watercourse of the Lackawanna River in an area known as Everhart Island, which may be considered as "waters of the Commonwealth". Additional title abstract work is necessary to confirm ownerships and jurisdictions of all of these primary parcels.

- SITE F includes the Lower Lackawanna Valley Sanitary Sewer Authority treatment plant along Coxton Road.

- SITE G is an approximate 80 acre parcel located between the treatment plant and the Reading and Northern Rail Road Coxton Rail Yards. This parcel holds flooded gravel quarry pits and an area of flood plain riparian forest cover. Its western edge along Coxton Road holds a portion of the former Lehigh Valley Sibley Branch Right-of-Way. This rail right-of-way is of interest and should be conserved in the event that there is a need or interest to extend rail service to the proximity of the mine drainage treatment plant. The balance of SITE G may have conservation uses.

- SITE H is the Reading and Northern Railroad Coxton Yards. It is several hundred acres of very active railroad operations with rail links to the Canadian Pacific, Norfolk Southern, and CSX Railroads. The Coxton Rail Yard runs from Pittston Junction, crossing the Lackawanna River and following the Susquehanna River northwesterly through the Wyoming Water Gap below the Campbell's Ledge escarpment. The Coxton Yards property also holds several important cultural sites that are managed by the Frances Dorrance Chapter of the Pennsylvania Archaeological Society in cooperation with the Reading and Northern Railroad Company. The development of a mine drainage treatment plant and associated industrial activities may engender an economic synergy with rail operations. It is an objective of this plan to encourage that synergy. The remnants of the Lehigh Valley Coxton Round House and locomotive shop and service structures are located at the western end of the rail yard. There was a used auto tire storage pile located here that caught fire approximately 20 years ago. The remnant tire pile still contains several thousands of tires in need of removal.

- SITE I is a 33 acre parcel immediately at the LSCA at Coxton Point. It contains the remnants of excavated topsoil pits that are partially inundated with ground water seeps of mine drainage waters associated with the Twin Shaft disaster site. This parcel known as the Coxton Point Preserve is owned by the Lackawanna Valley Conservancy, a not-for-profit land trust affiliated with the LRCA.

- SITE J is a 66 acre parcel of former topsoil pits that is owned by Waste Management Corporation. It holds a wetland mitigation project and is managed for conservation purposes.

- SITE "K" is an approximate 60 plus acre site located in the City of Pittston. It lies between the Lackawanna River across from Coxton Point and is bounded on the landward by tracks of the Reading and Northern Railroads and the Luzerne County Redevelopment Authority. There are several seeps of mine drainage from the Twin Shaft mine area. The remnant of the Twin Shaft entry was located on this parcel near the rail grade. It has recently been sealed and the surface features removed by redevelopment work presently under way on the property.

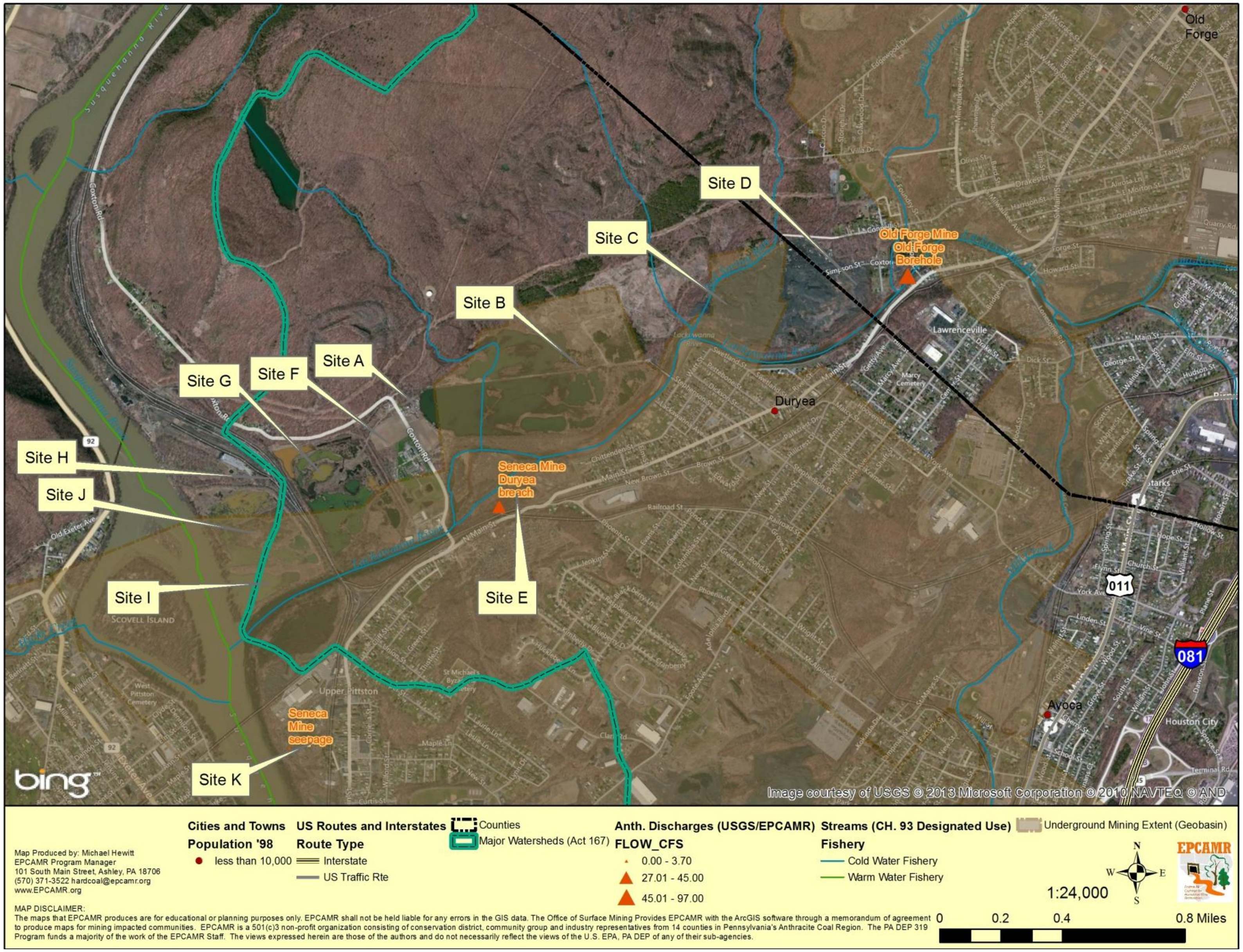

Figure 7-2 Possible Large (30+ acre) Sites for Mine Drainage Treatment within the Lackawanna Susquehanna Confluence Area.

7.3 Developmental Constraints

There are several sets of constraints to the redevelopment of the LSCA encompassing the primary and secondary parcels as described in the previous section. Some of those constraints extend to the third set of parcels and existing business sites in the Lower Lackawanna area between Old Forge and Pittston. These constraints are physical, infrastructural, and jurisdictional.

The physical constraints are related to the physical condition of the land with the presence of AML impacts, disruption of the natural topography, soil, and geologic structure impacts, compromised drainage patterns related to surface strip mining, and gravel quarrying and subsurface stability issues related to subterranean mining conditions. Other physical constraints relate to the degree of slope on the upland portions of the area and the presence of potentially recoverable anthracite coal reserves.

The primary constraint on the very large flood plain area is the impact of 500 year flood events on the Susquehanna River. Two such events, Agnes in 1972 and Lee in 2011, have flooded large portions of the LSCA. The need to retrofit critical infrastructure, such as the Lower Lackawanna Valley Sewer Plant, to protect and flood proof are included in this plan as recommended actions. All other facility development within the 500 year flood range will need to be designed to absorb and sustain flood damages, have critical portions protected, or included in a loss calculation program.

The second set of development constraints in the LSCA is the inadequacy of infrastructure, especially roads and bridges. The road network along the main street corridor from Old Forge through Duryea to Pittston is grossly insufficient to support expanded development. The steel truss that carries Main Avenue over the Lackawanna River between Old Forge and Duryea is falling apart. The roadway lanes are restricted. Weight limitations are likely in the very near future. Another bridge nearby carrying Main Avenue in Moosic over Spring Brook has collapsed and has been closed for over a year. The intersection of Coxton Road with Main Street is archaically obsolete.

There are several potential alternative roadway corridors, which could connect Keyser Avenue to Main Street via the west side of the Lackawanna River. One specific alignment could roughly follow through the Connell’s Patch neighborhood near Pagnotti Park, crossing into Duryea, then to “paper streets” such as Swamp Road to Coxton Road. This again highlights the need for a redesigned and expanded intersection at Coxton Road and Main Street.

A larger and bolder proposal would upgrade the Keyser Avenue /Swamp Road alignment as a multi-lane carriageway through the LSCA along the base of the West Mountain to the vicinity of the Coxton Yard Round House. At that site, a flood damaged orphan railroad bridge could be removed and replaced with a new roadway bridge to carry this new roadway across the Susquehanna to a junction with Pa Route 92, a major road corridor linking Pittston and Tunkhannock.

This proposal could be further expanded to up-grade the Back Road alignment from the Route 92 junction all the way to intersect with the Route 309 Cross Valley Expressway in Luzerne. This would effectively provide a multi-lane arterial along the base of the West Mountain from the Wyoming Valley to link to the PA Turnpike Keyser Avenue exit in Taylor.

Upgraded intersections and capacity improvements at Union Street-Main Street in Old Forge, Stevenson Street at Main Street in Duryea, and Coxton Road at Main Street in Duryea are needed. In addition, a roadway plan to upgrade Swamp Road in Duryea and align it with Coxton Road-Union Street intersection and or Connell Street and Villa Drive- Keyser Avenue in Old Forge are recommended as an action to the Luzerne Lackawanna Metropolitan Planning Organization. Getting several of these projects developed and advanced on the Regional Transportation Improvement Plan and included in the Commonwealth's 12-year Transportation Plan will enable the redevelopment of the LSCA to advance.

The third major constraint to development in the Lower Lackawanna is that the area is divided by being in two counties and three municipalities. There is no comprehensive plan for the area nor has there been an advocate working to advance the restoration and redevelopment of the area in any effective way across the regional stage.

7.4 Developmental Opportunities

The Lower Lackawanna Confluence Coalition (LLCC), a community based partnership of stakeholders, is offered as a recommendation in this plan to create an entity with focused community participation to act as an advocate to advance the agenda for a restoration program for the LSCA.

In order to build a consensus for these recommendations and for the establishment of the LLCC with a mission to advocate for the LSCA needs, LRCA is reaching out to property owners, business interests, and elected officials at the local, regional, and state level to share the perspective contained in the overall set of recommendations in this LLR-WRAP.

The Borough of Duryea has been advocating for the modernization of the intersection of Coxton Road and Main Street. The Borough and local legislators are collaborating to advance this work and secure project design funding in the Regional Transportation Improvement Plan (TIP). The LLR-WRAP recommends that the Coxton Road Main Street intersection project be advanced with the highest priority on the Luzerne-Lackawanna MPO TIP. This plan also recommends that the replacement of the Old Forge Main Street Lackawanna River Bridge be advanced on the MPO TIP as well.

The LRCA, EPCAMR, and SRBC will continue to collaborate and involve the PA DEP BCR and BAMR with the completion of the QHUP for Lower Lackawanna River. The qualification of these AMD discharges and AML sites will allow federal abandoned mine reclamation funds to be used to develop an AMD plant at an appropriate location near the boundary of Old Forge and Duryea. This LLR-WRAP suggests that several development synergies can be harnessed using the development of the AMD treatment plant as a factor that can engender related industrial and commercial development.

The further development of the LLCC into a Community Development Corporation with a mission to create the roadways and other infrastructures needed to facilitate a treatment plant can serve to open portions of underutilized adjoining properties for redevelopment in the context of a comprehensive Lower Lackawanna Confluence Development Plan.

An AMD treatment plant may attract users of iron oxide byproducts, consumptive water users, alternate energy interests, or water resource companies and others serving the nearby shale gas industry. The proximity of rail service and the opportunity to extend that service a short distance to several of the alternative AMD plant sites can also create business development synergies.

The primary objective of this LLR-WRAP is the installation of an AMD treatment plant. That installation can be accomplished without many of the secondary suggestions offered above. Modest improvements to the Union Street-Main Street intersection and similar upgrades to Stevenson Street and onsite roadway construction in the context of a subdivision development for the treatment plant can open several of the alternative plant sites within the cost arena of a small 20 to 30 acre industrial or commercial site. This will continue to be the goal advocated by LRCA, to get a PA DEP SMCRA funded AMD facility constructed and operational within the next 10 years or sooner.

However, since just the AMD treatment goal holds many challenges and variables, advancing the larger goal-set for the LSCA remains an opportunity waiting for an advocate. LRCA will continue to collaborate with all stakeholders to advance the formalization of a LLCC.

8 Lackawanna Confluence Eco-Industrial Development Program Recommendations

1. This plan recommends the incorporation of a new 501-C(3) not-for-profit corporation called the Lower Lackawanna Confluence Coalition (LLCC) with a broad enough mission that it can:
    a. Acquire funding and other resources to acquire land, easements and design, develop, permit, construct and employ or contract staff to operate a mine drainage treatment works and immediately related utility, conduit and roadway improvements to treat the OFB and DB outfalls.
    b. Function as a community development corporation to develop financial and investment collaborations to acquire real estate directly itself or form real estate ownership collaborations to design, permit, and develop the road and utility infrastructure and an industrial subdivision that will function as an Eco Industrial Conservation Park.

2. This plan recommends that the Boards of Directors of the LRCA and EPCAMR institute a cooperative agreement with a goal to incorporate the LLCC as a not-for-profit charitable and educational organization consistent with section 501 C(3) of the Internal Revenue Code of the United States.

3. The LLCC will be affiliated with the LRCA and have a distinct mission to acquire the resources and work with the Commonwealth of PA and other agencies, public and private, to design, build and operate a mine drainage treatment works to treat mine water drainage in the LSCA.

4. The LLCC, functioning as a community development corporation, will have a further mission to work with public and private agencies to facilitate additional planning and investment programs with a goal to create a Lower Lackawanna Eco Industrial Park.

5. This plan recommends that the Lackawanna County Commissioners, the Luzerne County Council, the Boroughs of Old Forge and Duryea, and the City of Pittston adopt resolutions supporting the recommendations in this plan to develop a mine drainage treatment works in the LSCA and further designate representatives to serve on a working group with LRCA , EPCAMR and SRBC representatives to facilitate the incorporation and mission of the LLCC.

6. This plan recommends that the LLCC develops cooperative agreement with the Lower Lackawanna Valley Sewer Authority (LLVSA) to utilize the capacity of the governmental powers of the authority as a major planning and implementation partner within the LLCC to develop and operate the mine water treatment works and to facilitate related programs.

7. This plan recommends that the members of the General Assembly and Senate of the Commonwealth of PA in the Luzerne /Lackawanna County region collaborate with the LLCC to support the further development of the mine drainage treatment plant and the related development of the Lower Lackawanna Eco Industrial Park.

8. This plan recommends that the Governor of PA consider the opportunities inherent in this plan and designate members of his executive and regional staffs to collaborate with LRCA and the LLCC to facilitate its mission to get a mine drainage treatment works constructed and to facilitate the further development of the Lower Lackawanna Eco Industrial Park. This collaboration will include the facilitation of funding applications and permit applications through appropriate agencies and other policy considerations to prioritize the goals and mission of the LLCC.

9. This plan recommends that PA DEP BCR prioritize the review and adoption of a QHUP status for the Lower Lackawanna River, particularly the OFB and DB Outfalls, and collaborate with the LLCC to advance the design, construction, and operation of a mine drainage treatment plant at an appropriate site in the LSCA. This plan further recommends that PA DEP BAMR work with adjacent property owners to facilitate surface mine reclamation needs as may be identified in conjunction with the development of the mine drainage treatment works and the proposed eco industrial park.

10. This plan further recommends that the PA DEP Bureau of Water Quality facilitate the plan review, permitting process, and interagency coordination with other regulatory agencies on the state and federal level for the mine drainage treatment works and associated development deriving from this plan.

11. This plan recommends that the Northeast Pennsylvania Congressional Delegation collaborate to support the plan recommendations and facilitate applications for federal funding and permitting review as may be needed.

12. The plan recommends that local economic development agencies collaborate on marketing and facilitate investment referrals as may be appropriate.

Acronyms and Abbreviations

AMD - abandoned mine drainage
AML - abandoned mine land
AMLIS - Abandoned Mine Land Inventory System
BWT - Butler Water Tunnel
CMP - Central Mine Pool
CWA - Clean Water Act
CSO - combined sewer overflows
CFS - cubic feet per second
DB - Duryea Breach
EPCAMR – Eastern Pennsylvania Coalition for Abandoned Mine Reclamation
EPA - Environmental Protection Agency
FPW – Foundation for Pennsylvania Watersheds
GIS - geographic information system
Fe - iron
KW - kilowatts
LLCC - Lower Lackawanna Confluence Coalition
LLR-WRAP - Lower Lackawanna River Watershed Restoration and Assessment Plan
LLVSA - Lower Lackawanna Valley Sewer Authority
LLWSG - Lower Lackawanna Watershed Stakeholders Group
LRBSA - Lackawanna River Basin Sewer Authority
LRCA – Lackawanna River Corridor Association
LSCA – Lackawanna / Susquehanna Confluence Area
LWV - Lackawanna-Wyoming Valley
MSMP - Metropolitan Scranton Mine Pool
MGD - million gallons per day
MCHU - multi-colliery hydrogeological units
MS4 - Municipal Separate Storm Sewer System
MPO TIP – Metropolitan Planning Organization Transportation Improvement Plan
NPDES - National Pollution Discharge and Elimination System
NAF - Northern Anthracite Field
#9MP - No. 9 Mine Pool
OFB - Old Forge Borehole
OSM - Office of Surface Mining (U.S. Department of the Interior)
PAWC - Pennsylvania American Water Company
PA DEP – Pennsylvania Department of Environmental Protection
PEC - Pennsylvania Environmental Council
PG&W - Pennsylvania Gas and Water Company
lbs/day - pounds per day
QHUP - Qualified Hydrologic Unit Plan
SRBC – Susquehanna River Basin Commission
SMCRA - Surface Mining Control and Reclamation Act
TMDL - Total Maximum Daily Load
USBM – United States Bureau of Mines
USGS - United States Geologic Service

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