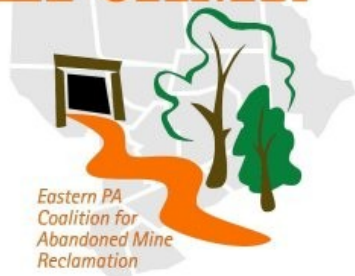


EPCAMR



September 14, 2011

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Dan Koury, Watershed Manager
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RE: Mine Reclamation-Eastern Pennsylvania (Project # PD060367) Final Report

Dear Dan:

EPCAMR's project has ended and we wanted to take this time to reflect on the planning, implementation, research, hydrogeological investigations, mine pool mapping, and our ability to utilize our best professional judgment to evaluate our project completion. Contained within this letter, you will find our Final Report, which includes a Narrative Description of the Project, answers to the questions (a-h) proposed under the ***Final Report Guidelines from 2006***, when our project was first granted, a Summary in 50 words or less suitable for sharing with the public, and a Summary of our Goals and Accomplishments.

The actual 200 page, detailed Technical Report, entitled ***MINE WATER RESOURCES OF THE ANTHRACITE REGION OF PENNSYLVANIA***, along with Digital Photographs, Mine Pool Maps, Mine Map Cross Sections, Tables, Charts, Graphs, Figures, and Financial Documentation (in the form of a ***Final Application for Reimbursement Following Standard Procedures*** were mailed on June 30, 2011). All of the referenced Appendices have been mailed along with the report on a CD on September 6, 2011 and should reach you by the end of the week or early next week.

1. Narrative Description of the Project:

a.) A comprehensive updated inventory of underground mine pools or mine pool complexes currently does not exist for Pennsylvania. It is not our intent to go into great detail about abandoned mine drainage (AMD) discharges throughout the entire Anthracite Coal Region in this Project. Our focus is supposed to be on obtaining the elevations of the mine pools, determining the potential storage capacity in the mine pools, calculating volumes estimates of mine water contained within the mine pools, the reuse of mine pool water, determination of current flow patterns of underground mine water, and making our best professional judgments on hydrogeological connections from one multi-colliery hydrologic unit to other. EPCAMR has a great desire to allow for all partners and the general public involved to gain a better understanding of the underground mine pool complexes of the Anthracite Region. This Project contains some general information applicable to all four Anthracite Coal Fields, and some specific information for these fields, as well. Other parts of this Project will include reports that will deal mostly with the Western Middle Coal Field and some investigations into the Southern Coal Field. This Project focuses on some aspects of the Northern and Eastern Middle Coal Fields that have been the subject of many other reports. Those two fields, respectively, will be looked at further by EPCAMR in other projects of shared importance in the future. This Project also references some of the out of print, obscure, hard to find, and otherwise, unavailable reports and studies on the Anthracite Coal Fields.

Far more is known about the stratigraphy of the Bituminous Coal Region of western Pennsylvania than the Anthracite Coal Region. This is for several reasons, including the abundance of drill hole data, the availability of paleontological information, and the fact that it is less difficult to correlate strata between drill holes and other exposures in the relatively flat-lying strata of the Allegheny Plateau than in the structurally complex Anthracite coal region. The stratigraphy of the Anthracite Region of eastern Pennsylvania has not been studied as extensively as that of Pennsylvania's bituminous coal region. Geologic and mining engineering work done in the Anthracite Region over the past 150 years documents some significant stratigraphic differences between the Anthracite and Bituminous Coal Regions. The complexity of the geologic structure, resulting in nearly vertical beds of coal and other rocks in some areas of the Anthracite fields, has impeded the acquisition of stratigraphic data from routine exploration drilling. Detailed mine maps of the abandoned underground mines and cross-sections through vertical shafts and nearly horizontal tunnels have added to the understanding of the structure and stratigraphy of the Anthracite coal fields, however most stratigraphic efforts have been directed toward coal seam delineation.

b.) EPCAMR has undertaken the challenge of digitizing and geo-referencing hundreds of these mine maps in the Anthracite Region over the last 5 years to create the most comprehensive digital collection of underground mining maps, complete with cross-sections, and 3-dimensional structural contour models of some of the major marker Anthracite coal beds including the Mammoth Vein and the Buck Mountain Vein. EPCAMR completed the majority of the mapping for the Western Middle Anthracite Coal Fields underground mine pools, major coal seams that were extracted, locations of boreholes, current mine pool surface elevations, a portion of the Southern Anthracite Coal Fields, and an even greater understanding of the multi-colliery hydrogeologic units of underground mine pool water that flow beneath the coal fields, with the completion of this Project.

EPCAMR worked with our independent Researcher, Ian C. Palmer to gather water quality data from surface mining permits for the entire coal fields that were only in paper copy and converted them to an electronic database format. Unfortunately, our leading Professional Geologist passed away in March 2010. He was assisting EPCAMR with the development of determining the multi-colliery hydrologic units for the underground mine pools, leaving EPCAMR to figure it out for ourselves, upon reviewing voluminous notes from our Professional Geologist and the Geologic Cross Sections and Office of Surface Mining Folios Maps. This element of the plan for completion of the project exhumed a large amount of EPCAMR Staff time that had already been working on the development of the GIS portion of the Project. The time it took EPCAMR to complete the work required us to request an extension of the project, which was granted until June 30, 2011.

The hydrogeology of the Anthracite and Bituminous Coal Regions of Pennsylvania is the product of the topography, geologic structure and stratigraphy of these regions. Whereas the Bituminous Region has a more conventional integration of these geologic factors, the hydrogeology of the Anthracite Region is largely controlled by the hydrology of the mine pools related to large abandoned underground mine complexes, or collieries as they are called in the region. However, in considering the integration of these geologic factors, the hydrogeology of the Anthracite Region is much simpler in some respects, while being more complex than the bituminous regions hydrogeology in other respects. Part of the simplicity is that a large portion of the groundwater in the four Anthracite coal fields is accounted for by about **100** large mine pool discharges, in comparison to the many thousands of mine drainage discharges and AMD seeps in the Bituminous coal fields of Pennsylvania. In addition, much is known about the areal extent,

depth and other aspects of the geometry and hydrology of the Anthracite mine pools along with their interconnections from the detailed mine maps that are available for most of the abandoned deep underground mines.

The complexity of the Anthracite Region hydrogeology is largely a result of the complexity of the geologic structure and how that complex structure is translated into an elaborate system of mine development patterns, including numerous overlapping gangways, chutes or breasts, and slopes, that are interconnected by nearly horizontal rock tunnels and vertical shafts. The configuration of anticlinal and synclinal folds and the presence of significant faults can often be interpreted from the mine development patterns on the colliery maps. The gangways are frequently significant components of groundwater flow patterns, analogous to the conduit and sinkhole systems in karst hydrology, because the gangways are long voids developed parallel to the strike of the beds, that are often connected vertically to the land surface by cropfalls (mine subsidence features), which resemble sinkholes and promote infiltration of surface water into the groundwater flow system. EPCAMR describes the underground mining operations for the layperson to be able to understand how mining was completed.

c.) EPCAMR believes that our successes were the following:

1. The completion of the updated 200-page ***MINE WATER RESOURCES OF THE ANTHRACITE REGION OF PENNSYLVANIA*** Report.
2. The completion of the **EPCAMR Mine Drainage Water Quality Samples Inventory Database**
3. The complete mapping of the Western Middle Anthracite Coal Fields and portions of the Southern Anthracite Coal Fields using the best available mapping resources available
4. The creation of new GIS layers related to the underground mining features throughout the Anthracite Region
5. The completion of the **Mine Pool Hydrology in the Eastern Half of the Western Middle Anthracite Coal Field (Schuylkill County): Colliery, Basin(s), Pool(s), Borehole(s), Barrier(s), Discharge(s), Water-filled Pit(s)**
6. The completion of an exhaustive compilation of mine water reuse projects, ideas, and cost estimates
7. The completion of the **USGS's Water Budgets & Groundwater Volumes for Abandoned Underground Mines in the Western Middle Anthracite Coalfield, Schuylkill, Columbia, & Northumberland Counties, PA—Preliminary Estimates with Identification of Data Needs** Report

8. EPCAMR Staff becoming the only two non-profit environmental professionals from across the country to become trained in *EarthVision 2D & 3D Software Technology* to aide in the technical challenges of mapping out the underground mines in Northeastern PA's Anthracite Coal Fields.

- d.) Some of the problems that were encountered were that our ability for our EPCAMR computers to utilize the software that we were running to produce the GIS Mapping in ArcView ArcGIS v10 and to run the 3D Models. Our laptops are several years old and not up to speed when it comes to operating speeds and being the most efficient operating systems around. were fairly slow and inconsistent. EPCAMR would experience crashes on numerous occasions for no reason and lose some data and have to start all over, even after autosaving our work, repeatedly. We also needed to purchase additional hardware (external hard drive) that were external to our lap tops to store data because the OSM Mine Map Folios were very large, in terms of storage capacity and file size. We also had to compress files that were very large into a format that was easy to use and could be sent electronically to technical team members. Files became very large and cumbersome to work with and we could not send most of them electronically. We had to burn the data to a CD and mail it to our technical team members and then wait for a response.

The passing of Roger Hornberger, our independent Professional Geologist, mentor, and friend dealt a big blow to the Project. He had a vision to see this Project through and guided us along the way until his premature death. This situation caused the EPCAMR Staff to take on an additional workload that took us an extra year to complete the project because, not only did we have to transcribe many of Roger's notes, which were on several dozen notepads, we had to also continue to write the report in the same process that he had utilized as we laid out the Chapter Plans early on in the Project. Thankfully, the EPCAMR Staff have nearly 20+ years combined between the two of them of Anthracite History, Geology, AMD, and water quality associated with mine pools. We asked for the extension and it was granted. Another problem was a reduction in funding for the Project that was originally proposed caused EPCAMR to have to provide nearly \$54,560 in matching funds alone (far exceeding the match requirements for the grant) matching funds that we could not get reimbursed for at the end of the Project. This did not take into account the value of the software, equipment, and technology that were being used by EPCAMR to produce the GIS and the Mine Pool Mapping work. There was a reduction of \$50,000 from the initial project request for funding. Fortunately, towards the end of the project, EPCAMR was able to request that the remaining funds that could not be utilized by our independent contractor who passed away, were

1. better characterization of the locations and volumes of mine pools on a regional level;
2. better characterization of the variation in water quality parameters at various mine pools on a regional level;
3. hydrological information relating to recharge rates of the mine pools;
4. funding of more regional mine pool evaluations for industrial reuse and economic redevelopment within PA;
5. provide a clearinghouse of reference documents and reports on mine pools, water quality, mining, AMD, water resources, coal mining, research and development, special investigations, and other materials that could be made available online in one location, such as the www.amrclearninghouse.org , www.treatminewater.com , www.epcamr.org site, in addition to the PA DEP website, www.dep.state.pa.us
6. funding for water quality monitoring equipment and devices that can be fished down existing boreholes to obtain water quality data from various depths from within the mine pool complexes and multi-colliery hydrologic units
7. the potential for ground surface subsidence as water is drawn down or removed from mine pools;
8. additional support for private investment opportunities from the private sector in creating partnerships that can capitalize on the reuse of the mine pool water and the mineral extraction of the iron oxides, manganese oxides, and aluminum oxides most commonly found in our AMD Treatment Systems and on our stream beds upon precipitation outside of the mines;
9. additional funding for GIS and 3-D Software packages and extensions that will drive the innovation of the mine mapping technology to the forefront of the mining industry;
10. increased partnerships with the mining sector to obtain additional mine pool maps and coal mining maps that are not necessarily proprietary to the company and would benefit the entire community where existing AMD problems within the watersheds exist where they operate;
11. provide funding for EPCAMR to train PA DEP District Mining, Professional Geologists, Surface Mine Inspectors, Water Pollution Biologists, GIS Technicians, and Hydrogeologists Staff on the use of Earthvision9 and R2V software;
12. the feasibility of using mine pools as heat sinks over several decades;
13. fund an re-establish a long term borehole and shaft monitoring program
14. develop actual costs associated with treatment, pumping, and piping mine pool water;

15. development of clear Federal and State policies on withdrawal of the mine pool water and the determination as to whether or not it is solution mining due to the dissolved mineral rich nature of the water;
16. additional boreholes drilled within each of the 4 coalfields to obtain better water elevation data across the mine pools;
17. funding for the replacement or daylighting of existing boreholes throughout the Coal Fields to obtain additional water elevation levels on a monthly or more frequent basis;
18. create an awareness campaign to alert local municipalities and PA Department of Transportation of the need to not tar patch, coat, seal, blacktop, or cap, boreholes within their road infrastructure system;
19. continued entry into the water quality database created by EPCAMR at the District Mining Offices throughout PA to develop a comprehensive digital and electronic copy of water quality data from the Surface Mine Permit files as opposed to continuing to file paper copies within the permit that do not lend themselves to interpretation graphically as they do in a database format that can be used in GIS;
20. create a Mine Map Index within the District Mining Offices that is available for public review based on colliery divisions and or mine pool multi-colliery hydrologic units;
21. evaluation of mine pool resources in other states for comparison;
22. tie our efforts into the Flood Forecasting System with the National Weather Service, NOAA, and the SRBC, given the most recent flooding issues that has occurred throughout Northeastern PA, particularly in the Wyoming Valley;
23. The completion of the **Mine Pool Hydrology in the Western Half of the Western Middle Anthracite Coal Field (Schuylkill County, Columbia, Northumberland): Colliery, Basin(s), Pool(s), Borehole(s), Barrier(s), Discharge(s), Water-filled Pit(s)** needs to be completed
24. The completion of the **Mine Pool Hydrology in the Southern Anthracite Coal Field (Schuylkill and Dauphin County): Colliery, Basin(s), Pool(s), Borehole(s), Shaft (s), Barrier(s), Discharge(s), Water-filled Pit(s)** needs to be completed; and
25. improve the coordination and sharing of information efforts on the subject of mine pool mapping between State and Federal agencies in collaboration with Colleges, Universities, EPCAMR, Deep Mine Safety, and the National Mine Map Repository so that maps are readily accessible.

g.) EPCAMR plans to disseminate the results of our work, once cleared by the PA DEP through our online website at www.epcamr.org and our FaceBook Account Social Media outlet (Type EPCAMR) and through reaching out to the regional news media outlets following a press release on the completion of our

work. A link to the 200 page Technical Report will be made available our website as well. GIS files will be made available and Maps can be purchased from EPCAMR for the use of our color plotter if large-scale maps need to be utilized by agencies, municipal governments, local community groups, and other region non-profit users. EPCAMR will also be submitting an abstract to make a presentation at the 2012 PA Annual Abandoned Mine Reclamation Conference.

h.) Our spending didn't align with our modified budget very well. It aligned with our original budget very closely. Technically, EPCAMR was over budget, due to the amount of funding that we received, but if one looked at the amount of matching funds generated for the project, one could make a case that the Project was underfunded in the Salary/Benefits and Equipment/Supplies categories. This Project was a very data intensive process and technical report interpretation and writing. Field analyses could have been greater and used more often, if time prevailed and allowed for future field investigations. If other equipment had been considered in the initial grant, EPCAMR probably could have monitored the water quality of the mine pools as well. Possibly, that can occur in a future grant opportunity.

2. Summary in 50 words or less suitable for sharing with the public:

EPCAMR has digitized and geo-referenced maps in the Anthracite Coal Fields to create a comprehensive digital collection of underground mining maps, geologic cross-sections, faults, tunnels, underground mine pools, major coal seams that were extracted, locations of boreholes, current mine pool surface elevations, and 3-dimensional structural contour models of some of the major marker PA Anthracite coal beds. This Project will provide an even greater understanding of underground mine pool water.

3. Accomplishment Worksheets-See Accomplishment Worksheet Categories Completed Below that corresponded to the Watershed Assess & Development of Watershed Restoration and/or Protection Plans

a. Area Assessed-

~**58,443 acres** (91 sq. miles) for the Southern Coal Fields

~**54,912 acres** (85.8 sq. miles) for the Western Middle Coal Fields

b. Data Gathered-

24,375 individual sampling data events, **579** water quality monitoring points

c. Monitoring Measurements-

Compiled **20** years worth of water elevation data from PA DEP BAMR on **30** boreholes and **15** shafts in the Western Middle and Southern Coal Fields, respectively

d. Maps Developed-

10 C-Series Maps, **3** Mine Pool Maps, **1** Anthracite Region Colliery Boundary Map

e. Surveys Completed-

- **163** Mine Pools and hydrogeologic basins digitized for the Western Middle and Southern Coal Fields, of which **112** were separate mine pools in the underground abandoned mine workings, according to the Ash Reports, **51** were separate areas that drain to a mine pool or an aboveground outlet, not defined by Ash, but were discovered by other surveyors at a later time;
- **12** new Western Middle Coal Fields Mine Pools were delineated by EPCAMR
- **69** Western Middle Coal Fields collieries were delineated by EPCAMR that contained **19** multi-colliery hydrologic units (MCUs)
- **60** Southern Coal Fields collieries were delineated by EPCAMR that contained **20** multi-colliery hydrologic units (MCUs)
- **27** Infiltration points were found by EPCAMR and digitized for the Southern Coal Fields
- **300** Mine Pool Flow Direction Lines were delineated by EPCAMR for the Western Middle and Southern Coal Fields
- **43** Drainage Tunnels were digitized and located by EPCAMR for the Western Middle and Southern Coal Fields
- **118** Barrier Pillars were digitized and delineated by EPCAMR for the Western Middle and Southern Coal Fields
- **108** Major Anti-Clines, Synclines, and Faults were digitized and delineated by EPCAMR for the Western Middle and Southern Coal Fields
- **105** “Old Workings” were created, digitized, and delineated by EPCAMR for the Southern Coal Fields
- **1838** Buck Mountain Marker Bed C-Series structural contour line segments were delineated, digitized, and drawn by EPCAMR for the Western Middle and Southern Coal Fields

f. Education/Outreach-

- ESRI International User's Conference-San Diego, CA-2008; co-presented by EPCAMR Staff
- SRBC Water Quality Advisory Committee Mtg-2008; presented by Robert E. Hughes-EPCAMR
- SRBC Executive Committee Mtg with Paul Schwartz-2009; co-presented by EPCAMR Staff
- SRBC/EPCAMR Meeting at PSU Hazleton-2009
- PA Abandoned Mine Reclamation Conference, State College-2009; presented by Roger Hornberger
- PA Association of Environmental Professionals Annual Mtg-Macungie-2010; presented by Michael A. Hewitt-EPCAMR
- PA Abandoned Mine Reclamation Conference/ASMR, Pittsburgh-2010- presented by Michael A. Hewitt-EPCAMR
- ASMRE Conference Presentation by USGS-2010; presented by Chuck Cravotta and Dan Goode
- National Association of Abandoned Mine Land Programs, Scranton-2010; presentation submitted by EPCAMR Staff electronically for the CD, was not able to attend to speak due to inability to cover registration costs to attend, although invited as a speaker
- PA Anthracite Section SME Annual Mtg-2011; presented by Robert E. Hughes-EPCAMR
- Several technical committee meetings were convened over the course of the project with our project partners (2006-2010) informing them of EPCAMR's progress on the grant and to both answer questions and obtain further information from the members of the technical committee as well as to ask additional questions regarding gaps that we were coming up with in the data collection and research gathering during the project
- Final Project Presentation is expected to be an Abstract for the 2012 PA Abandoned Mine Reclamation Conference and a press release will be put out in September to refer interested parties to our website to obtain a copy of the Final Report

4. **Photographs** – See CD submitted on September 6, 2011
5. **Detailed Technical Report-** See CD submitted on September 6, 2011
6. **Operation, Maintenance, and Replacement Plans-**Not Applicable


B. Financial Report-

See Final Application for Reimbursement Following Standard Procedures submitted on June 30, 2011.

EPCAMR was unable to obtain a clean copy online of the 2006 Final Report Guidelines, but was able to basically re-write the categories above (a-f) to correspond to the information that was listed on the Watershed Assessments and Develop of Watershed Restoration and/or Protection Plans Form that was originally included with our grant application (*1000-FM-OA0053, 3/2005*).

In conclusion, EPCAMR believes that the summary above includes the most comprehensive set of numbers that we were able to glean from the work that had taken us nearly 5 years to complete, with a small staff of 2 full-time employees, seasonal interns, and 2 independent contractors. EPCAMR was not able to completely get through the ENTIRE Western Middle Coal Fields nor were we able to investigate and delineate a more thorough analyses of the mine pools for the Southern Coal Fields, due to the lack of mapping, funding, and data resources available under the course of this particular grant, we do believe that should the opportunity arise for us to apply for additional funding to complete the remaining Volumes of work that need to be completed, EPCAMR is more than willing to finish where we left off.

Respectfully submitted,



Robert E. Hughes
EPCAMR Executive Director