

SUMMARY AND CONCLUSIONS

On 02/22/05, the Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation (**BAMR**) issued a 90-day emergency contract to Environmentally Innovative Solutions, LLC (**EIS**) to identify and to evaluate options to control an abandoned mine pool creating public health and safety issues within the town of McDonald, PA. With an initial flow rate estimated at 10,000 gpm on 01/25/05, the discharge was controlled by the US Department of Interior, Office of Surface Mining for the first month by pumping at the "blowout" prior to transferring the effort to BAMR. In addition to the constant noise and cost of the pumping operation, closure of public streets and sidewalks was required for continuous access to the pump and to convey the discharge through town about 800 feet, by drain hose and piping, to a stream.

Working with BAMR, EIS developed a team approach with local, state, and federal agencies; local businesses; and residents to maximize data gathering related to the abandoned underground mine, existing public utilities, and current topography. This approach also facilitated the installation and monitoring of piezometers, excavation of test pits, and acquisition of property access. Based on the available data, options were developed for a permanent solution to control the mine pool. During the evaluation of data and development of options with BAMR, EIS continued pumping operations at the "blowout" as necessary.

Based on data obtained from the excavation of test pits, construction of a temporary gravity drain began on 04/09/05. The purpose and result was to discharge water from the abandoned mine pool to "Alexander Run" about ½-mile northeast of the "blowout" on undeveloped land. The landowner, The Aloe Family Limited Partnership, granted full access for temporary activities and permanent facilities. The receiving stream, locally referred to as "Alexander Run", was previously severely impacted by abandoned mine drainage.

Comparing water levels measured at the "blowout", in the piezometers, and at a test pit on "Miller Run" during operation of the temporary drain, identified that converting the temporary facility to a permanent gravity drain (Primary Drain) was the option of choice. Evaluation also supported the installation of a "back-up" facility (Secondary Drain) for alternatively discharging to "Miller Run" and of an Early Warning System at the "blowout". On 04/18/05, a "Design-Build" proposal was submitted to BAMR for implementation of the option. Incorporating recommendations from BAMR and continuing the team approach utilizing local businesses, the following facilities were placed online:

- Primary Drain (05/20/05),
- Secondary Drain (05/09/05), and
- Early Warning System (05/09/05).

Subsequent monitoring by BAMR and EIS confirm the facilities are functioning as designed and intended.

INTRODUCTION

Statement of Problem

Underground mining has been conducted in western Pennsylvania for more than two centuries. Many long-established communities are centered near old mining operations with homes built over workings. (See Appendix A to compare McDonald, PA in 1897 with 2000 aerial photography.) Subsidence problems and drainage associated with abandoned mines can often occur slowly over time or quickly without warning.

On 01/25/05, there was a catastrophic "blowout" from a mine pool in the abandoned Nickle Plate Mine (ca. 1890s thru 1930s) in the Pittsburgh coalbed (Pittsburgh Fm., Monongahela Gp.). The extent of the mine workings is estimated to underlie more than a thousand acres and to interconnect with other abandoned underground and surface mines. (See Appendix B for overlay of Underground Mine Map.)

The "blowout" was responsible for damage to public streets and utilities and to private property. Reportedly, with minimal excavation to determine if a water main leak was responsible for the discharge, the mine pool was under such pressure (confined condition) that an open conduit ("hole") was created into a mine void, enlarged by roof collapse, within 10 feet of the surface.

In order to restore the use of public streets and sidewalks and to eliminate noise and costs associated with pumping, a permanent or long-term solution with minimal impact to the community had to be developed and implemented.

Project Location

The "blowout" occurred at 135 Liberty Street, between the sidewalk and the cartway, in McDonald Borough, Washington County, PA. Options to control the mine pool were considered in that area underlain by, or in the immediate vicinity of, abandoned workings associated with the Nickle Plate Mine in McDonald Borough, Washington and Allegheny Counties, Robinson Township, Washington County, and North Fayette Township, Allegheny County. (See Site Plan for project location and Appendix C - Conceptual Options.)

Three permanent facilities were constructed as part of the project. The receiving streams listed in the table below are tributaries to Robinson Run within the Chartiers Creek Watershed, Ohio River Basin.

Permanent Facilities

Facility	Location Description	Latitude/Longitude
Primary Drain	Aloe Family Limited Partners property (at Test Pit 1) "Alexander Run" Subwatershed North Fayette Township, Allegheny County	40.37844774/-80.23009914
Secondary Drain	Aloe Family Limited Partners property (at Test Pit 3) "Miller Run" Subwatershed North Fayette Township, Allegheny County	40.37631529/-80.23032449
Early Warning System	135 Liberty Street (at "blowout" in replaced sidewalk) Robb Run Subwatershed McDonald Borough, Washington County	40.37269150/-80.23388143

Scope of Work

Initially, the Scope of Work included the following tasks:

- (1) continued pumping at the "blowout" to control mine pool elevation until implementation of a permanent solution,
- (2) development of cooperative efforts with McDonald Borough Council, local businesses, and residents,
- (3) compilation and evaluation of all available, relevant, historical data, including mine maps and previous investigations by US OSM in 2005 and by the former PA Department of Environmental Resources in 1979, 1980, 1981, 1987, as provided by BAMR,
- (4) development of a monitoring program to include the installation of piezometers,
- (5) evaluation of monitoring data collected daily throughout the work week by BAMR,
- (6) investigations of site conditions, including location of existing public utilities and private structures, and
- (7) determination and evaluation of options for an effective and economical permanent or long-term solution to control the mine pool with low impact to the community.

Upon evaluation of the selected option with the implementation and available monitoring of temporary facilities, a conceptual design and proposal to build permanent facilities were submitted to BAMR on 04/18/05. With incorporation of recommended revisions by BAMR, the Scope of Work was revised to include the installation of the following permanent facilities:

- (1) **Primary Drain** to discharge by gravity to "Alexander Run" in order to control the mine pool elevation at the "blowout", includes flexibility to manipulate mine pool elevation, as needed,
- (2) **Secondary Drain** to provide a "back-up" discharge point to "Miller Run" in the event of compromise to the Primary Drain and/or change in mine hydrology over time, and
- (3) **Early Warning System** at "blowout" on Liberty Street to allow the mine pool to remain unconfined (prevent pressure "build-up" of mine pool) in the event of compromise of both the Primary and Secondary Drains and/or of substantial change to in-mine conditions.

The Primary Drain and the Early Warning System are to be equipped with dataloggers for continuous, long-term monitoring of the mine pool. The ability to monitor the mine pool at the Secondary Drain, by manual, downhole, methods, has also been provided.

PROJECT PARTNERS

Numerous government agencies, local businesses, and residents worked together to focus on the development and installation of a permanent, low maintenance solution with minimal impact to the community to prevent the recurrence of the mine pool "blowout" in McDonald, PA.

Partner	Role
PA DEP, Bureau of Abandoned Mine Reclamation	Project management, historical data, public outreach (Rich Beam); weekday monitoring of piezometers and "blowout" (Ray Lardin, Rick Palmer); surveys of piezometers, etc. (Dale Stiffler, Mitchell Smith, Denny Lewis); 24-Hr. Mine Pool Response Test assistance (Rich Campbell); construction oversight (Rick Palmer)
US DOI, Office of Surface Mining	Issuance of initial emergency contract; installation of two piezometers (Steve Rathburn; Eles Bros.)
SPSI	Initial pumping under OSM contract; placement of drain hose and pipe (Mark Slack)
McDonald Borough Council and Police Dept.	Approval of piezometer installations within public streets; approval of Early Warning System at "blowout"; familiarize residents with plans
PA One Call	Coordinate the location of numerous underground facilities for installation of piezometers, test pits, and permanent drains
McKay & Gould Drilling Co.	Completion of 27 drill holes with installation of 13 piezometers (Lynn Gould, Mike Hollabaugh)
Aloe Family Limited Partners (property owners)	Access for study, exploration, evaluation, and installation of Primary & Secondary Drains
David Menke (McDonald Boro. resident)	Replacement of sidewalk and assistance in construction of Early Warning System at "blowout"
James Taborski (McDonald Boro. resident)	Access for drill hole # 22
Rich Dolenc (local resident)	Pump operation, maintenance, and mine pool monitoring at "blowout"
Bruce Leavitt, PE, PG	Review of hydrologic investigation and proposed Primary & Secondary Drain; datalogger evaluation
Whitney, Bailey, Cox and Magnani, LLC	Structural engineering review of Primary Drain
Chester Engineers	Plans of sanitary sewer installation on Fannie Street
Kehm Oil Company	Fuel supply for pump
Wayne Blumling (local resident)	Crane operation for placement of pre-cast concrete at Primary Drain
Frantangelos Gardens	Reclamation supplies
Riverside Builders Supply	Ready-mix concrete
Poland Concrete Products, Inc.	Pre-cast concrete for Primary & Secondary Drains
Environmentally Innovative Solutions, LLC	Prime contractor; project management; contract & subcontract admin.; coordinate project partners; compile data; site investigation; evaluate options; public relations; design & install Primary & Secondary Drains and Early Warning System

INVESTIGATIONS

Available References

Allegheny Co. Tax Maps #4 & 5, McDonald Borough, (undated)

Chester Engineers, 1999, McDonald Borough Center Avenue Area, Sanitary Sewer Replacement, Contract #99-1 (Dwg. # 3691-80 thru 86), McDonald Sewer Authority

Chester Engineers, rev. 1999, McDonald Borough Fannie Street Sewer Extension (Dwg.# 3691-70 thru 73), McDonald Sewer Authority

Chester Engineers, 2001, Item No. 1 – Fannie Street Sanitary Sewer Improvements, Contract #2001-01, Plan and Profile (Dwg. # 3691-94 & 95), McDonald Sewage Authority

Copple-Rizzo & Assoc., 1995, Robinson Coal Co., Brown/Hickman Mine

Environmental Planning & Design, LLC, 2002, Imperial Land & Aloe Family Property (Dwg. # 1906-02-08)

Environmental Planning & Design, LLC, 2005, Existing Topography, Quality Aggregates (Dwg. # 1906-05-02)

Fowler, T. M., 1897, McDonald, PA: published by T. M. Fowler & James B. Moyer (as retrieved in 2005 from Library of Congress)

PA DEP BAMR (formerly PA DER)

SL 474-101.5: 1980 Core Boring Subsurface Investigation, McDonald Borough, Allegheny & Washington Counties

SL 474-102.5: 1982 Core Boring Subsurface Investigation, McDonald Borough, Allegheny & Washington Counties

SL 474-102.5 (Addendum 1): 1990 Core Boring Subsurface Investigation, McDonald Borough, Allegheny & Washington Counties

OSM PA(811)103.5: 1987 Work Site No. 10, McDonald Borough

OSM 63(1441)101.1: 2005 Control Report for McDonald South, McDonald Borough, Washington Co., PA

OSM 63(1441)101.1: 2005 Aerial Photos 001-001 thru 011; 002-110 thru 011; 003-001 thru 011

Portion of Nickle Plate Mine Hard Backs (undated), Pittsburgh Coal Co., (as traced from records at University of Pittsburgh)

Underground Mapping [Nickle Plate Mine], (undated; untitled) (as provided by Aloe Family)

US Dept. of Interior, Office of Surface Mining, (undated), Drill Logs for GH1 [P1] and H2 [P2], (as received 5/16/05)

WPA Project No. 4483, (ca. 1945), Carnegie Sheet #4, Pittsburgh Seam

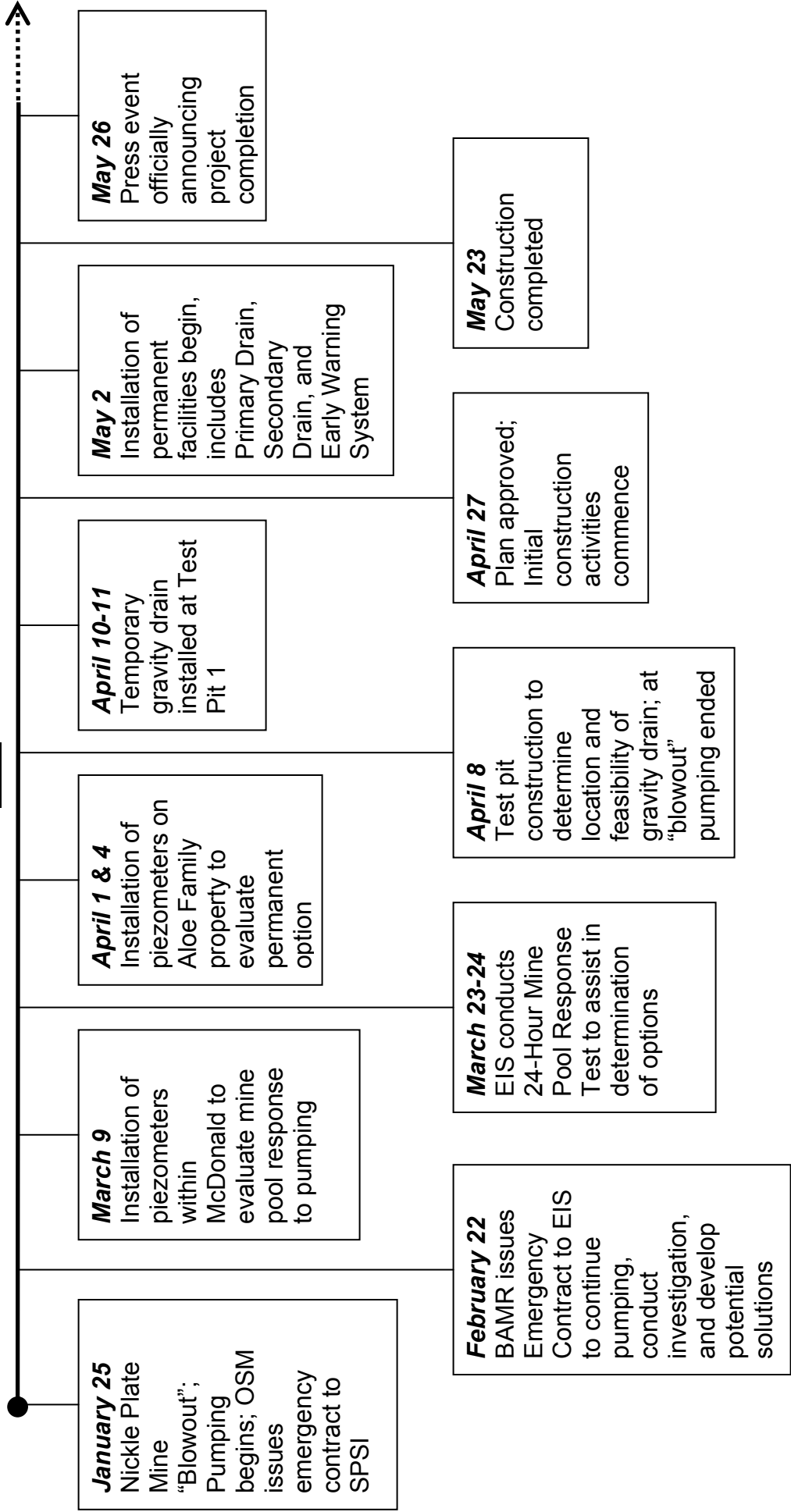
Current Investigations

The following efforts were conducted within the time constraints of the project: (See Appendix B for drill logs and water monitoring data.)

- compile selected information from data provided by BAMR and OSM from previous investigations,
- install 13 piezometers during drilling program of 27 test holes which were located by BAMR survey crew,
- monitor water levels in the piezometers, drill holes (prior to backfilling), at the "blowout", and at the temporary and permanent Primary and Secondary Drains, (weekday monitoring of piezometers, "blowout", and Primary Drain conducted by BAMR with supplemental monitoring by EIS),
- conduct field tests and collecting and submitting water samples for analyses from piezometers, seeps, and ponds,
- conduct 24-Hour Mine Pool Response Test upon cessation of pumping at the "blowout",
- identify subsidence depressions and other features related to abandoned underground mining activities,
- excavate four test pits to intercept, as feasible, the existing mine pool, and,
- install a temporary gravity drain to intercept the existing mine pool.

PROJECT TIMELINE "Highlights"

2005



PROJECT TIMELINE
"Details"

Date	Description
1/25/05	"Blowout" of Nickle Plate Mine Pool at 135 Liberty Street, McDonald, PA; Flow estimated by BAMR to be ~10,000 gpm
1/26/05-1/27/05	Pumping initiated by 0330 on 1/26/05 with 8" & 12" pumps; overflow continues at "blowout"; Total flow estimated by BAMR to be ~8,000 gpm; By 0800 on 1/26/05 continued pumping results in no overflow at "blowout"
1/28/05-2/07/05	Pumping at "blowout" continues with 8" & 12" pumps; Flow estimated ~4,000 gpm; No overflow; 24-hr. periods w/no pumping
2/08/05-2/15/05	12" pump removed; Pumping at "blowout" continues with 8" pump
2/15/05-2/18/05	Daily monitoring of water levels at "blowout", P1, P2 begins by BAMR
2/1705-2/22/05	No pumping at "blowout"
2/22/05 OSM EMERGENCY CONTRACT EXPIRES AND BAMR EMERGENCY CONTRACT ISSUED	
2/22/05	SPSI Emergency Contract with OSM expires; Emergency Contract issued to EIS by BAMR; Field meeting - BAMR, SPSI, EIS; SPSI continues pumping operation under EIS contract for continuity
2/22/05-2/25/05	Daily monitoring of water levels at "blowout", P1, P2 by BAMR
2/22/05-2/24/05	No pumping at "blowout"
2/25/05	Pumping at blowout resumes with 8" pump and continues through out weekend; Number of pumping hours varies
2/28/05-3/04/05	Daily monitoring of water levels at "blowout", P1, P2 by BAMR
2/28/05-3/03/05	Pumping at "blowout" continues with 8" pump; Number of pumping hours varies
3/01/05	Site investigation by EIS; SPSI ceases pumping as subcontractor to EIS; EIS delivers replacement pump; Preliminary pump test
3/02/05	SPSI removes pump and equipment; EIS installs pump and begins pumping to reduce cost and noise
3/03/05	Marked proposed drilling areas in streets of McDonald for PA One Call
3/03/05-3/06/05	Pumping at "blowout" continues with 4" pump until new 6" pump arrives on afternoon of 3/04/05; Number of pumping hours varies
3/04/05	PA One Call Notification
3/07/05	Field meeting with Columbia Gas to review drilling program
3/07/05	McDonald Borough Council meeting; EIS attended and presented
3/07/05-3/10/05	Daily monitoring of water levels at "blowout", P1, P2 by BAMR
3/07/05-3/14/05	Pumping at "blowout" continues with 6" pump; Number of pumping hours varies
3/09/05-3/10/05	Drilling and installation of piezometers conducted by EIS with drilling company subcontractor McKay & Gould Drilling Co.
3/11/05	Monitoring of water levels by EIS; Monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B by BAMR
3/14/05	Monitoring of water levels by EIS
3/14/05-3/18/05	Daily monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B by BAMR
3/14/05- 3/21/05	Pumping at "blowout" continues with 6" pump; Number of pumping hours varies
3/18/05	Monitoring of water levels by EIS; Piezometers bailed for water sampling
3/21/05	Water sampling and monitoring of water levels by EIS
3/21/05-3/25/05	Daily monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B by BAMR
3/21/05-3/28/05	Pumping at "blowout" continues with 6" pump; Number of pumping hours varies; Scheduled cessation of pumping on Easter to decrease disturbance to community
3/23/05-3/24/05	EIS conducts 24-Hour Mine Pool Response Test
3/28/05	Site investigation by EIS; PA-One-Call notification for additional drilling
3/28/05-4/01/05	Daily monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B by BAMR
3/28/05-4/03/05	Pumping at "blowout" continues with 6" pump; Number of pumping hours varies
3/31/05	EIS and BAMR options meeting; Submission of draft documents

4/01/05	Drilling of boreholes and installation of piezometers
4/04/05	McDonald Borough Council meeting; EIS attended and presented
4/04/05	Drilling of boreholes and installation of piezometers
4/04/05-4/08/05	Daily monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B by BAMR; Monitoring wells 25A, 26A, 27B, 29, 31 added starting 4/6/05
4/04/05-4/08/05	Pumping at "blowout" continues with 6" pump; Number of pumping hours varies
4/04/05	Installation of siphons 1 & 2
4/05/05	Initiated siphons 1 & 2
4/06/05	Monitoring of water levels by EIS; Piezometers bailed for water sampling
4/07/05	Water sampling and monitoring of water levels by EIS
4/08/05	Construction inspection; Moved and set-up siphons 3 & 4; Begin test pit excavations; Pumping ceased at "blowout"; Pump maintained at "blowout" for "back-up" to protect densely-populated residential area and public utilities
4/09/05	Monitoring of water levels by EIS; Pumping and lowering of mine pool from sump in "Alexander Run" Watershed with second 6" pump
4/10/05-4/11/05	Temporary gravity drain installed at Test Pit 1 in "Alexander Run" Watershed; Mine Pool Investigation/Draw-down
4/11/05-4/15/05	Daily monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B, 25A, 26A, 27B, 29, 31 by BAMR
4/13/05	Initial "Miller Run" Sump Riser at Test Pit 3 installed due to safety considerations
4/18/05-4/22/05	Daily monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B, 25A, 26A, 27B, 29, 31 by BAMR
4/18/05	Design-Build Proposal and Cost Estimate submitted to BAMR
4/20/05	Site visit with Rich Beam, BAMR
4/25/05-4/29/05	Daily monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B, 25A, 26A, 27B, 29, 31 by BAMR
4/26/05	BAMR response with comments to EIS Design-Build Proposal
4/27/05	Response to BAMR comments regarding EIS Design-Build Proposal; Pre-construction field meeting; Housley property protection issues addressed
4/29/05	Final Design Proposal sent to Bruce Leavitt for review
5/02/05-present	Twice weekly monitoring of water levels at "blowout", P1, P2, 15, 16, 17B, 18, 19, 20, 21, 24B, 25A, 26A, 27B, 29, 31 by BAMR
5/02/05	McDonald Borough Council meeting; EIS attended and presented
5/02/05-5/05/05	Primary Drain design, construction, and footer installation
5/06/05-5/09/05	Installed Secondary Drain and Early Warning System
5/13/05-5/19/05	Primary Drain construction
5/13/05	Field meeting with Bruce Leavitt
5/16/05	Bruce Leavitt response to review
5/20/05	Adjustable weir, grate, lid, stilling well, and staff gage installation at Primary Drain
5/23/05	Construction completed (facilities online) for Primary Drain, Secondary Drain, and Early Warning System
5/24/05	Post-construction inspection
5/26/05	Press event for final solution; Appears on TV Channels 4 and 11 evening news
5/27/05	Article "Fixing McDonald's Water Woes" appears in Observer Reporter and "State unveils 'permanent' fix to town's gushing coal mine" article appears in Pittsburgh Post-Gazette
6/10/05	EIS receives call from McDonald Borough Secretary that "blowout" leaking water; Borough Secretary later reports that water is from a break in a municipal water line not mine; EIS on site in 20 minutes; Monitoring of water levels by EIS; Final Report Meeting with BAMR
6/16/05	Monitoring of water levels at Primary and Secondary Drains and Early Warning System by EIS

APPROACH AND FINDINGS

Utilization of Previous Investigations

Interpretation of existing data assisted in the determination of site conditions including depth of coal, extent of mine workings, probable location of haulage ways and entries, historical mine pool elevations, attitude of Pittsburgh coalbed, and overburden characteristics. This information was particularly instrumental in the effective and efficient development of successful exploratory drilling programs and location of the permanent Primary Drain.

Approach of Current Investigations

Current investigations were used to gather necessary supplemental information to be integrated with available data from earlier efforts. For instance, eight piezometers were initially installed in McDonald Borough to provide the opportunity to monitor the mine pool in response to pumping and non-pumping periods at the "blowout". Responses (measurement of water levels during specific intervals) were then used to construct water level change maps to determine areas of highest hydraulic conductivity (most rapid response). (See Appendix B for overlay of Mine Pool Response Test.) This hydrologic relationship also appeared to be reflected/substantiated by the water quality in the piezometers. (See Appendix B - Water Sample Analyses.)

Available mapping of the Nickle Plate Mine (See Appendix B for overlay of Underground Mine Map.) was reviewed and spatially adjusted to fit data obtained from the drilling program to aid in locating near-surface entries and haulage ways on undeveloped, private property owned by cooperative landowners. These entries and haulage ways were expected to provide major conduits that would allow the control of the mine pool to be relocated outside of McDonald Borough. Additional site investigations were conducted to identify surface expressions of these major conduits. As surface mining operations conducted in the 1940s eliminated or significantly obscured drift entries at or near the coal crop, further drilling, including the installation of five additional piezometers, was completed to observe mine pool fluctuations responding to pumping/non-pumping at the "blowout". The installation of the additional piezometers greatly assisted in determining areas for excavation of test pits and in evaluating attempts to relocate control of the mine pool to the undeveloped property.

Upon identifying potential areas to install a permanent gravity drain, four test pits were excavated. Mine voids were encountered in Test Pit 1 and Test Pit 3. As Test Pit 1 appeared to provide the highest potential discharge and was located in the area with the least constraints (downstream road culverts with adequate capacity, for example) regarding installation of a permanent gravity drain, pumping (6" pump) at a rate of about 1200 gpm was initiated. Monitoring indicated that within 6 hours, the water level at the "blowout", about ½-mile to the southwest, was being lowered. A temporary gravity drain was installed and the proposal to design and build permanent facilities was submitted to BAMR for consideration. The proposal included the installation of a Primary Drain at Test Pit 1, a Secondary ("Back-Up") Drain at Test Pit 3, and an Early Warning System at the "blowout".

(See Project Timeline, Highlights and Details. See also Site Plan, and Appendix B - Generalized Columnar Section, Geologic Cross-Section, and Bed Map overlay.)

DESIGN DESCRIPTION

Mine Pool Discharge Rate

The estimate of the initial "blowout" discharge rate was reported to be about 10,000 gpm. Within 24 hours through an OSM Emergency Contract with SPSI, two diesel pumps (8" and 12") were deployed with a combined estimated discharge rate of about 8,000 gpm. Continuous pumping was needed by both pumps for about one full day to eliminate the surface discharge at the "blowout". Upon lowering the mine pool elevation below the ground surface, both pumps were reported to have been "throttled back" to a combined estimated flow rate of about 4,000 gpm. The mine pool elevation continued to decrease and pumping was periodically ceased to observe mine pool response. Within two weeks, the 12" pump was removed leaving the 8" pump, with an estimated maximum discharge rate of about 2,500 gpm, on-site. This pump was operated on a periodic basis to maintain the mine pool at about 3 - 5 feet below the surface of the ground. (Reported by Mark Slack, SPSI.)

The 8" pump was eventually replaced with a Gorman-Rupp model 16C2-4045D diesel pump (6" pump) on 03/04/05. Approximate installation parameters for the 6" pump: 25' suction hose; 8' suction head; 1,000' discharge hose; and about 70' elevation difference from the pump (at ~1055 feet) near the "blowout" to Robb Run (at ~985 feet) along the southern boundary of the McDonald Borough Building parking lot. Information provided by the manufacturer on 3/16/05 (personal communication) indicated that the estimated flow rate for the given parameters would be about 1,200 gpm.

Continuous pumping (24 hrs/day, 7 days/wk) with only short periodic interruptions for minor maintenance and refueling, was conducted from 03/04/05 to 03/16/05. During this period the mine pool was observed to be lowering about 0.1' per day. Based on this information, the target design flow rate for the permanent solution was estimated to be about 1,000 gpm.

Site Considerations

In order to achieve the ultimate project goal of providing a permanent, low-maintenance, non-pumping conveyance for the drainage to a receiving stream, numerous options were developed and evaluated. Paramount to the site design considerations was public health and safety followed by effectiveness, community impact, long-term maintenance requirements, installation cost, and finally, aiding future work including grouting to address mine subsidence issues and treatment of the discharge. (See Appendix C - Conceptual Design Options.)

"Miller Run" (Option #2, 3, 8): The options reviewed included draining the mine pool to the watercourse; however, existing permanent facilities that convey "Miller Run" along the foundation of a private dwelling include a 24" vitreous clay pipe that was observed to be in poor condition. Downgradient of this residential property, this culvert pipe enters stormwater facilities that convey this flow and other drainage under East Lincoln Avenue (Noblestown Road) to discharge via a 36" concrete culvert to a channel which confluences with Robinson Run. In order to avoid potential public road flooding issues and impact to private property, these options were given a low priority. The option to horizontally bore to an area that appeared very responsive to pumping operations at the "blowout", was also given a low priority based on the above noted site conditions and cost considerations.

"Home Run" (Option #4): Mine pool response tests and monitoring indicated a strong hydrologic connection between the "blowout" and monitoring well 24B located near the headwaters of "Home Run". This option was all but abandoned due to the potential impact to numerous private properties and dwellings, a recently installed sanitary sewer (circa 2004), as well as the absence of a continuous, open-channel, receiving stream, and adequate storm drainage facilities.

Robb Run (Option #5, 9): Abandoned Mine Drainage (AMD) sewer options were evaluated to drain the mine directly from the location of the "blowout". One option was to install an AMD sewer along Liberty Street and either cross North McDonald Street, traverse private property, and empty into Robb Run, or turn along North McDonald Street, cross Valley Street and empty into Robb Run. Another option was to install an AMD sewer easterly along Liberty Street and tie into an existing 12" storm sewer along Fannie Street. These options seemed viable but were ranked low due to community impact and capacity of the existing stormwater facility, respectively. In addition, the drainage would need to remain anoxic to minimize maintenance issues caused by metal precipitate accumulation. Maintaining anoxic conditions in an open channel flow-type sewer system would be problematic. Other AMD sewer options not shown on the attached plan (See Appendix C - Conceptual Options.) included a more direct route to Robb Run via School Street; however, this option was essentially eliminated at the request of the McDonald Borough Council in order to preserve the historic, brick-surfaced, roads (Coal and School Streets).

"Alexander Run" (Option #1, 6, 7): Based on field investigations, the closest and most robust existing storm drainage facility, was located ~1/3 mile east of McDonald Borough under Noblestown Road near the intersection with Alexander Drive. A relatively new arch-type culvert (approximately 4' H X 9' W) conveys the drainage of "Alexander Run" toward Robinson Run. This was the receiving watercourse chosen for the permanent solution due to the existing hydraulic capacity of the receiving watercourse and related drainage facilities, as well as for essentially eliminating impact to the densely populated residential area. In addition, cost of installation would be substantially less by implementation in this undeveloped area, as there are no impacts to utilities, private buildings, roadways, or other infrastructure. Furthermore, the proposed facilities would be located on property owned by a cooperative and helpful landowner who provided written permission to conduct drilling, excavate test pits, and install permanent facilities to control the mine pool.

Mine Pool Elevation

Ideally, the water level in the Nickle Plate mine pool would be controlled at an elevation that allowed the Pittsburgh No. 8 coalbed to be perpetually inundated while concurrently providing an adequate amount of "freeboard" between the mine pool elevation and unplanned or unwanted discharges (i.e., at the Liberty Street "blowout" location). Drilling data indicate that the coalbed has small local "rolls" within the project area. A difference in elevation of up to nine feet on the base of the Pittsburgh No. 8 coal has been noted within a few hundred feet horizontally. The controlling factor, therefore, is the mine pool elevation at the Liberty Street "blowout". The marker at the "blowout" during the investigation was the "top-of-brick" with an elevation of 1051.2 feet above mean sea level. A consensus was reached between BAMR and EIS that the

mine pool should be maintained about sixty inches (60" or 5') below the "top-of-brick". The calculated design elevation for the mine pool at the "blowout" is 1046.2 feet.

Preliminary indicators observed during the investigation period in April 2005, a time without significant precipitation, showed a mine pool elevation delta of about 1.3 feet between the "blowout" and the proposed permanent gravity drain located on "Alexander Run". (Water elevations based on measurements taken by EIS personnel on 4/13/05 at about 1900 EDST: "Blowout" = 1047.0'; Temporary Primary Drain = 1045.7') A measurable hydraulic gradient was not unexpected given the likely partially collapsed nature of the Nickle Plate Mine. The mine pool elevation at the permanent gravity drain, therefore, would need to be about 1044.9 feet. Additional elevation information pertaining to the temporary and permanent gravity drain is presented on the attached graph "Mine Pool Response by Discharging at Primary Drain". These data indicate that the delta between the Early Warning System (EWS), located at the "blowout", and the Primary Drain has ranged from 1.2' to 1.7'.

Permanent Solution Description (See attached "As-Builts" with plan views and sections.)

Primary Drain Design: The outlet of the permanent Primary Drain is a rectangular concrete structure. The structure, approximately four feet wide, five feet high, and thirteen feet long (4'W x 5'H x 13'L), includes a "weir-like" water level control feature that facilitates limited mine pool elevation manipulation (maximum ~5') as well as relatively accurate flow rate estimations. The structure has been set on two concrete footers with wing walls extending to the top outside of the structure to provide a solid foundation in addition to functioning as "anti-seep" devices to prevent unwanted discharge of the mine pool around the facility.

At the inlet end of the structure, flow is intercepted and conveyed by the following three components: three, 8" perforated pipes extended into the mine void, an 18" perforated vertical riser with 18" perforated barrel, and a non-calcareous, R-4, (6" average diameter) rock drain. The vertical riser was installed in the temporary "mine sump" area, excavated as Test Pit 1 (TP1). This riser allows monitoring and access for pumping if needed in the future. The top of the riser is protected by a concrete manhole with the access cover secured by bolts. The cover has a single 1" perforation at the center to allow for manual water level measurements and venting of gases, if present. The TP1 sump area was backfilled with R-4 rock then geotextile fabric was used for layer separation of select on-site fill. Where appropriate, the area was graded and revegetated.

The channel is covered with a concrete lid approximately six feet wide and nine feet long (6'W x 9'L). The lid deters unauthorized entry and provides a secure outlet. Locking and hinged grating has been placed immediately above the weir portion of the channel for access if needed for mine pool manipulation as well as continued monitoring. A stilling well has also been installed to facilitate water level measurements. A riprap-lined (R-4) channel conveys the discharge to "Alexander Run".

Primary Drain Hydraulic Capacity: Each of the three 8" pipes has two perforated sections (~13' in length) placed into the mine void. These pipes were perforated with a row (along pipe circumference) of five holes (1" in diameter) every 6½". This results in about 240 perforations per run and a total of 720 perforations for all three runs. Each of the runs extends about 60'

from the mine void to the concrete outlet structure. For the design flow of 1,000 gpm, the approximate head loss for the 8" piping, without taking into consideration the R-4 stone or perforated 18" riser and barrel, is as follows: Flow into perforations 0.0'; Perforated pipes into mine 0.2'; Solid pipe runs from mine void to outlet structure 0.3'; Total Head Loss 0.5'.

The 18" vertical riser is perforated from the bottom elevation at ~1034' to about the elevation of the top of the concrete outlet structure at about ~1048'. There are rows of about seven, 1" perforations every 3½", totaling 48 rows and subsequently a total of about 336 perforations in the riser. Assuming a design mine pool elevation of 1044.9', approximately 260 perforations in the vertical riser are within the saturated zone. Using an assumed head of 0.1', the capacity of the perforations is about 970 gpm. For the barrel extending from the riser to the outlet structure, using an assumed head based on a full 18" pipe, the barrel has a capacity of about 3,500 gpm. The perforations at the given elevation are the flow-limiting factor; however, the first section of pipe extending from the 45° elbow towards the outlet structure is also perforated in a similar manner as the riser to allow additional water to enter the pipe. To supplement the 3 runs of 8" pipe and the 18" riser and pipe, water can also be conveyed from the mine void through the R-4, non-calcareous, riprap to the in-by side of the concrete channel.

Based on the estimated design flow of 1,000 gpm, a rectangular weir installed within the concrete outlet structure with a 3' wide crest would have a head of about 0.4' using the Francis Formula for a fully contracted weir. Note that due to the design of the concrete outlet structure and adjustable weir, the conditions for the weir are neither fully contracted nor fully suppressed, but rather partially contracted. The differences between the contracted and suppressed weir conditions yield calculated flow differences of about 2% at about 700 gpm and approach 8% for calculated flows around 4,300 gpm. Measurements taken 06/16/05 with a temporary "test weir" were: L = 3.33' (weir length) and H = 0.25' (height of water above weir measured at stilling well). The calculated flow using the Francis Formula: $3.33 H^{1.5}(L-0.2H)$ was about 613 gpm (+/- about 2%).

Based on the weir flow calculations and mine pool measurements, a 3.0' wide, sharp-crested, rectangular-notch weir was installed in the Primary Drain. The notch was cut into ½" Tivar installed on the upstream face of the stainless steel stoplogs. Using the 1,000-gpm, design flow and calculated required head, by setting the crest of the weir at 1044.5', the projected target mine pool elevation of about 1046.2' at the EWS would not be exceeded. (Note: If all stoplogs were inserted, the crest of the weir would be about 1047.5'. The Secondary Drain with an overflow pipe invert at about 1048' would discharge as the mine pool at the EWS reached the pre-"blowout" elevation of about 1049', as reported for Borehole #7 drilled in 1980.) Assuming that the delta between the EWS and Primary Drain is maintained at 1.3' as noted above, at a flow rate of 1,000 gpm with a water depth of 0.4' at the weir (difference of pool and crest elevations), the water elevation at the EWS will be 1046.2'. The measured depth from the center hole on the manhole cover at the EWS is projected to be about 5.5'. This weir has a total maximum measurable depth of 1.3' that results in a maximum measurable flow of about 6,000 gpm. Any discharge over and above this volume will be flowing above the weir and additional calculations would be needed to estimate flow; however, this situation is highly unlikely.

Secondary Drain Design: The Secondary Drain was included to provide access for mine pool elevation monitoring and for future pumping if needed. The Secondary Drain was also installed to provide an outlet for the mine pool should the Primary Drain be compromised or other significant hydrologic changes occur within the mine. The top of the riser is protected by a concrete manhole with an access cover secured by bolts. The cover has a single 1" perforation at the center to allow manual water level measurements and venting of gases, if present.

An 18" riser pipe diameter was chosen to facilitate a typical intake basket (reportedly, ~12 inches in diameter) for an 8" diesel pump suction line and to allow a reasonable annulus for flow within the riser. An 18" overflow pipe was included in the design to provide a "safety relief" for the mine pool. From a 45° WYE installed near the bottom of the riser, the 18" overflow pipe with 45° elbow was then installed in order to direct overflow to a constructed channel and eventually to "Miller Run".

During the April 2005 investigation phase, as noted on the attached "Mine Pool Response by Discharging at Primary Drain" graph, the delta between the EWS ("blowout") and the Secondary Drain ranged from 0.8' to 1.3', which was less than the delta between the EWS and Primary Drain. For this reason, the overflow pipe crest elevation was set at 1048'. If the mine pool elevation would rise at the EWS to about 1049', approximately 3' below the surface at the EWS, the Secondary Drain is projected to discharge. The overflow pipe diameter was chosen to provide sufficient carrying capacity within the pipe at minimal flow depths for the given pipe gradient. The pipe and subsequent channel gradients were limited to about 1% based on topographic constraints as well as significant shallow subsurface water encountered during the installation of the culvert under the access road.

Secondary Drain Hydraulic Capacity: The vertical riser was perforated with 1" holes, 0.4' on-center, from the bottom of the riser extending upward 6'. There are approximately two hundred 1" holes. Approximately 0.2' of head is required to pass about 1,000 gpm. This riser is connected to an 18" overflow pipe installed at a ~1% slope. A flow depth of about 0.4' within the pipe would be needed to convey 1,000 gpm.

Early Warning System Design: This component of the permanent solution allows for continued monitoring of the mine pool elevation at the "blowout" location, as well as an additional "safety relief" point that will function as an Early Warning System in the unlikely event that the mine pool elevation rises to ground level. The "blowout" was cleaned to the maximum extent practicable with a rubber-tired backhoe. A 15" SDR35 riser, with 1" and 1 1/8" perforations (about 50% of each) on 6" centers spaced both vertically and horizontally, was set into the void. A short piece of 6" SDR35 pipe perforated with five 5/8" holes every 6" was inserted "back into" the mine void as feasible and connected to the 15" riser below design water elevation. PADOT #3, non-calcareous, aggregate was placed around the pipe to the level of the bottom of the sidewalk. The top of the riser is protected with a cast-iron manhole access cover set in concrete with bolted lid. The lid has been perforated with seven 1" holes to allow water level measurements. In addition to monitoring, this perforated cover will allow water to discharge in a highly visible area of a residential section of McDonald Borough. If this were to occur, the local residents would be able to alert the proper authorities to implement corrective measures.

Continued Mine Pool Elevation Monitoring: Post-construction monitoring on 06/16/05, with the "Test Weir" installed at the Primary Drain, indicated that the delta between the EWS and the Secondary Drain was greater than the delta between the EWS and the Primary Drain. With a mine pool elevation of 1044.1' established by the "Test Weir" at the Primary Drain, the recharge to the Secondary Drain had been decreased. Stoplogs have since been added to raise the mine pool at the Primary Drain to the proposed design elevation of 1044.9'.

As previously noted, in order to monitor the mine pool elevation manually at the EWS, Secondary Drain, and Primary Drain, 1" holes were provided in the cast-iron lids covering, and securing access to, the risers.

To provide the ability to monitor on a more continuous basis, dataloggers are to be installed at the EWS and the Primary Drain. The depth to water measurements collected at the EWS may be downloaded periodically to evaluate the impact of precipitation events and to show evidence of unwanted mine pool elevation changes under a densely populated residential area. To complement the datalogger at the EWS, the datalogger installed within a stilling well located in the concrete outlet structure of the Primary Drain will not only provide water level information for the underground mine pool in the area of the Primary Drain but also provide measurements that may be used to calculate flows in conjunction with the weir-type outlet. Comparison of the information collected by both dataloggers may also be used to graph the hydraulic gradient of the mine pool relative to the EWS and Primary Drain to aid in documenting significant hydrologic changes.

As of the writing of this report, the installed facilities have functioned as designed and installed.