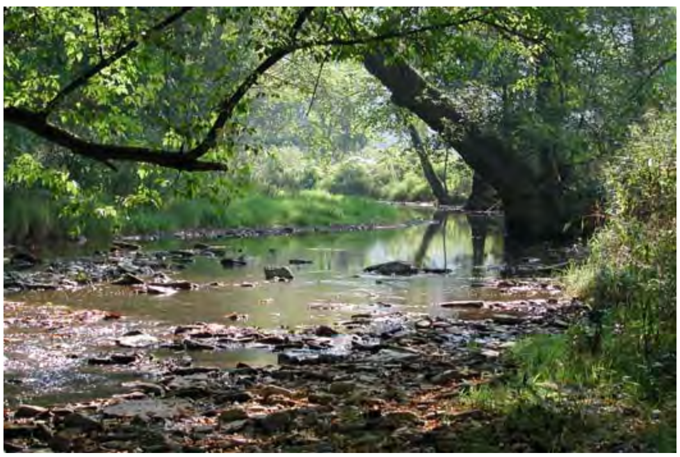
Undermining the Public Trust

A Review and Analysis of PADEP's Fourth Act 54 Five-Year Assessment Report



Prepared for:

CITIZENS COAL COUNCIL

Prepared by:

Schmid & Company, Inc.
Consulting Ecologists

March 2015

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Public Trust Doctrine

Definition from Nolo's Plain-English Law Dictionary

The principle that certain natural and cultural resources are preserved for public use, and that the government owns and must protect and maintain these resources for the public's use.

Pennsylvania Constitution Article 1, Section 27 (Environmental Rights Amendment)

"The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people."

Cover photo credits:

Top left: Enlow Fork, Sept. 2000 (Jody Rosenberg, PennFuture)
Bottom left: Unknown PA stream (Chad Shmukler, Hatch Magazine, www.hatchmag.com)
Right: UNT to Dunkard Fork, March 2003 (Raymond Proffitt Foundation)

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1 BACKGROUND

On 30 December 2014, the Pennsylvania Department of Environmental Protection (the "Department") released on its website a report prepared on its behalf by the University of Pittsburgh, entitled *"The Effects of Subsidence Resulting from Underground Bituminous Coal Mining, 2008-2013*". That report represents the fourth Five-Year Assessment prepared in accordance with Section 18.1 of Act 54 (see box below).

> ***ACT 54 (P.L. 357, No. 54) Section 18.1. Compilation and analysis of data.***
> *(a) The department shall compile, on an ongoing basis, the information contained in deep mine permit applications, in monitoring reports and other data submitted by operators, from enforcement actions and from any other appropriate source for the purposes set forth below.*
> *(b) Such data shall be analyzed by the department, utilizing the services of professionals or institutions recognized in the field, for the purpose of determining, to the extent possible, the effects of deep mining on subsidence of surface structures and features and on water resources, including sources of public and private water supplies.*
> ***(c) The analysis of such data and any relevant findings shall be presented in report form to the Governor, the General Assembly and to the Citizens Advisory Council of the department at five-year intervals commencing in 1993.***
> *(d) Nothing contained herein shall be construed as authorizing the department to require a mine operator to submit additional information or data, except that it shall require reporting of all water loss incidents or claims of water loss.* [Color added for emphasis]

The main purposes of the Five-Year Assessments are to identify and analyze the impacts that occurred as a result of underground bituminous coal mining during the previous 5-year period. The *need* for these assessments is based on the fact that, twenty years ago, Act 54, for the first time, specifically **allowed damages** to occur at the land surface as a consequence of underground coal mining. For 28 years prior to that, the Pennsylvania underground mining law (known as the Bituminous Mine Subsidence and Land Conservation Act [BMSLCA] of 1966; P.L. 31, No. 1) had *prohibited* damage to homes built prior to 1966, as well as to public buildings, noncommercial structures used by the public (such as churches, schools, and hospitals), and cemeteries. The 1966 Mining Law's prohibition on damaging those structures had indirectly protected other features in the vicinity of those structures such as streams, springs, wetlands, aquifers, parkland, and farmland.

Prior to Act 54, most underground coal mining was done using the traditional room-and-pillar method, which extracts about 40%-60% of the coal in an area, but leaves enough coal in place (in the pillars) to support the mine roof and prevent surface subsidence. Room-and-pillar mining has been practiced in Pennsylvania since the late 1700s (PADEP 2014a), and continues to be used profitably today. It does not cause surface subsidence, at least not intentionally and not if the mine is properly designed and operated to preserve roof support. Prior to the advent of longwall mining another underground mining method, known as retreat mining or pillar removal mining, was sometimes used to extract a higher percentage of coal (60% to 70%) than could be produced by traditional room-and-pillar mining. Retreat mining was used to selectively remove pillars of coal that had been left in place in completed sections of a room-and-pillar mine. The removal of the support pillars, however, often resulted in the collapse of the overburden (rock above the mine) and in the weakening of adjacent pillars, causing surface subsidence to occur, often at unpredictable times.

In the 1970s, longwall mining was being introduced into southwestern Pennsylvania as a high-extraction mining method that was safer and more predictable than retreat mining. Using longwall methods up to 75% of the coal in an area can be removed. It starts out using traditional room-and-pillar methods to develop access "gates" and entryways around the perimeter of large rectangular "panels". It then removes all of the coal from the panels themselves. Surface subsidence is an intrinsic part of longwall mining because it provides no surface support (except in the narrow gates between the panels). Consequently, longwall mining often results in damage to structures and other features on the surface, and thus was incompatible with the 1966 Mining Law's prohibition on surface damage.

> There were 46 underground bituminous coal mines active at some point during the 4th Act 54 Assessment period, including 7 longwall mines, 34 room-and-pillar mines, and 5 retreat mines. During the 3rd Assessment period, there were 50 underground mines (8 longwall, 36 room-and-pillar, and 6 retreat). During the 2nd Assessment period, there were 68 underground mines (10 longwall, 44 room-and-pillar, and 14 retreat). As **Figure A** shows, each type of mine uses room-and-pillar methods in part of its operation, but only longwall mines use longwall methods and only retreat mines use pillar removal methods. The acreage of traditional room-and-pillar mines has been increasing during the last three Assessment periods, unlike the other two methods.

During the 1980s mine operators seeking to expand the use of longwall mining in Pennsylvania unsuccessfully tried to overturn the 1966 Mining Law on legal grounds. After appealing their losses at every lower level, the industry lost at the US Supreme Court [Keystone Bituminous v. DeBenedictis, 480 U.S. 470 (1987)] in a 5-4 decision. They then enlisted several conservation groups to help them craft a so-called "compromise" bill that would change the law and allow the use of the longwall technology. As a result, Act 54 was passed in 1994 to amend the 1966 Mining Law.

Act 54 changed crucial language in the 1966 Mining Law. Where previously the "***prevention** of damage from mine subsidence*" was required, Act 54 required the "*prevention **or restoration** of damage from mine subsidence*". Beginning in 1994, damage was allowed to all features and structures no matter when they were built, but with the provision that certain damages were to be either repaired or restored. The common understanding at the time was that *any* damage associated with underground coal mining would be repaired, because the amendment was promoted by the Department as a "you break it, you fix it" law[1]. Act 54 mandated remedies for certain structures and water supplies damaged by underground mining, and called attention to the fact that the Act did not supersede, but was meant to work in conjunction with, other environmental protections (see box below). Indeed, the Department is obligated to comply with all environmental

[1] That phrase was used in the June 1999 letter of PADEP Secretary James Seif transmitting the first Act 54 Five-Year Assessment to Governor Tom Ridge, the General Assembly, the Citizens Advisory Council, and the Environmental Quality Board.

FIGURE A. The charts below identify the amount of acreage, by mining method and by mine type, during each of the last three Act 54 Five-Year Assessment periods. During the 4th Assessment period (bottom) for example, longwall mines used both longwall and room-and-pillar methods and undermined a total of 17,005 acres, but longwall mining methods were used directly beneath only 12,380 acres (73%).

2nd Period 1998-2003

MINE TYPE	MINING METHOD Longwall	R&P	Retreat	TOTAL
LWM	19,704	7,804	--	**27,508**
R&P	--	6,975	--	**6,975**
Retreat	--	3,158	871	**4,029**
TOTAL	**19,704**	**17,937**	**871**	**38,512**

3rd Period 2003-2008

MINE TYPE	MINING METHOD Longwall	R&P	Retreat	TOTAL
LWM	17,605	7,002	--	**24,607**
R&P	--	11,552	--	**11,552**
Retreat	--	1,821	276	**2,097**
TOTAL	**17,605**	**20,375**	**276**	**38,256**

4th Period 2008-2013

MINE TYPE	MINING METHOD Longwall	R&P	Retreat	TOTAL
LWM	12,380	4,625	--	**17,005**
R&P	--	12,353	--	**12,353**
Retreat	--	1,702	283	**1,985**
TOTAL	**12,380**	**18,680**	**283**	**31,343**

LWM = longwall
R&P = room-and-pillar
Retreat = retreat or pillar recovery

Note: Data from the 1st Assessment period (1993-1998) were not included because they were not similarly disaggregated, and retreat mining was lumped in with room-and-pillar mining.

laws, and not just those primarily administered by the individual bureau in which the action occurs[2].

> Section 9.1(d) of *Act 54* states:
>
> ***Nothing in this act shall be construed to amend, modify or otherwise supersede standards related to prevailing hydrologic balance*** *contained in* [the federal Surface Mining Control and Reclamation Act of 1977]*……* ***nor any standard contained in*** *the act of June 22, 1937 (P.L. 1987, No. 394), known as* ***"The Clean Streams Law," or any regulation promulgated thereunder*** *by the Environmental Quality Board.* [BOLD ADDED]

While it was expected in 1994 that some surface damage would occur once Act 54 was adopted and longwall mining became acceptable, it was less clear how extensive that damage would be, how much damage would need to be repaired, or how effective any restoration might prove to be. It also was unclear how much collateral damage was going to occur to local and regional water resources, which previously had been protected --- at least indirectly --- by the 1966 Mining Law, but which received no mandatory compensation or restoration under the new law. Thus, the General Assembly wisely inserted the Section 18.1 reporting requirement into Act 54 to provide an update on the state of affairs in the coalfields every five years.

Act 54 did more than simply open the door to longwall mining. It fundamentally changed the basic framework of how underground coal mining would be regulated by the Pennsylvania Department of Environmental Protection.

Historically, environmental regulation had focused on "protection" of environmental resources. Environmental regulation previously involved a sequential process to provide that protection: first avoid impacts ... then minimize impacts ... and finally mitigate unavoidable impacts. Project proponents were expected to *avoid* causing impacts as much as possible. To the extent it was not possible to avoid an impact, measures were to be taken to ensure that an impact was *minimized* as much as possible. Any impacts that could not be avoided and which had been minimized as much as practicable then could be authorized only if the developer committed to compensate for or "*mitigate*" the remaining effects.

Act 54 effectively eliminated the first two steps in the context of underground coal mining. Act 54 essentially said that impacts resulting from longwall mining would be allowed, no matter where they occurred or what resources were being impacted. The only stipulation imposed was that the impact was not supposed to be irreparable, and so when an impact occurred, the operator was supposed to fix it.

In conjunction with the first three Five-Year Assessments, this 4th one conclusively demonstrates that Act 54 is not working as intended. Despite very poor recordkeeping by PADEP, enough data has been compiled to shed light on what

[2] Oley Township v. DEP and Wissahickon Spring Water, Inc., 1996 EHB 1098. See 11 also, Valley Creek Coalition v. DEP, 1999 EHB 935, slip op. at 11 (citing to Oley Township for this legal principle).

actually has been happening these past 20 years. The longwall extraction method has been responsible for the overwhelming majority of underground coal mining impacts. Even when the acreage undermined by longwall methods decreases (as it has over each of the last 5-year Assessment periods, see Figure A), the adverse effects associated with longwall mining increase in number, in part due to advances in longwall technology that continue unfettered by the need to avoid or minimize impacts.

Time to the recorded "resolution" of longwall-related impacts often is measured in years. "Repair" and/or "recovery" typically represent the smallest proportion of so-called resolutions. More than two-thirds of structure and water supply impacts are "resolved" by private agreement, whereby the actual outcome typically is not publicly disclosed. Changes in regulatory requirements are being implemented slowly and incompletely. A major policy shift for "surface water protection" was adopted ten years ago (PADEP 2005), yet its effectiveness cannot yet be accurately evaluated. Despite the implementation of ostensibly stronger stream protection requirements, during this latest five-year assessment period at least 6 streams were formally determined by the Department to have suffered irreparable flow loss as a result of longwall mining. No such damage has ever been attributed to traditional room-and-pillar mining in Pennsylvania.

Many practical and needed changes are recommended in this latest Assessment. Some are the same as those recommended in years past. Unfortunately, the Department has not yet indicated whether it agrees with any of the recommendations or is willing to commit to implement any of them. Previous recommendations for improving the regulatory program and the Act 54 assessment process largely have been ignored. Even when changes have been made they have not been timely or effective, which is unsurprising given that the Department has been plagued by a chronic lack of adequate funding and resources.

Even if all of the changes suggested in this 4th Act 54 Assessment could be adopted immediately, however, the effect mainly would be a clearer identification of the many impacts occurring throughout the coalfields. What is needed is not more accurate recording and tracking of the damages. The real problem is the damage itself --- and the fact that it keeps happening in increasing numbers and severity. The related problems are that some impacts that could be repaired often are not, and some impacts, particularly to natural systems, cannot be repaired at all. To address these problems requires more fundamental changes, including better inventories of all resources at risk from mining, a clearer understanding of the causes of the damage, and a goal to avoid and minimize damage. Continuation of the status quo amounts to a violation of the Department's public trust responsibility to the people of the Commonwealth.

The four Five-Year Assessments that have been prepared to date by the Department in accordance with Section 18.1 of Act 54 are summarized below:

Report	Year Released	Prepared by	5-Year Period	Report Cost
1st	1999	PADEP	1993-1998	N/A
1st (supplement)	2001	PADEP	1993-1998	N/A
2nd	2005	California University of Pennsylvania	1998-2003	$200,000
3rd	2011	University of Pittsburgh	2003-2008	$313,000
4th	2014	University of Pittsburgh	2008-2013	$603,000

2 EXECUTIVE SUMMARY

Commissioned by the Citizens Coal Council (CCC), this report examines the information and findings of the Fourth Act 54 Five-Year Assessment (University of Pittsburgh 2014). Like a similar review of the Third Assessment (Schmid & Company, Inc. 2011), also prepared on behalf of CCC, this report points out both shortcomings and positive aspects of the latest Assessment. We conclude that (A) due in large part to inadequate recordkeeping, this 4th Assessment does not properly comply with the Section 18.1 mandate of Act 54 to determine the effects of underground coal mining, (B) the permitting and enforcement activities of the Department's Mining Program are not set up to identify and monitor, much less prevent or oversee repairs of, wide scale impacts to surface features from longwall mines, and (C) as a result, major changes are needed to align the Department's Mining Program with the basic intentions of Act 54 and the environmental rights provisions of the Pennsylvania Constitution.

Pennsylvania's 1966 Mining Law specifically <u>prohibited</u> damage to surface structures, a legislative directive that was aligned with the public trust doctrine. That prohibition survived every level of a protracted legal challenge by longwall mine operators that went all the way to the US Supreme Court. Act 54 fundamentally changed that dictate when it was enacted in 1994. Under Act 54, mine-related damages were <u>allowed</u>, with the expectation that any damages that occurred would be repaired. Avoidance and minimization of damage were no longer expected.

This Fourth Act 54 Assessment, like the assessments before it, factually documents how Act 54 is ***not*** working as intended, although that is nowhere stated in its 470 pages. Most impacts to structures and water supplies are <u>not</u> being repaired or restored as anticipated by the Act. Impacts to natural features --- streams, wetlands, groundwater --- almost exclusively are associated with one underground mining method, *i.e.*, longwall mining. The effects that longwall mining is having on the various elements of the hydrologic balance (see box at right) are incompletely understood, are largely unpredicted, and are being addressed in a slow and haphazard fashion that has no chance of restoring premining conditions even if those conditions were known. Premining conditions, of course, typically are *not* known because analysis of the hydrologic balance in the context of underground coal mining remains fragmentary. This situation has persisted for more than 20 years now and is getting steadily worse, not improving. The inescapable conclusion is that significant structural, operational, and regulatory changes are needed. This report concludes with specific suggestions about the kinds of changes that might be appropriate.

> **HYDROLOGIC BALANCE:** The relationship between the quality and quantity of water inflow to, water outflow from and water storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake or reservoir. It encompasses the dynamic relationships among precipitation, runoff, evaporation and changes in groundwater and surface water storage. (25 Pa. Code 89.5)
>
> **The** [mining] **operation ... shall ... ensure the protection of the hydrologic balance and ... prevent adverse hydrologic consequences.** (25 Pa. Code 89.36)

3 Data Are Inadequate for Act 54 Analysis

SUMMARY: More than 20 years after adoption of Act 54, the Department still does not have in place a standardized database to accurately track all of the impacts associated with underground mining activities, to compare impacts among the several different coal mining methods being practiced, or to monitor the resolution of those impacts. As a result, the Department is unable to determine whether Act 54 is working as intended and has no basis for making any necessary adjustments in its regulatory programs.

One of the major issues associated with each of the previous Act 54 Assessments, and which has not yet been resolved, is a lack of adequate information upon which to conduct evaluations. This is true not only for evaluations needed during the five-year assessment process, but also in the daily operation of the underground mining regulatory program. In the past the main problem was a lack of premining/baseline data, but more recently it is reflected in inadequate postmining data as well. In order to understand the effect that underground mining has on a feature, wetlands for example, one first needs to know where the wetlands were (and their condition) before mining began. Only then is it possible to assess or evaluate the location and condition of wetlands after mining has been completed. Accurate premining and postmining data are crucial. This is just common sense.

Unfortunately, this simple concept seems to be exceptionally difficult for the Department's Mining Program to implement. This may be due, in part, to the historic focus of the District Mining Office on room-and-pillar mines, which if properly designed, would not cause damage to surface structures or water resources. Prior to Act 54 widespread surface impacts were not supposed to occur at underground mines, so the primary focus of the Mining Program review was on ensuring that mines were properly designed and not on identifying surface resources at risk outside specific surface facilities. This regulatory focus was never reoriented after passage of Act 54 to systematically collect and compile the resource information needed to evaluate widespread impacts (as required by the Act's Section 18.1), much less to address or regulate the surface and larger hydrologic impacts associated with longwall mine subsidence. Almost every longwall-related approval since Act 54 was adopted has been an incremental expansion of an existing mine, and it has been the tendency of the Mining Program to focus only on the expansion area itself, rather than on the cumulative impacts of the entire mine over time or on the cumulative and regional watershed impacts of numerous longwall mine operations in an area.

This latest 5-Year Assessment clearly shows that the Department's mine permit application and review processes, even after 20 years, do not track well with the requirements of the Commonwealth's mining laws and the Department's own regulations. For example, implicit in the Chapter 89 underground coal mining requirement to protect the hydrologic balance and prevent adverse hydrologic consequences (see box in Section 2 above) is the notion that there must be a clear understanding of an area's complex and interconnected surface water and groundwater systems *before* mining begins. Information regarding the hydrologic balance of each proposed new mine (and every proposed expansion) should have been required as part of every permit application and approval, with each new one adding to the overall understanding gleaned from all previous ones about how mining activities are affecting the various components of local and regional hydrologic systems. After 20 years' experience examining and evaluating how changes in specific mining parameters (such as depth of mining, width of longwall panels, etc.) affect surface and groundwater flow patterns, by now it should be clear where, how, and why impacts are likely to occur. Unfortunately, that is far from the case, as this 4th Act 54 Assessment clearly shows.

Historically, one of the primary sources of data relied upon for analysis in these five-year Assessments has been the BUMIS (Bituminous Underground Mining Information System) records maintained by the Department's District Mining Office. Numerous problems, however, have been identified time and again by Act 54 Assessment researchers with the accuracy and completeness of the BUMIS records, such as this from the 4th Assessment[3]:

> **"BUMIS cannot be relied upon as the authoritative source of information on undermined surface features, impacts, or impact resolution. Spatial coordinates ... were rarely provided in BUMIS ..... over 40% of BUMIS features** [initially] **lacked a unique identification number. ....** [the] **final pass through BUMIS revealed that the percentage of features lacking a feature identification number remained around 30 percent. ... Data entry is often incomplete.... In some cases, impacts are missing altogether."** (II-6)

After 20 years, one would have expected that by now the two surface features that Act 54 focused on most prominently --- structures and water supplies --- at minimum would be carefully tracked. Yet BUMIS appears to be only *fair* in recording structure and well water features and impacts, and downright *poor* in documenting stream, spring, wetland, and groundwater resources and impacts.

> **"The BUMIS database contains significant occurrences where water supplies were classified as land reported effects and vice-versa. The same problem was true of BUMIS structure data...."** (V-2)
>
> **"BUMIS did not contain enough information to match structures projected on maps with a BUMIS record. Therefore information on the number and kind of structures undermined during the 4th assessment period is not presented. ....in BUMIS, 46% of all reported structural effects for this assessment period were classified as 'Unknown' use."** (IV-2 and IV-9)

> **"Because BUMIS was not designed to track the complexity of stream impacts, PADEP has struggled to develop a system for recording stream data."** (EX-3)

[3] All yellow-shaded boxes in this report are direct excerpts from the 4th Act 54 Five-Year Assessment.

"During the course of data collection, the University discovered that BUMIS is incomplete. Two of the nine stream investigations from this [4th] **period were not tracked in BUMIS – only in paper files at CDMO."** (VII-26)

"... 25% of the stream impacts from [the 3rd Assessment] **period are not identified in the BUMIS database."** (VIII-2)

Because BUMIS records were so incomplete, for this 4th Assessment the University commendably often supplemented the BUMIS data with paper maps and other files for information regarding stream impacts, bioassessments, investigations, and restoration attempts. In one sense this should have provided a more complete picture of stream impacts than previous Act 54 Assessments, because it incorporated data from multiple sources and offices within the Department. Unfortunately, as the University readily admitted, the format and quality of those data were inconsistent and their veracity often was questionable. The mine operators themselves also were contacted by the University and they reportedly supplied useful guidance and information as well as digital data files containing information not readily available from the Department, but those data often existed in inconsistent and non-standardized formats.

The Department's data collection and recordkeeping leaves information scattered in various places and inconsistently accessible. As a result, many trends regarding the number and types of effects from underground mining, including differences between mines and methods of mining, cannot be identified and evaluated by assessment preparers or anyone else.

Twenty years ago, following the passage of Act 54, the Department should have established formal tracking procedures to allow it to meet the requirements of Section 18.1. It did not. Instead, every five years the Department and its contractors have been attempting unsuccessfully to make sense of whatever data happen to be on hand and mold them into something that might resemble a serious assessment of the effects of underground coal mining --- a largely futile task, given the lack of credible data.

Because the Department had failed to establish a reliable and comprehensive data-tracking and evaluation system, the University of Pittsburgh undertook to create one for this 4th Assessment at considerable cost to the Commonwealth. Using all of the digital and paper files it was provided, the University created a new GIS database which it called the "Act 54 Geographic Information System" (Act54GIS).

"Data collection, error checking, and incorporation in the ....Act54GIS collectively represented by far the largest proportion of total University effort on this project..... The Act54GIS makes possible analysis and reporting of information required by the ... contract between the University and PADEP, including comparisons with past assessment periods. Further, it provides a useful basis for organizing the information necessary for future reports." (XI-2 to XI-3)

The University of Pittsburgh had created a similar database in compiling the 3rd Act 54 Assessment (which it called the "University GIS Database" [UGISdb]), so it is unclear why this task needed to be done anew this time. The University claims to have made use of the spatial datasets compiled for both the 2nd and 3rd Act 54 Assessments. Unfortunately, important mine-specific information that was mapped in the 3rd Assessment from those datasets (including, for each of the fifty mines active during that period, the location of the Rebuttable Presumption Zone and a 200-foot buffer, the location of every structure and water supply with and without reported effects, and the locations of major roads, streams, and overburden contours) were not similarly mapped in the 4th Assessment.

Thanks to the efforts of the University of Pittsburgh, the Commonwealth now has a new underground mining-related GIS database. Like any database, however, it is only as good as the data put into it. Unless the Department improves its data collection and recordkeeping along the lines recommended in this 4th Assessment and by others, the effort and public money spent to create the database will not provide their potential benefit. In the interest of transparency, the GIS database, or at minimum some form of it, should be made publicly available.

A few of the relevant and practical recommendations from the 4th Assessment are listed below. Many of the recommendations are very basic, like the use of quality control protocols, but all of them should be given serious consideration. The Department must identify specific measures and practices it intends to adopt to improve both the Act 54 assessment process and the operation of its Mining Program.

- All information should be submitted in electronic form.
- A protocol for submission of each type of data should be developed and disseminated.
- All features should be input in BUMIS with geographic coordinates from either field GPS devices or computer geographic information system software. The coordinates should be given to the tenth of a second or to the ten-thousandths of a degree.
- Quality control and quality checking protocols should be developed and implemented.
- ALL information that can be georeferenced and is pertinent to permitting, regulation, and reporting should be included in BUMIS to create a true information system where all relevant information can be accessed.
- Requiring submission of information from the mining operators and from DEP field agents in standardized formats (see Section X.B.1 above) will greatly facilitate the efficiency with which the above steps can be implemented.
- For both spatial and non-spatial information, it is possible to link all pertinent information in a single electronic system. (X-2 to X-3)

The efficiencies associated with standardizing the type and format of data required to be submitted, and providing it in digital format, should appeal to mine operators and the Department alike, and could improve the public accessibility of the data and the overall transparency of the underground mine permit process.

4 HYDROLOGIC IMPACTS

4A Streams

SUMMARY: All underground mine-related stream impacts reported during the last two Assessment periods were associated with longwall mining. For the first time ever, during this latest 5-year period the Department acknowledged that a stream had been *irreparably* damaged by longwall mining subsidence; and it was not just one isolated case, but at least six streams that had been dewatered and could not be restored to premining conditions despite multiple years of trying. Incidents of irreparable stream damage are never predicted in permit applications.

Longwall vs Room-and-Pillar Impacts

Section VII, the longest (81 pages) in the 4th Assessment, discusses the effects of underground mining on streams during this latest five-year review period. Section VIII (24 pages) then provides a followup discussion regarding streams that were damaged during the 3rd Assessment period, two-thirds of which remained unresolved at the end of that period. It is appropriate that so much attention is paid to streams in this Assessment, given that a lack of attention to stream impacts was a major criticism of all previous Act 54 reports.

This 4th Assessment's stream evaluation almost exclusively discusses the adverse effects associated with longwall mining activities, which again is appropriate inasmuch as all of the documented impacts to streams during the last two Assessment periods have been due to longwall mines.

> "[Our] **data and previous Act 54 reports.....demonstrate that longwall mining can cause flow loss and pooling impacts to undermined streams."** (VII-23)

The Assessment states: **While stream flow losses are rare in room and pillar mines, pillar failure can occur and cause fracturing of the aboveground rock strata.** (Page VII-27). The Assessment points out that pillar punching and pillar failure are the two ways that room-and-pillar mining can cause subsidence. Yet it fails to note that there were no instances of pillar failure identified during this latest 5-year period, and there has been only one instance of pillar punching reported during the past 10 years, and that was during the 3rd Assessment period. Thus, the real subsidence-related issues with streams all are associated with longwall mines.

The University of Pittsburgh was able to identify the lengths of streams undermined by every active mine during this Assessment period, and also the stream lengths directly overlying each mining method used. It was unable, however, to identify specific lengths or locations of streams that became pooled or suffered flow loss as a result of underground mining (all of which were due to longwall mining) because the Department does not accurately track that information. As a proxy for evaluating pooling impacts, the University identified the number of instances of gate cuts, and as a proxy for flow loss impacts it identified areas where grouting and/or augmentation were performed or where liners were installed in streambeds (more on this below under Technical Guidance Document 563-2000-655).

> **"Because streams from room-and-pillar mines did not receive augmentation or gate cuts, we focused exclusively on streams from longwall mines."** (VII-13)

The University offers one brief, but misleading, discussion about the effects of "room-and-pillar mining" on streams, which is summarized on Table VII-7 in the 4th Assessment. Unfortunately, it is a specious discussion because what it evaluates is not room-and-pillar mining *per se*, but rather the sections of five longwall mines where room-and-pillar *development* mining was used. The area directly above the room-and-pillar-mined areas which outline a longwall panel (*i.e*., the area *between* the longwall panels) typically is about 250 feet wide, and so it will be subject to subsidence stresses from, and will be affected by, the immediately adjacent longwall mining panels. It is disingenuous to suggest that subsidence effects experienced on land or in streams directly above the narrow areas *between* longwall panels are not due to longwall mining. Thus, the factual conclusion of Table VII-7 is that 63% of the stream miles over the five longwall mines examined (51.72 of 82.16 miles) were impacted by flow loss, pooling, or both along some part of their lengths. No such evaluation can be done for room-and-pillar mines because similar data do not exist.

Only one room-and-pillar mine is mentioned in this Assessment in terms of stream flow loss or pooling, but in that case (ST0903) the flow loss was determined by the Department not to be related to underground mining, but rather to drought conditions. Thus, all reported impacts to streams from underground mining during the 4th period (and during the 3rd period as well) were associated with longwall mining, a significant finding but one that is not clearly stated in either Assessment.

The apparent lack of stream impacts from room-and-pillar mines (other than direct impacts from surface facilities) would seem to be a major finding and an important consideration in an Act 54 evaluation of the effects of underground mining. If true, it should have been more prominently acknowledged in these most recent Act 54 reports. It is possible, however, that room-and-pillar mining *does* cause flow loss in streams, but that the Department merely has been unable to identify it. The Technical Guidance Document on stream protection (TGD 563-2000-655, discussed further below) does not require the same detailed collection of data (premining, during mining, or postmining) for most room-and-pillar mines (those with more than 100 feet of cover) as it does for longwall mines. Such room-and-pillar mines are not believed to "have the potential to cause flow loss" based on a report that now is more than 25 years old[4].

[4] According to page 11 of TGD 563-2000-655, "*Drainage of overlying strata generally extends 20 to 100 feet above room-and-pillar mine workings. (Rauch, H.W. A Summary of the Ground Water Impacts from Underground Mine Subsidence in the North Appalachians. 1989. Proceedings from Eastern Mineral Law Foundation Conference, Pittsburgh, Pa.*)"

Whether the 100-foot depth-of-cover standard currently is adequate to prevent flow loss in streams is unknown, and no data are being collected that would enable the Department to make that determination. A lack of documented impacts does not mean that impacts are not occurring from room-and-pillar mines --- without data, one cannot identify impacts. Though less obvious perhaps than the impacts from longwall mining, stream impacts may be associated with room-and-pillar mining as well, and so the Department should make an effort to determine whether that is the case.

Table VIII-1 lists the current status of the 55 stream segments where unpredicted impacts occurred during the 3rd Assessment period (all by longwall mining). Four of those cases still were not resolved as of the end of the 4th Assessment period (and thus have been unresolved for at least 7 to 8 years). Of the original 55, only 3 streams either had recovered on their own (2) or were repaired (1) as of the end of the 4th Assessment period. The final status of 35 cases is listed simply as "resolved", with no further explanation. A status of "resolved" does not mean the stream damage was repaired or restored. Those damage cases typically were resolved on the basis of some written agreement between the landowner and the mine operator (which likely is subject to nondisclosure restrictions and probably involved no actual stream restoration at all).

> **"Of the 10 cases in the 3rd assessment period that took over 5 years to resolve, 8 of these cases involve streams that the PA DEP ruled have not recovered from mining."** (VIII-5)

This finding, that 8 cases (which actually involves 7 different streams) have been determined to involve irreparable damage by longwall mining, does not receive the prominence in this 4th Assessment that it deserves. Indeed, this finding is one of the most significant findings of this or any previous Act 54 Assessment, and so it bears highlighting:

> **Longwall mining has been demonstrated to have irreparably damaged at least seven streams. Room-and-pillar mining has never been shown to cause such damage to streams in Pennsylvania.**

Technical Guidance Document (TGD) 563-2000-655

The adoption by the Department of TGD 563-2000-655 (PADEP 2005) during October 2005, and its full implementation by October 2007, is mentioned frequently in this 4th Assessment. That TGD was possibly the most significant change that the Mining Program has adopted since the enactment of Act 54. Its implementation seems to have been both positive as well as negative for its intended purpose of "surface water protection". On the positive side, longwall mine operators now are supposed to collect and submit substantially more, and more detailed, premining and during-mining data than previously to characterize stream flow and biological conditions. The data in turn are to be used to assess impacts from undermining and to monitor restoration results.

On the negative side, the TGD changed the way the Department tracks and monitors stream impacts and restoration activities. As a result, there is no way to directly compare stream impacts that occurred during this latest 5-year period with previous 5-year periods. There were 55 investigations of incidents of unpredicted flow loss and pooling reported during the 3rd Assessment period, but there were only 9 stream investigations officially initiated during the 4th. The reason for this is not that there necessarily were fewer stream damages during the 4th Assessment, but that the damages now are identified differently. According to the University of Pittsburgh, an official investigation no longer begins until a mine operator has been unable to restore premining conditions to a damaged stream after three years of trying.

This aspect of the new TGD has the potential to significantly undercount the number of stream impacts that occur. If an impact occurs, but is resolved within 3 years, no investigation is initiated, and apparently, no impact is recorded by the Department. If the stream impact is "resolved" by a private agreement between the landowner and the mine operator, not only is that impact not recorded, but the stream itself may not be restored. To correct this problem, all stream (and other) impacts should be reported/recorded as soon as they occur or are discovered.

As a proxy for the actual extent of stream impacts that occurred during the 4th Assessment, the University reported the number and types of stream restoration activities initiated for each type of impact (**Figure B**), which included:

- 28 stream segments received gate cuts (for pooling impacts)
- 57 streams received grouting (for flow loss impacts)
- 95 streams had augmentation installed, 74 of which were active (flow loss impacts)
- 3 streams had liners installed (flow loss impacts).

Clearly, these stream restoration activities reflect a much greater number of impacts than the 9 official stream investigations recorded per the TGD during this period.

Another negative factor associated with the new TGD is the length of time it has taken to evaluate its effectiveness. TGD 563-2000-655 was adopted and fully implemented by October 2007 (during the 3rd Assessment period), but because it was not in place during that full 5 years it purportedly could not be properly evaluated in that period's Assessment. Even during the 4th period, much of the active mining activity reportedly was approved before the TGD requirements had been fully implemented and thus lacked baseline data. Furthermore, as the 4th Assessment makes clear, the TGD procedures still are not consistently being followed or implemented either by mine operators or by the Department itself.

> **"For many of the stream investigations, flow data from the mine operator was inadequate to assess recovery......"** (VII-75)
>
> **"PADEP determinations of flow recovery were typically based on inadequate flow measurements and idiosyncratic methods of analysis."** (X-8)

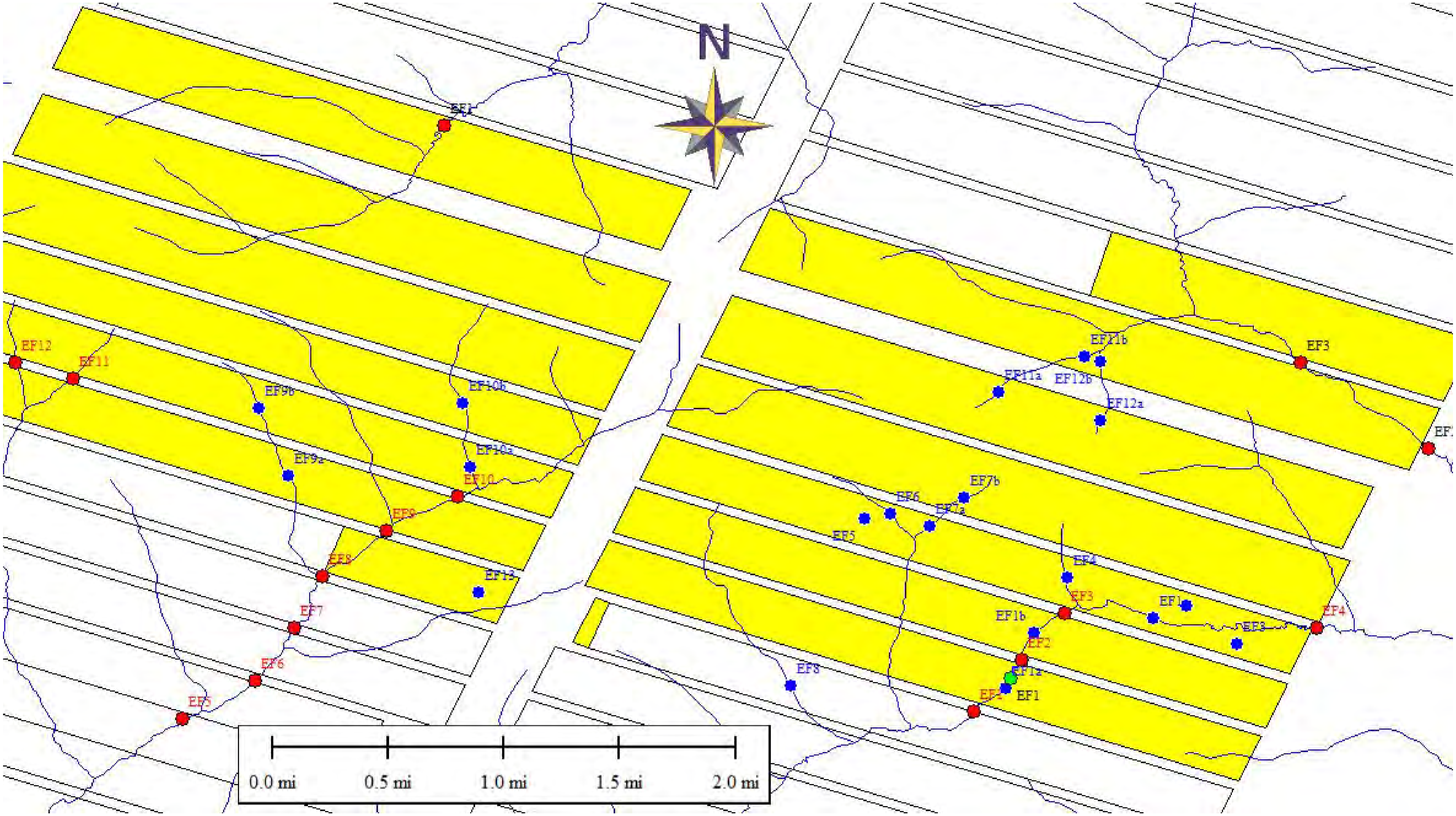

FIGURE B. Locations of proposed stream restoration reported during the 4th Assessment period at Enlow Fork Mine (yellow panels were active during the 2008-2013 period). Most undermined streams require some active intervention to restore premining conditions. **Blue dots** identify areas where **grouting** was performed to try to alleviate unpredicted flow loss impacts; **red dots** are areas where pooling had occurred and **gate cuts** were either conducted or planned, **green dot** is where a **liner** was installed. Figure compiled by Schmid & Company from data provided in 4th Assessment Tables VII-11, VII-12, VII-14, and VII-15.

> **"...control sites are not selected in the rigorous manner required by TGD 563-2000-655."** (X-9)

Thus, it may not be until the 5th Assessment is released in 2019 or 2020 before we finally have a clear indication of how effective the 2005 TGD has been. Such a time lag does not instill confidence that any new changes implemented in the near future will be able to be evaluated in a timely manner. Thus, if the Department adopts any of the recommendations in this 4th Assessment, it also should institute measures to ensure it does not take 10 to 15 years to evaluate their effectiveness.

All stream impacts from underground coal mining must be clearly identified and documented. The 4th Assessment shows that pooling impacts, in particular, are not:

> **"Unfortunately, the University was unable to complete Task 3 because the paper files that were made available at the CDMO did not contain maps for the vast majority of pooling impacts. ... the location and lengths of pooling could not be determined..."** (VII-22 to VII-23)

An accurate assessment of stream-miles adversely affected by underground mining is further thwarted by the fact that many small headwater tributaries are ignored, as explained below:

> "[In] **determining the miles of streams undermined during the 4th Act 54 assessment period...**[the University] **used ... the "Networked Streams of PA" .... The advantage ...is that it was used by two previous Act 54 reports ... so results are directly comparable with those reports. The drawback to using this streams layer is that it does not include many of the smaller tributaries in Pennsylvania... As a result, the analysis may underestimate the actual miles of stream undermined."** (VII-15)

Indeed, the underestimate of streams undermined, and damaged, is considerable. By failing to account for headwater streams (which are now being identified in applications per TGD 563-2000-655 but apparently are not being made available to, or used by, the Assessment preparers), the extent of stream damage is significantly undercounted. Headwaters comprise a large percentage of any watershed's total stream-miles, and their quantity and quality of flow are vitally important to the health of the entire watershed. Recent scientific investigations demonstrate that the headwaters of a stream are crucial to the water quality, nutrient cycling, biodiversity, and ecological functioning of downstream sections of that stream (USEPA 2015, Alexander *et al*. 2007; Meyer *et al*. 2007; Kaplan *et al*. 2008; Meyer *et al*. 2003; Pond *et al*. 2008; Stout 2004; and Clark *et al*. 2008). Because of their smaller size and drainage areas, headwater streams are more easily dewatered or otherwise damaged by subsidence than larger streams.

Although it notes that the previous two Act 54 Assessments used Networked Streams of PA (see box above), this 4th Assessment only addresses the miles of streams undermined by this (4th) one and the last (3rd) one. The available data from the 2nd Assessment also should have been included, evaluated, and compared, but were not.

Mitigation for Irreparably-Damaged Streams

Because they are classified as having a "final resolution" of "compensatory mitigation required", it is difficult to tell from Table VIII-1 in the Assessment that there were 7 cases of irreparably damaged streams. What this means, in fact, is that the Department determined that those streams had not recovered to their premining conditions despite many years of attempted restoration by the mine operator. Apparently, by assigning them a "resolution" status, the Department's clock is allowed to stop and the time to resolution for those cases is no longer being counted by the Department. The damages, however, have not yet been mitigated; the focus of the required mitigation merely has been changed from "on-stream" to "off-stream" --- and to lands possibly remote from the site of the actual impacts. The nature and outcome of any off-stream mitigation now “required” to compensate for these irreparable flow losses, or whether they have yet been designed, are not mentioned in the Assessment, although this should have been a major issue of discussion by the University of Pittsburgh reviewers.

Until the required off-stream mitigation has been successfully implemented for each of the irreparably damaged streams, compensation for them cannot be claimed to have been provided. According to TGD 563-2000-655, off-site mitigation can involve "*restoring or enhancing an equivalent length of stream in the same watershed or a nearby watershed in lieu of continuing to perform mitigation measures*". Off-site mitigation is more complicated than restoring the premining flow and biology of a damaged stream, because one first must determine what functions and values have been lost at the damaged stream, then one must determine how to replace those functions and values elsewhere, and finally one has to implement the off-site mitigation plan and monitor its success for a period of years. Thus, it is not as simple as just measuring the length of damaged stream and performing some sort of enhancement to that same length of stream elsewhere. The damaged stream will have provided minimal or none of the functions and values it previously had provided for the 5 or more years that the unsuccessful restoration efforts were ongoing (plus the additional years needed to implement and monitor the success of the off-site mitigation). That time lag must be factored into the "compensation". Also, the farther the off-site mitigation project is from the damaged stream, the less likely it is to actually offset any damage to the original watershed. That geographic dissimilarity must be factored into the "compensation". Finally, and most importantly, experience shows that stream restoration efforts are seldom successful in replacing lost functions and values (Doyle and Shields 2012, Stout 2004). That uncertainty must be factored into the "compensation" and addressed by careful monitoring before the success of any stream mitigation project can be evaluated.

The real question, then, is not how to pigeon-hole the "resolution status" of the irreparably damaged streams. The fundamental issue is whether allowance of irreparable stream damage from one method of coal extraction (when another economically viable method of coal extraction does *not* cause the same damage) aligns with the purpose or intent of Act 54 or with the public trust duty of the Commonwealth under Article 1, Section 27 of the Pennsylvania Constitution. A related question is, what consequences should a mine operator face for causing irreparable stream damage that was not predicted? This 4th Assessment, like all previous ones, makes no attempt to quantify the number of predicted (versus unpredicted) stream impacts or to evaluate whether any or all predicted impacts occurred to the same extent as predicted. Indeed, when longwall mining results in some type of damage to more than 60% of the streams undermined (as was the case during this 4th Assessment), then the only thing *unpredictable* is how permanent the damage will be. From an environmental protection standpoint, it should be assumed that permanent stream damage will be caused if longwall mining methods are used beneath or within some demonstrated angle of influence, and thus, in reviewing a mine application, a permit should be issued only if the mine operator can demonstrate that permanent stream damage will not result and agrees that if it does, the mine will be closed down. This, of course, is never done by PADEP.

Photo credit: Raymond Proffitt Foundation

Heaved and cracked streambed from longwall-induced subsidence

A related factor that is not explored by the 4th Assessment is that these irreparably-damaged streams likely represent just the first of many similar determinations still to come, now that the Department at long last has implemented a procedure and timeline for identifying at least some of them. The stream protection TGD guideline that led to these determinations did not become fully implemented until late 2007, and it set a limit of five years on the length of time a mine operator could make "technologically and economically feasible" efforts to restore a damaged stream before such efforts would be deemed futile and alternative mitigation would be necessary. It was in late 2012 (exactly five years later) that the Department made its determinations that six streams had met that criterion and were now considered irreparably damaged. As time goes on, additional streams that already have suffered flow loss or pooling and are now in some stage of attempted restoration are likely to be determined to have been irreparably damaged once they cannot be successfully restored within the 5-year timeframe of the Department's TGD.

As ever more streams are damaged by pooling or flow loss, as mine operators make attempts to restore premining flow and biological conditions to those streams for 5 or more years, and as mine operators design, build, and monitor alternative mitigation once streams are declared irreparably damaged, the costs devoted just to stream restoration activities will increase. At the same time, mining costs associated with extracting ever deeper and more difficult to reach coal reserves will be increasing, and Appalachian coal companies will be facing continued competition from cheaper sources of energy (such as western coal, natural gas, and renewables). All of these pressures and increasing costs could well threaten the economic viability of some coal operators, so the Department must give serious consideration to ensure that the bonds it requires for successful completion of stream restoration work is adequate, and that the Commonwealth is not left paying for any of the restoration work if a longwall mine operator becomes insolvent.

Resolutions Not in Accordance with TGD

According to Table VII-8 in the 4th Assessment, four of the nine stream investigations initiated during this latest five-year period were still pending ("not resolved") as of the end of the period. The other five reportedly had reached a "final resolution", which *sounds* like a positive outcome, but in general was not. In fact, the University identified problems with all five "resolved" cases.

Two of the "resolved" cases (including the one room-and-pillar case mentioned above) were determined "not due to underground mining", and one other "resolution" was a determination of "no actual problem", so in effect the flow losses in those three streams were not mining-related problems to begin with. In a fourth case classified as "resolved", the stream was determined to have been irreparably damaged, and the "resolution" was categorized as "compensatory mitigation required". As discussed above, the stream was irreparably damaged, but no mitigation has yet been proposed, approved, implemented, or evaluated. In the fifth "resolved" case (deemed "stream recovered") the University of Pittsburgh researchers found numerous irregularities: there was inadequate premining flow data, a control stream was not used to assess flow conditions, and the Department's determination of "resolution" appeared to be based largely on a single field visit in February 2012 during which the stream was flowing. In short, none of these five "resolutions" included credible evidence of a satisfactory outcome in accordance with the procedures outlined in the TGD.

Existing Uses of Undermined Streams

The value of streams being undermined and adversely affected are mentioned only briefly in this 4th Assessment, and then in an oddly inappropriate context.

> **"Using data from the Pennsylvania Aquatic Community Classification System, it was determined that many of the streams that were undermined are located in watersheds of high conservation concern for this region of Pennsylvania (Table VII-6; Walsh et al. 2007)..... Protection of streams in these high quality watersheds is thus an important conservation objective."** (VII-16 to VII-17)

While this is an interesting observation, the Pennsylvania Aquatic Community Classification System is not mentioned in any Department mining or water resource regulation. It would have been more useful to categorize streams undermined based on their 25 Pa. Code Chapter 93 designated and existing uses. Furthermore, the referenced table claims to identify "watersheds that were undermined during the 4th assessment", but it only identifies the watersheds associated with 4 longwall mines from among the 46 underground mines active during the period.

Streams in Pennsylvania that have been designated either Exceptional Value (EV) or High Quality (HQ) are considered "Special Protection" waters, and as such are to be afforded special consideration in regulatory and permitting matters[5]. Such streams represent the very best waterways in the Commonwealth, and to a large extent have been avoided to date by longwall mining (**Figure C**). However, just over half of the remaining unmined sections of the Pittsburgh Coalfield are overlain by Special Protection waters (**Figure D**), no doubt including unrecognized EV existing use streams, so they increasingly will be subject to mining pressure as time goes on. The failure of this Act 54 Assessment, like its predecessors, to discuss the extent of mining and mining impacts (especially hydrologic impacts) in terms of Special Protection waters and their watersheds is a major oversight.

Stream Water Quality

Another factor about streams that has received less attention than it deserves is the effect of undermining, and specifically longwall mine subsidence, on water quality. To its credit, the 4th Assessment makes that very observation:

> **"An important function of the Clean Streams Law ... is "regulating the impact of mining upon water quality, supply, and quantity". While TGD 563-2000-655 and the mine permit application provide for an assessment of stream flow and biological recovery, it does not currently assess impacts to stream water quality."** (X-10)

As further observed in this 4th Assessment, longwall mining can impact the quality of surface waters when flow loss impacts occur, as well as the quality of groundwater:

> **"Declines in water quality, including increases in conductivity and pH, also accompany mining-induced flow loss impacts."** (EX-2)

> **"...longwall mining may .... diminish water quality in wells situated in lower aquifers"** (VI-27)

Underground coal mines also affect water quality with their wastewater discharges. Like all previous ones, this 4th Assessment did not review any of the numerous underground mine DMR (discharge monitoring report) records. The absence of this information is significant: not only were there hundreds, and likely thousands, of violations when so-called discharge "limits" were exceeded during the review period, but enforcement of those violations by the Department likely was minimal, if they were noticed at all (Schmid & Company, Inc. 2010b, 2011).

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[5] Antidegradation protection of such streams in Pennsylvania was compelled by the federal court in *Raymond Proffitt Foundation v. USEPA* (930 *F. Supp*. 1088, 16 April 1996).

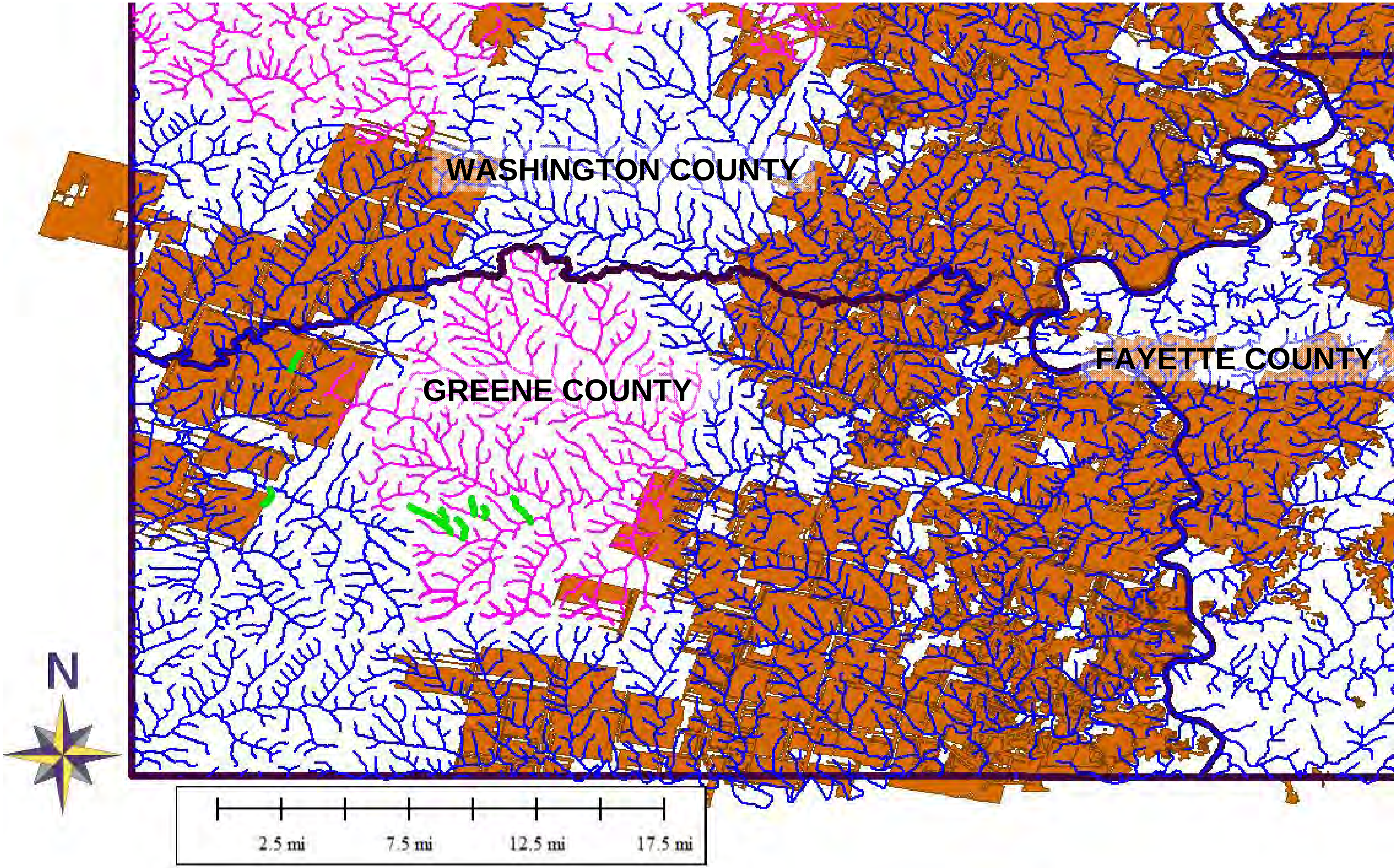

FIGURE C. Special Protection waters (EV in green, HQ in purple) largely have been avoided in previously-mined areas (dark shading), particularly in Greene County. Ordinary (non-Special Protection) waters are in blue. The several EV streams (green) in Greene County were recognized as having attained that higher existing use only in the last 7 years, in some cases because a mine operator had petitioned to *downgrade* them, but upon field investigation by the Department, they were found to be attaining uses better than their designated uses. It is likely that many forested headwater streams in undisturbed areas also are attaining uses higher than their designated uses (Schmid & Company, Inc. 2010a).

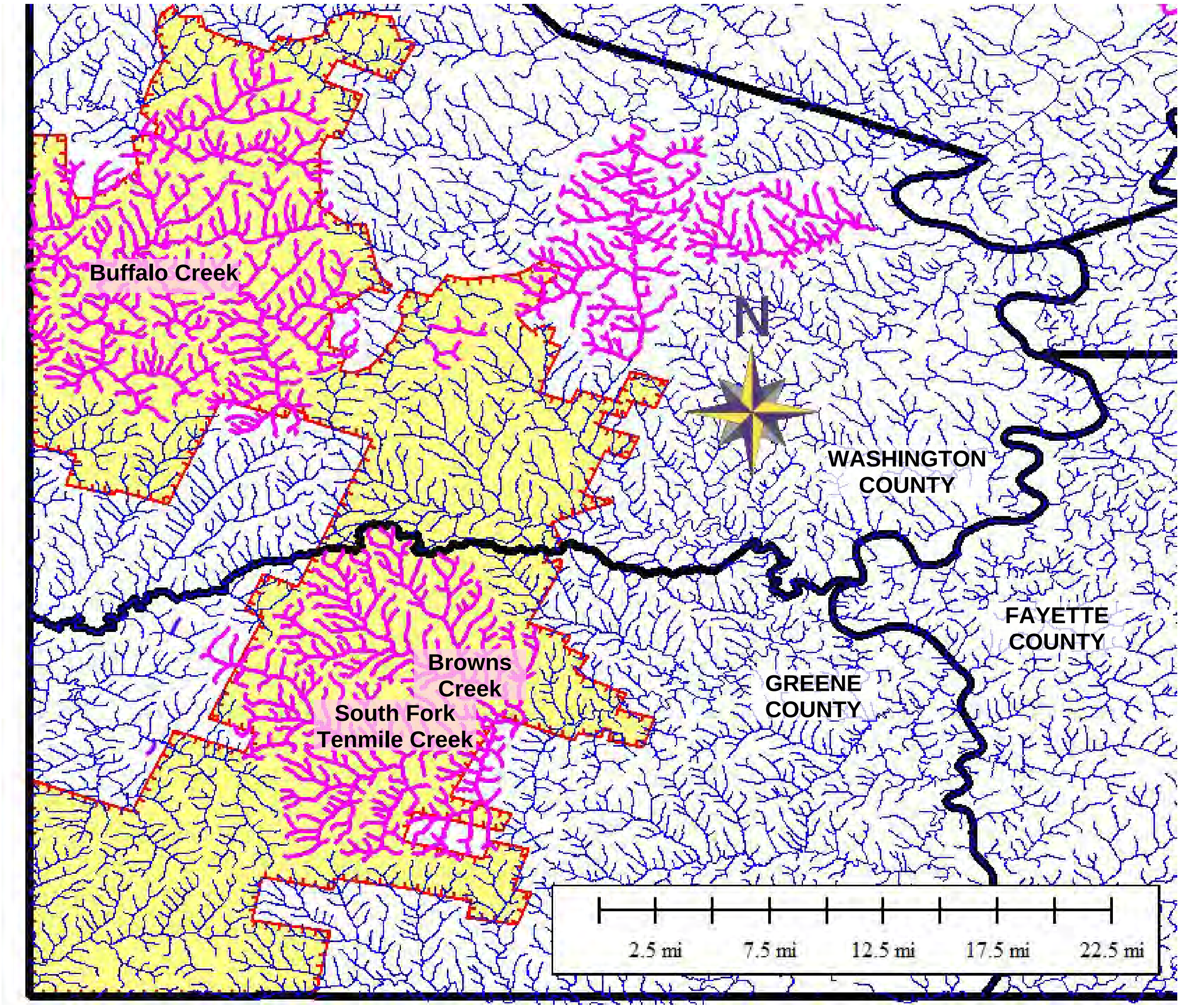

FIGURE D. The 4th Assessment estimated that it will take about 37 years to extract the remaining unmined coal of the Pittsburgh Coalbed (yellow) in Washington and Greene Counties. There are three major Special Protection watersheds (pink) in that unmined area, including Buffalo Creek (Washington County) and Browns Creek and South Fork Tenmile Creek (Greene County).

Not only does longwall mining adversely affect water quality, but the successful "restoration" of impacted streams (in accordance with the TGD) in terms of flow and macroinvertebrates may not provide a concurrent restoration of the chemical water quality:

> **"...biological recovery does not appear to be a function of recovery in stream chemistry. There was no significant relationship between time since mining and conductivity .... or pH .... , indicating that water quality does not return to pre-mining levels following mining."** (VII-60)

This is a striking observation, made for the first time in this 4th Assessment, and one that needs to be addressed by the Department going forward. Indeed, one of the many excellent recommendations of this 4th Assessment is:

> **"The University suggests that PADEP and future Act 54 reports further investigate the impacts of longwall mining on stream water quality in the Commonwealth"** (VII-27)

How the Department might implement that recommendation specifically, and how long it is likely to take to evaluate whether its implementation has been successful, is not addressed, but must be done if the Department is to uphold its public trust duty.

Related Stream Impacts

The 4th Assessment for the first time raises an important point about additional impacts to streams as a direct consequence of stream restoration activities undertaken to address subsidence damage.

> **"To fully understand the impacts of subsidence and subsequent restoration on stream ecosystems, it is important to consider the effect of road construction. ... Road construction is an ecological disturbance that is generally associated with declines in biodiversity in both terrestrial and aquatic communities..... "** (VII-56)

It notes that the ecological impacts associated with stream restoration activities are not required to be included in proposed mitigation plans, but that the University had the opportunity to review one report related to this matter. It found that Consol had constructed 15 miles of roads over a 2-year period to gain access to, and to otherwise implement, restoration at streams damaged by longwall mining. It suggests that the Department needs to further recognize, monitor, and evaluate these related types of impacts.

Other impacts to streams that are not being evaluated at all in these Act 54 reports are the extensive surface activities of underground mines, including the construction of mine portals, preparation plants, refuse disposal areas, and NPDES discharges. Just as there are distinct differences as well as similarities among underground mining methods, any differences and similarities in the surface activities of underground mines also should be identified and evaluated in Act 54 Assessments.

4B Wetlands

SUMMARY: The protection of wetlands in the context of underground coal mining is careless at best, perhaps because the Department's wetland expertise in the regional offices and its Chapter 105 Program are not being utilized by the District Mining Offices. While conceding that "*The analysis and reporting on underground mining effects on wetlands is still in its infancy*" (a surprising fact itself after 20 years), this section of the Assessment displays an astonishing misunderstanding of how wetlands are delineated and of how "no net loss" of wetlands could meaningfully be analyzed.

Wetlands are important natural features that typically occupy the transitional areas between dry land and water. Two decades ago wetlands were estimated to cover about 404,000 acres in Pennsylvania, or 1.4% of the land area (Tiner 1990). Wetlands are important because of the diverse and critical functions they perform. Wetlands can decrease flooding, remove pollutants from water, recharge groundwater, protect shorelines, provide habitat for fish and wildlife, and provide recreational, research, and educational opportunities. Wetlands also play a role in the cycling of carbon, nitrogen, and water and thus in the protection of water quality. There are different types of wetlands, and not every wetland performs every function. Yet the value of the services performed by wetlands greatly exceeds their scarcity in the landscape.

In Pennsylvania, wetlands are recognized as a special subset of a larger class of surface water resources known as "regulated Waters of the Commonwealth[6]". According to 25 *Pa. Code* Chapter 105 (§105.17): "*Wetlands are a valuable public natural resource. This chapter will be construed broadly to protect this valuable resource.*" Wetlands are defined similarly for both federal and Pennsylvania regulatory purposes. The Department uses the same technical criteria and methodologies to identify (delineate) the limits of wetlands based on plants, soils, and water as are used by the Army Corps of Engineers, and has adopted the current federal methodology for wetland delineation (25 *Pa. Code* 105.451).

> **"The analysis and reporting on underground mining effects on wetlands is still in its infancy. Many of the active mining operations during the 4th assessment received their permits prior to the deadline for compliance with TGD 563-2000-655. The permit applications therefore do not contain sufficiently detailed wetlands inventories, if any wetland information is present at all."** (XI-7)

Section IX in this 4th Assessment is devoted to wetlands. Like the section on streams, the wetland discussion is focused entirely on longwall mine subsidence with no mention of room-and-pillar mines. TGD 563-2000-655 devotes an entire section (Section IV.2) to wetland protection in the context of underground coal

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[6] "Regulated waters of this Commonwealth" are defined in 25 *Pa. Code* Chapter 105 as "Watercourses, streams, or bodies of water and their floodways wholly or partly within or forming part of the boundary of this Commonwealth". The Chapter 105 definition of "Body of water" is "A natural or artificial lake, pond, reservoir, swamp, marsh, or wetland."

mining[7]. The TGD standard for wetlands is "*no net loss*". (Note: This differs from the higher TGD standard for streams, which is to "*prevent adverse impacts*".) There are numerous obvious deficiencies in the TGD that inhibit wetland protection. Those deficiencies are carried forward into the Mining Program's permit application and review processes (and also into the Act 54 Assessments). Some of the biggest deficiencies are discussed below.

Accurate Wetland Delineation

In determining "no net loss" of wetlands, the University of Pittsburgh researchers compared the total applicant-reported acreage of wetlands premining with the total permittee-reported postmining wetland acreage, according to the operators' 5-year mine permit renewal files (those 5-year periods randomly intersect with the 5-year Assessment periods, as noted in the Assessment). There is no indication that the Department or the Corps of Engineers reviewed or confirmed the accuracy of any premining or postmining wetland delineations at any of the mine sites. This is a major procedural error, one that has been pointed out time and again[8]. If premining onsite wetland conditions are not accurately identified, any evaluation of the effects of mining on wetlands is severely compromised. This problem is compounded further when the postmining wetland conditions also are not accurately identified.

There is no excuse for inaccurate identification of wetlands. The Army Corps of Engineers has an established, straightforward, no-fee process/procedure for checking the accuracy of wetland delineations for federal and State purposes. The need to use this procedure was highlighted recently (Schmid & Company, Inc. 2014b) when the proposed Foundation Mine (Alpha Natural Resources) application was undergoing permit review. In the 1,867-acre surface facilities area for the proposed Foundation Mine, the applicant identified 16 wetlands where the National Wetlands Inventory (NWI) had mapped only 2, which seemed like a great improvement[9]. Following the Corps' field inspections for a JD (jurisdictional determination), however, a total of 44 wetlands was confirmed at the Foundation Mine surface facilities area. If the Corps had not examined the wetland delineations, and if any of those additional 28 wetlands which existed prior to mining had been adversely affected by mining, those impacts would not have been recognized. Furthermore, any or all of those 28 wetlands might have been identified postmining, in which case they would have been incorrectly counted as wetland “gains”. When

[7] The TGD protections apply to all longwall mining plus room-and-pillar mining of coal seams found less than 100 feet beneath any wetland. Seven (p. III-22) room-and-pillar operations reportedly had some sections of the mine with overburden less than 100 feet during the 4th Assessment period. None of those seven mines was discussed in the Assessment section on wetlands (perhaps because none of those shallow overburden areas were beneath wetlands, although there was no statement or documentation to that effect).

[8] The need for Corps oversight of wetland delineations was mentioned in the review of the 3rd Act 54 Assessment report (Schmid & Company, Inc. 2011) which was provided both to the University of Pittsburgh team and to the Department. It was mentioned again to the Department and the University in comments on the proposed work plan for the 4th Assessment that was provided to the CAC (Kunz 2012).

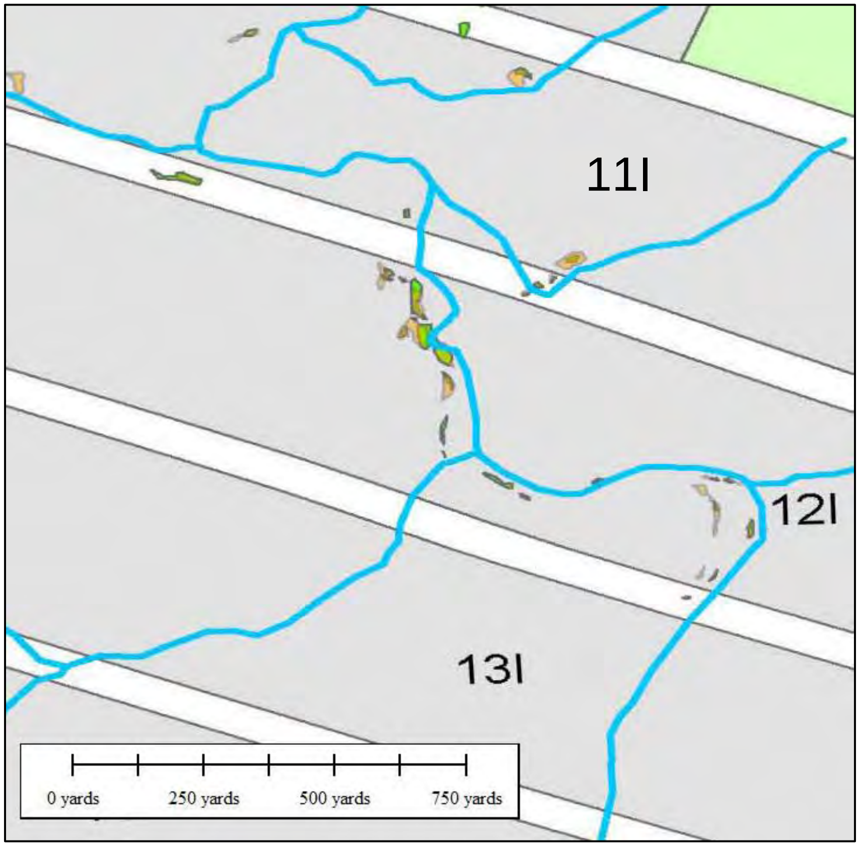
[9] It is finally becoming clear, in the context of underground coal mining, that NWI mapping is not, and never was intended to be, accurate for regulatory purposes, but is useful only as a rough approximation of the location of more obvious wetlands (see Schmid & Company, Inc. 2010b, 2011, and 2014b).

there is no chance that the premining delineations will be reviewed by anyone, it can be tempting for mine operators to be less diligent "finding" wetlands during a premining survey than in a postmining survey. This major problem could be easily avoided if the Department required a preliminary Corps Jurisdictional Determination for all areas to be affected by surface and underground activities in every coal mine application.

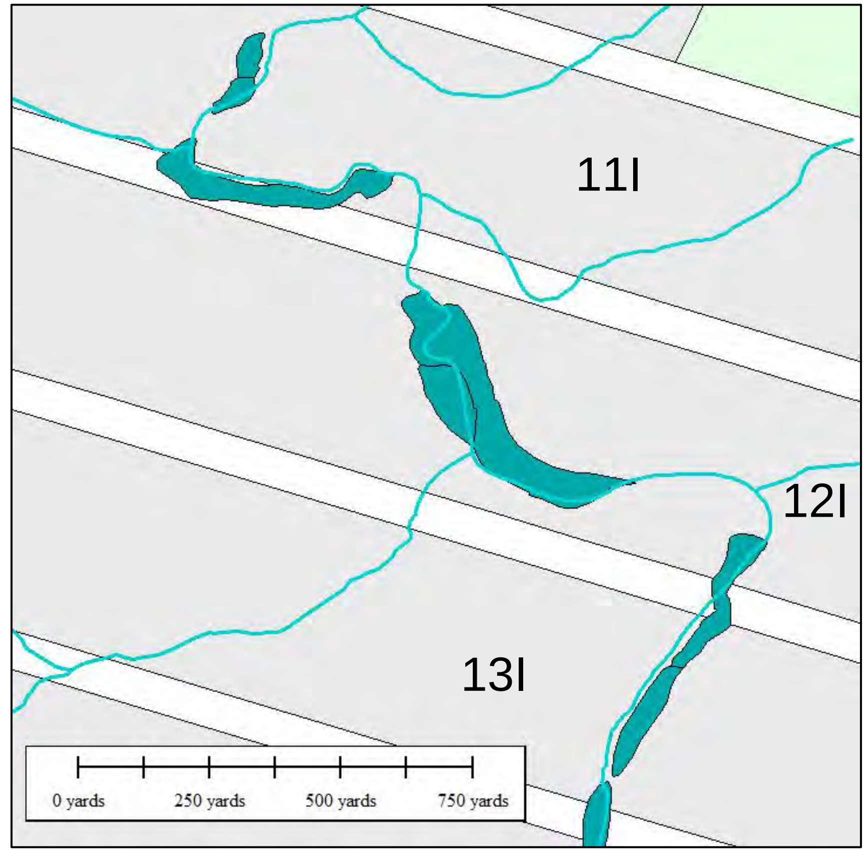
Table IX-1 (page IX-5) in the 4th Assessment identifies the premining wetland acreage reported for each of five longwall mines that were active throughout the period. Based on the total acreage mined, an average wetland density for each mine was computed. The wetland densities varied by more than an order of magnitude, from 2.92 acres of wetlands per 100 acres mined (Cumberland Mine) to 0.28 acre per 100 acres mined (Bailey Mine). Not mentioned or discussed in the 4th Assessment is *why* the reported densities varied so greatly. One would expect natural wetlands to be distributed fairly evenly across the maturely dissected southwestern Pennsylvania landscape. Indeed, the NWI mapping (as imprecise as it is) identifies just the opposite pattern for those two mines, showing the most wetlands above Bailey Mine panels active during this 5-year period and the fewest above Cumberland Mine panels. **Figure E** contrasts wetlands delineated by the mine operator's consultants at a section of Bailey Mine with NWI mapping there. Again, routine formal review and confirmation by the Corps of Engineers would usefully dispel questions about the accuracy of premining wetland delineations.

The 4th Assessment suggests that some of the gains and losses attributed to coal mine subsidence might instead be associated with weather or climatic variation, and thus may reflect natural changes in the size or prominence of wetlands. It is true that a given wetland may look "wetter" or "drier" depending on whether it is observed in March/April (the normal local wet season) or August/September (the normal local dry season). However, a professionally conducted onsite wetland delineation following the accepted federal methodology would take any such seasonal variations into consideration. Admittedly, wetland delineation is not a perfectly exact process, and two similarly-qualified wetland delineators may identify slightly different wetland boundaries on the same site, but the seasonal differences should be minor, perhaps within a few percent of one another in overall acreage.

To account for changes in wetland size due to climatic variation, the University recommends that the Department have mine operators set up a control group of wetlands delineated prior to mining, presumably distant from any potential mining effects. This, however, is likely to create extra, unnecessary work that will yield only indirect approximations of wetland changes. It would be much more straightforward to simply require that a Corps JD be obtained for all delineated wetlands pre- and post-mining. That way, all mine-related wetland delineations would be reviewed and confirmed by an impartial qualified professional from the Army Corps of Engineers. When issued, a Corps JD can be accepted and relied upon by everyone involved, including the mine operator, the Department, other agencies, and interest groups.



Wetlands per 4th Assessment, Appendix C



NWI Wetland Mapping, same area

FIGURE E. Comparison of wetlands identified at a portion of the Bailey Mine which was active during the 4th Assessment period (gray panels 11I, 12I, and 13I). On the left are wetlands delineated premining (green) and postmining (tan) by the mine operator. On the right are wetlands (dark blue) mapped by the National Wetlands Inventory (NWI). Note the large discrepancies. In particular, the NWI mapping shows significant areas of wetlands that either were not identified as premining wetlands, or were identified as postmining wetlands which supposedly were created by mine subsidence. NWI mapping is not necessarily accurate with respect to the extent of wetlands in a given area, but it tends to identify the more obvious wetlands. The large discrepancy here is one reason why it is important to obtain an Army Corps of Engineers field review and jurisdictional determination (JD) of all delineated wetlands, at minimum prior to undermining an area.

The identification by mine operators of wetland types appears to be somewhat problematic. Premining wetlands overwhelmingly (84%) were identified as emergent (PEM) during the 4th Assessment period, with only 1% identified as either forest (PFO) or scrub (PSS). The remaining wetlands represent mixes of these three types. Enlow Fork Mine, which reported more premining wetlands (both in numbers and acreage) than all of the other longwall mines combined, is the only one to have reported *any* forested wetlands (a total of 0.4 acre), and that involved only 3 of its 529 wetlands (0.6%). By comparison, the National Wetlands Inventory, which as noted above is by no means a perfectly accurate or exhaustive inventory of regulated wetlands in Pennsylvania, reported that forested wetlands accounted for 18.3% of all wetlands identified in Greene and Washington counties (Tiner 1990). It is unlikely that wetlands above longwall mines happen to be so different than wetlands elsewhere in the region. Rather, the Department routinely accepts wetland data for longwall mines that are incomplete and fragmentary.

> **"Bailey Mine ... gained acreage of an entirely new wetland type following mining. Post-mining surveys recorded 0.17 acres of palustrine emergent/palustrine unconsolidated bottom (PEM1B/PUBHh) wetlands...... The last modifier** ["h", which means due to a dike or impoundment per U.S. Fish and Wildlife Service 2014] **suggests that the new wetland acreage is not due to mine subsidence and rather is a result of changes in land use."** (IX-8 to IX-9)

It is unclear what is meant by the suggestion (above) that a new wetland type recorded in a post-mining survey may have been created by a land use change rather than by mining. The PUBHh wetland code for two "created" wetlands was assigned not by USFWS or another outside entity, but by the mine operator itself with the specific intention of characterizing a post-mine-subsidence related effect. If anything, the University of Pittsburgh reviewers should have questioned why no freshwater wetland pond (PUB) was reported in the premining surveys for any mine during the 4th Assessment period. As noted above, NWI mapping is far from perfect, but almost half (12 of 26) of the NWI wetlands mapped above the panels of the five longwall mines discussed in this 4th Assessment are classified as PUB, mainly because those little ponds are the easiest to identify from the high-altitude aerial photography used in the USFWS mapping program.

Compensating for Wetland Losses

Only after the location, size, and type of premining and postmining wetlands have been accurately identified can appropriate mitigation for adverse mine-related changes be considered. The 4th Assessment discuses two wetland mitigation projects (Dutch Run and Whitely Creek) associated with wetland losses at Cumberland Mine. The mitigation projects are evaluated against the Department's wetland replacement/ monitoring requirements in TGD 363-0300-001 (PADEP 1997). The Department's detailed criteria include a five-year monitoring period and a minimum 1:1 ratio for replacement of the lost wetland's area and functions (2:1 when the wetland loss was not approved beforehand, as would apply to all subsidence-related wetland losses, none of which is ever predicted ahead of time).

"... the mitigation does not provide a 1:1 functional replacement of the lost wetlands. Furthermore, the University could not evaluate the effectiveness of either mitigation project as the Dutch Run site was planted just months before the end of the reporting period and work on the Whiteley Creek site had not even begun." (IX-17)

The Assessment notes that the approved mitigation plan does not even propose to provide the minimum 1:1 ratio replacement. The Assessment provided no indication as to whether a full 5-year monitoring period was proposed in this case, or was routinely being followed in any other mine-related wetland replacement projects.

"... studies suggest that wetland mitigation projects in Pennsylvania have historically not been completely successful in replacing the function of lost wetland acreage." (IX-15)

The general observation above, which involves wetland losses of many kinds, also appears to accurately describe the two proposed mitigation projects discussed in the 4th Assessment at Cumberland Mine.

The University of Pittsburgh researchers (and quite likely, the Department's California District Mining Office) appear to misunderstand the directive in TGD 563-2000-655 which says that "*a mining operation that creates wetlands through subsidence may be allowed to use those wetlands to offset the wetland losses it has incurred*". "No net loss" of wetlands is not, however, simply a matter of adding up the acreage of premining and postmining wetlands and using the difference to determine whether and how much mitigation may be necessary. Every wetland must be evaluated on its own merits. If one 0.5-acre wetland is destroyed by mine subsidence, and another 0.5-acre wetland forms somewhere else, it is not true that the created wetland automatically compensates for the lost wetland. First, one must evaluate whether the two wetlands are equal in terms of structure and functions. If one is a forested wetland and the other is an herbaceous wetland, there may be a significant difference in overall functions and values despite their acreage being the same (Schmid & Company, Inc. 2014a). Even if the two wetlands are similar in type, the location of each is important. If the wetland destroyed was in the floodplain of a stream and was contributing to its water quality, but the created wetland is a depression in an upland field, the gain may not directly or fully offset the loss. A difference in ownership of the wetlands also can be an important consideration: the wetland lost might have been on public lands, but the new wetland formed on private land.

Finally, even if all of the factors just mentioned are the same for the two hypothetical wetlands, one must determine whether there is any assurance that a wetland accidentally created by mine subsidence will *remain* a wetland. If both wetlands happen to be depressions in two different private farmers' fields, the first farmer (where the wetland dried up) may be pleased he no longer has to plow around the wet spot in his field, while the second farmer is annoyed that he suddenly has a big wet obstruction in his field and so he orders several truckloads of topsoil to fill it in.

The loss of the first wetland is a regulated impact that must be compensated by the mine operator. Unless the mine operator obtains a formal agreement from the owner of the new (second) wetland to preserve it indefinitely, that "created" wetland cannot be counted as mitigation. Wetlands created as mitigation for approved wetland destruction typically must be guaranteed long-term protection by conservation easements or deed restrictions[10]. Each wetland that can be demonstrated to have formed (or gotten larger) as a result of mining must be evaluated for its size, functions, and values and compared against the size, functions, and values of each wetland that can be demonstrated to have been lost (or made smaller) as a result of underground mining. Furthermore, there must be clear acknowledgments and enforceable agreements ensuring that every newly-created wetland will be preserved in its wetland state forever into the future (or at least until a permit is obtained to disturb it) before it can be legitimately used/counted to offset any wetland losses. The 4th Assessment nowhere mentions any legal protections afforded any mining-created wetlands.

The reported loss of 27.8 acres of wetlands (prior to the inappropriate netting out of gains) due to longwall mine subsidence during this latest five-year Assessment period was not given appropriate attention and discussion. The magnitude, and thus the significance, of this loss of a valuable but rare natural resource is buried in this 4th Assessment in the netting-out of those losses by reported gains in wetlands, which as pointed out above is simply inappropriate. No accurate determination of wetland loss was ever made in a previous Act 54 report, not because wetlands weren't being destroyed, but because there previously was no recorded information --- the Department simply did not track wetlands premining and postmining.

> "**Very little documentation** [regarding wetlands] **was provided**"
> (3rd Assessment, page IX-2)
>
> **"... standards and protocols for dealing with stream and wetlands impacted by underground longwall mines have been developing over the last decade. ... Some period of time will be required to fully understand these impacts and to measure how effectively they return to their previous states."** (3rd Assessment, page EX-4)

Because the wetland regulatory principles discussed above appear to have been misunderstood in this 4th Act 54 Assessment, the discussions of wetland impacts are simplistic and ultimately meaningless. For example, wetland functions in this Assessment are ascribed solely on the basis of wetland structure (emergent, scrub, or forest), instead of the broader list of wetland functions that the Commonwealth claims to recognize, both in TGD 563-2000-655, Section IV.2.d.iii.D, and at 25 Pa. Code Chapter 105.13(d)(3).

[10] The Corps of Engineers and USEPA require that compensatory mitigation project lands be provided long-term protection through deed restrictions or a conservation easement (US Army Corps of Engineers and USEPA 2008). Absence of such protection is one reason that the Department's Wetland Replacement Program has been declared ineligible for consideration when mitigation is required by federal agencies.

Wetlands routinely are impacted by underground coal mines when their extensive requisite surface facilities (portals, preparation plants, refuse disposal areas, etc.) are constructed to support belowground operations. As the University of Pittsburgh aptly pointed out, work (like access roads) undertaken to restore premining flow and biological conditions to streams impacted by longwall mine subsidence often results in additional disturbances to the riparian ecosystems, and that would include wetlands. There is no evaluation in this or any previous Act 54 Assessment of the number or types of wetland impacts associated either with surface facilities or with stream restoration projects, nor how effective any wetland mitigation may have been in compensating for the lost functions and values of impacted wetlands.

In summary, resources such as wetlands which the Department recognizes as valuable in other regulatory contexts should not be treated so cavalierly in the context of underground coal mining. Wetlands are important elements of the "hydrologic balance" that is supposed to be protected from underground mining activities. To the extent that the protection of wetlands receives less attention in these Act 54 Assessments, and especially in the underground mine regulatory program, that would violate the Department's public trust responsibility.

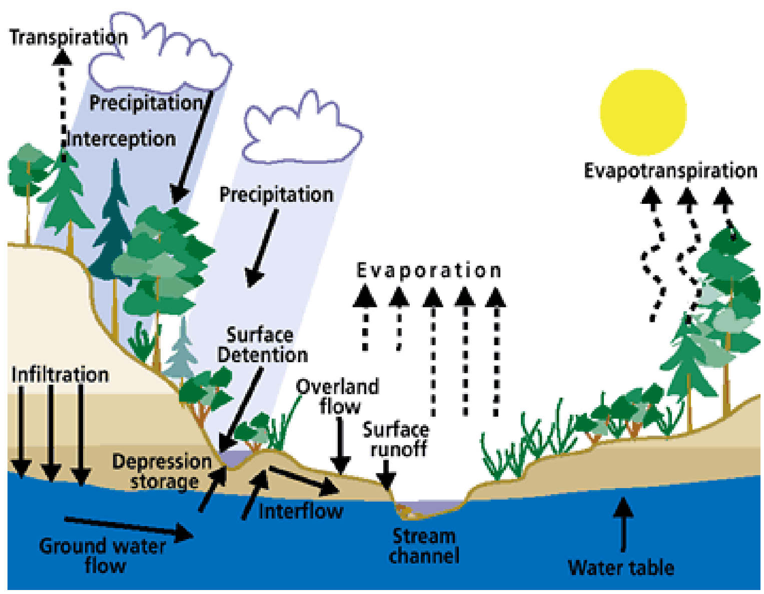
4C Groundwater

SUMMARY: For the first time ever, this 4th Assessment devotes an entire section to groundwater, in recognition of the important role it plays in the complex hydrologic system whose balance is supposed to be protected from underground mining activities. Unfortunately, most of the discussion focuses on the major inadequacies with the data being collected which give rise to a complete inability to evaluate hydrologic impacts.

State and federal mining laws prohibit adverse impacts to the hydrologic balance --- but unless and until one first identifies and *understands* the hydrologic system of an area to be undermined, there can be no chance of accurately evaluating any changes associated with mining. Understanding an area's hydrologic system is no easy thing, because it is a delicate balance of complex interrelationships between surface water and groundwater elements,[11] each one of which by itself can be complicated and difficult to understand.

This 4th Assessment devotes an entire section (Section VI, 45 pages) to groundwater impacts. This is commendable, because previous Act 54 assessments typically mentioned groundwater only incidentally in talking about well water supplies, and rarely if ever in terms of mining impacts to the overall hydrologic system. The section on groundwater is exclusively focused on *longwall* mine subsidence; there is no mention or discussion of room-and-pillar mining, presumably because University researchers found no PADEP-documented effects on groundwater from room-and-pillar mining.

THE HYDROLOGIC BALANCE



[11] The scope of the Pennsylvania Clean Streams Law (Act of 1937, P.L. 1987, No. 394) clearly encompasses both surface and groundwater, as noted in this definition from the Law: *"Waters of the Commonwealth" shall be construed to include any and all rivers, streams, creeks, rivulets, impoundments, ditches, water courses, storm sewers, lakes, dammed water, ponds, springs and all other bodies or channels of conveyance of surface and underground water, or parts thereof, whether natural or artificial, within or on the boundaries of this Commonwealth.* All these resources are components of the public trust.

The connections between groundwater and water supplies and between groundwater and surface water are more clearly made in this Assessment. This recognition of the complexity of the hydrologic system and the various interconnections is long overdue. In recognizing these complexities, however, the Assessment also acknowledges the total failure of the mine permitting process so far to elicit any real data that might characterize the premining hydrologic system and the effects that underground mining is having on it.

> **"The surface disturbances associated with longwall mining have significant implications for these** [ground]**water resources, including the potential "loss" of wells accessing these aquifers (i.e. diminished water yields or water quality from these wells) and the potential loss of flow from springs along the hillslope".** (I-14)

The Assessment notes that underground mine permit applications require surface water (stream) flow monitoring prior to mining, and also require a plan for permittee streamflow monitoring as often as weekly and daily during and after undermining a given stream. Such data are required to be *collected* by mine operators but are not required to be *reported* to the Department (that requirement should be changed). For groundwater monitoring, however, the permit requirements are not clear, and as a result, the data collected and/or reported to the Department are inconsistent and generally inadequate to characterize premining conditions, much less to evaluate mining-related changes.

In Hydrologic Monitoring Reports (HMRs) permittees are supposed to monitor surface and groundwater conditions, but the University identified numerous problems with HMRs:

> **"...within** [applicants'] **hydrologic monitoring reports (HMRs)... there is substantial variability in what is reported.... there are distinct differences in report formats....reporting formats often evolve over** [time]**... format changes occur within a single report for most of the mines... some data that is collected to meet permitting process requirements is not reported to PADEP in the HMRs."** (VI-10)

This observation is consistent with our findings in recent detailed reviews of pending applications for Foundation Mine (longwall) on behalf of CCC and for Donegal Mine (room-and-pillar) on behalf of PADEP (Schmid & Company, Inc. 2014b, 2012b).

The monitoring and assessment of impacts to groundwater at present are as fragmentary and uninformative for assessing mine-related effects as were the monitoring and assessment of impacts to surface waters 10 years ago, prior to the implementation of TGD 563-2000-655. This is most unfortunate, because impacts to groundwater from underground mining have been occurring regularly and with increasing frequency, as reflected in the water supply effects discussed in the Act 54 Assessments. Groundwater impacts also factor into surface water impacts, because the lowering of a water table and the loss of seeps and springs often translate into a loss of baseflow in headwater streams and wetlands.

"[The USGS] **groundwater monitoring network is decidedly sparser than the surface water observation network and continuous records closer to underground mining activity do not exist."** (VI-16)

"In general, very limited hydrogeologic information is provided in module 8.....logs of stratigraphic materials for these piezometers and groundwater wells are lacking. Therefore attribution of the wide variance in piezometers....to an actual difference in hydrogeologic materials is not possible." (VI-18)

"One of the challenges in reconstructing hydrologic changes following undermining is synthesizing the baseline information provided in module 8 of the mining permit, particularly given the incremental nature of changes made as part of the revisions to the permit." (VI-22)

It is unclear why permit application requirements for collecting and documenting groundwater and other information relating to the hydrologic balance should be so lacking when the 25 Pa. Code Chapter 89 regulations, adopted in 1980, appear to be quite clear on what is needed:

§ 89.34. Hydrology.

(a) The operation plan shall contain premining or baseline hydrologic information representative of the proposed permit, adjacent and general areas.

(1) Groundwater information shall include:

(i) The results of a groundwater inventory of existing wells, springs and other groundwater resources, providing information on location, ownership, quality, quantity, depth to water and usage for the proposed permit area and adjacent area.

(ii) Other information on the baseline hydraulic and hydrogeologic properties of the groundwater system shall be included with the application.

(iii) A groundwater monitoring plan under §89.59 (relating to surface water and groundwater monitoring). The plan shall logically relate to the analysis of the baseline information and the prediction of the probable hydrologic consequences of mining and reclamation required by §89.35 (relating to prediction of the hydrologic consequences). The plan shall identify monitoring locations and sampling frequency.

§ 89.35. Prediction of the hydrologic consequences.

The operation plan shall include a prediction of the probable hydrologic consequences of the proposed underground mining activities upon the quantity and quality of groundwater and surface water within the proposed permit, adjacent and general areas under seasonal flow conditions, and whether underground mining activities may result in contamination, diminution or interruption of any water supplies within the permit or adjacent area. The prediction shall be based on baseline data collected at the proposed mine site or data statistically representative of the site or a combination of both. The prediction required by this section may be developed using modeling techniques, but the Department may require verification of any models.

§ 89.36. Protection of the hydrologic balance.

(a) The operation plan shall describe, with appropriate maps and cross sections, the measures to be taken to ensure the protection of the hydrologic balance and to prevent adverse hydrologic consequences. The measures shall address:

(1) The quality and quantity of surface and groundwater within the proposed permit and adjacent areas.

(2) The rights of present users to surface and groundwater.

(3) The control of surface and groundwater drainage into, through and out of the permit area.

(4) The treatment, when required, of surface and groundwater drainage from the permit area, and proposed quantitative limits on pollutants in discharges as provided in §89.52 (relating to water quality standards, effluent limitations and best management practices).

(b) The operation plan shall also describe how the proposed mine development plan will prevent or minimize adverse hydrologic consequences. The plan shall consider:

(1) The location of mine openings to prevent postmining discharges as required by §89.54 (relating to preventing discharges from underground mines).

(2) Possible alterations in the mine development plan or method of mining in response to adverse impacts on the hydrologic balance as indicated by the groundwater monitoring system.

Information to address the paper requirements in the box above is poorly elicited by the specific modules of the PADEP underground mine permit application (Schmid & Company, Inc. 2014b, 2012b, 2010b)

With respect to groundwater, every underground mine permit applicant is supposed to characterize local groundwater levels and trends based on existing wells in the permit area. Forms are provided in the permit application to record the results of well pumping tests and to report such information as the pumping rate, the water level before and after pumping, the gallons of water pumped, the length of the pumping test, and the specific capacity. Results are to be interpreted in light of the season and hydrological conditions. With many dozens of wells in a typical permit area, this information would seem to be quite useful. Unfortunately, most mine operators do not collect such information until *after* mining has been approved and has approached within 1,000 feet of a well, by which time the groundwater may already be experiencing adverse effects from the longer and wider panels of modern longwall mines.

The failure on the part of the Department to consistently require the collection of comprehensive premining information on groundwater, including pumping tests of all wells within and adjacent to a proposed permit area, precludes not only the evaluation of mining effects on the hydrologic balance, but also the ability to accurately determine whether, and to what extent, any individual water supply has been damaged. This critical data gap was mentioned in the 4th Assessment:

> **"...observations of groundwater are limited to relatively few and spatially limited points (i.e., wells). In general, HMR data is collected from a subset of existing wells and nests of piezometers... Analysis of affected water supplies relative to lowered water tables is challenging given the existing data is limited in spatial and temporal density. ... Few piezometer, spring, or well HMR points were in close proximity to most of the reported effects."** (VI-27 to VI-29)

It is commendable that the University even discusses, for the first time in any Act 54 Assessment, the existence and relevance of HMRs (hydrologic monitoring reports). Unfortunately, as noted in the box above, the HMR data that are being collected by mine operators are not adequate either to characterize premining hydrology or to evaluate hydrologic changes related to underground coal mining, as the Department's regulations require (see large box on previous page).

It is especially important that existing wells located near, but outside, the 35° Rebuttable Presumption Zone (RPZ; see page 42 below) should be measured prior to mining. The 4th Assessment found that 25% of mining-related water supply effects were located outside the RPZ, and that they extended outward as much as 85° (page XI-4). Actual comprehensive survey and testing of wells prior to mining might result in a more accurate accounting of water supply damages.

When the water supply in a well diminishes or dries up entirely as a result of underground coal mining, it is not an isolated incident. Water wells are nothing more than "straws" stuck into a large "pool" of water encased in bedrock. When those wells go dry, it is not because something is wrong with the wells themselves --- it is because the "pool" of water (the actual water supply) has been lowered by the distortion and fracturing of the underlying bedrock. While each well owner may end up with a satisfactory resolution (e.g., the well is dug deeper, public water lines are extended to serve the house, or the homeowner is paid to relocate elsewhere), that does nothing to address the real problem --- which is that the water supply (the aquifer) has been lowered. Without the collection (and *reporting*) of comprehensive data on the normal levels and quality of groundwater over the course of several years prior to undermining, it is impossible to determine with any precision what kinds of effects mining may have caused or whether there has been any eventual recovery.

> **"In general, we found a quarterly sampling frequency** [of groundwater elevations] **inadequate to characterize impacts to system hydrology....even daily sampling frequency cannot necessarily capture rapid changes occurring during subsidence".** (X-5)

> **"...given the hydrologic complexity of the region and the resulting complexity in hydrologic response, the data, as reported, is insufficient to allow clear assessment of hydrologic impacts."** (VI-44)

The University makes numerous practical recommendations for how the collection, storage, and monitoring of groundwater data could be improved, not only to allow Act 54 reviewers to do a proper analysis, but also to help ensure that the Department's Mining Program can properly review underground mine permit applications. One recommendation they failed to make, but which probably should be done, is the adoption by the Department of a Technical Guidance Document on "Groundwater Protection" for underground coal mining (similar to TGD 563-2000-655 for Surface Water Protection). Such a TGD could incorporate and formalize the relevant recommendations and suggestions of the University (at minimum).

The downside associated with adopting any new TGD is that it is likely to take too long to evaluate its effectiveness. As discussed above in Section 4A, even if a comprehensive new TGD on groundwater protection were adopted this year, recent experience with TGD 563-2000-655 suggests that it might not be sooner than the release of the 6th Assessment (late 2024 or early 2025) before its effectiveness can be known. With proper diligence, however, the Department could ensure that a new TGD on groundwater does not take so long to implement and evaluate.

5 Available Data Show Significant, Increasing Impacts

SUMMARY: The total number of active underground coal mines decreased by 4 (50 to 46) from the 3rd to the 4th Assessment period, and the total acreage undermined decreased by 18% (from 38,256 to 31,343 acres). Yet total reported effects increased by 8% (1,247 to 1,350) and mining-liable water supply impacts from active mines increased 40%. Although longwall mine acreage decreased by 31%, and room-and-pillar acreage increased by 7%, longwall mines were responsible for 97% of the mining-liable structure impacts (230 of 238), for 89% of all reported land impacts (94 of 106), and for 100% of the mining-liable stream impacts.

The total acreage of underground bituminous coal mines has been decreasing during each successive 5-year period over the past 15 years. During the 2nd Assessment period, a total of 38,512 acres was undermined. The total undermined acreage declined slightly during the 3rd Assessment period to 38,256 acres. During the most recent (4th) Assessment period, 31,343 acres were undermined, which represents an 18% decrease over the previous period. Longwall mining acreage has decreased at a greater rate than the average, while room-and-pillar mining acreage has increased each period (**Figure F**). Retreat (pillar recovery) mining, which has always represented a small proportion, also has been decreasing.

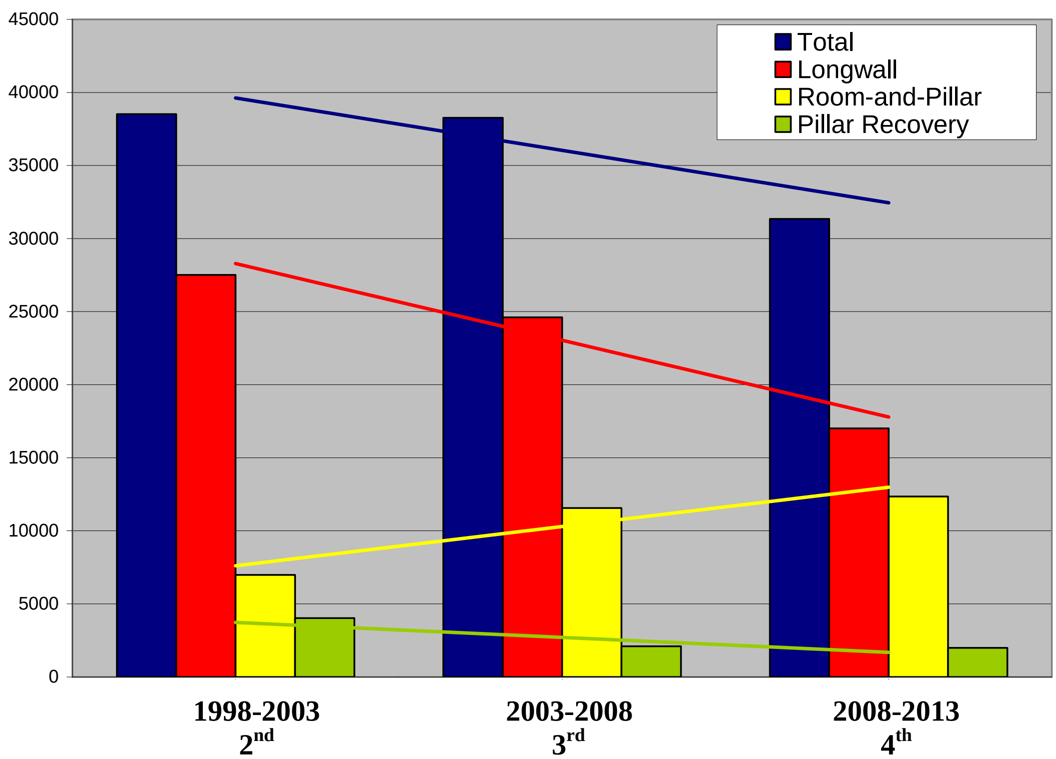


FIGURE F. Acres undermined by mine type during the three most recent 5-year Act 54 Assessment periods, based on data extracted by Schmid & Company from the respective Assessment reports. Trendlines also are noted.

Between the 3rd and the 4th Assessment periods, the acreage undermined by longwall mines (red in Figure F) decreased by 31% (from 24,607 to 17,005); from the 2nd to the 3rd period, longwall mine acreage had decreased by 11%. The acreage of room-and-pillar mines (yellow) increased by 66% from the 2nd to the 3rd period, and then increased by another 7% from the 3rd to the 4th period. Pillar recovery mine acreage (green) declined almost by half (4,029 to 2,097 acres) from the 2nd to the 3rd period, and then remained near that same level during the 4th period (1,985 acres).

As a result of these general trends in acreage by mine type, the proportion of land currently being undermined by longwall mines as a group (54% of the total in the 4th Assessment period) is only slightly higher than that of the more numerous room-and-pillar and pillar recovery mines combined.

Despite the overall decrease in the acres being undermined during the last 15 years, there has been a steady *increase* in the total number of "reported" adverse effects[12]. During the 2nd Assessment period, there was a total of 1,092 effects reported to structures, water supplies, and land (the Assessment reports account separately for stream impacts). During the 3rd Assessment period, that total had increased to 1,247 effects, and during the 4th Assessment period, the total increased again to 1,350 (**Figure G**). With the general increase in the acreage of room-and-pillar mines and the decrease in longwall mine acreage, one might expect that the increase in impacts is due to room-and-pillar mines, but that is not the case. According to Department data, in all three periods the impacts associated with longwall mines have far outnumbered those from room-and-pillar and pillar recovery mines.

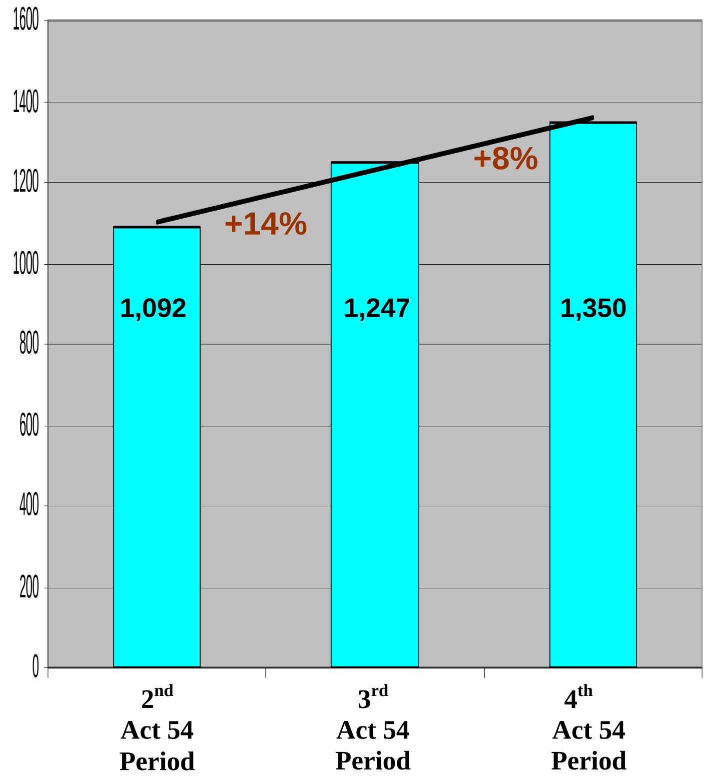


FIGURE G. Total reported effects[12] (for structures, water supplies, and land) during the three most recent 5-year Act 54 Assessment periods, based on data extracted by Schmid & Company from the respective Assessment reports. Trendline also is shown.

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12 Note: not all "reported" effects ultimately are determined to be related to underground mining ("mining-liable"), but "reported" effects are graphed because that is the only way impacts were consistently documented across the five-year Act 54 Assessment periods.

Subsidence is the primary cause of damage to homes, water supplies, land, and streams. Subsidence occurs in underground mining when coal is removed from a large enough area that the adjacent rock collapses into the void, causing deformation and fracturing of rock layers above the void, which can result in vertical and horizontal movements at the surface above.

> **"...longwall mining produces the highest numbers of subsidence related impacts to surface structures and water supplies..." "Room-and-pillar developments do not generally directly cause measurable surface subsidence..."** (III-10)

Room-and-pillar mining is designed to prevent subsidence by extracting coal (from the "rooms") and leaving enough support (in the pillars) to prevent collapse of the mine roof. As a result, room-and-pillar mining rarely causes subsidence if the pillars have been properly designed. Even in pillar recovery mining, any subsidence that may occur typically is localized and minor. During the 4th Assessment period, of all impacts reported for active mines to structures, land, and water supplies that were determined to be due to mining (n=694), pillar recovery accounted for only 2% (n=15).

Subsidence is directly and intrinsically associated with longwall mining. Longwall mining removes 100% of coal in large rectangular panels where no permanent support is left in place. Temporary support of the mine roof is provided by huge hydraulic shields in the immediate work area where the shearer slices coal from the face of the seam (**Figure H**), but once the coal has been removed, the hydraulic shields move forward into the newly created cavity, allowing the overlying strata to collapse into mined-out void behind.

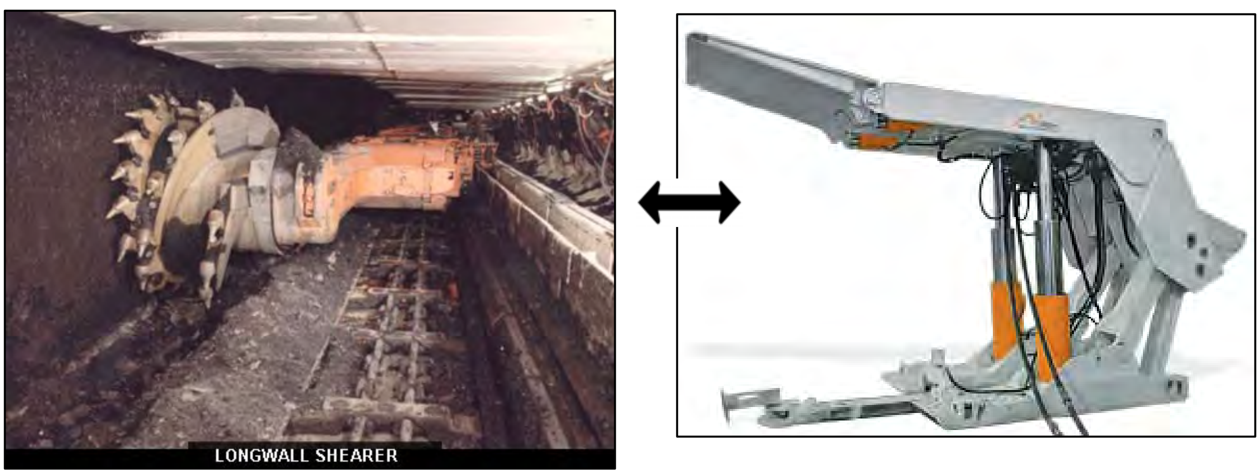

FIGURE H. Large hydraulic shields (a model of one is shown at right) provide temporary support at the working face of the coal seam in a longwall operation, and then are advanced into the mined-out area, allowing the overlying rock strata to collapse into the void behind.

A longwall panel can be thought of as an extremely large "room" in room-and-pillar mining. The gates and entryways around the perimeter of the panel (which *are* mined by room-and-pillar methods) essentially provide the only permanent support, protecting the tunnels used by people and equipment moving between the underground mine and the surface. To avoid surface subsidence, the longwall panel must be either very narrow or sited very deep below the land surface. There is a direct relationship between the width of a longwall panel, the depth of mining, and the certainty of subsidence.

> **"A subsidence basin typically forms when the ratio of the extraction zone width (width of the longwall panel) to overburden thickness (depth of mine panel)** [W/h] **exceeds 0.25 .... Pennsylvania longwall panels tend to be greater than 1000-ft wide, therefore subsidence basins are expected to form with every mined panel."** (VI-4)

Given the W/h ratio of 0.25, for every one foot increase in width of a longwall panel, the roof of the mined panel would have to be 4 feet deeper in order to maintain the same probability of subsidence occurring (or not). During the 4th Assessment period longwall mining was conducted at an average depth of 783 feet, which means that the panels would need to be an average of 195 feet wide to avoid causing subsidence. Yet most longwall panels during the period were wider than 1,000 feet as noted above, and several of the mines active during the period had panels wider than 1,500 feet. With the maximum depth of the Pittsburgh Seam in Pennsylvania being only 1,433 feet (Page III-26 of the 4th Assessment), and given the width of modern longwall mine panels, surface subsidence is always a certainty. The PADEP Mining Program provides no incentives to encourage the use of measures that might avoid or reduce longwall mine subsidence[13], so such practices have not been adopted by longwall mine operators in Pennsylvania.

As the laws and regulations currently are being administered, preventing or minimizing subsidence is not a priority for longwall mine operators. Rather, advancements in longwall mining technology are such that panel widths have increased fourfold since the 1970s, from about 400 feet to about 1,600 feet. During just the 4th Assessment period, the width of the longwall panels at Enlow Fork Mine increased 42%, from 1,061 feet to 1,502 feet. Technological advancements, not environmental damage concerns, appear to be the limiting factor in the size of longwall panels.

> **"For any given year, technology limitations represent a major restriction above the zone of practical panel layout design"** (III-26)

As **Figure I** below illustrates, the 7 longwall mines active during the 4th Assessment period were determined to be responsible for more impacts (517 of 694, 74%) than all 39 room-and-pillar and pillar recovery mines together, even though longwall mines undermined only about half (54%) of the total acreage during the five-year period.

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[13] Measures such as backstowing of waste coal refuse or other material before the unsupported roof collapses have been used successfully in parts of Europe (NSW Minerals Council 2007). A case study of the feasibility of backstowing at a longwall mine in southwestern Pennsylvania (Sanzotti et al. 1994) found that backstowing was technically feasible and could reduce subsidence by about 50%, but would not be economically feasible (profitable) because it would decrease the rate of coal production and increase operating and manpower costs. Any such reuse of coal refuse in Pennsylvania would, of course, need to ensure that it does not create any groundwater contamination problems.

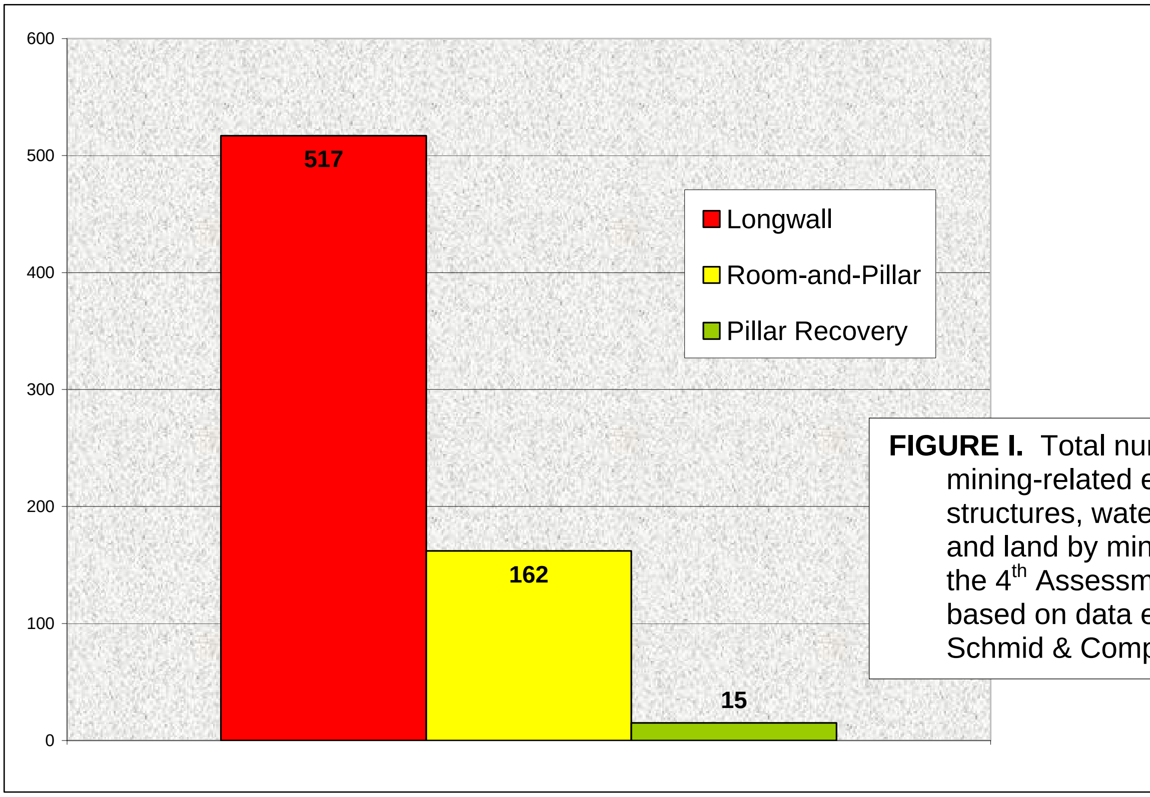


FIGURE I. Total number of mining-related effects to structures, water supplies, and land by mine type during the 4th Assessment period, based on data extracted by Schmid & Company.

A similar discrepancy is evident across all four Act 54 Assessment periods for most "reported" effects (see footnote on page 33 above) as shown in the charts below (**Figure J**) based on data extracted by Schmid & Company. As the four charts illustrate, with respect to structures, land, and streams, reported impacts at active mines were overwhelmingly associated with longwall mining during each of the four 5-year assessment periods. Longwall mines also were associated with more reported water supply effects during each assessment period, although a considerable number of water supply effects have been reported for room-and-pillar mines as well.

The increasing number of impacts reported over time, even as the overall acreage being undermined has decreased, are important facts that have not been given adequate prominence in the Act 54 Assessment reports. Equally important, yet equally downplayed, is the fact that the longwall mining method of underground coal extraction has consistently been responsible for the overwhelming majority of adverse impacts.

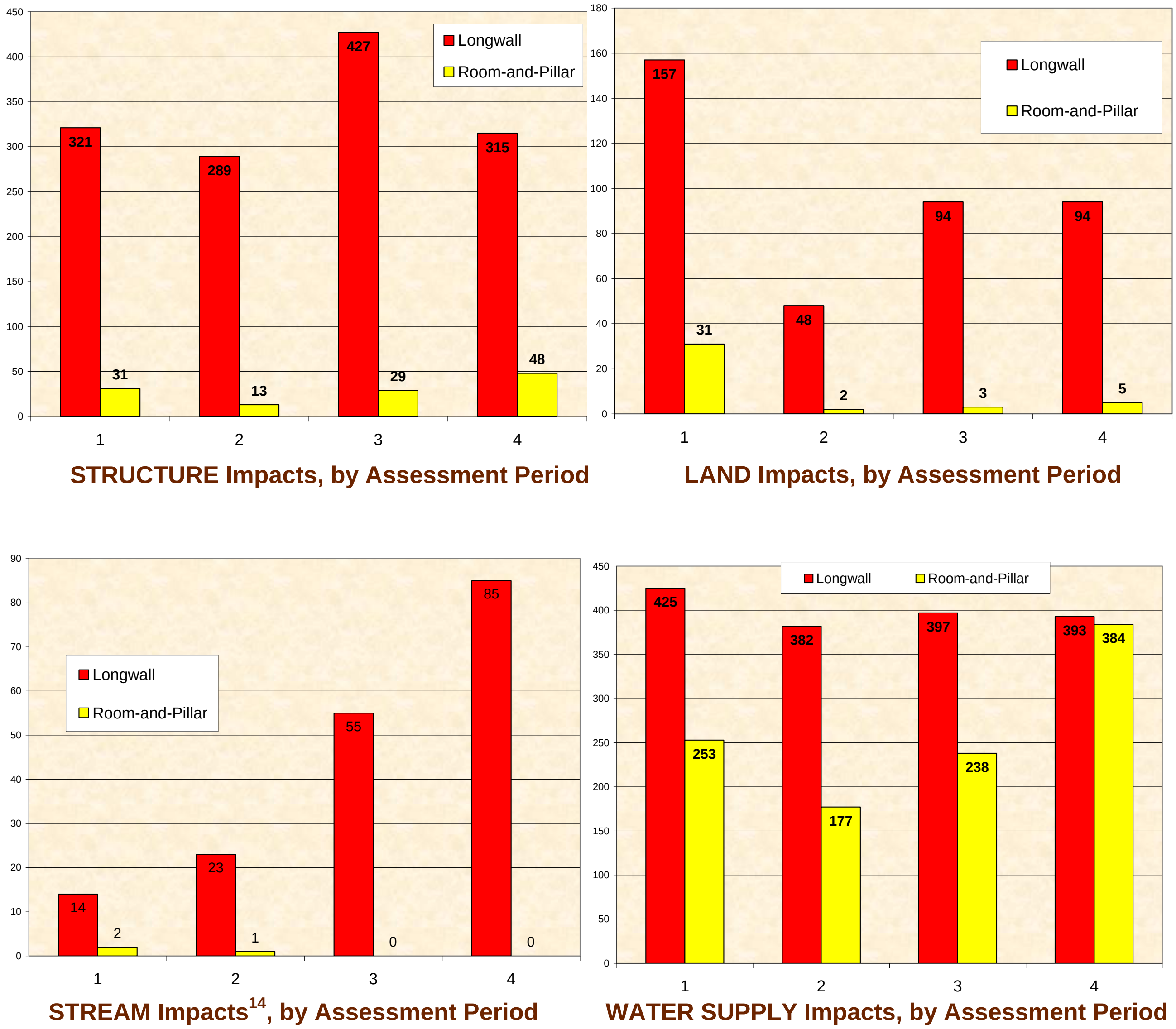


FIGURE J. Comparison of "total reported effects" due to longwall mines (red) versus room-and-pillar mines (yellow) active during each of the four 5-year Act 54 Assessment periods, for structures, land, streams, and water supplies. Pillar recovery impacts were counted in with room-and-pillar impacts in the 1st Assessment period, making that category appear to be larger than it actually was. "Total reported effects" includes both mine-related and non-mine related impacts; when only mine-related impacts are counted, the percentage associated with longwall mines increases.

[14] Stream damages were counted differently in the 4th Assessment period than in the others. For the chart in Figure J above, the 85 stream damages noted for the 4th Assessment include 28 streams receiving gate cuts (for pooling impacts) and 57 streams receiving grouting (for heaving and flow loss impacts). Not added to the total were 74 dewatered streams receiving active augmentation and 3 dewatered streams where liners were installed, because those instances likely overlap to some extent the 85 stream impacts reported (see also page 13 above).

6 Damages Are Not Fixed, Resolutions Are Not Timely

SUMMARY: Act 54 anticipated that most damages resulting from underground coal mining would either be repaired or restored, but that has not been the case: for mining-liable impacts in the last 5 years, only 4% of the structures were "repaired", and only 12% of the water supplies "recovered" or were "repaired". More than 62% of structure and water supply impacts were "resolved" by private agreements, the non-disclosure clauses of which prevent knowing the actual final outcome. It takes, on average, 682 days (1.9 years) to begin restoration of streams impacted by pooling. None of the stream damages evaluated in the 4th Assessment could definitively be determined to have been successfully restored to premining conditions in accordance with PADEP-prescribed requirements.

Despite assertions by industry and the Department when Act 54 was passed that damages would be repaired or that impacted features would be replaced, most damaged structures, water supplies, and streams are not being restored to their premining condition. This situation has existed for twenty years, but only gradually is being exposed. Of 237 incidents reported during the 4th Assessment period where structure impacts were determined by the Department to be due to underground mining, only 9 cases (4%) are categorized as "repaired". In 157 cases (66%), the damage was resolved by an "agreement" with the surface landowner (premining agreement, n=41; unspecified agreement, n=116). Another 66 cases (28%) were resolved by purchase of the property with the damaged structure by the mine operator. Thus, in 223 cases (94%) there was no indication that a damaged structure ever was repaired.

Of 371 incidents reported during the 4th Assessment period where water supply damages were determined to be due to underground mining, only 45 cases (12%) are categorized as "repaired" [15], "water supply recovered" [29], or "stream recovered" [1]. In 257 cases (69%), some type of "agreement" was the basis for the resolution, which in most cases was not specified.

That such a small proportion of damages to structures and water supplies is known to have been repaired or replaced is a factor that was documented in the 3rd Assessment as well. During that period (2003-2008), of 269 water supply effects where underground coal mining was found to be liable and a final resolution was reached, nearly half (131, or 49%) were “resolved” by an agreement between the surface landowner and the mining company or by the mining company buying the property. Only 7% of the water supplies "recovered", and only 2% were "repaired" *in situ*. Similarly, of 300 structure impacts, actual repair was documented in only 19 instances (6%). By contrast, in 211 cases (70%) the mine company either bought the property or relied upon a confidential agreement.

"Legally, PADEP is not privy to the details of these private agreements, so the extent to which the damage was repaired or the structure was replaced is unknown." (XI-4)

Rather than outright repair, in the majority of cases involving structure or water supply damages a private agreement is reached between the mine operator and a landowner. Those agreements typically contain a nondisclosure clause which prevents anyone (including the Department) from knowing whether the damage actually was repaired. It also is unclear whether damages are being consistently reported or recorded, much less repaired, when the affected well or structure is on land owned by a mine operator.

"In accordance with Act 54, mining companies are required to restore or replace water supplies that are [damaged]**.......**[but a] **mining company and a property owner may settle a claim with a private agreement. ... When an effect....is given a final resolution status...** [it] **indicates** [either] **that there is no further impact....or the case is closed due to an agreement regardless of whether the water supply is restored"** (V-4 to V-5)

A private agreement may provide an acceptable outcome to an individual landowner if he or she is compensated fairly for damages inflicted on their property. However, a simple payoff for a lost water supply or even a total buyout of a damaged property, without any repairs, does nothing to restore premining conditions or preserve the Commonwealth's aquatic resources long-term. Where structures or water supplies on multiple properties are damaged and the mine operator simply purchases those properties, there is a cumulative adverse effect not only on community cohesion but also on the local tax base. Following release of the 1st Assessment the Department commissioned several reports, one of which focused on the effects of longwall mining on real property values and the tax base (Resource Technologies Corporation 2002). Among the findings of that report: *"... on average, properties located above longwall mining operations are more likely to receive assessment reductions from County Assessment Boards than properties located elsewhere in the County..... coal companies typically pay more to the landowner for damages than the landowner is granted in county value reduction."* Thus, a resolution favorable to an individual still can have a net adverse effect locally, if a once-taxable structure is removed from the tax rolls and/or the property no longer has a potable water supply, even without considering any impacts on surface water quality and quantity.

When repairs actually are made, final restoration typically takes many years, during which time a landowner may have to spend his own time and money trying to prove the extent of his damage or monitoring the quality of the repair work, all the while enduring inconvenience or worse.

"In general, reported [structure] **effects with the longest resolution times are those that required repairs from the company... the longest .... took 933 days.... Ninety-eight percent of all reported** [structure] **effects were resolved within 2 years."** (IV-7 to IV-8)

While the last sentence above is meant to be a positive sentiment, it also means that 2% of all structure damages are taking longer than 2 years to be resolved, which is a long time for a homeowner to wait for resolution.

As with structure damages, resolutions for water supply effects can take considerable time.

> **"...75%** [of water supply impacts] **are resolved within a year. The time to resolution for the remaining 25% of effects is between one and four and one-half years."** (V-7)
> **.... when the mine operator was found liable for water supply impacts, the time to resolution exceeded one year (415 days)."** (EX-2)

This 4th Assessment is more candid than previous ones in acknowledging the difficulty associated with repairing natural, as opposed to man-made, systems.

> **"While mining companies are generally either able to repair, replace, or financially compensate for damages to structures, the ability to repair damage to streams remains largely unknown."** (V-7)

The time lag between when a stream impact occurs and when the stream restoration process begins, much less when it is successfully completed, typically is measured in years.

> **"On average, it takes 682 days once mining has occurred for restoration work to begin on pooling impacts. However, there is significant variation across mines .... the average gate cut in Cumberland and Emerald Mines is not initiated until nearly three years after mining."** (VII-40)

Just to <u>begin</u> attempted restoration of stream impacts may take 2 to 3 years. In some cases, restoration attempts then can be ongoing for up to 5 more years. If restoration is deemed unsuccessful at that time (after 7 to 8 years), the stream could be declared irreparably damaged and some unspecified alternative mitigation will be required offsite, something that occurred with 6 separate streams during the last 5-year Assessment period.

A surface owner typically is affected multiple times by each subsidence-related incident. After their home, water supply, land, or stream is damaged, they then must spend lengthy periods of time fighting for a reasonable resolution, often at considerable personal expense.

> "*Act 54 is unique in a sense that it ... requires proactivity and certain legal responsibilities on the part of the persons who are affected. In other words, Act 54 requires the affected party to take steps to ensure that they are compensated, and shoulder downstream legal responsibilities, though they are damaged through no fault of their own*." (The Monaco Group, Inc. 1999)

7 Underlying Assumptions, Predictions, and Models

SUMMARY: The various models and assumptions being used to anticipate damage from subsidence were developed more than 20 years ago, when longwall panels were significantly smaller. None of those models has been re-evaluated or recalibrated under current mining conditions. There has never been any comparison of the number or severity of "predicted" impacts with those not predicted. Impacts to wetlands and groundwater, and flow loss in streams, are *never* predicted because there is no "model" to do so. Yet they occur frequently.

Planned Subsidence Preferable

One assumption leading to adoption of Act 54 more than twenty years ago was that “planned” subsidence associated with longwall mines was better than unplanned subsidence from abandoned room-and-pillar mines. This reasoning plays on the idea of *"better the devil you know than the devil you don't"*. In effect, it suggests that damage resulting from planned subsidence is preferable because it is more predictable and immediate, and thus can be repaired in a timely manner while the mining company is still in business. It plays on fears of sudden and unexpected damage occurring to homes built above long-abandoned mines.

In reality, however, damage from subsidence from abandoned mines occurs only rarely, and the State offers inexpensive mine subsidence insurance (MSI[15]) to homeowners living in potentially affected areas. During the last 10 years, the MSI program statewide reimbursed 19 claims on average each year: 12 (on average) for bituminous claims and 7 (on average) for anthracite claims. By comparison, during the last two 5-year Act 54 Assessment periods, there was a total of 536 structure impacts attributed to underground mining, of which 530 (99%) were due to longwall mining of bituminous coal. This total averages 53 structures each year damaged by active longwall mining, more than 4 times as many as were damaged annually by abandoned room-and-pillar bituminous mines.

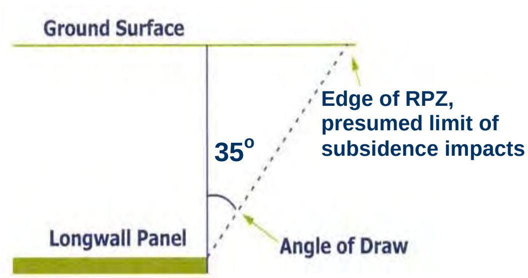
It would be useful if Act 54 Assessments would fact-check the assumption that "planned" subsidence has been preferable to or better than unplanned subsidence, but of course none has. To do so, one would need to evaluate how often subsidence damage is predicted, how accurate those predictions are, and how incidents of “predicted” damage compare with unplanned damage incidents in terms of numbers, types of damage, types of resolution, cost of resolution, and time to

[15] In 1961 Pennsylvania was the first state to start a *Mine Subsidence Insurance Program* to address the issue of unplanned subsidence from abandoned coal (and clay) mines. The Program operates as part of PADEP. Information about the MSI Program can be found here: http://www.dep.state.pa.us/dep/deputate/minres/bmr/MSIpage/msi_info.htm

resolution. Unfortunately, no such comparisons or evaluations have ever been attempted by the Department or the Act 54 Assessment authors, and no data that would support such analyses are requested of mine operators by PADEP.

35° Rebuttable Presumption Zone (RPZ)

Despite the fact that the average depth of underground mines has been increasing over time (which mine operators suggest should *lessen* impacts on the surface), water supply impacts have been increasing. Between the 3rd and the 4th Assessment periods, even as the overall acreage of undermined land decreased by 18%, the number of water supply impacts attributed to mines active during the period increased by 40% (256 to 358). Act 54 established a rebuttable presumption zone (RPZ) within which a mine operator is presumed to be liable for any contamination, diminution, or interruption to water supplies. The RPZ is an area above the mine that is determined by projecting a line 35 degrees from vertical from the roof of the mine to the surface (see graphic). Recent Act 54 Assessments suggest that the 35° angle may not be adequate because many effects are being reported outside that presumed limit of influence of the subsidence trough.



".... 25% of effects lie outside of the RPZ, as much as 85 degrees outward and upward from the edge of mining. " (XI-4)

Ten years ago the authors of the 2nd Act 54 Report (California University of Pennsylvania 2005) questioned the validity of the 35°-angle standard, suggesting that a fixed horizontal distance (they suggested 328 feet) from the edge of longwall panels might be more realistic. That suggestion has not been followed-up in the 3rd or 4th Assessments, even as the much publicized damage to the dam at Ryerson Station State Park occurred nearly twice (66°) the predicted angle of influence from nearby mining (PADEP 2010). Clearly, however, the current validity of the original 35°-angle RPZ needs to be reevaluated given that so many water supply impacts are occurring not only outside the RPZ, but so far outside it.

30° Zones

In accordance with its regulations at §89.141, the Department requires a mine operator to prepare a Subsidence Control Plan which describes the measures to be taken to "control" subsidence effects. At a minimum, the plan must address all areas within a 30° angle of influence. Since damages have been occurring well beyond even the 35° RPZ angle, however, this 30° angle would seem to be inadequate.

Perhaps to complement its Subsidence Control Plan requirement, the Department also uses a 30° angle for notification purposes. As described in a brochure on Act

54 (PADEP 2014b), a 30° angle is used to determine properties located within the potential subsidence profile of a longwall mine. The mine operator is responsible for notifying each property owner within this zone of its planned mining operations. As above, this 30° angle would seem to be inadequate.

Peng Model for Pooling

The only model that has been developed to date to predict any type of stream impact involves pooling. Pooling occurs when the area above a longwall panel subsides, capturing the stream in a pool behind a dam formed above the unsubsided gate. Pooling causes increased sedimentation, which degrades the aquatic habitat for fish and macroinvertebrates, and causes long-term instability in the stream (USFWS 2004). In the 1980s Dr. Syd S. Peng, a mine engineer at West Virginia University, developed a model to predict where longwall mining subsidence would result in stream pooling. The Peng computer model[16] currently is used to predict which streams may experience pooling based on such factors as depth of mining, rock type, and gradient of the stream. The underground mine application requires applicants to predict potential pooling, but only where the stream gradient is 2% or less, and then only requires submission of a mitigation/restoration plan for any stream where pooling is *predicted* to be 1 foot or more in depth.

Pooled stream in subsided area upstream from gate has drastic effects on fish and invertebrates.

It is unclear what scientific basis was used to establish those regulatory thresholds, or whether significant impacts to a stream also occur if the stream gradient is greater than 2% or the depth of pooling is less than 1 foot. The Peng model now is more than 2 decades old. No recent studies have been done to evaluate whether those thresholds continue to be relevant to subsidence from modern longwall mine practices, or whether they should be made more stringent for certain (i.e., Special Protection) streams. The Peng model does not forecast or evaluate how the predicted pooling will alter the biological condition of any stream, including its effects on the numbers, diversity, or kinds of fish, macroinvertebrates, and other stream biota present before mining. The model does not predict how long the pooling will last or how expensive will be the work necessary to repair the damage to the stream, if it can be remediated at all. All of these factors related to pooling must be examined if any genuine protection is to be provided by the Department in accordance with its Constitutional responsibility as trustee of these public resources.

[16] Comprehensive and Integrated Subsidence Prediction Modeling (CISPM) was developed in the 1980s and early 1990s (Peng & Chiang 1984, Peng 1992, Peng & Luo 1994).

Predicting Flow Loss

Unlike pooling, flow loss is never predicted with any certainty. The underground mine permit application asks applicants to "*provide a prediction of the location, magnitude, and duration of mining induced flow loss*," but there is no tool available to predict flow loss comparable to the Peng model for predicting pooling. Coal companies apparently lack either the ability or the motivation (or both) to predict where specific streams will dry up. Yet flow loss occurs, and it occurs often. During the 3rd Assessment period, 53 of 55 *unpredicted* stream impact incidents involved flow loss. During the 4th Assessment period, as discussed above under "Stream Impacts", more than 130 sections of streams received grouting or flow augmentation in attempts to restore premining conditions following flow loss. Indeed, at least six streams during the period ultimately were determined to have been irreparably damaged by flow losses resulting from longwall mine subsidence.

For many years it has been clear that there are several factors that contribute to flow loss in streams. The importance of any single factor, or the ability of any group of factors taken together to predict where and when flow loss may occur, apparently is less clear. There are at least three different sets of relevant factors, as follows:

Flow loss factors per Consol Bailey Mine Revision 150:	**Flow loss factors per TGD 563-2000-655:**	**Factors per Mine Application Module 8 (since 2008):**
1 *Drainage/watershed area*	*Depth of cover*	*Mining height*
1 *Streambed lithology*	*Mining height*	*Overburden geology/thickness*
1 *Depth of cover*	*Overburden geology*	*Streambed lithology*
1 *Percent of watershed mined*	*Streambed lithology*	*Stream orientation*
2 *Overburden geology*	*Stream orientation* `	*Natural fracture zones*
2 *Stream orientation*	*Presence of natural fracture zones*	*Drainage/watershed area*
2 *Presence of natural fracture zones*	*Drainage/watershed area*	*Extent of mining beneath valley floor*
Mining height	*Extent of mining beneath valley floor*	*Potential loss of feeder springs*
	Potential loss of feeder springs	*Mining induced fracturing*
1 = Primary factor		*Aquifer dewatering*
2 = Secondary factor		*Interference w/groundwater flow*

"... eight factors have been identified as contributing to flow loss impacts on undermined streams (Bailey Mine, Permit Revision 150) and are summarized again below along with explanations on how each factor contributes to post mining hydrologic change." (VI-7)

The 4th Assessment mentions only the set of factors which one mine operator proposed, rather than either of the two sets of factors that the Department has adopted. The list from Consol has one factor (*Percent of watershed mined*) that is not in the other two lists, but it omits two factors (blue) that are in TGD 563-2000-655 and it omits five factors (blue) in the list included in Module 8 of the underground mine application form (see above).

"Mining height" (the thickness of the coal seam being mined) is a factor in all three lists, although it is not categorized as either "primary" or "secondary" by Consol, presumably because the thickness of the Pittsburgh Coalbed does not vary much (only by about 2 feet, from roughly 5 to 7 feet) and so it is probably not a significant factor.

None of the three lists includes "panel width" as a contributing factor to flow loss, despite the acknowledgment that the width of a longwall panel and the depth of mining are directly related to the certainty of surface subsidence (see discussion in Section 5, above). Indeed, if "depth of cover" is a *primary* factor (according to the Consol ranking), panel width should be as well, and even more so inasmuch as every one-foot increase in the width of a panel must be offset by a four-foot increase in depth of cover to maintain the same subsidence potential.

Unlike mining height which hardly changes at all, and even depth of cover which changes gradually, longwall panel width is one factor that has changed significantly over time. As noted in the 4th Assessment:

> **"The average size of longwall panels has increased nearly four-fold since the method's introduction in Pennsylvania around 1970, from about 400-ft in width originally to as much as 1,560-ft currently."** (XI-3)

One example of the difference between the size of older and more recent longwall panels is illustrated on **Figure K.** Several panels mined during the 1980s at Emerald Mine in Greene County were about 610 feet wide, but newer panels at the same mine about a mile away were more than 1,400 feet wide. The proposed longwall panels in the recently-reviewed Foundation Mine permit application were expected to be 1,600 feet wide or wider (Schmid & Company, Inc. 2014b).

The relationship between longwall panel width and flow loss in streams needs to be given much more serious consideration. If a longwall mine operator seeks to expand a mine that already has caused flow loss, and suggests that the same outcome will not occur because of a greater depth of cover, that assertion must be evaluated in terms of the panel widths involved. Furthermore, panel width should be a key factor in the development of a model to predict flow loss and other hydrologic impacts.

As with stream flow loss, there currently are no models being used to predict wetland or groundwater impacts. As discussed at length above, premining data collection for both wetlands and groundwater is limited and inadequate for identifying or evaluating changes from longwall mine subsidence. The regulatory requirements for identifying stream characteristics prior to mining (per TGD 563-2000-655) are at least 10 years ahead of any such requirements for wetlands or groundwater.

> **"The PA DEP is ...seeking a greater scientific understanding of the integrated hydrologic systems that link groundwater and surface water properties. The long-term goal is to better understand the effects of subsidence on the hydrology of undermined areas and thereby improve the PA DEP's ability to predict sustained damage to streams."** (I-6)

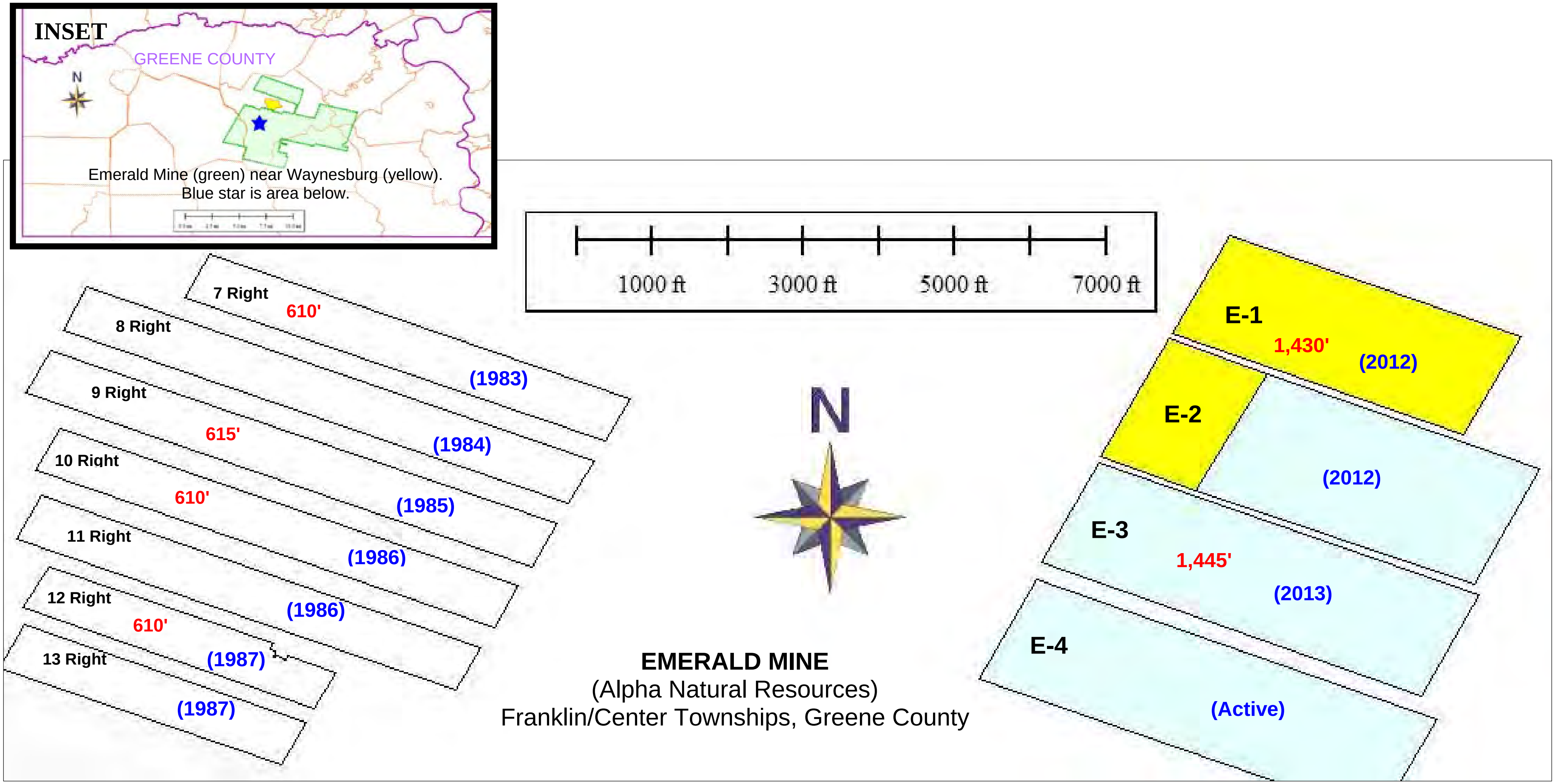


FIGURE K. A section of Emerald Mine just southwest of Waynesburg, Pennsylvania (blue star on inset) illustrates the increases in longwall panel widths over time. Yellow represents panels reportedly active during the 4th Assessment period. Light blue panels reportedly were active after the close of the 4th Assessment period. White panels were completed in previous years. Panel name/number and selected panel widths are noted, as is the year the panel was completed (in blue parentheses) according to PADEP-Bureau of District Mining Operations.

Older panels (mined in the 1980s), located about one mile to the west of the newest ones, were about 610 feet wide. Recently mined panels are more than twice that, at about 1,430+ feet wide.

The above quote is one of several naïve pronouncements by the authors of this 4th Assessment, for which no evidence is provided. Indeed, as discussed at length above, the Department has been making no attempt to ensure that mine operators disclose or compile, or itself to compile, any of the necessary information for hydrologic analysis or damage prediction. The Department may have as "*a long-term goal*" a better understanding of the hydrologic balance in the coalfields, but its existing Chapter 89 regulations require the "protection of the hydrologic balance" from underground mining and the prevention "of adverse hydrological consequences", which cannot be done unless and until the premining hydrologic balance is accurately understood for each and every mine.

In sum, existing models and techniques for predicting pooling and other potential hydrologic impacts must be re-examined and updated to reflect the realities of modern longwall mining practices. A model must be developed specifically to predict streams at risk of flow loss. Accurate predictions of impacts to the hydrologic balance will not be made unless and until the Department consistently requires mine applicants (a) to collect and report pre-mining data on all the surface water and groundwater resources of the area, (b) to use that information to model existing hydrologic patterns, (c) to monitor and report surface water and groundwater resources during mining and post-mining, (d) to compare changes observed between pre-mining and post-mining periods, and (e) to enter all relevant data into a region-wide database that will enable it to be utilized in analyzing and evaluating future mine applications. The databases developed by the University of Pittsburgh in compiling the 3rd and 4th Assessments for the Department likely are not set up to accomplish this task. Thus, the Department should take the initiative to collect all relevant existing data from all mine operators past and present and commission its own analysis to model hydrologic conditions.

8 ACT 54 Implementation vis-à-vis the Pennsylvania Constitution

SUMMARY: The Act 54 "allowance" of damages so long as they are repaired or compensated eventually may provide satisfaction to individual property owners, but on balance it causes adverse effects on communities and public resources. The permanent lowering of a water table or loss of flow in a stream violates the environmental rights of Commonwealth residents, now and in the future.

Acid mine drainage historically was one of the worst threats to streams and water quality from unregulated coal mining, but now has largely been brought under control through the adoption and enforcement of environmental controls. Twenty years ago Act 54 authorized a new threat to our precious water resources. Coal extraction using longwall methods has caused an ever-increasing number and severity of impacts to streams, groundwater, and other natural resources of the Commonwealth, as documented in four Act 54-mandated Assessments. Since other viable methods of underground coal extraction are not associated with the same level of damage, continuation of the status quo does not appear to comport with the rights which are guaranteed to Pennsylvania citizens and which Commonwealth agencies are responsible for upholding (see box below).

Article 1, Section 27, Pennsylvania Constitution
(Environmental Rights Amendment)

"The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people."

In *Robinson Township v. Commonwealth of Pennsylvania*[17], the Pennsylvania Supreme Court held unconstitutional major parts of a 2012 law (Act 13) designed to facilitate the development of a high-extraction method of producing natural gas from Marcellus Shale. The 162-page plurality opinion written by Chief Justice Ronald Castille was grounded on Article I, Section 27 of the Pennsylvania Constitution, which Mr. Castille noted was drafted in part to correct abuses inflicted on the environment by past coal mining:

> *When coal was "King," there was no Environmental Rights Amendment to constrain exploitation of the resource, to protect the people and the*

[17] *Robinson Township et al. v. Commonwealth et al.*, Nos. 63 MAP 2012, 64 MAP 2012, 72 MAP 2012, 73 MAP 2012, 2013 WL 6687290 (Pa. Dec. 19, 2013). http://www.pacourts.us/assets/opinions/Supreme/out/J-127A-D-2012oajc.pdf

environment, or to impose the sort of specific duty as trustee upon the Commonwealth as is found in the Amendment. ... the riverways remain, not as pure as when William Penn first laid eyes upon his colonial charter, but cleaner and better than they were in a relatively recent past, when the citizenry was less attuned to the environmental effects of the exploitation of subsurface natural resources. ... the landscape bears visible scars, too, as reminders of the past efforts of man to exploit Pennsylvania's natural assets. Pennsylvania's past is the necessary prologue here: the reserved rights, and the concomitant duties and constraints, embraced by the Environmental Rights Amendment, are a product of our unique history. ... By any responsible account, the exploitation of the Marcellus Shale Formation will produce a detrimental effect on the environment, on the people, their children, and future generations, and potentially on the public purse, perhaps rivaling the environmental effects of coal extraction.

The Constitutional rights to pure water and the preservation of the natural values of the environment extend not only to current residents, but to future generations as well. This 4th Assessment gives a glimpse of what the future holds for southwestern Pennsylvania. All longwall mines operate in the relatively thick and uniform Pittsburgh coal seam. The University of Pittsburgh researchers estimated that there are about 308,000 acres of unmined coal remaining in the Pittsburgh Coalbed in southwestern Pennsylvania (green in **Figure L** below). During the last 10 years

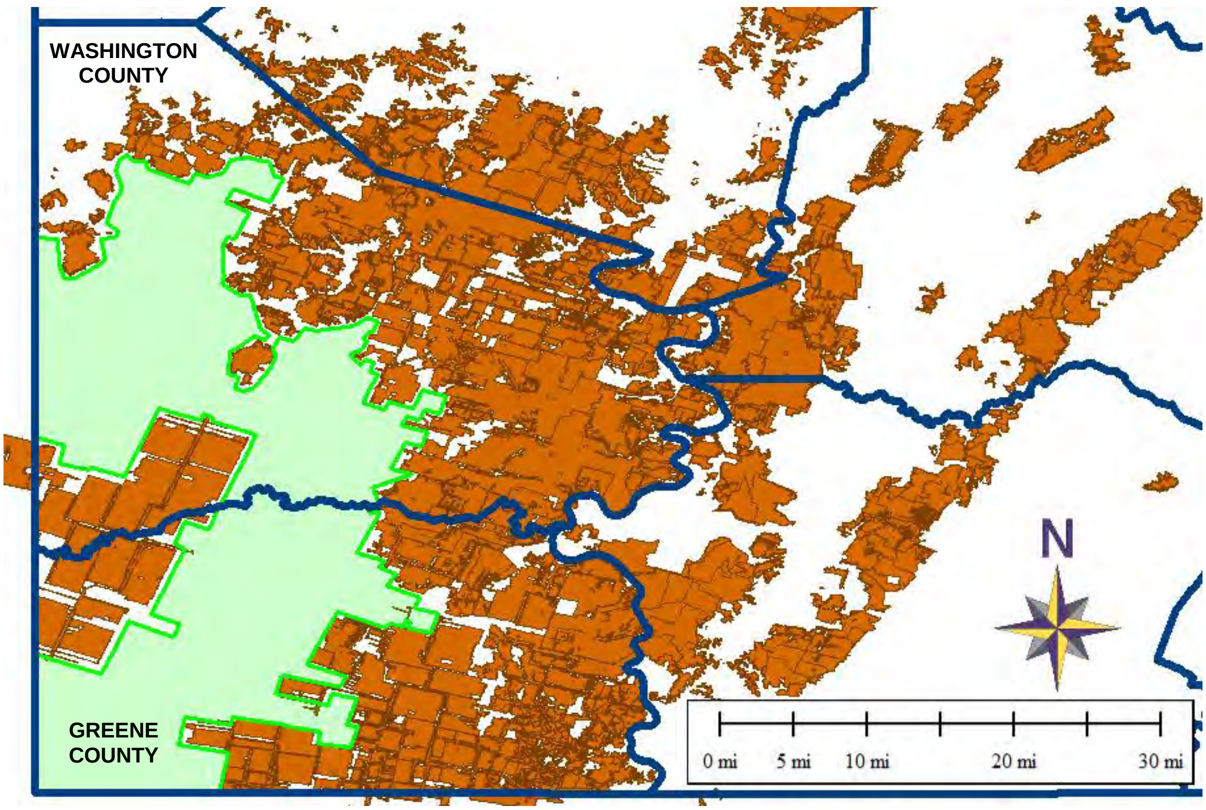


FIGURE L. Unmined areas (green) of the Pittsburgh Coalbed in southwestern Pennsylvania cover about 308,000 acres according to Figure III-19 in the 4th Assessment. Mined-out areas (orange) also are shown, based on digitized data from the PADEP Bureau of District Mining Operations. Subsidence from longwall mining in the Pittsburgh seam renders overlying coal seams unmineable.

longwall mines undermined 4,161 acres annually on average. Assuming that rate continues, and that only half of the unmined total (154,000 acres) is mineable "*due to adverse coal thickness or land ownership*" (which is not further defined), the University estimated that it will take approximately 37 years to mine the remaining coal in the Pittsburgh Coalbed. Others have estimated that the recoverable reserves at existing Pennsylvania coal mines will be depleted in less than a decade[18].

Not mentioned in the 4th Assessment discussion is the fact that much of the mining to date has involved the easier to extract coal in less sensitive areas (see Figure C in Section 4A above). As a result, future mining will tend to be concentrated in more sensitive areas. If those areas are protected as they should be, the University estimate of remaining years for longwall mining may be high. Of the remaining 308,000 acres, Special Protection (EV and HQ) watersheds overlie about 155,800 acres (51%), and Environmental Justice areas overlie 97,930 acres (32%). Accounting for some overlap, together these two features constrain about 217,500 acres, or 71% of the total remaining unmined Pittsburgh Coalbed (**Figure M**).

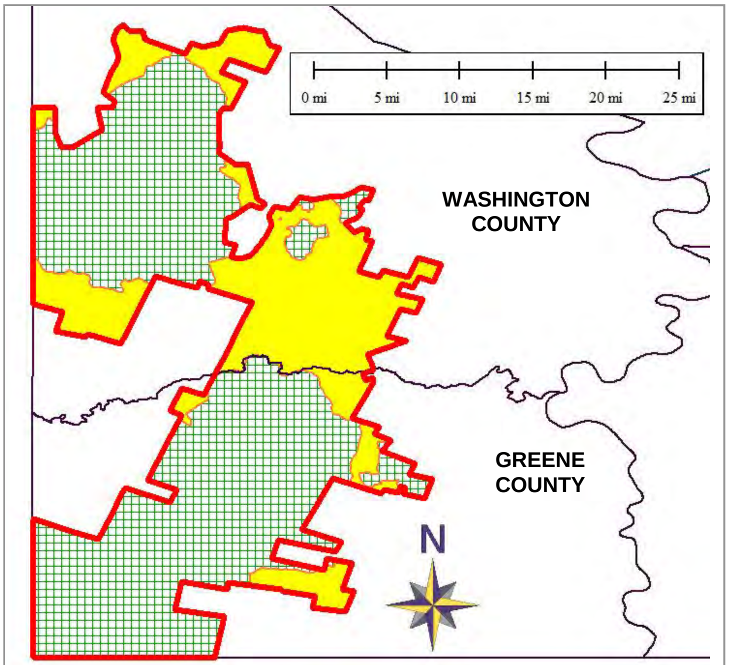


FIGURE M. Remaining unmined Pittsburgh Coalbed (red outline) in Washington and Greene Counties, according to the 4th Assessment. Areas constrained by either Special Protection watersheds or Environmental Justice areas are green cross-hatched. Areas not constrained by those features (yellow) represent about 30% of the total.

Scientific research shows that attempts to restore damages to natural systems rarely are 100% successful. A recent study (Doyle and Shields 2012) found that physical manipulation alone is unlikely to result in biological restoration of damaged streams. As discussed above, in late 2007, the Department's TGD 563-2000-655 (on stream protection) established a biological yardstick for determining when streams had been irreparably damaged by underground coal mine subsidence. If a damaged stream could not be restored to premining conditions within 5 years of doing everything "technologically and economically feasible", alternative mitigation measures could be

[18] "Coal: Cheap and Abundant…, Or Is It? Why Americans Should Stop Assuming that the U.S. has a 200 Year Supply of Coal."
http://cleanenergyaction.files.wordpress.com/2011/10/coal_supply_constraints_cea_0212091.pdf

used instead to compensate for the loss. In late 2012 (5 years later), the Department determined that six separate streams had met that criterion. That finding strongly suggests, first of all, that other streams in the past likely had been irreparably damaged by longwall mine subsidence, but because there was no yardstick available, the losses could not be documented. Second, it is reasonable to assume that these six streams represent the leading edge of a wave of similar outcomes for streams undermined by longwall methods. As more data are compiled and more stream restoration projects reach their 5-year limit without being successful, additional streams will be pronounced "irreparably damaged". Over the next few dozen years, many streams in many southwestern Pennsylvania watersheds are destined to meet the same fate, including some of the very best waters (EV and HQ) designated for Special Protection. Damage to these sensitive water resources is contrary to Article 1, Section 27, of the Pennsylvania Constitution.

Only when the coal reserves run out will this unfortunate series of events come to an end, although the damage already inflicted on the waters of the Commonwealth will persist. As trustee of these resources the Department must implement changes to its policies and procedures soon. Otherwise, future generations will be unable to enjoy the benefits these streams have provided for farmers, children, hikers, fishermen, hunters, and any other outdoor enthusiast.

9 Moving Forward

SUMMARY: Improvements in BUMIS and procedural changes in the permitting and regulatory program as recommended in the 4th Assessment will help in better identifying and evaluating impacts from underground mining. They will not, however, resolve a fundamental problem created by Act 54: the *allowance* of damages that in many cases are not being, and in some cases cannot be, repaired. The time-tested model of environmental protection --- avoid, minimize, mitigate --- must be incorporated into the Department's regulatory program, with clearly defined and consistently applied standards for recognizing successful mitigation, as well as explicit consequences for non-compliance.

There are numerous opportunities for improving the current situation as we move ahead. We offer several suggestions that we believe would be worthwhile. No single change will be a silver bullet, but as with most things, multiple changes incorporated together are likely to be the most effective.

1. Return to previous focus of environmental protection – no damage

One concern expressed about the 1966 Mining Law was that it only protected structures built prior to 1966. In 1994, Act 54 could have addressed that shortcoming by extending the prohibition on damage to all structures in place at the time a mine application is made, no matter when the structure had been built. Instead, Act 54 *removed* the protection and allowed any and all structures (and other features and resources) to be damaged, along with the expectation of repair.

Clearly, Act 54's allowance of damage to one property owner by another is not working. It may even be unconstitutional, because damages for the most part are not being repaired. We know that actual repair of damaged structures was the final "resolution" in only 9 (4%) of the 237 instances where mining was found to be liable during the 4th Assessment period (and only 19 of 300 [6%] during the 3rd Assessment period). For water supplies the outcome has been similar: only 11% (70 of 640) of water supplies that were determined to have been damaged due to mining recovered or were repaired during the 10 years covered by the 3rd and 4th Assessments. Other types of "resolutions," such as private agreements or company purchase of damaged properties, occur the vast majority of the time. Additionally, collateral damages not specifically addressed in Act 54 are being inflicted on coalfield residents and landscapes without redress. At minimum, the prior standard of protection --- a *prohibition* on damage --- should be reestablished in terms of both structures and water supplies. To the extent that this is accomplished by using room-and-pillar methods, it incidentally may increase mine employment.

A prohibition on damage will provide a powerful incentive to mine operators to improve coal extraction technologies in ways that protect other surface features at the same time. As Act 54 currently is implemented, no such incentive exists.

Longwall operators already have available to them at least one option to do this, although it is rarely used. It was pointed out in the 4th Assessment that longwall mine panels traditionally have followed an approximately N 60^{o} W orientation (Assessment page III-17). However, at least two mines (Mine 84 and Dilworth Mine) in the past have utilized longwall panel orientations that were rotated 45^{o} or 90^{o} from the usual orientation (**Figure N**). By altering the panel size and/or orientation, it would be possible for mine operators to avoid or minimize subsidence impacts in some locations that would otherwise result from the traditional orientation. Mining methods that are known to be less damaging to surface features (traditional room-and-pillar) should be used beneath sensitive features such as streams. Other techniques are available to reduce subsidence, including backstowing which has been used successfully in Germany and Poland and overburden grout injection which has been used successfully in China (NSW Minerals Council 2007), and should be developed and implemented in southwestern Pennsylvania as appropriate.

2. Adopt Recommendations of 4th Assessment

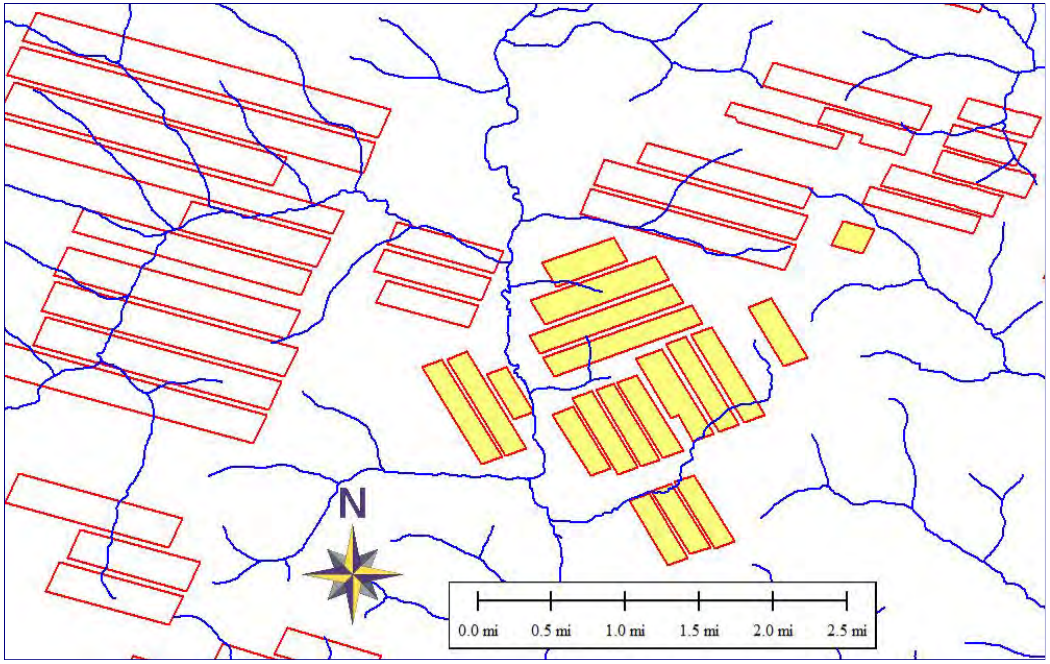
Section X of the 4th Assessment provides 11 pages of recommendations on "*how to improve the implementation of Act 54*". Most of those recommendations are quite practical and relevant to the issues and problems discussed.

In accordance with Section 18.1 of Act 54 the preparation of the 5-year Assessments is the legal responsibility of the Department of Environmental Protection. Although the Department utilized the services of the University of Pittsburgh to prepare this latest report, at the end of the day it is the Department's report. Yet more than six months (as of this writing) after the final 4th Assessment report was provided to it there has been no indication whether the Department agrees with any of the suggestions and recommendations made in it. The letter from the Department transmitting the Assessment to the Citizens Advisory Council is noncommittal, saying only that the University of Pittsburgh did "*a commendable job*" and that the report is "*informative*". The Department should indicate which (if any) specific recommendations it intends to adopt and implement, and should provide an estimated timetable for when that will be accomplished.

Without some formal follow-through by the Department, especially after specific problems have been identified and specific suggestions for improvement have been offered, this Act 54 Assessment will have served no useful purpose other than to waste more than $600,000 of taxpayer dollars.

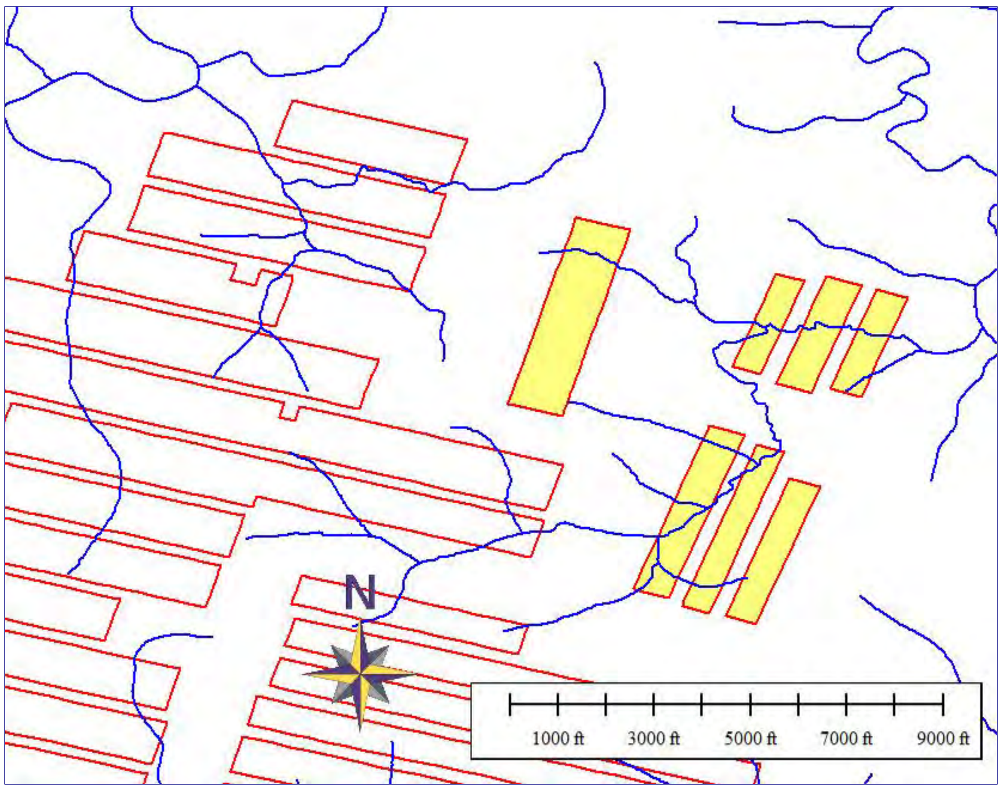
3. Insert explicit environmental protections

Experience and data from the past 20+ years demonstrate that underground coal mining, and particularly longwall mining, is causing damage to streams, wetlands,



Mine 84
Washington County PA

Alternative panel layouts (yellow shading) were mined between 1979 and 1990.



Dilworth Mine
Greene County PA

Alternative panel layouts (yellow shading) were mined between 1984 and 2002.

FIGURE N. Longwall mine panel orientation at two mines in southwestern Pennsylvania. According to the 4th Assessment, traditional panel layout is oriented approximately N 60° W (red outlined unshaded rectangles). Longwall mine operators, however, can alter panel size and orientation for various purposes including to avoid or minimize surface impacts.

and groundwater. However, the Department even now has not acknowledged the significant differences between longwall mining and traditional room-and-pillar mining in their impacts on natural resources. To a large extent comprehensive premining inventories of water resources still are not being required of mine operators before permits are issued. Accurate predictions of where hydrologic impacts are most likely to occur are not being made, even as surface and groundwater impacts continue to occur with greater frequency. After impacts have occurred, too much time is allowed to elapse before restoration activities are initiated, and in some (perhaps in many) cases, full restoration of premining conditions ultimately is found to be impossible.

To help avoid these same outcomes in the future, the following at minimum should be done. No permit should be issued by the Department until at minimum two years of "normal" surface water and groundwater conditions have been inventoried, including pump tests of yields at all existing wells and widespread and frequent measurements of groundwater levels. The actual existing uses (not just the listed designated uses) of all surface waterways should be determined before a permit is issued to undermine a stream. Penalties should be imposed if false information is submitted to the Department by mine operators or their consultants as allowed by existing regulations.

All Special Protection waters should be field-identified and specific measures should be proposed to afford them the higher level of protection they warrant. Models should be developed, refined, and used in every mine application to predict when and where impacts to water resources are likely to occur. Predicted impacts should be avoided or minimized as much as practicable. When unpredicted water resource impacts occur, or if actual impacts turn out to be more severe than predicted in applications, those impacts must be addressed and remedied in a timely manner.

4. Establish Strict Timeframes for Repair, Strict Penalties for Unpredicted Damage

Damages resulting from underground mining should be limited to those which are truly accidental or unavoidable, and then they should be repaired as expediently as possible. Damage should not be expected or accepted as a “given”; rather, it should be viewed as the rare exception, and then repaired with the urgency it deserves. Damages to surface and groundwater resources that are not predicted should elicit severe penalties. Mitigation for unpredicted impacts should be double that required for predicted ones. If natural resource damages are determined to be irreparable, the operator must be required to provide alternative natural resource restoration elsewhere, and the property owners where the original damage occurred also must be compensated for their loss.

Whenever underground mining is found to have adversely affected a structure or other manmade feature, the mine operator should be required immediately to identify and assess any and all other direct and indirect damages that have occurred in that area (under the assumption that if subsidence was severe enough to cause structural or water supply damage, it may have caused other less obvious damage as well). All damages must be repaired within strict timeframes; we suggest no longer than 1 year. If established timeframes for repair are not met, the operator should be required to cease operation of the mine until all of the damages have been successfully repaired.

5. Revamp Mine Subsidence Insurance (MSI) Fund

According to the Work Agreement between the University of Pittsburgh and the Department (Appendix A in the 4th Assessment), the "mine subsidence insurance records" (among other sources of information) were to be used in preparing the report. MSI was included in the list of acronyms, but is not discussed in the report.

The Mine Subsidence Insurance Program covers subsidence-related damages from abandoned mines. The MSI Fund currently is accumulating a huge and ever increasing balance[19] because, in reality, subsidence damage from abandoned room-and-pillar mines is minimal across the Pennsylvania coalfields. Eligibility for the MSI Program should be expanded to cover damage from all active underground mines, and to cover damages to water supplies in addition to structures. Payouts should be used only for actual repair or restoration of damage, and not as cash compensation. Mine operators should be required to insure and pay the annual premiums for every property that they propose to undermine. By expanding the number of properties participating in the MSI Program in this way, the average cost of premiums can remain low. If widespread mining damages occur, a rise in claim payouts will cause MSI premiums to also rise. Mine operators thus will have an incentive to develop and employ best management practices that will avoid and minimize surface impacts, because reductions in their insurable losses will result in savings through premium rate reductions.

6. Revise Bonding Requirements

It is becoming increasingly important to ensure that any proposed restoration of damages has an adequate source of funding in the event that a mine operator is unable (either technically or financially) to successfully complete the work. This is particularly important for damages to natural features such as streams and wetlands, which can be difficult to restore to pre-disturbance conditions in the best of cases, and especially so when the disturbance involves the widespread hydrologic changes that occur with longwall mine subsidence. The ability to more accurately predict where and how much damage might occur would greatly improve the calculation of likely restoration costs.

[19] The MSI fund started in 1961 with a $1 million endowment. As of June 2014 it had a balance of about $95 million. Interest on the fund balance amounts to nearly $2 million per year, and policy premiums collected bring in about $5 million per year. Since only about $1 million per year is paid out in claims, the Fund balance grows larger each year. In its more than 50 years of existence the MSI Program has paid out a total of $28 million, less than one-third of its current balance.

Restoration bonds must fully cover the costs necessary to restore premining flow, chemistry, and biological conditions to streams damaged by either pooling or flow loss, and for an appropriate period of monitoring to ensure long-term success. Penalty payments should be made to landowners whose homes or water supplies have not been repaired within some reasonable established timeframe (one year, for example) and bonding should be sufficient to cover such additional payments. Likewise, bonding should be established to provide financial compensation for those landowners whose streams are adversely affected by mining and which are determined to have been irreparably damaged after 5 years of attempted restoration.

7. Revise Reporting and Public Disclosure

To the extent that the numbers of mine-related damages are reduced by avoidance and minimization, then the identification, recording, and monitoring of any remaining impacts should become less of a burden for the Department. Evaluating and tracking impacts from underground coal mining would become a more straightforward task. Interim Act 54 Assessments should be prepared annually, as recently was suggested by a member of the Citizens Advisory Council. That would provide more immediate feedback on the status of damages and restoration efforts, and also would make compilation of the five-year Assessments easier. In the interest of greater transparency, most if not all of the permit application and enforcement files, data, and correspondence should be put online. By making this information more readily available (it already is publicly available through the more burdensome and time-consuming Right-to-Know Law process), the public can provide another level of review to ensure that information upon which permits have been issued is accurate and to provide missing information as may be necessary.

10 Summary and Conclusions

The Pennsylvania Department of Environmental Protection has a trustee responsibility under the Pennsylvania Constitution to protect and preserve the waters of this Commonwealth and other natural resources for current residents and for future generations. When Act 54 was passed 21 years ago, it *allowed* certain damages from underground coal mining that previously had been prohibited by the 1966 Mining Law, but with the expectation that any damages that did occur would be fixed. To ensure that would happen in accordance with the trustee duty of the State, the General Assembly inserted into Act 54 a requirement that the Department compile and analyze data on the effects of mine-related subsidence on surface features and water resources. The results of those analyses were to be compiled in report form every five years and presented to the Governor, the General Assembly, and the Citizens Advisory Council. Presumably, if the five-year report showed that things were not working as intended, changes would have to be made.

This 4th Act 54 Assessment clearly shows that things are not working as intended.

First, the Department has not been systematically collecting and compiling the data necessary to adequately determine the extent of damages from mine-related subsidence on surface features and water resources. Although it has been more than 20 years since Act 54 was adopted, the Department still does not have in place a standardized database to accurately identify and monitor all of the resources at risk and impacts actually occurring in conjunction with underground coal mining activities. The various models and assumptions being relied upon to predict damage from subsidence were developed decades ago, when longwall panels were significantly smaller. None of those models has been re-evaluated or recalibrated in accordance with modern practices and conditions. A large percentage of impacts is occurring outside of presumed "zones of influence". Certain impacts, such as to wetlands and groundwater as well as streamflow loss, are *never* predicted because there currently is no "model" in place to do so. Rather than insisting that mine applications include the types of data and analyses that will clearly identify whether and where impacts to the hydrologic balance and other resources will occur, the Department has used a lack of such data to deny or ignore the extent of impacts that have been occurring.

Second, it is clear that all damages related to mine-related subsidence are not being repaired or replaced. In approximately two-thirds of the incidents involving structures and water supplies, the Department simply does not know the final outcome because the damage was "resolved" by a private agreement, typically with a non-disclosure clause. Only about 10% or less of damaged structures or water supplies have reliably been determined to have been repaired.

Third, damages are taking a significant amount of time to reach "resolution", often measured in years. Two percent of reported structure effects during the 4th Assessment period required more than 2 years to resolve, the longest taking 933 days. For water supply impacts, 25% of the damages took between 1 and 4.5 years to resolve. For pooling impacts to streams, it took an average of 682 days (1.9 years) after mining had occurred for restoration work to *begin*. Attempts at stream restoration can last several years, and in some cases damaged streams cannot be fixed. This 4th Assessment notes that at the end of 2012 the Department acknowledged that 6 streams had been irreparably damaged by longwall mining subsidence after each dewatered stream could not be restored to premining conditions despite multiple years of trying. That the Department has permitted these longwall mines to continue operating and even to expand despite that irreparable damage clearly is a violation of its public trust responsibility.

Fourth, while some progress has been made in characterizing streams and identifying their impacts, much less information is being developed regarding other elements of the hydrologic balance that is required to be protected according to the Department's existing regulations. Comprehensive and accurate baseline information on wetlands and groundwater still is not being collected, and cumulative impacts to water resources at individual mines and regionwide are not being evaluated. It is doubtful whether complex natural systems such as streams, wetlands, or groundwater can ever be fully restored to their former condition after longwall mine subsidence has irreparably altered their hydrology.

Fifth, such information as has been collected shows that reported effects overall have been increasing even as the total acreage being undermined has decreased. The vast majority of impacts are due to one method of underground coal extraction -- longwall mining -- which during the last 5-year period accounted for 97% of structure impacts which were determined to be the result of underground mining (230 of 238), for 89% of all reported land impacts (94 of 106), and for 100% of the mining-related stream impacts. These same trends are evident in the data compiled for the first three 5-year Assessment periods.

The Act 54 "allowance" of damages as long as they are repaired or compensated may eventually provide satisfaction to an individual property owner, but on balance it causes adverse effects to communities and public resources. The permanent lowering of a water table or loss of flow in a stream violates the environmental rights of Commonwealth residents, now and in the future. Going forward, the Department must do more than improve its ability to better identify and track impacts from underground mining. The Department must exercise its trustee responsibility and insure that permanent damages to the resources of the Commonwealth will not be permitted. If damages occur, they must be fully repaired in a timely manner, and if they occur repeatedly by the same mine operation, it must cease operating or radically change its method of coal extraction.

A renewed focus on environmental protection would provide numerous benefits, besides the obvious preservation of sensitive public resources. It would provide the incentive for mine operators to develop more efficient methods of coal extraction that are less destructive of surface resources. It may increase employment in mining operations as additional operational components are added to the mining process to provide the additional protection. If overall coal production is reduced marginally to accommodate the necessary changes, that will serve to extend the time before mineable reserves are exhausted.

11 Authorship and Acknowledgments

This report was prepared by Stephen P. Kunz with the assistance of James A. Schmid. Both are senior ecologists with Schmid & Company, Inc. Mr. Kunz has been a consulting ecologist since receiving a degree in human ecology from Rutgers University in 1977. Dr. Schmid is a biogeographer with more than 40 years of experience in ecological consulting. Both Mr. Kunz and Dr. Schmid are certified as *Senior Ecologists* by the Ecological Society of America and as *Professional Wetland Scientists* by the Society of Wetland Scientists.

Mr. Kunz and Dr. Schmid offer outstanding credentials as experts in ecology, wetlands, environmental regulation, and impact assessment. They have analyzed the environmental impacts of many kinds of proposed development activities in many states, including coal mining facilities, industrial facilities, transportation facilities, commercial developments, and residential developments. They have written Environmental Impact Statements under contract to the US Environmental Protection Agency, Army Corps of Engineers, Interstate Commerce Commission, various agencies of State and local governments, and a diverse array of private sector entities. They have prepared comprehensive analyses of environmental regulations of nationwide scope. They have investigated the impacts of coal mining for USEPA in several regions of the United States. They have prepared several reports on underground coal mining in Pennsylvania at the request of organizations such as Citizens Coal Council, Citizens for Pennsylvania’s Future, Center for Coalfield Justice, University of Pittsburgh Environmental Law Clinic, Robert C. Byrd National Technology Transfer Center at Wheeling Jesuit University, Mountain Watershed Association, Buffalo Creek Watershed Association, Sierra Club, Raymond Proffitt Foundation, and Pennsylvania Department of Environmental Protection.

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