SECTION 1: Introduction

1.A - Overview

This section describes the need for this study and a list of its aims and objectives. The Introduction also contains background explanations of certain topics that are relevant to the report and that provide context for subsequent sections.

1.A.1 - Need for this Study

Section 18.1 of the Bituminous Mine Subsidence and Land Conservation Act (BMSLCA) requires

> (a) The department [i.e., the Pennsylvania Department of Environmental Protection (PADEP)] 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.

PADEP initiated a contract (Appendix L) with the University of Pittsburgh (hereafter: The University) and the Carnegie Museum of Natural History on 1 September 2017 with an official start date of 6 November 2017 to fulfill the assessment and reporting requirements for the period from 21 August 2013 to 20 August 2018 (hereafter: 5th assessment period).

1.B - Environmental Laws and Coal Mining

The Act 54 provisions emerge from over 150 years of coal mining in Pennsylvania. Based on the University's analysis, this coal mining will continue for at least 20 years and four more Act 54 assessment periods (Appendix C).

In the 1940s the Commonwealth began to legislatively recognize the necessity of environmental stewardship during mining to prevent permanent and widespread destruction of its land and water. The Clean Streams Law was amended in 1945 to include acid mine drainage as a pollution source that required regulation. In that same year, the Commonwealth passed the Surface Mining Conservation and Reclamation Act (Act 418), representing its first comprehensive attempt to prevent pollution from surface coal mining. From this point forward, the Commonwealth passed several laws that directly addressed environmental issues associated with the deep mining of bituminous coal beds.

1.B.1 - Bituminous Mine Subsidence and Land Conservation Act of 1966 (BMSLCA)

The most significant of these laws was the BMSLCA of 1966. For the first time, certain structures built before April 1966 had to be protected from subsidence regardless of coal ownership rights beneath the structure. This law suggested that coal extraction ratios of less than 50 % be used to protect surface properties, but also indicated that specific guidelines could be set by the state.

Gray and Meyers (1970) investigated the pillar support area required underground to minimize subsidence damage on the surface. That area was dependent on the selection of an angle of support (Figure 1-1). An adequate angle of support was most dependent on the geologic character of the rocks; in their report angles varied from 15 to 25-degrees. Their method required the support base (the width of the pillar) at the mining level to increase between 53 to 93-ft along its horizontal axis with every 100-ft of overburden. The outcome was a support area for 500-ft of overburden that was equivalent to 3.4 times the support area required at 100-ft of overburden. This method remains the basic support area design for structures requiring damage prevention.

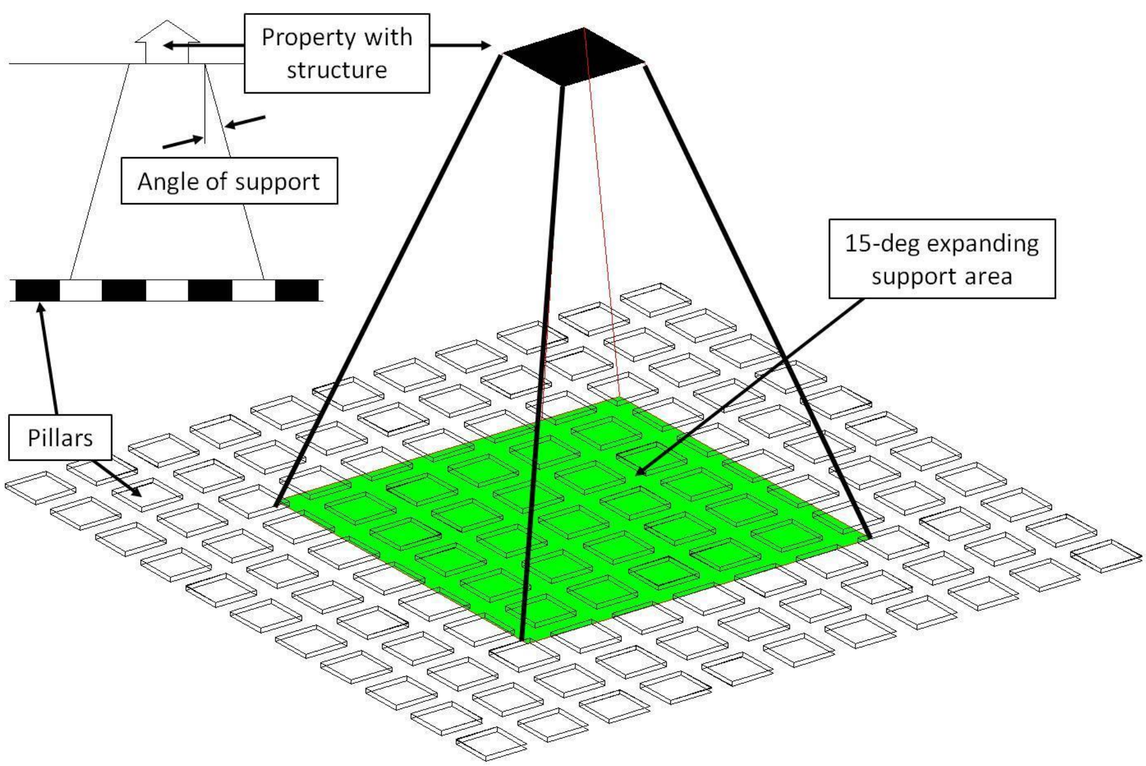

Figure 1-1. An interpretation of pillar support required by the BMSLCA (1966) to protect structures from subsidence damage.

The BMSLCA also established various requirements such as permitting, mapping, protection of certain structures from subsidence damage, repair of subsidence damage to certain structures, and the right of surface owners to purchase support for their structures. Section 4 prohibited subsidence damage to certain structures, homes, public buildings, noncommercial structures, and cemeteries that were in place on 27 April 1966. Section 6 required operators of underground mines to 1) repair damage within six months and 2) secure a surety bond to cover possible future property damage. Section 15 provided certain owners the right to purchase the coal located beneath their property. This law did not contain any provisions addressing water supplies.

1.B.2 - 1980 amendments to BMSLCA

The BMSLCA was first amended in 1980 to help bring PA law into compliance with the minimum requirements of the recently passed federal Surface Mining Control and Reclamation Act of 1977 (SMCRA). Section 4, which provided protection to certain structures, was amended to allow the current owner of the structure to consent to subsidence damage, but the damage had to be repaired or the owner compensated. Section 5 was amended to require an operator of an underground mine to adopt measures to prevent subsidence causing material damage to the extent technologically and economically feasible, as well as to maximize mine stability and to maintain the value and reasonably foreseeable use of the surface. These measures were to be described in the permit application. The new language also specifically provided that the new subsection was not to be construed to prohibit planned subsidence or standard room-and-pillar mining.

1.B.3 - Act 54 Amendments

By the mid-1980’s, new environmental concerns were being raised about the BMSLCA. In 1986, Arthur Davis, a Professor at the Pennsylvania State University, organized the Deep Mine Mediation Project to bring together the underground bituminous coal industry, agricultural, and non-governmental organizations for the purpose of attaining a consensus position on the BMSLCA.

Ultimately, the state legislature prepared a number of statutory amendments to BMSLCA in 1992 and it became effective on 21 August 1994. This legislation is commonly referred to as Act 54. For the first time, the law extended the obligation of coal companies to pay for damage caused to homes and businesses, regardless of when they were constructed. The Act 54 amendments also provided for the replacement of impaired water supplies and provided additional remedies for structural damage:

BMSLCA – revised water supply replacement provisions

- Established a rebuttable presumption zone (RPZ). The RPZ consists of an area above the mine that is determined by projecting a 35-degree line (from vertical) from the edge of mining to the surface. Within this zone, the mine operator is assumed liable for any contamination, diminution or interruption to water supplies, but the mine operator and the PADEP have the opportunity to present evidence to the contrary, i.e., to rebut the assumption of mine operator liability.

- Entitled landowners with affected water supplies in the RPZ to a temporary water supply and restoration or replacement of a permanent supply by the mine operator.
- Entitled landowners with affected water supplies outside of the RPZ to permanent water supply restoration or replacement if found to be likely caused by mining. Outside of the RPZ, the burden of proof is borne by landowner and PADEP.
- Established that the RPZ does not apply if a landowner did not allow pre-mining surveys by the mine operator.
- Allowed for voluntary agreements between landowners and mine operators that stipulate the manner in which the water supply is to be restored or an alternate supply provided or that provide fair compensation for the impacts.

BMSLCA – revised structural damage repair provisions

- Mine operators were required to repair or compensate for subsidence damage to any building accessible to the public, non-commercial buildings customarily used by the public, dwellings used for human habitation, permanently affixed appurtenant (secondary) structures and improvements, and certain agricultural structures.
- Entitled the structure owner or occupant to payments for temporary relocation and other incidental costs.
- Allowed the mine operator to conduct a pre-mining survey of the structure prior to the beginning of mining.
- Voluntary agreements were authorized between mining operators and landowners.
- Allowed underground mining beneath any structure, except a certain limited class of structures and features (churches, cemeteries, schools, hospitals, etc.), as long as the consequential damages are not irreparable and are repaired should they occur.
- Stipulated that irreparable damage can only occur with the consent of the owner.

Act 54 imposed certain restrictions and responsibilities on mine operators and on PADEP. Coal operators were responsible for the restoration and/or replacement of a range of features located above, and adjacent to, active underground coal mines. PADEP was designated to conduct field investigations, examine and approve permits, and report to the general public and industry representatives with their findings.

Act 54 also explicitly acknowledges the Commonwealth's responsibility to protect the surface waters of the Commonwealth, as codified in the Clean Streams Law, PA Code Title 25 Chapters 89, 93, 94, 96, and 105. Consequently, underground mine operators are required to demonstrate that their activities will prevent damage to aquifers and perennial streams.

1.B.4 - Act 54 Reporting Requirements

Act 54 contained a special provision requiring PADEP to produce an assessment of the surface impacts of underground bituminous coal mining every five years. To date four reports have been issued:

- 1st assessment: Completed by the PADEP in 1999 (PADEP 1999; later amended, PADEP 2001). Covered the period 21 August 1993 to 20 August 1998.

- 2nd assessment: Completed in conjunction with California University of Pennsylvania in 2005 (Conte and Moses 2005). Covered the period 21 August 1998 to 20 August 2003.
- 3rd assessment: Completed in conjunction with the University of Pittsburgh in 2011 (Iannacchione et al. 2011). Covered the period 21 August 2003 to 20 August 2008.
- 4th assessment: Completed in conjunction with the University of Pittsburgh in 2014 (Tonsor et al. 2014). Covered the period 21 August 2008 to 20 August 2013.

The University of Pittsburgh and the Carnegie Museum of Natural History (CMNH) were contracted by PADEP in 2017 to conduct the 5th assessment.

Each report has generated productive discussions between the citizens of the Commonwealth and PADEP regarding desired enhancements to the content of the reports. This in turn has led to modifications of PADEP's reporting requirements associated with mining permits. The University's contract for production of the 5th report (Appendix L) also reflects those discussions.

1.C - Impacts of Underground Mining on Surface Features and Structures

Subsidence impacts occur due to adjustments in rock strata following the creation of voids at depth (These adjustments and their influence on subsidence are discussed in Appendix D). The majority of possible impacts related to underground mining discussed in this report are associated with mining induced surface subsidence.

1.C.1 - Structures: Impacts of Underground Mining

Any structure that falls within the subsidence basin has the potential to be impacted. The reasons for this are many, including rapidly changing surface slope, curvature, and horizontal strain conditions. Impacts to buildings and structures include shifting of foundations, extensional cracks in walls and floors, and buckling of walls and floors.

1.C.2 - Water supplies: Impacts of Underground Mining

Subsidence-related impacts to water supplies can diminish water flow or alter hydrologic flow paths changing water chemistry and sometimes reduce its residential, agricultural and commercial value and use. Impacts to water supplies have been occasionally known to extend beyond the subsidence basin (Witkowski 2011).

Room-and-pillar mining may also affect water supplies. The altered groundwater flow paths that occur under specific conditions may impact the quantity and quality of water produced by wells and springs.

1.C.3 - Hydrology: Impacts of Underground Longwall Mining

Subsidence associated with underground mining has the potential to alter the hydrologic cycle in overlying areas. Changes to surface water flows, either through impedance (i.e. pooling) or routing of surface waters through sub-surface flow paths (i.e. flow loss), are described below. However, the hydrological impacts to non-stream portions of the landscape are less well characterized. Southwestern Pennsylvania's geologic template results in substantial groundwater aquifers that sustain surface water flow during periods without precipitation and provide drinking water for more than 3 million residents of Pennsylvania living beyond public water distribution networks (Swistock et al. 2009). The surface disturbances associated with longwall mining have significant implications for these 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 in surface waters.

1.C.4 - Streams: Ecology and the Impacts of Underground Mining

With over 83,000 miles of streams (U.S. EPA 1998), Pennsylvania is rich in aquatic resources. Pennsylvania has the greatest miles of stream per square mile of land surface of any state in the continental U.S., with three-fold more than Ohio and 1.5-fold that of West Virginia. The total economic benefits derived from rivers and streams are substantial (U.S. National Park Service 2001). For example, angler use and harvest from trout-stocked streams in Pennsylvania generated over $65.7 million across the first eight weeks of the 2005 trout season (Greene et al. 2006). Thus, understanding the impact of underground coal mining on streams and rivers is an especially important issue in the Commonwealth.

In general, subsidence impacts geological structures altering flow paths and impacting streams. The formation of subsidence basins above the longwall panels can create barriers to stream flow above the un-subsided gate road entries. The uneven subsidence between panels and gate road entries creates a dam-like barrier and stream water pools upstream of the gate road entries. "Pooling" typically occurs in flat reaches (i.e., valley slopes at less than 2 % slope). In more headwaters systems, compressive and tensile forces generated in the bedrock between the mine and the surface can cause bedrock fracturing within and beneath the streambed. The fractures can lead to draining of surface water into deeper strata and loss of stream flow and riparian aquifer storage.

Disturbances in stream flow and changes in stream chemistry are widely regarded as the most critical factors influencing stream ecosystems (Resh 1988, Lake 2000, Bunn & Arthington 2002). The effects of pooling disturbances are likely similar to those associated with dams and weirs. Reduction in flow variability and lowered flows adversely affect stream ecology (reviewed in Bunn & Arthington 2002). Impacts include excessive stream vegetation growth (Walker et al. 1994), increases in undesirable insect species such as blackflies (De Moor 1986), reduced aquatic insect diversity (Williams and Winget 1979) and ultimately reductions in fish populations (Converse et al. 1998). The effects of subsidence-induced flow loss disturbances are analogous to those of a drought disturbance. During drought, flow loss creates a reduction in habitat space (Lake 2000). As a result, biota are forced to exist in higher densities in small pools where predation and competition pressure may intensify. Further, smaller pools are more sensitive to abiotic stressors such as increased water temperatures and associated decreases in dissolved oxygen content. Ultimately, the continuity of the stream system is broken, as resources that are introduced upstream are no longer carried downstream. Overall, pooling and flow loss result in physiochemical changes that can impact the aquatic life of a stream and the ability of the stream to support a healthy stream community of fish and compromise the designated uses of the stream.

Under the authority of the Pennsylvania Clean Streams Law (35 P.S. §691.1 et seq.) and regulations in PA Code Title 25, including Chapters 86, 89, 93, 96 and 105, the PADEP "will ensure that underground mining activities are designed to protect and maintain the existing and designated uses of perennial and intermittent streams" (PADEP 2005). In Pennsylvania, four designated uses for streams are identified and required by law (PA Code, Title 25, Chapter 93.3) to be maintained and propagated:

- Cold water fishes – waters containing or suitable for fishes, flora, and fauna that prefer cold water habitats, including fish species of the family Salmonidae (e.g. trout)
- Warm water fishes – waters containing or suitable for fishes, flora, and fauna that prefer warm water habitats
- Migratory fishes – water periodically containing or suitable for fishes that must move through flowing habitats to their breeding ground to complete their life cycle
- Trout stocking – waters stocked with trout and fishes, and the flora and fauna that are indigenous to warm water habitats

In addition, Technical Guidance Document 391-0300-002 (PADEP 2003) specifies criteria for classification as High Quality or Exceptional Value Waters. The ultimate criteria for establishment as Exceptional Value waters, and an important general criterion for establishing designated use category and its attainment, is based on the aquatic macroinvertebrate community the waters contain. Macroinvertebrate community composition generally predicts a stream's fish community (e.g. Lammert & Allan 1999). In addition, macroinvertebrate taxa span a wide range of trophic levels and pollution tolerance, so macroinvertebrate community composition can reflect the physical and chemical characteristics of the stream (Barbour et al. 1999). Measures of the macroinvertebrate community are therefore appropriate for assessing the influence of mining on local stream stretches.

1.C.5 - Wetlands: Ecology and Impacts of Mine Subsidence

In Pennsylvania, wetlands are defined as "areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas" (PA Code, Title 25, Chapter 105.1; adopted from U.S. Army Corps of Engineers). Wetlands can provide several critical ecosystem services for humans, including flood mitigation, storm abatement, groundwater recharge, pollution prevention, and recreation (Mitsch and Gosselink 2007). Wetlands also provide critical habitat for animal and plant species, many of which are threatened or endangered. Indeed, 28 % of plants and 68 % of birds listed under the U.S. Endangered Species Act occupy wetland habitats (Mitsch and Gosselink 2007). As a result of their importance to both humans and wildlife, wetlands are protected under federal law. The primary regulation guiding wetland protection is Section 404 of the Federal Water Pollution Control Act (commonly known as the Clean Water Act). The U.S. Army Corps of Engineers is responsible for administering Section 404, with assistance from the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and state agencies such as PADEP.

Wetlands are generally characterized by three features – wetland hydrology, hydric soils, and vegetation (Environmental Laboratory 1987). Ultimately, the ecological characteristics of wetlands are dictated by surface and groundwater inputs (Keddy 2000). Changes in water level can simultaneously create and destroy microhabitats within wetlands and affect the size and overall function of the wetland.

Mining-related subsidence can affect water levels in wetlands through three primary mechanisms. First, subsidence-induced pooling along streams can result in flooding of riparian wetlands. The excess surface water can increase the duration and extent of wetland saturation, resulting in the conversion of upland habitat to wetland habitat. Generally, these impacts are predicted to result in a net gain of wetland acreage. In contrast, subsidence-induced flow loss in streams can diminish surface water and groundwater inputs to riparian wetlands. Surface and sub-surface cracks in the bedrock can drain water from wetlands, decreasing the zones of inundation and/or saturation. These impacts are predicted to result in a net loss of wetland acreage. Lastly, migration of springs and seeps down slope following mine subsidence could result in the relocation of slope-side wetlands. The migration of a spring or seep and loss of the groundwater discharge at that location is expected to result in the loss of wetland habitat. If the spring re- appears downslope, then a new wetland may be created at that location. Overall, impacts from underground mining can either increase or decrease wetland acreage. To comply with federal regulations, mine operators must show that no net loss of wetlands occurs.

1.D - Recommendations from the 4th assessment report and internal review

During the 4th assessment (Tonsor et al. 2014), the PADEP tasked the University to provide recommendations based on data to improve the implementation of Act 54. The University provided general recommendations on data submission, management and retrieval, and specific recommendations to monitor impacts on structures, water supplies, groundwater, streams, and wetlands. The PADEP conducted an internal review of the 4th assessment report with workgroup participants from the Bureau of Mining Programs, the Bureau of Point and Non-Point Source Management, and the California District Mining Office (PADEP 2015). The PADEP also assessed public comments made on the report that were collected through the Citizen's Advisory Council's public hearings, summarizing public concern about "quantity and quality of data, access to the data, a perceived lack of data organization and management, dissatisfaction with the current Act and processes allowed under the law, and transparency" (PADEP 2015).

In their internal review of the 4th assessment report, the PADEP workgroup (1) identified 95 issues to address, (2) responded to each of the 95 issues, and (3) prepared 45 recommended actions for PADEP executive staff to improve implementation of Act 54 (PADEP 2015). The workgroup summarized key recommendations from the 4th assessment report and internal review. PADEP executive staff completed 30 of these 45 action items. Though 15 of the 45 action items for executive staff are not completed because they are ongoing or long-term, the University observed PADEP making a good-faith effort to address the concerns and recommendations from the 4th assessment report. The University is confident that PADEP will implement electronic data submission, update data standards for uniformity in operator submission and staff review, review stream guidance policy, and implement research to evaluate effects of longwall mining on stream water quality and quantity. Other recommendations are more challenging but worthy of pursuit and investment. For example, replacing BUMIS is a challenging long-term goal recommended in the 4th assessment report that is not currently being pursued by PADEP. But a replaced database could improve staff implementation of Act 54 requirements, reduce agency costs over time, and reduce costs of mine operators.

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