# Mining Waste Treatment Technology Selection

## Regulatory Issues/Challenges

The ITRC Mining Waste Team searched statutes, regulations, or policies that impede or slow the use of new technologies in the reduction of threats to human health and the environment related to mining waste. During the investigative process, the team has searched for a variety of solutions to these barriers and recommended ways to overcome them. ITRC's experience in past projects suggests that statutory and regulatory barriers often do not exist since exceptions, variances, or waivers are available. Even so, these are time-consuming, costly, uncertain, and biased toward existing or conventional technologies. This bias is part of what we are trying to overcome to allow new technologies to be tested, demonstrated, and earn an appropriate place in the toolbox of environmental professionals. The Mining Waste Team has identified the following issues.

### 1. Issue #1: Water Quality Standards

A barrier to the use of an innovative technology is the ability to consistently meet all ambient water quality standards. For example, wetland treatment systems almost always provide treatment but may not always consistently meet numeric water quality standards. To understand how a technology may address a portion of the overall water quality concerns, one must first understand that development of a water quality standard has two considerations to address:

- Designated Use and Antidegradation
  - When specifying designated uses, states are required to consider the use and value of water for public water supplies; protection and propagation of fish, shellfish, and wildlife; recreation in and on the water; agricultural and industrial uses, and other purposes.
  - Typically, states designate the most protective use to their waters when possible due to the large number they oversee and the antidegradation policy of the Clean Water Act (CWA).
- Water Quality Criteria
  - Water quality criteria (narrative and numeric) are considered during the development of a standard to protect the designated uses of a particular water body. There are two types of criteria which a standard incorporates:
    - Narrative criteria are general protective statements that usually specify that water be free from specific conditions, such as concentrations of pollutants that impair aquatic life.
    - Numeric criteria are estimations of concentrations of chemicals and degree of aquatic life toxicity allowable in a water body without adversely impacting its designated uses. Numerical criteria supplement narrative criteria for specific physical, chemical, and radiological characteristics of the water.

#### 1.1 Specific Challenges

- Requirements to comply with strict water quality standards and not allowing partial water quality improvements often delay remediation.
- Designation of water bodies with the highest possible use qualification regardless of monitoring data to determine whether the specified use is being achieved throughout the watershed.
- Reliance on numeric criteria to represent and be protective of a highly complex and variable aquatic ecosystems may exceed the potential performance of current engineering practices and know-how.
- Use of broad, jurisdiction-wide use classifications and lists of associated chemical criteria that lack precision can inadvertently result in either a lesser or greater level of protection than was actually intended when the water quality standards were adopted.

#### 1.2 Potential Solutions

Establish site-specific cleanup goals using the following:

1. **Performance-Based Criteria:** Water quality and sediment criteria and benchmark values for ecological protection are generally derived based upon toxicological data obtained from standardized studies using multiple species. The final standard is set to be protective of sensitive organisms. It has been widely recognized that the biological community present at a particular site may share little in common with the species used for testing. As a consequence, "real life" aquatic systems would not be expected to respond in the same way to environmental stressors and in fact may be less susceptible, making traditional standards

and benchmarks over- (or under-)protective. In lieu of conventional standards based upon the concentrations of contaminants in water or sediments, goals can be developed which use the natural systems as the measure.

Fish and benthic macroinvertebrates have been used routinely to gauge aquatic community health. Performance-based criteria using either (or both) can be established using regional or site-specific reference conditions to define a healthy condition. Productivity (organism count, biomass), species richness/diversity, evenness, functional diversity, and/or multimetric index systems can be used to quantify site conditions for comparisons. The success of preventive or remedial measures would be judged based upon whether the community in site (or affected) systems is sufficiently similar to that in the reference area(s). This approach has been successfully implemented as part of the Lower North Potato Creek project in the Copper Basin of eastern Tennessee.

2. **Risk Assessment:** Human health risk-based screening values or water quality criteria are derived using a standard set of scenarios and assumptions. As previously discussed, water and sediment quality standards for ecological receptors are typically based upon protection of sensitive species using toxicological data obtained from standardized studies. Often the test conditions, ecological communities and/or exposure scenarios/assumptions are inconsistent with those at a particular site. Regulatory agencies have various regulations and guidance outlining the role of and means by which risk assessments may be used in setting media quality objectives for site-specific conditions.

   From a human health perspective, it may be implausible for individuals to routinely contact contaminated water or sediment or consume fish caught from a water body. In these cases, risk assessment tools can be used to develop more appropriate scenarios and assumptions based upon site location, demographics, land use, and other factors. The form of the chemical present can also have a significant bearing on the potential human health outcome associated with exposure. For example, the bioavailability of lead can vary substantially depending upon the compound present. Exposure and toxicological assessment information specific to the site can be combined to derive cleanup standards more in line with the actual risks posed.

   Ecological receptors can also respond differently to the same contaminant concentration in a medium based on site-specific conditions. In water, the presence of competing cations, complexing substances (organic carbon, iron oxyhydroxides), and other constituents can significantly affect the toxicity of mining-related contaminants. Procedures such as the “water effects ratio” can be used to derive water quality criteria consistent with surface water composition at a site. For sediment, bioavailability can be affected by various factors, including acid volatile sulfide, organic carbon, and chemical form. With reduced bioavailability, sediment contaminant concentrations above generically derived quality criteria may be tolerated, and a healthy aquatic community may still be supported. ITRC’s Web-based contaminated sediment technical and regulatory guidance (in progress) identifies and describe various tools and methodologies to evaluate the bioavailability of chemicals and their role in assessing human and ecological exposure derived for fresh and marine water contaminated sediments.

3. **Use Attainability Analysis:** A Use Attainability Analysis (UAA) may be employed to remove a designated use, specified in the CWA, from a stream segment. The UAA is a structured scientific assessment of a stream segment that considers physical, chemical, biological, and economic factors. A designated use may be removed if it can be demonstrated that attaining the use is not feasible. Situations limiting the attainability of the designated use may include any of the following:

   a. naturally occurring pollutant concentrations
   b. physical conditions such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality
   c. human-caused conditions (dams and diversions or sources of pollution) that would cause more environmental damage if remediated than left in place.

   For additional information and case studies where UAA have been applied go to http://water.epa.gov/scitech/swguidance/standards/uses/uaa/about_uaas.cfm

4. **Technical Impracticability:** When a system is unable to meet effluent standards, EPA recognizes through its many years of experience that restoration to at least drinking water quality may not always be achievable due to limitations of available remediation technologies or conditions at the

> The National Oil and Hazardous Substances Pollution Contingency Plan preamble states that a technical impracticality determination should be based on “…engineering feasibility and reliability, with cost generally not a major factor unless compliance would be inordinately costly.”

site. In these cases, EPA must evaluate whether existing standards (e.g., MCLs) are attainable from a technical and practical perspective. For information on technical impracticability see the following:

- Technical Impracticability for Groundwater Cleanups
  www.epa.gov/superfund/health/conmedia/gwdocs/tec_imp.htm
- EPA Guidance for Evaluating Technical Impracticability of Groundwater Restoration
  www.epa.gov/superfund/health/conmedia/gwdocs/techimp.htm
- USACE (January 2002) Technical Impracticability Waivers: Guidelines for Site Applicability and the Application Process, Phase I Final Report
  www.clu-in.org/download/remed/aec-ti-waiver-guidance.pdf

**5. Alternate Cleanup Levels**

For the most recent “Summary of Key Existing EPA CERCLA Polices for Groundwater Restoration,” OSWER Directive 9283.33 (June 2009) go to www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

Alternate Cleanup Levels (ACLs) can be established at regulated (RCRA) units if constituents will not pose a substantial present or potential hazard to human health or the environment as long as the ACL is not exceeded. The following will be considered, including but not limited to (1) potential adverse effects on groundwater quality and (2) potential adverse effects on hydraulically connected surface-water quality when establishing ACLs. EPA policy regarding the use of ACLs includes (1) groundwater plumes should not increase in size or concentration above allowable health or environmental exposure levels, (2) increased facility property holdings should not be used to allow a greater ACL, and (3) ACLs should not be established so as to contaminate off-site groundwater above allowable health or environmental exposure levels. Although ACLs do not apply to facility-wide corrective action at solid waste management units, many of the ACL concepts and approaches can also be used to develop cleanup levels for site-wide corrective action. Excellent reference information may be found at the following:

EPA Alternate Concentration Levels (ACLs)
www.epa.gov/superfund/health/conmedia/gwdocs/acls.htm (40 CFR 264.94)

For Superfund sites, under limited circumstances specified in CERCLA §121(d)(2)(B)(ii), ACLs may be established in lieu of cleanup levels that would otherwise be ARARs (e.g., MCLs). The conditions under which ACLs may be considered are where:

a. Contaminated groundwater discharges to surface water.
b. Such groundwater discharge does not lead to “statistically significant” increases of contaminants in the surface water.
c. Enforceable measures can be implemented to prevent human consumption of the contaminated groundwater.

In general, ACLs may be used where the preceding conditions are satisfied and where restoration of the groundwater is found to be impracticable, based on a balancing of the remedy selection criteria (www.epa.gov/superfund/health/conmedia/gwdocs/acls.htm and www.epa.gov/superfund/policy/remedy/rules/rulesthm.pdf). The CERCLA ACL provision is directed at standards that are “otherwise applicable for hazardous constituents in groundwater.” Examples of such standards may include state requirements to clean up groundwater to background levels (e.g., some state antidegradation requirements) or state requirements for groundwater cleanup. Such standards must otherwise qualify as an applicable standard pursuant to section 121(d)(2)(A) (e.g., must be properly promulgated, enforceable, consistently applied).

**6. Water Quality Trading:** Water quality trading is a recent approach to achieve water quality goals more efficiently. Trading is based on the reality that different sources in a watershed can face very different costs to control the same pollutant. Trading programs allow facilities facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent pollution reductions from another source at lower cost, thus achieving the same water quality improvement at lower overall cost. For an example of a state program for water quality trading, specifically for nutrients, see Pennsylvania DEP (2009) at http://www.dep.state.pa.us/river/Nutrient%20Trading.htm.

Total maximum daily limits (TMDLs) are developed to improve and protect watersheds that are currently impaired (water quality is such that it affects designated uses, for example, fisheries). The limits are unique to each watershed and basically define the total amount of material (e.g., copper) that can be discharged into the watershed. If the current load exceeds the TMDL, no new discharges are allowed. Loads in historic mining districts are often very high, and uses are affected. Some states have allowed mining companies to treat discharges adjacent to their operation to reduce the total load to the watershed. By treating adjacent historic discharges as well as the new discharges, the total load with new mining is less than the original load, and the overall quality of the watershed is improved.

## 2. Issue #2: Third-Party Impediments to Full or Partial Cleanups

When a responsible party is not available to perform response work, other third parties can at times decide (based on benefits they see) to take on necessary work to return mining-impacted sites to beneficial use. Costs and liability for work performed can be impediments to having either full or partial cleanups pursued. A few tools are available to assist with addressing the costs and liability concerns that can arise at mining-impacted sites.

**Potential Solutions**

There are initiatives beginning to help reduce liability posed upon third parties deciding to perform response action to address (in part or full) impacts to beneficial uses they want to restore. The following are examples of such initiatives to help reduce costs and liability third parties face.

1. **Abandoned Mine Reclamation Grants:** As an example, on May 22, 1996, Pennsylvania's Surface Mine Conservation and Reclamation Act (Act of May 31, 1945, P.L. 1198) was amended to provide for, among other things, the awarding of federal funds received by Pennsylvania from the Surface Mining Conservation and Reclamation Fund through the Federal Office of Surface Mining (OSM). The authority to award grants is contained in Section 18(j) of that Act (52 P.S. 1396.1 et seq.). Grants may be awarded to municipalities, municipal authorities, and nonprofit organizations for the purpose of conducting abandoned coal mine reclamation projects, including acid mine drainage (AMD) abatement projects. In order to respond fairly and consistently to requests for such grants, the Department has developed guidance for use by interested parties intending to submit such requests. This guidance can be found at http://www.depweb.state.pa.us/portal/server.pt/community/abandoned_mine_reclamation/.

2. **Environmental Good Samaritan Legislation:** The EPA has proposed an Environmental Good Samaritan Act, which is intended to encourage county and local government agencies, nonprofit organizations, as well as individuals to reclaim abandoned mineral extraction lands to eliminate water pollution caused by abandoned mines, oil and gas wells. This act (or state equivalents) is intended to protect the groups that volunteer to complete such projects from civil and environmental liability. All individuals, corporations, nonprofit organizations, or government entities that participate in a reclamation or water pollution abatement project are eligible for protection if they meet the following conditions:

   - The third party provides equipment, materials, or services for the project for no profit.
   - The third party did not cause or create the abandoned mineral extraction land or water pollution.
   - The third party was not ordered by the state or federal government to do the work.
   - The third party is not performing the work under a contract for profit, such as a competitive bid project or a government-financed construction contract.
   - The third party is not the financial institution that issued the bond (or other surety) for the site.

   Additionally, any local government, organization, or individual providing access to the site without charge or compensation for a reclamation or water pollution abatement project is also eligible for protection under the federally proposed Environmental Good Samaritan Act. Typical situations that are eligible for land reclamation projects include, but are not limited to, abandoned mine pits; underground mine entrances; refuse piles; dangerous highwalls, structures, or equipment from past mineral-extraction operations; sites where the bonds were forfeited; and unplugged oil and gas wells. For additional information on EPA's Good Samaritan Initiative visit http://water.epa.gov/action/goodsamaritan/.

3. **Pennsylvania's Environmental Good Samaritan Act:** Pennsylvania's Environmental Good Samaritan Act (Act) was signed into law, along with the Growing Greener (see #4 below) Environmental Stewardship and Watershed Protection Act, in December 1999. These two programs are the largest environmental initiatives in Pennsylvania's history to address the Commonwealth's critical environmental priorities. The Act is also one of the program initiatives of Reclaim PA, a program designed to maximize reclamation of Pennsylvania's quarter-million acres of abandoned mineral-extraction lands, through increased mine operator, volunteer, and PADEP efforts. Pennsylvania's Environmental Good Samaritan Act encourages

landowners and others to reclaim Pennsylvania's abandoned mineral-extraction lands and abate water pollution caused by abandoned mines. The act protects landowners, private organizations and groups, and individuals who volunteer to do such projects from civil and environmental liability.

Eligible projects are those that restore mineral-extraction lands that have been abandoned or not completely reclaimed. This also includes areas where the mine operator has forfeited bonds on the site. Typical conditions that are suitable for land reclamation projects include abandoned mine pits and underground mine entrances, refuse piles, dangerous highwalls, and unplugged oil and gas wells. Projects addressing areas where abandoned structures or equipment from past mineral-extraction operations are located are also eligible.

For more detailed information on Pennsylvania's Environmental Good Samaritan Act, see the following:

- Technical Guidance Document: Environmental Good Samaritan Projects (TGD# 562-2000-001) http://www.depgreenport.state.pa.us/elibraryredirect/dsweb/Get/Document-47918/562-2000-001.pdf
- Fact Sheet: Environmental Good Samaritan Act (5600-FS-DEP2490 http://www.amrclearinghouse.org/Sub/LEGAL/GoodSamaritanFactsheet.pdf
- Environmental Good Samaritan Project Proposal http://www.depgreenport.state.pa.us/elibraryredirect/dsweb/View/Collection-9735

4. **Pennsylvania's Growing Greener: Environmental Stewardship and Watershed Protection Act:** The Growing Greener: Environmental Stewardship and Watershed Protection Act is the largest single investment of state funds in Pennsylvania's history to address Pennsylvania's critical environmental concerns. This program is intended to reduce the backlog of farmland-preservation projects statewide, protect open space, eliminate the maintenance backlog in state parks, clean up abandoned mines and restore watersheds, provide funds for recreational trails and local parks, help communities address land use, and provide new and upgraded water and sewer systems.

   Since 2004, the state of Pennsylvania, through the Growing Greener Grant program has funded 172 projects for Acid Mine Drainage and mine reclamation. The individual grant amounts awarded for each project ranged from $1,400 to $1,000 000. Approximately $26,000,000 has been awarded to date. Since the conception of the program, the total dollar commitment to the program has doubled from $645 million to $1.3 billion and has been extended through 2012 by a permanent dedication of a new $4/ton municipal waste disposal fee as well as funds obtained from the state's General Fund. Due to this increase in funds, the state's Department of Environmental Protection's (PADEP) portion of the program has been able to provide grants to a variety of organizations, such as county and local government programs, waste water and water authorities, conservation districts, watershed associations, and other nonprofit groups involved in watershed restoration and protection. These organizations are then able to carry out activities that include abandoned mine cleanup efforts, abatement of acid mine drainage, oil and well plugging, the organization of watershed groups, watershed assessments, the development of a watershed restoration or protection plan, the implementation of a watershed restoration or protection plan, and demonstration and education and outreach projects.

   For more information on Pennsylvania's Growing Greener: Environmental Stewardship and Watershed Protection Act, December 1999, visit
   http://www.dep.pa.gov/

## 3. Issue # 3: Solid Mining Waste

Solid mining waste is not a specifically regulated waste and involves huge volumes of material. The volume of material alone makes some techniques for minimizing the risk unreasonably costly. On the other hand, the exposure posed by direct and indirect ingestion of some of this waste is a major health concern.

**Potential Solutions**

The team has investigated, using case studies of field or lab tests, new or emerging technologies to minimize the threat from solid mining wastes. Following the collection of data and information on a suite of potentially available treatment technologies, the team concludes that regulatory flexibilities may allow for the following:

All of these applications may be limited by varying degrees of public support and concern.

1. **Land Application:** There is a potential to covering more-contaminated unvegetated or sparsely vegetated mine waste areas with less-contaminated soil excavated from residential yards. This is especially effective when excavated soils have been treated to reduce metal bioavailability. However, there are situations, such as using chat and tailings as agricultural lime, which should be avoided (see the Reuse and Reprocessing technology overview).
   - **Benefit:** Reduces contaminant footprint and may reduce contaminant concentrations at the surface, thus reducing potential for exposure to contaminants.
   - **Benefit:** Provides for a disposal location on site for downgradient or off-site impacted soils, thus reducing transportation cost and disposal fees.

2. **Reuse:** In some cases, waste material can be reused as a product constituent, such as aggregate for asphalt and concrete, which have been determined to be environmentally safe. In these uses, the material has been encapsulated and is not readily available for exposure.
   - **Benefit:** There becomes an economic benefit to the owner of the material, with a result being a net reduction in amount of contaminated material.

3. **Reprocessing and Remining (beneficiation):** This involves reprocessing and recovering additional metals from mine wastes already at the surface.
   - **Benefit:** Reduces metal concentrations in waste materials and obtains a product while not damaging any more land.
   - **Benefit:** The value of the recovered metal may offset the cost of waste management.

4. **Facilitated Third-Party Response Work:** Implementing a state or federal Good Samaritan Act and Brownfields Act may encourage some level of cleanup in exchange for some reduction in liability to third parties, from past uses. However, care should be taken to avoid improper end uses or unintended consequences (e.g., transportation incidents, etc.)
   - **Benefit:** May encourage cleanups and reuse of areas which may not be addressed otherwise.
   - **Benefit:** Encourages redevelopment without requiring full cleanup.

5. **Reduce Bioavailability or Mobility:** There are several technologies available which may alter chemical properties of the waste (chemical stabilization, heap leach/flushing detoxification). Application of these technologies may allow for more remediation options, including reuse.
   - **Benefit:** It renders the hazardous material potentially inert, which reduces threats of risk and potentially allows for the impacted material to be reused.

6. **Treatment and Closure in Place:** There are several technologies which may be implemented in place to reduce bioavailability or mobility, reducing the need for excavation and disposal (passivation, immobilization, chemical stabilization). While contaminant concentrations are generally not reduced when these technologies are used, contaminants are chemically bound to reduce the potential for exposure.
   - **Benefit:** The potential for exposure is reduced, wastes are allowed to remain in place, and a large repository may not be required because the impacted material does not represent an exposure risk.