Step 4: Understanding Clean-Up Options

In This Chapter...

- Targeting Clean-Up Sites
- Overview of Treatment Approaches
- Reclamation and Remediation
- Resource Information

TARGETING CLEAN-UP SITES

Understanding the various CMD treatment methodologies will help you understand the engineering portion of your project. A brief overview of these approaches appears below. More details on treatment methods are included in **Appendix E.** These systems involve assessment, design, and construction assistance from qualified professionals and are presented here only in summary form.

OVERVIEW OF TREATMENT APPROACHES

Assessing CMD sites for possible construction of treatment systems involves analyzing four basic criteria: water chemistry, flow rate, available land, and financial/in-kind resources.

Treatment methods to address CMD focus on neutralizing, isolating, stabilizing and/or removing problem pollutants through various chemical, physical and biological processes. There are two

basic types of treatment systems. Active treatment involves the addition of alkaline chemicals such as lime, soda ash, or ammonia, with the contaminated drainage to decrease its acidity and speed up the removal of metals. Passive systems clean contaminants from mine drainage by exposing it to air, limestone, cattails and other vegetation that form carefully designed components of ponds, neutralization ditches, buried channels, and wetlands.

Technical and Economic Factors to Consider for Active Treatment Systems

Technical factors include the acidity level of the discharge, rate of flow, types and concentration of metals in the water, rate and degree of pH increase desired, and the solubility of the chemicals in the water.

Economic factors include cost of the reagents, handling costs (labor, machinery, and equipment), and the number of years that treatment will be needed.

Active Treatment Systems

Active CMD treatment uses strong alkaline chemicals such as lime, caustic soda, ammonia, and calcium oxide to neutralize acid so that metals can be precipitated and removed. Active treatment systems are classified by the chemical used to treat the CMD.

There are six chemical reagents which are typically mixed with contaminated mine drainage in active systems. Each chemical has characteristics that make it more or less appropriate for a specific condition. The best choice among the alternatives depends on both technical and economic factors.

- Limestone (calcium carbonate)
- Hydrated Lime (calcium hydroxide)
- Pebble Quick Lime (calcium oxide)
- Soda Ash Briquettes (sodium carbonate)
- Caustic Soda (sodium hydroxide)
- Ammonia (anhydrous ammonia)

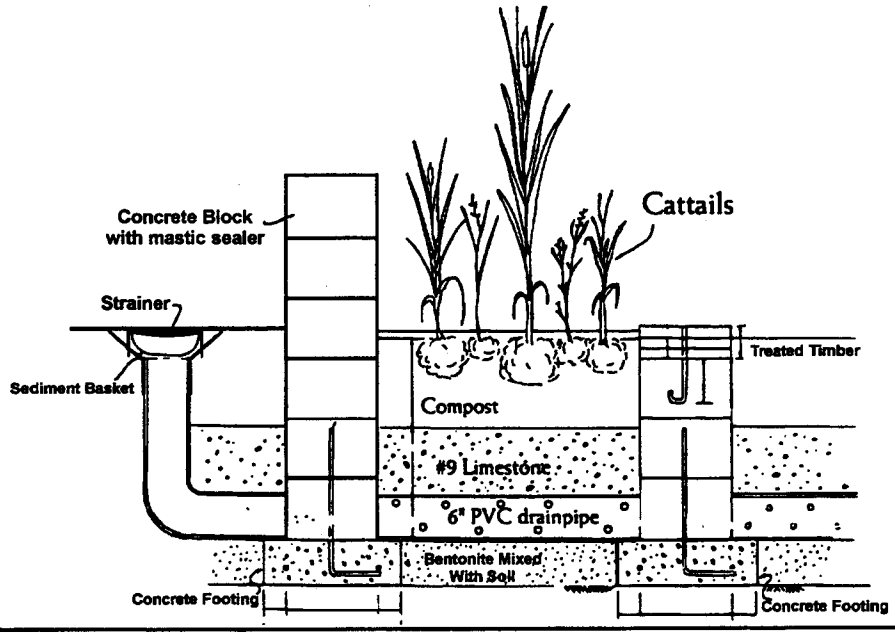
Mill Creek

The CMD treatment methodology chosen involved the use of anoxic limestone drains (ALDs) which fed constructed anaerobic wetlands. In the fall of 1991, the Howe Bridge Site treatment system was constructed to treat two adjacent CMD discharges. The flow rate of the two discharges was between 30 and 40 gallons per minute (gpm), which loaded 100 to 125 pounds of iron and acidic water (pH = 3.0) into Mill Creek each day. Damariscotta Environmental Consultants designed the system, and the 876th Engineer Battalion of National Guard Company B, stationed at Punxsutawney in Jefferson County, built it. Documented performance of the system included the removal of 90 to 95 percent of the iron, and a 300-fold increase in pH (from a pH of 3.0 to a reading of 6.0).

The National Guard built two more systems in 1992, improving the water quality of the discharges to the same standards as the first treatment system. The three systems eliminated high levels of iron and low (acidic) pH readings from the discharges that entered Mill Creek for a distance of six miles. In 1994, a system was built for Little Mill Creek to clean up the last six miles of the main stem of Mill Creek.

Cross Section of Passive Treatment System

(from University of Kentucky, Department of Agronomy)



Passive Treatment Systems

Passive systems remove or neutralize contaminants in mine drainage by exposing them to air, limestone, vegetation in ponds, neutralization ditches, buried channels, and wetlands. Exposing CMD to air helps to precipitate metals through oxidation processes; limestone contact neutralizes acid by adding alkalinity; vegetation such as cattails filter contaminants and aid in oxidation and metals removal; and organic wetlands remove metals and provide habitat for bacteria that break down sulfates.

Since passive systems are designed to make use of gravity flow through ponds, buried channels, ditches and wetlands, they can treat CMD without the continual addition of chemicals or neutralizing agents. In general, ponds are used to collect mine drainage, settle out larger particles of sediment, oxidize metals, and can reduce acidity when underlain with organic material and limestone. Ditches convey drainage to ponds or wetland cells, and often contain crushed limestone rock for acid reduction. Wetlands serve a variety of treatment functions, including filtration of smaller sediment particles, uptake of water and some contaminants, oxidation/adsorption of metals, and removal of sulfates through bacterial action.

Aerobic wetlands

Aerobic wetlands are used for low-acid CMD to collect flows, settle out sediments and provide residence time so that metals in the water can precipitate. Cattails and other wetland vegetation are

Constructed aerobic wetlands typically consist of:

- *A basin having a natural or constructed low-permeability barrier of soil;*
- *Synthetic liner material to minimize seepage;*
- *Substrate (soil or another suitable growing medium), placed over the barrier to support and nourish vegetation; and*
- *Wetland plants such as cattails and other planted or emergent vegetation.*

planted in an aerobic wetlands substrate to promote the uptake of water and small quantities of metals and other contaminants.

Anaerobic wetlands

These wetlands are used to treat CMD that is higher in acidity or sulfate concentrations. Anaerobic wetlands are similar to aerobic wetlands in appearance; however, they are underlain with an organic muck (substrate) and a layer of limestone.

Cooperation between your partnership, regulatory agency personnel, private contractors, funding sources, and elected officials will be vitally important during the design and construction phase of your clean-up plan.

Anoxic Limestone Drains (ALDs)

ALDs are buried trenches or channels containing crushed limestone into which acidic CMD is channeled. As the CMD flows through, the limestone is dissolved, alkalinity is added and pH is increased. The channels are covered to reduce or eliminate the presence of oxygen; the elimination of oxygen prevents the development of an iron oxide coating (armor) on the limestone.

Alkalinity Producing Systems (APS or SAPS, Successive Alkalinity Producing Systems)

APS or SAPS combine the use of ALDs and anaerobic wetlands. Elevated dissolved oxygen concentrations are often a design limitation for ALDs. If dissolved oxygen concentrations are above 1 or 2 mg/l, the water can be collected in a pond underlain with drainage pipes which are covered by limestone and capped off with organic material.

Limestone Ponds (LSPs)

LSPs are a new passive treatment approach in which a pond is constructed on the upwelling of an AMD seep or underground water discharge point. Limestone is placed in the bottom of the pond and the contaminated water flows upward through the neutralizing limestone.

Reverse Alkalinity Producing Systems (RAPS)

RAPS are similar to limestone ponds in design and installation, but are more efficient in removing metals.

Open Limestone Channels (OLCs)

OLCs can be used to increase alkalinity and reduce acid, but armoring reactions promoted by contact with the air will reduce their effectiveness somewhat.

OVEN RUN

Plans for CMD treatment in the watershed include the use of rock-lined channels to divert CMD surface water, and a combination of alkalinity producing systems, settling ponds, and wetlands using composted mushroom spoil and cattails.

During construction, erosion and sediment control practices will be applied, and existing areas of erosion and infiltration to ground water will be addressed

Design Considerations for Passive and Active Systems

Trenches, wetlands, and ponds of treatment systems must be designed to handle the CMD flow and predicted rainfall. These constructed devices should be impermeable to prevent seepage of the CMD into the ground, where it can bypass the remainder of the treatment system and contaminate ground water. Linings can be clay or grassed if the flow is not excessive. If the flow is considerable, rip-rap (large rocks that do not contain acid-producing material) can be used to slow the flow, or other nondegradable, nonerodible material like plastic liners can be used. Sometimes check dams made of rip-rap or straw bales are installed to reduce the velocity of CMD flows through channels or ditches, and they must be designed and constructed to ensure containment of the flow plus predicted rainfall.

Side slopes of ponds, wetlands and other embankments must be designed and constructed to prevent slippage and erosion, which usually involves establishing a thick stand of grass. Kentucky Bluegrass, tall fescue, reed canarygrass and Bermuda grass make excellent vegetative covers for embankments and ditch features.

RECLAMATION AND REMEDIATION

Sometimes it is possible to prevent the formation of contaminated drainage at abandoned mine sites through reclamation, remining or other remediation approaches. This option removes the need for treatment, which is often expensive, labor intensive and long-term.

Capping

One common preventive approach involves capping mine wastes with a layer of impermeable clay to restrict rainwater percolation and formation of CMD. If a field investigation determines that rain water is flowing into underground mine works through identifiable openings at the surface, it is advisable to fill and/or seal the openings to prevent CMD. Remediation can also include re-directing streams to reduce contact with contaminant sources like coal waste piles.

Remining

In other cases, there is still recoverable coal in the vicinity of contaminated mine drainage. Before CMD sites are scheduled for expensive treatment system construction, it may be worthwhile to

have a geologist determine whether enough coal is present at the site to justify remining. Some old mines were worked before the development of modern equipment, so it is possible that significant coal reserves are still present. The remining contractors would apply for permits that would ensure that their operations prevent the generation of CMD by careful planning, engineering and operational approaches to the remining work.

RESOURCE INFORMATION

Treatment Technologies

(**Appendix E** of this guide includes detailed descriptions and limitations on various treatment technologies for CMD.)

Development of New Technologies for the Utilization of Municipal Sewage Sludge on Surface Mined Lands. Final Report. Haering, K.C. and W.L. Daniels. October 1, 1991. Department of Crop and Soil Environmental Sciences, Virginia Polytechnic Institute and State University. Report investigates new technologies that revolve around using sewage sludge mixtures as a soil type to support plant growth on coal refuse piles for stabilization.

Kentucky Coal Mining Practice Guidelines for Water Quality Management, Kentucky Division of Water and University of Kentucky Agronomy Dept.; Natural Resources and Environmental Protection Cabinet, Commonwealth of Kentucky; March, 1996.

Lime Substitutes for the Treatment of Acid Mine Drainage. Heunisch, G.W. 1987. Mining Engineering. pp. 33-36. Two new lime substitutes for treating AMD were tested and compared. Sludge settling rates are faster with the new lime substitutes than those obtained using real lime.

Managing Environmental Problems at Inactive and Abandoned Metals Mine Sites, U.S. Environmental Protection Agency Office of Research and Development, EPA 625-R-95-007.

Passive Treatment of Coal Mine Drainage, U.S. Department of the Interior, Bureau of Mines Information Circular 9389, 1994.

Practices for Protecting and Enhancing Fish and Wildlife on Coal Surface-Mined Land in Central and Southern Appalachia. U.S. Fish and Wildlife Service. 1983. FWS/OBS-83/08. Information on best current practices (BCPs) to protect and enhance fish and wildlife resources on surface-mined land in central and southern Appalachia.

Renovation of a Failed Constructed Wetland Treating High Metal Load Acid Mine Drainage in the Rock Creek Watershed. Barton, C.D., and A.D. Karathanasis. 1996. In 1996 Kentucky Nonpoint Source Pollution Conference Proceedings, Kentucky Division of Water, September 1996.

Revegetation and Minesoil Development of Coal Refuse Amended with Sewage Sludge and Limestone. Joost, R.E., R.J. Olsen, and J.H. Jones. 1987. Journal of Environmental Quality. 16(1)65-68. Study in So. Illinois found that the use of dried sewage sludge and/or limestone to ameliorate acid coal refuse for establishment and survival of three forage grasses is indeed effective.

Statement of Mutual Intent Strategic Plan for Restoration and Protection of Streams and Watersheds Polluted by Acid Mine Drainage from Abandoned Coal Mines: 1995 Progress Report. U.S. Environmental Protection Agency and the U.S. Department of the Interior. Discusses current mine drainage control activities in VA, PA, WV, MD, and OH, as well as future CMD activities.

This page intentionally left blank.