Reclamation Guidelines

For Surface Mined Land in Southwest Virginia

POWELL RIVER PROJECT

Constructing Wetlands During Reclamation to Improve Wildlife Habitat

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Introduction

Over half of the nation's wetlands have been drained or filled since colonial times. Virginia has experienced a similar amount of wetland loss. Declining wetland acreage is considered to be a national problem because wetlands provide valuable services which benefit society.

The purpose of this publication is to provide guidelines for use by mine operators in constructing wetlands on surface coal mines. During mine reclamation, heavy equipment moves large quantities of earth and stone while producing a landscape that conforms to the dictates of federal law. Wetlands can be constructed during this process at very little (if any) additional cost to the mining operator.

Wetlands constructed on mine sites can provide benefits to mine operators and landowners as well as to the general public. In addition to serving as wildlife habitat, wetlands trap sediments, store rainwater, recharge groundwater, and reduce flood potentials. These benefits are of particular importance in Appalachian coal-mining areas where steep slopes create flooding dangers, usable groundwater resources are limited, and lack of available water limits wildlife abundance on many reclaimed-mine areas.

Benefits Provided by Wetlands on Reclaimed Mine Areas

Wetlands form in shallow landscape depressions where constant or seasonal water flows occur, and in other areas that are seasonally or permanently wet. Wildlife habitat is perhaps the best known, most widely recognized, and most appreciated of the benefits provided by wetlands. Wetlands serve as water sources for a variety of birds and mammals, including game species, and they serve as habitat for those plant and animal species that are typically found only where water is present.

As wetlands develop, they trap sediments, organic materials, and nutrients carried by water from upstream areas. These resources contribute to wetlands' high levels of biological productivity. Water held in wetlands also moistens nearby soils, thus improving the biological productivity of adjacent lands. As a result, organic materials accumulate over time both within and adjacent to the wetland. These materials allow the fully developed wetland to act like a sponge, absorbing runoff waters during heavy rains and then releasing it slowly afterwards to surface streams. Wetlands improve water quality by trapping sediments and chemical water contaminants, thus protecting fish and wildlife resources downstream.

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Mine operators can benefit from the ability of wetlands to trap sediments and promote healthy vegetative growth. Erosion can occur on recently mined acreages, especially if vegetation is slow to establish. The presence of wetlands can help mine operators minimize erosion-control problems and expenses in several ways. First of all, sediments produced by areas above a constructed wetland often become trapped within the wetland. Thus, these sediments are kept out of the sediment pond, which reduces the operator's pond-cleaning expenses.

Wetlands can also reduce erosion within drainage channels and on adjacent areas. Because the presence of a wetland tends to increase moisture within adjacent soils, vegetation survival and growth on such areas will be improved. Lush vegetative growth will help to minimize erosion while acting as a barrier to movement of soils eroded from upland areas into the water course. The presence of wetlands in drainage channels also tends to reduce flow velocities and peaks, thus reducing erosion within the channel itself. Vigorous plant growth within the wetland also tends to slow water flow rates, thus aiding in the capture of sediments that might be carried by waters flowing through the wetland.

Landowners can benefit from wetland construction during mine reclamation in several ways. The presence of wildlife will be an asset to many post-mining land uses. Wetlands provide water sources for wildlife, and thus increase wildlife presence. The presence of a wetland will also increase the site's capability to produce vegetation in the immediate vicinity. Since the area actually covered by a wetland is generally small (effective wetlands can be constructed in areas of one acre or less), the presence of wetlands will provide only minimal interference with other land uses.

The general public benefits from constructed wetlands, especially in areas such as southwestern Virginia. Wetlands created as catchments on surface mines enhance groundwater recharge; many southwestern Virginia residents depend upon groundwater for their household water supplies. The presence of wetlands can also reduce flood potentials by temporarily storing surface runoff during heavy rains.

Wetlands also improve the ability of downstream waters to serve as habitat for fish (including game species) and other animals, especially after the wetlands have fully developed and reclamation is complete. By trapping sediments, wetlands improve water quality downstream. As wetlands release their waters slowly to streams after a rain, dry-weather "base flows" are increased. Some of the organic material produced in the wetland will be carried downstream; these materials act as a food resource for aquatic organisms, improving these streams as habitat for fish and other game species.

A single wetland will improve a mined site's wildlife habitat potential while providing other service benefits, but construction of several wetlands in series will have a greater effect. The hydrologic benefits discussed above (such as flood peak reduction and groundwater recharge) will be most noticeable if several wetlands are constructed within a single watershed.

Wetland Construction Research

The information that follows was developed through research sponsored by the U.S. Office of Surface Mining Reclamation and Enforcement and the Powell River Project, in cooperation with the Virginia Division of Mined Land Reclamation and several Virginia mining operators. Our goal was to develop guidelines for constructing wetlands during reclamation that are sensitive to cost and capable of providing all of the benefits described above.

Figure 1. *An "accidental wetland" formed on a pre-1977 reclaimed mine area in Wise County, Virginia, one of the twelve accidental wetlands studied during this research.*

Accidental Wetlands as Models

Wetlands can differ in depth, water source and quality, soil type, and plant and animal communities. Some wetlands provide more benefits than others. In conducting this research, we asked the question: How should wetlands be constructed so as to offer the greatest level of benefits to the mine operator, land owner, and general public?

Developing construction procedures designed to replicate natural wetlands would seem, at first, to be a sensible way to begin answering this question. However, several factors limit the potential for replicating natural wetlands on reclaimed mine sites. Only 6% of Virginia's wetlands occur west of the Blue Ridge Mountains, and many of these have been altered by timber harvesting and pre-1977 mining. Thus, data on natural, undisturbed wetland conditions in the coalfield region are difficult to obtain.

However, hundreds of small wetlands were formed accidentally on coal surface mine sites before the Surface Mining Control and Reclamation Act (SMCRA) was passed in 1977. Most were constructed on mine benches that were sloped back towards the highwall, a common pre-1970 reclamation practice. Many of these wetlands have been in existence for 25 years or more. Because they were constructed by mining operations, these wetlands may be more easily copied than "natural" wetland systems. We called these systems "accidental wetlands" while studying twelve in detail from 1991 through 1994 (Figure 1). We learned several important facts about wetland design during this portion of our study.

The twelve accidental wetlands chosen for detailed study were located in Wise County, Virginia, and averaged 25 years of age; all were found to be performing key ecosystem services. Two distinct types of plant communities were found to be present in many accidental wetlands.

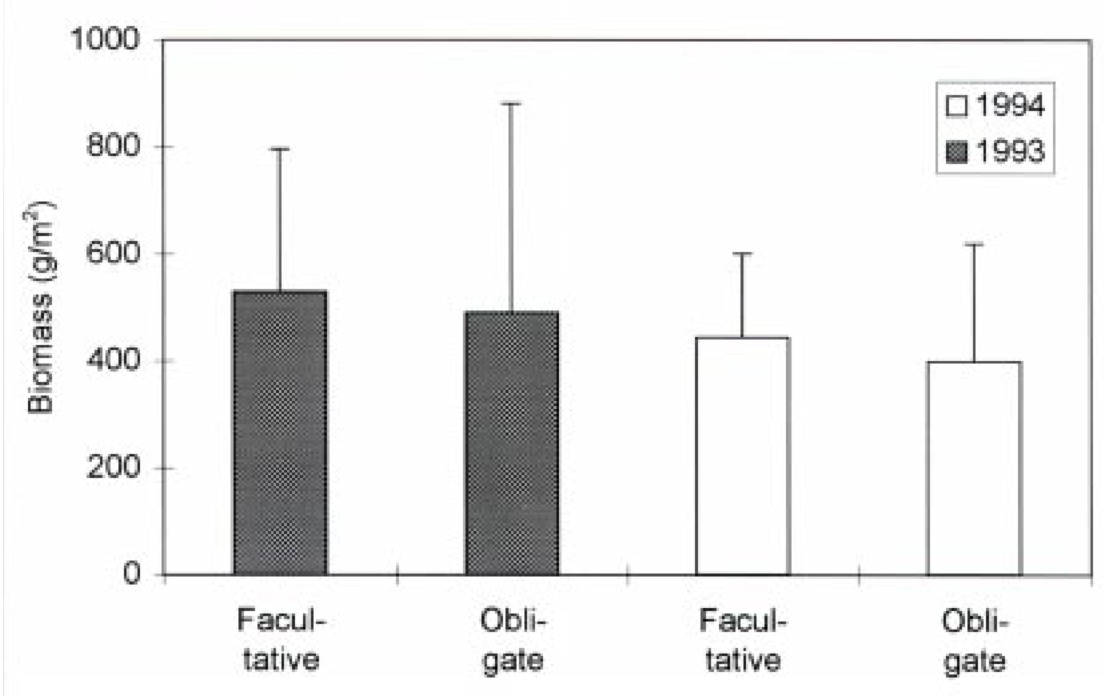

Figure 2. Mean and Maximum Biomass Accumulation in Facultative and Obligate Communities at 12 Accidental Wetlands in Wise County, Virginia

One community type was dominated by species such as cattail, which are considered *obligate wetland* species (species that occur in wetland habitats greater than 99% of the time); this community type tended to occur in areas that were under water most or all of the time. The other type of wetland community was dominated by species such as woolgrass and needle rush, most of which are considered *facultative wetland* plants (species that occur in wetlands between 67 and 99% of the time).

Wetland plant communities are critical to the wetland's ability to provide ecosystem-service benefits. In particular, biological productivity and species richness (a component of diversity) are essential elements of wildlife habitat. Plant species richness was found to be quite high in the accidental wetlands — over 94 plant species (including 2 species of orchids) were identified in the 12 accidental wetlands that we studied.

Biological productivity levels of the accidental wetlands were found to be comparable to productivity levels of wetlands that occur naturally in other areas. We measured aboveground plant biomass as an indicator of biological productivity in 1993 and 1994 at the 12 accidental wetlands, finding both facultative and obligate wetland-vegetation communities to be productive (Figure 2). We also assessed the effect of 14 environmental variables on plant productivity and found that the two most important are sediment depth and water depth. Plant growth tended to be greatest in the wetlands containing deeper sediments and shallower water. Sediment concentrations of phosphorus, and to some extent nitrogen, also influenced the biological productivity of these wetland areas.

Twenty-six animal wildlife species, including several species of, rabbits, raccoons, deer, turkeys, bears, and a number of amphibians and reptile species were found to be using these 12 accidental wetlands (Table 1). In addition, a great variety of birds (including wood ducks, turkeys, redwing blackbirds, and several other songbirds) were observed at the accidental wetlands.

Table 1. Listing of amphibian, reptile, and mammal species observed at various sites in Wise County, Virginia, during the summers of 1994 and 1995.

	Reference Sites[1]	Accidental Wetlands[2]	Constructed Wetlands[3]	Reclaimed Uplands[4]
Amphibians				
Red spotted newt	¸	¸		¸
Spotted salamander		¸		
Seal salamander	¸			
Long-tailed salamander		¸		
Northern red salamander	¸			
Green frog	¸	¸	¸	
Northern leopard frog		¸		
Pickeral frog			¸	
Fowler's toad			¸	
Spring peeper	¸	¸	¸	
Crayfish	¸	¸		
Reptiles				
Northern black racer	¸	¸		
Northern water snake		¸	¸	
Timber rattlesnake		¸		
Eastern box turtle	¸			¸
Snapping turtle		¸		
Mammals				
Southern red-backed vole		¸		
Meadow vole	¸		¸	¸
Woodland vole	¸	¸		¸
Masked shrew	¸	¸	¸	¸
Northern Short-tailed shrew	¸	¸	¸	¸
Least shrew	¸			
Pygmy shrew	¸			
Smoky shrew	¸	¸	¸	¸
Woodland jumping mouse	¸			
White-footed mouse	¸	¸	¸	¸
Deer mouse	¸			
Eastern cottontail		¸	¸	¸
Raccoon	¸	¸	¸	
Opossum	¸	¸	¸	¸
Groundhog		¸		¸
Skunk	¸	¸		
Beaver		¸		
Muskrat		¸		
Red fox		¸	¸	¸
Gray fox		¸	¸	¸
Black bear		¸		
Coyote	¸			
White tailed deer	¸	¸	¸	¸

Notes:

1. Intermittant stream channels in undisturbed forest adjacent to reclaimed mines.
2. Wetland areas occurring on pre-1977 reclaimed mine sites.
3. Wetlands constructed by mine operators during mine reclamation in summer 1992 and spring 1993.
4. Reclaimed mine areas that do not contain any apparent water catchments or conveyances.

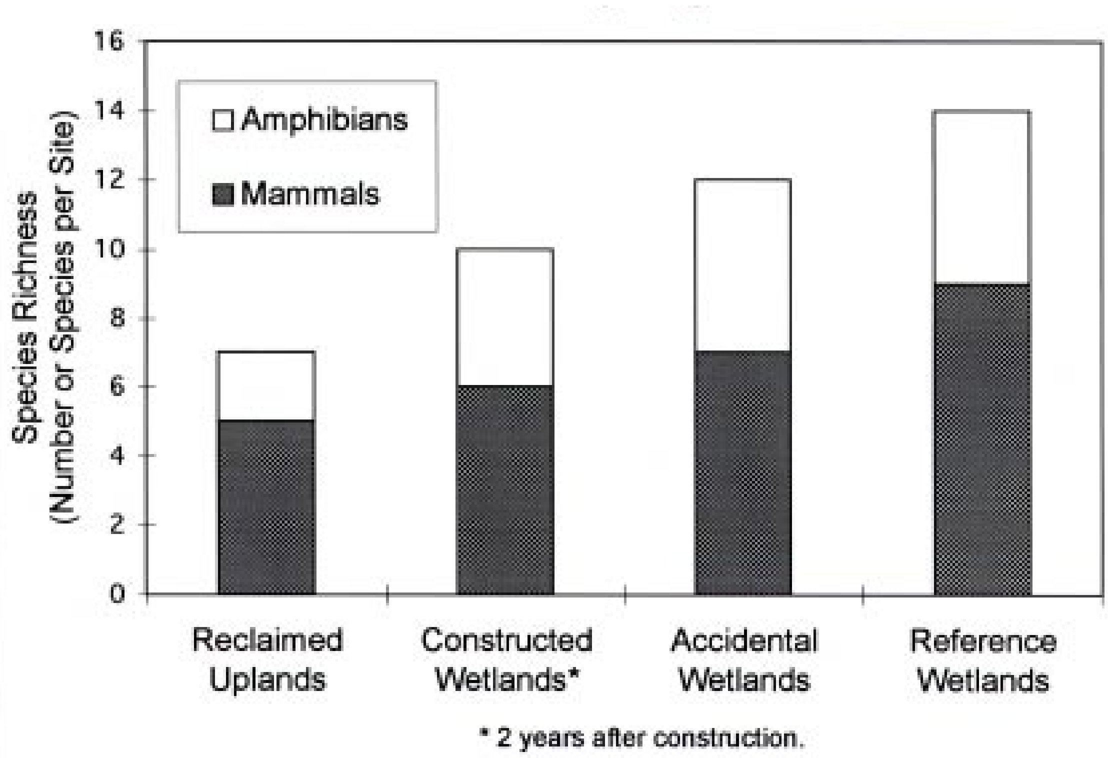

Figure 3. Vertebrate Species Richness as Determined by Trapping Studies at Four Types of Sites in Wise County, Virginia.

Controlled observations designed to assess and compare vertebrate species richness at four types of sites found species richness in the accidental wetlands to be comparable to richness at the natural "reference wetland" sites (Figure 3). The constructed wetlands were only two years old at the time of sampling.

Weather conditions during the summer of 1993 provided further support for the use of accidental wetlands as models for wetland construction during reclamation, as the biological communities within the accidental wetlands easily survived the extreme drought of that year. Based on these findings, accidental wetlands were used as models for constructing six experimental wetlands through cooperation with active mines.

Constructed Wetlands

Six experimental wetlands were constructed during the summer of 1992 and spring of 1993. During 1994 and 1995, we gathered a variety of data to document the actual levels of "ecosystem services" (benefits) produced by these constructed wetland areas.

We found that wildlife began using the constructed wetlands shortly after construction. By the second year after construction, more vertebrate species were found near the constructed wetlands than on reclaimed areas away from wetlands. However, more species of wildlife were using pre-1977 accidental wetlands than the newly-constructed experimental wetlands. The difference in wildlife usage appeared to result from two factors: (i) the biological communities within accidental wetlands were more developed than the constructed wetland communities, and (ii) the vegeta-

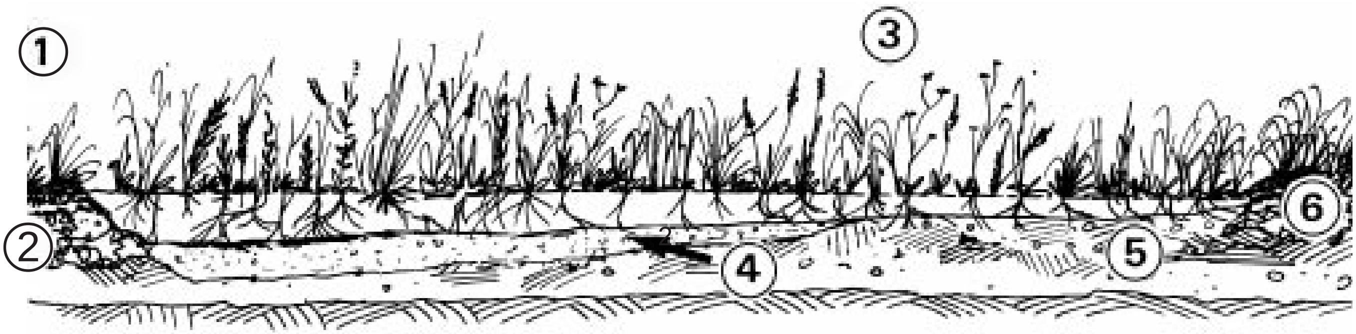

Figure 4. *A cross-sectional representation of a mine-site wetland constructed using the guidelines presented in this chapter.*

1. The wetland is constructed as a landscape depression; no berm is present.
2. The wetland depression is constructed in loose, uncompacted spoil that has been placed above a more compacted spoil layer.
3. Vegetation enhances the wetland's ability to deliver "ecosystem services" by storing stormwaters, capturing sediments, and providing wildlife habitat.
4. Sediments eroded from upland areas have accumulated in the wetland depression, sealing its bottom and serving as a rooting medium for vegetation. Maximum water depth does not exceed 4 feet when the depression is filled to capacity.
5. The bottom of the wetland depression has a moderate slope of 2 percent (1 vertical to 50 horizontal) or less.
6. Soils adjacent to the wetland have a high moisture level; vegetation can be planted to provide wildlife food and cover in these areas.

tion adjacent to the accidental wetlands was more diverse and mature than the vegetation adjacent to the constructed wetlands. We believe that wildlife use of constructed wetlands will increase as their plant communities continue to develop.

The findings of the research described above were used to generate the wetland design and construction guidelines that follow.

Wetland Design and Construction Guidelines

The following guidelines describe practices appropriate for an ideal wetland construction situation. Due to the variability of mine reclamation sites, mine operators may find it necessary to modify these practices to suit site conditions.

Reclaimed-mine wetlands are constructed as surface depressions in areas of either seasonal or permanent water flows. The depression should be formed while equipment is engaged in reclamation so as to avoid the unnecessary costs of an "add-on" procedure. Our recommendations for wetland construction are summarized in Figure 4. Additional detail follows.

Bottom Slopes

An important component of constructed wetland design is the slope of the depression, which influences water levels. Bottom slopes of less than 1v:50h (2 % grade) are desirable for two reasons. First, the gradual change in water level allows for greater numbers of plant species. Second, gradual slopes increase the chance that at least some portion of the wetland will remain filled with water during most of the year. Wetland size and water depth may change with time, but wetland vegetation will become established in at least some portion of the depression if gradual slopes are constructed. If enough area is available, slope gradients of less than 2 percent should be used in bottom construction.

Depth of Depression

The attention to bottom gradients in wetland construction influences other design considerations. Because slopes are to be gradual, the maximum depth of a depression will be limited by the area available for construction. If the water course is wide, sufficient space may be available for a wetland up to 4 feet in depth while still maintaining the desired slope, which would lead to a wetland that covers a fairly large area. Conversely, if the water course is narrow, space constraints will require shallow maximum depths.

Berms

Although, generally speaking, berms are not a desirable feature of wetland construction, at least a partial berm may be a practical necessity on some sites. Several of the experimental wetlands constructed during our study required berms. These were constructed of common mine spoil, approximately 2 feet high, 10 feet wide, and 70 feet long. In conjunction with a 2 foot depression, the 2 foot-high berms were used to produce wetlands of 4 foot depths. Placement of rock lining within discharge channels across the berms was required to prevent erosion.

Where site conditions make use of a barrier or berm a practical necessity for wetland construction, the berm should be constructed to conform with regulatory requirements for permanent impoundments. Even if rock rip-rap is used to construct the discharge channel, berms may erode after several years. The durability of a constructed wetland can be improved by building it in a depression rather than by constructing a berm.

Wetland Width

The cross dimension of the wetland depression should be appropriate for the water course; a 30-to-60-foot width is usually about right for small, intermittent flows.

Loose Spoil over Compacted Spoil

The recommended depth of the constructed wetland is also influenced by the depth of loose mine spoil and/or accumulated sediments above compacted material. We recommend that a zone of compacted spoil be located within a few feet of the wetland bottom. Compaction can be achieved by driving haulage vehicles over the spoil during spoil placement.

In constructing the area to include the wetland and adjacent lands, a zone of loose spoil or soil should then be placed above the compacted spoil layer as needed to prepare an uncompacted land-surface with favorable qualities for plant growth. The uncompacted spoil/soil layer is typically constructed by end-dumping closely placed piles of materials suitable for plant growth over the compacted layer. The placement of a 4-to-6-foot thickness of uncompacted soil or spoil at the reclaimed minesite's surface is consistent with Powell River Project reclamation guidelines (*e.g.*, see VCE Publications 460-121 and 460-136)

Whenever possible, the wetland should be constructed by forming a depression within this uncompacted surface material. Dozer time for excavation can be eliminated by preplanning — the depression can be left during operational grading, rather than excavated afterwards.

Timing of Wetland Construction

Wetlands should be constructed during final grading prior to hydroseeding. Of course, it will usually be cost-effective to construct the wetland depression during final grading, when equipment is present. Construction prior to vegetation establishment will also benefit the mining operator by allowing eroded sediments to accumulate in the wetland depression rather than the sediment pond.

As discussed above, a moderate accumulation of sediments will aid wetland development. As surface runoff deposits sediments in a wetland depression, the accumulated sediments enhance

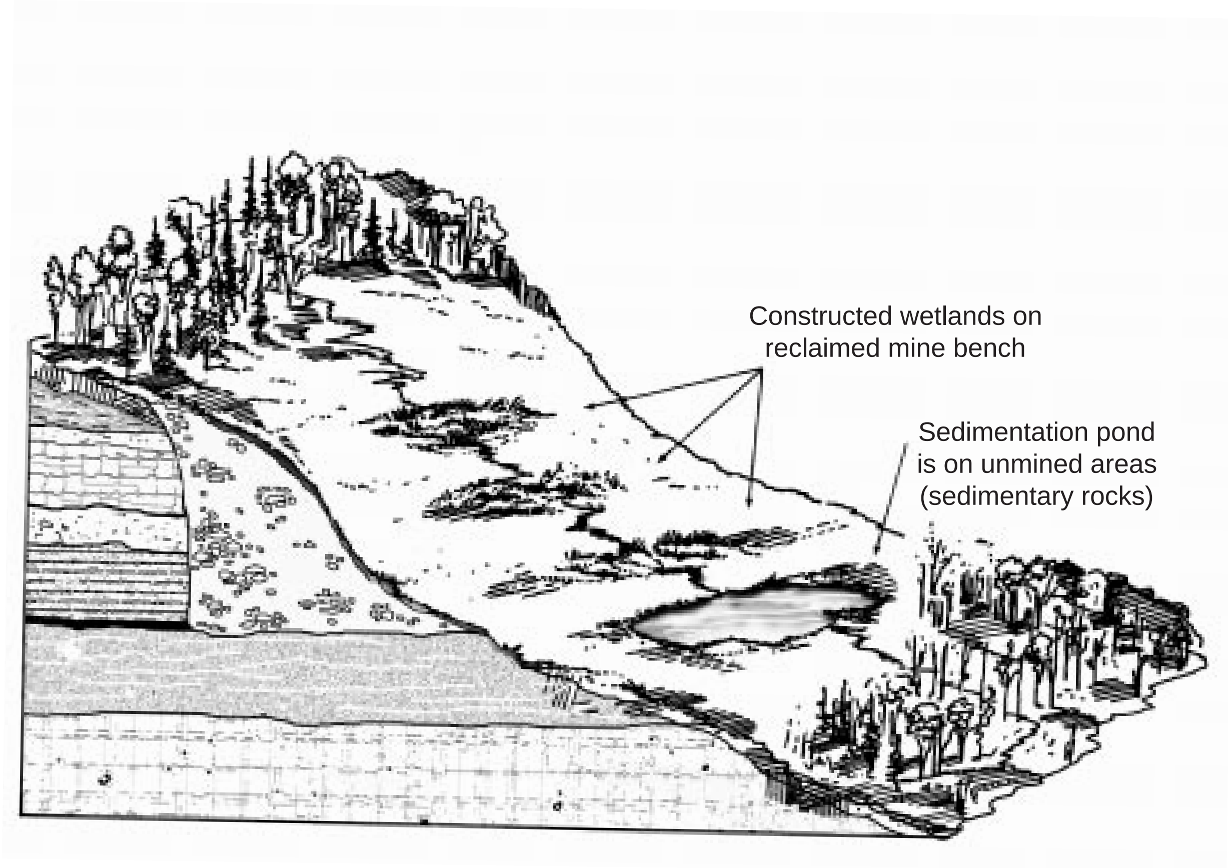

Figure 5. *A representation of a reclaimed mine site where a series of wetlands has been constructed within a drainage channel above a sediment pond. Due to its landscape position, the lowest of the three wetlands would be expected to have the greatest chance of retaining moisture throughout the year.*

the depression's ability to hold water and provide a rooting medium for wetland vegetation.

Landscape Position

Generally, wetland construction will be most effective at improving wildlife habitat if the constructed wetland remains wet during most (or all) of the year. Wetlands constructed in locations where moisture tends to accumulate naturally — such as at the base of a slope and/or adjacent to a permanent stream channel — will be more likely to remain moist throughout the year than wetlands constructed as depressions in otherwise-dry upland areas.

Connecting Adjacent Wetlands

The benefits of wetlands are maximized when several wetland areas are connected in series. A series of wetlands and associated vegetation can form a corridor of favorable wildlife habitat, providing wildlife access to a greater portion of the reclaimed mine site (Figure 5).

When water courses are sufficiently broad, wetlands and the rock drains that connect them can be constructed to meander across the water course. This type of construction will maximize ecosystem services such as sediment entrapment and wildlife habitat.

Wetland Construction to Replace Rock Drain Channels

In some situations, wetland depressions can be used to replace segments of rock drain structures in locations where rock drains are not a regulatory requirement. Rock drains are effective in reducing erosion within drainage channels, but they are expensive to construct. Placement of wetland depressions within rock drain structures can lead to reclamation cost savings, as a wetland depression can often be constructed for less cost than an equivalent linear footage of rock drain. The presence of the wetland will reduce the water's flow rate and its erosive power while trapping sediments. One mining operator constructed three wetlands along a rock drain in association with this study; that operator experienced a definite cost savings. Virginia DMME does not support the concept of using wetlands in high water-flow areas to replace rock-lined channels required for regulatory compliance.

Compatibility with Other Land Uses

The presence of a series of wetlands along one or more natural drainageways on a bench can enhance intended uses of adjacent reclaimed lands. Properly constructed wetlands that provide wildlife habitat will enhance recreational and residential land uses of adjacent property. Properly constructed wetlands on reclaimed mines will hold moisture, allowing vegetation on adjacent land areas to thrive.

Regulatory Concerns

Compliance with state and federal mine-reclamation regulations can easily be achieved and demonstrated by wetland construction. Virginia reclamation regulations allow "small" depressions to be left within reclaimed land surfaces, but no maximum dimensions are specified. Such depressions can be left within larger areas intended for forest, wildlife habitat, hayland - pasture, and similar land uses.

Allowable depth and berm dimensions for areas intended for post-mining land use as wetlands were established during meetings with the Division of Mined Land Reclamation (DMLR). Those dimensions are (1) a maximum total depth of 4.0 feet, and (2) a maximum berm height of 2.0 feet.

A recent directive from the U.S. Office of Surface Mining Reclamation and Enforcement (OSM) clarifies OSM policy regarding construction of wetlands during reclamation to "supplement and enhance postmining land use" (TSR-14, 31 January 1995). This document was developed by OSM based on the research results reported in this paper. (As used by OSM in this document, the term "wetlands" does *not* refer to areas providing biological treatment of acid mine drainage.) The OSM directive establishes minimal criteria for success of wetlands, requiring only that the definition of a wetland be met. The federal definition of a wetland is given in the Federal Register (1980) 33 C.F.R. Sec. 328.3(7)(b):

Those areas that are inundated or saturated by surface or groundwater at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

One year after wetlands were constructed by cooperating mining operators in association with this research, all of our sites met the wetland definition. Those wetlands were constructed using the design specifications presented in this publication.

Landowners often cite one major disadvantage to wetland construction during mine reclamation: the potential for a voluntarily constructed wetland to become "jurisdictional" under the Clean Water Act. Jurisdictional wetlands are subject to the "no-net-loss" requirements of federal law, meaning that the landowner would be required to mitigate (or offset) any future disturbance of the reclaimed-mine wetland by constructing a substitute wetland area. The practical result is that an owner of mined land who allows voluntary wetland construction to occur during reclamation, when not required by federal statute, effectively loses some control over future landuse within the voluntary wetland area.

A recent Army Corps of Engineers policy change [Federal Register, 13 December 1996 - Nationwide Permit 27] relaxes this restriction for wetlands constructed voluntarily "on reclaimed surface coal mined lands, in accordance with a Surface Mining Control and Reclamation Act permit issued by the Office of Surface Mining or the applicable state agency." Under the terms of this nationwide permit, "reversion of the area to its documented prior condition and use" is allowable during the period when the mining permit is in force. This language was developed with the intent of providing an incentive for voluntary wetland construction under SMCRA. The language does not apply to wetlands constructed for mitigation purposes, or to wetlands that are created as mitigation banks. Unfortunately, the term "reversion" has not been defined formally by the Army Corps, but efforts currently underway within the agency are intended to define this term explicitly. The Army Corps is also in discussion with OSM regarding the potential to establish a means of extending the period during which voluntarily constructed wetlands would be eligible for reversion under Nationwide Permit 27.

The opportunity to "bank" wetlands constructed during reclamation creates a potential incentive for construction. If a wetland is constructed voluntarily and entered into a wetland "bank," the rights to use that wetland to offset wetland loss at some other location and some future date may be held by the landowner. If a future land development project imperils a natural wetland area, the banked wetland may be used to offset that wetland destruction. If the land development which imperils the natural wetland is being conducted by a party other than the banked-wetland owner, that owner can sell rights for mitigation use of the banked wetland to the land developer. Federal regulations defining wetland banks are in the Federal Register [28 November 1995, 58605-614]. The fact that no entity has established a wetland bank in western Virginia acts as a barrier to cost-effective wetland banking by the state's mined-land owners and mining firms.

Acknowledgments

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