MINERAL MINE OPERATOR'S MANUAL

APRIL 2024

Virginia Department of Energy - Mineral Mining Program

900 Natural Resources Drive , Suite 400

Charlottesville, Virginia 22903

CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The *Operator Assistance Manual* is intended to aid mine operators, and contractors, in complying with the requirements set forth in the *Virginia Mineral Mine Reclamation Law and Regulations*. The guidelines and design examples provided in this manual are not the only tools available to assist with implementation of law and regulation requirements. Other guidelines and design methods may be better suited to the problem you are working on. This manual provides examples that may be acceptable as methods of compliance, however, successful performance, as stipulated by the law and regulations, is the threshold that must be achieved. Any questions concerning the requirements for successful performance should be directed to a Compliance/Assistance Specialist in the Mineral Mining Program.

1 MINE PERMITS

1.1 New Permit Application Process

1.1.1 Permit Package

A mine permit/license issued by the Mineral Mining Program is required prior to any commercial extraction and/or sale of mineral. The prospective operator should either contact the Mineral Mining Charlottesville office to obtain a permit application package, submit the application online using the Mineral Mining e-Forms Center, or download the permit package from the Printable Forms page on the Mineral Mining website. The completed forms along with maps, engineering plans, and other required information must be reviewed and approved by the Mineral Mining Program, and any required bond must be posted, prior to commencing mining. Mineral Mining field staff are available to assist potential mine operators with completing permit applications. See the brochure Virginia Requirements for New Permits for additional information including permit fees and bond costs.

The following is an outline of the steps necessary to complete a permit application.

Permit/License Application DMM-101

The prospective operator shall complete the Mineral Mining Permit/License Application addressing all questions. The application form contains the general information pertaining to the 1) ownership, 2) operations, and 3) the operating and reclamation plans.

Please note that the issuance of any Virginia Department of Energy permit does not preclude the need to obtain federal, other state, or local authorizations as required by law.

Notice of Application to Mine DMM-103

The law requires that the prospective operator notify all owners of property within 1000 feet of the proposed permit boundary of their intent to obtain a mineral mine permit/license. The Notice of Application to Mine (DMM-103) shall be either sent by certified mail return receipt required or hand delivered to all identified landowners, and proof of delivery provided to the Mineral Mining Program. Hand delivered Notices must be signed by the landowner to be accepted. **The Notices should not be mailed or delivered until the application is ready to be submitted.** A list of all persons sent this notification shall be kept on the included form DMM-103a (page 2 of the DMM-103 form) and the list, return receipts, or other proof of delivery, provided to the Mineral Mining Program with the completed permit/license application. Proof of notification to the local chief administrative official, usually the county administrator or city manager, as well as proof of notification to all utilities with facilities (power lines, pipelines, towers, etc) within 500 feet of the permit boundary, must also be submitted with the application.

An additional Notice of Application to Mine must be sent to the Mineral Mining Program's Charlottesville office at the same time the other notifications are mailed to property owners, administrative officials, or utilities.

Operations, Drainage, and Reclamation Plans

The contents for the required operations, drainage, and reclamation plans are outlined in the Permit Application Checklist (DMM-148). Mining activities should be designed to maximize the recovery of the mineral resource while protecting the environment and minimizing impact to the mine's neighbors. Reclamation activities must achieve the specified post-mining land use. Refer to this application checklist for items to be addressed in the operations plan.

A General Permit for Sand and Gravel less than 10 acres is available for applicable small mine operations. More detail is provided later in this chapter.

Sediment control structures must be in place prior to disturbance of any land. Drainage plans shall detail what drainage controls are to be employed and include engineering designs and calculations, where necessary. Construction, maintenance, and abandonment of drainage structures shall also be addressed within the drainage plan. Additional information on drainage and sediment controls can be found in Chapter 2 of this document.

A reclamation plan outlining the measures to be used to reclaim the mined area once mining ceases shall also accompany the permit application. The land use to which the mined land will be returned, once mining is complete, must be specified as part of the mine permit application. This post-mining land use should be beneficial, and conform to surrounding land uses and county zoning ordinances. Common issues addressed in this section include, but are not limited to:

1. The backfilling and re-grading of disturbed areas
2. The application of soil amendments
3. The revegetation process

Additional information on mined land reclamation practices can be found in Chapter 6 of this document.

Mapping

A permit map must be included as part of the permit application. The map must be of a scale no less than 1" equal to 400' and show the entire permit area. Refer to Section 4VAC 25-31-150 of the Virginia Mineral Mine Reclamation Regulations for the detailed map requirements. All permit maps must be accompanied by a Map Legend, form DMM-109, Permit maps are color coded as indicated on the DMM-109 Map Legend form. Two full scale paper copies of the map must be submitted with the application package. Large paper maps should be submitted folded to an 8"x11" size.

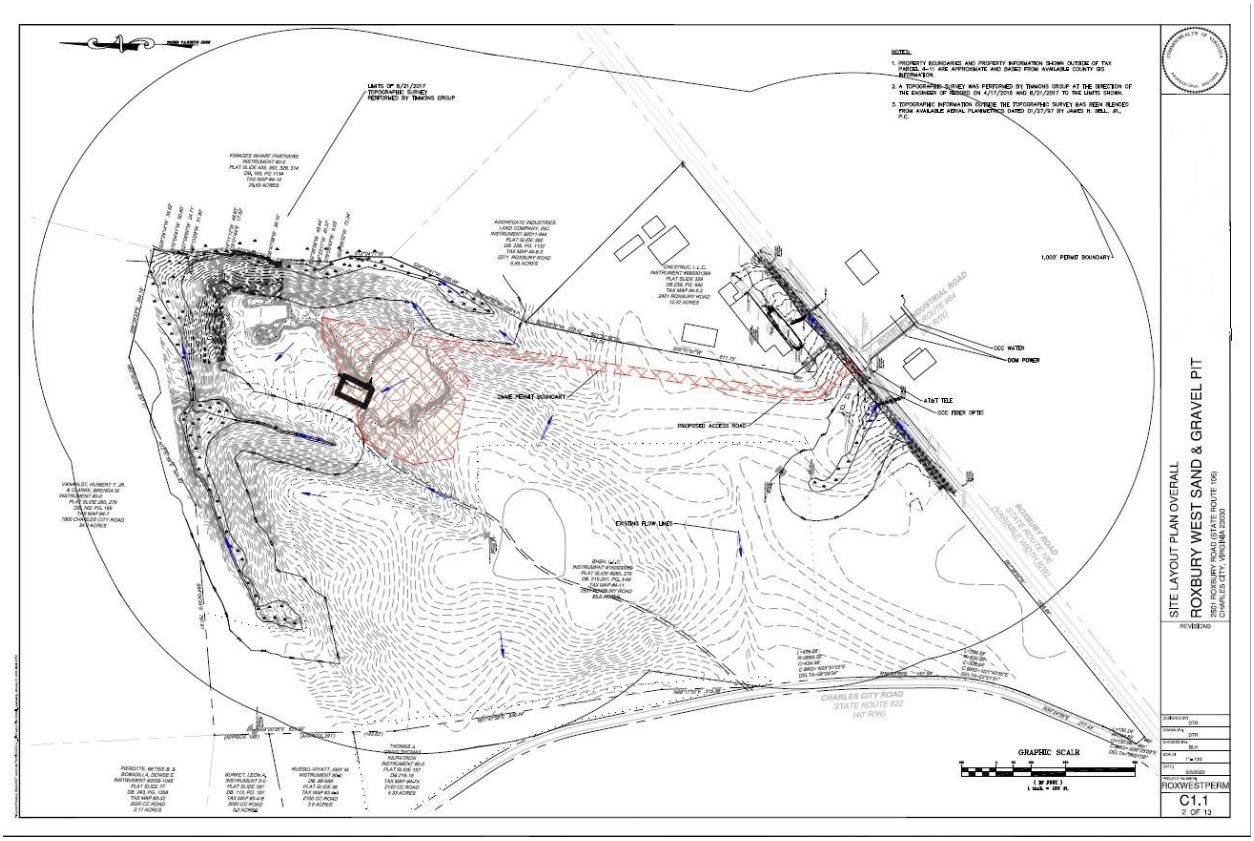

Figure 1-1: Sample New Permit Map

New permit applications are required to have a map that shows the general location, sensitive features, and property owner information. These maps can be separate from the permit map or all of this information contained within the initial permit map as shown in Figure 1-1.

Sensitive features within 500 feet of the permit boundary must be shown on a map. Sensitive features include: state waters, cemeteries, oil and gas wells, underground mine workings, public utilities and utility lines, buildings, roads, schools, churches, and occupied dwellings.

Property ownership should be shown within 1,000 feet of the proposed permit boundary. This property ownership will be compared with the DMM-103a list and Notices of Application to Mine submitted by with the permit application to verify the required notifications were made prior to the issuance of a Mineral Mine Permit.

VIRGINIA Energy

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MAP LEGEND

(✓)Application Map ( )Renewal Map ( )Amendment Map
( )Completion Map ( )Bond Release ( )Relinquishment Map

Permit Number _____ County Nansemond

Company Name/Mine ABC Mining Inc. / Roxbury West Sand & Gravel

Map Scale 1"= 120' USGS Quadrangle Nansemond

COLOR CODE

Outline Red	Acres currently covered by this permit	0
Dashed Outline Red	Acres to be added (identified on map)	+ 4.96
Cross-Hatch Red	Acres to be deleted (identified on map)	- 0
Cross-Hatch Purple	Acres to be relinquished (identified on map)	- 0
	Total Number of Acres Permitted	= 4.96
Yellow	Acres currently disturbed, including access roads	0
Cross Hatch Brown	Additional acres to be disturbed during the next 12 months	+ 4.96
Green	No. of acres revegetated and under bond (outlined in black with date vegetated)	+ 0
Blue	No. of acres of permanent water bodies under bond	+ 0
Cross-Hatch Green	No. of acres proposed for bond release (must be approved by Inspector)	- 0
	Total Number of Acres under Bond	= 4.96
Cross-Hatch Black	Acres previously released from bond (outline in black and show date released)	0
Cross – Hatch Blue	Water bodies not under bond	0
Blue Lines, Arrows	Streams and drainage patterns	

Map prepared by Joe Smith - Director of Engineering
Name *Title*

I, the undersigned, hereby certify that this map is correct and shows to the best of my knowledge and belief, all the information required by the mineral mining laws and regulations of the DMME.

Sign Here — Signature
11/8/2019 — Date

DMM-109
Rev 09/21

Figure 1-2: Sample Map Legend (DMM-109)

Right of Entry

The prospective operator for a proposed mineral mine must submit documents with the application that show proof that the right to enter the property and conduct mining operations has been established. If the prospective operator owns the property, information must be provided that lists the deed book number, page number, parties to the deed or lease, and date of execution. In lieu of this, the prospective operator can provide a copy of the deed. If the prospective operator does not own the property, a lease or other agreement between the prospective operator and the land owner giving the prospective operator the right to enter the property and conduct mining operations must be provided with the application. This is necessary for all parcels within the proposed mining permit area.

VDOT Land Use Permit

A copy of the Virginia Department of Transportation (VDOT) land use permit must be submitted with the application for all proposed mine roads that connect to public roads. The prospective operator should contact the VDOT District Office for the area to obtain this permit.

Initial Site Investigation

Once the prospective operator for the proposed mineral mine has prepared all forms, mine plans, and maps, they must be reviewed for completeness by the mine inspector assigned to the area. Part of the review must include an initial site visit by the Mineral Mining Inspector. This step must be completed before the permit package will be accepted by the Mineral Mining Charlottesville office for final technical review. The mine inspector will reference his review to those items found on the Mineral Mining Application Checklist (Form DMM-148). Any necessary changes, additions, or corrections will be detailed and listed in the report. All items noted by the mine inspector must be addressed prior to submittal of the permit package to the Mineral Mining Program office.

1.2 General Permit for Sand and Gravel Operations Less than Ten Acres in Size

The general permit (DMM-168) governs the mining of sand, or sand and gravel, that affects a total disturbed area of less than 10 acres in size. The general permit is not applicable to dredging operations or those that otherwise intend to mine below the groundwater table.

This permit provides for standards for operations, drainage, and reclamation plans, eliminating the need for detailed design plans and narratives. Variations from these standards cannot be granted under this permit. Prospective operators who cannot mine within these guidelines must obtain a permit under the normal permit application process. Those operators that have obtained a general permit and find that actual mining conditions make mining under these guidelines impractical or impossible, such as: 1) mining will impact the groundwater table, 2) haul back of off-site material is necessary or desirable, or 3) where other deviations from the general permit requirements are involved, must submit a permit amendment requesting the necessary changes to the permit before continuing with mining activities.

In special cases involving public safety or environmental concerns, the Mineral Mining Program Director may deny the application for a general permit and require application for an individual permit.

Issuance of this general permit does not preclude the need to obtain other federal, state, or local authorizations as required by law. The general permit may be re-evaluated and/or revoked at any time under circumstances including, but not limited to:

1. Failure to comply with the terms and conditions of the permit
2. Submittal of a permit application that proves to be false, incomplete, or inaccurate
3. Change of permit conditions

Upon re-evaluation, the general permit may remain in effect pending the approval of an amendment or other items to address special circumstances.

1.3 Permit/License Renewal

All permits/licenses issued by the Mineral Mining Program are valid for one year from the date of issuance and must be renewed annually thereafter on their anniversary date, in accordance with the provisions of Section 4VAC 25-31-210 of the Mineral Mining Reclamation Regulations.

Ninety days prior to the permit anniversary date, the Mineral Mining Program will send the mine operator a Renewal Special Order Notice (DMM-106) notifying them of their upcoming renewal. Permit renewal applications can be submitted electronically by using the Mineral Mining e-Forms system, or in paper form. Paper Renewal Forms can be obtained from the Mineral Mining website or by contacting the Mineral Mining office or assigned Inspector. A Permit Renewal Checklist is available to assist operators in complying with the requirements for permit renewal. An updated permit map will also be required where significant changes to the mine have taken place during the past 12 months. These changes may include additional disturbed acreage, revegetation of portions of the disturbed area, request for additional disturbed acreage that is contained within the existing permitted area, or requests for release of bond on reclaimed land. When no changes have taken place, a Map Statement indicating this may be submitted in lieu of the updated permit map.

Once completed, the renewal application must be reviewed by the operator's area mine inspector prior to the permit anniversary. The mine inspector will schedule a site visit at which time the areas disturbed, re-graded, and vegetated will be checked against those indicated on the updated permit map. The mine operator is invited to accompany the inspector on this site visit. The mine inspector will review all permit renewal documents for completeness and accuracy.

Mineral Mining e-Forms system renewal applications that need correction or additions will be rejected electronically and the operator will have the opportunity to resubmit after the necessary changes are made. Once the operator is notified that the e-Forms renewal application has been approved, the renewal fees can be paid. Fees must be paid prior to permit anniversary date.

All paper renewal applications will be returned to the operator after Inspector review with a Permit Renewal Checklist. This checklist will include any corrections or additions that are needed for the renewal application to be approved. The mine operator must make all necessary corrections and additions to the renewal materials as noted by the inspector on the Permit Renewal Check List and then submit the renewal package including all forms, fees and the checklist to the Mineral Mining office.

Permit renewals must be submitted no later than 10 days prior to the anniversary date. Failure to meet this deadline will result in the issuance of a Notice of Non-Compliance and a Closure Order. Failure to submit within 10 days of issuance of the Notice of Non-compliance can result in forfeiture of the bond and revocation of the mining permit/license.

1.4 Reclamation Bonding and Bond Release

Any company or individual having an unrestricted Virginia mining permit is required to post bond with the State of Virginia through the Mineral Mining Program. These bonds serve as a guarantee that reclamation will be completed on mineral mining sites. These bonds are refundable when reclamation has been performed and approved by the Mineral Mining Program. Generally, reclaimed areas that have gone through two full growing seasons may be considered for Bond Release.

1.4.1 Acceptable Bond Types

There are four types of bonds that are acceptable to the Mineral Mining Program. The prospective operator should evaluate the different types available and select the one that best fits their needs. The four types are:

1. Surety Bond (DMM-107)
2. Irrevocable Letter of Credit (DMM-108)
3. Certificate of Deposit (DMM-169)
4. Cash

Note: Surety Bonds, Irrevocable Letter of Credits, and Certificates of Deposit **must be submitted on their respective Mineral Mining forms**. This often requires coordination with the Surety company or bank utilized. Bond providers and their representatives **must be registered to do business in the Commonwealth of Virginia**. Prospective operators should contact bond providers during the process and discuss these requirements to prevent unwanted delays once the permit application is approved.

After five years of satisfactory operation, mine operators will be enrolled in the Minerals Reclamation Fund in accordance with 45.2-1235 of the Code of Virginia. Minerals Reclamation Fund participation will replace the existing bonds and these bond instruments will be returned to the operator.

1.4.2 Bond Release

Once reclamation of a disturbed area is completed. The mine operator can request that the bond for that area is released. The following procedures are required to obtain a Bond Release:

1. The mine operator shall contact the mine inspector to request a Bond Release Inspection. Such an inspection may be conducted as part of a regular inspection of the mine. The operator and mine inspector meet to agree on those areas suitable for Bond Release.
2. The mine operator must prepare two copies of the permit map and color code the areas agreed upon for Bond Release. The map legend needs to be complete with the number of acres to be released. The disturbed acreage also needs to be modified to reflect the

reclaimed acreage. If the released acreage is to remain as part of the permit (not deleted), then the total permit acreage will be unchanged on the permit map and legend. Bond Release requests are processed through a permit amendment application or through a permit renewal application.

3. Once the Bond Release Inspection has been made and the maps provided to the mine inspector, a Bond Release Inspection Form will be completed by the inspector and the documents submitted to the Mineral Mining office for processing once the permit amendment or permit renewal application has been approved.

4. Once the Mineral Mining Program completes the Bond Release processing, the released bond will be returned to the permittee. A copy of a Release of Bond Form will be also be sent to the permittee.

1.5 Temporary Cessation

Mines may be idled for extended periods of time. Temporary cessation is a permit status granted to surface mining operations under the Reclamation Regulations for Mineral Mining Section 4VAC25-31-430.B where the mine operator intends to remain idle for a continuous period of at least 12 months, while maintaining a current permit/license under the provisions of Title 45.2 Chapter 12. **Temporary cessation should only be sought where proven mineral reserves remain to be mined.**

1.5.1 Request for Temporary Cessation

When the mine operator anticipates inactivity at a mine for a period in excess of 12 months the operator will contact the mine inspector to arrange a site visit to discuss temporary cessation. During the site visit, steps necessary to comply with 4VAC 25-31-430 B.1 through 4 of the Mineral Mining Regulations should be discussed with the mine inspector. Specific items of discussion should include those measures listed below. Specific time frames to implement these measures should also be established at this meeting.

1. Surface regrading must be current with the operation and reclamation plan.
2. Exposed toxic or toxic forming materials must be covered with a minimum of four feet of non-toxic material, capable of supporting vegetative cover.
3. All approved re-graded areas must be revegetated.
4. Areas that will be re-disturbed shall be revegetated with temporary cover.
5. All drainage structures must be in place and properly maintained. Drainage structures must be inspected at least monthly and after every major storm event to insure their proper function and integrity.
6. Ponding of water in the mine pit will not be allowed unless stipulated as part of the post-mining land use of ponds or lakes.
7. All mobile equipment will be removed from the permit and portable stationary equipment will be removed where deemed necessary. Permanent stationary equipment will be in acceptable working order, properly maintained, and fenced or barricaded where necessary to prevent unauthorized access.

8. All supplies of fuel, oil, and lubricants shall be removed from the mine and metal, lumber and other miscellaneous debris will be properly disposed of.
9. All access roads will be closed or barricaded and quarry walls shall be fenced in compliance with Mineral Mine Safety & Health Regulation 4VAC25-40-300. See chapter 6 of this document for additional fencing details. Pit walls shall be sloped in accordance with the approved operational plan to eliminate hazards and vegetated to prevent erosion and slope failures.

Requests for Temporary Cessation can be made through the Mineral Mining e-Forms system through the submittal of a DMM-179 form or during permit renewals. Paper requests can be made by submitting the DMM113 (Request for Amendment).The request must include the following:

1. A statement of the reason for temporary cessation instead of final reclamation and closure
2. The date that the mine last operated
3. The anticipated date that operations will resume, **not to exceed one year**
4. A narrative detailing what measures will be taken to comply with Section 4VAC25-31-430B.1 through 4 and the time frame for completion of these measures; and
5. A certification statement that states:

> ***"I hereby certify that the information provided herein and all attachments submitted herewith are true to the best of my knowledge and belief. I understand that this temporary cessation does not relieve any of my obligations under Title 45.2 of the Code of Virginia or provisions of the approved permit. I will notify the Mineral Mining Program in writing 10 days prior to resumption of mining activities. I realize that this notice will expire on (the date shown in response to item 4 above)."***

Temporary cessation status is subject to review at the end of the requested temporary cessation period. Each temporary cessation period lasts for one year and a request to renew temporary cessation status should be submitted with each permit and license renewal. Temporary cessation for more than 12 months may require additional grading and revegetation to meet the approved post mining land use.

2 DRAINAGE AND SEDIMENT CONTROL

2.1 Introduction

The key to providing adequate drainage and sediment control is the proper management of flowing water. Water flow over barren, unconsolidated soils will place the soil particles into suspension and transport them from one location to another. The greater the disturbed area and water flow, the greater the potential for erosion and the quantity of sediment transported off-site.

Erosion and sediment control measures must be designed and constructed using sound engineering principles applied to site specific environments. Factors such as topography, the size of the watershed, the types of cover across the watershed, soil conditions, weather patterns, and the duration of the exposure must all be considered. To ensure effective controls, their design should be based on worst case scenarios.

A successful sediment control program will consist of two parts:

1. Control runoff to prevent erosion from occurring. When controls are used to minimize the effect of water flowing over bare ground, the amount of erosion and sediment produced will be decreased. Erosion may be minimized by diverting upland runoff around the mine disturbance, increasing the porosity of the surface, decreasing the velocity of flowing water, and stabilizing the disturbed area.
2. Collect sediment that is the product of erosion. Sediment laden runoff from disturbed areas needs to be collected and treated before it leaves the mine site. Temporary sediment controls, such as silt fence or brush barriers, should be installed around the perimeter of the disturbance while long term sediment controls are being put in place. Long term sediment control may be provided by vegetated filter strips, rock filter berms, sediment ditches, traps, or ponds.

Under the Virginia Reclamation Regulations for Mineral Mining, Section 4VAC25-31-450. Sediment basins requires that all drainage from disturbed areas be directed into sediment controls before it is discharged from the permit area. Those sediment control measures must be installed prior to land disturbing activities. Furthermore, Regulation 4VAC25-31-440. Drainage and sediment control requires all mining operations to have adequate drainage, erosion, and sediment control measures installed and maintained in accordance with the approved drainage plan. Guidelines for controlling runoff and providing sediment control are discussed within this section of the manual.

Point Source Discharges may also require a permit from the Virginia DEQ under their Regulation 9VAC25-190 – Conditions applicable to all permits. Additional contact information for the DEQ may be found in the Appendix. Operators are encouraged to contact the DEQ during the planning phases of the project to determine if a permit will be required.

Large impoundments that meet the following criteria must be designed and constructed according to the standards of Chapter 13 of Title 45.2 of the Code of Virginia.

1. Structures that impound water or sediment to a height of 5 feet or more above the lowest natural ground area within the impoundment and have a storage volume of 50 acre-feet or more, or
2. Structures that impound water or sediment to a height of 20 feet or more regardless of storage volume.

In addition to the cited law requirement, these impoundments must meet the requirements of 4VAC25-31-500.A. While structures of this size may be used to provide sediment control, they are usually constructed to retain process tailings. Additional information on impoundments may be found in Chapter 7: Water Impoundments.

2.2 Buffer Zones

Buffer zones are protective strips of vegetation that retard runoff and help collect and trap transported material. They may be used to accomplish the following objectives:

1. Decrease runoff quantities to reduce or prevent erosion.
2. Improve water quality by preventing sediment from leaving the mine site.
3. Serve as a buffer between disturbed and undisturbed areas.

This practice applies where runoff quantities are small, and soil is transported primarily by sheet flow.

2.2.1 Design Criteria

Table 2-1 is a guide for determining the width of a buffer zone.

Table 2-1: Buffer Zone Width

Slope of Land Between Disturbed Area and Area to be Protected (%)	Min. Buffer Zone Width (feet)
0-6	50
7-12	65
13-18	85
19-23	105
24-27	125
28-31	145
32-35	165

2.2.2 Planning Considerations

Effective buffer zone widths may vary from 50 feet in relatively well drained flat areas to as much as several hundred feet in steeper, more impermeable areas. Required width is largely a

judgmental factor that is often determined by local experience. The following is a partial list of parameters that should be considered in arriving at the width of the required buffer zone.

1. Slope of the land within the buffer zone.
2. Susceptibility of soil to erosion.
3. Quantity of runoff that will pass over the buffer zone.
4. Type of vegetation in the buffer zone.
5. Degree of management that the buffer zone will receive.

2.2.3 Buffer Zone Establishment and Maintenance

Vegetation within the buffer zone must be well established, mature, and provide adequate coverage throughout the area. If the buffer zone is going to be mowed, it should not be cut below six inches and should only be cut in late summer or fall. This will ensure a higher, more efficient vegetative cover during periods of highest rainfall.

2.3 Temporary Sediment Controls

Temporary sediment barriers are constructed with porous filter materials placed around the perimeter of disturbed areas. Straw bale barriers, brush barriers, and silt fence are considered temporary sediment controls. These structures will help prevent sediment from leaving disturbed areas and decrease the erosive force of flowing water.

2.3.1 Conditions Where Practice Applies

Sediment controls need to be provided for all land disturbing activities. In most cases, the first land disturbing activity during mine development is the construction of sediment basins and diversion berms or ditches. Large areas may be disturbed and subject to erosion while the approved sediment control device is being constructed. Temporary sediment controls such as straw bale barriers, silt fence, or brush barriers should be installed around the lower perimeter of these construction projects to provide sediment control until they are completed and stabilized.

When disturbed areas are small and construction timeframes are short, temporary sediment controls may be the only sediment control necessary. In those cases, it is very important that construction remain on schedule and steps be taken to establish a vegetative cover as soon as grade work is complete.

2.3.2 Design Criteria

No formal design criteria are required for temporary sediment control measures. However, the location of the structure must be shown on the permit map and construction, maintenance, and abandonment plans should be detailed in the permit operations narrative.

Temporary sediment controls should be used:

1. Where disturbed areas are small and only subject to sheet or rill erosion.
2. Where effective sediment control is only required for three months or less.
3. Where supplemental sediment control is needed to reduce sedimentation in permanent sediment control facilities.
4.

Temporary sediment controls should not be used:

1. In areas of concentrated flow, except where temporary structures are needed to provide sediment control while more permanent sediment controls are constructed.
2. Where rock or other hard surfaces prevent the full and uniform anchoring of the barrier and its filter medium.

2.3.3 Silt Fence

Silt fence consists of a synthetic filter fabric stretched between supporting posts. The bottom portion of the fabric is buried in an excavated trench to form a seal between the fence and the ground surface.

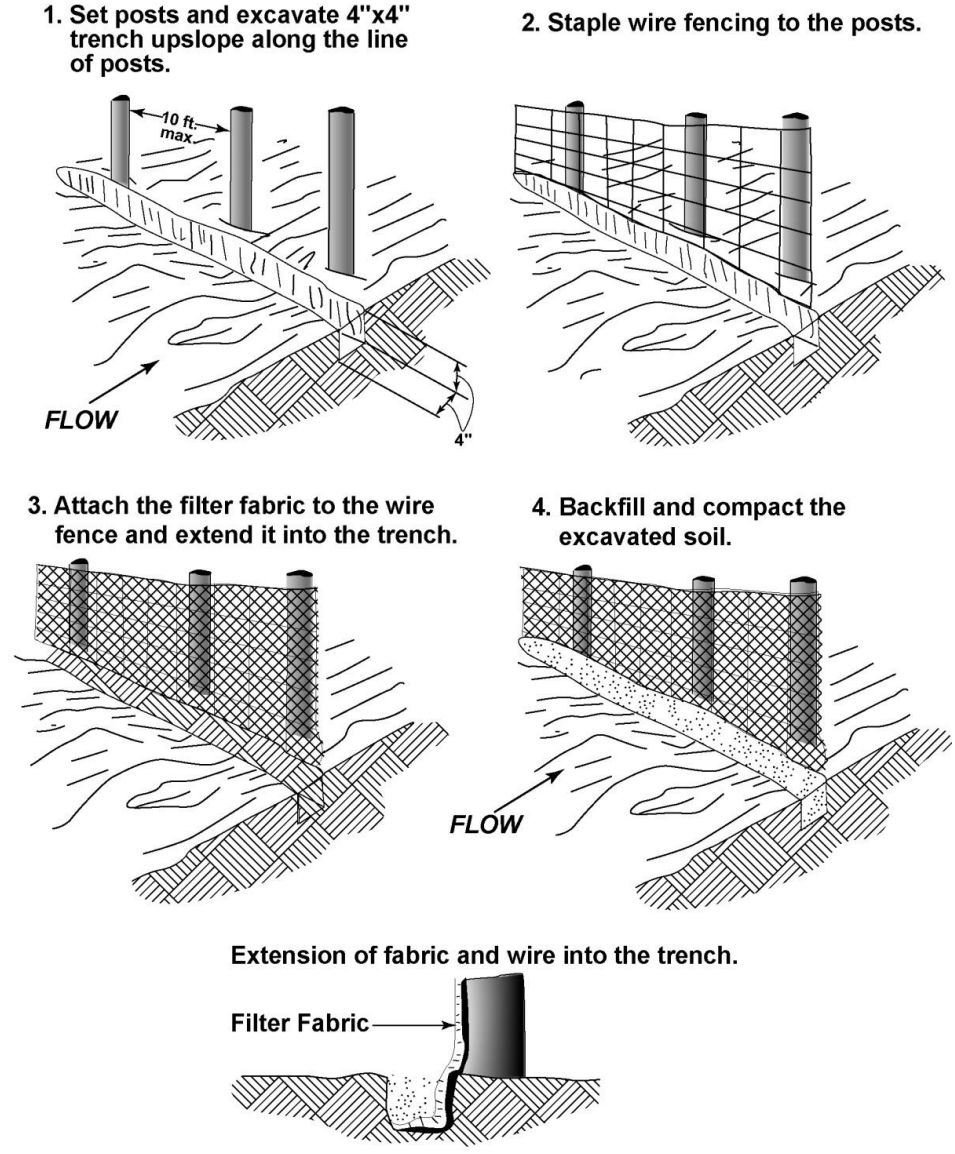
Silt fence may be:

1. Extra strength filter fabric supported between posts with no wire mesh reinforcement. Extra strength filter fabric has reinforcing fibers sown into the fabric.
2. Standard strength filter fabric supported by posts with a wire mesh backing.
3. Prefabricated silt fence. Prefabricated silt fence is purchased with the filter fabric already attached to wooden or metal stakes uniformly spaced along the length of the material. Varying fence heights and lengths are available.

Construction Specifications

1. Silt fence should be installed at least 10 to 15 feet from the base of a disturbed slope. This allows room for sediment accumulation and maintenance access.
2. Synthetic filter fabric should be a permeable sheet of propylene, nylon, polyester, or ethylene containing ultraviolet ray inhibitors to ensure a life of at least 6 months.
3. Filter fabric having a minimum tensile strength of 30-lbs./linear inch should be reinforced with wire fence with maximum mesh spacing of 6 inches. (Figure 2-1)
4. Filter fabric having a minimum tensile strength of 50-lb./linear inch may be fastened directly to posts without wire fence reinforcement. (Figure 2-2)
5. Wooden or metal stakes may be used to support the fabric. These supports must be of suitable size, height, and spacing to support the anticipated loads.
6. The height of the silt fence should be at least 16 inches above the original ground.
7. A trench should be excavated approximately 4 inches wide and 4 inches deep on the upslope side of the proposed location of the fence.
8. Where wire support is used with standard strength filter fabric, posts should be placed a maximum of 10 feet apart. The wire mesh must be fastened to the upslope side of the posts using heavy-duty wire staples, tie wires, or hog rings. The wire should extend into the trench a minimum of 2 inches. The filter fabric should be stapled or wired to the wire fence. Eight inches of the fabric should be extended into the trench.
9. When wire support is not used, extra strength filter fabric should be used. Posts for extra strength fabric should be placed a maximum of 6-feet apart. The filter fabric should be fastened securely to the upslope side of the posts using one-inch-long heavy-duty wire staples or tie wires. Eight inches of the fabric should be extended into the trench.
10. All fabric and wire splices must be made at supporting posts. Fabric should be sown together with tire wire.
11. The 4-inch by 4-inch trench should be backfilled and the soil compacted over the filter fabric.

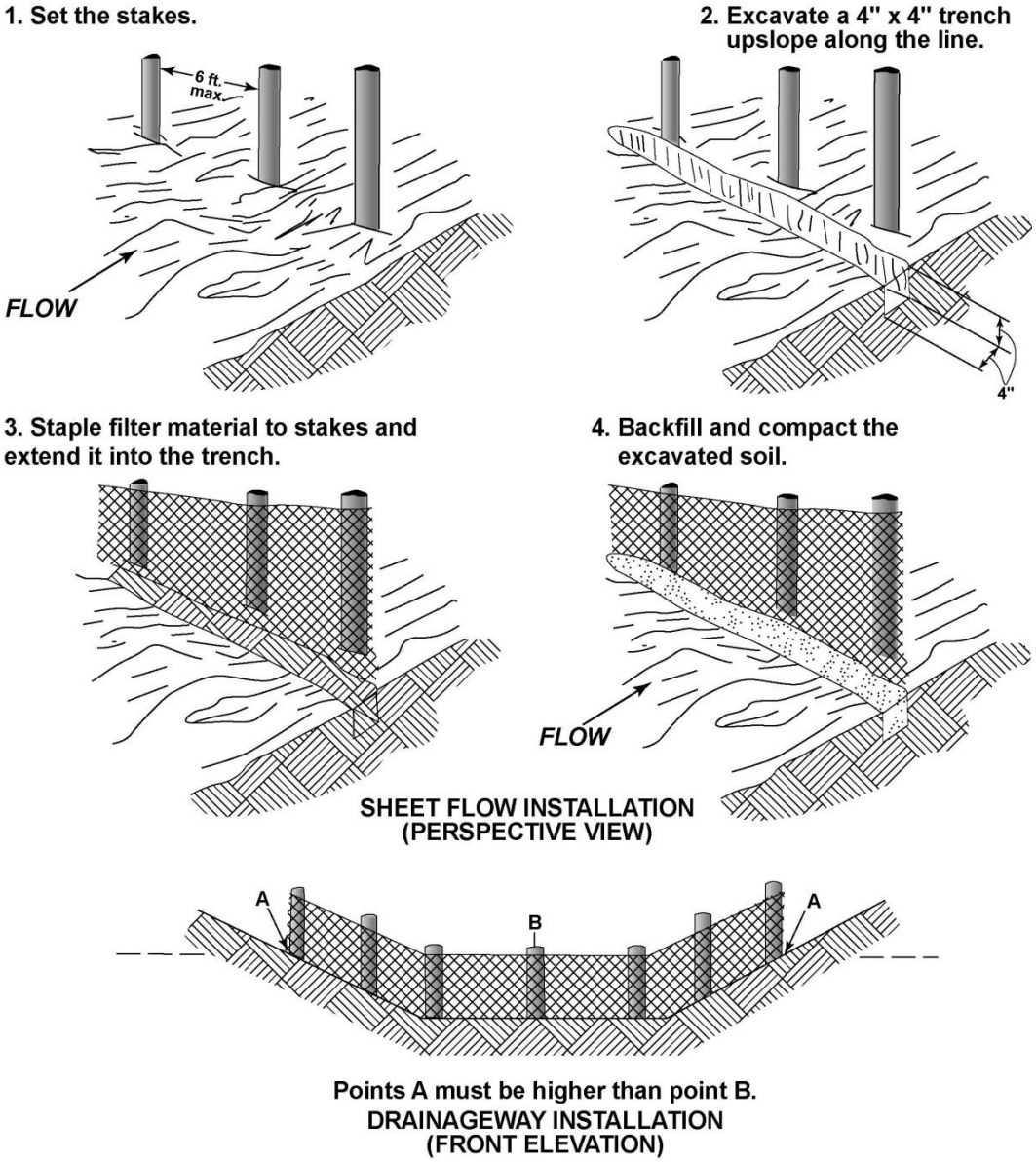
CONSTRUCTION OF A SILT FENCE (WITH WIRE SUPPORT)



Source: Adapted from *Installation of Straw and Fabric Filter Barriers for Sediment Control* Sherwood and Wyant

Figure 2-1: Construction of a silt fence with wire support

CONSTRUCTION OF A SILT FENCE (WITHOUT WIRE SUPPORT)



Source: Adapted from *Installation of Straw and Fabric Filter Barriers for Sediment Control* Sherwood and Wyant

Figure 2-2: Construction of a silt fence without wire support

Maintenance

1. Silt fences should be inspected after heavy rainfalls. Any required repairs should be made immediately.
2. Decomposed or torn fabric should be replaced with new material stretched from one stake to another.
3. Sediment deposits should be removed when deposits reach approximately one-half the height of the barrier.

Abandonment

1. Silt fences should be removed when they have served their usefulness, but not before the up-slope areas have been permanently stabilized.
2. Filter fabric and steel stakes must be properly disposed of on-site or in an approved landfill.
3. Any sediment deposits remaining in place after the silt fence is no longer required should be dressed to conform to the existing grade and seeded.

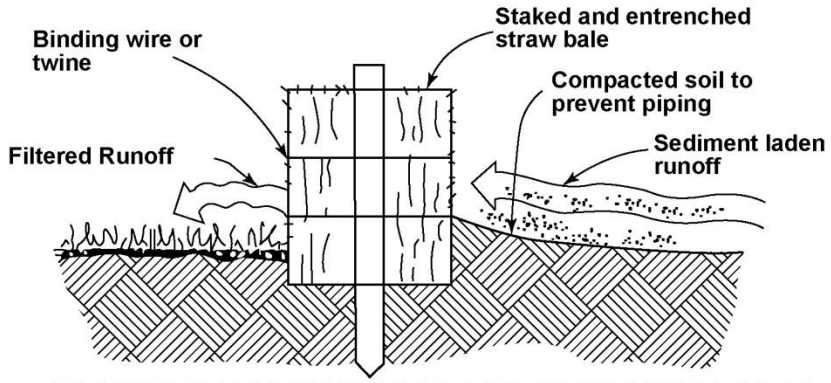
2.3.4 Straw Bale Barrier

Straw bale barriers are constructed of straw bales aligned in a continuous row. The bales are placed in a shallow trench to ensure full ground contact and are anchored in place by wood or metal stakes.

Construction Specifications

1. Straw bale barriers should be installed at least 10 to 15 feet from the base of a disturbed slope. This allows room for sediment accumulation and maintenance access (Figure 2-3).
2. Bales should be placed in a single row, lengthwise, with ends of adjacent bales tightly abutting one another.
3. All bales should be either wire-bound or string-tied. Straw bales should be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to slow deterioration of the bindings.
4. Straw bale barriers should be entrenched and backfilled. The trench should be excavated to a minimum depth of 4 inches.
5. Each bale should be securely anchored by at least two wooden or steel stakes driven through the bale. Stakes should be securely driven into the ground.
6. The gaps between bales should be chinked with straw to prevent water from escaping between the bales. Loose straw scattered over the area immediately uphill from a straw bale barrier will increase barrier efficiency.
7. Excavated soil should be backfilled against the barrier. Backfill soil should be built up to 4 inches against the uphill side of the barrier.

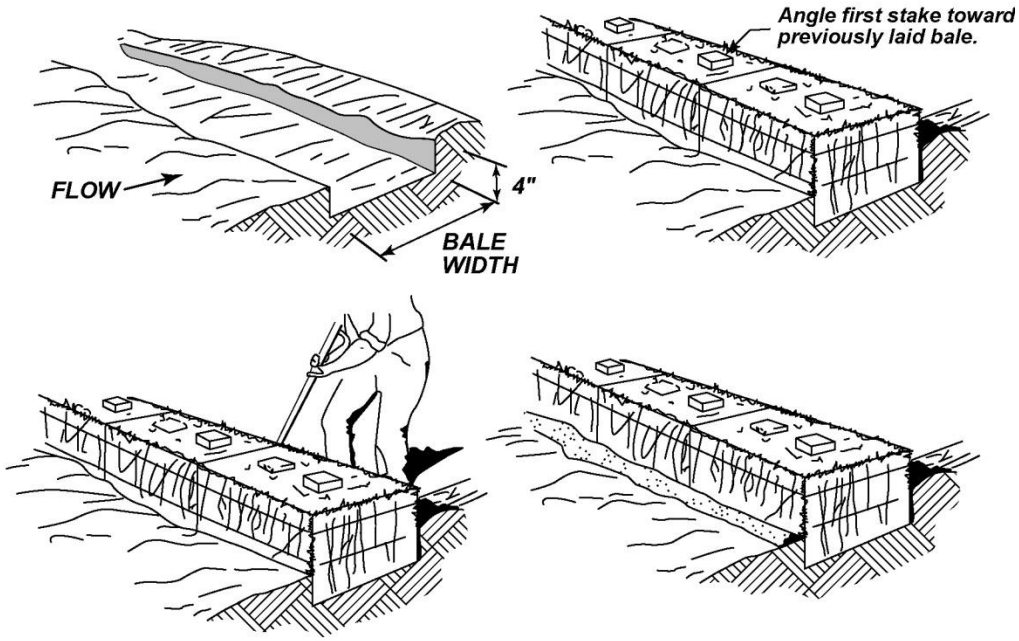
STRAW BALE BARRIER



PROPERLY INSTALLED STRAW BALE (CROSS-SECTION)

1. Excavate the trench.

2. Place and stake straw bales.



3. Wedge loose straw between bales.

4. Backfill and compact the excavated soil.

CONSTRUCTION OF STRAW BALE BARRIER

Source: VA DSWC

Figure 2-3: Straw Bale Barrier

Maintenance

1. Straw bale barriers should be inspected after heavy rainfalls. Any required repairs should be made immediately.
2. Close attention should be paid to the repair of damaged bales, end runs, and undercutting beneath bales.
3. Sediment deposits should be removed when the level of deposition reaches approximately one-half the height of the barrier.

Abandonment

1. Straw bale barriers may be removed when they have served their usefulness, but not before the up-slope areas have been permanently stabilized.
2. Any sediment deposits remaining in place after the straw bale barrier is no longer required should be dressed to conform to the existing grade and seeded.
3. Steel stakes must be properly disposed of on-site or in an approved landfill.
4. Depending on the post mining use of the property and the location, the straw bales may be left to deteriorate naturally.

2.3.5 Brush Barrier

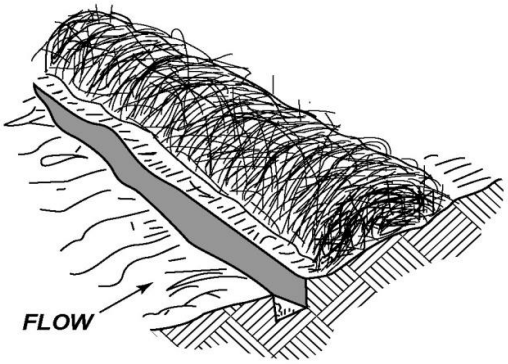
Brush barriers (Figure 2-4) are constructed of brush and woody plant material removed from the site during clearing and grubbing operations. The brush is windrowed along the contour below the disturbed area.

Construction Specifications

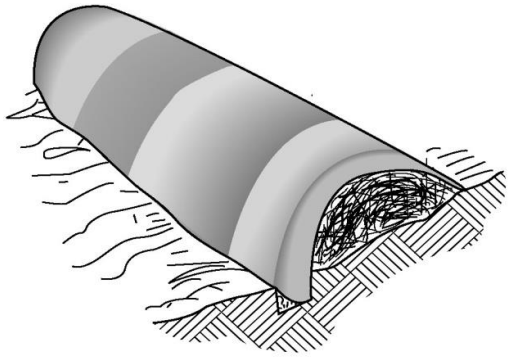
1. The height of brush barriers should be a least 2 feet.
2. The width of brush barriers should be at least 4 to 6 feet.
3. The brush placed in the barrier should be less than 6 inches in diameter. Large stumps and tree trunks should not go in the barrier unless they are needed to anchor it in place on the downslope side.
4. The effectiveness of brush barriers can be increased by lining the upslope side with filter fabric. Filter fabric should be a permeable sheet of propylene, nylon, polyester or ethylene yarn, and should contain ultraviolet ray inhibitors to insure stability of the fabric for the useable life of the structure.
5. If filter fabric is installed with the brush barrier, a 4 by 4-inch trench will have been excavated along the length of the barrier on its upslope side. The filter fabric should be cut into lengths sufficient to lie across the barrier from its up-slope base to just beyond its peak. Where joints are necessary, the fabric should be spliced together with a minimum 6-inch overlap and sown together with tie wire. The filter fabric should be secured in the trench with stakes set approximately 36 inches on center. The trench should be backfilled with soil compacted over the fabric. The filter fabric should be anchored to the crest of the brush barrier by tying twine from the fabric to stakes or tree limbs secured within the down slope side of the barrier.

CONSTRUCTION OF A BRUSH BARRIER COVERED BY FILTER FABRIC

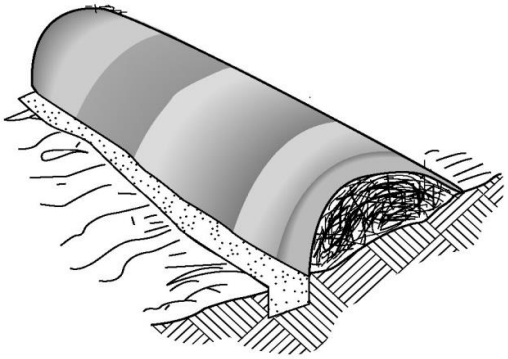
(TREE/RESIDUAL MATERIAL WITH DIAMETER < 6")



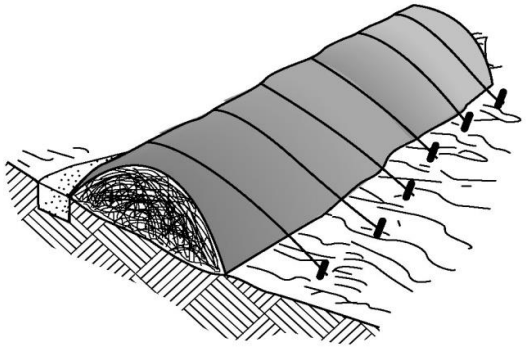
1. **Excavate a 4"x4" trench along the uphill edge of the brush barrier.**



2. **Drape filter fabric over the brush barrier and into the trench. Fabric should be secured in the trench with stakes set approximately 36" O.C.**



3. **Backfill and compact the excavated soil.**



4. **Set stakes along the down hill edge of the brush barrier, and anchor by tying twine from the fabric to the stakes.**

Source: VA DSWC

Figure 2-4: Construction of a Brush Barrier Covered by Filter Fabric (Tree/Residual Material with Diameter < 6")

Maintenance

1. The brush barrier should be inspected after heavy rainfalls. Any required repairs should be made immediately.
2. Sediment deposits must be removed when they reach one-half the height of the barrier.

Abandonment

1. Brush barriers may be removed when they have served their usefulness, but not before the up-slope areas have been permanently stabilized.
2. Any sediment deposits remaining in place after the brush barrier is no longer required should be dressed up to conform to the existing grade and seeded.
3. Filter fabric and steel stakes must be properly disposed of on-site or in an approved landfill.
4. Depending on the post mining use of the property and the location, the brush may be left to deteriorate naturally.

2.3.6 Straw Wattles

Straw wattles are temporary barriers used to detain runoff long enough to reduce flow velocity and filter out sediment. They come in different diameters and are made of different materials. Diameters typically range from 8" -12". Lengths range from 6 to 30 ft. The outside tube can be made of jute, nylon, or photo degradable materials. Wattles are generally stuffed with straw, rice. or wheat.

In most cases, straw wattles are used to break up slope length, like rock check dams. However, they have also been used in small drainages to detain small amounts of suspended sediments. Straw wattles work well on slopes up to about 40 percent.

Construction Specifications

The correct installation of straw wattles is crucial to their effectiveness. Like silt fence and straw bale barriers, straw wattles need to have good ground contact and anchoring. Wattles can be anchored to the ground by trenching and backfilling or staking. Wooden stakes should be driven through the wattle and into the ground, so the stake is at least 6 inches in the ground and about two inches above the wattle. In most cases stakes can be set on 5 ft. centers but should be spaced close enough to ensure effective anchoring on uneven ground. Ends should be overlapped at least two feet.

Maintenance

1. Straw wattles should be inspected after heavy rainfalls. Any required repairs should be made immediately.
2. Close attention should be paid to the repair of damaged wattles, end runs, and undercutting beneath wattles.

3. Sediment deposits should be removed, or another layer of wattles should be installed upstream of the original barrier, when the level of deposition reaches one-half the height of the barrier.

Abandonment

1. Straw wattles may be removed when they have served their usefulness, but not before the up-slope areas have been permanently stabilized.
2. Any sediment deposits remaining in place after the straw wattles is no longer required should be dressed to conform to the existing grade and seeded.
3. Steel stakes must be properly disposed of on-site or in an approved landfill.
4. Depending on the post mining use of the property and the location, the straw wattles may be left to deteriorate naturally.

2.4 Rock Filter Berms

Rock filter berms are most often used as a means of temporary sediment control. However, they are a more permanent alternative to silt fence, straw bales or brush barriers and do a better job of resisting the effects of heavy water flow, wind and heavy sediment loads. They are very effective in trapping sediment and are often installed above larger sediment control structures to decrease the frequency of clean-out maintenance.

In some cases, rock filter berms are used to provide long-term sediment control when drainage areas are less than 5 acres in size. Rock filter berms may also double as safety berms along elevated haulroads, particularly where they cross streams or run beside sediment control structures.

2.4.1 Design Criteria

No formal design criteria are required for rock filter berms. However, the location of the structure must be shown on the permit map and construction, maintenance, and abandonment plans should be detailed in the permit operations narrative.

Rock filter berms should be used:

1. Where disturbed areas are small and only subject to sheet or rill erosion.
2. Where effective sediment control is required for an extended period of time.
3. Where supplemental sediment control is needed to reduce sedimentation in permanent sediment control facilities.

Rock filter berms should <u>not</u> be used:

1. In areas of concentrated flow, except where temporary structures are needed to provide sediment control while more permanent sediment controls are constructed.
2. Where rock or other hard surfaces prevent the full and uniform anchoring of the barrier and its filter medium.

2.4.2 Construction Specifications

1. Rock filter berms should be installed at least 10 to 15 feet from the base of a disturbed slope. This allows room for sediment accumulation and maintenance access.
2. Rock filter berms should be at least 2 feet high and should be constructed of either a mix of VDOT #3's and #57's or Class I riprap faced with one foot of VDOT #57's. Heavier stone is needed where greater flows are anticipated. To increase effectiveness, filter fabric should be placed between the coarse and small aggregate layers.

2.4.3 Maintenance

1. Rock filter berms should be inspected after heavy rainfalls. Any required repairs should be made immediately.
2. Sediment deposits should be removed when deposits reach approximately one-half the height of the barrier. If voids in the filter stone become filled and the structure impedes water flow, the stone should be replaced.

2.4.4 Abandonment

1. Rock filter berms should be removed when they have served their usefulness, but not before the up-slope areas have been permanently stabilized.
2. Any sediment deposits remaining in place after the filter berm is no longer required should be dressed up to conform to the existing grade and seeded.
3. If left in place, rock filter berms should be less than 2 ft. high and should not concentrate flow if failure were to occur. Sediment control structures that are left in place may accumulate organic debris that will cause water to back up behind them. If pooled water overtops the structure, it may lead to a blowout that could cause downstream erosion.

2.5 Sediment Basins

Sediment basins are used to clarify runoff prior to its discharge from the mine site. Sediment basins should be used wherever large areas are disturbed or long-term impacts are present.

They should also be used in critical areas where steep slopes, easily erodible material, concentrated drainage, or other difficult situations exist that may increase the quantity of runoff and transported sediment. Properly designed and maintained basins are very effective in handling heavy water flow and trapping heavy sediment loads. Sediment basins should remain in place until the sediment producing area is permanently stabilized.

Sediment basins include ponds or traps that are constructed for the purpose of providing sediment retention and water clarification.

1. Sediment Traps may be used when watersheds are less than three acres. The embankment height of sediment traps must be limited to 5 feet. Rock lined open channel spillways must be provided. The minimum width of spillways must be 6 feet for each acre in the watershed above the trap and the spillway must be set at least 1 foot below the crest of the embankment. If the trap meets these standards, it may be field approved by the Division.
2. Sediment Ponds are required below watersheds equal to or greater than three acres. Since these structures may impound large quantities of water, they must be designed by a qualified person using current, prudent engineering practices. Upstream embankment

heights must be kept below 20 feet, and storage volumes must be kept below 50 acre-feet to prevent the structure from falling under the Chapter 13 standards.

3. Excavated basins are constructed in undisturbed ground without an embankment that retains water. Therefore, they must be excavated below grade. If an embankment is present, it should only be used to direct water to a stabilized outlet designed to reduce the energy of water discharging from the basin.
4. Embankment basins are created by the construction of an embankment or dam across a drainageway or low area. Sediment basins cannot be located in perennial streams.
5. Temporary basins will be removed before, or during, final reclamation of the mine site. Temporary basins may use decant pipes and/or open channel spillways to decant the runoff from a 50-year storm event.
6. Permanent basins will remain in place after mine operations have ceased. Sediment ponds may use decant pipes but must have an open channel emergency spillway capable of safely decanting a 100-year storm event.

The following considerations should be taken into account when choosing a location for a sediment basin:

1. The ground should be stable and suitable for construction of the structure.
2. The basin should be located where it will impound the greatest volume of water within the available construction area.
3. Access should be available to the basin for inspection, maintenance and clean-out.

Design and construction should comply with State regulations, and local ordinances when more stringent. Basins that do not impound 50 acre-feet or more in volume or impound water or sediment to a height of 20 feet or more, must be designed and constructed to the standards set by Regulation 4VAC25-31-500.B. Water impoundments. That regulation requires that impoundments meet the following criteria:

1. Be designed and constructed using current, prudent engineering practice to safely perform the intended function.
2. Be constructed with slopes no steeper than two-horizontal-to-one-vertical in predominantly clay soils or three-horizontal-to-one-vertical in predominantly sandy soils.
3. Safely pass the runoff from a 50-year storm event for temporary (life of mine) structures and a 100-year storm event for permanent (to remain after mining is completed) structures.
4. Be closed and abandoned to ensure continued stability and compatibility with the post-mining use.
5. Be inspected and maintained to ensure proper functioning.
6. Provide adequate protection for adjacent property owners and ensure public safety.

Basins that impound water or sediment solely by excavation must be designed and constructed to the standards set by Regulation 4VAC25-31-500.C. Water impoundments.

Plans for sediment basins must address the structure's purpose; construction, maintenance and reclamation plans; design calculations; and design drawings. (See Appendix B for the Permit Amendment Requirements for Sediment Basins.)

2.5.1 Storage volume

In order to function properly, sediment basins need to capture and slow flowing water. Reducing the velocity of flowing water allows the sediment carried by the water to drop out. Generally, the greater the volume within the structure, the slower water will flow through it and the more sediment will drop out. The length of time that water stays within the basin is called retention time. To ensure adequate retention time within the sediment basin:

1. It should have a volume, below the discharge point, of at least 0.125 acre-feet for each acre of disturbed area draining into the basin.
2. The basin outlet should be located as far away from the inlet as possible.
3. The basin should have a cross-sectional area large enough to ensure slow water movement through the basin. Long, narrow basins are not effective where large flows are anticipated.

Note: An acre-foot is equivalent to a one-acre area, one-foot deep.
1 ac-ft. = 43,560 ft^3
0.125 acre-feet/acre = 5,445 cubic feet/acre = 201.67 cubic yards/acre

2.5.2 Clean out

It is important to maintain the design volume of the sediment basin during its use. Virginia Department of Energy regulations require that basins be cleaned out when sediment accumulations reach 60 percent of the design capacity. Construction drawings must indicate the 60 percent cleanout elevation. Staking the clean-out elevation will aid in making this determination.

2.5.3 Structure in Series or Parallel

When site topography or other physical restraints restrict the available area needed to construct sediment basins, smaller structures may be built in series or parallel (refer to Figure 2-5).

Basins are often constructed in series when construction of one large basin becomes impractical. An example of this would be constructing several small basins in series at the base of a narrow valley that drops in elevation. When basins are constructed in series, the sum of their volumes should equal the total volume necessary for the disturbed area they are treating. The discharge capacity of each spillway in the series should be capable of handling runoff from the total drainage area above the structures.

Basins are often constructed in parallel when it becomes desirable to decrease the size of the watersheds above the basins. An example of this would be constructing several basins along the lower perimeter of a watershed and using diversions to divide the watershed between the basins. When basins are constructed in parallel, each basin and spillway is individually designed based on the size of the disturbed area and watershed above the basin.

2.5.4 Outlet Facilities

Most sediment basins are constructed with outlets, or decants, consisting of both pipe and open channel spillways. (Figure 2-6) When used together, these are sometimes referred to as principal and emergency spillways. They may also be referred to as pipe decants and open channel spillways. Together, or by themselves, these decants should be capable of safely passing the

peak runoff from the entire watershed above the basin for the design storm. Decants should be capable of preventing the embankment from being overtopped and eroded. The combined capacities of the principal and emergency spillways may be utilized to accomplish this requirement. Temporary basins should have decants capable of safely passing the peak runoff from a 50-year storm event. Permanent basins should be constructed with an open channel spillway capable of safely passing the peak runoff from a 100-year storm event. Runoff computations should be based upon the worst-case ground cover conditions anticipated within the watershed above the basin.

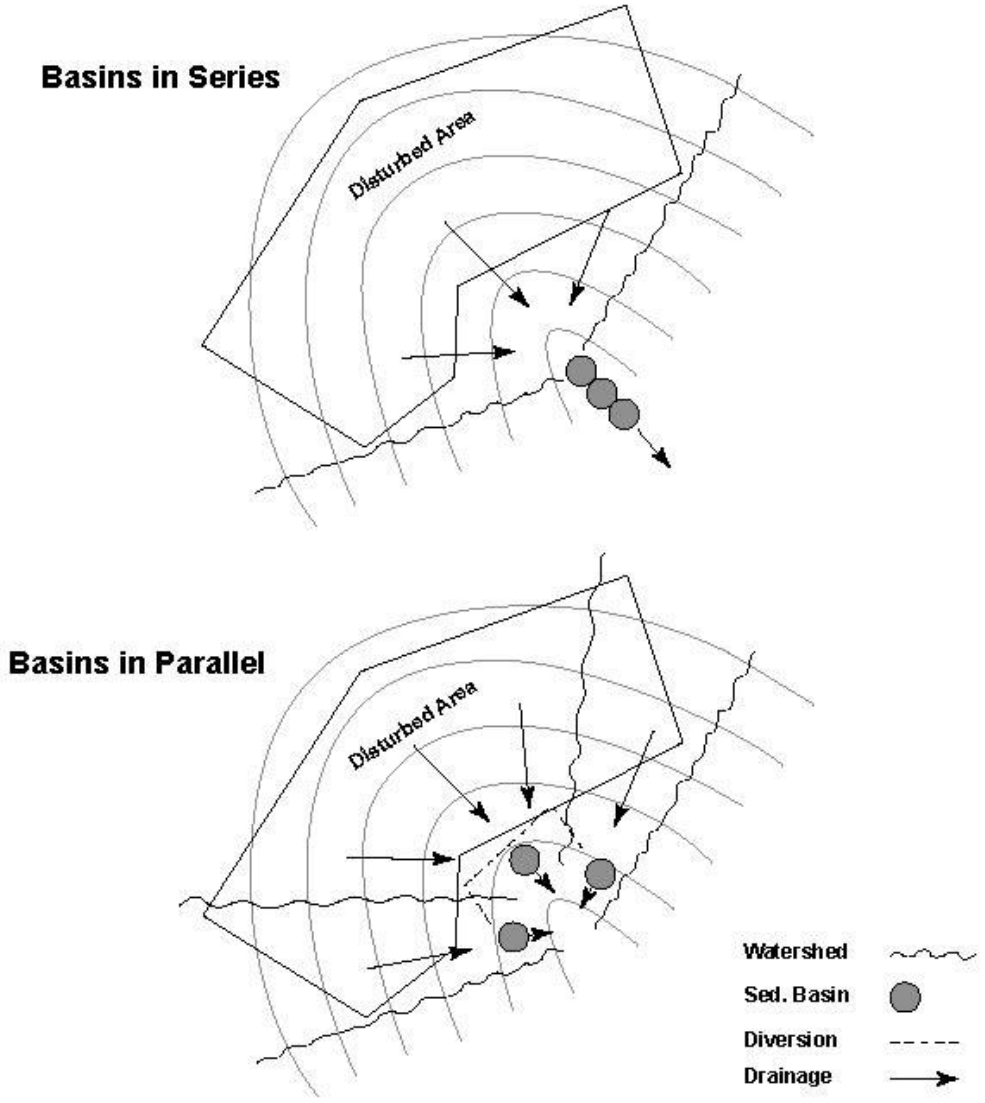


Figure 2-5: Sediment Basins in Series and Parallel

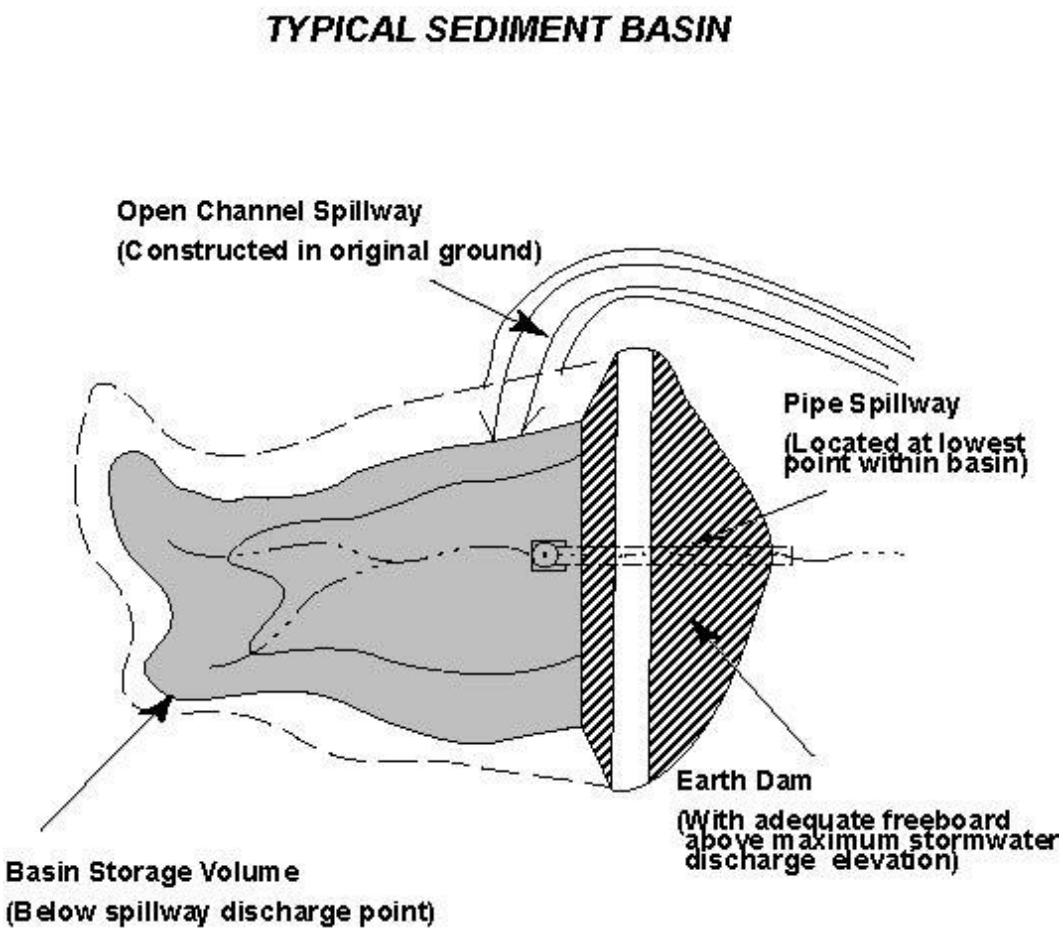


Figure 2-6: Typical Sediment Basin

Decants must be set above the design volume of the basin and far enough below the embankment to prevent it from being overtopped. In other words, the basin needs to provide the required storage volume below the base of the lowest decant structure. And, decants should be adequate to ensure at least one foot of freeboard between the maximum storm surge elevation of impounded water and the lowest point in the basin embankment.

2.5.5 Pipe Decants

A pipe decant normally consists of a vertical pipe or weir joined with watertight connections to a barrel pipe, which extends through the embankment and discharges beyond the downstream toe of the dam. It is a good practice to design pipe decants with a cross sectional area that will ensure the design storm runoff quantity can flow into the top of the riser at a maximum depth of six inches. This will help to ensure that the hydraulic efficiency of the structure is maintained.

2.5.6 Open Channel Spillways

Open channel spillways should be trapezoidal channels constructed adjacent to the embankment in original ground. The spillway should be lined with riprap placed on filter cloth or a bed of granular materials. It may also be paved with concrete or asphalt. Discharge velocities should be within the allowable safe range for the type of erosion protection used. (Figures B-1 and B-2, Tables B-3 and B-4 in Appendix B) It is a good practice to design open channel spillways with enough width to ensure the design storm runoff quantity can flow through the channel at a maximum depth of six inches. This will help to ensure that the erosion velocity of the channel liner is not exceeded.

Freeboard

Freeboard is the difference between the design head over the spillway and the top of the settled embankment. Design head is the depth of water flowing through the spillway during the design storm.

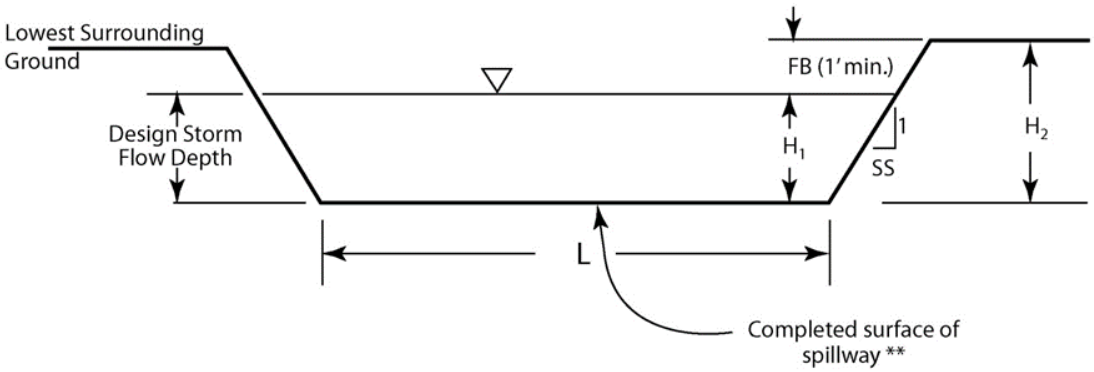
A minimum of 1 foot of freeboard should be maintained between the design head flowing thru an open channel spillway and the lowest point in the embankment. (Figure 2-7)

When used in combination with open channel spillways, the top of a pipe decant should be no more than 6 inches below the base of the completed open channel spillway. (Figure 2-8)

If no open channel spillway is used, the top of the pipe decant should be set at least 2-feet below the top of the embankment and at least 1 foot of freeboard should be maintained between the design head entering the pipe and the lowest point in the embankment. (Figure 2-8)

Outlet Design Details
(Open Channel Spillway)

FB = Freeboard
H_1 = Design storm flow depth through spillway
H_2 = Completed depth of spillway



$H_2 = H_1 + FB$

** Erosion Protection: Proper erosion protection must be applied to the base and sides of the spillway. In most cases, riprap is used but grass, grass reinforced with geotextiles or concrete pavement may also be used. In most cases, grass lined channels should not be used where flow velocities will exceed 5 ft./second. The use of geotextiles, or soil stabilization blankets, may allow grass lined channels to withstand flow velocities up to 10 ft./second. Properly sized and placed riprap will handle much higher velocities. All forms of protection should be inspected on a regular basis and repaired as necessary.

Figure 2-7: Outlet Design Details (Open Channel Spillway)

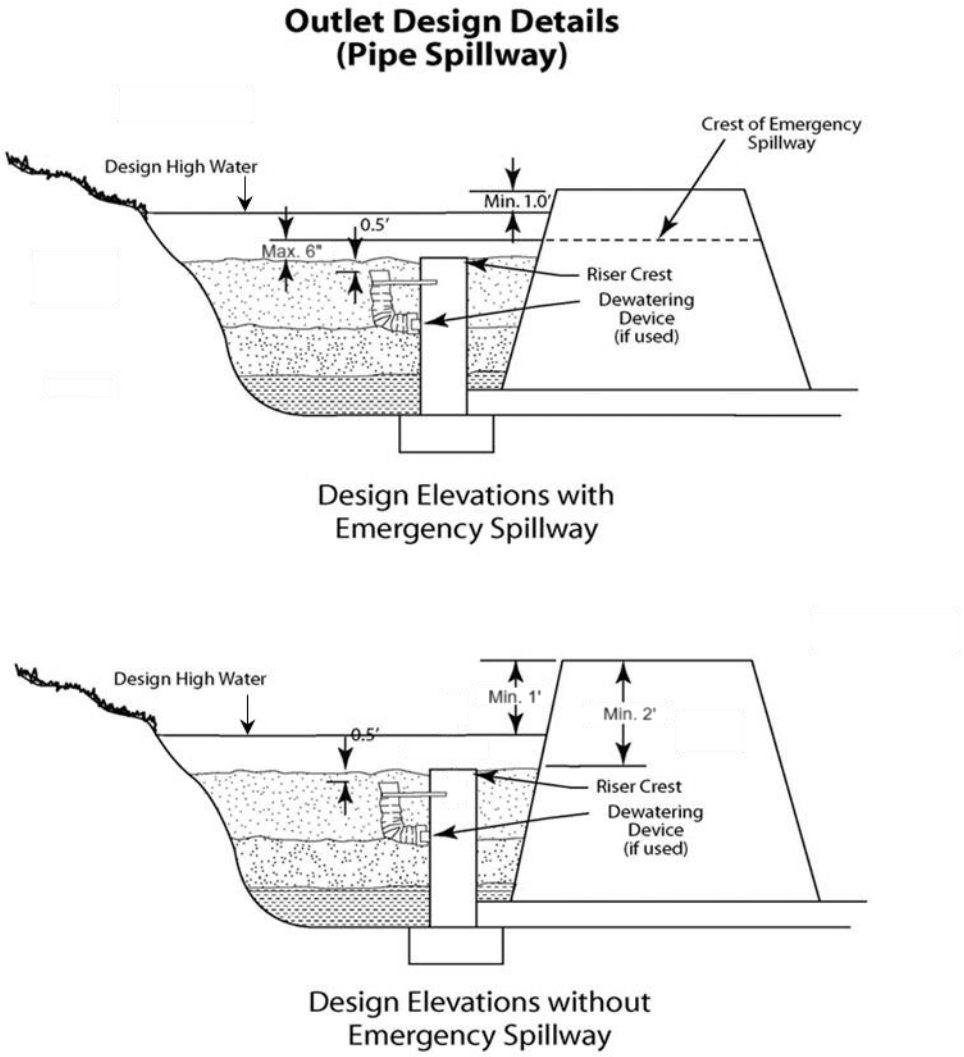


Figure 2-8: Outlet Design Details (Pipe Spillway)

Perforated Riser

Sometimes decant pipes are perforated to provide for a gradual draw down after storm events. Partial draw down, in preparation for the next storm event, can actually improve the basin's ability to remove sediment. However, only "cleaner" water in the top half of the basin should be drawn off. Therefore, perforations should never extend below the upper half of the riser pipe. Risers should not be perforated with holes greater than ½-inch in diameter. Perforations should be wrapped in filter fabric resistant to UV light. Filter stone placed around the riser can also be used, with the filter fabric, to provide additional filtering capacity.

Anti-vortex Device and Trash Rack

An anti-vortex device and trash rack should be securely installed on top of all decant pipes. Anti-vortex devices may be of the concentric type or plate type.

The concentric type of trash rack and anti-vortex device consists of a cylindrical cap, larger in diameter than the riser pipe, which is placed over the top of the riser. The cylindrical trash rack also functions as a skimmer in the event that oil is spilled into the basin. The skimmer will prevent oil floating on top of the water from entering the top of the riser pipe. See Figure 2-10 and Table B-5 in Appendix B for construction specifications.

The plate type trash rack and anti-vortex device consists of a rigid vertical plate firmly attached to the riser pipe and oriented perpendicular to the centerline of the dam. The plate is supported by a bar type trash rack. Dimensions of the plate should be: length = diameter of riser + 12 inches; height = diameter of the riser pipe. The plate type anti-vortex device must be installed with a trash rack as illustrated in Figure 2-9.

Riser Base

The bottom of the riser should be located at the low point in the basin to allow complete drainage if necessary. The riser should be anchored with sufficient weight to prevent its flotation. (Figure 2-11) Two types of bases are: (1) a reinforced concrete base at least 18 inches thick; or (2) a ¼-inch steel plate attached to the base of the riser with a continuous, watertight weld. The steel plate should have 24 inches of stone, gravel, or tamped earth placed on it to prevent flotation. Each side of the square plate should be twice the riser diameter. If a concrete riser is used, then the weight of the concrete in the riser should be greater than the weight of the water displaced by the riser. If this cannot be achieved, then one of the two anchoring methods described above should be used.

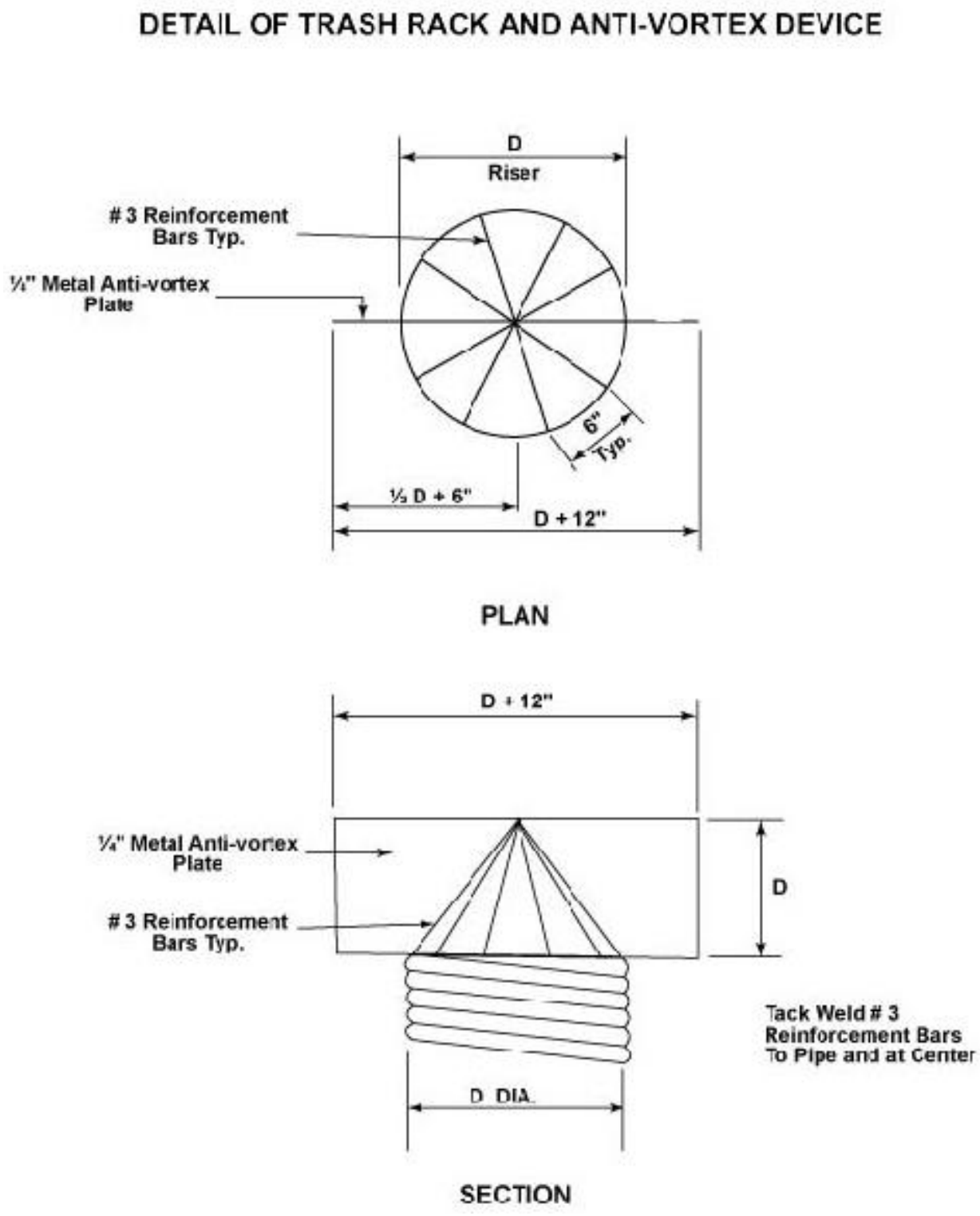


Figure 2-9: Detail of Trash Rack and Anti-Vortex Device

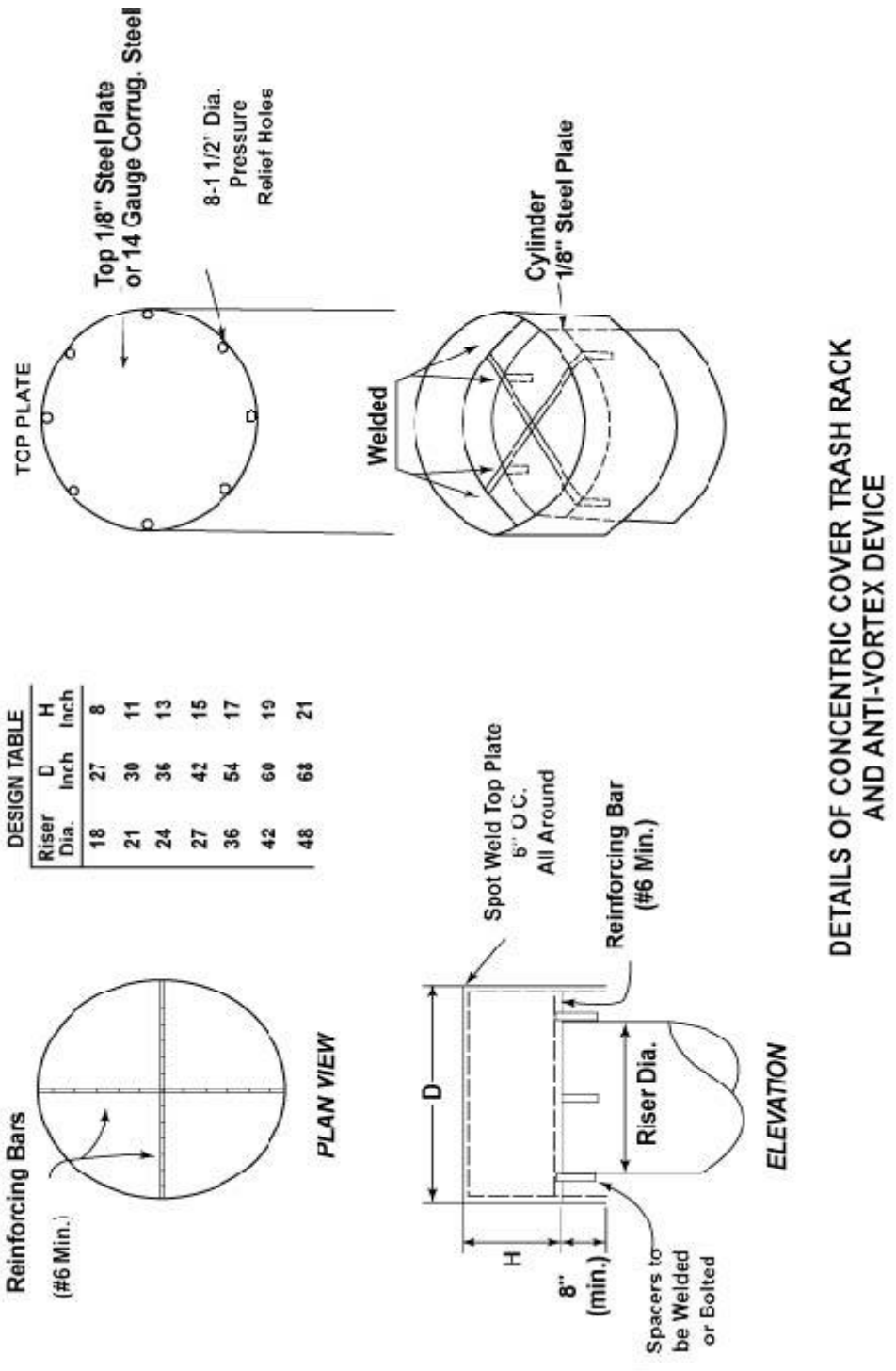


Figure 2-10: Details of Concentric Cover Trash Rack and Anti-Vortex Device

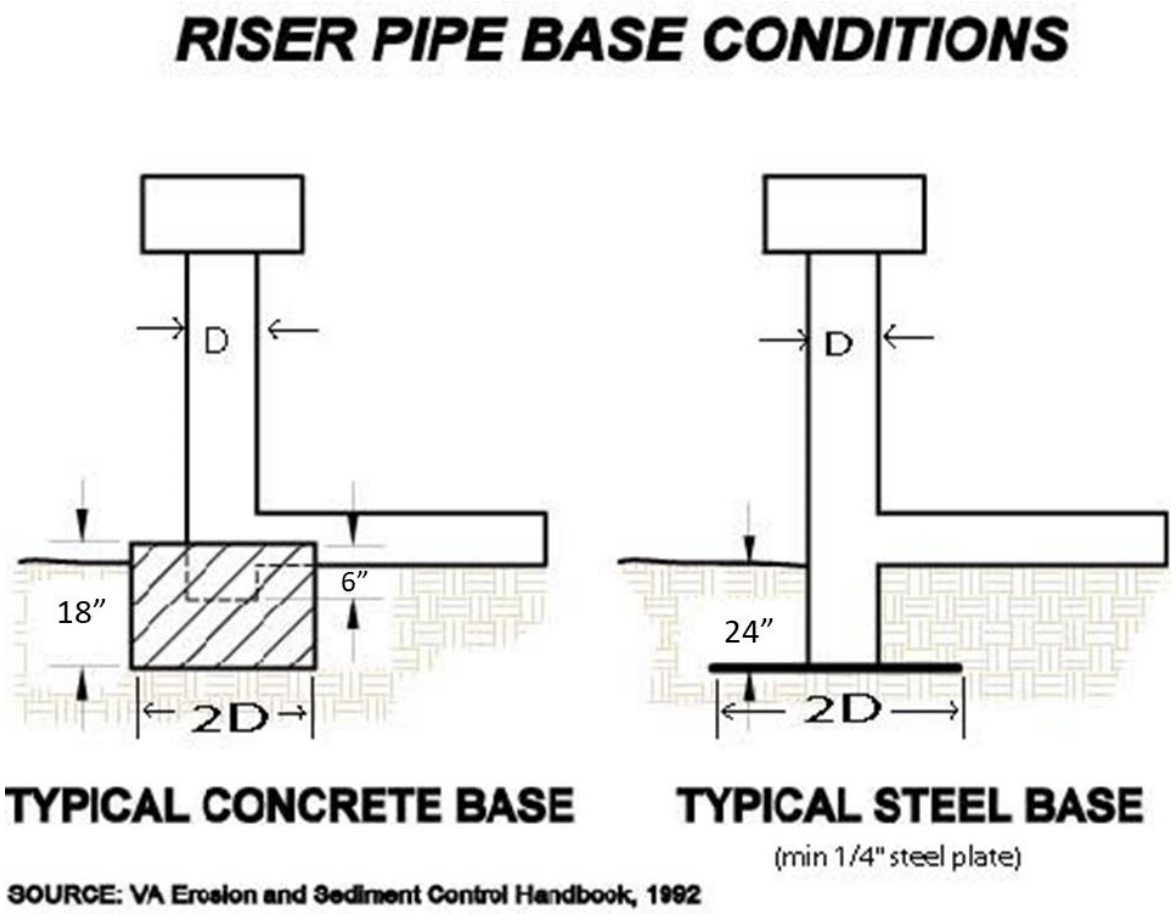


Figure 2-11 : Riser Pipe Base Conditions

Anti-Seep Collars

Anti-seep collars should be installed around the barrel pipe, within the normal saturation zone of the embankment. Anti-seep collars should be adequately sized to increase the seepage length by at least 10 percent when either of the following conditions exists:

1. The settled height of the dam exceeds 10 feet.
2. The embankment material has a low silt or clay content, and the barrel pipe diameter is 12 inches or greater

The anti-seep collar and its connection to the barrel pipe should be watertight. The maximum spacing should be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Minimum thickness of anti-seep collars should be ¼-inch. Collars should not be located within 2 feet of a pipe joint. (Refer to Figure 2-12)

In some cases, the design engineer may opt to install a blanket drain below the decant pipe instead of an anti-seep collar. This may be the case in large, long-term impoundments where access to a leaking decant pipe would be difficult or impossible. If used, a blanket drain should be installed under the downstream 3/4 to 2/3 of the decant pipe to convey the discharge from seepage or a leaking pipe to the fill surface. A properly designed and constructed blanket drain should prevent these water sources from saturating the impoundment and causing structural weakness. Blanket drains should be constructed of durable stone, wrapped in filter fabric, and sized to convey the maximum anticipated flow from seeps or leaks. The outlet end should be open to prevent sediment from blocking the drain.

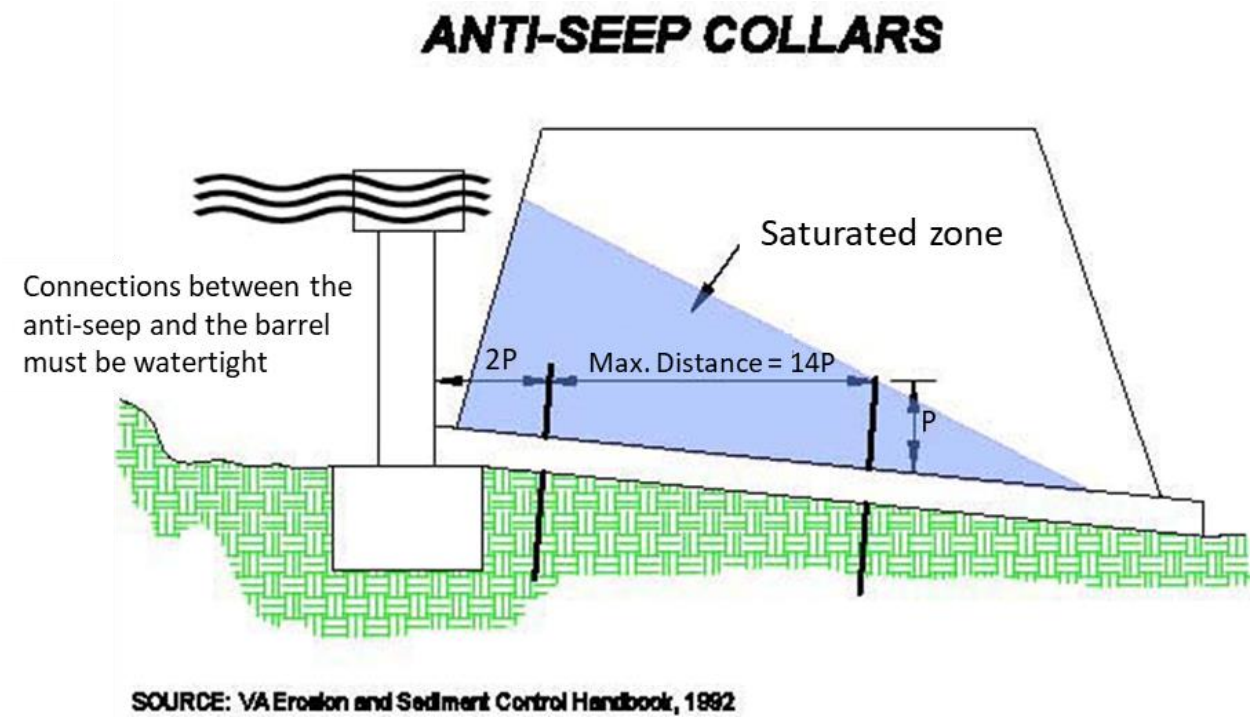


Figure 2-12: Anti-Seep Collars

Outlet Protection

Outlet protection is necessary at the discharge end of barrel pipes and open channel spillways to reduce the potential for downstream erosion and protect the outlet structure. These structures are commonly referred to as level spreaders or energy dissipaters. They should be adequate to absorb the impact of the water being discharged and reduce the flow velocity to a point where it will not erode the receiving channel or area. In most cases outlet protection consists of a riprap discharge apron installed on a level grade. These aprons should be designed and constructed per Figure 2-13 and Figures B-3 and B-4 in Appendix B. Outlet protection below open channel spillways should extend a distance equal to twice the width of the spillway.

Channels Directing Runoff into Basins

Channels directing runoff into basins should be protected with riprap or other soil stabilization methods to prevent bank erosion. Diversions should be installed as necessary to ensure runoff is directed to protected entry points.

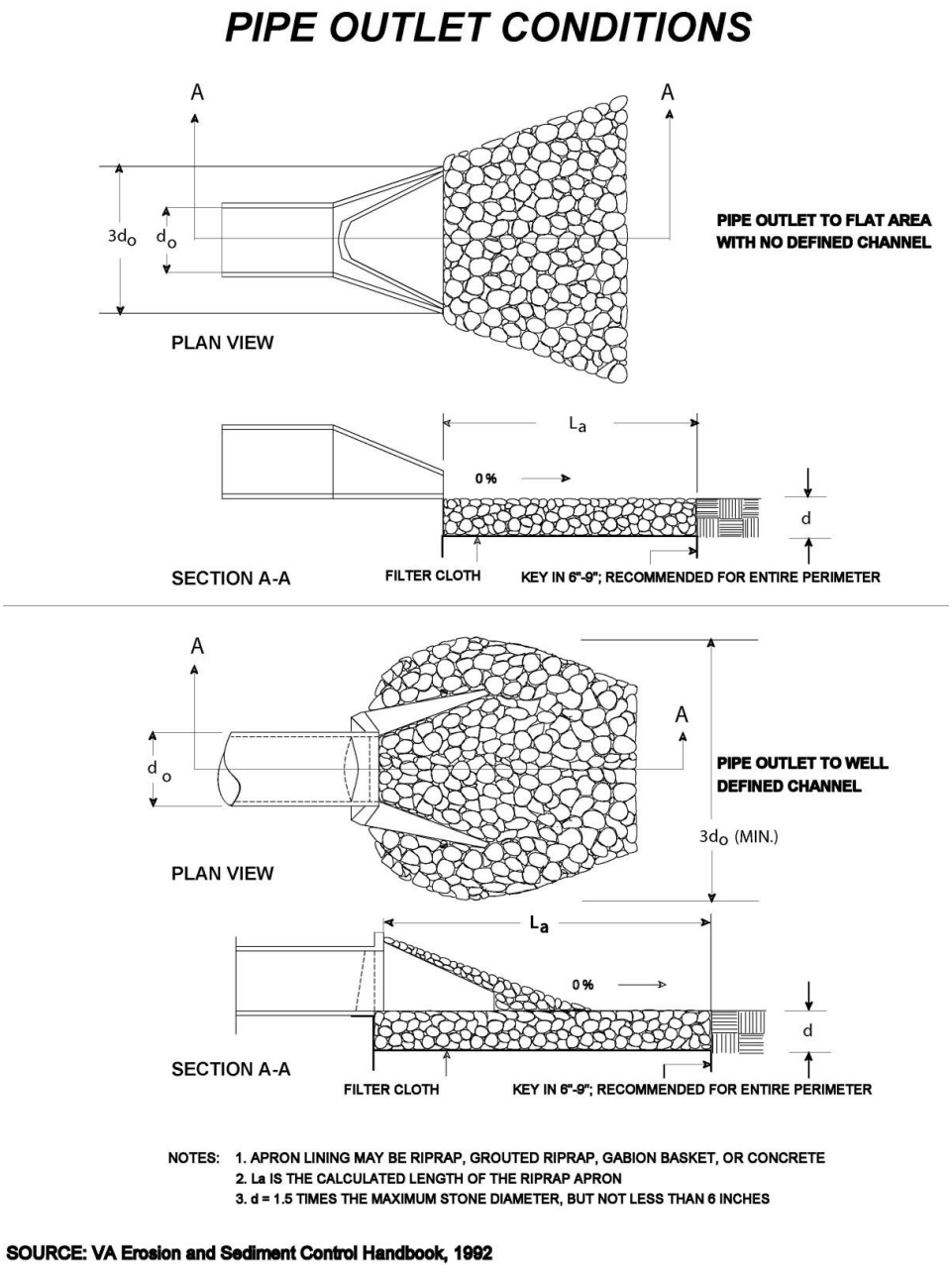


Figure 2-13: Pipe Outlet Conditions

2.5.7 Sediment Basin Construction Specifications

Site Preparation

Areas under an embankment or any other structural works should be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots, large rocks, or other objectionable material. In order to maintain an unobstructed spillway and facilitate future clean-out, the pool area (as measured up to the top of the spillway) should be cleared of all brush and trees. Material removed during site preparation should be disposed of in a location where it will not wash back into the basin.

Cut-Off Trench

A cut-off trench should be excavated along the dam centerline for all earthen embankments. The minimum depth should be 2 feet. The cut-off trench should extend up both abutments to the crest elevation. The bottom should be wide enough to permit operation of compaction equipment. Compaction requirements should be the same as those for the embankment. Side slopes should be no steeper than 1:1. The trench should be kept drained during the backfilling and compacting operations.

Embankment

Embankment construction material should be taken from borrow areas that contain enough clayey material to allow sufficient compaction, impermeability, and stability to be attained. Only clean mineral soil, free of roots, woody vegetation, stones over 6 inches, and other objectionable material, should be used. Preferred embankment construction soils are sandy clay, gravely clay or low liquid limit clays. The most impervious material available should be used in the cut-off trench and center portion of the dam. If sandy or gravely soil is encountered, it should be placed in the outer shell, preferably in the down-stream portion of the dam. As a rule of thumb, where test facilities may not be available, the fill material should contain sufficient moisture so that it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction.

Fill material should be placed in 1-foot continuous layers over the entire length of the fill. Each layer should be compacted and scarified prior to placement of the next layer. Fill material should be placed at or near optimum moisture content and should be compacted by routing rubber-tired construction equipment over the entire fill surface. All fill material should be traversed by at least one wheel of the equipment. Fill material may also be compacted by sheep-foot compactors or vibratory compactors as long as it is scarified prior to placement of the next layer. Fill material should be compacted to 95 percent of optimum density. The embankment should be constructed to an elevation 10 percent higher than the design height to allow for settlement if compaction is obtained with hauling equipment. If compactors are used for compaction, the overbuild may be reduced to not less than 5 percent.

Pipe Spillways

The riser should be securely attached to the barrel, and all connections should be watertight. The riser and barrel should be placed on a firm smooth foundation. The riser should be firmly anchored to prevent floating. Only good quality, clean mineral soil should be used as fill material around the pipe. Fill material around the pipe should be placed in 4-inch layers and compacted under the shoulders and around the pipe to at least the same density as the adjacent

embankment. Particular attention should be given to the compaction of fill material adjacent to anti-seep collars and blanket drains. To protect the pipe during construction, the minimum depth of compacted backfill should be two feet, or ½ the diameter, whichever is greater.

Open Channel Spillways

The open channel spillway must ***not*** be installed in fill unless approved to do so by the Mineral Mining Program. Design dimensions, slopes, and erosion protection are critical to the successful operation of the emergency spillway and should be adhered to closely during construction. If riprap is used to armor the spillway, its excavated depth and width should be sufficient to accommodate the riprap at its specified depth. The depth of the completed spillway should be measured from the top of the riprap lining, not from the earth below. The width of the completed spillway should be measured across the completed riprap surface, not from the earthen slopes on either side. The completed spillway should be level across its design width and drop slightly as it crosses the embankment.

Vegetative Treatment

The completed embankment and open channel spillway should be stabilized immediately with vegetation or riprap. If completion of a structure is delayed more than 14 days, all disturbed areas should be stabilized with a temporary vegetative cover by seeding with appropriate rapidly growing annual plants such as millet (in hot weather) or annual ryegrass (in cool weather).

2.5.8 Maintenance

The completed impoundment should be inspected as often as necessary to ensure it is functioning properly. Inspections should examine the embankment for adequate sediment retention capacity, freeboard, seepage, erosion, and signs of instability. Decant structures should be inspected to ensure they are clear and functioning as intended. Floating debris should be removed from the pool area. Brush should be cut off embankments and spillways.

Any seepage should be assessed by a competent engineer. In most cases, seepage may be sealed off on the interior slopes of the dam or controlled on the outslopes of the dam. Interior slopes may be sealed by excavation of deleterious material and placement of an impermeable barrier. Seepage may be controlled on outslopes with the installation of subsurface drains or drainage blankets. In cases of severe seepage, large volumes or cloudy discharge, the embankment may need to be dewatered as quickly as possible.

All impoundment failures need to be reported to the Mineral Mining Program by the quickest available means.

2.5.9 Abandonment Procedure for Temporary Basins

After all disturbed areas above the basin are stabilized, the basin should be backfilled or removed. Standing water should be pumped or siphoned out of the basin and all sediment should be removed, prior to placing backfill or removing the dam.

The area occupied by the basin should be returned to its original profile and cross-section. Any remaining channel should be riprapped or stabilized with a vegetative cover. Riprap used to line the base of the channel should extend at least 1 foot above the point that water is expected to

flow through the channel. All areas disturbed during abandonment of a sediment basin should be vegetated as soon as possible after the project is completed.

2.6 Sediment Channel

A sediment channel is a long, wide, nearly level ditch used to provide sediment control. A sediment channel can be described as a long, narrow sediment pond with stone barriers and protected outlets. They are used to control runoff, trap sediment, and clarify water prior to discharge from the mine site.

2.6.1 Conditions Where Practice Applies

Sediment channels are often used to provide sediment control in areas where there is not enough room to construct sediment basins. They are best suited for disturbed areas that are more subject to sheet erosion than erosion from concentrated flow. They work well below screening berms that may need to be constructed close to adjacent property lines.

2.6.2 Design Criteria

Just like any other sediment basin, sediment channels must provide a sediment storage capacity of 0.125 acre-feet per disturbed acre in the watershed above the structure. The storage capacity of a sediment channel is based on the available volume between check dams within the channel. See the design example in this section.

1. Sediment channels are easier to construct in flat to gently rolling terrain in order to insure near level sections within the channel. If constructed in steep terrain, the channel must follow the contours of the ground.
2. The channel should be located far enough from the toe of slopes so that accidental sloughing will not fill or block the channel. An access road should be provided beside the channel to allow for inspection and maintenance.
3. The channel must be constructed with a trapezoidal cross section. They should be as wide as possible to minimize flow velocity along their length. All sediment control structures work best when flow through the structure is slowed down and retention time is increased. The depth of a sediment channel should not exceed 5 feet. Cut slopes should not exceed 1 horizontal to 1 vertical (1:1) and fill slopes should not exceed 2 horizontal to 1 vertical (2:1). (Figure 2-14)
4. Where possible, sediment channels should be excavated structures. If embankments need to be constructed to form the channel, sediment basin construction specifications should be followed.
5. Rock check dams are used within in the channel to filter out sediment and slow the flow of water along the channel. (Figure 2-15) They are placed at intervals that will cause water and silt to back up from the top of the downstream dam to the toe of the upstream dam. Therefore, the distance between two check dams is be based on the height of the downstream dam and the grade of the ditch between it and the upstream dam. Normally, check dams are constructed at intervals of 200 feet or less to provide adequate sediment storage capacity.
6. Check dams should be constructed of Class I riprap faced with at least 1 foot of VDOT #57's on the upstream side. The top width of the completed check dam should be level across its width and at least 5 feet deep. A spillway should be provided across the top of each check dam by ensuring that the top of the dam is set at least 1 foot below the top of

the channel. The spillway should be capable of conveying the runoff from a 25-year storm event while providing at least 6 inches of freeboard. At least one foot of riprap should extend from the outside edges of the check dam to the top of the sediment channel to prevent scouring of channel sidewalls.

7. Outlets from the sediment channel may consist of open channel spillways or decant pipes or a combination of the two. (Figure 2-16) The spillway should be capable of safely conveying the runoff from a 25-year storm event while providing at least 6 inches of freeboard. Spillways should be located at each point where an additional five acres of watershed has accumulated above the ditch. All outlets must be provided with suitable erosion protection.

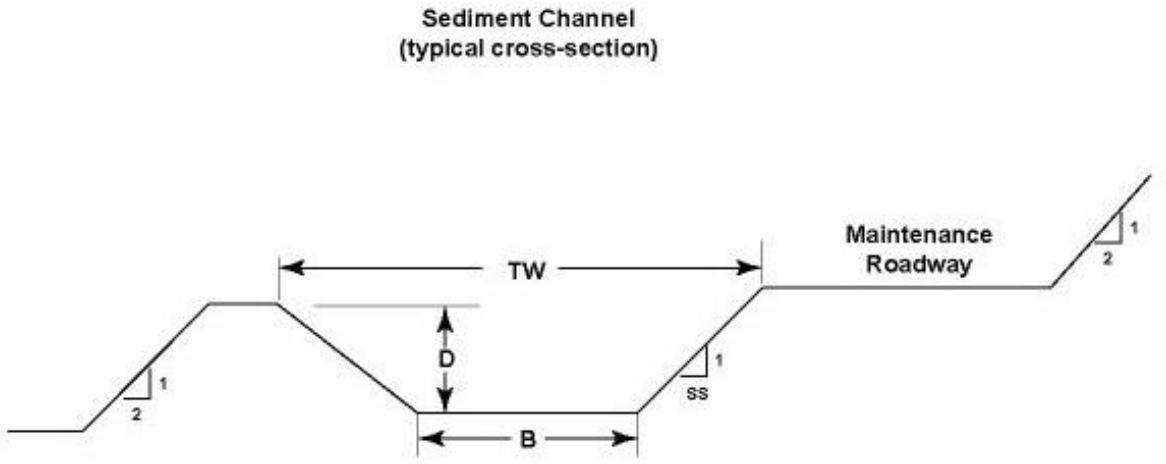


Figure 2-14: Sediment Channel (Typical Cross-Section)

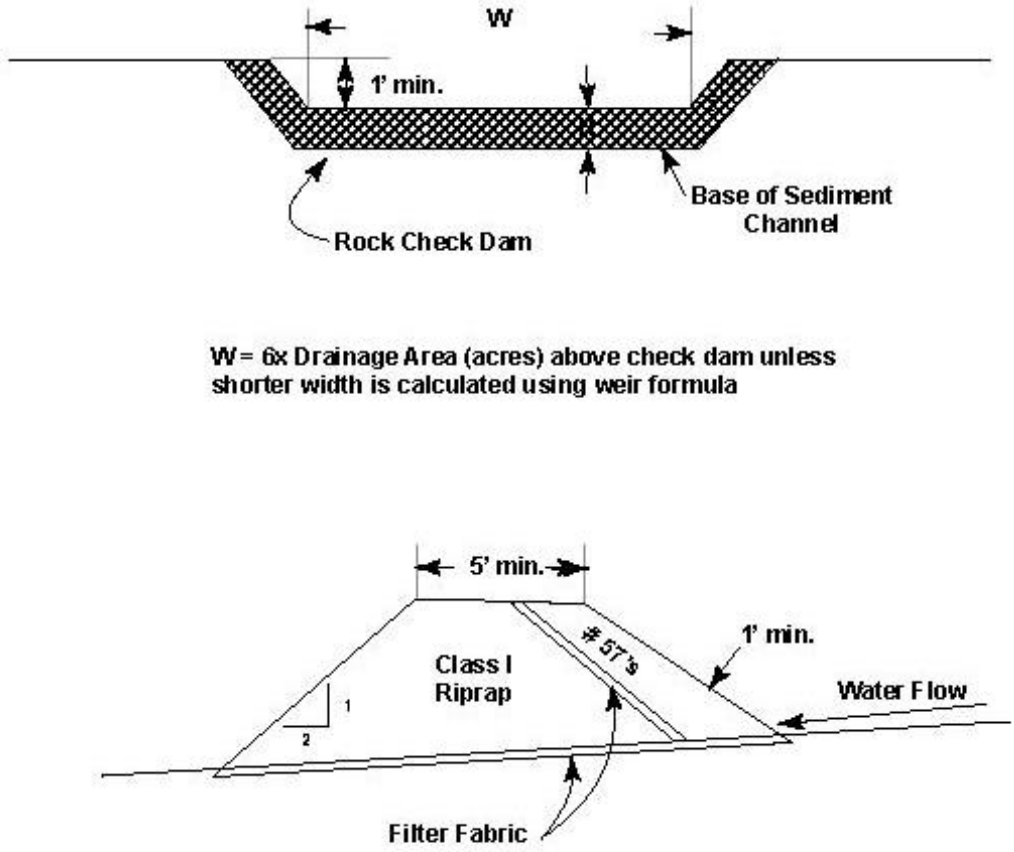


Figure 2-15: Typical Sediment Channel Rock Check Dam

Open Channel Spillways

Unless designed by a qualified engineer, the width of open channel spillways should be 6 feet times the drainage area above that segment of the sediment channel. The spillway should be lined with at least 1 foot of Class I riprap with the top surface of the riprap set 1 foot below the lowest point along the top of the channel. At least one spillway should be provided for every 5 acres of watershed above the sediment channel. Spillways should be located where the cumulative drainage area equals 5 acres or less and should discharge onto natural drainageways.

Decant Pipe Spillways

Unless designed by a qualified engineer, decant pipe spillways should be sized byTable 2-2. Decant pipe spillways should consist of a riser and outlet pipe passing through the channel embankment. The diameter of the riser must be the same or larger than the diameter of the outlet

pipe. The top of the riser should be set at least 1.5 feet below the lowest point along the top of the channel embankment. The top two thirds of the riser may be perforated to provide draw down between storm events. Suitable perforations are ½-inch diameter holes spaced 8 inches vertically and 10 to 12 inches horizontally around the circumference of the riser. Filter fabric and crushed stone should be used as a filter around the perforated riser. At least one spillway should be provided for every 5 acres of watershed above the sediment basin.

Table 2-2: Decant Pipe Spillway Size Chart

Maximum Drainage Area	Minimum Pipe Diameter
1 acre	12 inches
2 acres	18 inches
3 acres	21 inches
4 acres	24 inches
5 acres	30 inches

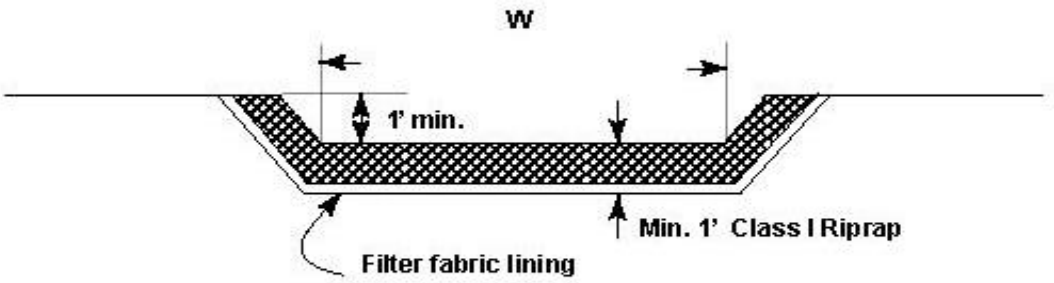


Figure 2-16: Typical Riprap Lined Channel Outlet

2.6.3 Construction Specifications

1. Install temporary sediment controls around the perimeter of the construction site.
2. Clear the area of trees, vegetation, topsoil and any other unsuitable materials.
3. Construct the channel to approved specifications.
4. If embankments are necessary to form the channel, their construction should follow applicable construction specifications for sediment basins.
5. Seed and revegetate all areas disturbed in the construction process.

2.6.4 Maintenance

The completed channel should be inspected on a regular basis to ensure that it is structurally sound, free from damage and functioning as intended. All damage should be repaired immediately. Sediment should be removed from the channel when it reaches 60 percent of the channel's storage capacity. Debris should be removed from spillways and decant pipes.

2.6.5 Abandonment

When upstream disturbed areas have been stabilized with a vegetative cover and the sediment channel is no longer needed, it should be reclaimed. The area occupied by the channel should be backfilled or returned to its original contours. If the channel is going to be reclaimed in place, all accumulated sediment should be removed from the channel and the check dams should be knocked down and spread out to prevent concentrated flow. If riprap is necessary to stabilize the channel, it should be used to line the base of the channel and should extend at least 1 foot above the point that water is expected to flow through the channel. Riprap requirements may be waived when the bottom and/or sides of the channel consist of stable bedrock. All areas disturbed during abandonment of a sediment channel should be vegetated in accordance with revegetation guidelines.

2.7 Diversion Berms and Ditches

Diversion berms and ditches can be constructed above disturbed areas to divert stormwater runoff away from the unprotected area, or they can be used to divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or basin. Diversions may be berms, ditches, or a combination of the two. In most cases, berms are more effective, and will last longer because they won't fill up with sediment as quickly as ditches, and when they do fill up, they are easier to clean and re-establish.

The *Reclamation Regulations for Mineral Mining* , Section 4VAC25-31-480. Diversions requires surface water diversions to be installed where run-off has the potential for damaging property, causing erosion, contributing to water pollution, flooding, or interfering with the establishment of vegetation. Diversions that will be removed in 18 months or less shall convey the peak run-off of a 1-year, 24-hour storm. Diversions that function more than 18 months shall be able to convey the peak run-off of a 10-year, 24-hour storm.

2.7.1 Construction

1. When installed below disturbed slopes, diversions should be at least 15 to 20 feet from the base of the slope. This allows room for sediment accumulation and maintenance access.

2. If constructed across a slope, the slope should not exceed a 2:1 grade and the foundation of the diversion berm should be cut into the slope.
3. To be effective, diversion berms should be at least 18 inches high as measured from the upslope side of the berm.
4. The top of the berm should be at least 2 ft. across to ensure adequate mass and resistance to erosion. The berm should be adequately compacted to prevent failure.
5. Side slopes should be at the angle of repose or shallower to prevent sloughing and allow the establishment of vegetation. The berm should be seeded immediately following its construction.
6. The channel behind the berm shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2%, no stabilization is required. If the slope is greater 2%, the channel shall be stabilized with vegetation or riprap.
7. The diverted runoff, if free of sediment, must be released through a stabilized outlet or channel. Sediment-laden runoff must be diverted through a sediment trapping facility.

2.7.2 Maintenance

Diversions should be inspected after every storm and repairs as necessary. Damage caused by erosion, construction traffic, or other activity must be repaired before the end of each working day.

2.7.3 Abandonment

Diversions should be removed when they have served their usefulness, but not before the up slope or downslope areas they are protecting have been permanently stabilized.

Any sediment deposits remaining in place after the diversion is no longer required should be dressed up to conform to the existing grade and seeded.

2.8 Rock Check Dams

Rock check dams are constructed across swales or drainage ditches to reduce the velocity and erosive power of concentrated stormwater flows. Check dams may also be effective in trapping sediment but should not be used as a substitute for sediment traps or ponds. Check dams should be limited to small open channels that drain 10 acres or less.

2.8.1 Construction

1. Rock check dams may be constructed with Gabion or Class I Riprap if intended solely for velocity control. If the check dam is also constructed to aid in sediment control, it should be faced with filter stone. (Figure 2-18)
2. Stone should be extended to the top of channel banks on both sides and the center of the check dam should be at least 6 inches lower than the outer edges to ensure overflow crosses the center of the check dam and does not scour the outside edges.
3. The maximum height of check dams should be limited to 3 feet.
4. For added stability, the base of the check dam can be keyed into the soil approximately 6 inches.
5. The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam (Figure 2-17).
6. Filter cloth may be used under the stone to provide a stable foundation and to facilitate the removal of the stone.

2.8.2 Maintenance

Check dams should be inspected for sediment accumulation after each runoff-producing storm event. Sediment should be removed when it reaches one half of the original height of the measure. Erosion caused by high flows around the edges of the dam should be corrected immediately.

2.8.3 Abandonment

Unless they will be incorporated into a permanent stormwater management program, check dams must be removed when disturbed areas above them have been disturbed. The area beneath the check dams should be seeded and mulched immediately after they are removed.

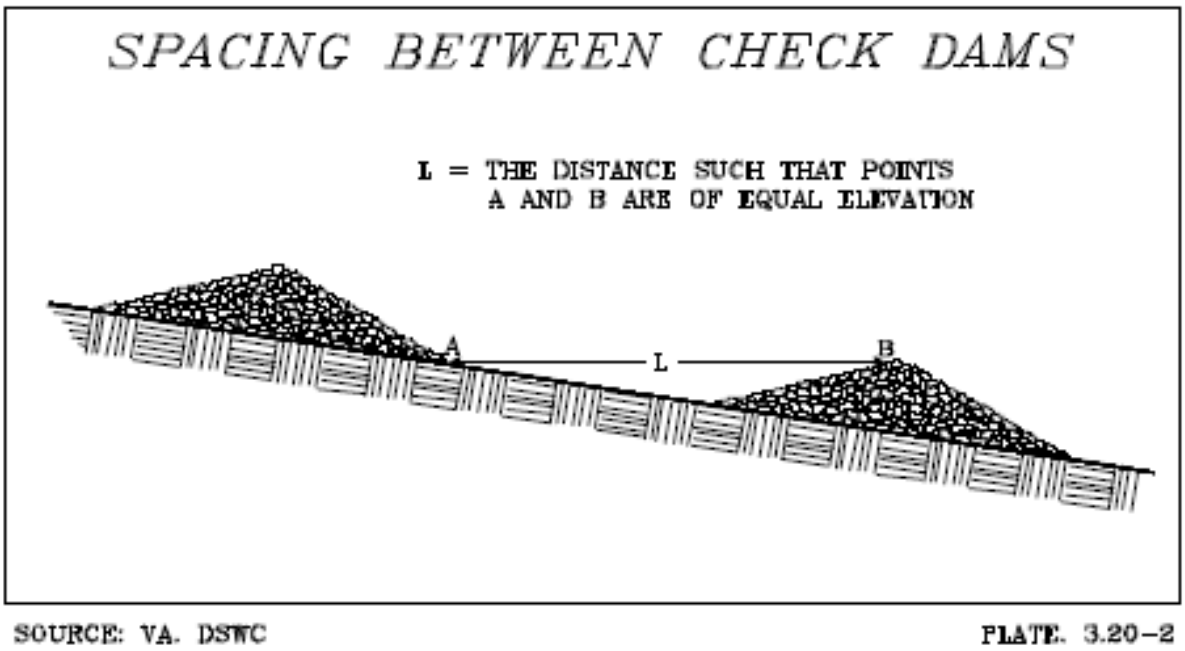


Figure 2-17: Spacing Between Check Dams

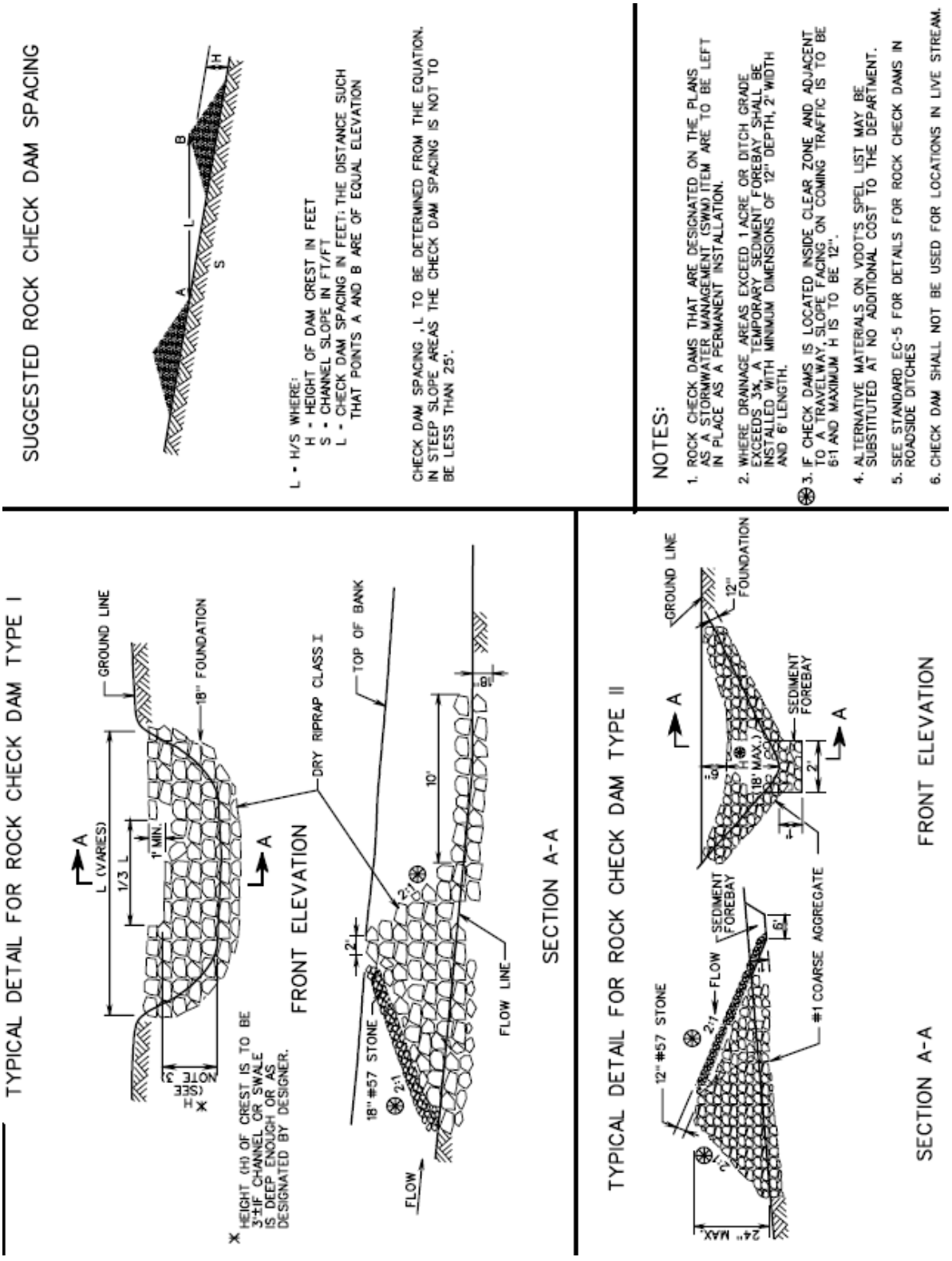


Figure 2-18: Rock Check Dam Design Detail and Spacing

2.9 Pipe Slope Drains

Pipe slope drains are rigid or flexible pipes used to convey stormwater runoff down the face of an earthen slope without causing erosion to the slope or the area below. They are easier and faster to install than rock slope drains and are often the most economical way to control runoff down steep slopes. If constructed properly, using water and UV resistant materials, pipe slope drains should function as intended long after the slope has been stabilized with a permanent cover of vegetation.

2.9.1 Design Criteria

Pipe slope drains must be designed to carry the peak flow from a 10-year, 24-hour storm. Drainage calculations do not have to be submitted for review and approval if the pipe slope drain is sized per Table 2-3. Pipe slope drains should not be used on slopes steeper than 2:1 (50%). Drainage areas above the pipes should not exceed 5 acres.

When slope drains are used to drain multiple benches in overburden and waste disposal areas, they should be located above one another as additional levels are added to the fill. This will minimize the erosive effect of flowing water at the discharge end of the pipes and along the benches of the fill.

2.9.2 Construction

It is very important that pipe slope drains be installed properly, since their failure will often result in severe slope erosion and sedimentation below the slope. The entrance section must be adequately secured, all connections must be watertight, and the conduit must be staked in place to prevent it from sliding down the slope and breaking apart. The pipe used in these structures should be designed for this purpose. The diameter of the pipe must be consistent over its length. All sections of the pipe must be securely fastened together and have watertight fittings. The pipe should be corrugated or provided with reinforced hold-down grommets spaced at maximum 10-foot intervals. Heavy-duty steel stakes should be used on both sides of the pipe on 10-foot intervals to secure it in place. If corrugated pipe is used, the stakes should be set across from one another and pulled into the corrugations with heavy duty galvanized tie wire. The pipe may also be buried under lightly compacted fil to help secure it in place.

Table 2-3: Size of Pipe Slope Drain

Maximum Drainage Area (acres)	Minimum Pipe Diameter (inches)
0.5	12
1.5	18
2.5	21
3.5	24
5.0	30

Source: VA. DSWC

Entrance Sections

The entrance to the pipe slope drain may be a standard flared end-section or a T-section. Inlet protection such as filter fence or filter stone should be provided around the entrance (refer to Figure 2-19). The entrance section must slope toward the slope section at the minimum rate of ½-inch per foot.

Diversion Berm Design

Pipe slope drains must be used in conjunction with diversion berms to convey runoff from the drainage area to the inlet end of the drain. The height of the berm at the slope drain inlet should be adequate to secure the inlet in place and ensure all runoff enters the drain. The berm should cover a width of the pipe equal to twice the diameter of the pipe to ensure a good seal around the pipe. The soil around and under the entrance section should be hand-tamped in 8-inch lifts to the top of the berm to prevent piping failure around the inlet. The berm should have 2:1 or flatter side slopes.

Outlet Protection

The outlet of the slope drain must be protected from erosion. The discharge end of the conduit should extend at least 5 feet onto flat ground from the toe of the slope. A riprap discharge apron should be installed below the outlet. This apron should consist of:

1. Class I riprap placed to a depth equal to the pipe diameter
2. Length equal to 5 times the pipe diameter
3. Width equal to 3 times the diameter.

2.9.3 Reclamation

Pipe slope drains must be inspected and maintained throughout their life. Prior to requesting bond release, each pipe slope drain must be re-evaluated, with the Mineral Mining Program's concurrence, based on its condition and the level of vegetation in the watershed above the structure. The evaluation will determine if pipe slope drains in the proposed bond release area may be left in place as permanent structures, or removed and the affected area reclaimed, or replaced with rock slope drains.

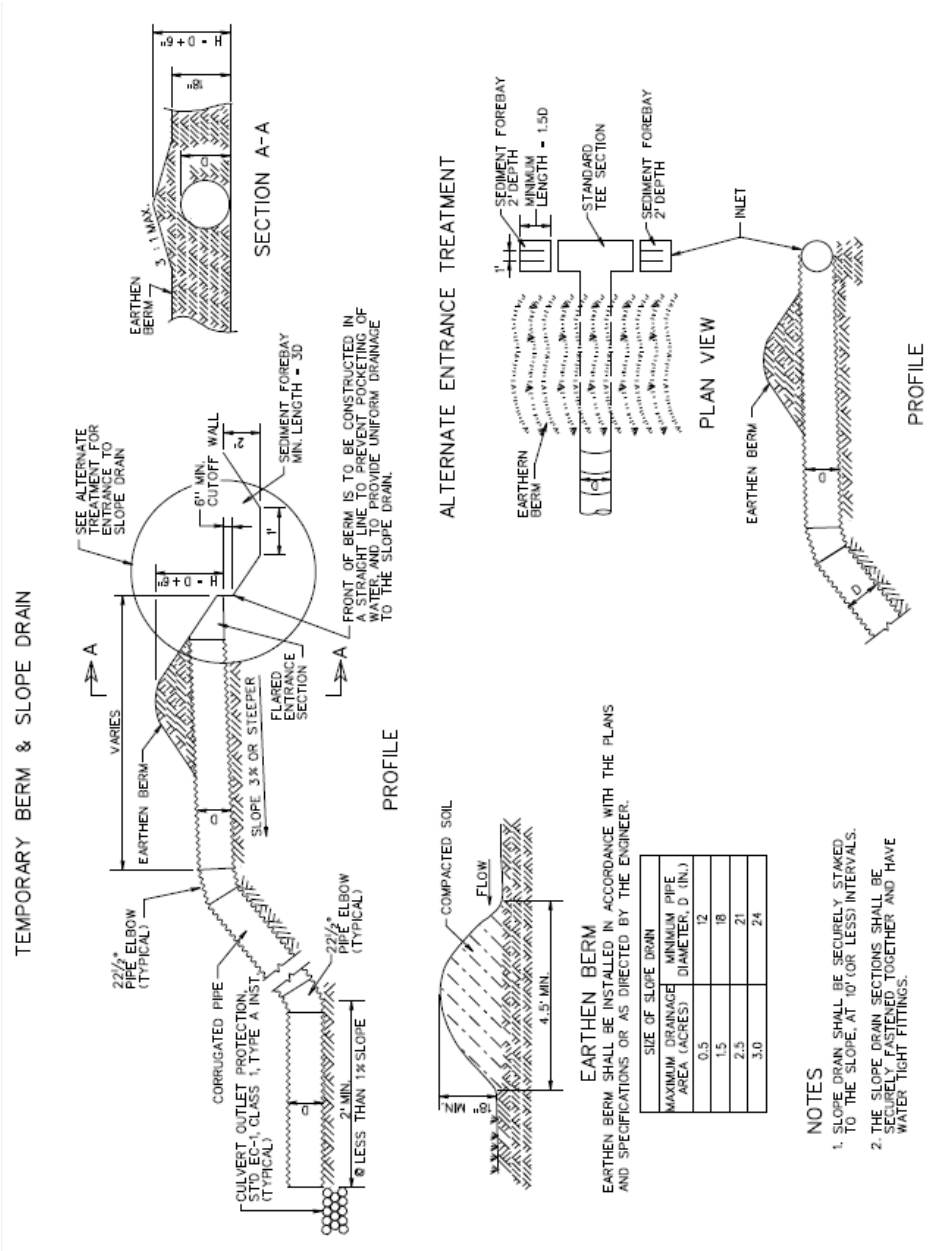


Figure 2-19: Pipe Slope Drain

2.10 Rock Slope Drains

Rock slope drains are riprap lined channels used to convey stormwater runoff down the face of an earthen slope without causing erosion to the slope or the area below. They are more difficult and time consuming to install than pipe slope drains but will typically last longer and require less maintenance if properly constructed.

2.10.1 Design Criteria

Rock slope drains may be used to provide temporary or permanent protection of slopes. Temporary drains must be designed to carry the peak flow from a 50-year, 24-hour storm. While permanent drain must be designed to carry the peak flow from a 100-year, 24-hour storm. Drainage calculations should be submitted for review and approval by the Mineral Mining Program. Drainage areas reporting to the channel should not exceed 5 acres.

When slope drains are used to drain multiple benches in overburden and waste disposal areas, they should be located above one another as additional levels are added to the fill. This will minimize the erosive effect of flowing water at the discharge end of the drains and along the benches of the fill.

2.10.2 Construction

It is very important that rock slope drains be installed properly, since their failure will often result in severe slope erosion and sedimentation below the slope. The entrance section must be keyed in and set below surrounding grade. Inlet protection, such as filter fence or filter stone are not required but may be used if heavy erosion is anticipated above the slope drain.

The rock slope drain should be constructed on undisturbed soil or well-compacted fill. The base of the drain must be level from side to side to prevent concentrated flow and erosion in low areas. A nonwoven geotextile must be used to line the base of the channel.

Riprap placement should begin at the lower end of the structure and proceed uphill to provide a foundation for the material placed above. Four to six inches of crusher run should be placed on the geotextile before riprap placement to prevent damage from large, angular stone. Riprap must be non-acid or toxic forming durable, rectangular rock such as sandstone, limestone, granite or diabase that will not slake in water and is free of soil and non-durable rock such as shale. Shale and slate cannot be used for riprap. Recycled concrete may be used, with approval from the Mineral Mining Program, as long as it is not spalling and is free of wire or rebar reinforcement. Generally, riprap should be placed in tight blankets 1.5 feet thick. Twenty-five percent (25%) of the rock should be the calculated size for the intended purpose. The remaining seventy-five percent (75%) should be well graded material with sufficient amounts of rock small enough to fill the voids between the larger rock. No single rock should be larger than the thickness of the riprap blanket.

Riprap must be properly sized, bedded and backfilled to prevent it from sliding down the slope under maximum flow conditions.. Surge stone or a #357 blend may be used to backfill and tighten-up the riprap. The top surface of the riprap drain must be level with, or slightly below, existing ground to allow the free entry of water into the structure as shown in Figure 2-20

Diversion berms must be used along the crest of the slope to convey runoff from the drainage area to the inlet end of the drain.

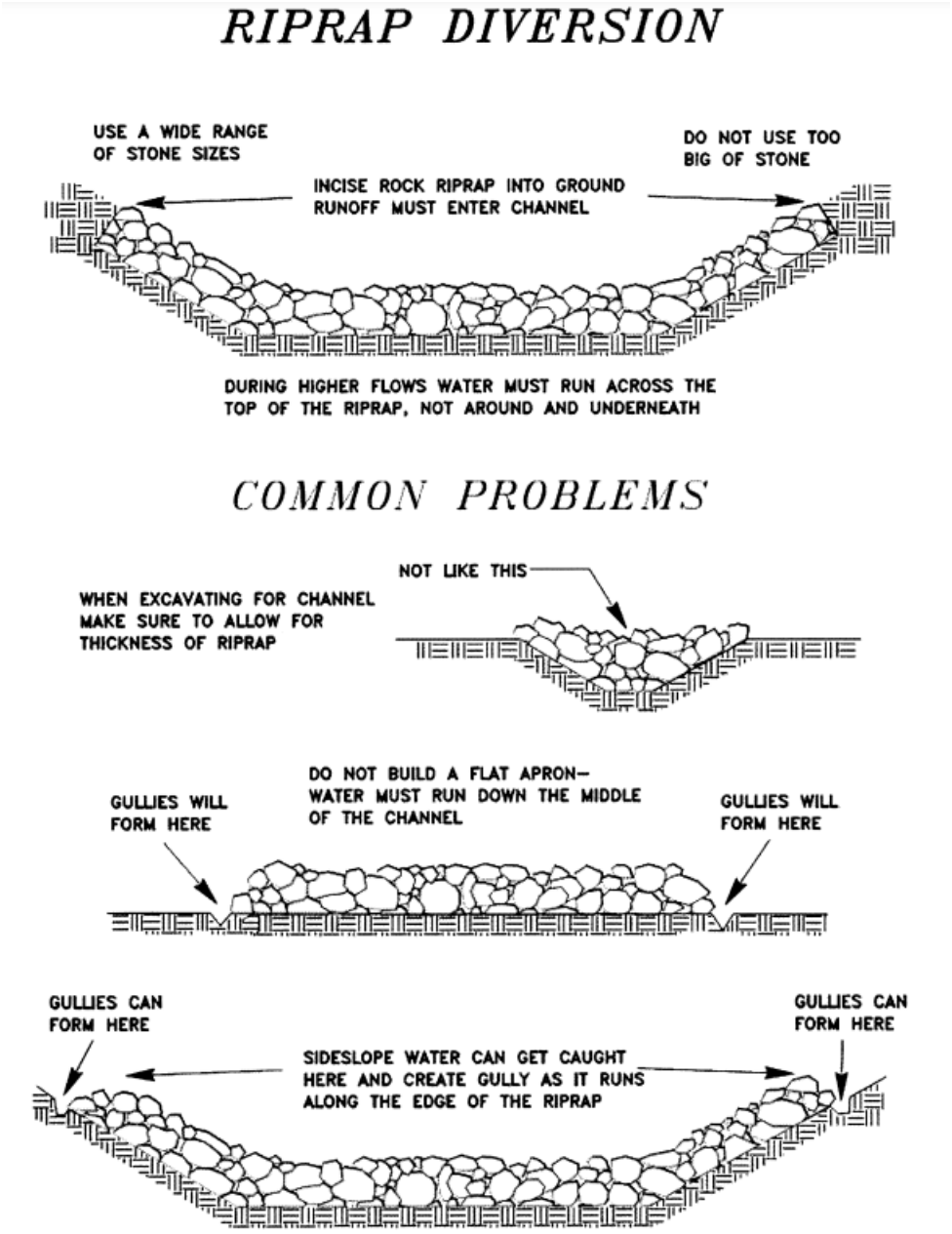


Figure 2-20: Common problems of rip rap lined channels. (Source: WV DEP)

2.11 Geotextiles

2.11.1 Products and Uses

Geotextiles are available in many different forms. They may be used to provide sediment and/or erosion control, and stabilize drainways, roadways and slopes. Most geotextiles are non-biodegradable, permeable fabrics that allow water to pass through but restrict and retain fine soil particles. These characteristics can be used to prevent the transport of silt from disturbed areas to undisturbed areas, enable underdrains to last longer by preventing soil from filling the voids between rocks, provide resistance to soil erosion under riprap drainage channels, temporarily line drainways that will be permanently stabilized with vegetation, and prevent road surfaces from sinking while allowing them to drain. Manufacturers of these products should be consulted to assist in determining the type of geotextile to use.

2.11.2 Soil Stabilization Matting

Soil stabilization mats are used to aid in the establishment of vegetation in areas where water flow can make it difficult for vegetation to take hold. Slopes, ditches and shorelines are some of the areas where these mats may be used. Biodegradable mats are made from jute, straw, or coconut fibers. Non-biodegradable mats are manufactured using nylon fibers or polyethylene. Some mats are available with seed and fertilizer as part of the blanket. All of these mats are woven with a loose weave allowing vegetation to penetrate and entangle itself in the weave while growing through it. Manufacturers of these products should be consulted to assist in determining the type of mat to use.

Non-biodegradable, plastic soil stabilization matting is classified by VDOT as EC-3 matting. This type of matting may be used to stabilize problem slopes (3:1 or steeper) and permanent stormwater conveyance channels. When properly installed in stormwater channels, it acts with the vegetative root system to form an erosion resistant cover, which resists hydraulic lift and shear forces from flowing water. The resultant matrix of root growth and matting can withstand a flow velocity up to 10 feet/second. Design velocities greater than this will require the use of riprap or a durable pavement.

2.11.3 Installation

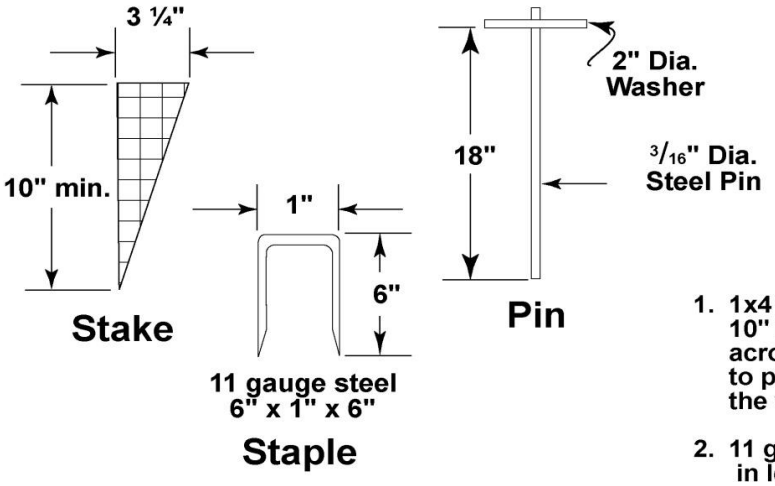
Soil stabilization matting should be placed on undisturbed soil or well-compacted fill. Surfaces should be free from dirt clods and rocks larger than one inch in diameter, or any other foreign material that could puncture the matting or prevent direct contact with the soil surface. The area below the mat should be shaped to eliminate abrupt changes in the ground surface that could create voids under the secured mat.

Mats should be started at the top of the channel or slope and unrolled downgrade. They should be allowed to lie loosely on the soil without being stretched. The upslope ends of the matting should be buried in anchor slots no less than 12 inches deep. Check slots should be used in channels to prevent water flow from undermining the material. Mats should overlap one another by at least 6 inches along their sides and 3 feet at terminal ends. Stakes, staples, or pins should be used as noted in Figure 2-21 through Figure 2-24, or as specified by the manufacturer, to secure the mats to the ground.

Four to six inches of crusher run should be placed on geotextiles to prevent damage if the matting needs to be crossed with equipment during installation, or if heavy, angular riprap is going to be dropped onto the matting from a significant height.

Periodic inspections should be made after installation to check for erosion and undermining. If washouts or breakage occur, the matting should be reinstalled only after the slope or ditch is repaired.

STAKES, STAPLES, & PINS FOR INSTALLATION OF TREATMENT - 2 SOIL STABILIZATION MATTING



1. 1x4 triangular survey stake - minimum 10" in length. Placement of the stake across the flow of the water is thought to provide a pinball effect to help slow the velocity.
2. 11 guage steel - minimum 1" wide by 6" in length steel staple - 2" x 8" staple may be required in certain soil conditions.
3. Steel pins - 3/16 diameter steel pin by 18" in length with a 2" diameter washer on top. (See Illustration)

Source: Product literature from Greenstreak, Inc.

Figure 2-21: Stakes, Staples, and Pins for Installation of Soil Stabilization Matting

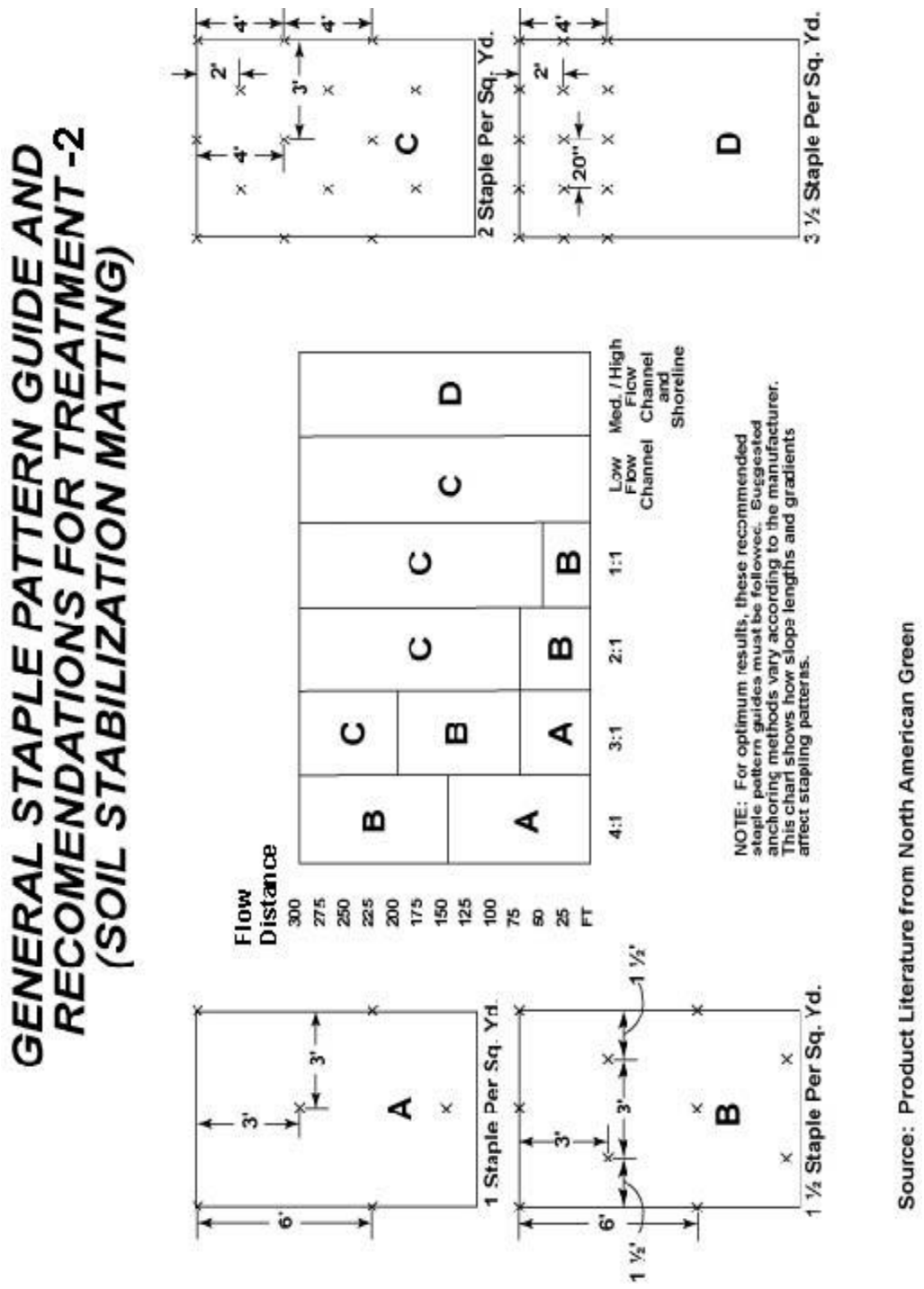


Figure 2-22: General Staple Pattern Guide and Recommendations for Treatment – 2 (Soil Stabilization Matting)

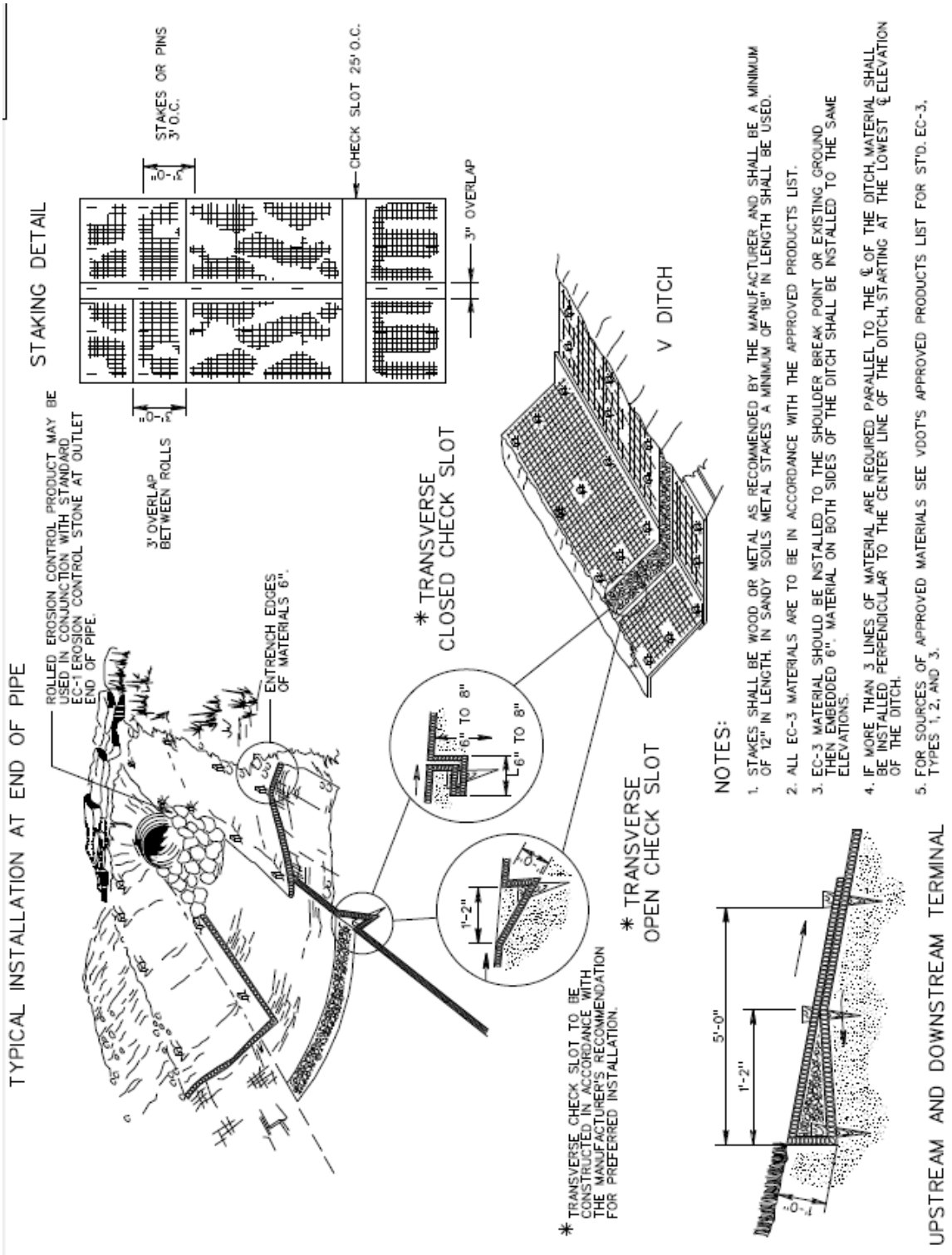


Figure 2-23: Typical Soil Stabilization Matting Installation

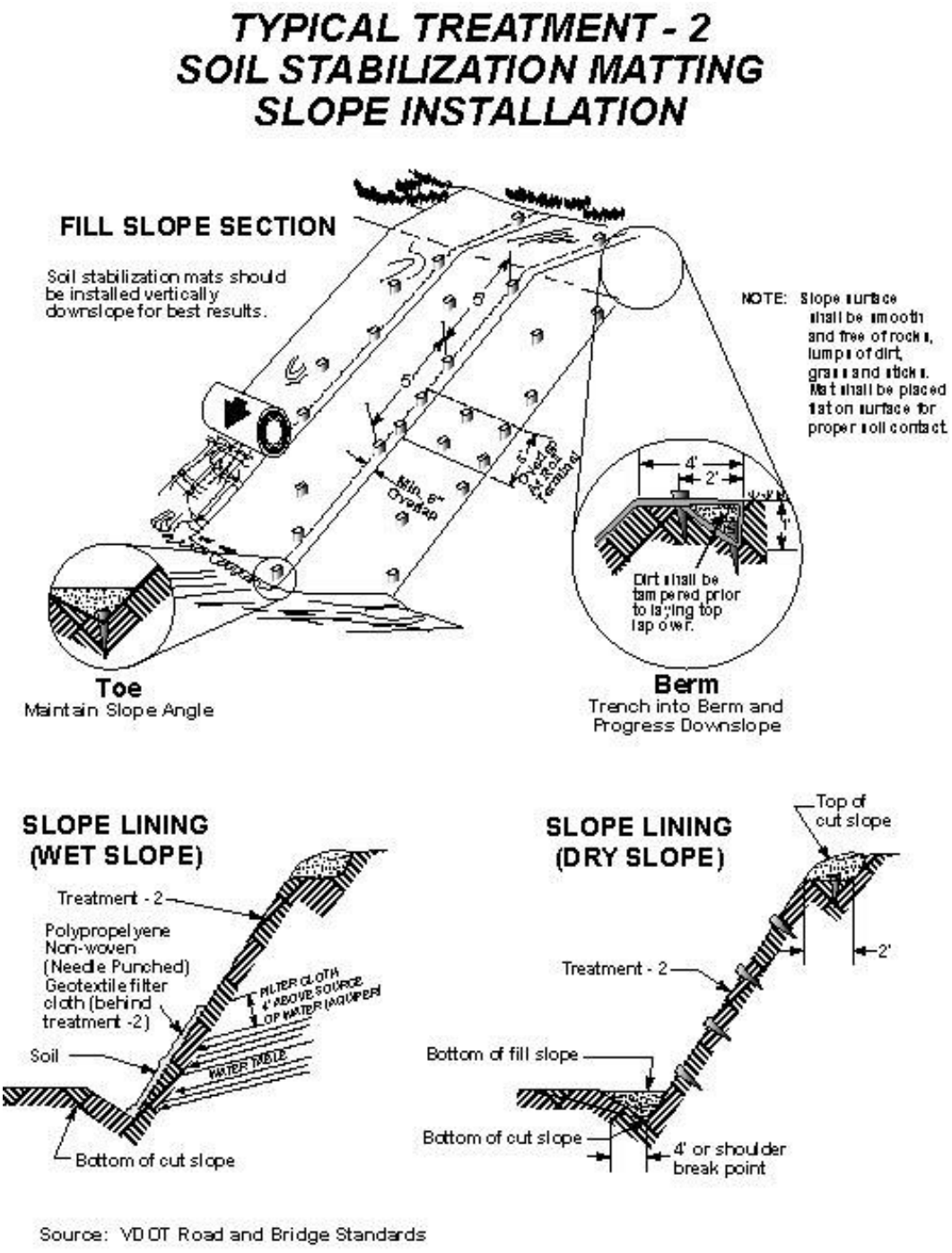


Figure 2-24 : Typical Treatment – 2 Soil Stabilization Matting Slope Installation

2.12 Riprap

2.12.1 Definition and Purpose

Riprap is broken stone or concrete placed over an erodible soil to prevent erosion. Riprap may be used as culvert inlet and outlet protection; lining diversion ditches, basin entrance flumes, and spillways; and embankment protection.

2.12.2 Specifications

Riprap must be non-acid or toxic forming, durable rock such as sandstone, limestone, granite or diabase that will not slake in water and is free of soil and non-durable rock such as shale. Shale and slate should not be used as riprap due to weathering problems and their flat nature. Riprap should be proportioned so that neither the breadth nor the thickness of a single rock is less than one-third the length. Recycled concrete may be used, with approval from the Mineral Mining Program, as riprap as long as it meets the above durability and proportion requirements and is free of wire or rebar reinforcement.

2.12.3 Use

The thickness of the rock layer should be sufficient to allow at least two overlapping layers of the nominal rock size. Generally, riprap should be placed in tight blankets 1.5 feet thick. Twenty-five percent (25%) of the rock should be the calculated size for the intended purpose. The remaining seventy-five percent (75%) should be well graded material with sufficient amounts of rock small enough to fill the voids between the larger rock. No single rock should be larger than the thickness of the riprap blanket.

Since the angle of repose of riprap averages 40 degrees (84%) (1.2:1), it should not be placed on slopes steeper than 27 degrees (50%) (2:1). This allows a modest safety factor to address the tractive force of flowing water across the stone. Crushed rock is more stable than natural rounded stone. If rounded stone is used as riprap, its size should be increased by 35% to offset the tractive force of flowing water. Unproperly sized and placed riprap can flow downstream, just like the soil it is intended to protect, when enough water flows across its surface. Riprap must be placed on undisturbed soil or well-compacted fill. A 6-inch layer of crusher run, or a geotextile cloth with sufficient strength to withstand the placement of rock, must be placed under the riprap to prevent scour underneath. Four to six inches of crusher run should be placed on geotextiles to prevent damage if riprap is heavy and angular or is dropped from a significant height.

3 MINE RECLAMATION

3.1 Revegetation and post mining land use

A well-defined mining plan will create order and objectivity to the entire mining operation, including reclamation. A proper reclamation plan will define the Post-Mining Land Use (PMLU), and all reclamation activity should be designed to accomplish that use. Consideration should be given to the aspects of reclamation that follow in this section. The plan will include maps showing contour lines, natural and man-made drainage ways, public and company roads, physical structures, screens (both vegetated and man-made), plant species to be used, and any special planting mediums as determined by those plant species. Maps need to be drawn to scale in order to present an accurate picture of the appearance of the area before, during and following operations.

The plan can be very useful when working with adjacent communities and local governing bodies in the pursuit of opening a new mine.

The mine reclamation plan should include a narrative section for describing the objectives of the plan, sequence of events towards its development, and **must be designed to achieve the approved post-mining land use.**

Most planning objectives fall into the following categories:

- Desired post mining land use
  - Compatibility with surrounding land uses considered
- Demolition and Grading
  - Disposition of structures, basins and roads
  - Disposal of metal, lumber and debris
  - Reclamation of waste disposal areas
  - Grading and drainage plans
- Revegetation
  - Seedbed preparation and topsoil reapplication
  - Soil sampling and testing
  - Selection and application of soil amendments
  - Seed mixtures and application rates
  - Tree species and stocking rates

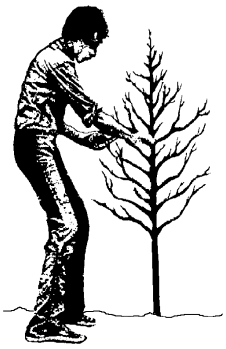
Most post mining land uses fall into one of the following categories:

- Wildlife habitat
- Forest
- Pasture/hayland
- Intensive agriculture
- Residential/industrial development

Each of the post mining land uses and objectives for planting have similar, and unique, requirements to achieve the desired result. This section will concentrate on those similarities and then recommend planting mixes and methods to successfully achieve the forestry and wildlife habitat post mining land uses. The pasture/crops and development land uses are dependent on

the crops planted and the type of development, therefore they are more site specific as to the plantings.

3.2 Public Considerations



Property values, noise, dust and effects on lifestyles are primary concerns of the local public where mine operations are being considered, or are underway. The general public is concerned with the future use of the land, as well as the appearance of the mine site during and following operations. At the same time, society is served by having the use of the product being mined at the lowest possible cost. A well-conceived, and executed, mining and reclamation, plan shows consideration for public as well as operational needs.

3.3 Operational Considerations – Simultaneous Reclamation

How the mining operation is planned and carried out will have a great effect on the reclamation aspect of the mining operation. The sequence of mining should be planned in such a way that once an area is mined, it can be concurrently reclaimed while mining progresses to a new area. Roads and access to new mining areas should be planned far in advance so that access and disturbance across reclaimed areas will be minimized. Minimizing disturbance to reclaimed areas will give the best chance for vegetation to establish in the area. By mining the permit systematically, areas of mines can be simultaneously reclaimed to achieve permanent vegetative cover.

3.4 Grading

Once mining disturbances have been completed in an area, reclamation of the area should begin as soon as practical. Grading of the area should be performed to achieve the contour required by the approved post-mining land use. VA mine reclamation regulations specify that slopes shall not exceed 2 horizontal to 1 vertical (2:1) in unconsolidated mineral soils, and shall not exceed 3:1 in sandy soils. Grading must be done to achieve the contour necessary while limiting the compaction of the material being graded. **Soil compaction increases water runoff from precipitation and is a limiting factor in the success of vegetation.**

Depending on the type of vegetation to be planted, grading may require achieving a relatively smooth slope which is then tracked to hold seed, or in other situations rough grading with shallow, horizontal ripping or disking perpendicular to the slope may suffice. The latter increases percolation of runoff into the soil and subsoil, reduces surface runoff and reduces compaction of the graded materials. **In either case the fewest passes that can be made over the area with heavy equipment, the better.**

3.5 Developing a Favorable Planting Medium

The natural surface soil is most suitable as a growth medium for plants. The Virginia Reclamation Regulations for Mineral Mining require that all topsoil required for reclamation be recovered and saved for use in reclamation of disturbed mined land. The use of original topsoil to immediately reclaim mined areas is highly recommended. The most effective use of topsoil is in immediately utilizing it to cover disturbed areas, thereby taking advantage of the existing native seed source

and eliminating the possibility of contamination with other materials. The partially decomposed rock material beneath topsoil can also be used in the five-foot surface layer.

When topsoil is insufficient or unavailable, the addition of organic materials to subsoil materials, in lieu of fertilizer, can be beneficial.

Mine operators can create a favorable growing medium from overburden and soil materials generated during the mining operation. By careful selection, segregation and handling of these materials, a medium with the proper physical and chemical properties can be achieved. It is important during the selection process to consider pH, nutrient content, and media composition (sand, silt, clay). All these aspects are important in developing a medium that will sustain long-term vegetative cover.

Most mine operators have a general knowledge of the geologic and soil conditions in the area that they mine. They may not however have the ability to determine the specific chemical and physical characteristics necessary to achieve successful revegetation of the lands disturbed by mining. Assistance is available in determining necessary soil supplements, such as lime, fertilizer, or organic matter; and which type of plants are most suitable in achieving long term vegetative cover and land restoration. Operators can contact their Mineral Mining Program mine inspector, county extension agent, Natural Resources Conservation Service, or Virginia Department of Forestry for questions and assistance.

The depth and quality of soil media are the major factors in developing a suitable planting medium. The most limiting factor on plant growth is soil moisture. Shallow soils and spoil layers, as well as heavily compacted soils, can restrict root growth and contribute to drought like conditions. Soil media should be four to five feet in depth and be comprised of non-toxic material which has the physical and chemical properties required to support vegetation. Materials toxic to root development and plant growth must be excluded from the five-foot surface layer. Certain stratum in overburden may contain plant nutrient bearing minerals (e.g., phosphorus, potassium, calcium, magnesium), as well as micronutrients, which could be set aside for use in the growing medium. Likewise, acid producing minerals, such as pyrite and other sulfides, may inhibit the growth of vegetation.

This goal can be achieved by proper planning and action during the stripping phases of mining. During stripping, the operator should develop techniques for recognizing beneficial and toxic materials in overburden, as well as the potential for toxicity in by-product materials. Overburden that has desirable properties for the growing media should be segregated and stockpiled. Soil tests are available to determine if desirable nutrients are present in the material. Toxic, potentially toxic, and otherwise unsuitable materials should be placed below the surface five-foot layer.

3.6 Selecting Material for Planting Medium

Some soils and overburden can contain acid forming minerals or base forming minerals. The resulting soil reaction, or pH, is dependent upon the proportion and type of minerals present. Minerals high in calcium, magnesium, potassium, and sodium are more likely to produce neutral to alkaline soil upon weathering. Minerals containing sulfur oxidize in the presence of air and water to form strongly acidic soil conditions. The acid producing potential of soils should be determined for each mine site and their individual soil types. Material from acid producing soils

should be buried and covered with a minimum of five feet of non-toxic material to prevent surface contamination of soils and water.

Some soils in Virginia have very heavy clay sub-soils, which restrict root growth. These are more commonly found in northern Virginia. The heavy clay layers from these soils should be buried five feet deep and covered with more friable material. Soil scientists from the Extension Service and the Natural Resources Conservation Service can assist operators in identifying heavy clay layers in soils as well as friable material to substitute for it.

Overburden material, or by-products of certain processing operations, can contain concentrations of certain elements that are toxic to plant growth. Toxic producing materials include by-products, or waste materials, containing toxic levels of manganese, iron, zinc, and certain other heavy metals. Ground limestone (minus 20 mesh) and residues of burnt and hydrated lime are also toxic to plant growth when they comprise a substantial proportion of the growing medium. Materials toxic to plant growth must be buried at least five feet deep, to avoid pollution and revegetation problems.

3.7 Tests Useful in Selecting Overburden Materials

Rock layers or overburden strata often vary in chemical and physical properties from those above or below them. Samples from the different layers can be tested for mineral content, calcium carbonate (lime) equivalent, and minerals containing the plant nutrients phosphorus and potassium. Routine soil sampling tests include:

1. *pH test*. The critical pH level is 4.0. Material with pH values below 4.0 generally contains toxic concentrations of sulfide minerals. Material with pH values above 4.5, preferably above 5, is safe to use as a planting medium.
2. *Soil tests*. These tests will provide an indication of the dilute acid extractable phosphorus, potassium, calcium, and magnesium content of overburden material and its pH level. The tests may or may not be an accurate indication of the availability of plant nutrients for plant growth, but may be a guide as to whether or not minerals containing these plant nutrients are present in the overburden. The above tests are run routinely. Additional tests for soluble salts, manganese, and zinc can be useful.
3. *Other tests*. Overburden samples can be sent to commercial laboratories for tests on acid forming sulfides, basic minerals, heavy metals, and minerals containing phosphorus and potassium. Such tests provide information on the mineral content of rock layers or overburden strata.

3.8 Composition of Planting Medium

The proportions of rock to soil in mine spoil influences the amount of air movement, the evaporation rate, and the amount of water available for plants. Spoil composed of rock and coarse rock fragments usually has too much internal air movement and therefore, is prone to be drought like. However, too much clay or silt may form a dry, tightly packed soil that can prevent germination of seeds and seedling emergence. Soils with a mixture of small rocks and soil are best for seedbeds and planting of all types.

An inadequate amount of soil and finer textured overburden in the surface of mine spoils is another common problem. If at all possible, overburden consisting of surface soil and finer textured spoil material should be saved, and stockpiled for coverage of large and intermediate type rocks, as well as toxic materials. Forming the surface layer from such materials will increase the success of new seedlings and other plantings.

Spoil material arrangement may also influence the success of revegetation. A deep layer of large and medium size rock material on the surface contributes to a droughty condition. For best results and ease of planting, coarse spoil materials should be covered with three to four feet of soil, or a mixture of soil and small rocks. The finer materials are placed on the surface to reduce the movement of air through the large spaces surrounding the coarser rock fragments. Reduction in the movement of air through the soil reduces loss of moisture by evaporation.

Soil and fine textured overburden placed on the surface increases the success of seeding and revegetation on mine spoils. Soil containing humus, releases nitrogen and phosphorus as it degrades, creating an available form for the growth of plants. Soil also has a much greater moisture-holding capacity than coarse spoil material. Natural soil materials contain microorganisms that assist in improving soil aggregation, and organic matter content. They also aid in the release of plant nutrients.

3.9 Surface and Seedbed Characteristics

A moderately rough surface made with dozer tracking or disc harrow is the best type of surface for broadcast seeding. The seed falls into depressions between clods or into small cracks where it may germinate and establish.

The first one to two feet of soil should be free of rocks larger than three inches in diameter with one third to one half of the weight made up of sand, silt, and clay sized material. Silt and clay tends to seal overburden from rainfall, and rock material can be difficult to vegetate as it lacks the ability to retain water.

3.10 Soil Testing, Liming and Fertilization

The goal of reducing Nonpoint Source Pollution from nitrogen and phosphorus runoff should be a major concern when revegetating mine lands. The lime and fertilizer requirement for revegetation of mined areas depend upon the intent of revegetation. If revegetation is mainly for erosion control, stabilization, and wildlife habitat, only moderate amounts of lime and fertilizer are needed depending upon results of soil tests. Vegetation to be used for grazing by livestock, or harvested for forage, should use lime and fertilization application programs comparable to those used for agricultural purposes. Fertilizer and lime should be limited when seeding native seed. Soil samples are recommended, specifying the use of native seed.

3.10.1 Soil Testing

Soil testing and analysis must be an integral part of any reclamation program. Proper testing is used to determine the amounts of lime and fertilizer that must be applied to mined areas. This testing can save on lime, fertilizer, seed, labor, and machine use, as well as increase the rate of plant growth, expediting the reduction or release of bond.

Soil test measurements, including the degree of acidity, pH, and soluble salts, reveal much about the suitability of spoil or mined areas for revegetation. However, one or more plant nutrients can also be so deficient as to limit or prevent growth of plants.

Soil samples can be sent to the Virginia Tech Soil Testing Laboratory in Blacksburg for analysis. Local Cooperative Extension Offices in counties or cities throughout the state can provide soil sample boxes and information sheets. The results of the tests are sent to the Extension Agent who develops lime and fertilizer recommendations based on the species of plant intended to be sown, as indicated by the mine operator on the soil sample information sheet.

3.10.2 Collecting Soil Samples

Soil samples that are improperly taken are misleading and lead to poor germination, seedling growth, and vegetative cover. A typical sample should weigh approximately half a pound. Care should be taken when collecting samples. It must be done properly for such a small sample to adequately represent several acres of soil. To obtain a representative sample, it is necessary to collect, in a clean bucket, 15 to 20 sub-samples of about the same quantity from across the larger area. Depth of sampling should be four to six inches. A small pick and/or mattock and garden trowel are the best tools for collecting soil samples. The area represented by one sample should not be more than two to five acres depending upon uniformity of the soil. In sampling soil, collect sub-samples that are uniform in color, rock material, and amount of soil. Suspected problem areas should be sampled separately. A pictorial guide to soil sampling is available on the Virginia Tech Soil Testing Lab website.

3.10.3 Lime

Lime is used to raise soil pH. Few plants can survive in soil material when the pH is below four. Most plants have poor growth when the pH is below five. In general, where stabilization, erosion control, or wildlife habitat is the main concern, the pH of soil should be raised to five and a half or above. Certain plant species, however, may require an even higher pH level to achieve optimal growth.

Based on soil tests, soil type, soil pH and type of vegetation to be planted, correct lime rates per acre can be established. Liming before hydro seeding is preferred since this will give lime time to work into soil and increase the pH. A routine test package for soil samples can be obtained through the Virginia Tech Soil Testing Laboratory. The package includes recommendations on the use of fertilizer and lime.

3.11 Fertilization

Mine spoils are generally deficient in nitrogen and can have varying levels of phosphorus and potassium. Soil test information on spoil material takes the guesswork out of planning a lime and fertilization program. It will increase the likelihood of successfully revegetating areas after initial seed application.

Nitrogen and phosphorus are especially important for new seedlings on mine soil. A readily available source of phosphorus assures good seed germination and growth through the seedling stage, while nitrogen promotes rapid top growth and vegetative cover. Potassium, while important during the seedling stage of development, has a greater influence at later stages of growth.

The post mining use of the area (e.g., recreation, agriculture, etc.) will determine the type of fertilization used on soil materials. It is advisable to keep records of what has worked in the past for similar soils.

Legumes play an important role in the long-term success of revegetation on mined areas. Properly inoculated with Rhizobium bacteria, legumes are capable of fixing atmospheric nitrogen. The legume uses the nitrogen fixed in this manner and a certain amount becomes available to other vegetation present in the mixture. Grasses are unable to provide for their own nitrogen needs and must obtain it from the breakdown of organic matter, nitrogen based fertilizer, or an associated legume.

3.12 Establishing Vegetation

Defining Native and Naturalized Species

- Native – A species that existed prior to European settlement.
- Ecotype – A native species found in a defined area, state, or region.
- Naturalized – A species not native to a certain area that grows, reproduces, and maintains itself without interference.
- Variety – A subdivision of a native or naturalized species having a distinct consistent difference.

Fall vs. Spring Seeding

Traditionally seeding has been thought of as a spring activity, however many restoration projects are completed in the summer and require fall seeding. There are some noteworthy advantages to fall seeding. You have the option of seeding in the spring or in the fall. In Virginia, seeding should be timed with the available moisture which is from February 15 to April 15 and from September 1 to October 15 or during the dormant season as noted below. Early fall seeding has proven to be the preferred seeding season, especially in the Eastern Piedmont and Coastal Plain of Virginia.

Fall Seeding

Advantages and disadvantages:

- Fall seeding imitates natural reseeding
- Cooler temperatures and soil moisture may be more conducive to successful germination
- Fall seeding should not be attempted past October 15 in most areas due to the possibility of frost heave killing the young plants.
- Seed mixes should include a quick growing cover crop (i.e. winter rye, wheat)
- Some cool season species will establish during the fall/winter; however warm season grasses and most forbs will germinate in the spring
- Seed with a hard coat may need to overwinter before they will germinate causing some seed to be lost.
- Mulching is an important element of fall seeding to protect both the seed and soil and retain moisture

Spring Seeding

Advantages and disadvantages:

- Cool season species germinate soon after seeding. Germination of warm season species generally occurs within three weeks of the soil temperature reaching 55 °F
- Spring seeding is not recommended after April 15 due to the possibility of drought killing the plant before its roots reach a dependable source of moisture.
- Seed loss due to decay and wildlife consumption is minimized
- Seed-to –soil contact should be accomplished by working the seed into the soil (1/4" – ½" deep)
- Seeding can be delayed until weed control can be accomplished to improve establishment
- Irrigation during periods of dry weather may be needed for proper germination
- Light mulching is an important element of seeding to protect both the seed and soil and retain moisture

3.12.1 Seed Mixes

For best results it is required that seed mixes for mine reclamation include, at a minimum, a cover crop, a mix of annual and perennial grasses, and legumes.

3.12.2 Hydroseeding

Please consult Appendix C for information concerning the advantages and disadvantages of utilizing hydroseeding vs conventional seeding techniques.

3.12.3 Cover Crops

Cover crops typically are species that germinate quickly, grow rapidly for a portion of a growing season, and then die. Natural reseeding from the cover crop is typically insignificant. The cover crop provides quick soil stabilization, shade and moisture holding capacity to aid in the successful germination and growth of the other grasses and legumes in the seed mix. Common cover crop species for fall seeding are wheat, winter rye, and oats. For spring seeding foxtail millet and pearl millet. See Table for more examples of cover crops and application rates.

3.12.4 Annuals

Annuals complete their life cycle (germination, growth, seed set) in only one growing season. Annuals provide a stable food source for seed-eating forms of wildlife and provide rapid cover. Recommended annuals suitable for mined areas include annual lespedeza, foxtail millet, and grain crops.

3.12.5 Perennial Grasses and Legumes

In addition to providing erosion control, perennial grasses and legumes provide long-term cover and food source for many forms of wildlife. The seeds and succulent green parts are a favorite food for many birds and small mammals. Legumes are particularly attractive to a variety of wildlife. Recommended perennial grasses and legumes include fescues, orchard grass, perennial ryegrass, appallo lespedeza, red and ladino clover, crownvetch, and birdsfoot trefoil.

3.12.6 Woody Perennials

Woody perennials are a source of food and cover for wildlife, and provide essential habitat for many tree-nesting birds. The nuts, fruits, and seeds of woody plants are excellent sources of food, while dense shrubs and conifers provide excellent cover. Some recommended vines, shrubs, and trees for wildlife include wild grape, bicolor or shrub lespedeza, tartarian honeysuckle, black locust, apples, and blackberries.

3.12.7 Establishment Guides for Native and Reclamation Grasses

Note:

Native seeds will not germinate suspended in mulch, therefore mulch should not be used when hydro seeding native seed. Good soil contact is essential.

Fertilizer and lime should be limited when seeding native seed. Soil samples are recommended, specifying the use of native seed. The use of original topsoil to immediately reclaim areas which have been mined or when topsoil is depleted or removed the addition of organic materials in lieu of fertilizer is highly recommended.

The native seed mixes below are only examples. An internet search of native grass suppliers will provide not only sources of native grass seeds, but also, numerous seed mixes for different land uses.

Native Grass Mix:

35%	Schizachyrium scoparium	Little Bluestem
25%	Elymus virginicus	Virginia Wild Rye
18%	Sorghastrum nutans	Indiangrass
15%	Andropogon gerqardii	Big Bluestem, 'Niagara'
6%	Panicum virgatum	Switchgrass, 'Shelter'
1%	Agrostis perennans	Autumn Bentgrass

Seeding Rate: 10-15 lbs per acre.
Develops slowly, but will become a permanent cover for several years.

Deer and Turkey Mix

30%	Trifolium repens	White Clover, 'Ladino"
30%	Trifolium repens	White Clover, 'New Zealand
20%	Medicago saliva	Vernal Alfalfa
10%	Dactylis glomerata	Orchard Grass
10%	Lolium perenne	Perennial Ryegrass, Tetraploid

Seeding Rate: 30 lbs per acre.
A long lasting seed mix that provides erosion control and good nutrition for wildlife.

Native Upland Wildlife Forage and Cover Meadow Mix

20%	Elymus virginicus	Virginia Wild Rye

20%	Schizachyrium scoparium	Little Bluestem
10%	Panicum virgatum	Switchgrass, 'Shelter'
10%	Sorghastrum nutans	Indiangrass
10%	Tripsacum dactyloides	Eastern Gamma Grass
5%	Coreopsis tinctoria	Plains Coreposis
5%	Panicum amarum	Coastal Panic Grass, 'Atlantic"
5%	Poa palustris	Fowl Bluegrass
4%	Andropogon gerqardii	Big Bluestem, 'Niagara'
4%	Chamaecrista fasciculate	Partridge Pea
3%	Rudbeckia hirta	Black Eyed Susan
2%	Desmodium canadense	Showy Tick Trefoil
2%	Heliopsis helianthoides	Ox Eye Sunflower

Seeding Rate: 15 lbs per acre.

This mix provides forage and cover for a wide range of desirable wildlife, including butterflies and pollinators.

Riparian Buffer Mix:

10%	Carex vulpinoidea	Fox Sedge
8%	Panicum clandestinum	Deer Tongue, 'Tioga'
8%	Schizachyrium scoparium	Little Bluestem
6%	Chamaecrista fasciculate	Partridge Pea
6%	Elymus riparius	Riverbank Wild Rye
6%	Elymus virginicus	Virginia Wild Rye
6%	Verbena hastate	Blue Vervain
5%	Andropogon gerqardii	Big Bluestem, 'Niagara'
5%	Heliopsis helianthoides	Ox Eye Sunflower
5%	Virurnum dentatum	Arrow Wood
4%	Cornus amomum	Silky Dogwood
4%	Panicum virgatum	Switchgrass, 'Shelter'
4%	Sorghastrum nutans	Indiangrass
2%	Asclepias syriaca	Common Milkweed
2%	Desmodium canadense	Showy Tick Trefoil
2%	Eupatorium fistulosum	Joe Pye Weed
2%	Eupatorium maculatum	Spotted Joe Pye Weed
2%	Eupatorium perfoliatum	Boneset
2%	Juncus effuses	Soft Rush
2%	Monarda fistulosa	Wild Bergamot
2%	Penstemon digitalis	Tall White Beard Tougue
2%	Rhus typhina	Staghorn Sumac
2%	Rudbeckia hirta	Black Eyed Susan
1%	Baptisia australis	Blue False Indigo
1%	Euthamia graminifolia	Grass Leaved Goldenrod
1%	Vernonia gigantean	Giant Ironweed

Seeding Rate: 15 lbs per acre.

Establishes in 2-3 years, and develops into a biodiverse cover that can replicate our native vegetation.

Native Biomass Mine Mix

30%	Panicum amarum	Coastal Panic Grass, 'Atlantic'
30%	Panicum virgatum	Switchgrass, 'Cave-in Rock'
20%	Elymus virginicus	Virginia Wild Rye
15%	Andropogon gerqardii	Big Bluestem, 'Niagara'
5%	Desmodium canadense	Showy Tick Trefoil

Seeding Rate: 15 lbs per acre.

Provides food and cover for wildlife, straw could be used for biomass energy.

Cool Season Grass and Legume Mixes

Table 3-1 and Table 3-2 identify different types of grasses that may be used for revegetation. Table 3-1 identifies turf type perennial ryegrasses. Table 3-2includes the common name, scientific name, plant height, growing season, texture and type of growth, planting times, recommended seed rates (lbs./acre), and comments. The tables can be used to develop seed mixtures depending on type of cover desired (i.e., lawn areas, entrance ways, office areas, wildlife habitat, erosion control, and type of slopes). Usually more than one type of seed is used in a seed mixture. The overall mixture is based on the desired end result and should include fast growing species to provide shade and protection for seeds that take longer to germinate. Using these charts and consulting with the Mineral Mining Inspector, Department of Game and Inland Fisheries, Department of Forestry, and other sources, the operator can select a seed mixture that will give good results.

Table 3-1: Turf Type Perennial Ryegrass

Turf type perennial ryegrasses are excellent for use when rapid establishment is essential. They may be used in mixtures, but will tend to dominate the stand if percentage of ryegrass is too high. Ryegrasses are also excellent for use in high traffic areas such as athletic fields. The newer varieties have good drought tolerance, but may require irrigation if under drought stress or heavy traffic.

Bare Ground—6 to 8 pounds per 1,000 square feet.

Overseed—4 to 6 pounds per 1,000 square feet.

Overseed Warm Season Grasses—8 to 12 pounds per 1,000 square feet.

VARIETY	Color	Leaf Texture	Spring Green Up	Heat Tolerance	Drought Tolerance	Leaf Spot	Red Thread	Brown Patch	Endophyte Level	Recommended for use in Virginia
Citation II	G	G	E	E	G	G	G	G		√
Goalie	P	G	P	E	P	E	E	P		√
Palmer	G	G	G	G	G	G	G	G		√
Prelude	G	G	G	G	G	G	G	G		√
Rebel	G	G	E	E	E	G	P	G	E	√
Alliance Blend	E	E	E	E	E	G	E	E		√

E—Excellent G—Good P—Poor

Source: Turf-Seed, Inc./Lofts Seed, Inc.

Table 3-2: Highway and Erosion Control Seeds

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Redtop Agrostis alba	T	C	S	F/S	2 Mixtures	Quick cover for grassed waterways, diversions, road-banks. Produces an effective cover the first year. Grows in low-fertility, very acid, clayey, loamy and sandy soils. Fair drought tolerance; poor shade tolerance, will tolerate poorly drained soil. Widely used as a component in mixtures.
Bermudagrass Cynodon dactylon	S-T	W	S	S/Sum/F	40-75	Used as turf in athletic fields for stabilizing disturbed areas that are to be mowed. Bermudagrass grows only in the warmer time of the year and turns brown in the Fall after the first frost. Grows in low-fertility acid, clayey, loamy and sandy soils; excellent drought tolerance; poor shade tolerance; tolerates moderately well in drained soils. Use "hulled" seed in the Spring, "un-hulled" seed in the Fall.
Orchardgrass Dactylis glomerata 'Potomac'	M-T	C	B	F/S	8-15 Pure Stand 3-12 Mixtures	Primarily used for pasture or forage, Orchardgrass is long-lived and deep-rooted. The variety 'Potomac' has vigorous growth, rust resistance, leafiness, and persistence. Best time for planting is in the Fall. May be Spring planted.

[1]Short (S) is 1-12 inches; Medium (M) is 13-24 inches; and Tall (T) is 25 inches or taller.
[2] F-Fall; F/S-Fall or Spring; S-Spring; Sum-Summer.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Weeping Lovegrass Eragrostis curvula	M-T	W	B	S/Sum	20-40 Pure Stand 4-20 Mixtures	Fast growing cover for erosion control; may be a permanent cover on southern exposures and deep sandy soils; good nesting cover for birds. Produces complete cover in four to five months. Grows in low-fertility acid, loamy and sandy soils; excellent drought tolerance; poor shade tolerance; requires well-drained soil. Weeping Lovegrass can be established by seeding after severe Winter frosts have ended through July.
Tall Fescue Fescue arundinacea 'Kentucky 31' 'Maximize'	T	C	B	F/S	175-250 Pure Stand 40-100 Forage	Most versatile and widely used grass for conservation in the transition Zone. Stabilizes grassed waterways, streams and road-banks; used as a turfgrass for lawns; food for geese, deer and cottontail; cover for birds; forage for winter grazing. Use the variety "Maximize" for livestock, as it does not contain endophytes, which have been found harmful to grazing animals. Good drought tolerance; fair shade tolerance; somewhat tolerant to poorly drained soils. Please see the turfgrass section for improved Turf-Type varieties of Tall Fescue.
Hard Fescue Festuca longifolia 'Scaldis' 'Aurora'	M	C	B	F/S	130-170	Ideal for low maintenance sites such as cemeteries, parks, roadsides, ski slopes, industrial sites and reclamation area. Produces complete cover within one year. Very adaptable turfgrass that performs well in sun or shade without fertilization or supplemental irrigation. Hard Fescue produces a hardy, attractive, leafy turf of fine texture with a dark green color. Can be used as a companion grass in wildflower mixtures.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Sheep's Fescue Festuca Ovina 'MX-86' 'Bighorn'	M	C	B	F/S	175-250	Small bunchgrass with blue-green foliage that is tolerant to drought and gravelly or exposed sites. Adapts well to well-drained, medium textured soils. Sheep's fescue is an attractive grass that is frequently used in wildflower mixtures.
Red Fescue Festuca rubra 'Pennlawn'	M-T	C	S	F/S	125-175	Red Fescue has narrow, bright-green leaves. It spreads by short, underground stems to produce a tight sod. Grows in medium-fertility, slightly acid, clayey and loamy soils; fair drought tolerance; good shade tolerance; requires well-drained soil. For use in fine textured lawn mixtures.
Annual Ryegrass Lolium Multiflorum	T	C	A[3]	F/S	10-30 Mixtures	Used primarily as a temporary cover or nurse grass, to allow for germination of proprietary seeds, generally used in mixes for erosion control. Can be planted from early March to early May and from early August to mid October. Grows best in neutral to slightly acid, moist soils of moderate to high fertility.

[3] Annual Grass (A): Grasses that do not live longer than one year.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Perennial Ryegrass Lolium perenne	M-T	C	B	F/S	125-200	Fast-growing, short-term stabilizing cover. Also used for soil improvement, lawns (see Turfgrass section), and pastures. Grows in medium fertility, slightly acid, clayey and loamy soils. Rapid growth rate is the primary conservation value of perennial ryegrass. Establish by drilling or broadcasting seed with mulch in Spring or Fall.
Reed Canarygrass Phalaris arundinacea	T	C	S	F/S	12-15	One of the best grasses for swampy and wet areas. Performs well on poorly drained soils, tolerates moderate salt and alkali. Will withstand flooding, yet is quite drought tolerant when mature. An excellent grass for stabilizing waterways, healing and controlling gullies, and protecting shorelines of ponds and reservoirs from wave action. Grows 4 to 7 feet, providing good cover for shooting preserves.
Kentucky Bluegrass Poa pratensis	M	C	S	F/S	120 Pure Stand	Used for lawns, pasture, recreational, turf and erosion control. Choice food for grouse, turkeys, deer, and rabbits. Becomes dormant during dry or hot weather; however, it will normally survive severe drought. Requires a firm, weed-free seedbed. And a fertilizer high in phosphorous. Adequate lime is important, also. This grass is usually seeded with a mixture of other grasses or legumes, several varieties of Bluegrass should be used together to ensure good stand survival. See Turfgrass section for improved varieties of Kentucky Bluegrass.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Cereal Ryegrass Secale cereale 'Abruzzi'	T	C	A+	F/S	100 Pure Stand 10-15 Mixtures	Often referred to as Winter Rye because of its Winter hardiness, it is the most commonly used small grain grass for soil stabilization. Provides temporary cover in the Fall and Winter months. Germinates quickly and is tolerant of poor soils.
Foxtail Millet Setaria italica 'German Strain'	T	W	A+	F/S/Sum	25-45 Pure Stand 10-20 Mixtures	May be used as a quick cover component of mixtures from May through July for erosion control and forage. Dies at first frost.
Brown Top Millet Brachiaria ramose 'Dixie Signalgrass'	T	W	A+	S/Sum	20-25 Pure 10-15 Mixture	Often planted as a cover crop with other pasture grasses. It germinates quickly to hold the soil and provide shade for the pasture grass seedlings. It has a 90 growth cycle and gives way to more aggressive pasture grasses after going to seed.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Crownvetch Coronilla varia 'Penngift'	M-T	C	G	F/S	15-20 Mixtures	Used as a group cover for steep road banks, mine spoil and industrial waste sites, where low maintenance is important. It is also useful as a residential ground cover, and provides forage for wildlife. Crownvetch grows best on well-drained soils and will persist on more acid soils for a prolonged period once established. Seeding in the Spring is the most successful. Since an established stand of Crownvetch takes 2-3 years, it is recommended that a companion grass such as Perennial Ryegrass or Redtop be added to the initial planting. Crownvetch grows aggressively and blooms profusely during May and June. Can also be established by planting crowns or root divisions.
Chewings Fescue Festuca rubra commutata 'Jamestown II'	M-T	C	S	F/S	130-170	Ideal for low maintenance areas such as estates, parks and cemeteries. Also used for erosion control. It is a dark green, low growing turf grass with fine leaves and abundant tillering. It is persistent under low cutting and gives a close-knit, fast-establishing turf. Does best in shad and dry, infertile conditions. Grows in acidic, dry soils and is tolerant of drought stress.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Flatpea Lathyrus sylvestris 'Lathco'	M-T	C	G	F/S/Sum	20-40 Pure Stand 15-20 Mixtures	Deep-rooted, viny legume that grows to a height of 30 inches. Used for erosion control on road banks, logging roads, dams, gravel pits, mine spoil and industrial waste areas; cover for small mammals. Flatpea produces cover in 2-3 years, and should be planted with tall fescue or other fast-growing grasses. Flatpea is adaptable to a wide variety of soil conditions. Has excellent drought tolerance; good shade tolerance; requires well-drained soil; tolerates more acid and droughty sites than most legumes.
Bicolor Lespedeza Lespedeza bicolor	T	W	FR	S	15-20 Mixtures	Used as a food for quail, dove and wild turkey, and cover for these and other birds and mammals. Grows in most soil conditions except those with poor drainage. Bicolor Lespedeza is an upright shrub that grows to a height of 12 feet. The plants will produce seed in three to four years, which provides food for quail. Establish by direct seeding or by planting seedlings in early Spring. Plant in strips, borders or compact blocks to provide both food and cover.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Annual Lespedezas Lespedeza striata 'Korean' Lespedeza stipulaceae 'Kobe' (common)	S	W	A	S	40 Pure Stand 25 Mixtures	Annual warm season legumes used in pasture, hay, erosion control, soil improvement and wildlife food. Korean Lespedeza is larger and coarser than Common, or Kobe Lespedeza and grows to about 12 inches. Will grow in soil textures ranging from sands to clays and through a wide range of fertility conditions. May be seeded alone or mixed with grasses or small grains. Should not be mowed at less than three inches.
Birdsfoot Trefoil Lotus corniculatus	M	C	G	F/S	20-30 Mixtures	Birdsfoot Trefoil is an herbaceous forage legume that grows to a height of 1-2 feet. It is used in erosion control, soil improvement, and as forage for livestock and deer. Produces bright yellow blooms May through July. Grows better on poorly drained soil than most legumes, but is not as drought or heat tolerant as Flatpea or Crownvetch. Does not tolerate shade very well. Establish by seeding in April, in early May, or early in Fall.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Deer Tongue Panicum clandestinum	M-T	C	G	S/Sum	10-20 Mixtures	Plant cover for acid, infertile and dry sites such as old strip-mined spoils or acidic coal wastes. Also excellent feed and cover for deer and turkey. Produces a dense stand in 3-4 years. Therefore, a temporary cover species (Birdsfoot Trefoil, Weeping Lovegrass, small grains, i.e., oats) should be used in conjunction to aid in the establishment of Deer Tongue. Does well in low fertility or acid soils that are well drained or poorly drained. Deer Tongue may be seeded from March to early July. Do not add Deer Tongue to seed mixtures containing Tall Fescues or Ryegrass as they will out-compete the Deer Tongue.
Medium Red Clover Trifolium pratense	T	C	G	F/S	8-10 Pure Stand 2-8 Mixtures	Tall, short-lived perennial (actually a biennial), used widely in pasture mixes, as a rotation crop, and as a companion to legumes for forage land. Adapted to cool, moist sites. Poor acid tolerance. Easily established from early Spring through 30 days prior to first frost.
White Dutch Clover	C	S	G	F/S	2-6 Mixtures	Short, shallow-rooted, creeping perennial, used widely in pasture and lawn mixtures. Adapted to cool, moist sites. Slightly acidic to mildly alkaline tolerant. Easily established; cold hardy.

Reclamation Grasses and Legumes						
Common Name Scientific Name Varieties	Height [1]	Cool or Warm Season	Bunchgrass or Sod Former	Planting Time[2]	Seeding Rate (lbs./acre)	Adaptation and Comments
Ladino Clover Trifolium repens latum	T	C	G	F/S	2-6 Mixtures	Ladino white clover is very similar to White Dutch clover in all respects except size. It is a tall growing variety with thick stems and stolons that is used primarily in pastures with tall growing grasses, and in mined land reclamation.

3.13 Winter Revegetation

Establishing vegetative cover is sometimes required during the winter months to stabilize a disturbed area and to prevent erosion. Table 3-3 will aid the operator in establishing temporary stabilizing vegetation in the winter months. Reseeding will be required during regular planting seasons.

Table 3-3: Quick reference of temporary seeding specifications.

TABLE 3.31-B
(Revised June 2003)
TEMPORARY SEEDING SPECIFICATIONS
QUICK REFERENCE FOR ALL REGIONS

SEED		
APPLICATION DATES	**SPECIES**	**APPLICATION RATES**
Sept. 1 - Feb. 15	50/50 Mix of Annual Ryegrass (lolium multi-florum) & Cereal (Winter) Rye (Secale cereale)	50 -100 (lbs/acre)
Feb. 16 - Apr. 30	Annual Ryegrass (lolium multi-florum)	60 - 100 (lbs/acre)
May 1 - Aug. 31	German Millet	50 (lbs/acre)

FERTILIZER & LIME

- Apply 10-10-10 **fertilizer** at a rate of 450 lbs. / acre (or 10 lbs. / 1,000 sq. ft.)
- Apply **Pulverized Agricultural Limestone** at a rate of 2 tons/acre (or 90 lbs. / 1,000 sq. ft.)

NOTE:
1 - A soil test is necessary to determine the actual amount of lime required to adjust the soil pH of site.
2 - Incorporate the lime and fertilizer into the top 4 – 6 inches of the soil by disking or by other means.
3 - When applying Slowly Available Nitrogen, use rates available in Erosion & Sediment Control Technical Bulletin # 4, 2003 Nutrient Management for Development Sites at http://www.dcr.state.va.us/sw/e&s.htm#pubs

Note: Consultation with local seed vendors may be beneficial to the development of a good winter stabilization crop.

3.14 Invasive Species

Highly Invasive Species are not allowed for mined land reclamation. A list of highly invasive plant species is maintained by the Virginia Department of Conservation and Recreation.

Some plant species previously used in mine reclamation such as serecia lespedeza and autumn olive are no longer acceptable and will not be approved in a mine reclamation plan.

3.15 Vegetation of Critical or Problem Areas

Critical areas with inadequate vegetation can be the result of low or high pH values, hard or crusted surface, inadequate lime, fertilization, seeding rate, and/or use of poor quality seed. The first step in working with critical areas is to determine the cause(s) of the failure. A step-by-step procedure is listed below:

- Soil test to determine lime and fertilizer requirements.
- Lime and fertilize in accordance with soil test recommendations.
- Incorporate lime and fertilizer into spoil surface. If trouble spots must be covered with better materials, these materials also must be tested and pH and nutrient problems corrected.
- Check seeding surface for hardness and crusting. Tracking with a bulldozer, tillage with a heavy disc, or similar type surface scarification can be used to create a more favorable seedbed condition.
- Check the viability of seed. If deficient, correct by increasing the recommended per acre rate of viable seed, or use new seed that meets specifications.
- Consider use of non-vegetative stabilization measures as an aid to establish cover.
- Investigate alternative seed mixes with local vendors which have proven successful in similar conditions.

3.16 Mulches

Mulch should be applied on all areas. Minimum application rates should be as follows:

1. **Hay or Straw** should be applied at the rate of one ton per acre with less than ten percent of the soil surface exposed. This type of mulch should be anchored to the seeded surface by spraying with a wood cellulose fiber mulch at the rate of 1,000 pounds per acre or by crimping with a disc or other suitable equipment. Mulch could also be tied with stakes and string.
2. **Wood cellulose fiber** should be applied by hydro seeder at the rate of 1,500 pounds per acre. It should be color-dyed to provide visual metering of its application. Mulch should not be used in the hydroseeder when applying native grasses.
3. **Alternate mulches** may be utilized, but must be approved by the Mineral Mining Program prior to application.

Appropriate seeding mixtures adapted to the specific region should be used in reseeding critical areas. The required mixture will be determined by the date the area is to be sown. Lime and fertilizer requirements are to be in accordance with lime tests. Seeding rates for critical or problem areas should be increased 100 percent from normal to promote a quick vegetation cover. Also non-vegetative stabilization measures can be used as an aid to establish vegetation cover.

3.17 Forestry Reclamation Approach

Mine land reclamation in the past has often produced excessively compacted soil, which makes successful tree growth difficult. Often times mine operators believe that other post mining land uses, in particular hay and pastureland, are easier and cheaper to achieve than forestry. With the Forestry Reclamation Approach (FRA), the company can reduce grading cost, reduce fertilizer and seeding cost, and reduce maintenance cost.

5 Steps of the FRA:

1. Create a suitable rooting medium for good tree growth that is no less than 4 feet deep and comprised of topsoil, weathered stone, and/or the best available material
2. Loosely grade the topsoil or topsoil substitutes established in step one to create a non-compacted growth medium
3. Use ground covers that are compatible with growing trees
4. Plant two types of trees – 1) early succession species for wildlife and soil stability, and 2) commercially valuable crop trees
5. Use proper tree planting techniques

While the research and techniques utilized under the Forestry Reclamation Approach were developed primarily for coal mined lands, the techniques are transferrable and often times easier to accomplish on mineral mined lands.

3.17.1 Tree Planting - General

Areas for trees should be considered for all factors of multiple-use lands (i.e., wood products, wildlife, recreation, water, aesthetics, and environmental enhancement). For additional information and assistance, contact your County Extension Agent or District Forester, Virginia Department of Forestry.

3.17.2 Planting of Seedlings

Even distribution of seedlings over the area can minimize the variability of density, stocking, and species composition. Tree species and their adaptability to various regions of the state are shown in Table 3-4. Unless specifically prepared for tree plantings, mine overburden can be a difficult growing medium, particularly when substances toxic to plants are present, or if soluble salt content is high.

Relatively flat areas are ideal for tractor-drawn planting machinery. Approximately 5,000 seedlings can be planted per day per machine, using this method. Slopes are usually hand planted with a planting bar. Five hundred to 800 seedlings per worker per day is possible for an experienced planting crew.

The planting hole should be large enough to allow the seedling roots to spread out and extend downward. The roots must not be planted in the form of a "U". Soil should be firmly packed around the seedling.

Pine seedlings, such as loblolly or white pine, should be planted at a spacing of 6 x 6 feet and up to 8 x 8 feet. Spacing for other types of trees is shown in Table 5-3. Seedlings, spacing, and population required per acre are as follows:

6 x 6 feet = 1,200	7 x 7 feet = 890
6 x 7 feet = 1,037	8 x 8 feet = 680
6 x 8 feet = 907	

3.17.3 Seedling Care

Seedlings are delivered in bundles of 500 to 2,000. When the seedlings are taken from the bundle for planting, the roots should be kept moist. Do not carry seedlings with the roots exposed. It is essential that the roots of the seedlings not dry out or freeze before planting. The bundles should be stored in a cool, moist, dark area.

3.17.4 Time of Planting

Seedlings can be planted from December through April. On some sites, spring planting is preferable to winter planting. Some frost heaving may occur in loose material.

3.17.5 Seedling Sources

Seedlings are available from state and commercial nurseries. Availability from the state nursery depends upon the supply and the demand for seedlings. Seedlings may be ordered from the Virginia Department of Forestry through the County Chief Forest Warden and on the internet. Unless special arrangements are made, payment for seedlings must accompany the order. Early ordering is recommended.

3.17.6 Soil Stabilization Prior to Tree Planting

Trees alone do not provide acceptable soil stabilization on reclaimed mine lands and therefore areas to be planted in trees must be sown in grasses and legumes prior to tree planting. The seed mix must be compatible with tree planting i.e. it must include species that are relatively low growing, and that will provide initial soil stabilization, but will be minimally competitive with tree seedlings. The seed mix sown will also include lower rates of seed/acre, and fewer types of seed. An example of a seed mix compatible with the establishment of tree seedlings might include a cover crop, one or two types of grass (i.e annual ryegrass, perennial ryegrass) and a low growing legume (i.e. Korean or Kobe lespedeza, white clover).

Table 3-4: Types of Trees and Their Adaptability to Various Regions of the State of Virginia. Note: Table abbreviations defined on next page

	Erosion Control Only	Erosion Control and Screening	Screen Only	Erosion Control and Wildlife Habitat	Wildlife Habitat	Erosion Control and Noise Abatement	Noise Abatement	Erosion Control and Timber Production	Timber Production
Loblolly Pine			G[6]		A		E[6]		G[6]
White Pine			E		A		E		E[7, 8]
Shortleaf Pine			A		A		G		A
Virginia Pine	G[1]	E[1]	G	G[1]	G	G[1]	E	E[1]	G
Red pine			E[2]		A	A[2]	E[2]		E[2]
Scotch Pine	G[7]	G[7]	E[7]		A[7]	G[7]	E[7]		E[7, 8]
Pitch Pine	A[2]		G[2]		A[2]	A[2]	A[2]		
Red Cedar	A[1 ,3]	E[1, 3]	E[3]	G[1, 3]	G[3]	G[1, 3]	E[3]		[3]
Norway Spruce			E	A[4]	E[4]				A
Black Locust	E[1]	G[1]	A	G[1]	G	G[1]	A	A[1]	A
Yellow Poplar			A		A		A		A
Ash	A	A	A		G		A		G
Sycamore	A	A	A		A		A		G
Sweet Gum			A		A		A		A
Red Oak									A
Black Walnut					G[5]				G[5]
Sawtooth Oak					G[5]				
Persimmon					G				A
BiColor Lesp	A			A	E	A	A		
Bristly Locust	G[1]	A[1]	A	E[1]	E	A[1]	A		
Spacing Guide	6' x 6'	6' x 6'	7' x 8'[9]	6' x 6'	10' x 10'[10]	6' x 6'	6' x 6'[11]	6' x 6'	7' x 8'[12]

A—Acceptable G—Good E—Excellent

[1]A straw mulch should be used in conjunction with tree planting.

[2]Only above 2,000 feet in elevation.

[3]Where pH range is 4.0 to 8.0.

[4]For wildlife cover only.

[5]Only on a site suited for B. Walnut.

[6]Coastal Plain, Piedmont and limited to better sites elsewhere.

[7]Shenandoah Valley and Mountain Areas.

[8]Where Christmas Tree production is the objective.

[9]Minimum of 3 rows, 5 rows preferred, with seedlings staggered with rows.

[10]Except for BiColor Lespedeza, which should be spaced 3'x 3'

[11]A minimum of 100-foot wide strip needed. Where species are mixed, do not mix within rows.

[12]Spacing on white pine 10' x 10', hellow pines 7' x 8', and hardwood 12' x 12'.

Spacing	Seedlings/Acre
3' x 3'	4,840
6' x 6'	1,210
7' x 8'	778
10' x 10'	436
12' x 12'	302

Tree seedlings for the above species can be obtained from the Virginia Department of Forestry.

3.17.7 Plantation Management

Seedlings should be protected from grazing animals and fire. Technical and educational assistance is available through the Virginia Department of Forestry and the Cooperative Extension Service in all aspects of tree planting and forest management.

3.17.8 Screening, Noise, and Dust Abatement

Trees are an effective means of screening mine sites from residential areas and highways. They are also effective for reducing noise pollution and to some extent dust pollution. Evergreens or conifers are best for this purpose as they provide "year-round" foliage cover. It is suggested that Mineral Mining Program mine inspectors, local foresters and landscape architects be consulted regarding the varieties of trees to use for a particular screen, type of mining operation, and planting medium.

3.18 Establishing a Wildlife Habitat

3.18.1 General Habitat Requirements

The place where a wildlife species normally lives is called its habitat. Food, cover, water and the interspersion of those essential components are essential to the wildlife species survival and success. These habitat components are briefly discussed here because an understanding of them is imperative in developing a comprehensive wildlife plan.

Mined areas can be effectively managed for wildlife while meeting reclamation standards. The types and numbers of wildlife attracted to these areas will depend on existing wildlife populations and quality of habitat in the vicinity. This will be particularly true for game species such as deer, wild turkey, quail, grouse, dove, rabbits, squirrels, and raccoons. A wide variety of wildlife species can use mined areas and a realistic goal would be to manage for the maximum diversity of wildlife, not just one or two species. In this section, consideration is given primarily to wildlife species that can be supported by habitats provided during the initial stages of revegetation, or by combinations of revegetated mined land and adjacent undisturbed land. For example, species such as ruffed grouse should be considered only if the land adjacent to the mined site is natural forest or woodland. It should also be noted that not all of the wildlife species discussed are widespread throughout Virginia. Therefore, before attempting to develop habitat for some species, such as wild turkey or quail, populations of that species should be present in the vicinity of the mined area.

3.18.2 Food

The availability of the staple foods for a wildlife species is a critical consideration in developing a wildlife plan. Food supplies must be within the foraging range of the species of interest and available during all seasons. Wildlife diets change with the seasons as the availability of certain foods and the needs of the animals vary. Food sources must be available to resident wildlife in the winter to prevent starvation. Entire plants or various parts of plants may serve as food sources for wildlife.

3.18.3 Cover

Cover is as critical to wildlife as food. There are different types of cover, all of which may be required by a species. Plants provide brooding and nesting cover, escape cover, and shelter.

Although all plants provide a certain degree of cover, some plants are more suitable than others for specific cover needs.

3.18.4 Water

Requirements for water are met in various ways for different wildlife species. Not all wildlife species require surface water in the form of streams, ponds, seeps, etc. Some species are able to obtain their necessary moisture from the succulent plants they consume, from dew, or from their own metabolic processes. Snow also provides a source of water in the winter.

3.18.5 Considerations for Specific Wildlife

Areas containing the largest variety of plant species and ground forms are capable of supporting the greatest diversity of wildlife. Mined areas can improve the overall wildlife of the region by adding to its diversity. This can be accomplished by the use of a variety of plant species including annuals, perennial grasses and legumes, and woody perennials such as vines, shrubs, and trees. A diverse vegetative cover generally will support a variety of insect life, which is an important food of young birds. If surrounding areas are forested, then mined areas reclaimed to grasses, legumes, low-growing shrubs, annual millets, sorghums and grains are highly beneficial to deer, rabbits, grouse, turkey, and quail.

Reclamation should be directed towards the establishment of habitat that will meet the needs of the wildlife species desired. Habitat requirements may be similar for several species of wildlife, thus leaving a choice during reclamation planning. The wildlife plan may concentrate on providing a suitable habitat for one species in particular, a "featured species", or may consider favoring several different species. Either way, more species than expected may result, but, through planning, the area can support higher populations of the species desired.

In selecting wildlife and preparing for them, the present and future land use objectives must be considered. If the future use of the land ultimately is to be timber production, revegetation efforts will be directed towards forest development. Wildlife species that benefit from this type of vegetative environment can then be assisted by manipulating the habitat to provide specific requirements. If the mined area is to be reclaimed to farmland, wildlife species that thrive in an agricultural environment can be easily accommodated. In many instances wildlife enhancement may be a secondary benefit to the primary land use without modifying the vegetation plans to any great extent.

The DGIF may provide assistance/recommendations in designing wildlife enhancements on reclaimed mined land. VDGIF has a bobwhite quail restoration project with cost share money available for creating habitat conducive to bobwhite quail.

In order to protect the existing wildlife populations from disease, it is strongly recommended that there be no stocking of game animals, unless specifically approved by the Department of Game and Inland Fisheries.

Neither the Mineral Mining Program nor the Department of Game and Inland Fisheries (DGIF) are responsible for the stocking of game animals.

3.18.6 Planting Design

The planting design is as important as the selection of plant species. Annual and perennial grasses, and legumes, should be seeded in mixtures according to recommendations listed previously in this guidance. The key to good wildlife management is to keep plantings small and interspersed. Many small irregular shaped patches are better than a few large tracts. Interspersion or the arrangement of food and cover areas within the home range of the species is very important to the success of wildlife populations. Failure of otherwise favorable habitats may occur simply because the arrangement of food patches and cover was not carefully planned.

Clumps of woody perennials or conifers should be interspersed with the herbaceous vegetation. Each wildlife plot should be arranged to break up vast open areas and create an edge effect.

If unmanaged and given enough time, reclaimed mined areas will eventually return to a natural stand of hardwoods. This process of replacement is called plant succession. The rate at which succession takes place will depend upon the soil, climate, drainage and other environmental factors. As succession proceeds, wildlife habitat will evolve through natural stages, thus noticeable changes will occur in wildlife population. Succession often proceeds at a different rate on different parts of the mine, thus contributing to the natural diversity so important to wildlife.

For more information and assistance, contact County Extension Agents, Natural Resource Conservation Service, and District Wildlife Biologists of the Virginia Department of Game and Inland Fisheries.

3.19 Plantings for Wildlife Habitat

The Mineral Mining Program, in cooperation with the Department of Game and Inland Fisheries, has prepared suggested plantings for use in reclamation, which are also ideal for wildlife enhancement. The attached list includes selected species that are most likely to succeed on mine soils. The purpose for these plantings is to replenish the wildlife food supply, cover, and set the stage for natural succession of growth in the plant community.

The trees and shrubs listed are species recommended based on their high ability to produce wildlife food, mature early, and should grow well on mined areas. Table 3-5 and Table 3-6 are suggested species of trees, shrubs, grasses, and legumes for use. Other species proposed for use may be approved based on a demonstration of their value to wildlife and suitability to the site. Native, warm season grass mixes can also be tailored to enhance wildlife habitat.

Table 3-5: Trees and Shrubs

Common Name	Scientific Name	Spacing (feet)
Sawtooth Oak	Quercus acutissima	8x8
Bear Oak	Quercus ilicifolia	8x8
European Alder (wet areas)	Alnus glutinosa	8x8
Flowering Crabapple	Malus spp.	10x10
Toringo Crabapple	Malus sieboldii	10x10
Siberian Crabapple	Malus bacca-ta	10x10
Hawthorns	Crataegus	10x10

Eastern White Pine	Pinus strobus	8x8
Virginia Pine (stress areas)	Pinus virginiana	8x8
Eastern Redbud	Cercis candensis	8x8

Table 3-6: Grasses and Legumes

Common Name	Scientific Name	Rate/acre
Winter Wheat	Triticum aestivum	25 lbs.
Orchard Grass	Dectylis glomerata	25 lbs.
Buckwheat	Fagopyrum sppl.	25 lbs.
White Dutch Clover	T. repens	10 lbs.
Red Clover	T. pratense	10 lbs.
Foxtail Millet	Setaria italica	10 lbs.
Crown Vetch	Coronilla varia	10 bs.

3.20 Fencing

The reclamation of mining operations where highwalls or openings exist that are impractical to backfill or close often requires fencing to mitigate potential safety hazards to the public and wildlife. The use of fencing in reclamation should be approved by the Mineral Mining Program in the reclamation plan for the mine.

3.20.1 Fencing Requirements:

Per 4VAC 25-40-300 of the Mineral Mine Safety Regulations, hazardous conditions that exist in relation to roads, openings, or pits shall be effectively closed or fenced and posted with warning signs prior to abandonment. In order to help operators comply with this regulation, the following fencing requirements have been usually deemed as the minimum acceptable requirements by the Department:

Fencing materials must comply with the following specifications. Alternative materials may be used if approved in advance by the Mineral Mining Program.

Materials

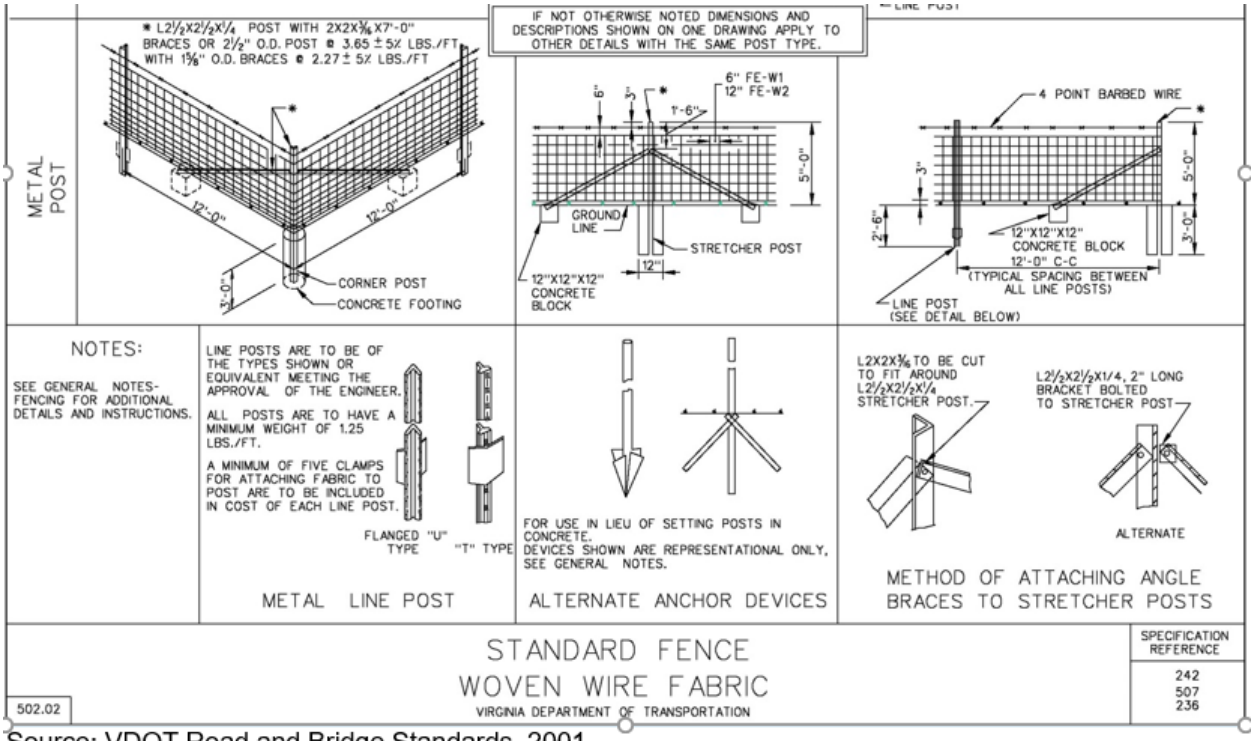
- Woven Wire Fence Fabric: shall conform to ASTM A116 for Design Number 1047-6-11 for Class 3 galvanized wire with six-inch stay spacing and 47 inch height fence
- Posts:
  - Line post should be either galvanized flanged "U" or "T" type with a minimum weight of 1.25 pounds per foot and with a minimum of five clamps for attaching fence fabric.
  - Corner and Line Brace Posts should be either galvanized "L" 2-1/2 X2-1/2 x 1/4 with "L" 2x2x3/16 braces, or galvanized 2-1/2 OD pipe with 1-5/8" OD braces.
  - Gateposts should be 4" OD galvanized pipe.

- Fittings and Supports: Fitting shall be 11 gauge galvanized steel wire or seven gauge aluminum wire clamps. Fittings and supports shall be galvanized in accordance with ASTM A123 or A153, as applicable.
- Barbed Wire: shall be double stranded, 12-1/2 gauge with four-point barbs on approximately five-inch centers and conforming to ASTM A585, Type 1 with 0.3-oz/sq. ft. of aluminum coating.
- Concrete: Concrete should be Class A, 3000-PSI mix design, or high strength, quick-set grout, where applicable.
- Signage: Danger Signs should be fabricated from steel or aluminum sheet with red background (film or painted) and with two-inch black letters (film or painted) in block format for the message. Each sign should have at least two holes suitably located for mounting to fence fabric. Sign materials and fabrications should be warranted for at least five years against fading, cracking and peeling. Message should read: "DANGER KEEP OUT". Signs shall be installed in sight of one another.

Installation

- Prior to installation, the fence line should be staked out and all utility lines and services should be located and preserved
- Woven wire should be installed to a minimum height of 48 inches with the strand of barbed wire installed 6 inches above the top of the woven wire section. The woven wire section should be installed just above the ground surface.
- Line posts should be spaced between 8 and not to exceed 12 foot spacing and should be set in the ground 36 inches into unconsolidated material.
- Line posts that are driven into rock must be set in rock for a minimum of 18 inches and secured with concrete.
- Line brace posts should be installed on 500 feet maximum spacing, adjacent to water gates and fence gates, and whenever the fencing vertical alignment changes 15 degrees or more.
- Corner braces should be installed whenever the corner angle is 15 degrees or more.
- Concrete must be allowed to cure for a minimum of 7 days prior to the installation of the woven wire fencing
- Danger signs should be installed within sight of each other and should be fabricated from steel or aluminum sheet with a red back background and with two-inch block format, black letters. Sign should be warranted for at least five years against fading, cracking, and peeling. Message should read: "**DANGER KEEP OUT**"
- Posts that are misaligned, bent, or broken, should be replaced immediately.
- Fencing should conform to the Virginia Department of Transportation (VDOT) Standard Fence Woven Wire Fabric design, shown in Figure 3-1, unless otherwise stated.

Failure to adhere to the above fencing requirements, or other comparable deterrent measures deemed acceptable by the Director, can delay bond release and final reclamation. Specifications for acceptable comparable deterrent measures must be submitted and approved by the Division prior to construction.



Source: VDOT Road and Bridge Standards, 2001

Figure 3-1: Standard woven wire fence construction (VDOT).

4 ROADWAYS AND STREAM CROSSINGS

4.1 Definition

Any road located within the mine permit area that is constructed or improved for the transportation of personnel, equipment, or materials.

4.2 Purpose

To provide a route for access to permit areas and for moving equipment, supplies, and materials within the permit area.

4.3 Condition Where Practice Applies

This section describes design and construction practices to control runoff, sediment, and dust originating from roadways. These practices apply to permitted access roads and internal service roads that may impact areas outside the permit area.

4.4 Design Criteria

Principal access roads and internal service roads should be planned, constructed and maintained to minimize the impact of traffic, vehicle noise, runoff, and dust on areas beyond the permit.

4.4.1 Access Roads

Access roads that intersect public roads should be paved with an approved all-weather surface capable of preventing the deposition of mud or debris onto the public road. Where possible, access roads should enter public roads at an uphill grade with drainage directed back to sediment controls within the permit area.

Key design features when designing mine entrances:

A. Hard surfacing:
    a. Should be able to carry the weight of loaded trucks.
    b. Should extend an adequate distance to remove debris from tires.
B. Good drainage:
    a. Runoff should leave the road surface by the shortest path.
    b. Drainage should be directed away from the intersection with the public road.
C. Good traffic control:
    a. Slow the approach to the stop point to minimize braking stress on the road surface.
    b. Avoid mixing on and off-road equipment, where possible.
D. Ease of maintenance:
    a. Allow room to wet and sweep the road surface.
    b. Provide adequate debris storage adjacent to the road to prevent build up on the shoulder.

Additional design considerations:

A. Minimize hard turns that concentrate wear on the road surface.
B. Curbs, posts, or rocks will help to keep traffic on the hard surface.
C. A concrete surface at the braking point or speed bump before the braking point will help to prevent potholes.
D. Design sediment control and debris storage that can be cleaned with rubber-tired equipment.
E. Consider the use of a wheel wash and clarification basin

Essential maintenance equipment:

A. Water truck equipped with pressurized fan spray and wash down hose
B. Enclosed cab sweeper
C. Road grader to maintain stone surfaced roads
D. Small rubber-tired loader to clean debris storage areas and sediment traps

Highway land use permits for commercial entrances must be obtained from the Virginia Department of Transportation and installed in accordance with the approved VDOT permit. These plans must be submitted to the Mineral Mining Program as part of the permit package. Additional contact information for the Virginia Department of Transportation is available Appendix A of this manual.

4.4.2 Internal Service Roads

Internal service roads should be surfaced with an approved all-weather surface capable of stabilizing the road. All-weather surfacing may consist of asphalt, concrete, crushed stone, or sand and gravel. Roads should not be surfaced with any acid producing material or any material that may produce a high concentration of dust or suspended solids in adjacent drainageways.

When crossing areas of soft ground, geotextiles may be used to improve road stability. There are a number of geotextile products manufactured for use in road construction. When used under road surfacing materials, these fabric underlayments spread out the load of passing equipment and help prevent sinking and rutting of road surfacing materials. The geotextile should extend under the entire width of the road and should not surface where it could be snagged by road maintenance equipment.

Basic criteria for road designs are listed below and shown in Figure 4-1. Numbers correspond with those shown in the cross sections.

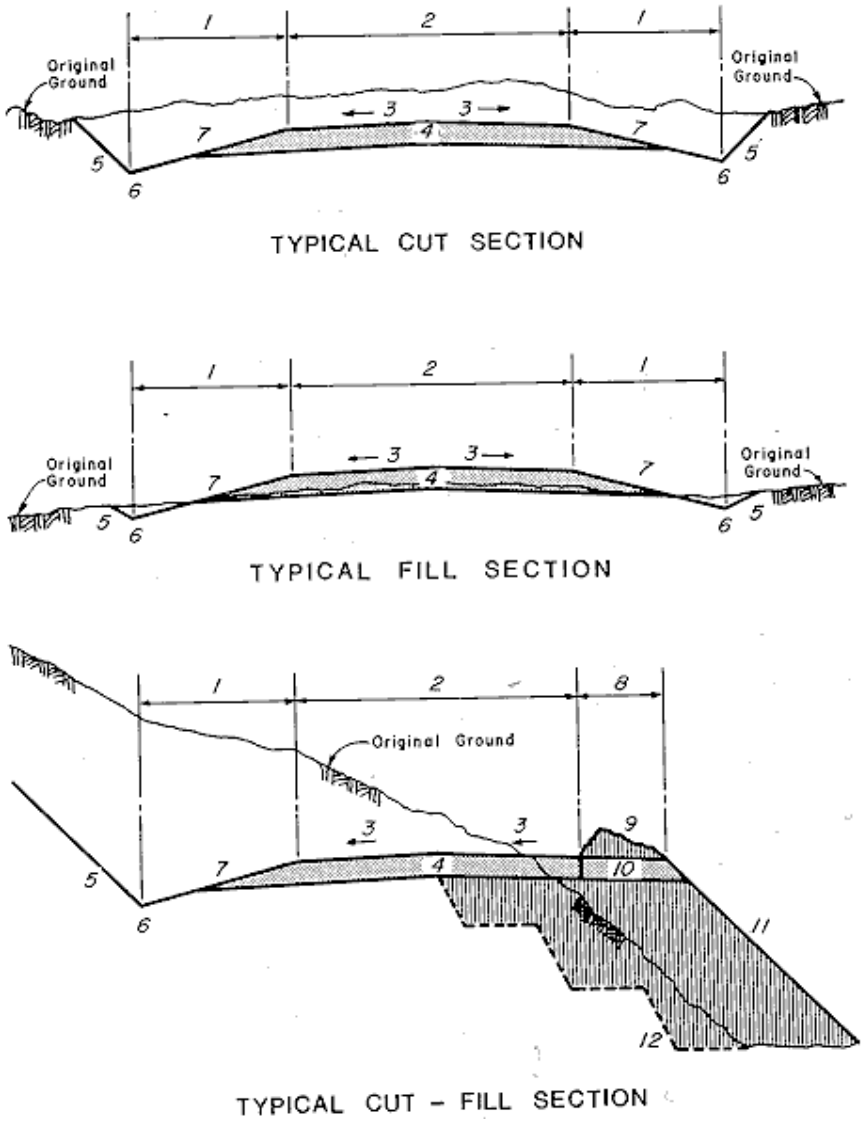


Figure 4-1: Typical Haulageway Sections

1. Lane edge to centerline of ditch. Dimensions will vary with the centerline depth (6) and required slope (7). Adequate shoulder width and slope should be provided to ensure that drainage within the ditch lines does not contact and soften road surfaces.
2. Lane width. This should be based on the dimension of the largest vehicle and the number of travel lanes desired. A single lane road should be twice the width of the largest vehicle. Dual lane roads should be 3 ½ times the size of the largest vehicle to allow half a vehicle width on both sides of passing vehicles.
3. Typical cross slope for excavated sub grade and road surface. The grade from the road centerline should be either ¼ or ½ inch per foot, depending on the surface material used. Roads that require safety berms on their outer edge should be banked away from the berm to their inside edge.
4. Combined surface and subbase. The depth of surfacing will ultimately depend on the required wheel loads and bearing capacity of the soil beneath the road. At a minimum, the road surface should consist of six inches of coarse rock base and two inches of crusher run. Using too little surfacing material during road construction will only lead to additional material being applied during subsequent, and often, maintenance.
5. Ditch outslope. In rock, this may approach a vertical slope. In less consolidated material, a 2:1 slope should be used.
6. Depth at centerline of ditch. The depth of ditches must be sufficient to handle the runoff from adjacent watersheds and ensure that the drainage within the ditch does not contact and soften road surfaces. The depth of the ditch below the sub base should be equal to the total depth of runoff anticipated within the ditch. In cut sections, drainage should be carried on both sides of the road.
7. Ditch slope adjacent to roadway. The slope of the ditch adjacent to the roadway should be 4:1 or flatter except in extreme restrictive conditions. It should not exceed a 2:1 slope.
8. Additional Lane Width. Road widening to accommodate safety berm. Dimension varies with berm size required. The width of the berm should be added to the lane width to ensure the lane is wide enough for safe travel.
9. Safety berm. Safety berms should be constructed with maximum 1:1 slopes and stabilized with vegetation. The final height and outslope of the berm will depend on the rolling radius of the largest tires to traverse the road, the grade of the road, anticipated vehicle speeds and the type of material available to construct the berm. The completed berm must be able to stop and catch the largest vehicle that will travel the road.
10. Berm support. Placed and compacted to support berm. This material should extend a foot or more beyond the outslope of the berm to ensure its integrity and minimize future maintenance.
11. Fill or cut slopes. Fill material may be obtained from cut portions of the road or other excavated material from the mining operation. It should be select material, free from large rocks, roots or other debris and excessive moisture. The use of saturated or poorly drained material may result in slope failure under load. Fill material and road cuts should be sloped to minimize erosion and support a vegetative cover. Slopes should be completed on a grade not to exceed two horizontal to one vertical (2:1) in clayey soils. In sandy soils, slopes should be completed on grades not to exceed three horizontal to one vertical (3:1).

12. Fill bench. Benching prior to fill placement is required whenever the slope of original ground is 1:1 or steeper. Benches should be cut eight to 10 feet wide and eight to 10 feet deep with cut slopes on 0.5:1 grade or steeper. Terracing should begin at the toe of the slope in original ground and continue uphill until the road sub grade is reached.

When roads are abandoned, immediate steps shall be taken to minimize erosion and establish the post-mining use in accordance with the approved reclamation plan. This normally requires that the road surface be scarified to a depth of 12 inches or more, covered with at least six inches of topsoil, and be planted to meet the approved post-mining land use. The road may be left un-reclaimed for post-mining access to the affected property as long as it is in a stable, well-maintained condition and approved as part of the post-mining land use.

4.4.3 Drainage and Sediment Control

Good drainage is necessary to ensure the stability of roads. Standing water in rutted sections of a road will continue to soften the road and deepen the ruts with each pass of mobile equipment. Access roads and internal service roads should be banked or crowned to ensure positive drainage from their surface. Where it is impractical to bank or crown a road, water bars may be necessary to divert runoff to adjacent ditch lines.

Ditches, of sufficient capacity to control surface runoff, should be provided along roadways. For most situations, V-ditches are recommended due to their relative ease of design, construction and maintenance. Where possible, ditches should be located in undisturbed earth or rock. Due to their likelihood to erode, ditches should not be located in fill material.

The capacity of ditches to handle runoff depends on their configuration, grade and the type of lining provided within the ditch. Generally, loose, porous linings on shallow grades will reduce flow rates and increase flow depths, thereby requiring larger ditches. Ditches should be at least one-foot-deep, as measured from the lowest point in the road surface adjacent to the ditch and should be adequate to carry runoff from a 10-year storm event. Ditches excavated in earthen material should be stabilized with rock or vegetation and check dams should be utilized along steep sections of ditch line to prevent erosion. Ditches may be grass lined up to an eight percent slope, but geotextiles are necessary on grades steeper than three percent to provide extra stabilization. Culverts, slope drains or relief ditches shall be installed at appropriate intervals to prevent overloading of roadside ditches.

Sediment control shall be provided along all roads to minimize the amount of sediment that leaves the disturbed area. Appropriately sized sediment traps shall be installed and maintained at all ditch relief points to provide sediment control along the roadway. Sediment traps shall be installed at all four corners of stream crossings unless other steps are taken to provide drainage and sediment control.

When roads are constructed through heavy forest cover, additional consideration should be given to maintaining a dry running surface. Pines and deciduous trees, when in leaf, can produce significant amounts of shade and prevent adequate air flow. To maintain a dry running surface during the wet and cold seasons of the year, it may be necessary to extend the limits of clearing

further than necessary to construct the road and ditch lines. A good rule of thumb is to clear a right of way that is at least 1-½ times the width of the road and ditch lines.

Roads should be located away from streams and wetlands wherever possible. Where the two are in close proximity, a protective buffer of undisturbed vegetation should be maintained between them to prevent runoff from entering the stream. If possible, this buffer strip should be at least 50 feet wide. The width of buffer zones is dependent on their slope. See the Buffer Zone portion of Chapter 2. Stream and wetland impacts will require additional permits from the Army Corps of Engineers, Virginia Department of Environmental Quality, and Virginia Marine Resources Commission. Please see Appendix A for additional information on these agencies.

4.4.4 Culverts

Culverts should be used wherever necessary to facilitate drainage along roadways and prevent runoff from overloading ditches. As a rule, culvert spacing should not exceed the following limits.

1000 feet on grades from 0 to 3 %

800 feet on grades from 3 to 6 %

500 feet on grades from 6 to 9 %

300 feet on grades steeper than 9 %

Culverts should be sized to accept the maximum runoff from the watershed above them using Talbot's Formula, given in Appendix D. Where possible, the pipe diameter should be large enough to accept the required flow without creating a backup at the pipe inlet. Figure D-1 in Appendix D may be used to determine culvert size based on flow requirements. Flows in cubic feet per second on the left side of the chart should be read to their intersection with the solid diagonal line and then down to the corresponding minimum pipe diameter necessary to handle the flow. The corresponding diameter should be rounded up to the next largest manufactured culvert size to specify a pipe capable of handling the required flow. This is the minimum diameter pipe that will flow full without any water backup at the inlet. Where it is desirable to install smaller size culverts, the dashed lines on the chart may be used to size a pipe based on the amount of allowable headwater that may be created behind the pipe. Due to the problems that can be created by backing water up in ditch lines, the practice of creating inlet headwater is discouraged.

Culverts should be installed in accordance with the following (Figure 4-2):

1. Culverts should be placed on a minimum grade of one percent to ensure free drainage. They should be bedded on firm material free from large rocks or soft spots that could cause damage to the culverts or uneven settling along their length. Particular care should be taken to ensure that culverts lay on the same grade relative to one another when connections need to be made between them.
2. Culverts lengths should be adequate to extend beyond the full width of backfill to ensure the ends are not accidentally covered.

3. Culverts should be covered by compacted, select fill, free from large rocks, roots or other debris, to prevent damage from equipment that will use the road. If multiple culverts are used, they should be separated by at least 12 inches of fill. Fill material should be carefully compacted around the culverts in lifts not exceeding eight inches. Care should be taken to ensure that connections between culvert sections are tight and properly made up without gaps. The minimum depth of cover placed over the culvert should be equal to one-half the diameter of the culvert, or 12 inches, whichever is greater.
4. The inlet end of the culvert shall be protected by a headwall of suitable material such as a manufactured flared end section, concrete retaining wall, sand bags, rock riprap, or other approved material.
5. The outlet end shall discharge onto an apron of rock riprap or other approved material capable of preventing soil erosion. When practical, the outlet end should be placed at the toe of fill material. If discharging onto a fill slope, drainage must be conveyed down the fill by pipe slope drain, rock slope drain, or other means to prevent erosion.
6. Culverts should not be less than 12 inches in diameter and should be adequate to carry runoff from a 10-year storm event.
7. Solid or perforated risers shall be used on the upstream end of culverts used to drain roadway sediment traps, or the invert end of the culvert shall be set at least 2 feet above the base of the trap.
8. Adequately sized culverts shall be placed in natural water courses intersected by roadways. See stream crossing section of this manual.

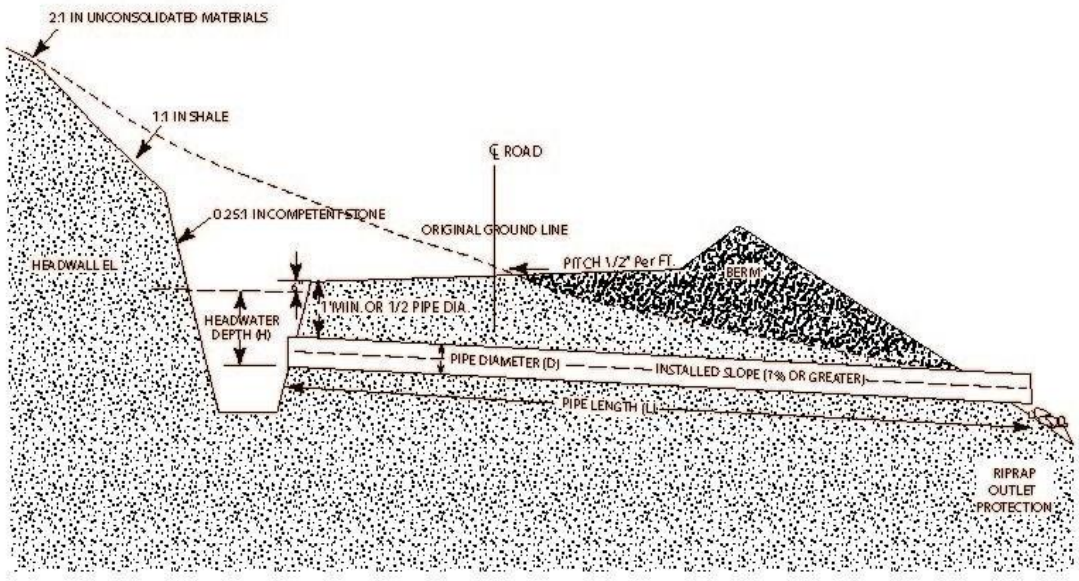


Figure 4-2: Typical Haulageway Section Showing Installation of Ditch Relief Culvert

4.5 Road Maintenance

Maintenance is required to insure the proper functioning of the road and drainage system. Maintenance of the road system shall consist of inspecting, repairing and cleaning roadways, ditches, culverts and bridges, as often as necessary, to ensure their proper functioning. Particular attention should be given to removing debris from culvert inlets. Road surfaces shall be repaired and resurfaced with durable material where rutted, eroded or otherwise damaged.

4.6 Stream Crossings

4.6.1 Definition

A structural span installed across an intermittent or perennial watercourse for use by mine traffic. Structures may include round pipes, pipe arches, oval pipes or box culverts.

4.6.2 Purpose

To provide a means for mine traffic to cross streams without damaging the channel or banks or tracking sediment or other pollutants into the stream.

4.6.3 Conditions Where Practice Applies

Temporary Crossings: Generally applies to crossings that will remain in service during the life of the mining activity, or a fraction thereof.

Permanent Crossings: Applies to crossings that will remain in service during mining and will be utilized as part of the post mining land use.

4.6.4 Planning Consideration

Alteration or relocation of natural drainageways may be permitted if the integrity of the drainageway is maintained and adjoining landowners are protected from damage resulting from the alteration/relocation. Stream crossings and wetland impacts may require a permit from the Army Corps of Engineers, Virginia Department of Environmental Quality, and Virginia Marine Resources Commission. Additional contact information for these agencies can be found in Appendix A. Operators are encouraged to contact them during the planning phases of the project to determine if a permit will be required.

Stream crossings must be designed and constructed to prevent stream flows from being restricted. The crossing should be adequate to convey runoff from the upstream watershed during its expected lifespan. From a safety and utility standpoint, the designer must also be sure that the span is capable of withstanding the expected loads from heavy equipment that will cross the structure. The structure should also be wide enough to accommodate the largest piece of equipment to use the crossing and allow adequate room for safety berms or guardrails.

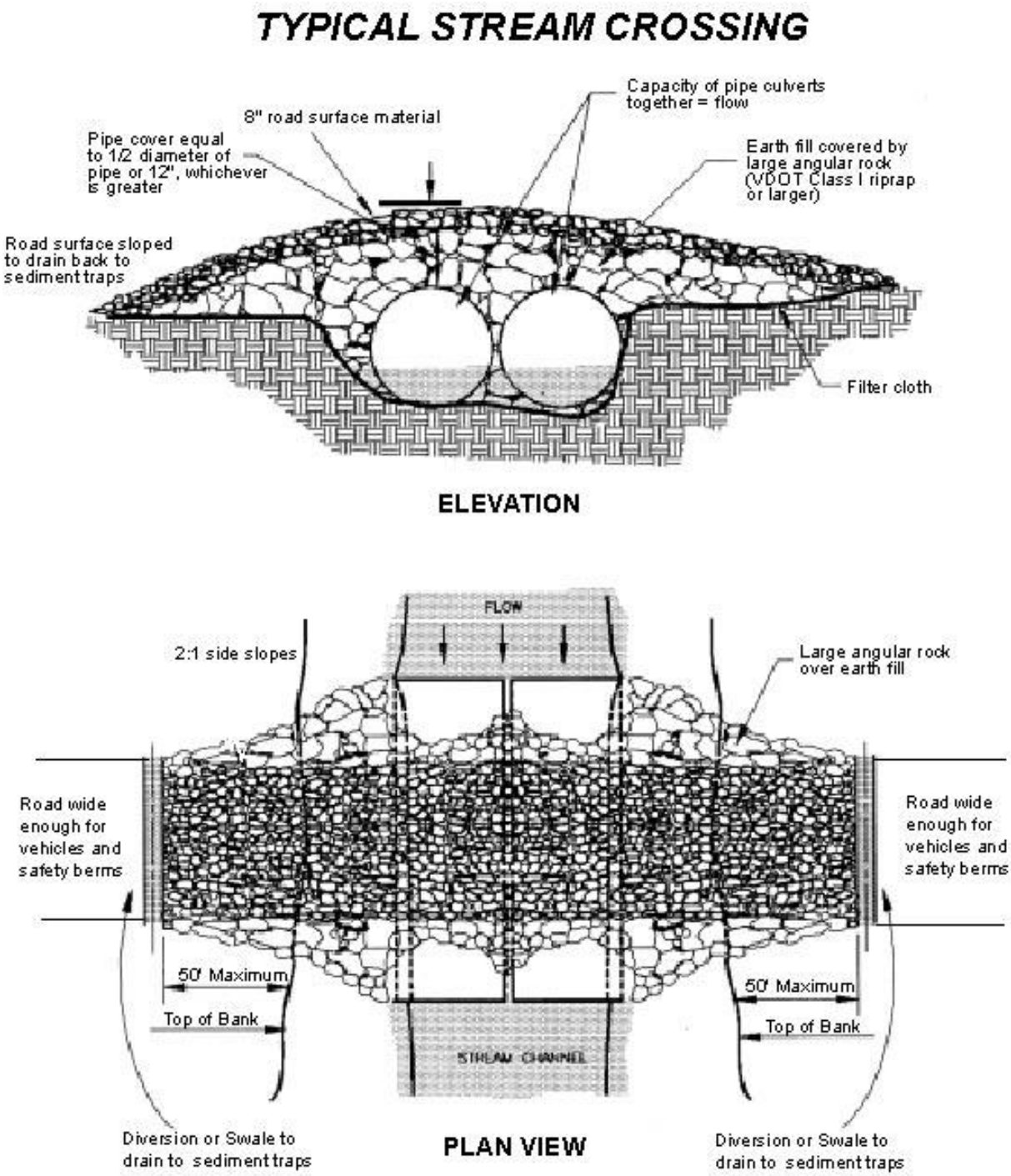
4.6.5 Design Criteria

A stream crossing may consist of circular pipes, pipe arches, oval pipes or boxes constructed of corrugated metal, structural plate, high-density polyethylene or reinforced concrete. Culverts are normally used where the channel is too wide for single span bridge construction or the anticipated loading of vehicles may be unsafe for a single span bridge. Stream crossings should be installed in accordance with the following standards. (Figure 4-3)

1. Stream crossings should be constructed at right angles to the stream, wherever possible. Where approach conditions dictate, the crossing may vary 15° from the perpendicular. Wherever possible, the centerline of both roadway approaches should coincide with the crossing alignment centerline for a minimum distance of 50 feet from each bank of the stream. This will minimize wear and tear on the crossing as vehicles pass back and forth. When fill is required to build up the approach roadways, it should be limited to a maximum height of two feet above the flood plain elevation.
2. Culverts lengths shall be adequate to extend beyond the full width of backfill to ensure the ends are not accidentally covered.
3. All culverts should be strong enough to support their cross-sectional area under maximum expected loads.
4. Multiple culverts may be used in place of one large culvert if they have the equivalent capacity of the larger culvert. Culverts used to cross a stream should not be less than 18 inches in diameter.
5. Reinforced concrete headwalls should be used where backfill is likely to wash or where excessive flow velocities are encountered.
6. The crossing should be crested in its center and bermed along its sides to direct runoff down the road approaches. Water diverting structures or swales should be constructed across both roadway approaches within 50 feet of the crossing. The diversions should direct runoff from the road and stream crossing into properly sized sediment traps on both sides of the crossing. This method of grading the crossing will prevent water from building up on the crossing and will direct surface runoff into a sediment control structure before entering the waterway.

4.6.6 Construction Specifications

1. Clearing and excavation of the streambed and banks should be kept to a minimum. The inlet and outlet ends of culverts should be installed on natural ground within the streambed to minimize interference with fish and animal movement along the stream. Culverts should not be buried in the streambed since that will decrease their flow capacity. However, it is important to ensure that the culverts are bedded on firm material free from large rocks or soft spots that could damage them or cause uneven settling along their length. Particular care should be taken to ensure that culverts lay on the same grade relative to one another when connections need to be made between them. Once initiated, construction shall be completed as soon as possible to minimize degradation of the stream channel. If possible, construction work should be scheduled to take advantage of periods of low flow.
2. Filter cloth should be placed on the streambed and stream banks prior to placement of culverts and aggregate necessary to construct the stream crossing. The filter cloth should cover the streambed and extend six inches to one foot beyond the end of the culverts and bedding material. The filter cloth will reduce fill material settlement and improve crossing stability.



Source: VA Erosion and Sediment Contral Handbook, 1992

Figure 4-3: Typical Stream Crossing

3. The culverts should extend a minimum of one foot beyond the upstream and downstream toe of the aggregate used to stabilize the stream crossing. This is necessary to ensure that sloughing material does not cover the culvert ends.
4. Care should be taken to ensure that connections between culvert sections are tight and properly made up without gaps. If gaps form at connection points, backfill may erode through the gap and create cavities that will eventually lead to road failure.
5. Culverts should be covered by compacted, select fill, free from large rocks, roots or other debris, to prevent damage from equipment that will use the road. If multiple culverts are used, they should be separated by at least 12 inches of fill. Fill material should be carefully compacted around the culverts in lifts not exceeding eight (8) inches. The minimum depth of cover placed over the culvert should be equal to one-half the diameter of the culvert, or 12 inches, whichever is greater. Fill embankments should be completed on 2:1 grades. Class I riprap, or larger material, as appropriate, should be used to cover the crossing and protect the sides of the adjacent stream channel from erosion.
6. When a temporary crossing has served its purpose, and is no longer necessary, the culverts, bedding and filter cloth should be removed from the stream bed. It is normally best to remove a crossing in the reverse order of its construction, leaving removal of the culverts and adjacent headwall material for last. Whenever possible, the structure should be removed and the area cleaned without construction equipment entering the waterway. Once initiated, removal of the crossing should be completed as soon as possible to minimize degradation of the stream channel. Construction work should be scheduled to take advantage of periods of low flow. Upon removal of the structure, the stream channel should be reshaped to its original cross-section and stabilized with appropriately sized clean riprap. Stream banks should be vegetated with suitable grasses and shrubs.

5 OVERBURDEN AND SPOIL DISPOSAL AREAS STORAGE

5.1 Definitions

Overburden and spoil may be disposed of in valleys (valley fills), on hillsides (side hill fills) or on flat terrain (mounded fills). These fills represent designated areas within the permit for either temporary or permanent disposal of overburden or spoil.

- Overburden is defined as 1. All of the earth and other material which lie above a natural deposit of minerals, ores, rock or other solid matter and 2. Other materials after removal from their natural deposit in the process of mining.
- Spoil is any overburden or other material removed from its natural state in the process of mining. This generally includes process waste and pond dippings.
- Structural fill is material that buttresses and provides confinement to the internal portion of the waste disposal structure. This may be the fill outslope or starter dam depending on the material to be disposed of. Competent soils, capable of good compaction, should be used for structural fill.
- Non-structural fill is the material within the buttress, or confining portion of the fill. Process spoil should be disposed of in the non-structural portion of a fill.

5.2 Purpose

Permitted disposal areas allow placement of overburden and process spoils in a controlled manner to ensure long term stability, adequate drainage and sediment control, and concurrent reclamation of the disposal area.

5.3 Conditions Where Practice Applies

Mine operations plans should include plans for waste disposal areas when considerable amounts of overburden or spoil will be generated See 4VAC25-31-400 for the regulatory requirement.. Disposal area designs depend on a variety of factors. These include the availability of suitable disposal areas, site topography and drainage, the type of material to be placed in the disposal area, the quantity of material to be disposed of, and the desired post mining land use. Efforts should be made, where possible, to place fills in areas previously disturbed for mining purposes, such as old pits. In that way, fills may be incorporated into the active mining operation as a reclamation activity. When overburden and spoils have to be disposed of above grade, an effort should be made to locate the disposal area on moderately sloping and naturally stable ground away from seeps, springs, or waterways.

5.4 Construction Specifications

Development of overburden and spoil disposal areas may require a series of activities that include construction of perimeter drainage and sediment controls, removal of topsoil and clearing debris, installation of subsurface drainage systems, fill placement, and reclamation. Material should be placed in a controlled manner, compacted as necessary to ensure mass stability and prevent mass movement, and graded to ensure drainage is compatible with the natural surroundings.

- *Adequate drainage and sediment controls* must be provided prior to site preparation and fill construction. These controls are normally installed after tree clearing but before ground disturbing activities. Drainage control may be provided by diversion ditches or diversion

berms. Sediment control may be provided by sediment basins, sediment ditches, or other approved structures as outlined in this manual. Drainage and sediment controls shall be constructed in a manner that will allow access for maintenance along their entire length.

- *Clear water diversions* may be used to direct surface runoff from undisturbed areas away from the fill construction area. This is especially true with valley fills and side hill fills that may be constructed near the base of existing slopes. Clear water diversions should be lined with riprap on filter cloth or a seed-over geotextile to stabilize the excavation as quickly as possible.
- *Trees, shrubs and other vegetative debris* need to be cleared from areas under the proposed fill. Woody material, less than six inches in diameter, may be windrowed below the fill area to provide supplemental sediment control. All useable trees should be salvaged to promote conservation of that resource. Large stumps must be grubbed from foundation areas that will be covered by structural fill. It may be permissible to dispose of woody material within non-structural portions of the fill with approval from the Mineral Mining Program. Requests of this nature should be included in the construction specifics for the disposal area. .
- All *topsoil and unstable soils* must be removed from the fill foundation. Topsoil must be stored for use in final reclamation of the fill and other disturbed areas. Topsoil is particularly helpful in stabilizing overburden and spoil because it is more resistant to erosion and more likely to quickly establish vegetation. Oftentimes, the seedbank and root-stock within the topsoil will develop a healthy vegetative cover that will supplement the application of seed. Unstable soils, such as plastic clays, may be left under non-structural portions of the fill if their presence will not reduce the stability of the fill.
- Good *foundation drainage* is necessary to ensure the stability of fills. This is especially important on low ground, or in valleys or ravines, where natural drainage systems may be present. Underdrains should be installed in these areas to convey the discharge from seeps or springs to the fill exterior. Properly designed and constructed underdrains should prevent seeps or springs from saturating the fill and causing structural weakness. (See Section 5.5 – Subsurface Drains) The placement of coarser materials in the toe of the fill will also facilitate drainage and enhance fill stability.

5.4.1 Construction Methods

There are *two basic ways to construct fills* - lift construction or dump construction.

Lift Construction

Lift construction provides the greatest stability and should be used whenever fills are constructed on ground with a slope greater than 35 percent, or the height of individual levels exceeds 25 feet. In lift construction, fill material is deposited in layers beginning at the toe, or lowest point, of the fill. Each layer should be "stepped", or keyed, into the hillside with a dozer cut to help prevent slides along the fill / hillside interface as weight is added to the fill.

Each layer is constructed in a three step process. This starts with placement of material on the last completed layer, or surface, of the fill. As material is hauled in and dumped, care should be taken to maintain room between the piles of dumped material to insure unobstructed drainage from the area. Secondly, as the piled material covers the fill surface, it should be spread into a uniform layer and firmed up with a dozer. The thickness of each fill

layer should not exceed four feet. Finally, the new layer is compacted by routing rubber-tired haulage equipment over the entire area. This is done by routing the haulage equipment along a new path each time a trip is made to and from the fill to dump another load of material.

Dump Construction

Dump construction fills are generally easier and faster to construct, but are less stable and should only be used in areas where stability is less of a concern. Dump construction should not be used to construct a fill on ground with a slope greater than 35 percent, they should not be used to construct a fill with individual levels that exceed 25 feet, and they should never be used to impound water. These fills are commonly used on level or gently sloping ground to dispose of dry overburden or spoil.

Dump construction fills are normally constructed in a two-step process. Material is hauled in and dumped short of the face. A rubber-tired loader or dozer is then used to push the material over the face. These fills are usually started from the high end of a gentle slope or from a pile of material created by lift construction. Like lift construction fills, they should always be constructed from the bottom up.

Care should be taken with both types of fills to ensure positive drainage from intermediate levels and the top surface. An adequately sized safety berm should be maintained above all slopes and elevated roads. Haulage equipment should be kept a safe distance back from the working edge of the fill.

5.4.2 Construction Considerations

On-site generated waste material (steel, conveyor belts, off road tires, etc.) may be disposed of within fills if specifically approved by the Mineral Mining Program. This material should never be deposited within the outslope, or structural portion, of a fill. Care should be taken during the placement of this material to ensure that fill material does not bridge across it. Bridged material may collapse after the fill is completed. This will encourage water to enter the fill and may lead to slope failures.

The *outslopes of completed fills* should be completed on a 2:1 grade (two horizontal feet to one vertical foot), unless the fill material is sandy or silty. If that is the case, fill material should be completed on a 3:1 grade (three horizontal feet to one vertical foot). (See helpful slope conversions and formulas in Appendix E)

Drainage benches should be constructed on fill outslopes to decrease the height of the slope and decrease the potential for slope erosion. To minimize erosion, slope distances should not exceed 95 feet (2:1 slope 40 feet high or 3:1 slope 30 feet high). 20 ft. wide drainage benches should be sloped back into the fill on 5% grades (one foot of drop to the interior) and placed on 1% grades along their length to direct runoff to slope drains and sediment control structures.

The *top of the fill* should be crowned and graded no steeper than 5% toward constructed drainways around the perimeter of the fill. Care should be taken to ensure that water is not impounded on top of the fill. Drainage should only be directed over the outslopes of the fill where pipe or rock slope drains are constructed for that purpose.

Surface runoff from the fill should be diverted to stabilized channels that will safely pass the runoff from 10 year storm events. Rock or pipe slope drains should be adequately sized and spaced to ensure that drainage can be conveyed to the toe of slopes without erosion damage. Earthen berms should be maintained around the top edge of all outslopes to direct runoff to the slope drains. Rock filter berms should be constructed around the inlet of all slope drains to help prevent debris from blocking the drain.

Reclamation of the fill shall be concurrent with fill construction. Each section or level of the fill should be completed to its full extent before the next level is started. As each level is completed, it should be placed on final grade and stabilized with vegetation as the next level is started. Completed slopes should be faced with six to 12 inches of topsoil, then tracked in with a low ground pressure dozer to minimize erosion and provide a catch for soil amendments and seed. The top of the completed fill should be graded to achieve positive drainage. Seed mixtures should contain at least one perennial grass, one legume, and one nurse crop. Lime and fertilizer should be applied as necessary per soil test results. Mulch should be applied over all seeded areas and tacked in place to prevent wind scour. Proper application of mulch is particularly important in areas subject to the afternoon sun and prevailing wind. Those areas are more difficult to vegetate since they will dry out faster than sheltered areas.

5.5 Subsurface Drains

Subsurface drains are installed beneath fills, where necessary, to intercept and convey groundwater to the fill's exterior. The need for subsurface drains should be evaluated wherever seepage, wet soil conditions, or wetland type vegetation indicate the presence of excessive groundwater. If properly sized and constructed, subsurface drains will prevent the accumulation of groundwater within the fill and help to ensure its long term stability.

5.5.1 Planning Considerations

There are two types of subsurface drains:

Relief drains, or underdrains, shown in Figure 5-1, are typically started where springs or wet areas occur and are extended to the toe of the fill where they are provided with a surface outlet. Oftentimes they will follow the base of the valley or ravine where a fill is constructed.

Interceptor drains are used to remove water from multiple seeps. They are normally installed across short distances to a relief drain.

A completed drain system may be installed in herringbone or random patterns dependent on the source of groundwater to be collected and drained as shown in Figure 5-2.

5.5.2 Construction Specifications

A properly designed and constructed underdrain should prevent seeps or springs from saturating the fill and causing structural weakness. They should be sized to convey the maximum anticipated flow from the seeps or springs. Underdrains may be constructed of durable stone or perforated pipe wrapped in filter fabric to prevent clogging. Dimensions for the trench or drainpipe

are dependent on the permeability of surrounding soil and the quantity of water that needs to be drained.

Stone underdrains should be constructed of stone that is durable, clean, non-acidic, and non-toxic. No more than 10 percent of the drain material should be less than 12 inches in size. No single rock should exceed one fourth of the total drain width. Underdrains should be capable of decanting all of the seasonal flow from seeps or springs covered by the fill. Unless designed by a qualified engineer, the minimum size of underdrains should be 10 feet wide by four feet high. The filter fabric wrap should be loosely laid to minimize tearing during stone placement and covering with fill. Sheet ends should be overlapped at least two feet to minimize gaps between sheets. The outlet end should be open, and above standing water, to prevent sediment from blocking the drain.

Pipe trenches should be constructed on a continuous grade of one to two percent. The trench foundation should be stabilized with crushed stone to prevent deformation during the covering process. If soft spots are not stabilized, sags may develop in the drain due to the weight of overlying material. The trench should be lined with filter fabric prior to the placement of the pipe and bedding material. Filter cloth should be adequate in width to allow it to be wrapped across the top of the bedding material prior to backfilling the trench. At least 24 inches of overlap should be provided between the ends of sheets. Manufacturer's specifications should be used to determine the wall thickness of the drainpipe. Wall thickness should be sufficient to withstand the bearing weight of soil placed above the pipe and the weight of equipment that may cross the pipe. Drain outlets should be set above water level in any receiving channel or pond. They should be protected against the entry of small animals.

Drains should be checked periodically to ensure they are not clogged with sediment or other debris.

TYPICAL CROSS-SECTION OF UNDERDRAIN

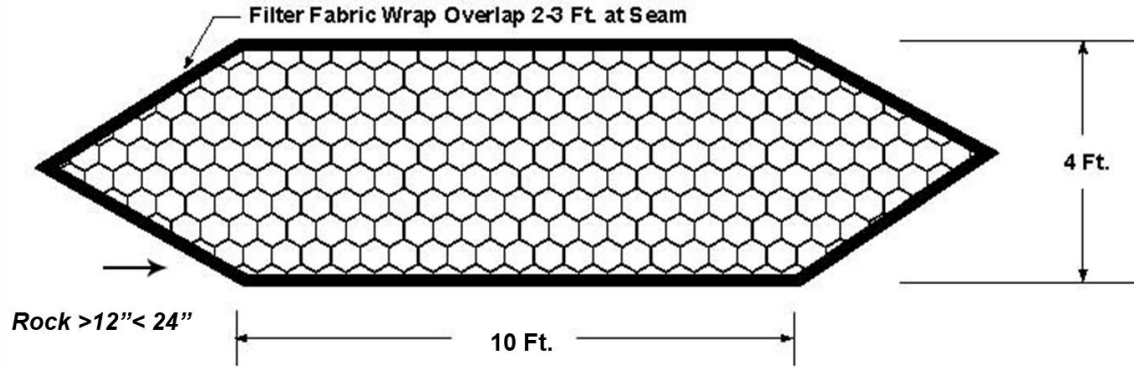


Figure 5-1: Subsurface Drain Cross Section

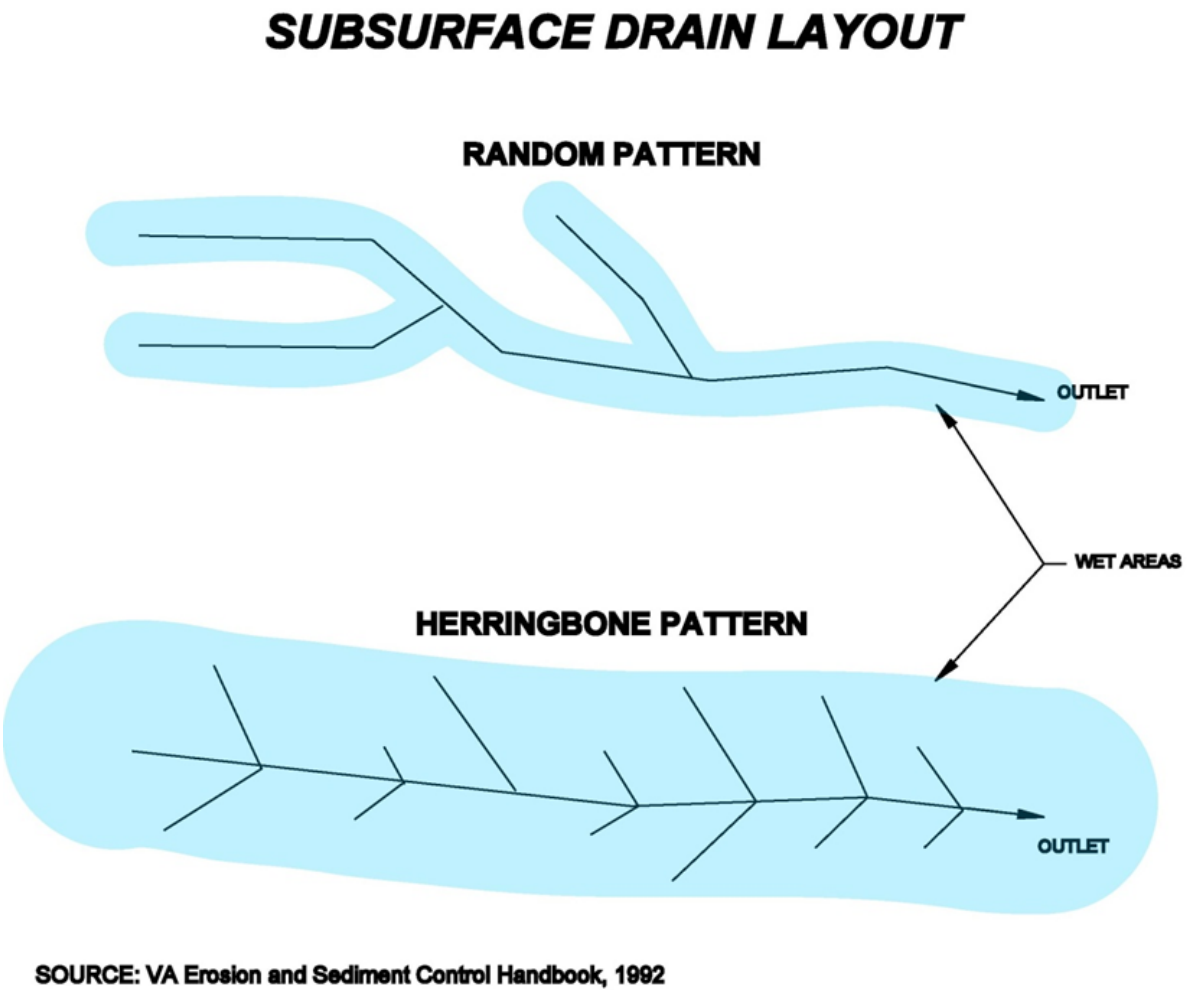


Figure 5-2: Subsurface Drain Layout

5.6 Plan Preparation and Approval

Plans for the overburden and spoil disposal area must be submitted to the Mineral Mining Program for review and approval prior to initiating fill construction. The application or amendment needs to address all applicable requirements of 4VAC25-31-400 (of the *Virginia Reclamation Regulations for Mineral Mining* and should contain the following parts:

- A plan narrative – In addition to addressing the requirements of 4VAC25-31-400 the narrative should address the purpose of the fill, the type of material to be placed in the fill, and its construction timeframe.
- A plan view of the fill, associated access roads, drainage and sediment controls, etc.
- Lateral and transverse cross-sections of original ground and the proposed fill.
- An updated permit map showing the location of the proposed fill.

Figure 5-3 and Figure 5-4 show a typical hollow fill and cross-sections. Figure 5-5and Figure 5-6 show a typical side hill fill and cross-sections.

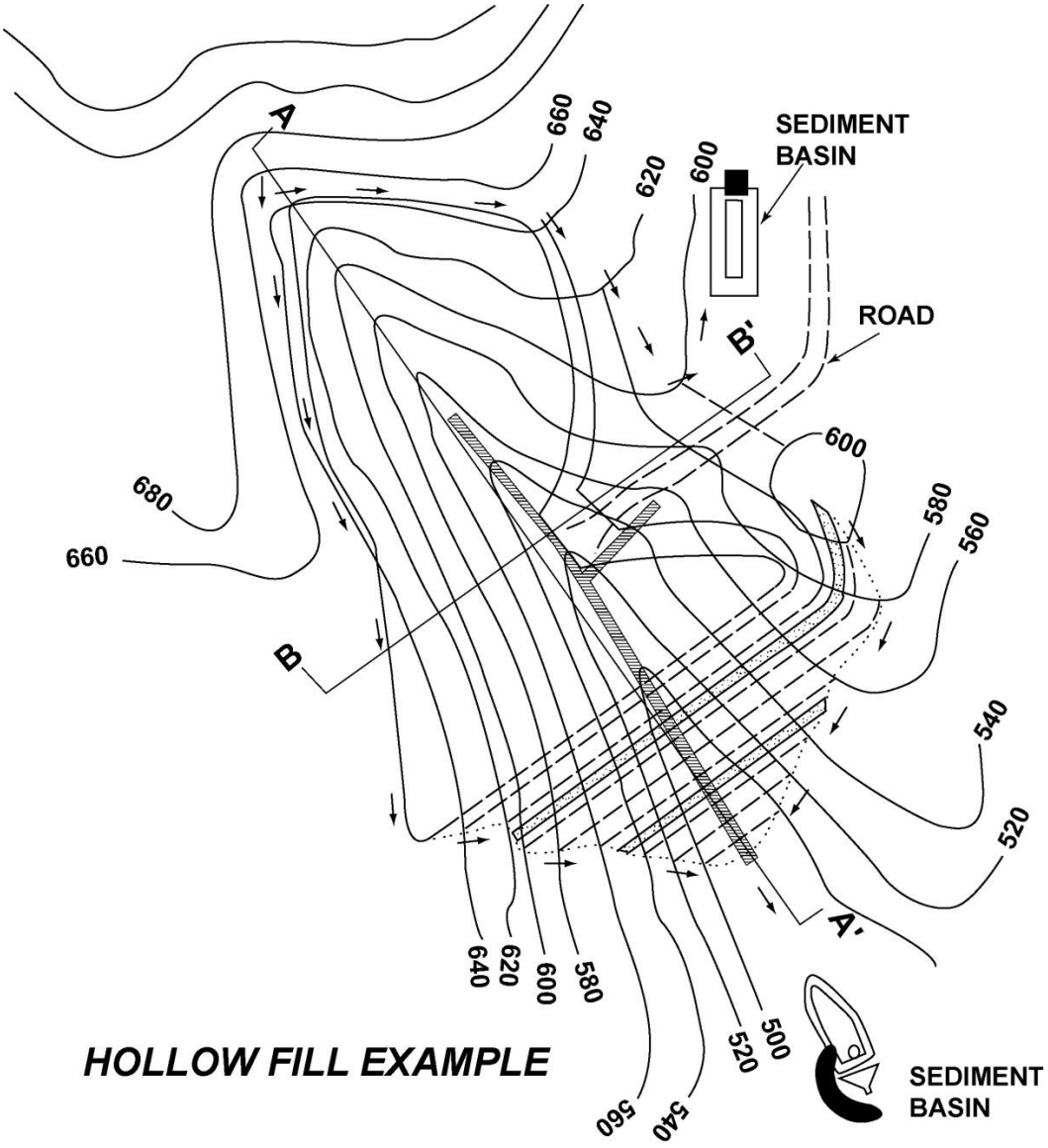


Figure 5-3: Hollow Fill Plan View

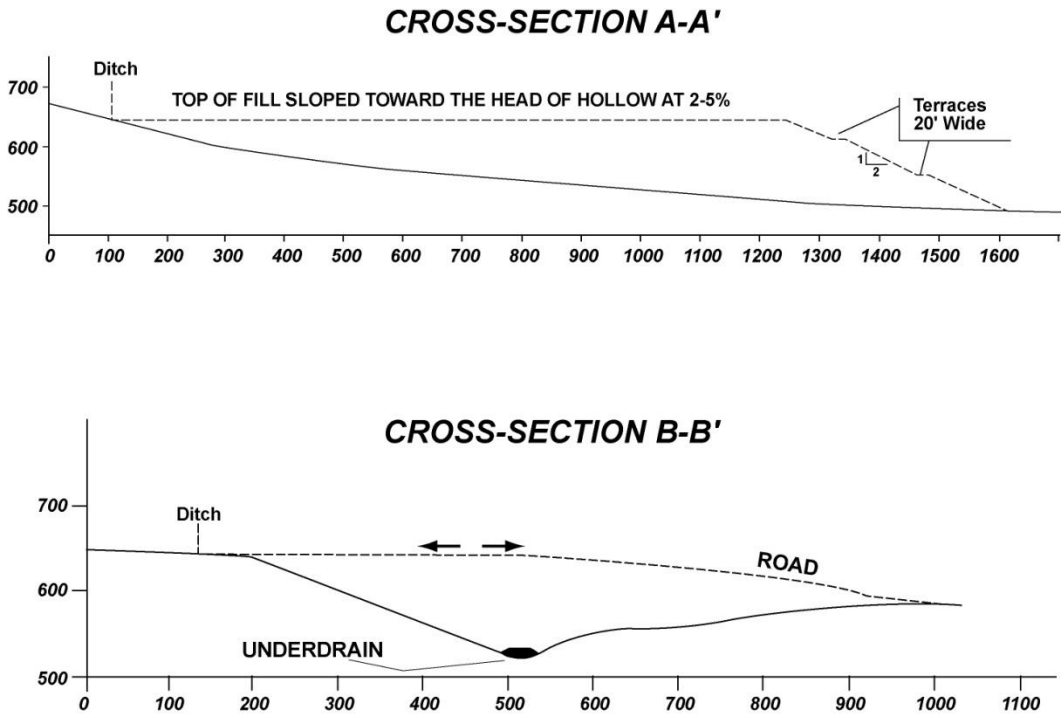


Figure 5-4: Hollow Fill Cross-Sections

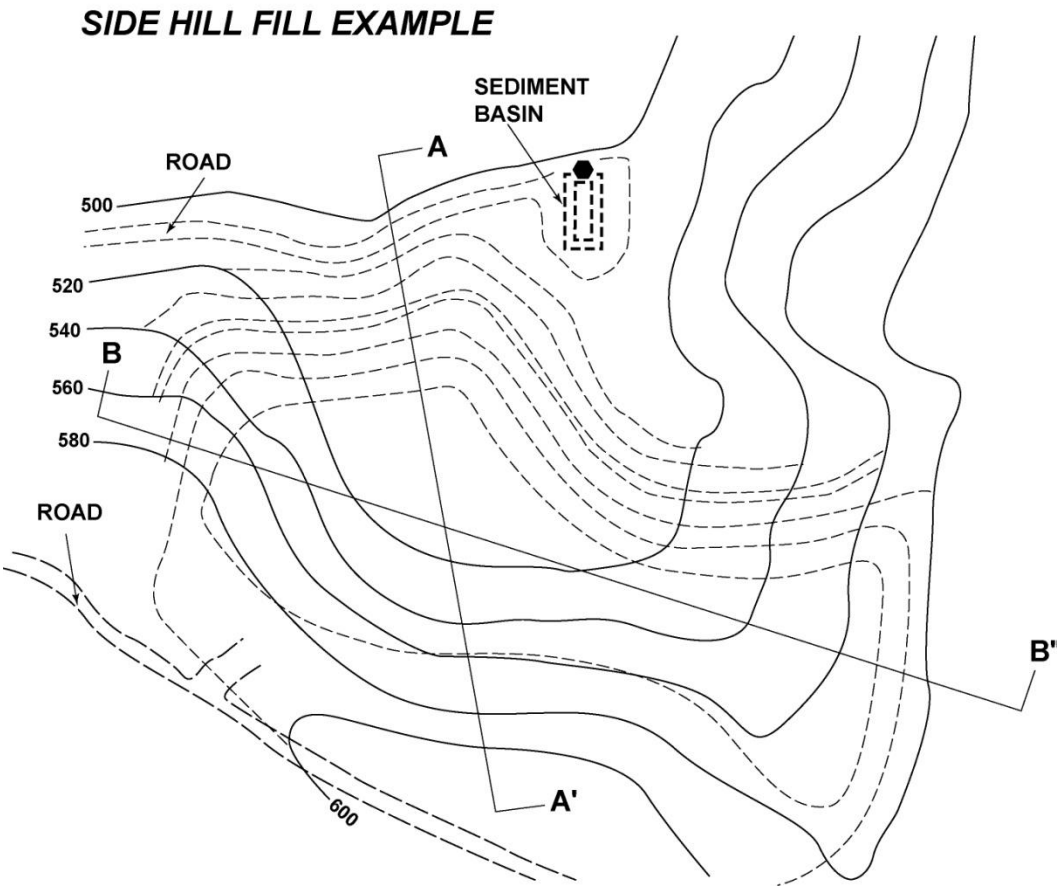


Figure 5-5: Side Hill Fill Plan View

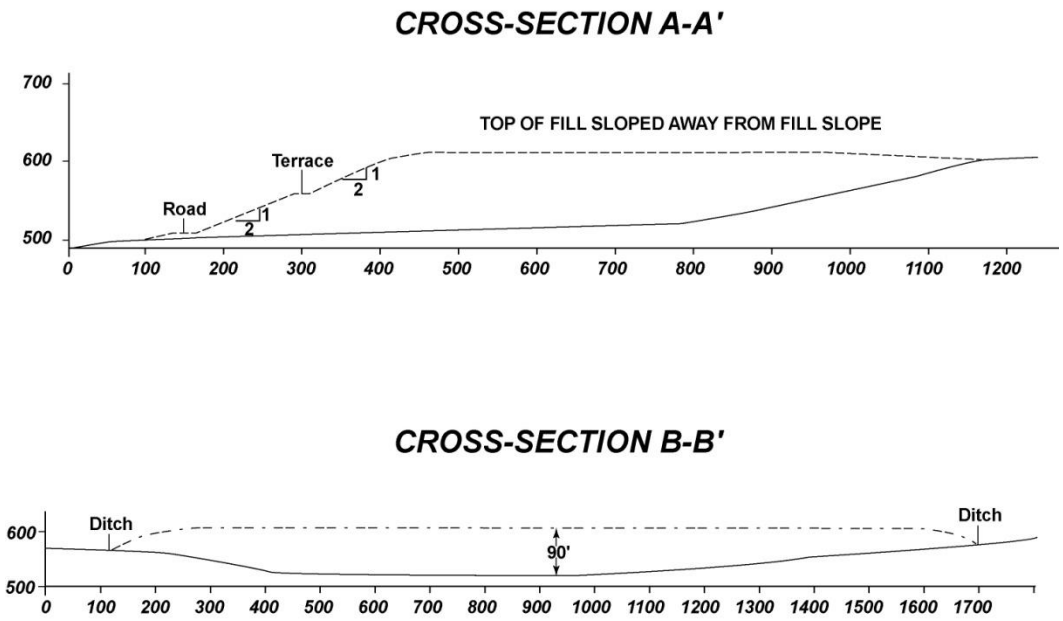
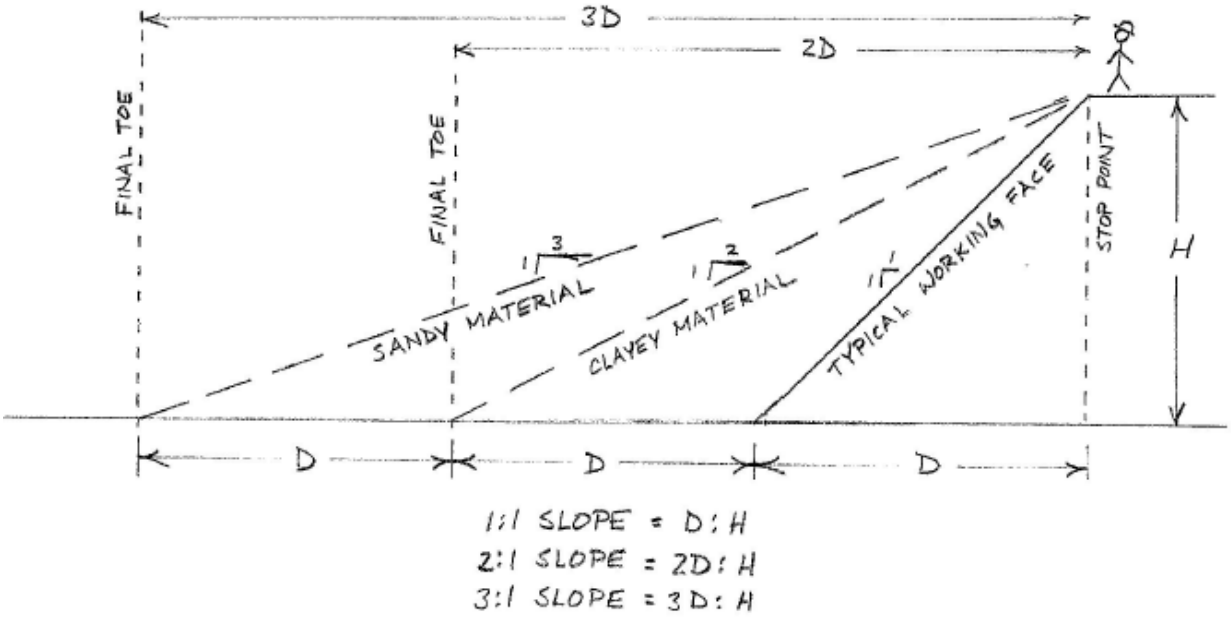


Figure 5-6: Side Hill Fill Cross-Sections

5.7 Determining the Stop Point on Dump Construction Fills

When constructing any fill, it is important to familiarize yourself with the approved plan and ensure the plan is followed. In addition to good site preparation before fill placement, care needs to be taken to ensure that fill material can be reclaimed concurrently with placement. Reclamation regulations require completed slopes on 2:1 or 3:1 grades, depending on the type of material placed in the fill. Since the active face of a dump construction fill will only roll out to the angle of repose, fill placement must stop short of the final toe to allow room for the slope to be pushed out to final grade. When the outslope is placed on final grade, material can be pushed off the top of the fill, or additional material can be added to the slope to achieve the required grade. But, if the active face is pushed out too far, material may have to be pulled back, or pushed off and hauled away, to achieve the planned configuration of the fill.

To determine the stop point of an active fill slope, you must first determine the location of the final toe. During site preparation, it is good practice to have a survey crew mark the final toe with stakes and flagging. Once the final toe is established, the active slope stop point is easy to locate. The crest of a 2:1 final slope should be stopped short a distance equal to twice its height, and a 3:1 final slope should be stopped short a distance equal to three times its height, as shown in Figure 5-7.



2:1 FINAL SLOPE - Active slope stop point = two times the height of fill being placed
3:1 FINAL SLOPES - Active slope stop point = three times the height of fill being placed

Figure 5-7: Final Slope distances for clayey and sandy materials

The same principle can be applied to the establishment of drainage benches between fill levels. It is good practice to establish 20 foot wide drainage benches to allow access for seeding and maintenance equipment.

6 GROUNDWATER PROTECTION

6.1 Definitions

"Adverse impact" means a reduction in groundwater level or a change in groundwater quality that limits the ability of any existing groundwater user lawfully withdrawing or authorized to withdraw groundwater to continue to withdraw the quantity and quality of groundwater required by the existing use.

"Aquifer" means a water-bearing layer of rock, including unconsolidated sediments that will yield water in a usable quantity to a well or spring.

"Confined water" means groundwater that is separated from the atmosphere by impermeable geologic material called a confining bed; artesian.

"Consumptive use" means the withdrawal of groundwater, without recycle of said waters to their source of origin.

"Hydraulic head" means the height above a datum plane of a column of water. In a groundwater system it is composed of elevation head and pressure head; the water level elevation in a well, or elevation to which the water of a flowing artesian well will rise in a pipe.

"Groundwater" means any water, except capillary moisture, that occurs beneath the land surface in the zone of saturation, including perched zones of saturation, which could produce usable water.

"Unconfined water" means groundwater that is in direct contact vertically with the atmosphere through open spaces in permeable material.

"Water table" means the surface of a body of unconfined groundwater (i.e. saturated zone) at which the hydraulic pressure is equal to atmospheric pressure and is represented by the water level in a well.

"Well" means any artificial opening or artificially altered natural opening, however made, by which groundwater is sought or through which groundwater flows under natural pressure or is intended to be withdrawn.

6.2 Purpose

Mineral mining activities conducted below the water table may cause alterations to groundwater flow and distribution patterns, which can affect other sources of groundwater use. Mine excavations that expose a drinking water aquifer to activities at the land surface also open pathways for potential contamination and degradation of water quality. Regulation 4 VAC 25-31-130(6) of the Virginia Reclamation Regulations for Mineral Mining requires that mine operators provide a plan for the minimization of adverse effects on water quality or quantity if mining below the water table is to take place.

This plan, hereafter referred to as the "Groundwater Protection Plan", must be approved by Mineral Mining Program prior to the commencement of such mining activities and applies to all sites where mining activities extend below the water table.

A Groundwater Protection Plan requires a hydrologic baseline and impact assessment for the affected area. This assessment will provide the basis for a mining plan that is effectively designed to minimize adverse hydrologic effects and should include:

1. An evaluation of the baseline conditions of the local and/or regional hydrologic system, and
2. A determination of the probable impacts of the proposed operation on that system.

This chapter identifies and summarizes the key steps towards developing a Groundwater Protection Plan in a manner that should be useful to individuals with no technical background in hydrology. The majority of this chapter pertains to identifying and understanding baseline assessment conditions and is primarily intended for small, relatively shallow mine operations; not large, deep excavations or operations which require extensive de-watering below the water table. Larger, deeper operations and those operations that have more complex hydro-geologic settings should use this chapter as guidance but will need to utilize the services of professional hydrologist to develop an acceptable Groundwater Protection Plan.

> **It is in the best interest of Mine Operators to incorporate groundwater monitoring at least one (1) year prior to operating below the water table to measure their compliance with the performance-based standards.**

There are many alternatives to the methods described in this section, and the operator is encouraged to utilize other methods where appropriate.

6.3 Developing the Groundwater Protection Plan

1. Complete an evaluation of the baseline hydrologic conditions in the local area and/or region surrounding the mining operation. Depending upon the specific mining plan, the following items should be addressed:
   - Creation of an inventory of existing groundwater use,
   - depth to the static water table and maximum depth of mining
   - hydraulic gradient and direction of groundwater movement;
   - sources and rates of natural discharges;
   - natural recharge rate;
   - groundwater velocity;
   - physical properties of aquifers;
   - geologic factors;
   - land use;
   - ambient groundwater chemistry
2. Complete an assessment of the potential impacts of the mining operation on groundwater quality and water quantity. Depending upon the specific operating plan, the assessment might include:
   - effects of groundwater withdrawal (mine de-watering) on water supply;
   - effects of removing portions of an aquifer on water supply;
   - plans for managing withdrawn groundwater;

- expected changes in groundwater quality as a result of mining and reclamation;
- potential for accidental releases of pollutants

3. Based upon the results of the hydrologic baseline and impact assessment (Steps 1 and 2), design a groundwater protection plan that will minimize any likely adverse impacts on groundwater quality or quantity as a result of mining or reclamation operations.

6.3.1 Evaluation of Baseline Hydrologic Conditions

Baseline information describes site-specific conditions prior to mining and provides a starting point from which to make predictive estimates of the probable hydrologic impacts, if any, of the proposed operation. Where applicable, baseline information should be collected and analyzed well in advance of the proposed mining operation, and in such a manner as to provide a statistically valid representation of the site water supply.

For larger or more complex operations, the process of data collection and analysis for many of these factors may require well drilling, aquifer pump testing, laboratory analysis, and model simulations.

Inventory of Existing Groundwater Use

The baseline assessment should include an inventory of all sources of groundwater use within a minimum of 1000 feet of the mining permit boundary. The inventory should encompass groundwater sources for residential, commercial, industrial, municipal and recreational use.

Key information includes:

- the owner,
- type of use,
- geographic coordinates,
- wellhead elevation,
- static groundwater elevation,
- date of measurement.

Other categories of information include:

- total well depth,
- year drilled,
- well diameter,
- casing length,
- screen length and size,
- type and intervals of seals and grout,
- reported well yields,
- flow rates, etc.

If the groundwater source is used for a drinking water supply, much of this latter information will be contained in the well driller's report and well construction report that is available from the Virginia Department of Health, Office of Environmental Health Services.

6.3.2 Static Water Table and Maximum Depth of Mining

An estimate of the position of the static water table relative to the maximum depth of the proposed mine is required as part of the mine permit application. The static water table represents the pre-mining level of groundwater in the area of the proposed excavation.

6.3.3 Estimating Natural Groundwater Discharge

Natural discharges of groundwater occur as seepage to springs and gaining streams, as evaporation and transpiration, and as subsurface outflow. Discharge is usually expressed in units of volume of water per unit time.

6.3.4 Estimating Natural Recharge

Natural recharge occurs as direct precipitation in the watershed, as seepage from losing streams, and as subsurface inflow. Recharge is typically expressed in units of volume of water per unit time

6.3.5 Groundwater Velocity

The rate of groundwater movement is an important parameter in the hydrologic assessment, particularly if there exists the possibility of a water quality impact as a result of mining or reclamation.

6.3.6 Aquifer Properties

Many of the preceding methods for characterizing baseline conditions of the hydrologic system required estimated values for physical properties of the aquifer including porosity, hydraulic conductivity, and transmissivity. Methods to fully evaluate these and other important properties for specific site conditions often involve well drilling, aquifer pump testing, and laboratory analysis. Values obtained in this way are typically used in complex hydrologic investigations that involve analytical solutions or numerical modeling techniques. For the majority of small mine operations, this level of characterization is impractical, yet it may be useful to understand the type of information that would be provided by their measurement.

6.3.7 Porosity and Specific Yield

Total Porosity (n) of a geologic material is the percentage of the bulk volume that is occupied by interstices, or voids. In unconsolidated sediments such as sand, gravel, and clay the total porosity is determined not so much by grain size, but rather the range of variation in grain size, also referred to as the degree of sorting. Since fine-grained deposits tend to be better sorted, they tend to have larger porosities. In consolidated rocks such as sandstone, limestone, and granite the voids are typically secondary fractures and dissolution openings. The total porosity of these rocks is typically much smaller than that of unconsolidated deposits.

In hydrology, total porosity is an indicator of the maximum amount of water that the material can contain when fully saturated. However, depending upon the type of material, not all of the water may be available to supply a well or spring.

6.3.8 Hydraulic Conductivity

Hydraulic Conductivity (K), also known as the permeability coefficient, is a measure of the ability to transmit water through an aquifer. Hydraulic conductivity is dependent upon the size and connectivity of water-transmitting voids in the aquifer material as well as on the dynamic properties of the fluid being transmitted.

6.3.9 Transmissivity

Transmissivity describes the rate at which water of the prevailing kinematic viscosity is transmitted through a unit thickness of the aquifer under a unit hydraulic gradient.

6.3.10 Geologic Factors

The baseline hydrologic assessment should incorporate discussion of the geologic setting of the proposed mine site, particularly in cases where geologic features may influence hydrologic conditions.

6.3.11 Land Use

Information concerning historic or present-day land use that may have an influence on groundwater resources in the proposed mine area should be included in the assessment of baseline conditions.

6.3.12 Groundwater Chemistry

If there exists the potential for introducing pollutants to groundwater as a result of mining or reclamation, the hydrologic assessment should include laboratory and/or field measurements of the appropriate water quality parameters to establish baseline conditions of water quality.

6.4 Assessment of Potential Impacts

Predictive estimates of the impacts of the proposed mining operation on groundwater quality and supply should be quantitative to the extent practicable. Supporting data may include analytical and statistical results as well as conceptual models where appropriate. For larger or more complex operations, hydrologic models ranging from simple empirical equations to numerical computer simulations may be used for estimating hydrologic impacts. Models should be calibrated with site-specific data or data that is otherwise representative of the site. Extrapolation of data from a nearby area to the proposed permit area is acceptable when the similarity of the areas is established and information is available to justify the correlations. Seasonal operating conditions should also be considered.

The assessment should include a prediction of impacts that will occur during the proposed mining and reclamation operations and also the potential for longer-term impacts, if any. Other factors that presently contribute to or may contribute to future changes in water quantity and quality, but are not related to the proposed mining operation, should be identified and quantified to the extent possible.

6.4.1 Managing Pumped Groundwater

There are a number of alternative methods for managing groundwater after it has been pumped from a mine excavation including:

- discharging the water into an existing stream channel;
- storing the water in a lined impoundment for future use;
- conveying the water to an unlined impoundment that serves as an infiltration gallery or groundwater recharge facility;
- re-injecting the water into the subsurface through a well.

The choice of management option will largely depend upon site conditions, the rate of groundwater withdrawal, water quality factors, and other key mine operating parameters. Wise management of groundwater after it has been withdrawn will effectively minimize the potential impacts on both water supply and water quality to down-gradient sources.

Regulatory authority over the disposal of groundwater that is pumped from mine excavations to the land surface is vested in the Virginia Department of Environmental Quality (DEQ), and administered as part of the Virginia Pollutant Discharge Elimination System (VPDES) permit program. Mineral mine operators that are considering this program have available to them the option of applying for the General VPDES Permit for Nonmetallic Mineral Mining. Additional information concerning this program is available by contacting DEQ or visiting their website.

6.4.2 Expected Changes in Groundwater Quality

The composition and concentration of substances dissolved in groundwater depends upon biological and chemical reactions occurring at the land surface and in the soil zone, and the mineral composition of the aquifers and confining beds through which the water moves.

With the onset of mining, the surface and groundwater hydrology of the area will be altered, disrupting the existing equilibrium. Groundwater quality impacts resulting from mining activities may involve changes in the concentration of existing constituents dissolved in the water and/or the addition of new chemical constituents mobilized by oxidation/reduction reactions. Increased mineral concentrations may result from (1) increases in surface area of exposed material; (2) increased oxidation/reduction reactions in the disturbed materials; (3) increase in rate of recharge and movement of water through overburden, mine waste, and mine product stockpiles; and (4) increase in mineral solubility and mobilization due to pH changes caused by the oxidation of pyrite and other sulfide minerals. Sources of poor quality surface water that may recharge the water table aquifer include acid drainage, water released from mineral processing plants, and fertilizers and other soil additives used during reclamation.

For most small non-metallic mineral mining operations, the potential for impacts to groundwater quality is greatest during reclamation, when fertilizers or other soil additives are used to promote re-vegetation. In addition to the Mineral Mining Program revegetation guidelines concerning plant nutrient requirements, the impact assessment should consider such factors as the depth to groundwater beneath the reclaimed land surface and the proximity of sensitive groundwater discharge areas identified in the baseline assessment such as springs, stream base flow, and wetlands. Monitoring inorganic water chemistry prior to and during mining activities will provide the basis for evaluating possible source areas if future impacts occur.

Mineral mining operations that produce metals either as mine product, byproduct, or waste, should complete a full assessment of the potential impacts of the operation on groundwater quality. Contaminant transport computer models are widely available for use in analyzing the

movement, mixing, and chemical reactions of contaminated water through an aquifer system. These models are typically coupled to a groundwater flow model.

6.4.3 Potential for Accidental Release of Pollutants

For most small mineral mining operations, accidentally released pollutants that have the potential to impact groundwater include oils, fuels, and cleaning solvents. The most likely pathway for contamination is by direct contact of the pollutant with groundwater or the aquifer stratum that is exposed in the mine excavation. Since these pollutants do not naturally occur in groundwater, the hydrologic assessment of baseline water quality parameters will not likely include their determinations, unless a pre-existing condition was suspected. The assessment of potential impacts should include an evaluation of safeguard measures to ensure that these pollutants are stored, distributed, transferred, and disposed of in a manner that will minimize the potential for impacting groundwater quality.

7 WATER IMPOUNDMENTS

The requirements for the design, construction, and maintenance of structures designed to impound water or sediment on Virginia's mineral mines can vary depending on the size and impounding capacity.

Chapter 13 of the Code of Virginia and Sections 4VAC 25-31-180 and 4VAC 25-31-500(A) of the Virginia Mineral Mine Reclamation Regulations address the requirements for large Mineral Mining Refuse Piles and Water and Silt Retaining Dams that meet or exceed a certain size criteria. These structures have additional design, construction, planning, and inspection requirements. Operators should be aware of these considerations prior to planning large retaining structures at the mine.

Section 4 VAC25-31-500(B) of the Virginia Mineral Mine Reclamation Regulations addresses Regular Impoundment structures that do not meet the Chapter 13 size criteria.

7.1 Definitions

"Acre-foot" means a unit of volume equal to 43,560 cubic feet or 325,853 gallons. Once acre-foot of water is equivalent to one acre covered by water one foot deep.

"Dam Break Inundation Zone" means the area downstream of a dam that would be inundated or otherwise directly affected by the failure of a dam.

"Probable Maximum Flood (PMF)" means the flood that might be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. The PMF is derived from the current probable maximum precipitation (PMP) available from the National Weather Service, National Oceanic and Atmospheric Administration. In some cases, local topography or meteorological conditions will cause changes from the generalized PMP values; therefore, it is advisable to contact local, state, or federal agencies to obtain the prevailing practice in specific cases.

"Qualified Person" means a person who is suited by training or experience for a given purpose or task.

"Spillway Design Flood (SDF)" means the largest flood that needs to be considered in the evaluation of the performance for a given project. The impounding structure shall perform so as to safely pass the appropriate SDF. Where a range of SDF is indicated, the magnitude that most closely relates to the involved risk should be selected.

7.2 Size Criteria

Structures that exceed any of the following criteria are considered to be Chapter 13 impoundments. These criteria are:

1. Impound water or sediment to a height of five feet or more above the lowest natural ground area within the impoundment and have a storage volume of 50 acre-feet or more.
2. Impound water or sediment to a height of 20 feet or more regardless of the storage volume.

7.3 Chapter 13 Impoundments

7.3.1 Design Considerations

Impoundments meeting or exceeding the size criteria for a Chapter 13 impoundment must meet the following design requirements (including modifications to existing impoundments):

- Must be designed and constructed by, or under the direction of, a qualified professional engineer licensed in Virginia and experienced in the design and construction of impoundments.
- Designs must meet the requirements of 4VAC 25-31-500(A) of the Virginia Mineral Mine Reclamation Regulations and use current prudent engineering practices.
- Components of the impounding structure, the impoundment, the outlet works, drain system and appurtenances shall be durable in keeping with the design and planned life of the impounding structure.
- All new impounding structures, regardless of their hazard potential classification, shall include a device to permit draining of the impoundment within a reasonable period of time. At a minimum, the draining device shall be able to lower the pool level six vertical inches per day, as determined by the owner's professional engineer, subject to approval by the director. The Virginia Department of Conservation and Recreation (DCR) has a guidance document on Design and Use of Devices to Lower Water Levels that may be a resource.
- Impoundments with a hazard potential of high, significant, or low shall have a minimum static safety factor of 1.5 for a normal pool with steady seepage saturation conditions and a seismic safety factor of 1.2.
- Impoundments shall be designed utilizing a spillway flood and hazard potential classification as specified in Table F.1 Impoundment Class and SPF found in the appendix.
- A list of acceptable design procedures and references are available found in 4VAC25-31-500.A.4.

7.3.2 Plans and Specifications

The minimum requirements for the plans and specifications of a Chapter 13 impoundment are detailed and can be found in 4VAC 25-31-500.A.2.c of the Virginia Mineral Mine Reclamation Regulations. Included in these are:

- Detailed engineering drawings
- Impoundment classification (See 4VAC50-20-40 for more information)
- Cross sections, profiles, test boring logs, and geotechnical test data
- Principal and emergency spillway design
- Construction methods and quality control

7.3.3 Emergency Action Plans (EAP)

Operators are required to prepare an Emergency Action Plan (EAP) to coordinate activities in case of a potential imminent impoundment failure. The EAP will contain the following information:

- A notification chart of persons or organizations to be notified, the persons or persons responsible for notifications, and the priority in which notifications are issued. Notifications shall include at a minimum the division, the local government authority responsible for emergency response, and the Virginia Department of Emergency Management.
- Procedures used for timely and reliable detection, evacuation, and classification of emergency situations considered to be relevant to the structure and its setting.
- Designation of responsibilities for EAP tasks. These responsibilities include: the notification of known local occupants, owners, and lessees downstream that could be affected by the emergency and the designation of the responsible party for making the decision that the emergency no longer exists.
- A section describing actions to be taken in preparation for impoundment emergencies, both before and during the development of emergency conditions.
- Dam Break Inundation Maps. Maps provided for high and significant potential hazard classifications must be prepared and sealed by a professional engineer. Dam Break Inundation Maps should be no larger than 11"x17" to facilitate copying for emergency response.
- Appendices containing supporting and supplemental information used for the development of the EAP. Plans for training, exercising, and updating the EAP should be included.
- A section identifying all parties with EAP responsibilities and signed certifications indicating that they have received a copy of the EAP.
- The time period for review or revision of the EAP that is acceptable to the director.

The Virginia Department of Conservation and Recreation (DCR) has a fillable EAP form for low hazard impounding structures that may be a potential resource for operators planning low hazard structures. DCR also has other guidance documents on Dam Break Inundation Zone Modeling, PMP, and Hazard Classification that may be useful

EAP Assistance Documents that can be found in the appendix.

7.3.4 Inspection Requirements

Chapter 13 impoundments shall be inspected daily during each normally scheduled workday for visual structural weakness, volume overload and other hazards by a Qualified Person designated by the licensed operator. When rising water and silt reaches eighty percent by volume of the safe design capacity of the dam, examinations shall be made more often as required by the Mineral Mining Program. **Frequent examinations in exceedance of the daily inspection requirements must be made during periods of rainfall that could create flooding conditions.**

Qualified Person generally means that the individual has received documented training on impoundment inspections. MSHA annually conducts impoundment inspection training at the Mine Academy in Beckley, WV. This is one potential source of this training.

Records of these inspections shall be kept and certified by the licensed operator or his agent. Such records shall be kept on the surface at the office or designated station of the mine.

A sample Daily Impoundment Inspection Form can be found in the Appendix.

7.3.5 Impoundment Closures

Chapter 13 impoundments shall be closed and abandoned in a manner that ensures stability and compatibility with the approved post mining land use. Operators are to submit proposed closure plans to the Mineral Mining Program in an amendment for review and approval prior to initiating the work.

Permanent impoundments will need to be permitted by the Virginia Department of Conservation and Recreation (DCR) prior to bond release of the impoundment structure and affected areas.

7.4 Regular Impoundments

These structures do not meet the size criteria for a Chapter 13 impoundment.

7.4.1 Requirements

- Be designed and constructed using current, prudent engineering practices.
- Constructed with slopes not to exceed 2:1 in predominately clay soils and 3:1 in predominately sandy soils.
- Designed to safely pass the runoff from a 50-year storm event for temporary (life of the mine) structures and the 100-year storm event for permanent (to remain after mining is completed) structures.
- Be closed and abandoned in a manner to ensure stability and compatibility with the post mining land use.
- Be inspected and maintained to ensure proper functioning.
- Provide adequate protection for adjacent property owners and ensure public safety.

Note: The Mineral Mining Program typically requires as-built surveys for regular impoundments that are within 90% of any Chapter 13 criteria.

7.5 Reporting Impoundment Failures

All partial or complete failures of **any impoundment** must be reported to the Mineral Mining Program immediately.

Mineral Mining Program Contact Information

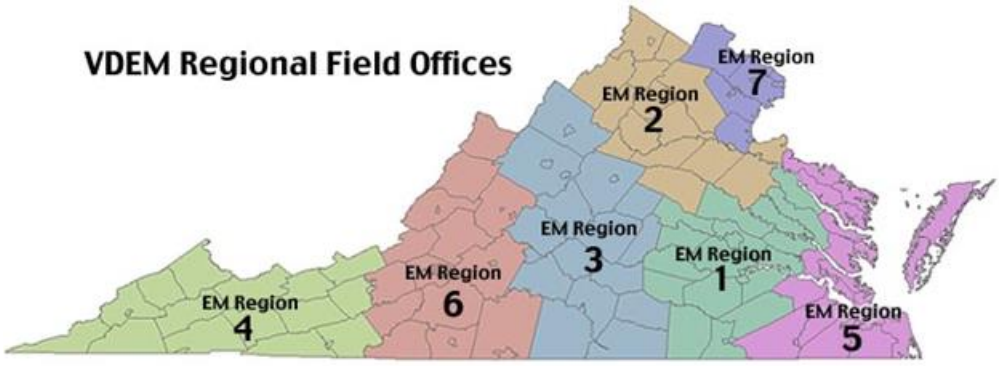
APPENDIX A: PERMITTING RESOURCES

Hazardous Situation Contacts

Type of Hazard	Control Agency	Telephone Number
Environmental Emergencies	Virginia Department of Emergency Management	804-674-2400
Air Pollution	Virginia Department of Environmental Quality (DEQ) – Air Division	804-698-4000 800-592-5482 (Toll Free in VA)
Etiological Agents		
Disease Causing	Virginia Department of Health (VDH), Emergency Preparedness & Response Programs	804-267-7600
	VDH Office of Epidemiology	804-864-8141
Radioactive Materials	VDH Radiological Health Section	804-864-8150
Toxic Substances	DEQ, Division of Solid and Hazardous Waste	804-698-4000 800-592-5482 (Toll Free in VA)
	Virginia Department of Labor & Industry, Occupational Safety & Health	804-786-7776 (Safety) 804-786-0574 (Health)
	Division of Consolidated Laboratories Emergency Response	804-648-4480
Explosives	Virginia State Police	
	Administrative Headquarters	804-674-2000 (24 hours)
	Division I - Richmond	800-552-9965
	Division II - Culpeper	800-572-2260
	Division III - Appomattox	800-552-0962
	Division IV - Wytheville	800-542-8716
	Division V - Chesapeake	800-582-8350
	Division VI – Salem/Roanoke	800-542-5959
	Division VII - Fairfax	800-572-4510
	Bureau of Alcohol, Tobacco, Firearms and Explosives (ATFE), Explosives Theft Hotline	800-461-8841

Pesticides	Virginia Department of Agriculture and Consumer Services, Virginia Pesticide Control Board	804-786-3798
	National Chemical Response and Information Center (CHEMTREC)	800-262-8200
Water Pollution	DEQ Pollution Response Program	800-468-8892 (in Virginia) 804-674-2400 (Out of State)
Transportation Spills	National Chemical Response and Information Center (CHEMTREC)	800-262-8200

Virginia Department of Emergency Management Field Offices



Region 1: Richmond
3310 Deepwater Terminal
2nd floor
Richmond, VA 23234
(804) 267-7600

Region 2: Culpeper
13206 Lovers Lane
Culpeper, VA 22701

Region 3: Central VA
116 North Main St
Farmville, VA 23901

Region 4: Southwest
225 State Street
Marion, VA 24354
(Building B)

Region 5: Tidewater
7511 Burbage Drive
Suffolk, VA 23435

Region 6: Roanoke Area
4504 Starkey Road Suite 100
Roanoke, VA 24018

Region 7: Northern VA
4975 Alliance Dr. 4E
Fairfax, VA 22030

Permitting Resources

In addition to a permit from the Mineral Mining Program, operators may be required to obtain permits from other regulatory agencies. This section contains common regulatory agencies that mine operators work with, as well as other resources which may be helpful during the permitting process. This list is not inclusive and operators should do their due diligence in obtaining the proper permits relevant to their individual site prior to starting work.

US Department of Labor: Mine Safety and Health Administration (MSHA)

- New mine operators should contact MSHA before starting operations. The operator must provide MSHA with the mine name, location, company name, mailing address, person in charge, approximate date that the operation will commence, and whether the operation will be continuous or intermittent**.** The notification may be made by using MSHA's online filing web interface, by calling 1-800-746-1553. It is recommended by the Mineral Mining Program that all mailed notifications be sent by Certified Mail with Signature Confirmation.

Virginia 811**, Utility Location**

- All new mineral mining permit applications must notify utilities on or within 500 feet of the permit area of their intent to mine. Utilities can be located by dialing 811 in Virginia or 1-800-552-7001. Marking services for utilities onsite are available as well.

US Army Corps of Engineers: Waters of the US disturbance permits

- The US Army Corps of Engineers (Corps) oversees disturbances and discharges into the Nation's tidal marshes, seasonally saturated forested and non-forested wetlands, swamps, rivers, bays, and streams. Any disturbances to these areas require the appropriate permit from the Corps. If a site has wetlands or supposed wetlands, it is highly recommended that a Jurisdictional Determination be made by the Corps. The Corps offers assistance in recognizing wetlands and making official determinations on whether an area is classified as a wetland. An overview of the Corps regulatory permitting program is given in this pamphlet. The Norfolk District office issues all disturbance permits; however, assistance can be given by local offices as well. Initial assistance can be given by the Corps' Regulator of the Day by calling (757) 201-7652.

Virginia Marine Resources Commission: Habitat Management Permits

- Virginia Marine Resources Commission (VMRC) oversees all construction, dredging, filling or excavating of dune and beach resources and tidal and non-tidal water bodies, including wetlands, in the Commonwealth. Prior to disturbing these areas for excavation or construction activities (i.e. bridges), a permit from multiple regulatory agencies including VMRC, the Corps, DEQ, and/or Local Wetlands Boards is required. VMRC uses the Joint

Permit Application, or JPA, for these activities. The JPA serves as the single application form for all agencies involved in the project. The VMRC acts as the "information clearinghouse" for the JPA and reviews and distributes the application to appropriate agencies. Two JPA forms are available; however, dredging and excavation projects must use the Standard JPA form.

Virginia Department of Historic Resources

- Per Mineral Mining Program permit map requirements, sensitive features within 500 feet of the permit boundary must be listed, including cemeteries. The DHR Archives maintain a cemetery database of all known cemeteries in Virginia. The Archives are located in Richmond and available for public use. For a fee, DHR can perform a search of their archives to locate known cemeteries. To find cemeteries within or around the permit area, please fill out the Archive Search Form and return to DHR.
- If human remains must be relocated from a known cemetery or grave in the mining area, the operator must apply for a Burial Permit for the Relocation of Human Remains from the VDHR. If an operator comes across an unmarked grave or Indian burial ground while mining, he must stop immediately and report the grave to local or state police. Per VDHR, "Disinterring (removing from a grave) or displacing part or all of any buried human remains is a Class 4 felony under Virginia law (§18.2-126). Conviction is punishable by two to ten years in prison and up to $100,000 in fines. This law applies to all human burials, whether prehistoric, historic, or modern."

Virginia Department of Health: Radiological Health and Potable Water

- Sites mining, processing, and/or shipping radioactive should contact the Virginia Department of Health Radiological Health Division. VDH's Environmental Monitoring Program (EMP) "monitors radiation and radioactivity in the work environment, estimates radiation doses to individuals and populations, and assesses the likely effects of specific radiation hazards." The EMP can offer radiation exposure reduction recommendations for sites mining and processing such products. The VDH Radiological Health Division can be contacted at (804) 864-8150.
- Sites wishing to install or remove/abandon a private well for potable water or a septic system should contact their local health department for necessary permitting and construction information.

Virginia Department of Conservation and Recreation, Floodplain Disturbance

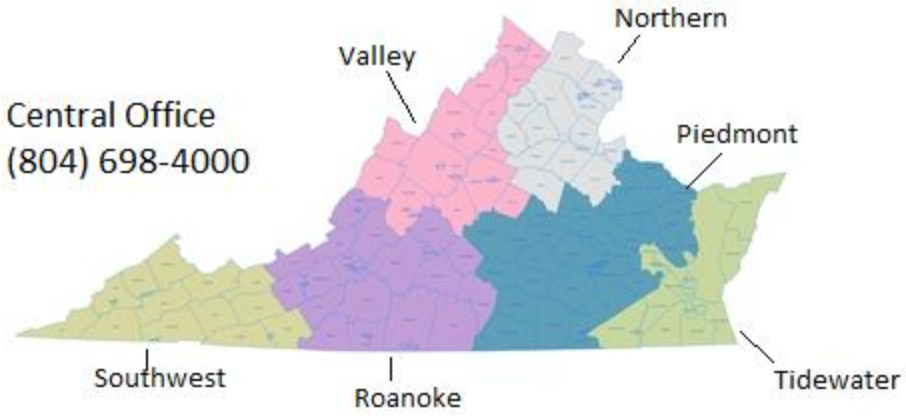
- Any operator disturbing a floodplain must notify the local county's floodplain administrator and may be required to apply for a floodplain disturbance permit. To determine if the mine site is located within a floodplain, DCR maintains the Virginia Flood Risk Information System (VFRIS) mapping tool. Within the mapping tool, operators can search for their site and view the floodplain layers. Additionally, many individual county GIS mapping tools also contain floodplain layers. If the mine site is in a floodplain, the operator should contact the local floodplain administrator. DCR maintains a database of the local floodplain

administrators and can provide operators with the appropriate contact information. To find the local floodplain administrator, or for additional floodplain information, please contact DCR's Floodplain Management staff.

Virginia Department of Environmental Quality

- Virginia Pollutant Discharge Elimination System (VPDES) Permits: Virginia DEQ requires a VPDES permit for "Any person who discharges or proposes to discharge any pollutant into surface waters of the Commonwealth from a point source, including stormwater discharges from certain industrial facilities." Mineral mining sites which will discharge water from the site may be required to obtain a VPDES permit. Operators should contact their local field office to determine if they need to apply for a VPDES permit. Field office contact information is shown below. VPDES application information can be found here.
- Air Permits: Sites that will be processing material, especially crushing and grinding, will need to apply for an Air Permit from DEQ. Two options are available for operators. Operators can apply for a Minor New Source Review Permit, or a Nonmetallic Mineral Processing General Permit.
- Waste Permits: The Division of Mineral Mining oversees the disposal of **inert** offsite waste and soil materials on mine sites. Any operator wishing to dispose of hazardous material, wishing to have a PMLU of a landfill, or who wishes to produce compost onsite should contact DEQ for the appropriate waste permit. A listing of available waste permits is given on the DEQ website.
- Biosolids Application: Any site wishing to utilize biosoilds during reclamation will be required to get a Virginia Pollution Abatement (VPA) Permit. Biosolids application is handled through the DEQ Office of Land Application Programs which has biosolids experts stationed throughout the state. Specific contact information for DEQ's Biosolids Program can be found here.

Department of Environmental Quality Regional Contacts



DEQ Regional Offices for Air, Waste, and Water

Tidewater Regional Office

5636 Southern Blvd.
Virginia Beach, VA 23462
(757) 518-2000

Southwest Regional Office

355-A Deadmore Street
Abingdon, Virginia 24210
(276) 676-4800

Valley Regional Office

4411 Early Road
Mailing address P.O. Box 3000
Harrisonburg, VA 22801
(540) 574-7800

Northern Regional Office

13901 Crown Court
Woodbridge, VA 22193
(703) 583-3800

Roanoke Office

901 Russell Drive Salem, Virginia 24153
(540) 562-6700

Piedmont Regional Office

4949-A Cox Road
Glen Allen, VA 23060
(804) 527-5020

Virginia Department of Transportation: Land Use Permits

- Operators must submit a copy of the Virginia Department of Transportation (VDOT) land use permit for roads that connect to public roads with the initial mine permit application. A permit must be obtained before disturbing any VDOT highway right-of-way. Depending on the size and expected traffic at the entrance road, the operator may be required to obtain a commercial entrance permit. Additional assistance can be obtained from the VDOT field office serving the mine's location:

Virginia Department of Transportation Field Offices

District	Residency	Number	Counties
Bristol	Abingdon	276-676-5503	Washington, Smyth and I-81/I-77 Interstate Maintenance
	Lebanon	276-889-7600	Buchanan, Russell, Tazewell
	Wise	276-328-9331	Lee, Dickenson, Scott, Wise
	Wytheville	276-228-2153	Bland, Grayson, Wythe
Culpeper	Charlottesville	434-293-0011	Albemarle, Greene, Madison
	Louisa	540-967-3710	Louisa, Fluvanna, Orange
	Warrenton	540-347-6441	Culpeper, Fauquier, Rappahannock
Fredericksburg	Fredericksburg	540-899-4300	Stafford, Spotsylvania, Caroline
	Northern Neck	804-333-3697	Lancaster, Richmond, Westmoreland, Northumberland, King George
	Saluda	804-758-2321	Mathews, Middlesex, Gloucester, King and Queen, King William, Essex
Hampton Roads	Accomac	757-787-5856	Accomack,Northampton
	Franklin	757-346-3072	Isle of Wight, Southampton, Greensville, Sussex
	Williamsburg	757-253-5138	Surry, James City, York
Lynchburg	Appomattox	434-352-7135	Appomattox, Amherst, Nelson, Campbell
	Dillwyn	434-983-2017	Buckingham, Prince Edward, Cumberland, Charlotte
	Halifax	434-476-6342	Halifax, Pittsylvania
Northern Virginia	Fairfax	703-259-0243	
	Prince William	703-259-0244	

	Leesburg	703-259-0245	
	Arlington Interstate	/703-259-0246	
Richmond	Ashland	804-585-3600	Hanover, Goochland, New Kent, Charles City, Henrico
	Chesterfield	804-674-2800	Amelia, Chesterfield, Powhatan
	Petersburg	804-863-4000	Dinwiddie, Prince George, Nottoway
	South Hill	434-774-2300	Brunswick, Lunenburg, Mecklenburg
Salem	Bedford	540-586-7910	Bedford, Franklin
	Christiansburg	540-381-7201	Floyd, Giles, Montgomery, Pulaski
	Martinsville	276-629-2581	Henry, Carroll, and Patrick
	Salem	540-387-5488	Roanoke, Craig, Botetourt
Staunton	Edinburg	540-984-5600	Clarke, Frederick, Shenandoah, Warren
	Harrisonburg	540-434-2586	Augusta, Page, Rockingham
	Lexington	540-463-3108	Alleghany, Bath, Highland, Rockbridge

Reclamation Resources

Virginia Tech Soil Testing Lab**,** (540) 231-6893

- The Virginia Tech Soil Testing Lab analyzes soil samples for pH, P, K, Ca, Mg, Zn, Mn, Cu, Fe, and B. Fertilizer and lime recommendations based on a specified post mining planting are given on each soil sample report. The Soil Testing Lab website contains instructions for taking a soil sample as well as forms to be sent off with the soil samples. Mine operators should use this form for surface mined areas. Soil sample boxes are available from county extension offices. Phone number for local county offices can be found online.

Virginia Cooperative Extension

- The Virginia Cooperative Extension offers a number of useful reclamation-related publications. These publications cover a wide range of topics from agricultural plantings, pasture and forestry management, to reclamation on surface mined lands in Virginia (specific reclamation publications are available here). Local extension agents can also be helpful in interpreting soil test results and making fertilizer, lime, or seeding application recommendations. Phone number for local county offices can be found here.

Virginia Department of Forestry

- For the early stages of mine development, the Department of Forestry can offer timber sale assistance for currently forested sites. For mines to be returned to forest, the Department of Forestry can inspect the area and offer site preparation recommendations and recommend tree species best suited for the site to increase growing success. The Department of Forestry also sells mass quantity pine and hardwood seedlings.
- Phone numbers for local forestry agents are listed online, or can be found by calling one of the following offices:

Headquarters – Charlottesville	(434) 977-6555
Eastern Regional Office – Providence Forge	(804) 966-5092
Central Regional Office – Charlottesville	(434) 977-5193
Western Regional Office –Salem	(540) 387-5461

Virginia Department of Game and Inland Fisheries

- For wildlife habitat post mining land uses, the Virginia Department of Game and Inland Fisheries (DGIF) has a number of links to helpful planting resources for wildlife habitats, such as native plant lists, growing native meadows, and tree and shrub selections for birds. In addition to planting help, the DGIF website has species-specific information showing the distribution of certain species throughout the state and their food sources, a very helpful resource for mine operators wishing to create a species-specific habitat. The DGIF operates out of 6 offices across the state:

Headquarters – Henrico	(804) 367-1000
Region 1 Office – Charles City	(804) 829-6580
Region 2 Office – Forest	(434) 525-7522
Region 3 Office – Marion	(276) 783-4860
Region 4 Office – Fredericksburg	(540) 899-4169
Region 4 Office – Verona	(540) 248-9360

Virginia Department of Conservation and Recreation

- The Department of Conservation and Recreation (DCR) manages the state's dam safety program and establishes floodplains. Impoundments on mine sites will be turned over to DCR and treated as dams after reclamation is complete and the bond is released. The DCR website also provides a variety of native plant species lists, separated by Virginia geographical location. DCR maintains a list of invasive plant species. **Species on this list are prohibited from being used in the reclamation seed mix.**

Natural Resources Conservation Service (NRCS)

- The NRCS has resources for developing wildlife habitats and information on land conservation. For operators with an agricultural or forest PMLU, NRCS provides free technical assistance to farmers and forest managers to help conserve resources on the land.

Mineral Mining Program Form Guide

Click on the paper form number to open a printable form from the Mineral Mining Program website.

Action	Paper Form Number	E-form Number
New permit application		
Permit/License Application	DMM-101	170
Permit/License Application *For Sand & Gravel < 10 Acres Only*	DMM-168	170
Notice of Application to Mine	DMM-103	Upload paper form to page 2 of 170
Bond Form	DMM-107	
Irrevocable Letter of Credit Form	DMM-108	
Certificate of Deposit	DMM-169	
Map Legend	DMM-109	Upload paper from to page 3 of 170
Contractor Identification Form	DMM-166	166
Permit Renewal		
License Renewal Application	DMM-157	170
Yearly Progress Report	DMM-105	170
Map Legend	DMM-109	Upload paper form oto page 3 of 170
Statement of no map changes	DMM-164	170
Surety Rider	DMM-167	
Contractor Identification Form	DMM-166	166
Permit Transfer		
Relinquishment of Mining Permit	DMM-112	Upload paper form to page 4 of 170
Permit Transfer Acceptance Form	DMM-161	Upload paper form to page 4 of 170
Annual Reporting		
Annual Tonnage Report	DMM-146	146

Contractor Annual Report	DMM-146C	146C
Permit Amendments		
Request for Amendment	DMM-113	170
Notice of Operator Intent	DMM-156	176
Request for Temporary Cessation		179
Accident Reporting		
Accident Form	DMM-104C	172

Virginia Energy Mineral Mining Program Requirements for Permit Maps

Checklist:

1. Legend attached and completed?
2. Legend acres correct? Add up?
3. Legend signed and dated?
4. General location map shown for new permit applications?
5. Permit areas shown?
6. Bonded areas shown?
7. Add to permit and bond areas correctly colored and labeled?
8. North arrow shown?
9. Principal facilities labeled? (pit, plant, stockpiles, process water ponds, reservoirs, drainage and sediment controls, etc.)
10. Stream and wetland crossings shown?
11. Landfills shown?
12. Contours or drainage patterns shown?
13. Property boundaries and ownership shown within 100 feet of permit boundary? (1000 feet for new permits)
14. Sensitive features shown and labeled within 500 feet of permit boundary?
    a. Roads and rail lines
    b. Rivers and streams
    c. Major utilities (power, gas, water, sewer,…)
    d. Public buildings
    e. Occupied dwellings
    f. Cemeteries, oil and gas wells, underground mines
15. Last map changes incorporated into present map?
16. Seeding progress noted and dated?
17. Bond release areas noted and dated?
18. Is the following hierarchy of colors used when map legend line colors overlap?
    1. Green and Green X-Hatch areas seeded
    2. Yellow areas disturbed
    3. Black X-Hatch areas released from bond
    4. Brown X-Hatch areas to be disturbed
    5. Blue and Blue X-Hatch water bodies

APPENDIX B: DRAINAGE AND SEDIMENT CONTROL RESOURCES

Permit Amendment Requirements for Sediment Basins

1. Narrative outlining:
    1. Purpose of the amendment
    2. Construction and maintenance plans
    3. Reclamation plans

2. Design Calculations showing:
    1. Permanent or temporary design basis
    2. Disturbed watershed and pond volume calculations
    3. Total watershed and pond decant calculations
    4. Any other calculations necessary to support the design of the basin or related structures

3. Design Drawings showing:
    1. Plan view of structure
    2. Cross-section of structure through decants
    3. Any details that cannot be shown sufficiently in the above drawings

4. Permit Map showing:
    1. The location of the structure on the mine site
    2. The disturbed area and watershed above the structure
    3. Drainage patterns and controls
    4. All other requirements of 4VAC25-30-210

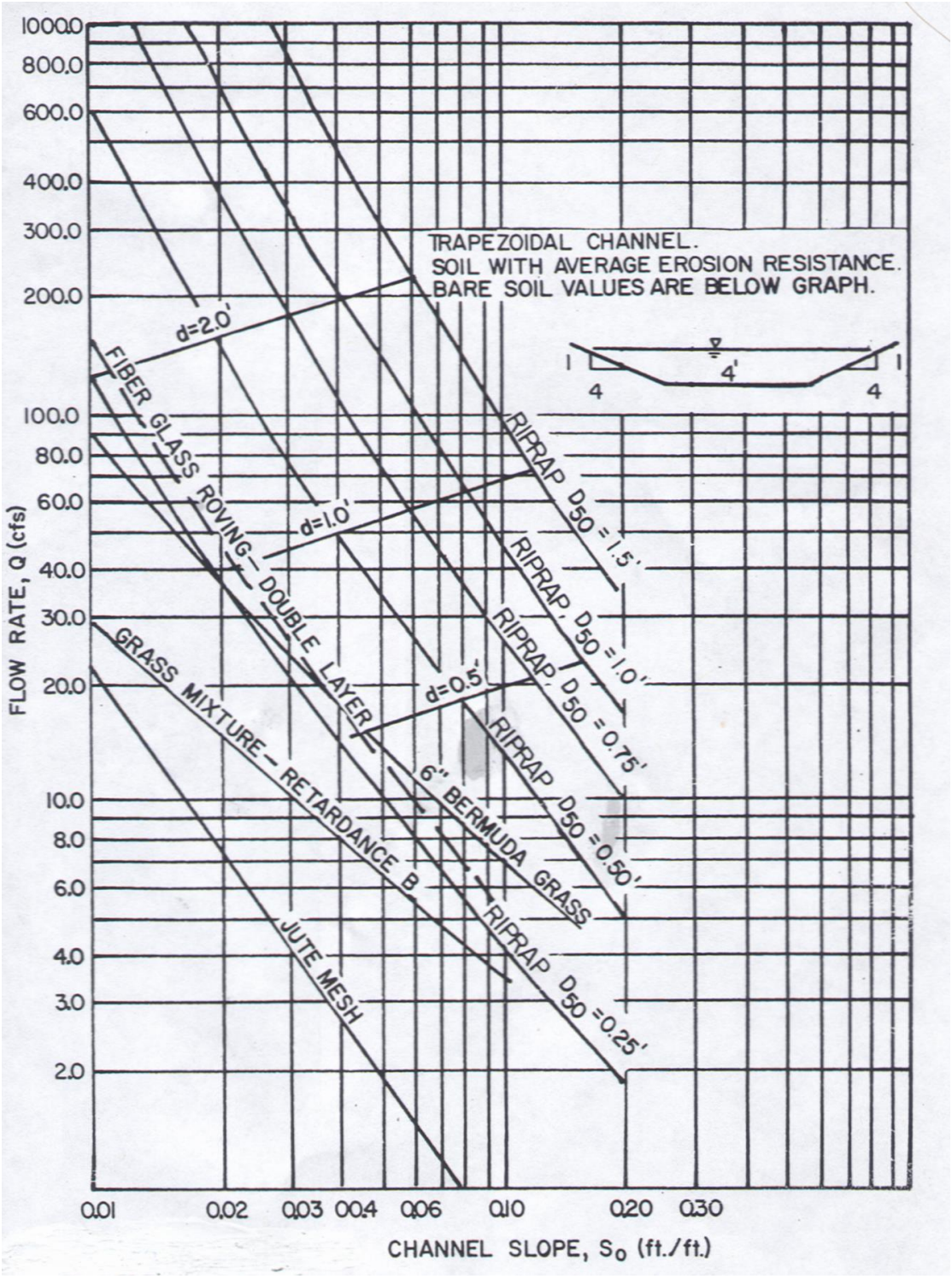
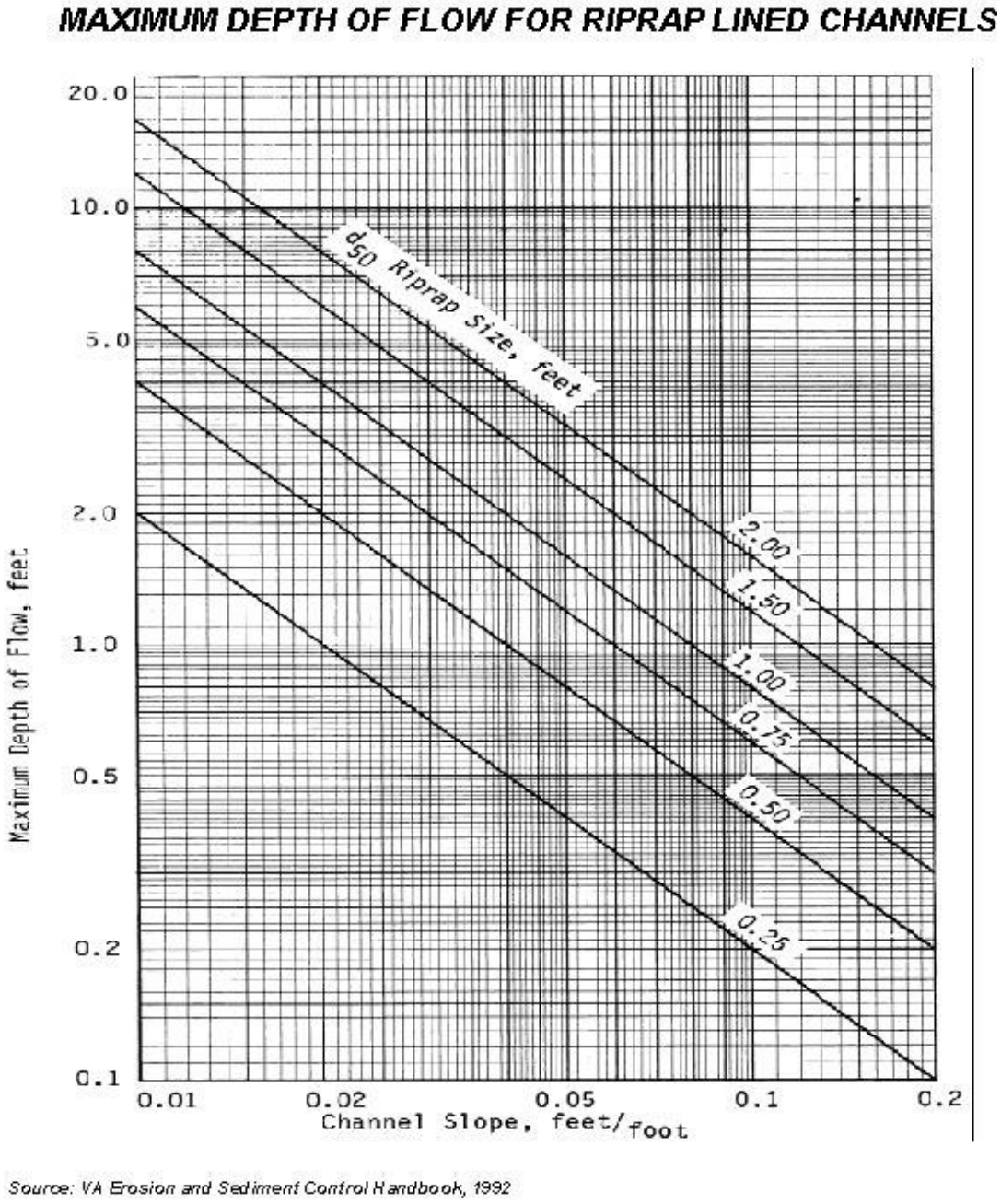


Figure B-1: Comparison of Maximum Flow Rate Versus Slope for Various Channel Linings (Source: Open Channel Hydraulics)



Source: VA Erosion and Sediment Control Handbook, 1992

Figure B-2: Comparison of Maximum Flow Rate Versus Slope for Various Channel Linings

Table B-3: Permissible Velocities for Grass-Lined Channels

Channel Slope	Lining	Velocity * (ft/sec)
0-5%	Bermuda grass	6
	Reed Canarygrass Tall fescue Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue Redtop Sericea lespedeza Annual lespedeza Small grains Temporary vegetation	2.5
5-10%	Bermuda grass	5
	Reed Canarygrass Tall fescue Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Bermuda grass	4
	Reed Canarygrass Tall fescue Kentucky bluegrass	3

* for highly erodible soils, decrease permissible velocities by 25%

Table B-4: Permissible Velocities for Earth Linings

Soil Types	Permissible Velocities (ft/sec)
Fine Sand (noncolloidal)	2.5
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	5.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5
Shales and Hard Pans	6.0

Table B-5: Concentric Track Rack and Anti-Vortex Device Design

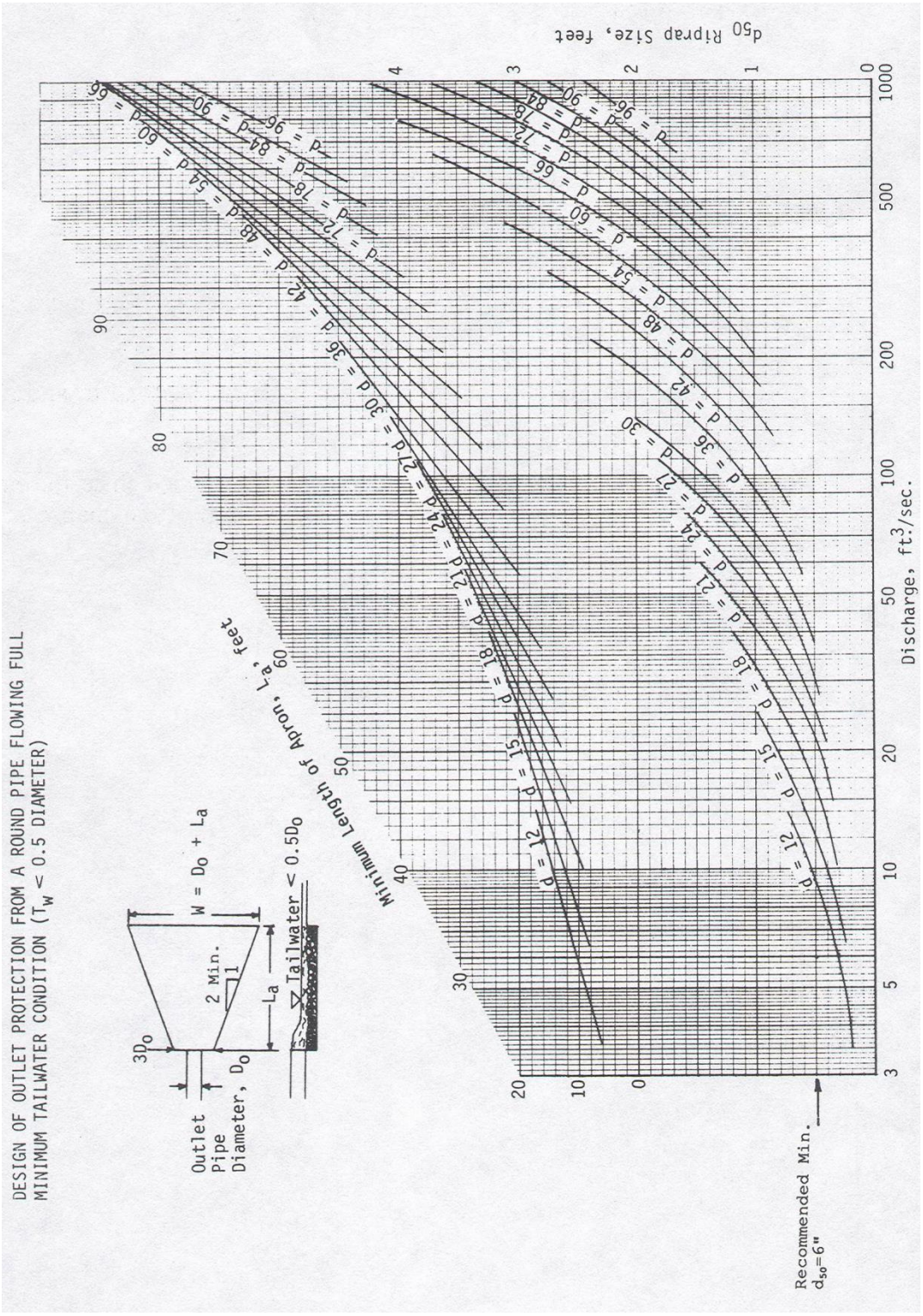
Riser Diameter (inches)	Cylinder		Height (inches)	Minimum Size Support Bar	Minimum Top	
	Diameter (inches)	Thickness (gage)			Thickness	Stiffener
12	18	16	6	#6 Rebar or 1 1/2 x 1 1/2 x 3/16 angle	16 ga. (F&C)	–
15	21	16	7	" "	" "	–
18	27	16	8	" "	" "	–
21	30	16	11	" "	16 ga. (C), 14 ga. (F)	–
24	36	16	13	" "	" "	–
27	42	16	15	" "	" "	–
36	54	14	17	#8 Rebar	14 ga. (C), 12 ga. (F)	–
42	60	16	19	" "	" "	–
48	72	16	21	1 1/4 pipe or 1 1/4 x 1 1/4 x 1/4 angle	14 ga. (C), 10 ga. (F)	–
54	78	16	25	" "	" "	–
60	90	14	29	1 1/2" pipe or 1 1/2 x 1 1/2 x 1/4 angle	12 ga. (C), 8 ga. (F)	–
66	96	14	33	2" pipe or 2 x 2 x 3/16 angle	12 ga. (C), 8 ga. (F) w/stiffener	2 x 2 x 1/4 angle
72	102	14	36	" "	" "	2 1/2 x 2 1/2 x 1/4 angle
78	114	14	39	2 1/2" pipe or 2 x 2 x 1/4 angle	" "	" "
84	120	12	42	2 1/2 " pipe or 2 1/2 x 2 1/2 x 1/4 angle	" "	2 1/2 x 2 1/2 x 5/16 angle

Note$_1$: The criterion for sizing the cylinder is that the area between the inside of the cylinder and the outside of the riser is equal to or greater than the area inside the riser. Therefore, the above table is invalid for use with concrete pipe risers.

Note$_2$: Corrugation for 12"-36" pipe measures 2 2/3" x 1/2"; for 42"-84" the corrugation measures 5" x 1" or 8" x 1".

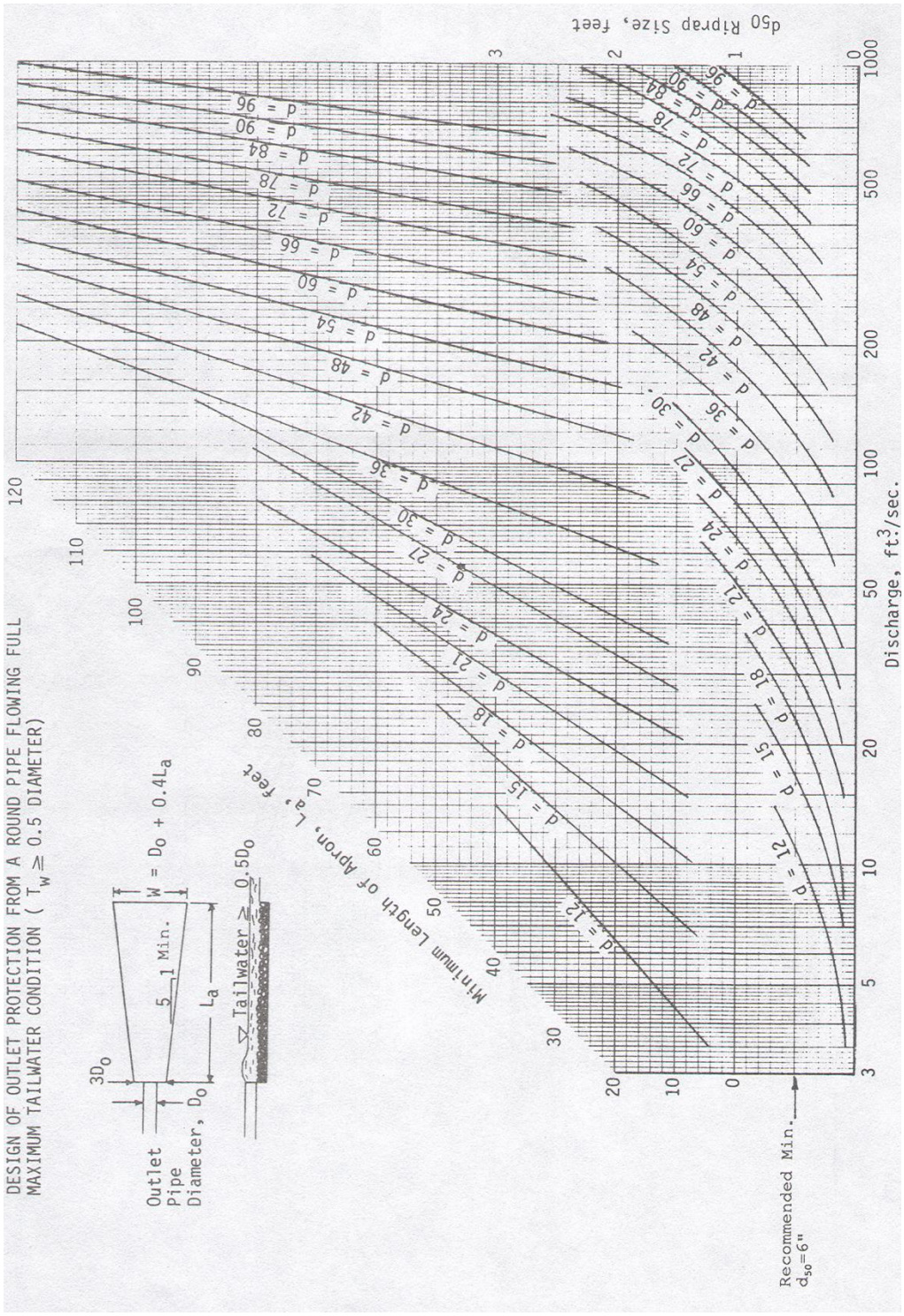
Note$_3$: C = corrugated; F = flat.

Figure B-3: Design of Outlet Protection from a Round Pipe (Minimum Tailwater)



Source: VA Erosion and Sediment Control Handbook, 1992

Figure B-4: Design of Outlet Protection from a Round Pipe Flowing Full (Maximum Tailwater)



Source: VA Erosion and Sediment Control Handbook, 1992

APPENDIX C: RECLAMATION RESOURCES

Hydroseeding

Definition

Hydroseeding is a mechanical method of applying seed, fertilizer, and mulch to land in one step.

Description and Purpose

Hydroseeding typically consists of applying a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydro-mulch equipment, which temporarily protects exposed soils from erosion by water and wind.

The practice may also be called hydro mulching, hydraulic planting, hydraulic mulch seeding, hydraseeding

Pollutant(s) controlled:

- Suspended Sediments

Pollution Removal Efficiencies:

- Hydroseeding initially reduces sediment generation by 70 to 80% as compared to sediment production off bare slopes.

Companion and Alternative BMPs

- Mulching
- Seeding/Vegetation
- Rolled Erosion Control Products

Advantages and Disadvantages

Advantages:

- Tackifiers can be used with the application to help keep the seed in place
- Provides mulching medium around the seed to hold moisture

Disadvantages:

- Hydroseeding may be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and erosion control. Otherwise, hydroseeding must be used in conjunction with a soil binder or mulching
- Hydroseeding may be inappropriate in dry periods without supplemental irrigation
- Wood fiber hydraulic mulches are generally short-lived (only last a part of a growing season) and need 24 hours to dry before rainfall occurs to be effective.
- May not be able to access remote areas with hydroseeder

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APPENDIX D: ROADWAY RESOURCES

Table D-1:
Approximate Method of Determining Required Culvert Sizes by Talbot's Formula

TALBOT'S LAW: $A = C (a^3)^{1/4}$

WHERE: A = CROSS SECTIONAL AREA REQUIRED (FT^2)
C = TALBOT'S COEFFICIENT
a = AREA DRAINED IN ACRES

VALUES OF TALBOT'S COEFFICIENT
C = 1.0 (MOUNTAINOUS TERRAIN)
C = 0.6 TO 0.8 (HILLY TERRAIN)
C = 0.4 TO 0.5 (ROLLING TERRAIN)
C = 0.2 TO 0.3 (FLAT TERRAIN)

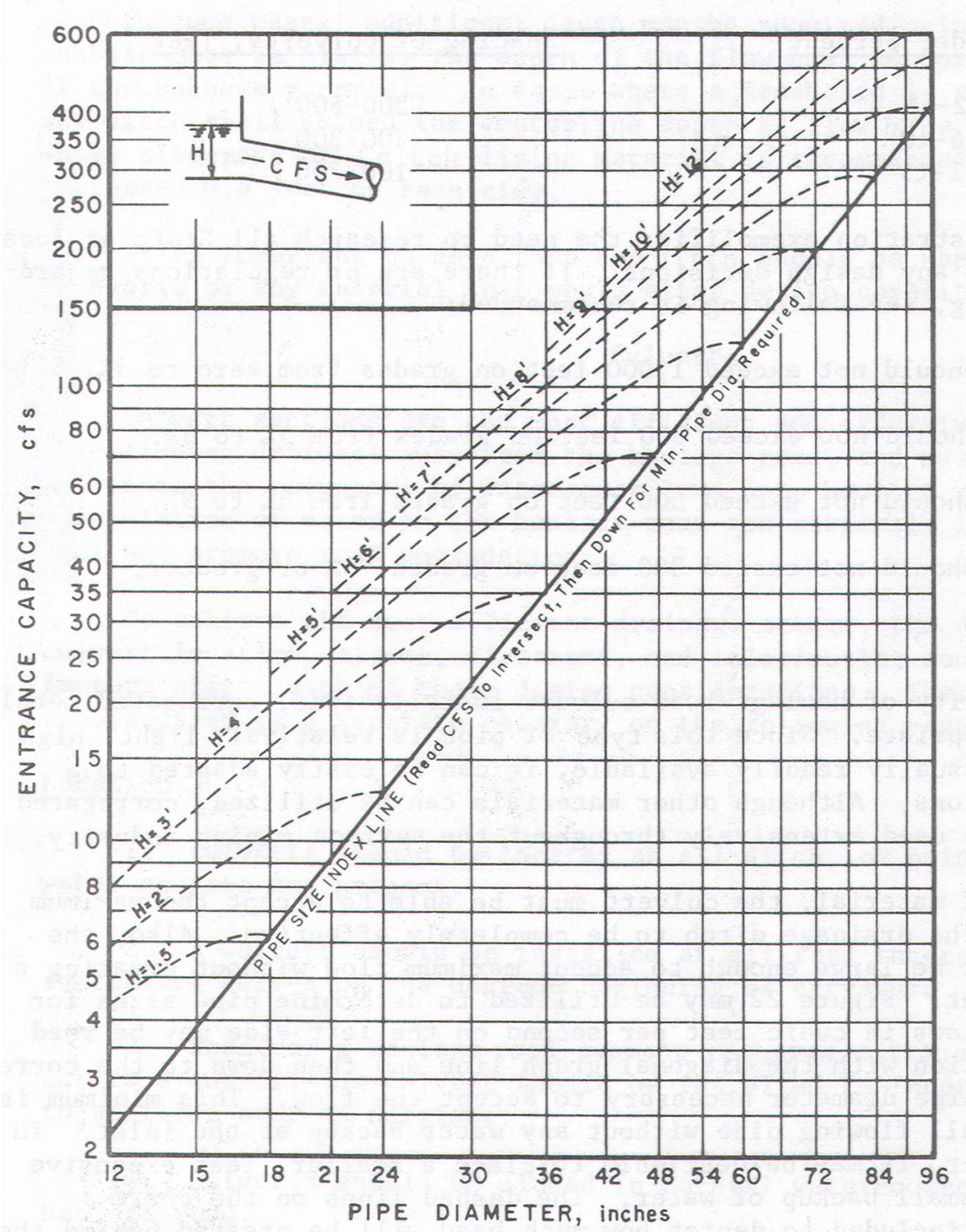
CROSS-SECTIONAL AREAS OF PIPE (FT^2)

12" = 0.79	42" = 9.62	72" = 28.3
18" = 1.78	48" = 12.6	84" = 38.5
24" = 3.14	54" = 16.0	96" = 50.3
30" = 4.91	60" = 19.6	108" = 63.6
36" = 7.07	66" = 23.8	120" = 78.5

APPROXIMATE CROSS-SECTIONAL AREA REQUIRED (FT^2)

ACRES DRAINED	MOUNTAINOUS TERRAIN (>12%)	HILLY TERRAIN (8-12%)	ROLLING TERRAIN (4-8%)	FLAT TERRAIN (0-4%)
1	1.0	0.7	0.45	0.3
2	1.5	1.2	0.75	0.4
3	2.3	1.3	1.0	0.5
4	2.8	2.0	1.3	0.7
5	3.3	2.3	1.5	0.8
6	3.8	2.7	1.7	1.0
7	4.3	3.0	1.9	1.1
8	4.8	3.4	2.2	1.2
9	5.2	3.6	2.3	1.3
10	5.6	4.0	2.5	1.5
15	7.6	5.4	3.4	1.9
20	9.5	6.7	4.3	2.4
25	11.1	7.8	5.0	2.8
30	12.8	8.9	5.8	3.2
35	14.4	10.1	6.5	3.6
40	15.9	11.1	7.2	4.0
45	17.4	12.2	7.8	4.4
50	18.8	13.2	8.5	4.7
75	25.5	17.9	11.5	6.4
100	31.6	22.1	14.2	7.9
150	42.9	30.0	19.3	9.3
200	53.2	37.2	24.0	13.3
300	72.1	50.0	32.4	18.0
400	89.4	62.6	40.2	22.3
500	105.7	74.0	47.6	26.4
600	121.2	84.8	54.5	30.4

Figure D-1: Graph Showing Pipe Culvert Capacity



Source: USBM Information Circular 8758

Manning's Formula to Determine Flow in Streams

Manning's Formula may be used to determine the quantity of water that must be carried by the culvert(s).

$$Q = VA$$

Where:

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

Q = stream flow in cubic feet per second, f^3/sec.
V = flow velocity, ft/sec.
A = cross sectional area of stream channel perpendicular to flow, ft^2
R = hydraulic radius*, ft (Table 9-2)
S = slope of the stream channel, ft/ft (Table 9-3)
n = Manning's "n" (coefficient of stream bed roughness) (Table 9-4)

*$hydraulic\ radius = \frac{Area\ of\ Waterway}{Wetted\ Perimeter}$

Example:

Find the flow rate for an existing waterway with a measured wetted perimeter = 24 ft., cross sectional area = 40 ft^2, slope = 2 feet per one hundred feet, a meandering channel with a few weeds in the channel and heavy brush on the banks.

Where Q = VA

and $V = \frac{1.486}{n} R^{2/3} S^{1/2}$

$R = \frac{A}{P} = \frac{40\ ft^2}{24\ ft} = 1.66\ ft$

S = 0.02 ft/ft
n = 0.07(from table 9-4)

$$Q = VA = \left(\frac{1.486}{n} R^{2/3} S^{1/2}\right) A = \left(\left(\frac{1.486}{0.07}\right)(1.66\ ft)^{2/3}(0.02\ ft/ft)^{1/2}\right)(40\ ft^2) = \boxed{\underline{168\ cfs}}$$

Follow the procedure found in Section 7.6 of this document to determine the pipe size required to handle a stream flow = 168 cfs.

Table D-2:
Manning's "n" for Natural Stream Channels
(surface width at flood stage less than 100 feet)

Natural stream channels	n
1. Fairly regular section:	
Some grass and weeds, little or no brush	0.030 - 0.035
Dense growth of weeds, depth of flow materially greater than weed height	0.035 - 0.050
Some weeds, light brush on banks	0.050 - 0.070
Some weeds, heavy brush on banks	0.060 - 0.080
Some weeds, dense willows on banks	0.010 - 0.020
For trees within channel, with branches submerged at high stage, increase above values by	0.010 - 0.020
2. Irregular sections, with pools, slight channel meander; increase values given above by	0.010 - 0.020
3. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stage:	
Bottom of gravel, cobbles, and few boulders	0.040 - 0.050
Bottom of cobbles with large boulders	0.050 - 0.070

Source: (Highway Task Force, 1971)

NOTE: Lower "n" values should be given to stream channels that are more hydraulically efficient and higher values should be assigned to stream channels that are less hydraulically efficient.

APPENDIX E: OVERBURDEN DISPOSAL AREA RESOURCES

Helpful Slope Conversions and Formulas

1:1 = 1 horizontal to 1 vertical distance = 100% grade = 45.0 degrees
1½:1 = 1½ horizontal to 1 vertical distance = 67% grade = 33.7 degrees
2:1 = 2 horizontal to 1 vertical distance = 50 % grade = 26.6 degrees
3:1 = 3 horizontal to 1 vertical distance = 33 % grade = 18.4 degrees

To determine percent grade:

Percent grade = 100 x (vertical distance / horizontal distance)

To convert a slope ratio to degrees:

Slope degrees = inverse tangent of (vertical distance / horizontal distance)

To determine the slope distance for a given slope degree and vertical distance:

Slope distance = vertical distance / Sine (slope degrees)

To determine the height of slope for a given horizontal distance and slope degrees.

Slope height = horizontal distance x Tan (slope degrees)

APPENDIX F: IMPOUNDMENT RESOURCES

Date Prepared: _____
Prepared By: _____

EMERGENCY PREPAREDNESS PLAN FOR LOW HAZARD VIRGINIA REGULATED IMPOUNDING STRUCTURES

Reference: Impounding Structures Regulations, 4VAC 50-20-10 et seq., including 4VAC 50-20-177, Virginia Soil and Water Conservation Board

1. Name of Impounding Structure: _____
   Inventory Number: _____ City/County: _____
   Other Name (if any): _____
   Stream Name: _____
   Latitude: _____ Longitude: _____

2. Name of Owner: _____
   Address: _____
   Telephone: (Residential) _____ (Business) _____
   Other means of communication: _____
   (Note: 24-hour telephone contact required)

3. Name of Impounding Structure Operator: _____
   Address: _____
   Telephone: (Residential) _____ (Business) _____
   Other means of communication: _____
   (Note: 24-hour telephone contact required)

   Name of Alternate Operator: _____
   Telephone: (Residential) _____ (Business) _____
   Other means of communication: _____
   (Note: 24-hour telephone contact required)

4. Name of Rainfall and Staff Gage Observer for Dam: _____
   Address: _____
   Telephone: (Residential) _____ (Business) _____
   Other means of communication: _____
   (Note: 24-hour telephone contact required)

   Name of Alternate Rainfall and Staff Gage Observer: _____
   Telephone: (Residential) _____ (Business) _____
   Other means of communication: _____
   (Note: 24-hour telephone contact required)

5. 24-Hour Dispatch Center Nearest Impounding Structure – Police/Fire/Sheriff's Department: _____
   Address: _____
   24-Hour Telephone: _____

(DCR199-103) (09/08) Page 1 of 5

6. Name of City/County Emergency Services Coordinator(s): _____

Address: _____

_____

_____

Telephone: _____

Other means of communication _____

(Note: 24-hour telephone contact required)

7. Describe the procedure and the responsible parties for notifying to the extent possible any known local occupants, owners, or lessees of downstream properties potentially impacted by the dam's failure.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

8. Discuss the procedures for timely and reliable detection, evaluation, and classification of emergency situations considered to be relevant to the project setting and impounding features. Each relevant emergency situation is to be documented to provide an appropriate course of action based on the urgency of the situation

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

9. Attach a simple dam break inundation map, demonstrating the general inundation that would result from an impounding structure failure.

10. If there are public roads downstream from the impounding structure, identify by highway number and distance below dam:

Route # _____ , _____ Miles Route # _____ , _____ Miles

Route # _____ , _____ Miles Route # _____ , _____ Miles

Provide name of resident engineer, VA Department of Transportation, (or City/County engineer):

_____

Address: _____

_____

_____

Telephone: (Residential) _____ (Business) _____

Other means of communication: _____

(Note: 24-hour telephone contact required)

_____

(DCR199-103) (09/08) Page 2 of 5

Definitions:

Stage I Condition – A flood watch, or heavy continuous rain or excessive flow of water from ice or snow melt.

Stage II Condition – A flood watch, or emergency spillway activation or dam overtopping/breach may be possible.

Stage III Condition – Emergency spillway activation, dam overtopping or imminent failure is probable.

---

11. Amount of rainfall that will initiate a:

Stage II Condition _____ **Inches per 6 hrs.**
_____ **Inches per 12 hrs.**
_____ **Inches per 24 hrs.**
Stage III Condition _____ **Inches per 6 hrs.**
_____ **Inches per 12 hrs.**
_____ **Inches per 24 hrs.**

The amount of flow in the emergency spillway that will initiate a:

Stage II Condition _____ **Feet (depth of flow)**
Stage III Condition _____ **Feet (depth of flow)**

Total depth of emergency spillway available before crest of dam is overtopped: _____ **Feet**

---

12. Does a staff gage exist? ____ Yes ____ No
Staff Gage Location and Description: _____

Frequency of observations by rainfall/staff gage observer during a:

Stage I Condition _____
Stage II Condition _____
Stage III Condition _____ **(recommend continuous)**

Clearly identify access route and means of monitoring during flood conditions at the dam.

(DCR199-103) (09/08) Page 3 of 5

Note: It is recommended that the Observer remain on post until potentially serious or serious conditions subside.

13. Evacuation Procedures:
    a. The dam owner/operator should notify the local emergency services office (i.e., the city/county 24-hour dispatch center). Phone number should be listed in #5 above.
    b. Once the local emergency services office has been notified of any problem at a dam site, it should take appropriate protective measures in accordance with the local Emergency Operations Plan and this Emergency Preparedness Plan. Local emergency services actions will include:
        (1) Notify the individuals who own downstream property
        (2) Begin Alert, Notification, and Warning
        (3) Immediately evacuating the inundation areas, when stage III conditions warrant.
        (4) Begin Emergency Public Information procedures open emergency shelters.
        (5) Provide Situation Reports to the State Emergency Operations Center (804) 674-2400 or (800) 468-8892.

    c. Once the local government has been notified of a condition requiring evacuation, the dam owner/operator and local government are mutually responsible for effecting evacuation.
        (1) The dam owner/operator will:

        (2) Local emergency services will:

    d. Methods for notification and warning to evacuate include:
    Check appropriate method(s)

    _____ (1) Telephone
    _____ (2) Police/fire/sheriff radio dispatch vehicles with loudspeakers, bullhorns, etc.
    _____ (3) Personal runners for door-to-door alerting
    _____ (4) Radio/television broadcasts for areas involved

(DCR199-103) (09/08) Page 4 of 5

CERTIFICATION BY OWNER

I certify that a copy of this plan has been filed with _____ (City/County) and _____ (Name), the local Emergency Services Coordinator. Also, that a copy of this form has been filed with the State Department of Emergency Management; that this plan shall be adhered to during the life of the project; and that the information contained herein is current to the best of my knowledge.

Signed: _____

Owner's Signature Print Name

This _____ day of _____ , 20 ____ .

Please fill out and mail to:

Virginia Department of Emergency Management
Plans Division
10501 Trade Court
Richmond, Virginia 23236

Mail the executed form to the appropriate
Department of Conservation and Recreation
Division of Dam Safety and Floodplain Management
Regional Engineer

(DCR199-103) (09/08) Page 5 of 5

EMERGENCY RESPONSE PLAN FOR LARGE DAMS AND MINE REFUSE PILES

Section 45.1-225.2 of the Mineral Mine Safety Laws of Virginia requires that operators of large dams have emergency response plans in place to be implemented in the event of a hazardous condition at the dam or impoundment.

COMPANY_____ **PERMIT #**_____

Dam or Waste Structure Information

Name of Structure _____ Capacity _____ Ac-Ft
Exact Location of Dam or Structure _____
_____

Hazard Potential From Table Below _____

Hazard Class	Potential for Loss if Failure Occurs
High	dams that upon failure would cause probable loss of life or serious economic damage
Medium	dams that upon failure might cause loss of life or appreciable economic damage
Low	dams that upon failure would lead to no expected loss of life or significant economic damage. Special criteria: This classification includes dams that upon failure would cause damage only to property of the dam owner.

Water Level That Activates Emergency Response Plan

Water level ____ feet below the crest of the embankment. Go to Observation Status
Water level ____ feet below the crest of the embankment. Go to Alert Status
Water level ____ feet below the crest of the embankment. Go to Evacuation Ready Status
Water level <____ feet below the crest of the embankment. Go to Evacuation Status

Rainfall Events That Activate Emergency Response Plan

Flood watch for the area is issued by the National Weather Service. Go to Observation Status
Rainfall accumulation ≥ _____ inches or ____ percent of design storm. Go to Alert Status
Rainfall accumulation ≥ _____ inches or ____ percent of design storm. Go to Evacuation Ready Status

Ownership and Responsibility Information

Company Name_____ Mine Location_____
Responsible Party_____
Address_____
Telephone_____ Business _____ Home

Emergency Response Team

Team Leader_____
Address_____
Telephone_____ Business_____ Home

Team member_____
Address_____
Telephone_____ Business_____ Home

Team member_____
Address_____
Telephone_____ Business_____ Home

Emergency Response Officials To Contact

Nearest 24 Hour Dispatch center for Police, Fire, or Sheriff's Department_____
Location_____ Contact Name_____

Name of City or County Emergency Services Coordinator_____
Address_____
Telephone_____ Business_____ Home

Division Of Mineral Mining Site Mine Inspector_____
Address_____
Telephone_____ Business_____ Home

Division Of Mineral Mining Mine Inspector Supervisor_____
Address_____
Telephone_____ Business_____ Home

Division Of Mineral Mining Division Director_____
Address_____
Telephone_____ Business_____ Home

Residents in the Inundation or Danger Zone to be Notified:

Name	Address	Telephone

Business, Commercial or Recreational Facilities in the Inundation or Danger Zone to be Notified

Name	Address	Telephone

Property Owners in the Inundation or Danger Zone to be Notified:

Name	Address	Telephone

Notification of Virginia Department of Transportation if Roads or Highways are in the Inundation or Danger Zone

Highway Route Number	Distance Below Dam (miles)

Virginia Department of Transportation Resident Engineer:
Name_____
Address_____
Telephone_____ Business_____ Home

EMERGENCY RESPONSE PROCEDURE

Section 45.1-225.2 of the Mineral Mine Safety Laws of Virginia requires that emergency response plans and procedures be in place for large impoundments. This procedure is for example only and should not be considered all-inclusive. Other activities may need to be added to address site specific conditions.

The mining company will designate a responsible person with authority to make decisions regarding the operation of the facility, initiating the Emergency Response Plan (ERP), notifying local officials and procuring resources, personnel and equipment to function in the event of an emergency.

The responsible person will insure that the ERP is developed and that team members are assigned and trained in their duties and responsibilities under the ERP.

The responsible person, in conjunction with the company engineering staff or consultant, will establish the conditions that trigger the appropriate actions in the ERP and develop procedures for eliminating hazardous conditions.

The ERP will set the activities, the notifications and the persons with responsibility for the actions for each status level used in the ERP.

The responsible person will initiate actions and acquire personnel and equipment to repair or alleviate hazardous conditions that may develop at the facility.

Observation Status

1. The responsible person or one of the team members will be assigned responsibility to observe and monitor the facility during a flood watch issued by the National Weather Service or when the water reaches a certain level on the facility embankment. A backup person or other redundant process will be established to ensure coverage.

2. The responsible person or assigned team member will monitor the facility periodically during the period when the Observation Status conditions exist.

3. A time schedule or interval will be established for the observations. The observations and rainfall readings should be made and recorded. Weather or local radio/television broadcasts should be monitored.

4. If status changes to where water levels are below the Observation Status or the flood watch is lifted, the responsible person should be notified and the Observation Status canceled if it is determined the situation has passed.

5. If status changes to where water levels reach Alert Status or the rainfall amounts specified in the ERP, the responsible person or assigned team members will make any necessary contacts and initiate the procedure for the updated status.

Alert Status

1. The responsible person will assign one of the emergency response team members the responsibility to observe and monitor the facility while the Alert Status is in effect. Communication with the responsible person or other team member will be provided and assured.

2. The responsible person will notify all team members of the Alert Status and call them in as necessary. The responsible person will also notify the Mineral Mining Program Director or Mine Inspector and company management as needed.

3. The responsible person will contact local officials (sheriff, fire and rescue) and inform them of the Alert Status.

4. If the status changes due to rain stopping, storm passing and/or water levels receding, the person monitoring the dam or embankment will contact the responsible person and advise them of the status. Monitoring should continue until danger has passed.

5. The responsible person should notify all alerted parties of the status change.

6. If the status changes due to increased rainfall and higher water levels the observer must contact the responsible person.

7. The responsible person must initiate the procedure for the updated status.

Evacuation Ready Status

1. The responsible person will assign a team member to observe and monitor the facility while the Evacuation Ready Status is in effect. Communications with the responsible person will be provided and assured. The responsible person will be notified of any observed changes or conditions.

2. The responsible person will notify the Mineral Minng Program Director or Mine Inspector and emergency response team members of the facility condition and status. Company management will also be notified to ensure the availability of personnel and equipment. All necessary personnel and equipment will be placed on standby.

3. The responsible person and selected team members will notify local officials (sheriff, fire, rescue, hospitals and shelters) and broadcast public notice of the situation.

4. The responsible person and team members will notify residents, property owners and businesses in the danger zone of the facility condition and emergency status.

5. Virginia Department of Transportation will be notified of the facility status and the names and numbers of any roads that may be endangered.

6. If the status is downgraded due to rain stopping and water receding the facility observer will contact the responsible person to notify them of the change in condition. The observer will continue to monitor the facility until danger has passed and conditions return to normal.

7. If the status is upgraded from Evacuation Alert Status the responsible person will initiate procedures to evacuate all persons in the danger zone.

Evacuation Status

1. The responsible person will assign a team member to observe the facility status and maintain communications with the observer.

2. The responsible person will contact the Mineral Mining Program Director or Mine Inspector and all local authorities, alert emergency shelters and mobilize all persons, equipment and vehicles necessary to evacuate all persons in the danger zone. Public notice of the situation will be broadcast on local media.

3. The responsible person will acquire all personnel and equipment necessary and direct all activities dealing with mitigation, repair or reduction of the hazardous condition.

4. The responsible person and emergency team will continue to monitor the facility and conduct response duties until the hazard has been abated and the status of the facility returns to normal.

5. The responsible person will notify all alerted parties of the status changes until danger has passed.

6. Public notice that danger has past should be broadcast on local media.

DAILY IMPOUNDMENT INSPECTION FORM

Dams and refuse piles with embankments 5 feet high and storage volumes of 50 acre feet or greater and impoundments with embankments capable of impounding water to a height of 20 feet or more must be inspected daily in accordance with Section 45.1-225.2 of the Mineral Mine Safety Laws of Virginia.

COMPANY _____ **PERMIT #** _____

Impoundment, Tailings Pond or Waste Fill Identification Number or Name_____

Embankment

A.1. Are there any new surface cracks on the embankment?	YES ☐	NO ☐
A.2. Have any existing cracks enlarged?	YES ☐	NO ☐
A.3. Have any repaired cracks reopened?	YES ☐	NO ☐
A.4. Are there any slips or slides on the embankment?	YES ☐	NO ☐
A.5. Are there any slips or slides adjacent to the embankment?	YES ☐	NO ☐
A.6. Are there any signs of seepage from the embankment?	YES ☐	NO ☐
A.7. Are there any signs of seepage from the ground around the embankment?	YES ☐	NO ☐
A.8. Are there any cracks or slides in areas beyond the toe of the embankment?	YES ☐	NO ☐
A.9. Are there any depressed or bulging areas on the embankment?	YES ☐	NO ☐
A.10. Has the crest of the embankment settled or shifted?	YES ☐	NO ☐
A.11. Are there signs of erosion on the embankment?	YES ☐	NO ☐
A.12. Are there any trees growing on the embankment?	YES ☐	NO ☐
A.13. Are there any animal burrows on the embankment?	YES ☐	NO ☐
A.14. Are there any sections of the embankment that are saturated or marshy?	YES ☐	NO ☐
A.15. Are there any other signs of weakness or instability in the structure?	YES ☐	NO ☐
A.16. Has water over topped the embankment?	YES ☐	NO ☐

Principal Spillway

B.1. Is the principal spillway inlet open and clear of debris?	YES ☐	NO ☐
B.2. Is the principal spillway discharging?	YES ☐	NO ☐
B.3. Are trash racks and anti-vortex devices in place and functioning?	YES ☐	NO ☐
B.4. Is outlet protection in place and functioning?	YES ☐	NO ☐
B.5. Is the outlet open and unobstructed by debris or high water?	YES ☐	NO ☐

Emergency Spillway

C.1. Is there any flow in the emergency spillway?	YES ☐	NO ☐
C.2. Has there been any flow in the Emergency spillway since last inspection?	YES ☐	NO ☐
C.3. Does it appear that freeboard was/is maintained between the high flow and the crest of the dam?	YES ☐	NO ☐
C.4. Is spillway lining in good shape?	YES ☐	NO ☐
C.5. Are there any signs of erosion in the emergency spillway?	YES ☐	NO ☐

Reservoir

D.1. What is the water level (percentage of normal pool)? _____
D.2. What is the sediment/waste level (percentage of capacity)? _____
D.3. Are there any slides in the reservoir area? YES ☐ NO ☐
D.4. Are there any new sources of inflow into the reservoir? YES ☐ NO ☐

Down Stream Development

E.1. Are there any new houses, roads, public or commercial buildings, being developed in the down stream impact area? YES ☐ NO ☐
E.2. Has the Emergency Response Plan be modified to alert these occupants and facilities? YES ☐ NO ☐

Action Summary

Question	Recommendations	Action Taken	Date Completed

Recommended Maintenance

Next Week _____
Next Month _____
Next Year _____

Signature and Certification

Inspection Completed By _____ Date _____
Observations or Notice of Hazardous Conditions Reported To _____

_____ _____
SIGNATURE OF OPERATOR OR AGENT REVIEWING THIS RECORD DATE

Reservoir

D.1. What is the water level (percentage of normal pool)? _____
D.2. What is the sediment/waste level (percentage of capacity)? _____
D.3. Are there any slides in the reservoir area? YES ☐ NO ☐
D.4. Are there any new sources of inflow into the reservoir? YES ☐ NO ☐

Down Stream Development

E.1. Are there any new houses, roads, public or commercial buildings, being developed in the down stream impact area? YES ☐ NO ☐
E.2. Has the Emergency Response Plan be modified to alert these occupants and facilities? YES ☐ NO ☐

Action Summary

Question	Recommendations	Action Taken	Date Completed

Recommended Maintenance

Next Week_____
Next Month_____
Next Year_____

Signature and Certification

Inspection Completed By _____ Date_____
Observations or Notice of Hazardous Conditions Reported To_____

_____ _____
SIGNATURE OF OPERATOR OR AGENT REVIEWING THIS RECORD **DATE**

Table F-1: Impoundment Design Criteria

1. Impoundments meeting or exceeding the size criteria set forth in this section shall be designed utilizing a spillway flood and hazard potential classification as specified in the following table:

Class of Impoundment*	Spillway Design Flood (SDF)**	Minimum Threshold for Incremental Damage Analysis ***
High Hazard	PMF	0.50 PMF
Significant Hazard	0.50 PMF	100-year storm
Low Hazard	100-year storm	50-year storm

*Size and hazard potential classifications shall be proposed and justified by the operator and shall be subject to approval by the director. Present and projected development in the inundation zone downstream from the structure shall be used in determining the classification.

**The complete definitions of hazard potential are those contained in 4VAC50-20-40.

***The establishment of rigid design flood criteria or standards is not intended. Safety must be evaluated in the light of peculiarities and local conditions for each impounding structure and in recognition of the many factors involved, some of which may not be precisely known. Such can only be done by competent, experienced engineering judgment, which the values in the table are intended to add to, not replace.

Reductions in the SDF may be evaluated by use of incremental damage analysis described in 4VAC50-20-52. Note that future development downstream may increase the required SDF.

CHAPT. 13 IMPOUNDMENT
DAILY INSPECTION REPORT

MINE:	
FACILITY:	
YEAR:	

Inspect impoundment when active and more frequently during rainfall that could create flooding conditions.

Inform mine management of any deficiencies as they are found. Deliver completed checklist to management.

	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
DATE:							
CONDITION OF:							
Crest*							
Interior Slope*							
Exterior Slope*							
Exterior Toe*							
Vegetation							
Decant Pipe**							
Spillway**							
Freeboard (estimated)							

	Date:	
Comments:		

I have inspected the impoundment for abnormal conditions that might endanger its structural integrity.

Signature:							

* Examine for cracks, slumps, bulges, seepage, erosion, standing water, and other dangerous conditions

** Examine for damage, debris accumulation, and other dangerous conditions

Condition: (S) Satisfactory
(U) Unsatisfactory and specific condition noted
(NA) Not Active this day