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DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF MINING PROGRAMS

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TITLE: Liners and Caps for Coal Refuse Disposal Areas

EFFECTIVE DATE: Upon publication of notice as final in the *Pennsylvania Bulletin*

AUTHORITY: 25 Pa. Code Chapters 86, 88, and 90

POLICY: The Department will ensure that coal refuse disposal areas have appropriate barrier layers that are designed and constructed in a manner which prevents adverse impacts to surface and groundwater and prevents precipitation from contacting the coal refuse within the coal refuse disposal areas.

PURPOSE: The purpose of this guidance is to document the criteria and procedures that the Department will use in approving liners and caps in facility designs and as-built certifications for coal refuse disposal areas.

APPLICABILITY: This guidance applies to coal refuse disposal areas as defined in Chapter 90.

DISCLAIMER: The policies and procedures outlined in this guidance document are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of the Department to give these rules that weight or deference. This document establishes the framework, within which the Department will exercise its administrative discretion in the future. The Department reserves the discretion to deviate from this policy statement if circumstances warrant.

PAGE LENGTH: 7 pages

A. BACKGROUND

The Bureau of District Mining Operations (BDMO) issues permits for the construction and operation of coal refuse disposal areas (CRDAs). These facilities may have operating lives of ten years or more and, if not properly constructed, have a high probability to contribute contaminants to the surface water or into groundwater over time as precipitation and groundwater encounter coal refuse. The operator is required to protect the quality of surface and groundwater within the proposed permit and adjacent areas (25 Pa. Code §§ 88.291 & 90.35) and CRDAs are required to have a system to prevent adverse impacts to surface and groundwater. Further, the systems are required to prevent precipitation from contacting the coal refuse as the portions of the disposal area reach capacity, upon final completion, and during periods of temporary cessation longer than 90 days (25 Pa. Code §§ 88.310 & 90.50).

Several regulatory requirements pertain to the construction and performance of coal refuse disposal areas:

Chapter 88 (25 Pa. Code § 88.310(j)) requires that a system must be in place for areas of anthracite coal refuse disposal to prevent adverse impacts to surface water and groundwater and to prevent precipitation from coming in contact with the coal refuse material. 25 Pa. Code § 88.310(k) requires that a system to prevent precipitation from contacting the coal refuse material must be installed if a temporary cessation at the site exceeds 90 days in duration.

Chapter 90: Coal Refuse Disposal includes the design criteria for groundwater and surface water protection systems (liners and caps) (25 Pa. Code § 90.50), requires that coal refuse disposal prevent material damage and pollution to the surface and groundwater (25 Pa. Code § 90.101), and provides water quality standards for discharges from facilities (25 Pa. Code § 90.102). 25 Pa. Code § 90.122 is specific to coal refuse sites requiring that the leachate from the coal refuse fill does not degrade the surface or ground waters. This section includes specific requirements for long-term stability, underdrains, a system to prevent precipitation from coming into contact with the refuse material in a completed area, slope protection and diversions to control surface runoff, and placement of the coal refuse. 25 Pa. Code § 90.167(d) requires that a system to prevent precipitation from contacting the coal refuse material must be installed if a temporary cessation at the site exceeds 90 days in duration.

The means to achieve these pollution controls are through constructed liners and protective capping ("barrier layers"). This guidance serves to describe the types of applicable liners and caps, their criteria for approval in a permit application, as-built testing requirements, and applicability during temporary cessation.

This TGD was revised from its original use as a guide for liners for impoundments and stockpiles to specific use at CRDAs. And, the obligation for a cap barrier layer was added. The requirements for lining all other types of impoundments, treatment ponds, and stockpile areas are described in the Engineering Manual for Mining Operations (Chapter 3.0 Sediment Control Impoundmants, Section 3.17 Liners (Impoundment and Storage Area) (25 Pa. Code §§ 91.34 and 91.35)).

The regulations at 25 Pa. Code § 90.50 specifically mention the previous version of this guidance as a reference. The Department will eventually revise this portion to reflect this new version. In addition, the references to "earthen" and "admixed" liners or caps is removed from this guidance. "Clay or low hydraulic conductivity (HC) soil" replaces "earthen". "Admixed" is removed from the specific barrier

layer type description as it is no longer widely used. The option of "Other" types is included to cover any proposed materials other than clay/HC soils and synthetic barrier layers.

B. BARRIER LAYER TYPES

A barrier layer generally consists of a low hydraulic conductivity layer of clay soil or synthetic material as an under-liner for coarse coal refuse embankments and synthetic material as an under-liner for fine coal refuse slurry impoundments. Caps over the finished emplacement generally consists of synthetic material or an equivalent system. A suitable liner and cap are required to achieve regulatory requirements of pollution prevention for a CRDA.

For facilities that will experience high hydraulic head conditions, the liner may include overlying hydraulic head controls such as a pervious layer above the liner to reduce the head and limit potential migration of the leachate through the underlying liner. All CRDA sites include leachate collection systems or underdrains. There are two primary types of low permeability/impermeable barrier layers.

Low hydraulic conductivity soils ("clay")

Clay soils may be used if the material is of a specific quality and consistency. The applicant must provide documentation for the quality, quantity and suitability of clay for the proposed barrier layer. Because it is a natural product that is not homogeneous, the use of clay requires American Society of Testing Materials (ASTM) tests to be conducted prior to and during the placement of the material as well as additional justifications needed during the application review process. Large volumes of high-quality material needed for CRDAs may not be readily available. In some cases, this material is not suitable to meet the requirements as a barrier layer because of the low hydraulic conductivity values or potential for degradation that compromises its use. For example, clay liners exposed to hydraulic head pressures are known to fail under such conditions, so they are unsuitable for use as barrier layers for impounding structures. The Department has documented several cases where clay liners have failed beneath fine coal refuse slurry impoundments.[1] Also, clay caps crack and shrink in dry conditions creating secondary porosity and pathways for plant root penetration that compromises the barrier function.

Therefore, the Department has concluded that clay caps are generally unsuitable for circumstances with high hydraulic head conditions, for slurry impoundments, or as a permanent cap for any coal refuse. In these situations, the use of synthetic materials is encouraged.

Synthetic

Flexible polymeric sheets or flexible membrane liners (FML) are polymer fabrics or a composite of fabric and other material to enhance impermeability.

Continuous sheets of polyvinyl chloride (PVC), linear low-density polyethylene (LLPE), and high-density polyethylene (HDPE) composition are most common synthetic material for CRDA barrier layers. These have very low HC - effectively impermeable - if uncompromised and installed to specifications. The sheets are overlapped and fused at the seams thermally or chemically. A protective

[1] California DMO staff has documented several cases where slurry impoundment clay liners have failed. For coarse refuse facilities where clay was used, preferential flow occurs out of the embankment and typically does not reach the clay liner system.

layer of sand, soil or other approved material can be used above and below the membrane to avoid damaging the material.

Synthetic material is preferred by the Department for use as liners and caps for CRDAs to prevent groundwater contamination because of its combination of cost-effectiveness, impermeability, and availability. This material also is most likely to meet the requirements for a system to prevent precipitation from contacting coal refuse and to minimize the potential for incurring treatment obligations resulting from groundwater contamination. Because this is a manufactured product subject to quality controls, less testing is needed than for a clay barrier layer.

Other

The Department will consider other technologies that can meet or exceed the requirements set forth in this document. The applicant can attempt to demonstrate that an alternative to these two options will serve as a barrier layer and will adequately prevent pollution in accordance with the regulatory requirements, but this demonstration must be approved by the Department. Consideration of an alternative material should be discussed in advance during a pre-application process. Because of a potentially extended timeline for review of an alternate material, alternates should not be proposed during a permit revision or in response to a compliance issue.

Coal ash or low-permeability waste General Permit materials will not be considered as viable alternatives for barrier layers at CRDAs as the long-term impermeability needed for large CRDAs cannot be adequately demonstrated. These materials may potentially be used to provide additional safety measures if the applicant can justify their suitability for that use. The applicant will be required to demonstrate there is no presumptive evidence of potential pollution of the waters of this Commonwealth through their proposal (25 Pa. Code § 86.37(a)(3)). These materials will not be allowed if they provide no demonstrable beneficial use other than convenience disposal regardless of any waste approval. See "Beneficial Use of General Permit (GP) Materials at Active Coal Mines" No. 563-2112-001.

C. STANDARDS

The following sections describe thickness standards, testing requirements, and related thresholds for proposed liners when utilized under the given conditions. In instances where site-specific engineering factors result in a need to deviate from the outlined design criteria, the operator must demonstrate to the Department that any alternative liner design is at least as equal and effective in protecting groundwater and surface water from pollutive discharges.

No Head Conditions for Coarse Coal Refuse Disposal Areas

The following requirements must be met for utilizing clay as a liner in a coarse coal refuse disposal area only.

1. Material
   a. Grain size distribution (ASTM D422) - 95% of the particles with a maximum dimension not greater than one inch and 50% or more must pass through the No. 200 sieve with no particles greater than 2 inches in diameter
   b. Atterberg limits (ASTM D4318) - plasticity index of 10 or greater
   c. Free from roots and debris

d. Cannot be placed when frozen

e. The top/final 4.0 feet of the cap suitable for revegetation as required by 25 Pa. Code § 90.125.

2. Compaction

a. Standard proctor test (ASTM D698) for maximum dry density and optimum moisture content of clay using nuclear density gauge

b. Material compaction of 95 percent of the maximum dry density as determined by a standard proctor test (ASTM D698)

c. In-place density determined using a nuclear density gauge (ASTM D2922, D3017, or D1556)

3. Thickness

a. Justification of the proposed maximum thickness of the liner

b. Minimum thickness for low clay soil is 2.0 feet (0.61 m)

c. Soil lifts cannot exceed 8.0 inches in thickness

Low Head Conditions

When low head conditions exist, the specific discharge / permeability for a clay-soil lined impoundment must be calculated (and be no greater than 1×10^{-7} centimeters per second) in addition to meeting the requirements for utilizing a clay liner in a coarse coal refuse disposal area. To calculate the specific discharge of the clay-soil material, use the following equation.

Specific discharge is defined as follows:

$$D_s = KI = K\frac{H+L}{L}$$

D_s = specific discharge (cm/sec)
K = hydraulic conductivity of liner (cm/sec)*
I = hydraulic gradient (dimensionless)
H = height of water above liner (length)
L = thickness of liner (length)

*Hydraulic conductivity test (ASTM D5084)

Synthetic

When a synthetic liner is proposed, the following manufacturer's information must be submitted with a demonstration of additional requirements:

1. Certification specifying the material is a minimum of 30 mils
2. Specific discharge rate of 1×10^{-7} cm/sec or less
3. Quality Assurance/Quality Control information
4. Liner specifications
5. A minimum of 1-foot of topsoil or soil suitable to support vegetation on top of a flexible membrane cap

6. A protective cover over the cap provided by a geotextile, sand, or soils, or other material that meets requirements established by the manufacturer.

The U.S. Department of Labor's Mine Safety and Health Administration (MSHA) Engineering and Design Manual for Coal Refuse Disposal Facilities (Rev, Aug 2010) is a useful reference for liner design.

Permanent Capping to Prevent Precipitation

The Department will accept synthetic or pre-approved alternative materials that provide equivalent performance to prevent precipitation from contacting refuse. The alternative material must meet the standards listed under **Section C Standards** of this guidance.

In instances where site-specific engineering factors result in a need to deviate from the outlined design criteria, the operator must demonstrate that any alternative liner design is at least as equal and effective in protecting groundwater and surface water from pollutive discharges and to prevent associated water treatment obligations.

Underdrains

All CRDAs require an underdrain system that creates a preferential flow to an appropriate treatment system, which prevents excessive hydrostatic pressure and aids in system stability. The effluent from the underdrains is sent to an appropriate treatment system prior to discharge. The placement of a final capping layer should effectively eliminate the underdrain effluent.

D. PERMIT APPLICATIONS

The following information is required in the permit application as documentation:

Liners

1. Drawings showing the location, dimensions, and construction of each facility to be lined. Include type and thickness of liner and depth to groundwater.
2. A description (analysis, if available) of the fluid or material to be retained by the liner, including a statement concerning the potential presence of oil, grease, solvents, etc. Include a statement regarding the compatibility of the liner and the waste type.
3. The specific discharge rate (D_s) for the liner (as designed).
4. A description of the equipment and procedures used to install the liner, including a construction quality assurance plan.
    a. For clay liners: address the availability of appropriate materials, type of compaction, lift thickness, methods of tying lifts together, installation on sloping surfaces, scarifications, etc., and a detailed description of the borrow area(s) which will serve as the source of the material. Include soil material processing procedures.
    b. For synthetic or other, address the method to be used to seal joints or seams.
5. A description of marker layers or other measures which will be used to protect the liner when excavating materials.
6. A description of the procedures and testing methods to be used for cases where the subgrade must be prepared prior to liner placement.

7. A description of the method which will be used to test the liner prior to putting it into service.

Caps

1. Drawings showing the location and dimensions of each facility to be capped.
2. Type of capping material and a justification for its suitability.
3. A description of the equipment and procedures that will be used to install the liner, including a construction quality assurance plan. For soil cover, address type of compaction, lift thickness, methods of tying lifts together, installation on sloping surfaces, scarifications, etc. For all other types, address the method to be used to seal joints or seams.
4. For non-synthetic cap proposals, a demonstration that the proposed capping system will prevent precipitation from coming into contact with coal refuse (e.g. Hydrologic Evaluation of Landfill Performance (HELP) Model [2] or other suitable predictive method of infiltration rate).

E. AS-BUILT TESTING AND ACCEPTANCE REQUIREMENTS

As part of the acceptance of the final clay liner system, newly installed liners must have in-place testing. All liners must have an in-place density test and moisture determination with a nuclear density gauge at one test/acre/lift.

Testing must include the following (per acre unless specified):

1. Grain size distribution (ASTM D422)
2. Moisture-density relationship (ASTM D698)
3. In-place density (D2922, D3017, or D1556)*
4. Atterberg limits (ASTM D4318)
5. Total thickness verification
6. Permeability testing for impoundments require at one test per side and one on bottom. (ASTM D5084)

**Soils are to be compacted to attain the remolded sample densities utilized in the permeability testing.*

Synthetic material must be tested and certified for the intended use. Manufacturer specifications should be followed regarding testing of seams and visual tests for penetration. Manufacturers' specifications and material certification is required for installation of synthetic liners/caps. These items must be reviewed and approved by California District Mining Office (Cal DMO) staff prior to placement of material on the liner or covering of the cap.

Facilities relying on alternative designs or modified testing protocols may be subject to additional in-place testing. The operator should document construction with photographs. These should be submitted with a map showing testing locations. The mine inspector or designee should be present for the selection of random sampling locations per acre.

[2] The HELP model estimates water balances for landfills and other land disposal systems. The program models rainfall, runoff, infiltration, and other water pathways to estimate how much water builds up above each landfill liner.

TEMPORARY CESSATION

During periods of temporary cessation exceeding 90 days, the operator is required to install a system for preventing precipitation from contacting coal refuse (§90.167(d)). The operator must provide a narrative addressing the temporary cessation that includes plans to establish positive drainage to appropriate controls. The operator must also demonstrate that the clay, synthetic, or approved equivalent materials meets the requirements listed under Section C Standards of this guidance. If any deviations from the plan are considered, the operator should notify the Department before proceeding.