NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING
BENTONITE TREATMENT

(No.)

CODE 521C

DEFINITION

A liner for a pond or waste storage impoundment consisting of a compacted soil-bentonite mixture.

PURPOSE

To reduce seepage losses from ponds or waste impoundments for water conservation and environmental protection.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soils are suitable for treatment with bentonite.
- Ponds or waste storage impoundments require treatment to reduce seepage rates and to impede the migration of contaminants to within acceptable limits.

CRITERIA

General Criteria Applicable to All Purposes

Bentonite treated soil liners shall comply with all federal, state, and local laws, rules, and regulations.

Bentonite treated soil liners shall be filter-compatible with the sub-grade on which they are compacted to prevent loss of the liner soil into larger openings in the sub-grade material. The National Engineering Handbook, Part 633, Chapter 26-Gradation Design of Sand and Gravel Filters, provides criteria on filter compatibility.

The bentonite shall be a sodium bentonite with a free swell of at least 22 milliliters as measured by ASTM Standard Test Method D5890, unless laboratory tests using other bentonite types are used for design.

When laboratory permeability tests are required to determine application rates, the tests shall be performed using bentonite of the same quality and fineness as that proposed for use.

For protection against bentonite dust, personnel on site during bentonite application and mixing shall wear mask and goggles.

Compaction. Compact the treated layer to a minimum 90 percent of the maximum density as determined by the Standard Proctor Test, ASTM D-698

Storage. Stored bentonite must be covered with a plastic sheet or tarpaulin until used. The work must be staged so that the contractor can complete subgrade preparation, scarification, soil moisture adjustment, spreading and mixing the bentonite, and compaction of the bentonite treated soil. Wet bentonite is difficult to work with.

Criteria Applicable to Ponds

Design. Design of bentonite treated soil liners for ponds not storing animal waste shall be designed to reduce seepage to rates that will allow the pond to function suitably as intended.

Application Rate. For ponds, in the absence of laboratory tests or field performance data on soils similar to those to be treated, the minimum application of a finely ground bentonite per 1-inch thickness of constructed liner shall be:

Pervious Soil Description	Application rate (lb/ft^2)
Silts (ML, CL-ML)	0.375

Silty Sands (SM, SC-SM, SP-SM)	0.5
Clean Sands (SP, SW)	0.625

Liner Thickness. In the absence of more detailed testing and analyses, liner thickness shall be according to the following table:

Water Depth (feet)	Liner Thickness (inches)
≤ 8	6
8.1 – 16	12
16.1 – 24	18
24.1 - 30	24

Criteria Applicable to Waste Impoundments

Design. Design of the bentonite treated soil liners for waste storage impoundments shall be designed to reduce specific discharge (unit seepage) to rates recommended in the National Engineering Handbook Series, Part 651, Agricultural Waste Management Field Handbook (AWMFH), Chapter 10, Appendix 10D or rates mandated in state regulations if they are more restrictive. Lower specific discharge rates may be used at the discretion of the Designer.

Liner Thickness. The minimum thickness of the finished compacted treated liner shall be the greater of:

- that required to achieve a specific discharge (unit seepage) design value selected by the designer,
- that required by state regulations, or
- that given in the following table. The water depth to be used in the table is the normal full pool storage depth in the impoundment.

Water Depth (feet)	Liner Thickness (inches)
≤ 16	12
16.1 – 24	18
> 24	24

Other Criteria

Liner Construction. Use methods described in Appendix 10D to the AWMFH for liner construction.

Liner Protection. Bentonite treated soil liners shall be protected against damage caused by the effects of water surface fluctuations, desiccation and cracking, wave action, rainfall during periods when the liner is exposed, water falling onto the liner from pipe outlets, agitation equipment, solids and sludge removal activity, animal activity, penetrations through the liner, and any other activity capable of causing physical damage to the liner. A minimum thickness of 12 inches is recommended for all areas in the vertical range of water fluctuation. Provide a minimum 12-inch compacted layer of untreated soil over the treated liner where shoreline erosion or wetting and drying from fluctuating water levels exist.

Design should include measures to protect against damage to a bentonite treated soil liner due to uplift water pressures if a seasonal high water table occurs at a level above that of the lowest potential level of liquid in the impoundment. Examples of protective design measures are the use of perimeter drains to lower the water table, maintaining minimum liquid depth in the impoundment, and using liners thick enough to resist uplift water pressures.

Protection of the finished liner from the effects of desiccation during periods when the pond or impoundment is empty is advisable. A protective soil cover may be considered. The soil cover shall be of a soil type, thickness, and density that is resistant to erosion and desiccation. Provide, at a minimum, 6 inches of compacted soil cover over the soil-bentonite liner.

Side Slopes. The side slopes of ponds or waste storage impoundments should be 3H: 1V or flatter to facilitate mixing of the bentonite when the bathtub method of construction as described in Appendix 10D, AWMFH, is used. Slopes as steep as 2H: 1V may be considered if the stair-step method of construction as described in Appendix 10D to the AWMFH is

used for constructing the liner. Maintenance requirements should also be considered when selecting a side slope.

CONSIDERATIONS

Consider using a flexible geomembrane or geosyntheitic clay liner for sites that have water depths greater than 24 feet.

Alternatives to bentonite treated soil liners should be considered for poor foundation conditions such as karstic bedrock, joints or other discontinuities of the underlying bedrock.

PLANS AND SPECIFICATIONS

Plans and specifications for bentonite treated soil liners for ponds and waste impoundments shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Plans and specifications shall include such drawings, specifications, material requirements, quantities, construction requirements, equipment requirements, and other documents as necessary to describe the work to be done.

Construction. The area to be treated shall be drained and dried.

Remove from the pool area all vegetation, stumps, trash, stones and other objects of a size sufficient to interfere (usually less than 1/3 of the treated soil depth) with the operation.

Fill and compact holes or crevices beneath the layer to be treated to a minimum density of 90 percent of Standard Proctor with soil at optimum moisture content. Cover areas of exposed gravel or fractured rock with a minimum of 12 inches of soil that has a minimum of 20 percent clay content and is compacted to the specified density.

Spread finely ground bentonite evenly over the subgrade surface at the specified rate. Use bentonite that is free flowing, high swelling, granular sodium bentonite. The bentonite shall be American Colloid Company, Volclay SG-40, Wyo-Ben, Envirogel-10, or equivalent.

Mix the material thoroughly to the specified depth with rotary tiller or similar equipment using multiple cross-direction passes. A disc is not recommended because of its poor mixing capabilities.

Compact treated layers a dry density of 90 percent or more of standard Proctor with soil at optimum moisture content.

At the interface between a previous day's work and the next day's work, re-mix and compact a transition zone that is a minimum of 3 feet wide.

Special attention must be given to sealing around pipes and structures. Compact 3 parts soil with 1 part bentonite near optimum moisture into a notch in the subgrade and hand compact.

Protect treated areas from damage by livestock. Protect areas near the water line and at points of concentrated surface flow against erosion.

OPERATION AND MAINTENANCE

Maintenance activities required for this practice consist of those operations necessary to prevent and/or repair damage to the bentonite treated soil liner. This includes, but is not limited to; excluding animals and equipment from the treated area; repairing damage to the liner occurring from erosion during initial filling; erosion resulting from wave action after the impoundment fills, and erosion caused by agitation, pumping operations, as well as activities involved in removal of solids and sludge. Damage that might be caused by roots from trees and large shrubs should be prevented by removing such vegetation at first appearance. If the liner is damaged, any disturbed or eroded areas should be repaired to restore the liner to its original thickness and condition.

SUPPORTING DATA AND DOCUMENTATION

Field Data and Survey Notes

The following is a list of the minimum data needed:

1. System plan sketch;
2. Topographic survey of the site showing elevations and control features;
3. Soils investigation showing seasonal high water table, location of test holes, and gradation and classification of soils to be sealed.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the EFH, Part 650. The following is a list of the minimum required design data:

1. Statement concerning location and type of leaks or excessive permeability and description of foundation preparation to be made;
2. All required permits and documentation on file with the design information;
3. Plan view including, location map, all system components, material and construction specifications;
4. Rate of application and thickness of the treated blanket, method of mixing materials, method of compaction and protection, construction drawings, and component details;
5. Quantities estimate;
6. Job class on plan;
7. Details of foundation drainage, when required;
8. Planting plan. This must meet the criteria, specifications, and documentation requirements of the Maryland conservation practice standard for Critical Area Planting (Code 342).

Construction Check Data/As-built

Record on survey notepaper, SCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted on plans in red. The following is a list of minimum data needed for As-builts:

1. Documentation of site visits on CPA-6. Include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed, and decisions made and by whom;
2. Actual dimensions of installed lining;
3. Verification of adequate foundation preparation;
4. Documentation of installation of foundation drainage;
5. Certification by the manufacturer that the material is suitable for the intended use, Certification statement from the contractor(s) that they have constructed the liner in accordance with the plans and specifications;
6. Statement on seeding and fencing;
7. Final quantities and documentation for quantity changes, and materials certification;
8. Sign and date checknotes and plans by a person with appropriate engineering approval authority. Include statement that practice meets or exceeds plans and NRCS practice standards.

REFERENCES

USDA, Natural Resources Conservation Service. *Engineering Field Manual, Chapter 4, "Elementary Soil Engineering" and Chapter 11, "Ponds and Reservoirs;"*

USDA, Natural Resources Conservation Service, *Maryland Field Office Technical Guide, Section IV, Standards and Specifications*;

USDA, Natural Resources Conservation Service. *National Engineering Handbook, Chapter 26, Part 633*.

USDA, Natural Resources Conservation Service. *National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook, Chapter 10, Appendix 10D.*