

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD  
ARIZONA**

**POND SEALING OR LINING – BENTONITE TREATMENT**

(No.)

**CODE 521C**

**DEFINITION**

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

*consistent with sound engineering principles and/or manufacturer recommendations.*

**PURPOSE**

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

**Laws and Regulations.** Bentonite treated soil liners shall *be planned, designed and installed* to comply with all federal, State, Tribal and local laws, rules, regulations. *Laws and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species. State water quality standards for seepage loss shall be followed.*

**CONDITIONS WHERE PRACTICE APPLIES**

This practice *may be applied as part of a conservation management system* where:

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

*The owner is responsible for securing necessary permits and water rights, complying with all laws and regulations, and meeting legal requirements applicable to the installation, operation, and maintenance of this practice and associated structures.*

**CRITERIA**

**General Criteria Applicable to All Purposes.**

*Structures and/or facilities shall be designed on an individual basis to meet site conditions and functional requirements. They shall be part of an approved and overall engineering plan for irrigation, drainage, wildlife, recreation, channel improvement, or similar purposes.*

**Cultural Resources and Wildlife Habitat.** *Impact to cultural resources, wetlands and Federal and state protected species shall be evaluated and avoided or minimized to the extent practicable during planning, design and implementation of this conservation practice in accordance with established National policy, General Manual (GM) Title 420-Part 401; Title 450-Part 401, Title 190-Parts 410.22 and 410.26, National Planning Procedures Handbook (NPPH), National Cultural Resources Procedures Handbook (NCRPH), National Food Security Act Manual (NFSAM), and the National Environmental Compliance Handbook (NECH).*

*Design and implementation of subsidiary components and/or structures shall meet all applicable Natural Resource Conservation Service (NRCS) conservation practice standards. The criteria for the design of any components not specifically addressed in NRCS practice standards or specifications shall be*

**Design.** *Design and implementation of bentonite lined structures shall meet all applicable Natural Resource Conservation Service (NRCS) standards. All inlets, outlets, ramps, and other appurtenances shall be*

*installed in a manner that does not damage or impair the proper operation of the liner.*

*Ponds to be treated shall be constructed to meet applicable standards for IRRIGATION PITS or REGULATING RESERVOIRS (552), IRRIGATION STORAGE RESERVOIRS (436), IRRIGATION SYSTEM, TAILWATER RECOVERY (447), PONDS (378), WASTE STORAGE PONDS (425), WASTE TREATMENT LAGOONS (359), TROUGH or TANK (614), as appropriate.*

Bentonite treated soil liners shall be filter compatible with the natural foundation materials on which they are compacted according to Chapter 26 (*Gradation Design of Sand and Gravel Filters*), Part 633 (*Soil Engineering*) of the National Engineering Handbook, or an equivalent recognized industry standard.

The minimum thickness of the finished compacted liner (*as measured perpendicular to the finished surface*) shall be 6 inches. *Thicker liners shall be constructed in multiple layers. The final compacted thickness of each individual layer shall not exceed six inches, and each layer shall be compacted before the next layer is placed.*

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. *Laboratory permeability testing to determine application rates and liner thickness shall be required for agriculture waste storage.*

For protection against bentonite dust, personnel on site during bentonite application and mixing shall wear a mask and goggles. *Provisions will also be made to minimize off-site dust.*

**Soil Properties.** *Soil properties shall meet the following criteria:*

1. *Unified Soil Classifications where bentonite can be used effectively as a sealant are ML, SM, SC, GM and GC. Course-grained soil must have 30-50% fines.*
2. *Where the soils are classed as SP, SW, SP, SM (and other dual classifications) GP, GW, and fractured bedrock, a soil containing fines may have to be transported to the site. Bentonite is then mixed with the soil to form a sealing layer.*

*Since bentonite is expensive at some locations in Arizona, an evaluation of the cost of additional bentonite versus the cost of transporting finer-grained soil to the site should be made.*

### **Criteria Applicable To Waste Impoundments**

**Design.** Design of bentonite treated soil liners for waste impoundments shall be in accordance with National Engineering Handbook Series, Part 651, Agricultural Waste Management Field Handbook, Chapter 10 (*Agricultural Waste Management System Component Design*), Appendix 10D (*Geotechnical, Design, and Construction Guidelines*) and/or in compliance with applicable state and local regulatory requirements. *In the absence of detailed laboratory testing and analysis, application rates and liner thickness shall be as shown below.*

**Liner Protection.** The liner shall be protected against desiccation cracking, *frost action*, the effects of water surface fluctuations, wave action, surface erosion, erosion from pipe inlets, agitation equipment, animals, or items installed through the liner. Protective measures shall be designed into the system to protect the liner for these cases. *As a minimum, at least 6 inches of soil cover shall be placed over the soil-bentonite liner.*

### **Criteria Applicable To Ponds**

**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 finely ground bentonite per 1-inch thickness of constructed liner shall be:

| Pervious Soil Description          | Application Rate (lb./ ft <sup>2</sup> ) |
|------------------------------------|--|
| Clays (CL)                         | 0.345 – 0.380                            |
| Silts (ML, CL-ML)                  | 0.375 – 0.385                            |
| Clayey Sands (SC)                  | 0.420 – 0.430                            |
| Silty Sands (SM, SC-SM, SP-SM)     | 0.500 – 0.515                            |
| Clean Sands (SP, SW)               | 0.625 – 0.640                            |
| Fractured rock or gravels (GW, GP) | 0.675 – 0.700                            |

**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 or less          | 6                        |
| 8.1 – 16           | 12                       |
| 16.1 – 24          | 18                       |
| 24.1 – 30          | 24                       |

### **Investigations, Surveys and Design**

**Criteria.** Documentation requirements will be as outlined below, in addition to the documentation requirements of the practice components used in the system.

*Make a preliminary site assessment or reconnaissance to determine if the practice is feasible, considering the field or system layout, soils, crops, topography, water supply, and may include:*

1. Soil borings, geological site investigation or soil survey, depending on existing site conditions or scope and complexity and to determine foundation materials or conditions or soil limitations (Soil classification by the Unified Soil Classification System).
2. Lining material selection, or alternatives.
3. Verify appropriate state laws for permitting and notify landowner of his/her responsibilities.
4. Verification or certification of used materials (if any).

*To adequately plan and layout this practice, a detailed topographic survey is required, that adequately details:*

1. Site topography, as needed to show the practice and component layout, physical features of the site (field boundaries and slope), including existing features/practices, ground elevations (slopes), location of any utilities or markers, etc.
2. Profiles and cross sections, as required to determine location, material quantities/sources, etc. Survey shall extend 100 feet (minimum) beyond the limits of the proposed lining;
3. If applicable, a permanent benchmark(s) may be set and described. Preferably, the elevations and coordinates should be based on a local (assumed) or coordinate system (State or grid) and clearly stated on the plan. Datum may be in the form of Northing and Easting coordinates or Longitude and Latitude.

*The design of a practice is the application of Field Office Technical Guide practice standards, and using experience and judgment in the development of a solution to the problem or the objective. All computations and decisions made during the design of a practice are to be checked by another qualified individual and appropriate notations made. Design computations, calculations or analysis shall meet the following criteria:*

1. Determine the size, type and lining material properties (thickness), including foundation or subgrade preparation requirements.
2. Include estimates of earthwork, pipe, fittings and appurtenances, concrete, vegetative components, etc.
3. Subsidiary and applicable components shall be designed in accordance with applicable conservation practice standards (i.e., pipelines shall meet the requirements of Conservation Practice 430 – Irrigation Pipeline, etc.);

**Installation and Basis of Acceptance.** For construction that does not meet State, OSHA, or Tribal criteria or requirements where deficient construction materials were used, NRCS may

*consider a waiver request for approval of construction after it has received a signed and sealed construction and/or material exemption from a licensed engineer. Required exemption shall be for installation of materials that do not meet minimum quality criteria as found in applicable Standards, Specifications, ASTM's, AWWA standards, etc.*

*Contractors performing work under this practice shall abide by all Federal, State or Tribal laws or criteria, and must be licensed by the state DWR or board of technical registers where the work is being implemented.*

## CONSIDERATIONS

Flattening the slopes of ponds or waste impoundments to facilitate compactive efforts during construction should be considered. The stair-step method of construction as outlined in *National Engineering Handbook Series, Part 651 (Agricultural Waste Management Field Handbook), Chapter 10 (Agricultural Waste Management System Component Design), Appendix 10D (Geotechnical, Design, and Construction Guidelines)* may be considered in lieu of slope flattening.

A protective compacted soil cover (*minimum 6-inch*) should be considered for protecting the soil-dispersant bentonite liner for ponds.

Consider using a flexible membrane liner for sites that have water depths greater than 24 feet.

*Consider filling pond with water after construction to prevent desiccation.*

*Consider weather conditions such as wind and precipitation when planning construction.*

*Design alternatives presented to the client should address economics, ecological concerns and acceptable level of risk for design criteria as it relates to hazards to life or property.*

## PLANS AND SPECIFICATIONS

*Use Arizona standard drawings to the extent possible. These may be supplemented by additional drawings or specification notes on the drawings to provide full installation instructions.*

*Construction plans shall include all components needed for the safe operation of the proposed improvements such as railing, fencing, or warning signs as appropriate. The plans shall address operations near existing utilities, trench excavations and any other items related to construction of the structure that may pose a safety risk to those involved.*

*Development of plans and specifications for bentonite treated soil liners for ponds and waste impoundments will be guided by the National Engineering Handbook, Part 650, the Engineering Field Handbook, Chapter 5, and shall be in accordance with the National Engineering Manual, Parts 541 and 542, shall be prepared for specific field site, 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 are necessary to describe the work to be done. As a minimum, the plans and specifications shall provide the following:*

- *Project location map, including section, township and range, North arrow, cooperator/owner acknowledgement and certification signature blocks, engineering job class (cover sheet);*
- *References that the owner/cooperator are responsible for all permits, rights-of-way, easements and the contact, coordination and location determination of any existing utilities or clearances (buried utility disclaimer);*
- *If applicable, a map showing the location of the practice(s) or system in reference to a known or established benchmark or reference point with the location, description and elevation clearly shown. Topographical features and/or*

controls shall be shown, showing tie in with existing or other planned practices;

- Field surveys and notes, soil investigations or geologic soil boring locations and soil classifications, earthwork or material estimates/quantities (if applicable);
- Overall system plan view (i.e., layout of the containment structure, collection points, water transfer locations or pipelines, and topography of the site; required liner properties including details of the type and quality, cushion or padding materials, and pipeline materials; location and cross section of facility and liner showing dimensions and location of anchoring trenches, vents, depth of cover material and maximum storage depth of water or waste; special foundation or subgrade preparation and details, including tolerances on smoothness of the finished grade; details of liner installation, seaming requirements, and requirements for attachments and appurtenances; quality control testing; fence and signage requirements, if required; vegetative requirements; construction/installation criteria, State and Federal [OSHA] safety requirements, etc.), type, quality and quantity as necessary;
- Sufficient sectional, dimension or detail views of all system components and appurtenances (inlet and outlet pipes; method and details to protect liner including soil cover requirements; structural details, if required; drain and vent location and details; quality of materials; etc.) as required, for proper system functionality;
- Use Arizona Construction and Material Specifications for each item of work and material, as applicable and available. Additional specifications may need to be written to provide full material and installation instructions. Fill in blanks and add or delete items from the specifications to make them fit the job as needed.

All designs completed by non-NRCS personal shall meet minimum State licensing board requirements and NRCS requirements and criteria as outlined in the General Manual, the National Engineering Manual (including Arizona Supplements), and the National Engineering Handbook.

**ONCE ALL PARTIES HAVE ACCEPTED AND SIGNED THE PLANS AND SPECIFICATIONS, NO CHANGES SHALL BE MADE TO THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF NRCS.**

## **OPERATION AND MAINTENANCE**

A plan for operation and maintenance (O&M) of the liner and structure, specific to each site, shall be prepared and reviewed with the landowner, cooperators or individual responsible for operation and maintenance and shall be commensurate with the size and complexity of the project. The plan shall be consistent with the purposes of the type of liner chosen, intended life, safety requirements and design criteria. It shall document needed actions, including reference to periodic inspections and the prompt repair or replacement of damaged components, and should provide specific instructions for operating and maintaining facilities to ensure they function properly.

Maintenance activities required for this practice consist of those operations necessary to prevent damaging the treated soil liner. This includes, but is not limited to:

- excluding animals and equipment from the treated area,
- protection of the liner during initial filling, agitation, or pumping operations, and
- repair of disturbed or eroded areas.
- Design capacity and liquid level of the structure.
- Periodic inspection of the following:
  - Visible portions of the liner for tears punctures, or other damage;
  - Liner interface with inlets, outlets, ramps, or other appurtenances for damage;
  - Liquid level in the structure;
  - Ballooning of the liner indicating presence of gas beneath the liner.
- Appurtenances such as trash racks, outlet structures, and valves shall be kept free of trash, debris, foreign materials or blockage and replaced when needed to prevent clogging of outlet and overflow pipes
- Eradicate or otherwise remove all rodents or burrowing animals that have or may potentially

*damage any part of the delivery or application facilities. Immediately repair any damage caused by their activity.*

- *The practice should be inspected periodically and especially after storm events to determine whether it is functioning properly or if repairs are needed.*
- *Immediately repair any damage resulting from vandalism, vehicles, or livestock.*

## **REFERENCES**

- *Quality Assurance and Quality Control for Waste Containment Facilities, EPA/1600/R-93/182, September 1993.*
- *ASTM D5890*
- *NRCS, National Engineering Handbook – Part 633, Chapter 26.*
- *NRCS, “Agricultural Waste Management Field Handbook”, National Engineering Handbook, Part 651.*
- *National Engineering Handbook - Part 650, Engineering Field Handbook, Chapter 1 – Engineering Surveys; Chapter 3 – Hydraulics; Chapter 4 – Elementary Soils Engineering; Chapter 5 – Preparation of Engineering Plans; Chapter 6 – Structures; Chapter 10 – Agricultural Waste, and Chapter 17 – Construction & Construction Materials*
- *National Engineering Manual, Part 531 Geology 531.31, USDA, Natural Resources Conservation Service*
- *USDA-NRCS, TR-62 Engineering Layout, Notes, Staking and Calculations;*
- *General Manual, Title 420-Part 401, Title 450-Part 401, Title 190-Parts 410.22 and 410.26*
- *National Environmental Compliance Handbook*
- *National Planning Procedures Handbook*
- *USDA NRCS, Engineering Design Standards – Far West States*
- *National Cultural Resources Handbook*