

**NATURAL RESOURCES CONSERVATION SERVICE
DOCUMENTATION REQUIREMENTS FOR
POND SEALING OR LINING**

CODE 521

The following provides guidelines for the investigation, design, construction, and certification of liners for the bottom and sides of earthen agricultural waste ponds, waste treatment lagoons, and similar practices where seepage is to be minimized. These types of liners include the following:

- In situ soils with acceptable permeability
- Compacted clay liner
- Compacted bentonite clay liner
- Compacted clay liner with soil dispersants
- Flexible membrane

For other liner materials such as reinforced concrete, the designer should follow proper engineering practices for the design of these liners.

Geologic investigations of the proposed sites for animal waste storage ponds and waste treatment lagoons shall be conducted by a geologist, soil scientist, or others with training and experience in geologic investigations.

At least 2 borings or equivalent excavations shall be performed for each 3 acres occupied by a waste storage pond. A minimum of 2 borings are required regardless of size. The area occupied by the storage pond is the surface area measured at the top elevation.

In Situ Soils with Acceptable Permeability

In some instances, the natural soil (Groups III and IV in [Appendix 10D in National Engineering Handbook Part 651 \[NEH 651\]](#), [Agricultural Waste Management Field Handbook](#)) at and below the excavated depth may have permeability characteristics that result in acceptable seepage losses.

- Investigation
 1. Perform soil borings or equivalent excavations in the pond area to determine depth to water tables, verify required separation distance, describe the soil layers, and obtain undisturbed samples of the natural in-place material below the bottom and side slopes of the proposed pit.
 2. Test the samples for permeability as described in [Section KS651.1086\(e\) in NEH 651](#).

- Design

If the soil permeability test results show that the in-place soil permeability and thickness meet the seepage rates of the appropriate practice standard, then this is documented in the pond design, and a liner is not required.

Show soil boring location and data on plan and section views.

- Construction

Verify that the soil uncovered during construction is similar to the tested soil.

Compacted Clay Liner

If the natural soil is too permeable, then a compacted clay liner may be a possibility to meet the seepage requirements. To design the compacted clay liner will require soil mechanics or field tests of the soil that will be used in the liner. This could be the local soil or imported soil. The soil will be tested to provide a combination of soil density and moisture that will provide the minimum permeability needed for a stated liner thickness and required minimum seepage rate.

Procedure When Using Soil Mechanics Center Tests for a Compacted Clay Liner

- Investigation

1. Perform soil borings or equivalent excavations in the pond area to determine water tables, verify required separation distance, and describe the soil layers.
2. Obtain samples of the soil or borrow material to be used for the liner.
3. Test the soil for permeability when remolded to the moisture and density (compaction) and liner thickness specifications that you plan to achieve in the field. Use the test procedures as described in [Section KS651.1086\(e\) in NEH 651](#).

- Design

If the soil test results support the planned design, the following items are needed on the drawings or in the construction specifications:

1. Plan view with dimensions and location relative to other facilities.
2. Cross section views showing elevation, slopes, thickness of liner, and dimensions.
3. Soil boring location and data on cross section and plan views.
4. Borrow area and soil boring information—This can be the same view as Item 3 above if the liner material is coming from pond excavation.
5. Soil moisture percent and soil density as dictated by the testing results—As an alternative to specifying actual numbers, a construction method can be stated to achieve the soil density and a soil moisture percent. These method specifications shall be based on documented tests of previous soil moisture and density tests or documented liner posttests. A folder or file shall be maintained to document this information.

- Construction

1. Verify pond location, size, depth, soil materials, and slopes.
2. Verify liner thickness by cross section surveys before and after the liner installation.
3. Verify that the liner placement specifications are met by taking in-place density and moisture tests. A minimum of 1 location on the bottom and side slope per acre per lift should be tested. The density and soil moisture tests can be done using the methods referenced in [Section KS651.1086\(e\) in NEH 651](#).
4. Calculate in-place dry density and compare the results to the standard density (American Society for Testing and Materials [ASTM] D 698) to determine if specification requirements are met (for example, density \geq 90 percent of Standard Proctor and 2 to 4 percent above optimum moisture). Record the test results and attach the test record to the checkout and certification documentation.
5. As an alternative to Item 4 above, plot the moisture and dry density of the in-place soils on [Figure 1, Density and moisture combinations to meet permeability requirements for waste storage pond liners](#). If the point(s) plot between the 80 percent saturation and 100 percent saturation (zero air voids) curves, the clay liner is acceptable. Record and document the results with certification and checkout notes.
6. As an alternative to density and moisture testing (Items 3, 4, and 5 above), perform 1 of the following tests:
 - a. Permeability test of in-place samples of the liner in accordance with standard procedures—At least 1 sample site per acre (rounded up to the next whole acre) shall be selected for testing. The surface area or the pond is measured at the top of berm elevation.
 - b. The "whole pond" seepage test with documentation that it was completed in accordance with established procedures.

Procedure When Using Field Tests for a Compacted Clay Liner (Alternative to Soil Mechanics Center Tests)

- Investigation
 1. Perform soil borings or equivalent excavations in the pond area to determine water tables, verify required separation distance, and describe the soil layers.
 2. Sample the soil or borrow material and determine classification of the soil (such as CL, CH, MH, or SC) based on field tests.
- Design

The following items are needed on the plans and specifications:

 1. Plan view with dimensions and location relative to other facilities.
 2. Cross section views showing elevation, slopes, thickness of liner, and dimensions.
 3. Soil boring and data on cross section and plan views.
 4. The borrow area with soil boring information—This can be the same view as Item 3 above if the liner material is coming from pond excavation.
 5. Soil moisture and a construction method compaction that you expect will result in a liner meeting the requirements—These method specifications shall be based on documented tests of previous soil moisture and density tests or documented liner posttests. A folder or file shall be maintained to document this information.
- Construction
 1. Verify pond location, size, depth, soil materials, and slopes.
 2. Verify liner thickness by cross section surveys before and after the liner installation.
 3. Verify the liner moisture and density by taking in-place density and moisture tests. A minimum of 1 location on the bottom and side slope per acre per lift should be tested. The density and soil

moisture tests can be done using the methods referenced in [Section KS651.1086\(e\) in NEH 651](#). Plot the point(s) on [Figure 1](#). If the point(s) plots between the 80 percent saturation and 100 percent saturation (zero air voids) curves, the clay liner is acceptable. Record and document the results with certification and checkout notes.

4. Verify the specified construction method is being used.
5. As an alternative to density and moisture testing (Item 3 above), perform 1 of the following tests:
 - a. Permeability test of in-place samples of the liner in accordance with standard procedures—At least 1 sample site per acre (rounded up to the next whole acre) shall be selected for testing. The surface area of the pond is measured at the top of berm elevation.
 - b. The "whole pond" seepage test with documentation that it was completed in accordance with established procedures.

Compacted Bentonite Clay Liner

As stated in [Appendix 10D in NEH 651](#), soils in Groups I and II will not achieve the required permeability without the addition of an amendment. Bentonite is commonly used with these soils to meet the permeability requirements. [Appendix 10D in NEH 651](#); [Conservation Practice Standard \(CPS\) 521C, Pond Sealing or Lining—Bentonite Treatment](#); and [Section KS651.1086 in NEH 651](#) have additional information on bentonite quality and the design and construction of bentonite clay liners.

For investigation, design, and construction information, use the procedure below for compacted clay liners with soil dispersants.

Compacted Clay Liner with Soil Dispersants

Some soils in Group III that contain high amounts of calcium may be more permeable than Group III soils without calcium. These soils require some type of treatment to serve as an acceptable liner. A soil dispersant additive

containing sodium is usually used. Soda ash is the most common soil dispersant used in Kansas.

[Appendix 10D in NEH 651](#); [CPS 521B, Pond Sealing or Lining–Soil Dispersant Treatment](#); and [Section KS651.1086 in NEH 651](#) have information on the design and construction of a compacted clay liner with soil dispersants.

The following information can be used when either bentonite or soil dispersants are added to the local soil or borrow material.

Procedure When Using Soil Mechanics Center Tests for a Compacted Clay Liner with Soil Dispersants

- Investigation

1. Perform soil borings or equivalent excavations in the pond area to determine water tables, verify required separation distance, and describe the soil layers.
2. Obtain samples of the soil or borrow material to be used for the liner.
3. Test the soil mixed with either bentonite or soil dispersants for permeability when remolded to the moisture and density, liner thickness, and additive rate specified in accordance with the information in [Section KS651.1086\(e\) in NEH 651](#).

- Design

If the soil test results support the planned design, the following items are needed on the drawings or in the construction specifications:

1. Plan view with dimensions and location relative to other facilities.
2. Cross section views showing elevation, slopes, thickness of liner, and dimensions.
3. Soil boring location and data on cross section and plan views.
4. Borrow area with soil boring information—This can be the same view as Item 3 above if the liner material is coming from pond excavation.

5. Soil moisture percent, soil density, and additive amount as dictated by the testing results—As an alternative to specifying actual numbers, a construction method can be stated to achieve the soil density and a soil moisture percent. These method specifications shall be based on documented tests of previous soil moisture and density tests or documented liner posttests. A folder or file shall be maintained to document this information.

- Construction

1. Verify pond location, size, depth, soil materials, and slopes.
2. Verify liner thickness by cross section surveys before and after the liner installation.
3. Document the volume or weight of the additive used to meet specifications and document the mixing or blending operations and the observed results.
4. Verify that the liner placement specifications are met by taking in-place density and moisture tests. A minimum of 1 location on the bottom and side slope per acre per lift should be tested. The density and soil moisture tests can be done using the methods referenced in [Section KS651.1086\(e\) in NEH 651](#).
5. Calculate in-place dry density and compare the results to the standard density (ASTM D 698) to determine if specification requirements are met (for example, density \geq 90 percent of Standard Proctor and 2 to 4 percent above optimum moisture). Record the test results and attach the test record to the checkout and certification documentation.
6. As an alternative to Item 5 above, plot the moisture and dry density of the in-place soils on [Figure 1](#). If the point(s) plot between the 80 percent saturation and 100 percent saturation (zero air voids) curves, the clay liner is acceptable. Record and document the results with certification and checkout notes.

7. As an alternative to density and moisture testing (Items 4, 5, and 6 above), perform 1 of the following tests:
 - a. Permeability test of in-place samples of the liner in accordance with standard procedures—At least 1 sample site per acre (rounded up to the next whole acre) shall be selected for testing. The surface area or the pond is measured at the top of berm elevation.
 - b. The "whole pond" seepage test with documentation that it was completed in accordance with established procedures.

Procedure When Using Field Tests for a Compacted Clay Liner with Soil Dispersants (Alternative to Soil Mechanics Center Tests)

- Investigations
 1. Perform soil borings or equivalent excavations in the pond area to determine water tables, verify required separation distance, and describe the soil layers.
 2. Sample the soil or borrow material and determine classification of the soil (such as CL, CH, MH, or SC) based on field tests.
- Design

The following items are needed on the plans and specifications:

 1. Plan view with dimensions and location relative to other facilities.
 2. Cross section views showing elevation, slopes, thickness of liner, and dimensions.
 3. Soil boring and data on cross section and plan views.
 4. The borrow area with soil boring information—This can be the same view as Item 3 above if the liner material is coming from pond excavation.
 5. Soil moisture, amount of additive, and a construction method compaction that you expect will result in a liner meeting the requirements—These method specifications shall be based on documented tests of previous soil moisture and density tests or

documented liner posttests. A folder or file shall be maintained to document this information.

- Construction
 1. Verify pond location, size, depth, soil materials, and slopes.
 2. Verify liner thickness by cross section surveys before and after the liner installation.
 3. Document the volume or weight of the additive used to meet specifications and document the mixing or blending operations and the observed results
 4. Verify the liner moisture and density by taking in-place density and moisture tests. A minimum of 1 location on the bottom and side slope per acre per lift should be tested. The density and soil moisture tests can be done using the methods referenced in [Section KS651.1086\(e\) in NEH 651](#). Plot the point(s) on [Figure 1](#). If the point(s) plots between the 80 percent saturation and 100 percent saturation (zero air voids) curves, the clay liner is acceptable. Record and document the results with certification and checkout notes.
 5. Verify the specified construction method is being used.
 6. As an alternative to density and moisture testing (Item 4 above), perform 1 of the following tests:
 - a. Permeability test of in-place samples of the liner in accordance with standard procedures—At least 1 sample site per acre (rounded up to the next whole acre) shall be selected for testing. The surface area or the pond is measured at the top of berm elevation.
 - b. The "whole pond" seepage test with documentation that it was completed in accordance with established procedures.

Flexible Membrane

Another option for a liner is to use a flexible membrane. Flexible membranes consist of a functionally continuous sheet of synthetic or partially synthetic material. Examples are high

density polyethylene, linear low density polyethylene, polyvinyl chloride, geosynthetic clay liner, and synthetic rubber. Information on the design and construction of these liners can be found in [CPS 521A, Pond Sealing or Lining—Flexible Membrane](#), and in manufacturer's literature.

- Investigation

1. Perform soil borings or equivalent excavations in the pond area to determine water tables and verify required separation distance.
2. Sample the soil to be used as the liner cover (if required). Many geosynthetic or plastic liner materials need to be covered with pliable soil materials such as SM or ML.
3. Conduct field soil tests to determine the use of the soil for foundation under the flexible liner.

- Design

The following items are needed on the drawing and in the specifications:

1. Plan view with dimensions and location relative to other facilities.
2. Section view showing elevations and slopes and details of the liner placement, joining seams, and anchoring the edges.
3. The borrow area for the soil to be placed over the liner, as appropriate.
4. Location and type of foundation material.

- Construction

1. Verify location, size, depth, and slopes.
2. Verify foundation material for use under the liner and record observations.
3. Verify liner placement, record observation, and take photos.

Figure 1—Density and moisture combinations to meet permeability requirements for waste storage pond liners

