

WISCONSIN CONSTRUCTION SPECIFICATION

300. CLAY LINER

1. SCOPE

The work shall consist of:

1. Construction of a clay liner as shown on the construction plans.
or
2. Re-compaction of the upper one foot of clay material specific to WI NRCS Conservation Practice Standard (WI CPS) 313 Table 1.

2. CLAY LINER MATERIAL

Clay liner material shall have a minimum plasticity index of 12 ($PI \geq 12$) and a minimum percentage passing the No. 200 sieve (P_{200}) as specified in the construction plans. The clay liner material shall be capable of providing a liner with a maximum hydraulic conductivity (permeability) of 1×10^{-7} centimeters per second.

Proposed liner material properties shall be determined in the lab prior to placement for each different borrow area and material, at the specified minimum frequency shown in Table 1. These tests are typically done in the design phase with additional tests required when unpredicted changes in borrow material are observed.

A standard or modified proctor test density curve, and optimum moisture, shall be developed from the borrow materials. A hydraulic conductivity (permeability) shall be determined on a re-compacted sample. The sample shall be re-compacted to the minimum density and moisture content specified in Section 6, Compaction.

Test Reference	Minimum Frequency
Standard Proctor (ASTM D 698) <i>or</i> Modified Proctor (ASTM D 1557)	1 per 5,000 cubic yards of estimated in-place liner quantity
Atterberg Limit (ASTM D 4318) and Percent Fines (ASTM D 1140)	1 per 5,000 cubic yards of estimated in-place liner quantity
Permeability (ASTM D 5084)	1 per 5,000 cubic yards of estimated in-place liner quantity

3. FOUNDATION PREPARATION

Foundation surfaces shall be graded to remove surface irregularities and shall be scarified or otherwise acceptably scored or loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the clay liner. The surface materials of the foundation shall be compacted and bonded with the first layer of the clay liner as specified for subsequent layers of clay liner.

4. PLACEMENT

The clay liner shall not be placed until the required foundation preparation has been completed and the foundation has been inspected and approved by the Technician or Engineer. The clay liner shall

not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the clay liner.

Clay materials shall contain no sod, brush, roots, frozen soil, or other perishable materials. Rock particles larger than 3 inches shall be removed prior to compaction of the clay.

The clay liner shall be placed in lifts. The thickness of each lift before compaction shall not exceed the smaller of 6 inches or the length of the teeth of the footed compactor used.

The distribution of materials throughout the clay liner shall be essentially uniform, and the clay liner shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.

If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified to a depth of not less than 2 inches before the next layer is placed.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of the clay liner, the moisture content of the clay being placed shall be maintained above the optimum moisture as determined by the standard proctor test or modified proctor test.

The application of water to the clay shall be accomplished at the borrow areas in-so-far as practicable. Water may be applied by sprinkling the clay after placement and before compaction of the liner, if necessary. Uniform moisture distribution shall be obtained by disking.

6. COMPACTION

The clay liner shall be compacted to a minimum of 95% of standard proctor dry density or to a minimum of 90% of modified proctor dry density.

The clay liner shall be compacted with a footed compactor weighing at least 25,000 pounds, operated continuously over the clay material.

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE LINER

Clay liner placed at densities lower than the specified minimum density or at moisture contents lower than the optimum moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the specifications or removed and replaced. The replacement clay material and the fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control, and compaction.

8. TESTING METHOD SPECIFICATIONS

- ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
- ASTM D 4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D 1140 Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 µm) Sieve
- ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

- ASTM D7698 Standard Test Method for In-Place Estimation of Density and Water Content of Soil and Aggregate by Correlation with Complex Impedance Method
- ASTM D 2937 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
- ASTM D 2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
- ASTM D 5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

9. TESTING FREQUENCY

Clay liner construction shall be tested and documented by a third party engineering or testing firm at the specified minimum frequency shown in Table 2.

Field density tests shall be completed on the compacted in-place clay liner, as the liner is being placed. Atterberg limit and percent fines shall be completed on samples obtained next to the field density test. After the completion of the liner, undisturbed samples shall be taken from the constructed clay liner for permeability verification.

Copies of the test locations and test results (documentation report) shall be provided to the owner to document compliance with this specification.

Table 2 Liner Testing

Test Reference	Minimum Frequency (Standard mathematical rounding rules apply)
Field Density (ASTM D 2922, or D 6938, or D 2167, or D 1556 or ASTM D 7698)	1 test per 500 cubic yards of in-place liner, distributed throughout the structure (Horizontally and Vertically)
Atterberg Limit (ASTM D 4318) and Percent Fines (ASTM D 1140)	1 test per 2000 cubic yards of in-place liner
Permeability (ASTM D 5084)	1 per 5,000 cubic yards of in-place liner (2 minimum per facility) ¹

1. At least one of these tests should be obtained from the side slope of the facility

All undisturbed sample test holes in the constructed clay liner shall be backfilled using powdered bentonite mixed with clay soil used in liner construction and compacted by hand tamping. The clay shall be broken down into clods less than ½ inch in diameter. A minimum of 25% of each backfilled test hole volume shall be occupied by powdered bentonite after backfilling.

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Addendum A

This addendum clarifies the specification's scope #2. (The re-compacted layer (Upper 1' of soil) required by WI NRCS Conservation Practice Standard (WI CPS) 313, Table 1. All other parts of the Wisconsin Construction Specification 300 Clay Liner apply.

1. RE-COMPACTED CLAY MATERIAL

Re-compacted clay material shall have the same properties and tested for Standard or Modified Proctor, Atterberg Limits, and Percent Fines as specified above in 2. CLAY LINER MATERIAL.

The clay material may be obtained from any location within the footprint to the proposed waste storage facility.

2. FOUNDATION PREPARATION

The facility shall be excavated 12 inches below the designed bottom elevation. The surface shall be scarified or otherwise acceptably scored or loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified above in 5. CONTROL OF MOISTURE CONTENT. The foundation materials shall be compacted and bonded with the first clay material lift.

3. PLACEMENT

The first clay material lift shall not be placed until the required foundation preparation has been completed and the foundation has been inspected and approved by the Technician or Engineer.

The re-compacted layer shall be placed in lifts. The thickness of each lift before compaction shall not exceed the smaller of 6 inches or the length of the teeth of the footed compactor used. The placement and compaction process continues until the specified elevation has been achieved.

The re-compacted layer shall then be tested and documented by a third party engineering or testing firm at the specified minimum frequency shown in Table 2 for Field Density, Atterberg Limits, and Percent Fines.