Construction Quality Assurance Plan

City of Pierre Municipal Solid Waste Regional Landfill

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1.0 Introduction

As required by South Dakota Department of Agriculture and Natural Resources (SD-DANR) Administrative Rules 74:27:12:22, this manual describes the Construction Quality Assurance (CQA) procedures for the construction of the Pierre Regional Landfill (Landfill) including landfill cells, final cover system, and leachate pond. The leachate pond and storm water sedimentation pond were constructed in 2003/2004. Landfill liner and leachate collection system for Cells #1 and #2 were constructed in 2003/2004 and 2009, respectively. Landfill liner and leachate collection system for Cell #3 was constructed in 2015. Cell #4 is anticipated to be constructed in 2025.

This manual addresses the engineering techniques that will be utilized in the field to obtain a "quality" product for "assurance" that the Landfill meets or exceeds all the construction requirements set forth in the Administrative Rules of South Dakota, Title 74 (ARSD 74). At completion of the work, a certification report that documents the testing results for grading, liners, geotextiles, and piping systems will be submitted to the SD-DANR.

2.0 Responsibilities and Authority

This section describes the responsibilities and authority of key personnel and organizations involved with facility construction.

2.1 City of Pierre, South Dakota

The City, as Owner of the site, will be responsible for complying with the requirements of the SD-DANR in order to obtain a permit and for assuring, by the submission of CQA documentation, that the facility was constructed as specified in the design. The City has the authority to select and dismiss organizations charged with design, CQA, and construction activities. The City also has the authority to accept or reject design plans and specifications, CQA Plans, reports, recommendations of the CQA officer, and the materials and workmanship of the Contractor. The City will be responsible for operation of the facility.

2.2 South Dakota Department of Environment and Natural Resources

SD-DANR will be responsible for review of this CQA Plan upon its submittal with the permit renewal application. SD-DANR will also be responsible for reviewing all CQA documentation during and after construction to ensure that the CQA Plan is being followed and that the facility is constructed as specified in the design.

2.3 Design Engineer

The City may contract with a third-party Engineer to assist with liner and final cover system designs, construction administration activities, and CQA.

2.4 CQA Personnel

The CQA officer for construction of the Landfill will oversee CQA personnel and activities. CQA personnel will consist of designated employees and/or agents of the City. The overall responsibility of CQA personnel will be to perform activities specified in this CQA Plan. CQA personnel will include a CQA officer and the necessary supporting inspection personnel. The specific responsibilities and authority of each of these individuals are defined below, and in the specifications and documents for the facility design.

Responsibilities of the CQA officer will include:

- Review of liner or closure design criteria, plans, and specifications for clarity and completeness.
- Scheduling and coordinating CQA inspection activities.
- Directing and supporting the CQA inspection personnel in performing observations and tests by:
  - Submitting samples for analysis by the CQA inspection personnel and testing laboratories as specified in the plan.
  - Confirming that regular calibration of field-testing equipment is properly conducted and recorded.
  - Confirming that the testing equipment, personnel, and procedures are consistent or making sure that any inconsistencies do not adversely impact the inspection process.
  - Confirming that the test data are accurately recorded and maintained.
- Providing reports on the inspection results, which will include:
  - Review and interpretation of all data sheets and reports.
  - Identification of work that should be accepted, rejected, or uncovered for observation or that may require special testing, inspection, or approval.
  - Rejection of defective work and verification that corrective measures are implemented.
- Reporting to the Contractor results of all observations and tests as the work progresses, interacting with the Contractor to provide assistance in modifying the materials, and working to comply with the specified design.

The supporting CQA inspection personnel will be employees or agents of the City with specific responsibilities, as follows:

- Observing construction activities.
- Performing independent on-site inspection of the work in progress to assess compliance with the design criteria, plans, and specifications.
- Calibrating field-testing equipment.
- Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by the specifications.
- Reporting to the CQA officer results of all inspections.

2.5 Construction Contractor

The construction contractor (Contractor) will be responsible for construction of the liner, leachate collection and final cover systems in accordance with design criteria, plans, and specifications.

3.0 Personnel Qualifications

This section identifies the required qualifications of the CQA officer and the CQA inspection personnel and describes their expected duties.

3.1 CQA Officer

The CQA officer is responsible for all aspects of the CQA Plan implementation. The CQA officer will possess adequate training in civil engineering. The CQA officer will ensure that all CQA-related matters are conveyed to and acted upon by the affected organizations. The CQA officer will be a professional engineer registered in the State of South Dakota.

3.2 CQA Inspection Personnel

The CQA inspection personnel will possess sufficient practical, technical, and administrative experience to execute and record inspection activities. This will include knowledge of specific field practices relating to construction techniques used for liner and soil cover systems, observation and testing procedures, equipment, documentation procedures, and site safety.

3.3 Geologic Inspection Personnel

The Geologic Inspection Personnel will be a qualified third-party Professional Geologist or equivalent, experienced in the hydrogeology of glacial till. The Geologic Inspection Personnel will be onsite as necessary during the cell excavation to ensure that the in-situ clay soils are of the characteristics stated in the permit application and, if necessary, make recommendations for field adjustments.

3.4 Consultants

Authorities in engineering, geology, geotechnical engineering, civil engineering, and other technical disciplines may be called in from external organizations in the event that unusual site conditions or inspection results cannot be resolved by the City. Documentation of consultant qualifications will be taken when outside testing or technical judgments are used as a basis for decision in some aspect of construction quality assurance.

4.0 Inspections, Sampling, and Testing

The following is an overview of CQA and CQC activities, by major physical components, to be undertaken before, during or after construction. Final construction plans and specifications may further delineate sampling strategies, including methods of determining sample locations, frequency of sampling, acceptance and rejection criteria, and methods of implementing corrective measures.

If CQA testing indicates that improper soils or construction methods were used, the defective material will either be: 1) removed and replaced; or 2) conditioned and reworked in place. The contractor will make all repairs required to correct deficiencies. CQA personnel will observe all repairs and perform additional testing to confirm suitable construction and conformance with project specification.

4.1 Liner Earthwork Construction

CQA testing on the landfill liner, drainage layer, and subgrade will be performed by a representative designated by the City of Pierre for the Landfill. The testing will consist of observation of the work, field and laboratory testing, and surveying. All testing will be conducted on samples obtained from the site or from representative samples of off-site materials utilized in construction.

A. OBSERVATION OF THE WORK

Observation of the liner earthwork construction is necessary to document that the construction procedures utilized by the contractor meet the requirements of the project specifications. These requirements will include observation and documentation of:

- clay liner placement and lift thickness
- clay liner compaction
- drainage layer placement and thickness
- protective soil cover material placement and thickness
- subgrade preparation

B. LABORATORY AND FIELD TESTING

The representative or agent of the City for CQA of the Landfill will conduct field and laboratory tests prior to and during the construction of the landfill cells, leachate pond, and sedimentation pond to document the construction of these portions of work to ensure compliance with the project specifications and ARSD 74. Construction of the sedimentation pond and leachate pond were completed in 2004.

Table 1 identifies the following laboratory tests to be utilized to determine material acceptability.

Table 1 – Laboratory Tests

Parameter	Method	ASTM#
Compaction (Moisture/Density Relationship)	Standard Proctor Test	D698
Liquid Limit, Plastic Limit, Plasticity Index	Atterberg Limits	D4318
Particle Size Distribution	Sieve and/or Hydrometer Analysis	D6913 D1140
Permeability	Flexible Wall Falling Head Permeability Test	D5084
	Rigid Wall Constant Head Permeability Test	D5866

Table 2 identifies the following tests to be performed in the field during and after construction to determine acceptability.

Table 2 – Field Tests

Parameter	Method	ASTM#
Field Moisture/Density Determination	Nuclear Methods	D6938
	Sand Cone Method	D1556
	Rubber Balloon Method	D2167
Permeability	Thin-Walled Tube Sampling	D1587

Nuclear methods of testing for permeability (ASTM D6938) are preferred due to the ease of testing and the short amount of time required for each test. Nuclear testing machines will be calibrated prior to testing in the field, and any questions of accuracy will be addressed by repeating the test in the same location or with another test method. An in-place permeability test is usually conducted on a test pad constructed with the same techniques, however, a representative number of thin-walled samples tested in the laboratory usually provide better overall construction results and is the preferred method.

The quality assurance testing for the Landfill is presented in Table 3 for the various components of the project. All sampling locations will be selected by the representative of the City in accordance with the frequency provided in Table 3. Locations of all tests will be recorded for the Quality Assurance Report. Sampling frequency may be increased at the discretion of the representative of the City when visual observations indicate a suspected problem.

Table 3 – Liner System Soils Construction Testing Frequency

Test	Clay Liner	Drainage Layer	Coarse Aggregate Aggregate
Permeability	One Undisturbed Test per Acre of Liner	One Remolded Lab Test per acre of Material Placed	N/A
Grain Size Distribution	One Representative Sample Per Acre of Liner Placed	Four Representative Sample to the #200 Sieve per acre of Material Placed	One Representative Sample Per 500 LF of Trench
Dry Density & Moisture Content	Testing on 200 Ft Grid Pattern on Each Lift of Clay Liner Placed	N/A	N/A
Atterberg Limits	One Representative Sample Per 7,000 CuYds of Liner Placed	N/A	N/A
Standard Proctor	One Representative Sample Per 3,500 CuYds of Liner Placed	N/A	N/A

Additional testing may be required for the following:

- lift thickness greater than specified
- soil is at improper moisture content or mixing of water and soil is variable
- insufficient compaction on layers is provided
- material significantly changes
- clogged teeth in sheepsfoot compactor
- during adverse weather
- if materials fail to meet project specifications

The soils testing for embankments and excavations other than components for the liner will be tested on a frequency that will be determined in the field. Standard proctor densities will be completed on samples in frequency that corresponds to visual material changes. Nuclear moisture/densities will be taken during compaction of embankments and subgrades to ensure proper compaction and moisture contents. Densities will be taken on a minimum 100-foot grid interval for embankment and subgrade construction on each lift of material placed. All pipe bedding, road surfacing, and engineered fill materials will be tested for grain size distribution, standard proctor densities, and in-place densities on representative samples of each material and in frequency as needed to ensure uniform placement and compliance with the project specifications.

Perforations in the liner and embankments will occur during the construction due to testing. This includes testing for permeability with thin-walled tubes, nuclear density probes, or probe for checking lift thickness. All perforations will be hand tamped and filled with clay liner material or with a soil/bentonite mixture.

C. SURVEY OF EARTHWORK

The survey of various locations within the project will ensure proper liner and cover placement and depths. The major components of the survey will include the following:

- surface elevations and grades of the subgrade (or in-situ liner floor grades)
- surface elevations and grades of the clay liner, if required
- surface elevations of drainage layers
- surface elevations and grades of drainage channels
- invert elevations of drainage structures

Cut and fill staking for the grades and elevations required will be conducted in 50-foot grid intervals and at all break points or more frequently if required by the contractor. All quality assurance survey work will be performed by a qualified representative of the City of Pierre.

4.2 Leachate Collection Piping

The leachate collection piping is an important component of landfill construction. The purpose of the quality assurance program for the leachate collection system is to identify the material to be placed, ensure placement at proper grades and elevations, and observe the placement of piping materials.

The designated representative or agent of the City will identify all piping components to ensure compliance with the project specifications. Documentation of all materials will be obtained for the report. The grades and elevations of all piping and piping structures will be surveyed in the field to ensure proper placement and for preparation of as-constructed drawings. Visual observation of the placement and density testing of backfill materials will ensure compliance with the project specifications.

4.3 Final Cover System

CQA testing on the landfill final cover system will be performed by a representative designated by the City of Pierre for the Landfill. The testing will consist of observation of the work, field and laboratory testing, and surveying. All testing will be conducted on samples obtained from the site or from representative samples of off-site materials utilized in construction.

The overall properties of the final cover system, relative to QC, CQC, and CQA are essentially the same as those provided for the soil liner and leachate collection system with the following variations:

- An intermediate cover/buffer layer will serve as the foundation for the clay soil layer (i.e. infiltration layer or soil barrier layer). Compaction requirements will be based on visual confirmation of firm foundation for the infiltration layer (by CQA and CQC personnel) rather than specific density requirements.
- Piping and vertical pipe penetrations will occur through the final soil cover for passive gas venting.
- The recompacted clay, infiltration layer will be tested or otherwise demonstrated to have a hydraulic conductivity of $1x10^{-7}$ cm/sec or less for the conventional clay cover system. Quality control for this infiltration layer will be similar to the method described above for clay liner.
- Only soil (or conditioned soil) able to support vegetation will be used in the Topsoil Layer.

A. OBSERVATION OF THE WORK

Observation of the final cover system will include:

- Subgrade preparation, intermediate cover/soil buffer layer placement and thickness
- Clay cap placement, compaction and lift thickness
- Topsoil layer placement and thickness

Visual observation of the Topsoil Layer will aid in precluding soils that are unsuitable for supporting vegetation.

B. LABORATORY AND FIELD TESTING

Quality control testing will be performed on soil materials used in construction of the final cover system. Source testing will be conducted by the contractor to define material properties that govern material suitability and placement. These material properties tests will typically include Atterberg limits, standard proctor, and permeability for clay soils, and agricultural properties for topsoil (e.g., pH and nutrient levels). Samples will be collected on a random basis within a delineated sampling location. Source testing will be identified in the specifications for the contractor to complete.

Quality assurance testing for clay infiltration layer includes the same testing requirements as specified in Table 3 above for clay liner. Visual observation will be used to supplement compliance testing. Acceptance of an area will be based on testing, establishing a suitable thickness and vegetative growth environment.

C. SURVEY OF FINAL COVER SYSTEM

The survey of the final cover system will ensure proper cover soil placement and depths. The major components of the survey will include the following:

- surface elevations and grades of the intermediate cover/buffer layer
- surface elevations and grades of the clay infiltration layer
- surface elevations and grades of the topsoil layer
- locations of passive gas vents

All quality assurance surveying for the final cover grades and elevations will be conducted in 100-foot grid intervals and at all break points. Survey work will be performed by a qualified representative of the City of Pierre.

5.0 Quality Assurance Report and Record Drawings

The quality assurance report is a summary of all field-testing and observations during the construction of the major components of the Landfill. The report will contain a discussion of the construction procedures along with a listing of the key personnel involved in the construction. The report will also include tabulated results from field and laboratory testing along with the locations of areas tested.

The report will include drawings of construction record which will provide as-constructed grades and elevations of the clay liner (in-situ floor grades) and drainage layer, access roads, drainage ditches, drainage structures, piping invert elevations, piping structure elevations, final cover layers and passive gas vent locations, and material quantities.

The report will be certified by a Professional Engineer Registered in the State of South Dakota.