

COMMONWEALTH OF VIRGINIA
Department of Environmental Quality

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LANDFILL CONSTRUCTION OVERSIGHT INSPECTIONS

To: Regional Land Protection Program Managers, Solid Waste Permit Writers, and Solid Waste Compliance Inspectors

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Copies: Deputy Director, Waste Enforcement Manager, Regional Directors, Deputy Regional Directors, Solid Waste Permit Coordinator, Solid Waste Compliance Coordinator

Summary:

This guidance provides an implementation document to assist internal staff during landfill construction projects. It provides the necessary steps, events, and actions for staff to examine during cell construction at landfill. It details the items to be looked for during an oversight inspection and how to follow-up to noted deficiencies.

Electronic Copy:

An electronic copy of this guidance is available on Virginia's Town Hall website at <http://www.townhall.state.va.us/L/GDocs.cfm?boardid=119>.

Contact Information:

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Disclaimer:

This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate any particular method nor does it prohibit any alternative method. If alternative proposals are made, such proposals should be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.



LANDFILL CONSTRUCTION OVERSIGHT INSPECTIONS

I. Introduction

This guidance has been created to outline new landfill construction oversight inspection procedures, which has been developed as part of a risk-based approach to issuing Certificates-to-Operate for new landfill cell construction and closure acknowledgements for final cover installation. These oversight inspections will replace lengthy review of Construction Quality Assurance (CQA) Reports submitted after construction completion and will allow DEQ staff the opportunity to observe landfill construction projects and point out deficiencies or deviations from approved plans and permits at the time of inspection. Previously, issues with construction were discovered during the CQA Report review, making it difficult to correct.

II. Background

In accordance with 9 VAC 20-81-130.Q., facilities are required to have a Construction Quality Assurance (CQA) Plan that outlines a CQA program to be implemented during landfill construction that will ensure that constructed units meet or exceed all design criteria and specifications outlined in the permit. Prior to any anticipated new disposal unit construction or final cover installation, the facility will select a CQA Officer to implement the approved CQA Plan. It is the CQA Officer's job to observe construction activities to ensure construction takes place in accordance with approved plans and permits.

Once construction is complete, facilities submit CQA Officer and Design Engineer certifications in accordance with 9 VAC 20-81-130.Q.3. and 9 VAC 20-81-490.A.1. for new disposal unit construction and CQA Officer certification in accordance with 9 VAC 20-81-160.D.4. for landfill cap construction. Accompanying these certifications is a CQA Report (sometimes referred to as a Construction Certification Report or CCR), which often consists of 1-2 large (3-4" binders) containing a summary report of the construction activities and appendices containing construction and testing logs, field and lab test results, geosynthetic material documentation, facility as-builts, photographs, etc. The report size has resulted in extensive review times by DEQ and delays issuing a Certificate-to-Operate for new disposal units or closure acknowledgement for closed units. In addition, any problems found during review of the CQA Report are found after construction which makes it difficult and costly to repair, if deemed necessary.

III. Authority

§ 10.1-1402.11 of the Virginia Waste Management Act ("Act"), Chapter 14 (§ 10.1-1400 *et seq.*) of Title 10.1 of the Code of Virginia, authorizes the Virginia Waste Management Board to promulgate regulations, and provide for reasonable variances and exclusions, necessary to carry out its powers and duties and the intent of the Act.

§ 10.1-1456 of the Act authorizes the Director or authorized staff to "enter at any reasonable time onto any property to inspect; investigate, evaluate, conduct tests or take samples for testing as he reasonably deems necessary" to ensure compliance with the Act and VSWMR. This authorization is reiterated in Module I, Condition I.B.7. of solid waste permits.

IV. Definitions

The definitions in § 10.1-1400 of the Code of Virginia and 9 VAC 20-81-10 of the VSWMR apply to this guidance document.

"Construction" means the initiation of permanent physical change at a property with the intent of establishing a solid waste management unit. This does not include land-clearing activities, excavation for borrow purposes, activities intended for infrastructure purposes, or activities necessary to obtain Part A siting approval (i.e., advancing of exploratory borings, digging of test pits, groundwater monitoring well installation, etc.). (9 VAC 20-81-10)

"Construction Quality Assurance (CQA) Plan" means the permit document outlining the CQA Program. The CQA Plan addresses the items specified under 9 VAC 20-81-130.Q.2. and 9 VAC 20-81-470.B.3.

"Construction Quality Assurance (CQA) Program" means a planned system of activities developed and implemented under the direction of a CQA officer that ensures the constructed disposal unit meets or exceeds all design criteria and specifications in the permit. The program addresses the construction of landfill disposal unit foundations; low-hydraulic conductivity soil liners; synthetic membrane liners; leachate collection and removal systems including a protective layer; gas management components; and final cover systems. Construction quality assurance addresses observations and tests that will be used before, during, and after construction to ensure that the construction materials and the installed unit components meet the design specifications.

"CQA Officer" or "CQA Engineer" means a professional engineer who is responsible for carrying out the CQA Plan and ensuring that the landfill disposal unit is constructed in accordance with permitted design plans and technical specifications. Once construction is complete, the CQA Officer provides certification that the approved CQA plan has been successfully carried out and that the unit meets the requirements of 9 VAC 20-81-130 or 9 VAC 20-81-160. The CQA Officer functions separately from the contractors and owner/operator.

"Design Engineer" means a professional engineer who is responsible for certifying that a landfill disposal unit has been constructed in accordance with permitted design plans and technical specifications and the disposal unit is ready to begin operation. The Design Engineer does not have to be the engineer who submitted the design plans or technical specifications for approval.

"Disposal Unit" means any area, possibly identified with a Cell or Phase letter or number in a facility's permit, within or coincident to the permitted "disposal unit boundary" or "DUB" as defined under 9 VAC 20-81-10.

"Manufacturer Quality Assurance (MQA)" means a planned system of activities that provides assurance that the materials were manufactured to meet project specifications and contract plans. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract plans for a project. (USEPA, 1993)

"Professional engineer" means an engineer licensed to practice engineering in the Commonwealth as defined by the rules and regulations set forth by the Board of Architects, Professional Engineers, Land Surveyors, and Landscape Architects (18VAC10-20).

"Technical Specifications" mean the permit document containing the set of requirements to be satisfied by each material, product, or service to be employed during landfill disposal unit construction activities. Individual specifications are provided for initial site preparation activities identified under 9 VAC 20-81-470.B.3. and for all materials to be installed.

V. Guidance Document

The intent of this guidance is to outline the procedures and inspection criteria to be implemented under a landfill construction oversight program. Inspections during landfill construction are meant to evaluate construction activities at the time of inspection to determine compliance with the facility's permit (design plans, technical specifications, CQA Plan, etc.). Inspections should be scheduled to observe the following construction phases of new disposal unit construction and final cover installation:

- Borrow source evaluation, subgrade placement/evaluation, and/or test pad construction/evaluation;
- Infiltration layer (Compacted Clay Liner, CCL, or Geosynthetic Clay Liner, GCL) placement and evaluation;
- Flexible membrane liner (also referred to as a barrier layer) placement, seaming, and testing; and
- Leachate collection piping and drainage layer material evaluation and placement.

Please note that inspections can be combined, for example, when installing GCL, FML is often installed at the same time to prevent GCL exposure to the elements. If a facility is installing both at the time of inspection, items from both sections of the CQA Oversight Inspection checklist can be marked as reviewed. It is the goal that an inspection will occur during each construction phase; however, scheduling conflicts and/or workload may result in skipping a construction phase. The facility is NOT required to wait for a DEQ inspection before continuing on with the next construction phase. If a construction phase is missed, DEQ staff can discuss construction items during the next construction inspection and/or review that section of the CQA Report in more detail to ensure compliance.

Once construction activities are complete, facilities will notify DEQ by providing the certifications required under 9 VAC 20-81-490.A. (for new disposal unit liner construction); 9 VAC 20-81-160.D.4. or D.5.d. (for final cover construction); and 9VAC20-81-130.Q.3. A final site inspection should be arranged to ensure the site is either ready to accept solid wastes, in the case of new disposal unit construction, or to ensure a good stand of vegetation has been established and ensure appropriate closure activities have been completed, in the case of final cover construction. Following these inspections, if site evaluations are acceptable, DEQ staff should issue either a Certificate-to-Operate (CTO) or acknowledgement of final cover construction.

Guidance Limitations

Due to the variability in permitted landfill designs and materials available for landfill construction projects, it is impossible to design a construction oversight program to address all construction oversight issues. The above construction phases have been identified as key phases. In the sections that follow, guidance is provided for DEQ staff to evaluate each identified construction phase during on-site inspections. Facilities with permitted liner systems that include alternate or additional construction phases should modify this program to suit the facility's needs. For facilities with permitted double and triple liner systems, only one inspection is needed for each duplicate or triplicate liner layer (i.e., staff only need to observe one instance of FML installation and seaming); inspections should be scheduled to accommodate DEQ staff and facility schedules.

Scheduling Inspections

Scheduling inspections can be a cumbersome process as there are many factors such as material delivery, contractor and CQA officer schedules, DEQ staff schedules and weather to contend with. In the case of new disposal unit construction, there is no regulatory requirement for facilities to notify DEQ prior to commencing construction, therefore, DEQ permitting and compliance staff should communicate with each other and with the facility to determine when new disposal unit construction is anticipated. For final cover construction, 9 VAC 20-81-160.B.5. requires facilities to notify DEQ 180 days prior to closure construction initiation, so at least there is a notification for closure so that inspections can be worked into regional staff work plans, if applicable.

Once a tentative construction schedule has been established, the assigned staff should keep in contact with the CQA officer or engineering firm to determine the best times to schedule site visits. Ask the CQA officer or firm to keep you updated of any schedule changes due to material delivery, contractor, and/or weather delays. When scheduling, it may be best to aim for a week to visit and then narrow down to the specific day once that week starts that way adjustments can be made to accommodate weather.

Preparing for an Inspection

Upon notification of the intent to construct a new disposal unit, the Regional Land Protection Manager (LPM) shall assign the construction oversight project to a specific regional staff member or staff team. The assigned DEQ staff should review the CQA Plan and Technical Specifications to extract site-specific construction details. Any alternate or additional test procedures outlined in the facility's Plan should be noted on the Construction Inspection Checklist provided in Attachment A.

Equipment Considerations (excerpt from the Solid Waste Inspector's Manual, May 2010)
Appropriate equipment should be assembled prior to conducting any inspection. Typical equipment that may be utilized during inspections is listed in the below tables.

Typical Inspection Equipment

Camera	Calculator
Tape measure	Pens, pencils, highlighters
Flashlight (non-sparking)	Ruler
Binoculars	Regulations
Multi-tool	Brief case or backpack
Photo ID	Checklists and field notebook

Compass or Global Positioning System (GPS) unit

Current Permit and last inspection report

Personal Protective Equipment (PPE)

Hard hat

Safety glasses or sunglasses

Ear plugs

Safety vest

Steel-toed boots (no spikes)

Bug spray or sun screen

Hand sanitizer

Disposable towels or napkins

Not all equipment will be carried throughout the inspection but may be kept in the facility office or secured in the DEQ vehicle so it is available if needed.

Construction Oversight Inspections

When evaluating each construction phase, DEQ staff should observe constructed areas, material storage areas, and current construction activities and talk with facility and CQA personnel to evaluate whether the observations are in accordance with the permitted design and CQA Plan. Staff should mark the 'I' column on the checklist to note items that are inspected. Any deviations or deficiencies observed during the inspection should be denoted by marking in the 'N' column and be pointed out to the CQA officer and facility representative during an exit interview. Any items that are not applicable to the facility being inspected should be marked in the 'NA' column. A copy of the Construction Inspection Checklist (see Attachment A) and Responding to Identified Deficiencies handout (Attachment B), if applicable, shall be left with the facility representative.

Upon return to the office, the inspection should be entered as a permit event into CEDS using the CQAINSSWP – Construction Inspection event code.. The comments should indicate what was inspected, e.g. Cell 3 construction, Phase II closure, etc. The resulting Construction Inspection Checklist shall be scanned and uploaded into ECM.

and DEQ staff may need to refer the issue to the appropriate E&S authority (either the locality or DEQ E&S group).

- Borrow source samples are obtained and tested per approved Technical Specifications and CQA Plan.
Test results may not be on-site at the time of inspection. Observing sample collection and/or records of samples taken is adequate. If results are available, spot check to confirm soils are within allowable range as specified in the Technical Specifications. For example, if the soil tested is to be used as low permeability soil (i.e. having a hydraulic conductivity $\leq 1 \times 10^{-7}$ cm/sec), confirm test results show the material has an appropriate permeability. Also, if soil is to be used for the landfill subgrade, confirm that soil has a Unified Soil Classification of SC, ML, CL, MH, or CH.
- Processed borrow soils are free of roots and debris.
- Processed borrow soils are free of rocks exceeding size limitations identified in Technical Specifications.

2. **Subgrade Placement / Evaluation Inspection Items**

If subgrade is being placed and/or evaluated during the site inspection, the following inspection items are proposed:

- CQA Personnel are on site during subgrade placement and/or sampling.
- Subgrade consists of materials meeting Technical Specifications.
For facilities installing the sanitary landfill alternate liner specified under 9 VAC 20-81-130.J.1.b. (FML/GCL liner), the subgrade shall be a minimum of 12 inches thick and consist of soils having a Unified Soil Classification of SC, ML, CL, MH, or CH.
- Subgrade tested for compaction and density.
For facilities installing the sanitary landfill alternate liner specified under 9 VAC 20-81-130.J.1.b. (FML/GCL liner), the subgrade shall be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D698 (Standard Proctor).
- Subgrade surface is free of rocks exceeding size limitations identified in Technical Specifications.
For facilities installing the sanitary landfill alternate liner specified under 9 VAC 20-81-130.J.1.b. (FML/GCL liner), the subgrade surface shall be rolled smooth and free of rocks or stones in excess of 0.75 inches prior to placement of the overlying GCL. Walking at least an approximate 10ft x 10ft area of the subgrade should be done to observe the surface conditions.
- Final subgrade surveyed for proper grade.
Proper grade is typically a minimum of 2% slope on the disposal unit floor and a maximum 33% slope on the side slopes. If a survey plat is available, slope is calculated by determining the ratio of the rise over run. The rise, or vertical distance, is the difference between the highest and lowest elevations or topographic contour lines and the run, or horizontal distance, is determined by measuring with a ruler the distance between the highest and lowest elevations or topographic contours and applying the map scale. Dividing the rise by the run and multiplying by 100% will result in the percent slope.
- Written acceptance of the subgrade has been provided.

3. **Test Pad Construction / Evaluation Inspection Items**

A test pad is required for facilities constructing a low permeability soil liner. The purpose of the test pad is to demonstrate the ability of the proposed soil to be used as liner material and establish the range of criteria that can be expected to achieve a low permeability soil liner meeting the requirements of the permit. If the test pad is being constructed and/or tested during the site inspection, the following inspection items are proposed:

- The number of test pads is adequate.

According to 9 VAC 20-81-130.Q.2.g.(1) at least one test pad is required for every source of low permeability soil. However, if borrow sources are consistent (i.e. similar USCS soil type, liquid and plastic limits, grain size distribution, moisture density relationship, and permeability characteristics) then only one test pad is need; otherwise one test pad is needed for EACH borrow source, subject to CQA personnel. In addition, if soils within a borrow source are non uniform, a test pad is needed for each soil type.

- Test pad size (area) and thickness is adequate.

The test pad area should match the Technical Specifications and CQA Plan, typically this is 33-50 ft in width by 50-100 ft in length. The test pad thickness should match the proposed liner system (i.e. 2 ft of compacted clay for Subtitle D liner, 9 VAC 20-81-130.J.1.a.).

- Samples of the constructed test pad are obtained and tested.

Per 9 VAC 20-81-130.Q.2.g.(1) the test pad's permeability shall be correlated with grain size analysis, liquid and plastic limits, moisture content, relative compaction, remolded permeability, undisturbed Shelby tube sample permeability, and in-situ permeability determined by field tests. Frequency of samples for testing should be in accordance with the CQA Plan and Technical Specifications. In addition, collected samples should be preserved according to appropriate ASTM requirements.

- Test pad is protected against elements during testing.

Protection typically involves the placement of a geosynthetic on the finished test pad. Spot check the test pad for desiccation cracks, rocks > 0.75 inches, and frozen ruts > 0.5 inches. Presence of these things can affect test pad results which will be relied on to establish criteria for installing the soil liner

B. Infiltration layer (Compacted Clay Liner, CCL, or Geosynthetic Clay Liner, GCL) placement and evaluation

1. Compacted Clay Liner (CCL)

a. Material Conformance: Soils

If not previously reviewed, ask to review any on-site records regarding the adequacy of the borrow source soils to be used as low permeability soil. If records are not available, discuss with CQA personnel the procedures taken to ensure the borrow source material is appropriate for use in constructing the CCL. See Section V.A. for additional information on material conformance.

- Certification of off-site material conformance is provided by the supplier.

Not all facilities have low permeability soil available on site. If low permeability soil is delivered from off site, the supplier (or contractor) will provide documentation (certifications and test results) that the material delivered meets project specifications. Conformance testing by the CQA Officer may also be performed.

b. *Bentonite Soil Amendments*

- Certification of bentonite conformance is provided by the supplier.

- Bentonite conformance testing by CQA personnel was performed as required by the CQA Plan and Technical Specifications.
EPA's Technical Guidance Document recommends performing conformance testing at a frequency of 1 per truckload or 2 per rail car and suggests testing bentonite for its liquid limit (ASTM D-4318), free swell, and grain size (ASTM D-422). Tests as noted in the facility's CQA Plan or Technical Specifications should be performed.

- Bentonite content of soil amendments was confirmed as required by the CQA Plan and Technical Specifications.
EPA's Technical Guidance Document recommends performing testing to verify the bentonite content. Testing may include the methylene blue test (Alther (1983); 1 per 1,000 m³); compaction curve (ASTM D-698 or D-1557; 1 per 5,000 m³); and hydraulic conductivity (ASTM D-5084; 1 per acre per lift). Tests as noted in the facility's CQA Plan or Technical Specifications should be performed.

c. *Installation: Placement of Loose Lifts & Compaction of Clay*

- CQA Personnel are on site during clay placement and/or testing.

- Loose lift thickness is monitored.
The CQA Plan and/or Technical Specifications will specify the thickness of loose lifts to be placed. Methods of monitoring thickness may include direct observation during placement (ruler), using grade stakes, or surveying using laser sources and receivers.

- Loose lift soil sampling is performed as required by the CQA Plan and Technical Specifications.
EPA's Technical Guidance Document recommends performing testing loose lifts soil (i.e. after placement but before compaction) for percent fines (ASTM D-1140), percent gravel (ASTM D-422), liquid and plastic limits (ASTM D-4318), percent bentonite (Alther 1983) at a frequency of 1 per 800 m³ (approx. 1,050 cy and compaction curve). Tests as noted in the facility's CQA Plan or Technical Specifications should be performed. In lieu of loose lift sampling, CQA personnel may perform all testing on soils at the borrow source.

- Equipment and use to compact liner is the same as used to construct test pad.
As discussed in Section V.A.3. above, the purpose of the test pad is to establish the range of criteria (compaction, moisture content, USCS classification, and grain size) that can be expected to achieve a low permeability soil liner. Equipment types and use can be correlated with resulting test pad soil test results.

- Surface of each lift is scarified prior to receiving next lift of soil.
Roughening the compacted soil surface prior to placing the next lift of soil will promote soil good contact between lifts and improve hydraulic conductivity. When soil is scarified it is usually roughened to a depth of about 1 inch.

- Samples of the constructed liner are obtained and tested.
Sampling and testing frequency as described in the CQA Plan and Technical Specs should be carried out. 9 VAC 20-81-130.Q.2.g.(2) indicates tests shall include compaction, moisture content, grain size, and the liquid and plastic limits of the soil; however, much of this sampling is performed on soil prior to compaction.

- One lab permeability test per acre per lift is performed on constructed liner.
9 VAC 20-81-130.Q.2.g.(2) requires performing a lab permeability at a frequency of one per acre; however, EPA's Technical Guidance Document recommends a frequency of 1 test per acre per lift. One per acre per lift is more appropriate since the specimen height for the permeability test is about three inches, so one per acre of the finished CCL would not be representative of the two-foot clay layer. Testing and results should be consistent with Test Pad results and recommended ranges.
- Shelby tube samples of nonconforming areas are obtained.
9 VAC 20-81-130.Q.2.g.(2) requires that nonconforming areas (those not meeting the range of criteria established by the test pad) shall be further tested by obtaining an undisturbed Shelby tube sample of the constructed liner and performing a lab permeability on it.
- Field logs are maintained by installer and/or CQA Officer.
- Holes from sampling are backfilled.
EPA's Technical Guidance Document recommends backfilling holes with bentonite or a bentonite-soil mix. Backfill should be placed in loose approx. 2-inch lifts and tamped with a steel rod or suitable devise, repeating until filled. Backfilling methods as noted in the facility's CQA Plan or Technical Specifications should be performed.
- Top of CCL surveyed for proper grade and thickness.
- Written acceptance of the CCL has been provided.

2. **Geosynthetic Clay Liner (GCL)**

If GCL is being placed and/or seamed during the site inspection, the following inspection items are proposed:

a. *Material Conformance & Storage*

- Rolls are stored on dry ground and roll wrappings are in-tact and labeled.
On-site storage areas should be secure; and rolls should be protected from UV light, heavy winds, precipitation, temperature extremes, and vandals. If bentonite and GCL rolls are stored outside they should be covered by plastic sheet/tarp.
- Appropriate material is being used.
Check roll labels to confirm material delivered and being installed meets requirements of the permit design.
- Manufacturer certification of GCL conformance is provided.
Manufacturer certifications of bentonite, geotextile or geomembrane, and GCL product along with manufacturer conformance testing results may not be on-site at the time of inspection.

b. *Installation: Placement, Seaming, and Repair*

- CQA Personnel are on site during GCL installation and/or testing.
- Subgrade is smooth and free of cracks, rocks, and deformations.
If GCL is being deployed directly over a soil subgrade or CCL, the surface of the soil layer should be rolled smooth and free of desiccation cracks, rocks > 0.75 inches, tire deformations > 1 inch, and frozen ruts > 0.5 inches.
- Anchor trenches are free of debris.

Anchor trenches should be free of rocks and debris (roots and organic matter), with smooth corners to avoid sharp bends in the FML.

- Subgrade accepted by GCL installer.
In this instance subgrade refers to the layer directly beneath the GCL. This may be a soil subgrade, CCL, FML, or geotextile.
- Deployment of GCL using spreader bar and core pipe, unrolled down slope.
The core pipe and spreader bar should not bend or flex excessively (> 3 inches per CETCO) when full roll is lifted. On side slopes, GCL should run perpendicular to the top of the slope. Slip sheets (smooth thin polyethylene or woven slit film geotextiles) can be used to assist with GCL deployment and prevent dislodging stones when sliding GCL into place for seaming.
- Panels are deployed with proper side up/down.
Check CQA Plan and Technical Specifications for details.
 - *If using a GCL where bentonite is adhered to a HDPE liner (e.g. Gundseal), in both bottom liner and final cover uses, the HDPE membrane faces up if a separate FML is not included in the liner system; otherwise, the HDPE membrane faces down.*
 - *If using a GCL where bentonite is sandwiched between two geotextiles (e.g. Bentofix or Bentomat), the woven geotextile should not face the FML.*
- Panels are overlapped minimum required distance.
Panel overlap should be as specified by manufacturer or CQA Plan/Technical Specifications. Typically side seams are overlapped a minimum of 6 inches and upwards of 12 inches. End of roll overlap is typically a minimum of 12 inches and upwards of 24 inches. Often the overlap distance will be marked on the GCL by the manufacturer.
- Overlapped panels are free of dirt and debris.
- Granular bentonite is added to overlapped panels.
The manufacturer or facility CQA Plan and Technical Specifications will denote whether the addition of granular bentonite is needed for panel and end-roll overlaps.
- Overlap shingling is in direction of leachate flow.
- Holes or tears are patched with additional piece of GCL and granular bentonite.
According to CETCO, patches should be cut to size such that a minimum overlap of 12 inches is achieved around all parts of the damaged area, with placement of granular bentonite prior to patch. Adhesives may be needed to keep the patch in place during cover placement.
- Areas of excessively hydrated GCL are marked for replacement.
Signs of excessive hydration include areas darkened by moisture and visible deformations, such as foot prints, resulting in bentonite displacement. Panels with excessive hydration should be cut out and replaced with new GCL.

c. *Protection*

- GCL is covered within 2 months of placement.
The FML/GCL alternate liner requirements indicate if the liner system is exposed prior to placement of protective cover for a period exceeding two months, the CQA report should discuss the adequacy of the GCL panel overlap. EPA guidance indicates GCL should be covered before rainfall or snowfall occurs, but not prior to approval by CQA personnel, and Koerner indicates that the upper geotextile of GCL

has 2-6 wk lifespan in VA sun.

- No equipment, other than ATVs, is used directly on top of GCL.
Standard practice is that no equipment other than ATVs should be allowed on geosynthetic liner components. The facility's specifications should dictate what equipment is allowed and if there are any operating restrictions regarding allowed equipment.
- GCL wrinkles or waves are worked out during next layer deployment.

C. Flexible membrane liner (barrier layer) placement, seaming, and testing

If flexible membrane liner (FML) is being placed, seamed, and/or tested during the site inspection, the following inspection items are proposed:

1. Material Conformance & Storage

- Rolls or pallets are stored on dry ground and roll/pallet wrappings are in-tact and labeled.
On-site storage areas should be secure; and rolls/pallets should be protected from UV light, heavy winds, precipitation, temperature extremes, and vandals. If the material is stored outside in excess of 6 months, they should be under a cover (i.e. covered trailer or shelter). CQA conformance sampling is recommended for all stored material.
- Appropriate material is being used.
Check roll or pallet labels to confirm material delivered and being installed meets requirements of the permit design (e.g. 40mil vs. 60 mil, HDPE vs. LLDPE vs. PVC, textured vs. smooth, etc.)
- Manufacturer certification of FML conformance is provided.
Manufacturer certifications of resin and FML product along with manufacturer conformance testing results may not be on-site at the time of inspection.
- FML rolls delivered using single-use slings/straps.

2. Installation: Placement of FML, Seaming, Testing, and Repairs

- CQA Personnel are on site during FML installation and/or testing.
- Subgrade is smooth and free of cracks, rocks, and deformations.
If FML is being deployed directly over a soil subgrade or CCL, the surface of the soil layer should be rolled smooth and free of desiccation cracks, rocks > 0.75 inches, tire deformations > 1 inch, and frozen ruts > 0.5 inches.
- Anchor trenches are free of debris.
Anchor trenches should be free of rocks and debris, with smooth corners to avoid sharp bends in the FML.
- Subgrade accepted by FML installer.
In this instance subgrade refers to the layer directly beneath the FML. This may be a soil subgrade, CCL, GCL, or geotextile.
- Deployment of FML using spreader bar, unrolled down slope.
On side slopes, FML should run perpendicular to the top of the slope. Slip sheets (smooth thin

polyethylene or woven slit film geotextiles) can be used to assist with FML deployment and prevent dislodging stones when sliding FML into place for seaming.

- Deployed panels are proper side up and labeled.
Panels are field numbered. Identification marks may include a panel number (P-88), FML roll number (131329), time, date, and length deployed. These panel numbers will match up with panel layout drawings prepared for the CQA Report.
- Trial seam log maintained by installer and/or CQA Officer.
All seaming should be performed within the specified atmospheric temperature range. If outside the range, trial seams should show adequate seam performance before seaming occurs on full panels.
- Panels are overlapped minimum required distance.
Panel overlap should be a minimum of 4 inches, or distance dictated by CQA Plan and/or Technical Specifications. Often the overlap distance will be marked on the FML by the manufacturer.
- Overlapped panels are clean prior to seaming.
Clean means free from dirt, dust, and moisture.
- Seaming method is appropriate.
*Extrusion weld: applicable for HDPE, LLDPE, and fPP only; typically it is used for detail and repair work.
Hot Wedge fusion weld: applicable for HDPE, LLDPE, fPP, PVC, and TPO only
Chemical Fusion: applicable to PVC only
Adhesive Tape: applicable to PVC and EPDM*
- Overlap shingling is in direction of leachate flow.
- Panels protected against wind uplift.
Typical measures to prevent against uplift due to wind are placing sandbags. Other methods are also acceptable. If panels are displaced by wind, panels should be inspected for damage and repaired or replaced as necessary.
- Nondestructive test (NDT) log maintained by installer and/or CQA Officer.
- Panel seam and patch NDT pass/fail marked on FML.
Test results are often marked directly on the FML surface next to the NDT start point. Markings are also made for NDT of FML patches. The marking should include test method (i.e. VT – vacuum test or AT – air test), tester's initials, start and end time of the NDT, start and end pressure of the NDT, and date.
- Destructive Test (DT) log maintained by installer and/or CQA Officer.
- Field tensometer peel and shear tests on DT samples are passing.
Observed destructive test samples show failure in the FML and not the seam.
- Repair and/or Patch log maintained by installer and/or CQA Officer.
- Patches are labeled with identifying marks.
Patch marks usually identify patch number, welder initials, date, time, and NDT testing on the patch

seam.

- Prior to seaming patch, textured FML extrusion weld seam area is ground down.
The width of the grinding should be less than the width of the extrusion weld.
- Geomembrane is covered within 3 months of CQA acceptance.
The three-month specification is provided for the FML/GCL alternate liner. 9 VAC 20-81-130.J.1.b.(4)(d) indicates the leachate collection system should be placed within 3 months of FML acceptance by the CQA engineer.
- No equipment, other than ATVs, is used directly on top of FML.
- FML wrinkles or waves are worked out during next layer deployment.
Note that FML naturally wrinkles in warmer weather. Deployed FML will look drastically different if inspected in the early morning versus the late afternoon due to temperature variances. The important takeaway is that wrinkles or waves are not entombed during backfill.

D. Leachate collection piping and drainage layer material evaluation and placement

- CQA Personnel are on site during drainage material placement and/or testing.

1. Soil or Granular Drainage / Protection Materials

- Appropriate material is being used.
Observe drainage material stockpiles. Drainage material most often consists of gravel, but sand, tire chips, or other materials may be approved in the permit. Often, these materials are not excavated from the borrow area, but instead are delivered from off-site.
- Material is free of oversized, angular debris and fine materials.
- Material sampling is performed as required by the CQA Plan and Technical Specifications.
Samples may be collected for testing material stockpiles and/or in place materials. Typical testing includes grain size analysis (ASTM D-422); hydraulic conductivity (ASTM D-2434, HC typically in the range of 1cm/sec to 1×10^{-3} cm/sec; permit will specify); and carbonate content (ASTM D-4373, shall be no greater than 15%).
- Thickness of drainage material placed is monitored.
The CQA Plan and/or Technical Specifications will specify the thickness of drainage material to be placed. Methods of monitoring thickness may include direct observation during placement (ruler), using grade stakes, or surveying using GPS or laser sources and receivers.
- For material backfill over geosynthetics, lift thickness between vehicles and geosynthetic material is adequate.
Drainage layers typically consist of 18 inches of material, but to prevent damage to the underlying geosynthetics, often an additional 18 inches of material is placed in areas where equipment will be used. CQA Plans and Technical Specifications should dictate the appropriate thickness of drainage material.
- Wrinkles or waves in underlying geosynthetics are worked out during backfill.

2. Geosynthetic Drainage / Protection Materials (Geotextiles, Geonets, and Geocomposites)

- Rolls are stored on dry ground and roll wrappings are in-tact and labeled.

On-site storage areas should be secure; and rolls should be protected from UV light, heavy winds, precipitation, temperature extremes, and vandals.

- Appropriate material is being used.
Check roll labels to confirm material delivered and being installed meets requirements of the permit design (e.g. thickness, woven vs. nonwoven, needle-punched, etc.)
- Manufacturer certification of material conformance is provided.
Manufacturer certifications of resin and product along with manufacturer conformance testing results may not be on-site at the time of inspection.
- Geonet / Geocomposite installed in direction of slope and in intended direction of flow
Geonet is installed down slope similar to GCL and FML. The orientation of the geonet is important as it will facilitate movement of leachate to the leachate collection system.
- Roll edges overlap minimum distance, joined by tying and/or seaming.
***Geotextile:** Seaming by overlap and sewing, or thermal bond; if sewing, seams should be continuous, oriented down slope, and use polymeric thread with chemical resistance equal to or exceeding the geotextile; if heat seaming, perform fusion welding techniques per the manufacturer.
Geonet: Minimum overlap distance is typically 6 inches. Overlapped edges are usually joined using cable ties spaced every 5 feet along the roll length.
Geocomposite: Adjacent edges of internal geonet placed with edges butted against each other, with overlaps joined with cable ties spaced every 5 feet along roll length. Top geotextile usually seamed*
- Roll end overlap shingling down slope, joined appropriately.
Adjoining rolls across the roll width should be shingled down in the direction of the slope and joined with cable ties spaced every foot along the roll width (for geonets) or sewn/heat seamed for (geotextiles). Both the geonet and upper geotextile of geocomposites are joined using appropriate methods.
- Panels secured in anchor trench, sandbags used if needed.
In the presence of wind, sand bags or equivalent should be used to protect against uplift. Sandbags shall remain in place until replaced with cover material.
- No equipment is used directly on the material.
Per CQA Plan and/or Technical Specification, fill material placed on top of the geosynthetic drainage material shall be placed and spread with appropriate equipment, maintaining minimum distance between the material and equipment to prevent damage to the geosynthetic.
- Damaged areas are patched.
***Geotextile:** Patches shall be secured to the original geotextile by sewing or approved seaming technique with appropriate overlap according to technical specifications. In some cases, replacement of the entire roll width may be necessary.
Geonet & Geocomposite: Patches shall be secured to the original geonet by tying every 6 inches with approved tying devices. If the area to be repaired is more than 50% of the panel width, the damaged area shall be replaced with new geonet.*
- Geosynthetic material is covered within timeframe specified by CQA Plan.
The CQA plan should specify max length of time geotextile and geocomposites can be exposed to the elements. Koerner recommends that under Virginia sun, geotextile should be covered within 3wks of placement, while GSE is more conservative and indicates material should be covered within 15 days.

3. *Leachate Collection / Detection Pipe*

The checklist items pertaining to leachate collection and detection piping should pertain to piping for collection of leachate in addition to piping for cleanouts, sideslope risers, and conveyance piping outside the disposal unit.

- Pipe type, size/thickness, and perforation match permit.
The pipe installed should match the material specified in the permit design and Technical Specifications. The pipe material should be of the same type (i.e. HDPE vs. PVC), and size/thickness with perforations (slots or holes in proper orientation) per design. Pipe shavings and debris should be removed from the pipe before it is covered.
- Manufacturer certification of pipe conformance is provided.
Manufacturer certifications of pipe conformance to ASTM standards or AASHTO specification along with manufacturer conformance testing results may not be on-site at the time of inspection.
- Pipes stored on dry, level ground.
EPA's guidance indicates that the location of field storage should not be in areas where water can accumulate. Pallets should be on level ground and oriented so as not to form a dam creating ponding and should not be stacked more than 3 high. Outdoor storage should not exceed 12 months; longer storage should be under cover
- Configuration of pipe, geosynthetic, and drainage material matches permitted design.
- Pipe penetrations constructed per design and technical specifications.
FML: The pipe boot skirt should have at least 12 inches of geomembrane on all sides of the pipe and seamed to the base geomembrane by extrusion fillet or chemical bonding (depending on FML type). NDT on seam should be completed.
CCL or GCL: Excess dry bentonite should be placed around the pipe per plans and specifications.

E. Final Construction Inspections & Approvals

1. *Certificate-to-Operate Inspection for New Cell Construction*

After construction is complete, the facility must notify the DEQ Regional Office and provide certifications from both a Design Engineer and CQA Officer in accordance with 9 VAC 20-81-490.A.1. and 9 VAC 20-81-130.Q.3., respectively. A CQA Report summarizing the construction and CQA activities and providing documentation supporting the CQA Officer certification accompanies these certifications. This documentation should be reviewed for completeness only (check for presence of the certifications, summary report, and referenced appendices). A spot-check of low permeability soil/drainage material sampling results may also be warranted in instances where test results of low permeability soil and/or drainage material were not available during field inspections. The purpose of the spot check is to ensure materials used were within the allowable ranges for soil classification, grain size, and hydraulic conductivity/permeability.

Once these documents are received, 9 VAC 20-81-490.A.2. directs DEQ staff to perform a site visit to confirm the site is ready to begin operation. During this site inspection, the assigned DEQ staff should fill out the CTO inspection checklist (see Attachment C), which confirms all requirements of Part III of the VSWMR applicable to new disposal unit construction are completed. This checklist should be completed and provided to the facility

as an attachment to the issued Certificate-to-Operate (see Attachment D). In instances where the review of the CQA documentation and/or site inspection reveals deficiencies, DEQ staff should provide written correspondence to the facility and CQA Officer identifying the deficiencies and requesting a course of action.

Tracking in CEDS

The receipt and review of CQA certifications and reports along with CTO issuance dates should be entered into CEDS for the permitted facility requesting operation of a new cell. The permit writer should enter the dates under the Waste Permits Screen, Events Tab.

Information about the CQA Review and CTO, to include designation of the phase/cell constructed and approved for use should be indicated in the comments field for the event code.

Events that should be tracked in CEDS include:

Event Code	Description
CQAINSSWP	Construction inspection (enter for each construction inspection)
CQARCV	CQA report received
CQARVW	CQA review
CQAREV	CQA revision received
CTOINS	CTO inspection conducted
CTOISS	CTO issued

2. *Finished Closure Construction Inspection and Closure Acknowledgement*

Once the closure cap has been installed and vegetation is established, the facility must notify the DEQ Regional Office and provide certification, signed by a professional engineer, verifying that closure has been completed in accordance with the closure plan. A CQA Report summarizing the construction and CQA activities and providing documentation to support the certification shall also be provided. Following closure of the final disposal unit, the above certification shall also include verification that closure has been completed in accordance with the requirements of 9 VAC 20-81-160.D.5.a. through 5.c. This documentation should be reviewed for completeness only (check for presence of the certifications, summary report, and referenced appendices). A spot-check of low permeability soil/drainage material sampling results may also be warranted in instances where test results of low permeability soil and/or drainage material were not available during field inspections. The purpose of the spot check is to ensure materials used were within the allowable ranges for soil classification, grain size, and hydraulic conductivity/permeability.

Once these documents are received, 9 VAC 20-81-160.D.6. directs DEQ staff to inspect the facility to confirm that the closing is complete and adequate. This includes determining that vegetation is established, landfill gas extraction wells are installed and operational, and ensuring that the closure measures of 9 VAC 20-81-160.D.5. have been carried out, if applicable. If closure is adequate, a letter acknowledging closure is adequate (see Attachment E) should be provided to the facility. In instances where the review of the CQA documentation and/or site inspection reveals deficiencies, DEQ staff should provide written correspondence to the facility and CQA Officer identifying the deficiencies and requesting a course of action.

Tracking in CEDS

The receipt and review of CQA certifications and reports along with closure dates should be entered into CEDS for the permitted facility certifying landfill closure. The permit writer should enter the dates under the Waste Permits Screen, Events Tab.

Information about the CQA Review and closure, to include designation of the phase/cell closed and approved for use should be indicated in the comments field for the event code.

Events that should be tracked in CEDS include:

Event Code	Description
CQAINSSWP	Construction inspection (enter for each construction inspection)
CQARCV	CQA report received
CQARVW	CQA review
CQAREV	CQA revision received
SWPCLOSED	SW Facility Date of Final Closure (date of P.E. certification for final area)
XACT	Acknowledgement sent (DEQ acknowledgement of closed area)

VI. Collaboration Process

No project team was formed to develop this guidance.

VII. Attachments

- A. Construction Oversight Checklist
- B. Responding to Identified Deficiencies Handout

VIII. Additional Reference Documents (Solid Waste Permit Writers Manual)

- A. CTO Inspection Checklist
- B. CTO Approval Letter
- C. Closure Acknowledgement Letter: Partial Closure or Full Closure

IX. References

CETCO, "Bentomat® Installation Guidelines: Geosynthetic Clay Liners," December 2010.

GSE, "Drop-in Specifications for Geocomposites," June 18, 2012.

GSE, "Drop-in Specifications for Geonets," May 23, 2011.

(<http://www.gseworld.com/content/documents/product-sheets/geonets-drop-in-specifications.pdf>)

GSE, "Drop-in Specifications for Nonwoven Geotextiles," June 18, 2012.

Koerner, Bob. Quality Control/Quality Assurance of Geosynthetics in Waste Containment Facilities. Powerpoint lecture presented at the DEQ-Central Office, Richmond, VA, May 2, 2012.

PVC Geomembrane Institute, "PVC Geomembrane Fabrication and Installation Specification," August 20, 2006.

(http://www.layfieldgeosynthetics.com/Content_Files/Files/FullSpecs/PGISpecification.pdf)

U.S. EPA, "Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182; U.S. EPA, Office of Research and Development; Washington DC 20460, 1993.

Virginia DEQ, Landfill Liner 101 [Recorded Webinar], (2012)
(Located on WPC Common Drive \ Training \ Landfill Liner 101)

ATTACHMENT B
**RESPONDING TO IDENTIFIED DEFICIENCIES NOTED ON THE
LANDFILL CONSTRUCTION INSPECTION CHECKLIST**

Today's inspection of your solid waste management facility construction project focused on construction and construction quality assurance practices. Items marked in the 'N' column on the checklist provided to you indicate potential deviations from the facility's permit or standard practice. These items identified may warrant further consideration by facility management and the Construction Quality Assurance (CQA) Officer or CQA consulting firm (see potential responses below). The items identified may necessitate changes to construction practices, **but do not require the facility to stop construction**. The Department has not made a case decision regarding compliance with the facility's permit and this checklist and noted deficiencies are not a case decision pursuant to the Virginia Administrative Process Virginia Code § 2.2-4000 *et. seq.*

As a result of this inspection, the following types of facility actions may be necessary:

- Lack of records: If documentation of CQA testing, material certifications, etc. are not available at the facility during the inspection, please ensure the appropriate documentation is provided with the CQA Report provided to the Department.
- CQA Plan / Technical Specification revisions:
 - If a new/revised CQA Plan or Technical Specifications were developed for the current construction project, provide the revised document(s) with the CQA Report outlining the construction project and request a minor permit modification to incorporate the revised plans and specifications.
 - If a new/revised CQA Plan or Technical Specifications haven't been developed, consult with your CQA Officer/consulting firm regarding the permitted plans and determine if revisions are necessary. Again, any revisions should be submitted with the CQA Report along with a request for a minor permit modification.
- Deviations from permitted design: If construction deviates from permitted design, whether to account for field conditions or otherwise, the Design Engineer and/or CQA Engineer should be consulted. Deviations and corrections should be addressed in the CQA Report. Deviations and reasoning should also be addressed in the Design Engineer's certification required by 9 VAC 20-81-490.A.1. to be provided with the CQA Report. Modifications to the facility's permit may also be necessary.
- Presence of deleterious material: If deleterious materials are observed in the subgrade, compacted clay liner, anchor trenches, or other liner layers, the facility may need to remove items and reconstruct. The facility should consult with the CQA Engineer to determine the extent of the repairs and document repairs in the CQA Report.
- Problems noted with geosynthetics and/or installation: If holes or seaming issues are identified, the facility should ensure that CQA personnel and contractors take steps necessary to patch holes or tears and correct any seaming problems. Patches should be documented on logs provided with the CQA Report.

If the problems identified on the checklist are not identified above, please consult with the Regional Office staff for appropriate actions. It is anticipated that most corrections can be identified in correspondence accompanying the CQA Report.