C.7. Landfills

Attachment C.7 Landfill

Landfill design, construction, operating and maintenance requirements can be found in Rule 619, 620, 621 and 622 of Michigan administrative rules promulgated pursuant to Part 111, 1994 P.A. 451, as amended. The attachments of Wayne Disposal Inc.'s (WDI) application was created in accordance with these requirements. This attachment is intended to reference the applicable attachments that demonstrate compliance with these requirements.

R 299.9619 Landfills. Rule 619.

(1) Owners or operators of facilities that use landfills to dispose of hazardous waste shall comply with the design and operating requirements of 40 C.F.R. part 264, subpart N, except 40 C.F.R. §264.301(f).

See Attachment B.6. Engineering Drawings, B.10 Construction Certifications, Attachment A.2 Chemical and Physical Waste Analysis Plan, Attachment A.5 Inspection Schedule, and A.11 Closure and Post Closure Care Plan.

(2) In addition to the liner system requirements of 40 C.F.R. §264.301, the owner or operator of a landfill shall design the liner system to meet the requirements of R 299.9620.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(3) All landfills shall contain a leak detection, collection, and removal system beneath the liner system that is designed, constructed, operated, and maintained pursuant to R 299.9622, unless the landfill is exempted pursuant to R 299.9622. 197

See Attachment B.6. Engineering Drawings and Attachment B.5. Environmental Monitoring: Leak Detection Sampling and Analysis Plan.

(4) In addition to the requirements of 40 C.F.R. §264.301(a), the leachate collection and removal system shall include all of the following:

(a) Not less than 30 centimeters of granular material that has a permeability of 1 x 10-2 cm/second or greater, as determined by ASTM standard no. D2434-68, or a layer of geosynthetic drainage materials with a transmissivity of 3 x 10-5 m2 /second or greater covered by a minimum of 30 centimeters of a protective layer of granular material with a permeability of 1 x 10-3 cm/second or greater, as determined by ASTM standard no. D2434-68.

(b) Either of the following:

(i) Provisions for discharging the leachate directly to a wastewater treatment unit.

(ii) Provisions for storing the quantity of leachate that is expected to be generated from all cells during a 24-hour, 100-year storm.

(c) Leachate sumps that have all of the following:

(i) A volume that can properly maintain a leachate head of no more than 30 centimeters (12 inches) on the liner.

(ii) A leachate removal system to remove liquid from the sump.

(iii) A device for continuously monitoring the quantity of leachate in the sump and removed from the landfill.

See Attachment B.6. Engineering Drawings, B.10 Construction Certifications and Attachment B.5. Environmental Monitoring: Leachate Collection and Removal System Sampling and Analysis Plan.

(5) The director may approve alternate design or operating practices to those specified in subrule (4) of this rule if the owner or operator demonstrates to the director that such design and operating practices, together with location characteristics, comply with both of the following requirements:

(a) The alternate design and operating practices shall prevent the migration of any hazardous constituent into the groundwater or surface water at least as effectively as the leachate collection and removal systems specified in subrule (4) of this rule.

(b) The alternate design and operating practices shall allow the detection of leaks of hazardous constituents through the top liner at least as effectively as the leachate collection and removal systems specified in subrule (4) of this rule.

Not Applicable

(6) In addition to the closure and postclosure care requirements of 40 C.F.R. §264.310, the owner or operator of a landfill shall do all of the following with respect to closure and postclosure care:

(a) Close the facility so that the final cover includes all of the following unless the owner or operator substitutes an equivalent design which shall include a flexible membrane liner component with a minimum thickness of 1 millimeter (40 mil), depending on the type of material selected, and demonstrates to the director that it provides equivalent environmental protection:

(i) Compacted clay which is in compliance with the requirements of R 299.9620(3) and which is not less than 90 centimeters thick.

(ii) A flexible membrane liner shall be placed directly over the compacted clay layer required pursuant to subdivision (i).

(iii) Not less than 60 centimeters of additional material, such as topsoil, subsurface drainage media, or cobbles to prevent animal burrowing. The additional material shall be applied in a manner that protects the clay and any synthetic component from the effects of temperature, erosion, and rooted vegetation. For temperature protection, the additional material thickness shall equal not less than 60 centimeters or the maximum depth of frost penetration, whichever is greater. In order to provide a minimum base for root penetration, the top component of the additional material shall consist of not less than 15 centimeters of topsoil. (iv) Slopes of the barrier layer, the drainage layer, and the top of the cover system shall not be less than 4% at any location.

(b) Establish shallow-rooted grasses at the earliest possible time and maintain the vegetation or use other erosion control measures so as to stabilize the cap and prevent erosion. Erosion shall be limited to not more than 2 tons per acre per year based on the universal soil loss equation.

(c) Establish a venting system to prevent the accumulations of gas. The venting system shall be installed in a manner that does not adversely affect the permeability of the cap and, if required pursuant to part 55 of the act, gas emissions shall be monitored, collected, and treated. The director shall exempt the owner or operator from this requirement if the owner or operator demonstrates that gas will not be generated in the landfill.

See Attachment B.6. Engineering Drawings and Attachment A.11 Closure and Post-closure Plan

(7) The director may approve alternative designs and maintenance practices to those specified in subrule (6) of this rule for beneficial uses of closed landfills if the owner or operator demonstrates to the

director that such designs and maintenance practices for the landfill cover system will provide equivalent environmental protection.

See Attachment B.6. Engineering Drawings and Attachment A.11 Closure and Post-closure Plan

R 299.9620 Liner requirements for landfills, surface impoundments, and waste piles.

Rule 620. (1) A liner system shall be located, designed, constructed, and operated so that there is no direct contact between the liners and groundwater in a saturated zone such that moisture content would adversely affect the structural and containment integrity of the liners.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(2) The primary liner for a landfill shall be a composite liner. The composite liner shall be designed to have a flexible membrane liner meeting the requirements of 40 C.F.R. 264, subpart N, directly over compacted clay which is a minimum of 150 centimeters thick and meets the requirements of subrule (3) of this rule.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(3) A compacted clay liner that is designed to meet the requirements of 40 C.F.R. §§264.221, 264.251, and 264.301, which are adopted by reference in R 299.11003, or R 299.9619 shall meet all of the following requirements for that clay liner:

(a) Comply with the criteria for a unified soil classification of CL or CH as determined by the provisions of ASTM standard D2487-11.

(b) Have more than 25% of the soil particles be less than 5 microns in size.

(c) Be placed in horizontal lifts of not more than 25 centimeters and be uniformly and thoroughly compacted to the standards approved in the design. The lift thickness shall not be more than 25 centimeters (six inches) after compaction. However, the material shall not be compacted to less than 90% of the maximum dry density, as determined by the modified proctor test described in the provisions of ASTM standard D1557-12, or 95% of the maximum dry density, as determined by the standard proctor test described in the provisions of ASTM standard D698-12, which are adopted by reference in R 299.11001, and the moisture content shall be within a range of -2% to +5% of the optimum moisture content.

(d) Have a maximum permeability coefficient of 1.0 x 10-7 cm/sec or less at all points.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(4) The waste pile or landfill base floor shall be graded to a minimum slope of 2% in directions perpendicular to the leachate collection pipes to promote drainage. The leachate pipes shall be laid on a slope of 1% or more in a direction to intercept liquid flow. The director may approve an alternate design to those specified in this subrule if the owner or operator demonstrates to the director that such design, together with location characteristics, complies with both of the following requirements:

(a) The alternate design will prevent the migration of any hazardous constituent into the groundwater or surface water at least as effectively the design requirements specified in this subrule.

(b) The alternate design will allow the detection of leaks of hazardous constituents through the top liner at least as effectively as the design requirements specified in this rule.

See Attachment B.6. Engineering Drawings, and B.10 Construction Certifications

(5) Liner systems and leachate collection systems shall be designed to prevent the damage of the materials of both systems in the event of differential settlement of the foundation under worst case

See Attachment B.6. Engineering Drawings, B.10 Construction Certifications and Attachment B.5. Environmental Monitoring: Leachate Collection and Removal System Sampling and Analysis Plan.

R 299.9621 Quality control for landfills, surface impoundments, and waste piles.

Rule 621. (1) Owners or operators of landfills, surface impoundments, and waste piles shall conduct a quality control program during construction which shall assure all of the following:

(a) That the natural clay base meets or exceeds the thickness and permeability requirements of R 299.9603(5), by doing either of the following:

(i) Obtaining soil borings and determining the natural moisture content as determined by ASTM standard D2216-10, grain size distribution (sieve and hydrometer) as determined by ASTM standards D6913-04 and D7928-16, classification by the unified soil classification system as determined by ASTM standard D2487-11, and Atterburg limits of the soil as determined by ASTM standard D4318-10 at varying depths every 100 feet, and the permeability of an undisturbed sample every 200 feet as determined by ASTM standard D5084-10.

(ii) Utilizing resistivity surveys to replace or supplement borings specified in paragraph (i) of this subdivision. Such resistivity surveys shall employ an electrode spacing to give an effective depth of penetration. A sufficient number of stations shall be used to insure that complete coverage to the edge of the waste management area is provided and correlation with borings or wells is obtained.

(b) That the natural clay base provides an adequate sub-base for overlying liners and leachate collection and removal systems, by evaluating the subgrade conditions for stability and correcting wet or unstable areas.

(c) That compacted clay liners meet or exceed the requirements of R 299.9620(2), by doing all of the following:

(i) Constructing the liner such that the bottom liner and the side wall liner (dike) will be continuous and completely keyed together at all construction joints.

(ii) During winter construction, removing all ice and snow before placing the liner and not using frozen soil in any part of liner.

(iii) Determining the field density-moisture of the liner material by utilizing the provisions of ASTM standard D6938-15 for each 1,000 cubic yards placed, with a minimum of 1 test per day of construction or layer of clay placed.

(iv) Determining the particle size distribution (sieve and hydrometer) according to ASTM standards D6913-04 and D7928-16, Atterburg limits according to ASTM standard D4318-10, and natural moisture content according to ASTM standard D2216-10 of random samples of liner material from each 5,000 cubic yards of material placed.

(v) Redetermining the density of liner materials by the modified proctor test, ASTM standard D1557-12, when the texture of the soil changes and every 5,000 cubic yards placed. (vi) Determining the permeability with water of a soil sample every 10,000 cubic yards placed by using ASTM standard D5084-10, which is adopted by reference in R 299.11001, or other method approved by the director on a sample that is not less than 2.8 inches in diameter.

(vii) Verifying liner thickness and subgrade slope by a final elevation check to ensure that all of the following requirements are met:

(A) The final elevation shall be within plus or minus 0.2 feet of the approved plans.

(B) The slope reduction of the subgrade shall not be greater than 10% of the approved slopes.

(C) The final clay liner thickness shall not be less than the approved thickness at any point. (d) That synthetic liners are properly installed, by doing all of the following:

(i) Properly preparing the foundation for the liner by doing all of the following:

(A) Compacting to the requirements of R 299.9620.

(B) Grading the foundation to a smooth and true line.

(C) Grading consistent with approved plans

(D) Grading the foundation to be free from stones or deleterious material.

(E) Removing any vegetation from the foundation before installation of the liner.

(ii) Insuring that field seaming is done under the direction of a registered professional engineer and when weather conditions are favorable for installation.

(iii) Insuring that field seams, joints, and mechanical seals are properly made by wiping contact surfaces clean of dirt, dust, moisture, or other foreign material, assuring that seaming is done in accordance with manufacturer specifications, and testing all field seams by nondestructive tests approved by the director. (iv) Recording the ambient temperature and liner temperature hourly during liner installation or field seaming.

(e) That leachate collection and leak detection, collection, and removal systems are installed such that the requirements of this rule are met, by doing both of the following:

(i) Making elevation checks at least every 200 feet to verify the appropriate thickness of granular material.

(ii) Sampling randomly at least every 5,000 cubic yards placed to verify the required aggregate classification.

(2) The quality control program required by subrule (1) of this rule shall be documented by written daily records of all work and tests performed during construction. All daily records shall be kept in the operating record for the facility and be made available for inspection by the director or his or her authorized representative.

(3) ASTM standards D2216-10, D2487-11, D1557-12, D2434-68, D4318-10, D5084-10, D6913-04, and D7928-16 are adopted by reference

See Wayne Disposal, Inc. Construction Quality Assurance Plan Master Cell VI (2021)

R 299.9622 Leak detection systems.

Rule 622. (1) Each new unit and lateral expansion or replacement of an existing unit at a landfill, surface impoundment, waste pile, or land treatment facility shall include a leak detection system capable of detecting, collecting, and removing leaks of hazardous constituents at the earliest practicable time.

(2) If contamination is detected in the leak detection system required by this rule, the owner or operator shall do all of the following:

(a) Immediately notify the director or his or her designee.

(b) Within 30 days, determine what failures have occurred in the liner system.

(c) If failures have occurred, do either of the following on a schedule which insures the protection of human health and the environment:

(i) Repair the failures in the liner system and obtain the certification of a registered professional engineer that, to the best of his or her knowledge and opinion, the failure has been corrected.

(ii) Cease placing waste in the failed unit and take action to prevent the migration of hazardous waste and hazardous waste constituents from the facility.

(3) The director shall grant an exemption from the requirements for a leak detection system if the owner or operator satisfies the waiver requirements for 2 liners and a leachate collection system between such liners established under the provisions of 40 C.F.R. part 264.301.

See Attachment B.6. Engineering Drawings, B.10 Construction Certifications and Attachment B.5. Environmental Monitoring: Leak Detection Sampling and Analysis Plan.

270.21 Specific part B information requirements for landfills

Except as otherwise provided in § 264.1, owners and operators of facilities that dispose of hazardous waste in landfills must provide the following additional information:

(a) A list of the hazardous wastes placed or to be placed in each landfill or landfill cell;
See Attachment A2.B.2 Chemical and Physical Waste Analysis Plan

(b) Detailed plans and an engineering report describing how the landfill is designed and is or will be constructed, operated, and maintained to meet the requirements of §§ 264.19, 264.301, 264.302, and 264.303 of this chapter, addressing the following items:

(1)(i) The liner system (except for an existing portion of a landfill), if the landfill must meet the requirements of § 264.301(a) of this chapter. If an exemption from the requirement for a liner is sought as provided by § 264.301(b) of this chapter, submit detailed plans, and engineering and hydrogeological reports, as appropriate, describing alternate designs and operating practices that will, in conjunction with location aspects, prevent the migration of any hazardous constituents into the ground water or surface water at any future time;

(ii) The double liner and leak (leachate) detection, collection, and removal system, if the landfill must meet the requirements of § 264.301(c) of this chapter. If an exemption from the requirements for double liners and a leak detection, collection, and removal system or alternative design is sought as provided by § 264.301(d), (e), or (f) of this chapter, submit appropriate information;

(iii) If the leak detection system is located in a saturated zone, submit detailed plans and an engineering report explaining the leak detection system design and operation, and the location of the saturated zone in relation to the leak detection system;

(iv) The construction quality assurance (CQA) plan if required under § 264.19 of this chapter;

(v) Proposed action leakage rate, with rationale, if required under § 264.302 of this chapter, and response action plan, if required under § 264.303 of this chapter;

See Attachment B.6. Engineering Drawings

(2) Control of run-on;

WDI maintains controls for a 25 year, 24 hour storm, per Stormwater Management Plan.

(3) Control of run-off;

WDI maintains controls for a 100 year, 24 hour storm, per Stormwater Management Plan.

(4) Management of collection and holding facilities associated with run-on and run-off control systems; and

See Storm Water Management Plan

(5) Control of wind dispersal of particulate matter, where applicable;

See Fugitive Dust Plan

(c) A description of how each landfill, including the double liner system, leachate collection and removal system, leak detection system, cover system, and appurtenances for control of run-on and run-off, will be inspected in order to meet the requirements of § 264.303(a), (b), and (c) of this chapter. This information must be included in the inspection plan submitted under § 270.14(b)(5);

See B5 Environmental Monitoring.

(d) A description of how each landfill, including the liner and cover systems, will be inspected in order to meet the requirements of § 264.303 (a) and (b). This information should be included in the inspection plan submitted under § 270.14(b)(5).

See Wayne Disposal, Inc. Construction Quality Assurance Plan Master Cell VI (2021)

(e) Detailed plans and an engineering report describing the final cover which will be applied to each landfill or landfill cell at closure in accordance with § 264.310(a), and a description of how each landfill will be maintained and monitored after closure in accordance with § 264.310(b). This information should be included in the closure and post-closure plans submitted under § 270.14(b)(13).

See Attachment A11 Closure Plan

(f) If ignitable or reactive wastes will be landfilled, an explanation of how the standards of § 264.312 will be complied with;

Not applicable. WDI does not accept waste that is ignitable or reactive until the waste is deactivated.

(g) If incompatible wastes, or incompatible wastes and materials will be landfilled, an explanation of how § 264.313 will be complied with;

Not applicable. WDI does not landfill incompatibles.

(h) If bulk or non-containerized liquid waste or wastes containing free liquids is to be landfilled prior to May 8, 1985, an explanation of how the requirements of § 264.314(a) will be complied with;

WDI does not bulk free liquids.

(i) If containers of hazardous waste are to be landfilled, an explanation of how the requirements of § 264.315 or § 264.316, as applicable, will be complied with.

Containers will be at least 90% full when placed in the landfill or crushed, shredded or similarly reduced in volume to the maximum practical extent before burial in the landfill.

(j) A waste management plan for EPA Hazardous Waste Nos. FO20, FO21, FO22, FO23, FO26, and FO27 describing how a landfill is or will be designed, constructed, operated, and maintained to meet the requirements of § 264.317. This submission must address the following items as specified in § 264.317:

(1) The volume, physical, and chemical characteristics of the wastes, including their potential to migrate through soil or to volatilize or escape into the atmosphere;

(2) The attenuative properties of underlying and surrounding soils or other materials;

(3) The mobilizing properties of other materials co-disposed with these wastes; and

(4) The effectiveness of additional treatment, design, or monitoring techniques.

Waste is placed directly in the active face of the landfill and immediately buried.

WAYNE DISPOSAL, INC.

CONSTRUCTION QUALITY ASSURANCE PLAN

MASTER CELL VI-E, VI-F, and VI-G

2021

Wayne Disposal, Inc.
49350 North I-94 Service Drive
Belleville, Michigan 48111

November 2021
Rev. 1

WAYNE DISPOSAL, INC.
CONSTRUCTION QUALITY ASSURANCE PLAN
MASTER CELL VI-E, VI-F, AND VI-G

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WAYNE DISPOSAL, INC.
CONSTRUCTION QUALITY ASSURANCE PLAN

This Construction Quality Assurance Plan (CQA Plan, Plan) has been prepared for Wayne Disposal, Inc. (WDI). WDI is a licensed Type I hazardous waste disposal facility located in Belleville, Michigan. This CQA Plan has been developed to ensure high quality installation and construction of various landfill components including the foundation liner and final cover systems at WDI. This Plan shall be implemented at the direction of WDI, under the direction of a CQA Officer designated by WDI, who is a registered professional engineer. This Plan addresses the following components:

- Foundation of Master Cell VI-F and Master Cell VI-G:
  - Structural fill including perimeter berms;
  - Attenuation layer;
  - Subgrade;
  - Geosynthetic clay liner;
  - Geomembrane;
  - Geogrid, Geonet, Geotextile, and Geocomposite;
  - Leak detection and leachate collection systems;
  - Granular soils and select aggregate, and
  - Piping.
- Final cover systems over Master Cell VI-E, VI-F, and VI-G.

1 RESPONSIBILITY AND AUTHORITY

This section contains a general description of the responsibility and authority of the parties involved in construction projects. All parties involved in construction projects at WDI shall comply with the responsibilities presented in this section.

1.1 Owner

Wayne Disposal, Inc. (WDI) is the Owner/Operator to whom all subcontractors are directly responsible. Referred to herein as WDI, WDI will employ all parties performing work described in this Plan.

1.2 Construction Contractor

The Construction Contractor may be one or several parties. The Owner may hire a General Contractor who shall assume responsibility for the entire construction project, including the hiring and managing of subcontractors. If the Owner does not hire a General Contractor to manage the project, construction projects shall, at a minimum, involve an Earthwork Contractor and a Geosynthetics Contractor.

The Earthwork Contractor is responsible for the proper construction of the earthwork-related portions of the liner and/or final cover system. These tasks could include site preparation, excavation, pre-processing of soil materials, backfilling, placement and compaction of soil components, grading the construction area, placement of granular materials, protection of the soil components during construction, stormwater management/dewatering and placement of vegetative cover.

The Geosynthetics Contractor is contracted directly by the Owner or Subcontracted to the General Contractor to install the specified geosynthetic materials. The Geosynthetics Contractor is responsible for supplying all labor and equipment needed to install the geosynthetic materials which meet the project standards as well as all geosynthetic materials not supplied by Others.

1.3 Design Engineer

The Design Engineer is responsible for the project design and shall prepare the project plans and drawings. The design shall meet the approved permit plans and Owner's operational and performance requirements for the landfill. Additionally, the Design Engineer is responsible for the review, generation, and approval of all design and/or specification modifications which apply to the design. The Design Engineer reports directly to the Owner.

1.4 Construction Quality Assurance Consultant

The Construction Quality Assurance (CQA) Consultant is responsible for the implementation of the CQA Plan for the construction project. The CQA Consultant shall be responsible for construction monitoring to observe compliance with the project plans, drawings, and the CQA Plan. The CQA Consultant shall observe and document the completion of each component of the project prior to the placement of subsequent components. Specific duties of the CQA Consultant include observation of construction materials, documentation of construction conditions, performance testing in accordance with project plans and the CQA Plan, documentation that construction is performed in substantial conformance with the approved project plans and drawings, preparation of as-constructed records, and preparation of a final construction documentation report detailing the observations and testing associated with the construction.

1.5 Construction Quality Assurance Officer

The CQA Officer shall be a Professional Engineer registered in the State of Michigan with experience in civil engineering and construction projects. The CQA Officer is typically an employee of the CQA Consultant. The CQA Officer is responsible for the overall coordination of documentation submitted in support of the CQA. Additionally, the CQA Officer is responsible for implementation of this CQA Plan and shall certify that the construction of project components is performed in substantial conformance with the project plans and drawings.

1.6 Surveyor

The Surveyor shall provide equipment and personnel needed to perform surveying activities as required by the construction project.

1.7 Testing Laboratory

The Testing Laboratory is responsible for providing soil and/or geosynthetic testing as required in the project plans and drawings.

2 DOCUMENTATION

The CQA Consultant shall prepare a daily written summary report for each day's construction and monitoring activities. The daily reports shall contain, at a minimum, the following information:

1. Date, project name, location, unit or area under construction, personnel involved in major activities, and other relevant identification information.
2. Name and title of the construction supervisor.
3. Description of weather conditions including maximum and minimum temperatures, and amount of precipitation, if any.
4. Time work starts and ends each construction day. Additionally, include any stoppages in work due to weather conditions or insufficient equipment or personnel.
5. Specific work units and locations of construction underway during that day.
6. Equipment and personnel being utilized in each work task, including subcontractors.
7. Identification of areas or units of work being inspected.
8. Chronological description of progress.
9. Description of off-site materials received, including any quality control data provided by the supplier.
10. Calibrations conducted for field test equipment.
11. Decisions made regarding approval of units of material or work, and/or corrective action, to be taken in areas that require rework.
12. Laboratory samples collected, identified, forwarded to the testing laboratory, and identity of the laboratory.
13. Results of monitoring activities and data, including material delivery report, geomembrane deployment, trial weld information, geomembrane seaming and repair

records, non-destructive seam testing, destructive sample records, soil placement, test pad information, and soil samples/tests taken. This data shall be maintained on appropriate forms and shall be cross-referenced, as necessary.

2.1 Report Forms and Record Keeping Documents

The CQA Consultant is responsible for preparing all field report forms, checklists, and data sheets to substantiate that the required construction monitoring tasks have been implemented. Typically, these report forms and checklists shall include: Daily Field Report, Design and/or Specification Modification/Clarification Form, and Photographic Records.

2.2 Identification and Resolution of Construction Challenges

A challenge is defined as material or workmanship that does not meet the requirements of the project plans or the CQA Plan, or any obvious defect in material or workmanship, even if there is conformance with the above referenced plans.

At a minimum, identification and resolution shall be documented in written communication with the Owner and shall include:

1. A description of the problem or deficiency
2. A discussion of the probable cause of the problem or deficiency.
3. Reference to any test results or retests performed.
4. Detailed description of measures implemented to resolve the problem and prevent recurrence.

2.3 Final Construction Report

Upon completion of the construction project, the CQA Consultant shall prepare a final construction report for the Owner. At a minimum, the final construction report shall contain the following information:

1. A description of the construction project and activities.
2. Project parties.
3. Project submittals.
4. As-constructed report to document elevations and locations of the construction project. Record drawings shall indicate the following information: (1) dimensions and elevations of each landfill cell; (2) the location and elevation of sumps and leachate collection pipelines; and (3) the surface elevation of the final cover system. Tolerance requirements for the surveyed components are listed in the respective Sections of this Plan.
5. Field test data summaries including sample numbers, test locations, lift, and pass/fail status for each test.
6. Laboratory samples collected and test results reported by the laboratory.
7. Diagrams which indicate location of tests, as necessary.
8. Geomembrane drawings that show the location of destructive tests, repairs, and panel layouts.
9. Summary of construction problems/deficiencies that were identified and resolutions of the problems/deficiencies, as necessary.
10. Documentation that all applicable project plans, drawings, and the CQA Plan were met.
11. A certification by the CQA Officer that the construction meets the requirements of the applicable Rules, permits, and plans.

3 PROJECT MEETINGS

3.1 Preconstruction Meeting

After the Owner selects the contractor(s) for the construction project, and prior to initiation of any construction activities, a Preconstruction Meeting may be conducted to review the scope of the project. The meeting may be attended by all parties involved. The CQA Consultant shall document the Preconstruction Meeting discussions which may include the following topics:

1. Roles and responsibilities of all parties as defined in the project plans, and CQA Plan.
2. Lines of communication and authority.
3. Testing frequency and procedures.
4. Procedures for documentation and report submittals.
5. Coordination of work effort.
6. Project schedule.
7. On-site safety.
9. Soil requirements and specifications.
10. Geosynthetic requirements and specifications.
11. Equipment and usage.
12. Procedures for final acceptance of work.

3.2 Weekly Progress Meetings

Routine weekly progress meetings may be held and attended by the Owner, the Contractor(s), the CQA Consultant, and the CQA Officer, as appropriate to agenda topics for each meeting. Additionally, the attendance of subcontractor(s), supplier(s), or the Surveyor may be necessary. The weekly meetings may be held to review the construction progress of the previous week, the status of the project schedule, construction challenges

and resolutions, and the proposed construction schedule for the next week. The weekly progress meeting will be documented by the CQA Consultant.

3.3 Challenge Resolution Meeting

A challenge resolution meeting between appropriate parties may be held as necessary to review any construction issue that has been identified. The intent of the meeting is to identify, isolate, and resolve the challenge to meet the specifications of the project. This meeting shall be documented by the CQA Consultant.

4 FOUNDATION FOR MASTER CELL VI-F AND VI-G

The foundation for Master Cell VI-F shall be formed on native ground and on the closed Master Cell IV. The foundation for Master Cell VI-G shall be formed on native ground and on the closed Master Cell I. Where the foundation is formed over native ground, vegetation and topsoil shall be stripped and the underlying soils excavated to meet design specifications. Where the foundation is formed over closed cells, vegetation and topsoil shall be stripped from the existing cover and the foundation shall be regraded prior to placing components of the new cell.

4.1 Inspection of Foundation Surface

The foundation surface for placement of new cell components will be visually inspected by the CQA Consultant to locate unacceptable foundation conditions. Unacceptable foundation surface conditions include but are not limited to moisture seeps and soft spots identified during proof rolling of the subgrade. Where unacceptable foundation surface conditions exist, the surface shall be re-compacted or over-excavated. When the foundation is over-excavated, the resulting excavation may be backfilled with structural fill if the excavation is in existing clay materials or may be backfilled with existing waste if the excavation is in the existing underlying waste mass. Requirements for waste fill will be specified on the project Plans and drawings.

5 STRUCTURAL FILL

Structural fill consists of granular and/or cohesive soils used to construct the perimeter berm, cell floor, and other earthwork. The soil used in the construction of structural fill shall be relatively free of organic material, debris, or other deleterious material such that none of these deleterious materials are visible in the completed layer and do not penetrate the overlying layers. Material used as structural fill must meet the requirements of the project plans and drawings.

5.1 Pre-Construction Testing

For every structural fill material type, source, or when visual observations indicate that a change has occurred in the soils, obtain a soil sample and perform the following tests. These tests must be performed and acceptable results obtained prior to construction.

The CQA Consultant shall perform the following:

1. Index Testing
    - Natural Moisture Content according to ASTM D2216. One test per 5,000 cubic yards of material.
    - Grain Size according to ASTM D6913. One test per 5,000 cubic yards of material.
    - Atterberg Limits according to ASTM D4318. One test per 5,000 cubic yards of cohesive soil material.
    - Unified Soil Classification according to ASTM D2487. One test per 5,000 cubic yards of material.
2. Compaction Testing
    - Modified Proctor Compaction Test according to ASTM D1557. One test per 5,000 cubic yards of material.

3. Strength Testing

Reconstituted test specimens shall be prepared according to the results of the compaction test(s). Initial specimens shall be prepared at 90% of maximum dry unit weight and optimum moisture content according to the results of the ASTM D1557 compaction test(s). Subsequent test specimens may be prepared at different moisture contents to establish the maximum acceptable value for compaction. The laboratory may consider preparing a range of different moisture contents (such as +0, +4, +6% of ASTM D1557 optimum moisture content) for this purpose so that the resulting strength-based compaction criteria are comprehensive. Subsequent test specimens may also be prepared to greater unit weights as needed to achieve the minimum required strength. Reconstituted test specimens shall be subject to one of the following tests, depending on the character of the sample:

- One test per 10,000 cubic yards of material.
- Unconfined Compressive Strength (for samples exhibiting cohesive or cementing behavior only) according to ASTM D2166. A minimum passing result is 3,000 pounds per square foot (psf). If the strength tests fail to meet the minimum required strength, the samples shall be reconstituted to a higher density and retested. Three reconstituted specimens prepared and unconfined compressive strength measured shall constitute one test. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place dry unit weight.
- As an alternative to the unconfined compressive strength test for samples exhibiting cohesive or cementing behavior, vane shear testing may be used according to ASTM D2573. A minimum passing result is 1,500 pounds per square foot. If the strength tests fail to meet the minimum required values, the samples shall be reconstituted to a higher density and retested. Three reconstituted specimens prepared and vane shear tests measured shall constitute one test. The

moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place dry unit weight.

- Direct Shear Strength (for samples exhibiting non-cohesive behavior) according to ASTM D3080. Normal stresses of 2, 10, and 20 pounds per square inch (psi) shall be applied. A minimum passing result of 32 degrees peak friction angle is required. If the strength tests fail to meet the minimum required strength, the samples shall be reconstituted to a higher density and retested. Alternatively, the project-specific soil strength parameters may be evaluated by a qualified geotechnical engineer with respect to the specific berm geometry and anticipated loadings. If this evaluation meets the slope stability criteria from the design slope stability analyses, the test results may be accepted by the CQA Officer. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place unit weight. For granular soils, preconstruction strength testing frequencies may be reduced if the CQA Officer determines that 1) the initial three strength tests show consistent results, 2) the resulting strength parameters exceed minimum requirements, 3) the source material exhibits consistent gradation (+/- 10% passing each sieve by weight) as determined by ASTM D6913, and 4) the strength parameters are insensitive to dry unit weight.

5.2 Testing During Construction

CQA Consultant

During construction, the CQA Consultant will monitor and document the placement and compaction of the soils used for structural fill. The CQA Consultant will determine the in-place moisture content and dry unit weight of the structural fill material following ASTM D6938, latest edition. In-place tests will be performed at a minimum frequency of

one test for each 1,000 cubic yards placed, with a minimum of one test per day of construction or per lift of clay placed to verify compliance with the requirements of Items 1 and 2 below, unless otherwise indicated in the project plans.

1. Verify that structural fill is compacted to at least the minimum acceptable in-place density determined from the strength testing as described above, unless otherwise indicated in the project plans.

2. Verify that the in-place moisture content is between -4 and +0 percentage points of the maximum acceptable in-place moisture content determined from the strength testing as described above, unless otherwise indicated in the project plans.

3. Perform photographic documentation of construction to confirm conformance to project requirements.

Earthwork Contractor

The Earthwork Contractor will perform all the following during construction of structural fill:

1. Place and compact each lift with a general thickness of 9-inches after compaction for cohesive soils and 12-inches after compaction for granular soils, unless otherwise indicated in the project plans. In cases where the first lift of soil material is placed over geosynthetics, it will be placed at a minimum thickness of 18 inches after compaction, unless otherwise indicated in the project plans.

2. Compact each soil lift thoroughly and uniformly to the required density.

3. Protect the structural fill from detrimental climatic effects during construction. Remove all ice, snow, and frozen soil during cold weather construction prior to placing a lift and do not use any frozen soil in any part of the structural fill.

4. Remove observed roots, rocks, rubbish, or soils that do not meet the specifications of the project plans and drawings.

6 ATTENUATION LAYER

Attenuation layer material consists of cohesive materials which are used for the purpose of the attenuation layer. The soil used in the construction of the attenuation layer shall be relatively free of organic material, debris, or other deleterious material such that none of these deleterious materials are visible in the completed layer and do not penetrate the overlying layers. Material used as attenuation layer will meet the classification requirements of SC, CH, CL, CL/ML, or ML per the Unified Soil Classification System, ASTM D2487. Modified proctor moisture-density correlation (ASTM D1557) will also be tested to determine the maximum dry density of the soil.

6.1 Pre-Construction Testing

For every attenuation layer material type, source, or when visual observations indicate that a change has occurred in the soils, a soil sample will be collected, tested and acceptable results obtained prior to utilizing soil in construction.

The CQA Consultant shall perform the following tests:

1. Index Testing

    - Natural Moisture Content according to ASTM D2216. One test per 5,000 cubic yards of material.

    - Grain Size according to ASTM D6913. One test per 5,000 cubic yards of material.

    - Atterberg Limits according to ASTM D4318. One test per 5,000 cubic yards of material.

    - Unified Soil Classification according to ASTM D2487. One test per 5,000 cubic yards of material.

2. Compaction Testing

    - Modified Proctor Compaction Test according to ASTM D1557. One test per 5,000 cubic yards of material.

3. Strength Testing

    Reconstituted test specimens shall be prepared according to the results of the compaction test(s). Initial specimens shall be prepared at 90% of maximum dry unit weight and optimum moisture content according to the results of the ASTM D1557 compaction test(s). Subsequent test specimens may be prepared at different moisture contents to establish the maximum acceptable value for compaction. The laboratory may consider preparing a range of different moisture contents (such as +0, +4, +6% of ASTM D1557 optimum moisture content) for this purpose so that the resulting strength-based compaction criteria are comprehensive. Subsequent test specimens may also be prepared to greater unit weights as needed to achieve the minimum required strength. Reconstituted test specimens shall be subject to one of the following tests, depending on the character of the sample:

    - One test per 10,000 cubic yards of material.
    - Unconfined Compressive Strength (for samples exhibiting cohesive or cementing behavior only) according to ASTM D2166. A minimum passing result is 3,000 pounds per square foot (psf). If the strength tests fail to meet the minimum required strength, the samples shall be reconstituted to a higher density and retested. Three reconstituted specimens prepared and unconfined compressive strength measured shall constitute one test. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place dry unit weight.
    - As an alternative to the unconfined compressive strength test for samples exhibiting cohesive or cementing behavior, vane shear testing may be used

according to ASTM D2573. A minimum passing result is 1,500 pounds per square foot. If the strength tests fail to meet the minimum required values, the samples shall be reconstituted to a higher density and retested. Three reconstituted specimens prepared and vane shear tests measured shall constitute one test. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place dry unit weight.

- Direct Shear Strength (for samples exhibiting non-cohesive behavior) according to ASTM D3080. Normal stresses of 2, 10, and 20 psi shall be applied. A minimum passing result of 32 degrees peak friction angle is required. If the strength tests fail to meet the minimum required strength, the samples shall be reconstituted to a higher density and retested. The moisture content at which the sample is tested and passes shall be recorded as the maximum acceptable in-place moisture content. The dry unit weight at which the sample is tested and passes shall be recorded as the minimum acceptable in-place unit weight.

6.2 Testing During Construction

CQA Consultant

During construction, the CQA Consultant will monitor and document the placement and compaction of the soils used for attenuation layer. The CQA Consultant will determine the in-place moisture content and dry unit weight of the attenuation layer material following ASTM D6938, latest edition. In-place tests will be performed at a minimum frequency of one test for each 1,000 cubic yards placed, with a minimum of one test per day of construction or per lift of clay placed to verify compliance with the requirements of Items 1 and 2 below, unless otherwise indicated in the project plans.

1. Verify that attenuation layer is compacted to at least the minimum acceptable in-place density determined from the strength testing as described above, unless otherwise indicated in the project plans.

2. Verify that the in-place moisture content is between -4 and +0 percentage points of the maximum acceptable in-place moisture content determined from the strength testing as described above, unless otherwise indicated in the project plans.

3. Perform photographic documentation of construction to confirm conformance to project requirements.

Earthwork Contractor

The Earthwork Contractor will perform all the following during construction of the attenuation layer:

1. Place and compact each lift, except the first lift of material over geosynthetics, with a general thickness of 6-inches after compaction. The first lift of soil material over geosynthetics will be placed at a minimum thickness of 12-inches after compaction, compacted with a Caterpillar D6 dozer or equivalent to achieve compaction specifications, unless otherwise indicated in the project plans. All required in-place density testing must meet specifications prior to placement of subsequent lifts.

2. Compact each soil lift thoroughly and uniformly to the required density.

3. Protect the attenuation layer material from detrimental climatic effects during construction by doing all the following:

    - Remove all ice, snow, and frozen soil during cold weather construction prior to placing a lift and do not use any frozen soil in any part of the attenuation layer;

- Recompact any soil lift of which its integrity is so adversely affected by weather that it no longer meets the requirements of the CQA Plan or project plans, at the discretion of the Owner and CQA Officer;

- Provide cover to prevent frost penetration during and following placement during winter construction; and

4. Remove observed roots, rocks, rubbish, or soils that do not meet the specifications of the project plans and drawings.

7 SUBGRADE PREPARATION

Surveyor

Prior to installation of geosynthetic material, the Surveyor shall establish a 100-foot survey grid system and survey locations along the cell perimeter to verify proper line and grade in accordance with the drawings. The grade tolerance for the landfill cell subgrade shall be 0.0 to -0.1 feet for the bottom of the structural fill layer and top of the secondary liner grades and 0.0 to +0.1 for the top of the attenuation layer. The final thickness of structural fill and attenuation layers shall not be less than the design thickness at any point.

CQA Consultant

During preparation of the subgrade for the Geosynthetic Clay Liner (GCL) and/or other geosynthetic installation, the CQA Consultant shall verify that:

1. The Surveyor has documented that the subgrade is properly prepared for the installation of geosynthetic materials and complies with the following:
    - The underlying soil has been smooth drum rolled, adequately compacted or hand-worked and is free of irregularities, protrusions, loose soil and abrupt changes in grade.
    - The surface is free of roots, standing water, stones or desiccation cracks which would adversely affect the performance of the soil.
    - Elevations of the subgrade are verified before geosynthetics installation and are within the tolerance specified.
2. Areas that do not meet the requirements of the CQA Plan are properly repaired and documented.

Earthwork Contractor

The Earthwork Contractor shall perform the following during the preparation of subgrade for geosynthetics installation:

1. Prepare the soil to a smooth surface, using a smooth drum roller or other suitable equipment, to grades which meet the project plans and grade tolerances.
2. Remove debris, organic materials, roots, any angular or sharp rocks or other material which may damage the geosynthetics. All protrusions (stone, etc.) greater than 1-inch in size, or more angular than "sub-rounded" in shape will be removed and the remaining cavity will be backfilled with clay.
3. Repair any surface which exhibits significant desiccation cracking as directed by the CQA Consultant. All backfill soils used for repair shall meet the applicable requirements of the CQA Plan.
4. Protect the prepared surface from damage from desiccation, flooding, and freezing.

Geosynthetics Contractor/Installer

The Geosynthetics Contractor/Installer shall perform the following during the preparation of the subgrade for geosynthetics installation:

1. Inspect the subgrade surface.
2. Accept, with the Geosynthetic Installer's signature on a Subgrade Acceptance Certification form, that the soil surface is acceptable for geosynthetics installation prior to deployment of the geosynthetic material.

8 GEOSYNTHETIC CLAY LINER

Geosynthetic Clay Liners (GCLs) consist of low hydraulic conductivity montmorillonite-rich expansive clay (bentonite) core, supported by geotextile and/or geomembranes which are held together by needling, stitching or chemical adhesives.

8.1 Materials

The GCL Manufacturer shall submit copies of the GCL roll Quality Control (QC) Certificates to the CQA Consultant for review and approval. These certificates shall be supplied at the minimum frequency as detailed in the Standard Practice for Quality Control of Geosynthetic Clay Liners (ASTM D5889). The results reported on the GCL roll QC Certificates shall, at a minimum, meet the property values detailed in the project plans.

The GCL Manufacturer shall submit representative samples taken from the proposed product for direct shear interface testing as required by the drawings. The CQA Consultant shall manage the direct shear testing of the GCL samples, as needed, per the direction of the Design Engineer and in accordance with the design requirements of the project. Proposed GCL rolls shall not be accepted for installation until the manufacturer provides GCL samples representative of the rolls proposed for installation with test results satisfactory to the Design Engineer according to the design requirements. The Design Engineer and the CQA Consultant shall reject any proposed GCL rolls and/or products that do not demonstrate the design requirements when subjected to direct shear interface testing.

8.2 Geosynthetic Contractor Submittals

When providing materials, the Geosynthetic Contractor will submit a schedule of GCL delivery and installation to the Owner prior to the start of the GCL installation.

The CQA Consultant shall verify that all submittals required of the Geosynthetic Contractor have been received and meet the requirements of the CQA Plan. The schedule

and any drawings submitted by the Geosynthetic Contractor, once approved by the CQA Consultant, shall be the basis of GCL deployment.

8.3 GCL Delivery and Storage

Geosynthetic Contractor

The Geosynthetic Contractor shall perform the following:

1. Prepare the GCL roll storage area to protect the GCL from dirt, mud, dust, moisture, and damage prior to deployment (i.e. a well-drained area protected from the elements and high traffic areas.) The GCL rolls shall be protected against adverse weather and other hazards. The rolls should be stored per the GCL Manufacturer's recommendations and to allow access for roll identification. The integrity and legibility of roll labels must be maintained during storage. The rolls must be protected from the elements by the application and maintenance of a proper cover.
2. Be responsible for off-loading the GCL rolls when delivered to the Site.
3. Instruct all personnel of the proper handling techniques so as not to damage the GCL rolls. Lifting of rolls shall be performed so as not to cause damage to the GCL or the protective covering.
4. Assure that the GCL rolls are packaged, shipped, and stored on-site in such a manner that the GCL rolls are not subjected to damage or moisture.
5. Identify and separate all damaged rolls from undamaged rolls and store these rolls at a location designated by the Owner until disposition of the damaged roll(s) is determined.

CQA Consultant

The CQA Consultant shall perform the following:

1. Inspect the GCL roll storage area to verify compliance with the CQA Plan.
2. Visually inspect the surface of all GCL rolls for visible defects and/or damage.

3. Compare the roll number against the GCL Manufacturer's QC Certifications for compliance with the project plans and the CQA Plan. Any damage detected shall be documented and the Geosynthetic Contractor shall be notified.

8.4 GCL Installation

The GCL can be deployed on the soil subgrade which has been inspected and accepted by the CQA Consultant and the Geosynthetic Contractor.

8.4.1 Weather Conditions

The Geosynthetic Contractor shall not deploy the GCL material during precipitation events or on areas with frost or precipitation accumulation. The GCL material shall not be deployed on softened or unstable subgrade.

8.4.2 Placement

GCL panels shall be placed in a controlled manner to prevent damage to the GCL materials or other in-place material. Any such damage shall be repaired by the Geosynthetic Contractor.

Personnel working on the GCL shall not smoke, wear damaging shoes, or engage in other activities which could damage the material. Wheeled vehicle traffic on the GCL panels is prohibited. Permission to drive other equipment on the GCL will only be granted in writing by the manufacturer on a case-by-case basis as outlined in the Manufacturer's installation guidelines. Foot traffic on the GCL panels shall be minimized. The Geosynthetic Contractor shall provide protection of the GCL from equipment or concentrated personnel traffic associated with the project.

GCL panels shall be deployed in such a manner as to minimize seams, be in contact with the material directly beneath it, and preclude folds or wrinkles which may become folds, and bridging. Any wrinkle, fold, or bridging that is observed shall be removed through

realignment of the GCL panel or cutting and repairing the panel in accordance with the CQA Plan.

Each adjoining GCL panel shall be overlapped a minimum of 6-inches on each side and a minimum end-to-end overlap of 12- inches or greater if required by the Manufacturer's installation recommendations. The minimum overlap shall be indicated by a line, or series of lines spaced no more than 50-feet on the exposed surface of the GCL panel. The overlap area shall be free of dirt, gravel, and debris. The overlap shall be shingled following the presumed flow direction. The overlap shall be maintained to prevent seam openings during the installation and covering process. The Geosynthetic Contractor is responsible for assuring that the GCL panels remain overlapped throughout the installation process and until the overlying material is placed. Bentonite clay powder, or other approved supplement, shall be applied between the GCL layers in the overlap area as required by the GCL Manufacturer's specifications and the Geosynthetic Contractor's Installation QC Procedures.

Overlapping seams of adjacent GCL panels will be offset between layers of GCL to ensure that each overlap seam in the upper GCL does not vertically coincide with the overlap seam in the lower GCL (see figure below).

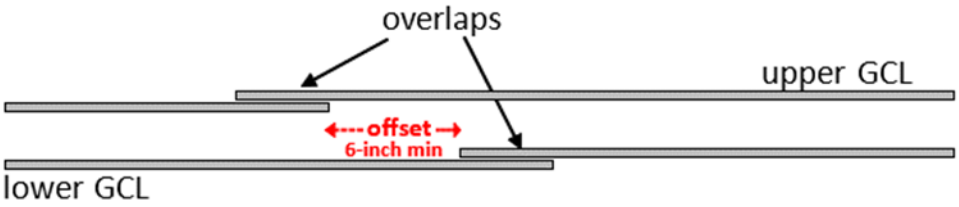

Figure 1. Offset of Overlap Seams between Upper and Lower GCL

Horizontal GCL seams on sideslopes greater than 5 percent shall be minimized. If horizontal seams are required due to the length of the sideslope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered

by a minimum distance of 25-feet. Panels shall be placed such that the up-slope panels overlie those down-slope.

Placement of the GCL shall be in such a manner as to reduce the risk of water infiltration into the bentonite clay portion of the GCL. The GCL shall be covered with geomembrane and/or soil materials as required by the project design, as soon as practical, to provide maximum protection against the elements. The Geosynthetic Contractor shall direct stormwater drainage away from the GCL by construction of temporary stormwater diversion berms or other similar structures.

The Geosynthetic Contractor shall not install more GCL panels than can reasonably be covered with geomembrane that same day. The Geosynthetic Contractor shall also limit the installation of GCL panels during periods of impending bad weather such that the amount of uncovered GCL panels is minimized.

Premature hydration of the GCL prior to completion of the project may be cause for removal of the hydrated material, as directed by the CQA Officer.

If the bentonite clay portion of the GCL becomes prematurely hydrated, the CQA Officer shall inspect the material to ensure the integrity of the GCL has not been compromised. The CQA Officer shall inspect the material to ensure that significant thinning of the GCL has not occurred, that the reinforcing geotextile fibers have not been broken causing the internal strength of the GCL to be reduced, or that other properties of the GCL have not been detrimentally affected. The CQA Officer shall also consult with the Design Engineer to ensure that the stability of the liner has not be affected. If the CQA Officer finds that the integrity and or stability of the GCL has been compromised, the Geosynthetic Contractor shall either install new GCL over the compromised GCL or replace the compromised GCL, as directed by the CQA Officer after consultation with the Design Engineer.

The Geosynthetic Contractor shall clean the work area daily by removing scrap material and other debris associated with geosynthetic activities and dispose of scrap material properly.

The CQA Consultant shall observe and document the GCL deployment to verify that all provisions of the CQA Plan have been followed.

8.4.3 Temporary Anchoring

The Geosynthetic Contractor is responsible for the temporary anchoring of the GCL during construction. The Geosynthetic Contractor shall use sandbags or other means necessary to restrain the GCL without damage and to prevent the material from being pulled from proper alignment. Areas of damage caused by improper or insufficient temporary anchoring shall, as determined by the CQA Consultant and required by the Owner, be repaired or removed, disposed, and replaced by the Geosynthetic Contractor.

8.4.4 Permanent Anchoring

The Earthwork Contractor is responsible for the permanent anchoring of the GCL material. Permanent anchorage shall comply with the project plans and shall be installed as soon as practical following installation of the GCL material and the installation of the overlying materials.

8.4.5 Repairs

Holes, tears, or damage to the GCL material shall be repaired by placing a patch extending a minimum of 1-foot in all directions beyond the edges of the defect. Bentonite clay powder or other approved supplement shall be applied between the GCL panel and the patch as required by the GCL Manufacturer's installation recommendations and the Geosynthetic Contractor's Installation QC Procedures.

GCL panels with holes or tears extending more than 25 percent across the panel width shall be removed and replaced or covered by a single patch. GCL panels, or portions of

panels, which contain excessive patching, as determined by the Owner, shall be removed and replaced or repaired with a single patch.

The CQA Consultant shall verify and document that GCL repairs are performed as required by the CQA Plan.

8.5 GCL Acceptance

The Geosynthetic Contractor shall retain ownership and responsibility of the GCL until acceptance by the Owner or Owner's representative. Acceptance of the GCL will be complete when:

1. All required documentation from the GCL Manufacturer and the Geosynthetic Contractor has been received and accepted.
2. The geosynthetic installation is complete, the GCL material is intact and the GCL is not in a hydrated condition.
3. All repairs have been completed and tested.

9 GEOMEMBRANE

Geomembranes are synthetic membrane liners with very low permeability. They are used in landfill lining, capping and other fluid control systems. This section is applicable to field and factory fabricated panels of smooth and textured linear low density polyethylene (LLDPE) and high density polyethylene (HDPE) materials but is not valid when using geomembranes manufactured with other materials such as polyvinyl chloride (PVC).

9.1 Materials

9.1.1 Resin

The geomembrane manufacturer shall provide the following information prior to delivery of the geomembrane to the Site:

1. The resin supplier's name, resin production facility, resin identification, and production date of the resin.

2. A copy of the quality control certificates issued by the resin supplier.

3. Results of tests conducted by the resin supplier to verify the raw material quality including specific gravity and carbon black content.

4. A certification from the resin supplier that the polymer used in the geomembrane meets the criteria of the specifications.

5. Reports of tests or a certification by the manufacturer verifying the quality of the raw materials including specific gravity and melt flow index. These tests shall be performed at a frequency of at least one per resin batch but not less than once per 180,000 pounds of resin used in the manufacturing of the geomembrane.

6. A certification that reclaimed polymer is not added to the resin and that polymer recycled during the manufacturing process does not exceed 2 percent of the resin.

The CQA Consultant shall review the submittals provided by the manufacturer to verify compliance with the requirements of the specifications.

9.1.2 Geomembrane

Geomembrane Manufacturer

The geomembrane manufacturer shall perform the following:

1. Provide a certification that the geomembrane manufactured for this project meets the following criteria:

    a) The geomembrane contains no more that 1 percent by weight of additives, fillers, or extenders, excluding carbon black.

    b) The geomembrane is without holes, cracks, thin spots, tears, punctures, blisters, undispersed raw materials, roughness other than produced due to texturing, or any other indication of contamination.

    c) HDPE geomembrane must conform to the minimum properties of the project plans and the latest revisions to Geosynthetic Research Institute Test Method GRI-GM13.

2. Provide a copy of the manufacturer's geomembrane properties and quality control requirements, and instructions for geomembrane delivery, storage and handling.

3. Provide QC Certificates which represent each roll of geomembrane to be delivered to the job site. Each QC Certificate shall include:

    a) Roll number, geomembrane type, thickness, manufacturer, date of production, and roll dimensions. Each finished roll shall be identified by a number corresponding to the batch of resin used.

    b) The manufacturer's test results on samples from rolls from the same production lot, which verify that the rolls meet the requirements of the project plans. These

samples shall be tested to confirm that the requirements of the project plans are met, except that testing for environmental stress crack resistance and low temperature impact need not be performed. The test data shall be identified by roll number.

c) Certification that the roll meets the requirements of the project plans.

4. The manufacturer is responsible for the production of extrusion beads and/or welding rod from polyethylene resin which shall meet the requirements of the project plans.

CQA Consultant

The CQA Consultant shall verify that the manufacturer's submittals meet the requirements of the project plans.

The Manufacturer shall also submit representative samples taken from the proposed product for direct shear interface testing as directed by the CQA Consultant. The CQA Consultant shall manage the direct shear testing of the geomembrane samples, as needed, per the direction of the Design Engineer and in accordance with the design requirements. Proposed geomembrane rolls shall not be accepted for installation until the manufacturer provides geomembrane samples representative of the rolls proposed for installation with test results satisfactory to the Design Engineer according to the design requirements. The Design Engineer and the CQA Consultant shall reject any proposed geomembrane rolls and/or products that do not demonstrate the design requirements when subjected to direct shear interface testing.

9.2 Geosynthetics Contractor Submittals

Geosynthetics Contractor

The Geosynthetics Contractor shall submit to the Owner the following information prior to the start of geomembrane installation:

1. Schedule of geomembrane installation.

2. Panel layout drawings.

3. Drawings of construction details for anchor trenches, sumps and other features as required by the CQA Consultant.

4. A resume for the Master Seamer to be assigned to the project. A Master Seamer must be present on-site during all geomembrane seaming operations and shall have completed seaming on at least 1,000,000 square feet of polyethylene geomembrane, using both extrusion and fusion welding methods.

5. A resume for each Seamer to be assigned to the project. Each Seamer shall have completed seaming on a minimum of 100,000 square feet of polyethylene geomembrane.

6. A resume for each Seamer subsequently assigned to the project shall also be submitted. Seamer apprentices or assistants do not need the requisite experience if they are working under the direct supervision of a qualified Seamer.

CQA Consultant

The CQA Consultant shall verify that all submittals required of the Geosynthetics Contractor have been received and meet the requirements of the CQA Plan. The schedule and drawings submitted by the Geosynthetics Contractor, once approved by the CQA Consultant, shall be the basis of geomembrane deployment.

9.3 Geomembrane Delivery and Storage

The Contractor handling the supplied materials shall perform the following:

1. Assure that the geomembrane rolls or panels are packaged, shipped, off-loaded, and stored on-site in such a manner that the rolls are not subjected to damage.

2. Prepare the roll storage area to protect the geomembrane from dirt, mud, dust, and damage at all times prior to deployment. The geomembrane shall be protected against adverse weather, and other hazards.

3. Be responsible for off-loading of the geomembrane rolls when delivered to Site.
4. Instruct all personnel of the proper handling techniques so as not to damage any of the geomembrane rolls.
5. Assure that the geomembrane material is not folded. Folded geomembrane material shall be rejected.
6. Stack the geomembrane rolls per the manufacturer's recommendations but no more than five rolls high.
7. Identify and separate all damaged rolls from undamaged rolls and store these rolls at a location designated by the Owner until disposition of the damaged rolls is determined.

CQA Consultant

The CQA Consultant shall perform the following:

1. Inspect the geomembrane roll storage area to verify compliance with the CQA Plan.
2. Document the following information for all liner material delivered to the Site:
    - Storage location,
    - Name of the manufacturer and fabricator,
    - Name, type and thickness of the liner,
    - Batch code,
    - Roll number or Panel number (if prefabricated),
    - Date of fabrication, and
    - Physical dimensions.
3. Observe the material off-loading and storage of geomembrane rolls to verify compliance with the requirements of the CQA Plan.

4. Visually inspect the surface of all geomembrane rolls for visible defects and/or damage. Any damage observed shall be documented.

9.4 Geomembrane Installation

9.4.1 Anchor Trench

CQA Consultant

The CQA Consultant shall verify that the anchor trench has been constructed according to the requirements of the project plans and drawings. The CQA Consultant shall observe and document the placement of the geomembrane in the anchor trench and the placement of the anchor trench backfill material as required by the project plans and drawings. The anchor trench shall not be backfilled until the destructive and non-destructive testing of the seams to be buried have met requirements of the CQA Plan.

Earthwork Contractor

The Earthwork Contractor shall perform the following:

1. Construct anchor trenches to the nominal dimensions shown on the project plans and drawings plans with rounded edges and maintain trenches until properly backfilled.
2. Provide for adequate drainage of anchor trenches.
3. Backfill the anchor trench according to the drawings and the CQA Plan.

9.4.2 Weather Conditions

The CQA Consultant shall verify and document that geomembrane seaming is performed only during weather conditions which are considered acceptable, as described in the following sections.

All reasonable efforts will be made to install geomembrane when the geomembrane sheet temperature and the ambient temperature (measured 1 to 3 feet above the geomembrane) are above 32 degrees Fahrenheit. Welding performed at temperatures below 32 degrees Fahrenheit will only occur as allowed by the manufacturer's installation

guidelines and with authorization by the Owner or CQA Consultant. If authorized, welding at temperatures below 32 degrees Fahrenheit shall be performed in accordance with Geosynthetic Research Institute Test Method GRI-GM9 and in accordance with the following procedures:

1. CQA Consultant shall continue to monitor and record the ambient temperature and geomembrane sheet temperature hourly during liner installation or field seaming. If seaming is occurring in an enclosed structure, recorded temperatures shall be those in the enclosure. Maximum geomembrane sheet temperatures will be determined based on the geomembrane manufacturer's installation guidelines.
2. Extrusion welding shall be performed only with a hot air pre-heat operating immediately in front of the extrusion nozzle.
3. A specimen will be obtained from the end of each fusion welded seam that exceeds 25 feet in length, exclusive of cross-seams. The specimen will be hand-tested for peel adhesion. The result of peel testing will be recorded as a pass/fail on the CQA Consultant's Panel Seaming Form.
4. Destructive sample test frequency may be increased based on observation and determinations of the CQA Consultant.

Cold weather seaming procedures may be revised or modified with approval of the CQA Consultant.

Geosynthetics Contractor

The Geosynthetics Contractor shall:

1. Not weld during precipitation events, in the presence of excess moisture (i.e. heavy fog or dew, in an area of ponded water), or during conditions of winds which affect the control of the welding temperatures (unless engineering controls are installed).

2. Ensure that field seaming is not performed in adverse weather conditions that could impair the quality of the geomembrane installation unless protective structures or other methods are used to maintain seam integrity during construction.

9.4.3 Deployment Methods

The Geosynthetics Contractor shall install the geomembrane according to the panel layout drawings previously submitted to the Owner. Any changes to the panel layout must be approved by the Owner. The geomembrane shall be deployed so that it is in a loose and relaxed condition at the time of geomembrane seaming.

9.4.4 Prevention of Damage

The Geosynthetics Contractor shall be responsible to assure that:

1. Installation personnel do not use equipment or tools that may damage the geomembrane.
2. No installation personnel shall smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.
3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the underlying materials.
4. The method used to deploy the geomembrane shall minimize wrinkles.
5. Bridging of grade changes by the geomembrane shall be removed as directed by, and at the discretion of, the CQA Consultant.
6. Adequate loading (i.e. sandbags or similar items that will not damage the geomembrane) shall be placed on the geomembrane to prevent uplift and relocation of panels by wind.
7. Direct contact with the geomembrane shall be minimized (i.e. geomembrane in traffic areas shall be protected by geotextiles, additional geomembrane layers, or other materials approved by the CQA Consultant).

8. Use of wheeled vehicles driving on underlying geosynthetic material is prohibited.

9.4.5 Field Panel Identification and Deployment

The CQA Consultant or their representative shall assign each field panel a unique identification number consistent with the panel layout drawings submitted to the Owner. The Geosynthetics Contractor shall deploy field panels according to the panel layout drawing. Deviations from the approved panel layout drawing shall be approved in advance by the CQA Consultant. Each panel deployed shall be recorded by the Geosynthetics Contractor. Identification number, location, and date shall be recorded.

The CQA Consultant shall perform the following activities regarding geomembrane placement:

1. Verify that each panel is clearly identified, and its location noted.
2. Verify and document that the panel deployment proceeds according to the panel layout drawing and that pertinent information including panel overlap is recorded.
3. Visually observe the geomembrane for uniformity, damage and imperfections, including any of the following: holes, cracks, thin spots, tears, punctures, blisters or foreign material.

9.4.6 Geomembrane Panel Thickness Measurements

Panel thickness measurements shall be provided by the geomembrane manufacturer on the material certifications. Panels suspected to not meet the requirements based on field observations may be removed.

9.5 Seaming Specifications

9.5.1 General Procedures

The Geosynthetics Contractor shall perform the following:

1. Overlap (shingle) the geomembrane panels such that any fluid flowing across the seams would flow from the top panel to the underlying panel.
2. Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams on sideslopes greater than 5 percent should be minimized. If horizontal seams are required due to the length of the sideslope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet. Panels shall be placed such that the up-slope panels overlie those down-slope. Geomembrane panels placed on slopes shall extend a minimum 5-feet beyond the toe of the slope.
3. Clean the seam area such that the seam area is free of moisture, dust, dirt, debris, and foreign matter of any kind prior to seaming.
4. Align seams with the least possible number of wrinkles and "fish mouths". Fish mouths are to be cut, removed, and patched.
5. Field seam only in weather conditions which shall not impair the quality of the geomembrane, unless approved by the Owner.

The CQA Consultant shall verify that all geomembrane Seamers meet the experience requirements of the CQA Plan and that a Master Seamer who meets the experience requirements of the CQA Plan is present on-site whenever seaming is conducted. The CQA Consultant shall observe and document the geomembrane seaming activities to verify that the requirements of the CQA Plan are met.

9.5.2 Trial Welds

The Geosynthetic Contractor shall perform the following:

1. Begin geomembrane seaming only after Seamers and their assigned seaming equipment have successfully completed trial welds.
2. Perform trial welds at: (1) at the beginning of each seaming period; (2) at least once each 5-hour period; (3) after extended periods of shutdown; or (3) as directed by the CQA Consultant if materials, equipment or environmental conditions have changed since the last successful trial weld.
3. Perform trial welds using similar materials and in the same surroundings and environmental conditions as the production welds.
4. The trial weld specimen shall be a minimum of 10-feet long for self-propelled seaming(fusion) devices, and a minimum of 3-feet long for hand-held (extrusion) devices.
5. One-inch wide cutouts of the trial weld shall be subject to shear and peel adhesion testing in the field. A minimum of two cutouts shall be tested for bonded seam strength (shear) and an additional three cutouts shall be tested for peel adhesion using a properly calibrated digital readout tensiometer and the testing procedures of ASTM D6392.

A trial weld sample shall be considered passing, according to the following table (Table 9.1), for all specimens tested in shear and peel adhesion:

Table 9.1

Smooth or Textured Geomembrane Seam Strength Requirements

Property	Criteria		
	40 mill HDPE	60 mil HDPE	80 mil HDPE
1. Shear Strength (lb./inch)	80	120	160
2. Peel Adhesion (lb./inch) - Fusion	60	91	121
3. Peel Adhesion (lb./inch) - Extrusion	52	78	104

For trial welds, all specimens must meet the seam strength criteria with 0 percent incursion into the welded area.

A failed trial weld shall not be retested. The seaming equipment and the Seamer that produced the failed trial weld shall not be allowed to weld the geomembrane until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

The CQA Consultant shall observe the trial weld preparation and testing and verify that requirements of the CQA Plan are met. The CQA Consultant shall document trial welds, test results, and appropriate responses.

9.5.3 Seaming and Testing Equipment

Approved processes for field seaming are fusion and extrusion welding. Fusion welding shall be the primary (production) seaming method with extrusion welding used for geomembrane repairs unless specified otherwise by the Design Engineer. Proposed alternate processes shall be documented and submitted by the Geosynthetics Contractor to the CQA Consultant for approval prior to use in the field.

The Geosynthetics Contractor shall:

1. Use dual track fusion welders and extrusion welders for field seaming. Extrusion welders shall be equipped with gauges to indicate the temperature in the welder and in the pre-heat nozzle.
2. Provide a properly calibrated field tensiometer for on-site shear and peel adhesion tests. This device shall meet the requirements for testing shear and peel adhesion according to ASTM D6392.
3. Provide an air pressure/vacuum pump, air pressure measuring devices, and vacuum testing viewing boxes with the capabilities for air pressure and vacuum box nondestructive testing as required by the CQA Plan.
4. Provide a coupon die and press to produce test specimens (coupons) in the field for shear and peel adhesion testing.
5. Provide protective lining material and a splash pad large enough to collect spilled fuel under generators if portable gasoline-powered electric generators are used.

9.5.4 Fusion Welding Seam Preparation

The Geosynthetics Contractor shall:

1. Overlap the geomembrane panels a minimum of 4 inches.
2. Clean the geomembrane seam area prior to seaming to assure that the area is clean and free from moisture, dirt, dust, and debris. No grinding is required for fusion geomembrane welding.
3. Use a protective, moveable layer (“rub sheet”) directly below the overlap of geomembrane to be seamed, as required, to prevent build-up of moisture between the panels.
4. The welding technician shall legibly mark the following information on the geomembrane at the start of each seam:

- Date and start time,
- Technician identification, and
- Welding machine identification.

The CQA Consultant shall verify and document that geomembrane overlapping and preparation for fusion seaming is performed as required by the CQA Plan.

9.5.5 Extrusion Welding Seam Preparation

The Geosynthetics Contractor shall:

1. Overlap the geomembrane panels to be welded a minimum of 3-inches. Unless approved by the Engineer, extrusion welding shall not be used as the primary (production) field seaming method.
2. Clean the geomembrane panels prior to seaming to assure that the area is clean and free of moisture, dirt, dust, and debris.
3. For geomembranes greater than 60 mils in thickness, the edge of the upper geomembrane to be extrusion welded shall be beveled with a hand grinder at a 45-degree angle prior to heat tacking into place.
4. Weld the geomembrane within 15 minutes of grinding and cover all abraded areas with extrudate.
5. Purge the extruder prior to beginning the seam to remove all heat degraded extrudate from the barrel of the extrusion machine.
6. Keep the welding rod clean and dry.
7. All extrusion welds serving as a tie-in between two cells will be capped.
8. The welding technician shall legibly mark the following information on the geomembrane at the start of each seam or repair:
    - Date and start time,

- Technician identification, and
- Welding machine identification.

The CQA Consultant shall verify and document that geomembrane seam overlapping and preparation for extrusion welding is performed as required by the CQA Plan.

9.6 Non-Destructive Seam Testing

The Geosynthetic Contractor shall perform non-destructive tests on all field seams and repairs over their full length. Test equipment required for non-destructive testing shall be furnished and operated by the Geosynthetics Contractor. Where the seam cannot be non-destructively tested, as determined by the CQA Consultant, the Geosynthetics Contractor shall submit to the CQA Consultant an alternate testing method for approval. Non-destructive testing shall be performed as the seaming work progresses, not at the completion of all field seaming.

The CQA Consultant shall observe and document the results of all non-destructive seam testing. The CQA Consultant shall verify that the test methods meet the requirements of the CQA Plan and document that all seams which fail non-destructive tests are repaired according to the CQA Plan.

9.6.1 Air Pressure Testing

Air pressure testing is applicable to dual track fusion welding which produces a double seam separated by an air channel.

The Geosynthetics Contractor shall perform the following:

1. Conduct air pressure testing wherever determined feasible by the CQA Consultant on dual track fusion seams.
2. Use the following equipment for air pressure testing of dual track fusion seams:
   a) An air pump or pressure tank equipped with a pressure gauge capable of generating and sustaining a minimum pressure of 50 psi and mounted on a

cushion to protect the geomembrane. The air pump may be manual or motor driven.

b) A manometer or other pressure measuring device capable of indicating the air pressure in 1.0 psi increments within the test range and equipped with a sharp needle.

3. Use the following procedures when performing air pressure testing:

a) Seal the air channel at both ends of the seam area to be tested.

b) Insert a manometer or other approved pressure gauge directly into the air channel created by the dual track fusion welding. Means of pressurizing must be provided.

c) Energize the air pump to a minimum pressure of 30 psi. The air pump valve shall be closed and the pressure shall be allowed to stabilize for 2 minutes. After the stabilization period, the pressure must be sustained for an additional 5 minutes.

d) If there is a loss of pressure exceeding 3 psi, or if the pressure does not stabilize, the reason for failure shall be investigated and the faulty area shall be located, repaired, and the seam retested.

e) Ensure that the air channel is not obstructed by releasing air from the end of the seam opposite the manometer and observing the resulting pressure drop on the manometer.

f) Remove the manometer and repair the holes.

9.6.2 Vacuum Box Testing

Vacuum box testing is applicable to extrusion welded seams. Fusion welded seams which cannot otherwise be air pressure tested may be vacuum box tested with prior approval of the CQA Consultant.

The Geosynthetics Contractor shall:

1. Use the following equipment for vacuum pressure testing:
    a) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft gasket attached to the bottom, a valve assembly, and a vacuum gauge.
    b) A vacuum pump assembly equipped with a pressure controller and pipe connections.
    c) Additional fittings and connections as needed to perform the tests.
2. Use the following procedure when performing the vacuum pressure testing:
    a) Trim excess geomembrane sheet overlap, if any.
    b) Apply a soapy solution to a length of the geomembrane approximately 12 inches by 48 inches along the seam (approximately the length of the vacuum box).
    c) Place the vacuum box over the area wetted by the soapy solution and apply pressure to seal the box over the seam. Apply a minimum vacuum pressure of five pounds per square inch gauge (psig) to the interior of the box.
    d) For a period of approximately 10 seconds, examine the geomembrane seam through the viewing window for the indication of soap bubbles.
    e) If no bubbles appear, release the vacuum and move the vacuum box to the next area of the seam, with a minimum 3-inch overlap. Repeat the process.
    f) Mark all areas where soap bubbles formed and repair the marked seam as required. Retest the repaired seam.

9.7 Destructive Seam Testing

The purpose of destructive testing is to evaluate seam strength. Destructive seam testing shall be performed as the seaming work progresses, not at the completion of all field seaming.

9.7.1 Sampling

Geosynthetic Contractor

The Geosynthetic Contractor shall:

1. Obtain at least one destructive test sample per day per seaming crew or machine, or every 500-feet of seam, whichever is greater, from locations specified by the CQA Consultant. Additional destructive test samples shall be taken as directed by the CQA Consultant.

2. Cut the destructive test samples as seaming progresses in the locations designated by the CQA Consultant. The destructive test samples shall be nominally 12-inches wide by 42-inches long, with the seam centered lengthwise. One cutout from each end of the sample shall be field tested prior to destructive testing. The remaining sample shall be cut into thirds (two 15-inch samples, one 12-inch sample), with two pieces given to the CQA Consultant (one 15-inch laboratory sample and one 12-inch archive sample) and the other sample retained by the Geosynthetics Contractor.

3. Label all samples with the location and seam number and record the date, location, panel numbers, seam number, welding machine and welding technician.

4. Repair all holes in the geomembrane resulting from obtaining the destructive test samples. All extrusion welded patches shall be vacuum tested.

CQA Consultant

The CQA Consultant shall:

1. Determine and identify the locations for destructive test sampling.

2. Verify and document that the Geosynthetic Contractor's destructive sampling and testing procedures meet the requirements of the CQA Plan.

3. Send the destructive test samples to an off-site laboratory for testing described below. On-site destructive testing performed in a controlled environment by qualified individuals of the CQA Consultant may be utilized in place of an off-site laboratory, if approved by the CQA Officer.

4. Verify and document that all destructive test results meet the requirements of the CQA Plan. Observe and document all subsequent activities relating to the repair and patching of the destructive test sample location.
5. Locate and document the destructive test sample locations on the panel layout drawing.

9.7.2 Testing

The CQA Consultant shall perform the following:

1. Test destructive samples for bonded seam strength (shear) and for peel adhesion. Samples from dual track welds shall be tested for peel adhesion on both tracks of the seam.
2. Cut out ten, 1-inch wide specimens from the destructive test sample. Test five specimens for shear and five specimens for peel strength in accordance with ASTM D6392. The passing criteria is as follows:
    a) For peel testing, five out of five test specimens must each pass the criteria listed in Table 9.1, with 25 percent or less seam separation as a percentage of the total weld area.
    b) For shear testing, five out of five test specimens must each pass the criteria listed in Table 9.1 with 50 percent seam elongation achieved at break and 25 percent or less seam separation as a percentage of the total weld area
    c) Geomembrane destructive sample test results must conform to the minimum requirements of the CQA Plan and the latest revisions to Geosynthetics Research Institute Test Method GRI-GM19a.

9.7.3 Destructive Test Failure

The Geosynthetic Contractor shall ensure that the following procedures are followed if a sample fails a field destructive test:

1. Retrace the welding path to an intermediate location (approximately 10-feet from each side of the failed test), at the CQA Consultant's discretion, and take additional destructive test samples. If the bounding test passes the CQA Plan criteria, then the seam shall be repaired between that location and the original failed test location. If the test fails, the process is repeated. All failed test samples must be bounded by passing test samples or bounded by the point at which the seamer/seaming device was taken out of service.
2. With approval from the CQA Consultant, a laboratory destructive test of a previously performed trial weld may be used as a bounding sample for a failed destructive test.
3. Over the length of seam failure, either cut out the old seam, reposition the panel and re-seam, or install a cap-strip, as required by the CQA Consultant.
4. In lieu of installing a cap-strip over a failed fusion-welded seam, the Geosynthetics Contractor may elect to extrusion weld the upper flap of the fusion seam to the lower geomembrane, provided that the upper flap has a 2-inch minimum extension beyond the fusion weld.
5. Vacuum test all extrusion weld repairs. Additional destructive samples shall be taken at the discretion of the CQA Consultant.

9.8 Destructive Testing of Tie-in Seams to Existing Geomembrane

The following section applies to tie-in seams with existing cells where the existing geomembrane has been in place for more than 2 years.

Trial welds shall be conducted using the same geomembrane material as the actual production seams, e.g. new geomembrane to existing geomembrane, following the requirements of Section 9.5. The production weld shall be destructively and

nondestructively tested following the requirements of Sections 9.6 and 9.7. See Figure 2 below for identification of the production weld.

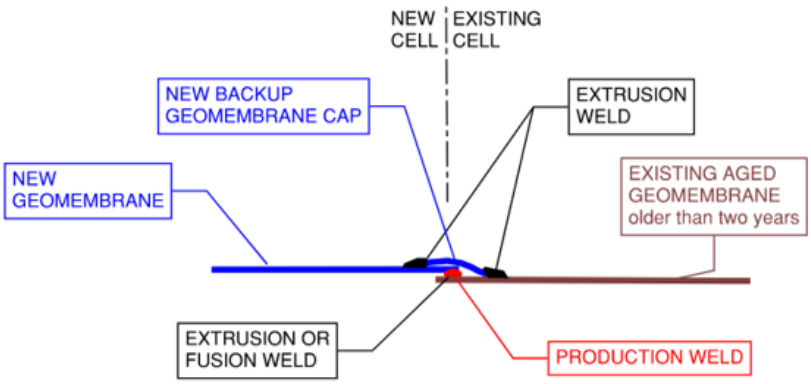

Figure 2. Location of Production Weld in Tie-in Seams to Existing Geomembrane

Based on destructive test results, any failed production weld shall be resampled, tested, and reconstructed per the requirements of Section 9.7. Additional destructive testing may be performed on any production weld geomembrane cap at the discretion of the CQA Consultant (Figure 3 below).

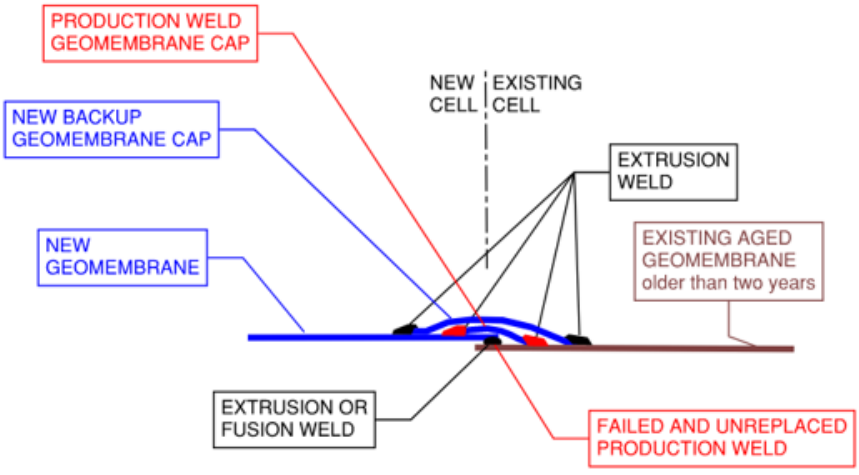

Figure 3. Location of Production Weld Geomembrane Cap

Upon receipt of successfully passing production weld destructive testing results, a final backup geomembrane cap will be extrusion welded over the entire length of the production weld, including over any production weld geomembrane cap. The final backup geomembrane cap shall be nondestructively tested per the requirements of Section 9.6. Destructive testing of the final backup geomembrane cap is not required.

9.9 Defects and Repairs

The CQA Consultant shall perform the following:

1. As each geomembrane panel is deployed, or as soon as possible after deployment, observe the geomembrane surface for damage and imperfections including holes, cracks, thin spots, tears, punctures, blisters, and foreign material. The surface of the geomembrane shall be clean at the time of the CQA Consultant's observations.
2. Identify, mark, and observe non-destructive testing of suspect locations.
3. Verify and document that all defects found as a result of: (1) the inspection and testing of suspected areas;(2) non-destructive tests; (3) destructive tests; and (4) any other inspection or observation, are identified for repair.
4. Verify and document that all identified defects are properly repaired in accordance with the CQA Plan. Repair equipment, materials, and procedures are subject to the approval of the CQA Consultant.
5. Verify and document that all repairs are non-destructively tested and either pass the tests or are again repaired and tested until passing test results are achieved.
6. Record the locations and types of defects and record the repairs and non-destructive testing at these locations.

The Geosynthetic Contractor shall perform the following:

1. Clean the geomembrane surface prior to inspection of the geomembrane by the CQA Consultant. The geomembrane surface shall be brushed, blown, or washed if the amount of dust or mud inhibits observations.

2. Perform non-destructive tests of each suspect location in the presence of the CQA Consultant. Each location that fails the non-destructive tests shall be marked by the CQA Consultant and repaired according to the procedures in the CQA Plan.

3. Repair any portion of the geomembrane which exhibits a flaw or fails a destructive or non-destructive test as follows:

    a) Small holes shall be repaired by extrusion welding. If the hole is larger than 0.25-inches, the hole shall be patched.

    b) Failed seams shall be repaired in accordance with the sections above.

    c) Tears shall be repaired by patching. If the tear is on a slope or an area of stress and has a sharp edge, the tear shall be rounded by cutting prior to patching.

    d) Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by large patches.

    e) Surfaces of the geomembrane which are to be patched shall be abraded and cleaned no more than 15 minutes prior to the repair. All abraded areas shall be covered by extrudate. No more that 5-10 percent of the thickness shall be removed by abrading.

    f) Folded geomembrane that has been creased or otherwise damaged shall be replaced. Patching shall be permitted with the approval of the CQA Consultant.

    g) Patches shall be round or oval shaped, made of the same geomembrane, and extend a minimum of 6-inches beyond the edge of the defect. All patches shall be of the same compound and thickness as the geomembrane being repaired.

h) All surfaces must be clean and dry at the time of repairs. All seaming equipment used in the repairs must be approved by the CQA Consultant. All repair procedures, materials, and techniques must be approved by the CQA Consultant.

4. Perform non-destructive tests on each repair location. Repairs that pass the non-destructive test shall be noted as an acceptable repair. Failed tests indicate that the repair shall be repeated and retested until a passing test is achieved. The CQA Consultant may also require a destructive seam test sample to be taken from a repaired seam. Acceptance of the repaired seam shall then also be subject to the sampling, testing, and acceptance criteria of the CQA Plan.

9.10 Geomembrane Acceptance

The Geosynthetic Contractor shall retain ownership and responsibility for the geomembrane until acceptance by the Owner. The Owner shall accept the geomembrane installation when:

1. All required documentation from the geomembrane manufacturer and the Geosynthetics Contractor has been received and accepted.
2. The geomembrane installation is complete.
3. Verification that all field seams and repairs, including associated testing is complete.
4. The geosynthetic installation has been accepted in a final approval notice signed by the Geosynthetics Contractor and the CQA Consultant.

10 GEOGRID, GEONET, GEOTEXTILE, AND GEOCOMPOSITE MATERIALS

The design may include geogrid, geonet, geotextile, and/or geocomposite materials as indicated in the project plans and drawings for drainage and stability purposes in the landfill foundation liner and final cover system. This section of the CQA Plan addresses geogrid, geonet, geotextile, and geocomposite materials for use in the landfill liner system and/or the final cover.

10.1 Submittals

The manufacturer of the geogrid, geonet, geotextile, and geocomposite shall submit the following:

1. Manufacturer's specifications and certification stating that the materials meet or exceed the applicable requirements of the project plans and drawings.
2. Manufacturer's instructions for handling and storage of the geogrid, geonet, geotextile, and/or the geocomposite.
3. Manufacturer's QC test results for geogrid, geonet, geotextile, and/or geocomposite. These test results shall identify each roll of geocomposite with the corresponding roll identifications of the geonet and geotextiles incorporated therein such that the results of the following tests can be positively correlated with the geocomposite roll identification. The testing shall be performed by the manufacturer as follows:
    a) The geogrid shall be sampled at a minimum frequency of one sample for each 100,000 square feet delivered and shall be tested by the manufacturer to verify that the requirements in the project plans and drawings are met.
    b) The geonet shall be sampled at a minimum frequency of one sample for each 100,000 square feet delivered and shall be tested by the manufacturer to verify that the requirements in the project plans and drawings are met.
    c) The geotextile shall be sampled at a minimum frequency of one sample for each 100,000 square feet delivered and shall be tested by the manufacturer to verify

that the requirements in the specifications are met. Testing for UV Resistance is not required. Certification by the manufacturer that the UV Resistance requirement is achieved shall be provided.

d) The geocomposite shall be sampled at a minimum frequency of one sample for each 100,000 square feet delivered. The geonet and the geotextile from the geocomposite samples shall be certified that the requirements of the project plans and drawings are met.

The CQA Consultant shall verify and document that the information submitted by the manufacturer meets the requirements of the project plans and drawings.

The Manufacturer shall also submit samples taken from the proposed product rolls for direct shear interface testing as requested by the CQA Consultant. The CQA Consultant shall manage the direct shear testing of the geosynthetic samples, as needed, per the direction of the Design Engineer. Proposed geosynthetic rolls shall not be accepted for installation until the manufacturer provides geosynthetic samples representative of the rolls proposed for installation with test results satisfactory to the Design Engineer according to the design requirements. The Design Engineer and the CQA Consultant shall reject any proposed geosynthetic rolls and/or products that do not demonstrate the design requirements when subjected to direct shear interface testing.

10.2 Materials

10.2.1 Geogrid

The geogrid shall be comprised of geosynthetic materials and shall meet the minimum average roll values outlined in the project plans and drawings.

10.2.2 Geonet

The geonet shall be comprised of HDPE and shall meet the minimum average roll values outlined in the project plans and construction drawings.

10.2.3 Geotextile

The geotextile shall consist of continuous filament, needle punched, non-woven material and shall meet the minimum average roll values outlined in the project plans and drawings.

10.2.4 Geocomposite

The geocomposite shall be comprised of a geonet heat-bonded to geotextile. The geonet and geotextile shall meet the requirements of the project plans and drawings. Additionally, the geocomposite shall meet the requirements of the project plans and drawings.

10.3 Material Delivery, Handling, and Storage

The Geosynthetics Contractor shall perform the following:

1. Assure that the geogrid, geonet, geotextile, and geocomposite rolls are packed, shipped, off-loaded and stored by appropriate methods to prevent damage. The Geosynthetics Contractor shall be responsible for replacing any damaged or unacceptable material.
2. Protect the materials from mud, dust, dirt, and other damaging conditions. The manufacturer's procedures for shipping, handling, and storage shall be followed.
3. Assure that the geogrid, geonet, geotextile, and the geocomposite rolls are clearly labeled with the manufacturer's name, roll number, lot number, and batch number. Information shall be provided by the manufacturer which clearly identifies the corresponding roll information for the geonet and geotextiles incorporated into the geocomposite.

The CQA Consultant shall observe the off-loading of the geogrid, geonet, geotextile, and geocomposite and shall visually inspect the surface of all rolls for defects and/or damage. The CQA Consultant shall document any observed damage to any of the rolls.

10.4 Material Deployment

The Geosynthetics Contractor shall perform the following:

1. Assure that all geogrid, geonet, geotextile, and geocomposite materials are handled in a manner to prevent damage.
2. Assure that no materials are placed over the geomembrane until all required documentation regarding the geomembrane installation is complete.
3. Assure that the surface on which the materials are to be placed does not contain stones or excessive dust that could cause damage to any geosynthetic component.
4. In periods of high winds, weight all geosynthetic components with sandbags or similar material. The Geosynthetics Contractor shall be responsible for damage to the geosynthetic components resulting from wind damage.
5. Cut the geogrid, geonet, geotextile, and geocomposite materials using an approved tool. Care must be taken to protect the underlying geomembrane when the materials are being cut in-place.
6. Use equipment to deploy the geosynthetic components that shall not cause damage to any material.
7. Assure that no personnel working on the geosynthetic materials shall smoke, wear damaging shoes, or engage in other activities that could damage the materials.
8. Use of wheeled vehicles driving on underlying geosynthetic materials is prohibited.
9. If tri-planar geocomposite is used, the geocomposite roll should be installed in the direction of the slope. Tri-planar geocomposite directs flow predominately in the machine direction (along the roll length) and thus should be installed in the intended direction of flow or as specified by the Design Engineer.

The CQA Consultant shall observe and document the deployment of geogrid, geonet, geotextile, and geocomposite to verify that the provisions of the CQA Plan are met.

10.5 Field Seams

The Geosynthetic Contractor shall perform the following:

1. Field seams for geogrid:
    a) The overlap for seams shall be as specified by the geogrid manufacturer.
    b) Adjacent panels of the geogrid shall be joined as specified by the geogrid manufacturer.
    c) Where more than one layer of geogrid is installed, overlaps must be staggered.
    d) Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams shall be minimized. If horizontal seams are required due to the length of the slope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet.
2. Field seams for geonet:
    a) The overlap for seams shall be 4-inches along panel edges and 6-inches at panel ends.
    b) Adjacent panels of the geonet shall be joined using self-locking nylon straps placed at 5-feet intervals along the seam length on the sides and at one-foot intervals along the seam length at the ends. Only ties which do not damage the underlying geomembrane shall be used. Metal ties shall not be allowed.
    c) Ties shall be white or bright colored for easy identification.
    d) Where more than one layer of geonet is installed, overlaps must be staggered and layers tied together.
    e) Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams shall be minimized. If horizontal seams are required due to the length of the slope,

horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet.

3. Field seams for geotextile:

   a) The initial overlap for seams shall be at least 4-inches, configured into a “prayer” seam for sewing.

   b) The geotextile shall be continuously sewn between panels. Alternate methods of bonding the geotextile must be approved by the CQA Consultant prior to use.

   c) The thread used to sew the geotextile panels together shall meet the manufacturer's requirements.

   d) Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams shall be minimized. If horizontal seams are required due to the length of the slope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet.

4. Field seams for geocomposite:

   a) The overlap for seams shall be 4-inches along panel edges and 12-inches along panel ends.

   b) Adjacent panels of the geonet shall be joined using self-locking nylon ties placed at 5-feet intervals along the seam length on the sides and at 1-foot intervals along the seam length on the ends. End seams shall be covered by a piece of geotextile overlapped 6-inches on each side of the geocomposite seam and heat bonded in place. Only ties which do not damage the underlying geomembrane shall be used. Metal ties shall not be allowed.

   c) Ties shall be white or bright colored for easy identification.

   d) The geotextile shall be continuously sewn between panels. Alternate methods of bonding the geotextile must be approved by the CQA Consultant prior to use.

e) The thread used to sew the geotextile panels together shall meet the manufacturer's requirements and be white or bright colored for easy identification.

f) Orient all seams located on slopes steeper than 5 percent parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams shall be minimized. If horizontal seams are required due to the length of the slope, horizontal seams shall be bounded on each side by continuous panels and horizontal seams shall be staggered by a minimum distance of 25-feet.

The CQA Consultant shall observe and document the seaming of geogrid, geonet, geotextile, and geocomposite to verify that the following requirements of the CQA Plan are met:

1. Observations that all synthetic drainage materials are placed according to project plans.
2. Observations and measurements to ensure that the overlap of all synthetic drainage materials or geotextiles specified in the design and this CQA Plan are achieved.
3. Observations to verify that the synthetic drainage materials and geotextiles are placed free from excessive wrinkles or folds.
4. Observations to verify that weather conditions are appropriate for the placement of the synthetic drainage layer or geotextile materials and that exposure to rain, wind, and direct sunlight during and after installation follows the manufacturer’s recommendations.

10.6 Defects and Repairs

The Geosynthetic Contractor shall repair any holes or tears in the geosynthetic materials as follows, using patches made from the same material:

1. Damaged areas of geotextile shall be repaired by sewing or heat-bonding a patch in place with a 12-inch overlap in all directions.

2. Damaged areas of geogrid shall be repaired by placing a patch overlapping 2-feet beyond the edges of the hole or tear in all directions or according to the procedures recommended by the manufacture.

3. Damaged areas of geonet shall be repaired by placing a patch overlapping 2-feet beyond the edges of the hole or tear in all directions.

4. A geogrid or geonet patch shall be secured to the original geonet every 6-inches using nylon ties. If the damaged area comprises over 50 percent or more of the geonet roll width, the damaged area shall be cut out and the two portions of the geonet shall be joined.

5. Damage to the geocomposite shall be repaired as noted for geonets and the upper geotextile of the patch shall be sewn or heat-bonded to the upper geotextile of the geocomposite.

6. Use of equipment producing an open flame is prohibited when combustible gas including methane may be present.

The CQA Consultant shall observe and document the repairs made to the geogrid, geonet, geotextile, and geocomposite to verify that repairs are made according to the requirements of the CQA Plan.

10.7 Material Acceptance

The Geosynthetics Contractor retains ownership and responsibility for the geogrid, geonet, geotextile, and geocomposite materials until accepted by the Owner.

The Owner shall accept the geosynthetic components installation when:

1. All required documentation from the manufacturer and the Geosynthetics Contractor has been received and accepted.

2. The installation is complete.

3. The completion of field seams and repairs, including associated testing, is verified.

4. Written certification documents, including drawings, sealed by the CQA Consultant have been received by the Owner.

11 LEAK DETECTION AND LEACHATE COLLECTION SYSTEM

11.1 Leak Detection System

The leak detection system is comprised of geosynthetic materials installed by the Geosynthetics Contractor and may also include sumps and sampling pipes. Geosynthetic materials will be handled and installed in accordance with Section 10 of this Plan. Leak detection system materials will meet the specifications listed in the project plans and drawings.

11.2 Leachate Collection System

The leachate collection system is comprised of geosynthetic materials, granular soils, aggregate materials, and piping as shown on the project plans and drawings. Materials will be handled and installed in accordance with corresponding sections of this CQA Plan. Leachate collection system materials will meet the specifications listed in the project plans and drawings.

12 GRANULAR SOILS AND SELECT AGGREGATE

All granular materials and select aggregates used in landfill cell and final cover construction shall meet the requirements of the project plans and this section of the CQA Plan.

12.1 Materials

The granular soils and select aggregates used in the leachate collection and removal system and drainage layer components of the final cover shall meet the following requirements:

1. The granular soil and drainage aggregate shall be free of organic material, debris, trash, clay clods, or other deleterious material. No sharp-edged rocks or hard objects shall be allowed.
2. The granular soil drainage layer shall have maximum particle size as required by the drawings and project plans. The granular soil drainage layer shall be comprised of clean, subangular material of durable non-carbonate origin and shall be free of any materials capable of damaging the liner material.
3. Granular drainage soils shall have a minimum permeability shown in the project plans.
4. The drainage aggregate used around the leachate collection system piping and in sumps shall meet the requirements shown on the drawings and project plans.
5. In no instance shall the drainage aggregate be place directly on the geomembrane.
6. Granular soil samples shall be obtained on a frequency of at least one per every 5,000 cubic yards placed and tested for grain size distribution using a sieve analysis in accordance with ASTM D6913.
7. Granular soil samples shall be obtained on a frequency of at least one per every 5,000 cubic yards placed and tested for permeability in accordance with ASTM D2434.

8. The granular soil samples shall be collected and tested by the CQA Consultant. The CQA Consultant shall verify that the test results meet the requirements of the project plans and CQA Plan.

12.2 Construction Methods / Placement

Earthwork Contractor

The Earthwork Contractor shall install the granular soils in accordance with the following:

1. Low ground-pressure tire or track equipment shall be utilized for work on the granular soil materials whenever the thickness of the granular soil material is less than 24-inches. The granular soil beneath roadways for transporting material over the cell floor and sideslopes shall always be at least 3-feet thick. Excessive rutting shall be prevented. No portion of any earthmoving equipment shall be allowed to contact the underlying geomembrane material at any time.
2. Granular soil material shall be placed to minimize stresses on the underlying geomembrane. Placement of granular soil shall generally proceed by pushing the granular soil up the sideslope. No granular soil shall be allowed to fall or slide into place down the sideslopes.
3. During granular soil material placement, wrinkle propagation of geosynthetic materials shall be minimized.

CQA Consultant

The CQA Consultant shall perform the following:

1. Observe the placement of the granular soil and document soil material uniformity and the presence or absence of foreign materials.
2. Observe for potential and actual damage to the geomembrane during granular soil placement. When damage is suspected, the geomembrane surface shall be exposed to verify its condition. Actual damage to the geomembrane shall be documented and

corrective action shall be taken in accordance with procedures outlined in the CQA Plan.

3. Observe construction procedures to prevent the transport of fine soil particles by surface water run-off into the leachate collection system.

4. Observe and document that the granular soil material meets the material specifications, placement procedures, and thickness requirements of the project plans and the CQA Plan.

12.3 Survey

The Surveyor shall survey the granular soil layer on a 100-foot grid system to verify thickness. Alternately, direct depth checks may be performed by the CQA Consultant to determine the granular soil layer thickness. Locations where the granular soil layer thickness is less than required shall be corrected. The CQA Consultant shall document the placement of additional granular soil material to meet the requirements of the project plans and drawings.

13 PIPING

All piping used in the landfill cell construction or final cover shall meet the requirements of the project plans.

13.1 Pipe Materials

The pipe manufacturer shall provide the CQA Consultant documentation that the pipe provided meets the project plans and drawings.

The CQA Consultant shall review the manufacturer's information to verify that the project plans and CQA Plan requirements are met.

13.2 Delivery and Storage

The CQA Consultant shall obtain the following information when the pipe is delivered to the Site:

1. Name of manufacturer;
2. Product type and identification number;
3. Pipe diameter; and
4. Pipe wall thickness schedule or Standard Dimension Ratio.

The pipe shall be protected during shipment from excessive heat or cold, puncture, or other damage. The pipe shall be stored on-site in a manner to protect it from damage.

The CQA Consultant shall inspect the pipe delivery paperwork to ensure that the information is correct. The CQA Consultant shall also document the pipe material delivery in the daily summary report.

13.3 Pipe Installation

The pipe shall be joined by methods as defined by the pipe manufacturer and the project plans and drawings.

CQA Consultant

The CQA Consultant shall perform the following:

1. Inspect the pipe material for compliance with the project plans.
2. Observe and document the placement and joining of the pipe for compliance with the pipe manufacturer's specifications and the project plans and drawings.
3. Observe and document the backfill of the pipe for compliance with the project plans.
4. Observe and document the placement of filter materials, if used, around the pipe for compliance with project plans.

Earthwork Contractor

The Earthwork Contractor shall perform the following:

1. Pipe placement shall not be performed in the presence of excessive moisture.
2. Prepare the pipe subgrade condition and slope according to the project plans.
3. Join the pipe sections according to the pipe manufacturer's specifications and the project plans and drawings.
4. After joining, de-bead the pipe as required by the Owner.
5. Backfill the pipe according to the project plans.

The Surveyor shall survey the installed pipe every 100-feet and at appurtenances to verify that the pipe grade is in conformance with the project plans and drawings.

14 FINAL COVER SYSTEM

The final cover system may contain geosynthetic, granular, aggregate, piping, and soil components. Geosynthetic, granular, aggregate, and piping components of the final cover system will be installed per the project plans and drawings and according to corresponding sections of this CQA Plan. Soil components will be installed per the project plans and drawings and according to the installation guidelines of the following subsections.

14.1 Soil Material

The protective soil layer and topsoil layer of the final cover will meet the specifications of the approved project plans, drawings, and this section of the CQA Plan. Protective soil and topsoil will meet the following requirements:

1. The protective soil layer shall be free of debris, trash, stumps, or other deleterious materials. No sharp-edged rocks or other hard objects which could damage the geosynthetics shall be allowed.
2. The topsoil layer shall be capable of supporting shallow rooted vegetation and shall conform to the specifications of the project plans and drawings.

14.2 Soil Material Construction and Placement

CQA Consultant

The CQA Consultant shall perform the following:

1. Observe and document the placement of the soil layers. Visually inspect for material uniformity and the presence or absence of foreign materials.
2. Monitor the placement of the soil layers for potential or actual damage to the underlying components of the final cover system. Where damage of underlying geosynthetic material is suspected, the geosynthetic material surface shall be exposed to verify its condition. If damage of geosynthetic material is found, the damage shall

be documented, and corrective actions and repairs shall be made according to the CQA Plan.

3. Conduct field and laboratory testing at the frequency specified by project plans and drawings.
4. Certify that the soil layers have been placed and tested in accordance with the specifications of the project plans and drawings.

Earthwork Contractor

The Earthwork Contractor shall perform the following:

1. Place and compact each lift, except the first lift of material over geosynthetics, with a general thickness of 6-inches after compaction. The first lift of soil material over geosynthetics will be placed at a minimum thickness of 1 foot after compaction, unless otherwise indicated in the project plans.
2. Monitor the placement of the soil layers for potential or actual damage to the underlying components of the final cover system. Where damage of underlying geosynthetic material is suspected, the geosynthetic material surface shall be exposed to verify its condition. If damage of geosynthetic material is found, the damage shall be documented, and corrective actions and repairs shall be made according to the CQA Plan.
3. Soil placement shall be accomplished to minimize stresses on the underlying geosynthetic components of the final cover system.

Surveyor

The Surveyor shall survey the final cover soil components on a 100-foot grid system to verify thickness. Alternately, direct depth checks may be performed by the CQA Consultant to determine soil thickness. Locations where soil thickness is less than required shall be corrected. The CQA Consultant shall document placement of additional soil material to meet the requirements of the project plans and drawings.

STORMWATER MANAGEMENT PROGRAM

1. After a storm event WDI will lower the water level in each Collection Structure to or below the applicable Maximum Target Elevation (MTE) in accordance with this procedure. WDI will operate treatment systems as specified in the effective NPDES permit and POTW industrial pretreatment permit in such a manner as to restore water levels below the applicable MTE as quickly as practicable. Pumping will not begin until after the WWTP Manager or designee has determined that Sedimentation has reached an acceptable point.
2. After receiving authorization from the WWTP Manager or designee:
   2.1. Water from the Lined Pond and South Sedimentation Basin (SSB) will be treated in accordance with WDI's effective NPDES and POTW industrial pretreatment permits.
   2.2. Water will be pumped from the North Sedimentation Basin (NSB) to the SSB to be treated through the SSB treatment system. The transfer of water from the NSB to the SSB will normally not occur until the water level in the SSB is below the MTE and managed to ensure the SSB MTE is not exceeded. However, the WWTP Manager or designee may authorize pumping from the NSB to the SSB to begin before the water level in the SSB is below the MTE if, based on the sound judgment of the WWTP or designee, it is believed that such action is necessary in order to avoid overtopping the NSB and is expected to be accomplished without risk of overtopping the SSB.
3. Sediment levels will be measured annually in June (or as soon thereafter as practicable if water level prevents measurement) at the following locations. Annual measurement is considered an acceptable frequency because the average rate of sediment accumulation is on the order of six inches per year or less.
   3.1. Sedimentation Basins: Sediment elevations will be measured within each of the sampling sectors described in the Sedimentation Basins Sampling and Analysis Plan.
   3.2. Lined Pond: The Lined Pond will be divided into four equal quadrants. At least one measurement will be collected within each quadrant for a total of four measurements.
4. The elevation of the surface of accumulated sediment in each Collection Structure will be measured utilizing a GPS system or equivalent that is capable of measuring the elevation and x-y coordinates at each location. Either of the

following two approaches may be used to measure the elevation of the surface of sediment:

4.1. The Collection Structure drained such that the elevation of the surface of the sediment may be directly measured; or

4.2. From a boat the water surface elevation will be measured by survey and the depth below the water surface to the top of the sediment measured using a rope and a light-weight disc (disc must be heavy enough to sink in water but light enough to not sink in the sediment). The elevation of the surface of the sediment will then be calculated by subtracting the distance between the water surface and the sediment surface from the water surface elevation.

5. If the elevation of the surface of accumulated sediment in a Collection Structure is less than two feet below the MTE, WDI will remove the sediment to at least two feet below the MTE within 90 days.
6. Sediment removal from the sedimentation basins will be managed in accordance with the requirements of the Sedimentation Basins Sampling and Analysis Plan and the Hazardous Waste Management Facility Operating License.
7. Sediments removed from the Lined Pond will be managed in accordance with applicable federal, state and local regulations.
8. During a storm event that equals or exceeds a 25-year, 24-hour storm runoff may back up in the storm sewers, overtop certain catch basins and be contained on surrounding pavement by Critical Curbing until the sewers are able to catch up and the standing water drains away. According to calculations by CTI and Associates, a 25-year, 24-hour storm could cause standing water to reach an average depth of 7 inches in the area shown on Figure 02B-3 of the Storm Water Management System Evaluation Report (CTI and Associates, August 2021). These depths are not considered problematic for on-site traffic management. If any excess soil or debris remain on the pavement after the standing water has drained away, these residuals will be removed in a timely manner (e.g., sweeper or by washing the residuals into the nearest catch basin).

INSPECTIONS

1. Significant Rainfall Event Inspection: When a Significant Rainfall Event occurs, the Landfill Manager or designee will perform an inspection the next business day and document the inspection on the After-Storm Inspection form.
2. Storm Water Management System Inspection: The storm water Conveyance and Collection Structures will be inspected by the Landfill Manager or designee at the frequencies specified on the Storm Water Management

System Inspection form. This form lists the items to be inspected and has instructions for identifying unacceptable conditions and corrective actions. The form includes a set of figures and a table that identify the locations of components to be inspected and minimum required elevations (or heights) of diversion berms, ditches and curbing at specified inspection checkpoints.

DEFINITIONS:

Collection Structures: Refers to the lined pond, south sedimentation basin and north sedimentation basin.

Conveyance Structures: Ditches, culverts, diversion berms, Critical Curbing, catch basins, manholes and storm sewers that transmit storm water to the Collection Structures.

Critical Curbing. Curbing that is required in the Storm Water Management System Evaluation Report (CTI and Associates, August 2021) in order to contain runoff in excess of the transmission capacity of storm sewers. Also includes curbing that is necessary to direct pavement runoff to catch basins.

Design Storm:
A 100-year, 24-hour storm defined as 5.12 inches of rainfall in 24 hours from NOAA Atlas 14, Volume 8, Version 2
A 25-year, 24-hour storm defined as 3.95 inches of rainfall in 24 hours from NOAA Atlas 14, Volume 8, Version 2
A 10-year, 24-hour storm defined as 3.28 inches of rainfall in 24 hours from NOAA Atlas 14, Volume 8, Version 2

Maximum Target Elevation (MTE): The maximum target elevations is the water elevation within each collection structure below which a design storm will not result in an over flow. As an operational practice, it is desirable to keep water levels well below the MTE and to restore levels below the MTE as soon as practicable if the MTE is exceeded. The MTE in each collection structure must be marked with a monument that is surveyed and adjusted as required.

1. Lined Pond and South Sedimentation Basin: Maximum elevation above mean sea level of standing water that may occur within a Collection Structure at the start of the Design Storm that will provide a minimum of 0.5 feet of freeboard within the basin.
2. North Sedimentation Basin: The maximum elevation above mean sea level of standing water that may occur at the start of the Design Storm that will, after the Design Storm, leave freeboard for a minimum of 0.5 feet and an additional 3.28 inches of rainfall (10-yr, 24 hr).
3. MTEs, as calculated by CTI and Associates in a Technical Memorandum dated August 19, 2021 are:

3.1. Lined Pond:
3.2. North Sedimentation Basin:
3.3. South Sedimentation Basin:

Sedimentation: The removal of suspended solids by gravity settling from water retained in the Collection Structures.

Significant Rainfall Event: 0.5 inches or more of rainfall within a 24-hour period.

Attachment 1
Storm Water Repurposing Approval

Per EGLE approval, when needed, treated storm water from the South Sedimentation Basin may be used instead of potable water for spraying onto pavement, as well as dust suppression inside the active landfill. Water will be collected after carbon adsorption, but before discharge to the POTW. Runoff generated from the use of this water will collect in the Lined Pond, to then be discharged.

Mon 11/27/2017 10:50 AM

Taylor, Al (DEQ) <TAYLORA@michigan.gov>

RE: Storm water repurposing

To Sylwia Scott

Cc Quackenbush, Peter (DEQ); Tyson, Kimberly (DEQ); Busse, Mike (DEQ); Kecskemeti, Tracy (DEQ)

You forwarded this message on 11/27/2017 11:58 AM.

Good morning Sylwia –

As discussed during our last "touch base" call on November 13, 2017, MDI and WDI is approved to use the treated wastewater from the South Sedimentation Basin in lieu of potable water for the activities described your note below. We view this as a sustainable use of the carbon treated water.

Please contact me if you have questions or concerns.

Thank you,

Al

Allan B. Taylor, Manager
Hazardous Waste Section
Waste Management and Radiological Protection Division
Michigan Department of Environmental Quality
517-614-7335
taylora@michigan.gov

Mon 11/27/2017 10:50 AM

Taylor, Al (DEQ) <TAYLORA@michigan.gov>

RE: Storm water repurposing

To Sylwia Scott

Cc Quackenbush, Peter (DEQ); Tyson, Kimberly (DEQ); Busse, Mike (DEQ); Kecskemeti, Tracy (DEQ)

You forwarded this message on 11/27/2017 11:58 AM.

From: Sylwia Scott
Sent: Monday, August 21, 2017 8:12 AM
To: 'Taylor, Al (DEQ)'
Cc: Quackenbush, Peter (DEQ) (QUACKENBUSHP@michigan.gov); Kim Tyson (tysonk@michigan.gov)
Subject: Storm water repurposing

Al,

On our last bi-weekly call we discussed using treated storm water from the south sedimentation basin instead of potable water for spraying onto pavement as well as dust suppression inside the active landfill. This storm water is treated in accordance with our NPDES permit by sedimentation, filtration and activated carbon adsorption before discharge. When needed we propose to collect the water after carbon adsorption, but before discharge. When applied to paved areas, runoff generated from the use of the water will collect in the lined pond which also goes through sedimentation, filtration and carbon adsorption, but the water is then discharged to South Huron Valley Utility Authority POTW.

If you have any questions please let me know.

Sylwia Scott
Environmental Manager

WIND SPEED MONITORING PROGRAM

1.0 The Primary Wind Speed Sensor (PWSS) continually records and displays the Average Hourly Wind Speed (AHWS) and the Instantaneous Wind Speed (IWS) at the elevation corresponding to the Primary Active Face (PAF).

2.0 The PWSS is required to be positioned as follows:

2.1 The MMD/EGLE requires the PWSS be positioned along the southwest slope of Master Cell VI.

2.2 The MMD/EGLE requires the PWSS must be positioned at an elevation above mean sea level that is no lower than ten feet below the elevation at which waste is being placed. The PWSS may always be higher than this but never lower. The height of the sensor above its base must be taken into account when locating the appropriate position for the base. The elevation of the sensor, not the base, must be no lower than ten feet below the elevation of the location at which waste is being placed.

2.3 Coastal Environmental, the manufacturer of the current PWSS, requires the WeatherPak field sensor be maintained in an approximately vertical position to achieve maximum measurement accuracy.

3.0 If the PWSS indicates a Wind Speed Exceedance Level 1 (WSE1) at the PAF elevation:

3.1 WDI will conduct water application in accordance with SOP LOM-OP-009-BEL Standard Operating Procedure for Fugitive Dust Management.

4.0 If the PWSS indicates a Wind Speed Exceedance Level 2 (WSE2) at the PAF elevation:

4.1 All WDI Waste Placement Operations will stop immediately.

4.2 The PWSS may be moved to a lower elevation along the southwest slope of Master Cell VI corresponding to the elevation of an Alternate Active Face (AAF).

4.2.1. If there is not a WSE at the elevation of the AAF, waste placement operations may resume at the AAF and the Transfer Box. Waste placement may not occur at the PAF until the WSE at the elevation of the PAF has stopped.

4.2.2. If there is a WSE at the PAF and AAF or if there is not an AAF available, waste placement may not occur at the PAF or AAF until the WSE at those elevations has stopped; and the PWSS may be moved down the southwest slope of Master Cell VI to an elevation corresponding to the Transfer Box, which means an elevation not lower than ten feet below the elevation of the top edge of the wall of the WDI Transfer Box.

4.3 If there is a WSE at the PAF and the AAF, the PWSS may be moved to a lower elevation along the southwest slope of Master Cell VI corresponding to the elevation of the Transfer Box.

4.3.1. If there is not a WSE at the elevation of the Transfer Box, and if authorized by the Landfill Manager or designee, waste may be deposited into the Transfer Box; and waste may be pushed into piles in the Transfer Box to create as much temporary capacity in the Transfer Box as possible. However, normal waste segregation practices must continue to be observed in the Transfer Box, and waste may not be piled above the rim of the transfer box, until the WSE at the PAF or AAF has stopped.

4.3.2. If there is a WSE at the elevation of the Transfer Box:

4.3.2.1. None of the aforementioned waste placement operations may occur at the Transfer Box. However, if approved by the Landfill Manager or designee, non-bulk waste (e.g., containers, transformers, etc.) may be staged for inspection and sampling at the staging area adjacent to the WDI Transfer Box. Waste may not be placed into the Transfer Box or moved beyond the limits of the staging area until the WSE at the elevation of the Transfer Box stops and only if approved by the Landfill Manager or designee. Before authorizing non-bulk waste to be offloaded to the staging area, the Landfill Manager or designee must take into consideration the risk that non-bulk waste will have to be placed back on the delivery vehicle and rejected if the WSE preventing waste placement does not stop by the end of the operating day or if it is not desirable or possible to leave the waste in the Transfer Box in the event that only Restricted Waste Placement Operations are possible.

4.3.2.2. A handheld wind speed monitor may be used to check wind speed at the Transfer Box. The handheld monitor will be positioned at or above the top of the wall of the Transfer Box and within 20 feet laterally from the edge. IWS will be measured at least once per minute and the WSO will record IWS and calculated AHWS on the Handheld Wind Speed Monitor Log. If there is not a WSE, and if authorized by the Landfill Manager or designee, waste may be deposited into the Transfer Box and waste may be

pushed into piles in the Transfer Box to create as much temporary capacity in the Transfer Box as possible. However, normal waste segregation practices must continue to be observed in the Transfer Box and waste may not be piled above the rim of the transfer box.

5.0 In the event the PWSS is offline, switch to the Secondary Wind Speed Sensor (SWSS). At present the SWSS is located on the roof of the Receiving Department building because it is not a wireless system and there must be a direct connection between the sensor and the Receiver.

5.1 Because of the location of the SWSS, the MMD/EGLE requires that when using the SWSS the definition for a WSE be reduced 5 miles per hour lower than the definition of a PWSS WSE as defined in the Definitions section of this SOP.

5.2 The SWSS may be used as a substitute for the PWSS for up to two weeks unless a request for extension is approved by the MMD/EGLE.

5.3 WDI voluntarily operates a SWSS so that it is immediately available in the event the PWSS goes offline. Although WDI voluntarily operates a SWSS, WDI is not obligated to operate the SWSS, or record and store data output from the SWSS, until such time that the PWSS is offline and waste placement operations are occurring.

5.4 If the PWSS is offline and the SWSS indicates a WSE:

5.4.1. All WDI waste placement operations will stop immediately and may not resume until the WSE has stopped.

5.4.2. A handheld wind speed monitor may be used instead of the SWSS. The handheld monitor must be positioned at the same location and elevation that would otherwise have been required for the PWSS; all the same procedures described for PWSS monitoring followed; the definition of a PWSS WSE will apply; IWS will be measured once per minute; and the WSO will record IWS and calculated AHWS (calculated every 10 minutes) on the Handheld Wind Speed Monitor Log.

6.0 If the PWSS and SWSS are both offline:

6.1 A handheld wind speed monitor may be used. The handheld monitor must be positioned at the same location and elevation that would otherwise have been required for the PWSS; all the same procedures described for PWSS monitoring followed; the definition of a PWSS WSE will apply; IWS will be measured once per minute; and the WSO will record IWS and calculated AHWS (calculated every 10 minutes) on the Handheld Wind Speed Monitor Log.

6.2 The hand held wind speed monitor may be used as a substitute for the PWSS and SWSS for up to two weeks unless a request for extension is approved by the MMD/EGLE.

7.0 Whenever Waste Placement Operations are occurring at WDI, someone trained on the applicable parts of this procedure must perform the responsibilities of the Wind Speed Observer (WSO). This is required whether during normal receiving hours or outside of normal receiving hours including during waste transfer from MDWTP to WDI. Normally the WSO will be a Receiving Coordinator. If someone other than a Receiving Coordinator is acting as the WSO, that person will be responsible for performing all of the WSO duties described below.

7.1 Depending on the method of wind speed monitoring, the WSO may or may not need to be present in the Receiving building to access wind speed data.

7.1.1. The PWSS may be remotely monitored through the internet or by being present in the Receiving building.

7.1.1.1. If present in the Receiving building it is not necessary for the WSO to observe the wind speed display because an audible alarm will sound for the duration of any WSE.

7.1.1.2. If the WSO is remotely monitoring the PWSS through the internet, the WSO must observe the wind speed display at least once per 10 minutes to visually verify there is not a WSE.

7.1.2. The SWSS can only be monitored from the Receiving building. However, it is not necessary for the WSO to observe the wind speed display because an audible alarm will sound for the duration of any WSE.

7.1.3. When a handheld wind speed monitor is being used, the WSO may either be the person directly collecting wind speed measurements or may be remotely available to receive the data from the person performing the measurements. But in any case, someone must be present to perform and record the wind speed measurements and to calculate and record the AHWS.

7.2 The WSO will notify the Landfill Operators at the start and finish of each WSE. If the WSE occurs during an after hours waste transfer from MDWTP, the only notification by the WSO is to the MDWTP Shift Supervisor who will notify the MDWTP Waste Transfer Operator at the start and finish of each WSE.

7.3 The WSO will complete the Wind Speed Monitoring Equipment Downtime Log when the PWSS is offline. It is not required to document when the SWSS is offline unless both the PWSS and SWSS are offline.

7.4 During any after hours waste transfer from MDWTP to WDI, it is the responsibility of the MDWTP Shift Supervisor to act as the WSO or to designate an alternate WSO that has been trained on all the applicable parts of this procedure.

8.0 If directed by the Landfill Manager or designee, dust control operations may occur within the active area of the landfill during a WSE if necessary to manage dust emissions. However, during such activities, vehicle speeds will be minimized to reduce dust generation.

9.0 Daily cover will be placed at the end of each operating day whether or not there is an on-going WSE. However, if daily cover is placed during a WSE, dust generation will be managed by minimizing the speeds of vehicles used in the application of daily cover.

10.0 Only the Landfill Manager or designee may authorize PWSS power to be disconnected. Any employee that disconnects the power supply to the PWSS or is aware that the PWSS is offline for any reason must immediately notify the WSO so that a notation can be made to the Wind Speed Monitoring Equipment Downtime Log. If the Coastal Environmental WeatherPak is unplugged from its power source or loses power, it takes exactly one hour from the time power is restored before the AHWS will be displayed because it takes one hour to accumulate enough data to calculate AHWS (other data will be displayed in ten minutes). Until the AHWS display resumes, the SWSS must be temporarily used as the PWSS and the loss of power must be documented on the Wind Speed Monitoring Equipment Downtime Log. If the cause of the power loss is that someone has unplugged the sensor, even if unintentionally, that must be noted in the log.

11.0 Each day the Receiving Supervisor or designee will check wind speed forecasts for the next three business days and communicate forecasted WSEs to all of the following: WDI Director of Operations; WDI Landfill Manager; MDWTP General Manager; Customer Service Manager; Scheduling Coordinator; Transportation Manager; Rail Manager.

12.0 Whenever a WSE or series of WSEs causes time on site for any waste delivery vehicle to exceed three hours, the Receiving Supervisor will contact the appropriate USE Customer Service representatives to discuss whether trucks should be diverted to other facilities (e.g., WDI to MDWTP if possible) or scheduled to return on a different day.

CALIBRATION, MAINTENANCE AND DATA MANAGEMENT

1.0 Calibration/Service

1.1 PWSS: The Coastal Environmental WeatherPak does not require calibration per the owner's manual. However, preventive maintenance is recommended by the manufacturer every 12 months.

It is the responsibility of the Landfill Manager or designee to send the WeatherPak to Coastal Environmental for preventive maintenance every 12 months. The preventive maintenance schedule will be documented in the Compliance Calendar. Further, the alarm within receiving can be tested manually by blowing air across the sensor with an air compressor. This will be done annually as well or if it appears the alarm has malfunctioned.

1.2 SWSS: This sensor does not require calibration unless the propeller or propeller shaft have been damaged or distorted. WDI will send the sensor to the manufacturer every 2 years for evaluation of all bearings and preventive maintenance as needed to assure it is operating within factory standards. This preventive maintenance will be scheduled on the Compliance Calendar.

1.3 Handheld wind speed monitor: This sensor does not require calibration. Maintenance involves battery replacement as needed, and impeller replacement if it has become damaged or worn. The impeller must be totally intact and rotate freely without excessive play. in any case, WDI will replace the impeller every 2 years to assure the sensor is operating within standards. This preventive maintenance will be scheduled on the Compliance Calendar.

2.0 Data Storage

2.1 Only wind speed data collected during landfill waste transfer and placement operations is required to be stored however nothing in this procedure precludes WDI from storing more data.

2.2 PWSS:

2.2.1. Data must be stored electronically.

2.2.2. The Coastal Environmental PWSS generates one electronic data file per 24-hour day.

2.2.3. Coastal Environmental PWSS electronic data is stored at K:\Intercept Data\.

2.2.4. Electronic data files will be saved in the designated electronic folder at least once per week for any week in which the PWSS was the active wind speed sensor.

2.3 SWSS:

2.3.1. Data collected by the SWSS is not required to be stored unless the SWSS is the active wind speed sensor but if it is stored it should also be stored electronically.

2.3.2. R.M. Young SWSS electronic data is stored at: K:\RMY\.

2.3.3. Electronic data files will be saved in the designated electronic folder at least once per week for any week in which the SWSS was the active wind speed sensor.

2.4 Handheld wind speed monitor: Data collected by the hand held wind speed monitor, if any, must be documented on the Handheld Wind Speed Monitor Log which is stored in the Receiving building.

3.0 Time Settings

3.1 The Coastal PWSS receiver displays Coordinated Universal Time (abbreviated UTC, not CUT, consistent with international standards). The time setting on the Coastal receiver does not change throughout the year between Standard Time and Daylight Savings Time so the time setting should not need to be adjusted. UTC is 5 hours ahead of local time during Standard Time (first Sunday in November to the second Sunday in March) and 4 hours ahead of local time during Daylight Savings Time (second Sunday in March to first Sunday in November). UTC is often referred to as Greenwich Mean Time (GMT) although strictly speaking UTC's atomic time scale is only approximately the same as GMT. Time zones around the world are expressed as positive or negative offsets from UTC. In this role as the zero-point reference, UTC is also referred to as Zulu time (Z).

3.2 The R.M. Young SWSS time must be changed the first Sunday in November (Standard Time – back one hour) and the second Sunday in March (Daylight Savings Time – forward one hour) to stay current with local time. This is the responsibility of the Receiving Supervisor or designee.

INSPECTIONS

1.0 Once per operating day PWSS is verified to meet the following requirements

1.1 In accordance with MMD/EGLE requirements, the PWSS is positioned along the southwest slope of Master Cell VI.

1.2 In accordance with MMD/EGLE requirements, the PWSS is positioned at an elevation above mean sea level that is no lower than ten feet below the elevation at which waste is being placed. The PWSS may always be higher than this but never lower. The height of the sensor above its base must be taken into account when locating the appropriate position for the base. The elevation of the sensor, not the base, must be no lower than ten feet below the elevation of the location at which waste is being placed.

1.3 In accordance with Coastal Environmental requirements, the manufacturer of the current PWSS, the WeatherPak field sensor is maintained in an approximately vertical position to achieve maximum measurement accuracy.

2.0 Once per operating day verify that the Wind Speed Monitoring Equipment Downtime Log is up to date.

3.0 Once per week:

3.1 Verify that wind speed electronic data files have been stored in the designated electronic folders. This check will be documented on the Wind Speed Data Storage Verification Log. If corrective action is necessary, it will be noted on the Wind Speed Data Storage Verification Log.

3.2 Verify whether a Handheld Wind Speed Monitoring Log was generated since the previous inspection and, if so, whether the Log was properly filed. This check will be documented on the Wind Speed Data Storage Verification Log.

DEFINITIONS:

Alternate Active Face: An alternative location within the active area of the landfill that is at a lower elevation, and presumably experiencing a lower wind speed, compared to the Primary Active Face.

After Hours Waste Transfer: The transfer of waste from MDWTP into the WDI Transfer Box when no WDI Landfill Operators are present.

Average Hourly Wind Speed (AHWS): AHWS is the average of all wind speed data recorded in the most recent 60-minute interval. This number is a "rolling average" re-calculated every ten minutes using the most recent 60-minutes' data. So, for example, at 9:10 am the wind speed data collected from 8:10 am to 9:10 am is used to calculate AHWS. The PWSS and SWSS AHWS appears on the display screens from 9:10 am until 9:20 am at which time the AHWS is re-calculated using all wind speed data collected from 8:20 am to 9:20 am. The Coastal Environmental, R.M. Young, and Kestrel wind speed sensors calculate AHWS slightly differently:

1. Coastal Environmental PWSS: Measures wind speed once per second (60 readings per minute, 3,600 readings per hour) and then every 10 minutes it calculates the average of the most recent 3,600 measurements. The average of the most recent 3,600 measurements is the AHWS. This calculation is performed in the Weatherpak field sensor and then the calculated result is transmitted to the receiver once every 10 minutes.
2. R.M. Young SWSS: Measures the number of sensor revolutions that occur in each minute to calculate a one-minute average wind speed. Then, once

every ten minutes, it calculates the average of the 60 most recent one-minute average speeds.

3. Kestrel handled wind speed monitor: The WSO monitors the IWS and records it into the Handheld Wind Speed Monitor Log at least every minute. From these entries the WSO calculates and records the AHWS at least every 10 minutes.

Coastal Environmental: Manufacturer of the current PWSS. The component that is located in the field and measures wind speed is referred to by Coastal Environmental as the "WeatherPak." The Receiver is located in the Receiving building. The WeatherPak is not directly wired to the Receiver. Wind speed data is transmitted wirelessly from the WeatherPak to the Receiver. For help, contact Technical Support, Coastal Environmental, Seattle, WA, 206-682-6048 ext 138 or 800-488-8291 ext 138. See WeatherPak 2000 User Manual for additional details. Other information is available at www.coastalenvironmental.com.

Instantaneous Wind Speed (IWS): The Coastal Environmental, R.M. Young, and Kestrel wind speed sensors calculate IWS slightly differently:

1. Coastal PWSS: Measures a true instantaneous wind speed every second and then once a minute calculates the average of the most recent 60 readings. This average is reported as the IWS. This calculation is performed in the Weatherpak field sensor and then the calculated result is transmitted to the receiver once every minute.
2. R.M. Young SWSS: Measures the number of sensor revolutions that occur within each minute and converts number of sensor revolutions to an average wind speed for that minute.
3. Kestrel handheld wind speed monitor: The IWS is actually the average wind speed over the preceding 3-second observation period. The IWS is updated on the display every second. The WSO observes IWS and records it into the Handheld Wind Speed Monitor Log at least every minute."

Kestrel: Manufacturer of the current hand held wind speed monitor. See Kestrel 1000 Pocket Weather Meter Instruction Manual for further details. This sensor and instruction manual are retained in the office of the Landfill Manager.

Primary Active Face: The location within the active area of the landfill where waste is normally being placed at any given time.

Primary Wind Speed Sensor (PWSS): The device normally used to measure wind speed at WDI.

R.M. Young: Manufacturer of the current SWSS. Model number 05103. Web site is www.youngusa.com. See the MODEL 05103 WIND MONITOR MANUAL PN 05103-90 for further details. The sensor is located on the roof of the Receiving building. The receiver is located in the Receiving office. The sensor is connected to the receiver.

Secondary Wind Speed Sensor (SWSS): The device normally used as backup to the Primary Wind Speed Sensor to measure wind speed at WDI.

Waste Placement Operations: Unloading waste into the WDI Transfer Box; hauling waste from the Transfer Box to the Primary Active Face; spreading and compacting waste at the Primary Active Face.

WeatherPak: The component of the Coastal Environmental PWSS that is located outside and measures wind speed.

Wind Speed Exceedance Level 1 (WSE1):

1. If the PWSS is active or if a handheld wind speed monitor is being used: AHWS reaches or exceeds 20 miles per hour or IWS reaches or exceeds 25 miles per hour.
2. If the SWSS is active: AHWS reaches or exceeds 15 miles per hour or IWS reaches or exceeds 20 miles per hour.

Wind Speed Exceedance Level 2 (WSE2):

1. If the PWSS is active or if a handheld wind speed monitor is being used: AHWS reaches or exceeds 30 miles per hour or IWS reaches or exceeds 35 miles per hour.
2. If the SWSS is active: AHWS reaches or exceeds 25 miles per hour or IWS reaches or exceeds 30 miles per hour.

FUGITIVE DUST MANAGEMENT

1. **E ngineering Controls** - Engineering controls refer to physical features and equipment within the Active Area (Figure 1) that are used for management of fugitive dust.

    1.1. **Mobile Wind Screens -** WDI uses mobile wind screens at or near the active waste face to reduce wind speed, and to thereby reduce suspension and transport of dust, from the area of the active face. The number and location of screens deployed depend upon wind conditions and the size and location of the active face. WDI's objective is to maximize the number of mobile wind screens placed upwind of the active face; however, WDI's ability to place mobile wind screens may be limited by the size, surface and location of the active face. Mobile wind screens may occasionally need to be removed from the hazardous waste landfill for repairs which will temporarily limit availability for use.

    1.2. **Stationary Wind Screens -** WDI uses stationary wind screens around the waste transfer box to reduce wind speed, and thereby suspension and transport of dust, from waste transfer operations.

2. **O perational Controls -** Operational controls refer to activities that are used to manage fugitive dust. WDI shall take the following precautions to manage fugitive dust:

    2.1. **Size of the Active Face -** WDI will minimize the size of the active face to minimize the surface area exposed to wind erosion.

    2.2. **Daily Cover** - WDI applies ConCover™ daily cover products (ProGuard IIB Plus and SB) or an equivalent product or geotextile (GSE and/or Propex or an equivalent product) or six inches of soil to the active waste face at the end of each working day or other product approved by the OWMRP/MDEQ. If the working day ends early due to excessive wind speeds the daily cover will be applied at that time.

    2.3. **Speed Limit -** Vehicle speeds on paved areas are limited by posted signs to 6 mph with the exception of the road located between the WDI wheel wash facility and the WDI transfer box which has a posted limit of 16 mph. Speeds are limited for all non-paved areas of the site by posted signs at 16 mph. Employees are trained to observe vehicle speed limits. When a vehicle is observed exceeding the speed limit, the driver will be issued a warning. Warnings for non-USE employees are recorded in the Receiving Department and repeated

offenses may result in being banned from the site. Speeding by USE employees is handled by USE conduct policies. Within the active landfill, operators are trained to drive slowly to control dust emissions.

2.4. **Street Sweeping and Water Application** - All paved areas are swept or wetted at least once every operating day weather permitting. The application of water to paved areas is done on an as-needed basis to supplement sweeping. If the application of water is used as a substitute for sweeping due to sweeper maintenance, water will be applied as-needed to control dust for no longer than two (2) weeks unless DEQ approves a request for extension. Within the Active Area, water is applied to roads as soon as possible, weather permitting, following the observation of visible dust emissions from the roads.

2.5. **Snow Removal** - Snow removed from paved areas will either be stockpiled on pavement that drains to the lined pond or placed within the Active Area. Snow removed from paved areas will not be stockpiled on unpaved surfaces.

2.6 **Truck Tarps** - All trucks are to remain tarped unless they are being sampled/inspected or are being off-loaded. Signs posting this policy are present along the waste transport route and drivers are reminded at the waste acceptance area.

2.7 **Wind Speed Monitoring** - Wind speeds are continually monitored in accordance with the SOP LOM-OP-013-BEL Standard Operating Procedure for Wind Speed Monitoring. If wind speed limits are reached or exceeded during operating hours, alarms sound within the Receiving Building and the landfill operations staff are immediately instructed to act as follows:

- Wind Speed Exceedance Level 1 (WSE1): Conduct water application per Section 2.8 below.

- Wind Speed Exceedance Level 2 (WSE2): Immediately stop all waste placement operations. Follow the requirements of SOP LOM-OP-013-BEL for restart of operations.

2.8 **Water Application** - During times when wind speeds reach or exceed WSE1 but are below WSE2, WDI will apply water to the waste at the primary active waste face as follows:

Water Source and Application Equipment:

- 5000 gallon insert tank on articulated off-road truck, or 2500 gallon tank on daily cover machine on trailer.

- Hydraulically driven water pump.

- Conical or fan-pattern spray nozzle.
- Application Spray Options:
    - Spray nozzles on the rear of the insert tank assembly (one man operation and preferred method for personnel safety).
    - 50’ (minimum), 1” (minimum) diameter water hose (two man operations and secondary method as necessary during waste unloading).

Water Source and Application Equipment:

- The water source, application equipment and operating personnel will be deployed sufficiently near the location of unloading and waste placement to reach the waste.
- The operating personnel will continually observe unloading and placement operations at the active face. If water source and application equipment are not present or functional, or if operating personnel are not present to continually observe and apply water as needed, waste unloading and placement activities at the active face will stop.
- The operating personnel will use the water source and application equipment to apply water to the waste as necessary to prevent visible dust generation at all times during waste unloading and placement operations at the active face.

DEFINITIONS:

Active Area: Refers to any part of the landfill that has not yet been closed by construction of a final cover barrier or interim closed with two feet of clay or other interim barrier approved by the Michigan Department of Environmental Quality Waste and Hazardous Materials Division. The boundary of the Active Area is identified as the edge of final cover or interim final cover barriers.

Affected Employees: Any employee that has to work in, or in close proximity to, the Active Area.