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September 16, 2022

Ms. Ann Bekta
Wisconsin Department of Natural Resources
Janesville Service Center
2514 Morse Street
Janesville, WI 53545-0249

Subject: Waste Management of Wisconsin, Inc. - Orchard Ridge Recycling and Disposal Facility
Proposed Eastern Expansion, Southern Unit
Plan of Operation - Addendum 1
Village of Menomonee Falls, Waukesha County, Wisconsin
License No. 4491

Dear Ms. Bekta:

On behalf of Waste Management of Wisconsin, Inc. (WMWI), this letter provides responses to the Wisconsin Department of Natural Resources (WDNR)'s March 23, 2022 Incompleteness Determination (Incompleteness Letter) for the Orchard Ridge Recycling and Disposal Facility (Orchard Ridge RDF) Eastern Expansion, Southern Unit (Southern Unit). This is Addendum 1 to the February 18, 2022 Plan of Operation (Feb 2022 POO) for the Southern Unit.

Attachment 1 to this addendum includes certification statements relating to Addendum 1.
Attachment 2 contains the above-referenced WDNR Incompleteness Letter.

This addendum is presented in the form of a letter such that each item requiring additional information is shown in bold text followed by WMWI's response. The Incompleteness Letter is broken into three parts (A, B, and C). This addendum addresses the incompleteness items from part A of the Incompleteness Letter. Responses to parts B and C will be provided under a separate cover.

If additional materials are needed to supplement the textual response, these supplemental materials are provided within attachments to this Addendum 1.

PART A

The following responses to Items A.1 to A.27 address the required additional information requested in "Part A – Information Required to Complete the Plan of Operation" of the Incompleteness Letter.

A.1 Noncompliance with Plans or Orders [s. 289.34, Stats. and s. NR 514.04(3), Wis. Adm, Code]: Please review the related information you provided in your recent feasibility report, update it as necessary to reflect current conditions, and indicate whether or not all plan approvals and orders relating to the identified facilities are being complied with.

Response: The August 2022 compliance status with plans and orders is provided in **Attachment 3**.

A.2. Condition 5 of the department's July 30, 2021 feasibility determination: The report did not include a description of the health and safety protocols to be used during the Boundary Road Landfill (BRL) exhumation process.

Response: Section 4.5.2 of the Property Redevelopment Plan (Appendix C of the Feb 2022 POO), describes the minimum health and safety requirements to protect workers potentially exposed to hazardous substances.

A.3. Condition 9 of the department's July 30, 2021 feasibility determination: The report did not include a plan to evaluate for potential endangered or threatened wildlife species that may be impacted during construction events before each construction event and how any potential impacts would be addressed.

Response: Section 1.6 Item 9 in the Feb 2022 POO did provide a plan to evaluate for potential endangered or threatened wildlife species that could be impacted during construction events and how potential impacts could be addressed. Specifically, before each construction event an evaluation will include a review specifically of the potential for the construction event to create impacts to Bald Eagles to the extent that these impacts may constitute "disturbance." The assessment of impacts and subsequent mitigation strategies to address construction event impacts that could cause a disturbance of Bald Eagles will be generally carried out using the U.S. Fish and Wildlife Services "National Bald Eagle Management Guidelines" published in May 2007. Potential mitigation strategies that may be implemented during construction events to limit potential "disturbances" to Bald Eagles include: providing an adequate buffer from identified nesting sites, limiting the duration of the event, or avoiding certain construction activities such as clearing and grubbing within specified distances of an identified nest during the breeding season.

A.4. Condition 14 of the department's July 30, 2021 feasibility determination: The report did not include a clear proposal for drainage of granular or silty soil encountered at subbase grades as necessary to allow removal of the granular or silty soils and replacement with compacted clay soils. Different methods are mentioned within the report but are not explained how or when they would be used.

Response: Experience gained from landfill construction adjacent to the Southern Unit indicates there will be minimal need to provide more than a typical pump to dewater granular or silty soil encountered at subbase grades to allow removal of the granular or silty soils and replacement with compacted clay soils. Section 2.6.1 of the Feb 2022 POO describes the rationale for subbase grades which includes providing separation from the intermediate sand seam which will limit the need to drain granular or silty soil encountered at subbase grades. In addition, the East Expansion and each phase of the Southern Unit includes an underdrain system which is and will continue to lower the immediate groundwater table adjacent to the subsequent construction phase. Therefore, as indicated in the response to Condition 14 on page 1-23 of the POO, the means and methods for removal of granular or silty soils encountered during subbase preparation will be evaluated on a case-by-case basis. Should waste and/or soils that require excavation below proposed subbase grades be found in a saturated condition to the extent that they cannot be removed and replaced with traditional undercut and backfill methods, dewatering methods using a pump will be used as needed to maintain suitable water levels for removal and

replacement of these materials. Dewatering will continue until subbase fill has been adequately placed and compacted to the proposed subbase grades.

The recommended construction sequence and procedures for removing and replacing saturated waste and/or soils below subbase grades are described below:

- Remove BRL waste and overburden soils to subbase grades and evaluate if remaining waste and soils below subbase grades can be removed and replaced with subbase fill utilizing traditional excavation and backfilling methods without dewatering. This may be evaluated by excavating a pit in waste and soils below subbase and visually inspecting to see if the pit fills in with free liquids or if the sidewalls of the excavation slough due to saturated conditions.

- If the conditions above are not exhibited, subbase excavation and backfilling may proceed without dewatering. Should these conditions be exhibited, a dewatering system will be constructed and operated to maintain free liquid levels below the bottom of the subbase over excavated areas until backfilling with subbase fill material to subbase elevations is complete.

- Dewatering may be accomplished by excavating a temporary sump below the excavation elevation and placing and operating a pump to remove and maintain free liquid level below the excavation until all materials have been removed and backfilled to subbase elevations.

A.5. Condition 16 of the department's July 30, 2021 feasibility determination: The report did not include a detailed description of subbase construction methods in the area of BRL waste exhumation and the BRL pond removal.

Response: As provided in Section 2.4 of the Feb 2022 POO, "the over-excavation will be backfilled to proposed subbase grades with subbase fill." Additionally, Section 2.6.1 (Subbase Grades) specifically includes detailed construction methods, specifications for acceptable materials, compaction requirements, and references the Quality Assurance Manual in Appendix H which specifies necessary subbase construction testing methods, frequencies, and documentation requirements.

A.6. Condition 18 of the department's July 30, 2021 feasibility determination: The report did not include a detailed proposal of methods to continuously remove leachate from the existing leachate sump during the extension of the sump riser pipe and manhole to be located in the Triangle Area. Also, not all of the information provided in the April 1, 2021 Addendum #2 was provided in this report.

Response: As detailed in Section 3.7.3.2 of the Feb 2022 POO, leachate head levels within Phase 2 will be maintained during construction of the proposed extension of the sideslope riser manhole SSR03E. Temporary leachate extraction infrastructure may be used such as aboveground leachate forcemain, manual extraction operations, or other similar options. At no time during construction of the extension of the sideslope riser will head be allowed to accumulate in amounts greater than 1-foot on the liner. The recommended construction sequence for this sideslope riser extension is:

- Keep existing leachate sideslope riser, and pump, active by utilizing a temporary forcemain pipe within the limits of waste of East Expansion Phase 2 to convey liquids from the SSR03E north to a connection point on the existing forcemain outside the tie-in limits proposed for Southern Unit Phase 5 Liner.

- Construct the Phase 5 Module 1 composite liner.

- Construct the perimeter infrastructure, including the new sideslope riser manhole, forcemain, and electric panel.

- Abandon the existing sideslope riser, install the 18-inch sideslope riser pipe from Phase 2 to the new sideslope riser manhole, install pump, and energize system.

- Abandon the old electrical panel.

After reviewing the April 1, 2021, Addendum #2 the only information not called out was the 18-inch-diameter fabricated pipe bend installed at the transition between the existing East Expansion 3:1 sideslope and the proposed grades in the Triangle Area initiating the relocation extension (Detail 1 on Sheet 34). This fitting is not called out in the POO because as called out additional stone is being shown under the riser pipe to support the pipe and minimize the slope transition so that a fitting may not be necessary. Orchard Ridge RDF would like the option to make this transition without a fitting, if possible. Pump installation and removal will not be impacted by the presence or absence of a fitting at this transition.

A.7. Condition 23 of the department's July 30, 2021 feasibility determination: The storm water pollution prevention plan did not adequately address storm water pollution prevention measures related to the exhumation of BRL, including the transport of exhumed waste between landfills.

Response: Section 3.7 of the Storm Water Prevention Plan discusses erosion and sediment control practices to be implemented as part of construction, which includes exhumation of BRL.

Waste handling, contact water, and leachate management are addressed in the Property Redevelopment Plan. Pertinent sections relating to this information request are summarized below.

- Section 4.3.2 of the Property Redevelopment Plan describes the typical waste handling procedures, including materials that are saturated when excavated will be allowed to drain and/or be mixed with drier waste prior to loading into trucks to prevent the separation of liquids from the waste during transportation or placement.

- Section 4.8 of the Property Redevelopment Plan address procedures for contact water and leachate collection. More specifically, leachate and/or groundwater that is encountered during excavation of BRL, including contact water that is generated by precipitation falling on the waste, will be collected to the extent possible, and will be discharged to the sanitary sewer or another approved discharge option.

- Section 5.1 of the Property Redevelopment Plan describes leachate and contact water management. Specifically, collected leachate, groundwater, and contact water will be discharged to the sanitary sewer, consistent with current management of BRL leachate, unless alternative leachate discharge options are approved.

A.8. Condition 26 of the department's July 30, 2021 feasibility determination: The report did not include an evaluation of the existing gas header pipe to determine if modifications are needed to manage the additional landfill gas generated by the expansion.

Response: The Feb 2022 POO, Appendix Q: Landfill Gas Management System Calculations include assessment of the existing gas header pipes to the destruction equipment and demonstrates that the designed system is adequately sized.

A.9. Condition 27 of the department's July 30, 2021 feasibility determination: The report did not address the abandonment procedures for gas extraction wells in the area outside of BRL; specifically, gas extraction wells which are abandoned in areas with final cover.

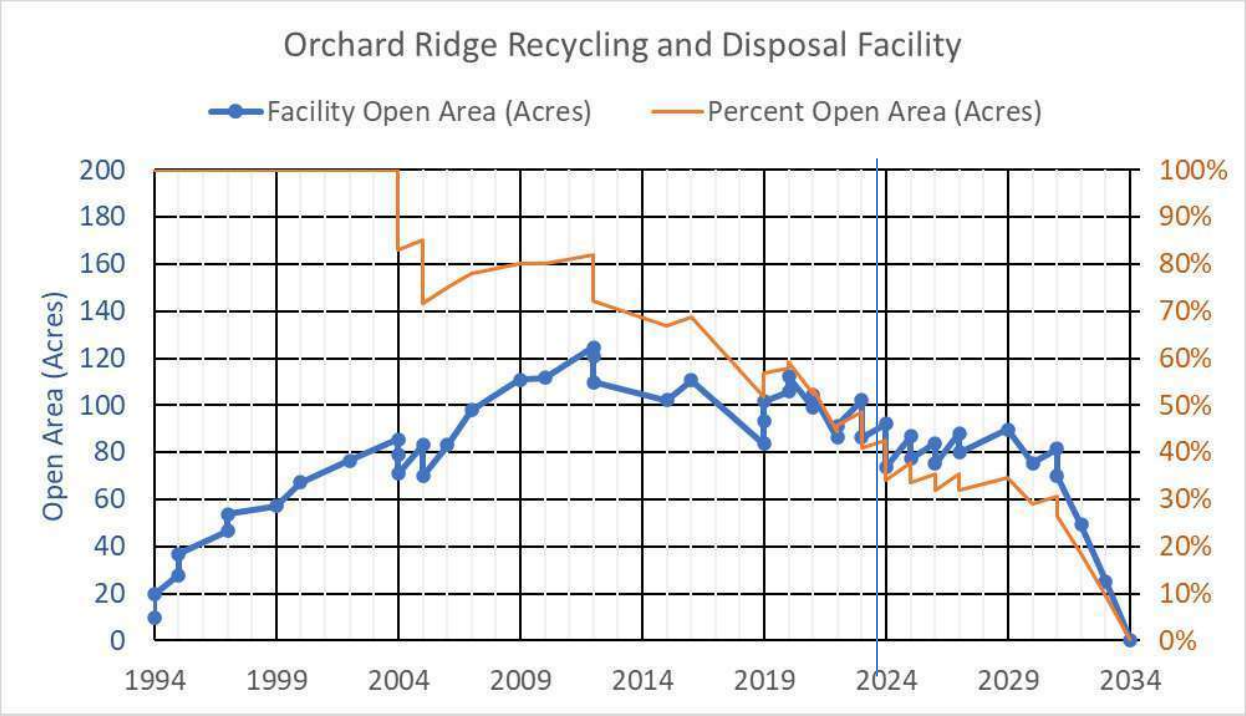
Response: Existing landfill gas extraction well abandonment within intermediate or final cover typically includes:

- Excavating a minimum 5-feet below existing grade.
- Filling the existing well pipe with expanding foam and allowing foam to set.
- Once foam is set, pulling the well out may be attempted. If the well will not pull out, a hard cap shall be installed on top of well casing.
- A minimum 2-foot thick bentonite plug shall be installed over existing well or borehole
- Backfill excavation, repair and document impacted final cover components with materials and methods meeting the specifications and requirements of the POO and QAM.

A.10. Condition 30 c. and d. of the department's July 30, 2021 feasibility determination: The report did not include a detailed description of the phased development, filling, and closure sequencing that minimizes the time and area outer side slopes are under intermediate cover and filling so final grades are reached as soon as possible.

Response: Detailed phased development, filling and closure sequencing is described in Plan Sheets 8-14 and 17 and in Section 6.4 of the POO text. Filling and sequencing will be conducted in a manner to minimize the time and area of the outer slope that is under intermediate cover. In order to relocate waste from BRL as quickly as possible and minimize the timeframe that this waste mass is uncovered during excavation, the sequencing presented in the POO does require the presence of intermediate slopes on the north side of Phases 3 and 4B to help expedite the waste relocation process. Orchard Ridge RDF will place and maintain 24 inches of intermediate cover on these slopes during the BRL waste relocation process, and until this area is laid over with waste placed in Phases 3B and 4C.

The following chart and table show the currently active facility liner and cover construction sequencing events starting in 1994 through closure which is anticipated to be in 2034 for both license numbers 3360 (Orchard Ridge North and South) and 4491 (East Expansion and Southern Unit). The information is presented to demonstrate that Orchard Ridge RDF requires substantial open active areas due to its proximity to the Milwaukee metro area. Orchard Ridge RDF facility accepts more waste volume and waste types on a daily basis than any other landfill in Wisconsin. The size and complexity of this site requires a larger operational space than other typical Wisconsin landfills to operate safely and efficiently at its current waste acceptance and construction rates. More specifically, operational safety includes having multiple access roads and points for managing various materials, sufficient area for various size trucks to turn around in the active area and to access the tipper alongside the compactors and dozers. Operations also manages large quantities of material in the open landfill areas, including clean fill for daily and intermediate cover, beneficial use materials for daily cover, and biosoil processing. Despite these requirements for space, final cover construction is planned to occur almost every year for the remainder of the landfill life. As detailed below Orchard Ridge RDF continues to minimizes the time and area of the outer side slopes that are under intermediate cover and the current capping schedule will continue to minimize the percent of open area at the facility.



Year Constructed	Landfill License and Construction Events	Construction Event Acres	Facility Open Area (acres)	Percent Open Area (acres)
1994	3360 Phase 1 Mod 1	9.9	9.9	100%
1994	3360 Phase 1 Mod 2	9.8	19.7	100%
1995	3360 Phase 2 Mod 1	8.0	27.7	100%
1995	3360 Phase 2 Mod 2	9.0	36.7	100%

Year Constructed	Landfill License and Construction Events	Construction Event Acres	Facility Open Area (acres)	Percent Open Area (acres)
1997	3360 Phase 3 Mod 1	10.0	46.7	100%
1997	3360 Phase 3 Mod 2	7.0	53.7	100%
1999	3360 Phase 3 Mod 2B	3.5	57.2	100%
2000	3360 Phase 4 Mod 1	10.0	67.2	100%
2002	3360 Phase 4 Mod 2	9.4	76.6	100%
2004	3360 Phase 1A	9.0	85.6	100%
2004	3360 cap 2004-1	(6.6)	79.0	92%
2004	3360 cap 2004-2	(8.0)	71.0	83%
2005	3360 Phase 1B	12.0	83.0	85%
2005	3360 cap 2005	(13.2)	69.8	72%
2006	3360 Phase 2	13.4	83.2	75%
2007	3360 Phase 3	14.7	97.9	78%
2009	3360 Phase 4	13.1	111.0	80%
2010	3360 Phase 4 West	0.7	111.7	80%
2012	3360 Phase 5	13.0	124.7	82%
2012	3360 cap 2012-1	(4.0)	120.7	79%
2012	3360 cap 2012-2	(10.9)	109.8	72%
2015	3360 cap 2015	(7.7)	102.1	67%
2016	3360 Phase 6	8.5	110.6	69%
2019	3360 cap 2019	(27.1)	83.5	52%
2019	4491 Phase 1A	9.8	93.3	55%
2019	4491 Phase 2	8.2	101.5	57%
2020	4491 Phase 1B	4.4	105.9	58%
2020	4491 Phase 3A	6.4	112.3	59%
2021	3360 cap 2021	(13.2)	99.1	52%
2021	4491 Phase 4A	5.1	104.2	53%
2022	3360 cap 2022	(17.8)	86.4	44%
2022	4491 Phase 4B	4.8	91.2	46%
2023	4491 Phase 5 Mod 1	10.9	102.1	49%
2023	3360 cap 2023	(15.9)	86.2	41%
2024	4491 Phase 5 Mod 2	5.8	92.0	43%
2024	3360 cap 2024	(18.4)	73.6	34%
2025	4491 Phase 6 Mod 1	13.2	86.8	38%
2025	3360 cap 2025	(9.6)	77.2	34%
2026	4491 Phase 6 Mod 2	6.7	83.9	36%
2026	3360 cap 2026	(8.7)	75.2	32%
2027	4491 Phase 7 Mod 1	12.8	88.0	35%

Year Constructed	Landfill License and Construction Events	Construction Event Acres	Facility Open Area (acres)	Percent Open Area (acres)
2027	4491 Area A cap	(8.2)	79.8	32%
2029	4491 Phase 7 Mod 2	10.0	89.8	35%
2030	4491 Area B cap	(14.5)	75.3	29%
2031	4491 Phase 3B & 4C	6.2	81.5	31%
2031	4491 Area C cap	(11.5)	70.0	26%
2032	4491 Area D & E cap	(20.7)	49.3	19%
2033	4491 Area F & G cap	(24.2)	25.1	9%
2034	4491 Area H & I cap	(25.1)	0.0	0%

A.11. Condition 34 of the department's July 30, 2021 feasibility determination: The report did not provide a clear plan for protecting wetlands and waterways from indirect impacts. The response to condition 34 differs from other areas of the report, such as 3.2.1.

Response: Subsection 3.2.1 of the Feb 2022 POO details the protective measures that are proposed to be implemented during construction and prior to final stabilization, to protect the remaining wetland and waterway areas from indirect impacts. As detailed, these measures include demarcating the boundary and installing barriers/erosion and sediment control features along the boundary. This practice would prevent vehicle encroachment into the protected areas and provide protection from sediment and erosion impacts prior to the site's final stabilization.

Condition 34 of the Department's July 30, 2021, feasibility determination referenced s. NR 151.12(5)(d)(1), which details post-construction performance standards following construction and after final stabilization has occurred. Specifically, s. NR 151.12(5)(d)(1) details the protective area widths for wetland and waterways to protect the features from indirect runoff impacts. The response provided to Condition 34 in the Feb 2022 POO is related to meeting this post-construction standard.

As detailed in the Condition 34 response, the wetlands observed in the vicinity of the Southern Unit require protective areas that range from 30 feet to 50 feet, which encompasses the outboard slope of the perimeter berms of the Southern Unit. However, the access road is located outside the protective area; therefore, the constructed area within the protective area is not considered impervious. Once final stabilization is met, the area will be maintained with a vegetative cover of 70% or greater, meeting the requirements of s NR. 151.12(5)(d)(3)(b).

In addition, storm water management features that discharge into wetland and waterway areas are designed to reduce total suspended solids during post-development by 80%, providing additional protection to wetland and waterway areas from indirect impacts. The outlets from the storm water management features have been designed to discharge in a controlled manner that limits impacts to the wetlands and waterways.

Wetland and waterway permits for the Southern Unit project and associated impacts, consistent with the Feb 2022 POO, were issued by the Wetland and Waterway Section of the WDNR and United States Army of Corps of Engineers, dated September 13, 2021 (amendment issued September 30, 2021) and December 7, 2021, respectively.

A.12. Geocomposite Lined Landfills [s. NR 504.06(3)(e), Wis. Adm. Code]: The report did not include information regarding geomembrane panels being welded by double-tracked, fusion welding machines for all linear seams, corners, butt seams and long repairs.

Response: Sections 11.7.2 and 12.6.2 of the QAM were updated to clarify that geomembrane panels made of polyethylene resins shall be welded by double−tracked, fusion welding machines for all linear seams. Corners, butt seams and long repairs shall be fusion welded where possible. Extrusion or fusion welding shall be used for all other repairs, detail work and patches. Department approval shall be obtained prior to use of any other welding method for either panel seaming, repairs, or construction of details. The revised QAM is provided in **Attachment 4**.

A.13. Leachate Collection System [s. NR 504.06(5)(j)5, Wis. Adm. Code]: The report did not include information regarding the area of the sump and depth of gravel fill being sized to allow remedial installation of access and hardware for removal of leachate in the event of failure of the sideslope riser and pump system.

Response: Leachate sump details are provided on Sheet 30. As shown, the sumps are 4 to 5 feet deep and 12 to 14 feet wide and long. Appendix K.7 provides more specific information on the leachate sump sizing. In the event of a failure of the sideslope riser and pump system, which is extremely rare, vertical wells can be drilled to install a remedial pump system to remove leachate.

A.14. Active Gas Extraction [s. NR 504.08(2)(a), Wis. Adm. Code]: Plan sheet 18 did not include vertical gas extraction wells throughout the entire landfill with a maximum radius of influence of 150 feet per well.

Response: Drawing Sheet 18 and Section 2.14.3 of the Feb 2022 POO provides the radius of influence (ROI) for each gas extraction well with a maximum 150 feet. Drainage mounds associated with these proposed gas extraction wells are installed during liner construction. In the future, supplemental wells may be proposed as needed to support enhanced landfill gas extraction if needed to meet compliance goals or support future projects such as renewable gas to energy.

A.15. Active Gas Extraction [s. NR 504.08(2)(b)-(f) and (l), Wis. Adm. Code]: The report did not include the information regarding vertical gas extraction wells.

Response: Vertical landfill gas extraction wells are described in Section(s): 2.14.3, and 3.11.1 of the Feb 2022 POO. These sections of the report reference details in the POO Plan Set which include information relevant to s. NR 504.08(2)(b)-(f) and (l). Furthermore, Section 2.12.4 specifically describes the use of polyethylene pipe being used for header and lateral pipes per s. NR 504.08(2)(l). The typical vertical gas extraction well detail is called out on Plan Sheet 18 as Detail 7 of Sheet 40. This detail describes:

- The gas extraction well shall extend to a minimum of 10 feet above the leachate collection drainage layer and is installed in a 36” diameter borehole per s. NR 504.08(2)(b).
- The minimum pipe diameter for the well must be six inches per s. NR 504.08(2)(c).

- The backfill around the slotted or perforated pipe in the borehole to be one to one and 1/2 inch washed stone, and that the top 10 feet of the borehole shall be sealed per s. NR 504.08(2)(e).

- The wellhead detail is called out as Detail One on Sheet 41 which contains a flow control valve and sampling access port s. NR 504.08(2)(f).

Detail 7 on Sheet 40 has been updated to further clarify compliance with [s. NR 504.08(2)(b)-(f), Wis. Adm. Code] and is provided in **Attachment 5**.

A.16. Miscellaneous [s. NR 504.09(2)(g), Wis. Adm. Code]: The report did not include information regarding the landfill being designed such that final waste grades are reached as soon as possible, and open refuse filling area is minimized.

Response: See response to Comment A.10 which indicates how landfill construction will be timed to match the incoming waste volume thereby requiring establishment of final waste grades as soon as possible while also accommodating efficient BRL waste relocation, operational considerations, including vehicle and equipment access, liner, and cover materials management, and achieving organic stability goals.

A.17. Leachate Recirculation [s. NR 504.095(1)(f), Wis. Adm. Code]: The report did not include specific information regarding operations expected in all weather and seasons of operation.

Response: Appendix L Leachate Recirculation Plan describes the operational requirements for recirculating leachate within the waste mass at Orchard Ridge RDF. Section 5 of this plan describes warning symptoms and failure thresholds that Orchard Ridge RDF must monitor for during all weather and seasons. Should any of the warning symptoms or failure thresholds be triggered as a result of climate, weather, or seasonality changes recirculation operations will cease until further investigation or operational modifications can prove the conditions causing the warning symptom are no longer present. Specific measure to be taken during expected weather or seasonal changes include:

- Measures shall be taken to prevent cold weather freeze up of leachate distribution equipment if used during the winter months.

- Leachate recirculation will be suspended upon discovery of warning symptoms as presented in Section 5.1, and should weather/climate or seasonality events be attributed to the root cause of the warning symptom recirculation will be suspended until the warning symptom subsides or is remedied.

- Leachate recirculation will be suspended whenever the failure thresholds identified in Section 5.2 are exceeded due to weather/climate or seasonality events and will not resume until WDNR has reviewed and approved changes to the system that will result in meeting the thresholds.

A.18. Existing Conditions [s. NR 514.05(2), Wis. Adm. Code]: The drawings did not include an existing condition plan which included a detailed topographic map of the existing

Orchard Ridge Eastern Expansion Landfill. The drawing should also depict the existing leachate forcemain on the south side of the Eastern Expansion.

Response: Existing conditions Plan Sheets 3 and 4 have been updated and are included in **Attachment 5**.

A.19. Waste Final Grades [s. NR 514.05(7), Wis. Adm. Code]: The drawings did not include a final waste plan which shows final waste grades without the 5% intermediate waste grades.

Response: Sheet 15 shows final waste contours. The points provided are to be cross referenced with Sheet 16 for the 5% intermediate waste grades.

A.20. Design Rationale [s. NR 514.06(3), Wis. Adm. Code]: The report did not include design rationale for phases of landfill development and closure specifically relating to construction of Phases 3B and 4C, how delaying that construction impacts final cover placement, and justification for the exhumation of the Boundary Road Landfill occurring over 6 to 8 years. Also, include a revised construction sequencing table (Section 6.1) with total acres open/closed after each construction event and review calculations that utilize the acreage for the maximum open area.

Response: Refer to response to Comment A.10 which provides a summary of cell and cover construction sequencing.

A.21. Stormwater Management [s. NR 514.06(5)(d), Wis. Adm. Code]: The report did not include a list of anticipated actions and materials needed for sediment and erosion control.

Response: The Feb 2022 POO detailed several items that may be used for sediment and erosion control and provided estimated quantities of silt fencing that would be needed on Plan Sheets 8-14. The Orchard Ridge Storm Water Pollution and Prevention Plan (SWPPP) was updated for the proposed project and included as Appendix P of the Feb 2022 POO. The SWPPP details several erosion and sediment control practices utilized at the facility in Section 3.5 and 3.7 of the SWPPP.

Subsection 2.12 of the Feb 2022 POO detailed that temporary diversion berms and/or ditches, silt fence, and/or hay bale check dams will be used to divert surface water and control erosion during active construction. In addition, Subsection 3.2.1 detailed the use of silt fence for wetland protection against indirect impacts. During operation and following closure the use of drainage ditches and sedimentation basins will be used to manage surface water. The storm water management system is proposed to be inspected after each rainfall event of ½-inch or greater during construction, as detailed in Subsection 3.9.1, along with weekly inspections during construction. Repairs will be made as soon as possible to restore the storm water system to proper operating condition.

A.22. Long-Term Care [s. NR 514.06(11), Wis. Adm. Code]: The report did not include a discussion of inspection procedures, such as an inspection checklist, for monitoring devices during the long-term care period.

Response: A long-term care inspection checklist is provided as **Attachment 6**.

A.23. Design Calculations [s. NR 514.06(14), Wis. Adm. Code]: The report did not include refuse to cover balance computations.

Response: As detailed in Appendix E, Table E-1, Note 4 of the Feb 2022 POO, waste to daily cover ratio = 5:1 (5 parts waste to 1-part daily cover). Treated biosoil from the Boundary Road Landfill grading layer is assumed to be available as daily cover material.

A.24. Financial Responsibility [s. NR 514.06(15), Wis. Adm. Code]: The report did not include assumptions used in developing the cost estimates and rationale for the selected cost factors.

Response: The closure and long-term care activities and cost estimates were presented in the November 6, 2018, East Expansion Plan of Operation, Addendum 3, in accordance with s. NR 520.07, Wis. Adm. Code. The East Expansion Plan of Operation was approved by WDNR in a letter dated February 27, 2019. The Feb 2022 POO presented updated site closure and long-term care costs to match the largest final cover closure area of 89.9 acres, anticipated to occur in year 2029 as indicated in Item A.10 above. The acreage accounts for liner and closure construction activities associated with License Number 4491. The closure and long-term cost estimates were provided in Appendix T as Tables T-1 and T-2, respectively. Costs are presented in 2022 dollars based on recent contractor and supplier costs for applicable items (i.e., third party estimates).

Site closure components include construction of the landfill gas extraction system, final cover, storm water control system, landscaping, testing, and engineering/documentation. The final cover configuration is based on using a soil barrier layer, geosynthetic clay liner (GCL), 40-mil double-sided textured LLDPE geomembrane, geonet geocomposite drainage layer, a rooting zone layer, and topsoil. The cost estimate assumes the use of imported clean borrow for the soil barrier layer, rooting zone, and topsoil. These types of materials are currently imported to the site (for clean fill disposal) and are expected to remain readily available locally at a reasonable cost to a third-party contractor.

Long-term care activities include annual costs for environmental monitoring, land surface maintenance and inspections, groundwater wells maintenance, gas extraction system operation and maintenance, leachate collection and treatment, electrical, and reporting. The costs are presented in 2022 dollars and reflect third party sampling and laboratory fees for applicable items (i.e., third party estimates).

WMWI will continue to use a letter of financial credit to provide proof of financial responsibility for closure and long-term care costs.

A.25. Closure of Landfills with Composite Liners and Composite Caps [s. NR 514.07(3)(b), Wis. Adm. Code]: The report did not include the information regarding no additional waste placement in areas which have reached final grades and received intermediate cover.

Response: When waste have reached final grades or the maximum 5 percent overfill elevation (to accommodate settlement) and intermediate cover has been placed, additional waste will not be received in those areas. As specified in Subsection 2.10.1 of the Feb 2022 POO, waste that does not settle to the proposed final waste grades at the time of final cover construction will be relocated as needed.

A.26. Other Requirements [s. NR 514.07(6)(c), Wis. Adm. Code]: The report did not include information relating to pump selection based on highest leachate flow rate which includes leachate recirculation.

Response: Appendix K.7 has been revised to include the additional leachate generation due to leachate recirculation practices. The proposed pump is sufficient to empty the worst-case leachate volume scenario during open conditions and maintain liquid levels within the sump volume when operating at reduced pumping rates. The revised appendix is included in **Attachment 7**.

A.27. Extended Collection Lines [s. NR 514.07(8)(c)1, Wis. Adm. Code]: The report did not include pipe strength calculations for wet unit weights, densified waste after consolidation and decomposition, and the potential use of leachate recirculation.

Response: The unit weight for waste utilized in Appendix K.5 – Pipe Strength Calculations was 83 pounds per cubic feet. The justification behind utilizing this unit weight for waste was provided in Appendix I.2 – Geomembrane Protection, and is as follows:

> "The overlying waste material is assumed to have a field unit weight of 83 pounds per cubic foot (pcf). Based on the Wisconsin Department of Natural Resources (WDNR) Landfill Tonnage Reports, the waste density at the Orchard Ridge RDF generally range from 1,600 pounds per cubic yard (pcy) to 2,000 pcy. The most recent waste densities ranged from 1,600 pcy to 1,750 pcy, which correlates to a unit weight ranging between 59 pcf to 64 pcf.
>
> The Southern Unit is also proposing to recirculate leachate and RDD liquids into the waste mass, which would increase the unit weight due to the added moisture in the waste mass. To account for these additional liquids, a unit weight of 83 pcf was assumed for the waste mass. In addition, a unit weight of 83 pcf is an approximate average of unit weights expected for MSW (Zekkos, et al, 2006)."

The assumed unit weight utilized throughout our calculations is a conservative assumption based on the average unit weights currently being achieved at the facility along with a 40% increase to account for potential use of leachate recirculation and additional densification. This unit weight of 83 pcf was consistently used throughout the calculations for the leachate collection system with results meeting the required factors of safety. Based on the provided analysis, the proposed pipe design is adequate and appropriate for the anticipated construction, operation, and closure loading conditions.

WMWI and TRC trust that we have provided the information requested by the Department. Additional copies of this POO Addendum 1 have been distributed according to the attached distribution list.

WMWI is requesting that the WDNR review and provide a favorable feasibility determination for the proposed Southern Unit. Please feel free to contact Tyler Field at 262-443-2240 or Michael Amstadt, P.E. at 608-358-2669 with questions regarding this document.

Sincerely,

TRC

Michael Amstadt, P.E.
Principal Project Manager

Stephen Sellwood, P.G.
Project Hydrogeologist

cc: See attached Distribution List

List of Enclosures:

Attachment 1: Addendum Certification Statement

Attachment 2: WDNR Incompleteness Determination for the Plan of Operation for the Proposed Orchard Ridge Eastern Expansion, Southern Unit – Monitoring #4491, dated March 23, 2022

Attachment 3: August 2022 Compliance Status with Plans and Orders

Attachment 4: Quality Assurance Manual

Attachment 5: Revised Drawings
- Plan Sheet 3 – Existing Conditions Map and Site Layout
- Plan Sheet 4 – Supplemental Existing Conditions Map
- Plan Sheet 40 – Details - Gas System

Attachment 6: Long-Term Care Inspection Checklist

Attachment 7: Appendix K.7 - Leachate Sump Capacity Calculations

Distribution List

Recipient	Hard Copy	Electronic Copy [1]
Ann Bekta Wisconsin Department of Natural Resources Janesville Service Center 2514 Morse Street Janesville, WI 53545-0249	1	Yes
Alicia Zewicki Wisconsin Department of Natural Resources Waukesha Service Center 141 NW Barstow Street, Suite 180 Waukesha, WI 53188-3789	2	Yes
David Buser Wisconsin Department of Natural Resources Milwaukee Service Center 2300 North Dr. Martin Luther King Drive Milwaukee, WI 53212-3128	1	Yes
Tyler Field Waste Management of Wisconsin W132 N10487 Grant Drive Germantown, WI 53022	1	Yes
Brett Coogan/Ryan Baeten Waste Management of Wisconsin Orchard Ridge RDF W124 N9355 Boundary Road Menomonee Falls, WI 53051	1	Yes

Footnotes:

[1] Electronic copies to be sent via an e-mail link.

Attachment 1

Addendum Certification Statement

Certification

I, _____, hereby certify that I am a registered professional engineer
Michael Amstadt

in the State of Wisconsin, registered in accordance with the requirements of Chapter A-E 4, Wisconsin Administrative Code; that this document has been prepared in accordance with the Rules of Professional Conduct in Chapter A-E 8, Wisconsin Administrative Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in Chapters NR 500 to NR 538, Wisconsin Administrative Code.

Michael Amstadt
Digitally signed by Michael Amstadt
Date: 2022.09.16 12:43:41 -05'00'

I, _____, hereby certify that I am a licensed professional geologist
Stephen Sellwood

in the State of Wisconsin in accordance with the requirements of Chapter GHSS 2, Wisconsin Administrative Code; that the preparation of this document has not involved any unprofessional conduct as detailed in Chapter GHSS 5, Wisconsin Administrative Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in Chapters NR 500 to NR 538, Wisconsin Administrative Code.

Attachment 2

WDNR Incompleteness Determination for the Plan of Operation for the Proposed Orchard Ridge Eastern Expansion, Southern Unit – Monitoring #4491, dated March 23, 2022

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
Waukesha Service Center
141 NW Barstow St. Room 180
Waukesha, WI 53188

Tony Evers, Governor
Preston D. Cole, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

March 23, 2022

FID # 268696560
Waukesha County
SW/Correspondence

Mr. Brett Coogan
Orchard Ridge Recycling & Disposal Facility
W124 N9355 Boundary Road
Menomonee Falls, WI 53051

Subject: Incompleteness Determination for the Plan of Operation for the Orchard Ridge Recycling & Disposal Facility (RDF) Eastern Expansion, Southern Unit, License #4491

Dear Mr. Coogan:

The Department of Natural Resources (department) has reviewed for completeness a report and set of plan sheets submitted on behalf of Waste Management of Wisconsin, Inc. (WMWI) by TRC entitled: "Plan of Operation, Orchard Ridge RDF Eastern Expansion, Southern Unit, Village of Menomonee Falls, Waukesha County Wisconsin", dated February 18, 2022, and received by the department on February 21, 2022. The feasibility determination was issued on July 30, 2021. Based on our review, the department has determined the plan of operation is not complete since the minimum requirements of ch. NR 514, Wis. Adm. Code and the conditions of the department's July 30, 2021 feasibility determination have not been met.

Part A of this letter identifies the information needed to fulfill the minimum plan of operation requirements. Part B lists additional information the department needs to make a plan of operation decision. Part C provides additional comments the department has on specific aspects of the plan of operation.

A. INFORMATION REQUIRED TO COMPLETE THE PLAN OF OPERATION

The following information must be provided in order for the department to issue a determination that your plan of operation is complete:

1. **Noncompliance with Plans or Orders [s. 289.34, Stats. and s. NR 514.04(3), Wis. Adm. Code]**: Please review the related information you provided in your recent feasibility report, update it as necessary to reflect current conditions, and indicate whether or not all plan approvals and orders relating to the identified facilities are being complied with.

2. **Condition 5 of the department's July 30, 2021 feasibility determination**: The report did not include a description of the health and safety protocols to be used during the Boundary Road Landfill (BRL) exhumation process.

3. **Condition 9 of the department's July 30, 2021 feasibility determination**: The report did not include a plan to evaluate for potential endangered or threatened wildlife species that may be impacted during construction events before each construction event and how any potential impacts would be addressed.

4. **Condition 14 of the department's July 30, 2021 feasibility determination**: The report did not include a clear proposal for drainage of granular or silty soil encountered at subbase grades as necessary to allow

removal of the granular or silty soils and replacement with compacted clay soils. Different methods are mentioned within the report but are not explained how or when they would be used.

5. **Condition 16 of the department's July 30, 2021 feasibility determination**: The report did not include a detailed description of subbase construction methods in the area of BRL waste exhumation and the BRL pond removal.

6. **Condition 18 of the department's July 30, 2021 feasibility determination**: The report did not include a detailed proposal of methods to continuously remove leachate from the existing leachate sump during the extension of the sump riser pipe and manhole to be located in the Triangle Area. Also, not all of the information provided in the April 1, 2021 Addendum #2 was provided in this report.

7. **Condition 23 of the department's July 30, 2021 feasibility determination**: The storm water pollution prevention plan did not adequately address storm water pollution prevention measures related to the exhumation of BRL, including the transport of exhumed waste between landfills.

8. **Condition 26 of the department's July 30, 2021 feasibility determination**: The report did not include an evaluation of the existing gas header pipe to determine if modifications are needed to manage the additional landfill gas generated by the expansion.

9. **Condition 27 of the department's July 30, 2021 feasibility determination**: The report did not address the abandonment procedures for gas extraction wells in the area outside of BRL; specifically, gas extraction wells which are abandoned in areas with final cover.

10. **Condition 30 c. and d. of the department's July 30, 2021 feasibility determination:** The report did not include a detailed description of the phased development, filling, and closure sequencing that minimizes the time and area outer side slopes are under intermediate cover and filling so final grades are reached as soon as possible.

11. **Condition 34 of the department's July 30, 2021 feasibility determination:** The report did not provide a clear plan for protecting wetlands and waterways from indirect impacts. The response to condition 34 differs from other areas of the report, such as 3.2.1.

12. **Geocomposite Lined Landfills [s. NR 504.06(3)(e), Wis. Adm. Code]**: The report did not include information regarding geomembrane panels being welded by double-tracked, fusion welding machines for all linear seams, corners, butt seams and long repairs.

13. **Leachate Collection System [s. NR 504.06(5)(j)5, Wis. Adm. Code]**: The report did not include information regarding the area of the sump and depth of gravel fill being sized to allow remedial installation of access and hardware for removal of leachate in the event of failure of the sideslope riser and pump system.

14. **Active Gas Extraction [s. NR 504.08(2)(a), Wis. Adm. Code]**: Plan sheet 18 did not include vertical gas extraction wells throughout the entire landfill with a maximum radius of influence of 150 feet per well.

15. **Active Gas Extraction [s. NR 504.08(2)(b)-(f) and (l), Wis. Adm. Code]**: The report did not include the information regarding vertical gas extraction wells.

16. **Miscellaneous [s. NR 504.09(2)(g), Wis. Adm. Code]**: The report did not include information regarding the landfill being designed such that final waste grades are reached as soon as possible, and open refuse filling area is minimized.

17. **Leachate Recirculation [s. NR 504.095(1)(f), Wis. Adm. Code]**: The report did not include specific information regarding operations expected in all weather and seasons of operation.

18. **Existing Conditions [s. NR 514.05(2), Wis. Adm. Code]**: The drawings did not include an existing condition plan which included a detailed topographic map of the existing Orchard Ridge Eastern Expansion Landfill. The drawing should also depict the existing leachate forcemain on the south side of the Eastern Expansion.

19. **Waste Final Grades [s. NR 514.05(7), Wis. Adm. Code]**: The drawings did not include a final waste plan which shows final waste grades without the 5% intermediate waste grades.

20. **Design Rationale [s. NR 514.06(3), Wis. Adm. Code]**: The report did not include design rationale for phases of landfill development and closure specifically relating to construction of Phases 3B and 4C, how delaying that construction impacts final cover placement, and justification for the exhumation of the Boundary Road Landfill occurring over 6 to 8 years. Also, include a revised construction sequencing table (Section 6.1) with total acres open/closed after each construction event and review calculations that utilize the acreage for the maximum open area.

21. **Stormwater Management [s. NR 514.06(5)(d), Wis. Adm. Code]**: The report did not include a list of anticipated actions and materials needed for sediment and erosion control.

22. **Long-Term Care [s. NR 514.06(11), Wis. Adm. Code]**: The report did not include a discussion of inspection procedures, such as an inspection checklist, for monitoring devices during the long-term care period.

23. **Design Calculations [s. NR 514.06(14), Wis. Adm. Code]**: The report did not include refuse to cover balance computations.

24. **Financial Responsibility [s. NR 514.06(15), Wis. Adm. Code]**: The report did not include assumptions used in developing the cost estimates and rationale for the selected cost factors.

25. **Closure of Landfills with Composite Liners and Composite Caps [s. NR 514.07(3)(b), Wis. Adm. Code]**: The report did not include the information regarding no additional waste placement in areas which have reached final grades and received intermediate cover.

26. **Other Requirements [s. NR 514.07(6)(c), Wis. Adm. Code]**: The report did not include information relating to pump selection based on highest leachate flow rate which includes leachate recirculation.

27. **Extended Collection Lines [s. NR 514.07(8)(c)1, Wis. Adm. Code]**: The report did not include pipe strength calculations for wet unit weights, densified waste after consolidation and decomposition, and the potential use of leachate recirculation.

B. INFORMATION NEEDED FOR PLAN OF OPERATION APPROVAL

The information below is not required for a completeness determination, but the department will need to receive it in order to make a plan of operation decision:

1. Provide clarification on the landfill name and expansion name and use consistent references throughout the report. The feasibility report refers to the existing landfill as the Orchard Ridge RDF East Expansion (East Expansion) and the proposed expansion as the Eastern Expansion, Southern Unit (Southern Expansion). Throughout the report there are references to the Eastern Expansion and Southern Unit.

2. Provide additional information/justification to demonstrate that the exemption request is a special case and will not cause environmental pollution in accordance with s. NR 500.08(4), Wis. Adm. Code which includes the following:

    a. Venting of manholes – describe actions that will be taken to protect health and safety where manholes would not be vented; describe environmental impacts/benefits; and other specific information that supports the request.

    b. Slope transitions greater than 4:1 – provide information (calculations, length of slope, etc.) for slopes that require transitions greater than 4:1 and request an exemption to the requirements of s. NR 504.09(2)(g), Wis. Adm. Code with supporting justification. Alternatively, the request could be withdrawn and requested at a later date when specific information would be available to support the exemption.

3. Provide discussion on the history, design, and depth of the cutoff wall on the south side of BRL. Also include discussion on how the cutoff wall will be removed or if left in place how it may impact construction of the landfill liner.

4. Provide clarification on the use of screening berms. Page 2-6 says soil excavated from areas not in contact with the BRL waste will be used for several things including screening berms. There was no other discussion of screening berms or locations/details in the plan sheets.

5. Provide clarification on the underdrain collection sumps. Page 2-8 says there will be underdrain collection sumps along the western toe of slope but does not have any narrative about the underdrain header pipe shown on detail 3/26.

6. Provide discussion on the location and construction of the existing leachate forcemain on the south side of the East Expansion and how it may be impacted by the Southern Unit expansion.

7. Provide additional information on the horizontal directional drilling proposed for the leachate forcemain which includes the following:

    a. A more detailed explanation of where and when the directional drilling will occur.

    b. Discuss specific methods for protection of the wetland and watery areas.

    c. Explain/show where the drilling fluids will be released/collected during the drilling process.

    d. Explain how forcemain directional drilling construction will be documented.

8. Provide clarification on haul road grades. Page 2-31 says that the haul roads over the waste typically have a maximum grade of 10 percent and Page 3-27 says that the perimeter and internal roads have grades less than 10 percent. NR 504.09(2)(d) say that all access roads which are used by over the highway vehicles shall be designed with a maximum grade no greater than 10 percent.

9. Clarify how the largest open area was calculated for the leachate generation calculations and revised closure cost estimates. The acreages used do not appear to correlate with the acreages included in the report and on the phasing plan sheet. Revise the calculations, report, and plan sheets, as appropriate.

10. Provide revised long-term care costs which include pumping of groundwater from the underdrain system and pump replacement. Because the horizontal portion of the Southern Expansion is not a zone of saturation landfill, the underdrain system pumping may not be discontinued.

11. Provide the ability to collect samples and provide a sampling plan for individual underdrain sumps in each phase of the Southern Expansion.

12. Provide clarification on whether WMWI is requesting a public meeting be held as part of this plan of operation review for the acceptance of dredge waste. Under s. 289.54, Wis. Stats. the department may not approve a request to dispose of dredge materials that contain PCBs or heavy metals unless the department holds a public meeting. The Eastern Expansion does not currently have an approval to accept dredge material.

13. Provide a revised environmental monitoring plan sheet 19 which includes the following:

    a. Include leachate line televising to the long-term care activities table.

    b. Remove the leachate head well location within waste and label the leachate head well sampling location at the edge of waste.

14. Provide an explanation of the cross section on plan sheet 20. The cross section shows a change in grade at the center of the landfill base grades.

15. Provide clarification on where detail 1/29 – Delineation Berm Type A with the leachate pipe is used. Based on the phasing plan sheets it appears that the west end of Phase 7 Module 2, where the only leachate header pipe is used, is constructed at the same time as Phase 7 Module 1 and so the leachate pipe would not need to be capped.

16. Provide a revised plan sheet 41. The gas header details (2/41 and 3/41) show waste slopes of 2:1. Section NR 504.09(2)(g), Wis. Adm. Code allows a maximum waste grade of 4:1.

17. Provide details on phan sheet 40 or 41 of the gas system belly collectors, side slope gas extraction collectors, and horizontal gas wells discussed in Section 2.14.3.

18. Provide a revised Boundary Road Landfill Property Redevelopment Plan (Appendix C) which includes the following:

    a. Discussion of removing BRL waste that may be beyond the proposed expansion waste limits shown on the plan sheets.

b. Discussion of restoration of areas of BRL exhumation that are outside the proposed waste limits.

c. Address the testing of soils below BRL for PCBs. The Figure 3 – Soil Below Waste flow diagram for soil evaluation and classification indicates soils will be analyzed for PCBs, but the report does not discuss this.

d. Section 6.2.3 of the redevelopment plan states soil from below the base of the landfill that is visually or otherwise noticeably impacted by waste products will be excavated and classified as Type 2 soil without testing, for use within the lined landfill. Type 2A and 2B soils must be compared to RCL limits for classification prior to use within the landfill; therefore, testing is required.

e. If Type 2A soils are proposed for use in the final cover for the Orchard Ridge Landfill (ORL), this needs to be addressed within the final cover design section of the report.

f. Provide additional details on the screening procedures and documentation that will be used during active waste excavation, including information on what is meant by "other field evidence of significant impacts" in section 4.3.1 of the plan.

g. Provide clarification on waste screening described in section 4.3.1 of the plan, such as whether confirmation samples will be collected from waste in the immediate vicinity of samples indicating the potential for characteristically hazardous waste.

h. Provide additional rationale and clarification on whether special consideration will be given to waste surrounding crushed or empty drums, which section 4.3.5 of the plan states will "not be segregated from the waste and will be handled in the same manner as the general excavated waste". Crushed drums were documented in the WCIR and in at least one boring indicating the potential for hazardous waste.

i. Provide clarification on why "the bulk suspicious materials most likely to be encountered are waste or soils containing high concentrations of VOCs", as stated in section 4.3.6 of the plan. For example, additional explanation on why this is not the case for contaminants such as lead or PCBs, and/or what information in the WCIR supports this approach.

j. Provide additional details on the information provided in section 4.5.1 of the plan on what will happen if air monitoring results are above screening levels (e.g., department notification).

k. Discussion or revisions to address comments listed in Attachment 1 of this letter.

19. Provide clarification on the special waste plan (Appendix D). The plan of operation report lists alternate daily cover (ADC) materials that were approved for the East Expansion; however, an Addenda to the East Expansion plan of operation stated that WMWI would be submitting a revised plan to address those materials. The department approved those materials in the interim with the understanding that a plan would be provided to address those materials. Clarify whether the revised special waste acceptance plan will be applied for determining suitable ADC materials, or if WMWI intends to rely on past plans/approvals for those materials than provide a copy of the prior plans/approvals for each of the materials, which were under the Orchard Ridge RDF, Lic. #3360.

20. Provide a revised Quality Assurance Manual (Appendix H) which includes the following:

    a. Clarification on the compactor foot length. Page 3-8 says the foot length will be as long as the loose lift height and page 25 of the Quality Assurance Manual says the compactor foot length will be a minimum 6 inches.

    b. Clarification on providing guidance for machine operators placing soil on geomembrane. Page 3-11 include discussion on the item; however, it is not discussed in the Quality Assurance Manual.

    c. Addition of a section for installation of the clay wedge that discusses construction of the wedge over the drainage blanket stone, prevention of the drainage blanket from being contaminated with clay and documentation of observations by the quality assurance personnel.

21. Provide a revised leachate recirculation plan (Appendix L) and research, development and demonstration (RDD) plan (Appendix M) which includes the following:

    a. The RDD and leachate recirculation plans need to address limitations due to the placement of BRL waste and/or how the acceptance of liquid waste will be integrated with the acceptance of BRL waste. Also, capacity and geotechnical calculations need to consider that the characteristics of BRL waste may be different than the incoming waste stream.

    b. If dredge material containing free liquids will be accepted, clarify the volumes anticipated and address the stability and operational procedures for placement of dredge waste within the landfill. Also, a public meeting is required prior to department approval of dredge material as noted above.

    c. The plan of operation (Section 3.5.4.1) states that drilling fluids will be disposed of or recycled per the Special Waste Management Plan. Note that the disposal of drilling fluids with free liquids would only be allowable if covered under an approved RDD plan.

    d. Other than being aqueous phase and meeting TCLP limits, address acceptance protocol and monitoring to ensure the disposal of liquid waste will not interfere with landfill chemistry and normal waste degradation. Note EPA's guidance titled, Monitoring Approaches for Landfill Bioreactors, indicates potential problems with the following waste streams: surfactant-based waste streams, pickling waste streams, streams related to aluminum dross, and waste streams with high sulfate concentrations, in addition to oily or low pH waste.

    e. Rapid infiltration trenches are not allowed under s. NR 504.095(2)(a), Wis. Adm. Code. Provide additional information for evaluating the use of rapid infiltration trenches under the RDD plan, if proposed.

    f. Under warning symptoms, clarify what is meant by excessively acidic leachate chemistry.

    g. If proposing to add contact water or potentially contaminated liquids from BRL, address how the contact water or potentially contaminated underdrain liquids will be evaluated for hazardous waste characteristics.

h. The plan of operation discusses the addition of leachate and liquids within the lower 10-feet of waste. Note that Condition 34 of the plan of operation approval for the East Expansion requires a minimum separation of 10-feet from the leachate drainage blanket and a minimum separation of 50-feet from gas well gravel mounds.

Note: The department is reviewing the revised plan as part of the plan of operation review, but the department is not considering this a renewal request because the annual/final report for the test period and other information required by s. NR 514.10, Wis. Adm. Code has not been provided. Due to the complexity of the plan of operation, it would be best to submit the final report/renewal request separately in advance of the expiration date.

22. Provide additional information to address the following comments regarding the organic stability plan (Appendix N):

a. Clarify what is meant by continuing in-landfill anaerobic decomposition under Section 3.0. Describe how this is different from normal landfill operations.

b. The timeframe of the proposed delay in final cover placement needs to be clearly laid out as previously noted. Note that the plan of operation for the East Expansion only approved delaying final cover placement up to 2 years after attaining final waste grades to allow for settlement, not as an organic stability measure.

23. Provide information/clarification to address the following comments regarding the groundwater monitoring and response actions in sections 4.1 through 4.1.7 and 4.6 through 4.7.1.4:

a. Provide rationale for annual VOC sampling in September, rather than March. The department understands the March event to be intended as the “wet” season and likewise the September event as the “dry” season, in which case there are concerns whether this schedule would sufficiently evaluate contamination within the capillary fringe area (“smear zone”).

b. Provide an explanation of what the difference is between the grayed symbols and the dark symbols separated with “or” provided under the “Existing” column in the Features section of the Standard Legend on plan sheet 2.

c. Provide clarification on what considerations or thresholds would be used by WMWI to identify “groundwater quality changes” as mentioned in section 4.7.1 of the plan of operation submittal. It states that it “presents a comprehensive plan of action to be taken in the event that groundwater quality changes are detected”.

d. Provide additional information on what WMWI would consider “a significantly elevated concentration of a monitoring parameter” over the course of two consecutive sampling events, as stated in section 4.7.1.3 of the plan of operation submittal.

e. Provide an explanation of potential actions concerning ES exceedances. Section 4.7.1.3 of the plan of operation submittal states one would be to “[r]esample and obtain additional analytical data for the affected monitoring well(s) to verify concentrations”. Without an adequate explanation of an anomalously high concentration in the first place (e.g., cross-contamination),

the department does not necessarily believe the second sample would be any more representative than the first.

f. Provide a plan to evaluate if the completion of the BRL waste relocation project improves groundwater quality to the extent which would warrant rescission of any NR 140 groundwater standard exemptions and removal of approved ACLs as well as lowering any approved PALs for indicator parameters. The proposed plan should consider time for concentrations to stabilize after waste removal is completed by waiting a period of time such as 5 years and again at 10 years to do the evaluation following complete relocation of the BRL waste.

24. Provide information/clarification to address the following comments regarding the groundwater sampling and analytical plan (Appendix R):

a. Confirmation that each of the required groundwater parameters will be analyzed by a Wisconsin-certified laboratory in accordance with ch. NR 149, Wis. Adm. Code.

b. Provide additional information on any examples of WMWI having performed alternative purge water management at adjacent WMWI facilities (e.g., East Expansion), and/or an explanation of what criteria are used to determine "highly impacted" groundwater. The sampling plan provided as Appendix R states the results from past sampling events "may prevent disposal of purge water to the ground", and if "groundwater is highly impacted at a location".

C. ADDITIONAL COMMENTS ON THE PLAN OF OPERATION

The department noted the following additional issues with the plan of operation during our review. Should the department approve the plan of operation, these issues may result in conditions of approval if not addressed.

1. The plan in Appendix R states the water level used for static water level measurements "should be recorded to the nearest hundredth of a foot". Be advised that section 2.2.1 of the department's *Groundwater Sampling Desk Reference* states static water levels "must be accurate and precise to ±0.01 foot (±0.25 cm)".

2. The plan in Appendix R states that for wells that go dry, "the sample will be obtained after water recharges to acceptable sample volume". Be advised that section 2.5.3 of the department's *Groundwater Sampling Desk Reference* states that if time permits, "purge the well a second time and collect samples within 24 hours".

3. The plan in Appendix R states that "samples should ideally be cooled to 4 degrees Celsius". Unless there are extenuating circumstances (e.g., sample collected very recent to laboratory's receipt), be advised that section 2.9.2 of the department's *Groundwater Sampling Desk Reference* states that samples "must remain at or below 4C throughout handling, storage and shipping".

Due to the complexity of the plan of operation report, the department may have additional incompleteness items and/or additional information requests as the review of the report continues. Note that the BRL redevelopment plan is currently under review by the Remediation and Redevelopment program.

This incompleteness determination is not a denial of your proposal, but merely indicates that additional information is needed to continue the department's review. Submittal of this information does not ensure

approval, nor does it preclude the department from requiring additional information if continued review indicates it is needed.

If you have any question regarding this letter, please contact Ann Bekta at (608) 287-4492 or email at Ann.Bekta@wisconsin.gov or David Buser at (414) 550-8189 or email at david.buser@wisconsin.gov.

Sincerely,

Natasha Gwidt, P.E.

Natasha Gwidt on behalf of:
James C. Delwiche
Waste and Materials Management Program Supervisor
Southeast Region

cc: Tyler Field – tfield1@wm.com
Ryan Baeten - rbaeten@wm.com
Michael Amstadt - MAmstadt@trccompanies.com
Alicia Zewicki – DNR/WA (e-copy)
Susan Fisher – DNR/WA (e-copy)
David Buser – DNR/WA (e-copy)
Valerie Joosten – DNR/WA (e-copy)
Joe Lourigan – DNR/WA (e-copy)
Mike Ellenbecker – DNR/WA (e-copy)
Kendra Fisher – DNR/AM (e-copy)
Pete Wood – DNR/WT (e-copy)
Erin Endsley – DNR/RR (e-copy)
Bruce LeRoy – DNR/RR (e-copy)
Sharon Fandel – DNR/NH (e-copy)

Attachment 1
Comments provided by the Hazardous Waste Program on the Boundary Road Landfill Property Redevelopment Plan (Appendix C)

Section 1.1
WMWI
"This document is intended to serve as a guide to establishing the procedures for appropriately characterizing, handling, and relocating soil and waste materials."
Hazardous Waste Program
The concern is that the term 'guide' does not necessarily mean that the document has to be followed. Perhaps replace with plan, which is used in the next paragraph.

Section 2.2
Hazardous Waste Program
When making a hazardous waste determination s. NR 662.011 Wis. Adm. Code must be followed. The Property Redevelopment Plan is not a substitute for the hazardous waste determination steps specified in s. NR 662.011 Wis. Adm. Code for when encountering suspicious wastes.

WMWI
"As explained further below, for waste characterization purposes in the execution of this project, waste characterization would occur upon exhumation of the BRL material because that is when the waste is "generated" for waste characterization purposes in a remediation context."
Hazardous Waste Program
The act of excavation does not necessarily cause the generation of waste. It is when placement occurs.

WMWI
"If documentation of the source of contamination is unavailable or inconclusive and obvious evidence of the waste origin is not found with the waste, then the waste or soil can be assumed not to contain a listed hazardous waste."
Hazardous Waste Program
Does 'waste origin' mean who generated the waste and/or how the waste was generated. If waste origin is limited to who generated the waste, then add language discussing how the waste was generated. For example, a label on a drum could state 'waste toluene solvents from paint cleaning operation' This can show that the drum contains a F005 listed hazardous waste; however, it does not point to the origin of who generated the waste. This issue is addressed in the next paragraph.

WMWI
"In situ soil excavated from below the waste would be classified as a hazardous waste only if it exceeds a TCLP limit when excavated, because that is when the waste is generated. Soil mixed with waste will be managed in the same manner as the waste."
Hazardous Waste Program
It is not exhumation that causes the waste to be generated. It is placement.

WMWI
"Bulk waste or contaminated soil that is classified as characteristic hazardous waste, based on TCLP testing, will be treated on site and rendered non-hazardous prior to disposal in ORL or it will be transported off site for treatment and/or disposal at a facility licensed to accept it. Waste or soil identified as hazardous waste must be treated to meet the RCRA Land Disposal Restrictions (LDRs) prior to disposal in ORL, as described in Section 4.3.6."
Hazardous Waste Program

The sample collected for TCLP testing must be representative.
Activities in which placement (e.g., In-situ management) does not occur do not trigger RCRA. Activities in which placement occur trigger RCRA.

WMWI
"Wastes in intact drums or containers will be evaluated for a hazardous waste determination as described in **Section 4.3.5** and will be managed as hazardous wastes, if appropriate."
Hazardous Waste Program
Under RCRA container also include pumps, thermometers, manometers, batteries, and ampuls.

Section 2.3.1
WMWI
"Regulatory options for ex situ treatment without triggering hazardous waste treatment licensing requirements include treatment in containers, which is exempt by rule, or treatment under the terms of a remediation variance."
Hazardous Waste Program
The code that allows treatment in container and tanks without a license is s. NR 670.001(3)(b)11. Wis. Adm. Code.

Section 2.3.3
WMWI
"The AOC policy will not be used with regard to the final placement of BRL waste, but will allow exhumed wastes and contaminated soil from the BRL site to be temporarily stockpiled within the BRL footprint, without triggering hazardous waste testing requirements or LORs."
Hazardous Waste Program
What is meant by 'final placement of BRL waste' with regards to the AOC policy will not be used?

Section 3.2
WMWI
"The waste excavation and relocation or processing phases are estimated to occur over a 6- to 8-year period, starting in 2022 following approval of the Eastern Expansion, Southern Unit POO."
Hazardous Waste Program
Remediation variances issue under s. NR 670.079 Wis. Adm. Code are limited to 5 years.

Section 4.2
WMWI
"Waste will generally be removed in lifts, similar to the typical filling procedure in reverse. The surface of the waste lift will be sloped to the interior and will drain to temporary sumps excavated in the waste to facilitate leachate collection and removal.
Hazardous Waste Program
The leachate is subject to the waste determination requirements under s. NR 662.011 Wis. Adm. Code.

WMWI
"Like the landfill final cover material, asphalt and the underlying gravel base will be assumed to be uncontaminated unless the visual appearance or odor indicates potential impact."
Hazardous Waste Program
The concern is that visual appearance or odor are the factors being used in making a determination. Is there a reason why these materials may be impacted with hazardous constituents?

Section 4.3

Hazardous Waste Program
Who will be doing these waste procedures? What type of training or background do they have in these waste procedures?

Section 4.3.2
WMWI
"If typical waste materials are waterlogged with leachate when excavated, they will be allowed to drain and/or be mixed with drier waste prior to loading into trucks to prevent the separation of liquids from the waste during transportation or placement, unless the disposal of BRL leachate in ORL is approved under the ORL Research, Development, and Demonstration (RD&D) Plan."
Hazardous Waste Program
Mixing a hazardous waste with drier waste may constitute impermissible dilution (i.e., treatment) under RCRA.

Section 4.3.5
WMWI
"A technician will be onsite working with the operator(s) and documenting the waste removal process, but the technician will not be in the excavation area monitoring during active waste removal due to safety concerns."
Hazardous Waste Program
It was our understanding that based on January 6 virtual meeting with SCS that a technician would also be present during the excavation. Safety concerns could be addressed by having the technician located an appropriate distance away from the excavator and wearing a high visibility vest.

WMWI
"Non-intact drums that appear to contain water or leachate based on field observations and/or field screening (i.e., liquid most likely accumulated after disposal) will be managed as non-suspicious waste and transferred with the surrounding waste to ORL for disposal."
Hazardous Waste Program
Explain how field observation can differentiate water or leachate from a liquid that is not water or leachate.

WMWI
"Intact drums and containers segregated from the waste and staged in the secure storage area will be screened in the storage area using a combination of visual observation of physical characteristics and fingerprint analysis."
Hazardous Waste Program
Explain what the combination of visual observation of physical characteristics and fingerprint analysis will consist of.

WMWI
"Labeling, if any, will be evaluated to identify whether the contents may be a listed waste."
Hazardous Waste Program
What training does the person evaluating the label have in detriment if the contents of the container are a listed hazardous waste?

WMWI
"Stockpiles of otherwise inert materials will not be covered for short-term storage."
Hazardous Waste Program
These would be suspicious material which could be a hazardous waste. The concern is runoff from the stockpile (i.e., leachate) could be a hazardous waste. This issue is somewhat addressed in the next paragraph.

WMWI
"Based on the site history, characterization to determine the need for treatment prior to disposal in ORL will be limited to VOCs unless field screening (i.e., visual or odor) indicates a significant likelihood that the material could fail the TCLP test for metals or semivolatile compounds. Based on the WCIR data, the single occurrence of metals in excess of TCLP limits appears to be lead that may have been associated with paint waste."
Hazardous Waste Program
Several concerns with this sentence:

- Site history is limited.
- That characterization is limited to VOC field screening (i.e., visual or odor).
- What would indicate a significant likelihood that the material could fail the TCLP test for metals or semivolatile compounds.
- How does WCIR data compare to this site given the site's limited site history.

Explain how this meets the waste determination requirements under s. NR 662.011 Wis. Adm. Code.

4.3.6
WMWI
"The minimum goal of on-site treatment will be to reduce contaminant concentrations to below the TCLP limits, so that it meets the ORL acceptance limits. For disposal, the RCRA LDR treatment standards will also apply."
Hazardous Waste Program
It is the LDR treatment standard and not the TCLP limits that determines if a waste can be land disposed. Arsenic (D004), Mercury (D009), and selenium (D010) have LDR standards that are equal to greater than the TCLP limit. These waste – even if the LDR standard is meet – must go to a hazardous waste landfill.

WMWI
"For contaminated soil, including suspicious waste that is primarily soil, the alternative LDR treatment standards for contaminated soil ins. NR 668.49, Wis. Admin. Code, will apply."
Hazardous Waste Program
The hazardous waste program will need to do regulatory research to determine if a mixture of mostly soil and wastes would still be eligible for the alternative treatment standard that apply to soils.

4.7
WMWI
"Leachate and/or groundwater that is encountered during excavation of BRL, including contact water that is generated by precipitation falling on the waste, will be collected to the extent possible, and will be discharged to the sanitary sewer or another approved discharge option as discussed in Section 5.1."
Hazardous Waste Program
Water in contact with waste requires a hazardous waste determination per under s. NR 662.011 Wis. Adm. Code.

6.1.1
WMWI
"Excavated soils will be classified into types as defined below, based on the contaminant concentrations, with the allowable reuse options defined for each type. Laboratory testing parameters for soil may include: …"
Hazardous Waste Program
Since 'may include' Is not a must/shall. If testing is not done how will the soils be classified?

6.2.2
WMWI
"Based on the soil sampling performed for the WCIR, the BRL grading layer soils will primarily be classified as Type 2A soils. Most samples from the grading layer contained at least one petroleum

compound at a concentration exceeding the Ch. NR 720, Wis. Adm in. Code, RCL for the groundwater pathway, but none exceeded the Ch. NR 720, Wis. Admin. Code, RCL for the industrial direct contact pathway or the TCLP limit."

Hazardous Waste Program

It is the LDR treatment standard and not the TCLP limits that determines if a waste can be land disposed.

6.2.5

WMWI

"Metals and PCB analysis on deeper samples will be performed only if the concentrations in the upper sample exceed RCLs established for the project."

Hazardous Waste Program

In section 6.2.3 it states "The shallowest sample collected in each boring will be analyzed for VOCs, RCRA metals, and PCBs. Metals and PCB analysis on deeper samples will be performed only if the concentrations in the upper sample exceed RCLs established for the project."

Why are VOCs eliminated in section 6.2.5?

Attachment 3

August 2022 Compliance Status with Plans and Orders

WASTE MANAGEMENT

W132 N10487 Grant Drive
Germantown, Wisconsin 53022

September 2022

Mrs. Ann Bekta
Wisconsin Department of Natural Resources
Janesville Service Center
2514 Morse St.
Janesville, WI 53545

Subject: Compliance Status with Plans and Orders
Proposed Eastern Expansion, Southern Unit (License No. 4491)
Orchard Ridge Recycling and Disposal Facility
Village of Menomonee Falls, Waukesha County, Wisconsin
Plan of Operation

Dear Mrs. Bekta:

Waste Management of Wisconsin, Inc. (WMWI) submits the following statements as part of the Plan of Operation Report process for the Orchard Ridge Recycling and Disposal Facility (RDF) – Eastern Expansion, Southern Unit located in the Village of Menomonee Falls, Waukesha County, Wisconsin.

WMWI, a Wisconsin corporation, is both the sole owner of the real property upon which the expansion will be located, and the sole applicant seeking to construct and operate the proposed expansion. WMWI is a Wisconsin corporation that is wholly owned subsidiary of Waste Management Holdings, Inc., a Delaware corporation.

The Wisconsin solid or hazardous waste facilities which are owned by WMWI are identified in Attachment 1.

WMWI has greater than 10% interest in the Metro RDF in Wisconsin and it was in noncompliance with the Plan of Operation approval issued by the Department on July 31, 1981. WMWI has greater than 10% interest in the Omega Hills North Landfill, and WMWI entered into a Stipulation and Judgment with the State of Wisconsin in 1989. The leachate head levels set forth in the Stipulation and Judgment are unachievable and are being replaced with a Long-Term Care and Corrective Action Plan Modification. WMWI has provided the Department with proof of financial responsibility for the Metro RDF and the Omega Hills North Landfill to ensure the availability of funds to comply with the Plan of Operation and the Stipulation and Judgment using methods described in §.289.41 Stats.

With the exception of the Metro RDF and the Omega Hills North Landfill, neither WMWI, nor any person owning 10% or greater legal or equitable interest in WMWI, or the assets of WMWI are:

a. In noncompliance with the plan approvals or orders issued by the Department for a solid or hazardous waste facility in Wisconsin.
b. An owner or previously owned a 10% or greater legal or equitable interest in person, or in assets of a person, who is not in compliance with a plan approval or order issued by the Department for a solid or hazardous waste facility in Wisconsin.

If you have any questions regarding this information, please contact me at (262) 443-2240.

Sincerely,

Tyler Field

Tyler Field
Senior Engineering Manager

Attachments:

1. List of Wisconsin Solid or Hazardous Waste Facilities Owned by WMWI

cc: Brett Coogan, WMWI

ATTACHMENT 1

List of Solid or Hazardous Waste Facilities Owned by WMWI

DISPOSAL FACILITIES – OWNED, ACTIVE/CLOSED

NAME	ADDRESS	CITY	STATUS
Boundary Road	W124 N89255	Menomonee Falls	Closed
Brookfield Landfill	18860 Rivendell Drive	Brookfield	Closed
City Disposal Corp Landfill		Dunn	Closed
Eaton Landfill	Trestle Rd. approx.. .75 miles south of Hwy 29	Eaton	Closed
Hagen Farm		Stoughton	Closed
Madison Prairie RDF	6002 Nelson Rd.	Sun Prairie	Active
Metro RDF	10712 S. 124th St	Franklin	Active
Muskego Landfill		Muskego	Closed
Neosho Landfill	Station Road approx.. 1550 feet east of Hwy 67	Rubicon	Closed
Omega Hills Landfill	N29 W12730 County Lind Rd	Germantown	Closed
Orchard Ridge RDF	W124 N9355 Boundary Rd.	Menominee Falls	Active
Pheasant Run RDF	19414 60th St	Bristol	Active
Polk Landfill	Hwy 175 at intersection Hwy 164	Slinger	Closed
Reclamation Landfill	43rd Street approx. 2760 feet north of 7 Mile Road	Raymond	Closed
Ridgeview RDF	6207 Hempton Lake Rd	Whitelaw	Active
Rusk County Small C&D Landfill	County Road G at intersection with Old Airport Road	Ladysmith	Closed

Sawyer County Small C&D Landfill	14612 W County Road B	Hayward	Closed
Stone Ridge Landfill	S82W21595 Wauer Lane	Muskego	Closed
Timberline Trail RDF	N4581 Hutchinson Rd.	Weyerhaeuser	Active
Valley Trail RDF	N9101 S. Willard Rd	Berlin	Active
SOLID WASTE DISPOSAL FACILITIES – SOLD			
Clark County Small C&D Waste Facility		Thorp	Sold
SOLID WASTE TRANSFER FACILITIES – OWNED, ACTIVE OR CLOSED			
WM - Ashland Transfer	510 Industrial Park Rd.	Ashland	Active
WM - Green Bay TS	1861 Allouez Ave.	Green Bay	Active
WM - Hayward Transfer	14612 W. County Hwy B	Hayward	Closed
WM - La Crosse	415 Island St.	La Crosse	Active
WM - Lake Delton	S 2439 Highway 12	Baraboo	Active
WM - Menasha Transfer	1860 Novak Dr	Menasha	Active
WM - River Falls	250 Summit St.	River Falls	Active
WM – Osceola TS	2312 Oak Dr.	Osceola	Active
WM - Peshtigo	N3989 County E	Peshtigo	Closed
Phillips Transfer	310 S. Airport Rd	Phillips	Closed
Somerset Transfer Station	611 Laser Drive	Somerset	Closed
WMI of WI-Prairie du Chein	62949 Vineyard Coulee Rd	Prairie du Chein	Active
SOLID WASTE TRANSFER FACILITIES – SOLD OR DIVESTED			
WM – Antigo	1715 Deleglise St.	Antigo	Divested as result of ADS acq

WM - Chippewa Falls	11888 30th Ave.	Chippewa Falls	Divested as result of ADS acq
WM Darlington	11500 Ames Rd	Darlington	Divested as result of ADS acq
WM - Door County TS	1509 Division Road	Sturgeon Bay	Sold
WM-Janesville	304 W. Sunny Lane	Janesville	Divested as result of ADS acq
WM - Ladysmith Transfer Station	W8527 Gokey Rd	Ladysmith	Sold
WM - Madison	2418 W. Badger Rd	Madison	Sold
WM - Mosinee	1372 State Hwy 34	Mosinee	Divested as result of ADS acq
WM - Sheboygan Falls T/S	115 Birch Rd	Sheboygan Falls	Divested as result of ADS acq
WM of Southeast Wisconsin	1508 S. Popple Avenue	Marshfield	Sold
Waupaca TS	E1571 Stratton Lake Road	Waupaca	Sold

Attachment 4

Quality Assurance Manual

Quality Assurance Manual for the Construction of the Southern Unit

Orchard Ridge RDF
Eastern Expansion, Southern Unit
Village of Menomonee Falls, Waukesha County, Wisconsin

August 2022

WDNR License No. 4491

Waste Management of Wisconsin, Inc.

TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENTS

1.0 General

1.1 Scope

This Quality Assurance Manual (QAM) addresses the quality assurance of the installation of soil and geosynthetic materials at the Orchard Ridge Recycling and Disposal Facility (Orchard Ridge RDF). This manual is one component of the overall quality assurance plan developed for each project. Extreme care and detailed documentation are required in the selection and installation of soil materials and the production and installation of the geosynthetic materials used in waste containment applications.

In the context of this manual, quality assurance refers to means and actions employed to assure conformity of the lining system production and installation with the project-specific design and permit requirements. A party independent from production and installation will provide quality assurance. Quality control refers only to those actions taken to ensure that materials and workmanship meet the requirements of the plans and permit conditions. Quality control is provided by the manufacturers, suppliers, contractors, and installers of the various components of the lining system and final cover.

The scope of this manual applies to selecting, testing, handling, and installation of soil components and to manufacturing, shipment, handling, and installation of geosynthetics components of the lining and cover systems. This plan should contain the elements necessary to ensure that the project is constructed in accordance with design plans and permit conditions.

This QAM was developed consistent with Wisconsin Department of Natural Resources (WDNR) regulations governing Construction Quality Assurance (CQA) requirements listed in Chapter NR 516, Wisconsin Administrative Code (ch. NR 516 when referencing the entire chapter or s. NR 516.05 when referencing a specific section within the chapter), at the date of this revision.

1.2 Parties

The parties discussed in this section are associated with the ownership, design, supply, manufacture, transportation, installation, and quality assurance of a lining system and final cover. The definitions, qualifications, and responsibilities of these parties are outlined in the following subsections.

1.2.1 Owner

1.2.1.1 Definitions

Orchard Ridge RDF is the entity this site-specific QAM applies to.

1.2.1.2 Responsibilities

Orchard Ridge RDF is responsible for the overall construction and operation of the municipal solid waste facility. Orchard Ridge RDF must comply with all the applicable conditions and approvals issued by the WDNR in accordance with applicable Wis. Adm. Codes. Orchard Ridge RDF must comply with the requirements of the WDNR and shall retain an independent construction quality assurance (CQA) organization to verify the quality of construction. Orchard Ridge RDF has final

authority to accept or reject the final CQA program, reports, and recommendations of the CQA Manager.

1.2.2 Project Manager

1.2.2.1 Definitions

The Project Manager is the official representative of Orchard Ridge RDF; in this manual, the term Project Manager shall apply equally to “Construction Coordinator,” i.e., the individual responsible for coordinating construction and quality assurance activities for the project.

1.2.2.2 Responsibilities

The Project Manager is responsible for construction quality assurance activities. Other responsibilities include selection or approval of the earthwork contractor, geosynthetic installer, quality assurance consultant and the quality assurance laboratory.

The Project Manager shall serve as communications coordinator for the project, initiating the resolution, pre-construction, and construction meetings outlined in Subsection 1.3. As communications coordinator, the Project Manager shall serve as a liaison between the parties involved in the project to ensure that communications are maintained.

The Project Manager shall also be responsible for proper resolution of the quality assurance issues that arise during construction. Project Manager shall coordinate the shipping, packaging, and storage of laboratory samples and archive samples. Project Manager shall notify the WDNR if ch. NR 500 conditions or CQA Manual Procedures could not be met and alternatives which require regulatory interaction are proposed.

1.2.3 Designer

1.2.3.1 Definitions

The Designer is the individual and/or firm responsible for the preparation of the design, including project-specific plans for the lining system and final cover.

1.2.3.2 Responsibilities

The Designer is responsible for performing the engineering design and preparing the associated drawings for the lining system. The Designer is responsible for approving design changes and making design clarifications necessitated during construction of the lining system and final cover. Upon the request of the Project Manager, the Designer may attend the meetings outlined in Subsection 1.3 of this manual.

1.2.3.3 Qualifications

The Designer shall be a qualified engineer, certified or licensed as required by regulation. The Designer shall be familiar with the use of soils and/or geosynthetics including detailed design methods and procedures. In addition, the Designer should be familiar with applicable regulatory requirements.

1.2.3.4 Submittals

The Designer shall submit the project design drawings, specifications and associated engineering calculations reports to the Project Manager. The Designer shall also submit completed design clarification forms to the Project Manager in a timely manner upon request. Other information may also be required by Orchard Ridge RDF.

1.2.4 Geosynthetic Manufacturer

1.2.4.1 Definitions

The Manufacturer is the firm responsible for production of any of the various geosynthetic liner system components outlined in this QAM. In the case of a geocomposite, the Manufacturer is the firm responsible for combining the components into the final product.

1.2.4.2 Responsibilities

Each Manufacturer is responsible for the production of its geosynthetic product. In addition, each Manufacturer is responsible for the condition of the geosynthetic until the material is accepted by the Project Manager upon delivery. Each Manufacturer shall produce a consistent product meeting the manufacturer's technical specifications. Each Manufacturer shall provide quality control documentation for its product as specified in this QAM.

1.2.4.3 Qualifications

Each Manufacturer shall:

1. Be pre-qualified and approved by Orchard Ridge RDF.
2. Provide sufficient production capacity and qualified personnel to meet the demands of the project.
3. Have an internal quality control program for its product that meets the requirements presented in this QAM.

1.2.4.4 Submittals

Pre-qualification

A Manufacturer shall meet the following requirements and submit the following information to be considered for pre-qualification:

1. The origin (supplier's name and production plant) and identification (brand name and number) of resin proposed for manufacturing the product for this project.

Pre-installation

Prior to the installation of any geosynthetic material, a Manufacturer shall submit to the Project Manager quality control documentation required by the appropriate section of this QAM. This documentation shall be reviewed by the Geosynthetic Quality Assurance Consultant as outlined in Subsection 1.2.8 of this QAM before installation can begin.

1.2.5 Earthwork Contractor

1.2.5.1 Definitions

The Earthwork Contractor is the firm responsible for the earthwork site preparation and construction of the soil components of the lining system and final cover.

The Superintendent is responsible for the Earthwork Contractor's field crew. The superintendent shall represent the Contractor at site meetings and shall be responsible for acting as Contractor's spokesman on the project.

1.2.5.2 Responsibilities

The Earthwork Contractor is responsible for constructing soil components of the lining systems and final cover in conformance to the project design and permit conditions. The Earthwork Contractor may also be responsible for locating and transporting the required earth and granular materials, concrete, pipe, and other work, as outlined in the project plans.

1.2.5.3 Qualifications

The Earthwork Contractor shall be:

1. Pre-qualified and approved by Orchard Ridge RDF.
2. Able to provide qualified personnel and equipment to meet the demands of the project.

1.2.5.4 Submittals

Pre-Construction

Prior to commencement of the earthwork activities, the Earthwork Contractor shall submit to the Project Manager:

1. Resume of the Superintendent to be assigned to this project, including the dates and duration of employment.
2. Schedule of construction activities.
3. List of specific equipment and personnel to be used on the project.

1.2.6 Installer

1.2.6.1 Definitions

The Installer is the firm responsible for installation of the geosynthetics components of the lining system. The Installer may be affiliated with the Manufacturer.

The Superintendent is responsible for the Installer's field crew. The Superintendent shall represent the Installer at site meetings and shall be responsible for acting as the Installer's spokesman on the project.

The Master Seamer shall be the most experienced seamer of the Installer's field crew. The Master Seamer shall provide direct supervision over less experienced seamers.

1.2.6.2 Responsibilities

The Installer shall be responsible for field handling, storing, deploying, seaming, seam testing, temporary restraining and other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of these materials to the site and for anchor systems, if required by the project specifications.

1.2.6.3 Submittals

Pre-installation

Prior to commencement of the installation, the Installer must submit to the Project Manager:

1. Resume of the Superintendent to be assigned to this project, including dates and duration of employment.
2. Resume of the Master Seamer to be assigned to this project, including dates and duration of employment.
3. A panel layout drawing showing the installation layout identifying field seams as well as any variance or additional details which deviate from the engineering drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc. The installed panel layout may deviate from the panel layout drawing due to sequencing, work area access, etc.
4. Installation schedule.
5. A list of personnel performing field seaming operations along with pertinent experience information.
6. Geosynthetic quality control certificates as required by this QAM (unless submitted directly to the Project Manager by the Manufacturer).
7. Certification of the tensiometer (must be calibrated within 3 months of the start of geomembrane installation).

This documentation shall be reviewed by the Geosynthetic Quality Assurance Consultant (Geosynthetic QAC), as outlined in Subsection 1.2.8, before installation of the geosynthetic can begin.

Installation

During the installation, the Installer shall be responsible for the submission of:

1. Quality control documentation and recording installation activities.
2. Subgrade surface acceptance certificates for each area to be covered by the lining system and final cover, signed by the Installer.

Completion

Upon completion of the installation, the Installer shall submit:

1. The warranty obtained from the Manufacturer if materials are provided by the Installer.
2. Installation warranty.
3. Documentation of material quantities installed.

1.2.7 Soil Quality Assurance Consultant

1.2.7.1 Definitions

The Soil Quality Assurance Consultant (QAC) is the firm responsible for observing and documenting activities related to the quality assurance of the installation of the soil components of the lining system and final cover. The Soil Quality Assurance Consultant shall be separate of the owner, operator, and installer. The Soil QAC and Geosynthetic QAC may be the same party.

In this QAM, the term Soils Quality Assurance Engineer (QAE) refers to the person who is personally in charge of the quality assurance work. The Soils QAE is an employee of the Soil QAC. In some cases, the duties of the Soils QAE described below may be shared by two individuals: a Soil Quality Assurance Managing Engineer (QAME) and a Soil Quality Assurance Resident Engineer. The personnel of the Soil QAC also include Soil Quality Assurance Monitors who are located at the site for construction observation and documentation.

1.2.7.2 Responsibilities

The Soil QAC is responsible for observing and documenting activities related to the quality assurance of the construction of the soil components of the lining systems and reviewing quality control data submitted by the Earthwork Contractor. The Soil QAC is also responsible for issuing a certification report, sealed by a registered professional engineer, as outlined in Subsection 2.5 of this QAM. Other duties of the Soil QAC shall include overseeing the soil laboratory testing.

The specific duties of the Soil QAC personnel are as follows:

1. The Soils QAE:
    a. Review design drawings and specifications.
    b. Develops, if necessary, a site-specific addendum for quality assurance of soil components with the assistance of the Project Manager.
    c. Administers the soil portions of the QAM, including assigning and managing soil quality assurance personnel, reviews field reports, and provides engineering review of quality assurance related issues.
    d. Reviews changes to design drawings as issued by the Designer.
    e. Acts as on-site (resident) representative of the Soil QAC.
    f. Familiarizes the Soil Quality Assurance Monitors with the site and the project QAM.
    g. Attends quality assurance related meetings, including resolution, pre-construction, daily, and weekly meetings.

h. Manages the preparation of the documentation drawings related to soil work.

i. Reviews the Soil Quality Assurance Monitor's daily reports, logs, and photographs.

j. Notes any on-site activities that could result in damage to the installed soil components.

k. Reports to the Project Manager, and logs in the daily report, relevant observations reported by the Soil Quality Assurance Monitors.

l. Prepares a summary of soil quality assurance activities at the end of each week of the construction activity.

m. Oversees marking, packaging, and shipping of laboratory test samples.

n. Reviews the results of laboratory testing and makes appropriate recommendations.

o. Designates a Soil Quality Assurance Monitor to represent the Soil QAE whenever he is absent from the site while operations are ongoing.

p. Reports unapproved deviations from the QAM to the Project Manager.

q. Prepares the final certification report for soil components of the liner system and final cover.

2. The Soil Quality Assurance Monitor:

   a. Monitors, logs, photographs and/or documents soil component installation operations. Photographs shall be taken routinely and in critical areas of the installation sequence. These duties shall be assigned by the Soil QAE.

   b. Monitors the following operations for soil components:

      (1) Material delivery.

      (2) Unloading and on-site transport and storage.

      (3) Sampling and conformance testing.

      (4) Deployment operations.

      (5) Condition of the soil components as placed.

      (6) Visual observation, by walkover, of the finished soil components.

      (7) Sampling and field testing of the finished soil components.

      (8) Repair operations, when necessary.

   c. Document on-site activities that could result in damage to the constructed soil components. Problems noted shall be reported as soon as possible to the Soil QAE. The Soil QAE will bring this immediately to the Project Manager's attention.

Differences of the Soil QAC's interpretation of the plans and specifications from the Contractor's interpretation shall be properly and adequately assessed by the Soil QAC. If such assessment indicates actual or suspected work deficiencies, the Soil QAC shall inform the Contractor, or the Contractor's representative, of these deficiencies.

1.2.7.3 Qualifications

The Soil QAC shall be pre-qualified and approved by Orchard Ridge RDF. The Soil QAC shall hold "umbrella coverage" and other coverage as required by statute and contractual agreement.

The Soil QAC shall be experienced in the preparation of quality assurance documentation including quality assurance forms, reports, certifications, and manuals.

The Soils QAE shall hold a B.S., M.S., or Ph.D. degree in civil engineering or related fields. The Soils QAE shall be specifically experienced in the installation of compacted select clay fill liners and shall have the necessary training and certification by the Soil QAC in the duties of a Soil QAE.

1.2.7.4 Submittals

Pre-construction

Prior to beginning work on a project, the Soil QAC shall, in writing, provide the Project Manager with the following:

1. Resumes of personnel to be involved in the project including Soil QAE and Soil Quality Assurance Monitors.
2. Proof of the required soil components quality assurance experience of the quality assurance personnel.

1.2.8 Geosynthetic Quality Assurance Consultant

1.2.8.1 Definitions

The Geosynthetic QAC is a firm that is responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system on behalf of Orchard Ridge RDF. The Geosynthetic QAC shall be separate of the owner, operator, manufacturer, and installer. The Geosynthetic QAC and Soil QAC may be the same party.

In this QAM, the term Geosynthetic QAE shall be used to designate the person (working for the Geosynthetic QAC) in charge of the quality assurance work. In some cases, the duties of the Geosynthetic QAE described below may be shared by two individuals: a Geosynthetic QAME and a Geosynthetic Quality Assurance Resident Engineer. The personnel of the Geosynthetic QAC also include Geosynthetic Quality Assurance Monitors who are located at the site for construction observation and documentation. Although not necessarily located at the site, the Geosynthetic QAME shall visit the site often enough to be familiar with the project specifics.

1.2.8.2 Responsibilities

The Geosynthetic QAC is responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system. The Geosynthetic QAC is responsible for implementation of the project QAM prepared by the Project Manager and Management of the Geosynthetic Quality Assurance Laboratory. The Geosynthetic QAC is also responsible for issuing a final geosynthetic certification report, sealed by a registered professional engineer, as outlined in Subsection 2.5 of this QAM.

The specific duties of the Geosynthetic QAC personnel are as follows:

1. The Geosynthetic QAE:
    a. Reviews design drawings and ch. NR 516 requirements.

b. Reviews other site-specific documentation, including proposed layouts, and manufacturer's and installer's literature.

c. Develops a site-specific addendum for quality assurance of geosynthetics (if necessary) with the assistance of the Project Manager.

d. Administers the geosynthetic portions of the QAM, e.g., assigns and manages geosynthetic quality assurance personnel, reviews field reports, and provides engineering review for quality assurance related issues.

e. Reviews changes to design drawings as issued by the Designer.

f. Acts as the on-site (resident) representative of the Geosynthetic QAC.

g. Familiarizes Geosynthetic Quality Assurance Monitors with the site and the project QAM.

h. Attends quality assurance related meetings, e.g., resolution, pre-construction, daily, weekly.

i. Reviews Manufacturer and Installer certifications and documentation and makes appropriate recommendations.

j. Manages the preparation of the documentation drawing(s).

k. Reviews the calibration certification of the on-site tensiometer.

l. Reviews Geosynthetic Quality Assurance Monitor's daily reports, logs, and photographs.

m. Notes on-site activities that could result in damage to the geosynthetics.

n. Reports to the Project Manager, and logs in the daily report, relevant observations reported by the Geosynthetic Quality Assurance Monitors.

o. Prepares a daily summary of the quantities of geosynthetics installed that day.

p. Prepares the weekly summary of geosynthetic quality assurance activities.

q. Oversees the marking, packaging, and shipping of laboratory test samples and archive samples.

r. Reviews the results of laboratory testing and makes appropriate recommendations.

s. Designates a Geosynthetic Quality Assurance Monitor to represent the Geosynthetic QAE whenever he is absent from the site while operations are ongoing.

t. Reports unapproved deviations from the QAM to the Project Manager.

u. Prepares the final certification report for the geosynthetic components of the lining system.

2. The Geosynthetic Quality Assurance Monitor:

a. Monitors, logs, photographs and/or documents geosynthetic installation operations. Photographs shall be taken routinely and in critical areas of the installation sequence. These duties shall be assigned by the Geosynthetic QAE.

b. Monitors the following operations for geosynthetics:

(1) Material delivery.

(2) Unloading and on-site transport and storage.

(3) Sampling for conformance testing.

(4) Deployment operations.

(5) Joining and/or seaming operations.

(6) Condition of panels as placed.

(7) Visual inspection by walkover.

(8) Repair operations.

c. Monitors and documents the geomembrane seaming operations, including:

(1) Trial seams.

(2) Seam preparation.

(3) Seaming.

(4) Nondestructive seam testing.

(5) Sampling for destructive seam testing.

(6) Field tensiometer testing.

(7) Laboratory sample marking.

(8) Repair operations.

d. Documents on-site activities that could result in damage to the geosynthetics. Problems noted shall be reported as soon as possible to the Geosynthetic QAE.

Differences in the Geosynthetic QAC's interpretation of the plans and specifications from the Installer's interpretation shall be properly and adequately assessed by the Geosynthetic QAC. If such assessment indicates any actual or suspected work deficiencies, the Geosynthetic QAC shall inform the Installer, or the Installer's representative, of these deficiencies.

1.2.8.3 Qualifications

The Geosynthetic QAC shall be pre-qualified by Orchard Ridge RDF. The Geosynthetic QAC shall be experienced in quality assurance of geosynthetics with emphasis on polyethylene geomembranes. The Geosynthetic QAC shall be experienced in the preparation of quality assurance documentation including quality assurance forms, reports, certifications, and manuals.

The Geosynthetic QAE shall hold a B.S., M.S. or Ph.D. degree in civil engineering or related fields. The Geosynthetic QAE shall comply with the experience requirements listed in the previous paragraph. The Geosynthetic QAE shall be specifically experienced in the installation of geosynthetics and shall be trained and certified by the Geosynthetic QAC in the duties of a Geosynthetic QAE.

Geosynthetic Quality Assurance Monitors shall be quality assurance personnel who have been specifically trained in the quality assurance of geosynthetics.

1.2.8.4 Submittals

Pre-installation

Prior to beginning work on a project, the Geosynthetic QAC must provide the Project Manager with the following information:

1. Resumes of personnel to be involved in the project including Geosynthetic QAE, and Geosynthetic Quality Assurance Monitors.
2. Proof of the required quality assurance experience of the quality assurance personnel with emphasis on polyethylene geomembranes.

1.2.9 Construction Quality Assurance Officer (Certifying Engineer)

1.2.9.1 Definitions

The CQA Officer is a person who meets the qualifications of the Soil QAME or the Geosynthetic QAME as defined in Subsections 1.2.7 and 1.2.8 of this QAM and is a registered Professional Engineer in the State of Wisconsin.

1.2.9.2 Responsibilities

The CQA Officer is that individual assigned the responsibility for the aspects of CQA Plan implementation. The CQA Officer shall ensure that communications of CQA-related matters are conveyed to and acted upon by the affected organizations.

1.2.9.3 Qualifications

The CQA Officer shall be a registered Professional Engineer in the State of Wisconsin, possess adequate formal academic training in engineering, geology, or closely associated disciplines and sufficient practical, technical, and managerial experience to successfully oversee and implement Construction Quality Assurance activities for disposal facilities.

1.2.10 Soil Quality Assurance Laboratory

1.2.10.1 Definitions

The Soil Quality Assurance Laboratory (QAL) is a firm responsible for conducting tests on soil samples taken from the site. The Soil QAL and Geosynthetic QAL may be the same party.

1.2.10.2 Responsibilities

The Soil QAL is responsible for conducting the appropriate laboratory tests as directed by the Soil QAE and Project Manager. The test procedures shall be done in accordance with the test methods outlined in this QAM.

1.2.10.3 Qualifications

The Soil QAL shall be approved by Orchard Ridge RDF. The Soil QAL shall have properly maintained and periodically calibrated appropriate testing equipment. The Soil QAL shall also

ensure that laboratory soil testing is performed by personnel with experience and/or training in soil testing fundamentals. The laboratory personnel shall be familiar with ASTM International (ASTM), American Association of State Highway and Transportation Officials (AASHTO), the U.S. Army Corps of Engineers (COE), and other applicable test standards. The Soil QAL shall be capable of providing test results within project deadlines throughout the installation phase of the soil components.

1.2.10.4 Submittals

The Soil QAL shall submit test results within project deadlines to the Soil QAE. Soil test results shall be provided by fax or email to the Soil QAE as soon as possible after test completion. Written test results shall be in a format approved by the Project Manager and include references to the standard test methods used.

1.2.11 Geosynthetic Quality Assurance Laboratory

1.2.11.1 Definitions

The Geosynthetic QAL is a firm responsible for conducting tests on samples of geosynthetics taken from the site. The Geosynthetic QAL and the Soil QAL may be the same party.

1.2.11.2 Responsibilities

The Geosynthetic QAL shall be responsible for conducting the appropriate laboratory tests as directed by the Geosynthetic QAE. The test procedures shall be done in accordance with the test methods outlined in this QAM.

1.2.11.3 Qualifications

The Geosynthetic QAL shall have experience in testing geosynthetics and be familiar with ASTM, Federal Test Method Standard (FTMS), National Sanitation Foundation (NSF), the Geosynthetic Institute (GRI), and other applicable test standards. The Geosynthetic QAL shall be capable of providing verbal results of destructive seam tests within 24 hours of receipt of test samples and shall maintain that standard throughout the installation. The Geosynthetic QAL shall be approved by Orchard Ridge RDF.

On-site laboratory facilities may be used by the Geosynthetic QAL, provided they are appropriately equipped and approved by the Geosynthetic QAC and the Project Manager.

1.2.11.4 Submittals

The Geosynthetic QAL shall submit destructive seam test results to the Geosynthetic QAE in written form within 48 hours of receipt of test samples unless otherwise specified by the Project Manager. Geomembrane destructive test results shall typically be provided by fax or e-mail to the Geosynthetic QAE within 24 hours of receipt of test samples. Written test results shall be in a format approved by the Project Manager and include references to the standard test methods used.

1.3 Communication

To guarantee a high degree of quality during installation and assure a final product that meets the minimum project requirements, clear, open channels of communication are essential. This section discusses appropriate lines of communication and describes the necessary meetings.

1.3.1 Lines of Communication

The Soil QAE and Geosynthetic QAE shall be capable of direct communication with the Project Manager. Access to Orchard Ridge RDF personnel is also available for issue resolution, if necessary.

1.3.2 Resolution Meeting

Following permit approval and the completion of the construction drawings and specifications for the project, a resolution meeting may be held. If a resolution meeting is required, it is recommended that the meeting be held prior to bidding the construction work and include the parties then involved, typically including the Project Manager, Designer, Soil/Geosynthetic QAE, and an Orchard Ridge RDF representative. If necessary, this meeting can be held in conjunction with the pre-construction meeting.

The purpose of this meeting is to establish lines of communication, review construction drawings for completeness and clarity, begin planning for coordination of tasks, anticipate potential problems which might cause difficulties and delays in construction, and clarify the QAM. Aspects of the design shall be reviewed during this meeting so that clarification and/or design changes may be made before the construction work is bid. In addition, the guidelines regarding quality assurance testing and problem resolution must be known and accepted by the parties involved.

1.3.3 Pre-Construction Meeting

A pre-construction meeting shall be held at the site prior to beginning of the lining system and final cover installation. Typically, the meeting shall be attended by the Project Manager, Earthwork Contractor, Geosynthetic Installer, Soil/Geosynthetic QAE, WDNR Review Engineer and an Orchard Ridge RDF representative.

Specific topics considered for this meeting include review of the project QAM for potential problems or additions. In addition, the responsibilities of each party shall be reviewed and understood clearly. The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to the appropriate parties.

1.3.4 Progress Meetings

A daily progress meeting shall be held between the Soils QAE/Geosynthetic QAE, Contractor's/Installer's Superintendent, Project Manager, and other parties requested by Project Manager. This meeting shall discuss current progress, planned activities for the day, issues requiring resolution, and new business or revisions to the work. The Soil/Geosynthetic QAE shall log problems, decisions, or questions arising at this meeting in his weekly report. If matters remain unresolved at the end of this meeting, the Project Manager shall be responsible for the resolution of the matters and the communication of the decision to the appropriate parties.

2.0 Documentation

The Soil/Geosynthetic QAC shall provide the Project Manager with signed descriptive remarks, data sheets, and checklists to verify that monitoring activities have been carried out. The Soil/Geosynthetic QAC shall also maintain at the job site a complete file of documents which comprise the QAM, including plans, checklists, test procedures, daily logs, and other pertinent documents. The Soil/Geosynthetic QAC shall document that requirements in the lining portions of the project QAM including ch. NR 516 have been addressed and satisfied.

2.1 Daily Reports

2.1.1 Soils Reports

Each Soil Quality Assurance Monitor shall complete a daily report and/or logs on prescribed forms, outlining monitoring activities for that day. The report at a minimum shall consist of field notes, observations and test data sheets, and construction problems and solution data sheets. A summary of supporting data sheets along with final testing results and Soils QAE's approval of the work shall be required upon completion of construction.

The Project Manager shall be made aware of any significant recurring non-conformance with the minimum project requirements. The Project Manager shall then determine their cause and recommend appropriate changes. When this type of evaluation is made, the results must be documented, and revisions to procedures shall be approved by the Owner and Designer.

2.1.2 Geosynthetic Reports

Each Geosynthetic Quality Assurance Monitor shall complete a daily report and/or logs on prescribed forms, outlining monitoring activities for that day. The precise areas, panel numbers, seams completed and approved, and measures taken to protect unfinished areas overnight shall be identified. Failed seams or other panel areas requiring remedial action shall be identified with regard to nature of action, required repair, and precise location. Repairs completed must also be identified. Problems or concerns with regard to operations on-site should also be noted. This report must be completed at the end of each monitor's shift, prior to leaving the site, and submitted to the Soils/Geosynthetic QAC.

The Soil/Geosynthetic lead monitor shall review the daily reports submitted by the Quality Assurance Monitors and incorporate a summary of their reports into the lead monitor's daily report. Matters requiring action by the Project Manager shall be identified. The report shall include a summary of the quantities of material installed that day. This report must be completed daily, summarizing the previous day's activities, and a copy submitted to the Project Manager at the beginning of the workday following the report date.

The Project Manager shall be made aware of significant recurring non-conformance with the minimum project requirements. The Project Manager shall then determine their cause and recommend appropriate changes. When this type of evaluation is made, the results must be documented, and revision to procedures shall be approved by the Project Manager. The Project Manager shall determine if such changes are regulatory compliance issues and obtain resolution, as necessary. Orchard Ridge RDF shall be notified if minimum project requirements or CQA Manual Procedures could not be met and alternatives which require regulatory interaction or require permit modification are proposed.

2.2 Test Reports

2.2.1 Soils Field Testing Reports

Records of field and laboratory testing performed on the soil components of the landfill shall be collated by the Soil QAC. A summary list of test results shall be prepared by the Soil QAC on an ongoing basis and submitted with the weekly progress reports.

2.2.2 Geosynthetic Destructive Testing Reports

The destructive test reports from sources shall be collated by the Geosynthetic QAC. This includes field tests, Installers laboratory tests (if performed), and Geosynthetic QAL tests. A summary list of test samples pass/fail results shall be prepared by the Geosynthetic QAC on an ongoing basis and submitted with the weekly progress reports.

2.3 Progress Reports

Progress reports shall be prepared by the Soil/Geosynthetic lead monitor and submitted to the Project Manager. These reports shall be submitted every week, starting the first Friday of soil placement or geosynthetics deployment on-site. This report shall include: an overview of progress to date; an outline of changes made to the plans, drawings, or permit requirements. The report shall also include problems or deficiencies in installation at the site, an outline of action taken to remedy the situation, a summary of weather conditions and a brief description of activities anticipated for the next reporting period. Daily reports for the period should be appended to each progress report.

2.4 Documentation Drawings

2.4.1 Soils Drawings

Documentation drawings shall be prepared by the Soil QAC. The documentation shall include, at a minimum, the information required by s. NR 516.05(1) and s. NR 516.06(1).

2.4.2 Geosynthetic Drawings

Documentation drawings shall be prepared by the Geosynthetic QAC. The documentation drawings shall include, at a minimum, the information for geomembranes shall comply with the requirements listed in s. NR 516.05(1) and s. NR 516.06(1).

2.5 Final Certification Report

Upon completion of the work, the Soil/Geosynthetic QAC shall submit a final certification report to the Project Manager. This report shall summarize the activities of the project, and document aspects of the quality assurance program performed.

The final certification report shall include, at a minimum, the information required by s. NR 516.04(3), s. NR 516.05(2), and s. NR 516.06(2).

3.0 Lining System Acceptance

3.1 Soil Components Acceptance

Upon written recommendation by the Soil QAC, the Project Manager shall consider accepting the soil components of the lining system. The Earthwork Contractor will retain the responsibility for the soil lining components until acceptance by Orchard Ridge RDF. The conditions of acceptance are described below. At Orchard Ridge RDF discretion, the soil lining system or final cover may be accepted in sections or at points of substantial completion.

The soil components of the lining system will be accepted by Orchard Ridge RDF when:

1. The installation of the soil components is finished.
2. Verification of the adequacy of the constructed components, including repairs, is completed in accordance with the project specific QAM.
3. Documentation of installation is completed.
4. The Soil QAC recommends acceptance.

The Soil QAC shall certify that installation of the soil components has proceeded in accordance with the project specific QAM except as noted by the Project Manager. This certification shall be provided in the final certification report as outlined in Subsection 2.5.

3.2 Geosynthetic Components Acceptance

Upon written recommendation by the Geosynthetic QAC, the Project Manager shall consider accepting the geosynthetic components of the lining system or final cover. The conditions of acceptance are described below. The Installer and Manufacturer(s) will retain ownership and responsibility for the geosynthetics in the lining system until acceptance by Orchard Ridge RDF. At Orchard Ridge RDF discretion, the geosynthetic lining system may be accepted in sections or at points of substantial completion.

The geosynthetic lining system will be accepted by Orchard Ridge RDF when:

1. The installation of the geosynthetic component of the lining system, or section thereof, is finished.
2. Verification of the adequacy of seams and repairs, including associated testing, is completed.
3. Documentation of installation is completed.
4. The Geosynthetic QAC recommends acceptance.

The Geosynthetic QAC shall certify that installation has proceeded in accordance with the geosynthetic portions of the project QAM except as noted to the Project Manager. This certification shall be provided in the final certification report as outlined in Subsection 2.5.

4.0 Subbase Preparation

4.1 Description and Applicability

This section includes the quality assurance requirements for the preparation of the subbase grades.

4.2 Construction Observation

During subbase preparation, existing waste and soils from the Boundary Road Landfill (BRL) will be removed from the site. Procedures relating to the handling, treatment, disposal, and use of materials exhumed from the BRL are detailed in the Property Redevelopment Plan (Appendix C of the Southern Unit POO). BRL waste located below the proposed subbase grades shall also be removed. The resultant excavation will be backfilled with compacted fine-grained soil (subbase fill) meeting the requirements in Table 4 to the proposed subbase grade elevations.

Upon completion of the subbase grade preparation work, the Soil QAC shall inspect the subbase grades. The Soil QAC shall verify, at a minimum, that:

1. Borings, backhoe pits, or other means of exposing subsoils during liner construction have been performed on a 100-foot grid to a minimum depth of 5 feet below the underdrain layer (subbase grade elevation), and coarse-grained or non-plastic soils as defined by s. NR 500.03(86) and ASTM D2487 within that 5-foot-depth have been removed and replaced with compacted, fine-grained soil per s. NR 504.06(4)(d). The Soil QAC will record the approximate location, depth, and lateral extent of the granular or silty soil excavations. In areas where proposed backfill thicknesses to construct subbase grades will exceed 5 feet, no test pits and/or soil boring will be performed because the subsoils will be known. Soil excavated will be evaluated in accordance with the Property Redevelopment Plan for beneficial reuse.
2. Subbase grade hand probes have been performed to identify soft or loose soils. If any soft or loose soils are identified, the soft or loose soils shall be removed and recompacted and/or replaced with compacted fine-grained soils. The Soil QAC will record the approximate location, depth, and lateral extent of the soft or yielding soil excavations. Soil excavated will be evaluated in accordance with the Property Redevelopment Plan for beneficial reuse. Subbase soil probe investigation for determining subbase acceptance is described in Subsection 4.3.3.
3. A qualified land surveyor has verified the lines and grades on the 50-foot grid points as required by s. NR 516.05(1)(a), as identified in Table 5.
4. A qualified engineer has verified that the subbase grade soil meets the criteria in the project specifications and s. NR 516.07(1m), as summarized by Table 4.

4.3 Construction Quality Assurance Testing

Construction quality assurance testing shall be conducted in accordance with the project specifications, or as directed by the Project Manager. Field and laboratory tests shall be conducted on samples taken from subbase fill soil (general fill and fine-grained soil backfill) during the course of the construction work. Construction quality testing shall consist of laboratory and field testing as described in Subsections 5.3.1 and 5.3.2.

4.3.1 Field Testing

Field testing for subbase fill is detailed in Subsection 5.3.1. Acceptance criteria for field testing performed on subbase fill is specified in Table 4.

4.3.2 Laboratory Testing

Laboratory testing for subbase fill is detailed in Subsection 5.3.2. Acceptance criteria for laboratory testing performed on subbase fill is specified in Table 4.

4.3.3 Subbase Soil Probe Investigation

A soil probe investigation will be conducted on the subbase in areas where potential soft/unsuitable soil is identified in the subbase. The soft/unsuitable soil areas will be probed by the Soil QAE with a metal probe to determine the depth and extent of the soft/unsuitable soil. If unsuitable soil is encountered within a minimum of 3-feet of subbase grades (based upon the soil probe results), the unsuitable material will be removed and replaced with general fill (subbase fill).

5.0 General fill

5.1 Description and Applicability

This section includes quality assurance requirements for placement, compaction, and grading of general fill. General fill may be any inorganic soil, except for subbase backfill which will consist of fine-grained soils. General fill consists of material taken from on-site, approved off-site excavations, or stockpiles used for non-critical applications. Soil used as general fill consist of a broad range of soils relatively free of organics, trash, or other deleterious matter can be used to fulfill the purpose of general fill construction.

General fill will be used in construction of the following components:

- Perimeter Berm
- Subbase fill (fine-grained backfill only)
- Final Cover (rooting zone and grading layer)
- Access Roads and perimeter ditches
- Sedimentation basins

Testing and/or material qualification requirements specified for the general fill are provided in Table 1 and 4.

5.2 Construction Observation

The Soil QAC shall verify the requirements of Tables 1 and 3 are met.

Subbase fill, consisting of fine-grained soil meeting the requirements of Table 4, will be used within 5 feet of subbase grades or in areas where the BRL waste was located below subbase grades. Subbase fill will be placed to the subbase grades to support the 4-foot select clay fill liner within the limits of waste. The Soil QAC will observe subbase fill placement activities in subbase areas and will document relevant observations to support certification of the following requirements:

1. The Soil QAC will periodically observe loads of subbase fill for general conformance to material specifications and may randomly sample loads. The Soil QAE will perform routine conformance sampling as defined in Subsection 5.3.
2. No frozen soil will be used for backfilling. Frozen soil in the compaction work area will be removed.
3. Lift thickness for subbase fill compaction will not exceed 12 inches after compaction.
4. General soil used as structural fill (i.e., subbase preparation, perimeter landfill berms and roads) will be compacted to a minimum of 90 percent or 95 percent of the maximum dry density as determined by the Modified or Standard Proctor test, respectively.
5. Unacceptable compaction density, as defined above, will be reported to the CQA Officer by the Soil QAC. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort, as necessary.

6. The Soil QAC will confirm the subbase is acceptable and ready for select clay fill placement prior to placement of select clay fill over the subbase. The Soil QAC will notify the CQA Officer of soft appearing areas of the subbase during subbase development and prior to select clay fill placement.

The Soil QAC will observe general fill soil placement activities and will document relevant observations to support certification of the following requirements:

1. The Soil QAC will periodically observe loads of general fill for general conformance to material specifications and may randomly sample loads. The Soil QAC will perform routine conformance sampling as defined in Subsection 5.3.
2. No frozen soil will be used for backfilling. Frozen soil in the compaction work area will be removed.
3. Loose lift thickness for general soil compaction will not exceed 12 inches, except when being placed in the rooting zone layer in the final cover where lifts will be placed up to 30 inches.
4. General fill outside the limits of waste will be compacted to 85 percent of modified Proctor or 90 percent standard Proctor. General fill moisture will be adjusted between -2 percent and +5 percent of optimum moisture content per modified or standard Proctor (ASTM D1557 or D698) laboratory results.
5. Unacceptable compaction density, as defined above, will be reported to the CQA Officer by the Soil QAC. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort as necessary.

Infield material testing for field moisture content and density (ASTM D6938) shall be recorded on a 100-foot grid per 1-foot completed material thickness or at a minimum of once per lift. The Soil QAC shall report non-conformance to the Project Manager.

Upon completion of subbase grades, grading layer, or rooting zone construction, the Soil QAC shall evaluate each component and prepare a certificate of acceptance to be submitted to the Project Manager. The Soil QAC shall verify, at a minimum, that:

1. For subbase grades:
    a. A qualified land surveyor has verified the lines and grades on the 50-foot grid points as required by s. NR 516.05(1)(a), as identified in Table 5.
    b. A qualified engineer has verified that the subbase fill meets the criteria in Table 4.
2. For final cover components:
    a. A qualified land surveyor has verified the lines and grades on the 100-foot grid points as required by s. 516.06(1)(a) and (d), as identified in Table 5.

5.3 Construction Testing

Testing is required for the subbase fill and general fill used to construct the perimeter berm and its features.

Construction quality assurance testing shall be conducted in accordance with the project specifications, or as directed by the Project Manager. Field and laboratory tests shall be conducted on samples taken from the subbase fill and perimeter berm general fill during the course of the construction work. Construction quality testing shall consist of laboratory and field testing as described in Subsections 5.5.1 and 5.5.2. Testing and sampling procedures shall be observed and documented by the Soil QAC. Documentation and reporting of test results shall be in accordance with the requirements identified in Section 2 of this manual.

Laboratory and Field Tests: The soil types listed in Tables 1 and 3 are defined by the following:

- General Fill: Random granular or cohesive material used for construction (such as perimeter berm, grading layer, or rooting zone).
- Subbase Fill: Fine-grained soil used to replace over-excavated subbase areas and where subbase grades are located above the base of the BRL waste. Fine-grained soil shall have at least 50% by weight passing the #200 sieve, a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit shall falls on or above the ASTM D2487 "A" line as required by s. NR 500.03(86).

Under "field tests," the moisture/density tests should correspond to Table 3.

5.3.1 Field Testing

The Soil QAC shall perform the following field tests on each 1-foot thickness of subbase fill and for placed:

1. Field Moisture Content (ASTM D6938).
2. Field Density (ASTM D6938).

Density and moisture content testing shall be performed in accordance with frequencies stated in Table 3. Sampling locations shall be selected by the Soil QAC.

In-place density and water content of soil and soil-aggregate by nuclear methods (ASTM D6938) shall be preferred for field testing. The location of routine in-place density tests shall comply with s. NR 516.07(1m)(a). Questions concerning the accuracy of a single test shall be addressed by re-testing in the same general location.

Field testing is not required for rooting zone soil or grading layer material.

The minimum acceptance criteria are provided in Table 4.

5.3.2 Laboratory Testing

Representative samples of the subbase fill and structural general fill will be obtained at the frequency listed on Table 1. The following tests shall be performed on the representative samples:

1. Atterberg Limits (ASTM D4318).
2. Grain Size (ASTM D7928 with hydrometer).
3. Laboratory Modified Proctor Compaction (ASTM D1557) or Standard Proctor Compaction (ASTM D698).

The minimum acceptance criteria for subbase fill are provided in Table 4. There are no acceptance criteria for general fill.

5.4 Defects and Repairs

If a defect is discovered in the finished general earthwork, the Soil QAC shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the Soil QAC shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the Soil QAC deems appropriate.

5.4.1 Notification

After determining the extent and nature of the defect, the Soil QAC shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held between the Earthwork Contractor, the Soil QAC, and the Project Manager to assess the problem, review alternative solutions, and implement an action plan.

5.4.2 Repairs and Re-testing

The Earthwork Contractor shall correct deficiencies to the satisfaction of the Soil QAC. If a project criterion cannot be met, or unusual weather conditions hinder work, the Soil QAC shall develop and present to the Project Manager suggested solutions for approval. The Project Manager shall determine if such changes are regulatory compliance issues and obtain resolution as necessary. WDNR shall be notified if permit, Wisconsin Administrative Code requirements, or QAM Procedures could not be met and alternatives which require regulatory interaction or require permit modifications are proposed.

The Soil QAC shall schedule appropriate retests, if required, when the work defect has been corrected. Re-tests by the Soil QAC must verify that the defect has been corrected in the area of the deficiency before additional work is performed by the Earthwork Contractor.

6.0 Compacted Select Clay Fill

6.1 Description and Applicability

Compacted select clay fill generally consists of cohesive soils with low hydraulic conductivity used as barriers in lining or final cover systems (if a select clay fill option is selected by Owner).

Soils used in compacted select clay fill liners, in the compacted clay wedge at the top of liner sidewalls, and in the compacted select clay fill section of the final cover system shall consist of a clean, select material free of organics, trash, excess silt, or other deleterious matter. Select clay fill shall be classified according to the Unified Soil Classification System as CL or CH. Organic soils shall not be used. Initial acceptance of material should be within the range of PI% - 10 percent minimum, 12 percent average and LL% - 20 percent minimum, 25 percent average of the Atterberg limits, a minimum 50 percent P200 content. When compacted to a minimum of 90 percent modified Proctor (at a moisture content at least 2 percent wet of optimum) or 95 percent standard Proctor (at a moisture content wet of optimum), the saturated hydraulic conductivity of the select clay fill shall be 1×10^{-7} cm/sec or less.

6.2 Conformance Testing

Conformance testing of the compacted select clay fill shall be performed prior to compaction (bulk sample) and after compaction (undisturbed Shelby tube). Conditioning may be required to meet the project specification and include adjustments in the compaction and moisture content.

The following tests shall be performed:

1. Moisture Content (ASTM D2216).
2. Particle Size (ASTM D7928 with hydrometer).
3. Atterberg Limits (ASTM D4318).
4. Laboratory Modified Proctor Compaction (ASTM D1557) or Standard Proctor Compaction (ASTM D698).
5. Laboratory Hydraulic Conductivity (ASTM D5084).

As specified in ch. NR 516, tests shall be performed at a frequency indicated in Tables 1, 2, and 3.

The Soils QAE shall examine the test results and report non-conformances to the Project Manager. The Project Manager shall accept or reject the soil based on this review and the requirements of Table 4. Additional soil testing may be done at the request of the Project Manager and/or the Soils QAE.

6.3 Subgrade Preparation

The Earthwork Contractor shall be responsible for preparing the subgrade soil for compacted select clay fill liner, following the exhumation of existing waste and soils from the Boundary Road Landfill (BRL), or for final cover placement.

The Soil QAC shall verify, at a minimum, that:

1. A qualified land surveyor has verified the lines and grades on the 50-foot or 100-foot grid points as required by ss. NR 516.05(1)(a), 516.06(1)(a), and (d), as identified in Table 5.
2. A qualified engineer has verified that the subgrade soil meets the criteria in the project specifications and s. NR 516.07(1m), as summarized by Table 4. Subbase grade preparation is detailed in Section 4.0.

During construction, the Soil QAC shall indicate to the Project Manager locations, which are not adequate for the placement of compacted select clay fill. Such defects in the subgrade soil shall be repaired by the Earthwork Contractor, at the direction of the Project Manager, such that the properties of the repaired areas meet the minimum requirements shown in Table 4.

6.4 Construction Observation

Observation of the compacted select clay fill construction shall be coordinated with the construction testing described in Subsection 6.5. Acceptance criteria for construction work shall be as identified in Table 4.

Soil QAC shall observe the following during the construction of compacted select clay fill:

1. Water content and consistency of the soil during processing, placement, and compaction.
2. Disking and mechanical processing of the clay as required to break up clods and adjust the clay moisture content.
3. Type and level of compactive effort:
    a. Compactor type (footed compaction equipment having feet at least as long as the loose lift height).
    b. Compactor weight (minimum static weight of 30,000 pounds [lbs]).
    c. Number of passes.
    d. Methods utilized in its placement.
4. Maximum clod size (maximum 4 inches).
5. Quality of select clay fill and the condition of the select clay fill stockpile (if applicable).
6. Loose and compacted lift thickness (maximum loose 8 inches and maximum compacted 6 inches). The initial lift of clay liner material placed over the underdrain layer will have a thickness of approximately 8 to 12 inches to avoid damaging the underdrain layer. The initial lift of clay material placed for the clay wedge at the top of liner sidewalls will also have a thickness somewhat greater than 6 inches to avoid having the compactor come in direct contact with the underlying materials.
7. Method of tying together the lifts and keying into previously placed clay layers.
8. Dimensions of the compacted embankment.
9. Areas where damage due to excess moisture, insufficient moisture, or freezing, if applicable.

An evaluation of the compacted select clay fill to determine if homogenous soil exists by examination of the layer bonding and moisture conditioning may be determined by using Shelby tubes.

Upon completion of the compacted select clay fill construction, the Soil QAC shall evaluate the compacted select clay fill and prepare a certificate of acceptance and submit to the Project Manager. The Soil QAC shall verify, at a minimum, that:

1. A qualified land surveyor has verified the lines and grades as required by s. NR 516.05(1)(c) (composite liner system) and s. NR 516.06(1)(a) (final cover system) as identified on Table 5.
2. A qualified engineer has verified that the select clay fill meets the criteria in Table 4.
3. Stones in excess of 1-inch-diameter, angular stones, and other foreign objects have been removed from the finished surface of the select clay fill.
4. The select clay fill has sufficient smoothness for geomembrane deployment and that the clay surface is free of damage from rain, rutting, etc.

Note: Surface preparation prior to geomembrane deployment is addressed in Subsection 11.5.1 for the liner system and Subsection 12.4.1 for the final cover system.

6.5 Construction Testing

Construction quality assurance testing shall be conducted in accordance with the project specifications, or as directed by the Project Manager. Field and laboratory tests shall be conducted on samples taken from the compacted select clay fill during the course of the construction work. Construction quality testing shall consist of laboratory and field testing as described in Subsections 6.5.1 and 6.5.2. Testing and sampling procedures shall be observed and documented by the Soil QAC. Documentation and reporting of test results shall be in accordance with the requirements identified in Section 2 of this manual.

Under “field tests,” the moisture/density tests correspond to Table 3.

6.5.1 Field Testing

The Soil QAC shall perform the following field tests on each 1-foot thickness of the compacted select clay fill:

1. Field Moisture Content (ASTM D6938).
2. Field Density (ASTM D6938).

Unless otherwise specified, nuclear density and moisture content testing shall be performed in accordance with frequencies stated in Table 3. Sampling locations shall be selected by the Soil QAC.

In-place density and water content of soil and soil-aggregate by nuclear methods (ASTM D6938) shall be preferred for field testing. The location of routine in-place density tests shall comply with s. NR 516.07(1)(a). Questions concerning the accuracy of a single test shall be addressed by re-testing in the same general location.

Unless otherwise noted in the project specifications, or as directed by the Project Manager, perforations of the clay liner shall be backfilled. Perforations that must be backfilled shall include, but not limited to, the following:

- Nuclear density test probe locations.
- Shelby tube sampling locations.

Perforations shall be backfilled with a clay bentonite.

At the discretion of the Project Manager, if one or more of the following conditions develop during construction, an increased frequency of testing shall be used based on recommendations from the Soil QAC:

1. Sheepsfoot Compactor slip during operation.
2. General fill and clay liner soil are at variable moisture content.
3. Dirt-clogged compactor feet are used to compact the material.
4. The degree of compaction of the material is suspect.
5. Weather conditions are adverse.
6. Compaction equipment at less than optimum ballast (30,000 lbs minimum).
7. Equipment breaks down frequently.

Acceptability criteria for the compacted select clay fill are provided in Table 4.

6.5.2 Laboratory Testing

The following tests shall be performed on undisturbed samples (Shelby tube) to confirm the adequacy of the material in the compacted select clay fill:

1. Atterberg Limits (ASTM D4318).
2. Hydraulic Conductivity (ASTM D5084).
3. Grain Size (ASTM D7928 with hydrometer).
4. Moisture Content (ASTM D2216).
5. Dry Density (ASTM D7263)

Undisturbed samples will be obtained at the frequencies detailed in Table 2. Hydraulic conductivity of the compacted soil shall be determined on undisturbed samples obtained from the constructed compacted select clay fill. Laboratory hydraulic conductivity samples shall be taken such that the sample tube is inserted into the liner perpendicular to the plane of the constructed surface. The tube shall be inserted by applying a gradually increasing pressure. Laboratory hydraulic conductivity testing of the undisturbed compacted select clay fill samples shall be performed according to ASTM D5084.

In addition to the undisturbed samples, representative (grab) samples shall be obtained at the frequency specified on Table 1.

1. Atterberg Limits (ASTM D4318).

2. Grain Size (ASTM D7928 with hydrometer).
3. Laboratory Modified Proctor Compaction (ASTM D1557) or Standard Proctor Compaction (ASTM D698).

Acceptability criteria for select clay fill are provided in Table 4.

6.6 Defects and Repairs

At locations where the field density and moisture content testing indicate compaction was performed below the requirements of the specifications, the Soil QAC shall determine the extent and the nature of the defect.

If the compacted select clay fill is partially constructed and left exposed over winter, the compacted select clay fill will be re- tested as described in Subsection 6.6.2. If the results of this testing indicate the compacted select clay fill meets the requirements specified in ch. NR 504, then the top 6-inch select clay fill layer shall be disked, recompacted, and tested in accordance with Wisconsin Administrative Code requirements. However, if the compacted select clay fill does not meet the requirements for density and/or hydraulic conductivity, the WDNR shall be contacted as described in Subsection 6.6.1.

If the compacted select clay fill has been subjected to other adverse weather conditions, the Soil QAC shall re-inspect the liner for possible damage to determine the extent and nature of the defect and provide notification to the Project Manager and the Earthwork Contractor as discussed in Subsection 6.6.1.

6.6.1 Notification

After determining the extent and nature of the defect, the Soil QAC shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held between the Earthwork Contractor, Soil QAC, and the Project Manager to assess the problem, review alternative solutions, and implement an action plan.

If the compacted select clay fill is partially constructed and left exposed over winter and the re-tested layer does not meet the requirements for density and/or hydraulic conductivity, the WDNR shall be contacted in writing (email acceptable) to obtain concurrence on a proposal for compacted select clay fill repair and/or re-testing. If an alternative method for confirming the integrity of partially constructed compacted select clay fill that is exposed over winter is proposed, the WDNR shall be contacted in writing to obtain its concurrence (email acceptable) prior to implementing the alternative method.

6.6.2 Repairs and Re-testing

The Earthwork Contractor shall correct deficiencies to the satisfaction of the Soil QAC. If a permit or code condition cannot be met, or unusual weather conditions hinder work, the Soil QAC shall develop and present to the Project Manager suggested solutions for his approval. The Soil QAC shall schedule appropriate re-tests when the work defect has been corrected. Re-tests by the Soil QAC shall verify that the defect has been corrected in the area of the deficiency before additional work is performed by the Earthwork Contractor.

If the compacted select clay fill is partially constructed and left exposed over winter, the 1-foot-thick select clay fill layer below the top 6-inch lift shall be re-tested for density and hydraulic conductivity in accordance with ch. NR 516. Alternative confirmation methods may be proposed as described in Subsection 6.6.1.

7.0 Granular fill

7.1 Description and Applicability

Granular Fill includes select aggregate fill and select granular fill.

Select aggregate fill consists of high permeable materials used in the following applications:

1. Underdrain system trench drainage layer,
2. Leachate collection pipe bedding,
3. Leachate collection drainage layer,
4. Pipe bedding in the final cover drain outlets (intermediate and toe drains).

Limestone and dolomite will be used in the leachate collection system because no other suitable material is reasonably available in the market area. Select aggregate fill used in the leachate collection system shall be rounded to subangular. Select aggregate fill shall meet the requirements listed in Table 4.

Select aggregate fill that consists of 1-to-1.5-inch clean stone shall be used for the filter pack for the landfill gas extraction wells.

Select granular fill refers to bedding materials for structural support of non-perforated pipes outside the limits of waste. These include forcemains, culverts, and storm water conveyance structures.

7.2 Construction Observation

The Soil QAC shall observe the procedures used by the Earthwork Contractor during placement of the granular fill materials and will document relevant observations to support certification of the following requirements:

1. The Soil QAC will periodically observe loads of granular soil for general conformance to material specifications and may randomly sample loads. The Soil QAC will perform routine conformance sampling as defined in Subsection 7.3.
2. No trucks or heavy equipment will travel directly on the geomembrane. Only low-ground pressure tracked equipment (< 5 psi) may operate above the geomembrane when there is a minimum 12-inch–thick layer of select aggregate fill in-place between the tracks of the equipment and the geomembrane. A minimum of 2 feet of material will be required to be placed over the geomembrane prior to operating other tracked and flotation tire–equipped vehicles. Rubber-tired equipment may not travel above the geomembrane unless a minimum of 3 feet of material is in-place over the geomembrane. Procedures for deployment of pipe, select aggregate fill, select granular fill, and geotextiles overlying geomembranes will be planned at the preconstruction meeting. Special requirements for geomembrane protection and equipment necessary to deploy materials must be approved by the CQA Officer.

3. Care will be exercised during placement of granular fill to prevent undue damage to pipes, geomembrane, and geotextiles. Geomembrane wrinkles which were higher than they were wide were removed. Stone will not be dropped from a height greater than 3 feet above the pipe trench or sump.
4. A geotextile cushion will be placed between the geomembrane and the leachate collection drainage layer, and the pipe bedding in accordance with Section 13.
5. Select aggregate fill or collection trench/sump stone material to verify that the materials are placed at the specified thickness as shown on the Drawings.
6. If granular soil is stockpiled on-site prior to use, measures will be taken to minimize contamination by fines such as wind-blown particles and surface soil during loading operations.

In addition, the Soil QAC will provide continuous observations during pipe and trench construction including observations of pipe bedding material being spaded or shovel sliced so that the material fills and supports the haunch area of the pipe. Subsection 11.11 addresses geomembrane protection.

Upon completion of construction, the Soil QAC shall evaluate the granular fill components and prepare a certificate of acceptance to be submitted to the Project Manager. The Soil QAC shall verify, at a minimum, that:

1. Leachate Collection Drainage Layer only: The Soil QAC has verified the granular fill materials as required by s. NR 516.05(2)(b). The thickness of the leachate collection drainage layer will be surveyed by a qualified land surveyor according to the frequencies specified in Table 5.
2. A qualified engineer has verified that the granular fill meets the criteria in Table 4.

7.3 Conformance Testing

Conformance testing of the select aggregate fill shall be performed to establish the consistency of the drainage layer material properties. No field testing will be required for granular fill materials; however, the Soil QAC shall perform visual inspection of granular fill materials for conformance to material specifications and may randomly sample deliveries.

For laboratory testing, representative (grab) samples will be obtained from the proposed select granular fill, select aggregate fill, and landfill gas extraction wells filter pack material sources prior to delivery of the material. The source sampling frequency will be dependent on the apparent uniformity of the source and must be approved by the CQA Officer.

The following tests shall be performed at the frequency specified on Table 1:

1. Particle Size (ASTM C136 or ASTM D6913).
2. Constant Head Permeability (ASTM D2434) – leachate collection drainage layer only.

The Soil QAE shall examine test results and report non-conformances to the Project Manager. The Project Manager shall accept or reject the material based on this review and the requirements listed in Table 4.

7.4 Defects and Repairs

If a defect is discovered in the leachate collection drainage layer or pipe bedding material, the Soil QAC shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the Soil QAC shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the Soil QAC deems appropriate.

7.4.1 Notification

After determining the extent and nature of the defect, the Soil QAC shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held between the Earthwork Contractor, the Soil QAC, and the Project Manager to assess the problem, review alternative solutions, and implement an action plan.

7.4.2 Repairs and Re-testing

The Earthwork Contractor shall correct deficiencies to the satisfaction of the Soil QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, the Soil QAC shall develop and suggest solutions to the Project Manager for his approval. The Project Manager shall determine if such changes are regulatory compliance issues and obtain resolution, as necessary.

The Soil QAC shall schedule appropriate re-tests when the work defect has been corrected. Re-tests by the Soil QAC shall verify that the defect has been corrected in the area of the deficiency before additional work is performed by the Earthwork Contractor.

8.0 Collection and Extraction System Pipe and Fittings

8.1 Description and Applicability

The leachate collection and extraction pipe as well as landfill gas collection pipe will be constructed with HDPE pipe of various sizes. This section is applicable to the ranges in pipe size and fitting. Specifically, the HDPE pipes for this project will be used in the construction of the following systems:

- Leachate collection system
- Leachate conveyance system (forcemain)
- Underdrain conveyance system (forcemain)
- Gas Collection and Control System (GCCS)
- Final cover toe and intermediate drain collection and discharge piping

Individual pipe sizes and standard dimension ratios (SDRs) to be used for each individual pipe installation are not detailed in this section; the construction plans and specifications will be used for the determination of correct size and wall thickness.

8.2 Field Handling and Storage

Persons transporting and handling PE piping products should be familiar with applicable governmental safety regulations. Manufacturer handling and unloading recommendations are typically given to the truck driver when the load leaves the manufacturing plant and should be followed by jobsite personnel upon delivery. Pipe, fittings, fabrications, tanks, manholes, and other components must not be pushed or rolled or dumped off the delivery truck or dropped.

For storage, the site and its layout should provide adequate protection against physical damage to the components before their installation. General storage area requirements include sufficient size to accommodate components, allow room for handling equipment, and to have a relatively smooth, level surface.

Temperatures near or below freezing will affect PE pipe by increasing stiffness and reducing resistance to impact damage. In colder conditions, allow more time to conduct handling and installation procedures that bend and flex the pipe.

8.3 Quality Control Documentation

Prior to installation of HDPE pipe and fittings, the HDPE pipe supplier will provide the Project Manager with the following information:

1. Pipe shall be stamped or labeled with identification of size, schedule, standard dimension ratio, and pressure rating as a minimum.
2. Inspect for damage such as cuts, scrapes, gouges, tears, cracks, punctures, and the like that may occur during handling and installation. Document any excessive damage and/or repairs and replacements that were made.

The Geosynthetic QAE shall review the quality control data and report discrepancies with the project specifications to the Project Manager. The Geosynthetic QAE shall verify that shipped pipe has appropriate labeling and condition of pipe.

8.4 Observations of Leachate Line Installation

Observations made by the Geosynthetic QAE of the collection trench and leachate collection pipe installation should include:

1. Verification that collection pipe is handled and placed in a manner that prevents holes from being blocked by mud and that holes are located 45 degrees from the springline.
2. Records shall note any changes in alignment of collection trenches or leachate collection pipes and construction methods, which produce potential obstructions or interference with pipe cleaning equipment.

8.5 Documentation of Leachate Line Installation

Documentation of the collection trench and leachate collection pipe installation should include:

1. Specifications of pipe, specialty fittings, and sweep bends installed.
2. Documentation of sweep bends shall include the fabricated or field-achieved radius of bend and conformance with minimum radii of bend specified by approved plans.
3. Documentation of methods used to provide support and cover for collection pipe, specialty fittings, and sweep bends.

8.6 HDPE Pipe Welding

For joints, the Geosynthetic QAE shall:

1. Observe general welding procedure. Procedure shall include, but not be limited to:
    a. Use of properly trained and qualified personnel, as befits the type of welding.
    b. Component ends should be clean, dry, and free of detrimental surface defects before the connection is made.
    c. A temporary shelter should be set-up around the joining operation in the event of inclement weather. If operations cannot be protected against dust contamination, operations should temporarily cease until conditions improve.
2. Record pipe size, ambient temperature, time, date, name of welder or installer, and outcome of welding.
3. Inform the Installer and Project Manager of required repairs.

8.7 Nondestructive Testing of Joints

After installation of the piping, leak pressure testing should be conducted. If leaks exist, they may manifest themselves by leakage or rupture. Generally, liquids such as water are preferred as test fluids because less energy is released if something in the test section fails catastrophically. Where hydrostatic testing is specified, never substitute with pneumatic testing.

Non-perforated HDPE butt-fused pipe, used in pressure or vacuum applications, shall be pressure tested to determine integrity of joints. The Geosynthetic QAE shall monitor testing prior to placement of pipe.

Nonperforated pipe joints shall only be nondestructively tested. These pipe joints will be tested using the pressure test and shall pass the ratings as specified by the manufacturer. Other nondestructive test methods may be used only when:

- The Installer can prove its effectiveness.
- The method is approved by the Pipe Manufacturer.
- The method is approved by the Project Manager.

The Project Manager and the QAE will verify the effectiveness and validity of the test method. The piping manufacturer should be consulted before using pressure testing procedures other than those specified in this document and as detailed in Chapter 2 of *The Plastics Pipe Institute Handbook of Polyethylene Pipe* (2nd Edition).

8.7.1 Low Air Pressure Testing

Typical non-destructive joint testing methods include either water or air for pressure testing. Pressure testing requirements shall be determined by the Project Manager. Should pressure testing be conducted, the applied test pressure should equal to or be greater than 10 pounds per square inch (psi), as long as air temperature is less than 80°F (27°C). Test plugs will be fitted to both ends of the section of pipe to be pressure tested. The test duration should be a minimum period of 1 hour. For a successful pressure test, the test pressure should hold for 1 hour with no pressure loss. The results shall be documented, including the amount of loss and the applied pressure readings. Gauge readings shall be taken initially at 10-minute intervals and the gauge should be capable of reading to the nearest 1 psi.

8.7.1.1 Failed Pressure Testing

In case of a failed pressure test, portions of the pipe which fail the air pressure will segmentally be tested to detect the leak location. Pipe segments failing the pressure test will be removed and a new section will be fused into place.

The Geosynthetic QAE will report any nonconformance of testing methods to the Project Manager.

8.7.2 Hydraulic Testing

After installation of the force main or other hydraulic conveyance pipe, the Contractor shall perform a hydraulic or air pressure test of the system. Pressurized systems shall be tested at a minimum of 30 psi or the design system operating pressure, whichever is greater. The hydraulic pressure test is acceptable if the pressure remains within 5 percent of the target value for 1 hour once the target pressure is reached. The QAE shall observe the testing and record the following data:

1. Date, time, and location of pipe being tested.
2. Test pressure and flow rate.

3. Documentation of leakage and repair steps.
4. Pump control operation in hand and automatic modes.

8.7.2.1 Hydraulic Test Failure

The Contractor shall report hydraulic test failures to the Project Manager. The repair or replacement measures required of the Contractor will be recorded by the QAE. Following repairs, the failed portion of the system will be retested. Testing and results shall be included in the CQA report.

8.8 Grades and Locations

A surveyor will document the grade and location of the carrier pipe, vaults, and associated manholes. Horizontal control shall be in accordance with the site grid system and shall be located with 0.5 feet absolute. The leachate collection trench elevations shall be documented every 25 linear feet. If a total station or laser equipment is used to set elevations, the leachate collection trench elevations may be taken every 50 linear feet. Vertical control shall be USGS elevations and documented at structures and fittings. The final grades and locations shall be recorded within the final certification report.

8.9 Leachate Extraction Riser Pipe Installation

Fabrication of the HDPE pipe shall be in accordance with the manufacturer's literature and design requirements. The pipe may be either prefabricated or assembled on-site. A 60-mil textured HDPE rubsheet will be installed on the sideslope prior to installation of the leachate extraction riser pipe. The rubsheet will extend into the anchor trench down the sideslope to the base of the sump. To allow for some movement of the riser pipe, the rubsheet will not be fastened, anchored, or welded to the underlying geosynthetic layers. The HDPE flatstock (corners shall be rounded and edges beveled) will add an additional layer of protection to the underlying liner system and will aid in the installation of the riser pipe. See construction drawings detail for sump geotextile, rub sheet and flat stock installation.

8.10 Leachate Collection Pipe Cleaning

The leachate collection piping shall be cleaned by the Contractor following the placement of the leachate collection layer. Piping may be cleaned with the water-jet process, or may be pigged. Pigging involves forcing a resilient plastic plug (soft pig) through the pipeline. Soft pigs must be used with PE pipe. Usually, pressure is applied behind the pig to move it down the pipeline, and a pig launcher and pig catcher should be used.

Documentation of the initial leachate collection pipe cleaning after placement of the leachate collection layer shall include:

1. The equipment, methods and chemicals used to insert cleanout devices through the leachate collection pipes from each access point to the toe of the opposite sideslope.
2. The minimum hose or machine pressures, nozzles, and other features necessary to achieve successful cleaning of the leachate collection pipes.
3. Significant adaptations needed to complete pipe cleaning, and any problems encountered.

4. Repairs or modifications made to the collection piping in response to the pipe cleaning operation.

9.0 Soil Barrier Layer

9.1 Description and Applicability

The f soil barrier layer generally consists of fine-grained soils or well-graded sandy soils with fines underlying the Geosynthetic Clay Liner (GCL) in the final cover system options presented in the POO. Soils used in the final cover barrier layer shall consist of a clean, select material free of organics, trash, or other deleterious matter. It should be classified according to the Unified Soil Classification System as either ML, CL, CH, SM, SC, or dual symbol classification of these soils.

9.2 Conformance Testing

Conformance testing of the soil barrier layer shall be performed to ensure the consistency of the properties of the soil quality received from the borrow source. These tests are to be performed prior to compaction (bulk sample). Conditioning may include adjustments in the compaction and moisture content.

The following tests shall be performed:

1. Particle Size (ASTM D6913/D928 with hydrometer).
2. Laboratory Modified Proctor Compaction (ASTM D1557) or Standard Proctor Compaction (ASTM D698).
3. Atterberg Limits (ASTM D4318).

As specified in site-specific approvals, tests shall be performed at a frequency indicated in Table 1.

The Soils QAE shall examine the test results and report non-conformance to the Project Manager. The Project Manager shall accept or reject the soil based on this review and the requirements of Table 4. Additional soil testing may be done at the request of the Project Manager and/or the Soils QAE.

9.3 Subgrade Preparation

The Earthwork Contractor shall be responsible for preparing the subgrade soil for the soil barrier layer placement. Subgrade preparation may include top-of-waste regrading, grading layer placement, or top of grading layer regrading, at the discretion of the Owner.

The subgrade will consist of a minimum 6-inch–thick soil grading layer placed on top of the waste. The soil grading layer will consist of general fill material and will typically be installed as a normal part of landfill operations (see Section 7.0). If topsoil material was used as part of the grading layer placed during normal landfill operations, the Contractor will remove and salvage the temporary topsoil layer. The Soil QAE will inspect the subgrade, upon completion of the grading layer work and will verify, at a minimum, the following:

1. A qualified land surveyor has verified the lines and grades on the 100-foot grid points as required by ss. NR 516.06(1)(a) and (d) as identified in Table 5.
2. A qualified engineer has verified that the grading layer soil meets the depth criteria in the project specifications.

During construction of the final cover barrier layer, the Soil QAC shall indicate to the Project Manager locations that are not adequate for placement of the soil barrier layer. Such defects in the subgrade soil shall be repaired by the Earthwork Contractor, at the direction of the Project Manager.

9.4 Construction Observation

Observation of the soil barrier layer construction shall be coordinated with the construction testing described in Subsection 9.5. The lower and upper barrier layers shall meet the requirements listed in Table 4. The Earthwork Contractor must verify that there is a minimum of 6 inches of soil grading layer and lower 1-foot lower barrier layer in-place to the satisfaction of the Soil QAE prior to placement of the upper 1-foot barrier layer. Acceptance criteria for construction work shall be as identified in Table 4.

Soil QAE shall observe the following during the construction of final cover barrier layer:

1. Confirm the uniformity of the barrier layer soil. The Soil QAE will monitor the soil barrier layer for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content. The Earthwork Contractor will segregate and/or remove unsuitable materials, such as soil not meeting acceptance criteria, boulders, cobbles, and organic material.
2. Water content and consistency of the soil during processing, placement, and compaction.
3. Disking and mechanical processing of the soil as required to break up clods and adjust the moisture content
4. Type and level of compactive effort:
    a. Compactor type (footed compaction equipment with minimum 6-inch-long feet).
    b. Compactor weight (minimum static weight of 30,000 lbs or a static weight greater than 15,000 lbs with vibration exceeding 30,000 lbs of compactive energy).
    c. Number of passes.
    d. Methods utilized in its placement.
5. Action of compaction equipment on the soil surface (sheepsfoot penetration, pumping, cracking, etc.).
6. Maximum clod size (maximum 4 inches).
7. Quality of soil.
8. Loose and compacted lift thickness (maximum compacted 12 inches).
9. Areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.
10. Key into adjacent clay or soil barrier layers by overlapping using a minimum of 2 steps that have a minimum width of 2 feet per step.

Upon completion of the final cover barrier layer construction, the Soil QAC shall evaluate the barrier layer and prepare a certificate of acceptance to be submitted to the Project Manager. The Soil QAC shall verify, at a minimum, that:

1. The Soil QAC has verified the soil barrier layer thicknesses as required by s. NR 516.06(2)(b). The thickness will be surveyed according to the frequencies specified in Table 5. Thickness will be determined by surveying.
2. A qualified engineer has verified that the final cover barrier layer soil meets the criteria in Table 4.
3. Fractured coarse gravel and cobbles generally greater than 1-inch in diameter and other foreign objects have been removed from the finished surface of the soil barrier layer.
4. The liner has sufficient smoothness for GCL and geomembrane deployment and that the barrier layer surface is free of damage from rain, rutting, etc.

Note: Surface preparation prior to GCL deployment is addressed in Section 15.5.

9.5 Construction Testing

Construction quality assurance testing shall be conducted in accordance with the project specifications, or as directed by the Project Manager. Field and laboratory tests shall be conducted on samples taken from the soil materials during the course of construction work. Construction quality testing shall consist of laboratory and field testing as described in Subsections 9.5.1 and 9.5.2. Testing and sampling procedures shall be observed and documented by the Soil QAC. Documentation and reporting of test results shall be in accordance with the requirements identified in Section 2 of this manual.

Acceptance criteria are provided in Table 4.

9.5.1 Field Testing

The Soil QAC shall perform the following field tests on each 1-foot thickness of the final cover barrier layer:

1. Field Moisture Content (ASTM D6938).
2. Field Density (ASTM D6938).

Unless otherwise specified, nuclear density and moisture content testing shall be performed in accordance with frequencies stated in Table 3. Sampling locations shall be selected by the Soil QAC.

In-place density and water content of soil and soil-aggregate by nuclear methods (ASTM D6938) shall be preferred for field testing. The location of routine in-place density tests shall comply with s. NR 516.07(2m)(b)(1). Questions concerning the accuracy of a test shall be addressed by re-testing in the same general location.

Unless otherwise noted in the project specifications, or as directed by the Project Manager, perforations of the final cover barrier layer shall be backfilled. Perforations that must be backfilled shall include, but not limited to, the following:

- Nuclear density test probe locations.
- Thickness verification soil boring and settlement plate locations.

Perforations shall be backfilled with a clay bentonite.

9.5.2 Laboratory Testing

The following tests, at the frequencies detailed on Table 1, shall be performed to confirm the adequacy of the material in the compacted soil barrier layer:

1. Atterberg Limits (ASTM D4318).
2. Grain Size (ASTM D7928 with hydrometer).
3. Laboratory Modified Proctor Compaction (ASTM D1557) or Standard Proctor Compaction (ASTM D698).

Acceptability criteria for soil barrier layer are provided in Table 4.

9.6 Defects and Repairs

At locations where the field density and moisture content testing indicate compaction performed below the requirements of the specifications, the Soil QAC shall determine the extent and the nature of the defect.

If the compacted soil barrier layer has been subject to adverse weather conditions, the Soil QAC shall re-inspect the liner for possible damage.

9.6.1 Notification

After determining the extent and nature of the defect, the Soil QAC shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held between the Earthwork Contractor, Soil QAC, and the Project Manager to assess the problem, review alternative solutions, and implement an action plan.

9.6.2 Repairs and Re-testing

The Earthwork Contractor shall correct deficiencies to the satisfaction of the Soil QAC. If a permit or code condition cannot be met, or unusual weather conditions hinder work, the Soil QAC shall develop and present to the Project Manager suggested solutions for approval.

The Soil QAC shall schedule appropriate re-tests when the work defect has been corrected. Re-tests by the Soil QAC shall verify that the defect has been corrected in the area of the deficiency before additional work is performed by the Earthwork Contractor.

10.0 TOPSOIL AND SEED

10.1 Description and Applicability

This section includes the quality assurance requirements for the excavation and placement of the topsoil and for the fertilization, seeding, mulching, and watering of the topsoil layer for vegetation. Topsoil is the final layer of soil material installed on the final cover system, along the outside slopes of the perimeter berms, along the ditches, and on other perimeter areas. Topsoil for non-wetland restoration areas will be obtained from existing on-site stockpiles, from soil excavated by the clearing of the landfill footprint and associated disturbed perimeter areas, or will be hauled in from an off-site source. In addition, topsoil may be supplemented by mixing with compost. Topsoil for areas of proposed wetland restoration will be obtained from the clearing completed when the wetland was disturbed.

10.2 Construction Observation

Work covered by this section will be performed in accordance with the construction plans and specifications.

The final cover seed mix will consist of a Wisconsin Department of Transportation (WisDOT) Section 630.2.1 Seed Mixture No. 20 or 75, or an equivalent if approved by Owner. The WisDOT seed mixes will be applied at the rates specified in WisDOT Section 630.3.3.5. If another seed mix, approved by Owner, is selected, an application rate for the specific seed mix shall be determined and approved by Owner.

Finely chopped straw mulch or equivalent will be applied per WDNR Technical Standard 1058.

Seeding requirements for disturbed wetland areas to be restored and waterway improvement area are detailed in the approved Wetland and Waterway Restoration, Monitoring, and Corrective Measures Plan (Attachment 1).

The Soil QAE will observe topsoil placement activities and will document relevant observations to support certification of the following requirements:

1. The Soil QAE will confirm the source and uniformity of topsoil used. Soil excavation and placement will be monitored for minimization of inorganic soil not compatible for establishment of vegetation.
2. Prior to seeding, the topsoil will be worked to prepare a suitable seedbed.
3. Fertilizing, seeding, and mulching will be performed in a timely manner.

Upon completion of topsoil construction, the Soil QAC shall evaluate the topsoil and prepare a certificate of acceptance to be submitted to the Project Manager. The Soil QAC shall verify, at a minimum, that the Soil QAC has verified the soil layer thicknesses as required by s. NR 516.06(2)(b). The thickness of topsoil placement on final cover areas will be documented on the frequency specified in Table 5. Thickness will be determined by surveying, settlement plate observation or by hand shoveling and measuring the observed thickness of topsoil.

10.3 Conformance Testing

Topsoil will be suitable for the establishment and long-term maintenance of the selected vegetation seed mix with appropriate fertilization. At the Soil QAC's discretion, samples may be collected for laboratory testing.

11.0 Base Liner Geomembranes

11.1 Description and Applicability

Geomembranes are low permeability geosynthetic barriers used in lining systems. This Section is applicable to smooth and textured high-density polyethylene (HDPE) geomembranes for base lining systems. The base lining system is defined as the liner on the bottom and inside sideslope surfaces of a landfill cell. This Section may need to be modified when using other geomembranes.

11.2 Manufacturing Plant Inspection (Optional)

The plant inspection is optional for manufactures previously used by Orchard Ridge RDF. A plant inspection may be necessary for a new product or supplier.

11.3 Quality Control Documentation

Prior to the installation of geomembrane, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. Copies of dated quality control certificates issued by the resin supplier.
2. Written certification that minimum values given in Tables 6a and 6b are guaranteed by the Manufacturer.
3. Quality control certificates signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for test properties and frequencies per GRI test method GM 13 per latest revision for smooth and textured HDPE geomembranes.

The following shall be maintained by the Manufacturer and will be available upon request:

1. The origin (supplier's name and production plant) and identification (brand name and number) of the resin used to manufacture the geomembrane.
2. Results of tests conducted by the Manufacturer to verify that the resin used to manufacture the geomembrane meets the project specifications.
3. A list of the materials which comprise the geomembrane, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.

The Manufacturer shall identify rolls of geomembranes with the following:

1. Manufacturer's name.
2. Product identification.
3. Thickness.
4. Roll number.
5. Roll dimensions.

The Geosynthetic QAE shall review these documents and shall report discrepancies with the above requirements to the Project Manager. The Geosynthetic QAE shall verify that:

1. Property values certified by the Manufacturer meet its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for the rolls, and that each certificate identifies the rolls related to it.
4. Rolls are appropriately labeled.
5. Certified minimum properties meet the project specifications.
6. A copy of this QAM is provided by the Project Manager to the Installer.

The Geosynthetic QAE will review the storage and protection of the geomembrane prior to installation. The geomembrane rolls will be stored on-site in a designated area and will be protected from long-term ultraviolet exposure prior to actual installation. The following practices will be used as a minimum in receiving and storing geomembrane rolls in the designated storage area at the job site:

- While unloading or transferring the geomembrane rolls from one location to another, care will be taken to prevent damage to the geomembrane itself. The preferred method involves using a spreader-bar, straps, and a loader. Rolls will not be dragged.
- Geomembrane rolls will be stored in a manner so that they are adequately protected from the following:
  - Equipment damage
  - Strong oxidizing chemicals, acids, or bases
  - Flames, including welding sparks
  - Temperature exceeding 160 degrees F
  - Dust and dirt

11.4 Conformance Testing

Conformance testing is required as specified in s. NR 516.07(2)(a).

11.4.1 Sampling Procedures

Upon delivery of the rolls of the geomembrane, the Geosynthetic QAC shall ensure conformance test samples are obtained for the geomembrane. The geomembrane rolls to be sampled shall be selected by the Geosynthetic QAC. Samples shall be taken across the entire width of the roll judged by the Geosynthetic QAC not to be damaged. Unless otherwise specified by the Project Manager, samples shall be 3 feet long by 3 feet wide. The Geosynthetic QAC shall mark the machine direction on the samples with an arrow.

If the Project Manager desires, the Geosynthetic QAC/QAL can collect the conformance samples at the manufacturing plant. This may be advantageous in expediting the installation process. These samples shall be forwarded to the Geosynthetic QAL for testing.

11.4.2 Conformance Tests

The following conformance tests shall be conducted as required by s. NR 516.07(2)(a):

1. Density (ASTM D752 or ASTM D1505).
2. Melt Flow Index (ASTM D1238).
3. Tensile properties (ASTM D6693 Type IV).
4. Thickness (ASTM D5994 or D5199). Five areas per roll during field deployment or by the QAL on samples collected at the manufacturing facility.
5. Environmental stress crack resistance (ASTM D5397 - single point) is required unless the manufacturer performed a minimum of one test per resin blend.

11.4.3 Test Results

Conformance test results shall be reviewed and accepted or rejected by the Geosynthetic QAE prior to the deployment of the geomembrane. The Geosynthetic QAE shall examine results from laboratory conformance testing and shall report nonconformances to the Project Manager. The Geosynthetic QAE shall be responsible for checking that test results meet or exceed the required values listed in Tables 6a and 6b.

If the Manufacturer has reason to believe that non-conforming tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be re-tested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. Alternatively, the Manufacturer may have the sample re-tested at two different Owner-approved Geosynthetic QALs. If both laboratories produce conforming results, the material shall be accepted. If both laboratories do not produce conforming results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with non-conforming test results is subject to the approval of the Project Manager.

If a test result is in nonconformance, material from the lot represented by the failing test should be considered out-of-specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the project specification. This procedure is valid only when rolls in the lot are consecutively produced and numbered from one manufacturing line. To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

11.5 Subgrade Preparation

11.5.1 Surface Preparation

The Earthwork Contractor shall be responsible for preparing the underlying soil (clay liner) prior to geomembrane placement. The Project Manager shall coordinate the work of the Earthwork Contractor and the Installer so that the requirements of this QAM are met.

Before the geomembrane installation begins, the Geosynthetic QAC shall verify that:

1. A land surveyor has verified lines and grades per Table 5.
2. The CQA Officer has verified that the underlying soil meets the criteria specified in Table 4 and Section 4.0 and that passing results have been obtained for tests required in Tables 1, 2, and 3.
3. The underlying soil surface to be lined has been rolled, compacted, or hand-worked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.
4. The surface of the underlying soil does not contain stones in excess of 1-inch diameter, angular stones, or other foreign objects, which may be damaging to the geomembrane.
5. No areas exist of excessively soft material resulting from high water content.
6. No areas exist where the underlying soil surface contains desiccation cracks, which may damage the geomembrane.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Geosynthetic QAC prior to commencement of geomembrane deployment in the area under consideration. The Project Manager shall be given a copy of this certificate by the Geosynthetic QAC.

After the underlying soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Project Manager changes in the underlying soil condition that may require repair work. The Project Manager may consult with the Geosynthetic QAC regarding the need for repairs. If the Geosynthetic QAC concurs with the Installer, the Project Manager shall verify that the underlying soil is repaired.

Before or during the geomembrane installation, the Geosynthetic QAC shall indicate to the Project Manager locations, which may not be adequately prepared for the geomembrane.

11.5.2 Anchor Trench

The Geosynthetic QAC shall verify:

1. The anchor trench has been constructed according to the project plans.
2. Rounded corners are provided in the trench so as to avoid sharp bends in the geomembrane.
3. Excessive amounts of loose soil are not present under the geomembrane in the anchor trench.
4. The anchor trench is adequately drained to prevent ponding or softening of the adjacent soils while the trench is open.
5. The anchor trench is backfilled and compacted promptly after geomembrane deployment.

Care shall be taken when backfilling the trenches to prevent damage to the geosynthetic components. The Geosynthetic QAC shall observe the backfilling operation and advise the Project Manager of potential problems. Potential problems shall be documented by the Geosynthetic QAC in his daily report.

11.6 Geomembrane Deployment

11.6.1 Panel Nomenclature

A field panel is defined as a unit of geomembrane, which is to be seamed in the field. A field panel is a roll or a portion of a roll cut in the field. The Geosynthetic QAC shall be responsible to verify that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be as simple and logical as possible and shall be agreed upon by the Project Manager, Installer, and Geosynthetic QAC.

In general, it is not appropriate to identify panels using roll numbers since roll numbers established in the manufacturing plant are usually cumbersome and are not related to location in the field. The Geosynthetic QAC shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for quality assurance records.

11.6.2 Panel Deployment Procedure

The Geosynthetic QAC shall review the panel deployment progress of the Installer and advise the Project Manager on changes in panel deployment. The Geosynthetic QAC shall also review the panel deployment for suitability to actual field condition such as issues relating to wind, rain, compacted select clay fill desiccation and other site-specific conditions. The Geosynthetic QAC shall verify the condition of the underlying soil does not change detrimentally during installation. The Geosynthetic QAC shall record the identification code, location, and date of installation of each field panel.

11.6.3 Deployment Weather Conditions

Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

The normal acceptable weather conditions for seaming are as follows:

1. Ambient temperature between 32°F and 104°F.
2. Dry conditions (no precipitation or other excessive moisture).
3. No excessive winds.

Ambient temperature shall be measured and ambient conditions appraised by the Geosynthetic QAC in the area in which the panels are to be placed.

The Geosynthetic QAC shall inform the Project Manager of any weather-related problems, which may not allow geomembrane placement to proceed. The Project Manager will determine if the installation is to be stopped or special procedures are to be used.

11.6.4 Method of Deployment

Before the geomembrane is handled on-site, the Geosynthetic QAC shall verify deployment equipment and method of deployment proposed by the Installer to be used on the site is adequate and does not pose risk of damage to the geomembrane or underlying subgrade. If vehicles are used which must operate on the geomembrane, drivers shall proceed with caution during

deployment of the geomembrane to prevent spinning of tires, sharp turns, and quick stops. During handling, the Geosynthetic QAC shall observe and verify that the Installer's personnel handle the geomembrane with care.

The Geosynthetic QAC shall verify the following:

1. Equipment used does not damage the geomembrane or underlying subgrade by handling.
2. The prepared surface underlying the geomembrane is acceptable immediately prior to geomembrane placement.
3. Geosynthetic elements immediately underlying the geomembrane are clean and free of debris.
4. Personnel do not wear damaging shoes while working on the geomembrane, or engage in other activities, which could damage the geomembrane.
5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.
6. The method used to place the panels minimizes wrinkles especially differential wrinkles between adjacent panels.
7. Adequate temporary loading and/or anchoring (such as sandbags), not likely to damage the geomembrane, are placed to prevent uplift by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels.
8. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where repeated traffic use may be expected. See Section 9.11 for geomembrane protection.
9. Liner has promptly been anchored in trench where applicable.

The Geosynthetic QAC shall inform the Project Manager if the above conditions are not fulfilled.

11.6.5 Damage and Defects

Upon delivery to the site, the Geosynthetic QAC shall conduct a surface observation of the rolls for defects and for damage. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Geosynthetic QAC shall advise the Project Manager, in writing, of rolls or portions of rolls which should be rejected and removed from the site because they have severe flaws, and/or minor repairable flaws.

The Geosynthetic QAC shall examine each panel, after placement and prior to seaming, for damage and/or defects. The Geosynthetic QAC shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the Geosynthetic QAC. Repairs shall be made using procedures described in Section 9.10.

11.6.6 Writing on the Liner

To avoid confusion, the Installer and the Geosynthetic QAC shall each use different colored markers or other materials approved by the Project Manager that are readily visible for writing on

the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane. The Installer shall use a white marker to write on the geomembrane while the Geosynthetic QAC shall use a yellow marker.

11.7 Field Seaming

11.7.1 Seam Layout

Before the scheduled geosynthetic preconstruction conference, the Installer shall provide the Project Manager and the Geosynthetic QAC with a panel layout drawing. This drawing shall present the proposed seams of the lining system at the facility. The Geosynthetic QAE shall review the panel layout drawing and verify that it is consistent with accepted state-of-practice.

In general, seams should be oriented parallel to the line of maximum slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet from the toe or crest of the slope, or from areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

Horizontal seams may be allowed by the Designer and the Geosynthetic QAC under the following conditions:

- Seams are offset in adjacent panels by one full panel width.
- Seams are “shingled” downhill.
- Horizontal seams are staggered.

A seam numbering system compatible with the panel numbering system shall be used by the Geosynthetic QAC.

11.7.2 Accepted Seaming Methods

Approved processes for field seaming are fusion welding and extrusion welding. Geomembrane panels made of polyethylene resins shall be welded by double−tracked, fusion welding machines for all linear seams. Corners, butt seams and long repairs shall be fusion welded where possible. Extrusion or fusion welding shall be used for all other repairs, detail work and patches. Proposed alternate processes shall be documented and submitted by the Installer to the Project Manager for approval. The Project Manager shall obtain approval from the department prior to use of any other welding method for either panel seaming, repairs, or construction of details.

11.7.2.1 Fusion Process

The Geosynthetic QAC shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report non-compliance to the Project Manager.

The Geosynthetic QAC shall also verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus agreed upon at the pre-construction meeting.
2. Equipment used for seaming is not likely to damage the geomembrane.

3. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane and any fuel spills promptly cleaned up. Fuel shall not be stored on liner surface.
4. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.
5. A movable protective layer is used as required by the Installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and to prevent debris from collecting around the pressure rollers.
6. In general, the geomembrane panels are aligned to have an overlap of 4 to 6 inches for fusion welding. The final overlap shall be sufficient to allow peel tests to be performed on the seam.
7. No solvent or adhesive is used.
8. The geomembrane is protected from damage in heavy traffic areas.

11.7.2.2 Extrusion Process

The Geosynthetic QAC shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report non-compliances to the Project Manager.

The Geosynthetic QAC shall verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus agreed upon at the pre-construction meeting.
2. Equipment used for seaming is not likely to damage the geomembrane.
3. Prior to beginning a seam, the extruder is purged until heat-degraded extrudate has been removed from the barrel.
4. Clean and dry welding rods or extrudate pellets are used.
5. The electric generator is placed on a smooth base and rub sheet such that no damage occurs to the geomembrane.
6. Grinding is completed no more than one hour prior to seaming.
7. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs.
8. The geomembrane is protected from damage in heavy traffic areas.
9. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instances, shall exposed grinding marks extend more than 1/4-inch (6 mm) from the finished seamed area.
10. In general, the geomembrane panels are aligned to have a nominal overlap of 3 inches for extrusion welding. The final overlap shall be sufficient to allow peel tests to be performed on the seam.
11. No solvent or adhesive is used.
12. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged.

11.7.3 Seam Preparation

The Geosynthetic QAC shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris, or foreign material. If seam overlap grinding is required, the Geosynthetic QAC shall ensure that the process is completed according to the Manufacturer's instructions within 1 hour of the seaming operation, and in a way that does not damage the geomembrane. The Geosynthetic QAC shall also verify that seams are aligned with the fewest number of wrinkles and "fishmouths."

11.7.4 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once every 5 hours and with additional test runs per s. NR 516.07(2)(4)(b), for each production seaming apparatus used that day. Trial seams shall be made under the same conditions as production seams. For cold weather seaming, refer to the recommendations in GRI Test Method GM9.

The trial seam sample shall be at least 5 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Subsection 11.7.2. Ten specimens shall be cut from the sample with a 1-inch-wide die. The specimens shall be cut by the Installer at locations selected randomly along the trial seam sample by the Geosynthetic QAC.

The specimens shall be tested in peel adhesion (five) and shear mode (two) using a field tensiometer. The field tensiometer shall be calibration certified within 3 months prior to the start of geomembrane deployment per s. NR 516.07(2)(c)(4). The tensiometer shall be capable of maintaining a constant jaw separation rate of 2 inches per minute for HDPE. They should not fail in the seam as described in Subsection 11.9.5. If a specimen fails, the entire trial seam operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The Geosynthetic QAC shall observe trial seam procedures.

The remainder of the successful trial seam sample shall be retained until project completion in the QAC's archives for possible laboratory testing. Each sample shall be assigned a number and marked accordingly by the Geosynthetic QAC, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

11.7.5 General Seaming Procedures

During general seaming, the Geosynthetic QAC shall ensure the following:

1. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and portions where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in every direction.
2. If seaming operations are carried out at night, adequate illumination shall be provided. If dew develops on sheets during welding, moisture shall be removed ahead of welding machine.

3. Seaming shall extend to the outside edge of panels placed in the anchor trench.
4. Cross seam tees should be extrusion welded to a minimum distance of 4 inches on each side of the tee.
5. A firm substrate shall be required to be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

The Geosynthetic QAC shall verify that the above seaming procedures or other procedures agreed upon and indicated in the project QAM are followed and shall inform the Project Manager of nonconformances.

11.7.6 Seaming Weather Conditions

11.7.6.1 Cold Weather Conditions

To ensure a quality installation, if seaming is conducted when the ambient temperature is below 32°F, the following conditions shall be met:

1. Refer to the recommendations in GRI Test Method GM9.
2. Geomembrane surface temperatures shall be determined by the Geosynthetic QAC at intervals of at least once per 100 feet of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32°F.
3. For fusion welding, preheating may be waived by the Project Manager based on a recommendation from the Geosynthetic QAE, if the Installer demonstrates to the Geosynthetic QAE's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
4. If preheating is required, the Geosynthetic QAC shall observe areas of geomembrane that have been preheated by a hot air device prior to seaming, to verify that they have not been overheated.
5. Care shall be taken to confirm that wind chill does not adversely affect the pre-heat requirements specified for welding. It may be necessary to provide wind protection for the seam area.
6. Preheating devices shall be approved prior to use by the Project Manager.
7. Sheet grinding may be performed before preheating, if applicable.
8. Trial seaming, as described in Subsection 11.7.4, shall be conducted under the same ambient temperature and preheating conditions as the production seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 10°F from the initial trial seam test conditions. Such new seams shall be conducted upon completion of seams in progress during temperature drop.

11.7.6.2 Warm Weather Conditions

At ambient temperatures above 104°F, no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Project Manager that geomembrane seam quality is not compromised. Trial seaming, as described in Subsection 11.7.4 shall be

conducted under the same ambient temperature conditions as the production seams. At the option of the Geosynthetic QAC, additional destructive tests may be required for suspect areas.

11.8 Nondestructive Seam Testing

11.8.1 Concept

The Installer shall nondestructively test field seams over their full length using an air pressure test (for double fusion seams only), a vacuum test or other approved method. Air pressure testing and vacuum testing are described in Subsections 11.8.2 and 11.8.3, respectively. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of field seaming.

For seams, the Geosynthetic QAC shall:

1. Observe nondestructive testing procedures.
2. Record location, data, test unit number, name of tester, and outcome of testing.
3. Inform the Installer and Project Manager of required repairs.

11.8.2 Air Pressure Testing

Air pressure testing is applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment for air pressure testing shall consist of the following:
    a. An air pump (manual or motor driven), equipped with pressure gauge and capable of generating and sustaining a pressure of 35 psi.
    b. A rubber hose with fittings and connections.
    c. A sharp hollow needle, or other pressure feed device, approved by Project Manager.
2. The following procedures shall be followed:
    a. Seal both ends of the seam to be tested.
    b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.
    c. Insert a protective cushion between the air pump and the geomembrane.
    d. Pressurize the air channel to the pressure specified in Table 6a or 6b. Close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.
    e. If loss of pressure exceeds the maximum permissible pressure differential specified in Table 6a or 6b or does not stabilize, locate faulty area and repair in accordance with Subsection 11.10.3.
    f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest un-pressurized area. Seam the cut end of the air channel.

g. Remove needle or other approved pressure feed device and seal the hole in the geomembrane.

11.8.3 Vacuum Testing

Vacuum testing is applicable to extrusion welding and to non-seam areas of the liner.

1. The equipment shall consist of the following:
   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
   b. A pump assembly equipped with a pressure controller and pipe connections.
   c. A rubber pressure/vacuum hose with fittings and connections.
   d. A soapy solution. (Geosynthetic QAC shall confirm the solution makes bubbles when air is passed through. Windshield washer fluid shall be used or anti-freeze in cold weather.)
   e. A bucket and wide paint brush, or other means of applying the soapy solution.
2. The following procedures shall be followed:
   a. Wet a strip of geomembrane approximately 12 inches by 48 inches with the soapy solution.
   b. Place the box over the wetted area.
   c. Apply vacuum.
   d. Ensure that a leak-tight seal is created.
   e. Perform vacuum box testing as specified in Table 6a or 6b.
   f. Areas where soap bubbles appear shall be marked and repaired in accordance with Subsection 11.10.3.

11.8.4 Leak Location Testing

Leak location testing of the installed geomembrane liner shall be completed by or observed by the Geosynthetic QAC. Leak location testing shall be conducted after the leachate collection layer has been placed on the base grades and lower half of the sideslopes. Liner leak location tests shall be completed in accordance with ASTM D7007, "Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials." Documentation of the testing method shall include description of the procedures and photo documentation.

11.8.5 Test Failure Procedures

The Installer shall complete required repairs in accordance with Subsection 11.10. For repairs, the Geosynthetic QAC shall:

1. Observe and document the repair and testing of the repair.
2. Mark on the geomembrane that the repair has been made.
3. Document the repair procedures and test results.

11.9 Destructive Seam Testing

11.9.1 Concept

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

In the event that, during the course of construction, geomembrane materials are obtained from a different manufacturer or are made from different resins, seam samples formed by joining the original and the proposed geomembrane will be tested to confirm the construction compatibility of the two geomembrane materials. A minimum of two seamed samples of the dissimilar materials will be submitted to the geosynthetics laboratory for destructive seam testing as described below. The QAE will review the testing results prior to approving the new geomembrane material.

11.9.2 Location and Frequency

The Geosynthetic QAC shall select where seam samples will be cut out for laboratory testing. The frequency and locations shall be established as follows:

1. A minimum frequency of one test location per 500 feet of production seam length or one test location per 1,000 feet if leak location testing is performed. This frequency is to be determined as an average taken throughout the entire facility.
2. Test locations shall be determined during seaming at the Geosynthetic QAC's discretion. Special consideration shall be given to locations where the potential for imperfect welding, such as overheating, contamination, offset welds exists.
3. (End Bone) Destructive seam samples shall be taken from at least one end of each fusion weld greater than 100 feet long and field sample tested a minimum of once in the peel and shear mode on the field tensiometer per s. NR 516.07(2)(c)(3). Laboratory testing of end bone samples is not required.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

11.9.3 Sampling Procedures

Samples shall be cut by the Installer at locations chosen by the Geosynthetic QAC as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The Geosynthetic QAC shall:

1. Observe sample cutting.
2. Assign a number to each sample, and mark it accordingly.
3. Record sample location on layout drawing.
4. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

Holes in the geomembrane resulting from destructive seam sampling shall be repaired in accordance with repair procedures described in Subsection 11.10.3 immediately following receipt

of successful test results. The continuity of the new seams in the repaired area shall be tested according to Subsection 11.8.3.

11.9.4 Sample Dimensions

At each sampling location, two types of samples shall be taken by the Installer. First, at least five specimens for field testing should be taken for each set of peel and shear tests (10 specimens total). Half of the specimens will be collected 30 inches from the other half of the specimens. Each of these samples shall be cut with a 1-inch wide die for testing peel adhesion and shear strength, with the seam centered parallel to the width. If these samples pass the field test described in Subsection 11.9.5, a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the samples for field testing. The sample shall be 12 inches wide by 30 inches long with the seam centered lengthwise. The sample shall be cut into two parts and distributed as follows:

1. One 12-inch wide by 18-inch long portion for Geosynthetic QAL testing.
2. One 12-inch wide by 12-inch long portion to the QAC.

Final determination of the sample sizes shall be made at the pre-construction meeting.

11.9.5 Field Testing

The five 1-inch-wide specimens for each peel adhesion and shear strength mentioned in Subsection 11.9.4 shall be tested in the field using a tensiometer and shall not fail in film tear bond. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it is non-conforming, the seam should be repaired in accordance with Subsection 11.9.7. Final judgement regarding seam acceptability, based on the failure criteria, rests with the Geosynthetic QAE.

The Geosynthetic QAE shall witness field tests and mark samples and portions with their number. The Geosynthetic QAE shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description.

11.9.6 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the Geosynthetic QAC in a manner which will not damage the test sample. The sample shall be shipped as soon as possible to expedite laboratory testing. The QAC will be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetic QAL.

Testing shall include seam strength and peel adhesion (ASTM D6392). The minimum acceptable values to be obtained in these tests shall be as provided in Tables 6a and 6b. At least five specimens shall be tested successfully, each in both shear and peel as required by s. NR 516.07(2)(c)(2). Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear). A passing test shall meet the minimum acceptable values (see Table 6a and 6b).

The Geosynthetic QAL shall provide test results within 24 hours of receiving the samples. The Geosynthetic QAE shall review laboratory test results as soon as they become available and make appropriate recommendations to the Project Manager.

11.9.7 Destructive Test Failure

When a sample fails a destructive test, whether that test is conducted by the Geosynthetic QAL or by field tensiometer, the Installer has two options:

1. The Installer can repair the seam between any two passing destructive test locations.
2. The Installer can trace the welding path to an intermediate location, 10 feet minimum from the point of the failed test in each direction and take a sample with a 1-inch wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Subsection 11.7.4 may be used as a boundary for the failing seam if approved by the Geosynthetic QAE. In cases exceeding 150 feet of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Subsection 11.10.

The Geosynthetic QAC shall document actions taken in conjunction with destructive test failures.

11.10 Defects and Repairs

11.10.1 Identification

Seams and non-seam areas of the geomembrane shall be examined by the Geosynthetic QAC for identification of defects, holes, blisters, undispersed raw materials, large wrinkles, and signs of contamination by foreign matter. The geomembrane surface shall be cleaned by the Installer prior to examination if the Geosynthetic QAC determines that the amount of dust or mud inhibits examination.

11.10.2 Evaluation

Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Subsection 11.8. Each location, which fails the nondestructive testing shall be marked by the Geosynthetic QAC and repaired by the Installer. Work shall not proceed with materials that will cover locations, which have been repaired until successful nondestructive and/or laboratory tests are obtained.

When seaming of the geomembrane is completed, and prior to placing overlying materials, the Geosynthetic QAC shall indicate to the Project Manager large wrinkles, which should be cut and re-seamed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation period, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over on to

itself, which is generally a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be nondestructively tested.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the Geosynthetic QAC to ensure that wrinkle formation is minimized and that the geomembrane is not folded over on itself.

11.10.3 Repair Procedures

Portions of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Project Manager, Installer, Designer, and Geosynthetic QAC.

1. The repair procedures available include:
    a. Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter.
    b. Spot welding used to repair pinholes, or other minor, localized flaws.
    c. Capping used to repair large lengths of failed seams.
    d. Extrusion welding the flap, used to repair areas of inadequate fusion seams that have an exposed edge, if approved by Geosynthetics QAC.
    e. Removing bad seam and replacing with a strip of new material welded into place.
2. For repair methods, the following provisions shall be satisfied:
    a. Surfaces of the geomembrane that are to be repaired using extrusion methods shall be ground no more than 1 hour prior to the repair.
    b. Surfaces shall be clean and dry at the time of the repair.
    c. Seaming equipment used in repairing procedures shall meet the requirements of this project QAM.
    d. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and corners of patches shall be rounded with a radius of approximately 3 inches.

11.10.4 Repair Verification

The Geosynthetic QAC shall observe nondestructive testing of repairs and shall record the number of each repair, date, and test outcome. Each repair shall be nondestructively tested using the methods described in Subsection 11.8 as appropriate. Repairs, which pass the nondestructive test, shall be taken as an indication of an adequate repair. Repairs more than 150 consecutive feet long require destructive test sampling. Failed tests require that the repair shall be redone and retested until a passing test result.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their

growth. The placement of cover materials shall be observed by the Geosynthetic QAC to ensure that wrinkle formation is minimized and that the geomembrane is not folded over on itself.

11.11 Geomembrane Protection

The quality assurance procedures indicated in this Subsection are intended only to assure the installation of adjacent materials does not damage the geomembrane. The quality assurance of the adjacent materials themselves is covered in separate Sections of this manual.

11.11.1 Soils

A copy of the project specifications prepared by the Designer for placement of soils shall be given to the Geosynthetic QAE by the Project Manager. The Geosynthetic QAE shall verify that these project specifications are consistent with geosynthetic state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F nor above 104°F unless otherwise specified.
2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.
3. Equipment used for placing soil shall not be driven directly on the geomembrane.
4. A minimum thickness of 1 foot of soil is specified between a low ground pressure dozer, with a ground pressure of 5 psi or less. The cover thickness over the geosynthetics will be a minimum of 2 feet thick for other tracked vehicles and flotation tire equipped vehicles. The Earthwork Contractor shall provide the low ground pressure dozer weight with track contact area to confirm that less than 5 psi pressure is applied at the underlying geosynthetic surface.
5. In areas traversed by vehicles other than low ground pressure vehicles approved by the Project Manager, the soil layer shall have a minimum thickness of 3 feet. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns. Trucks and other wheeled hauling equipment shall be confined to approved corridors.
6. Soil may only be pushed up slopes.
7. An observer shall be present at the leading edge of soil placement to confirm no damage to underlying geomembrane.

The Geosynthetic QAC shall measure soil thickness and verify that the required thickness is present. The Geosynthetic QAC shall also verify that final thickness is consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The Geosynthetic QAE shall inform the Project Manager if the above conditions are not fulfilled.

11.11.2 Sumps and Appurtenances

A copy of the plans and project specifications prepared by the Designer for sumps and appurtenances shall be given by the Project Manager to the Geosynthetic QAC. The Geosynthetic QAC shall review these plans and verify that:

1. Installation of the geomembrane in sump and appurtenant areas, and connection of geomembrane to sumps and appurtenances have been made according to project specifications. The panel layout shall attempt to limit the seams in the sump and center of leachate collection lines.
2. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.
3. The geomembrane has not been visibly damaged while making connections to sumps and appurtenances.
4. A representative of the Geosynthetic QAC shall be present when the Installer is welding geomembrane to appurtenant structures.

The Geosynthetic QAC shall inform the Project Manager in writing if the above conditions are not fulfilled.

12.0 Final Cover Geomembranes

12.1 Description and Applicability

Geomembranes are low permeability geosynthetic barriers used in final cover systems. This Section is applicable to the textured polyethylene (all types) geomembrane used in the final cover system and optional integrated geomembrane drainage systems (IDS) (e.g., Agru MicroDrain Liner) that can be used in the final cover system.

12.2 Quality Control Documentation

Prior to the installation of geomembrane, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. A specification for the geomembrane, which includes the properties contained in the project specifications, measured using the appropriate test methods.
2. Written certification that minimum manufacturer technical values in Table 6c are guaranteed by the Manufacturer.
3. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for test properties and at frequencies per GRI test method GM 17 per latest revision for textured linear low density polyethylene (LLDPE) geomembrane.
    a. If integrated geomembrane drainage systems or an approved alternative is used, the properties shall meet or exceed the parameters as outlined in s. NR 516.07(2), and shall be equivalent or exceed GRI GM-17 LLDPE requirements.

The Manufacturer shall identify rolls of geomembranes with the following:

1. Manufacturer’s name.
2. Product identification.
3. Thickness.
4. Roll number.
5. Roll dimensions.

The Geosynthetic QAE shall review these documents and shall report discrepancies with the above requirements to the Project Manager. The Geosynthetic QAE shall verify that:

1. Property values certified by the Manufacturer meet its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for the rolls, and that each certificate identifies the rolls related to it.
4. Rolls are appropriately labeled.
5. Certified minimum properties meet the project requirements as listed in Table 6c.

6. A copy of this QAM is provided by the Project Manager to the Installer.

The Geosynthetic QAE shall review the storage and protection of the geomembrane prior to installation. The geomembrane rolls shall be stored on-site in a designated area and will be protected from long-term ultraviolet exposure prior to actual installation. The following practices shall be used as a minimum in receiving and storing geomembrane rolls in the designated storage area at the job site:

- While unloading or transferring the geomembrane rolls from one location to another, care will be taken to prevent damage to the geomembrane itself. The preferred method involves using a spreader-bar, straps, and a loader. Rolls will not be dragged.
- Geomembrane rolls shall be stored in a manner so that they are adequately protected from the following:
  - Equipment damage
  - Strong oxidizing chemicals, acids, or bases
  - Flames, including welding sparks
  - Temperatures exceeding 160 degrees F
  - Dust and dirt

12.3 Conformance Testing

Conformance testing is required as specified in s. NR 516.07(2)(a).

12.3.1 Sampling Procedures

Upon delivery of the rolls of the geomembrane, the Geosynthetic QAC shall ensure conformance test samples are obtained for the geomembrane. The geomembrane rolls to be sampled shall be selected by the Geosynthetic QAC. Samples shall be taken across the entire width of the roll judged by the Geosynthetic QAC not to be damaged. Unless otherwise specified by the Project Manager, samples shall be 3 feet long by 3 feet wide. The Geosynthetic QAC shall mark the machine direction on the samples with an arrow.

If the Project Manager desires, the Geosynthetic QAC can collect the conformance test samples at the manufacturing plant. This may be advantageous in expediting the installation process.

Samples shall be taken at a rate of not less than that specified in Table 6c. These samples shall be forwarded to the Geosynthetic QAL for testing.

12.3.2 Conformance Tests

The following conformance tests shall be conducted as required by s. NR 516.07(2)(a):

1. Density (ASTM D792 or ASTM D1505).
2. Melt flow index (ASTM D1238).

3. Tensile properties (ASTM D6693 Type IV).
4. Thickness (ASTM D5199 or D5994). Five areas per roll during field deployment or collected and tested by the QAL at the manufacturing facility.

12.3.3 Test Results

Conformance test results shall be reviewed and accepted or rejected by the Geosynthetic QAE prior to the deployment of the geomembrane. The Geosynthetic QAE shall examine results from laboratory conformance testing and shall report nonconformances to the Project Manager. The Geosynthetic QAE shall be responsible for checking that test results meet or exceed the property values listed in Table 6c.

If the Manufacturer has reason to believe that non-conforming tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be re-tested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. Alternatively, the Manufacturer may have the sample re-tested at two different Owner-approved Geosynthetic QALs. If both laboratories produce conforming results, the material shall be accepted. If both laboratories do not produce conforming results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with non-conforming test results is subject to the approval of the Project Manager.

If a test result is in nonconformance, material from the lot represented by the failing test should be considered out-of-specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the project specification. This procedure is valid only when rolls in the lot are consecutively produced and numbered from one manufacturing line. To isolate the out-of-specification material, additional samples shall be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

12.4 Subgrade Preparation

12.4.1 Surface Preparation

The Earthwork Contractor shall be responsible for preparing the underlying soil (soil barrier layer and GCL or compacted select clay fill) prior to geomembrane placement. The Project Manager shall coordinate the work of the Earthwork Contractor and the Installer so that the requirements of Section 6.0 and Section 9.0 of this project-specific QAM are met.

Before the geomembrane installation begins, the Geosynthetic QAC shall verify that:

1. The underlying surface has been prepared to meet the project requirements.
2. A land surveyor has verified lines and grades per Table 5.

3. The CQA Officer has verified that the underlying soil meets the criteria specified in Table 4 and Section 6.0 or 9.0 and that passing results have been obtained for tests required in Tables 1, 2, and 3.
4. The underlying soil surface to be lined has been rolled, compacted, or hand-worked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.
5. The surface of the underlying soil does not contain stones in excess of 1-inch diameter, angular stones, or other foreign objects, which may be damaging to the geomembrane.
6. No areas exist of excessively soft material resulting from high water content.
7. No areas exist where the underlying soil surface contains desiccation cracks, which may damage the geomembrane.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Geosynthetic QAC prior to commencement of geomembrane deployment in the area under consideration. The Project Manager shall be given a copy of this certificate by the Geosynthetic QAC.

After the underlying surface has been accepted by the Installer, it is the Installer's responsibility to indicate to the Project Manager changes in the underlying surface condition that may require repair work. The Project Manager may consult with the Geosynthetic QAC regarding the need for repairs. If the Geosynthetic QAC concurs with the Installer, the Project Manager shall ensure that the underlying surface is repaired.

Before or during the geomembrane installation, the Geosynthetic QAC shall indicate to the Project Manager the locations, which may not be adequately prepared for the geomembrane.

12.4.2 Anchor Trench

The Geosynthetic QAC shall verify:

1. The anchor trench has been constructed according to the project plans.
2. Rounded corners are provided in the trench so as to avoid sharp bends in the geomembrane.
3. Excessive amounts of loose soil are not allowed to underlie the geomembrane in the anchor trench.
4. The anchor trench is adequately drained to prevent ponding or softening of the adjacent soils while the trench is open promptly after geomembrane deployment.
5. The anchor trench is backfilled and compacted promptly after deployment.

Care shall be taken when backfilling the trenches to prevent damage to the geosynthetic components. The Geosynthetic QAC shall observe the backfilling operation and advise the Project Manager of problems. Problems shall be documented by the Geosynthetic QAC in his daily report.

12.5 Geomembrane Deployment

12.5.1 Panel Nomenclature

A field panel is defined as a unit of geomembrane, which is to be seamed in the field. A field panel is a roll or a portion of a roll cut in the field. The Geosynthetic QAC shall be responsible to verify that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be as simple and logical as possible and shall be agreed upon by the Project Manager, Installer and Geosynthetic QAC.

In general, it is not appropriate to identify panels using roll numbers since roll numbers established in the manufacturing plant are usually cumbersome and are not related to location in the field. The Geosynthetic QAC shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for quality assurance records.

12.5.2 Panel Deployment Procedure

The Geosynthetic QAC shall review the panel deployment progress of the Installer and advise the Project Manager on changes in panel deployment. The Geosynthetic QAC shall also review the panel deployment for suitability to actual field condition such as issues relating to wind, rain, compacted select clay fill or soil barrier layer with GCL desiccation and other site-specific conditions. The Geosynthetic QAC shall verify the condition of the underlying surface does not change detrimentally during installation. The Geosynthetic QAC shall record the identification code, location, and date of installation of each field panel.

12.5.3 Deployment Weather Conditions

Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

The normal acceptable weather conditions for seaming are as follows:

1. Ambient temperature between 32°F and 104°F.
2. Dry conditions (no precipitation or other excessive moisture).
3. No excessive winds.

Ambient temperature shall be measured, and ambient conditions appraised by the Geosynthetic QAC in the area in which the panels are to be placed.

The Geosynthetic QAC shall inform the Project Manager of weather-related problems, which may not allow geomembrane placement to proceed. The Project Manager will determine if the installation is to be stopped or special procedures are to be used.

12.5.4 Method of Deployment

Before the geomembrane is handled on-site, the Geosynthetic QAC shall verify that deployment equipment and method of deployment proposed by the Installer to be used on the site is adequate and does not pose risk of damage to the geomembrane or underlying subgrade. Drivers shall proceed with caution during deployment of the geomembrane to prevent spinning of tires, sharp

turns, and quick stops. During handling, the Geosynthetic QAC shall observe and verify that the Installer's personnel handle the geomembrane with care.

The Geosynthetic QAC shall verify the following:

1. Equipment used does not damage the geomembrane by handling.
2. The prepared surface underlying the geomembrane is acceptable immediately prior to geomembrane placement.
3. Geosynthetic elements immediately underlying the geomembrane are clean and free of debris.
4. Personnel do not wear damaging shoes while working on the geomembrane, or engage in other activities, which could damage the geomembrane.
5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting surface.
6. The method used to place the panels minimizes wrinkles especially differential wrinkles between adjacent panels.
7. Adequate temporary loading and/or anchoring (such as sandbags), not likely to damage the geomembrane, are placed to prevent uplift by wind. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels.
8. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected. See Subsection 12.10 for geomembrane protection.

The Geosynthetic QAC shall inform the Project Manager if the above conditions are not fulfilled.

12.5.5 Damage and Defects

Upon delivery to the site, the Geosynthetic QAC shall conduct a surface observation of the rolls for defects and for damage. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Geosynthetic QAC shall advise the Project Manager, in writing, of any rolls or portions of roll, which should be rejected and removed from the site because they have severe flaws.

The Geosynthetic QAC shall examine each panel, after placement and prior to seaming, for damage and/or defects. The Geosynthetic QAC shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the geosynthetic QAC. Repairs shall be made using procedures described in Subsection 12.9.

12.5.6 Writing on the Liner

To avoid confusion, the Installer and the Geosynthetic QAC shall each use different colored markers or other materials approved by the Project Manager that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane.

12.6 Field Seaming

12.6.1 Seam Layout

Before the scheduled geosynthetic pre-construction conference, the Installer shall provide the Project Manager and the Geosynthetic QAC with a panel layout drawing. This drawing shall present the proposed seams of the lining system at the facility. The Geosynthetic QAE shall review the panel layout drawing and verify that it is consistent with accepted state-of-practice.

In general, seams should be oriented parallel to the line of maximum slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet from the toe or crest of the slope, or from areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

Horizontal seams may be allowed if written approval is received by the Designer and Geosynthetic QAE under the following conditions:

- Seams are offset in adjacent panels by one full panel width.
- Seams are “shingled” downhill.
- Horizontal Seams shall be staggered.

If IDS geomembrane is installed, it will be angled to avoid head build up against the extrusion welds. For future tie-in along an extended horizontal seam at the top edge of liner, options can be employed to improve drainage including installing mid-slope drains, heat tacking a patch of drainage material (e.g., double side geocomposite [DSGC] or inverted IDS product) at the seam transition, or laying out a stepped geosynthetics tie-in.

A seam numbering system compatible with the panel numbering system shall be used by the Geosynthetic QAC.

12.6.2 Accepted Seaming Methods

Approved processes for field seaming are fusion welding and extrusion welding. Geomembrane panels made of polyethylene resins shall be welded by double−tracked, fusion welding machines for all linear seams. Corners, butt seams and long repairs shall be fusion welded where possible. Extrusion or fusion welding shall be used for all other repairs, detail work and patches. Proposed alternate processes shall be documented and submitted by the Installer to the Project Manager for approval. The Project Manager shall obtain approval from the department prior to use of any other welding method for either panel seaming, repairs, or construction of details.

12.6.2.1 Fusion Process

The Geosynthetic QAC shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any non-compliance to the Project Manager.

The Geosynthetic QAC shall also verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus agreed upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.
3. The electric generator is placed on a smooth base and rub sheet such that no damage occurs to the geomembrane and fuel spills are promptly cleaned up. Fuel shall not be stored on liner surface.
4. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.
5. In general, the geomembrane panels are aligned to have an overlap of 4 to 6 inches for fusion welding. The final overlap shall be sufficient to allow peel tests to be performed on the seam.
6. The geomembrane is protected from damage in heavy traffic areas.

12.6.2.2 Extrusion Process

The Geosynthetic QAC shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any non-compliance to the Project Manager.

The Geosynthetic QAC shall verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus agreed upon at the pre-construction meeting.
2. Equipment used for seaming is not likely to damage the geomembrane.
3. Prior to beginning a seam, the extruder is purged until heat-degraded extrudate has been removed from the barrel.
4. Clean and dry welding rods or extrudate pellets are used.
5. The electric generator is placed on a smooth base and rub sheet such that no damage occurs to the geomembrane and fuel spills promptly cleaned up. Fuel shall not be stored on liner surface.
6. Grinding is completed prior to seaming.
7. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs.
8. The geomembrane is protected from damage in heavy traffic areas.
9. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than 1/4-inch from the finished seamed area.
10. In general, the geomembrane panels are aligned to have a nominal overlap of 3 inches for extrusion welding. The final overlap shall be sufficient to allow peel tests to be performed on the seam.
11. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of temporary welding apparatus is controlled such that the geomembrane is not damaged.

12.6.3 Seam Preparation

The Geosynthetic QAC shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material. If seam overlap grinding is required, the

Geosynthetic QAC must ensure that the process is completed according to the Manufacturer's instructions seaming operation, and in a way that does not damage the geomembrane. The Geosynthetic QAC shall also verify that seams are aligned with the fewest number of wrinkles and "fishmouths".

12.6.4 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each 5 hours and with additional tests run per s. NR 516.07(2)(4)(b), for each production seaming apparatus used that day. Trial seams shall be made under the same conditions as production seams. For cold weather seaming, refer to the recommendations in GRI Test Method GM9.

The trial seam sample shall be at least 5 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Subsection 12.6.2. The specimens shall be cut by the Installer at locations selected randomly along the trial seam sample by the Geosynthetic QAC.

The specimens shall be tested for peel adhesion (five) and shear mode (five) using a field tensiometer. The field tensiometer shall be calibration certified within 3 months prior to the start of geomembrane deployment per s. NR 516.07(2)(c)(4). They should not fail in the seam as described in Subsection 12.8.5. If a specimen fails, the entire trial seam operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The Geosynthetic QAC shall observe trial seam procedures.

The remainder of the successful trial seam sample shall be retained by the QAC for possible additional testing. Each sample shall be assigned a number and marked accordingly by the Geosynthetic QAC, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

12.6.5 General Seaming Procedures

During general seaming, the Geosynthetic QAC shall verify the following:

1. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and portions where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in every directions.
2. If seaming operations are carried out at night, adequate illumination shall be provided.
3. Seaming shall extend to the outside edge of panels placed in the anchor trench.
4. Installer may adjust fusion welder speed setting ±1.0 speed setting to account for minor changes in field conditions without the need to complete new trial welds.

The Geosynthetic QAC shall verify that the above seaming procedures or other procedures agreed upon and indicated in the project QAM are followed and shall inform the Project Manager of nonconformances.

12.6.6 Seaming Weather Conditions

12.6.6.1 Cold Weather Conditions

To ensure a quality installation, if seaming is conducted when the ambient temperature is below 32°F, the following condition shall be met:

Trial seaming, as described in Subsection 12.6.4, shall be conducted under the same ambient temperature and preheating conditions as the production seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 10°F from the initial trial seam test conditions. Such new seams shall be conducted upon completion of seams in progress during temperature drop.

12.6.6.2 Warm Weather Conditions

At ambient temperatures above 104°F, no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Project Manager that geomembrane seam quality is not compromised. Trial seaming, as described in Subsection 12.6.4, shall be conducted under the same ambient temperature conditions as the production seams.

12.7 Nondestructive Seam Testing

12.7.1 Concept

As described in Subsection 12.6.2, seams can be made using fusion or extrusion welding procedures. Fusion welding can be done by either a solid heated wedge, which will produce a single seam, or by a double wedge which will produce two parallel but narrower seams. Of the testing procedures, which follow, vacuum tests may be used for each seam types, while air pressure testing can only be used on double fusion welds.

One of, or in some cases, a combination of these procedures shall be designated by Owner and shall be applied in accordance with the following procedures:

12.7.2 Air Pressure Testing

Air pressure testing is applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment for air pressure testing shall consist of the following:
    a. An air pump (manual or motor driven), equipped with pressure gauge and capable of generating and sustaining a pressure of 35 psi and mounted on a cushion to protect the geomembrane.
    b. A rubber hose with fittings and connections.
    c. A sharp hollow needle, or other pressure feed device, approved by Project Manager.
2. The following procedures shall be followed:

a. Seal both ends of the seam to be tested.

b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.

c. Insert a protective cushion between the air pump and the geomembrane.

d. Pressurize the air channel to the pressure as specified in Table 6c and 6d, close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 2 minutes.

e. If loss of pressure exceeds the maximum permissible pressure differential as specified in Table 6c and 6d or does not stabilize, locate faulty area and vacuum test in accordance with Subsection 12.7.3. If the vacuum test fails, repair in accordance with Subsection 12.9.3.

f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest un-pressurized area. Seam the cut end of the air channel.

g. Remove needle or other approved pressure feed device and seal the hole in the geomembrane.

12.7.3 Vacuum Testing

Vacuum testing is applicable to any type of seam.

1. The equipment shall consist of the following:
   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
   b. A pump assembly equipped with a pressure controller and pipe connections.
   c. A rubber pressure/vacuum hose with fittings and connections.
   d. A soapy solution. (Geosynthetic QAC shall ensure solution makes bubbles when air is passed through.)
   e. A bucket and wide paint brush, or other means of applying the soapy solution.
2. The following procedures shall be followed:
   a. Wet a strip of geomembrane approximately 12 inches by 48 inches with the soapy solution.
   b. Place the box over the wetted area.
   c. Close the bleed valve and open the vacuum valve.
   d. Ensure that a leak-tight seal is created.
   e. Perform vacuum box testing as specified in Table 6c.
   f. All areas where soap bubbles appear shall be marked and repaired in accordance with Subsection 12.9.3.

12.7.4 Test Failure Procedures

The Installer shall complete any required repairs in accordance with Subsection 12.9. For repairs, the Geosynthetic QAC shall:

1. Observe the repair and testing of the repair.
2. Mark on the geomembrane that the repair has been made.
3. Document the repair procedures and test results.

12.8 Destructive Seam Testing

12.8.1 Concept

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

In the event that, during the course of construction, geomembrane materials are obtained from a different manufacturer or are made from different resins, seam samples formed by joining the original and the proposed geomembrane will be tested to confirm the construction compatibility of the two geomembrane materials. A minimum of two seamed samples of the dissimilar materials will be submitted to the geosynthetics laboratory for destructive seam testing as described below. The Geosynthetics QAE will review the testing results in order to approve the new geomembrane material.

12.8.2 Location and Frequency

The Geosynthetic QAC shall select where seam samples will be cut out for laboratory testing. The frequency and locations shall be established as follows:

1. A minimum frequency of one test location per 500 feet of production seam length as required by s. NR 516.07(2)(c)(2). This frequency is to be determined as an average taken throughout the entire facility.
2. Test locations shall be determined during seaming at the Geosynthetic QAC's discretion. Special consideration shall be given to locations where the potential for imperfect welding, such as overheating, contamination, offset welds exists.
3. (End Bone) Destructive seam samples shall be taken from at least one end of each fusion weld greater than 100 feet long and field sample tested a minimum of once in the peel and shear mode on the field tensiometer per s. NR 516.07(2)(c)(3). Laboratory testing of end bone samples is not required.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

12.8.3 Sampling Procedures

Samples shall be cut by the Installer at locations chosen by the Geosynthetic QAC as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The Geosynthetic QAC shall:

1. Observe sample cutting.
2. Assign a number to each sample, and mark it accordingly.
3. Record sample location on layout drawing.
4. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

Holes in the geomembrane resulting from destructive seam sampling shall be repaired in accordance with repair procedures described in Subsection 12.9.3. The continuity of the new seams in the repaired area shall be tested according to Subsection 12.7.3.

12.8.4 Sample Dimensions

At each sampling location, two types of samples shall be taken by the Installer. First, at least five specimens for field testing should be taken for each set of shear and peel tests (10 specimens total). Half of the specimens will be collected 30 inches from the other half of the specimens. Each of these samples shall be cut with a 1-inch wide die for testing peel adhesion and shear strength, with the seam centered parallel to the width. If these samples pass the field test described in Subsection 12.8.5, a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the samples for field testing. The sample shall be 12 inches wide by 30 inches long with the seam centered lengthwise. The sample shall be cut into two parts and distributed as follows:

1. One 12-inch-wide by 18-inch-long portion for Geosynthetic QAL testing.
2. One 12-inch-wide by 12-inch-long portion to the QAC.

Final determination of the sample sizes shall be made at the pre-construction meeting.

12.8.5 Field Testing

The five 1-inch-wide specimens for each peel adhesion and shear strength mentioned in Subsection 12.8.4 shall be tested in the field using a tensiometer and shall not fail in film tear bond. The tensiometer shall be capable of maintaining a constant jaw separation rate of 2 inches per minute for HDPE and 20 inches per minute for LLDPE geomembrane. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it is non-conforming, the seam should be repaired in accordance with Subsection 12.8.7. Final judgment regarding seam acceptability, based on the failure criteria, rests with the Geosynthetic QAE.

The Geosynthetic QAC shall witness field tests and mark samples and portions with their number. The Geosynthetic QAC shall log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description.

12.8.6 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the Geosynthetic QAC in a manner, which will not damage the test sample. The sample shall be shipped as soon as possible to expedite laboratory testing. The QAC will be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetic QAL.

Testing shall include seam strength and peel adhesion (ASTM D6392). The minimum acceptable values to be obtained in these tests shall be as provided in Tables 6c and 6d. Five specimens shall be tested successfully, each in both shear and peel as required by s. NR 516.07(2)(c)(2). Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear). A passing test shall meet the minimum acceptable values (see Table 6c and 6d [if applicable]).

The Geosynthetic QAL shall provide test results within 24 hours of receiving the samples. The Geosynthetic QAE shall review laboratory test results as soon as they become available and make appropriate recommendations to the Project Manager.

12.8.7 Destructive Test Failure

When a sample fails a destructive test, whether that test is conducted by the Geosynthetic QAL or by field tensiometer, the Installer has two options:

1. The Installer can repair the seam between two passing destructive test locations.
2. The Installer can trace the welding path to an intermediate location 10 feet minimum from the point of the failed test in each direction and take a sample with a 1-inch wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Subsection 12.6.4 may be used as a boundary for the failing seam if approved by the Geosynthetic QAE. In cases exceeding 150 feet of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Subsection 12.9.

The Geosynthetic QAC shall document actions taken in conjunction with destructive test failures.

12.9 Defects and Repairs

12.9.1 Identification

Seams and non-seam areas of the geomembrane shall be examined by the Geosynthetic QAC for identification of defects, holes, blisters, undispersed raw materials, large wrinkles and signs of contamination by foreign matter. The geomembrane surface shall be cleaned by the Installer prior to examination if the Geosynthetic QAC determines that the amount of dust or mud inhibits examination.

12.9.2 Evaluation

Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Subsection 12.7. Each location which fails the nondestructive testing shall be marked by the Geosynthetic QAC and repaired by the Installer. Work shall not proceed with materials that will cover locations which have been repaired until successful verification by, nondestructive tests are obtained.

When seaming of the geomembrane is completed, and prior to placing overlying materials, the Geosynthetic QAC shall indicate to the Project Manager large wrinkles that should be cut and re-seamed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation period, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over on to itself, which is generally a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be nondestructively tested.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the Geosynthetic QAC to ensure that wrinkle formation is minimized and that the geomembrane is not folded over on itself.

12.9.3 Repair Procedures

Portions of the geomembrane exhibiting a flaw, or failing destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Project Manager, Installer, Designer, and Geosynthetic QAC.

1. The repair procedures available include:
    a. Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter.
    b. Spot welding used to repair pinholes, or other minor, localized flaws.
    c. Capping, used to repair large lengths of failed seams.
    d. Extrusion welding the flap, used to repair areas of inadequate fusion seams which have an exposed edge.
    e. Removing bad seam and replacing with a strip of new material welded into place.
2. For repair methods, the following provisions shall be satisfied:
    a. Surfaces of the geomembrane that are to be repaired using extrusion methods shall be ground prior to the repair.
    b. Surfaces shall be clean and dry at the time of the repair.
    c. Seaming equipment used in repairing procedures shall meet the requirements of this project QAM.
    d. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and corners of patches shall be rounded with a radius of approximately 3 inches.

12.9.4 Repair Verification

The Geosynthetic QAC shall observe nondestructive testing of repairs and shall record the number of each repair, date and test outcome. Each repair shall be nondestructively tested using the methods described in Subsection 12.7 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the Geosynthetic QAC to ensure that wrinkle formation is minimized and that the geomembrane is not folded over on itself.

12.10 Geomembrane Protection

The quality assurance procedures indicated in this Section are intended only to assure that the installation of adjacent materials does not damage the geomembrane. The quality assurance of the adjacent materials themselves are covered in separate Sections of this QAM.

12.10.1 Soils

A copy of the project specifications prepared by the Designer for placement of soils shall be given to the Geosynthetic QAE by the Project Manager. The Geosynthetic QAE shall verify that these project specifications are consistent with geosynthetic state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F nor above 104°F unless otherwise specified.
2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.
3. Equipment used for placing soil shall not be driven directly on the geomembrane.
4. A minimum thickness of 1 foot of soil is specified between a low ground pressure dozer with a ground pressure of 5 psi or less. Other tracked vehicles and flotation tire equipped vehicles shall travel over a sufficient thickness to exert less than 5 psi of ground pressure on the underlying geosynthetic surface.
5. In areas traversed by vehicles other than low ground pressure vehicles approved by the Project Manager, the soil layer shall have a minimum thickness of 3 feet. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns. Trucks and other wheeled hauling equipment shall be confined to approved corridors.
6. Soil shall only be pushed up slopes.
7. An observer shall be present at the leading edge of soil placement to confirm no damage to underlying geomembrane.

The Geosynthetic QAC or surveyor shall measure soil thickness and verify that the required thickness is present. The Geosynthetic QAC must also verify that final thickness is consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The Geosynthetic QAE shall inform the Project Manager if the above conditions are not fulfilled.

12.10.2 Appurtenances

A copy of the plans and project specifications prepared by the Designer for appurtenances such as the pipe risers for gas or leachate collection systems shall be given by the Project Manager to the Geosynthetic QAC. The Geosynthetic QAC shall review these plans and verify that:

1. Installation of the geomembrane appurtenant areas, and connection of geomembrane to risers and appurtenances have been made according to project specifications.
2. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.
3. The geomembrane has not been visibly damaged while making connections to appurtenances.
4. A representative of the Geosynthetic QAC shall be present when the Installer is welding geomembrane to appurtenant structures.

The Geosynthetic QAC shall inform the Project Manager in writing if the above conditions are not fulfilled.

13.0 Geotextiles

13.1 Definition and Applicability

Geotextiles are used in protection and filtering applications in lining systems. This Section does not describe procedures for other applications such as erosion control or reinforcement. This Section is applicable to nonwoven geotextiles made of polyester or polypropylene and not applicable to woven geotextiles. A 16-ounce per square yard (oz/sy) geotextile cushion is required below the select aggregate fill in leachate collection pipe trenches to meet the requirements in Table 7, the 16 oz/sy geotextile cushion may be replaced by two layers of 12 oz/sy geotextile cushion.

13.2 Manufacturing Plant Inspection (At Owner's Discretion)

The plant inspection is optional for manufactures previously used by Orchard Ridge RDF. A plant inspection may be necessary for a new product or suppliers.

13.3 Quality Control Documentation

Prior to the installation of the geotextile, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. Reports on quality control tests conducted by the Manufacturer to verify that the geotextile manufactured for the project meets the minimum requirements of Table 7.
2. A specification for the geotextile that includes the properties published by the Manufacturer, measured using the appropriate test methods.
3. Written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle-free.
4. Written quality control certificates signed by a responsible party employed by the Manufacturer and stating that the product will meet the minimum average roll values (MARV) given in the specification are guaranteed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures and results of quality control tests. Required properties, test methods, and values for cushion geotextiles used for geomembrane protection shall be per the current GRI Test Method GT12a – ASTM version or as required by project specifications. Refer to Table 7.

The following shall be maintained by the Manufacturer and will be available upon request:

1. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.
2. Reports on tests conducted by the Manufacturer to verify that resin used to manufacture the geotextile meets the Manufacturer's resin specifications.
3. A list of the materials which comprise the geotextile, expressed in the following categories as percent by weight: base polymer, carbon black, other additives.

The Manufacturer shall identify the rolls of geotextiles with the following:

1. Manufacturer's name

2. Product identification
3. Roll number
4. Roll dimensions

The Geosynthetic QAE shall review these documents and shall report discrepancies with the above requirements to the Project Manager. The Geosynthetic QAE shall verify that:

1. Property values certified by the Manufacturer meet its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for the rolls and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum average roll values meet the requirements of Table 7.
6. Project specifications and a copy of the QAM were submitted by the Project Manager to the Installer.

13.4 Conformance Testing (At Owner's Discretion)

If required, conformance tests shall be tailored to the intended application of the geosynthetic (e.g., filtration, cushioning, or reinforcement). Refer to Table 7.

13.5 Geotextile Deployment

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, moisture, mud, dirt, dust, puncture, cutting, or other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall not be removed until shortly before deployment.

The Geosynthetic QAC shall observe rolls upon delivery at the site. Apparently damaged or improperly wrapped rolls shall be reported to the Project Manager.

The Installer shall verify that geotextiles are not damaged during handling. The geotextile shall be deployed as described below:

1. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.
2. In the presence of wind, geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in-place, special care shall be taken to protect other materials from damage, which could be caused by the cutting of the geotextiles.
4. The Installer shall take the necessary precautions to prevent damage to underlying layers during placement of the geotextile.

5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

The Geosynthetic QAC shall note noncompliance and report it to the Project Manager.

13.6 Seaming Procedures

Geotextiles shall be overlapped a minimum of 3 inches prior to seaming. In general, no horizontal seams shall be allowed on sideslopes (seams along, not across, the slope) except as part of a patch. When horizontal seams are necessary and approved by the Designer and Geosynthetic QAE, adjacent seams shall be offset in adjacent panels and shall be “shingled” downhill.

On slopes steeper than 10:1 (horizontal:vertical), geotextiles shall be continuously sewn or fusion welded. Spot sewing or welding is not allowed. On bottoms and slopes shallower than 10:1, geotextiles shall be continually sewn, fusion welded, or thermally bonded with the written approval of the Project Manager.

Sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. The color of the sewing thread shall contrast the background color of the geotextile. Sewing shall be done using machinery and stitch types specified in the project specifications or as approved in writing by the Project Manager and the Geosynthetic QAE.

13.7 Defects and Repairs

13.7.1 Identification

If a defect is identified in the geotextile, the Geosynthetic QAC shall determine the extent and nature of the defect. If the defect is indicated by unsatisfactory test result, the Geosynthetic QAC shall determine the extent of the deficient area by additional tests, observations, a review of records and other means that the Geosynthetic QAC deems appropriate.

13.7.2 Notification

After determining the extent and nature of the defect, the Geosynthetic QAC shall promptly notify the Installer and Project Manager. A work deficiency meeting shall be held as required between the Installer, Geosynthetic QAC, Designer, Project Manager, and other necessary parties to assess the problem, review alternative solutions, and implement an action plan.

13.7.3 Repair Procedures

The final decision as to the appropriate repair shall be agreed upon between the Project Manager, Installer, Designer, and Geosynthetic QAE.

Holes or tears in the geotextile shall be repaired using the following two procedures.

1. On sideslopes, a patch made from the same geotextile shall be thermally bonded or sewn into place in accordance with the project specifications.

2. On non-sideslope areas, a patch made from the same geotextile shall be thermally bonded or sewn into place with a minimum of 12-inch overlap in each directions. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

The Geosynthetic QAC shall observe repairs and report noncompliance with the above requirements in writing to the Project Manager.

13.8 Geotextile Protection

Soil materials located on top of a geotextile shall be deployed in such a manner as to ensure:

1. The geotextile and underlying lining materials are not damaged.
2. Minimal slippage of the geotextile on underlying layers occurs.
3. No excess tensile stresses occur in the geotextile.

Noncompliance with these guidelines or the project specifications shall be noted by the Geosynthetic QAC and reported to the Project Manager.

14.0 Geocomposite

14.1 Definition and Applicability

Geocomposite are used as a filter and drainage media in lining or final cover systems. A geomembrane and geocomposite or integrated drainage system geomembrane and drainage geotextile will be installed in the final cover. A geocomposite drain will be installed as an underdrain layer below the liner system. This Section is applicable to geocomposites made of polyester or polypropylene nonwoven geotextiles bonded to both sides of a high density polyethylene (HDPE) geonet. The actual type of geocomposite shall be specified in the project specifications.

14.2 Manufacturing Plant Inspection (At Owner's Discretion)

The plant inspection is optional for manufactures previously used by Orchard Ridge RDF. A plant inspection may be necessary for a new product or suppliers.

14.3 Quality Control Documentation

Prior to the installation of a geocomposite, the geocomposite Manufacturer or Installer shall provide the Project Manager with the following information:

1. The origin (supplier's name and production plant) and identification (brand name and number) of the geotextile and geonet or core material used to fabricate the geocomposite.
2. Copies of dated quality control certificates issued by the geotextile and geonet or core supplier. These certificates shall contain the results of the quality control tests performed on the geocomposite components outlined in Section 13 and 14, and Tables 7, 8, and 9 of this QAM.
3. A specification for the geocomposite, which includes the properties published by the Manufacturer, measured using the appropriate test methods.
4. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
5. Quality control certificates for the geocomposite, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures and results of quality control tests. At a minimum, results shall be given for:
    a. Mass per unit area (ASTM D5261) – Geonet only
    b. Thickness (ASTM D751 or D5199) – Geonet only
    c. Peel Strength (ASTM F904 or D413) – Geocomposite only
    d. Transmissivity (ASTM D4716)

Quality control tests shall be performed at the frequencies as specified in Table 8 and 9.

The Manufacturer shall identify the rolls of geocomposite with the following:

1. Manufacturer's name

2. Product identification
3. Roll number
4. Roll dimensions

The Geosynthetic QAE shall review these documents and shall report any discrepancies with the above requirements to the Project Manager. The Geosynthetic QAE shall verify that:

1. Property values certified by the Manufacturer meet its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for the rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum roll properties meet the project specifications.
6. Project specifications and the QAM were submitted by the Project Manager to the Installer.

14.4 Conformance Testing

Testing will be performed as listed in Table 8 and 9.

14.5 Geocomposite Deployment

During shipment and storage, the geocomposite shall be protected from ultraviolet light exposure, moisture, mud, dirt, dust, puncture, cutting, or other damaging conditions. Geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrappings. The roll wrappings shall be removed shortly before deployment.

For one-sided geocomposite, the Geosynthetic QAC shall verify that the geonet is free of dirt and dust prior to installation. The Geosynthetic QAC shall identify dirty rolls and report them to the Project Manager. If the geonet is judged to be dirty or dusty by the Geosynthetic QAE, it shall be cleaned by the Installer prior to installation. Washing operation shall be observed by the Geosynthetic QAC and improper washing operations shall be reported to the Project Manager.

The Geosynthetic QAC shall observe rolls upon delivery at the site and deviations from the above requirements shall be reported to the Project Manager.

The Installer shall handle geocomposite in such a manner as to ensure they are not damaged, and the following shall be complied with:

1. On slopes, the geocomposite shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.
2. In the presence of wind, geocomposites shall be weighted with sandbags or the equivalent. Sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. Unless otherwise specified, single-sided geocomposite shall not be welded to the geomembrane.

4. Geocomposites shall be cut using a hook blade or other tool approved by the Project Manager. If in-place, special care shall be taken to protect underlying geosynthetics from damage which could be caused by the cutting of the geocomposite. Care shall be taken not to leave the tools in the geocomposite.
5. The Installer shall take the necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
6. During placement of geocomposite, care shall be taken not to entrap in or beneath the geocomposite, stones, or dirt that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming. If dirt or excess dust is entrapped in the geonet of single-sided geocomposite, it should be washed clean prior to placement of the next material on top of it. In this regard, care shall be taken with the handling of sandbags, to prevent puncturing the sandbag.
7. A visual examination of the geotextile component of the geocomposite shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects are present.

Deployment for high capacity geocomposite will be in accordance with the manufacturer's recommendations.

The Geosynthetic QAC shall note noncompliance and report it to the Project Manager.

14.6 Seaming Procedures

In general, no geocomposite horizontal seams shall be allowed on sideslopes thus seams shall be along, not across, the slope, except as part of a patch, unless approved by the Geosynthetics QAC. If horizontal seams are required, offset adjacent horizontal seams.

Horizontal seams for geocomposite shall be allowed under the following conditions:

- Seams are offset in adjacent panels by one full panel width.
- Seams are "shingled" downhill.
- Horizontal seams shall be staggered.

At a minimum, the following requirements shall be met for geocomposite:

1. Adjacent composite shall be overlapped so that the geonet overlaps by at least 4 inches and geotextile overlap by at least 3 inches.
2. If two sided composite or the geotextile is on bottom, overlap geotextile.
3. The geonet overlaps shall be tied with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
4. Tying shall be every 5 feet along the slope, every 6 inches in the anchor trench, and every 6 inches along end-to-end seams on the base of the landfill.
5. In the corners of the sideslopes where overlaps between perpendicular strips are required, an extra layer of geotextile shall be unrolled along the slope, on top of the previously installed geocomposite, from top to bottom of the slope. Exposed geonet at tie-ins shall be covered with a layer of geotextile.

6. When more than one layer of geocomposite is installed, joints shall be staggered.
7. Once geonet is tied, the top layer of geotextile of the geocomposite shall be seamed. On slopes steeper than 10:1 (horizontal:vertical), geotextiles shall be continuously sewn. Spot sewing is not allowed. On bottoms and slopes shallower than 10:1, geotextiles shall be sewn (preferred), or thermally bonded with the written approval of the Project Manager. The Installer shall pay particular attention to seams to ensure that no earth cover material could be inadvertently inserted beneath the geotextile, if applicable.
8. Sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using machinery and stitch types specified in the project specifications or as approved in writing by the Project Manager and the Geosynthetic QAE.

Seaming for high capacity geocomposite will be in accordance with the manufacturer's recommendations.

The Geosynthetic QAC shall note noncompliance and report it to the Project Manager.

14.7 Defects and Repairs

14.7.1 Identification

If a defect is identified in the geocomposite or high capacity geocomposite, the Geosynthetic QAC shall determine the extent and nature of the defect. If the defect is indicated by unsatisfactory test result, the Geosynthetic QAC shall determine the extent of the deficient area by additional tests, observations, a review of records and other means that the Geosynthetic QAC deems appropriate.

14.7.2 Notification

After determining the extent and nature of the defect, the Geosynthetic QAC shall promptly notify the Installer and Project Manager. A work deficiency meeting shall be held as required between the Installer, Geosynthetic QAC, Designer, Project Manager and other necessary parties to assess the problem, review alternative solutions, and implement an action plan.

14.7.3 Repair Procedures

The final decision as to the appropriate repair shall be agreed upon between the Project Manager, Installer, Designer, and Geosynthetic QAE. Prior to acceptance of the geocomposite, the Installer shall locate and repair damaged areas as directed by the Geosynthetic QAC. Care shall be taken to remove soil or other material which may have penetrated the torn geotextile. The Geosynthetic QAC shall observe repairs and report noncompliance with the following requirements in writing to the Project Manager.

If in the Geosynthetic QAC's judgement, the defect is determined to be small, typically smaller than 3 feet by 3 feet, the geocomposite shall be repaired as follows:

1. If the geonet is judged to be undamaged but the geotextile is damaged, a patch of geotextile shall be placed. The geotextile patch shall be thermally bonded in-place with a minimum of 12-inch overlap in each direction.

2. If the geonet is judged to be damaged, the damaged geonet shall be removed. A section of geonet shall be cut to replace the removed section. The geonet shall be tied to the existing geonet using white plastic fasteners placed at least every 6 inches on overlap. A geotextile patch shall be placed over the repaired geonet section. The geotextile patch shall be thermally bonded in-place with a minimum of 12-inch overlap in each direction.

If in the Geosynthetic QAC's judgement, the defect is determined to be large, typically larger than 3 feet by 3 feet, the geocomposite shall be replaced.

14.8 Geocomposite Protection

The quality assurance procedures indicated in this Section are intended only to assure that the installation of adjacent materials does not damage the geomembrane and geocomposite. The quality assurance of the adjacent materials themselves are covered in separate Sections of this QAM.

A copy of the project specifications prepared by the Designer for placement of soils shall be given to the Geosynthetic QAE by the Project Manager. The Geosynthetic QAE shall verify that these project specifications are consistent with geosynthetic state-of-practice such as:

1. Placement of soils on the geomembrane and geocomposite shall not proceed at an ambient temperature below 32°F nor above 104°F unless otherwise specified.
2. Placement of soil on the geomembrane and geocomposite should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.
3. Equipment used for placing soil shall not be driven directly on the geomembrane and geocomposite.
4. With the exception of the geocomposite underdrain layer, a minimum thickness of 1 foot of soil is specified between a low ground pressure dozer, ground pressure of 5 psi or less. Other tracked vehicles and flotation tire equipped vehicles shall maintain a minimum thickness to ensure less than 5 psi pressure will be exerted at the geomembrane and geocomposite surface. The thickness for the initial lift of clay liner placement over the geocomposite drain shall be in accordance with the manufacturer's recommendations. The Geosynthetic QAE shall approve the minimum thickness based on supporting data provided by Earthwork Contractor.
5. In areas traversed by any vehicles other than low ground pressure vehicles approved by the Project Manager, the soil layer shall have a minimum thickness of 3 feet. This requirement may be waived if provisions are made to protect the geomembrane and geocomposite through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns. Trucks and other wheeled hauling equipment shall be confined to approved corridors.
6. Soil shall only be pushed up slopes.
7. The geocomposite and underlying lining materials are not damaged.
8. Minimal slippage of the geocomposite on underlying layers occurs.
9. No excess tensile stresses occur in the geocomposite.

The Geosynthetic QAC or surveyor shall measure soil thickness and verify that the required thickness is present. The Geosynthetic QAC must also verify that final thickness is consistent with

the design and verify that placement of the soil is done in such a manner that geomembrane and geocomposite damage is unlikely. The Geosynthetic QAE shall inform the Project Manager if the above conditions are not fulfilled.

Noncompliance with these guidelines or the project specifications shall be noted by the Geosynthetic QAC and reported to the Project Manager.

15.0 Geosynthetic Clay Liner

15.1 Definitions and Applicability

Geosynthetic Clay Liners (GCLs) are geocomposite materials that consist of a uniform layer of low hydraulic conductivity, pure sodium bentonite clay, which is encapsulated between two geotextile layers. GCLs are used as the clay component of barriers in lining and cover systems.

15.2 Manufacturing Plant Inspection (At Owner's Discretion)

The plant inspection is optional for manufactures previously used by Orchard Ridge RDF. A plant inspection may be necessary for a new product or suppliers.

15.3 Quality Control Documentation

Prior to the installation of any GCL, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. Copies of dated quality control information issued by the bentonite supplier.
2. Results of quality control tests conducted by the GCL Manufacturer to verify that the bentonite supplied meet the GCL Manufacturer's specifications. The quality control tests that shall be performed on the bentonite are specified in Table 10.
3. Written certification that the minimum values given in the project specifications are guaranteed by the Manufacturer and that the GCL is needle-free.
4. Quality control certificates signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. Required properties, test methods, and minimum values for GCL (as manufactured) shall be per GRI-GCL3 Standard Specification with the most recent revision date as the effective version.
5. Preliminary panel layout drawings for installation.

The following shall be maintained by the Manufacturer and be available upon request:

1. The origin (supplier's name and location of material source) and identification of the bentonite used for production of the GCL.
2. Copies of dated quality control information provided by the geotextile Manufacturer.

The Manufacturer shall identify the rolls of GCL with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

The Geosynthetic QAE shall review these documents and shall report discrepancies with the above requirements to the Project Manager. The Geosynthetic QAE shall verify that:

1. Property values certified by the Manufacturer meet its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for the rolls, and that each certificate identifies the rolls related to it.
4. Rolls are appropriately labeled.
5. Project specifications were submitted by Project Manager to the Installer.

15.4 Conformance Testing

Conformance testing is required as specified in s. NR 516.07(2m)(a).

15.4.1 Sampling Procedures

Upon delivery of the rolls of GCL, the Geosynthetic QAC shall confirm that conformance test samples are obtained in accordance with industry accepted standards such as ASTM D6072. The rolls to be sampled shall be selected by the Geosynthetic QAC. Samples shall not be taken from a portion of a roll which has been damaged. Unless otherwise specified, samples shall be 2 ft long by 3 ft wide or minimum required by Geosynthetic QAL. The Geosynthetic QAC shall mark the machine direction on the samples with an arrow.

If the Project Manager desires, the Geosynthetic QAC can collect the conformance test samples at the manufacturing plant. This may expedite the installation process for certain projects. Unless otherwise specified in the project specifications, samples shall be taken at a rate as specified in Table 10. Samples for clay mass per unit area conformance tests shall be taken at a rate as specified in Table 10. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance to the project specifications

15.4.2 Conformance Tests

Conformance tests and frequencies of testing are specified in Table 10.

15.4.3 Test Results

Conformance test results shall be reviewed and accepted or rejected by the Geosynthetic QAE prior to the deployment of the GCL. The Geosynthetic QAE shall examine the results from laboratory conformance testing and shall report nonconformances to the Project Manager. The Geosynthetic QAE shall be responsible for checking that test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be re-tested by the Geosynthetic QAL with a technical representative of the manufacturer present during the testing. Alternatively, the Manufacturer may have the sample re-tested at two different Owner-approved Geosynthetic QALs. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Project Manager.

If a test result is in noncompliance, the material from the lot represented by the failing test should be considered out-of-specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that, bracket a greater number of rolls within the lot.

15.5 GCL Surface Preparation

GCL liner installation will not begin until a proper subgrade has been prepared to accept the GCL. The soil barrier layer shall be installed and tested as specified in Section 9.0. The Earthwork Contractor shall be responsible for preparing the underlying soil prior to GCL and geomembrane placement. The Project Manager shall coordinate the work of the Earthwork Contractor and the Installer so that the requirements of the QAM are met.

Before the GCL installation begins, the Geosynthetic QAC shall verify that:

1. A land surveyor has verified all lines and grades per Table 5.
2. The CQA Officer has verified that the underlying soil meets the criteria specified in Table 4 and Section 9.0 and that testing identified in Tables 1 and 3 have been completed with passing results.
3. The underlying soil surface to be lined has been rolled, compacted, or hand-worked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.
4. The surface of the underlying soil does not contain stones or other foreign objects, which may be damaging to the GCL and geomembrane.
5. No areas are excessively softened by high water content.
6. No areas exist where the underlying soil surface contains desiccation cracks, which may damage the GCL and geomembrane.

The Installer shall certify in writing that the surface on which the GCL will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Geosynthetic QAC prior to commencement of GCL deployment in the area under consideration. The Project Manager shall be given a copy of this certificate by the Geosynthetic QAC.

After the underlying soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Project Manager changes in the underlying soil condition that may require repair work. The Project Manager may consult with the Geosynthetic QAC regarding the need for repairs. If the Geosynthetic QAC concurs with the Installer, the Project Manager shall ensure that the underlying soil is repaired.

Before or during the GCL installation, the Geosynthetic QAC shall indicate to the Project Manager the locations that may not be adequately prepared for the GCL.

15.6 GCL Deployment

During shipment and storage, the GCL shall be protected from ultraviolet light exposure, moisture, excessive humidity, puncture, cutting, or other damaging conditions. GCL rolls shall be shipped and stored in relatively opaque and water-resistant wrappings. GCL rolls shall be stored on a flat dry surface and covered with a tarp or under a roof. The roll wrappings shall only be removed shortly before deployment. The GCL shall be covered with a geomembrane the same day that it is unpacked and placed in position. The GCL shall not be installed in standing water or during rain. The GCL shall be dry when installed and covered. GCL exhibiting unconfined swelling shall be removed and replaced.

The Geosynthetic QAC shall observe rolls and track log numbers upon delivery and prior to deployment at the site and report deviations from the above requirements to the Project Manager.

The Geosynthetic QAC shall review the GCL panel deployment progress and advise the Project Manager on its conformance with the actual field conditions. The Geosynthetic QAC shall verify that the Installer handles the GCL material in such a manner as to verify that it is not damaged, and the following are complied with:

1. On slopes, the GCL rolls shall be deployed down the slope in such a manner as to keep slack out of the GCL panel. The GCL shall be installed in a relaxed condition and shall be free of tension or stress upon completion of installation. Stretching of the GCL to fit shall not be allowed.
2. The GCL should be installed with the proper side (woven or nonwoven, if applicable) of the material facing upward. The proper orientation of the material should be as specified by the project specifications.
3. If the GCL is cut in-place, special care shall be taken to protect underlying geosynthetic materials from damage, which could be caused by cutting of the GCL.
4. The Installer shall take the necessary precautions to prevent damage to underlying layers during placement of the GCL.
5. During placement of the GCL, care shall be taken not to entrap beneath the GCL stones, excessive dust or moisture that could damage the GCL or the underlying geosynthetics.
6. After installation, a visual examination of the GCL shall be carried out over the entire surface to verify that no potentially harmful foreign objects, contaminated soil or damaged areas are present.
7. Excess loss of bentonite on edges during deployment should be minimized.
8. Loose bentonite or bentonite amended soil shall be placed at penetrations.

9. A rub sheet shall be placed over the GCL during installation of a geomembrane if a textured geomembrane will be deployed over the GCL to prevent tearing or combing out of the geotextile fibers on the GCL.
10. If the GCL is being tied into a clay cap, the GCL shall be connected to a compacted clay layer and be extended over the edge of the compacted clay at least 3 feet.

The Geosynthetic QAC shall verify that no more GCL material is deployed during one working day than can be covered by the end of that day. Exceptions to this requirement may be given by the Project Manager if dry weather is forecast for several consecutive days. GCL deployment shall not be undertaken during precipitation or when there is an immediate threat of precipitation.

The Geosynthetic QAC shall note noncompliance and report them to the Project Manager.

15.7 Seaming Procedures

15.7.1 Seam Overlap

Adjacent GCL panels shall be joined according to project plans and specifications. At a minimum, the Geosynthetic QAC shall verify the Installer complies with the following requirements:

1. Edge (longitudinal) seam overlaps shall be a minimum of 6 inches.
2. Roll end seam overlaps shall be a minimum 20 inches.
3. The addition of bentonite to seam locations shall be in accordance with the manufacture's specifications.

Prior to approval of the GCL by the Geosynthetic QAC, the following requirements should be visually verified by the QAC:

1. The required overlaps are provided.
2. The amount of the bentonite powder, if required, is placed on the seam overlap per the manufacturer's specifications.

The Geosynthetic QAC shall note noncompliance and report them to the Project Manager.

15.8 Defects and Repairs

Portion of the GCL exhibiting flaws shall be repaired. Prior to acceptance of the installed GCL, the Installer shall locate, and repair damaged areas of the liner as directed by the Geosynthetic QAC. Defects or damage can be identified by either rips, tears, premature hydration of the GCL or de-lamination of the geotextiles.

Rips or tears in the GCL shall be covered by another piece of material meeting the project specifications. The material shall extend over the entire damaged area with a minimum 12-inch overlap in every direction. Addition of bentonite to patches shall be in accordance with the project specifications.

15.9 GCL Protection

Materials located on top of the GCL shall be deployed in such a manner as to ensure:

1. The GCL and underlying liner materials are not damaged.
2. Minimal slippage of the GCL on underlying layers occurs.
3. No excess tensile stress occurs in the GCL.

Noncompliance with these guidelines or the project specifications shall be noted by the Geosynthetic QAC and reported to the Project Manager.

Table 1: Construction Testing Frequency for Disturbed (Bulk Sample) Material Evaluation for Soil Components of Lining and Final Cover Systems

Test and ASTM No.	Subbase Fill/Perimeter Berm General Fill	Select Clay Fill	Soil Barrier Layer	Granular Fill
Particle Size Cohesive - ASTM D7928 Granular - ASTM C136 or D6913	1 per 5,000 cubic yards (cy)(1)	1 per 5,000 cy(1)	1 per 5,000 cy(1)	1 per 5,000 cy for leachate collection drainage layer (2),(3) 1 per 1,000 linear feet leachate collection trench (minimum of 3)(3) 1 per 500 cy collection sump(3) 1 per 1,000 cy of stone used for final cover intermediate drain and toe drain pipe bedding and drain outlets(3) 1 per 1,000 linear feet of non-perforated leachate or transfer pipe bedding (minimum of 3)(3) 1 per source for gas well stone
Atterberg Limits ASTM D4318	1 per 5,000 cy(1)	1 per 5,000 cy(1)	1 per 5,000 cy(1)	--
Compaction ASTM D1557 or ASTM D698	1 per 5,000 cy(1)	1 per 5,000 cy(1)	1 per 5,0000 cy(1)	--
Laboratory Permeability Granular - ASTM D2434 Cohesive - ASTM D5084	--	--	--	See Note 2

Footnotes:

(1) One moisture-density curve or line of optimums analysis shall be developed for every 5,000 cy or less of material placed and for each major soil type utilized. At least 5 points shall be established on each curve. If a line of optimums analysis is performed, at least two curves shall be included for each analysis. A representative sample for every 5,000 cy or less of material placed shall be analyzed for grain size distribution through the 0.002-millimeter particle size and for Atterberg limits. If apparent changes in soil quality are observed during material placement, a 1-point Proctor analysis shall be utilized to verify the applicability of previously analyzed moisture-density curves.

(2) Leachate Collection Drainage Layer - During placement of the leachate collection drainage layer over the liner, the following testing shall be performed:

- One grain size distribution to the No. 200 sieve for each 5,000 cy of material placed. For smaller landfills where construction of a liner area involves lesser volumes, a minimum of 2 samples shall be tested.
- The department may require that chemical durability testing of the material when exposed to leachate be performed.
- A minimum of one hydraulic conductivity test performed on representative samples of select aggregate fill used for the leachate collection drainage layer and for the leachate collection trench backfill. The test procedure and any adaptations used to accommodate high−capacity drainage material shall be identified.

(3) Bedding Material - During placement of leachate collection pipes, lysimeter pipes, and groundwater collection pipes, (if applicable) the following tests shall be performed on the bedding material:

- One grain size distribution to the No. 200 sieve for each 1,000 linear feet of trench. For construction projects with combined trench lengths of less than 3,000 feet, a minimum of 3 grain size analyses shall be conducted. Bedding for solid wall piping associated with transfer of leachate, groundwater, or lysimeter fluids shall be tested at the same frequency but only to the No. 4 sieve. Leachate collection line pipe bedding material shall be composed of coarse uniform gravel with a hydraulic conductivity that is greater than or equal to the hydraulic conductivity of the leachate collection drainage layer.
- One grain size distribution to the No. 200 sieve for each 500 cy of drainage material placed in collection sumps.
- The department may require that chemical durability testing of the material when exposed to leachate and laboratory hydraulic conductivity testing be performed.
- One grain size distribution to the No. 200 sieve for each 1,000 cy of stone used for pipe bedding and drain outlets for the final cover drain layer and toe drain.

Table 2: Construction Testing Frequency for Undisturbed (Shelby Tube) Material Evaluation for Select Clay Fill Components of Liner and Final Cover Systems

Test and ASTM No.	Clay Liner/Cap
Moisture Content ASTM D2216	1/acre/1-foot thickness(1)
Lab Dry Density ASTM D7263	1/acre/1-foot thickness(1)
Particle Size Cohesive - ASTM D7928	1/acre/1-foot thickness(1)
Atterberg Limits ASTM D4318	1/acre/1-foot thickness(1)
Permeability Cohesive - ASTM D5084	Every 3rd sample/acre/1-foot thickness(1)

Footnotes:

(1) A minimum of one undisturbed sample for each acre or less for every 1-foot thickness of select clay fill placement shall be retrieved and analyzed for Atterberg limits, grain size distribution through the 0.002-millimeter particle size, moisture content, and dry density. Laboratory hydraulic conductivity tests using effective stresses less than or equal to 5 psi and hydraulic gradients less than or equal to 30 shall be performed on every third undisturbed sample. The department may require that a portion of the hydraulic conductivity testing for liner documentation be performed using leachate.

Table 3: Field Construction Testing Frequency for Soil Components of Liner and Final Cover System

Test and ASTM No.	Subbase Fill and Perimeter Berm General Fill	Select Clay Fill	Soil Barrier Layer	Soil Cover Over Geomembrane
Field Moisture Content/Density[1] ASTM D6938	1 per 100-foot grid[2] per 1-foot thickness	1 per 100-foot grid[3] per 1-foot thickness	1 per 100-foot grid[4] per 1-foot thickness	Not Required

Footnotes:

[1] Location as selected by Soils QAC, nuclear density meter probe depth at 12 inches.

[2] Dry density and as-placed moisture content shall be determined on an approximate 100-foot grid pattern for each 1-foot thickness of soil placed. The grid pattern shall be offset on each subsequent layer of tests. A minimum of two density and moisture content tests for each 1-foot thickness of soil placed shall be performed to fully define the degree of soil compaction obtained in confined areas where equipment movement is hindered or hand compaction is necessary.

[3] Dry density and as-placed moisture content shall be determined on an approximate 100-foot grid pattern for each 1-foot thickness of select clay fill placed. The grid pattern shall be offset on each subsequent layer of tests. A minimum of two density and moisture content tests for each 1-foot thickness of clay placed shall be performed to fully define the degree of soil compaction obtained in confined areas where equipment movement is hindered or hand compaction is necessary.

[4] Dry density and as-placed moisture content shall be determined on an approximate 100-foot grid pattern for each 1-foot thickness of soil barrier layer placed. The grid pattern shall be offset on each subsequent layer of tests. A minimum of two density and moisture content tests for each 1-foot thickness of soil barrier layer placed shall be performed to fully define the degree of soil compaction obtained in confined areas where equipment movement is hindered or hand compaction is necessary.

Table 4: Minimum Criteria for Soils and Granular Materials

Soil Specifications	
Subbase Fill	
Compaction (ASTM D1557 or ASTM D698)	≥90% of dry density based upon modified Proctor or ≥95% based on standard Proctor
USCS Classification (ASTM D2487)	USCS Classification of CL or CH
Grain Size (ASTM D7928 or D6913)	P200 Content ≥50% by weight
Plasticity Index (ASTM 4318)	≥ 4% minimum
General Fill	
Compaction (ASTM D1557 or ASTM D698)	≥90% of dry density based upon modified Proctor or ≥95% based on standard Proctor
Select Clay Fill	
Permeability (ASTM D5084)	Maximum $1x10^{-7}$ cm/sec
Compaction (ASTM D1557 or ASTM D698)	≥90% of dry density based upon modified Proctors or ≥ 95% based on standard Proctor
Moisture Content (ASTM D2216)	+2% wet of optimum for modified Proctor or +0% wet of optimum for standard Proctor
USCS Classification (ASTM D2487)	USCS Classification of CL or CH
Grain Size (ASTM D7928)	P200 Content ≥50% by weight
Liquid Limit (ASTM D4318)	≥25% average, 20% minimum
Plasticity Index (ASTM D4318)	≥12% average, 10% minimum
Clod Size	Maximum of 4 inches
Compacted Lift Thickness	Maximum of 6 inches
Clay Cap Thickness	Minimum of 2 feet
Clay Liner Thickness	Minimum of 4 feet
Select Aggregate Fill (Leachate Collection Drainage Layer)[1)]	
Permeability (ASTM D2434)	1 cm/sec or greater
Grain Size (ASTM C136 or D6913)	Maximum 5% passing No. 200 sieve by weight, maximum of approximately 1-1/2 inches (up to 6% retained on 1 ½-inch sieve)
Uniformity Coefficient	Cu <4
Select Aggregate Fill (Leachate Collection Pipe Trench Stone)[(2)(3)]	
Permeability (ASTM D2434)	Greater than or equal to leachate collection drainage layer
Grain Size (ASTM C136 or D6913)	Maximum of 1-1/2 inches, D85 > 1/2 inch with maximum 5% passing No. 4 sieve by weight, consist of rounded or subangular gravel
Uniformity Coefficient	Cu <4

Table 4: Minimum Criteria for Soils and Granular Materials

Soil Specifications	
Select Aggregate Fill (Final Cover Intermediate Drain and Toe Drain Pipe Bedding)	
Grain Size (ASTM C136 or D6913)	D_{85} > 0.175 inch with maximum 5% passing No. 200 sieve by weight
Permeability (ASTM D2434)	$\geq 1x10^{-2}$ cm/sec
Select Aggregate Fill (Landfill Gas Extraction Well)	
Grain Size (ASTM C136 or D6913)	Maximum of 1-1/2 inches, D_{85} > 1/2 inch with maximum 5% passing No. 4 sieve by weight, consist of rounded or subangular gravel
Select Granular Fill (Bedding for Solid Wall Pipes Outside Limits of Waste)	
Grain Size (ASTM C136 or D6913)	Primarily sand size particles; maximum particle size of 1.5 inch
Final Cover Soil Barrier Layer (Below GCL)	
USCS Classification (ASTM D2487)	USCS Classification of CL, CH, ML, SM, SC, or dual-symbol classification of these soils.
Grain Size (ASTM D7928 or D6913)	P200 Content $\geq$25% by weight, Maximum particle size of 2 inches on upper 1-foot lift and maximum particle size of 4 inches on the lower 1-foot lift
Compaction (ASTM D1557 or ASTM D698)	$\geq$90% of dry density based upon modified Proctors or $\geq$ 95% based on standard Proctor, moisture content at or wet of optimum
Compacted Lift Thickness	Maximum of 12 inches
Cover Soil Barrier Layer Thickness	Minimum of 2 feet
Clod Size	Maximum of 4 inches

Footnotes:

(1) **Compare maximum particle size with liner geotextile cushion requirements in Table 7.**

The drainage blanket shall meet graded filter requirements such that it will not be subject to piping of fines when used in conjunction with proposed pipe bedding. The D_{15} of the filter material divided by the D_{85} of the finer material shall be less than or equal to 5. The D_{50} of the filter material divided by the D_{50} of the finer material shall be less than or equal to 25. The D_{15} of the filter material divided by the D_{15} of the finer material shall be less than or equal to 20.

(2) **Compare maximum particle size with liner geotextile cushion requirements in Table 7.**

The pipe bedding shall meet graded filter requirements such that it will not be subject to piping of fines when used in conjunction with proposed drainage blanket. The D_{15} of the filter material divided by the D_{85} of the finer material shall be less than or equal to 5. The D_{50} of the filter material divided by the D_{50} of the finer material shall be less than or equal to 20. The D_{85} of the filter material divided by the collection pipe hole diameter shall be greater than or equal to 1.2.

(3) **Limestone and dolomite will not be used for leachate collection trench backfill unless no other suitable material is reasonably available.**

Table 5: Construction Survey Requirements for Soil Components of Liner and Final Cover Systems

As a minimum, the following surfaces shall be certified:

Cover System	Liner Systems
• Top of waste including daily and intermediate cover. • Top of grading layer. • Top of soil barrier layer or select clay fill layer. • Top of topsoil cover. • As directed by the Owner or Owner's representative.	• Top of subbase. • Leachate collection trench invert at subbase and base grade (at 25-foot intervals or 50-foot intervals if a total station or laser equipment is used to record elevations). • Top of select clay fill. • Top of leachate collection drainage layer. • Subbase and base elevation of sumps. • As directed by Owner or Owner's representative.

Each layer shall be documented and certified in the following manner:

1. Surveying shall be done on a minimum 50-foot grid on the liner and on a 100-foot grid for areas greater than 4 acres or on a 50-foot grid for areas less than 4 acres on the cover and shall include other grade breaks such as:
   - Select Clay Fill or Soil Barrier Layer Limits
   - Crest of Slopes
   - Toe of Slopes
   - Perimeter Anchor Trench
   - Location of all Cover Penetrations
2. Soil survey shall be shot from the same grid points to verify minimum individual soil layer thickness requirements.

Misc. Items

- Landfill Gas Collection and Condensate Pipes (at gas wells, major changes in slope, fittings, structures, anti-seep collars)
- Gas Wells and Vertical Leachate Head wells
- Leachate Collection Pipe (25-foot intervals unless total station or laser equipment is used, then 50-foot intervals)
- Sideslope Riser and Horizontal Leachate Head wells (top, toe, and end of screen)
- Leachate Cleanouts (top and toe)
- Sideslope Riser Vault and Manholes (center, top, and bottom)
- Leachate Tanks, Transfer Pipes, Forcemain
- Drainage Features, Culverts, and Berms

Table 6a: 60-Mil Smooth HDPE Geomembrane - Specifications

Properties	Test Method	Manufacturer QC Test Frequency[1]	Conformance QA Test Frequency	Required Test Values[2]
Physical Properties				
Nominal Thickness (per NR 504)				60 mil
Thickness (min. average) • Lowest individual of 10 values	ASTM D5199	1 per Roll	5 per Roll	60 mil 54 mil
Melt Flow Index (maximum)	ASTM D1238	N/A	1 per 100,000 sf [3]	1.0 g/10 min
Sheet Density (min.)	ASTM D792 or ASTM D1505	1 per 50,000 sf, or 1 per 200,000 lbs	1 per 100,000 sf [3]	0.940 g/cc
Mechanical Properties				
Tensile Properties [4] (min. average) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693 Type IV	1 per 50,000 sf, or 1 per 20,000 lbs	1 per 100,000 sf [5]	126 lb/in. 228 lb/in. 12 % 700 %
Tear Resistance (min. average)	ASTM D1004	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	42 lbs
Puncture Resistance (min. average)	ASTM D4833	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	108 lbs
Environmental Properties				
Stress Crack Resistance [6] (min.)	ASTM D5397 (App.)	(Per GRI-GM10[2]) 1 per every 2 resin lots	[7]	500 hours
Carbon Black Content (range)	ASTM D4218 [8]	1 per 50,000 sf, or 1 per 20,000 lbs	N/A	2-3%
Carbon Black Dispersion[9]	ASTM D5596	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	[9]
Oxidative Induction Time (OIT) (min. average)[10] • Std. OIT or • High Pressure OIT	ASTM D8117 ASTM D5885	1 per 200,000 lbs [11]	N/A	100 min. 400 min.
Oven Aging at 85°C [10][12] • Std. OIT (min. average) % retained after 90 days or • High Pressure OIT (min. average) % retained after 90 days	ASTM D5721 ASTM D8117 ASTM D5885	Per Formulation [11]	N/A	55% 80%

Table 6a: 60-Mil Smooth HDPE Geomembrane - Specifications

Properties	Test Method	Manufacturer QC Test Frequency(1)	Conformance QA Test Frequency	Required Test Values(2)
UV Resistance (13) • Std. OIT (14) (min. average) or • High Pressure OIT (min. average) % retained after 1600 hrs (15)	ASTM D7238 ASTM D8117 ASTM D5885	Per Formulation (11)	N/A	Not Recommended(14) 50

Footnotes:

(1) Use the more frequent of the listed frequencies. Sampling frequency by weight is based on GRI GM13, Rev. 16, 3/17/21.

(2) Based on GRI GM13, Rev. 16, 3/17/21. Acceptable values shall meet the most recent update to GRI GM13 standards.

(3) In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed, unless documentation is provided which shows the manufacturer performed testing at the same frequencies.

(4) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

- Yield elongation is calculated using a gage length of 1.3 inches.
- Break elongation is calculated using a gage length of 2.0 inches.

(5) A minimum of one test for each batch of resin used to manufacture the rolls delivered on site unless documentation is provided that shows the manufacturer performed testing at the same frequency.

(6) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(7) A minimum of one test for each batch of resin used to manufacture the rolls delivered on site unless documentation is provided that shows the manufacturer performed testing at the same frequency.

(8) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(9) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- 9 in Categories 1 or 2, and 1 in Category 3

(10) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(11) Manufacturer may provide certification letter.

(12) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(13) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(14) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(15) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 6a: 60-Mil Smooth HDPE Geomembrane - Specifications (continued)

Properties	Test Method [1]	Sample Size	Minimum Test Frequency	Acceptance Criteria
Shear Test [2][3]	ASTM D6392 GRI GM19a	42-in along seam, 12-in wide	Average 1 every 1,000 lf for each type of welding and 1 per fusion weld >100 lf [4]	Minimum yield strength for the seam is 120 lb/in [5] Minimum elongation of 50% (laboratory test only)
Peel Test [2][3] Hot Wedge Fusion	ASTM D6392 GRI GM19a		Average 1 every 1,000 lf for each type of welding and 1 per weld >100 lf [4]	Minimum yield strength for the seam is 91 lb/in [5] Maximum peel separation is 25%
Peel Test [2] Fillet Extrusion	ASTM D6392 GRI GM19a		Average 1 every 1,000 lf for each type of welding	Minimum yield strength for the seam is 78 lb/in [5] Maximum peel separation is 25%
Air-Pressure	GRI GM6	N/A	All Dual track seams tested by Air Pressure	For 60 mil, not to exceed 4 psi drop with initial pressure 27-30 psi for 5 minutes, following an initial 2-minute stabilization period.
Vacuum	ASTM D4437 ASTM D5641	N/A	All single track wedge and extrusion seams tested by Vacuum	Examine weld for approximately 10 seconds through window of vacuum of minimum 3 psig

Footnotes:

[1] Destructive seams will be evaluated for strength parameters according to ASTM D6392 (excluding Section 6.3 "Conditioning"). Destructive seams will be evaluated for elongation during cold weather seaming. Refer to Cold Weather Operations section of CQA plan and GRI Test Method GM9.

[2] Film Tear Bond (FTB) is unacceptable. FTB definition: A failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area. Examples of FTB and the associated locus of break codes are provided in ASTM D6392. For laboratory-tested samples, unacceptable locus-of-break codes are:

- Fusion: AD and AD-BRk > 25%
- Extrusion: AD1, AD2
- AD-WLD is acceptable if strength is achieved.
- Separation in plane (SIP) is acceptable if strength, shear elongation, and peel separation criteria are met.

For laboratory-tested samples, 5 out of 5 test specimens must pass the locus-of-break, shear elongation, and peel separation.

[3] For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed above.

[4] Field test sample cut from each end of production field seam; can be cut from portion of seam extending into/past anchor trench.

[5] GRI GM19a specification. Five out of five specimens shall pass shear and peel strength minimum values. Also refer to GRI Test Method GM9 for cold weather seaming recommendations. Acceptance criteria shall meet the current GRI GM19a specification.

Table 6b: 60-Mil Textured HDPE Geomembrane - Specifications

Properties	Test Method	Manufacturer QC Test Frequency[1]	Conformance QA Test Frequency[2]	Required Test Values[3]
Physical Properties				
Nominal Thickness (per NR 504)				60 mil
Thickness (min. average) • Lowest individual for 8 out of 10 values • Lowest individual for any of the 10 values	ASTM D5994	1 per Roll	5 per Roll	Nom. 57 mil 54 mil 51 mil
Asperity Height (min. average) [4][5]	ASTM D7466	Every 2nd Roll	N/A	16 mil
Melt Flow Index (max.)	ASTM D1238	N/A	1 per 100,000 sf [6]	1.0 g/10 min
Sheet Density (min.)	ASTM D792 or ASTM D1505	1 per 50,000 sf, or 1 per 200,000 lbs	1 per 100,000 sf [6]	0.940 g/cc
Mechanical Properties				
Tensile Properties[7] (min. average) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693 Type IV	1 per 50,000 sf, or 1 per 20,000 lbs	1 per 100,000 sf [8]	126 lb/in 90 lb/in 12% 100%
Tear Resistance (min. average)	ASTM D1004	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	42 lbs
Puncture Resistance (min. average)	ASTM D4833	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	90 lbs
Environmental Properties				
Stress Crack Resistance [9]	ASTM D5397 (App.)	Per GRI-GM10 [3] per every resin lots	(10)	500 hours
Carbon Black Content (range)	ASTM D4218 [11]	1 per 50,000 sf, or 1 per 20,000 lbs	N/A	2-3%
Carbon Black Dispersion [12]	ASTM D5596	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	See note 12
Oxidative Induction Time (OIT) (min. average) [13] • Std. OIT or • High Pressure OIT	ASTM D8117 ASTM D5885	1 per 200,000 lbs [14]	N/A	100 min. 400 min.

Table 6b: 60-Mil Textured HDPE Geomembrane - Specifications

Properties	Test Method	Manufacturer QC Test Frequency[1]	Conformance QA Test Frequency[2]	Required Test Values[3]
Oven Aging at 85°C [13][15]				
• Std. OIT (min. average), % retained after 90 days	ASTM D5721 ASTM D8117	Per Formulation [14]	N/A	55%
or				
• High Pressure OIT (min. average), % retained after 90 days	ASTM D5885			80%
UV Resistance [16]				
• Std. OIT [17] (min. average)	ASTM D7238 ASTM D8117	Per Formulation [14]	N/A	Not Recommended[17]
or				
• High Pressure OIT (min. average) % retained after 1600 hrs [18]	ASTM D5885			50%

Footnotes:

[1] Use the more frequent of the listed frequencies. Sampling frequency by weight is based on GRI GM13, Rev. 16, 3/17/21. If changes to the sampling frequency by weight in GRI GM13 are made, the most recent revision shall be followed.

[2] Conformance QA testing is also required for direct shear (ASTM D5321) of the interfaces in contact with clay liner and geotextile cushion materials. Wet interfaces will be tested at normal stresses of 200, 400, and 600 psf. Use a direct shear strain rate of 0.004 inch per minute for interface with clay. Clay liner will be compacted to 90% of modified proctor maximum dry density at moisture contents of at least 2% wet of optimum. Interface friction angle limits are contained within Appendix I.4.

[3] Based on GRI GM13, Rev. 16, 3/17/21. If changes to the acceptable values in GRI GM13 are made, the most recent revision shall be followed.

[4] Alternate measurement side for double sided textured sheet.

[5] Test each side of the textured geomembrane recording a measurement every lineal foot of textured roll width.

[6] In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed, unless documentation is provided which shows the manufacturer performed testing at the same frequencies.

[7] Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

- Yield elongation is calculated using a gage length of 1.3 inches.
- Break elongation is calculated using a gage length of 2.0 inches.

[8] In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed.

[9] The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

[10] A minimum of one test for each batch of resin used to manufacture the rolls delivered on site unless documentation is provided that shows the manufacturer performed testing at the same frequency.

[11] Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

[12] Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- 9 in Categories 1 or 2, and 1 in Category 3

[13] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

[14] Manufacturer may provide certification letter.

[15] It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

[16] The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

[17] Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

[18] UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 6b: 60-Mil Textured HDPE - Specifications (Continued)

Properties	Test Method [1]	Sample Size	Minimum Test Frequency	Acceptance Criteria
Shear Test [2][3]	ASTM D6392 GRI GM19a	42-in along seam, 12-in wide	Average 1 every 1,000 lf for each type of welding and 1 per fusion weld >100 lf [4]	Minimum yield strength for the seam is 120 lb/in [5] Minimum elongation of 50% (laboratory test only)
Peel Test [2][3] Hot Wedge Fusion	ASTM D6392 GRI GM19a		Average 1 every 1,000 lf for each type of welding and 1 per weld >100 lf [4]	Minimum yield strength for the seam is 91 lb/in [5] Maximum peel separation is 25%
Peel Test [2] Fillet Extrusion	ASTM D6392 GRI GM19a		Average 1 every 1,000 lf for each type of welding per welder	Minimum yield strength for the seam is 78 lb/in [5] Maximum peel separation is 25%
Air-Pressure	GRI GM6	N/A	All Dual track seams tested by Air Pressure	For 60 mil, not to exceed 4 psi drop with initial pressure 27-30 psi for 5 minutes, following an initial 2-minute stabilization period.
Vacuum	N/A	N/A	All single track wedge and extrusion seams tested by Vacuum	Examine weld for approximately 10 seconds through window of vacuum of minimum 3 psig

Footnotes:

[1] Destructive seams will be evaluated for strength parameters according to ASTM D6392 (excluding Section 6.3 "Conditioning"). Destructive seams will be evaluated for elongation during cold weather seaming. Refer to Cold Weather Operations section of CQA plan and GRI Test Method GM9.

[2] FTB is unacceptable. FTB definition: A failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area. Examples of FTB and the associated locus of break codes are provided in ASTM D6392. For laboratory-tested samples, unacceptable locus-of-break codes are:

- Fusion: AD and AD-Brk > 25%
- Extrusion: AD1, AD2
- AD-WLD is acceptable if strength is achieved.
- Separation in plane (SIP) is acceptable if strength, shear elongation, and peel separation criteria are met.

For laboratory-tested samples, 5 out of 5 test specimens must pass the locus-of-break, shear elongation, and peel separation.

[3] For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed above.

[4] Field test sample cut from each end of production field seam; can be cut from portion of seam extending into/past anchor trench.

[5] GRI GM19a specification. Five out of five specimens shall pass shear and peel strength minimum values. Also refer to GRI Test Method GM9 for cold weather seaming recommendations. Acceptance criteria shall meet the current GRI GM19a specification.

Table 6c: Final Cover Textured LLDPE Geomembrane - Specifications

Properties	Test Method	Manufacturer QC Test Frequency[1]	Conformance QA Test Frequency [2]	Required Test Values [3]	
Physical Properties					
Nominal Thickness (per NR 504)				40 mil	50 mil
Thickness (min. average) • Lowest individual for 8 out of 10 values • Lowest individual for any of the 10 values	ASTM D5994	1 per Roll	5 per Roll	Nom. 38 mil 36 mil 34 mil	Nom. 47.5 mil 45 mil 42.5 mil
Melt Flow Index (max.)	ASTM D1238	1 per Batch	1 per 100,000 sf [4]	1.0 g/10 min	1.0 g/10 min
Sheet Density (max.)	ASTM D792 or ASTM D1505	1 per 50,000 sf, or 1 per 200,000 lbs	1 per 100,000 sf [4]	0.939 g/ml	0.939
Asperity Height (min. average) [5][6]	ASTM D7466	Every 2nd Roll	N/A	16 mil	16 mil
Mechanical Properties					
Tensile Properties [7] (min. average) • Break strength • Break elongation	ASTM D6693 Type IV	1 per 50,000 sf, or 1 per 20,000 lbs	1 per 100,000 sf [8]	 60 lb/in. 250%	 75 lb/in 250%
Tear Resistance (min. average)	ASTM D1004 Die C	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	22 lbs	27 lbs
2% Modulus (max.)	ASTM D5323	Per Formulation	N/A	2,400 lb/in	3000 lb/in
Puncture Resistance (min. average)	ASTM D4833	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	44 lbs	55 lbs
Axi-Symmetric Break Resistance Strain (min.)	ASTM D5617	Per Formulation	N/A	30%	30%
Environmental Properties					
Carbon Black Content (range)	ASTM D4218 [9]	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	2-3%	2-3%
Carbon Black Dispersion [10]	ASTM D5596	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	[10]	[10]
Stress Crack Resistance [11]	ASTM D5397 (App.)	N/A	N/A	[11]	[11]

Table 6c: Final Cover Textured LLDPE Geomembrane - Specifications

Properties	Test Method	Manufacturer QC Test Frequency[1]	Conformance QA Test Frequency [2]	Required Test Values [3]	
Oxidative Induction Time (OIT) (min. average) [12]					
• Std. OIT or	ASTM D8117	200,000 lbs [13]	N/A	100 min.	100 min.
• High Pressure OIT	ASTM D5885			400 min.	400 min.
Oven Aging at 85°C [12][14]					
• Std. OIT (min. average), % retained after 90 days	ASTM D5721 ASTM D8117	Per Formulation [13]	N/A	35%	35%
or					
• High Pressure OIT (min. average), % retained after 90 days	ASTM D5885			60%	60%
UV Resistance [15]					
• Std. OIT [16] (min. average)	ASTM D7238 ASTM D8117	Per Formulation [11]	N/A	Not Recommended [16]	Not Recommended [16]
or					
• High Pressure OIT (min. average) % retained after 1600 hrs [17]	ASTM D5885			35%	35%

Footnotes:

[1] Use the more frequent of the listed frequencies. Sampling frequency by weight is based on GRI GM17, Rev. 14, 3/17/21. If changes to the sampling frequencies by weight in GRI GM17 are made, the most recent revision shall be followed.

[2] Conformance QA testing is also required for direct shear (ASTM D5321) of the interfaces in contact with the clay cap material or GCL and the geotextile of the cover geocomposite. Wet interfaces will be tested at normal stresses of 200, 400, and 600 psf. Use a direct shear strain rate of 0.004 inch per minute for interface with clay. Clay cap will be compacted to 90% of modified proctor maximum dry density at moisture contents of at least 2% wet of optimum. Interface friction angle limits are contained within Appendix I.4.

[3] Based on GRI GM17, Rev. 14, 3/17/21. If changes to the acceptable values in GRI GM17 are made, the most recent revision shall be followed.

[4] In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed, unless documentation is provided which shows the manufacturer performed testing at the same frequencies.

[5] Alternate measurement side for double sided textured sheet.

[6] Test each side of the textured geomembrane recording a measurement every lineal foot of textured roll width.

[7] Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

- Break elongation is calculated using a gage length of 2.0 inches at 2.0 in/min.

[8] In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed.

[9] Other methods such as method D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

[10] Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- 9 in Categories 1 or 2, and 1 in Category 3

[11] Not tested on LLDPE products per GRI GM17.

[12] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

[13] Manufacturer may provide certification letter.

[14] It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

[15] The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

[16] Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

[17] UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 6c: Final Cover Textured LLDPE - Specifications (Continued)

Properties	Test Method [1]	Sample Size	Minimum Test Frequency	Acceptance Criteria	
Nominal Thickness (per NR 504)				40 mil	50 mil
Shear Test[2][3]	ASTM D6392 GRI GM19a	42-in along seam, 12-in wide	Average 1 every 500 lf for each type of welding and 1 per fusion weld >100 lf [4]	Min. strength for seam: 60 lb/in [5] Min. elongation: 50% (lab test only)	Min. strength for seam: 75 lb/in [5] Min. elongation: 50% (lab test only)
Peel Test [2][3] Hot Wedge Fusion	ASTM D6392 GRI GM19a		Average 1 every 500 lf for each type of welding and 1 per fusion weld >100 lf [4]	Min. strength for seam: 50 lb/in [5] Max. peel separation: 25%	Min. strength for seam: 63 lb/in [5] Max. peel separation: 25%
Peel Test [2] Fillet Extrusion	ASTM D6392 GRI GM19a		Average 1 every 500 lf for each type of welding	Min. strength for seam: 44 lb/in [5] Max. peel separation: 25%	Min. strength for seam: 57 lb/in [5] Max. peel separation: 25%
Air-Pressure	GRI GM6	N/A	All Dual track seams tested by Air Pressure	4 psi drop with initial pressure 20-30 psi for 2 minutes, following an initial 2-minute stabilization period.	
Vacuum	N/A	N/A	All single track wedge and extrusion seams tested by Vacuum	Examine weld for approximately 10 seconds through window of vacuum of minimum 3 psig	

Footnotes:

[1] Destructive seams will be evaluated for strength parameters according to ASTM D6392 (excluding Section 6.3 "Conditioning"). Destructive seams will be evaluated for elongation during cold weather seaming. Refer to Cold Weather Operations section of CQA plan and GRI Test Method GM9.

[2] FTB is unacceptable. FTB definition: A failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area. Examples of FTB and the associated locus of break codes are provided in ASTM D6392. For laboratory-tested samples, unacceptable locus-of-break codes are:

- Fusion: AD and AD-Brk > 25%
- Extrusion: AD1, AD2
- AD-WLD is acceptable if strength is achieved.
- Separation in plane (SIP) is acceptable if strength, shear elongation, and peel separation criteria are met.

For laboratory-tested samples, 5 out of 5 specimens must pass locus-of-break, shear elongation, and peel separation.

[3] For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed above.

[4] Field test sample cut from each end of production field seam; can be cut from portion of seam extending into/past anchor trench.

[5] GRI GM19a specification. Five out of five specimens shall pass shear and peel strength minimum values. Also refer to GRI Test Method GM9 for cold weather seaming recommendations.

Table 6d: Final Cover Textured HDPE Geomembrane - Specifications

Properties	Test Method	Manufacturer QC Test Frequency[1]	Conformance QA Test Frequency[2]	Required Test Values[3]
Physical Properties				
Nominal Thickness (per NR 504)				50 mil
Thickness (min. average) • Lowest individual for 8 out of 10 values • Lowest individual for any of the 10 values	ASTM D5994	1 per Roll	5 per Roll	Nom. 47.5 mil 45 mil 42.5 mil
Asperity Height (min. average) [4][5]	ASTM D7466	Every 2nd Roll	N/A	16 mil
Melt Flow Index (max.)	ASTM D1238	N/A	1 per 100,000 sf [6]	1.0 g/10 min
Sheet Density (min.)	ASTM D792 or ASTM D1505	1 per 50,000 sf, or 1 per 200,000 lbs	1 per 100,000 sf [6]	0.940 g/cc
Mechanical Properties				
Tensile Properties[7] (min. average) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693 Type IV	1 per 50,000 sf, or 1 per 20,000 lbs	1 per 100,000 sf [8]	105 lb/in 75 lb/in 12% 100%
Tear Resistance (min. average)	ASTM D1004	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	35 lbs
Puncture Resistance (min. average)	ASTM D4833	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	75 lbs
Environmental Properties				
Stress Crack Resistance [9]	ASTM D5397 (App.)	Per GRI-GM10 [3] per every resin lots	[10]	500 hours
Carbon Black Content (range)	ASTM D4218 [11]	1 per 50,000 sf, or 1 per 20,000 lbs	N/A	2-3%
Carbon Black Dispersion [12]	ASTM D5596	1 per 50,000 sf, or 1 per 45,000 lbs	N/A	[12]
Oxidative Induction Time (OIT) (min. average) [13] • Std. OIT or • High Pressure OIT	ASTM D8117 ASTM D5885	1 per 200,000 lbs[14]	N/A	100 min. 400 min.

Table 6d: Final Cover Textured HDPE Geomembrane - Specifications

Properties	Test Method	Manufacturer QC Test Frequency[1]	Conformance QA Test Frequency[2]	Required Test Values[3]
Oven Aging at 85°C [13][15] • Std. OIT (min. average), % retained after 90 days or • High Pressure OIT (min. average), % retained after 90 days	ASTM D5721 ASTM D8117 ASTM D5885	Per Formulation [14]	N/A	55% 80%
UV Resistance [16] • Std. OIT [17] (min. average) or • High Pressure OIT (min. average) % retained after 1600 hrs [18]	ASTM D7238 ASTM D8117 ASTM D5885	Per Formulation [14]	N/A	Not Recommended [17] 50%

Footnotes:

[1] Use the more frequent of the listed frequencies. Sampling frequency by weight is based on GRI GM13, Rev. 16, 3/17/21. If changes to the sampling frequency by weight in GRI GM13 are made, the most recent revision shall be followed.

[2] Conformance QA testing is also required for direct shear (ASTM D5321) of the interfaces in contact with clay liner and geotextile cushion materials. Wet interfaces will be tested at normal stresses of 200, 400, and 600 psf. Use a direct shear strain rate of 0.004 inch per minute for interface with clay. Clay liner will be compacted to 90% of modified proctor maximum dry density at moisture contents of at least 2% wet of optimum.

[3] Based on GRI GM13, Rev. 16, 3/17/21. If changes to the acceptable values in GRI GM13 are made, the most recent revision shall be followed.

[4] Alternate measurement side for double sided textured sheet.

[5] Test each side of the textured geomembrane recording a measurement every lineal foot of textured roll width.

[6] In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed, unless documentation is provided which shows the manufacturer performed testing at the same frequencies.

[7] Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

- Yield elongation is calculated using a gage length of 1.3 inches.
- Break elongation is calculated using a gage length of 2.0 inches.

[8] In addition to the minimum frequency noted, a minimum of one test for each batch of resin used to manufacture the rolls delivered on site must be performed.

[9] The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

[10] A minimum of one test for each batch of resin used to manufacture the rolls delivered on site unless documentation is provided that shows the manufacturer performed testing at the same frequency.

[11] Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

[12] Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- 9 in Categories 1 or 2, and 1 in Category 3

[13] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

[14] Manufacturer may provide certification letter.

[15] It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

[16] The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

[17] Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

[18] UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 6d: Final Cover Textured HDPE - Specifications (Continued)

Properties	Test Method [1]	Sample Size	Minimum Test Frequency	Acceptance Criteria
Shear Test [2][3]	ASTM D6392 GRI GM19a	42-in along seam, 12-in wide	Average 1 every 1,000 lf for each type of welding and 1 per fusion weld >100 lf [4]	Minimum yield strength for the seam is 100 lb/in [5] Minimum elongation of 50% (laboratory test only)
Peel Test [2][3] Hot Wedge Fusion	ASTM D6392 GRI GM19a		Average 1 every 1,000 lf for each type of welding and 1 per weld >100 lf [4]	Minimum yield strength for the seam is 76 lb/in [5] Maximum peel separation is 25%
Peel Test [2] Fillet Extrusion	ASTM D6392 GRI GM19a		Average 1 every 1,000 lf for each type of welding per welder	Minimum yield strength for the seam is 65 lb/in [5] Maximum peel separation is 25%
Air-Pressure	GRI GM6	N/A	All Dual track seams tested by Air Pressure	For 50 mil, not to exceed 4 psi drop with initial pressure 27-30 psi for 5 minutes, following an initial 2-minute stabilization period.
Vacuum	N/A	N/A	All single track wedge and extrusion seams tested by Vacuum	Examine weld for approximately 10 seconds through window of vacuum of minimum 3 psig

Footnotes:

[1] Destructive seams will be evaluated for strength parameters according to ASTM D6392 (excluding Section 6.3 “Conditioning”). Destructive seams will be evaluated for elongation during cold weather seaming. Refer to Cold Weather Operations section of CQA plan and GRI Test Method GM9.

[2] FTB is unacceptable. FTB definition: A failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area. Examples of FTB and the associated locus of break codes are provided in ASTM D6392. For laboratory-tested samples, unacceptable locus-of-break codes are:

- Fusion: AD and AD-Brk > 25%
- Extrusion: AD1, AD2
- AD-WLD is acceptable if strength is achieved.
- Separation in plane (SIP) is acceptable if strength, shear elongation, and peel separation criteria are met.

For laboratory-tested samples, 5 out of 5 test specimens must pass the locus-of-break, shear elongation, and peel separation.

[3] For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed above.

[4] Field test sample cut from each end of production field seam; can be cut from portion of seam extending into/past anchor trench.

[5] GRI GM19a specification. Five out of five specimens shall pass shear and peel strength minimum values. Also refer to GRI Test Method GM9 for cold weather seaming recommendations. Acceptance criteria shall meet the current GRI GM19a specification.

Table 7: Geotextile Material Specifications[1]

Property	Test Method	6 oz/yd^2 in Cover Geonet Geocomposite[2]	8 oz/yd^2 Filter and in Underdrain Geonet Geocomposite [2]	12 oz/yd^2 Cushion [3][4]	16 oz/yd^2 Cushion [3] [5]	Manufacturer QC Test Frequency [6]	Conformance QA Test Frequency [7]
Mass Per Unit (min. average)	ASTM D5261	6 oz/yd^2	8 oz/yd^2	12 oz/yd^2	16 oz/yd^2	1 per 100,000 sf	N/A
Apparent Opening Size (AOS) (max)	ASTM D4751	0.25 mm	0.25 mm	N/A	N/A	1 per 540,000 sf	N/A
Grab Tensile Strength (min. average)	ASTM D4632	157 lbs	200 lbs	300 lbs	370 lbs	1 per 100,000 sf	N/A
Grab Tensile Elongation (min. average)	ASTM D4632	50 %	50 %	50 %	50 %	1 per 100,000 sf	N/A
Puncture Strength (CBR) (min. average)	ASTM D6241	310 lbs	430 lbs	800 lbs	900 lbs	1 per 100,000 sf	N/A
UV Resistance retained after 500 hours exposure	ASTM D4355 ASTM D7238	50% strength	50% strength	70% strength [8]	70% strength [8]	1 per resin formulation	N/A
Permittivity (min. average)	ASTM D4491	0.2 sec $^{-1}$	0.2 sec $^{-1}$	N/A	N/A	1 per 540,000 sf	N/A

Footnotes:

[1] Provide a non-woven product comprised of polyester or polypropylene.

[2] Based on GRI GN4, Rev. 4, 7/9/2020. The most recent revision shall be met.

[3] Based on GRI GT12(a), Rev. 2, 3/3/16. The most recent revision shall be met.

[4] Approximate maximum particle size of 1 inch (no more than 6% retained on 1-inch sieve).

[5] Approximate maximum particle size of 1½ inches (no more than 6% retained on 1½-inch sieve).

[6] Manufacturer may elect to provide certification of values for geotextiles.

[7] Conformance QA testing is required for direct shear (ASTM 5321) of the geotextile cushion interfaces in contact with the textured HDPE geomembrane and the leachate collection drainage layer, and the cover geocomposite geotextiles in contact with the textured LLDPE geomembrane and the rooting zone material. Wet interfaces will be tested at normal stresses of 200, 400, and 600 psf. Leachate collection drainage layer and rooting zone material will be lightly tamped at the as-received moisture content. Interface friction angle limits are contained within Appendix I.4.

[8] Evaluation to be on a 2.0-inch strip tensile specimens after 500 hours of exposure.

Table 8: Underdrain Geocomposite

Properties	Test Method	Manufacturer QC Test Frequency[1]	Conformance QA Test Frequency	Underdrain Required Test Values [2]	
				Double-Sided Geocomposite	High Capacity Single-Sided Geocomposite
Material Specifications Geonet Properties					
Thickness (min. average)	ASTM D5199	1 per 100,000 sf or 50,000 lbs	N/A	300 mil	330 mil
Density (min. average)	ASTM D792 or ASTM D1505	1 per 100,000 sf or 50,000 lbs	N/A	0.95 g/cc	0.94 g/cc
Tensile Strength (MD) (min. average)	ASTM D7179	1 per 100,000 sf or 50,000 lbs	N/A	75 lb/in [3]	75 lb/in [3]
Carbon Black Content (range)	ASTM D1603 or ASTM D4218 [4]	1 per 100,000 sf or 100,000 lbs	N/A	1.5-3%	2-3%
Finished Geocomposite Product [5][6]					
Ply Adhesion [7] (min. average)	ASTM D7005	1 per 100,000 sf or 100,000 lbs	N/A	1.0 lb/in	0.5 lb/in
Transmissivity [7] (min. average)	ASTM D4716	1 per project [9]	1 per project [10]	1.70×10^{-3} m^2/sec [8.2 gpm/ft] [11]	5.60×10^{-3} m^2/sec [27.1 gpm/ft] [11]
Combined Geocomposite Transmissivity [8] (min. average)	ASTM D4716	1 per project	1 per project [10]	7.30×10^{-3} m^2/sec [35.3 gpm/ft] [11]	

Footnotes:

[1] Use more frequent frequency. Frequency by weight is based on GRI GN4, Rev. 4, 7/9/2020. If changes to the frequency by weight are made the most recent revision shall be followed.

[2] Based on GRI GN4, Rev. 4, 7/9/2020. If changes to the specifications are made the most recent revision shall be followed.

[3] Required value shall be taken from manufacturer's standard material specification sheet for the selected geonet/geocomposite material.

[4] Other methods such as D6370 (TGA) are acceptable if an acceptable correlation to D4218 (muffle furnace) can be established.

[5] Geocomposite shall be manufactured by heat bonding the geotextile to the geonet on one or both sides (pending on the geocomposite). No burn through geotextiles nor glue or adhesive shall be permitted.

[6] Testing for the geonet component shall be performed in accordance with the upper portion of this table. The geotextile component shall meet the required test values from Table 7 and the manufacturer's QC test frequency requirements. Tracking of the frequency of Manufacturer QC testing and Conformance QA testing shall be based on the geocomposite roll numbers.

[7] Properties of the geocomposite drain only.

[8] Combined transmissivity of geocomposite and high-capacity drainage geocomposite.

[9] Transmissivity shall be measured in a 12-inch x 12-inch box using the same boundary conditions, load, duration and gradient as those used by the manufacturer to establish the min. average for the required test value.

[10] Conformance testing of the geocomposite shall be performed using site conditions and site soils:

[11] Geocomposite drain sandwiched between two layers of clay liner material compacted to 90% modified proctor maximum dry density at a moisture content at least 2% wet of optimum.

[12] Geocomposite drain and high-capacity drainage geocomposite sandwiched between two layers of clay liner material compacted to 90% modified proctor maximum dry density at a moisture content at least 2% wet of optimum.

Table 9: Final Cover System Geocomposite Material Specifications

Properties	Test Method	Manufacturer QC Test Frequency [2]	Conformance QA Test Frequency	Final Cover Required Test Values [1]
Geonet Properties				
Thickness (min. average)	ASTM D5199	1 per 100,000 sf or 50,000 lbs	N/A	200 mil
Density (min. average)	ASTM D792 or ASTM D1505	1 per 100,000 sf or 50,000 lbs	N/A	0.95 g/cc
Tensile Strength (MD) (min. average)	ASTM D7179	1 per 100,000 sf or 50,000 lbs	N/A	45 lb/in [4]
Carbon Black Content (range)	ASTM D1603 or ASTM D2418[3]	1 per 100,000 sf or 100,000 lbs	N/A	1.5-3%
Finished Geocomposite Product[5][6]				
Ply Adhesion (min. average)	ASTM D7005	1 per 100,000 lbs	N/A	1.0 lb/in
Transmissivity (min. average)	ASTM D4716	1 per 200,000 lbs[7]	1 per project [8]	$1x10^{-3}$ m^2/sec [9]

Footnotes:

[1] Based on GRI GN4, Rev. 4, 7/9/2020. If changes to the specifications are made the most recent revision shall be followed.

[2] Use more frequent frequency. Frequency by weight is based on GRI GN4, Rev. 4, 7/9/2020. If changes to the frequency by weight are made the most recent revision shall be followed.

[3] Other methods such as D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

[4] Required value shall be taken from manufacturer's standard material specification sheet for the selected geonet/geocomposite material.

[5] Testing for the geonet component shall be performed in accordance with the upper portion of this table. The geotextile component shall meet the required test values from Table 7 and the manufacturer's QC test frequency requirements. Tracking of the frequency of Manufacturer QC testing and Conformance QA testing shall be based on the geocomposite roll numbers.

[6] Geocomposite shall be manufactured by heat bonding the geotextile to the geonet on both sides. No burn through geotextiles nor glue or adhesive shall be permitted.

[7] Transmissivity shall be measured in a 12-inch x 12-inch box using the same boundary conditions, load, duration and gradient as those used by the manufacturer to establish the min. ave. for the required test value.

[8] Conformance testing of the geocomposite shall be performed using site conditions and site soils:

- Final Cover – Normal stress = 375 psf; hydraulic gradient = 0.25

[9] Final cover geocomposite between layers of LLDPE geomembrane and lightly tamped rooting zone material at the as-received moisture content.

Table 10: Final Cover System Geosynthetic Clay Liner (GCL) Material Specifications

Properties[1]	Test Method	Manufacturer QC Test Frequency[2]	Conformance QA Test Frequency [3]	Required Test Values [4]
Bentonite Mass/Unit Area (min. ave.) [5]	ASTM D5993	1 per 45,000 sf	1 per 40,000 sf	0.75 lb/sf
Index Flux (max.)	ASTM D5887[6]	1 per 250,000 sf	1 per 100,000 sf	1x 10^{-8} m^3/sec-m^2
Permeability (max.)	ASTM D5887[6]	1 per 250,000 sf	1 per 250,000 sf	5x 10^{-9} cm/sec
Grab Tensile Strength[1]	ASTM D6768	1 per 225,000 sf	1 per 100,000 sf	23 lbs/in MARV[7]
Peel Strength (min. ave.) [1]	ASTM D6496	1 per 45,000 sf	1 per 100,000 sf	1 lbs/in.
Swell Index in Bentonite Recovered from GCL (min.)	ASTM D5890	1 per 100,000 lbs	1 per 100,000 sf	24 ml/2g
Fluid Loss, max. (Bentonite Property)	ASTM D5891	1 per 100,000 lbs	N/A	18 ml
Internal Shear Strength (min.).	ASTM D6243	1 per project	1 per project	131 lbs/sf [8]

Footnotes:

[1] Machine direction and cross direction

[2] Geotextile components of GCL shall be QC tested in accordance with the manufacturer's Quality Control Program.

[3] Conformance QA testing is also required for direct shear (ASTM D6243) of the GCL interfaces in contact with the barrier layer material and the textured LLDPE geomembrane. Wet interfaces will be tested at normal stresses of 200, 400, and 600 psf. Barrier layer material will be compacted to 90% of modified Proctor maximum dry density at optimum moisture content or at a moisture content wet of optimum. Interface friction angle limits are contained within Appendix I.4.

[4] Based on representative manufacturer's product data and current Geosynthetics Institute GRI-GCL3 Standard Specification.

[5] Bentonite mass/unit area measured after oven drying.

[6] De-Aired Tap Water at 5 psi (34.5 kPa) maximum effective confining stress and 2 psi (13.8 kPa) head.

[7] MARV=Minimum average roll value (machine direction).

[8] Internal shear strength provided in the table is required to obtain a slope stability factor of safety of 1.5 as presented in the Orchard Ridge RDF East Expansion Plan Modification, dated March 25, 2020.

Attachment 1: Wetland and Waterway Restoration, Monitoring, and Corrective Measures Plan

8.0 Wetland and Waterway Restoration, Monitoring, and Corrective Measures Plan

8.1 Wetland and Waterway Restoration

The following subsections describe restoration activities that are proposed for adjacent regulated and jurisdictional wetland and waterway areas.

8.1.1 Waterway Restoration and Seeding

The proposed realigned waterway will be constructed to be 1 foot deep and 5 feet wide. The waterway will meander within a 30-foot-wide corridor as depicted on Figure F3. The waterway will have an asymmetrical longitudinal meander. Once the waterway is excavated, coir-logs (or

a similar alternative) will be installed along the entirety of both inside edges of the carved path to stabilize and maintain bed and bank for the waterway. The upper banks of the waterway and the coir-logs (or similar) will be seeded using a native seed mix. Refer to Table 8-1. This type of seed mix is suitable for establishing native vegetation in low-lying areas that are adjacent to the proposed realigned waterway.

Table 8-1: Wet Mesic to Mesic Seed Mix - 8.0 PLS LBS/Acre (82.0 Seeds/ Sq. Ft)

Wildflowers		**Oz/Acre**
Alisma subcordatum	Mud Plantain	1.0
Asclepias incarnata	Marsh (Red) Milkweed	3.0
Aster novae-angliae	New England Aster	1.0
Aster puniceus	Swamp Aster	1.0
Eupatorium maculatum	Spotted Joe Pye Weed	1.0
Eupatorium perfoliatum	Boneset	0.5
Helenium autumnale	Sneezeweed	0.3
Helianthus grosseserratus	Sawtooth Sunflower	0.5
Liatris spicata	Marsh Blazing Star	3.0
Lobelia cardinalis	Cardinal Flower	0.30
Lobelia siphilitica	Great Blue Lobelia	0.35
Pycnanthemum virginianum	Mountain Mint	0.5
Rudbeckia laciniata	Wild Golden Glow	3.0
Silphium perfoliatum	Cup Plant	4.0
Solidago riddellii	Riddell's Goldenrod	4.0
Verbena hastata	Blue Vervain	2.0
Vernonia fasciculata	Ironweed	4.0
Zizia aurea	Golden Alexanders	4.0
Grasses, Sedges, and Rushes		**Oz/Acre**
Bromus ciliatus	Fringed Brome	24.0
Carex vulpinoidea	Brown Fox Sedge	4.0
Elymus riparius	River Bank Wild Rye	30.0
Elymus virginicus	Virginia Wild Rye	24.0
Glyceria grandis	Reed Manna Grass	2.0
Leersia oryzoides	Rice Cut Grass	2.0
Scirpus atrovirens	Dark-Green Bulrush	1.0
Scirpus cyperinus	Wool Grass	0.25
Scirpus fluviatilis	River Bulrush	3.0
Scirpus validus	Great Bulrush	0.30
Spartina pectinata	Prairie Cordgrass	4.0

8.1.2 Native Shrub and Tree Planting

Native shrubs will be planted within the wetland adjacent to the realigned waterway to enhance the floristic quality of the surrounding riparian wetlands. Some shrubs will be sourced from on-

site or within 100 miles of the Project site or Southeast Wisconsin and will be planted as live staking. Others will be sourced from local nurseries that supply native plants. Brief specifications on native shrub and tree planting and live staking are provided below.

8.1.2.1 Native Shrub Planting

One hundred #3 size containerized native shrubs will be installed within the riparian area of the realigned waterway. Native shrubs will consist of a mix of two or three of the species listed in Table 8-2, with each species comprising no more than 80 percent of the mix.

Table 8-2: Native Shrubs

Shrub Type	
Cornus amomum	Silky dogwood
Salix interior	Sandbar willow
Sambucus canadensis	American elderberry

The source of all containerized native shrubs will be from a reputable nursery in Wisconsin that provides native plant material. WMWI will maintain a 1 year, 75 percent care and replacement plan for native shrubs. Placement of the native shrubs will be within the wetland in the riparian zone of the waterway, but not within the waterway channel. Native shrubs will be installed above the low flow water surface and below the seasonal flooding elevation. Native shrubs will be clustered in a random pattern throughout the planting area at a density of 3 native shrubs per five square yards. Shrubs will be planted during a time of year most likely to result in survivorship, such as in early-spring or late-fall.

8.1.2.2 Live Staking

One hundred live stakes will be installed within the riparian area of the realigned waterway; in or behind the coir-logs (or similar). Live stakes will consist of a mix of two or three of the species listed in Table 8-3, with each species comprising no more than 80 percent of the mix.

Table 8-3: Live Stake species

Species Type	
Cornus amomum	Silky dogwood
Salix interior	Sandbar willow
Sambucus canadensis	American elderberry

The source of all live cuttings will be from purchased stock, from on-site, or from within 100 miles of the Project site or Southeast Wisconsin. Placement of the live stakes will be in or behind the biologs, but not within the waterway channel between the logs. Live stakes will be installed above the low flow water surface and below the seasonal flooding elevation. Live stakes will be clustered in a random pattern throughout the planting area at a density of 3 live stakes per square yard. Live stakes will be installed during a time of year most likely to result in survivorship, such as in early-spring or late-fall.

8.1.3 Waterway Shoreline Protection

Root wads and footer logs will be installed so as to protect the outside bank of meanders from erosion and to provide fish habitat. Woody materials for root wads and footer logs are to be harvested from the trees that will be removed as a result of the proposed landfill expansion. Materials will be from living trees or trees that have recently died and have sound, undecomposed wood. Footer logs will be installed below low flow water elevations, at an angle to stream flow directions. The quantity will be based on the availability and suitability of materials on-site, but will include no less than five.

8.1.4 Wetland Restoration

Temporary wetland disturbances will be restored to their former condition post construction. In areas of temporary wetland disturbance, as detailed in Subsection 5.1.3, topsoil will be segregated from subsoil during construction. Post construction, the soil will be returned in kind and excess soil will be disposed of in an upland location. These areas will be restored utilizing the applicable seed mix at the listed rates as described below.

Seed will be of high quality, comply with Wisconsin Seed and Weed Laws, and will originate from the United States. Seed used will be purchased on a "Pure Live Seed" (PLS) basis for seeding. A list of recommended of wetland plants and seeding rates are provided in Table 8-4. This would be used for temporarily disturbed wetlands not adjacent to a waterway.

Table 8-4: Full Sun to Part Sun Wetland Seed Mix – 3.25 PLS LBS/Acre

Wildflowers		**Oz/Acre**
Alisma subcordatum	Mud Plantain	1.5
Asclepias incarnata	Marsh (Red) Milkweed	4.0
Aster novae-angliae	New England Aster	0.25
Aster puniceus	Swamp Aster	0.50
Eupatorium perfoliatum	Boneset	0.25
Helenium autumnale	Sneezeweed	0.50
Iris versicolor	Northern Blue Flag Iris	4.50
Lobelia cardinalis	Cardinal Flower	0.75
Lobelia siphilitica	Great Blue Lobelia	0.50
Lycopus americanus	Water Horehound	0.25
Minmulus ringens	Monkey Flower	0.10
Penthorum sedoides	Ditch Stonecrop	0.05
Polygonum pensylvanicum	Pinkweed	1.00
Pycnanthemum virginianum	Mountain Mint	0.50
Solidago graminifolia	Grass-Leaved Goldenrod	0.10
Solidago riddellii	Riddell's Goldenrod	0.50
Verbena hastata	Blue Vervain	0.75

Table 8-4: Full Sun to Part Sun Wetland Seed Mix – 3.25 PLS LBS/Acre

Grasses, Sedges, and Rushes		Oz/Acre
Bromus ciliatus	Fringed Brome	16.0
Poa palustris	Fowl Bluegrass	0.50
Elymus virginicus	Virginia Wild Rye	0.50
Carex bebbii	Bebb's Oval Sedge	0.50
Carex crinita	Fringed Sedge	0.50
Carex hystericina	Porcupine Sedge	0.25
Carex lacustris	Common Lake Sedge	0.75
Carex stipata	Common Fox Sedge	0.25

8.2 Wetland and Waterway Restoration Monitoring

The realigned waterway will be monitored for a period of three years to confirm that the banks have revegetated and there is no significant bank erosion. Shrub plantings will be monitored for one full growing season post construction to confirm that 75% of the planted shrubs survive for a full growing season. Temporarily disturbed wetland areas along the bank of the realigned waterway and the areas summarized in Subsection 5.1.3 will be monitored for three years to confirm 80% revegetation. Because the existing herbaceous vegetation is dominated by invasive and exotic species including reed canary grass and invasive cattails, WMWI will not be monitoring for floristic quality performance standards.

8.3 Waterway Restoration Corrective Measures

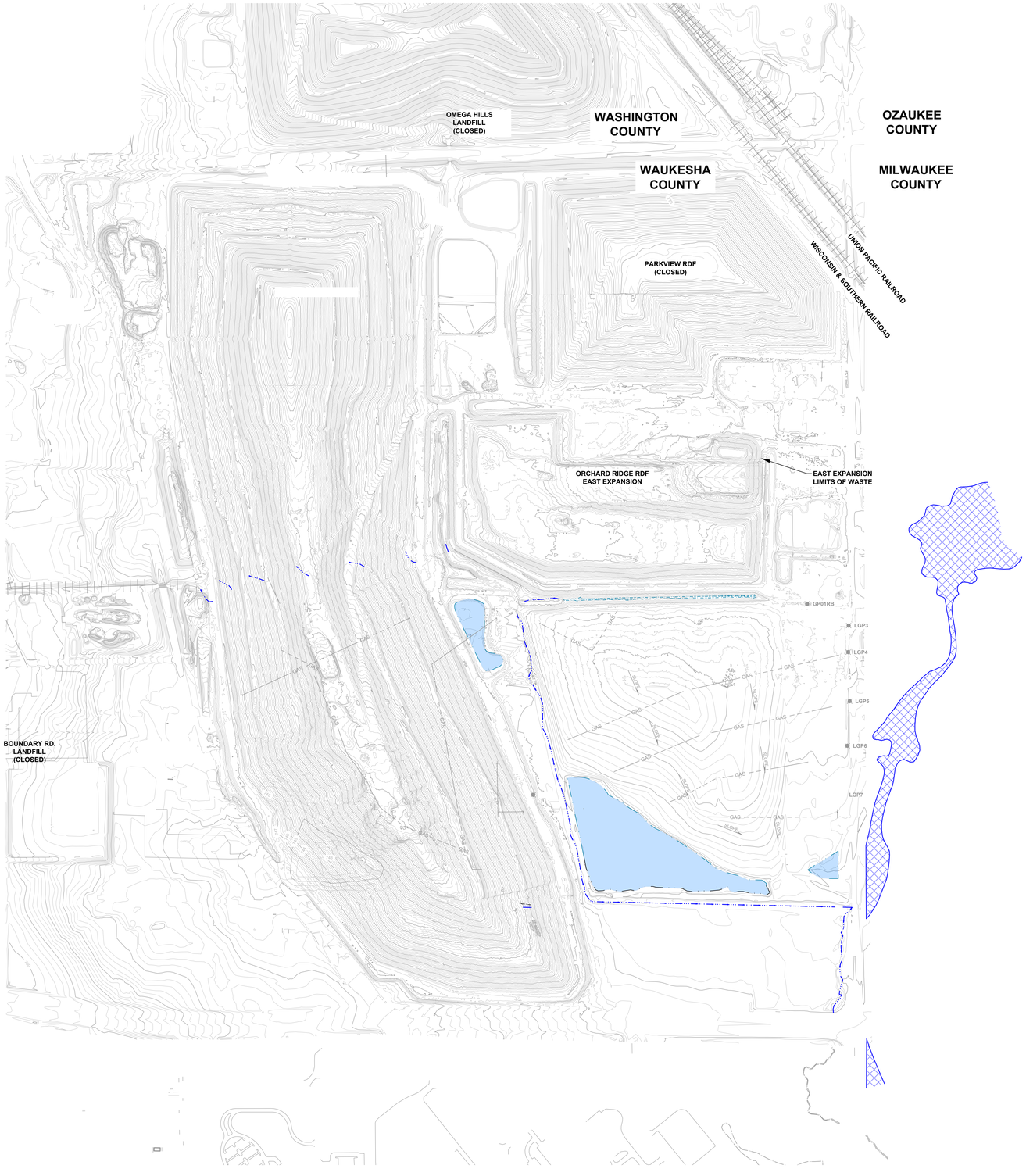
Corrective measures will be taken if, based upon the Waterway Restoration Monitoring, the waterway restoration does not appear to be successful. If there is excessive erosion, bank failure, or unsuccessful vegetation establishment, WMWI will repair or replant as appropriate. Corrective measures may include regrading/reshaping the waterway, replacing bio logs, repairing erosion damage, or replanting/seeding plants.

As noted in Subsection 4.2, native plant seed will be introduced; however, it is not anticipated that native plants that germinate would persist and outcompete the invasive plants that currently dominate the wetlands. Therefore, establishment of wetland vegetation will be considered a success even if the dominant vegetation established is comprised of invasive species.

Attachment 5

Revised Drawings

- Plan Sheet 3 – Existing Conditions Map and Site Layout
- Plan Sheet 4 – Supplemental Existing Conditions Map
- Plan Sheet 40 – Details - Gas System



- THE EXISTING TOPOGRAPHIC FEATURES (ROADS/TREES/BUILDINGS, ETC.) WAS DEVELOPED FROM REFERENCE FILES FROM PROJECTS PREPARED BY SCS ENGINEERS.
- THE TOPOGRAPHY WAS OBTAINED FROM DRAWING PREPARED BY TETRA TECH, "ACTIVE ENVIRONMENTAL MONITORING SYSTEM" DATE MARCH 2022.
- ADDITIONAL LOCATIONS OF ON SITE UTILITIES WERE OBTAINED FROM SURVEYS PERFORMED BY TETRA TECH - SEPTEMBER AND OCTOBER 2020.

Michael Amstadt

Digitally signed by Michael Amstadt
Date: 2022.09.16 12:45:02 -05'00'

WISCONSIN
MICHAEL J. AMSTADT
E-31270
MADISON
WI
PROFESSIONAL ENGINEER

NO.	BY	DATE	REVISION	APP'D.
1	GTA	05/02/2022	EXIST CONTOURS, EXIST FORCEMAIN AND LABELS	MA

PROJECT: **WASTE MANAGEMENT OF WISCONSIN, INC.**
PLAN OF OPERATION
ORCHARD RIDGE RDF - EASTERN EXPANSION, SOUTHERN UNIT
VILLAGE OF MENOMONEE FALLS, WAUKESHA CO., WI

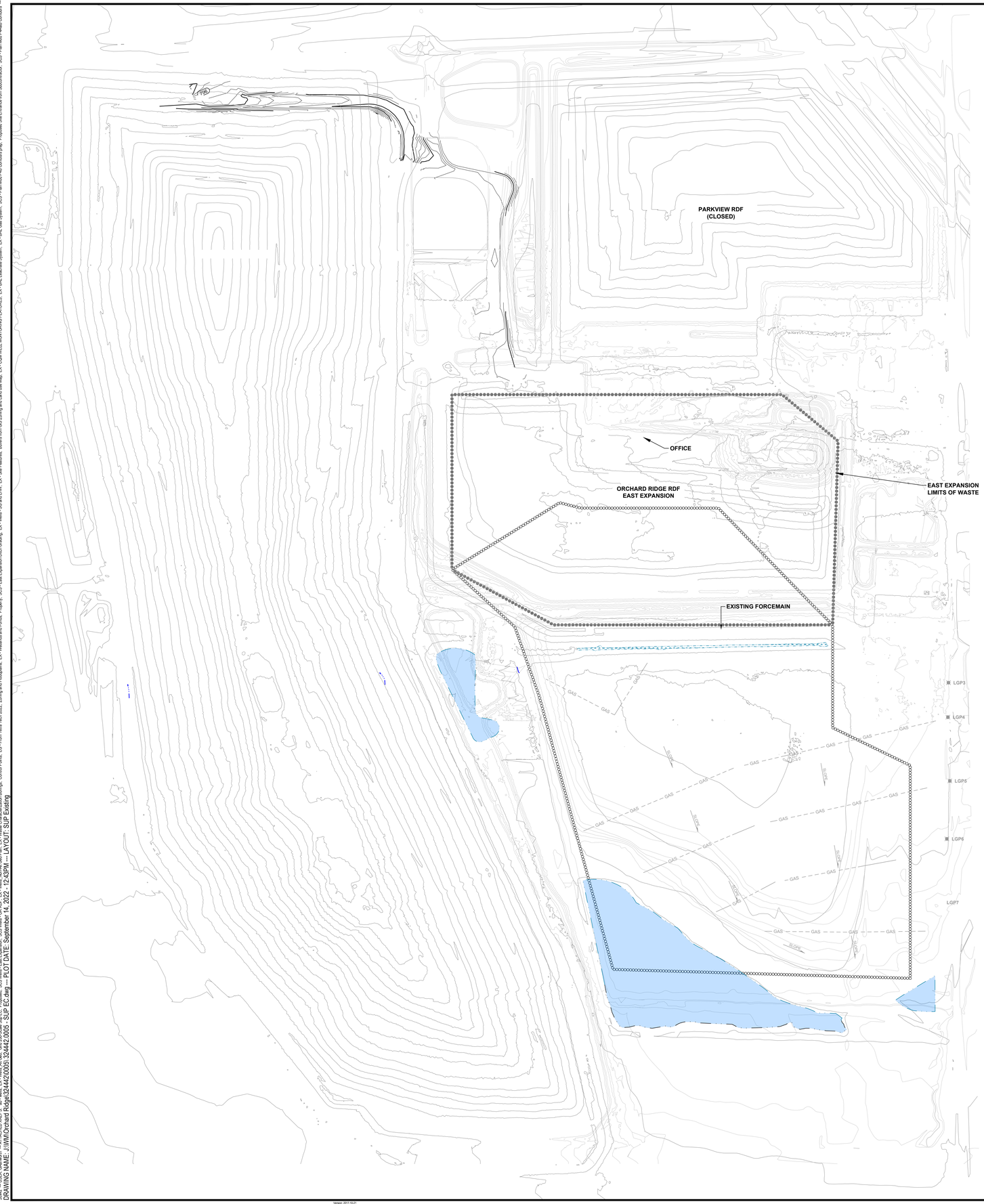
TITLE:
EXISTING CONDITIONS MAP AND SITE LAYOUT

DRAWN BY:	G. ASHWORTH	PROJ NO.:	324442.0005.0000
CHECKED BY:	T.HALENA/B.KAHNK		
APPROVED BY:	M. AMSTADT		SHEET 3 OF 42
DATE:	FEBRUARY 2022		

WASTE MANAGEMENT

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 324442.0005.EC.dwg



- THE EXISTING TOPOGRAPHIC FEATURES (ROADS/TREES/BUILDINGS, ETC.) WAS DEVELOPED FROM REFERENCE FILES FROM PROJECTS PREPARED BY SCS ENGINEERS.
- THE TOPOGRAPHY WAS OBTAINED FROM DRAWING PREPARED BY TETRA TECH, "ACTIVE ENVIRONMENTAL MONITORING SYSTEM" DATE MARCH 2022.
- ADDITIONAL LOCATIONS OF ON SITE UTILITIES WERE OBTAINED FROM SURVEYS PERFORMED BY TETRA TECH - SEPTEMBER AND OCTOBER 2020.

Michael Amstadt

Digitally signed by Michael Amstadt
Date: 2022.09.16 12:45:36 -05'00'

WISCONSIN
MICHAEL J. AMSTADT
E-31270
MADISON
WI
PROFESSIONAL ENGINEER

NO.	BY	DATE	REVISION	APP'D.
1	GTA	05/02/2022	EXIST CONTOURS, EXIST FORCEMAIN AND LABELS	MA

PROJECT: **WASTE MANAGEMENT OF WISCONSIN, INC.**
PLAN OF OPERATION
ORCHARD RIDGE RDF - EASTERN EXPANSION, SOUTHERN UNIT
VILLAGE OF MENOMONEE FALLS, WAUKESHA CO., WI

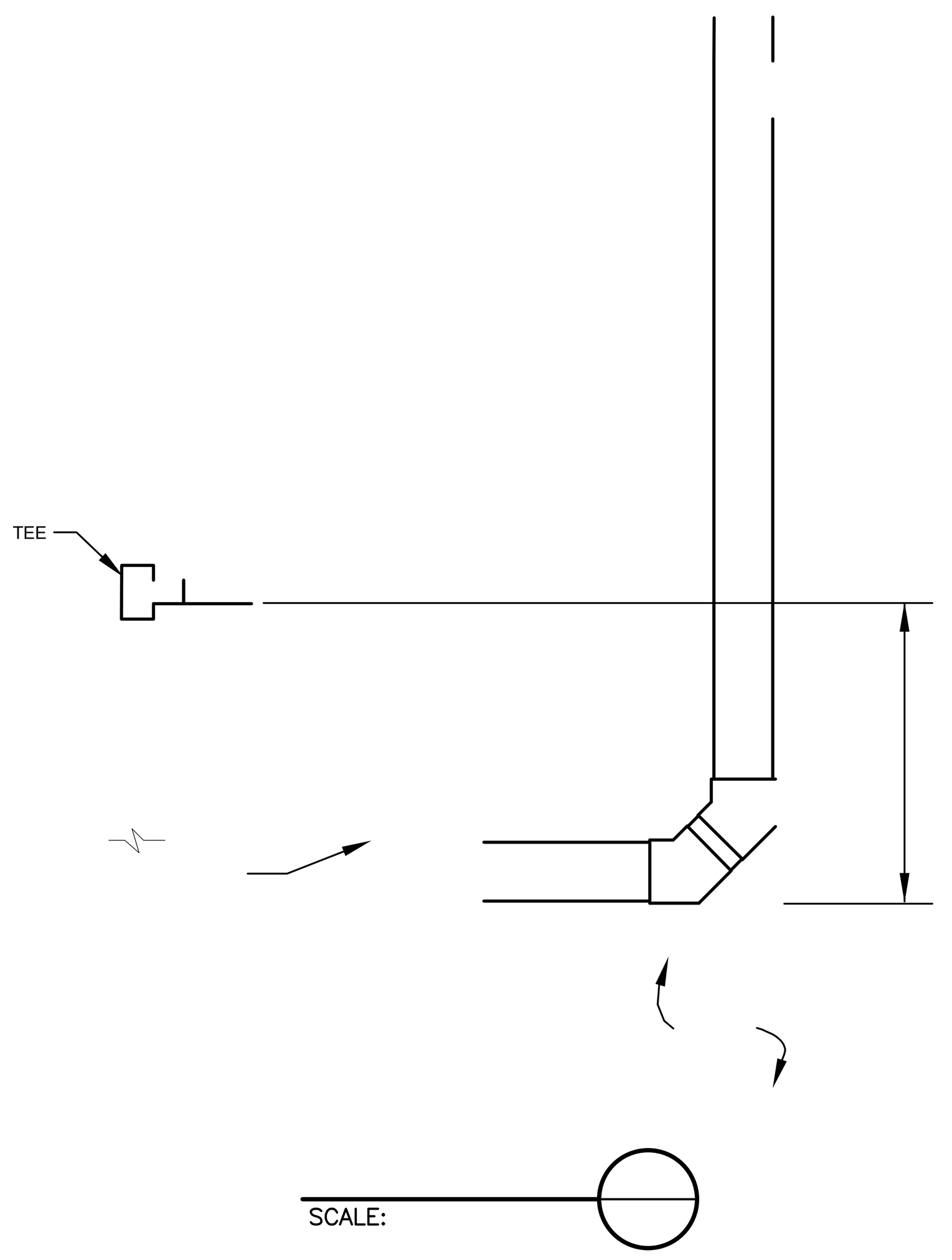
TITLE:
SUPPLEMENTAL EXISTING CONDITIONS MAP

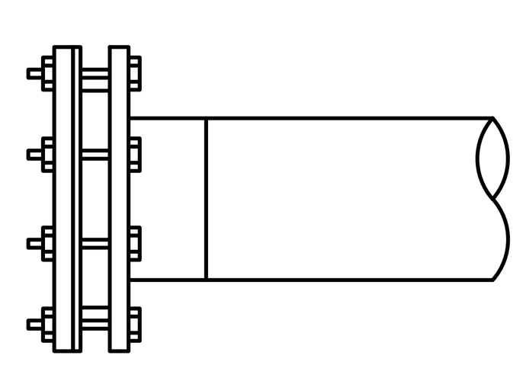
DRAWN BY:	G. ASHWORTH	PROJ NO.:	324442.0005.0000
CHECKED BY:	T.HALENA/B.KAHNK		SHEET 4 OF 42
APPROVED BY:	M. AMSTADT		
DATE:	FEBRUARY 2022		

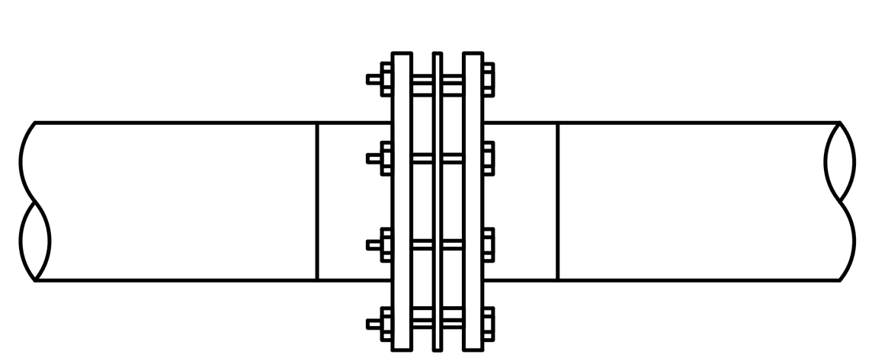
WASTE MANAGEMENT

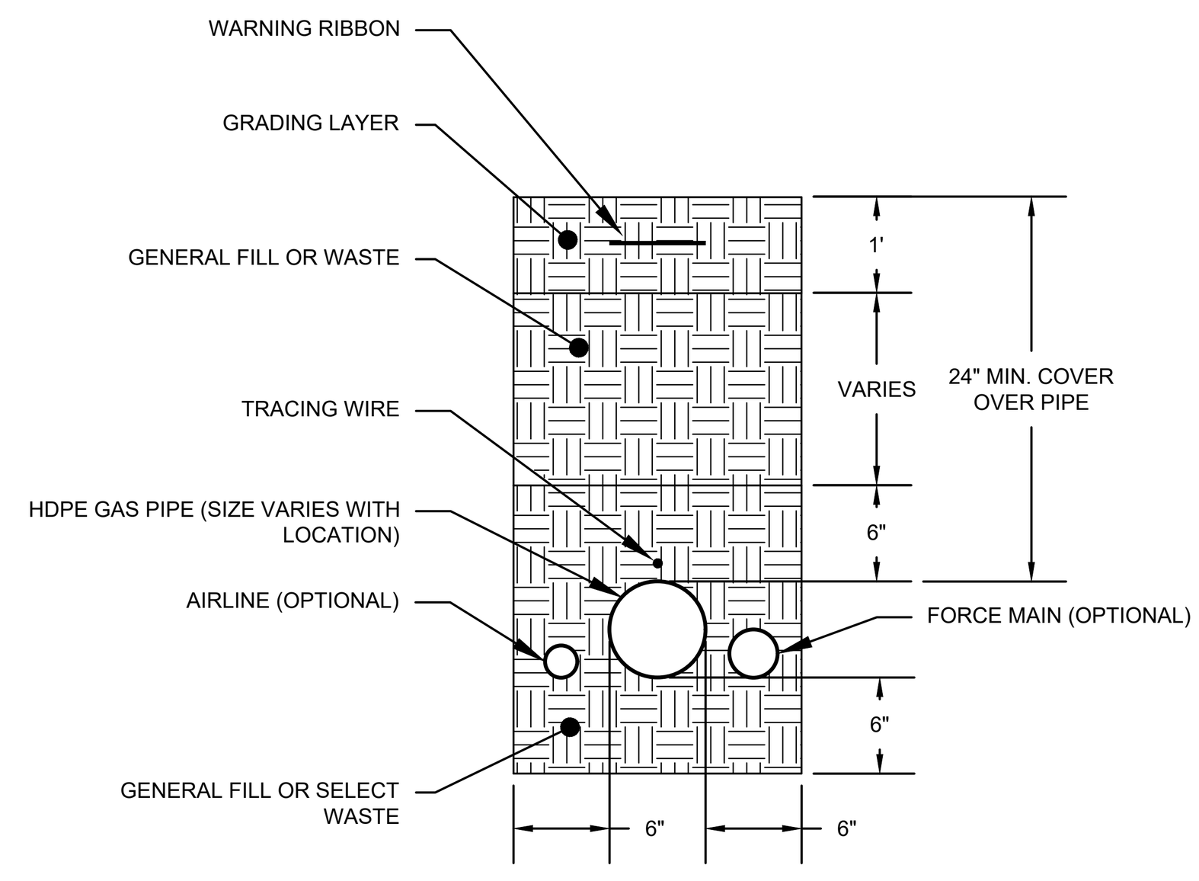
TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 324442.0005 - SUP EC.dwg

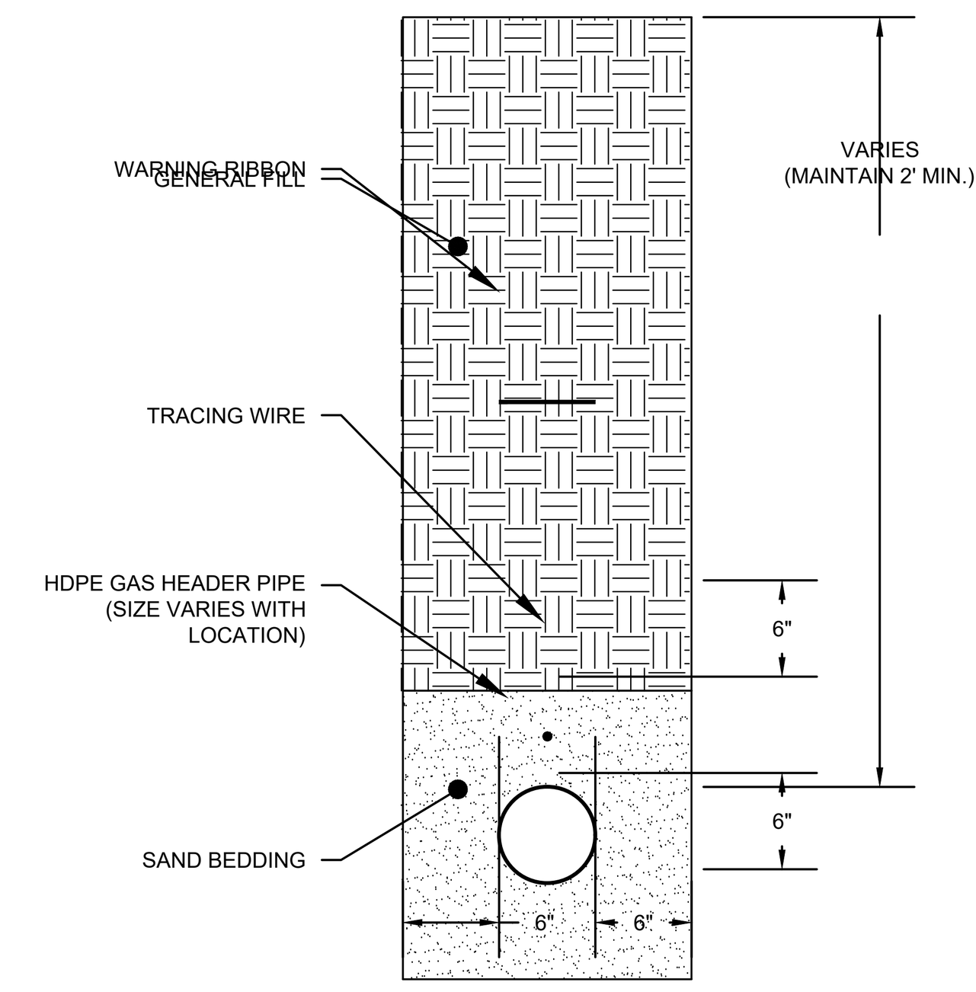




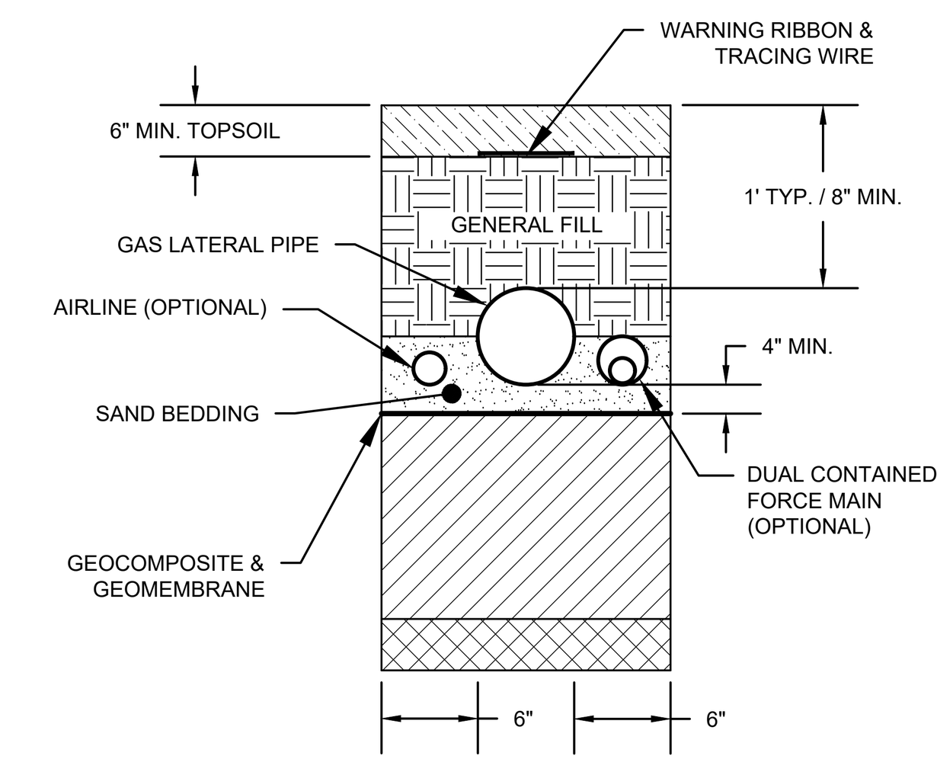




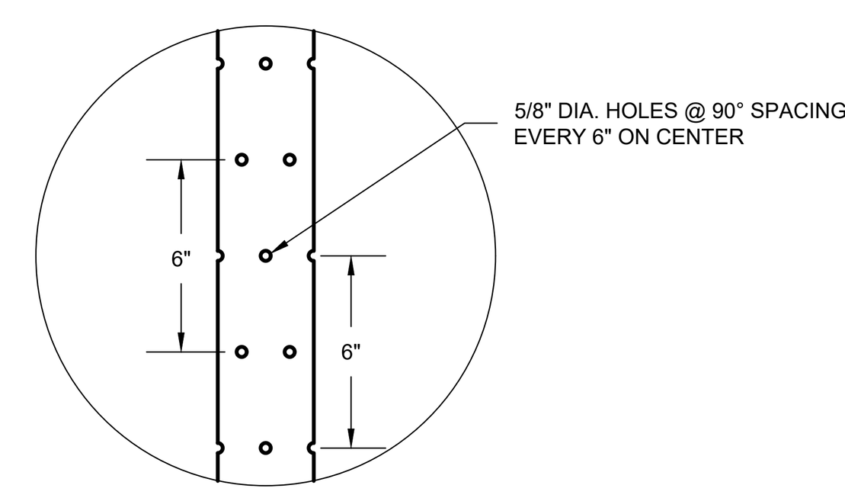
INSIDE LANDFILL WASTE LIMITS

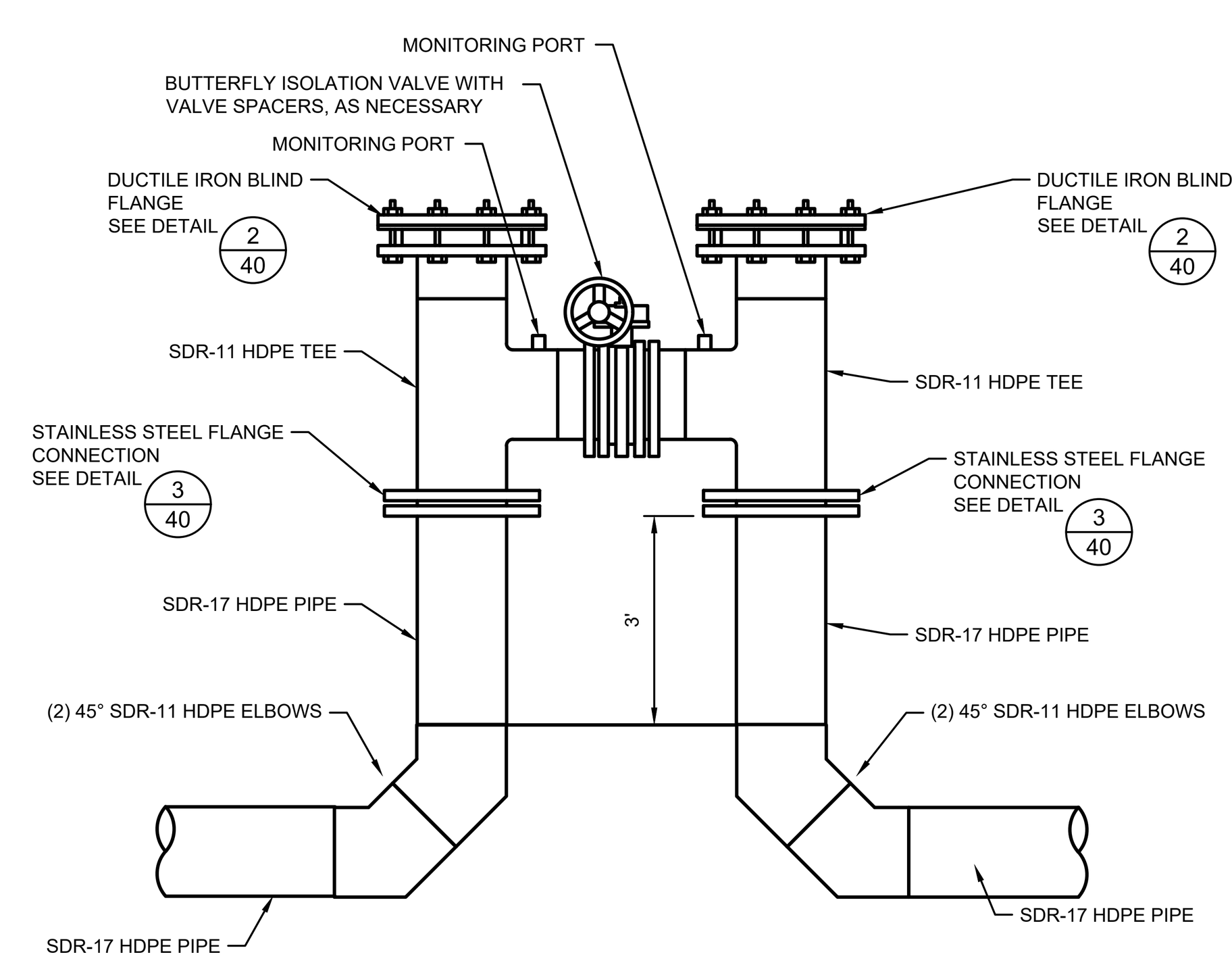


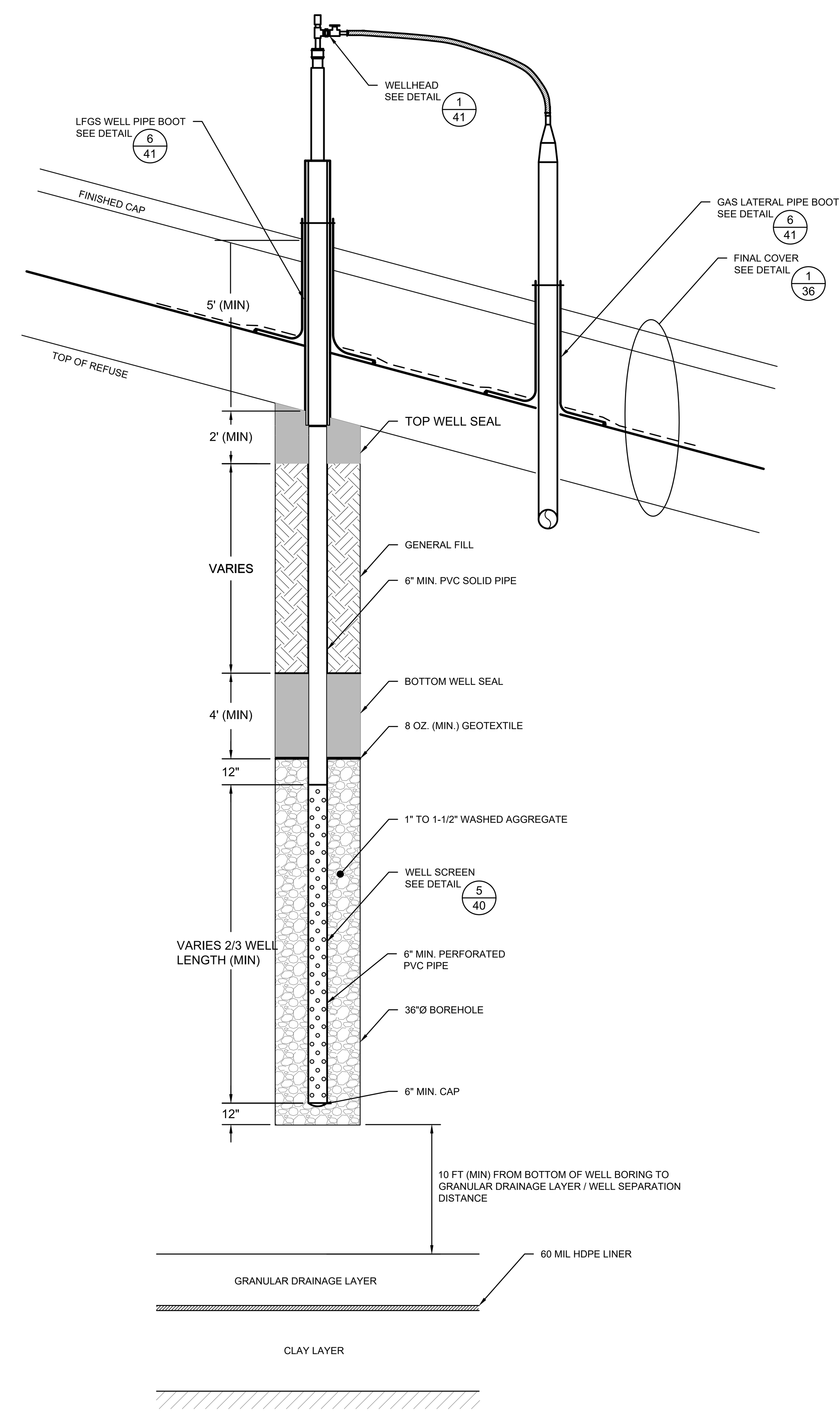
OUTSIDE LANDFILL WASTE LIMITS



INSIDE FINAL COVER







WISCONSIN PROFESSIONAL ENGINEER

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE FEB. …2 DRAWN BY RBN DESIGNED BY RBN CHECKED BY CLD APPROVED BY CLD

PLAN OF OPERATION
DETAILS - GAS SYSTEM

SHEET NO. **40**

PROJECT NO. 4211645

File: X:\PROJECTS\ORCHARD RIDGE\4211645 - OCCS Layout_Plan Sheet\40-MAOR1645-5-07.dwg Layout: 40 User: randy.nolden Feb 04, 2022 - 10:13am

Attachment 6

Long-Term Care Inspection Checklist

Long-Term Care Maintenance Checklist
Orchard Ridge RDF
Eastern Expansion, Southern Unit

Maintenance / Inspection Item	Comments
Final Cover Maintenance	
Settlement Repair	Fill/regrade low spots as required to maintain positive drainage
Erosion Repair	As Required
Vegetation Maintenance	
Mowing	Annually or as required
Revegetation of Bare Areas	Place seed, fertilizer, and mulch as required
Storm Water Runoff Management System Maintenance	
Sediment Accumulation	Remove sediment as required
Control Structures	Inspect annually and repair as required
Erosion Repair	As required
Landfill Gas System Maintenance	
Vegetative Stress / Landfill Gas Odor	Evaluate as part of system performance review
System Performance	Evaluate possible header pipe blockages and need for blower, flare, gas-to-energy system maintenance / replacement
Leachate Collection System Maintenance	
Leachate Collection Line Cleaning	Clean annually
Underdrain and Gradient Control System Maintenance	Inspect components still in use annually and repair as required
Groundwater Monitoring Well Maintenance	Repair any damage as required

Attachment 7

Appendix K.7 - Leachate Sump Capacity Calculations

708 Heartland Trail, Suite 3000 (53717) Madison, WI 608.826.3600

PROJECT/PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
	By:	Date:	By:	Date:	
Waste Management of Wisconsin, Inc. Orchard Ridge RDF Eastern Expansion, Southern Unit Plan of Operation	J. Bell; A. Rowley; B. Kahnk	5/27/2021; 11/9/2021; 4/25/2022	A. Rowley; B. Kahnk; T. Halena	7/19/2021; 11/10/2021; 4/26/2022	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS

Purpose:

The purpose of this calculation is to verify that the proposed leachate collection sumps and corresponding pumps can adequately handle the anticipated leachate flow to the sumps, underdrain volume pumped to the sumps, and anticipated leachate recirculation flows for the proposed Orchard Ridge Recycling and Disposal Facility (Orchard Ridge RDF) Eastern Expansion, Southern Unit (Southern Unit).

Methodology:

An in-house TRC spreadsheet was used to analyze the volume of the proposed leachate collection sumps and corresponding pumps for the proposed modules. The proposed leachate collection sumps are expected to handle the leachate generated from the Southern Unit along with the underdrain liquids pumped from the underdrain sumps.

As detailed in Subsection 2.6.2 of the Southern Unit Plan of Operation (POO), three methods are proposed to manage underdrain liquids. One of these methods consists of underdrain liquids being pumped from the underdrain sump via a sideslope riser and conveyed to the leachate access manhole atop the perimeter berm. The underdrain liquids would then gravity flow through the leachate collection system sideslope riser into the leachate collection sump to be pump with the leachate to the nearby wastewater treatment plant for treatment via the forcemain. The potential underdrain flow rates were calculated in Appendix G.4 of the Southern Unit POO.

As detailed in the Leachate Recirculation Plan (Appendix L of the Plan of Operation), leachate recirculation is limited to 7,450 gallons per acre per day for the Southern Unit. This correlates to an additional 8.35 inches per month. However, it is assumed that only half of this additional rate will be collected in the leachate collection system and the other half is absorbed by the waste mass (Shaw and Carey, 1996). Therefore, the design flow from leachate recirculation is 4.18 inches per month.

Leachate generation calculations were used to determine the approximate worst-case volume of leachate drainage to each sump during active and closed conditions.

The functional volume of the sumps were determined in order to establish the required pumping interval for the sumps. The functional volume at each location was determined by calculating the overall sump volume minus the area occupied by the gravel bedding material and the inaccessible area below the pump inlet. The total pump volume was determined by finding the volume of the sump base and the base of the collection trench entering into the sump as to not cause backup into the leachate collection trenches.

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PROJECT/PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
	By:	Date:	By:	Date:	
Waste Management of Wisconsin, Inc. Orchard Ridge RDF Eastern Expansion, Southern Unit Plan of Operation	J. Bell; A. Rowley; B. Kahnk	5/27/2021; 11/9/2021; 4/25/2022	A. Rowley; B. Kahnk; T. Halena	7/19/2021; 11/10/2021; 4/26/2022	324442.0005

A pump typical to this application was assumed for this analysis (a more in-depth analysis of the pump sizing will be performed prior to construction). The pump run-time to draw down the liquid level in the sump was compared to the required pumping interval to ensure the sump will not overfill. The proposed pump size will be used at all sump locations in the proposed landfill.

Assumptions:

The following assumptions were made in the analysis of the leachate sump capacity:

- The leachate generation rate during active conditions was approximately 6 inches per year (for a composite liner), as determined by s. NR 512.12(3).
- The leachate generation rate during closed conditions was approximately 1 inches per year (for a composite cap), as determined by s. NR 512.12(3).
- Leachate generation rate due to leachate recirculation is 4.18 inches per month during open conditions. No additional flow due leachate recirculation will occur during closed conditions.
- The leachate sump will be filled with select aggregate fill with a porosity of 30 percent.
- Sedimentation build-up will reduce the effective porosity of the select aggregate fill by approximately 5 percent.
- The base of the sump will be at a uniform grade.
- Due to the pump wheels, pump inlet location, etc., approximately 12 inches of inaccessible (dead) space is assumed to be located at the bottom of the sump.
- A Grundfos 62S15-4 Teflon-fitted submersible pump operating at 57.7 gallons per minute (gpm) was used for leachate collection. Pump curves for the selected pump are attached.
- Underdrain flow rates were calculated in Appendix G.4 of the Southern Unit POO.

Results:

The sumps are adequately sized to handle the estimated worse-case leachate volume at the landfill during active and closed conditions at the Southern Unit. A maximum pumping rate of 57.7 gallon per minute is sufficient to dewater the sumps in the worse-case condition; however, it is anticipated that true leachate generation rates will be less than the evaluated scenarios.

It should be noted that in Appendix K.8, it was detailed that the pumps may operate at reduced efficiencies (pumping rates), assuming up to 10 pumps operated at the same time. These reduced pumping rates are sufficient to maintain the volume of liquid to be contained within the sump. Therefore, leachate will not back up onto the liner/leachate collection trench.

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PROJECT/PROPOSAL NAME	PREPARED		CHECKED		PROJECT/PROPOSAL NO.
	By:	Date:	By:	Date:	
Waste Management of Wisconsin, Inc. Orchard Ridge RDF Eastern Expansion, Southern Unit Plan of Operation	J. Bell; A. Rowley; B. Kahnk	5/27/2021; 11/9/2021; 4/25/2022	A. Rowley; B. Kahnk; T. Halena	7/19/2021; 11/10/2021; 4/26/2022	324442.0005

The site may choose to utilize larger pumps as needed to optimize the performance of their leachate collection system and maintain 1-foot or less of leachate head on the liner system. During closed conditions, the site may choose to downsize its pumps. Further analysis for pump selection will be performed prior to construction.

Refer to the attached calculations for pumping intervals and sump volumes.

References:

Shaw, P. and P. Carey. 1996. Leachate recirculation considerations for design and implementation. Emerging Issues in Landfill Design, Construction, and Operations Conference. March 1996.

Calculations

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PROJECT NAME: Waste Management of Wisconsin, Inc. - Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: A. Rowley	DATE: 11/9/2021	PROJECT NO.
CHECKED BY: B. Kahnk	DATE: 11/10/2021	324442.0005

LANDFILL LEACHATE COLLECTION SYSTEM SUMP DATA

Sump	Trench Invert Elevation into Sump[a]	Bottom of Sump Elev.	Total Sump Depth (ft)	Dead Space Height[b] (ft)	Pump Kick Off Elev.	Available Sump Depth[c] (ft)	Total Sump Volume[d]		Max. Volume of Liquid in Sump[de]		Max. Vol. Liquid in Sump Above Dead Space[df]	
							(ft^3)	(gal)	(ft^3)	(gal)	(ft^3)	(gal)
Phase 5 Module 1 W	747.93	744.80	3.13	1.00	745.80	2.13	1804.4	13498.8	451.1	3374.7	378.1	2828.8
Phase 5 Module 2 W	749.75	745.83	3.92	1.00	746.83	2.92	2784.0	20826.9	696.0	5206.7	623.0	4660.9
Phase 6 Module 1 W (N)	746.60	744.28	2.32	1.00	745.28	1.32	1057.1	7907.8	264.3	1976.9	191.3	1431.1
Phase 6 Module 1 W (S)	747.08	744.22	2.86	1.00	745.22	1.86	1525.5	11412.3	381.4	2853.1	308.4	2307.2
Phase 6 Module 2 W	747.55	744.26	3.29	1.00	745.26	2.29	1978.0	14797.6	494.5	3699.4	421.5	3153.5
Phase 7 Module 1 W (N)	745.44	742.90	2.54	1.00	743.90	1.54	1234.4	9234.8	308.6	2308.7	235.6	1762.8
Phase 7 Module 1 W (S)	745.91	742.84	3.07	1.00	743.84	2.07	1745.0	13054.4	436.3	3263.6	363.3	2717.7
Phase 5 Module 1 E	744.08	740.90	3.18	1.00	741.90	2.18	1861.4	13925.0	465.3	3481.2	392.4	2935.4
Phase 5 Module 2 E	747.25	744.20	3.05	1.00	745.20	2.05	1718.3	12854.5	429.6	3213.6	356.6	2667.7
Phase 6 Module 1 E	740.28	737.00	3.28	1.00	738.00	2.28	1975.1	14775.3	493.8	3693.8	420.8	3148.0
Phase 6 Module 2 E	742.01	740.00	2.01	1.00	741.00	1.01	828.1	6194.9	207.0	1548.7	134.1	1002.9
Phase 7 Module 1 E	739.94	736.70	3.24	1.00	737.70	2.24	1925.1	14401.7	481.3	3600.4	408.3	3054.5
Phase 7 Module 2 E	744.81	741.50	3.31	1.00	742.50	2.31	2000.2	14963.2	500.0	3740.8	427.1	3194.9

Notes:

a. Trench invert elevation into the sump is the elevation of water in the leachate collection sump when the pump will kick on, preventing water from backing up into the leachate trench.

b. Dead space height is the height of water above the sump bottom, where the pump will kick off, leaving the pump submerged.

c. Available sump depth is difference in pump on (trench invert) and pump off (dead space) elevations.

d. Sump volumes were calculated from TRC drawing files, maximum liquid volumes are based on 25% effective porosity for drainage stone in the sump.

e. Maximum volume of liquid in sump is the volume of pore space between the trench invert and bottom of sump elevations.

f. Maximum volume of liquid in sump above dead space is pore space volume between dead space elevation and trench invert elevation.

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PROJECT / PROPOSAL NAME: Waste Management of Wisconsin, Inc. - Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: A. Rowley	DATE: 11/9/2021	PROJECT / PROPOSAL NO.
CHECKED BY: B. Kahnk	DATE: 11/10/2021	324442.0005

LEACHATE GENERATION FOR A LANDFILL

Leachate Generation Rate = (Annual Precipitation) x (Phase Area) x (Conversion Factor)

Conversion Factor = ((43560 sf/ac) x (7.48 gal/cf)) / ((12 in/ft) x (365 days/yr)) = 74.39

LANDFILL PHASE STATUS	PHASE/ CELL NUMBER	ANNUAL PRECIPITATION (inches)	PHASE/CELL AREA (acres)	LEACHATE GENERATION RATE (gpd)
Phase 5 - Module 1 - West Sump				
Open Conditions		6.0	5.3	2,400
Closed Condition		1.0	5.3	400
Total			**5.3**	**2,800**
Phase 5 - Module 2- West Sump				
Open Conditions		6.0	3.0	1,300
Closed Condition		1.0	3.0	200
Total			**3.0**	**1,500**
Phase 5 - Module 1 - East				
Open Conditions		6.0	4.9	2,200
Closed Condition		1.0	4.9	400
Total			**4.9**	**2,600**
Phase 5 - Module 2 - East				
Open Conditions		6.0	2.7	1,200
Closed Condition		1.0	2.7	200
Total			**2.7**	**1,400**
Phase 6 - Module 1 - West (North) Sump				
Open Conditions		6.0	3.0	1,300
Closed Condition		1.0	3.0	200
Total			**3.0**	**1,500**
Phase 6 - Module 1 - West (South) Sump				
Open Conditions		6.0	3.0	1,300
Closed Condition		1.0	3.0	200
Total			**3.0**	**1,500**
Phase 6 - Module 2 - West Sump				
Open Conditions		6.0	3.0	1,300
Closed Condition		1.0	3.0	200
Total			**3.0**	**1,500**
Phase 6 - Module 1 - East Sump				
Open Conditions		6.0	7.3	3,200
Closed Condition		1.0	7.3	500
Total			**7.3**	**3,700**

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PROJECT / PROPOSAL NAME: Waste Management of Wisconsin, Inc. - Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: A. Rowley	DATE: 11/9/2021	PROJECT / PROPOSAL NO.
CHECKED BY: B. Kahnk	DATE: 11/10/2021	324442.0005

LEACHATE GENERATION FOR A LANDFILL

Leachate Generation Rate = (Annual Precipitation) x (Phase Area) x (Conversion Factor)

Conversion Factor = ((43560 sf/ac) x (7.48 gal/cf)) / ((12 in/ft) x (365 days/yr)) = 74.39

LANDFILL PHASE STATUS	PHASE/ CELL NUMBER	ANNUAL PRECIPITATION (inches)	PHASE/CELL AREA (acres)	LEACHATE GENERATION RATE (gpd)
Phase 6 - Module 2 - East Sump				
Open Conditions		6.0	3.7	1,600
Closed Condition		1.0	3.7	300
Total			**3.7**	**1,900**
Phase 7 - Module 1 - West (North) Sump				
Open Conditions		6.0	3.0	1,300
Closed Condition		1.0	3.0	200
Total			**3.0**	**1,500**
Phase 7 - Module 1 - West (South) Sump				
Open Conditions		6.0	7.7	3,400
Closed Condition		1.0	7.7	600
Total			**7.7**	**4,000**
Phase 7 - Module 1 - East Sump				
Open Conditions		6.0	6.9	3,100
Closed Condition		1.0	6.9	500
Total			**6.9**	**3,600**
Phase 7 - Module 2 - East Sump				
Open Conditions		6.0	5.2	2,300
Closed Condition		1.0	5.2	400
Total			**5.2**	**2,700**

Note: The leachate generation rate is rounded to the nearest 100 gallons per day (gpd).

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PROJECT NAME: Waste Management of Wisconsin, Inc. - Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Landfill Underdrain System Groundwater Generation		
PREPARED/UPDATED BY: A. Javes	DATE: 6/23/2021; 11/10/2021	PROJECT NO.
CHECKED BY: A. Graham	DATE: 11/16/2021	324442.0005

LANDFILL UNDERDRAIN SYSTEM GROUNDWATER GENERATION

Generation Rate at Sump = (Location Design Generation Flow Rate) x (Sump Drainage Area) / (Total Location Drainage Area)

Location Design Generation Flow Rate (Design Discharge Flow determined in Dewatering a Rectangular Excavation in Appendix G.2):

West Drainage Area	10 gpm	14400 gpd
East Drainage Area	16 gpm	23040 gpd

Total Location Drainage Areas:

Western Modules:	1218099 square feet	28.0 acres
Eastern Modules:	1333092 square feet	30.6 acres

Sump Location	Sump Drainage Area		Portion of East/West Drainage Area	Location Design Generation Rate	Weighted Design Generation Rate at Sump	
	(ft^2)	(acre)		(gpm)	(gpm)	(gpd)
Phase 5 Module 1 West	230072	5.3	0.19	10	1.89	2700
Phase 5 Module 2 West	130332	3.0	0.11	10	1.07	1500
Phase 6 Module 1 West (North)	130508	3.0	0.11	10	1.07	1500
Phase 6 Module 1 West (South)	130293	3.0	0.11	10	1.07	1500
Phase 6 Module 2 West	130271	3.0	0.11	10	1.07	1500
Phase 7 Module 1 West (North)	130930	3.0	0.11	10	1.07	1500
Phase 7 Module 1 West (South)	335693	7.7	0.28	10	2.76	4000
Total West Sumps	1218099	28.0	1.00	10	10.00	14400
Phase 5 Module 1 East	211596	4.9	0.16	16	2.54	3700
Phase 5 Module 2 East	119172	2.7	0.09	16	1.43	2100
Phase 6 Module 1 East	316519	7.3	0.24	16	3.80	5500
Phase 6 Module 2 East	159081	3.7	0.12	16	1.91	2700
Phase 7 Module 1 East	301216	6.9	0.23	16	3.62	5200
Phase 7 Module 2 East	225508	5.2	0.17	16	2.71	3900
Total East Sumps	1333092	30.6	1.00	16	16.00	23000

Note: The weighted design generation rate is rounded to the nearest 100 gallons per day (gpd).

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PROJECT NAME: Waste Management of Wisconsin, Inc. - Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Recirculation Volume		
PREPARED BY: B. Kahnk	DATE: 4/25/2022	PROJECT NO.
CHECKED BY: T. Halena	DATE: 4/26/2022	324442.0005

LEACHATE GENERATION DUE TO LEACHATE RECIRCULATION

Generation Rate at Sump = (Annual Flow Rate) x (Phase Area) * (Conversion Factor)

Conversion Factor = ((43560 sf/ac) x (7.48 gal/cf)) / ((12 in/ft) x (365 days/yr)) = 74.39

Sump Location	Sump Drainage Area		Design Leachate Recirculation Rate			
	(ft^2)	(acre)	(in/month)	(in/year)	(gpm)	(gpd)
Phase 5 Module 1 West	230072	5.3	4.18	50.10	13.68	19,700
Phase 5 Module 2 West	130332	3.0	4.18	50.10	7.78	11,200
Phase 6 Module 1 West (North)	130508	3.0	4.18	50.10	7.78	11,200
Phase 6 Module 1 West (South)	130293	3.0	4.18	50.10	7.71	11,100
Phase 6 Module 2 West	130271	3.0	4.18	50.10	7.71	11,100
Phase 7 Module 1 West (North)	130930	3.0	4.18	50.10	7.78	11,200
Phase 7 Module 1 West (South)	335693	7.7	4.18	50.10	19.93	28,700
Phase 5 Module 1 East	211596	4.9	4.18	50.10	12.57	18,100
Phase 5 Module 2 East	119172	2.7	4.18	50.10	7.08	10,200
Phase 6 Module 1 East	316519	7.3	4.18	50.10	18.82	27,100
Phase 6 Module 2 East	159081	3.7	4.18	50.10	9.44	13,600
Phase 7 Module 1 East	301216	6.9	4.18	50.10	17.92	25,800
Phase 7 Module 2 East	225508	5.2	4.18	50.10	13.40	19,300

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PROJECT / PROPOSAL NAME: Waste Management of Wisconsin, Inc. Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 5 MODULE 1 W

LEACHATE GENERATION:

Open Conditions:	2,400	gallons/day =	1.7 gallons/min
Closed Conditions:	400	gallons/day =	0.3 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	2,700	gallons/day =	1.9 gallons/min
Closed Conditions:	2,700	gallons/day =	1.9 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	19,700	gallons/day =	13.7 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	24,800	gallons/day =	17.2 gallons/min
Closed Conditions:	3,100	gallons/day =	2.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.13	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1804.4 ft^3**	**13,498.8 gallons**
Maximum Volume of Liquid in Sump:	**451.1 ft^3**	**3,374.7 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1512.5 ft^3**	**11,315.3 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**378.1 ft^3**	**2,828.8 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 3 hours

For Closed Conditions:
Full sump would be required to be pumped every: 22 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:			
Pump will be able to pump water down in:	**1.16 hours**	**OK**	**1.16 < 3**
Pump cycle time:	3.9 hours		
For Closed Conditions:			
Pump will be able to pump water down in:	**0.85 hours**	**OK**	**0.85 < 22**
Pump cycle time:	23 hours		

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PROJECT / PROPOSAL NAME: Waste Management of Wisconsin, Inc. Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 5 MODULE 2 W

LEACHATE GENERATION:

Open Conditions:	1,300	gallons/day =	0.9 gallons/min
Closed Conditions:	200	gallons/day =	0.1 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	1,500	gallons/day =	1.0 gallons/min
Closed Conditions:	1,500	gallons/day =	1.0 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	11,200	gallons/day =	7.8 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	14,000	gallons/day =	9.7 gallons/min
Closed Conditions:	1,700	gallons/day =	1.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.92	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**2784.0 ft^3**	**20,826.9 gallons**
Maximum Volume of Liquid in Sump:	**696.0 ft^3**	**5,206.7 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**2492.1 ft^3**	**18,643.4 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**623.0 ft^3**	**4,660.9 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 8 hours

For Closed Conditions:
Full sump would be required to be pumped every: 66 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**1.62 hours**	**OK**	**1.62 < 8**
Pump cycle time:	9.6 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**1.37 hours**	**OK**	**1.37 < 66**
Pump cycle time:	67 hours		

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PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 5 MODULE 1 E

LEACHATE GENERATION:

Open Conditions:	2,200	gallons/day =	1.5 gallons/min
Closed Conditions:	400	gallons/day =	0.3 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	3,700	gallons/day =	2.6 gallons/min
Closed Conditions:	3,700	gallons/day =	2.6 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	18,100	gallons/day =	12.6 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	24,000	gallons/day =	16.7 gallons/min
Closed Conditions:	4,100	gallons/day =	2.8 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.18	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1861.4 ft^3**	**13,925.0 gallons**
Maximum Volume of Liquid in Sump:	**465.3 ft^3**	**3,481.2 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1569.5 ft^3**	**11,741.5 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**392.4 ft^3**	**2,935.4 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 3 hours

For Closed Conditions:
Full sump would be required to be pumped every: 17 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**1.19 hours**	**OK**	**1.19 < 3**
Pump cycle time:	4.1 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.89 hours**	**OK**	**0.89 < 17**
Pump cycle time:	18 hours		

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PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 5 MODULE 2 E

LEACHATE GENERATION:

Open Conditions:	1,200	gallons/day =	0.8 gallons/min
Closed Conditions:	200	gallons/day =	0.1 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	2,100	gallons/day =	1.5 gallons/min
Closed Conditions:	2,100	gallons/day =	1.5 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	10,200	gallons/day =	7.1 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	13,500	gallons/day =	9.4 gallons/min
Closed Conditions:	2,300	gallons/day =	1.6 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.05	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1718.3 ft^3**	**12,854.5 gallons**
Maximum Volume of Liquid in Sump:	**429.6 ft^3**	**3,213.6 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1426.4 ft^3**	**10,671.0 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**356.6 ft^3**	**2,667.7 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 5 hours

For Closed Conditions:
Full sump would be required to be pumped every: 28 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**0.92 hours**	**OK**	**0.92 < 5**
Pump cycle time:	5.7 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.79 hours**	**OK**	**0.79 < 28**
Pump cycle time:	29 hours		

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PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 6 MODULE 1 W(N)

LEACHATE GENERATION:

Open Conditions:	1,300	gallons/day =	0.9 gallons/min
Closed Conditions:	200	gallons/day =	0.1 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	1,500	gallons/day =	1.0 gallons/min
Closed Conditions:	1,500	gallons/day =	1.0 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	11,200	gallons/day =	7.8 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	14,000	gallons/day =	9.7 gallons/min
Closed Conditions:	1,700	gallons/day =	1.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	2.32	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1057.1 ft^3**	**7,907.8 gallons**
Maximum Volume of Liquid in Sump:	**264.3 ft^3**	**1,976.9 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**765.2 ft^3**	**5,724.3 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**191.3 ft^3**	**1,431.1 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 2 hours

For Closed Conditions:
Full sump would be required to be pumped every: 20 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**0.50 hours**	**OK**	**0.50 < 2**
Pump cycle time:	3.0 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.42 hours**	**OK**	**0.42 < 20**
Pump cycle time:	21 hours		

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SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 6 MODULE 1 W(S)

LEACHATE GENERATION:

Open Conditions:	1,300	gallons/day =	0.9 gallons/min
Closed Conditions:	200	gallons/day =	0.1 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	1,500	gallons/day =	1.0 gallons/min
Closed Conditions:	1,500	gallons/day =	1.0 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	11,100	gallons/day =	7.7 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	13,900	gallons/day =	9.7 gallons/min
Closed Conditions:	1,700	gallons/day =	1.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	2.86	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1525.5 ft^3**	**11,412.3 gallons**
Maximum Volume of Liquid in Sump:	**381.4 ft^3**	**2,853.1 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1233.6 ft^3**	**9,228.8 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**308.4 ft^3**	**2,307.2 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 4 hours

For Closed Conditions:
Full sump would be required to be pumped every: 33 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**0.80 hours**	**OK**	**0.80 < 4**
Pump cycle time:	4.8 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.68 hours**	**OK**	**0.68 < 33**
Pump cycle time:	33 hours		

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SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 6 MODULE 2 W

LEACHATE GENERATION:

Open Conditions:	1,300	gallons/day =	0.9 gallons/min
Closed Conditions:	200	gallons/day =	0.1 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	1,500	gallons/day =	1.0 gallons/min
Closed Conditions:	1,500	gallons/day =	1.0 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	11,100	gallons/day =	7.7 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	13,900	gallons/day =	9.7 gallons/min
Closed Conditions:	1,700	gallons/day =	1.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.29	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1978.0 ft^3**	**14,797.6 gallons**
Maximum Volume of Liquid in Sump:	**494.5 ft^3**	**3,699.4 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1686.2 ft^3**	**12,614.1 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**421.5 ft^3**	**3,153.5 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 5 hours

For Closed Conditions:
Full sump would be required to be pumped every: 45 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**1.09 hours**	**OK**	**1.09 < 5**
Pump cycle time:	6.5 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.93 hours**	**OK**	**0.93 < 45**
Pump cycle time:	45 hours		

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PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 6 MODULE 1 E

LEACHATE GENERATION:

Open Conditions:	3,200	gallons/day =	2.2 gallons/min
Closed Conditions:	500	gallons/day =	0.3 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	5,500	gallons/day =	3.8 gallons/min
Closed Conditions:	5,500	gallons/day =	3.8 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	27,100	gallons/day =	18.8 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	35,800	gallons/day =	24.9 gallons/min
Closed Conditions:	6,000	gallons/day =	4.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.28	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1975.1 ft^3**	**14,775.3 gallons**
Maximum Volume of Liquid in Sump:	**493.8 ft^3**	**3,693.8 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1683.2 ft^3**	**12,591.9 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**420.8 ft^3**	**3,148.0 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 2 hours

For Closed Conditions:
Full sump would be required to be pumped every: 13 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4
Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**1.60 hours**	**OK**	**1.60 < 2**
Pump cycle time:	3.7 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.98 hours**	**OK**	**0.98 < 13**
Pump cycle time:	14 hours		

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PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 6 MODULE 2 E

LEACHATE GENERATION:

Open Conditions:	1,600	gallons/day =	1.1 gallons/min
Closed Conditions:	300	gallons/day =	0.2 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	2,700	gallons/day =	1.9 gallons/min
Closed Conditions:	2,700	gallons/day =	1.9 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	13,600	gallons/day =	9.4 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	17,900	gallons/day =	12.4 gallons/min
Closed Conditions:	3,000	gallons/day =	2.1 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	2.01	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**828.1 ft^3**	**6,194.9 gallons**
Maximum Volume of Liquid in Sump:	**207.0 ft^3**	**1,548.7 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**536.2 ft^3**	**4,011.5 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**134.1 ft^3**	**1,002.9 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 1 hours

For Closed Conditions:
Full sump would be required to be pumped every: 8 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**0.37 hours**	**OK**	**0.37 < 1**
Pump cycle time:	1.7 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.30 hours**	**OK**	**0.30 < 8**
Pump cycle time:	8 hours		

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PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 7 MODULE 1 W(N)

LEACHATE GENERATION:

Open Conditions:	1,300	gallons/day =	0.9 gallons/min
Closed Conditions:	200	gallons/day =	0.1 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	1,500	gallons/day =	1.0 gallons/min
Closed Conditions:	1,500	gallons/day =	1.0 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	11,200	gallons/day =	7.8 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	14,000	gallons/day =	9.7 gallons/min
Closed Conditions:	1,700	gallons/day =	1.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	2.54	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1234.4 ft^3**	**9,234.8 gallons**
Maximum Volume of Liquid in Sump:	**308.6 ft^3**	**2,308.7 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**942.6 ft^3**	**7,051.4 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**235.6 ft^3**	**1,762.8 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 3 hours

For Closed Conditions:
Full sump would be required to be pumped every: 25 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**0.61 hours**	**OK**	**0.61 < 3**
Pump cycle time:	3.6 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.52 hours**	**OK**	**0.52 < 25**
Pump cycle time:	25 hours		

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PROJECT / PROPOSAL NAME: Waste Management of Wisconsin, Inc. Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk; T. Halena	DATE: 7/19/21; 11/10/21; 4/26/22	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 7 MODULE 1 W(S)

LEACHATE GENERATION:

Open Conditions:	3,400	gallons/day =	2.4 gallons/min
Closed Conditions:	600	gallons/day =	0.4 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	4,000	gallons/day =	2.8 gallons/min
Closed Conditions:	4,000	gallons/day =	2.8 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	28,700	gallons/day =	19.9 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	36,100	gallons/day =	25.1 gallons/min
Closed Conditions:	4,600	gallons/day =	3.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.07	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1745.0 ft^3**	**13,054.4 gallons**
Maximum Volume of Liquid in Sump:	**436.3 ft^3**	**3,263.6 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1453.1 ft^3**	**10,870.9 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**363.3 ft^3**	**2,717.7 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 2 hours

For Closed Conditions:
Full sump would be required to be pumped every: 14 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**1.39 hours**	**OK**	**1.39 < 2**
Pump cycle time:	3.2 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.83 hours**	**OK**	**0.83 < 14**
Pump cycle time:	15 hours		

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PROJECT / PROPOSAL NAME: Waste Management of Wisconsin, Inc. Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk	DATE: 7/19/2021; 11/10/2021	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 7 MODULE 1 E

LEACHATE GENERATION:

Open Conditions:	3,100	gallons/day =	2.2 gallons/min
Closed Conditions:	500	gallons/day =	0.3 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	5,200	gallons/day =	3.6 gallons/min
Closed Conditions:	5,200	gallons/day =	3.6 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	25,800	gallons/day =	17.9 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	34,100	gallons/day =	23.7 gallons/min
Closed Conditions:	5,700	gallons/day =	4.0 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.24	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1925.1 ft^3**	**14,401.7 gallons**
Maximum Volume of Liquid in Sump:	**481.3 ft^3**	**3,600.4 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1633.2 ft^3**	**12,218.2 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**408.3 ft^3**	**3,054.5 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 2 hours

For Closed Conditions:
Full sump would be required to be pumped every: 13 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**1.50 hours**	**OK**	**1.50 < 2**
Pump cycle time:	3.6 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.95 hours**	**OK**	**0.95 < 13**
Pump cycle time:	14 hours		

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PROJECT / PROPOSAL NAME: Waste Management of Wisconsin, Inc. Orchard Ridge RDF Eastern Expansion, Southern Unit		
SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk	DATE: 7/19/2021; 11/10/2021	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 7 MODULE 2 E

LEACHATE GENERATION:

Open Conditions:	2,300	gallons/day =	1.6 gallons/min
Closed Conditions:	400	gallons/day =	0.3 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	3,900	gallons/day =	2.7 gallons/min
Closed Conditions:	3,900	gallons/day =	2.7 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	19,300	gallons/day =	13.4 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	25,500	gallons/day =	17.7 gallons/min
Closed Conditions:	4,300	gallons/day =	3.0 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.31	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**2000.2 ft^3**	**14,963.2 gallons**
Maximum Volume of Liquid in Sump:	**500.0 ft^3**	**3,740.8 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1708.3 ft^3**	**12,779.7 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**427.1 ft^3**	**3,194.9 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 3 hours

For Closed Conditions:
Full sump would be required to be pumped every: 18 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 57.7 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**1.33 hours**	**OK**	**1.33 < 3**
Pump cycle time:	4.3 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**0.97 hours**	**OK**	**0.97 < 18**
Pump cycle time:	19 hours		

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SUBJECT: Leachate Collection Sump/Pump Sizing Calculation		
PREPARED BY: J. Bell; A. Rowley; B. Kahnk	DATE: 7/22/21; 11/9/21; 4/25/22	PROJECT / PROPOSAL NO.
CHECKED BY: A. Rowley; B. Kahnk	DATE: 7/19/2021; 11/10/2021	324442.0005

LEACHATE SUMP CAPACITY CALCULATIONS
PHASE 7 MODULE 1 W(S)

LEACHATE GENERATION:

Open Conditions:	3,400	gallons/day =	2.4 gallons/min
Closed Conditions:	600	gallons/day =	0.4 gallons/min

GROUNDWATER GENERATION:

Open Conditions:	4,000	gallons/day =	2.8 gallons/min
Closed Conditions:	4,000	gallons/day =	2.8 gallons/min

LEACHATE RECIRCULATION:

Open Conditions:	28,700	gallons/day =	19.9 gallons/min
Closed Conditions:	0	gallons/day =	0.0 gallons/min

TOTAL GENERATION VOLUME TO SUMP:

Open Conditions:	36,100	gallons/day =	25.1 gallons/min
Closed Conditions:	4,600	gallons/day =	3.2 gallons/min

SUMP CALCULATIONS:

Total Depth of Sump:	3.07	feet
Porosity of Stone in Sump:	30	percent
Porosity Loss due to Sedimentation:	5	percent
Effective Porosity:	25	percent

SUMP VOLUME OUTPUT FROM AUTOCAD VOLUME SURFACE:

Volume of Sump:	**1745.0 ft^3**	**13,054.4 gallons**
Maximum Volume of Liquid in Sump:	**436.3 ft^3**	**3,263.6 gallons**

Depth in Sump that the Pump(s) Can Actually Pump (i.e., Dead Space Calculations)

Bottom of Sump vs. Top of Deadspace AutoCAD Output Volume:	**10.81 yd^3**	**291.87 ft^3**
Volume of Sump Above Dead Space:	**1453.1 ft^3**	**10,870.9 gallons**
Maximum Volume of Liquid in Sump Above Dead Space:	**363.3 ft^3**	**2,717.7 gallons**

PUMP CALCULATIONS:

Sump Dewatering Times

For Active Conditions:
Full sump would be required to be pumped every: 2 hours

For Closed Conditions:
Full sump would be required to be pumped every: 14 hours

Note: Calculations completed for closed conditions to allow the site to down-size pumps upon closure.

Proposed Pump Run-Times

Model: Grundfos 62S15-4

Pump Rate: 31 gallons/minute

For Active Conditions:

Pump will be able to pump water down in:	**1.46 hours**	**OK**	**1.46 < 2**
Pump cycle time:	3.3 hours		

For Closed Conditions:

Pump will be able to pump water down in:	**1.63 hours**	**OK**	**1.63 < 14**
Pump cycle time:	16 hours		

Pump and Motor Specifications

GRUNDFOS

Company name:
Created by:
Phone:

Date: 7/2/2021

Count	Description
1	**62S15-4**

Product No.: 98924075
Multi-stage submersible pump for raw water supply, groundwater lowering and pressure boosting. The pump is suitable for pumping clean, thin, non-agressive liquids without solid particles or fibers.

horizontal and vertical installation.
The pump is fitted with a built-in non-return valve.

type with a sand shield, liquid-lubricated bearings and pressure-equalizing diaphragm.

Liquid:

Pumped liquid:	Water
Maximum liquid temperature:	140 °F
Selected liquid temperature:	68 °F
Density:	62.29 lb/ft³

Technical:

Pump speed on which pump data is based:	3450 rpm
Rated flow:	57.7 US gpm
Rated head:	83.67 ft
Actual impeller diameter:	2.78 in
Curve tolerance:	ISO9906:2012 3B

Materials:

Pump:	Stainless steel EN 1.4301 AISI 304
Impeller:	Stainless steel EN 1.4301 AISI 304

Installation:

Pump outlet:	2"NPT
Motor diameter:	4 inch

Electrical data:

Rated power - P2:	1.5 HP

Others:

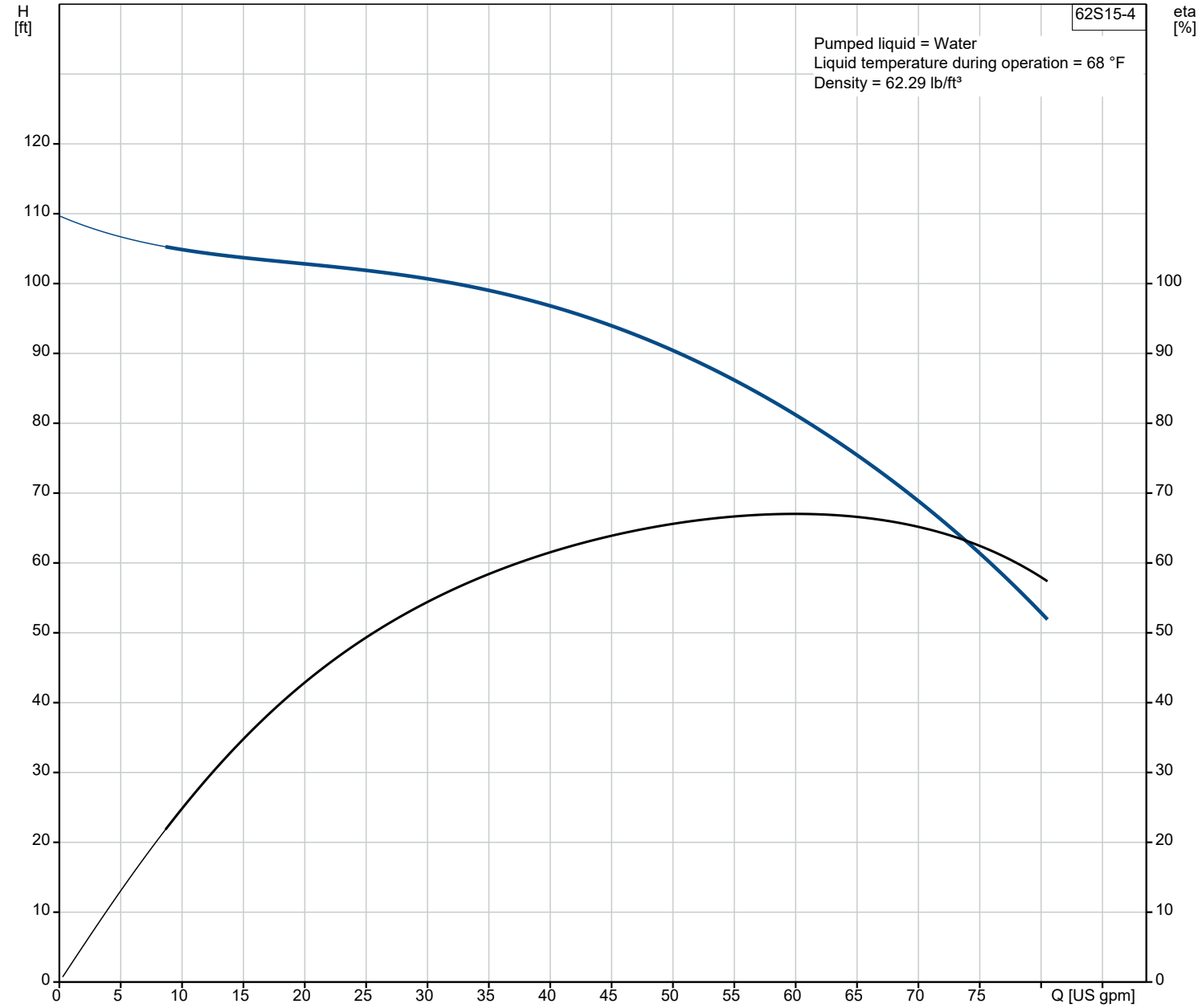
DOE Pump Energy Index CL:	0.88
ErP status:	EuP Standalone/Prod.
Net weight:	14.6 lb
Gross weight:	17.6 lb
Shipping volume:	0.39 ft³
Country of origin:	US
Custom tariff no.:	8413.70.2004

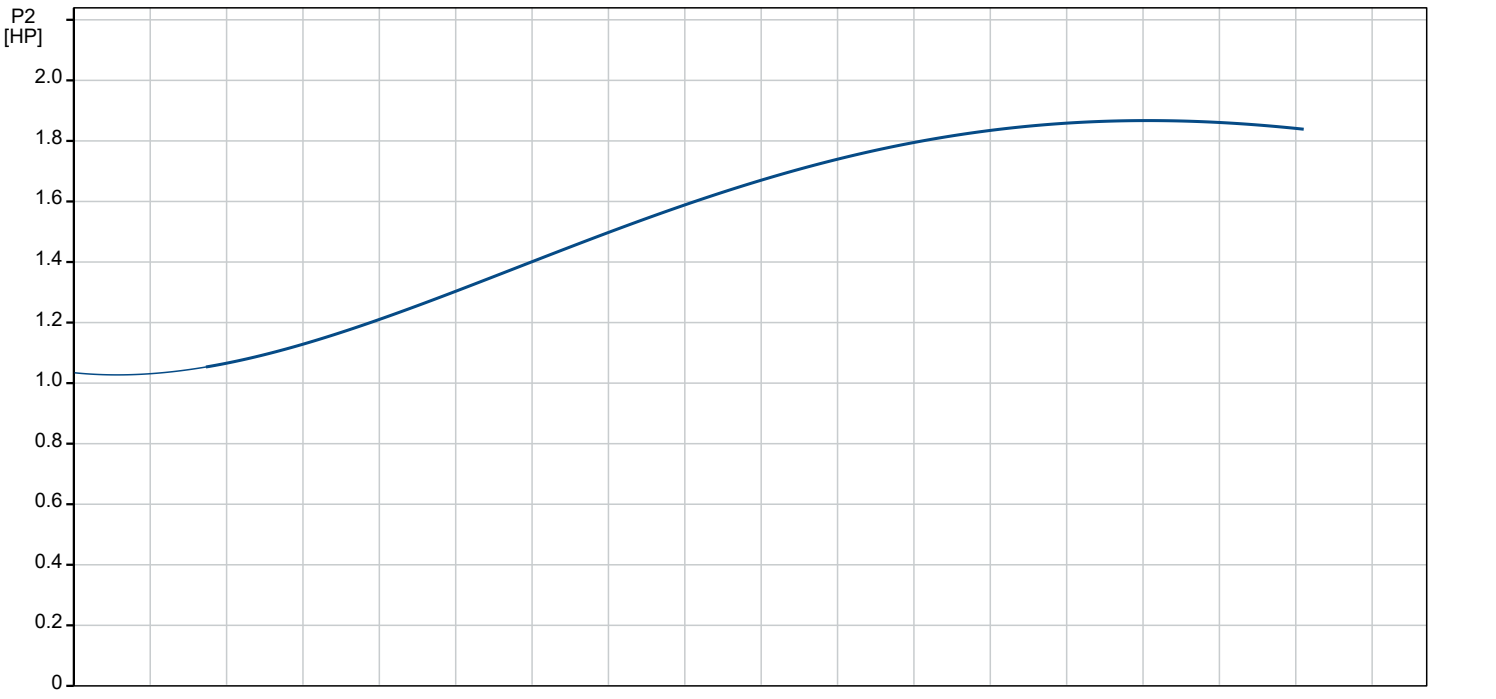
GRUNDFOS

Company name:
Created by:
Phone:

Date: 7/2/2021

98924075 62S15-4 60 Hz

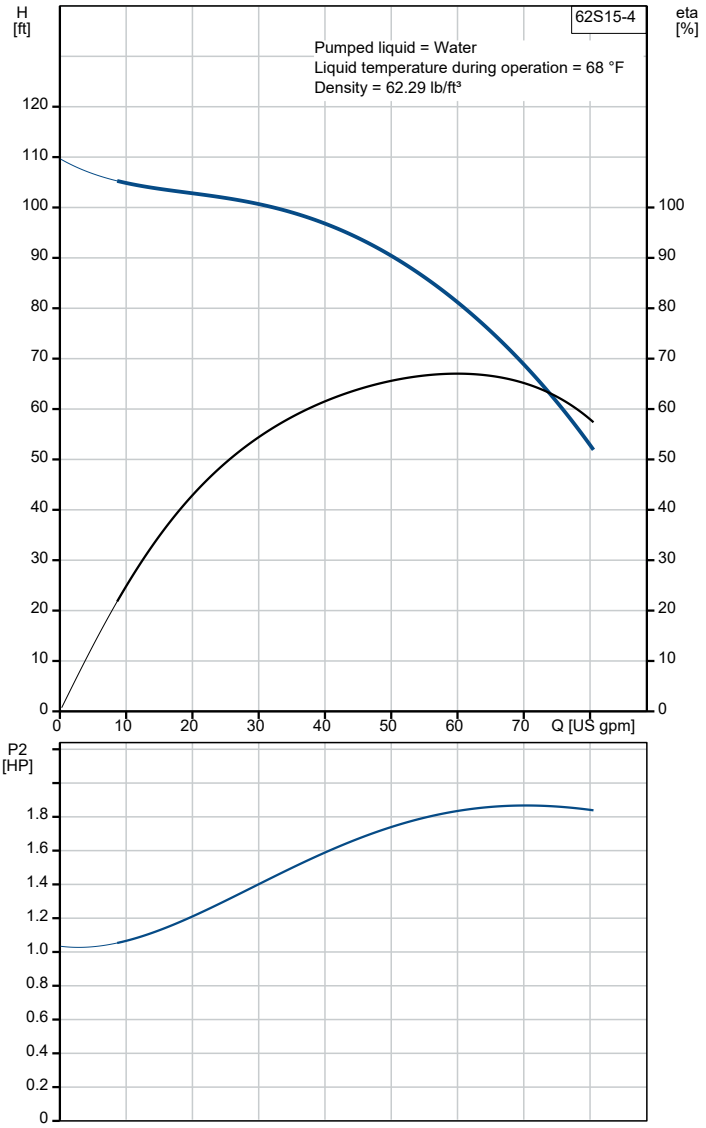


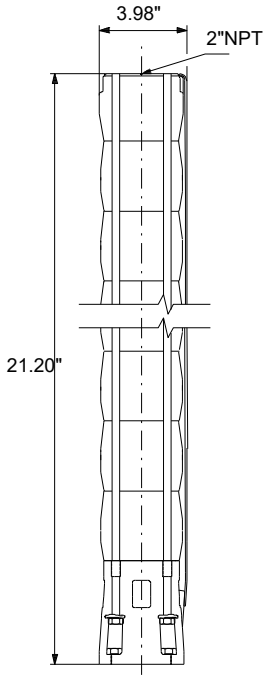


Company name:
Created by:
Phone:

Date: 7/2/2021

Description	Value
General information:	
Product name:	62S15-4
Product No.:	98924075
EAN:	5712603656632
Technical:	
Pump speed on which pump data is based:	3450 rpm
Rated flow:	57.7 US gpm
Rated head:	83.67 ft
Actual impeller diameter:	2.78 in
Stages:	4
Impeller reduc.:	NONE
Curve tolerance:	ISO9906:2012 3B
Model:	A
Valve:	YES
Materials:	
Pump:	Stainless steel
Pump:	EN 1.4301
Pump:	AISI 304
Impeller:	Stainless steel
Impeller:	EN 1.4301
Impeller:	AISI 304
Installation:	
Pump outlet:	2"NPT
Motor diameter:	4 inch
Liquid:	
Pumped liquid:	Water
Maximum liquid temperature:	140 °F
Selected liquid temperature:	68 °F
Density:	62.29 lb/ft³
Electrical data:	
Applic. motor:	NEMA
Rated power - P2:	1.5 HP
Others:	
DOE Pump Energy Index CL:	0.88
ErP status:	EuP Standalone/Prod.
Net weight:	14.6 lb
Gross weight:	17.6 lb
Shipping volume:	0.39 ft³
Country of origin:	US
Custom tariff no.:	8413.70.2004



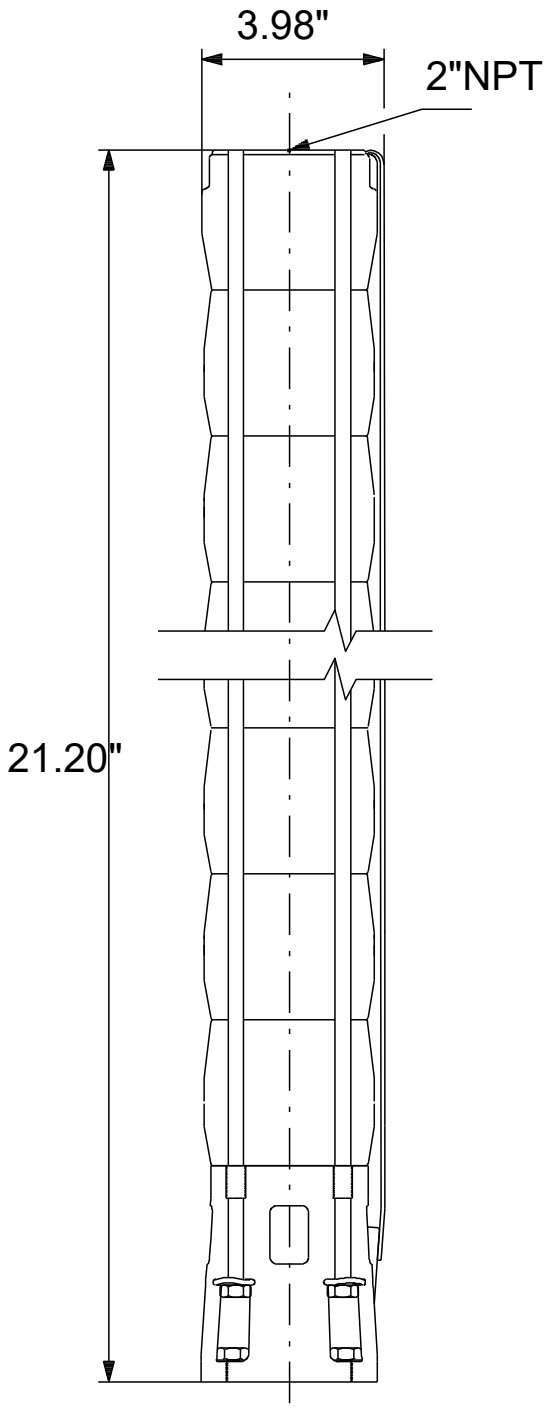


GRUNDFOS

Company name:
Created by:
Phone:

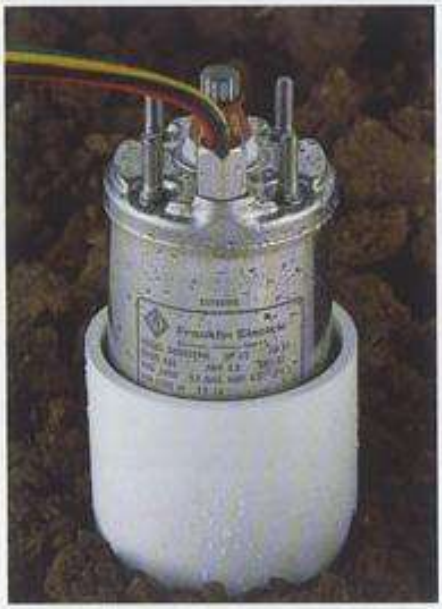
Date: 7/2/2021

98924075 62S15-4 60 Hz



Note! All units are in [in] unless otherwise stated.
Disclaimer: This simplified dimensional drawing does not show all details.

Product Data



4" Pollution Recovery Submersible Motors

2-wire: 1/3 through 1 1/2 Hp
3-wire: 1/3 through 2 Hp
Single-phase - 115, 230 volt / 60 Hz; 220 volt / 50 Hz
Three-phase - 200, 230, 380, 460, 575 volt / 60 Hz;
220, 380 volt / 50 Hz

APPLICATION DATA

These motors are built for dependable operation in 4" diameter or larger environmental water wells. Continuous rating in 86°F (30°C) water. Rotation: CCW facing shaft end. These motors have the same electrical characteristics as the standard 2-wire, 3-wire and 3-phase Super Stainless motors.

For further information, refer to Franklin Electric's "Submersible Motors: Application, Installation, Maintenance Manual."

BASIC FEATURES

- Corrosion-Resistant All Stainless Steel Exterior Construction
- Stainless Steel Splined Shaft
- Hermetically-Sealed Windings
- Anti-Track Self-Healing Resin System
- Water Lubrication
- Filter Check Valve
- Kingsbury-type Thrust Bearing
- Pressure Equalizing Diaphragm
- Built-In Lightning Arrestors (all single-phase; 200 and 230 volt 3-phase)
- Removable "Water-Bloc" Lead Connector (Sold Separately)
- UL 778 Recognized
- CSA C22.2 #108 Certified
- NEMA Mounting Dimensions

SPECIAL FEATURES

- Pollution Recovery motors are equipped for use in monitoring and recovery wells in which hydrocarbons and other chemicals may be present.
- Special Viton rubber parts and other construction materials defined on the reverse side.
- Special Pollution Recovery lead assemblies are sold separately. See reverse side.
- No flow inducer sleeve required in water up to 86°F (30°C).
- Two-wire motors are split-phase designs with integral starting components and do not require a control box. They feature FRANKLIN'S patented 2-wire BIAC starting switch which provides automatic torque reversal to aid starting in adverse environments and prevents extreme fast cycling (e.g. due to water logged tank).
- Three-wire motors use FRANKLIN'S exclusive 3-wire QD (Quick-Disconnect) Control Box with the patented QD Relay. This relay provides the ultimate in operational life.
- #316 stainless steel: special construction options for acid, low pH and seawater applications.

WARNINGS: Serious or fatal shock may result from failure to connect all metal plumbing, and the motor, if outside a drilled well, to the power supply grounding terminal with no wire smaller than motor cable wires. Do not use motor in swimming areas.

Franklin Electric