Appendix D

Field Investigations, Methods, and Procedures

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This appendix discusses field investigations conducted by Engineering & Environmental Solutions *(E&E Solutions)* at the Ottawa County Farms Landfill, Ottawa County, Michigan. Field investigations included exploratory drilling, soil sampling, and well installation and development.

Exploratory Drilling and Soil Sampling

During October and November 2015, *E&E Solutions* personnel supervised the drilling of twenty one soil borings by Stearns Drilling Company of Dutton, Michigan. During December 2015, *E&E Solutions* personnel supervised the drilling of an additional three soil borings by Superior Environmental Corp, Michigan. Monitoring wells DB-24 through DB-28 were installed in five of the exploratory borings and gas probes MM-17 through MM-21 (Figure 14) were installed in five of the exploratory borings. A total of 10 clay confirmation borings and four sand verification borings were drilled within the footprint of the proposed eastern expansion. The location of the monitoring wells and soil borings are shown on Figure 3.

All of the borings were drilled using 4.25-inch inner diameter hollow-stem augers and hydraulically driven truck-mounted drilling rigs. A split-barrel soil sampling device was used to obtain soil samples at each boring using sampling techniques in accordance with ASTM procedure D 1586. Shelby tubes were pushed hydraulically with the drill rig. In borings were bedrock was encountered, drilling was continued using 5-foot long, diamond-tipped rock coring bit which was extended to bedrock inside the hollow-stem augers. All borings not converted to groundwater monitoring wells or gas monitoring probes were grouted to the surface using bentonite slurry. For a complete description of the earth materials encountered during drilling, refer to the soil boring logs provided in Appendix B and the physical soil test results provided in Appendix E.

Monitoring Wells, Clay Confirmation Borings, and Gas Probes

The following is a generalized description of the monitoring well construction, clay confirmation borings, sand verification borings, and gas probes installation procedures. Specific construction details are provided in Appendix B.

Monitoring Wells

Exploratory borings DB-24, DB-25, and DB-26 were advanced to depths of 170 to 184 feet below ground surface (BGS) and exploratory boring DB-27 was advanced to a depth of 88 feet BGS. Well DB-27 is part of the shallow/deep well pair (DB-27/DB-28). See Figure 3 for well locations. All borings were advanced using hollow-stem auger drilling methods. At borings DB-24, DB-25, and DB-26, split spoon samples were collected from the ground surface to approximately 100 feet BGS at 5 foot intervals and continuous split spoon samples were collected from 100 feet BGS to the top of bedrock (approximately 180 feet BGS). All samples were logged consistent with the unified soil classification system. The target depth of these borings was the top of bedrock. The exploratory borings were used to characterize the subsurface distribution of the sedimentary units that contain the upper aquifer beneath the eastern expansion. Monitoring wells were constructed in each of these borings at depths of approximately 143 to 170 feet BGS (Table 2). Each monitoring well was constructed with a 2-inch diameter, flush-thread, Schedule 40, polyvinyl chloride (PVC) casing, and a 5-foot long 0.010-inch machine slotted screen.

Bedrock monitoring well DB-28 was installed at a depth of 215 feet BGS using hollow-stem auger drilling and bedrock coring/reaming methods. Split spoon samples were collected from the ground surface to 100 feet BGS at 5 foot intervals, continuous split spoon samples were collected from 100 feet BGS to top of bedrock (165 feet BGS), and bedrock core samples were collected from 165 to 215 feet BGS. All soil samples were logged consistent with the unified soil classification system. The monitoring well was construct with 2-inch diameter, flush-thread, Schedule 40, PVC casing, and a 5-foot long 0.010-inch machine slotted screen. The screen interval at monitoring well DB-28 is 209 to 214 feet BGS (Table 2).

All well casings were extended a minimum of 2-feet above grade. A filter sand was placed around and a minimum of 4 feet above the well screens and the wells were developed to tighten the sand pack around the screen and remove fines. The remainder of the annulus was back filled with bentonite grout to the ground surface. Each monitoring well was constructed with the following features to be in compliance with Part 115 rules:

- the top-of-casing was permanently marked to indicate where to measure water levels;
- the caps or well are vented;
- a protective casing and concrete pad was placed around each monitoring well;
- steel bumper posts were installed to protect the well monuments;
- each protective casings was labeled with a permanent placard to identify the well; and
- each protective casing is locked with locks that are keyed alike.

A well located near the southwest corner of Phase 7 was abandoned as part of this investigation. The well is believed to have been installed during the 1994 Hydrogeological field investigation. The well was not part of the site's groundwater monitoring program. The well was over-drilled, removed, and backfilled with bentonite grout to the ground surface.

Clay Confirmation Borings

A total of ten clay confirmation borings (SB-31 through SB-40) were drilled within the footprint of the expansion area to confirm the presence of clay beneath the liner subgrade (Natural Soil Barrier). Five of the borings (SB-38 and SB-41 through SB-44) were also used to verify the depth of the upper sand unit. See Figure 3 for the boring locations. At borings SB-31 through SB-40, continuous split spoon samples were collected from the ground surface to the bottom of the borings. Standard geotechnical investigations using split spoon sampling methods (ASTM D1586, Standard Penetration Test) were used. At the sand verification borings, continuous split spoon samples were collected from approximately 30 feet BGS to the bottom of the borings. All borings in the landfill footprint were backfilled to the ground surface with bentonite.

Information collected from the clay confirmation borings was used to characterize and verify a minimum 10-foot-thick natural soil barrier beneath the bottom of the proposed landfill liner/sump. At each clay confirmation boring, continuous split spoon samples were collected through the natural soil barrier. In addition, fourteen Shelby tubes samples were collected from the clay unit. Samples collected from the clay unit were tested for particle size distribution by sieve and hydrometer, Atterberg limits (ASTM 4318), soil classification (ASTM 2847), and hydraulic conductivity using the methods approved in Rule 299.4920. See Table 1 for a summary of soil testing results.

Results of this investigation along with a demonstration of homogeneity will be used to propose an alternate frequency for future borings to verify a natural soil barrier consistent with OWMRP-115-26. Future subsurface investigations with additional clay confirmation borings will be conducted, as needed, for new cell certification. Based on the lateral consistency and uniform characteristics of the upper clay unit, as documented, one clay confirmation boring is recommended for every 2 acres of natural soil barrier for the eastern expansion.

Gas Probes

A total of five dedicated gas monitoring probes (MM-17 through MM-21) were installed around the perimeter of the site. The locations of the gas probes are shown on Figure 14. The locations are based on potential receptors surrounding the site as well as on-site structures. Gas probe MM-17 was installed along the northwestern perimeter of the site between the site office/garage and the recycling facility northwest of the site. This probe is between the landfill and the farming structures west of the site. Gas probe MM-18 was installed along the southwestern perimeter of the site between the landfill gas generation plant and the RRC office. Gas probes MM-19 and MM-20 were installed along the north-central and south-central perimeters of the site and gas probe MM-21 was installed along the eastern perimeter of the site. The gas probes extend to the depth of the landfill and are designed to detect the migration of potential subsurface landfill gas. Depths and construction details of the gas probes are provided on the boring logs (Appendix B) and are discussed below.

The gas probe borings were advanced to a total depth of 31 to 56 feet BGS to match the total depth of the adjacent landfill. Split spoon samples were collected at 5-foot intervals from the ground surface to the bottom of the borings. The subsurface materials encountered were predominately low-permeability clay. The gas probes were constructed with 2-inch diameter PVC casing and 21 to 46 feet of 0.010-inch slotted PVC screen. The screens were placed from approximately 6 feet BGS to 5 feet from the bottom of each boring. A 5-foot-deep sump was included at the bottom of each boring to collect potential water seepage from the clay.

All probe casings were extended a minimum of 2-feet above grade. A pea stone filler (#3 Global gravel pack) was placed around and 1 foot above the probe screens. The remainder of the annulus was back filled with bentonite chips to the ground surface (5-foot-thick bentonite surface seal). A protective casing and concrete pad was placed around each gas probe with steel bumper posts to protect the monuments. Each protective casings is labeled with a permanent placard to identify the probe and each protective casing is locked with locks that are keyed alike.

Laboratory Testing (Groundwater)

A minimum of eight background samples will be collected from six monitoring wells (DB-23 through DB-28) installed around the proposed eastern expansion. Background samples will be collected during individual sampling events beginning in December 2015 and ending in December 2016. The samples were tested for the full list of Part 115 parameters. The background groundwater analytical data will be used to develop proposed statistical limits.

Laboratory Testing (Soil)

During the field investigation, soil sampling was conducted at all 24 soil borings. Of the 721 soil samples collected during the field investigation, approximately 584 samples were taken from the upper clay unit, 84 samples were collected from the upper sand unit, 46 samples were collected from the lower clay unit, and 7 samples were collected from the lower sand unit. Bedrock core samples were recovered from deep boring DB-28. Field descriptions and laboratory classification of the soil samples are presented on the boring logs (Appendix B).

During the 2015 field investigation, representative soil samples from 20 soil borings were tested consistent with Part 115 requirements. Samples were tested for particle size distribution (sieve and hydrometer; Rule 299.4904[4][e][i][A]; ASTM D422) and Atterberg limits (Rule 299.4904[4][e][i][B]: ASTM D4318) if they contain cohesive soils. Shelby tubes samples of the upper clay unit were tested to determine hydraulic conductivity using the methods approved in Rule 299.4920 (STM D5084). Results of the laboratory testing were used to classify the soils under the Unified Soil Classification system (Rule 299.4904[4][e][i][C]). Soil testing results are provided in Appendix E and summarized in Table 1. Permeability test results for the clay, silt, and sand units are summarized in Table 4.

Groundwater Elevation Survey

After installation of the monitoring wells the top-of-casings and ground surface was surveyed at each well location. Stabilized groundwater elevations at the wells were used to evaluate groundwater flow directions and gradients and determine groundwater separation beneath the proposed landfill.

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Revised Date:

Reformatted Date:
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A DEQ of Environmental Quality (DEQ) Policy and Procedure cannot establish regulatory requirements for parties outside of the DEQ. This document provides direction to DEQ staff regarding the implementation of rules and laws administered by the DEQ. It is merely explanatory; does not affect the rights of, or procedures and practices available to, the public; and does not have the force and effect of law.

INTRODUCTION, PURPOSE, OR ISSUE:

The purpose of this policy and procedure is to provide guidance on acceptable methods of verifying natural soil barriers used in the construction of solid waste landfills.

AUTHORITY:

Part 115, Solid Waste Management, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended.

STAKEHOLDER INVOLVEMENT:

This policy was developed with input from the Michigan Waste Industries Association, Technical Standards Committee.

DEFINITIONS:

The composition of a natural soil barrier is defined in Rule 104(f) of Part 115 as "any combination of natural or recompacted solid which is not less than 10 feet thick and which consists predominately of soils that have a unified soil classification of SC, ML, CL, CL/ML, or CH. A natural soil barrier may contain soil types other than SC, ML, CL, CL/ML or CH if the anomalous soils are not hydraulically connected to the uppermost aquifer, do not extend beyond the solid waste boundary, and are not considered as part of the thickness determination."

POLICY:

Rule 912 of Part 115 requires verification of a natural soil barrier used in landfill construction. The composition of a natural soil barrier is defined in Rule 104(f). Read together, these rules require a demonstration of the effectiveness of the natural soil component of landfill liner systems, including the side slopes and cell bottom. This demonstration can be completed prior to issuance of a construction permit, or a plan can be approved as part of a construction permit to complete the demonstration prior to cell licensure. This includes identification and delineation of any sand seams, root layers, saturated materials, desiccation cracks, solution zones, and other features that will increase the hydraulic conductivity of liquids through the natural soil barrier layer.

Rule 912(4) requires the facility owner or operator to obtain soil borings on grid spacing approved by the Director of the DEQ. In general, the DEQ considers that an adequate grid spacing would consist of a minimum of one boring per acre, or portion of an acre to be certified, centered unless the DEQ approves an alternative location. Borings should be placed evenly on a grid pattern within the footprint of the cell unless another grid pattern is approved by the DEQ in accordance with the provisions specified by Rule 912(4). Geophysical methods (or other subsurface testing methods) may be used to replace or supplement test borings specified in Rule 912(4), if a work plan for such a survey is approved by the Director or his or her representative in accordance with the provisions specified by Rule 912(5) prior to the work plan being initiated.

Soil borings must utilize continuous sampling methods throughout the depths, or zone, of certification. Representative samples must be collected and tested for all of the items listed in Rule 912(3).

On a case-by-case basis, the number of hydraulic conductivity tests required by Rule 912 may be reduced if all of the following criteria are met:

1. Hydraulic conductivity data from other areas, per Rule 920 has been submitted and accepted as appropriate.

2. An established relationship among particle size distribution, soil type, atterberg limits, and hydraulic conductivity has been determined.

3. The boring data submitted is representative of existing site conditions.

4. Boring data submitted was taken from previously agreed upon strategic locations.

5. Available hydraulic conductivity and soil boring data indicates that the site soils appear homogenous in nature.

6. The percent distribution of sand, silt, and clay has been determined for soil samples meeting the minimum requirements for hydraulic conductivity for a natural soil barrier.

7. The boring samples considered for elimination of hydraulic conductivity testing:

    a. Exhibit less than a five percent variation in clay, sand, or silt content (established by sieve and hydrometer testing) from the samples tested and meeting the acceptable standards for hydraulic conductivity, and

    b. The variation does not change the atterberg limits and result in a Unified Soil Classification System classification of ML or SM.

Unsuitable materials or saturated conditions encountered within the zone of certification must either be excavated until acceptable soils and conditions are reached or those materials must not be included in the zone to be certified. Exclusion requires full delineation of the horizontal extent of the unsuitable materials or conditions by additional borings or, on a case-by-case basis, geophysical methods approved per Rule 912(5). It is expected that the additional borings would consist of at least eight borings placed radially, no more than 45 degrees apart, and stepped out sufficiently to conclusively delineate the excluded area. It is recommended that a work plan be submitted to the DEQ for concurrence, prior to initiating this work.

The evaluation of site earth materials required by Rule 904(4)(e) as part of the facility hydrogeologic report must be submitted in conjunction with certification of the natural soil barrier pursuant to Rule 912. The items listed in Rule 904(4)(e)(i) - (iv) must be included in the log for each soil boring. Further, the geologic cross-section required by Rule 904(4)(f) must include a compilation of all boring logs for the site referenced to a site map with cross-sections identifying the items listed in Rule 904(4)(f)(i) - (viii). This includes borings used to certify the natural soil barrier.

REFERENCES:

The Unified Soil Classification System standard may be found in ASTM D2487-11: "Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)." The ASTM standard may be purchased from the American Society for Testing and Materials, Sales Services, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania, 19428 or from the ASTM Web site at www.astm.org.

OFFICE CHIEF APPROVAL:

Elizabeth M Browne — November 16, 2012

Elizabeth M. Browne, Chief
Office of Waste Management and Radiological Protection

Date

DEPUTY DIRECTOR APPROVAL:

Jim Sygo — November 30, 2012

Jim Sygo, Deputy Director

Date