Mill Seat Landfill Expansion

Facility ID No. 8-2648-00014

Town of Riga, New York

Draft Supplemental Environmental Impact Statement

Volume 2

Attachment C – Hydrogeologic Report

April 2015

DSEIS Volume 2

For the Proposed Mill Seat Landfill Expansion
303 Brew Road
Town of Riga, Monroe County, New York
Facility ID No. 8-2648-00014

Attachment C – Hydrogeologic Report

April 2015

DSEIS Prepared for:

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Table of Contents

Section

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Hydrogeologic Report

For the Proposed Mill Seat Landfill Expansion

303 Brew Road
Town of Riga, Monroe County, New York
Facility ID No. 8-2648-0014

Hydrogeologic Report

Prepared For:

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February 2015

Table of Contents

Tables

Figures

Plates

Appendices

Glossary of Terms

6 NYCRR Part 360 Permit Application **–** In order to modify, the County must demonstrate compliance with the design, construction, operation, and closure requirements of 6 NYCRR Part 360 to demonstrate the expansion's compliance with current regulations.

AMSL **–** Above Mean Sea Level

B&L **–** Barton & Loguidice, D.P.C.

cfm **–** cubic feet per minute

cm/s **–** centimeters per second

County **–** Monroe County, New York.

CSS **–** Critical Stratigraphic Section

CY **–** cubic yard(s)

DSEIS **–** Draft Supplemental Environmental Impact Statement

EMP **–** Environmental Monitoring Plan

fasl **--** feet above sea level

fbgs **--** feet below ground surface

FEIS -- Final Environmental Impact Statement

FIDs **--** fracture intensification domains

ft/day **–** feet per day

GEI **-** GEI Consultants, Inc. (P.C.)

GWSS – Groundwater suppression system

***Hydrogeologic Investigation Area* –** The area studied for bedrock and groundwater characteristics for siting the Proposed Landfill Expansion. This area stretches across the Proposed Site over the existing monitoring well network and various borings, test pits, and piezometers installed as part of previous and current hydrogeologic investigations. This area stretches north to the existing landfill infrastructure, south across Bovee Road to the Proposed Wetland Mitigation Area, and is bounded to the east and west by Wetlands RG-7 and RG-5, respectively and the Proposed Wetland Mitigation Area property boundaries.

***Landfill Lease Agreement* –** The Agreement by and between Monroe County, New York (Lessor) and WMNY (Lessee) dated January 14, 2002 and any Amendments thereafter.

***LFG* –** Landfill gas

***mg/L* –** milligram per liter

***Mill Seat Landfill* –** Currently permitted landfill and associated operations.

***MSW* –** Municipal solid waste

***NYCRR* –** New York Official Compilation of Codes, Rules and Regulations

***NYGWQS* –** New York Groundwater Quality Standards as provided in Technical and Operational Guidance Series (TOGS) 1.1.1 and in 6 NYCRR Part 703

***NYSDEC* –** New York State Department of Environmental Conservation

***NYSDOH* –** New York State Department of Health

***Owner* –** Monroe County is the owner of the Mill Seat Landfill

***6 NYCRR Part 360* –** NYSDEC's solid waste management regulations, codified at 6 NYCRR Part 360 (Title 6 of the Official Compilation of Codes, Rules, and Regulations of the State of New York), effective May 12, 2006.

***Permitted Footprint* –** The existing 98.6 acres of the Permitted Site allocated for solid waste disposal within a double composite liner system.

***Permitted Site* –** The land on which the Permitted Footprint and associated support features (including buildings and structures, stormwater ponds, access roads, and borrow areas) is located, and the land included as part of the Landfill Lease Agreement. The Permitted Site totals 485 acres.

***Primary Water Supply Aquifer or Primary Aquifer* –** Highly productive aquifers presently utilized as sources of water supply by major municipal water supply systems.

***Principal Aquifer* –** Aquifers known to be highly productive or whose geology suggests abundant potential water supply, but which are not intensively used as sources of water supply by major municipal systems at the present time.

***Proposed Footprint* –** The 118.3 acres allocated for solid waste disposal within the proposed double composite liner system in addition to and directly adjacent to the Permitted Footprint.

***Proposed Landfill Expansion* –** The addition of a contiguous footprint to the south of the Permitted Footprint. This defined term is specific to the Proposed Footprint of an additional 118.3 acres, 39.2 acres of overlay onto the Permitted Footprint, and any support features (stormwater management structures, access roads, LFG collection and control infrastructure, and leachate conveyance infrastructure).

***Proposed Wetland Mitigation Property* –** The parcels are located south of the Permitted Site across Bovee Road. The property is proposed as remediation to mitigate impacts to wetlands from the Proposed Landfill Expansion.

***QA/QC* –** Quality Assurance/Quality Control

***RQD* –** Rock Quality Designation

***SIP* --** Site Investigation Plan

***SRP* –** Stormwater Retention Pond

***SPT* --** Standard Penetration Testing

***tsf* –** Tons per square foot

***ug/L* –** microgram per liter

***USCS* –** Unified Soil Classification System

***USDA* –** United States Department of Agriculture

***USEPA* –** United States Environmental Protection Agency

***Wetlands* –** A land area that is inundated or saturated (or meets other primary or secondary indicators of hydrology) by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Under normal conditions, an area needs to satisfy three (3) criteria to be deemed a wetland: presence of wetland hydrology indicators, presence of hydric soil indicators, and a dominance of hydrophytic (water-loving) vegetation.

***WMNY* –** Waste Management of New York, LLC operates the Mill Seat Landfill under a lease agreement with Monroe County.

1. Introduction

This Hydrogeologic Report has been prepared by GEI Consultants, Inc. P.C. (GEI) in accordance with the requirements in 6 NYCRR Part 360-2.11. The report is submitted to the NYSDEC in support of a 6 NYCRR Part 360 Permit Application for lateral expansion of the Mill Seat Landfill. It documents hydrogeologic conditions at the Mill Seat Landfill through implementation of a Draft Site Investigation Plan (SIP) (June 2013) which was provided to the NYSDEC for comment with regard to the adequacy of methods proposed to satisfy 6 NYCRR Part 360-2.11 requirements for the Proposed Landfill Expansion. The scope of work included Draft SIP clarifications and work scope modifications summarized in a GEI memorandum dated July 31, 2013 following a meeting with the NYSDEC on July 26, 2013 and NYSDEC email correspondence dated August 6, 2013.

1.1 Background

The Mill Seat Landfill is located in the Town of Riga, Monroe County, New York (Figure 1). The Mill Seat Landfill is owned by Monroe County (County) and is operated by Waste Management of New York, LLC (WMNY) under the landfill's Solid Waste Management Facility (SWMF) Permit I.D. 8-2648-0014. The Mill Seat Landfill is currently leased to WMNY and occupies approximately 385 acres. The land surrounding the Permitted Footprint is used for site roadways, buffer areas, leachate collection and retention basins and support facilities including buildings used for administration, maintenance, and landfill gas power generation. More than 250 acres of land is undeveloped grass and woodlands owned by the County. Additional land, adjacent to the County-owned property, is currently owned by WMNY. The County and WMNY-owned land and the Mill Seat Landfill are shown in Figure 2. The final cells of the Permitted Footprint have been constructed and landfill operations are expected to reach permitted capacity in 2020 based on current disposal rates.

The Proposed Footprint occupies approximately 118 acres of land encompassing the permitted soil borrow mining areas, Wetland RG-6, farmland, and undeveloped land covered by grasses and brush. The Proposed Footprint is shown in Figure 3. The hydrogeologic investigation characterized the property in and around the Proposed Footprint.

1.2 Report Objectives and Format

This hydrogeologic report addresses the primary objectives stated in the SIP and includes:

- Integration of hydrogeologic data collected from the Mill Seat Landfill completed during the late 1980s and early 1990s with hydrogeologic data from SIP implementation and other studies conducted in the area south of the Mill Seat Landfill for soil borrow area permitting.

- Provision of data necessary for landfill design and construction to meet engineering requirements of 6 NYCRR Part 360.
- Defines the critical stratigraphic section for the Proposed Landfill Expansion to develop an appropriate environmental monitoring and groundwater protection program for the Proposed Landfill Expansion.

In addition, the investigation findings are compared to 6 NYCRR Part 360-2.12 siting requirements applicable to landfill expansion.

As stated in the Draft SIP (June 2013), a substantial database of geologic, hydrogeologic and groundwater quality data exist for the Mill Seat Landfill. These data were collected during site investigations conducted to support permitting of the Permitted Footprint and soil borrow areas south of the Permitted Footprint. The investigation work described in this report supplements that information and has been used to comprehensively document the hydrogeologic conditions, not only for the Proposed Footprint, but for the Proposed Site. This report is divided into the following:

- Section 2 describes site history and prior site investigations
- Section 3 describes the Site Investigation Plan for hydrogeologic investigation
- Section 4 describes regional geologic and hydrogeologic conditions including groundwater usage
- Section 5 describes comprehensive site investigation findings for the Proposed Site including definition of the Critical Stratigraphic Section
- Section 6 provides a conceptual plan to adequately monitor environmental conditions at the Mill Seat Landfill and Proposed Landfill Expansion
- Section 7 summarizes design considerations and investigation conclusions

In addition to figures referenced in Section 5, Plate size sheets are provided for most figures presenting hydrogeologic information in this report.

2. Site History and Summary of Previous Investigations

2.1 Site History

Investigations for landfill siting and site characterization were completed by several consulting firms from 1980 through 1991 for permitting of the Mill Seat Landfill. Hydrogeologic data gathered during these site investigations were peer reviewed by a group of qualified professionals commissioned by the County known as the Monroe County Landfill Coordinating Committee. The committee engaged consultants working under contract with the County to fully characterize site conditions, recommended field programs to address data gaps, and assisted in the interpretation of geologic and hydrogeologic data. Following these investigations, a 6 NYCRR Part 360 Permit Application for the Mill Seat Landfill was submitted to the NYSDEC in December 1989.

An FEIS was prepared and submitted to the NYSDEC in October 1990 by Clark Engineers. In April 1993, the County received a permit from the NYSDEC to operate the Mill Seat Landfill. The County and WMNY entered into a Landfill Lease Agreement in 2002, whereby WMNY assumed operation and maintenance of the Mill Seat Landfill and ownership of the Permitted Site is retained by the County.

Additional investigations were conducted by AMEC Geomatrix between 2006 and 2010 in support of the permitting for two (2) soil borrow areas located south of the Permitted Footprint.

2.2 Previous Hydrogeologic Investigations

Site investigations have been completed in and around the area of the Permitted Footprint. This section summarizes investigations completed to support construction of the Permitted Footprint and to support two (2) soil borrow areas situated south of the Permitted Footprint.

2.2.1 Existing Landfill Area Hydrogeologic Investigations

Seven (7) subsurface exploration programs were conducted at the Permitted Site during the time-period from 1980 to 1991 in support of the permit application to construct and operate the Mill Seat Landfill. These programs were reported in the following reports:

1. Todd Giddings Associates, Inc. (TGA) – June 1980
2. TGA – September through October 1982
3. TGA and Erdman, Anthony Associates (EAA) – April through November 1984
4. Dunn Geoscience Corporation (Dunn)– October through December 1986

5. H&A of New York – September 1988
6. H&A of New York – February through March 1989
7. H&A of New York – May through July 1989
8. H&A of New York – May 1990 through October 1991

A summary of the investigation findings is presented below.

1. TGA – June 1980

The initial subsurface exploration program was conducted by TGA from June 2 – 5, 1980 and consisted of seven (7) test pits and four (4) test borings (B-1, B-2, B-3 and B-2A). Test borings B-1 and B-2 were completed as observation wells. This study indicated the surficial soil material consisted of dense glacial till of sufficient thickness to provide adequate cover material for development of a sanitary landfill.

2. TGA – September through October 1982

Field investigations were conducted from September 29 through October 14, 1982 by TGA to further assess the suitability of the site and to provide data for consideration of a permit application. This investigation included 14 test pits and nine (9) test borings (DH-1, -2, -3, -4, -5, -6, -7, -8, and -9), five (5) of which were completed as observation wells. Falling head permeability tests were conducted in glacial till. As part of the investigation, an inventory of domestic water wells was conducted in the area surrounding the site and water levels were measured in accessible wells. TGA concluded the site was hydrogeologically very suitable for development as a landfill.

3. TGA – April through November 1984

Differing interpretations of the available groundwater information by the NYSDEC and the Monroe County Landfill Coordinating Committee resulted in the development and implementation of a subsequent expanded investigation by TGA and Erdman, Anthony Associates (EAA) in 1984. Twelve additional test pits were excavated and nine (9) monitoring well pairs (M1-A, M2-A, M3-A, M4-A, M5-A, M6-A, M7-A, M8-A and M9-A) and four (4) multi-piezometer clusters (PC-1A, PC-2A, PC-3A and PC-4A) were installed. Soil and bedrock data were collected from borings that were drilled for the installation of wells and piezometers, and hydraulic conductivity testing was conducted at completed piezometer and monitoring wells. Twenty soil samples were analyzed according to ASTM D-2487-69 “Standard Test Method for Classification of Soils for Engineering Purposes”. The report concluded the site is geologically suitable for landfill development.

4. Dunn Geoscience Corporation (Dunn) – October through December 1986

Dunn participated in field investigations in conjunction with EAA from October through December 1986. The objective of these field investigations was to define the site hydrogeology in the detail required by the NYSDEC for consideration of the site as a municipal waste landfill and to address comments on the site hydrogeology from both the NYSDEC and the Monroe County Landfill Coordinating Committee. The field investigations included the installation of three (3) additional piezometer clusters (PC-5A, PC-6A and PC-7A) and the performance of numerous hydraulic conductivity tests. Soil and bedrock data were collected from the borings drilled for the piezometers.

5. H&A of New York (H&A) – September 1988

H&A was retained by Clark Engineers in the fall of 1988 for further investigation of the site. The initial field investigation program conducted by H&A took place September 7-8, 1988 and was designed to obtain additional data on subsurface conditions and to obtain soil samples for laboratory testing (consisting of grain size analysis, compaction tests, and permeability testing). Ten (10) test pits were excavated and logs were developed from these test pits.

6. H&A of New York (H&A) – February through March 1989

H&A conducted a second phase of subsurface explorations in February and March 1989. This program consisted of five (5) test borings (B101, B102, B103, B104 and B105) completed at the site during the period of February 22 through March 1, 1989 by Empire Soils Investigations, Inc., and six (6) test pit excavations.

H&A provided the NYSDEC with a draft Hydrogeologic Site Investigation Work Plan on May 8, 1989 in preparation of the hydrogeologic report that would be submitted for landfill permitting. The draft Work Plan was subsequently revised to incorporate comments from the NYSDEC.

7. H&A of New York (H&A) – May through July 1989

H&A conducted further field investigations in accordance with the approved Work Plan. The additional subsurface exploration program was conducted from May 15 through July 27, 1989 to provide data to specifically address 6 NYCRR Part 360 (December 31, 1988).

Fourteen piezometers, four (4) monitoring wells, and one (1) test boring were installed (B201, B202, B203, B204, B205, B206, B210, B211, M1Z, M2Z, M9Z, M10-A, M10-B, P8S, P8Z, P9Z, PC-3Z, PC-7P and PC-7Z). Packer testing was performed on various intervals of the bedrock and falling/rising head tests were conducted on numerous piezometers screened in the overburden below the proposed landfill liner base. Hydraulic conductivities were calculated from these tests. The upper 15 feet of the bedrock was cored and packer tests were run in several borings. Bedrock wells were sampled to evaluate groundwater quality and to determine vertical horizontal gradients deeper within bedrock.

Test boring P-8S was drilled 100 feet into competent bedrock as a site stratigraphic test and borehole geophysical logs were obtained.

A pumping well was installed in the northwest portion of the site where relatively high hydraulic conductivities in nearby wells had been noted from previous investigations and where linear features were observed in aerial photographs. A pumping test was conducted for 48 hours from July 25 to 27, 1989. The discharge from the pumping well was monitored continuously and water levels were taken at designated time intervals during drawdown and recovery. Testing results indicated that groundwater flowing at the bedrock/overburden interface was not in strong hydraulic communication with deeper sections of the pumping well (Z-zone well equivalent).

8. H&A of New York (H&A) – May 1990 through October 1991

H&A completed supplemental hydrogeologic assessments of regional scale areas including an assessment of the Village of Bergen public water supply well head area and the Comstock Foods water production wells. They concluded that a zone of low permeability bedrock occurs between the Mill Seat Landfill and the water supply well head area to the north. No hydraulic effects were observed near the Mill Seat Landfill from pumping at the Comstock Foods production wells. In 1991, H&A installed 27 groundwater monitoring wells to monitor the existing Mill Seat Landfill area as described in the original EMP approved for the Mill Seat Landfill.

A synopsis of the investigation results summarized above, and a comprehensive assessment of the geologic and hydrogeologic conditions at the Permitted Site is documented in "Hydrogeologic Summary Report for the Mill Seat Landfill" prepared by Geomatrix Consultants, Inc. (Geomatrix) in September 2006. WMNY transmitted this report to the Region 8 NYSDEC Office on September 29, 2006.

2.2.2 Soil Borrow Area Hydrogeologic Investigations

AMEC Geomatrix, Inc. completed investigations south of the Permitted Footprint during separate phases between 2006 and 2010. The investigations focused on characterizing geologic and hydrogeologic conditions in the overburden across an investigation area that extended from the southern footprint of the Permitted Footprint southward to Bovee Road in the area between Wetland RG-5 and an area a few hundred feet east of Brew Road north of Hotel Creek. The property south of the Mill Seat Landfill had not been characterized previously and the data were used to support permitting of the eastern and western soil borrow areas which are situated south of the Permitted Footprint (see Figure 2). The AMEC Geomatrix investigations were conducted using methods consistent with 6 NYCRR Part 360, effective May 12, 2006 and included the following:

- electromagnetic geophysical survey
- test pit excavations
- completion of soil borings to the top of bedrock
- installation of temporary piezometers to monitor groundwater elevations in the glacial overburden
- installation of monitoring wells screened in the till and weathered bedrock
- hydraulic conductivity testing
- physical testing of site soil
- groundwater and surface water elevation monitoring

The geologic and hydrogeologic conditions in the study area were documented in "Hydrogeologic Investigation Report – Potential Soil Borrow Area for the Mill Seat Landfill" prepared by AMEC Geomatrix in January 2011. The report was transmitted to the NYSDEC Region 8 Office as an appendix to the DEIS for the proposed soil borrow area project. The soil borrow area project received NYSDEC permit approval effective on July 11, 2011.

3. Site Investigation Plan

A Draft SIP for the Proposed Landfill Expansion was prepared for WMNY by GEI and transmitted to the NYSDEC Region 8 office in June 2013. A meeting was held between NYSDEC Region 8, WMNY personnel and GEI on July 26, 2013 to discuss the proposed scope of work described in the Draft SIP. During the meeting, it was agreed that the vertical extent of the Critical Stratigraphic Section (CSS) needed to be adequately characterized in the Proposed Landfill Expansion. Previous investigations at the Mill Seat Landfill concluded that the vertical extent of the CSS is approximately 30 to 40 feet below the top of rock, which was based on higher hydraulic conductivities in this zone. WMNY agreed that packer testing of bedrock core holes would continue until lower hydraulic conductivity bedrock was encountered, indicating the bottom of the CSS. The criteria for discontinuing vertical packer testing along with a complete summary of meeting discussion items was provided in a GEI memorandum dated July 31, 2013 and submitted to NYSDEC. A copy of this memorandum is provided in Appendix A.

NYSDEC requested additional modifications to the Draft SIP in email correspondence to WMNY and GEI dated August 6, 2013. In the e-mail, NYSDEC described a need to characterize deeper Z-Zone bedrock hydrogeology and groundwater quality in the area of the Proposed Landfill Expansion. The email also outlined the requirements for background groundwater quality testing and monitoring well/piezometer abandonment. The August 6, 2013 email correspondence is also provided in Appendix A.

3.1 Literature Search

A comprehensive review of available reports and literature was performed prior to beginning the field investigation and during the compilation of regional and site-specific information. The review included appropriate documents referenced in previous hydrogeologic investigations performed by TGA and H&A during site characterization. Some of the sources used to more comprehensively understand the physical site setting included, but was not limited to:

- The United States Geological Survey
- The United States Department of Agriculture
- The New York State Geological Survey
- The Monroe County GIS Services Division (http://www.monroecounty.gov/gis-index.php)
- The U.S. Army Corps of Engineers
- The New York State Department of Health
- The Monroe County Department of Health

- The Monroe County Division of Pure Waters
- The NYSDEC
- The New York State Department of Transportation
- The United States Environmental Protection Agency

Seismic, geologic, and hydrologic information was obtained from academic research papers and other resources to complete the understanding of regional and site conditions.

3.2 Water Well Survey

A water well survey was documented in the December 1990 permit application submittal for the Mill Seat Landfill. More than 70 private home owner wells were identified within a one (1) mile radius downgradient from the planned site for the Mill Seat Landfill. Since that time, the County and WMNY acquired numerous properties near the Mill Seat Landfill and Monroe County Pure Waters installed water lines to provide municipally supplied water to nearby residential properties. In 2014, the survey was updated to include a search of the Monroe County Department of Health and the NYSDEC water well database for private water wells installed within one-quarter mile upgradient and one (1) mile downgradient of the Proposed Site in accordance with 6 NYCRR Part 360 2.11(1)(a)(5). The search area is shown in Figure 4. Additionally, WMNY mailed a water well survey questionnaire to the 83 property owners (non-County and WMNY owned properties) identified in the search radius. The results of the water well survey are summarized in Section 4.2.4.

3.3 Surface Geologic Mapping

The US Department of Agriculture Soil Conservation Service (SCS) soil series and associated hydrologic soil groups were identified for the Proposed Site soils. Soil information obtained from the SCS was compared with shallow boring data obtained during the site investigation for confirmation of soil type. Results of the surface soil mapping are discussed in Section 5.1.1.

3.4 Subsurface Investigation Activities

A substantial amount of investigation work was completed in the area of the Proposed Landfill Expansion between 2006 and 2010 in support of investigation of additional soil borrow material. This work included the completion of 41 soil borings, excavation of 14 test pits, installation of 11 piezometers and installation of two (2) groundwater monitoring wells. Activities were completed in accordance with 6 NYCRR Part 360 protocols under the direction of a senior level hydrogeologist. Borings, monitoring wells, piezometers and test pits completed in the expansion area are listed in Table 1 and their locations are shown on Figure 5. The data obtained from the investigations in the area of the Proposed Landfill Expansion are of suitable quality to adequately characterize the overburden soil type and thickness, bedrock topography, and overburden groundwater flow direction across the area of the Proposed Landfill Expansion. As such, the implementation of the SIP has addressed data gaps described in the Draft SIP and collected additional hydrogeologic and water quality data required to meet 6 NYCRR Part 360 requirements.

Field activities associated with the 2013-2014 hydrogeologic investigation described in the Draft SIP were performed between August 22, 2013 and April 3, 2014 and included:

- Completion of two (2) soil borings with geologic sampling;
- Installation of five (5) monitoring wells to monitor B-Zone groundwater (overburden/bedrock interface);
- Installation of six (6) monitoring wells to monitor A-Zone groundwater (upper 20 to 30 feet of bedrock);
- Installation of five (5) monitoring wells/piezometers to monitor the deep Z-Zone bedrock flow system (between 40 and 100 feet below top of bedrock);
- In-situ hydraulic conductivity testing of B-Zone, A-Zone and Z-Zone monitoring wells and piezometers including the performance of straddle-packer tests and rising-head (slug) tests; and
- Collection of groundwater elevation and preliminary groundwater quality data.

Potable water was used for bedrock coring and packer testing, as well as, steam cleaning between drilling locations. A sample of the potable water used during the investigation was collected on August 27, 2013 from the on-site fire hydrant which is a municipally supplied water source and analyzed for the 6 NYCRR Part 360 Baseline parameter list including special compounds listed in the EMP. The following halogenated volatile organic compounds:

- Bromodichloromethane (11 ug/L);
- Chloroform (24 ug/L); and
- Dibromochloromethane (3.7 ug/L)

were detected at low part per billion level concentrations in the potable water sample. These compounds are common artifacts from chlorination disinfection of water in municipal water supply systems.

The locations of borings and monitoring wells completed during the 2013-2014 hydrogeologic investigation are shown on Figure 5 along with previous investigation locations and the Mill Seat Landfill detection monitoring network. The subsurface investigation was implemented in a single phase to complete investigation activities needed to address 6 NYCRR Part 360 requirements. However, based on Permitted Footprint geometry, cell construction progression, and groundwater flow direction in the B-Zone and in the A-Zone, the full suite of groundwater monitoring well installations required to monitor the expanded Mill Seat Landfill during its operational and post-closure existence will be implemented as described in the Environmental Monitoring Plan (EMP).

3.4.1 Existing Piezometer/Monitoring Well Assessment

Piezometers and monitoring wells installed previously in the area of the Proposed Landfill Expansion were inspected for suitability to provide water level monitoring and groundwater quality information in support of the hydrogeologic investigation. The assessment was performed on September 4, 2013 and included:

- Determining the accessibility of each well or piezometer,
- Assessing the integrity of the surface completion of the well/piezometer, including riser condition and locking mechanism where originally present;
- Development of existing monitoring wells (2" casing diameter and larger) and monitoring recovery to determine a hydraulic conductivity value. Groundwater elevations and total well depths were measured in wells from the top of the riser using an electric water level meter to the nearest 0.01 foot, to determine if current groundwater elevations are similar to historic measurements, and;
- Comparing measured well depths to existing well completion logs.

All existing monitoring wells and piezometers in the area of the Proposed Landfill Expansion were determined to be suitable for the purposes of groundwater elevation or groundwater quality monitoring except for piezometer PZ-1-2006, which was previously cut-off at the ground surface and was not located during the assessment. PZ-1-2006 was a 1" diameter, PVC well that was installed to monitor the lower portions of the till unit. An attempt will be made to locate piezometer PZ-1-2006 using existing survey data. If the piezometer is located, the monitoring point will be repaired or decommissioned in accordance with 6 NYCRR Part 360 requirements.

3.4.2 Soil Borings

Soil borings B-SEA-1 and B-SEA-2 were completed in areas not previously investigated, at locations where information was needed to better define site geology. A soil boring was not completed in Wetland RG-6 as proposed in the SIP due to the lack of an access permit necessary for wetland area drilling. It was decided that depth to bedrock in this area of the property was deeper than 10 feet and that verification could be completed during pre-design data gathering for cell construction in that area of the property. At each soil boring location, the soil was drilled using 2 3/4-inch diameter hollow stem augers with an all-terrain drill rig. The soil profile was continuously sampled using 2-inch diameter stainless steel split spoons in accordance with 6 NYCRR Part 360 requirements. Blow counts for Standard Penetration Testing (SPT) were recorded during soil sample collection. The soil was continuously logged by a GEI hydrogeologist in accordance with the Unified Soil Classification System (USCS). Representative soil samples from each split spoon were placed in a glass jar and labeled with the boring number, date, and sample collection depth, and packaged neatly for archive at the Mill Seat Landfill. Each soil boring was advanced to sampler refusal in the Vernon Shale bedrock. Following the completion of each boring, the boring was backfilled to ground surface using a cement-bentonite grout mixture emplaced using tremie methods. Soil boring logs are provided in Appendix B. Passero Associates surveyed the location and obtained the surface elevation of each soil boring.

3.4.3 Geotechnical Soil Sample Collection and Analysis

Representative soil samples were collected during the investigation of soils for geotechnical analysis by 3rd Rock, LLC which maintains AASHTO accreditation. The geotechnical laboratory reports are included in Appendix C. Soils considered representative of laterally extensive soil types were collected at the following six (6) locations:

- B-SEA-1 (4-16’)
- B-SEA-2 (0-14’)
- B-SEA-2 (14-36’)
- MW-SEA-3 (12-15’)
- MW-SEA-5 (0-20’)
- MW-SEA-6 (0-19’)

Samples were analyzed for the following parameters as required by 6 NYCRR Part 360 2.11 (a)(9)(ii):

- Atterberg limits – ASTM D4318
- Grain Size Gradation (grain size distribution sieve and hydrometer analysis – ASTM D422

An attempt was made to advance a Shelby tube sampler into the coarser grained till at two (2) locations and two (2) locations in the dense lodgment till. At each location, the thin wall tube bent upon advancement, and Shelby tube samples could not be collected for analysis. Due to the lack of in-situ Shelby tube samples, the following tests were not performed:

- Consolidated/Undrained Tri-axial Shear Test w/ pore pressures monitored (5 tons per square foot (tsf), 7.5 tsf, 10 tsf) - ASTM D4767
- Consolidation test - ASTM D2435.

As an alternative to Shelby tube samples, soil was collected at three (3) soil boring locations for remolded soil permeability measurement by ASTM D5084 Method C to assess the permeability of unsaturated and saturated soils. Soil geotechnical data for samples collected during 2013 field investigation activities and previous investigations completed in the area of the Proposed Landfill Expansion are summarized in Table 2.

3.4.4 Monitoring Well Installations

Groundwater monitoring wells were installed to monitor the groundwater in the area of the Proposed Landfill Expansion between August 22 and September 23, 2013. Monitoring well installations included five (5) B-Zone wells (MW-SEA-B series), six (6) A-Zone wells (MW-SEA-A series) and five (5) Z-Zone (MW-SEA-Z series) monitoring wells, as shown on Figure 5. Monitoring wells completed in the Proposed Landfill Expansion were installed to monitor zones consistent with the B, A, and Z monitoring zones designated for the Mill Seat Landfill, and are as follows:

- B-Zone monitoring wells monitor the lower portions of the saturated overburden materials and uppermost portions of the weathered Vernon Shale bedrock (regolith).
- A-Zone monitoring wells were installed to monitor the unweathered portions of the Vernon Shale bedrock generally between 15 and 30 feet below the top of bedrock.
- Deeper bedrock Z-Zone monitoring wells were installed to monitor bedrock intervals generally between 30 and 80 feet below the top of bedrock.

Monitoring well construction details are summarized in Table 3.

As discussed in the introduction to Section 3.0, NYSDEC outlined a requirement of the Draft SIP to investigate and characterize the Z-zone bedrock flow system in the area of the Proposed Landfill Expansion. In fulfillment of this requirement, five (5) Z-zone monitoring wells/piezometers were installed to monitor the deep bedrock flow regime at locations shown on Figure 5. Z-zone bedrock core holes were advanced until RQD values generally improved to a value above 25% or lower permeability values were obtained from packer tests.

One (1) of the A-zone wells (MW-SEA-4A) was paired with existing monitoring well pair MW-1S (2006) and MW-1D (2006) previously constructed according to 6 NYCRR Part 360 monitoring well construction requirements. In field notes, MW-1D (2006) is sometimes referred to as MW-SEA-4B based on the positioning of the well screen (B-zone).

At the MW-SEA-3 well series, a deep exploratory core hole (PZ-SEA-3Z) was completed to characterize and monitor the hydraulic characteristics of the lower portions of the Vernon "C" Horizon at a depth of approximately 100 feet below ground surface. A piezometer was constructed in the core hole that screens an interval from 89-99 feet below ground surface. Piezometer construction (identical to monitoring well construction) is summarized in Table 3.

The boring for each well was advanced using 4 ¼-inch diameter hollow stem augers to auger refusal in weathered bedrock. At each bedrock monitoring well location, the augers were removed and a 6-inch diameter permanent steel casing was grouted in a 2-4 foot deep rock socket. At Z-zone monitoring well locations (or deepest well at nested well locations), the bedrock was cored using an HQ diameter core barrel and logged according to the 6 NYCRR Part 360 2.11 (a)(10)(ii) requirements. The rock core was placed in appropriately labeled wooden core boxes, photographed, and placed in on-site storage for archive. Bedrock core photographs are included in Appendix D. Discrete depth packer tests were performed on the deepest bedrock core hole at each well cluster to assess bedrock hydraulic conductivity in ten (10) foot increments. The continuous 10 to 20 foot zone having the highest hydraulic conductivity was selected for monitoring. The packer testing procedure is described in Section 3.5. Following testing and monitoring interval selection, the bedrock core hole was reamed using a 5-7/8 inch roller bit. The estimated volume of potable water introduced to the bedrock formations during coring, reaming and packer testing is summarized in Appendix B. Following the completion of the packer tests and prior to monitoring well construction in the core hole, each bedrock core hole was developed with the drill rig using air-lift methods to remove potable water introduced to the bedrock formations. Development water was discharged to the ground surface. At each well location, the monitoring well consisted of a 10 to 20-foot long, 2-inch diameter continuous slot wire-wrapped PVC well screen and associated schedule 40 PVC flush-joint riser. Each monitoring well was completed with a lockable protective surface casing and appropriately labeled for incorporation into the Proposed Site groundwater monitoring network. Each monitoring well construction conforms to those requirements outlined in 6 NYCRR Part 360 2.11(a)(8)(ii), “Construction of Monitoring Wells and Piezometers”. All drilling equipment including augers, drill rods and sampling spoons were decontaminated with high-pressure steam between monitoring well and boring locations.

Each newly-installed monitoring well was manually developed no sooner than one (1) week following well installation. Monitoring wells were developed using a bottom-discharging bailer to remove groundwater and any accumulated sediment on the well bottom. Approximately ten (10) casing volumes of water were removed from each newly installed well. Water removed during development was discharged to the ground surface. Passero Associates surveyed the location and obtained elevations of each newly installed monitoring well.

3.5 Hydraulic Conductivity Testing

Hydraulic conductivity estimates for monitoring wells and piezometers installed in the Proposed Landfill Expansion were obtained by performance of rising head (slug) tests in completed wells and using an inflatable double-packer system in open rock holes.

Slug tests were performed on October 1 and 2, 2013. At each monitoring well location, a depth to water was measured to establish the static water level. A known volume of water was removed from the well casing using a bailer and the recovery of the water level in the casing was measured using a down-hole pressure transducer. The water level was monitored until the level had recovered to at least 80% of the static level or sufficient data were available for reliable analysis. Slug test recovery data was analyzed using the Hvorslev calculations to yield estimates of hydraulic conductivity of B-Zone, A-Zone and Z-zone monitoring wells. Hydraulic conductivity calculations are provided in Appendix E.

Where bedrock was cored, bedrock straddle packer tests using an inflatable double packer assembly were performed to estimate hydraulic conductivity to aid in the selection of well screen placement depths in A-Zone and Z-Zone wells. Packer tests were completed with a ten (10) foot packer assembly at the following boring locations:

- PZ-SEA-1Z
- MW-SEA-2A
- MW-SEA-3Z
- MW-SEA-4A
- PZ-SEA-5Z
- PZ-SEA-6Z

A summary of the bedrock intervals that were tested in each bedrock core hole is provided below. Packer testing calculations are provided in Appendix F. Table 4 presents a summary of hydraulic conductivity values.

PZ-SEA-1Z

Straddle packer tests were performed on two (2) bedrock intervals in well PZ-SEA-1Z; 45-55 feet below ground surface (bgs) and 55-65 feet bgs. The 35-45 feet bgs bedrock interval was not tested due to poor bedrock quality (4 to 8% RQD) present in the interval. The highly fractured and rough nature of the borehole wall caused damage to the inflatable packer (puncture) and it was determined that hydraulically isolating the 35-45 foot test interval from adjacent intervals was not feasible.

MW-SEA-2A

Straddle packer tests were performed on three (3) bedrock intervals in well MW-SEA-2A; 22-32 feet bgs, 32-42 feet bgs and 42-52 feet bgs.

MW-SEA-3Z

Straddle packer tests were performed on four (4) bedrock intervals in well MW-SEA-3Z; 20-26 feet bgs, 26-36 feet bgs, 36-36 feet bgs and 46-58 feet bgs. The lowermost 58-68 foot interval was not tested due to damage sustained to the inflatable packer and the inability to produce a hydraulic seal from the upper interval. The monitoring well installed in MW-SEA-3Z was constructed to screen the 55-68 foot bedrock interval. A hydraulic conductivity estimate for the lower interval was calculated from a rising head test performed on the monitoring well.

MW-SEA-4A

One (1) straddle packer test was performed on monitoring well MW-SEA-4A at the 42-52 feet bgs bedrock interval. A hydraulic conductivity estimate for the upper bedrock interval (28-38 bgs) was previously calculated from adjacent monitoring well MW-SEA-4B. An attempt was made to perform a straddle packer test on the lower bedrock interval 52-68 feet bgs, however damage was sustained to the inflatable packer and it was determined that the zone could not be hydraulically isolated from adjacent intervals to perform the test. The monitoring well was constructed in the MW-SEA-4A borehole consists of a 20-foot long well screen, spanning an interval of 40.5-60.5 feet bgs. A hydraulic conductivity estimate for this interval was obtained through the performance of a rising head test.

PZ-SEA-5Z

Three (3) straddle packer tests were performed in the PZ-SEA-5Z core hole at the following intervals: 23-33 feet bgs, 32-42 feet bgs and 42-52 feet bgs. A one (1) foot overlap between the upper two (2) intervals was necessary in order to keep the two (2) foot long upper inflatable packer situated in the bedrock core hole, which began at 21 feet bgs.

MW-SEA-6Z

Four (4) straddle packer tests were performed in the PZ-SEA-6Z bedrock core hole at the following intervals: 30-40 feet bgs, 40-50 feet bgs, 50-60 feet bgs and 60-70 feet bgs.

For each bedrock interval tested, potable water (the same water source used for drilling) was injected at variable pressures between 15 and 45 psi at 15 psi increments. The volume of water pumped into the formation at each pressure increment was measured over a two (2) to three (3) minute time period and recorded. The observed values were related to hydraulic conductivity by the relationship below:

$$K_h = \frac{q * Ln[\frac{m*L}{D} + \sqrt{1+(\frac{m*L}{D})^2}]}{2\pi * L * H_C}$$

Where H_c (total head of water) is defined as:

$$H_C = \frac{p}{.433} + h - h_f$$

And L (Lugeons) is defined as:

$$L = \frac{q(ft^3/\min) * (142)}{H_c(ft) * L(ft) * (0.01076) * (0.433)}$$

The packer testing procedure and calculation of hydraulic conductivity are generally consistent with methods used previously by H&A during the 1989 hydrogeologic characterization of the Mill Seat Landfill. Hydraulic conductivity data and a discussion of Lugeon patterns are presented in Section 5.0.

3.6 Groundwater Elevation Monitoring and Monitoring Well Sampling

A comprehensive round of groundwater elevations was measured in each newly installed monitoring well, existing piezometers and the following monitoring wells near the Mill Seat Landfill: M1, M2, M7, and M14 clusters. Groundwater elevations were measured on the following dates:

- September 24 – October 2, 2013
- November 12, 2013
- February 20, 2014
- April 3, 2014

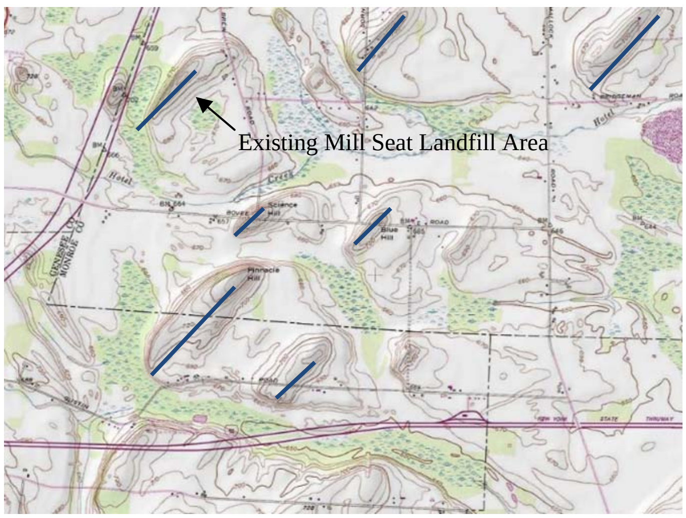
A summary of groundwater elevations for monitoring wells and piezometers installed in the Proposed Landfill Expansion and the Mill Seat Landfill monitoring network is provided in Table 5.

Two (2) rounds of groundwater samples were collected from the newly-installed monitoring wells by an Amherst, NY-based Test America Laboratory field sampling crew. The first sampling round was performed from October 31 through November 1, 2013 during the Fourth Quarter sampling event for the Mill Seat Landfill. Samples were analyzed for the 6 NYCRR Part 360 Expanded Parameter list. A second round of groundwater samples was collected by Test America between April 2 and April 8, 2014 during the Second Quarter 2014 sampling event for the Mill Seat Landfill. Second Quarter 2014 samples collected from the Proposed Landfill Expansion were analyzed for the 6 NYCRR Part 360 Baseline Parameter list and included special parameters listed in the current EMP. Water levels measured during each monitoring event are summarized in Table 5.

4. Regional Physical Setting

The Mill Seat Landfill is situated within the Erie-Ontario Lowlands physiographic province. The region is typified by broad plains of relatively low relief, underlain by gently south-southwestward dipping sedimentary bedrock of the early Paleozoic age. Land surface elevations in the lowlands province vary between 245 feet above sea level (fasl) at the Lake Ontario Shore, to nearly 1600 fasl in the Southern Tier of New York State, at the boundary of the Allegheny Plateau (Appalachian Uplands province). The regional bedrock is covered by a veneer of glacially derived sediments that exhibit four (4) distinct glacial successions during the Pleistocene Era.

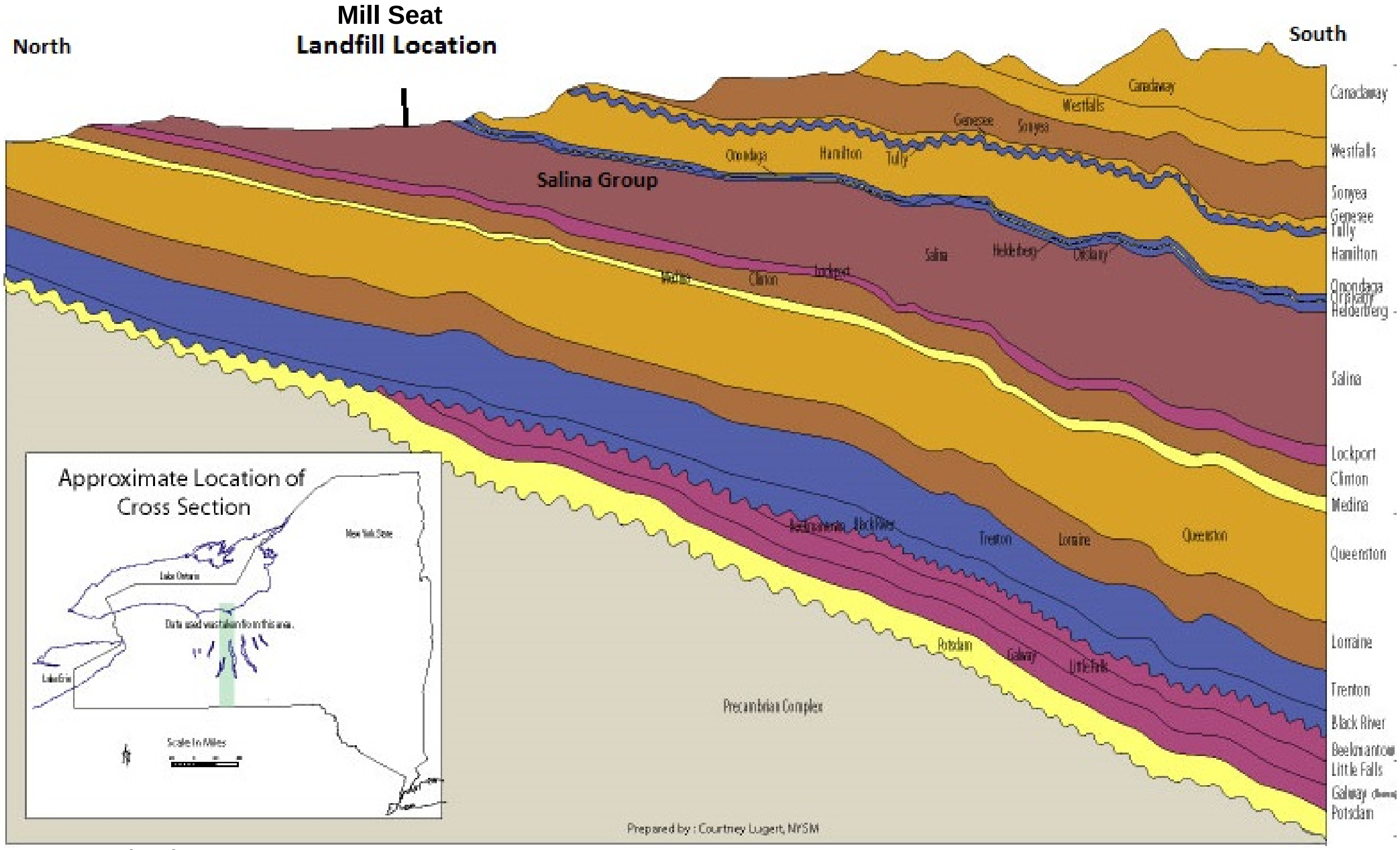
Fairchild (1907) described drumlin presence in central and west central New York State. Drumlins shape the topographic landscape in the southern portion of Monroe County as elongated hills. As shown in the topographic map below that pre-dates Mill Seat Landfill construction, numerous drumlins exist in the area of the Proposed Site. The northeast – southwest trending axial orientations of individual drumlins are highlighted.



The drumlins are composed of till consisting of densely packed clay, silt, sand, gravel, and boulder size material and are typically 0.5 to 1 mile in length.

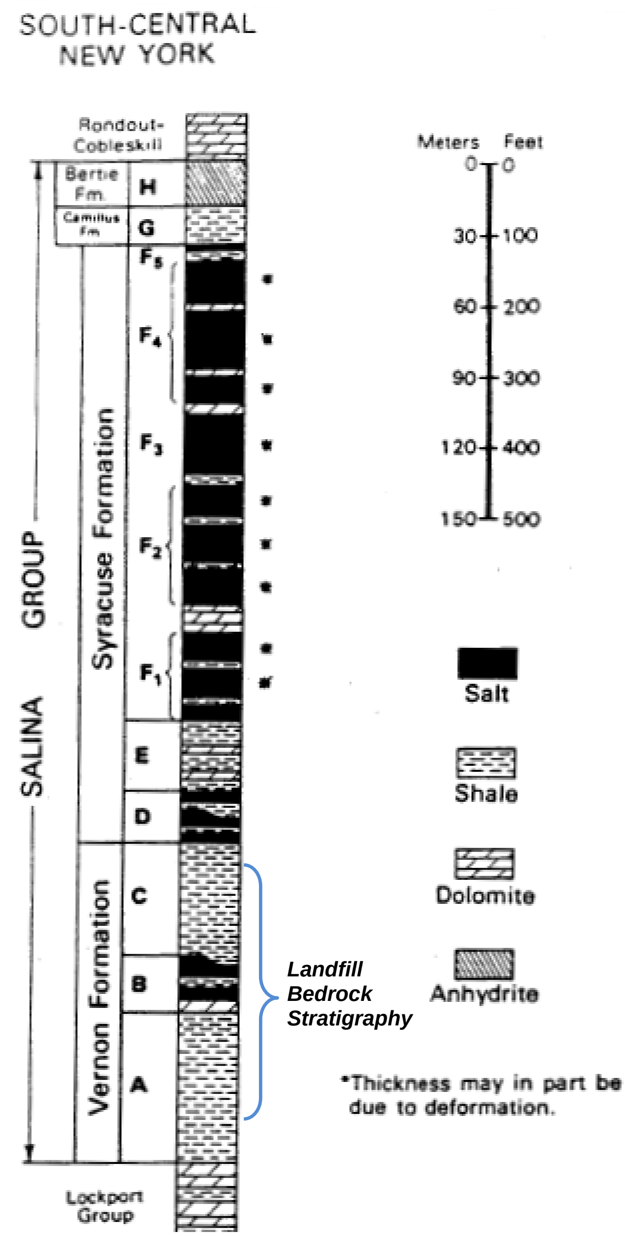
4.1 Bedrock Geology

Bedrock units in western New York strike east-west and dip south-southwest at an angle of 1^0 to 2^0 (50 to 80 ft./ mile). As shown in the figure below representing generalized New York State bedrock geology from North to South, bedrock units range in age from the upper Ordovician Queenston Formation near Lake Ontario to the Upper Devonian shales of the Allegheny Plateau near the Pennsylvania border.



From: Modified from C. Lugert 2006, NYS Museum

The bedrock in the southern portion of Monroe County consists of rock units of the Upper Silurian Salina Group (Rickard, 1969). The bedrock formations contain evaporite lithology (gypsum and halite {salt}) with interbedded dolomite, shale, and mudstone. Along the outcrop region in western and central New York, thickness of the Salina Group increases from 400 feet near Buffalo to 1000 feet near Syracuse. The Syracuse and Vernon Formations of the Salina Group outcrop in southern Monroe County. Bedrock surface exposures are limited to areas where excavations and streams and creeks have cut through glacial sediment to expose bedrock surfaces.



The bedrock underlying the Proposed Site consists of the Vernon Formation (see above). The Vernon Formation is typically a dolomitic shale with dolostone interbeds and has been further subdivided into three (3) units as follows:

- Vernon C Unit (includes a dolostone marker bed known as the CB Horizon)
- Vernon B Unit
- Vernon A Unit

Historic study of the Mill Seat Landfill area prior to site development (H&A, 1989) correlated the site bedrock strata to regional bedrock formations outcropping and subcropping in Monroe, Genesee and Livingston Counties within 15 miles of the Mill Seat Landfill. This was accomplished using correlated salt bed mapping cross-sectional data from Rickard (1969) with rock core description information and litho-density gamma ray logs from deep exploratory well P8S (previously abandoned by H&A) located beneath the Permitted Footprint. This work correlated the upper 100 feet of bedrock beneath the site to regional correlative members within the Vernon Formation. Based on rock core descriptions and gamma ray log information, it was determined that the Proposed Site, including the Proposed Landfill Expansion, overlies the Vernon C Unit of the Vernon Formation.

4.1.1 Geologic Structure and Seismicity

As shown in the regional geologic cross-section in Section 4.1, regional structure is a broad, south-southeastward dipping homocline produced by the upper surface of the Grenville Precambrian basement. Regionally, the sedimentary strata above the basement are unfolded. The Clarendon-Linden Fault system is the closest major, large scale structural feature in the area of the Proposed Site. The Clarendon-Linden Fault system trends in a north-south direction extending beneath Lake Ontario to the north and The Allegheny Plateau to the south. The fault zone has been extensively studied and is categorized as a Class C Fault Zone which is defined by the USGS as, “Geologic evidence is insufficient to demonstrate (1) the existence of tectonic faulting, or (2) Quaternary slip or deformation associated with the feature” (USGS Earthquake Hazards Program, 2000, 2014). The fault system has been mapped in detail in the subsurface by Van Tyne (1975) and work by Faukendiny and Pomeroy has shown it to consist of a series of high angle reverse faults with three (3) subparallel main segments and a southwest trending branch forming horst and graben type features. Most recently, Jacobi and Fountain (1997 and 1998) have studied gas seeps along the basement controlled faults to assess the extent of the fault system.

In recent recorded history, an earthquake having an epicenter near the fault zone in the area of Attica, NY occurred in 1929. Two (2) more recent earthquakes had epicentral locations inside the 14-km-wide fault zone with depths 2-3 km below ground (Herrmann, 1978). Johnston (1993) estimated that earthquakes of this size in stable continental regions like western New York State might typically have rupture zones with diameters of 0.6 km. Presumably rupture zones of this size would have occurred on faults at least several times larger, and the only large faults known in the area at the shallow depths of the hypocenters are the strands of the Clarendon-Linden fault zone. Thus, the locations, depths, rupture-zone sizes, and nodal-plane orientations of the 1966 and 1967 earthquakes are unusually good matches to the locations, depths, and orientations of the strands of the Clarendon-Linden fault zone. However, paleoseismological evidence was not found to suggest the fault zone slipped during the Quaternary. Several researches have searched for (Tuttle and others (1995; 1996)), but did not find, historic or prehistoric liquefaction features in the liquefiable deposits in the meizo-seismal area of the 1929 Attica earthquake and the area south of Attica along the fault zone. Various soft-sediment structures were observed, but all could be more reasonably attributed to glacial, sedimentological, or mass wasting processes (Tuttle and others, 1995; 1996; Young and Jacobi, 1998). The lack of observed paleoliquefaction features may indicate that earthquakes of magnitude larger than 6.0 have not occurred along the Clarendon-Linden fault zone during the last 12,000 years (Tuttle and others, 1995). However, smaller earthquakes could occur without leaving a detectable paleoliquefaction record. The USGS reports no paleoseismological evidence of prehistoric Quaternary seismic reactivation.

Jacobi et. al (2002) studied lineaments across Upstate New York using Earthsat and Lidar imagery and correlated zones of highly fractured bedrock (fracture intensification domains [FIDs]) with deeper basement structures. Their work identified a high frequency of joint and fracture networks across the entire state. New York State FID mapping is summarized in Figure 6. Regional bedrock joint systems are reported in a predominant northwest trending compressive stress during late Paleozoic Appalachian deformation producing orthogonal, nearly vertical fractures. Joints identified in the Bergen and Churchville topographic quadrangle, which encompass the site, have primary orientations of N40E, N10E, N63W and N45W, and an east-west trending set. Joint mapping and bedrock structural features in the Bergen and Churchville area are discussed in the H&A Report (1989) and shown on Figure 7.

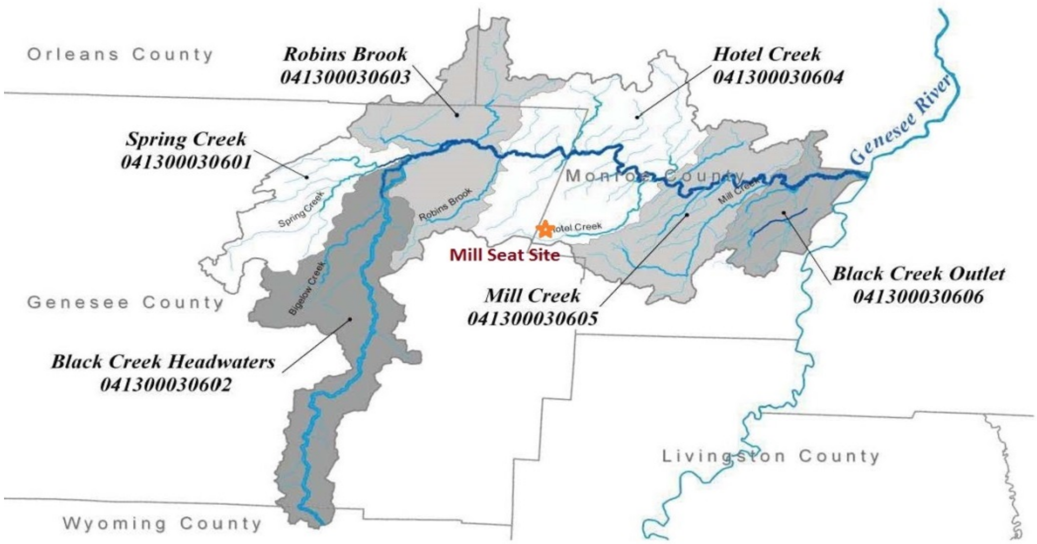
The H&A Report also described the potential for secondary fractures caused by tensile stresses from subsidence caused by dissolution of evaporites in the Salina Group. These features are oriented more commonly in an east-west direction parallel with bedrock strike and are described by Wallach and Prucha, (1979). Where present, these features produce higher frequencies of bedding plane fractures.

4.2 Regional Hydrogeology

4.2.1 Watershed

The Mill Seat Landfill is located within the Genesee River Basin. The Genesee River watershed encompasses approximately 2,500 square miles composed predominantly of agricultural areas. The Genesee River originates in the hills of northern Pennsylvania and flows northward to Lake Ontario. The 125 square mile Black Creek watershed is a sub-watershed of the Genesee River and its drainage area includes the Mill Seat Landfill, the towns of Riga, Chili, Wheatland, Sweden, and Ogden in Monroe County, as well as a large portion of eastern Genesee County. The Bergen Swamp in Genesee County is located in the extreme upper reach of the watershed, and acts as one of the major sources of Black Creek. The extent of the Black Creek Watershed is shown in the figure below. Six (6) sub-watersheds divide the Black Creek Watershed. Hotel Creek is a sub-watershed of Black Creek, and is the watershed potentially influenced by the site. The Hotel Creek watershed encompasses approximately 7.5 square miles from its origin in the Village of Bergen to the confluence with Black Creek northeast of the Proposed Site. The Mill

Seat Landfill is located in the southern portion of the Hotel Creek sub-watershed as shown below.



The Permitted Footprint covers approximately 0.18 square miles and the Proposed Footprint covers an additional 0.19 square miles. Collectively, the Permitted Footprint and Proposed Footprint, when fully developed, would encompass approximately 4.9 percent of the Hotel Creek sub-watershed. Hotel Creek has an average stream gradient of 3.6 feet per 1,000 feet (linear distance) as it travels approximately 5.5 miles just south of the Permitted Site to Black Creek. The low stream gradient combined with generally flat lying topography (excluding drumlins) indicates that stream base flow and peak discharge flows are controlled by the storage volume and hydrogeology of the numerous wetlands that the creek flows near or through.

4.2.2 Regional Groundwater Flow

Groundwater flow across the region occurs within the fractured bedrock and, to a lesser extent, the overlying unconsolidated glacial deposits (overburden). The fine grained nature of these deposits generally confines groundwater within the bedrock units and groundwater occurrence within a few feet of the ground surface may often exist as water table or perched conditions. Discharge areas for overburden groundwater include streams and seeps, springs, or wetlands where the overburden-bedrock interface intersects the land surface. Precipitation which falls on exposed areas of bedrock and precipitation that slowly infiltrates through the glacial overburden recharges bedrock groundwater throughout the region. Groundwater flow within the bedrock units occurs principally within the interconnected network of horizontal and high angle fractures and joints. Typically, the fracture frequency increases toward the bedrock surface, resulting from both weathering and erosional stress relief. As fracture frequency and interconnections decrease with depth, the volume of groundwater flow correspondingly decreases. Although several small-scale bedrock groundwater divides occur throughout the region, the dominant bedrock groundwater flow direction is northeast toward the Genesee River.

4.2.3 Primary/Principal Aquifers

Primary aquifers mapped in the vicinity of the Mill Seat Landfill are shown on GIS mapping (source: NYS GIS Clearinghouse, 2014) and provided on Figure 8. As shown on the figure, the Batavia Water Supply Aquifer and the Irondo-Genesee Aquifer are the closest mapped Primary Aquifers to the Permitted Site. The Batavia Water Supply Aquifer, also known as the Tonawanda Creek aquifer, is located approximately 12 miles southwest of the Mill Seat Landfill. The aquifer materials consist of unconfined, stratified and well sorted glacial outwash sand and gravel deposits (USGS Water Resources Investigation Report, 85-4096). The aquifer occurs within the Tonawanda Creek water shed and has no hydraulic connection to water-bearing deposits in the area of the Mill Seat Landfill. The Irondo-Genesee Aquifer is located approximately 18 miles northeast of the Mill Seat Landfill and is situated east of the Genesee River beneath the valley fill area of Irondequoit Creek. The aquifer materials consist of stratified glacial till, glacial drift, cemented sand and gravel, and deeply buried cobbles and boulder deposits. These deposits in-fill a remnant channel of the historic flow path of the Genesee River which were deposited during deglaciation of the Wisconsin ice sheet (USGS Water Resources Investigation Report, 88-4145). The Irondo-Genesee Primary Aquifer is located east of a major groundwater flow divide associated with the Genesee River and its water quality could not be affected by the Mill Seat Landfill.

NYSDEC TOGS 2.1.3 - Memorandum for Primary and Principal Aquifer Determinations, was prepared to clarify the meaning of the terms “Primary Water Supply Aquifer” and “Principal Aquifer” and to establish guidance for determining whether an aquifer is designated as such. The memorandum lists Primary and selected Principal aquifers in Upstate New York. Both the Irondo-Genesee and Batavia Primary Aquifers are listed in Table 1 of TOGS 2.1.3 which is consistent with NYS GIS mapping. A Principal Aquifer in close proximity to the Proposed Site is not listed in TOGS 2.1.3.

A search of current NYS GIS water resource mapping shows a “mid-yield unconfined aquifer” (not a Primary Aquifer) transecting the Proposed Site. The source of the GIS data , according to the NYS Clearinghouse metafile data, is historic mapping of surficial unconsolidated sand and gravel deposits mapped at a scale of 1:250,000 and reported by T. S. Miller (1988) in USGS Water Resources Investigation Report, 88-4076 . Miller based his maps mainly on area well yields and county and state surficial geologic mapping that was conducted prior to investigations completed in the Town of Riga related to the Mill Seat Landfill. Permeable, unconfined saturated sand and gravel deposits were not identified in the area of the Mill Seat Landfill during the numerous hydrogeologic investigations conducted for the Permitted Footprint. Consistent with those investigations, recent hydrogeologic investigations of saturated soils in and adjacent to the Proposed Landfill Expansion identified fine-grained soils having low hydraulic conductivity with low well yields. Based on guidance in TOGS 2.1.3 for classifying aquifers, it is concluded that a Principal Aquifer does not exist on property in the area of the Proposed Landfill Expansion.

This conclusion is consistent with findings presented in the Hydrogeologic Investigation Report prepared by H&A (1989). The report was submitted to the NYSDEC with the original permit application for existing Mill Seat Landfill construction. Section 3.2.4.4 of the H&A report documented that the NYSDEC reviewed available data concerning aquifers in the area of the Proposed Landfill Expansion during the DEIS process, and, in a May 25, 1989 comment letter, stated the following, "staff have reviewed the site-specific hydrogeologic information, and it is our official determination that a principal aquifer does not underlie the site". Hydrogeologic data collected during investigations on property south of the Mill Seat Landfill are consistent with hydrogeologic conditions encountered in the area of the Mill Seat Landfill. Based on NYSDEC guidance described in TOGS 2.1.3 and site conditions found during subsequent investigations of the Proposed Site, evidence has not been found to contradict the 1989 NYSDEC determination that a principal aquifer does not underlie the Proposed Site.

4.2.4 Groundwater Usage

Prior to original landfill development, municipal water was not available in the area and an investigation of groundwater usage in the vicinity of the Permitted Site was conducted in 1989 by H&A as part of the original 6 NYCRR Part 360 Permit application for the Mill Seat Landfill. The survey documented properties having domestic and municipal groundwater wells within approximately one (1) mile of the Proposed Landfill Expansion. In addition, the Village of Bergen municipal well field and the production well field serving Comstock Foods were evaluated at that time to determine if the Mill Seat Landfill was situated within the well head areas for each of these well fields. The assessment concluded that the Mill Seat Landfill did not exist within the well head area for either well field based on the presence of a low-permeability stratigraphic unit subcropping between the Village and the Mill Seat Landfill.

The area within the 2014 water well survey area described in Section 3.2 is now serviced with municipal water provided by Monroe County Water Authority. Water lines were constructed in the area during the early 1990s and the majority of the wells within the H&A survey area were decommissioned. The Monroe County Water Authority conducts inspections once every five (5) years at residential properties where groundwater wells are used for residential irrigation.

To further assess groundwater in the area of the Proposed Landfill Expansion, Monroe County Department of Health and NYSDEC water well program database records were searched for private water wells installed within one-quarter mile upgradient and one (1) mile downgradient of the Proposed Site. Well locations are shown on Figure 9. Additionally, water well survey questionnaires were mailed to 83 property owners within the survey area described in Section

3.2. The database of survey results is included in Appendix G. Questionnaire respondents having either “in use” or “operable” (not in-filled or abandoned) wells are shown on Figure 9. The locations of public water supply lines installed by the Monroe County Water Authority are also shown on the figure.

5. Site Investigation Results

This section describes site geology and hydrologic conditions at the Mill Seat Landfill and Proposed Landfill Expansion.

5.1 Geology

Glacially-derived soils cover sedimentary bedrock in the Proposed Landfill Expansion and the area surrounding the Mill Seat Landfill. Principal geologic units encountered at both the Mill Seat Landfill and Proposed Landfill Expansion include:

- Isolated surficial sand and gravel deposits
- Coarser grained till
- Dense lodgment till
- Shale and limestone/dolostone bedrock

Geologic units identified above are described in the following sections and presented on geologic cross-section profiles oriented north-south and east-west on Figure 10 (Plate A) are shown on Figures 11and 12 (Plates B and C). The sections below describe geologic materials encountered.

5.1.1 Overburden

The United States Department of Agriculture (USDA) soils database was utilized to generate a map of surficial soil types present in the Mill Seat Landfill and Proposed Landfill Expansion and is provided as Figure 13. A description of soil types identified in the area of interest is included in Appendix H. The USDA soil mapping indicates that the Proposed Landfill Expansion and surrounding property are dominated by several silt-loam and silty clay-loam soils with surface slopes typically varying between 3 and 8% with slopes between 8 and 25% present along the flanks of the drumlins. Isolated areas of gravelly loam and gravelly fine sandy loam are also identified by USDA mapping within the Proposed Landfill Expansion. Wetland areas RG-5, RG-6 and RG-7 are identified as having a “muck” surficial soil expression. The surficial soil types identified in the USDA database are consistent with the USCS classifications of soil types identified in previous investigations. The presence of silty soil types with occasional, isolated areas of gravel loam were verified during site investigations completed south of the Permitted Footprint.

The thickness of the overburden materials encountered in borings completed in the Proposed Landfill Expansion area ranges from being absent (TP-9 2008) to 37 feet (SB02 2008). The greatest natural thickness of unconsolidated materials occurs in the central eastern portion of the Proposed Landfill Expansion area near Brew Road. Science Hill, located outside the Proposed Landfill Expansion area near the intersection of Brew and Bovee Roads southeast of the

Proposed Landfill Footprint, is a drumlin with over 40 feet of unconsolidated material. Areas having no or a thin cover of unconsolidated material occur in the southwestern portion of the investigation area in the wetland area (Wetland RG-5) of Hotel Creek and along Bovee Road west of the Science Hill drumlin. The isopach map shown on Figure 14 (Plate D) summarizes the total thickness of unconsolidated deposits in and around the Proposed Landfill Expansion area.

Based on a review of borings completed for the Mill Seat Landfill and Proposed Landfill Expansion area, laterally extensive overburden materials include: 1. Two (2) glacial till units: - a coarser-grained till and a dense lodgment till; and 2. a surficial deposit of sand and gravel. Overburden materials are described below:

Dense Lodgment Till: The dense lodgment till is laterally extensive beneath the Mill Seat Landfill and Proposed Landfill Expansion area. The till was found to directly overlay bedrock in the central and eastern portions of the Proposed Landfill Expansion area and was encountered beneath the sand and gravel unit (discussed below) in the southern and south-eastern portions of the Proposed Landfill Expansion. Where encountered, the dense lodgment till ranged in thickness between 3.6 feet (SB-2) and 28.8 feet (SB-02-2010) and was characterized as a dense to very dense red-brown to purple-red till composed of generally more than 50% fines (silt and clay fraction), with fine sand and trace to little gravel. The till exposed in test pits had a massive, blocky form, low moisture content, and was very hard. The till in several test pit exposures exhibited moderate plasticity. It was often difficult to excavate with a large track-mounted excavator due to its high degree of compaction. Typical N-values obtained from Standard Penetration Testing (SPT) were greater than 40 blows per foot. Permeability estimates for the till are very low (see Table 2). This would be expected based on grain size curves provided in Appendix C. As shown on grain, typical D_{10} coefficients of grain size are in the clay size particle range (<0.002 mm). D_{10} coefficients dictate soil permeability which is supported by Hazen’s Approximation for permeability estimates from grain size.

Coarser-Grained Till: The coarser-grained till is also laterally extensive and was found to cover the dense lodgment till across much of the Mill Seat Landfill and Proposed Landfill Expansion area except in the central and south-central portion of the Proposed Landfill Expansion area where the lodgment till is absent. In the eastern portions of the Proposed Landfill Expansion area, the coarser-grained till is less prevalent and is replaced by the sand and gravel deposits (described below) which directly overly the dense lodgment till. This relationship is illustrated on geologic cross sections A-A’ through C-C’ presented on Plates B and C. The coarser-grained till unit was present at its greatest thickness (45.2 feet) at boring SB-11(2008) located on the flank of the Science Hill Drumlin southeast of the Proposed Landfill Expansion area. Where present and excluding boring SB-11(2008), the coarser-grained till varied in thickness between less than one (1) foot at the SEA-1 series monitoring wells and 21.7 feet at SB-08 (2008). The till is a dark brown to reddish brown sandy, clayey silt with little fine sand. Frequent large cobbles and small boulders were encountered within the coarser-grained till during the test pit investigation program and grain size analysis indicate the coarse-grained till frequently has higher percentages of gravel than the lodgment till. The coarser-grained till is less dense than the lodgment till as indicated by Standard Penetration Testing (SPT) N-values which are typically less than 20 blows per foot. The density and composition difference between the two (2) tills was readily apparent during the test pit program and most split spoon samples. The coarser-grained till was generally easier to excavate than the lodgment till and included cobble and boulder size material. Typical D_{10} coefficients for coarser-grained till samples were clay size particles suggesting low permeability similar to lodgement till.

The permeability of the till soil is low based on measured values obtained by slug tests completed in saturated till material and laboratory testing of remolded and in-situ soil (the till density was sufficient to obtain one Shelby tube at SB-7, collected during the 2006 Geomatrix investigation) by ASTM D5084 Method C. Till soil permeability is in a range of 7.96×10^{-6} cm/s to 2.7×10^{-8} cm/s.

Sand and Gravel Deposits: Sand and gravel deposits were encountered beneath the ground surface in the southeastern portion of the Proposed Landfill Expansion area near Brew Road and a few isolated areas in the western and southern portion of the Proposed Landfill Expansion area. The sand and gravel unit is described as loose to firm, well graded sand with medium to coarse subangular gravel. Substantial quantities of cobble size materials were observed in each of the test pit excavations. The lithology of the gravel and cobbles is generally shale and limestone. The subangular shape of the gravel and cobbles and compact nature of the sand and silt matrix suggests glacial deposition (non-fluvial or non-lacustrine).

A 2008 geophysical survey conducted by AMEC-Geomatrix proved successful in mapping the extent of sand and gravel in the 2006 and 2008 investigation areas. The geophysical survey results were field verified through test pit excavation and/or soil borings sampled in areas where sand and gravel presence/absence was inferred from the survey. The sand and gravel deposits encountered in the investigation area are isolated and discontinuous. Figure 15 (Plate E) depicts the mapped extent and thickness of sand and gravel deposits identified across the Proposed Landfill Expansion area. The most expansive area of surficial sand and gravel deposits occurs in the central-eastern portion of the Proposed Landfill Expansion area, in the vicinity of the MW-SEA-4 series monitoring wells. The sand and gravel deposits in that portion of the investigation area cover approximately 18 acres of the Proposed Site. Smaller areas covered by sand and gravel deposits (less than three {3} acres) were encountered at test pit TP-03 (2008) and soil borings SB-06 (2008), SB-08 (2006) and SB-01-2010. The maximum thickness of sand and gravel encountered was 17 feet at soil boring SB-01-2010 in the southeastern portion of the Proposed Landfill Expansion area. Seasonally saturated conditions were noted in the bottom one (1) to two (2) feet of the sand and gravel deposits during the 2008 AMEC-Geomatrix test-pit investigation which occurred during a high water table condition (March). However, the sand and gravel deposits are typically unsaturated and would be removed for base grade preparation during landfill construction.

5.1.2 Bedrock

The bedrock in the area of the Mill Seat Landfill is the Vernon Formation (C-Horizon) which has been extensively evaluated during investigations for the original permit application for the existing permitted footprint. The bedrock is composed of an interbedded shale and limestone/dolostone that frequently exhibits a high degree of weathering near its top and where shale is more prevalent than limestone. In most areas, the weathered bedrock is sufficiently soft to be recovered by a split-spoon sampler and was easily excavated during test pit excavation. The weathered bedrock is described as a gray to olive brown shale with interbedded clay and resistant layers of limestone. The weathered bedrock zone was typically one (1) to three (3) feet thick and as much as ten (10) feet thick at well MW-02 (2006) and 14 feet thick at TP09 (2008).

Figure 16 (Plate F) depicts the bedrock topography using a two (2) foot contour interval across the Mill Seat Landfill and the Proposed Landfill Expansion area. The bedrock surface generally slopes from west to east with its highest elevation occurring at Proposed Landfill Expansion area monitoring well MW-SEA-1B (671.08 feet msl) and its lowest elevation occurring east of Brew Road at SB-02-2010 (632.1feet msl). The bedrock occurs closest to the ground surface in the investigation area northwest of the Proposed Landfill Expansion area at monitoring well cluster MW-SEA-1, where less than one (1) foot of overburden material is present and beneath the nearby wetland RG-5 located directly west. Weathered shale bedrock is also exposed at the ground surface at test pit location TP-09 (2008), adjacent to Wetland RG-5 where it parallels Hotel Creek south of the proposed expansion.

In the Proposed Landfill Expansion area, the Vernon CB Horizon is a thin, one (1) to three (3) foot thick zone of argillaceous dolomite located within the Vernon C Horizon and is characterized by a grey color, abundant vugs and comparatively fewer joints and fractures than the surrounding C Horizon. The Vernon CB Horizon was encountered in the Proposed Landfill Expansion area in rock core at piezometer locations PZ-SEA-1Z (59 fbgs), PZ-SEA-3Z (75.5 fbgs) and PZ-SEA-5Z (48 fbgs).

The Vernon B Horizon was encountered at deep exploratory boring P-8S (at an approximate elevation of 618 fasl) and at monitoring wells M-8B and M-8Z (at an approximate elevation of 630 fasl) during the 1989 and 1991 H&A investigations, respectively. The Vernon B Horizon is described as a grey-green mudstone with interbedded dolomitic shale and dolostone beds, evaporite (gypsum) seams and a 10-foot thick highly evaporitic interval. The Vernon B Horizon reaches a thickness of approximately 40 feet in the study area.

The Vernon A Horizon was encountered in boring P-8S, at an approximate elevation of 578 fasl and is the lowermost stratigraphic unit characterized at the Mill Seat Landfill. The Vernon A Horizon consists locally of approximately 150 feet of grey-green interbedded shale, mudstone, dolomitic shales, dolostones and evaporate deposits, and is bounded at the base by the Lockport Formation. The stratigraphic relationship between the Vernon A, B, C and CB Horizons is shown on geologic cross- sections A-A’ through F-F’, provided on Plates B and C.

5.2 Hydrogeology

The hydrogeology of the Mill Seat Landfill and the Proposed Landfill Expansion area has been characterized as consisting of four (4) distinct flow zones. The results of the 2013-2014 GEI hydrogeologic investigation are discussed below and are based on the following flow zones documented in previous investigations at the Mill Seat Landfill:

- ***Water Table:*** occurring in the shallow unconsolidated materials generally within seven (7) to ten (10) feet of the ground surface.

- ***B Zone***: consisting of the lowermost portions of the unconsolidated overburden and a portion of the upper weathered bedrock.

- ***A Zone:*** consisting of unweathered portions of the Vernon Shale bedrock generally between 15 and 30 feet below the top of bedrock.

- ***Z Zone:*** consisting of deeper bedrock intervals generally between 30 and 80 feet below the top of bedrock.

A discussion of the hydrogeologic characteristics of each is provided in the following sections. Tables 6 and 7 summarize calculations of horizontal and vertical hydraulic gradients and groundwater seepage velocities for each of the zones above, respectively.

5.2.1 Water Table

Unconfined groundwater exists in the Proposed Landfill Expansion area. When compared to the existing Mill Seat Landfill, the thicker section of saturated, low permeability glacial material and limited areas of sand and gravel deposits in the Proposed Landfill Expansion area allow water table conditions to occur. The water table beneath the existing Permitted Landfill was generally eliminated during the excavation of overburden materials and installation of the groundwater suppression system (GWSS) during initial development.

In the Proposed Landfill Expansion area, the unconfined groundwater was studied by seven (7) piezometers and monitoring wells installed in the overburden materials and water table surface water expressions using four (4) staff gauges installed in Wetlands RG-5, RG-6 and in Hotel Creek. Groundwater elevations were measured at each of these monitoring locations in November 2013 and April 2014, considered to be representative of typical seasonal low and seasonal high groundwater conditions, respectively. Groundwater contour maps were prepared using the November 2013 and April 2014 events and are shown on Figures 17 and 18 (Plates G and H). Under current conditions (undeveloped), the movement of shallow groundwater (water table flow) is directed radially southward from Wetland RG-6 and discharges to Hotel Creek and Wetlands RG-5 and RG-7. Horizontal hydraulic conductivity estimates for unconfined groundwater in the Proposed Landfill Expansion area are based on rising head tests performed in piezometers PZ-01-2010 (1.60×10^{-6} cm/s) and MW-1S (2006) (7.92×10^{-6} cm/s). A geometric mean hydraulic conductivity value of 3.68×10^{-6} cm/s was calculated for the saturated unconsolidated materials at the Mill Seat Landfill (removed during site development) and in the Proposed Landfill Expansion. This hydraulic conductivity value for the unconsolidated deposits meets the landfill siting minimum permeability requirements presented in 6 NYCRR Part 360-2.12(a)(1)(vi).

The average linear groundwater flow velocity (seepage velocity) of unconfined groundwater was calculated between piezometers PZ-2 (2006) and PZ-05 (2008). Using a conservative effective porosity value (n_e) of 15% (Fetter, 1994) for the overburden till material, the average linear velocity of groundwater seepage in the saturated till is 1.72x10-7 cm/s (0.0005 ft/day).

As landfill development extends into the Proposed Landfill Expansion area, the relocation of Wetland RG-6, removal of overburden material, and construction of the landfill liner system will eliminate vertical beneath the Proposed Footprint. As a result, the water table in the Proposed Expansion Area will be lowered to levels corresponding to the B-Zone (see Section 5.2.2). This condition occurred beneath the Mill Seat Landfill where 22 of 23 gravity flow underdrain outlets beneath the landfill that collected overburden groundwater during early landfill development became dry.

5.2.2 B-Zone

Referred to as the B-Zone in studies completed for hydrogeologic characterization for the Permitted Footprint and the “upper water-bearing zone” in studies completed for the soil borrow areas, groundwater occurring in the till and shallow weathered bedrock comprise the upper saturated portion of the CSS described in Section 5.6. The weathered bedrock is described as bedrock which is soft enough to auger into and sample with a split spoon sampler. The saturated thickness of the B-Zone is variable ranging from approximately 15 to 20 feet within the low hydraulically conductive soil located in the central portion of the Proposed Landfill Expansion and thins to only one (1) to two (2) feet in a southerly direction toward Hotel Creek.

Groundwater elevation data for the water level monitoring events recorded in November 2013 and April 2014 for wells and piezometers screened in the B-Zone in the Proposed Landfill Expansion area are contoured on Figures 19 and 20 (Plates I and J), respectively. Groundwater flow in the B-Zone is east to northeastward beneath the Mill Seat Landfill with discharge to Wetland RG-7. The groundwater flow direction is also eastward across much of the Proposed Landfill Expansion area, with a southerly flow component discharging to Wetland RG-5 and Hotel Creek in the southernmost portions. A horizontal hydraulic gradient of 0.002 was calculated for the dominant easterly groundwater flow component in the B-Zone flow regime across the Proposed Landfill Expansion area for both the November 2013 and April 2014 groundwater elevation measurement events. The calculation was performed between the SEA-1 series and SEA-5 series monitoring wells.

Vertical hydraulic gradients between the B-Zone and A-Zone are generally flat, with a slightly downward component across the Proposed Landfill Expansion area ranging in magnitude from 0.01 at the SEA-1and SEA-4 series wells, to 0.23 at the SEA-5 series wells. Across the Mill Seat Landfill, upward vertical gradients from the A-Zone to the B-Zone flow system are seasonally persistent along the eastern and northeastern flank of the Mill Seat Landfill (at monitoring well series M14, M15, M16, M17 and M19) where B-Zone groundwater discharges to surface water in Wetland RG-7. Along the northern flank of the Mill Seat Landfill (monitoring well series M8, M19, M20 and M22) the vertical gradient was slightly downward from the B-Zone to the underlying A-Zone during the November (low groundwater) elevation monitoring event and upward during the April 2014 (high groundwater) monitoring event. Hydraulic conductivity estimates for B-Zone monitoring wells in the Proposed Landfill Expansion area range from a low of $5.2x10^{-6}$ cm/s at MW-SEA-5B to $2.3x10^{-3}$ cm/s at MW-SEA-2B. A geometric mean hydraulic conductivity value of $1.06x10^{-3}$ cm/s was calculated for wells screening the B-Zone flow system (Table 4). An average linear groundwater flow velocity of $3.2x10^{-4}$ cm/s (0.91 ft/day) was calculated for the B-Zone (see Table 7).

Hydraulic conductivity values for the weathered bedrock comprising the B-Zone flow system are substantially higher than the till above which suggests that nearly all shallow bedrock groundwater recharge occurs in wetland areas at the property boundaries (well beyond the extent of the Proposed Site) where little to no low permeability soil is present.

5.2.3 A-Zone

Groundwater flow in the A-Zone occurs primarily in bedding plane fractures and in moderately to severely weathered vertical and high angle joint sets identified in rock core retrieved from the Vernon C Horizon. Based on the review of boring logs completed during previous investigations and rock core obtained during the 2013-2014 GEI investigation, the A-Zone portion of the CSS extends to a depth of approximately 30 feet below the top of bedrock in the Proposed Landfill Expansion area. The upper-most portions of the A-Zone bedrock are characterized in bedrock core as having Rock Quality Designation values typically less than 20% and is described as "intensely fractured".

Groundwater contour maps for the A-Zone bedrock flow were prepared for the November 2013 and April 2014 groundwater elevation measurement events and are provided as Figures 21 and 22, respectively (Plates K and L). A-Zone groundwater elevations are highest in the west-central portion of the Proposed Landfill Expansion area near monitoring well MW-SEA-1A. From this groundwater high, A-zone groundwater flow is northeasterly beneath the Permitted Footprint and easterly to southeasterly across the Proposed Landfill Expansion area. A horizontal hydraulic gradient of 0.003 was calculated between the MW-SEA-1 series and MW-SEA-5 series in the A-Zone flow regime for both the November 2013 and April 2014 groundwater elevation measurement events. As discussed in Section 5.2.2, vertical hydraulic gradients between the A-Zone and overlying B-Zone are slightly downward in the Proposed Landfill Expansion area and are seasonally and spatially variable across the Mill Seat Landfill. Calculated vertical gradients between the A-Zone and deeper Z-Zone flow in the Proposed Landfill Expansion were generally flat and ranged from slightly upward (-0.003 to -0.06) toward the A-Zone in monitoring well series MW-SEA-1 and MW-SEA-3 and slightly downward (0.003 to 0.17) in well series MW-SEA-5 and MW-SEA-6 for both groundwater elevation measurement events. No definitive vertical groundwater flow direction was observed in bedrock below the Proposed Landfill Expansion area and flow is generally horizontal.

Beneath the Permitted Site and Proposed Landfill Expansion, vertical hydraulic gradients between the A-Zone and Z-Zone are spatially variable; however, the magnitude and direction of the gradients are generally consistent between seasonal high and low water level conditions in each well series. A summary of vertical hydraulic gradient calculations is presented in Table 6.

Horizontal hydraulic conductivity estimates for A-Zone flow (Vernon C & CB Horizons) were calculated for wells installed during the 2013-2014 GEI investigation and are compiled with hydraulic conductivity data from previous investigations. In the Proposed Landfill Expansion, A-Zone well hydraulic conductivity values calculated from rising head tests range between 7.8×10^{-3} cm/s at MW-SEA-3A to 2.6×10^{-1} cm/s at MW-SEA-1A with a geometric mean of 1.0×10^{-3} cm/s. An average linear groundwater flow velocity of 3.3×10^{-4} cm/s (0.93 ft/day) was calculated for the A-Zone flow regime (Table 7).

Hydraulic conductivity estimates were also calculated from straddle packer tests described in Section 3.5. Packer testing calculation sheets are presented in Appendix F. Hydraulic conductivity values for each tested interval are provided in Table 4. The values are derived from methods presented in Houlsby (1976) which establishes a representative hydraulic conductivity (or Lugeon value) based on the progression of Lugeon patterns for each tested interval. A-Zone hydraulic conductivity values estimated from packer tests were generally an order of magnitude lower than slug test data for comparable test intervals and packer test hydraulic conductivity values ranged from 8.9×10^{-4} cm/s (MW-SEA-3Z, 26-36’ bedrock test interval) to 1.4×10^{-3} cm/s (MW-SEA-2A, 22-32 fbgs bedrock interval).

5.2.4 Z-Zone

The Z-Zone is the lowermost hydrogeologic unit characterized for the Permitted Footprint and Proposed Footprint. The Z-Zone consists of a bedrock interval generally between 40 and 80 feet below the top of bedrock which includes the Vernon C, CB and B Horizons beneath the Mill Seat Landfill where the stratigraphically lower Vernon B Horizon is closer to the ground surface and the Vernon C and CB Horizons beneath the Proposed Footprint (see Geologic Cross Sections A-A’ through C-C’ on Plate B) RQD values for Z-Zone rock core retrieved from borings in the Proposed Footprint vary between 27% and 63% indicating that groundwater flow within the Z-Zone is dominated by secondary porosity attributed to only slightly weathered bedding plane fractures and regional joint sets in the shale/dolostone bedrock. The groundwater flow direction in the Z-Zone is north-easterly beneath the Mill Seat Landfill and easterly beneath the Proposed

Footprint. Groundwater contour maps generated for the Z-Zone bedrock are provided on Figures 23 and 24 (Plates M and N) for the November 2013 and April 2014 groundwater elevation measurement events, respectively. Z-Zone groundwater elevations generally vary less than three (3) feet seasonally, and the vertical hydraulic gradients between the Z-Zone and the A-Zone are seasonally similar in magnitude and direction in each well series.

Horizontal hydraulic conductivity estimates for the Z-Zone bedrock were calculated from rising head tests performed on monitoring wells installed during the 2013-2014 GEI investigation which are compiled in Table 4 with hydraulic conductivity data from previous investigations performed for the Mill Seat Landfill. A site-wide geometric mean hydraulic conductivity value of $2.09x10^{-4}$ cm/s was calculated for monitoring points screening the deep Z-Zone flow regime, approximately an order of magnitude lower than the geometric mean for the overlying A-Zone bedrock interval ($1.09x10^{-3}$ cm/s). Hydraulic conductivity estimates calculated from straddle packer testing at comparable Z-Zone bedrock intervals are generally an order of magnitude lower than data calculated from rising head tests from comparable test intervals. An average linear groundwater flow velocity of $8.36x10^{-5}$ cm/s (0.24 ft/day) was calculated for the Z-Zone flow regime (Table 7) which is about 75% lower than the A-Zone flow velocity.

5.3 Groundwater Quality

Groundwater quality at the Mill Seat Landfill has been monitored for nearly two (2) decades. The current groundwater quality monitoring program for the Mill Seat Landfill includes sampling of: 17 wells screened in the B-Zone (lower overburden/weathered bedrock interface), 18 wells screened in the A-Zone (upper 20 feet of bedrock), and seven (7) wells screened in the Z-Zone (approximately 40 to 80 below the top of bedrock).

Groundwater monitoring wells installed in and around the Proposed Landfill Expansion were sampled during the Fourth Quarter 2013 and the Second Quarter 2014, concurrent with the existing quarterly landfill monitoring program, to assess groundwater quality in the Proposed Landfill Expansion area. The timing of sampling was such that seasonal low and seasonal high groundwater conditions were represented. Laboratory analytical data are included in Appendix I. MAKuel Company reviewed the Category 4 laboratory data packages and five (5) percent of the sampled data were validated. The data validation report is included in Appendix J. Laboratory data for samples collected during each sampling event in the Proposed Landfill Expansion area are summarized in Tables 8 and 9.

Groundwater quality in the B-Zone, A-Zone, and Z-Zone in the Proposed Landfill Expansion area is discussed below and includes a comparison of constituent concentrations with NYS TOGS 1.1.1 Groundwater Quality Standards (NYGWQS), as well as, comparisons to general water quality results observed in the area of the Permitted Footprint. Hydrogeochemical plots (Stiff and Piper Diagrams) were prepared for groundwater samples collected from wells monitoring the Mill Seat Landfill and the Proposed Landfill Expansion area for both the November 2013 and April 2014 groundwater sampling events. Hydrochemical plots are provided in Appendix K. These plots support the evaluation of groundwater in the Proposed Landfill Expansion area.

5.3.1 B-Zone

In general, groundwater in the lower overburden and weathered bedrock is commonly high in total hardness having typical concentrations above 1,000 mg/L. Total dissolved solids (TDS) and dissolved concentrations of naturally-occurring metals including iron, magnesium and sodium are frequently elevated when compared to NYGWQS in groundwater. This is true in both the Mill Seat Landfill and in the Proposed Landfill Expansion area.

B-Zone groundwater in the Proposed Landfill Expansion area plots consistently on the left side of the central trilinear (Piper) diagram for both the November 2013 and April 2014 sampling events, indicating a dominance of calcium and magnesium type cations and bicarbonate and sulfate type anions. This would be expected for a calcareous shale bedrock having gypsum and dolomite mineralization. The variability in the B-Zone groundwater plot locations in the central field of the Piper diagram and on the Stiff plots is due to the varying sulfate and carbonate concentrations in groundwater samples. Locally variable sulfate concentrations in B-Zone groundwater is likely affected by well screen depth in bedrock, the presence of evaporate minerals (e.g., gypsum), and distance to Wetlands RG-5 and RG-7 which discharge/recharge upper bedrock groundwater. Comparing the B-Zone water quality from wells installed in the Proposed Landfill Expansion area to those monitoring the Mill Seat Landfill, the B-Zone wells in the Proposed Landfill Expansion area tend to have lower sulfate concentrations as they are more distant from the wetland areas. The Stiff diagrams prepared for B-Zone groundwater also reflect local variability in groundwater geochemistry for both the Mill Seat Landfill and the Proposed Landfill Expansion area, with calcium and sulfate concentrations largely dictating the shape of each plot.

The overall B-Zone groundwater quality in the Proposed Landfill Expansion area is comparable to groundwater quality at the Mill Seat Landfill. Sample results for B-Zone wells monitoring the Proposed Landfill Expansion area frequently exhibit naturally elevated concentrations of TDS, iron, magnesium and, to a lesser extent, sodium when compared to NYGWQS. Color and turbidity were also frequently elevated. These constituents are also found to occur naturally at elevated concentrations in upgradient and downgradient wells that monitor the Mill Seat Landfill. In addition to the above mentioned constituents that are naturally elevated in background groundwater quality, the following constituents were detected above NYGWQS in the B-Zone groundwater from wells in the Proposed Landfill Expansion area during the November 2013 sampling event:

- Arsenic (0.027 mg/L – NYGWQS is 0.025 mg/L) and selenium (0.068 mg/L – NYGWQS is 0.010 mg/L) at MW-SEA-2B; and

- Hexavalent chromium (0.011 mg/L- NYGWQS is 0.05 mg/L) at MW-SEA-4B

The metals listed above were not detected at elevated concentrations in other B-Zone wells. Volatile organic compounds, semi-volatile organic compounds, and PCBs were either not detected or detected at concentrations below NYGWQS. Alpha-BHC, an organochlorine pesticide (insecticide), was detected in the sample collected from well MW-SEA-4B at a concentration of 0.011 ug/L, slightly above the NYGWQS of 0.01 ug/L.

During the April 2014 sampling event, the following constituents were detected above NYGWQS in Proposed Landfill Expansion groundwater from the B-Zone:

- Nitrate in MW-1S (10.8 mg/L) and MW-SEA-2B (15.6 mg/L) which are above the NYGWQS of 10 mg/L

Arsenic and selenium were not detected in at MW-SEA-2B during the second sampling event. Hexavalent chromium was not detected in well MW-SEA-4B during the second sampling event. The detections of these metals may be a false positive and four (4) quarters of background sampling will confirm the positive detections of these metals in B-zone groundwater. Nitrate presence in B-Zone wells is not surprising since much of the property surrounding and including the Proposed Footprint has been used as farmland and nitrogen-based fertilizers were applied for nutrient addition for crop growth.

5.3.2 A-Zone

Shallow bedrock groundwater at both the Mill Seat Landfill and in the Proposed Landfill Expansion area is generally comparable to the B-Zone although sulfate, total hardness and TDS concentrations are typically higher in A-Zone groundwater. A-Zone groundwater samples from both the Mill Seat Landfill and the Proposed Landfill Expansion area occupy similar plot locations as B-Zone groundwater on the Piper diagram with a more prevalent dominance of the sulfate anion (see Appendix K). Samples from wells that plot lower on the diagram are likely reflective of locally lower sulfate concentrations. Similarly to B-Zone groundwater, Stiff diagram shape is driven largely by the relative concentrations of calcium and sulfate ions, with no significant variability in overall geochemistry between the November 2013 and April 2014 sampling events.

Besides the B-Zone mentioned constituents that are naturally elevated in background groundwater quality, bromide (3.3 mg/L) was the other naturally occurring constituent detected above NYGWQS in Proposed Landfill Expansion A-Zone wells during the April 2014 sampling event. Bromide was not detected in samples collected from the well during the November 2013 sampling event. Bromide is a constituent found in salt and is occasionally detected at elevated concentrations in wells monitoring the Mill Seat Landfill. Salt presence is natural to the Vernon Formation and bromide detection is not considered anomalous in bedrock groundwater at the Mill Seat Landfill or Proposed Landfill Expansion.

5.3.3 Z-Zone

The deep bedrock Z-Zone groundwater quality is generally marked by increased concentrations of sulfate, TDS and total hardness when compared to the A- and B- Zones at the Mill Seat Landfill and in the Proposed Landfill Expansion area. Deeper bedrock groundwater samples also reflect increased concentrations of dissolved metals, including boron, calcium, magnesium, potassium and sodium. Slightly to moderately reducing conditions are often encountered in the deeper bedrock flow system beneath the Mill Seat Landfill, however; Proposed Landfill Expansion deep bedrock wells exhibited slightly to moderately oxidizing conditions during the November 2013 and April 2014 sampling events. Piper plots generated for the Mill Seat Landfill and Proposed Landfill Expansion Z-Zone groundwater samples indicate a dominance of the sulfate and calcium ions for both the November 2013 and April 2014 sampling events (see Appendix K). Excluding well M1Z in November 2013 and PZ-SEA-3Z in April 2014, located in the southwest corner of the Mill Seat Landfill which exhibits higher concentrations of carbonate alkalinity and lower sulfate concentrations driving its plot location lower in the central field for both sampling events, Z-Zone wells plot at apex of the Piper Plot. Stiff diagram shapes differ from B- and A-Zone groundwater due to higher concentrations of cations and anions.

Besides the naturally elevated constituent concentrations in background groundwater quality (boron, iron, magnesium, sulfate, TDS, color and turbidity), no other constituents were detected above NYGWQS in the Z-Zone groundwater samples analyzed from the Proposed Landfill Expansion.

5.4 Surface Water Quality

Surface water quality in Hotel Creek and surrounding wetland areas is monitored on a quarterly basis at seven (7) locations shown on Figure 25. Monitoring locations S-3 and S-4 monitor surface water quality in Wetland RG-7 and location S-6 monitors surface water quality in the northwest corner of Wetland RG-5. Monitoring locations S-1, S-2 and S-5 monitor surface water quality in Hotel Creek south of the Mill Seat Landfill. Monitoring location S-8 is located approximately three (3) miles downstream of the Mill Seat Landfill and monitors surface water quality in Hotel Creek at an intersection with State Route 33. Time-series plots of several leachate indicator parameters were generated for each surface water quality monitoring point using historic analytical data dating from pre-landfill construction monitoring to present and are presented in Appendix L. Plots were generated for the following parameters:

- Dissolved Oxygen
- Chemical Oxygen Demand (COD)
- Biological Oxygen Demand (BOD)
- Total Dissolved Solids (TDS)
- Chloride

- Sulfate
- pH

A linear regression analysis trend line is provided on each time-series plot to establish the overall trend in concentration of each analyte. Monitoring locations that are situated nearby public or landfill access roadways (locations S-2, S-3, S-4, S-5 and S-8) exhibit a slightly upward chloride concentration trend over the duration of the 27 year monitoring period. This trend is most likely attributable to the application of deicing materials (road salt) on roadways during the winter months.

Dissolved oxygen concentrations at wetland surface water monitoring locations (S-3, S-4 and S-6) have exhibited a slight decrease over the monitoring period. These wetland areas are generally characterized as containing abundant organic matter and minimal water flow leading to more stagnant conditions and oxygen deprived conditions than the Hotel Creek monitoring locations. It is hypothesized that this somewhat oxygen-depleted surface water from Wetlands RG-5 and RG-7 that discharge to Hotel Creek south of the Permitted Site may influence dissolved oxygen concentrations at surface water sampling locations S-2 and S-5, which also exhibit a slight downward trend over time. Upgradient surface water sampling monitoring location S-1 exhibits a neutral to slightly upward dissolved oxygen trend.

As reported in quarterly environmental monitoring reports, landfill related constituents have not been detected in groundwater or surface water discharging from the Mill Seat Landfill. Changes in surface water quality to nearby wetlands or Hotel Creek are not landfill related.

5.5 Groundwater/Surface Water Interaction

Surface water is present in the Proposed Landfill Expansion area at Wetland RG-6 and the drainage swale that flows south to Hotel Creek. Surface water is also present west and east of the Proposed Landfill Expansion area at Wetland RG-5 and Wetland RG-7, respectively. The wetlands serve as temporal recharge/discharge areas of overburden and, in the case of Wetlands RG-5 and RG-7, upper bedrock groundwater. Wetland RG-6 is uniquely different from RG-5 and RG-7 in that RG-6 is comparatively small, isolated, lies in an elevated area of thicker till deposits, and is recharged almost exclusively by on-site precipitation and surface runoff (AMEC Geomatrix, 2011).

The surface water elevation in Wetland RG-6 (SG-2) varied by less than 0.6 feet during water level monitoring conducted during several years of monitoring. H&A (1989) also noted a near static head in the wetland during the hydrogeologic investigation of the Permitted Site. Surface water elevation in the wetland is held relatively constant through surface water discharge to the drainage swale that flows south across the investigation area to Hotel Creek. As reported by AMEC Geomatrix (2011), heads in wells located in close proximity to Wetland RG-6 (M-7B and PZ-2) were higher than the wetland surface water elevations recorded in 2007; however, the head at well M-7B was lower in 2008. During the 2013/2014 investigation, heads in M-7B and PZ-2 were lower than the surface water elevation at SG-2 in November 2013 and February 2014 but higher in April 2014. These data indicate that Wetland RG-6 is a seasonally dependent area of both groundwater recharge and discharge.

Precipitation that falls on Wetland RG-6 and precipitation that falls on the land surface near the wetland and on the south side of the Mill Seat Landfill flows overland (runoff) and recharges surface water in Wetland RG-6. As mentioned previously, groundwater temporally recharges the wetland. However, the volume of recharge from groundwater is substantially lower compared to the volume of recharge from precipitation and runoff. This is due to the low hydraulic conductivity of the saturated till and the low hydraulic gradients in the area of the wetland that effectively constrain the volume of groundwater that discharges to the wetland.

As reported by AMEC Geomatrix (2011), the volume of precipitation that annually falls in the area of Wetland RG-6 that could flow overland into the wetland is estimated to be 9,900 cubic feet per day. During hydraulic conditions that favor groundwater discharge to the wetland, the volume of groundwater discharging to the wetland is conservatively estimated to be 20 cubic feet per day. Precipitation and runoff is the dominant mechanism of recharge to Wetland RG-6, with groundwater discharge accounting for less than one half of one percent (<0.5%) of the total flow to the wetland. The calculation was performed by AMEC Geomatrix and is provided in Appendix M.

Surface water elevations measured in Wetland RG-5 (SG-3) are nearly ten (10) feet lower than Wetland RG-6. In fact, the surface water elevation in Wetland RG-5 is similar to the elevation of the bedrock surface and bedrock groundwater elevations measured in well M-1A (the B-well at that location is dry). These data support a conclusion that Wetland RG-5 is a receptor of overburden and shallow bedrock groundwater (B-zone groundwater flow) west of the investigation area in addition to precipitation and surface water runoff. Similar conditions are anticipated for Wetland RG-7 which is located more than 1,000 feet east of the Proposed Footprint. The ground surface topography drops rapidly into the wetland area east of Brew Road and the overburden thickness thins allowing bedrock groundwater to discharge to the wetland. Precipitation and surface water runoff are the primary mechanisms of recharge to these wetland areas. The discussion below supports this statement.

As mentioned above, Wetlands RG-5 and RG-7 are recharged by direct precipitation falling on the wetland, overland transport of precipitation falling within the wetland watershed area, and the discharge of groundwater from bedrock and, to a lesser extent, overburden. GEI estimated the average annualized recharge rate to Wetland RG-5 and Wetland RG-7 under current site conditions in Appendix M. The calculation assumes 50% of the annual precipitation that falls directly on the wetland areas and 20% of the precipitation that falls within the watershed area of each wetland reaches the wetland areas via overland flow. The calculation also estimates a Darcy groundwater discharge rate using the average hydraulic conductivity of the B-zone (lower overburden and upper bedrock), B-zone horizontal hydraulic gradient, and cross-sectional flow inclusive of the length of the wetland perpendicular to groundwater flow and the upper 30-feet of the bedrock (inclusive of B- and A-Zone groundwater). Based on this calculation, annualized recharge rates to the adjacent wetlands are as follows:

Wetland RG-5

- Recharge via direct precipitation and overland flow = 33,065 cubic ft/ day
- Recharge via groundwater discharge = 1,744 cubic ft/day
- Recharge via RG-6 outlet (outlet flows through RG-5 before discharging to Hotel Creek) = 9,900 cubic ft/day

Estimated Total Annualized Wetland RG-5 Recharge Rate = 44,700 cubic ft/day

Wetland RG-7

- Recharge via direct precipitation and overland flow = 36,312 cubic ft/ day
- Recharge via groundwater discharge = 2,066 cubic ft/day

Estimated Total Annualized Wetland RG-7 Recharge Rate = 38,400 cubic ft/day

Based on these calculations, 95% or more of wetland recharge is derived from precipitation and overland flow to the nearby wetlands.

The surface water elevation of Hotel Creek near Brew Road (SG-1) was approximately 651 feet msl during each of the three (3) monitoring events. The creek is situated in a topographic low approximately 3,500 feet south of the Mill Seat Landfill and approximately 400 feet south of the southernmost portion of the Proposed Footprint. As observed by site reconnaissance and in test pit excavations completed immediately north of Hotel Creek, bedrock outcrops in the topographically low area near Hotel Creek in the area of Wetland RG-5. Where shallow water table conditions exist in the bedrock, bedrock groundwater discharges to Hotel Creek in the area of Wetland RG-5. Hotel Creek receives overland flow from surface area within its watershed (see Section 4.2.1).

Landfill construction will alter the annualized recharge rates calculated for Wetland RG-5, RG-6, and RG-7. Wetland RG-6 lies within the Proposed Footprint and will be relocated to the Proposed Wetland Mitigation Property south of Bovee Road. As a result, discharge from the Proposed Footprint will be diverted to either RG-5 or RG-7. In addition, the contour of the proposed final landfill cover and slope of landfill perimeter drainage ditches will redirect a portion of surface water drainage currently flowing to Wetland RG-5 (approximately 57 acres) to Wetland RG-7 via the proposed eastern storm water detention pond. The calculation of watershed flow diversion after landfill construction is included in Appendix M. As shown in the calculation, landfill construction is estimated to result in an approximate 10% increase in recharge to the southern portion of Wetland RG-7 and an approximate 9% reduction in the annualized recharge to the eastern portion of Wetland RG-5 paralleling Hotel Creek west of Brew Road. Since surface water in Wetlands RG-5 and RG-7 ultimately discharge to Hotel Creek, no net decrease or increase in annualized flow would be measured in Hotel Creek east of the Proposed Footprint at Johnson Road as a result of landfill expansion.

5.6 Critical Stratigraphic Section

The CSS below a solid waste facility is defined in 6 NYCRR Part 360 as all stratigraphic units into which contaminants that theoretically escape from the facility might reasonably be expected to enter and cause contamination. Definition of the CSS at the Mill Seat Landfill was a major goal of the 1989 Hydrogeologic Investigation, which concluded that the CSS is composed of the overburden and upper 30 feet of the Vernon Shale bedrock (B-Zone and A-Zone groundwater). During the initial investigation for the Mill Seat Landfill, the bedrock portion of the CSS was established from approximation of groundwater flow paths inferred from pumping tests and packer tests. The conclusion was based on bedrock hydraulic conductivity values that were two (2) orders of magnitude greater for wells screened in the upper 30 feet of bedrock compared to those estimated for bedrock deeper than 40 feet (Z-Zone).

For the Permitted Site, previous hydrogeologic investigations defined the CSS as “groundwater flow in the unconsolidated glacial deposits and upper 30 to 40 feet of bedrock.” The detection monitoring well network at the Mill Seat Landfill monitors two (2) distinct sections of the CSS:

- B Zone wells – screened to monitor the upper portion of the CSS that includes the overburden and a portion of the weathered upper bedrock surface; and

- A Zone wells – screened to monitor the lower portion of the CSS, generally between 15 to 30 feet below the top of bedrock.

During a meeting between NYSDEC, WMNY and GEI on July 26, 2013 and documented in e-mail correspondence dated August 6, 2013 (Appendix A), NYSDEC set forth a requirement that the Proposed Landfill Expansion area investigation include a detailed characterization of the deep bedrock (Z-Zone) groundwater flow regime and a re-evaluation of the vertical extent of the CSS in the Proposed Landfill Expansion area. Similar to the hydrogeologic investigation for the existing Mill Seat Landfill, the investigation of the Proposed Landfill Expansion area included characterization of the upper 100 feet of geologic material. Following a review of physical hydrogeologic data and groundwater chemistry in the Proposed Landfill Expansion area, the definition of the CSS for the active Mill Seat Landfill described above applies to the Proposed Landfill Expansion area. This conclusion is based on the following observations:

- RQD values increase and fracture frequency decreases in bedrock core retrieved from the deepest wells and geometric mean hydraulic conductivity values calculated from rising head tests are an order of magnitude higher in B-Zone and A-Zone wells (upper 30 to 40 feet of bedrock) compared to deeper Z-Zone wells which indicates preferential groundwater flow in B-Zone and A-Zone well depths.

- Pumping test results for P-8S at the Mill Seat Landfill during the H&A investigation indicated that groundwater flowing at the bedrock/overburden interface was not in strong hydraulic communication with deeper sections of the pumping well (Z-zone well equivalent).

- Groundwater flow in bedrock is nearly horizontal with little to no vertical component of flow which is demonstrated by very low vertical head gradients.

- Average linear groundwater flow velocity in the Z-Zone bedrock is about 75% lower than the A-Zone flow velocity.

- Deeper bedrock background groundwater chemistry (Z-Zone wells) is substantially elevated in naturally occurring cations (boron, calcium, magnesium, potassium and sodium) and anions (chloride and sulfate) when compared with shallower (B-Zone and A-Zone) groundwater for wells more distant from wetland areas, indicating little mixing between the shallow and deeper bedrock groundwater.

The CCS for the Mill Seat Landfill and Proposed Landfill Expansion is highlighted on the general stratigraphic section shown on Figure 26.

In the unlikely scenario where landfill leachate leakage occurs in the Proposed Landfill Expansion area, the dissolved phase constituents present in leachate would migrate very slowly in low permeability till. Seepage velocities calculated for the groundwater flowing in the till were calculated to flow at a rate of a few inches per year. Attenuation to soil particles and organic matter in the till would further retard the rate of constituent migration. Investigation data indicates water in the till flows toward the upper weathered bedrock (B-Zone). If constituents reached the bottom of the till, they would travel laterally in the B-Zone. Dispersion and diffusion could allow constituents to migrate laterally downward into shallow bedrock groundwater (A-Zone). Groundwater flow in bedrock is uniform and predominantly horizontal. Flow vectors are upward near the wetland areas east of the landfill as evidenced by artesian flow conditions in some existing wells located closest to Wetland RG-7. Dissolved phase constituents present in the A-Zone would not migrate vertically deeper based on essentially horizontal hydraulic gradients measured between the A-Zone and Z-Zone wells and a much greater horizontal flow component. Water quality deeper than 40 feet in the bedrock would not be affected by a hypothetical release of leachate from the Proposed Landfill Expansion.

6. Environmental Monitoring

An Environmental Monitoring Plan (EMP) is currently in place for the Mill Seat Landfill. The EMP for the site was most recently updated in May 2011. The EMP describes the on-site and off-site monitoring programs for all environmental media, including groundwater, surface water, leachate, landfill gas, noise and dust. The EMP includes descriptions of sampling locations and schedule, analyses to be performed, statistical methods, and reporting requirements. The EMP was prepared consistent with regulations in 6 NYCRR Part 360-2.11(c).

The Proposed Landfill Expansion would expand disposal operations into adjoining double-composite lined cells on the Proposed Site. As a result, the EMP will require an update to incorporate monitoring of environmental media to include the Proposed Landfill Expansion. Based on CCS definition for the Mill Seat Landfill and Proposed Landfill Expansion, operational groundwater quality monitoring at the Proposed Site will focus the assessment of water quality at the overburden/bedrock interface (B-Zone) and the shallow bedrock (A-Zone).

Elements of the revised EMP include:

- A schedule for B-Zone and A-Zone monitoring well installation around the perimeter of the Proposed Footprint allowing sufficient time to collected background water quality data per Part 360-2.11(c)(5)(b)
- A schedule for sampling frequency of groundwater monitoring wells located around the perimeter of the Permitted Footprint as construction progresses in the Proposed Expansion Area
- Monitoring of groundwater elevations in Z-Zone wells to monitor the horizontal and vertical gradient below the CCS
- A schedule for monitoring well/piezometer decommissioning as Proposed Landfill Expansion occurs
- Identification of landfill system monitoring points (i.e., primary and secondary leachate collection systems, landfill GWSS) and storm water retention ponds
- Identification of surface water monitoring points in adjacent wetlands and Hotel Creek
- Identification of landfill gas (LFG), noise and particulate monitoring stations and frequency of monitoring

The revised EMP for the Mill Seat Landfill (inclusive of the Permitted Footprint and Proposed Expansion) is included as Appendix N to support the permit application for the Proposed Landfill Expansion.

7. Design Considerations and Conclusions

The geologic, hydrogeologic and hydrochemical conditions were investigated for the Proposed Landfill Expansion on to property adjacent to and south of the Permitted Footprint. Site hydrogeologic conditions were previously characterized through investigations performed to support permit applications for development of the Permitted Footprint and the eastern and western soil borrow areas. The site investigations for the Proposed Landfill Expansion were conducted as described in the Draft Site Investigation Plan to expand the existing database of physical and chemical conditions for the Proposed Landfill Expansion area.

The investigation assessed the suitability of the Proposed Landfill Expansion area for development of landfill operations (6 NYCRR Part 360-2.12 Landfill Siting), provided information to develop an EMP, and provided geotechnical information for landfill design.

The following is concluded for the Proposed Landfill Expansion regarding landfill siting:

- The Proposed Landfill Expansion is not located in an area of prohibited siting (identified in 6 NYCRR Part 360-1.7(a)(2)) as Wetland RG-6 will be located to the Proposed Wetland Mitigation Area south of Bovee Road.

- The Proposed Landfill Expansion is not situated above bedrock subject to rapid or unpredictable groundwater flow.

- The Proposed Landfill Expansion is not in the proximity of any mines, caves or other anomalous features that may alter groundwater flow.

- The soil thickness below the Proposed Footprint meets the siting requirement of ten (10) feet of soil above bedrock (or could be constructed to have such) for Permitted Footprints operating under an active 6 NYCRR Part 360 permit.

- The soils in the Proposed Landfill Expansion have a geometric mean hydraulic conductivity of 3.68×10^{-6} cm/s which meets 6 NYCRR Part 360-2.12 siting requirements of 50% of the soil having a maximum in-situ permeability of 5×10^{-6} cm/s.

- The Proposed Landfill Expansion is not located over or within the recharge area of a primary water supply aquifer or a principal aquifer, nor is it located within an area of hydraulic influence from a public water supply.

- The Proposed Landfill Expansion is not located within a minimum distance of 100 feet to surface waters that are actively used as sources of municipal supply.

- The Proposed Landfill Expansion is not located over unstable soils or karst terrain and is not located within 200 feet of a fault with known displacement in Holocene time.

- The Proposed Landfill Expansion is more than 10,000 feet from the nearest airport runway.

The following is concluded for the Proposed Landfill Expansion regarding environmental monitoring:

- The investigation sufficiently characterized groundwater and surface water flow to identify upgradient and downgradient directions and existing water quality in the Proposed Landfill Expansion has been characterized.

- The hydrogeologic investigation has demonstrated that groundwater in the Proposed Landfill Expansion is monitorable with highly predictable groundwater flow.

- The critical stratigraphic section for the Proposed Landfill Expansion area, which is consistent with the Mill Seat Landfill, includes the following units:

    - Low permeability soil consisting of till and the upper weathered bedrock characterized as the B-Zone
    - Bedrock groundwater flowing in the upper 40 feet of bedrock (A-Zone)

- The EMP to be developed for the entire Permitted Site and Proposed Landfill Expansion should focus long-term groundwater quality monitoring of the B-Zone and A-Zone and is submitted as Appendix N.

The following is concluded for the Proposed Landfill Expansion regarding landfill design and construction:

- A small localized area in the northwestern and southwestern corner of the Proposed Footprint would require the placement of additional low permeability soil to meet a 10-foot separation between the landfill double composite liner base and the top of bedrock.

- Based on existing data, the thickness of the overburden below Wetland RG-6 is greater than 10 feet; however, a soil boring should be completed in that area prior to design of cells in that portion of the property for the purpose of verification.

- Isolated areas of surficial sand and gravel deposits containing boulders and cobbles within the Proposed Footprint should be removed during landfill base grade preparation/construction.

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