NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF ENGINEERING DESIGN AND CONSTRUCTION

BROOKFIELD AVENUE LANDFILL REMEDIATION
CONTRACT LF-BAL-1G

FINAL ENGINEERING REPORT

VOLUME 1 - Narrative

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1.0 INTRODUCTION

1.1 Purpose and Scope

The purpose of this report is to describe the construction and inspection of the remediation of the Brookfield Avenue Landfill (the “site”, or “landfill”) located in Staten Island, New York, performed under the City of New York Department of Environmental Protection Contract LF-BAL-1G titled ‘Brookfield Avenue Landfill Remediation – Operable Unit 1’ (herein, referred as the “Contract”). The remediation of the landfill was based on the remedy chosen in the Record of Decision (ROD) issued by the New York State Department of Environmental Conservation (NYSDEC), dated March 2002.

As a prerequisite to the landfill remediation, a second entrance to the Landfill was constructed that connected the Landfill with the Korean War Veterans Parkway (KWVP), a New York State roadway. This entrance provided the primary access to the Landfill for delivery of all soil and stone fill materials during the Landfill remediation. While this entrance was just one component of the many required to complete the remediation, it is discussed in detail in Section 1.5 of this report.

This report also provides a New York State Licensed Professional Engineer’s certification that the remediation of the landfill was conducted and completed in accordance with the relevant Contract Drawings and Specifications, including some minor revisions which do not affect the intent of the design.

This final engineering report has been prepared to meet the requirements for preparation of a final engineering report as described in NYSDEC Solid Waste Regulations 6 NYCRR Part 360-2.8 and Part 360-2.13, effective December 31, 1988.

The following entities were involved with the remediation of the landfill:

<u>Owner of the landfill:</u> The landfill’s owner is the New York City Department of Environmental Protection (NYCDEP).

<u>Regulatory Agency:</u> NYSDEC was involved with the review and approval, of the Contract Drawings and Specifications, as well as contributing towards the cost for the remediation of the landfill.

<u>Professional Engineer:</u> CDM Smith Incorporated was the Owner’s Design Engineer and URS Corporation was the owner’s Construction Manager, Resident Engineer, and Quality Assurance Inspector. Also, URS is providing the New York State Licensed Professional Engineer’s certification that the remediation of the landfill was conducted and completed in accordance with the relevant Contract Drawings and Specifications, including some minor revisions which do not affect the intent of the design.

General Contractor: Brookfield Construction Associates, LLC ("BCA", or the "Contractor") was the general contractor that was contracted by the NYCDEP to construct the remediation components as described in the Contract Drawings and Specifications.

The Brookfield Avenue Landfill is located in the Borough of Staten Island, Richmond County, City of New York. The landfill is bounded on the north by Richmond Creek, on the west by Richmond Avenue, on the south by Arthur Kill Road and on the east by Colonial Square Condominiums and Latourette Park. The landfill property encompasses approximately 272 acres of which 128 acres received a NYSDEC Part 360 landfill cap.

1.2 Site History

The site was opened for receipt of municipal solid waste in 1966, operated 24 hours per day, six days per week and accepted approximately 1,000 tons of solid waste per day. The landfill ceased operation in 1980. In 1982, testimony before the New York State Select Committee on Crime indicated that, during the period from 1974 through 1980, industrial hazardous waste including waste oil, sludges, metal plating wastes, lacquers and solvents were dumped at several New York City landfills, including the Brookfield Avenue Landfill.

Beginning in 1982 and in the following years, numerous site investigations were undertaken at the site in response to the allegation that illegal dumping had occurred, and to health related complaints that were made regarding the vapors/odors that were released during the excavation for a sewer line through the landfill. In 1983, the NYSDEC conducted a New York State Superfund Phase I site assessment, and the site was listed as a Class 2a Inactive Hazardous Waste Disposal Site. Class 2a is a temporary classification assigned to sites that have inadequate and/or insufficient data for inclusion in any of the other classifications.

In 1986, a reevaluation of existing data and testimony at the Senate Subcommittee hearing led the NYSDEC to upgrade the site to a Class 2 Inactive Hazardous Waste Disposal Site, meaning that "a significant threat to the public health or environment exists, and that action is required." In 1993, there was an allegation that illegal disposal of hazardous waste had occurred at Colonial Square, a housing development located on the eastern edge of the landfill. An Immediate Investigation Work Assignment (IIWA) was performed at this site. The Colonial Square Condominium development is 7 acres in size and is adjacent to Richmond Creek (and its unnamed tributaries). The investigation revealed the presence of some building debris, but did not indicate that hazardous waste was disposed at that site.

From 1982 to 1999, activities were undertaken to address off-site migration of methane, to remove onsite fuel tanks, and to prevent unauthorized access to the site. Methane is a combustible gas and a component of landfill gas which is generated as garbage decomposes.

In 1982, capping of the eastern end of the site commenced, along with the installation of 10 passive gas vents. In 1984, a passive gas trench system was installed at the site in the vicinity of Brookfield and Colonial Avenues in response to high methane concentrations found off-site. In

1986, this trench was extended to further inhibit gas migration. In 1995, two 550 gallon diesel fuel tanks were removed from the area of the site entrance. In 1998, a sorbent boom was placed to contain an observed oil seep in the center of the southern east cell of the landfill. In 1998 and 1999, additional fencing was placed to further limit access via the southern and western site borders.

1.3 Site Conditions Prior To Landfill Closure

The Landfill consisted primarily of two mounds identified throughout this report as the West and East Cells. Prior to commencement with the final Landfill closure activities, Landfill elevations ranged approximately 30 to 40 feet above Richmond Creek. The cells were bisected by a sewer culvert and access road to the Eltingville Pump Station which is oriented north-south and approximately 20 feet lower in elevation. This sewer easement and corridor between both cells consists of several acres, historically used by operators of the NYCDEP to access and operate the Eltingville Pump Station which was constructed in 1985. The existing pump station is used to move sewage from the surrounding community to the Oakwood Beach Water Pollution Control Plant. Additionally, the West Cell is bisected by a service road which is built on top of a sanitary sewer trunk line that feeds the Eltingville Pump Station. The entrance to the former Landfill and NYCDEP Eltingville Pump Station is directly off Brookfield Avenue via the main entry gate. This main entrance was used when the Landfill was active and accepting waste.

Soil cover above the refuse within the cells were found to be generally thin (<6 inches). An Interim Remedial Measure (IRM) was performed in 1993 to cover all exposed refuse areas with soil. Stressed vegetation was evident throughout the site. The vegetation consisted primarily of phragmites australis, lower lying grasses and sparsely situated trees and shrubs. Wildlife observed at the site included deer, geese, birds, hawks, pheasants, rabbits, and rodents.

The site in general is surrounded by water, either by wetlands, drainage channels or Richmond Creek; with the only exception being along the stretch of solid land located on the northern side of Arthur Kill Road between Abingdon Avenue and Colon Avenue.

1.4 Remedial Construction History

Contract bid documents for the Landfill remediation construction were entitled "*Brookfield Avenue Landfill Remediation – Operable Unit 1, Contract LF-BAL-1G'*, dated April 2007, prepared by CDM Corporation, now known as CDM Smith Corporation. The NYCDEP awarded the construction contract to Brookfield Construction Associates, LLC (BCA) of Clark, NJ, in a contract amount of $241,357,000.00. The Notice to Proceed was issued on September 28, 2009, which notified BCA to fully complete the work on or before March 28, 2017 (2,738 consecutive calendar days).

BCA commenced work on September 28, 2009 and was substantially complete with Milestone 1 on December 31, 2013, 277 days past the originally scheduled Milestone Completion date of

March 29, 2013. The Milestone 1 delays were predominantly related to Superstorm Sandy assessments and repairs as well as coordination and inspection issues with other city agencies.

1.5 Korean War Veterans Memorial Parkway Truck Entrance

As part of the Landfill closure, it was anticipated that large quantities of various materials, such as soils, gravels and riprap would need to be imported to the Landfill site and that importation was to be executed via trucking. Estimates of the number of trucks peeked at approximately two hundred (200) trucks per day would need to enter the Brookfield Avenue Landfill, deliver their loads and exit onto local streets. In order to avoid having these trucks on the already crowded local streets, a Memorandum of Understanding (MOU) was reached and agreed to between the New York State Department of Transportation and the New York City Department of Environmental Protection for the temporary use of the Korean War Veterans Memorial Parkway (KWVMP) as a truck route for materials being transported to the Brookfield Avenue Landfill construction effort. This MOU also allowed for the temporary connection of the Eltingville Park-n-Ride facility KWVMP off ramp to the abandoned portion of the KWVMP which terminates at the western limit of construction for the Landfill.

A temporary truck haul road was constructed on site to connect the Landfill with the KWVMP termination which allowed for direct access from the KWVMP to the Landfill while removing all the anticipated truck traffic from local streets.

At the end of material importation process and all the truck traffic was concluded, the temporary connection to the abandoned portion of the KWVMP was restored to original condition and the on-site haul roads were removed. The only portion of the work that remain, is a three hundred foot long extra lane along the entrance to the Eltingville Park-n-Ride, which was allowed to remain based on permission and acceptance by the New York State Department of Transportation.

1.6 Components of the Remedial Construction Contract

The Brookfield Avenue Landfill was constructed under contract with the NYCDEP solely for use in the closure of the Landfill. The cover system was designed to control moisture and percolation from entering the Landfill, promote surface water runoff, minimize erosion, prevent direct exposure to waste, control animal and/or plant intrusion, control gas emissions, control odors, and meet aesthetic and other end use purposes. The Contract consisted of the design and installation of construction engineering controls for the major items of work summarized below and in subsequent sections of this report and specified in detail on the Drawings and Specifications of the Contract.

In general, the cap consists of a geocomposite gas venting layer, a LLDPE membrane liner (40 or 60-mil), a geocomposite drainage layer, 12- inches of barrier protection material and 6 inches of topsoil. A Landfill gas collection system consists of extraction wells interconnected an underground network of pipes to safely draw off the landfill gas and thermally dispose of the gas at a central gas flare station. A leachate collection system consists of a series of gravity fed sumps encompassing the northern perimeter of the landfill which draw off the landfill leachate which is collected, pretreated and disposed of through the Eltingville Pump Station. Planting islands and vegetative mounds were designed to accomplish several objectives including erosion control, improve aesthetics, and allow for wildlife habitation of the area.

The major components of the Contract performed by the NYCDEP included the following work:

- <u>Site Preparation</u>: Surveying and construction layout services; clearing and grubbing; implementing erosion and sediment control measures, which were maintained throughout the duration of the contract; grading, reshaping, waste excavation and re-grading of the existing Landfill surface to promote manageable slopes and minimize grading fill for positive drainage and liner placement;

- <u>Slurry Wall:</u> The soil bentonite/cement bentonite slurry vertical barrier wall, essentially a stable sub-surface continuous vertical clay barrier wall to prevent horizontal flow of groundwater through the soil overburden at the source area. The barrier slurry wall separating the Landfill waste mass from the surrounding soil prevents contaminated groundwater within the Landfill from entering the adjacent wetlands and protects the lower elevations of the Landfill from being inundated during tidal surges was built of low-permeability clay (from the on-site glacial till and offsite clays) placed around the perimeter of both cells;

- <u>Intermediate Layer:</u> The intermediate cover layer also referred to as the sub-grade layer consisted of filling and shaping the top of waste, with material referred to as Landfill Common Fill (LFCF) with a minimum thickness of 12-inches, in preparation for placement of geosynthetic materials;

- <u>Drainage Control Features</u>: Construction of basins, drainage channels and diversion swales including culverts, weirs and outfalls;

- <u>Landfill Gas Management</u>: The Landfill gas (LFG) management system is the active system of the gas collection wells, surface and subsurface pipes, gas extraction pumps (termed “blowers”) and a flare. Construction of the system including one hundred (100) vertical extraction wells placed into the Landfill mass and thirty one thousand five hundred and sixty (31,560) linear feet of LFG surface header piping for the conveyance of the LFG to the blower and flare facility was instituted to manage and control all off gas migration from the Landfill as emission to the atmosphere or laterally into the unsaturated soil (or vadose zone) and groundwater. Installation and operation of the Landfill gas blower and flare facility thermally destroys the LFG including odors that are directed to the flare via the LFG collection piping.

- Leachate Collection System – The construction of the leachate collection and conveyance system, also known as the Leachate Management System (LMS), consisted of drains, pumps and pipes designed to be installed, built and operated for collecting water (leachate) trapped inside the Landfill, below the liner for treatment and disposal. The LMS, working in conjunction with the liner's barrier systems minimizes the potential for lateral seepage exfiltrating or infiltrating into the surrounding groundwater and other environmental media.

- Geosynthetic Geomembrane Layer: The approved Landfill selected a cover system using a flexible geosynthetic membrane liner and two geosynthetic geocomposite drainage layers, one for gas and one for drainage. Installation of the geosynthetic cap comprised of a combination of either a 40mil or 60mil Linear Low Density Polyethylene (LLDPE) geomembrane, including geocomposites below and above the geomembrane liner, as well as a geosynthetic clay liner (GCL) in various areas of the Landfill surface. A geosynthetic geocomposite gas venting layer was placed directly above the approved intermediate subgrade layer. The geocomposite drainage layer was placed on top of the LLDPE geomembrane liner.

- Barrier Protection Layer Soil (BPL): Installation of a minimum 12-inch compacted barrier protection layer over the geosynthetics cap was completed to protect the underlying liner from damage and future erosion. The BPL comprised of sand and clay and was chosen based on the availability and cost of materials, ease of installation, and higher degree of quality control associated.

- Topsoil and Seeding: Installation of a 6" minimum and up to a 3.0' layer of topsoil cover mound with seeding and erosion control to establish a permanent vegetative layer. Revegetation of cover mounds also accomplished several objectives including: erosion control, improved aesthetics and habitation for resident wildlife. The grass seeds chosen were of a native varieties common to this location.

- Plantings: The installation and maintenance of the plantings (trees and shrubs) was required under the contract but not part of this certification report.

All construction work performed under the Contract was completed by the Brookfield Construction Associates, LLC workforce, which included the following major subcontractors:

Company Name		**Work Description**
1	ALR Environmental Corp.	Asbestos Removal and Disposal
2	Aspen Landscaping Contracting	Supply of Cover Soils, Furnish and Install Landscaping Seeding and Plantings
3	Barbella Environmental Technology, Inc.	Provide Local 282 Teamsters and On-Site Trucks
4	Chenango Contracting, Inc.	Supply and Install Geosynthetic lining, Supply Geotextile, Geogrid and Bentonite
5	DMD Trucking, Inc.	Mobilization / De-mobilization of Equipment (Off-site Services)
6	Design Plumbing & Heating Services, Inc.	HVAC
7	Escambray Leasing	Supply of Soils
8	Excel Environmental Resources, Inc.	Air Monitoring, Soil Chemical Testing, Environmental Consulting, Hazardous Area Monitoring
9	J. Fletcher Creamer & Son, Inc.	Supply & Install Timber Guide Railing, Supply & Install Heavy Post Blocked out Corrugated Guide Rail
10	French & Parrello Associates	Provide Laboratory Testing and On-Site QC Testing
11	Gold Security Guard Services, Inc.	Security Guard Services
12	HazTek, Inc.	Professional Services - Safety Consultants
13	Inquip Associates, Inc.	Technical Assistance for the Soil Bentonite Slurry Wall
14	J. D'Annunzio & Sons, Inc.	Supply Carpenters, Dock Builders and Iron Workers to Construct Various Structures
15	Jersey Boring & Drilling Co., Inc.	Perform Test Boring
16	J M Stokes, Inc. T/A JMS Visual	Construction Photos and Video
17	Kleinberg Electric, Inc.	Furnish and Install Electrical Items - Supply Leachate Pumps and Gas Flare System
18	K.E.B. Pest Control Services, LLC	Pest Control Services
19	Mueser Rutledge Consulting Engineers	Consultant Professional Engineering Services
20	Layout, Inc.	Construction Surveying / Layout
21	Moretrench American Corporation	install Landfill Gas Collection Wells, Landfill Gas Monitoring Wells, and Piles for Landfill Gas Flares
22	MS Construction Corp.	Furnish and Install Chain Fence and Ornamental Fence, Traffic Striping (Removal and Installation)
23	Naughton Energy Corporation	On-Site Fueling
24	National Water Main Cleaning Company	Video Interceptor Sewer

25	Oracle Trucking, Inc.	Supply Landfill Common Fill, Common Fill, Bridge Lift Material, Clay Cap Material
26	Rebar Steel Corp.	Installation of Reinforcing Steel
27	Rockborn Trucking & Excavation, Inc.	Asphalt Milling and Paving
28	Tricon Enterprises Incorporated	Supply Common Fill
29	Windward Partners Inc. d/b/a Anchor Modular	Furnish & Install resident Engineer's Field Office
30	Executives Cleaning Services, LLC	Cleaning Services for Engineer's Trailer, Cleaning Services
31	Yaboo Fence Co., Inc.	Supply / Install Fence

1.7 Existing Documents

The following documents which describe the construction, quality control and basis of the design of the remediation contract that were used for the closure of the Landfill:

- Information for Bidders, Standard Construction Contract, and Specifications for Furnishing all Labor and Material Necessary for: Contract LF-BAL-1G, Remedial Action for Brookfield Avenue Landfill, Prepared by CDM, Dated April 2007.
- Brookfield Avenue Landfill Remediation, Operable Unit 1, Contract No. LF-BAL-1G, NYSDEC, Prepared by CDM, Dated April 2007 (Drawing Set).
- Record of Decision, titled " Brookfield Avenue Landfill Site, New York City, Richmond County, Site Number 2-43-006, Operable Unit 1, Prepared by NYSDEC, Division of Environmental Remediation, Dated March 2002.
- Final Remedial Investigation Report for Brookfield Avenue Landfill Remediation Project, prepared in compliance with the Order of Consent: NYSDEC Index No, 2-43-006, by New York City Department of Environmental Protection, Office of Environmental Planning and Assessment, with the assistance of: CDM Camp Dresser & McKee, Dated September 1998.

2.0 LANDFILL CLOSURE ACTIVITIES

2.1 Mobilization

In November of 2009, the New York City Department of Environmental Protection (NYCDEP), the Construction Manager (CM – URS/LKB) and the Contractor (Brookfield Construction Associates, LLC) held preconstruction meetings and mobilized to the site in preparation for commencement of Landfill closure activities. Mobilization activities began with general material deliveries, delivery of heavy equipment and set up of the site trailers. The entrance to the project site was off Arthur Kill Road at Brookfield Avenue and was used as the primary entrance for all staff and labor and was identified as the Main gate. The project facilities for the Resident Engineer consisted of a 5-wide trailer office facility also utilized by the NYCDEP, the CM staff as well as specialty Subcontractors to the CM. The Contractor constructed a 4-wide trailer office facility with several other single trailer offices located in the same vicinity near the main gate utilized for security guard services, union personnel and subcontractors. During the remedial construction operations and Landfill closure process, site security was positioned at the Main gate as well as roving patrols were maintained 24 hour 7 days a week including full site perimeter inspections.

2.2 Site Preparation

Site preparation tasks performed by the Contractor were designed to provide full site access, to shape the Landfill surface to promote positive drainage, minimize imported fill material and to receive the various geosynthetic components and engineering controls of the cap. These site activities began early spring of 2010 and were divided into a progression of steps including: clearing and grubbing, erosion and sediment control, and rough grading. Just prior to performing any existing site disturbance, ground intrusive activities, or any clearing and grubbing, the Contractor staked out the Limits of Work and installed the initial perimeter silt fence as the first step in implementing the NYSDEC approved Stormwater Pollution Prevention Plan (SWPPP) for this site.

2.3 Clearing and Grubbing

The Landfill is divided into two main sections or cells; a 88 acre East Cell and a 40 acre West Cell. Once initial SWPPP controls were in place Clearing and Grubbing activities commenced on the southern portions of the West cell and progressed to the northern portions of the West cell, then to the northern portions of the East cell and completing the effort on the southern portions of the East Cell. As areas were cleared and grubbed, additional stormwater controls were installed and maintained during the progression of the work in compliance with the approved SWPPP. During the course of the Clearing activities existing vegetation including trees, brush and shrubs were stockpiled to be chipped used as daily cover material on exposed waste areas. Grubbing activities included removal and stockpiling of stumps, partially buried logs, root mats and other organic materials within the Contract Limits of Work, and in accordance with the Contract Specifications. All removed stumps and logs were also chipped and used as cover material on the Site.

All trees and shrubs within the limit of disturbance were removed unless marked to remain. Trees and shrubs that were marked to remain were all located within the limits of disturbance, but outside the limits of the cap and were evaluated by a restoration specialist as being healthy. Simultaneous with the Clearing and Grubbing effort, construction of temporary haul and construction access roads were performed to create a safe and efficient network of roadways throughout the Landfill for moving personnel and materials.

Upon completion of Clearing and Grubbing operations, equipment utilized for this effort was decontaminated and inspected prior to their demobilization in accordance with the site safety and health plan.

2.4 Stormwater Pollution Prevention, Erosion & Sedimentation Control

As Landfill areas were cleared and grubbed, additional silt fence and other stormwater controls such as earth berms, rock dams, ditches, hay bale emplacements as well as surface contouring were installed in accordance with the approved Storm Water Pollution Prevention Plan (SWPPP) to control flows of surface waters. Stormwater pollution prevention, erosion and sediment control measures were initiated during mobilization and continues during subsequent activities. The perimeter silt fence was maintained around the entire Landfill for the duration of the work until final site stabilization was achieved which was documented by the issuance of the Notice of Termination , SPDES General Permit (SWPPP) on May 14, 2014.

During the construction period all SWPPP requirements were implemented and completed in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP) and construction drawings and specifications. SWPPP-related inspections were performed weekly and reports were documented on a regular basis in accordance with regulatory equivalency permit (See Appendix A, titled ‘Permits’). Appendix B, titled ‘Construction Management Daily Reports’ presents all daily reports prepared by the CM QA inspectors during the construction phase of the project as well as the weekly and monthly SWPPP reports.

2.5 Waste Excavation and Grading

Immediately following clearing, grubbing and tree removal in the planned progression of the areas of the Landfill, but prior to any initial waste excavation and grading, a topographic survey of the areas was performed. A “Certified Field Topographic Map” was developed to depict existing conditions of the entire Brookfield Avenue Landfill Remediation project area, including the construction access/haul roads, the Arthur Kill Road Improvement area and to determine current ground elevations prior to initiating grading activities, which may have changed since the original design survey due to settlement. Simultaneously and in conjunction with the topographic survey, the contractor began identifying and confirming the locations of all existing surface and subsurface utilities with horizontal and vertical data depicting water, gas, sewer, and stormwater pipes, access manholes, wells and other structures. This information was prepared and used primarily for the purpose of updating, verifying the location and elevations of all existing utilities and for excavation planning.

Initial waste grading activities started in the Spring of 2010 at the completion of the initial top of waste topographic surveys. Waste grading activities included cutting (excavation) and filling various areas in order to reshape the Landfill surfaces to promote proper drainage for the proposed final subgrade elevations, slopes and contours as shown on the Contract drawings. Subgrade preparation involved establishment of a top of waste working subgrade prior to placement of subsequent cap closure layers (i.e. intermediate/closure subgrade layer, geomembrane, barrier protection layer, topsoil, etc). To establish the “Top of Waste” sub-grade elevation for the entire surface of Landfill, the Contractor graded and compacted the existing Landfill waste surface to the contours shown on Contract drawings.

This waste layer established a firm base on which the subsequent cap components (i.e. intermediate/closure subgrade layer, geomembrane, barrier protection layer, topsoil, etc) would be constructed. All excess reworked waste material from one part of the Landfill was relocated to other areas within the limits of Landfills cap construction as shown on the approved plans. No material was removed from the site. After existing Landfill soil material and exposed waste were relocated, and prior to placement of any imported material, the Contractor's Surveyor performed the topographical survey for the Top of Waste. The "Certified Top of Waste" record drawing can be found in Appendix L, titled 'Record Drawings'.

3.0 CLOSURE SUBGRADE LAYER

3.1 General

The Closure Subgrade Layer, also called the "Intermediate Layer", was constructed following acceptance of the "Top of Waste Survey". The commencement of the closure subgrade layer initiated the final closure shape of the Landfill in accordance with the Contract drawings and creation of the base to construct the multi-layered geosynthetic and subsequent soil material final cap layers. Prior to placement of the Landfills closure subgrade layer, the "Top of Waste" surface was inspected for signs of soft unstable soils or areas of poor drainage and repaired as needed. The "Top of Waste Survey" was used to establish a baseline reference to determine the final thickness of subsequent layers and to determine settlement, if any. Once the "Top of Waste" survey was accepted and the Landfill surface was inspected and approved, the contractor began placement of imported fill for the closure subgrade layer (Intermediate Layer). By the beginning of June 2010, Landfill grading activity changed from balancing Landfill refuse and final shaping of the Landfills waste surface to commencement of delivery and placement of imported off-site material to cover the waste with a minimum 12-inch lift of imported soil. The depths of the closure subgrade layer grading fill varied in order to achieve the final closure design contours throughout the Landfill. During the process of grading, the subgrade was maintained to promote positive and controlled drainage.

Once the final closure design contours were achieved a survey was performed to document the top of intermediate subgrade. A record drawing was produced from this survey titled "Certified Top of Intermediate Subgrade" and it depicts spot elevations on a fifty (50) foot grid with two (2) foot contours on a 1"=50' scaled drawing. The survey contains the elevation data to (the hundredth of a foot) for the previous subsurface(s) at each 50-foot grid point elevation. See Appendix L titled 'Record Drawings'.

3.2 Material Sources for Closure Subgrade Layer

The soil used for the closure subgrade layer material is referred to and classified as Landfill Common Fill (LFCF) which is characterized as a non-hazardous soil. Various offsite material sources (i.e. construction sites, mining pits and dredge sites), from New Jersey and New York, were able to supply the soil that met the specified criteria for the construction of closure subgrade layer for the project. Approximately 694,100 tons of LFCF/subgrade material was imported and used for filling and shaping the Landfill subgrade. All LFCF grading fill material used on the project was delivered via dump truck with with each truck having between a 20 to 24 ton capacity. All LFCF had to meet specific chemical and geotechnical requirements prior to delivery and placement. Refer to Section 3.4 below for all QA/QC procedures and testing requirements for all closure subgrade materials.

Table 3.1 (below) presents all the approved sources and their location that provided Landfill Closure Subgrade (LFCF) for the project. Appendix B, titled 'Construction Management Daily Reports' includes inspection reports and photographs associated with material placement activities during construction of the intermediate/closure subgrade.

TABLE 3.1

Material Type/Use	Source Name	Source Locations
Landfill Common Fill	Clean Earth Inc.	24 Middlesex Avenue, Carteret, NJ 07008
Landfill Common Fill (PDM only)	Clean Earth Inc.	1 Fish House Road, Kearny, NJ 07032
Landfill Common Fill (PDM only)	Clean Earth Inc.	1 Linden Avenue East, Jersey City, NJ 07305
Landfill Common Fill	Amboy Aggregates	175 Main Street, South Amboy, NJ 08879
Landfill Common Fill	Vanbro Co.	1900 South Avenue, Staten Island, NY 10314

3.2.1 Processed Dredge Material

Processed Dredge Material (PDM) was used as part of the closure subgrade material (LFCF) grading effort due to its availability, physical composition and its ability in meeting the specified requirements for the project. PDM is composed of sediment from nearby tidal waters, harbors, navigation channels and shipping berths that is blended and processed with amendments (8% cement) that improve geotechnical properties while also binding some contaminants and reducing leachability of others.

Use of PDM as fill material for construction sites in the State of New York typically requires a Beneficial Use Determination also known as a BUD. A BUD, is a designation made by the NYSDEC as to whether Part 360 of the Solid Waste Management Facilities regulations have jurisdiction over material delivered to a construction site which is to be beneficially used. Once the NYSDEC grants a BUD, the waste material ceases to be considered a solid waste (for the purposes of Part 360) when used as described and can be used as a nonstructural fill. Pursuant to discussions with and correspondence from NYSDEC, a BUD was not required for the Brookfield

Avenue Landfill and was exempted for the project. However, in lieu of the BUD exemption granted by NYSDEC, facilities that process, produce or transfer PDM as nonstructural fill from New Jersey must obtain an Acceptable Use Determination also known as an AUD from the New Jersey Department of Environmental Protection (NJDEP). All the Processed Dredge Material (PDM) used on the Brookfield Avenue Landfill was used as and has an Intermediate Layer/Subgrade Layer Acceptable Use Determination (AUD) and copies of which are part of the documentation included in Appendix C, titled 'Landfill Common Fill'.

All PDM material was blended with amendments (8% cement), tested and confirmed by the supplier to be in conformance to State and Federal regulatory requirements. PDM sources originated from one of three Clean Earth facilities located in NJ (see Table 3.1 above).

3.3 Installation of Subgrade Closure Layer

The installation of the Closure Subgrade layer, consisting of LFCF, was placed in preparation for the deployment of the geosynthetic materials and follow-on placement of subsequent soil cap layers. The contractor performed general closure subgrade grading with the LFCF by placing these imported soils over the waste to complete subgrade closure per the Contract drawings and specifications. Upon material arrival, the trucks containing LFCF were weighed in at the on-site New York State certified scale house and directed to their unloading location, either directly at the point of use or to a stockpile for later use. Material placement was tracked by the CM\QA staff via the truck weigh tickets on a 200' x 200' alpha numeric grid drawing created for tracking soil placement on the site. All material was placed in one foot lifts, compacted with a minimum of three passes of a smooth drum roller and continued with varying lifts and thickness's not exceeding one foot as required by Contract drawings and specifications. LFCF was compacted to an in-place minimum density of 90 percent of the maximum dry density, as determined by ASTM D-698.

PDM material was also delivered in a condition suitable for placement without the need for size reduction, disking, physical, or chemical stabilization or other conditioning and was delivered at a moisture content suitable for placement (less than 30%) and suitable for compaction to 90% Standard Proctor without moisture conditioning. All PDM imported to the project satisfied the specific criteria for LFCF and was used primarily as a 2 to 4 inch cushion layer on top of all quarry grade LFCF for the entire closure subgrade surface. The LFCF PDM met the contract requirement of a maximum particle size of one half inch minus within the top two to four inch cushion layer directly below final subgrade elevations. After the surface of the closure subgrade layer was rolled, a total of 4 in-place density tests (Method ASTM D-2922) were performed per acre of material placed. Non-conforming areas were re-compacted and tested until the compaction requirement was attained.

LFCF material tracking was keyed to construction grid cells, each uniquely identified. Each day, cell identification with construction activities and/or final placement of imported fill were recorded in daily reports and forms. See Appendix B, titled 'Construction Management Daily Reports' for inspection reports, including photographs associated with material placement activities during construction of the intermediate/closure subgrade. A total of 694,100 tons of LFCF grading fill was imported and placed as Intermediate/Closure Subgrade.

3.4 Quality Assurance/Quality Control

3.4.1 General

QA/QC procedures were developed and followed for all fill material sources used in the subgrade layer before and during construction. All closure subgrade material (LFCF) and their respective source facilities were visually inspected by QA/QC personnel. All subgrade closure material identified as LFCF, incorporated into the landfills Final Cover System by being placed under the geosynthetic materials were tested by having analytical samples collected for quality assurance and quality control purposes in accordance with NYSDEC Part 360 requirements and the Contract specifications. The CM ensured that both QA and QC laboratories met the minimum standards set forth by: ASTM D-3740: Standard Practice for Minimum requirements for Agency engaged in the Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction; and ASTM E-548: Standard Guide for General Criteria used for Evaluating Laboratory Competence. QC personnel were required to provide all records of QC analytical results in accordance with the specifications and regulatory protocols. QA personnel received and reviewed, and either approved or rejected the material based on the results. All QC submitted analytical data, QC truck weigh tickets, QC in-situ sampling and testing results (including State and regulatory agency permits) were reviewed by the CM's Quality Assurance Manager (QAM) to ensure compliance with the Contract documents and NYSDEC Part 360.

The QAM also performed additional QA inspections and testing on at least 10% of QC closure subgrade fill material results and related data.

3.4.2 Quality Control

Prior to procuring fill material and initiating importation of off-site soil materials, the Contractor was required to provide fill material acceptance related submittals for QA approval. Subgrade Layer fill material related submittals included the following information:

- Name and location of suppliers (see Table 3.1)
- Certificate of compliance for each source of material
- 50-lb sample of material
- Documentation of the availability of quantities from any proposed borrow source
- Optimum moisture - maximum density curves and reports
- Material Handling Plan describing source locations and frequency testing
- Certified Quality Control material conformance test results on soil material (See Appendix C, titled ‘Landfill Common Fill’)
- Certificate that soil testing laboratory is in compliance with ASTM E-329. (See Appendix C, titled ‘Landfill Common Fill’)
- Quality Control during Construction

During earthwork construction on the landfill, the Contractor was required to procure offsite material from outside sources and provide continuous QC testing and inspection services from an independent Quality Control Laboratory (QCL) approved by the NYCDEP in accordance with the Contract specifications.

The Contractor was solely responsible for Quality Control testing, including sample collection, laboratory testing of stockpiles prior to delivery and field testing of in-place material. All QC laboratory and field testing was performed by an approved independent chemical laboratory and an approved independent geotechnical laboratory, employed by the contractor. The Contractor’s laboratories all had adequate experience with the chemical and physical testing of soils, met all applicable regulatory requirements and conducted testing in accordance with American Society for Testing and Materials (ASTM) and other required analytical test methods. The soils laboratory was capable of providing test results in accordance with the Contract Specifications.

In-Place Density testing was performed by French and Parillo of Parlin, New Jersey; geotechnical analyses were provided by A&L Laboratories, Inc. of Richmond, Virginia; chemical analyses were provided by Accredited Laboratories, Inc. of Carteret, New Jersey. Table 3.2 presents the number of Quality Control sets of tests performed based on a frequency of one test every two thousand five hundred (2,500) cubic yard stockpile intended for delivery to the project site.

TABLE 3.2

Site Material Use	Off-site Source Name	QC Tests Performed
Landfill Common Fill	Clean Earth Inc. (Carteret)	55
Landfill Common Fill (PDM)	Clean Earth Inc. (Kearny)	12
Landfill Common Fill (PDM)	Clean Earth Inc. (Jersey City)	42
Landfill Common Fill	Amboy Aggregates	20
Landfill Common Fill	Vanbro Co.	44

Table 3.3 presents the Geotechnical Criteria from the Contract specifications that all the LFCF was required to meet through the Quality Control Testing as well as the Quality Assurance Testing performed.

TABLE 3.3

Geotechnical Requirements	
Test	Criteria
Max Stone Size	3"
Sieve Analysis No. 200	85% Max
Organics	Free
Atterberg Limits (Liquid Limits)	<60
Atterberg Limits(Plasticity Index)	<40

Table 3.4 presents the Chemical Criteria from the Contract specifications that all LFCF was required to meet through the Quality Control Testing as well as the Quality Assurance Testing performed.

TABLE 3.4

Chemical Requirements	
Maximum Allowable Levels	
Waste Characteristic	Criteria
Ignitability	Rate >2.2 mm/sec
Corrosivity	2 < pH <12.5
Reactivity (Cyanide)	< 250 ppm reactive
Reactivity (Sulfide)	< 500 ppm reactive
TCLP Arsenic	5.0 mg/L
TCLP Barium	100.0 mg/L
TCLP Benzene	0.5 mg/L
TCLP Cadmium	1.0 mg/L
TCLP Carbon tetrachloride	0.5 mg/L
TCLP Chlordane	0.03 mg/L
TCLP Chlorobenzene	100.0 mg/L
TCLP Chloroform	6.0 mg/L
TCLP Chromium	5.0 mg/L
TCLP o-Cresol	200.0 mg/L
TCLP-Cresol	200.0 mg/L
TCLP p-Cresol	200.0 mg/L
TCLP 2,4-D	10.0 mg/L
TCLP l,4-Dichlorobenzene	7.5 mg/L
TCLP 1,2-Dichloroethane	0.5 mg/L
TCLP 1,1-Dichloroethylene	0.7 mg/L
TCLP 2,4-Dinitrotoluene	0.13 mg/L
TCLP Endrin	0.02 mg/L
TCLP Heptachlor	0.008 mg/L
TCLP Hexachlorobenzene	0.13 mg/L

Chemical Requirements	
Maximum Allowable Levels	
Waste Characteristic	Criteria
TCLP Hexachloro-1,3-butadiene	0.5 mg/L
TCLP Hexachloroethane	3.0 mg/L
TCLP Lead	5.0 mg/L
TCLP Lindane	0.4 mg/L
TCLP Mercury	0.2 mg/L
TCLP Methoxychlor	10.0 mg/L
TCLP Methylethyl ketone	200.0 mg/L
TCLP Nitrobenzene	2.0 mg/L
TCLP Pentachlorophenol	100.0 mg/L
TCLP Pyridine	5.0 mg/L
TCLP Selenium	1.0 mg/L
TCLP Silver	5.0 mg/L
TCLP Tetrachloroethylene	0.7 mg/L
TCLP Toxaphene	0.5mg/L
TCLP Trichloroethylene	0.5 mg/L
TCLP 2,4,5-Trichlorophenol	400.0 mg/L
TCLP 2,4,6-Trichlorophenol	2.0 mg/L
TCLP 2,4,5-TP	1.0 mg/L
TCLP Vinyl Chloride	0.2 mg/L
PCBs, Total	10 mg/kg
Sulfides	5000 mg/kg
Ammonia	200 mg/kg
Asbestos Fiber	1% (by weight)

3.4.3 Quality Assurance

Prior to the Contractor procuring any fill materials and initiating construction activities at the Site, the QA Site Manager reviewed and verified fill material submittal information and sample results from the QC Site Manager. Prior to acceptance, the QA Site Manager's responsibility was to visit each material source to verify that pre-delivery samples submitted by the QC Site Manager were representative of the material at the source. If material samples were not comparable based on a visual inspection, the QA Site Manager requested a justification or rejected the material and requested a new sample of the material. As construction began, material deliveries were sampled and tested at an established rate to monitor consistency. A full time QA/Geotechnical Inspector visited each source, quarry or borrow pit on a daily basis to observe operations and changes in material properties. During construction, Quality Assurance performed in-process observations and sampling of the closure subgrade/intermediate layer material, included laboratory analysis of stockpile samples, field-testing and full-time inspection by owner's representative at frequencies specified in the contract documents.

The QA geotechnical testing frequency was one test for every twenty thousand (20,000) cubic yards of each material type delivered to the site. The QA chemical testing frequency was one test for every sixty thousand (60,000) cubic yards of each material type delivered to the site. Geotechnical and chemical related QA testing was performed in accordance with contract documents: As stated in the contract documents, the chemical criteria must pass TCLP requirements. See Tables 3.3 and 3.4 above for geotechnical and chemical testing criteria.

Table 3.5 presents the number of Quality Assurance sets of tests performed based on the above stated frequencies.

TABLE 3.5

Site Material Use	Off-site Source Name	QA Tests Performed
Landfill Common Fill	Clean Earth Inc. (Carteret)	7
Landfill Common Fill (PDM)	Clean Earth Inc. (Kearny)	5
Landfill Common Fill (PDM)	Clean Earth Inc. (Jersey City)	5
Landfill Common Fill	Amboy Aggregates	3
Landfill Common Fill	Vanbro Co.	7
Landfill Common Fill	BayShore Recycling Corp.	1

3.4.4 Quality Assurance/Quality Control during Construction

3.4.4.1 General

The QAM used an independent analytical chemical laboratory/testing lab to conduct QA tests on stockpiled material and on in-place closure subgrade soils. Laboratory and field testing were performed by approved independent certified chemical laboratory and independent certified geotechnical laboratory. The independent QA laboratories reported confirmatory test results directly to the CM/QAM. Geotechnical and Chemical analyses were both provided by GenTech Chemical Lab of Cliffwood Beach, New Jersey and geotechnical analysis was also performed by RSA GeoLab located of Union, New Jersey. Both geotechnical and chemical testing laboratories have extensive experience in testing soils and other construction materials and familiar with related ASTM, NYSDOT and other construction material test standards.

3.4.4.2 Stockpile Testing QA/QC

Source testing was performed on each source of LFCF grading fill. Once approved, borrow-site stockpiles of material was produced and separated into volumes not exceeding twenty five hundred (2,500) cubic yards apiece. The Contractors QC Manager conducted the required testing of all production stockpiles and the certified QA laboratory was responsible for conducting random tests on soil samples taken from off-site sources, on-site borrow pits and stockpiles used in the construction of the closure subgrade layer at frequencies discussed above. The certified QC laboratories as well as the certified QA laboratories performed the designated tests using the specified methods with equipment that has been appropriately calibrated. The QC Manager reported all results to the CM/QAM, and any material results not meeting the criteria was not shipped to the site. QA testing was performed in accordance with testing criteria presented in Tables 3.3 and 3.4 above. Refer to Appendix C, titled 'Landfill Common Fill' for all geotechnical and chemical test results of LFCF for the project performed by the CM/QAM. Refer to Tables 3.6 thru 3.15 below for the QC summary results of frequency testing.

3.4.4.3 In-Place Closure Subgrade Testing

The independent soils laboratory/geotechnical testing firm provided on-site testing (e.g., in-place compaction testing) in accordance with the ASTM D-698 or other test methods specified in the Technical Specifications. After compacting the LFCF closure subgrade material to the in-place minimum density of 90 percent dry density by the Contractor, the QA Geotechnical Inspectors make a visual inspection and periodically tested the material at placement locations to ensure overall consistency. If changes in the material occurred, or was suspect, the QA Manager retested the work area and collected additional in-place density tests. If the work area failed, then the QAM would reject the work performed, and direct that the soil area should be redisced, recompacted and moisture-adjusted until the results meet the contract specifications. Appendix D, titled 'In-Place Density Testing' presents the results of the in-place density testing for the subgrade layer performed by the Contractor in accordance with specifications.

TABLE 3.6

Landfill Common Fill, Amboy Aggregates, South Amboy, NJ			
QC Geotechnical Test Results Summary			
Test	**Criteria**	**Minimum**	**Maximum**
Max Stone Size	***3"***	<3"	<3"
Sieve Analysis No. 200	***85% Max***	1.10%	2.70%
Organics	***Free***	Free	Free
Atterberg Limits (Liquid Limits)	**<60**	NV	NV
Atterberg Limits (Plasticity Index)	***<40***	NP	NP

Table 3.7

Landfill Common Fill, Clean Earth, Carteret, NJ			
QC Geotechnical Test Results Summary			
Test	**Criteria**	**Minimum**	**Maximum**
Max Stone Size	***3"***	<3"	<3"
Sieve Analysis No. 200	***85% Max***	14.00%	41.20%
Organics	***Free***	Free	Free
Atterberg Limits (Liquid Limits)	**<60**	NV	36
Atterberg Limits (Plasticity Index)	***<40***	NP	15

Table 3.8

Landfill Common Fill, Clean Earth, Jersey City, NJ			
QC Geotechnical Test Results Summary			
Test	**Criteria**	**Minimum**	**Maximum**
Max Stone Size	***3"***	<3"	<3"
Sieve Analysis No. 200	***85% Max***	11.30%	76.40%
Organics	***Free***	Free	Free
Atterberg Limits (Liquid Limits)	**<60**	NV	68
Atterberg Limits (Plasticity Index)	***<40***	NP	13

Table 3.9

Landfill Common Fill, Clean Earth, Kearny, NJ			
QC Geotechnical Test Results Summary			
Test	**Criteria**	**Minimum**	**Maximum**
Max Stone Size	***3"***	<3"	<3"
Sieve Analysis No. 200	***85% Max***	8.10%	69.10%
Organics	***Free***	Free	Free
Atterberg Limits (Liquid Limits)	**<60**	NV	56
Atterberg Limits (Plasticity Index)	***<40***	NP	8

Table 3.10

Landfill Common Fill, Vanbro, Staten Island, NY			
QC Geotechnical Test Results Summary			
Test	**Criteria**	**Minimum**	**Maximum**
Max Stone Size	***3"***	<3"	<3"
Sieve Analysis No. 200	***85% Max***	22.40%	36.90%
Organics	***Free***	Free	Free
Atterberg Limits (Liquid Limits)	**<60**	NV	23
Atterberg Limits (Plasticity Index)	***<40***	NP	8

TABLE 3.11

Landfill Common Fill, Amboy Aggregates, South Amboy, NJ			
QC Chemical Test Results Summary			
Waste Characteristic	**Criteria (Maximums)**	**Minimum**	**Maximum**
Ignitability	**Rate > 2.2 mm/sec**	non-ignitable	non-ignitable
Corrosivity	**2 < pH <12.5**	7.93	8.42
Reactivity (Cyanide)	**< 250 ppm reactive**	ND	ND
Reactivity (Sulfide)	**< 500 ppm reactive**	ND	ND
TCLP Arsenic	**5.0 mg/L**	ND	ND
TCLP Barium	**100.0 mg/L**	ND	ND
TCLP Benzene	**0.5 mg/L**	ND	ND
TCLP Cadmium	**1.0 mg/L**	ND	ND
TCLP Carbon tetrachloride	**0.5 mg/L**	ND	ND
TCLP Chlordane	**0.03 mg/L**	ND	ND
TCLP Chlorobenzene	**100.0 mg/L**	ND	ND
TCLP Chloroform	**6.0 mg/L**	ND	ND
TCLP Chromium	**5.0 mg/L**	ND	ND
TCLP o-Cresol	**200.0 mg/L**	ND	ND
TCLP-Cresol	**200.0 mg/L**	ND	ND
TCLP p-Cresol	**200.0 mg/L**	ND	ND
TCLP 2,4-D	**10.0 mg/L**	ND	ND
TCLP l,4-Dichlorobenzene	**7.5 mg/L**	ND	ND
TCLP 1,2-Dichloroethane	**0.5 mg/L**	ND	ND
TCLP 1,1-Dichloroethylene	**0.7 mg/L**	ND	ND
TCLP 2,4-Dinitrotoluene	**0.13 mg/L**	ND	ND
TCLP Endrin	**0.02 mg/L**	ND	ND
TCLP Heptachlor	**0.008 mg/L**	ND	ND
TCLP Hexachloro-l,3-butadiene	**0.5 mg/L**	ND	ND
TCLP Hexachloroethane	**3.0 mg/L**	ND	ND
TCLP Lead	**5.0 mg/L**	ND	ND
TCLP Lindane	**0.4 mg/L**	ND	ND
TCLP Mercury	**0.2 mg/L**	ND	ND
TCLP Methoxychlor	**10.0 mg/L**	ND	ND
TCLP Methylethyl ketone	**200.0 mg/L**	ND	ND
TCLP Nitrobenzene	**2.0 mg/L**	ND	ND
TCLP Pentachlorophenol	**100.0 mg/L**	ND	ND
TCLP Pyridine	**5.0 mg/L**	ND	ND
TCLP Selenium	**1.0 mg/L**	ND	ND
TCLP Silver	**5.0 mg/L**	ND	ND
TCLP Tetrachloroethylene	**0.7 mg/L**	ND	ND
TCLP Toxaphene	**0.5mg/L**	ND	ND
TCLP Trichloroethylene	**0.5 mg/L**	ND	ND

TCLP 2,4,5-Trichlorophenol	**400.0 mg/L**	ND	ND
TCLP 2,4,6-Trichlorophenol	**2.0 mg/L**	ND	ND
TCLP 2,4,5-TP	**1.0 mg/L**	ND	ND
TCLP Vinyl Chloride	**0.2 mg/L**	ND	ND
PCBs, Total	**10 mg/kg**	ND	ND
Sulfides	**5000 mg/kg**	ND	ND
Ammonia	**200 mg/kg**	1.12	1.85
Asbestos Fiber	**1% (by weight)**	ND	ND

Table 3.12

Landfill Common Fill, Clean Earth, Carteret, NJ			
QC Chemical Test Results Summary			
Waste Characteristic	**Criteria (Maximums)**	**Minimum**	**Maximum**
Ignitability	**Rate > 2.2 mm/sec**	non-ignitable	non-ignitable
Corrosivity	**2 < pH <12.5**	2.17	12.3
Reactivity (Cyanide)	**< 250 ppm reactive**	ND	ND
Reactivity (Sulfide)	**< 500 ppm reactive**	ND	ND
TCLP Arsenic	**5.0 mg/L**	ND	ND
TCLP Barium	**100.0 mg/L**	0.349	2.49
TCLP Benzene	**0.5 mg/L**	ND	ND
TCLP Cadmium	**1.0 mg/L**	ND	ND
TCLP Carbon tetrachloride	**0.5 mg/L**	ND	ND
TCLP Chlordane	**0.03 mg/L**	ND	ND
TCLP Chlorobenzene	**100.0 mg/L**	ND	ND
TCLP Chloroform	**6.0 mg/L**	ND	ND
TCLP Chromium	**5.0 mg/L**	ND	ND
TCLP o-Cresol	**200.0 mg/L**	ND	ND
TCLP-Cresol	**200.0 mg/L**	ND	ND
TCLP p-Cresol	**200.0 mg/L**	ND	ND
TCLP 2,4-D	**10.0 mg/L**	ND	ND
TCLP l,4-Dichlorobenzene	**7.5 mg/L**	ND	ND
TCLP 1,2-Dichloroethane	**0.5 mg/L**	ND	ND
TCLP 1,1-Dichloroethylene	**0.7 mg/L**	ND	ND
TCLP 2,4-Dinitrotoluene	**0.13 mg/L**	ND	ND
TCLP Endrin	**0.02 mg/L**	ND	ND
TCLP Heptachlor	**0.008 mg/L**	ND	ND
TCLP Hexachlorobenzene	**0.13 mg/L**	ND	ND
TCLP Hexachloro-l,3-butadiene	**0.5 mg/L**	ND	ND
TCLP Hexachloroethane	**3.0 mg/L**	ND	ND
TCLP Lead	**5.0 mg/L**	0.394	4.21
TCLP Lindane	**0.4 mg/L**	ND	ND
TCLP Mercury	**0.2 mg/L**	ND	ND
TCLP Methoxychlor	**10.0 mg/L**	ND	ND
TCLP Methylethyl ketone	**200.0 mg/L**	ND	ND
TCLP Nitrobenzene	**2.0 mg/L**	ND	ND
TCLP Pentachlorophenol	**100.0 mg/L**	ND	ND
TCLP Pyridine	**5.0 mg/L**	ND	ND
TCLP Selenium	**1.0 mg/L**	ND	ND
TCLP Silver	**5.0 mg/L**	ND	ND
TCLP Tetrachloroethylene	**0.7 mg/L**	ND	ND
TCLP Toxaphene	**0.5mg/L**	ND	ND
TCLP Trichloroethylene	**0.5 mg/L**	ND	ND
TCLP 2,4,5-Trichlorophenol	**400.0 mg/L**	ND	ND
TCLP 2,4,6-Trichlorophenol	**2.0 mg/L**	ND	ND
TCLP 2,4,5-TP	**1.0 mg/L**	ND	ND

TCLP Vinyl Chloride	**0.2 mg/L**	ND	ND
PCBs, Total	**10 mg/kg**	0.0494	5.7
Sulfides	**5000 mg/kg**	177.8	330.4
Ammonia	**200 mg/kg**	1.9	28
Asbestos Fiber	**1% (by weight)**	ND	ND

Table 3.13

Landfill Common Fill, Clean Earth, Jersey City, NJ			
QC Chemical Test Results Summary			
Waste Characteristic	**Criteria (Maximums)**	**Minimum**	**Maximum**
Ignitability	**Rate > 2.2 mm/sec**	non-ignitable	non-ignitable
Corrosivity	**2 < pH <12.5**	6.62	12.4
Reactivity (Cyanide)	**< 250 ppm reactive**	ND	ND
Reactivity (Sulfide)	**< 500 ppm reactive**	ND	ND
TCLP Arsenic	**5.0 mg/L**	ND	ND
TCLP Barium	**100.0 mg/L**	0.253	0.58
TCLP Benzene	**0.5 mg/L**	ND	ND
TCLP Cadmium	**1.0 mg/L**	ND	ND
TCLP Carbon tetrachloride	**0.5 mg/L**	ND	ND
TCLP Chlordane	**0.03 mg/L**	ND	ND
TCLP Chlorobenzene	**100.0 mg/L**	ND	ND
TCLP Chloroform	**6.0 mg/L**	ND	ND
TCLP Chromium	**5.0 mg/L**	ND	ND
TCLP o-Cresol	**200.0 mg/L**	ND	ND
TCLP-Cresol	**200.0 mg/L**	ND	ND
TCLP p-Cresol	**200.0 mg/L**	ND	ND
TCLP 2,4-D	**10.0 mg/L**	ND	ND
TCLP l,4-Dichlorobenzene	**7.5 mg/L**	ND	ND
TCLP 1,2-Dichloroethane	**0.5 mg/L**	ND	ND
TCLP 1,1-Dichloroethylene	**0.7 mg/L**	ND	ND
TCLP 2,4-Dinitrotoluene	**0.13 mg/L**	ND	ND
TCLP Endrin	**0.02 mg/L**	ND	ND
TCLP Heptachlor	**0.008 mg/L**	ND	ND
TCLP Hexachlorobenzene	**0.13 mg/L**	ND	ND
TCLP Hexachloro-l,3-butadiene	**0.5 mg/L**	ND	ND
TCLP Hexachloroethane	**3.0 mg/L**	ND	ND
TCLP Lead	**5.0 mg/L**	ND	ND
TCLP Lindane	**0.4 mg/L**	ND	ND
TCLP Mercury	**0.2 mg/L**	ND	0.013
TCLP Methoxychlor	**10.0 mg/L**	ND	ND
TCLP Methylethyl ketone	**200.0 mg/L**	ND	ND
TCLP Nitrobenzene	**2.0 mg/L**	ND	ND
TCLP Pentachlorophenol	**100.0 mg/L**	ND	ND
TCLP Pyridine	**5.0 mg/L**	ND	ND
TCLP Selenium	**1.0 mg/L**	ND	ND
TCLP Silver	**5.0 mg/L**	ND	ND
TCLP Tetrachloroethylene	**0.7 mg/L**	ND	ND
TCLP Toxaphene	**0.5mg/L**	ND	ND
TCLP Trichloroethylene	**0.5 mg/L**	ND	ND
TCLP 2,4,5-Trichlorophenol	**400.0 mg/L**	ND	ND
TCLP 2,4,6-Trichlorophenol	**2.0 mg/L**	ND	ND
TCLP 2,4,5-TP	**1.0 mg/L**	ND	ND
TCLP Vinyl Chloride	**0.2 mg/L**	ND	ND
PCBs, Total	**10 mg/kg**	0.0362	0.87
Sulfides	**5000 mg/kg**	339.3	778

Ammonia	**200 mg/kg**	8.24	237
Asbestos Fiber	**1% (by weight)**	ND	ND

Table 3.14

Landfill Common Fill, Clean Earth, Kearny, NJ			
QC Chemical Test Results Summary			
Waste Characteristic	**Criteria (Maximums)**	**Minimum**	**Maximum**
Ignitability	**Rate > 2.2 mm/sec**	non-ignitable	non-ignitable
Corrosivity	**2 < pH <12.5**	9.87	12.33
Reactivity (Cyanide)	**< 250 ppm reactive**	ND	ND
Reactivity (Sulfide)	**< 500 ppm reactive**	ND	ND
TCLP Arsenic	**5.0 mg/L**	ND	ND
TCLP Barium	**100.0 mg/L**	0.282	1.2
TCLP Benzene	**0.5 mg/L**	ND	ND
TCLP Cadmium	**1.0 mg/L**	ND	ND
TCLP Carbon tetrachloride	**0.5 mg/L**	ND	ND
TCLP Chlordane	**0.03 mg/L**	ND	ND
TCLP Chlorobenzene	**100.0 mg/L**	ND	ND
TCLP Chloroform	**6.0 mg/L**	ND	ND
TCLP Chromium	**5.0 mg/L**	ND	ND
TCLP o-Cresol	**200.0 mg/L**	ND	ND
TCLP-Cresol	**200.0 mg/L**	ND	ND
TCLP p-Cresol	**200.0 mg/L**	ND	ND
TCLP 2,4-D	**10.0 mg/L**	ND	ND
TCLP l,4-Dichlorobenzene	**7.5 mg/L**	ND	ND
TCLP 1,2-Dichloroethane	**0.5 mg/L**	ND	ND
TCLP 1,1-Dichloroethylene	**0.7 mg/L**	ND	ND
TCLP 2,4-Dinitrotoluene	**0.13 mg/L**	ND	ND
TCLP Endrin	**0.02 mg/L**	ND	ND
TCLP Heptachlor	**0.008 mg/L**	ND	ND
TCLP Hexachlorobenzene	**0.13 mg/L**	ND	ND
TCLP Hexachloro-l,3-butadiene	**0.5 mg/L**	ND	ND
TCLP Hexachloroethane	**3.0 mg/L**	ND	ND
TCLP Lead	**5.0 mg/L**	ND	1.03
TCLP Lindane	**0.4 mg/L**	ND	ND
TCLP Mercury	**0.2 mg/L**	ND	ND
TCLP Methoxychlor	**10.0 mg/L**	ND	ND
TCLP Methylethyl ketone	**200.0 mg/L**	ND	ND
TCLP Nitrobenzene	**2.0 mg/L**	ND	ND
TCLP Pentachlorophenol	**100.0 mg/L**	ND	ND
TCLP Pyridine	**5.0 mg/L**	ND	ND
TCLP Selenium	**1.0 mg/L**	ND	ND
TCLP Silver	**5.0 mg/L**	ND	ND
TCLP Tetrachloroethylene	**0.7 mg/L**	ND	ND
TCLP Toxaphene	**0.5mg/L**	ND	ND
TCLP Trichloroethylene	**0.5 mg/L**	ND	ND
TCLP 2,4,5-Trichlorophenol	**400.0 mg/L**	ND	ND
TCLP 2,4,6-Trichlorophenol	**2.0 mg/L**	ND	ND
TCLP 2,4,5-TP	**1.0 mg/L**	ND	ND
TCLP Vinyl Chloride	**0.2 mg/L**	ND	ND
PCBs, Total	**10 mg/kg**	0.0401	0.677
Sulfides	**5000 mg/kg**	262.8	440.8
Ammonia	**200 mg/kg**	4.58	195.8
Asbestos Fiber	**1% (by weight)**	ND	ND

Table 3.15

Landfill Common Fill, Vanbro, Staten Island, NY			
QC Chemical Test Results Summary			
Waste Characteristic	**Criteria (Maximums)**	**Minimum**	**Maximum**
Ignitability	**Rate > 2.2 mm/sec**	non-ignitable	non-ignitable
Corrosivity	**2 < pH <12.5**	7.57	8.97
Reactivity (Cyanide)	**< 250 ppm reactive**	ND	ND
Reactivity (Sulfide)	**< 500 ppm reactive**	ND	ND
TCLP Arsenic	**5.0 mg/L**	ND	ND
TCLP Barium	**100.0 mg/L**	0.496	1.01
TCLP Benzene	**0.5 mg/L**	ND	ND
TCLP Cadmium	**1.0 mg/L**	ND	ND
TCLP Carbon tetrachloride	**0.5 mg/L**	ND	ND
TCLP Chlordane	**0.03 mg/L**	ND	ND
TCLP Chlorobenzene	**100.0 mg/L**	ND	ND
TCLP Chloroform	**6.0 mg/L**	ND	ND
TCLP Chromium	**5.0 mg/L**	ND	ND
TCLP o-Cresol	**200.0 mg/L**	ND	ND
TCLP-Cresol	**200.0 mg/L**	ND	ND
TCLP p-Cresol	**200.0 mg/L**	ND	ND
TCLP 2,4-D	**10.0 mg/L**	ND	ND
TCLP l,4-Dichlorobenzene	**7.5 mg/L**	ND	ND
TCLP 1,2-Dichloroethane	**0.5 mg/L**	ND	ND
TCLP 1,1-Dichloroethylene	**0.7 mg/L**	ND	ND
TCLP 2,4-Dinitrotoluene	**0.13 mg/L**	ND	ND
TCLP Endrin	**0.02 mg/L**	ND	ND
TCLP Heptachlor	**0.008 mg/L**	ND	ND
TCLP Hexachlorobenzene	**0.13 mg/L**	ND	ND
TCLP Hexachloro-l,3-butadiene	**0.5 mg/L**	ND	ND
TCLP Hexachloroethane	**3.0 mg/L**	ND	ND
TCLP Lead	**5.0 mg/L**	0.264	0.313
TCLP Lindane	**0.4 mg/L**	ND	ND
TCLP Mercury	**0.2 mg/L**	ND	ND
TCLP Methoxychlor	**10.0 mg/L**	ND	ND
TCLP Methylethyl ketone	**200.0 mg/L**	ND	ND
TCLP Nitrobenzene	**2.0 mg/L**	ND	ND
TCLP Pentachlorophenol	**100.0 mg/L**	ND	ND
TCLP Pyridine	**5.0 mg/L**	ND	ND
TCLP Selenium	**1.0 mg/L**	ND	ND
TCLP Silver	**5.0 mg/L**	ND	ND
TCLP Tetrachloroethylene	**0.7 mg/L**	ND	ND
TCLP Toxaphene	**0.5mg/L**	ND	ND
TCLP Trichloroethylene	**0.5 mg/L**	ND	ND
TCLP 2,4,5-Trichlorophenol	**400.0 mg/L**	ND	ND
TCLP 2,4,6-Trichlorophenol	**2.0 mg/L**	ND	ND
TCLP 2,4,5-TP	**1.0 mg/L**	ND	ND
TCLP Vinyl Chloride	**0.2 mg/L**	ND	ND
PCBs, Total	**10 mg/kg**	0.0224	0.106
Sulfides	**5000 mg/kg**	ND	ND
Ammonia	**200 mg/kg**	1.48	10.5
Asbestos Fiber	**1% (by weight)**	ND	ND

4.0 SLURRY (BARRIER) WALL

4.1 General

The Brookfield Avenue Landfill has a Slurry (Barrier) Wall surrounding the perimeters of both the East Cell and the West Cell. A Slurry (Barrier) Wall is a subsurface, low permeability soil material vertical wall that extends several feet below the ground surface. It is engineered as a groundwater barrier wall containment system to prevent groundwater migration into the Landfill as well as lateral migration of leachate out of the perimeter boundary. A Slurry (Barrier) Wall, is considered an engineering control for a landfill and is an integral part of the primary remedy for the closure of this Landfill.

There were two types of slurry walls used for the closure of the Brookfield Avenue Landfill. They is 1) a soil-based backfill and bentonite slurry wall; and 2) a self-hardening cement bentonite slurry wall. The "Soil-based backfill and bentonite slurry wall", as name implies, is made with a clay-based slurry which was either imported or found on-site during excavation and are primarily comprised of soil, water with clay (bentonite); and the "Self-hardening cement bentonite slurry wall" containing water, clay (bentonite) and cementituous materials (Portland cement). The Brookfield Avenue Landfill slurry wall backfill mixes consist of either a soil-bentonite backfill or a cement-bentonite backfill mixture and both were selected and approved by the Engineer-of-Record(EOR).

Both the slurry design mixes and construction of the slurry walls were done in accordance with *Title 6, Official Compilation of Codes, Rules and Regulations of the State of New York Part 360*.

4.2 Mix Design and Preparation

The mix design of the soil bentonite barrier wall was designed to have an effective hydraulic conductivity of less than or equal to 1×10^{-7} cm/sec. Review of the soil present in the ground at the Landfill indicated that a soil-bentonite backfill mixture consisting of onsite soils, offsite soils, and bentonite would be an adequate blend of soil to achieve an effective hydraulic conductivity of less than or equal to 1×10^{-7}cm/sec for this project. Prior to mobilization, testing and approval of the mixture were made to ensure that a continuous, homogeneous mixture of soil and bentonite, having a hydraulic conductivity less than or equal to 1×10^{-7} cm/sec was attained.

Refer to Appendix E, titled 'Slurry (Barrier) Wall' for the results of the laboratory mix designs. The following is a summary of the study that was performed and includes a discussion of the materials and equipment that were used to achieve the intended permeability and the mix design parameters to be used during construction.

4.2.1 Bench Scale Study

A bench-scale study for the soil bentonite slurry wall was performed to confirm the mix design met the required parameters. Four soil bentonite mixes were prepared during the study. All four of the mixes were prepared and tested for hydraulic conductivity. Based on mix design testing results and laboratory testing data results, an addition of 0.7% dry bentonite was required to obtain a factor of safety of 2 for hydraulic conductivity. The optimum soil bentonite backfill consisted of 50% site sand clays and silts mixed with 50% of offsite clay borrow. Based upon the study, the data obtained from these mix designs and the backfill results required to achieve the requirements of the construction specification, the final mix design was selected. The final mix design consisted of the following recipe:

- Minimum of 50% off site borrow
- Maximum of 50% on site sand, silts and clays
- 1 % dry Bentonite by weight of soil
- Bentonite Slurry

4.2.2 Materials

The off-site borrow soil used in the soil-bentonite backfill was imported from County Concrete, of Kenvil, New Jersey. County Concrete, operates a virgin mine whose material exhibits a homogenous and very uniform composition. The characteristics of the on-site soil excavated from locations in the alignment of the slurry wall trench were also found to be suitable. Water from an on-site hydrant with bulk quantities of imported bentonite was used to make the bentonite slurry. The following materials were used in the laboratory mix design during the construction of the barrier wall:

- Site water: Obtained from on-site fire hydrant.
- Borrow soil: Off-site borrow soil obtained from County Concrete.

- Sand: On-site sand that was obtained throughout the site at various depths.
- Clay: On-site clays that were obtained throughout the site at various depths.
- Bentonite: Bentonite was obtained from bentonite manufacturer.

4.2.3 Slurry Mixing Preparation, Layout and Equipment

Mobilization of the slurry mixing plant and all related pumping equipment was initially set up and laid out at a central location in a northern most part of the east cell. During the construction of the perimeter slurry wall, all of the slurry mix utilized for this work was prepared at this on-site slurry plant. The bentonite slurry mixing and pumping equipment consisted of a high velocity high pressure venturi-jet mixer with a high speed, high shear pump. This mixing plant was predominantly a mechanical agitation system with pumps, valves, hoses, pipe and tools, all of which were an integral function in the preparation and delivery of slurry for the project. This system in combination with mixing pads and construction of hydration ponds provided a continuous supply of slurry mixture for the wall construction throughout the duration of this task.

Once the offsite borrow and the onsite soils were determined to be acceptable, the soil materials (either imported off-site or from slurry trench excavation) were delivered by trucks to the stockpile area near the slurry mixing plant adjacent to the remote mix pad. This remote mix pad and a storage pad were constructed using Landfill common fill and on site borrow soils. The pads were constructed large enough to allow the mixing of the soil and bentonite backfill via a low ground pressure bulldozer, front-end loader and excavator. Dual slurry hydration ponds were also constructed directly above the Landfill subgrade using Landfill common fill. Each slurry hydration pond entailed bermed embankments each with an approximate capacity of 300 cubic yards. This mixing process layout and equipment was set up to achieve a complete dispersion of the bentonite. Once the soils were placed on the remote mix pad, the dry bentonite was added by bags (the quantity of the dry bentonite was calculated by weight - by the number of bags) and the soil was sluiced with bentonite slurry from either the slurry pond or the actual trench around the perimeter of the Landfill. The equipment utilized was capable of continually mixing and maintaining a uniform blend of slurry product. A low-ground pressure bulldozer, in conjunction with an excavator, was used to blend the soils and slurry together into a homogenous mix. Once the mix was homogenous, i.e. free from large lumps or pockets of fines, sand or gravel, then the mix was found to achieve the specified result. At this juncture, the soil-bentonite backfill was dozed or pushed into a loading area and an excavator loaded the homogenously mixed backfill into trucks for hauling as backfill to the slurry trench.

4.3 Installation

4.3.1 General

The construction of the slurry (barrier) wall began during July of 2010. The slurry mixture for the barrier wall would be introduced into the trench by utilizing it as a backfill material or used to stabilize the trench sidewalls while being pumped into the trench via pipes/hoses.

Construction of the barrier wall platform with the protective barrier wall cap began on the West Cell at approximately Station 19+00 and proceeded counter-clockwise around the West Cell. The barrier wall on the East Cell started at approximately station 75+00 and proceeded counter-clockwise around the East Cell. The construction dates for the West Cell was June 2010 to October 2010 and the East Cell was July 2011 to November 2011**.**

The final configuration and dimensions of the barrier wall surrounding each Landfill cell is 3 feet wide at depths ranging from 25 to 40 feet below the ground surface. The wall is a continuous, stable barrier designed and intended to slow down and stop continued migration and horizontal flow of groundwater through the Landfill.

The majority of the perimeter wall consists of a homogeneous mixture of soil bentonite and slurry, and in some areas “self-hardening” cement/bentonite slurry was used. The self-hardening cement-bentonite slurry was used to achieve a higher strength while maintaining the same permeability result. The self-hardening cement-bentonite slurry was prepared per design to be used in areas that trench stability was uncertain and possibly unattainable with typical soil-bentonite slurry.

4.3.2 Work Platform

Prior to excavating and trenching for the slurry wall, truck traffic routes and perimeter working platforms were established. A primary advantage of soil based backfill slurry wall was the elimination of excess soil and disposal by incorporating the excavated wall material back into the backfill for the wall, however, a relatively wide and flat working surface was required.

The process for the installation of the slurry wall was based upon trucks and equipment continuously moving in a one way traffic pattern on a stable working platform. The majority of the work platform was constructed on the inboard side (Landfill) of the slurry trench alignment due to the instability and unsuitable nature of the outboard side existing soil/materials. Constructing the platform to the inside of the Landfill minimized the disturbance to surrounding wetlands areas and other ecologically sensitive areas. The platform width on the inboard side also provided a stable and safe platform for the slurry wall excavator as well truck traffic delivering and removing pre- and post-processed soil backfill. The surveyor laid out the wall alignment from the centerline of the slurry wall with the outboard dimension of the platform being approximately 10 feet and the inboard (Landfill side) dimension of the platform being approximately 30 feet.

The contractor began construction of the work platform by cutting or filling the existing landfill surface to a subgrade elevation of 10.00 feet above sea level. In some areas, unsuitable soils (debris and over-saturated soils) were undercut and backfilled to elevation 10.00 feet with suitable soil (landfill common fill). Once the base elevation or subgrade elevation (elevation 10.00 feet) was achieved, the contractor began to install a uniform 2-foot thick (18-inches of platform backfill and 6-inches of NYSDOT subbase Type 4 stone) layer to form the final platform elevation of 12.00. As part of the installation of the uniform 2-foot thick working platform, the contractor installed a woven geotextile (Carthage FX-66) as platform reinforcement on the inboard side of the platform at subgrade elevation 10.00. The contractor then placed and compacted a 6 to 8 inch lift of platform backfill (Landfill Common Fill) on the inboard and outboard sides of the work platform. A bi-axial geogrid (Tensar BX1200) was then used on the inboard and outboard sides of the platform approximately 16 to 18 inches from the top of the platform. The geotextile was installed lengthwise along the roll with the seams being overlapped by 2-feet. The geogrid was also installed lengthwise along the roll and was overlapped 6-inches with hog-rings installed every 2-feet along the sides of the geogrid. The placement of the geogrid, always allowed a 5-foot opening at the centerline of the slurry wall so that the excavator would not tear any of the installed geogrid during the excavation of the slurry trench. Once the geogrid was in place, the remaining platform backfill was placed and compacted with the final 6-inches of NYSDOT subbase Type 4 stone placed and compacted to have a top of a stable work platform uniformly at elevation 12.00 along the alignment of the slurry wall.

4.3.3 Trench Excavation and Backfill

Prior to trenching, the barrier wall centerline was staked at 10 foot intervals to insure that the excavation was on the proper alignment. Slurry wall excavation began with a 1H:1V lead-in trench for soil bentonite backfill placement which allowed the initial backfill to slide down the lead in slope until its angle of repose was achieved and the crest of the soil bentonite backfill reached the working surface level. A Komatsu PC800LC hydraulic excavator and long stick excavator, equipped with a 36-inch wide bucket were utilized to provide a continuous wall around the landfill cell perimeters to depths indicated on the drawings. Tri-axial end-dump dump trucks were used for soil material transportation during trenching and backfilling. The toe of the soil-bentonite backfill was maintained at least 30 feet from the toe of the excavation. Appendix B, entitled ‘Construction Management Daily Reports’ presents all daily reports and cross sections of the trench alignment prepared by the CM QA inspectors during construction phase of the Barrier wall.

Trucks loaded with soil bentonite backfill material traveled continuously to the area of trenching ready to backfill the trench. Placement operations proceeded so that the soil bentonite backfill slope followed a reasonably smooth grade and not contain pockets of bentonite slurry. Subsequent loads of backfills were placed on previously placed slurry backfill, continuously in the direction of the excavation from the beginning of the trench to the end of the trench each day.

Bulldozers were utilized to push the overflow material into the trench. Once the material is offloaded, the empty truck would proceeded along the excavated trench alignment to the slurry wall trenching excavator for loading with excavated soils from the leading end of the trench for that day. Excavated soils from the trench were visually inspected and samples were frequently obtained to verify if material was suitable for mixing with the slurry. Once loaded, trucks then proceeded to either the slurry mixing staging area along the unexcavated slurry wall platform road to deliver this load of excavated on-site trench borrow soils consisting of clays, sands and silts for either mixing or was staged on the landfill as an off spec material.. This cycle was repeated throughout the entire phase of wall construction.

Some areas, along the alignment of Landfill perimeter Barrier Wall, required placement of Self-Hardening Slurry, which installation procedures typically remained the same as the soil-bentonite slurry wall. The Contract drawings identified specific locations along the alignment of the slurry wall that required installation of the self-hardening slurry wall; additionally at other locations along the alignment of the slurry wall self-hardening slurry wall was installed based upon field conditions at the time of trenching.

Modifications of the barrier wall alignment were necessary due to field conditions as well as utilization of sections of self-hardening slurry wall. The changes are presented in Appendix L, titled 'Record Drawings'.

4.3.4 Excess Soil, Protective Cap & Site Cleanup Procedures

After completion of the slurry wall trench backfilling, all remaining excavated material and slurry was removed from within 25-feet of the barrier wall and the surface was back-bladed with a dozer. A minimum of 7 days was allowed after completion and before installation of the protective cap over the wall. Traffic over the barrier wall was not allowed for at least thirty days after completion of the protective cap. The open trench and barrier wall was not crossed by construction equipment until the protective cap was in place above the backfilled wall.

All excess slurry mixture material was combined with the excavated soils from the trench and placed within graded areas on the Landfill, below the cap. Some of this material was also used as intermediate cover material and integrated with additional Landfill Common Fill, below the cap prior to geomembrane liner installation.

4.4 Quality Assurance/Quality Control

4.4.1 General

Quality Assurance (QA) and Quality Control (QC) procedures during barrier wall installation were followed from the onset of construction and installation of the barrier wall to verify and document satisfactory completion of the work. Commencing immediately after proper selection and design of the backfill mix, quality assurance/quality control procedures out in the field became essential to produce consistent results, as those achieved during initial laboratory bench-scale testing and throughout the installation process. The QA/QC team of inspectors provided oversight of the remedial activities being performed and visually and continuously inspected the Barrier Wall installation and all components of the system to determine compliance with the specifications and to ensure and maintain technical control associated with performance of work. The on-site Slurry Trench Specialist was identified as Inquip Associates, Inc. The CM supervised the installation of the slurry trench and the quality control and quality assurance procedures. QA/QC personnel maintained documentation and followed the specified testing requirements for the all components of the barrier wall system.

The following tables provide a summary of the specific QA/QC protocols followed during construction of the barrier wall, including the on-site and off-site fill material, LFCF, sand and clay soil testing, trench depth verification, etc. and is based on visual observations and measurements collected in the field. All excess slurry wall material categorized as LFCF was tested in accordance with the part 360 and the contract specifications and incorporated into the Final Cover System placed under the liner. All excess slurry wall material that exhibited the low permeability fill characteristics were all also tested in accordance with the part 360 and the contract specifications and was used to construct the barrier wall protective cap. Appendix E, titled ‘Slurry (Barrier) Wall’ presents additional and supplementry data and analytical results of barrier wall related lab reports, that were reviewed and approved by the QA team.

- Table 4.1: Sampling Requirements and Testing Frequencies
- Table 4.2: East Cell Permeability Testing
- Table 4.3: East Cell Compression Cement Testing
- Table 4.4: West Cell Permeability Testing
- Table 4.5: West Cell Compression Cement Testing
- Table 4.6: QC Geotechnical Analysis – Slurry/Barrier Wall Fill
- Table 4.7 QA Chemical Analysis – Slurry

4.4.2 Trench Continuity and Key

Trench continuity was assured by witnessing the action of movement of the trench excavation equipment such that the digging tools can be passed vertically from top to bottom of the trench as well as moved horizontally along the axis of the trench without encountering unexcavated material. The final excavated trench depth was verified by collecting key-in material samples and performing direct measurements of the trench dimensions at 45ft intervals. Penetration of the bottom of the trench into the key-in material was demonstrated by observation of the excavation spoils from the trench. QC depth measurements to the top of the designated stratum were taken every 10 ft along the trench centerline using a weighted tape or cable.

Additionally, the QA inspector would record depths of the trench and other pertinent data (i.e. profile of backfill slope) in a daily report after requiring the excavator operator to pass the excavator stick and bucket along the completed section along the trench line at the completion of the excavation of a section of trench for the day to confirm continuity with the specified design depths and contract documents. Slurry levels were also monitored and the contractor was required to maintained levels within 6" of the top of the work pad at the lowest elevation of the open trench. At night and during other non-working periods, the slurry levels were raised to the work pad elevation at its lowest point along the open trench. The QA team verified the trench was continuous and keyed into the minimum specified depth of the designated stratum and observed and documented the following:

- Top of Key Stratum: The top elevation of the key stratum determined based on an examination of the cut taken during excavation.
- Bottom of Excavation Prior to Backfilling: Measured soundings to monitor for sidewall collapse and accumulation of sediments.
- Profile of Backfill Slope: The backfill mix slope and trench bottom was sounded at the beginning and end of each shift by QC (verified by QA) and converted to an as-built drawing by the Contractor. Data was reviewed daily by both QC & QA personnel for any indication of trench collapse, excessive settlement or sloughing.

4.4.3 Materials Testing

A qualified off-site laboratory was engaged to perform all QA/QC testing during installation and an on-site field laboratory was constructed and equipped with testing apparatus and supplies to perform all batch plant sampling. QA Inspectors verified and documented that the lab and batch plant were acceptable, that calibration logs and forms were being completed regularly, samples were collected, delivered to the laboratory and test results were reported the same week as the samples were received. Onsite testing consisted of the slump (ASTM C 143) and density (API 13B). Slurry tests and the onsite soil bentonite backfill tests were performed daily and results of the tests were also provided daily but on 8 hour lag time interval. Offsite Laboratory testing consisted of gradation (ASTM D422), moisture content (ASTM D22l6), Atterberg Limits (ASTM D4318), and hydraulic conductivity (ASTM D5048). Laboratory testing results were reviewed by QA within 24 hours of receipt from the JLT Laboratories, Inc. of Canonsburg, PA. Material testing was assured by witnessing and testing the following:

- Bentonite: Inspectors collected copies of Manufacturer's Certificate of Compliance with the API specification obtained by the contractor from the manufacturer for each shipment of bentonite (Federal Gel 90 bentonite) delivered to the site.
- Appendix E, titled 'Slurry (Barrier) Wall' presents the results of the laboratory mix.
- Water: Water for slurry mixing was tested weekly by QC.
- The site water was also blended with Federal Gel 90 bentonite for a 40 second Marsh Funnel Viscosity.
- The bentonite slurry was tested for viscosity, fluid loss, pH and density. Inspectors collected and verified that tests were performed and results were submitted weekly. See Appendix E, titled 'Slurry (Barrier) Wall'.
- On-site Soils: On-site Suitable soil excavated from the trench were loaded into trucks and hauled to the stockpile area adjacent to the remote mix pad for usage in the barrier wall fill mix. All soils were observed and documented to be sorted and verified that it consisted of a well graded material with less than 4-inch particles, free of organic content, organic silts, peat and peat-like material with relatively high organic content. Soils were also documented to display a consistency of predominantly red-brown silt, clay and sand as described in project boring logs. Sampling Requirements and Testing Frequencies for the Slurry Trench and Soil/Bentonite Slurry Wall Construction are in Table 4.1.
- Unsuitable soil excavated from the trench that failed to meet specified requirements was segregated, removed from the mixing area, loaded into trucks and hauled to other areas on the Landfill area, which were used as grading fill within the Landfill under the cap.
- Off-site Soils: Off-site borrow soils used to prepare the barrier wall fill mix were both QA and QC verified. Inspectors verified that off-site imported borrow soils obtained from an approved source were well graded with soil particles less than 4-inches and free from chemical contamination. Off-site soils were geo-technically tested every 250 cys and chemically tested every 2,500 cys by QC. QA Inspectors obtained and verified all QC test results and collect verification samples every 2,500 cys for geotechnical analysis. Results are shown on Table 4.6 and backup data are presented in Appendix E, titled 'Slurry (Barrier) Wall'.

- Prepared Backfill: The prepared soil-bentonite backfill mix consisted of both onsite soils and offsite borrow material with mix ratios of 50% offsite borrow, maximum of 50% onsite sand and silt and clay, and 1% dry Bentonite by weight of soil with bentonite slurry. The prepared backfill mix was tested daily by QC for geotechnical parameters listed in the specifications and summarized herein on Table 4.6. QA/QC Inspectors obtained all test results on a daily basis and performed individual testing once for every 1,000 cys of mixed backfill produced to verify that the prepared material mix meets the design parameters. This testing included the following: Backfill Slump (ASTM C 143), Backfill Density (API 13B), Backfill Gradation (ASTM 422), Backfill Moisture Content (ASTM 02216), Backfill Atterberg Limits (ASTM 04318), Backfill Triaxial Hydraulic Conductivity (remolded) (ASTM 05048). Suitable excavated onsite trench soil and offsite borrow material was loaded onto the remote mix pad using a front end loader and a truck, or a front-end loader directly. The quantity of soil by volume (counting loader buckets) and borrow soil was added at the required ratio as determined via field QA/QC laboratory testing results. Additionally, coupled with field and laboratory testing, the QA/QC process for this process involved the backfill mixture to be visually inspected ensuring that the mixing and blending of the soil-bentonite backfill into a homogeneous mass was free from large lumps or pockets of fines, sand or gravel..
- Fresh Slurry: A complete series of API tests were conducted by QC from the mixer or tank containing fresh slurry ready for introduction in the trench at least once per day. Inspectors obtained all QC test results on a daily basis and performed equivalent series of API tests every other day. Test parameters and sampling frequencies for the Fresh Slurry are in Appendix E, titled ‘Slurry (Barrier) Wall’.
- In-Trench Slurry: Slurry in the trench was tested via API methods at least twice per day start and end of each day by the Contractors QC personnel. Slurry samples were obtained from within 10 feet of the bottom of the trench at the toe of the backfill mix slope near the excavator. Inspectors obtained all QC test results on a daily basis and performed similar field testing every other day. All slurry tests were conducted in accordance with API 13B, latest edition (Temperature, pH, Unit Weight, Sand Content, Viscosity, Gel Strength). These tests were conducted onsite using specified apparatus. Test parameters and sampling frequencies for the In-Trench Slurry are in Appendix E, titled ‘Slurry (Barrier) Wall’.

- Barrier Wall Permeability: The permeability, strength, compressibility, and density of the barrier wall were verified through the collection of Shelby tube core samples. Shelby tube samplers advanced by hand were used to evaluate the permeability of the slurry wall after construction prior to placement of cap. Shelby tube samplers recover relatively undisturbed soil of the completed wall suitable for laboratory tests of engineering properties.

4.4.4 Documentation

During construction, the Contractor conducted and submitted results of all construction testing, (i.e. trench depth measurements, water quality tests results, backfill, profile measurements, barrier wall surface elevations and wall alignment surveys, daily field reports, etc.). All material that was used for the construction of the barrier wall was tested and accepted and results of all tests performed were recorded on forms submitted daily for QA verification and signed by the QA/QC personnel.

TABLE 4.1

Sampling Requirements and Testing Frequencies
Slurry Trench and Soil/Bentonite Slurry Wall Construction

Material	**Sampling and Testing Requirement**	**Criteria**	**QC**	**QA**
Water - *(hydrant location)*	• pH • Hardness • Conductivity • TDS • TOC	• pH in the range of 7 • hardness less than 50 ppm • Conductivity - information • TDS below 500 ppm • TOC less than 50 ppm	Tested weekly	Verify test performed & results submitted
Bentonite	• statement from supplier detailing properties and composition • certificates of compliance that bentonite is natural and API grade	• product of sodium montmorillonite bentonite • min barrel yield of 90 barrels per ton • viscometer reading, water loss, • % moisture and yield point • wet screen analysis for residue min of 80% (+/-2%) finer than the 200 sieve	Each truck load delivered to the site	Verify test performed & results submitted
Barrier Wall Fill /Soil Prior to Mixing - *(random samples)*	• grain size analysis (sieve only - ASTM D422) • atterberg limits (ASTM D4318) • particle size < 4" • TCLP chemical analysis per contract specification section 02108	• on-site trench soil used as Barrier Wall Fill - well graded soil particles < 4", free of organics, wood, debris. Soils should be red brown silt and clay and sand. • imported / off-site soils used as Barrier Wall Fill - well graded soil particles < 4", approved source, obtain ASTM results, free from chemical contamination.	Geotech test - every 250 cys (off-site soil only); Chemical tested – every 2,500cys	Offsite-Collect geotech every 2,500 cys; verify chem results; collect daily sample of onsite soil used prior to mixing
Fresh Slurry - *(sampled prior to entering trench)*	• % bentonite (API 13B) • unit weight (API RP 13B) • viscosity (API RP 13B) • filtrate Loss (API PR 13B) • pH and temp & gel strength	• % bentonite >6% by weight • unit weight > 63.5 pcf • apparent viscosity > 35 sec - Marsh Funnel 68ºF • rate of filtrate loss < 25 cc in 30 min@100 psi • pH between 7 and 10	1/day	3/week
Prepared SBSW/Barrier Wall Backfill Mix - *(random sample collected immediately prior to placing in trench) (prior to mixing with slurry)*	• slump (ASTM C 143) • density (API 13B) • moisture (ASTM 2216) • % bentonite (API 13B) • atterberg Limits (ASTM 4318) • unit weight (API 13B) • triaxial hydraulic conductivity (remolded) (ASTM 5084) • gradation (ASTM 422)	• slump is 4" to 6" • moisture -workable • bentonite between 4-6% of the dry weight • Atterberg limits – for info • unit weight > 100 pcf • unit weight is 15 pcf > than the in-trench slurry • hydraulic conductivity < 1 x 10-7 cm/sec • reasonably well-graded w/ a max particle < 4" • gradation classification: 100% - 4 inches; 80% to 100% - 1 inch; 40% to 95% -No. 10; 30% to 90% - No. 40; 20% to 85% - No. 200	1/day	1/1000 cys
In-Trench Slurry - *(sample taken **within 10 feet** of bottom of trench at toe of backfill slope)*	• temperature and pH • apparent Viscosity (API RP 13B) • gel strength (API RP 13B) • sand content (for info purposes only based on slurry density) • unit weight (API RP 13B) • percent solids	• pH between 7 and 10; • viscosity capable of passing thru Marsh funnel; • gel strength recorded for information only • sand content < 15% passing No. 200 sieve • unit weight > 78 but < 90 pcf • percent solids	Twice daily - sampled and tested at the start and end of each work shift	1/day
SB Slurry Wall *(sample after wall complete)*	• laboratory permeability testing (ASTM 5084) collected via Shelby tube (ASTM 1587) sample pushed by hand to within 7 days after completion	Finished In place soil-bentonite wall; minimum width of 36" installed to the minimum depths shown on the drawings with a hydraulic conductivity of less than or equal to 1 x 10-7 cm/sec.	NA	1/500lf for the first 1000ft then 1/1000lf thereafter

All samples collected under ASTM standard require outside laboratory testing. All samples collected under API standards can be tested in the field.

Table 4.2

East Cell Permeability Testing						
Quality Control						
Station	**Sample Date**	**Moisture Content**	**% Passing 200 Sieve**	**Liquid Limit**	**Plastic Limit**	**Permeability k (cm/sec)**
Cement Bentonite Wall Constructed from Station 0+00 to 7+00						
7+20	**10/20/10**	31.70%	74.3	26	19	5.52×10^{-8}
9+40	**10/21/10**	32.10%	74.4	26	20	2.19×10^{-8}
11+90	**10/22/10**	26.10%	72.6	26	19	3.53×10^{-8}
12+20	**10/25/10**	30.10%	69.3	27	21	3.07×10^{-8}
12+80	**10/27/10**	31.90%	71	27	21	2.53×10^{-8}
15+40	**10/28/10**	25.40%	62.7	27	20	6.37×10^{-8}
17+90	**10/29/10**	28.10%	70	28	21	4.33×10^{-8}
Cement Bentonite Wall Constructed from Station 18+80 to 27+30						
27+50	**11/18/10**	29.80%	71.7	27	21	6.02×10^{-8}
27+60	**11/19/10**	27.40%	67.7	26	20	4.29×10^{-8}
27+50	**11/22/10**	31.90%	67.8	27	20	4.39×10^{-8}
27+60	**11/23/10**	31.00%	68.9	27	20	4.02×10^{-8}
30+10	**11/24/10**	26.90%	56.1	27	20	3.53×10^{-8}
31+00	**11/29/10**	29.40%	65.3	27	21	2.79×10^{-8}
31+30	**11/30/10**	29.90%	58.6	27	20	4.04×10^{-8}
32+80	**12/02/10**	27.90%	59.3	27	20	3.09×10^{-8}
34+20	**12/03/10**	29.60%	60.5	26	20	3.00×10^{-8}
39+00	**12/07/10**	26.60%	57.4	26	19	4.30×10^{-8}
41+20	**12/08/10**	24.10%	56.4	26	20	3.59×10^{-8}
37+40	**12/06/10**	28.20%	54.2	26	20	3.18×10^{-8}
42+30	**12/09/10**	27.30%	52.6	27	20	2.72×10^{-8}
44+40	**12/10/10**	26.10%	56.1	27	21	2.88×10^{-8}
44+90	**12/13/10**	27.20%	52.3	26	20	2.20×10^{-8}
46+40	**12/15/10**	29.00%	58.5	25	20	4.63×10^{-8}
0+00/90+16	**03/22/11**	26.60%	59.2	28	18	3.17×10^{-8}
90+10	**03/23/11**	25.70%	56.1	29	18	5.11×10^{-8}
89+40	**03/24/11**	29.00%	64.6	26	19	5.44×10^{-8}
88+90	**03/25/11**	29.20%	63.8	27	19	4.00×10^{-8}
28+00	**03/28/11**	31.00%	65.5	28	18	4.33×10^{-8}
83+80	**03/29/11**	33.70%	65.1	28	18	5.19×10^{-8}
48+20	**03/31/11**	28.50%	55.7	28	18	4.07×10^{-8}
48+40	**04/01/11**	29.60%	57.9	26	20	2.84×10^{-8}
48+80	**04/04/11**	26.10%	59.4	28	17	5.24×10^{-8}

Station	Sample Date	Moisture Content	% Passing 200 Sieve	Liquid Limit	Plastic Limit	Permeability k (cm/sec)
49+30	**04/06/11**	27.70%	61.1	29	19	4.28×10^{-8}
49+80	**04/07/11**	27.60%	56.6	29	18	4.55×10^{-8}
50+10	**04/08/11**	30.00%	56.2	25	18	5.50×10^{-8}
50+60	**04/11/11**	28.40%	60	26	19	3.91×10^{-8}
51+90	**04/12/11**	26.50%	57.3	27	19	4.64×10^{-8}
60+60	**04/13/11**	29.90%	65.7	27	19	5.76×10^{-8}
60+90	**04/14/11**	27.60%	60.7	27	19	4.62×10^{-8}
63+00	**04/15/11**	30.30%	58.1	26	19	3.67×10^{-8}
63+60	**04/19/11**	41.70%	64.6	26	19	2.77×10^{-8}
65+20	**04/20/11**	29.20%	56.3	27	19	3.18×10^{-8}
66+00	**04/21/11**	27.10%	44	26	18	5.43×10^{-8}
66+90	**04/26/11**	31.60%	54	30	20	6.58×10^{-8}
67+00	**04/27/11**	28.80%	47.8	33	21	3.02×10^{-8}
66+40	**04/25/11**	29.70%	48.9	31	19.5	3.15×10^{-8}
70+00	**05/11/11**	30.00%	50.7	29	18	3.39×10^{-8}
55+80	**05/12/11**	26.70%	45.6	29	19	6.37×10^{-8}
68+10	**05/10/11**	26.60%	46.6	29	19	3.20×10^{-8}
53+90	**05/20/11**	27.50%	49	28	20	5.72×10^{-8}
53+80	**05/23/11**	25.70%	52.6	28	20	6.05×10^{-8}
54+00	**05/24/11**	23.90%	44	27	20	7.78×10^{-8}
55+90	**05/25/11**	26.60%	41.5	28	19	6.42×10^{-8}
57+40	**11/08/11**	25.10%	42.1	28	20	4.86×10^{-8}
58+00	**11/09/11**	24.50%	42.9	28	19	5.49×10^{-8}
60+10	**11/10/11**	23.90%	43.5	27	18	6.05×10^{-8}
70+20 (lead in 1)	**06/02/11**	23.40%	44	28	18	8.77×10^{-8}
70+20 (lead in 2)	**06/06/11**	29.60%	53	28	18	8.9×10^{-8}
70+80	**06/07/11**	27.00%	61.2	28	18	6.65×10^{-8}
72+00	**06/08/11**	29.60%	64.7	27	18	6.42×10^{-8}
73+70	**06/10/11**	29.30%	65.4	27	18	5.95×10^{-8}

Table 4.3

East Cell Compression Cement Testing			
Station	Sample Date	Quality Control	
		Unconfined Strength (psi) (28-day)	Permeability k (cm/sec)
00+40	10/07/10	142.0	1.0×10^{-7}
00+80	10/08/10	85.6	7.0×10^{-8}
01+00	10/11/10	98.7	8.0×10^{-8}
01+30	10/14/10	89.1	5.0×10^{-8}
02+00	10/18/10	168.7	3.0×10^{-8}
02+50	10/14/10	121.0	6.0×10^{-8}
03+00	10/12/10	106.6	1.0×10^{-7}
03+70	10/18/10	157.6	5.0×10^{-8}
05+00	10/13/10	108.5	8.0×10^{-8}
06+10	10/15/10	124.1	8.0×10^{-8}
06+60	10/15/10	99.3	5.0×10^{-8}
07+00	11/11/10	149.2	5.0×10^{-8}
15+50	11/11/10	145.8	6.0×10^{-8}
16+75	11/12/10	138.8	2.0×10^{-7}
17+25	11/12/10	155.0	5.0×10^{-8}
19+30	11/01/10	186.0	2.0×10^{-7}
19+80	11/01/10	166.2	1.0×10^{-7}
20+20	11/02/10	188.1	1.0×10^{-7}
20+70	11/02/10	198.3	5.0×10^{-8}
21+20	11/03/10	170.9	3.0×10^{-8}
21+70	11/03/10	178.9	5.0×10^{-8}
22+10	11/04/10	160.7	8.0×10^{-8}
22+40	11/04/10	182.1	6.0×10^{-8}
22+60	11/04/10	166.2	9.0×10^{-8}
23+10	11/05/10	181.1	5.0×10^{-8}
23+60	11/05/10	178.3	9.0×10^{-8}
24+10	11/08/10	181.3	1.0×10^{-7}
24+60	11/08/10	196.4	5.0×10^{-8}

East Cell Compression Cement Testing			
Station	Sample Date	Quality Control	
		Unconfined Strength (psi) (28-day)	Permeability k (cm/sec)
25+20	11/09/10	168.6	1.0×10^{-7}
25+70	11/09/10	148.0	8.0×10^{-8}
26+60	11/10/10	141.8	5.0×10^{-8}
27+10	11/10/10	109.2	1.0×10^{-7}
27+19	11/10/10	161.4	5.0×10^{-8}
27+45	03/15/11	180.2	9.73×10^{-8}
79+60	03/16/11	105.1	8.22×10^{-8}
80+10	03/16/11	56.7	1.56×10^{-7}
80+50	03/17/11	62.4	1.35×10^{-7}
81+00/80+90	03/17/11	67.8	8.13×10^{-8}
78+60	03/18/11	135.3	9.67×10^{-8}
79+10	03/18/11	86.6	9.76×10^{-8}

Table 4.4

West Cell Permeability Testing						
Quality Control						
Station	**Sample Date**	**Moisture Content**	**% Passing 200 Sieve**	**Liquid Limit**	**Plastic Limit**	**Permeability k (cm/sec)**
17+00 Lead-In-1	**08/18/10**	20.50%	42.6	27	20	2.01×10^{-8}
17+00 Lead-In-2	**08/19/10**	22.70%	43.1	27	20	2.78×10^{-8}
15+60	**08/20/10**	22.40%	40.7	28	21	2.20×10^{-8}
12+80	**08/23/10**	24.30%	47.3	28	19	2.81×10^{-8}
11+20	**08/24/10**	25.00%	62.8	26	19	2.42×10^{-8}
9+80	**08/25/10**	25.40%	54.1	26	19	3.38×10^{-8}
9+00	**08/26/10**	30.00%	63.8	26	18	2.31×10^{-8}
6+60	**08/27/10**	28.20%	63.8	26	20	3.77×10^{-8}
5+50	**08/30/10**	26.50%	53.1	26	20	3.40×10^{-8}
3+70	**08/31/10**	27.20%	53.7	26	19	2.52×10^{-8}
0+00	**09/01/10**	21.70%	45.7	25	18	1.99×10^{-8}
50+30	**09/02/10**	26.60%	56.8	27	20	2.35×10^{-8}
48+20	**09/03/10**	26.50%	61.8	26	19	3.10×10^{-8}
46+90	**09/07/10**	25.90%	61.8	26	19	2.69×10^{-8}
46+80	**09/08/10**	25.30%	53.7	26	18	4.24×10^{-8}
43+20	**09/09/10**	26.80%	57.7	27	19	2.75×10^{-8}
40+40	**09/10/10**	29.30%	70.3	26	18	3.85×10^{-8}
39+30	**09/13/10**	31.30%	74.3	27	19	4.12×10^{-8}
39+60	**09/14/10**	30.40%	IP	26	20	3.38×10^{-8}
34+60	**09/15/10**	24.40%	IP	27	19	3.22×10^{-8}
32+80	**09/17/10**	31.10%	69.9	26	18	4.05×10^{-8}
31+60	**09/20/10**	33.80%	67.7	28	18	4.40×10^{-8}
29+40	**09/21/10**	26.70%	61.7	27	18	4.89×10^{-8}
28+00	**09/22/10**	29.90%	64.7	29	18	3.95×10^{-8}
26+20	**09/23/10**	31.40%	71.8	28	19	2.55×10^{-8}
26+30	**09/24/10**	33.40%	74.7	26	20	2.72×10^{-8}
25+50	**09/27/10**	32.30%	74.4	28	20	3.82×10^{-8}
23+70	**09/28/10**	28.90%	51.7	27	18	2.89×10^{-8}
22+50	**09/29/10**	33.80%	76.5	29	19	3.05×10^{-8}
21+00	**10/04/10**	31.90%	71.7	27	20	2.48×10^{-8}
18+00	**10/05/10**	28.10%	71.9	26	21	2.52×10^{-8}

Table 4.5

West Cell Compression Cement Testing			
Quality Control			
Station	**Sample Date**	**Unconfined Strength (psi) (28-day)**	**Permeability k (cm/sec)**
23+00	**11/16/10**	89.1	1.0×10^{-7}
24+00	**11/16/10**	88.8	7.0×10^{-8}

Table 4.6

QC Geotechnical Analysis Slurry/Barrier Wall Fill			
Test	**Criteria**	**Min**	**Max**
Max Stone Size	***3"***		
Sieve Analysis 0.75	-	98.2	100
Sieve Analysis 0.375	-	97.3	100
Sieve Analysis #4	-	96.6	100
Sieve Analysis #10	-	96	100
Sieve Analysis #16	-	95.5	99.9
Sieve Analysis #30	***85% Max***	94.6	99.9
Sieve Analysis #60		92.7	99.6
Sieve Analysis #100		88.8	99
Sieve Analysis #200	***Free***	64.9	97.2
Compaction Test (Optimum Water Content)	-		
Compaction Test (Max. Dry Density)	-		
Natural Moisture Content	-	8	23
Atterberg Limits (Liquid Limits)	**<60**	NP	38
Atterberg Limits (Plastic Limits)		NP	23
Atterberg Limits (Plasticity Index)	***<40***		

Table 4.7

QA Chemical Analysis Slurry/Barrier Wall Fill			
Waste Characteristic	**Criteria**	**Min**	**Max**
Ignitability	**Rate > 2.2 mm/sec**	ND	ND
Corrosivity	**2 < pH <12.5**	7.08	7.86
Reactivity (Cyanide)	**< 250 ppm reactive**	ND	ND
Reactivity (Sulfide)	**< 500 ppm reactive**	ND	ND
TCLP Arsenic	**5.0 mg/L**	ND	ND
TCLP Barium	**100.0 mg/L**	0.62	0.91
TCLP Benzene	**0.5 mg/L**	ND	ND
TCLP Cadmium	**1.0 mg/L**	ND	ND
TCLP Carbon tetrachloride	**0.5 mg/L**	ND	ND
TCLP Chlordane	**0.03 mg/L**	ND	ND
TCLP Chlorobenzene	**100.0 mg/L**	ND	ND
TCLP Chloroform	**6.0 mg/L**	ND	ND
TCLP Chromium	**5.0 mg/L**	ND	ND
TCLP o-Cresol	**200.0 mg/L**	ND	ND
TCLP-Cresol	**200.0 mg/L**	ND	ND
TCLP p-Cresol	**200.0 mg/L**	ND	ND
TCLP 2,4-D	**10.0 mg/L**	ND	ND
TCLP l,4-Dichlorobenzene	**7.5 mg/L**	ND	ND
TCLP 1,2-Dichloroethane	**0.5 mg/L**	ND	ND
TCLP 1,1-Dichloroethylene	**0.7 mg/L**	ND	ND
TCLP 2,4-Dinitrotoluene	**0.13 mg/L**	ND	ND
TCLP Endrin	**0.02 mg/L**	ND	ND
TCLP Heptachlor	**0.008 mg/L**	ND	ND
TCLP Hexachlorobenzene	**0.13 mg/L**	ND	ND
TCLP Hexachloro-l,3-butadiene	**0.5 mg/L**	ND	ND
TCLP Hexachloroethane	**3.0 mg/L**	ND	ND
TCLP Lead	**5.0 mg/L**	ND	ND
TCLP Lindane	**0.4 mg/L**	ND	ND
TCLP Mercury	**0.2 mg/L**	ND	ND
TCLP Methoxychlor	**10.0 mg/L**	ND	ND
TCLP Methylethyl ketone	**200.0 mg/L**	ND	ND
TCLP Nitrobenzene	**2.0 mg/L**	ND	ND
TCLP Pentachlorophenol	**100.0 mg/L**	ND	ND
TCLP Pyridine	**5.0 mg/L**	ND	ND
TCLP Selenium	**1.0 mg/L**	ND	ND
TCLP Silver	**5.0 mg/L**	ND	ND
TCLP Tetrachloroethylene	**0.7 mg/L**	ND	ND
TCLP Toxaphene	**0.5mg/L**	ND	ND
TCLP Trichloroethylene	**0.5 mg/L**	ND	ND
TCLP 2,4,5-Trichlorophenol	**400.0 mg/L**	ND	ND
TCLP 2,4,6-Trichlorophenol	**2.0 mg/L**	ND	ND
TCLP 2,4,5-TP	**1.0 mg/L**	ND	ND
TCLP Vinyl Chloride	**0.2 mg/L**	ND	ND
PCBs, Total	**10 mg/kg**	ND	ND
Sulfides	**5000 mg/kg**	ND	ND
Ammonia	**200 mg/kg**	1.17	3.42
Asbestos Fiber	**1% (by weight)**	ND	ND

5.0 GEOCOMPOSITE (Gas Venting Layer/Drainage Layer)

5.1 General

Geocomposite was utilized for two distinct applications, 1) a geosynthetic stormwater drainage net layer; and 2) a geosynthetic gas venting layer, as part of the landfill closure. The geocomposite consists of a geonet between layers of geotextile fabric above and below the geonet used on the landfill. These three layers of synthetics are adhered together via heat bonding of the geotextile to the geonet and are designed to provide a plane of high void space which permits a high degree of in-plane air or liquid flow (transmissivity).

5.2 Manufacturer – Geocomposite

The manufacturer of the geocomposite used in the landfill cover was identified as GSE Lining Technology, Inc. Houston, Texas. The material used for the geocomposite was manufactured from appropriate polymers and compounding ingredients that was in conformance with the Contract Specifications. The geocomposite used on the project was tested and approved per the QA/QC requirements of the Specifications prior to being imported for use at Brookfield Avenue Landfill.

The Manufacturer was required to provide evidence of the geonet and geotextile physical properties compliance with the specification. Additionally the Contractor submitted the Manufacturer's background and product information which included:

- Information on factory size, equipment, personnel, number of shifts per day and production capacity per shift.
- List of material properties and samples of drainage net with attached certified test results.
- Manufacturer's Quality Control program and manual including description of laboratory facilities.
- A list of ten completed facilities where the composite drainage net was used
- Shop Drawings, providing panel layout, details of overlap of the composite drainage net, anchoring, connections, and other reconstruction details.
- Installation schedule.

- Manual that specifically defines the Quality Control and Quality Assurance program during installation including Manufacturer's installation instructions.
- Copy of Quality Control certificates.
- Roll identification information delivered
- Product identification
- Roll Thickness
- Roll number
- Roll dimensions

As there was no minimum number of tests specified nor any periodic testing required, the installer, Chenango Contracting supplied manufacturer's testing data and certifications for every roll delivered. Table 5.1 shows test properties and test frequency and Table 5.2 presents the submittals required by the contractor. Appendix F, titled 'Geosynthetic QA/QC' presents the results for the physical laboratory testing, raw data and the full manufacturer data sheets for the product along with all the certifications and layout.

Table 5.1

MATERIAL TESTING			
Test	**Component**	**QC Frequency**	**QA Frequency**
Transmissivity	Geocomposite	200,000 ft^2	2,000,000 ft^2
Peel Adhesion	Geocomposite	50,000 ft^2	500,000 ft^2
Density	Resin/Geonet	per lot/50,000 ft^2	500,000 ft^2
Melt Index	Resin	Once per lot	Random
Carbon Black	Geonet	50,000 ft^2	500,000 ft^2
Nominal Thickness	Geonet	50,000 ft^2	500,000 ft^2
Tensile Strength	Geonet	50,000 ft^2	500,000 ft^2
Unit Weight	Geotextile	100,000 ft^2	1,000,000 ft^2
Grab Tensile	Geotextile	100,000 ft^2	1,000,000 ft^2
Puncture Resistance	Geotextile	100,000 ft^2	1,000,000 ft^2
AOS	Geotextile	500,000 ft^2	5,000,000 ft^2
Permittivity	Geotextile	500,000 ft^2	5,000,000 ft^2

Table 5.2

SUBMITTALS	
Manufacturer's background information	A list completed facilities where composite net is used
Information on factory equipment etc.	Shop Drawing of panel layout & details of overlap, etc.
Material properties list with certified test results.	Installation schedule
Mfg's QC program and manual	A manual that specifically defines the QA/QC program
Samples of drainage net	Copy of QC certificates
Manufacturer's name on each roll delivered	Roll ID number
Product identification on each roll delivered	Roll dimensions
Thickness for each roll delivered	QC certificates signed by mfrs QA w/ ID & test results

5.3 Installation – Geocomposite

The geocomposite placed for landfill gas venting was installed on subgrade as indicated on the Contract Drawings. The geocomposite was secured and then rolled downslope perpendicular to the grading contour lines in such a way as to keep the sheet in tension under self-weight only. Adjacent rolls were overlapped by at least six (6) inches while horizontal overlaps (seams parallel to grading contour lines) were not permitted on slopes exceeding 12 percent unless approved by QA, and unless the manufacturer’s recommendations of additional permanent reinforcement for horizontal overlaps were incorporated.

The geocomposite incorporated into the drainage system within the final cover system was installed by Chenango Contracting (Chenango) for Brookfield ConstructionAssociates, LLC (BCA) after the underlying geomembrane was installed and approved. Prior to installation of the drainage geocomposites, the underlying geomembrane was cleaned and free of dirt, dust or any other objectionable materials, which could inhibit the ability of the drainage system to transmit water.

During placement of the gas venting layer and the drainage geocomposites, both were inspected by the QA personnel and the QC personnel on both sides for imperfections, damage and defects. Any gaps or tears which developed in the geonet were repaired by placing a patch extending two (2) feet beyond the edges of the gap or tear. The patch was secured to the original geonet by spot gluing, spot welding to geonet or tying every six (6) inches. All necessary precautions were taken to prevent damage to the underlying layers of geosynthetics. Field personnel were prohibited from using sharp tools, cigarettes, solvents, or any other materials which could cause damage to the geocomposite and/or underlying geosynthetics.

Overlaps were secured by tying (the geonet) and sewing (the geotextile). The geonet was tied by using white plastic fasteners (white for easy inspection). Metallic tying devices were not permitted as per Contract Specifications. The geonet overlaps were tied every five (5) feet down the slope, every two (2) feet across the slope, and every six (6) inches in anchor trenches.

The geotextile component of the geocomposite was stitched using a handheld sewing machine and a polymeric thread with chemical resistance properties equal to or exceeding those of the geotextile.

The Contract Specifications required the Contractor to cover the geocomposites and geotextiles to be within the two weeks after installation. In some instances the BCA failed to comply with this requirement. In such cases the exposed areas were visually re-checked by QA for damage and for clogging due to run-on of fines from eroded soil areas. Where clogging or damage was found, those areas were marked in the field by QA staff and were replaced by the Chenango. In addition, the longest-exposed section of geocomposite was sampled, and to be sample analyzed for weakening due to ultraviolet exposure. The strength of the sample remained above the Specification value so removal was not necessary.

5.4 Quality Assurance/Quality Control

5.4.1 General

QA and QC procedures were followed for all geocomposites before and during construction.

5.4.2 Quality Control

Prior to the Contractor procuring the geocomposite, QC collected and performed a review the information provided from the manufacturer for compliance with the specifications. Each certificate has a roll identification number, sampling procedures, frequency and test results. QC material testing was provided by an independent laboratory retained by the contractor for the parameters and frequencies listed in the contract specifications. Testing frequencies were performed in accordance with test requirements specified in contract per Part 360.

The Contractor was also required to submit results of direct shear testing of the interface between the non-woven side of the composite drainage net and both the Barrier Protective Layer and intermediate cover soil, and in accordance with ASTM D5321 that verify acceptable interface shear strength. The actual materials to be used on the project were used in all tests. Each interface shear strength evaluation shall consist of at least 3 separate shear tests run at normal stresses (σ) of 1, 2, and 4 psi. Table 5.3 shows the testing frequencies required by QC/QA. Table 5.4 and Table 5.5 show QC conformance results for FS200 and FS300 geocomposites respectively.

Table 5.3

<table>
<tr><th colspan="4">CONFORMANCE TESTING</th></tr>
<tr><th colspan="2">Properties</th><th>QC</th><th>QA</th></tr>
<tr><td>Density
ASTM D1505
Geonet only</td><td>Transmissivity (ASTM D4716),
Geocomposite</td><td rowspan="4">Every
100,000sf</td><td rowspan="4">Every
1,000,000sf</td></tr>
<tr><td>Carbon Black Content
ASTM D4218
Geonet only</td><td>Tensile Strength (ASTM D5035),
Geonet only</td></tr>
<tr><td>Thickness
ASTM D5199
Geonet only</td><td>Peel Adhesion (GRI GC-7),
Geocomposite</td></tr>
<tr><td>Direct shear testing (ASTM- D5321)</td><td></td></tr>
<tr><td colspan="4">Note: Direct shear testing of the interface between the non-woven side of the composite drainage net and both the Barrier Protective Layer and intermediate cover soils, shall consist of at least 3 separate shear tests run at normal stresses (σ) of 1, 2, and 4 psi.</td></tr>
</table>

Table 5.4

STANDARD GEONET (FS200)				
QC TESTING RESULTS				
Specification			**Testing**	
Test Property	**Method**	**Value & Unit**	**Range**	**No. of Tests**
Density	ASTM D1505	0.940 g/cc	0.9525 - 0.9558	167
Tensile Strength	ASTM D4595/ ASTMD5035	45 lbs/in	60.00 - 76.00	167
Carbon Black Content	ASTM D4218	2-3% range	2.33 - 2.59	167
Nominal Thickness	ASTM D5199	200 mil	209.00 - 230.00	167
Melt Index condition 190/2.16	ASTM D1238	1.0 g/10 minutes (max)	0.320 - 0.390	167

STANDARD GEOTEXTILE - QC TESTING RESULTS				
Specification			**Testing**	
Test Property	**Method**	**Value & Unit**	**Range**	**No. of Tests**
Unit weight	ASTM D5261	6 oz/yd^2	6.05 - 9.99	84
Grab Tensile	ASTM D4632	160 lbs	160.00 - 264.00	84
Puncture Resistance	ASTM D4833	90 lbs	90.00 - 177.70	84
AOS	ASTM 4751	70 sieve (0.212 mm)	0.150 - 0.212	17
Permittivity	ASTM 4491	1.0 sec^{-1}	1.522 - 2.635	17
Transmissivity	ASTM D4716	1.0E-04 m^2/sec	1.05E-03 - 2.28E-03	42
Peel Adhesion	ASTM D7005/ GRI-GC7	1.0 lb/in	3.1 - 8.3	167

Table 5.5

HIGH-FLOW GEONET (FS300)				
QC TESTING RESULTS				
Specification			Testing	
Test Property	**Method**	**Value & Unit**	**Range**	**No. of Tests**
Density	ASTM D1505	0.940 g/cc	0.9529 - 0.9563	56
Tensile Strength	ASTM D4595/ ASTMD5035	75 lbs/in	104 - 150	56
Carbon Black Content	ASTM D4218	2-3% range	2.39 - 2.56	56
Nominal Thickness	ASTM D5199	300 mil	317 - 339	56
Melt Index condition 190/2.16	ASTM D1238	1.0 g/10 minutes (max)	0.320 - 0.360	56
HIGH-FLOW GEOTEXTILE - QC TESTING RESULTS				
Specification			**Testing**	
Test Property	**Method**	**Value & Unit**	**Range**	**No. of Tests**
Unit weight	ASTM D5261	6 oz/yd^2	6.030 - 8.270	28
Grab Tensile	ASTM D4632	160 lbs	160.00 - 285.99	28
Puncture Resistance	ASTM D4833	90 lbs	95.00 - 137.31	28
AOS	ASTM 4751	70 sieve (0.212 mm)	0.510 - 0.212	6
Permittivity	ASTM 4491	1.1 sec^{-1}	1.503 - 2.600	6
Transmissivity	ASTM D4716	2.0E-03 m2/sec	3.47E-03 - 4.29E-03	14
Peel Adhesion	ASTM D7005/ GRI-GC7	0.5 lb/in	4 - 9.1	56

5.4.3 Quality Assurance

The QA Site Manager reviewed the certified QC information from the manufacturer and conformance testing results. Conformance testing is required to assure that the supplied material conforms to the Specifications and to the Manufacturer's Quality Control certificates. Conformance testing was performed by an independent Quality Assurance Laboratory (QAL) retained by the Contractor and approved by the NYCDEP. During construction, the QA inspectors continuously and visually inspected the geocomposite as it was being deployed and installed to determine compliance with specifications and manufacturer’s recommendations for installation. QA also documented all Bill of Ladings (BOLs), panel placement and installation and directed the contractor to obtain samples from the delivered material and mark the machine direction and identification number for conformance testing. Inspections were performed to ensure that conformance testing samples obtained by the contractor for testing were taken across the entire roll width and excluded the first 3ft and were performed by an independent Laboratory retained by the Contractor at a rate of one per 100,000 square feet of installed material or at least once per lot whichever was greater.

The Contractor obtained samples from the delivered material and marked the machine direction and identification number as directed by NYCDEP's QA representatives. Samples were taken at a rate of one per 100,000 square feet of installed material and at least once per lot defined as a group of consecutively numbered rolls from the same manufacturing line. The samples were taken across the entire roll width and did not include the first 3ft. The following conformance tests were conducted at the laboratory:

- Density (ASTM D1505), Geonet only
- Carbon Black Content (ASTM D4218), Geonet only
- Thickness (ASTM D5199), Geonet only
- Transmissivity (ASTM D4716), Geocomposite
- Tensile Strength (ASTM D5035), Geonet only
- Peel Adhesion (GRI GC-7), Geocomposite

Table 5.3 above summarizes the testing frequency. The CM QA team also performed third party testing to test and verify QC samples at will.

QA obtained samples of the geonet and geotextile components from the BCA and forwarded them to an independent QA laboratory for testing to verify conformance with the Contract Specifications.

Samples were taken, they were obtained from across the entire width of the roll and did not include the first three (3) feet of the roll's long dimension. Samples were three (3) feet long times the roll width.

QA examined all results from the laboratory testing for conformance.

Appendix F, titled 'Geosynthetic QA/QC' presents the results for the physical QA laboratory certifications testing and raw data.

As construction progressed, the CM's QA Geosynthetic Inspector visually and continuously inspected the geocomposite as it was being deployed and installed to determine compliance with the specifications and manufacturer's recommendations for installation. If any material was damaged, it was repaired in accordance with the specifications or removed from the site. The QA Geosynthetic Inspector and the Contractor's QC Inspector documented all panel placements and installations.

6.0 GEOMEMBRANE

6.1 General

The Contract Specifications and Drawings required the installation of a co-extruded, light reflective Linear Low Density Polyethylene (LLDPE) Geomembrane layer for the Final Cover System. Two types of LLDPE Geomembrane cover systems were used, 1) a white, textured, 40-mil thick and, 2) a white, smooth, 60-mil thick LLDPE geosynthetic geomembrane.

6.2 Manufacturer – LLDPE Geomembrane

The manufacturer of the LLDPE geomembrane was GSE Lining Technology LLC of Westfield, Texas (GSE). The manufacturer was responsible for the production of the materials and providing quality control during production including certification that its materials conform to the Contract Specifications. GSE was required to provide certification that its materials conformed to the Contract Specifications and was required to submit certification that the LLDPE geomembrane was formulated and manufactured from 100% virgin raw material, specifically compounded for use in hydraulic structures and using only first quality plastics and elastomers. The manufacturer was also required to submit written certification that each lot of material met or exceeded the technical specifications that were written to meet Part 360.

Both GSE (liner Manufacturer) and Chevron Philips (the resin manufacturer) also provided test results for both the raw material (resin) used to fabricate the geomembrane and the individual finished rolls of geomembrane.

Testing results and manufacturers certifications are presented in Appendix F, titled ‘Geosynthetic QAQC’.

Certificates of Analysis from Chevron Philips and all test results confirming that each lot of material meets Technical Specifications were provided by the manufacturer. The manufacturer also submitted certified test results that attested to the compliance with the geomembrane based on properties of the contract specifications.

Manufacturers test data has been provided for each roll and the frequency of testing meets and exceeds the minimum industry guidelines for liner manufacturing. The Manufacturer provided certifications documenting the physical test data for all geomembrane rolls. These certifications are presented Appendix F, titled 'Geosynthetic QAQC'.

6.3 Pre-Installation – LLDPE Geomembrane

The geosynthetic geomembrane for this project was installed by Chenango Contracting, Inc. (Chenango) of Johnson City, New York. As a subcontractor to BCA, Chenango was responsible for on-site management of the LLDPE geomembrane, including handling, storage, placement, installation and testing in accordance with an approved LLDPE geomembrane panel layout and the Contract Specifications.

Prior to installation, as each delivery order arrived on site, a team of QA/QC inspectors would witness the off-loading event to verify that the material delivered to the site was the material that was manufactured for this project by matching the roll numbers with the certified bills of lading provided by the manufacturer.

Quality Control during LLDPE geomembrane installation was performed by BCA. Quality Assurance during LLDPE geomembrane installation was performed by the CM. The LLDPE geomembrane rolls were off-loaded and staged near the work area at their intended location and prepared for deployment over the next few days. Storage of material was not excessive and never did exceed specified guidelines. Table 6.1 presents QC information that was submitted prior to procuring the LLDPE material.

Table 6.1

SUBMITTALS	
Corporate Background	Background Information
Manufacturing capabilities	Installation capabilities
The origin of the resin	A list of five completed facilities
Fingerprint results of mfr's liner resin properties	Panel layout identifying field seams
Certification that all resin meets fingerprinting	Details of seaming the liner, anchoring, and other
Copy of manufacturer QC certificates	Installation schedule
Certification that liner & extrudate have same	Resume Installation Supervisor, Master Seamer & QC
QC Documentation certified by the manufacturer	List of field seaming personnel
Conformance testing results	Sample material warranty & sample guarantees
QC manual that specifically defines the QA program	

QC conformance samples were required per specifications. The QA/QC team also reviewed the certified information from the manufacturer and conformance testing results. Conformance testing was required to assure that the supplied material conforms to the conformance testing specifications and to the Manufacturer's Quality Control certificates. Conformance testing was performed by an independent lab retained by the Contractor and approved by the NYCDEP. QA conformance testing was also performed via independent geosynthetics QA lab at frequencies listed below in Table 6.2. Table 6.3 presents the conformance testing specification limits.

TABLE 6.2

CONFORMANCE TESTING FREQUENCY				
Property			**QC**	**QA**
Thickness	Puncture Resistance	Multi-Axial Tension	Every 100,000sf	Every 1,000,000sf
Density	Oxidative Induction Time	Carbon Black Content		
Tensile Properties	Seam Peel Adhesion	Carbon Black Dispersion		
Tear Resistance	Bonded Shear Strength			

Table 6.3

LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINER

Property	Spec Limit
Thickness	Min Avg – 40mil / 60mil
Density	Max 0.939g/cc
Tensile Properties (Each Direction)	ASTM D6693 Type IV
Multi-Axial Tension Test, Axi-Symmetric	Min 30%
Tear Resistance	Min 22 lbs / 33 lbs
Puncture Resistance	Min 44 lbs / 84 lbs
Carbon Black Content	2% to 3%
Carbon Black Dispersion	1 in Category 3
Bonded Shear Strength	FTB and 44 lbs/in
Seam Peel Adhesion	FTB and 40 lbs/in
Oxidative Induction Time	100 minutes

6.4 Quality Assurance/Quality Control during Installation

6.4.1 General

Immediately after delivery acceptance, prior to roll and panel deployment, the Closure Subgrade subbase was re-inspected and approved by both the QA and QC team of inspectors. Any defects and impurities were removed or repaired before the membrane was installed on the Landfill. Panel deployment would not begin until Subgrade Approval Forms (see Appendix F, titled 'Geosynthetic QAQC') were completed and subgrade was signed and approved by both QA and QC personnel.

Panels were deployed using rubber-tracked skid steer equipment and laborers. All geomembrane rolls were thoroughly inspected as they were unwound during installation. Both the smooth and textured LLDPE geomembrane were installed directly upon the geocomposite gas venting layer per the Contract Drawings and per existing field conditions. Inspectors observed and inspected each panel after placement & prior to seaming for damage or defects. Visual inspection was performed for defects such as thin spots, the presence of contaminants or foreign particles, pinholes, tears, punctures, blisters, and any other imperfections. For every defective or damaged roll noted during unloading, the product was marked, then re-inspection and approved if properly repaired or replaced.

6.4.2 Placement – LLDPE Geomembrane

Only textured LLDPE geomembrane was used on slopes at or exceeding 10 percent. In general, seams were oriented parallel to the line of maximum slope, (i.e., oriented along, not across the slope). Seams on slopes exceeding 15 percent were not permitted to be at more than 30 degrees from parallel with the direction of the slope. Cross-slope seams were kept to a minimum and in no case were within five feet of adjacent panel cross-slope seams.

The LLDPE geomembrane panels were carefully placed at the proper location and each panel was overlapped at a minimum of three (3) inches, as required for proper seaming. Each LLDPE geomembrane panel was inspected by QA/QC personnel for any defects as it was placed and assigned a corresponding panel number. The LLDPE geomembrane panels were installed in a relaxed condition free of tension or stress.

6.4.3 Trial Seams (Start-Ups) – LLDPE Geomembrane

LLDPE geomembrane trial seams, also known as qualifying seams or start-ups, were an integral aspect of the QA/QC procedures. The purpose of these trail seams was to serve as a daily pre-qualifying experience for personnel, equipment and procedures for field fabricating seams on the geomembrane material under the same climatic conditions as the actual field seams. The test strips were made on narrow pieces of excess geomembrane with a minimum length of three (3) feet.

The goal of the start-ups was to reproduce all aspects of the production field seaming activities intended to be performed in the immediately upcoming work sessions in order to determine equipment and operator proficiency. For the double hot-wedge fusion welding process, the QA Inspectors required that start-ups be performed every four (4) hours, whenever personnel or equipment changed, and when climatic conditions reflected wide changes in geomembrane temperature (based on changes in ambient air temperature).

The start-ups were destructively tested for peel and shear as soon as the seam cooled using a field tensiometer. A minimum of six (6) one-inch wide specimens were cut out of each test weld and were subjected to shear and peel adhesion testing at the site (i.e., three specimens for peel, and three specimens for shear testing.) If all specimens passed, the technician was approved to weld. If any one of the test specimens failed, a new test strip was fabricated by varying the temperature, speed or pressure, as applicable. If additional specimens failed, the seaming apparatus and technician were not allowed to seam until the deficiencies were corrected and successful start-ups were achieved.

Refer to Appendix F, titled ‘Geosynthetic QAQC’ for Trial Seam results.

6.4.4 LLDPE Geomembrane Field Seaming and Joining

The field seaming of the deployed LLDPE geomembrane panels is an integral aspect of the proper functioning of the LLDPE geomembrane as the low permeability barrier of the final cover system.

Prior to field seaming, the contact surfaces of the panels to be seamed were wiped clean to remove all dirt, dust, moisture and other foreign materials. The lap joints were formed by lapping the edges of the panels at a minimum of three (3) inches. Any portion of the LLDPE geomembrane damaged during installation was removed or repaired using an additional piece of LLDPE geomembrane, as per the Technical Specifications.

All penetrations, such as pipes, monitoring wells and gas extraction wells, were “booted” with 40-mil LLDPE geomembrane in accordance with the Contract Drawings and Specifications.

QA maintained a Pipe Boot/Special Connection Log which is presented in Appendix F, titled ‘Geosynthetic QAQC’.

6.4.5 Non-Destructive Testing of Field Seams – LLDPE Geomembrane

The primary purpose of the non-destructive seam testing was to ensure continuity along the entire seam length. Non-destructive testing was performed by Chenango and witnessed by QA to validate 100% of the seams.

For this project, all field seams were non-destructively tested over their full length using either vacuum box or pressurized air-channel testing. Appendix F, titled ‘Geosynthetic QAQC’ presents the non-destructive test methods and results used for the LLDPE geomembrane.

6.4.6 Destructive Testing of Field Seams – LLDPE Geomembrane

Samples from the production of field-fabricated geomembrane seams for destructive testing were taken at a minimum frequency of one destructive test sample for every 500 linear feet of field seam, as specified in the Contract Specifications. Destructive testing of the geomembrane seams was performed by cutting out and removing a portion of the completed production field seam, and then further dividing the sample into specimens for testing in accordance with ASTM D 4437 – Practice for Determining the Integrity of Field Seams used in Joining Flexible Polymetric Sheet Geomembranes.

Field cutouts were conducted on the field seams. For every 500 linear feet of field seam (including seams created for repairs), and as directed by URS personnel, a short section (3 feet long) of the fabricated seam was cut from the installed geomembrane and distributed as follows:

- One portion field tested on site by the QC for peel adhesion and shear strength;
- One portion for laboratory tensile testing by independent QC testing laboratory;
- One portion to URS for testing by the independent QA testing laboratory;

- One portion to URS for NYCDEP’s archive storage.

All testing confirmed that the geomembrane placed met the Technical Specifications. Refer to Appendix F, titled ‘Geosynthetic QAQC’ for the results of all testing of the LLDPE geomembrane. See below for QC and QA summary tables of testing results:

Table 6.4

QUALTIY CONTROL TESTING - TEXTURED 40 mil LLDPE				
Specification			**Testing**	
Test Property	**Method**	**Value & Unit**	**Range**	**No. of Tests**
Thickness	**ASTM D5994**	**Avg min 40 mils**	41 - 42	52
Density	**ASTM D1505**	**max. 0.939 g/cc**	0.9328 - 0.9383	52
Break Strength	***ASTM D6693**	**min. 60 Ib/in**	142 - 211	52
Break Elongation	***ASTM D6693**	**min. 250 %**	502 - 651	52
AxI-Symmetric Break Resistance Strain	**ASTM D5617**	**min. 30 %**	38 - 106	52
Tear Resistance	**ASTM D1004**	**min. 22 Ib**	25 - 39	52
Puncture Resistance	**ASTM D4833**	**min. 44 Ib**	96 - 117	52
Carbon Black Content	**ASTM D1603**	**range 2.0 to 3.0 %**	2.25 - 2.6	52
Carbon Black Dispersion	**ASTM D5596**	**rating Cat 1 or 2**	1 - 1	52
Bonded Shear Strength	**ASTM D6392**	**FTB and 44**	FTB and 61 -107	52
Seam Peel Adhesion	**ASTM D6392**	**FTB and 40**	FTB and 88 - 118	52

Table 6.5

QUALITY ASSURANCE TESTING - TEXTURED 40 mil LLDPE				
Specification			**Testing**	
Test Property	**Method**	**Value & Unit**	**Range**	**No. of Tests**
Thickness	**ASTM D5994**	**Avg min 40 mils**	40.1 - 46.7	8
Density	**ASTM D1505**	**max. 0.939 g/cc**	128.56 - 193.3	8
Break Strength	***ASTM D6693**	**min. 60 Ib/in**	604.6 - 724.8	8
Break Elongation	***ASTM D6693**	**min. 250 %**	596.4 - 724.8	8
Tear Resistance	**ASTM D1004**	**min. 22 Ib**	26.005 - 35.79	8
Puncture Resistance	**ASTM D4833**	**min. 44 Ib**	83.11 - 113.4	8
Carbon Black Content	**ASTM D1603**	**range 2.0 to 3.0 %**	2.2 - 2.66	8
Carbon Black Dispersion	**ASTM D5596**	**rating Cat 1 or 2**	1 - 1	8

Table 6.6

QUALTIY CONTROL TESTING - SMOOTH 60 mil LLDPE				
Specification			**Testing**	
Test Property	**Method**	**Value & Unit**	Range	No. of Tests
Thickness	**ASTM D5199**	**Avg min. 60 mils**	61 - 62	6
Density	**ASTM D1505**	**max. 0.939** g/cc**	0.9363 - 0.9368	6
Break Strength	***ASTM D6693**	**min. 228 Ib/in**	336 - 354	6
Break Elongation	***ASTM D6693**	**min. 800 %**	1067 - 1114	6
AxI-Symmetric Break Resistance Strain	**ASTM D5617**	**min. 30 %**	80 - 94	6
Tear Resistance	**ASTM D1004**	**min. 33 Ib**	44 - 46	6
Puncture Resistance	**ASTM D4833**	**min. 84 Ib**	118 - 124	6
Carbon Black Content	**ASTM D1603**	**range 2.0 to 3.0 %**	2.32 - 2.44	6
Carbon Black Dispersion	**ASTM D5596**	**rating Cat 1 or 2**	1 - 1	6
Bonded Shear Strength	**ASTM D6392**	**FTB and 44**	FTB and 90 - 127	6
Seam Peel Adhesion	**ASTM D6392**	**FTB and 40**	FTB and 120 - 137	6

Table 6.7

QUALTIY ASSURANCE TESTING - SMOOTH 60 mil LLDPE				
Specification			**Testing**	
Test Property	**Method**	**Value & Unit**	**Range**	**No. of Tests**
Thickness	**ASTM D5199**	**Avg min. 60 mils**	60.4 - 62.9	2
Density	**ASTM D1505**	**max. 0.939** g/cc**	0.9457 - 0.9294	2
Break Strength	***ASTM D6693**	**min. 228 Ib/in**	302.7 - 282.5	2
Break Elongation	***ASTM D6693**	**min. 800 %**	806.9 - 892.7	2
Tear Resistance	**ASTM D1004**	**min. 33 Ib**	43.47 - 40.12	2
Puncture Resistance	**ASTM D4833**	**min. 84 Ib**	136.36 - 120.18	2
Carbon Black Content	**ASTM D1603**	**range 2.0 to 3.0 %**	2 - 2.58	2
Carbon Black Dispersion	**ASTM D5596**	**rating Cat 1 or 2**	1 - 1	2

Upon completion, 630,622 square yards (130.3 acres) of LLDPE geomembrane were deployed with 573,367 square yards (118.5 acres) being the 40 mil textured LLDPE geomembrane and 57,255 square yards (11.8 acres) being 60 mil smooth LLDPE geomembrane.

7.0 GEOSYNTHETIC CLAY LINER

7.1 General

Geosynthetic clay liner (GCL) is a component of the final cover. The GCL when combined with the geomembrane creates a multi-layer barrier to fluid flow and is sometimes referred to as a composite liner system. The composite liner is used at the Brookfield Avenue Landfill in low lying wetland pond areas located within the cap perimeter. GCL is a thin liner, comprised of sodium bentonite sandwiched between two geotextile layers for support. The hydraulic conductivity of the GCL is extremely low, on the order of 1×10^{-9} cm/s. Use of GCL on the site was to serve as a composite cover placed directly over the installed geocomposite drainage net (either the gas venting layer or drainage layer depending upon the application). The GCL comes from a single source however quantities discussed are inclusive of all GCL installed at the Landfill.

7.2 Manufacturer – GCL

The manufacturer of the GCL was GSE BentoLiner of Spearfish, South Dakota. The manufacturer was responsible for supplying material and providing quality control during production. Standard manufactured roll dimensions for the GCL are 15.5 ft width by 150 ft length. GSE BentoLiner was required to provide certification that its materials conformed to the Contract Specifications. In addition, the manufacturer was required to submit written certification that each lot of material met or exceeded the technical specifications that were written to meet Part 360. GSE BentoLiner also provided test results for both the raw material (clay) used to fabricate the GCL and the individual finished rolls. Certificates of Analysis from GSE BentoLiner and all test results confirming that each lot of material met the Technical Specifications are located in Appendix F, titled ‘Geosynthetic QAQC’ and summarized below in Table 7.1.

Table 7.1

GCL – QC					
GEO-SYNTHETIC CLAY LINER - QC TESTING RESULTS					
Specification				**Testing**	
Material	**Test**	**Method**	**Value & Unit**	**Range**	**No. of Tests**
BENTONITE	Free Swell	ASTM D5890	24 mL/2g min	29 - 31	21
	Fluid Loss	ASTM D5891	18 mL max.	14.8 - 15.6	21
GEOTEXTILE	Mass per unti area (woven)	ASTM D5261	3.1 oz./sy MARV	3.7 - 4.0	21
	Mass per unti area (non-woven)	ASTM D5261	6.0 oz./sy MARV	8.1 - 8.4	21
GCL	Bentonite Mass per unit area (at 0% MC)	ASTM D5993	0.75 lbs/sf MARV	1.01 - 1.08	21
	Peel Strength	ASTM D6496	2.5 lbs/in min.	11 - 15.4	21
	Tensile Strength	ASTM D6768	23 lbs/in min.	69 - 88	21
	Index Flux	ASTM D5877	1E-8 m^3/m^s/sec max.	8.6E-10 - 1.7E-08	21

7.3 Installation – GCL

QA/QC procedures for the (GCL) material installation including off loading, storing and placement of the GCL, were followed before and during construction. Prior to the Contractor procuring the GCL material, the QA Site Manager reviewed the information provided by the Contractor from the geosynthetic manufacturer and installer. A summary of this data was provided above in Table 7.1. Geosynthetic Clay Liner was installed at locations as shown on the Drawings and as specified by the Resident Engineer.

The contractor began installation by preparing the GCL liner system installation surface (geocomposite) as specified. The GCL was placed directly over the installed geocomposite drainage net, either the gas venting layer or drainage layer depending upon the application, see the contract drawings for details of the installation locations. Following QA/QC inspection the Contractor proceeded with GCL installation and associated layers of LLDPE geomembrane liner, drainage net composite, and or sand). Any GCL damaged during installation was repaired or replaced in accordance with the contract specifications and in conformance with the manufacturers repair recommendations.

Anchor trenches were constructed as shown on the design drawings. Rounded corners were provided in the trench to avoid sharp bends in the GCL. The anchor trenches were adequately drained to prevent water ponding and softening of adjacent soils and backfilled with common fill and compacted to 90 percent of modified proctor density, ASTM D 1557. The amount of trench open at any time was limited to one day of GCL installation capacity. The anchor trench was backfilled and compacted at the end of each day and subsequently protected and covered with plastic sheeting if necessary.

7.4 Placement – GCL

Placement of the GCL was conducted in accordance with the manufacturer's recommendations. Each panel of the GCL was rolled out and installed in accordance with the approved shop drawings. The minimum allowable size for a GCL "panel" shall be 120 square feet. The layout was designed to keep field joining of the GCL to a minimum and consistent with proper methods of GCL installation. GCL rolls were placed using proper spreader and rolling bars with chain or cloth slings. If a sheet was replaced a distance greater than its width, a slip or rub sheet was used. The QA/QC team inspected each panel, after placement and prior to seaming, for damage and/or defects. Defective or damaged panels were documented replaced or repaired.

During placement, the QA/QC team ensured that all seams or edges of GCL material exposed for more than 24 hours or considered partially hydrated when seaming occurred received a minimum 3-foot overlap (rainlap) from the adjoining GCL panels. The installer avoided dragging the GCL sheets on the geocomposite drainage net material. The GCL was properly weighted to avoid uplift due to wind and kept free of debris, and unnecessary tools and materials. Vehicular traffic across the GCL was not allowed. Upon completing placement of GCL panels in any area, the LLDPE geomembrane or sand barrier protective layer material was immediately installed over the GCL panels.

The GCL was not allowed to get wet before or during installation. The GCL was not installed during periods of precipitation. If a precipitation event occurred after the installation of a GCL panel, but prior to covering with an LLDPE panel or the sand barrier protective layer material, a thin film plastic sheeting was used to cover and temporarily protect the GCL from moisture. GCL placement also did not proceed in the presence of excessive moisture, in areas of ponded water, or times of excessive wind.

Panels were placed with the non-woven geotextile side facing down and from the highest elevation to the lowest within the area to be lined to facilitate drainage in the event of precipitation. Panels were placed free of tension or stress without wrinkles or folds. It was not permissible to stretch the GCL in order to fit a designated area. Panels were not be dragged across the subgrade into position except when necessary to obtain the correct overlap for adjacent panels. Panel ends were not closer than three feet from the top or toe of slopes. When covering GCL installed on sloped areas steeper than 6H: 1 V, the cover material was pushed upslope to minimize tension on the GCL. All leading edges of panels left uncovered were protected at the end of the working day with a waterproof sheet which was adequately secured with sandbags and other ballast.

At completion, 83,990.00 square yards (17.35 acres) of Geosynthetic Clay Liner (GCL) were deployed.

7.5 Quality Control/Quality Assurance During Installation

7.5.1 General

During construction and liner installation operations, the QA Inspectors reviewed the delivery and off-loading of materials and verified that the material delivered to the site is the material that was manufactured for the project by matching the roll numbers with the certified bills of lading provided by the manufacturer. QA observed deployment of GCL & inspected each panel after placement & prior to seaming for damage or defects.

7.5.2 Quality Assurance

Prior to the Contractor procuring the GCL, the QA Site Manager reviewed the information provided by the Contractor from the manufacturer. This information was provided by the Contractor only after the QC Site Manager reviewed it for compliance with the specifications. This information included: Submittals relating to GCL manufacturer and GCL material (i.e. list of material properties, certified test results, manufacturer's Quality Control program, the origin of the bentonite and geotextiles to be used in the manufacturing of the GCL, Minimum Average Roll Values (MARVs), batch identifications, roll numbers permeability, bentonite content etc.). See Table 7.1 above and Appendix F, titled ‘Geosynthetic QAQC’ for additional information and data.

As construction progressed, the QA Geosynthetic Inspector visually and continuously inspected the GCL as it was being deployed and installed to determine compliance with the specifications and manufacturer’s recommendations for installation. If any material was damaged, the panel was physically marked and documented for repair or removal. The QA Geosynthetic Inspector and the Contractor’s QC Inspector documented all panel placement and installation.

7.5.3 Quality Control

Prior to the Contractor procuring the GCL, the QC Site Manager collected and reviewed all required information from the manufacturer for compliance and approval with the specifications. This information included: Submittals relating to GCL manufacturer and GCL material (i.e. list of material properties, certified test results, manufacturer's Quality Control program, the origin of the bentonite and geotextiles to be used in the manufacturing of the GCL, Minimum Average Roll Values (MARVs), batch identifications, roll numbers permeability, bentonite content etc.). Each roll delivered to the Project site had manufacturer's name, product identification, gcl roll weight, roll number, lot number and roll dimensions. Once approved, the QC Manager submitted the documentation certified by the manufacturer for the material delivered for the Project. Quality Control certificates, signed by the manufacturer's Quality Assurance Manager with roll identification number, sampling procedures, frequency and test results were provided.

Conformance testing was performed by an independent Quality Assurance Laboratory (QAL) approved by the QA Site Manager and the NYCDEP and retained by the Contractor. A Quality Assurance Technician (QAT) from the QAL obtained the samples from the roll, and marked the sample with an appropriate identification number. These conformance tests were reviewed by the QA Site Manager and accepted or rejected, prior to the placement of the GCL. All test results met or exceeded, the property values listed in Detailed Specification.

8.0 GEOTEXTILE

8.1 General

The geotextile were both used independently as filter fabric and as a component of geosynthetic product. In this section the discussion will be on geotextile used independently as filter fabric where as the geosynthetic's geotextile component was discussed in Section 5 'Geocomposite'.

8.2 Manufacturer – Geotextile

The manufacturer of the 187,300 sq yards of geotextile used onsite as filter fabric was from SKAP Industries, Georgia. SKAPS geotextiles are a needle-punched nonwoven geotextile made of 100% polypropylene staple fibers, which are formed into a random network for dimensional stability. The material used for the geotextile was manufactured from polymers formulated to enhance the geotextiles' resistance to environmental degradation including ultraviolet exposure. Table 8.1 shows the specifications for the geotextiles and properties of the materials submitted. Submittals for the geotextiles are in Appendix F, titled 'Geosynthetic QAQC'.

Table 8.1

Geotextile – Minimum Physical Requirements

Property	Test Method	Units	Filter Fabric	
			Specified	Submitted
Fabric Weight	ASTM D-5261	Oz./yd2	8	8
Grab Strength	ASTM D-4632	Lbs	215	225
Grab Elongation	ASTM D-4632	%	50	50
Puncture Resistance	ASTM D-4833	Lbs	100	130
Permittivity	ASTM D-4491	SEC-1	1.25	1.26
Apparent Opening Size	ASTM D-4751	Mm	0.180	0.180

8.3 Installation – Geotextile

The geotextiles were installed by the Contractor at the locations shown on the Contract Drawings. All bedding geotextile seams within drainage channels, and geotextile seams within the final cover system drainage layer, consisted of adjacent panels sewn securely together.

The geotextiles were installed to the lines and grades as shown on the Contract Drawings. The geotextiles were rolled down the slope in such a manner as to continually keep the sheet in tension of self-weight. The geotextiles were secured in anchor trenches as required and temporarily weighted with sandbags as needed. A minimum buried flap of geotextile of two (2) feet by the length of the anchor was required for anchor trenches. Geotextiles were not exposed to precipitation prior to installation and was not exposed to direct sunlight for more than 24 hours prior to placement.

Geotextiles used with the final cover system were seamed by stitching methods as recommended by the manufacturer and approved by Engineer. Any deviations from the seam procedures were approved on a case-by-case basis after review by the CM inspectors. Sewing was done using nylon thread with chemical resistance properties equal to those of the geotextile for this application. All sewn seams were continuous and spot seaming was not permitted for sewn seams. Seams were oriented down slopes perpendicular to grading contours unless otherwise specified by the CM.

8.4 Quality Assurance/Quality Control

The Contract Specifications do not require a minimum number of QC tests by the Contractor during installation, but allows the Engineer to test QA samples at will.

URS examined the geotextile rolls upon delivery to the site and reported any deviation from the Contract Specifications to the Contractor. In these instances, the Contractor performed the necessary repairs and replaced any damaged products delivered to the site, as directed by the Engineer. Any holes or tears which developed in the geotextile were repaired by the Contractor, by placing a fabric patch of the same geotextile, then seamed into place no closer than three (3) inches from any edge of the patch. Prior to repair, the Contractor completely removed any soil or other material which penetrated a damaged geotextile. Tears, holes, or other damage to the fabric were repaired to the satisfaction of CM inspectors and the NYCDEP.

9.0 BARRIER PROTECTIVE LAYER

9.1 General

The Barrier Protective Layer (BPL) is a layer of soil that was placed over the geosynthetics (LLDPE geomembrane, the geocomposite gas and drainage layers) to anchor and protect from weathering, surface traffic (human and animal), impacts, and minimize frost action, root penetration, burrowing animals and other damage. The BPL material also has a special requirement that the permeability be between $1x10^{-4}$ to $1x10^{-6}$ cm/sec at 90% standard compaction to control the rate of rainwater infiltration reaching the geosynthetic drainage layer. A minimum of twelve (12) inch thickness of compacted BPL soil was placed directly on top of the geosynthetic layer (geocomposite and LLDPE geomembrane).

9.2 Material Source – Barrier Protective Layer

The soil material used for Barrier Protective Layer construction was environmentally clean in accordance with NYSDEC TAGM HWR-94-4046 (Technical and Administrative Guidance Memorandum), and was in conformance with the Contract Specifications. The barrier protection soil used on the project was tested and approved per the QA/QC requirements of the specifications prior to being imported for use at the Brookfield Avenue Landfill. Approximately 798,250 tons of material were delivered and placed as BPL over the geosynthetics.

The BPL soil sources, consisted of a mixture of imported sands and clays from Clayton (NJ) of Jackson, NJ and County Concrete Corp. of Kenvil, NJ. NYCDEP and URS inspected the borrow site and loading facilities prior to general acceptance and procurement. Source testing was performed at the frequency specified in the contract documents. All BPL soil material was delivered to the Brookfield Avenue Landfill pier via truck transportation.

Table 9.1 shows the source testing requirement.

Table 9.1

Source – Laboratory Minimum Testing Requirements

Property	Test Method	Frequency
Particle-Size Analysis with Hydrometer	ASTM D-422	every 2500 CYs
Standard Proctor Density	ASTM D-698	every 2500 CYs
Organic Content	ASTM D-2974	every 2500 CYs
Atterberg Limits	ASTM D-4318	every 2500 CYs
Chemical Analysis	Per Specifications	every 2500 CYs
Water (Moisture) Content	ASTM D-2216	every 2500 CYs
Soil Classification	ASTM D-2488	every 2500 CYs

The general requirements and results for BPL are shown in Table 9.2

Table 9.2

QC Geotechnical Analysis			
Test	**Criteria**	**MIN**	**MAX**
Permeability (@ 90% Std. Compaction)	$1x10^{-4}$ to $1x10^{-6}$ cm/sec	$6.5x10^{-6}$	$1.7x10^{-3}$
Minimum Shear Strength value (phi)	30^{o} (degrees)	30.9	45.1
Max Stone Size	<3"	<3"	<3"
Sieve Analysis 1"	100%	85.4%	100%
Atterberg Limits (Plasticity Index)	<20	Non-Plastic	16

Refer to Appendix G, titled ‘Barrier Protective Layer Testing Results’.

9.3 Installation – Barrier Protective Layer

Appropriate care and procedures were used in the placement of the BPL over the LLDPE geomembrane material and composite to avoid wrinkling or over-stressing the geocomposites. BPL soil was installed with a minimum lift thickness of twelve (12) inches.

The BPL soil was generally stockpiled near the lower edge of exposed liner in working BPL fill areas and then pushed over the liner with low ground pressure (LGP) bulldozers riding on the layer of BPL as it was placed. Fill was placed from lower elevations to higher as required by the

Specifications, except where impractical and approved otherwise. Temporary roads constructed of additional BPL material up to four feet thick were also built over the liner where needed to allow articulated off-road dump trucks to access approved areas for fill placement without undue stress on the underlying geosynthetics. These thicker roadway areas were later graded down to the required 12 inch thickness using Global Positioning System (GPS) guided dozers with surveyed liner elevations. Thickness was confirmed periodically by hand digging test holes.

During the course of the BPL installation, the pH of the material was continually tested for detection of any rapid spikes in acid or pH changes after the material was placed onsite. The pH values of soil which previously was within specifications remained constant throughout the project to levels within specification limits and deemed acceptable. Retesting of onsite BPL material confirmed this to be a consistently occurring throughout the Landfill.

9.4 Quality Assurance/Quality Control

Quality assurance and quality control during construction of the BPL consisted of full-time observation in addition to laboratory and field-testing. The contractor used their survey control and GPS system to control the depth of material. The thickness of the BPL was verified by hand digging a minimum of four test holes per acre, as directed by and confirmed by QA personnel. After measurements were made, the holes were backfilled with BPL soil and hand tamped. QA personnel observed the digging and backfilling of test holes to ensure that the contractor exercised care not to damage the underlying geosynthetic materials.

All QC laboratory and field testing was performed by French & Parrello Associates, P.A. Consulting Engineers of Wall, New Jersey, an approved independent geotechnical laboratory. Chemical analyses were provided by Accredited Analytical Laboratories, LLC, of Carteret, New Jersey an approved independent chemical labortory. Field moisture density testing (IPA) onsite testing using nuclear density test meter, was also performed by French & Parrello Associates, P.A. Consulting Engineers of Wall, New Jersey. Periodic quality control testing was performed by the contractor in accordance with the Contract Specification. Results are available in Appendix G, titled ‘Barrier Protective Layer Testing Results’.

All QA laboratory and field testing was performed by the approved independent chemical laboratory and geotechnical laboratory, employed by the CM. Chemical analyses were provided by Accutest Laboratories of Dayton, NJ. Geotechnical analysis was performed by RSA GeoTest LLC of Union, NJ and Terra Sense, LLC of Totawa, NJ.

QA field moisture-density (IPD) was performed by a Gentech Engineering onsite using nuclear densometer gauge by trained and certified personnel. Periodic quality assurance inspections and tests were performed to verify the QC testing results. The BPL was compacted to a minimum density of 90 percent of the maximum dry density with the optimum moisture based on the Standard Proctor Test, as determined by ASTM D-698. The moisture and density of the BPL were measured in the field to a 6-inch depth by a nuclear densometer gauge. Field density and moisture tests on the BPL were performed at approximately 100-foot intervals. These field density tests are also referred to as IPD (in place density) elsewhere in this report.

Refer to table 9.2 (above) for geophysical results and table 9.3 (below) for chemical results summaries of BPL testing. For in place field testing (IPD), test data sheets are in Appendix G, titled ‘Barrier Protective Layer Testing Results’. No summary table is provided of any out of range test results, since the contractor would re-compact the soil prior to re-testing the soil and obtaining the required density result.

The moisture content of the soil was not performed since the material was processed, placed and compacted on site. After compaction the moisture content was measured by the Troxler density gauge and compared to the proctor test results as to achieving 90% density. Any material that was excessively wet was stockpiled to dry.

For the chemical testing summarized below in Table 9.3 each sample was analyzed for all contaminants, so the number of samples tested is always the same for each contaminant shown. There were 182 samples tested for the Barrier Protective Layer material which was accepted and delivered to the Brookfield Avenue Landfill project.

Refer to Appendix G, titled ‘Barrier Protective Layer Testing Results’ for all field, chemical and geotechnical test results for BPL.

TABLE 9.3

BPL QC Chemical Analysis Results Summary			
Volatile Organic Contaminants			
Contaminant	**Soil Use Criteria (mg/kg)**	**MIN**	**MAX**
Total VOCs	**10**	ND	ND
Acetone	**0.2**	ND	0.036
Benzene	**0.06**	ND	ND
Bromodichloromethane	*	ND	ND
Bromoform	*	ND	ND
Bromomethane	*	ND	ND
2-Butanone	**0.3**	ND	0.0032
Carbon Disulfide	**2.7**	ND	ND
Carbon Tetrachloride	**0.6**	ND	ND
Chlorobenzene	**1.7**	ND	ND
Chloroethane	**1.9**	ND	ND
Chloroform	**0.3**	ND	ND
Chloromethane	*	ND	ND
Cis-I,3-Dichloropropene	*	ND	ND
Di bromochloromethane	*	ND	ND
1,1-Dichloroethane	**0.2**	ND	ND
I 2-Dichloroethane	**0.1**	ND	ND
1,I-Dichloroethene	**0.4**	ND	ND
1,2-Dichloroethene (total)	*	ND	ND
1,2-Dichloropropane	*	ND	ND
1,3-Dichloropropene (trans)	*	ND	ND
Ethylbenzene	**5.5**	ND	ND
2-Hexanone	*	ND	ND
Methylene Chloride	**0.1**	ND	0.052
4-Methyl-2-Pentanone	**1**	ND	ND
Styrene	*	ND	ND
Tetrachloroethene	**1.4**	ND	ND
1,1,1-Trichloroethane	**0.8**	ND	ND
1,1,2-Trichloroethane	*	ND	ND
1,1,2,2-Tetrachloroethane	**0.6**	ND	ND
Toluene	**1.5**	ND	ND
Trichloroethene	**0.7**	ND	ND
Vinyl Chloride	**0.2**	ND	ND
Xylenes (Total)	**1.2**	ND	ND

Table 9.3 (continued)

BPL QC Chemical Analysis Results Summary			
Semi-Volatile Organic Contaminants			
Contaminant	**Soil Use Criteria (mg/kg)**	**MIN**	**MAX**
Total SVOCs	**500**	ND	ND
Total CPAHs	**10 ****	ND	ND
Acenaphthene	**50**	ND	ND
Acenaphthylene	**41**	ND	ND
Anthracene	**50**	ND	0.106
Benzo(g,h,i)perylene	**50**	ND	0.0964
Benzo(k)fluoranthene	**1.1**	ND	0.215
bis(2-ethylhexyl)phthalate	**50**	ND	0.163
bis-(2-Chloroethy)ether	**0.58***	ND	ND
bis-(2-Chloroethoxy)methane	**50**	ND	ND
4-Bromophenylphenylether	**50**	ND	ND
Butyl benzylphtha1ate	**50**	ND	ND
Carbazole	**32***	ND	ND
4-Chloroaniline	**0.220 or MDL**	ND	ND
4-Chloro-3-methy1phenol	**0.240 or MOL**	ND	ND
2-Chlorophenol	**0.8**	ND	ND
4 Chlorophenylphenylether	**50**	ND	ND
2 Chloronaphthalene	**50**	ND	ND
2,4-Dinitrotoluene	**50**	ND	ND
Dibenzofuran	**6.2**	ND	ND
1,2-Dichlorobenzene	**50**	ND	ND
1,3-Dichlorobenzene	**50**	ND	ND
1,4-Dichlorobenzene	**50**	ND	ND
3,3’ -Dichlorobenzidine	**1.4***	ND	ND
2,4-Dichlorophenol	**0.4**	ND	ND
4,6 Dinitro-2-methylphenol	**50**	ND	ND
2,4-Dimethylphenol	**50**	ND	ND
2,4-Dinitrophenol	**0.200 or MDL**	ND	ND
2,6-Dinitrotoluene	**1**	ND	ND
Diethy1phthalate	**7.1**	ND	ND
Dimethylphthalate	**2**	ND	0.0819
Di-n-butylphthalate	**8.1**	ND	0.213
Di-n-octylphthalate	**50**	ND	ND
Fluoranthene	**50**	ND	0.431

Table 9.3 (continued)

BPL QC Chemical Analysis Results Summary			
Semi-Volatile Organic Contaminants			
Contaminant	**Soil Use Criteria (mg/kg)**	**MIN**	**MAX**
Fluorene	**50**	ND	ND
Hexachlorobenzene	**0.41**	ND	ND
Hexachlorobutadiene	**8.2***	ND	ND
Hexachloroethane	**46***	ND	ND
Hexachlorocyclopentadiene	**50**	ND	ND
Isophorone	**4.4**	ND	ND
2-Methytnaphthalene	**36.4**	ND	ND
2-Methylphenol	**0.100 or MDL**	ND	ND
4-Methy1phenol	**0.9**	ND	ND
Naphthalene	**13**	ND	0.0727
Nitrobenzene	**0.200 or MDL**	ND	ND
2-Nitroaniline	**0.430orMDL**	ND	ND
4 Nitroaniline	**50**	ND	ND
2-Nitrophenol	**0.330 or MDL**	ND	ND
4-Nitrophenol	**0.100 or MDL**	ND	ND
3-Nitroaniline	**0.500 or MDL**	ND	ND
N-Nitroso-di-n-propylamine	**0.091 ***	ND	ND
N-Nitrosodiphenylamine	**50**	ND	ND
2,2'-oxybis(1-Chloropropan e)	**50**	ND	ND
Pentachlorophenol	**1.0 or MDL**	ND	0.0874
Phenanthrene	**50**	ND	0.492
Phenol	**0.03 or MDL**	ND	ND
Pyrene	**50**	ND	0.49
1,2.4-Trichlorobenzene	**50**	ND	ND
2,4,5-Trichlorophenol	**0.1**	ND	ND
2,4.6-Trichlorophenol	**50**	ND	ND

Table 9.3 (continued)

BPL QC Chemical Analysis Results Summary			
Organic Pesticides and PCBs			
Contaminant	**Soil Use Criteria (mg/kg)**	**MIN**	**MAX**
Total Pesticides	**10 ppm**	ND	ND
Aldrin	**0.041**	ND	0.002
alpha-BRC	**0.11**	ND	ND
Endrine aldehyde	*****	ND	ND
Alpha-chlordane	*****	ND	0.0069
beta-BHC	**0.2**	ND	ND
delta-BHC	**0.3**	ND	0.015
4,4'-DDD	**2.9**	ND	ND
4,4'-DDE	**2.1**	ND	0.00217
4,4'-DDT	**2.1**	ND	0.0079
Dieldrin	**0.044**	ND	0.0049
Endosulfan 1	**0.9**	ND	ND
Endosulfan 11	**0.9**	ND	ND
Endosulfan sulfate	**1**	ND	ND
Endrin	**0.1**	ND	0.0061
Endrin ketone	**N/A**	ND	ND
Gamma-BHC (Lindane)	**0.06**	ND	0.002
Gamma-chlordane	**0.54**	ND	0.009
Heptachlor	**0.1**	ND	0.0023
Heptachlor epoxide	**0.02**	ND	ND
Methoxychlor	*****	ND	ND
Total PCBs	**1**	ND	0.111
Toxaphene	*****	ND	ND

*Contaminants mark with an (*) do not have individual limits in the NYSDEC's TAGM 4046: however, the total pesticide and PCB concentrations shall be less than the maximum allowable concentration listed above as Total Pesticides and Total PCB's respectively.

Table 9.3 (continued)

BPL QC Chemical Analysis Test Results Summary			
Heavy Metals, Asbestos, and Conventionals			
Contaminant	**Soil Use Criteria (mg/kg)**	**MIN**	**MAX**
Aluminum	**33,000**	526	20400
Antimony	**10**	ND	3.9
Arsenic	**10**	0.77	10
Barium	**300**	3.22	92.3
Beryllium	**1**	ND	0.891
Cadmium	**5**	ND	0.533
Chromium	**160**	0.34	67.6
Cobalt	**60**	0.636	10.1
Copper	**115**	1.9	23
Cyanide	**4**	ND	2.42
Iron	**30,000**	1280	28500
Lead	**400**	ND	29.8
Manganese	**1300**	12.5	660
Mercury	**0.6**	ND	0.07
Nickel	**75**	1.12	106
Selenium	**2**	ND	1.9
Silver	**200**	ND	0.39
Thallium	**20**	ND	3.5
Vanadium	**150**	10	51.5
Zinc	**100**	ND	61.2
Asbestos Fiber Content	**1% (by weight)**	ND	ND
pH	**5.5 - 7.5**	5.85	7.5
Sulfides	**50,000**	ND	426
Ammonia	**40**	ND	26

10.0 TOPSOIL, SEEDING & EROSION CONTROL FABRIC

10.1 General

The final step in the installation of the Landfill final cover system was the construction of a 12-inch thick layer of topsoil over the entire cap and plus additional topsoil, up to three (3.0) feet thick in areas designated as planting islands or berms. All the topsoil was placed on top of the previously installed barrier protection layer soil to sustain a well-established vegetative cover which will protect the cap from erosion. Upon placement of the topsoil, it was seeded in accordance with the Contract requirements and protected with a natural, biodegradeable straw mat to protect the emerging grass seed from heavy rains, wind and hold needed moisture during the early growth period.

10.2 Material Source – Topsoil

The material used for the topsoil layer construction was in conformance with the Contract Specifications. All topsoil sources used on the project were tested and approved per the QA/QC requirement of the Specifications prior to delivery at the Brookfield Avenue Landfill.

The topsoil was a manufactured soil formulated to meet a specific range of agricultural parameters, for vegetative growth and health as well as specific geotechnical and chemical parameter as specified in the Contract requirements. Additionally, the topsoil was free of refuse, hard clods, woody vegetation, stiff clay, construction debris, boulders, stones larger than one and one-half inches, hydrocarbons, petroleum materials, chemicals toxic to plants, and other miscellaneous or otherwise unstable or undesirable materials.

The 554,647 tons of topsoil used on this project was a mixed material that was manufactured and supplied by a main supplier: Excavating Materials and Equipment (EME) of New Egypt, New Jersey. EME supplied two (2) types of soil for the landfill, the first and main type was the base contract specification for topsoil with its' requirements presented in Table 10.5 below and the second type, also known as Type 'A' topsoil was based on a New York City Department of Parks and Recreation blend with its' requirements present in Table 10.10 below. This project utilized 48,549 tons of Type 'A' topsoil out of the 554,647 total tons of topsoil used on this project, for placement on the future proposed West Cell athletic field as well as along the Arthur

Kill Road frontage of the project site. All topsoil was blended from mined sand and from leaf compost according to approved mix ratio of four (4) parts sand to one (1) part compost.

QA provided a full-time onsite inspector at the supplier to observe the staging, blending process, material quality, collect samples of each stockpile for QA analyses, and observed all Contractor QC sample collection events. The QA inspector would also track the onsite movement of each approved stockpiles and the trucking of each stockpile. This was critical to maintain the integrity and quantities of each pile. Table 10.1 shows the source testing requirements. The general requirements (macro & micro nutrients, etc.) for Topsoil are shown in Table 10.2. Appendix H, titled ‘Topsoil Testing Results’ presents all Source testing results.

10.3 Installation - Topsoil

All topsoil was received via truck and either temporarily stockpiled or directly placed on the Landfill. Temporary stockpiles were placed and graded for proper drainage and were not placed near the edge of side slopes. Topsoil delivered to the site was visually and continuously inspected by the CM during placement to ensure consistency in materials and procedures. No topsoil was permitted to be spread until the underlying barrier protection layer and the topsoil were approved by QA personnel and NYCDEP.

Topsoil was evenly placed with a LGP bulldozer to a minimum of either six (6) inches or up to three (3) feet in areas designated as (tree/shrub) planting islands, within the limit of final cover system and limits of the work area. A Global Positioning System (GPS) install on the bulldozer’s blade as well as grade stakes were used as the survey technique of choice to ensure that the proper lift and contours were achieved. Topsoil was not placed when the subgrade surface was frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to the proposed follow-on seeding program. In addition, mud, snow, ice or frozen earth was not permitted to be incorporated in the topsoil. Topsoil work within the limits of the final cover system was executed in conformance with the lines and grades shown on the Drawings.

For all work within the limit of the final cover system, slopes had a minimum of 1.7 percent and a maximum of 25 percent. During installation and final fine grading, topsoil was placed in a manner that allowed the surface to always be free draining. Also during installation, runoff and other water was directed into both temporary and permanent ditches and channels to the site perimeter storm water management system.

10.4 Quality Assurance/Quality Control - Topsoil

10.4.1 General

As the construction progressed, QA/QC conformance sampling and testing for agricultural, chemical and geotechnical analyses were conducted per the Specifications at specified frequencies at no less than one test for every 2,500 cubic yards of topsoil material delivered to the site.

10.4.2 Quality Control

Quality control during the topsoil layer construction included full-time observation, laboratory testing and field-testing. In addition, QC personnel were required to verify the topsoil layer thickness by hand digging test holes in the presence of QA inspectors. In place density testing (bulk density) was also conducted to verify compliance to the contract requirements. However, prior to procurement of the proposed Topsoil material, the Contractor was required to submit information to the QA Site Manager for review and approval including:

- Organic content analyses conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware. Bulletin #493, 12/95).
- USDA soil texture gradation (sand, silt and clay) analyses and sand sieve analyses, with full reporting of all information in USDA sieve sizes, in accordance with the Soil Survey Laboratory Methods Manual (No. 42, November 2004).
- pH tests conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States," 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95).
- Soluble salts test conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition.
- Nutrient analyses test conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition, Northeast Regional

Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95).

- Inorganic nitrogen and total Kjedahl nitrogen tests conducted in accordance with the methodologies utilized by the Northeast Coordinating Committee on Soil Testing, NEC-67.
- Acid-producing (iron sulfide) test conducted in accordance with the methodologies utilized by the Northeast Coordinating Committee on Soil Testing, NEC-67.
- Chemical analyses conducted in accordance with Detailed Specification section 02108 – Chemical Testing of Soil.

As delivery of topsoil to the site progresses, the testing continued on the topsoil at the frequency of testing is one for every 2,500 CY delivered. Results of tests were submitted for QA review and approval. The Contractor QC personnel were required to submit all topsoil thickness measurements, after such measurements have been verified by the QA Site Manager.

All QC laboratory (chemical and geotechnical) and field testing were performed by the approved independent chemical laboratories and approved independent geotechnical laboratories, employed by Contractor. Chemical analyses were provided by Accredited Laboratories, Inc., located in Carteret, New Jersey and Chemtech, of Mountainside, New Jersey. Geotechnical analyses were provided by French and Parrillo Laboratories, Inc., located in Howell, New Jersey. Field in-place density testing (IPD) was performed by French & Parrillo also. Nutrient analyses were provided by A&L Eastern Agricultural Laboratories located in Richmond, Virginia. The quality control testing was performed by the contractor in accordance with Table 10.5 thru 10.12.

10.4.3 Quality Assurance

Prior to procuring any material or starting construction, the QA Site Manager reviewed and verified the submittal and sample information provided by the Contractor QC team. In addition, the QA Site Manager made field trips to the borrow source to verify material to be provided by the Contractor is representative of the proposed material at the source. The QA Site Manager determined that the material was acceptable and was comparable to the standards by the U.S. Department of Agriculture via the initial sampling round. As Construction Progressed, the QA Geotechnical Inspectors performed the periodic QA testing at a frequency of one test every 15,000 CY delivered to the site. Samples from the borrow site, were all sent to the QA

Laboratory to perform the following conformance and frequency testing for the imported material:

- Organic content analyses conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware. Bulletin #493, 12/95).
- USDA soil texture gradation (sand, silt and clay) analyses and sand sieve analyses, with full reporting of all information in USDA sieve sizes, in accordance with the Soil Survey Laboratory Methods Manual (No. 42, November 2004).
- pH tests conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States," 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95).
- Soluble salts test conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition.
- Nutrient analyses test conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95).
- Inorganic nitrogen and total Kjedahl nitrogen tests conducted in accordance with the methodologies utilized by the Northeast Coordinating Committee on Soil Testing, NEC-67.
- Acid-producing (iron sulfide) test conducted in accordance with the methodologies utilized by the Northeast Coordinating Committee on Soil Testing, NEC-67.
- Chemical analyses conducted in accordance with Detailed Specification section 02108 – Chemical Testing of Soil.

In addition to the QA Geotechnical Inspector, the QA Ecological Restoration Specialist from Amy S. Greene Environmental Consultants visually and continuously inspected the topsoil material delivered to the site to check for consistency and for any material that may have an adverse effect on the proposed vegetation. If changes in material occured, then the QA Geotechnical Inspector and the QA Ecological Restoration Specialist informed both the QA and

QC Site Managers. Any rejected work was reworked by the Contractor using the new material until the construction QA and QC procedures were correctly executed and approved by the QA Site Manager at the expense of the Contractor.

All QA laboratory and field testing was performed by the approved independent chemical laboratory and geotechnical laboratory, employed by CM. Chemical analyses were provided by Accutest Laboratories located in Dayton, New Jersey. Geotechnical analysis for QA was performed by RSA Geo Soil Testing Laboratory located in Totowa, NJ. QA testing was performed in accordance with Table 10.1, 10.2 and 10.4. Refer to Appendix H, titled 'Topsoil Testing Results' for all geotechnical, chemical and field test results.

Table 10.1
Source Approval - Laboratory Minimum Testing Requirements

Property	Test Method	Frequency
Particle-Size Analysis with Hydrometer	ASTM D-422	One per source
pH	See Note 1 Below	One per source
Organic Content	See Note 1 Below	One per source
Soluble salts	See Note 1 Below	One per source
Macro/Micro Nutrients	See Note 1 Below	One per source
Nitrogen (inorganic and TKN)	NEC-67(see 2 below)	One per source
Acid Producing Soil (iron sulfide)	Rutgers University Soils Lab	One per source
Chemical Analysis	USEPA SW-846	One per source

NOTES: 1. These soil tests were conducted in accordance with Soil Testing Procedure for the Northeastern United States, 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95.
2. Method is as referenced in the Northeast Coordinating Committee on Soil Testing NEC-67.

Table 10.2
Topsoil Requirements

Property	Criteria
Estimated Bulk Density	1.0 - 1.4 (g/cm3)
Organic Content	2.5% - 5%
Gravel Content	≤ 8%
Sand Content	60% - 80%
Silt Content	10% - 20%
Clay Content	10% - 20%
USDA Classification	Sandy Loam
Max Grain Size	≤ 1.5´´
pH	5 -7
Acid Producing Soil Test	pH > 4.5
Soluble Salts	0 - 0.4 mmhos/cm
Nitrogen Total (TKN)	0.06%-0.15%
Nitrate Content	< or = 12 ppm

Property	Criteria
Macronutrients	
Phosphorus (P)	20 – 80 lbs/acre
Potassium (K)	70 – 225 lbs/acre
Magnesium (Mg)	200–300 lbs/acre
Calcium (Ca)	400–2000 lbs/acre
Total (Mg+K+Ca)	< or = 2500 lb/acre
Micronutrients	
Zinc (Zn)	1 ppm – 12 ppm
Copper (Cu)	0.1 ppm – 4 ppm
Manganese (Mn)	2 ppm – 25 ppm
Boron (B)	0.8 ppm – 3 ppm

Table 10.3
Quality Control – Field and Laboratory Minimum Frequency Testing Requirements

Property	Test Method	Frequency
Particle-Size Analysis with Hydrometer	ASTM D-422	One test every 2,500 yd^3
pH	See Note 1 Below	One test every 2,500 yd^3
Organic Content	See Note 1 Below	One test every 2,500 yd^3
Soluble salts	See Note 1 Below	One test every 2,500 yd^3
Macro/Micro Nutrients	See Note 1 Below	One test every 2,500 yd^3
Nitrogen (inorganic and TKN)	NEC-67(see 2 below)	One test every 2,500 yd^3
Acid Producing Soil (iron sulfide)	Rutgers University Soils Lab	One test every 2,500 yd^3
Chemical Analysis	USEPA SW-846	One test every 2,500 yd^3
Field Density (IPD)	ASTMD-2922	100 ft grid
Thickness check	Manual / Visual	50 ft grid

NOTES:
1. These soil tests were conducted in accordance with Soil Testing Procedure for the Northeastern United States, 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95.
2. Method is as referenced in the Northeast Coordinating Committee on Soil Testing NEC-67.

Table 10.4
Quality Assurance – Field and Laboratory Minimum Frequency Testing Requirements

Property	Test Method	Frequency
Particle-Size Analysis with Hydrometer	ASTM D-422	One test every 2,500 yd^3
pH	See Note 1 Below	One test every 2,500 yd^3
Organic Content	See Note 1 Below	One test every 2,500 yd^3
Soluble salts	See Note 1 Below	One test every 2,500 yd^3
Macro/Micro Nutrients	See Note 1 Below	One test every 2,500 yd^3
Nitrogen (inorganic and TKN)	NEC-67(see 2 below)	One test every 2,500 yd^3
Acid Producing Soil (iron sulfide)	Rutgers University Soils Lab	One test every 2,500 yd^3
Chemical Analysis	USEPA SW-846	One test every 60,000 yd^3

NOTES:
1. These soil tests were conducted in accordance with Soil Testing Procedure for the Northeastern United States, 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95.
2. Method is as referenced in the Northeast Coordinating Committee on Soil Testing NEC-67.

Table 10.5

QC Contract Specification Topsoil Agricultural Testing Results Summary				
Requirements	Acceptance Criteria		MIN[1]	MAX[1]
	A minimum of 75% of the samples provided will meet or exceed criteria (02925) shown below	A maximum of 25% of the samples provided can exceed the specified criteria (02925) to the limits shown below		
Estimated In Place Bulk Density	1.0 - 1.4 (g/cm^3)	1.0 - 1.4 (g/cm^3)	1.0<x<1.4	1.0<x<1.4
Maximum Grain Size Gradation	1.5 inches	1.5 inches	<1.5	<1.5
% Organic Content LOI	2.5% to 5.0%	2% to 5%	1.3%	4.4%
pH	5.0 to 7.0	5.0 to 7.0	5.5	6.9
Acid Producing (iron sulfide) [2] Test NJDEP, 12/2008	pH > 4.5	pH > 4.5	5.75	7.03
USDA Soil Classification	Loamy Sand	Loamy Sand / Sandy Loam	Loamy Sand	Loamy Sand
% Gravel Content (2" to 2.0mm)	0.0% to 8.0 %	0.0% to 15 %	1.18	12.61
% Sa0 Content (2.0mm to 0.05mm)	70.0% to 85.0%	60% to 85.0%	72.8%	88%
% Silt Content (0.05mm to 0.002mm)	10.0% to 15.0%	5% to 25%	3.2%	16.4%
% Clay Content (< 0.002mm)	5.0% to 15.0%	5% to 20%	4.8%	19.6%
Very Coarse Sa0 (Reportable Value Required) %	2.0mm to 1.0mm	2.0mm to 1.0mm	2.21	7.69
Coarse Sa0 (Reportable Value Required) %	1.0mm to 0.5mm	1.0mm to 0.5mm	3.04	19.57
Medium (Reportable Value Required) %	0.5mm to 0.25mm	0.5mm to 0.25mm	8.52	38.21
Fine (Reportable Value Required) %	0.25mm to 0.1mm	0.25mm to 0.1mm	12.79	58.1
Very Fine (Reportable Value Required) %	0.1mm to 0.05mm	0.1mm to 0.05mm	2.33	9.79
Soluble Salts	0 to 0.4 mmhos/cm	0 to 0.4 mmhos/cm	0.1	0.43
Kjeldahl Nitorgen (%)	0.06% to 0.15%	0.06% to 0.15%	0.03%	0.108%
NO_3 Nitrate	< or = 12 ppm	< or = 15 ppm	1	18
Total (Mg+K+Ca)	< or = 2000 lb/acre	< or = 2500 lb/acre	1038	3048
P (Phosphorus)	45 lb/acre to 80 lb/acre	45 lb/acre to 80 lb/acre	24	226
K (Potassium)	100 lb/acre to 225 lb/acre	100 lb/acre to 225 lb/acre	59	254
Mg (Magnesium)	200 lb/acre to 300 lb/acre	200 lb/acre to 300 lb/acre	124	372
Ca (Calcium)	400 lb/acre to 2000 lb/acre	400 lb/acre to 2000 lb/acre	834	2422
MN (Manganese)	2 ppm to 20 ppm	2 ppm to 20 ppm	5	20
B (Boron)	0.8 ppm to 3 ppm	0.8 ppm to 3 ppm	0.1	1.6
Cu (Copper)	0.1 ppm to 4 ppm	0.1 ppm to 4 ppm	0.7	2.3
Zn (Zinc)	1 ppm to 12 ppm	1 ppm to 12 ppm	3.2	19.4

[1] All variances where reviewed and accepted by the Resident Engineer, Site Ecological Restoration Specialist and NYCDEP.

Table 10.6 QC Contract Specification Topsoil Chemical Testing Results Summary			
Volatile Organic Contaminants			
Acceptance Criteria		**MIN**	**MAX**
Contaminant	**Soil Use Criteria (mg/kg)**		
Total VOCs	**10**	ND	0.0081
Acetone	**0.2**	ND	0.054
Benzene	**0.06**	ND	ND
Bromodichloromethane	*	ND	ND
Bromofonn	*	ND	ND
Bromomethane	*	ND	ND
2-Butanone	**0.3**	ND	ND
Carbon Disulfide	**2.7**	ND	ND
Carbon Tetrachloride	**0.6**	ND	ND
Chlorobenzene	**1.7**	ND	ND
Chloroethane	**1.9**	ND	ND
ChlorofOlTIl	**0.3**	ND	ND
Chloromethane	*	ND	ND
Cis-1,3-Dichloropropene	*	ND	ND
Di bromochloromethane	*	ND	ND
l,l-Dichloroethane	**0.2**	ND	ND
1 2-Dichloroethane	**0.1**	ND	ND
1,I-Dichlorocthcnc	**0.4**	ND	ND
1,2-Dichloroethenc (total)	*	ND	ND
1,2-Dichloropropanc	*	ND	ND
1,3-Dicbloropropcne (trans)	*	ND	ND
Ethylbenzene	**5.5**	ND	ND
2-Hexanone	*	ND	0.0028
Methylene Chloride	**0.1**	ND	0.034
4-Methyl-2-Pentanone	**1**	ND	ND
Styrene	*	ND	ND
Tetrachloroethene	**1.4**	ND	ND
I,I,I-Trichloroethane	**0.8**	ND	ND
1,1,2-Trichloroethane	*	ND	ND
1,1,2,2-Tetrachloroethane	**0.6**	ND	ND
Toluene	**1.5**	ND	ND
Trichloroethene	**0.7**	ND	ND
Vinyl Chloride	**0.2**	ND	ND
Xylenes (Total)	**1.2**	ND	ND

* Contaminants with an”*” do not have individual limits in the NYSDEC’s TAGM 4046. The total of all TCL volatile organic compounds, however, shall not exceed the maximum allowable concentration listed above as Total VOCs.

Table 10.7

QC Contract Specification Topsoil Chemical Testing Results Summary			
Semi-Volatile Organic Contaminants			
Acceptance Criteria		**MIN**	**MAX**
Contaminant	**Soil Use Criteria (mg/kg or ppm)**		
Total SVOCs	**500**	ND	ND
Total CPAHs	**10 ****	ND	0.831
Accnaphthene	**50**	ND	ND
Acenaphthylene	**41**	ND	ND
Anthracene	**50**	ND	ND
Benzo(g,h,i)perylene	**50**	ND	0.097
Benzo(k)fluoranthene	**1.1**	ND	0.185
bis(2-ethylhexyl)phthalate	**50**	ND	0.309
bis-(2-Chloroethyl)ether	**0.58***	ND	ND
bis-(2-	**50**	ND	ND
4-Bromophenylphenylether	**50**	ND	ND
Butyl benzylphthalate	**50**	ND	0.38
Carbazole	**32***	ND	ND
4-Chloroaniline	**0.220 or MDL**	ND	ND
4-Chloro-3-methylphenol	**0.240 or MDL**	ND	ND
2-Chlorophenol	**0.8**	ND	ND
4 Chlorophenylphenylether	**50**	ND	ND
2 Chloronaphthalenc	**50**	ND	ND
2,4-Dinitrotoluene	**50**	ND	ND
Dibenzofuran	**6.2**	ND	ND
1,2-Dichlorobenzene	**50**	ND	ND
1,3-Dichlorobenzene	**50**	ND	ND
1,4-Dichlorobenzene	**50**	ND	ND
Diethylphthalate	**7.1**	ND	ND
Dimethylphthalate	**2.0**	ND	0.334
Di-n-butylphthalate	**8.1**	ND	ND
Di-n-octylphthalatc	**50**	ND	0.0485
Fluoranthene	**50**	ND	0.282
Fluorene	**50**	ND	ND
Hexachlorobenzene	**0.41**	ND	ND
Hexachlorobutadienc	**8.2***	ND	ND
Hexachloroethane	**46***	ND	ND
Hexachlorocyclopentadiene	**50**	ND	ND
Isophorone	**4.4**	ND	ND
2-Methylnaphthalene	**36.4**	ND	ND
2-Methylphenol	**0.100 or MDL**	ND	ND
4-Methylphenol	**0.9**	ND	ND
Naphthalene	**13**	ND	ND
Nitrobenzene	**0.200 or MDL**	ND	ND
2-Nitroaniline	**0.430 or MDL**	ND	ND
4 Nitroanilinc	**50**	ND	ND
2-Nitrophenol	**0.330 or MDL**	ND	ND

4-Nitrophenol	**0.100 or MOL**	ND	ND
3-Nitroaniline	**0.500 or MDL**	ND	ND
N-Nitroso-di-n-propylamine	**0.091***	ND	ND
N-Nitrosodiphenylamine	**50**	ND	ND
3,3'• Dichlorobenzidine	**1.4***	ND	ND
2,4-Dichlorophenol	**0.4**	ND	ND
4,6 Dinitro-2-methyiphenol	**50**	ND	ND
2,4-Dimethylphenol	**50**	ND	ND
2,4-Dinitrophenol	**0.200 or MDL**	ND	ND
2,6-Dinitrotoluene	**1**	ND	ND
2,2'-oxybis(1-Chloropropane)	**50**	ND	ND
Pentachlorophenol	**1.0 or MDL**	ND	ND
Phenanthrene	**50**	ND	0.155
Phenol	**0.03 or MDL**	ND	ND
Pyrene	**50**	ND	1.6
1,2.4-Trichlorobenzene	**50**	ND	ND
2,4,5-Trichlorophenol	**0.1**	ND	ND
2,4.6-Trichlorophenol	**50**	ND	ND

* Contaminants with an”*” do not have individual limits in the NYSDEC’s TAGM 4046. The total of all TCL volatile organic compounds, however, shall not exceed the maximum allowable concentration listed above as Total VOCs.

Table 10.8

QC Contract Specification Topsoil Chemical Testing Results Summary			
Organic Pesticides and PCBs			
Acceptance Criteria		MIN	MAX
Contaminant	**Soil Use Criteria (mg/kg or ppm)**		
Total Pesticides	**10 ppm**	ND	ND
Aldrin	**0.041**	ND	0.0018
alpha-BHC	**0.11**	ND	ND
E0rine aldehyde	*****	ND	ND
Alpha-chlordane	*****	ND	0.00401
beta-BHC	**0.2**	ND	ND
delta-BHC	**0.3**	ND	ND
4,4'-DDD	**2.9**	ND	0.0029
4,4'-DDE	**2.1**	ND	0.00216
4,4'-DDT	**2.1**	ND	0.00223
Dieldrin	**0.044**	ND	0.0099
E0osulfan 1	**9**	ND	ND
E0osulfan II	**0.9**	ND	ND
E0osulfan sulfate	**1**	ND	ND
E0rin	**0.1**	ND	ND
E0rin ketone	**N/A**	ND	ND
Gamma-BHC (Li0ane)	**0.06**	ND	0.00086
Gamma-chlordane	**0.54**	ND	0.0064
Heptachlor	**0.1**	ND	ND
Heptachlor epoxide	**0.02**	ND	0.0011

Methoxychlor	*****	ND	ND
Total PCBs	**1**	ND	ND
Toxaphene	*****	ND	ND

* Contaminants with an"*" do not have individual limits in the NYSDEC's TAGM 4046. The total of all TCL volatile organic compounds, however, shall not exceed the maximum allowable concentration listed above as Total VOCs.

Table 10.9

QC Contract Specification Topsoil Chemical Testing Results Summary			
Heavy Metals, Asbestos, and Conventionals			
Acceptance Criteria		MIN	MAX
Contaminant	**Soil Use Criteria (mg/kg or ppm)**		
Aluminum	**33,000**	ND	5070
Antimony	**5.1**	ND	0
Arsenic	**7.5**	ND	6.18
Barium	**300**	ND	19.1
Beryllium	**0.55**	ND	0
Cadmium	**1**	ND	1.88
Chromium	**25**	ND	44.3
Cobalt	**30**	ND	4.08
Copper	**30.6**	ND	10.9
Cyanide	**3.9**	ND	0
Iron	**26,000**	ND	22100
Lead	**400**	ND	11.3
Manganese	**550**	ND	102
Mercury	**0.2**	ND	0
Nickel	**23**	ND	5.8
Selenium	**2**	ND	1.47
Silver	**200**	ND	0.661
Thallium	**20**	ND	0
Vanadium	**150**	ND	62.6
Zinc	**75**	ND	76
Asbestos Fiber Content	**1% (by weight)**	ND	0
pH	**5.5 -7.5**	ND	7.23
Sulfides	**50,000**	ND	0
Ammonia	**40**	ND	33.7

Table 10.10

QC Type 'A' Topsoil Agricultural Testing Results Summary				
Requirements	Acceptance Criteria		MIN[1]	MAX[1]
	A minimum of 75% of the samples provided will meet or exceed criteria (02925) shown below	A maximum of 25% of the samples provided can exceed the specified criteria (02925) to the limits shown below		
Estimated In Place Bulk Density	1.0 - 1.4 (g/cm^3)	1.0 - 1.4 (g/cm^3)	1.0<x<1.4	1.0<x<1.4
Maximum Grain Size Gradation	1.5 inches	1.5 inches	<1.5	<1.5
% Organic Content LOI	2.5% to 5.0%	2% to 5%	3.1	5.2
pH	5.0 to 7.0	5.0 to 7.0	5.9	6.9
Acid Producing (iron sulfide)[2] Test NJDEP, 12/2008	pH > 4.5	pH > 4.5	5.87	6.84
USDA Soil Classification	Loamy Sand	Loamy Sand/ Sandy Loam	Loamy Sand/ Sandy Loam	Loamy Sand/ Sandy Loam
% Gravel Content (2" to 2.0mm)	0.0% to 8.0 %	0.0% to 15 %	0	5.02
% Sand Content (2.0mm to 0.05mm)	70.0% to 85.0%	60% to 85.0%	76.4	84.4
% Silt Content (0.05mm to 0.002mm)	10.0% to 15.0%	5% to 25%	5.6	12.8
% Clay Content (< 0.002mm)	5.0% to 15.0%	5% to 20%	4.8	14.8
Very Coarse Sand (Reportable Value Required) %	2.0mm to 1.0mm	2.0mm to 1.0mm	2.71	7.01
Coarse Sand (Reportable Value Required) %	1.0mm to 0.5mm	1.0mm to 0.5mm	6.42	18.44
Medium (Reportable Value Required) %	0.5mm to 0.25mm	0.5mm to 0.25mm	10.24	33.8
Fine (Reportable Value Required) %	0.25mm to 0.1mm	0.25mm to 0.1mm	14.69	51.79
Very Fine (Reportable Value Required) %	0.1mm to 0.05mm	0.1mm to 0.05mm	1.97	21.8
Soluble Salts	0 to 0.4 mmhos/cm	0 to 0.4 mmhos/cm	0.13	0.4
Kjeldahl Nitorgen (%)	0.06% to 0.15%	0.06% to 0.15%	0.047	0.127
NO_3 Nitrate	< or = 12 ppm	< or = 15 ppm	1	9
Total (Mg+K+Ca)[1]	< or = 2000 lb/acre	< or = 2500 lb/acre	603	4344
P (Phosphorus)[1]	45 lb/acre to 80 lb/acre	45 lb/acre to 80 lb/acre	30	236
K (Potassium)[1]	100 lb/acre to 225 lb/acre	100 lb/acre to 225 lb/acre	90	312
Mg (Magnesium)[1]	200 lb/acre to 300 lb/acre	200 lb/acre to 300 lb/acre	230	464
Ca (Calcium)[1]	400 lb/acre to 2000 lb/acre	400 lb/acre to 2000 lb/acre	177	3670
MN (Manganese)[1]	2 ppm to 20 ppm	2 ppm to 20 ppm	9	32
B (Boron)[1]	0.8 ppm to 3 ppm	0.8 ppm to 3 ppm	0.7	10.6
Cu (Copper)[1]	0.1 ppm to 4 ppm	0.1 ppm to 4 ppm	1	3.6
Zn (Zinc)[1]	1 ppm to 12 ppm	1 ppm to 12 ppm	4.6	14.1

[1] All variances where reviewed and accepted by the Resident Engineer, Site Ecological Restoration Specialist and NYCDEP.

Table 10.11

QC Type 'A' Topsoil Chemical Testing Results Summary			
Volatile Organic Contaminants			
Acceptance Criteria		**MIN**	**MAX**
Contaminant	**Soil Use Criteria (mg/kg)**		
Total VOCs	**10**	ND	ND
Acetone	**0.2**	0.0028	0.028
Benzene	**0.06**	ND	ND
Bromodichloromethane	*	ND	ND
Bromofonn	*	ND	ND
Bromomethane	*	ND	ND
2-Butanone	**0.3**	ND	ND
Carbon Disulfide	**2.7**	ND	ND
Carbon Tetrachloride	**0.6**	0.0108	0.0108
Chlorobenzene	**1.7**	ND	ND
Chloroethane	**1.9**	ND	ND
ChlorofOlTIl	**0.3**	ND	ND
Chloromethane	*	ND	ND
Cis-1,3-Dichloropropene	*	ND	ND
Di bromochloromethane	*	ND	ND
l,l-Dichloroethane	**0.2**	ND	ND
1 2-Dichloroethane	**0.1**	ND	ND
1,I-Dichlorocthcnc	**0.4**	ND	ND
1,2-Dichloroethenc (total)	*	ND	ND
1,2-Dichloropropanc	*	ND	ND
1,3-Dicbloropropcne (trans)	*	ND	ND
Ethylbenzene	**5.5**	ND	ND
2-Hexanone	*	ND	ND
Methylene Chloride	**0.1**	0.00202	0.0107
4-Methyl-2-Pentanone	**1**	ND	ND
Styrene	*	ND	ND
Tetrachloroethene	**1.4**	ND	ND
I,I,I-Trichloroethane	**0.8**	ND	ND
1,1,2-Trichloroethane	*	ND	ND
1,1,2,2-Tetrachloroethane	**0.6**	ND	ND
Toluene	**1.5**	ND	ND
Trichloroethene	**0.7**	ND	ND
Vinyl Chloride	**0.2**	ND	ND
Xylenes (Total)	**1.2**	ND	ND

* Contaminants with an"*" do not have individual limits in the NYSDEC's TAGM 4046. The total of all TCL volatile organic compounds, however, shall not exceed the maximum allowable concentration listed above as Total VOCs.

Table 10.12

QC Type 'A' Topsoil Chemical Testing Results Summary			
Semi-Volatile Organic Contaminants			
Acceptance Criteria		**MIN**	**MAX**
Contaminant	**Soil Use Criteria (mg/kg or ppm)**		
Total SVOCs	**500**	ND	ND
Total CPAHs	**10 ** **	ND	ND
Accnaphthene	**50**	ND	ND
Acenaphthylene	**41**	ND	ND
Anthracene	**50**	ND	ND
Benzo(g,h,i)perylene	**50**	ND	ND
Benzo(k)fluoranthene	**1.1**	ND	ND
bis(2-ethylhexyl)phthalate	**50**	ND	ND
bis-(2-Chloroethyl)ether	**0.58***	ND	ND
bis-(2-Chloroethoxy)methane	**50**	ND	ND
4-Bromophenylphenylether	**50**	ND	ND
Butyl benzylphthalate	**50**	ND	ND
Carbazole	**32***	ND	ND
4-Chloroaniline	**0.220 or MDL**	ND	ND
4-Chloro-3-methylphenol	**0.240 or MDL**	ND	ND
2-Chlorophenol	**0.8**	ND	ND
4 Chlorophenylphenylether	**50**	ND	ND
2 Chloronaphthalenc	**50**	ND	ND
2,4-Dinitrotoluene	**50**	ND	ND
Dibenzofuran	**6.2**	ND	ND
1,2-Dichlorobenzene	**50**	ND	ND
1,3-Dichlorobenzene	**50**	ND	ND
1,4-Dichlorobenzene	**50**	ND	ND
Diethylphthalate	**7.1**	ND	ND
Dimethylphthalate	**2.0**	0.0643	0.0643
Di-n-butylphthalate	**8.1**	ND	ND
Di-n-octylphthalatc	**50**	ND	ND
Fluoranthene	**50**	ND	ND
Fluorene	**50**	0.044	0.0466
Hexachlorobenzene	**0.41**	ND	ND
Hexachlorobutadienc	**8.2***	ND	ND
Hexachloroethane	**46***	ND	ND
Hexachlorocyclopentadiene	**50**	ND	ND
Isophorone	**4.4**	ND	ND
2-Methylnaphthalene	**36.4**	ND	ND
2-Methylphenol	**0.100 or MDL**	ND	ND
4-Methylphenol	**0.9**	ND	ND
Naphthalene	**13**	ND	ND
Nitrobenzene	**0.200 or MDL**	ND	ND
2-Nitroaniline	**0.430 or MDL**	ND	ND
4 Nitroanilinc	**50**	ND	ND
2-Nitrophenol	**0.330 or MDL**	ND	ND
4-Nitrophenol	**0.100 or MOL**	ND	ND

3-Nitroaniline	**0.500 or MDL**	ND	ND
N-Nitroso-di-n-propylamine	**0.091***	ND	ND
N-Nitrosodiphenylamine	**50**	ND	ND
3,3'• Dichlorobenzidine	**1.4***	ND	ND
2,4-Dichlorophenol	**0.4**	ND	ND
4,6 Dinitro-2-methyiphenol	**50**	ND	ND
2,4-Dimethylphenol	**50**	ND	ND
2,4-Dinitrophenol	**0.200 or MDL**	ND	ND
2,6-Dinitrotoluene	**1**	ND	ND
2,2'-oxybis(1-Chloropropane)	**50**	ND	ND
Pentachlorophenol	**1.0 or MDL**	ND	ND
Phenanthrene	**50**	ND	ND
Phenol	**0.03 or MDL**	ND	ND
Pyrene	**50**	0.0423	0.0522
1,2.4-Trichlorobenzene	**50**	ND	ND
2,4,5-Trichlorophenol	**0.1**	ND	ND
2,4.6-Trichlorophenol	**50**	ND	ND

* Contaminants with an”*” do not have individual limits in the NYSDEC’s TAGM 4046. The total of all TCL volatile organic compounds, however, shall not exceed the maximum allowable concentration listed above as Total VOCs.

Table 10.13

QC Type 'A' Topsoil Chemical Testing Results Summary			
Organic Pesticides and PCBs			
Acceptance Criteria		**MIN**	**MAX**
Contaminant	**Soil Use Criteria (mg/kg or ppm)**		
Total Pesticides	**10 ppm**	ND	ND
Aldrin	**0.041**	ND	ND
alpha-BHC	**0.11**	ND	ND
Endrine aldehyde	*****	ND	ND
Alpha-chlordane	*****	0.00125	0.0318
beta-BHC	**0.2**	ND	ND
delta-BHC	**0.3**	ND	ND
4,4'-DDD	**2.9**	ND	ND
4,4'-DDE	**2.1**	ND	ND
4,4'-DDT	**2.1**	ND	ND
Dieldrin	**0.044**	0.0021	0.0021
Endosulfan 1	**9**	ND	ND
Endosulfan II	**0.9**	ND	ND
Endosulfan sulfate	**1**	ND	ND
Endrin	**0.1**	ND	ND
Endrin ketone	**N/A**	ND	ND
Gamma-BHC (Lindane)	**0.06**	ND	ND
Gamma-chlordane	**0.54**	0.00119	0.00328
Heptachlor	**0.1**	ND	ND
Heptachlor epoxide	**0.02**	v	0
Methoxychlor	*****	0	0
Total PCBs	**1**	0	0
Toxaphene	*****	0	0

* Contaminants with an”*” do not have individual limits in the NYSDEC’s TAGM 4046. The total of all TCL volatile organic compounds, however, shall not exceed the maximum allowable concentration listed above as Total VOCs.

Table 10.14

QC Type ‘A’ Topsoil Chemical Testing Results Summary			
Heavy Metals, Asbestos, and Conventionals			
Acceptance Criteria		**MIN**	**MAX**
Contaminant	**Soil Use Criteria (mg/kg or ppm)**		
Aluminum	**33000**	1270	2980
Antimony	**5.1**	ND	ND
Arsenic	**7.5**	1.32	4.14
Barium	**300**	7.16	14.2
Beryllium	**0.55**	ND	ND
Cadmium	**1**	ND	ND
Chromium	**25**	6.74	18.5
Cobalt	**30**	0.778	0.941
Copper	**30.6**	2.68	6.52
Cyanide	**3.9**	ND	ND
Iron	**26000**	3870	7110
Lead	**400**	3.48	6.94
Manganese	**550**	16.6	145
Mercury	**0.2**	ND	ND
Nickel	**23**	0.88	2.43
Selenium	**2**	ND	ND
Silver	**200**	ND	ND
Thallium	**20**	ND	ND
Vanadium	**150**	7.13	21.8
Zinc	**75**	9.34	30.9
Asbestos Fiber Content	**1% (by weight)**	ND	ND
pH	**5.5 -7.5**	6.32	7.43
Sulfides	**50,000**	ND	ND
Ammonia	**40**	5.63	30

10.5 Seeding

Seed mixture and application rates conformed to the “Seed Mixture” Tables of the Contract Specifications. BCA submitted certificates attesting that the seed mixture was composed of the specified varieties and proportions as called for in the Detailed Specifications. Refer to Appendix H, titled ‘Topsoil Testing Results’ for a copy of the seed mixture certificate of compliance.

Seed mixed prior to delivery was approved on the basis of a certification by the vendor stating the minimum percentage of germination and variety of each kind of seed, and the quantity of each kind of seed in the mixture. This was redone annually for each crop of seed.

Areas to be seeded were scarified sufficiently to break up the surface crust immediately before seeding except where the ground was loose and subject to rolling or sliding. Rocks, debris and all other objects were removed.

Organic biofertilizer was applied to the areas of seeding. Biofertilizer for warm-season grasses and wildflowers was provided at a minimum of 200 pounds per acre of Plant Health Care's "Healthy Start" (3-4-3) in accordance with the Contract Specifications.

Seed was mechanically placed by a Trillion drill seeder. Calibration of the Trillion drill seeder was completed for each seeding application onsite in accordance with the manufacturer's recommendations. When the Trillion drill seeder was used, the seed was not to be planted any deeper than one-quarter of an inch. The seed was applied prior to and in a separate operation from placement of erosion control Fabric (mats). Any non-growing areas observed after growth of the grass were re-seeded. All seeded areas were immediately covered with erosion control fabric (mats).

10.6 Erosion Control Fabric

Subsequent to the seeding installation, all seeded areas on the landfill received erosion control fabric in accordance with the approved plans and technical specifications. Erosion control fabric was Curlex I as manufactured by American Excelsior Company or approved equal, which is pure straw product and is 100% biodegradeable. All Erosion control fabric was installed in accordance with the manufacturer's installation instructions.

11.0 WETLANDS SAND

11.1 General

Installation of topsoil per original contract specifications made no differentiation between topsoil used for uplands and wetlands. During the review process, changes were made to specify more appropriate soil types suitable for a wetlands environment. Contract Change Order 1G-4 ‘Modification of Cover Soil Specifications and Revised Placement Plan’, established two additional topsoil types. These types were designated as Wetland Sand (Freshwater) and Wetlands Sand (Salt Marsh). Both types were specified to meet agricultural and geotechnical requirements that were applicable to a freshwater wetland environment and for a salt marsh environment. No change was made to the general chemistry requirements of the Contract.

11.2 Material Source – Wetlands Sand

Wetland Sand was a manufactured soil formulated specifically to meet the chemical, geotechnical and agricultural parameters of the Contract. Both Wetland Sand types were free of refuse, hard clods, woody vegetation, construction debris, boulders, stones larger than one and one-half inches, hydrocarbons, petroleum materials or chemicals toxic to plants, and other miscellaneous or otherwise unstable or undesirable materials. Refer to the Quality Assurance and Quality Control section below for material testing details and Appendix H, titled ‘Topsoil Testing Results’ for material testing results.

The 124,830 tons of Wetland Sand was imported for this project. Of the 124,830 tons of Wetland Sand provided, 80,600 tons was specified for the Freshwater Wetlands which was manufactured and supplied to the Brookfield Avenue Landfill by Clayton Sand, of Jackson, New Jersey and 44,230 tons was specified for the Salt Marsh Wetlands and was provided by Amboy Aggregates of South Amboy, NJ.

11.3 Installation – Wetlands Sand

Approved Wetland Sand was received via truck and stockpiled or directly placed within the surveyed and demarcated wetlands limits. Sand delivered to the site was continuously inspected by the CM during placement, to ensure material consistency and placement procedures were followed.

Perimeter wetlands were excavated down to Contract specified subgrade elevations and verified by survey prior to being backfilled with Wetland Sand. For interior wetlands, those wetlands constructed on the cap, no Wetland Sand was permitted to be placed until the underlying geosynthetics was approved by QA personnel and the CM.

Wetland Sand was evenly placed with LGP bulldozers within the limits of the final cover for the wetlands construction on the cap as well as to the limits of the wetlands work areas on the perimeter wetlands. Grade stakes were used on a limited basis along with GPS guidance systems attached to the LGP bulldozer blades to ensure that the proper lift levels were achieved including the creation of plant islands with the wetland areas in accordance with the approved wetlands drawings.

11.4 Quality Assurance/Quality Control

All Wetland Sand sources used on the project were tested and approved by the QA/QC requirement of the Specifications prior to arrival at the Brookfield Avenue Landfill. Prior to procuring any material or starting construction, the QA Site Manager reviewed and verified the submittal and sample information provided by the Contractor QC team. In addition, the QA Site Manager made field trips to the borrow source to verify material to be provided by the Contractor is representative of the proposed material at the source.

The CM geotechnical inspector performed periodic QA testing at a frequency of one test every 15,000 CY delivered to the site. Samples from the borrow site, were all sent to the QA Laboratory to perform the following conformance and frequency testing for the imported material:

- Organic content analyses conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware. Bulletin #493, 12/95);

- USDA soil texture gradation (sand, silt and clay) analyses and sand sieve analyses, with full reporting of all information in USDA sieve sizes, in accordance with the Soil Survey Laboratory Methods Manual (No. 42, November 2004);
- pH tests conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States," 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95);
- Soluble salts test conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition;
- Nutrient analyses test conducted in accordance with the referenced standard (Soil Testing Procedures for The Northeastern United States, 2nd Edition, Northeast Regional Publication, Agricultural Experiment Station, University of Delaware, Bulletin #493, 12/95);
- Inorganic nitrogen and total Kjedahl nitrogen tests conducted in accordance with the methodologies utilized by the Northeast Coordinating Committee on Soil Testing, NEC-67;
- Acid-producing (iron sulfide) test conducted in accordance with the methodologies utilized by the Northeast Coordinating Committee on Soil Testing, NEC-67;
- Chemical analyses conducted in accordance with Detailed Specification section 02108 – Chemical Testing of Soil;

If changes in material occurred, then the QA Geotechnical Inspector informed the QA and QC Site Managers. All rejected work was reworked by the Contractor using the new material until the construction QA and QC procedures were correctly executed and approved by the QA Site Manager at the expense of the Contractor.

All QA laboratory and field testing was performed by the approved independent chemical laboratories and geotechnical laboratories, employed by CM. Chemical analyses were provided by Accutest Laboratory, located in Dayton, New Jersey. Geotechnical analysis for QA was performed by RSA Geo Soil Testing Laboratory in Totowa, NJ and Gentech of Cliffwood Beach, NJ. QA and QC testing was performed in accordance with Table 11.1 below. QA inspection and testing was performed by the QA team to verify the QC testing. In addition, QA Geotechnical Inspectors visually and periodically inspected the material delivered to the site to ensure consistency. Refer to Appendix H, titled 'Topsoil Testing Results' for all geotechnical, chemical and field test results.

All agricultural testing procedures were performed in accordance with the standards and methodologies utilized by the Northeast Coordinating Committee on Soil Testing, NEC-67 *Soil Survey Laboratory Methods Manual (No. 42, November 2004)* in accordance with the Contract Specifications.

As delivery of Wetland Sand to the site progressed, the QC testing continued on the sand at the frequency of testing of one for every 2,500 CY delivered in accordance with the Contract Specifications. Results of tests were submitted for QA review and approval. The Contractor QC personnel were required to submit all Wetland Sand thickness measurements, after such measurements were verified by the QA Site Manager.

All QC laboratory (chemical and geotechnical) and field testing were performed by the approved independent chemical laboratories and approved independent geotechnical laboratories, employed by Contractor. Chemical analyses were provided by Accredited Laboratories, Inc., located in Carteret, New Jersey and Chemtech, of Mountainside, New Jersey. Geotechnical analyses were provided by French and Parrillo Laboratories, Inc., located in New Jersey. Nutrient analyses were provided by A&L Eastern Agricultural Laboratories located in Richmond, Virginia. Periodic quality control was performed by the contractor in accordance with Table 11.1 below.

Table 11.1

Wetland Sand Geotechnical Specification		
Parameters	**Freshwater Requirements**	**Salt Marsh Requirements**
pH	5.0 to 7.0	5.0 to 8.5
% Passing # 4 Sieve	> 50%	> 50%
% Passing # 40 Sieve	< 70%	< 70%
Soluble Salts	0 to 0.40 mmhos/cm	No Requirement

12.0 COMMUNITY AIR MONITORING PLAN

12.1 Community Air Monitoring Plan (CAMP)

Section 01102 0f the Contract Specifications required that the Contractor prepare a Community Air Monitoring Plan (CAMP) to cover all remediation onsite work. This plan, which was prepared by the Contractor and approved by the NYCDEP, the NYSDEC and the NYS Department of Health (NYSDOH) established in detail the protocols necessary for preventing, recognizing, evaluating, and controlling emissions associated with each construction task performed.

As per the Specifications, the CAMP addressed the following:

- Control of airborne contaminant emissions;
- Air quality monitoring procedures;
- Descriptions of the air quality equipment to be used;
- Organizational structure of the program indicating personnel responsibilities;
- Plans for response if unacceptable air quality occurred;

As per the Specifications, the CAMP included the 10 specified Perimeter Air Monitoring Stations at which sampling platforms were constructed for the collection of continuous air samples using fixed monitoring equipment for dust and Total Organic Vapor (TOV). These CAMP monitoring stations were properly protected and secured to maintain the integrity of the data obtained.

Also as part of the CAMP, the Contractor furnished and maintained a meteorological station onsite to provide continuous observation and recording of wind speed, wind direction, ambient air temperature, atmospheric pressure, atmospheric humidity, solar insolation, and precipitation. The station maintained temperature and rainfall gauges with a continuous readout.

In addition to this continuous measurement of dust and TOV, the CAMP included the collection of Integrated Air Monitoring samples once per month at the 10 CAMP stations. These samples were analyzed by a NYSDEC-approved laboratory for the specific components of TOV and dust, including polycyclic aromatic hydrocarbons and metals.

12.2 CAMP Reporting

The continuous air monitoring results were summarized by the Contractors Air Quality Specialist and submitted to DEP for review on a weekly basis. These reports included:

- Date and time of monitoring;
- Air monitoring location;
- Monitoring instrument, model number, serial number;
- Calibration/background levels;

- Results of monitoring;
- AQS / Air Monitoring Sampling Technician signatures;
- Discussion of results;

Similarly, The Integrated Air Monitoring results were summarized on a monthly basis, including all laboratory analytical data.

After review by DEP, these reports were forwarded to NYSDEC and NYSDOH for review and approval. Copies of each report were also sent to the Citizens Advisory Committee for this project.

A summary report, including copies of all daily and monthly monitoring reports for the project, will be submitted to NYSDEC under separate cover.

12.3 Results

The NYSDEC and NYSDOH reviewed each monitoring report as they were submitted, and concluded for each that the remediation construction activities for this project had no adverse environmental impacts to the surrounding community.

13.0 COARSE AGGREGATE AND RIPRAP

13.1 General

The coarse aggregate and riprap utilized for this project were incorporated into the design to control erosion on some steeper side slopes sections, around drainage outlets and outflow locations and to ensure proper flow lines along high flow swales and channels.

13.2 Material Source - Quality Control

All the coarse aggregate and riprap materials utilized for the Landfill closure were environmentally clean stone and in conformance with the Contract Specifications. The coarse aggregate and riprap were tested and approved as per the QA/QC requirements of the Specifications prior to being imported for use at the Brookfield Avenue Landfill.

For NYSDOT based material items, quarry NYSDOT certifications and/or laboratory test results were submitted, attesting that all NYSDOT and Contract requirements were met prior to transporting the material to the project.

QA Geotechnical Inspectors visually and periodically inspected the material delivered to the site to ensure consistency. NYCDEP and URS inspected the borrow site prior to acceptance and procurement. All coarse aggregate and riprap material was delivered to the Brookfield Avenue Landfill via truck transportation. All certifications and Laboratory Tests Results are in Appendix I, titled ‘Coarse Aggregate and Rip Rap’.

13.3 Installation and Placement

Medium sized rip rap and 3”-5” stone were used on perimeter slopes, drainage outfall aprons, West Cell south side rip rap slope erosion control, East Cell south side rip rap erosion control slope (near pond), general riprap erosion control, drainage channels in East Cell and other areas as shown on the Contract drawings and as directed by the Resident Engineer. All coarse aggregate and riprap were installed in prepared and compacted areas on top of previously prepared subgrade and directly on installed filter fabric geotextile to ensure installation stability.

CM Quality Assurance personnel and Contractor Quality Control personnel were present at all times during delivery and placement of the coarse aggregate and riprap as well as performed required field-testing to ensure consistency.

14.0 LANDFILL MECHANICAL AND ELECTRICAL SYSTEMS

14.1 Water Main, Drainage and Sewer System

The water main that services the Brookfield Ave Landfill is located outside the Landfill on Arthur Kill Road. This main is a twenty (20) inch diameter standard NYC ductile iron pipe. This main water line was tapped and a new eight (8) inch ductile iron water main was installed from the tap north to the Flare Station compound where it terminates at two NYC FDNY approved fire hydrants for emergency use at the Flare compound. An above ground backflow preventer was installed on this line and it is located just inside the property line along Arthur Kill Road directly after the tap. This above ground backflow preventer is equipment with a heated hot box enclosure to prevent the water line from freezing during low ambient temperature periods.

Existing site utilities include an inflow sanitary sewer that feeds the Eltingville Pump Station and an outflow sanitary sewer that feeds the Oakwood Beach Treatment Facility from the Eltingville Pump Station. During construction, these sanitary sewers were protected, maintained and were not interrupted due to Landfill closure construction activities. Other existing sewers included a triple wide rectangular stormwater outflow sewer that passes through the center of the Brookfield Avenue Landfill, south to north, between the East and West cells. During construction, this stormwater outflow sewer was protected, maintained and was not interrupted due to Landfill closure construction activities.

14.2 Electrical Service

As part of the engineering controls for the Site, the contractor was required to provide and install a complete and fully functional underground, electrical system to operate and maintain Leachate Collection, Gas Collection and necessary modifications (indoor and outdoor) to the Eltingville Pump Station electrical systems to accommodate these new remedial systems.

The main power source for the Site originates from two existing service poles located near the entrance to the Landfill. Over the course of Landfill closure activities, the contractor installed a new underground electrical service for all permanent Site closure controls. There were existing utility poles onsite that supplied power to the existing Eltingville Pump Station but the service was upgraded and converted to an underground service . The above ground utility poles were removed. Power to run the flare system and leachate collection system are run via underground utility lines extended from the Eltingville Pump Station to the nearby flare station compound.

Specific electrical work performed for the remedial systems (Flare Station and Leachate Collection System) and the Eltingville Pump Station included the following:

- Removal of all overhead power lines;
- Installation of medium voltage (13kV) power duct bank from Arthur Kill Road to the Eltingville Pump Station;
- Installation of new underground electrical manholes and hand holes;
- Installation of power panels and control boards;
- Installation of grounding, ammeters, motor control center, heat trace control panel, heat tracing and heat trace insulation;
- Installation of power and control cables, conduit, combination motor starters;
- Installation of retrofit circuit breakers, circuit breaker modifications, terminal boxes, pull boxes;
- Fire Alarm system installation;
- Communication system installation;
- Interface with power utility (Con Edison)

Refer to Appendix L, titled ‘Record Drawings’ for additional information.

14.3 Communications

A new underground communications system was installed from Arthur Kill Road and terminates at the Main Control Panel and Fire Control Panel of the flare station. A fiber optic cable was run from Arthur Kill Road to the Eltingville Pump Station, a transfer box was installed at the pump station which converted the fiber optic line to a standard FDNY required copper service, then continues underground to the Main Control Panel and Fire Control Panel of the flare station to operate the three phone numbers extended to this location (one line for control panel remote communications and two lines for remote FDNY communications).

15.0 LEACHATE COLLECTION AND TREATMENT SYSTEM

15.1 General

All of the leachate generated from the Landfill is collected from a leachate collection system installed by the contractor. The leachate collection and treatment system is comprised of the following major components:

- Nine (9) leachate collection sumps – three (3) on the West Cell and six (6) on the East Cell;
- Nine (9) valve vaults – three (3) on the West Cell and six (6) on the East Cell;
- Eighteen (18) submersible leachate pumps – two (2) in each leachate collection sump;
- Four (4) leachate cleanout manholes – two (2) on the West Cell and two (2) on the East Cell;
- One (1) leachate metering manhole and Parshall Flume;
- One (1) West Cell northern perimeter leachate interceptor trench – 1,800 linear feet in length;
- One (1) West Cell northern perimeter leachate forcemain – 2,150 linear feet in length;
- One (1) East Cell northern perimeter leachate interceptor trench – 4,000 linear feet in length;
- One (1) East Cell northern perimeter leachate forcemain – 3,965 linear feet in length;
- Two (2) Parallel Oil/Water Separators;

The oil/water separator system pre-treats the generated leachate prior to being discharged to the Oakwood Beach WPCP via the Eltingville Pump Station. An ultrasonic level sensor and transmitter is used to measure the discharge flows via the Parshall Flume located in the metering manhole at the leachate system discharge point.

For an overview of the leachate collection system layout and location, refer to Appendix L, titled 'Record Drawings'.

15.2 Operation of Sumps and Process Piping Flow

Leachate is collected through the leachate interceptor trenches containing a six inch diameter HDPE perforated leachate collection pipe. The leachate within the collection pipe flows via gravity towards a leachate collection sump. Each leachate collection sump has two leachate collection trenches feeding it. Once the leachate is collected in a leachate collection sump it is then pumped via one of the two submersible leachate pumps (only one operates while the 2nd one is on standby) to a central forcemain that runs adjacent to each leachate collection sump. Once the leachate is in the forcemeain, it is pumped to the pretreatment system which consists of two parallel oil\water separators. Upon completion of the pretreatment, the leachate flows via gravity through the Parshall flume for metering and directly into the Eltingville Pump station for ultimate disposal at the Oakwood Beach WPCP.

A NYCDEP discharge permit is in place. Based on the permit, leachate samples are obtained on a monthly basis and reported to the NYCDEP on a quarterly basis. The samples are collected and analyzed for VOCs, PCBs, Oil/Grease, TPH, TSS, Flashpoint and pH. To date all collected and analyzed samples have met permit discharge requirements.

15.3 Performance Testing

Phase I and II Start-Up and Performance Testing were conducted after the system was installed. During the period of testing, the system operated 24 hours per day while meeting the discharge requirements. Water samples were collected and tested, the results were analyzed and met permit discharge requirements.

Appendix J, titled ‘Leachate Collection System’ presents the permit and discharge limitations; operation and maintenance reports as well as quarterly permit compliance reports sent to NYCDEP.

15.4 Operation and Maintenance

The system continues to operate on a 24 hours per day schedule. Routine maintenance is performed in accordance with the manufacturer's O&M manuals and preventative maintenance is performed to keep the system operating efficiently and maintain the equipment warranties.

16.0 LANDFILL GAS COLLECTION SYSTEM

16.1 General

The Brookfield Avenue Landfill closure includes the installation of an active landfill gas management system. The primary components of the Landfill Gas management system consists of a system of wells embedded into the landfill interconnected by an underground network of pipes, a gas venting layer just below the cap geomembrane, gas extraction pumps (termed "blowers"), and a landfill gas flare to combust the extracted Landfill Gas. The purpose of the LFG management system is to control odor and off-site migration of LFG as emission to the atmosphere or laterally into the unsaturated soil (or vadose zone) and groundwater. In order to comply with regulatory requirements, Landfill gas collected at the Brookfield Avenue Landfill is processed through the Flare system. Flaring involves combustion of Landfill gas at high temperatures for thermal destruction of both methane and non-methane organic compounds. A description of each of the components of the Landfill gas management system follows:

- Geocomposite Landfill Gas Venting Layer - provides for passive gas collection below the final cover, installed over the entire cap area.
- Landfill Gas Collection Wells—these wells collect Landfill gas under vacuum produced by the blowers. Located at a spacing of approximately one per acre, these wells extend vertically downward to approximately the saturated zone of the refuse.
- Landfill Gas Header Pipes—a network of non-perforated, lateral pipes which lays atop the geomembrane layer of the cover system. These pipes transmit gas collected from the wells via vacuum toward the flare station.
- Condensate Drains—located at low points along the header piping system, each drain collects liquid that condenses from the Landfill gas. This liquid is subsequently drained below the liner and released back into the Landfill.
- Landfill Gas Blowers—provide the necessary vacuum to draw Landfill gas from the extraction well field and convey it to the flare station, from which it is conveyed to the Landfill gas flare for high temperature combustion.
- Flare Station—located behind and adjacent to the Eltingville Pump Station and sited on ½-acre pad, the flare station serves as a final destination for the network of Landfill gas collection pipes prior to combusting all collected and recovered Landfill gas.

- Perimeter Landfill Gas Monitoring Wells - Landfill gas monitoring wells are distributed throughout the Landfill complex located along the Landfill perimeter and placed outside the barrier wall. These monitoring wells will be periodically sampled and analyzed for Landfill Gas parameters to monitor the effectiveness of the cap and barrier wall.

16.2 Placement of Gas Venting Layer and Installation of LFG Wells/Vaults

The Brookfield Avenue Landfills gas management system consists of the construction of the Landfill Gas Venting Layer, LFG Wells and supporting Well Vaults. The construction of the gas collection system began with the drilling of one hundred (100) gas wells (approximately one per acre) directly into the waste followed by placement of a gas venting layer (geocomposite) above the waste, directly on top of the intermediate soil layer and below the geomembrane.

All LFG extraction wells were installed within the Landfill cap at the locations and to the depths indicated on the plans and specifications. Slight changes in the depths and locations of the wells were made to accommodate existing site conditions or conflicts (such as underground boulders or harden waste material such as concrete), but did not materially affect the design intent as all the wells were installed within ten (10) feet horizontally of their original design location. Boring logs for completed LFG extraction wells are included in Appendix K, titled ‘Landfill Gas Flare Collection System’.

At completion of the installation of the LFG extraction wells, pre-constructed well vaults were installed over and around each well. These vaults were designed to encase the top of each well, its’ well head as well as accommodation for the gas collection piping to attach to the well head. Each vault consists of a reinforced fiberglass box-like structure as well as an AASHTO H-20 rated locking top lid to allow access only by authorized personnel. The whole structure is installed in such a manner that the top lid is flush with the ground surface at that location.

16.3 Installation of Gas Collection Piping and Header System

After the installation of the gas extraction wells, the contractor placed an inter-connected LFG piping network via Landfill trenches and collection pipes above the impermeable geomembrane liner and routed the collection piping through to an outdoor permanent flaring station/flare compound located just north of the Eltingville Pump station between the East and West cells of the Landfill. The LFG collection piping and header system was installed and tested in conformance to the plans and specifications using high density polyethylene (HDPE) piping, fittings and appurtenances. The contractor installed thirty one thousand, five hundred and sixty (31,560) linear feet of gas collection piping.

16.4 Installation of Landfill Gas Flare Station

The LFG Blower and Flare system and all appurtenances were installed in accordance with the plans and specifications. The initial construction consisted of sixteen (16) 60 foot long grouted piles to support the stack pad and blower pad. The flare stack and blower skid were installed on their respective pads, leveled, anchored, and grounded. Main piping, electrical connections and pilot fuel supply (propane) were installed (refer to Appendix L titled ‘Record Drawings’.

During the initial startup, a series of demonstrations and QA inspections were performed to verify the proper functioning of all the system components. During this period various subcontractors and equipment vendors performed, witnessed and verified their installation.

Equipment suppliers demonstrated the equipment capabilities, certified the equipment & instrumentation, and proper installation. The system inspection included the following:

- connections to the gas collection headers;
- a nitrogen bottle and appurtenances for the operation of the main system motorized shutoff valve**;**
- Two (2) knockout pots and their respective appurtenances;
- Two (2) two hundred (250) CFM Landfill gas blowers and their respective appurtenances;
- a stainless steel header system between the knockout pots and the flare stack;
- a 7’ diameter, 50’ high, stainless steel, flare stack and respective appurtenances;
- a flare control panel, rack and supports to include connections to the power supply;
- a flame arrestor, gas analysis cabinet**,** (2) ultra violet flame detectors**,** (8) combustible gas indicators and respective appurtenances;
- FDNY fire alarm panel with one manual pull station linked to a central station monitoring unit for fire alarm notification.

16.5 Phase I Operations Start-Up

Phase I startup included the initial operation of individual pieces of equipment associated with the gas collection and flare system and was intended to demonstrate that the equipment was installed properly and is operating satisfactorily. Equipment operation demonstrated in Phase I included the blower equipment skid, connecting header-line piping and valves, well field header-line and lateral piping, vertical and horizontal extraction wells, and condensate collection systems. Throughout the construction period, the QA/QC team inspected and tested the individual pieces of equipment as required by the manufacturers during installation. Collection system components were energized and inspected for proper operation. After review of all certifications and review of test data by the Resident Engineer, the Phase I Operation Startup period was concluded via an approval letter and direction to proceed with Phase II Operations Start-Up from the Resident Engineer.

16.6 Phase II Operations Start-Up

Following approval of Phase 1 Operations Start-Up, Phase 2 Operations Start-Up commenced which includes a trial operations period as well as the initial stack test.

Phase II operations start-up demonstrated that the flare station and LFG collection system components operated properly under long-term conditions. As part of Phase II Operations Start-Up the gas collection system was adjusted to produce a balance between the production and collection of' LFG. Upon receipt and review of the initial stack test results and all required test data, Phase II Operations Start-Up was completed and approved by the Resident Engineer via letter on December 31st, 2013. The results from initial stack test are in Appendix K, titled 'Landfill Gas Flare Collection System'.

16.7 Operation Period

After approval of Phase II operational period, the flare continues to operate. During this period, (2) additional Flare Stack Testing will be performed in accordance with the Contract requirements. Compliance monitoring, operation, and maintenance activities continues in accordance with Contract requirements. The LFG extraction wells continued to be monitored and adjusted once each month as part of the on-going OM&M plan.