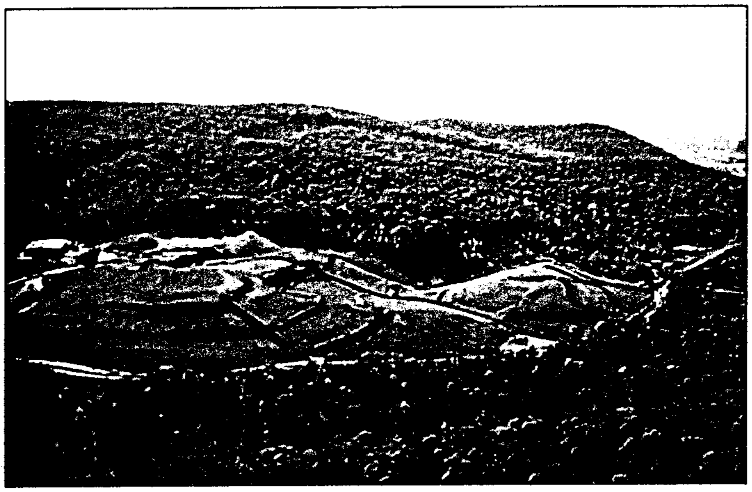
Construction Monitoring Report
Ramapo Landfill Remediation



NYSDEC SITE NO. 3-44-004

prepared for:

THE TOWN OF RAMAPO
RAMAPO, NEW YORK

prepared by:

URS GREINER, INC.
282 DELAWARE AVENUE
BUFFALO, NEW YORK 14202

DECEMBER 1998

CONSTRUCTION MONITORING REPORT
RAMAPO LANDFILL REMEDIATION
TOWN OF RAMAPO, NEW YORK

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RECORD DRAWINGS

1.0 INTRODUCTION

1.1 Background

The Ramapo Landfill is located on a 96-acre tract own of Ramapo, Rockland County, New York. It lies at the base of the Ramapo Mountains, 5 miles northwest of New York City. Over 50 acres of the site have been used for landfill act Refer to Figures 1, 2, and 3.

Prior to landfill operations, portions of the site cavated as a source of gravel in the 1950s and 1960s. In 1971, the Rockland County Departn Health granted a permit to the Town of Ramapo for the operation of a sanitary landfill. M al waste was accepted unti 984. construction and demolition debris until 1989.

The filled portion of the landfill occurs in two m oes (northern and southe which slope steeply to the west toward Torne Brook, a Class B wa nd the Ramapo River. Tor rook is a tributary of the Ramapo River, a Class A water. At its point approach, the Rama River lies approximately 300 feet from the southwest corner o ite. Groundwater is withd n for potable use from areas south and west of the site. Water su wells, operated by United W of New York/New Jersey and serving a population of over 2 00, are located across the Ramapo River both upstream and downstream of the site. Four of these wells are located within 1,500 feet of the landfill. In addition, two residential wells, supplying a total of approximately 55 residents, are located within 1,200 feet of the site, the closest of which is approximately 400 feet from the limits of landfill waste.

The Town of Ramapo (the Town) constructed a leachate collection and treatment system along the downgradient (western) edge of the landfill in 1984 and 1985. Surface water and groundwater were conveyed to a wastewater treatment pond on site, allowed to settle and aerate, and discharged to the Ramapo River. Beginning in 1990, the collected wastewater was discharged to the Village of Suffern Wastewater Treatment Plant.

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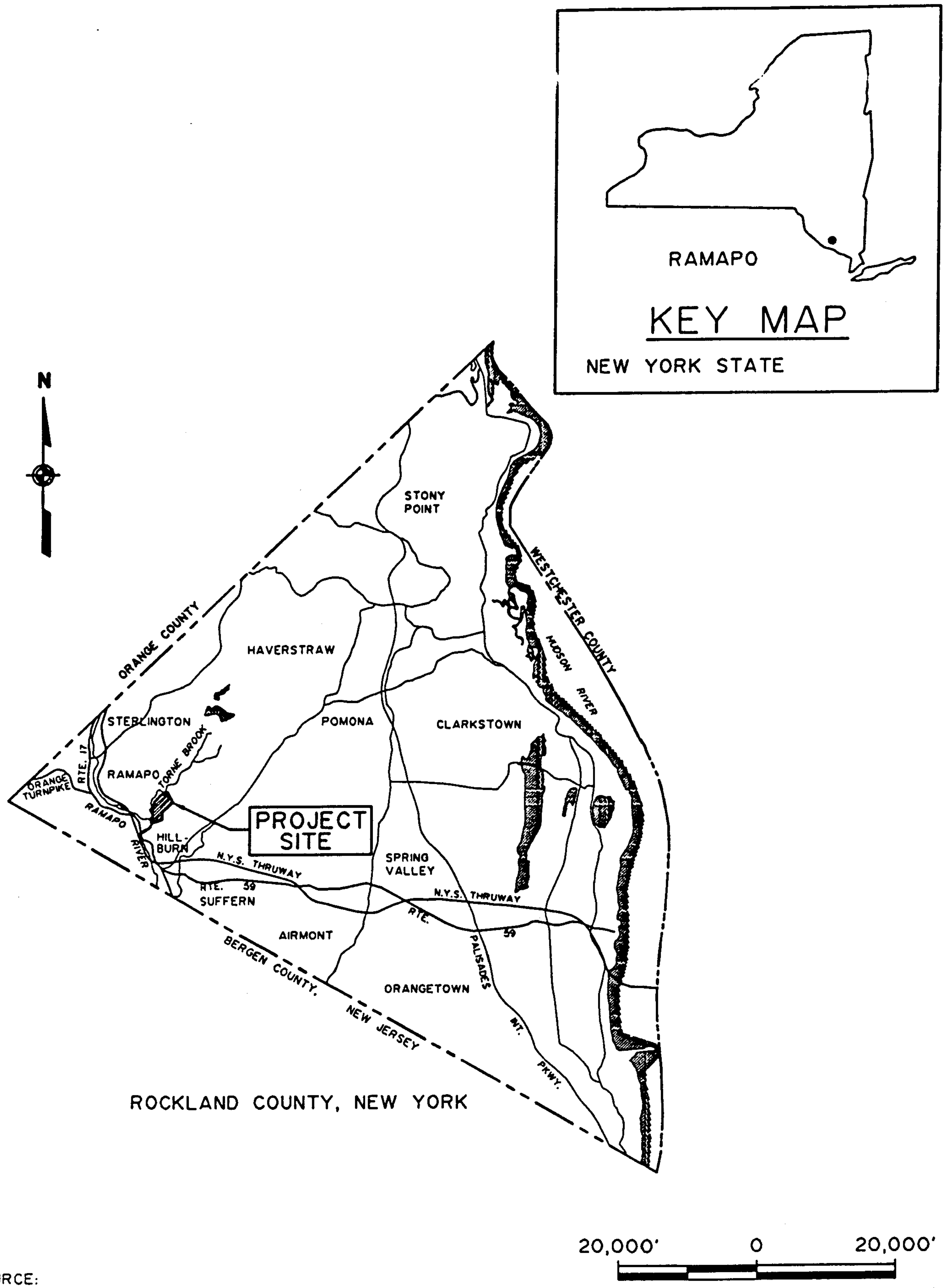


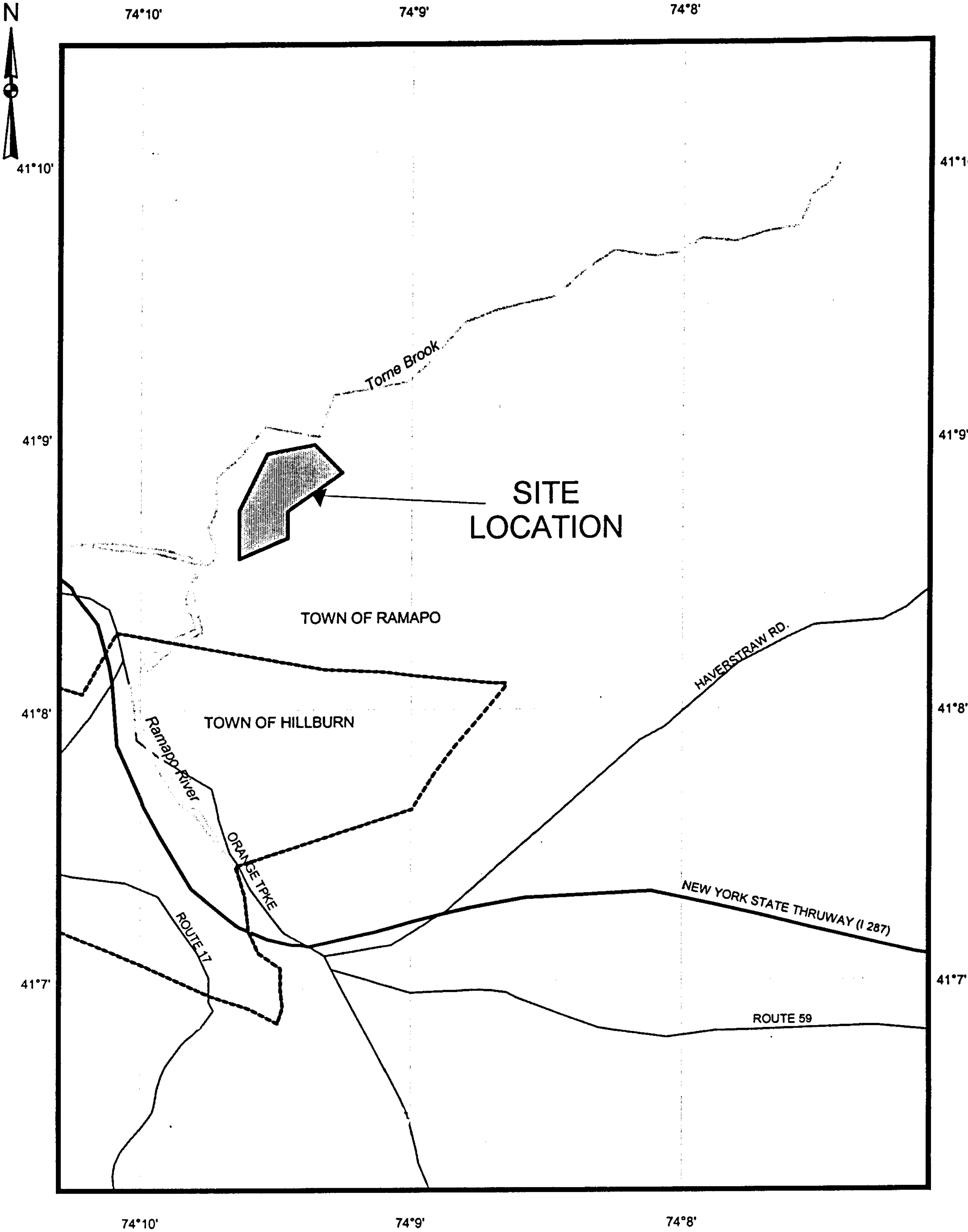
SOURCE:
HAGSTROM COMPANY, INC.

AC-13240

URS Greiner Consultants, Inc.

RAMAPO LANDFILL CMR
REGIONAL MAP

FIGURE 1

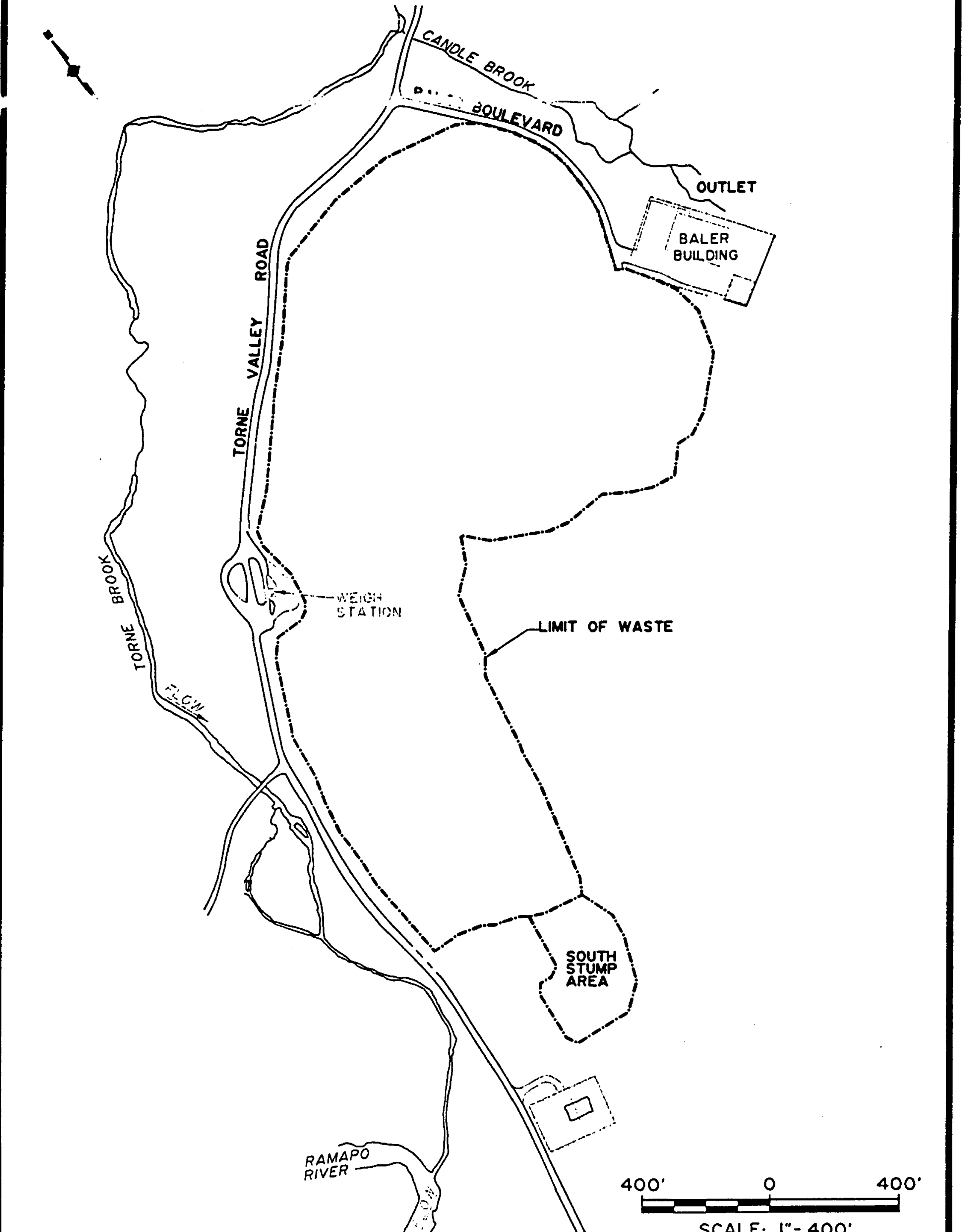


SOURCE: ArcView GIS StreetMap
Sloatsburg, NY-NJ
NW/4 Ramapo 15' Quadrangle

3000 0 3000 Feet

URS Greiner	RAMAPO LANDFILL CMR VICINITY MAP	**Figure 2**

j:\35314\db\gis\site.apr VICINITY MAP
12/22/1998



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URS Greiner Consultants, Inc.

RAMAPO LANDFILL CMR
SITE LOCATION MAP

FIGURE 3

A Remedial Investigation (RI) Report (September 1991) was prepared by URS Consultants, Inc. now URS Greiner, Inc. (URSG) for the Town of Ramapo. During the RI, it was determined that New York State Department of Environmental Conservation (NYSDEC) Water Quality Standards and Guidelines and/or United States Environmental Protection Agency (USEPA) Primary Drinking Water Standards were being contravened in surface water, and groundwater monitoring wells in the overburden, intermediate layer, and bedrock aquifers. No federal or state drinking water standards were exceeded in samples taken from nearby public or private water supply wells. One air sample exceeded NYSDEC guidelines. Contaminants were detected above background concentrations in onsite waste and soil samples and to some extent in sediment samples collected from Torne Brook.

A baseline health risk assessment was performed during the RI in compliance with USEPA guidelines. Human health risks were evaluated for both carcinogenic and noncarcinogenic chemicals. In the absence of remedial measures, the hazard index for noncarcinogenic risks exceeded a value of one, indicating that the potential exists for health effects to occur as a result of site-related exposures. Under future-use conditions (onsite residents using onsite groundwater), the carcinogenic risk was above the acceptable cancer risk range of 1×10^{-6} indicating the potential exists for health effects to occur for onsite residents.

An identification and analysis of remedial alternatives was presented in the Feasibility Study Report (January 1992) for the site. The recommended alternative was to cap the landfill and improve on the existing leachate collection system.

A Record of Decision (ROD) was issued by the USEPA for the Ramapo Landfill Site on March 31, 1992. As stated in the ROD:

> "The purpose of this response action is to reduce the present risk to human health and the environment due to contaminants leaching from the landfill mound. The capping of the landfill will minimize the infiltration of rainfall and snowmelt into the landfill, thereby reducing the potential for contaminants leaching from the landfill and negatively impacting the wetland habitats and groundwater quality. Capping will prevent direct contact exposure to contaminated soils, and as such will result in risks which are less than USEPA's target levels of 10^{-6} and 1 for carcinogenic risks and the noncarcinogenic hazard index, respectively.

Pumping and treating the groundwater will contain the groundwater contamination within the site boundary and will ensure that groundwater beyond the site boundary meets applicable or relevant and appropriate state and federal standards for groundwater. The extracted leachate and groundwater will be discharged to a POTW for off-site treatment.

The response action also reduces the movement and toxicity of the contaminated landfill leachate into groundwater, and subsequent downgradient migration of contaminants."

In response to the ROD, URSG completed supplementary investigations, predesign studies, and a remedial design as detailed in the Design Analysis Report (DAR) (URSG 1994). The purpose of the remedial design was to implement a response action to address the principal threats to human health and the environment by effectively controlling the sources of contamination, and by extracting and treating contaminated groundwater. The major components of the design which would achieve this response action included:

- Regrading of the landfill and installing of a multi-media cap
- Modifications to the existing leachate collection system and installation of groundwater extraction wells
- Continued offsite treatment of contaminated leachate and groundwater
- Construction of surface water controls
- Performance of air monitoring
- Imposition of property deed restrictions
- Performance of a maintenance and sampling program upon closure
- Development of a contingency plan

The remedial design was approved by the Town of Ramapo and the NYSDEC in April 1994, and June 1994, respectively. The project was bid on August 2, 1994 with the subsequent award being made to Geo-Con, Inc. on October 4, 1994. Construction started in December 1994. The dates for the completion of the major construction activities were as follows:

•	South lobe subgrade	July 1995
•	North lobe subgrade	October 1995
•	South lobe geosynthetic cover	November 1995

- North lobe geosynthetic cover — June 1996
- South lobe soil cover — April 1996
- North lobe soil cover — July 1996
- South lobe swales/downchutes — July 1996
- North lobe swales/downchutes — August 1996
- South lobe topsoil/seeding — September 1996
- North lobe topsoil/seeding — November 1996
- Groundwater extraction wells — May 1996
- Leachate collection/transfer system startup — November 1997
- Leachate storage tank — September 1996
- Wetlands Restoration — November 1996

1.2 Purpose

The purpose of this Construction Monitoring Report (CMR) is to document the construction phase of the Ramapo Landfill remediation project. All discussions within this CMR show that only approved methods, materials, and equipment, as required by the Contract documents, were implemented unless otherwise clarified, and as otherwise described in the following section on variances and change orders. Provided within this document are:

- Descriptions of construction methods, materials, and equipment
- Record drawings
- Construction Quality Assurance/Quality Control (QA/QC) results
- Discussion of any variances and change orders.

1.3 Variances and Change Orders

1.3.1 Variances

The following list identifies variances from the Contract Documents which were implemented following either a request by the construction contractor, Geo-Con, Inc. (Geo-Con) or initiated by URSG. Full discussions of variances are provided in the respective geomembrane and soils sections of this report.

1. Deletion of the general/select general fill record survey and associated mapping. **URSG initiated.**

2. Reduction of the frequency of in-place density tests on structural fill placed around small structures inside and outside the limits of the landfill cap. **Geo-Con request.**

3. Increase in the maximum permissible lift thickness for unclassified trench backfill outside the limits of the landfill cap, from the specified 1-foot lift thickness to a 2- to 3-foot lift thickness. **Geo-Con request.**

4. Decrease in the minimum required percent passing the No. 200 sieve for general/structural fill from 20 percent to 15 percent. **Geo-Con request.**

5. Increase in the maximum permissible organic content for the general/structural fill from zero to 5 percent. **Geo-Con request.**

6. Increase in the maximum permissible organic content for the AGM from zero to Not To Exceed 20 percent.

7. Increase in the number of non-film tear bond adhesive failures (full sheet separation) on the 40-mil LLDPE geomembrane from zero to one, provided the minimum strength values were also achieved. **Geo-Con request.**

8. "Oversize" material (maximum particle size above the specified maximum of three-eighths inch) was permitted, up to one-half inch, in the select general fill soil cover. **Geo-Con request.**

9. "Oversize" material (maximum particle size above the specified maximum of three inches) was permitted in the general fill soil cover on the North lobe. **Geo-Con request.**

10. "Oversize" material (maximum particle size above the specified maximum of three inches) was permitted in the structural fill swale berms on the North lobe. **Geo-Con request.**

1.3.2 Change Orders

The following list identifies Contract modifications which were incorporated into the project by approved Change Orders. A summary of change orders is provided in Appendix C.

CHANGE ORDER	DATE ISSUED	CONTENT
CO G-1	March 10, 1995	Substitute LLDPE geomembrane material in lieu of the specified VLDPE geomembrane material.
CO G-2	June 22, 1995	Substitute Alternate Grading Material (AGM) in lieu of owner-supplied material for use as grading fill.
CO G-3	May 13, 1996	Installation of 16 inch x 16 inch x 6inch tee and 6-inch gate valve on water line being constructed by the Town's Contractor, T&T Commonwealth, as part of a separate contract.
CO G-4	July 11, 1996	Removal and disposal of onsite surficial tires.
CO G-5	July 11, 1996	Replacement of approximately 360 LF existing 6-inch leachate forcemain.

CO G-6	July 11, 1996	Electrical modifications for the leachate collection/transfer system.
CO G-7	July 11, 1996	Sample and test 40 mil LLDPE geomembrane liner exposed during winter.
CO G-8	August 13, 1996	Addition of two air release valves for the leachate transfer forcemain.
CO G-9	November 13, 1996	Prefinal quantity adjustment for:

Payment Item 023	CMP Surface Drainage
Payment Item 024	CMP Surface Drainage
Payment Item 025	Gas Vent Riser Pipe
Payment Item 028	Gravity Main - 4 inch Diameter
Payment Item 037	Cast-in-Place Concrete
Payment Item 045	Manhole Section Extension

CO G-10	November 13, 1996	Addition of an alarm system (auto dialer) for the leachate collection/transfer/storage system.
CO G-11 & Final	December 10, 1997	Leachate system electrical modifications and miscellaneous Geo-Con Requests for Change.

1.4 Final Inspection

The final inspection of the project was conducted on September 11, 1997. The inspection was attended by representatives from the NYSDEC, USEPA, Town of Ramapo Department of Public Works, URS Greiner, Inc., and Geo-Con, Inc.

Based on the final inspection, it was determined that the construction of the project was complete with the exception of the punchlist items noted below:

1. Removal of silt from various drainage swales on the North lobe.
2. Replacement of topsoil, seed, and mulch on the crown of the North lobe.
3. Replacement of washed out drainage apron stone at the upper end of Baler Blvd.
4. Replacement of rip rap and bedding stone, and debris from the outlet of the existing concrete surface collector near the discharge to Torne Brook.
5. Removal and disposal of rip rap, bedding stone, and debris from the outlet of the existing concrete surface collector near the discharge to Torne Brook.
6. Demonstration of the leachate collection/transfer/storage alarm system.

1.6 Key Aspects of the Operation and Maintenance Plan

The Operation and Maintenance (O&M) Manual is provided under separate cover. It was prepared as required by the ROD and meets the requirements of 6NYCRR Part 360. The manual provides a comprehensive discussion of the necessary monitoring, routine maintenance, emergency contingencies, personnel, record keeping, and reporting associated with the 30-year post-closure period. This section of the CMR summarizes key aspects of the O&M Manual.

Inspections and Routine Maintenance:

Site maintenance covers the routine inspection and upkeep of all of the major site components and their respective functions over the 30-year post closure care period. The minimum initial frequency of inspections will be four times per year, then less frequent pending the condition of site features, unless otherwise indicated or approved by the NYSDEC. All records on frequency of inspection and general maintenance will be submitted to the NYSDEC as discussed in Section 7.

The following scheduled maintenance activities should be adequate to maintain the remedial system in proper operating condition.

The Town of Ramapo Department of Public Works or a contracted landscaping firm will perform the required routine maintenance which will include the following:

- Cutting of the vegetation on the final cover and grass-lined ditches and swales three times a year (late spring, mid-summer, and late autumn). The seed mix specified for the final cover is designed for the infrequent mowings which are necessary to prevent the invasion of weeds and brush.

- Fertilization, liming, and other vegetation-maintenance chores will be conducted annually in the spring. The level of fertilization and liming will be selected for the grass species, soil type, and setting. The seeding requirements will be provided in the O&M Manual.

- Cleaning the swales, ditches, and downchute of accumulated leaves, twigs, and other debris concurrently with mowing of the vegetation. Failure to remove debris from the drainage features could result in scour or breaching of the channel.

Quarterly inspections of the remedial components will be performed after scheduled maintenance tasks by a qualified civil or environmental engineer experienced in the construction and function of a multi-layered cover system. In addition, an inspection will be performed after all significant rain event. The purpose of these inspections will be to identify any potential problems with the remedial system that are not being addressed adequately by routine maintenance, and to document the current condition of the system. The engineer will complete the site inspection checklist after each inspection and submit it to the NYSDEC as soon after the inspection as possible. The engineer will prepare an annual report for submission to the NYSDEC which will document the current condition of the system.

For each inspection will the engineer evaluate the following items and will estimate the nature and extent of corrective action required.

- Surface Water Control Features - Channel cross-sections must be inspected to ensure that sideslopes are stable. Checks will be made for scour, sediment deposition, breaches, rodent holes, and other damage. The riprap-lined downchutes also will be checked for undermining and damage to geotextile.

- Leachate Seeps - Any areas of leachate seeps will be noted and monitored. The need for adding remedial controls in any such areas will be assessed.

- Landscaping - The vigor and density of the vegetative cover on the cap, channels, and swales will be assessed. The location and extent of bare, sparse, and undernourished areas will be noted. Areas of significant weeds, woody brush, or deep-rooted vegetation will be noted.

- Vermin Control - The cap will be inspected for damage due to vectors and/or burrowing animals. Any damaged areas will be flagged and noted.

- Erosion - The presence and extent of any rills or other signs of erosion of the final cover, ditches, swales, or downchutes will be noted.

- Gas Vents - The condition of gas vents will be inspected and noted. Checks will be made for clogging of the vent opening by birds or insects.

- Settlements - Visual evidence of differential settlement of the final cover will be noted and its impact on the integrity of the final cover, swales, or required drainage patterns will be assessed.

- Fence - The fence will be inspected for signs of vandalism and other damage. No scheduled maintenance is required.

- Access Roads -Vehicular traffic across the landfill cap will be limited to the engineered access roads. These vehicles will be necessary to inspect and maintain the site, and to perform necessary services. Rutting, cracking, or other damage to the across roads across the landfill will be noted.

- Leachate Collection System - Discussed below.

The leachate collection system components include the manholes and leachate collection pipes, located on both sides of Torne Valley Road. Manholes serve as cleanouts to all reaches of the network of collection piping. Inspection of each manhole will include, at a minimum, removing the covers and using artificial light if necessary, inspecting all characteristics and components in the manholes. Gravity mains will also be inspected for proper function. The condition of the manholes themselves will be noted, including any cracks, leaks, or misalignment. Pipe entrances and exits to manholes will be inspected for sediment build-up and tight seals. If necessary, the inspector will enter the manholes for best viewpoint. Pipes will be inspected by qualified personnel with video camera equipment if deemed necessary.

Maintenance and repairs will be performed when required so that proper function is not interrupted. Maintenance may include manual labor to remove sediment or possibly sewer snaking mechanical methods. Chronic problems such as large sediment accumulations may be indicative of a pipe breach, so video camera equipment may be deployed in such instance to verify. Necessary repairs including pipe replacement will be considered as applicable. Temporary portable pumps may also be considered. Gravity mains will be cleaned out when necessary and repaired/replaced if warranted.

The leachate collection/transfer/storage electro-mechanical and alarm system components will be inspected and maintained in accordance with the respective manufacturer's operation and maintenance manuals. These manuals are presented as appendices in the O&M Manual for the Ramapo Landfill Remediation project. Operational procedures for the leachate system are discussed in the O&M Manual.

Significant Concerns

Significant problems other than those previously discussed, require an event-specific solution. A qualified civil/environmental engineer must perform the following:

Emergency Contingencies

- Determine the nature and extent of the problem
- Identify the cause of the problem and the steps required to prevent it from recurring
- Determine how to repair the failed area to original operating condition

This process should begin immediately upon discovery of the problem. The NYSDEC will be notified of the nature and extent of the problem within 30 days of its discovery.

Remedial Materials

Materials removed from remediation areas may be reused in the remedy provided they are uncontaminated or not altered from their required originally-constructed state. Products such as stone and drainage net contaminated by sediments may be taken offsite and washed free of sediments. Geotextile material used in landfill cap construction must be new since degradation and clogging may not be visible to the human eye. Geotextile is typically bonded to drainage net so it appears likely that geonet will be replaced along with any replaced geotextile. Geomembrane can be re-used provided it appears in new condition and excessive strain (maximum 10 percent) has not occurred.

Earthen materials may be re-used in the remediation provided they are not commingled with adjacent materials. All materials to be disposed will be taken off of the landfill site and disposed at the Town's own expense. Materials contaminated with leachate will be disposed of at a facility permitted to landfill such waste.

Water and Air Sampling

Groundwater and surface water samples will be collected on a regular basis, three times during 1998, for site-related parameters from nearby residential wells and from selected existing monitoring wells. If increases are noted through this monitoring program at or immediately upgradient of the residences, the State and USEPA will make a determination of the need for appropriate action (e.g., extension of a public water line) to remedy the situation.

The Post-Construction Air Monitoring Program will consist of regular monitoring, of the air and landfill gases near the landfill. The initial sampling event included analysis for volatile organic compounds (VOCs). The VOC analytical results were used in conjunction with an air dispersion model to estimate contaminant concentrations at potential offsite receptors.

2.0 GENERAL CONSTRUCTION REQUIREMENTS

Features discussed in this section include those activities which are common to all major aspects of the project. They are provided here to avoid repeating a discussion of these features under each report section.

2.1 Record Conditions

2.1.1 Record Drawings

Geo-Con prepared red-line drawings to show the "as-built" condition of the work completed. Terry Bergendroff Collins, Professional Land Surveyor, obtained record information which included field modifications. URSG used CADD to modify the original Contract and incorporate the information shown on the red-line drawings provided by the Geo-Con. The record drawings, prepared by URSG using information supplied by Geo-Con are attached.

2.1.2 Supplemental Record Drawings

Terry Bergendoff Collins prepared Supplemental Record Drawings to demonstrate conformance of the grading fill (subgrade) with the project plans and specifications. The following supplemental Record Drawings, are attached:

- Grading Fill (Subgrade) Record Drawings
- LLDPE Geomembrane Panel Record Drawings

2.2 Onsite Inspection

Daily inspection of construction activities was provided by URSG throughout the contract. URSG prepared daily inspection reports to document the work performed by the Contractor, the equipment and labor used, and verification that the requirements of the contract documents were satisfied.

2.3 Construction Photographs

Color photographs and slides were taken throughout the duration of the construction. Regular photographic documentation of construction progress was provided by both the Contractor, as required by the contract documents, and by URSG. Color photographs of major project aspects are included in Appendix B.

2.4 Survey

The Contractor obtained the services of Terry Bergendroff Collins, to perform all survey work required during the construction. All work was referenced to the existing horizontal and vertical control utilized during previous phases of the project established at the site. Horizontal control was referenced to a site-specific Northing and Easting system. Vertical control was based upon National Geodetic Vertical Datum 1929 (sea level).

2.5 Grade Control

Throughout the course of construction, a continuous 50-foot x 50-foot grid was staked over the entire work area to establish grades and location. Additional grade stakes were utilized to delineate changes in grade occurring between grid stakes. The grade stakes were referenced to a Northing and Easting System which was assumed from previous phases of the project and site specific. Vertical control (elevations) was based upon National Geodetic Vertical Datum 1929 (sea level).

2.6 Sedimentation and Erosion Control

The Contractor was required to take all necessary measures to minimize the migration of sediments off site and establish run-on/ run-off control. These measures included:

- Installation and maintenance of a perimeter silt fence
- Construction of temporary ditches and diversion berms to divert overland flows

- Placing haybales and check dams in drainage ditches
- Construction of temporary sedimentation ponds
- Temporary over-excavation of the South Wetland area for stormwater run-off retention

In addition, the Contractor was required to minimize the build-up of soil on Torne Valley Road and Baler Blvd during construction. The roads were machine-swept and washed down using a water truck as needed.

2.7 Construction Equipment

Construction methods and equipment used are discussed in sections, where they are specifically applicable. A summary of the equipment used is presented in Table 2.1.

2.8 Nuclear Densitometer Calibration

Nuclear Densitometers Troxler Models 3440 and 3440A, and Humboldt Scientific Model 5001-P were used to measure in-place moisture-density of the compacted soil lifts for the final cover construction and structural backfill. They were also used to measure the in-place moisture and density of compacted aggregate materials and compacted asphaltic concrete. Testing was performed in accordance with manufacturers recommendations, ASTM D-2922, and ASTM D-3017. The instruments were calibrated each day as recommended by the manufacturers.

2.9 Subcontractors

Geo-Con utilized the following subcontractors on the Ramapo Landfill Remediation project:

Terry Bergendorff Collins, L.S. - Surveying; Brewster, NY.
Bernstein Associates - Construction photographs; Mt. Vernon, NY.
A. Reginatto Consulting Engineers - Laboratory testing; soil analysis, aggregate, and concrete testing; Totowa, NJ.

TABLE 2.1

LIST OF CONSTRUCTION EQUIPMENT

EXCAVATORS

Caterpillar 245 Backhoe w/G120 Rammer Hydraulic attachment
Caterpillar 320L Backhoe
Caterpillar 325L Backhoe
Caterpillar 330L Backhoe
Caterpillar 416B Rubber Tire Backhoe
Caterpillar 446 Rubber Tire Backhoe
Daewoo Solar 280LC - III Backhoe
Daewoo DH 280 Backhoe w/Hydraulic Hammer
Daewoo DH320 Backhoe
Hitachi EX200LC Backhoe
Hitachi EX700 Backhoe
Komatsu PC220LC Backhoe
Cat Mini Giant Backhoe
Daewood Solar 280LC - III Backhoe
John Deere 510D Turbo Rubber Tire Backhoe

LOADERS

Caterpillar 966F Loader
Komatsu WA450 Loader
Komatsu WA250 Forklift w/2CY bucket attachment
Caterpillar IT28F Loader w/forklift attachments
Caterpillar IT18B Loader
Case 621B Loader
John Deere 544G Loader

COMPACTION EQUIPMENT

2420 Vibratory Smoothdrum Roller
Hamm 3011 Vibratory Smoothdrum Roller
Hamm 4011 Vibratory Smoothdrum Roller
Caterpillar CS-563 Vibratory Smoothdrum Roller
Wacker Plate Tamper
Wacker Jumping Jack
Wacker RT 820 Remote Sheepsfoot Roller

BULLDOZERS

Caterpillar D4H Dozer
Caterpillar D4H LGP Dozer
Caterpillar D5H LGP Dozer
Caterpillar D5H Series II Dozer
Caterpillar D6H LGP Dozer
Caterpillar D6H XL Dozer
Caterpillar D8N Dozer
Komatsu D65E Dozer
Komatsu D65PX Dozer
Komatsu D135A Dozer
John Deere 450G Dozer
John Deere 550G LGP Dozer
John Deere 650G LGP Dozer

TRUCKS

Volvo BMA30 End Dump
Volvo BMA35 End Dump
Caterpillar D25C End Dump
Caterpillar D300D End Dump
Caterpillar D350C End Dump
Caterpillar D350D End Dump
Moxy 6227B End Dump
Hertz 2 Ton Dump Truck

MISCELLANEOUS EQUIPMENT

Hertz Water Truck
3" soil screen
Bobcat 753 w/broom attachments
Mechanic Tool Truck
Ford Water Truck
Ingersoll-Rand Generator
2" Electric Pump
3" Gas Pump
4" Gas Pump
1 ½" Electric Pump
6" Gorman - Rupp Pump
Electric Chipping Hammer
Yamaha Generators
Ford Pickup Trucks
Electric and Gas Blowers
Lysters
Sewing Machines
Wedge and Extrusion Welding Machines
Tensitometer

Fairway Testing - Laboratory testing; soil analysis, aggregate, concrete, and asphalt testing; Stony Point, NY.

Geotesting Express - Laboratory testing; geosynthetic interface shear testing, peel and shear destructive geomembrane testing; Action, MA.

Accredited Labs - Laboratory testing; TCLP testing, AGM sulfide content testing; Carteret, NJ.

TRI/Environmental - Laboratory testing; geosynthetic QA/QC testing; Austin, TX.

Pittsburgh Tank and Tower, Inc. - Leachate storage tank erection; Henderson, KY.

JCA Associates - Extraction well construction; Mt. Laurel, NJ.

West-Fair Electric, Inc. - Electrical construction; Nyack, NY.

Old Oak Landscaping - Landscaping; Glenham, NY.

DaCosta Associates - Wetlands vegetation; Ossiwing, NY.

Heritage Construction Services - Gabion wall construction; Fort Lee, NJ.

Krismar Construction - Leachate trench excavation; Upper Saddle River, NJ.

Valery Drilling & Blasting - Blasting; Stafford Spring, CT.

Bernie's Welding - Welding; Poughquag, NY.

Ego Spirit, Inc. - Cast-in place concrete, 48-inch box culvert installation; Cambria Height, NY.

Hi-Tech Security Services, Inc. - Leachate system equipment alarms; Suffern, NY.

Lucius Street Construction & Paving, Inc. - Paving; Spring Valley, NY.

3.0 SITE GRADING AND LANDFILL SUBGRADE PREPARATION

3.1 Construction Requirements

In order to prepare the subgrade for the final cover system, the Contractor was required to clear the area, place acceptable fill material, and provide a suitable condition for over-lying cover materials.

Clearing and grubbing of the landfill and adjacent surfaces was required to remove all vegetation and debris. Topsoil stripped from the work areas was stockpiled in designated areas on site. Throughout the duration of the contract, the Contractor was required to construct and maintain temporary erosion and sedimentation controls around the topsoil stockpiles. Surficial debris (tires) was removed and disposed of at an offsite facility.

The required subgrade for most of the landfill final cover system was attained by placing acceptable offsite material and material obtained from onsite activities such as excavations. Onsite material used as fill included material from clearing operations, trench-excavated soil from the leachate collection system, existing landfill waste excavated for landfill regrading, materials excavated for closing the leachate storage pond, from activities both within and outside the limits of landfill waste.

After an offsite facility final cover subgrade elevations were achieved, the Contractor was required to prepare the subgrade suitable for the overlying final cover. Subgrade preparation was required on all existing in-place materials and on imported grading fill prior to placing overlying layers of the landfill final cover system. Requirements included a subgrade surface free of stones greater than 1-inch, organic matter, irregularities, protrusions, loose soil, any debris which could be detrimental to the integrity of the final cover system, and cause any abrupt changes in grade. The subgrade was damp to dry, structurally sound, and compacted or mechanically tamped to ensure a smooth and stable surface.

Grading operations occurring outside the limits of the final cover system were performed in accordance with the requirements of the Contract drawings. As necessary, these areas were graded to ensure proper stormwater drainage (run-off) by blending the new contours into the existing contours.

3.2 Soil Excavation (including contaminated soil)

Excavation was required for both clean soil upgradient of the landfill, as well as potentially contaminated soil downgradient and within the leachate pond. Excavation of the south leachate collector and a portion of the PVC gravity main including manholes was performed by Krismar Construction, Inc. Subcontractor to Geo-Con Excavation of the north and west leachate collectors, the remaining portion of the PVC gravity main including manholes, the east perimeter channel, plunge pools, gabion walls, and wetland restoration was performed by Geo-Con.. Excavation for the 48-inch box culvert at the corner of Torne Valley Road and Baler Blvd. was performed by Ego Spirit, Inc., Subcontractor to Geo-Con. All excavated material, including contaminated soils, was hauled, placed as grading on the landfill in 12-inch loose lifts, and compacted. Leachate pond sediments were mixed with dry soil and spread out to dry on the landfill surface prior to final placement and compaction. There was not analytical testing of this material because it was disposed of at the source of contamination (landfill). Excavated soils from the wetlands excavation were placed, graded, and seeded at the Contractor's own expense on the west side of Torne Valley Road in the west leachate collector area, west of the North Lobe. The location of the leachate collection system, including manholes, is shown on Contract Drawing No. 32. The location of the perimeter drainage system, including plunge pools, gabion walls, and the new wetlands is shown on Contract Drawing Nos. 7, 8, and 31, respectively.

3.3 Surficial Debris and Solid Waste Excavation

Excavation into waste was required for construction both within and outside of the landfill for subgrade preparation and gas vent installation. All excavated material was hauled, placed, and compacted in 12-inch loose lifts on site. Surficial debris removal including tires and stumps from the south stump area was performed. Debris was disposed of at an offsite facility.

3.4 Offsite Grading Fill and Alternate Grading Materials

Grading fill was provided by two offsite sources; AMR of Emerson, NJ and Marangi Brothers of Hillburn, NY. The alternate grading material (AGM) was provided by one offsite source, Karta Container and Recycling of Peekskill, NY. Grading fill material was placed in 12-inch loose lifts by a bulldozer and compacted with two to four passes of a vibratory smooth drum roller.

3.5 Construction QA/QC Monitoring

3.5.1 QA/QC Requirements

The QA/QC monitoring requirements for site grading and subgrade preparation included visual observation, laboratory testing, and survey results. Offsite grading materials were subject to the laboratory tests identified on Tables 3.1 through 3.4. URSG visually verified that rocks 6 inches or greater or other deleterious materials had been removed prior to compaction. Unsuitably wet soil materials were aerated, regraded, and rerolled. Unacceptable soil materials were removed and properly disposed of off site. For areas of the landfill where leachate seeps were encountered, the wet/unstable material was removed and disposed of in the landfill. The excavation was backfilled with washed, crushed stone which was wrapped in a geotextile envelope. There was no Contract requirement for in-place density testing of the subgrade, however compaction was verified by visual observation.

After the subgrade was prepared as required and approved by URSG based on visual observation, the Contractor submitted Record Drawings showing the landfill grades on a 50-foot by 50-foot grid, including final subgrade contours for URSG's review. The landfill grades were checked by URSG verifying that the subgrade slopes were between 3 percent and 33 percent. Where corrective grading was required, the affected area was regraded, recompacted, resurveyed, and Record Information was resubmitted to URSG for review. Final subgrade contours are presented on attached Supplemental Record Drawing Nos. 1 thru 37. Only after all the QA/QC requirements were satisfactorily met, was the Contractor allowed to place the vertical gas vents which are a component of the final cover system.

TABLE 3.1

SOIL GRADING FILL - TEST FREQUENCY SUMMARY
Preconstruction

Marangi Grading Fill

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	1	1
Standard Proctor ASTM D-698	1/5,000 cy and when a change in material occurs.	1	1
As Received Moisture Content ASTM D-2216	None	None	1
Atterberg Limits ASTM D-4318	1/1,000cy	3	3
Organic Content	None	None	Visual Inspection
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

1) Total number of tests required is based on less than 2500 cubic yards of earth fill in place

The quantity of QA/QC tests performed and the number required is presented in Table 3.1 and 3.3. QA test results are presented in Table 3.2 and 3.4.

TABLE 3.2

SOIL GRADING FILL-RANGE OF TEST RESULTS
Preconstruction

Marangi Grading Fill

Test Description	Range of Test Results	Requirement
Grain Size w/Hydrometer ASTM D - 422 % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100% 20% 4%	 100% 20 - 40% < 10%
Standard Proctor ASTM D - 698 Maximum Dry Density Optimum Moisture Content	 129.1pcf 8.3%	 None None
Organic Content	Visual Inspection	None
As received Moisture Content ASTM D - 2216	9.2%	None
Interface Friction ASTM D - 5321	31.8 °	≥ 26 °

TABLE 3.3

AGM GRADING FILL - TEST FREQUENCY SUMMARY

Karta

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	18	20
Standard Proctor ASTM D-698	None	None	None
As Received Moisture Content ASTM D-2216	None	None	100
Atterberg Limits ASTM D-4318	1/1,000cy	None	20
Sulfide Reactivity	1/Daily Total Received	71	71
Organic Content	1/Daily Total Received	71	79
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:
1) Total number of tests required is based on 44,915 cubic yards of earth fill in place.

TABLE 3.4

AGM GRADING FILL - RANGE OF TEST RESULTS

Karta

Test Description	Range of Test Results	Requirement
Grain Size w/Hydrometer % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100% 22.5% 0.5 - 1.8%	 100% 20 - 40% < 10%
Standard Proctor Maximum Dry Density Optimum Moisture Content	 74.9pcf 30.6%	 None None
Organic Content	6.2 - 19.9%	* ≤ 20%
As received Moisture Content	6.7 - 29.6%	None
Sulfide Reactivity	ND	ND
Sulfide	ND - .040%	< .5%
Interface Friction	35.6° - 36.4°	26°

Note: ND = Not Detected.
* See Section 1.3.1; Item 6.

4.0 PERMANENT SURFACE WATER MANAGEMENT

Drawing No. 31 provides the locations of the permanent surface water management structures which include:

1. Swales and downchutes on the landfill surface.

2. Riprap-lined channels within and around the landfill, perimeter channels lined with half (semi-circular).

3. Sections of CMP and RCP pipe.

4. A 48-inch concrete box culvert underneath Torne Valley Road at Baler Boulevard.

5. Energy-dissipating plunge pools.

6. A concrete surface collector (gutter) adjacent to (east of) Torne Valley Road,

7. An asphalt-lined channel adjacent to Baler Boulevard.

4.1 Drainage Swales, Downchutes, and Rip Rap Channels

Sixteen drainage swales were constructed on top of the final cover system to control surface run-off. Structural fill material was utilized to construct the swales directly on top of the general fill layer of the final cover system. The structural fill was placed and compacted in maximum 12-inch lifts to a total berm height which varied depending on the slope of the landfill. The structural fill material was compacted to a minimum of 95 percent of the standard proctor maximum dry density. There was no numerical moisture content requirement. In-place density tests were performed at a frequency of one test per 100 lineal feet of swale. Test results are presented in Appendix E. The swale surface lining consists of 12 inches of rip-rap, New York State Department of Transportation Standard Specification (NYSDOTSS) No. 2 stone, underlain by, from top downward, 6 inches of washed bedding stone, geocomposite geosynthetic drainage system (GDS) layer, LLDPE geomembrane, and 16-ounce geotextile cushion fabric installed along the entire length of the swale berm.

Fifteen of the swales discharge into four downchutes. The remaining swale discharges into the rip rap-lined channel between the construction and demolition debris (C&D) mound and North Lobe. A gabion apron was constructed to dissipate stormwater flow at the North Lobe and South Lobe downchute outlets terminating at the existing concrete surface collector. Plunge Pool No. 3 was constructed to dissipate the stormwater flow from the downchute located on the south slope of the South Lobe prior to discharge into Wetland No. 4. The downchute located on the upper west slope of the North Lobe flows into the riprap-lined channel between the North and South Lobes. This riprap-lined channel discharges stormwater into the existing concrete surface collector inlet located south of the Town's Weigh Station. The side berms of the downchutes were constructed of structural fill material and subjected to QA/QC testing in the same manner as the swales. The test results are presented in Appendix E. The downchute surface lining consists of 18 inches of riprap underlain by, from top downward, 4 inches of washed bedding stone, geotextile filter fabric, and 12 inches of general fill installed along the entire length. The downchutes carry stormwater flow from the swales to lined channels within and around the landfill, with eventual discharge to the Ramapo River.

4.2 Half-CMP and Half-RCP Perimeter Drainage Channels

Forty-eight-inch diameter half CMP pipe was installed on the east side of the North Lobe outside and nearly adjacent to the landfill limits. Thirty-six-inch half CMP pipe was installed on the south side of the North Lobe outside and nearly adjacent to the landfill limits.

- Geo-Con elected and was granted permission to install a 48-inch RCP half pipe on the south side of the South Lobe outside the landfill limits in lieu of the specified 48-inch CMP half pipe due to a material price reduction.

- All of the half pipe was bedded in NYSDOTSS No. 1 stone with a 4-foot wide concrete sidewalk installed on both sides of the half pipe, which acts as a foot path for inspection as well as providing physical tie-in to the final cover system.

4.3 Culverts and Headwalls

A twin 48-inch square precast concrete box culvert was installed underneath Torne Valley Road just south of Baler Boulevard. The box culvert was realigned from the proposed location shown on the Contract Drawings due to the reconstruction/widening of Torne Valley Road by the Rockland County Highway Department. Cast-in-place concrete headwalls and wingwalls were installed on the inlet (landfill) side of the box culvert. The outlet section on the Torne Brook side was deleted from this contract because the road modifications included widening on the outlet side of the box culvert. In order not to delay construction, an agreement was made between the Town of Ramapo and the Rockland County Highway Department to have the highway department's Contractor install the outlet end section and cutoff wall. No impact on the required performance of this feature is anticipated.

4.4 Plunge Pools

Three plunge pools were constructed to collect and dissipate flows from surface stormwater run-off. Twenty-seven inches of riprap line the plunge pools which are completely underlain by, and contiguous with 6 inches of bedding stone, geotextile cushion, LLDPE geomembrane, and geocomposite of the final cover system. The location of the three plunge pools are shown on Drawing No. 31.

4.5 Stone and Asphalt Concrete Lined Perimeter Drainage Channels

Perimeter drainage channels were also constructed to collect and control both surface water run-on and run-off. Channel lining consisted of either stone or asphalt, depending on the application. Channel, in general, are underlain by geosynthetics and No. 2 stone.

The perimeter channel carrying flow from the north to south along the east side of the South Lobe outside the landfill limits is also lined with geomembrane to prevent infiltration of surface water. Like the plunge pools, the channel is lined with riprap and completely underlain by, and contiguous with geotextile cushion, LLDPE geomembrane, and geocomposite of the final cover system.

The perimeter drainage channel east of the North Lobe carries flow to the north and west along the east side of the pistol range area outside the limits of the landfill.

A channel is located over the final cover tie-in at Baler Boulevard to carry flow from the southeast to northwest along the east side of the pistol range, a portion of which is outside the limits of the landfill. The channel eventually feeds the riprap-lined channel between the North Lobe and C&D mound. Eighteen inches of riprap line this perimeter ditch and is completely underlain by geocomposite, LLDPE geomembrane, and geocomposite.

The perimeter channel at the Weigh Station carries flow from north to south along the west side of the North Lobe outside the limits of the landfill. Eighteen inches of riprap line the perimeter channel which is completely underlain and contiguous with the landfill cover system geocomposite, LLDPE geomembrane, and geocomposite.

4.6 Outlying Drainage Channels

There are two surface water outlets from the landfill. The South discharge enters the Ramapo River near the Wetland Area No. 4; the North discharge enters Torne Brook near Baler Boulevard.

The North-South geomembrane-lined channel into Wetland Area 4 will carry flows from Plunge Pool No. 3 which originate from both the North and South Lobes as well as from the existing mountainside east of the South Lobe. Eighteen inches of riprap lines the channel which is completely underlain by 6 inches of bedding stone, as well as 16-ounce geotextile cushion above and below the LLDPE geomembrane to prevent infiltration to groundwater.

The existing east-west stormwater discharge channel to Torne Brook carries flows from south to north and east to west outside the limits of the North Lobe. Stormwater flows originate from behind the pistol range, traveling east-west, south of the Baler building, and west in the riprap-lined ditch between the North Lobe and the C&D mound to the 48-inch box culvert under Torne Brook Road at Baler Boulevard. Eighteen inches of riprap line the discharge channel which is completely underlain by geotextile filter fabric.

Stormwater run-off from Baler Boulevard is collected and discharged into the 48-inch box culvert via an asphalt concrete-lined channel installed east-west, south of Baler Boulevard (landfill side) which feeds into the 48-inch box culvert discussed above.

4.7 QA/QC Material Testing

There were no QA/QC tests required because the No. 1 and No. 2 stone came from a NYSDOT-approved source; Tilcon Quarries, Tomkins Cove/Haverstraw Plant. However, confirmatory tests were performed and the results are presented in Tables 4.1 and 4.2.

TABLE 4.1

AGGREGATE MATERIAL - TEST FREQUENCY SUMMARY

Tilcon Quarries
No. 1 Stone - Tomkins Cove/Haverstraw Plant

Test Description	Min. Frequency Required	Total Tests Required	Total Test Performed
Grain Size NYSDOTTSS Table 703-4	1/1,000 cy	2	4
Permeability	1 /Source	1	1
MAX. - MIN. Index Density ASTM D4253	1/Source	1	2

NOTES:

1) Total Number of tests required is approximately 2,000 cy.

TABLE 4.2

AGGREGATE MATERIAL - RANGE OF TEST RESULTS

Tilcon Quarries
No.1 Stone - Tomkins Cove/Haverstraw Plant

Test Description	Range of Test Results	Requirement
Grain Size % finer than 1 inches % finer than 1/2 inch % finer than 1/4 inch % finer than #200 seive	 100 % 91 - 94 % 1.1 - 9 % .5 - .8 %	 100 % 90 - 100 % 0 - 15 % None
Maximum - Minimum Index Density	Max. 105.9 - 106.7 pcf Min. 94.2 - 95.0 pcf	None
Permeability	2.6 cm/sec @ 105.6 pcf	1.0 x 10E-3 cm/sec @ 100% of Max. Index Density

5.0 STRUCTURAL FILL

5.1 Material Requirements

Structural fill was utilized to construct the drainage swales and downchutes located on the landfill and to construct the berms of Plunge Pool No. 2. Structural fill was also utilized to fill in the existing leachate storage pond, thereby creating a foundation for the Leachate Storage Tank. Structural fill also was placed as backfill around buried precast concrete structures. Structural fill material met the requirements for General Fill with the added requirements of a maximum particle size of 3 inches.

5.2 Material Quality Testing

Structural fill consisted of material from several offsite borrow sources. Screening took place either at the borrow pit or onsite. Structural fill was placed in stockpiles after screening in preparation for QA/QC sampling and testing.

Stockpiles were sampled at random locations representative of the soil, for laboratory tests by Geo-Con in the presence of a URSG representative. Laboratory testing was performed by A. Reginatto Consulting Engineers, P.C. Samples were tested for grain size analysis, Atterberg limits, and Standard Proctor (moisture-density) testing. Multiple Proctor tests were performed on a particular lot of soil in the pit, exceeding the minimum required number of tests, if there appeared to be a change in material from that originally tested. In some instances the most conservative value (i.e., highest maximum dry density) was assigned to that stockpile for subsequent density testing but, typically, a single Proctor test result was appropriate for a particular lot of soil. The quantity of QA/QC tests performed versus the number required for each source is given in Table 5.1.

Specific Atterberg limit test results were not required as an acceptance requirement, but used to aid soil classification and to determine if unacceptable clays were present at the pit. For example, a Unified Soil Classification System description of CH would be unsuitable on steep slopes for slope stability reasons. Moisture-density curves were the primary bases for determining if in-place

TABLE 5.1

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

CM & Sons

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	12	26
Standard Proctor ASTM D-698	1/5,000 cy and when a change in material occurs.	6	7
As Received Moisture Content ASTM D-2216	1/1,000cy	29	48
Atterberg Limits ASTM D-4318	1/1,000cy	29	48
Interface Friction ASTM D-5321	1/5 acres	4	4

NOTES:

(1) Total number of tests required is based on 29,008 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Van Orden

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	8	11
Standard Proctor ASTM D-698	1/5,000 cy and when a change in material occurs.	4	5
As Received Moisture Content ASTM D-2216	1/1,000cy	20	29
Atterberg Limits ASTM D-4318	1/1,000cy	20	29
Interface Friction ASTM D-5321	1/5 acres	3	3

NOTES:

(1) Total number of tests required is based on 19,678 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Sawmill "A"
General/Structural Fill

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	1	2
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	1	1
As Received Moisture Content ASTM D-2216	1/1,000cy	3	5
Atterberg Limits ASTM D-4318	1/1,000cy	3	5
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

1) Total number of tests required is based on 2411 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Sawmill "B"

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	3	4
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	2	3
As Received Moisture Content ASTM D-2216	1/1,000cy	7	11
Atterberg Limits ASTM D-4318	1/1,000cy	7	11
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

(1) Total number of tests required is based on 6319 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Sawmill "C"

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	1	2
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	1	1
As Received Moisture Content ASTM D-2216	1/1,000cy	2	5
Atterberg Limits ASTM D-4318	1/1,000cy	2	5
Interface Friction ASTM D-5321 (2)	1/5 acres	———	———

NOTES:

(1) Total number of tests required is based on 1852 cubic yards of earth fill in place.
(2) Combination of Sawmill Stockpiles "A" , "B" , & "C" = 10582 cubic yards of earth fill in place. Total tests required is 1.31 for Interface Friction.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Stockpile "D" Owner Supplied

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	3	4
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	2	2
As Received Moisture Content ASTM D-2216	1/1,000cy	6	10
Atterberg Limits ASTM D-4318	1/1,000cy	6	10
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

(1) Total number of tests required is based on 5,772 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Stockpile "E" Booton

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	1	3
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	1	1
As Received Moisture Content ASTM D-2216	1/1,000cy	2	3
Atterberg Limits ASTM D-4318	1/1,000cy	2	3
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

(1) Total number of tests required is based on 1,428 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Stockpile "F" Owner

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	3	4
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	2	2
As Received Moisture Content ASTM D-2216	1/1,000cy	6	9
Atterberg Limits ASTM D-4318	1/1,000cy	6	9
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

(1) Total number of tests required is based on 5,081 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Stockpile "G" Waldwick

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	3	4
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	2	2
As Received Moisture Content ASTM D-2216	1/1,000cy	6	10
Atterberg Limits ASTM D-4318	1/1,000cy	6	10
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

(1) Total number of tests required is based on 5,667 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Servidone (Monroe)

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	4	8
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	2	4
As Received Moisture Content ASTM D-2216	1/1,000cy	10	16
Atterberg Limits ASTM D-4318	1/1,000cy	10	16
Interface Friction ASTM D-5321	1/5 acres	2	2

NOTES:

(1) Total number of tests required is based on 9,989 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

D.T. Allen

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	4	6
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	2	3
As Received Moisture Content ASTM D-2216	1/1,000cy	9	15
Atterberg Limits ASTM D-4318	1/1,000cy	9	15
Interface Friction ASTM D-5321	1/5 acres	2	2

NOTES:

(1) Total number of tests required is based on 8,052 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Franklin Lakes

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	3	4
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	2	2
As Received Moisture Content ASTM D-2216	1/1,000cy	6	9
Atterberg Limits ASTM D-4318	1/1,000cy	6	9
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

(1) Total number of tests required is based on 5,355 cubic yards of earth fill in place.

TABLE 5.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Royal Land

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	1	2
Standard Proctor ASTM D-698	1/5,000 cy or when a change in material occurs.	1	1
As Received Moisture Content ASTM D-2216	1/1,000cy	3	6
Atterberg Limits ASTM D-4318	1/1,000cy	3	6
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

(1) Total number of tests required is based on 2,061 cubic yards of earth fill in place.

compaction and moisture content requirements were satisfied. A copy of the structural fill construction quality tests is provided in Appendix D. The range of QA test results by source is provided in Table 5.2.

In general, structural fill material requirements were met. On August 25, 1996, Geo-Con excavated test holes in Swales 7N, 7S, 8, and 9 and verified the suspected existence of material exceeding the maximum permissible particle size, designated as oversize material. This soil was from the D.T. Allen borrow source. Oversize material from D.T. Allen placed on December 8, 1995 was also present in Swale No. 6. It was determined that time delays which would occur to remove the material would be detrimental to the work. A tight soil matrix was still achieved and no nearby geosynthetics could be damaged. A variance was granted by URSG and the oversize material was not removed. The Owner received a cost credit since screening operations to remove oversize material were not performed.

5.3 Construction Methods and Equipment

Structural fill was placed in maximum one-foot lifts and compacted to a minimum density of 95 percent of the Standard Proctor test maximum dry density. There was no numerical requirement for moisture content. The soil surface was scarified to ensure proper bonding to subsequent lifts.

As required by the specifications, the methods and efforts required to meet placement requirements were established during the construction of a test pad. The test pad was constructed for both General and Structural fill. General Fill is discussed in more detail in Section 9 of this report. Density test values were evaluated during pad construction. Equipment and operations which attained acceptable test pad results were then utilized throughout the project.

Structural fill was transported to the work area by off-road trucks. Compaction equipment included vibratory smoothdrum rollers. Specific equipment usage stayed consistent with respect to test pad operations.

TABLE 5.2

GENERAL/STRUCTURAL FILL - RANGE OF TEST RESULTS

Saw Mill "A"

Test Description	Range of Test Results	Requirement
Grain Size w/Hydrometer ASTM D-422 % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 31 - 38 % 7 - 9.5 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 128.6 pcf 8.7 %	 None None
As received Moisture Content	7.0 - 8.6 %	None
Atterberg Limits	NP	NP
Interface Friction	33.8°	≥ 26°

NOTE:

NP = Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL -RANGE OF TEST RESULTS

Saw Mill "B"

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 32.8 - 36.5 % 3.9 - 9.5 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 113.5 - 128.0 pcf 11.5 - 13.8 %	 None None
As received Moisture Content	7.9 - 9.2 %	None
Atterberg Limits	NP	NP
Interface Friction	32°	≥ 26°

NOTE:

NP = Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL -RANGE OF TEST RESULTS

Saw Mill "C"

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 29 - 32 % 7 - 8.5 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 131.0 pcf 9.5 %	 None None
As received Moisture Content	9.8 -10.8 %	None
Atterberg Limits	NP	NP
Interface Friction	---	≥ 26°

NOTE: NP - Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL - RANGE OF TEST RESULTS

Stockpile "D"

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 29 - 35 % 4.2 - 6.4 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 128.5 - 130.8 pcf 7.3 - 8.5 %	 None None
As received Moisture Content	7.2 - 8.5 %	None
Atterberg Limits	NP	NP
Interface Friction	28.9°	≥ 26°

NOTE: NP - Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL - RANGE OF TEST RESULTS

Stockpile "E" Booton

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 21 - 30 % 5 - 9 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 129.7 - 130.6 pcf 8.4 - 10.0 %	 None None
As received Moisture Content	1.9 - 14.9 %	None
Atterberg Limits	NP	NP
Interface Friction	33.3°	≥ 26°

NOTE: NP = Non-plastic

TABLE 5.2 (Continued)

GENERAL STRUCTURAL/FILL - RANGE OF QA TEST RESULTS

Stockpile "F" Owner

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 24.2 - 33 % 5.5 - 9 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 123.4 - 125.5 pcf 9.2 - 9.6 %	 None None
As received Moisture Content	3.4 - 7.9 %	None
Atterberg Limits	NP	NP
Interface Friction	36.4°	≥ 26°

NOTE: NP = Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL - RANGE OF TEST RESULTS

Stockpile "G" Waldwick
General/Structural Fill

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 15.0 - 21.9 % 2.9 - 5 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 126.2 - 132.6 pcf 7.7 - 10.2 %	 None None
As received Moisture Content	4.0 - 5.2 %	None
Atterberg Limits	NP	NP
Interface Friction	29.3°	≥ 26°

NOTE: NO = Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL - RANGE OF TEST RESULTS

Servidone (Monroe)

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 24 - 38 % 5 - 11 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 126.8 - 129.9 pcf 8.8 - 11.2 %	 None None
As received Moisture Content	9.5 - 11.8 %	None
Atterberg Limits	NP	NP
Interface Friction	31.1° - 37.1°	≥ 26°

NOTE: NP = Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL - RANGE OF TEST RESULTS

D.T. Allen

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 21 - 36 % 2 - 6 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 121.2 - 128.8 pcf 11.2 -12.2 %	 None None
As received Moisture Content	8.0 - 18.0 %	None
Atterberg Limits	NP	NP
Interface Friction	30.0° - 31.5°	≥ 26°

NOTE: NP = Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL - RANGE OF TEST RESULTS

Franklin Lakes

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 29 - 32 % 2 - 8 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 129.1. - 129.8 pcf 9.3 - 9.6 %	 None None
As received Moisture Content	7.4 - 27.5 %	None
Atterberg Limits	NP	NP
Interface Friction	36.1°	≥ 26°

NOTE: NP = Non-plastic

TABLE 5.2 (Continued)

GENERAL/STRUCTURAL FILL - RANGE OF TEST RESULTS

Royal Land

Test Description	Range of Test Results	Requirement
Grain Size % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 23 - 28 % 1 - 2.5 %	 100 % 20 - 40 % < 10 %
Standard Proctor Maximum Dry Density Optimum Moisture Content	 109.6 pcf 10.5 %	 None None
As received Moisture Content	7.7 - 8.7 %	None
Atterberg Limits	NP	NP
Interface Friction	____	≥ 26°

NOTE = Non-plastic

5.4 Construction QA/QC Monitoring

5.4.1 QA/QC Requirements

QA/QC monitoring requirements for the placement and compaction of the structural fill included visual observation that the previous lift was scarified, and free of cobbles or other deleterious materials prior to placement of the next lift. In-place moisture-density testing was performed using a nuclear densitometer at a minimum frequency of one test per 100 lineal foot intervals along the centerline of swale berms.

In-place moisture-density testing performed on structural backfill for precast concrete structures were at a minimum frequency of two tests per lift. The required test frequency was reduced from the Contract Documents requirements of four to two tests per lift based on the Contractor's demonstration of consistent high quality compaction completely around the structures and the resulting time savings.

5.4.2 QA/QC Results

Structural fill construction monitoring was carried out in accordance with the QA/QC requirements. Acceptability of the work was determined by testing for in-place density with a nuclear densitometer, supplemented by visual observation. The results show that the structural fill was placed and compacted in accordance with the requirements set forth in the Contract Documents. Copies of all the field in-place moisture-density test reports are included in Appendix E. A summary of in-place moisture-density test results for structural fill is given in Table 5.3.

TABLE 5.3

STRUCTURAL FILL - IPD SUMMARY

Test Description	Min. Frequency Required	Total Tests Required	Total Test Performe d	Actual Frequency
Standard Proctor ASTM D-698	9/Acre/Lift	NA	NA	NA
North Lobe (1) Swales and Downchutes Structural Fill	1/100LF/Lift	130	176	1/65LF/Lift
South Lobe (2) Swales and Downchutes Structural Fill	1/100LF/Lift	71	96	1/65LF/lift
Leachate Pond (3) Structural Fill	9/Acre	8	18	20/Acre

NOTES:

1) Total number of tests required is based on 12,930 lineal feet of earth fill berms in place.

2) Total number of tests required is based on 7,128 lineal feet of earth fill berms in place.

3) Total number of tests required is based on 39,042 square feet of earth fill in place.

6.0 GEOTEXTILES, GEOCOMPOSITES, AND EROSION CONTROL PRODUCTS

6.1 Construction and Material Requirements

A geosynthetic drainage system (GDS) was constructed directly on top of the 40 mil LLDPE geomembrane to collect infiltration to the final cover and transmit it to landfill swales and perimeter channels. The GDS was required primarily on slopes greater than 10 percent. The GDS was constructed of a single layer of geonet with geotextile bonded to it on both sides. The top geotextile functioned as a filter geotextile and the bottom geotextile functioned as a friction geotextile for necessary interface friction purposes. This material was required to provide a transmissivity of at least 9.7 x 10-5 square meters per second (m^2/sec). This material was also required to provide a minimum interface friction angle with the adjoining layers of 26 degrees. These requirements were to provide seepage stability.

A total of 6.9 acres of slopes flatter than 10 percent were exempt from this requirement since the flatter slopes cause no seepage stability concerns, and fine-grained (i.e., top size ⅜ inch) soils were placed as General Fill on top of the geomembrane for puncture resistance. These soils provide sufficient transmissivity to allow efficient draining. This area is shown in the Contract Drawing for both the North and South Lobe and is discussed in Section 9. Per the Alternate Bid Item, 01A, Select General Fill (less than 10 percent slope area), the Contractor elected to place this fine-grained soil, instead of placing coarser-grained General Fill directly on top of a (cushioning) GDS in the "less than 10 percent" flatter areas. GDS cushion in this flatter area would have required no friction geotextile.

Prior to the placement of geocomposite in any area of the landfill, subgrade drawings were submitted to URSG for review. Any slope section either less than 3 percent or more than 33 percent was identified for rectification. The Contractor regraded such section and resubmitted a new subgrade drawing.

6.2 Material Quality Testing

Laboratory testing of the GDS was required by the Contract Documents. This system was tested for transmissivity with the actual materials used in construction to simulate field conditions. The geocomposite provided a transmissivity rate of greater than 9.7 x 10^{-5} m^2/sec. Friction angle testing resulted in a friction angle exceeding the minimum required. All material quality testing results exceeded requirements. Testing was performed by TRI/Environmental. Test reports are provided in Appendix F.

As per the Contract Documents, all geotextile was required to be covered within 14 days of deployment. This requirement was permitted to be changed to 28 days due to construction coordinating difficulties. The geotextile manufacturer concurred that such a change would not be detrimental to the geotextile. During the 1995-96 winter shutdown period, portions of GDS were left exposed to the weather. Six representative samples were extracted from these exposed areas of both North and South Lobes and tested for geotextile integrity. The Geotextile was tested for grab breaking load, elongation, mass per unit area and water permeability by permissibility. All the test results exceeded the minimum requirements set forth in the Contract Documents.

6.3 Construction Methods and Equipment

Prior to installing the GDS, all the QA/QC requirements were successfully met for the 40 mil LLDPE geomembrane. Also, the Contractor swept or washed the geomembrane to remove accumulated dust, dirt, and debris prior to placement of the GDS.

After the proposed GDS installation area was cleaned, the geocomposite was rolled down the slope perpendicular to grading contour lines in such a manner as to continually keep the sheet in tension under its own weight. If necessary, the geocomposite was stretched by hand after unrolling to minimize wrinkles. A minimum seam overlap of 4 inches was maintained. The geonet-to-geonet laps were tied using plastic fasteners at 5-foot intervals along the roll lengths and at 6-inch intervals at butt seams. Butt seam overlaps measured foot minimum. All seams of geotextile filter for adjacent panels were continuously machine sewn together. In instances where a sewing machine could not be used, geotextile was thermal bonded using a lyster.

During the placement of the overlying general fill soil layer, there were several instances when the GDS required repair due to rain events. During rain events, the GDS would become clogged with soil fines. The entire portion of the clogged GDS was cut out and repaired by tying in a new piece.

6.4 Construction QA/QC Monitoring Requirements

6.4.1 QA/QC Requirements

The construction QA/QC monitoring requirements for the placement of the GDS included the following:

- Visual observation of materials for damage or irregularities
- Inspection of GDS panel installation and seaming to verify that tying, sewing, and thermal bonding operations met requirements

6.4.2 QA/QC Results

The GDS layer installation was conducted in accordance with QA/QC requirements. QA/QC monitors observed material placement. All work was monitored continuously to ensure that overlap and seaming standards were met with no siltation occurring. The QA/QC monitors determined acceptability of the in-place product by observing the work and by QA/QC test results.

7.0 PASSIVE GAS VENTING SYSTEM

7.1 Construction and Material Requirements

A passive gas venting system was constructed on top of the prepared landfill subgrade to vent any gases which may accumulate underneath the final cover. The system consisted of a continuous GDS type of gas collection layer plus gas vent riser pipes. A total of 59 gas vents were installed. As required, gas vent riser pipes were constructed at a minimum of one per acre as shown on the Contract Drawings. Gas vents V-28, V-33 and V-34 along the west pistol range berm were relocated from their proposed location due to the presence of boulders which would inhibit gas vent burial operations. The berm was predominately constructed of a soil/boulder matrix from the landfill. Gas vent V-39 near the valley between the North and South Lobes was relocated from its proposed location due to high leachate levels, about 1 foot below the proposed final cover subgrade elevation. An additional gas vent V-21A, beyond that originally proposed, was installed at the east berm of pistol range to ensure proper venting by compensating for the relocated gas vents. All gas vents were constructed a minimum of 3 feet into the waste and extended a minimum of 3 feet above the top of the final cover. The sub-liner perforated section of the vent pipe was surrounded by NYSDOTSS No.1 stone. Slot size was 0.125 inch and the pipe had an opening area of 45 square inches per foot. The vent and U-shape outlet of the top is constructed of Schedule 40 PVC pipe. The ends of the outlets were equipped with screen to keep birds out. Furnco (flexible) coupling and blast gates were also installed on each vent to allow this system to connect to an active collection system into future, if such conversion is required.

On slopes greater than 10 percent, and on some slopes less than 10 percent, a gas collection layer consisting of a GDS-type geocomposite (geonet which functions as the gas venting layer, sandwiched between two geotextiles) was constructed as required to extend radially outward at least 5 feet beyond the limit of waste. Upper geotextile for this application functions as a friction geotextile and lower geotextile functions as a filter geotextile.

Within major landfill plateau areas with less than 10 percent slopes, geocomposite was a two-layer system made of geonet and geotextile filter. The geocomposite met the requirement of producing a minimum gas phase transmissivity of 9.7 x 10^{-5} m^2/sec. The geocomposite was tested for the transmissivity by the Contractor's independent testing laboratory resulting in conformance to the Contract Documents. This material was also required to provide a minimum interface friction angle with adjoining layers of 9 degrees on less than 10 percent slopes and 26 degrees on 33 percent slopes.

7.2 Construction Methods and Equipment

Gas vents were installed using an excavator to penetrate the final cover subgrade to depth of 3 feet. The excavations were backfilled with the riser pipe and stone. The riser pipe was extended above the subgrade and protected with duct tape for subsequent final cover construction. Upon completion of the final cover system, a Furnco (flexible) coupling, blast gate and U-shape bend with bird screen covering the outlet was installed at each gas vent.

After a review of subgrade drawings, URSG field personnel checked the corresponding area for any deleterious materials and conditions such as sharp objects, tires, leachate seeps and compaction for final approval. Geocomposite was rolled down the slope perpendicular to the grading contours in such a manner as to continually keep the sheet in tension under self weight. If necessary, the geocomposite was stretched by hand after unrolling to minimize wrinkles. A minimum seam overlap of 4 inches was maintained. The geonet-to-geonet laps were tied using white plastic fasteners at 5-foot intervals along the roll lengths and at 6-inch intervals at butt seams. Butt seam overlaps measured 1 foot minimum. Outside of major landfill plateau areas having slopes less than 10 percent, friction geotextile between adjacent panels was sewn together. Geotextile filter was sewn in the less than 10 percent slope area. In instances where the sewing could not be performed, geotextile was fused with a lyster.

Gas vent geocomposite was placed radially outward at least 5 feet beyond the limit of waste. Beyond that, geotextile cushion was placed, overlapping with geocomposite by 1 foot. Friction geotextile and geotextile cushion were heat bonded together with a lyster.

During the subsequent installation of the geomembrane overlying the gas vent composite, there were several instances when the gas vent layer required repair due to rain events. During rain events, the geocomposite portion of the gas vent system occasionally would become clogged with silt. The entire portion of clogged geocomposite was removed, and a new section of geocomposite installed by tying and continuously seaming the geotextile.

7.3 Construction QA/QC Monitoring and Requirements

The construction QA/QC monitoring requirements for the placement of the gas venting system included the following:

- Visual observation of materials for damage or irregularities
- Inspection of geocomposite panel installation and seaming to verify that tying, sewing and heat fusion operations met the requirement
- Observation of gas vent pipe installation

7.4 QA/QC Results

The geocomposite gas vent layer installation was conducted in accordance with QA/QC requirements. Acceptability of the in-place product was determined by observing the work and by QA/QC test results. URSG field personnel observed material placement. All work was monitored continuously to ensure that overlap and seaming standards were met with no siltation occurring.

8.0 LLDPE GEOMEMBRANE SYSTEM

8.1 Geomembrane System

8.1.1 Construction and Material Requirements

The LLDPE geomembrane layer for the final cover system was required to be textured and have a minimum thickness of 40 mils. The LLDPE geomembrane was required to be manufactured from an approved resin having a minimum (blended) density of 0.915 gram per cubic centimeter and a maximum melt flow index of 1.3 grams per 10 minutes. Physical and environmental standards specified for the final geomembrane product were provided in the Contract Documents. Interface friction requirements were established for all materials in contact with the geomembrane as detailed in the previous sections.

1. Geocomposite Drainage System - 26 Degrees at 1V:3H slopes

2. Gas Vent Layer - 26 Degrees at 1V:3H slopes
   Gas Vent Layer - 9 degrees at less than 10 percent slopes

3. Minimum required seam strengths were as follows:

Material	Peel Adhesion	Shear
Textured 40 mil	20 lb/in	30 lb/in

All welds were required to exhibit a film-tear-bond (FTB) during destructive seam testing, meaning the geomembrane sheet itself must tear before the weld failed.

8.1.2 Material Quality Testing

Material QA/QC testing included that performed by the manufacturer's. This testing was conducted on both LLDPE resin and finished geomembrane product. Resin testing was performed to determine melt flow index and density. Geomembrane rolls were tested for sheet thickness, melt flow index, tensile properties, tear strength, puncture resistance, carbon black content, and carbon black dispersion. A summary of test results is given in Table 8-1. The rolls received are identified in the tables following Table 8.1. Manufacturers' test results are provided in the LLDPE Installation Report (Appendix G).

Interface friction testing of the LLDPE was performed by an independent laboratory under contract to the Contractor. All tested friction angle values exceeded the minimum required project specifications. Tests reports are provided in Appendix G.

Because of the excellent durability of LLDPE geomembrane, the Contract Documents did not specify that the geomembrane should be covered within a certain period of time after deployment. The Contractor left approximately 640,200 square feet (SF) of geomembrane exposed during the 1995-96 winter shutdown; 496,200 SF on the North Lobe and 144,000 SF on the South Lobe. For quality assurance, the Contractor was required to remove two 4-foot by 4-foot samples from the area exposed during the winter. URSG's field personnel and the Contractor's QA/QC officer chose the locations of these two sample locations of which are shown on the attached supplemental record drawings. The test results of these two samples exceeded the minimum specifications requirements. The associated test reports are provided in Appendix G.

8.1.3 <u>Gas Vent Layer Acceptance</u>

Prior to the placement of any geomembrane, the URSG field personnel and the Contractor's QA/QC officer inspected the gas vent layer and geotextile cushion, as applicable, for any damage or conditions which may affect the integrity of the subsequently placed geomembrane. The gas vent composite was deployed a minimum 5 feet beyond the limit of waste.

TABLE 8.1

LLDPE - RANGE OF LABORATORY TEST RESULTS

Property	Test Method	Specification Requirement	Actual Range	Units
Thickness	ASTM 1593	≥40	41-44	mil
Melt Index	ASTM D1238	≤ 1.3	.850 - .970	g/10 min
Density	ASTM D1505	(0.915 -0.927)	.918 - 0.919	g/cc
Carbon Black Content	ASTM D1603	2.0-3.0	2.16 - 2.97	%
Carbon Black Dispersion	ASTM D3015	A-1, A-2, B-1	A-2	----
Tensile Strength at Break	ASTM D-638	≥55	CD 150-254 MD 151-249	lb/inch
Elongation at Break	ASTM D-638	≥225	CD 556-941 MD 510-969	%
Tear Resistance	ASTM D1004	≥15	CD 26-42 MD 26-39	lbs.
Puncture Resistance	FTMS 101C Method 2065	≥40	61-86	lbs.
Low Temperature Impact	ASTM D-746 Procedure B	≤-70	≤-70	°C
Dimensional Stability (each direction)	ASTM D-1204 212°F, 1 hour	±3.0	CD 0.0 - 1.0 MD 0.0 - 1.8	% change max.
Environmental Stress Crack	ASTM D-1693-B	≥1500	pending	hours

* CD - Cross Direction
MD - Machine Direction

LLDPE ROLLS DELIVERED

DATE DELIVERED	BATCH\ROLL NUMBER	DATE DELIVERED	BATCH\ROLL NUMBER
5/22/95	AE-8432	5/30/95	AE-8347
5/22/95	AE-8438	6/5/95	AF-0112
5/22/95	AE-8425	6/5/95	AF-0114
5/22/95	AE-8426	6/5/95	AF-0111
5/22/95	AE-8433	6/5/95	AF-0115
5/22/95	AE-8437	6/5/95	AF-0095
5/22/95	AE-8405	6/5/95	AF-0107
5/22/95	AE-8439	6/5/95	AF-0113
5/22/95	AE-8428	6/5/95	AF-0106
5/22/95	AE-8427	6/5/95	AF-0108
5/22/95	AE-8423	6/5/95	AF-0091
5/22/95	AE-8331	6/5/95	AF-0096
5/30/95	AE-8330	6/13/95	AF-0098
5/30/95	AE-8340	6/13/95	AF-0117
5/30/95	AE-8409	6/13/95	AF-0103
5/30/95	AE-8408	6/13/95	AF-0105
5/30/95	AE-8346	6/13/95	AF-0122
5/30/95	AE-8394	6/13/95	AF-0123
5/30/95	AE-8352	6/13/95	AF-0097
6/13/95	AF-0119	7/5/95	AF-0573
6/13/95	AF-0099	7/5/95	AF-0631
6/13/95	AF-0118	7/5/95	AF-0587
6/13/95	AF-0126	7/5/95	AF-0590
6/26/95	AF-0602	7/5/95	AF-0632

DATE DELIVERED	BATCH\ROLL NUMBER	DATE DELIVERED	BATCH\ROLL NUMBER
6/26/95	AF-0605	7/5/95	AF-0586
6/26/95	AF-0604	7/5/95	AF-0591
6/26/95	AF-0639	7/11/95	AF-1434
6/26/95	AF-0603	7/11/95	AF-1443
6/26/95	AF-0644	7/11/95	AF-1432
6/26/95	AF-0638	7/11/95	AF-1442
6/26/95	AF-0571	7/11/95	AF-1425
6/26/95	AF-0569	7/11/95	AF-1424
6/26/95	AF-0572	7/11/95	AF-1426
6/26/95	AF-0635	7/11/95	AF-1439
6/26/95	AF-0640	7/11/95	AF-0577
7/5/95	AF-0648	7/11/95	AF-1433
7/5/95	AF-0647	7/11/95	AF-1435
7/5/95	AF-0585	7/17/95	AF-1910
7/17/95	AF-1854	7/24/95	AF-2326
7/17/95	AF-1911	8/8/95	AF-3075
7/17/95	AF-1484	8/8/95	AF-2396
7/17/95	AF-1485	8/8/95	AF-1516
7/17/95	AF-1844	8/8/95	AF-2308
7/17/95	AF-1845	8/8/95	AF-3076
7/17/95	AF-1437	8/8/95	AF-2956
7/17/95	AF-0651	8/8/95	AF-2291
7/17/95	AF-0652	8/8/95	AF-2292
7/24/95	AF-2327	8/8/95	AF-2955

DATE DELIVERED	BATCH\ROLL NUMBER	DATE DELIVERED	BATCH\ROLL NUMBER
7/24/95	AF-2299	8/8/95	AF-2950
7/24/95	AF-2300	8/8/95	AF-2949
7/24/95	AF-2330	8/8/95	AF-2289
7/24/95	AF-1515	8/8/95	AF-2947
7/24/95	AF-2302	8/8/95	AF-2304
7/24/95	AF-2329	8/8/95	AF-2286
7/24/95	AF-2301	8/8/95	AF-2285
7/24/95	AF-1514	8/8/95	AF-2394
7/24/95	AF-2403	8/8/95	AF-2290
8/8/95	AF-2395	10/19/95	AF-3054
8/8/95	AF-2303	10/19/95	AF-3055
8/8/95	AF-2405	10/19/95	AF-3056
8/8/95	AF-2948	10/19/95	AF-3057
9/26/95	AF-3699	10/19/95	AF-5974
9/26/95	AF-3681	10/19/95	AF-5975
9/26/95	AF-3702	5/25/96	AF-7414
9/26/95	AF-3678	5/25/96	AF-7411
9/26/95	AF-3700	5/25/96	AF-7412
9/26/95	AF-3679	5/25/96	AF-7436
9/26/95	AF-3680	5/25/96	AF-7432
9/26/95	AF-3694	5/25/96	AF-7413
9/26/95	AF-3701	5/25/96	AF-7435
9/26/95	AF-3698	5/25/96	AF-7430
9/26/95	AF-3697	5/25/96	AF-7438

LLDPE ROLLS DELIVERED (Continued)

DATE DELIVERED	BATCH\ROLL NUMBER	DATE DELIVERED	BATCH\ROLL NUMBER
10/19/95	AF-1876	5/25/96	AF-7437
10/19/95	AF-1880	5/25/96	AF-7431
10/19/95	AF-1881	5/25/96	AF-7433
10/19/95	AF-3053	5/29/96	AF-7428
5/29/96	AF-7434	6/24/96	AH-2572
6/10/96	AF-4878	6/24/96	AH-1181
6/10/96	AH-3100	6/24/96	AH-1120
6/10/96	AH-3090	6/24/96	AF-9296A
6/10/96	AH-3092	6/24/96	AH-3005FF
6/10/96	AH-1124	6/24/96	AH-3056FF
6/10/96	AH-3086	6/24/96	AF-9297B
6/10/96	AH-2569	8/17/96	AF-6073
6/10/96	AH-2466	8/17/96	AF-7429
6/10/96	AH-3088	8/17/96	AH-2470FF
6/10/96	AH-3094	8/17/96	AF-7445
6/10/96	AF-9297A	8/17/96	AF-0614FF
6/10/96	AH-1180	8/17/96	AE-6617FF
6/24/96	AF-7427	8/17/96	AH-2472FF
6/24/96	AF-9688	8/17/96	AH-2471FF
6/24/96	AF-9296B		

8.2 Construction Methods and Equipment

Geomembrane panels were placed perpendicular to the grading contours. Geomembrane rolls were transported and installed using a rubber-tired fork lift with a telescopic boom. Panels were carefully set in place and unrolled by hand.

The seams were welded together by a fusion or an extrusion welding process. The fusion welding process employed a double hot-wedge welder which fused the two panels together into a double seam with an air channel in the between. The extrusion welding process utilized an extrusion welder to place a bead of LLDPE weld between two panels. In the fusion process, the panels were prepared by being cleaned immediately prior to welding. The extrusion welding process was used for most patches and in areas where the fusion welder could not be utilized due to access constraints. Panels welded together by an extrusion weld were first tack-welded with a lyster, then abraded in the seam area with a grinding wheel prior to application of the extrusion weld.

All penetrations, such as gas vent pipes and manholes, were constructed using pipe boots to maintain the integrity of the geomembrane system during such fine work. Pipe boots consist of a section of LLDPE geomembrane with a protruding pipe-like section. The boots were welded to the surrounding geomembrane and welded or clamped to the pipe or manhole. The Contractor constructed all the boots in the field as per approved shop drawings in the Contract Documents.

8.3 Construction QA/QC Testing

8.3.1 QA/QC Requirements

Construction QA/QC monitoring requirements and reporting for the placement of the LLDPE geomembrane included the following:

- Start-up testing
- Destructive seam testing
- Nondestructive seam testing

- Panel placement report
- Welding report
- Installation report

8.3.1.1 Start-up Testing

At the start of each work day and after each break that resulted in an equipment shutdown, a start-up field test of the seaming equipment was performed on a test strip at or near the work location under the same conditions that existed for the geomembrane welding. The test weld, which was required to be a minimum of 3 feet in length, was run for each welding machine used. During winter when the temperature dropped below 41 degrees Fahrenheit (F), the minimum test lengths were extended to 5 feet for extrusion welds and 24 feet for fusion welds. No welding was allowed below 20 degrees F. One-inch wide cutouts of the test strips were subjected to tensile testing (bonded seam strength) and peel adhesion testing at the site.

A seam test was considered a failure if:

- In the one-dimensional linear tension test (bonded seam strength), the bonded portion of the seam tore before the adjacent sheet material.

- In the peel adhesion test, the two sheets comprising the seam separated at the bond interface before tearing an individual sheet.

- In addition to the above criteria, the bonded seam strength testing and peel adhesion testing was required to meet specified minimum strengths (see Section 8.1.1 of this report).

A log was maintained by the Contractor and URSG for the purpose of recording all test results.

8.3.1.2 Destructive Seam Testing

At a minimum frequency of one test per 500 lineal feet of weld, a short section of the fabricated seam was cut from the installed geomembrane and tested on site for linear tension and peel adhesion. A duplicate sample concurrently was sent to the Contractor's laboratory for the peel and shear tensile testing. The cutout sections were wide enough to perform the required field tests, as well as to obtain a minimum of ten 1-inch wide specimens for laboratory tensile testing (i.e. five 1-inch specimens for laboratory peel, and five 1-inch specimens for laboratory shear testing). The size of cutout section for the laboratory testing was a minimum of 24 inches wide by 15 inches long with the longer dimension parallel to the seam. The sample for the laboratory testing was cut into two parts for distribution as follows:

- One sample for laboratory testing by an independent testing laboratory.
- One sample for Town of Ramapo archive storage.

When the total constructed seam in a working day was less than 500 feet but more than 250 feet, one destructive sample was collected. No samples were collected on any days that less than 250 feet was welded.

8.3.1.3 Nondestructive Seam Testing

URSG field personnel and the Contractor's QA/QC officer visually inspected all seams together. In addition, the Contractor was required to test all seams (in the presence of the URSG field personnel monitor) utilizing a vacuum box or air pressure testing as nondestructive testing. The URSG field personnel monitor observed all nondestructive seam testing and documented all results.

8.3.1.4 Panel Placement Report

Prior to panel placement, URSG field personnel inspected the gas vent layer and geotextile cushion, as applicable, for any damage or conditions which would interfere with the integrity of the geomembrane. After the geomembrane was deployed, URSG field personnel walked with the Contractor's QA/QC officer to jointly look for any damage in the geomembrane which required repair. The Contractor's Panel Placement Report is included in Appendix G.

8.3.1.5 Welding Report

Double hot-wedge fusion welders were used to weld the panels as they were deployed. When it was not feasible to use double hot-wedge fusion welders due to repairs, gas vent, and manhole penetrations, etc., an extrusion welder was used. The Contractor's welding report is included in Appendix G.

8.3.2 QA/QC Test Results

Installation of the LLDPE geomembrane layer for the final cover system was carried out in accordance with the Contract documents. The results of the QA/QC testing are discussed below.

8.3.2.1 Start-up (Trial) Testing

Start-up (trial) samples were tested in the field on a Columbine International Tensile and Peel Test Machine (Tensiometer). The tensiometer was calibrated by Strain Sense Enterprise. If the welding machines failed their start-up calibration tests, then one or more parameters (e.g., preheat or extruded temperature, machine speed) were varied until passing results were obtained. A copy of the start-up test results from the Contractor and URSG are included in Appendix G.

8.3.2.2 Destructive Seam Test Results

Destructive seam testing was carried out in accordance with QA/QC requirements. The total measured seam length of LLDPE geomembrane is 124,335 LF. The work is represented by 253 destructive tests, not including additional tests which were performed to successfully bracket initially failed tests. Field tests were conducted on a portion of the samples on the same tensile and peel machine described. If the field tests satisfied the Contract requirements, then the samples were sent to the independent laboratory for laboratory peel and shear testing. The locations of all destructive seam samples are shown on the attached supplemental record drawings. The LLDPE geomembrane destructive seam test reports from the Contractor and URSG are included in Appendix G.

When a sample failed either its field or laboratory testing, additional destructive seam samples were collected and tested to bracket the failed seam area. These samples were noted as "B" (before) and "A" (after) to indicate their locations in relation to the failed sample and the direction of travel of the welding machine. "A" or "B" samples were always taken from seams made by the same machine on the same day as the failed sample. These additional (bracket) samples were 10 feet apart from the failed sample. When both "A" and "B" samples passed laboratory testing, the seam between them would be covered with a strip, or cap, of geomembrane and then welded. On occasion, an "A" or "B" sample would not required to be collected if the failed seam location was within 10 feet of the beginning or end of the weld constructed that day.

8.3.2.3 Non-Destructive Seam Test Results

The entire length of all seams for LLDPE geomembrane was nondestructively tested by Contractor and observed by the Contractor's QA/QC monitor and URSG field personnel. The results of all testing were recorded by the monitor and documented by Geo-Con.

Double fusion welded seams created by the hot double-wedge welder were air pressure tested. In this method, both ends of the seam were sealed off and a test needle connected to a pressure gauge was inserted in one end of the seam. The air in the channel was pressurized to between 25 and 32 pounds per square inch (psi). If the pressure was maintained with less than a 4 pounds per square inch (psi) drop over 5 minutes, the seam was deemed acceptable. The seam was then opened at the far end from the pressure gauge and the drop in pressure observed by the URSG field personnel as verification that the entire length of seam had been opened and tested. Seams which failed air-pressure testing were rewelded and then vacuum-box tested.

Where possible, all the extrusion welds were vacuum tested. A soap and water solution was applied to the seam area. A minimum of 5 psi suction was maintained for 15 seconds or until a leak was observed in the seam. In the few instances where a vacuum box could not be applied to a portion of a seam due to gas vent and manhole penetrations, etc., such welds were carefully scrutinized by visual inspection. Such inspections were always carried out by a qualified inspector.

All the boots for gas vents, conduits, manholes, poles and supporting cables were field fabricated. All the boots were vacuum tested and visually inspected.

Any holes or leaks detected by the nondestructive seam tests were repaired, and the resultant patch tested. Only when all portions of a seam had been successfully tested would the Contractor and URSG concur that the entire seam, including patches, had passed the nondestructive seam test. Copies of all nondestructive seam test reports from the Contractor and URSG are included in Appendix G.

8.3.2.4 Panel Placement

Each roll of geomembrane was assigned a panel number or numbers. A panel is define as the unit area of continuous in-place geomembrane sheet which is to be seamed. One roll may constitute one panel if the roll was uncut or the roll could be cut into several panels. All panels were welded with 3-inch overlap on the same day that they were deployed. Even though the cover system is considered veneer-stable with no interface friction concerns, all the cross-seams (seams parallel to grading contours) on slopes greater than 10 percent were welded at about 45 degree angles to the contour so that primary stresses were not oriented perpendicular to the seam. These cross-seams were at least 45 degree angles apart on the adjacent panels. At the end of each working day, panels were properly secured with sand bags. The length of every panel was measured along the center of the panel. The typical width of each panel was 23 feet. Most of the "pie-type", pieces such as at corners, were triangular in shape. Surface areas for all the pie-pieces were calculated in the Contractor's Panel Placement Report. The Panel Placement Report includes panel number, roll number, date of deployment, surface area, and approximate location. The Panel Placement Report from the Contractor is included in Appendix G.

8.3.2.5 Welding Report

The machines which were start-up tested were used to weld the panels together after their deployment. The parameters monitored, like preheat temperature and speed, were the same as those in the start-up tests. All seams are identified in the Contractor's Welding Report, a copy of which is included in Appendix G.

8.3.2.6 Installation Report

The Contractor prepared and submitted an Installation Report which included all the field quality control forms and test results completed by the Contractor during the installation of LLDPE geomembrane. Specifically, the Installation Report includes the following:

- Certification letter
- Geomembrane roll numbers and certifications
- Panel roll numbers and placement date
- Geomembrane seaming records
- Geomembrane seam test records
- Geomembrane trial seam records
- Geomembrane seam destructive log
- Repair log
- Subgrade acceptance
- Installer warranty
- Record drawing coordinates

A copy of the Installation Report is included in Appendix G.

8.4 HDPE Geomembrane (Secondary Containment)

8.4.1 Construction and Material Requirements

The secondary containment barrier layer for the leachate storage tank area was required to be an HDPE geomembrane with a minimum thickness of 60 mils with textured surfaces.

The HDPE geomembrane was required to be manufactured from resin having a minimum (blended) density of 0.94 gram per cubic centimeter and a maximum flow index of 0.3 gram per 10 minutes. Physical and environmental standards specified for the final geomembrane product were provided in the site Contract Documents. All welds were required to exhibit an FTB during destructive seam testing, meaning the geomembrane sheet itself must have torn before the weld failed. All welds were required to meet the following seam strengths:

Peel Adhesion	Shear
70 lb/in	105 lb/in

8.4.2 Material Quality Testing

Material QA/QC testing included those performed by the manufacturer themselves. This testing was conducted on both HDPE resin and finished HDPE geomembrane product. Resin testing was performed to determine melt flow index and density. Geomembrane rolls were tested for sheet thickness, melt flow index, tensile properties, tear strength, puncture resistance, carbon black content, and carbon black dispersion. Manufacturers' test results are provided in the HDPE Installation Report presented in Appendix G.

A summary of test results is given in Table 8-2.

TABLE 8.2
HDPE-RANGE OF LABORATORY TEST RESULTS

Property	Test Method	Specification Requirement	Actual Range	Units
Thickness	ASTM 1593	≥60	60-61	mils
Density	ASTM D-1505	≥0.930	0.945-0.948	grams/cubic centimeter
Melt Flow Index	ASTM D-1238 Condition E	≤ 0.3	0.09-0.15	g/10 min
Carbon Black Content	ASTM D-1603	2.0-3.0	2.4	%
Carbon Black Dispersion	ASTM D3015	A-1, A-2, B-1	A-1	----
Tensile Strength at Break	ASTM D-638	≥75	174-216	lb/in width
Elongation at Break	ASTM D-638	≥150	381-584	%
Tear Resistance	ASTM D-1004 Die C	≥40	62-66	lbs.
Puncture Resistance	FTMS 101C Method 2065	≥75	125-127	lbs.
Low Temperature Impact	ASTM D-746 Procedure B	≤-70	Not tested	°C
Dimensional Stability (each direction)	ASTM D-1204 212°F, 1 hour	±2.0	Not tested	% change max.
Environmental Stress Crack	ASTM D-1693-B	≥1500	Pending	hours

NOTE: A total of 2 rolls were tested. (Roll #04018453 & 04019406)

8.4.3 Subgrade Acceptance

Prior to placement of HDPE geomembrane in the leachate storage tank area, the URSG field personnel and Contractor's QA/QC officer together inspected the previously placed geotextile cushion for any damage or conditions which may have interfered with the integrity of the geomembrane.

8.4.4 Construction Methods and Equipment

HDPE geomembrane was installed both inside the ring wall (underneath the tank) and outside of the concrete ring wall, as secondary containment. To create a continuous barrier and to seal off the concrete, polylock, an HDPE surface "anchor" cast into the concrete, was installed to weld the geomembrane to the concrete ring wall. An HDPE boot was also installed at the central tank support. The construction methods and equipment used for the 60 mil HDPE geomembrane installation are consistent with those used for the 40 mil LLDPE geomembrane installation.

8.4.5 Construction QA/QC Testing

Most of the construction QA/QC requirements for the 60 mil HDPE geomembrane are similar to those for 40 mil LLDPE geomembrane (as discussed in Section 8.3), except the HDPE geomembrane implemented the following:

- Typical roll width was 22 feet.
- Polylock welding was visually inspected and was not considered in total seam length.
- Total measured seam length for HDPE geomembrane was 1,507 feet.
- The work was represented by three destructive seam tests

The HDPE geomembrane QA/QC tests results recorded by both the Contractor and URSG are included in Appendix G.

8.4.6 <u>Installation Report</u>

Geo-Con prepared and submitted an Installation Report which included all field quality control forms and test results completed by the Contractor during installation of the HDPE geomembrane. Specifically, the Installation Report includes the following:

- Certification letter
- Geomembrane roll numbers and certifications
- Panel roll numbers and placement date
- Geomembrane seaming records
- Geomembrane seam test records
- Geomembrane trial seam records
- Geomembrane seam destructive log
- Repair log
- Subgrade acceptance
- Installer warranty
- Record drawing coordinates

9.0 GENERAL FILL and SELECT GENERAL FILL LAYERS

9.1 Construction and Material Requirements

General fill is the layer directly beneath the topsoil of the final cover system and on top of the GDS layer. General fill was placed in a single 12-inch thick layer except in the pistol range area which required two separate 12-inch thick layers for a total thickness of 24 inches. The maximum particle size in this material is 3 inches measured in its greatest dimension. Each lift was required to be compacted to a minimum of 90 percent of the Standard Proctor maximum dry density. There was not any specific numerical moisture requirement for general fill.

Select general fill performs the same function as general fill beneath the topsoil layer of the final cover system except that, due to its small (3/8 inch) top grain size, it was placed directly on top of the geomembrane with no GDS in between. This material was used on slopes less than 10 percent on the North Lobe over approximately 5.9 acres. Select general fill was placed in a 12-inch thick layer. Each lift was required to be compacted to a minimum of 90 percent of the Standard Proctor maximum dry density. There was not any specific numerical moisture requirement.

9.2 Construction Methods and Equipment

As mentioned in Section 5, a test pad procedure was also required for general fill. The general methods and procedures employed in the successful completion of the test pad were implemented for the placement of the General Fill layer as part of the final cover system. The test pad was constructed on top of the GDS layer of the in-place final cover except for Sawmill stockpiles A, B, and C which were removed because they were constructed on the subgrade prior to geomembrane placement.

The borrow material was generally hauled directly from the stockpiles to the area of placement using offsite trucks from both the Owner-furnished sources and the offsite Contractor-furnished sources. The soil was spread over the GDS using a low ground pressure dozer. Care was taken to prevent damage to the underlying GDS during the placement operation. Each lift was compacted with a minimum of two to four passes with a vibratory smoothdrum roller.

In the pistol range area, upon successful testing of the first lift, the surface was scarified for bonding with the second lift. The second lift was placed and compacted in the same manner as the first.

The general methods and procedures employed in the successful completion of the test pad were implemented for the placement of the 12-inch Select General Fill layer. The test pad was constructed as part of the Select General Fill Layer. The borrow material was hauled directly from the sources to the area of placement generally using 10-wheel dump trucks or 18-wheel tractor trailer dump trucks. The 12-inch lift was spread over the LLPDE geomembrane using a low ground pressure dozer. Care was taken to prevent damage to the underlying geomembrane during the placement operation.

If a lift failed in-place moisture-density testing, the affected area would receive either additional compaction or be completely reworked depending on the cause of failure. The Contractor made additional passes with the vibratory smoothdrum roller if the lift required additional compaction. This procedure was repeated until the area met the moisture-density requirements.

9.3 Construction QA/QC Monitoring Requirements, and Results

9.3.1 QA/QC Requirements

Construction QA/QC monitoring of the placement of General and Select General fill soils included visual inspection of placement procedures, as well as moisture-density tests performed on the compacted fill using a nuclear densitometer. Nuclear densitometer tests were conducted in accordance with ASTM D3017 and D2922. These tests determined the in-place moisture content and dry density, respectively. The minimum frequency of tests was nine test per acre-lift. The acceptance criterion for moisture-density tests was in-place dry density greater than 90 percent of the Standard Proctor maximum dry density.

The general and select general fill layers were placed in a 12-to 15-inch thickness to avoid damaging the underlying geosynthetics. In-place moisture-density tests taken on these layers generally were performed at a 10-inch depth to assure that the underlying geosynthetics were not punctured during testing. All holes left by the nuclear densitometer were filled with soil of the same type as the fill layer itself and compacted prior to placement of the topsoil layer.

The quantity of QA/QC tests performed versus the number required is presented in Table 9.1. The range of QA test results is presented in Table 9.2

9.3.2 QA/QC Test Results

In-place moisture-density tests were performed on each lift of the general and select general fill layers at or exceeding the minimum frequency of 9 per acre per lift. The total number of tests required versus the total number of in-place moisture-density tests performed for QA/QC testing is presented in Table 9.3. This table demonstrates that the number of tests performed satisfies the required testing frequency.

TABLE 9.1

SELECT GENERAL FILL - TEST FREQUENCY SUMMARY

Royal Land

Test Description	Min. Frequency Required	Total Tests Required (1)	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	6	6
Standard Proctor ASTM D-698	1/5,000 cy and when a change in material occurs.	3	3
As Received Moisture Content ASTM D-2216	1/1,000cy	12	16
Atterberg Limits ASTM D-4318	1/1,000cy	12	16
Interface Friction ASTM D-5321	1/5 acres	1	1

NOTES:

1) Total number of tests required is based on 11,149 cubic yards of earth fill in place.

TABLE 9.1 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Stockpile "I"

Test Description	Min. Frequency Required	Total Tests Required	Total Test Performed
Grain Size w/ Hydrometer ASTM D-422	1/2,500 cy	1	1
Standard Proctor ASTM D-698	1/5,000 cy and when a change in material occurs.	1	1
As Received Moisture Content ASTM D-2216	1/1,000cy	1	2
Atterberg Limits ASTM D-4318	1/1,000cy	1	2
Interface Friction ASTM D-5321	1/5 acres	1	1

Note:

(1) Stockpile "I" is part of stockpile "D".

TABLE 9.2

SELECT GENERAL FILL - RANGE OF TEST RESULTS

Royal Land

Test Description	Range of Test Results	Requirement
Grain Size ASTM D -422 % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 100 % 22 - 28 % 0 - 4 %	 100 % 20 - 40 % < 10 %
Standard Proctor ASTM D - 698 Maximum Dry Density Optimum Moisture Content	 118.1 - 119 .7 pcf 10.5 - 11.9 %	 None None
As received Moisture Content ASTM D - 2216	7.3 - 14.5 %	None
Atterberg Limits ASTM D - 4318	NP	None
Interface Friction ASTM D - 5321	30.6 °	≥ 9 °

TABLE 9.2 (Continued)

GENERAL/STRUCTURAL FILL - TEST FREQUENCY SUMMARY

Stockpile "I"

Test Description	Range of Test Results	Requirement
Grain Size ASTM D - 422 % finer than 3 inch % finer than #200 seive % finer than 0.002 mm	 98 % 32 % 0 - 4 %	 100 % 20 - 40 % < 10 %
Standard Proctor ASTM D - 698 Maximum Dry Density Optimum Moisture Content	 129.2 pcf 8.0 %	 None None
As received Moisture Content ASTM D - 2216	9.2 - 9.4 %	None
Atterberg Limits ASTM 4318	NP	None
Interface Friction ASTM 5321	37.7°	≥ 9°

Note:

(1) Stockpile "I" is part of Stockpile "D".

TABLE 9.3

GENERAL

Test Description	Min. Frequency Required	Total Tests Required	Total Test Performe d	Actual Frequency
North Lobe (1) General Fill	9/Acre	313	445	13/Acre/Lift
South Lobe (2) General Fill	9/Acre/Lift	126	239	17/Acre/Lift
North Lobe (3) Select General Fill	9/Acre/Lift	49	66	12/Acre/Lift
South Lobe (4) Select General Fill	9/Acre/Lift	14	22	15/Acre/Lift

NOTES:

1) Total number of tests required is based on approximately 34.7 acres of earth fill in place.

2) Total number of tests required is based on approximately 14.0 acres of earth fill in place.

3) Total number of tests required is based on approximately 5.4 acres of earth fill in place.

4) Total number of tests required is based on approximately 1.5 acres of earth fill in place.

10.0 LEACHATE COLLECTION SYSTEM IMPROVEMENTS

Leachate collection system improvements consist primarily of deepening existing stone-filled collector trenches and constructing new stone-filled trenches, new extraction wells, new lift pump stations, a new leachate storage tank, and abandoning existing features such as manholes, collector pipes, and the leachate storage pond.

The Leachate Collection System Improvements are found on drawings 9, 10, 32, 33, 48, and 49.

10.1 Trench Excavation

Existing stone-filled collector trenches were excavated to 6 inches below the proposed pipe invert except in areas where rock was encountered. In these areas the excavation was carried to 12 inches below the proposed pipe invert. Unexpected rock was encountered and removed between MH A-13 and MH A-14 in the West Collector. The rock was approximately one foot higher than therefore, 13 cubic yards was removed. Likewise, high elevations of rock, 24 feet higher than expected were discovered along the North Collector. Six test pits were excavated parallel with the centerline of the existing North Collector to determine the top of rock elevation. These pits were to confirm the findings of a geophysical study by Woodward Clyde. Approximately 59 cubic yards of rock needed to be removed between MH A-19 and MH- A19A along the North Collector. There also was approximately 119 cubic yards of boulders removed from this excavation. The trench excavation was benched back to approximately a 2V:1H slope for stability. Trench boxes were used to support the lower portions of the trench excavation.

Groundwater was encountered during the excavation of all three collector sections. The trenches were dewatered into the existing leachate collection system.

10.2 Piping, Bedding, and Backfill (including gravity mains)

The Leachate Collection Pipe was a 12-inch diameter schedule 80 PVC pipe with two ⅜-inch holes staggered 12 inches apart at 120 degrees over the entire length of the pipe. The orientation of the perforations was upward.

Water/leachate transferred from the new extraction wells and lift stations was conveyed in gravity mains to the pump pit (wet well). The gravity main consists of a 4-inch and six 6-inch diameter solid schedule 80 PVC pipe. The 6-inch gravity main segments on the west side of Torne Valley Road and the road crossing into MH A-5, and 4-inch gravity main segments east of Torne Valley Road including the road crossing out of MH C-30.

After several attempts to hydrostatically pressure test the 6-inch gravity main between MH A-5 and well W-7 with failing results and discovering several leaks, the Contractor decided to completely replace the 6-inch gravity main between MH A-5 and well W-4; leaks were successfully repaired between well W-4 and W-7.

Table 10.1 provides hydrostatic pressure test results. As a result of a failing hydrostatic pressure test , the Contractor was permitted to use a 2-inch diameter HDPE pipe with welded joints to slip-line the 4-inch gravity main between W-6 and MH C-30 and also for the road crossing between MH C-30 and the 6-inch gravity main. This was as a result of a failing hydrostatic pressure test in the above mentioned gravity mains. The slip lining proved successful.

This procedure was used to avoid:

- Excavation across Torne Valley Road.
- Leaks were under TV Road and/or under approved sections of the landfill cap.
- Engineering calculations showed that 2" and HDPE was hydraulically sufficient to carry the anticipated leachate/groundwater volumes

TABLE 10.1

HYDROSTATIC PIPE TEST RESULTS

Pipe Name	Portion of Line Tested	Pipe Size	Pipe Material	Initial Pressure (PSI)	Final Pressure (PSI)	Test Duration (HRS)	Test Result
Leachate Transfer	Post Aeration Tank to Meter Pit	6"	PVC	150	150	4	Passed
Leachate Transfer (4)	Pump Pit to Meter Pit thru V.C. No. 1	6"	PVC	99	99	4	Passed
Leachate Transfer (5)	Pump Pit to Meter Pit thru V.C. No. 1	6"	PVC	104	104	2	Passed
Gravity Main	MH-A-5 to MH W-1	4"	PVC	105	105	4	Passed
Gravity Main	MH-A-5 to W-20	4"	PVC	108	108	2	Passed
Gravity Main	MH W-6 to MH C-30	2"	HDPE	102	102	3	Passed
Gravity Main (1)	MH C-30 to 6" Gravity Main	3"	HDPE	110	108	2	Passed
Gravity Main (2)	MH A-10 to MH A-5	6"	PVC	115	109	19.25	Passed
Leachate Transfer	Pump Pit to Leachate Storage Tank thru V.C. No. 1	4"	PVC	90	90	4	Passed

Pipe installation commenced at the lower end of the pipeline with the bell end upgradient. The bell and spigot was cleaned with a pipe cleaner prior to applying a PVC cement glue.

Compacted NYSDOTSS No. 1 stone was used for pipe bedding 8 inches below the pipe. Additional stone was placed and compacted to the pipe spring-line and then to a minimum 12 inches above the pipe.

NYSDOTSS No. 1 stone was also used to bed and backfill around the leachate collector pipe. This stone and pipe was encapsulated in a geotextile filter fabric.

Trench-excavated material was reused as trench backfill, placed and compacted in 12-inch lifts. A vibratory plate tamper and/or jumping jack was used to compact the backfill for the gravity main. A Wacker RT 820 remote sheepsfoot roller was used to compact the backfill in the south and west leachate collectors. The Contractor requested and received a variance in the lift thickness and compaction method for backfilling the North leachate collector. The variance permitted a 2-foot lift compacted with the bucket of both a Caterpillar and a Hitachi backhoe, in areas outside of road crossings. For road crossing areas, NYTDOTSS No. 2 stone and Item No.4 subbase stone was placed and compacted in 12-inch lifts.

10.3 Lift Pump Stations and Extractions Wells

There were three lift stations proposed in this contract. The lift station proposed at MH-A-19 was eliminated because rock was encountered approximately 19 feet higher than expected. A pair of submersible effluent pumps with a one-half horsepower motor were installed in each of the two remaining proposed lift stations, Lift Station A-10 and W-20, to transfer leachate from the lift station, through the gravity mains, to the leachate storage and/or final treatment destination. The submersible effluent pumps were manufactured by Goulds Pumps. The flow rate exceeded the minimum specified capacity required by the Contract documents. The pumps are controlled by a float-type level switch and will operate based on the liquid level in the lift station.

JCA Drilling drilled boreholes for extraction wells W-1 to W-7 to determine the geological formation at each well location. This information was used to determine the required depths, slot size, and filter pack gradation for the wells. Stainless steel 8-inch diameter schedule 40 risers and 0.020 inch screen were installed in each well. One submersible pump was installed in each well to lift and transfer leachate from the extraction wells. One-third horsepower motors were installed in wells W-1, W-5 and W-6 which are not expected to receive large flows. One-half horsepower motors were installed in wells W-2, W-3, W-4, W-7 which are located in more porous soils on the west side of Torne Valley Road. The submersible pumps installed were manufactured by Grundfos. The flow rates exceeded the minimum specified capacity in the Contract Specifications. See Table 10.2 for actual flow rates determined by field pump tests. The pumps are controlled by an electronic level sensor and will operate based on the groundwater level in the well.

Each lift station and extraction well has a local control panel.

10.4 Leachate Pond Decommission

The existing leachate pond was located at the south end of the landfill between existing Wetland No.4 and the new South Wetlands. It was decommissioned to allow for the construction of the new leachate storage tank. The work consisted of excavation of existing leachate contaminated soils and existing concrete slabs. Leachate pond sediments were mixed with dry soil and spread out to dry on the landfill surface prior to final placement and compaction. All leachate contaminated material was disposed of in the North lobe (west of the pistol range), prior to installation of the geomembrane system. The contaminated concrete was reduced in size prior to disposal in the landfill. There was no analytical testing of the leachate contaminated material because it was disposed of at the source of contamination (landfill).

After the excavation was complete, the floor and side slopes were graded, shaped, and compacted to the approximate lines and grades indicated on the Contract drawings. Structural fill was then placed for the soil foundation of the leachate storage tank.

10.5 Leachate Storage and Transfer System

After the subgrade for the leachate storage tank foundation was prepared, the Contractor formed and placed approximately 75 cubic yards of reinforced 4,500 psi concrete to comprise the ring foundation for the storage tank. Pittsburgh Tank and Tower erected the 250,000-gallon, 55-foot diameter steel tank with a center column support. The interior and exterior tank surfaces were sandblasted to a SSPC-SP10 and SSPC-SP6 finish respectfully, prior to applying approved Sherwin-Williams primer and paint.

The seams in the bottom were vacuum tested and the side walls x-rayed showing no apparent deficiencies. The tank was also hydrostatically tested for a 24-hour period with no evidence of leakage.

An HDPE geomembrane was installed as part of the Secondary Containment System. Installation details and test results are provided in Section 8.4.

As much of the existing components of the previously existing forcemain were utilized as possible. A 6-inch diameter schedule 80 PVC leachate transfer pipe line was installed between the previously used post-aeration tank and meter pit. A 4-inch diameter PVC Schedule 80 gravity return line was installed from the leachate tank to the pump pit. The existing 6-inch diameter PVC force main between the pump pit and previously used post aeration tank was replaced because several leaks were found during hydrostatic testing by Geo-Con.

The existing submersible pumps in the pump pit were replaced with three KSB submersible pumps to transfer the landfill leachate to the POTW (RCSD #1). The flow rate exceeded the minimum design capacity required by the Contract Specifications. See Table 10.2 for actual flow rates estimated/determined in the field. New mercury level float switches were installed at specified levels to control the pumps. A level sensor was installed in the Leachate Storage Tank and in the Secondary Containment System which will disable the pumps in the pump pit if a high level alarm occurs.

TABLE 10.2

PUMP TEST FLOW RATE RESULTS

PUMP NO.	FLOW RATE (GPM)
Extraction Well W-1	21.5
Extraction Well W-2	26.2
Extraction Well W-3	25.4
Extraction Well W-4	24.3
Extraction Well W-5	5.95
Extraction Well W-6	7.9
Extraction Well W-7	7.6
Lift Station A-10, Pump 1	71.1
Lift Station A-10, Pump 2	66.6
Lift Station W-20, Pump 1	73.4
Lift Station W-20, Pump 2	72.3
Wet Well Pump LP-11	328.4
Wet Well Pump LP-12	332.5
Wet Well Pump LP-13	300.4

10.6 Control Room

West-Fair Electric modified the existing pump control room adjacent to the pump pit with devices to interface between existing and newly-installed equipment. Switches, relays, and timers were installed along with controls and alarms.

Hi-Tech Services installed an auto-dialer in the pump control room and a computer with a printer in the Town of Ramapo police station to remotely monitor alarm conditions for the leachate collection/transfer/storage system at the landfill.

11.0 SPECIAL FEATURES

11.1 Gabion Retaining Wall

Two gabion retaining walls were constructed along Torne Valley Road, one at the South and one at the North Lobe. The gabion units were installed on a 6-inch thick concrete "mud" slab foundation. The gabion units consisted of rectangular compartment basket containers either 18 inches x 36 inches x 36 inches, or 36 inches x 36 inches x 36 inches constructed of hot-dipped galvanized steel wire gage No. 11. The baskets were filled with NYSDOTSS SECTION 712-15 stone which consisted of a minimum size of 4-inch and a maximum size of 12-inch stone. The gabion units were laced together using a continuous stitch tie wire to obtain a monolithic structure.

11.2 Wetlands

The Contractor constructed two new wetland areas; the North wetlands and South wetlands. Both are adjacent to the leachate tank area, and the North wetlands is also adjacent to existing Wetland Area 4. All three wetland areas were lined with geosynthetic clay liners due to disturbances caused by temporary erosion and sediment control there. The subgrade was prepared to design grade prior to deploying Bentomat ST and Claymax 500SP geosynthetic clay liners. These clay liners were covered with 6 inches of topsoil.

DaCosta Landscaping Contractors Corp. established a 2-foot grid on center for the plantings. A timed-released fertilizer was placed in 2 to 4-inch deep holes in the topsoil. Typha species was planted on the wetland floor; Scirpus and Carex species were randomly mixed and planted on the side slopes up to the wetland boundaries.

The primary method used to measure the wetlands mitigation success was visual observation. After the wetland plantings were in-place, Geo-Con employed netting draped over the new plantings to protect against the native waterfowl.

During the period of plant establishment, the plantings were visually monitored for acceptable growth. The netting was then removed and any plantings which did not survive were replanted at Geo-Con's expense.

The wetlands receive rainwater runoff from the landfill and Bear Mountain to the east.

11.3 Pistol Range

The Pistol Range was re-constructed on the southeast portion of the North Lobe and configured in a horseshoe shape. This area is approximately 5.5 acres. The general fill layer is 24 inches thick in this area, 12 inches thicker than other final cover areas to act as a physical cushion barrier against bullets. Electrical conduit and handholes were installed around the pistol range perimeter to accommodate wiring and lighting which will be installed by others at a later date. The North lobe access road also serves to provide accessibility to the pistol range.

12.0 TURF

12.1 Construction and Material Requirements

A 6-inch topsoil layer was placed above both the general fill and select general fill layers to complete the final cover system. Approximately 6.5 acres of the landfill surface was covered with owner supplied topsoil (existing on-site material which was stripped by Contractor). The remaining 54.4 acres was covered by Contractor supplied topsoil from off-site sources provided by AMR/Emerson and Royal Land. Offsite topsoil generally met the contract requirements. Final acceptance based on an acceptable stand of turf. The entire landfill site subsequently was mulched, fertilized, and seeded to establish vegetative growth in accordance with the Contract Specifications.

12.2 Construction Methods and Equipment

Both the Contractor-furnished and Owner-furnished topsoil materials were hauled directly to the area of placement using dump trucks. The topsoil was spread in a minimum 6-inch layer using bulldozers. Required thicknesses for the topsoil were verified using grade stakes on a grid no greater than 40 feet x 40 feet.

12.3 Construction QA/QC Monitoring Requirements

To demonstrate a minimum of 6 inches of topsoil was placed, the Contractor hand dug test holes on a grid no greater than 40 feet x 40 feet. A URSG representative was present to verify the results. In area where less than 6 inches of topsoil was observed, additional topsoil was placed and graded, with subsequent depth verification.