OPERATION AND MAINTENANCE MANUAL
POST-CLOSURE CARE AND MONITORING

TOWN OF WALLKILL LANDFILL
ORANGE COUNTY, NEW YORK
SITE REGISTRY NO. 3-36-017

Prepared for

TOWN OF WALLKILL

By

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TOWN OF WALLKILL

OPERATION AND MAINTENANCE MANUAL
POST-CLOSURE CARE AND MONITORING

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Section 1

1.0 INTRODUCTION

This Operation and Maintenance (O&M) Manual is prepared to provide for 30-year post-closure care and monitoring following the remediation/closure of the Town of Wallkill Landfill, which is a New York State Class 2 Superfund Site (Site Registry No. 336017).

1.1 Site Description

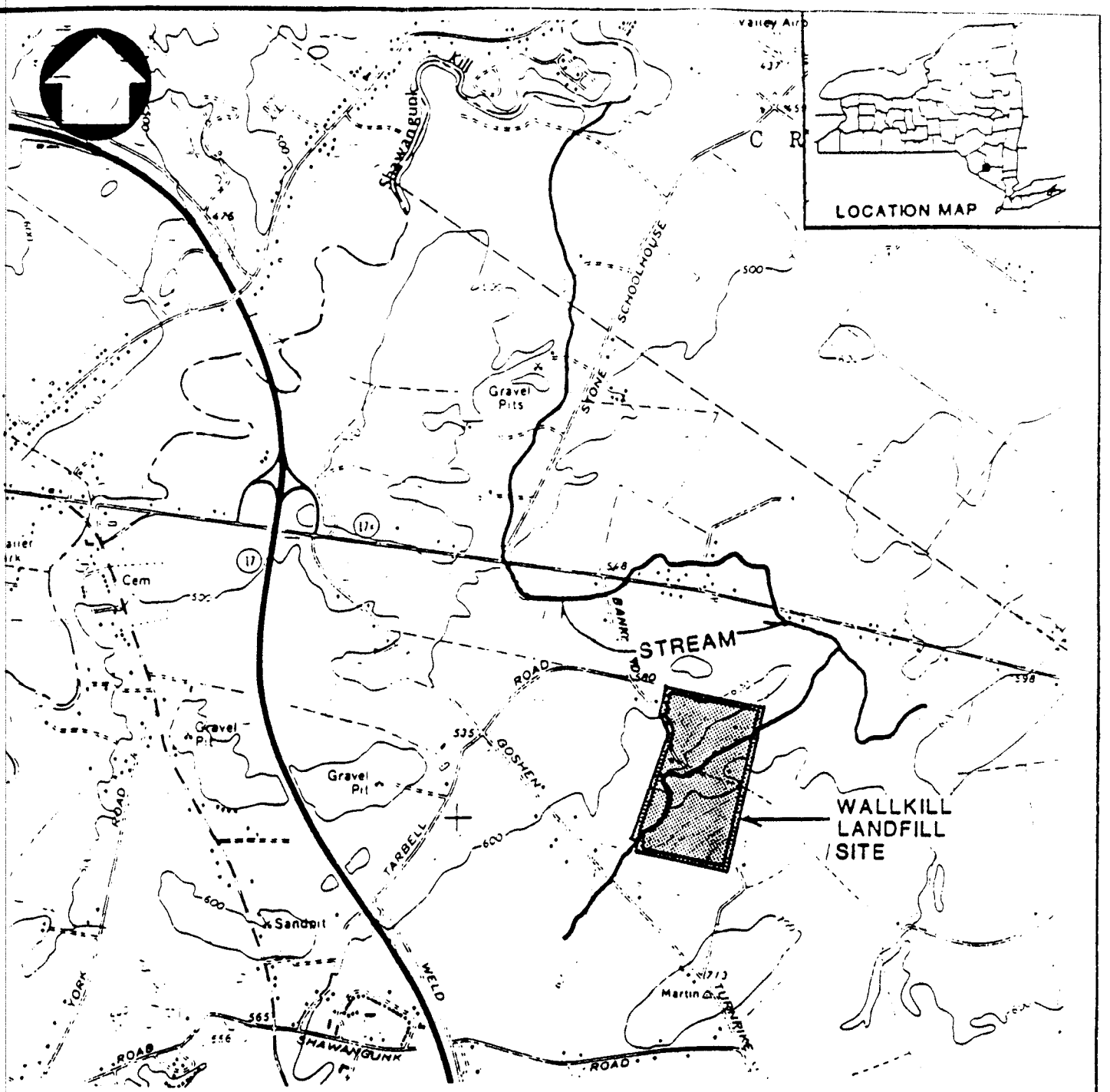
The Town of Wallklill Landfill, owned and formerly operated by the Town of Wallkill, is located in the westernmost portion of the Town of Wallkill, in Orange County, New York, between Route 17K and the Goshen Turnpike, at the terminus of Banke and Tarbell Roads (see Figure 1). Prior to operating as a municipal landfill, the property was owned by the Dickenson Sand and Gravel Company and served as a sand and gravel mining operation.

The site consists of approximately 68 acres of land, of which approximately 23 acres were utilized for the disposal of municipal and industrial solid waste. The area immediately surrounding the site consists of agricultural/farmland, open fields, woods and some low lying marsh areas. An unnamed stream (Tributary 20 of the Shawangunk Kill [NYSDEC stream classification system]) traverses the site, flowing in a northeasterly direction.

The landfill waste mass is defined by two separate and distinct, unlined cells which are separated by Tributary 20. The waste mass lying to the north and west of Tributary 20 (approximately 8 acres) is referred to as the North Cell. The waste mass lying to the south and east of Tributary 20 (approximately 15 acres) is referred to as the South Cell.

1.2 Site History

The Town of Wallkill Landfill was a sanitary landfill from 1965 to 1974. In addition to residential and commercial solid waste, the site also accepted battery recycling by-products, drummed wastes of unknown origin and contents, and sludge from the Town's municipal



Source: U.S.G.S. WURTSBORO QUADRANGLE

0 1000 2000
SCALE IN FEET

TOWN OF WALLKILL, ORANGE COUNTY, NEW YORK

SITE LOCATION MAP

WILLIAM F. COSULICH ASSOCIATES, P.C.
ENVIRONMENTAL ENGINEERS

FIGURE 1 - 1

wastewater treatment facility during its period of operation. Subsequent to closure of the landfill in September 1974, it is reported that a final cover comprising approximately two feet of soil was placed on the areas used for landfilling in accordance with New York State regulations in effect at that time.

Investigations at the site were performed in early 1981 by the New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH), which included sampling and analysis of landfill leachate and residential water supply wells. Results of these sampling programs identified low levels of volatile organics and metals in leachate from the landfill. However, neither metals nor organic compounds were detected in the private water supply wells. Subsequently, the Town of Wallkill applied to New York State for funding to undertake an environmental evaluation/investigation of the former landfill site. The resulting investigation consisted of the installation of nine groundwater monitoring wells and the sampling and analysis of leachate, soil, surface water and groundwater. Based upon the findings of this investigation, it was concluded that the landfill did not pose a significant threat to the environment. However, from a review of background information during this study, it was indicated that a number of 55-gallon drums were buried at the site during the mid-1970s at the time the landfill was being closed.

Based upon this finding, the State of New York appropriated funds in August 1984, for the removal of drums that could be located at that time. The removal program included a magnetometer survey to more accurately define the location of the buried drums, excavation of soil and drums in two phases, and testing of the drum contents. The program was completed in September 1986. Of the 208 drums removed, 10 were determined to contain hazardous waste. All drums were disposed at a permitted hazardous waste treatment/disposal facility. Samples of excavated soil, groundwater and surface water contiguous to the areas of excavation indicated no significant contamination from the drums.

As a result of the previous investigations and removal action performed at the former Town of Wallkill Landfill, the Town entered into an Order on Consent with NYSDEC in June

1989, and was required to perform a Remedial Investigation and Feasibility Study (RI/FS) to determine the existence of residual contamination at the site, if any, and to develop a remedial action plan, if required.

1.3 Nature and Extent of Contamination

The following is a brief summary of the findings and conclusions of the RI/FS according to the environmental media investigated at the site.

Subsurface soils were found to contain four contaminants of concern comprised of the organic compounds tetrachloroethene, chrysene, naphthalene and PCB-aroclor 1254. With the exception of chrysene, only one sample of each of the above mentioned contaminants from 12 subsurface soil samples collected were found to exceed applicable Standards, Criteria and Guidelines (SCGs). Chrysene exceeded SCGs in two of the 12 samples. The samples were all located either in or immediately below landfill refuse material.

Groundwater contamination was detected almost exclusively in shallow overburden monitoring wells screened within the boundary of the landfill mass. Several organic contaminants were found to exceed SCGs in the shallow groundwater, including the volatile organic compounds (VOCs) benzene, toluene, chlorobenzene, ethylbenzene and xylene, as well as the semi-VOCs benzoic acid, 4-chloro-3-methylphenol and naphthalene. The heavy metal, lead, was detected at concentrations exceeding SCGs in shallow overburden wells screened within the landfill mass, as well as in one overburden/bedrock interface monitoring well which is upgradient of the site with respect to overburden groundwater flow patterns.

The contaminants of concern identified for surface waters were the semi-VOC bis(2-ethylhexyl)phthalate and the metals aluminum, hexavalent chromium, iron and zinc. Hexavalent chromium was detected at concentrations below SCGs at locations along Tributary 20 immediately downstream of the site.

The contaminants of concern for surface water sediment comprise arsenic, manganese, mercury, nickel and zinc.

Contaminants of concern identified in landfill leachate include the metals manganese, mercury, silver, sodium, vanadium and zinc.

Soil-gas, primarily methane, was detected in areas where garbage and trash were formerly disposed and also in the former sludge lagoon area.

1.4 Remediation Plan

Based on the results of the RI/FS, a remediation plan was developed for the Town of Wallkill Landfill. The basic purpose of the plan was remediate the site by removing contaminated sediment in Tributary 20 and placing the material in the waste mass, and capping the sediment and waste mass with a low permeability liner. Elements of the remedial design comprised the following:

- Construction of a temporary stream bypass culvert and pipe;
- Construction of the relocated stream channel and retention pond;
- Excavation and relandfilling of municipal solid waste, soils and sediments to reduce the footprint of the waste mass;
- Placement and compaction of contour grading material to establish the prepared subgrade for the landfill capping system;
- Construction of the landfill capping system and landfill gas vents;
- Construction of drainage swales and perimeter roadways;
- Abandonment of existing groundwater monitoring wells;
- Construction of replacement groundwater monitoring wells;
- Construction of landfill gas monitoring wells;
- Recolonization of disturbed wetlands;

- Creation of new wetlands to replace existing wetlands which were lost as a result of construction;
- Hydroseeding of the landfill areas, wetlands, stream relocation corridor, drainage swales and disturbed areas;
- Installation of wetlands grasses and sedges in the recolonized and/or created wetlands areas and the relocated stream channel;
- Excavation, management and storage of buried drums; and
- Provision of the required Quality Assurance/Quality Control, documentation and performance testing of materials as required by the specifications.

The design of the capping system comprised the following:

- Vegetative Soil Layer: A 6-inch surface layer of uncompacted soil capable of supporting vegetation;
- Barrier Protection Layer: A 18-inch layer of clean general fill;
- Geomembrane Liner: A 60-mil textured high density polyethylene (HDPE) geosynthetic liner. In areas with slopes greater than 25%, a geocomposite drainage layer was installed above the geomembrane liner.
- Gas Venting Layer: A gas venting layer of 12 inches of soil with a minimum coefficient of permeability of 1×10^{-2} cm/sec. A layer of 6 oz/yd^2 non-woven geotextile was placed beneath this soil layer to separate it from the subgrade. Passive gas vents were placed to vent this layer; and
- Prepared Subgrade: General fill and processed construction and demolition (C&D) material as a subgrade to the final capping system. The site was regraded, as appropriate, to provide a minimum cover over the waste of 6 inches of general fill material.

1.5 Purpose and Scope

The purpose of the Post-Closure O&M Manual is to define, in general terms, the procedures for all personnel performing routine inspection, maintenance, repair work and monitoring on the Town of Wallkill Landfill following its remediation/closure. This O&M

Manual has been prepared in accordance with the "Superfund Remedial Design and Remedial Action Guidance" (OSWER 1986) and "Considerations for Preparation of Operations and Maintenance Manuals" (EPA 1972).

The guidelines and procedures presented in the Post-Closure O&M Manual are in general conformance with the 6 NYCRR Part 360 Requirements (effective October 1993) and are based on a review of site-specific information, including the remedial design contract documents and as-built drawings.

This Operation and Maintenance Manual includes the following information:

- Site inspection guidelines;
- Maintenance and repair procedures;
- Groundwater monitoring plan;
- Gas monitoring plan;
- Surface water and sediment monitoring plan;
- Personnel and equipment requirements;
- Contingency plan;
- Annual cost estimate;
- Communication procedures;
- Recordkeeping and reporting; and
- Financial assurance.

Section 2

2.0 SITE INSPECTION GUIDELINES

Following the closure of the Town of Wallkill Landfill, the site will be monitored in general accordance with 6 NYCRR Part 360-2.15 criteria. The first step in the monitoring process requires the inspection of the site at least four times a year, by qualified, trained personnel. In addition, inspections will also be performed after a major rainfall event (5-year storm). The results of these inspections will be recorded on the Standard Inspection Report Form, a copy of which is provided in Appendix A. The location and extent of any damage discovered during an inspection will be noted on the standard inspection checklist form, along with any necessary additional information. Any irregularities found during these site inspections will be remediated according to the guidelines provided in Section 3 of this report. A copy of all the inspection reports will be submitted to the NYSDEC as soon after the inspection as possible and will also be included in the facility's annual report.

2.1 Cap Integrity

During closure construction, a minimum of 24 inches of soil cover was placed over the geomembrane. The cap must be inspected to assure its continued integrity.

2.1.1 Soil cover

The soil cover will be visually inspected for signs of erosion damage, settlement, cracking, vectors, leachate or waste breakthrough, vandalism, litter and unauthorized dumping. Erosion, settlement or cracking of the soil cover will be considered damaging based upon whether the function of the final cover had been impaired in the affected area, e.g., ponded storm water. However, the minimum final cover thickness must be maintained at 24 inches.

2.1.2 Vegetation

The soil cover was vegetated during the cap construction according to the seeding schedule provided in the Remedial Design specifications and is included as Appendix B of this Manual. Inspections of this vegetation will be performed to monitor the vegetative growth and identify problem areas which require reseeding. The vegetative cover will be inspected for bare spots, dead species and undesirable species. Bare or dead areas of vegetation will be further examined for the possibility of landfill gas, leachate, erosion or vector damage. The apparent cause of any damage will be noted in the inspection report.

2.2 Leachate Collection System

The Wallkill Landfill was constructed without a leachate collection system. In addition, no remedial system was installed to collect leachate. However, leachate will be monitored by identifying any surface outbreaks on the landfill (Section 3.1.1 - Leachate Control). The identification of any uncontrolled leachate will be documented (Section 7 - Leachate Monitoring Plan). Surface leachate investigations will be performed when groundwater levels are at seasonal high levels.

2.3 Storm Water Collection System

The storm water collection system for the closure construction consists of perimeter swales and culverts which convey the collected storm water runoff to Tributary 20 which flows through the landfill.

All of the storm water collection, conveyance and drainage structures will be visually inspected for obstructions, siltation, ponded water and erosion damage, such as wash-outs. The location of any obstruction or damage, and its cause, if known, will be noted in the inspection report. Perimeter swales will also be inspected for loss of vegetation or erosion control matting.

2.4 Access Road

The access road around the landfill is a continuation of the road installed during the closure of the landfill. The road was constructed of crushed stone having a minimum thickness of 6 inches. Visual inspections of the road will be conducted for potholes or burrow holes, erosion gullies, loss of stone cover and obstructions. The results of these inspections will be noted in the inspection report.

2.5 Landfill Gas Monitoring

2.5.1 Passive Venting System

A passive venting system was installed on the landfill to allow venting of landfill gases through the geomembrane. During the post-closure monitoring period, these vents will be inspected for damage, such as excessive settlement which causes stress on the geomembrane, or signs of vandalism. The vents will also be inspected for signs of vector infestation. The inspection report will reflect any damage noticed during the inspection. The functioning of these vents will be monitored during air quality testing which will be performed at the site according to the guidelines provided in Section 5 of this Manual.

2.5.2 Perimeter Monitoring Wells

Perimeter gas monitoring wells are located along the northwestern edge of the landfill. The intent of the regular monitoring at these locations is to identify the presence and concentration of explosive gases and determine the extent of landfill gas migration in proximity to residences closest to the landfill.

Gas monitoring wells will be visually examined during each routine inspection and the functioning of each well will be checked during each monitoring event. (The details of the gas monitoring program are presented in Section 5 of this Manual). If a monitoring well sustains

damage, or cannot provide a representative gas reading, the well will be examined to determine whether the problem can be corrected. This determination will be facilitated by comparing data from previous monitoring activities to determine the cause of the problem.

The inspection report will include the details of any gas monitoring well damage and the appropriate action that will be taken to correct the problem, as presented in Section 3 of this Manual.

2.6 Groundwater Monitoring Wells

Groundwater monitoring wells will be visually examined during each routine inspection and the functioning of each well will be checked during each quarterly sampling event. The details of the groundwater sampling program are presented in Section 4 of this Manual. If a monitoring well sustains damage, or cannot provide representative groundwater samples, the well will be examined to determine whether the problem can be corrected. This determination will be facilitated by comparing data from previous monitoring activities to determine the cause of the problem. In particular, the following signs of damage or deterioration will be examined.

- Signs of encrustation and corrosion;
- An exceptional increase in solids content (e.g., from the breakdown of the screen); and
- An appreciable decrease in groundwater elevation, perhaps the result of these problems.

The inspection report will include the details of any groundwater well damage and the appropriate action that will be taken to correct the problem, as presented in Section 3 of this Manual. Damaged wells that cannot be rehabilitated will be decommissioned by appropriate methods (i.e. overdrilling, pulling of casing or grouting in place).

Section 3

3.0 MAINTENANCE AND REPAIR PROCEDURES

The need for maintenance or repair work will be governed by the observations made during the regular site inspections previously described in Section 2, and records of this work will be maintained in the permanent landfill files at the Town Hall. This section describes the maintenance and repair procedures which will be followed during the post-closure inspection and monitoring period for the Wallkill Landfill. The personnel and equipment requirements for this 30-year period are presented in Section 8 of this Manual.

3.1 Maintenance

Routine maintenance work will be performed, as necessary, during the 30-year post-closure monitoring period. Mowing, regrading of the cover soils and the access road, additional seeding, vector control and the removal of undesirable vegetation species are considered normal (typical) maintenance tasks and will be discussed in this section.

3.1.1 Leachate Control

Because the landfill was constructed without a base liner and leachate collection system, the only leachate maintenance that will take place during the post-closure period will be associated with the monitoring of potential outbreaks on the landfill's sideslopes and around the perimeter of the landfill base. If leachate is observed and ultimately tracked to a failure of the cap system, the failed area of the cap membrane will be repaired as described in Section 3.2.4 of this Manual.

3.1.2 Landfill Gas Control

In addition to the landfill gas monitoring program that will occur at the perimeter monitoring wells, maintenance of the gas vents will also occur. During the post-closure period, the vents, pipes and connections will be inspected and maintained on a regular basis.

3.1.3 Drainage and Erosion Control

Surface drainage (conveyance) features to control storm water runoff have been designed for the 25-year, 24-hour storm. The perimeter swales will be maintained with grassed channels. Complete vegetative coverage will be maintained and will be inspected at the same time the landfill cap is inspected. Areas of erosion will be noted and repaired as soon as possible to maintain the integrity of the cap. The swales and culverts will be inspected for foreign debris and sediment which may interfere with its proper functioning, and for areas of erosion which may degrade the integrity of the cap.

3.1.4 Vegetative Cover

The vegetative (grass) cover will be maintained at a minimum height of 18 inches, or mowed at least once each year during the first three years to control the growth of wild and deep-rooted species, and minimize potential for introducing vector habitats. Following this initial period, the frequency of each mowing event will be determined by the site conditions. Undesirable species such as saplings or other vegetation with penetrating roots discovered during inspections will be removed if their presence poses a threat to the integrity of the cover system. Application of herbicides and pesticides will not be used to control undesirable plant and/or animal species unless the non-chemical methods do not yield desired results. Areas of the cap with dead vegetation or lack of vegetation will be inspected by qualified personnel for possible causes of defoliation and devegetation. The bare areas of the cap will be seeded according to the seeding schedule provided in Appendix B of this Manual.

3.1.5 Regrading

The effects of landfill subsidence, vandalism or gulleying from minor precipitation events (i.e., not causing extensive damage to the site) may result in the need to regrade the cover soils of the cap system. The areas of erosion or landfill subsidence which affect the performance of the cap system will be brought back to original grade according to the procedures described for

constructing the cover. Deterioration of the access road will be repaired by regrading where possible, or by the placement of additional gravel, if necessary, to provide access for routine inspections and maintenance activities. If vandalism is detected on the site, such as off-road vehicle tracks, the Town of Wallkill Police will be contacted and efforts will be made to further restrict access to the site.

3.1.6 Vector Control and Aesthetics

Vectors common to active landfill operations are not expected to be a problem at the landfill. However, suspected rodent or insect infestation will be responded to by contacting qualified licensed exterminators. Prior to initiating an extermination program, the Town will advise the NYSDEC of the situation and, if necessary, develop and submit to NYSDEC an extermination work plan for review and approval. Details of the communication procedures for non-routine events are provided in Section 11 of this Manual.

3.1.7 Access

Access to, and onto the landfill will be continually maintained. The perimeter roadway, as well as the roadway onto the landfill, will be monitored for signs of subsidence, erosion and other forms of degradation. Vehicular access will be limited to authorized personnel and will only be accomplished through the main site entrance off Banke Road. The access roadways will be inspected for foreign objects and vegetative growth which could degrade their integrity and prohibit access.

3.2 Repairs

This section details the procedures which could be used to perform non-routine repairs of the cap system and, as such, are considered to be outside of the scope of the normal maintenance procedures for the landfill. These activities may include, but not be limited to, repair of gas

vents, groundwater monitoring wells, storm water structures, vegetative cover and the geomembrane.

3.2.1 Storm Water Structures

On occasion, storm water control structures can become damaged and diminished in function by intense rainfall events or by alternating freeze-thaw cycles. If erosion or undermining is observed, the Town will notify the NYSDEC and corrective action will be taken. Any obstructions found in and along the storm water collection route will be promptly removed.

3.2.2 Gas Collection and Treatment System

Landfill gas vent damage will be most likely to occur during normal maintenance of the site, such as during mowing. If damage occurs to the exposed piping of a gas vent on the landfill, the piping will be replaced according to the approved construction documents. Breakage of landfill vents, which can damage the membrane beneath the cover soils or the water-tight seal around the pipe penetration, will be examined thoroughly. The cover soils will be removed, and the membrane and pipe penetration boot inspected for damage. If damage has not occurred, the soil layers around the vent will be replaced by hand and compacted to a minimum thickness of 24 inches. All repair will be such that replacement layers will match, and tie directly into the undisturbed portion of the cap. Damage to the membrane or the pipe penetration boot will be repaired according to the guidelines provided in Section 3.2.4 of this Manual.

3.2.3 Groundwater Monitoring Wells

The repairs required for groundwater monitoring wells may involve:

1. Redevelopment of the well;
2. Removal and replacement of the well screen; or

3. The installation of a new monitoring well.

The repair technique used will be determined by the extent of the damage observed. However, any remedial actions will be discussed with the NYSDEC prior to their implementation.

Damaged monitoring wells that cannot be rehabilitated will be decommissioned in a manner appropriate for the existing geologic conditions at the site. This will prevent potential contaminant migration downward through/along the monitoring well.

The monitoring well decommissioning procedure will follow NYSDEC protocol and comprise the following:

- Overboring and removal of the casing, if present, to the greatest extent possible (minimum 5 feet);
- Perforation of any casing remaining in the borehole;
- Pressure grouting of the borehole from the base of the borehole with cement-bentonite grout to a depth of 5 feet below the ground surface using the tremie method;
- Backfilling the remaining 5 feet with native soil and compacting to avoid settlement;
- Grouted area will be periodically inspected for possible settlement; and
- If subsequent settlement occurs, native material will be placed into the depression and repacked to grade level. If severe settlement occurs, the settled portion will be regrouted and backfilled with native soil.

3.2.4 Cap Membrane

It is anticipated that the cap membrane will not be adversely affected by settlement during the landfill post-closure inspection and monitoring period. Nevertheless, during the 30-year post-closure period for the site, there is the possibility that damage could occur to the cap

membrane. As such, the damaged sections will be removed and evaluated by a manufacturer's representative to determine the extent of the damage and the required repair techniques. The manufacturer's representative will approve the necessary repairs to the membrane according to the Remedial Design Plans and Specifications. Specifications for the membrane are presented in Appendix C of this Manual. In addition, each repair will be tested according to these documents.

Section 4

4.0 GROUNDWATER MONITORING PLAN

The procedures described below will be followed during the sampling and analysis associated with the groundwater monitoring plan. These procedures are expected to continue to be followed for all routine (scheduled) sampling and analysis of groundwater conducted at the landfill. Detailed sample collection, and quality assurance and control procedures and requirements are provided in Appendix D (Quality Assurance/Quality Control Plan).

Groundwater sampling will be conducted on a quarterly basis for the first 3 years of the post-closure period, after which the results will be evaluated to determine if the frequency, number of wells and monitoring parameters can be modified/reduced. The locations of the groundwater monitoring wells are shown in Figure 2 (see map pocket). During each sampling event, each well will be purged a minimum of three well volumes prior to sample retrieval. This procedure will prevent the sampling of stagnant water and the possibility of collection a sample that is not representative. Either dedicated or disposable bailers will be used to collect samples after this purging procedure. Chain of custody documents for each sample retrieved will be maintained by both the company and the laboratory performing the quarterly sampling and analysis.

Field measurements will be obtained for temperature, conductivity and pH, and the static water level of each well will be determined prior to purging each groundwater monitoring well.

The samples will be collected and preserved as outlined in the USEPA document Manual of Methods for Chemical Analysis of Water and Wastes (EPA 600/47-9020) dated March of 1983. An excerpt from this document is presented in Appendix E.

The groundwater samples obtained will be analyzed for Target Compound List (TCL) Volatile Organic Compounds (VOCs) and Target Analyte List (TAL) metals in accordance with the USEPA Contract Laboratory Program (CLP) or a NYSDOH test method approved program. VOCs and metals were the primary contaminants of concern identified at the Wallkill Landfill.

The laboratory performing the analysis will be Environmental Laboratory Approved Program (ELAP) certified by NYSDOH.

A representative for the Town will compare results of each new laboratory analysis to the concentration of constituents from past analyses to determine if there are any significant changes.

Section 5

5.0 GAS MONITORING PLAN

The purpose of this monitoring plan, which will be conducted on a quarterly basis for the first 3 years of the post-closure period and modified accordingly thereafter, is to detect the possible migration of methane across the boundaries of the site to neighboring properties before the gas becomes a hazard to the public safety. The procedure for methane gas monitoring is contained in Appendix E.

Each gas monitoring well will be monitored for the percent of methane accumulated in the well's atmosphere. The locations of these monitoring wells are shown in Figure 2. The results of the monitoring will be submitted to the NYSDEC. Any indication of dangerous levels of methane in the wells will be reported to the appropriate authorities for immediate action. The lower explosive limit (LEL) of methane is 5 percent, by volume, in air. When levels of methane reach 25 percent of this amount, the Contingency Plan, as described in Section 9, will be implemented. The Contingency Plan identifies the appropriate authorities to contact should excessive levels of methane be detected.

Section 6

6.0 SURFACE WATER AND SEDIMENT MONITORING PLAN

The purpose of this monitoring plan, which will be conducted on a quarterly basis for the first 3 years of the post-closure period and modified accordingly thereafter, is to detect releases of contaminants from the landfill to Tributary 20. At each of the sample points to be monitored, surface water and sediment samples will be analyzed for TCL VOCs and TAL metals. The locations of these sample points are shown in Figure 2. The procedures for collection of surface water and sediment samples, and the quality assurance/quality control requirements, are provided in Appendix D.

Section 7

7.0 LEACHATE MONITORING PLAN

Because Cell No. 1 contains no base liner, no leachate collection system was installed. The form of leachate monitoring during the post-closure period will consist principally of: 1) visual inspection of the landfill sideslopes for leachate outbreaks and seeps; 2) monitoring surface water and sediment of Tributary 20; and 3) visual inspection of the area outside the perimeter road for wet spots and seeps. Suspect wet areas will be noted, and if they persist, they will be sampled for TCL VOCs and TAL metals. If the samples are determined to contain landfill related contaminants, the NYSDEC will be notified, and a plan will be developed to determine the cause of the leakage.

Section 8

8.0 PERSONNEL AND EQUIPMENT REQUIREMENTS

8.1 Staffing Plan

The personnel required to conduct quarterly inspections and perform routine maintenance and repairs will consist of a Site Manager or Supervisor, one heavy equipment operator and two laborers who are employees of the Town of Wallkill. Monitoring will be performed by a qualified environmental firm retained under contract to the Town. All work conducted as part of the post-closure period will be supervised/managed by the Town of Wallkill Department of Public Works Commissioner. For events occurring outside the scope of the routine maintenance and repair program, specific assistance will be required as described in Sections 9 and 11. Sections 8.1.1 and 8.1.2 provide a summary of the required training for the landfill staff. Records will be routinely kept by the Town personnel and are described in Section 12.

8.1.1 Staff Training

Town personnel will be trained in general closure inspection operations and specific duties at the site. They will also be given additional training in the recognition of, and response techniques to hazardous and otherwise unacceptable waste materials, first aid and basic firefighting. These training programs will be updated annually and as newly developed techniques are implemented. The environmental firm retained by the Town will conduct the comparative data (laboratory and field) analyses and identify when significant changes occur in data from period to period, as well as identify unusual occurrences. If unusual circumstances or conditions occur, the Town will notify the NYSDEC. Evaluations of corrective measures and implementation of solutions will be directed by the Town Commissioner of Public Works.

8.1.2 Safety Plan

Based upon available information, the Wallkill Landfill contains the following potential chemical and physical hazards, which should be taken into consideration during the post-closure inspection and monitoring period:

- Methane gas;
- Open drainage swales;
- Exposure to the (weather) elements; and
- Ticks.

The Town personnel will be informed of these potential hazards, given special instructions as needed, and issued safety equipment (as necessary) in conformance with the OSHA requirements.

8.1.2.1 - Methane Gas

Methane, an odorless, colorless and tasteless gas, is a simple asphyxiant, under high concentrations. There are no systemic effects, either at 5 percent concentration or for long-term exposure. Neither are there any Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL), National Institute of Occupational Safety and Health (NIOSH) recommended exposure limit, or American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values. The prime concern associated with methane is the hazard of fire and explosion. The Lower Explosive Limit (LEL) for methane is 5 percent of air volume and the Upper Explosive Limit (UEL) is 15 percent of air by volume.

The post-closure monitoring personnel will be briefed on: 1) the presence of methane gas on site; 2) the potential hazards associated with methane gas; and 3) the procedures to be followed to detect methane. Personnel will be directed to avoid generating arcs, sparks or flames

in areas where methane gas is detected at levels of 10 percent of the LEL, or greater, and will be prohibited from smoking on site. An explosive gas/oxygen analyzer will be used to detect the presence of methane gas and determine its concentration.

8.1.2.2 - Open Drainage Swales

The access road which travels around each cell of the landfill is bordered by a drainage swale or Tributary 20. Consistent with typical industry practice, the swales, as well as the stream, are not fenced and, therefore, could be a potential physical hazard to personnel inspecting and monitoring the site. Personnel performing monitoring, inspection, maintenance or repair work will be informed of this potential hazard and the necessary precautions needed to be taken to avoid it becoming a hazard.

8.1.2.3 - Severe Weather

The landfill is exposed to both the sun and the wind which can aggravate extremes of temperature. In the winter, there is little protection from the wind, and in summer there is no screening of the sun. This can potentially contribute to physical hazards such as hypothermia, dehydration and frostbite in the cold weather, and heat rash, heat cramps, heat exhaustion and heat stroke in hot weather. Personnel performing monitoring, inspections, maintenance and repair work will be advised of the severe weather hazards and necessary precautions as part of the safety orientation program. A description of these is presented in Appendix F of this Manual.

8.1.2.4 - Deer Ticks

Personnel working at the landfill will take the precautions described below against possible deer tick bites. Deer ticks are carriers of the spirochete (borrelia bergdorf) which causes Lyme Disease and can be transmitted to humans when bitten.

Signs and symptoms of Lyme Disease may include the following:

- The most well-known warning sign is a rash, classically described as a small red area that starts at the site of a tick bite and gradually enlarges over several days. The rash, which does not appear until three to 30 days after the tick bite, may grow to several inches in diameter and is circular with a central clearing. It may be obvious or very faint. Multiple, usually smaller, rashes without central clearing may develop in some individuals.
- Flu-like symptoms may precede or accompany the onset of the rash. Symptoms may include chills and fever, headache, malaise and fatigue, stiff neck and, in some cases, pain in the joints.
- If Lyme Disease is diagnosed and treated early, the prognosis is excellent. If the initial stage is not discovered and treated promptly, later stages may develop. Chronic arthritis, and in some cases heart and nervous system disorders, may develop weeks to months after the tick bites.

Some infected individuals may not develop either rash or symptoms. Thus, anyone bitten or thought to be bitten by a deer tick, or developing signs or symptoms of Lyme Disease, is advised to see a physician promptly for an examination and possibly a blood test. Prophylaxis or treatment with antibiotics (tetracycline) may be a recommended course of action.

To prevent tick bites, personnel should wear long pants, made of light colored, tightly woven cloth; tuck pants legs inside of socks; use an insect repellent; check themselves frequently; and wash themselves thoroughly at the end of each day. Personnel will be advised of the risk of deer tick bites, the initial symptoms and the precautions to be taken.

8.2 Equipment

The equipment utilized for the post-closure inspection and monitoring of the Wallkill Landfill will consist of standard construction equipment from the Town's inventory. Highway maintenance equipment, such as mowers and trimmers, will be used to maintain the site following closure.

8.2.1 Minimum Requirements

The principal operations to be performed on a regular basis during the post-closure period will be mowing of the vegetation and the repair of soil cover erosion. The mowing operations will require the use of a heavy equipment mower which can be operated safely on sideslopes. The soils repair will be accomplished with a front-end loader, a vibratory drum roller and a grader, as necessary, depending upon the size and depth of the area which has been eroded. This equipment is currently available in the Town's inventory and is expected to be available for use at the site during the post-closure period. The equipment will be outfitted with rollover protection cabs and backup alarms meeting the OSHA requirements for this type of machinery. The equipment will be maintained according to the Town's current maintenance schedule and reserve equipment for emergencies will always be available from the Town's inventory. Because the landfill is not an operating solid waste management facility, resources will not be designated solely for landfill post-closure activities. In general, the landfill resources will be used whenever necessary on site and based on availability.

8.2.2 Firefighting Equipment

Fire extinguishers will be carried on all equipment used on the site for maintenance or repair work. The Circleville Fire Department will provide assistance and/or equipment, as needed, to control any fires which may occur at the site.

Section 9

9.0 CONTINGENCY PLAN

The objective of the Contingency Plan is to address the events which may occur outside of the scope of the routine maintenance program. The Contingency Plan will be implemented following the discovery of a condition at the landfill which cannot be covered by routine maintenance. Natural occurrences, such as storms, drought and landfill settlement, are considered "expected occurrences" and have been addressed in the previous sections of this Manual. Other situations, such as war, an earthquake or other catastrophic events cannot be reasonably expected to occur and, therefore, are not specifically addressed in this Manual.

The Contingency Plan which follows addresses new degradation of the groundwater quality, the migration of methane gas and the possibility of a fire on the landfill. Contingencies for Severe Weather are presented in Appendix F of this Manual. The guidelines which follow will be used to determine when the Contingency Plan should be implemented and which corrective measures should be enacted. The appropriate regulatory agencies and public officials will be notified for any emergency which is governed by this plan.

9.1 Groundwater Contamination

Groundwater will be monitored quarterly during the first 3 years of post-closure period according to the provisions of Section 4 of this Manual. In the event that a statistically significant increase in the level of contamination emanating from the landfill via the groundwater pathway occurs, the NYSDEC will be notified. As a result, the next round of sampling may include testing of an expanded list of parameters, such as the full Target Compound List (TCL)+30 to determine specific constituents. Should the elevated levels continue or if new contaminants are discovered, the NYSDEC may request that a work plan be developed that investigates the nature, extent and cause of the contamination, including the installation of additional groundwater monitoring wells.

Upon acceptance of the work plan and completion of the work involved, a report will be prepared and submitted to NYSDEC. The report will describe the findings of the investigation and make recommendations for corrective measures, if necessary. The Town and NYSDEC will determine the specific corrective measure to be taken and make the necessary appropriations for implementation. At a minimum, any corrective action will be accomplished in accordance with 6 NYCRR 360-2.20 (reference Appendix G).

9.2 Surface Water and Sediment Contamination

Surface water and sediment from Tributary 20 will be collected quarterly for the first 3 years of the post-closure period and tested as described in Section 2.3. In the event that laboratory analysis indicates elevated levels of constituents indicative of contamination from the landfill, the next round of sampling (after a major rainfall event) may include testing for expanded parameters including full TCL+30 constituents. At this point, should levels of constituents indicative of landfill contamination continue to be present, the NYSDEC may request that a work plan be developed that investigates the nature, extent and cause of the contamination. Upon acceptance of the work plan and completion of the work involved, a report will be prepared and submitted to NYSDEC. The report will present the findings of the investigation and recommended corrective actions. The Town and NYSDEC will select the preferred corrective action and appropriate implementation. At a minimum, any corrective action will be accomplished in accordance with 6 NYCRR 360-2.20 (reference Appendix G).

9.3 Landfill Gas Migration

Methane gas that is vented to the atmosphere does not present a risk to human health. However, migration of gas off-site and a build-up of gas within a confined space may create an explosion hazard. If it is suspected that methane gas generation poses a human health hazard, the NYSDEC will be notified and an investigation undertaken to determine whether the vent system is functioning properly. The possible responses to a gas venting problem include replacing

portions of the venting system, adding new vents or a venting trench, or installing an active gas withdrawal system.

Currently, a gas monitoring system exists in the northwest area of the landfill nearest residences to the landfill. The landfill gas monitoring wells are designed to detect the presence of methane migration toward the residences. A description of the routine gas monitoring plan is provided in Section 5 of this Manual.

In the event that methane gas is detected at a level equal to, or greater than, 25 percent of the LEL (5 percent, by volume) during the monitoring period, the NYSDEC will be notified and all steps necessary will be immediately undertaken to ensure safety and protection of human health. If deemed necessary, the following will be implemented.

- Within seven days of detection, the Town will submit to the NYSDEC a report of the methane gas levels detected and provide a description of the steps that will be taken to protect human health; and
- Within 45 days of detection, the Town will submit a plan to implement a remediation plan for the methane gas releases and a schedule for implementation of the plan within 60 days after date of detection. The plan will assess the nature and extent of the gas release problem and describe the proposed remedy.

9.4 Fire and Explosion

The Wallkill Landfill has been inactive since 1974. As a result, the likelihood of an underground fire in the waste is relatively low. However, an aboveground (vegetation) fire is a possibility and will be reported to the local fire department (Circleville) immediately if it occurs. The appropriate response measure, including the safety of the personnel on the site, will be the responsibility of the fire department (Section 9.5). Any damage to the landfill closure structures will be repaired according to the guidelines in Section 3, after extinguishing the fire.

9.5 Emergency Response

Emergencies are events which fall outside of the reasonable range of occurrence and have not been included in the Contingency Plan. Such events may include, but not be limited to, a catastrophic failure of one of the storm water control features, a catastrophic failure of one of the landfill cap, or a fire caused by the release of high concentration of methane at the perimeter gas monitoring wells.

9.5.1 Notification Procedure

For emergencies that present an immediate danger or threat to human health and welfare, the Town of Wallkill Police and Circleville Fire Departments will be notified; the affected area(s) secured; and local residents warned or evacuated. For emergencies that do not present an immediate threat or danger to human health and welfare, the New York State Health Department will be notified, as well as the NYSDEC.

9.5.2 Telephone Numbers

Telephone numbers for emergency response personnel are presented on the following page.

Emergency Response Telephone Numbers

Town of Wallkill Supervisor's Office Wallkill, NY	(914) 692-7832
Town of Wallkill Department of Public Works Wallkill, NY	(914) 361-1106
Town of Wallkill Police Department Wallkill, NY	(914) 692-6757
Circleville Fire Department Wallkill, NY	(914) 361-3461
Orange County Health Department	(914) 291-2330
New York State Health Department Center of Environmental Health Albany, NY	(518) 458-6438
NYSDEC Region 3 Office New Paltz, NY	(914) 256-3003
NYSDEC Division of Hazardous Waste Remediation Albany, NY	(518) 457-3976

Section 10

10.0 POST-CLOSURE COST ESTIMATE

This section of the report presents an estimate of the costs expected to be incurred during the inspection, maintenance and monitoring of the Wallkill Landfill closure system. This annual cost estimate is based on 1996 dollars. The projected cost of the three basic components (inspections, maintenance, and monitoring) are presented below. The total projected annual cost during the 30-year post-closure period based on quarterly inspection and monitoring, and an escalation rate of 5% annually, is approximately $4,000,000. However, certain variables may affect these estimated costs:

- The extent or severity of storms which exceed the design standards and result in severe erosion or other natural calamities;
- Weather extremes, such as drought or extensive frozen ground;
- A change in groundwater quality which could require the installation of additional wells or more testing of the existing wells, as well as surface water and sediment;
- A change in groundwater, surface water and sediment quality which could require less testing; and
- Increase in annual excalation rate, fees, special levies, changes in insurance rates or other unexpected administrative costs.

10.1 Inspection Costs

It is expected that the inspection, as well as routine maintenance and repair of the landfill cap system will be performed by Town personnel. Assuming that it will take two staff members to perform the inspection, a combined hourly rate is estimated to be $50 per hour. Assuming that the inspection will be performed during a normal 8-hour work day, this would amount to $400 per inspection. The landfill will be inspected four times per year; therefore, the annual estimated cost of performing the site inspections is estimated to be $1,600 per year.

Table 10-1

POST-CLOSURE COST ESTIMATE - ANNUAL SUMMARY

Routine Maintenance and Repair	10,000
Contingency Repair	2,000
Gas Monitoring	1,400
Surface Water and Sediment Monitoring	
Sample Collection	1,400
Laboratory Analysis	6,400
Groundwater Monitoring	
Sample Collection	7,800
Laboratory Analysis	24,000
Report Preparation	9,600
Total	$60,600

10.2 Maintenance Costs

Routine maintenance of the landfill cap is anticipated to include three activities: 1) repairing erosion damage to landfill cap and perimeter features, including the access road; 2) mowing landfill grass and maintaining general landscaping; and 3) removing silt and debris from drainage structures. Estimating this work requires assumptions based on previous post-closure monitoring experience, as well as a knowledge of the site weather history. Repair costs will generally involve a minimum of two workers and appropriate equipment. Routine repairs are anticipated to involve one 8-hour day per specific component (e.g., drainage culvert and swale), and routine repair to the access roadway and landfill cover system is anticipated to take two days for each occurrence.

On average, it is expected that the mowing/landscaping, erosion repair and maintenance of the swales and culverts will require silt twice per year. Routine erosion repair to conveyance features will probably occur twice per year. The cost of these maintenance services is anticipated to average approximately $8,000 annually (Table 10-2). The cost of this maintenance work may be greater during the first 3 years of the post-closure period as the vegetative cover develops, but is expected to decrease to a lower value for the remainder of the 30-year post-closure period.

Other costs which may be incurred during this maintenance period include groundwater and gas monitoring well repair or replacement, gas vent repair or replacement, access road maintenance and repair, reconstruction of drainage structures, or repairs to the geomembrane or barrier protection cover. These costs are contingent upon need and, therefore, are unable to be estimated at this time. However, an amount equal to 25 percent of the routine inspection and maintenance costs is estimated for contingencies. This amount for these non-routine (contingent) repairs is estimated to be $2,000 per year. This amount should be budgeted for each of the 30 post-closure monitoring years. While it is not expected to be used each year, it is anticipated that over the post-closure life of the facility, non-routine repairs will occur that will necessitate the

Table 10-2

ROUTINE MAINTENANCE AND MONITORING SCHEDULE
ANNUAL POST-CLOSURE BUDGET

Activity	No. of Personnel	Labor Combined Rates $/hr	Labor Combined Rates $/day	Days/yr.	Total Labor $/yr.	Equipment $/day	Equipment $/yr.	Sample Analysis $/sample	No. of Samples yr.	Total Analysis $/yr.	Total $
Landscaping											
• Mowing	2	50	400	4	1,600	100	400	-	-	-	2,000
• Miscellaneous	2	50	400	2	800	100	200	-	-	-	1,000
Storm Water Control Features											
• Swales	2	50	400	2	800	100	200	-	-	-	1,000
• Culverts	2	50	400	2	800	100	200	-	-	-	1,000
Environmental Monitoring											
• Gas Wells	2	75	300*	4	1,200	50	200	-	-	-	1,400
• Groundwater Wells	2	75	600	12	7,200	50	600	400	60	24,000	31,800
• Surface Water and Sediment	2	75	300*	4	1,200	50	200	400	16	6,400	7,800
Cell Cap											
• Soil/Veg.Cover	2	50	400	4	1,600	100	400	-	-	-	2,000
Access Road	2	50	400	2	800	100	200	-	-	-	1,000
General Site Maintenance	2	50	400	4	1,600	100	400	-	-	-	2,000
Recordkeeping	1	40	320	30	9,600	-	-	-	-	-	9,600
Total					27,200		3,000			30,400	60,600

* Four-hour day

use of contingent monies. Therefore, it is important that this contingency budget be carried over, and accrued, from year to year.

10.3 Monitoring Costs

10.3.1 Groundwater Monitoring

Fifteen (15) wells will be utilized to monitor groundwater during the landfill post-closure period. It is anticipated that well sampling will be conducted by two field personnel, and that three (8-hour) days will be required for collection of a complete round of samples. With four rounds of monitoring required each year, a field labor budget of $7,800 is anticipated.

Groundwater samples will be analyzed quarterly for TCL VOCs and TAL metals. The annual budget for laboratory analyses of groundwater samples is estimated to be $24,000, resulting in a total groundwater monitoring budget of $31,800 per annum.

10.3.2 Surface Water and Sediment Monitoring

Surface water and sediment monitoring will be conducted on a quarterly basis during the post-closure period. Samples will be collected up stream and down stream of the landfill. Assuming that it will take 4 hours to collect two surface water and sediment samples and prepare them for laboratory analysis, the annual field labor budget is estimated to be $1,400. The surface water samples will be analyzed for TCL VOCs and TAL metals. The estimated cost for laboratory analyses is $400 per sample and $6,400 per year. Therefore, the estimated budget for surface water and sediment monitoring is $7,800 per year.

10.3.3 Gas Monitoring

Gas monitoring will be conducted on a quarterly basis during the first 3 years of the post-closure period. This involves the effort of two individuals, representatives from the environmental firm retained by the Town for a 4-hour day for each monitoring event. This results in a labor and equipment expense of $1,400 on an annual basis.

Section 11

11.0 COMMUNICATION PROCEDURES

During the 30-year post-closure period at the Wallkill Landfill, routine inspections will be performed quarterly as described in Section 2 of this Manual. In addition to these scheduled inspections, non-routine inspections may be necessary as a result of extraordinary incidences which may occur at the site such as fires, natural disasters or significant vandalism. Section 2 and 3 of this Manual identify the procedures to be followed for routine site inspections and scheduled for maintenance and repair. The procedures outlined in Sections 2 and 3 will also be followed in the event that a non-routine inspection is required. This section of the plan outlines the recommended communication procedures to be followed in the event that a component of the landfill cap becomes damaged, inoperative or requires non-routine repairs.

Section 9.5.2 lists the addresses and telephone numbers of the appropriate authorities to contact in case of emergencies.

11.1 Vandalism

Routine inspection of the soil cover will reveal if any unauthorized dumping or vandalism has occurred on site, as described in Section 2. Should this occur, inspection personnel will record evidence of such activity (e.g., vehicle tracks) or attempt to identify the source of the illegally placed waste, and immediately notify the NYSDEC.

When vandalism, trespassing or unauthorized dumping has occurred, the Town will evaluate site security procedures to identify the probable access route and will augment the security procedures to prevent such access, as needed.

In addition, to determine if any of the landfill components have been damaged as the result of significant vandalism, an emergency site inspection will take place. The Town will coordinate and direct all emergency repairs and notify the NYSDEC of any adverse conditions at the site.

11.2 Fires

All on-site equipment used for maintenance and/or repair work will be equipped with fire extinguishers, as described in Section 6. However, should a fire occur which cannot be contained by on-site personnel or equipment, the Circleville Fire Department will be contacted. In addition, the NYSDEC will be notified immediately.

After a fire, the Town will determine if any of the landfill components were damaged. A site investigation will be undertaken according to the procedures outlined in Section 2 of this Manual. The Town will coordinate and direct all emergency repairs and notify NYSDEC of any adverse conditions at the site.

11.3 Natural Disasters

Some natural disasters that might occur at the landfill may include, but not be limited to, hurricanes, heavy rains, ice storms, lightening strikes and/or floods. Other natural phenomena, such as tornadoes and seismic events, are unlikely to occur at the site due to its geographic location. Should one or more of these events take place at the site, the Town will follow emergency procedures to ensure protection and prevent personal injury during the event and will notify the NYSDEC of any evident damage or threatening conditions that have been created as a result of the event. Damage that might occur as a result of such events include erosion of the cover/cap system and blockage of storm water conveyance features. Lightening strikes to trees could result in trees falling across site roadways and fire.

If a severe storm event or other natural phenomena has caused significant damage to the landfill, or if the site has sustained significant damage, an emergency site inspection will be undertaken to determine the extent of such damage. When the Town determines that conditions are safe to inspect the site, a team of qualified personnel will inspect the site as described in

Section 2 of this Manual. The Town will coordinate and direct all emergency repairs and notify the NYSDEC of adverse conditions at the site.

11.4 Vectors

During routine and incidental site inspections, vector infestation may be evidenced by the presence of burrow holes or nests. Should infestation be discovered that poses a potential threat to the integrity of the landfill cover system, the Town will be notified of these conditions. The Town will contact an appropriate extermination service to eliminate rodents or insects, as needed.

11.5 Methane

The site will be monitored quarterly. Nine wells will be monitored to determine the percent of methane accumulated within the well's atmosphere. These results will be reported to the NYSDEC on a quarterly basis. In the event that the recorded methane levels exceed 25 percent of the lower explosive limit (LEL) contingency planning will be implemented.

11.6 Dust

Prolonged dry periods are not expected to present problems at the landfill because of the presence of vegetative cover. To prevent blowing dust, the landfill cap must maintain complete vegetative cover. This will prevent the cap from desiccation under prolonged dry conditions. However, during such periods, areas that are not vegetated (e.g., access roads) will be watered, if necessary, utilizing an on-site water truck, and use of the roads will be minimized.

11.7 Storm Water Control System

The storm water control system (swales and culverts) will be inspected to determine if siltation or placement of debris has occurred which would impede the flow of storm water

through the system or discharge to Tributary 20. In the event that siltation or debris blockage has occurred, the Town will take the appropriate action to clean the conveyance system.

11.8 Excessive Landfill Settlement

Intermittent topographic surveys for cap integrity and differential settlement will be arranged by the Town to determine if a change has occurred which could indicate potential malfunction of the landfill closure components. If it is determined through the evaluation, that certain areas have settled to the point where the integrity of the cap system may be jeopardized, the Town will notify the NYSDEC. Upon an examination of the site by the Town and the NYSDEC, a work plan will be prepared to remediate any damage that may have been caused to the landfill cover system.

11.9 Groundwater and Surface Water/Sediment Contamination

Should there be a significant increase in the level of contamination emanating from the site via the groundwater or seepage pathway, the NYSDEC will be notified and increased frequency, parameter and groundwater monitoring wells will be implemented, as necessary. Should the elevated levels continue, or if new contaminants are discovered, the Town will prepare a work plan to investigate the nature, extent and cause of the contamination. The work plan will be submitted to the NYSDEC for approval. Following implementation of this work plan, the results will be evaluated and recommendations for corrective measures will be made to NYSDEC and implemented.

Section 12

12.0 RECORDKEEPING AND REPORTING

12.1 Recordkeeping

The Town will maintain records of inspections, maintenance (routine and non-routine), repair and environmental monitoring of the landfill. This information will be recorded and maintained in the Town files. Some of the information will be reported to the NYSDEC as presented in Section 12.2. The remaining information will be available in the files maintained at Town Hall. Records also will be maintained regarding the results of the environmental monitoring plan as presented in Sections 4 and 5 of this Manual. In addition, records will also be maintained for landfill personnel. Such record information would include, but not be limited to: 1) personal information (name, address, date of birth, etc.); 2) length of employment, including start date; 3) landfill/site duties; and 4) history of health examinations.

12.2 Reporting

The Town of Wallkill will prepare and submit quarterly monitoring reports on groundwater, surface water, sediment and landfill gas quality, and an annual report summarizing the maintenance and repair (if any) of the landfill as described below.

12.2.1 Monitoring Reports

Quarterly Monitoring Reports (for groundwater, surface water and sediment) will be prepared and submitted to the Region 3 Office of the NYSDEC. These reports will contain the following information:

- Results of groundwater, surface water and sediment sampling, and landfill gas monitoring events to be conducted quarterly; and
- An analytical review of the data to determine exceedences of applicable water and sediment quality criteria, as well as discernible trends in data.

12.2.2 Annual Report

An annual report for the landfill will be submitted to the NYSDEC no later than 60 days after the first day of January of each year. This report will include:

- A summary of all routine operations and maintenance activities;
- A summary of all routine inspections of components of the landfill;
- A summary of all non-routine inspections of components of the landfill;
- A compilation and summary of all emergency activities;
- A compilation and summary of all water quality (surface water, sediment and groundwater) data collected throughout the year;
- A compilation and summary of all landfill gas data collected during the year;
- A summary of all expenses incurred throughout the year, both routine and contingent; and
- Any changes from the approved reports, plans and specifications will be listed, with justification for each change given.

Section 13

13.0 FINANCIAL ASSURANCE

The Town of Wallkill will utilize Town personnel to conduct routine and normal post-closure maintenance activities at the landfill. The Town will retain an environmental firm to conduct the monitoring at the landfill. Post-closure cost estimates have been prepared and are presented in Section 10 of this Manual. The post-closure cost estimate has included both annual and periodic costs. The Town will provide continuous financial coverage for post-closure care and monitoring until released from financial assurance requirements by the NYSDEC.

13.1 Adjustments to Cost Estimates

The post-closure care cost estimate will be adjusted annually for inflation and a copy submitted to the NYSDEC. The NYSDEC will be notified, and the financial assurance documentation revised and resubmitted, if changes occur to the post-closure care activities. A justification will also be submitted, which could include adjustments for 1) inflation; 2) routine maintenance; 3) landfill personnel; and 4) landfill conditions. Justification will also include a description of any corrective measures that may have been implemented.

13.2 Increase in Costs

The Town will notify the NYSDEC and increase the post-closure care cost estimate and the amount of financial assurance, if increases in inflation, significant changes in landfill conditions, and additions to the post-closure plan occur during the post-closure care period. The Town will, in the case where corrective measures have been implemented, annually adjust cost estimates and financial assurance. As with routine post-closure care, the Town will also provide continuous coverage for corrective measures, until released from financial assurance requirements by the NYSDEC.

Appendix A

WALLKILL LANDFILL

POST-CLOSURE SITE INSPECTION CHECKLIST

DATE: _____

INSPECTED BY: _____

Item	Acceptable	Not Acceptable	Present	Not Present	Location	Remarks
1) Vegetative Cover:						
a) Landfill Site:						
bare spots						
dead areas						
undesirable growth						
b) Drainage Structures:						
bare spots						
dead areas						
undesirable growth						
2) Ground Water Monitoring Wells:						
damage/vandalism						
settlement						
vector infestation						
3) Soil Cover:						
erosion damage						
settlement						
holes						
vector infestation						
waste breakthrough						
leachate breakthrough						
vandalism						
unauthorized dumping						
litter						

ADDITIONAL COMMENTS:

_____

_____

_____

_____

WALLKILL LANDFILL

POST-CLOSURE SITE INSPECTION CHECKLIST

DATE: _____

INSPECTED BY: _____

Item	Acceptable	Not Acceptable	Present	Not Present	Location	Remarks
4) Access Roads:						
potholes/burrow holes						
erosion gullies						
loss of stone cover						
obstructions						
5) Gas Venting and Monitoring System:						
odor						
damage/vandalism						
settlement						
vector infestation						
passive gas venting system efficiency						
6) Storm Water Collection:						
a) Diversion Swales:						
silt accumulation						
ponded water						
wash outs						
vegetative cover						
b) Perimeter Swales:						
silt accumulation						
ponded water						
vegetative cover						
erosion control matting						

ADDITIONAL COMMENTS:

_____

_____

_____

_____

WALLKILL LANDFILL

POST-CLOSURE SITE INSPECTION CHECKLIST

DATE: _____

INSPECTED BY: _____

Item	Acceptable	Not Acceptable	Present	Not Present	Location	Remarks
c) Culverts:						
damage/instability						
soil erosion beneath						
loose ties						
silt accumulation						
debris blockage						

ADDITIONAL COMMENTS:

_____

_____

_____

_____

Appendix B

2.5 Landscaping

A. Scope

1. The Contractor shall furnish all labor, materials, equipment, services, incidentals, etc. required to seed, landscape and establish a viable vegetative cover over the landfill closure area, drainage swales, relocated stream channel, created and/or recolonized wetlands, and adjacent areas as specified, as shown on the Plans and as directed by the Engineer.

2. The work shall include the hand planting of wetlands grasses and sedges in the relocated stream channel and the created and/or recolonized wetlands areas, as shown on the Plans, as specified and as directed by the Engineer.

3. The work shall also include applying amendments to the topsoil layer, as required, and the installation of erosion control fabrics and erosion control blankets as specified in these Contract Documents.

B. Quality Assurance

1. The Contractor shall retain the services of a qualified landscaping subcontractor. The landscaping subcontractor shall have a minimum of 5 years experience performing substantially similar work. The Contractor may qualify as the landscaping subcontractor if the Contractor can document that he possesses the necessary experience.

2. All landscaping materials shall be shipped with certificates of inspection as required by governmental authorities. All landscaping materials shall comply with governing regulations applicable to landscaping materials.

3. The Contractor shall not make substitutions without the prior written approval of the Engineer. Substitutions may be allowed by the Engineer at the varietal level only. In order for a substitution to be considered, the Contractor must document the nonavailability of the specified material and propose the use of an equivalent material.

4. Engineer will request inspection of delivery slips for materials to verify specified quantities of bulk deliveries of soil amendments and fertilizers.

5. Materials furnished as standardly manufactured products shall include manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Analytical Chemists, wherever applicable or as further specified.

6. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.

   - ANSI Z60.1-90, American Standard for Nursery Stock
   - ASTM D2487, Classification of Soils for Engineering
   - Association of Official Analytical Chemists, Official Methods of Analysis
   - American Joint Committee on Horticultural Nomenclature, Standardized Plant Names
   - Official Seed Analysis of North America, Standards of Quality
   - FSO-F-241D, Fertilizer, Mixed, Commercial
   - FSO-P-166E, Peat Moss; Peat, Humus, and Peat, Reed-sedge

C. Submittals

1. Shop Drawings: Submit 10 copies of the following for review and approval:

   a. Planting schedule showing scheduled dates for turf work.

b. Manufacturer's or suppliers specifications and installation instructions for all materials required.

c. Certificates from seed vendors for each seed mixture required, stating botanical and common name, percentage by weight and percentages of purity, germination, and weed seed for each species.

2. Operation and Maintenance Data: Submit 10 copies of the following for review and approval:

a. Typewritten instructions recommending procedures to be established by Owner for the maintenance of landscape work. Submit prior to initiation of required maintenance period(s). Include moisture requirements of each type of planting and insect prevention measures including types of spray and application instructions. The Contractor shall implement these operation and maintenance procedures for the 1-year guarantee period following Final Acceptance.

D. Planting Guarantee

1. The Contractor shall maintain for a period of ten weeks (except as specified in Section 2.4 - Stream Relocation) and guarantee for a period of one year all areas planted by him within the limits of this Contract, in accordance with the Plans and Specifications and directions of the Engineer. The maintenance period shall commence upon completion of the planting work and shall be extended as required until provisional acceptance is achieved. The guarantee period shall commence upon provisional acceptance of the planting work.

2. Maintenance for all areas shall include watering, weeding, fertilizing, cultivating, control of insects, fungus and other diseases; repair of minor washouts and gullies up to 12 inches in depth and other horticultural operations necessary for proper growth and for keeping the entire area within the Contract Limits neat in appearance, as directed by the Engineer. The Contractor shall pay special attention to weeding during the first growing season. No weeds should be allowed to grow in excess of 6 inches and a thorough weeding of

the entire area should be done every 4 weeks during the growing season.

3. The Contractor shall repair or replace, in accordance with the Plans and Specifications, any areas or plantings that are dead or, in the opinion of the Engineer, are in an unhealthy or unsightly condition due to inadequate or improper maintenance during the maintenance period, or other causes, by the date of 1 year after the completion and provisional acceptance of the whole planting work. The cost of repair or replacement shall be included in the price bid by the Contractor.

E. Product Delivery, Storage and Handling

1. Deliver packaged materials in original, unopened containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery.

2. Furnish seed in sealed, standard containers.

3. Notify Engineer of delivery schedule in advance so materials may be inspected upon arrival at job site.

4. Remove and replace material which does not meet the requirements of ANSI Z60.1-90 specifications.

5. Store and cover materials to prevent deterioration. Remove and replace packaged materials which have become wet or show deterioration or water marks. Replace at no additional cost to the Owner.

6. Seed that is wet or moldy or that has been otherwise damaged in transit or storage is not acceptable. Replace at no additional cost to the Owner.

7. Materials shall be stored in areas designated by the Engineer.

8. Chemical treatment materials shall not be stored with other landscape materials, chemicals shall be stored in areas approved by Engineer.

9. Do not dump or drop materials from vehicles, with exception of certain bulk deliveries approved by Engineer.

F. Job Conditions

1. Proceed with and complete the work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.

2. Do not spread seed when wind velocity exceeds 5 miles per hour.

3. Do not plant when drought, or excessive moisture, or other unsatisfactory conditions prevail.

4. Plant or install materials only during normal planting seasons for each type of landscape work required.

G. Materials

1. Soil amendments, if required by topsoil analysis, see Section 4.6 Topsoil:

a. Lime: Natural limestone containing not less than 85% of total carbonates, ground so that not less than 90% passes a 10-mesh sieve and not less than 50 percent passes a 100-mesh sieve.

b. Peat Humus: Peat humus which is a natural product of either sphagnum moss, reed, or sedge peat, taken from a freshwater site. Supply shredded material, free from lumps, roots, stones and other extraneous foreign matter, capable of passing through a 1/2-inch screen, which can easily be incorporated with the topsoil. Supply material which has been conditioned in storage piles after excavation for at least 6 months, including one freezing and thawing period. Supply peat humus with the following analysis:

a) Not less than 90% organic matter by weight on an oven dry basis

b) pH range 5.0 to 7.5

c) Moisture content 35% at time of incorporation into soil

d) Water absorbing ability 150% to 350% by weight.

2. Commercial Fertilizers:

a. Complete fertilizer of neutral character, with a minimum of 75% nitrogen derived from natural organic sources of ureaform, 40-50% of the nitrogen shall be water soluble. Available phosphoric acid derived from superphosphate, bone, or tankage. Potash derived from muriate of potash, containing 60% potash. The fertilizer shall be uniform in composition, free-flowing and suitable for application with approved equipment. Provide fertilizer with the percentages as specified herein.

b. Superphosphate shall be a soluble mixture of treated minerals with 20% available phosphoric acid.

3. Seed Mixtures

a. The Contractor shall furnish fresh, clean seed of the latest crop and which complies with the tolerance for purity an germination established by the Official Seed Analysts of North America. Provide seed of the grass and crownvetch species, proportions and minimum percentages of purity, germination and maximum percentage of weed seed as specified herein. Provide inoculant type Nod-o-gen, or approved equal, at a rate 4 times that specified by the manufacturer. The inoculant must be used prior to its stated expiration date and must be kept cool until used. Do not use inoculant when temperatures are above 80°F.

b. The seed mixture for the landfill cover (Landfill Cover Seed Mixture) shall be placed over the entire area of the landfill cap as bounded by the Proposed Extent of Waste as shown on the Plans. The Landfill Cover Seed Mix shall be prepared and applied in the following proportions (by weight):

Common Name	Application Rate (lbs./acre)
Crownvetch	20
White Clover	10
Palmer Perennial Ryegrass	25
Little Bluestone	15
Chewings Red Fescue	35
Kentucky 31 Tall Fescue	25
Redtop	25
	155 lb./acre

The seed provided for the Landfill Cover Seed Mix shall comply with the following specifications for purity and germination:

Common Name	Latin Name	Minimum Purity (%)	Minimum Germination (%)
Crownvetch	Coronilla varia	95	70 (total)
White Clover	Trifolium repens	96	90
Palmer Perennial Ryegrass	Lolium perenne "Palmer"	98	85
Little Bluestone	Andropogon scoperius	55	60
Chewings Red Fescue	Festuca rubra, commutata	97	85
Kentucky 31 Tall Fescue	Festuca arundincaea	97	85
Redtop	Agrostis alba	92	80

The seed mixture shall contain less than 2.5% weed seed. The seed mixture shall not contain the following prohibited noxious weeds; Bindweed, Canada thistle, quackgrass, hedge bindweed, horse nettle, wild garlic, bermuda grass, cheat, wild onion, corn cockle, Johnson grass, perennial sweet sudan grass, sorghhum alum and other perennial sorghum hybrids.

The crownvetch seed shall have a minimum ready germination rate of 35% and a minimum hard seed content of 35%.

The Landfill Cover Seed Mixture shall be applied with a commercial fertilizer which has a classification of 10-20-10. The fertilizer shall be applied at a rate of 500 pounds per acre. The Contractor shall cover the Landfill Cover Seed Mixture areas with an Erosion Control Blanket as specified in Section 4.7 - Erosion Control Materials.

c. The seed mixture for the perimeter drainage swales shall be a Meadow Grass Seed Mixture. The Meadow Grass Seed Mixture shall be placed over the entire perimeter drainage swale from the boundary of the Proposed Extent of Waste to the inboard edge of

the perimeter road. For areas where the perimeter drainage swale is outboard of the perimeter road, the Meadow Grass Seed Mixture shall be applied from the boundary of the Proposed Extent of Waste to the inboard edge of the perimeter road *and* from the outboard edge of the perimeter road through the drainage swale and ten feet beyond the upper edge of the drainage swale. The Meadow Grass Seed Mixture shall be prepared and applied in the following proportions (by weight):

Common Name	Application Rate (lbs./acre)
Kentucky Bluegrass	35
Chewings Red Fescue	65
Redtop	50
Palmer Perennial Ryegrass	25
White Clover	20
	195 lbs./acre

The seed provided for the Meadow Grass Seed Mixture shall comply with the following specifications for purity and germination:

Common Name	Latin Name	Minimum Purity (%)	Minimum Germination (%)
Kentucky Blue Grass	Poa Pretensis	95	75
Chewings Red Fescue	Festuca rubra, commutata	97	85
Redtop	Agrostis alba	92	80
Palmer Perennial Ryegrass	Lolium perenne "Palmer"	95	85
White Clover	Trifolium repens	96	89

The seed mixture shall contain less than 2.5% weed seed. The seed mixture shall not contain the following prohibited noxious weeds; Bindweed, Canada thistle, quackgrass, hedge bindweed, horse nettle, wild garlic, bermuda grass, cheat, wild onion, corn cockle, Johnson grass, perennial sweet sudan grass, sorghhum alum and other perennial sorghum hybrids.

The Meadow Grass Seed Mixture shall be applied with a commercial fertilizer which has a classification of 10-20-10. The fertilizer shall be applied at the rate of 500 pounds per acre. The Contractor shall cover the seeded perimeter drainage swales with an Erosion Control Fabric as specified in Section 4.7 - Erosion Control Materials.

d. The seed mixture for the creation and recolonization of wetlands areas and for the restoration of disturbed wetlands (Wetlands Seed Mixture) shall be placed in the areas as shown on the Plans. Following placement of the Wetlands Seed Mixture, the Contractor shall plant the area with Wetlands Grasses and Sedges, then mulch the area.

The Wetlands Seed Mixture shall be prepared and applied in the following proportions (by weight):

Common Name	Application Rate (lbs./acre)
Switchgrass	25
Reed Canary Grass	5
Barnyard Grass	20
Annual Rye Grass	45
	95 lbs./acre

The seed provided for the Wetlands Seed Mixture shall comply with the following specifications for purity and germination:

Common Name	Latin Name	Minimum Purity (%)	Minimum Germination (%)
Switchgrass	Panieum virgatum	60 PLS	
Reed Canary Grass	Phalaris arundinacea	95	70
Barnyard Grass			
Annual Rye Grass	Lolium multiflorum	95	85

The seed mixture shall contain less than 2.5% weed seed. The seed mixture shall not contain the following prohibited noxious weeds; Bindweed, Canada thistle, quackgrass, hedge bindweed, horse nettle, wild garlic, bermuda grass, cheat, wild onion, corn cockle, Johnson grass, perennial sweet sudan grass, sorghhum alum and other perennial sorghum hybrids.

$$\text{PLS} = \text{Pure Live Seed} = \frac{\text{Percent Pure Seed} \times \text{Percent Ready Germination}}{100}$$

The Wetlands Seed Mixture shall be applied with a commercial fertilizer which has a classification of 10-20-10. The fertilizer shall be applied at a rate of 500 pounds per acre. The contractor shall hay mulch the Wetlands Seed Mixture area with a uniform layer of salt hay applied at a rate of 2 tons (4,000 pounds) per acre.

Immediately following the application of mulch to the Wetlands Seed Mixture area, the Contractor shall plant Wetlands Grasses and Sedges through the mulch into the underlying topsoil. The Wetlands Grasses and Sedges shall be healthy, established, rooted, nursery grown plantings in 3 inch or 4 inch pots. The Wetlands Grasses and Sedges shall be hand planted in mixed groupings. Each grouping shall consist of three individual and distinct plants. *The groupings shall be uniformly spaced eighteen (18) inches on center.* The Contractor shall vary the makeup of each grouping in order to utilize approximately an equal number of each of the five types of grasses or sedges in a given area. The Wetlands Grasses and Sedges are as follows:

Common Name	Latin Name
Switchgrass	Panieum virgatum
Manna Grass	Glyceria grandis
Tussock Sedge	Carex strieta
Soft Stemmed Bulrush	Scirpus validus
Bristlebract Sedge	Carex tribuloides

e. The seed mixture for the Wetlands Border Area shall be the Meadowgrass Seed Mixture and application rates as specified herein. The Wetlands Border Area shall be defined as the sloping areas adjacent to created or recolonized wetlands starting at an elevation 18 inches above the water table and extending upslope to the outbound edge of the perimeter road. The Meadow Grass Seed Mixture shall be applied with a commercial fertilizer which has a classification of 10-20-10. The fertilizer shall be applied at a rate of 500 pounds per acre. The Contractor shall cover the seeded Wetlands Border Areas with an Erosion Control Blanket as specified in Section 4.7 - Erosion Control Materials.

f. The seed mixture for the Relocated Stream Channel shall be the Meadowgrass Seed Mixture and application rates as specified herein. The Relocated Stream Channel Area shall be bounded by the outboard edge of the perimeter road for the North Cell, across the Relocated Stream Channel, to the outboard edge of the perimeter road for the South Cell. The Meadowgrass Seed Mixture shall be applied with a commercial fertilizer which has a

classification of 10-20-10. The fertilizer shall be applied at a rate of 500 pounds per acre.

- The Contractor shall cover the seeded Relocated Stream Channel Area with Erosion Control Fabric as specified in Section 4.7 - Erosion Control Materials.

  Immediately following the placement of the Erosion Control Fabric, the Contractor shall plant the Stream Channel bottom (10 feet wide) *plus* four linear feet up each channel sideslope (total width equals 18 feet) with Wetlands Grasses and Sedges. The Wetlands Grasses and Sedges shall be planted through the Erosion Control Fabric into the underlying topsoil.

  The Wetlands Grasses and Sedges shall be as specified herein. The Wetlands Grasses and Sedges shall be hand planted in mixed groupings. Each grouping shall consist of three individual and distinct plants. *The groupings shall be uniformly spaced twelve (12) inches on center.* The Contractor shall vary the makeup of each grouping in order to utilize approximately an equal number of each of the five types of grasses or sedges in a given area. The Contractor shall install additional staples to secure the Erosion Control Fabric at each location where the fabric is cut to allow the planting of the groupings. The Erosion Control Fabric shall not be cut away to provide an opening for the plants, but rather, will be cut with an "X" to allow the plants to be inserted and the cut flaps of the fabric to be placed back in position.

4. Hay

   a. Hay for mulching shall be mowings of acceptable herbaceous growth which is free of mold, undesirable seeds, coarse or deleterious materials or from noxious weeds. Materials which are low grade and unfit for farm use such as "U.S. sample grade" will be acceptable.

5. Hydromulch

   a. Hydromulch shall be comprised of wood fiber cellulose or shredded newspaper processed so that the fibers will remain in uniform suspension in

water under agitation and will blend with grass seed, fertilizer and other additions to form a homogeneous slurry. It shall have the characteristics which, upon hydraulic application, shall form a blotter-like ground coating with moisture absorption and percolation properties and the ability to cover and hold grass in intimate contact with the soil.

b. The hydromulch material shall contain no growth or germination inhibiting factors, and shall be dyed green. Hydromulch material shall be supplied in the manufacturer's standard containers, and shall be labeled to identify the product, the manufacturer, and the air dried weight of the contents (maximum 10% moisture). Hydromulch shall be applied at a minimum rate of 1600 pounds per acre.

6. Hydromulch Adhesive

a. Hydromulch adhesive shall be a non-ionic galatomannan polysaccharide that forms a colloidal dispersion. Once adhesive film is formed and has been allowed to dry or cure, its resistance to solubility increases. Adhesive film shall be biodegradable, so that it is eventually broken down by water and/or microbial action. The material shall be furnished in the manufacturer's standard container and shall be labeled to identify the product, the manufacturer, and the instructions for mixing and application. The materials shall be mixed and applied in accordance with the manufacturer's recommendations.

7. Mulch Anchorage

a. Mulch anchorage shall be a non-staining, commercially available product that is specifically formulated for the purpose of anchoring or tacking hay mulch. The material shall be furnished in the manufacturer's standard container and shall be labeled to identify the product, the manufacturer and the instructions for mixing and application. The materials shall be mixed and applied in accordance with the manufacturer's recommendations.

8. Water

a. All water required for the prosecution and maintenance of the landscaping work may be nonpotable water. The Contractor shall furnish the nonpotable water from an approved source and shall pay all fees associated with connection, permitting, usage, etc. The nonpotable water shall be clean, free from oil, acids, alkalis and other deleterious water soluble or insoluble substances.

b. The water shall be transported to the site in clean, dedicated vehicles or containers which have only been used for the storage and transport of water. The Contractor shall provide a written certification that the proposed water storage and transportation vehicles or containers have only been used for water.

H. Seeding Time

1. Seeding Time

a. Sow seed from April 1 to June 1 for the spring-summer planting and from August 15 to October 15 for the fall planting.

b. Seeding, mulching and conditioning shall only be performed during those periods within the seasons which are normal for such work as determined by the weather and locally accepted practice, as approved by the Engineer.

c. If permanent seeding cannot be performed within the prescribed dates, the Contractor shall apply temporary seed and mulch to the completed areas as follows: The period between June 1 and August 15, the temporary seed shall be Annual Ryegrass applied at a minimum rate of 40 pounds per acre, uniformly mulched with hay at a minimum rate of 2 tons per acre and secured with mulch anchorage in accordance with the manufacturer's recommendations. For the period between October 15 and April 1, the temporary seed shall be winter rye or winter wheat applied at a minimum rate of 180 pounds per acre, uniformly mulched with hay at a minimum rate of 2 tons per acre and secured with mulch anchorage in accordance with the manufacturer's recommendations.

Temporary plant materials must be cut and removed or otherwise killed back prior to placement of final cover materials and permanent seedings.

2. Bed Preparation

a. The Contractor shall place the topsoil layer in accordance with Section 4.6 - Topsoil.

b. The topsoil shall be graded to eliminate rough, low or soft areas and to ensure positive drainage.

c. Apply lime at an adequate rate (not to exceed 3 ton per acre) based on pH test results to achieve a pH between 5.5 and 6.8. The lime shall be broadcast over the soil prior to seeding. Lime shall be applied under low wind conditions to minimize the loss of lime or the creation of a dust nuisance. Work the surface lightly to incorporate the lime into the top 3 inches of the topsoil layer, at least 2 days and no more than 5 days prior to seeding, breaking up the surface crust and leaving the surface in a loose, friable uniformly textured condition. The Contractor shall remove all exposed stones in excess of 1 inch in diameter and extraneous foreign material. Should a surface crust occur prior to seeding, the Contractor shall re-scarify the surface immediately prior to seeding.

3. Seed Applications

a. Seeding shall be done within 5 days following soil preparation. Seed shall be applied hydraulically at the rates and percentages specified. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed, fertilizer, and mulch shall be equal in quantity to the specified rates. Prior to the start of work, the Contractor shall furnish the Engineer with a certified statement as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the Contractor's hydroseeder. Upon completion of seeding operations, the Contractor shall furnish the Engineer with a certified statement on the actual quantity of solution applied.

b. In order to prevent unnecessary erosion of newly topsoiled and graded slopes and unnecessary siltation of drainageways, the Contractor shall carry out seeding and mulching as soon as a unit or portion of the project has been satisfactorily completed. For the purpose of this project a unit is defined as 10,000 square feet.

c. Immediately following the placement of seed, the Contractor and Engineer shall inspect the seeded area to determine that the seed mixture appears to be uniformly distributed throughout the area. The Contractor shall reseed any areas which appear to be deficient.

d. The Contractor shall immediately install the erosion control blanket, erosion control fabric, or hay mulch as specified for the subject area.

e. The Contractor shall provide against washouts by an approved method. Any washout which occurs shall be regraded and reseeded at the Contractor's expense until such time as the vegetation is well established.

4. Maintenance, and Provisional Acceptance

a. The Contractor shall keep all seeded and/or planted areas watered, and in good condition, reseeding all seeded areas or replanting all planted areas if and when necessary until a good, healthy, uniform growth is established over the entire area seeded and/or planted areas and shall maintain all seeded and/or planted areas in an approved condition until provisional acceptance. See Section 2.4 - Stream Relocation for maintenance requirements and acceptance of vegetation for the relocated stream channel.

b. The Engineer will inspect all work for provisional acceptance at the end of the ten week maintenance period (which may be extended as required) upon the written request of the Contractor received at least ten days before the anticipated date of inspection.

c. A satisfactory stand for seeded areas will be defined as a section of turf of 10,000 square feet or larger that has:

1. No bare spots larger than two square feet.

2. Not more than five percent of total area with bare spots larger than one square foot.

3. Not more than ten percent of total area with bare spots larger than 6-inch square.

d. Planted areas (grasses and sedges) must have, as a minimum, an eighty-five (85) percent survival and/or coverage rate as determined by the Engineer.

e. After the inspection has occurred, but prior to provisional acceptance, a soil test shall be performed by the Contractor in the presence of the Engineer to determine if additional fertilization should occur. If necessary, additional fertilizer not to exceed 30 lbs. per 1,000 square feet of 10-20-10 shall be applied as directed by the Engineer.

f. The Contractor shall furnish full and complete written instructions for maintenance of the seeded and/or planted areas to the Owner at the time of provisional acceptance.

g. The inspection of the Engineer will determine whether maintenance shall continue in any area or manner.

h. After all necessary corrective work and clean-up has been completed, and maintenance instructions have been received by the Owner, the Engineer will certify in writing the provisional acceptance of the seeded and/or planted areas. The Contractor's responsibility for maintenance of seeded and/or planted areas, or parts of seeded and/or planted areas shall cease on receipt of provisional acceptance.

5. Guarantee Period and Final Acceptance

a. All seeded and/or planted areas shall be guaranteed by the Contractor for not less than one full year from the time of provisional acceptance.

b. At the end of the guarantee period, inspection will be made by the Engineer upon written request submitted by the Contractor at least ten (10) days

before the anticipated date. Seeded areas not demonstrating satisfactory stands as outlined above, as determined by the Engineer, shall be renovated, reseeded and maintained meeting all requirements as specified herein.

Planted areas not exhibiting a minimum of eighty-five (85) percent survival and/or coverage shall be renovated, replanted and maintained, meeting all requirements as specified herein.

c. After all necessary corrective work has been completed, the Engineer shall certify in writing the final acceptance of the seeded and/or planted areas.

Appendix C

4.3 Geomembranes

A. Scope

1. The Contractor shall furnish all labor, materials, equipment, services, incidentals, etc. necessary for the placement and installation of 60 mil High Density Polyethylene (HDPE) textured geomembrane for the landfill capping system as shown on the Plans and as specified.

2. The 60 mil HDPE geomembrane shall be installed on a prepared, compacted subgrade. The limits of the 60 mil textured HDPE geomembrane shall be as shown on the Plans and as directed by the Engineer.

3. The subgrade surface for placement of the geomembrane must be prepared to provide a uniformly firm, finished surface suitable to provide full, intimate contact with the geomembrane. The prepared subgrade surface must be free of loose dirt, mud, debris, stones, irregularities, protrusions or other deleterious material which may detrimentally impact the function of the geomembranes.

4. The textured HDPE geomembrane must exhibit a minimum interface friction angle of 25 degree between itself and the underlying and overlying materials (Gas Venting Layer and Geocomposite or Barrier Protection Layer, respectively).

5. Before placing any geomembrane over the prepared subgrade, the Engineer, the Contractor and his Geomembrane Installer will visually inspect the prepared subgrade to evaluate the suitability of the subgrade and ensure that the surface is properly compacted, smooth and uniform, and that the elevations are consistent with the Plans, or as directed by the Engineer.

B. Geomembrane Manufacturer/Installer

1. Manufacturer's Qualifications

a. The geomembrane manufacturer shall be a specialist in the manufacture of HDPE geomembrane and shall have at least five years of experience in the manufacture of polyethylene geomembrane. Geomembrane manufacturer shall have manufactured at least

ten (10) million square feet of HDPE geomembrane during the last 5 years.

2. Installer's Qualifications

b. The installer shall be the manufacturer or an approved contractor trained and licensed to install the manufacturer's geomembrane.

c. The geomembrane installer shall be a specialist in the installation of HDPE geomembranes and shall have at least five years of experience in the installation of polyethylene geomembranes. Geomembrane installer shall have installed at least ten (10) million square feet of HDPE geomembrane during the last five years.

d. Installation shall be performed under the constant direction of a single Field Installation Supervisor who shall remain on-site and be in responsible charge, throughout the liner installation, for liner layout, seaming, patching, testing, repairs, and all other activities by the Installer. This Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 3,000,000 square feet of polyethylene geomembrane.

e. Seaming shall be performed under the direction of a Master Seamer (who may also be the Installation Supervisor) who has seamed a minimum of 3,000,000 square feet of polyethylene geomembrane, using the same type of seaming apparatus specified for this project. This Installation Supervisor and/or Master Seamer shall be present whenever seaming in performed.

C. Submittals

1. Geomembrane Manufacturer

a. The Contractor shall submit ten (10) copies of manufacturer's data, specifications, installation instructions and dimensions.

b. Information provided by the manufacturer shall include the following:

1) Information on factory size, equipment, personnel, number of shifts per day, and capacity per shift.

2) Quality control program and manual, or descriptive documentation.

3) List of material properties and samples of liner.

4) A list documenting no less than 10 completed facilities totaling a minimum of 10,000,000 square feet. Each entry in this list should specify the name and purpose of the facility, its location and date of installation, the name of the owner, the project manager, designer, fabricator (if any), and the installer, as well as the name and telephone number of the contact at the facility who can discuss the project. In addition, the geomembrane thickness and total square footage of the installation surface should be included.

2. Geomembrane Installer

a. The Contractor shall submit ten (10) copies of background information and qualification proof for the geomembrane installer.

b. Information provided by the installer shall include the following:

1) Certification that both the Installation Supervisor and the Master Seamer have reviewed the Quality Assurance Plan and the Project Plans.

2) Brief historical background, installation capabilities and information on equipment and personnel.

3) List of at least 10 completed facilities, totaling a minimum of 3,000,000 square feet for which the Installer has installed a HDPE geomembrane. For each installation, the installer shall provide the name and purpose of facility, its location, the date of installation; name of Owner,

Design Engineer, Manufacturer, Fabricator, if applicable, name and telephone number of contact at the facility; thickness of geomembrane and surface area of the installed geomembrane; type of seaming, patching, and tacking equipment; a copy of the Manufacturer's and/or Fabricator's approval letter(s) and/or license(s), if applicable; resume of the qualifications of the Installation Supervisor and Master Seamer to be assigned to this project.

c. The Contractor shall submit three field seam samples fabricated by the installer. The Contractor shall also provide a list of seam properties, minimum values, and test methods employed by the installer.

3. Prequalification of the Geomembrane

a. The Contractor shall prequalify the source(s) of the Geomembrane prior to use on the Project Site.

b. Prior to procurement of the Geomembrane materials, the Contractor shall submit to the Engineer the following information for approval:

- Origin and identification of the raw materials used to manufacture the geomembrane.

- A copy of QC certificate (sample) regarding the raw materials issued by the producer of the raw materials, including, as a minimum, specific gravity, melt flow index, and a complete stress rupture curve.

- A copy of QC certificate (samples) issued by the manufacturer of the geomembrane that the material is continuously inspected for uniformity, damage, imperfections, holes, cracks, thin spots, tears, punctures, blisters and foreign materials. A history of the nature and frequency of repair, the method of repair and remediation, and results of retesting of the geomembrane material shall be reported. In addition,

the method of transportation, loading and unloading of the material must be submitted.

- A copy of the Contractor's QC plan regarding the installation of the geomembrane which shall include, as a minimum requirement, the following information:

  - Installation procedures
  - Field seaming procedures
  - Defects documentation and repair procedures.

- A Certificate of Compliance and warranty from the manufacturer of the geomembrane that the material to be supplied meets all the material specifications for the geomembrane.

- A copy of the manufacturer's warranty, in effect for a period of twenty (20) years, for the quality and integrity of the geomembrane.

- Certified results of testing by the QC Geosynthetic Laboratory for the following properties:

  - Interface friction test performed for the interface between the proposed textured geomembrane and Gas Venting Layer in accordance with ASTM Standard Test Method D5321-92, Determining the Coefficient of Geosynthetic/Geosynthetic and Soil/Geosynthetic Friction by the Direct Shear Method.

  - Interface friction test performed for the interface between the proposed textured geomembrane and Barrier Protection Layer Soil in accordance with ASTM Standard Test Method D5321-92, Determining the Coefficient of Geosynthetic/Geosynthetic and Soil/ Geosynthetic Friction by the Direct Shear Method.

  - Interface friction test performed for the interface between the proposed

Geocomposite material and proposed textured geomembrane in accordance with ASTM Standard Test Method D5321-92, Determining the Coefficient of Geosynthetic/Geosynthetic and Soil/ Geosynthetic Friction by the Direct Shear Method.

4. Preconstruction Requirements

a. Prior to commencement of the installation, the Contractor shall provide to the Engineer the following submittals from the Geosynthetic Installer. All submittals must be approved by the Engineer prior to beginning installation of the geomembrane.

- A drawing showing the panel installation layout identifying both fabricated (if applicable) and proposed locations of all field seams as well as any variance or additional details which deviate from the engineering drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc. Factory seams (if any) shall be clearly identified.

- Installation schedule.

- A list and resumes of qualified personnel performing field seaming operations along with pertinent experience information. All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. Seaming personnel must have seamed at least 10,000 linear feet of HDPE geomembrane seams using the same type of seaming apparatus to be used on this project. At lease one seamer shall have experience seaming a minimum of 100,000 linear feet of HDPE geomembrane seams using the same type of seaming apparatus in use at the Project Site. The most experienced seamer, the Master Seamer, shall provide direct supervision, as required, over less experienced seamers. No field seaming shall take place without the Master Seamer being present in the active area of seaming.

- The field crew foreman for the Geosynthetic Installer must have a documented minimum experience (qualification) of successful installation of at least 50 acres of landfill systems on a minimum of five (5) different projects.

- The Contractor shall submit the name and model of all seaming apparatus to be used, as well as any alterative processes for the Engineer's approval.

- Copies of test results as required by the specifications.

- Copies of certification of acceptance of subgrade as outlined in the specification prior to commencement of work in that area.

- A copy of the Installer's warranty, in effect for a period of twenty (20) years, for the installation of geomembrane.

D. Materials

1. HDPE Resin

a. The geomembrane shall be manufactured of new, first quality resin and shall be designed, compounded and manufactured specifically for use in geomembrane. The resin manufacturer shall certify each batch for Specific Gravity and Melt Flow Index

b. Reclaimed polymer shall not be added to the resin; however, the use of polymer recycled during the manufacturing process shall be permitted if it is utilized within appropriate deadlines and if the recycled polymer does not exceed 2% by weight of the total polymer weight.

c. The High Density Polyethylene (compounded) resin shall conform to the following properties:

Property	Test Method	Requirements
Specific Gravity	(ASTM D 1505)	>0.94g/cm^3

Melt Index	(ASTM D 1238 Condition E)	<0.4g/10 min.
Carbon Black Content	(ASTM D 1603)	2-3%

d. The resin used for extrusion bonded seams shall be identical in all respects to the HDPE resin used to manufacture the geomembrane sheet.

2. HDPE Geomembrane Sheets

a. The geomembrane shall be seamless across its width and in its length. Factory seams within a roll of a geomembrane will not be acceptable.

b. The HDPE liner materials shall be formulated from the appropriate polymers and compounding ingredients to form a HDPE sheet material that meets all requirements for use as a liner for a municipal waste landfill. The sheet material shall be capable of being bonded to itself by thermal bonding in accordance with the sheet manufacturer's recommendations and instructions.

c. The geomembrane may contain a maximum of 1% by weight of additives, fillers or extenders (not including carbon black).

d. The geomembrane shall be manufactured to a nominal thickness as specified. The thickness tolerance shall be plus (+)10 percent, minus (-) 10 percent.

e. The surface of the geomembrane shall not have striations, pinholes, or bubbles and shall be free of holes, blisters, undispersed raw materials, or any contamination by foreign matter.

f. Liner sheets which have repair patches upon delivery to the site shall not be accepted. Liner sheets which have factory seams upon delivery to the site shall not be accepted.

g. The HDPE geomembrane shall be a low permeability geosynthetic and shall control fluid migration into the landfill.

h. The minimum roll width shall be 22.5 feet. The roll length shall be maximized in order to minimize the number of field seams.

i. Textured geomembrane shall be textured on both sides of the sheet.

j. Sixty (60) mil textured HDPE geomembrane shall be as manufactured by Gundle Lining Systems, Inc., Poly-America, Inc., or approved equal.

k. HDPE 60 mil geomembranes shall conform to the properties listed in Table 4.3-1.

l. Pipe Penetration Materials

1) Sponge Rubber Sheeting: Sponge rubber sheeting shall be type SCE-41, Neoprene/EPT/SBR, Closed Cell Medium, 1/4 inch thick, one side adhesive.

2) Neoprene Adhesive: Neoprene adhesive such as PYTHON shall be used for gluing sponge rubber sheeting to concrete and HDPE surfaces.

3) Metal Battens: Batten strips shall be Type 304 stainless steel. Width of strips shall be two inches minimum. Thickness shall be 1/4 inch.

4) Worm gear/band type pipe clamps for securing pipe boot sleeve to gas vent riser shall be stainless steel.

E. Quality Control During Manufacturing

1. Sampling shall be performed by the geomembrane manufacturer, at no additional cost to the Owner, throughout the production run to assure proper quality control. Sampling frequency shall be as specified herein.

Table 4.3-1

60 MIL TEXTURED HDPE GEOMEMBRANE

Property	Test Method	Units	Specified Value	Qualifiers[1]
Thickness	ASTM D751	Mils	54	Minimum
Density	ASTM D1505	g/cc	0.94	Minimum
Melt Flow Index	ASTM D1238 Condition E (190°C,2.16 kg.)	g/10 minutes	0.4	Maximum
Carbon Black %	ASTM D1603	%	2-3	
Carbon Black Dispersion	ASTM D3015	Rating	A-1, A-2, B-1	
Tensile Properties	ASTM D638 Type IV, 2" gauge length Dumb-bell @2 ipm			
· Strength at Yield		PPI	140	MARV[2]
· Strength at Break		PPI	75	MARV[2]
· Elongation at Yield		%	13	MARV
· Elongation at Break		%	150	MARV
Tear Resistance	ASTM D1004 Die C	Pounds	45	MARV
Puncture Resistance	FTMS 101B Method 2065	Pounds	80	MARV
Environmental Stress Crack	ASTM D1693 10% Igepal, 50°C	Hours	1500	Minimum
Dimensional Stability	ASTM D1204 100°C, 1 hour	% change	±2	Maximum
Thermal Stability OIT	ASTM D3895 130°C, 800 PSI O_2	Minutes	2000	Minimum
Low Temperature Brittleness	ASTM D746 Procedure B	Degree F	-107	Maximum
Coefficient of Linear Thermal Expansion	ASTM D696	$x10^{-4}$ cm/cm°C	2.0	Maximum

Table 4.3-1 (continued)

60 MIL TEXTURED HDPE GEOMEMBRANE

Property	Test Method	Units	Specified Value	Qualifiers[1]
Volatile Loss	ASTM D1203	%	0.3	Maximum
Water Absorption	ASTM D570	%	0.1	Maximum
Resistance to Soil Burial	ASTM D3083 (as modified in NSF 54 Appendix A)			
· Tensile Strength at Yield and Break		% change	10	Maximum
· Elongation at Yield and Break		% change	10	Maximum
Hydrostatic Resistance	ASTM D751	PSI	350	MARV
Seam Strengths	ASTM D4437			
Peel Strength	(Wedge)	PPI	88 & FTB	Minimum
Peel Strength	(Extrusion)	PPI	63 & FTB	Minimum
Shear Strength		PPI	151 & FTB	Minimum

(1) MARV = Minimum Average Roll Values

(2) The values given correspond to a yield stress of 2300 psi and a break stress of 1250 psi for textured HDPE geomembrane

FTB = Film Tearing Bond

2. All resins for use in the geomembrane must pass a candidate preapproval process before being eligible for use. Each incoming railcar shall be sampled, by compartment, with testing performed and compared to the requirements specified herein. Testing shall include Density (ASTM D 1505) and Melt Flow Index (ASTM D 1238).

3. All additives and concentrates must pass a candidate preapproval process. All incoming materials are to be statistically sampled with testing performed and compared to the manufacturer's specifications. Testing shall include Density (ASTM D 1505), Melt Flow Index (ASTM D1238) and Carbon Black Content (ASTM D 1603).

4. Each roll of geomembrane shall be subjected to continuous on-line monitoring for thickness, pinholes and visual imperfections.

5. For each roll of geomembrane sheet, a full width sample shall be cut from the end of each roll, and thickness shall be checked across the entire sample as per ASTM D751. The thickness shall be measured every 8-12 inches +/- across the width of the roll.

6. During production, the geomembrane sheet shall be constantly monitored for sheet surface appearance and knife cut edge. The geomembrane sheet shall be visually inspected to assure that material is free of holes, blisters, undispersed raw material, foreign matter, folds, creases, abrasions or other damage.

7. Certified reports on QC tests conducted by the geomembrane manufacturer to verify that the geomembrane meets the specification requirements shall be prepared by the manufacturer and submitted by the Contractor to the Engineer.

8. Certified results of the following QC testing from the geomembrane manufacturer. The frequency of the QC testing performed by the manufacturer on the finished geomembrane shall be as specified:

   - Density - ASTM D 792 Method A [Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement], or ASTM D 1505 (Test Method for Density of Plastics by the

Density-Gradient Technique). Frequency: Twice per day minimum.

- Carbon black content - ASTM D 1603 (Test Method for Carbon Black in Olefin Plastics). Frequency: Four times per day, minimum.

- Carbon black dispersion - ASTM D 3015 (Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds). Frequency: Twice per day, minimum.

- Thickness - ASTM D751. Frequency: Every roll.

- Tensile strength - ASTM D 638 (Test Method for Tensile Properties of Plastics) with no requirement for sample conditioning time. Frequency: Every other roll, minimum.

9. The Contractor shall furnish to the Engineer the following certifications provided by the geomembrane manufacturer or geomembrane installer:

   - Certification that nondestructive seam testing was performed on all factory fabricated seams (e.g., pipe boots) over their full length using a test method acceptable to the Engineer.

   - Certified results from the HDPE geomembrane manufacturer of tests conducted to verify the quality of the manufacturing of the geomembrane. Tests for density, melt flow index, carbon black dispersion thickness, tensile strength, carbon black percent content. Tear and puncture resistance must be performed using the test methods specified.

   - Reports of tests conducted by the resin suppliers and the geomembrane manufacturer to verify the quality of the raw materials used to manufacture the geomembrane. Tests for specific gravity and melt flow index must be performed using the methods specified.

   - The geomembrane manufacturer shall certify to test results or properties of the geomembrane for the following categories: Environmental Stress Crack, Dimensional Stability, Oxidative Induction Time (OIT), Resistance to Soil Burial, and Low Temperature Brittleness.

10. The Owner and Engineer, at their discretion, shall employ and pay for an independent testing laboratory to perform additional testing of the liner materials. This testing may include all properties specified herein and need not be limited to the testing performed by the manufacturer. The Contractor shall, at no additional cost, provide samples to the Engineer as required.

11. The Contractor shall be solely responsible to the Owner for the quality of the material provided. Should any of the tests performed on the material yield unsatisfactory results, the Contractor will be responsible for replacing the material with satisfactory material without delaying the total project time and without any cost to the Owner.

12. No geomembrane shall be installed until the corresponding certifications and quality control certificates have been submitted to and approved by the Engineer.

13. The geomembrane manufacturer shall permit the Owner and Engineer to visit the manufacturing plant for project specific visits. If possible, the visit will be prior to or coincide with the manufacturing of the geomembrane rolls for this project. During the visit, the geomembrane manufacturer shall provide supervised access to the facility and allow the Owner and Engineer to:

    - Review the manufacturing process, quality control procedures, laboratory facilities and testing procedures.

    - Verify that properties guaranteed by the geomembrane manufacturer comply with the specifications.

    - Verify that the required measurements of properties by the geomembrane manufacturer are properly documented and that the test methods utilized are acceptable.

    - Spot inspect geomembrane rolls for evidence of holes, blisters, undispersed materials, or any sign of contamination by foreign matter.

- Review packaging, warehousing, and transportation procedures to verify that the procedures are not damaging the geomembrane.

- Verify that roll labels are in place and properly documented in accordance with these specifications.

F. Execution

1. Material Handling, Delivery and Storage

a. Each roll of geomembrane delivered to the site shall be labelled by the manufacturer. The label shall clearly state the manufacturer's name, product identification, lot number, roll number, roll dimensions (length and width), thickness of the material, and direction to unroll the material.

b. No materials shall be shipped to the Project site prior to approval of the requisite submittals.

c. Transportation of the geomembrane is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to and during transportation to the site.

d. Handling and storage of the geomembrane prior to installation at the site, is the responsibility of the Contractor. During storage, the geomembrane shall be protected from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane shall be stored in accordance with additional requirements of the Manufacturer. The Contractor shall be liable for all damage to the materials incurred prior to final acceptance of the final cover system.

e. The transporter will ensure that all rolls of geomembrane are shipped on open trailers (no enclosed vans) for ease and safety of unloading the material.

f. The Contractor shall provide all labor and equipment required to assist the Engineer in

inspection and sampling of material upon delivery to the site.

g. The Engineer shall randomly sample the delivered material to verify the thickness of the geomembrane. The measurements shall be performed with a fine point micrometer with a 1/32" tip. A minimum of five (5) measurements across the width of the roll shall be taken and averaged.

h. Rolls shall be stored in a manner which protects them from the elements.

i. Upon delivery of the rolls of geomembrane, the Engineer shall obtain a copy of the certificate from the manufacturer certifying that the current batch of geomembrane material delivered to the site was manufactured and QC inspected, and transported without damage. The Engineer shall visually inspect the material.

j. The Engineer shall obtain conformance samples from the delivered material at a minimum rate of one sample per lot, and no less frequently than one conformance sample per 100,000 square feet of geomembrane. The conformance sample shall be taken across the entire width of the roll. Samples shall be three (3) feet long by the roll width. All QA conformance test results, which may be performed at the discretion of the Engineer, shall be reviewed and approved by the Engineer prior to any geomembrane placement. If a conformance test result fails the specification requirements, at least two additional conformance tests shall be performed on samples taken immediately from adjacent numbered rolls. If the test results pass the specification requirements, the entire lot or 100,000 square feet shall be accepted except that roll from which the failed sample is taken. If any of the conformance test results fails for the (minimum) two additional samples, the entire lot or 100,000 square feet shall be rejected by the Engineer.

k. IT IS IMPERATIVE THAT THE CONTRACTOR SCHEDULE THE DELIVERIES OF GEOMEMBRANE IN ORDER TO ALLOW AMPLE TIME FOR THE TAKING AND TESTING

OF CONFORMANCE SAMPLES. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ANY DELAYS, DAMAGE, ETC., RESULTING FROM IMPROPER SCHEDULING OF THESE DELIVERIES AND/OR FAILED TEST RESULTS FOR THESE CONFORMANCE SAMPLES.

1. The Contractor shall properly store and handle any solvents used in the prosecution of the work in accordance with the Material Safety Data Sheets.

2. Surface Preparation

   a. The Contractor shall be responsible for preparing and maintaining the subgrade in a condition suitable for installation of geomembrane, including any repair or rework as required by the Engineer or the Geomembrane Installer.

   b. Prior to each day's liner deployment, the geosynthetic installer shall certify in writing that the surface on which the geomembrane will be installed is free of stones and objects that can damage the geomembrane, and is free from frozen ground, frost, standing water and surface saturation. This certification of acceptance shall be given to the Engineer prior to commencement of geomembrane installation in the area under consideration.

   c. Prior to the placement of geomembrane, the Contractor/Geomembrane Installer shall verify:

      - The Contractor's surveyor has verified all lines and grades in areas of placement.

      - The soil layer beneath the geomembrane meets the specification requirements, including compaction.

   d. Special care should be taken to maintain the prepared soil surface.

   e. Any damage to subgrade caused by installation activities shall be promptly repaired at the Contractor's expense.

f. No loose soil shall be allowed beneath the geomembrane.

g. The anchor trench shall be excavated prior to geomembrane placement, to the lines and grades shown on the drawings. The trench shall have a configuration as shown on the drawings.

h. Slightly rounded corners shall be provided in the trench where the geomembrane adjoins the trench so as to avoid sharp bends in the geomembrane.

i. The anchor trench shall be backfield as required and compacted by hand to 90 percent of the Standard Proctor density. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane.

3. Deployment

a. The Contractor/Geomembrane Installer, on a daily basis, shall certify that the surface on which the geomembrane will be installed is acceptable. After the supporting soil surface has been accepted, it shall be the Contractor's responsibility to indicate to the Engineer any change to its condition due to natural causes or occurrences that may require work.

b. Care shall be taken to keep the geomembrane clean and free from debris prior to and during installation.

c. The layout of geomembrane sheets shall minimize the length of field seaming required and locate seams where applied stresses will be minimal. Sheet layout shall take into consideration any expansion and contraction anticipated due to ambient temperature variations. The Geomembrane Installer shall inform the Engineer regarding changes in field seam locations during installation and obtain written approval before actual seaming. Unless otherwise modified and approved during the prosecution of the work, the deployment and placement of the geomembrane shall be conducted in accordance with the approved panel layout.

d. Each field panel shall be given a unique identification code (using a convention approved by the Engineer) which is consistent with the approved panel layout plan. The field panel identification code shall be related, through a table or chart, to the original resin and the constituent rolls and factory panels (if appropriate).

e. Field panels shall be placed one at a time, and each field panel shall be seamed immediately after its placement in order to minimize the number of unseamed field panels exposed to wind.

f. All geomembranes shall be weighted with sandbags or the equivalent to prevent uplift by wind. In case of high winds, the geomembranes shall be continuously loaded along the edges of the panels to minimize risk of wind flow under the panels.

g. Geomembrane deployment shall proceed between ambient temperatures of 40 degrees F to 104 degrees F. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, rain, dew) or in the presence of winds in excess of 20 mph, as determined by the Engineer.

h. The Contractor shall ensure that:

1) No equipment used shall damage the geomembrane in any way.

2) No personnel working on the geomembrane shall smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane.

3) The method used to unroll the panels shall not cause scratches or chips in the geomembrane and shall not damage the supporting soil.

4) The prepared surface underlying the geomembrane must not be allowed to deteriorate after acceptance, and must

remain acceptable up to the time of geomembrane placement.

5) The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).

6) No vehicular traffic shall be allowed on the geomembrane.

i. Any field panel or portion thereof which becomes seriously damaged (torn, twisted, or crimped) shall be replaced at no cost to the Owner. Less serious damage may be repaired at the Engineer's option. Damaged panels or portions of damaged panels which have been rejected shall be removed from the work area, immediately, and shall not be reused in any portion of the work and shall be removed from the Project site.

j. The Contractor shall be solely responsible for locating and installing passive gas vents (flaps) in the geomembrane to protect and safeguard the unballasted geomembrane from damage due to the accumulation of decomposition gases under the geomembrane, or damage due to combustion of the decomposition gases.

k. The Contractor shall be solely responsible to protect and safeguard the geomembrane from damage due to vandalism, lightning, decomposition gases, fire, animals, etc., and shall repair or replace any damaged geomembrane at no additional cost to the Owner.

4. Field Seaming

a. Seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized and located outside the corners.

b. No horizontal seam shall be closer than 5 feet from the top or toe of the slope. Seams shall be aligned with the least possible number of wrinkles and "fishmouths." If a fishmouth or wrinkle is found, it shall be relieved and cap-stripped.

c. All geomembrane sheet surfaces to be seamed shall be free of dust, dirt and moisture. Water shall be prevented from ponding on the geomembrane.

d. All geomembrane surfaces to be seamed by extrusion welding shall be roughened with a sander or other suitable means no more than 1 hour prior to seaming to remove surface oxidation. Geomembrane edges to be seamed shall lay flat against each other during seaming until the seam has reached specified strength. The grind depth shall not exceed 10 percent of the geomembrane thickness. Grind marks shall not appear 1/4 inch beyond the extruded seam after it is placed.

e. Seaming shall result in a homogeneous joint with a bonded seam strength conforming to the tensile properties specified herein.

f. Field seams shall be extrusion bonded type, produced by extruding molten parent material between or over the edge of two overlapped liner sheets, or double wedge hot shoe fusion weld type, produced by melting the edges of two overlapped liners to a molten state by means of a hot plate and then fusing them together.

g. Panels of geomembrane shall have finished overlap of a minimum of 5 inches for hot shoe fusion welding and 3 inches for extrusion welding, but in any event sufficient overlap shall be provided to allow peel tests to be performed on the seam.

h. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane. The temperature of hot air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

i. Field test (trial) seams shall be conducted on geomembrane liner to verify that seaming conditions are satisfactory. Test seams shall be conducted at the beginning of each seaming period, at the Engineer's discretion, and at least once each 4 hours, for each seaming apparatus and each seamer used that day.

j. All test seams shall be made at a location selected by the Engineer in the area of the seaming to be conducted and in contact with the subgrade. The test seam samples shall be 5 feet long and one (1) foot wide for hot shoe welding and 5 feet long and one (1) foot wide for extrusion welding with the seam centered lengthwise. Adjoining specimens 1 inch wide shall be cut from the test seam by the Contractor. The Contractor shall use a tensiometer to test these specimens for shear and peel. If a test seam fails to meet field seam specifications, the seaming apparatus and/or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. No production seaming shall be allowed until a passing result is observed.

k. Only seaming apparatus which has been specifically approved by make and model shall be used.

l. The extrusion welding apparatus shall be equipped with gauges giving the temperature in the apparatus and at the nozzle. The Contractor shall provide documentation regarding the extrudate to the Engineer and shall certify that the extrudate is compatible with the specifications, and in any event is comprised of the same resins as the geomembrane sheeting. The Contractor shall maintain at least one spare operable seaming apparatus on-site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be especially protected from damage in heavily trafficked areas. The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, the barrel

shall be purged of all heat degraded extrudate. The electric generator shall be placed on a smooth base such that no damage occurs to the geomembrane. Similarly, a smooth insulation plate or fabric shall be placed beneath the hot welding apparatus after usage.

m. The fusion welding apparatus must be automated vehicular-mounted devices. The fusion welding apparatus shall be equipped with gauges giving the applicable temperature and pressures. The Contractor shall maintain at least one spare operable seaming apparatus on-site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be protected from damage in heavily trafficked areas. For cross seams associated with fusion welding, the edge of the cross seams shall be abraded to a smooth-incline (top and bottom) prior to welding. The electric generator shall be placed on a smooth base such that no damage occurs to the geomembrane. Similarly, a smooth insulation plate or fabric shall be placed beneath the hot welding apparatus after usage. A movable protective layer may be used directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets.

n. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

o. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

p. If seaming operations are carried out at night, adequate illumination shall be provided.

q. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a

minimum of 6 inches beyond the cut in all directions.

r. Field seaming in cold weather conditions (below 40 degrees F) will not be permitted.

s. No field seaming shall be conducted if ambient temperature is above 104 degrees F, unless:

- The Geomembrane Installer can demonstrate to the satisfaction of the Engineer that the quality of seaming is not compromised.
- Additional destructive tests shall be performed by the Engineer for any suspected areas.

t. Field seaming shall not be performed during any precipitation, in the presence of excessive moisture (e.g., fog, rain, dew) or excessively moist underlying soils, or in the presence of winds in excess of 20 mph, as determined by the Engineer.

u. The ambient temperature shall be measured 6 inches above the geomembrane layer.

5. Pipe Penetration Sealing System

a. The pipe penetration sealing system shall consist of a prefabricated HDPE boot assembly comprised of a welded HDPE barrel and flange. The HDPE flange shall be secured to the HDPE liner material by extrusion welding. The barrel portion of the boot assembly shall be secured to the penetrating pipe by means of a stainless steel clamp. A neoprene strip shall be installed to prevent damage to the boot assembly.

b. During installation, the boot assembly should be properly positioned so that it is not over stressed during placement of the overlying materials or due to subsidence.

6. Nondestructive Seam Testing

a. All field seams shall be nondestructively tested over their full length. All test equipment shall be furnished by the

Contractor. Nondestructive seam testing shall closely follow the seaming operation.

b. Nondestructive tests shall be performed by experienced personnel thoroughly familiar with the specified test methods.

c. The Contractor shall field demonstrate all test methods to verify to the Engineer that the test procedures are valid.

d. Extrusion Weld Seams

1) Extrusion weld seams shall be vacuum box tested. The vacuum box test equipment shall be comprised of, but not limited to, a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge; a steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket and wide paint brush; and a soapy solution. The vacuum box shall be similar to the series A 100 Straight Seam Tester as supplied by the American Parts Service Company.

2) Excess sheet overlap shall be trimmed away.

3) The window and gasket surfaces shall be cleaned and checked for leaks.

4) The vacuum pump shall be energized and the tank pressure reduced to approximately 5 psi.

5) The Contractor shall ensure that a leak tight seal is created by wetting a strip of geomembrane approximately 12 inches by 48 inches (length of box) with the soapy solution, placing the box over the wetted area and then compressing. The Contractor shall then close the bleed valve, open the vacuum valve, and for a period of approximately 10 seconds, examine the geomembrane through the

viewing window for the presence of soap bubbles. If no bubbles appear after 10 seconds, the area shall be considered leak tight. The box shall be moved over the next adjoining area with a minimum 3 inches overlap and the process shall be repeated.

6) All areas where soap bubbles appear shall be marked and repaired and then retested.

7) At locations where seams cannot be nondestructively tested, as determined by the Engineer, if the seam is accessible to testing equipment prior to final installation, the seam shall be nondestructively tested prior to final installation.

8) At locations where seams cannot be nondestructively tested, as determined by the Engineer, if the seam cannot be tested prior to final installation, the seaming operations shall be observed by the Engineer for uniformity and completeness, and the subject seam shall be cap-stripped.

e. Double Fusion Seams

1) Double fusion seams with an enclosed space shall be air pressure tested.

2) Equipment for testing double fusion seams shall be comprised of, but not limited to, an air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane, and a rubber hose with fittings and connections equipped with a sharp hollow needle, or other approved pressure feed devise.

3) The Contractor shall demonstrate that the length of air channel is continuous over the length to be tested by allowing air to be introduced at one end and escape at the other prior to sealing or

securing the air channel as required to conduct the pressure test.

4) The Contractor shall ensure that a leak tight seal is created. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be energized to a pressure between 25 and 30 psi, the valve closed and the pressure sustained for approximately 5 minutes. If pressure is maintained, the seam shall be considered leak tight. The needle or other approved pressure feed device shall be removed and the feed hole sealed.

5) If loss of pressure exceeds 4 psi, or pressure does not stabilize, the faulty area shall be located, repaired and retested.

f. All field seams shall be visually inspected for edge bonding to find unbonded areas.

7. Destructive Seam Testing

a. Destructive seam tests shall be performed on samples collected from selected locations. The purpose of these tests is to evaluate seam strength and integrity. Seam destructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

b. A minimum average frequency of one destructive test sample per 500 feet of seam length shall be provided from a location specified by the Engineer. The Contractor shall not be informed in advance of the sample location. Test locations shall be determined during seaming and may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming. The minimum average frequency of one destructive test sample per 500 feet of seam length shall be determined as an average taken throughout the entire facility. In addition, a minimum

of one test for each seaming machine per day shall be conducted. However, nothing shall prevent this frequency from being increased to address observation, concerns, or actual performance results from samples taken.

c. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Contractor as the seaming progresses. Sampling times and locations shall be determined by the Engineer. Engineer will witness the obtaining of all field samples and the Contractor shall mark all samples with their location, sample number, roll and seam number. The Contractor shall record in written form the date, time, location, roll seam number, reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane), ambient temperatures, and pass or fail description. The Contractor shall record the location of the sample on the "As-Built" Panel Layout. A copy of the information must be attached to each sample portion. All holes in the geomembrane resulting from obtaining the seam samples shall be immediately repaired. All patches shall be vacuum tested. The patch shall extend a minimum of 6 inches beyond the periphery of the hole and the corners of the patch shall be rounded with a radius of approximately 3 inches.

d. The destructive testing seam samples shall be 12 inches wide by 50 inches long with the seam centered lengthwise. One 1-inch wide strip shall be cut from each end of the sample and these shall be tested in the field by the Contractor. The remaining sample shall be cut into three parts and distributed as follows:

- One portion (12 inches by 12 inches) to the Contractor/Geosynthetic Installer for testing.

- One portion (12 inches by 18 inches) to the Engineer for laboratory testing by an independent geosynthetic laboratory.

- One portion (12 inches by 18 inches) to the Engineer for archive storage.

The two 1-inch strips shall be tested in the field, by hand or tensiometer, for peel and shear, respectively, and shall not fail in the seam. If any field test sample fails to pass, then the procedures described in "Defects and Repair" shall be instituted.

e. The destructive seam sample shall be prepared for testing by cutting at least ten 1-inch wide specimens or coupons. At least 5 specimens shall be tested for Seam (Shear) Strength (ASTM D 3083 as modified in NSF 54 Appendix A, tested at 2 inches per minute) and at lease 5 specimens shall be tested for Peel Adhesion (ASTM D 413 as modified in NSF 54 Appendix A, tested at 2 inches per minute). The specimens shall be selected for testing on an alternating basis (i.e., sample specimen No. 1 tested for peel, sample specimen No. 2 tested for shear, etc.). The specimens must exhibit a Film Tearing Bond (FTB) and minimum acceptable values for shear strength and for peel strength as specified herein.

In order for a destructive seam sample to be considered acceptable, a minimum of 4 out of the 5 specimens for peel adhesion must satisfy the above requirements and a minimum of 4 out of the 5 specimens for shear strength must satisfy the above requirements.

Any specimen that fails through the weld or by adhesion at the weld/sheet interface is a Non-FTB break and shall be considered a failure.

5. Destructive Test Failure

a. If a sample fails any of the field or laboratory destructive tests, the Contractor shall reconstruct the seam between the failed location and any two locations were destructive seam tests passed.

b. The Contractor can retrace the welding path to an intermediate location (at a minimum of 10 feet in each direction from the location

of the failed test), at the Engineer's discretion, and take a small sample at each location for additional field tests. If these additional samples pass tensiometer testing, then full destructive laboratory samples are taken. If these destructive laboratory sample pass the tests, then the seam is reconstructed between these locations by capping. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken.

c. If an extrusion weld type seam fails destructive testing, the only acceptable method of repair is to cap the seam. Extrusion welding of the failed seam is not acceptable.

d. If a fusion type seam fails destructive testing, the only acceptable method of repair is to cap or replace the seam.

e. Applying topping is not an acceptable method of reconstructing long lengths of seam.

f. In cases where the length of reconstructed seam exceeds 150 feet, a sample shall be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing. If the sample does not pass destructive testing, then the above procedure must be repeated.

g. The Contractor will document all actions taken in conjunction with destructive test failures.

h. All inadequate seams or portions thereof shall be corrected in accordance with the approved method. Should differences of opinion between the Contractor and the Engineer develop during the installation relevant to seam integrity, the Engineer may, at his discretion, obtain samples of the seams in dispute for field and/or laboratory testing by the independent geosynthetic testing laboratory. The Contractor shall be

responsible for providing samples and patching the resulting void in accordance with the previously approved testing procedures at no additional cost.

G. Defects and Repairs

1. All seams and nonseam areas of the geomembrane shall be inspected for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of inspection. The geomembrane shall be brushed, blown, or washed by the Contractor if the amount of dust or mud inhibits inspection. The Engineer shall decide if cleaning of the geomembrane is needed to facilitate inspection.

2. Each suspect location in seam and nonseam areas shall be nondestructively tested as appropriate in the presence of the Engineer. Each location that fails the nondestructive testing shall be marked and documented by the Engineer, and repaired accordingly.

   a. Small holes (pinholes) shall be repaired by extrusion cap welding. If the hole is larger than 1/4 inch, it shall be patched.

   b. Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded prior to patching.

   c. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.

   d. Long lengths of failed seams shall be repaired by capping.

   e. Topping may be used to repair short areas of inadequate seams, provided the seam has an exposed edge, and the inadequate seam is less than five (5) feet in length.

   f. Abrading (grinding) and reseaming may be used to repair small sections of extrusion welded

seams, provided the seam is less than five (5) feet in length.

g. Nothing above shall preclude a bad seam from being removed and replaced with a strip of new material seamed into place.

h. Surfaces of HDPE which are to be patched or extrusion welded shall be abraded and cleaned no more than 1 hour prior to repair. No more than 10% of the thickness shall be removed. Grinding shall be performed in such fashion that the grinding marks (swirl marks) are perpendicular to the seam, not parallel to the seam in order to avoid gouging which may precipitate sheet failure. Grinding shall be limited to the area and just immediately beyond the area to be extrusion welded.

i. Patches shall be rounded or oval in shape, made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects. The corners of the patch shall have a minimum radius of 3 inches. All patches shall be of the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled with an angle grinder prior to the placement on the geomembrane. Patches shall be applied using approved methods only.

j. The extrusion welding repair process shall start by grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous seam by at least 2 inches. Reseaming over an existing seam without regrinding shall not be permitted.

k. All surfaces associated with a repair (i.e., parent sheet, patch, cap strip, etc.) must be clean and dry at the time of making the repair.

l. Only seaming equipment and seamers which have been tested and approved may be used in making the repairs.

m. All repair procedures, materials and techniques must be approved in advance by the Engineer.

n. In areas where a large cap strip is to be installed, the underlying geomembrane should be cut in areas of low stresses in order to avoid the accumulation of water or gas between the two membranes.

o. Each repair shall be identified, numbered, located on the "As Built" panel layout and nondestructively tested. The Engineer may, at any time, require a destructive seam sample be obtained from a repaired seam. Large caps may be of sufficient extent (in excess of 150 feet of seam length) to require that destructive seam testing be conducted. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests shall mandate that the repair shall be repeated and retested until passing test results are achieved.

p. Daily documentation of all nondestructive and destructive testing shall be provided to the Engineer by the Contractor. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

q. Wherever possible, the cause of damage to the geomembrane shall be determined and immediately corrected.

r. Any repairs caused by negligence of the Contractor shall be solely at the Contractor's expense.

3. When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the Engineer shall identify all excessive geomembrane wrinkles. The Contractor shall cut and reseam all wrinkles so identified. The seam thus produced shall be tested like any other seam. Folding over wrinkles will not be acceptable.

H. Backfilling of Anchor Trench

1. The anchor trench shall be backfilled and compacted by the Contractor as approved by the Engineer. Trench backfill material shall be placed in lifts and compacted by hand or other light compaction equipment to a minimum of 90 percent Standard Proctor density.

2. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. At no time, shall construction equipment come into direct contact with the geomembrane. If damage occurs, it shall be repaired by the Contractor prior to the completion of backfilling.

I. Placement of Overlying Materials

1. No materials shall be placed over the HDPE geomembrane until it has been properly and completely installed, tested, repaired, retested as necessary, and documented.

2. The Contractor shall exercise extreme care when placing or installing any of the materials which overlie the HDPE geomembrane. These materials shall include, but not be limited to Geocomposite, Barrier Protection Layer material, LFG vent piping, storm water management systems, structures, drainage materials, etc. The Contractor shall take all necessary precautions so that the installation of these materials does not damage the HDPE geomembrane.

3. Placement of the Barrier Protection Layer material on the HDPE geomembrane shall not proceed at an ambient temperature below 32 degrees F or above 104 degrees F, unless otherwise specified. Equipment used for placing Barrier Protection Layer material shall not be driven directly on the geomembrane. A minimum thickness of 1 foot of Barrier Protection Layer material is required between a low ground pressure tracked vehicle and the geomembrane. The maximum ground pressure of tracked equipment shall be 4.7 psi. Rubber-tire vehicles shall not be operated unless there is a minimum of 3 feet of material above the geomembrane.

4. The Contractor should attempt to schedule the placement of Barrier Protection Layer material during the coolest parts of the day (i.e., early morning hours or after periods of prolonged

overcast skies) to mitigate the potential for developing large wrinkles in the HDPE geomembrane.

5. All Barrier Protection Layer material shall be placed from the toe of slope up to the top of slope, never down the slope.

6. The Contractor shall provide spotters for each piece of heavy equipment to ensure that any stones, debris, oversized or deleterious materials are removed from the soil layer to ensure that they are not in contact with the geomembrane. The heavy equipment must be operated in such fashion to avoid any sudden braking or turning motions which may damage the underlying geomembrane.

7. In the event a piece of equipment "spins" its tracks, the covering operation should immediately cease and a manual uncovering and examination of the geosynthetics be conducted. Any damage must be promptly repaired, documented and tested.

As-built Drawings

1. The Contractor/Geomembrane Installer shall maintain and prepare at the site of the work, an "As-built" drawing which details and delineates all field panels, seams, repairs, destructive samples, dimensions, penetrations, roll numbers, seam numbers, etc., to fully and comprehensively describe the as-built conditions.

2. The Contractor shall submit three (3) copies of the "As-built" drawings with each partial payment request. The partial "As-built" shall be current and up-to-date coinciding with the date of the partial payment request.

3. The Contractor shall submit a reproducible copy of the final "As-built" drawing within fifteen days of the completion of the installation of the geomembrane to the Engineer for review and approval. The Contractor shall correct, review and resubmit the "As-built" drawing as required.

Gundle®

GUNDLINE INSTALLATIONS

FOR COMPLETE INSTALLATIONS LIST,
CALL GUNDLE LINING SYSTEMS, INC., HOUSTON, TX.
(713-443-8564 OR 1-800-435-2008)

CONTACT: ANNA SPENCER

Gundle Lining Systems Inc

Gundle®

Gundline® HDT and Gundline® VLT

Textured Gundline® HDT Maximizes Slope Stability

Gundle Lining Systems has developed a method for adding a rough texture to the surface of our durable High Density Polyethylene (HDPE) liners. The result is a high performance product called Gundline HDT which increases slope stability in engineered landfills and other lining applications.

Gundline HDT's special textured surface dramatically improves slope stability by increasing friction between the synthetic liner and soils, geotextiles, and other geosynthetics. Cover soils are held on the liner with the greatly increased friction, and safety-conscious engineers can improve factors of safety on slopes of varying steepness. Table 1 lists the improvements in friction angle for Gundline HDT, determined by direct shear box testing.

The innovative friction surface of Gundline HDT is manufactured simultaneously with extrusion of the solid barrier portion of the liner as opposed to being added after extrusion. It's a rough surface, fully integrated with the sheet during the molten phase of manufacture. As a result, it has excellent abrasion resistance and remains intact regardless of chemicals contacting the sheet surface.

Gundline® VLT

Gundline VLT combines the exceptional elongation and elastic properties of Gundline® VL (Very Low Density Polyethylene Liner) with the outstanding friction characteristics and slope stabilizing qualities of Gundline® HDT! The combination makes the liner ideal for landfill closures and other applications where elongation, flexibility, and slope stability are important. The excellent multi-axial elongation of Gundline VLT accommodates differential settlement while the textured surface provides long term slope stability.

TABLE 1: DIRECT SHEAR FRICTION ANGLES*

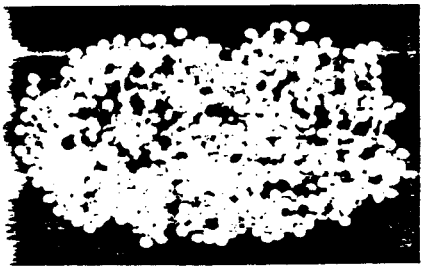
SLIDING SURFACE	FRICTION ANGLE (DEGREES) POLYETHYLENE	TEXTURED
Gundline/H.R. Clay	16	24
Gundline/Ottawa Sand	17	26
Gundline/Geotextile (Nonwoven)	11	29

*Note: Friction angles for the products listed are typical only and may vary with local soil conditions. Accordingly, engineers must test friction angles for the product using site specific soil composition for all designs incorporating the product.

Gundline HDT Retains The Important Advantages Of Gundline® HD.

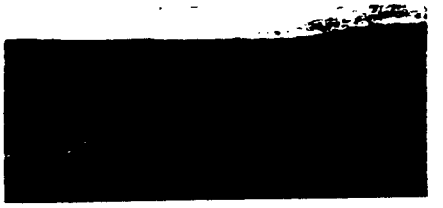
Manufactured in 22.5 foot wide seamless rolls and in thicknesses ranging from 40-100 mils of barrier wall, Gundline HDT features the same important qualities that have made Gundline HD the world's leading lining system. Tensile strength before yielding, biaxial elongation, tear resistance, puncture resistance, ultraviolet light resistance, chemical resistance, dimensional stability, heat resistance, and stress crack resistance are all excellent. So is resistance to microorganisms and rodent damage.

As with Gundline HD, Gundle manufactures Gundline HDT with only the top performing pipe grade HDPE resin. The superior high grade resin creates an ideal structure to the finished sheet.



HDPE resin and carbon black used in manufacturing.

Gundline HDT Provides Solutions To Difficult Applications.



A recent problem at Islip, New York illustrates the effectiveness of Gundline HDT. It began when the city's municipal landfill neared capacity. The problem was then compounded by the lack of available land for expansion. But Gundle provided the solution. After considering all available options, it was decided to expand vertically—a process dubbed "piggybacking." A new cell would be created to sit atop the existing closed and capped landfill. However, it was critical to establish slope stability for the new, steep slopes of this 80-foot high addition. So Gundle manufactured and installed 1.2 million square feet of Gundline HDT and successfully increased the friction angle between the liner and the sand over sixty percent.

Today, not only does Islip have 1.8 million cubic yards of new refuse disposal capacity, but they also have peace of mind knowing it's lined with the industry's most stable and durable liner.

GUNDLINE® HDT/VLT SPECIFICATIONS

TYPICAL PROPERTIES	TEST METHOD	GUNDLINE® HDT GAUGE (NOMINAL)					GUNDLINE® VLT GAUGE (NOMINAL)			
		30 mil	40 mil	60 mil	80 mil	100 mil	30 mil	40 mil	60 mil	80 mil
Density (g/cc)	ASTM D1505	.94 Min	.94 Min	.94 Min	.94 Min	.94 Min	.910 -.925	.910 -.925	.910 -.925	.910 -.925
Melt Flow Index (Max.) (190 C, 2.16 kg, g/10 minutes)	ASTM D1238 Condition E	.3	.3	.3	.3	.3	.6	.6	.6	.6
Carbon Black (%)	ASTM D1603	2 - 3	2 - 3	2 - 3	2 - 3	2 - 3	2 - 3	2 - 3	2 - 3	2 - 3
Tensile Properties	ASTM D638 Modified Type IV Dumb bell @ 2 ipm									
Strength at Yield (PPI)		70	95	140	190	240	NA	NA	NA	NA
Strength at Break (PPI)		30	50	75	100	125	56	84	112	169
Elongation at Yield (%)		13	13	13	13	13	NA	NA	NA	NA
Elongation at Break (%)		150	150	150	150	150	400	400	400	400
Multi Axial Elongation at Break (%, Min.)	GRI-GM4	15	15	15	15	15	75	75	75	75
Tear Resistance (Pounds)	ASTM D1004 Die C	22	30	45	60	75	12	18	27	36
Puncture Resistance (Pounds)	FTMS 101 Method 2065	30	52	80	105	130	51	64	75	85
Environmental Stress Crack (Hours, Min.)	ASTM D1693 10% Igepal, 50°C	1500	1500	1500	1500	1500	1500	1500	1500	1500
Dimensional Stability (% Change)	ASTM D1204	+/-2	+/-2	+/-2	+/-2	+/-2	+/-2	+/-2	+/-2	+/-2
Thermal Stability OIT (Minutes)	ASTM D3895 130°C, 800 PSI O_2	2000	2000	2000	2000	2000	2000	2000	2000	2000
Low Temperature Brittleness (°F)	ASTM D746 Procedure B	-112	-112	-112	-112	-112	-112	-112	-112	-112
Coefficient of Linear Thermal Expansion (x 10^{-4}/cm/cm°C)	ASTM D696	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Water Vapor Transmission (g/m^2/day Max.)	ASTM E96	.1	.1	.1	.1	.1	.1	.1	.1	.1

Note: All values, except when specified as minimum or maximum, are typical test results.

SUPPLY SPECIFICATIONS

The following describes typical roll dimensions for Gundline HDT and VLT.

NOMINAL THICKNESS		WIDTH		LENGTH		AREA	
mil	mm	ft.	m	ft.	m	ft. 2	m2
30	0.75	22.5	6.86	625	190	14,063	1306
40	1.0	22.5	6.86	600	183	13,500	1254
60	1.5	22.5	6.86	420	128	9,450	878
80	2.0	22.5	6.86	320	97	7,200	669
100*	2.5	22.5	6.86	250	76	5,625	522

* 100 mil is only available in HDT

GUNDLINE HDT and GUNDLINE VLT are rolled on 6" I.D. hollow cores. Each roll is provided with 2 slings to aid handling on site. Dimensions and weights are approximate. Custom lengths available upon request.

Gundle Lining Systems Inc

"If it needs lining, it needs Gundle."
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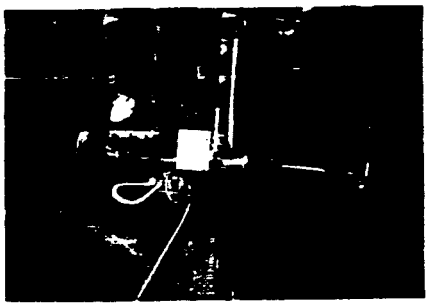
These specifications are to be used only as a general guideline for use by engineers in formulating preliminary specifications, and should not be relied upon absent site-specific product testing; and Gundle assumes no responsibility for the improper reliance upon or misuse of such data. In addition, product design and specifications are subject to change without notice.

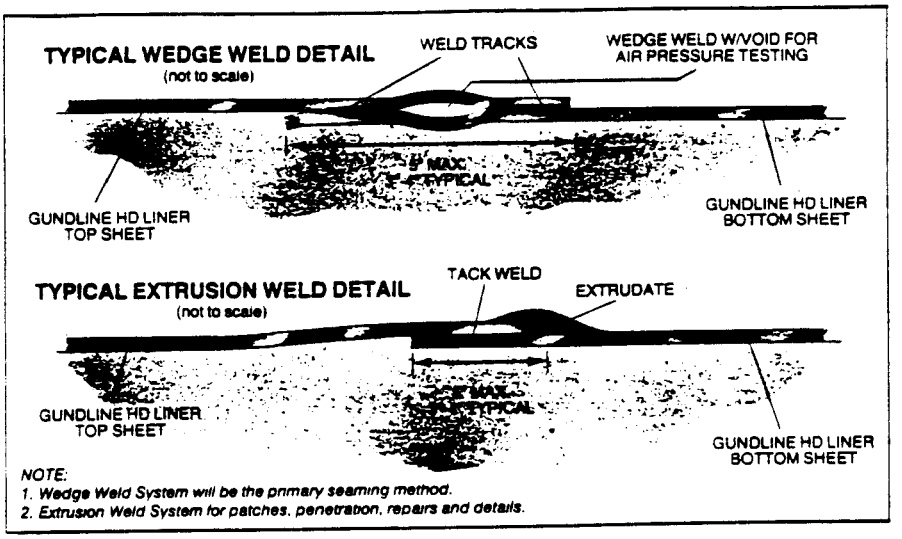
The Gundle Hot Wedge Weld: Effective And Efficient

Gundle's new generation hot wedge welders add versatility, speed and performance to Gundle's seaming capabilities. Together with the patented "mixing tip" fillet extrusion welders, Gundle offers the most advanced systems available today.

The Gundle hot wedge welder offers a number of important advantages over traditional seaming methods. As the welder propels itself along the sheets it draws a hot wedge between them. The heated sheets are then fed between a set of pressure rollers, creating a dual track seam. The Gundle hot wedge welder automatically adjusts the roller gap and wedge position to accommodate different sheet thicknesses. An air blower, mounted on the welder, directs a stream of air ahead of the path of the wedge to blow away dust particles. This air can be heated to dry or preheat the sheet during extreme cold. The Gundle welder also positions the wedge accurately at the edge of the top sheet for ease of non-destructive seam testing.

These features enable the Gundle hot wedge to weld sheets from 20 mil to 140 mil at speeds of up to 15 feet per minute. The welder has enough power to weld vertical seams, and yet, with its modern materials and innovative design, is 40% lighter than other welders, reducing operator fatigue and errors. Using appropriate temperature and speed settings, the hot wedge welded seams provide excellent results in peel and shear destructive tests.





NOTE:
1. Wedge Weld System will be the primary seaming method.
2. Extrusion Weld System for patches, penetration, repairs and details.

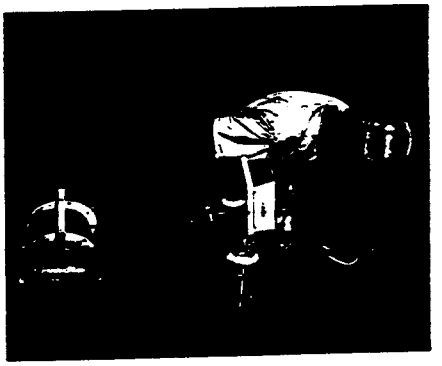
The Gundle hot wedge welder is a precision-machined assembly in which all drive components are totally enclosed and sealed from site dirt. This compact machine hardly lifts the upper sheet, which minimizes the formation of "fish mouths." Fish mouths are often caused by bulkier welding machines which stretch the top sheet. These features, together with automatically controlled temperature and speed, result in extremely consistent welds while reducing operator adjustments to an absolute minimum.

Since fillet extrusion welding is always necessary at penetrations and when patching, Gundle's hot wedge welder used alongside Gundle's patented extrusion welder with mixing action provides Gundle customers with the finest combination of welding technology available.

The Gundle Extrusion Weld: Improved Heat Transfer For Top Quality Extrusion Welding

Gundle Lining Systems' patented extrusion weld provides the combination of heating, extrudate deposition, and mixing action that results in a truly homogeneous bond between liner sheets.

Gundle's special extrusion welding gun stirs the molten extrudate against and into the liner. This mixing action greatly improves heat transfer and blends the extrudate bead into both sheets, creating a homogeneous weld. The result is a fully integrated connection through the seam. Since there is a continuous connection through the seam, and because the extruded bead is as thick as the liner sheet, the resulting seam is as strong as the sheet itself. Due to the extremely efficient heat transfer of Gundle's



patented mixing action, installations welded at 15°F have provided the same high quality test results as installations welded at 70°F.

The Gundle extrusion welder extrudes the identical polymer mix from which Gundline® HD sheet is made. The high quality pipe grade HDPE extruded to form the seam, therefore, has the same excellent resistance to a wide range of waste solutions. These include metal hydroxides, salts, acids, alkalis, oils, and hydrocarbon solvents including most chlorinated hydrocarbons (along with many other chemicals). The extrusion weld system must be used for patches, penetrations, repairs, and detail work.

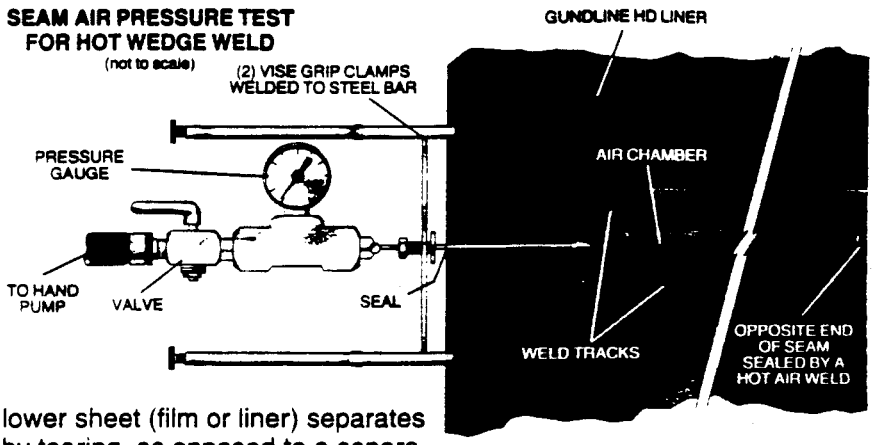
Both the Gundline extrusion weld and the Gundle hot wedge weld result in a truly homogeneous bond between the liner sheets. Therefore, there is no interface between the sheets which could be disrupted by absorbed solvents. Both Gundle seams offer the same chemical resistance as Gundle sheets and both can be used with Gundline HD, Gundline® HDT, Gundline VL, and Spectraline.

Destructive Testing At The Lab And On-Site

All Gundle seams are subjected to destructive testing. Samples cut from site welds are tested in the laboratory according to ASTM D638 (shear test) and ASTM D413 (peel test). These tests prove the quality of the Gundle welds.

Shear testing applies a tensile stress from the top sheet through the weld and into the bottom sheet. Peel testing peels the overlapped edge of the bottom sheet away from the top sheet in order to observe if separation occurs. The peel test indicates whether or not the sheets are continuously and homogeneously welded at the seam.

The important criterion in the peel test is that the test sample demonstrates what is called a Film Tear Bond (FTB). This means that as the weld is tested, the upper or lower sheet (film or liner) separates by tearing, as opposed to a separation between the top surface and bottom surface of the seam itself. A Film Tear Bond test result means the seam is good; a fully integrated weld.



Weld samples are sent by Express Mail to Gundle's laboratory in Houston from project sites. The Gundle Lab provides 24-hour turnaround for results on destructive test samples.

Gundle regularly conducts destructive seam tests at the jobsite too. This is to properly set welding conditions prior to start-up each morning and after work each work break, as well as to augment the official Gundle Lab testing of destructive seam samples.

Non Destructive Air Pressure Testing

The standard procedure for Gundle installations is to test 100% of the seam footage for leaks. With the Gundle hot wedge welder, non-destructive testing is made more efficient by air pressure testing of the gap between the "dual" wedge weld tracks on all welds 30 mils and greater. A single weld track is used on 20 mil, and an air lance or probe is used for non-destructive testing. The gap is pressurized by air injected through a needle inserted into the gap between weld tracks. Possible leaks are indicated by a loss of pressure over 5 minutes after the gap has been pressurized by a hand pump, and sealed by a valve. Very long sections of seam (up to 500 ft.) can be quickly tested for leaks, resulting in very efficient installation QC. Note that after a seam has passed a pressure test, pressure is released at the seam end opposite the pump/gauge assembly. This ensures that the seam is continuous and has been 100% tested.

Non Destructive Vacuum-Box Testing

Where air pressure testing is not applicable, Gundle technicians use a vacuum chamber to test 100% of the seamed footage. This test also confirms that no leaks are present in the seams. To perform a vacuum test, a soap solution is sprayed on top of the seam. Then a rectangular plexiglass-faced vacuum box is placed on the seam and a 5 psi vacuum is pulled in the box.

Visual inspection of Gundle extrusion welds, which are on top of the sheet, is also an important part of quality control on all Gundle installations.

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Appendix D

QUALITY ASSURANCE/QUALITY CONTROL PLAN

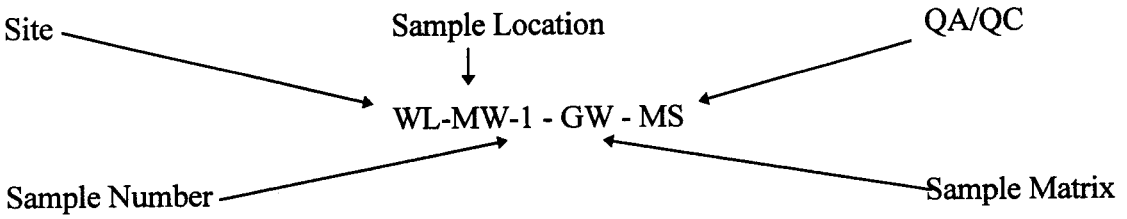
1.0 Sampling Procedures

1.1 Sample Identification

All samples collected will be labeled with a sample identification code. The code will identify the site, sample location, sample matrix and series numbers for sample locations with more than one sample. Samples will be labeled according to the following system:

- Site: - Site name "WL"(Wallkill Landfill)
- Sample Location and Number: - Monitoring Well Number "MW-1", etc.
  - Tributary 20, Location Number "T-1", etc.
- Sample Matrix: - Surface Water "SW"
  - Groundwater "GW"
  - Sediment "SD"
- Quality Assurance/ Quality Control (QA/QC): - Matrix Spike "MS"
  - Matrix Spike Duplicate "MSD"
  - Field Blank "FB"
  - Trip Blank "TB"

Based upon the above sample identification procedures, an example of a sample label may be:



1.2 Sample Handling, Packaging and Shipping

All samples will be placed in the appropriate containers as specified in the 1991 NYSDEC ASP. The holding time criteria identified in the ASP will be followed.

Prior to packaging any samples for shipment, the sample containers will be checked for proper identification and compared to the field log book for accuracy. The samples will then be wrapped with a cushioning material and placed in a cooler (or laboratory shuttle) with a sufficient amount of bagged ice or "blue ice" packs in order to keep the samples at 4°C until arrival at the laboratory.

All necessary documentation required to accompany the sample during shipment will be placed in a sealed plastic bag and taped to the underside of the cooler lid. The cooler will then be sealed with fiber (duct) or clear packing tape, and custody seals will be placed in such a manner that any opening of the cooler prior to arrival at the laboratory can be detected.

All samples will be shipped to ensure laboratory receipt within 48 hours of sample collection in accordance with NYSDEC requirements. The laboratory will be notified prior to the shipment of the samples.

1.2.1 - Surface Water Sediment

1. Be certain that the sample location is noted on Location Sketch.
2. Unless using disposable equipment, be certain that the sampling equipment (long handle polyethylene scoop) has been decontaminated utilizing the procedures outlined in Section 2.0.
3. Remove laboratory precleaned sample containers from sample cooler, label container with an indelible marker, fill out Sample Information Record and Chain of Custody Form.
4. Wear disposable gloves and boots if it is necessary to enter the water.
5. Insert scoop slowly at 0-6 inches into the sediment and remove sample.

6. With a disposable polyethylene scoop or sterile wooden tongue depressor, transfer the sample into the open sample container taking care not to spill sample on the outside of the container or overfill container and replace cover on the sample container.

7. Return sample container to cooler.

8. If reasonable, decontaminate the sampling equipment according to the procedures outlined in Section 2.0.

9. Place all disposable personal protective equipment and disposable sampling equipment into a 55 gallon drum and store in a secure area (fenced, if possible).

1.2.2 - Surface Water

1. Be certain that sample location is noted on Location Sketch.

2. Be certain that the sample equipment (long handle polyethylene scoop) has been decontaminated utilizing the procedures outlined in Section 2.0.

3. Remove laboratory precleaned sample containers from sample cooler, label container with an indelible marker, fill out Sample Information Record and Chain of Custody Form.

4. Wear disposable gloves and boots if it is necessary to enter the water.

5. Enter the water downstream of the sample location with minimum disturbance of the sediment and lower the scoop (or glass sample container) slowly into the water making sure that the sample is taken below the surface of the water (or at the water/air interface if there is a sheen present) and raise the sample out of the water. Sample surface water first at the most downstream location and move sequentially upstream. Also sample water before sediment to avoid introduction of sediment into the water column.

6. Gently pour the sample into the sample container, if not sampled directly, taking care not to spill the sample on the outside of the container or overfill container, and replace cover of the sample container. For volatile organic samples, make sure that there are no air bubbles in the sample vial after it has been capped. This is done by filling the vial such that there is a meniscus on top. Carefully slide the septum, Teflon side down, onto the top of the vial and cap the vial. Check for bubbles by turning the vial upside down and tapping it lightly. If the bubbles appear, reopen the vial, remove septum and add more sample (or resample). Replace septum, recap and check for bubbles. Continue until vial is bubble-free.

7. Return sample container to sample cooler. If sample is obtained directly with a sample container, dry the exterior of the bottle before placing into cooler.

8. If reusable, decontaminate the sampling equipment according to the procedures outlined in Section 2.0.

9. Place all disposable personal protective equipment and disposable sampling equipment into a 55 gallon drum and store in a secure area (fenced, if possible).

1.2.3 - Groundwater

1. Measure the depth of water using a decontaminated water level indicator and compute the volume of standing water in the well.

2. Remove three to five times the volume of standing water from the well until field measurements (pH, conductivity, temperature and turbidity) stabilize, or until the well is dry, whichever occurs first. Turbidity should be less than 50 NTUs prior to collection of a sample for metals analysis.

3. Remove the laboratory precleaned sample containers from sample cooler, label container with an indelible marker, fill out Sample Information Record and Chain of Custody Form.

4. Obtain a sample by using a disposable polyethylene bailer.

5. If the turbidity of the sample is greater than 50 NTUs, the metals; (iron and manganese) portion of the sample will be filtered in the field or by the laboratory. Both the filtered and unfiltered portion of the sample will be analyzed.

6. Gently pour the sample into the sample container taking care not to spill on the outside of the container or overfill container and replace the cover on the sample container. Samples for volatile organic analyses will have no air space in the sample vial prior to sealing. This is done by filling the vial such that there is a meniscus on top. Carefully slide the septum, Teflon side down, onto the top of the vial and cap the vial. Check for bubbles by turning the vial upside down and tapping it lightly. If bubbles appear, reopen the vial, remove the septum and add more sample (or resample). Replace the septum, recap and check for bubbles. Continue until vial is bubble-free.

7. Return sample container to sample cooler.

8. Place all disposable personal protective equipment and disposable sampling equipment into a 55 gallon drum and store in a secure area (fenced, if possible).

2.0 Decontamination Procedures

Whenever possible, all field sampling equipment will be sterile/disposable and dedicated to a particular sampling point. In instances where this is not possible, a field cleaning/decontamination procedure will be used in order to mitigate cross contamination between sample locations. A

decontamination station/pad will be established for all field activities. This will be an area located away from the source of contamination so as not to adversely impact the decontamination procedure, but close enough to the sampling locations to keep equipment transport handling to a minimum after decontamination.

2.1 Field Decontamination Procedures

All nondisposable equipment will be decontaminated at appropriate intervals (e.g., prior to initial use, prior to moving to a new sampling location and prior to leaving the site). Different decontamination procedures are used for various types of equipment that are used to collect samples. When using field decontamination, sampling should commence in the area of the site with the lowest contamination, if known or probable, and proceed through to the areas of highest contamination.

2.1.1 - Decontamination Procedure for Sampling Equipment

Teflon, PVC, polyethylene and stainless steel sampling equipment decontamination procedures will be the following:

- Wash thoroughly with nonresidual detergent (alconox) and clean potable tap water using a brush to remove particulate matter or surface film.
- Rinse thoroughly with tap water.
- Rinse thoroughly with distilled water.
- Rinse in a well ventilated area with methanol (pesticide grade) and air dry.
- Rinse thoroughly with distilled water and air dry.
- Wrap completely in clean aluminum foil with dull side against the equipment. For small sampling items, such as scoops, decontamination will take place over a drum specifically used for this purpose.

The first step, a soap and water wash, will be performed to remove all visible particulate matter and residual oils and grease. This step will be followed by a tap water rinse and a

distilled/deionized water rinse to remove the detergent. Next, a high purity solvent rinse will be used for trace organics removal. Methanol has been chosen because it is not an analyte of concern on the Target Compound List. The solvent will be allowed to evaporate and then a final distilled/deionized water rinse will be performed. This rinse removes any residual traces of the solvent. The aluminum wrap will protect the equipment and keep it clean until it is used at another sampling location.

3.0 Laboratory Sample Custody Procedures

A NYSDOH ELAP and CLP certified laboratory meeting the requirements for sample custody procedures, including cleaning and handling sample containers and analytical equipment, will be used to analyze samples collected during the remedial investigation. The selected laboratory's Standard Operating Procedures will be made available upon request.

4.0 Field Management Documentation

Proper management and documentation of field activities is essential to ensure that all necessary work is conducted in accordance with the sampling plan and QA/QC Plan in an efficient and high quality manner. Field management procedures will include following proper chain of custody procedures to track a sample from collection through analysis, noting when and how samples are split (if required); preparing a Sample Location Sketch; completing Sample Information Records, Chain of Custody Forms; maintaining a daily Field Log Book; preparing Daily Field Activity Reports; completing Field Change Forms; and filling out a Daily Air Monitoring Form. Proper completion of these forms and the field log book are necessary to support the consequent actions that may result from the sample analysis. This documentation will support that the samples were collected and handled properly.

4.1 Sample Location Sketch

For each sampling point, a Sample Location Sketch will be completed using permanent references and distances to the sampling point noted, if possible.

4.2 Sample Information Record

At each sampling location, a Sample Information Record Form will be filled out including, but not limited to, the following information:

- Site name
- Sample crew
- Sample location
- Field sample identification number
- Date
- Time of sample collection
- Weather conditions
- Temperature
- Sample matrix
- Method of sample collection and any factor that may affect its quality adversely
- Well information (groundwater only)
- Field test results
- Analysis to be performed
- Remarks

4.3 Chain of Custody

The Chain of Custody Form will be completed and is initiated at the laboratory with container preparation and shipment to the site. The form remains with the sample at all times and bears the name of the person assuming responsibility for the samples. This person is tasked with ensuring secure and appropriate handling of the containers and samples. When the form is complete, it will indicate that there was no lapse in sample accountability.

A sample is considered to be in an individual's custody if any of the following conditions are met:

- It is in the individual's physical possession, or
- It is in the individual's view after being in his or her physical possession, or
- It is secured by the individual so that no one can tamper with it, or
- The individual puts it in a designated and identified secure area.

In general, Chain of Custody Forms are provided by the laboratory selected to perform the analytical services. At a minimum, the following information will be provided on these forms:

- Project name and address
- Project number
- Sample identification number
- Date
- Time
- Sample location
- Sample type
- Analysis requested
- Number of containers and volume taken
- Remarks

- Type of waste
- Sampler(s) name(s) and signature(s)
- Spaces for relinquished by/received by signature and date/time.

For this particular study, forms provided by the laboratory will be utilized.

The Chain of Custody Form will be filled out and signed by the person performing the sampling. The original of the form will travel with the sample and will be signed and dated each time the sample is relinquished to another party, until it reaches the laboratory or analysis is completed. The field sampler will keep one copy and a copy will be retained for the project file. The sample bottle will also be labeled with an indelible marker with a minimum of the following information:

- Sample number
- Analysis to be performed
- Date of collection

A copy of the completed form will be returned by the laboratory with the analytical results.

4.4 Split Samples

Whenever samples are being split with another party, a Receipt for Samples Form will be completed and signed. A copy of the Chain of Custody Form will accompany this form.

4.5 Field Log Book

Field log books will be bound and have consecutively numbered, water resistant pages. All pertinent information regarding the site and sampling procedures will be documented. Notations

will be made in log book fashion, noting the time and date of all entries. Information recorded in this notebook will include, but not be limited to, the following:

The first page of the log will contain the following information:

- Project name and address
- Name, address and phone number of field contact
- Waste generator and address, if different from above
- Type of process (if known), generating waste
- Type of waste
- Suspected waste composition, including concentrations

Daily entries will be made for the following information:

- Purpose of sampling
- Location of sampling point
- Number(s) and volume(s) of sample(s) taken
- Description of sampling point and sampling methodology
- Date and time of collection, arrival and departure
- Collector's sample identification number(s)
- Sample distribution and method of storage and transportation
- References, such as sketches of the sampling site or photographs of sample collection
- Field observations, including results of field analyses (e.g., pH, temperature, specific conductance), water levels, drilling logs, and organic vapor and dust readings
- Signature of personnel responsible for completing log entries.

4.6 Daily Field Activity Report

At the end of each day of field work, this form will be completed noting personnel on-site and summarizing the work performed that day, equipment, materials and supplies used, results of field analyses, problems and resolutions. This form will be signed and subject to review.

4.7 Field Changes and Corrective Actions

Whenever there is a required or recommended investigation/sampling change or correction, a Field Change Form will be completed.

5.0 Calibration Procedures and Preventive Maintenance

The following information regarding equipment will be maintained at the project site:

1. Equipment calibration and operating procedures which will include provisions for documentation of frequency, conditions, standards and records reflecting the calibration procedures, methods of usage and repair history of the measurement system. Calibration of field equipment will be performed daily at the sampling site so that any background contamination can be taken into consideration and the instrument calibrated accordingly.
2. A schedule of preventive maintenance tasks, consistent with the instrument manufacturer's specific operation manuals, that will be carried out to minimize down time of the equipment.
3. Critical spare parts, necessary tools and manuals will be on hand to facilitate equipment maintenance and repair.

Calibration procedures and preventive maintenance, in accordance with the NYSDEC 1991 ASP, for laboratory equipment, will be contained in the laboratory's standard operating procedures (SOP) which will be available upon request.

6.0 Documentation, Data Reduction and Reporting

A NYSDOH ELAP and CLP certified laboratory meeting the New York State requirements for documentation, data reduction and reporting will be used. All data will be cataloged according to sampling locations and sample identification nomenclature which is described above in "Sample Identification."

NYSDEC "Sample Identification and Analytical Requirement Summary" and "Sample Preparation and Analysis Summary" forms (for VOC and inorganic analysis) will be completed and included with each data package. The sample tracking forms are required and supplied by the 1991 NYSDEC ASP.

7.0 Data Validation

Summary documentation regarding data validation will be completed by the laboratory using NYSDEC forms contained in the 1991 NYSDEC ASP and submitted with the data package.

Data validation will be performed in order to define and document analytical data quality in accordance with NYSDEC requirements that investigation data must be of known and acceptable quality. The analytical and validation processes will be conducted in conformance with the NYSDEC ASP dated December, 1991.

Because the NYSDEC Analytical Services Protocol is based on the USEPA CLP, the USEPA Functional Guidelines for Evaluating Organics and Inorganics Analyses for the Contract Laboratory Program (CLP) will assist in formulating standard operating procedures (SOPs) for the data validation process. The data validation process will ensure that all analytical requirements specific to this work plan, including the QA/QC Plan are followed. Procedures will address validation of routine analytical services (RAS) results based on the NYSDEC Target Compound List for standard sample matrices.

The data validation process will provide an informed assessment of the laboratory's performance based upon contractual requirements and applicable analytical criteria. The report generated as a result of the data validation process will provide a base upon which the usefulness of the data can be evaluated by the end user of the analytical results. The overall level of effort and specific data validation procedure to be used will be equivalent to a "100% validation" of all analytical data in any given data package.

During the review process, it will be determined whether the contractually required laboratory submittals for sample results are supported by sufficient back-up data and QA/QC results to enable the reviewer to conclusively determine the quality of data. Each data package will be checked for completeness and technical adequacy of the data. Upon completion of the review, the reviewers will develop a QA/QC data validation report for each analytical data package.

"Qualified" analytical results for any one field sample will be established and presented based on the results of specific QC samples and procedures associated with its sample analysis group or batch. Precision and accuracy criteria (i.e., QC acceptance limits) will be used in determining the need for qualifying data. Where test data have been reduced by the laboratory, the method of reduction will be described in the report. Reduction of laboratory measurements and laboratory reporting of analytical parameters will be verified in accordance with the procedures specified in the NYSDEC program documents for each analytical method (i.e., recreate laboratory calculations and data reporting in accordance with the method specific procedure). The standard operating guideline manuals and any special analytical methodology required will specify documentation needs and technical criteria and will be taken into consideration in the validation process. Copies of the complete data package and the validation report, including the laboratory results data report sheets, with any qualifiers deemed appropriate by the data reviewer, and a supplementary field QC sample result summary statement, will be submitted to the NYSDEC.

The following is a description of the two-phased approach to data validation which will be used in the remedial investigation. The first phase is called checklisting and the second phase is the analytical quality review, with the former being a subset of the latter.

- Checklisting - The data package will be checked for correct submission of the contract required deliverables, correct transcription from the raw data to the required deliverable summary forms and proper calculation of a number of parameters.
- Analytical Quality Review - The data package will be closely examined to recreate the analytical process and verify that proper and acceptable analytical techniques have been performed. Additionally, overall data quality and laboratory performance will be evaluated by applying the appropriate data quality criteria to the data to reflect conformance with the specified, accepted QA/QC standards and contractual requirements.

At the completion of the data validation, a Summary Data Validation/Usability Report will be prepared and submitted to NYSDEC.

8.0 Performance and System Audits

A NYSDOH ELAP and CLP certified laboratory which has satisfactorily completed performance audits and performance evaluation samples will be used to perform sample analyses.

9.0 Corrective Action

A NYSDOH ELAP and CLP certified laboratory will meet the requirements for corrective action protocols, including sample "clean up" to attempt to eliminate/mitigate matrix interference.

The 1991 NYSDEC ASP protocol includes both mandatory and optional sample cleanup and extraction methods. Cleanup is required by the 1991 NYSDEC ASP in order to meet contract required detection limits. There are several optional cleanup and extraction methods noted in the 1991 NYSDEC ASP protocol. These include: florisil column cleanup, silica gel column cleanup, acid-base partition, steam distillation and sulfuric acid cleanup for PCB analysis.

High levels of matrix interference may be present in waste, soil and sediment samples. This interference may prevent the achievement of ASP detection limits if no target compounds are

found. In order to avoid unnecessary dilutions, the optional cleanup methods noted in the 1991 NYSDEC ASP will be required to be performed by the laboratory as necessary.

It should be noted that if these optional cleanup and extraction methods are utilized, holding time requirements will not be exceeded due to negligence of the laboratory. Subsequent to selection of the analytical laboratory for this project, a meeting or telephone conference call will be undertaken with representatives of the NYSDEC, the Consultant and the laboratory to discuss these issues and establish procedures to ensure effective and timely communications among all parties.

10.0 Trip Blanks (Travel Blanks)

The primary purpose of a trip blank is to detect other sources of contamination that might potentially influence contaminant values reported in actual samples, both quantitatively and qualitatively. The following have been identified as potential sources of contamination:

- Laboratory reagent water;
- Sample containers;
- Cross contamination in shipment;
- Ambient air or contact with analytical instrumentation during preparation and analysis at the laboratory; and
- Laboratory reagents used in analytical procedures.

A trip blank will consist of a set of 40 ml sample vials filled at the laboratory with laboratory demonstrated analyte free water. Trip blanks will be handled, transported and analyzed in the same manner as the samples acquired that day, except that the sample containers themselves are not opened in the field. Rather, these sample containers only travel with the sample cooler. The temperature of the trip blanks will be maintained at 4°C while on-site and during shipment. Trip blanks will return to the laboratory with the same set of bottles they accompanied in the field.

The purpose of a trip blank is to control sample bottle preparation and blank water quality as well as sample handling. Thus, the trip blank will travel to the site with the empty sample bottles and back from the site with the collected samples in an effort to simulate sample handling conditions. Contaminated trip blanks may indicate inadequate bottle cleaning or blank water of questionable quality. Trip blanks will be implemented only when collecting water samples, including field blanks, and analyzed for volatile organic compounds only.

11.0 Method Blanks/Holding Blanks

A method blank is an aliquot of laboratory water or soil which is spiked with the same internal and surrogate compounds as the samples. The purpose of the method blank is to define and determine the level of laboratory background contamination. Frequency, procedure and maximum laboratory containment concentration limits are specified in the 1991 NYSDEC ASP. A holding blank is an aliquot of analyte-free water that is stored with the environmental samples in order to demonstrate that the samples have not been contaminated during laboratory storage. This blank will be analyzed using the same analytical procedure as the samples.

12.0 Matrix Spikes/Matrix Spike Duplicates and Spiked Blanks

Matrix spike samples are quality control procedures, consistent with 1991 NYSDEC ASP specifications, used by the laboratory as part of its internal Quality Assurance/Quality Control program. The matrix spikes (MS) and matrix spike duplicates (MSD) will be aliquots of a designated sample (water or soil) which are spiked with known quantities of specified compounds. These QA/QC samples will be used to evaluate the matrix effect of the sample upon the analytical methodology, as well as to determine the precision of the analytical method used. A matrix spike blank will be an aliquot of analyte-free water, prepared in the laboratory, and spiked with the same solution used to spike the MS and MSD. The matrix spike blank (MSB) will be subjected to the same analytical procedure as the MS/MSD and used to indicate the appropriateness of the spiking solution by calculating the spike compound recoveries. The procedure and frequency regarding the MS, MSD and MSB samples are defined in the 1991 NYSDEC ASP.

Appendix E

STANDARD OPERATING PROCEDURE FOR GAS MONITORING

The following procedure is to be followed for monitoring landfill gas wells:

1. Unlock well cap.

2. Place magnehelic pressure gauge on well probe, open probe and record pressure on a landfill gas monitoring form.

3. Close probe, remove pressure gauge.

4. Open probe and, using a combustible gas meter (methane), record lower explosive limit.

5. Close probe, repeat steps 2 through 4 on other probes in well cluster.

6. Close and lock well cap.

7. Weather conditions (i.e. temperature, ambient barometric pressure and direction - rising or falling) shall also be recorded on the monitoring forms for each well.

Appendix F

SEVERE WEATHER PRECAUTIONS

Cold Weather Dangers

Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm, sweet drinks and soups will be provided for caloric intake and fluid. The intake of coffee should be limited because of its diuretic and circulatory effects.

Shielding the work area from the wind or wearing a windbreaker will reduce wind chill effect. A water-repellant outer garment with good ventilation should be worn. Older workers or workers with circulatory problems require special precautionary protection against cold injury. The use of extra insulating clothing and/or a deduction in the duration of the exposure period are among the special precautions which should be considered. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve.

Hypothermia is defined as a decrease in a person's body core temperature to 95°F (35°C). A freezing or rapidly dropping temperature is not needed to produce hypothermia. A person's ability to maintain normal body temperature may be affected by medications/drugs, alcohol, wind, or by becoming wet. The use of prescribed drugs during site activities should be reviewed with the site safety officer. Alcoholic beverage and illegal drug intake are strictly forbidden during site-work activities.

Although protective clothing provides protection from many sources of external wetting, perspiration is often increased while working, causing the skin and clothing to become moist or wet. Wet clothes and skin can result in a rapid loss of body heat. In addition, the effects of wind can exacerbate this problem, creating a condition for extreme loss of body heat. Any exposed skin should be covered when the wind chill factor results in a relative temperature of -25°F or below, and wet clothes should be replaced at temperatures below 36°F.

With proper surveillance, hypothermia can be identified in its earliest stage, thus preventing a potential hazard to the worker. The single most important sign of hypothermia is a change in behavior, which is often subtle and best recognized by a co-worker. Other changes may include:

- a decrease in usual efficiency;
- forgetfulness and a decreased level of communication;
- decline in manual dexterity;
- poor motor skills or repetitive behavior;

- poor judgment; and
- lack of concern for physical needs.

Physical signs of hypothermia include a cold, pale skin appearance, shivering, and "goose flesh." Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 95°F. This must be taken as a sign of danger to workers and exposure to cold should be immediately terminated.

Mild hypothermia is treated by rewarming the affected person by:

- moving to a protected area;
- removing wet or damp clothing;
- providing hot fluids; and
- wrapping the person in dry blankets.

More severe cases of hypothermia require prompt intervention by medical personnel in addition to the above activities.

Frostbite is a local cold injury which rarely occurs unless environmental temperatures are less than freezing and usually less than 20°F (-6.7°C). Frostbite commonly occurs on the exposed portions of flesh (e.g., ears, nose, hands) and is recognized by a whitened area which, in mild cases, is slightly burning or painful.

Frostbite can be prevented by:

- covering exposed flesh with loose, dry clothing;
- avoiding skin contact with bare metal, gasoline, or other hydrocarbons;
- avoiding tobacco and drug use; and
- maintaining dry clothing.

Field personnel should frequently (i.e., every 15 minutes) inspect each other for signs of frostbite during very cold weather conditions.

Mild cases of frostbite, where the affected area is still painful, may be treated in the field by rewarming. More serious cases of frostbite should be treated at a medical facility since attempting to thaw the frozen area can cause severe damage. A victim of serious

frostbite should be protected from the environment and further heat loss prevented, but the skin should not be rubbed or thawed with warm water or dry heat.

Hot Weather Dangers

To keep internal body temperature within the safe limits, the body rids itself of excess heat. This automatic response results in blood circulating closer to the surface of the skin where excess heat is lost to a cooler environment. If the air temperature is as warm or warmer than the skin, the blood brought to the body's surface cannot lose heat. The evaporation of sweat becomes the principal effective means of cooling the body. Sweating does not cool the body unless the moisture is removed from the skin by evaporation. In high humidity, the evaporation of sweat is decreased, and the body's efforts to maintain an acceptable body temperature are impaired.

Heat stress is probably one of the most common and potentially serious illnesses which may occur at a hazardous waste site. The potential for heat stress is dependent on a number of factors, including environmental conditions, clothing, workload, physical conditioning, and age. The effects of heat stress can range from mild symptoms, such as fatigue, irritability, and decreased mobility, to severe symptoms, such as nausea, dizziness, and coma, and in extreme cases, even death. The body's responses to heat stress include the following:

- Heat Rash: A result of continuous exposure to heat and humidity, heat rash decreases the body's ability to tolerate heat.

- Heat Cramps: A result of profuse perspiration with inadequate fluid intake and chemical replacement, heat cramps are signalled by muscle spasms and pain in the abdomen and extremities.

- Heat Exhaustion: A result of increased stress on various organs. The signs of heat exhaustion include shallow breathing; pale, cool, moist skin; profuse sweating; dizziness and lassitude.

- Heat Stroke: The most severe form of heat stress, heat stroke must be relieved immediately to prevent severe injury or death. The signs of heat stroke are red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; coma. The body must be cooled by soaking with water, fanning or other means, and medical attention sought immediately.

Preventative measures to avoid heat stress include regular work breaks during field activities, regular fluid replenishment, and the availability of shelter (e.g., shaded area, trailer, etc.). As a part of the site safety orientation, all personnel will be made aware of the symptoms of heat stress. Should one or more symptoms be detected, the affected worker will be assisted to seek shade, drink plenty of fluids, and seek medical attention, as required.

Increased body temperature and physical discomfort also promote irritability and a decreased attention to the performance of hazardous tasks. The following measures are recommended to avoid the hazards of heat stress:

- Establish work-rest cycles (short and frequent breaks are more beneficial than infrequent breaks of long duration).
- Identify a cool, shaded area for breaks.
- Rotate personnel and alternate job functions to equally distribute the most labor-intensive work.
- Drink plenty of water. Over the course of an 8-hour work day, 50 ounces of fluids should be consumed at regular intervals, regardless of thirst.
- Eat lightly salted foods to replace lost salt.
- Save the most strenuous tasks for early morning or early evening (non-peak heat hours).
- Avoid caffeine during prolonged periods of heat as it causes dehydration.

If the ambient temperatures exceed 85°F, site personnel should monitor their heart rate as an indicator of heat stress. Count the radial pulse during the 30-second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, it is recommended that the next work cycle be shortened by one third while keeping the rest period the same. If the heart rate still exceeds 100 beats per minute at the next rest period, the following work cycle should be shortened by one third.

Appendix G

(c) Corrective measure implementation.

(1) Once the corrective measure work plan is approved by the department the facility owner or operator must:

(i) establish and implement a corrective measure groundwater monitoring program, approved in advance by the department, that:

(a) meets the requirements of subparagraph 360-2.11(c)(5)(iii) of this Subpart and any additional condition imposed by the department as part of a permit, administrative order, or court order;

(b) indicates the effectiveness of the corrective measure;

(c) complies with the groundwater protection standard specified in this section; and

(ii) implement the corrective measure selected under subdivision (b) of this section in accordance with the terms, conditions and schedule set forth in an approved corrective measures work plan; and

(iii) take any interim measures necessary to protect public health, safety, the environment and to ensure the protection of natural resources.

(2) The department may determine that compliance with paragraph 360-2.20(b)(2) of this Subpart is not being achieved through the selected corrective measure. In these cases, the department may require the facility owner or operator to implement other methods or techniques that could practically achieve compliance with paragraph 360-2.20(b)(2) of this Subpart, unless the department makes a determination under paragraph (3) of this subdivision.

(3) If the facility owner or operator determines that they cannot practically achieve the requirements of paragraph 360-2.20(b)(2) of this Subpart with any currently available methods, then the owner or operator must:

(i) submit a justification for the department's approval, which indicates that the requirements under paragraph 360-2.20(b)(2) of this Subpart cannot be practically achieved with any currently available methods;

(ii) implement alternate measures acceptable to the department, to control exposure to humans, wildlife, the environment or other receptors to residual contamination;

(iii) implement any technically practical measures acceptable to the department, for control of the sources of contamination, or for removal or decontamination of equipment, units, devices, or structures that are consistent with the overall objective of the corrective measure; and

(iv) notify the department that the report justifying the alternative measures has been placed in the operating record. The department must be notified within 14 days prior to implementing the alternative measures.

(4) All solid wastes that are managed according to a corrective measure required under this section must be managed in a manner that:

(i) protects public health, safety or welfare, the environment or natural resources; and

(ii) complies with applicable State and federal requirements and this Part.

(iii) All actions required to complete the corrective measure have been satisfied.

(6) The facility owner or operator must notify the department within 14 days that the corrective measure has been completed according to the requirements of paragraph (5) of this subdivision. The certification must be signed by the facility owner or operator and be approved by the department.

(7) When, upon completion of the certification, the department determines that the corrective measure has been completed in accordance with the requirements under paragraph (5) of this subdivision, then the facility owner or operator shall be released from the requirements for financial assurance for corrective measure under section 360-2.19 of this Subpart.

(5) Corrective measures selected according to subdivision (b) of this section are considered complete when:

(i) The facility owner or operator complies, to the satisfaction of the department, with the groundwater protection standards specified in this section at all points within the plume of contamination that lie beyond the groundwater monitoring wells system established pursuant to subdivision 360-2.11(c) of this Subpart.

(ii) The facility owner or operator complies with the groundwater protection standards specified in this section.
This is demonstrated when concentrations of contaminants required to be measured have not exceeded the groundwater protection standard for three consecutive years using the procedures and performance standards in the environmental monitoring plan under clause 360-2.11(c)(4)(i)(d) of this Subpart. The department may specify an alternative length of time during which the facility owner or operator must demonstrate that concentrations of baseline and expanded parameters have not exceeded the groundwater protection standard(s) taking into consideration:

(*a*) extent and concentration of the release;

(*b*) behavior characteristics of the contaminants in the groundwater;

(*c*) accuracy of monitoring or modeling techniques, including any seasonal, meteorological, or other environmental variabilities that may affect the accuracy; and

(*d*) characteristics of the groundwater.